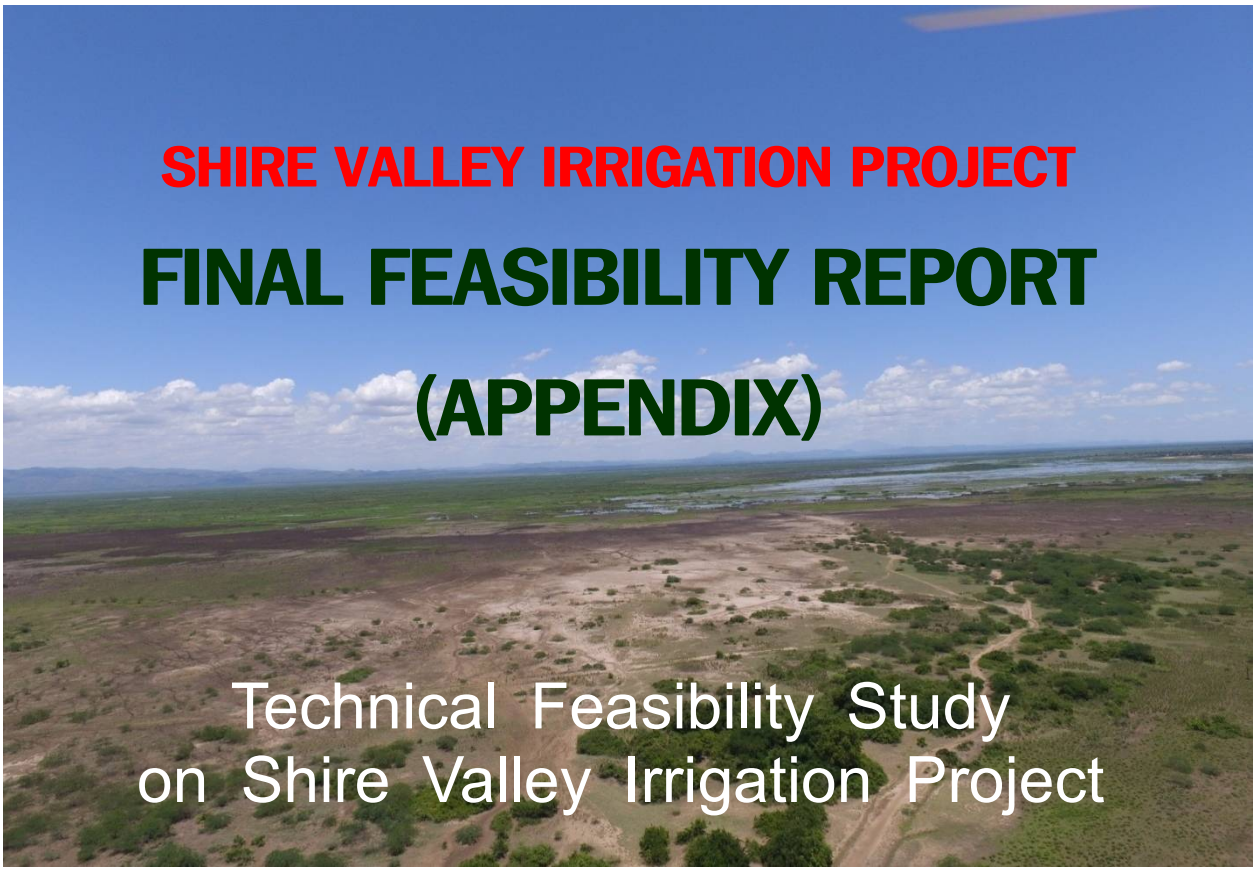
MINISTRY OF AGRICULTURE, IRRIGATION AND WATER DEVELOPMENT



SHIRE VALLEY IRRIGATION PROJECT

FINAL FEASIBILITY REPORT

(APPENDIX)

Technical Feasibility Study
on Shire Valley Irrigation Project

March 2017

KOREA RURAL COMMUNITY CORPORATION

in Joint Venture with

DASAN CONSULTANTS CO., LTD.,

GK WORKS CIVIL AND STRUCTURAL ENGINEER

APPENDIX LIST

APPENDIX 1

PTT Activities and Lessons

GOVERNMENT OF MALAWI

MINISTRY OF AGRICULTURE, IRRIGATION AND WATER DEVELOPMENT

SHIRE VALLEY IRRIGATION PROJECT (SVIP)

PROJECT TECHNICL TEAM ACTIVITES AND LESSONS

1. Background

The Government of Malawi intends to proceed with the implementation of the Shire Valley Irrigation Project (SVIP) under the framework of the Green Belt Initiative (GBI). The SVIP and other related GBI projects are being implemented to attain objectives of the Malawi Growth and Development Strategy II (MGDS II). The MGDS II is the country's overarching operational medium-term strategy to attain the nation's Vision 2020. The MGDS II recognizes Irrigation as one of the key priority areas.

For the implementation of the preparatory phase, the Government recruited a Project Technical Team comprising The Project Technical Team Coordinator (PTTC), a Community Development Specialist (CDS) an Irrigation Specialist, a Finance Specialist, a Procurement Specialist and an Office Manager. These were recruited on consultancy basis. The PTT also includes a Senior Irrigation Officer on secondment. The PTT reports to Government through the following structure:

1) The Project Task Force (PTF) involving all the sectoral ministries with a stake in the project;
2) The Project Technical Project Technical Committee (PTC) at Directors level; and
3) The Project Steering Committee (PSC) at PS level.

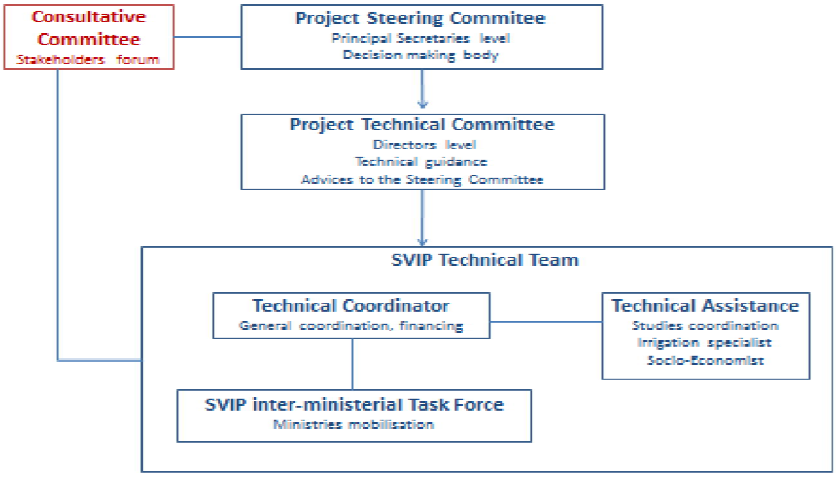


Figure 1: Organisational Chart for SVIP

The Government engaged consultants to conduct detailed studies and design the Project and these were the KRCC (Technical Feasibility Study), COWI (Communications, Community Participation ,Land Tenure and Resettlement Policy Framework), Pricewaterhouse Coopers (Agricultural Development Planning Strategy), BRLi (Environmental and Social Impact Assessment [ESIA] and the Pest Management Plan [PMP]), BRLi (Public – Private Partnership Feasibility Study), Arteria (Hydraulic Modeling of Intake) and a Panel of Experts on Safety of Kapichira Dam. The feasibility studies of the project were completed in December 2016.

Apart from the feasibility studies that were undertaken, there were also other activities being conducted by the Project Technical Team with support from the field staff at the SVADD and District level. These activities have included i) field visits to Illovo, Kasinthula Cane Growers Association, Phata Cane Growers Cooperative and Katunga - Maseya (KAMA) Cooperative; ii) awareness and sensitization meetings at the community level; iii) awareness and sensitization workshops with GVHs and VHs; iv) stakeholder consultation meetings and v) a study tour to Swaziland.

2. Lessons learnt

During the field visits, consultation meetings, awareness campaigns and study tour, the PTT gathered useful information and learnt quite a lot. This section describes the main lessons learnt. KAMA is in its formative stages and no lessons can be learnt yet from them.

i) Kasinthula Cane Growers Association

The main features of Kasinthula include the fact that it is a sugarcane growing Association with total reliance on Illovo Sugar Corporation for the purchase of the cane. Secondly, Kasinthula is a Government initiative and the Board is appointed by the Government. Thirdly, Kasinthula has a three tier governance structure consisting of the Board, the Association and Kasinthula Cane Growers Limited Company which manages the farm. Fourthly, for each phase, land is distributed equally without regard to the size of the landholdings the members had prior to joining the Association. Lastly, at Kasinthula, dividends are paid in advance on a monthly basis before sales and declaration of profits.

The main lesson from Kasinthula is establishment of own farm management company. This is quite innovative and if performed professionally it can be a model to be emulated. On the other hand, the reliance of Illovo for marketing the produce makes the Association vulnerable. Furthermore, the advance payment of dividends is not in conformity with modern business practice and has resulted in bank loans which the Cooperative has had difficulty paying back. Association members have expressed dissatisfaction with the land distribution and they say it is not fair. Furthermore, the governance structure is considered heavy and the involvement of Government appears to be encouraging and reinforcing the dependency syndrome as members believe Government can always come in to rescue them from trouble.

ii) Phata Cane Growers Cooperative

Phata Cane Growers Cooperative is a kind of "home grown" smallholder business enterprise. It appears to have learnt quite a lot from Kasinthula and adapted some of the features to suit the wishes of its members. Like Kasinthula, it is a sugarcane based venture and relies on Illovo to purchase the cane. However, unlike Kasinthula, Phata has a unitary governance structure with the Board at the top and an executive committee made up of the members below the Board. The Board is appointed by the Cooperative. The farm is managed by a professional manager, a company known as Agricane. The management company signs a performance based five-year contract with Phata Cooperative. The Executive Committee works with the Company on a day to day basis.

Only those smallholder farmers who had land in the area that was developed into a consolidated farm are members of the cooperative. The landholdings are converted into shares and one hectare is one share. Those with less than a hectare they own an equivalent fraction of a hectare as their share. Share distribution in the cooperative is proportionate to the land holding size of the member. Dividends are declared at an annual general meeting (AGM) and are paid twice a year.

A good lesson from Phata is the farmers self-initiative to start a farming venture through consolidation of land. They have a lean governance structure which appears to be effective and efficient. Sugarcane is made to be an easy business because of there is a ready market.

The engagement of a professional company with a performance based contract is also a good idea and will be quite useful when dealing with complex farming businesses other than sugarcane where production decisions and knowledge of the market become critical. Phata members have also experienced less dissatisfaction because of the equitable land distribution. The payment of dividends after the AGM has allowed Phata to make good business decisions in terms of what to do with profits. Hence, they have paid off all their loans and members lives have changed dramatically.

The Phata story is that since 2012, Phata Cooperative members built brick houses with cement floors and iron roofs. They sleep on beds with mattresses. Some are buying livestock, pumps for irrigation, push bikes as well as motor cycles. Again there are others who have used the proceeds from the cooperative to start small businesses as insurance again crop failure or market failure. Members the PTT has talked to say they are able to pay school fees for children and buy good clothes and are generally well fed.

In general this story is also true for Kasinthula members but it is tainted by the burden of the bank loans which threaten the very survival of the Association.

iii) Awareness and Sensitization Meetings

The PTT organized and conducted community awareness and sensitization campaigns in the SVIP area. The aim of these campaigns was to let people know the key design principles of the SVIP and what will be required of them. The main messages were formation of organisations, payment of user fees for the water, consolidation of land to form large farms, production of commercial crops and working with professional managers.

In total 156 communities covering 4,813 men and women were sensitized and 14 workshops were held with GVHs and VHs. Generally farmers are eager to be part of the SVIP. They all agreed with formation of organisations, payment of user fees for the water, consolidation of land to form large farms, production of commercial crops and working with professional managers.

iv) Sensitization of Land Consolidation using Phata model

The awareness and sensitization workshops targeted Group Village Headmen (GVHs) and the Village Headmen (VHs). The objectives of the workshops were:

i) To make community leaders understand land consolidation using the Phata model;

ii) To sensitize community leaders on the key success factors of organized farming; and

iii) To ask community leaders to take a leading role in sensitizing people in their communities on coming project and what would be required for its success.

Over 500 GVHs and VHs attended these workshops. Generally the community leaders found the Phata model of organisation as well as the type of land consolidation to be very attractive and acceptable.

v) Consultation Meetings with Members of Parliament

The PTT held consultative meetings with the Parliamentary Committees on Agriculture and Irrigation and Budget and Finance. Both meetings were successful and members of Parliament were keen to visit Phata. A visit to Phata was organized for both committees and was conducted successfully. The members of Parliament were convinced that the SVIP has potential to transform smallholder farming in the Shire Valley. They pledged to lend their support and lobby for it to be funded.

vi) Swaziland Study Tour

The PTT conducted a study tour of Swaziland 20th September to 24th September 2016. The overall objective of the study tour was to learn how Swaziland has managed to accelerate smallholder irrigation development and management for application in the development and management of the Shire Valley Irrigation Project. The specific objectives were to learn land tenure issues; land compensation and resettlement; water management; operation and maintenance of irrigation infrastructure; and crop diversification.

Institutions that were visited included the Ministry of Agriculture; Swaziland Sugar Association (SSA); Swaziland Cane Growers Association (SCGA); Swaziland Water and Agricultural Development Enterprise (SWADE) both Komati Downstream Development Project (KDDP) and Lower Usuthu Smallholder Irrigation Project (LUSIP); Millers and their Out-grower Extension Services at Royal Swaziland Sugar Cooperation (RSSC) in Mhlume and Illovo Ubombo Mill in Big Bend; Tabankulu Estate and Seed Cane Contractor at Malkerns. The team learnt a lot of lessons which can be considered in the implementation of the Shire Valley Irrigation Project.

a) Lessons from Swaziland Smallholder Outgrower Companies

- Consolidation of land was not easy as disputes were there in the initial phase. The main challenge was that during land consolidation, every member got an equal share regardless of the original size of land that a member contributed in the estate.
- The membership was open only to people who originally owned land in the area.
- The interest rate on loans obtained by farmers from commercial banks is only 11%.
- Due to their land management system in Swaziland, collateral is usually in form of a Chief's Letter to the bank.
- Smallholder farmers hire Managers depending on their expertise

- Although the sugar industry is a private industry, the Ministry of Agriculture provides support to the industry through close policy guidance and legislation for sugar industry.
- The water sector is well regulated with well-established structures in place even at basin level.
- Being a Kingdom, the local chiefs work on behalf of the king. The chiefs are treated with respect and are considered legitimate leaders. This has proven to be useful in community development. Issues of land conflict are not pronounced because of this structure unlike in Malawi where legitimacy of chiefs is usually questioned.

b) The SSA is self-regulated industry that has worked well:

- There is a sense of ownership, as everybody in the value chain is recognised; in other words, decision making is by consensus as millers are not ultimate decision makers.
- There is a cordial relationship as industry parties are affiliated to the SSA (and essentially this is because of the regulatory framework that is in place).
- An agriculture extension service should be well established and developed for the industry. Extension service is centralised at SSA through the millers.
- Primary seed-cane production is contracted out. There is only one service provider who is responsible for this activity. The industry provides intensive monitoring to make sure that the nursery is well managed especially on pest and disease and seed purity
- Smallholder farmers' revolving fund given by government but managed by sugar mills has helped to subsidise investment costs for farmers.
- Public infrastructure investments such as dams, good road network are a pre-requisite in reducing farmers' costs.
- Process of regulatory framework development requires serious scrutiny. There should be no short cuts as they may haunt the industry
- The SSA as a regulatory body which is neutral and independent is wholly made up of growers and millers. SSA has garnered trust from both growers and millers
- The system in Swaziland encourages efficient system for irrigation
- Commercial farming needs to be complimented with high-tech management system
- Soil classification should always be available to assist in crop selection and irrigation water management.
- It is important to have a smaller number of people to increase landholding size.
- The use of sucrose content for purposes of determining how much money a farmer should earn as well as tonnage increases farmers' income and satisfaction.
- A drought strategy plan is very important and should be developed before occurrence of the event.

- Water charge should be both volumetric for variable costs and area specific for fixed cost, and measurement meters should be installed at tertiary intake units.
- There should be a ready market for every crop that is grown. SSA helps to establish demand ahead of a growing season.
- Illovo in Swaziland has a fund which helps out-growers in some aspects, e.g. inputs, equipment, transport etc.
- A strong and independent institution like SSA which regulates the sugar industry is a must for a country.
- The Government of Swaziland demonstrates commitment towards irrigated farming through allocation of substantial funding to irrigation and donors come in to complement government efforts.
- There is a need to create a harvesting group for farmers which will be responsible for negotiating prices.

c) Recommendations for the SVIP

There is need to establish a Government agency to accelerate implementation of the Shire Valley Project. Some of the options proposed are:

- The current SVIP Project Technical Team should be transformed into this body
- The Green Belt Initiative may evolve into a well-designed independent body with reviewed functionality to be able to effectively discharge its mandate and be able to attract finances.
- Turning the National Irrigation Board into a parastatal

On marketing, the PTT felt there was no need to create another market body since ADMARC has a well-defined mandate which may need to be strengthened to be in a better position to assist SVIP farmers. There is need to improve certain aspects of ADMARC's mandate so that it should link up with say, chain stores, processors, or outside markets in order to find markets for SVIP farmers the same way SSA was doing it.

- With the erratic weather pattern due to climate change, there is need that irrigation development should be coupled with investments in huge water harvesting reservoirs and installation of efficient water application systems
- Lending rates are prohibitive for agriculture development in Malawi. Swaziland's base lending rate of plus 3% above the inflation rate seems affordable. Currently the lending rate is at 11%. There is need for the Reserve Bank of Malawi to regulate the prevailing high interest rates (i.e. 40-45%) in Malawi so that farmers may be in a position to borrow money for irrigation development Government should be providing grants for the development of smallholder farmers
- Women and youth should be involved starting from the early stage to ensure continuity

- Holding of one's positive cultural value is very important for a nation to develop. Swaziland has demonstrated that some cultural aspects can impact positively to the development of the projects.
- The training process of elevating smallholder farmers should be a continuous process and it should target every farmer and not only local leaders.
- Farmers should be given an opportunity of either to register as a cooperative or a company
- Farmers should adopt a system of ordering water, say a week prior to the day of abstraction. This may promote a sense of economic value of water among farmers. There is a need to strengthen regulation of the seed industry in both production and distribution, and making a public redress mechanism if the company sells non-viable seeds. This may include improving the traceability of the origin of seed producers.
- The importance of government institution (in this case SWADE) facilitates the recruitment of farm managers for smallholder farmers.
- The use of ICT in sharing information and remote monitoring of flow of water has great impact as it builds trust on how much the water is being used.
- SSA conducts independent research and trials and this has been useful to the industry.

vii) Lesson on Land Tenure

Security of tenure is of paramount important to the farmer organisation in the SVIP and the country. This is one of the reasons all organisations apply for lease of their land. In line with the just passed Customary Land Bill, land management matters for the cooperatives and associations may be under the organisational structures described in new law i.e. Land Management Committees and Land Tribunals. The new law provides an opportunity for the consolidated farms to get a customary estate title which is quasi-freehold and superior to a leasehold title. Furthermore, the new law provides for the possibility of farmers to lease out land to private interests. Of course, if the consolidated farms are registered under the Registered Land Act, they will be no need for the involvement of the Land Management Committees or Land Tribunals; keeping in mind that customary estate title is better than leasehold title.

For purposes of land consolidation, it will be important to recognise the two dominant inheritance systems in the project area i.e. matrilineal and patrilineal systems. This is usually made complicated under the virilocal and uxorilocal (chitengwa and chikamwini) marriage types. Although the just passed law protects both men and women by ensuring that they inherit the spouse's land, custom is strongly against this in uxorilocal marriages. Hence when land is being consolidated, it will be absolutely essential to pay attention to the marriage types.

APPENDIX 2

Minute of Meeting with ILLOVO

MINUTES OF MEETING OF THE NEGOTIATION MEETING WITH ILLOVO ON THE SHIRE VALLEY IRRIGATION PROJECT (SVIP) HELD AT ILLOVO HEAD OFFICE IN LIMBE ON 12TH OCTOBER 2016 STARTING AT 14:00 PM

PRESENT

ID	NAME	ORGANISATION	POSITION	CONTACT	EMAIL ADDRESS
1	F. Tukula	MoLHUD	Commissioner	0999950751	fctukula60@gmail.com
2	S.K. Chisale	Ministry of Industry & Trade	Director	0999869323	chisalek@yahoo.co.uk
3	R. Perekamoyo	Ministry of FEP&D	DD (Budget)	0999242929	rperekamoyo@yahoo.com
4	P.K. Simbani	EP&D	Director (Dev)	0999135245	petersimbani@yahoo.com
5	Chizaso Nyirongo	MoJCA	CLC	0995553554	clc.justice@gmail.com
6	Jimmy Lipunga	PPP Commission	CEO	0999975900	jlipunga@pppc.mw
7	Rodrick MA Champiti	SVIP	PTTC	0999865290	champitir@gmail.com
8	Geoffrey Mamba	DoI-MoAIWD	DIS	0888891821	mamba.geoffrey5@gmail.com
9	S. Khaila	SVIP	CDS	0999930235	sckhaila@gmail.com
10	A. Nigussie	SVIP	IS	0993073385	anigussie2000@gmail.com
11	A Luwayo	Ministry of Industry & Trade	ECONOMIST	0999132103	atupeleluwayo@gmail.com
12	J. Nthakomwa	MITC	Director (Investment)	0993886658	jnthakomwa@mitc.mw
13	Charlie Msusa	DPD	PPP Commission	0995767767	cmsusa@pppc.mw
14	Gerry Garson	Co. Secretary ILLOVO	ILLOVO	0999963999	ggarson@illovo.co.za
15	Ray de Allende	MD ILLOVO	ILLOVO	01843988	rdeallende@illovo.co.za
16	Lekani Katandula	F.D. ILLOVO	ILLOVO	0991968666	lkatandula@illovo.co.uk

1. The meeting was opened with self introductions. This was followed by remarks from the CEO of the PPP Commission and the Director of Irrigation Department.

2. A PowerPoint presentation was made by PTT to appraise the Illovo team on the Shire Valley Irrigation Project (SVIP). The presentation highlighted the following:

a. Overall project objective
b. Irrigable area
c. Irrigation water demand
d. Available water and water balance at Kapichira Dam
e. Comparison of open or piped canal for Illovo

f. Supuni and Bangula canals
g. Pipe drop chutes with potential for power generation

3. After the presentation Illovo wanted to know whether this time around the project will materialize; knowing that the SVIP has been talked about for a long time. The Government side assured Illovo that this time it is real.

4. Illovo indicated that their current challenges include:

a. Power requirements for operating the irrigation system is costly (18 Megawatts needed to run the pumps);
b. This costs US$0.09/Kilowatt hour;
c. Quality of water (acidity - especially from Elephant Marsh);
d. Safety of the sugarcane in the estate;
e. Global market of sugar in the context of big producers such as Brazil; and
f. Water from the Shire River not reliable.

5. Currently Illovo generates 6 megawatts of power which is enough to run the factory. However, they will still need power from ESCOM (about 5 megawatts) to run the centre pivots.

6. They expressed concern on the reliability of the water supply from Kapichira Dam but were happy that smallholder farmers would be incorporated; observing that this has the potential to increase safety of their cane in the fields. One of their concern is that it appears water at Hamilton Rapids is clearer than at Kapichira Dam where much silt is noted. They were informed that water at Hamilton Rapids is moving fast and the silt is kept in suspense while at Kapichira Dam, much of the silt settles down, thereby reducing the impact of silt on users of the canal.

7. Illovo confirmed that a lined open canal will be satisfactory for their needs and the volume as provided to the consultants by their technical staff, 12.8 M^3/s for Phase I, is what they require.

8. They did not express any concern regarding sharing the canal (SUPUNI) with the communities as long as the canal carried enough water for them and it was metered at the farm gate.

9. Regarding a commitment letter, Illovo are very interested in this project. They have been doing their own work to try to improve efficiency of the irrigation system for sugarcane and other crops. Hence, they agreed to write to express their interest and commitment and requirements before the World Bank Mission in November.

10. The issue of payment in hard currency was discussed and Illovo's short answer was that paying in hard currency would be a problem because it will have a knock-on effect. However, they expressed interest in discussing other models such as the MERA model which requires periodic reviews of the price and adjustments in line with exchange rates.

11. In closing, the Chairperson thanked Illovo for according the team audience to discuss the project. He stated that this meeting was only the beginning of many meeting which will eventually lead to signing a Water Purchase Agreement.

12. The Director of Irrigation joined the CEO of the PPP Commission in thanking Illovo and, once again, assured Illovo that this time around the project is going to be implemented. The meeting was adjourned.

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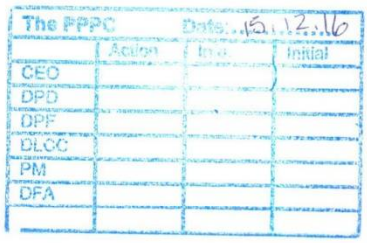


13 December 2016

The Chief Executive Officer
The Public Private Partnership Commission
2nd Floor
Livingstone Towers
Glyn Jones Road
P O Box 937
BLANTYRE
Malawi

Attention: Mr J Lipunga

Dear Sir

Letter of Commitment – Shire Valley Irrigation Project (SVIP)

Further to our meeting regarding the Shire Valley Irrigation Project (SVIP) that took place at the Illovo Malawi offices in Limbe on 12th October 2016 we would firstly like to place on record our sincere appreciation to you in leading the delegation to highlight the SVIP to us and for affording us the opportunity to better understand the project and its imminent implementation. This momentum is particularly exciting to us, given that many such discussions that have taken place in the past have not progressed further.

In brief the discussions reiterated that the full implementation of the project would open in excess of 43 000 ha in the Shire Valley to flood irrigation through the construction of an open canal with the off take point at Kapichira Dam supplying water not only to the Illovo Nchalo Estate but also to various current outgrower sugar cane schemes at Kasinthula, Phata and Kaombe and to various other already established irrigation schemes in the valley. The water would also be made available to various communities to off take water to irrigate various crops. A further benefit to the Illovo operations, in particular, would be the reduction of electricity consumption for the pumping of water to its existing cane fields. With the installation of "pipe drop chutes" along the canal, supplemental power generation, albeit on a small scale, could also be feasible.

It was also noted that substantial funding for the project had already been secured from both the World Bank and African Development Bank but a funding shortfall of approximately $ 80 million was expected against the proposed budget of $ 300 million for phase 1 of the project, which envisaged supplying water to the Illovo Nchalo Estate "farm gate".

We highlighted several challenges at present, including the paucity of the present electricity supply from Eskom, the quantity and quality (in terms of salinity) of the current water supply and the safety of communities who would live along the open canal. With the current high loading levels of silt in the Shire River the siting of the off-take point at the Kapichira Dam instead of at Hamilton Rapids was also questioned. Reservations were also expressed regarding the payment for any water usage from the canal in "hard" currency.

However, we expressed interest in the proposed canal and are committed to enter into further discussions, without obligation, as the project could have long term benefits in terms of a reduction in water pumping costs, less pump maintenance requirements and an improved overall water supply to the estate's operations. The project would also prove of immense benefit to communities surrounding the Estate.

With respect to our water supply requirements, we would require a consistent and reliable supply of water from phase 1 at the Nchalo Estate "farm gate" with a delivered volume of 12.8 cumecs (12.8 M^3/s) and water quality meeting a potential of Hydrogen (pH) level of between 5.8 to 7.5, Electrical Conductivity (EC) of <90mS/m and Sodium Adsorption Ratio (SAR) of <3mmol/l^.5. With regard to Suspended Solids (SS) for our drip irrigation system we would look for a value of <60ppm for sediment sizes of <100µm. Other methods of irrigation could handle heavier SS loads.

Should you require any further information kindly contact the undersigned at the above postal address or on e-mail at ggarson@illovo.co.za or on telephone at 01 843 988 / 09 999 63 999.

We look forward to working with you and the relevant stakeholders in the development of the project.

Yours sincerely

Illovo Sugar (Malawi) Limited

G S Garson
Company Secretary

APPENDIX 3

Minute of Meeting with Majete Reserve

SHIRE VALLEY IRRIGATION PROJECT

MINUTE OF THE TECHNICAL MEETING BETWEEN TFS CONSULTANT AND MAGETE RESERVE MANAGEMENT TEAM

OBJECT

- Explanation on the location of intake structure and the canal route
- Discussion on the mitigation measures for the canal section in the Reserve area
- Request mapping information of Majete Reserve boundary

Date: 05 December 2016

Place: Majete Reserve Manager Office

Present:

Majete Reserve	TFS
Craig Hay (Park Manager)	Jin-Hoon JO (Team Leader)
	Jae-Hyun RYU (Irrigation Engineer)

Craig Hay(Park Manager) and TFS Team have met at the Park Manager's office around 15:00. They have discussed on the issues above, and have agreed each other as below.

1. Location of intake structure and the canal route

- The intake structure shall be installed at the right hand side of Kapichira Dam, and the canal route will follow the contour line, the shortest course to minimize the environmental impacts.
- The first section of canal (755 m) shall be the siphon type which will be installed underground so that they would not interfere with the movement of animals.

- The first part of the canal is located in the Reserve area while the waterway is again passing through the end of the Reserve area.

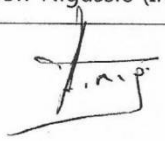
2. The two parties agreed on the mitigation measures for the canal section in the Reserve area as below:

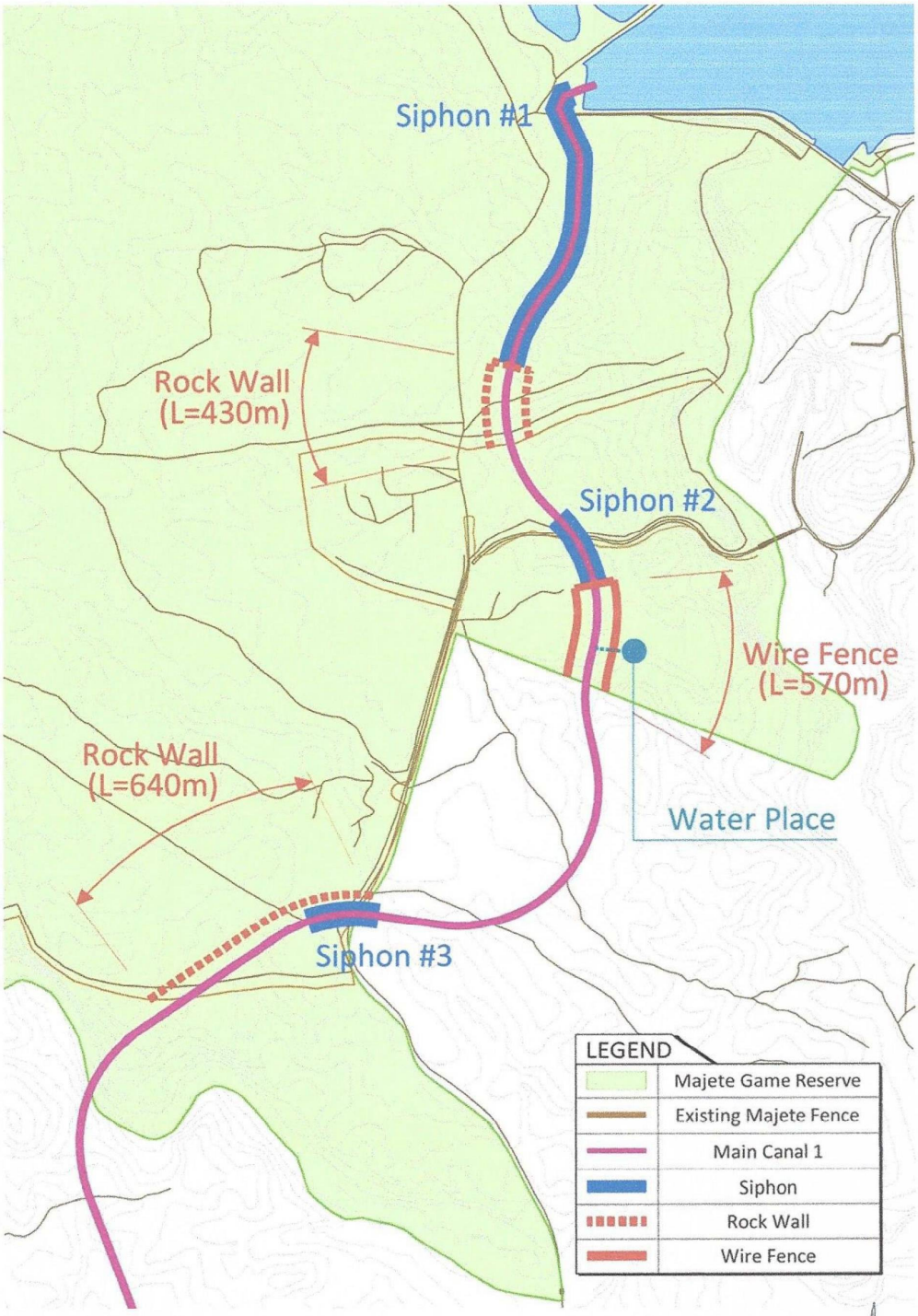
- Installation of rock (or brick) walls (a proposed type in the ESIA report) inside the fence protected area: STA. 0.8~ STA. 1.2 and STA. 2.7~ STA. 3.3 (430 m) A CROSSING BRIDGE INCLUDED OF (4m WID
- Installation of wire fence outside the fence protected area: STA. 1.2~ STA. 1.7 (570 m)
- Installation of cross roads: STA. 0.8~ STA. 1.0 and STA. 1.4~ STA. 1.7 (640 m) A CROSSING BRIDGE INCLUDED OF (4m WIDE)
- Watering point: STA. 1.4~ STA. 1.7 (Diameter 20 m circle type pond)
- A WATERING ACCESS POINT AT PARK HEADQUARTERS FOR WATER SUPPL

The figure attached shows the conceptual design.

- THIS IS NOT TO THE EXCLUSION OF OTHER MITIGATION MEASURES RECOMMENDED IN THE ESIA AND ESMP.

3. Craig Hay promised to send the mapping information of Majete Reserve boundary

On behalf of Majete Reserve	On behalf of TFS Team	Witness On behalf of PTT
Craig Hay (Park Manager)	Jin-Hoon JO (Team Leader)	Ayalew Nigussie (~~Inspector~~)
		


Siphon #1
Rock Wall
(L=430m)
Siphon #2
Wire Fence
(L=570m)
Rock Wall
(L=640m)
Water Place
Siphon #3
LEGEND
Majete Game Reserve
Existing Majete Fence
Main Canal 1
Siphon
Rock Wall
Wire Fence

APPENDIX 4

Cost Estimation
(BoQ, Unit Rate, Unit Price)

Project Cost of Phase I

(Thousand USD)

Item	Description	Unit	Quantity	Amount	Remark
I)	**Direct Total Cost**			**171,576**	
1	Intake	LS	1	4,564	
2	Main Canal 1	m	33,700	49,892	
3	Main Canal 2	m	18,400	21,830	
4	Main Canal 3	m	10,640	7,240	
5	Secondary Canal	m	92,400	17,020	
6	Drainage Canal	m	32,400	9,840	Flood Protection: 936
7	Night Storages	NO	12	1,610	
8	On Farm Works	ha	12,266	57,440	
9	SCADA	LS	1	1,110	
10	Water Supplying	LS	1	1,030	
II)	**The cost of compensation**	LS		**7,300**	
III)	**Contingency**	15%		**26,831**	15% of I) + II)
IV)	**Consultant**	6%		**10,295**	6% of I)
V)	**Additional Costs**	LS	1	**34,400**	
VI)	**Total Project Cost**			**250,402**	I) + II) + III) + IV) + V)

Project Cost of SVIP (Phase I + Phase II)

Item	Description	Amount (Thousand USD)		
		Phase I	Phase II	Total
I)	**Direct Total Cost**	**171,576**	**247,440**	**419,016**
1	Intake	4,564	-	4,564
2	Main Canal 1	49,892	-	49,892
3	Main Canal 2	21,830	45,370	67,200
4	Main Canal 3	7,240	-	7,240
5	Secondary Canal	17,020	32,460	49,480
6	Drainage Canal	9,840	15,680	25,520
7	Night Storages	1,610	3,080	4,690
8	On Farm Works	57,440	148,940	206,380
9	SCADA	1,110	1,910	3,020
10	Water Supplying	1,030	-	1,030
II)	**The cost of compensation**	**7,300**	**12,550**	**19,850**
III)	**Contingency (15% of I)+II))**	**26,831**	**38,990**	**65,821**
IV)	**Consultant (6% of I))**	**10,295**	**14,840**	**25,135**
V)	**Additional Costs**	**34,400**	**59,140**	**93,540**
VI)	**Total Project Cost**	**250,402**	**372,960**	**623,362**

Bill 1. Intake

Item		Description	Unit	Quantity	Rate (USD)	Amount (USD)
1.1.		**Earthworks**				
1.1.	1	Cofferdam Embankment	㎥	13,633	2.863	39,031
1.1.	2	Sheetpile(300*300*10*15)	NO	466	527.525	245,826
1.1.	3	Cofferdam demolish	㎥	10,006	2.712	27,136
1.2.		**Structural Work**				
1.2.	1	Excavation	㎥	22,958	2.123	48,739
1.2.	2	Backfill	㎥	2,907	3.153	9,165
1.2.	2	Con'C(B180)	㎥	8,066	127.943	1,031,988
1.2.	3	Con'C(B240)	㎥	1,488	127.943	190,379
1.2.	4	Plate form	㎡	6,474	12.421	80,413
1.2.	5	Scaffolding	㎡	15,762	6.896	108,694
1.2.	6	Support post	㎡	3,369	6.897	23,235
1.2.	7	Reinforcing steel	Ton	270	1,202	324,596
1.2.	8	Sand foundation	㎥	757	37.055	28,050
1.2.	9	Roller Gate(3.0 × 2.5 × 1)	NO	12	92,292	1,107,499
1.2.	10	Control Room	LS	1	35,000	35,000
1.2.	11	Electric Works	LS	1	26,500	26,500
1.2.	12	Aeration Tank	m	146	850	124,100
1.2.	13	Water drain	day	30	3.113	93
1.2.	14	Electrical Fence(h=1.8m)	m	253	96	29,556
1.2.	15	Temporary Noise Barrier(H3.0 x W2.0)	㎡	6,120	95.321	585,268
1.3		**Dredging**	LS	1	503,688.678	503,688
		Total	LS	1		4,563,688

Bill 2. Main Canal 1

Item		Description	Unit	Quantity	Rate (USD)	Amount (USD)
2.1.		**Earthworks**				
2.1.	1	Cut(earth) (Drop structure included)	m	2,858,106	2.712	7,751,183
2.1.	2	Cut(rock)	m³	153,000	4.655	712,215
2.1.	3	Embankment (Drop structure included)	m³	651,520	2.863	1,865,301
2.1.	4	Lined sod	m²	0	0.435	-
2.2.		**Structural Work**				
2.2.	1	Lining(t=0.10)	m²	80,404	123.066	9,894,998
2.2.	2	Reinforcing steel	ton	80	1,202	96,176
2.2.	3	Excavation	m³	208,251	2.123	442,116
2.2.	4	Backfill	m³	110,052	3.153	346,993
2.2.	5	Con'C(B180)	m³	3,660	122.81	449,484
2.2.	6	Con'C(B240) (Drop structure included)	m³	80,407	127.943	10,287,512
2.2.	7	Plate form (Drop structure included)	m²	194,726	12.421	2,418,691
2.2.	8	Scaffolding	m²	31,518	6.90	217,348
2.2.	9	Support post	m²	98,362	6.90	678,402
2.2.	10	Reinforcing steel (Drop structure included)	ton	8,751	1,202	10,520,548
2.2.	11	Concrete pipe	m	180	153.424	27,616
2.2.	12	Murram Pavement	m³	40,560	40.387	1,634,079
2.2.	13	Sand foundation	m³	230	37.055	8,522
2.2.	14	Diversion Gate(3.0*3.0)	NO	11	89,000	979,000
2.2.	15	Diversion Gate(2.5*2.5)	NO	14	75,000	1,050,000
2.2.	15	Diversion Gate(2.0*2.0)	NO	8	64,000	512,000
		Total	L=	33,800		49,892,282

Bill 3. Main Canal 2

Item		Description	Unit	Quantity	Rate (USD)	Amount (USD)
3.1.		**Earthworks**				
3.1.	1	Cut(earth)	m	214,720	2.712	582,320
3.1.	2	Embankment	m³	1,112,143	2.863	3,184,065
3.1.	3	Lined sod	m³	0	0.435	-
3.2.		**Structural Work**				
3.2.	1	Lining(t=0.10)	m³	34,197	123.066	4,208,488
3.2.	2	Reinforcing steel	ton	34	1,202	40,875
3.2.	3	Excavation	m³	101,545	2.123	215,580
3.2.	4	Backfill	m³	64,281	3.153	202,677
3.2.	5	Con'C(B180)	m³	2,537	122.81	311,568
3.2.	6	Con'C(B240)	m²	37,193	127.943	4,758,583
3.2.	7	Plate form	m²	105,683	12.421	1,312,688
3.2.	8	Scaffolding	m³	14,938	6.90	103,012
3.2.	9	Support post	m²	40,408	6.90	278,693
3.2.	10	Reinforcing steel	ton	4,365	1,202	5,247,651
3.2.	11	Concrete pipe	m	1,602	153.424	245,785
3.2.	12	Murram Pavement	m³	19,320	40.387	779,971
3.2.	13	Sand foundation	m³	433	37.055	16,044
3.2.	14	Diversion Gate(3.5*3.5)	NO	2	96,000	192,000
3.2.	15	Diversion Gate(2.5*2.5)	NO	2	75,000	150,000
		Total	L=	18,400		21,830,000

Bill 4. Main Canal 3

Item		Description	Unit	Quantity	Rate (USD)	Amount (USD)
4.1.		**Earthworks**				
4.1.	1	Cut(earth)	m³	168,788	2.712	457,753
4.1.	2	Embankment	m³	122,341	2.863	350,262
4.1.	3	Lined sod	m³	0	0.435	-
4.2.		**Structural Work**				
4.2.	1	Lining(t=0.10)	m³	10,933	123.066	1,345,480
4.2.	2	Reinforcing steel	ton	10	1,202	12,022
4.2.	3	Excavation	m³	51,090	2.123	108,464
4.2.	4	Backfill	m³	42,875	3.153	135,184
4.2.	5	Con'C(B180)	m³	808	122.81	99,230
4.2.	6	Con'C(B240)	m²	11,552	127.943	1,477,997
4.2.	7	Plate form	m²	33,492	12.421	416,004
4.2.	8	Scaffolding	m³	5,755	6.90	39,686
4.2.	9	Support post	m²	12,729	6.90	87,791
4.2.	10	Reinforcing steel	ton	1,751	1,202	2,105,071
4.2.	11	Concrete pipe	m	347	153.424	53,238
4.2.	12	Murram Pavement	m³	7,980	40.387	319,885
4.2.	13	Sand foundation	m³	104	37.055	3,853
4.2.	14	Diversion Gate(2.0*2.0)	NO	2	64,000	128,000
4.2.	15	Steel Pipe(D2000)	m	30	3,336	100,080
		Total	L=	10,640		7,240,000

Bill 5. Secondary Canal

Item		Description	Unit	Quantity	Rate (USD)	Amount (USD)
5.1.		**Earthworks**				
5.1.	1	Cut(earth)	㎥	464,460	2.712	1,259,614
5.1.	2	Embankment	㎥	600,346	2.863	1,718,791
5.1.	3	Lined sod	㎡	0	0.435	-
5.2.		**Structural Work**				
5.2.	1	Lining(t=0.10)	㎥	57,360	123.066	7,059,065
5.2.	2	Reinforcing steel	ton	57	1,202	68,526
5.2.	3	Excavation	㎥	12,929	2.123	27,448
5.2.	4	Backfill	㎥	4,987	3.153	15,724
5.2.	5	Con'C(B240)	㎥	13,201	127.943	1,688,975
5.2.	6	Plate form	㎡	32,504	12.421	403,732
5.2.	7	Scaffolding	㎡	4,055	6.90	27,963
5.2.	8	Support post	㎡	5,540	6.90	38,209
5.2.	7	Reinforcing steel	ton	2,241	1,202	2,694,154
5.2.	8	Concrete pipe	m	6,703	153.424	1,031,799
5.2.	9	Diversion Gate(3.0*3.0)	NO	3	89,000	267,000
5.2.	10	Diversion Gate(2.5*2.5)	NO	2	75,000	150,000
5.2.	11	Diversion Gate(2.0*2.0)	NO	8	64,000	512,000
5.2.	12	Diversion Gate(1.0*1.0)	NO	3	19,000	57,000
		Total	L=	92,400		17,020,000

Bill 6. Drainage Canal

Item		Description	Unit	Quantity	Rate (USD)	Amount (USD)
6.1.		Earth Works				
6.1.	1	Cut	m³	1,340,746	2.712	3,636,103
6.1.	2	Fill	m³	267,556	2.863	845,337
6.1.	3	Lined Sod	m²		0.435	
6.2.		Structural Work				
6.2.	1	Excavation	m³	5,652	2.123	11,999
6.2.	2	Backfill	m³	2,668	3.153	8,412
6.2.	3	Con'C(B240)	m³	4,500	127.943	575,743
6.2.	4	Plate form	m²	14,874	12.421	184,749
6.2.	5	Scaffolding	m²	5,845	6.90	40,307
6.2.	6	Support post	m²	10,574	6.90	72,928
6.2.	7	Reinforcing steel	ton	2,836	1202.211	3,409,470
6.3.		Flood Protection	0			
6.3.	1	Cut	m³	125,204	2.712	339,065
6.3.	2	Fill	m³	250,048	2,863	715,887
6.3.	3	Lined Sod	m²		0.435	-
		Total	L=	32,400		9,840,000

Bill 7. Night Storages

Item		Description	Unit	Quantity	Rate (USD)	Amount (USD)
7.1.		Earth Works				
7.1.	1	- Cut	m³	113,045	2.712	306,578
7.1.	2	- Fill	m³	77,386	2.863	221,556
7.1.	3	- Lined Sod	m²	0	0.435	-
						-
7.2.		Structural Work				-
7.2.	1	Excavation	m³	42	2.123	88
7.2.	2	Backfill	m³	21	3.153	66
7.2.	3	Con'C(B180)	m³	0	122.81	-
7.2.	4	Con'C(B240)	m³	892	127.943	114,125
7.2.	5	Plate form	m²	2,605	12.421	32,356
7.2.	6	Scaffolding	m²	0	6.90	-
7.2.	7	Support post	m²	0	6.90	-
7.2.	8	Reinforcing steel	ton	60	1202.211	77,231
7.2.	9	Concrete pipe	m	0	153.424	-
7.2.	10	Sand foundation	m³	0	37.055	-
7.2.	11	Diversion Gate(3.0*3.0)	NO	3	89,000	267,000
7.2.	12	Diversion Gate(2.5*2.5)	NO	2	75,000	150,000
7.2.	13	Diversion Gate(2.0*2.0)	NO	6	64,000	384,000
7.2.	14	Diversion Gate(1.0*1.0)	NO	3	19,000	57,000
		Total	NO	12		1,610,000

Bill 8. On Farm Works

Item		Description	Unit	Quantity	Rate (USD)	Amount (USD)
8.1.		Leveling Earth Works				
8.1.	1	- Cut	m³	7,856,202	2.762	21,698,830
8.1.	2	- Fill	m³	7,715,358	2.216	17,097,233
8.1.	3	- Lined Sod	m²	0	0.435	-
8.1.	4	- Topsoil Porterage & Granding	m²	0	3.988	-
8.2.		Canal Earth Works				
8.2.	1	- Cut	m³	424,029	2.712	1,149,966
8.2.	2	- Fill	m³	388,910	2.863	1,113,449
8.2.	3	- Lined Sod	m²	0	0.435	-
		Structural Work				
8.2.	4	Excavation	m³	0	2.123	-
8.2.	5	Backfill	m³	0	3.153	-
8.2.	6	Con'C(B180)	m³	0	122.810	-
8.2.	7	Con'C(B240)	m³	0	127.943	-
8.2.	8	Plate form	m²	0	12.421	-
8.2.	9	Reinforcing steel	ton	0	1,202.211	-
8.2.	10	Concrete pipe	m	0	153.424	-
8.2.	11	Sand foundation	m³	0	37.055	-
8.2.	12	Diversion Gate(0.72 x 0.72)	NO	2,438	600.000	1,462,800
8.3.		Road & Drainage Earth Works				
8.3.	1	- Cut	m³	365,726	2.712	991,848
8.3.	2	- Fill	m³	442,239	2.863	1,266,130
8.3.	3	- Lined Sod	m²	0	0.435	-
		Structural Work				
8.3.	4	Excavation	m³	86,075	2.123	182,737
8.3.	5	Backfill	m³	49,306	3.153	155,461
8.3.	6	Con'C(B240)	m³	31,754	127.943	4,062,702
8.3.	7	Plate form	m²	297,625	12.421	3,696,800
8.3.	8	Scaffolding	m²	17,812	6.896	122,831
8.3.	9	Support post	m²	14,703	6.897	101,406
8.3.	10	Reinforcing steel	ton	1,043	1,202.211	1,253,906
8.3.	11	Concrete pipe	m	14,346	153.424	2,203,901
8.3.	12	Murram Pavement	m³	21,800	40.387	880,000
		Total	ha	12,266		57,440,000

Bill 9. SCADA

Item		Description	Unit	Quantity	Rate (USD)	Amount (USD)
9.1.		System				
9.1.	1	Control Center	LS	1	92,773	92,773
9.1.	2	RTU	LS	18	21,956	395,212
9.1.	3	Blow meter	NO	18	30,000	540,000
9.2.		Office				
9.2.	1	Building	㎡	136	510	70,015
9.2.	2	Electric work	LS	1	12,000	12,000
		Total	LS	1		1,110,000

Bill 10. Water Supplying

Item	Description	Unit	Quantity	Rate (USD)	Amount (USD)
10.1.	Earth Works				
10.1. 1	Excavation	㎥	42,996	2.123	91,280
10.1. 2	Backfill	㎥	42,740	3.153	134,759
10.2.	Structural Work				
10.2. 3	Installation of PE pipe	LS	1	169,569	169,569
10.2. 4	Con'C(B180)	㎥	0	2.123	-
10.2. 5	Con'C(B240)	㎥	29	3.153	91
10.2. 6	Plate form	㎡	169	12.421	2,099
10.2. 7	Scaffolding	㎡	46	6.896	317
10.2. 8	Support post	㎡	46	6.897	317
10.2. 9	Reinforcing steel	ton	2	1,202	10,537
10.2. 10	Concrete pipe	m	0	153	-
10.2. 11	Sand foundation	㎥	0	37	-
10.2. 12	Water cleaning Facility(C-W2700S)	LS	1	596,031	596,031
10.2. 13	Water tank tower	LS	1	25,000	25,000
	Total	LS	1		1,030,000

Bill 11. Additional Costs

Item	Description	Unit	Quantity	Rate (USD)	Amount (USD)
11.1.	Phase 1				34,400,000
11.1. 1	Farm organization development and farm investment	LS	1	19,300,000	19,300,000
11.1. 2	Farm operations development (RAP)	LS	1	2,000,000	2,000,000
11.1. 3	Farm institutional support	LS	1	1,300,000	1,300,000
11.1. 4	Project management	LS	1	10,000,000	10,000,000
11.1. 5	Costmary land law implementation	LS	1	1,800,000	1,800,000
11.2.	Phase 2				59,140,000
11.2. 1	Farm organization development and farm investment	LS	1	33,180,000	33,180,000
11.2. 2	Farm operations development (RAP)	LS	1	3,440,000	3,440,000
11.2. 3	Farm institutional support	LS	1	2,240,000	2,240,000
11.2. 4	Project management	LS	1	17,190,000	17,190,000
11.2. 5	Costmary land law implementation	LS	1	3,090,000	3,090,000
	Total	LS	1		93,540,000

Unit Rate (USD)

No	Description	Unit	Total	Equipment	Labour		Material	
					Unskill	Skill	Local	Foreign
1	Cut(earth)	m^3	2.712	2.486	0.136	0.090		
2	Cut(rock)	m^3	4.655	3.452	0.722	0.481		
3	Embankment	m^3	2.863	2.112	0.451	0.300		
4	Lined sod	m^2	0.435	0.065	0.222	0.148		
5	Lining(t=0.10)	m^3	123.066	1.130	3.296	2.197	44.17	72.28
6	Con'C(B180)	m^3	122.810	1.130	3.143	2.094	44.17	72.28
7	Con'C(B240)	m^3	127.943	1.155	2.362	1.574	37.60	85.25
8	Reinforcing steel	ton	1,202.211	110.189	8.078	5.384	9.81	1,068.75
9	Excavation	m^3	2.123	1.416	0.425	0.282		
10	Backfill	m^3	3.15	2.333	0.492	0.328		
11	Plate form	m^2	12.42	1.415	0.821	0.546	9.64	
12	Scaffolding	m^2	6.90	0.806	0.359	0.238	5.49	
13	Support post	m^2	6.90	0.708	0.821	0.546	4.82	
14	Sand foundation	m^3	37.06	7.132	0.153	0.102	29.67	
15	Cutting(Land Consolidation)	m^3	2.76	2.536	0.136	0.090		
16	Banking(Land Consolidation)	m^3	2.22	1.990	0.136	0.090		
17	Topsoil Porterage & Graning	m^3	3.988	3.762	0.136	0.090		
18	Roller Gate(3.0x2.5x1)	LS	92,292	2708	21042	15833		52,708
19	Sheetpile(H-300x300x10x15)	NO	528	398.359	6.700	4.466		118
20	RTU(SCADA)	LS	21,956	150	358.5	239.0		21,209
21	Installation of 'PE pipe	LS	169,569	479.195	31,803.2	21,202.1		116,085
22	Water cleaning Facility	LS	596,031	120000.000	3,525.0	2,350.0		470,156
23	water drain	day	3.113	0.239	0.904	0.602		1.368
24	Murram Pavement	m^3	40.387	1.385	1.952	1.300	35.75	
25	Track load(28ton)	ton	258.165	200.892				57.273
26	20' CONTAINER (20ton)	TEU	2,656					2,656
27	Temporary Noise Barrier	m^2	95.321	4.227	2.226	1.483		87
28	Concrete pipe(800mm)	m	153.42	38.044	7.7	5.1	102.56	
29	Electrical Fence(h=1.8m)	m	96.000	5.670	4.8	3.2	5.52	76.8
30	Diversion Gate(0.72 x 0.72)	NO	600	278.964	28.0	18.7	274.40	
31	Diversion Gate(1.0*1.0)	NO	19,000	1900	1,140.0	760.0	950.00	14,250
32	Diversion Gate(2.0*2.0)	NO	64,000	6400	3,840.0	2,560.0	3,200.00	48,000
33	Diversion Gate(2.5*2.5)	NO	75,000	7500	4,500.0	3,000.0	3,750.00	56,250
34	Diversion Gate(3.0*2.5)	NO	84,000	8400	5,040.0	3,360.0	4,200.00	63,000
35	Diversion Gate(3.0*3.0)	NO	89,000	8900	5,340.0	3,560.0	4,450.00	66,750
36	Diversion Gate(3.5*3.5)	NO	96,000	9600	5,760.0	3,840.0	4,800.00	72,000
37	Tower Water Tank	LS	25,000	4500.000	1,500.0	1,000.0	9,500.00	8,500
38	Control Center	LS	92,773	8706.620	2,783.2	1,855.5	927.73	78,500
39	Blow meter	LS	30,000	200.000	1,800.0	1,200.0	300.00	26,500
40	Building	LS	510	155.200	30.6	20.4	193.80	110
41	Electric work	LS	12,000	1500.000	1,080.0	720.0	1,800.00	6,900

Breakdown of Unit Price

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 1
Work Item : Cutting
Unit Price : USD 2.712 Unit : 1 m³

Description	Currency Component		
	Unit Price (USD)	Local '(USD)	Foreign (USD)
1. Labour			
· Porterage(Labour:10%) Semiskilled Labour 0.5 man			
cost : 3.424 X 0.5 X 10% = 0.171			
· Porterage(Labour:10%)) Cultivator 1ton			
q=3.2*0.96=3.07, F=1.00/1.25=0.72, E=0.7, e=0.96			
L=50m, V1=57, V2=83, T=11			
cm=(L/V1+L/V2) + T = 1.22min			
Q=60*q*F*E/cm = 68.481 m³/hr			
cost : 7.000 / 68.481 X 10% = 0.010			
1) Sub Total of 1	0.181	0.181	
2. Equipment			
· Cutting(Machine:90%)) Bulldozer 19ton			
q=3.2*0.96=3.07, F=1.00/1.25=0.72, E=0.55, e=0.96			
L=20m, V1=40, V2=70, T=0.25			
cm=(L/V1+L/V2) + T = 1.18 min			
Q=60*q*F*E/cm = 73.05 m³/hr			
cost : 78 / 73.053 X 90% = 0.963			
· Porterage(Machine : 90%) Bulldozer 19ton			
q=3.2*0.96=3.07, F=1.00/1.25=0.72, E=0.7, e=0.96			
L=30m, V1=55, V2=70, T=0.25			
cm=(L/V1+L/V2) + T = 1.22 min			
Q=60*q*F*E/cm = 68.53 m³/hr			
cost : 78 / 68.526 X 90% = 1.026			
1) Sub Total of 2	1.989	1.989	
2. Direct Cost	2.170	2.170	0.000
3.Over head and profit	0.542	0.542	0.000
(25% of Direct Cost)			
TOTAL	2.712	2.712	0.000

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 2
Work Item : Cutting(Rock)
Unit Price : USD 4.655 Unit : 1 m³

Description	Currency Component		
	Unit Price (USD)	Local '(USD)	Foreign (USD)
1. Equipment			
· Hydraulic Ripper 20ton Bulldozer 19ton			
F=1.00/1.00=1.0, E=0.60, An=0.30			
L=20m			
cm=(0.05*L) +0.25 = 1.25 min			
Q=60*An* L *F*E/cm = 108.72 m³/hr			
cost : 80 / 108.72 X 100% = 0.737			
· Bulldozer 19ton Lodder			
q=3.2*0.96=3.07, F=1.00/1.30=0.77, E=0.35			
L=20m, V1=40, V2=46, T=0.25			
cm=(L/V1+L/V2) + T = 1.18 min			
Q=60*q*F*E/cm = 26.16 m³/hr 42.1			
cost : 78 / 26.163 X 100% = 2.987			
1) Sub Total of 2	3.724	3.724	
2. Direct Cost	3.724	3.724	0.000
3.Over head and profit (25% of Direct Cost)	0.931	0.931	0.000
TOTAL	4.655	4.655	0.000

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 3
Work Item : Embankment
Unit Price : USD 2.863 Unit : 1 m³

Description	Currency Component		
	Unit Price (USD)	Local '(USD)	Foreign (USD)
1. Equipment			
· Load Tire Loader 1.72㎥			
q=1.72, k=1.2, F=1.00/1.25=0.7, E=0.75			
M=1.8, L=8, T1=9, T2=14			
CM=(M·L) + T1+T2 = 37.40			
Q=3600*q*k*F*E/CM = 96.55 m³/hr			
cost : 44 / 96.55 = 0.456			
· Porterage Dump truck(15ton)			
q=15000/rt·L=10.4, k=1.2 F=1.00/1.25=0.8, E=0.9			
L=150m, T1=4.2, T2=2.41, T3=1.1 T4=0.42			
CM=T1 +T2 +T3 + T4 = 8.06 min			
Q=60*q*F*E/CM = 50.24 m³/hr			
cost : 44 / 50.238 = 0.876			
· Grading Bulldozer 19ton			
q=3.2*0.96=3.07, F=1.00/1.25=0.8, E=0.6, e=0.96			
L=20m, V1=75, V2=98, T=0.25			
CM=(L/V1+L/V2) + T = 0.72 min			
Q=60*q*F*E/CM = 110.52 m³/hr			
cost : 78 / 110.52 = 0.707			
· Compact Vibrating roller 10ton			
V=4.0, W=1.8, D=0.3, E=0.6, F=1.0, N=8			
Q=1000*V*W*D*E*F/N = 145.80 m³/hr			
cost : 37 / 145.8 X 100% = 0.253			
1) Sub Total of 1	2.292	2.292	
2. Direct Cost	2.292	2.292	0.000
3.Over head and profit	0.572	0.572	0.000
(25% of Direct Cost)			
TOTAL	2.863	2.863	0.000

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 4
Work Item : Lined sod
Unit Price : US$ 0.435 Unit : 1 m³

Description	Currency Component		
	Unit Price (USD)	Local '(USD)	Foreign (USD)
1. Labour			
· Porterage Unskilled labourer 0.001 man			
cost : 1.369 X 0.001 X 100% = 0.001			
· Planting			
Unskilled labourer 0.02 man			
cost : 1.369 X 0.02 X 100% = 0.027			
Skilled workers 0.02 man			
cost : 3.424 X 0.02 X 100% = 0.068			
· Lined sod			
0.200			
1) Sub Total of 1	0.296	0.296	
2. Equipment			
· Porterage Cultivator 1ton			
Q1=570/11=51.82, F=1.00, E=0.90			
V1=57, V2=83, T=16 CM=(L/V1 +L/V2) + T			
CM = 18.959 min			
Q=60*Q1*F*E/cm = 132.83 m³/hr			
cost : 7 / 132.83 = 0.053			
1) Sub Total of 2	0.053	0.053	
2. Direct Cost	0.349	0.349	0.000
3.Over head and profit (25% of Direct Cost)	0.087	0.087	0.000
TOTAL	0.435	0.435	0.000

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 5
Work Item : Lining(Con'c)
Unit Price : US$ 123.066 Unit : 1 m³

Description	Currency Component		
	Unit Price (USD)	Local '(USD)	Foreign (USD)
1. Labour			
· Concrete placing mixer — Concrete worker 0.94man			
cost : 4.109 X 0.94 = 3.862			
· Concrete placing mixer — Unskilled labourer 0.24man			
cost : 1.369 X 0.24 = 0.328			
· Concrete surface — Skilled labourer 0.06man			
cost : 3.424 X 0.06 = 0.205			
1) Sub Total of 1	4.395	4.395	
2. Material			
· Concrete 40-13			
cost : 83.89 X 105% = 88.086			
1) Sub Total of 2	88.086	40.520	47.566
3. Equipment			
· Concrete Mix — Mixer 0.10㎥			
q=0.10, E=0.8			
Q=60*q*E/4 = 1.08 m³/hr			
cost : 5.000 / 1.08 X 105% = 4.861			
· Concrete Compaction — Vibrator 4.0㎥/hr			
cost : 4.000 / 3.6 = 1.111			
1) Sub Total of 3	5.972	5.972	
2. Direct Cost	98.453	50.887	47.566
3.Over head and profit (25% of Direct Cost)	24.613	12.721	11.891
TOTAL	123.066	63.608	59.457

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 6
Work Item : Con'c(Reinforced B180)
Unit Price : US$ 123 Unit : 1 m³

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour			
· Concrete placing mixer — Concrete worker 0.94man			
cost : 4.109 X 0.94 = 3.862			
· Concrete placing mixer — Unskilled labourer 0.24man			
cost : 1.369 X 0.24 = 0.328			
1) Sub Total of 1	4.190	4.190	
2. Material			
· Concrete 40-13			
cost : 83.89 X 105% = 88.086			
1) Sub Total of 2	88.086	40.520	47.566
3. Equipment			
· Concrete Mix — Mixer 0.10㎥			
q=0.10, E=0.8			
Q=60*q*E/4 = 1.08 m³/hr			
cost : 5.000 / 1.08 X 105% = 4.861			
· Concrete Compaction — Vibrator 4.0㎥/hr			
cost : 4.000 / 3.6 = 1.111			
1) Sub Total of 3	5.972	5.972	
2. Direct Cost	98.248	50.682	47.566
3.Over head and profit (25% of Direct Cost)	24.562	12.670	11.891
TOTAL	122.810	63.352	59.457

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 7
Work Item : Con'c(B240)
Unit Price : US$ 127.94 Unit : 1 m³

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour			
· Concrete placing mixer Concrete worker 0.70 man			
cost : 4.109 X 0.70 = 2.876			
· Concrete placing mixer Unskilled labourer 0.20 man			
cost : 1.369 X 0.20 = 0.273			
1) Sub Total of 1	3.149	3.149	
2. Material			
· Concrete 40-21			
cost : 88.79 X 105% = 93.234			
1) Sub Total of 2	93.234	34.497	58.737
3. Equipment			
· Concrete Mix Mixer 0.10㎥			
q=0.10, E=0.8			
Q=60*q*E/4 = 1.20 m³/hr			
cost : 5.000 / 1.08 X 105% = 4.861			
· Concrete Compaction Vibrator 4.0㎥/hr			
cost : 4.000 / 3.6 = 1.111			
1) Sub Total of 3	5.972	5.972	
2. Direct Cost	102.355	43.618	58.737
3.Over head and profit	25.588	10.904	14.684
(25% of Direct Cost)			
TOTAL	127.943	54.522	73.421

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 8
Work Item : Reinforcing steel
Unit Price : US$ 1,202.211 Unit : 1 ton

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour			
· Manufacture and Erection			
Steel worker 2,76 man			
(Manufacture 1.07man / Erection 1.69man)			
cost : 3.424 X 2.76 X 0.971 = 9.176			
Unskilled labourer 1.04 man			
(Manufacture 0.35man / Erection 0.69man)			
cost : 1.369 X 1.04 X 0.971 = 1.382			
· Hire of Machines 2% of processing cost			
cost : 9 + 1.382 X 2% = 0.21			
1) Sub Total of 1	10.770	10.770	
2. Material			
· Binding Wire(0.9mm) 5.0kg			
cost : 1.800 X 5.0 = 9.000			
· Prime Cost of Reinforcing Steel 1ton			
cost : 915 X 1.0 = 915			
1) Sub Total of 2	924	9	915
3. Equipment			
· Transport fee 3% of material			
cost : 924 X 0.03 = 27.00			
1) Sub Total of 3	27	27	
2. Direct Cost	962	47	915
3.Over head and profit	240.442	11.692	228.750
(25% of Direct Cost)			
TOTAL	1,202.211	58.461	1,143.750

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 9
Work Item : Excavation
Unit Price : US$ 2.123 Unit : 1 m³

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour			
· Canal cutting			
Unskilled labourer 3 man			
cost : 1.369 X 3 X 10% = 0.410			
Working forman 0.3 man			
cost : 5.205 X 0.3 X 10% = 0.156			
1) Sub Total of 1	0.566	0.566	
2. Equipment			
· Canal cutting Excavated(Crawler) 0.7㎥			
q=0.7,k=0.7, F=1.00/1.25=0.8, E=0.6			
cm = 20min			
Q=3600*q*k*F*E/cm = 38.097 m³/hr			
cost : 48.000 / 38.097 X 90% = 1.133			
1) Sub Total of 2	1.133	1.133	
2. Direct Cost	1.699	1.699	0.000
3.Over head and profit (25% of Direct Cost)	0.424	0.424	0.000
TOTAL	2.123	2.123	0.000

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 10
Work Item : Backfill
Unit Price : US$ 3.153 Unit : 1 m³

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour			
· Backfill Unskilled labourer 3man			
cost : 1.369 X 3 X 10% = 0.410			
· Grading Unskilled labourer 0.2man			
cost : 1.369 X 0.2 X 90% = 0.246			
1) Sub Total of 1	0.656	0.656	
2. Equipment			
· Backfill Excavated(Crawler) 1.0㎥			
q=1.0,k=1.0, F=0.90/1.25=0.7, E=0.6 cm = 21 min			
Q=3600*q*k*F*E/cm = 64.80 m³/hr			
cost : 65.000 / 64.80 = 1.003			
· Compact Tamping **Compactor 1.5ton**			
Q=1000*V*W*D*E*F/N= 8.10 ㎥/hr			
cost : 7.000 / 8.10 = 0.864			
1) Sub Total of 2	1.867	1.867	
2. Direct Cost	2.523	2.523	0.000
3.Over head and profit (25% of Direct Cost)	0.630	0.630	0.000
TOTAL	3.153	3.153	0.000

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 11
Work Item : Plate form
Unit Price : US$ 12.421 Unit : 1 ㎡

Description							Currency Component		
							Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour									
· Plate form			Wood worker 0.3 man						
cost :	2.739	X	0.3	=	0.821				
· Plate form			Unskilled labourer 0.2 man						
cost :	1.369	X	0.20	=	0.273				
1) Sub Total of 1							1.094	1.094	
2. Material									
· Plate form			0.7931㎡						
cost :	9.200	X	0.7931	=	7.296				
· Rectangular timber			0.02926㎥						
cost :	-	X	0.02926	=	-				
· Steel wire			0.29kg						
cost :	1.800	X	0.29	=	0.522				
· Nail			0.2kg						
cost :	1.800	X	0.20	=	0.360				
· Separrating material			0.19ℓ						
cost :	3.500	X	0.19	=	0.665				
1) Sub Total of 2							8.843	8.843	
2. Direct Cost							9.937	9.937	-
3.Over head and profit (25% of Direct Cost)							2.484	2.484	-
TOTAL							12.421	12.421	0.000

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 12
Work Item : Scaffolding
Unit Price : US$ 6.896 Unit : 1 ㎡

