United States Agency for International Development

Egyptian Environmental Affairs Agency

LIFE Integrated Water Resources Management
Task Order No. 802
EPIQ II: Contract No. EPP-T-802-03-00013-00

Task 6: Improving Water Reuse Practices

DESIGN OF IRRIGATION NETWORK FOR THE DEMONSTRATION SITE IN LUXOR

Report No. 21

September 2005

International Resources Group
In association with EPIQ II Consortium

Ministry of
Water Resources and Irrigation

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Prepared by

Dr. Ahmed El Behery

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Table of Contents

List of Tables

List of Figures

Acknowledgements

This report was undertaken as a joint activity of the Ministry of State for Environmental Affairs (MSEA), the Egyptian Environmental Affairs Agency (EEAA), and the Livelihood and Income from the Environment–Integrated Water Resources Management Project (LIFE–IWRM) Team.

The LIFE–IWRM is a joint activity of the Ministry of Water Resources and Irrigation (MWRI), MSEA, and the United States Agency for International Development (USAID), and is being implemented by a consortium led by International Resources Group, Ltd. (IRG).

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- Eng. Mohamed Hamed, MWRI
- Eng. Wafaa Faltaous, Cognizant Technical Officer (CTO) for the project, USAID.

Acronyms and Abbreviations

AAU	Agricultural Administrative Unit
AHD	Aswan High Dam
APRP	Agricultural Policy Reform Program
BCWUA	Branch Canal Water User Association
BOD	Biological Oxygen Demand
BOD	Biological Oxygen Dissolved
C	Centigrade
CAD	Computer aided design
CDA	Community Development Association
CLAC	Central Lab for Agricultural Climate
CLEQM	Central Laboratory for Environmental Quality Monitoring (MWRI)
COD	Chemical oxygen demand
CY	Calendar Year
DO	Dissolved Oxygen
EEAA	Egyptian Environmental Affairs Agency
EMP	Environmental Monitoring Plan
EPADP	Egyptian Public Authority for Drainage Projects (MWRI)
EPIQ	Environmental Policy and Institutional Strengthening Indefinite Quantity Contract
ET	Evapotranspiration
EU	European Union
FAO	Food and Agricultural Organization
FC	Field Capacity
GB	Gigabyte
GIS	Geographic Information System
GOE	Government of Egypt
GPS	Global Positioning System
GW	Groundwater
GWS	Groundwater Sector
HD	(Aswan) High Dam
hp	Horsepower
IBRD	International Bank for Reconstruction and Development or World Bank
ID	Irrigation Department
IDS	Irrigation and Drainage System
IRG	International Resources Group (a Washington DC-based consulting firm that is prime contractor for the IWRMP)
IS	Information Systems
IT	Information Technology
IWMU	Integrated Water Management Unit (A unit of MWRI)
IWRM	Integrated Water Resources Management

IWRMP	Integrated Water Resource Management Project
KB	Kilobyte
kg	Kilogram(s)
LIFE	Livelihood and Income from the Environment (project)
LOE	Level of Effort
M&E	Monitoring and Evaluation
MALR	Ministry of Agriculture and Land Reclamation
MED	Mechanical & Electrical Department/MWRI
mg/l	milligrams per liter
MIC	Ministry Information Center/MWRI
MOE	Ministry of Education
MOH	Ministry of Health
MSEA	Ministry of Sate for Environmental Affairs
MWRI	Ministry of Water Resources and Irrigation
NASA	(United States) National Aeronautics and Space Administration
NGO	Non-governmental Organization
NPK	nitrogen, phosphorus, and potassium (especially in chemical fertilizers)
O&M	Operation & maintenance
OJT	On-the-Job Training
PC	Personal Computer
PH	Potential of Hydrogen ions (measure of acidity or alkalinity)
PM&E	Performance Monitoring and Evaluation
ppm	Parts per Million
PWP	Permanent Wilting Point
RSC/WP	Red Sea Coastal/Water Project (short name for USAID-funded Red Sea Coastal and Improved Water Resource Management Project)
RWS	Relative Water Supply
SIRs	Sub-Intermediate Results
SOs	Strategic Objectives
SS	Suspended Solids
STTA	Short-term Technical Assistance
SWERI	Soils, Water, and Environment Research Institute (MALR)
TA	Technical assistance
TDS	Total Dissolved Solids
TOR	Terms of Reference
TRG	Training Resources Group
TS	Total Solids
TS	Transition State (chemical)
TSS	Total Suspended Solids
TWW	Treated Wastewater
USAID	United States Agency for International Development
WCU	MWRI Water Communication Unit
WDC	MWRI Central Water Distribution Center
WQU	MWRI Water Quality Unit
WWTP	Wastewater Treatment Plant

1. Introduction

Water plays an essential role in providing the basis for population stability and civilization. The Nile River in Egypt has supported the longest civilization in the world, lasting more than 7,000 years. Throughout history, Egyptians have skillfully utilized the river, and in the middle of last century, built an invaluable water structure—the Aswan High Dam (HD). This dam helped in controlling the river's flood pattern, releasing water usefully throughout the year. It serves the 99 percent of the population that lives on just 4 percent of land area along the river. Egypt's share of Nile water controlled by the dam is 55.5 billion cubic meters (m^3) annually as stipulated and agreed upon between Egypt and Sudan in 1959. Following construction of the HAD, Egypt began a new era of development. Cultivated land has expanded to 8 million feddans, with an average of two harvests per year.

The Government of Egypt (GOE) continues to invest heavily in expanding the cultivated area, aiming to add another 3.4 million feddans of cultivated land by the year 2017 in order to secure food for the rapidly increasing population.

The level of 1,000 m^3 of water per capita per year, which is thought to be the threshold of water scarcity, has already been reached and it is anticipated that by the year 2025, only 630 m^3 water per person will be available.

To cope with the growing demand for water, the available water supply has to be augmented and water demand must be managed and controlled.

Water supply augmentation has been practiced in Egypt for few decades through recycling agricultural drainage water and shallow groundwater. In the Nile valley and Delta, water availability is dependent on the Nile flows and consequently any possible recycling of water represents raising the efficiency of the Nile system. Reusing agricultural drainage water began in the 1970s and has now reached a level of 4 billion m^3 annually. The GOE plans to increase the reuse of drainage water to 8 billion m^3 annually. Simultaneously, use of groundwater will increase from 4 to 7 billion m^3 per year in the Nile valley and Delta.

1.1 Background

Reclaiming municipal wastewater for agricultural reuse is increasingly recognized as an essential management strategy in areas where water is in short supply. Wastewater reuse has two major objectives: it improves the environment because it reduces the amount of waste (treated and untreated) discharged into water courses, and it conserves water resources by lowering the demand for freshwater abstraction. In the

process, reuse has potential to reduce the cost of both wastewater disposal and the provision of irrigation water, mainly around cities and towns with sewers.

The idea of recycling wastes to agriculture is not new. In China and other parts of Asia, 'night soil' (human feces and urine) has been used to fertilize crops and replenish depleted soil nutrients since ancient times. The earliest sewage farms documented in the literature appear to be those of Bunzlau, Germany, which were in operation in the 16th century. The 1950s saw a renewed interest in wastewater irrigation. One reason was rapid urbanization and the consequent rise in surface water pollution by wastewater discharges. Another reason was that in most cities, especially in arid areas, there was a scarcity of fresh water for irrigation and receiving water for sewage treatment plant effluent. These factors—and a better understanding of health risks—have resulted in increased reclamation of wastewater, primarily from treatment plant effluent.

In areas where water is in short supply, recycling of wastewater for agricultural irrigation can provide a strong economic impetus because it helps to conserve resources (including water and soil nutrients) and protect the environment by preventing river pollution, protecting water quality, and preventing seawater intrusion in coastal areas. In addition, recycling may often be the least costly solution for wastewater disposal.

Egypt has been using treated wastewater to produce wood and for other industrial uses since the mid-1990s. The Ministry of Agriculture and Land Reclamation (MALR) has established 23 water-reuse projects across the country to date. The most common crops include African Mahogany (*Khaya senegalensis)*, mulberry (*Morus spp*), and physic nut (*Jatropha curcas)*. So far, these projects have been exclusively government driven and private sector participation is absent. An inter-ministerial committee has recently approved the Egyptian Water Reuse Code and a Ministerial Decree giving it authority was issued in April 2005.

Task 6, Improving Water Reuse Practices, of the Livelihood and Income from the Environment–Integrated Water Resources Management (LIFE–IWRM) Project, aims to:

- Demonstrate the technical feasibility of water reuse, including environmental compliance and occupational safety
- Identify opportunities for the commercialization of existing crops through private sector participation
- Turn treated wastewater—a by-product of wastewater treatment (WWT)—from a disposal problem to an economic resource.

Appendix A includes more information on these goals, planned activities to accomplish them, potential stakeholders and partners, and methods for monitoring progress.

1.2 Report Purpose

The purpose of this report is to present the delivery and irrigation system at a demonstration site in Luxor. The consultant (whose Scope of Work is given in appendix B) prepared different alternatives for both delivery system and irrigation network.

1.3 Report Organization

This report is organized into four sections:

- Introduction and Background
- Selection of Pilot Area and Selection of Irrigation System
- Drip Irrigation Network Design
- Recommendations

2. Selection of Pilot Area

A site in Luxor to demonstrate the reuse of treated wastewater in agriculture was selected by the Ministry of State for Environmental Affairs (MSEA)/Egyptian Environmental Affairs Agency (EEAA), the MALR, and the LIFE–IWRM Project team. The criteria for selection was set in advance, taking into consideration that the demonstration site would be within one of the governorates where the project was active and it would be close to a wastewater treatment plant (WWTP). MSEA/EEAA worked with the Governor of Luxor, who approved designation of 10 feddans as a pilot area to promote wastewater use in irrigation. The site is in Luxor City, close to the local WWTP. A water source would be pumping directly from water pond lagoons.

The layout of the treated wastewater reuse demonstration site is included in appendix C, and results of an analysis of the soil, analysis of the treated wastewater, and climate data are given in appendices D, E, and F.

3. Selection of Irrigation System

Under normal conditions the type of irrigation method selected would depend on water supply conditions, climate, soil, crops to be grown, cost of irrigation method, and the ability of the farmer to manage the system. However, when using wastewater, other factors such as contamination of plants and harvested product, farm workers, the environment, salinity, and toxicity hazards should be considered.

The choice of irrigation method in using wastewater is governed by the following factors:

- Whether the foliage, fruits, or aerial parts of the plant will be wetted by the recycled wastewater
- Distribution of water, water and soil salinity, and contaminants in the soil
- Soil water potential could be maintained (field capacity)
- Efficiency of application
- Potential to contaminate farm workers, the environment, and crops.

Drip irrigation is the suggested system for the selected site. In general, this method is recommended for wastewater irrigation, particularly if filtration prevents clogging. Under drip irrigation, contact between the water and the crop foliage and fruit is greatly reduced. Moreover, no aerosols are formed—therefore no pollution of the atmosphere. However, some crops which is not suitable to use drip irrigation such as intensive crops, flood irrigation or improved furrow irrigation may be used.

Suspended solids should be removed as much as possible before sewage is used in the system. In this regard, the screen filtration would have an essential role in diminishing the problems created by solids in the effluents or biological growth at the emitters. In all cases, suspended solids (SS) should be removed as much as possible before sewage effluent is used.

4. Irrigation System Components

The major components of the system are:

1. Pump unit from the lagoon
2. Filters
3. Irrigation network.

4.1 Pump Unit

Due to the water quality issue, the project (in consultation with EEAA, MALR, the United States Agency for International Development (USAID), which funded the project, and the Luxor WWTP) decided to pump directly from the polishing lagoon pond of the WWTP. The project team was instructed not to put any equipment on the bank of the lagoon or drill any hole in the lining material. This restricted the design to consider sophisticated approaches to pump from the pond. The following alternatives were designed and presented to the project's Task 6 – Coordination Committee.

Alternative 1: Fixed Pump

This alternative is to install the pump on the other side of the bank of the lagoon and extend the suction pipes to the lagoon over the bank. The total length of the suction pipe would be about 40 m. To prime the pump, a water tank would be installed on top of the pumping house and opened during when the pump is started. During pumping, this tank would be automatically refilled for the next operation. This alternative has the advantages of security and protecting the water quality in the lagoon from pollution. However, it would require more energy and larger pump capacity (see figure 1).

Alternative 2: Floating Pump in the Lagoon

This alternative would have the pump unit fixed on a boat anchored to the far end of the bank by a steel wire. The draft pipe would cross the top of the bank to reach the filters on the other end of the bank, close to the demonstration site. This alternative has some advantages and disadvantages. It would reduce the suction head because the suction pipe would be small. It would also reduce the energy required and the pump power. However, this alternative might cause some pollution to the water of the lagoon due to leakage of oil and fuel from the pump into the pond. Security would be one problem as well as concerns that the pump might sink (see figure 2).

