AGRICULTURE RECONSTRUCTION AND DEVELOPMENT PROGRAM FOR IRAQ

STRATEGY FOR WATER AND LAND RESOURCES IN IRAQ
Inception Report

December 2005

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1 Introduction

1.1 Background/Project Preparation

A planning document for Iraq was prepared between 1972 and 1982 by Iraq's Ministry of Irrigation and the USSR institution Selkhozpromexport. This planning document covered water, salt and soil management, agriculture and irrigation, fisheries, water supply, hydropower, flood control, erosion control, and navigation. Thorough data collection, mathematical modelling, and evaluation of various scenarios led to a detailed proposal for action over the twenty-year period to 2000. This proposal, called the 'General Scheme Second Stage,' has guided much Iraq's policies and actions since then.

The planning horizon covered by the General Scheme Second Stage has passed, and due to significantly changed external circumstances, Iraq's Ministry of Water Resources (MoWR) has recognized the need for a new effort to create an updated integrated strategy plan for developing and managing Iraq's water resources. In 2003 the MoWR requested that the US Army Corps of Engineers (USACE) prepare a concept proposal. The resulting document, 'Strategic vision for management of Iraq's water resources – a concept proposal,' proposed a two-phase approach to the task, with Phase 1 lasting up to 18 months and Phase 2 taking four or five years.

The concept was further developed early in 2005, culminating in a scope of work that was presented at a meeting held in Amman from 7-9 June 2005, attended by the Agricultural Reconstruction and Development Program for Iraq (ARDI), the MoWR, and a number of other Ministries involved in the process. These ministries include the Ministries of Agriculture, Electricity, Transportation, Environment, Municipalities and Public Works, and the Ministries of Agriculture and Irrigation in Erbil and Sulaymaniyah (now the Ministry of Agriculture and Ministry of Irrigation of the Kurdish Regional Government).

During this initial meeting, the parties agreed to collaborate to develop a Strategy for Water and Land Resources in Iraq (SWLRI), in two phases. Phase 1, a 14-month long effort that began in June 2005, is a collaboration between ARDI and the participating Ministries, with extensive MoWR oversight. Phase 2 will be led mainly by the MoWR. Phase 1 is being funded as part of the ongoing USAID-funded ARDI program.

The overall long term objective of the strategic planning effort is to provide a sound and comprehensive basis for the management and development of Iraq's water and land resources over the next few decades, together with a framework and methodology for ongoing updates to the planning process.

1.2 Proposed Approach to Strategic Planning

The project aims to introduce modern concepts to the planning process, stressing the process rather than a fixed output such as the exhaustive 1982 General Scheme. If it is to be successful, the SWLRI must be 'owned' by the major Iraqi stakeholders. Therefore, a key objective of Phase 1 is to build agreement among the principal stakeholders on what form the Strategy should take. ARDI has proposed a planning model based on iterative review to develop a flexible approach that monitors and develops a rolling program of short, medium and long-term activities within a clear

strategic framework. There is also a need to provide Iraqi policymakers with a clear exposition of the alternatives in a way that is readily usable for decision making, whether for long-term national planning for development or for short-term or local-level planning.

Figure 1.1: SWLRI Planning Approach

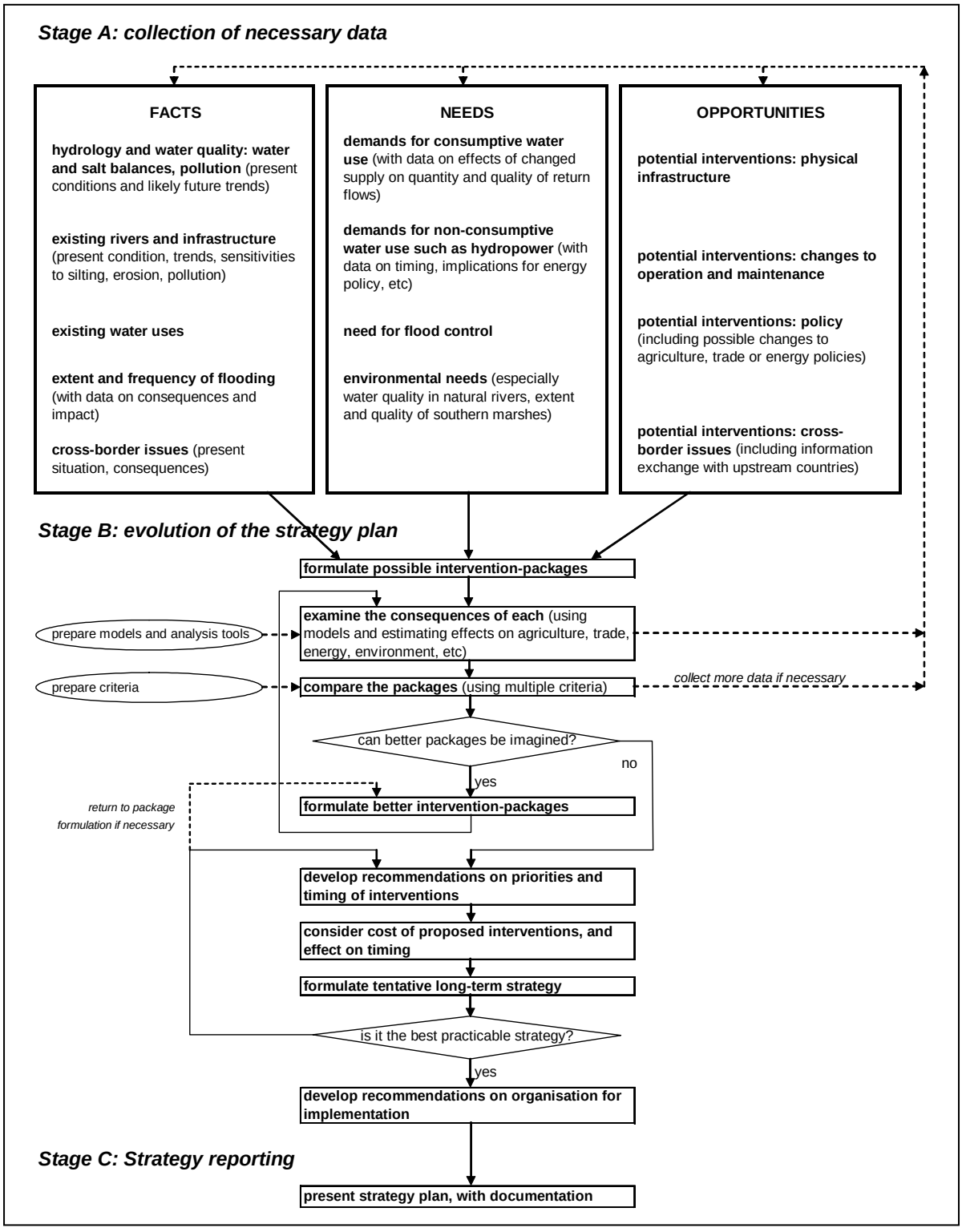


Figure 1.1 presents a diagrammatic representation of the proposed overall approach to the development of the SWLRI, both in Phase 1 and after Phase 1 is completed. The approach has the following features:

1. It emphasizes a distinction between facts and needs: facts about the present state of Iraq's water resources and its physical infrastructure (both natural channels and man-made infrastructure), as well as needs and desires for water use, flood control and environmental conditions.

2. It emphasizes, alongside facts and needs, a third data set concerning opportunities for the future; these include not only potential physical interventions like completing the Bekhme Dam, but also policy changes like a shift to cultivating different crops on irrigated land, a changed way of using hydropower stations within the national energy sector, or a different way of interacting with upstream countries.

3. It emphasizes interventions (as defined in point 2 above) and packages of interventions as units of the planning process.

4. It emphasizes the iterative nature of the evolution of a strategy plan.

It is envisaged that the three data sets, having been put together during Phase 1, will become permanent features of the ongoing planning process; they will be updated continually and will form the basis of revisions of the SWLRI. Figure 1.1 includes, as part of the 'facts' data set, possible or likely future trends in hydrology and water quality; this will include any estimated effects of climate change, as well as such external factors as developments in upstream countries.

The diagram divides the planning work into three functional stages and also emphasizes the iterative nature of the planning process. Stage B begins with the formulation of possible packages of interventions, using the set of opportunities prepared in Stage A, and also the preparation of models, analytical tools and comparison criteria, which will include not only technical but also social, economic and environmental considerations, and will be used to examine the consequences of each hypothetical package of interventions (which may be quite complex because of the nature of Iraq's interconnected rivers, canals, reservoirs and groundwater) and to compare them. The next step will be to consider whether at least some of the packages are useful and well-packaged, and if it is appropriate to revisit the formulation step and develop new packages. This step will be followed by a repeat of the examination and comparison steps. During this iterative process it may prove necessary to go back and seek additional data.

Acceptable packages will proceed to the stage of strategy formulation, which is in effect a prioritized set of intervention-packages, and this again is iterative. The formulation will make use of the earlier analyses of individual intervention-packages, and repeat them if necessary to refine the strategy. Costs will be considered to ensure that the timing of interventions is balanced from year to year to match the available or probable human and financial resources.

