# APPLICATIONS OF GROUND-WATER MODELING IN KINGS AND QUEENS COUNTIES, NEW YORK

By

Paul E. Misut, Elizabeth R. McNew-Cartwright, Christopher E. Schubert, Jack Monti Jr., and Anthony Chu

U. S. Geological Survey
2045 Route 112
Coram, New York 11727

## ABSTRACT

A three-dimensional finite-difference ground-water flow model with about 50,000 active cells is being coupled with a geographic information system (GIS) in a 5-year study to (1) simulate the effects of drought and three pumping scenarios in the two counties, (2) identify locations in which hydrogeologic data are insufficient, and (3) assess subterranean-structure dewatering alternatives. The GIS/modeling approach also is being used to evaluate proposed wellfield locations in terms of proximity to the present municipal-water delivery system, effects of withdrawals on ground-water levels and flow patterns, and capture of water contaminated by saltwater intrusion or human activities.

## INTRODUCTION

Pumping for ground-water supply in Kings and Queens Counties during the 1930's and 1940's caused large depressions in the water table and induced saltwater intrusion into the contributing areas of many water-supply wells. As a result, all pumping for public supply in Kings, and much of the pumping in Queens, was halted in 1947 (Soren, 1976). Water-table recovery during subsequent decades has caused flooding of subways and basements that were built in areas overlying water-table depressions, and constant dewatering is now needed to maintain an artificially lowered water table.

Surface water from upstate reservoirs currently supplies 100 percent of the demand in Kings County (1.5 million people) and 90 percent of the demand in Queens County (1.35 million people). During 1982-91, the volume supplied by this reservoir system exceeded the predicted long-term average capacity (Mayor's Task Force, 1992). Because expansion of the reservoir system is unlikely, concern that the water supply will be inadequate during future droughts or other emergencies has prompted investigations of alternative sources.

Previous studies of the Kings-Queens ground-water system in the 1980's entailed ground-water simulations to evaluate the effects of several pumping scenarios on ground-water levels (Buxton and others, in press). In 1992, the U.S. Geological Survey (USGS) began a 5-year study in cooperation with the New York City Department of Environmental Protection (NYCDEP) to further investigate the probable effects of resuming use of ground-water for public supply in Kings and Queens

Counties. The cooperative agreement calls for development of a ground-water-flow model to represent the hydrogeologic system at finer scale than that used by Buxton for improved local prediction and entails evaluation of three pumping scenarios that represent the range previously investigated by Buxton and others (in press): (1) continuous pumping at a rate of 100 Mgal/d (million gallons per day), (2) periodic pumping at a rate of 150 Mgal/d under recent (average 1990's) recharge and pumping conditions, and (3) periodic pumping at rates of 200 to 400 Mgal/d under "full ground-water reservoir" conditions, under which all public-supply and industrial pumping is stopped until water levels are allowed to recover fully before pumping begins. Simulations are also conducted to demonstrate the possibility of ground-water recharge with excess from upstate-surface water reservoirs. The results of Buxton and others (in press) indicated that periodic pumping at the specified ranges would provide an adequate supply for emergency use without inducing saltwater encroachment, provided that the interval between pumping periods was long enough to allow complete water-level recovery.

This study entails updating the model of Buxton and others (in press) with data collected since 1980 and using GIS to (1) display data-collection points in pertinent geologic units, (2) compile data sets for the model, (3) compare model results with measured values, and (4) display results of predictive simulations.

The following paragraphs summarize planned improvements to the model of Buxton and others (in press) and applications of the coupled GIS/ground-water-flow model.

## MODEL IMPROVEMENTS

Accuracy of model predictions depends on correct representation of several hydrogeologic factors, including extent of the freshwater body, extent and thickness of hydrogeologic units, water-transmitting properties of aquifers, recharge and discharge through system boundaries, and ground-water and surface-water heads. The GIS used in this study facilitates model development by providing more than 1,000 hydrogeologic data points in Kings and Queens that represent locations of surface features, such as streams and coastline; subsurface features, such as pumped well screen zones, the saltwater interface, and hydrologic units; and aquifer thickness, upper-surface altitude and configuration, and transmissivity. Simulations of the effect of pumping scenarios are currently being improved through the addition of recently collected field data, use of a nonlinear-regression calibration technique, and use of GIS to compile flow-model-input data. These procedures are expected to improve simulation efficiency.

## MODEL APPLICATIONS

The integrated GIS/modeling approach is being used to evaluate potential pumping durations and rates and the locations and depths from which ground water could be withdrawn, provide data for development of programs to monitor anticipated effects of withdrawals, examine the feasibility of locating public-supply wells that potentially capture water affected by saltwater intrusion or contaminants from surface sources, and locate dewatering wells that would mitigate the flooding of basements and subways and deliver water of suitable quality for domestic or industrial uses.

### Well Siting

Well-siting considerations include proximity to zones of known contamination from saltwater intrusion or from human activities (Haefner, 1992), and local ground-water-flow patterns as they affect contributing areas to wells. Other considerations include the effects of pumping rates on water levels and flow patterns, linkage to the municipal water-delivery infrastructure and to water-treatment facilities, and potential effects of increased withdrawals on nearby ground-water recharge areas.

### Basement and Subway Dewatering

Refinements to the ground-water flow model could provide information needed to improve the dewatering of flooded basements and subways, and use water pumped during dewatering to supplement the municipal surface-water supply without inducing saltwater encroachment. The model also could be used to locate sites for public-supply or dewatering wells that would provide uncontaminated water suitable for domestic or industrial uses.

## SUMMARY

A three-dimensional ground-water-flow model is being coupled with GIS technology to assess the feasibility of supplementing western Long Island's surface-water supply with ground water. Recently collected data are being used to improve specification of model geometry and boundary conditions, and model calibration. The modeling effort is expected to identify areas in which additional data collection is needed for future monitoring of the effects of specific stresses on water levels and for model improvement. Applications for the model are the evaluation of pumping scenarios and well siting.

## REFERENCES

Buxton, H.T., Smolensky, D.A., and Shernoff, P.K. (in press) Feasibility of using ground water as a supplemental supply for Brooklyn and Queens, New York City: U.S. Geological Survey Water-Supply Paper 2361B.

Haefner, R.J., 1992, Use of a geographic information system to evaluate potential sites for public-water-supply wells on Long Island, New York: U.S. Geological Survey Open-File Report 91-182, 33 p.

Mayor's Task Force, 1992. The future of the New York City Water Supply System: Final Report. Mayor's intergovernmental task force on New York City water supply needs 248 p.

Soren, Julian, 1976, Basement flooding and foundation damage from water-table rise in the east New York section of Brooklyn, Long Island, New York: U.S. Geological Survey Water-Resources Investigations Report 76-95, 14 p.