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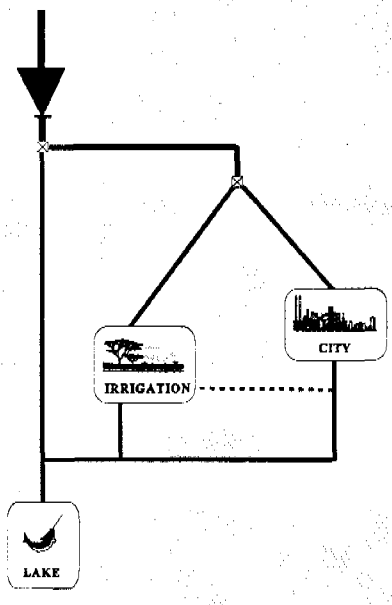
Series on

Water Demand Management

Volume III - Roleplay: Players' Manual



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International Institute for Infrastructural, Hydraulic and Environmental Engineering
The Netherlands

EDI-Worldbank

Roleplay
Water Demand Management

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Foreword

The roleplay is part of an educational tool on water demand management, which was prepared by IHE-Delft on request of the Economic Development Institute of the Worldbank. IHE acknowledges the contribution of ideas by Resource Analysis, Delft.

This note serves as a guideline for participants in the roleplay. Supported by an introduction from the facilitator, the participants should be able to understand the set-up of the roleplay and find in this note the necessary background data for playing their roles.

The note is Volume III in a series of four. Volume I, the lecture note, pays attention to the concepts and practices of Water Demand Management. Volume II contains the presentation sheets prepared for the lectures and the roleplay. Volume IV forms a trainers' manual for detailed operation of the roleplay.

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1 The Roleplay

In the Roleplay, participants represent institutions involved in the exploitation and management of a water resources system:
- the River Basin Authority
- the Water Supply Utility
- the Irrigation District.

The institutions are in charge of managing both water quantity and water quality. They are financially autonomous. Their management also influences the financial performance of the water-dependent economic sectors: Agriculture, Industry and Fisheries.

In the Roleplay, the three institutions formulate measures. The effects of the measures are simulated by a mathematical model of the water resources system and are reported to the institutions. The participants, representing the institutions, go through the following, iterative steps:
1. receive and study information on the present and future state of the water resources system, the institutions and the economic sectors under current management policies;
2. decide upon a policy and measures, which are entered on forms to facilitate input in the simulation model;
3. receive, study and debate the output from the simulation model;
4. return to step 2.

The model computes the effects of the measures over a period of twelve years, starting from the initial situation. After each round of simulation, the participants may decide upon an alternative set of measures, starting again from the same initial situation.

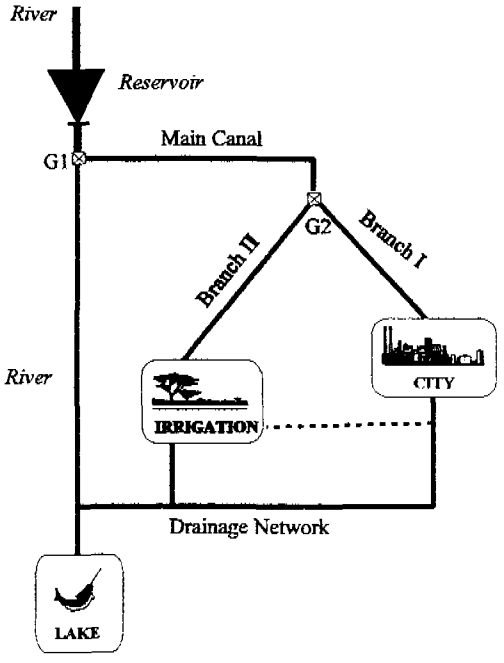
The water resources system is described in Chapter 2 and the institutions are described in Chapter 3. Appendix I gives a report on the state of the water resources system and institutions under current policies.

2 The Water Resources System

2.1 Description

The water resources system (WRS) is shown schematically in Figure 1, where also briefly the responsibilities of the institutions are noted. The WRS consists of:
- under the responsibility of the River Basin Authority (RBA):
  - a dam and a reservoir used for the storage of water
  - canals carrying water to the water supply utility and the irrigation district
  - a diversion weir in the river and a distribution gate in the main canal
  - a drainage network.
- under the responsibility of the Water Supply Utility (WSU):
  - a fresh water treatment plant for filtration and chlorination, including balancing reservoirs
  - a partly gravity, partly pumped distribution network
  - optional: a waste water treatment plant
- under the responsibility of the Irrigation District (ID):
  - a gravity distribution network with regulation and measurement devices.