Phase 1 will focus on Stage A and make a start on Stage B, particularly the preparation of models and other tools. By providing worked examples of the processes illustrated in

Figure 1.1, ARDI will help the MoWR staff to build their capacity to take the process forward – and develop the national strategy in later phases.

1.3 Project Organization

For the 14-month Phase 1 period, the focus of the project is on preparing the base data on which the strategic planning will be based. The project is being funded by USAID as part of the ARDI program. ARDI is managed by DAI, and the SWLRI project includes subcontractors Mott MacDonald (MM) and USACE's Hydrologic Engineering Center (HEC).

The intention is to support the MoWR as the agency with primary responsibility for water and land resources planning. This includes assisting with the establishment of a new SWLRI unit at the MoWR, delivering data sets, handing over models and other tools, and providing capacity building in modern techniques for planning. A Steering Committee has been formed to guide the Phase 1 data collection process. This committee, led by the MoWR, is comprised of representatives of ministries that are participating in the planning effort, including Ministries of Agriculture, Electricity, Transportation, Environment, Municipalities and Public Works, and the Ministries of Agriculture and Irrigation in Erbil and Sulaymaniyah (now the Ministry of Agriculture and Ministry of Irrigation of the Kurdish Regional Government).

The project organization for Phase 1 is multi-site based. Liaison with MoWR and the Steering Committee will generally take place in Iraq, using DAI's and MM's offices in Baghdad, Erbil and Basrah. Project management, and most of the analytical and report-writing work, is being done in MM's offices in the UK, with most of the hydrologic and hydraulic modelling, and related data handling, being done at the HEC in Davis, California. Data collection has naturally been done almost entirely in Iraq.

Staff responsibilities are shown in Figure 1.2.

Figure 1.2: Team Responsibilities

Staff Responsibility Matrix

Key

- ◆ Lead role for this activity
- ● Primary role
- ❍ Secondary role
- ✣ Watching brief / review

Nomination	Firm	Position	Project direction	Project Management / liaison	Water resources planing	Irrigation & Drainage Engineering	I&D / Agronomy	I&D management / WUAs	Water supply & sanitation engineering	Water supply & sanitation planning	Hydropower / energy sector planning	Economics	Planning / prioritisation	Groundwater development / planning	Hydrology	Reservoir and operation studies	Flood risk management	Water Quality	Water quality modelling	River hydraulics / nvigation	Watershed management / sediment expert	Environmental (ecological) requirements	Institutional strengthening	Capacity building / training	GIS / database	Management information systems	IT support	Data gathering / data management
A Y Stuck	MM	Project Manager / water resources planner		◆	◆	✣	✣	✣	✣	❍	✣	✣	●	❍	◆	❍	◆	◆	❍	❍	✣	❍	●	❍	❍	❍	✣	✣
M Snell	MM	Multipurpose planning advisor			●					❍	❍	◆						❍										
TBD Economist	MM	Economist			❍		❍	❍			◆	●																
C R C Jones	MM	Hydrogeologist / water resources planner			●	❍			❍	❍			◆					●	❍			❍						
TBD Hydropower	MM	Energy sector planner / hydropower			❍						◆	❍																
Peter Hunt	MM	Water supply & sanitation engineer		●					◆			❍	❍					●				❍						
A Keiller	MM	Water supply planning								◆			❍					❍										
A Paskins	MM	Water quality / pollution control							❍	❍	❍		❍					◆										
K Guganesharajah	MM	Hydraulics and Water quality expert																	◆	◆	❍							
M Johnston	MM	Environmentalist			❍													●				◆						
A Kirby	MM	Irrigation & drainage engineer				◆					❍	❍																
J F Pavey	MM	Water resources planner			●	❍	❍	❍			❍	●													❍			
A Badcock	MM	Hydrologist / surface water modeller														●		●	●									
A Sheekey	MM	GIS / database management specialist																							◆			
G Turley	MM	Project Direction (MM Iraq)	✣																									
M D Haigh	MM	Project Direction	◆																									
TBD Watershed	MM	Watershed management																		◆								
Nisrin	MM	TBD																										
Louay	MM	GIS																							●			
F Hanbali	HEC	Surface water modeller			❍									●	●	●									●			
M McPherson	HEC	Surface water modeller																										
D Davis/ Dunn	HEC	Surface water modeller		❍	❍										◆				❍									
J Gleason	DAI	ARDI Project Chief of Party	✣																			✣	✣					
O Kendrick	DAI	Project Direction (DAI Iraq)	✣																									
J Sevilla	DAI	Irrigation & drainage management specialist		●	❍	●	◆	◆										●			●		●	✣	❍			
E Stains	DAI	Project Direction / water resources planner	◆	●	●	❍						●								●			●	❍				
Ali Farhan	DAI	Liaison with MoWR strategic planning unit		◆	●								❍					●			●	◆	❍	❍				◆
Paiman	DAI	Capacity Building / Training Organiser		❍																			◆					
TBD IT	DAI	IT support																							●		◆	
B Bouvier	DAI	GIS / database management specialist																							●	❍		
N Waita	DAI	MIS specialist / TAMIS																								◆		
Pool of Iraqi staff (numbers and skills will vary as needed)																												
Iraqi Collection	DAI/MM	Data collection																										●
Iraqi Processing	DAI/MM	Data processing																							❍			●
Iraqi Drawing	DAI/MM	Drawing and report production																							❍			●
Iraqi Translation	DAI/MM	Translation		●																								❍
Iraqi Support	DAI/MM	Administrative support		●																								❍
Pool of Expertise to be called upon as necessary																												
TBD Water Law	DAI	International water law			●																							
TBD Agronomist	MM	Agronomist					●																					
S E Murphy	MM	Economist									●																	
H A Morrison	MM	Irrigation & Drainage				●																			❍			
P F Ede	MM	Hydrology/surface water resource systems			❍				❍		❍				●	●	❍											
Pool of Junior technical staff to be called upon as necessary																												
U Feistel	MM	Hydrology / water resources modeller													●	●	●											
J Prytherch	MM	Engineer				●																						
C Wilson	MM	Geology / hydrogeology											●															
P LeGouais	MM	Environmental scientist																			●							

2 Project Facilities and Systems

2.1 SWLRI Unit Office within the MoWR

2.1.1 Facilities

In collaboration with ARDI, the MoWR has established a SWLRI Unit. The unit is a part of the Hydrology Studies Center, which is attached to the General Directorate of Water Resources located in Baghdad. Other key branches of the MoWR, such as the GIS and Remote Sensing Center, are based at the same location. Four caravans, with a total area of 130 m^2, have been provided for the new unit and the office is being fully furnished and equipped with the necessary IT facilities.

2.1.2 Staffing

During Phase 1, the SWLRI Unit will be supported by ARDI staff to help to build capacity among the MoWR staff who were transferred to the unit from other branches of the Ministry. ARDI will fund four positions in the SWLRI Unit: a part-time water resources planner; two engineers; and one IT support position.

The SWLRI Unit will be comprised of the following staff from the MoWR: Two Senior Chief Engineers; one Expert Agronomist; two Irrigation Engineers; and two IT Engineers.

2.2 Web-based Project Collaboration

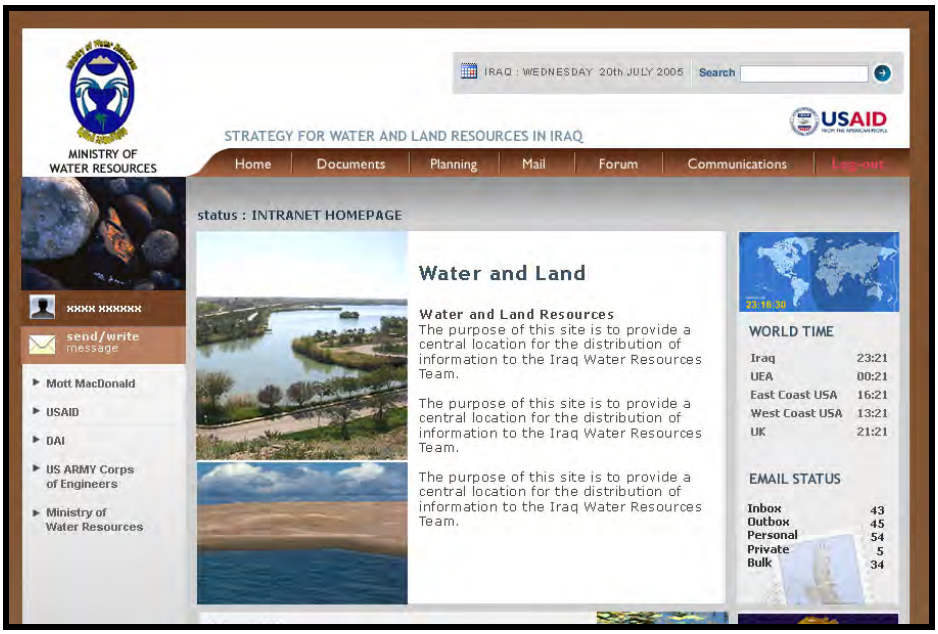
The project data management system had to be tailored to deal with the complex administrative arrangements necessitated by the multi-site organization of the project team:

- Team members and stakeholders spread over many locations (USA, UK, northern Iraq, Baghdad, and Basrah);
- Data collection within several ministries, supported by ARDI;
- Quality control checking of data by the MoWR and ARDI;
- Repository of data for the project (the ‘database’) to be managed by ARDI throughout Phase 1, but to be handed over for long term management by the MoWR;
- Data is expected to go through many revisions before an ‘approved’ data set is achieved, so a full audit trail is necessary;
- Security of the data is a very important issue, particularly until such time as formal data sharing protocols can be established between the various ministries.

