Contract Report 641

Dewatering Well Assessment for the Highway Drainage System at Five Sites in the East St. Louis Area, Illinois (FY94 - Phase 11)

by
Ellis W. Sanderson, P.E. and Robert D. Olson

Prepared for the
Illinois Department of Transportation
Division of Highways

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Illinois State Water Survey
Ground-Water Section
Champaign, Illinois

A Division of the Illinois Department of Natural Resources

DEWATERING WELL ASSESSMENT

FOR THE HIGHWAY DRAINAGE SYSTEM

AT FIVE SITES IN THE EAST ST. LOUIS AREA, ILLINOIS

FY 94 (Phase 11)

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ABSTRACT

In the East St. Louis vicinity, the Illinois Department of Transportation Division of Highways (IDOT) owns 55 high-capacity wells that are used to maintain the elevation of the ground-water table below the highway surface in areas where the highway is depressed below the original land surface. The dewatering systems are located at five sites in the alluvial valley of the Mississippi River in an area known as the American Bottoms. The alluvial deposits at the dewatering sites are about 90 to 115 feet thick and consist of fine sand, silt, and clay in the upper 10 to 30 feet, underlain by medium to coarse sand about 70 to 100 feet thick.

The condition and efficiency of a number of the dewatering wells became suspect in 1982 on the basis of data collected and reviewed by IDOT staff. Since 1983, IDOT and the Illinois State Water Survey have conducted a cooperative investigation to more adequately assess the operation and condition of the wells, to attempt to understand the probable causes of well deterioration, and to evaluate rehabilitation procedures used on the wells.

During FY 94 (Phase 11), four new dewatering wells were constructed at the Missouri Avenue overpass of southbound/westbound Interstates I-55/I-70 where storm water detention structures are located beneath the pavement. The boreholes for the wells were drilled using an auger bucket rig. Two wells were finished with 12-inch carbon steel casing and stainless steel well screen, and two wells were finished with 16-inch stainless steel casing and stainless steel well screen. Gravel pack material was selected by IDOT and installed based on the best aquifer material grain size information that was available. The well screens installed to retain the gravel pack are 30 or 50 feet in length and have slot openings of 0.050 inches. Three of the wells presently are equipped with 1,200/1,500 gallon per minute (gpm) well pumps, and one well remains available as an alternate for Well 3.

Work scheduled for FY 94 (Phase 11) included 11 step tests, monitoring of the rehabilitation of two wells, and checking eight dewatering wells for sand pumpage. Nine of the step tests were conducted to assess the present condition of wells either to determine their need for chemical treatment in the future or to monitor the results of previous chemical treatments. One of the wells was in acceptable to good condition with a specific capacity of about 100 gpm per foot of drawdown (gpm/ft), and two wells were in fair condition with a specific capacity of about 67 gpm/ft. Six wells were in poor condition with an average specific capacity of about 46 gpm/ft, and treatment was recommended.

Posttreatment step tests were used to help document the rehabilitation of two dewatering wells (I-70 Wells 2A and 9A) during FY 94 (Phase 11). Chemical treatments used to restore the capacity of these two wells were moderately successful. The improvement in specific capacity per well averaged about 66 percent based on specific-capacity data from pre- and posttreatment step tests. The specific capacity of I-70 Well 2A was restored to about 83 percent and I-70 Well 9A to about 104 percent of the average specific capacity of wells in good condition at the I-70 site.

The sand pumpage investigation conducted during eight step tests revealed that I-64 Wells 8 and 9 and Venice Well 4 are pumping sand. These conditions may pose a threat to the long-term operation of these wells, especially Venice Well 4. A very small amount of sand was found following the step test on Venice Well 3.

INTRODUCTION

Background

The Illinois Department of Transportation Division of Highways (IDOT) operates 55 high-capacity water wells at five sites in the East St. Louis area. The wells are used to control and maintain ground-water levels at acceptable elevations to prevent depressed sections of interstate and state highways from becoming inundated by ground water. When the interchange of Interstates I-55/I-70 and I-64 was originally designed, ground-water levels were at lower elevations because of large withdrawals by the area's industries. Due to a combination of water conservation, production cutbacks, and conversion from ground water to river water as a source, industrial ground-water withdrawals have decreased at least 50 percent since 1970. As a result, ground-water levels in many areas have recovered to early development levels, which exacerbates IDOT's need to keep ground-water levels below the areas of depressed highways.

Scope of Study

IDOT first installed 12 dewatering wells in 1973, followed by an additional 30 wells in 1975. By 1977, the initial 12 wells were showing signs of loss of capacity. As a result, all 42 wells in use then were chemically treated to restore capacity. Although good results were obtained for most of the wells, routine monitoring by IDOT showed that deterioration problems were continuing to develop. Isolated wells were chemically treated by IDOT personnel as required. Six more wells were installed in 1982. In October 1982, IDOT asked the Illinois State Water Survey (ISWS) to begin an investigative study to learn more about the condition of the dewatering wells, to determine efficient monitoring and operating procedures, and to determine suitable methods of well rehabilitation.

Phase 1 of the work, conducted from March 1983 through February 1984, included an assessment of the condition of 14 selected wells, a review of the IDOT monitoring program, a model study to outline efficient operating schemes, recommendations on wells to be treated, and recommendations for chemical treatment procedures (Sanderson et al., 1984).

Phase 2, conducted from March 1984 through June 1985, included an assessment of the condition of 12 selected wells; testing of a noninvasive, portable flowmeter; and an initial study of the chemistry of the ground water as it moved toward an operating well (Sanderson et al., 1987).

Phase 3, begun in July 1985 (FY 86), included an assessment of the condition of six wells; demonstration of a noninvasive, portable flowmeter; a continued study of ground-water chemistry; and documentation of the rehabilitation of seven dewatering wells, along with follow-up step tests (Olson et al., 1990).

Phase 4, begun in July 1986 (FY 87), included ten step tests; documentation of the treatment of five wells; documentation of the construction of I-70 Well 14 (Well 7A); investigation of I-70 Well 9 to determine the probable cause of gravel-pack settlement; specific-capacity testing using the noninvasive, portable flowmeter; and installation of piezometers at two underpass sites in East St. Louis (Wilson et al., 1990).

Phase 5, begun in July 1987 (FY 88), included nine step tests, documentation of the treatment of four wells, investigation of possible sand pumpage at three wells, and initial investigation of the condition of relief wells at two detention ponds near the intersection of I-255 and I-70/I-55 (Wilson et al., 1991).

Phase 6, begun in July 1988 (FY 89), included 12 step tests, review of the chemical treatment of four wells, investigation of possible sand pumpage at nine wells, continued investigation of the relief wells at the two detention ponds along I-255, and documentation of the installation of two replacement wells (I-70 Wells 8A and 9A) (Olson et al., 1992).

Phase 7, begun in July 1989 (FY 90), included 12 step tests, review of the chemical treatment of five wells, investigation of possible sand pumpage at ten wells, and the conclusion of the investigation of the condition of relief wells at the two detention ponds near the intersection of I-255 and I-55/I-70 (Sanderson et al., 1993).

Phase 8, begun in July 1990 (FY 91), included 20 step tests, review of the chemical treatment of four wells, documentation of the construction of four new wells (I-70 Wells 13 and 14, and Venice Wells 6A and 7), investigation of possible sand pumpage at 17 wells, and implementation of a ground-water-level measurement program (Sanderson and Olson, 1993).

Phase 9, begun in July 1991 (FY 92), included 16 step tests, review of the chemical treatment of three wells, documentation of the construction of five new or replacement wells (I-70 Wells 1A, 2A, 3A, 11A, and 15), downhole video inspection of I-70 Well 3 and 25th Street Well 6 to determine the probable cause of sand pumpage and settlement, and continuation of the ground-water-level measurement program implemented in FY 90 (Olson and Sanderson, 1997).

Phase 10, begun in July 1992 (FY 93), included 14 step tests, review of the chemical treatment of two wells, investigation of possible sand pumpage at ten wells, continuation of the ground-water-level measurement program, and an investigation of the chemical quality of the ground-water being discharged from the pumping stations that handle the discharge from the dewatering system (Sanderson and Olson, 1998).

Phase 11, begun in July 1993 (FY 94), included 11 step tests, monitoring of the chemical treatment of two wells, investigation of possible sand pumpage at eight wells, and continuation of the ground-water-level measurement program. Data collected during the field investigations are included in appendices A-G.

Physical Setting of Study Area

The study area is located in the alluvial valley of the Mississippi River in East St. Louis, Illinois, in an area known as the American Bottoms (see figure 1). The geology of the area consists of alluvial deposits overlying limestone and dolomite of the Mississippian and Pennsylvanian Age. The alluvium varies in thickness from zero to more than 170 feet, averaging about 120 feet. The region is bounded on the west by the Mississippi River and on the east by upland bluffs. The regional ground-water hydrology of the area is well documented (Bergstrom and Walker, 1956; Schicht, 1965; Collins and Richards, 1986; Ritchey et al., 1984; Kohlhase, 1987; Schicht and Buck, 1995). Except where it is diverted by pumpage or drainage systems, ground water generally flows from the bluffs toward the river.

Detailed location maps of the five dewatering sites operated by IDOT are shown in figures 2-4. The geology at these sites is consistent with regionally mapped conditions. The land surface lies at about 410 to 415 feet above mean sea level (ft-msl). Alluvial deposits are about 90 to 115 feet thick, which means the bedrock surface lies at approximately 300 to 320 ft-msl. The alluvium becomes progressively coarser with depth. The uppermost 10 to 30 feet consists of extremely fine sand, silt, and clay, underlain by the aquifer, which is about 70 to 100 feet thick. The elevation of the top of the aquifer is about 390 to 395 ft-msl.

Acknowledgments

This phase of the assessment of the condition of the highway dewatering well systems in the American Bottoms was funded by IDOT, Kirk Brown, Secretary. Barry Roberts, Pump Technician, District 8, reviewed and coordinated the investigation. He and maintenance personnel provided field support during step-drawdown tests on the selected wells. Mark Anliker, Bryan Coulson, and Sam Ralston ably assisted the authors with field data collection.

Analytical work by the Water Survey's Chemistry Division, Office of Analytical and Water Treatment Services, was performed under the direction of Loretta Skowron, with Brian Kaiser, Lauren Sievers, and Daniel Webb performing the lab analyses. Agnes Dillon edited the manuscript, Linda Hascall prepared the illustrations, and Pamela Lovett provided word processing support.

Any opinions, findings, and conclusions or recommendations expressed in this report are those of the authors and do not necessarily reflect those of the sponsor and the Illinois State Water Survey.

