

**MATHEMATICAL MODEL of AGRICULTURE  
DRAINAGE WATER POLLUTION and ITS EFFECT on  
EI-NOBARIA CANAL**

**Submitted by**

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B.Sc. of Civil Engineering, Faculty of Engineering,

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Master of (Irrigation & Hydraulics), Faculty of Engineering,

Alexandria University, 2004

A Thesis submitted in Partial Fulfillment

Of

The requirements for the Doctor of Philosophy Degree

In

Environmental Sciences

Department of Environmental Engineering Science

**Institute of Environmental Studies and Researches**

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## **Approval sheet**

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## **Abstract**

Water is life and the quality and adequacy of water is an essential measure of the quality of life or rather the existence of life. The management of water quality, or the protection of the aquatic ecosystem in a broader sense, means the control of pollution. El-Nobaria canal is largely used for constant disposal of untreated agriculture effluents. Consequently, water quality of the canal degrades particularly in the low flow months.

El-Nobaria canal irrigates  $1.076 \times 10^6$  feddans (451.535 ha). It is one of the most important drinking sources of Alexandria and El-Behera areas. Eight potable water intakes take their water from El-Nobaria canal and its branches, which suffer from pollution by agriculture drainage water at seven locations (point sources). A 59% of such drainage water is coming from El-Nasr-3 main drain. This tends to cause a deterioration of El-Nobaria canal water quality downstream El-Nasr-3 main drain outfall feeding all potable water intakes and several branches locating downstream km (52,960) on the canal.

In this study, four agricultural large catchments of El-Delengat Ext. drain, El-Bostan drain, El-Nasr-3 main drain and El-Nasr-1 drain are studied. DRAINMOD/ DRAINMOD-N/ DRAINMOD-S combined models have been tested at the field scale using the field data of 2006/07 & 2007/08 years to model the outflow discharge, salinity and nutrient load. Finally, the models' results from fields are integrated at each outlet of the four catchments. Graphical and Six Statistical measures comparisons are made between (Salinity, Nitrate and Total Nitrogen) concentrations measured by DRI and integrating results at each catchment level. Water quality models are water management tools used to diagnose

water quality problems and the impact of various environmental conditions. In this thesis, QUAL2K model inputs and characteristics of the model are explained. Then, QUAL2K model has been calibrated and validated on El-Nobaria canal using the field data during summer of 2007 and winter of 2008, respectively. The study concerned on salinity (TDS),  $\text{NO}_3\text{-N}$ , DO, TN and pH along El-Nobaria canal's length. The quality of El-Nobaria canal water has been investigated to estimate the impact of drain discharged on its quality. The results show that El-Nasr-3 main drain and El-Nasr-1 drain are highest pollution sources to El-Nobaria canal. The results show also that both combined models and QUAL2K represent the field measured data quite well.

A proposed drainage reuse scenario is presented in this study to improve the water quality of El-Nobaria canal. This thesis focuses on a proposal plan to manage the drainage water of El-Nasr-3 main drain and El-Nasr-1 drain by intermediate mixing of their water directly into El-Bostan canal at km (2.400) and El-Nasr canal at km (0.700), respectively, which serve agriculture uses only. The most suitable mixing locations are chosen according to the design values of discharges, levels, and measured salinities. The QUAL2K model is used to simulate water quality along El-Nobaria canal's length for the proposed scenario. The results show that TDS and  $\text{NO}_3\text{-N}$  values decrease from 850 mg/l to 370 mg/l and from 4.96 mg/l to 3.91 mg/l, respectively. The simulation shows that values of TDS and  $\text{NO}_3\text{-N}$  are lower than maximum permitted concentration of law 48 and drinking standards. This tends to cause an improvement of the canal water quality especially at points of the potable water intakes. This mixed water can be used as a safe drinking water abstraction source for the present water drinking plants and the planned ones. The proposed drainage reuse scenario is also found environmentally feasible.

## LIST of ABBREVIATIONS

BADP	= Bostan Agriculture Development Project
BCM/y	= Milliard Cubic Meter per year = $10^9 \text{ m}^3$ per year
BOD	= Biological Oxygen Demand
Ca	= Calcium
Cl	= Chloride
CO <sub>3</sub>	= Carbonate
COD	= Chemical Oxygen Demand
DO	= Dissolved Oxygen
DRI	= Drainage Research Institute
DW	= Drainage Water
DWIP	= Drainage water irrigation project
DWR	= Drainage Water Reuse
dS/m	= Dece Siemens per meter = 640 ppm
EC	= Electric Conductivity
EIA	= Environmental Impact Assessment
EPADP	= Egyptian Public Authority for Drainage Projects
ET	= Volume of irrigation water to be consumed by crops
FAO	= Food and Agriculture Organization of the United Nations
FW	= Fresh Water
FW-DW	= Mixed Water = Fresh water-Drainage water
GWT	= Ground Water Table
Ha	= Hectare
HAD	= High Aswan Dam
HCO <sub>3</sub>	= Bicarbonate
IAS	= Irrigation advisory service
IDR	= Intermediate drainage reuse

IIP	= Irrigation Improvement Project
K	= Potassium
Km	= Kilometer
$L_r$	= Leaching requirements
$m^3/sec$	= Cubic meter per second
MAR	= Monthly Average Rainfall
MCM/day	= Million Cubic Meter per day = $10^6 m^3$ per day
meq/L	= milli equivalent per liter = 10 dS/m
Mg	= Magnesium
mg/L	= Milligram per liter
MPN	= Most Probable Number of bacteria
MSL	= Mean Sea Level
MWRI	= Ministry of Water resources and Irrigation
Na	= Sodium
NARS	= Nobaria Agriculture Research Station
NDGD	= El-Nasr Drainage General Directorate
NIGD	= El-Nasr Irrigation General Directorate
$NO_3$	= Nitrate
NWRC	= National Water Research Center
OW	= Observation Well
Pathogens	= Bacteria
PCM	= Portable Conductivity Meter
pH	= Negative Logarithm of hydrogen ion concentration.
$PO_4$	= Phosphate
ppm	= part per million = mg/L = milligram per liter
PS	= Pumping Station
PVB	= Present Value of Benefit
PVC	= Present Value of Cost



PVNB	= Present Value of Net Benefits
PW	= Potable Water Intake
Q2K	= QUAL2K
$Q_{\text{Design}}$	= Discharge of the drain at the proposed reuse location.
SAR	= Sodium Adsorption Ratio
$\text{SO}_4$	= Sulphate
SRLQC	= Soil Research Laboratory and Quality Control
SRP	= Strategy Research Project
SDW	= Saline drainage water
TDS	= Total Dissolved Salts
UTM	= Universal Transfers Merkator
<u>WUAs</u>	= Water Users Association
Zn	= Zinc

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