- RIVER BASIN AUTHORITY
  - Operate, maintain and invest in Reservoir, Main Canal, Branches I & II
  - Assure water quality of the Lake
  - Set price of water
  - Set waste water charges
  - Assist the institutions in making investments in water use reducing technologies
  - Make users aware of need to reduce water consumption
- WATER SUPPLY UTILITY
  - Operate, maintain and invest in the city distribution system
  - Treat waste water
  - Set price of potable water
  - Set waste water charges
  - Assist and advise to users
- IRRIGATION DISTRICT
  - Operate, maintain and invest in the irrigation canal network
  - Efficient distribution and application of water
  - Invest in irrigation technology
  - Select cropping pattern
  - Set Irrigation Service Fee
  - Re-use irrigation drainage and city waste water



The River Basin Authority supplies water to two main users:
- the Irrigation District, which manages the agricultural area where irrigation is essential to obtain sufficiently high yields, farm income and employment;
- the Water Supply Utility, which manages the distribution of potable water and the collection of waste water for a large city where residential, industrial and municipal use of water is increasing rapidly.

There is a lake downstream of the city and the agricultural area. It receives water from the reservoir directly through the river and from the drainage canals.

The drainage canals carry effluent from the agricultural area and the city. The quality of the water depends upon the waste water treatment facility in the city and on the cropping pattern and agricultural technologies used by the farmers.

The income of the Fisheries Sector depends upon the quality of the water in the lake.

The income and growth of the Industrial Sector depend upon the availability of water.

The income of the Agricultural Sector is formed by the total income of the farmers in the irrigation district.

The water resources system and the tasks and responsibilities of the three institutions are described in the following chapters. The dimensions of the WRS and the current management policy may differ from case to case as the trainer has the option to set certain parameters.

2.2 Problem identification: present conditions in the WRS

The demand for water is increasing progressively because of the following trends:
- the population of the city is growing rapidly caused by the strong industrial and commercial growth. The growth depends upon the availability of water. Also the per capita demand of the residents is increasing because of an improving standard of living.
- the demand for water from agriculture has increased because farmers wish to cultivate the full area under command. Also it happens to be that with current price levels of water, the most profitable crops are grown during the dry season and require the larger amounts of water.

The capacity of the system has started to fail to meet the increasingly high demands for water. Predictions are that the water scarcity will grow fast and that it will have severely negative economic and social consequences. The scarcity may lead to a confrontation between the different users competing for the resource.

There is no real prospect of increasing the supply as virtually all river water is being diverted to the two main users. However, the RBA recognizes that water is not used very efficiently and that users are very much set in their patterns of water use, based on a rather long history of sufficient supply.

The predicted state of affairs in the WRS in the coming twelve years under the current policies of the three institutions is reported in Appendix I. It forms the starting point of the Roleplay.

3 The Institutions

3.1 The River Basin Authority

- ***Responsibilities***

The River Basin Authority (RBA) is a government agency in charge of the management and planning of the water resources in the river basin. The RBA is directly responsible for the following aspects of the operation of the WRS:
- operation and maintenance of the reservoir and main distribution system
- setting and collection of water charges
- setting and collection of wastewater charges
- monitoring and control of the water quality
- determining water use priorities in case of shortages.

- ***Infrastructure***

The dam across the river and the main canal network were built forty years ago to provide drinking and irrigation water to the region, which had suffered from severe droughts. The main distribution system consists of three non-lined canals:
- Main Canal, which receives water from a weir and intake structure G1 built on the river just downstream from the dam. The distribution gate G2 divides the water over the two branch canals;
- Branch I supplies water to the Water Supply Utility (WSU),
- Branch II provides water to the Irrigation District (ID).

The present maintenance of the main and branch canals consists only of the repair and cleaning of those specific points, where there is a clear disruption of the water flow, such as breaks in banks and obstructions in the canal. The level of maintenance influences the conveyance efficiency of the main canal system. The present allocation for maintenance is given in Appendix I.

- ***Characteristics of Demands***

The RBA will release as much water from the reservoir as is demanded by the users, whenever possible. In case the demands cannot be fulfilled, then the RBA has the right to give priority to one of the two users, which is done by regulating gate G2.

The RBA is obliged to release a minimum amount of fresh water to the lake. The amount is set by the government as the minimum ecological flow. It takes precedence over the other two users.

The demand from the city consists of residential, industrial and municipal use. The demand in summer is higher than in winter. The current gross demand of the Water Supply Utility is given in Table 1, while more detailed figures are given in Appendix I.

The demand of the Irrigation District depends upon the cropping pattern and the efficiency of the distribution system. The best cropping season is the dry season and consequently irrigation is required. The irrigation season lasts about eight months. In the remaining four months, irrigation is normally not required. It is during these four months that the reservoir is filled up again. There are four main crops: rice, alfalfa, maize and wheat. Rice requires much more water than alfalfa and maize. Wheat again requires much less water than the latter two. The current gross demand of the Irrigation District is given in Table 1, while more detailed figures are given in Appendix I.