Figure 1 Fixed Pump System

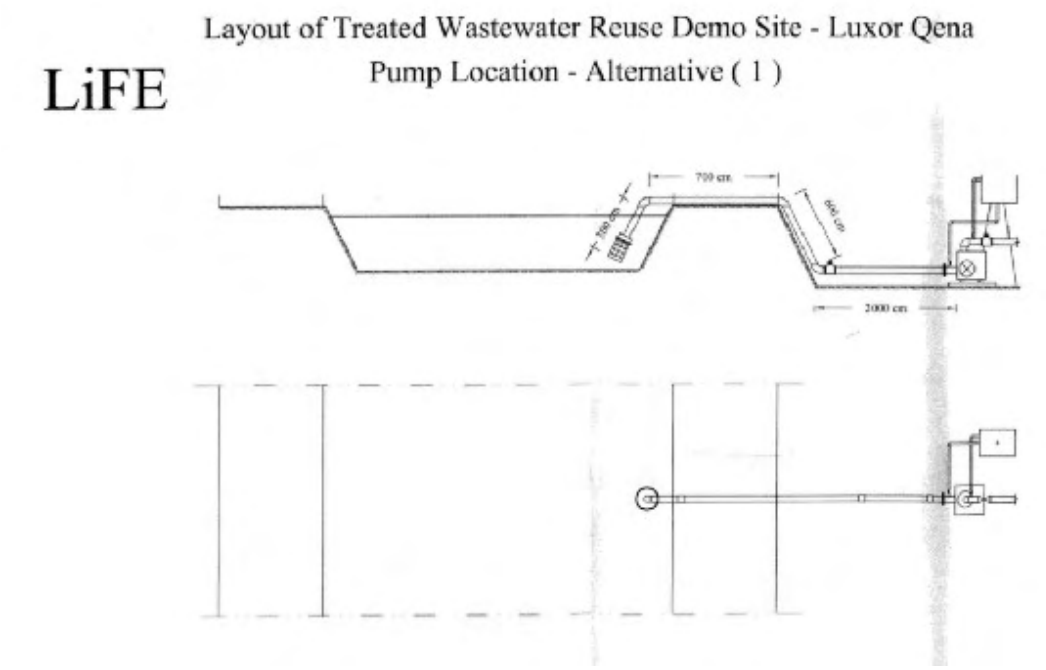
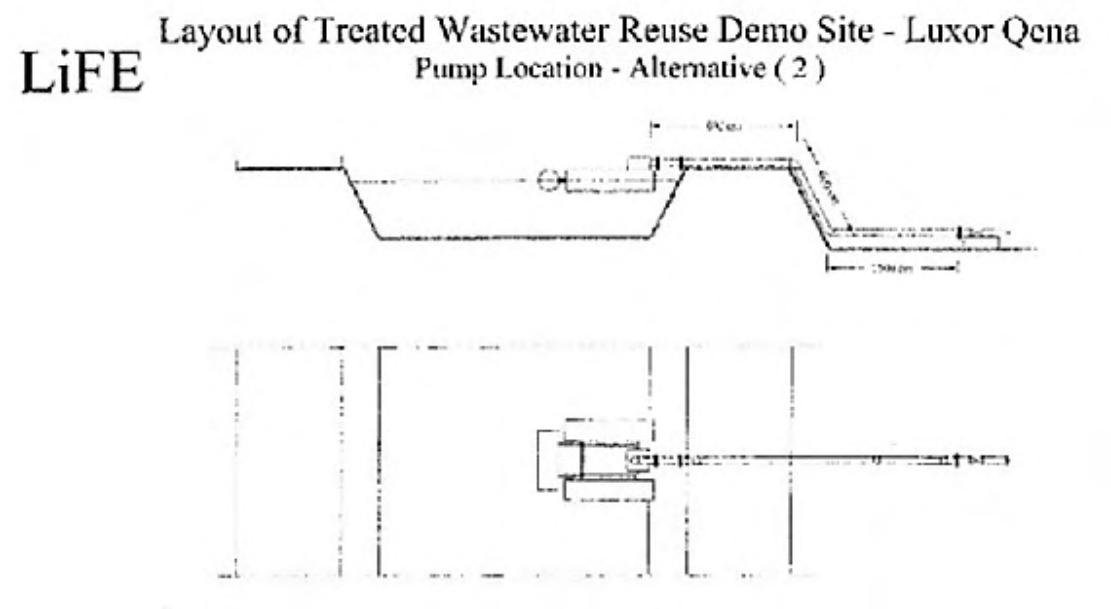


Figure 2 Floating Pump System



Energy Source for both Alternatives

Originally, plans called for use of a diesel pump. However, during the design stage, the team investigated using electricity. That option was rejected due to the high cost, but it would have the advantage of environmental protection.

Table 1 Pump Specifications

Item	Specifications
Pump unit	3/3-inch diameter with a discharge of 60-c.mt/hour at a head of 40-mts
Pump engine	25-hp and provided with a starter motor and battery with capacity of DIN 50
Priming	Self-priming pump
Propeller and pump case	Suitable for sewage water quality

4.2 Filters

There are two series of filters: gravel filters and screened filters. Each series would have three units. The gravel filter is 36-inch and the sand filter is 4-inch. Both filters are made of stainless steel or painted steel and epoxy. Drawings are included as appendix G.

4.3 Irrigation Network

The components of the irrigation network include main delivery lines, valves, meters, laterals, dripper lines, and the flushing exit. Drawings and a list of elements are included in appendix H.

Main Delivery Lines

The consultant presented two scenarios for main delivery lines: the first would provide the system with one main line followed by laterals; the second would split the main delivery line into two lines followed by laterals. One hundred twenty-five millimeter PVC pipe would be used, along with a meter and control valve.

Sub-main Lines (Lateral Lines)

Laterals would also be polyvinyl chloride (PVC) pipes with a diameter 75-mm. Each farm plot would have a valve and a meter, if possible.

Dripper Lines

Dripper lines would be 18-mm diameter, and the outlets to plants are spaghettis of 4-mm.

Flush Lines

At the end of dripper lines would be a collector to flush them.

4.4 Recommendation

A coordination meeting for Task 6 activities was held on 27 September 2005 at the EEAA offices. The committee decided to:

- Approve the pilot area layout
- Recommend the scenario of using a fixed diesel irrigation pump outside the lagoons
- Adopt the design for the drip irrigation network to be installed in the pilot area
- Approve the execution work plan
- Schedule irrigation during summer is to start at 5:00–10:00 a.m., with a second period beginning at 5:00 p.m. and ending at 8:00 p.m. Total is 8 hours per day.
- Schedule irrigation during winter is to start at 8:00 a.m. and end at 5:00 p.m. Total time available for irrigation is 8 hours, with one hour for lunch, although all 8 hours may not be needed.

4.5 Basics of Engineering Design

- Total area 10 feddans
- Peak water requirements during summer 40 m^3/feddan/day
- Total water requirements for 10 feddan/day 400 m^3
- Irrigation time during summer 8 hours/day
- Required pump discharge 50 m^3/hr
- Design pump discharge (50 × 1.2) 60 m^3
- Pump total head 40 mt
- Calculated losses
  - Operations loss
  - Filters loss
  - Pipes loss
- Field contours
- Soil analysis
  - Chemical
  - Mechanical
- Treated wastewater analysis
- Crop water requirements
- Labor skills in experimental area
- Recommended crops

- Irrigation network components available on the local market.

Appendix I contains selected engineering design charts.

وحدة ضخ مياه الصرف الصحى المعالجة:

المواصفات الفنية:

م	البيان	إجمالي
١	محرك ديزل رباعي الأشواط قدرة مناسبة لا تقل عن ٢٥ حصان - يرفق منحنيات المحرك والطلمبة للشركة المنتجة.	
٢	تبريد مياه.	
٣	تصرف لا يقل عن ٦٠م٣/ساعة عند رفع ٤٠م – ذاتية التحضير.	
٤	الإدارة بالمارش مع توريد البطارية.	
٥	الوحدة محملة على شاسية من الكمر شاملة خزان الوقود وجميع قواعد ماص الاهتزاز.	
٦	عدادات الضغط والحرارة والوقود.	
٧	الطلمبة تعمل لضخ مياه الصرف الصحي - يوضح نوع ومعدن الاكس ومروحة الطلمبة.	
الاجمـــــــــــــالى		

ملحقـــات:

م	البيان	إجمالي
١	يورد مع الطلمبة ماسورة سحب مجلفن لا تقل عن ٣ بوصة سمك لا يقل عن ٣ مم (كاملة بالكيعان والجوانات وفلانشات متحركة سمك ١٠ مم) بطول ٣م بصمام عدم رجوع ومصفاة السحب.	
٢	يورد مع الطلمبة ماسورة للسحب والطرد مجلفن قطر لا يقل عن ٣ بوصة سمك لا يقل عن ٣ مم كاملة بالكيعان والجوانات بطول ٥٠ م تقريبا و٢ محبس يوضح سمك الماسورة.	
٣	يورد جراب حديد نصف دائرة سمك ١٠ مم طول ٦ م عرض ١ م	
٤	يورد عدد (٢) اثنين وصلة مرنة لماسورة السحب والطرد.	
٥	تورد الوحدة والتركيب بموقع الغابة الشجرية بمدينة الأقصر – محافظة قنا- يتم اختبار الوحدة بالموقع على الحمل الكامل مدة الضمان لا تقل عن سنة..	
الاجمـــــــــــــالى		

خزان مياه بولى ايثيلين ١ م^3

م	البيان	إجمالي
١	يورد خزان مياه بولى اثيلين سعة ١ م^3 لتحضير الطلمبة كامل بالمواسير والوصلات والمحابس	
٢	يتم وضع الخزان أعلى غرفة الحراسة بارتفاع ٣ م تقريبا.	
	الاجمـــــــــــــالى	

البديـــل الثانى:

رصيف عائم لوحدة الضخ:

م	البيان	إجمالي
١	الشاسية من الكمر المجرى ١٠سم مجلفن مزود بخطاف التثبيت بالأرض جميع الخامات من الحديد والصاج المجلفن المستورد. جميع اللحامات طبقا لمواصفات الصناعة.	
٢	صاج العوامات سمك ٤مم من الصاج المجلفن	
٣	حوض تركيب طلمبة الضخ من الصاج المجلفن سمك ٤مم حسب الرسم المرفق.	
٤	تنفذ الوحدة طبقا للرسم المرفق بالأبعاد المطلوبة - يتم تركيب وحدة الضخ على الشاسية طبقا للمواصفات الخاصة بالشاسية - يتم اختبار الوحدة بالمصنع قبل التسليم لضمان عدم تسرب المياه داخل وحدات العوامة.	
٥	يورد عدد(٢) اثنين كإبل من الصلب كامل بالخطاف من الطرفين إحداهما يثبت بالأرض والآخر بالرصيف العائم للتحكم بالموقع مع مراعاة أن يكون الكابل داخل ماسورة حديد ٤ بوصة بطول لا يقل عن ١٠م.	
٦	يتم توريد الوحدة واختبارها بموقع المشروع بالغابة الشجرية بمدينة الأقصر- محافظة قنا.	
	الاجمـــــــــــــالى	

وحدة الفلاتر الرملية (زلطية)

الغابة الشجرية بالأقصر

م	البيان	الوحدة	إجمالي
١	وحدة فلاتر ميديا (زلطية) ٣٦" استانلس استيل أو من الحديد مدهونة بالايبوكسى اليكتروستاتيك مقاوم لمياه الصرف الصحي – الميديا مستوردة ويوضح بلد المنشأ	فلتر	٣
٢	وحدة مانيفولد كاملة بالحديد ٦" والمحابس وصمام الهواء – صمام تصرف الضغط هيدروليكي – عداد مياه – عدادات قياس الضغط – وجميع محابس التحكم والغسيل اللازمة وجميع الجوانات اللازمة. تورد الوحدة بموقع المشروع بموقع الغابة الشجرية بمدينة الأقصر- محافظة قنا (تلتزم الشركة بالتركيب والاختبار بالموقع).	وحدة	١

وحدة الفلاتر الشبكية

الغابة الشجرية بالأقصر

م	البيان	الوحدة	إجمالي
١	وحدة فلاتر شبكية ٤" دخول وخروج أو ديسك (قرصية) من الاستنلس استيل او من الحديد مستوردة مدهونة بالايبوكسى اليكتروستاتيك – يوضح بلد المنشأ	فلتر	٣
٢	الوحدة كاملة بالمانيفولد ٦" والمحابس اللازمة وعدادات الضغط للدخول والخروج – الشمعة (٨٠ – ١٠٠ مش) من الاستنلس استيل أو من الأقراص. تورد الوحدة بموقع المشروع بموقع الغابة الشجرية بمدينة الأقصر- محافظة قنا (تلتزم الشركة بالتركيب والاختبار بالموقع).	وحدة	١

قائمة بمكونات شبكة ري المساحة المقترحة

المقترح الاول للتصميم

م	البيـــــــــــــان	الوحدة	الإجمالي
١	مواسير ١٢٥مم ٦ض.ج	بالمتر	٢١٠
٢	مواسير ٧٥مم ٦ ض. ج	بالمتر	١٠٠٢
٣	بردة ١٢٥مم بالفلانشة الحديد	عدد	٨
٤	محبس ٣" إيطالي	عدد	١٤
٥	مجموعة مزدوجة ٣/٤"	عدد	٣
٦	T حديد ٤/٥/٥"	عدد	٣

