Evaluating the hydraulic feasibility of brackish groundwater supply for small-scale reverse osmosis plants in community centers in Kuwait

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Overview

- Introduction
- Objectives & Methodology
- Results
- Discussion
- Conclusions

Introduction

The Abdulla Al-Salem Cultural Center (ASCC) in Kuwait is planning to extract 250 m^3/h of brackish groundwater to supply small-scale RO desalination units for its own use.

The constraints for this water supply plan are as follows:

- The extraction rate from each well should not exceed 50 m^3/h and the total quantity from all existing wells ≤ 250 m^3/h.
- The TDS of extracted groundwater ≤ 10,000 mg/l.

Objectives

1) to evaluate the potential of groundwater supply with suitable quality to consistently yield 250 m^3/h.

2) to investigate the permissible limits of water quality for the utilized water from the existing wells in the study area.

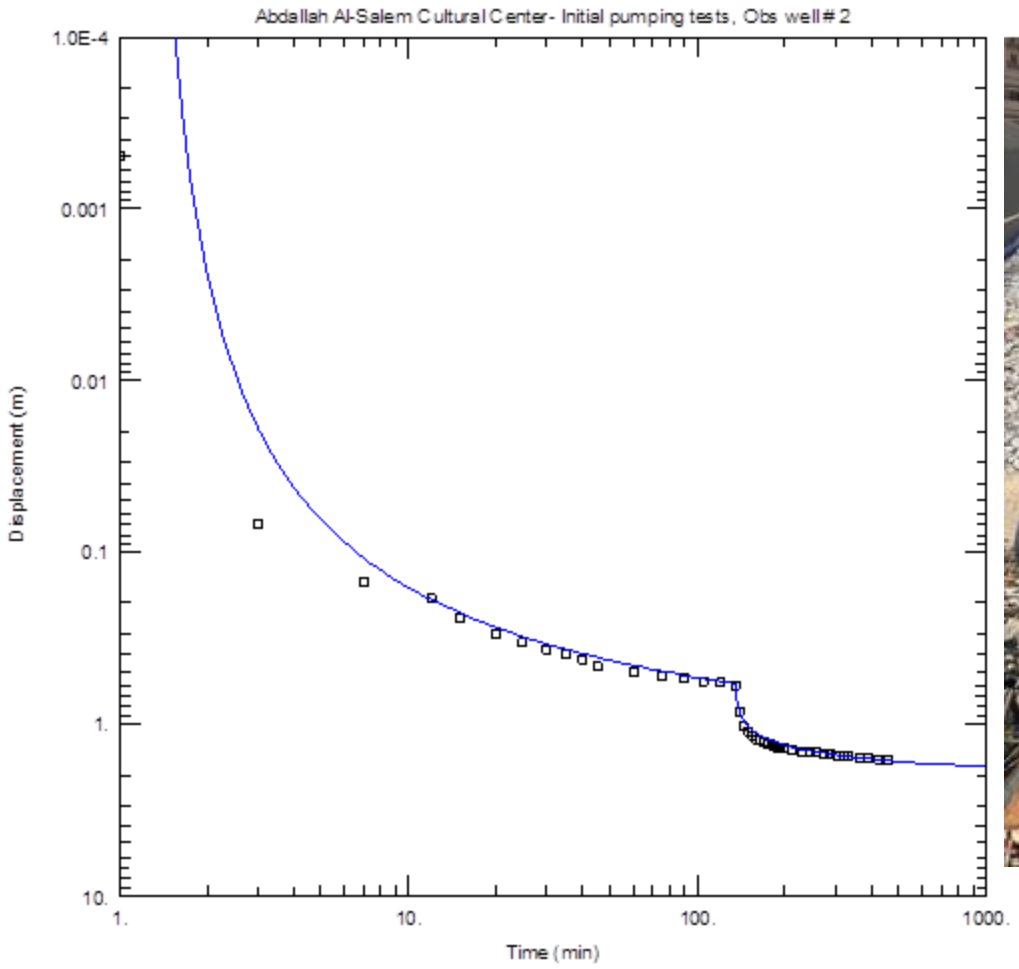
3) To assess the hydraulic feasibility of utilizing brackish groundwater for small-scale reverse osmosis (RO) plants in community centers in Kuwait.