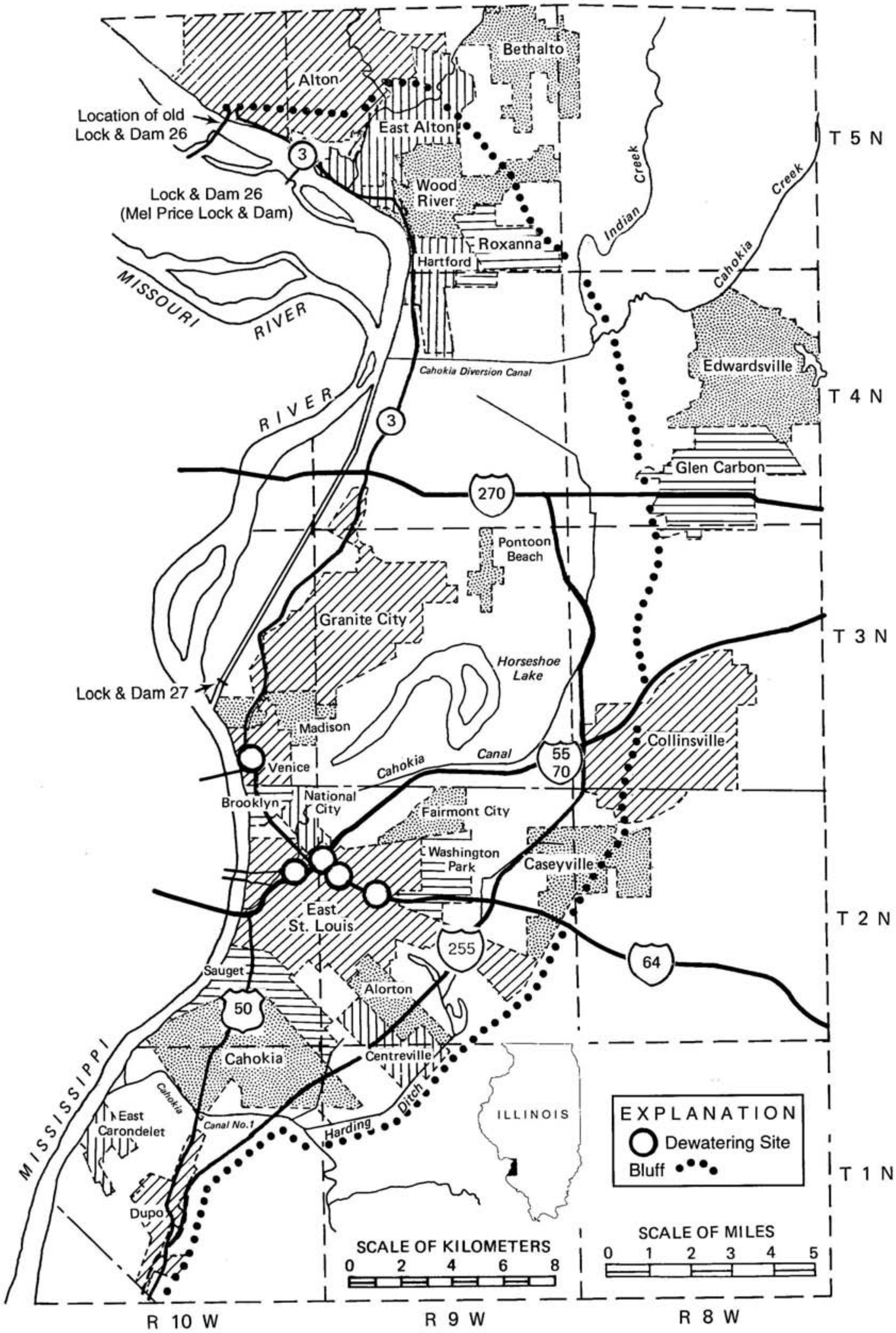

Figure 1. Location of the East St. Louis area

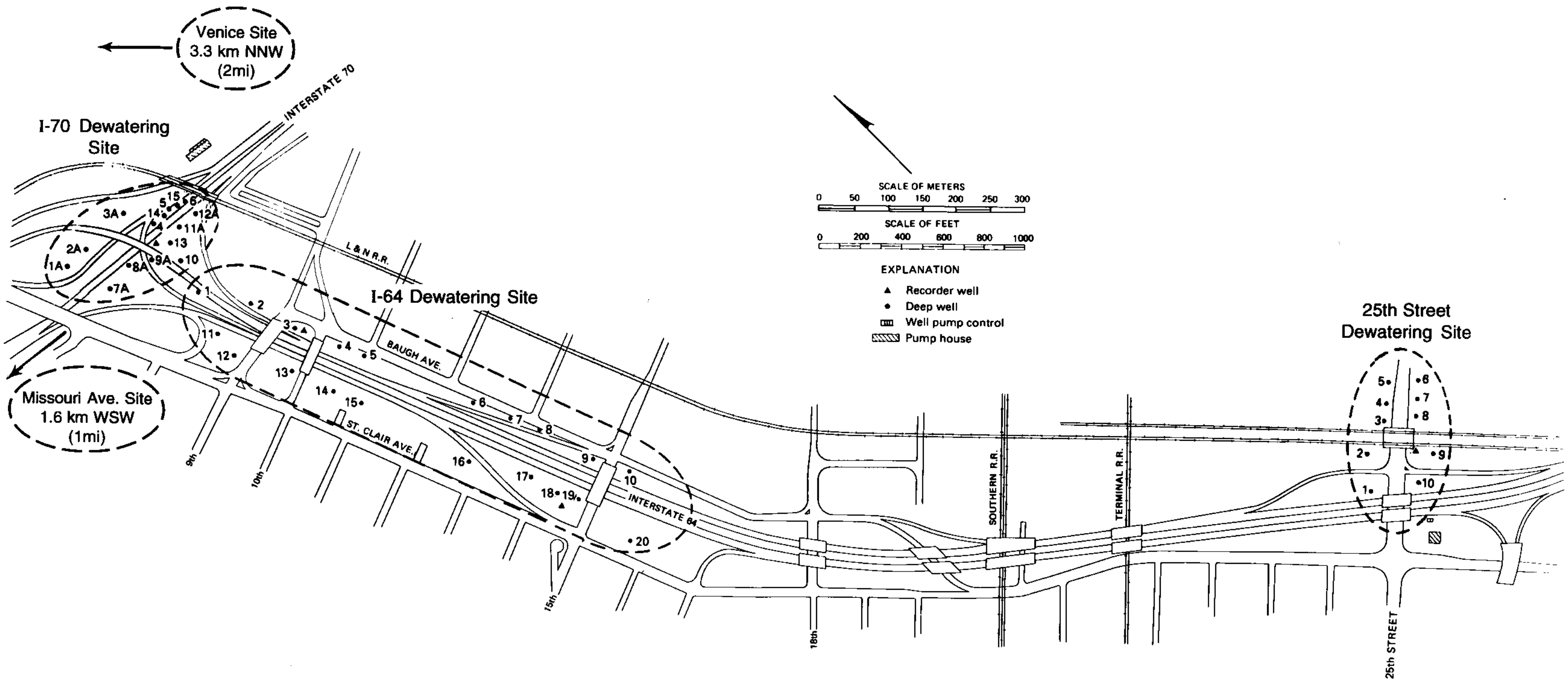

Figure 2. Locations of dewatering wells at the I-70 Tri-level Bridge, I-64, and 25th Street

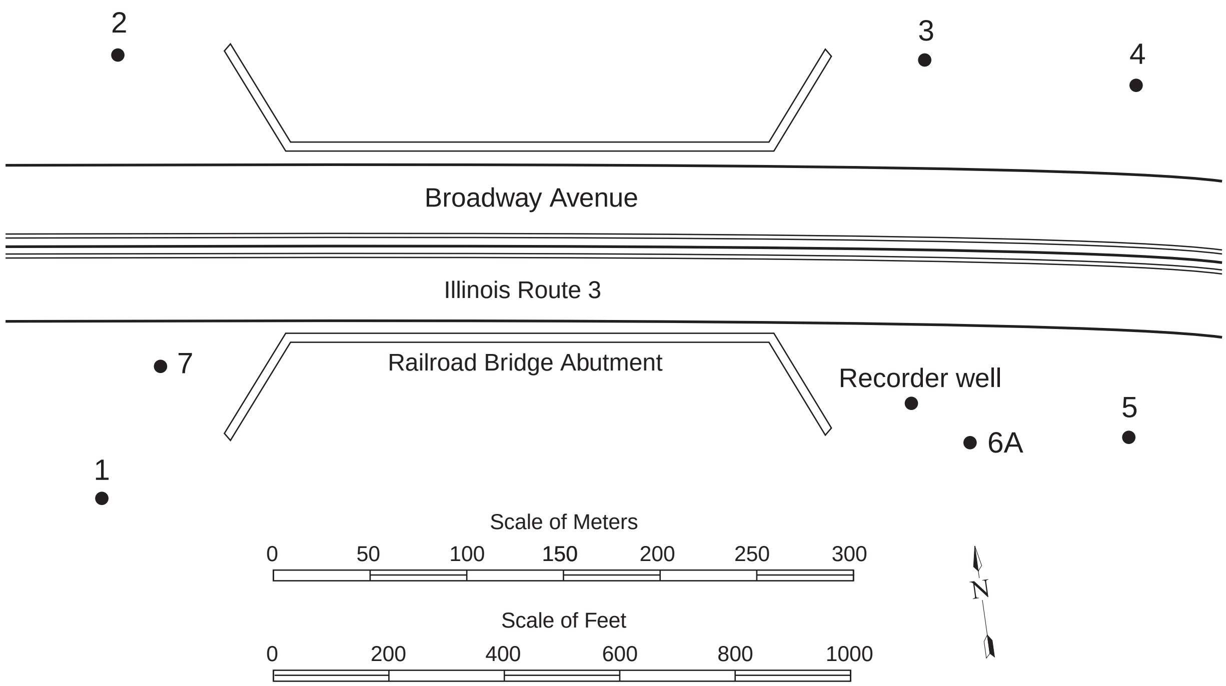

Figure 3. Locations of dewatering wells at the Venice Subway (Illinois Route 3)

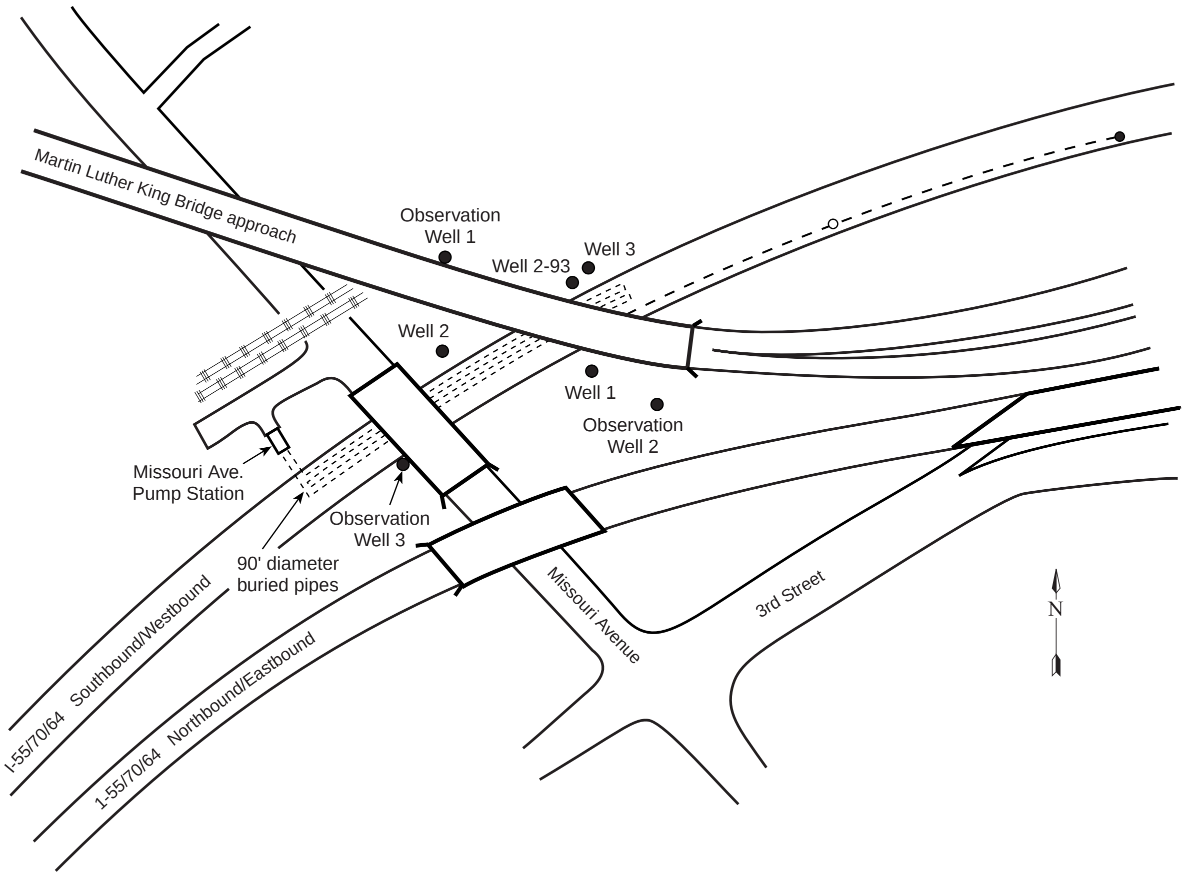

Figure 4. Locations of dewatering wells at Missouri Avenue

HISTORICAL SUMMARY OF DEWATERING DEVELOPMENT

The eastbound lanes of I-70 below the Tri-Level Bridge between St. Clair and Bowman Avenues in East St. Louis dip to an elevation 383.5 ft-msl, or approximately 32 feet below natural ground surface. When the highway was designed in 1958, the ground-water levels were near an elevation of 390 ft-msl, or about 6.5 feet above the planned highway (McClelland Engineers, Inc., 1971). Highway construction occurred in 1961-1962.

Horizontal Drain System

A horizontal French drain system was designed to control the ground-water levels along an 800-foot reach of depressed highway. However, for highway construction, the excavation area was temporarily dewatered by pumping from seven wells 100 feet deep and 16 inches in diameter. The wells were equipped with 1,800-gpm turbine pumps. The temporary construction dewatering system was designed to maintain the ground-water level at the site near an elevation of 370 ft-msl.

