This first phase of the research has developed the algorithmic structure necessary for simultaneous evaluation of water quantity and quality in a river basin network, as well as establishing interfaces for linking the network model with appropriate water quality models. The second phase of this research is applying MODSIMQ to a portion of the Arkansas River basin using water quantity and quality data collected by the U.S.Geological .Survey. Attempts are being made to analyze risks associated with satisfying water quality requirements as a result of water quality data uncertainties. A decision support system is being developed that links MODSIMQ with a graphical user interface and a data base management system in the Windows environment for PCs.

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Modeling Municipal Water Demands for a Pump Station Area

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Abstract

The Chasewood Pump Station / Residential Area in southwest Houston was selected for a detailed analysis of ground and surface storage water pumping by a University of Houston and City of Houston team. The recently improved KYPIPE2 computer simulation program from the University of Kentucky was utilized for the Chasewood Pump Station Area. Geographic Information System (G.I.S.) maps were also made for the pipe networks. Water pressures and flow rates were simulated for a variety of system conditions.

Introduction

For the southwest Houston area, the Atlas- Geographic Information System (G.I.S.) provided a system map of water pipes 12 inches (30.48cm) or larger. The skeletonized G.I.S. water and freeway system is shown in Figure 1.

For the Chasewood residential area, various water pipes larger than four inches (10.16cm) and pipe length were obtained from water block maps. The skeletonized pipe network for the Chasewood area is shown in Figure 2. (Some of the sequential node numbers were omitted to avoid diagram clutter.) The Chasewood Pumping Station is in the middle of the pipe network and has two pumps simulated with three centrifugal pumps installed.

The recently improved KYPIPE2 computer simulation program from the University of Kentucky (Wood, 1988, 1992) was adopted for the initial Chasewood area pipe simulations.

Selected literature reviewed for the analyses and simulation included Ormsbee and Wood (1985), Zessler and Shamir (1989), Brion and Mays (1991), Chase and Ormsbee (1990), Helweg and Jacob (1991), Cullinane, Lansy and Mays (1992).

Conditions for the Simulation Program

For the Chasewood area, water demands of 250 gpcd and 2.6 persons per lot were applied for lot groupings and grouped area demands. Water usage was simulated in multiples such as two to four times the assumed average demands. From USGS topography maps for flat terrain, the pipe elevations were estimated at five feet below ground elevation. Roughness coefficients were initially assumed for asbestos cement pipe (100), cast iron pipes (110), and recent PVC pipe (140).

Pump Characteristics

Pump capacity is noted as the flow and head delivered by the pump at its maximum efficiency. The relationship between head and flow is represented by a head characteristic or performance curve. Three data points for head and discharge were specified for each pump. Two centrifugal pumps in parallel were placed at the pumping station node to simulate the pump station although three pumps were available.

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Take-off Points and Simulation Conditions

Around the pipe network, pipes extending to the next areas were cut-off and flows were simulated as take-off points. The total demand required by the service area was calculated. An estimated discharge of 3 mgd was assumed to be leaving the pump station. The difference in the pump station discharge and the demand was distributed among the take-off points proportional to the pipe diameters as a first approximation. The City of Houston specifies maximum pressure of 65 psi at the pump station or reservoir and minimum 35 psi in the residential service line to meet Texas standards.

Results

Table 1 contains the results obtained when the Chasewood area was simulated with fixed demands at take-off points and an elevated tank at 220 feet head at the pump station. Pressures were compiled at selected junction nodes (194 (pump station), 88, 1, 189, 287) for comparison. For 1 times the demand (1D), the pump station (194) had a pressure of 66.63 psi. Since this was simulated as a fixed grade node, the pressures were about the same for 2 times the demand (2D)(66.60 psi) at node 194 (pump station). Node 189, which was farther away, had the lowest pressure at 66.28 psi for 1D while the pressure dropped to 64.42 psi for 2D. For 1D, the net system inflow was 2087.09 gpm and equal to the net system demand with no net system outflow.

Table 2 contains the results for two reservoirs at two take-off points with a reservoir head of 160 feet rather than the 220 ft. head in Table 1. The pump station (194) pressure dropped from 66.63 psi for 1D in Table 1 to 40.18 psi in Table 2. The lowest pressure in Table 2 was at node 88 at 38.23 psi due to the supply arriving from the nearer reservoir (274) rather than from the pump station (194). The net system inflow and demand dropped from 2087.09 gpm to 1819.19 gpm due to the dropping of demand at the two take-off points with reservoirs. Other simulation trials were performed with one pump closed, with reservoirs at two and all take-off points, and with regulating valves in two pipes.

Future Studies

Future studies of the Chasewood and southwest Houston pipe networks will involve ground water pumping, energy computations and optimization considerations. The framework for pump stations and water distribution pipe analyses in southwest Houston has been established in this phase.

