SW-57

Agenda Item IX

METROPOLITAN COUNCIL
300 Metro Square Building, St. Paul, Minnesota 55101

MEMORANDUM

January 23, 1981

TO: Solid and Hazardous Waste Management Advisory Committee

FROM: Environmental Planning (Paul Smith)

SUBJECT: Review of Supplements to the EISs on the Proposed Burnsville and Freeway Sanitary Landfill Expansions
City of Burnsville
Metropolitan Council District 15
Metropolitan Council Referral File 7568-1 and 7819-1

Supplements to the EISs on the proposed Burnsville and Freeway Sanitary Landfill expansions have been prepared and were recently mailed to you. Please remember to bring these documents to the Committee's February 4 meeting. The contents and findings of the supplements will be discussed.

The supplements describe the results of the City of Burnsville's water supply well field testing program. Groundwater characteristics in the vicinity of the well field and landfills are defined and the impact on the area's aquifer under various pumping conditions is determined.

In the case of the Burnsville Landfill no adverse impacts from the landfill or its expansion were found. The supplement on the Freeway Landfill, on the other hand, states that the potential exists for the landfill to adversely impact the City's well field.

The Council at its January 22 meeting took action to file with EQB the supplement to the EIS on the Freeway Landfill. The Council also set February 26 as a public meeting date to receive public comments on the document.

The supplement on the Burnsville Landfill did not find any new impacts or findings that were not contained in the draft EIS. The Council, therefore, decided that a public meeting was not necessary on this document. The supplement will be appended to the final EIS on the project.

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SUPPLEMENT TO
DRAFT ENVIRONMENTAL IMPACT STATEMENT
BURNSVILLE SANITARY LANDFILL EXPANSION
BURNSVILLE, MINNESOTA

January 20, 1981

Metropolitan Council
Suite 300 Metro Square Building
St. Paul, Minnesota 55101

INTRODUCTION

In August 1980, the Minnesota Environmental Quality Board granted the Metropolitan Council an extension of time to complete the environmental impact statement (EIS) on the Burnsville Sanitary Landfill expansion. The extension of time was necessary to await the results of a report being prepared for the City of Burnsville on its water supply well field expansion. The City's well field is located about a 1.5 miles east of the Landfill. The Council felt the City's report would provide further definition on the groundwater hydrology in the vicinity of the Landfill and any impacts that might occur to the groundwater and City's well field as a result of the Landfill's expansion.

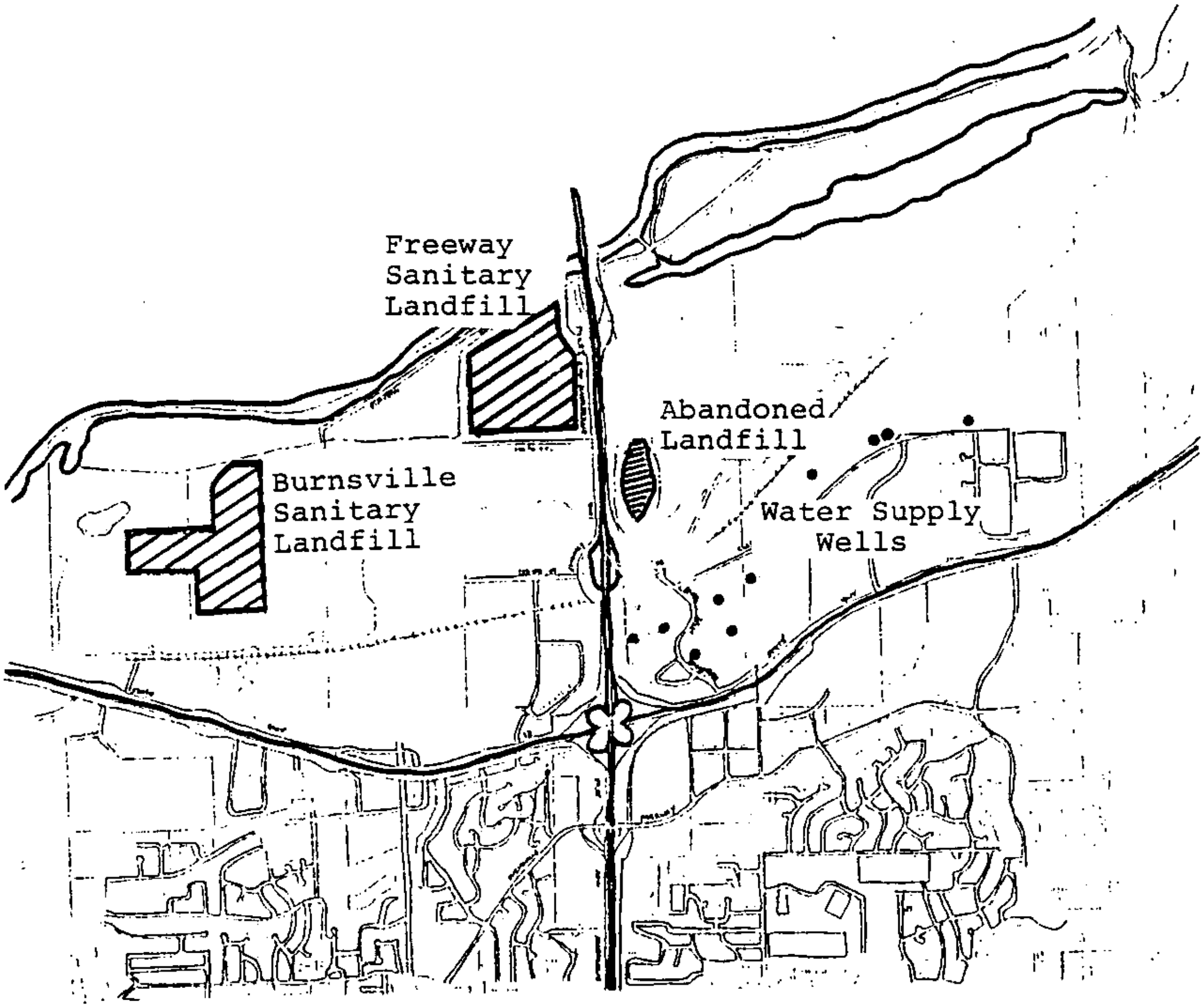
The City's report on its water supply well field expansion was completed in December 1980. The following analyses of the City's report will supplement the draft EIS on the Landfill expansion. The analyses will be contained in the groundwater sections of the final EIS.

WELL FIELD TESTING PROGRAM

Well field testing procedures, starting in March 1980, were conducted as part of Burnsville's continuing municipal water well development program. The well field testing program was undertaken in response to conclusions presented in a report regarding groundwater investigations in 1978 which identified a condition that posed a potential contamination threat to the Jordan aquifer in the well field area. According to the 1978 report, observed interference water level fluctuations indicated the possibility of groundwater gradient reversals extending beneath the Minnesota River floodplain.

The proximity of the City's water supply well field to the Landfill is shown in Figure 1. As can be seen, the Landfill is about 8,000 feet to the west of the well field. In addition, Figure 1 shows the location of the Freeway Sanitary Landfill and an abandoned landfill north and slightly west of the well field. The immediate location of the abandoned landfill to the well field was the major reason for the City to undertake the 1980 study. The possibility of leachate from this landfill descending to the Jordan aquifer during periods of pumping at the wells that produce the gradient reversal represented the most immediate potential threat.

The implementation of the well field testing procedures required as a basic minimum, one observation well in Jordan sandstone and one observation well in the Shakopee dolomite. Accordingly, the existing Jordan aquifer well located at the former site of the City's sewage treatment facility was modified for water level instrumentation and a new well was constructed in the Shakopee dolomite approximately 48 feet south of the Jordan aquifer well.



Burnsville's Water Supply Well Field

Figure 1

Water samples were collected weekly starting on July 1, 1980 and continuous water level recorders were installed at the Jordan and Shakopee observation wells on July 17, 1980. Pumping tests were then run at the City's water supply wells number 2, 3, 4, 6, 7, 8 and 10 during the month of August (see Figure 2). The tests consisted of pumping an individual well for two hours while the other wells remained off. The closest wells to the pumping well were used as observation wells. Water level fluctuations were also recorded at the Jordan and Shakopee observation wells.