- ***Water Quality and Pollution Control***

The RBA is responsible for the monitoring and control of the quality of the water in the system, including river water, canal water and return flows. Simple chemical analyses are carried out. The pollution is expressed in contamination units (CU). The level of pollution of water flowing into the lake determines the income of the fisheries sector.

The amount of waste water from the city depends upon the total amount of water used and the efficiency of water use. The level of pollution depends upon the waste water treatment capacity installed by the WSU. The pollution from agriculture depends upon the type of crops grown and the level of new technology applied.

The city at present produces almost 5,000 CU per year, the agricultural area about 1,000 CU. As a consequence the lake receives some 15-25 CU/Mm^3, depending upon the time of the year. The fisheries sector considers a pollution of 6 CU/Mm^3 a minimum requirement. Reports indicate that in the city, the total contamination by the industry is about double the contamination caused by the residential users.

- ***Finances***

The RBA is financially autonomous in the sense that it has to generate its own funds for the operation and maintenance of the WRS. There are no regulations and restrictions on setting water and waste water charges and cross-subsidies between water users may occur. The RBA may also use its funds to influence the demand for water, such as subsidizing technologies that reduce water use.

Water and waste water charges are RBA's only source of income. It charges the WSU and ID for water delivered at their intake at the end of the branch canals. The rate may be different for each institution. It charges the WSU also for the amount of waste water. Water is charged at a flat rate per m^3. The waste water charges are presently set according to simple standards based on the population of the city.

In case the RBA runs into debts, then it will receive a Loan on which it has to pay interest. Current charges and income are given in Table 1 and Appendix I.

Table 1 - Some planning figures for the RBA, for current policies

Infrastructure, Canals	Unit	Main Canal	Branch I	Branch II
Length	Km	15	10	30
Capacity (when well maintained)	m^3/s Mm^3/period	120 600	30 150	90 450
Cost of lining	M$	35	25	50
Cost of widening the canals	M$/$Mm^3$/per.	0.80	0.30	0.40

Gross demand of institutions	Total in Year	For each two-monthly period of the year					
		I	II	III	IV	V	VI
Water Supply Utility							
Year 1 in Mm^3	340	55	65	65	55	50	50
Predicted, Year 12 in Mm^3	370	62	70	70	60	52	52
Irrigation District							
Year 1 in Mm^3	400	10	120	200	75	0	0
Predicted, Year 12 in Mm^3	450	10	130	225	85	0	0

Current Finances of RBA		
Price of water charged to Water Supply Utility	c/m^3$	2.00
Price of water charged to Irrigation District	c/m^3$	1.00
Price for wastewater discharge, to Water Supply Utility	$/habitant	0.50
Capital, current, year 1	M$	20
Accumulated Capital, predicted, year 12	M$	50

3.2 The Water Supply Utility

The main aspects are described qualitatively below. More detailed quantitative data are given in Table 2, Page 12 and in Appendix I, which gives a reports on the WSU and the current conditions in the water resources system.

- ***Responsibilities***

  The Water Supply Utility (WSU) is a private, financially autonomous company in charge of supplying the population and the industry with safe drinking water, without unduly affecting the environment. In order to achieve this goal, the company has the following specific responsibilities:
  - operation and maintenance of the city water supply system, including reservoirs, pumps, distribution network and treatment plants
  - expansion of the distribution network to new users
  - operation and maintenance of waste water treatment plants
  - setting and collection of charges for water supply and waste water treatment.

- ***Infrastructure***

  The WSU receives all its water from the RBA through Branch I of the Main Canal. The water is stored in a small reservoir, from which it is pumped to a treatment plant for filtration and chlorination. The clean water passes to a reservoir from which it is distributed to the users.

The distribution network was installed about 30 years ago and is presently in a not so good condition; a major part of the network consists of old pipes, which break and leak easily also because the water pressure in the main system is being increased to cope with the ever rising demands.

The operation of the system consists of requesting water from the RBA, storing, treating and providing as much water as the city demands. There are no pressure regulation devices: indeed the pressure in the system is monitored and adjusted manually, only during the normal working hours and days. The maintenance of the distribution system consists of the repair of the relatively easy to detect and trouble making leaks. More intensive maintenance or a possible rehabilitation of the distribution system were considered to be too disturbing for the citizens and not feasible for economic reasons. The current expenditures on operation and maintenance are given in Appendix I.

The WSU is also responsible for extending the water distribution network to those areas where the city is expanding, in order to maintain full coverage of the population. The costs for the expansion are given in Appendix I.

- ***Characteristics of Demand***

The WSU serves three main groups of water users, which are briefly described below while quantitative figures are given in Table 2 on the next page and in more detail in Appendix I:

1. Residential use. Water is distributed to all households and all connections are metered. The average household consists of five persons. The actual demand is influenced by a number of factors, such as the price of water, people's appreciation of the need to reduce the use of water and to pay for the real price of water. However, if the water becomes too expensive, people will increasingly refuse to pay.
2. Industry and commerce. The water supply is all metered. The actual demand is influenced by the same type of factors as for residential use. The annual benefit and growth of the industrial sector are affected by water shortages in the city.
3. Municipal use. Water is used for public buildings, parks, cleaning services, fire extinction etc. The water is metered, but currently provided free of charge.