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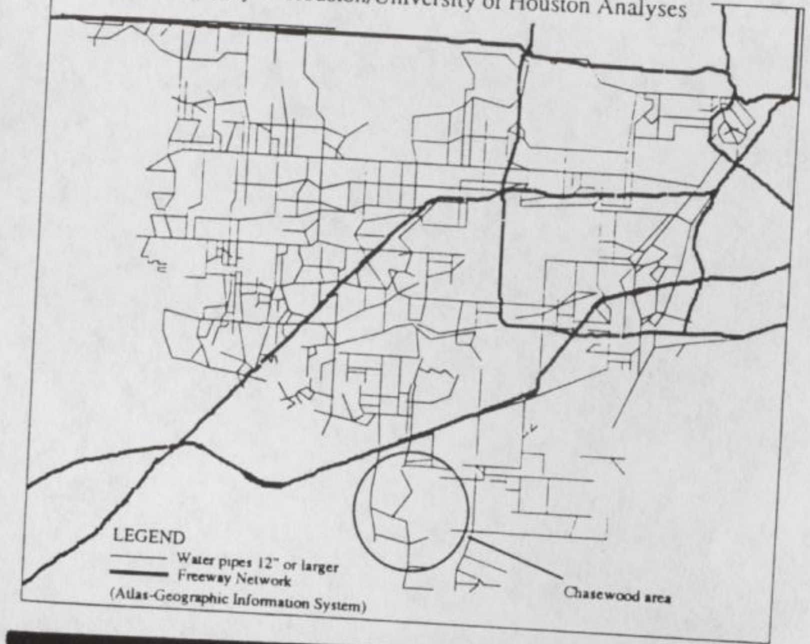
Figure 1. Southwest Houston Water Distribution System for City of Houston/University of Houston Analyses



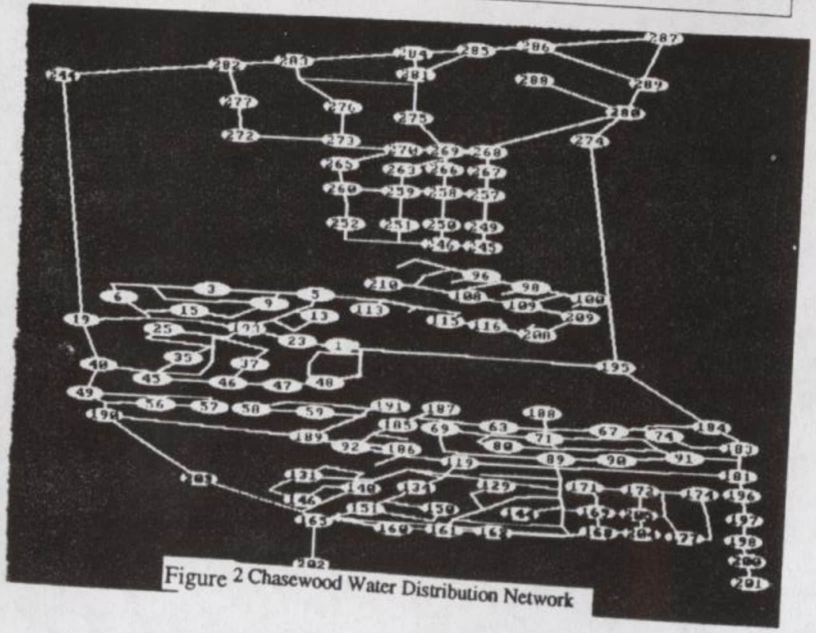


Figure 2 Chasewood Water Distribution Network

Table 1. Chasewood Subdivision KYPIPE2 Simulation with Storage Tank at Pumping Station with a Head of 220 feet

Pressures (psi)

Demand-D (gpm)	Node #194 Pumping Station	Node #88	Node #1	Node #189 Take-Off	Node #287 Take-Off
*D					
1.0	66.63	66.44	66.35	66.28	66.76
1.25	66.63	66.06	66.20	65.91	66.55
1.5	66.62	65.62	66.02	65.48	66.31
2.0	66.60	64.53	65.57	64.42	65.71

Table 2. Chasewood Subdivision KYPIPE2 Simulation with Reservoirs at Two Take-Off Points with a Head of 160 feet

Pressures (psi)

Demand-D (gpm)	Node #194	Node #88	Node #1	Node #189 Take-Off	Node #287 Reservoir
*D					
1.0	40.18	40.35	40.09	41.15	41.16
1.25	39.95	39.94	39.80	41.14	41.16
1.5	39.67	39.44	39.46	41.13	41.16
2.0	38.98	38.23	38.62	41.11	41.15

AQUIFER STORAGE AND RECOVERY IN THE FLORIDAN AQUIFER SYSTEM OF SOUTH FLORIDA

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ABSTRACT

This paper describes the feasibility, construction, testing, and storage zone development of the Boynton Beach Aquifer Storage and Recovery (ASR) well, the first successful ASR project in the Floridan Aquifer System of South Florida. ASR is the underground storage of water through a well into a suitable aquifer when excess supplies are available, and recovery from the same well during the dry season to meet seasonal, peak system, or emergency demands. ASR applications with treated drinking water require no additional treatment except basic disinfection during the recovery phase. This technology provides enormous storage potential at a cost savings that is usually over 50 percent when compared to that of surface storage reservoirs, and provides for greater flexibility. It is anticipated that treated water ASR wells completed in the upper Floridan Aquifer System of South Florida may store up to approximately 100 to 200 million gallons (MG) of water.

The City of Boynton Beach elected to utilize treated water ASR to meet seasonal and peak demands, provide an emergency supply, and provide additional storage capacity. Typical of most South Florida cities, Boynton Beach has a maximum day to average day demand ratio of about 1.5. The use of ASR will assist the City of Boynton Beach to meet peak demands, which occur during the dry season, without stressing production wells completed in the Surficial Aquifer System that are threatened by saltwater intrusion. With ASR, the City of Boynton Beach has also improved system-wide reliability during emergency conditions.

Cycle testing commenced immediately after completion of construction. During full-scale development, 60 MG were stored and recovered until chloride concentrations reached 250 milligrams per liter (mg/L). The recovery efficiency of the first five cycles has increased significantly with development of the storage zone.

INTRODUCTION

ASR is the underground storage of treated drinking water through a well when excess water supply is available, thus creating an "underground storage reservoir." Water is then recovered through the same well to meet seasonal, peak, long-term, or emergency demands. Figure 1 illustrates several ASR projects throughout the country that are either under development or in operation.

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