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Water Resources Management in New Reclamation Lands

A Thesis submitted in partial fulfillment of the requirements of the degree
of Master of Science in Civil Engineering
(Irrigation and Hydraulics)

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Statement

This thesis is submitted as a partial fulfilment of Master of Science in Civil Engineering (Irrigation and Hydraulics), Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Abstract

Egypt is currently establishing several projects in arid areas for the development of agricultural land such as North Sinai Agricultural Development Project (NSADP). The project aims to reclaim about 415,000 acres. Two-third of the total area is irrigated by Nile water in a 1:1 ratio mixed with the drainage water. The remaining area still needs a source of water. This study aims to investigate the hydraulic performance of the channels system conveying 5 Mm³/day from Bahr El-Baqar drain that will be treated to cover the extra required water for NSADP. A 1D hydraulic model using HEC-RAS is developed to find solutions for the potential hydraulic problems and propose the best operating scenarios for the required hydraulic structures. Four alternatives were studied; the study showed the need to implement two drops in the proposed channel bed in order to avoid the change in the water level of the sub drains and canals in the study area. In addition to the recommendation to construct three regulator structures one of them on Bahr El-Baqar drain and the two others on the new proposed channel, to solve water level and velocity problems. The study provides an integrated and overlapping management reference for the operation of the proposed regulators to ensure continuous flow of the required water amount will pass from Bahr El-Baqar drain to the proposed channel, despite the fluctuating discharges throughout the seasons.

Keywords: arid area reclamation; Bahr El-Baqar drain; HEC-RAS; Sinai; WRM; 1D-hydraulic model

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List of symbols

A	Channel cross section flow area	[m ²]
B	Height of gate opening	[m]
C	Chezy's Coefficient	[m ^{1/2} /s]
C_d	Discharge coefficient	[-]
c_f	Friction coefficient	[-]
E	Specific energy	[m]
F'_f	External force of friction	[N]
F_r	Froude Number	[-]
f	Coriolis parameter	[rad/s]
g	Acceleration of gravity	[m/s ²]
H	Upstream energy head	[m]
h	Difference between upstream and weir crest level	[m]
h_1	Difference between downstream water level and weir crest level	[m]
h_2	Difference between upstream and downstream water level	[m]
h_e	Energy head loss	[m]
L	Characteristic length	[m]
n	Manning's Coefficient	[s/m ^{1/3}]
Q	Channel Discharge	[m ³ /s]
q	Discharge through the gate per meter	[m ² /s]
R	Hydraulic radius	[m]
R_e	Reynold number	[-]
S	Slope of the energy line	[-]
S_0	Channel bed slope	[m/m]
S_f	Total energy line slope	[m/m]
u	the depth averaged velocities in the x- direction	[m/s]

V	Flow velocity	[m/s]
v	the depth averaged velocities in the y-direction	[m/s]
ν_t	Eddy viscosity coefficient	[-]
W	Fluid weight	[N]
Y	Flow depth	[m]
\bar{y}	Distance to the centroid	[m]
y_1	upstream depth	[m]
y_2	Downstream depth	[m]
y_c	Critical depth	[m]
y_n	Normal depth	[m]
Z	Channel invert level	[m]
α	Velocity weighting coefficients	[-]
β	Momentum correction factor	[-]
γ	Fluid specific weight	[N/m]
θ	Channel longitudinal slope	[-]
ν	kinematic viscosity	[m ² /s]

List of abbreviations

<i>1D</i>	1-Dimensional
<i>2D</i>	2-Dimensional
<i>A</i>	Adverse
<i>BCM</i>	Billion Cubic meter
<i>BOD-5</i>	Five-day biochemical oxygen demand
<i>C</i>	Critical
<i>ED</i>	Electrodialysis
<i>EEAA</i>	Egyptian Environmental Affairs Agency
<i>ESCE</i>	EI Salam Canal East of Suez Canal
<i>ESCW</i>	EI Salam Canal West of Suez Canal
<i>GWP</i>	Global Water Partnership
<i>H</i>	Horizontal
<i>HEC</i>	Hydrologic Engineering Center
<i>ICSS</i>	irrigation conveyance system simulation
<i>IWRM</i>	integrated water resources management
<i>M</i>	Mild
<i>MMRP</i>	Man-Made River Project
<i>MSF</i>	Multistage flashing
<i>MWRI</i>	Ministry of Water Resources and Irrigation
<i>NSADP</i>	North Sinai Agricultural Development Plan
<i>P.S.</i>	Pump station
<i>RAS</i>	River Analysis System
<i>RO</i>	Reverse osmosis
<i>S</i>	Steep
<i>TDS</i>	Total dissolved solids
<i>TWW</i>	Treated wastewater