The demand in the dry season is higher than the demand in the wet season. The reason is that during the dry season there is an increase of the discretional use of water due to activities like garden irrigation, recreation and car washing, which affects the residential and municipal water use. There is no large seasonal variation in the industrial and commercial use.

- ***Finances***

The WSU pays the RBA for water at a flat rate per m^3 and presently for waste water at a flat rate per habitant. The WSU does not operate any waste water plants at present. The current rates are given in Table 2. Other expenditures are the operation and maintenance of the distribution network, treatment of the fresh water and the yearly expansion of the system.

Water and waste water charges are the only source of income for the WSU. The charges are supposed to recover all the costs, including any planned investments. In case the WSU runs into debts, then it will receive a loan on which it has to pay interest.

Water is charged at a flat rate per m^3 and the rate is the same for any level of use. The rate may differ for each group of users: residential, industry and municipal. The municipality, being government, does presently not pay for the water. The waste water is charged at a fixed fee per connection, which again may be different for each user group.

Table 2 - Some planning figures for the WSU, for current policies

Demand City		Unit	Dry Season (year 1)	Wet Season (year 1)
Net Demand, estimated from meters:				
- domestic		l/capita/day	120	80
- industrial		m^3/conn./day	50	40
- municipal		m^3/conn./day	80	55
- domestic	(300,000 conn., Yr 1)	Mm^3/season	35	22
- industrial	(4,000 conn., Yr 1)	Mm^3/season	35	30
- municipal	(500 conn., Yr 1)	Mm^3/season	7	5
Net Demand City	actual Year1	Mm^3/season	80	55
	predicted Yr12	Mm^3/season	90	75
Gross Demand City	actual Year1	Mm^3/season	195	145
	predicted Yr12	Mm^3/season	225	160
Finances WSU				
Cost Full Rehabilitation		M$	150	
Cost Waste Water Treatment Plant		M$/$Mm^3$/year	0.5	
Current charge for water		c$/$m^3$	15	
Current charge for waste water		c$/connection	5.00	
Capital, current, year 1		M$	20	
Accumulated Capital, predicted, yr 12		M$	60	

3.3 The Irrigation District

The main aspects are described below. More detailed quantitative data are given in Table 3 and in Appendix I.

- ***Responsibilities***

The Irrigation District (ID) is an association of all the farmers in the region. They own the secondary and tertiary distribution system and enjoy financial autonomy.
They have the following responsibilities:
- to operate and maintain the distribution network and control structures;
- to select the cropping pattern;
- to invest in infrastructure and technology in order to use the water efficiently.

The farmers have to decide upon a cropping pattern and have to decide upon investments in the infrastructure, agricultural technologies and in the operation and maintenance of the irrigation system. When doing so, they will take strive:
- to maximize their net benefit;
- to diversify their risks;
- to rotate crops so as to avoid pests, diseases and soil degradation.

- ***Operation of Infrastructure***

The agricultural area covers a total of 24,000 ha and it is fully irrigated. The area is slowly expanding. The Irrigation District takes water from Branch II of the main canal, operated by the RBA. The irrigation system consists of non-lined canals with a total length of 30 km. The network

is provided with regulation and measurement devices. Water is distributed from the secondary canal to tertiary units.

The farming practices are based on tradition and experience. Only surface irrigation is currently applied. Although there is a rotational system of water distribution, deliveries take place both day and night. The price that farmers pay for the water does not constitute an important share of their total production costs and they do not have much reason to bother about how efficiently they use the irrigation water.

In case of water shortages, the farmers sometimes re-use some of their own drainage water or take water from the city drainage network. This water, however, is polluted, and will reduce the yields.

The efficiency of water use is expressed in the *distribution*, *managerial* and *application* efficiency, as follows:

- The distribution efficiency is a measure of the losses in the secondary canals, which are caused by technical reasons, such as leakage, seepage and capacity, but also by operational practices. The efficiency typically ranges from about 75 to 95 percent.
- The managerial efficiency is a measure of the management of the operational aspects of the distribution network. Factors that influence the efficiency are the size of the irrigation units, the scheduling of the irrigation supply, the level and means of controlling the flow of water. Typical effects of poor management are that farmers receive too much water, which they consequently drain off, or that water is delivered at the wrong place on the wrong moment, which also leads to spillage of water. The efficiency typically ranges from 50 to 80 percent.
- The on-farm application efficiency is a measure of the farming practices, such as the irrigation schedule and technology of distributing the water over the field. The maximum efficiency is also determined by the type of soil. The efficiency typically ranges from 50 to 80 percent.