HYDROLOGY

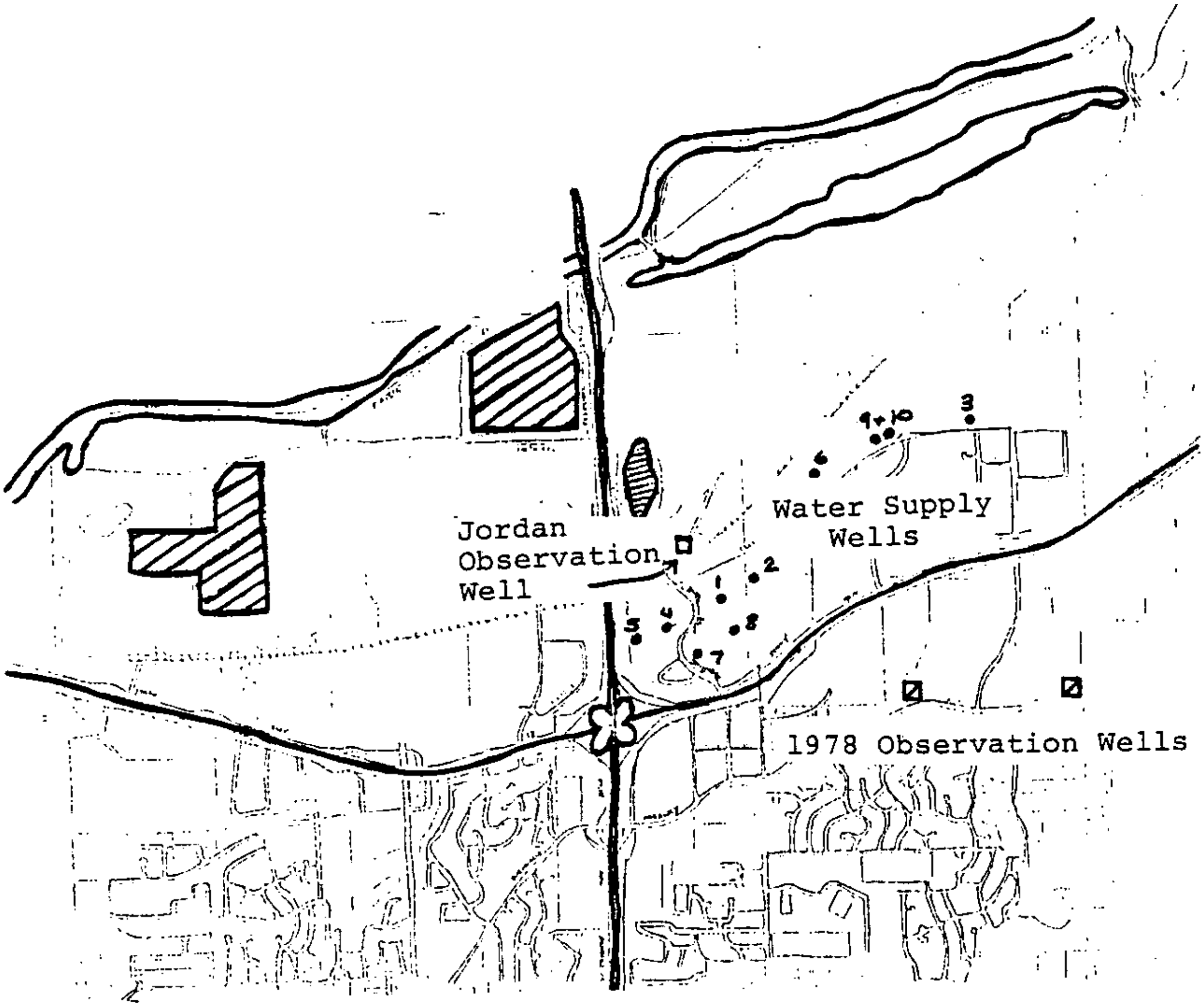
In evaluating an aquifer that is selected as a source of water supply, the recharge and discharge relationship with underlying and overlying aquifers must be considered. Under natural conditions the water in the Jordan sandstone was in a state of equilibrium. Although the water level fluctuated from season to season and year to year in response to changes in recharge and discharge, over long periods of time the average discharge was equal to the average recharge and the fluctuation occurred through a relatively narrow zone.

Prior to the development of groundwater supplies or other works of man that disturbed the natural flow of groundwater, recharge to the Jordan aquifer occurred mainly beneath the upland areas remote from the major stream valleys and discharge occurred through the overlying geologic units to the major streams and lakes located in the floodplains. At Burnsville, the natural groundwater discharge was concentrated in the Minnesota River Valley and ultimately, the groundwater left the area as stream flow or evapotranspiration.

A potentiometirc surface map based on available water levels in Jordan wells is shown on Figure 3.

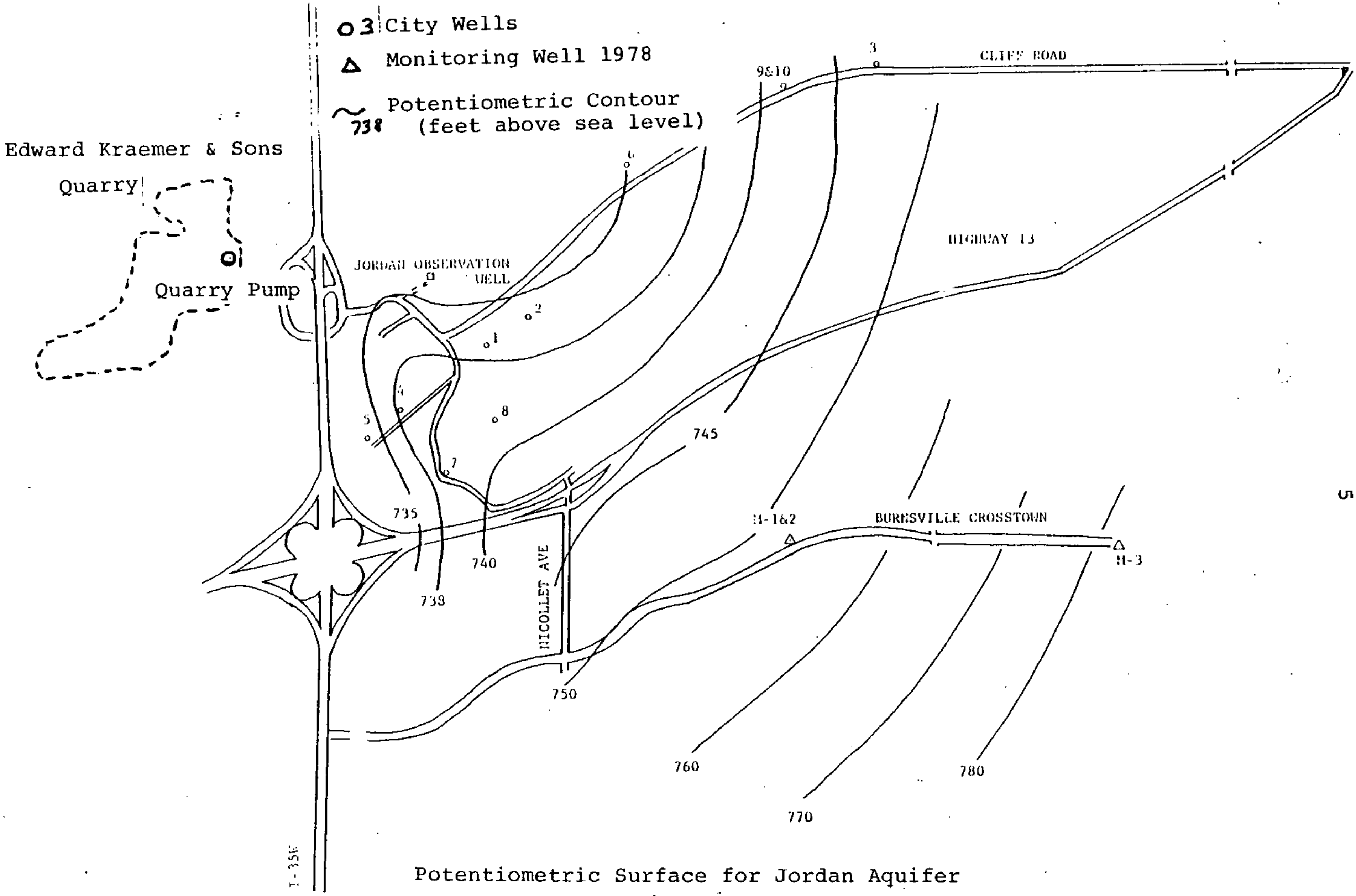
The installation of wells in the Jordan aquifer and development of a quarry in the overlying Shakopee-Oneota dolomites approximately 3,000 feet west (see Figure 3) of the observation wells tends to modify the natural equilibrium and distort the flow patterns within each unit as well as the groundwater transfer between the units. Dewatering operations at the quarry, which is in an area of natural groundwater discharge, created a cone of depression, increased the vertical gradient from the Jordan aquifer and consequently also increased the transfer of water from the Jordan. In contrast, the new wells open only to the Jordan aquifer, tend to reduce the vertical gradient in the areas of natural discharge and in heavily pumped areas cause a transfer of water from the dolomite to the sandstone.