م	البيـــــــــــــان	الوحدة	الإجمالي
٧	ولد حديد فلانشة قطر ٣"	عدد	١٢
٨	حرف S فلانشة وجلبة ٣"- (٢ كوع)	عدد	١٢
٩	طبة حديد ٥"	عدد	١
١٠	دكر ٣/٧٥	عدد	١٥
١١	دكر ٢/٧٥	عدد	١٥
١٢	طبة ٢" P.E	عدد	١٢
١٣	شعر كتان	كيلو	١
١٤	تيفلون	علبة	٥٠
١٥	كيس كاوتش ١٨مم	عدد	٥
١٦	كيس بداية ١٨مم	عدد	٥
١٧	كيس كوع ١٨مم	عدد	٥
١٨	كيس نهاية ١٨مم	عدد	٥
١٩	خرطوم ١٨مم	لفة (٤٠٠)	٦٠
٢٠	خرطوم اسباكيتى ٤مم	لفة	٢٠
٢١	جوان ٣"	عدد	٢٥
٢٢	جوان ٥"	عدد	٢٠
٢٣	مسمار بالوردة والصامولة – مقاسات	كيلو	٣٥
٢٤	لصق سيزرماجيك	كيلو	١٥

قائمة بمكونات شبكة ري المساحة المقترحة

المقترح الثانى

م	البيـــــــــــــان	الوحدة	الإجمالي
١	مواسير ١٢٥مم ٦ض.ج	بالمتر	٨٦٠
٢	مواسير ٧٥مم ٦ ض. ج	بالمتر	١٢٠٠
٣	بردة ١٢٥مم بالفلانشة الحديد	عدد	١٢
٤	محبس ٣" إيطالي	عدد	٣٢
٥	محبس ٢" إيطالي	عدد	٢٥
٦	مجموعة مزدوجة ٣/٤"	عدد	١٠
٧	حديد T"٤/٥/٥	عدد	١٠
٨	ولد حديد فلانشة قطر ٣"	عدد	٤٠
٩	فلانشة وجلبة ٣"Sحرف	عدد	٢٠
١٠	طبة حديد ٥"	عدد	١
١١	دكر ٣/٧٥	عدد	٤٥
١٢	دكر ٢/٧٥	عدد	٤٠

م	البيـــــــــــــان	الوحدة	الإجمالي
١٣	P.Eطبة ٢"	عدد	٢٠
١٤	شعر كتان	كيلو	١
١٥	تيفلون	علبة	٥٠
١٦	كيس كاوتش ١٨مم	عدد	١٠
١٧	كيس بداية ١٨مم	عدد	١٠
١٨	كيس كوع ١٨مم	عدد	١٠
١٩	كيس نهاية ١٨مم	عدد	١٠
٢٠	خرطوم ١٨مم	لفة (٤٠٠م)	٧٠
٢١	خرطوم اسباكيتى ٤مم	لفة	٢٠
٢٢	جوان ٣"	عدد	٢٥
٢٣	جوان ٥"	عدد	٢٠
٢٤	مسمار بالوردة والصامولة – مقاسات (٤ لنية ٦،٧سم)مجلفن	كيلو	٥٠
٢٥	وردة ٤ لنية مجلفن	كيلو	١٠
٢٦	لصق سيزرماجيك	كيلو	١٥
٢٧	عداد مياه ٤"	عدد	٧

أعمال الحفر والأعمال المدنية اللازمة

١- حفر خطوط المواسير ١٠٠٠م/ط.

٢- عمق الحفر لا يقل عن ٩٠سم للخطوط الرئيسية.

٣- عمق الحفر لا يقل عن ٦٠سم للخطوط التحت رئيسية.

٤- عرض الحفر لا يقل عن ٥٠سم.

٥- أرضية خرسانية طول ٥X٦X٠,٤م لتثبيت الفلاتر الزلطية والشبكية.

٦- إنشاء حجرة مكتب للإدارة مزودة بدورة مياه.

٧- إنشاء حجرة للحراسة – مزودة بدورة مياه.

٨- العمالة اللازمة (١٥ عامل X ١٠ يوم X ٢٥ جنية = ٣٧٥٠ جنية).

٩- جراب حديد سمك ١٠ مم لحماية مواسير السحب بالطريق طول ٦ م وعرض ١م.

١٠- قائمة بأسماء الشركات

م	الاسم	العنوان	تليفون	فاكس
١	جى . أم (الخليجية) – مواسير	٧٧ ب طريق النصر – مدينة نصر	٤٠٥٠٣٦٩	٤٠٥٠٣٧٦
٢	المتحدة للبلاستيك ولوازم الري	٣٣ ش عبد الوهاب القاضي – كلية البنات – مصر الجديدة	٤١٧٠٤٥١ ٤١٥٢٧٠٤	٤١٧٠١٨٠
٣	المصرية السعودية للصناعات البلاستيكية (مصر دريب)	١٥٨ ش الحجاز – مصر الجديدة	٦٤٢٣٣٤٢ ٦٤٢٣٣٢٥	٦٣٥٨٨٧٨
٤	الشركة المصرية لصناعة المواسير والكيماويات (آلفابيب)	مدينة بدر – المنطقة الصناعية (٤) قطعة ١٦ ، ١٨	٠١٥/٢١٠٦٠١ - ٠١٥/٢١٠٦٠٢	٠١٥/٢١٠٦٠٣
٥	الوايلر فريد حسانين	أبراج أغاخان – كورنيش النيل	٤٣٠١٨١٧ ٤٣٠١٥٣٠	
٦	تكنوجرين (فلاتر)	٥١ ش عثمان بن عفان – ميدان الإسماعيلية	٤١٧٨٦٤٦ ٤١٥٥١٣٣ ٤١٨٣١٤٧	
٧	رمسيس للتجارة والاستيراد	٥٦ ش الجمهورية	٥٩١١٤٦٧ ٥٩٢٦٢١٣	٥٨٨٠٠٠٢
٨	الأوربية للتنقيط (خراطيم)	١٦٤ ش الأهرام – جيزة	٣٨٧٢٤٣٧ ٣٨٧٢٤٣٨ ٣٨٧٢٤٣٩	٣٨٧٢٤٤١
٩	جرين تك للتوكيلات التجارية (د/ احمد بهجت)	٤ ش احمد نسيم الجيزة	٧٦١٨٨٠٥ ٧٤٩٨٦٧٧	٧٦١٨٨٠٤
١٠	شركة جيمكو	٢٤ عماد الدين	٥٧٩٤٧٠٣ م/ ٠١٢٤٢٤٨٤٦٠	٥٧٨٤٦٢٢
١١	الشركة الأوربية	٥٦ ش السبتية – برج الشبراويشى	٥٧٨١٩٥٨	
١٢	العالمية بلاست	٥٢ ش المنصورى – السبتية	م/٠١٢٣٩٠٤٤١٨	٥٧٩٧٧٩٥
١٣	شركة تنمية المشروعات	٣٨٠ ش جوهر النيل – المعادى	٥٢٥٦٦٩٢	
١٤	الشركة العربية الأوربية للرى والزراعة	١١ ش شهاب – المهندسين – الدور السادس	٣٤٨٦٤٦٠ ٣٦١٤٢٧٨	٣٦١٤٢٧٩
١٥	الشركة الكويتية المصرية لانتاج الأنابيب البلاستيك (اسلون مصر)	٣٤ ش قصر النيل	٣٩٢١٥٦٧ ٣٩٢٤٥٧٢ ٣٩٣٤٥٤٣	٣٩٢١٥٦٧
١٦	الشركة المتحدة لصناعة البلاستيك والرى الحديث	٣٣ ش الشهيد عبد الوهاب القاضى – كلية البنات – مصر الجديدة	٦٦٢٧٠٤ ٤١٧٠٤٥١	٦٦٦٨٤٧ ٤١٧٠١٨٠
١٧	شركة ايجكس للتجارة	٥٠ ش الجمهورية	٥٩١٨٠٣٥ – ٥٩١١٩٢٠	٩٠٥١٨٧

م	الاسم	العنوان	تليفون	فاكس
١٨	شركة ايه اتش مودرنا	٧ ش الهنيدى – مدكور – الهرم	٨٦٩٧٥٨	٣٦٠١٦١٤
١٩	شركة بكير للبلاستيك	ك ١٤ طريق القاهرة/ الاسكندرية الزراعى البطئ	٢١٥٦٢٤٤ ٢١٥٦٧٦٦	٢١٥٠٤٦١
٢٠	مؤسسة الحكيم	١ ش ممنون – الكوربة – مصر الجديدة	٢٩١٦٦٨٥ ٢٩١٥٧٩٨	٢٩١٥٧٩٨
٢١	مؤسسة حبيش للصناعة	١٣ ش المطبعة الاهلية – وكالة البلح	٧٦٢٠٣١ ٧٦١٦٣١	٧٧٩٧٩٩
٢٢	شركة احمد داود وشركاه (ماديكو)	١١ ش الشريفين	٣٩٣٥٠٨٦ ٣٩٢١٥٥٠ ٣٩٢١٧٨٨	٣٩٢١٥٠١
٢٣	شركة الشرق الاوسط (ميكو)	٢٨ ش مراد – الجيزة	٥٧٣٦٢٣٩	٥٦٨٧٢٤٢
٢٤	شركة حلوان لمحركات الديزل (٩٠٩ الحربى سابقا)	١٨ ش عماد الدين – القاهرة	٥٧٥٥٩١٩ ٥٧٨٨٨٤٠	٧٦٠٥٢٣
٢٥	شركة ديماوند العالمية للصناعات الهندسية	٢٠ ش عماد الدين –مبنى يونيكو	٥٧٤٥٥١٣ ٥٧٤٥٥٤٢	٤٧٤٥٧١١
٢٦	ابناء سعد حنا للتجارة والمقاولات	٤٣ ش نخلة المطيعى – ميدان تريومف	٦٣٣٥١٠٩ ٦٣٤١١١٣	٦٣٣٥١٠٧
٢٧	آى دبليو (أمين رشوان)	٣٧ ش الزهراء – متفرع من ش عمان	٧٤٨٠٤١٨ ٧٦٠٤٩٩٥	٧٤٨٠٤١٨
٢٨	الشركة الاوربية للرى بالتنقيط	مدينة السادات م.ص. ٤	٠١٠١٢١٠٧٥٥/م	٠٤٨٢٦٠٥٤٦١
٢٩	شركة ارامكو للاستيراد	٧١ ش الجمهورية – الازبكية	٥٩١٧٥٠٤ ٧٨٦٥٠٣١	
٣٠	يورودريب ايجيبت		٣٨٧٢٤٣٩ ٣٨٧٢٤٣٧	٣٨٧٢٤٤١

Appendix A Task 6 Objectives, Activities, and Partnerships

A.1 Objectives

The objectives of Task 6 are to:

- Demonstrate the technical feasibility of water reuse, including environmental compliance and occupational safety
- Identify opportunities for the commercialization of existing crops through private sector participation
- Turn treated wastewater (a by-product of WWT) from a disposal problem to an economic resource.

A.2 Background

Egypt has been using treated wastewater to produce wood and other commercial crops since the mid-1990s. The Ministry of Agriculture and Land Reclamation (MALR) so far has established 13 water-reuse projects across the country. The most common crops include African Mahogany (*Khaya senegalensis*), mulberry (*Morus spp*), physic nut (*Jatropha curcas*), and flax. To date, these projects have been exclusively government-driven and private sector participation is absent or negligible. An inter-ministerial committee recently approved the Egyptian Water Reuse Code and it was endorsed by the Council of Ministers in December 2004.

A.3 Approach

The Project's focus is to encourage private sector participation in the reuse of treated wastewater for cash and commercial crops. To change private sector attitudes, the Project addresses: 1) the potential environmental and health impacts of using treated wastewater for agriculture of specified crops according to the approved Egyptian Water Reuse Code; and 2) the economic feasibility of reusing treated wastewater on some commercial crops as approved by the Egyptian Code.

The Project approach is to involve the private sector in all project activities. This will include orientation and training of the private sector on sound cultivation and irrigation practices including environmental issues and mitigation measures. The Project will mobilize farmers' organizations and offer opportunities for non-employed agricultural graduates to secure jobs in connection with the demonstration site. The

Project is training the graduates on sound agricultural practices and environmental monitoring, where they will be responsible for marketing all yields from the demonstration site and will benefit from any returns from it.

A.4 Activities

To achieve the task objectives, the project team will implement the following activities:

1. Site selection
2. Crop selection and cropping layout
3. Participation of agricultural graduates
4. Orientation and training
5. Baseline assessment and Environmental Monitoring Plan
6. Irrigation and crop management plan
7. Field implementation and follow-up
8. Private sector participation
9. Preliminary economic evaluation of water reuse in Luxor.

The following sections provide a brief description of those activities.

Activity No. 1 Site Selection

The site is situated in Luxor, approximately 1 km from the local WWTP, measuring 5 feddans (550 m × 35 m). The project may expand it to 6.5 feddans (550 m × 50 m). A water conduit is already installed and the site would need to tap water from it.

