CHAPTER ONE

INTRODUCTION

1.1. General

There is an essential need to construct hydraulic structures along any waterway such as weirs, regulators….etc. Regulators are very important parts in the modern irrigation system, but they have some side effects as any other intervention. One of their negative impacts is the rise of the groundwater levels after construction. The rise in the groundwater levels affects negatively plants, building, people and sewer systems due to the interaction between the groundwater and wastewater.

The Egyptian government is replacing the existing Naga Hammadi barrage, located across the Nile River some 450 km south of Cairo, with the New Naga Hammadi barrage (NNHB) to incorporate a hydropower plant and to improve conditions for river traffic. The new structure will lead to an increase in river water levels, both locally near the new barrage and upstream. The rise in river water levels will in turn result in changes in groundwater levels in the aquifer system up and downstream of the barrages.

The Ministry of Water Resources and Irrigation, Egypt implementation unit gave detailed descriptions of the study region of Naga Hammadi. The future expected water table levels were predicted and future expected affected areas were identified. The critical areas (depth to water is less than 1.0m) in Naga Hammadi after NNHB implementation is shown in Figure (1-1).

In this thesis, an area is chosen, which is expected to suffer from a high groundwater table after the construction of the NNHB, to investigate the problem and propose alternatives for lowering the groundwater levels. The study area is a village called Bakhaness, with an area of 588 hectar. It is located some 1.5 km upstream of the NNHB. A computer model (MicroFEM) has been used to simulate the groundwater conditions before and after construction of the NNHB. Alternatives for lowering the groundwater table are proposed, simulated and evaluated. The systems, which are assessed are a municipal sewer system, a system of perforated pipes in urban areas, and tile drainage with different values of efficiency in agricultural areas.

The main contribution performed in this study is to provide a straight forward methodology to determine the best position for perforated pipes and its design.

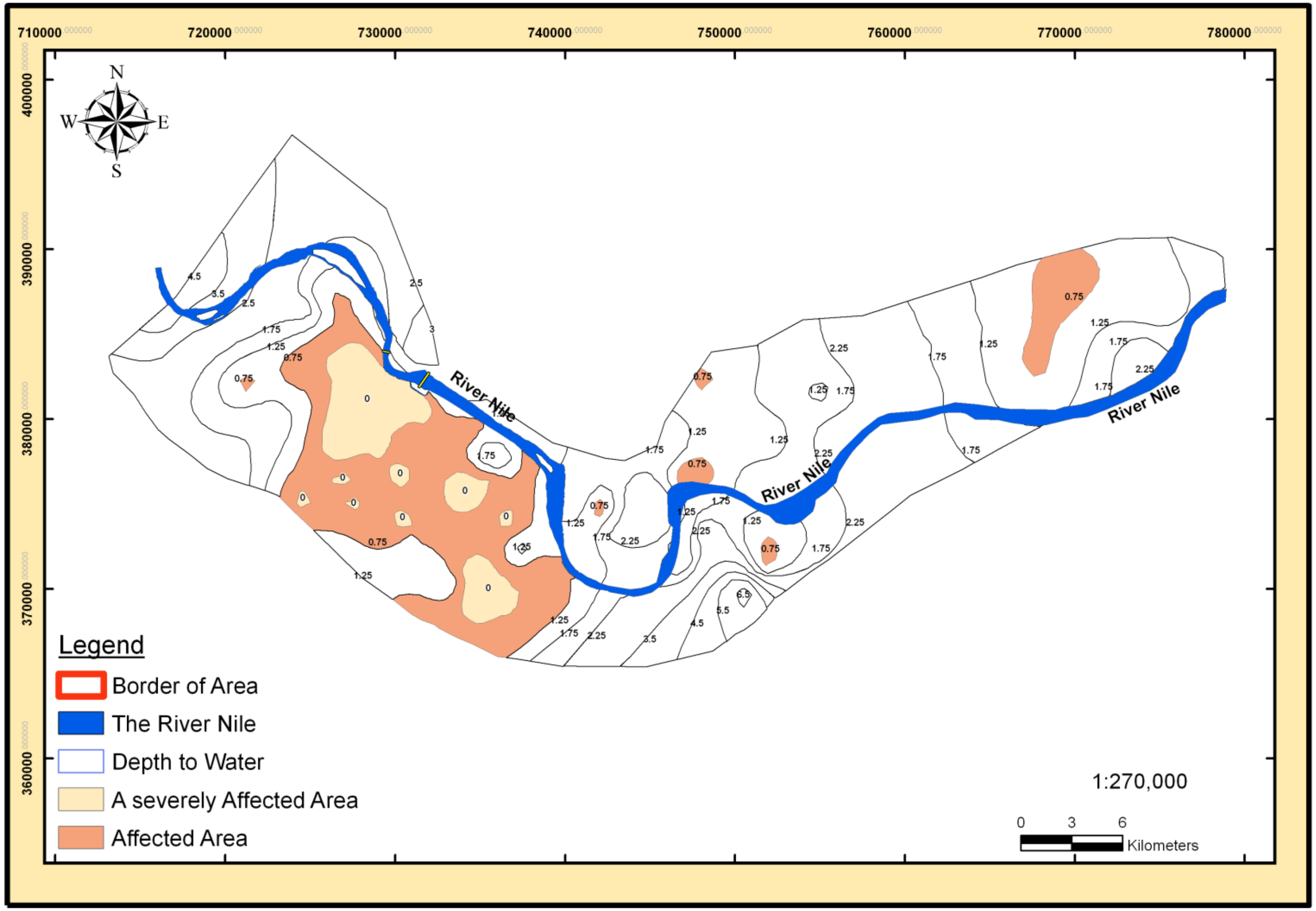

Figure (1-1): depth to water after NNHB implementation

The deducted model in this study is applicable for every soil of same geological composition as Nile Valley geology.