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour			
· Scaffoding Scaffoding man 0.10 man			
cost : 3.424 X 0.1 = 0.342			
· Scaffoding Unskilled workers 0.1 man			
cost : 1.369 X 0.10 = 0.136			
1) Sub Total of 1	0.478	0.478	
2. Material			
· Wood for a Scaffold 0.8m			
cost : 3.300 X 0.8000 = 2.640			
· Other materials 90% of materials			
cost : 2.640 X 0.90000 = 2.376			
· fee of tools 5% of Labour			
cost : 0.478 X 0.05 = 0.023			
1) Sub Total of 2	5.039	5.039	
2. Direct Cost	5.517	5.517	-
3.Over head and profit (25% of Direct Cost)	1.379	1.379	-
TOTAL	6.896	6.896	0.000

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 13
Work Item : Supporting post
Unit Price : US$ 6.90 Unit : 1 ㎡

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour			
· Shore Carpenter 0.3 man			
cost : 2.739 X 0.30 = 0.821			
· Shore Unskilled workers 0.2 man			
cost : 1.369 X 0.20 = 0.273			
1) Sub Total of 1	1.094	1.094	
2. Material			
· Wood for a Supporting post 0.2 no			
cost : 15.800 X 0.2000 = 3.160			
· Other materials 90% of materials			
cost : 3.160 X 0.10000 = 0.316			
· Transport fee 30% of materials			
cost : 3.160 X 0.30000 = 0.948			
1) Sub Total of 2	4.424	4.424	
2. Direct Cost	5.518	5.518	-
3.Over head and profit (25% of Direct Cost)	1.379	1.379	-
TOTAL	6.897	6.897	0.000

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 14
Work Item : Sand foundation
Unit Price : US$ 37.055 Unit : 1 m³

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour			
· Loading and unloading Unskilled workers 0.05 man			
cost : 1.369 X 0.05 = 0.068			
· Make even and Compact Unskilled workers 0.1 man			
cost : 1.369 X 0.10 = 0.136			
1) Sub Total of 1	0.204	0.204	
2. Material			
· Sand 1.04*1.600= 1.664			
cost : 22.900 / 1.400 X 1.664 = 27.218			
1) Sub Total of 2	27.218	27.218	
3. Equipment			
· Porterage Cultivator 1ton			
Q1=570/11=51.82, F=1.00, E=0.90			
V1=57, V2=83, T=11 CM=(L/V1 +L/V2) + T			
CM = 15.440 min			
Q=60*Q1*F*E/cm = 3.15 ton/hr			
cost : 7 / 3.15 = 2.222			
1) Sub Total of 3	2.222	2.222	
2. Direct Cost	29.644	29.644	-
3.Over head and profit (25% of Direct Cost)	7.411	7.411	-
TOTAL	37.055	37.055	0.000

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 15
Work Item : Cutting(Land Consolidation)
Unit Price : USD 2.762 Unit : 1 m^3

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Equipment			
· Cutting Bulldozer 19ton			
q=3.2*0.96=3.07, F=1.00/1.25=0.72, E=0.55, e=0.96			
L=20m, V1=40, V2=70, T=0.25			
cm=(L/V1+L/V2) + T = 1.18 min			
Q=60*q*F*E/cm = 73.05 m^3/hr			
cost : 78 / 73.053 = 1.070			
· Porterage Bulldozer 19ton			
q=3.2*0.96=3.07, F=1.00/1.25=0.72, E=0.7, e=0.96			
L=30m, V1=55, V2=70, T=0.25			
cm=(L/V1+L/V2) + T = 1.22 min			
Q=60*q*F*E/cm = 68.53 m^3/hr			
cost : 78 / 68.526 = 1.140			
1) Sub Total of 1	2.210	2.210	
2. Direct Cost	2.210	2.210	0.000
3.Over head and profit (25% of Direct Cost)	0.552	0.552	0.000
TOTAL	2.762	2.762	0.000

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 16

Work Item : Banking(Land Consolidation)

Unit Price : USD 2.216 Unit : 1 m³

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Equipment			
· Porterage Bulldozer 19ton			
q=3.2*0.94=3.0, F=1.00/1.25=0.8, E=0.60, e=0.94			
L=25m, V1=55, V2=70, T=0.25			
cm=(L/V1+L/V2) + T = 1.06 min			
Q=60*q*F*E/cm = 73.35 m³/hr			
cost : 78 / 73.35 = 1.066			
· Grading Bulldozer 19ton			
q=3.2*0.96=3.07, F=1.00/1.25=0.8, E=0.6, e=0.96			
L=20m, V1=75, V2=98, T=0.25			
CM=(L/V1+L/V2) + T = 0.72 min			
Q=60*q*F*E/CM = 110.52 m³/hr			
cost : 78 / 110.52 = 0.707			
1) Sub Total of 1	1.773	1.773	
2. Direct Cost	1.773	1.773	0.000
3.Over head and profit (25% of Direct Cost)	0.443	0.443	0.000
TOTAL	2.216	2.216	0.000

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 17
Work Item : Topsoil Porterage & Graning
Unit Price : US$ 3.988 Unit : 1 m³

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Equipment			
· Porterage Bulldozer 19ton			
q=3.2*0.96=3.07, F=1.00/1.25=0.72, E=0.7, e=0.96			
L=25m, V1=55, V2=70, T=0.25			
cm=(L/V1+L/V2) + T = 1.06 min			
Q=60*q*F*E/cm = 73.35 m³/hr			
cost : 78 / 73.35 = 1.065			
· Grading Work Bulldozer 19ton			
q=3.2*0.88=2.82, F=1.00/1.25=0.8, E=0.55, e=0.88			
L=20m, V1=40, V2=70, T=0.25			
cm=(L/V1+L/V2) + T = 1.82 min			
Q=60*q*F*E/cm = 36.76 m³/hr			
cost : 78 / 36.756 = 2.126			
1) Sub Total of 1	3.191	3.191	
2. Direct Cost	3.191	3.191	0.000
3.Over head and profit (25% of Direct Cost)	0.797	0.797	0.000
TOTAL	3.988	3.988	0.000

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 18
Work Item : Roller Gate(3.0 x 2.5 x 1)
Unit Price : US$ 92,291.67 Unit : 1 LS

Description						Currency Component		
						Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour								
· Making and processing cost				1 LS				
cost :	15,833	X	1.0	=	15,833			
· installation charges				1 LS				
cost :	15,833	X	1.00	=	15,833			
1) Sub Total of 1						31,667	31,667	
2. Material								
· Roller Gate				1 LS				
cost :	40,000	X	1.0	=	40,000			
1) Sub Total of 2						40,000		40,000
3. Equipment								
· Use of equipment				1 LS				
cost :	2,167	X	1.0	=	2,167			
1) Sub Total of 3						2,167		2,167
2. Direct Cost						73,833	31,667	42,167
3.Over head and profit (25% of Direct Cost)						18,458	7,917	10,542
TOTAL						92,292	39,583	52,708

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 19

Work Item : Sheet pile(H-300 x 300 x 10 x 15)

Unit Price : US$ 527.53 Unit : 1 NO

Description						Currency Component		
						Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour								
· Pile & Drawn			1 LS					
cost :	7.963	X	1.0	=	7.963			
· Load& Unload			1 LS					
cost :	0.970	X	1.00	=	0.970			
1) Sub Total of 1						8.933	8.933	
2. Material								
· Pile & Drawn			1 LS					
cost :	14.353	X	1.0	=	14.353			
· Load& Unload			1 LS					
cost :	0.334	X	1.00	=	0.334			
1) Sub Total of 2						14.687	0.334	14.353
3. Equipment								
· Sheet Pile			1 LS					
cost :	332	X	1.0	=	332			
· Pile & Drawn			1 LS					
cost :	66.40	X	1.0	=	66			
1) Sub Total of 3						398	66	332
2. Direct Cost						422	76	346
3.Over head and profit (25% of Direct Cost)						106	19	87
TOTAL						528	95	433

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 20
Work Item : RTU(SCADA)
Unit Price : US$ 21,956.25 Unit : 1 LS

Description							Currency Component		
							Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour RTU 1 LS									
· Inlet Works	cost :	67	X	1.0	=	67			
· Power Works	cost :	140	X	1.0	=	140			
· lighting Works	cost :	43	X	1.0	=	43			
· Grounding Works	cost :	114	X	1.0	=	114			
· CCTV Works	cost :	114	X	1.0	=	114			
1) Sub Total of 1							478	478	
2. Material RTU 1 LS									
· Inlet Materal	cost :	1,143	X	1.0	=	1,143			
· Power Material	cost :	2,120	X	1.0	=	2,120			
· lighting Material	cost :	1,565	X	1.0	=	1,565			
· Grounding Material	cost :	3,055	X	1.0	=	3,055			
· CCTV Material	cost :	9,084	X	1.0	=	9,084			
1) Sub Total of 2							16,967		16,967
3. Equipment									
· Transportation(Johannesburg →Location) 1 LS									
cost :	120	X	1.0	=	120				
1) Sub Total of 3							120		120
2. Direct Cost							17,565	478.0	17,087
3.Over head and profit (25% of Direct Cost)							4,391.25	119.50	4,271.75
TOTAL							21,956.25	597.50	21,358.75

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 21
Work Item : Installation of 'PE pipe
Unit Price : US$ 169,569.08 Unit : 1 LS

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour			
· PE Pipe installation 50% of Material			
cost : 84,808.50 X 0.50 = 42,404			
1) Sub Total of 1	42,404	42,404	
2. Material			
· PE Pipe 125mm 9500 m			
cost : 5.500 X 9500.0 = 52,250			
· PE Pipe 150mm 4600 m			
cost : 6.200 X 4600.0 = 28,520			
· others material 5% of Material			
cost : 80,770 X 0.05 = 4,039			
1) Sub Total of 2	84,809		84,809
3. Equipment			
· Transportation(Johnannesburg →Location) 1 LS			
cost : 8,442.515 X 1.00 = 8,442.51			
1) Sub Total of 3	8,442.51		8,442.51
2. Direct Cost	135,655	42,404	93,251
3.Over head and profit (25% of Direct Cost)	33,914	10,601	23,313
TOTAL	169,569	53,005	116,564

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 22
Work Item : Water cleaning Facility(C-W2700S)
Unit Price : US$ 596,031.25 Unit : 1 LS

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour			
· installation charges 1% of materials			
cost : 470,000 X 0.01 = 4,700			
1) Sub Total of 1	4,700	4,700	
2. Material			
· Water cleaning Facility(C-W2700S) 1 Set			
cost : 470,000 X 1.0 = 470,000			
1) Sub Total of 2	470,000		470,000
3. Equipment			
· Transportation(Johnannesburg →Location) 1 LS			
cost : 2,125 X 1.0 = 2,125			
1) Sub Total of 3	2,125		2,125
2. Direct Cost	476,825	4,700	472,125
3.Over head and profit	119,206	1,175	118,031
(25% of Direct Cost)			
TOTAL	596,031	5,875	590,156

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 23
Work Item : Water Drain
Unit Price : US$ 3.113 Unit : 1 day

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour			
· Machine driver — Machine driver 0.16 man			
cost : 7.534 X 0.16 = 1.205			
1) Sub Total of 1	1.205	1.205	
2. Material			
· Diesel Egine(9hp) — Diesel 1ℓ/hr — 10hr			
cost : 1.000 X 1.0 X 10 = 1.000			
1) Sub Total of 2	1.000		1.000
3. Equipment			
· Diesel Egine(9hp) — 10hr			
cost : 0.084 X 1.0 X 10 = 0.084			
· Pump(125mm 15hp 20m) — 10hr			
cost : 0.162 X 1.0 X 10 = 0.162			
· Section hose(125mm 6m) — 10hr			
cost : 0.041 X 1.0 X 10 = 0.040			
1) Sub Total of 3	0.286	0.286	
2. Direct Cost	2.491	1.491	1.000
3.Over head and profit (25% of Direct Cost)	0.622	0.372	0.250
TOTAL	3.113	1.863	1.250

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 24
Work Item : Murram Pavement Unit : 1 m³
Unit Price : US$ 40.39

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour			
· Water Tank(16000 Machine			
cost : 7.534 X 0.3 = 2.26			
· Skilled Labor 0.1			
cost : 3.424 X 0.10 = 0.34			
1) Sub Total of 1	2.602	2.602	
2. Material			
· Murram Porterage m³			
cost : 28.600 X 1.0 = 28.600			
1) Sub Total of 2	28.600	28.600	
3. Equipment			
· Surface Grading & Compaction			
cost : 22.17 X 0.050 = 1.108			
1) Sub Total of 3	1.108	1.108	
2. Direct Cost	32.310	32.310	-
3.Over head and profit (25% of Direct Cost)	8.077	8.077	-
TOTAL	40.387	40.387	0.000

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 25
Work Item : Truck Load (28ton)
Unit Price : USD 258.165 Unit : 1 ton

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Truck Load 28 ton			
· Full truck load 28mt Johannesburg - Blantyre USD 4,500.00			
FROM / TO / Truck Load (28ton): Johannesburg / Blantyre / 161 $/TON			
1) Sub Total of 1	160.714	160.714	
2. Cargomate Charges			
ITEMS / 28 ton			
Bond 100 USD / 3.571			
Agency 100 USD / 3.571			
Communcation 60 USD / 2.142			
Handling 30 USD per ton / 30			
Storage 6 USD per ton per day / 6			
Customs processing fee 15 USD / 0.535			
TOTAL / 45.819			
1) Sub Total of 2	45.819		45.819
2. Direct Cost	206.533	160.714	45.819
3.Over head and profit (25% of Direct Cost)	51.632	40.178	11.454
TOTAL	258.165	200.892	57.273

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 26
Work Item : 20' CONTAINER (20ton)
Unit Price : USD 2,656.250 Unit : 1 m³

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. 20' CONTAINER (20ton)			
· V= 32.22 ㎥ V=5.85*2.318*2.376 1.61 ㎥/ton			
L= 5.85 m B= 2.32 m H= 2.38 m			
POL: INCHEON~ / POD: Daressalaam / 20' CONTAINER: 375 $/TON, 232 $/㎥			
2. EVER LOGISTICS (EVER-2014-11-0055)			
POL: INCHEON / POD: Daressalaam / CONTAINER: 20' USD$ 3,200; 40' USD$ # 4,300			
3. ORIENTAL SHIPPING CO,LTD			
POL ~ POD: INCHEON~ DARESSALAAM / ITEMS: OCEAN FREIGHT 2,400 4,000; THC 108 148; W/F 4 8; DOC FEE 33 33; SEAL CHARGE 5 5; TOTAL 2,550 4,194			
4. Transport charge Port ~ Local 1,750 /TEU			
1) Sub Total of 1~4	2,125.000		2,125.000
2. Direct Cost	2,125.000		2,125.000
3.Over head and profit	531.250		531.250
(25% of Direct Cost)			
TOTAL	2,656.250		2,656.250

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 27

Work Item : Temporary Noise Barrier(H=3,000× W2,000)

Unit Price : US$ 95 Unit : 1 ㎡

Description	Currency Component		
	Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour			
· Pipe Installation Steel Worker 3 man 6 ㎡			
cost : 3.424 X 3.00 / 6 = 1.712			
· Noise Barrier Installation Steel Worker 3.5 mar 6 ㎡			
cost : 3.424 X 3.50 / 6 = 1.997			
1) Sub Total of 1	3.709	3.709	
2. Material			
· Noise Barrier 500*2000*34T H=300			
cost : 40 × 1 ㎡ = 40 US$			
· Other materials 43.5% of materials			
cost : 40 × 43.5% = 17 US$			
1) Sub Total of 2	57.000		57.000
3. Equipment			
· Transportation(Johnannesburg →Location) 1 LS			
cost : 258 /ton × 0.05 × 1 = 12.908			
· Excavator(Caterpillar) 0.4㎥			
cost : ##### × 0.12 hr = 2.640			
1) Sub Total of 3	15.548	2.640	12.908
3. Direct Cost	76.257	6.349	69.908
3.Over head and profit (25% of Direct Cost)	19.064	1.587	17.477
TOTAL	95.321	7.936	87.385

BREAKDOWN OF UNIT PRICE

Item No : SVIP- 28
Work Item : Dredging
Unit Price : USD 503,688.678 Unit : 1 LS

Description		Currency Component		
		Unit Price (USD)	Local (USD)	Foreign (USD)
1. Labour				
Dredging ship (L=2km, N=10, 2200HP)	31,398.624			
Transport dredging ship (Truck Trailer)				
Dredging (L=2km, N=10, 2200HP)	55,208.696			
Install & removal dredging ship	15,659.690			
Install & removal land pipe for pump dredging	880.640			
Install & removal underwater pipe for pump dredging	14,857.505			
1) Sub Total of 1	118,005.156	118,005	118,005	
2. Materials				
Dredging ship (L=2km, N=10, 2200HP)	5,747.380			
Transport dredging ship (Truck Trailer)				
Dredging (L=2km, N=10, 2200HP)	125,513.043			
Install & removal dredging ship	3,953.134			
Install & removal land pipe for pump dredging	109.885			
Install & removal underwater pipe for pump dredging	1,682.568			
1) Sub Total of 2	137,006.010	137,006		137,006
3. Equipment				
Dredging ship (L=2km, N=10, 2200HP)	17,792.368			
Transport dredging ship (Truck Trailer)	9,474.330			
Dredging (L=2km, N=10, 2200HP)	103,660.870			
Install & removal dredging ship	5,377.600			
Install & removal land pipe for pump dredging	180.118			
Install & removal underwater pipe for pump dredging	11,454.491			
1) Sub Total of 3	147,939.777	147,940		147,940
2. Direct Cost		402,951	118,005	284,946
3.Over head and profit (25% of Direct Cost)		100,738	29,501	71,236
TOTAL		503,689	147,506	356,182

Breakdown per Secondary Block (Phase 1)

Main Canal	Secondary Canal	Zone	Cost (USD)
Main 1	I1	I-1-a	2,904,000
Main 1	I2	I-1-a, I-a-c	16,166,000
Main 1	I3	I-1-d	1,534,000
Main 1	I4	I-1-a	3,175,000
Main 1	I5	I-1-a	4,863,000
Main 3	I6	I-1-a	1,557,000
Main 3	I7	I-1-a, I-1-b	6,578,000
Main 2	A1	A-a	2,375,000
Main 2	A2	A-e	954,000
Main 2	A3	A-b	1,006,000
Main 2	A4	A-b	1,375,000
Main 2	A5	A-b	1,749,000
Main 2	A6	A-b	4,680,000
Main 2	A7	A-b	6,864,000
Main 3	A8	A-c	734,000
Main 3	A9	A-d	926,000
Total			57,440,000

APPENDIX 5

Financial and Economic Analysis

A. Institutional cost

A.1 Water Service Provider
A.2 Cooperatives

B. Benefits

B.1 Crop budgets
B.2 Budget for Livestock improvement
B.3 Budget for Aquaculture

C. Cash Flow Analysis

C1.A Phase 1 and 2 combined,Cropping Pattern 1. Financial
C1. B Phase 1. and 2 combinedCropping Pattern 1 Economic
C2. A Phase 1 with Cost of Intake, Canal 1 and Canal 3 reallocated ,Cropping Pattern 1. Financial
C2. B Phase 1with Cost of Intake, Canal 1 and Canal 3 reallocated.Cropping Pattern 1 Economic
C3. A Phase 1 with Cost of Intake, Canal 1 and Canal 3 reallocated Cropping Pattern 2,. Financial
C3. B Phase 1with Cost of Intake, Canal 1 and Canal 3 reallocated.Cropping Pattern 2 Economic

D1 Cash flow of 1:10 flood protection, Financial prices and Economic Prices

E. Sensitivity Analysis

APPENDICES A: INSTITUTIONAL COST

Appendix A1:Cost of Water Service Provider

(Organisation Responsible for Operating and Maintaining the Shire Valley Irrigation system)

Investments

					Amount (USD)	
ITEM	**Unit**	**Nr of units**	**Unit cost**		**Finc.**	**Econ.**
Equipment						
Vehicles		7	18,000,000	126,000,000	168,000	
Pick-up for maintenance crew (engineer + masons)						
Motorbikes (?) for operators		3	4,000,000	48,000,000	64,000	
Generators		3	4,000,000	12,000,000	16,000	
Solar panels (?)						
Computers		15	800,000	12,000,000	16,000	
				-	-	
Communications		10	250,000	2,500,000	3,333	
Telephones		10	250,000	2,500,000	3,333	
					270,667	259,840
Machinery / Heavy Equipment						
Excavator		3	180,000,000	540,000,000	635,294	
Bulldozers		3	150,000,000	450,000,000	529,412	
Graders		2	85,000,000	170,000,000	200,000	
Loaders		1	70,000,000	70,000,000	82,353	
Dump truck		5	60,000,000	300,000,000	352,941	
Mobile Garage		1	80,000,000	80,000,000	94,118	
Fueling Tank		1	70,000,000	70,000,000	82,353	
					1,976,471	1,897,412
Total investment					2,247,137	2,157,252

Annually Recurrent

				750	**Kwachas / USD**
Staff	Number	Annual Salary (Kwachas per Month)	Amount per year		
			M Kwachas	US $ (Finc)	US $ (Econ)
1 Managing Director	1				
Salary		1,900,000	22,800,000	30,400	
Travel allowances		50,000	600,000	800	
2 Operations					

2.1	Head of operations	1	1,600,000	19,200,000	25,600	
	Headworks superintendant	1	1,200,000	14,400,000	19,200	
	Water bailiffs	4	1,000,000	12,000,000	16,000	
2.2	Operators (gates)	30	800,000	288,000,000	384,000	
3	Maintenance					
3.1	Head of maintenance	1	1,600,000	19,200,000	25,600	
3.2	Inspector irrigation	1	1,100,000	13,200,000	17,600	
3.3	Engineer	1	900,000	10,800,000	14,400	
3.4	Masons	4	500,000	24,000,000	32,000	
3.5	IT / computer expert	1	800,000	9,600,000	12,800	
3.6	Mechanics	2	700,000	16,800,000	22,400	
4	HR and Finance			-		
4.1	Head of HR and finance	1	1,600,000	19,200,000	25,600	
4.2	Staff to read water meters	5	200,000	12,000,000	16,000	
4.3	Billing Clerk	1	500,000	6,000,000	8,000	
4.2	Accountant	1	800,000	9,600,000	12,800	
5	Communication and complaints office					
5.1	Agricultural expert/ Agronomist	1	800,000	9,600,000	12,800	
5.2	Communication officer	1	800,000	9,600,000	12,800	
6	Support staff					
6.1	Secretaries	4	350,000	4,200,000	5,600	
6.2	Drivers	4	200,000	2,400,000	3,200	
6.3	Guards	3	80,000	960,000	1,280	
6.3	Office Cleaners	3	80,000	960,000	1,280	
Total STAFF					700,160	875,200

Office

Rent of an office building	1	1,500,000	18,000,000	24,000	
Utilities (water and electricity)		100,000	1,200,000	1,600	
Stationary		200,000	-	-	
				25,600	24,576

Operational Costs

Fuel for cars	7	200,000	16,800,000	22,400	
Fuel for motorbikes	3	60,000	2,160,000	2,880	
Fuel for generators	1	60,000	720,000	960	
Cost of phone calls	10	40,000	4,800,000	6,400	

Fuels for heavy Equipment	8	300,000	28,800,000	38,400	
				71,040	68,198

Maintenance (preventive and repair)

Cars	7	30,000	2,520,000	3,360	
Motorbikes	3	10,000	360,000	480	
Computers	15	5,000	900,000	1,200	
Telephones	10	3,000	360,000	480	
Maintenance of office	1	10,000	120,000	160	
Maintenance of heavy equipment	8	400,000	38,400,000	51,200	
				56,880	56,880
Total recurrent for operations			76,740,000	853,680	1,024,854

Appendix A2: Cost of Cooperatives (for a 500 ha coop)

Details	USD/unit	Quantity	Total cost (USD)		life time (in years)
			Financial Cost	Economic Cost	
(1)Capital Expenditure Iterms (year 1)					
Farm Buildings					
Fuel storage tanks	5,000	6	30,000	28,800	20
Farm machinery shed	15,000	6	90,000	86,400	20
Storage shed	10,000	6	60,000	57,600	20
Office block	20,000	6	120,000	115,200	20
Manager's house	15,000	1	15,000	14,400	20
Junior staff houses	10,000	60	600,000	576,000	20
Water treatment facility	10,000	6	60,000	57,600	20
Subtotal			**975,000**	**936,000**	
Farm Machinery					
Precision planters (5 metres)	15,000	12	180,000	172,800	10
Boom sprayer (10 metres)	10,000	6	60,000	57,600	10
Disk harrow (5 metres)	10,000	6	60,000	57,600	10
Tractors (100kW)	25,000	12	300,000	288,000	8
Tractors (60kW)	20,000	6	120,000	115,200	8
Trailers (5 tonne)	5,000	6	30,000	28,800	10
Water bowser (5000 litres)	2,000	6	12,000	11,520	20
Mobile fuel bowser (500 litres)	1,000	6	6,000	5,760	**20**
Fertiliser spreader	4,000	6	24,000	23,040	20
Miscellaneous equipment	5,000	6	30,000	28,800	10
Subtotal			**822,000**	**789,120**	
Motor Vehicles					
One-tonne truck	25,000	6	150,000	144,000	5
Manager's vehicle (D/cab)	30,000	1	30,000	28,800	5
Motor cycles (200cc)	5,000	24	120,000	115,200	5
Subtotal			**300,000**	**288,000**	
Cooperative Training		**covered in the Transformation Strategy**			
Total Investment required			**2,097,000**	**2,013,120**	

2) Recurrent Expenditures Items/year **in** USD per year

			Financial Cost	Economic Cost
O&M of buildings and equipment				
Farm buildings		2%	19,500	18,720
Farm machinery		5%	41,100	39,456
Motor vehicles		10%	30,000	28,800
Total O&M			**90,600**	**86,976**
Admin cost				
General Transport -			30,000	22,200
Salaries and Wages	months		300,000	375,000
Insurance	year	1	30,000	30,000
Communication (telephone, internet, etc.)			30,000	30,000
Subscriptions (to unions and professional organisations)			500	500
Electricity (overhead)	year	1	24,000	24,000
Local authority permits/taxes			12,000	12,000
Accounting/audit fees			10,000	10,000
Bank charges	year	1	5,000	5,000
Board/management committee expenses	year	1	12,000	12,000
Total Admin			123,500	123,500
Subtotal			**544,100**	**607,676**

Appendices B – CROP BUDGETS / GROSS MARGINS COMPUTATIOS (AT FARM GATE PRICESS)

APPENDIX B 1.1-1BANANAS FINANCIAL PRICES (WITH PROJECT)

YEAR	UNITS	USD/UNIT	1	2	3	4	5	6	7	8	9	10
PLANTING MATERIALS	seedlings	0.015	3,630									
Cost			**54.18**									
CHEMICALS												
Monocrotophos	l	10.37	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Copper oxychloride 85% w.p.	kg	10.49	0.20	0.42	0.81	2.00	2.00	2.00	2.00	4.11	4.11	4.11
Roundup/glyphosate	l	6.03	2.00									
Misting Oil	l	13.34	-	140.00	140.00	140.00	140.00	140.00	140.00	140.00	140.00	140.00
Tridex	l	13.97	1.00	2.50	2.50	2.80	3.00	3.00	3.00	3.00	3.00	3.00
Solubor	kg	1.78	0.13	0.28	0.54	1.30	1.30	1.30	1.30	2.74	2.74	2.74
Zinc oxide	kg	5.47	0.19	0.42	0.81	2.00	2.00	2.00	2.00	4.11	4.11	4.11
Diazanon	l	28.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
subtotal	**USD**		**34.7**	**1,925.5**	**1,932.1**	**1,956.7**	**1,959.5**	**1,959.5**	**1,959.5**	**1,995.7**	**1,995.7**	**1,995.7**
FERTILIZERS												
Manure	kg	0.05	10,000									
Compound (23:21:0+ 4S)	kg	0.73	550									
Muriate of potash	kg	0.91	500	200	200	200	200	200	200	200	200	200
Single superphosphate	kg	0.46	275	225	225	225	225	225	225	225	225	225
lime	kg	0.30	1,250									
transport	t/km	1.86	23	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Subtotal	**USD**		**1,901.6**	**285.7**	**285.7**	**286**	**286**	**286**	**286**	**286**	**286**	**286**
TILLAGE												
Ripping	l	1.61	22.00									
Ploughing	l	1.61	20.00									
Discing	l	1.61	10.00									
Subtotal			**83.82**									
SMALL TOOLS	**USD**		**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**
LABOUR	ld	1.34	200.0	200	200	200	200	200	200	200	200	200
Cost			**268.7**	**269**	**269**	**269**	**269**	**269**	**269**	**269**	**269**	**269**
IRRIGATION WATER	ml	8.60	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
	fixed (USD)		100	100	100	100	100	100	100	100	100	100
Cost	**USD**		**254.80**	**254.80**	**254.80**	**254.80**	**254.80**	**254.80**	**254.80**	**254.80**	**254.80**	**254.80**
Yield per ha	kg		-	20,000	30,000	40,000	50,000	50,000	50,000	50,000	50,000	50,000
TOTAL YIELD			-	20,000	30,000	40,000	50,000	50,000	50,000	50,000	50,000	50,000
Yield - processing & consump	kg	0.60	-	12,000	18,000	24,000	30,000	30,000	30,000	30,000	30,000	30,000
Yield - export	kg	0.40	-	8,000	12,000	16,000	20,000	20,000	20,000	20,000	20,000	20,000
Revenue - processing &consum	kg	0.11	-	1,343	2,015	2,687	3,358	3,358	3,358	3,358	3,358	3,358
Revenue - export	kg	0.15	-	1,194	1,791	2,388	2,985	2,985	2,985	2,985	2,985	2,985
GROSS CROP REVENUE PER HA	**USD**		**-**	**2,537**	**3,806**	**5,075**	**6,343**	**6,343**	**6,343**	**6,343**	**6,343**	**6,343**
PRODUCTION COSTS			**2,600.0**	**2,736.8**	**2,741.3**	**2,768.0**	**2,770.8**	**2,770.8**	**2,770.8**	**2,807.1**	**2,807.1**	**2,807.1**
Sundry		0.01	26.00	27.37	27	28	28	28	28	28	28	28
Total Variable Cost	**USD**		**2,626**	**2,764**	**2,769**	**2,796**	**2,799**	**2,799**	**2,799**	**2,835**	**2,835**	**2,835**
GROSS CROP MARGIN PER HA	**USD**		**(2,626)**	**(227)**	**1,037**	**2,279**	**3,545**	**3,545**	**3,545**	**3,508**	**3,508**	**3,508**
Cost maintenance on-field canals (USD/ha)			34	34	34	34	34	34	34	34	34	34
GM after deduction of cost maintenance on-field canals			**(2,626)**	**(227)**	**1,003**	**2,244**	**3,510**	**3,510**	**3,510**	**3,474**	**3,474**	**3,474**

APPENDIX B 1.1- 2 BANANAS ECONOMIC PRICES (WITH PROJECT)

YEAR	UNITS	USD/UNIT	1	2	3	4	5	6	7	8	9	10
PLANTING MATERIALS	seedlings	0.01	3,630									
Cost			**52.01**									
CHEMICALS												
Monocrotophos	l	9.96	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Copper oxychloride 85% w.p.	kg	10.07	0.20	0.42	0.81	2.00	2.00	2.00	2.00	4.11	4.11	4.11
Roundup/glyphosate	l	5.78	2.00									
Misting Oil	l	12.80	-	140.00	140.00	140.00	140.00	140.00	140.00	140.00	140.00	140.00
Tridex	l	13.41	1.00	2.50	2.50	2.80	3.00	3.00	3.00	3.00	3.00	3.00
Solubor	kg	1.71	0.13	0.28	0.54	1.30	1.30	1.30	1.30	2.74	2.74	2.74
Zinc oxide	kg	5.25	0.19	0.42	0.81	2.00	2.00	2.00	2.00	4.11	4.11	4.11
Diazanon	l	27.36	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
subtotal	**USD**		**33.22**	**1,848.44**	**1,854.86**	**1,878.40**	**1,881.09**	**1,881.09**	**1,881.09**	**1,915.87**	**1,915.87**	**1,915.87**
FERTILIZERS												
Manure	kg	0.05	10,000									
Compound (23:21:0+ 4S)	kg	0.70	550									
Muriate of potash	kg	0.51	500	200	200	200	200	200	200	200	200	200
Single superphosphate	kg	0.44	275	225	225	225	225	225	225	225	225	225
lime	kg	0.29	1,250									
transport	t/km	-	-	-	-	-	-	-	-	-	-	-
Subtotal	**USD**		**1,621**	**201**	**201**	**201**	**201**	**201**	**201**	**201**	**201**	**201**
TILLAGE												
Ripping	l	**1.61**	22.00									
Ploughing	l	**1.61**	20.00									
Discing	l	**1.61**	10.00									
Subtotal			**83.82**									
SMALL TOOLS	**USD**		**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**
LABOUR	ld	0.67	200.00	200	200	200	200	200	200	200	200	200
COST			**134.33**	**134**	**134**	**134**	**134**	**134**	**134**	**134**	**134**	**134**
IRRIGATION WATER	ml	8.60	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00	18.00
	fixed (USD)		100	100	100	100	100	100	100	100	100	100
Cost	**USD**		**254.80**	**254.80**	**254.80**	**254.80**	**254.80**	**254.80**	**254.80**	**254.80**	**254.80**	**254.80**
Yield per ha	kg		-	20,000	30,000	40,000	50,000	50,000	50,000	50,000	50,000	50,000
TOTAL YIELD			-	20,000	30,000	40,000	50,000	50,000	50,000	50,000	50,000	50,000
Yield - processing & consump	kg	0.60	-	12,000	18,000	24,000	30,000	30,000	30,000	30,000	30,000	30,000
Yield - export	kg	0.40	-	8,000	12,000	16,000	20,000	20,000	20,000	20,000	20,000	20,000
Revenue - processing &consum	kg	**0.11**	-	1,343	2,015	2,687	3,358	3,358	3,358	3,358	3,358	3,358
Revenue - export	kg	**0.15**	-	1,194	1,791	2,388	2,985	2,985	2,985	2,985	2,985	2,985
GROSS CROP REVENUE PER HA	**USD**		**-**	**2,537**	**3,806**	**5,075**	**6,343**	**6,343**	**6,343**	**6,343**	**6,343**	**6,343**
PRODUCTION COSTS			**2,181.77**	**2,441**	**2,445**	**2,471**	**2,473**	**2,473**	**2,473**	**2,508**	**2,508**	**2,508**
Sundry		0.01	21.82	24.41	24.45	24.71	24.73	24.73	24.73	25.08	25.08	25.08
Total Variable Cost	**USD**		**2,203.59**	**2,465**	**2,469**	**2,495**	**2,498**	**2,498**	**2,498**	**2,533**	**2,533**	**2,533**
GROSS CROP MARGIN PER HA	**USD**		**(2,204)**	**72**	**1,337**	**2,579**	**3,845**	**3,845**	**3,845**	**3,810**	**3,810**	**3,810**
Cost maintenance on-field canals (USD/ha)			28	28	28	28	28	28	28	28	28	28
GM after deduction of cost maintenance on-field canals			**(2,232)**	**44**	**1,309**	**2,551**	**3,817**	**3,817**	**3,817**	**3,782**	**3,782**	**3,782**

APPENDIX B 1.2-1 BEANS (DRY) FINANCIAL PRICES - WITHOUT PROJECT

Beans				
Details	**UNIT NO.**	**QUANTITY**	**UNIT PRICE**	**TOTAL PRICE**
REVENUE:				
Sales	t	**1.00**	746.27	746.27
Gross Revenue/ha				**746.27**
Costs USD/ha				
INPUTS				
Seed	kg	100	2.49	249.25
Sub-total				**249.25**
LABOUR (mandays/ha)				
Clearing	ld	20.0	0.00	0.00
Ridging	ld	22.0	0.00	0.00
Planting	ld	15.0	0.00	0.00
Gap filling	ld	3.0	0.00	0.00
First weeding	ld	10.0	0.00	0.00
Second weeding	ld	8.0	0.00	0.00
Banking	ld	5.0	0.00	0.00
Harvesting	ld	28.6	0.00	0.00
Stripping/threshing	ld	22.9	0.00	0.00
Drying	ld	7.1	0.00	0.00
Winnowing/Grading	ld	5.7	0.00	0.00
Packaging	ld	5.7	0.00	0.00
Loading	ld	2.9	0.00	0.00
Total mandays		**155.9**		**0.00**
POST-HARVEST COSTS				
Packaging materials		17.14	0.30	5.12
Sub-total				**5.12**
Grand total costs USD/ha				**254.37**
Gross Margin (USD/ha)				**491.90**

APPENDIX B 1.2-2 BEANS (DRY) FINANCIAL PRICES - WITH PROJECT

			1		2		3		4		5	
Inputs/outputs	**Unit**	**US$/unit**	**Quantity /ha**	**Subtotal US$/ha**	**Quantity /ha**	**Subtotal US$/ha**	**Quantity /ha**	**Subtotal US$/ha**	**Quantity /ha**	**Subtotal US$/ha**	**Quantity /ha**	**Subtotal US$/ha**
Yield												
- Local sales	t/ha	1,044.78	1.50	1,567.16	1.83	1,911.94	2.17	2,267.16	2.50	2,611.94	2.50	2,611.94
			60%								100%	
Gross crop revenue per ha	USD/ha			1,567.16								2,611.94
Seed	kg	2.49	100.00	249.25	100.00	249.25	100.00	249.25	100.00	249.25	100	249.25
Fertilizer				287.16		287.16		287.16		287.16		287.16
- cpd 23:21:0 + 4S	kg	0.73	300.00	218.96	300.00	218.96	300.00	218.96	300.00	218.96	300	218.96
- CAN	kg	0.67	100.00	67.46	100.00	67.46	100.00	67.46	100.00	67.46	100	67.46
- transport		1.86	400.00	0.74	400.00	0.74	400.00	0.74	400.00	0.74	400	0.74
Chemicals				26.88		26.88		26.88		26.88		26.88
- dimethoate	l	8.21	0.80	6.57	0.80	6.57	0.80	6.57	0.80	6.57	0.80	6.57
- dual	l	17.67	1.15	20.32	1.15	20.32	1.15	20.32	1.15	20.32	1.15	20.32
Labour	ld	1.34	134.00	180	134	180	134	180	134	180	134	180
Tillage (Fuels & Oils)	l	1.61	70	112.83	70.00	112.83	70.00	112.83	70.00	112.83	70	112.83
Water cost	ml	8.60	14.68	126.23	14.68	126.23	14.68	126.23	14.68	126.23	14.68	126.23
	fixed (USD)	100		100		100		100		100		100
	USD			**226.23**		**226.23**		**226.23**		**226.23**		**226.23**
Production costs per ha				**1,369.52**		**1,369.52**		**1,369.52**		**1,369.52**		**1,369.52**
Packaging				12.99		15.84		18.79		21.64		21.64
- bags	no.	0.30	8.96	8.96	10.93	10.93	12.96	12.96	14.93	14.93	50	14.93
- labour	ld	1.34	4.03	4.03	4.92	4.92	5.83	5.83	6.72	6.72	5	6.72
Sundry	% vc		1%	13.83	1%	13.85	1%	13.88	1%	13.91	1%	13.91
Total variable costs	**USD/ha**			**1,396**		**1,399**		**1,402**		**1,405**		**1,405**
Gross margin	**USD/ha**			**171**		**513**		**865**		**1,207**		**1,207**
Cost maintenance on-field canals (USD/ha)				34		34		34		34		34
GM after deduction of cost maintenance on-field canals				**136**		**478**		**830**		**1,172**		**1,172**

APPENDIX B 1.2-3 BEANS (DRY) ECONOMIC– WITHOUT PROJECT

Details	UNIT NO.	QUANTITY	UNIT PRICE	TOTAL PRI
REVENUE:				
Sales	t	1.00	746.27	746.27
Gross Revenue/ha				**746.27**
Costs USD/ha				
INPUTS				
Seed	kg	100	2.39	239.28
Sub-total				**239.28**
LABOUR (mandays/ha)				
Clearing	ld	20.0	0.67	13.40
Ridging	ld	22.0	0.67	14.74
Planting	ld	15.0	0.67	10.05
Gap filling	ld	3.0	0.67	2.01
First weeding	ld	10.0	0.67	6.70
Second weeding	ld	8.0	0.67	5.36
Banking	ld	5.0	0.67	3.35
Harvesting	ld	28.6	0.67	19.14
Stripping/threshing	ld	22.9	0.67	15.31
Drying	ld	7.1	0.67	4.79
Winnowing/Grading	ld	5.7	0.67	3.83
Packaging	ld	5.7	0.67	3.83
Loading	ld	2.9	0.67	1.91
Total mandays		155.9		**104.42**
POST-HARVEST COSTS				
Packaging materials		12	0.30	3.58
Sub-total				**3.58**
Grand total costs USD/ha				**347.29**
Gross Margin (USD/ha)				**398.98**

APPENDIX B 1.2-4 BEANS (DRY) ECONOMIC – WITH PROJECT

			1		2		3		4		5	
Inputs/outputs	**Unit**	**US$/unit**	**Quantity /ha**	**Subtotal US$/ha**	**Quantity /ha**	**Subtotal US$/ha**	**Quantity /ha**	**Subtotal US$/ha**	**Quantity /ha**	**Subtotal US$/ha**	**Quantity /ha**	**Subtotal US$/ha**
Yield												
- Local sales	t/ha	1,044.78	1.50	1,567.16	1.83	1,911.94	2.17	2,267.16	2.50	2,611.94	2.50	2,611.94
Gross crop revenue per ha	USD/ha			1,567.16		1,911.94		2,267.16		2,611.94		2,611.94
Seed	kg	2.39	100.00	239.28	100.00	239.28	100.00	239.28	100.00	239.28	100.00	239.28
Fertilizer				210.94		210.94		210.94		210.94		210.94
- cpd 23:21:0 + 4S	kg	0.70	300.00	210.20	300.00	210.20	300.00	210.20	300.00	210.20	300.00	210.20
- CAN	kg	0.00	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
- transport		1.86	400.00	0.74	400.00	0.74	400.00	0.74	400.00	0.74	400.00	0.74
Chemicals				25.81		25.81		25.81		25.81		25.81
- dimethoate	l	7.88	0.80	6.30	0.80	6.30	0.80	6.30	0.80	6.30	0.80	6.30
- dual	l	16.96	1.15	19.50	1.15	19.50	1.15	19.50	1.15	19.50	1.15	19.50
Labour	ld	0.67	134	90	134	90	134	90	134	90	134	90
Tillage (Fuels & Oils)	l	1.55	70.00	108.32	70.00	108.32	70.00	108.32	70.00	108.32	70.00	108.32
Water cost	ml	8.60	14.68	126.23	14.68	126.23	14.68	126.23	14.68	126.23	14.68	126.23
	fixed (USD)	100		100		100		100		100		100
	USD			**226.23**		**226.23**		**226.23**		**226.23**		**226.23**
Production costs per ha				**800.36**		**800.36**		**800.36**		**800.36**		**800.36**
Packaging			0.00	5.37	0.00	6.56	0.00	7.77	0.00	18.28	0.00	18.28
- bags	no.	0.30	8.96	2.67	10.93	3.26	12.96	3.87	14.93	14.93	50.00	14.93
- labour	ld	0.67	4.03	2.70	4.92	3.29	5.83	3.91	6.72	3.35	5.00	3.35
Sundry	% vc		1%	8.06	1%	8.07	1%	8.08	1%	8.19	1%	8.19
Total variable costs	**USD/ha**			**814**		**815**		**816**		**827**		**827**
Gross margin	**USD/ha**			**753**		**1,097**		**1,451**		**1,785**		**1,785**
Cost maintenance on-field canals (USD/ha)				28		28		28		28		28
GM after deduction of cost maintenance on-field canals				**725**		**1,069**		**1,423**		**1,757**		**1,757**

APPENDIX B 1.3-1 CASSAVA FINANCIAL PRICES WITHOUT PROJECT

Details	UNIT	QUANTITY	UNIT PRICE	Total
REVENUE:				
Yield	kg/ha	2,000	0.1452	290.45
Gross Revenue/ha				**290.45**
Costs USD/ha				
INPUTS				
Seed-cuttings		400	0.22	89.55
Cypermethrin	Sacks	279	0.01	2.17
Sub-total				**91.72**
Land Clearing	Mandays	5	0.00	0.00
Ridging	Mandays	8	0.00	0.00
Planting	Mandays	5	0.00	0.00
Weeding	Mandays	6	0.00	0.00
Grating	Mandays	15	0.00	0.00
Drying	Mandays	18	0.00	0.00
Sub-Total		**57.00**		**0.00**
Total Variable Costs				**91.72**
Gross Margin (USD/ha)				**198.73**

APPENDIX B 1.3-2 CASSAVA ECONOMIC PRICES WITHOUT PROJECT

Gross Margin Analysis - Cassava (dry)

Details	UNIT	QUANTITY	UNIT PRICE	Total
REVENUE:				
Yield	kg/ha	2,000	0.145	290.45
Gross Revenue/ha				**290.45**
Costs USD/ha				
INPUTS				
Seed-cuttings		400	0.21	85.97
Cypermethrin	Sacks	279	0.01	2.08
Sub-total				**88.05**
Land Clearing	Mandays	5	0.67	3.36
Ridging	Mandays	8	0.67	5.37
Planting	Mandays	5	0.67	3.36
Weeding	Mandays	6	0.67	4.03
Grating	Mandays	15	0.67	10.07
Drying	Mandays	18	0.67	12.09
Sub-Total		**57.00**		**38.28**
Total Variable Costs				**126.33**
Gross Margin (USD/ha)				**164.12**

APPENDIX B 1.4.-1CITRUS FINANCIAL PRICES

YEAR			1	2	3	4	5	6	7	8	9	10
	UNIT	UD$/UNIT										
YIELD	kg/tree		-	-	-	16	25	36	49	66	82	91
TREES	No./ha		385	385	385	385	385	385	385	385	385	385
TOTAL YIELD	kg/ha		-	-	-	6,006	9,510	14,014	19,019	25,526	31,532	35,035
Yield - processing	kg/ha	0.50	-	-	-	3,003	4,755	7,007	9,510	12,763	15,766	17,518
Yield - export	kg/ha	0.50	-	-	-	3,003	4,755	7,007	9,510	12,763	15,766	17,518
Revenue - processing	USD/kg	0.37	-	-	-	1,121	1,774	2,615	3,548	4,762	5,883	6,536
Revenue- export	USD/kg	0.45	-	-	-	1,345	2,129	3,137	4,258	5,715	7,059	7,844
GROSS REVENUE	**USD/ha**		**0**	**0**	**0**	**2465.15**	**3903.15**	**5752.01**	**7806.31**	**10476.88**	**12942.03**	**14380.04**
SEEDLINGS	**385**	**0.13**	**48.84**									
CHEMICALS												
- zinc oxide	kg	5.47	0.19	0.42	0.81	2.00	2.00	2.00	2.00	4.11	4.11	4.11
- manganese sulphate	kg	10.53	0.19	0.42	0.81	2.00	2.00	2.00	2.00	4.11	4.11	4.11
- copper oxychloride	kg	10.49	0.19	0.42	0.81	2.00	2.00	2.00	2.00	4.11	4.11	4.11
- solubor	kg	1.78	0.13	0.28	0.54	1.30	1.30	1.30	1.30	2.74	2.74	2.74
- sulphur w.p.	kg	5.24	0.26	0.52	1.04	2.57	2.57	2.57	2.57	5.27	5.27	5.27
- benomyl 50% w.p.	kg	12.05				0.14	0.14	0.14	0.14	0.29	0.29	0.29
- chlorpyrifos 48% e.c.	l	8.54	0.01	0.02	0.05	-	-	-	-	-	-	-
miscellaneous/allowances			300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00
SUBTOTAL	**USD**		**306.71**	**314.52**	**328.29**	**370.44**	**370.44**	**370.44**	**370.44**	**444.84**	**444.84**	**444.84**
FERTILIZER												
- ammonium nitrate	kg/tree	0.67	0.20	0.40	0.60	0.80	0.80	1.00	1.00	1.00	1.00	1.00
- lime	kg/tree	0.30	0.75									
- potassium chloride	kg/tree	0.69	0.05	0.05	0.10	0.50	1.00	1.50	1.50	1.50	1.50	1.50
- single superphosphate	kg/tree	0.46	1.15	0.25	0.25	0.35	0.35	0.50	0.50	0.50	0.50	0.50
total	**kg/ha**		**2.15**	**0.70**	**0.95**	**1.65**	**2.15**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
No. of TREES	number		385.00	385.00	385.00	385.00	385.00	385.00	385.00	385.00	385.00	385.00
Total fertiliser	kg		827.75	269.50	365.75	635.25	827.75	1,155.00	1,155.00	1,155.00	1,155.00	1,155.00
Fertiliser transport	t/km	1.86	**1.54**	**0.50**	**0.68**	**1.18**	**1.54**	**2.15**	**2.15**	**2.15**	**2.15**	**2.15**
SUBTOTAL	**USD**		**355**	**161**	**227**	**403**	**535**	**746**	**746**	**746**	**746**	**746**
TILLAGE												
Rip	l	1.61	22.00									
Plough	l	1.61	20.00									
Disc	l	1.61	10.00									
Slashing	l	1.61	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Tillage plus slashing cost	**USD**		**88.65**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**
SMALL TOOLS			2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16
LABOUR			**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**
Maintenance plus harvesting	ld	1.34	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00
IRRIGATION WATER	ml	8.60	12.40	12.40	12.40	12.40	12.40	12.40	12.40	12.40	12.40	12.40
	fixed (USD)		100	100	100	100	100	100	100	100	100	100
Cost	**USD/ha**		**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**
VARIABLECOST	**USD/ha**		**1,368**	**1,050**	**1,129**	**1,347**	**1,480**	**1,691**	**1,691**	**1,765**	**1,765**	**1,765**
SUANDRY @1% OF VC		0.01	14	11	11	13	15	17	17	18	18	18
TOTAL VARIABLE COST	**USD/ha**		**1,382**	**1,061**	**1,141**	**1,361**	**1,494**	**1,708**	**1,708**	**1,783**	**1,783**	**1,783**
GROSS MARGIN	**USD/ha**		**(1,382)**	**(1,061)**	**(1,141)**	**1,105**	**2,409**	**4,044**	**6,099**	**8,694**	**11,159**	**12,597**
Cost maintenance on-field canals (USD/ha)			34	34	34	34	34	34	34	34	34	34
GM after deduction of cost maintenance on-field canals			**(1,382)**	**(1,061)**	**(1,175)**	**1,070**	**2,374**	**4,010**	**6,064**	**8,660**	**11,125**	**12,563**

YEAR	11	12	13	14	15	16	17	18	19	20
YIELD	101	111	121	126	130	130	130	130	130	130
TREES	385	385	385	385	385	385	385	385	385	385
TOTAL YIELD	39,039	42,543	46,547	48,549	50,050	50,050	50,050	50,050	50,050	50,050
Yield - processing	19,520	21,271	23,273	24,274	25,025	25,025	25,025	25,025	25,025	25,025
Yield - export	19,520	21,271	23,273	24,274	25,025	25,025	25,025	25,025	25,025	25,025
Revenue - processing	7,283	7,937	8,684	9,058	9,338	9,338	9,338	9,338	9,338	9,338
Revenue- export	8,740	9,524	10,421	10,869	11,205	11,205	11,205	11,205	11,205	11,205
GROSS REVENUE	**16023.47**	**17461.47**	**19104.91**	**19926.62**	**20542.91**	**20542.91**	**20542.91**	**20542.91**	**20542.91**	**20542.91**
SEEDLINGS										
CHEMICALS										
- zinc oxide	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11
- manganese sulphate	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11
- copper oxychloride	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11
- solubor	2.74	2.74	2.74	2.74	2.74	2.74	2.74	2.74	2.74	2.74
- sulphur w.p.	5.27	5.27	5.27	5.27	5.27	5.27	5.27	5.27	5.27	5.27
- benomyl 50% w.p.	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
- chlorpyrifos 48% e.c.	-	-	-	-	-	-	-	-	-	-
miscellaneous/allowances	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00
SUBTOTAL	**444.84**	**444.84**	**444.84**	**444.84**	**444.84**	**444.84**	**444.84**	**444.84**	**444.84**	**444.84**
FERTILIZER										
- ammonium nitrate	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
- lime										
- potassium chloride	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
- single superphosphate	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
total	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
No. of TREES	385.00	385.00	385.00	385.00	385.00	385.00	385.00	385.00	385.00	385.00
Total fertiliser	1,155.00	1,155.00	1,155.00	1,155.00	1,155.00	1,155.00	1,155.00	1,155.00	1,155.00	1,155.00
Fertiliser transport	**2.15**	**2.15**	**2.15**	**2.15**	**2.15**	**2.15**	**2.15**	**2.15**	**2.15**	**2.15**
SUBTOTAL	**746**	**746**	**746**	**746**	**746**	**746**	**746**	**746**	**746**	**746**
TILLAGE										
Rip										
Plough										
Disc										
Slashing	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Tillage plus slashing cost	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**
SMALL TOOLS	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16
LABOUR	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**
Maintenance plus harvesting	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00
IRRIGATION WATER	12.40	12.40	12.40	12.40	12.40	12.40	12.40	12.40	12.40	12.40
	100	100	100	100	100	100	100	100	100	100
Cost	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**
VARIABLECOST	**1,765**	**1,765**	**1,765**	**1,765**	**1,765**	**1,765**	**1,765**	**1,765**	**1,765**	**1,765**
SUANDRY @1% OF VC	18	18	18	18	18	18	18	18	18	18
TOTAL VARIABLE COST	**1,783**	**1,783**	**1,783**	**1,783**	**1,783**	**1,783**	**1,783**	**1,783**	**1,783**	**1,783**
GROSS MARGIN	**14,241**	**15,679**	**17,322**	**18,144**	**18,760**	**18,760**	**18,760**	**18,760**	**18,760**	**18,760**
Cost maintenance on-field can	34	34	34	34	34	34	34	34	34	34
GM after deduction of cost n	**14,206**	**15,644**	**17,288**	**18,109**	**18,726**	**18,726**	**18,726**	**18,726**	**18,726**	**18,726**

APPENDIX B 1.4-2 - CITRUS ECONOMIC PRICES - WITH PROJECT

YEAR			1	2	3	4	5	6	7	8	9	10
	UNIT	UD$/UNIT										
YIELD	kg/tree		-	-	-	16	25	36	49	66	82	91
TREES	No./ha		385	385	385	385	385	385	385	385	385	385
TOTAL YIELD	kg/ha		-	-	-	6,006	9,510	14,014	19,019	25,526	31,532	35,035
Yield - processing	kg/ha	0.50	-	-	-	3,003	4,755	7,007	9,510	12,763	15,766	17,518
Yield - export	kg/ha	0.50	-	-	-	3,003	4,755	7,007	9,510	12,763	15,766	17,518
Revenue - processing	USD/kg	0.37	-	-	-	1,121	1,774	2,615	3,548	4,762	5,883	6,536
Revenue- export	USD/kg	0.45	-	-	-	1,345	2,129	3,137	4,258	5,715	7,059	7,844
GROSS REVENUE	**USD/ha**		**0**	**0**	**0**	**2465.15**	**3903.15**	**5752.01**	**7806.31**	**10476.88**	**12942.03**	**14380.04**
SEEDLINGS	**385**	0.12	**46.89**									
CHEMICALS												
- zinc oxide	kg	5.25	0.19	0.42	0.81	2.00	2.00	2.00	2.00	4.11	4.11	4.11
- manganese sulphate	kg	10.10	0.19	0.42	0.81	2.00	2.00	2.00	2.00	4.11	4.11	4.11
- copper oxychloride	kg	10.07	0.19	0.42	0.81	2.00	2.00	2.00	2.00	4.11	4.11	4.11
- solubor	kg	1.71	0.13	0.28	0.54	1.30	1.30	1.30	1.30	2.74	2.74	2.74
- sulphur w.p.	kg	5.03	0.26	0.52	1.04	2.57	2.57	2.57	2.57	5.27	5.27	5.27
- benomyl 50% w.p.	kg	11.57				0.14	0.14	0.14	0.14	0.29	0.29	0.29
- chlorpyrifos 48% e.c.	l	8.19	0.01	0.02	0.05	-	-	-	-	-	-	-
miscellaneous/allowances			300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00
SUBTOTAL	**USD**		**306.44**	**313.94**	**327.16**	**367.62**	**367.62**	**367.62**	**367.62**	**439.05**	**439.05**	**439.05**
FERTILIZER												
- ammonium nitrate	kg/tree	0.65	0.20	0.40	0.60	0.80	0.80	1.00	1.00	1.00	1.00	1.00
- lime	kg/tree	0.29	0.75									
- potassium chloride	kg/tree	0.51	0.05	0.05	0.10	0.50	1.00	1.50	1.50	1.50	1.50	1.50
- single superphosphate	kg/tree	0.44	1.15	0.25	0.25	0.35	0.35	0.50	0.50	0.50	0.50	0.50
total	**kg/ha**		**2.15**	**0.70**	**0.95**	**1.65**	**2.15**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
No. of TREES	number		385.00	385.00	385.00	385.00	385.00	385.00	385.00	385.00	385.00	385.00
Total fertiliser	kg		827.75	269.50	365.75	635.25	827.75	1,155.00	1,155.00	1,155.00	1,155.00	1,155.00
Fertiliser transport	t/km	1.86	1.54	0.50	0.68	1.18	1.54	2.15	2.15	2.15	2.15	2.15
SUBTOTAL	**USD**		**338**	**152**	**212**	**358**	**457**	**631**	**631**	**631**	**631**	**631**
TILLAGE												
Rip	l	1.61	22.00									
Plough	l	1.61	20.00									
Disc	l	1.61	10.00									
Slashing	l	1.61	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Tillage plus slashing cost	**USD**		**88.65**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**
SMALL TOOLS			2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16
LABOUR			**181.34**	**181.34**	**181.34**	**181.34**	**181.34**	**181.34**	**181.34**	**181.34**	**181.34**	**181.34**
Maintenance plus harvesting	ld	0.67	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00
IRRIGATION WATER	ml	8.60	12.40	12.40	12.40	12.40	12.40	12.40	12.40	12.40	12.40	12.40
	fixed (USD)		100	100	100	100	100	100	100	100	100	100
Cost	**USD/ha**		**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**
VARIABLECOST	**USD/ha**		**1,168**	**859**	**932**	**1,119**	**1,218**	**1,392**	**1,392**	**1,463**	**1,463**	**1,463**
SUANDRY @1% OF VC		0.01	12	9	9	11	12	14	14	15	15	15
TOTAL VARIABLE COST	**USD/ha**		**1,179**	**868**	**941**	**1,130**	**1,230**	**1,406**	**1,406**	**1,478**	**1,478**	**1,478**
GROSS MARGIN	**USD/ha**		**(1,179)**	**(868)**	**(941)**	**1,335**	**2,673**	**4,346**	**6,401**	**8,999**	**11,464**	**12,902**
Cost maintenance on-field canals (USD/ha)			28	28	28	28	28	28	28	28	28	28
GM after deduction of cost maintenance on-field canals			**(1,208)**	**(896)**	**(970)**	**1,307**	**2,645**	**4,318**	**6,372**	**8,971**	**11,436**	**12,874**

YEAR	11	12	13	14	15	16	17	18	19	20
YIELD	101	111	121	126	130	130	130	130	130	130
TREES	385	385	385	385	385	385	385	385	385	385
TOTAL YIELD	39,039	42,543	46,547	48,549	50,050	50,050	50,050	50,050	50,050	50,050
Yield - processing	19,520	21,271	23,273	24,274	25,025	25,025	25,025	25,025	25,025	25,025
Yield - export	19,520	21,271	23,273	24,274	25,025	25,025	25,025	25,025	25,025	25,025
Revenue - processing	7,283	7,937	8,684	9,058	9,338	9,338	9,338	9,338	9,338	9,338
Revenue- export	8,740	9,524	10,421	10,869	11,205	11,205	11,205	11,205	11,205	11,205
GROSS REVENUE	**16023.47**	**17461.47**	**19104.91**	**19926.62**	**20542.91**	**20542.91**	**20542.91**	**20542.91**	**20542.91**	**20542.91**
SEEDLINGS										
CHEMICALS										
- zinc oxide	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11
- manganese sulphate	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11
- copper oxychloride	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11	4.11
- solubor	2.74	2.74	2.74	2.74	2.74	2.74	2.74	2.74	2.74	2.74
- sulphur w.p.	5.27	5.27	5.27	5.27	5.27	5.27	5.27	5.27	5.27	5.27
- benomyl 50% w.p.	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
- chlorpyrifos 48% e.c.	-	-	-	-	-	-	-	-	-	-
miscellaneous/allowances	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00
SUBTOTAL	**439.05**	**439.05**	**439.05**	**439.05**	**439.05**	**439.05**	**439.05**	**439.05**	**439.05**	**439.05**
FERTILIZER										
- ammonium nitrate	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
- lime										
- potassium chloride	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
- single superphosphate	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
total	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**
No. of TREES	385.00	385.00	385.00	385.00	385.00	385.00	385.00	385.00	385.00	385.00
Total fertiliser	1,155.00	1,155.00	1,155.00	1,155.00	1,155.00	1,155.00	1,155.00	1,155.00	1,155.00	1,155.00
Fertiliser transport	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15
SUBTOTAL	**631**	**631**	**631**	**631**	**631**	**631**	**631**	**631**	**631**	**631**
TILLAGE										
Rip										
Plough										
Disc										
Slashing	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Tillage plus slashing cost	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**
SMALL TOOLS	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16
LABOUR	**181.34**	**181.34**	**181.34**	**181.34**	**181.34**	**181.34**	**181.34**	**181.34**	**181.34**	**181.34**
Maintenance plus harvesting	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00
IRRIGATION WATER	12.40	12.40	12.40	12.40	12.40	12.40	12.40	12.40	12.40	12.40
	100	100	100	100	100	100	100	100	100	100
Cost	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**	**206.64**
VARIABLECOST	**1,463**	**1,463**	**1,463**	**1,463**	**1,463**	**1,463**	**1,463**	**1,463**	**1,463**	**1,463**
SUANDRY @1% OF VC	15	15	15	15	15	15	15	15	15	15
TOTAL VARIABLE COST	**1,478**	**1,478**	**1,478**	**1,478**	**1,478**	**1,478**	**1,478**	**1,478**	**1,478**	**1,478**
GROSS MARGIN	**14,546**	**15,984**	**17,627**	**18,449**	**19,065**	**19,065**	**19,065**	**19,065**	**19,065**	**19,065**
Cost maintenance on-field cana	28	28	28	28	28	28	28	28	28	28
GM after deduction of cost ma	**14,517**	**15,955**	**17,599**	**18,421**	**19,037**	**19,037**	**19,037**	**19,037**	**19,037**	**19,037**

APPENDIX B 1.5-1COTTON FINANCIAL PRICES WITHOUT PROJECT

Details/Crops	UNIT	QUANTITY	UNIT PRICE	Total
REVENUE:				
Yield	kg/ha	900	0.45	402.99
Gross Revenue (USD/ha)				**402.99**
Costs USD/ha				
INPUTS				
Seed		24.5	1.79	43.96
Pesticides				
Cypermethrin	Bottles	3.3	1.79	5.86
Dimethoate 40 EC	Bottles	3.3	1.79	5.86
Sprayer Hiring		1.0	15.00	15.00
Sub-total				**70.69**
Land Clearing	Mandays	22.0	0.00	0.00
Ridging	Mandays	22.0	0.00	0.00
Planting	Mandays	17.0	0.00	0.00
Thining	Mandays	12.0	0.00	0.00
Supplying (gap filling)	Mandays	1.0	0.00	0.00
Weeding	Mandays	45.0	0.00	0.00
Pesticides Application	Mandays	15.0	0.00	0.00
Scouting	Mandays	6.5	0.00	0.00
Picking and baling	Mandays	18.8	0.00	0.00
Picking bags	No	4.1	5.00	20.45
Sub-Total		**163.45**		**20.45**
Total Variable Costs				**91.14**
Gross Margin (USD/ha)				**311.84**

APPENDIX B 1.5-2 COTTON FINANCIAL PRICES – WITH PROJECT

		Year	1		2		3		4		5	
Inputs/outputs	**Unit**	**USD/unit**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**
Crop management input												
Yield												
- Local sales	kg/ha	0.45	4,000	1,791	5,000.00	2,239	6,000	2,687	7,000	3,134	7,000	3,134
Gross crop revenue per ha	USD/ha			1,791		2,239		2,687		3,134		3,134
Seed	kg	1.79	30	54	30	54	30	54	30	54	30	53.7
Fertilizer				163		163		163	0	163	0	163
- DAP	kg	1.06	100	106	100	106	100	106	100	106	100	106
- Sulphate of ammonia	kg	0.57	100	57	100	57	100	57	100	57	100	57
- transport				0		0		0	0	0	0	0
Chemicals				41		41		41	0	41	0	41
- carbaryl	kg	13.43	1	13	1	13	1	13	1	13	1	13
- karate	l	14.69	1	9	1	9	0.63	9	0.63	9	0.63	9
- dimethoate	l	8.21	1	7	1	7	0.85	7	0.85	7	0.85	7
- cypermethrine	ml	0.01	1,500	12	1,500	12	1,500	12	1,500	12	1,500	12
Labour	ld	1.34	90	121	90	121	90	121	90	121	90	121
Tillage (Fuels & Oils)	l	1.61	70	113	70	113	70	113	70	113	70	113
Cost of water	ml	8.60	10.36	89.06	10.36	89	10.36	89	10.356	89	10.356	89
	fixed (USD)	100		100		100		100		100		100
	USD			**189**		**189**		**189**		**189**		**189**
Production costs per ha				680		680		680	0	680	0	680
Packaging				12		15		19	0	19	0	19
- bags	no.	0.30	29	9	36	11	43	13	50	13	50	13
- labour	ld	1.3	2.86	4	3.57	5	4.29	6	5	6	5	6
Sundry	% vc		1%	7	1%	7	1%	7	1%	7	1%	7
Total variable costs	**USD/ha**			**700**		**703**		**706**		**706**		**706**
Gross margin	**USD/ha**			**1,091**		**1,536**		**1,981**		**2,428**		**2,428**
Cost maintenance on-field canals (USD/ha)				34		34		34		34		34
GM after deduction of cost maintenance on-field canals				**1,057**		**1,501**		**1,946**		**2,394**		**2,394**

APPENDIX B 1.5-2 COTTONECONOMIC PRICES–WITHOUT PROJECT

Details/Crops	UNIT	QUANTITY	UNIT PRICE	Total
REVENUE:				
Yield	kg/ha	900	0.45	402.99
Gross Revenue (USD/ha)				**402.99**
Costs USD/ha				
INPUTS				
Seed		24.5	1.72	42.20
Pesticides				
Cypermethrin	Bottles	3.3	1.72	5.63
Dimethoate 40 EC	Bottles	3.3	1.72	5.63
Sprayer Hiring		1.0	15.00	15.00
Sub-total				**68.46**
Land Clearing	Mandays	22.0	0.67	14.74
Ridging	Mandays	22.0	0.67	14.74
Planting	Mandays	17.0	0.67	11.39
Thining	Mandays	12.0	0.67	8.04
Supplying (gap filling)	Mandays	1.0	0.67	0.67
Weeding	Mandays	45.0	0.67	30.15
Pesticides Application	Mandays	15.0	0.67	10.05
Scouting	Mandays	6.5	0.67	4.39
Picking and baling	Mandays	18.8	0.67	12.61
Picking bags	No	4.1	5.00	20.45
Sub-Total		**163.45**		**127.23**
Total Variable Costs				**195.69**
Gross Margin (USD/ha)				**207.30**

APPENDIX B 1.5-2 COTTON ECONOMIC PRICES – WITH PROJECT

Inputs/outputs	Unit	USD/unit	Quantity /ha	Subtotal USD/ha	Quantity /ha	Subtotal USD/ha	Quantity /ha	Subtotal USD/ha	Quantity /ha	Subtotal USD/ha	Quantity /ha	Subtotal USD/ha
Crop management input												
Yield												
- Local sales	kg/ha	0	4,000	1,791	5,000	2,239	6,000	2,687	7,000	3,134	7,000	3,134
Gross crop revenue per ha	USD/ha			1,791		2,239		2,687		3,134		3,134
Seed	kg	1.72	30	52	30	52	30	52	30	52	30	52
Fertilizer				101		101		101		101		101
- DAP	kg	0.51	100	51	100	51	100	51	100	51	100	51
- Sulphate of ammonia	kg	0.51	100	51	100	51	100	51	100	51	100	51
- transport				0		0		0		0		0
Chemicals				40		40		40		40		40
- carbaryl	kg	12.90	1	13	1	13	1	13	1	13	1	13
- karate	l	14.10	0.625	9	0.625	9	0.625	9	0.625	9	0.625	9
- dimethoate	l	7.88	0.85	7	0.85	7	0.85	7	0.85	7	0.85	7
- cypermethrine	ml	0.01	1500	11	1500	11	1500	11	1500	11	1500	11
Labour	ld	0.67	90	60	90	60	90	121	90	121	90	121
Tillage (Fuels & Oils)	l	1.55	70	108	70	108	70	108	70	108	70	108
Cost of water	ml	8.60	10.36	89.06	10.36	89	10.36	89	10.36	89	10.36	89
	fixed (USD)	100.00		100		100		100		100		100
	USD			**189**		**189**		**189**		**189**		**189**
Production costs per ha				450	0	450		511		511		511
Packaging				12		11		16	0	18	0	18
- bags	no.	0.30	28.6	9	35.7	11	42.9	13	50	15	50	15
- labour	ld	0.67	5	3		0	5	3	5	3	5	3
					0							
Sundry	% vc		1%	5		0	1%	5	0	5	0	5
Total variable costs	**USD/ha**			**467**		**461**		**532**		**534**		**534**
Gross margin	**USD/ha**			**1,324**	0.0	**1,778**		**2,154**		**2,600**		**2,600**
Cost maintenance on-field canals (USD/ha)				28		28		28		28		28
GM after deduction of cost maintenance on-field canals				**1,296**		**1,750**		**2,126**		**2,572**		**2,572**