The geologic cross sections shown on Figures 4 and 5 represent the stratigraphy of the Burnsville area and indicate the general direction of groundwater flow. In a natural condition the hydraulic gradient is from the south to the north, flowing towards the river. Under the influence of pumping of the city wells, this gradient is reversed in the area north of the well field, such that groundwater moves to the south towards the well field. Along with the reversal of the groundwater flow there is leakage from the Shakopee dolomite into the underlying Jordan sandstone.



Well Field Testing Program

Figure 2



Potentiometric Surface for Jordan Aquifer

Prepared by Bruce Liesch Associates for City of Burnsville

Figure 3

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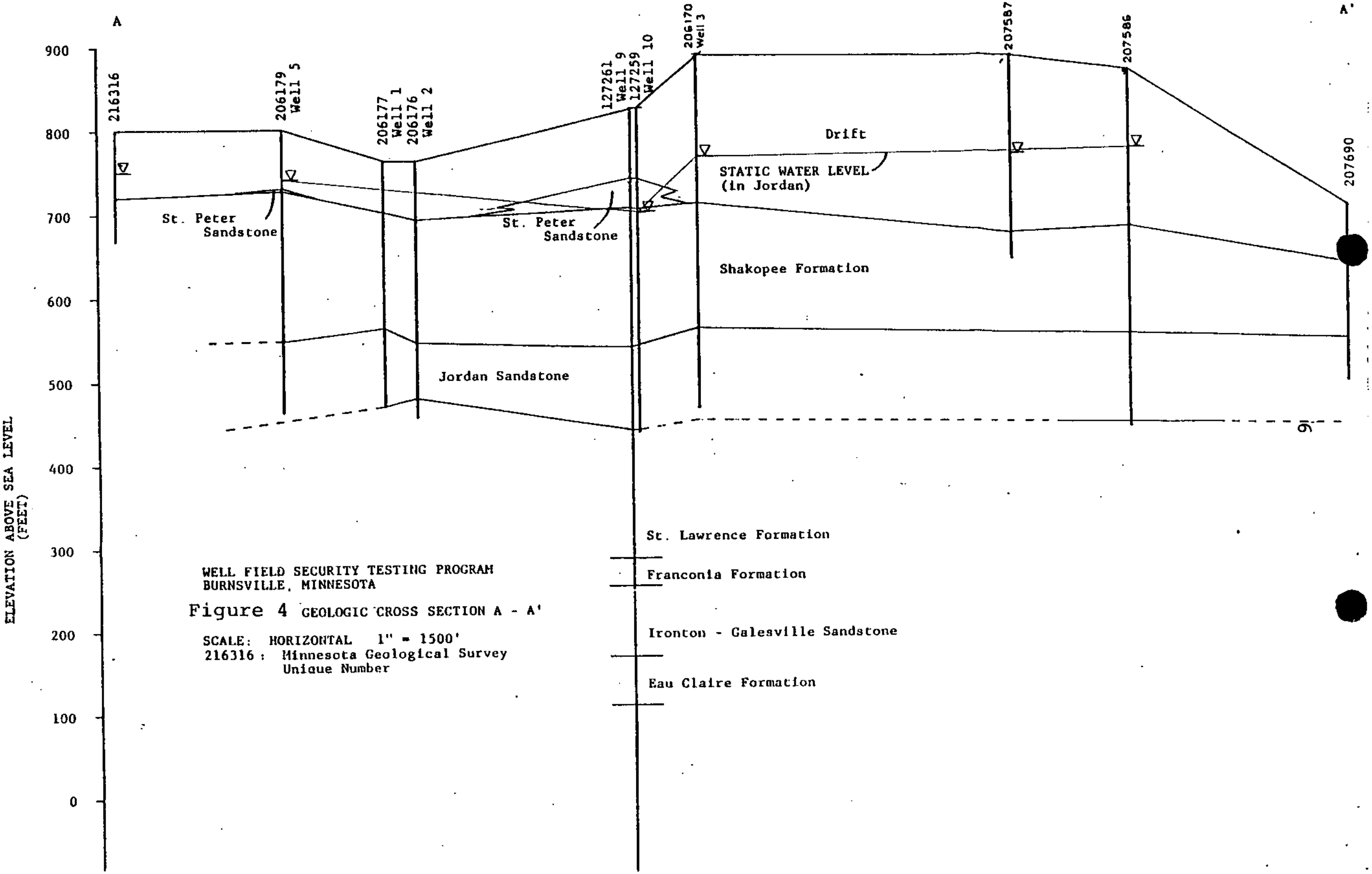

Figure 4 GEOLOGIC CROSS SECTION A - A'

SCALE: HORIZONTAL 1" = 1500'
216316 : Minnesota Geological Survey Unique Number

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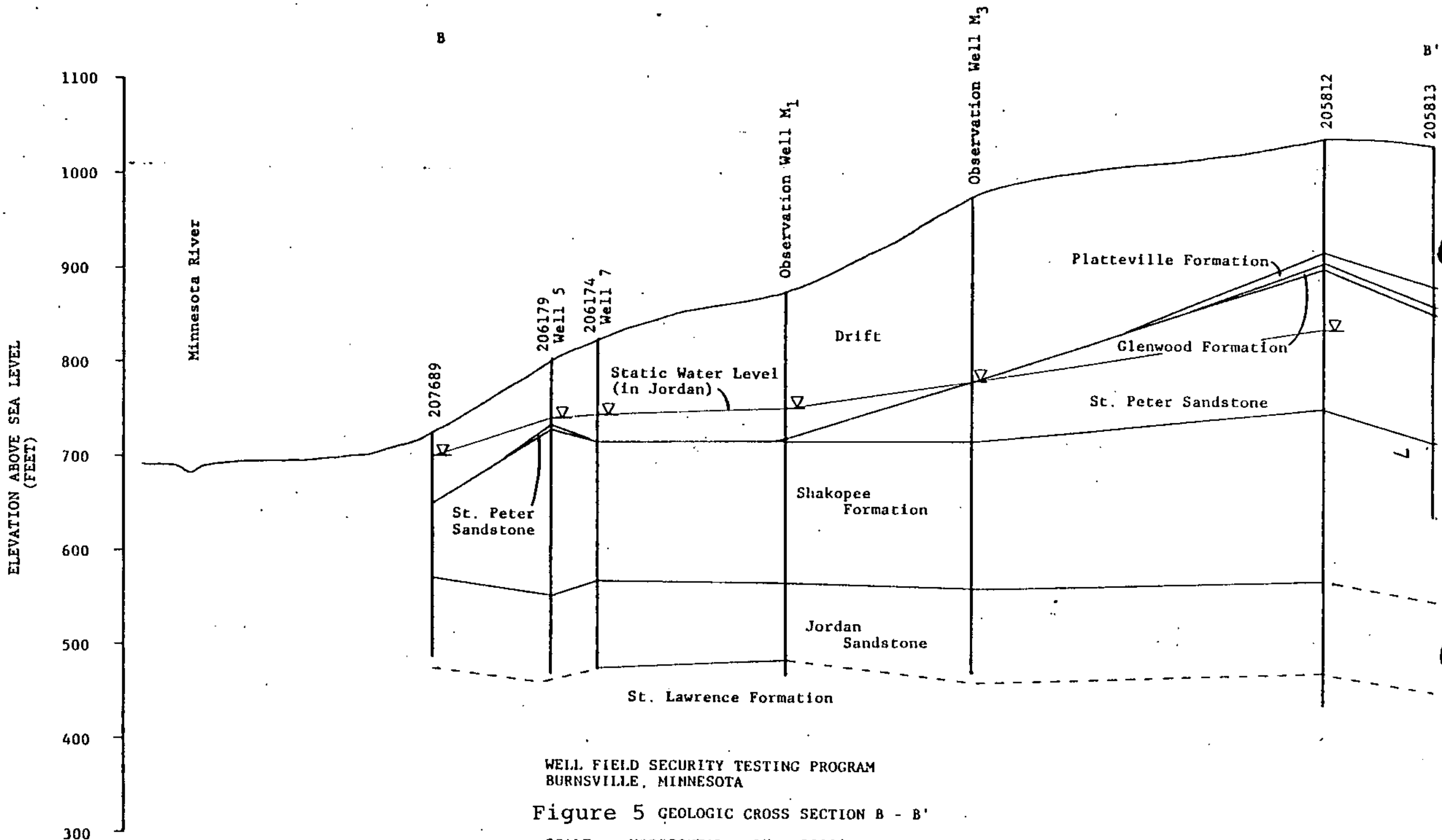