After an extensive product evaluation, a web-based collaboration system, Claromentis, was selected as the project data repository and email system. To encourage participation and eventual data sharing, Claromentis has been designed to give each ministry a secure, customized extranet area. In this extranet, each ministry is able to manage its own data (Figure 2.1).

The web-based collaboration system is a tool for helping to build strong links between the stakeholders and to provide opportunities for other ministries to benefit from the project's activities. The Claromentis system will enable the SWLRI Unit to maintain a shared library of reference material, links to other web sites, topographic maps and satellite imagery.

Figure 2.1: An Example Ministry Extranet



Note: This is an early screen shot before development of the site was completed.

The Claromentis discussion forum facility provides a way for stakeholders and experts to contribute to technical discussions regardless of where they are based. The discussion forums will provide an important avenue for direct participation by stakeholders, thus raising the profile of the SWLRI Unit and its work.

Documents are controlled by a rights management system and use a check-in and check-out system to avoid overwriting changes. Revision histories and roll-back are fully available. This allows a full audit trail of changes made to data files, which will be particularly useful during the quality control checking stage before any data is accepted.

A Data Security Report has been issued describing the Claromentis system in detail. In addition, two training sessions have been held with ARDI staff and staff of the participating ministries.

3 Data Collection and Review

3.1 Data Requirements

There are several types of information that must be compiled to provide the basis for strategic planning of water and land resources:

1. **Inventories** that list and map the locations of physical infrastructure (dams, boreholes, canals, drains, pumping stations, etc.) and monitoring points. The inventories should be 'live' and reflect the number and status of facilities in Iraq as they are now, and in some cases as they were in the past.

2. **Time series records** of river, canal and drain flows; water quality; population details; agricultural production statistics, etc. These should be regularly updated at a frequency to suit each type of data.

3. **Areal features** of the natural environment and anthropogenic activities (soil type, forestry, land classification, population distribution, cropping patterns, urban areas, seasonal flooding, salinization, etc.). When linked to remote sensing and to GIS, areal information can be obtained and presented in many ways that contribute to the strategic planning process.

4. The **planning framework**: details of national aspirations as expressed in government policies and legislation that provide the context for strategic planning for the water and agriculture sectors. This includes the policies and plans for other sectors (energy, health, trade etc.) that are linked directly or indirectly to the water and agriculture sectors. The water sector cannot be considered in isolation, and up-to-date information on the activities in other sectors will be needed.

5. **External pressures**, including economic status and relations, migration, international relations, climate change, international commodity prices, etc.

The following sections discuss the requirements in relation to the three data sets referred to in Figure 1.1: facts, needs, and opportunities.

3.1.1 The 'Facts' Data Sets

All the data types and examples listed above are associated with the 'facts' data. The General Scheme reports provided guidance as to which data should be collected in order to support the planning process. ARDI prepared a preliminary list of the required data to describe the baseline situation in terms of natural and man made elements. This list is reproduced in Appendix A. In addition, the ministries were asked to update various tables from the General Scheme – this particularly applied to agricultural data. Throughout, the need for geo-referenced data was emphasized so that the maximum use can be made of GIS and mapping tools.

3.1.2 Data on Needs

Needs data are more likely to be synthesized than measured, so compilation of this data set is more a matter of analysis of other data than the collection of actual records. Consumptive water uses (for agriculture, industry, or potable water) are not generally monitored with sufficient frequency or accuracy to make the data very practical for planning studies. In particular, records, where available, are usually for bulk abstraction and can be very difficult or impossible to disaggregate. Therefore, the needs data are typically built up using standard procedures and aggregated to give the estimated bulk demand. This process calls for other data from the 'facts' category. For example, in order to estimate irrigation water requirements for a whole scheme it is necessary to know what crops are being or are to be grown and over what area, the planting and harvesting dates, design meteorological conditions, land preparation requirements, and irrigation efficiency allowances, etc. If the estimate is for a future planning horizon, then the cropping pattern, the land preparation requirements and the irrigation efficiency could all be different depending on government policies and projected changes in the socio-economic situation.

Non-consumptive water use in hydropower generation is more likely to be monitored, but even here estimates may have to be built up from water levels and turbine characteristics.

Clearly, many of the needs are determined by policies and policy choices of the type that the SWLRI is seeking to inform. For example, the energy sector's need for water depends on the importance given to developing hydropower and on the need for cooling water for thermal stations.

Environmental requirements have only recently become a significant issue in strategic planning. In the case of the Southern Marshlands, major studies are underway in order to estimate the water level, quantity and quality regime that might be required to restore parts of the area. Information in this case will be collected from the ongoing Marshland studies (funded by UNEP, the Italian Government and USAID).

3.1.3 Information on Opportunities

Opportunities represent possible actions or interventions for the MoWR and other ministries to budget and program for, and to implement in the short, medium or long term horizons. They represent potential items in the national budget in the near and longer term, and as such need to be prioritized for the water and agriculture sectors as a whole. Opportunities cover an exceedingly wide range of possibilities, from new studies to actual construction, and from policy change to capacity building and training, etc.

It has been agreed to use a main planning horizon of 30 years, with greater detail for the next five years and some strategic consideration of the longer outlook beyond 30 years. The planning process is designed to be periodically updated in a rolling manner, for instance every three to five years.

Figure 3.1: Availability of Hydrometric Data

				1910 - 1919	1920 - 1929	1930 - 1939	1940 - 1949	1950 - 1959	1960 - 1969	1970 - 1979	1980 - 1989	1990 - 1999	2000 - 2004
				0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4
	EUPHRATES	HUSAYBA	monthly										
	EUPHRATES	HUSAYBA	daily										
	EUPHRATES	HADTIHA OUTFLOW	monthly										
	EUPHRATES	HADTIHA OUTFLOW	daily								x		x
	EUPHRATES	HADTIHA COMPUTED INFLOW	monthly										
	EUPHRATES	HADTIHA COMPUTED INFLOW	daily								x		x
	EUPHRATES	HIT	monthly		x								
	EUPHRATES	HIT	daily									x	
	EUPHRATES	DOWNSTREAM HINDIYA BARRAGE	monthly										
	EUPHRATES	DOWNSTREAM HINDIYA BARRAGE	daily			x		x				x	
	KHABUR	ZAKHO	monthly					x		x			
	KHABUR	ZAKHO	daily					x		x			
	TIGRIS	PAISH KHABUR - TUSAN	monthly										
	TIGRIS	PAISH KHABUR - TUSAN	daily					x					
	TIGRIS	PAISH KHABUR	daily			x							
	TIGRIS	MOSUL COMPUTED INFLOW	monthly			S							
	TIGRIS	MOSUL COMPUTED INFLOW	daily			S							
	TIGRIS	MOSUL OUTFLOW	monthly			S							
	TIGRIS	MOSUL OUTFLOW	daily			S						x	
	TIGRIS	MOSUL	monthly		x								
	TIGRIS	MOSUL	daily										
	BALIKIAN	BALIKIAN	monthly					x		x			
	BALIKIAN	BALIKIAN	daily							x			
	RAWANDUZ	JINDIAN	monthly					x	x x	x x			
	RAWANDUZ	JINDIAN	daily					x	x x	x x			
	GREATER ZAB	ESKI KELEK - GIRDMAMUKH - IFRAZ	monthly		x						x		
	GREATER ZAB	ESKI KELEK - GIRDMAMUKH - IFRAZ	daily			x					x		
	KHAZIR	MANQUBA	monthly				x					x	
	KHAZIR	MANQUBA	daily				x					x	
	LESSER ZAB	DIBS DAM OUTFLOW	monthly										
	LESSER ZAB	ALTUN KUPRI - GOMA ZERDELA	monthly		x						x		
	LESSER ZAB	ALTUN KUPRI - GOMA ZERDELA	daily								x		
	LESSER ZAB	DOKAN OUTFLOW	monthly							x			
	LESSER ZAB	DOKAN OUTFLOW	daily							x	x	x	
	LESSER ZAB	DOKAN COMPUTED INFLOW	monthly										
	LESSER ZAB	DOKAN COMPUTED INFLOW	daily										
	LESSER ZAB	DOKAN FERRY	monthly					x		x			
	LESSER ZAB	DOKAN FERRY	daily					x		x			