The French drain system failed shortly after the temporary construction dewatering system was turned off in the fall of 1962. This failure was attributed to the fact that the filter sand around the perforated diagonal drains and collector pipes was too fine for the ¼-inch holes in the drain pipes. A sieve analysis on the filter sand showed that 98.5 percent of the filter sand was finer than the ¼-inch perforations in the drain pipes. As a result, when the temporary construction dewatering system was turned off and ground-water levels rose above the drains, filter sand migrated through the holes into the drain pipes. The very fine "sugar" sand used as the pavement foundation was then free to move downward to the drains, resulting in development of potholes above the drains. Further migration of sand into the French drainage system was halted by operating the temporary construction dewatering system to lower the ground-water table. Because it was very likely that the foundation sands had been piped from beneath the pavement, the diagonal drains beneath the pavement were cement-grouted to prevent any further loss of support beneath the pavement (McClelland Engineers, Inc., 1971).

Horizontal and Vertical Well Drainage System

A new drainage system was designed and installed in early 1963. It consisted of 20 vertical wells and 10-inch- to 12-inch-diameter horizontal drain pipes. The 20 wells (10 wells on each side of the highway) were spaced about 75 feet apart. They were 6 inches in diameter, about 50 feet deep, and equipped with 32 feet of stainless steel well screen (Doerr) with 0.010-inch slots. The horizontal drains were sized for a flow of about 1 gpm/ft of drain, perforated with ⅜-inch-diameter holes on 3-inch centers, and surrounded with 6 inches of gravel-and-sand filter. A total of six 2-inch-diameter piezometers were installed for ground-water-level measurements.

Tests immediately after the installation indicated that the new system was performing satisfactorily, with a discharge of about 1,200 to 2,000 gpm, compared to a computed design flow of 4,500 gpm. Ground-water levels were lowered to an elevation of ±375.5 ft-msl, about 2 feet below the design ground-water elevation of 377.5 ft-msl, or about 8 feet below the top of the concrete pavement.

The system performed efficiently until March 1965, when a gradual rise in ground-water levels was detected. By July 1967 a 1-foot rise had occurred, and from July 1967 to April 1969 an additional 4-foot rise was observed. No additional rise was observed between August 1969 and August 1970.

Visual inspection during the late 1960s revealed some sinking of the asphalt shoulders and areas around the storm drainage inlets. Several breaks and/or blockages of the horizontal transit drain pipes were noted on both sides of the pavement, and a break in the steel tee in Well 17 also was observed. Depressions were noticed in the earth slopes immediately adjacent to the curb and gutter sections. Loss of foundation sands through the transit pipe breaks appeared to be the cause of these depressions. One manhole had settled a total of 15 inches. The attempt to correct this condition was suspended with the detection of a shift in the bottom of this manhole.

A thorough field investigation was begun to correct the damages to the underground system, or to replace it if necessary. During the cleaning process (using a hydrojet at the rate of 100 gpm under pressure of about 800 pounds per square inch or psi), a significant amount of scale was removed from inside the mild steel collector pipes, indicating serious corrosion. Nearly all the transit drain pipes also showed signs of stress. Some drains were broken and filled with sand. Attempts to clean or restore the drain pipes were abandoned in favor of a complete replacement of the system.

The field investigation also showed that the tees in the manholes, the collector pipes, and the aluminum rods on the check valves were badly corroded. Sinks, potholes, and general settlement of the shoulders required immediate attention. Television inspection of the vertical wells showed no damage to the stainless steel well screens.

Excessive corrosion of the mild steel tees, well risers, and collector pipes was one of the major causes or contributors to the overall failure of the drainage system. The investigations concluded that the corrosion was caused primarily by galvanic action between the stainless steel (cathode) and mild steel (anode) components of the drainage system, with anaerobic bacteria and carbonic acid attack from the carbon dioxide (CO_2) dissolved in the well water. Galvanic action was magnified by the lack of oxygen and the high chloride content of the water. Chemical analysis showed the extremely corrosive quality of the ground water as evidenced by:

- Extremely high concentrations of dissolved CO_2: 160 to 240 parts per million (ppm)
- Complete lack of oxygen: 0 ppm
- High chloride: 54 to 128 ppm; sulfates: 294 to 515 ppm; and iron concentrations: 12 ppm
- Biological activity

To withstand the possibility of severe corrosion caused by the chemical contents of ground water and to prevent galvanic action between different metals, the field investigators recommended the use of 304 stainless steel pipes throughout any replacement system (McClelland Engineers, Inc., 1971).

Individual Deep Well Systems

I-70 System

Experience during highway construction in 1961-1962 and during the 1963 drainage system replacement showed that individual deep wells were effective in temporarily maintaining ground-water levels at desired elevations. This alternative was, therefore, given further study as a permanent system. A consultant's report (Layne-Western Company, Inc., 1972) showed that water levels at the I-70 Tri-Level Bridge site could be maintained at desired elevations with 10 deep wells equipped with 600 gpm pumps. Two additional wells were included to permit well rotation and maintenance. These 12 wells were constructed in 1973, and the new system was placed in service in April 1974 (I-70 site). The 16-inch gravel-packed (42-inch borehole) wells had an average depth of about 96 feet, and they were equipped with 60 feet of Layne stainless steel well screen. Pumps with 600-gpm capacity and 6-inch-diameter stainless steel (flanged coupling) column pipe were set in the wells.

A recorder well, 8 inches in diameter and constructed of stainless steel casing and screen, was included in the well dewatering system to monitor ground-water levels near the critical elevation of the highway. A Leupold-Stevens Type F recorder is in use. Additionally, 2-inch-diameter piezometers with 3-foot-long screens were placed about 5 feet from each dewatering well to depths corresponding to the upper third point of each dewatering well screen. These piezometers provide information on ground-water levels and monitor the performance of individual wells by measuring water-level differences between the wells and the piezometers.

In the late 1970s, the exit ramp from the I-64 westbound lanes onto the I-55/I-70 northbound lanes was relocated, necessitating the abandonment of I-70 Well 12. Replacement Well 12A was then constructed at a nearby location using components similar to those in the original wells. The well screen in I-70 Well 7 reportedly failed in the 1970s, and an attempt was made to rehabilitate the well by inserting a new screen inside the old screen. The well's pumping capacity remained unsatisfactory following this modification, so the well was used only on an emergency basis until it was replaced in 1986. The replacement well (Well 7A) was constructed using components similar to those used in the original wells, with the exception of a continuous slot well screen designed on the basis of the sieve data from the nearest original test boring (Wilson et al., 1990).

In late 1986, loss of gravel pack was discovered at I-70 Well 9, and subsequent investigation revealed pumpage of fine sand, apparently from the upper 5 to 10 feet of well screen. In 1987, sand pumpage also was discovered at I-70 Wells 2 and 8, and at Venice Well 6. Replacement wells were constructed in the spring of 1989 for I-70 Well 8 (now Well 8A) and

I-70 Well 9 (now Well 9A). Continuous-slot well screens also were designed and used in these wells as in I-70 Well 7A (Olson et al., 1992).

In 1990 (FY 91), two new wells were added at the I-70 site to provide greater flexibility in operation, maintenance, treatment, and repair of the other wells at the site. These wells (I-70 Wells 13 and 14) were located on either side of the eastbound lanes of I-55/I-70 near the lowest point of the highway. The wells were similar in construction to the replacement wells (Wells 7A, 8A, and 9A) that were drilled in 1987 and 1989.

In 1991-1992 (FY 92), four replacement wells and one new well were added to the I-70 site. Because of various sand pumpage, settlement, and potential operational problems, replacement wells were constructed for Wells 1, 2, 3, and 11 (now Wells 1A, 2A, 3A, and 11A). The new well (Well 15) was placed between Wells 5 and 6. The wells were similar in construction to the new wells drilled in 1987, 1989, and 1990.

I-64 System

The western terminal of I-64 joins I-70 at the Tri-Level Bridge site. A 2,200-foot stretch of this highway also is depressed below the original land surface as it approaches the Tri-Level Bridge site. To maintain ground-water levels along I-64, a series of 20 wells was added to the dewatering system (I-64 site). The wells were built in 1975 and are essentially identical to the original wells constructed for the Tri-Level Bridge site.

25th Street System

About 6,200 feet southeast of the Tri-Level Bridge, at the interchange with I-64, East St. Louis 25th Street was designed to pass below the interstate highway and adjacent railroad tracks (now abandoned). As a result, the 25th Street pavement is about 3.5 feet below ground-water levels. Ten wells were installed in 1975 to control ground-water levels at the 25th Street site. These wells are identical in design to the original I-70 wells. Pumps installed in the wells along I-64 and at 25th Street have nominal pumping capacities of 600 gpm. Two 8-inch observation wells, located near each end of the I-64 depressed section, are used to monitor ground-water levels. An 8-inch observation well also was installed near the critical location at the 25th Street underpass. As at the I-70 wells, each dewatering well for I-64 and 25th Street has a piezometer located approximately 5 feet away to monitor performance at the installation.

Venice System

Approximately 2¼ miles north of the I-70 Tri-Level Bridge, Illinois Highway 3 passes beneath the Norfolk and Western, Illinois Central Gulf, and Conrail railroad tracks. When the highway was constructed, ground-water levels were controlled with a horizontal drain system placed 3 feet below the pavement. Problems with the pavement and drainage system were noted in May 1979 and were attributed to the above-normal ground-water levels resulting from 3 to 4 months of continuous flood stage in the Mississippi River (about 2,000 feet west). Subsequent investigation showed deterioration of the drainage system, and the consultants recommended installation of six wells to control ground-water levels at the site (Johnson, Depp, and Quisenberry, 1980). The wells were installed in 1982. They are 16 inches in diameter with 50 feet of well screen, range in depth from 78 to 89 feet below grade, and are equipped with submersible turbine pumps with nominal capacities of 600 gpm. One recorder well for the site and piezometers at each dewatering well were constructed to monitor system performance.

Problems were encountered with Venice Well 6 after chemical treatment in FY 88 (Phase 5). The well pumped sand-formation and gravel-pack particles, indicating a possible split or weld failure of the well screen or well casing. Replacement Well 6A was drilled, and a new Well 7 was added at the Venice site in FY 91 (Phase 8). District Highway staff considered the additional well desirable because of operational problems maintaining appropriate ground-water levels in 1984 when the Mississippi River was at high stages for several months. The wells are similar in construction to the original wells at this site.

Missouri Avenue System

During the spring and summer of 1993, the Mississippi River was at flood elevations for an extended period. Just east of the Martin Luther King Bridge near downtown East St. Louis and beneath the southbound/westbound lanes of I-55/I-64/I-70, two large diameter, stormwater detention structures were found to be subject to failure due to excessive infiltration of ground water and piping of foundation material into the structures. The IDOT engineers contracted, on an emergency basis, for the construction of four high-capacity dewatering wells to drawdown the high ground-water levels at the stormwater structures to help minimize the chance for their failure. Three wells presently are equipped with 1,200 to 1,500 gpm well pumps and are in regular use. The fourth well (Well 2-93) is capped to remain available as an alternate for nearby Well 3.