WELL FIELD SECURITY TESTING PROGRAM
BURNSVILLE, MINNESOTA

Figure 5 GEOLOGIC CROSS SECTION B - B'

SCALE: HORIZONTAL 1" = 2000'

207689: Minnesota Geological Survey Unique Number

This reversal of the groundwater flow takes place during part of the pumping cycle and during part of the recovery cycle. Reversal of flow is known to bé noncontinuous because after the pumping of all the city wells, the Jordan observation well recovers to the point where it is discharging at the surface while the Shakopee well has a water level 8 to 9 feet below the surface. This indicates that the Jordan is leaking into the overlying Shakopee and flow into the Jordan from above cannot take place.

PUMPING TEST ANALYSIS

During the testing procedure at each well, drawdown and recovery water levels were measured at the pumped well, at nearby municipal production wells and at the Jordan and Shakopee observation wells. The data were plotted and analyzed using the time-drawdown, time-recovery Theis non-equilibrium method modified by Jacob, and by distance-drawn equilibrium methods.

Upon completion of the analysis of the pumping data, a mathematical model, based on distance-drawdown curves, was developed to simulate the reaction of the aquifer and its potentiometric surface to varying pumping rates and well field configurations. This allowed a study of the reaction of the aquifer to the location and pumping of new wells in various configurations. As a calibration control for the model, a pumping test was run October 13 and 14, 1980. This test consisted of pumping all the wells except 6, and observing the drawdown in the wells throughout the 9.5 hours of pumping. Water levels were measured before the test to determine the trend caused by recovery from anticedent pumping and to determine the approximate projected water level in the flowing Jordan observation well.

The computed drawdowns derived from the mathematical model and the actual drawdowns observed in the October 13 and 14 pumping test were in very close agreement, expecially in the observation wells. This indicates that the model, based on the distance-drawdown curves, along with the assumptions are representative of the hydraulic conditions in the Burnsville well field area.

Drawdown maps were compiled using the aquifer mathematical model to observe the reaction to various well configurations. The first drawdown map, Figure 6, represents the drawdown associated with pumping all the present city wells at 1200 gpm for 10 hours, at which point equilibrium was reached. An additional well was then added at the intersection of Nicollet and Highway 13 (SW corner) and a drawdown map developed to study the change in the Jordan water levels, Figure 7. The proposed new well was assumed to be located in a segment of the aquifer represented by the model in the vicinity of well 8. With this new well pumping, additional drawdown observed at the Jordan observation well would be 2.6 feet after 10 hours of pumping. In a worst-case scenario the new well could follow the distance-drawdown curve for well 2 and cause 4.3 feet of drawdown at the Jordan observation well at equilibrium.

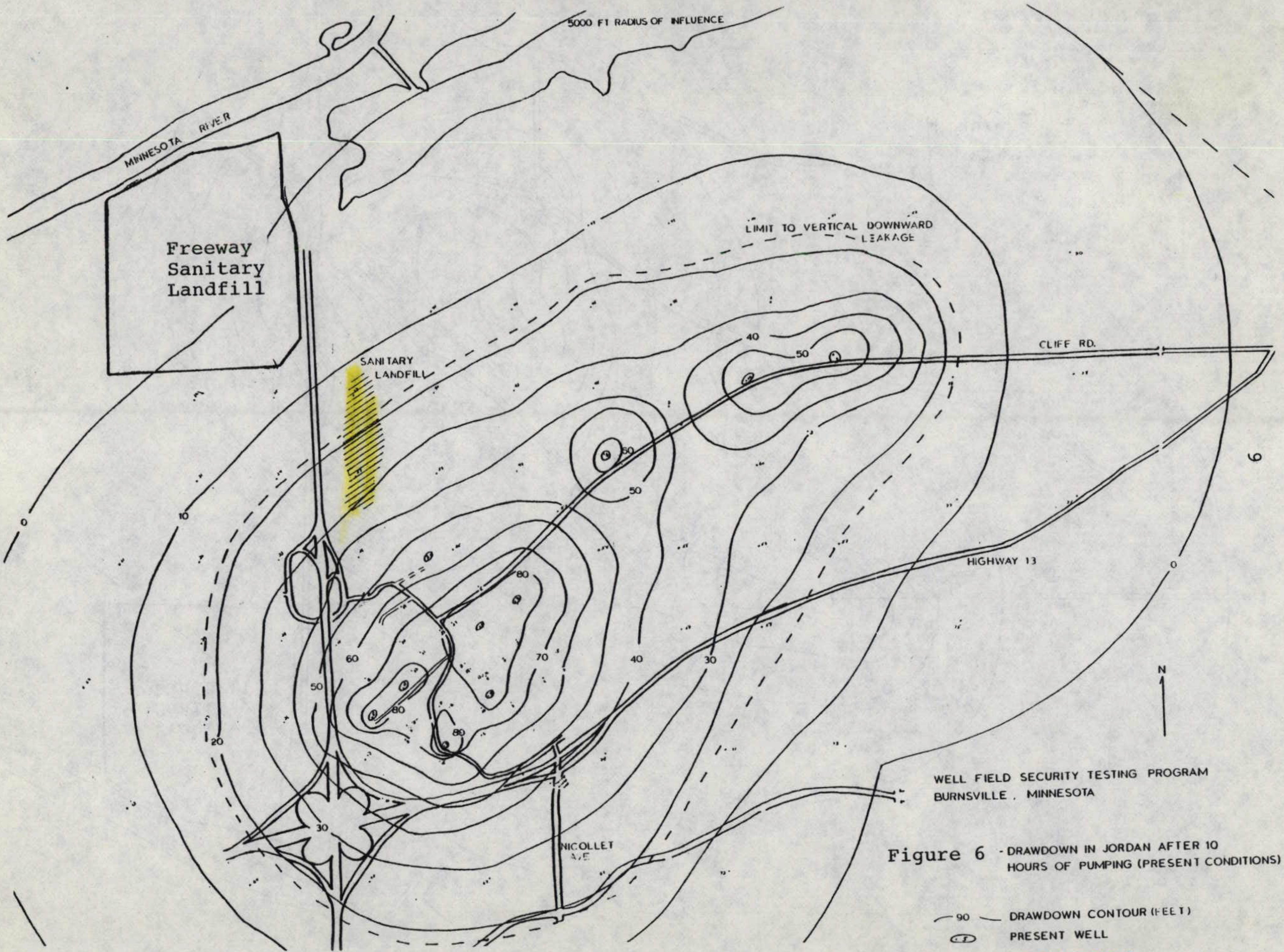

Figure 6 - DRAWDOWN IN JORDAN AFTER 10 HOURS OF PUMPING (PRESENT CONDITIONS)