Activity No. 2 Crop Selection and Cropping Layout

The area of reused treated wastewater in Luxor currently grows African Mahogany (*Khaya senegalensis*), Physic Nut (*Jatropha curcas*) and Japanese Mulberry (*Morus spp*). The project, through consultation with EEAA, USAID, and MALR, will select new crops such as flowers, grass, and flax. The selection will be dependent on the Egyptian Water Reuse Code. Once the crops are selected, the project team will prepare an optimal cropping layout based on the site topography and the number of crops selected.

Activity No. 3 Participation of Agricultural Graduates

To promote early private sector participation in this activity and create new job opportunities, the project will invite agricultural graduates to work at the demonstration site. The criteria and mechanism for doing this will be established and discussed with EEAA and USAID. El-Shams Project–AERI Horticultural Grant Component is one of several USAID projects aimed at alleviating poverty among the poorest rural households in Upper Egypt. El-Shams is helping farmers setup and organize associations. To date, El-Shams Project has established four Farmers'

Associations (FA) in Luxor. These associations are growing and marketing horticultural crops. At the same time, MWRI has established 43 Branch Canal Water Users Associations (BCWUAs) on all irrigation canals within Luxor. LIFE–IWRM project will work with these BCWUAs during the life of the project on strengthening them. Under Task 6, the project Team will approach El-Shams to select at least one FAs that would offer opportunities for overlap or linkages with one of the BCWUAs and select the non-employed agricultural graduates who will be partners in this demonstration activity.

Activity No. 4 Orientation and Training

The project will conduct orientation meetings for representatives from the FAs and BCWUAs on the objectives of the demonstration site. It will also train the nominated graduates on how to use treated wastewater in agriculture in a manner that is environmentally safe and compliant. The emphasis will be on the production of a targeted selection of commercial crops.

Activity No. 5 Baseline Assessment and Environmental Monitoring Plan

The Environmental Monitoring Plan (EMP) will define baseline data requirements at the onset of the project as well as monitoring requirements during the project's lifetime. At minimum, baseline data requirements will include treated wastewater quality, soil physical and chemical characteristics, groundwater level and quality, topography, biodiversity, and climatic data. The project will collect water samples from the exit from the WWTP and at the inlet of the irrigation site and send them to the MWRI Central Lab in Cairo. The Project will obtain climatic data from the Luxor meteorological station or MALR regional office to help finalize crop selection and prepare the irrigation and crop management plans. Baseline assessment of groundwater and biodiversity will depend on the availability of such data at MWRI and EEAA, respectively.

During project implementation (up to 4 years), the project will monitor a number of parameters periodically, including: effluent quality, soil quality, occupational health and safety, and groundwater table and quality. To monitor groundwater level and quality, two observation wells will be installed. Soil samples will be collected for analysis during the drilling of the observation wells. To the extent that they are available, the project will collect groundwater data from the Groundwater Sector at MWRI and/or other sources including the Desert Research Institute at MALR, as needed.

The EMP will spell out specific monitoring requirements (e.g., effluent, soil, groundwater, plants, and health and safety) and present recommendations to safeguard the physical/biological environment. The project will seek EEAA's approval prior to implementing the EMP. Mr. Karim El-Jisr, the environmental specialist on Task 6, will take the lead on this activity with technical input from the rest of the project team.

Activity No. 6 Irrigation and Crop Management Plan

The Irrigation and Crop Management Plan will consist of two components: (1) Irrigation Plan and (2) Crop Management Plan. The project will rely on one local Water Reuse Specialist who will develop the irrigation plan, taking into consideration site topography, effluent quality, and the type of crops. A local agronomist will develop the crop management plan based on the type of crops, soil quality, and climatic conditions in Luxor.

Activity No.7 Field Implementation and Follow-up

To establish the demo site, the project will:

- Provide shelter (for workers/farmers and, eventually, visitors as well)
- Provide a safe storage room (to keep all the supplies in one secure location)
- Install an irrigation system (e.g., pipes, fittings, and meters)
- Purchase seeds/seedlings and plant them
- Irrigate according to the irrigation plan
- Troubleshoot (e.g., refining irrigation schedules, implementing corrective measures in case of poor plant growth)
- Undertake sampling and analysis in accordance with the EMP.

Mr. Ayad Kariakos, Site Coordinator, will assume overall responsibility to implement this activity successfully with on-the-field support from the Demonstration Site Engineer (Mr. Awad Shafik) and logistical support from the project office in Cairo.

Activity No. 8 Private Sector Participation

In addition to the expected involvement of the graduates in managing the demonstration site and harvesting/marketing the produce, the project will seek ways to engage the private sector on a large scale. For example, the project will organize roundtables and workshops with local farmers and manufacturing industries to explain the project and its findings and draw attention to the approved Egyptian Wastewater Reuse Code.

Activity No.9 Preliminary Economic Evaluation of Wastewater Reuse in Luxor

At the end of the experiment, the project will conduct a preliminary economic evaluation of wastewater reuse based on the results of the demonstration site. Close to the end of the project, probably at the second quarter of 3rd year of LIFE–IWRM the project will issue a final report including all the economic evaluation and environmental issues.

A.5 Outputs

The expected deliverables for Task No. 6 are:

- List of crops and crop layout (Activity 2)
- Environmental Monitoring Plan (Activity 5)
- Irrigation and Crop Management Plan (Activity 6)
- Operational demonstration site (5 feddans) for water reuse in Luxor (Activity 7)
- Issues and Options paper on engaging the private sector in WWR (Activity 4 & 8)
- Nine seminars/workshops with the private sector, including farmers and industries
- Preliminary economic evaluation study (Activity 9)
- Final Activity report listing findings and recommendations (Activities 1–9).

A.6 Assumptions

The MSEA (EEAA) will facilitate and endorse the crop selection, crop layout, and the environmental monitoring plan in a timely manner. MSEA also will facilitate all communications with and approvals from MALR, MWRI, the Ministry of Housing, and the Ministry of Health.

A.7 Partners and Responsibilities

While MSEA is the primary beneficiary, several other ministries, agencies, and NGOs are critical to the success of this task, as outlined in table 2.

Table 2 Roles and Responsibilities of Stakeholders

Stakeholder	Role and Responsibilities
MSEA	• Facilitate communication with MOA • Provide free access to EEAA labs • Approve crop selection and Environmental Monitoring Plan • Survey biodiversity at target site in Luxor
MALR	• Provide office and storage facility • Permission to use available infrastructure (e.g., pumps, filtration unit) • Permission to use the designated site (about 5 feddans)
MWRI	Provide access to groundwater data in Luxor and water samples analysis
Ministry of Housing	Permission, if needed, to use TWW from Luxor treatment plant
Private Sector	• Farmers: participate in seminars/roundtables • Marketing and manufacturing industries: participate in seminars/workshops
NGOs	Farmer's Associations/Horticultural Export Improvement Association: host and facilitate organization of roundtables with farmers and workshops with manufacturing industries BCWUAs: provide the project with the names of Agricultural Graduates Farmers' Associations: assist selection of commercial crops and provide assistance to graduates for marketing the products

Appendix K lists the names of those who have been essentially involved with implementing this project.

Training

The project will provide orientation session to FAs and BCWUAs as well as formal and on-the-job training to fresh graduates and workers on safe and compliant agricultural practices.

Commodities

Commodities are grouped into nine categories:

1. Site preparation
2. Supply and installation of irrigation equipment
3. Agricultural inputs
4. Monitoring equipment and lab testing
5. Operation and maintenance (e.g., field labor, office expenses, and communication)
6. Office equipment
7. Transportation
8. Travel
9. Public awareness

Public Awareness, Education, and Communication Material

The project will design and produce an information leaflet on water reuse including dos and don’ts. It could be in the form of a semi-glossy foldout (A4 size), four colors, printing 5,000 copies for public distribution. The leaflet could also present relevant excerpts from the water reuse code.

A.8 Stakeholder Participation

See A-7.

A.9 Monitoring and Evaluation

Assuming the demonstration site will begin in 2005, a detailed implementation plan will be presented after selection of crops and collection of base-line information. The plan will include progress indicators and targets.

Appendix B Scope of Work: Irrigation System Design and Supervision of Installation Activities

B.1 Description of Work

General

Under this purchase order, the vendor will provide the LIFE–IWRM Project with local technical assistance to support the implementation of Task # 6 Improved Wastewater Reuse Practices. The vendor will work with the LIFE–IWRM TA Team, MSEA/EEAA, MALR, USAID, IWMU, and involved stakeholders to prepare design of the irrigation system and alternatives of the pump station to serve the demo site in Luxor. LIFE–IWRM is implementing a pilot activity to demonstrate different options for improving reuse of treated wastewater.

Specific

Specifically, the vendor with guidance and input from the IWRM team will carry out the following activities.

1. Review project documentation, including the requirements for the demo site in Luxor and the planned kind of crops as it was approved by the Coordination committee of the activity. The consultant will get copies of the water quality analysis in the site and effluent test results.
2. Visit the demonstration site in Luxor (located near the existing and expanded WWTP) as well as surrounding lands to become familiar with the agricultural activity in the areas, the type of crops, soil characteristics, and the potential demand for water reuse and to investigate the different alternatives for the pump site.
3. Prepare the irrigation designs for the demo site. The consultant will meet with MALR irrigation system design team to finalize effluent storage options, pumping requirements, design of delivery system and distribution network, selection of filtration and fertigation unit, and identification of other ancillary equipment as needed.
4. Finalize technical design specifications according to GOE standards to include design drawings, bill of quantities, and materials and equipment specifications
5. Present the different alternatives of the design for both the pump station and the irrigation net work to USAID and EEAA.
6. Prepare tender documents IAW USAID regulations to include specifications for procurement of equipment, materials, and civil works.

7. Conduct analysis of the bids and provide recommendations
8. Supervise the field construction and installation of all the system and report weekly on the accomplishments.
9. Test the pump station and pump units for its performance and conduct the final test for all the system to meet the specifications.
10. Brief and make presentations to the USAID Technical Officers, EEAA, MALR officials, and other stakeholders on behalf of LIFE–IWRM Program regarding specific work activities.

B.2 Work Schedule

All work performed under this purchase order is to be completed no later than October 31, 2005.

The tentative schedule of work is shown below and will be finalized at the time the work is performed.

Date	Activity
30 August 2005	Review project documentation
6-7 Sep. 2005	Visit the demonstration site in LUXOR
20 Sep. 2005	Prepare the draft of the irrigation designs for the demo site
25 Sep. 2005	Finalize technical design specifications according to GOE standards
	Present the different alternatives of the design
29 Sep. 2005	Prepare tender documents IAW USAID regulations
5 October 2005	Conduct analysis of the beds
10-25 October 2005	Supervise the field construction and installation
25 October 2005	Test the pump station
30 October 2005	Preparing Final Report
Upon request	Presenting The Outputs of The Assignment

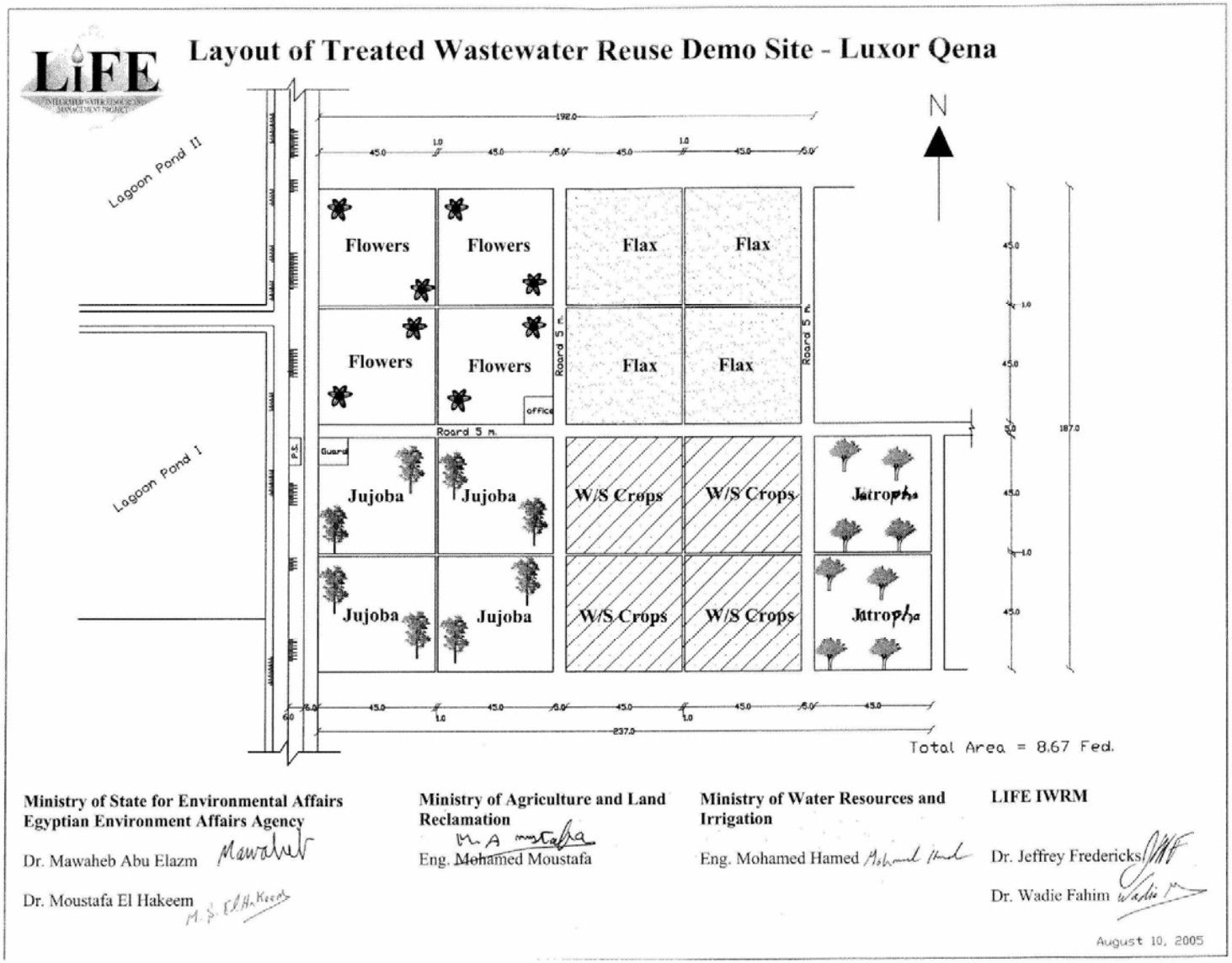
B.3 Deliverables (in hard copy and electronic copy on CD)