APPENDIX B 1.6-1COW PEAS FINANCIAL PRICES WITHOUT PROJECT

Details	UNIT NO.	QUANTITY	UNIT PRICE	TOTAL PRICE
REVENUE:				
Sales	kg	400	0.17058	68.23
Gross Revenue	**USD**			**68.23**
Costs USD/ha				
INPUTS				
Seed	kg	2.9	2.69	7.82
Carbaryl	kg	0.2	13.43	2.44
Cypermethrin	ml	181.8	0.01	1.41
Daconil	l	0.2	10.26	1.87
Storage pesticide	kg	0.2	11.17	2.03
Sub-total				**15.57**
LABOUR (mandays/ha)				
Clearing	ld	10.0	0.00	0.00
Ridging	ld	15.0	0.00	0.00
Planting	ld	10.0	0.00	0.00
First weeding	ld	10.0	0.00	0.00
Second weeding	ld	8.0	0.00	0.00
Pest and disease control	ld	5.0	0.00	0.00
Harvesting	ld	1.8	0.00	0.00
Threshing	ld	1.8	0.00	0.00
Drying	ld	0.5	0.00	0.00
Grading	ld	0.4	0.00	0.00
Packaging	ld	0.7	0.00	0.00
Total mandays		**63.27**		**0.00**
Cost of water	ML	8.60	0.00	0.00
POST-HARVEST COSTS				
Packaging materials	t	0.073	0.30	0.02
Sub-total				**0.02**
Grand total costs USD/ha				**15.59**
Gross Margin (USD/ha)				**52.64**

APPENDIX B 1.6-2 COW PEAS ECONOMIC PRICES –WITHOUT PROJECT

Details	UNIT NO.	QUANTITY	UNIT PRICE	TOTAL PRICE
REVENUE:				
Sales	kg	400	0.17058	68.23
Gross Revenue	**USD**			**68.23**
Costs USD/ha				
INPUTS				
Seed	kg	2.9	2.58	7.50
Carbaryl	kg	0.2	12.90	2.34
Cypermethrin	ml	181.8	0.01	1.35
Daconil	l	0.2	9.85	1.79
Storage pesticide	kg	0.2	10.72	1.95
Sub-total				**14.94**
LABOUR (mandays/ha)				
Clearing	ld	10	0.67	6.70
Ridging	ld	15.0	0.67	10.05
Planting	ld	10.0	0.67	6.70
First weeding	ld	10.0	0.67	6.70
Second weeding	ld	8.0	0.67	5.36
Pest and disease control	ld	5.0	0.67	3.35
Harvesting	ld	1.8	0.67	1.22
Threshing	ld	1.8	0.67	1.22
Drying	ld	0.5	0.67	0.37
Grading	ld	0.4	0.67	0.24
Packaging	ld	0.7	0.67	0.49
Total mandays		**63.27272727**		**42.39**
Cost of water	ML	8.60	0.00	0.00
POST-HARVEST COSTS				
Packaging materials	t	0.4	0.30	0.12
Sub-total				**0.12**
Grand total costs USD/ha				**57.45**
Gross Margin (USD/ha)				**10.78**

APPENDIX B 1.7-1MAIZEFINANCIAL PRICE WITHOUT PROJECT

Details	Unit	Quantity	Unit Price (USD)	Total
Revenue				
Yield	kg/ha	720	0.237270789	170.83
Total Revenue/ha				**170.83**
Cost of Production				
Inputs				
Seed	kg	5	2.61	13.43
Fertilizer (basal dressing)	kg	72	0.86	61.68
Fertilizer (top dressing)	kg	62	0.67	41.63
Storage pesticides	kg	0.50	11.17	5.59
Subtotal				**122.34**
Activity	**Mandays**			
Land clearing	ld	10.0	0.00	-
Ridging	ld	20.0	-	-
Planting	ld	12.5	-	-
Fertilizer applic	ld	15.0	-	-
Thinning	ld	3.0	-	-
Banking	ld	20.0	-	-
Stooking	ld	10.0	-	-
Harvesting	ld	3.1	-	-
Shelling	ld	2.6	-	-
Winnowing	ld	0.4	-	-
Bagging	ld	0.2	-	-
Sub total		**96.8**		**-**
Bagging materials	bags	3	1.86	5.50
Sub total				**5.50**
Total cost of production				**127.84**
Gross Margin (USD/ha)				**43.00**

APPENDIX B 1.7-2 MAIZE FINANCIAL PRICE WITH PROJECT

		YEAR	1		2		3		4		5	
Inputs/outputs	**Unit**	**USD/unit**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**
Crop												
Yield												
- domestic consumption	kg/ha	0.239	3,000.00	716.42	3,500.00	835.82	4,000.00	955.22	4500	1,074.63	5000	1,194.03
Gross crop revenue pe	USD/ha			716.42		835.82		955.22		1,074.63		1,194.03
Seed	kg	2.61	25.00	65.30	25.00	65.30	25.00	65.30	25.00	65.30	25.00	65.30
Fertilizer				380.63		380.63		380.16		380.16		380.63
- cpd 23:21:0 + 4S	kg	0.73	400.00	291.94	400.00	291.94	400.00	291.94	400.00	291.94	400.00	291.94
- Amonium Nitrate	kg	0.67	130.00	87.70	130.00	87.70	130.00	87.70	130.00	87.70	130.00	87.70
- transport to farm	t	1.86	530.00	0.98	530.00	0.98	530.00	0.52	530.00	0.52	530.00	0.98
Chemicals				**83.00**		**83.00**		**83.00**		**83.00**		**83.00**
- dipterex	kg	2.76	4.00	11.06	4.00	11.06	4.00	11.06	4.00	11.06	4.00	11.06
- atrazine	l	6.84	3.60	24.62	3.60	24.62	3.60	24.62	3.60	24.62	3.60	24.62
- Stella Star	l	59.15	0.80	47.32	0.80	47.32	0.80	47.32	0.80	47.32	0.80	47.32
Labour	ld	1.34	50.00	67.16	50.00	67.16	50.00	67.16	50.00	67.16	50.00	67.16
Tillage (Fuels & Oils)	l	1.61	70.00	112.83	70.00	112.83	70.00	112.83	70.00	112.83	70.00	112.83
Cost of water	ml	8.60	12.40	106.66	12.40	106.66	12.40	106.66	12.40	106.66	12.40	106.66
	fixed (USD)	100		100		100		100		100		100
	USD			**207**		**207**		**207**		**207**		**207**
Production costs per ha				915.57		915.57		915.11		915.11		915.57
Packaging				20.60		23.58		26.57		29.89		33.21
- bags	no.	0.30	60.00	17.91	70.00	20.90	80.00	23.88	90	26.87	100	29.85
- labour	ld	1.34	2.00	2.69	2.00	2.69	2.00	2.69	2.25	3.02	2.5	3.36
Sundry	% vc		0.01	9.36	0.01	9.39	0.01	9.42	0.01	0.30	0.01	0.33
Total variable costs	**USD/ha**			**945.53**		**948.54**		**951.10**		**945.30**		**949.11**
Gross margin - Labour co	**USD/ha**			**(229.11)**		**(112.72)**		**4.13**		**129.33**		**244.92**
Cost maintenance on-field canals (USD/ha)				34		34		34		34		34
GM after deduction of cost maintenance on-field canals				**(264)**		**(147)**		**(30)**		**95**		**210**

APPENDIX B 1.7-3MAIZE ECONOMIC PRICES - WITHOUT PROJECT

Details	Unit	Quantity	Unit Price (USD)	Total
Revenue				
Yield	kg/ha	720	0.2388	171.94
Total Revenue/ha				**171.94**
Cost of Production				
Inputs				
Seed	kg	5	2.51	12.90
Fertilizer (basal dressing)	kg	72	0.86	61.68
Fertilizer (top dressing)	kg	62	0.67	41.63
Storage pesticides	kg	1	10.72	5.36
Subtotal				**121.57**
Activity	**Mandays**			
Land clearing	ld	10.0	0.67	6.70
Ridging	ld	20.0	0.67	13.40
Planting	ld	12.5	0.67	8.38
Fertilizer applic	ld	15.0	0.67	10.05
Thinning	ld	3.0	0.67	2.01
Banking	ld	20.0	0.67	13.40
Stooking	ld	10.0	0.67	6.70
Harvesting	ld	3.1	0.67	2.07
Shelling	ld	2.6	0.67	1.72
Winnowing	ld	0.4	0.67	0.28
Bagging	ld	0.2	0.67	0.14
Sub total		**96.8**		**64.84**
Bagging materials	bags	14	1.86	26.75
Sub total				**26.75**
Total cost of production				**213.17**
Gross Margin (USD/ha)				**(41.23)**

APPENDIX B 1.7-4 MAIZE ECONOMIC PRICES - WITH PROJECT

			YEAR	1		2		3		4		5	
Inputs/outputs	**Unit**	**USD/unit**	**Quantity /ha**	**Subtotal USD/ha**		**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**
Yield	kg/ha	0.2794	3,000	838		3,500	978	4,000	1,118	4,500	1,257	5,000	1,397
Gross crop revenue per h	USD/ha			838.21			977.91		1,117.61		1,257.31		1,397.01
Seed	kg	2.61	25.00	65.30		25.00	65.30	25.00	65.30	25.00	65.30	25.00	65.30
Fertilizer				371.92			371.92		371.92		371.92		371.45
- cpd 23:21:0 + 4S	kg	0.70	400.00	280.26		400.00	280.26	400.00	280.26	400.00	280.26	400.00	280.26
- Amonium Nitrate	kg	0.65	140.00	90.67		140.00	90.67	140.00	90.67	140.00	90.67	140.00	90.67
- transport to farm	t	1.86	530.00	0.98		530.00	0.98	530.00	0.98	530.00	0.98	530.00	0.52
Chemicals				**79.68**			**79.68**		**79.68**		**79.68**		**79.68**
- dipterex	kg	2.65	4.00	10.61		4.00	10.61	4.00	10.61	4.00	10.61	4.00	10.61
- atrazine	l	6.57	3.60	23.64		3.60	23.64	3.60	23.64	3.60	23.64	3.60	23.64
- Stella Star	l	56.78	0.80	45.43		0.80	45.43	0.80	45.43	0.80	45.43	0.80	45.43
Labour	ld	0.67	50.00	33.50		50.00	33.50	50.00	33.50	50.00	33.50	50.00	33.50
Tillage (Fuels & Oils)	l	1.55	70.00	108.32		70.00	108.32	70.00	108.32	70.00	108.32	70.00	108.32
Cost of water	ml	8.60	12.40	106.66		12.40	106.66	12.40	106.66	12.40	106.66	12.40	106.66
	fixed (USD)	100		100			100		100		100		100
	USD			**207**			**207**		**207**		**207**		**207**
Production costs per ha			0.00	865.36		0.00	865.36	0.00	865.36	157.40	865.36	0.00	864.90
Packaging				19.25			22.24		25.22		28.37		31.53
- bags	no.	0.30	60.00	17.91		70.00	20.90	80.00	23.88	90.00	26.87	100.00	29.85
- labour	ld	0.67	2.00	1.34		2.00	1.34	2.00	1.34	2.25	1.51	2.50	1.68
Sundry	% vc		1%	8.85		1%	8.88	1%	8.91	1%	8.94	1%	8.96
Total variable costs	**USD/ha**			**893.46**			**896.48**		**899.49**		**902.68**		**905.39**
Gross margin - Labour coste	**USD/ha**			**(55.25)**			**81.43**		**218.12**		**354.64**		**491.62**
Cost maintenance on-field canals (USD/ha)				28			28		28		28		28
GM after deduction of cost maintenance on-field canals				**(83)**			**53**		**190**		**327**		**464**

APPENDIX B 1.8-1MANGOES FINANCIAL PRICES WITH PROJECTS

YEAR			1	2	3	4	5	6	7.0	8	9	10
	UNIT	USD/UNIT										
SEEDLINGS	Number	0.13	476.00									
Cost			63.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHEMICALS												
- copper oxychloride 85% WP	kg	10.49	7.50	7.50	7.50	7.50	15.00	15.00	15.00	15.00	24.00	24.00
- mancozeb 80% WP	kg	11.26			1.00	1.00	2.00	2.00	2.00	4.00	4.00	4.00
- bayleton 5% WP	kg	11.26			1.00	1.00	2.00	2.00	3.00	3.00	4.00	4.00
- parathion	l	1.87	0.50	0.50	0.50	0.50	2.00	2.00	2.00	2.00	3.00	3.00
- malathion 50% EC	l	8.96			1.00	1.00	1.00	1.00	1.50	1.50	2.00	2.00
SUBTOTAL	USD		79.58	79.58	111.06	111.06	215.04	215.04	230.78	253.31	365.30	365.30
FERTILIZER												
- ammonium nitrate	kg/tree	0.67	0.25	0.50	1.00	1.00	1.50	1.50	1.50	2.00	2.00	2.50
- lime	kg/tree	0.30	1.05									
- potassium sulphate	kg/tree	1.25				0.50	0.58	0.75	1.00	1.25	1.33	1.50
- single superphosphate	kg/tree	0.46	1.50	1.60	2.00	2.00	2.25	2.25	2.25	2.25	2.25	2.27
Total			2.80	2.10	3.00	3.50	4.33	4.50	4.75	5.50	3.33	4.00
No. of TREES	number	476.00	476.00	476.00	476.00	476.00	476.00	476.00	476.00	476.00	476.00	476.00
Total fertiliser	kg		1,333.00	999.60	1,428.00	1,666.00	2,061.08	2,142.00	2,261.00	2,618.00	1,585.08	1,904.00
Fertiliser transport	t/km	1.86	2.48	1.86	2.65	3.10	3.83	3.98	4.20	4.86	2.94	3.54
SUBTOTAL	USD		558	510	758	758	974	974	974	1,135	1,133	1,299
TILLAGE												
Ripping	l	1.6	20.0									
Ploughing	l	1.6	20.0									
Discing	l	1.6	10.0									
Slashing	l	1.61	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
SUBTOTAL	USD		85.43	4.84	4.84	4.84	4.84	4.84	4.84	4.84	4.84	4.84
SMALL TOOLS	USD		2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16
LABOUR	ld	1.34	270.00	270.00	270.00	270.00	270.00	270.00	270.0	270.00	270.00	270.00
COST	USD		362.69	362.69	362.69	362.69	362.69	362.69	362.7	362.69	362.69	362.69
IRRIGATION WATER	ml	8.60	11.18	11.18	11.18	11.18	11.18	11.18	11.2	11.18	11.18	11.18
	fixed (USD)		100	100	100	100	100	100	100	100	100	100
Cost	USD/ha		196.15	196.15	196.15	196.15	196.15	196.15	196.15	196.15	196.15	196.15
Yield per ha	kg/tree		0.00	0.00	5.00	10.00	20.00	35.00	45.0	55.00	60.00	65.00
TOTAL YIELD	kg/ha		0.00	0.00	2,380.00	4,760.00	9,520.00	16,660.00	21420.0	26,180.00	28,560.00	30,940.00
Yield - processing	60%		0.00	0.00	1,428.00	2,856.00	5,712.00	9,996.00	12852.0	15,708.00	17,136.00	18,564.00
Yield - export	40%		0.00	0.00	952.00	1,904.00	3,808.00	6,664.00	8568.0	10,472.00	11,424.00	12,376.00
Price - processing			0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Price - export			0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
GROSS CROP REVENUE PER HA	USD		0.00	0.00	717.55	1,435.10	2,870.21	5,022.87	6458.0	7,893.07	8,610.63	9,328.18
PRODUCTION COSTS	USD		1,347.49	1,155.07	1,434.71	1,435.16	1,754.69	1,754.84	1770.8	1,954.55	2,064.62	2,230.11
Sundry	1%		13.47	11.55	14.35	14.35	17.55	17.55	17.7	19.55	20.65	22.30
Total Variable Cost	USD		1,360.97	1,166.62	1,449.06	1,449.51	1,772.23	1,772.39	1788.5	1,974.09	2,085.27	2,252.41
GROSS CROP MARGIN PER HA	USD		(1,360.97)	(1,166.62)	-731.51	-14.40	1,097.97	3,250.48	4669.5	5,918.98	6,525.36	7,075.76
Cost maintenance on-field canals (USD/ha)			34	34	34	34	34	34	34	34	34	34
GM after deduction of cost maintenance on-field canals			(1,395)	(1,201)	(766)	(49)	1,063	3,216	4,635	5,885	6,491	7,041

YEAR	11	12	13	14	15	16	17	18	19	20
SEEDLINGS										
Cost	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
CHEMICALS										
- copper oxychloride 85% WP	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
- mancozeb 80% WP	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
- bayleton 5% WP	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
- parathion	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
- malathion 50% EC	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
SUBTOTAL	**365.30**	**365.30**	**365.30**	**365.30**	**365.30**	**365.30**	**365.30**	**365.30**	**365.30**	**365.30**
FERTILIZER										
- ammonium nitrate	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
- lime										
- potassium sulphate	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
- single superphosphate	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27
Total	**6.27**	**6.27**	**6.27**	**6.27**	**6.27**	**6.27**	**6.27**	**6.27**	**6.27**	**6.27**
No. of TREES	476.00	476.00	476.00	476.00	476.00	476.00	476.00	476.00	476.00	476.00
Total fertiliser	2,984.52	2,984.52	2,984.52	2,984.52	2,984.52	2,984.52	2,984.52	2,984.52	2,984.52	2,984.52
Fertiliser transport	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54
SUBTOTAL	**1,301**	**1,301**	**1,301**	**1,301**	**1,301**	**1,301**	**1,301**	**1,301**	**1,301**	**1,301**
TILLAGE										
Ripping										
Ploughing										
Discing										
Slashing	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
SUBTOTAL	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**
SMALL TOOLS	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**
LABOUR	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00
COST	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**
IRRIGATION WATER	11.18	11.18	11.18	11.18	11.18	11.18	11.18	11.18	11.18	11.18
	100	100	100	100	100	100	100	100	100	100
Cost	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**
Yield per ha	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00
TOTAL YIELD	33,320.00	33,320.00	33,320.00	33,320.00	33,320.00	33,320.00	33,320.00	33,320.00	33,320.00	33,320.00
Yield - processing	19,992.00	19,992.00	19,992.00	19,992.00	19,992.00	19,992.00	19,992.00	19,992.00	19,992.00	19,992.00
Yield - export	13,328.00	13,328.00	13,328.00	13,328.00	13,328.00	13,328.00	13,328.00	13,328.00	13,328.00	13,328.00
Price - processing	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Price - export	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
GROSS CROP REVENUE PER HA	**10,045.73**	**10,045.73**	**10,045.73**	**10,045.73**	**10,045.73**	**10,045.73**	**10,045.73**	**10,045.73**	**10,045.73**	**10,045.73**
PRODUCTION COSTS	**2,232.12**	**2,232.12**	**2,232.12**	**2,232.12**	**2,232.12**	**2,232.12**	**2,232.12**	**2,232.12**	**2,232.12**	**2,232.12**
Sundry	22.32	22.32	22.32	22.32	22.32	22.32	22.32	22.32	22.32	22.32
Total Variable Cost	**2,254.44**	**2,254.44**	**2,254.44**	**2,254.44**	**2,254.44**	**2,254.44**	**2,254.44**	**2,254.44**	**2,254.44**	**2,254.44**
GROSS CROP MARGIN PER HA	**7,791.29**	**7,791.29**	**7,791.29**	**7,791.29**	**7,791.29**	**7,791.29**	**7,791.29**	**7,791.29**	**7,791.29**	**7,791.29**
Cost maintenance on-field canals (USD/I	34	34	34	34	34	34	34	34	34	34
GM after deduction of cost maintenan	**7,757**	**7,757**	**7,757**	**7,757**	**7,757**	**7,757**	**7,757**	**7,757**	**7,757**	**7,757**

APPENDIX B 1.8-2 MANGOES ECONOMIC PRICES - WITH PROJECT

YEAR			1	2	3	4	5	6	7.0	8	9	10
	UNIT	USD/UNIT										
SEEDLINGS	Number	0.13	476.00									
Cost			**61.38**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
CHEMICALS												
- copper oxychloride 85% WP	kg	10.07	7.50	7.50	7.50	7.50	15.00	15.00	15.00	15.00	24.00	24.00
- mancozeb 80% WP	kg	10.81			1.00	1.00	2.00	2.00	2.00	4.00	4.00	4.00
- bayleton 5% WP	kg	10.81			1.00	1.00	2.00	2.00	3.00	3.00	4.00	4.00
- parathion	l	1.80	0.50	0.50	0.50	0.50	2.00	2.00	2.00	2.00	3.00	3.00
- malathion 50% EC	l	8.60			1.00	1.00	1.00	1.00	1.50	1.50	2.00	2.00
SUBTOTAL	**USD**		**76.40**	**76.40**	**106.62**	**106.62**	**206.44**	**206.44**	**221.55**	**243.18**	**350.69**	**350.69**
FERTILIZER												
- ammonium nitrate	kg/tree	0.65	0.25	0.50	1.00	1.00	1.50	1.50	1.50	2.00	2.00	2.50
- lime	kg/tree	0.29	1.05									
- potassium sulphate	kg/tree	1.20				0.50	0.58	0.75	1.00	1.25	1.33	1.50
- single superphosphate	kg/tree	0.44	1.50	1.60	2.00	2.00	2.25	2.25	2.25	2.25	2.25	2.27
Total			**2.80**	**2.10**	**3.00**	**3.50**	**4.33**	**4.50**	**4.75**	**5.50**	**3.33**	**4.00**
No. of TREES	number	476.00	476.00	476.00	476.00	476.00	476.00	476.00	476.00	476.00	476.00	476.00
Total fertiliser	kg		1,333.00	999.60	1,428.00	1,666.00	2,061.08	2,142.00	2,261.00	2,618.00	1,585.08	1,904.00
Fertiliser transport	t/km	1.86	2.48	1.86	2.65	3.10	3.83	3.98	4.20	4.86	2.94	3.54
SUBTOTAL	**USD**		**3.60**	**2.88**	**4.18**	**728**	**935**	**935**	**935**	**1,090**	**1,088**	**1,247**
TILLAGE												
Ripping	l	1.6	20.0									
Ploughing	l	1.6	20.0									
Discing	l	1.6	10.0									
Slashing	l	1.61	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
SUBTOTAL	**USD**		**85.43**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**
SMALL TOOLS	**USD**		**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**
LABOUR	ld	1.34	270.00	270.00	270.00	270.00	270.00	270.00	270.0	270.00	270.00	270.00
COST	**USD**		**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.7**	**362.69**	**362.69**	**362.69**
IRRIGATION WATER	ml	8.60	11.18	11.18	11.18	11.18	11.18	11.18	11.2	11.18	11.18	11.18
	fixed (USD)		100	100	100	100	100	100	100	100	100	100
Cost	**USD/ha**		**196.15**	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**
Yield per ha	kg/tree		0.00	0.00	5.00	10.00	20.00	35.00	45.0	55.00	60.00	65.00
TOTAL YIELD	kg/ha		0.00	0.00	2,380.00	4,760.00	9,520.00	16,660.00	21420.0	26,180.00	28,560.00	30,940.00
Yield - processing	60%		0.00	0.00	1,428.00	2,856.00	5,712.00	9,996.00	12852.0	15,708.00	17,136.00	18,564.00
Yield - export	40%		0.00	0.00	952.00	1,904.00	3,808.00	6,664.00	8568.0	10,472.00	11,424.00	12,376.00
Price - processing			0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Price - export			0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
GROSS CROP REVENUE PER HA	**USD**		**0.00**	**0.00**	**717.55**	**1,435.10**	**2,870.21**	**5,022.87**	**6458.0**	**7,893.07**	**8,610.63**	**9,328.18**
PRODUCTION COSTS	**USD**		**787.81**	**645.12**	**676.63**	**1,400.51**	**1,707.29**	**1,707.44**	**1722.8**	**1,899.20**	**2,004.79**	**2,163.68**
Sundry	1%		7.88	6.45	6.77	14.01	17.07	17.07	17.2	18.99	20.05	21.64
Total Variable CostTotal Variable Cost	**USD**		**795.68**	**651.57**	**683.40**	**1,414.51**	**1,724.36**	**1,724.51**	**1740.0**	**1,918.19**	**2,024.83**	**2,185.32**
GROSS CROP MARGIN PER HA	**USD**		**(795.68)**	**(651.57)**	**34.15**	**20.59**	**1,145.85**	**3,298.35**	**4718.0**	**5,974.89**	**6,585.79**	**7,142.86**
Cost maintenance on-field canals (USD/ha)			28	28	28	28	28	28	28	28	28	28
GM after deduction of cost maintenance on-field canals			**(824)**	**(680)**	**6**	**(8)**	**1,118**	**3,270**	**4,690**	**5,947**	**6,558**	**7,115**

YEAR	11	12	13	14	15	16	17	18	19	20
SEEDLINGS										
Cost	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
CHEMICALS										
- copper oxychloride 85%	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
- mancozeb 80% WP	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
- bayleton 5% WP	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
- parathion	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
- malathion 50% EC	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
SUBTOTAL	**350.69**	**350.69**	**350.69**	**350.69**	**350.69**	**350.69**	**350.69**	**350.69**	**350.69**	**350.69**
FERTILIZER										
- ammonium nitrate	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
- lime										
- potassium sulphate	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
- single superphosphate	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27
Total	**6.27**	**6.27**	**6.27**	**6.27**	**6.27**	**6.27**	**6.27**	**6.27**	**6.27**	**6.27**
No. of TREES	476.00	476.00	476.00	476.00	476.00	476.00	476.00	476.00	476.00	476.00
Total fertiliser	2,984.52	2,984.52	2,984.52	2,984.52	2,984.52	2,984.52	2,984.52	2,984.52	2,984.52	2,984.52
Fertiliser transport	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54
SUBTOTAL	**1,249**	**1,249**	**1,249**	**1,249**	**1,249**	**1,249**	**1,249**	**1,249**	**1,249**	**1,249**
TILLAGE										
Ripping										
Ploughing										
Discing										
Slashing	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
SUBTOTAL	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**	**4.84**
SMALL TOOLS	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**	**2.16**
LABOUR	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00	270.00
COST	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**	**362.69**
IRRIGATION WATER	11.18	11.18	11.18	11.18	11.18	11.18	11.18	11.18	11.18	11.18
	100	100	100	100	100	100	100	100	100	100
Cost	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**	**196.15**
Yield per ha	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00
TOTAL YIELD	33,320.00	33,320.00	33,320.00	33,320.00	33,320.00	33,320.00	33,320.00	33,320.00	33,320.00	33,320.00
Yield - processing	19,992.00	19,992.00	19,992.00	19,992.00	19,992.00	19,992.00	19,992.00	19,992.00	19,992.00	19,992.00
Yield - export	13,328.00	13,328.00	13,328.00	13,328.00	13,328.00	13,328.00	13,328.00	13,328.00	13,328.00	13,328.00
Price - processing	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Price - export	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
GROSS CROP REVENUE	**10,045.73**	**10,045.73**	**10,045.73**	**10,045.73**	**10,045.73**	**10,045.73**	**10,045.73**	**10,045.73**	**10,045.73**	**10,045.73**
PRODUCTION COSTS	**2,165.69**	**2,165.69**	**2,165.69**	**2,165.69**	**2,165.69**	**2,165.69**	**2,165.69**	**2,165.69**	**2,165.69**	**2,165.69**
Sundry	21.66	21.66	21.66	21.66	21.66	21.66	21.66	21.66	21.66	21.66
Total Variable Cost	**2,187.35**	**2,187.35**	**2,187.35**	**2,187.35**	**2,187.35**	**2,187.35**	**2,187.35**	**2,187.35**	**2,187.35**	**2,187.35**
GROSS CROP MARGIN I	**7,858.38**	**7,858.38**	**7,858.38**	**7,858.38**	**7,858.38**	**7,858.38**	**7,858.38**	**7,858.38**	**7,858.38**	**7,858.38**
Cost maintenance on-field ca	28	28	28	28	28	28	28	28	28	28
GM after deduction of cost	**7,830**	**7,830**	**7,830**	**7,830**	**7,830**	**7,830**	**7,830**	**7,830**	**7,830**	**7,830**

APPENDIX B 1.9-1PIGEON PEAS FINANCIAL PRICESWITHOUT PROJECT

Details/Crops	UNIT NO.	QUANTITY	UNIT PRICE	TOTAL PRICE
REVENUE:				
Yield (kg/ha)	kg	900	0.7452	670.67
Gross Revenue/ha				**670.67**
Costs USD/ha				
INPUTS				
Seed	kg	10	1.79	17.91
Sub-total				**17.91**
LABOUR (mandays/ha)				
Clearing	ld	18.0	0.00	0.00
Ridging	ld	25.0	0.00	0.00
Planting	ld	10.0	0.00	0.00
Weeding	ld	20.0	0.00	0.00
Banking	ld	16.0	0.00	0.00
Harvesting	ld	25.0	0.00	0.00
Threshing	ld	12.0	0.00	0.00
Grading	ld	2.0	0.00	0.00
Packaging	ld	2.0	0.00	0.00
Total mandays		**130.0**		**0.00**
POST-HARVEST COSTS				
Packaging materials	bags	18	0.30	5.37
Sub-total				**5.37**
Other Expenses				
Hoes - depreciated over 2 years				1.08
Sub-total				**1.08**
Grand total costs USD/ha				**24.37**
Gross Margin (USD/ha)				**646.31**

APPENDIX B 1.9-2PIGEON PEASFINANCIAL PRICES WITH PROJECT

		YEAR	1		2		3		4		5	
Inputs/outputs	**Unit**	**USD/unit**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**
Crop management input												
Yield												
- Local sales	kg/ha	0.75	1,800.00	1,343.28	1,950.00	1,455.22	2100	1,567.16	2250	1,679.10	2,500.00	1,865.67
Gross crop revenue per ha	USD/ha			1,343.28		1,455.22		1,567.16		1,679.10		1,865.67
Seed	kg	1.79	10.00	17.91	10.00	17.91	10.00	17.91	10.00	17.91	10.00	17.91
Fertilizer				72.99		72.99		72.99		72.99		72.99
- cpd S	kg	0.73	100.00	72.99	100.00	72.99	100.00	72.99	100.00	72.99	100.00	72.99
- transport				0.00		0.00		0.00		0.00		0.00
Chemicals				21.78		21.78		21.78		21.78		21.78
- dimethoate 20WP	kg	8.21	0.49	3.99	0.49	3.99	0.49	3.99	0.49	3.99	0.49	3.99
- carbaryl 85WP	kg	13.43	1.22	16.32	1.22	16.32	1.22	16.32	1.22	16.32	1.22	16.32
- karate	l	14.69	0.10	1.47	0.10	1.47	0.10	1.47	0.10	1.47	0.10	1.47
Labour	ld	1.34	40.00	53.73	40.00	53.73	40.00	53.73	40.00	53.73	40.00	53.73
Tillage (Fuels & Oils)	l	1.61	70.00	112.83	70.00	112.83	70.00	112.83	70.00	112.83	70.00	112.83
Cost of water	ml	8.60	8.06	69.35	8.06	69.35	8.06	69.35	8.06	69.35	8.06	69.35
	fixed (USD)	100		100		100		100		100		100
	USD			**169**		**169**		**169**		**169**		**169**
Production costs per ha				448.59		448.59		448.59		448.59		448.59
Packaging				20.42		22.12		23.82		25.52		28.36
- bags	no.	0.30	36.00	10.75	39.00	11.64	42.00	12.54	45.00	13.43	50.00	14.93
- labour	ld	1.34	7.20	9.67	7.80	10.48	8.40	11.28	9.00	12.09	10.00	13.43
Sundry	% vc		0.01	4.69	0.01	4.71	0.01	4.72	0.01	4.74	0.01	4.77
Total variable costs	**USD/ha**			**473.69**		**475.41**		**477.13**		**478.85**		**481.71**
Gross margin - Labour costed	**USD/ha**			**869.59**		**979.81**		**1,090.03**		**1,200.25**		**1,383.96**
Cost maintenance on-field canals (USD/ha)				34		34		34		34		34
GM after deduction of cost maintenance on-field canals				**835**		**945**		**1,056**		**1,166**		**1,349**

APPENDIX B 1.9-3 PIGEON PEAS ECONOMIC PRICES WITHOUT PROJECT

Details/Crops	UNIT NO.	QUANTITY	UNIT PRICE	TOTAL PRICE
REVENUE:				
Yield (kg/ha)	kg	900	0.7452	670.67
Gross Revenue/ha				**670.67**
Costs USD/ha				
INPUTS				
Seed	kg	10	1.72	17.19
Sub-total				**17.19**
LABOUR (mandays/ha)				
Clearing	ld	18.0	0.67	12.06
Ridging	ld	25.0	0.67	16.75
Planting	ld	10.0	0.67	6.70
Weeding	ld	20.0	0.67	13.40
Banking	ld	16.0	0.67	10.72
Harvesting	ld	25.0	0.67	16.75
Threshing	ld	12.0	0.67	8.04
Grading	ld	2.0	0.67	1.34
Packaging	ld	2.0	0.67	1.34
Total mandays		**130.0**		**87.10**
POST-HARVEST COSTS				
Packaging materials	bags	18	0.30	5.37
Sub-total				**5.37**
Other Expenses				
Hoes - depreciated over 2 years				1.08
Sub-total				**1.08**
Grand total costs USD/ha				**110.75**
Gross Margin (USD/ha)				**559.93**

APPENDIX B 1.9-4PIGEON PEASECONOMIC PRICES WITH PROJECT

			1		2		3		4		5	
Inputs/outputs	**Unit**	**USD/unit**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**
Crop management input												
Yield												
- Local sales	kg/ha	0.75	1,800.00	1,343.28	1,950.00	1,455.22	2,100.00	1,567.16	2,250.00	1,679.10	2,500.00	1,865.67
Gross crop revenue per ha	USD/ha			1,343.28		1,455.22		1,567.16		1,679.10		1,865.67
Seed	kg	1.72	10.00	17.19	10.00	17.19	10.00	17.19	10.00	17.19	10.00	17.19
Fertilizer				70.07		70.07		70.07		70.07		70.07
- cpd S	kg	0.70	100.00	70.07	100.00	70.07	100.00	70.07	100.00	70.07	100.00	70.07
- transport			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chemicals				20.91		20.91		20.91		20.91		20.91
- dimethoate 20WP	kg	7.88	0.49	3.83	0.49	3.83	0.49	3.83	0.49	3.83	0.49	3.83
- carbaryl 85WP	kg	12.90	1.22	15.67	1.22	15.67	1.22	15.67	1.22	15.67	1.22	15.67
- karate	l	14.10	0.10	1.41	0.10	1.41	0.10	1.41	0.10	1.41	0.10	1.41
Labour	ld	0.67	40.00	26.80	40.00	26.80	40.00	26.80	40.00	26.80	40.00	26.80
Tillage (Fuels & Oils)	l	1.55	70.00	108.32	70.00	108.32	70.00	108.32	70.00	108.32	70.00	108.32
Cost of water	ml	8.60	8.06	69.35	8.06	69.35	8.06	69.35	8.06	69.35	8.06	69.35
	fixed (USD)	100.00		100		100		100		100		100
	USD			**169**		**169**		**169**		**169**		**169**
Production costs per ha				412.63		412.63		412.63		412.63		412.63
Packaging				17.45		18.34		19.24		21.63		21.63
- bags	no.	0.30	36.00	10.75	39.00	11.64	42.00	12.54	50.00	14.93	50.00	14.93
- labour	ld	0.67	10.00	6.70	10.00	6.70	10.00	6.70	10.00	6.70	10.00	6.70
Sundry	% vc		0.01	4.30	0.01	4.31	0.01	4.32	0.01	4.34	0.01	4.34
Total variable costs	**USD/ha**			**434.38**		**435.29**		**436.19**		**438.60**		**438.60**
Gross margin	**USD/ha**			**908.90**		**1,019.94**		**1,130.97**		**1,240.50**		**1,427.07**
Cost maintenance on-field canals (USD/ha)				28		28		28		28		28
GM after deduction of cost maintenance on-field canals				**881**		**992**		**1,103**		**1,212**		**1,399**

APPENDIX B 1.10-1SESAME FINANCIAL PRICES – WITHOUT PROJECT

Details	UNIT NO.	QUANTITY	UNIT PRICE	TOTAL PRICE
REVENUE:				
Sales	kg/ha	300.00	0.2653	79.59
Gross Revenue/ha				**79.59**
Costs USD/ha				
INPUTS				
Seed	kg	3.00	0.30	0.90
Sub-total				**0.90**
LABOUR (mandays/ha)				
Clearing	ld	20.0	0.00	0.00
Ridging	ld	20.0	0.00	0.00
Planting	ld	10.0	0.00	0.00
Weeding	ld	20.0	0.00	0.00
Harvesting	ld	4.5	0.00	0.00
First Threshing	ld	0.8	0.00	0.00
Second Threshing	ld	0.8	0.00	0.00
Drying	ld	0.8	0.00	0.00
Packaging	ld	0.8	0.00	0.00
Total mandays		**77.5**		**0.00**
Cost of water	ML	6.87	8.60	59.08
POST-HARVEST COSTS				
Packaging materials	bags	6.00	0.30	1.79
Sub-total				**1.79**
Grand total costs USD/ha				**61.77**
Gross Margin (USD/ha)				**17.82**

APPENDIX B 1.10-2 SESAME ECONOMIC PRICES WITHOUT PROJECT

Details	UNIT NO.	QUANTITY	UNIT PRICE	TOTAL PRICE
REVENUE:				
Sales	kg/ha	300.00	0.2653	79.59
Gross Revenue/ha				**79.59**
Costs USD/ha				
INPUTS				
Seed	kg	3.00	0.29	0.86
Sub-total				**0.86**
LABOUR (mandays/ha)				
Clearing	ld	20.0	0.67	13.40
Ridging	ld	20.0	0.67	13.40
Planting	ld	10.0	0.67	6.70
Weeding	ld	20.0	0.67	13.40
Harvesting	ld	4.5	0.67	3.02
First Threshing	ld	0.8	0.67	0.50
Second Threshing	ld	0.8	0.67	0.50
Drying	ld	0.8	0.67	0.50
Packaging	ld	0.8	0.67	0.50
Total mandays		**77.5**		**51.93**
Cost of water	ML	6.87	8.60	59.08
POST-HARVEST COSTS				
Packaging materials	bags	6.00	0.29	1.72
Sub-total				**1.72**
Grand total costs USD/ha				**113.59**
Gross Margin (USD/ha)				**-34.00**

APPENDIX B 1.11-1 SORGHUM FINANCIAL PRICES – WITHOUT PROJECT

DETAILS	UNIT	QUANTITY	UNIT PRICE	TOTAL PRICE
REVENUE:				
Yield	kg/ha	800	0.1778	142.21
Gross Revenue/ha				**142.21**
Costs USD/ha				
INPUTS				
Seed	kg	5.00	0.67	3.36
Compound (23:21:0+ 4S)	kg	60.00	0.73	43.79
CAN	kg	40.00	0.67	26.99
transport	t/km	21.00	1.86	0.04
Sub-total				**74.17**
LABOUR				
Clearing	ld	20.0	0.00	0.00
Ridging	ld	15.0	0.00	0.00
Innoculation	ld	2.0	0.00	0.00
Planting	ld	10.0	0.00	0.00
Thinning	ld	2.0	0.00	0.00
Banking	ld	10.0	0.00	0.00
Harvesting	ld	3.0	0.00	0.00
Bagging	ld	0.2	0.00	0.00
Post harvest treating	ld	0.2	0.00	0.00
Total mandays		**62.4**		**0.00**
POST-HARVEST COSTS				
Packaging materials	bags	16	0.30	4.78
Sub-total				**4.78**
Grand total costs USD/ha				**78.95**
Gross Margin (USD/ha)				**63.26**

APPENDIX B 1.11-2 SORGHUM ECONOMIC PRICES –WITHOUT PROJECT

DETAILS	UNIT	QUANTITY	UNIT PRICE	TOTAL PRICE
REVENUE:				
Yield	kg/ha	800	0.1778	142.21
Gross Revenue/ha				**142.21**
Costs USD/ha				
INPUTS				
Seed	kg	5	0.64	3.22
Compound (23:21:0+ 4S)	kg	60	0.70	42.04
CAN	kg	40	0.65	25.91
transport	t/km	21	1.78	0.04
Sub-total				**71.21**
LABOUR				
Clearing	ld	20.0	0.67	13.40
Ridging	ld	15.0	0.67	10.05
Innoculation	ld	2.0	0.67	1.34
Planting	ld	10.0	0.67	6.70
Thinning	ld	2.0	0.67	1.34
Banking	ld	10.0	0.67	6.70
Harvesting	ld	3.0	0.67	2.01
Bagging	ld	0.2	0.67	0.13
Post harvest treating	ld	0.2	0.67	0.13
Total mandays		**62.4**		**41.81**
POST-HARVEST COSTS				
Packaging materials	bags	16	0.30	4.78
Sub-total				**4.78**
Grand total costs USD/ha				**117.79**
Gross Margin (USD/ha)				**24.42**

APPENDIX B 1.12-1 SOYA BEANS FINANCIAL PRICES –WITHOUT PROJECT

DETAILS	UNIT	QUANTITY	UNIT PRICE	TOTAL PRICE
REVENUE:				
Yield	kg/ha	500	0.2689	134.44
Gross Revenue/ha				**134.44**
Costs USD/ha				
INPUTS				
Seed	kg	100	1.68	167.91
Rhizobium (innoculant)	packet	4	1.49	5.97
Sub-total				**173.88**
LABOUR				
Clearing	ld	20	0.00	0.00
Ridging	ld	25	0.00	0.00
Innoculation	ld	10	0.00	0.00
Planting	ld	18	0.00	0.00
Gap filling	ld	4	0.00	0.00
First weeding	ld	24	0.00	0.00
Second weeding	ld	12	0.00	0.00
Banking	ld	16	0.00	0.00
Harvesting	ld	30	0.00	0.00
Stripping/threshing	ld	20	0.00	0.00
Winnowing/Grading	ld	20	0.00	0.00
Packaging	ld	5	0.00	0.00
Total mandays		**204**		**0.00**
POST-HARVEST COSTS				
Packaging materials	bags	10	0.30	2.99
Sub-total				**2.99**
Grand total costs USD/ha				**176.87**
Gross Margin (USD/ha)				**-42.42**

APPENDIX B 1.12-2 SOYA BEANS FINANCIAL PRICE - WITH PROJECT

		YEAR	1		2		3		4		5	
Inputs/outputs	**Unit**	**USD/unit**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**
Crop management input												
Yield												
- Local sales	kg/ha	0.27426	2,000.00	548.52	2,333	640	2,666	731	3000	823	3000	823
Gross crop revenue per ha	USD/ha			548.52		640		731		823		823
Seed	kg	1.68	100	168	100	168	100	168	100	168	100	168
Fertilizer				85.13		85.13		85.13		85.13		85.13
- cpd S	kg	0.73	100	72.99	100	72.99	100	72.99	100	72.99	100.00	72.99
- Rhizobium (innoculant)	packets	1.49	8	11.94	8	11.94	8	11.94	8	11.94	8.00	11.94
- transport	t	1.86	0	0.20	0	0.20	0	0.20	0	0.20	0.11	0.20
Chemicals				71.43		71.43		71.43		71.43		71.43
- carbaryl 85 WP	kg	13.43	1.22	16.39	1.22	16.39	1.22	16.39	1.22	16.39	1.22	16.39
- lasso/alachlor	l	6.84	2	13.68	2	13.68	2	13.68	2	13.68	2.00	13.68
- dual	l	17.67	2	35.33	2	35.33	2	35.33	2	35.33	2.00	35.33
- classic	g	0.20	30	6.03	30	6.03	30	6.03	30	6.03	30.00	6.03
Labour	ld	1.34	40	53.73	40	53.73	40	53.73	40	53.73	40.00	53.73
Tillage (Fuels & Oils)	l	1.61	35	56.41	35	56.41	35	56.41	35	56.41	35.00	56.41
Cost of water	ml	8.60	8.06	69.35	8	69.35	8	69.35	8	69.35	8.06	69.35
	fixed (USD)	100		100		100		100		100		100
	USD			169		169		169		169		169
Production costs per ha				603.96		603.96		603.96		603.96		603.96
Packaging				25.16		25.68		26.08		29.35		29.35
- bags	no.	0.30	46	13.64	47	13.93	47	14.14	53	15.92	53.32	15.92
- labour	ld	1.34	9	11.52	9	11.75	9	11.94	10	13.43	10.00	13.43
Sundry	% vc		0	6.29	0	6.30	0	6.30	0	6.33	0.01	6.33
Total variable costs	**USD/ha**			**635.41**		**635.94**		**636.34**		**639.64**		**639.64**
Gross margin	**USD/ha**			**(86.89)**		**3.91**		**94.84**		**183.14**		**183.14**
Cost maintenance on-field canals (USD/ha)				34		34		34		34		34
GM after deduction of cost maintenance on-field canals				**(121)**		**(31)**		**60**		**149**		**149**

APPENDIX B 1.12-3 SOYA BEANS ECONOMIC PRICES- WITHOUT PROJECT

DETAILS	UNIT	QUANTITY	UNIT PRICE	TOTAL PRICE
REVENUE:				
Yield	kg/ha	500	0.2689	134.44
Gross Revenue/ha				**134.44**
Costs USD/ha				
INPUTS				
Seed	kg	100	1.61	161.19
Rhizobium (innoculant)	packet	4	1.43	5.73
Sub-total				**166.93**
LABOUR				
Clearing	ld	20	0.67	13.40
Ridging	ld	25	0.67	16.75
Innoculation	ld	10	0.67	6.70
Planting	ld	18	0.67	12.06
Gap filling	ld	4	0.67	2.68
First weeding	ld	24	0.67	16.08
Second weeding	ld	12	0.67	8.04
Banking	ld	16	0.67	10.72
Harvesting	ld	30	0.67	20.10
Stripping/threshing	ld	20	0.67	13.40
Winnowing/Grading	ld	20	0.67	13.40
Packaging	ld	5	0.67	3.35
Total mandays		**204**		**136.68**
POST-HARVEST COSTS				
Packaging materials	bags	10	0.30	2.99
Sub-total				**2.99**
Grand total costs USD/ha				**306.59**
Gross Margin (USD/ha)				**-172.15**

APPENDIX B 1.12-2 SOYA BEANS ECONOMIC PRICES – WITH PROJECT

			YEAR	1		2		3		4		5	
Inputs/outputs	**Unit**	**USD/unit**		**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**	**Quantity /ha**	**Subtotal USD/ha**
Crop management input													
Yield													
- Local sales	kg/ha	0.27426		2000	548.52	2333	640	2666	731	3000	823	3000	823
Gross crop revenue per ha	USD/ha				548.52		640		731		823		823
Seed	kg	1.61	z	100	161.19	100	161	100	161	100	161	100	161
Fertilizer					81.53		81.53		81.53		81.53		81.53
- cpd S	kg	0.70		100	70.07	100	70.07	100	70.07	100	70.07	100	70.07
- Rhizobium (innoculant)	packets	1.43		8	11.46	8	11.46	8	11.46	8	11.46	8	11.46
- transport	t	0.00		0.108	0.00	0.108	0.00	0.108	0.00	0.108	0.00	0.108	0.00
Chemicals					68.57		68.57		68.57		68.57		68.57
- carbaryl 85 WP	kg	12.90		1.22	15.73	1.22	15.73	1.22	15.73	1.22	15.73	1.22	15.73
- lasso/alachlor	l	6.57		2	13.13	2	13.13	2	13.13	2	13.13	2	13.13
- dual	l	16.96		2	33.92	2	33.92	2	33.92	2	33.92	2	33.92
- classic	g	0.19		30	5.78	30	5.78	30	5.78	30	5.78	30	5.78
Labour	ld	0.67		40	26.80	40	26.80	40	26.80	40	26.80	40	26.80
Tillage (Fuels & Oils)	l	1.55		35	54.16	35	54.16	35	54.16	35	54.16	35	54.16
Cost of water	ml	8.60		8.06	69.35	8.064	69.35	8.064	69.35	8.064	69.35	8.064	69.35
	fixed (USD)	100			100		100		100		100		100
	USD				169		169		169		169		169
Production costs per ha					561.60		561.60		561.60		561.60		561.60
Packaging					19.39		19.79		20.10		22.62		22.62
- bags	no.	0.30		45.71	13.64	46.66	13.93	47.38	14.14	53.32	15.92	53.32	15.92
- labour	ld	0.67		8.57	5.74	8.75	5.86	8.89	5.95	10.00	6.70	10.00	6.70
Sundry	% vc			0.01	5.81	0.01	5.81	0.01	5.82	0.01	5.84	0.01	5.84
Total variable costs	**USD/ha**				**586.80**		**587.20**		**587.51**		**590.06**		**590.06**
Gross margin	**USD/ha**				**-38.27**		**52.65**		**143.67**		**232.73**		**232.73**
Cost maintenance on-field canals (USD/ha)					28		28		28		28		28
GM after deduction of cost maintenance on-field canals					**(66)**		**25**		**116**		**205**		**205**

APPENDIX B 1.13-1SUGAR CANEFINANCIAL PRICES -WITH PROJECT

a) Budget assumptions

Description	Quantity by year							Units	Price/cost	
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7		US$	per
Yield	110	110	110	110	105	105	105	t/ha	73.20	t
Planting material:										
Setts	10	0	0	0	0	0	0	t/ha	88.84	t
Tillage:										
Contract: ploughout	0	0	0	0	0	0	0	ha	112.83	ha
Ridge/re-ridge	20	20	20	20	20	20	20	l/ha	1.61	l
Transport	20	20	20	20	20	20	20	l/ha	1.61	l
Fertiliser and lime:										
Ammonium nitrate	425	500	500	500	500	500	500	kg/ha	0.67	kg
Potassium chloride	80	80	80	80	80	80	80	kg/ha	0.91	kg
Single superphosphate	500	0	200	200	200	200	200	kg/ha	0.46	kg
Lime	300	0	0	0	0	0	0	kg/ha	0.21	kg
Fertiliser transport	100	100	100	100	100	100	100	km	1.86	t/km
Chemicals:										
Bayleton 25%wp	0.20	0.00	0.00	0.00	0.00	0.00	0.00	kg/ha	12.05	kg
Dursban	2.00	2.00	2.00	2.00	2.00	2.00	2.00	l/ha	8.54	l
Atrazine	1.60	1.60	1.60	1.60	1.60	1.60	1.60	l/ha	6.84	l
Ametryne	1.00	1.00	1.00	1.00	1.00	1.00	1.00	kg/ha	8.74	kg
Agral	0.15	0.20	0.20	0.20	0.20	0.20	0.20	l/ha	17.57	l
Irrigation:										
Water (net)	13.50	13.50	13.50	13.50	13.50	13.50	13.50	Ml/ha	8.60	ML
fixed ISC (USD)									100	
Application efficiency	65.00	65.00	65.00	65.00	65.00	65.00	65.00	%		
Labour:	**170.21**	**120.21**	**120.21**	**120.21**	**120.21**	**120.21**	**120.21**			
Planting	50.00	0.00	0.00	0.00	0.00	0.00	0.00	LD/ha	1.34	LD
Maintenance	120.00	120.00	120.00	120.00	120.00	120.00	120.00	LD/ha	1.34	LD
Harvesting	0.21	0.21	0.21	0.21	0.21	0.21	0.21	LD/t	1.34	LD
Marketing:										
Transport/haulage	20.00	20.00	20.00	20.00	20.00	20.00	20.00	km	1.86	t/km

b) Budget summary and Gross Margin estimates

Description	Quantity by year							Average
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	
1. OUTPUTS								
Total yield (t)	110.00	110.00	110.00	110.00	105.00	105.00	105.00	107.86
Blend price (US$/t)	36.05	36.05	36.05	36.05	36.05	36.05	36.05	36.05
Gross Income	3,965.09	3,965.09	3,965.09	3,965.09	3,784.86	3,784.86	3,784.86	3,887.85
2. INPUTS								
Planting materials	888.42	0.00	0.00	0.00	0.00	0.00	0.00	126.92
Tillage	32.24	32.24	32.24	32.24	32.24	32.24	32.24	32.24
Fertiliser&lime	651.21	410.26	501.45	501.45	501.45	501.45	501.45	509.81
Chemicals	41.80	40.27	40.27	40.27	40.27	40.27	40.27	40.48
Input costs	1,613.67	482.76	573.95	573.95	573.95	573.95	573.95	709.45
3. LABOUR								
Labour days/ha	193.10	143.10	143.10	143.10	142.05	142.05	142.05	149.79
Labour cost	259.39	192.22	192.22	192.22	190.81	190.81	190.81	201.21
4. WATER								
Ml/ha (gross)	20.77	20.77	20.77	20.77	20.77	20.77	20.77	20.77
Water cost		278.62	278.62	278.62	278.62	278.62	278.62	278.62
5. TOTAL PRODUCTION COSTS	278.62	953.60	1,044.79	1,044.79	1,043.38	1,043.38	1,043.38	921.70
6. PRIMARY MARKETING	2,151.67							
Transport/haulage								
7. MARKETING COSTS		0.00	0.00	0.00	0.00	0.00	0.00	0.00
8. TOTAL VARIABLE COSTS	0.00	953.60	1,044.79	1,044.79	1,043.38	1,043.38	1,043.38	881.90
9. GROSS MARGIN	2,151.67	3,011.49	2,920.30	2,920.30	2,741.48	2,741.48	2,741.48	2,746.89
Cost maintenance on-field canals (USD/ha)		34	34	34	34	34	34	
GM after deduction of cost maintenance on-field can		**2,977**	**2,886**	**2,886**	**2,707**	**2,707**	**2,707**	2,812

APPENDIX B 1.13-2SUGAR CANEECONOMIC PRICES

a) Budget assumptions

Description	Quantity by year							Units	Price/cost	
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7		US$	per
Yield	110.00	110.00	110.00	110.00	105.00	105.00	105.00	t/ha	73.20	t
Planting material:										
Setts	10.00	0.00	0.00	0.00	0.00	0.00	0.00	t/ha	85.29	t
Tillage:										
Contract: ploughout	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ha	108.32	ha
Ridge/re-ridge	20.00	20.00	20.00	20.00	20.00	20.00	20.00	l/ha	1.55	l
Transport	20.00	20.00	20.00	20.00	20.00	20.00	20.00	l/ha	1.55	l
Fertiliser and lime:										
Ammonium nitrate	425.00	500.00	500.00	500.00	500.00	500.00	500.00	kg/ha	0.51	kg
Potassium chloride	80.00	80.00	80.00	80.00	80.00	80.00	80.00	kg/ha	0.51	kg
Single superphosphate	500.00	0.00	200.00	200.00	200.00	200.00	200.00	kg/ha	0.44	kg
Lime	300.00	0.00	0.00	0.00	0.00	0.00	0.00	kg/ha	0.20	kg
Fertiliser transport	100.00	100.00	100.00	100.00	100.00	100.00	100.00	km	0.00	t/km
Chemicals:										
Bayleton 25%wp	0.20	0.00	0.00	0.00	0.00	0.00	0.00	kg/ha	11.57	kg
Dursban	2.00	2.00	2.00	2.00	2.00	2.00	2.00	l/ha	8.19	l
Atrazine	1.60	1.60	1.60	1.60	1.60	1.60	1.60	l/ha	6.57	l
Ametryne	1.00	1.00	1.00	1.00	1.00	1.00	1.00	kg/ha	8.39	kg
Agral	0.15	0.20	0.20	0.20	0.20	0.20	0.20	l/ha	16.87	l
Irrigation:										
Water (net)	13.50	13.50	13.50	13.50	13.50	13.50	13.50	Ml/ha	8.60	ML
Fixed ISC									100.00	USD/ha
Application efficiency	65.00	65.00	65.00	65.00	65.00	65.00	65.00	%		
Labour:	170.21	120.21	120.21	120.21	120.21	120.21	120.21			
Planting	50.00	0.00	0.00	0.00	0.00	0.00	0.00	LD/ha	0.67	LD
Maintenance	120.00	120.00	120.00	120.00	120.00	120.00	120.00	LD/ha	0.67	LD
Harvesting	0.21	0.21	0.21	0.21	0.21	0.21	0.21	LD/t	0.67	LD
Marketing:										
Transport/haulage	20.00	20.00	20.00	20.00	20.00	20.00	20.00	km	1.78	t/km

b) Budget summary and Gross Margin estimates

Description	Quantity by year							Average
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	
1. OUTPUTS								
Total yield (t)	110.00	110.00	110.00	110.00	105.00	105.00	105.00	107.86
Blend price (US$/t)	36.05	36.05	36.05	36.05	36.05	36.05	36.05	36.05
Gross Income	3,965.09	3,965.09	3,965.09	3,965.09	3,784.86	3,784.86	3,784.86	3,887.85
2. INPUTS								
Planting materials	852.89	0.00	0.00	0.00	0.00	0.00	0.00	121.84
Tillage	30.95	30.95	30.95	30.95	30.95	30.95	30.95	30.95
Fertiliser&lime	536.32	294.46	382.00	382.00	382.00	382.00	382.00	391.54
Chemicals	40.12	38.65	38.65	38.65	38.65	38.65	38.65	38.86
Input costs	1,460.28	364.06	451.60	451.60	451.60	451.60	451.60	583.19
3. LABOUR								
Labour days/ha	193.10	143.10	143.10	143.10	142.05	142.05	142.05	149.79
Labour cost	129.69	96.11	96.11	96.11	95.41	95.41	95.41	100.61
4. WATER								
Ml/ha (gross)	20.77	20.77	20.77	20.77	20.77	20.77	20.77	20.77
Water cost	278.62	278.62	278.62	278.62	278.62	278.62	278.62	278.62
5. TOTAL PRODUCTION COSTS	1,868.59	738.79	826.33	826.33	825.62	825.62	825.62	962.41
8. TOTAL VARIABLE COSTS	1,868.59	738.79	826.33	826.33	825.62	825.62	825.62	962.41
9. GROSS MARGIN	2,096.50	3,226.30	3,138.76	3,138.76	2,959.24	2,959.24	2,959.24	2,925.43
Cost maintenance on-field canals (USD/ha)	28	28	28	28	28	28	28	
GM after deduction of cost maintenance on-field	**2,068**	**3,198**	**3,111**	**3,111**	**2,931**	**2,931**	**2,931**	2,897.33

APPENDIXB2 LIVESTOCK PRODUCTION FINANCIAL COST

WITH PROJECT FINANCIAL FROM PWC JAN 2017

Assumptions

Description	Unit	Number
Cow herd	number	100
Adult mortality rate (percentage)	%	3%
Replacement heifers	%	20%
Culling rate (percentage)	%	15%
Calving rate (percentage)	%	80%
Calf mortality	%	5%
Male calves	%	50%
Female calves	%	50%

Herd build-up projections

Description /Year	1	2	3	4	5	6	7	8	9	10
Adult cows	100	97	94	77	93	106	107	109	110	113
Cull cows				14	12	14	16	16	16	17
Heifers:										
Replacement heifers				30	30	20	21	21	22	22
Surplus heifers				6	5	14	18	23	24	24
Heifers (1-3 year old)			36	35	34	39	44	46	46	47
Weaner heifers		38	37	36	41	47	48	49	49	50
Steers:										
Steers (3-year old)				34	33	32	37	42	43	44
Steers (1-3 year old)			36	35	34	39	44	46	46	47
Weaner steers		38	37	36	41	47	48	49	49	50
Calves:	80	78	75	86	99	101	103	104	106	108
Female calves	40	39	38	43	49	51	51	52	53	54
Male calves	40	39	38	43	49	51	51	52	53	54
Closing balance	**180**	**251**	**315**	**389**	**421**	**459**	**486**	**505**	**513**	**521**

Income and expenditure estimates 990

Description/year	Weight/anim	Price-USD/	1	2	3	4	5	6	7	8	9	10
Income:												
Cull cows	450	2.20	0	0	0	14	12	14	16	16	16	17
Surplus heifers	415	2.20	0	0	0	6	5	14	18	23	24	24
Steers (3 year old)	415	2.20	0	0	0	34	33	32	37	42	43	44
Total sales (numbers)			**0**	**0**	**0**	55	50	60	70	82	83	85
Sub-total - Revenue (USD)			**0**	**0**	**0**	50,853	46,410	56,062	65,507	75,987	77,388	78,772
Expenditure:												
Induction cost		0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stables and troughs etc			100,000									
Cost of adult cows			99,000									
Cost of calfs			26,400									
Insurance		7.50	1,350	1,880	2,365	2,917	3,158	3,442	3,649	3,785	3,848	3,911
Supplementary feed												
Dipping		0.20	36	50	63	78	84	92	97	101	103	104
Dosing		1.88	338	470	591	729	790	860	912	946	962	978
Vaccination:												
Lumpy skin disease		1.20	216	301	378	467	505	551	584	606	616	626
Botulism and QE		0.80	144	200	252	311	337	367	389	404	410	417
FMD		2.00	360	501	631	778	842	918	973	1,009	1,026	1,043
Labour input (days)			1,825	2,028	2,231	2,433	2,636	2,839	3,042	3,244	3,447	3,650
Wages	3650	1.34	2,451	4,903	4,903	4,903	4,903	4,903	4,903	4,903	4,903	4,903
Sub-total - Expenditure (USD)			**232,120**	**10,333**	**11,413**	**12,616**	**13,256**	**13,972**	**14,549**	**14,999**	**15,316**	**15,632**
Gross margin (USD)			**(232,120)**	**(10,333)**	**(11,413)**	**38,237**	**33,154**	**42,090**	**50,959**	**60,988**	**62,073**	**63,140**

Description/year	11	12	13	14	15	16	17	18	19	20
Income:										
Cull cows	17	17	17	17	17	17	17	17	17	17
Surplus heifers	24	24	24	24	24	24	24	24	24	24
Steers (3 year old)	44	44	44	44	44	44	44	44	44	44
Total sales (numbers)	85	85	85	85	85	85	85	85	85	85
Sub-total - Revenue (USD)	78772	78772	78772	78772	78772	78772	78772	78772	78772	78772
Expenditure:	0	0	0	0	0	0	0	0	0	0
Induction cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stables and troughs etc										
Cost of adult cows	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cost of calfs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Insurance	3,911	3,911	3,911	3,911	3,911	3,911	3,911	3,911	3,911	3,911
Supplementary feed	-	-	-	-	-	-	-	-	-	-
Dipping	104	104	104	104	104	104	104	104	104	104
Dosing	978	978	978	978	978	978	978	978	978	978
Vaccination:	-	-	-	-	-	-	-	-	-	-
Lumpy skin disease	626	626	626	626	626	626	626	626	626	626
Botulism and QE	417	417	417	417	417	417	417	417	417	417
FMD	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043
Labour input (days)	3,650	3,650	3,650	3,650	3,650	3,650	3,650	3,650	3,650	3,650
Wages	4,903	4,903	4,903	4,903	4,903	4,903	4,903	4,903	4,903	4,903
Sub-total - Expenditure (USD)	**15,632**	**15,632**	**15,632**	**15,632**	**15,632**	**15,632**	**15,632**	**15,632**	**15,632**	**15,632**
Gross margin (USD)	**63,140**	**63,140**	**63,140**	**63,140**	**63,140**	**63,140**	**63,140**	**63,140**	**63,140**	**63,140**

Year 21 – 30 the same values as Year 11 -20

Discount rate	6%
FNPV	395,523
F B/C Ratio	1.98
FIRR	15%

APPENDIXB2 LIVESTOCK PRODUCTION ECONOMIC COST

Income and expenditure estimates

Description/year	Weight/ani	Price-USD	1	2	3	4	5	6	7	8	9	10
Income:												
Cull cows	450	2.2	0	0	0	14	12	14	16	16	16	17
Surplus heifers	415	2.2	0	0	0	6	5	14	18	23	24	24
Steers (3 year old)	415	2.2	0	0	0	34	33	32	37	42	43	44
Total sales (numbers)			**0**	**0**	**0**	55	50	60	70	82	83	85
Sub-total - Revenue (USD)			**0**	**0**	**0**	50,853	46,410	56,062	65,507	75,987	77,388	78,772
Expenditure:												
Induction cost		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stables and troughs etc			96,000.00									
Cost of adult cows			99,000									
Cost of calfs			26,400									
Insurance		7.50	1,350	1,880	2,365	2,917	3,158	3,442	3,649	3,785	3,848	3,911
Supplementary feed												
Dipping		0.20	36	50	63	78	84	92	97	101	103	104
Dosing		1.88	338	470	591	729	790	860	912	946	962	978
Vaccination:												
Lumpy skin disease		1.20	216	301	378	467	505	551	584	606	616	626
Botulism and QE		0.80	144	200	252	311	337	367	389	404	410	417
FMD		2.00	360	501	631	778	842	918	973	1,009	1,026	1,043
Labour input (days)			1,825	2,028	2,231	2,433	2,636	2,839	3,042	3,244	3,447	3,650
Wages	3650	0.67	2,451	2,451	2,451	2,451	2,451	2,451	2,451	2,451	2,451	2,451
Sub-total - Expenditure (USD)			**228,120**	**7,881**	**8,962**	**10,165**	**10,804**	**11,520**	**12,097**	**12,547**	**12,864**	**13,180**
Gross margin (USD)			**(228,120)**	**(7,881)**	**(8,962)**	**40,688**	**35,606**	**44,542**	**53,410**	**63,440**	**64,524**	**65,592**

Description/year	11	12	13	14	15	16	17	18	19	20
Income:										
Cull cows	17	17	17	17	17	17	17	17	17	17
Surplus heifers	24	24	24	24	24	24	24	24	24	24
Steers (3 year old)	44	44	44	44	44	44	44	44	44	44
Total sales (numbers)	85	85	85	85	85	85	85	85	85	85
Sub-total - Revenue (USD)	78,772	78,772	78,772	78,772	78,772	78,772	78,772	78,772	78,772	78,772
Expenditure:										
Induction cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stables and troughs etc										
Cost of adult cows										
Cost of calfs										
Insurance	3,911	3,911	3,911	3,911	3,911	3,911	3,911	3,911	3,911	3,911
Supplementary feed	-	-	-	-	-	-	-	-	-	-
Dipping	104	104	104	104	104	104	104	104	104	104
Dosing	978	978	978	978	978	978	978	978	978	978
Vaccination:	-	-	-	-	-	-	-	-	-	-
Lumpy skin disease	626	626	626	626	626	626	626	626	626	626
Botulism and QE	417	417	417	417	417	417	417	417	417	417
FMD	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043	1,043
Labour input (days)	3,650	3,650	3,650	3,650	3,650	3,650	3,650	3,650	3,650	3,650
Wages	2,451	2,451	2,451	2,451	2,451	2,451	2,451	2,451	2,451	2,451
Sub-total - Expenditure (USD)	**13,180**	**13,180**	**13,180**	**13,180**	**13,180**	**13,180**	**13,180**	**13,180**	**13,180**	**13,180**
Gross margin (USD)	**65,592**	**65,592**	**65,592**	**65,592**	**65,592**	**65,592**	**65,592**	**65,592**	**65,592**	**65,592**

Year 21 – 30 the same values as year 11 -20

Discount rate	6%
E NPV	430,729
E B/C Ratio	2.17
EIRR	16%

APPENDIX B 3 AQUACULTURE

Investment			per 1000 m2	per ha **Financial**	CF	per ha **Economic**
3 meters deep pond construction				USD		USD
Labour	people	45	20,000	900,000	12,000	0.50	6,000
Pipes and bends		4	7,500	30,000	400	0.96	384
Cement	bags	4	6,000	24,000	320	0.96	307
Wheel barrows		5	50,000	250,000	3,333	0.96	3,200
Shovels		10	8,000	80,000	1,067	0.96	1,024
Nets				400,000	5,333	0.96	5,120
Water							
	cub meter	3000			300		300
T0tal Investment				1,684,000	22,753		16,335

Recurrent cost	**per cycle of 6 months**				
Fingerlings			90,000	1,200	1,200
Lime			60,000	800	800
Manure			12,000	160	160
Feed			250,000	3,333	3,333
Labour			120,000	1,600	0.50	800
Harvesting						
Labour			2,000	27	0.50	13
Ice			12,000	160		160
Transport			15,000	200	0.96	192
Total variable cost			561,000	7,480		6,659	per 6 months

PRODUCTION

		kg	price (MK/kg)		per ha	per ha	
Cash In	Yield	700	1,500	1,050,000	14,000	14,000	per 6 months

Financial

year	Cash Out Invest	Maintenance	OP cost	Total Out	Cash In	Cash IN - OU
1	22,753		7,480	30,233	14,000	(8,753)
2		2,275	14,960	17,235	28,000	10,765
3		2,275	14,960	17,235	28,000	10,765
4		2,275	14,960	17,235	28,000	10,765
5		2,275	14,960	17,235	28,000	10,765
6		2,275	14,960	17,235	28,000	10,765
7		2,275	14,960	17,235	28,000	10,765