The maintenance of the distribution system consists of cleaning of about one forth of the canal network every year, and the repair of those parts where the flow is disrupted.

- ***Crops and demand for water***

The climate of the region is characterized by two different seasons, with a cold wet season and a hot dry season. The rainfall is highest in the mild but short spring and autumn.

Four crops are grown in the area: wheat, alfalfa, maize and rice. Table 3 shows their specific cropping season and net estimated water requirement, calculated on the basis of the representative Penman-evaporation and a generally accepted crop coefficient. The Table also gives an estimate of the sensitivity of the crops to shortages of water. At present each crop covers 25 percent of the total area. Typical agronomic and financial data on the four crops are given in Table 3 and in more detail in Appendix I. The table shows that the most profitable crops also require more inputs: water, labor, fertilizers and pesticides. The latter two are also responsible for the pollution of the drainage effluent.

From experience, the Irrigation District has developed the following rules:

- one crop cannot occupy more than half of the total area;
- each crop must occupy at least 10 % of the cropped area.

- ***Finances***

The Irrigation District pays for the amount of water as delivered by the RBA at the rate set by the RBA. The District is not charged for using the drainage system, irrespective of the quantity or the quality of the water drained off. Other cost to the Irrigation District consist of operation and

maintenance of the distribution system and any investments to be made. The income of the District consists of an Irrigation Service Fee charged to the farmers. The District does do not have any initial capital to make investments, but banks are willing to provide a loan, on which an interest has to be paid.

The sale of the agricultural product is the source of income for the farmers. They have to bear the agricultural production cost for labor, machinery, fertilizers and chemicals. In addition, they have to pay the irrigation service fee to the Irrigation District. The service fee is allocated to the different crop pro rata their water use and the area cropped.

An overview of the current level of costs, value of production and net income is given in Table 3 on the following page and in Appendix I.

Table 3 - Some planning figures for the Irrigation District, for current policies

Water Requirements						
Irrigation Season	Period I Month 1-2	Period II Month 3-4	Period III Month 5-6	Period IV Month 7-8	Period V Month 9-10	Period VI Month 11-12
- Rice (m^3/ha)	0	2250	4000	1700	0	0
- Alfalfa (m^3/ha)	200	1350	2450	1150	0	0
- Maize (m^3/ha)	0	750	3050	750	0	0
- Wheat (m^3/ha)	200	1100	0	0	0	0
Estimated Net Irrigation Water Requirement (m^3/ha/yr)			Rice 8,000	Alfalfa 5,100	Maize 4,600	Wheat 1,300
Sensitivity to water shortages Sensitivity to water quality			med-high low-med	high low-med	med-high low-med	low-med medium

Finances of Production	Unit	Rice	Alfalfa	Maize	Wheat
- Potential Gross Value Crops	$/ha	1,740	2,100	1,540	990
- Agricultural Cost	$/ha	600	1,100	800	470
- Irrigation Service Fee	$/ha	210	210	210	210
- Potential Net Value	$/ha	930	790	530	310
- Market Price	$/ton	260	105	192	157

Finances	Unit	Year 1	Year 12, predicted
Farmers, Net Income	M$	- 4.5	- 9.5
Irrigation District, Net Income	M$	+ 0.7	+ 1.2
Cost of Investments			
- Cost Lining Irrigation Canals	M$	20	
- Cost Small Reservoirs	M$	25	
- Irrigation Service Fee	M$	5	
- Re-use City drainage	M$	10	
- Re-use Agricultural Drainage	M$	10	

3.4 The Lake

The lake is fed mainly by water from the river. The government has set a minimum ecological flow to be released from the reservoir continuously. The drainage canals of the agricultural area and the city discharge into the river upstream from the lake. The proportion of the drainage discharge and the level of pollution of that water determine the quality of the water in the lake. The quality is expressed in Contamination Units. The present inflow contains some 15-25 CU/Mm^3, while a level of 5-7 CU/Mm^3 is considered desirable. The River Basin Authority is ultimately responsible for the quantity and quality of the water flowing into the lake.

The prosperity of the important fisheries sector is strongly related to the water quality. The present and predicted performance of the sector is given in Appendix I in the reports of the RBA.

3.5 The Industry

The annual growth of the industry and the net revenue of the industry both depend upon the degree of the water shortages. The present and predicted performance is given in Appendix I in the reports of the RBA.