1. Irrigation plan
2. Approved technical design specifications
3. Tender documents
4. Tender Evaluation for suppliers/contractors
5. Trip reports in memo format describing activities carried out during each field trip including places visited, persons met, and record of discussions with key

individuals and/or key meetings/communications, highlighting key issues and proposed action items

6. Final report presenting work done
7. Electronic versions of any presentation handouts or training material prepared under these Terms of Reference.

Appendix C Layout of Treated Wastewater Reuse Demonstration Site


LiFE
Layout of Treated Wastewater Reuse Demo Site - Luxor Qena
N
Lagoon Pond II
Lagoon Pond I
Flowers
Flowers
Flowers
Flowers
Flax
Flax
Flax
Flax
Road 5 m.
Road 5 m.
Road 5 m.
Office
Guard
P.S.
Jujoba
Jujoba
Jujoba
Jujoba
W/S Crops
W/S Crops
W/S Crops
W/S Crops
Jatropha
Jatropha
192.0
237.0
187.0
Total Area = 8.67 Fed.
Ministry of State for Environmental Affairs
Egyptian Environment Affairs Agency
Dr. Mawaheb Abu Elazm
Dr. Moustafa El Hakeem
Ministry of Agriculture and Land Reclamation
Eng. Mohamed Moustafa
Ministry of Water Resources and Irrigation
Eng. Mohamed Hamed
LIFE IWRM
Dr. Jeffrey Fredericks
Dr. Wadie Fahim
August 10, 2005

Appendix D Soil Analysis

Table 3 Locations of Soil Samples

N 25^0 37.882’
E 032^0 40.773’
(0,200)

N 25^0 37.772’
E 032^0 40.844’
(220,200)

● **C-1** N 25^0 37.841’ E 032^0 40.762’	M.A ● **C-2** N 25^0 37.812’ E 032^0 40.781’	● **C-3** N 25^0 37.781’ E 032^0 40.785’	M.A ● **C-4** N 25^0 37.766’ E 032^0 40.806’	C.A ● **C-5** N 25^0 37.747’ E 032^0 40.816’
M.A ● **B-1** N 25^0 37.828’ E 032^0 40.737’	● **B-2** N 25^0 37.799’ E 032^0 40.758’	C.A ● **B-3** N 25^0 37.774’ E 032^0 40.773’	● **B-4** N 25^0 37.756’ E 032^0 40.782’	M.A ● **B-5** N 25^0 37.746’ E 032^0 40.798’
C.A ● **A-1** N 25^0 37.817’ E 032^0 40.709’	● **A-2** N 25^0 37.783’ E 032^0 40.728’	● **A-3** N 25^0 37.756’ E 032^0 40.745’	M.A ● **A-4** N 25^0 37.740’ E 032^0 40.754’	● **A-5** N 25^0 37.722’ E 032^0 40.762’

(0,0)

N 25^0 37.827’
E 032^0 40.669’

(220,0)

N 25^0 37.724’
E 032^0 40.739’

● **Sites of collected analysis**

☐ **Location of samples for analysis**

C.A Complete analysis

M.A Mechanical analysis only

Table 4 Macro- and Micro-nutrient Concentration in Soil Samples (CA)

S. No.	Soil profile No.	Depth (cm)	mg/kg soil							
			N	P	K	Cu	Fe	Mn	Zn	B
1	A1	0-30	120.4	4.65	130.3	0.37	2.21	1.08	0.31	0.88
2		30-60	80.0	3.64	97.5	0.31	2.22	0.81	0.32	0.94
3		60-90	58.6	3.26	81.9	0.29	1.83	0.72	0.28	0.87
4	B2	0-30	77.3	1.41	171.6	0.41	2.23	0.57	0.27	1.34
5		30-60	88.0	1.25	124.8	0.46	2.25	0.06	0.32	1.38
6		60-90	92.3	1.25	106.9	0.41	2.16	0.06	0.31	1.20
7	C5	0-30	63.9	1.96	116.2	0.28	2.03	0.54	0.22	0.87
8		30-60	82.5	1.97	124.8	0.27	1.92	0.58	0.26	0.88
9		60-90	65.0	2.08	89.7	0.30	2.02	0.44	0.22	1.00

Table 5 Particle Size Distribution and Texture of Soil Samples

Soil profile No.	*Depth* (cm)	Particle size distribution (%)				Texture
		Clay	Silt	*Sand*		
				Fine	Coarse	
A1	0-30	2.4	6.98	4.62	86.0	*Sandy*
	30-60	2.34	7.15	4.41	86.1	
	60-90	4.51	15.2	2.89	77.4	*Sandy*
A4	0-30	27.3	63.6	3.46	5.55	*Silty Loamy*
	30-60	5738	31.6	8.92	1.68	Clay
	60-90	11.7	2.38	8.02	77.4	Loamy Sand
B1	0-30	1.06	1.67	7.21	90.1	Sandy
	30-60	2.07	5.52	6.31	86.1	Sandy
	60-90	1.04	4.08	4.18	90.7	Sandy
B5	0-30	1.94	9.27	1.49	87.3	Loamy Sand
	30-60	2.1	3.1	6.9	87.9	Sandy
	60-90	1.01	1.59	10.5	86.9	Sandy
B3	0-30	4.6	9.7	3.9	82.2	Loamy Sand
	30-60	0.97	3.86	6.67	88.5	Sandy
	60-90	1.93	5.21	7.56	85.3	Sandy

Soil profile No.	*Depth* (cm)	Particle size distribution (%)				Texture
		Clay	Silt	*Sand*		
				Fine	Coarse	
C2	0-30	2.77	7.77	12.2	77.3	Sandy
	30-60	4.9	10.2	10.00	74.9	Loamy Sand
	60-90	1.7	9.2	1.8	87.3	Loamy Sand
C4	0-30	1.71	4.67	1.92	91.7	Sandy
	30-60	1.74	4.96	2.8	90.5	Sandy
	60-90	1.07	11.4	4.93	82.6	Loamy Sand
C5	0-30	2.58	6.9	2.02	88.5	Sandy
	30-60	4.75	2.38	5.17	87.7	Sandy
	60-90	0.9	3.79	4.21	91.1	Sandy

Table 6 Chemical Analysis of Saturated Soil Paste Extract (CA)

Sample No.	Soil profile	Depth (cm)	pH	SP	EC (dS/m)	Anions (meq./l)				Cations (meq./l)				$CaCo_3$ (%)	O.M (%)
						Co^{--}_3	HCO^{-}_3	Cl^{-}	So^{--}_4	Ca^{++}	Mg^{++}	Na^{+}	K^{+}		
1		0-30	8.1	23	5	-	1.93	18.54	33.33	25.41	7.71	18.37	2.31	1.6	0.2
2		30-60	8	22	4.8	-	1.65	12.36	37.65	26.18	9.1	14.52	1.86	0.8	0.16
3	A1	60-90	7.95	22	4.8	-	1.65	14.42	35.65	26.95	9.77	13.97	1.25	0.8	0.45
4		0-30	8.45	29	7	-	1.1	25.75	48.37	26.18	17.02	30.16	1.86	1.2	0.53
5		30-60	8.05	25	6.7	-	1.1	28.84	40.56	28.49	11.11	26.25	1.65	0.8	0.43
6	B3	60-90	8.1	25	7.4	-	1.38	30.9	49.56	29.26	14.13	36.8	1.65	0.8	0.51
7		0-30	8.45	25	3.5	-	1.38	15.45	18.75	9.63	5.13	19.28	1.54	1.2	0.03
8		30-60	8.45	25	4.3	-	3.58	16.48	24.32	15.79	6.53	20.25	1.81	1.2	0.03
9	C5	60-90	8.35	24	3.8	-	1.93	15.45	21.68	13.86	7.38	16.48	1.34	1.2	0.03

Appendix E Treated Wastewater Analysis

مدينة الأقصر

ادارة مياه الشرب والصرف الصحى

معمل تحاليل الصرف الصحى

نتيجة تحليل عينة مياه صرف صحى من مدخل ومخرج محطة برك التثنيت (البوند)

تاريخ اخذ العينة ٢٠٠٥/٩/١٤

م	عنصر التحليل	الوحدة	مدخل المحطة	مخرج المحطة	الحد المسموح
١	درجة الحرارة	درجة مئوية	٣٧	٣٠	٣٥
٢	PHالأس الهيدروجيني		٦,٥	٧,٨	من ٦ الى ٩
٣	BODالأكسجين الحيوي الممتص	مج/ل	٢٢٠	٢٥	٤٠
٤	CODالأكسجين الكيماوي المستهلك	مج/ل	٢٦٥	٣١	٨٠
٥	DOالأكسجين الذائب	مج/ل	٠	٧,٥	لا يقل عن ٤
٦	TSالمواد الصلبة الكلية	مج/ل	٦٣٤	٤٥٤	٢٠٠٠
٧	TSSالمواد العالقة الكلية	مج/ل	٢١٥	٣٠	٤٠
٨	العد الاحتمالي للمجموعة القلونية فى ١٠٠ سم^{٣}	فى ١٠٠سم^{٣}	١٠٠٠٠٠٠	٢٤٠٠	٥٠٠٠

العينة مطابقة للمعايير طبقا لقرار وزير الاسكان رقم ٤٤ لسنة ٢٠٠٠

مدينة الأقصر

ادارة مياه الشرب والصرف الصحى

معمل تحاليل الصرف الصحى

نتيجة تحليل عينة مياه صرف صحى من مدخل ومخرج محطة برك التثنيت (البوند)

تاريخ اخذ العينة ٢٠٠٥/٩/١٥

م	عنصر التحليل	الوحدة	مدخل المحطة	مخرج المحطة	الحد المسموح
١	درجة الحرارة	درجة مئوية	٣٩	٣١	٣٥
٢	PHالأس الهيدروجيني		٦,٣	٨,٠٥	من ٦ الى ٩
٣	BODالأكسجين الحيوي الممتص	مج/ل	٢٠٥	٢٨	٤٠
٤	CODالأكسجين الكيماوي المستهلك	مج/ل	٢٤٥	٤٠	٨٠
٥	DOالأكسجين الذائب	مج/ل	٠	٨,٣	لا يقل عن ٤
٦	TSالمواد الصلبة الكلية	مج/ل	٦٣٣	٤٨٦	٢٠٠٠
٧	TSSالمواد العالقة الكلية	مج/ل	٢١٠	٣٢	٤٠
٨	العد الاحتمالي للمجموعة القلونية فى ١٠٠ سم^{٣}	فى ١٠٠سم^{٣}	١٠٠٠٠٠٠	٣٠٠٠	٥٠٠٠

العينة مطابقة للمعايير طبقا لقرار وزير الاسكان رقم ٤٤ لسنة ٢٠٠٠

مدينة الأقصر

ادارة مياه الشرب والصرف الصحى

معمل تحاليل الصرف الصحى

نتيجة تحليل عينة مياه صرف صحى من مدخل ومخرج محطة برك التثنيت (البوند)