Economic

year	Cash Out Invest	Maintenance	OP cost	Total Out	Cash In	Cash IN - OU
1	16,335		6,659	22,994	14,000	(8,994)
2		1,634	13,317	14,951	28,000	13,049
3		1,634	13,317	14,951	28,000	13,049
4		1,634	13,317	14,951	28,000	13,049
5		1,634	13,317	14,951	28,000	13,049
6		1,634	13,317	14,951	28,000	13,049
7		1,634	13,317	14,951	28,000	13,049

C1. B PHASE 1 AND 2 COMBINED CROPPING PATTERN 1 ECONOMICPRICES

PART A COST Phase 2 starting upon completion of Phase 1 (in year 4)

Year	Capital costs	Maintenance of irrigation scheme (a)	Compensation for Resettle-ment and loss of income	Cooperatives		Water Service Provider		Transformation Strategy	Loss of free roaming livestocck	Total Cost
				Establishment (equipm)	Operations and Maint.	Investment	O&M			
1	48,071,647	0	1,898,000	0	0	0	0	13,677,380	0	63,647,027
2	61,014,014	0	2,409,000	0	0	0	0	13,677,380	0	77,100,394
3	59,165,104	0	2,336,000	10,452,726	0	2,157,252	0	13,677,380	0	87,788,463
4	85,985,339	0	3,920,000	0	1,712,524	0	1,022,579	23,513,961	1,344,420	117,498,823
5	88,015,002	934,176	4,141,500	0	1,712,524	0	1,022,579	23,513,961	1,344,420	120,684,162
6	85,347,881	934,176	4,016,000	10,387,699	1,712,524	0	1,022,579	23,513,961	1,344,420	128,279,240
7	24,004,091	934,176	1,129,500	0	4,848,132	2,287,172	1,022,579	0	3,098,568	37,324,218
8	0	2,256,411	0	621,493	4,848,132	0	2,045,158	0	3,098,568	12,869,763
9	0	2,256,411	0	0	4,848,132	0	2,045,158	0	3,098,568	12,248,270
10	0	2,256,411	0	0	4,848,132	0	2,045,158	0	3,098,568	12,248,270
11	0	2,256,411	0	2,549,199	4,848,132	259,840	2,045,158	0	3,098,568	15,057,309
12	0	2,256,411	0	0	4,848,132	0	2,045,158	0	3,098,568	12,248,270
13	0	2,256,411	0	1,577,919	4,848,132	0	2,045,158	0	3,098,568	13,826,189
14	0	6,575,744	0	0	4,848,132	0	2,045,158	0	3,098,568	16,567,603
15	0	2,256,411	0	0	4,848,132	259,840	2,045,158	0	3,098,568	12,508,110
16	0	2,256,411	0	3,343,680	4,848,132	0	2,045,158	0	3,098,568	15,591,950
17	0	2,256,411	0	0	4,848,132	0	2,045,158	0	3,098,568	12,248,270
18	0	8,510,576	0	621,493	4,848,132	0	2,045,158	0	3,098,568	19,123,928
19	0	2,256,411	0	1,001,199	4,848,132	259,840	2,045,158	0	3,098,568	13,509,309
20	0	2,256,411	0	0	4,848,132	0	2,045,158	0	3,098,568	12,248,270
21	0	2,256,411	0	1,486,080	4,848,132	0	2,045,158	0	3,098,568	13,734,350
22	0	2,256,411	0	0	4,848,132	0	2,045,158	0	3,098,568	12,248,270
23	0	2,256,411	0	3,611,919	4,848,132	259,840	2,045,158	0	3,098,568	16,120,029
24	0	6,575,744	0	0	4,848,132	0	2,045,158	0	3,098,568	16,567,603

Cost Continued

Year	Capital costs	Maintenance of irrigation scheme (a)	Compensation for Resettlement and loss of income	Cooperatives		Water Service Provider		Transformation Strategy	Loss of free roaming livestocck	Total Cost
				Establishment (equipm)	Operations and Maint.	Investment	O&M			
25	0	2,256,411	0	0	4,848,132	0	2,045,158	0	3,098,568	12,248,270
26	0	2,256,411	0	8,591,400	4,848,132	0	2,045,158	0	3,098,568	20,839,670
27	0	2,256,411	0	1,001,199	4,848,132	259,840	2,045,158	0	3,098,568	13,509,309
28	0	8,510,576	0	621,493	4,848,132	0	2,045,158	0	3,098,568	19,123,928
29	0	2,256,411	0	0	4,848,132	0	2,045,158	0	3,098,568	12,248,270
30	0	2,256,411	0	0	4,848,132	0	2,045,158	0	3,098,568	12,248,270
31	0	2,256,411	0	1,486,080	4,848,132	129,920	2,045,158	0	3,098,568	13,864,270
32	0	2,256,411	0	0	4,848,132	0	2,045,158	0	3,098,568	12,248,270
33	0	2,256,411	0	1,577,919	4,848,132	0	2,045,158	0	3,098,568	13,826,189
34	0	6,575,744	0	0	4,848,132	0	2,045,158	0	3,098,568	16,567,603
35	0	2,256,411	0	761,199	4,848,132	0	2,045,158	0	3,098,568	13,009,469
36	0	2,256,411	0	3,343,680	4,848,132	0	2,045,158	0	3,098,568	15,591,950
37	0	2,256,411	0	0	4,848,132	0	2,045,158	0	3,098,568	12,248,270
38	0	8,510,576	0	621,493	4,848,132	0	2,045,158	0	3,098,568	19,123,928
39	0	2,256,411	0	0	4,848,132	0	2,045,158	0	3,098,568	12,248,270
40	0	2,256,411	0	3,773,119	4,848,132	0	2,045,158	0	3,098,568	16,021,388

Notes: (a) Maintenance only; operations is provided by the Water Service Providers and the Cooperatives

Total	451,603,078	108,984,593	19,850,000	53,657,874	165,125,924	5,873,544	71,580,544	111,574,023	109,384,572	1,106,255,402
NPV	359,338,380	31,003,116	15,677,999	25,089,214	52,478,687	3,806,801	23,670,083	89,332,474	40,974,057	634,297,723

ENPV US$)	214,853,167
EIRR	8.86%
B-C ratio	1.34
Discount rate	6%

PART B BENEFITS- ECONOMIC

Year	Phased incremental crop benefits - Non Sugar Cane	Incremental Sugar Cane benefits			Saving Capacity Electricity	Illovo's Saving in O&M cost of pumps	Improved catle raising
		New Area - KAMA	Increased Yield - outgrowers	Increased Yield _ Illovo			
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	7,085,708	5,839,772	282,788	1,138,193	34,833,784	0	(1,140,600)
6	10,193,440	9,144,428	574,163	1,138,193	696,676	0	(1,140,600)
7	13,162,440	8,888,380	551,587	958,757	696,676	0	(39,406)
8	33,836,691	8,888,380	1,317,905	958,757	696,676	0	(1,641,650)
9	42,740,108	8,363,266	1,271,606	958,757	696,676	0	148,274
10	48,793,602	8,363,266	1,207,281	96,455	696,676	0	115,295
11	57,031,969	8,363,266	1,207,281	1,225,687	696,676	0	507,529
12	59,570,855	5,839,772	984,783	1,138,193	696,676	0	516,291
13	55,901,346	9,144,428	967,040	1,138,193	696,676	0	628,991
14	57,362,566	8,888,380	1,349,270	958,757	696,676	0	696,493
15	58,537,498	8,888,380	1,317,905	958,757	696,676	0	766,698
16	60,234,834	8,363,266	1,271,606	958,757	696,676	0	774,290
17	62,057,276	8,363,266	1,207,281	96,455	696,676	0	781,762
18	63,812,408	8,363,266	1,207,281	1,225,687	696,676	0	781,762
19	65,298,060	5,839,772	984,783	1,138,193	696,676	0	781,762
20	66,954,188	9,144,428	967,040	1,138,193	696,676	0	781,762
21	68,044,138	8,888,380	1,349,270	958,757	696,676	0	781,762
22	68,964,823	8,888,380	1,317,905	958,757	696,676	0	781,762
23	69,901,386	8,363,266	1,271,606	958,757	696,676	0	781,762
24	70,020,953	8,363,266	1,207,281	96,455	696,676	0	781,762

BENEFITS ECONOMIC CONTINUED

Year	Phased incremental crop benefits - Non Sugar Cane	Incremental Sugar Cane benefits			Saving Capacity Electricity	Illovo's Saving in O&M cost of pumps	Improved catle raising
		New Area - KAMA	Increased Yield - outgrowers	Increased Yield _ Illovo			
25	70,595,820	8,363,266	1,207,281	1,225,687	696,676	0	781,762
26	70,883,254	5,839,772	984,783	1,138,193	696,676	0	781,762
27	71,098,829	9,144,428	967,040	1,138,193	696,676	0	781,762
28	71,098,829	8,888,380	1,349,270	958,757	696,676	0	781,762
29	71,098,829	8,888,380	1,317,905	958,757	696,676	0	781,762
30	71,098,829	8,363,266	1,271,606	958,757	696,676	0	781,762
31	71,098,829	8,363,266	1,207,281	96,455	696,676	0	781,762
32	71,098,829	8,363,266	1,207,281	1,225,687	696,676	0	781,762
33	71,098,829	5,839,772	984,783	1,138,193	696,676	0	781,762
34	71,098,829	9,144,428	967,040	1,138,193	696,676	0	781,762
35	71,098,829	8,888,380	1,349,270	958,757	696,676	0	781,762
36	71,098,829	8,888,380	1,317,905	958,757	696,676	0	781,762
37	71,098,829	8,363,266	1,271,606	958,757	696,676	0	781,762
38	71,098,829	8,363,266	1,207,281	96,455	696,676	0	781,762
39	71,098,829	8,363,266	1,207,281	1,225,687	696,676	0	781,762
40	71,098,829	5,839,772	984,783	1,138,193	696,676	0	781,762
Total	2,176,366,963	295,093,565	40,618,060	33,512,184	59,217,432	0	18,953,904
NPV	594,275,516	94,906,689	12,280,812	10,912,417	33,577,567	0	3,053,373

BENEFITS Continued

Year	Aquaculture	Drinking Water (Chikwawa Boma)	Flood Protecion		Paid Employment Generated			Total Benefits	Net benefits
			Irrigation scheme (1:5)	Additional 1:10	Agriculture	Construction	WSP and Cooperatives		
1	0	0	0	0	0	1,826,136	0	1,826,136	(61,820,891)
2	0	0	0	0	0	2,317,788	0	2,317,788	(74,782,606)
3	0	0	0	0	0	2,247,552	0	2,247,552	(85,540,910)
4	0	0	0	0	0	3,262,242	0	3,262,242	(114,236,581)
5	(134,908)	30,000	52,377	0	1,217,817	3,338,227	1,300,160	53,843,318	(66,840,844)
6	195,737	30,528	0	0	1,217,817	3,237,068	1,300,160	26,587,609	(101,691,631)
7	195,737	31,065	0	0	1,217,817	910,425	1,300,160	27,873,638	(9,450,581)
8	(152,325)	31,612	0	0	3,984,875	0	3,548,320	51,469,241	38,599,478
9	700,739	32,168	0	524,530	3,984,875	0	3,548,320	62,969,319	50,721,049
10	700,739	32,734	52,377	0	4,079,678	0	3,548,320	67,686,423	55,438,154
11	700,739	33,310	0	0	4,079,678	0	3,548,320	77,394,455	62,337,146
12	700,739	33,896	0	0	4,079,678	0	3,548,320	77,109,203	64,860,933
13	700,739	34,492	0	0	4,324,269	0	3,548,320	77,084,493	63,258,305
14	700,739	35,099	0	0	4,324,269	0	3,548,320	78,560,569	61,992,966
15	700,739	35,717	52,377	0	4,324,269	0	3,548,320	79,827,336	67,319,227
16	700,739	36,345	0	0	4,324,269	0	3,548,320	80,909,102	65,317,152
17	700,739	36,984	0	0	4,324,269	0	3,548,320	81,813,030	69,564,760
18	700,739	37,635	0	0	4,324,269	0	3,548,320	84,698,044	65,574,116
19	700,739	38,297	0	524,530	4,324,269	0	3,548,320	83,875,402	70,366,093
20	700,739	38,971	52,377	0	4,324,269	0	3,548,320	88,346,963	76,098,694
21	700,739	39,657	0	0	4,324,269	0	3,548,320	89,331,968	75,597,619
22	700,739	40,355	0	0	4,324,269	0	3,548,320	90,221,986	77,973,717
23	700,739	41,065	0	0	4,324,269	0	3,548,320	90,587,846	74,467,817
24	700,739	41,787	0	0	4,324,269	0	3,548,320	89,781,509	73,213,907

BENEFITS Continued

Year	Aquaculture	Drinking Water (Chikwawa Boma)	Flood Protecion		Paid Employment Generated			Total Benefits	Net benefits
			Irrigation scheme (1:5)	Additional 1:10	Agriculture	Construction	WSP and Cooperatives		
25	700,739	42,522	52,377	0	4,324,269	0	3,548,320	91,538,721	79,290,451
26	700,739	43,270	0	0	4,324,269	0	3,548,320	88,941,038	68,101,368
27	700,739	44,032	0	0	4,324,269	0	3,548,320	92,444,288	78,934,979
28	700,739	44,807	0	0	4,324,269	0	3,548,320	92,391,809	73,267,881
29	700,739	45,595	0	524,530	4,324,269	0	3,548,320	92,885,762	80,637,493
30	700,739	46,397	52,377	0	4,324,269	0	3,548,320	91,842,998	79,594,729
31	700,739	47,213	0	0	4,324,269	0	3,548,320	90,864,811	77,000,542
32	700,739	48,044	0	0	4,324,269	0	3,548,320	91,994,874	79,746,604
33	700,739	48,889	0	0	4,324,269	0	3,548,320	89,162,232	75,336,043
34	700,739	49,750	0	0	4,324,269	0	3,548,320	92,450,005	75,882,403
35	700,739	50,625	52,377	0	4,324,269	0	3,548,320	92,450,004	79,440,535
36	700,739	51,516	0	0	4,324,269	0	3,548,320	92,367,153	76,775,203
37	700,739	52,422	0	0	4,324,269	0	3,548,320	91,796,646	79,548,376
38	700,739	53,344	0	0	4,324,269	0	3,548,320	90,870,942	71,747,015
39	700,739	54,283	0	524,530	4,324,269	0	3,548,320	92,525,643	80,277,373
40	700,739	55,238	52,377	0	4,324,269	0	3,548,320	89,220,958	73,199,570
Total	22,527,895	1,489,663	419,020	2,098,120	144,941,769	17,139,438	120,995,040	2,933,373,054	1,827,117,652
NPV	6,263,865	431,500	176,499	801,286	42,702,165	13,638,690	36,333,798	849,150,889	214,853,167

C1. A PHASE 1 AND 2 COMBINED, CROPPING PATTERN 1. **FINANCIAL**

PART A COST (Phase 2 starting upon completion of Phase 1 (in year 4)

Year	Capital costs	Maintenance of irrigation scheme (a)	Compensation for Resettle-ment and loss of income	Cooperatives		Water Service Provider		Transformation Strategy	Loss of free roaming livestocck	Total costs
				Establishment (equipm)	Operations and Maint.	Investment	O&M			
1	58,986,370	0	1,898,000	0	0	0	0	11,466,667	0	72,351,037
2	74,867,316	0	2,409,000	0	0	0	0	11,466,667	0	88,742,983
3	72,598,610	0	2,336,000	11,992,809	0	2,247,137	0	11,466,667	0	100,641,223
4	105,486,127	0	3,920,000	0	1,726,552	0	853,680	19,713,333	1,344,420	133,044,113
5	107,970,629	1,146,282	4,141,500	0	1,726,552	0	853,680	19,713,333	1,344,420	136,896,396
6	104,698,791	1,146,282	4,016,000	10,820,520	4,534,108	0	853,680	19,713,333	1,344,420	147,127,135
7	29,446,535	1,146,282	1,129,500	0	4,534,108	2,382,471	853,680	0	3,098,568	42,591,144
8	0	2,768,732	0	626,083	4,534,108	0	1,707,360	0	3,098,568	12,734,851
9	0	2,768,732	0	0	4,534,108	0	1,707,360	0	3,098,568	12,108,768
10	0	2,768,732	0	0	4,534,108	0	1,707,360	0	3,098,568	12,108,768
11	0	2,768,732	0	2,583,622	4,534,108	270,667	1,707,360	0	3,098,568	14,963,057
12	0	2,768,732	0	0	4,534,108	0	1,707,360	0	3,098,568	12,108,768
13	0	2,768,732	0	1,632,996	4,534,108	988,235	1,707,360	0	3,098,568	14,729,999
14	0	8,068,775	0	2,167,200	4,534,108	0	1,707,360	0	3,098,568	19,576,011
15	0	2,768,732	0	0	4,534,108	270,667	1,707,360	0	3,098,568	12,379,435
16	0	2,768,732	0	3,405,600	4,534,108	0	1,707,360	0	3,098,568	15,514,368
17	0	2,768,732	0	0	4,534,108	988,235	1,707,360	0	3,098,568	13,097,003
18	0	10,442,912	0	626,083	4,534,108	0	1,707,360	0	3,098,568	20,409,031
19	0	2,768,732	0	1,035,622	4,534,108	270,667	1,707,360	0	3,098,568	13,415,057
20	0	2,768,732	0	0	4,534,108	0	1,707,360	0	3,098,568	12,108,768
21	0	2,768,732	0	1,548,000	4,534,108	0	1,707,360	0	3,098,568	13,656,768
22	0	2,768,732	0	2,167,200	4,534,108	0	1,707,360	0	3,098,568	14,275,968
23	0	2,768,732	0	3,666,996	4,534,108	270,667	1,707,360	0	3,098,568	16,046,431
24	0	8,068,775	0	0	4,534,108	0	1,707,360	0	3,098,568	17,408,811

Year	Capital costs	Maintenance of irrigation scheme (a)	Compensation for Resettle-ment and loss of income	Cooperatives		Water Service Provider		Transformation Strategy	Loss of free roaming livestocck	Total costs
				Establishment (equipm)	Operations and Maint.	Investment	O&M			
25	0	2,768,732	0	0	4,534,108	0	1,707,360	0	3,098,568	12,108,768
26	0	2,768,732	0	8,653,320	4,534,108	0	1,707,360	0	3,098,568	20,762,088
27	0	2,768,732	0	1,035,622	4,534,108	270,667	1,707,360	0	3,098,568	13,415,057
28	0	10,442,912	0	626,083	4,534,108	0	1,707,360	0	3,098,568	20,409,031
29	0	2,768,732	0	0	4,534,108	988,235	1,707,360	0	3,098,568	13,097,003
30	0	2,768,732	0	2,167,200	4,534,108	0	1,707,360	0	3,098,568	14,275,968
31	0	2,768,732	0	1,548,000	4,534,108	270,667	1,707,360	0	3,098,568	13,927,435
32	0	2,768,732	0	0	4,534,108	0	1,707,360	0	3,098,568	12,108,768
33	0	2,768,732	0	1,632,996	4,534,108	988,235	1,707,360	0	3,098,568	14,729,999
34	0	8,068,775	0	0	4,534,108	0	1,707,360	0	3,098,568	17,408,811
35	0	2,768,732	0	795,622	4,534,108	270,667	1,707,360	0	3,098,568	13,175,057
36	0	2,768,732	0	3,405,600	4,534,108	0	1,707,360	0	3,098,568	15,514,368
37	0	2,768,732	0	0	4,534,108	0	1,707,360	0	3,098,568	12,108,768
38	0	10,442,912	0	2,174,083	4,534,108	0	1,707,360	0	3,098,568	21,957,031
39	0	2,768,732	0	0	4,534,108	1,258,902	1,707,360	0	3,098,568	13,367,670
40	0	2,768,732	0	3,862,618	4,534,108	0	1,707,360	0	3,098,568	15,971,386
	Notes:	(a) Maintenance only; operations is provided by the Water Service Providers and the Cooperatives								
Total	554,054,379	133,729,671	19,850,000	64,311,257	157,612,783	11,736,118	59,757,600	93,540,000	109,384,572	1,212,373,105
NPV	440,863,329	38,042,410	15,677,999	28,963,092	51,339,180	5,309,769	18,641,981	74,893,415	40,974,057	708,950,132

FNPV US$)	107,062,375
FIRR	7.3%
B-C ratio	1.15
Discount rate	6%

PART B – Benefits

Year	Phased incremental crop benefits - Non Sugar Cane	Incremental Sugar Cane benefits			Illovo's Saving in O&M cost of pumps	Irrigation Service Charges			
		New Area - KAMA	Increased Yield - outgrowers	Increased Yield _ Illovo		Non-cane coops	KAMA	Other Outgrowers	Illovo
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	3,520,120	6,001,135	297,016	919,841	0	1,981,426	786,423	718,566	3,784,327
6	6,530,976	8,516,098	518,762	919,841	0	1,981,426	786,423	718,566	3,784,327
7	9,578,801	8,516,098	495,246	741,110	0	1,981,426	786,423	718,566	3,784,327
8	20,952,062	8,249,382	1,183,290	741,110	0	1,981,426	786,423	718,566	3,784,327
9	29,526,542	8,249,382	1,137,172	741,110	0	7,093,506	786,423	1,716,869	3,784,327
10	35,825,606	7,726,331	1,073,100	151,594	0	7,093,506	786,423	1,716,869	3,784,327
11	44,069,534	7,726,331	1,073,100	1,010,981	0	7,093,506	786,423	1,716,869	3,784,327
12	46,369,775	7,726,331	920,988	919,841	0	7,093,506	786,423	1,716,869	3,784,327
13	42,903,776	6,001,135	160,462	919,841	0	7,093,506	786,423	1,716,869	3,784,327
14	44,422,595	8,516,098	1,215,961	741,110	0	7,093,506	786,423	1,716,869	3,784,327
15	45,502,624	8,249,382	1,183,290	741,110	0	7,093,506	786,423	1,716,869	3,784,327
16	47,444,036	8,249,382	1,137,172	741,110	0	7,093,506	786,423	1,716,869	3,784,327
17	49,248,453	7,726,331	1,073,100	151,594	0	7,093,506	786,423	1,716,869	3,784,327
18	50,989,993	7,726,331	1,073,100	1,010,981	0	7,093,506	786,423	1,716,869	3,784,327
19	52,474,520	7,726,331	920,988	919,841	0	7,093,506	786,423	1,716,869	3,784,327
20	54,126,496	6,001,135	160,462	919,841	0	7,093,506	786,423	1,716,869	3,784,327
21	55,395,871	8,516,098	1,215,961	741,110	0	7,093,506	786,423	1,716,869	3,784,327
22	56,314,225	8,249,382	1,183,290	741,110	0	7,093,506	786,423	1,716,869	3,784,327
23	57,250,788	8,249,382	1,137,172	741,110	0	7,093,506	786,423	1,716,869	3,784,327
24	57,837,353	7,726,331	1,073,100	151,594	0	7,093,506	786,423	1,716,869	3,784,327

BENEFITS CONTINUED

Year	Phased incremental crop benefits - Non Sugar Cane	Incremental Sugar Cane benefits			Illovo's Saving in	Irrigation Service Charges			
		New Area - KAMA	Increased Yield - outgrowers	Increased Yield _ Illovo		Non-cane coops	KAMA	Other Outgrowers	Illovo
25	58,412,220	7,726,331	1,073,100	1,010,981	0	7,093,506	786,423	1,716,869	3,784,327
26	58,699,654	7,726,331	920,988	919,841	0	7,093,506	786,423	1,716,869	3,784,327
27	58,915,229	6,001,135	160,462	919,841	0	7,093,506	786,423	1,716,869	3,784,327
28	58,915,229	8,516,098	1,215,961	741,110	0	7,093,506	786,423	1,716,869	3,784,327
29	58,915,229	8,249,382	1,183,290	741,110	0	7,093,506	786,423	1,716,869	3,784,327
30	58,915,229	8,249,382	1,137,172	741,110	0	7,093,506	786,423	1,716,869	3,784,327
31	58,915,229	7,726,331	1,073,100	151,594	0	7,093,506	786,423	1,716,869	3,784,327
32	58,915,229	7,726,331	1,073,100	1,010,981	0	7,093,506	786,423	1,716,869	3,784,327
33	58,915,229	7,726,331	920,988	919,841	0	7,093,506	786,423	1,716,869	3,784,327
34	58,915,229	6,001,135	160,462	919,841	0	7,093,506	786,423	1,716,869	3,784,327
35	58,915,229	8,516,098	1,215,961	741,110	0	7,093,506	786,423	1,716,869	3,784,327
36	58,915,229	8,249,382	1,183,290	741,110	0	7,093,506	786,423	1,716,869	3,784,327
37	58,915,229	8,249,382	1,137,172	741,110	0	7,093,506	786,423	1,716,869	3,784,327
38	58,915,229	7,726,331	1,073,100	151,594	0	7,093,506	786,423	1,716,869	3,784,327
39	58,915,229	7,726,331	1,073,100	1,010,981	0	7,093,506	786,423	1,716,869	3,784,327
40	58,915,229	7,726,331	920,988	919,841	0	7,093,506	786,423	1,716,869	3,784,327
Total	1,752,209,221	279,491,045	33,754,972	27,047,778	0	234,917,904	28,311,222	57,814,065	136,235,768
NPV	466,370,655	89,825,749	10,278,652	8,788,707	0	86,000,166	11,498,278	17,143,356	43,827,013

BENEFITS CONTINUED

Year	Improved catle raising	Aquaculture	Benefits from drinking water supply	Flood Protecion		Paid Employment Generated			Total Benefits	Net benefits
				Irrigation scheme (1:5)	Additional 1:10	Agriculture	Construction	WSP and Cooperatives		
1	0	0	0	0	0	0	1,826,136	0	1,826,136	(70,524,901)
2	0	0	0	0	0	0	2,317,788	0	2,317,788	(86,425,195)
3	0	0	0	0	0	0	2,247,552	0	2,247,552	(98,393,671)
4	0	0	0	0	0	0	3,262,242	0	3,262,242	(129,781,871)
5	(1,160,600)	(131,300)	30,000	114,082	0	1,217,817	3,338,227	1,300,160	22,717,240	(114,179,157)
6	(51,663)	161,470	30,528	0	0	1,217,817	3,237,068	1,300,160	29,651,800	(117,475,335)
7	(57,067)	161,470	31,065	0	0	1,217,817	910,425	1,300,160	30,165,867	(12,425,277)
8	191,185	161,470	31,612	0	0	3,984,875	0	3,548,320	46,314,048	33,579,197
9	(1,459,069)	(177,284)	32,168	0	489,384	4,079,678	0	3,548,320	59,548,527	47,439,759
10	138,123	578,063	32,734	114,082	0	4,079,678	0	3,548,320	66,648,756	54,539,988
11	174,899	578,063	33,310	0	0	4,079,678	0	3,548,320	75,675,341	60,712,284
12	572,599	578,063	33,896	0	0	4,079,678	0	3,548,320	78,130,615	66,021,847
13	542,443	578,063	34,492	0	0	4,324,269	0	3,548,320	72,393,926	57,663,927
14	610,333	578,063	35,099	0	0	4,324,269	0	3,548,320	77,372,974	57,796,963
15	672,412	578,063	35,717	114,082	0	4,324,269	0	3,548,320	78,330,393	65,950,958
16	742,617	578,063	36,345	0	0	4,324,269	0	3,548,320	80,182,439	64,668,070
17	750,210	578,063	36,984	0	0	4,324,269	0	3,548,320	80,818,449	67,721,445
18	757,682	578,063	37,635	0	0	4,324,269	0	3,548,320	83,427,498	63,018,467
19	757,682	578,063	38,297	0	489,384	4,324,269	0	3,548,320	85,158,819	71,743,762
20	757,682	578,063	38,971	114,082	0	4,324,269	0	3,548,320	83,950,446	71,841,678
21	757,682	578,063	39,657	0	0	4,324,269	0	3,548,320	88,498,156	74,841,387
22	757,682	578,063	40,355	0	0	4,324,269	0	3,548,320	89,117,819	74,841,851
23	757,682	578,063	41,065	0	0	4,324,269	0	3,548,320	90,008,975	73,962,544
24	757,682	578,063	41,787	0	0	4,324,269	0	3,548,320	89,419,624	72,010,813

BENEFITS CONTINUED

Year	Improved catle raising	Aquaculture	Benefits from drinking water	Flood Protecion		Paid Employment Generated			Total Benefits	Net benefits
				Irrigation scheme (1:5)	Additional 1:10	Agriculture	Construction	WSP and Cooperatives		
25	757,682	578,063	42,522	114,082	0	4,324,269	0	3,548,320	90,968,695	78,859,927
26	757,682	578,063	43,270	0	0	4,324,269	0	3,548,320	90,899,542	70,137,454
27	757,682	578,063	44,032	0	0	4,324,269	0	3,548,320	88,630,157	75,215,100
28	757,682	578,063	44,807	0	0	4,324,269	0	3,548,320	92,022,663	71,613,631
29	757,682	578,063	45,595	0	489,384	4,324,269	0	3,548,320	92,213,447	79,116,443
30	757,682	578,063	46,397	114,082	0	4,324,269	0	3,548,320	91,792,830	77,516,862
31	757,682	578,063	47,213	0	0	4,324,269	0	3,548,320	90,502,925	76,575,491
32	757,682	578,063	48,044	0	0	4,324,269	0	3,548,320	91,363,143	79,254,375
33	757,682	578,063	48,889	0	0	4,324,269	0	3,548,320	91,120,736	76,390,737
34	757,682	578,063	49,750	0	0	4,324,269	0	3,548,320	88,635,875	71,227,064
35	757,682	578,063	50,625	114,082	0	4,324,269	0	3,548,320	92,142,564	78,967,506
36	757,682	578,063	51,516	0	0	4,324,269	0	3,548,320	91,729,984	76,215,616
37	757,682	578,063	52,422	0	0	4,324,269	0	3,548,320	91,684,772	79,576,004
38	757,682	578,063	53,344	0	0	4,324,269	0	3,548,320	90,509,056	68,552,025
39	757,682	578,063	54,283	0	489,384	4,324,269	0	3,548,320	91,858,765	78,491,095
40	757,682	578,063	55,238	114,082	0	4,324,269	0	3,548,320	91,241,168	75,269,781
Total	19,093,102	18,095,767	1,489,663	912,659	1,957,534	145,036,572	17,139,438	120,995,040	2,874,501,750	1,662,128,645
NPV	3,606,165	4,885,373	431,500	304,504	592,166	42,758,278	13,638,690	36,333,798	816,012,507	107,062,375

C2. A PHASE 1 WITH COST OF INTAKE, CANAL 1 AND CANAL 3 REAPPORTIONED ,CROPPING PATTERN 1. FINANCIAL

PART 1 COST

Year	Capital costs	Maintenance of irrigation scheme (a)	Compensation for Resettle- ment and loss of income	Cooperatives (2 non-cane + KAMA)		Water Service Provider		Transformation Strategy	Loss of free roaming livestocck	Total Cost
				Establishment (equipm)	Operations and Maint.	Investment	O&M			
1	46,232,348	0	1,898,000	0	0	0	0	11,466,667	0	59,597,015
2	58,679,519	0	2,409,000	0	0	0	0	11,466,667	0	72,555,186
3	56,901,352	0	2,336,000	11,992,809	0	2,247,137	0	11,466,667	0	84,943,965
4	16,003,505	0	657,000	0	1,726,552	0	853,680	0	1,344,420	20,585,157
5	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
6	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
7	0	907,033	0	0	1,726,552	135,333	853,680	0	1,344,420	4,967,019
8	0	907,033	0	626,083	1,726,552	0	853,680	0	1,344,420	5,457,769
9	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
10	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
11	0	907,033	0	1,035,622	1,726,552	135,333	853,680	0	1,344,420	6,002,641
12	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
13	0	907,033	0	1,632,996	1,726,552	0	853,680	0	1,344,420	6,464,681
14	0	5,334,502	0	0	1,726,552	0	853,680	0	1,344,420	9,259,154
15	0	907,033	0	0	1,726,552	135,333	853,680	0	1,344,420	4,967,019
16	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
17	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
18	0	907,033	0	626,083	1,726,552	0	853,680	0	1,344,420	5,457,769
19	0	907,033	0	1,035,622	1,726,552	135,333	853,680	0	1,344,420	6,002,641
20	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
21	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
22	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
23	0	907,033	0	3,666,996	1,726,552	135,333	853,680	0	1,344,420	8,634,015
24	0	5,334,502	0	0	1,726,552	0	853,680	0	1,344,420	9,259,154

Year	Capital costs	Maintenance of irrigation scheme (a)	Compensation for Resettle- ment and loss of income	Cooperatives (2 non-cane + KAMA)		Water Service Provider		Transformation Strategy	Loss of free roaming livestocck	Total Cost
				Establishment (equipm)	Operations and Maint.	Investment	O&M			
25	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
26	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
27	0	907,033	0	1,035,622	1,726,552	135,333	853,680	0	1,344,420	6,002,641
28	0	907,033	0	626,083	1,726,552	0	853,680	0	1,344,420	5,457,769
29	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
30	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
31	0	907,033	0	0	1,726,552	135,333	853,680	0	1,344,420	4,967,019
32	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
33	0	907,033	0	1,632,996	1,726,552	0	853,680	0	1,344,420	6,464,681
34	0	5,334,502	0	0	1,726,552	0	853,680	0	1,344,420	9,259,154
35	0	907,033	0	795,622	1,726,552	135,333	853,680	0	1,344,420	5,762,641
36	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
37	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
38	0	907,033	0	626,083	1,726,552	0	853,680	0	1,344,420	5,457,769
39	0	907,033	0	0	1,726,552	135,333	853,680	0	1,344,420	4,967,019
40	0	907,033	0	3,862,618	1,726,552	0	853,680	0	1,344,420	8,694,304
Total	177,816,724	45,935,607	7,300,000	29,195,235	63,882,431	3,465,137	31,586,160	34,400,000	49,743,540	443,324,835
NPV	156,291,733	14,166,889	6,416,324	14,418,408	21,363,122	2,574,588	10,562,826	30,650,537	19,812,422	272,771,243

Notes: (a) Maintenance only; operations is provided by the Water Service Providers and the Cooperatives

FNPV US$)	111,174,348
FIRR	9.33%
B-C ratio	1.41
Discount rate	6%

PART 2 BENEFITS – FINANCIAL

Year	Phased incremental crop benefits - Non Sugar Cane	Incremental Sugar Cane benefits			Illovo's Saving in O&M cost of pumps	Irrigation Service Charges			
		New Area - KAMA	Increased Yield - outgrowers	Increased Yield _ Illovo		Non-cane coops	KAMA	Other Outgrowers	Illovo
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	3,520,120	6,001,135	297,016	919,841	0	1,981,426	786,423	718,566	3,784,327
6	6,530,976	8,808,598	518,762	919,841	0	1,981,426	786,423	718,566	3,784,327
7	9,578,801	8,541,882	495,246	741,110	0	1,981,426	786,423	718,566	3,784,327
8	12,620,952	8,541,882	495,246	741,110	0	1,981,426	786,423	718,566	3,784,327
9	13,427,423	8,018,831	449,128	741,110	0	1,981,426	786,423	718,566	3,784,327
10	11,863,097	8,018,831	449,128	151,594	0	1,953,119	786,423	718,566	3,784,327
11	12,258,277	8,018,831	449,128	1,010,981	0	1,953,119	786,423	718,566	3,784,327
12	12,477,821	6,001,135	297,016	919,841	0	1,953,119	786,423	718,566	3,784,327
13	13,047,784	8,808,598	518,762	919,841	0	1,953,119	786,423	718,566	3,784,327
14	13,547,040	8,541,882	495,246	741,110	0	1,953,119	786,423	718,566	3,784,327
15	14,060,645	8,541,882	495,246	741,110	0	1,953,119	786,423	718,566	3,784,327
16	14,531,552	8,018,831	449,128	741,110	0	1,953,119	786,423	718,566	3,784,327
17	15,047,888	8,018,831	449,128	151,594	0	1,953,119	786,423	718,566	3,784,327
18	15,464,327	8,018,831	449,128	1,010,981	0	1,953,119	786,423	718,566	3,784,327
19	15,733,915	6,001,135	297,016	919,841	0	1,953,119	786,423	718,566	3,784,327
20	16,053,742	8,808,598	518,762	919,841	0	1,953,119	786,423	718,566	3,784,327
21	16,248,707	8,541,882	495,246	741,110	0	1,953,119	786,423	718,566	3,784,327
22	16,471,523	8,541,882	495,246	741,110	0	1,953,119	786,423	718,566	3,784,327
23	16,582,932	8,018,831	449,128	741,110	0	1,953,119	786,423	718,566	3,784,327
24	16,666,488	8,018,831	449,128	151,594	0	1,953,119	786,423	718,566	3,784,327

PART 2 BENEFITS – FINANCIAL CONTINUED

Year	Phased incremental crop benefits - Non Sugar Cane	Incremental Sugar Cane benefits			Illovo's Saving in O&M cost of pumps	Irrigation Service Charges			
		New Area - KAMA	Increased Yield - outgrowers	Increased Yield _ Illovo		Non-cane coops	KAMA	Other Outgrowers	Illovo
25	16,666,488	8,018,831	449,128	1,010,981	0	1,953,119	786,423	718,566	3,784,327
26	16,666,488	6,001,135	297,016	919,841	0	1,953,119	786,423	718,566	3,784,327
27	16,666,488	8,808,598	518,762	919,841	0	1,953,119	786,423	718,566	3,784,327
28	16,666,488	8,541,882	495,246	741,110	0	1,953,119	786,423	718,566	3,784,327
29	16,666,488	8,541,882	495,246	741,110	0	1,953,119	786,423	718,566	3,784,327
30	16,666,488	8,018,831	449,128	741,110	0	1,953,119	786,423	718,566	3,784,327
31	16,666,488	8,018,831	449,128	151,594	0	1,953,119	786,423	718,566	3,784,327
32	16,666,488	8,018,831	449,128	1,010,981	0	1,953,119	786,423	718,566	3,784,327
33	16,666,488	6,001,135	297,016	919,841	0	1,953,119	786,423	718,566	3,784,327
34	16,666,488	8,808,598	518,762	919,841	0	1,953,119	786,423	718,566	3,784,327
35	16,666,488	8,541,882	495,246	741,110	0	1,953,119	786,423	718,566	3,784,327
36	16,666,488	8,541,882	495,246	741,110	0	1,953,119	786,423	718,566	3,784,327
37	16,666,488	8,018,831	449,128	741,110	0	1,953,119	786,423	718,566	3,784,327
38	16,666,488	8,018,831	449,128	151,594	0	1,953,119	786,423	718,566	3,784,327
39	16,666,488	8,018,831	449,128	1,010,981	0	1,953,119	786,423	718,566	3,784,327
40	16,666,488	6,001,135	297,016	919,841	0	1,953,119	786,423	718,566	3,784,327
Total	532,397,816	285,751,082	16,065,282	27,047,778	0	70,453,821	28,311,222	25,868,381	136,235,768
NPV	153,069,289	91,957,345	5,173,735	8,788,707	0	28,675,769	11,498,278	8,321,852	43,827,013

PART 2 BENEFITS – FINANCIAL CONTINUED

Year	Improved catle raising	Aquaculture	Drinking Water (Chikwawa Boma)	Flood Protecion		Paid Employment Generated			Total Benefits	Net benefits
				Irrigation scheme (1:5)	Additional 1:10	Agriculture	Construction	WSP and Cooperatives		
1	0	0	0	0	0	0	1,826,136	0	1,826,136	(57,770,879)
2	0	0	0	0	0	0	2,317,788	0	2,317,788	(70,237,398)
3	0	0	0	0	0	0	2,247,552	0	2,247,552	(82,696,413)
4	0	0	0	114,082	0	0	632,124	0	746,206	(19,838,951)
5	(1,160,600)	(131,300)	30,000	0	0	1,217,817	0	1,300,160	19,264,931	14,433,245
6	(51,663)	161,470	30,528	0	0	1,217,817	0	1,300,160	26,707,231	21,875,546
7	(57,067)	161,470	31,065	0	0	1,217,817	0	1,300,160	29,281,225	24,314,207
8	191,185	161,470	31,612	0	489,384	1,217,817	0	1,300,160	33,061,559	27,603,790
9	165,771	161,470	32,168	114,082	0	1,312,620	0	1,300,160	32,993,505	28,161,820
10	210,452	161,470	32,734	0	0	1,312,620	0	1,300,160	30,742,520	25,910,834
11	254,794	161,470	33,310	0	0	1,312,620	0	1,300,160	32,042,004	26,039,363
12	304,940	161,470	33,896	0	0	1,312,620	0	1,300,160	30,051,333	25,219,647
13	310,364	161,470	34,492	0	0	1,312,620	0	1,300,160	33,656,526	27,191,845
14	315,701	161,470	35,099	114,082	0	1,312,620	0	1,300,160	33,806,844	24,547,690
15	315,701	161,470	35,717	0	0	1,312,620	0	1,300,160	34,206,984	29,239,966
16	315,701	161,470	36,345	0	0	1,312,620	0	1,300,160	34,109,350	29,277,665
17	315,701	161,470	36,984	0	0	1,312,620	0	1,300,160	34,036,811	29,205,125
18	315,701	161,470	37,635	0	489,384	1,312,620	0	1,300,160	35,802,670	30,344,901
19	315,701	161,470	38,297	114,082	0	1,312,620	0	1,300,160	33,436,671	27,434,030
20	315,701	161,470	38,971	0	0	1,312,620	0	1,300,160	36,672,301	31,840,615
21	315,701	161,470	39,657	0	0	1,312,620	0	1,300,160	36,398,986	31,567,301
22	315,701	161,470	40,355	0	0	1,312,620	0	1,300,160	36,622,501	31,790,815
23	315,701	161,470	41,065	0	0	1,312,620	0	1,300,160	36,165,450	27,531,436
24	315,701	161,470	41,787	114,082	0	1,312,620	0	1,300,160	35,774,295	26,515,142

PART 2 BENEFITS – FINANCIAL CONTINUED

Year	Improved catle raising	Aquaculture	Drinking Water (Chikwawa Boma)	Flood Protecion		Paid Employment Generated			Total Benefits	Net benefits
				Irrigation scheme (1:5)	Additional 1:10	Agriculture	Construction	WSP and Cooperatives		
25	315,701	161,470	42,522	0	0	1,312,620	0	1,300,160	36,520,335	31,688,649
26	315,701	161,470	43,270	0	0	1,312,620	0	1,300,160	34,260,135	29,428,450
27	315,701	161,470	44,032	0	0	1,312,620	0	1,300,160	37,290,107	31,287,466
28	315,701	161,470	44,807	0	489,384	1,312,620	0	1,300,160	37,311,301	31,853,532
29	315,701	161,470	45,595	114,082	0	1,312,620	0	1,300,160	36,936,788	32,105,102
30	315,701	161,470	46,397	0	0	1,312,620	0	1,300,160	36,254,339	31,422,653
31	315,701	161,470	47,213	0	0	1,312,620	0	1,300,160	35,665,639	30,698,621
32	315,701	161,470	48,044	0	0	1,312,620	0	1,300,160	36,525,857	31,694,171
33	315,701	161,470	48,889	0	0	1,312,620	0	1,300,160	34,265,754	27,801,073
34	315,701	161,470	49,750	114,082	0	1,312,620	0	1,300,160	37,409,907	28,150,753
35	315,701	161,470	50,625	0	0	1,312,620	0	1,300,160	36,827,736	31,065,095
36	315,701	161,470	51,516	0	0	1,312,620	0	1,300,160	36,828,627	31,996,941
37	315,701	161,470	52,422	0	0	1,312,620	0	1,300,160	36,260,364	31,428,678
38	315,701	161,470	53,344	0	489,384	1,312,620	0	1,300,160	36,161,154	30,703,385
39	315,701	161,470	54,283	114,082	0	1,312,620	0	1,300,160	36,646,178	31,679,159
40	315,701	161,470	55,238	0	0	1,312,620	0	1,300,160	34,272,103	25,577,800
Total	8,692,094	5,520,150	1,489,663	912,659	1,957,534	46,875,096	7,023,600	46,805,760	1,241,407,707	798,082,872
NPV	1,780,552	1,651,240	431,500	322,774	627,696	14,941,495	6,173,382	15,057,402	383,945,591	111,174,348

C2. B PHASE 1 WITH COST OF INTAKE, CANAL 1 AND CANAL 3 REAPPORTIONED. CROPPING PATTERN 1 ECONOMIC PRICES

PART 1 Cost

Year	Capital costs	Maintenance of irrigation scheme (a)	Compensation for Resettle-ment and loss of income	Cooperatives (2 non-cane + KAMA)		Water Service Provider		Transformation Strategy	Loss of free roaming livestocck	Total Cost
				Establishment (equipm)	Operations and Maint.	Investm+ Replacement	Annually Recurrent			
1	37,194,767	0	1,898,000	0	0	0	0	13,677,380	0	52,770,147
2	47,208,743	0	2,409,000	0	0	0	0	13,677,380	0	63,295,123
3	45,778,175	0	2,336,000	11,992,809	0	2,157,252	0	13,677,380	0	75,941,615
4	12,875,112	0	657,000	0	1,712,524	0	1,022,579	0	1,344,420	17,611,635
5	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
6	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
7	0	830,400	0	0	1,712,524	129,920	1,022,579	0	1,344,420	5,039,843
8	0	830,400	0	626,083	1,712,524	0	1,022,579	0	1,344,420	5,536,006
9	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
10	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
11	0	830,400	0	1,035,622	1,712,524	129,920	1,022,579	0	1,344,420	6,075,465
12	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
13	0	830,400	0	1,632,996	1,712,524	0	1,022,579	0	1,344,420	6,542,918
14	0	4,291,704	0	0	1,712,524	0	1,022,579	0	1,344,420	8,371,227
15	0	830,400	0	0	1,712,524	129,920	1,022,579	0	1,344,420	5,039,843
16	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
17	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
18	0	830,400	0	626,083	1,712,524	0	1,022,579	0	1,344,420	5,536,006
19	0	830,400	0	1,035,622	1,712,524	129,920	1,022,579	0	1,344,420	6,075,465
20	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
21	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
22	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
23	0	830,400	0	3,666,996	1,712,524	129,920	1,022,579	0	1,344,420	8,706,838
24	0	4,291,704	0	0	1,712,524	0	1,022,579	0	1,344,420	8,371,227

Part 1 COST Continued

Year	Capital costs	Maintenance of irrigation scheme (a)	Compensation for Resettle-ment and loss of income	Cooperatives (2 non-cane + KAMA)		Water Service Provider		Transformation Strategy	Loss of free roaming livestocck	Total Cost
				Establishment (equipm)	Operations and Maint.	Investm+ Replacement	Annually Recurrent			
25	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
26	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
27	0	830,400	0	1,035,622	1,712,524	129,920	1,022,579	0	1,344,420	6,075,465
28	0	830,400	0	626,083	1,712,524	0	1,022,579	0	1,344,420	5,536,006
29	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
30	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
31	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
32	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
33	0	830,400	0	1,632,996	1,712,524	0	1,022,579	0	1,344,420	6,542,918
34	0	4,291,704	0	0	1,712,524	0	1,022,579	0	1,344,420	8,371,227
35	0	830,400	0	795,622	1,712,524	0	1,022,579	0	1,344,420	5,705,545
36	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
37	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
38	0	830,400	0	626,083	1,712,524	0	1,022,579	0	1,344,420	5,536,006
39	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
40	0	830,400	0	3,862,618	1,712,524	0	1,022,579	0	1,344,420	8,772,541
	Notes:	(a) Maintenance only; operations is provided by the Water Service Providers and the Cooperatives								

Total	143,056,796	40,278,308	7,300,000	29,195,235	63,363,378	2,936,772	37,835,430	41,032,140	49,743,540	414,741,599
NPV	125,739,548	12,480,179	6,416,324	14,418,408	21,189,544	2,124,220	13,411,824	36,559,800	19,812,422	248,215,579

ENPV US$)	131,997,384
EIRR	10.76%
B-C ratio	1.53
Discount rate	6%

PART 2 BENEFITS - ECONOMIC

Year	Phased incremental crop benefits - Non Sugar Cane	Incremental Sugar Cane benefits			Saving Capacity Electricity	Illovo's Saving in O&M cost of pumps	Improved catle raising
		New Area - KAMA	Increased Yield - outgrowers	Increased Yield _ Illovo			
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	7,085,708	5,839,772	282,788	1,138,193	34,833,784	0	(1,140,600)
6	10,193,440	9,144,428	574,163	1,138,193	696,676	0	(39,406)
7	13,162,440	8,888,380	551,587	958,757	696,676	0	(44,810)
8	16,212,044	8,888,380	551,587	958,757	696,676	0	203,442
9	17,097,512	8,363,266	505,287	958,757	696,676	0	178,029
10	15,490,986	8,363,266	505,287	96,455	696,676	0	222,709
11	15,861,374	8,363,266	505,287	1,225,687	696,676	0	267,051
12	16,115,753	5,839,772	282,788	1,138,193	696,676	0	317,198
13	16,591,080	9,144,428	574,163	1,138,193	696,676	0	322,621
14	17,096,699	8,888,380	551,587	958,757	696,676	0	322,621
15	17,615,334	8,888,380	551,587	958,757	696,676	0	322,621
16	18,086,327	8,363,266	505,287	958,757	696,676	0	322,621
17	18,604,273	8,363,266	505,287	96,455	696,676	0	322,621
18	19,021,324	8,363,266	505,287	1,225,687	696,676	0	322,621
19	19,291,816	5,839,772	282,788	1,138,193	696,676	0	322,621
20	19,611,643	9,144,428	574,163	1,138,193	696,676	0	322,621
21	19,625,601	8,888,380	551,587	958,757	696,676	0	322,621
22	19,848,417	8,888,380	551,587	958,757	696,676	0	322,621
23	19,959,826	8,363,266	505,287	958,757	696,676	0	322,621
24	20,043,382	8,363,266	505,287	96,455	696,676	0	322,621

PART 2 BENEFITS – ECONOMIC CONTINUED

Year	Phased incremental crop benefits - Non Sugar Cane	Incremental Sugar Cane benefits			Saving Capacity Electricity	Illovo's Saving in O&M cost of pumps	Improved catle raising
		New Area - KAMA	Increased Yield - outgrowers	Increased Yield _ Illovo			
25	20,043,382	8,363,266	505,287	1,225,687	696,676	0	322,621
26	20,043,382	5,839,772	282,788	1,138,193	696,676	0	322,621
27	20,043,382	9,144,428	574,163	1,138,193	696,676	0	322,621
28	20,043,382	8,888,380	551,587	958,757	696,676	0	322,621
29	20,043,382	8,888,380	551,587	958,757	696,676	0	322,621
30	20,043,382	8,363,266	505,287	958,757	696,676	0	322,621
31	20,043,382	8,363,266	505,287	96,455	696,676	0	322,621
32	20,043,382	8,363,266	505,287	1,225,687	696,676	0	322,621
33	20,043,382	5,839,772	282,788	1,138,193	696,676	0	322,621
34	20,043,382	9,144,428	574,163	1,138,193	696,676	0	322,621
35	20,043,382	8,888,380	551,587	958,757	696,676	0	322,621
36	20,043,382	8,888,380	551,587	958,757	696,676	0	322,621
37	20,043,382	8,363,266	505,287	958,757	696,676	0	322,621
38	20,043,382	8,363,266	505,287	96,455	696,676	0	322,621
39	20,043,382	8,363,266	505,287	1,225,687	696,676	0	322,621
40	20,043,382	5,839,772	282,788	1,138,193	696,676	0	322,621
Total	657,309,088	295,093,565	17,662,717	33,512,184	59,217,432	0	8,997,002
NPV	193,899,193	94,906,689	5,679,902	10,912,417	33,577,567	0	1,895,238

PART 2 BENEFITS – ECONOMIC CONTINUED

Year	Aquaculture	Drinking Water (Chikwawa Boma)	Flood Protecion		Paid Employment generated			Total Benefits	Net benefits
			Irrigation scheme (1:5)	Additional 1:10	Agriculture	Construction	WSP and Cooperatives		
1	0	0	0	0	0	1,826,136	0	1,826,136	(50,944,011)
2	0	0	0	0	0	2,317,788	0	2,317,788	(60,977,335)
3	0	0	0	0	0	2,247,552	0	2,247,552	(73,694,063)
4	0	0	0	0	0	632,124	0	632,124	(16,979,511)
5	(134,908)	30,000	52,377	0	1,217,817	0	1,300,160	50,505,091	45,595,168
6	195,737	30,528	0	0	1,217,817	0	1,300,160	24,451,735	19,541,812
7	195,737	31,065	0	0	1,217,817	0	1,300,160	26,957,808	21,917,965
8	195,737	31,612	0	0	1,217,817	0	1,300,160	30,256,211	24,720,206
9	195,737	32,168	0	524,530	1,217,817	0	1,300,160	31,069,938	26,160,016
10	195,737	32,734	52,377	0	1,312,620	0	1,300,160	28,269,008	23,359,085
11	195,737	33,310	0	0	1,312,620	0	1,300,160	29,761,168	23,685,703
12	195,737	33,896	0	0	1,312,620	0	1,300,160	27,232,792	22,322,869
13	195,737	34,492	0	0	1,312,620	0	1,300,160	31,310,169	24,767,251
14	195,737	35,099	0	0	1,312,620	0	1,300,160	31,358,335	22,987,108
15	195,737	35,717	52,377	0	1,312,620	0	1,300,160	31,929,965	26,890,123
16	195,737	36,345	0	0	1,312,620	0	1,300,160	31,777,795	26,867,873
17	195,737	36,984	0	0	1,312,620	0	1,300,160	31,434,079	26,524,156
18	195,737	37,635	0	0	1,312,620	0	1,300,160	32,981,013	27,445,007
19	195,737	38,297	0	524,530	1,312,620	0	1,300,160	30,943,209	24,867,744
20	195,737	38,971	52,377	0	1,312,620	0	1,300,160	34,387,589	29,477,666
21	195,737	39,657	0	0	1,312,620	0	1,300,160	33,891,795	28,981,872
22	195,737	40,355	0	0	1,312,620	0	1,300,160	34,115,309	29,205,386
23	195,737	41,065	0	0	1,312,620	0	1,300,160	33,656,014	24,949,175
24	195,737	41,787	0	0	1,312,620	0	1,300,160	32,877,991	24,506,764

PART 2 BENEFITS – ECONOMIC CONTINUED

Year	Aquaculture	Drinking Water (Chikwawa Boma)	Flood Protecion		Paid Employment generated			Total Benefits	Net benefits
			Irrigation scheme (1:5)	Additional 1:10	Agriculture	Construction	WSP and Cooperatives		
25	195,737	42,522	52,377	0	1,312,620	0	1,300,160	34,060,336	29,150,413
26	195,737	43,270	0	0	1,312,620	0	1,300,160	31,175,219	26,265,296
27	195,737	44,032	0	0	1,312,620	0	1,300,160	34,772,011	28,696,546
28	195,737	44,807	0	0	1,312,620	0	1,300,160	34,314,726	28,778,720
29	195,737	45,595	0	524,530	1,312,620	0	1,300,160	34,840,044	29,930,121
30	195,737	46,397	52,377	0	1,312,620	0	1,300,160	33,797,280	28,887,357
31	195,737	47,213	0	0	1,312,620	0	1,300,160	32,883,417	27,973,494
32	195,737	48,044	0	0	1,312,620	0	1,300,160	34,013,480	29,103,557
33	195,737	48,889	0	0	1,312,620	0	1,300,160	31,180,838	24,637,919
34	195,737	49,750	0	0	1,312,620	0	1,300,160	34,777,729	26,406,502
35	195,737	50,625	52,377	0	1,312,620	0	1,300,160	34,372,922	28,667,376
36	195,737	51,516	0	0	1,312,620	0	1,300,160	34,321,435	29,411,512
37	195,737	52,422	0	0	1,312,620	0	1,300,160	33,750,928	28,841,005
38	195,737	53,344	0	0	1,312,620	0	1,300,160	32,889,548	27,353,542
39	195,737	54,283	0	524,530	1,312,620	0	1,300,160	34,544,249	29,634,326
40	195,737	55,238	52,377	0	1,312,620	0	1,300,160	31,239,564	22,467,023
Total	6,715,894	1,489,663	419,020	2,098,120	46,780,294	7,023,600	46,805,760	1,183,124,339	768,382,741
NPV	2,019,793	431,500	176,499	634,694	14,885,382	6,173,382	15,057,402	380,212,962	131,997,384

C3. A PHASE 1 WITH COST OF INTAKE, CANAL 1 AND CANAL 3 REAPPORTIONED CROPPING PATTERN 2**,. FINANCIAL PRICES**

PART 1 COST

Year	Capital costs	Maintenance of irrigation scheme (a)	Compensation for Resettle-ment and loss of income	Cooperatives (2 non-cane + KAMA)		Water Service Provider		Transformation strategy	Loss of free roaming livestocck	Total Cost
				Establishment (equipm)	Operations and Maint.	Investm+ Replacement	Annually Recurrent			
1	46,232,348	0	1,898,000	0	0	0	0	11,466,667	0	59,597,015
2	58,679,519	0	2,409,000	0	0	0	0	11,466,667	0	72,555,186
3	56,901,352	0	2,336,000	11,992,809	0	2,247,137	0	11,466,667	0	84,943,965
4	16,003,505	0	657,000	0	1,726,552	0	853,680	0	1,344,420	20,585,157
5	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
6	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
7	0	907,033	0	0	1,726,552	135,333	853,680	0	1,344,420	4,967,019
8	0	907,033	0	626,083	1,726,552	0	853,680	0	1,344,420	5,457,769
9	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
10	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
11	0	907,033	0	1,035,622	1,726,552	135,333	853,680	0	1,344,420	6,002,641
12	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
13	0	907,033	0	1,632,996	1,726,552	0	853,680	0	1,344,420	6,464,681
14	0	5,334,502	0	0	1,726,552	0	853,680	0	1,344,420	9,259,154
15	0	907,033	0	0	1,726,552	135,333	853,680	0	1,344,420	4,967,019
16	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
17	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
18	0	907,033	0	626,083	1,726,552	0	853,680	0	1,344,420	5,457,769
19	0	907,033	0	1,035,622	1,726,552	135,333	853,680	0	1,344,420	6,002,641
20	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
21	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
22	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
23	0	907,033	0	3,666,996	1,726,552	135,333	853,680	0	1,344,420	8,634,015
24	0	5,334,502	0	0	1,726,552	0	853,680	0	1,344,420	9,259,154

Note: * For the institutional cost: 2 non-cane cooperatives + KAMA

PART 1 COST Continued

Year	Capital costs	Maintenance of irrigation scheme (a)	Compensation for Resettle-ment and loss of income	Cooperatives (2 non-cane + KAMA)		Water Service Provider		Transformation strategy	Loss of free roaming livestocck	Total Cost
				Establishment (equipm)	Operations and Maint.	Investm+ Replacement	Annually Recurrent			
25	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
26	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
27	0	907,033	0	1,035,622	1,726,552	135,333	853,680	0	1,344,420	6,002,641
28	0	907,033	0	626,083	1,726,552	0	853,680	0	1,344,420	5,457,769
29	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
30	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
31	0	907,033	0	0	1,726,552	135,333	853,680	0	1,344,420	4,967,019
32	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
33	0	907,033	0	1,632,996	1,726,552	0	853,680	0	1,344,420	6,464,681
34	0	5,334,502	0	0	1,726,552	0	853,680	0	1,344,420	9,259,154
35	0	907,033	0	795,622	1,726,552	135,333	853,680	0	1,344,420	5,762,641
36	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
37	0	907,033	0	0	1,726,552	0	853,680	0	1,344,420	4,831,686
38	0	907,033	0	626,083	1,726,552	0	853,680	0	1,344,420	5,457,769
39	0	907,033	0	0	1,726,552	135,333	853,680	0	1,344,420	4,967,019
40	0	907,033	0	3,862,618	1,726,552	0	853,680	0	1,344,420	8,694,304

Notes: (a) Maintenance only; operations is provided by the Water Service Providers and the Cooperatives

Total	177,816,724	45,935,607	7,300,000	29,195,235	63,882,431	3,465,137	31,586,160	34,400,000	49,743,540	443,324,835
NPV	156,291,733	14,166,889	6,416,324	14,418,408	21,363,122	2,266,513	10,562,826	30,650,537	19,812,422	272,771,243

FNPV US$)	134,142,617
FIRR	9.82%
B-C ratio	1.49
Discount rate	6%

PART 2 BENEFITS Financial

Year	Phased incremental crop benefits - Non Sugar Cane	Incremental Sugar Cane benefits			Illovo's Saving in O&M cost of pumps	Irrigation Service Charges			
		New Area - KAMA	Increased Yield - outgrowers	Increased Yield _ Illovo		Non-cane coops	KAMA	Other Outgrowers	Illovo
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	1,574,307	6,001,135	297,016	919,841	0	1,924,659	786,423	718,566	3,784,327
6	5,015,577	8,516,098	518,762	919,841	0	1,924,659	786,423	718,566	3,784,327
7	8,137,008	8,249,382	495,246	741,110	0	1,924,659	786,423	718,566	3,784,327
8	11,956,456	8,249,382	495,246	741,110	0	1,924,659	786,423	718,566	3,784,327
9	13,667,456	7,726,331	449,128	741,110	0	1,924,659	786,423	718,566	3,784,327
10	13,667,456	7,726,331	449,128	151,594	0	1,924,659	786,423	718,566	3,784,327
11	15,642,580	7,726,331	449,128	1,010,981	0	1,924,659	786,423	718,566	3,784,327
12	16,678,452	6,001,135	297,016	919,841	0	1,924,659	786,423	718,566	3,784,327
13	17,513,908	8,516,098	518,762	919,841	0	1,924,659	786,423	718,566	3,784,327
14	18,054,755	8,249,382	495,246	741,110	0	1,924,659	786,423	718,566	3,784,327
15	18,696,392	8,249,382	495,246	741,110	0	1,924,659	786,423	718,566	3,784,327
16	19,087,529	7,726,331	449,128	741,110	0	1,924,659	786,423	718,566	3,784,327
17	19,534,542	7,726,331	449,128	151,594	0	1,924,659	786,423	718,566	3,784,327
18	19,758,049	7,726,331	449,128	1,010,981	0	1,924,659	786,423	718,566	3,784,327
19	19,925,679	6,001,135	297,016	919,841	0	1,924,659	786,423	718,566	3,784,327
20	19,925,679	8,516,098	518,762	919,841	0	1,924,659	786,423	718,566	3,784,327
21	19,925,679	8,249,382	495,246	741,110	0	1,924,659	786,423	718,566	3,784,327
22	19,925,679	8,249,382	495,246	741,110	0	1,924,659	786,423	718,566	3,784,327
23	19,925,679	7,726,331	449,128	741,110	0	1,924,659	786,423	718,566	3,784,327
24	19,925,679	7,726,331	449,128	151,594	0	1,924,659	786,423	718,566	3,784,327

BENEFITS – FINANCIAL CONTINUED

Year	Phased incremental crop benefits - Non Sugar Cane	Incremental Sugar Cane benefits			Illovo's Saving in O&M cost of pumps	Irrigation Service Charges			
		New Area - KAMA	Increased Yield - outgrowers	Increased Yield _ Illovo		Non-cane coops	KAMA	Other Outgrowers	Illovo
25	19,925,679	7,726,331	449,128	1,010,981	0	1,924,659	786,423	718,566	3,784,327
26	19,925,679	6,001,135	297,016	919,841	0	1,924,659	786,423	718,566	3,784,327
27	19,925,679	8,516,098	518,762	919,841	0	1,924,659	786,423	718,566	3,784,327
28	19,925,679	8,249,382	495,246	741,110	0	1,924,659	786,423	718,566	3,784,327
29	19,925,679	8,249,382	495,246	741,110	0	1,924,659	786,423	718,566	3,784,327
30	19,925,679	7,726,331	449,128	741,110	0	1,924,659	786,423	718,566	3,784,327
31	19,925,679	7,726,331	449,128	151,594	0	1,924,659	786,423	718,566	3,784,327
32	19,925,679	7,726,331	449,128	1,010,981	0	1,924,659	786,423	718,566	3,784,327
33	19,925,679	6,001,135	297,016	919,841	0	1,924,659	786,423	718,566	3,784,327
34	19,925,679	8,516,098	518,762	919,841	0	1,924,659	786,423	718,566	3,784,327
35	19,925,679	8,249,382	495,246	741,110	0	1,924,659	786,423	718,566	3,784,327
36	19,925,679	8,249,382	495,246	741,110	0	1,924,659	786,423	718,566	3,784,327
37	19,925,679	7,726,331	449,128	741,110	0	1,924,659	786,423	718,566	3,784,327
38	19,925,679	7,726,331	449,128	151,594	0	1,924,659	786,423	718,566	3,784,327
39	19,925,679	7,726,331	449,128	1,010,981	0	1,924,659	786,423	718,566	3,784,327
40	19,925,679	6,001,135	297,016	919,841	0	1,924,659	786,423	718,566	3,784,327
Total	637,349,412	276,976,082	16,065,282	27,047,778	0	69,287,710	28,311,222	25,868,381	136,235,768
NPV	179,624,779	89,165,949	5,173,735	8,788,707	0	22,289,839	9,107,713	8,321,852	43,827,013

BENEFITS – FINANCIAL CONTINUED

Year	Improved catle raising	Aquaculture	Drinking Water (Chikwawa Boma)	Flood Protecion		Paid Employment generated			Total Benefits	Net benefits
				Irrigation scheme (1:5)	Additional 1:10	Agriculture	Construction	WSP and Cooperatives		
1	0	0	0	0	0	0	1,826,136	0	1,826,136	(57,770,879)
2	0	0	0	0	0	0	2,317,788	0	2,317,788	(70,237,398)
3	0	0	0	0	0	0	2,247,552	0	2,247,552	(82,696,413)
4	0	0	0	0	0	0	632,124	0	632,124	(19,953,033)
5	(1,160,600)	(131,300)	30,000	114,082	0	1,262,696	0	1,300,160	17,421,311	12,589,626
6	(51,663)	161,470	30,528	0	0	1,262,696	0	1,300,160	24,887,444	20,055,759
7	(57,067)	161,470	31,065	0	0	1,262,696	0	1,300,160	27,535,044	22,568,025
8	191,185	161,470	31,612	0	0	1,262,696	0	1,300,160	31,603,291	26,145,522
9	165,771	161,470	32,168	0	489,384	1,262,696	0	1,300,160	33,209,648	28,377,962
10	210,452	161,470	32,734	114,082	0	1,262,696	0	1,300,160	32,290,078	27,458,392
11	254,794	161,470	33,310	0	0	1,262,696	0	1,300,160	35,055,423	29,052,782
12	304,940	161,470	33,896	0	0	1,262,696	0	1,300,160	34,173,580	29,341,895
13	310,364	161,470	34,492	0	0	1,262,696	0	1,300,160	37,751,767	31,287,085
14	315,701	161,470	35,099	0	0	1,262,696	0	1,300,160	37,829,593	28,570,439
15	315,701	161,470	35,717	114,082	0	1,262,696	0	1,300,160	38,585,929	33,618,910
16	315,701	161,470	36,345	0	0	1,262,696	0	1,300,160	38,294,443	33,462,758
17	315,701	161,470	36,984	0	0	1,262,696	0	1,300,160	38,152,581	33,320,895
18	315,701	161,470	37,635	0	0	1,262,696	0	1,300,160	39,236,125	33,778,356
19	315,701	161,470	38,297	0	489,384	1,262,696	0	1,300,160	37,925,353	31,922,712
20	315,701	161,470	38,971	114,082	0	1,262,696	0	1,300,160	40,287,436	35,455,751
21	315,701	161,470	39,657	0	0	1,262,696	0	1,300,160	39,705,075	34,873,389
22	315,701	161,470	40,355	0	0	1,262,696	0	1,300,160	39,705,773	34,874,087
23	315,701	161,470	41,065	0	0	1,262,696	0	1,300,160	39,137,314	30,503,299
24	315,701	161,470	41,787	0	0	1,262,696	0	1,300,160	38,548,520	29,289,367

BENEFITS – Financial Continued

Year	Improved catle raising	Aquaculture	Drinking Water (Chikwawa Boma)	Flood Protecion		Paid Employment generated			Total Benefits	Net benefits
				Irrigation scheme (1:5)	Additional 1:10	Agriculture	Construction	WSP and Cooperatives		
25	315,701	161,470	42,522	114,082	0	1,262,696	0	1,300,160	39,522,725	34,691,039
26	315,701	161,470	43,270	0	0	1,262,696	0	1,300,160	37,440,943	32,609,257
27	315,701	161,470	44,032	0	0	1,262,696	0	1,300,160	40,178,414	34,175,773
28	315,701	161,470	44,807	0	0	1,262,696	0	1,300,160	39,710,225	34,252,456
29	315,701	161,470	45,595	0	489,384	1,262,696	0	1,300,160	40,200,397	35,368,711
30	315,701	161,470	46,397	114,082	0	1,262,696	0	1,300,160	39,256,729	34,425,043
31	315,701	161,470	47,213	0	0	1,262,696	0	1,300,160	38,553,947	33,586,928
32	315,701	161,470	48,044	0	0	1,262,696	0	1,300,160	39,414,164	34,582,479
33	315,701	161,470	48,889	0	0	1,262,696	0	1,300,160	37,446,562	30,981,880
34	315,701	161,470	49,750	0	0	1,262,696	0	1,300,160	40,184,132	30,924,978
35	315,701	161,470	50,625	114,082	0	1,262,696	0	1,300,160	39,830,125	34,067,484
36	315,701	161,470	51,516	0	0	1,262,696	0	1,300,160	39,716,934	34,885,248
37	315,701	161,470	52,422	0	0	1,262,696	0	1,300,160	39,148,671	34,316,986
38	315,701	161,470	53,344	0	0	1,262,696	0	1,300,160	38,560,078	33,102,309
39	315,701	161,470	54,283	0	489,384	1,262,696	0	1,300,160	39,909,787	34,942,768
40	315,701	161,470	55,238	114,082	0	1,262,696	0	1,300,160	37,566,993	28,872,689
Total	8,692,094	5,520,150	1,489,663	912,659	1,957,534	45,457,057	7,023,600	46,805,760	1,335,000,152	891,675,317
NPV	1,780,552	1,651,240	431,500	322,774	627,696	14,941,495	6,173,382	15,057,402	406,913,860	134,142,617