Figure 3.1: Availability of Hydrometric Data

	WADI THATHAR	THARTHAR MAIN DIVERSION CANAL	monthly	? uncertain of beginning
	WADI THATHAR	DIVERSION TO THARTHAR U/S SAMMARA	monthly	? uncertain of beginning
	WADI THATHAR	DHIBBAN REGULATOR	monthly	? uncertain of beginning
	WADI THATHAR	THARTHAR LAKE INFLOW	monthly	? uncertain of beginning
	WADI THATHAR	THARTHAR LAKE OUTFLOW	monthly	? uncertain of beginning
	WADI THATHAR	IRWAHIA	monthly	? uncertain of beginning
	WADI THATHAR	AL-WARRAR CANAL	monthly	? uncertain of beginning
	TIGRIS	FATHA/BEIJI	monthly	X
	TIGRIS	FATHA/BEIJI	daily	X
	TIGRIS	SAMARRA	monthly	? uncertain of beginning
	ADHAIM	INJANA - NARROWS	monthly	X X X X
	ADHAIM	INJANA - NARROWS	daily	
	ADHAIM	ADHAIM RESERVOIR COMPUTED INFLOW	daily	
	TIGRIS	BAGHDAD	monthly	X X X
	TIGRIS	BAGHDAD	daily	X
	DIYALA	DERBENDI KHAN COMPUTED INFLOW	monthly	
	DIYALA	DERBENDI KHAN COMPUTED INFLOW	daily	
	DIYALA	DERBENDI KHAN OUTFLOW	daily	
	DIYALA	DOWNSTREAM DERBENDI KHAN	monthly	X X X
	DIYALA	DOWNSTREAM DERBENDI KHAN	daily	X X X
	DIYALA	HEMREEN INFLOW	monthly	
	DIYALA	HEMREEN OUTFLOW	monthly	
	DIYALA	HEMREEN OUTFLOW	daily	
	DIYALA	DISCHARGE SITE	monthly	X
	DIYALA	DISCHARGE SITE	daily	X
	DIYALA	AL KHALIS DIVERSION	monthly	? uncertain of beginning
	DIYALA	EL MUSHTARAK MAIN REGULATOR	monthly	? uncertain of beginning
	DIYALA	DOWNSTREAM DIYALA WEIR	monthly	? uncertain of beginning X X X
	GHARRAF CANAL	DOWNSTREAM HEAD REGULATOR	monthly	
	GHARRAF CANAL	DOWNSTREAM HEAD REGULATOR	daily	
	TIGRIS	DOWNSTREAM KUT BARRAGE	monthly	
	TIGRIS	DOWNSTREAM KUT BARRAGE	daily	

In DSS, QC finished
In DSS, QC unfinished
Record supplied, not entered into DSS
Record may exist, but not acquired
X some missing data in year
S have stages, not flows

not listed:
Majar Al-Kabir
Buteirah
Amara
Areedh
Kahla
Samarra
Musharrah

3.2 Data Collection Approach

3.2.1 Overall Approach and Set Up

Much of the effort in Phase 1 will be devoted to the preparation of the three data sets, especially in the inception period. These will never be finalized, in the sense that they will be periodically updated for years to come. However, in Phase 1 the data sets will be brought to the point where they cover all of Iraq and include all significant rivers, channels, lakes or other storages, all major structures, details of land and water use for agriculture, urban centers and industry.

There are a number of recent or ongoing projects in Iraq that have already compiled data sets that are useful for the SWLRI; an important step in the data collection process is to identify these sources. ARDI is a major source of such information; the Agro-economic Zones (AEZ) program in particular is providing very valuable data. Projects funded by USAID and by UNEP and the Government of Italy for the possible restoration of Iraq's Marshlands are also potential sources of detailed data and models. The MoWR's own GIS and Remote Sensing Center and CAD and Survey Center, and the GIS team at the Ministry of Agriculture are other examples of groups with whom the SWLRI Unit should be working closely to determine the availability of existing data sets. The search for other avenues for collaboration and data sharing with other project teams will continue throughout Phase 1.

Preparing data for use for the development of models and other tools comprises a number of distinct but related activities:

- Scanning hard copy data sheets, reports, drawings, maps, etc., in order to build up an electronic archive of available information;
- Transferring numerical information from hard copy data sheets to digital format (spreadsheet is the most common format but optical character reader (OCR), database, delimited text files, HEC-DSSVue are also in use);
- Translation – where necessary to allow key information to be shared between all parties;
- Identifying gaps and tracing missing information (data review);
- Data review for quality control.

Data review for quality control is a vital activity that will take a variety of forms depending on the types of data. This process is discussed in more detail in Section 3.4 below.

Many of the necessary data were already available on paper or in electronic format; however, a major collaborative effort was required to set up and implement the data collection exercise. The new SWLRI Unit is the repository for hard-copy data; the process of transferring already-collected data from he MM Basrah office is underway.

Data collection to date has focused on the 'facts' data set. A preliminary list of data to be collected was issued to participants at the July 2005 meeting. An updated list was issued at the August 2005 meeting. In conjunction with this, a number of spreadsheets were issued to the Ministries for completion. Finally, at the September 2005 meeting, participants spent sessions with the project manager going over data requirements. They also spent time with ARDI IT specialists learning about the concepts of the web-based Claromentis data management system planned for the project.

Regular consultation between the MoWR and ARDI staff has been crucial to keep the focus of attention on data collection. ARDI staff have made frequent visits to participating ministries to support the data compilation exercise.

Table 3.1: Meetings/Workshops on Data Collection

Location	Date
Erbil	July 2005
Baghdad	July 2005
Erbil	August 2005
Erbil	September 2005
Basrah	September 2005
Erbil	October 2005
Erbil	November 2005

As the data collection got underway, ARDI prepared a number of simple quality assurance procedures to be followed by their own staff handling incoming data. These procedures will need to be extended to encompass an approvals process for the data to be issued at each data milestone (see Section 3.6). They may also require some modification for use by SWLRI Unit staff dealing with incoming data in the future.

Procedures have been put in place to record receipt of information by the ARDI staff so that, where necessary, original material can be returned when it has been processed, and all information can be attributed to a source.

3.2.2 Scanning

During Phase 1, all of the key types of information needed to undertake integrated water and land resources planning should be brought together in one readily accessible place. Claromentis is the selected mechanism for providing this access.

Where the required data were only available in hard copy (data sheets, reports, scheme drawings and maps), they are being scanned and the files are being uploaded to Claromentis.

After scanning, the original documents are still required until the quality control checking is completed, after which they can be returned to their source ministry, or if they are copies be retained as the basis of a library in the SWLRI Unit office.

3.2.3 Creating Digital Records

When data are transferred from hard copy to digital format, a check must be made to ensure that no transcription errors have occurred. This applies both when an OCR is used and when the data have been entered manually. Double entry typing can be employed to reduce the burden of this checking. The digital data should not be uploaded to Claromentis until the transcription check has been completed.

Procedures have been put in place to record the transcription checking and uploading by ARDI staff, so that there is an audit trail.

Once uploaded, the data are then subject to full review/quality control.

3.3 Status of Data Collection

3.3.1 General

Since the data collection process is ongoing, it is difficult to give a clear indication of the present status; it is only possible to give a snapshot view, which would be out of date almost immediately. To know that large numbers of well logs have been scanned is not useful if there is no known total number of wells from which the proportion collected could be calculated. Also, without the second stage of data review being completed, it is not possible to say how much of the assembled information will be approved for further use in the strategy studies, and how much might be rejected as duplicated or unreliable data.

Some ministries have been able to provide data more quickly than others, and some have required more support from ARDI than others. In general there has been a good level of cooperation, and the frequent workshops attended by ARDI staff and the participating ministries have helped to provide guidance and encourage a quick pace to the data collection process. In cases where difficulties in data collection have arisen, there is a good liaison between ARDI staff and the MoWR to try to work around the problem. During the December 2005 workshop, which was devoted to the progress of data collection, the ministries provided a comprehensive status update.

The data set compiled by HEC with the MoWR's Hydrologic Studies Center is briefly reviewed below to illustrate the present status of this one data set.

3.3.2 Surface Water Quantity

The HEC has been working with the MoWR since 2003. During this time they have together compiled most of the hydrometric records and much of the information on Iraq's water control infrastructure. Figure 3.1 shows the present status of data collection for the hydrometric network. In addition to the information shown here, the MoWR has additional data in hard copy in a 'library' which should eventually be entered into Claromentis.

The HEC still needs to collect more data on water usage, including reservoir operation records, for their modelling and for their analysis of inflows from Turkey and Syria.

3.4 Data Review

3.4.1 Introduction

The nature and extent of the quality control checking will depend on the technical field. In the case of water level and discharge records, the HEC and the Hydrologic Studies Center have already undertaken a very comprehensive quality control exercise. However, both recognize that there is still a considerable amount of checking to complete, particularly on diversion quantities and water use. In the time frame of Phase 1 it will not be possible to complete full quality control on all the data types required for strategic planning.

However, procedures will be in place and have been demonstrated in each field to ensure that this ongoing process is established and that standards will be as high as possible. This is especially important for future incoming data, because it will enable immediate correction of errors.