Methodology

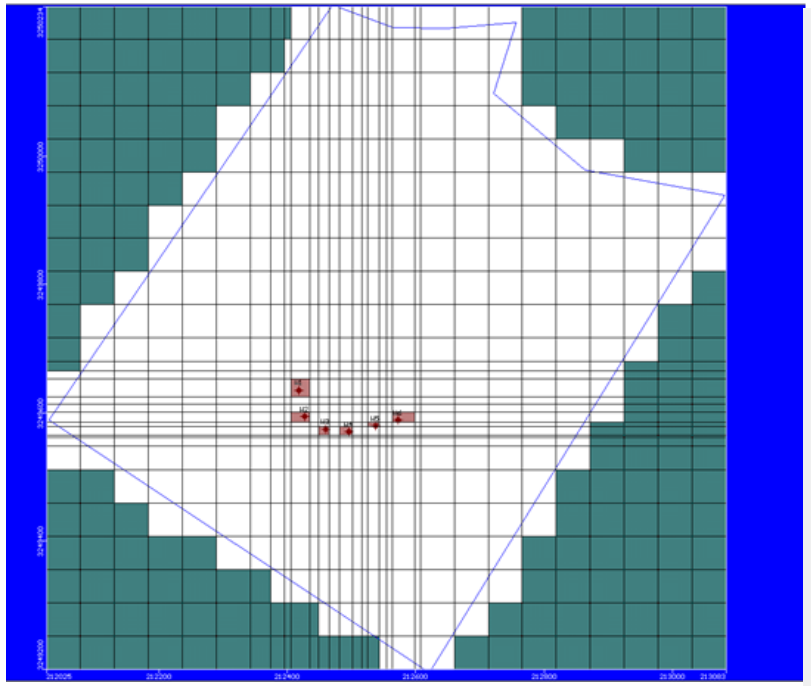
- Pumping tests using AQTESOLV software to determine hydraulic properties of the utilized aquifer in the study area.
- Numerical modeling using Visual MODFLOW (VMF) to determine the decline (drawdowns) in groundwater levels resulted from pumping activities by existing water supply wells in the study area.
- Water quality analysis of the samples collected through pumping activities in the study area.

Results

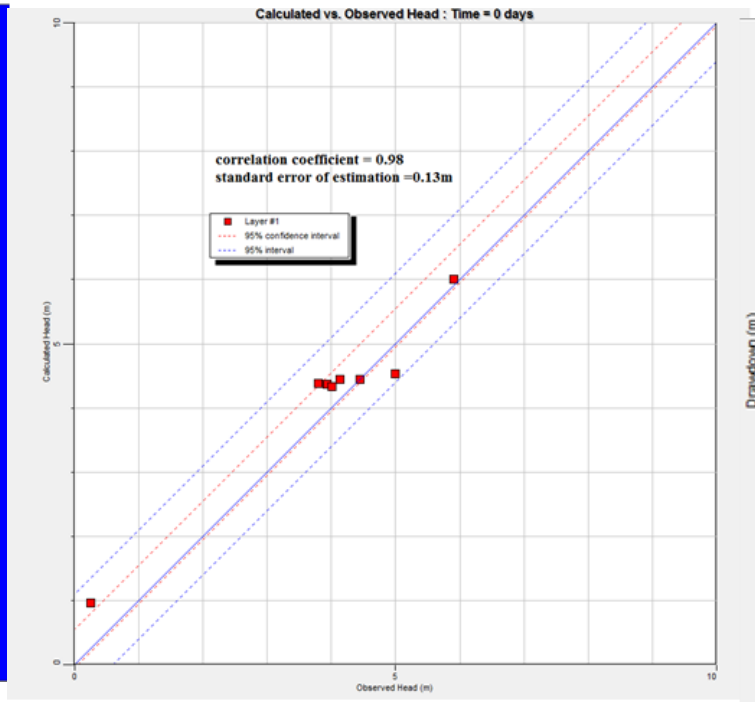
Pumping tests: T ~ 300 m^2/d, K ~ 10 m/d, Sy ~ 0.12.