C3. B PHASE 1 WITH COST OF INTAKE, CANAL 1 AND CANAL 3 REAPPORTIONED CROPPING PATTERN 2,. ECONOMIC

Part 1 Cost

Year	Capital costs	Compensation for Resettle-ment and loss of income	Resettlement Cost	Cooperatives (2 non-cane + KAMA)		Water Service Provider		Transformatio n strategy	Loss of free roaming livestocck	Total Cost
				Establishment (equipm)	Operations and Maint.	Investm+ Replacement	Annually Recurrent			
1	37,194,767	0	1,898,000	0	0	0	0	13,677,380	0	52,770,147
2	47,208,743	0	2,409,000	0	0	0	0	13,677,380	0	63,295,123
3	45,778,175	0	2,336,000	11,992,809	0	2,157,252	0	13,677,380	0	75,941,615
4	12,875,112	0	657,000	0	1,712,524	0	1,022,579	0	1,344,420	17,611,635
5	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
6	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
7	0	830,400	0	0	1,712,524	129,920	1,022,579	0	1,344,420	5,039,843
8	0	830,400	0	626,083	1,712,524	0	1,022,579	0	1,344,420	5,536,006
9	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
10	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
11	0	830,400	0	1,035,622	1,712,524	129,920	1,022,579	0	1,344,420	6,075,465
12	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
13	0	830,400	0	1,632,996	1,712,524	0	1,022,579	0	1,344,420	6,542,918
14	0	4,291,704	0	0	1,712,524	0	1,022,579	0	1,344,420	8,371,227
15	0	830,400	0	0	1,712,524	129,920	1,022,579	0	1,344,420	5,039,843
16	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
17	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
18	0	830,400	0	626,083	1,712,524	0	1,022,579	0	1,344,420	5,536,006
19	0	830,400	0	1,035,622	1,712,524	129,920	1,022,579	0	1,344,420	6,075,465
20	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
21	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
22	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
23	0	830,400	0	3,666,996	1,712,524	129,920	1,022,579	0	1,344,420	8,706,838
24	0	4,291,704	0	0	1,712,524	0	1,022,579	0	1,344,420	8,371,227

PART 1 COST Continued

Year	Capital costs	Compensation for Resettle-ment and loss of income	Resettlement Cost	Cooperatives (2 non-cane + KAMA)		Water Service Provider		Transformation strategy	Loss of free roaming livestocck	Total Cost
				Establishment (equipm)	Operations and Maint.	Investm+ Replacement	Annually Recurrent			
25	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
26	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
27	0	830,400	0	1,035,622	1,712,524	129,920	1,022,579	0	1,344,420	6,075,465
28	0	830,400	0	626,083	1,712,524	0	1,022,579	0	1,344,420	5,536,006
29	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
30	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
31	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
32	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
33	0	830,400	0	1,632,996	1,712,524	0	1,022,579	0	1,344,420	6,542,918
34	0	4,291,704	0	0	1,712,524	0	1,022,579	0	1,344,420	8,371,227
35	0	830,400	0	795,622	1,712,524	0	1,022,579	0	1,344,420	5,705,545
36	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
37	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
38	0	830,400	0	626,083	1,712,524	0	1,022,579	0	1,344,420	5,536,006
39	0	830,400	0	0	1,712,524	0	1,022,579	0	1,344,420	4,909,923
40	0	830,400	0	3,862,618	1,712,524	0	1,022,579	0	1,344,420	8,772,541

Notes: (a) Maintenance only; operations is provided by the Water Service Providers and the Cooperatives

Total	143,056,796	40,278,308	7,300,000	29,195,235	63,363,378	2,936,772	37,835,430	41,032,140	49,743,540	414,741,599
NPV	125,739,548	12,480,179	6,416,324	14,418,408	21,189,544	2,124,220	12,652,664	36,559,800	19,812,422	248,215,579

ENPV US$)	157,186,641
EIRR	11.33%
B-C ratio	1.63
Discount rate	6%

PART 2 BENEFITS – ECONOMIC

Year	Phased incremental crop benefits - Non Sugar Cane	Incremental Sugar Cane benefits			Saving Capacity Electricity	Illovo's Saving in O&M cost of pumps	Improved catle raising	Aquaculture
		New Area - KAMA	Increased Yield - outgrowers	Increased Yield _ Illovo				
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	5,067,829	5,839,772	282,788	1,138,193	34,833,784	0	(1,140,600)	(134,908)
6	8,544,578	9,144,428	574,163	1,138,193	696,676	0	(39,406)	195,737
7	11,666,556	8,888,380	551,587	958,757	696,676	0	(44,810)	195,737
8	15,302,702	8,888,380	551,587	958,757	696,676	0	203,442	195,737
9	17,095,955	8,363,266	505,287	958,757	696,676	0	178,029	195,737
10	18,054,333	8,363,266	505,287	96,455	696,676	0	222,709	195,737
11	18,986,041	8,363,266	505,287	1,225,687	696,676	0	267,051	195,737
12	20,022,312	5,839,772	282,788	1,138,193	696,676	0	317,198	195,737
13	20,857,768	9,144,428	574,163	1,138,193	696,676	0	322,621	195,737
14	21,398,615	8,888,380	551,587	958,757	696,676	0	322,621	195,737
15	22,040,252	8,888,380	551,587	958,757	696,676	0	322,621	195,737
16	22,431,389	8,363,266	505,287	958,757	696,676	0	322,621	195,737
17	22,878,402	8,363,266	505,287	96,455	696,676	0	322,621	195,737
18	23,101,909	8,363,266	505,287	1,225,687	696,676	0	322,621	195,737
19	23,269,539	5,839,772	282,788	1,138,193	696,676	0	322,621	195,737
20	23,269,539	9,144,428	574,163	1,138,193	696,676	0	322,621	195,737
21	23,269,539	8,888,380	551,587	958,757	696,676	0	322,621	195,737
22	23,269,539	8,888,380	551,587	958,757	696,676	0	322,621	195,737
23	23,269,539	8,363,266	505,287	958,757	696,676	0	322,621	195,737
24	23,269,539	8,363,266	505,287	96,455	696,676	0	322,621	195,737

BENEFITS – ECONOMC CONTINUNED

Year	Project incremental crop benefits - Non Sugar Cane	Incremental Sugar Cane benefits			Saving Capacity Electricity	Illovo's Saving in O&M cost of pumps	Improved catle raising	Aquaculture
		New Area - KAMA	Increased Yield -	Increased Yield _ Illovo				
25	23,269,539	8,363,266	505,287	1,225,687	696,676	0	322,621	195,737
26	23,269,539	5,839,772	282,788	1,138,193	696,676	0	322,621	195,737
27	23,269,539	9,144,428	574,163	1,138,193	696,676	0	322,621	195,737
28	23,269,539	8,888,380	551,587	958,757	696,676	0	322,621	195,737
29	23,269,539	8,888,380	551,587	958,757	696,676	0	322,621	195,737
30	23,269,539	8,363,266	505,287	958,757	696,676	0	322,621	195,737
31	23,269,539	8,363,266	505,287	96,455	696,676	0	322,621	195,737
32	23,269,539	8,363,266	505,287	1,225,687	696,676	0	322,621	195,737
33	23,269,539	5,839,772	282,788	1,138,193	696,676	0	322,621	195,737
34	23,269,539	9,144,428	574,163	1,138,193	696,676	0	322,621	195,737
35	23,269,539	8,888,380	551,587	958,757	696,676	0	322,621	195,737
36	23,269,539	8,888,380	551,587	958,757	696,676	0	322,621	195,737
37	23,269,539	8,363,266	505,287	958,757	696,676	0	322,621	195,737
38	23,269,539	8,363,266	505,287	96,455	696,676	0	322,621	195,737
39	23,269,539	8,363,266	505,287	1,225,687	696,676	0	322,621	195,737
40	23,269,539	5,839,772	282,788	1,138,193	696,676	0	322,621	195,737
Total	759,378,506	295,093,565	17,662,717	33,512,184	59,217,432	0	8,997,002	6,715,894
NPV	219,350,308	94,906,689	5,679,902	10,912,417	33,577,567	0	1,895,238	2,019,793

BENEFITS – ECONOMC CONTINUNED

Year	Drinking Water (Chikwawa Boma)	Flood Protection		Paid Employment generated			Total Benefits	Net benefits
		Irrigation scheme (1:5)	Additional 1:10	Agriculture	Construction	WSP and Coops		
1	0	0	0	0	1,826,136	0	1,826,136	(50,944,011)
2	0	0	0	0	2,317,788	0	2,317,788	(60,977,335)
3	0	0	0	0	2,247,552	0	2,247,552	(73,694,063)
4	0	0	0	0	632,124	0	632,124	(16,979,511)
5	30,000	52,377	0	1,262,696	0	1,300,160	48,532,091	43,622,168
6	30,528	0	0	1,262,696	0	1,300,160	22,847,753	17,937,830
7	31,065	0	0	1,262,696	0	1,300,160	25,506,804	20,466,961
8	31,612	0	0	1,262,696	0	1,300,160	29,391,748	23,855,742
9	32,168	0	524,530	1,262,696	0	1,300,160	31,113,260	26,203,337
10	32,734	52,377	0	1,262,696	0	1,300,160	30,782,430	25,872,508
11	33,310	0	0	1,262,696	0	1,300,160	32,835,911	26,760,446
12	33,896	0	0	1,262,696	0	1,300,160	31,089,428	26,179,505
13	34,492	0	0	1,262,696	0	1,300,160	35,526,934	28,984,016
14	35,099	0	0	1,262,696	0	1,300,160	35,610,328	27,239,101
15	35,717	52,377	0	1,262,696	0	1,300,160	36,304,959	31,265,116
16	36,345	0	0	1,262,696	0	1,300,160	36,072,933	31,163,011
17	36,984	0	0	1,262,696	0	1,300,160	35,658,285	30,748,362
18	37,635	0	0	1,262,696	0	1,300,160	37,011,675	31,475,669
19	38,297	0	524,530	1,262,696	0	1,300,160	34,871,010	28,795,544
20	38,971	52,377	0	1,262,696	0	1,300,160	37,995,562	33,085,639
21	39,657	0	0	1,262,696	0	1,300,160	37,485,810	32,575,887
22	40,355	0	0	1,262,696	0	1,300,160	37,486,508	32,576,585
23	41,065	0	0	1,262,696	0	1,300,160	36,915,804	28,208,965
24	41,787	0	0	1,262,696	0	1,300,160	36,054,225	27,682,998

BENEFITS – ECONOMC CONTINUNED

Year	Drinking Water (Chikwawa Boma)	Flood Protection		Paid Employment generated			Total Benefits	Net benefits
		Irrigation scheme (1:5)	Additional 1:10	Agriculture	Construction	WSP and Coops		
25	42,522	52,377	0	1,262,696	0	1,300,160	37,236,569	32,326,646
26	43,270	0	0	1,262,696	0	1,300,160	34,351,453	29,441,530
27	44,032	0	0	1,262,696	0	1,300,160	37,948,245	31,872,780
28	44,807	0	0	1,262,696	0	1,300,160	37,490,959	31,954,954
29	45,595	0	524,530	1,262,696	0	1,300,160	38,016,278	33,106,355
30	46,397	52,377	0	1,262,696	0	1,300,160	36,973,514	32,063,591
31	47,213	0	0	1,262,696	0	1,300,160	36,059,651	31,149,728
32	48,044	0	0	1,262,696	0	1,300,160	37,189,714	32,279,791
33	48,889	0	0	1,262,696	0	1,300,160	34,357,072	27,814,153
34	49,750	0	0	1,262,696	0	1,300,160	37,953,963	29,582,736
35	50,625	52,377	0	1,262,696	0	1,300,160	37,549,155	31,843,610
36	51,516	0	0	1,262,696	0	1,300,160	37,497,669	32,587,746
37	52,422	0	0	1,262,696	0	1,300,160	36,927,161	32,017,239
38	53,344	0	0	1,262,696	0	1,300,160	36,065,782	30,529,776
39	54,283	0	524,530	1,262,696	0	1,300,160	37,720,483	32,810,560
40	55,238	52,377	0	1,262,696	0	1,300,160	34,415,798	25,643,257
Total	1,489,663	419,020	2,098,120	45,457,057	7,023,600	46,805,760	1,283,870,521	869,128,922
NPV	431,500	176,499	672,775	14,623,524	6,173,382	15,057,402	405,402,219	157,186,641

APPENDIX D1. A CASH FLOW OF 1:10 FLOOD PROTECTION, FINANCIAL PRICES

YEAR	Investment	Maintenance	Total Cost	Loss of income prevented	Net Benefits
1	936,000	-	936,000	-	(936,000)
2		7,020	7,020	-	(7,020)
3		7,020	7,020	-	(7,020)
4		7,020	7,020	-	(7,020)
5		7,020	7,020	512,162	505,142
6		7,020	7,020	-	(7,020)
7		7,020	7,020	-	(7,020)
8		7,020	7,020	-	(7,020)
9		7,020	7,020	-	(7,020)
10		7,020	7,020	-	(7,020)
11		7,020	7,020	-	(7,020)
12		7,020	7,020	-	(7,020)
13		7,020	7,020	-	(7,020)
14		7,020	7,020	-	(7,020)
15		7,020	7,020	512,162	505,142
16		7,020	7,020	-	(7,020)
17		7,020	7,020	-	(7,020)
18		7,020	7,020	-	(7,020)
19		7,020	7,020	-	(7,020)
20		7,020	7,020	-	(7,020)
21		7,020	7,020	-	(7,020)
22		7,020	7,020	-	(7,020)
23		7,020	7,020	-	(7,020)
24		7,020	7,020	-	(7,020)
25		7,020	7,020	512,162	505,142
26		7,020	7,020	-	(7,020)
27		7,020	7,020	-	(7,020)
28		7,020	7,020	-	(7,020)
29		7,020	7,020	-	(7,020)
30		7,020	7,020	-	(7,020)
31		7,020	7,020	-	(7,020)
32		7,020	7,020	-	(7,020)
33		7,020	7,020	-	(7,020)
34		7,020	7,020	-	(7,020)
35		7,020	7,020	512,162	505,142
36		7,020	7,020	-	(7,020)
37		7,020	7,020	-	(7,020)
38		7,020	7,020	-	(7,020)
39		7,020	7,020	-	(7,020)
40		7,020	7,020	-	(7,020)

Total	936,000	273,780	1,209,780	2,048,649	838,869
Present Value	883,019	99,002	982,021	782,393	-199,628

Finc. NPV	-199,628
Finc. IRR	4.0%
Finc. B/C Rati	0.80
Discount rate	6%

APPENDIX D1.B CASH FLOW OF 1:10 FLOOD PROTECTION, ECONOMIC PRICES

YEAR	Investment	Maintenance	Total Cost	Loss of income prevented	Net Benefits
1	762,804	-	762,804	-	(762,804)
2		5,721	5,721	-	(5,721)
3		5,721	5,721	-	(5,721)
4		5,721	5,721	-	(5,721)
5		5,721	5,721	574,959	569,238
6		5,721	5,721	-	(5,721)
7		5,721	5,721	-	(5,721)
8		5,721	5,721	-	(5,721)
9		5,721	5,721	-	(5,721)
10		5,721	5,721	-	(5,721)
11		5,721	5,721	-	(5,721)
12		5,721	5,721	-	(5,721)
13		5,721	5,721	-	(5,721)
14		5,721	5,721	-	(5,721)
15		5,721	5,721	574,959	569,238
16		5,721	5,721	-	(5,721)
17		5,721	5,721	-	(5,721)
18		5,721	5,721	-	(5,721)
19		5,721	5,721	-	(5,721)
20		5,721	5,721	-	(5,721)
21		5,721	5,721	-	(5,721)
22		5,721	5,721	-	(5,721)
23		5,721	5,721	-	(5,721)
24		5,721	5,721	-	(5,721)
25		5,721	5,721	574,959	569,238
26		5,721	5,721	-	(5,721)
27		5,721	5,721	-	(5,721)
28		5,721	5,721	-	(5,721)
29		5,721	5,721	-	(5,721)
30		5,721	5,721	-	(5,721)
31		5,721	5,721	-	(5,721)
32		5,721	5,721	-	(5,721)
33		5,721	5,721	-	(5,721)
34		5,721	5,721	-	(5,721)
35		5,721	5,721	574,959	569,238
36		5,721	5,721	-	(5,721)
37		5,721	5,721	-	(5,721)
38		5,721	5,721	-	(5,721)
39		5,721	5,721	-	(5,721)
40		5,721	5,721	-	(5,721)

	762,804	223,120	985,925	2,299,837	1,313,913
	719,627	80,683	800,310	878,323	78,014

Econ. NPV	78,014
Econ. IRR	6.9%
Econ. B/C R	1.097
Discount rat	6%

APPENDIX D2 CASH FLOW OF COOPERATIVE, FINANCIAL PRICES

Farm Size: **3,390 ha**

		Year	0	1	2	3	4	5	6	7
		value/unit								
Investments										
farm buildings		975,000								
farm machinery		822,000								
motor vehicles		300,000								
Subtotal		2,097,000								
Training (budgeted in Transfo(rmation Strategy)		0								
Total Investment		2,097,000								
Recurrent expenditure										
maintenance of buildings		2%		19,500	19,500	19,500	19,500	19,500	19,500	19,500
maintenace of machinery		5%		41,100	41,100	41,100	41,100	41,100	41,100	41,100
maintenance of motor vehicles		10%		30,000	30,000	30,000	30,000	30,000	30,000	30,000
Replacement				0	0	0	0	300,000	0	0
Sub total maintenance buildings and equipm				90,600	90,600	90,600	90,600	390,600	90,600	90,600
Maintenance of On Farm Irrigation System		0.5%		116,868	116,868	116,868	116,868	116,868	116,868	116,868
Overhead										
General Transport -	USD/year	30,000		30,000	30,000	30,000	30,000	30,000	30,000	30,000
Salaries and Wages	USD/year	300,000		300,000	300,000	300,000	300,000	300,000	300,000	300,000
Insurance	USD/year	30,000		30,000	30,000	30,000	30,000	30,000	30,000	30,000
Communication (telephc	USD/t/year	30,000		30,000	30,000	30,000	30,000	30,000	30,000	30,000
Subscriptions (to unions	USD/year	500		500	500	500	500	500	500	500
Electricity (overhead)	USD/year	24,000		24,000	24,000	24,000	24,000	24,000	24,000	24,000
Local authority permits/	USD/year	12,000		12,000	12,000	12,000	12,000	12,000	12,000	12,000
Accounting/audit fees	USD/year	10,000		10,000	10,000	10,000	10,000	10,000	10,000	10,000
Bank charges	USD/year	5,000		5,000	5,000	5,000	5,000	5,000	5,000	5,000
Board/management con	USD/year	12,000		12,000	12,000	12,000	12,000	12,000	12,000	12,000
Subtotal overhead				453,500	453,500	453,500	453,500	453,500	453,500	453,500

	8	9	10	11	12	13	14
Investments							
farm buildings							
farm machinery							
motor vehicles							
Subtotal							
Training (budgeted in Transfo(rmation Strategy)							
Total Investment							
Recurrent expenditure							
maintenance of buildings	19,500	19,500	19,500	19,500	19,500	19,500	19,500
maintenace of machinery	41,100	41,100	41,100	41,100	41,100	41,100	41,100
maintenance of motor vehicles	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Replacement	420,000	0	660,000	0	0	0	0
Sub total maintenance buildings and e	510,600	90,600	750,600	90,600	90,600	90,600	90,600
Maintenance of On Farm Irrigation	116,868	116,868	116,868	116,868	116,868	116,868	116,868
Overhead							
General Transport -	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Salaries and Wages	300,000	300,000	300,000	300,000	300,000	300,000	300,000
Insurance	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Communication (telephone, internet	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Subscriptions (to unions and professi	500	500	500	500	500	500	500
Electricity (overhead)	24,000	24,000	24,000	24,000	24,000	24,000	24,000
Local authority permits/taxes	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Accounting/audit fees	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Bank charges	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Board/management committee expe	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Subtotal overhead	453,500	453,500	453,500	453,500	453,500	453,500	453,500

	15	16	17	18	19	20	21
Investments							
farm buildings							
farm machinery							
motor vehicles							
Subtotal							
Training (budgeted in Transfo(rmation Strategy)							
Total Investment							
Recurrent expenditure							
maintenance of buildings	19,500	19,500	19,500	19,500	19,500	19,500	19,500
maintenace of machinery	41,100	41,100	41,100	41,100	41,100	41,100	41,100
maintenance of motor vehicles	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Replacement	300,000	420,000	0	0	0	1,677,000	0
Sub total maintenance buildings an	390,600	510,600	90,600	90,600	90,600	1,767,600	90,600
Maintenance of On Farm Irrigat	116,868	116,868	116,868	116,868	116,868	116,868	116,868
Overhead							
General Transport -	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Salaries and Wages	300,000	300,000	300,000	300,000	300,000	300,000	300,000
Insurance	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Communication (telephone, inter	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Subscriptions (to unions and profe	500	500	500	500	500	500	500
Electricity (overhead)	24,000	24,000	24,000	24,000	24,000	24,000	24,000
Local authority permits/taxes	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Accounting/audit fees	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Bank charges	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Board/management committee e	12,000	12,000	12,000	12,000	12,000	12,000	12,000
Subtotal overhead	453,500	453,500	453,500	453,500	453,500	453,500	453,500

APPENDIX D2 CASH FLOW OF COOPERATIVE, FINANCIAL PRICES

				Year	0	1	2	3	4	5	6	7
				Area (ha) Y1-5								
Net revenues (cost inputs deducted)												
Cotton	USD/ha			1,129		1,231,766	1,733,631	2,235,496	2,740,886	2,740,886	2,576,433	2,576,433
Soya beans	USD/ha			1,129		(98,070)	4,417	107,047	206,715	206,715	194,312	194,312
Pigeon peas	USD/ha			1,129		981,508	1,105,916	1,230,324	1,354,731	1,562,078	1,468,353	1,468,353
Maize	USD/ha			1,695		(388,287)	(191,039)	6,994	219,185	415,074	390,170	390,170
Beans	USD/ha			1,695		289,520	868,939	1,465,917	2,045,336	2,045,336	1,922,616	1,922,616
Bananas				0		0	0	0	0	0	(178,014)	(15,380)
Mangoes				0		0	0	0	0	0	(92,260)	(79,085)
Citrus				0		0	0	0	0	0	(93,684)	(71,903)
TOTAL Net Revenues from Crops				6,776		2,016,437	3,521,865	5,045,778	6,566,853	6,970,089	6,187,926	6,385,516
Irrigation Service Charges						0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water Use (ML) Non- sugar cane						75,786.41	75,786.41	75,786.41	75,786.41	75,786.41	74,140.64	74,140.64
Water - variable cost						651,763.16	651,763.16	651,763.16	651,763.16	651,763.16	637,609.51	637,609.51
Water - fixed cost						338,950.00	338,950.00	338,950.00	338,950.00	338,950.00	338,950.00	338,950.00
Sub total for ISC						990,713.16	990,713.16	990,713.16	990,713.16	990,713.16	976,559.51	976,559.51
Livestock Cost		1	cattle farm			232,119.99	10,332.66	11,413.49	12,616.01	13,255.60	13,971.88	14,548.70
Livestock Revenue						0.00	0.00	0.00	50,853.00	46,409.86	56,062.26	65,507.44
Net Cash flow from Livestock						(232,119.99)	(10,332.66)	(11,413.49)	38,236.99	33,154.26	42,090.37	50,958.74
Aquaculture cost		3	ponds of 1 ha			90,700.00	51,706.00	51,706.00	51,706.00	51,706.00	51,706.00	51,706.00
Aquaculture revenue						42,000.00	84,000.00	84,000.00	84,000.00	84,000.00	84,000.00	84,000.00
Net Cash flow from Aquacult.						(48,700.00)	32,294.00	32,294.00	32,294.00	32,294.00	32,294.00	32,294.00
TOTAL Cost (apart from cost of inputs for crops)					2,097,000	1,974,501	1,713,720	1,714,801	1,716,003	2,016,643	1,703,205	1,703,782
Total Benefits					0	2,058,437	3,605,865	5,129,778	6,701,706	7,100,499	6,327,988	6,535,023
Net Benefits	USD				(2,097,000)	83,936	1,892,145	3,414,977	4,985,703	5,083,856	4,624,783	4,831,241

	8	9	10	11	12	13	14
Net revenues (cost inputs deducted)							
Cotton	2,576,433	2,576,433	2,576,433	2,576,433	2,576,433	2,576,433	2,576,433
Soya beans	194,312	194,312	194,312	194,312	194,312	194,312	194,312
Pigeon peas	1,468,353	1,468,353	1,468,353	1,468,353	1,468,353	1,468,353	1,468,353
Maize	390,170	390,170	390,170	390,170	390,170	390,170	390,170
Beans	1,922,616	1,922,616	1,922,616	1,922,616	1,922,616	1,922,616	1,922,616
Bananas	70,313	154,487	240,298	240,298	240,298	237,818	237,818
Mangoes	(49,589)	(976)	74,432	220,350	316,543	401,248	442,354
Citrus	(77,320)	74,875	163,284	274,168	413,428	589,373	756,485
TOTAL Net Revenues from Crops	6,495,288	6,780,269	7,029,897	7,286,700	7,522,153	7,780,322	7,988,541
Irrigation Service Charges	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water Use (ML) Non- sugar cane	74,140.64	74,140.64	74,140.64	74,140.64	74,140.64	74,140.64	74,140.64
Water - variable cost	637,609.51	637,609.51	637,609.51	637,609.51	637,609.51	637,609.51	637,609.51
Water - fixed cost	338,950.00	338,950.00	338,950.00	338,950.00	338,950.00	338,950.00	338,950.00
Sub total for ISC	976,559.51	976,559.51	976,559.51	976,559.51	976,559.51	976,559.51	976,559.51
Livestock Cost	14,998.69	15,315.54	15,631.82	15,631.82	15,631.82	15,631.82	15,631.82
Livestock Revenue	75,986.77	77,388.25	78,771.96	78,771.96	78,771.96	78,771.96	78,771.96
Net Cash flow from Livestock	60,988.07	62,072.71	63,140.14	63,140.14	63,140.14	63,140.14	63,140.14
Aquaculture cost	51,706.00	51,706.00	51,706.00	51,706.00	51,706.00	51,706.00	51,706.00
Aquaculture revenue	84,000.00	84,000.00	84,000.00	84,000.00	84,000.00	84,000.00	84,000.00
Net Cash flow from Aquacult.	32,294.00	32,294.00	32,294.00	32,294.00	32,294.00	32,294.00	32,294.00
TOTAL Cost (apart from cost of inp	2,124,232	1,704,549	2,364,865	1,704,865	1,704,865	1,704,865	1,704,865
Total Benefits	6,655,274	6,941,658	7,192,669	7,449,472	7,684,925	7,943,094	8,151,313
Net Benefits	4,531,042	5,237,109	4,827,804	5,744,607	5,980,060	6,238,228	6,446,447

	15	16	17	18	19	20	21
Net revenues (cost inputs deducted)							
Cotton	2,576,433	2,576,433	2,576,433	2,576,433	2,576,433	2,576,433	2,576,433
Soya beans	194,312	194,312	194,312	194,312	194,312	194,312	194,312
Pigeon peas	1,468,353	1,468,353	1,468,353	1,468,353	1,468,353	1,468,353	1,468,353
Maize	390,170	390,170	390,170	390,170	390,170	390,170	390,170
Beans	1,922,616	1,922,616	1,922,616	1,922,616	1,922,616	1,922,616	1,922,616
Bananas	237,818	237,818	237,818	237,818	237,818	237,818	237,818
Mangoes	479,666	528,171	528,171	528,171	528,171	528,171	528,171
Citrus	853,967	965,376	1,062,858	1,174,266	1,229,970	1,271,748	1,271,748
TOTAL Net Revenues from Crops	8,123,335	8,283,248	8,380,731	8,492,139	8,547,843	8,589,621	8,589,621
Irrigation Service Charges	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water Use (ML) Non- sugar cane	74,140.64	74,140.64	74,140.64	74,140.64	74,140.64	74,140.64	74,140.64
Water - variable cost	637,609.51	637,609.51	637,609.51	637,609.51	637,609.51	637,609.51	637,609.51
Water - fixed cost	338,950.00	338,950.00	338,950.00	338,950.00	338,950.00	338,950.00	338,950.00
Sub total for ISC	976,559.51	976,559.51	976,559.51	976,559.51	976,559.51	976,559.51	976,559.51
Livestock Cost	15,631.82	15,631.82	15,631.82	15,631.82	15,631.82	15,631.82	15,631.82
Livestock Revenue	78,771.96	78,771.96	78,771.96	78,771.96	78,771.96	78,771.96	78,771.96
Net Cash flow from Livestock	63,140.14	63,140.14	63,140.14	63,140.14	63,140.14	63,140.14	63,140.14
Aquaculture cost	51,706.00	51,706.00	51,706.00	51,706.00	51,706.00	51,706.00	51,706.00
Aquaculture revenue	84,000.00	84,000.00	84,000.00	84,000.00	84,000.00	84,000.00	84,000.00
Net Cash flow from Aquacult.	32,294.00	32,294.00	32,294.00	32,294.00	32,294.00	32,294.00	32,294.00
TOTAL Cost (apart from cost of i	2,004,865	2,124,865	1,704,865	1,704,865	1,704,865	3,381,865	1,704,865
Total Benefits	8,286,107	8,446,020	8,543,503	8,654,911	8,710,615	8,752,393	8,752,393
Net Benefits	6,281,241	6,321,155	6,838,637	6,950,046	7,005,750	5,370,528	7,047,528

APPENDIX D2 CASH FLOW OF COOPERATIVE, FINANCIAL PRICES

		Year	0	1	2	3	4	5	6	7
Net Benefits			(2,097,000)	83,936	1,892,145	3,414,977	4,985,703	5,083,856	4,624,783	4,831,241
Financing cost	Bank Credit	2,323,750								
interest		12%		(70,579)	(70,579)	(70,579)	(70,579)	(70,579)	(70,579)	
repayment of principle				0	(464,750)	(464,750)	(464,750)	(464,750)	(464,750)	
Profit before taxes				13,357	1,356,816	2,879,648	4,450,374	4,548,527	4,089,454	4,831,241
Taxes (after deduction of payment of interest)		20.2%		(16,955)	(288,334)	(595,946)	(913,233)	(933,059)	(840,327)	(975,911)
Net profit			(2,097,000)	(3,598)	1,068,483	2,283,703	3,537,142	3,615,468	3,249,127	3,855,330
Reservation	of net benefits after taxes	20%		(720)	213,697	456,741	707,428	723,094	649,825	771,066
Total for dividends				(2,878)	854,786	1,826,962	2,829,713	2,892,374	2,599,302	3,084,264
Dividends per hh	Phase 1			(0)	126	270	418	427	384	456
	Phase 2			(1)	174	373	577	590	530	629

	8	9	10	11	12	13	14
Net Benefits	4,531,042	5,237,109	4,827,804	5,744,607	5,980,060	6,238,228	6,446,447
Financing cost							
interest							
repayment of principle							
Profit before taxes	4,531,042	5,237,109	4,827,804	5,744,607	5,980,060	6,238,228	6,446,447
Taxes (after deduction of paymen	(915,271)	(1,057,896)	(975,216)	(1,160,411)	(1,207,972)	(1,260,122)	(1,302,182)
Net profit	3,615,772	4,179,213	3,852,588	4,584,196	4,772,088	4,978,106	5,144,265
Reservation	723,154	835,843	770,518	916,839	954,418	995,621	1,028,853
Total for dividends	2,892,617	3,343,370	3,082,070	3,667,357	3,817,670	3,982,485	4,115,412
Dividends per hh	427	494	455	542	564	588	608
	590	682	629	748	779	812	840

	15	16	17	18	19	20	21
Net Benefits	6,281,241	6,321,155	6,838,637	6,950,046	7,005,750	5,370,528	7,047,528
Financing cost							
interest							
repayment of principle							
Profit before taxes	6,281,241	6,321,155	6,838,637	6,950,046	7,005,750	5,370,528	7,047,528
Taxes (after deduction of paym	(1,268,811)	(1,276,873)	(1,381,405)	(1,403,909)	(1,415,161)	(1,084,847)	(1,423,601)
Net profit	5,012,431	5,044,282	5,457,233	5,546,137	5,590,588	4,285,681	5,623,927
Reservation	1,002,486	1,008,856	1,091,447	1,109,227	1,118,118	857,136	1,124,785
Total for dividends	4,009,945	4,035,425	4,365,786	4,436,909	4,472,471	3,428,545	4,499,142
Dividends per hh	592	596	645	655	661	506	665
	818	823	891	905	912	699	918

APPENDIX E SENSITIVITY ANALYSES

Cost of Intake, Canal 1 and 3 Reallocated Cropping Pattern 2

Discount rate	F B/C ratio	Econ B/C Ratio
1%	2.68	2.79
2%	2.38	2.50
3%	2.11	2.24
4%	1.88	2.01
5%	1.67	1.81
6%	1.49	1.63
7%	1.34	1.48
8%	1.20	1.34
9%	1.08	1.22
10%	0.98	1.12

Shadow Wage Rate - unskilled		
	EIRR	E C/B ratio
0.20	11.6%	1.67
0.30	11.5%	1.66
0.40	11.4%	1.65
0.50	11.3%	1.63
0.60	11.2%	1.62
0.70	11.1%	1.61
0.80	11.0%	1.60
0.90	11.0%	1.59
1.00	10.9%	1.57

Construction Cost					
	Finc IRR	Econ IRR		Finc B/C ratio	Econ B/C ratio
-20%	11.3%	12.9%	-20%	1.80	1.82
-10%	10.5%	12.1%	-10%	1.68	1.72
0%	9.8%	11.3%	0%	1.58	1.63
+10%	9.2%	10.7%	+10%	1.49	1.55
+20%	8.6%	10.1%	+20%	1.41	1.48

Maintenance cost					
	Finc IRR	Econ IRR		Finc B/C ratio	Econ B/C ratio
-75%	10.1%	11.6%	-75%	1.55	1.697
-50%	10.0%	11.5%	-50%	1.53	1.675
-25%	9.9%	11.4%	-25%	1.51	1.654
0%	9.8%	11.3%	0%	1.49	1.633
+25%	9.7%	11.2%	+25%	1.47	1.613
+50%	9.6%	11.1%	+50%	1.45	1.593
+75%	9.5%	11.0%	+75%	1.44	1.570

Cost of Transformation Strategy				
	FIRR	EIRR	Finc B/C ratio	Econ B/C ratio
-75%	10.9%	13.12%	1.63	1.84
-50%	10.5%	12.46%	1.58	1.76
-25%	10.1%	11.87%	1.53	1.70
0%	9.8%	11.33%	1.49	1.63
+25%	9.5%	10.83%	1.45	1.58
+50%	9.2%	10.37%	1.41	1.52
+75%	8.9%	10.00%	1.38	1.48

Compensation Cost				
	FIRR	EIRR	F B/C	E B/C
-75%	10.0%	11.6%	1.52	1.67
-50%	10.0%	11.5%	1.51	1.65
-25%	9.9%	11.4%	1.50	1.64
0%	9.8%	11.3%	1.49	1.63
+25%	9.7%	11.2%	1.48	1.62
+50%	9.7%	11.2%	1.47	1.61
+75%	9.6%	11.1%	1.47	1.60

Average Incremental Gross Margin Non -sugar cane				
	Finc IRR	Econ IRR	Finc B/C ratio	Econ B/C ratio
-75%	6.0%	5.9%	1.00	0.97
-50%	7.4%	7.9%	1.16	1.19
-25%	8.7%	9.7%	1.33	1.41
0%	9.8%	11.3%	1.49	1.63
+25%	10.8%	12.7%	1.66	1.85
+50%	11.8%	14.0%	1.82	2.08
+75%	12.7%	15.2%	1.99	2.30

Average Incremental Gross Margin New Sugar Cane				
	FIRR	EIRR	Finc B/C ratio	Econ B/C ratio
-75%	8.0%	9.1%	1.25	1.35
-50%	8.6%	9.9%	1.33	1.44
-25%	9.2%	10.6%	1.41	1.54
0%	9.8%	11.3%	1.49	1.63
+25%	10.4%	12.0%	1.57	1.73
+50%	11.0%	12.7%	1.66	1.82
+75%	11.5%	13.4%	1.74	1.92

Production value 2015 -16				
	FIRR	EIRR	F B/C ratio	E B/C ratio
-50%	9.9%	11.4%	1.50	1.64
0	9.8%	11.3%	1.49	1.63
+50%	9.7%	11.3%	1.48	1.63
+100%	9.7%	11.2%	1.47	1.62
+150%	9.6%	11.2%	1.46	1.62
+200%	9.5%	11.2%	1.45	1.61
+250%	9.4%	11.1%	1.44	1.61
+300%	9.3%	11.1%	1.43	1.60
+350%	9.3%	11.0%	1.42	1.59
+400%	9.2%	11.0%	1.40	1.59

APPENDIX 6

Water Requirement Analysis

Water Requirement Analysis

NO	Division	unit	1972	~	2014
①	Mean Temp	ºc			
②	Humidity	%			
③	Wind	km/day			
④	Mean Rainfall	mm			
⑤	Crop Coefficient Kc=				
⑥	ETo	mm/day			
⑦	Mean ET : ⑥X JAN month days	mm			
⑧	Consumptive use : ⑦*⑤	mm			
⑨	Land Preparation	mm			
⑩	Percolation Losses	mm			
⑪	Nursery Requirement	mm			
1)	Total Water Demand : ⑧+⑨+⑩+⑪	mm			
2)	Effective Rain	mm			
3)	Net Irrig. Requirement : 1)+2)	mm			
4)	Application Efficiency Ea				
5)	Distribution Efficiency Ed				
6)	Field Irrig. Requirement : 3)/4)*5)	mm			
7)	Conveyance Efficiency Ec				
8)	Gross Irrigation Req. : 6) / 7)	mm			
9)	Gross Daily Irrigation Req.	mm/day			
10)	Month Demand	㎥/m/ha			
11)	Daily Demand	㎥/day/ha			

- Water Demand : Jan.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	27.1	27.3	27.9	27.1	27.3	27.6	28.9	28.4	28.2	29.3	28
②	74	82	69	74	80	76	69	82	80	75	62
③	103	93.3	141.6	33.2	174.5	121	113	126.5	171.6	109.8	64.8
④	416.1	157.2	294.1	152.7	109.5	66.0	275.1	79.2	103.4	64.8	135.5
⑤	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
⑥	3.4	3.45	4.07	3.29	4.12	4.16	3.72	3.53	4.18	4.23	3.64
⑦	105.4	107	126.2	102	127.7	129	115.3	109.4	129.6	131.1	112.8
⑧	99.08	100.5	118.6	95.87	120.1	121.2	108.4	102.9	121.8	123.3	106.1
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	99.08	100.5	118.6	95.87	120.1	121.2	108.4	102.9	121.8	123.3	106.1
2)	308.9	101.8	211.3	98.2	63.6	29.6	196.1	39.4	58.7	28.9	84.4
3)	0	0	0	0	56.46	91.62	0	63.46	63.11	94.36	21.67
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	0	0	0	0	96.51	156.6	0	108.5	107.9	161.3	37.04
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	0	0	0	0	108.3	175.8	0	121.8	121.1	181	41.57
9)	0	0	0	0	3.494	5.67	0	3.928	3.905	5.84	1.341
10)	0	0	0	0	1083	1758	0	1218	1211	1810	415.7
11)	0	0	0	0	34.94	56.7	0	39.28	39.05	58.4	13.41

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	27.6	28.1	27.4	27.7	27.4	27.7	28.9	28.2	28.2	28.8	29.8
②	84	60	49	77	87	73	64	57	79	70	52
③	96.6	167.7	159.7	125.8	134.2	137	132.1	157.1	116.6	150.2	176.6
④	154.6	59.7	31.2	215.5	226.8	174.8	133.9	185.9	165.3	77.6	48.4
⑤	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
⑥	3.39	4.99	4.97	3.5	3.2	3.92	4.34	4.51	3.47	4.2	5.32
⑦	105.1	154.7	154.1	108.5	99.2	121.5	134.5	139.8	107.6	130.2	164.9
⑧	98.78	145.4	144.8	102	93.25	114.2	126.5	131.4	101.1	122.4	155
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	98.78	145.4	144.8	102	93.25	114.2	126.5	131.4	101.1	122.4	155
2)	99.7	25.8	8.7	148.4	157.4	115.8	83.1	124.7	108.2	38.1	19
3)	0	119.6	136.1	0	0	0	43.37	6.721	0	84.29	136
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	0	204.5	232.7	0	0	0	74.13	11.49	0	144.1	232.5
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	0	229.5	261.2	0	0	0	83.2	12.9	0	161.7	261
9)	0	7.402	8.425	0	0	0	2.684	0.416	0	5.216	8.418
10)	0	2295	2612	0	0	0	832	129	0	1617	2610
11)	0	74.02	84.25	0	0	0	26.84	4.16	0	52.16	84.18

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	27.6	28.6	28.1	28.7	28.3	28.8	27.9	29	27.7	28.6	28.4
②	81	66	78	80	84	87	88	74	84	82	84
③	134.1	176.5	139.1	129.9	117.9	128.3	113.9	169.1	126.8	159.5	127.7
④	418.3	193.6	161	187.4	124.9	154.2	299.6	108.4	164.9	202.6	316.2
⑤	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
⑥	3.48	4.45	4.55	4.94	4.53	4.19	3.83	5.16	4.41	5.37	4.68
⑦	107.9	138	141.1	153.1	140.4	129.9	118.7	160	136.7	166.5	145.1
⑧	101.4	129.7	132.6	144	132	122.1	111.6	150.4	128.5	156.5	136.4
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	101.4	129.7	132.6	144	132	122.1	111.6	150.4	128.5	156.5	136.4
2)	310.6	130.9	104.8	125.9	75.9	99.4	215.7	62.7	107.9	138.1	229
3)	0	0	27.79	18.05	56.1	22.7	0	87.66	20.61	18.38	0
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	0	0	47.5	30.86	95.9	38.8	0	134.9	31.7	28.28	0
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	0	0	53.31	34.63	107.6	43.54	0	151.4	35.58	31.74	0
9)	0	0	1.72	1.117	3.472	1.405	0	4.883	1.148	1.024	0
10)	0	0	533.1	346.3	1076	435.4	0	1514	355.8	317.4	0
11)	0	0	17.2	11.17	34.72	14.05	0	48.83	11.48	10.24	0

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
①	29.6	28.8	29.2	27.4	28.2	28.5	29.9	28.2	27.2	27.7	28.2
②	77	87	86	89	87	85	52	84	77	82	84
③	149.9	126.3	103.6	99.3	89.2	78.8	146.6	81.7	69.7	74.7	74.1
④	169.5	85.2	212.8	571.5	218.6	115.9	50.8	116	353.2	272.3	159.5
⑤	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
⑥	5.08	4.82	4.93	3.8	4.63	4.55	6.19	4.39	4.24	4.17	4.61
⑦	157.5	149.4	152.8	117.8	143.5	141.1	191.9	136.1	131.4	129.3	142.9
⑧	148	140.5	143.7	110.7	134.9	132.6	180.4	127.9	123.6	121.5	134.3
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	148	140.5	143.7	110.7	134.9	132.6	180.4	127.9	123.6	121.5	134.3
2)	111.6	44.2	146.2	433.2	150.9	68.7	20.5	68.8	258.6	193.8	103.6
3)	36.43	96.25	0	0	0	63.89	159.9	59.12	0	0	30.74
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	56.05	148.1	0	0	0	98.29	246	90.96	0	0	52.54
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	62.9	166.2	0	0	0	110.3	276.1	102.1	0	0	58.97
9)	2.029	5.361	0	0	0	3.558	8.905	3.293	0	0	1.902
10)	629	1662	0	0	0	1103	2761	1021	0	0	589.7
11)	20.29	53.61	0	0	0	35.58	89.05	32.93	0	0	19.02

- Water Demand : Feb.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	27.1	27.3	27.9	27.1	27.3	27.6	28.9	28.4	28.2	29.3	28.0
②	75	73	71	83	81	70	82	80	81	71	83
③	141	122.6	129.4	3.4	116.4	110.5	155.2	125.2	167.5	87.1	68.4
④	20.8	109.5	25.7	157.2	176.8	164.3	25.7	153.4	120.4	98	167.5
⑤	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
⑥	4.43	4.03	4.71	3.08	4.01	4.13	4.37	4.25	4.38	4.23	3.68
⑦	124	112.8	131.9	86.24	112.3	115.6	122.4	119	122.6	118.4	103
⑧	99.23	90.27	105.5	68.99	89.82	92.51	97.89	95.2	98.11	94.75	82.43
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	99.23	90.27	105.5	68.99	89.82	92.51	97.89	95.2	98.11	94.75	82.43
2)	2.5	63.6	5.4	101.8	117.4	107.4	5.4	98.7	72.3	54.4	110
3)	96.73	26.67	100.1	0	0	0	92.49	0	25.81	40.35	0
4)	0.7	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	165.4	45.59	171.1	0	0	0	158.1	0	44.12	68.98	0
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	185.6	51.17	192.1	0	0	0	177.4	0	49.52	77.42	0
9)	6.628	1.828	6.859	0	0	0	6.337	0	1.769	2.765	0
10)	1856	511.7	1921	0	0	0	1774	0	495.2	774.2	0
11)	66.28	18.28	68.59	0	0	0	63.37	0	17.69	27.65	0

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	27.6	28.1	27.4	27.2	27.6	28.9	27.5	26.8	28.4	28.8	29.6
②	86	76	80	85	81	68	83	88	83	78	42
③	107.1	136.6	128.9	122.2	131.1	168.8	140.7	77.5	127.8	117.2	187.4
④	196.9	120.6	261.2	194.6	179	38	253.4	226	45.3	93.1	8.6
⑤	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
⑥	3.61	4.25	3.83	3.61	3.98	5.1	3.71	3.39	4.05	4.02	6.29
⑦	101.1	119	107.2	101.1	111.4	142.8	103.9	94.92	113.4	112.6	176.1
⑧	80.86	95.2	85.79	80.86	89.15	114.2	83.1	75.94	90.72	90.05	140.9
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	80.86	95.2	85.79	80.86	89.15	114.2	83.1	75.94	90.72	90.05	140.9
2)	133.5	72.5	185	131.7	119.2	12.8	178.7	156.8	17.2	50.5	0
3)	0	22.7	0	0	0	101.4	0	0	73.52	39.55	140.9
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	0	38.8	0	0	0	173.4	0	0	125.7	67.6	240.8
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	0	43.55	0	0	0	194.6	0	0	141	75.87	270.3
9)	0	1.555	0	0	0	6.951	0	0	5.037	2.71	9.654
10)	0	435.5	0	0	0	1946	0	0	1410	758.7	2703
11)	0	15.55	0	0	0	69.51	0	0	50.37	27.1	96.54

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	28.4	27.4	28.6	28.1	26.4	28.4	27.7	28.5	27.4	27.8	28.8
②	81	61	70	87	91	87	89	86	91	82	86
③	142.2	156.8	160	139.9	120.2	137.4	107.2	105.9	99.6	134.4	128.1
④	37.3	44.7	100.8	214.2	347.7	113.4	265.8	208.8	280.2	169	135.2
⑤	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
⑥	4.15	4.86	5.73	4.45	3.41	4.82	3.61	4.66	3.52	5.03	4.9
⑦	116.2	136.1	160.4	124.6	95.48	135	101.1	130.5	98.56	140.8	137.2
⑧	92.96	108.9	128.4	99.68	76.38	108	80.86	104.4	78.85	112.7	109.8
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	92.96	108.9	128.4	99.68	76.38	108	80.86	104.4	78.85	112.7	109.8
2)	12.4	16.8	56.6	147.4	254.2	66.7	188.6	143	200.2	111.2	84.2
3)	80.56	92.06	71.75	0	0	41.27	0	0	0	1.472	25.56
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	137.7	157.4	122.7	0	0	70.54	0	0	0	2.516	43.69
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	154.6	176.6	137.7	0	0	79.17	0	0	0	2.824	49.04
9)	5.52	6.308	4.916	0	0	2.828	0	0	0	0.101	1.751
10)	1546	1766	1377	0	0	791.7	0	0	0	28.24	490.4
11)	55.2	63.08	49.16	0	0	28.28	0	0	0	1.009	17.51

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
①	28.2	28.9	29.2	28.5	27.8	28.2	28.6	27.6	28.6	27	27.3
②	85	84	87	86	83	86	76	79	82	84	88
③	120.7	142.3	111.8	96	114.1	121.4	108.8	141.9	93.7	79.7	67.8
④	102.9	61.9	93.3	119.9	40.7	72.6	148.7	55.8	94.9	219.4	147.4
⑤	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
⑥	4.57	5.29	5.23	4.81	5.17	4.91	4.51	5.22	5.11	4.45	4.08
⑦	128	148.1	146.4	134.7	144.8	137.5	126.3	146.2	143.1	124.6	114.2
⑧	102.4	118.5	117.2	107.7	115.8	110	101	116.9	114.5	99.68	91.39
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	102.4	118.5	117.2	107.7	115.8	110	101	116.9	114.5	99.68	91.39
2)	58.3	27.1	50.6	71.9	14.4	34.1	95	23.5	51.9	151.5	93.9
3)	44.07	91.4	66.55	35.84	101.4	75.88	6.024	93.43	62.56	0	0
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	75.33	156.2	113.8	61.27	173.3	129.7	10.3	159.7	106.9	0	0
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	84.55	175.3	127.7	68.77	194.6	145.6	11.56	179.2	120	0	0
9)	3.019	6.262	4.56	2.456	6.948	5.199	0.413	6.402	4.287	0	0
10)	845.5	1753	1277	687.7	1946	1456	115.6	1792	1200	0	0
11)	30.19	62.62	45.6	24.56	69.48	51.99	4.128	64.02	42.87	0	0

- Water Demand : Mar.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
②	27.1	27.3	27.8	26.9	26.5	27.2	27.3	27.6	27.1	27.1	27.1
③	73	82	79	78	76	62	82	80	78	65	62
④	138.9	116.5	131.5	5.3	155.9	140.7	136.8	128.3	142.7	109.7	76.5
⑤	49.8	18.5	67.1	247.4	32.8	105.4	177.0	184.9	230.6	118.4	111.9
⑥	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
⑦	4.81	4.62	4.85	3.68	4.78	4.61	4.19	4.2	4.13	4.71	4.36
⑧	149.1	143.2	150.4	114.1	148.2	142.9	129.9	130.2	128	146	135.2
⑨	101.4	97.39	102.2	77.57	100.8	97.18	88.33	88.54	87.06	99.29	91.91
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
1)											
2)	101.4	97.39	102.2	77.57	100.8	97.18	88.33	88.54	87.06	99.29	91.91
3)	19.9	1.1	30.3	173.9	9.7	60.3	117.6	123.9	160.5	70.7	65.5
4)	81.49	96.29	71.94	0	91.06	36.88	0	0	0	28.59	26.41
5)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
6)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
7)	139.3	164.6	123	0	155.7	63.04	0	0	0	48.87	45.14
8)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
9)	156.3	184.7	138	0	174.7	70.75	0	0	0	54.84	50.67
10)	5.044	5.959	4.452	0	5.636	2.282	0	0	0	1.769	1.634
11)	1563	1847	1380	0	1747	707.5	0	0	0	548.4	506.7

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	27.4	27.8	27	27.6	27.1	28.9	27.8	26.8	27.6	27.9	29.3
②	79	65	78	83	70	51	85	86	55	85	52
③	129.3	124.9	159.8	133	137	168.5	137.1	136.9	160	160.7	172.1
④	57.1	80.4	109.5	119.8	79.6	21.0	111.2	219.4	53.4	93.1	45.2
⑤	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
⑥	4.75	5.2	4.38	4.09	4.64	6.01	4.12	3.91	5.66	4.4	5.91
⑦	147.3	161.2	135.8	126.8	143.8	186.3	127.7	121.2	175.5	136.4	183.2
⑧	100.1	109.6	92.33	86.22	97.81	126.7	86.85	82.42	119.3	92.75	124.6
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	100.1	109.6	92.33	86.22	97.81	126.7	86.85	82.42	119.3	92.75	124.6
2)	24.3	40.3	63.6	71.8	39.7	2.6	65	151.5	22	50.5	17.1
3)	75.83	69.32	28.73	14.42	58.11	124.1	21.85	0	97.31	42.25	107.5
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	129.6	118.5	49.11	24.64	99.34	212.1	37.35	0	166.3	72.23	183.7
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	145.5	133	55.12	27.66	111.5	238.1	41.92	0	186.7	81.06	206.2
9)	4.693	4.29	1.778	0.892	3.596	7.68	1.352	0	6.022	2.615	6.652
10)	1455	1330	551.2	276.6	1115	2381	419.2	0	1867	810.6	2062
11)	46.93	42.9	17.78	8.922	35.96	76.8	13.52	0	60.22	26.15	66.52

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	27.7	27	28.7	26.6	28.3	29	27.7	28.1	27.8	28.1	28.4
②	71	60	56	87	87	85	88	87	89	71	87
③	163	155.3	219.3	136.8	173.4	171.1	175.4	111.9	138.1	151.5	134.4
④	35.0	69.0	26.3	146.3	42.6	23.9	129.6	149.7	135.9	69.1	104.4
⑤	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
⑥	5.04	5.17	6.59	3.99	4.69	5	4.38	4.57	4.19	5.09	4.42
⑦	156.2	160.3	204.3	123.7	145.4	155	135.8	141.7	129.9	157.8	137
⑧	106.2	109	138.9	84.11	98.87	105.4	92.33	96.34	88.33	107.3	93.17
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	106.2	109	138.9	84.11	98.87	105.4	92.33	96.34	88.33	107.3	93.17
2)	11	31.4	5.8	93	15.6	4.3	79.7	95.8	84.7	31.5	59.5
3)	95.24	77.58	133.1	0	83.27	101.1	12.63	0.536	3.625	75.8	33.67
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	162.8	132.6	227.6	0	142.3	172.8	21.59	0.916	6.197	129.6	57.56
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	182.7	148.8	255.4	0	159.7	194	24.23	1.028	6.955	145.4	64.6
9)	5.894	4.801	8.238	0	5.153	6.257	0.782	0.033	0.224	4.691	2.084
10)	1827	1488	2554	0	1597	1940	242.3	10.28	69.55	1454	646
11)	58.94	48.01	82.38	0	51.53	62.57	7.817	0.331	2.244	46.91	20.84

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
①	28.4	28.5	28	27.9	26.6	27.1	28.1	28.2	28	27.2	27.8
②	87	76	90	85	84	85	84	78	69	77	85
③	130.1	140	122.9	110.4	118.8	125	135.1	140.9	112	139.5	92.5
④	69.3	10.2	258.0	136.0	58.0	88.4	58.6	88.9	131.2	63.0	171.3
⑤	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
⑥	4.41	5.32	3.95	4.59	4.52	4.49	4.49	4.77	4.93	5.05	4.8
⑦	136.7	164.9	122.5	142.3	140.1	139.2	139.2	147.9	152.8	156.6	148.8
⑧	92.96	112.1	83.27	96.76	95.28	94.65	94.65	100.6	103.9	106.5	101.2
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	92.96	112.1	83.27	96.76	95.28	94.65	94.65	100.6	103.9	106.5	101.2
2)	31.6	0	182.4	84.8	24.8	46.7	25.2	47.1	81	0	5.2
3)	61.36	112.1	0	11.96	70.48	47.95	69.45	53.45	22.92	106.5	95.98
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	104.9	191.7	0	20.44	120.5	81.96	118.7	91.37	39.19	182	164.1
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	117.7	215.2	0	22.94	135.2	91.99	133.2	102.5	43.98	204.2	184.1
9)	3.798	6.94	0	0.74	4.362	2.967	4.298	3.308	1.419	6.588	5.94
10)	1177	2152	0	229.4	1352	919.9	1332	1025	439.8	2042	1841
11)	37.98	69.4	0	7.4	43.62	29.67	42.98	33.08	14.19	65.88	59.4

- Water Demand : Apr.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	26.5	26.5	25	24.6	25.7	25.3	25.8	26	25.7	26.3	24.8
②	71	73	72	77	77	69	77	75	80	69	49
③	147.9	135	134.3	110.3	108.1	107.1	172.7	127.2	150.8	98.7	83.1
④	3.6	51.6	41.4	62.0	15.0	48.5	5.6	67.6	21.3	30.0	77.8
⑤	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
⑥	5.41	4.96	4.49	4.3	4.66	4.19	5	4.42	4.86	4.89	4.6
⑦	162.3	148.8	134.7	129	139.8	125.7	150	132.6	145.8	146.7	138
⑧	94.13	86.3	78.13	74.82	81.08	72.91	87	76.91	84.56	85.09	80.04
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	94.13	86.3	78.13	74.82	81.08	72.91	87	76.91	84.56	85.09	80.04
2)	0	21	14.8	27.2	0	19.1	0	30.6	2.8	8	38.2
3)	94.13	65.3	63.33	47.62	81.08	53.81	87	46.31	81.76	77.09	41.84
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	160.9	111.6	108.2	81.4	138.6	91.98	148.7	79.16	139.8	131.8	71.52
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	180.6	125.3	121.5	91.36	155.6	103.2	166.9	88.84	156.9	147.9	80.27
9)	6.02	4.176	4.05	3.045	5.185	3.441	5.564	2.961	5.229	4.93	2.676
10)	1806	1253	1215	913.6	1556	1032	1669	888.4	1569	1479	802.7
11)	60.2	41.76	40.5	30.45	51.85	34.41	55.64	29.61	52.29	49.3	26.76

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	25.6	27.6	25	25.1	26.2	26.3	27.7	26	27.4	25.3	27.5
②	61	48	58	76	61	45	77	84	47	74	46
③	136.2	166.6	166	141.7	139.9	181.9	416.3	80.9	157.6	148.6	190.9
④	35.2	0.0	12.6	63.0	61.8	210.7	31.8	53.7	12.8	55.1	1.0
⑤	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
⑥	5.12	6.06	5.28	4.5	4.83	6.13	5.9	4.37	6.04	4.72	6.52
⑦	153.6	181.8	158.4	135	144.9	183.9	177	131.1	181.2	141.6	195.6
⑧	89.09	105.4	91.87	78.3	84.04	106.7	102.7	76.04	105.1	82.13	113.4
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	89.09	105.4	91.87	78.3	84.04	106.7	102.7	76.04	105.1	82.13	113.4
2)	11.1	0	0	27.8	27.1	144.6	9.1	22.2	0	23.1	0
3)	77.99	105.4	91.87	50.5	56.94	0	93.56	53.84	105.1	59.03	113.4
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	133.3	180.2	157	86.32	97.34	0	159.9	92.03	179.7	100.9	193.9
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	149.6	202.3	176.3	96.89	109.2	0	179.5	103.3	201.6	113.2	217.7
9)	4.987	6.743	5.875	3.23	3.641	0	5.983	3.443	6.721	3.775	7.255
10)	1496	2023	1763	968.9	1092	0	1795	1033	2016	1132	2177
11)	49.87	67.43	58.75	32.3	36.41	0	59.83	34.43	67.21	37.75	72.55

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	28	26.4	26.7	25.4	25.6	26.8	25.9	26.5	26.3	26.1	26
②	52	63	49	82	84	73	85	87	85	58	83
③	171.6	211.3	183.5	195.6	228.2	180.6	148.9	168.3	152.2	160.8	151.2
④	5.6	1.8	17.1	25.7	65.3	16.2	61.8	18.3	35.7	46.8	16.2
⑤	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
⑥	6.13	5.86	5.54	4.08	3.92	4.82	3.47	4.07	4.25	5.01	4.39
⑦	183.9	175.8	166.2	122.4	117.6	144.6	104.1	122.1	127.5	150.3	131.7
⑧	106.7	102	96.4	70.99	68.21	83.87	60.38	70.82	73.95	87.17	76.39
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	106.7	102	96.4	70.99	68.21	83.87	60.38	70.82	73.95	87.17	76.39
2)	0	0	0.3	5.4	29.2	0	27.1	1	11.4	18.1	0
3)	106.7	102	96.1	65.59	39.01	83.87	33.28	69.82	62.55	69.07	76.39
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	182.3	174.3	164.3	112.1	66.68	143.4	56.89	119.3	106.9	118.1	130.6
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	204.6	195.6	184.4	125.8	74.84	160.9	63.84	133.9	120	132.5	146.5
9)	6.821	6.521	6.145	4.195	2.495	5.363	2.128	4.465	4	4.417	4.885
10)	2046	1956	1844	1258	748.4	1609	638.4	1339	1200	1325	1465
11)	68.21	65.21	61.45	41.95	24.95	53.63	21.28	44.65	40	44.17	48.85

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
①	26.6	27.5	26.5	27.1	24.9	25	27.6	26.7	24.4	25.1	25.3
②	87	54	86	83	66	81	84	74	60	56	81
③	147.4	160.2	145	132	157.6	132.3	123.4	137.4	116.5	132.5	118
④	26.7	2.3	12.1	18.5	0.0	58.8	33.4	26.3	45.8	76.8	48.9
⑤	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
⑥	3.74	5.3	4.03	4.23	4.56	3.82	3.8	4.32	4.13	4.51	3.81
⑦	112.2	159	120.9	126.9	136.8	114.6	114	129.6	123.9	135.3	114.3
⑧	65.08	92.22	70.12	73.6	79.34	66.47	66.12	75.17	71.86	78.47	66.29
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	65.08	92.22	70.12	73.6	79.34	66.47	66.12	75.17	71.86	78.47	66.29
2)	6	0	0	1.1	0	25.3	10	5.8	17.5	37.4	19.3
3)	59.08	92.22	70.12	72.5	79.34	41.17	56.12	69.37	54.36	41.07	46.99
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	101	157.6	119.9	123.9	135.6	70.37	95.93	118.6	92.93	70.21	80.33
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	113.3	176.9	134.5	139.1	152.2	78.98	107.7	133.1	104.3	78.8	90.16
9)	3.778	5.898	4.484	4.637	5.074	2.633	3.589	4.436	3.476	2.627	3.005
10)	1133	1769	1345	1391	1522	789.8	1077	1331	1043	788	901.6
11)	37.78	58.98	44.84	46.37	50.74	26.33	35.89	44.36	34.76	26.27	30.05

- Water Demand : May.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	22.4	24.2	22.6	22.7	23.5	22.1	24.2	23	23.1	23.2	21.8
②	70	67	65	77	69	70	74	71	74	63	51
③	125.6	109.6	114.7	47.6	71.8	88.4	135.4	119.8	138.9	90.2	65.2
④	63.8	1.5	2.5	16.5	12.2	34.8	2.0	50.3	9.4	12.0	23.8
⑤	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
⑥	4.77	4.86	4.79	3.64	4.63	3.99	5.08	4.62	4.64	4.76	4.2
⑦	147.9	150.7	148.5	112.8	143.5	123.7	157.5	143.2	143.8	147.6	130.2
⑧	105	107	105.4	80.12	101.9	87.82	111.8	101.7	102.1	104.8	92.44
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	105	107	105.4	80.12	101.9	87.82	111.8	101.7	102.1	104.8	92.44
2)	28.3	0	0	0	0	10.9	0	20.2	0	0	4.3
3)	76.69	107	105.4	80.12	101.9	76.92	111.8	81.49	102.1	104.8	88.14
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	131.1	182.9	180.2	137	174.2	131.5	191.1	139.3	174.6	179.1	150.7
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	147.1	205.2	202.3	153.7	195.5	147.6	214.5	156.3	195.9	201	169.1
9)	4.746	6.62	6.525	4.958	6.307	4.76	6.92	5.043	6.32	6.484	5.455
10)	1471	2052	2023	1537	1955	1476	2145	1563	1959	2010	1691
11)	47.46	66.2	65.25	49.58	63.07	47.6	69.2	50.43	63.2	64.84	54.55

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	22.3	25.7	24.8	22.7	23.7	24.6	23.9	23.6	24.9	23.7	25.4
②	57	47	50	58	45	43	61	70	56	53	45
③	124.1	86.7	144.9	140.5	132.9	178.8	273	98.5	141.4	154.3	160
④	13.1	10.2	7.0	10.4	4.3	4.0	60.6	7.8	28.7	3.8	5.0
⑤	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
⑥	4.65	5.01	5.32	4.85	5.36	6	5.47	4.49	4.99	5.27	5.96
⑦	144.2	155.3	164.9	150.4	166.2	186	169.6	139.2	154.7	163.4	184.8
⑧	102.3	110.3	117.1	106.7	118	132.1	120.4	98.82	109.8	116	131.2
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	102.3	110.3	117.1	106.7	118	132.1	120.4	98.82	109.8	116	131.2
2)	0	0	0	0	0	0	26.4	0	7.2	0	0
3)	102.3	110.3	117.1	106.7	118	132.1	93.99	98.82	102.6	116	131.2
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	175	188.5	200.2	182.5	201.7	225.7	160.7	168.9	175.4	198.3	224.2
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	196.4	211.6	224.6	204.8	226.3	253.4	180.3	189.6	196.9	222.5	251.7
9)	6.334	6.824	7.247	6.606	7.301	8.173	5.817	6.116	6.352	7.179	8.118
10)	1964	2116	2246	2048	2263	2534	1803	1896	1969	2225	2517
11)	63.34	68.24	72.47	66.06	73.01	81.73	58.17	61.16	63.52	71.79	81.18

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	25.1	23.8	25	24.5	22.4	24.1	23.7	23.4	24.2	23.7	23.9
②	44	47	55	69	72	52	75	83	81	48	68
③	124.6	185.5	190	162.4	138.2	127.7	136.8	148.2	160.5	139.9	152.3
④	0.8	0.0	13.9	12.2	5.3	0.8	0.7	8.6	10.2	7.9	11.8
⑤	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
⑥	5.7	6.01	4.56	3.65	3.49	4.23	3.52	3.21	3.59	4.37	3.97
⑦	176.7	186.3	141.4	113.2	108.2	131.1	109.1	99.51	111.3	135.5	123.1
⑧	125.5	132.3	100.4	80.34	76.81	93.1	77.48	70.65	79.02	96.18	87.38
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	125.5	132.3	100.4	80.34	76.81	93.1	77.48	70.65	79.02	96.18	87.38
2)	0	0	0	0	0	0	0	0	0	0	0
3)	125.5	132.3	100.4	80.34	76.81	93.1	77.48	70.65	79.02	96.18	87.38
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	214.5	226.1	171.6	137.3	131.3	159.1	132.4	120.8	135.1	164.4	149.4
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	240.7	253.8	192.6	154.1	147.4	178.6	148.6	135.5	151.6	184.5	167.6
9)	7.764	8.187	6.211	4.972	4.754	5.762	4.795	4.372	4.89	5.953	5.408
10)	2407	2538	1926	1541	1474	1786	1486	1355	1516	1845	1676
11)	77.64	81.87	62.11	49.72	47.54	57.62	47.95	43.72	48.9	59.53	54.08

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
①	23.3	24.4	23.8	24.3	24.3	24.5	24.6	24.4	23.3	22.7	23.4
②	83	51	77	73	54	70	66	54	48	45	66
③	119.8	211.2	119.1	138.7	135	115.8	114.9	120.8	139.2	123.2	100.7
④	21.1	0.0	0.8	4.2	0.0	33.0	21.8	2.5	10.8	12.2	29.5
⑤	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
⑥	3.17	4.97	3.37	3.63	4.12	3.59	3.08	3.94	4.18	3.9	3.43
⑦	98.27	154.1	104.5	112.5	127.7	111.3	95.48	122.1	129.6	120.9	106.3
⑧	69.77	109.4	74.17	79.9	90.68	79.02	67.79	86.72	92	85.84	75.49
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	69.77	109.4	74.17	79.9	90.68	79.02	67.79	86.72	92	85.84	75.49
2)	2.7	0	0	0	0	9.8	3.1	0	0	0	7.7
3)	67.07	109.4	74.17	79.9	90.68	69.22	64.69	86.72	92	85.84	67.79
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	114.7	187	126.8	136.6	155	118.3	110.6	148.2	157.3	146.7	115.9
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	128.7	209.9	142.3	153.3	174	132.8	124.1	166.4	176.5	164.7	130.1
9)	4.151	6.77	4.59	4.945	5.612	4.284	4.004	5.367	5.694	5.312	4.196
10)	1287	2099	1423	1533	1740	1328	1241	1664	1765	1647	1301
11)	41.51	67.7	45.9	49.45	56.12	42.84	40.04	53.67	56.94	53.12	41.96