3.4.2 Identify Gaps

The hydrological data shown in Figure 3.1 illustrates a number of gaps where data are thought to exist but have not yet been found and collected. The gap can be pointed out to the relevant ministry so that they ARDI staff (if support is required) can try to locate the missing records, or to definitively say that no such record ever existed. This will usually require more diligent inquiries, perhaps at lower levels in the ministry's hierarchy (e.g. Governorate office, the gauge reader's own records etc.), to see if the records can still be located.

In addition, the HEC is also trying to locate records of water diversions at major hydraulic structures. This gap is of a different nature. These data may not have been part of the original data search, having only been identified as required once the model development was in progress. This illustrates that, as shown in Figure 1.1, it may sometimes be necessary to look for more data during advanced stages of the planning process.

Trying to fill gaps will be a key activity for the data collection teams in the first three months of 2006.

3.4.3 Quality Control Procedures

Each specialist from ARDI will prepare a brief checklist for the quality control requirements in his or her area of expertise, with more detailed procedural notes where appropriate. ARDI staff and the SWLRI Unit staff will then follow these procedures when carrying out the quality control of this type of data.

In all cases, the data must be finally signed off as 'approved' before they can be accepted as part of the strategy database. The approval process will be completed in stages. In some cases it may be necessary to use data which are still undergoing some checking in order to keep the development of models and tools going forward. These data would be identified as having had only second level approval. The approvals

process, which should actively involve the MoWR, needs to be more clearly defined early in 2006.

The HEC has already developed a number of procedures for quality control of hydrological records, some using DSSVue. These techniques have already been passed on to staff of the Hydrology Studies Center, and will continue to be used for the ongoing data processing.

A particular problem that can arise during a mass data collection exercise is that more than one version may have been collected for the same information and the two versions are different. Reconciling such differences may just be a case of raising the matter with the organizations from which the data originated, but in some cases it may not be possible to agree on which is the correct version despite considerable effort.

It is quite usual to deal with the uncertainty in data sets, particularly projections of any kind, by having a range of scenarios which represent an envelope within which the true values should lie. The only requirement is that all the assumptions behind the upper and lower bound scenarios are clearly documented. This is part of the standard audit trail.

3.5 Gap Filling/Alternative Data

3.5.1 Traditional Techniques

Where extensive searches have failed to locate missing records, the HEC has used correlation techniques to infill short periods of missing flow data where good relationships can be established with other more complete gauging station records. The degree of infilling and its impact on the reliability of the overall record must be recorded so that others using the data are fully aware that infilling has taken place.

In each technical field such data infilling may be necessary. This is acceptable as long as the procedure is fully documented and the data set is clearly identified as modified.

3.5.2 Alternative Data Sources

Given the recent history of Iraq, many of the statistics and data for recent years are likely to be of lower quality than earlier periods, or to be missing entirely. In some cases it is possible to use alternative means of estimating more realistic values; for example, remote sensing techniques can be used to estimate the irrigated area in a particular season.

As a first step, the project has been building up an inventory of the satellite imagery that might be available, and gathering information on the work of others that might provide relevant data.

Remote sensing techniques may also be used to develop new spatial data sets that might be highly relevant to water and land resources planning. Such work may not be possible during Phase 1, but opportunities of this type can be identified and recommended for Phase 2.

3.6 Data Milestones

While data collection is an integral part of the planning process and therefore a never ending task, it is necessary for the purposes of the overall Phase 1 program to set target dates or 'data milestones' at which times the currently held stock of data will be 'frozen.' This will ensure that the members of the project team who are developing models and other tools can work from an agreed upon (frozen) data set. The data collection, and more importantly the quality checking of the collected data, will continue after the data milestone date so that at a later target date (the next data milestone- see Section 4.1) a revised data set can be frozen and distributed to the project team for use.

4 Program for Remainder of Phase 1

4.1 Proposed Program

Figure 4.1 shows the work program from January to early September 2006. The remaining program can be divided into two sections separated by a data milestone (2), which falls at the beginning of April 2005. The present data collection and data review will continue throughout Phase 1, but the data set available at the start of April 2006 will be frozen and used for all the development of models and tools, and for the formulation of the first round of interventions. If there is sufficient additional data available at the end of July 2006, an updated data set will be issued (data milestone 3).

4.2 Data Collection and Data Review

In addition to the continuing data collection from other sources, the opportunities data must be assembled prior to data milestone 2.

ARDI will arrange meetings with all the stakeholder ministries in turn to jointly develop the ministries' long lists of opportunities and potential interventions. Once the long list is agreed upon, ARDI will assist each ministry to gather all the necessary details of the suggestions on the long list so that they can be compared. In the case of a major civil engineering proposal, such as Bekme Dam, the detailed information should come from design reports and drawings, cost estimates, planned mode of operation, etc. The level of information available is a factor in determining whether a suggestion on the long list can be taken forward in the near term – it may still be suitable for a longer term activity if more detailed information is collected by studies carried out as part of the short term plan. All suggestions for activities to be implemented in the short term (in the next five years) must have detailed information on costs and necessary resources.

4.3 Developing the Needs Data Set

This is programmed to take place using the data set established at milestone 2. ARDI will prepare a working paper for each ministry on the options from a theoretical standpoint. This should then be revised by the ministry staff, which should add the perspective of socio-economic factors, local tradition, etc. This process will involve considerable coordination between ARDI and ministry staff, assisted by the SWLRI unit staff. Population estimates, which are fundamental to the needs estimates for public water supply, are a good example of the potential difficulties that may have to be overcome:

- Baseline population figures might not be agreed upon; different organizations have different figures and these may not be reconciled by data milestone 2;
- High and low estimates of overall growth in population, and its distribution across the country, for five to 30 years ahead may not have been agreed to by all stakeholders;
- Trends in population such as urbanization are difficult to project;

- General uncertainty over the political and socio-economic situation makes projections 30 years ahead difficult.

The needs data sets will always contain a large measure of uncertainty because they are predictions. In order to make the best use of this type of information, it is usual to choose a range of values to reflect the fact that the estimates are uncertain. High and low estimates for population growth are one example. In all cases, assumptions made in preparing the estimated needs will be fully documented and made available to all the stakeholders.

4.4 Models and Tools

4.4.1 Introduction

Figure 1.1 shows how models and other analytical tools will be used to quantify and assess the consequences and effects of hypothetical intervention packages. Some water management models already exist, in particular a reservoir simulation model for the Tigris and Euphrates river basins in Iraq prepared jointly by HEC and the MoWR. This model is intended to serve both for long-term planning and for real-time operation, and can be progressively refined as more data become available. Other sorts of models or analytical tools will also be involved. For instance, agricultural and economic studies will have to produce ways of estimating the effect of any hypothetical change to irrigation water availability or allocation, and any related change in cropping, on the national economy and the people's wellbeing. Further studies must establish a model or procedure to assess the effect that any change in water availability and reservoir operation policy would have on the energy sector, via the hydropower stations. Yet more studies will be needed to examine environmental effects, and the linkages between water quantities (regulation, irrigation and other return flows) and water quality in the lower reaches (salinity, pollution); this may require mathematical modelling of water quality as well as quantity. Modelling will have to cover not only average or typical conditions, but also droughts and floods; droughts are already a problem in Iraq, and increasing upstream development may make this even more significant.

4.4.2 HEC Models of the Surface Water Resource System

The HEC has been working with the Hydrologic Studies Center (HSC) of the MoWR for the past two years to prepare data sets and develop models in order to route flows from the Turkish border to the Shatt al Arab through the existing hydraulic infrastructure. The function of the models was to investigate the availability of water to restore all or part of Iraq's Southern Marshlands. This work provides the ideal platform for providing the MoWR with an essential tool for in-depth investigation of the consequences for downstream users of any change in operation, new development, etc., anywhere on the main river systems. The modelling is based on the HEC package Res-Sim and has been divided into two components: above and below Kut Barrage and Hindiyah Barrage.

The HEC has developed three categories of data series which are crucial to the strategy studies:

- Historical flow series as measured, after quality control and correction of errors
- Unimpaired[1] historical flow series (as if no developments had taken place)
- Re-impaired[2] historical flow series, initially to 2004 usage (as if 2004 usage had existed for the entire period)

A considerable amount of manipulation of the data is required to prepare these data sets, and data on actual usage in various parts of the system are required for the analysis. As with any modelling exercise, the better the data driving the model, the more reliable the results. The HEC therefore proposes to spend the first three months of 2006 working closely with the HSC and ARDI staff to try to improve the data sets used to drive the models. At the beginning of April 2006 they will issue 'definitive' data series (data milestone 2) that will be used by all other contributors to the Phase 1 studies to develop tools and carry out the first round formulation.

4.4.3 Water Quality Modelling Tools

While the quantity of water may be a constraint to potential schemes, water quality can also be a major constraint. Iraq faces a worsening situation with regard to the quality of the incoming waters of the Tigris and Euphrates as Turkey and Syria and Iran increase irrigation in the basin.