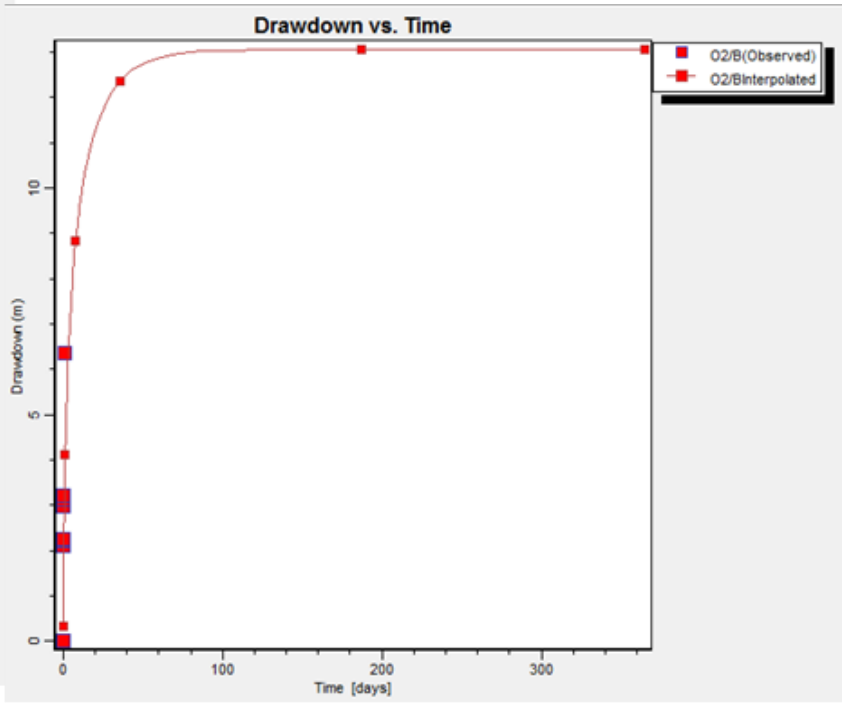
Numerical modelling calibration to trust results