- Water Demand : Jun.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	20.8	19.7	20.8	20.6	21.3	20.7	20.9	20.5	21.1	20.4	20.2
②	71	79	70	67	72	70	74	66	72	66	48
③	141.6	92.7	129.5	32	91.4	105.5	128.9	125.5	143.1	88.8	77.8
④	6.3	21.6	20.3	25.1	16.0	12.7	8.1	22.1	20.6	10.0	5.6
⑤	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
⑥	4.21	4.13	4.16	3.99	4.12	3.93	4.48	4.16	4.13	3.98	4.28
⑦	126.3	123.9	124.8	119.7	123.6	117.9	134.4	124.8	123.9	119.4	128.4
⑧	104.8	102.8	103.6	99.35	102.6	97.86	111.6	103.6	102.8	99.1	106.6
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	104.8	102.8	103.6	99.35	102.6	97.86	111.6	103.6	102.8	99.1	106.6
2)	0	0	2.2	5.1	0	0	0	3.3	2.4	0	0
3)	104.8	102.8	101.4	94.25	102.6	97.86	111.6	100.3	100.4	99.1	106.6
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	179.2	175.8	173.3	161.1	175.4	167.3	190.7	171.4	171.7	169.4	182.2
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	201.1	197.3	194.5	180.8	196.8	187.7	214	192.4	192.7	190.1	204.5
9)	6.704	6.576	6.484	6.027	6.561	6.258	7.134	6.413	6.423	6.338	6.815
10)	2011	1973	1945	1808	1968	1877	2140	1924	1927	1901	2045
11)	67.04	65.76	64.84	60.27	65.61	62.58	71.34	64.13	64.23	63.38	68.15

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	21.5	23.2	21.8	20.5	20.6	20.5	21.9	21.4	23.4	21.1	22.4
②	50	48	53	51	48	48	49	60	52	51	52
③	125.4	99.7	152.7	143.6	140.1	155.9	151.5	87.7	123	127.4	143.8
④	6.0	2.8	9.0	5.2	18.7	35.6	19.7	24.9	24.2	10.0	10.2
⑤	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
⑥	4.8	4.83	4.7	4.82	4.78	4.95	5.12	4.24	4.94	4.71	4.99
⑦	144	144.9	141	144.6	143.4	148.5	153.6	127.2	148.2	141.3	149.7
⑧	119.5	120.3	117	120	119	123.3	127.5	105.6	123	117.3	124.3
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	119.5	120.3	117	120	119	123.3	127.5	105.6	123	117.3	124.3
2)	0	0	0	0	1.2	11.4	1.8	4.9	4.5	0	0
3)	119.5	120.3	117	120	117.8	111.9	125.7	100.7	118.5	117.3	124.3
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	204.3	205.6	200.1	205.2	201.4	191.2	214.9	172.1	202.6	200.5	212.4
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	229.3	230.7	224.5	230.3	226	214.6	241.1	193.1	227.4	225	238.4
9)	7.643	7.691	7.484	7.675	7.535	7.153	8.038	6.438	7.579	7.5	7.946
10)	2293	2307	2245	2303	2260	2146	2411	1931	2274	2250	2384
11)	76.43	76.91	74.84	76.75	75.35	71.53	80.38	64.38	75.79	75	79.46

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	22	22.4	21.4	21.8	23.2	22.2	21.7	23.3	21.8	22.3	22.2
②	53	50	53	59	59	51	66	79	67	55	65
③	139.7	172.6	154.6	145.1	119.3	230.8	134.6	195.4	159.9	142.7	132.8
④	45.3	12.1	10.2	27.8	0.0	0.8	8.0	12.1	3.5	14.3	8.1
⑤	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
⑥	4.83	5.12	3.73	3.53	3.55	4.58	3.18	3.25	3.53	3.45	3.14
⑦	144.9	153.6	111.9	105.9	106.5	137.4	95.4	97.5	105.9	103.5	94.2
⑧	120.3	127.5	92.88	87.9	88.4	114	79.18	80.93	87.9	85.91	78.19
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	120.3	127.5	92.88	87.9	88.4	114	79.18	80.93	87.9	85.91	78.19
2)	17.2	0	0	6.7	0	0	0	0	0	0	0
3)	103.1	127.5	92.88	81.2	88.4	114	79.18	80.93	87.9	85.91	78.19
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	176.2	217.9	158.8	138.8	151.1	194.9	135.4	138.3	150.3	146.8	133.7
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	197.7	244.6	178.2	155.8	169.6	218.8	151.9	155.3	168.6	164.8	150
9)	6.591	8.153	5.94	5.193	5.653	7.293	5.064	5.175	5.621	5.494	5
10)	1977	2446	1782	1558	1696	2188	1519	1553	1686	1648	1500
11)	65.91	81.53	59.4	51.93	56.53	72.93	50.64	51.75	56.21	54.94	50

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
①	21.6	23.6	22.1	22.7	21.6	22.2	21.9	22.5	21.9	21.1	21.6
②	71	52	69	61	51	55	60	46	50	49	56
③	120.1	157.6	133.6	126.7	133.8	120.6	126.3	113.9	132.2	80.1	86.9
④	27.4	0.0	7.3	8.1	1.6	1.6	3.8	0.0	14.4	36.3	5.8
⑤	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
⑥	2.87	3.99	3.12	3.38	3.57	3.47	3.39	3.66	3.58	2.81	2.95
⑦	86.1	119.7	93.6	101.4	107.1	104.1	101.7	109.8	107.4	84.3	88.5
⑧	71.46	99.35	77.69	84.16	88.89	86.4	84.41	91.13	89.14	69.97	73.46
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	71.46	99.35	77.69	84.16	88.89	86.4	84.41	91.13	89.14	69.97	73.46
2)	6.4	0	0	7.2	0	0	0	0	0	11.8	0
3)	65.06	99.35	77.69	76.96	88.89	86.4	84.41	91.13	89.14	58.17	73.46
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	111.2	169.8	132.8	131.6	152	147.7	144.3	155.8	152.4	99.43	125.6
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	124.8	190.6	149	147.7	170.5	165.8	161.9	174.8	171	111.6	140.9
9)	4.161	6.354	4.968	4.922	5.685	5.526	5.398	5.828	5.701	3.72	4.697
10)	1248	1906	1490	1477	1705	1658	1619	1748	1710	1116	1409
11)	41.61	63.54	49.68	49.22	56.85	55.26	53.98	58.28	57.01	37.2	46.97

- Water Demand : Jul.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	20.5	20.8	20.4	20.7	20.9	19.8	21.1	19.2	21.2	20.5	20
②	66	69	66	67	63	66	67	63	61	55	50
③	127.5	135.4	133.5	21.9	89.7	113.8	169.8	127.5	149.6	123.6	247.3
④	10.4	7.6	30.0	28.7	1.0	8.1	8.6	15.0	43.9	14.0	32.2
⑤	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
⑥	4.32	4.27	4.37	3.44	4.31	4.36	4.34	4.11	4.4	4.3	5.33
⑦	133.9	132.4	135.5	106.6	133.6	135.2	134.5	127.4	136.4	133.3	165.2
⑧	129.9	128.4	131.4	103.4	129.6	131.1	130.5	123.6	132.3	129.3	160.3
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	129.9	128.4	131.4	103.4	129.6	131.1	130.5	123.6	132.3	129.3	160.3
2)	0	0	8	7.2	0	0	0	0	16.3	0	9.3
3)	129.9	128.4	123.4	96.24	129.6	131.1	130.5	123.6	116	129.3	151
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	222.1	219.5	211	164.5	221.5	224.1	223.1	211.3	198.3	221	258.1
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	249.2	246.3	236.8	184.6	248.6	251.5	250.4	237.1	222.6	248.1	289.6
9)	8.039	7.946	7.637	5.956	8.021	8.114	8.077	7.649	7.179	8.002	9.343
10)	2492	2463	2368	1846	2486	2515	2504	2371	2226	2481	2896
11)	80.39	79.46	76.37	59.56	80.21	81.14	80.77	76.49	71.79	80.02	93.43

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	20.7	22.9	22.4	20.9	20.7	20.8	21.7	21.2	21.7	21.6	21.9
②	56	48	45	45	44	41	47	50	44	50	50
③	123	88.4	187.6	155.7	168.1	180.8	167.9	87.1	162.2	143.1	186.5
④	30.5	41.4	0.0	4.6	2.0	0.0	16.8	43.7	5.0	15.8	15.8
⑤	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
⑥	4.33	4.51	5.31	4.99	4.97	5.54	5.09	4.42	5.25	4.77	5.22
⑦	134.2	139.8	164.6	154.7	154.1	171.7	157.8	137	162.8	147.9	161.8
⑧	130.2	135.6	159.7	150	149.4	166.6	153.1	132.9	157.9	143.4	157
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	130.2	135.6	159.7	150	149.4	166.6	153.1	132.9	157.9	143.4	157
2)	8.3	14.8	0	0	0	0	0.1	16.2	0	0	0
3)	121.9	120.8	159.7	150	149.4	166.6	153	116.7	157.9	143.4	157
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	208.4	206.5	272.9	256.5	255.5	284.8	261.5	199.5	269.9	245.2	268.3
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	233.9	231.8	306.3	287.9	286.7	319.6	293.4	223.9	302.9	275.2	301.1
9)	7.544	7.477	9.882	9.286	9.249	10.31	9.466	7.223	9.77	8.877	9.714
10)	2339	2318	3063	2879	2867	3196	2934	2239	3029	2752	3011
11)	75.44	74.77	98.82	92.86	92.49	103.1	94.66	72.23	97.7	88.77	97.14

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	22.6	22.3	22.5	20.4	21.1	22	21.7	21.7	21.6	23.2	21.2
②	52	50	48	54	62	50	60	70	60	45	60
③	167.7	217.7	187	151.3	173.6	185.5	176.3	153.4	168.5	132.7	183.4
④	4.6	5.6	7.1	36.5	50.5	6.7	25.5	17.5	28.7	14.7	31.9
⑤	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
⑥	5.01	5.31	4.29	5.03	3.36	4.21	3.46	3.2	3.65	3.99	3.67
⑦	155.3	164.6	133	155.9	104.2	130.5	107.3	99.2	113.2	123.7	113.8
⑧	150.7	159.7	129	151.3	101	126.6	104	96.22	109.8	120	110.4
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	150.7	159.7	129	151.3	101	126.6	104	96.22	109.8	120	110.4
2)	0	0	0	11.9	20.3	0	0	0	0	0	0
3)	150.7	159.7	129	139.4	80.74	126.6	104	96.22	109.8	120	110.4
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	257.5	272.9	220.5	238.2	138	216.4	177.8	164.5	187.6	205.1	188.6
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	289	306.3	247.5	267.3	154.9	242.9	199.6	184.6	210.6	230.2	211.7
9)	9.323	9.882	7.984	8.624	4.997	7.835	6.439	5.955	6.793	7.425	6.83
10)	2890	3063	2475	2673	1549	2429	1996	1846	2106	2302	2117
11)	93.23	98.82	79.84	86.24	49.97	78.35	64.39	59.55	67.93	74.25	68.3

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
①	21.3	22.3	22.3	21.5	21.9	21.1	22.3	20.4	20.8	20.4	21.6
②	60	53	59	58	48	58	60	50	44	51	51
③	113.9	161.4	146	136.1	151.3	137.4	160.4	123	127.6	110.9	111.3
④	32.7	21.3	0.0	28.6	4.7	10.7	30.3	14.4	0.0	12.0	25.2
⑤	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
⑥	3.12	3.86	3.55	3.34	3.83	3.33	4.36	3.36	3.58	3.38	3.27
⑦	96.72	119.7	110.1	103.5	118.7	103.2	135.2	104.2	111	104.8	101.4
⑧	93.82	116.1	106.7	100.4	115.2	100.1	131.1	101	107.7	101.6	98.33
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	93.82	116.1	106.7	100.4	115.2	100.1	131.1	101	107.7	101.6	98.33
2)	6.4	0	0	7.2	0	0	0	0	0	0	5.1
3)	87.42	116.1	106.7	93.23	115.2	100.1	131.1	101	107.7	101.6	93.23
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	149.4	198.4	182.5	159.4	196.9	171.2	224.1	172.7	184	173.7	159.4
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	167.7	222.7	204.8	178.9	221	192.1	251.5	193.8	206.5	195	178.9
9)	5.41	7.183	6.606	5.77	7.127	6.197	8.114	6.253	6.662	6.29	5.77
10)	1677	2227	2048	1789	2210	1921	2515	1938	2065	1950	1789
11)	54.1	71.83	66.06	57.7	71.27	61.97	81.14	62.53	66.62	62.9	57.7

- Water Demand : Aug.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	22.5	21.8	22.1	23.1	22.3	21	22.6	23.5	23.1	21.9	22.6
②	59	59	60	56	58	59	59	58	54	54	39
③	146.4	154.1	160.2	2.6	133.2	137.3	188.4	138.6	174.7	130.5	123.7
④	0.0	15.0	8.1	4.6	4.6	0.0	5.6	0.0	0.5	10.0	0.0
⑤	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
⑥	5.26	4.95	5.03	3.95	4.69	4.77	4.98	5.25	5.42	4.77	5.21
⑦	163.1	153.5	155.9	122.5	145.4	147.9	154.4	162.8	168	147.9	161.5
⑧	141.9	133.5	135.7	106.5	126.5	128.6	134.3	141.6	146.2	128.6	140.5
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	141.9	133.5	135.7	106.5	126.5	128.6	134.3	141.6	146.2	128.6	140.5
2)	0	0	0	0	0	0	0	0	0	0	0
3)	141.9	133.5	135.7	106.5	126.5	128.6	134.3	141.6	146.2	128.6	140.5
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	242.5	228.2	231.9	182.1	216.2	219.9	229.6	242	249.9	219.9	240.2
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	272.2	256.1	260.3	204.4	242.7	246.8	257.7	271.6	280.4	246.8	269.6
9)	8.78	8.262	8.396	6.593	7.828	7.962	8.312	8.763	9.047	7.962	8.696
10)	2722	2561	2603	2044	2427	2468	2577	2716	2804	2468	2696
11)	87.8	82.62	83.96	65.93	78.28	79.62	83.12	87.63	90.47	79.62	86.96

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	22.4	22.4	22.4	22.9	22.5	24.1	22.7	23.5	22.8	22.7	22.4
②	41	46	40	43	31	42	42	41	44	42	44
③	172.3	101.8	201	231.2	158.2	255.4	225.9	113.9	189.6	177.9	185.2
④	6.2	0.0	4.4	9.0	0.0	53.0	13.8	1.0	7.2	7.2	16.1
⑤	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
⑥	5.58	4.59	5.96	5.87	5.91	6.43	6	5.11	5.68	5.63	5.39
⑦	173	142.3	184.8	182	183.2	199.3	186	158.4	176.1	174.5	167.1
⑧	150.5	123.8	160.7	158.3	159.4	173.4	161.8	137.8	153.2	151.8	145.4
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	150.5	123.8	160.7	158.3	159.4	173.4	161.8	137.8	153.2	151.8	145.4
2)	0	0	0	0	0	21.8	0	0	0	0	0
3)	150.5	123.8	160.7	158.3	159.4	151.6	161.8	137.8	153.2	151.8	145.4
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	257.3	211.6	274.8	270.6	272.5	259.2	276.6	235.6	261.9	259.6	248.5
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	288.7	237.5	308.4	303.7	305.8	290.9	310.5	264.4	293.9	291.3	278.9
9)	9.314	7.661	9.948	9.798	9.864	9.383	10.01	8.529	9.481	9.397	8.997
10)	2887	2375	3084	3037	3058	2909	3105	2644	2939	2913	2789
11)	93.14	76.61	99.48	97.98	98.64	93.83	100.1	85.29	94.81	93.97	89.97

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	23.1	23.5	25.5	23	23.3	23.4	23.3	23.1	23.6	25	22.6
②	44	45	43	42	42	50	51	57	48	45	45
③	195.3	258.3	254.5	183	205.4	220.1	197.9	231.8	136.3	194	182.4
④	11.9	3.0	0.0	4.2	2.4	12.3	0.0	5.5	36.7	2.2	0.2
⑤	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
⑥	5.66	6.15	5.92	8.32	5.31	4.93	4.73	4.77	4.53	5.17	4.84
⑦	175.5	190.7	183.5	257.9	164.6	152.8	146.6	147.9	140.4	160.3	150
⑧	152.7	165.9	159.7	224.4	143.2	133	127.6	128.6	122.2	139.4	130.5
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	152.7	165.9	159.7	224.4	143.2	133	127.6	128.6	122.2	139.4	130.5
2)	0	0	0	0	0	0	0	0	12	0	0
3)	152.7	165.9	159.7	224.4	143.2	133	127.6	128.6	110.2	139.4	130.5
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	260.9	283.5	272.9	383.6	244.8	227.3	218.1	219.9	188.3	238.4	223.1
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	292.9	318.2	306.3	430.5	274.8	255.1	244.7	246.8	211.4	267.5	250.4
9)	9.447	10.27	9.881	13.89	8.863	8.229	7.895	7.962	6.818	8.629	8.079
10)	2929	3182	3063	4305	2748	2551	2447	2468	2114	2675	2504
11)	94.47	102.7	98.81	138.9	88.63	82.29	78.95	79.62	68.18	86.29	80.79

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
①	23.9	25.1	24.2	23.4	23.5	23.1	22.1	21.7	23.7	22.6	23.4
②	45	36	44	44	42	44	49	45	40	37	43
③	181.2	166.4	172.5	173.7	153.2	180.4	174.7	152.9	163.6	127.4	151
④	12.8	0.0	0.0	2.5	0.5	2.4	27.0	6.9	0.0	5.7	0.0
⑤	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
⑥	4.94	5.28	4.87	4.84	4.66	4.85	6.34	4.33	4.85	4.31	4.61
⑦	153.1	163.7	151	150	144.5	150.4	196.5	134.2	150.4	133.6	142.9
⑧	133.2	142.4	131.3	130.5	125.7	130.8	171	116.8	130.8	116.2	124.3
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	133.2	142.4	131.3	130.5	125.7	130.8	171	116.8	130.8	116.2	124.3
2)	0	0	0	0	0	0	6.2	0	0	0	0
3)	133.2	142.4	131.3	130.5	125.7	130.8	164.8	116.8	130.8	116.2	124.3
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	227.7	243.4	224.5	223.1	214.8	223.6	281.7	199.6	223.6	198.7	212.5
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	255.6	273.2	252	250.4	241.1	251	316.2	224	251	223	238.5
9)	8.245	8.813	8.129	8.079	7.778	8.095	10.2	7.227	8.095	7.194	7.695
10)	2556	2732	2520	2504	2411	2510	3162	2240	2510	2230	2385
11)	82.45	88.13	81.29	80.79	77.78	80.95	102	72.27	80.95	71.94	76.95

- Water Demand : Sep.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	24.9	25.8	25.9	24.5	25.2	25.4	26.3	25.8	26.1	26.2	24.9
②	54	52	54	54	60	54	54	50	53	53	35
③	197.1	176.8	173.3	5.9	170.2	200.4	232.2	184.5	187.7	136.7	137.1
④	0.0	2.0	0.0	4.3	0.0	1.8	20.3	0.0	2.0	4.0	11.0
⑤	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
⑥	5.82	5.81	5.75	3.87	5.47	5.69	6.13	5.78	5.79	5.36	5.5
⑦	174.6	174.3	172.5	116.1	164.1	170.7	183.9	173.4	173.7	160.8	165
⑧	137.9	137.7	136.3	91.72	129.6	134.9	145.3	137	137.2	127	130.4
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	137.9	137.7	136.3	91.72	129.6	134.9	145.3	137	137.2	127	130.4
2)	5.82	5.81	5.75	3.87	5.47	5.69	6.13	5.78	5.79	5.36	5.5
3)	132.1	131.9	130.5	87.85	124.2	129.2	139.2	131.2	131.4	121.7	124.9
4)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	225.8	225.4	223.1	150.2	212.3	220.8	237.9	224.3	224.7	208	213.4
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	253.5	253	250.4	168.5	238.2	247.8	267	251.7	252.2	233.4	239.5
9)	8.449	8.434	8.347	5.618	7.941	8.26	8.899	8.391	8.405	7.781	7.984
10)	2535	2530	2504	1685	2382	2478	2670	2517	2522	2334	2395
11)	84.49	84.34	83.47	56.18	79.41	82.6	88.99	83.91	84.05	77.81	79.84

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	24.1	26.3	26.1	26.5	25	26.9	25.8	25.2	24.7	26	26.5
②	40	29	32	34	35	35	37	36	39	31	32
③	211.6	118.7	248.7	239.8	246.8	292.6	283.1	187.3	203.2	182.3	234.3
④	15.4	0.0	0.0	0.0	2.1	55.1	6.2	10.4	8.6	4.8	0.0
⑤	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
⑥	6.1	5.58	7.17	6.87	6.73	7.67	7.36	6.13	5.99	6.3	7.12
⑦	183	167.4	215.1	206.1	201.9	230.1	220.8	183.9	179.7	189	213.6
⑧	144.6	132.2	169.9	162.8	159.5	181.8	174.4	145.3	142	149.3	168.7
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	144.6	132.2	169.9	162.8	159.5	181.8	174.4	145.3	142	149.3	168.7
2)	6.1	5.58	7.17	6.87	6.73	7.67	7.36	6.13	5.99	6.3	7.12
3)	138.5	126.7	162.8	155.9	152.8	174.1	167.1	139.2	136	143	161.6
4)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	236.7	216.5	278.2	266.6	261.1	297.6	285.6	237.9	232.4	244.5	276.3
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	265.7	243	312.3	299.2	293.1	334	320.5	267	260.9	274.4	310.1
9)	8.855	8.1	10.41	9.973	9.77	11.13	10.68	8.899	8.696	9.146	10.34
10)	2657	2430	3123	2992	2931	3340	3205	2670	2609	2744	3101
11)	88.55	81	104.1	99.73	97.7	111.3	106.8	88.99	86.96	91.46	103.4

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	26.4	26.7	27	26.8	26.1	26.7	25.5	27	25.9	27	26.4
②	36	37	34	36	53	36	42	39	38	40	40
③	250.2	281.5	274.5	362.8	248.6	269.9	226.2	222.5	196.1	261.4	228.4
④	0.0	5.7	0.0	22.0	7.7	0.5	15.5	0.0	20.0	3.4	2.3
⑤	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
⑥	6.91	7.43	7.34	8.12	5.8	7.2	6.23	6.7	6.21	6.96	6.55
⑦	207.3	222.9	220.2	243.6	174	216	186.9	201	186.3	208.8	196.5
⑧	163.8	176.1	174	192.4	137.5	170.6	147.7	158.8	147.2	165	155.2
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	163.8	176.1	174	192.4	137.5	170.6	147.7	158.8	147.2	165	155.2
2)	6.91	7.43	7.34	8.32	5.8	7.2	6.23	6.7	6.21	6.96	6.55
3)	156.9	168.7	166.6	184.1	131.7	163.4	141.4	152.1	141	158	148.7
4)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	268.1	288.3	284.8	314.7	225.1	279.4	241.7	260	241	270.1	254.2
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	300.9	323.6	319.7	353.2	252.6	313.6	271.3	291.8	270.4	303.1	285.3
9)	10.03	10.79	10.66	11.77	8.42	10.45	9.044	9.726	9.015	10.1	9.509
10)	3009	3236	3197	3532	2526	3136	2713	2918	2704	3031	2853
11)	100.3	107.9	106.6	117.7	84.2	104.5	90.44	97.26	90.15	101	95.09

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
①	26.2	26.8	25.5	26.6	26.3	26.8	25.4	25.7	26.9	26.5	25.3
②	41	37	43	38	35	36	37	35	35	32	38
③	224.6	206.4	227.6	219.1	181.5	217.1	221.9	202.6	183.3	156.6	162.5
④	9.9	21.0	0.0	2.5	7.0	0.0	1.2	7.5	0.0	34.5	1.8
⑤	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
⑥	6.34	6.38	6.2	6.52	6.02	6.45	6.9	6.22	6.14	5.66	5.68
⑦	190.2	191.4	186	195.6	180.6	193.5	207	186.6	184.2	169.8	170.4
⑧	150.3	151.2	146.9	154.5	142.7	152.9	163.5	147.4	145.5	134.1	134.6
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	150.3	151.2	146.9	154.5	142.7	152.9	163.5	147.4	145.5	134.1	134.6
2)	6.34	6.38	6.2	6.52	6.02	6.45	6.34	6.22	6.14	5.66	5.68
3)	143.9	144.8	140.7	148	136.7	146.4	157.2	141.2	139.4	128.5	128.9
4)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	246	247.6	240.6	253	233.6	250.3	268.7	241.4	238.3	197.7	198.4
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	276.1	277.9	270	283.9	262.2	280.9	301.6	270.9	267.4	221.8	222.6
9)	9.204	9.262	9	9.465	8.739	9.363	10.05	9.029	8.913	7.395	7.421
10)	2761	2779	2700	2839	2622	2809	3016	2709	2674	2218	2226
11)	92.04	92.62	90	94.65	87.39	93.63	100.5	90.29	89.13	73.95	74.21

- Water Demand : Oct.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	27.3	27.8	28.5	27.3	26.1	27.3	28.9	28.5	28.8	27.1	25.7
②	53	49	52	62	58	53	49	51	59	50	39
③	221.9	242.2	232.2	221.1	126.4	198.3	267.5	181.4	218.6	153.2	246.0
④	0.0	0.8	3.6	11.2	63.5	47.8	0.0	8.9	1.3	21.0	13.4
⑤	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
⑥	6.17	6.46	6.3	5.75	4.88	5.65	6.94	5.81	5.96	5.23	6.25
⑦	191.3	200.3	195.3	178.3	151.3	175.2	215.1	180.1	184.8	162.1	193.8
⑧	132	138.2	134.8	123	104.4	120.9	148.4	124.3	127.5	111.9	133.7
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	132	138.2	134.8	123	104.4	120.9	148.4	124.3	127.5	111.9	133.7
2)	6.17	6.46	6.3	5.75	4.88	5.65	6.94	5.81	5.96	5.23	6.25
3)	125.8	131.7	128.5	117.2	99.5	115.2	141.5	118.5	121.5	106.6	127.4
4)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	215.1	225.2	219.6	200.4	170.1	196.9	241.9	202.5	207.7	182.3	217.8
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	241.4	252.7	246.4	224.9	190.9	221	271.5	227.3	233.1	204.6	244.5
9)	7.786	8.152	7.95	7.256	6.158	7.13	8.758	7.332	7.521	6.6	7.887
10)	2414	2527	2464	2249	1909	2210	2715	2273	2331	2046	2445
11)	77.86	81.52	79.5	72.56	61.58	71.3	87.58	73.32	75.21	66	78.87

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	26.2	27	28.4	28	27.2	26.8	27.6	27.1	28.3	27.5	29.5
②	46	37	32	35	47	39	44	37	32	35	31
③	203.1	147.4	264.0	246.8	263.6	318.8	243.8	236.2	231.5	249.5	242.9
④	44.8	0.8	0.0	45.3	107.4	30.0	31.9	12.2	0.0	1.2	0.0
⑤	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
⑥	5.62	5.52	7.45	6.9	6.25	7.38	6.29	6.57	7.02	7.02	7.5
⑦	174.2	171.1	231	213.9	193.8	228.8	195	203.7	217.6	217.6	232.5
⑧	120.2	118.1	159.4	147.6	133.7	157.9	134.5	140.5	150.2	150.2	160.4
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	120.2	118.1	159.4	147.6	133.7	157.9	134.5	140.5	150.2	150.2	160.4
2)	5.62	5.52	7.45	6.9	6.25	7.38	6.29	6.57	7.02	7.02	7.5
3)	114.6	112.6	151.9	140.7	127.4	150.5	128.3	134	143.1	143.1	152.9
4)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	195.9	192.4	259.7	240.5	217.8	257.2	219.2	229	244.7	244.7	261.4
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	219.8	215.9	291.4	269.9	244.5	288.7	246.1	257	274.6	274.6	293.4
9)	7.092	6.966	9.401	8.707	7.887	9.313	7.937	8.291	8.858	8.858	9.464
10)	2198	2159	2914	2699	2445	2887	2461	2570	2746	2746	2934
11)	70.92	69.66	94.01	87.07	78.87	93.13	79.37	82.91	88.58	88.58	94.64

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	29.2	27	31.1	28.7	27.5	29.4	26.6	28.3	28.4	29.1	28.6
②	42	45	29	33	55	43	43	40	37	47	46
③	312.9	331.5	221.7	259.7	296.4	293.9	305.6	296.9	274.5	282.8	242.9
④	3.8	18.2	0.0	5.5	14.0	0.3	10.1	4.3	0.9	6.5	0.0
⑤	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
⑥	7.57	6.9	8.29	8.24	6.77	8.01	7.4	8.01	8.07	7.7	7.35
⑦	234.7	213.9	257	255.4	209.9	248.3	229.4	248.3	250.2	238.7	227.9
⑧	161.9	147.6	177.3	176.3	144.8	171.3	158.3	171.3	172.6	164.7	157.2
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	161.9	147.6	177.3	176.3	144.8	171.3	158.3	171.3	172.6	164.7	157.2
2)	7.57	6.9	8.29	8.12	6.77	8.01	7.4	8.01	8.07	7.7	7.35
3)	154.4	140.7	169	168.1	138	163.3	150.9	163.3	164.5	157	149.9
4)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	263.9	240.5	288.9	287.4	236	279.2	257.9	279.2	281.3	268.4	256.2
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	296.1	269.9	324.3	322.6	264.8	313.3	289.5	313.3	315.7	301.2	287.5
9)	9.553	8.707	10.46	10.41	8.543	10.11	9.338	10.11	10.18	9.717	9.275
10)	2961	2699	3243	3226	2648	3133	2895	3133	3157	3012	2875
11)	95.53	87.07	104.6	104.1	85.43	101.1	93.38	101.1	101.8	97.17	92.75

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
①	28.3	29.3	29.3	28.1	29	28	29	28	29.1	26.5	26.9
②	56	41	41	39	38	40	39	43	38	47	37
③	252.5	252.0	249.7	236.2	257.6	256.6	206.4	182.8	226.9	202.0	209.9
④	15.9	0.0	0.0	7.0	0.3	1.7	0.0	69.1	0.0	57.0	39.7
⑤	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
⑥	6.58	7.78	7.54	7.4	7.85	7.3	7.1	6.37	7.43	6.61	6.82
⑦	204	241.2	233.7	229.4	243.4	226.3	220.1	197.5	230.3	204.9	211.4
⑧	140.7	166.4	161.3	158.3	167.9	156.1	151.9	136.3	158.9	141.4	145.9
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	140.7	166.4	161.3	158.3	167.9	156.1	151.9	136.3	158.9	141.4	145.9
2)	6.58	7.78	7.54	7.4	7.85	7.3	6.9	6.37	7.43	6.61	6.82
3)	134.2	158.6	153.7	150.9	160.1	148.8	145	129.9	151.5	134.8	139.1
4)	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	229.3	271.2	262.8	257.9	273.6	254.4	247.8	222	259	230.4	237.7
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	257.4	304.3	295	289.5	307.1	285.6	278.1	249.2	290.7	258.6	266.8
9)	8.303	9.818	9.515	9.338	9.906	9.212	8.972	8.038	9.376	8.341	8.606
10)	2574	3043	2950	2895	3071	2856	2781	2492	2907	2586	2668
11)	83.03	98.18	95.15	93.38	99.06	92.12	89.72	80.38	93.76	83.41	86.06

- Water Demand : Nov.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	27.9	27.5	27.9	29.3	28.1	30	28.8	28.8	29	30.3	29.8
②	55	58	48	52	61	55	55	59	62	47	41
③	202.9	227.3	191.2	192.4	165.9	153	202.4	213.9	231.5	129.8	215.2
④	54.4	22.4	138.7	44.2	50.8	1.3	64.5	13.5	65.3	4.3	34.4
⑤	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
⑥	5.24	5.43	5.37	5.58	4.96	5.36	5.33	5.57	5.56	5.18	6.23
⑦	157.2	162.9	161.1	167.4	148.8	160.8	159.9	167.1	166.8	155.4	186.9
⑧	95.89	99.37	98.27	102.1	90.77	98.09	97.54	101.9	101.7	94.79	114
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	95.89	99.37	98.27	102.1	90.77	98.09	97.54	101.9	101.7	94.79	114
2)	22.6	3.4	87	16.5	20.5	0	28.7	0	29.2	0	10.6
3)	73.29	95.97	11.27	85.61	70.27	98.09	68.84	101.9	72.55	94.79	103.4
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	125.3	164	19.27	146.3	120.1	167.7	117.7	174.2	124	162	176.8
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	140.6	184.1	21.62	164.3	134.8	188.2	132.1	195.6	139.2	181.9	198.4
9)	4.687	6.137	0.721	5.475	4.494	6.273	4.402	6.519	4.639	6.062	6.613
10)	1406	1841	216.2	1643	1348	1882	1321	1956	1392	1819	1984
11)	46.87	61.37	7.208	54.75	44.94	62.73	44.02	65.19	46.39	60.62	66.13

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	27.4	30.3	28.3	27.8	27.9	29.9	26.7	28.9	28.4	28.4	30.3
②	45	36	49	46	50	38	45	37	45	50	47
③	295.6	160.2	251.4	221.8	233.6	303.5	242.4	229.3	258.2	237.5	250.6
④	16.9	20.8	51.8	90.6	68.3	27.4	83.4	96.4	42.5	102.8	32.9
⑤	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
⑥	6.55	5.82	5.8	6.93	5.38	7.44	7.46	7.16	6.12	7.4	7.04
⑦	196.5	174.6	174	207.9	161.4	223.2	223.8	214.8	183.6	222	211.2
⑧	119.9	106.5	106.1	126.8	98.45	136.2	136.5	131	112	135.4	128.8
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	119.9	106.5	106.1	126.8	98.45	136.2	136.5	131	112	135.4	128.8
2)	0.1	2.5	21.1	48.5	31	6.4	42.7	53.1	15.5	58.2	9.7
3)	119.8	104	85.04	78.32	67.45	129.8	93.82	77.93	96.5	77.22	119.1
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	204.7	177.8	145.4	133.9	115.3	221.8	160.4	133.2	165	132	203.6
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	229.8	199.5	163.2	150.3	129.4	248.9	180	149.5	185.1	148.1	228.6
9)	7.659	6.651	5.438	5.009	4.314	8.298	6	4.984	6.171	4.938	7.619
10)	2298	1995	1632	1503	1294	2489	1800	1495	1851	1481	2286
11)	76.59	66.51	54.38	50.09	43.14	82.98	60	49.84	61.71	49.38	76.19

NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	28.9	29.7	30.3	31.2	30	30.3	29.3	28.6	31	28.4	30.1
②	51	37	48	43	48	58	50	69	56	48	58
③	286.3	240.3	276.4	248.5	217.7	247.1	213.6	167	240	266.6	244.7
④	73.5	46.2	34.5	72.4	50.7	72.2	39.7	164.0	14.1	9.2	12.5
⑤	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
⑥	6.5	7.73	6.78	7.1	6.83	7.81	6.93	5.38	7.44	7.46	7.16
⑦	195	231.9	203.4	213	204.9	234.3	207.9	161.4	223.2	223.8	214.8
⑧	119	141.5	124.1	129.9	125	142.9	126.8	98.45	136.2	136.5	131
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	119	141.5	124.1	129.9	125	142.9	126.8	98.45	136.2	136.5	131
2)	34.8	17.7	10.7	33.9	20.4	33.8	13.8	107.2	0	0	0
3)	84.15	123.8	113.4	96.03	104.6	109.1	113	0	136.2	136.5	131
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	143.8	211.6	193.8	164.2	178.8	186.5	193.2	0	232.7	233.4	224
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	161.4	237.4	217.5	184.2	200.7	209.4	216.8	0	261.2	261.9	251.4
9)	5.381	7.914	7.25	6.141	6.689	6.978	7.228	0	8.707	8.73	8.379
10)	1614	2374	2175	1842	2007	2094	2168	0	2612	2619	2514
11)	53.81	79.14	72.5	61.41	66.89	69.78	72.28	0	87.07	87.3	83.79

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
①	29.4	30.9	29.3	29.6	30.3	28.9	30.1	29	28.9	29.5	27
②	63	50	46	58	42	49	45	47	41	46	41
③	174.1	211.6	211.8	191.1	237.3	201	193.8	198.9	239.8	204.6	193.2
④	41.9	64.3	66.8	145.2	14.1	65.6	31.5	45.4	7.3	26.3	3.6
⑤	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
⑥	6.12	7.4	7.04	6.5	7.73	6.78	7.1	6.83	7.81	7.49	6.53
⑦	183.6	222	211.2	195	231.9	203.4	213	204.9	234.3	224.7	195.9
⑧	112	135.4	128.8	119	141.5	124.1	129.9	125	142.9	137.1	119.5
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	112	135.4	128.8	119	141.5	124.1	129.9	125	142.9	137.1	119.5
2)	15.1	28.6	30.1	92.2	0	29.4	8.9	17.2	0	5.8	0
3)	96.9	106.8	98.73	26.75	141.5	94.67	121	107.8	142.9	131.3	119.5
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	165.6	182.6	168.8	45.73	241.8	161.8	206.9	184.3	244.3	224.4	204.3
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	185.9	204.9	189.4	51.32	271.4	181.6	232.2	206.8	274.2	251.8	229.3
9)	6.197	6.831	6.314	1.711	9.046	6.054	7.74	6.893	9.14	8.395	7.642
10)	1859	2049	1894	513.2	2714	1816	2322	2068	2742	2518	2293
11)	61.97	68.31	63.14	17.11	90.46	60.54	77.4	68.93	91.4	83.95	76.42

- Water Demand : Dec.

NO	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
①	28	29.8	27.8	28.7	28	28.4	28.5	27.5	27.9	28.5	28
②	69	68	72	64	65	69	77	90	67	63	56
③	144.9	152	158	159.5	102.5	100.3	128	160.9	183.3	103.3	172.2
④	138.9	72.9	151.6	75.7	121.9	257.6	231.1	269.5	47.2	178.3	91.8
⑤	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
⑥	3.95	4.62	3.81	4.09	3.82	3.52	3.66	3.02	4.26	3.73	4.63
⑦	122.5	143.2	118.1	126.8	118.4	109.1	113.5	93.62	132.1	115.6	143.5
⑧	90.61	106	87.4	93.82	87.63	80.75	83.96	69.28	97.72	85.57	106.2
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	90.61	106	87.4	93.82	87.63	80.75	83.96	69.28	97.72	85.57	106.2
2)	87.1	34.3	97.3	36.6	73.5	182.1	160.9	191.6	18.3	118.6	49.4
3)	3.513	71.68	0	57.22	14.13	0	0	0	79.42	0	56.81
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	6.005	122.5	0	97.82	24.16	0	0	0	135.8	0	97.11
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	6.74	137.5	0	109.8	27.11	0	0	0	152.4	0	109
9)	0.217	4.436	0	3.542	0.875	0	0	0	4.915	0	3.516
10)	67.4	1375	0	1098	271.1	0	0	0	1524	0	1090
11)	2.174	44.36	0	35.42	8.745	0	0	0	49.15	0	35.16

NO	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
①	28.3	28.4	28.3	27.8	28.1	29.8	27.6	27.9	29.7	28.5	29.7
②	46	60	67	73	64	51	60	58	50	46	65
③	166.5	110.5	186.7	143.7	174.4	170.9	222.6	161	218.7	218.7	137.9
④	174.9	222.5	171.1	171.7	42.0	117.6	208.2	104.5	25.8	8.6	129.8
⑤	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
⑥	5.07	3.99	3.98	3.4	4.32	4.94	4.79	4.25	5.71	5.6	4.1
⑦	157.2	123.7	123.4	105.4	133.9	153.1	148.5	131.8	177	173.6	127.1
⑧	116.3	91.53	91.3	78	99.1	113.3	109.9	97.5	131	128.5	94.05
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	116.3	91.53	91.3	78	99.1	113.3	109.9	97.5	131	128.5	94.05
2)	115.9	154	112.9	112.9	15.2	70.1	142.6	59.6	5.5	0	79.8
3)	0.406	0	0	0	83.9	43.22	0	37.9	125.5	128.5	14.25
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	0.694	0	0	0	143.4	73.89	0	64.78	214.5	219.6	24.37
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	0.779	0	0	0	161	82.93	0	72.7	240.8	246.5	27.35
9)	0.025	0	0	0	5.192	2.675	0	2.345	7.766	7.95	0.882
10)	7.785	0	0	0	1610	829.3	0	727	2408	2465	273.5
11)	0.251	0	0	0	51.92	26.75	0	23.45	77.66	79.5	8.821

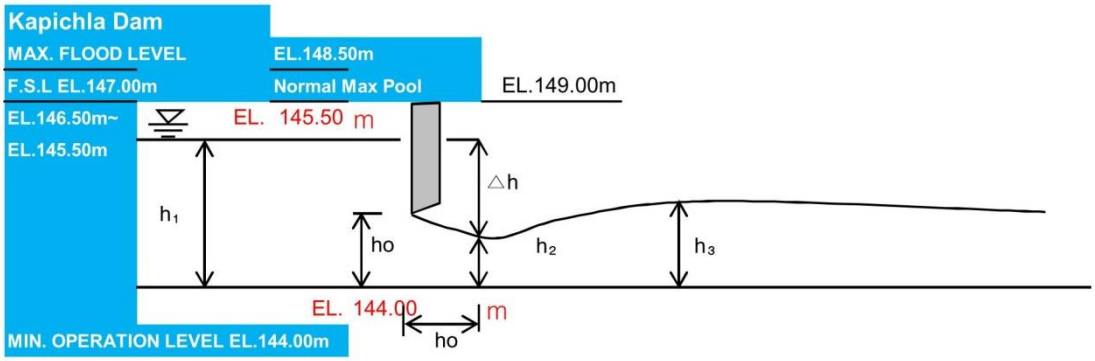
NO	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
①	30	29.4	28	28.4	28.7	28.8	29.8	27.9	29.9	29.1	30.4
②	48	53	78	66	79	77	58	75	74	58	72
③	248.3	189.7	193.3	156.9	193	160.2	215.8	155.4	150.1	199.4	175.9
④	75.3	29.5	206.3	119.9	104.1	218.0	64.2	97.1	113.9	33.4	17.8
⑤	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
⑥	6.18	5.21	4.93	5.46	4.99	5.09	6.82	5.02	5.38	6.44	6.17
⑦	191.6	161.5	152.8	169.3	154.7	157.8	211.4	155.6	166.8	199.6	191.3
⑧	141.8	119.5	113.1	125.3	114.5	116.8	156.5	115.2	123.4	147.7	141.5
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	141.8	119.5	113.1	125.3	114.5	116.8	156.5	115.2	123.4	147.7	141.5
2)	36.2	7.7	141	71.9	59.3	150.4	28.5	53.7	67.1	10	0.7
3)	105.6	111.8	0	53.35	55.17	0	128	61.46	56.32	137.7	140.8
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	180.5	191.1	0	91.2	94.31	0	218.7	105.1	96.27	235.4	240.8
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	202.5	214.5	0	102.4	105.8	0	245.5	117.9	108	264.2	270.2
9)	6.533	6.92	0	3.302	3.414	0	7.919	3.804	3.485	8.524	8.716
10)	2025	2145	0	1024	1058	0	2455	1179	1080	2642	2702
11)	65.33	69.2	0	33.02	34.14	0	79.19	38.04	34.85	85.24	87.16

NO	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
①	28.5	28.9	29.9	28.1	29.1	29.6	28.3	29.2	28.2	28.5	28.4
②	81	79	65	79	76	66	77	52	62	62	60
③	107.2	129.2	136.9	95.7	121.3	141.7	125.8	155.2	150.5	169	120
④	186.8	263.7	75.6	237.9	153.5	60.6	109.2	39.6	40.8	108.9	99.3
⑤	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
⑥	4.45	4.85	5.81	4.53	4.84	5.82	4.72	6.4	5.63	5.87	5.25
⑦	138	150.4	180.1	140.4	150	180.4	146.3	198.4	174.5	182	162.8
⑧	102.1	111.3	133.3	103.9	111	133.5	108.3	146.8	129.2	134.7	120.4
⑨	0	0	0	0	0	0	0	0	0	0	0
⑩	0	0	0	0	0	0	0	0	0	0	0
⑪	0	0	0	0	0	0	0	0	0	0	0
1)	102.1	111.3	133.3	103.9	111	133.5	108.3	146.8	129.2	134.7	120.4
2)	125.4	187	36.5	166.3	98.8	26.4	63.4	13.8	14.5	63.1	55.4
3)	0	0	96.78	0	12.23	107.1	44.88	133	114.7	71.56	65.04
4)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
5)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
6)	0	0	165.4	0	20.91	183.1	76.71	227.4	196	122.3	111.2
7)	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
8)	0	0	185.7	0	23.46	205.5	86.1	255.2	220	137.3	124.8
9)	0	0	5.99	0	0.757	6.629	2.777	8.232	7.096	4.429	4.025
10)	0	0	1857	0	234.6	2055	861	2552	2200	1373	1248
11)	0	0	59.9	0	7.569	66.29	27.77	82.32	70.96	44.29	40.25

APPENDIX 7

Calculation for Inflow Width of Intake

Inflow Width of Intake



Use the Orifice Formula $Q(m^3/s) = C*B*ho*(2g(h_1 - ho/2))^{(1/2)}$

where C = Coefficient of discharge, B = Inflow Width of Intake(m)

Result : When the sill elevation is 144.00m a.m.s.l

∴ The width of Intake B = 36 m

C	ho(m)	Q(m³/s)	B(m)	
0.581	0.5	50.305488	41	
0.580	0.6	50.39524	36	OK B(3m @12=36m)
0.580	0.7	50.099322	32	

$Q(m^3/s) = m * B * ho * (2g(h_1 - ho/2))^{1/2}$

Q(m³/s)	m	ho(m)	2g(m/s²)	h₁(m)	ho/2	(2g(h₁ -ho/2))^1/2	B(m)	Sill EL. 144.00
50.02	0.65	0.20	19.6	1.50	0.10	5.24	74	Min EL. 145.50
50.02	0.65	0.30	19.6	1.50	0.15	5.14	50	
50.02	0.65	0.40	19.6	1.50	0.20	5.05	39	
50.02	0.65	0.42	19.6	1.50	0.21	5.03	37	
50.02	0.65	0.43	19.6	1.50	0.22	5.02	36	
50.02	0.65	0.45	19.6	1.50	0.23	5.00	35	
50.02	0.65	0.50	19.6	1.50	0.25	4.95	32	
50.02	0.65	0.60	19.6	1.50	0.30	4.85	27	
50.02	0.65	0.70	19.6	1.50	0.35	4.75	24	
50.02	0.65	0.80	19.6	1.50	0.40	4.64	21	
50.02	0.65	0.90	19.6	1.50	0.45	4.54	19	Sill EL. 144.00
50.02	0.65	0.20	19.6	1.30	0.10	4.85	80	Min EL. 145.30
50.02	0.65	0.30	19.6	1.30	0.15	4.75	55	
50.02	0.65	0.40	19.6	1.30	0.20	4.64	42	
50.02	0.65	0.47	19.6	1.30	0.24	4.57	36	
50.02	0.65	0.60	19.6	1.30	0.30	4.43	29	
50.02	0.65	0.70	19.6	1.30	0.35	4.32	26	
50.02	0.65	0.80	19.6	1.30	0.40	4.20	23	
50.02	0.65	0.90	19.6	1.30	0.45	4.08	21	
50.02	0.65	1.00	19.6	1.30	0.50	3.96	20	Sill EL. 144.00
50.02	0.65	0.20	19.6	1.20	0.10	4.64	83	Min EL. 145.20
50.02	0.65	0.30	19.6	1.20	0.15	4.54	57	
50.02	0.65	0.40	19.6	1.20	0.20	4.43	44	
50.02	0.65	0.50	19.6	1.20	0.25	4.32	36	
50.02	0.65	0.60	19.6	1.20	0.30	4.20	31	
50.02	0.65	0.70	19.6	1.20	0.35	4.08	27	
50.02	0.65	0.80	19.6	1.20	0.40	3.96	25	
50.02	0.65	0.90	19.6	1.20	0.45	3.83	23	
50.02	0.65	1.00	19.6	1.20	0.50	3.70	21	

1. Hydraulic Analysis of Gate

1-1. Flow Capacity Calculation

1) Condition

① Minimum Water Elevation : EL = 145.50 m

② SILL Elevation : EL = 144.00 m

③ Flow Coefficient (Cq) 및 Contraction Coefficient(Cc) was choosen by the h_1/a in the Graph 1

④ Location of the contraction coefficient is the same length of openning height of gate

⑤ out water elvel is ignored, and water depth of downstream is zero

2) Discharge Calculation by the Gate Operation

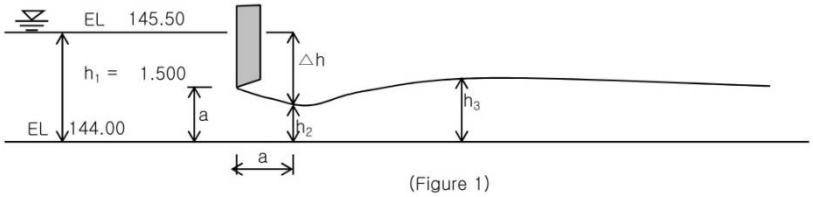
$q = Cq * a \sqrt{(2g * \triangle h)}$ ---------- (1)

where, q = discharge per unit width

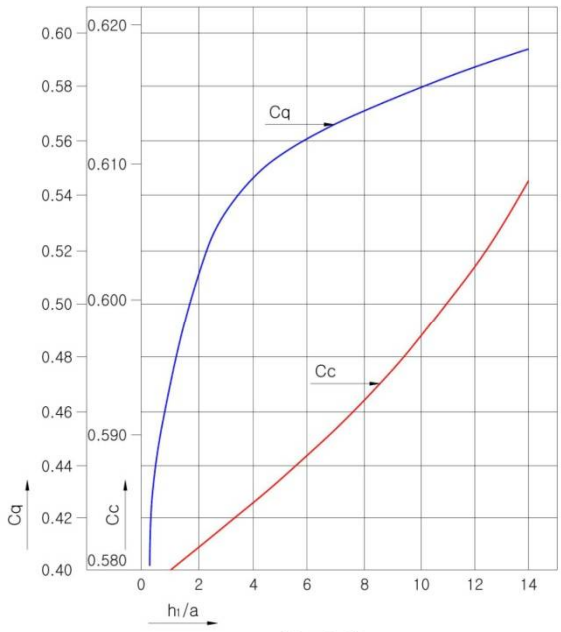
Cq = flow coefficient

a = openning height of the gate

$\triangle h$ = difference of water level ($h_1 - h_2$)



(Figure 1)



(Graph 1)

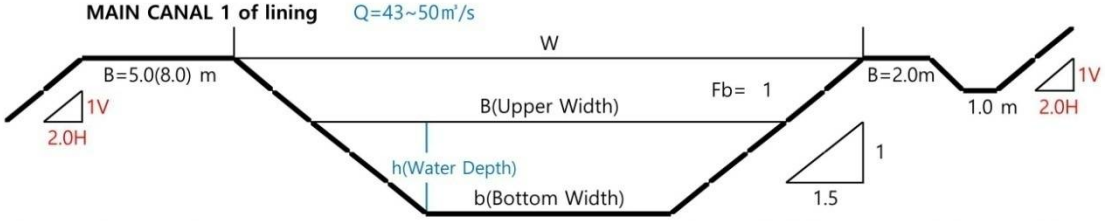
Dischqrge Calculation by the openning height of the gate

① Inside Water Depth (h_1)	② Openning Height of Gate (a)	③ Contraction Coefficient Cc	④ Contraction Height $h_2=Cc*a$	⑤ Differential Head $\triangle h=h_1-h_2$	⑥ Flow Coefficient Cq	⑦ Cq*a	⑧ $V_2=\sqrt{2g*\triangle h}$	⑨ Discharge per Unit Width q=⑦*⑧
1.50	0.1	0.594	0.059	1.441	0.575	0.058	5.314	0.306
1.5	0.2	0.585	0.117	1.383	0.55	0.110	5.206	0.573
1.5	0.3	0.583	0.175	1.325	0.533	0.160	5.096	0.815
1.5	0.4	0.582	0.233	1.267	0.517	0.207	4.984	1.031
1.5	0.5	0.581	0.291	1.210	0.504	0.252	4.869	1.227
1.5	0.6	0.580	0.348	1.152	0.491	0.295	4.752	1.400
1.5	0.7	0.580	0.406	1.094	0.483	0.338	4.631	1.566
1.5	0.8	0.580	0.464	1.036	0.474	0.379	4.506	1.709
1.5	0.9	0.580	0.522	0.978	0.469	0.422	4.378	1.848

APPENDIX 8

Calculation for Canal Optimization

MAIN CANAL 1 of lining Q=43~50㎥/s



Chace of Cross Section longitudinal slope = 1: 8000 0.000125

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	16+600	2.50	12.70	20.20	22.60	5.08	50.006	43,370	0.001153	50.274	1.2225	41.125	4~8	OK
~ STA	20+500	2.50	12.50	20.00	22.40	5.00	49.290	621		49.564	1.22	40.625	4~8	OK
~ STA	22+500	2.50	11.40	18.90	21.30	4.56	45.303	3,458		45.67	1.2058	37.875	4~8	OK
~ STA	28+600	2.50	11.20	18.70	21.10	4.48	44.924	328		44.964	1.203	37.375	4~8	OK
~ STA	31+100	2.50	11.00	18.50	20.90	4.40	44.141	679		44.258	1.2002	36.875	4~8	OK
~ STA	33+700(EP)	2.50	10.70	18.20	20.60	4.28	42.942	1,040		43.201	1.1959	36.125	4~8	OK

CASE h=2.6 Cross Section 4~8

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	16+600	2.6	11.70	19.50	21.90	4.5	50.006	43,370	0.001153	50.1171	1.23563	40.56	4~8	OK
~ STA	20+500	2.6	11.50	19.30	21.70	4.42	49.290	621		49.3637	1.23286	40.04	4~8	OK
~ STA	22+500	2.6	10.60	18.40	20.80	4.08	45.303	3,458		45.9811	1.21966	37.7	4~8	OK
~ STA	28+000	2.6	10.50	18.30	20.70	4.04	44.924	328		45.6062	1.21811	37.44	4~8	OK
~ STA	31+100	2.6	10.30	18.10	20.50	3.96	44.141	679		44.8568	1.21497	36.92	4~8	OK
~ STA	33+700(EP)	2.6	9.80	17.60	20.00	3.77	42.942	1,040		42.9868	1.20682	35.62	4~8	OK

CASE h=2.5 Cross Section

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	16+600	2.50	12.70	20.2	22.60	5.08	50.006	43,370	0.001153	50.2742	1.22247	41.125	4~8	OK
~ STA	20+500	2.50	12.50	20	22.4	5.00	49.290	621		49.564	1.22005	40.625	4~8	OK
~ STA	22+500	2.50	11.40	18.9	21.3	4.56	45.303	3,458		45.670	1.20581	37.875	4~8	OK
~ STA	28+000	2.50	11.20	18.7	21.1	4.48	44.924	328		44.964	1.20304	37.375	4~8	OK
~ STA	31+100	2.50	11.00	18.5	20.9	4.40	44.141	679		44.258	1.20022	36.875	4~8	OK
~ STA	33+700(EP)	2.50	10.70	18.2	20.6	4.28	42.942	1,040		43.201	1.19587	36.125	4~8	OK

CASE h=2.4 Cross Section

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	16+600	2.4	13.70	20.9	23.30	5.71	50.006	43,370	0.001153	50.1027	1.20671	41.52	4~8	OK
~ STA	20+500	2.4	13.50	20.7	23.1	5.63	49.290	621		49.4364	1.20459	41.04	4~8	OK
~ STA	22+500	2.4	12.40	19.6	22	5.17	45.303	3,458		45.7789	1.19216	38.4	4~8	OK
~ STA	28+000	2.4	12.30	19.5	21.9	5.13	44.924	328		45.447	1.19096	38.16	4~8	OK
~ STA	31+100	2.4	12.10	19.3	21.7	5.04	44.141	679		44.7837	1.18853	37.68	4~8	OK
~ STA	33+700(EP)	2.4	11.60	18.8	21.2	4.83	42.942	1,040		43.1275	1.18222	36.48	4~8	OK

CASE h=2.3 Cross Section

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	16+600	2.3	14.90	21.8	24.20	6.48	50.006	43,370	0.001153	50.2379	1.19033	42.205	4~8	OK
~ STA	20+500	2.3	14.60	21.5	23.9	6.35	49.290	621		49.3026	1.18759	41.515	4~8	OK
~ STA	22+500	2.3	13.50	20.4	22.8	5.87	45.303	3,458		45.8791	1.17684	38.985	4~8	OK
~ STA	28+000	2.3	13.40	20.3	22.7	5.83	44.924	328		45.5683	1.17581	38.755	4~8	OK
~ STA	31+100	2.3	13.10	20	22.4	5.70	44.141	679		44.6367	1.17264	38.065	4~8	OK
~ STA	33+700(EP)	2.3	12.60	19.5	21.9	5.48	42.942	1,040		43.0858	1.16716	36.915	4~8	OK

CASE h=2.2 Cross Section

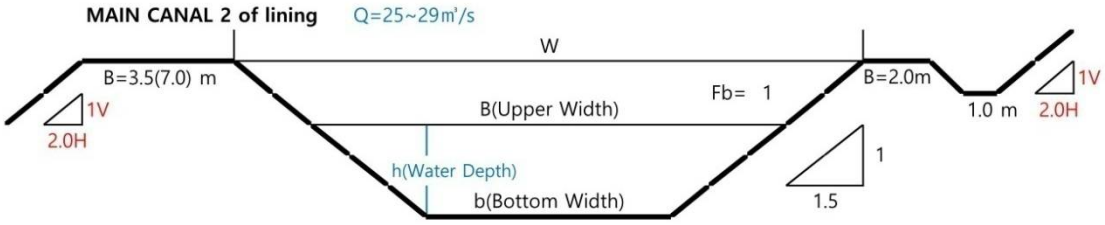
From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	16+600	2.2	16.20	22.8	25.20	7.36	50.006	43,370	0.001153	50.2756	1.17193	42.9	4~8	OK
~ STA	20+500	2.2	15.90	22.5	24.9	7.23	49.290	621		49.4034	1.16959	42.24	4~8	OK
~ STA	22+500	2.2	14.70	21.3	23.7	6.68	45.303	3,458		45.9199	1.15959	39.6	4~8	OK
~ STA	28+000	2.2	14.60	21.2	23.6	6.64	44.924	328		45.63	1.15871	39.38	4~8	OK
~ STA	31+100	2.2	14.30	20.9	23.3	6.50	44.141	679		44.7608	1.15601	38.72	4~8	OK
~ STA	33+700(EP)	2.2	13.70	20.3	22.7	6.23	42.942	1,040		43.0242	1.15038	37.4	4~8	OK

CASE h=2.1 Cross Section

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	16+600	2.1	17.60	23.9	26.30	8.38	50.006	43,370	0.001153	50.1705	1.15136	43.575	4~8	OK
~ STA	20+500	2.1	17.30	23.6	26	8.24	49.290	621		49.3603	1.14939	42.945	4~8	OK
~ STA	22+500	2.1	16.00	22.3	24.7	7.62	45.303	3,458		45.8543	1.14023	40.215	4~8	OK
~ STA	28+000	2.1	15.90	22.2	24.6	7.57	44.924	328		45.585	1.13948	40.005	4~8	OK
~ STA	31+100	2.1	15.50	21.8	24.2	7.38	44.141	679		44.508	1.13642	39.165	4~8	OK
~ STA	33+700(EP)	2.1	15.00	21.3	23.7	7.14	42.942	1,040		43.163	1.13244	38.115	4~8	OK

CASE h=2.0 Cross Section

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	16+600	2.0	19.20	25.2	27.60	9.60	50.006	43,370	0.001153	50.1311	1.12908	44.4	4~8	OK
~ STA	20+500	2.0	18.90	24.9	27.3	9.45	49.290	621		49.3818	1.12744	43.8	4~8	OK
~ STA	22+500	2.0	17.50	23.5	25.9	8.75	45.303	3,458		45.8887	1.11924	41	4~8	OK
~ STA	28+000	2.0	17.30	23.3	25.7	8.65	44.924	328		45.3902	1.11798	40.6	4~8	OK
~ STA	31+100	2.0	17.00	23	25.4	8.50	44.141	679		44.6427	1.11607	40	4~8	OK
~ STA	33+700(EP)	2.0	16.40	22.4	24.8	8.20	42.942	1,040		43.1488	1.11208	38.8	4~8	OK



Chace of Cross Section longitudinal slope = 1: 5000 0.000200

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	02+400	1.90	9.10	14.80	17.20	4.79	28.996	25,148	0.001153	29.023	1.2783	22.705	4~8	OK
~ STA	05+600	1.90	8.90	14.60	17.00	4.68	28.410	508		28.456	1.2746	22.325	4~8	OK
~ STA	07+960	1.90	8.90	14.60	17.00	4.68	28.175	204		28.456	1.2746	22.325	4~8	OK
~ STA	09+700	1.90	8.80	14.50	16.90	4.63	28.161	215		28.173	1.2728	22.135	4~8	OK
~ STA	11+200	1.90	8.70	14.40	16.80	4.58	27.823	294		27.89	1.2709	21.945	4~8	OK
~ STA	13+100	1.90	8.60	14.30	16.70	4.53	27.391	374		27.607	1.269	21.755	4~8	OK
~ STA	14+100	1.90	8.20	13.90	16.30	4.32	26.237	1,001		26.478	1.2611	20.995	4~8	OK
~ STA	18+400(EP)	1.90	8.00	13.70	16.10	4.21	25.699	1,468		25.914	1.257	20.615	4~8	OK

CASE h=1.9 Cross Section

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	02+400	1.90	9.10	14.80	17.20	4.79	28.996	25,148	0.001153	29.0228	1.27826	22.705	4~8	OK
~ STA	05+600	1.90	8.90	14.60	17.00	4.68	28.410	508		28.4561	1.27463	22.325	4~8	OK
~ STA	07+960	1.90	8.90	14.60	17.00	4.68	28.175	204		28.4561	1.27463	22.325	4~8	OK
~ STA	09+700	1.90	8.80	14.50	16.90	4.63	27.927	215		28.173	1.27278	22.135	4~8	OK
~ STA	11+200	1.90	8.70	14.40	16.80	4.58	27.836	294		27.89	1.27091	21.945	4~8	OK
~ STA	13+100	1.90	8.60	14.30	16.70	4.53	27.405	374		27.6072	1.26901	21.755	4~8	OK
~ STA	14+100	1.90	8.20	13.90	16.30	4.32	26.250	1,001		26.4776	1.26114	20.995	4~8	OK
~ STA	18+400(EP)	1.90	8.00	13.70	16.10	4.21	25.712	1,468		25.9138	1.25704	20.615	4~8	OK

CASE h=1.8 Cross Section

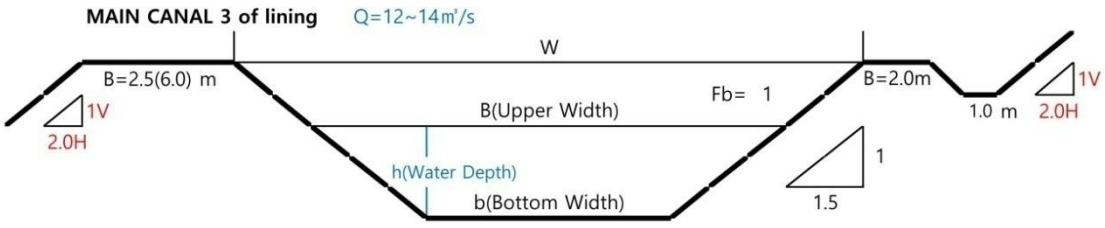
From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	02+400	1.80	10.20	15.60	18.00	5.67	28.996	25,148	0.001153	29.2316	1.2589	23.22	4~8	OK
~ STA	05+600	1.80	9.90	15.30	17.70	5.50	28.410	508		28.449	1.25438	22.680	4~8	OK
~ STA	07+960	1.80	9.90	15.30	17.70	5.50	28.175	204		28.449	1.25438	22.680	4~8	OK
~ STA	09+700	1.80	9.80	15.20	17.60	5.44	28.162	215		28.189	1.25284	22.500	4~8	OK
~ STA	11+200	1.80	9.70	15.10	17.50	5.39	27.823	294		27.928	1.25127	22.320	4~8	OK
~ STA	13+120	1.80	9.50	14.90	17.30	5.28	27.392	374		27.408	1.24808	21.960	4~8	OK
~ STA	14+100	1.80	9.10	14.50	16.90	5.06	26.238	1,001		26.368	1.24144	21.240	4~8	OK
~ STA	18+400(EP)	1.80	8.90	14.30	16.70	4.94	25.699	1,468		25.8491	1.23798	20.88	4~8	OK

CASE h=1.7 Cross Section

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	02+400	1.70	11.30	16.40	18.80	6.65	28.996	25,148	0.001153	29.0645	1.23442	23.545	4~8	OK
~ STA	05+600	1.70	11.10	16.20	18.60	6.53	28.410	508		28.587	1.23195	23.205	4~8	OK
~ STA	07+960	1.70	11.10	16.20	18.60	6.53	28.175	204		28.587	1.23195	23.205	4~8	OK
~ STA	09+700	1.70	11.00	16.10	18.50	6.47	28.162	215		28.349	1.23069	23.035	4~8	OK
~ STA	11+200	1.70	10.80	15.90	18.30	6.35	27.823	294		27.872	1.22813	22.695	4~8	OK
~ STA	13+120	1.70	10.70	15.80	18.20	6.29	27.392	374		27.634	1.22683	22.525	4~8	OK
~ STA	14+100	1.70	10.20	15.30	17.70	6.00	26.238	1,001		26.445	1.22005	21.675	4~8	OK
~ STA	18+400(EP)	1.70	9.90	15.00	17.40	5.82	25.699	1,468		25.7319	1.21578	21.165	4~8	OK

CASE h=1.6 Cross Section

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	02+400	1.60	12.70	17.50	19.90	7.94	28.996	25,148	0.001153	29.1914	1.20825	24.16	4~8	OK
~ STA	05+600	1.60	12.40	17.20	19.60	7.75	28.410	508		28.541	1.20528	23.680	4~8	OK
~ STA	07+960	1.60	12.40	17.20	19.60	7.75	28.175	204		28.541	1.20528	23.680	4~8	OK
~ STA	09+700	1.60	12.30	17.10	19.50	7.69	28.162	215		28.324	1.20427	23.520	4~8	OK
~ STA	11+200	1.60	12.10	16.90	19.30	7.56	27.823	294		27.891	1.20221	23.200	4~8	OK
~ STA	13+120	1.60	11.90	16.70	19.10	7.44	27.392	374		27.458	1.2001	22.880	4~8	OK
~ STA	14+100	1.60	11.40	16.20	18.60	7.13	26.238	1,001		26.377	1.19461	22.080	4~8	OK
~ STA	18+400(EP)	1.60	11.20	16.00	18.40	7.00	25.699	1,468		25.9448	1.19231	21.76	4~8	OK



Option of Cross Section longitudinal slope = 1: 3000 0.000333

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	00+700	1.30	6.70	10.60	13.00	5.15	13.979	12,124	0.001153	14.542	1.2932	11.245	4~8	OK
~ STA	02+400	1.30	6.50	10.40	12.80	5.00	13.595	333		14.152	1.2883	10.985	4~8	OK
~ STA	07+700	1.30	5.60	9.50	11.90	4.31	11.973	1,407		12.405	1.2639	9.815	4~8	OK
~ STA	09+317	1.30	5.50	9.40	11.80	4.23	11.797	152		12.212	1.2609	9.685	4~8	OK
~ STA	13+120(EP)	1.30	5.40	9.30	11.70	4.15	11.569	198		12.018	1.2578	9.555	4~8	OK

CASE h=1.50 Cross Section

From	To	h(수심)	b(저폭)	B(상폭)	W(전폭)	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	00+700	1.50	4.80	9.30	11.70	3.20	13.979	12,124	0.001153	14.1192	1.33515	10.575	4~8	OK
~ STA	02+400	1.50	4.60	9.10	11.50	3.07	13.595	333		13.637	1.32716	10.275	4~8	OK
~ STA	07+700	1.50	4.00	8.50	10.90	2.67	11.972	1,407		12.197	1.30102	9.375	4~8	OK
~ STA	09+317	1.50	3.90	8.40	10.80	2.60	11.797	152		11.958	1.29631	9.225	4~8	OK
~ STA	13+120(EP)	1.50	3.80	8.30	10.70	2.53	11.568	198		11.720	1.29148	9.075	4~8	OK

CASE h=1.40 Cross Section

From	To	h(수심)	b(저폭)	B(상폭)	W(전폭)	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	00+700	1.40	5.60	9.80	12.20	4.00	13.979	12,124	0.001153	14.1744	1.31488	10.78	4~8	OK
~ STA	02+400	1.40	5.40	9.60	12.00	3.86	13.607	322		13.739	1.30844	10.500	4~8	OK
~ STA	07+700	1.40	4.70	8.90	11.30	3.36	11.984	1,407		12.221	1.28371	9.520	4~8	OK
~ STA	09+317	1.40	4.60	8.80	11.20	3.29	11.805	156		12.005	1.27986	9.380	4~8	OK
~ STA	13+120(EP)	1.40	4.50	8.70	11.10	3.21	11.576	198		11.790	1.27592	9.240	4~8	OK