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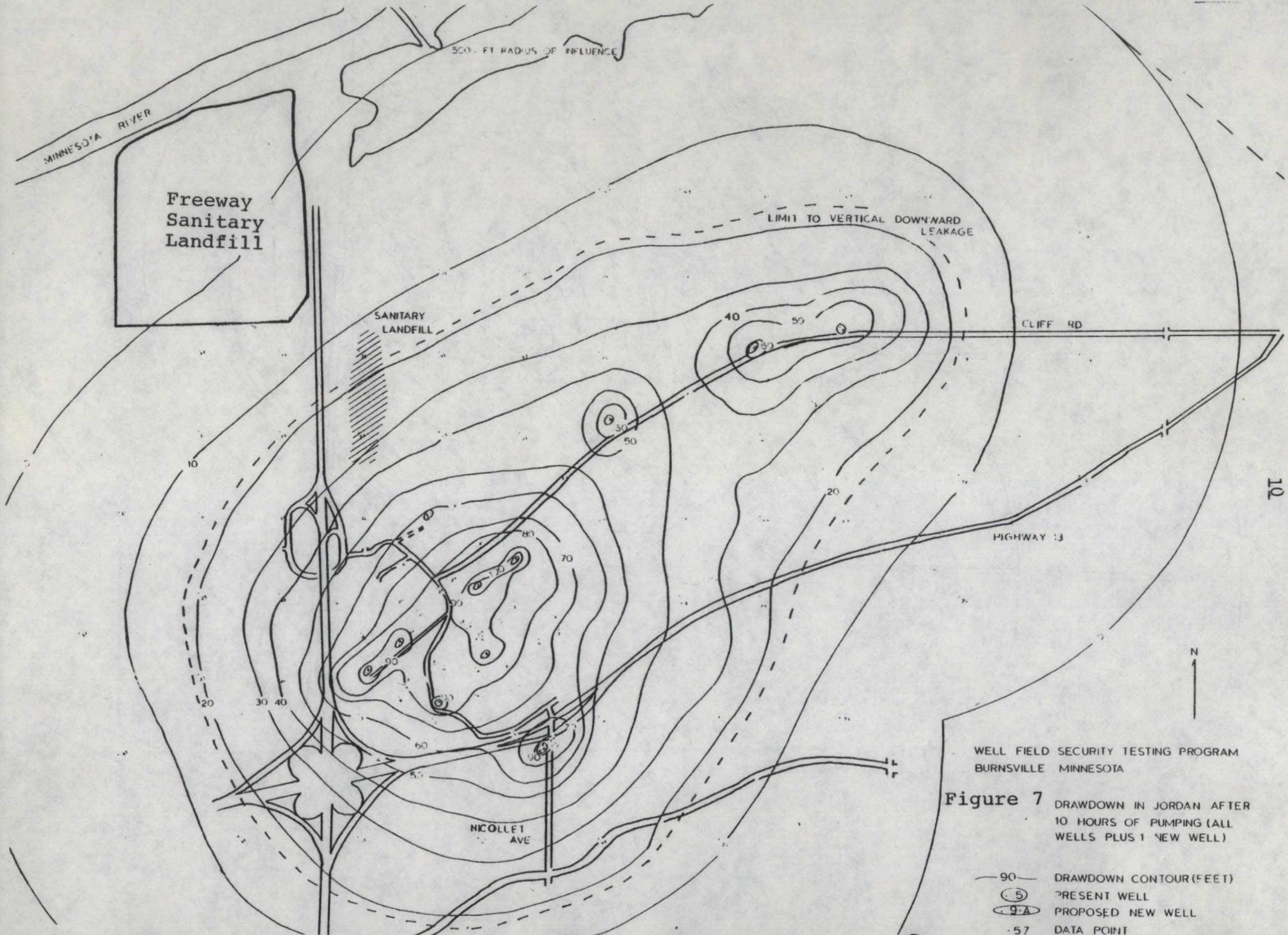

WELL FIELD SECURITY TESTING PROGRAM
BURNSVILLE MINNESOTA

Figure 7 DRAWDOWN IN JORDAN AFTER 10 HOURS OF PUMPING (ALL WELLS PLUS 1 NEW WELL)

—90— DRAWDOWN CONTOUR (FEET)
(5) PRESENT WELL
(9-A) PROPOSED NEW WELL
·57 DATA POINT

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A major concern in Burnsville is the possible contamination of the water supply from leachate at the abandoned landfill site north of the well field. Upon analysis of the drawdown maps of Figures 6 and 7, it appears that no appreciable change is observed in the Jordan water surface by the addition of a well at the intersection of Nicollet and Highway 13. The distance between the new well and the southern-most extent of the landfill is approximately 4,100 feet. At this distance the new well would cause a maximum increase in drawdown under the landfill of 1.2 to 1.9 feet, dependent on the assumed distance-drawdown relationships. At a point approximately three-quarters of the way through the landfill there would be no drawdown change caused by the new well.

Hydrographs of the Shakopee and Jordan observation wells under the conditions of all wells pumping are shown in Figures 8 and 9. The intersections of the hydrographs indicate points where flow direction between the two formations is reversed. By extrapolating the Jordan observation well recovery curve to a status level, the drawdown in the Jordan at which leakage begins to occur can be determined. During the drawdown and recovery cycle, leakage between formations is reversed at a drawdown of between 14 and 17 feet. A line of leakage is assumed to be between the 10- and 20-foot drawdown contour lines in Figures 6 and 7. Under both well configurations studied, three fourths of the landfill is in an area of vertical leakage from the Shakopee dolomite into the Jordan sandstone during part of the pumping cycle.

The drawdown contours in Figure 6 were further defined in Figure 8 by using a computer model. Figure 8 shows the drawdown contour with pumping all of the present city wells at 1200 gpm for 10 hours. The Burnsville Landfill is about one mile west of the vertical leakage line according to Figure 8.

The hydrograph of Figures 9 and 10 gives some idea as to the length of time leakage from the Shakopee into the Jordan takes place. To determine how long leakage occurs under the abandoned landfill site, these water level curves have to be modified. Figure 10 shows the modification of the drawdown trends, indicating the water levels in the formations underlying the abandoned landfill.

According to Figure 8, the abandoned landfill's southern most extent is overlying an area which has 40 feet of drawdown associated with steady state pumping and a northern-most extent associated with 20 feet of drawdown at steady state. Figure 11 shows that leakage starts at the Jordan and Shakopee observation wells 15 minutes after pumping begins but does not start at the beginning of the landfill until the pumps have been going for 150 minutes. Figure 11 also indicates that at 18 feet of drawdown or less, there is no leakage from the Shakopee into the Jordan. The 18-foot drawdown contour line shown in Figures 6, 7 and 8 represents the limit of vertical leakage form the Shakopee to the Jordan at steady state conditions. Since the pumps are seldom run long enough to attain a steady state condition, the drawdown under the abandoned landfill and the leakage associated with the drawdown is almost always less than predicted.