Summary

The highway dewatering operation in the American Bottoms presently consists of 55 individual dewatering wells finished in the water-bearing sand-and-gravel aquifer. The wells are distributed at five sites as follows:

I-70 (Tri-Level Bridge)	-	15 wells
I-64	-	20 wells
25th Street	-	10 wells
Venice (Route 3)	-	7 wells
Missouri Avenue	-	3 wells

The wells are of similar construction, generally with 16-inch-diameter stainless steel casing and screen (figure 5). IDOT's early experience with severe corrosion problems showed that corrosion-resistant materials are required to maximize service life. Except for Missouri Avenue, each well is equipped with a 600-gpm submersible pump with bronze impellers, bowls, and jacket motors and a 6-inch diameter stainless steel column pipe. Five 8-inch recorder wells are available to monitor ground-water elevations near critical locations at these four sites. Most

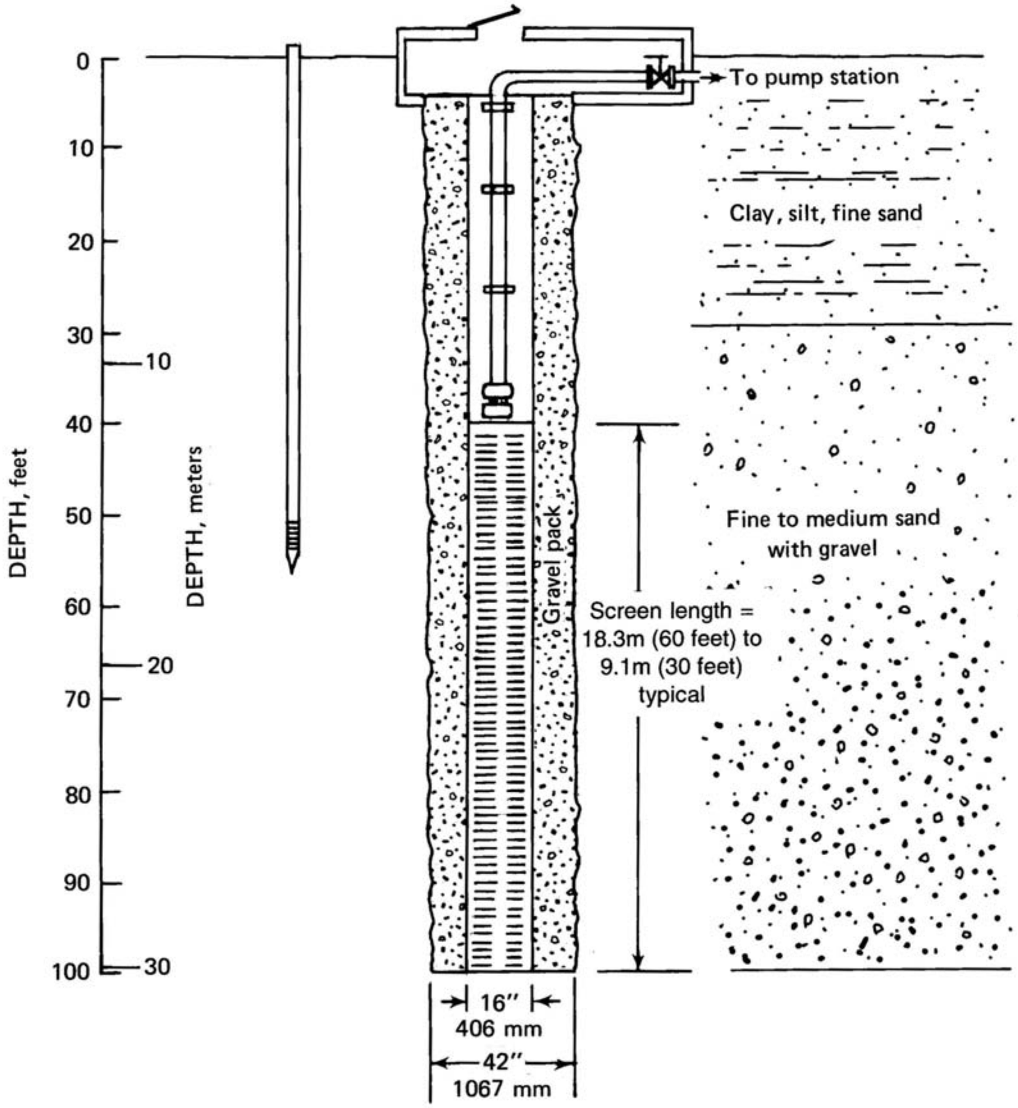

Figure 5. Typical features of a dewatering well

of the 52 wells have a 2-inch-diameter piezometer to help monitor individual well performance. The wells at Missouri Avenue are equipped with 1,200 to 1,500 gpm pumps with niresist impellers and bowls, stainless steel jacket motors, and 6- to 8-inch-diameter stainless steel column pipes. Three 2-inch diameter piezometers are measured periodically to monitor ground-water elevations at the site.

Usually, about one-third of the wells operate simultaneously. Total pumpage was estimated to be about 23 million gallons per day (mgd) in 1993, about twice the average estimated amount because of the 1993 Mississippi River flood conditions.

DEWATERING SYSTEM MONITORING

When originally constructed, the well installations at I-70, I-64, and 25th Street included pitot-tube flow-rate meters. A combination of corrosion and chemical deposition caused premature failure of these devices. Flow rates were occasionally checked with a pitot-tube meter temporarily inserted, but the field crew reported erratic results. The six installations at Venice in 1982 included a venturi tube coupled to a bellows-type differential pressure indicator to measure the flow rate. However, the water quality and environment in the well pits also adversely impacted the operation of these instruments. Accurate flow measurements became impossible, within a few years, and the field crew reported at least one direct failure of the venturi tube. These meters were subsequently disconnected.

As part of the scope of work in FY 85-FY 87 (Phases 2-4), a noninvasive, portable ultra-sonic flowmeter was tested, calibrated, and used to check the specific capacity of 21 dewatering wells. Although the application of this meter was found to be limited in some cases, it was turned over to IDOT for use in their routine monitoring program.

Operational records have shown that wells are pumped for periods of about two to nine months, then not pumped for longer periods while another set of wells is operated. No standard sequence of pumping rotation is followed because of maintenance and rehabilitation require-ments. Annual withdrawals currently are calculated on the basis of pumping time and estimated pumping rates.

Until November 1989, IDOT highway maintenance personnel periodically measured water levels at each dewatering well to monitor the overall performance of the dewatering system. Due to internal reorganization of the highway maintenance staff in District 8, Water Survey staff began monitoring ground-water levels at the dewatering sites at the end of February 1990. Water levels are measured every two months in each dewatering well and in the adjacent piezometer of each pumping well. Data collected during FY 94 (Phase 11) have been tabulated (appendix G).

Each dewatering well site (except Missouri Avenue) also includes at least one observation well (two at the I-64 site) equipped with a Leupold-Stevens Type F water-level recorder. Recorder charts are changed monthly and provide a continuous record of water levels near the critical location at each dewatering site. Because of the District 8 reorganization activities mentioned above, the Water Survey also assumed responsibility for the monthly servicing of the recorders beginning at the end of November 1989.

Each time measurements are collected, the Water Survey forwards a report to IDOT of the ground-water level data, including any recommendations. This information is used to monitor ground-water levels in relation to the pavement elevation for determining whether any adjustments in pumpage are necessary. The data also are useful for assessing the condition of individual dewatering wells. Water-level differences of 3 to 5 feet between the pumping wells and the adjacent piezometers are considered normal by IDOT. Greater differences are interpreted to indicate that well deterioration is occurring.

INVESTIGATIVE METHODS AND PROCEDURES

Well Loss

When a well is pumped, water is removed from storage within the aquifer, causing water levels to decline over time in the vicinity of the well. This effect, referred to as drawdown, is most pronounced at the pumped well and gradually diminishes at increasing distances away from the well. Drawdown is the distance that the water level declines from its nonpumping stage. Under ideal conditions, drawdown is a function of pumping rate, time, and the aquifer's hydraulic properties. Aquifer boundaries, spatial variation in aquifer thickness or hydraulic properties, interference from nearby wells, and partial-penetration conditions all can affect observed drawdowns at both pumping and observation wells. However, well loss or additional drawdown inside the pumped well due to turbulent flow of water into and inside the well is a measure of the hydraulic efficiency of the pumping well only, reflecting the unique flow geometry of the borehole, well screen, and pump placement.

Because of well loss, the observed drawdown in a pumped well is usually greater than that in the aquifer formation outside the borehole. In addition to considerations of flow geometry, as noted above, the amount of well loss also can depend on the materials used (screen openings, gravel-pack size distribution, drilling fluids, etc.) and the care taken in constructing and developing the well using mechanical and hydraulic means to remove drilling fluids from the borehole. Some well loss is natural because of the physical blocking of the aquifer interstices caused by the well screen and the disturbance of aquifer material around the borehole during construction. However, an improperly designed well and/or ineffective well construction and development techniques can result in excessive well losses. In addition, well losses often reflect a deterioration in the condition of an existing well, especially if well losses increase over time.

Specific capacity, the quotient of pumping rate divided by the drawdown observed after a given time period, is often used in the field as an indicator of well performance. However, specific capacity combined with an analysis of well loss provides a more complete picture of the condition of the well that allows for normalization and comparison at various pumping rates.

Well loss is a function of pumping rate but ideally not of time. It is associated with changes in flow velocity in the immediate vicinity of the well, resistance to flow through the well screen, and changes in flow path and velocity inside the well, all of which cause the flow to change from laminar to turbulent in form. Head losses under turbulent conditions are nonlinear; that is, drawdowns increase more rapidly with increases in pumping rate than under laminar conditions, as discussed below.

Although it is possible to have turbulent flow within the aquifer and laminar flow within a pumping well, under near-ideal conditions the observed drawdown (s_o) in a pumping well is made up of two components: the formation loss (s_a), resulting from laminar flow head loss within the aquifer; and well loss (s_w), resulting from the turbulent flow of water into and inside the well, as shown in equation 1.

$$s_o = s_a + s_w \tag{1}$$

Jacob (1947) devised a technique for separating well losses from formation losses, assuming that all formation losses are laminar and all well losses are turbulent. These components of theoretical drawdown, s, in the pumped well are then expressed as being proportional to pumping rate, Q, in the following manner:

$$s = BQ + CQ^2 \tag{2}$$

where B is the formation-loss coefficient per unit discharge, and C is the well-loss coefficient. For convenience, s is expressed in feet and Q in cubic feet per second (ft^3/sec). Thus, the well loss coefficient C has units sec^2/ft^5.

Rorabaugh (1953) suggested that the well-loss component be expressed as CQ^n, where n is a constant greater than 1. He thus expressed the drawdown as:

$$s = BQ + CQ^n \tag{3}$$

To evaluate the well-loss component of the total drawdown, one must know the well-loss coefficient (if using equation 2) or both the coefficient and the exponent (if using equation 3). These analyses require a controlled pumping test, called a step drawdown test (described below), in which total drawdown is systematically measured while pumping rates are varied in a stepwise manner.

Methodology for Determining Well Loss

If Jacob's equation is used to express drawdown, then the coefficients B and C must be determined. A graphical procedure (Bierschenk, 1964) can be employed after first modifying equation 2 as:

$$s/Q = B + CQ \tag{4}$$

A plot of s_o/Q versus Q can be prepared on arithmetic graph paper from data collected during a step drawdown test, substituting the observed drawdown, s_o, for s. The slope of a line fitted to these data is equal to C, and the y-intercept is equal to B, as shown in figure 6. If the data do not fall within a straight line, but instead curve concavely upward, the curvature of the plotted data indicates that the second-order relationship between Q and s_o is invalid and that the Rorabaugh method of analysis usually is appropriate.

Occasionally the data plot of s_o/Q versus Q may yield a straight-line fit with essentially zero slope or with a negative slope, or the date may be too scattered to allow a reasonable fit to be made at all. In these instances, the well-loss parameters are immeasurable. Possible explanations for this are: 1) turbulent well loss was negligible for the range of pumping rates used during the test; 2) inadequate data collection or test methods were used during the test; 3) the hydraulic condition of the well was unstable, as is the case during well development; or 4) the contribution of water from the aquifer was not uniform along the entire length of well screen over the range of pumping rates, as might occur due to the pump setting in relation to the screen or to vertical heterogeneity of the aquifer materials.

If Rorabaugh's equation is used, then coefficients B and C as well as the exponent n must be determined. To facilitate a graphical procedure, equation 3 is rearranged as:

$$(s/Q) - B = CQ^{n-1} \qquad (5)$$

Taking logs of both sides of the equation,

$$\log [(s/Q) - B] = \log C + (n - 1) \log Q \qquad (6)$$

A plot of $(s_o/Q) - B$ versus Q can be made on logarithmic graph paper from step-test data by replacing s with s_o. Values of B are determined by trial and error until the data form a straight line (figure 7). The slope of the line equals n - 1, from which n can be found. The value of C is determined from the y-intercept at Q = 1. In the example shown, plotting the data is facilitated if Q is plotted as cubic feet per second (ft^3/sec), and $(s_o/Q) - B$ is plotted as seconds per foot squared (sec/ft^2). It also is convenient (although not mandatory) to use these same units in the Jacob method.

Step-Test Procedure

The primary objective of a step drawdown test (or step test) is to determine the well-loss coefficient (and exponent, if Rorabaugh's method is used). With this information, the turbulent well-loss portion of drawdown for any pumping rate of interest can be estimated. During the test, the discharge rate is successively increased or decreased over the previous rate, in approximately equal increments, in order to facilitate the data analysis. Each pumping period at a given rate is called a step, and all steps are of equal time duration. Generally, the pumping rates increase from step to step, but the test also can be conducted by decreasing pumping rates. Conducting the steps at decreasing rates has been found to be the most efficient procedure at the dewatering well sites.