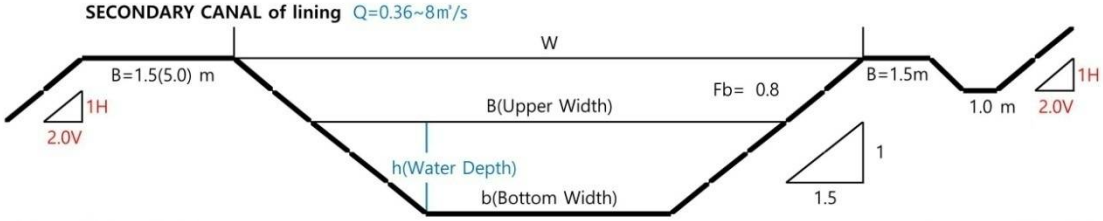
CASE h=1.30 Cross Section

From	To	h(수심)	b(저폭)	B(상폭)	W(전폭)	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	00+700	1.30	6.70	10.60	13.00	5.15	13.979	12,124	0.001153	14.5423	1.29322	11.245	4~8	OK
~ STA	02+400	1.30	6.50	10.40	12.80	5.00	13.607	322		14.152	1.28834	10.985	4~8	OK
~ STA	07+700	1.30	5.60	9.50	11.90	4.31	11.984	1,407		12.405	1.26388	9.815	4~8	OK
~ STA	09+317	1.30	5.50	9.40	11.80	4.23	11.805	156		12.212	1.26088	9.685	4~8	OK
~ STA	13+120(EP)	1.30	5.40	9.30	11.70	4.15	11.576	198		12.018	1.25782	9.555	4~8	OK

CASE h=1.20 Cross Section

From	To	h(수심)	b(저폭)	B(상폭)	W(전폭)	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	00+700	1.20	7.50	11.10	13.50	6.25	13.979	12,124	0.001153	14.0016	1.25462	11.16	4~8	OK
~ STA	02+400	1.20	7.30	10.90	13.30	6.08	13.607	322		13.658	1.25071	10.920	4~8	OK
~ STA	07+700	1.20	6.40	10.00	12.40	5.33	11.984	1,407		12.115	1.23121	9.840	4~8	OK
~ STA	09+317	1.20	6.30	9.90	12.30	5.25	11.805	156		11.944	1.22883	9.720	4~8	OK
~ STA	13+120(EP)	1.20	6.10	9.70	12.10	5.08	11.576	198		11.603	1.22392	9.480	4~8	OK

SECONDARY CANAL of lining Q=0.36~8㎥/s



Option of Cross Section longitudinal slope = 1: 3000 0.000333

No	Location	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
I 1 M1	16+600	0.70	1.70	3.80	5.60	2.43	1.432	621	0.001153	1.48669	0.77231	1.925	2~4	OK
I 2 M1	20+500	1.10	5.10	8.40	10.80	4.64	3.987	3,458		8.47601	1.14155	7.425	4~8	OK
I 3 M1	22+500	0.50	1.70	3.20	5.00	3.40	0.756	328		0.79298	0.64733	1.225	2~4	OK
I 4 M1	28+600	0.70	1.90	4.00	6.40	2.71	1.566	679		1.62047	0.78473	2.065	2~4	OK
I 5 M1	31+100	0.80	2.30	4.70	7.10	2.88	2.398	1,040		2.42162	0.86487	2.8	2~4	OK
I 6 M3	00+700	0.50	1.70	3.20	5.00	3.40	0.768	333		0.79298	0.64733	1.225	2~4	OK
I 7 M3	02+400	0.80	3.30	5.70	8.10	4.13	3.245	1,407		3.27302	0.90917	3.6	4~8	OK
A1 M2	02+400	0.60	1.90	3.70	5.50	3.17	1.171	508		1.21592	0.72376	1.68	2~4	OK
A2 M2	05+600	0.40	1.50	2.70	4.50	3.75	0.470	204		0.475	0.56543	0.840	2~4	OK
A3 M2	07+960	0.50	1.00	2.50	4.30	2.00	0.497	215		0.525	0.60015	0.875	2~4	OK
A4 M2	09+700	0.50	1.50	3.00	4.80	3.00	0.678	294		0.716	0.63605	1.125	2~4	OK
A5 M2	11+200	0.60	1.40	3.20	5.00	2.33	0.862	374		0.956	0.69288	1.380	2~4	OK
A6 M2	13+100	0.80	2.20	4.60	7.00	2.75	2.308	1,001		2.338	0.8594	2.720	2~4	OK
A7 M2	14+100	0.90	2.70	5.40	7.80	3.00	3.385	1,468		3.431	0.94119	3.645	4~8	OK
A8 M3	07+700	0.50	1.00	2.50	4.30	2.00	0.351	152		0.525	0.60015	0.875	2~4	OK
A9 M3	09+317	0.50	1.10	2.60	4.40	2.20	0.457	198		0.563	0.60841	0.925	2~4	OK

Secondary Canal I 1

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	01+988	0.70	1.70	3.80	5.60	2.43	1.432	621	0.001153	1.48669	0.77231	1.925	2~4	OK
~ STA	03+773	0.60	1.70	3.50	5.30	2.83	1.005	185		1.111	0.71245	1.560	2~4	OK
~ STA	05+885	0.50	1.30	2.80	4.60	2.60	0.622	166		0.639	0.6232	1.025	2~4	OK
~ STA	07+529(EP)	0.50	1.00	2.50	4.30	2.00	0.396	98		0.525	0.60015	0.875	2~4	OK

Secondary Canal I 2

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	04+536	1.10	5.10	8.40	10.80	4.64	3.987	3,458	0.001153	8.47601	1.14155	7.425	4~8	OK
~ STA	06+062	1.10	4.40	7.70	10.10	4.00	3.001	855		7.451	1.1196	6.655	4~8	OK
~ STA	13+149	1.00	4.30	7.30	9.70	4.30	1.849	999		6.153	1.06082	5.800	2~4	OK
~ STA	16+757	1.00	4.00	7.00	8.80	4.00	1.481	319		5.779	1.05067	5.500	2~4	OK
~ STA	18+516(EP)	0.90	3.80	6.50	8.30	4.22	0.346	985		4.572	0.98649	4.635	2~4	OK
06+062	10+337(EP)	0.50	1.50	3.00	4.80	3.00	0.666	577		0.716	0.63605	1.125	2~4	OK

Secondary Canal I 3

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	01+337(EP)	0.50	1.70	3.20	5.00	3.40	0.756	328	0.001153	0.79298	0.64733	1.225	2~4	OK

Secondary Canal I 4

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	01+128(EP)	0.70	1.90	4.00	6.40	2.71	1.566	679	0.001153	1.62047	0.78473	2.065	2~4	OK

Secondary Canal I 5

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	01+335	0.80	2.30	4.70	7.10	2.88	2.398	1,040	0.001153	2.42162	0.86487	2.8	2~4	OK
~ STA	03+151(EP)	0.50	1.50	3.00	4.80	3.00	0.778	702		0.716	0.63605	1.125	2~4	NO
01+335	03+255(EP)	0.40	0.90	2.10	3.90	2.25	0.230	100		0.316	0.52601	0.600	2~4	OK

Secondary Canal I 6

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	00+700(EP)	0.50	1.70	3.20	5.00	3.40	0.768	333	0.001153	0.79298	0.64733	1.225	2~4	OK

Secondary Canal I 7

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~		0.80	3.30	5.70	8.10	4.13	3.245	1407	0.001153	3.27302	0.90917	3.6	4~8	OK

STA 0~	00+045	0.70	1.50	3.60	5.40	2.14	1.308	567	0.001153	1.35398	0.75853	1.785	2~4	OK
STA 0~	01+600	0.80	1.80	4.20	6.60	2.25	1.937	840	0.001153	2.00397	0.83499	2.4	2~4	OK
~ STA	03+244	0.80	1.50	3.90	6.30	1.88	1.699	103		1.757	0.81346	2.160	2~4	OK
~ STA	07+130	0.50	1.40	2.90	4.70	2.80	0.668	447		0.677	0.62984	1.075	2~4	OK
~ STA	09+133(EP)	0.40	0.90	2.10	3.90	2.25	0.309	155		0.316	0.52601	0.600	2~4	OK
07+130	07+416(EP)	0.40	0.90	2.10	3.90	2.25	0.313	136		0.316	0.52601	0.600	2~4	OK

Secondary Canal A1

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	01+300	0.60	1.90	3.70	5.50	3.17	1.171	508	0.001153	1.21592	0.72376	1.68	2~4	OK
~ STA	03+186(EP)	0.40	1.50	2.70	4.50	3.75	0.462	200		0.475	0.56543	0.840	2~4	OK

Secondary Canal A2

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	06+360	0.40	1.50	2.70	4.50	3.75	0.470	204	0.001153	0.47496	0.56543	0.84	2~4	OK
~ STA	07+544(EP)	0.40	0.80	2.00	3.80	2.00	0.230	100		0.290	0.51719	0.560	2~4	OK

Secondary Canal A3

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	00+547	0.50	1.00	2.50	4.30	2.00	0.497	215	0.001153	0.52513	0.60015	0.875	2~4	OK
~ STA	01+969(EP)	0.40	0.80	2.00	3.80	2.00	0.263	114		0.290	0.51719	0.560	2~4	OK

Secondary Canal A4

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	01+052(EP)	0.50	1.50	3.00	4.80	3.00	0.678	294	0.001153	0.71556	0.63605	1.125	2~4	OK

Secondary Canal A5

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	00+883(EP)	0.60	1.40	3.20	5.00	2.33	0.862	374	0.001153	0.95618	0.69288	1.38	2~4	OK

Secondary Canal A6

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	00+800	0.80	2.20	4.60	7.00	2.75	2.308	1,001	0.001153	2.33757	0.8594	2.72	2~4	OK
~ STA	02+754	0.80	1.70	4.10	6.50	2.13	1.644	288		1.921	0.82816	2.320	2~4	OK
~ STA	05+233	0.70	1.40	3.50	5.30	2.00	1.144	217		1.288	0.75106	1.715	2~4	OK
~ STA	06+971	0.50	1.40	2.90	4.70	2.80	0.641	218		0.677	0.62984	1.075	2~4	OK
~ STA	08+656(EP)	0.30	0.60	1.50	3.30	2.00	0.093	238		0.134	0.42693	0.315	2~4	OK

Secondary Canal A7

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	00+000	0.90	2.70	5.40	7.80	3.00	3.385	1,468	0.001153	3.43062	0.94119	3.645	4~8	OK
~ STA	00+243	0.80	1.60	4.00	6.40	2.00	1.768	702		1.839	0.82099	2.240	2~4	OK
~ STA	01+187	0.80	1.40	3.80	6.20	1.75	1.555	92		1.676	0.80555	2.080	2~4	OK
~ STA	03+683	0.70	1.10	3.20	5.00	1.57	1.063	213		1.093	0.72592	1.505	2~4	OK
~ STA	07+518(EP)	0.50	1.10	2.60	4.40	2.20	0.527	233		0.563	0.60841	0.925	2~4	OK
STA 0~	00+927	0.80	1.60	4.00	6.40	2.00	1.769	767		1.839	0.82099	2.240	2~4	OK
~ STA	02+847	0.80	1.30	3.70	6.10	1.63	1.554	93		1.594	0.79721	2.000	2~4	OK
~ STA	05+698	0.70	1.30	3.40	5.20	1.86	1.178	163		1.223	0.74317	1.645	2~4	OK
~ STA	08+338	0.50	1.10	2.60	4.40	2.20	0.562	267		0.563	0.60841	0.925	2~4	OK
~ STA	09+926(EP)	0.40	0.70	1.90	3.70	1.75	0.252	134		0.264	0.50746	0.520	2~4	OK

Secondary Canal A8

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	00+766	0.50	1.00	2.50	4.30	2.00	0.351	152	0.001153	0.52513	0.60015	0.875	2~4	OK
~ STA	01+540	0.30	1.00	1.90	3.70	3.33	0.154	85		0.200	0.45923	0.435	2~4	OK

Secondary Canal A9

From	To	h	b	B	W	Varies	Dischage	Net Area	Unit	Q=A V	V	A		
STA 0~	00+170	0.50	1.10	2.60	4.40	2.20	0.457	198	0.001153	0.56278	0.60841	0.925	2~4	OK
00+000	01+589	0.30	1.00	1.90	3.70	3.33	0.136	139		0.200	0.45923	0.435	2~4	OK

APPENDIX 9

Ground Control Point Survey Result

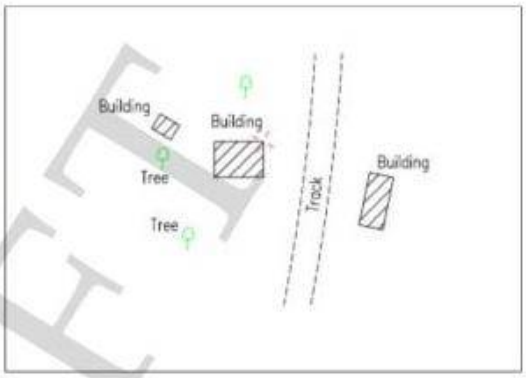
Ground Controll Points Survey Results

For

Image Map & Spatial Information

GCPs - Quality Control

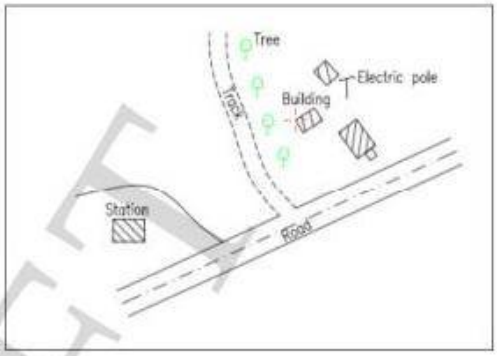
GCP ID: **Q01**



Local Coordinates

- Easting *(m)*: 689 397.70
- Northing *(m)*: 8 234 880.09
- Z *(m)*: 97.18

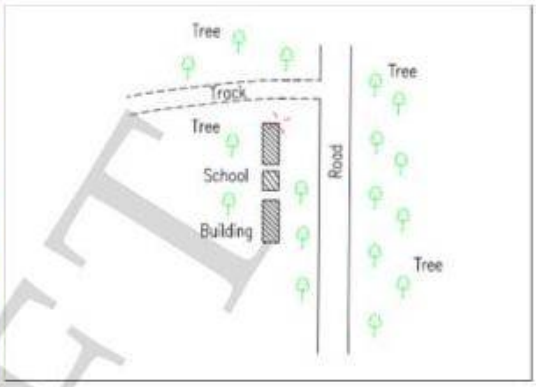
GCP ID: **Q02**



Local Coordinates

- Easting *(m)*: 692 857.25
- Northing *(m)*: 8 226 621.71
- Z *(m)*: 105.38

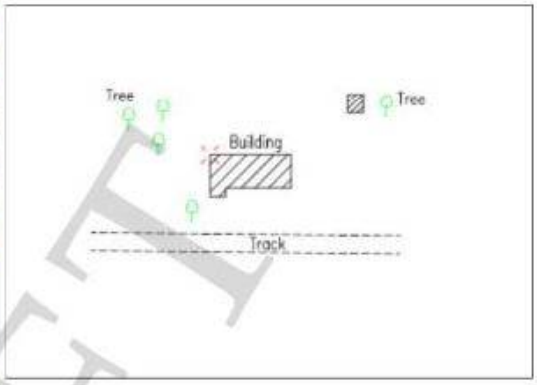
GCP ID: **Q03**



Local Coordinates

- Easting *(m)*: 691 882.80
- Northing *(m)*: 8 226 450.58
- Z *(m)*: 110.63

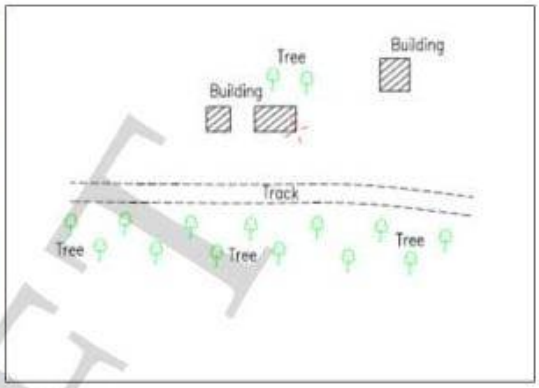
GCP ID: **Q05**



Local Coordinates

- Easting *(m)*: 685 841.05
- Northing *(m)*: 8 222 923.70
- Z *(m)*: 132.66

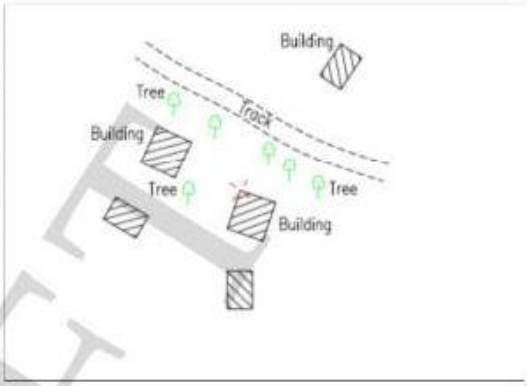
GCP ID: **Q06**



Local Coordinates

- Easting *(m)*: 688 395.35
- Northing *(m)*: 8 223 813.01
- Z *(m)*: 116.29

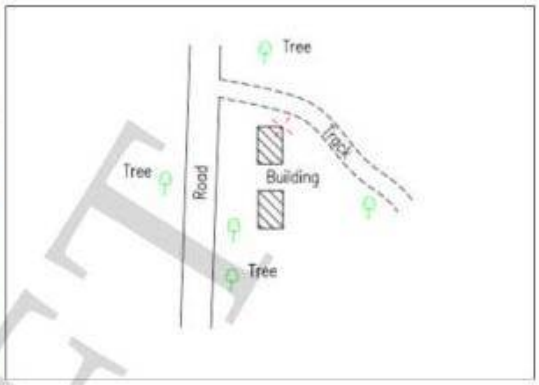
GCP ID: **Q07**



Local Coordinates

- Easting *(m)*: 691 135.09
- Northing *(m)*: 8 222 931.06
- Z *(m)*: 104.60

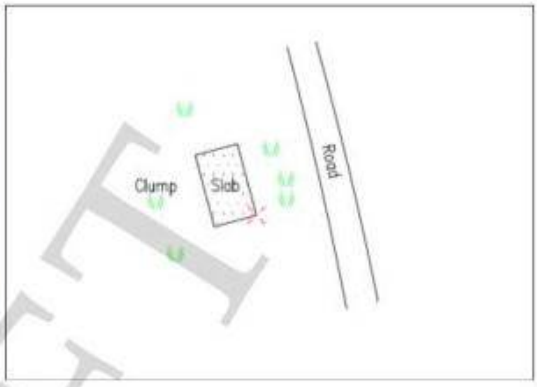
GCP ID: **Q08**



Local Coordinates

- Easting *(m)*: 695 041.45
- Northing *(m)*: 8 222 869.74
- Z *(m)*: 89.45

GCP ID: **Q11**



Local Coordinates

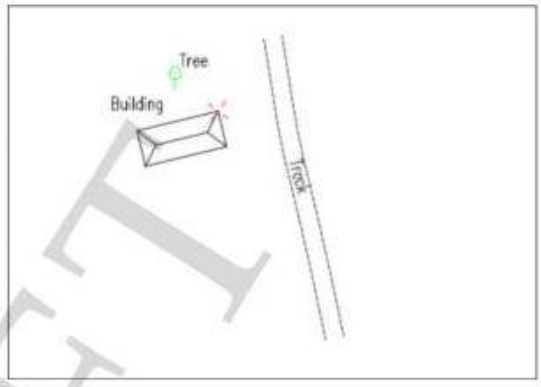
- Easting *(m)*: 695 987.17
- Northing *(m)*: 8 219 934.13
- Z *(m)*: 77.28

GCP ID: Q12

Local Coordinates

- Easting *(m)*: 698 351.05
- Northing *(m)*: 8 219 805.92
- Z *(m)*: 79.66

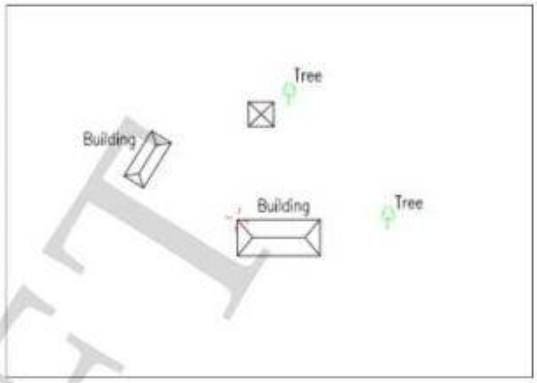
GCP ID: Q13



Local Coordinates

- Easting *(m)*: 691 370.94
- Northing *(m)*: 8 216 203.29
- Z *(m)*: 92.89

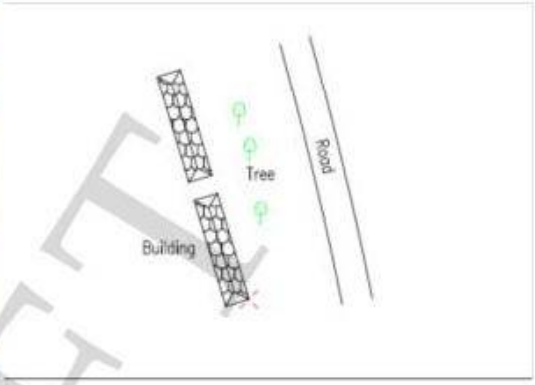
GCP ID: **Q14**



Local Coordinates

- Easting *(m)*: 695 014.82
- Northing *(m)*: 8 215 325.77
- Z *(m)*: 87.36

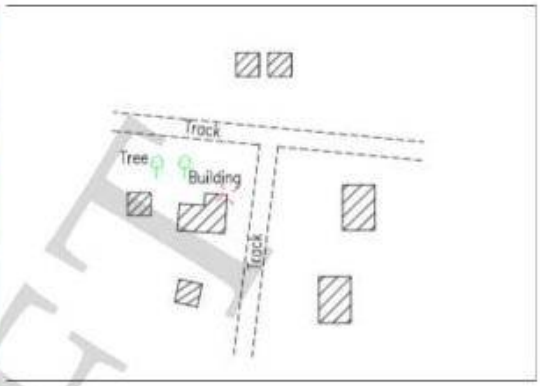
GCP ID: **Q16**



Local Coordinates

- Easting *(m)*: 697 385.63
- Northing *(m)*: 8 214 565.65
- Z *(m)*: 84.38

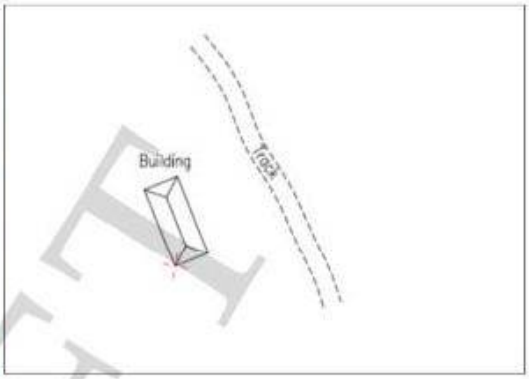
GCP ID: **Q17**



Local Coordinates

- Easting *(m)*: 673 698.13
- Northing *(m)*: 8 220 054.48
- Z *(m)*: 144.82

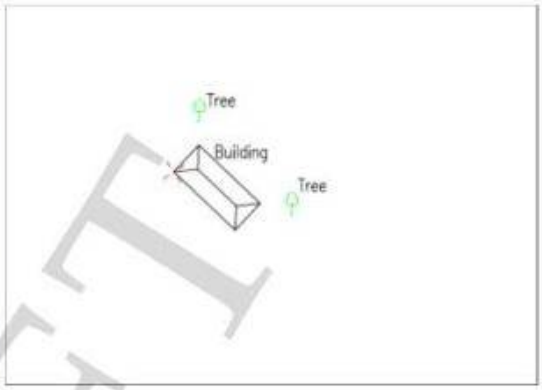
GCP ID: **Q18**



Local Coordinates

- Easting *(m)*: 680 394.39
- Northing *(m)*: 8 213 610.08
- Z *(m)*: 123.72

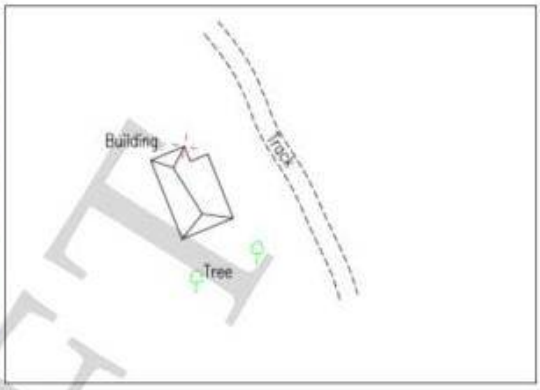
GCP ID: Q19



Local Coordinates

- Easting *(m)*: 689 459.63
- Northing *(m)*: 8 210 851.67
- Z *(m)*: 100.46

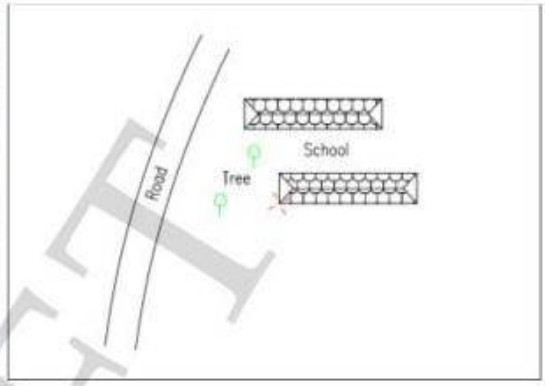
GCP ID: Q20



Local Coordinates

- Easting *(m)*: 682 051.11
- Northing *(m)*: 8 206 335.97
- Z *(m)*: 126.50

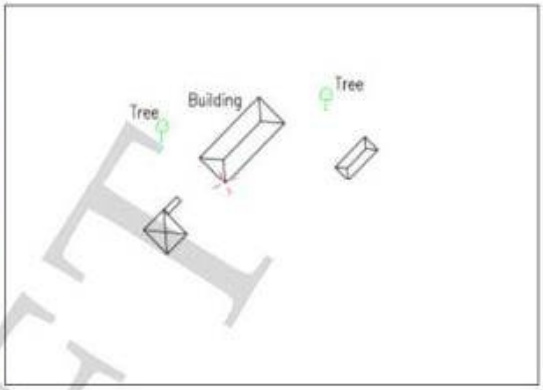
GCP ID: **Q21**



Local Coordinates

- Easting *(m)*: 699 669.43
- Northing *(m)*: 8 201 884.35
- Z *(m)*: 75.06

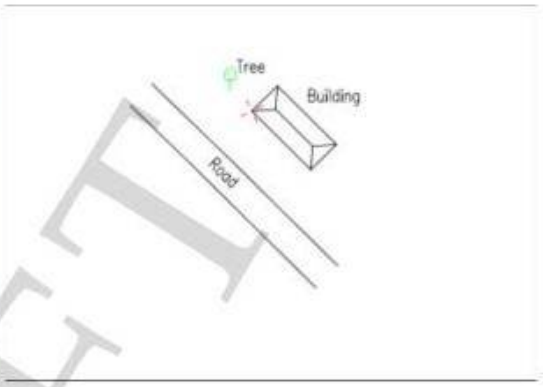
GCP ID: **Q23**



Local Coordinates

- Easting *(m)*: 694 841.85
- Northing *(m)*: 8 194 118.68
- Z *(m)*: 105.74

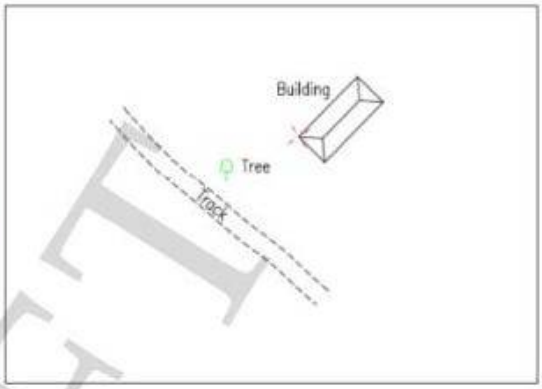
GCP ID: **Q25**



Local Coordinates

- Easting *(m)*: 698 816.12
- Northing *(m)*: 8 184 848.12
- Z *(m)*: 107.52

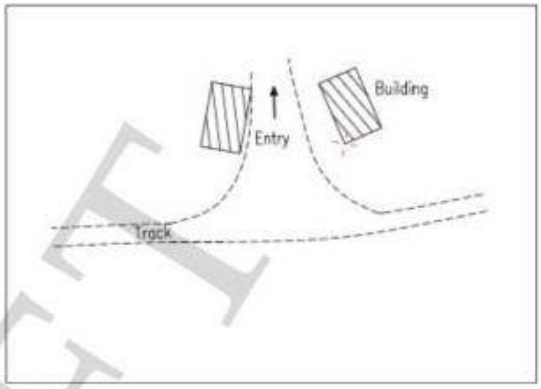
GCP ID: **Q26**



Local Coordinates

- Easting *(m)*: 703 652.46
- Northing *(m)*: 8 175 218.94
- Z *(m)*: 115.73

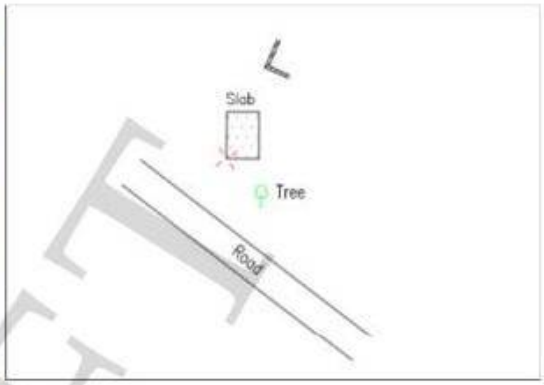
GCP ID: **Q27**



Local Coordinates

- Easting *(m)*: 711 678.83
- Northing *(m)*: 8 178 322.05
- Z *(m)*: 61.42

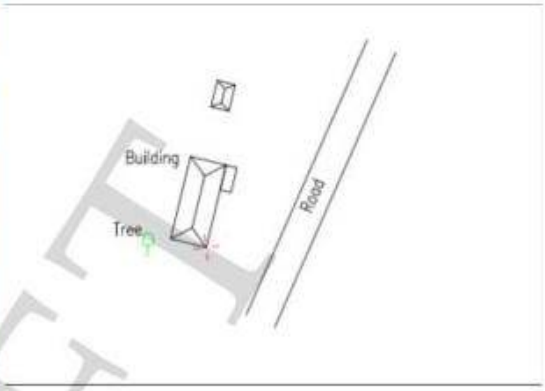
GCP ID: **Q28**



Local Coordinates

- Easting *(m)*: 714 896.60
- Northing *(m)*: 8 170 194.83
- Z *(m)*: 82.43

GCP ID: **Q29**



Local Coordinates

- Easting *(m)*: 723 217.61
- Northing *(m)*: 8 165 595.56
- Z *(m)*: 72.79

end

APPENDIX 10

National Standard of Geographic Feature Code

National Standard of Geographic Feature Codes

for

Topographic Map & Spatial Information

Contents

1. Purpose of Standard

The object of this standard is to provide unified code lists of features in digital map produced in different scales for consistent maintenance which can make digital maps easy to be used.

This standard intends to make the user-friendly consistent codes for topography and facilities by adding and amending feature codes with increase of various demand of digital map in the future.

2. Summary of Contents

Main contents include different types of categories of topography and facilities for unified code lists of features by deleting unnecessary or duplicate codes, or merging with landmark information

3. Applicable Fields of Industry and its Effect

This standard is designed to integrate the feature classification standards ensuring consistency of standards code. Based on digital maps, this standard makes it ensure to produce unified high-quality digital map which can be used to promote users' understanding about spatial information and to make GIS industries prosper.

4. Reference Standards(Recommendations)

4.1. International Standards(Recommendations)

- None

4.2. Domestic Standards

- None

4.3. Other Regulations

- NSDC Data Standards Document v1.0 (Mar.2014) - DRAFT

5. Relationship to Reference Standards(Recommendations)

5.1. Relationship of Reference Standards(Recommendations)

- None

5.2. Differences between Reference Standard(Recommendation) and this Standard

- None

5.3. Relationship of Other Regulations

Integrated standard of feature code for making digital map was established by consulting rules for making digital map(Ministry of Land and Housing, Department of Surveys) was established for the purpose of unified types of feature classification system for digital topographic maps. From producing to using the digital maps, unified codes will be used the other digital map, improve work process of making digital map, also, regulation for making digital topographic(National Spatial Data Center) map will be reformed for integrated standard code and making property list.

In this standard, for the purpose of gaining to connect and match technical reference(rules for making digital map and regulations for making digital topographic map) with spatial information standard, it unifies features at digital map, and present classification method and integrated code.

6. Statement of Intellectual Property Rights

IPRs related to the present document may have been declared to Ministry of Land and Housing, Department of Surveys.

7. Statement of Testing and Certification

7.1. Object of Testing and Certification

- None

7.2. Standards of Testing and Certification

- None

8. History of Standard

8.1. Change History

Edition	Issued date	Name
The 1st edition(Draft)	2004. Mar.	NSDC Data Standard Document
The 2nd edition(Draft)	2015. Dec.	National Standard of Geographic Feature Codes For Topographic Map & Spatial Information

In this standard, it revises classification method of feature for making digital map and rules of setting number, and how to unify spatial information system that expresses digital map in scale and type, so it makes possible to improve ability of making and using digital map constantly.

NSDC Data Standard Document	National Standard of Geo-Codes	Remarks
1) Feature Catalogue		a.s.a.p
2) Definition of terms and notation 2.1 definition of terms Feature : non Code : non 2.2 Notation : non	2) Definition of terms 2.1 Feature GIS objects that actually exist with respect to the specified object or concept 2.2 Code Features and properties in accordance with the classification given by separating letters, numbers and symbols. 2.3 Digital map Digital map that is completed after plotting or digital editing process through rectification to revise and keep up-to-date data using field inspection and survey data 2.4 GIS Database Digital map that is completed after structurize editing based on creating into geometry forms using recticified map features and objects to check data geological relations	Revised

3) Feature Class • Classified as a three-step • Classified as a 7 Category • Each Class have subclass and feature type • 7 Classes ① Boundaries ② Infrastructure ③ Built-up areas or Buildings ④ Land use/cover ⑤ Relief ⑥ Drainage ⑦ Spatial references	3) Feature classification • Classified as a three-step • Classified as a 8 Category • Layer : Category is classified as a basic item and objects that have similar characteristics are grouped by type • Classification : Middle category should be separated by object/purpose. • Detailed Classification : Sub category should be separated by specific category items according to object/purpose • 8 Layers ① Transportation ② Building ③ Facility ④ Vegetation ⑤ Drainage ⑥ Terrain ⑦ Boundary ⑧ Annotation	
4)The Principle of How to give Feature Code : none	4)The Principle of How to give Feature Code • Layer using the one-character. • Classification using 3digit number. it means can using from 001 to 999. Given the feature code allows the user to easily search the landmark nature sorted order after a similar item will give the code. • Detailed Classification using 4digit number under middle category. it means can using from 0000 to 9999. Sub category feature code given by order that • Feature using 8-digit code. ○ □□□ △△△△ - □ : one-character Alphabet - ○ : one-character numeral - △ : one-character numeral Layer : One-character Alphabet Classification : 3digit number) Detailed Classification : 4digit number)	Revised

※ The feature code cannot be modified. if there are needs to apply different codes by each divisions, the NSDC permission must be obtained and available to use codes with defining as standard per its' revision cycle.

APPENDIX 11

Geographic Feature Codes

Appendix I.

Feature Code(Geo-Code)

• Feature Main Category(Layer) Code

(table 1) Feature Main Category

Item	code	Scale
		1:5,000
Layers	A	Transportation
	B	Building
	C	Facility
	D	Vegetation
	E	Drainage
	F	Terrain
	G	Boundary
	Z	Annotation

• Feature Code Format : ○ □□□ △△△△

○ : Main Category : A ~ Z

□□□ : Classification : 000 ~ 999

△△△△ : detailed Classification : 0000 ~ 9999

(Table 2) Landmark Feature Code

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5,000
Transportation (A)	Road Boundary (001)	Road boundary(non-classified)	A0010000	-
		(Existing roads)non-classified	A0013110	line
		(Existing roads)Expressway	A0013111	line
		(Existing roads)Highway	A0013112	line
		(Existing roads)Local Road	A0013113	line
		(Existing roads)Capital city	A0013114	line
		(Existing roads)City	A0013115	line
		(Existing roads)county	A0013116	line
		Road in Site	A0013118	line
		Road in Tunnel	A0013122	line
		(Construction planning)non-classified	A0013130	line
		(Construction planning)Expressway	A0013131	line
		(Construction planning)Highway	A0013132	line
		(Construction planning)Local Road	A0013133	line
		(Construction planning)Capital city	A0013134	line

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5.000
Transportation (A)	Road Boundary (001)	(Construction planning)city	A0013135	line
		(Construction planning)country	A0013136	line
		(under Construction)non-classified	A0013140	line
		(under Construction)Expressway	A0013141	line
		(under Construction)Highway	A0013142	line
		(under Construction)Local Road	A0013143	line
		(under Construction)Capital city	A0013144	line
		(under Construction)city	A0013145	line
		(under Construction)country	A0013146	line
		(convenient facilities)non-classified	A0013360	line
		(Etc)non-classified	A0013370	line
		(Road number Sign)non-classified	A0013430	point
		(Road number Sign)Expressway	A0013431	point
		(Road number Sign)Highway	A0013432	point
		(Road number Sign)Local Road	A0013433	point
		(Road number Sign)Capital city	A0013434	point
		(Road number Sign)city	A0013435	point
		(Road number Sign)country	A0013436	point
		(Road number)non-classified	A0013440	point
		(Road number)Expressway	A0013441	Character
		(Road number)Highway	A0013442	Character
		(Road number)Local Road	A0013443	Character
		(Road number)Capital city	A0013444	Character
		(Road number)city	A0013445	Character
		(Road number)country	A0013446	Character
	Road Centerline (002)	Road centerline(non-classified)	A0020000	line
		path	A0023119	line
		(Road centerline)non-classified	A0023210	line
		(Road centerline)Expressway	A0023211	line
		(Road centerline)Highway	A0023212	line
		(Road centerline)Local Road	A0023213	line
		(Road centerline)Capital city	A0023214	line
		(Road centerline)city	A0023215	line
		(Road centerline)country	A0023216	line

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5.000
Transportation (A)	Footpaths (003)	Footpaths(non-classified)	A0033320	line
		Footpaths	A0033324	line
		Bicycle road	A0033327	line
	Crosswalk (004)	Crosswalk	A0043325	polygon
	Traffic Safety Zone (005)	Traffic Safety zone	A0053326	polygon
	Overpass (006)	overpass	A0063321	polygon
	Bridge (007)	Bridge(non-classified)	A0070000	polygon
		(Bridge)non-classified	A0073340	polygon
		(Bridge)Concrete Bridge	A0073341	polygon
		(Bridge)Steal Bridge	A0073342	polygon
		(Bridge)Wooden Bridge	A0073343	polygon
		(Railroad Bridge)non-classified	A0071210	polygon
		Railroad Bridge	A0071211	polygon
		(Railroad Bridge)overpass	A0071212	polygon
		Railroad Tunnel	A0071213	polygon
	Intersection (008)	Intersection	A0080000	polygon
	Overpass Intersection (009)	Intersection(non-classified)	A0090000	polygon
		(Intersection)non-classified	A0093350	line
		(Intersection)overpass	A0093351	line
		(Intersection)underpass	A0093352	line
	Interchange (010)	Interchange	A0100000	polygon
	Tunnel (011)	Tunnel	A0110020	polygon
	Tunnel Entrance (012)	Tunnel Entrance	A0123373	line
	Station (013)	Station	A0131122	polygon
	Stop (014)	Stop(non-classified)	A0140000	point
		(Stop)non-classified	A0143410	point
		(Srop)Bus Stop	A0143411	point
		(Stop)Taxi Stop	A0143412	point
	Railroad	Railroad(non-classified)	A0150000	line
		(Track)non-classified	A0151110	line

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5,000
Transportation (A)	(015)	(Track)Usually railway	A0151111	line
		(Track)Special railway	A0151112	line
		(Track)Track in Tunnel	A0151113	line
		(Track)Under Construction Railroad	A0151114	line
		Subway(Underground)	A0151115	line
		Subway(ground)	A0151116	line
		Rope way	A0151117	line
		Overpass(Road Facility)	A0151118	line
		(track production charter)non-classified	A0151120	line
		Double-track railway	A0151121	line
		Rail(Monorail)	A0151123	line
		Entrance of Subway Station	A0151224	polygon
		(Amenities Facilities/others)non-classified	A0151220	polygon
	Railroad Boundary (016)	Railway Land Boundary	A0160024	polygon
	Railroad Centerline (017)	Railroad Centerline	A0171119	line
	Railroad Turntable (018)	Railroad Turntable	A0180000	point
	Platform (019)	Platform	A0191221	line
	Platform Roof (020)	Platform Roof	A0201222	line
	Ferry (021)	Ferry(non-classified)	A0210000	point
		Ferry(people)	A0212255	point
		Ferry(car)	A0212256	point
	Ferry Route (022)	Ferry Route	A0222257	line
Building	Building	Building perimeter(non-classified)	B0010000	polygon
		(Building perimeter)non-classified	B0014110	polygon
		Building without Housing	B0014111	polygon
		Housing	B0014112	polygon
		Townhouse	B0014113	polygon

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5.000
(B)	(001)	Under construction Building	B0014114	polygon
		Apartment	B0014115	polygon
		Wall-less Building	B0014116	polygon
		Greenhouse	B0014117	polygon
		Temporary Building	B0014118	polygon
		Settlement Boundary	B0014119	polygon
		(Local Administration)non-classified	B0014210	point
		Capital City Hall	B0014211	point
		Metropolitan City Hall	B0014212	point
		Province Government Building	B0014213	point
		City Hall	B0014214	point
		County	B0014215	point
		Ward Office Building	B0014216	point
		Town Hall	B0014217	point
		-		
		(Safety Administration)non-classified	B0014220	point
		Court	B0014221	point
		Police	B0014222	point
		Police Station	B0014223	point
		Police Substation	B0014224	point
		Prison, Jail	B0014225	point
		Reformatory	B0014226	point
		(Other Administration)non-classified	B0014230	point
		Fire Station	B0014231	point
		Public Health	B0014232	point
		Tax Office	B0014233	point
		Customs	B0014234	point
		Post Office	B0014235	point
Building (B)	Building (001)	Weather Station or Bureau	B0014236	point
		Telephone Office	B0014237	point
		Military Manpower Administration	B0014238	point
		(Other Admin. 2) non-classified	B0014240	point
		Other Offices	B0014241	point
		Agricultural Technology Center	B0014242	point
		Forest Service	B0014243	point
		(Government investment agencies)non-classified	B0014250	point
		Power Corporation	B0014251	point
		Water Resources Corporation	B0014253	point
		Road Corporation	B0014254	point
		Land & Housing Corporation	B0014255	point
		National Oil and Gas Corporation	B0014257	point

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5,000
Building (B)	Building (001)	Rural Community Corporation	B0014258	point
		(Industry)non-classified	B0014310	point
		Factory	B0014311	point
		Power Station	B0014312	point
		Substation	B0014313	point
		(Commerce)non-classified	B0014320	point
		Market	B0014321	point
		Department Store	B0014322	point
		Restaurants	B0014323	point
		Marketplace	B0014324	polygon
		(Other Agriculture)non-classified	B0014330	point
		Pump stations	B0014331	point
		Drain Facility	B0014332	point
		Pump and Drain Facility	B0014333	point
		Water Intake Plant	B0014334	point
		Cattle Shed	B0014335	point
		Livestock Breeding Farm	B0014336	point
		Slaughterhouse	B0014337	point
		Mill	B0014338	point
		Water Treatment Plant	B0014339	point
		(Sewerage)non-classified	B0014340	point
		Sewage Treatment Symbol	B0014341	point
		Wastewater Treatment Symbol	B0014342	point
		Simple Sewage Treatment	B0014343	point
		(Education, Sports)non-classified	B0014410	point
		School	B0014411	point
		Kinder garden, Nursery,	B0014412	point
		Library	B0014413	point
		Gymnasium	B0014414	point
		Swimming Pool	B0014415	point
		Academy	B0014416	point
		Dormitory	B0014417	point
		(Culture, Religion)non-classified	B0014420	point
		Church	B0014421	point
		Cathedral	B0014422	point
		Temple	B0014423	point
		Other Religion Facility	B0014424	point
		Museum	B0014425	point
		Gallery	B0014426	point

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5,000
Building (B)	Building (001)	(Media agencies)non-classified	B0014430	point
		TV Station	B0014431	point
		Radio Station	B0014432	point
		Newspaper	B0014433	point
		Magazine.	B0014434	point
		CATV Station	B0014435	point
		(Lodge)non-classified	B0014510	point
		Hotel	B0014511	point
		Motel	B0014512	point
		Condominium	B0014513	point
		(Transportation, Warehousing)non-classified	B0014520	point
		Station	B0014521	point
		Express Bus Terminal	B0014522	point
		Intercity Bus Terminal	B0014523	point
		Warehousing	B0014524	point
		Airport	B0014525	point
		Car Repair Shop	B0014526	point
		Car Wash	B0014527	point
		(Finance, Cooperative)non-classified	B0014530	point
		Bank	B0014531	point
		Cooperative	B0014532	point
		Other Financial Institutions	B0014533	point
		Insurance Companies	B0014534	point
		(Hospital)non-classified	B0014610	point
		General Hospital	B0014611	point
		Tuberculosis Hospital	B0014612	point
		Only Leprosy	B0014613	point
		Psychiatric Hospital	B0014614	point
		Pharmacy	B0014615	point
		(Child welfare)non-classified	B0014620	point
		Infants Facilities	B0014621	point
		Child Consultation Center	B0014622	point
		Independence Support Facilities	B0014623	point
		Childcare Facilities	B0014624	point
		Infants Facilities	B0014625	point
		Temporary shelters for children	B0014626	point
		Child Occupation Facilities	B0014627	point
		(Social Welfare)non-classified	B0014630	point
		Nursing home	B0014631	point
		Rehabilitation Facilities	B0014632	point
		Mother & Child Protection Facilities	B0014633	point

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5.000
		Single Mothers Asylum	B0014634	point
		Senior Welfare Center	B0014635	point
		Women Welfare Center	B0014636	point
		Social Welfare Center	B0014637	point
	Wall (002)	Wall(non-classified)	B0020000	line
		(Wall)non-classified	B0024120	line
		Stone & Concrete Wall	B0024121	line
		Plank Fence	B0024122	line
		Natural Fence	B0024123	line
		Earthen Wall	B0024124	line
		Wire Entanglements	B0024125	line
		Iron Fence	B0024126	line
		Door post	B0024127	polygon
Facility (C)	Dam (001)	Dam(non-classified)	C0010000	polygon
		Dam(Top)	C0012216	line
		Dam(Bottom)	C0012217	line
	Pier (002)	Wharf Crane.	C0025336	polygon
	Wharf (003)	Wharf	C0032254	polygon
	Dock (004)	Dock	C0040000	polygon
	Embankment (005)	Levee(non-classified)	C0050000	line
		(Levee)non-classified	C0052210	line
		Concrete Bank(Top)	C0052211	line
		Concrete Bank(Bottom)	C0052212	line
		Earth Bank(Top)	C0052213	line
		Earth Bank(Bottom)	C0052214	line
		-	-	-
		(Dike)non-classified	C0052220	line
		Concrete Dike(Top)	C0052221	line
		Concrete Dike(Bottom)	C0052222	line
		Earth Dike(Top)	C0052223	line
		Earth Dike(Bottom)	C0052224	line
		-	-	-
		(Breakwater)non-classified	C0052230	line
		Breakwater(Top)	C0052231	line
		Breakwater(Bottom)	C0052232	line
		-	-	-
	Floodgate (006)	Floodgate(non-classified)	C0060000	line
		(Floodgate)non-classified	C0062240	point
		Floodgate	C0062241	point

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5,000
Facility (C)		Drain Locks	C0062242	line
		Security Locks	C0062243	line
	Culvert (007)	Culvert(non-classified)	C0070000	line
		(Drainage)non-classified	C0076110	line
		Culvert	C0076116	line
		Gutter	C0076117	line
	Pier (008)	Pier(non-classified)	C0080000	line
		-	-	-
		Pier(Concrete)	C0082251	polygon, line
		Pier(Wooden)	C0082252	polygon, line
		Pier(Floating)	C0082253	polygon
	Well /Fountain (009)	Well/Fountain(non-classified)	C0090000	point
		Underground Water(non-classified)	C0096310	point
		Well	C0096311	point
	Tube Well (010)	Tube Well.	C0106312	point
	Fountain (011)	Fountain	C0116313	point
	Hot Spring (012)	Hot Spring	C0125335	point
	Nursery (013)	Nursery(non-classified)	C0130000	point
		Fish Farm	C0132327	point
		Fish Farm Symbol	C0136357	point
		Fish Farm Boundary	C0136358	polygon
	Fishing (014)	Fishing	C0142263	point
	Beach (015)	Beach Symbol	C0152261	point
	Lighthouse (016)	Lighthouse(non-classified)	C0160000	point
		Lighthouse(with guard)	C0166233	point
		Lighthouse(without guard)	C0166234	point
		Air Lighthouse	C0166235	point
	Pool (017)	Pool(non-classified)	C0170000	-
		(Storage Facility)non-classified	C0176320	point
		Reservoir	C0176321	point
		Oil Storage Tank	C0176322	point
		Other Storage	C0176323	point

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5.000
Facility (C)	Tank (018)	Tank	C0186115	line
	Mine (019)	Mine(non-classified)	C0190000	point
		(Mine)non-classified	C0195330	point
		Mine	C0195334	point
	Stockyard (020)	Stockyard(non-classified)	C0200000	point
		Stockyard	C0200120	polygon
		(Landfill, Others)non-classified	C0205340	point
		Open Area	C0205341	point
		Yard	C0205342	point
		Reclaimed Land	C0205343	point
		Waste Landfill	C0205344	point
		Waste Disposal Site	C0205345	polygon
	Pit (021)	Pit(non-classified)	C0210000	-
		Pit	C0210140	-
		Stone Pit	C0215331	point
		Borrow Pit	C0215332	point
		Aggregate Pit	C0215333	point
	Light (022)	Light(non-classified)	C0220000	-
		Utility Pole with Light	C0220205	-
		Street Light	C0223367	point
		(Lighting)non-classified	C0226230	point
		Lighting	C0226231	point
		Security Light	C0226232	point
	Power line /Telephone Pole (023)	Power Line pole/Telephone Pole(non-classified)	C0230000	-
		(Utility Pole)non-classified	C0236240	point
		Telephone Pole	C0236241	point
		Power Line Pole	C0236242	point
		Cable Line Pole	C0236243	point
		Utility Pole	C0236244	point
	Manhole (024)	Manhole(non-classified)	C0240000	-
		District Heating Manhole	C0240016	-
		Pipeline Manhole	C0240017	-
		(Pipeline-ground)non-classified	C0246120	line
		(Pipeline-ground)waterworks	C0246121	line
		(Pipeline-ground)sewer	C0246122	line
		(Pipeline-ground)pipeline	C0246123	line
		(Pipeline-ground)gas pipeline	C0246124	line
		(Pipeline-ground)transmission	C0246125	line
		(Pipeline-ground)communication lines	C0246126	line
		(Pipeline-underground)non-classified	C0246130	line
		(Pipeline-underground)waterworks	C0246131	line

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5.000
Facility (C)		(Pipeline-underground)sewer	C0246132	line
		(Pipeline-underground)pipeline	C0246133	line
		(Pipeline-underground)gas pipeline	C0246134	line
		(Pipeline-underground)transmission	C0246135	line
		(Pipeline-underground)communication lines	C0246136	line
		(manhole)non-classified	C0246340	point
		(manhole)Common duct	C0246341	point
		(manhole)gas pipeline	C0246342	point
		(manhole)Telephone lines	C0246343	point
		(manhole)electric power line	C0246344	point
		(manhole)sewer	C0246345	point
		(manhole)waterworks	C0246346	point
		(manhole)communication lines	C0246347	point
	Fireplug (025)	Fireplug(non-classified)	C0250000	-
		Fireplug	C0256324	point
		Fireplug(standing)	C0256325	point
	Observatory (026)	Observatory(non-classified)	C0260000	-
		(Observatory)non-classified	C0266330	point
		Gauging station	C0266331	point
		Stream Gauging station	C0266332	point
		Rainfall Station	C0266333	point
		water quality observation post	C0266334	point
		wave observation post	C0266335	point
		wind observation post	C0266336	point
		air monitoring stations	C0266337	point
	Campsite (027)	campsite	C0270000	-
	Cemetery (028)	cemetery(non-classified)	C0290000	-
		boundary of cemetery	C0295113	point
		public burial ground	C0295312	point
		royal tomb or historical tomb	C0295313	point
	Historic Sites (030)	historic sites	C0305316	point
	Cultural Heritage (031)	Cultural Heritage(non-classified)	C0310000	-
		(Cultural)non-classified	C0315310	point
		Scenic spots	C0315314	point
	Castle (032)	castle	C0325315	line
	Zeolite /Monument (033)	zeolite/monument(non-classified)	C0330000	-
		(object symbol)non-classified	C0336210	point
		monument	C0336211	point

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5,000
Facility (C)		gravestone	C0336212	point
	Tower (034)	Tower(non-classified)	C0340000	-
		Light Towers	C0340032	point
		Clock Tower	C0340325	point
		(Tower)non-classified	C0346220	point
		Fire Tower	C0346221	point
		Water tower	C0346222	point
		intake tower	C0346223	point
		Propagation antenna tower	C0346224	point
		Transmission tower	C0346225	polygon
		water feed tower	C0346226	polygon
	Statue (035)	statue(non-classified)	C0350000	-
		statue	C0356213	point
		stone lantern	C0356214	point
	Pay Phone (036)	Pay phone	C0363361	point
	Mailbox (037)	mailbox	C0373362	point
	Playground (038)	Playground(non-classified)	C0380000	-
		Playground	C0380100	-
		swimming pool	C0380110	-
		(Leisure, sports)non-classified	C0382260	point
		swimming pool symbol	C0382262	point
		(sports complex)non-classified	C0385320	polygon
		Golf course	C0385321	point
		tennis court	C0385322	point
		sports ground	C0385323	point
		Children's playground	C0385324	point
		ski resort	C0385325	point
		Outdoor pool	C0386356	point
	Stairs (039)	Stairs(non-classified)	C0390000	-
		stands	C0390130	-
		Stairs stands	C0393323	polygon
	Notice Board (040)	notice board(non-classified)	C0403360	-
		notice board	C0403366	point
		Advertising boards	C0403426	point
	Sign (041)	sign(non-classified)	C0410000	-
		Milestones	C0412258	point
		(transportation sign)non-classified	C0413420	point
		Road information plate	C0413421	point
		Information signs	C0413422	point
		Instruction signs	C0413423	point

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5.000
Facility (C)		Regulatory signs	C0413424	point
		Caution Signs	C0413425	point
	Gas Station (042)	gas station	C0423365	point
	Parking Lot (043)	parking lot(non-classified)	C0430000	-
		parking lot boundry	C0430230	-
		parking lot	C0433364	point
	Rest Area (044)	rest area	C0443363	point
	Underpass (045)	underpass	C0453322	polygon
	Underpass Entrance (046)	underpass entrance	C0463374	polygon
	Underground Ventilation (047)	Underground ventilation(non-classified)	C0471220	-
		subway air duct	C0471223	polygon
		Underground ventilation	C0476355	polygon
	Chimney (048)	chimney	C0486353	point
	Traffic Light (049)	Traffic Light	C0493376	point
	Breaker (050)	Breaker(non-classified)	C0500000	-
		Crossing breaker	C0503375	-
		Street Light Controller	C0503377	-
		Traffic Controller	C0503378	-
		Electric Controller	C0503379	-
	Road Reflectors (051)	Road Reflectors	C0513369	point
	Road Dividers (052)	road dividers(non-classified)	C0520000	-
		(road dividers)non-classified	C0523120	line
		road dividers	C0523121	line
	Hedge (053)	hedge(non-classified)	C0530000	-
		(structure)non-classified	C0536110	line
		Rockfall preventive measures	C0536111	line
		Firewall	C0536112	line
		Shading wall	C0536113	line

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5.000
		Noise preventive measures	C0536114	line
		other concrete structure	C0536117	line
		Guard rail	C0536118	line
		Guard fence	C0536119	line
	Tollgate (054)	tollgate	C0540000	-
	Helipad (055)	helipad	C0556354	point
Vegetation (D)	Farmland Boundary (001)	farmland boundary(non-classified)	D0010000	-
		farmland boundary	D0015112	line
		(farmland)non-classified	D0015210	point
		paddy	D0015211	point
		field, farm	D0015212	point
		orchard	D0015213	point
		(Landscape)non-classified	D0015220	point
		grass	D0015221	point
		flower bed	D0015222	point
		Garden tree	D0015223	point
	Land Type Boundary (002)	land type boundary(non-classified)	D0020000	-
		street trees/flower bed guard	D0023371	line
		street trees	D0023372	point
		(land type boundary)non-classified	D0025110	line
		land type boundary	D0025111	line
		Forestry boundary	D0025114	point
		other boundary	D0025115	point
		wilderness	D0025215	point
		plantation	D0025216	point
Vegetation (D)		(Forestry)non-classified	D0025230	point
		broad leaf trees	D0025231	point
		needle leaf trees	D0025232	point
		mixed woodland	D0025233	point
		bamboo grove	D0025234	point
	Distinct Tree (003)	Distinct tree(non-classified)	D0030000	-
		Distinct tree(broad leaf)	D0036351	point
		Distinct tree(needle leaf)	D0036352	point
	Pasture (004)	pasture(non-classified)	D0040000	-
		pasture and boundary	D0040001	-
		grassland	D0045214	point
Drainage (E)	Border Rivers (E001)	Border Rivers	E0010001	-
	River	river center line(non-classified)	E0020000	-

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5.000
	Centerline (E002)	(river)non-classified	E0022110	line
		river center line	E0022115	line
		stream	E0022112	line
		dry stream	E0022113	line
	Brook (E003)	Brook	E0032111	line
	Stream Direction (E004)	stream direction	E0042326	point
	Lake /Reservoir (E005)	Lake, Reservoir	E0052114	polygon
	Irrigation Channel (E006)	irrigation channel(non-classified)	E0060000	-
		(irrigation channel)non-classified	E0062270	line
		Industrial waterways(ground)	E0062271	line
		Industrial waterways(under ground)	E0062272	line
		Agricultural waterways(ground)	E0062273	line
		Agricultural waterways(under ground)	E0062274	line
		water conduction tunnel	E0062275	line
	Fall (007)	Fall	E0072325	point
	Coastline (008)	coastline(non-classified)	E0080000	-
		(Sea)non-classified	E0082120	line
		coastline(shore)	E0082121	line
		coastline(island)	E0082122	polygon
Terrain (F)	Contour line (001)	Contour line(non-classified)	F0010000	-
		(Convex land)non-classified	F0017110	line
		(Convex land)intermediate contour	F0017111	line
		(Convex land)half interval contour	F0017112	line
		(Convex land)supplementary contour	F0017113	line
		(Convex land)index contour	F0017114	line
		(concave land)non-classified	F0017120	line
		(concave land)intermediate contour	F0017121	line
		(concave land)half interval contour	F0017122	line
		(concave land)supplementary contour	F0017123	line
		(concave land)index contour	F0017124	line
		(numeric value)non-classified	F0017130	Character
		hight value	F0017131	Character
	Top Height (002)	Top Height(non-classified)	F0020000	-
		Top Height Value	F0027132	Character
		Top Height	F0027217	point

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5.000
	Fill/Cut Ground (003)	fill/cut ground(non-classified)	F0030000	-
		(Artificial)non-classified	F0037220	line
		Fill-up ground(top)	F0037221	line
		Cutting(top)	F0037222	line
		Fill-up ground(bottom)	F0037223	line
	Retaining Wall (004)	Retaining Wall(non-classified)	F0040000	-
		concrete Retaining Wall(top)	F0047224	line
		concrete Retaining Wall(bottom)	F0047225	line
		Stonework Retaining Wall(top)	F0047226	line
		Stonework Retaining Wall(bottom)	F0047227	line
		slop protection cage	F0047228	line
	Cave Entrance (005)	Cave Entrance	F0057215	point
District Boundary (G)	Administrative Boundary (001)	Administrative boundary(non-classified)	G0010000	-
		Capital city boundary	G0010012	-
		provincial boundary	G0010013	-
		county boundary	G0010118	-
		(boundary line)non-classified	G0018110	line
		borderline	G0018111	line
		city boundary	G0018112	line
	Boundary in Waterline Area (002)	Boundary in waterline area(non-classified)	G0020000	-
		(boundary)non-classified	G0022310	line
		foreshore(mud)	G0022311	line
		sand	G0022312	line
		marsh	G0022313	line
		wallow	G0022314	polygon
		saltern	G0022315	line
		water use area	G0022316	line
		Catchment boundary(sewer)	G0022317	line
		waterline boundary(하천)	G0022318	line
		Dam basin boundary	G0022319	line
		(symbol)non-classified	G0022320	point

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5.000
District Boundary (G)		foreshore symbol	G0022321	point
		sand symbol	G0022322	point
		marsh symbol	G0022323	point
		saltern symbol	G0022324	point
	Other Boundary (003)	other boundary(non-classified)	G0030000	-
		(nature)non-classified	G0037210	line
		sink	G0037211	line
		landslide	G0037212	line
		rimrock	G0037213	line
		boulder	G0037214	line
		Ridge	G0037216	line
		others(non-classified)	G0036350	line
		(Industry Area boundary)non-classified	G0038210	line
		Industrial Complex	G0038211	line
		Local industrial park	G0038212	line
		agricultural industrial complex	G0038213	line
		stockbreeding complex	G0038214	line
		Land Development Plan related	G0038215	line
		(environmental protection area)non-classified	G0038220	line
		natural environmental protection area	G0038221	line
		Natural ecosystems conservation area	G0038222	line
		Water source protection areas	G0038223	line
		Restricted Development Area	G0038224	line
		Special area of Conservation Measures	G0038225	line
		(Cultural Tourism Area)non-classified	G0038230	line
		Cultural Heritage Zone	G0038231	line
		Tourist Complex	G0038232	line
		Entertainment complex	G0038233	line
		(Residential area boundary)non-classified	G0038240	line
		Foreigners residential area	G0038241	line
District Boundary (G)				
Annotation (Z)	Map Sheet (001)	map sheet(non-classified)	H0010000	-
		non-classified	H0010500	-
		note marginal/annotation	H0010601	-
		map sheet	H0017334	line
	Control Points (002)	benchmark(non-classified)	H0020000	-
		Triangulation value	H0027133	Character
		benchmark value	H0027134	Character
		Integrated reference points	H0027135	Character
		(National benchmark)non-classified	H0027310	point
		Triangulation	H0027311	point
		Benchmark	H0027312	point
		Integrated reference point	H0027313	point

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5,000
Annotation (Z)		(Photogrammetry ground control point)non-classified	H0027320	point
		horizontal reference points	H0027321	point
		vertical control points	H0027322	point
		Aerial Photo reference point	H0027323	point
		(other control points)non-classified	H0027330	point
		Cadastral	H0027331	point
		waterway	H0027332	point
		others	H0027333	point
	Grid (003)	Grid	H0037335	line
	Nomination (004)	nomination(non-classified)	H0040000	point
		Residential Facilities	H0040010	point
		Agricultural facilities	H0040011	point
		Ocean, Lake	H0040104	point
		terrain	H0040154	point
		Pasture/Grazing	H0040203	point
		scene	H0040205	point
		(road)non-classified	H0049110	Character
		road	H0049111	Character
		toll road	H0049112	Character
		Road infrastructure	H0049113	Character
		bridge	H0049114	Character
		tunnel	H0049115	Character
		Destination name	H0049116	Character
		(railroad)non-classified	H0049120	Character
		railroad	H0049121	Character
		Railway facilities	H0049122	Character
		Railway Bridge	H0049123	Character
		Railway Tunnel	H0049124	Character
		Railway Destination name	H0049125	Character
		(Rivers)non-classified	H0049130	Character
		Rivers	H0049131	Character
		stream	H0049132	Character
		River facilities	H0049133	Character
		underground waterway	H0049134	Character
		(building)non-classified	H0049140	Character
		Local administrations	H0049141	Character
		Security administration	H0049142	Character
		Other administrations	H0049143	Character
		Industrial facilities	H0049144	Character
		Cultural, Educational facilities	H0049145	Character
		Service facilities	H0049146	Character

Layers	Classification	Detailed Classification (Feature Name)	Code	Vector Map 1:5.000
Annotation (Z)	Nomination (004)	Health, welfare facilities	H0049147	Character
		(Land type)non-classified	H0049150	Character
		Vegetation	H0049151	Character
		Plains, Fields	H0049152	Character
		strain feature	H0049154	Character
		(facility)non-classified	H0049160	Character
		Aid feature	H0049161	Character
		Targets feature	H0049162	Character
		(Built-up area)non-classified	H0049210	Character
		capital	H0049211	Character
		city	H0049212	Character
		province	H0049213	Character
		county	H0049214	Character
		(Rural Areas)non-classified	H0049215	Character
		Natural Village	H0049226	Character
		(Area name)non-classified	H0049230	Character
		Industry area name	H0049231	Character
		Environmental Locality	H0049232	Character
		Tourism, Cultural Locality	H0049233	Character
	Mountain/ Mountains (005)	Mountain/Mountains	H0059153	Character

APPENDIX 12

GIS Training

Education Attendees

2016. 11. P.
1000 ~ 1260

no	Name	Organization	Phone Number	E-Mail Address	SIGN
1	James Chilungu	BLISA/SVIP	0994289915	jameschilungu@gmail.co	
2	F. Wadi	DoI	0999126360	frncswadi@yahoo.co.uk	
3	B. Banda	DOI	0888549234	Lembanyanja@yahoo.com	
4	S. Mbendera	DOI	0999367119	scottombendera@gmail.ca	
5	M. Mulenga	DoI	0995437721	m.r.mulenga@yahoo.co.uk	
6					
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Instruction Plan

1. **File Download & Install. Manual& Start guide Memory Distribution ----10’**
2. **File Open and button menu ----------5’**
3. **DEM Generate & Slop, Slop direction ----------10’**
4. **3Dimension Viewing with DEM - Canal Line changed ----------5’**
5. **Read Attribute with Schools (students number) ---------- 5’**
6. **Read Attribute with Water Point (How many points) ----------5’**
7. **Example of Catography. With Road & Stream ----------5’**
8. **Cutting Data by Crop in DEM ----------5’**

Q & A

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Welcome to Global Mapper

Thank you for downloading Global Mapper®, the all-in-one GIS application that everyone can use. This remarkable software combines a powerful array of spatial data processing tools with an unmatched list of compatible file formats resulting in a program that no GIS professional or map enthusiast should be without.

As you begin to explore the wealth of features and functions in Global Mapper, you will quickly learn that this is a truly unique software tool. Nowhere else will you find a single application that offers the level of data support, digitizing capabilities, spatial analysis, and map creating tools, at a cost that will ensure a rapid return on your investment.

At Blue Marble Geographics, we are committed to ensuring our customers are provided with the information and tools necessary to effectively use the software they have purchased. To that end, we are pleased to offer a number of resources to help you get *up and running* in no time.

This Getting Started Guide is designed to assist you with the basic operation of Global Mapper and to help you understand some of the commonly used features and functions. For a complete guide to all the software's capabilities, click the Help menu and choose Help… or click the F1 key on your keyboard.

Contents

Installation and Registration

Installing Global Mapper

The current version of Global Mapper is freely downloadable from the following web page: www.bluemarblegeo.com/global-mapper/product/download_complete.php

Depending on your computer's operating system, you can choose either the 32-bit or 64-bit version. The latter will allow you to take full advantage of the extra memory available for 64-bit applications and will improve the performance of the software. To install Global Mapper, simply double-click or run the downloaded executable file (global_mapper_setup.exe or global_mapper_setup_64bit.exe). Installation will take no more than a couple of minutes.

Registering Global Mapper

The first time you launch Global Mapper, you will see the **Register Global Mapper** window. The option you select will determine the level of functionality available to you when you run the software.

- **Order ID from Recent Purchase**
  Enter your order number and Global Mapper will be automatically registered, unlocking the full functionality of the software. This procedure requires an internet connection.
- **Connect to a Network License Server**
  If your company has chosen to deploy Global Mapper using the convenient network licensing option, you can connect to the appropriate server to register your version of Global Mapper
- **Select a License File (.lic) File Provided via Email**
  If you work in an offline environment, you may request a License File to manually register Global Mapper. If this is the case, you will be prompted to browse to the location where you saved this file, after which, you will have full access to the software. To request a .lic file, please contact Blue Marble at authorize@bluemarblegeo.com
- **Request a Two-Week Trial License**
  To evaluate Global Mapper, you can request a 14-day trial license that will allow you to test all of its features and functions. During this time, you will be limited to two exports for each file type (vector, raster, and elevation).

Activating Optional Modules or Extensions

In recent releases of Global Mapper, additional functionality has be added to the software through preconfigured modules or third party extensions. To activate these add-on components, click the Help menu and choose **Module/Extension License Manager**. Modules require the purchase of the appropriate license and include the LiDAR module (for more information, see page 19). Extensions are typically developed and registered by third party developers. Two preconfigured extensions are installed with Global Mapper: the Overview Map extension and the COAST extension for analyzing the financial impact of coastal flooding.