Location of wells

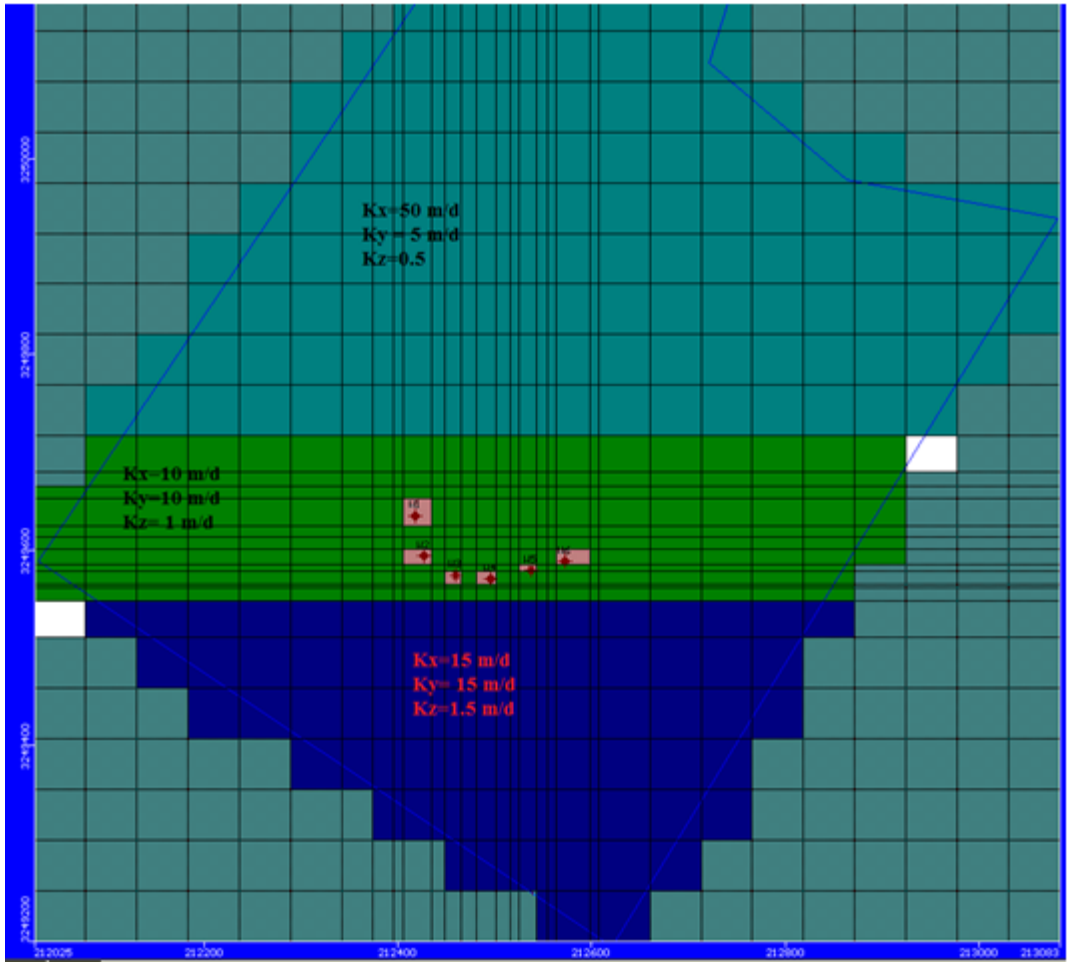


Steady state calibration

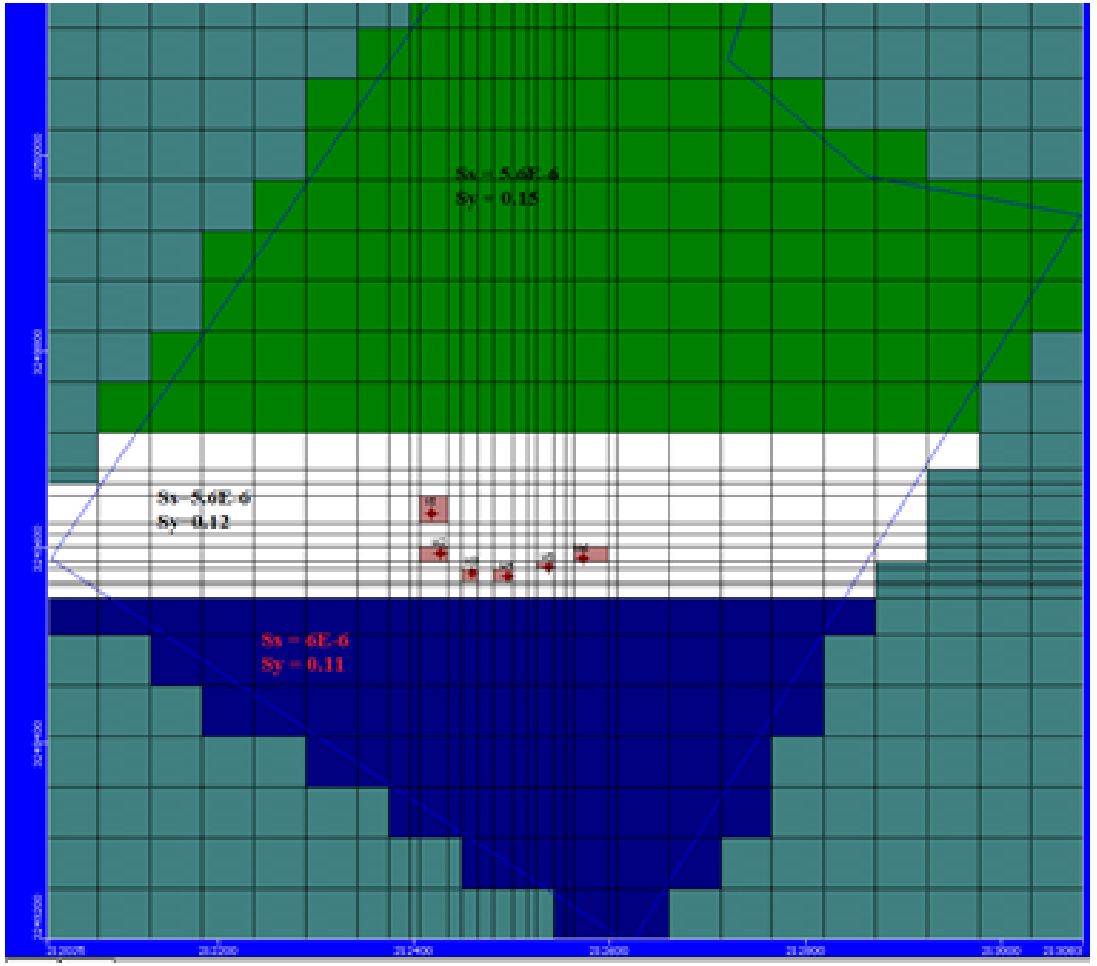


Transient state calibration