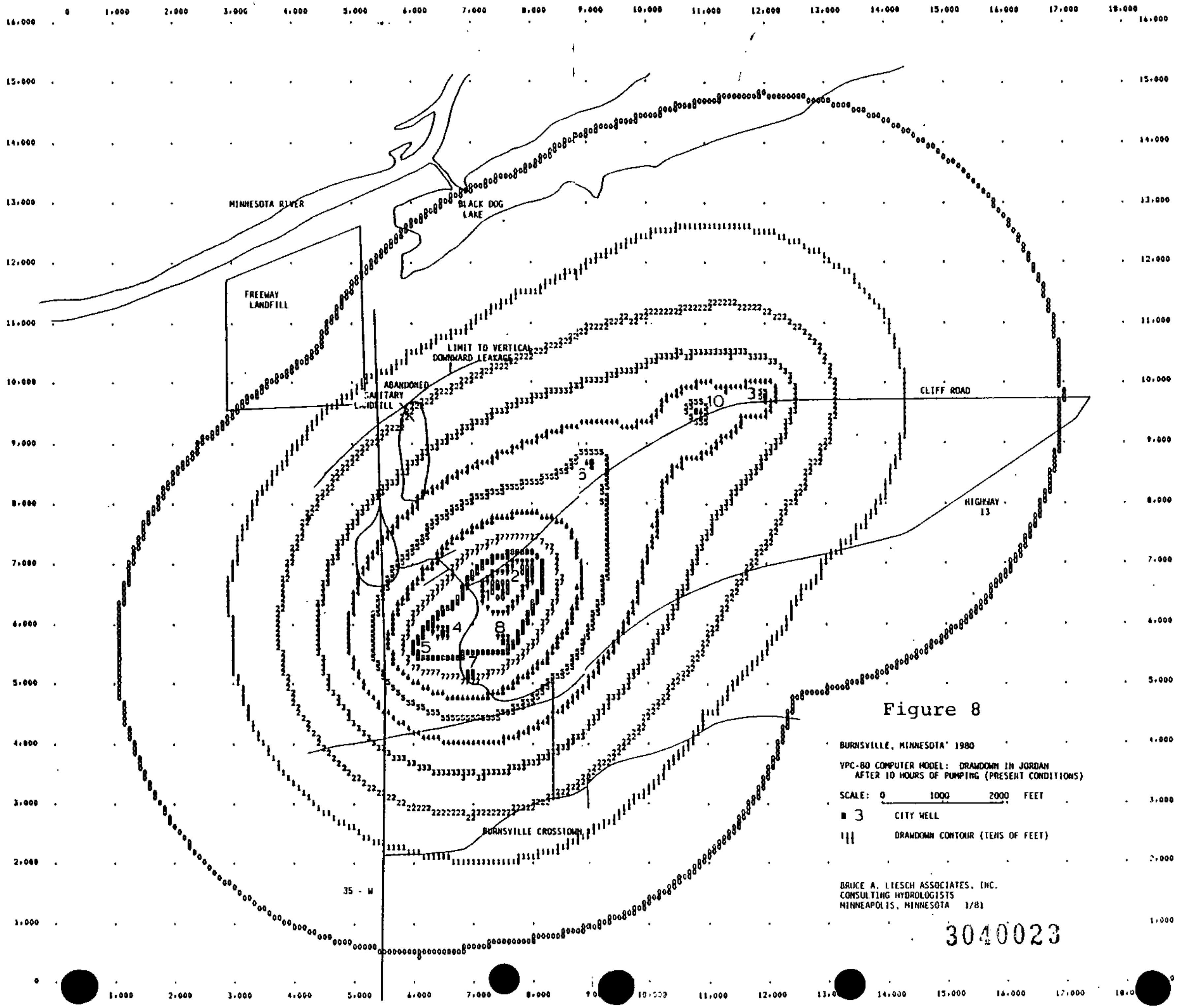

Figure 8

BURNSVILLE, MINNESOTA 1980

YPC-80 COMPUTER MODEL: DRAWDOWN IN JORDAN AFTER 10 HOURS OF PUMPING (PRESENT CONDITIONS)

SCALE: 0 1000 2000 FEET

■ 3 CITY WELL

||| DRAWDOWN CONTOUR (TENS OF FEET)

BRUCE A. LIESCH ASSOCIATES, INC.
CONSULTING HYDROLOGISTS
MINNEAPOLIS, MINNESOTA 1/81

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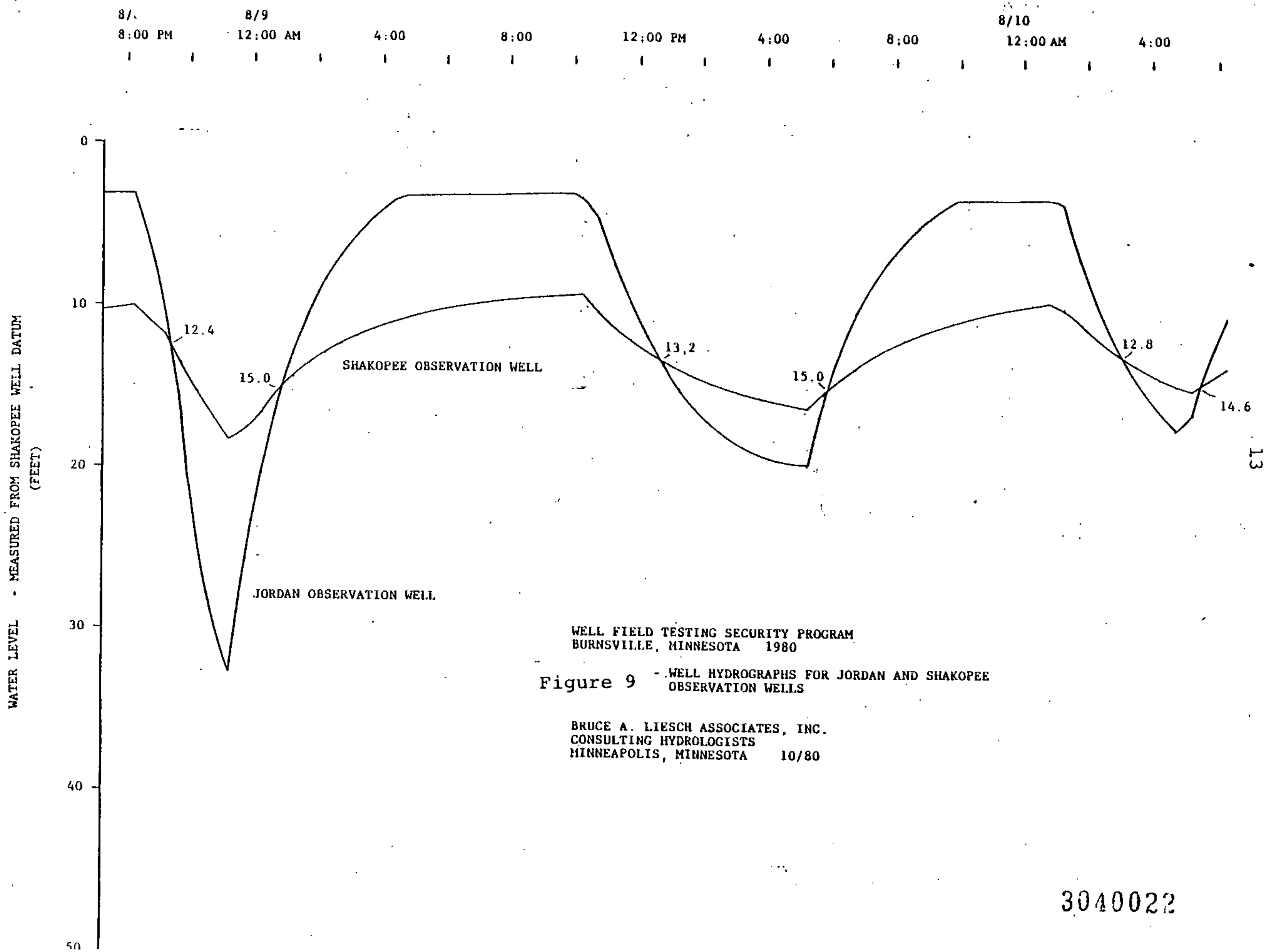
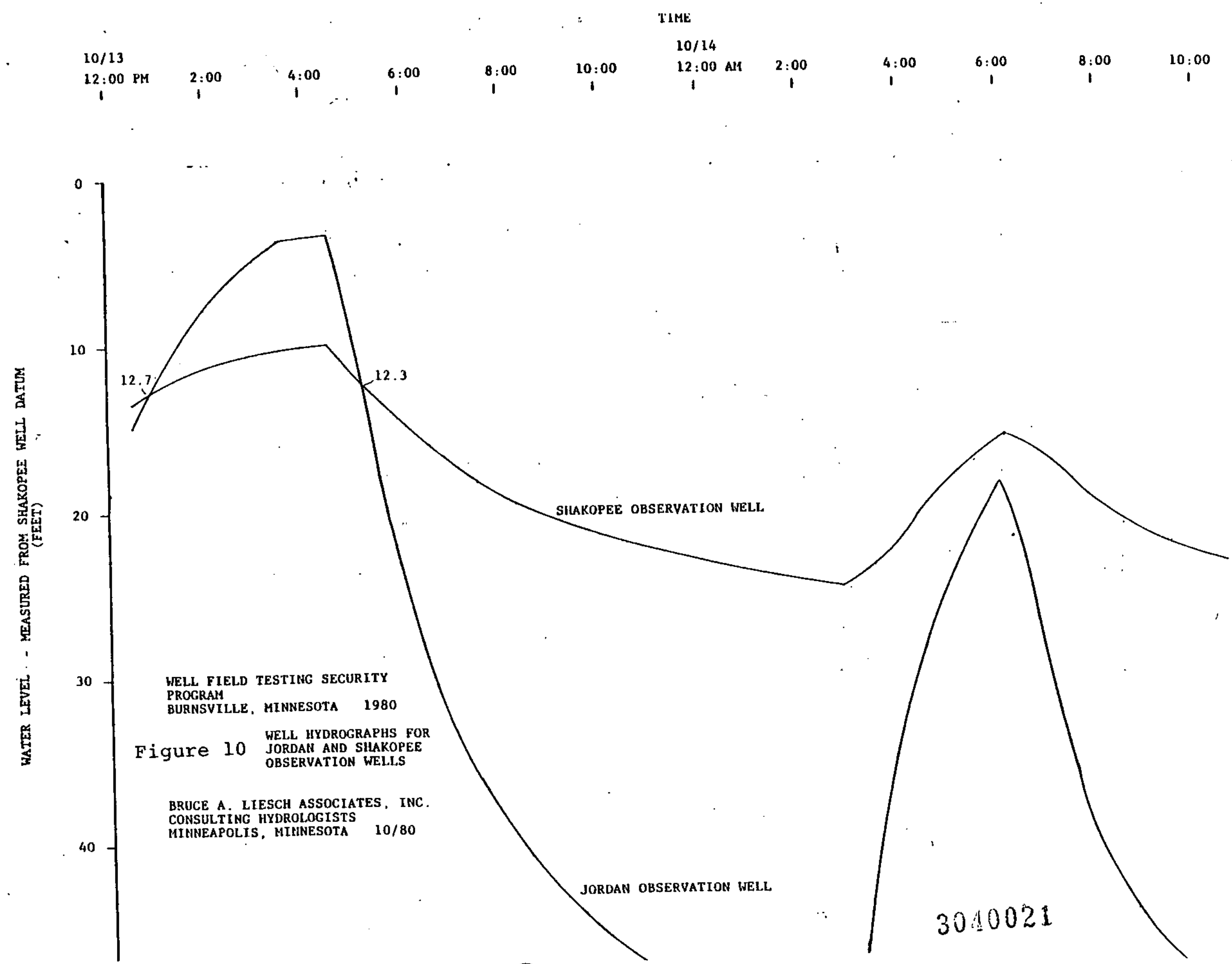