Appendix I

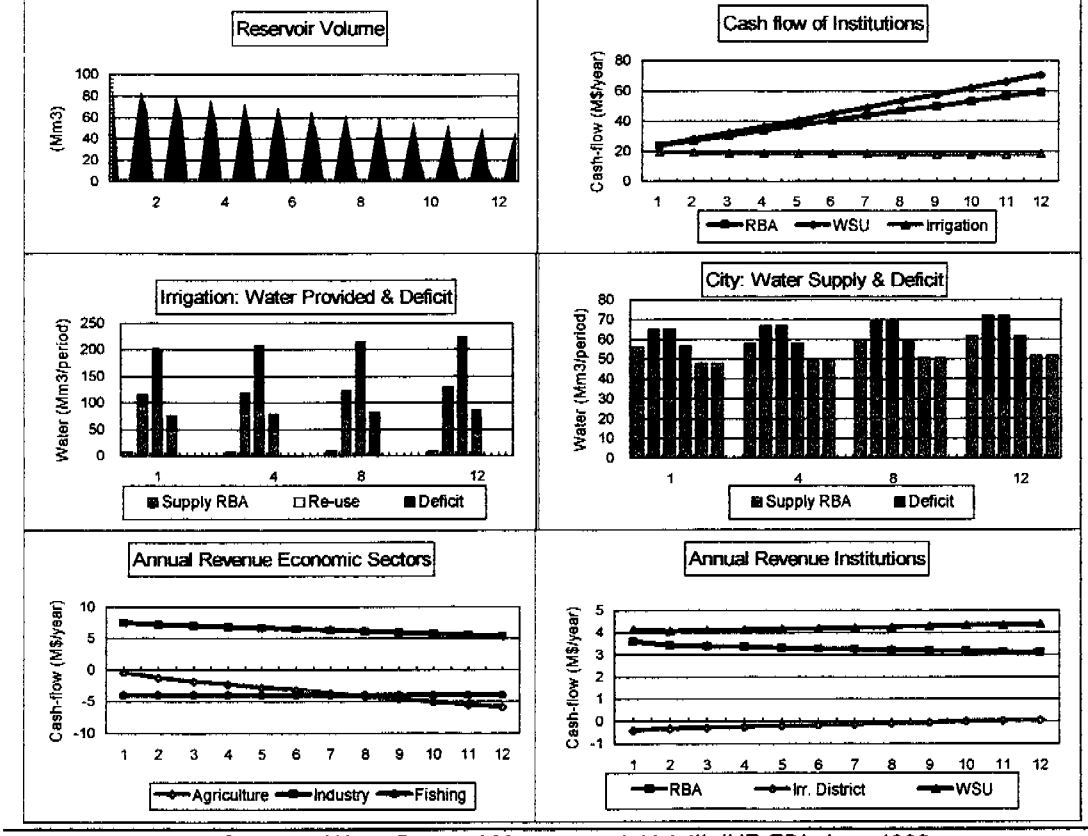
Reports on Current Situtation
&
Predicted Conditions in Year 12
under Current Policies

Summary
River Basin Authority
Water Supply Utility
Irrigation District

Water Resources System Performance Report
Case: Current 11:31 15-Jun-01

		Calculated Strategy		Other Strategies				
		Current		Current Policies		Current Policies		Current
		Year 12	Av.	Year 12	Av.	Year 12	Av.	Total 1-12
Volume Diverted from River at G1	Mm3	700	743	700	743	700	743	8,918
Volume Supplied to WSU + ID	Mm3	448	476	448	476	448	476	5,707
Gross Demand by WSU + ID	Mm3	820	780	820	780	820	780	9,363
Net Demand Users of WSU + ID	Mm3	279	265	279	265	279	265	3,186
Losses in system of RBA	% of supply	36	36	36	36	36	36	44
Losses in system of WSU	% of supply	61	61	61	61	61	61	61
Losses in system of ID	% of supply	70	70	70	70	70	70	70
Losses in WRS as a whole	% of supply	60	64	60	64	60	64	65
Expenditures on WRS by RBA	M$		5		5		5	60
Expenditures on WRS by WSU	M$		15		14		14	175
Expenditures on WRS by ID	M$		5		5		5	62
Total Expenditures on WRS	M$		25		25		25	297
ayments for water + waste to WSU	M$	19	19	19	19	19	19	226
Payments for water to ID	M$	5	5	5	5	5	5	60
ayments for water + waste to RBA	M$	8	8	8	8	8	8	99
Revenues Industry	M$	5	6	5	6	5	6	76
Revenues Agriculture	M$	-6	-3	-6	-3	-6	-3	-41
Revenues Fisheries	M$	-4	-4	-4	-4	-4	-4	-48
Total Revenues Economy	M$	-5	-0	-5	-0	-5	-0	-1