تاريخ اخذ العينة ٢٠٠٥/٩/١٧

م	عنصر التحليل	الوحدة	مدخل المحطة	مخرج المحطة	الحد المسموح
١	درجة الحرارة	درجة مئوية	٣٧	٣٠	٣٥
٢	PHالأس الهيدروجيني		٦,٥	٨	من ٦ الى ٩
٣	BODالأكسجين الحيوي الممتص	مج/ل	٢٢٠	٢٥	٤٠
٤	CODالأكسجين الكيماوي المستهلك	مج/ل	٢٦٥	٣١	٨٠
٥	DOالأكسجين الذائب	مج/ل	٠	٦,٢	لا يقل عن ٤
٦	TSالمواد الصلبة الكلية	مج/ل	٦٣٤	٤٧٦	٢٠٠٠
٧	TSSالمواد العالقة الكلية	مج/ل	٢١٥	٢٨	٤٠
٨	العد الاحتمالي للمجموعة القلونية فى ١٠٠ سم^{٣}	فى ١٠٠سم^{٣}	١٠٠٠٠٠٠	٣٠٠٠	٥٠٠٠

العينة مطابقة للمعايير طبقا لقرار وزير الاسكان رقم ٤٤ لسنة ٢٠٠٠

مدينة الأقصر

ادارة مياه الشرب والصرف الصحى

معمل تحاليل الصرف الصحى

نتيجة تحليل عينة مياه صرف صحى من مدخل ومخرج محطة برك التثنيت (البوند)

تاريخ اخذ العينة ٢٠٠٥/٩/١٨

م	عنصر التحليل	الوحدة	مدخل المحطة	مخرج المحطة	الحد المسموح
١	درجة الحرارة	درجة مئوية	٣٧	٣٠	٣٥
٢	PHالأس الهيدروجيني		٦,٥	٨,٥	من ٦ الى ٩
٣	BODالأكسجين الحيوي الممتص	مج/ل	٢٠٥	٢٨	٤٠
٤	CODالأكسجين الكيماوي المستهلك	مج/ل	٢٦٥	٣١	٨٠
٥	DOالأكسجين الذائب	مج/ل	٠	٨	لا يقل عن ٤
٦	TSالمواد الصلبة الكلية	مج/ل	٦٣٤	٤٥٠	٢٠٠٠
٧	TSSالمواد العالقة الكلية	مج/ل	٢١٥	٢٥	٤٠
٨	العد الاحتمالي للمجموعة القلونية فى ١٠٠ سم^{٣}	فى ١٠٠سم^{٣}	١٠٠٠٠٠٠	٣٤٠٠	٥٠٠٠

العينة مطابقة للمعايير طبقا لقرار وزير الاسكان رقم ٤٤ لسنة ٢٠٠٠

مدينة الأقصر

ادارة مياه الشرب والصرف الصحى

معمل تحاليل الصرف الصحى

نتيجة تحليل عينة مياه صرف صحى من مدخل ومخرج محطة برك التثنيت (البوند)

تاريخ اخذ العينة ٢٠٠٥/٩/١٩

م	عنصر التحليل	الوحدة	مدخل المحطة	مخرج المحطة	الحد المسموح
١	درجة الحرارة	درجة مئوية	٣٧	٣٠	٣٥
٢	PHالأس الهيدروجيني		٦,٥	٨,٥	من ٦ الى ٩
٣	BODالأكسجين الحيوي الممتص	مج/ل	١٩٠	٢٥	٤٠
٤	CODالأكسجين الكيماوي المستهلك	مج/ل	٢٦٥	٣١	٨٠
٥	DOالأكسجين الذائب	مج/ل	٠	٧,٥	لا يقل عن ٤
٦	TSالمواد الصلبة الكلية	مج/ل	٦٣٤	٤٥٤	٢٠٠٠
٧	TSSالمواد العالقة الكلية	مج/ل	٢١٥	٣٠	٤٠
٨	العد الاحتمالي للمجموعة القلونية فى ١٠٠ سم^{٣}	فى ١٠٠سم^{٣}	١٠٠٠٠٠٠	٢٤٠٠	٥٠٠٠

العينة مطابقة للمعايير طبقا لقرار وزير الاسكان رقم ٤٤ لسنة ٢٠٠٠

Appendix F Luxor Climate Data

Central Laboratory for Agricultural Climate (CLAC)
www.clac.edu.eg

Annual Data

Luxor

Longitude: 32.7 E
Latitude: 25.48 N
Altitude: 88 meter

month no.	Avg. Temperature (^oC)	Max. Temperature (^oC)	Min. Temperature (^oC)	Relative Humidity (%)	Wind Speed (Knot)	Avg. Sun shine (Hours)	Avg. Radiation (MJ/M^2)	Total Rain (mm)	Avg. Et_0 (mm)
1	14	23	5.4	52	3.2	9.1	16	0.1	2.6
2	16	25.5	7	42	3.6	9.7	19.1	0.2	3.5
3	20.2	29.5	10.6	34	4.3	10.1	22.4	0	5
4	26	34.8	15.7	26	4	10.8	25.3	0	6.4
5	30	38.7	20	22	3.7	11.6	27.4	0.3	7.3
6	32.4	41.1	23	23	3.5	13.1	29.7	0	7.9
7	32.9	40.6	23.6	26	3.2	13	29.3	0	7.7
8	32.5	40.7	23.4	27	3	12.2	27.7	0	7.1
9	30	38.6	21.5	32	2.6	11.8	25.4	0	6.1
10	25.4	35.3	17.5	40	2.8	10.8	21.3	0	4.8
11	20	29.6	12.1	47	3	9.6	17.2	0	3.5
12	15	24.6	7.2	53	3	9	15.2	0	2.6

Central Laboratory for Agricultural Climate (CLAC)
www.clac.edu.eg

Annual Data

Luxor 2002

Month no.	Max. Temperature (°C)	Min. Temperature (°C)	Max.RH (%)	Min.RH (%)	Total Rain (mm)	Max. Soil Temperature at 20 cm ² (°C)	Min. Soil Temperature at 20 cm ² (°C)	ET_o (mm)
1	22.2	2.5	68.5	11.9	0	17.1	15.6	1.8
2	27.6	7.4	49.5	12	0	20.5	18.4	3.5
3	30.5	11.4	34	12	0	24.8	22.4	6
4	35.3	15.4	39.7	20	0	29.2	26.4	6.8
5	37.1	19.4	31.2	22	0	32.6	29.9	10.1
6	40.7	19.5	40.2	14.3	0	35	32.9	8
7	39	27	56.5	24.1	0	33.8	32.5	9.3
8	40	20.7	52.9	25	0	38.2	34.9	7.8
9	40.7	19.5	40.2	14.3	0	35	32.9	8
10	38.7	17.3	83.1	2.5	0	30.7	27.5	6.8
11	32.2	10.3	49.8	23	0	24.8	22.1	4.9
12	25.3	3.9	50.5	12	0	19.5	17.7	2.2

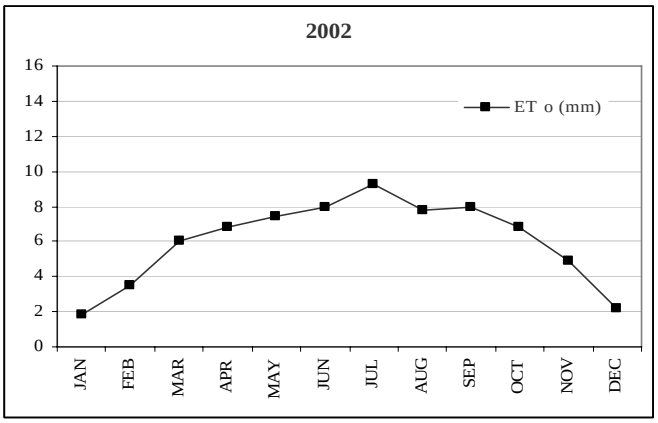
Luxor 2003

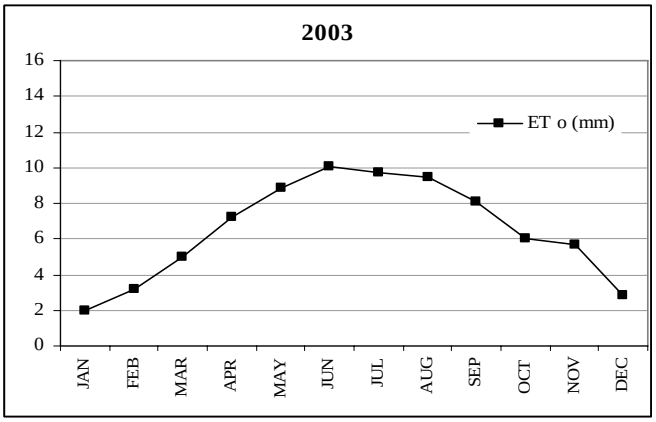
Month no.	Max. Temperature (°C)	Min. Temperature (°C)	Max.RH (%)	Min.RH (%)	Total Rain (mm)	Max. Soil Temperature at 20 cm ² (°C)	Min. Soil Temperature at 20 cm ² (°C)	ET_o (mm)
1	25.7	10.4	72.1	39.5	0	27.8	13.4	2
2	24.2	8.9	52.8	34.8	0	29.8	12.4	3.2
3	26.1	12.8	54	31.8	0	33.2	16.5	5
4	37.1	17.7	48.1	24.7	0	42.1	23.5	7.2
5	41.2	21.5	40.3	24.7	0	45.7	28.8	8.9
6	42.5	23	43.2	26	0	40.3	37.4	10.1
7	42.8	23.1	46	27.7	0	41	49.7	9.7
8	42.8	24.2	51.4	28.8	0	40.9	38.4	9.5
9	39.9	17.7	54.5	22	0	33.7	31.6	8.1
10	38.1	20.7	93.1	22	0	29.2	27.3	6
11	31.7	10.9	96.8	2.6	0	22.5	21.1	5.7
12	25.9	5.8	98.8	5.7	0	17.3	16.1	2.8

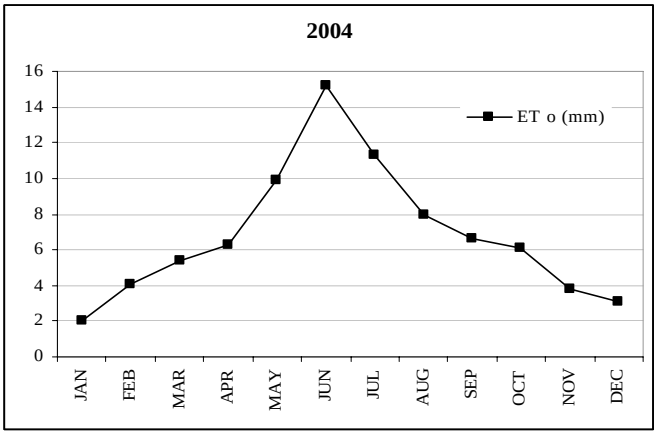
Luxor 2004

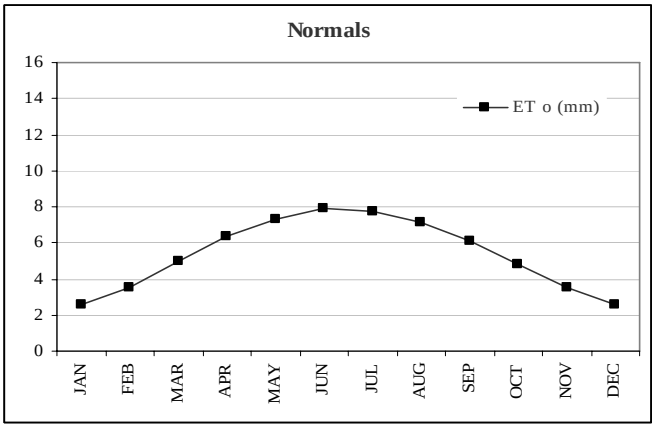
Month no.	Max. Temperature (°C)	Min. Temperature (°C)	Max.RH (%)	Min.RH (%)	Total Rain (mm)	Max. Soil Temperature at 20 cm ² (°C)	Min. Soil Temperature at 20 cm ² (°C)	ET_o (mm)
1	23.9	4	97.4	3.6	0	15.7	14.1	2
2	29.3	4.7	98.9	12	0	18.4	16.5	4.1
3	34	9.3	92.2	3.6	0	24.2	22.1	5.4
4	37	13	63.3	12	0	29.5	26.8	6.3
5	41.3	22.2	40.2	11.9	0	34.2	30.4	9.9
6	40.6	21.3	26.5	12	0	36.9	33	15.2
7	41.8	21.5	35	12	0	37.3	34.3	11.3
8	40	20.1	57.9	24.8	0	36.2	33.4	8
9	42.6	20.3	64.7	21.1	0	36	32.8	6.6
10	37.5	15.1	79.9	22	0	36.1	33.2	6.1
11	31.1	10.1	93.1	22	0	21.6	21.5	3.8
12	26.6	4.2	93.2	2	0	34.4	30.5	3.1

Luxor Station (Source: Central Laboratory for Agricultural Climate)