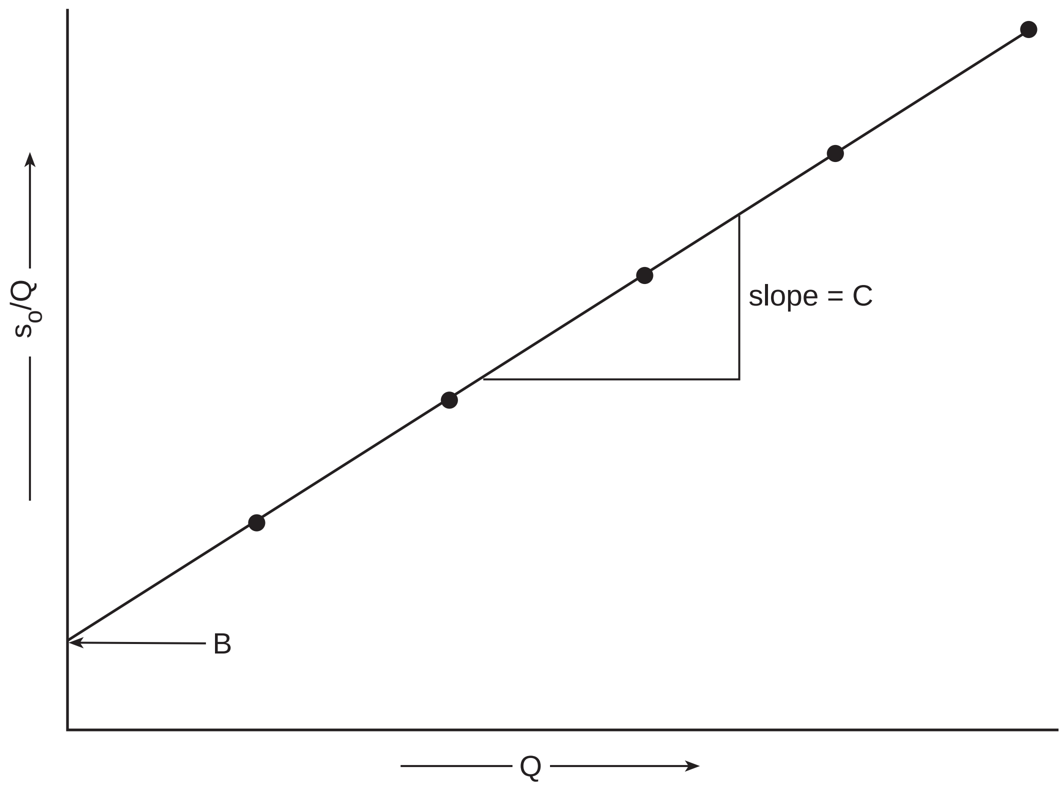

Figure 6. Graphical solution of Jacob's equation for well loss coefficient C

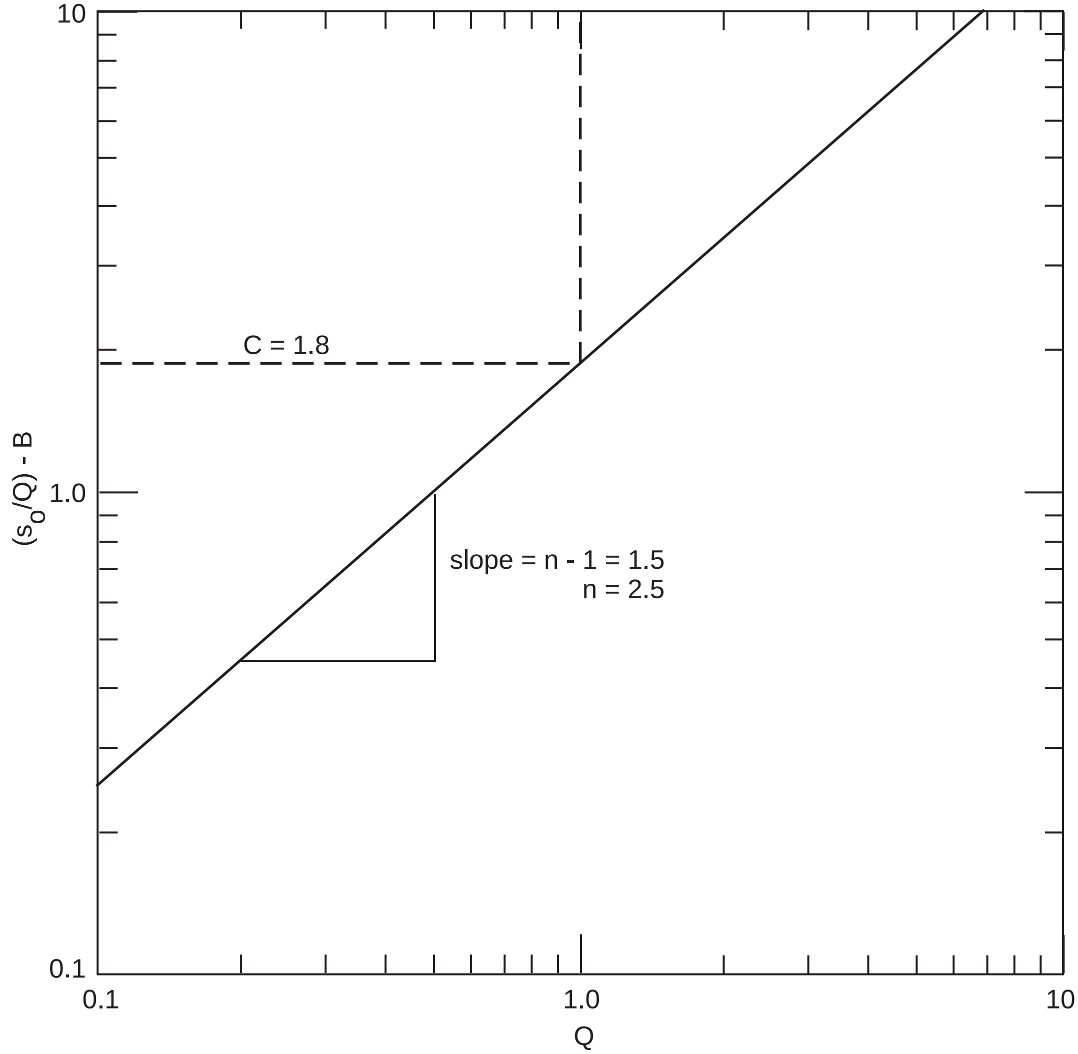

Figure 7. Graphical solution of Rorabaugh's equation for well loss coefficient C and exponent n

During each step, pumpage is held constant. If data are collected manually, water-level measurements are made every minute for the first six minutes, every two minutes for the next ten minutes, and then every four to five minutes thereafter until the end of the step. For the step tests in this study, either an Omnidata datalogger, an InSitu Hermit datalogger, or an electric dropline was used to collect the data. Generally, the dataloggers were programmed to collect water level data at least once each minute during the step test. Water levels were measured for 30 minutes per step for this investigation. At the end of each 30-minute interval, the pumping rate was immediately changed, and water levels were monitored for another 30-minute interval until a wide range of pumping rates within the capacity of the pump was tested.

Schematically, the relationship between time and water level resembles that shown for a five-step test in figure 8. Incremental drawdowns for each step (shown as Δs_i) are measured as the distance between the extrapolated water levels from the previous step and the final water level of the current step. For step 1, the nonpumping water-level trend prior to the start of the test is extrapolated, and Δs_1 is measured from this datum. All data extrapolations should be performed on semilog graph paper for the most accurate results. For the purpose of plotting s_o/Q versus Q or (s_o/Q) - B versus Q, values of observed drawdown s_o are equal to the sum of Δs_i for the step of interest. Thus, for step 3, $s_o = \Delta s_1 + \Delta s_2 + \Delta s_3$.

Piezometers

Piezometers–small-diameter wells with a short length of screen–are used to measure water levels (head) at a point in space within an aquifer and are often used in clustered sets to measure variations in water levels with depth. In the case of well-loss studies, piezometers can be employed to measure head losses across a well screen, gravel pack, or well bore. As previously described, 52 of the IDOT dewatering wells (except at Missouri Avenue) have piezometers drilled approximately 5 feet from the center line of each well and finished at a depth corresponding to approximately the upper third point of the screen in the pumping well. Historical monitoring of the difference in head (Δh) between water levels in the well and in the adjacent piezometer has been used to help detect and track well deterioration problems.

Measuring piezometer water levels continuously during each step test also allows an indication of turbulent well losses in the pumped well to be found by plotting the Δh data over a large range of pumping rates. If turbulent losses exist within that range, the head differences should be nonlinear with increasing pumping rate. In addition, it sometimes can be useful to simply plot depth to water (or drawdown) in the piezometer versus pumping rate. If turbulence extends outward from the well to the piezometer, this relationship will be nonlinear.

FIELD RESULTS

Construction of New Wells

During FY 94 (Phase 11), IDOT contracted for the construction of six dewatering wells by Layne-Western Company, Inc., Fenton, Missouri, at a new site located in East St. Louis along

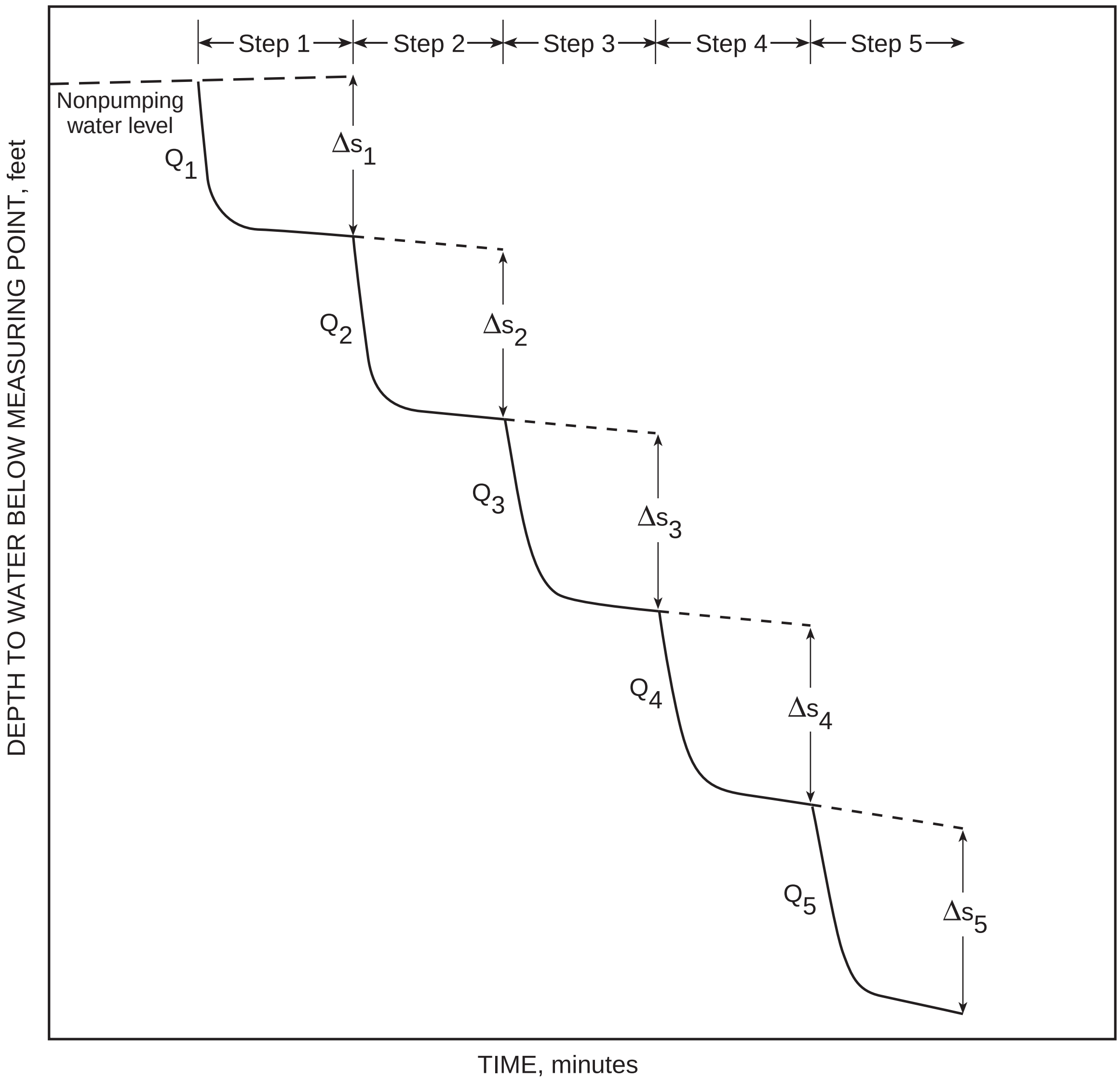

Figure 8. Relationship between time and water level during a five-step drawdown test

the southbound/westbound lanes of I-55/I-64/I-70 near the overpasses for Missouri Avenue and the approach lanes to the Martin Luther King Bridge. Well design (diameter, well screen, and gravel pack) and construction activities were overseen by IDOT engineers. The following information for this design and construction episode was reported to the Water Survey by IDOT and the Layne-Western Company, Inc.