To allow water quality concerns to be addressed, particularly salinity, ARDI proposes to develop model(s) that work with the HEC water quantity simulation. Of concern to resource planners are more localized pollution problems, such as the downstream spread of pollution from large sewage works or industrial sources. ARDI will provide software tools to model this situation and will, with the assistance of the ministries, select a reach to demonstrate its application.

The third area where water quality problems need to be considered relates to progressive salinization of irrigated lands where poor management techniques and a lack of drainage contribute to a worsening problem. An ARDI groundwater specialist and the modellers will collaborate to provide tools for the analysis of this problem based on recent work in Central Asia.

The development of the water quality tools will be based initially on the data milestone 1 data set, moving over to the data milestone 2 data set when it becomes available.

4.4.4 Spatial Data/GIS/Maps

Maps and GIS tools are extremely important in strategic planning. Not only are they actively used by the planners but they are a vital component of the important task of selling the resulting plans to others: politicians, other ministries, and the general public.

During the inception phase, ARDI has been building up a picture of what satellite imagery, maps and drawings are available in various centers within the ministries and held by other projects. It is important to avoid developing competing databases and

[1] Sometimes referred to as 'naturalised'

[2] 'De-naturalised'

mapping systems. Every effort will be made to build on existing data and software to minimize the amount of capacity building required. The GIS and Remote Sensing Center at MoWR is based at the same location as the SWLRI Unit, so collaboration with the SWLRI Unit should be easy to maintain. Collaboration will also be required with the Ministry of Agriculture GIS team.

Some GIS requirements can be identified immediately: map of borehole locations, map of climate stations, map showing location of water quality monitoring, etc. Other GIS and mapping needs will arise as the first round of formulation for the interventions takes place, hence the long time period for development allowed for in Figure 4.1.

4.4.5 Economic Models

Other analytical tools will include ways of estimating the agricultural, economic, social and livelihood effects of potential interventions concerning irrigation and energy policy, or domestic and industrial water supply. They will probably not be formal mathematical models, but pragmatic analysis routines with agreed upon methods and criteria. For instance, evaluation of a potential change to cropping patterns in irrigation schemes will require estimates of crop water requirements, crop budgets, and economic benefits. Evaluation of a change to the way hydropower stations and their reservoirs are operated will involve consideration of the availability and unit costs associated with alternative energy sources at various load factors.

Such models are usually set up in Excel workbooks.

4.4.6 Reporting Formats

As with maps, it is important for the SWLRI Unit to have a range of standard reporting options to issue the results of their work to other parties. ARDI will provide the MoWR with a range of examples from other organizations to show potential formats. The planning process combines technical and political aspects, and it is vital that the technical points can be made clearly to ensure that the political decision-making is properly informed. As discussed above, maps and GIS outputs also have an important part to play in this process of publicizing the results of the planning studies.

4.5 First Round Formulation/Comparison

4.5.1 Introduction

Phase 1 is 14 months in duration, and much of this period will be taken up by data compilation. Given this relatively short period, the first round of formulation/comparison can only be a preliminary run-through to demonstrate models, tools, and the overall planning approach. The greater the comprehensiveness of the data sets, particularly on needs and opportunities, that are prepared to launch the first round formulation, the more likely it is that this Phase 1 exercise will give a good indication of appropriate strategies, especially for the near term (five year) planning horizon.

The initial set of possible intervention-packages will emerge naturally from the data collection and collation in Stage A (see Figure 1.1), particularly from the set of opportunities. The central study team will use that source, in addition to suggestions from all stakeholders, to distill a manageable set of packages for the initial comparisons. Some packages may involve only one intervention, if it stands alone and does not need others for the realization of its objectives and benefits. Later refinements will remain possible, in Phase 1 if time permits and otherwise in Phase 2. Then this initial set of packages will be compared, using the models and analytical tools already prepared (and serving to refine and improve them where appropriate). Various hypothetical scenarios can in principle be modelled, for instance involving different assumptions about the future balance between hydropower and irrigation in Turkey, but this may have to wait for Phase 2. The extent and level of detail of this activity in Phase 1 will depend on the progress and timing of other activities.

4.5.2 Multi-criterion analysis

After the consequences of various potential intervention-packages have been worked out, the next step will be to compare the packages. There will likely be a wide variety of packages, so simple comparisons will not be possible. It is proposed to use a form of multi-criterion analysis, which should be systematic and transparent so that decision-makers can understand how the recommendations have been arrived at. This will make it more likely that decisions will actually be implemented.

Two methods are considered most appropriate: a numerical one called the *weighted-average method* and a non-numerical one called *systematic verbal comparison*. These are now briefly described in turn.

Where it is possible to describe the consequences of a set of packages in terms of a single set of characteristics, their relative merits can be expressed in numbers, for instance ranging from 0 for very unfavorable characteristics to 100 for very favorable ones. Typical characteristics might be environmental impact, short-term social impact, cost-effectiveness (if it is quantifiable), or degree of vulnerability to cross-border factors. Using the *weighted-average method*, a table is set up where each competing package is listed and its scores against each characteristic are tabulated. The scoring rule for each characteristic is the way in which the facts about a package are converted into its merit score. Systems can be mathematical, like a proportional relationship between cost-benefit ratio and score, or they can be subjective, described in words. Each characteristic corresponds to a criterion, and its scoring rule corresponds to the way the

decision-makers want that criterion to be applied. In addition to the set of scoring rules and the set of scores for various packages, the method needs a set of criterion importance weights. After these steps, the analysis is simple arithmetic: for each package an overall merit score is calculated as the weighted average of its scores under the different criteria. If there are more than about ten criteria, it may be useful to gather them into groups, both for the discussion of their importance weights and for the presentation of results; for successful decision-making both these elements must be very clear to the main participants. It is proposed to set up a simple form of this analysis early in the process, so that stakeholders can begin to become familiar with how it works, and then to refine the list of criteria and their weights, and the set of scoring rules, in an iterative discussion.

There may be some comparisons where the packages are so different in nature that a single set of criteria for numerical analysis cannot be formulated. In this case the *systematic verbal comparison* method can be used. Using this method, tables are set up with a cell for every package and every criterion, and then verbal comments are written in the cells, rather than numerical scores. Overall conclusions about the merits of the packages can then be arrived at by systematically reviewing all these comments. This method appears more subjective than the numerical one, but in fact the numerical method's scoring rules can be equally subjective. There are other methods, but they are not considered to be sufficiently transparent.

It will probably not be possible to get very far with this process in Phase 1, but we propose to start the preparation and use of criteria, at least in a preliminary version of the package comparisons. This will give stakeholders time to become familiar with the methods used before the definitive analysis and the final decisions are made.

4.5.3 Analysis of the Opportunities Long List

The agreed-upon criteria will be applied to the long list, at least with a preliminary version of the multi-criterion analysis, and a number of the suggested opportunities will immediately drop out of the running for first round formulation. ARDI may further reduce the number, or combine options, in order to have a manageable number of alternatives with which to demonstrate the methods and tools.

The scenarios for surface water resources interventions need to be carefully considered, both because of the run time of the hydrological model (several hours for each run) and because the results may be difficult to attribute to the particular intervention if too many aspects are changed at one time. The HEC modelling team will therefore be very involved in determining the options and permutations that will be investigated to ensure that the model's capabilities are fully demonstrated within the three month time frame (Figure 4.1).

ARDI will develop a number of scenarios for other aspects of land and water resources planning to demonstrate the capabilities of the new tools; for example, a range of farm budgets for alternative cropping or livestock farming options. Simple models like a farm budget can be set up and run for many alternatives; thus not all aspects of the formulation/comparison process need be constrained by the scenarios adopted for the HEC model runs.

Once the various options and scenarios have been analyzed, the multi-criterion analysis will be used to sift or prioritize the interventions. The output of the first round will be a prioritized list of interventions from the original long list of opportunities. The degree to which this output can be regarded as fully developed will depend on the extent to which the data and the models are assumed to be reliable. At this stage the objective is to try to provide usable results from this first round as well as provide an adequate demonstration of the planning process, but the outputs must be subject to careful review before being circulated outside ARDI and the SWLRI Unit of the MoWR.

4.5.4 Review of the Results of the First Round

A key step at the end of Phase 1 will be to review how all aspects of the process worked and to provide feedback. This will have an impact on the recommendations for activities put forward for Phase 2. The participation of the stakeholder ministries will be encouraged so that the lessons learned are widely accepted.

4.5.5 Capacity Building

The planning capacity of staff in the MoWR and other ministries and institutions will be enhanced in the first instance by their involvement in the Phase 1 work, which will be as collaborative as possible given the geographical distribution of participants and security requirements. Early drafts of working papers, models, analytical tools and such elements will be circulated for discussion whenever possible, both to further their preparation and to foster wide involvement which will help to make considerable numbers of Iraqi professionals more familiar with the planning process.

Regular telephone or video conference calls can be very effective in increasing interaction. HEC have a well established routine of weekly telephone discussions with their counterparts in the Hydrology Studies Center. Claromentis will play an important part in this interaction, thanks to the discussion forums and document sharing capability.