Results numerical calibrated parameters



Results from steady state calibration
K=10 m/d

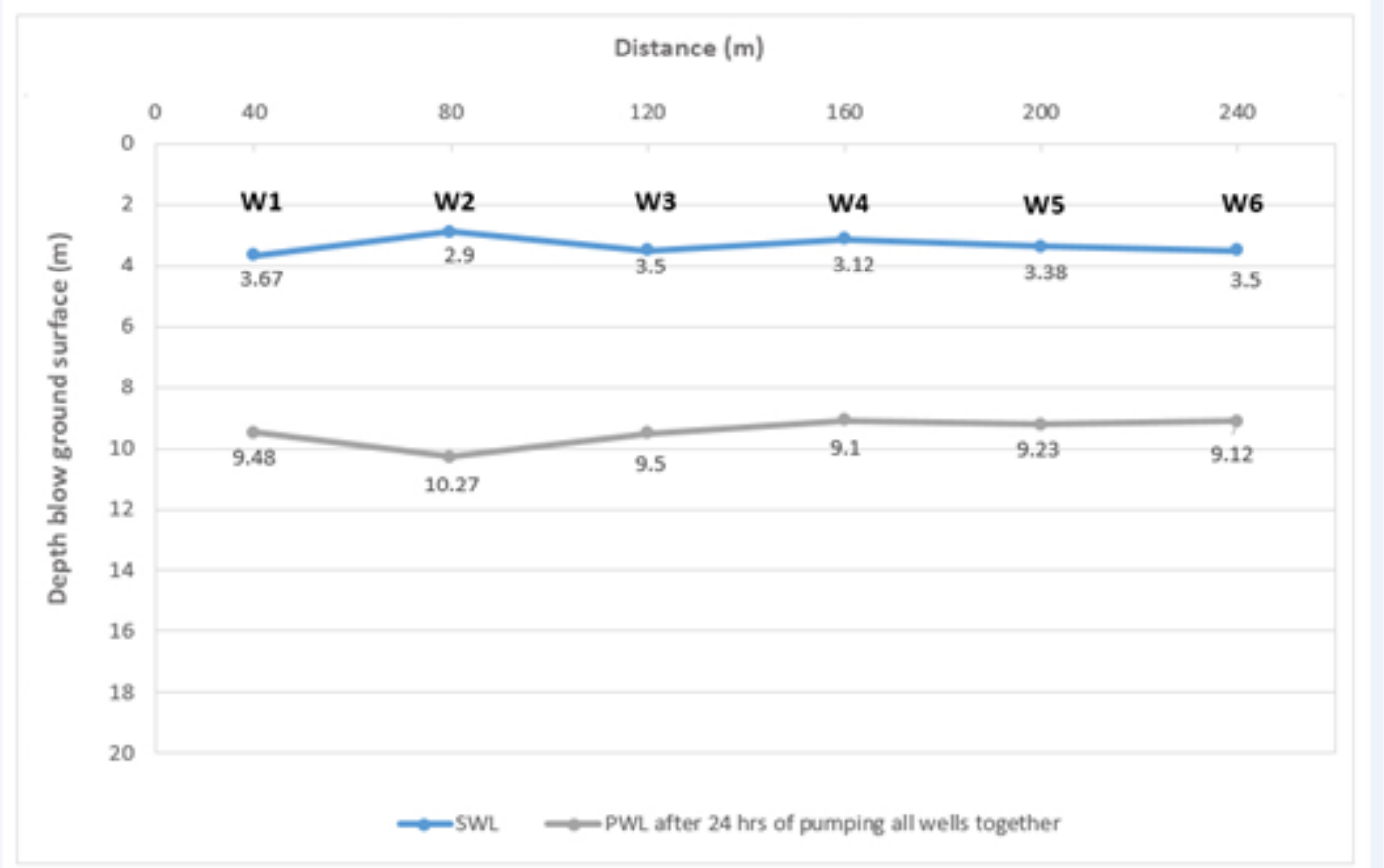