The Missouri Avenue wells were constructed to draw down the high ground-water elevation at this site, exacerbated by the record Mississippi River flood of 1993, that was causing the loss of foundation material piping through openings in two 90-inch-diameter stormwater detention structures buried longitudinally beneath the southbound/westbound lanes of I-55/I-64/I-70. The lowest invert elevation of these pipes occurs adjacent to the pump station at 384.5 ft-msl. When the problem was first discovered in late spring 1993, two dewatering wells (construction details and pumping rates unknown) were drilled under emergency conditions in the westbound lanes east of Missouri Avenue near the eastern end of the 90-inch structures to dewater the area while crews made repairs. These wells were removed after repairs were completed but, shortly thereafter, ground-water levels returned to an excessively high elevation, causing additional buoyancy stress on the detention structures and endangering the pavement stability. As a stopgap measure to help reduce the possibility of total failure of the roadbed, another set of two dewatering wells, numbered 1-93 and 2-93 by the Layne-Western Company, Inc., was promptly drilled just off the shoulder on each side of the highway, at the eastern end of the drainage pipes. Well construction materials were limited to what was easily available on short notice from the Layne-Western Company, Inc. High-capacity pumps were installed in these wells to lower the ground-water level elevation to an acceptable level.

After Wells 1-93 and 2-93 were in operation, IDOT designed two additional high-capacity wells (Wells 3-93 and 4-93) for construction on the north (west) side of the I-55/I-64/I-70 southbound/westbound lanes and east of Missouri Avenue, as a solution to the high ground-water levels. In order to keep the ground-water levels under control, pumping rates were based largely on the brief earlier experience in operating the emergency dewatering wells. After Wells 3-93 and 4-93 were put in service, the pump was removed from Well 2-93, which is located only 11.5 feet away from Well 3-93. Thus, three of these wells are equipped with high-capacity submersible pumps (1,200 to 1,500 gpm, nominal capacity) and remain as permanent dewatering wells. The wells are now identified as Missouri Avenue Wells 1 (formerly Well 1-93), 2 (formerly Well 4-93), and 3 (formerly Well 3-93). Well 2-93 remains at the site as an alternate for Well 3. Periodic water-level measurements in Well 2-93 are used to track the condition of Well 3 in a way similar to the method used for the piezometers near the dewatering wells at the other sites. Three piezometers also were drilled by IDOT at this time for the purpose of monitoring ground-water elevations at the site. A detailed location map of the site is shown in figure 4.

The four wells were constructed and brought on line during June, July, and August 1993. The well boreholes reportedly were drilled using an auger bucket rig and water but no drilling fluid additives. Appendix H includes the Illinois Department of Public Health's Well Construction Reports that were filed by the drilling contractor, sieve analysis results from samples collected by the IDOT drill crew at a site boring, and the specifications for the gravel-pack materials used in the well construction. Above ground wellheads and pump discharge piping were used, eliminating the problems associated with the well pits that have been used on previously constructed dewatering wells.

Missouri Avenue Well 1 (Well 1-93) is 74 feet 8 inches deep from a wellhead elevation of about 408.7 ft-msl (figure 9). The wellhead is about 0.6 feet above ground level. A 36-inch-diameter hole was bored to a depth of 75 feet. The well is equipped with 34 feet, 8 inches of 12-inch-diameter carbon steel casing and 40 feet of 12-inch-diameter, 50-slot (0.050 inch openings), stainless steel, continuous slot well screen, with the bottom set at an elevation of about 334 ft-msl. Merimec gravel pack (grain size unknown) from Winter Brothers Gravel Co., St. Louis, Missouri, was used to fill the annulus between the borehole and casing-well screen assembly. This well does not fully penetrate to bedrock. A 1,200 gpm, 10-inch-diameter, 16-stage, 3,450 revolutions per minute (rpm) Crown submersible pump and 60 HP Franklin motor with 6-inch-diameter stainless steel column pipe (Victaulic couplings) were set in this well to an intake depth of about 65 feet below the wellhead.

Missouri Avenue Well 2 (Well 4-93) is 108.5 feet deep from a wellhead elevation of about 417.6 ft-msl (figure 10). The wellhead is about 1.5 feet above ground level. A 36-inch-diameter hole was bored to a depth of 108.5 feet. The well is equipped with 78.5 feet of 16-inch-diameter stainless steel casing and 30 feet of 16-inch-diameter, 50-slot (0.050 inch), stainless steel, continuous slot well screen, with the bottom set at an elevation of about 309.1 ft-msl. The well is gravel packed with 8-16 (U.S. Sieve No.) material from Colorado Silica Sand, Inc., Colorado Springs, Colorado. A 1,500 gpm, 10-inch-diameter, 1,750 rpm, 5-stage, Crown submersible pump and 60 HP Pleuger motor with 8-inch-diameter stainless steel column pipe (flanged couplings) were set in this well to an intake depth of about 95.5 feet below the wellhead.

Missouri Avenue Well 2-93 is 84 feet deep (as measured by the Water Survey) from a wellhead elevation of about 415.5 ft-msl (figure 11). The wellhead is about 1.7 feet above ground level. A 36-inch-diameter hole was bored to a depth of 84.5 feet. The well is cased with 12-inch-diameter carbon steel casing and has 25 feet of 12-inch-diameter, 50-slot (0.050 inch), stainless steel, continuous slot well screen, with the bottom set at a depth of 84 feet. The well is not equipped with a well pump and remains as an alternate, should Well 3 become inoperable.

Missouri Avenue Well 3 (Well 3-93) is 99 feet deep from a wellhead elevation of about 415.4 ft-msl (figure 12). The wellhead is about 1.8 feet above ground level. A 36-inch-diameter hole was bored to a depth of 99 feet. The well is equipped with 69 feet of 16-inch-diameter stainless steel casing and 30 feet of 16-inch-diameter, 50-slot (0.050 inch), stainless steel, continuous slot well screen, with the bottom set at an elevation of about 316.4 ft-msl. The well is gravel packed with 8-16 (U.S. Sieve No.) material from Colorado Silica Sand, Inc., Colorado Springs, Colorado. A 1,500 gpm, 10-inch-diameter, 1,750 rpm, 5-stage, Crown submersible pump and 60 HP Pleuger motor with 8-inch-diameter, stainless steel column pipe (flanged couplings) were set in this well to an intake depth of about 75.5 feet below the wellhead.

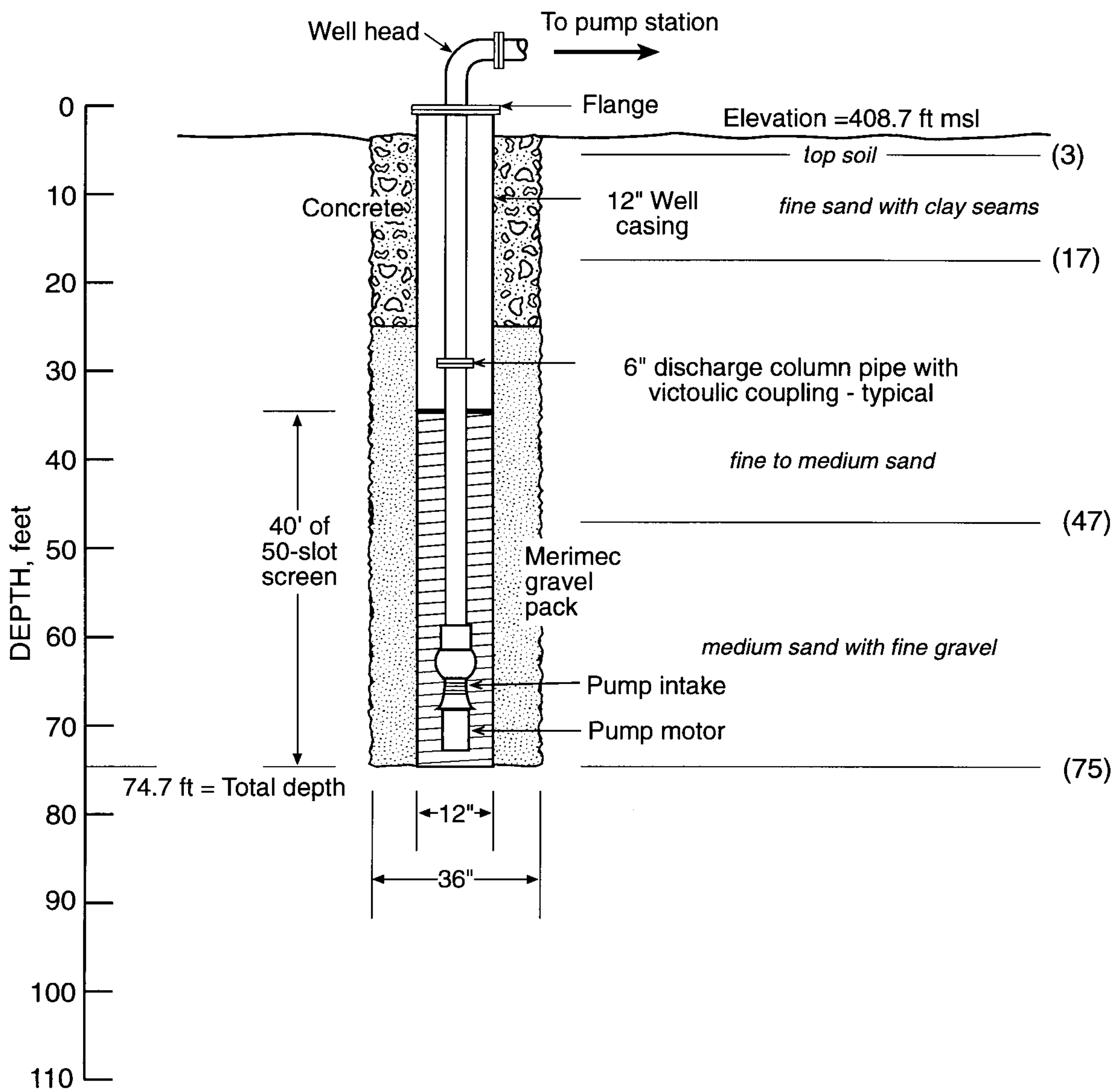

Figure 9. Construction features of Missouri Avenue Well 1 (1-93)