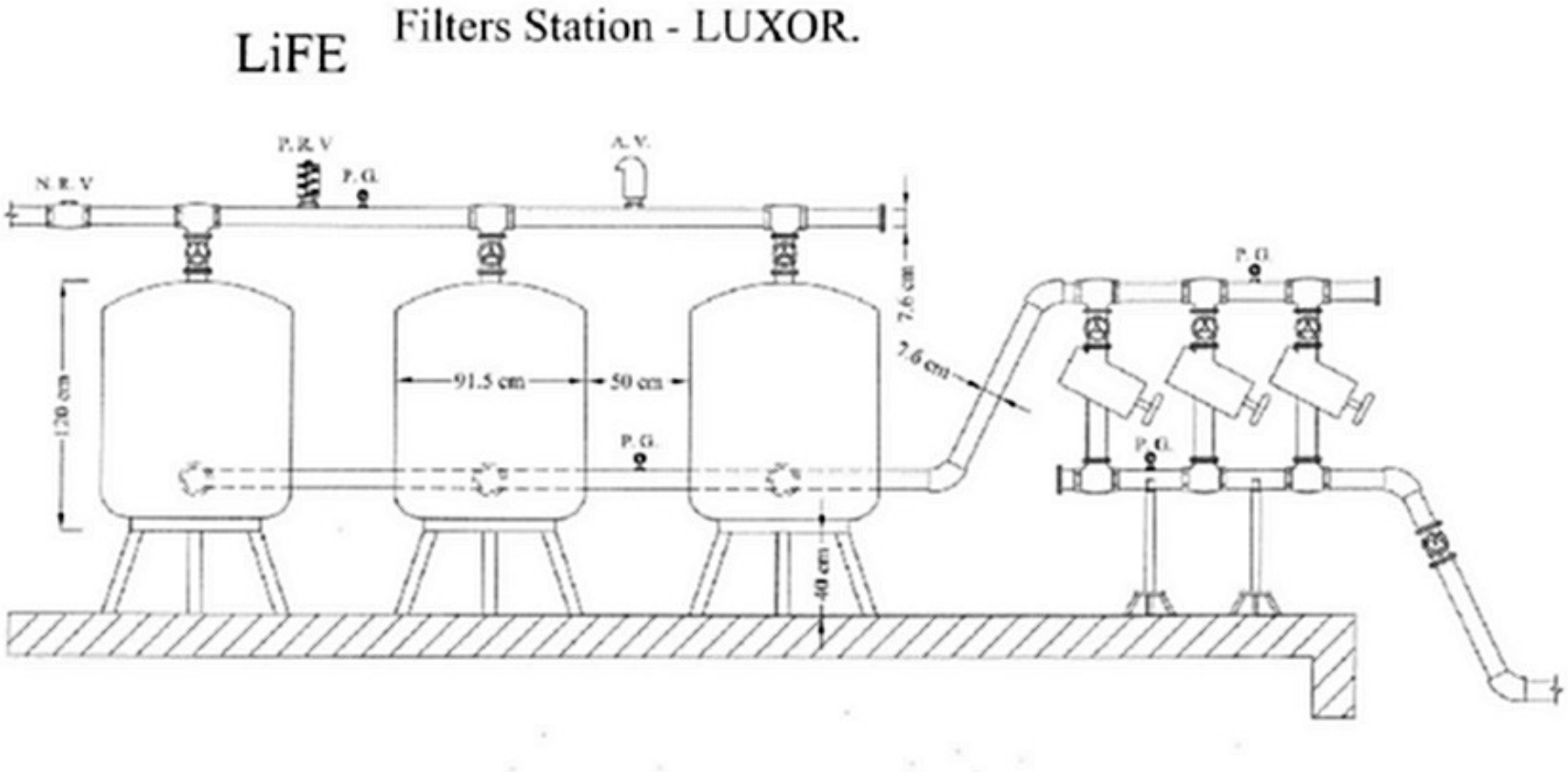




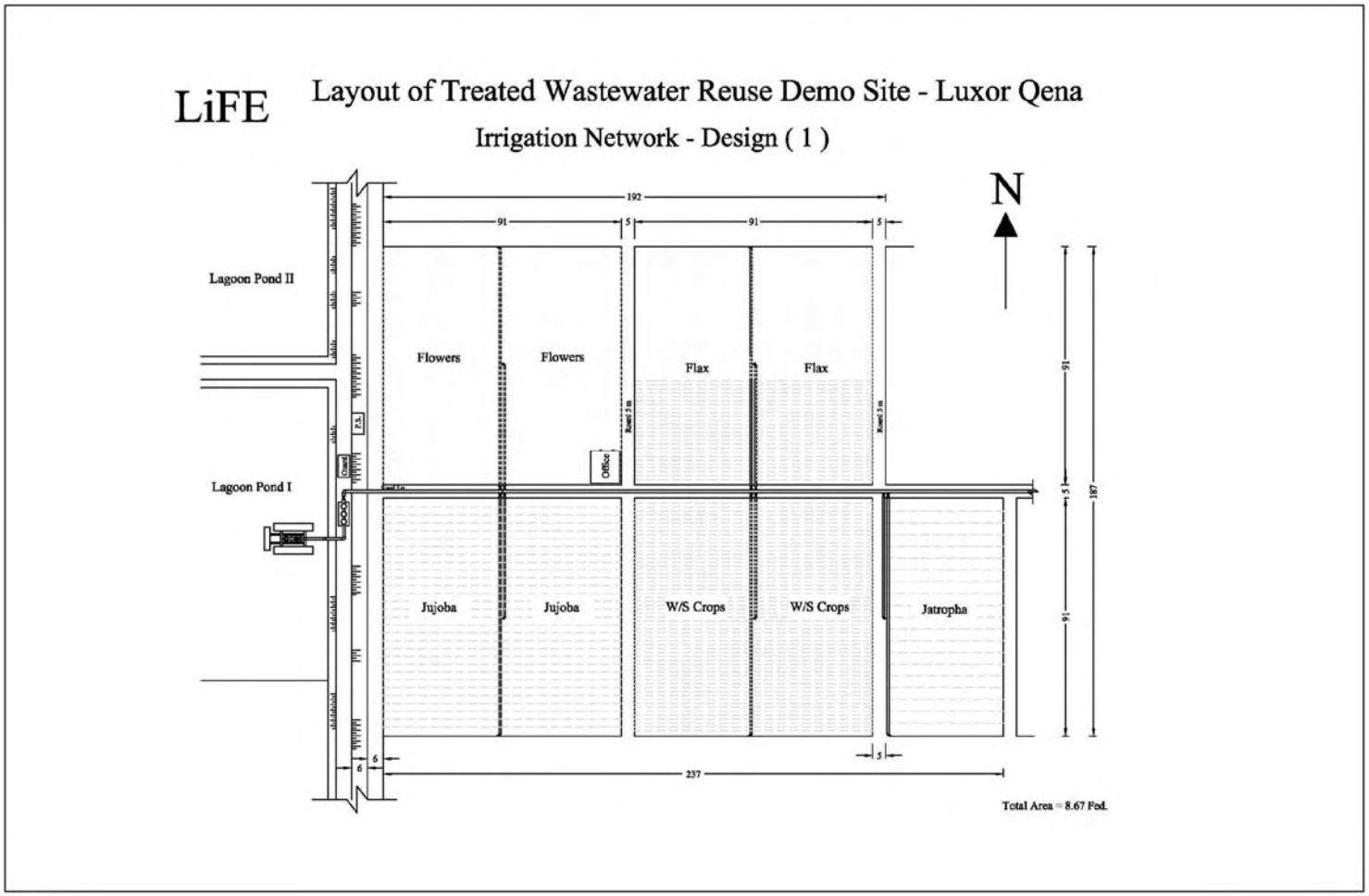


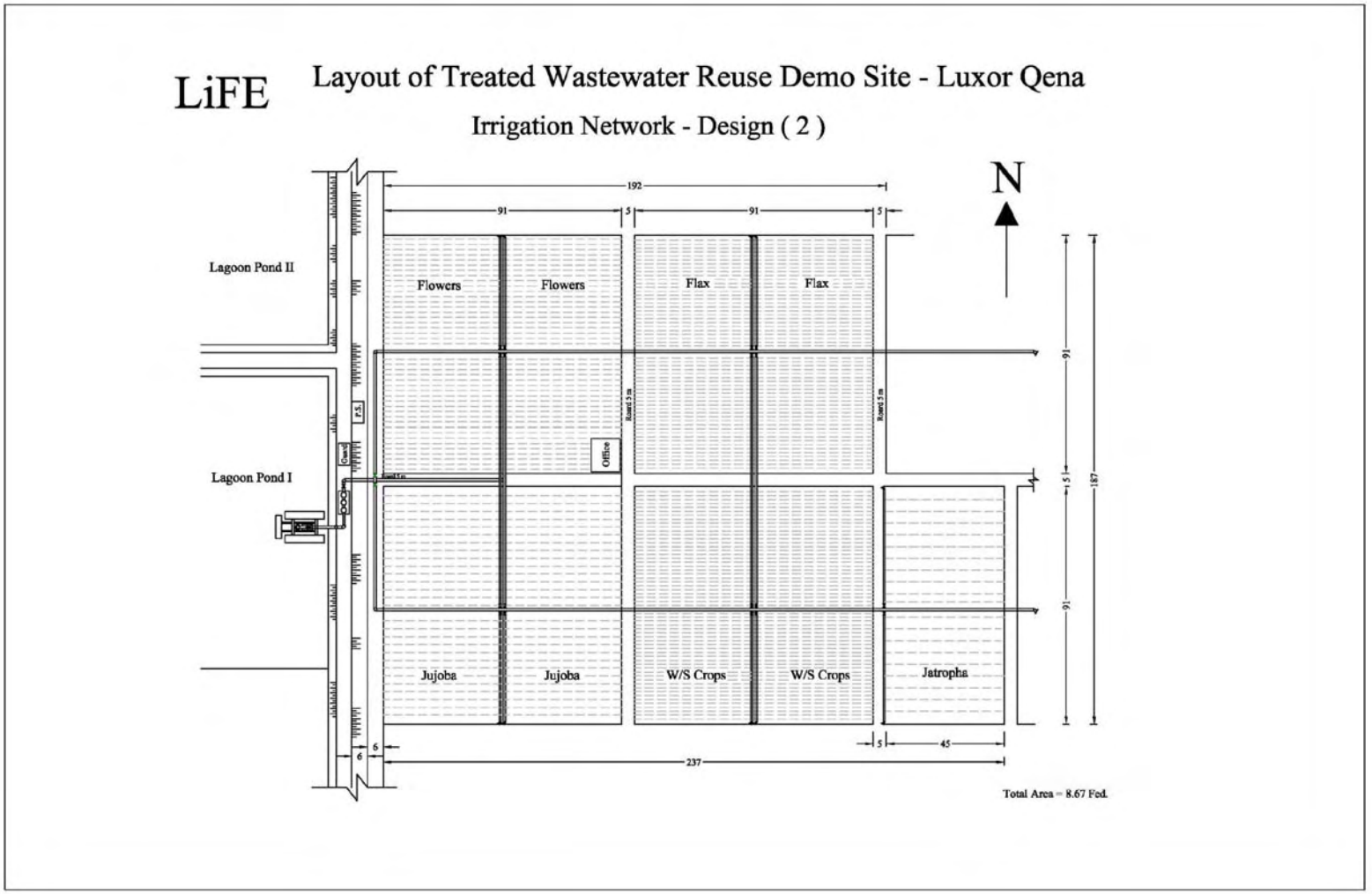


Appendix G Filters

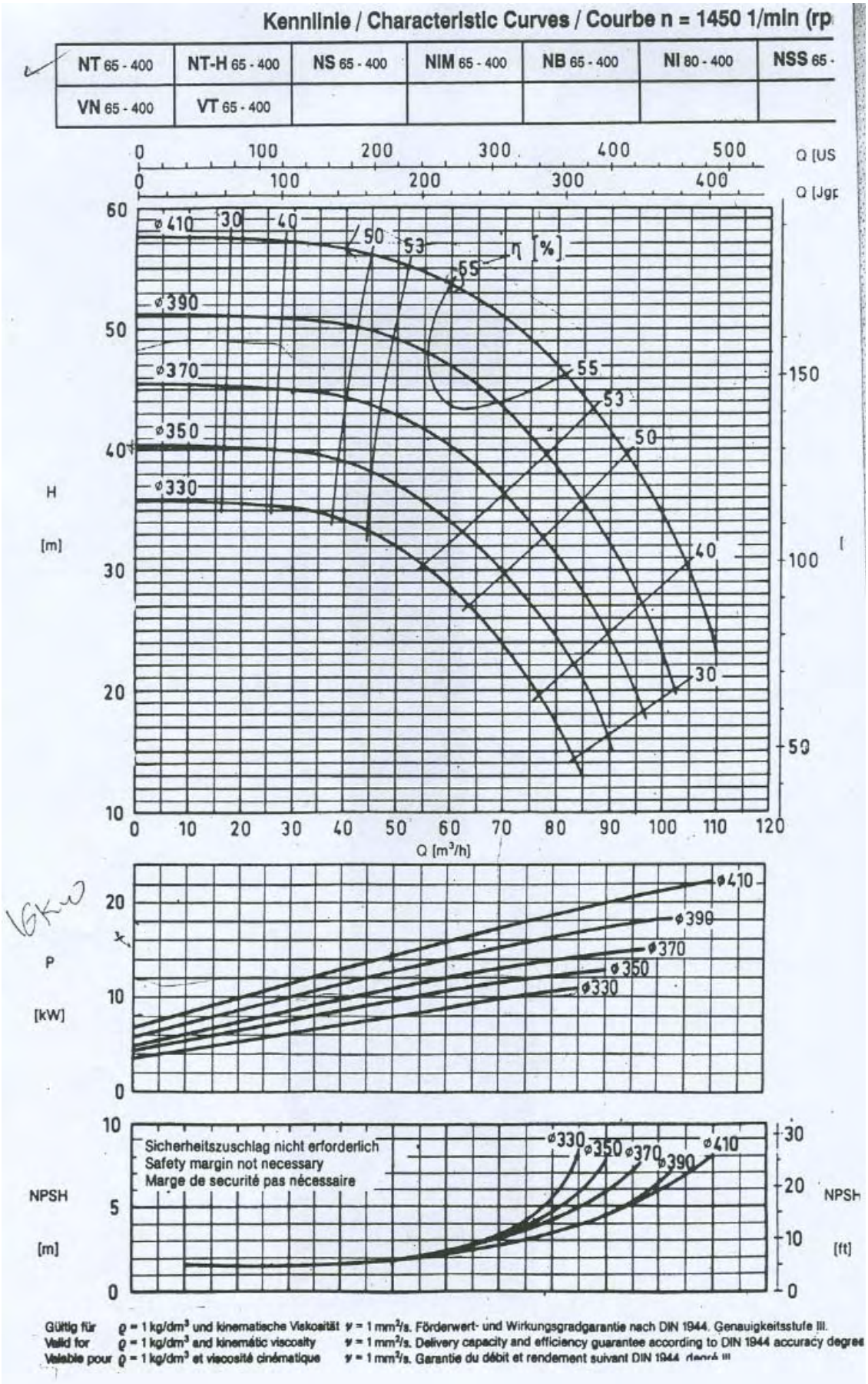

LiFE
Filters Station - LUXOR.
N.R.V
P.R.V
P.G.
A.V.
P.G.
7.6 cm
7.6 cm
91.5 cm
50 cm
120 cm
P.G.
P.G.
40 cm