Results from transient state calibration
Sy = 0.12

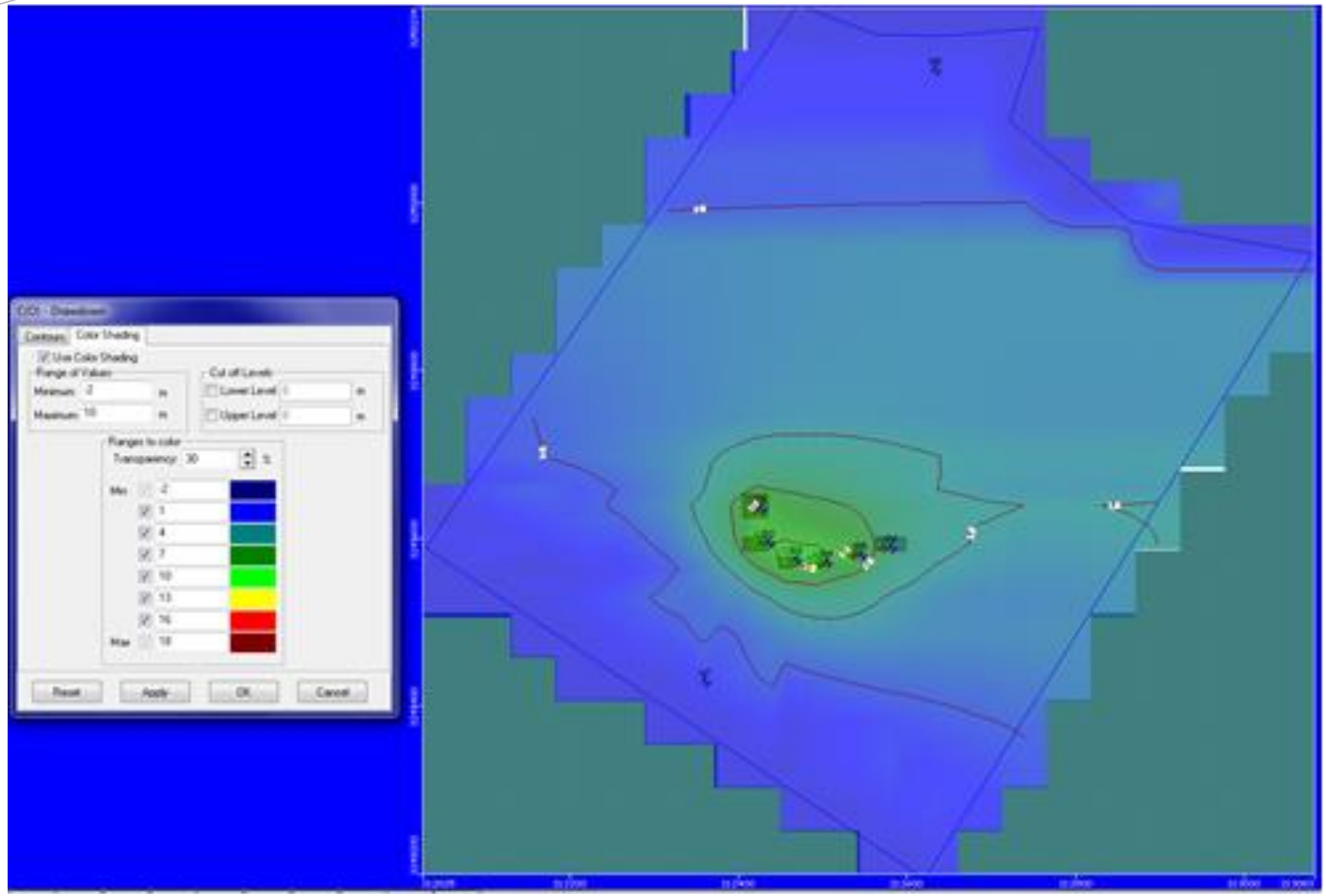
Results of trusted drawdowns from calibrated parameters