Other options for increased interaction might include:

- Training with HEC (some MoWR staff have already benefited from this);
- Assistance with the data review process at the MM office in Cambridge;
- Assistance with the formulation of intervention packages for round one;
- Study tour in the region – Egypt and Jordan are both potential locations for study tours to observe best practices;
- Training of key staff on the operation of the various models developed under the project.

The best approaches for capacity building will vary from time to time depending on the types of data and analysis work being undertaken.

4.7 Reporting

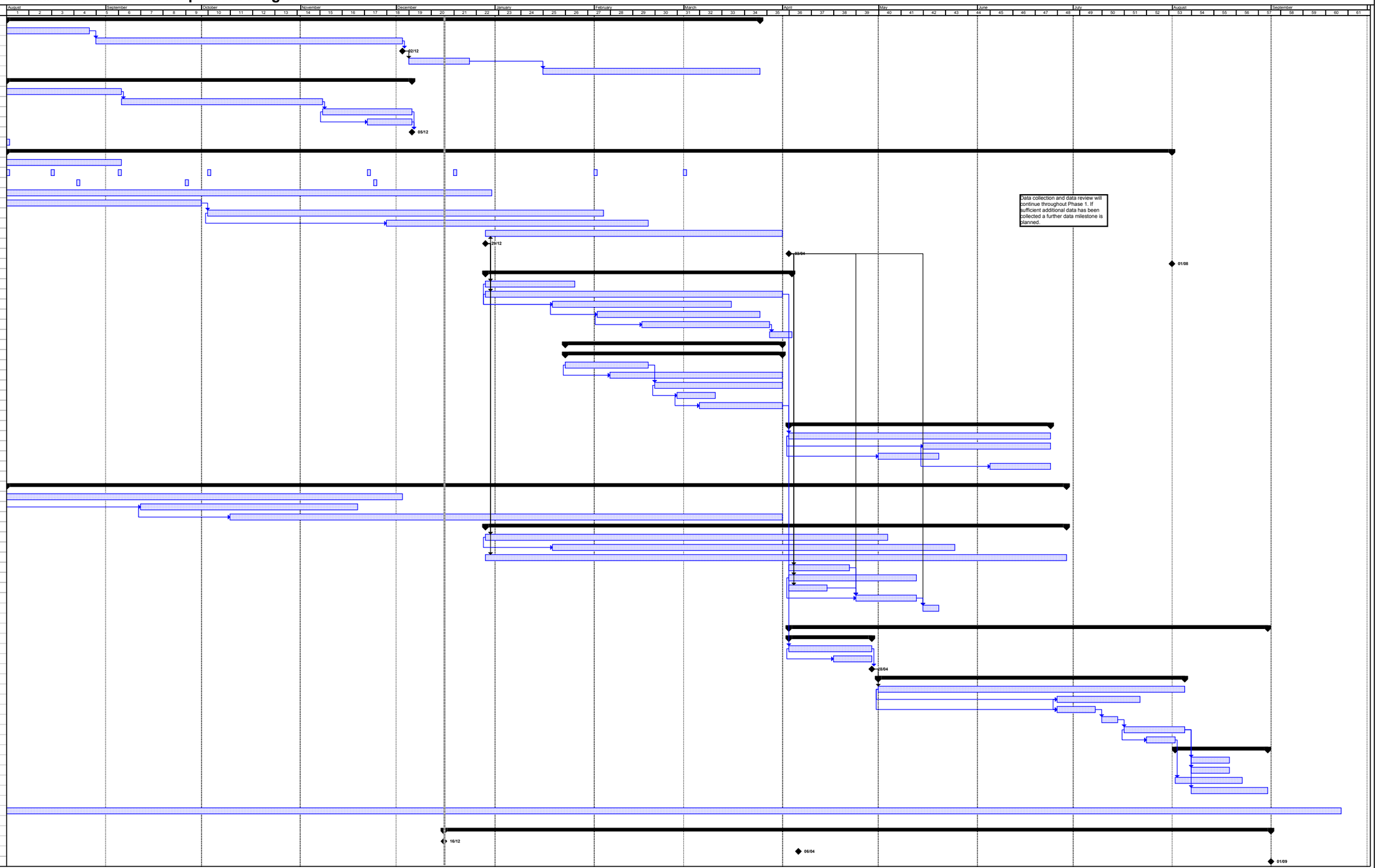
An interim report is scheduled to be completed in April 2006 (data milestone 2). This report will focus on the data set that will form the basis for subsequent modelling and package comparison.

Phase 1 will include the careful formulation of proposals for Phase 2. Initial suggestions will be drawn up by the central study team and then circulated to interested stakeholders as a draft for discussion. It will be essential that the MoWR and the other participating ministries are comfortable with the final recommendations.

The Phase 1 completion report will be issued in September 2006. It will provide a concise record of the overall activities in the phase, summarize the first round of package formulation/comparison, provide feedback on the process and on the performance of the tools provided, and will include a scope of work for Phase 2.

Strategy for Water and Land Resources in Iraq - Work Program

ID	Task Name
1	**Facilities and equipment**
2	Identify MoWR needs
3	Procure office & equipment
4	Strategy Unit office operational
5	Identify further needs
6	Procure/implement to fulfil needs
7	**Data Management**
8	Plan approach
9	Select IT collaboration system
10	Customise Claromentis
11	Claromentis training
12	Claromentis live
13	Claromentis training
14	**Data collection (Facts)**
15	Planning Data Collection
16	**Meetings on data collection**
25	**Meetings of IT reps**
29	Assist ministries with data collection
30	Procure equipment
31	Scanning raw data
32	Translation
33	OCR/data entry
34	Data milestone 1
35	Data milestone 2
36	Data milestone 3
37	**Data review (Facts)**
38	Identify gaps
39	Specialist review
40	Query data with ministries
41	Assist ministries with queries
42	Stage 1 approvals
43	Stage 2 approvals
44	**Data collection (Opportunities)**
45	**Develop long list with Ministries**
46	Ministry meetings
47	Collect details for long list entries
48	Specialist review
49	Identify gaps
50	Assist ministries to fill gaps
51	
52	**Data preparation (Needs)**
53	Specialist analysis
54	Ministry input to projections
55	Fundamentals
56	Projections short/med/long term
57	
58	**Models and Tools**
59	Review ongoing projects by others
60	Plan approach
61	Collaborate with others
62	**Develop models and tools**
63	Water resources models
64	Water quality models
65	Spatial data GIS maps
66	Hydropower economic models
67	Water supply models
68	Farm budget models
69	Economic models
70	Reporting formats
71	
72	**First round formulation/comparison**
73	**Develop criteria for comparison**
74	Specialist analysis
75	Ministry input to criteria
76	Issue criteria to team
77	**Analysis of Opportunities Long List**
78	SU team and specialist inputs
79	Ministry input to analysis
80	Apply criteria to each proposal
81	Multi-criterion analysis
82	Discuss results with team
83	Discuss results with ministries
84	**Review results of first round**
85	Feedback to model development
86	Feedback to capacity building
87	Feedback to ministries on proposals
88	Recommendations for Phase 2
89	
90	**Capacity building**
91	
92	**Reporting**
93	Inception Report
94	Interim Report
95	Phase 1 Completion Report



Project: Overall Programme rev0
Date: Fri 16/12/05

Task | Split | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Split | Rolled Up Milestone | Rolled Up Progress | External Tasks | Project Summary

Appendix A

The Work Plan, discussed and agreed to by the participants at the initial SWLRI meeting in Amman 7-9 June 2005, outlined a two phase approach. The 14 month Phase 1 concentrates on data compilation and the development of tools for use in strategic planning. This document is intended to start the process of data compilation. It provides a very long list of information that will be useful for strategic planning – not all of which may be available at this time. The list is almost certainly incomplete so comments, additions or deletions are welcome.

Details of Information Requirements for SWLRI

Scene Setting

Detailed overview of infrastructure:

Maps showing all major waterways, ideally as time series, e.g. map of systems in 1960s, 1970s, present.

Maps showing irrigated areas, on and off stream reservoirs, water supply intakes, offtakes and discharges, canal and drain systems

Surface Water Data (Rivers - canals and drains see I&D data)

(Note much of this information has already been collected by the MoWR with HEC on the marshlands restoration project)

Gauging station (GS) locations (grid reference)

Date of opening and closing of GS

Method of measurement (automatic water level recorder, 3xday staff gauge, cableway etc)

Suitability of site: full range? Stable control? Bypassed during floods? Etc.

Indication of reliability (poor/medium/good) with justification

Daily mean discharges (m^3/s) for full period of record at each gauging station

Annual maximum instantaneous water level and discharge

All GS rating curves (current and past with dates and water level ranges for application)

All current meter measurements taken to calibrate rating curves (date of measurement, water level, discharge)

All GS channel sections (all topographic records for each site)

Water level records – required if rating curves suspect and discharges need reprocessing

History of major river engineering works (dates, locations, consequences) including temporary and permanent diversions, provision of storage.

Details of seasonal water management practices

Use of the data: water availability, flood and drought flows, peak flood levels, check on reliability of rating curves and therefore flow estimates, estimate of any rehabilitation/upgrading needed.