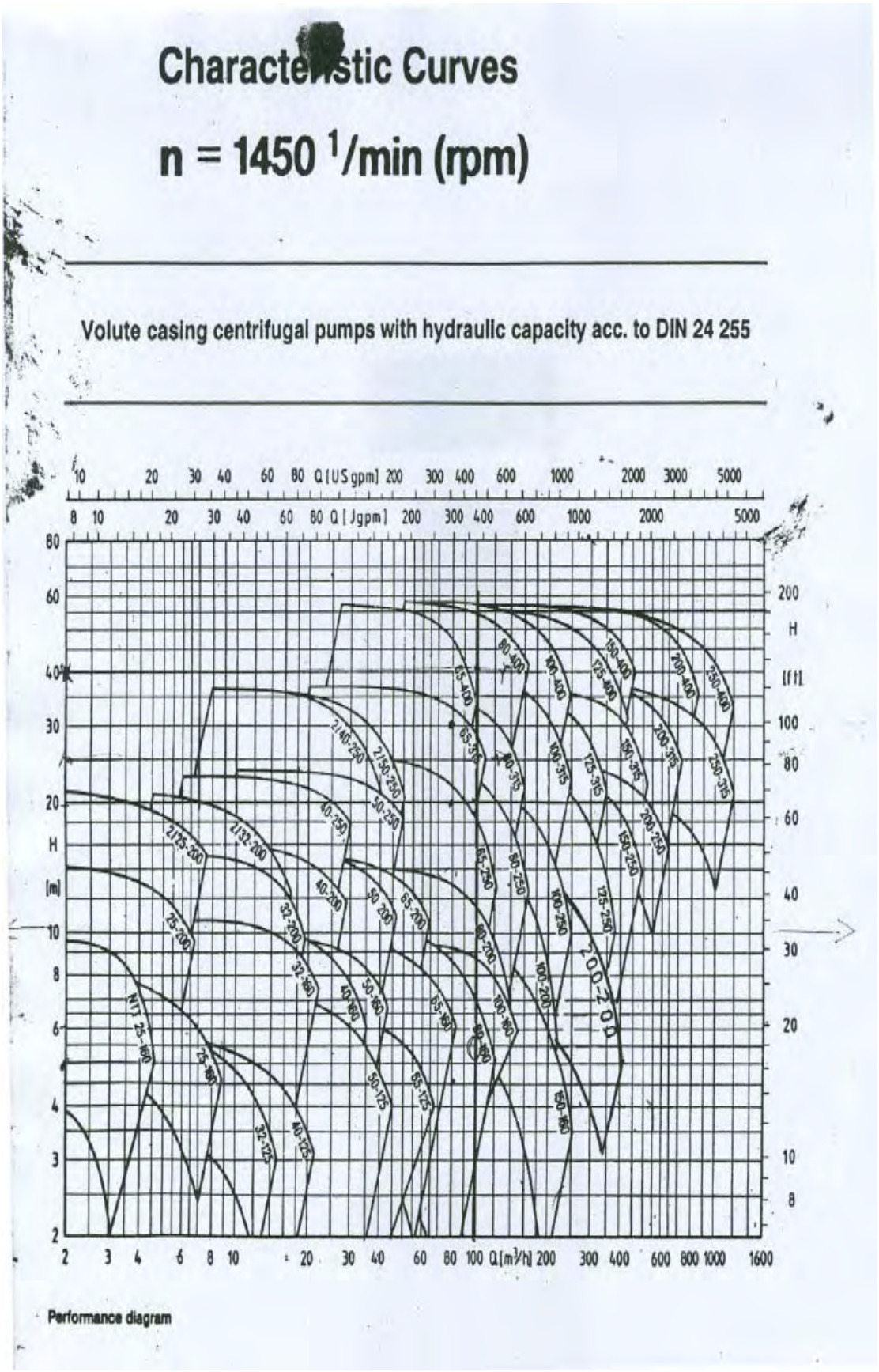
Appendix H Irrigation Network Drawings and Elements

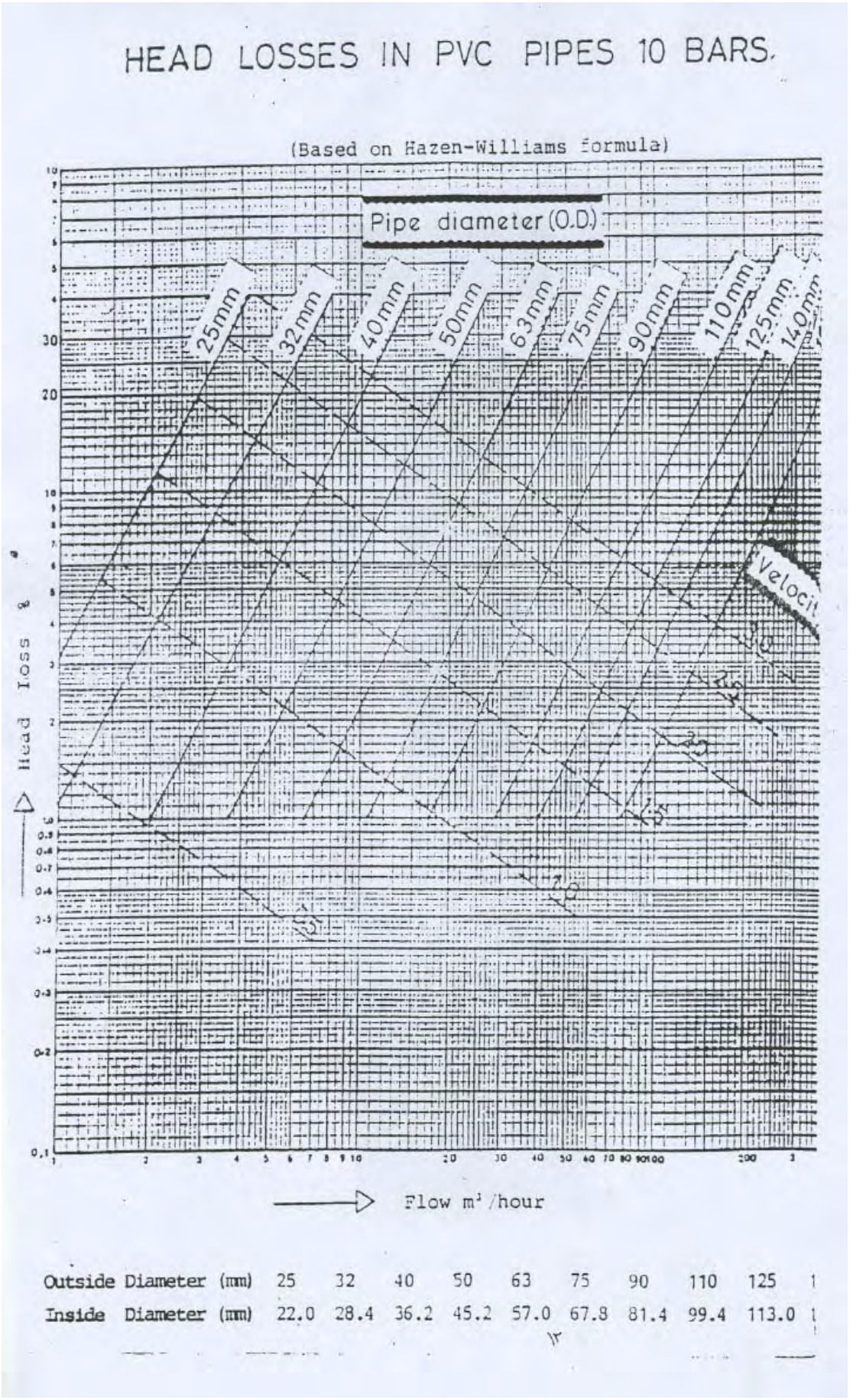

LiFE
Layout of Treated Wastewater Reuse Demo Site - Luxor Qena
Irrigation Network - Design (1)
N
Lagoon Pond II
Lagoon Pond I
Flowers
Flowers
Flax
Flax
Jujoba
Jujoba
W/S Crops
W/S Crops
Jatropha
Office
192
91
5
91
5
91
51
187
237
6
6
5
Total Area = 8.67 Fed.


LiFE
Layout of Treated Wastewater Reuse Demo Site - Luxor Qena
Irrigation Network - Design (2)
N
Lagoon Pond II
Lagoon Pond I
Flowers
Flowers
Flax
Flax
Jujoba
Jujoba
W/S Crops
W/S Crops
Jatropha
Office
Road 5 m
192
91
5
91
5
91
5
187
5
45
6
6
237
Total Area = 8.67 Fed.

Appendix I Engineering Design Charts


Kennlinie / Characteristic Curves / Courbe n = 1450 1/min (rp
NT 65 - 400
NT-H 65 - 400
NS 65 - 400
NIM 65 - 400
NB 65 - 400
NI 80 - 400
NSS 65 -
VN 65 - 400
VT 65 - 400
Q [US
Q [Jgr
H
[m]
Q [m³/h]
η [%]
P
[kW]
NPSH
[m]
NPSH
[ft]
Sicherheitszuschlag nicht erforderlich
Safety margin not necessary
Marge de securité pas nécessaire
Gültig für ϱ = 1 kg/dm³ und kinematische Viskosität ν = 1 mm²/s. Förderwert- und Wirkungsgradgarantie nach DIN 1944. Genauigkeitsstufe III.
Valid for ϱ = 1 kg/dm³ and kinematic viscosity ν = 1 mm²/s. Delivery capacity and efficiency guarantee according to DIN 1944 accuracy degree
Valable pour ϱ = 1 kg/dm³ et viscosité cinématique ν = 1 mm²/s. Garantie du débit et rendement suivant DIN 1944


Characteristic Curves
n = 1450 1/min (rpm)
Volute casing centrifugal pumps with hydraulic capacity acc. to DIN 24 255
Q [US gpm]
Q [Igpm]
H [m]
H [ft]
Q [m³/h]
200-200
Performance diagram



Outside Diameter (mm)	25	32	40	50	63	75	90	110	125	
Inside Diameter (mm)	22.0	28.4	36.2	45.2	57.0	67.8	81.4	99.4	113.0	

Appendix J Agencies, Groups, and Individuals Involved in Project Activities

Dr. Mawaheb Abu Elazm	Head of Environmental Quality Sector, EEAA
Dr. Moustafa El Hakeem	Afforestation Consultant, EEAA
Eng. Mohamed Mostafa	Under Secretary for Forestation and Environment, MALR
Eng. Abd El Aziz Megahed	Technical Engineer, MALR
Eng. Wafaa Falatous	CTO, USAID
Dr. Wadie Fahim	Task Leader, LIFE–IWRM
Eng. Karim El Jisr	Expert STTA, LIFE–IWRM
Mohamed Hamed	IWMU, MWRI
Eng. Awad Basil	D.G for Forestation, Luxor, MALR
Eng. Aiad Sahbt	Coordinator, HEIA
Eng. Mohamed Abou Zaid	D.G Sewage Treatment Dept. Luxor City
Eng. Yahia Yousef	Integrated Water Management Project, Qena
Eng. Wagih Wadia	Plant Nursery Director
Eng. Said Gomaa	Plant Nursery Supervisor