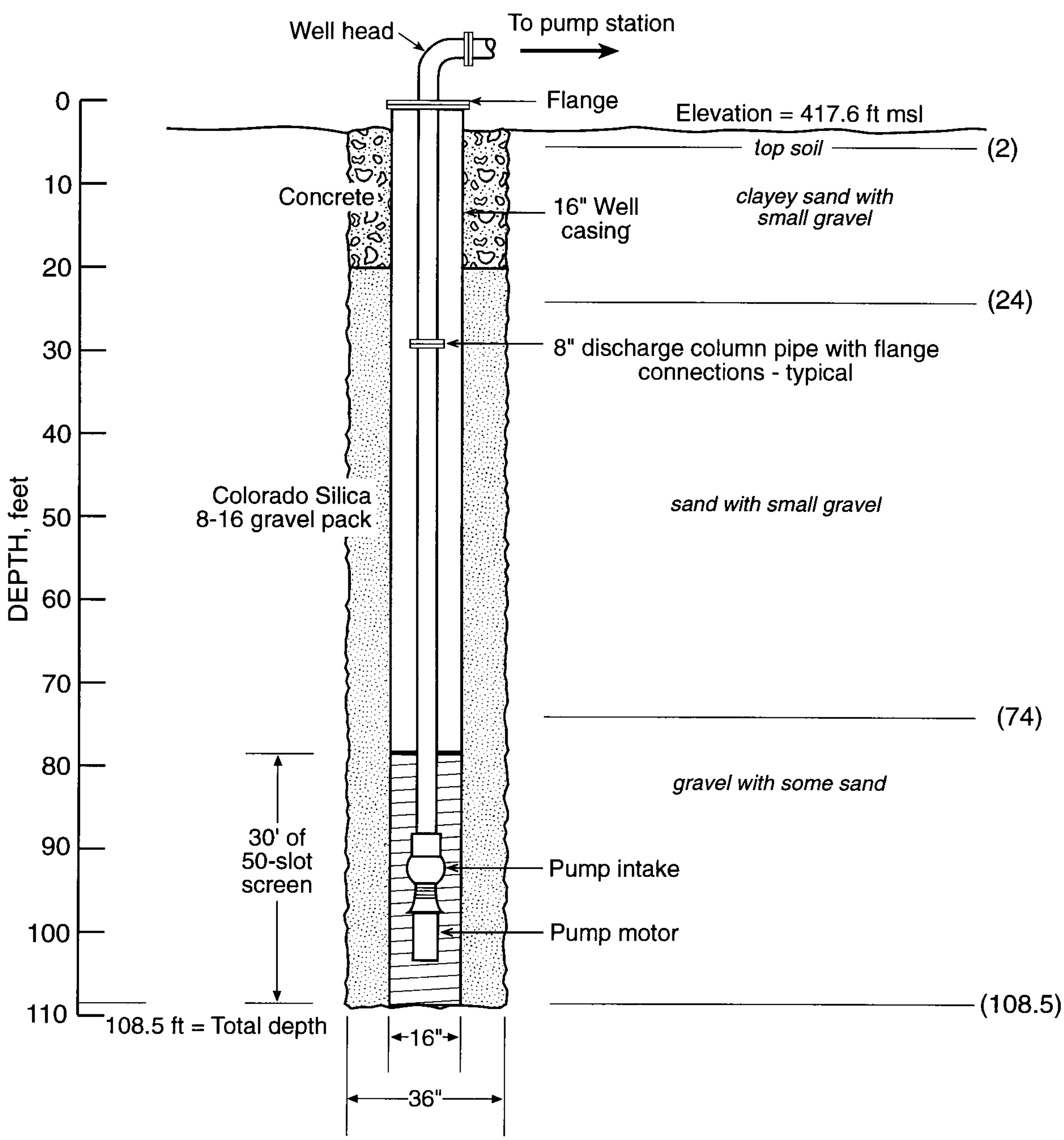

Figure 10. Construction features of Missouri Avenue Well 2 (4-93)

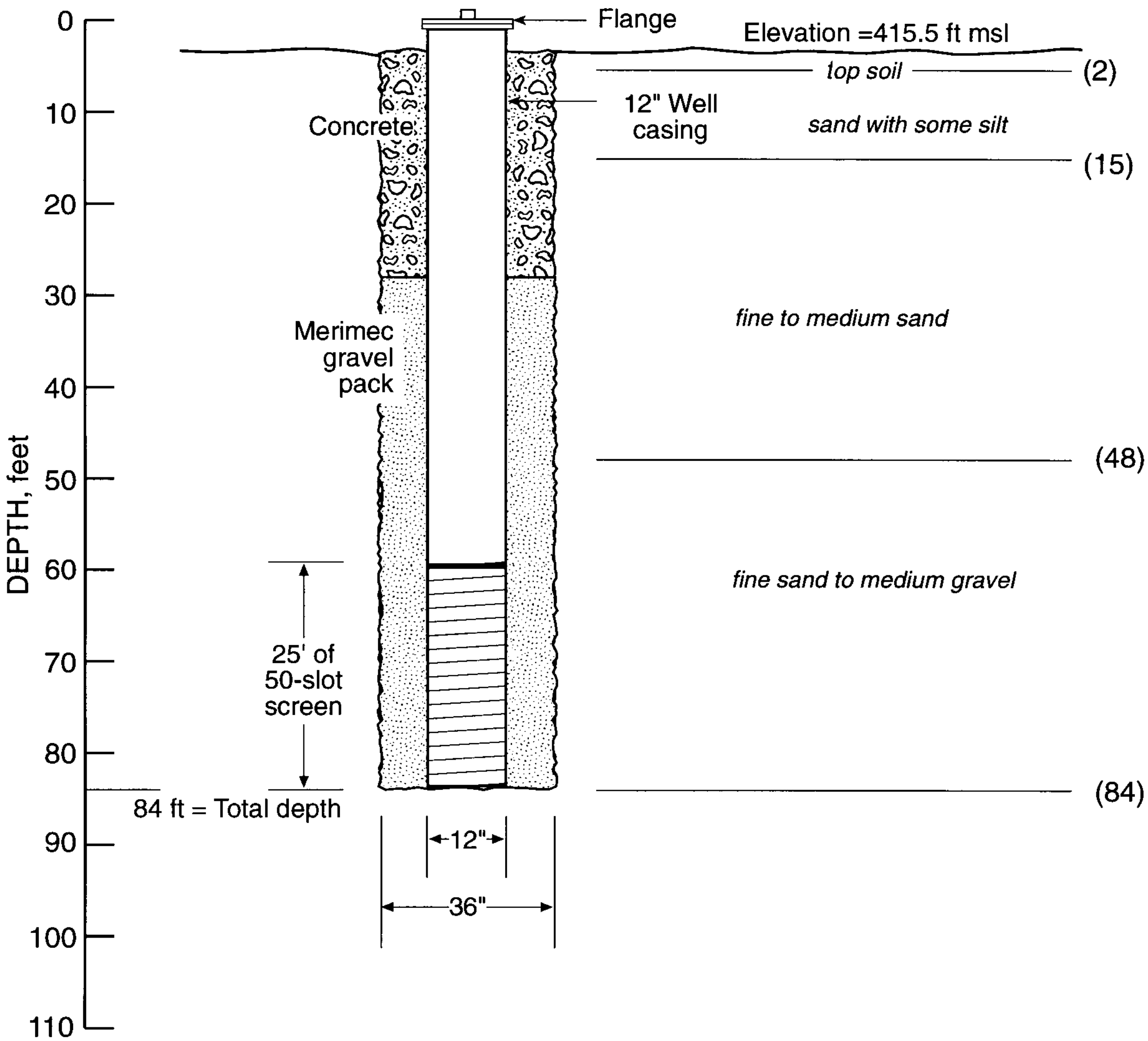

Figure 11. Construction features of Missouri Avenue Well 2-93

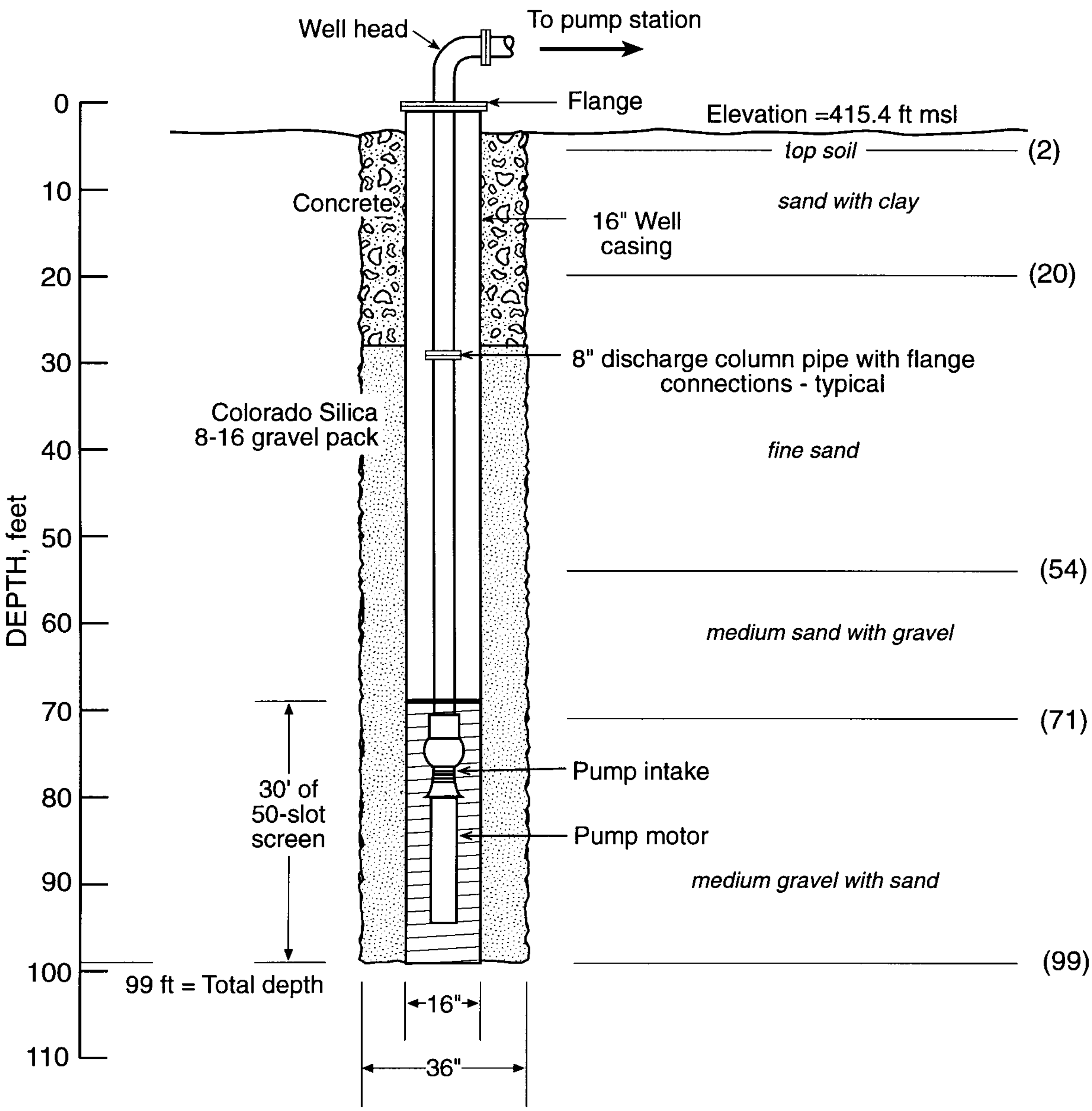

Figure 12. Construction features of Missouri Avenue Well 3 (3-93)

Pumping rate and drawdown data from when these wells were constructed are not available to determine the specific capacities for these wells. The Water Survey conducted condition-assessment step tests on Wells 1-3 in February 1995, as part of the scope of work for FY 94. The results of these step tests and the associated water quality samples are described in the following sections. In December 1993, water-level measurements began in the dewatering wells at Missouri Avenue as part of the previously described ground-water-level monitoring program for the dewatering system conducted by the Water Survey.

Three piezometers or observation wells also were installed at the Missouri Avenue site by the IDOT drill crew to provide ground-water elevations. The piezometers are cased with 2-inch-diameter polyvinyl chloride (PVC) pipe and have an unknown length of slotted pipe or well screen open to the aquifer. Observation Well 1 (northwest) was measured 80.5 feet deep from the measuring point at elevation 416.75 ft-msl. Observation Well 2 (southeast) was measured 55.5 feet deep from a measuring-point elevation of 418.67 ft-msl. Observation Well 3 (at the south Missouri Avenue Bridge pier) was measured 25.0 feet deep from a measuring-point elevation of 402.49 ft-msl. Water levels are regularly measured in these wells by the Water Survey for the dewatering system ground-water-level monitoring program.

The use of above ground wellheads and pump discharge at the Missouri Avenue dewatering site has eliminated access and sanitary problems associated with the well pits that are used at the other dewatering sites. However, the diameter and the installed well screens of these wells are inadequate for the intended pumping rates, according to Water Survey well design criteria and experience. Based on these criteria and experience gained with the design and operation of the other dewatering wells, the long-term pumping rate for Wells 1, 2, and 3 probably should be about 700 gpm. Even under optimistic aquifer and water quality conditions (which do not appear to be present at this location), well pumping rates likely should be no more than about 1,200 gpm. At these higher pumping rates the wells will likely be more susceptible to well deterioration problems and loss of production capacity.