Case: Current 11:31 15-Jun-01



River Basin Authority Report, Page 1
Case: Current 15/06/01

	Unit	Year 1		Year 4	Year 8	Year 12		Total 1-12
DEMAND and SUPPLY								
Gross Demand WSU + Irrigation	Mm3/yr	741		762	791	820		9,363
Supplied to WSU + Irrigation	Mm3/yr	511		487	467	448		5,707
Supply / Demand	%	69		64	59	55		61
Water Supply to Lake	Mm3/yr	30		30	30	30		360
Actual Release from Reservoir	Mm3/yr	829		791	760	730		9,278
Required Release from Reservoi	Mm3/yr	1158		1191	1236	1281		14,990
POLLUTION								
Contamination from WSU	CU	4795		4868	4929	4965		58,780
Contamination from Irrigation	CU	1231		1268	1320	1373		15,611
Average Contamination into Lake	CU/Mm3	17		18	19	20		
FINANCES								
Total Expenses	M$/yr	5.0		5.0	5.0	5.0		60
Total Revenues	M$/yr	8.6		8.3	8.2	8.1		99
Net Income	M$/yr	3.6		3.3	3.2	3.1		39
Accumulated Capital	M$	23.6		33.7	46.8	59.3		
ECONOMIC SECTORS								
Net Income Agriculture	M$/yr	-0.4		-2.3	-4.2	-5.9		-41
Net Income Industry	M$/yr	7.4		6.8	6.1	5.3		76
Net Income Fisheries	M$/yr	-4.0		-4.0	-4.0	-4.0		-48
Total Net Income	M$/yr	3.1		0.5	-2.1	-4.6		-13

CAPACITY CANALS		Main Canal	Branch I	Branch II
Year 1, Peak Demand	Mm3/per.	417	81	252
Year 12, Peak Demand	Mm3/per.	464	90	281
Year 12, Capacity	Mm3/per.	533	133	356

	Unit	Year 1		Year 4	Year 8	Year 12		Total 1-12
Water Demand WSU	Mm3/yr	338		348	359	371		4,257
Water Supplied WSU	Mm3/yr	269		263	259	255		3,127
Water Demand Irrigation	Mm3/yr	403		415	432	449		5,106
Water Supplied Irrigation	Mm3/yr	242		224	208	193		2,580

	Unit	Year 1		Year 4	Year 8	Year 12		Total 1-12
EXPENSES								
Investments last 4 years	M$	0.0		0.0	0.0	0.0		0
Operation & Maintenance	M$/yr	5.0		5.0	5.0	5.0		60
Grants Technology	M$	0.0		0.0	0.0	0.0		0
Subsidies Crops	M$/yr	0.0		0.0	0.0	0.0		0
Irrigation Assistance Service	M$/yr	0.0		0.0	0.0	0.0		0
Mass Media	M$/yr	0.0		0.0	0.0	0.0		0
Interest on Debts	M$/yr	0.0		0.0	0.0	0.0		0
REVENUES								
Unit price water for Irrigation	c$/m3	1.00		1.00	1.00	1.00		
Unit price water for WSU	c$/m3	2.00		2.00	2.00	2.00		
Water Bills	M$/yr	7.8		7.5	7.3	7.0		88
Waste Water Fees	M$/yr	0.8		0.8	1.0	1.1		11

Irrigation District and Farmers Report, Page 1
Case: Current 15/06/01

	Unit	Year 1		Year 4	Year 8	Year 12		Total 1-12
DEMAND and SUPPLY								
Net irrigation Demand Crops	Mm3	120		123	128	133		1,516
Gross Demand from RBA	Mm3	403		415	432	449		5,106
Supplied by RBA	Mm3	242		224	208	193		2,580
Re-use of Drainage Water	Mm3	0		0	0	0		0
Irrigation Supplied to Crops	Mm3	72		67	62	57		766
YIELD								
Actual / Potential for Wheat	%	93		89	85	82		
Actual / Potential for Alfalfa	%	45		39	34	29		
Actual / Potential for Maize	%	49		45	41	38		
Actual / Potential for Rice	%	54		50	46	42		
FINANCES								
FARMERS, Net Income	M$/yr	-0.4		-2.3	-4.2	-5.9		-41
Accumulated Income Farmers	M$/yr	-0.4		-5.9	-19.8	-40.9		
Revenues Farmers	M$/yr	23.4		22.0	20.9	20.0		257
Expenses Farmers	M$/yr	23.7		24.3	25.1	25.9		298
IRR. DISTRICT, Net Income	M$/yr	-0.4		-0.2	-0.1	0.1		-2
Accumulated Capital Irr. District	M$	19.6		18.7	18.2	18.2		
Revenues Irrigation District	M$/yr	5.0		5.0	5.0	5.0		60
Expenses Irrigation District	M$/yr	5.4		5.2	5.1	4.9		62

AGRONOMIC DATA	Unit	Year 1		Year 4	Year 8	Year 12		Total 1-12
Area cropped, Wheat	Ha	6,313		6,504	6,768	7,043		
Area cropped, Alfalfa	Ha	6,313		6,504	6,768	7,043		
Area cropped, Maize	Ha	6,313		6,504	6,768	7,043		
Area cropped, Rice	Ha	6,313		6,504	6,768	7,043		
Yield, average for Wheat	ton/ha	5.9		5.6	5.4	5.1		
Yield, average for Alfalfa	ton/ha	9.0		7.8	6.7	5.9		
Yield, average for Maize	ton/ha	3.9		3.6	3.3	3.0		
Yield, average for Rice	ton/ha	3.6		3.3	3.1	2.8		
Production Wheat	kton	37		36	36	36		436
Production Alfalfa	kton	57		51	46	41		574
Production Maize	kton	25		23	22	21		272
Production Rice	kton	23		22	21	20		253