Groundwater and Spring sources

Location of monitored springs (grid reference)

Location of piezometers (grid reference)

Aquifer characteristics: stratigraphy, permeability, transmissivity, storage, hydrochemistry

Regional and subregional geological reports and maps

Hydrogeological reports and maps

Piezometer drilling records – depth, location of screen, drilling logs
Water level records from piezometers
Discharge records from springs
Borehole drilling records – depth, diameter, depth of casing, screen details, logs
Borehole locations (grid reference), pump type and characteristics, yield
Pump test records
Records of groundwater pollution
Details of groundwater pollution monitoring

Use of data: water availability, seasonal water table movement, drought water levels, estimate any rehabilitation/upgrading needed for monitoring network.

Water Quality information

Location of *routine* monitoring points for both surface and groundwaters (grid reference)
- Method of sampling and immediate treatment of samples to be taken to a laboratory
- Field test procedures
- Laboratory procedures
- Records of Parameter values, e.g. sediment, salinity, total dissolved solids, chemical analysis, etc.

Location of temporary or project monitoring points (grid reference)
- Method of sampling and immediate treatment of samples to be taken to a laboratory
- Field test procedures
- Laboratory procedures
- Records of Parameter values, e.g. sediment, salinity, total dissolved solids, chemical analysis, etc.
- Details of laboratories carrying out water quality sampling (name, ministry or local authority name, location, range of parameters that it is equipped to test for, etc.)

Reservoirs

(Note much of this information has already been collected by the MoWR with HEC on the marshlands restoration project)

Date construction started, date filling completed
Design and current purpose of reservoir
Storage volume/Area/Elevation curves
Spillway details, dam height, dead storage allocation, outlet details, offtake arrangement details
Operating rules/procedures
Organization responsible for reservoir operation
Authority responsible for providing operating rules/capacity to override rules

Regulating Structures

Date construction started and finished
Details of gates etc
Function
Capacity
Operational records
Operating rules/procedures
Current status of mechanical, electrical and civil works. Is it fully or partially operable?
Is water control achieved at present?

Data for: assessing rehabilitation/upgrading of structure, investigate operating rules

Irrigation & Drainage Systems
Irrigation system boundaries (geo-referenced)
Drainage system boundaries (geo-referenced)
Water user associations (area covered, date formed)
Reuse of drainage water
Details of water management systems (monitoring - where, how, and how often), method of communication of operational information
Number of farms overall and by size
Population directly dependent on irrigation system for majority of their income (farmers, truck drivers, local traders, support services, resident family members) – approximate population of local towns/villages is an acceptable proxy.
Design reports and feasibility studies (bibliography and location where copies obtainable, if known)

Pumping stations (fixed installations)
Location (grid reference)
Command area – design
Lift
Date construction started and finished
Energy supply
Details of installed capacity and type of pump(s)
'passport'
Current status of mechanical electrical and civil works

Small mobile pumping plant
Estimate of numbers
Capacity of typical unit
Energy supply

Regulating structures
Location (grid reference)
Date construction started and finished
Design capacity
Energy supply
Notional hydraulic characteristics
Operator's records (flow/setting)
Current status of mechanical electrical and civil works

Flood Management
Levees: location, type, nominal protection level (elevation), condition
Escapes: location of intentional breaches and escape canals
Planning regulations (zoning) and accepted return period for design (e.g. in urban areas the target for defense works could be from all floods up to 100 year flood)
Current forecasting and warning practice
Historical flooded areas (focus on Baghdad and other population centers)
Records of damage caused by flooding (monetary value and year)

Policies: Past, Current, and under development, by sector
Trade (including import/export)

Agriculture
Melioration
Water supply and sanitation
Water charges
Licensing of abstractions for surface or groundwater
Water user associations
Environment – water quality, wildlife, sustainability
Energy especially policies on role of hydropower
Transport especially policies on role of inland waterways
Industry
Institutional structures – roles of ministries, state organisations, local government, private companies/organizations

Legal Agreements, Treaty obligations
International basins
Transboundary water related agreements, e.g. Shatt al Arab
Environmental standards (including water quality)
Bibliography of all current legislation affecting water and the water-related environment

Public Water Supply and Sewage Disposal
Demography and spatial distribution of population
Socio-economic data (income levels)
Numbers of houses with full piped water/flush toilets
Numbers of houses with septic tank
Demand forecasts
Urban and rural population (past and forecast)
Percentage of population with access to treated drinking water
Percentage of population served by distribution systems
Percentage of distribution system requiring rehabilitation
Percentage population served by sewage systems
Percentage of sewerage system requiring rehabilitation
Location of potable water treatment works (grid reference)
Type of water treatment at each works
Each works: abstraction from what? and where is intake or borehole (grid reference)
Water quality at intake and after treatment (range of values)
Water quality problem areas and their extent
Location of sewage treatment works (grid reference)
Type of sewage treatment at each works
Each works: discharge to what? and where is outlet (grid reference)
Water quality of effluent (range of values)

Industrial Water Use and Discharges
Estimate of usage provided through public water supply systems
Demand forecasts
Location of industrial user (grid reference)
Type of industry and nature of use of water
Discharge to what? And where is outlet (grid reference)
Water quality of effluent (range of values)
Details of any on-site effluent treatment
Water quality problem areas and their extent

Industrial Water Use and Discharges

Estimate of usage <u>not</u> provided through public water supply systems
Demand forecasts
Location of industrial user (grid reference)
Type of industry and nature of use of water
Each intake: abstraction from what source? and where is intake or borehole (grid reference)
Water quality at intake (range of values)
Discharge to what? And where is outlet (grid reference)
Water quality of effluent (range of values)
Water quality problem areas and their extent

<u>Land/Agriculture</u>
Land use (current and trends)
Irrigated lands
Cropped area by crop type and district
Crop water requirements including land preparation/leaching needs
Agricultural production statistics by district and by crop
Constraints to land development options, e.g. maps showing steep slopes, areas subject to serious soil erosion, areas subject to salinization, areas subject to seasonal flooding
Details of any studies on constraints (bibliography)
Land condition: salinity level, depth to water table, quality of shallow groundwater
Agricultural drainage: presence/absence, type of system, conditions (functioning/ barely functioning/not functioning)
Livestock numbers estimates by district and type (current and trends)
Details of agri-processing plant (e.g. sugar refinery location, capacity, current production level)

<u>Energy Sector</u>
National generation capacity kWhr by year and maximum load kW
Annual pattern of load
Daily pattern of load (winter and summer separately)
List of power stations by region with installed capacity and type
Projections of future power demand
Transmission system description

<u>Hydropower Installations</u>
Location
Installed capacity and when installed
Type of turbines, turbine characteristics
Is it a multipurpose reservoir/barrage? If so what is the priority of the needs of power generation compared to the other uses?
Operating rules
Operating records (discharges, power generated, e.g. monthly)

<u>Channel Morphology</u>
Known problem areas for erosion/deposition
Navigation routes and target depths
Number/capacity of dredgers
Annual volume of dredging by river reach
Annual cost of dredging
Cross sections with date of survey

Navigation
Location and physical characteristics of locks
Location of ports/docks
Locking arrangements
Estimates of traffic (past and current)
Value of cargo transported
Operation costs (boat running costs, cost of maintaining locks, wharves etc)
Forecast traffic and cargo
Estimated volume of cargo transported by land
Proportion of annual cargo transported carried by water
List constraints to navigation and proposed measures

GIS (geo-referenced in accordance with coordinate system to be used throughout the project)
Satellite imagery for base mapping
Rivers/lakes geo-referenced
Administrative boundaries
Hydrologic and hydrogeologic sub-basin boundaries

Meteorological Information
Location of synoptic, agrometeorological and rainfall stations
Periods of record
Indication of reliability
Parameter values: temperature, humidity, wind, sunshine, evaporation

Economic Aspects
Tariff for power
Water charging structures
Cost information for engineering works to build up cost estimates for potential development or rehabilitation packages
Agricultural prices (inputs and outputs), subsidies.
Taxes and duties affecting water users (municipal, rural, industrial)
State guaranteed price arrangements

Environment
Boundaries of any designated nature reserves, Ramsar sites etc
Details of studies, e.g. Marshlands Restoration
Red data species or habitats
Shatt al Arab and obligations to Gulf water quality

Upstream Countries
(such information as can be obtained from published sources or informal contacts)
Planned developments on rivers draining to Iraq
Policies for development in water sector
Studies on developments
Studies on environmental impact of planned developments

Institutional Structures
Government organizational structures as affects water/agriculture/environment sector

Details of rights enjoyed by Government (national and local) and its agents to act in these sectors
Chain of command and reporting for operation of water-related infrastructure
Chain of command and reporting for monitoring of water resources and their use; i.e. where is monitoring data processed and where is it stored (locally/centrally etc.)

References/Studies, etc.
Updating the preliminary list of relevant papers, studies etc. circulated at the Amman meeting on completed or ongoing projects
Schedule of proposed project support, e.g. plans of various UN agencies described by the UNESCO representative at the Amman meeting.