WELL FIELD TESTING SECURITY PROGRAM
BURNSVILLE, MINNESOTA 1980

Figure 9 - WELL HYDROGRAPHS FOR JORDAN AND SHAKOPEE OBSERVATION WELLS

BRUCE A. LIESCH ASSOCIATES, INC.
CONSULTING HYDROLOGISTS
MINNEAPOLIS, MINNESOTA 10/80



WELL FIELD TESTING SECURITY PROGRAM
BURNSVILLE, MINNESOTA 1980

Figure 10 WELL HYDROGRAPHS FOR JORDAN AND SHAKOPEE OBSERVATION WELLS

BRUCE A. LIESCH ASSOCIATES, INC.
CONSULTING HYDROLOGISTS
MINNEAPOLIS, MINNESOTA 10/80

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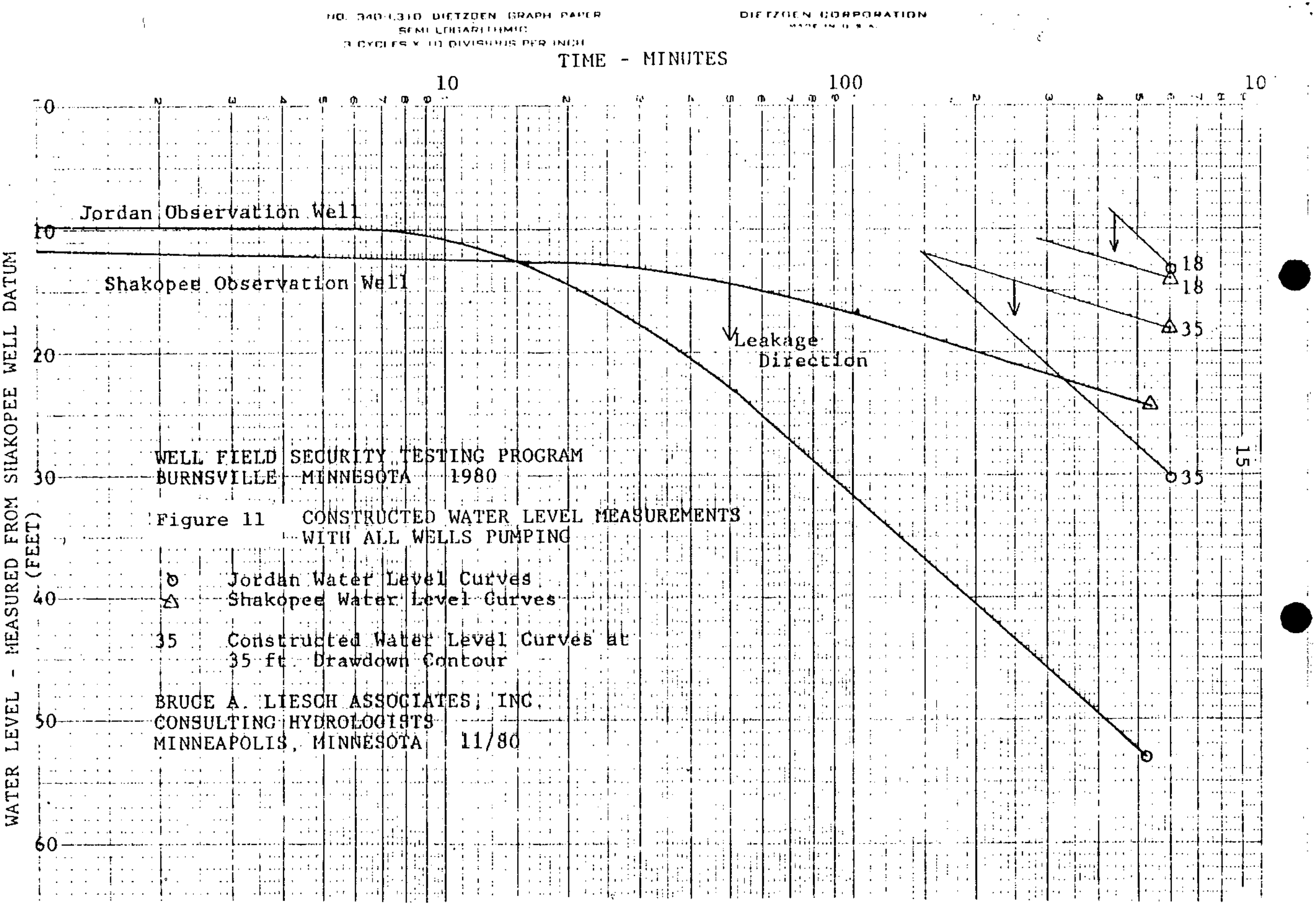
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TIME - MINUTES
10
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20
30
40
50
60
WATER LEVEL - MEASURED FROM SHAKOPEE WELL DATUM (FEET)
Jordan Observation Well
Shakopee Observation Well
Leakage Direction
18
18
35
35
15
WELL FIELD SECURITY TESTING PROGRAM
BURNSVILLE, MINNESOTA 1980
Figure 11 CONSTRUCTED WATER LEVEL MEASUREMENTS WITH ALL WELLS PUMPING
Jordan Water Level Curves
Shakopee Water Level Curves
35 Constructed Water Level Curves at 35 ft. Drawdown Contour
BRUCE A. LIESCH ASSOCIATES, INC.
CONSULTING HYDROLOGISTS
MINNEAPOLIS, MINNESOTA 11/80

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TABLE 1 - Analysis of Leakage Direction Measured at the Jordan and Shakopee Observation Wells 7/22-7/28, 1980.

Date July 1980	Flow Into Jordan Start	Flow Into Jordan Stop	Flow Into Shakopee Start	Flow Into Shakopee Stop	Total Time Hrs.	Total Time Min.
22	1:10P	5:20P			4	10
22			5:20P	6:40P	1	20
22-23	6:40P	4:30A			9	50
23			4:30A	10:20A	5	50
23	10:20A	4:40P			6	20
23			4:40P	5:00P		20
23-24	5:00P	8:50A			15	50
24			8:50A	10:20A	1	30
24-25	10:20A	5:00A			18	40
25			5:00A	6:30A	1	30
25	6:30A	11:00A			4	30
25			11:00A	2:30P	3	30
25	2:30P	7:20P			4	50
25			7:20P	10:40P	3	20
25-26	10:40P	3:00A			4	20
26			3:00A	11:30A	8	30
26	11:30A	3:40P			4	10
26			3:40P	5:00P	1	20
26-27	5:00P	12:00A			7	0
27			12:00A	9:30A	9	30
27-28	9:30A	11:00A			25	30

An analysis was conducted to determine the length of time that groundwater leaked from the Shakopee dolomite into the Jordan sandstone during the period of maximum pumpage. Table 1 shows the results of the analysis, indicating that the leakage from above occurs over a much longer time period than the natural flow from the Jordan to the Shakopee. At one point there are 25.5 hours of leakage over three pumping cycles in which the water level in the Jordan is below the water level in the Shakopee at the observation wells.