REVENUES FARMERS	Unit	Year 1		Year 4	Year 8	Year 12		Total 1-12
Market Value Wheat	M$/yr	5.8		5.7	5.7	5.7		68
Market Value Alfalfa	M$/yr	5.9		5.3	4.8	4.3		60
Market Value Maize	M$/yr	4.7		4.5	4.2	4.1		52
Market Value Rice	M$/yr	6.9		6.5	6.2	5.9		76
Subsidies on Crops	M$/yr	0.0		0.0	0.0	0.0		0
EXPENSES IRRIGATION DISTR.								
Water bill paid to RBA	M$/yr	2.4		2.2	2.1	1.9		26
Investments last 4 years	M$	0.0		0.0	0.0	0.0		0
Operation & Maintenance	M$/yr	3.0		3.0	3.0	3.0		36
Total Water Related Cost	M$/yr	5.4		5.2	5.1	4.9		62
Interest on Debts	M$/yr	0.0		0.0	0.0	0.0		0
EXPENSES FARMERS								
Production Cost Wheat	M$/yr	3.0		3.1	3.2	3.3		38
Production Cost Alfalfa	M$/yr	6.9		7.2	7.4	7.7		88
Production Cost Maize	M$/yr	5.1		5.2	5.4	5.6		64
Production Cost Rice	M$/yr	3.8		3.9	4.1	4.2		48
Total PRODUCTION Cost	M$/yr	18.7		19.3	20.1	20.9		238
Irrigation SERVICE FEE	M$/yr	5.0		5.0	5.0	5.0		60
Employment	Manyears	29,984		30,284	30,893	31,514		380,277

Water Supply Utility Report, Page 1
Case: Current 15/06/01

	Unit	Year 1		Year 4	Year 8	Year 12		Total 1-12
Population	no.	1,545,000		1,688,263	1,900,155	2,138,641		
Number of Industries	no.	4,000		3,913	3,724	3,470		
WATER DEMAND and SUPPLY								
Estimated Net Demand Users	Mm3/yr	133		136	141	145		1,669
Gross Demand from RBA	Mm3/yr	338		348	359	371		4,257
Supplied by RBA to WSU	Mm3/yr	269		263	259	255		3,127
Supplied by WSU to Users	Mm3/yr	106		103	102	100		1,227
FINANCES								
Net Benefit on Water	M$/yr	0.7		0.5	0.2	(0.0)		4
Net Benefit on Waste Water	M$/yr	3.4		3.7	4.0	4.4		47
Annual Benefit, WSU	M$/yr	4.1		4.1	4.3	4.4		51
Accumulated Capital	M$	24.1		36.4	53.3	70.6		
ESTIMATED NET DEMAND	Unit	Year 1		Year 4	Year 8	Year 12		Total 1-12
Residential	Mm3/yr	56		61	68	77		789
Industrial	Mm3/yr	65		63	60	56		734
Municipal	Mm3/yr	12		12	12	12		146
TREATMENT WASTEWATER								
Waste water treated	Mm3	0		0	0	0		0
Waste water not treated	Mm3	202		197	194	191		2,345
FINANCES WSU - WATER								
Investments last 4 years	M$	0.0		0.0	0.0	0.0		0
Water bill paid to RBA	M$/yr	5.4		5.3	5.2	5.1		63
Operation & Maintenance	M$/yr	4.2		4.2	4.2	4.2		50
Expansion system	M$/yr	1.4		1.5	1.7	1.9		20
Treatment of water	M$/yr	2.7		2.6	2.6	2.5		31
Total Expenses, Water	M$/yr	13.7		13.6	13.7	13.8		164
Total Revenues, Water	M$/yr	14.4		14.1	13.9	13.7		168
FINANCES - WASTE WATER								
Investments last 4 years	M$	0.0		0.0	0.0	0.0		0
Charges waste water by RBA	M$/yr	0.8		0.8	1.0	1.1		11
Waste water treatment	M$/yr	0.0		0.0	0.0	0.0		0
Total Expenses, Waste Water	M$/yr	0.8		0.8	1.0	1.1		11
Total Revenues, Waste Water	M$/yr	4.2		4.5	5.0	5.5		58
Interest on Debts	M$/yr	0.0		0.0	0.0	0.0		0
INDUSTRY, NET BENEFIT	M$/yr	7.4		6.8	6.1	5.3		76
WILLINGNESS TO PAY:								
- Households, water bill	%	100		100	100	100		
- Industries, water bill	%	100		100	100	100		
- Municipality, water bill	%	100		100	100	100		
- Users, waste water fee	%	100		100	100	100		

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