Stabilized Drawdowns after pumping

Well No.	Drawdown (m)
1	5.81
2	7.37
3	6
4	5.98
5	5.85
6	5.62



Results of trusted drawdowns from calibrated parameters

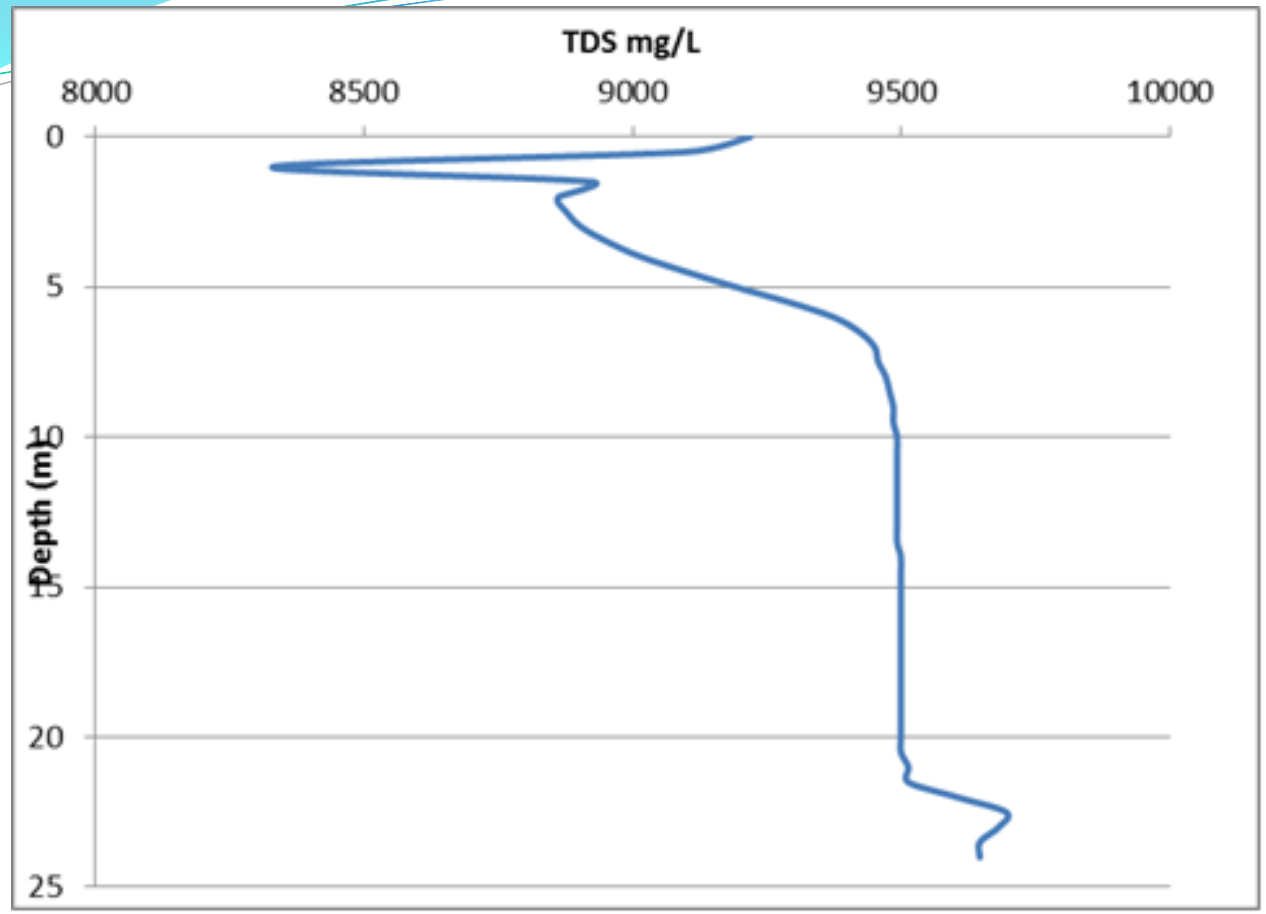


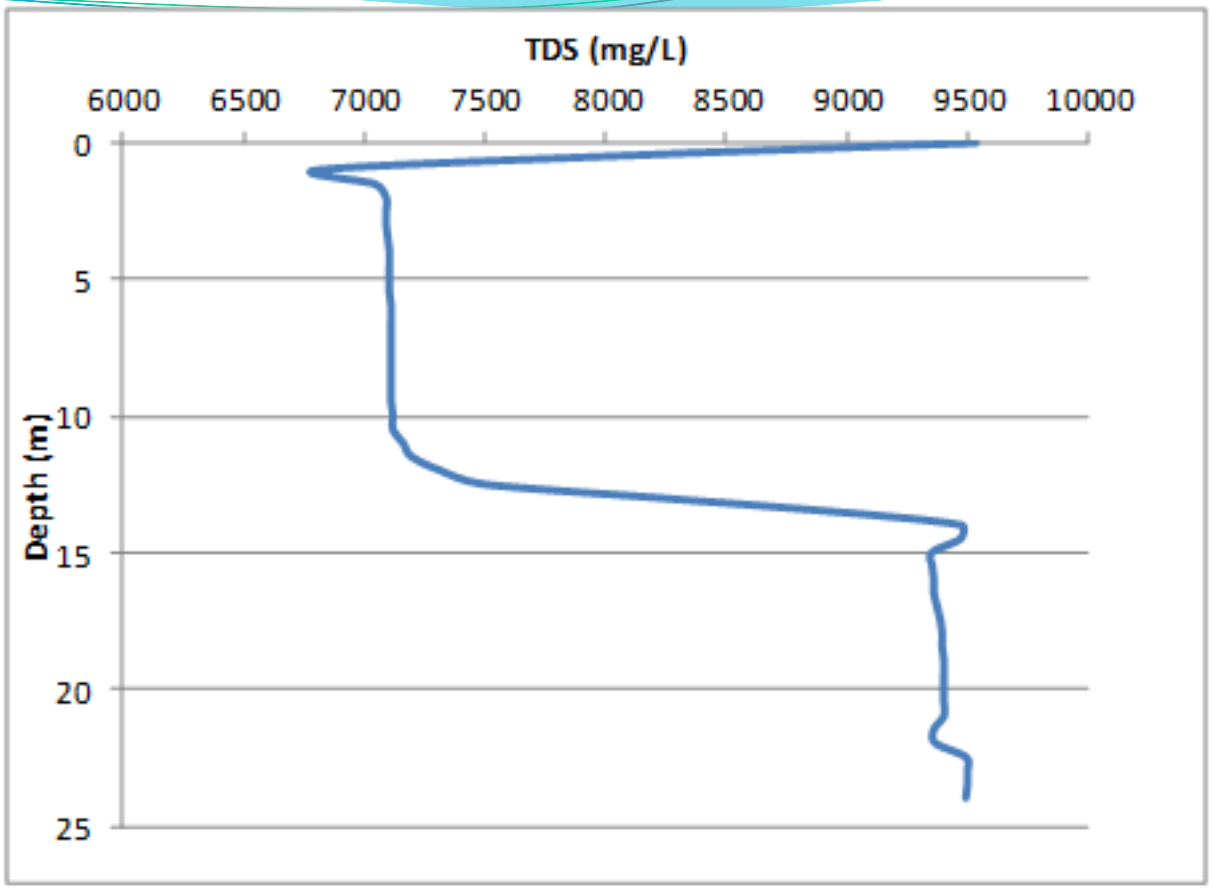
Numerical simulations by VMF Version 7

Final Drawdowns

- ✓ after 365 days of pumping
- ✓ All wells in operation simultaneously
- ✓ Total pumping rate = 250 m3/h
- ✓ Maximum drawdown ≤ 10 m.

Results of water quality deterioration





TDS in vertical profile < 10,000 mg/l

First 2 meters are still affected by drilling operations

Conclusions and Recommendations

Water quality conclusions

- The TDS content of ≤ 10,000 mg/l in the study area indicates brackish water quality
- There is no evidence of groundwater contamination.
- Throughout the pumping process, there were no significant fluctuations in groundwater quality.

Well hydraulic conclusions

- An optimal total pumping rate has been determined of 250 m^3/hr through the operation of the 5 wells simultaneously, with a sixth well designated as standby.
- This configuration maintains this optimal total pumping rate (250 m^3/hr) ensuring a compound drawdown < 10 m and TDS levels ≤ 10,000 mg/l.
- Activating the sixth well alongside the other five would violate the established conditions. Therefore, the sixth well should remain on standby status only.

Recommendations

- It is recommended to employ a combination of surging and airlifting development techniques for the existing wells because mud is still there affecting the efficiency of the pumping wells.
- This approach facilitates the removal of mud from the wells, subsequently enhancing their yield without inducing undesirable drawdowns.


Thank you