The Nile Valley aquifer system is composed of Late Pleistocene graded sand and gravel capped with a Holocene silty clay layer. In the central portion of the Nile Valley, the Holocene layer acts as a semi-confining layer to the underlying Pleistocene aquifer. The thickness of the upper layer varies in the central portion and in places is up to some 20m thick. In the outer fringes, the silty clay layer disappears and the aquifer becomes unconfined, see Figure (1-2). The intervention of the upper layer and the lower one is affected on the lowering of the groundwater level and the optimal design of the dewatering system.

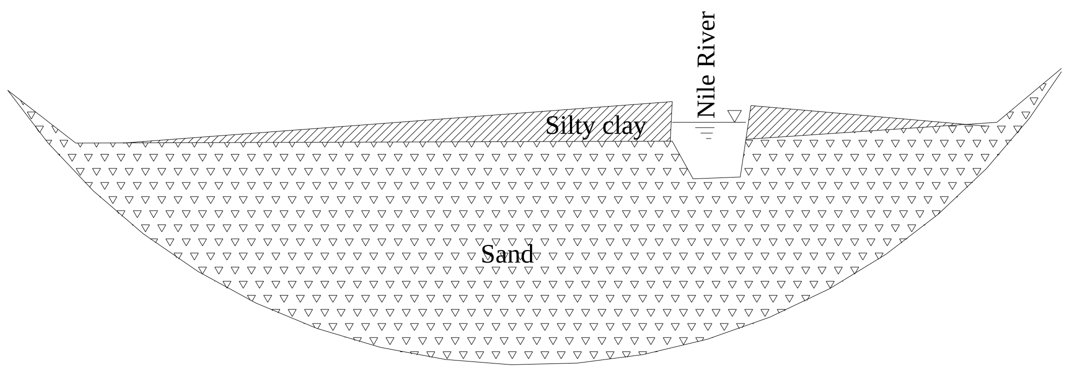

Figure 1: Cross Section in the Nile Valley

1.2. Objective of the Present Research

The main objectives of this study are directed towards achieving the following goals:

1. Studying the effect of soil characteristics on the percentage area of holes in the perforated pipe and developing empirical equations that evaluate the percentage area of holes with respect to the soil conductivity, the amount of flow through the pipe and the initial water head above the pipe.
2. Studying the effect of the tile drainage efficiency.
3. Studying the effect of perforated pipe network and sewer system for lowering the high groundwater level.
4. Developing the equations which incorporate the effect of thickness of top layer and soil parameters on perforated pipe discharge and spacing between pipes.

5. Developing a computer program to design the perforated pipe networks.

1.3. Study Scope and Methodology

The methodology of this study is as follows:

i) The previous literature that covers the mathematical and numerical models available to design the lowering system is reviewed. Also review of literature of physical models and different approaches used for groundwater table lowering is conducted.

ii) Experimental runs are carried out using a seepage tank in the Hydraulics Laboratory of the Faculty of Engineering, Cairo University to derive equations for estimating the optimal pipe holes percentage for different working conditions and the corresponding discharge.

iii) A groundwater model (MicroFEM) is used to simulate the case study with or without its dewatering system. Empirical equations which incorporate the effect of thickness of top layer and soil parameters on perforated pipes, discharge and spacing between pipes are developed.

iv) The proposed model is applied to data collected from the field to lower the groundwater levels in the Bakhaness Area.

The thesis consists of eight chapters and four appendices

Chapter One

This chapter contains the introduction, objectives of the study and scope of the work

Chapter Two

This chapter contains the literature review of the previous work dealing with lowering groundwater levels.

Chapter Three

This chapter contains the description of the groundwater model (Micro FEM) and its governing equations which have been used in the study.

Chapter Four

This chapter contains a description of the experimental work and the analysis of the experimental results.

Chapter Five

In this chapter, a study area which suffers from a high groundwater level is chosen. The study area is a village affected by the new Naga Hammadi Barrage and is called Bakhaness.

Chapter Six

This chapter evaluates different alternatives for lowering the groundwater level in the case study area before and after building the New Naga Hammadi Barrage.

Chapter Seven

In this chapter, the design equations for perforated pipes network are developed and a computer program using a Visual Basic language is built to design the network and determine the holes percentage in the pipes.

Chapter Eight

This chapter presents the conclusions and recommendations of this study.

Appendix A

This appendix contains the summary of the experimental runs.

Appendix B

This appendix contains the conductivity and classification of soil for the case study area.

Appendix C

This appendix includes all results obtained from numerical runs for the derivation of the empirical equations.

Appendix D

This appendix contains scrap shots of the visual basic program used for the New Design of the Perforated Pipe Networks (NDPPN).