Navigating the Interface

Software Layout

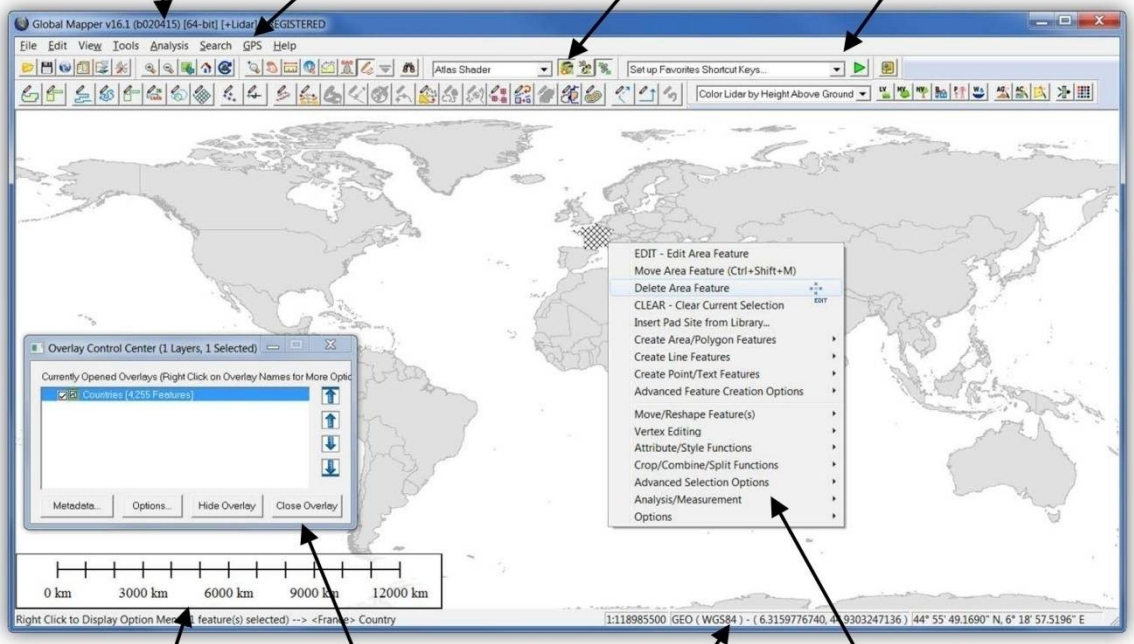
Global Mapper's user interface has been designed to provide easy and intuitive access to all of the software's features and functions. The key elements of the interface are the menus, the toolbar, and, of course, the map window itself. A variety of dialog boxes and floating windows provide access to additional tools or more advanced functionality.

The **Title Bar** displays information about the version of Global Mapper and the name of the current **Workspace**. For more information, see page 8.

Menus provide access to most of Global Mapper's core functionality. For more information, see page 4.

The **Toolbar** offers a convenient way to select a tool, apply a specific function, or change a setting. For more information, see page 5.

The **Favorites List** provides easy access a customizable list of frequently-used tools. For more information, see page 5.



The **Scale Bar** and other display features are managed using the **Map Layout** function.

The **Overlay Control Center** lists all loaded layers and allows certain settings to be applied to these layers.

Information about a selected feature as well the coordinates of the cursor are displayed on the **Status Bar.**

The **Digitizer Right-Click** Menu offers an extensive collection of tools for creating or editing features on the map. For more information, see page 12.

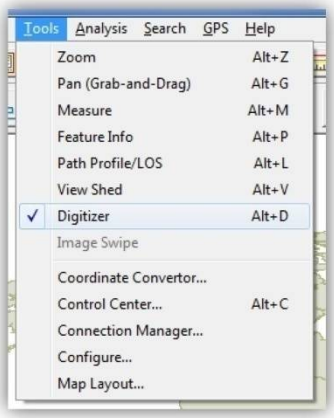
Navigating the Interface (continued)

Menus

The menus in Global Mapper are intuitively organized by function and offer access to all of the features and functions in the application. Note that, as with other software titles, there are often many ways to access a particular function in Global Mapper. For example the action of importing a layer can be performed using the Open Data File option in the File menu; the Open Data File button in the toolbar; or by using the Ctrl+O keyboard shortcut. How you chose to perform this and other commonly used functions comes down to your personal preference.

The following summarizes the primary function of each menu:

- **File**
  The File menu contains all of the options for importing, exporting and saving data. It also includes a list of recently imported files, providing convenient access to frequently used layers.
- **Edit**
  The singular function of the Edit menu is to enable the copying and pasting of features and to control the associated options.
- **View**
  The View menu includes an array of settings for configuring the appearance of the interface and of the map itself. There are also options for manually adjusting the zoom level and for saving and restoring a specific map view.
- **Tools**
  As its name implies, the Tools menu contains a selection of tools that are used to interact with features on the map. Based on what is selected, the function of the cursor on the map will change. This menu also provides access to certain other dialog boxes such as the Overlay Control Center and the Map Layout options.



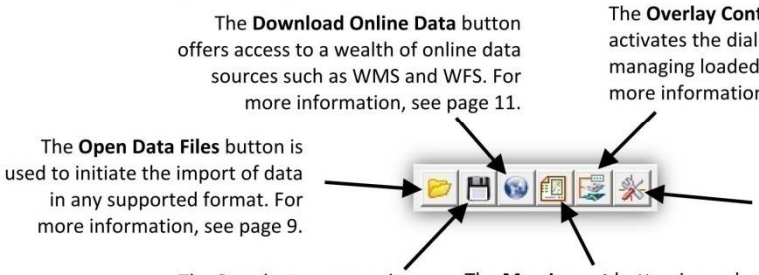
- **Analysis**
  A relatively new addition to the software, the Analysis menu consolidates many of the analysis functions into a convenient single list. With an elevation layer loaded, you can perform a variety of terrain analysis processes, such as generating contours and delineating watersheds.
- **Search**
  The Search menu offers several options for querying or editing feature attributes. It also includes an address search function that includes geocoding capability.
- **GPS**
  When a compatible GPS receiver is connected to your computer, your position can be represented by a symbol on the map. The GPS menu controls the configuration and interaction between Global Mapper and your GPS device.
- **Help**
  The Help menu provides a single point of access for the various help options and other resources that are available for Global Mapper. For more information, see page 22.

Navigating the Interface (continued)

The Toolbar

The various buttons on Global Mapper's toolbar offer the most convenient way to select a tool, to open certain dialog boxes, or to switch between one function and another. If necessary, button groups, denoted by a dividing line, can be removed from the toolbar using the Toolbars option in the View menu, or can be undocked or moved to another position in the toolbar.

The following are the key buttons in the toolbar:



The **Download Online Data** button offers access to a wealth of online data sources such as WMS and WFS. For more information, see page 11.

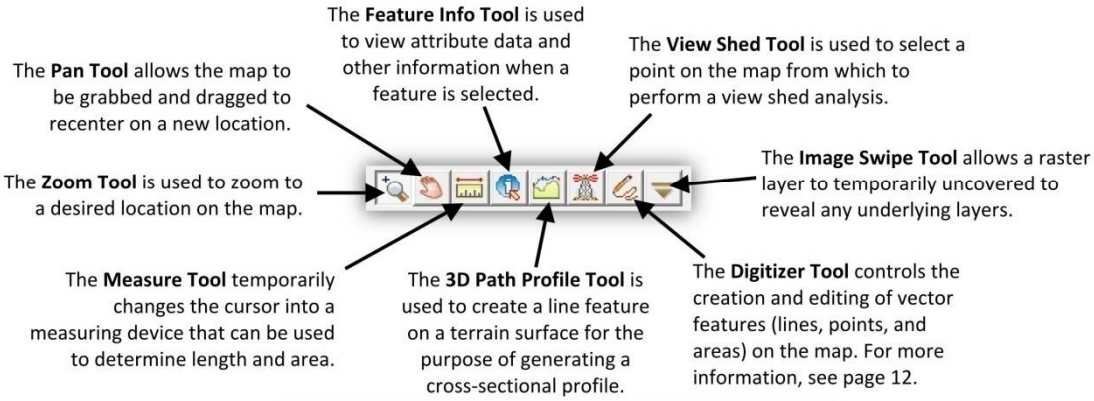
The **Overlay Control Center** button activates the dialog box for managing loaded data layers. For more information, see page 7.

The **Open Data Files** button is used to initiate the import of data in any supported format. For more information, see page 9.

The **Configuration** button opens the Configuration window that is used to establish numerous settings in the software. For more information, see page 6.

The **Save** button saves the status of all imported data, digitized features and configuration settings to a **Workspace** file.

The **Map Layout** button is used to add cartographic features such as a scale bar, legend, and a compass rose to the map.



The **Feature Info Tool** is used to view attribute data and other information when a feature is selected.

The **View Shed Tool** is used to select a point on the map from which to perform a view shed analysis.

The **Pan Tool** allows the map to be grabbed and dragged to recenter on a new location.

The **Zoom Tool** is used to zoom to a desired location on the map.

The **Image Swipe Tool** allows a raster layer to temporarily uncovered to reveal any underlying layers.

The **Measure Tool** temporarily changes the cursor into a measuring device that can be used to determine length and area.

The **3D Path Profile Tool** is used to create a line feature on a terrain surface for the purpose of generating a cross-sectional profile.

The **Digitizer Tool** controls the creation and editing of vector features (lines, points, and areas) on the map. For more information, see page 12.

The customizable **Favorites List** provides easy access to frequently used tools and allows keyboard shortcuts to be assigned to selected functions.

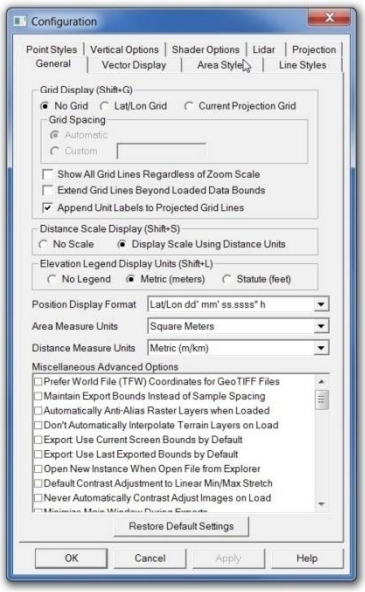
The **Run Favorite** button initiates the function selected in the **Favorites List.**

Setting Preferences

The Configuration Dialog Box

The Configuration dialog box can be opened from the Tools menu or by clicking the Configuration button in the toolbar. Organized in a series of tabs, it provides a single location for establishing personal settings and preferences that control many of the features and functions of the software.

The following summarizes the settings available in each tab:



- **General**
  The General tab options include the establishment of default units of measurement, map grid display, coordinate format, as well as numerous miscellaneous settings.
- **Vector Display**
  The function of the Vector Display tab is to control the appearance of point, line, and area features on the map. Specific options include filtering data types, adjusting the layer display order, rendering deleted features, and enabling or disabling snapping when drawing new features.
- **Area/Line/Point Styles**
  These tabs are used to create and manage feature types that can be assigned to polygons, lines, or points. Applying a feature type to a vector feature will automatically adjust the appearance of the feature and assign a custom list of attributes if required.
- **Vertical Options**
  The Vertical Options tab offers a number of settings that control the display of elevation of terrain layers. These settings include the selection of a shader pattern, customization of the hill shading or shadow display, and the rendering of a simulated water level at a defined height.
- **Shader Options**
  The Shader Options tab controls the visual display of several preconfigured elevation and slope shader patterns and allows new patterns to be created.
- **Lidar**
  The Lidar tab provides settings for filtering a point cloud based on classification or return types.
- **Projection**
  The Projection tab is used to alter the coordinate reference information for both onscreen display and export of data. Numerous preconfigured projection and datum options are available and custom systems can be added as needed. This is the feature to use if you need to reproject a layer from one system to another before exporting.

While the Configuration dialog box offers access to most of Global Mapper's preferences and settings options, many other components of the software contain feature-specific settings that are established when performing that function. For example, when exporting a file in a particular format, many of the preferences associated with the exported file are set in the Export Options dialog box.

Layer and File Management

The Overlay Control Center

The Overlay Control Center is Global Mapper's layer management tool. It can be opened from the Tools menu, by clicking the Open Control Center button in the Toolbar, or by using the keyboard shortcut Alt+C. Unlike most other dialog boxes, the Overlay Control Center can remain open while using other tools in the software. Many Global Mapper users prefer to keep this dialog box visible as it is frequently needed to hide or show specific layers, to adjust certain charcteristics of the layers, or to perform other layer-specific functions.

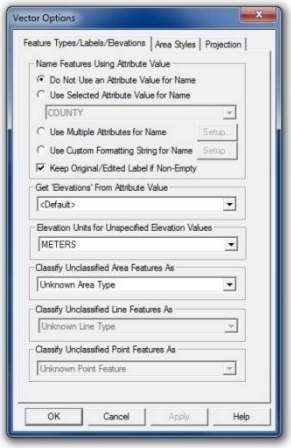
There are two ways in which a layer or overlay can be removed from the map display: the adjacent box in the Overlay Control Center can be unchecked or the selected layer can be removed completely by clicking the Close Overlay button. Using the uncheck option, the layer is retained and can be simply checked on again when needed. Closing an overlay permanently removes it and any unsaved edits or created features will be lost.

The key functional components of the Overlay Control Center are the Options button, which opens the Options dialog box that is used to adjust certain settings pertaining to a layer, and the list of tools or commands that is displayed after right-clicking on a layer. In both cases, the available functions and tools apply only to the selected layer and will vary depending on the type of data (raster, vector, LiDAR or elevation) contained within this layer.

The Options Dialog Box

The tabs in the Options dialog box differ depending on the type of data contained in the selected layer:

- **Vector Options**
  The primary functions of the Vector Options dialog box include managing the display of labels; assigning features to a feature-type category; and adjusting the display characteristics of the features in the layer (fill pattern, symbol style, etc.).
- **Raster Options**
  The Raster Options dialog box includes tools for establishing transparency; adjusting color balance, contrast, etc.; and cropping an image to a defined area.
- **Elevation Options**
  The available Elevation Options include tools for offsetting elevation values in the layer and for defining the range of visible elevations.

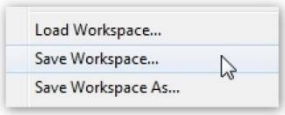


Each of the Options dialog boxes includes a Projection tab, which is used to reinterpret the coordinate values associated with the selected layer. Adjusting these projection parameters will result in the contents of the layer being physically moved to a new location and should only be performed when you know the original coordinate settings were incorrect. To simply reproject your map, use the Projection tab in the Configuration dialog box (for more information, see page 6).

Layer and File Management (continued)

Saving Your Workspace

The workspace is the core file management component of Global Mapper. It allows you to store information about the layers that are displayed on the map as well as any settings or configuration that have been applied to these layers. At its most basic level, a workspace is a file (*.gmw) that records a snapshot of your current map view.



To save your workspace, click the Save button in the toolbar or click the File menu and select Save Workspace... If a workspace was not previously saved, you will be prompted to name and choose a location for the file. You can also create a duplicate of an existing workspace by using the File > Save Workspace As... option. This function is useful for establishing a workspace template, possibly containing all possible layers or covering the full extent of your area of interest. Any workspaces created from this template using the Save Workspace As... command will inherit all of the layers and settings from the original and can then be individually modified to reflect the requirements of a particular project or jobsite.

Working with Imported Layers

An important consideration when working with workspace files is that they do not actually contain the map data from any files that are imported. Instead, the workspace records the path to the original file location as well as any edits or configuration that has been applied to this layer. If the path to the file location is broken, such as when you disconnect from your local network or when the file is deleted or moved to a new location, the workspace will not load correctly and an error message will be displayed. For this reason, workspace files should typically not be shared with other Global Mapper users, based on the assumption that the path to the included data is unique to the original computer.

Working with Digitized Features

Points, lines, and area features that are created using Global Mapper's Digitizer tools are stored directly in the workspace file. Modifications or additions made to any imported data are similarly archived internally within the software and are only applied to the original external data using the export function.

Global Mapper Package Files

An efficient way to share data among Global Mapper users is to create a Global Mapper Package file (.gmp). Unlike the aforementioned workspace format, a package file contains all of the map data from any previously imported layers and it retains all of the configuration settings and edits that where applied to these layers. A single Global Mapper package file can contain data in any format (raster, vector, and/or elevation) and as such, it provides an extremely efficient tool for exchanging maps and spatial data among Global Mapper users.

Global Mapper package files also offer a simple way to create backups of important datasets that can easily be reimported in the event of a loss of the original data or hardware failure.

For more information on exporting, see page 20.

Importing Data

Supported Data Formats

One of the defining characteristics of Global Mapper is the volume and variety of file formats that can be imported into the software. In the current version, over 250 file-types are supported, including all common spatial formats, such as ESRI shapefiles, KML files, MrSID imagery, and LiDAR point clouds. Virtually any type of geospatial data is supported in Global Mapper, including raster, vector, 2D, and 3D, whether referenced or not. If Global Mapper doesn't support your data, contact Blue Marble and the software development team will determine if the format is compatible. A list of the currently supported formats is available in the Global Mapper section of bluemarblegeo.com

Importing Vector, Raster, and Elevation Layers

There are several ways to import data into Global Mapper. You can use the File > Open Data File(s) command; you can click the Open Data File(s) button in the toolbar; or you can use the Ctrl+O keyboard shortcut. In each case, you will be prompted to browse to the required file to initiate the import process.

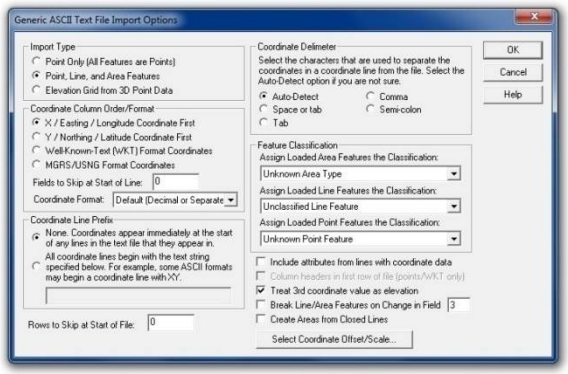
Aside from text files, as noted below, all vector, raster, and elevation formats are imported using the same dialog box and the same procedure. Global Mapper is able to differentiate the different formats and automatically assigns each to the appropriate overlay type. If required, you may be asked to define the coordinate parameters, to verify the data format for files with unconventional suffixes, or to manual rectify the file if there is no inherent geographic reference information. For more information on the rectification process, see page 10.

When importing, it is possible to select multiple files by holding down the Ctrl or Shift key while selecting the required files in the Open dialog box. Alternatively, you can open all compatible files in a specified folder or directory tree using the File>Open All Files in a Directory Tree command.

Finally, and perhaps most conveniently, you can simply drag and drop a compatible file onto the Global Mapper window to automatically initiate the import process.

Importing Text Files

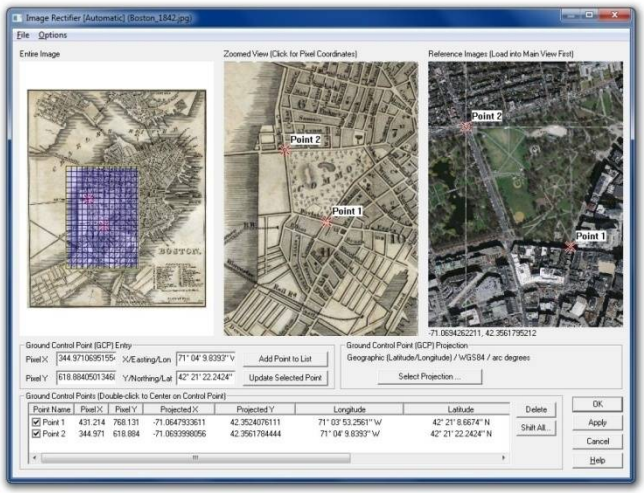
Text files containing a list of coordinate values can be imported into Global Mapper and used to create points, lines, or area features. To initiate the text file import process, use the File > Import Generic ASCII Text File(s) command.



After selecting the required file, you will be prompted to assign certain parameters for the imported file such as the order and format of the coordinate values, the number of header rows in the file, and whether or not to import accompanying attributes.

Geo-rectifying Image Files

Global Mapper's Image Rectifier function provides a powerful tool for creating a geographically referenced raster layer from virtually any image file or PDF. The procedure usually involves identifying visible features in the imported image and tagging each of these with their corresponding coordinates.



To import an image, you can either use the standard File > Open (Ctrl +O) command or File > Rectify (Georeference) Imagery. If you choose the latter, you have the option to directly export the resulting raster file after the required control points have been assigned.

After selecting the file to be imported, the Image Rectifier dialog box is displayed showing an overview of the image; a zoomed view of the image in which the control points can be precisely placed; and a zoomable view of the current map. To begin the process, click an identifiable point on the image, click the corresponding point in the adjacent map, and click the Add Point to List button. Repeat this process for several additional points spaced as far apart as possible. Alternatively, you can manually type the X and Y pixel values from the image and/or type the corresponding coordinate values derived from surveyed ground control points.

After all of the control points have been assigned, click the OK button to create a new raster layer. To correct any errant registration points, select the layer in the Overlay Control Center, right-click and choose RECTIFY – Modify Layer Position/Projection.

Working with Spatial Databases

As an alternative to importing files, advanced users can establish a direct connection to an existing spatial database, which allows Global Mapper to both read and write vector data directly from the database tables. Among the supported database types are ESRI ArcSDE, ESRI File and Personal Geodatabases, MS SQL Spatial, Oracle Spatial, PostGIS, and Spatialite. The ESRI databases also support raster data formats but are only available in the 32-bit version of Global Mapper.

To establish a connection to a spatial database, open the Spatial Database Connection Manager (Tools > Connection Manager), click the New button, and enter the required settings. To import data from a connected database, click the File menu and choose Open Spatial Database, select the database name, click the Open button, and select from the available tables.

Accessing Data Online

Using the Download Online Data Function

A great way to get started making maps with Global Mapper is to download some of the many free online datasets. Numerous government agencies, organizations, and commercial companies provide direct streaming access to their spatial data archives though Web Map Service (WMS), Web Coverage Service (WCS) and other online protocols. Global Mapper includes preconfigured links to many of these servers.

To initiate the download process, click the Download Free Maps/Imagery from Online Sources quick-start button on the introductory screen or click the Download Online Data button from the toolbar. In both cases, the resulting dialog box will list all of the available Data Sources, categorized by type or by geographic area. After expanding a category list, simply select the required data source and set the extent of the data to download using the options at the bottom of the window.

On occasion, you may find that the service that you require is not available and you will see an error message to that effect. This circumstance may be due to routine system maintenance, excessive traffic, or other technical issues. Unfortunately Blue Marble has no control over the availability of these online map sources so it is recommended that you save the data to a local file so you do not have to continually depend on the streamed service. See below for more information.

Premium Data Sources

Blue Marble has partnered with several commercial data providers to offer convenient access to high-quality imagery and elevation datasets. If you select one of the Premium Content options in the Online Data Source dialog box, you will be prompted to enter the appropriate log-in details or data access ID number to download the data. Information on subscribing to these services can be obtained from the data provider's web site.

Adding Custom Data Sources

While Global Mapper includes a number of preloaded maps services, you can also add custom online sources if they are available for your area of interest. Many GIS departments now use the web as an efficient delivery mechanism for their datasets and Global Mapper allows you to set up a direct link to this data. After clicking the Add New Source button in the Online Data dialog box, simply enter the appropriate URL to establish this link.

Saving Data for Use Offline

Because the availability of the streaming data services cannot be guaranteed, it strongly recommended that you save a local copy of any online map data. Not only will this ensure that you will always have access to the required layers, even when offline, but it will significantly speed up the map draw speed when working with this data.

To save downloaded data, click the File menu and select Export > Export Raster/Image Format, choose a file format when prompted, and enter the file settings as needed. A good format choice is JPEG 2000 (.jp2) as it provides a balance between file size and image quality. Before finalizing the export, click the Export Bounds tab in the Export Options dialog box and choose one of the available options to limit the geographic extent of the exported file, otherwise you may inadvertently generate an extremely large file. Note that saving data will take considerably longer than simply displaying it on the map, so be prepared to wait some time for the file to be saved.

Using the Digitizer

The Digitizer Tool

Arguably the most powerful tool in Global Mapper, the Digitizer allows you to create, delete, edit, move, reconfigure, and copy points, lines, and area features on the map. The most frequently used digitizer components can be accessed directly from the toolbar at the top of the map window but many more tools are available by right-clicking on the map after the Digitizer has been enabled.

When used by itself, the Digitizer is a selection tool. After clicking the Digitizer button in the toolbar, the position of the cursor is represented by a crosshair with the word EDIT displayed below, and in this mode, points, lines, and area features can be selected in preparation for editing, moving etc. Individual features can be selected by simply clicking the feature on the map or multiple features can be simultaneously selected by clicking and dragging a box that encompasses the extent of the required features or by holding the Ctrl key while selecting multiple individual features.

Drawing Freehand Features

The following buttons are used to manually create vector features on the map:

Use this tool to create area features or polygons by repeatedly left-clicking on the map. Right-click to add the final point, which is automatically connected to the first point.

Regular rectangle areas are created using this tool by left-clicking and dragging your mouse to the opposite corner. To create a square, hold the Shift button down while dragging.

The vertex-mode line tool is used to create line features by clicking at each desired shape point on the map. The line is terminated using the right mouse button.

Use the trace-mode line tool to create freehand lines by clicking and holding the left mouse button while moving the mouse.

Similar to the rectangle area tool, the rectangle line tool creates squares or rectangles by left-clicking and dragging your mouse. In this case, only the perimeter line is drawn.

Point features or text are created by selecting this tool and simply clicking at the required location on the map.

When using any of these tools, the completion of the drawing function triggers the Modify Feature Info dialog box, in which the name, feature-type, attributes, and target layer are assigned.

Additional Digitizer Buttons

The Global Mapper toolbar contains a number of additional buttons for activating specialized vector creation tools. The CoGo tool is used to create line or area features by entering specific dimensions and bearings; the Range Ring tool generates concentric circular area features of a specified dimension around a point; and the Grid tool is used to create an array of grid tiles of a user-specified width and height.

Most of the remaining buttons on the Digitizer toolbar are for editing selected vector features and will be discussed below.

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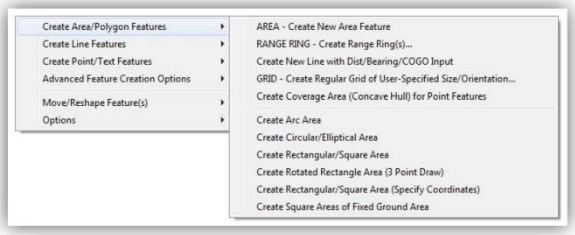
Using the Digitizer (continued)

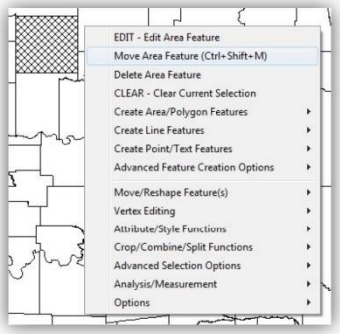
Advanced Digitizing Tools

While most standard vector features can be created using the previously listed buttons, there are a number of additional Digitizer tools that are accessed by right-clicking on the map. These tools are organized in submenus by type (areas, lines, and points) and provide more advanced drawing functionality.



Editing Vector Features

Global Mapper provides tools for editing both the geometry and physical appearance of vector objects as well as the attributes or information that is associated with each feature. Edits can be applied to features created in Global Mapper or to features from an imported vector layer. Note modifications made to an imported layer are not applied to the source file and the layer must be exported to apply these updates in the original file format.



Before initiating any editing function, the feature or features must be selected with the Digitizer tool as previously described. The act of selecting a feature activates several additional buttons in the toolbar that offer such options as moving, rotating, scaling, and converting features. Additional geometric editing options are available by right-clicking on the map.

Global Mapper also provides the ability to edit the shape and size of individual lines or area features by adding, moving, or deleting vertices or shape points. To enable this function, make sure the option to display vertices for selected objects (right-click > Options) is enabled. Vertices can then be selected with the Digitizer tool and, using the right-click > Vertex Editing function, can be modified in several ways.

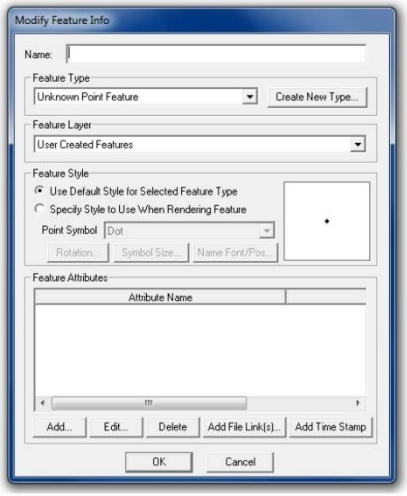
To restore the original geometric shape or position of a feature, select it with the Digitizer tool and choose Move/Reshape Feature(s) > Restore Original Shape of Selected Features.

Deleting Features

The easiest way to delete a feature in Global Mapper is to select it with the Digitizer tool and use the Delete key on your keyboard. Although the feature will be removed from view, it is not permanently erased and can be easily recovered if necessary. Using the keyboard shortcut Ctrl+Z immediately after deleting the feature will undo the deletion. Alternatively, you can toggle the display of all deleted features using the keyboard shortcut Ctrl+Shift+D and, using the Digitizer tool, right-click and choose the Undelete option.

Working with Attributes

The Modify Feature Info Dialog Box



The Modify Feature Info dialog box appears whenever a new feature is created or when the right-click > EDIT option is chosen after a feature has been selected with the Digitizer tool. This dialog box offers several tools for establishing the style settings of the features and for adding or editing attributes either individually or collectively.

The Feature Type dropdown list provides the means to assign the selected feature to a preformatted classification, which automatically determines the visual characteristics as well as the attribute fields that are associated with this type.

Attributes can also be manually added or edited for selected features using the appropriate buttons at the bottom of the Modify Feature Info dialog box.

Advanced Attribute Options

Global Mapper provides several options for automatically creating or updating attributes. After selecting a feature or features on the map with the Digitizer tool, the right-click menu offers an Attributes/Style Functions submenu that can be used to automatically assign attributes using a variety of criteria. For instance, with an underlying elevation layer, you can assign elevation and slope values to selected features or you can add an attribute with a count of the number or point features inside a selected area.

Joining and Calculating Attributes

The join process in Global Mapper allows external data to be assigned to the appropriate features in an existing layer for the purpose of creating additional attribute fields. Before beginning this procedure, it is essential that the each feature has an existing attribute that matches a corresponding value in the data being joined. The join can be based on a one-to-one match, where each entry in the imported data matches just one feature on the map, or it can be based on a one-to-many approach, where an individual record in the data being joined is assigned to several features on the map.

To initiate the join process, right-click on the target layer in the Overlay Control Center and choose JOIN TABLE. Supported formats for the external tabular data include .txt, .csv, and dbf.

The attribute calculation function, which is also accessed by right-clicking on the layer in the Overlay Control Center, is used to create a new attribute field by applying a calculation to an existing attribute. Calculation options include standard numeric operations, such as add and multiply; text-based operations, such as append or prepend text; or advanced formulaic operations.

Using the 3D Functionality

Working with 3D Data

In order to utilize Global Mapper's 3D functionality, the data with which you are working, must have an inherent elevation or height value. Both vector features and appropriately formatted raster layers can include this "Z" value and can be modeled in a three-dimensional perspective.

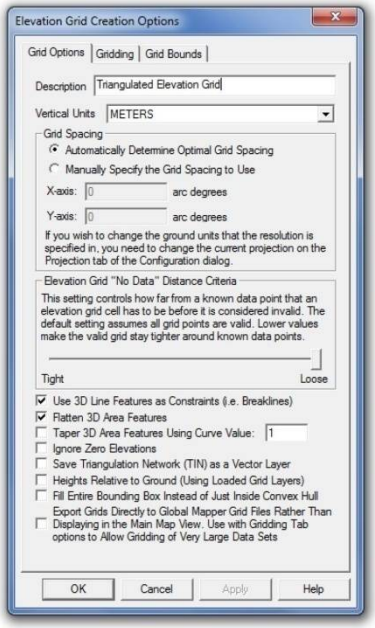
The most common application for 3D data is to generate a terrain surface, which is the basis of many of Global Mapper's analytical functions, such as watershed delineation and flood level modeling. A height value can also be applied to a vector feature or to individual vertices that comprise a vector feature, which allows the feature to be extruded from a terrain surface.

Where to Find 3D Data

As with the standard raster and vector data formats, there are numerous sources of 3D or elevation data. Global Mapper's Download Online Data function provides several preformatted datasets that can be downloaded free of charge or through a subscription to one of the listed data providers. Global Mapper also supports dozens of preexisting elevation formats, such as DEM and Arc/Info Grid files that are imported using the normal File > Import process. Simple text files that include elevation values along with coordinates can be imported using the File > Import Generic ASCII Text File(s) command and can be gridded to create an elevation layer. Finally LiDAR (Light Detection and Ranging) data can be imported and processed to create a high-resolution surface model. For more information on working with LiDAR in Global Mapper, see page 19.

Creating a Terrain Map from 3D Vector Features

The process of generating a raster elevation layer from an array of vector features that contain an elevation value involves gridding the data. This procedure typically follows the import of an XYZ text file or LiDAR file, but it can also be performed using other vector files such as contours. To create an elevation grid from a selected layer, right-click on the layer in the Overlay Control Center and choose GRID or, if gridding several layers, choose Create Elevation Grid from 3D Vector Data from the Analysis menu. In both cases, the Elevation Grid Creation Options dialog box will appear, which offers a number of options for configuring the gridding process.



3D Options and Preferences

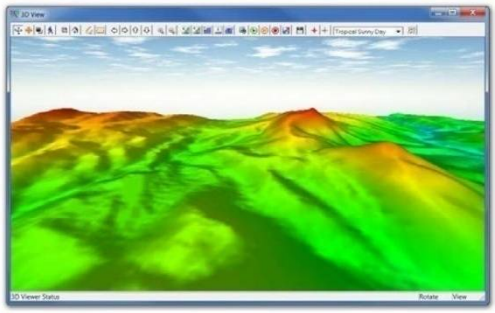
By default an elevation layer will be displayed using the multi-colored Atlas Shader, although there are several additional options in the Shader dropdown list in the toolbar. A simulated hill shade or shadow effect will also be applied to accentuate variations in the terrain. This can be disabled using the Hill Shade button in the toolbar. 

Additional 3D options can be established in the Configuration dialog box. For more information, see page 6.

Using the 3D Functionality (continued)

Visualizing the Map as a 3D Model

A supplementary map window in Global Mapper provides the means to view any data with a height or elevation value as a three-dimensional model. This window is opened using the Show 3D View button in the toolbar. 



Many of the same zooming and panning functions that are used in the 2D map view are also available in the 3D window. Additional tools allow the vertical exaggeration to be increased, the perspective to be changed to ground level, and water inundation to be simulated. The 3D window also includes a Save function that allows the current 3D view to be saved as an image.

Working with LiDAR Data

A rapidly emerging source of data in the GIS field, LiDAR (Light Detecting and Ranging) data provides the raw material for creating highly accurate terrain surfaces or other elevation-derived layers. In its native format, LiDAR is a series of closely-spaced points, each of which contains precise coordinates, an elevation, a classification that denotes the type of feature that the point represents (ground, vegetation, building, etc.), and several additional attributes. Recent developments in Global Mapper have expanded support for both the standard LiDAR files (.las) as well as the compressed version of the format (.laz). An optional LiDAR Module is available that offers advanced LiDAR processing tools for more information, see page 19.

LiDAR data is imported using the standard import procedure (Ctrl+O) however the subsequent import options dialog box is unique to this format. In this window, the data can be filtered, sampled, and if required, can be directly gridded, avoiding the need to render the point data.

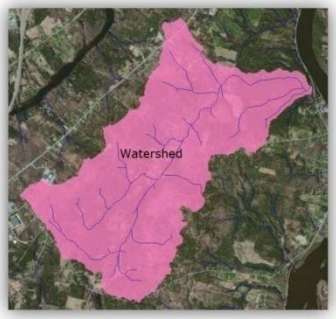
If the point cloud itself is imported, the points will inherit the colors of the currently selected shader and will reflect the elevation value if no actual color values have been assigned to each point. Using the layer's options dialog box, the color of the points can be changed to represent other variables such as classification or intensity. Also unique to this format is the Edit function, which is accessed by right-clicking after selecting one or more of the LiDAR points on the map. In this dialog box, the point's classification can be edited and other attributes modified.

Creating a terrain surface from loaded LiDAR data involves using Global Mapper's standard gridding tool (for more information, see page 15) and using the resulting elevation layer, any of the 3D analysis processes can be performed with a high level of precision.

Using the 3D Functionality (continued)

3D Analysis Functions

Global Mapper offers a number of analysis tools that utilize loaded elevation or terrain layers. Unless noted, these tools are accessed from the Analysis menu:



- **Watershed Modeling**
  This tool is used to delineate the potential for the terrain to support the flow of water using linear features to represent stream channels and area features to outline watersheds or catchment areas.
- **Path Profile/Line-of-Site**
  A Path Profile is a cross-sectional view of the terrain as represented by a line feature. The Line-of-Site analysis, which will only work with a single segment line, shows where obstructions impede the view or transmission path from one end of the line to the other.
- **View Shed Analysis**
  The View S.hed analysis tool outlines which areas are visible or are within the broadcast range of defined location. Options such as azimuth range, distance, and height of the point of origin can be customized in the view shed analysis setup dialog box.
- **Water Level Rise/Flood Simulation**
  Based on a selected area or on actual sea level, the Water Level Rise/Flooding tool outlines those areas that will be impacted by a specified increase in water level.
- **Generating Contours**
  The creation of contour lines is one of the most common uses for elevation data in Global Mapper. The Contour Generation Options dialog box allows the contour interval to be established, supplementary areas features to be created, and other settings to be applied.

- **Calculating Volume Between Surfaces**
  With two overlapping elevation layers loaded, such as a surface layer and a subsurface bedding plane, this straightforward tool calculates the volume of material between the two.
- **Comparing/Combing Terrain Surfaces**
  This tool creates a new elevation layer from an operation or calculation applied to the elevation values in two overlapping layers. Operators include subtraction, average and maximum.
- **Cut and Fill Calculation**
  Available as a right-click option when either a line or area feature has been selected with the Digitizer, the Cut and Fill calculation tool determines the volume of material that will need to be removed and/or added to create an artificially flattened surface.

For more information or specific instructions on the use of these analysis tools, refer to the help documentation that is accessible in the Help menu in the software.

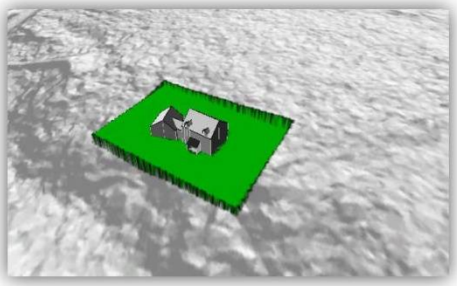
Using the 3D Functionality (continued)

Assigning Height or Depth to Vector Features

Any point, line, or area feature can have a z value associated with it, which allows it to be modeled in a 3D environment relative to other vector features or to a loaded terrain surface.

When importing a vector layer, Global Mapper will automatically look for an existing vertical attribute, such height or elevation and use that as the z value. To manually assign a z value, simply add a new attribute to the required feature or features and type the elevation, height, or depth. To make sure Global Mapper recognizes this attribute as a z value, open the Options dialog box for the layer in the Overlay Control Center and choose the appropriate attribute field from the Get 'Elevations' from Attribute Value dropdown list.

It is also possible to add a different z value to each vertex that comprises a line or area feature. This procedure is initiated by clicking the Vertices button in the Modify Feature Info dialog box for a selected feature. If an elevation value does not already exist for each listed vertex, click the Add Elevs button and update each individual vertex as needed.



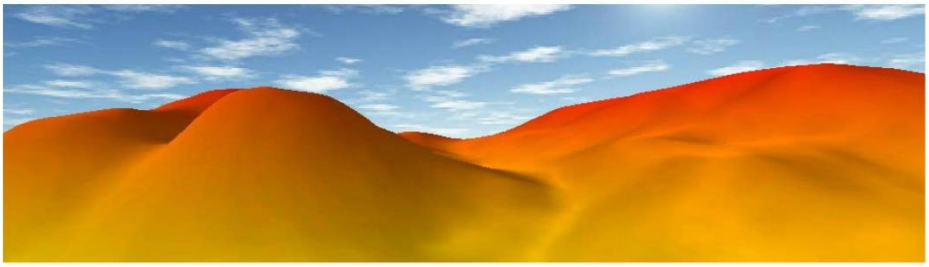
When rendered in Global Mapper's 3D window, vector features with an associated z value will appear above or below a loaded terrain surface layer. The 3D View Properties dialog box provides several check boxes that are used to control the display of these vector features.

Creating 3D Fly-Through Recording

Global Mapper provides a simple tool for creating a video file that records a user-defined path through any 3D environment. The process of creating the path is initiated with the Digitizer tool and can use a drawn line, imported line feature, or GPS track file. The line itself does not have to contain any particular characteristics or attributes but is simply used to define the course of the flight.

After selecting the line, the Edit Fly-Through Path button will be available in the Digitizer toolbar. Clicking this button opens the Fly-Through Path Properties dialog box, in which the flight settings are established. These settings include height above ground, flight duration, camera angle, and pitch.

In the 3D Viewer, a series of buttons control the preview, playback, and recording of the video file.



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Using the LiDAR Module

Module Overview

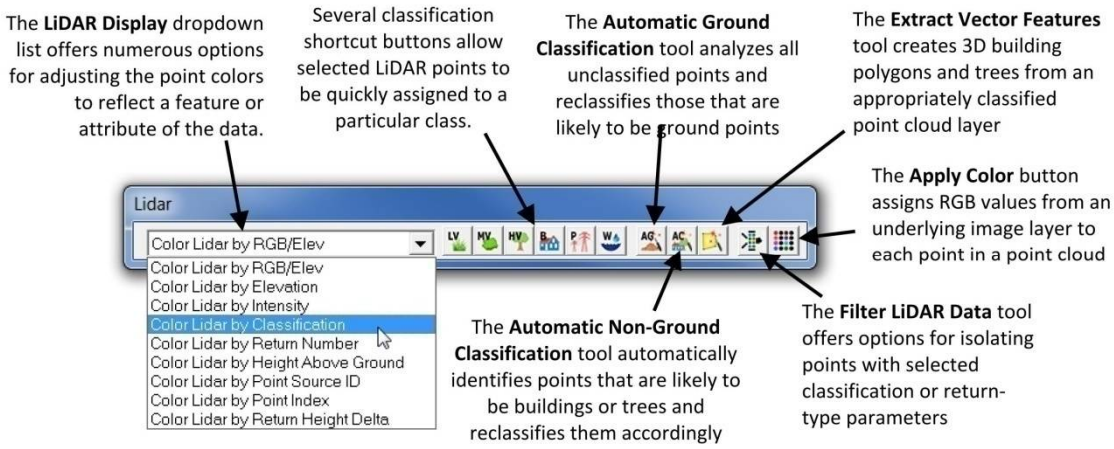
The Global Mapper LiDAR Module is an optional add-on component of the software that significantly enhances the LiDAR processing functionality. The key feature of the module is a toolbar that includes buttons for reclassifying LiDAR points, applying filters, and extracting vector features from a point cloud.

Activating the Module

The LiDAR Module is installed with the standard version of Global Mapper however a valid registration key is required to activate it. This key can be ordered on the Blue Marble website or it can be added to your original purchase or upgrade to the latest version of the software. To activate the module, click the Help menu and choose Module/Extension License Manager. Simply checking the box next to the LiDAR module will trigger the registration window, which is similar to the main software registration window. After activating the license, the LiDAR toolbar will automatically appear.

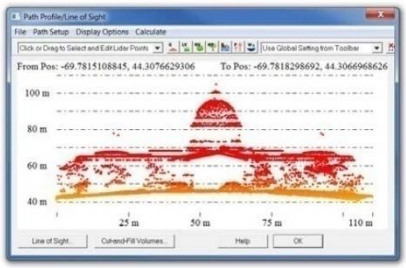
The LiDAR Toolbar

Like all of the other Global Mapper toolbars, the LiDAR toolbar can be enabled or disabled from the View menu. It can also be undocked from the top of the screen and dragged to any location on the map window.



Creating a LiDAR Profile

The LiDAR Module enables the Path Profile tool to be used to create a cross sectional view of a swath of points. The width of the swath is entered by right-clicking on the map prior to creating the path. As in the 2D map, points in the profile view can be selected and edited, which makes reassignment of distinct features such as buildings quick and accurate.



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Exporting and Printing Maps

General Export Considerations

Efficient file exporting and map sharing are essential components of any GIS and play a major role in the functional makeup of Global Mapper. Just as the software can support a vast array of file formats for importing, similarly hundreds of file-types can be exporting ensuring Global Mapper's interoperability with countless third-party applications.

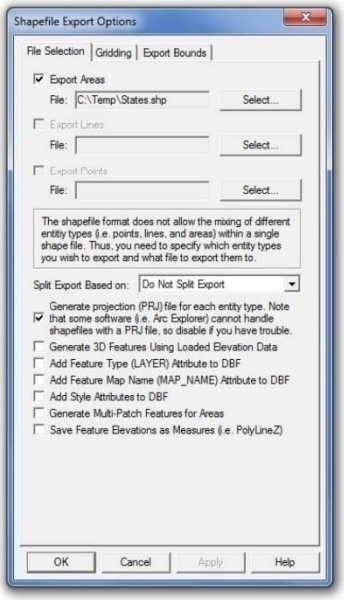
When exporting data from Global Mapper, there are several issues and factors that need to be taken into account:

- All compatible layers and/or visible features will be exported by default. In other words, Global Mapper will create a single file for all layers by merging multiple layers into one file. In order to export the contents of a specific layer, it will first be necessary to deselect the unrequired layers in the Overlay Control Center.
- There is no automated process for saving edits or additions to an imported file. In order to save changes to the source file, you need to export the layer in the same format and overwrite the original file.
- The projection and coordinate settings for any exported data are established in the Projection tab of the Configuration dialog box (for more information, see page 6). Regardless of the projection parameters of each imported layer, this global projection will be assigned to all exports.
- Each export format's options dialog box has a set of format-specific settings that are applied to the file being exported. Common to all formats are an Export Bounds option, that can be used to limit the geographic extent of the data being exported, and a Gridding or Tiling option that can be used to break up a single large file into several smaller files.

Exporting Global Mapper Package Files

When sharing data with other users of Global Mapper, the Global Mapper Package format is the preferred choice. This proprietary format supports all compatible data-types and allows multiple layers to be simultaneously transferred in a single compressed file. When imported, the Global Mapper package file will recreate the layer structure of the original data.

Global Mapper package files can also be employed as a means for backing up critical datasets. This ensures that the data can be effectively restored in the event of a loss of the original data or hardware failure. To create a package file, click the File menu and select Export > Export Global Mapper Package File...



Exporting Vector, Raster, and Elevation Layers

Unlike Global Mapper's import process in which a single Open command is used to access all compatible data, exporting requires the selection of a data type (vector, raster, or elevation) and subsequently a specific file format. The Export submenu under the File menu offers these three options. The selection of a format for the exported data will depend on the intended use of the resulting file and its compatibility with the third party software into which it will be imported.

Exporting and Printing Maps (continued)

Exporting to a Spatial Database

In the same way that Global Mapper provides a streamlined way to import data from a spatial database, any loaded data, regardless of its origin, can be written out to any of the supported database formats. As when exporting data in file format, the Export submenu provides three database export options: raster, vector, and elevation. For more information on establishing a connection to a spatial database, see page 10.

Exporting Web-Ready Files

Global Mapper offers several options for creating web-ready files from any loaded data layers. Under the File menu, the Export submenu offers the Export Web Format option that opens a dialog box in which the required format can be chosen. Several raster tile options are available including Google and Bing Map Tiles. Selecting a tiled format will produce multiple image tiles as well as an accompanying HTML file that automatically renders the map display interface, map controls, and base map data for the chosen format.

The Export Web Format command also offers the option to create Keyhole Markup Language (KML or KMZ) files that can be imported into Google Earth or Google Maps.

Printing the Map

Before sending a map to a connected printer, Global Mapper offers several page layout options that can be used to add cartographic elements such as a title, legend, and scale bar to the map. The Map Layout button in the toolbar provides access to the Page Layout Setup dialog box. Additionally, the File > Open Data File at Fixed Screen Location… command allows any supported image file, such as a company logo, to be placed a specified location within the page layout.

In the File menu, the Print Preview command displays a low resolution view of the map to be printed allowing the layout to be modified if needed. The Print… command will send the map to the selected printer based on the Print Setup settings (page size, orientation, etc.) that were previously established.

Creating a Geospatial PDF

Capturing a map view as a Portable Document Format (PDF) allows the map to be shared with virtually anyone, regardless of their computer's operating system. Global Mapper's PDF export function also retains the inherent layering structure and geographic referencing information so that the map viewer can turn on and off layers as needed, can see the coordinates when their cursor is moved over the map, and can perform simple cartographic functions such as measuring distances.

Exporting a PDF is similar to sending a map to a printer and includes many of the same setup options. To create a PDF, click File > Export > Export PDF File…

Capturing a Screenshot

Perhaps the simplest way to share a map, the Capture Screen Contents to Image command is an available option in the File menu or by using the Shift+C keyboard shortcut. The resulting dialog box offers the choice of four common image formats and includes an option to save a projection and/or world file that will allow the image to be imported into third party GIS application.

Where to Find Help

Global Mapper Help Documents

Global Mapper's searchable help system is automatically installed with the software and is accessed from the Help menu or by clicking the F1 key. You can either browse through the contents section or search for a keyword to find information on the function in question. Embedded hyperlinks help you navigate between sections and provide supplementary information about the selected topic.

Online Resources

- An online version of the complete User's Manual is available here: www.bluemarblegeo.com/knowledgebase/global-mapper/Help_Main.html
- The content of the various help pages are also available in PDF format: www.bluemarblegeo.com/knowledgebase/global-mapper/GlobalMapperHelp.pdf
- Recordings of the monthly Global Mapper webinar series, which cover a variety of topics in the software can be viewed here: www.bluemarblegeo.com/products/previous-webinars.php

The Global Mapper Forum

The Global Mapper Forum is an active online community of users and experts from a wide variety of industries and fields. Forum participants have the opportunity to ask questions, offer tips, and participate in discussions about the use of the software and its future development. Many new users find browsing through the posted topics to be an invaluable part of their learning experience.

A link to the Global Mapper Forum is available in the software's Help menu or you can navigate directly to the following site: www.globalmapperforum.com.

Training Opportunities

Both public and company-specific training opportunities are available to help you get the most out of the software. The availability of scheduled public classes and information about registering is posted here: www.bluemarblegeo.com/solutions/geodesy-training.php

Customized onsite or online classes can also be arranged for individual companies or organizations. For information, email training@bluemarblegeo.com.

Global Mapper Support

After all other self-help options have been tried, on-demand support is available to resolve any issues with the installation, registration, or performance of the software. All support requests are initiated using the preconfigured form on the following web page: www.bluemarblegeo.com/support/support.php

Useful Keyboard Shortcuts

General Application

Open the User Guide F1
Display 3D Window ..... Ctrl+3
Print ..... Ctrl+P
Alt+X ..... Exit Global Mapper

File Management

Open data file (import) ..... Ctrl+O
Save the current workspace ..... Ctrl+S
Load a workspace ..... Ctrl+W
Unload (remove) all layers ..... Ctrl+U
Copy selected features to the clipboard ..... Ctrl+C
Delete and copy selected features to the clipboard ..... Ctrl+X
Paste features from the clipboard to a selected layer ..... Ctrl+V
Open the Overlay Control Center ..... Alt+C

Tools Selection

Digitizer Tool ..... Alt+D
Feature Info Tool ..... Alt+P
Measure Tool ..... Alt+M
Zoom Tool ..... Alt+Z

Zooming and Panning

Zoom in ..... Page Down
Zoom out ..... Page Up
Zoom to full extent of all loaded data ..... Home
Pan the Map (¼ screen increments) ..... Arrow Keys
Pan the Map (Entire screen) ..... Ctrl+ Arrow Keys

Digitizer Functions

Edit the feature under the cursor ..... Left Double-Click
Select a feature and automatically enter move mode ..... Alt+Left Click
Undo last operation ..... Ctrl+Z
Cancel the current operation ..... Esc
Delete the selected feature ..... Delete
Undelete the selected feature ..... Shift+Delete
Temporarily disable snapping when drawing a feature ..... Alt+Left Click

Custom Keyboard Shortcuts

Additional keyboard shortcuts can be manually assigned using the Favorites dropdown list in the toolbar. For more information, see page 5.

APPENDIX 13

ESCOM Data of the Kapichira Dam

DESCRIPTION

The Kapichira Hydro-electric Power Scheme is located at the site of Kapichira falls, formerly known as Livingstone falls, named after the all-time great Scottish Missionary Explorer, Dr David Livingstone. The falls are the last reach of the 80km long cataracts on the middle Shire River stretching from Matope down to Chikwawa, and is the last important rapids reach of the river, the others being at Tedzani, Nkula (already fully developed), Mpatamanga and Kholombidzo.

Civil Works and Hydraulic Steel Structures

The salient features of phase 1 of Kapichira Hydro-electric Power Scheme comprise a composite rock and earth-fill embankment dam, 5-gated concrete spillway structure, bell-mouth 4-gated buried concrete intake structure, 550m concrete/steel lined tunnel with a 50m deep concrete lined shaft at the intake end, 84m steel penstock branching into 4 manifolds feeding 4 Nos. machines (2Nos. to be installed in the 2nd phase) housed in a concrete powerhouse with a structural steel roof and a 15m wide by 320m long rock-cut tail-race channel. The powerhouse is a multi-storey building sitting in a deeply cut terrace, rendering it almost invisible even from the nearby environs; an environmental attraction designed to render the otherwise tall building less obtrusive to the eye.

Civil and hydraulic steel structure works were basically split into three major parts, viz.: power intake structures, waterways structures and generating/transmitting structures.

The intake structure works involved the construction of a 830m long composite rock and earthfill embank-ment dam with clay impermeable core, behind which the power plantís reservoir with an active storage of 3.5 x 106 m≥ would be held; a 90m long by 20m high 5-radial gated spillway in reinforced concrete; and a 48m wide by 19m high 4-waterway 4-roller gated intake structure in reinforced concrete.

The waterways works involved the construction of a square to circular 8.8m wide/diameter 50m deep rein-forced concrete-lined shaft in rock-cut and rock-fill; a 550m long 8.8m diameter power tunnel, 474m of it reinforced concrete lined and 76m steel lined with mass concrete envelope; a throttled 25m diameter by 30m high (above ground level) reinforced concrete surge chamber with a 7m diameter by 20m deep orifice; a steel reinforced-concrete-enveloped penstock, 84m long by 8.8m in diameter and branching into 4 Nos. steel manifolds, each 3.2m in diameter; and a 15m wide by 320m long open tailrace channel in rock-cut.

The generating structure works involved the construction of an 86m long by 25m wide by 44m high rein-forced concrete and structural steel 4 by 32 megawatt-machine-space powerhouse with 4 Nos bulkhead type draft tube gates, operated by a gantry crane; and outbuildings comprising an emegernc diesel gen-erator building, GIS building and workshop and stores building, all in concrete., brick and structural steel.

Advanced civil works comprised the upgrading and re-alignment of the existing 20km long dirt road, from Chikwawa Boma to Majete Game Reserve, (D135)to an all-weather standard gravel road, construction of a new access steel bailey bridge to Kapichira site across the Shire River, various site roads, 20 senior staff houses, 20 junior staff houses, a staff clinic, guesthouse, clubhouse, junior school (kindergarten), office buildings and a potable water treatment plant and associated reticulation system.

Data

Reservoir

Maximum operating level	:	El. 147.00m
Minimum operating level	:	El. 144.00m
Active storage	:	3.5million cubic metres

Dam

Type	:	Embankment, with clay impermeable core
Length	:	830m
Maximum height	:	30m (at river closure section)

Spillway

Type	:	Gate controlled ogee (crest of ogee at El. 134.00m and approach channel base at El.130m)
Gates	:	5 x 15.24m wide x 13m high radial gates
Capacity	:	8750 cubic metres per second

Intake

Type	:	Bell-mouth 4 waterway 4-gated
Sill level	:	El. 138.00m
Width	:	48.00m

Gates	:	4 No. roller type
Capacity	:	270cubic metres per second

Waterways

Intake	:	8.80m square to circular section, 50m deep
Power tunnel	:	Concrete lined (8.80m diameter, 474m long)
Penstock tunnel	:	Steel lined (8.80m diameter, 76m long)
Surge chamber	:	25m diameter chamber with 7m diameter orifice
Bifurcator & Manifolds	:	Reinforced-concrete-encased steel
Tailrace	:	Open channel (15m wide, 320m long)

Powerhouse

Type	:	Surface concrete structure with structural steel Roof
Dimensions	:	86m long x 25m wide x 44m high
Drafttube gates	:	Gantry crane operated bulkhead type, 4 No. 8m wide x 5m high sliding gates

Power Generation

Turbines

In the current phase of the project, 2 generating sets are installed, each set comprising a Francis turbine directly coupled to the generator. The turbines are each equipped with a butterfly inlet valve. Two more inlet valves for future units 3 and 4 are also installed complete with the associated hydraulic equipment.

Each turbine has a rated output of 33MW under a net head of 54m and a normal speed of 214.3rpm. A state-of-the-art electro-hydraulic governor is installed on each machine with an electronic governor providing stable operation at various loading conditions.

Oil for the turbine guide bearing and the generator bearings, the governor sump tank and the station air compressors as well as the generator air coolers are all cooled by means of a closed circuit cooling water system which is in turn cooled by an interconnected raw water system tapped from the upstream of each main inlet valve and discharged into a tundish on the tailrace side of the powerhouse.

Normal drainage is achieved by a network of gullies in the powerhouse which are channelled into two interconnected drainage and de-watering sumps at the lowest level of the powerhouse. Each sump houses two drainage pumps of nominal capacity 25l/s per pump. In addition, two emergency and de-watering pumps each with a nominal capacity of 3000l/s are provided in each pit for use in a flood condition and during penstock de-watering.

Turbine Data

Type	:	Francis vertical axis
Number	:	2
Runner band diameter	:	2926mm
Net Head	:	54.0m
Discharge at net head	:	67.29cubic metres per second
Rated Power	:	33MW
Normal Speed	:	214.29rpm
Governor Type	:	VGC 211-3P1
Inlet Valve Type	:	Butterfly
Inlet Valve Inner Diameter	:	3600mm

Generators

The Generators are of 3-phase salient pole AC synchronous and vertical shaft type directly coupled to the Francis water turbine. Their rated and runaway speeds are 214.3rpm and 415 rpm respectively.

The generator bearing system comprises a combined thrust and guide bearing located just below the rotor and an upper guide bearing located above the rotor. The bearings are of self lubricating type with oil circulation through the bearings and external coolers maintained by rotation of the set.

The stator frames have been transported to site in segments and have been welded together on site. The stator core has been built up from laminations and forms a complete ring.

The generator rotors are of laminated rim type and were assembled at site. The combined weight of each rotor and shaft is 100.7 tons and represents the heaviest item to be handled by the power station overhead crane.

The generators are ventilated on a closed air circuit and the circulating air is cooled by means of water-cooled air coolers.

The machines are designed to be controlled manually or automatically from the control gallery 3.4m above the power station machine hall and remotely from the control room.

Lighting and small power supplies are provided to permit operation and maintenance of the machines at any time of the day or night.

The station supplies are derived from a 2 MVA 33kV/0.4kV core type transformer through a 15 MVA 132kV/33kV core-type transformer. Two diesel generators (1000kVA & 130kVA) have been installed at powerhouse and intake/spillway areas to provide power supply to station essential equipment in the event of mains failure.

Generator Data

Type	:	AC synchronous
Shaft	:	Vertical
Rated Apparent Power	:	36MVA
Rated Power Factor	:	0.9 lagging (over-excited)
Rated Voltage	:	11kV± 10%
Rated Current	:	1890A
Rated Frequency	:	50Hz
Number of Poles	:	28
Rated Speed	:	214.3 rpm
Run away Speed	:	415 rpm
Stator and Rotor Insulator Class	:	F
Weight of Stator	:	59.48 tonnes
Weight of Rotor	:	96.48 tonnes
Weight of Generator Rotating Parts	:	112.7 tonnes
Direction of Rotation Seen From Above	:	Anti-clockwise
Field Rated Voltage	:	78V
Field rated Current	:	1171A

Substation and Transmission

The power generated by the two machines is fed to two 11/132kV, 36MVA transformers via a heavy current air insulated bus bar system comprising phase-segregated connections in solid metallic enclosures. The power is connected to a double bus bar Gas Insulated Switchgear (GIS) substation through 132kV oil-immersed single core cross-linked polyethylene cables and 2 indoor high voltage metal enclosed sulphur hexaflouride (SF6) circuit breakers. The power is then connected to the transmission system through 3 circuit breakers of type stated above and outdoor SF6/air bushings.

The transmission system comprises two double circuit 132kV-transmission lines provided from Kapichira substation to join existing national grid.

The first line joins the existing network about 1km from the substation where one-circuit joins the existing 132kV line to Nchalo and the other circuit feeds into the existing 132kV line to Blantyre West substation.

The second line runs as double circuit for approximately 11km thereafter it changes into single circuit and continues for another 52km before it joins the existing Tedzani III substation from where power is fed into the national grid using the existing transmission network. The other circuit of the double circuit portion from Kapichira has not been strung making a provision for future interconnection to Blantyre West substation.

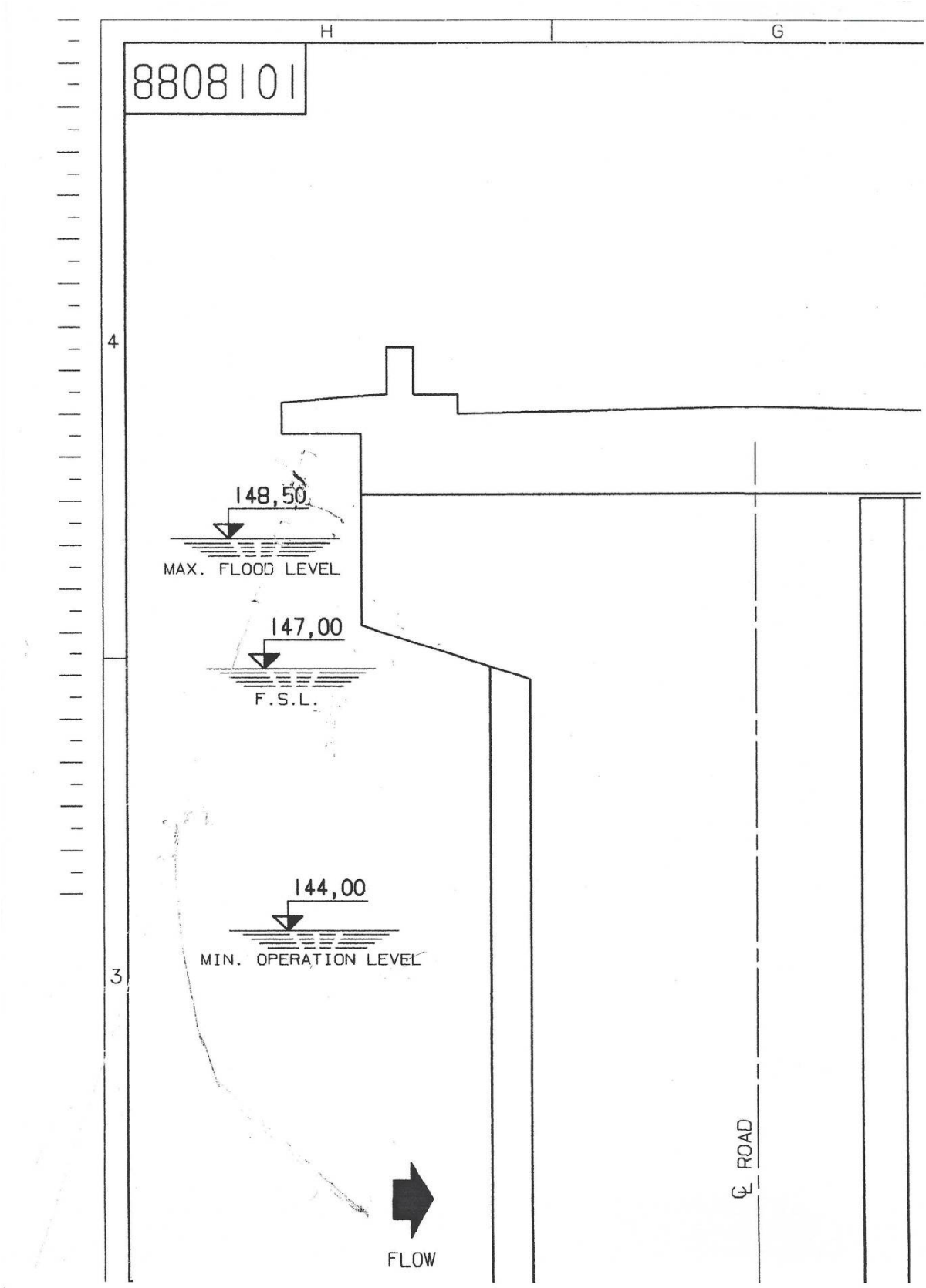
Substation and Transmission Data

Generation Transformers

Type	:	Core and Double Wound
Number	:	2
Rated Apparent Power	:	36MVA
No Load Voltage	:	11/132kV
Frequency	:	50Hz
Vector Group	:	YNd1
Cooling	:	ONAN/ONAF
Total Weight with Oil	:	66.5 tonnes

Station Transformer

Type	:	Core Double Wound
Number	:	1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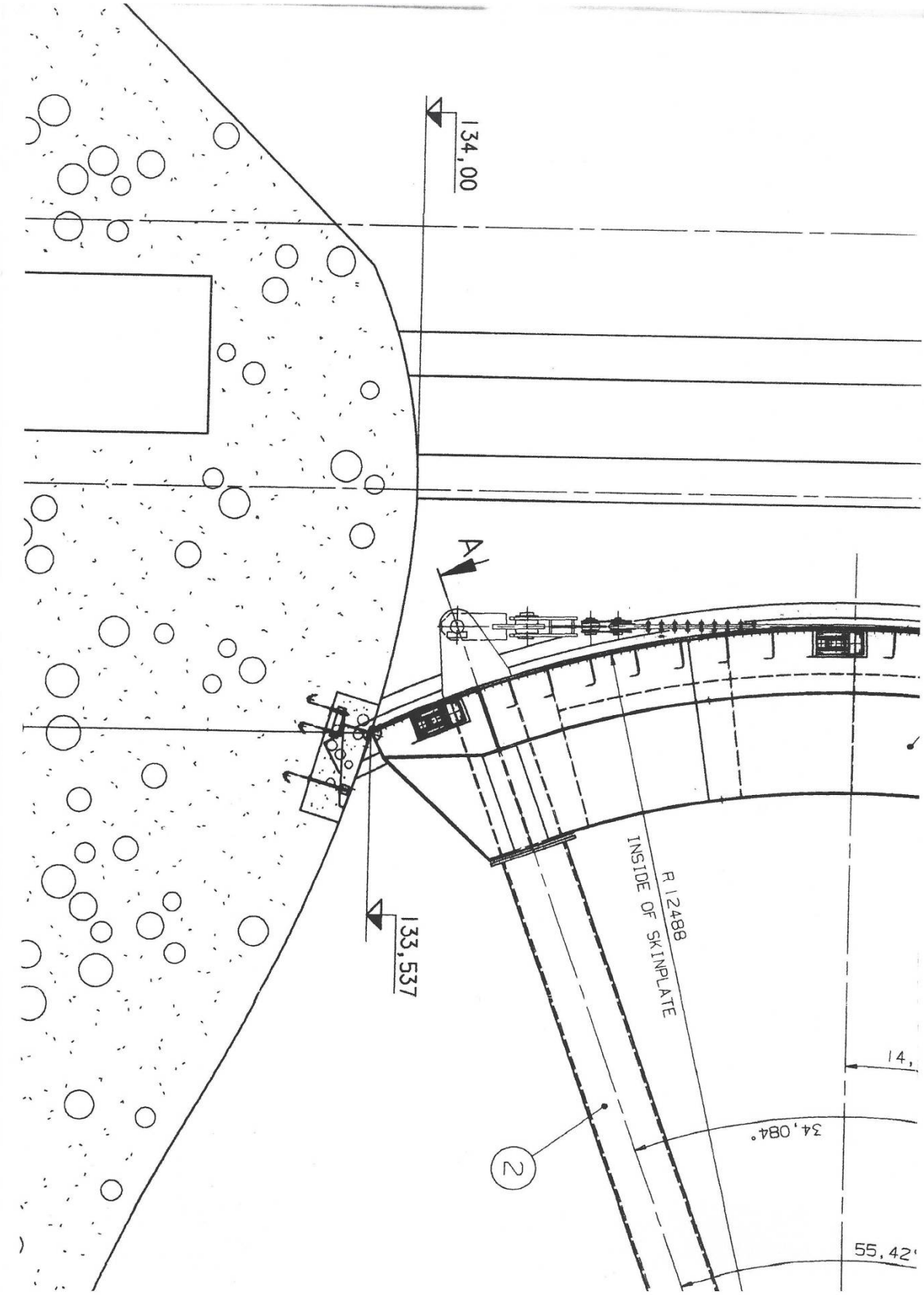
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