In contrast, hydrographs from two and one-half weeks later, Figure 9, indicate that the upward flow from the Jordan into the Shakopee occurs over much longer periods of time than reversed flow. During the pumping of August 9, flow was reversed for a period of five hours, followed by a period of upward flow of nine hours. Previous to the five hours of reversal, the flow was from the Jordan to the Shakopee over a 12-hour period. Figure 10 indicates an extended period of leakage into the Jordan during the middle of October. This was caused by extended pumping to fill a storage reservoir and does not represent a normal pumping period for October.

This analysis indicates that only over a short period of time during the year does leakage into the Jordan exceed the natural condition of leakage direction from the Jordan into the Shakopee.

HYDROLOGIC INVESTIGATION WEST OF THE BURNSVILLE WELL FIELD

On December 15, 1980, a meeting was held between representatives of the City of Burnsville, representatives of Ed Kraemer and Sons, and the Metropolitan Council staff. At the meeting concern was expressed witth respect to the effect that the Landfill would have on the Burnsville wells at their current pumping rates. The representatives of Burnsville felt that more information was needed to identify the hydrologic characteristics of the area west of the Burnsville well field.

To provide the information requested, a 10-hour pumping test was run by the City's consultant on December 29, 1980. The test consisted of pumping city wells 1, 2, 4, 5, 7 and 8 and observing drawdown in a Jordan well on the Kraemer quarry property as well as drawdown in city wells 3 and 6 and in the Shakopee and Jordan observation wells.

The results of the pumping test represent the actual drawdown expected during the peak pumping periods of the City's well field. The results were compared to the theoretical drawdown computed from the mathematical model developed for the Burnsville area and the conclusions drawn.

The water levels observed at the quarry well indicate a deep cone of depression in the Jordan aquifer caused by pumping from the quarry. The cone of depression beneath the quarry acts as a barrier sink to the movement of groundwater in the Shakoee-Oneota-Jordan aquifer system. The measured interference water level drawdown at the quarry well caused by the Burnsville Jordan wells pumping at a maximum rate for 10 hours was 1.35 feet. In contrast, the mathematical model indicated an interference drawdown of 17 feet. The lack of agreement

See revised pages 18 & 19 for Conclusions

These revisions occurred between Advisory Committee Action and Public Mtg 3/26/8?

between the actual observed interference conditions and the mathematical model may be attributed to a) a higher effective coefficient of transmissivity in the area of the quarry than has been assumed for the model, b) an increase in the coefficient of storage caused by partial dewatering of the Shakopee dolomite and partial transition from artesian to water table condition, c) higher leakage rates from the Shakopee to the Jordan in the intervening area between the well field and the quarry, d) a combination of all the factors a, b and c. A higher coefficient of transmissivity and higher leakage rates would be natural physical characteristics of the units. The increase in the coefficients of storage that would accompany a transition to partial water table conditions would be induced by the deep cone of depression in equilibrium beneath the quarry. A cessation of pumping at the quarry would cause a trend toward natural conditions and the protective effects of the barrier sink would be diminished or eliminated.

CONCLUSIONS

1. The mathematical model developed for the Burnsville well field is representative of the actual aquifer conditions and can be used to model varying well field configurations of future proposed wells.

2. In the vicinity of the Jordan and Shakoee observation wells the flow direction is reversed at a drawdown of between 14 and 17 feet where upon flow is from the Shakopee into the Jordan.

3. Under current pumping conditions and only during short periods of peak demand, the combined cones of depression in the Burnsville well field produce a net transfer of groundwater from the Shakopee-Oneota dolomites to the Jordan sandstone within the area encompassed by the dashed line between the 10-foot and 20-foot drawdown contours shown in Figure 6.

4. Only during short periods in the summer does the length of time of flow from the Shakopee dolomite into the Jordan sandstone exceed the length of time of flow from the Jordan sandstone into the Shakopee dolomite.

5. The potential for short-term groundwater contamination in a limited area adjacent to the abandoned landfill appears to be more a function of the duration of the pumping periods at the existing municipal wells rather than additional wells pumping at more remote sites to the south and east.

6. The potential for long-term, widespread contamination of the Jordan aquifer would be greatly enhanced by the extended pumping periods at the existing municipal wells resulting from an increase in the water requirements rather than by orderly expansion of new wells to the south and east.

7. During steady state conditions, the water pumped from the Jordan is replaced by groundwater leakage through the Shakopee-Oneota descending from the overlying geologic units. To avoid contamination it would be preferred that the replacement water be derived largely from the St. Peter sandstone and glacial drift deposits south of the well field rather than from the valley alluvium.

8. The combined cones of depression in the Burnsville well field shows no impact from the Burnsville Sanitary Landfill.

9. The Landfill is approximately one mile west of the City's well drawdown between 14 and 17 feet where upon flow is from the Shakopee into the Jordan. Distance alone appears to be a mitigating measure.

10. The quarry dewatering that exists between the Landfill and the municipal wells represents a second level of protection by intercepting any flow that could otherwise possibly occur between the Landfill and the wells.

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partial dewatering of the Shakopee dolomite and partial transition from artesian to water table condition, c) higher leakage rates from the Shakopee to the Jordan in the intervening area between the well field and the quarry, d) a combination of all the factors a, b and c. A higher coefficient of transmissivity and higher leakage rates would be natural physical characteristics of the units. The increase in the coefficients of storage that would accompany a transition to partial water table conditions would be induced by the deep cone of depression in equilibrium beneath the quarry. A cessation of pumping at the quarry would cause a trend toward natural conditions and the protective effects of the barrier sink would be diminished or eliminated.

CONCLUSIONS

1. The mathematical model developed for the Burnsville well field is representative of the actual aquifer conditions and can be used to model varying well field configurations of future proposed wells.

2. The mathematical model is theoretical in nature. Additional observation wells north of the City's well field would help to further define hydrologic characteristics in the vicinity of the Freeway Sanitary Landfill. In the vicinity of the Jordan and Shakoee observation wells the flow direction is reversed at a drawdown of between 14 and 17 feet where upon flow is from the Shakopee into the Jordan. The Freeway Sanitary Landfill is about 300 feet northwest of this vertical leakage line.

3. Because of the Freeway Landfill's close proximity to the vertical leakage line and the theoretical basis under which this line was determined, the potential exists for the City's water supply well field to be adversely impacted by contaminants from the landfill.

4. Under current pumping conditions and only during short periods of peak demand, the combined cones of depression in the Burnsville well field produce a net transfer of groundwater from the Shakopee-Oneota dolomites to the Jordan sandstone within the area encompassed by the dashed line between the 10-foot and 20-foot drawdown contours shown in Figure 8.

5. Only during short periods in the summer does the length of time of flow from the Shakopee dolomite into the Jordan sandstone exceed the length of time of flow from the Jordan sandstone into the Shakopee dolomite.

6. The potential for short-term groundwater contamination in a limited area adjacent to the abandoned landfill appears to be more a function of the duration of the pumping periods at the existing municipal wells rather than additional wells pumping at more remote sites to the south and east.

7. The potential for long-term, widespread contamination of the Jordan aquifer would be greatly enhanced by the extended pumping periods at the existing municipal wells resulting from an increase in the water requirements rather than by orderly expansion of new wells to the south and east.

8. During steady state conditions, the water pumped from the Jordan is replaced by groundwater leakage through the Shakopee-Oneota descending from the overlying geologic units. To avoid contamination it would be preferred that the replacement water be derived largely from the St. Peter sandstone and glacial drift deposits south of the well field rather than from the valley alluvium.

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O RVATION WELL LOCATIONS