Another potential contributor to well deterioration problems is that the well pump intakes in each of the Missouri Avenue wells were set within the well screen. The turbulence and pressure drop in the vicinity of the pump intake can cause changes in water chemistry that promote mineral deposition on the adjacent well screen that can have a detrimental effect on well capacity, especially if the water level in the well is drawn down near the pump intake. For these reasons, the pump intake is usually positioned above the screened interval in wells.

In addition, the use of 8-inch column pipe with flanged couplings in the 16-inch-diameter casing of Wells 2 and 3 leaves minimal annular space between the edges of flanges and the well casing, which makes physical measurement of water levels very difficult with temporarily inserted instruments. The ability to reliably measure ground-water levels in these wells is important as the regular observation of the ground-water elevation and periodic step tests are necessary to detect well deterioration problems and loss of production capacity.

If new wells are added at this site, it is recommended that longer well screens be installed and that the well casing and screen be at least 20 inches in diameter, if individual rates of 1,200 gpm or more are desired. Actual well design should be based on sieve data of formation samples collected from a test hole at the dewatering well location.

Well Selection for Step Tests

Eleven wells were step-tested in FY 94 (Phase 11). Six wells were selected for step tests to assess their condition, two posttreatment step tests were conducted on the two wells chemically treated to restore production capacity, and the initial step tests were conducted on the three new wells at Missouri Avenue.

The six wells that were selected for condition assessment step tests were:

I-70	Well 12A
I-64	Wells 8 and 9
Venice	Wells 2, 3, and 4

The two wells treated and then tested in posttreatment step tests were:

I-70	Wells 2A and 9A

The three new wells were:

Missouri Avenue	Wells 1, 2, and 3

Step Tests

Field Testing Procedure

Water Survey staff conducted field work with the assistance of the IDOT Bureau of Operations pump crew under the supervision of Barry Roberts. The IDOT crew made all necessary wellhead pipe modifications and provided special piping adapters that allowed connection of the Water Survey's flexible hose and orifice tube to measure the flow rate. Discharge from the orifice tube was directed to nearby stormwater drains.

Orifice tubes are standard equipment for accurately measuring flow rates. The orifice tube and orifice plate used to measure the range of flow rates was previously calibrated at the University of Illinois Hydraulics Lab under discharge conditions similar to those expected in the field.

The objective of each step test on the selected wells was to control the flow rate at increments of 50 gpm and to include as many 30-minute steps as possible at 300 gpm or greater for each well. Early experience with the step tests showed that, at rates of less than about 300 gpm, well-loss coefficients rarely could be determined from the collected data. Also such a low pumping rate often results from a very low specific capacity, indicating a well in poor condition.

When there is a maximum pumping rate less than about 300 gpm during a step test for a dewatering well, the drawdown in water levels is observed for a period of 30 to 60 minutes to obtain an approximate specific capacity for later comparison; this is then called a drawdown test instead of a step test.

Prior to the start of each test, the nonpumping water levels in the well and piezometer were measured with a steel tape or electric dropline. Pressure transmitters coupled to one of the previously mentioned dataloggers were placed in the pumped well and piezometer to measure water levels during the step tests.

During the step tests, the discharge from each well also was checked for the presence of sand (unless the site accessibility or site condition precluded set-up of the testing equipment) by directing the open flow from the orifice tube into a 1,000-gallon portable tank. The tank acts as a sedimentation basin, allowing sand grains to be caught, collected at the end of the step test as the tank is drained, and delivered to the geotechnical laboratory for analysis.

Highway construction projects and the 1993 record level flood of the nearby Mississippi River caused delay in the conduct of the step tests scheduled for FY 94. These delays resulted in only two of the scheduled 11 step tests being conducted within FY 94. One step test was delayed for almost two years. The step tests were conducted as follows: one well (Venice Well 4) in May 1994, one well (Venice Well 2) in June 1994, one well (Venice Well 3) in July 1994, one well (I-64 Well 9) in August 1994, three wells (Missouri Avenue Wells 1-3) in February 1995, one well (I-70 Well 12A) in August 1995, and one well (I-64 Well 8) in April 1996. Two wells (I-70 Wells 2A and 9A) were rehabilitated during July 12-August 3, 1994, with posttreatment step tests in August and September 1994, respectively.

Data for the 11 step tests are included in appendix A. Water samples were collected at the time of each test and analyzed for chemical/mineral content and nuisance bacteria. The results from the water sample analyses are described in the following sections and are presented in appendix B.

Results of Step Tests

The step-test data were analyzed by using the Jacob method, as described earlier in this report. Table 1 summarizes results of the analyses of data from the 11 step tests conducted for the FY 94 investigation. Because the amount of drawdown due to well loss is proportional to the pumping rate squared, the well loss reported in table 1 has been calculated for a standardized rate of 600 gpm using the well-loss coefficient determined from the analysis of the step-test data. This enables comparison among dewatering wells that operate at different rates. The standardized well loss also is reported in table 1 as a percentage of total drawdown calculated using equation 2 ($s = BQ + CQ^2$) at the base rate of 600 gpm. Likewise, the Δh values reported in table 1 also have been observed or estimated for the standardized rate of 600 gpm. However, comparisons of Δh values are only valid among step tests on the same well because of the varying distances of the piezometers from individual dewatering wells. All step tests conducted for FY 94 were run with steps at decreasing rates so the observed specific capacities included in

Table 1. Results of State Water Survey Step Tests on IDOT Wells, FY 94 (Phase 11)

Well	*Date of test*	*Well loss at 600 gpm (ft)*	*Drawdown at 600 gpm (ft)*	*Well loss portion (%)*	*Observed specific capacity (gpm/ft)*	*Δh* at 600 gpm (ft)*	*Observed Q_{max}, gpm*	*Remarks*
I-70								
No. 2A	8/22/94	0.28	7.59	3.7	79.7	2.3 e	525	Posttreat
No. 9A	9/9/94	**	5.9 e	**	99.8	1.6 e	515	Posttreat
No. 12A	8/2/95	0.68	11.2 e	6.1	54.3	P	517	
I-64								
No. 8	4/15/96	2.19	11.0 e	19.9	57.9	P	435	
No. 9	8/18/94	**	26.2 e	**	22.9	19.7 e	470	
Venice								
No. 2	6/21/94	**	9.0	**	67.6	4.37	745	
No. 3	7/1/94	**	9.2	**	65.8	5.03	760	
No. 4	5/11/94	**	13.5	**	44.7	P	760	
MO Ave.								
No. 1†	2/10/95	**	11.7 e	**	51.4	-	1,260	
No. 2	2/16/95	0.06	5.92 e	1.0	100.1	-	1,450	
No. 3‡	2/16/95	**	12.9 e	**	46.7	-	1,170	

Notes:

* Head difference between pumped well and adjacent piezometer.

** Coefficient immeasurable. Turbulent well loss negligible over the pumping rates tested.

† Drawdown test only (450 gpm). Cascading water interfered with measurement. Δh calculated with water-level data from Well 2-93 at 606 gpm.

‡ Drawdown test only; cascading water interfered with measurement.

e = Estimate based on interpolated values adjusted to 600 gpm.

T = Posttreatment step test.

P = Piezometer plugged or partially plugged.

table 1 were calculated based on the total observed drawdown at the end of the first step when the highest pumping rate was used. Thus, observed specific capacity values are calculated after 30 minutes of pumping but are not standardized to the 600 gpm rate.

Step tests were scheduled to assess the condition of eight existing wells and three new dewatering wells at the new Missouri Avenue site during FY 94. (For results of the posttreatment step tests conducted on I-70 Wells 2A and 9A, see the section “Well Rehabilitation-Chemical Treatment Results.”) However, highway construction projects at the I-70 Tri-Level Bridge site and record flood conditions during the summer of 1993 on the nearby Mississippi River, which had delayed step tests scheduled for FY 93, also caused, in turn, delay of 7 of the 11 FY 94 step tests to FY 95 and 2 step tests to FY 96. Dewatering wells scheduled for step tests for FY 94 included I-70 Wells 2A, 9A, and 12A; I-64 Wells 8 and 9; Venice Wells 2, 3, and 4; and Missouri Avenue Wells 1, 2, and 3.

The previous step test on I-70 Well 12A was on May 15, 1991. The observed specific capacity was about 133 gpm/ft, the well loss was about 23 percent, and the Δh value was about 2.0 feet. The step test conducted for FY 94 (delayed due to the backlog of scheduled step tests) on August 2, 1995, showed an observed specific capacity of about 54 gpm/ft and a well loss of about 6.1 percent. The Δh value could not be determined because of the plugged piezometer. Well 12A appears to be in poor condition, with an observed specific capacity about 57 percent of the average observed specific capacity of wells at the I-70 site in good condition.

A condition assessment step test was conducted on two wells at the I-64 site during FY 94. Well 8 at I-64 had never been step tested due to infrequent use on the south end of the depressed section of I-64. The observed specific capacity during this initial condition assessment step test conducted for FY 94, on April 15, 1996 (delayed due to the backlog of scheduled step tests), was about 58 gpm/ft, and the well loss was about 19.9 percent. The Δh value could not be determined because the piezometer was plugged. Well 8 appears to be in poor condition, with an observed specific capacity about 55 percent of the average observed specific capacity of wells at the I-64 site in good condition.

A previous step test on I-64 Well 9 on October 5, 1983, showed an observed specific capacity of about 97 gpm/ft, a well loss of about 5.9 percent, and a Δh value of about 2.3 feet. The condition assessment step test for FY 94 conducted on August 18, 1994, showed the observed specific capacity to be about 23 gpm/ft and the Δh value to be an estimated 19.7 feet. The well loss could not be determined from the collected data. Well 9 is in poor condition, with an observed specific capacity only about 22 percent of the average observed specific capacity of wells at the I-64 site in good condition.

Three wells at the Venice site were step tested in FY 94 for condition assessment. Venice Well 2 showed an observed specific capacity of about 93 gpm/ft during the previous step test conducted on October 2, 1991. The well loss was about 21 percent, and the Δh value was about 2.3 feet. The step test conducted on June 21, 1994, as part of the FY 94 work, showed an observed specific capacity of about 68 gpm/ft with the Δh value being about 4.4 feet. The well loss could not be determined from the collected data. This well is in fair condition with an observed specific capacity of about 69 percent of the average observed specific capacity of other wells in good condition at the Venice site.

A previous step test on Venice Well 3 was conducted on December 16, 1991, following chemical treatment. The observed specific capacity of Venice Well 3 was about 97 gpm/ft, and the Δh value was about 2.3 feet. The well loss could not be determined from the step test data. The FY 94 step test conducted on July 1, 1994, showed an observed specific capacity of about 66 gpm/ft and a Δh of about 5.0 feet. The well loss could not be determined. Venice Well 3 is in only fair condition, with an observed specific capacity of about 66 percent of the average observed specific capacity of other wells in good condition at the Venice site.

The previous step test on Venice Well 4 was conducted on September 17, 1991. Venice Well 4 showed an observed specific capacity of about 102 gpm/ft, a well loss of about 11.3 percent, and a Δh value of about 2.7 feet. The FY 94 step test conducted on May 11, 1994, showed an observed specific capacity of about 45 gpm/ft. The well loss could not be determined, and a plugged piezometer prevented Δh values from being measured. Venice Well 4 is in poor condition, with an observed specific capacity of about 45 percent of the average observed specific capacity of wells in good condition at the Venice site.

Deterioration of large storm drainage structures beneath southbound/westbound I-55/I-64/I-70 lanes at the Missouri Avenue overpass in East St. Louis caused IDOT to construct three permanent dewatering wells in 1993; these new wells will assist in protecting the storm drainage structures from excess ground-water infiltration. Three piezometers are present at this dewatering site to monitor ground-water levels, but the dewatering wells do not have adjacent piezometers to assist in monitoring their condition with Δh values.

The initial step test on Missouri Avenue Well 1 was conducted on February 10, 1995. The observed specific capacity was about 51 gpm/ft, but the well loss could not be determined from the collected data. No history of well performance is yet available for this site, but it appears that Missouri Avenue Well 1 is in poor condition.

The initial step test on Missouri Avenue Well 2 was conducted on February 16, 1995. The observed specific capacity was about 100 gpm/ft, and the well loss was about 1.0 percent. Missouri Avenue Well 2 appears to be in good condition.

The initial step test on Missouri Avenue Well 3 was conducted on February 16, 1995. The observed specific capacity was about 47 gpm/ft, but the well loss could not be determined. At 606 gpm, the Δh value was about 9.1 feet, as determined from water-level data in nearby Well 2-93. Missouri Avenue Well 3 appears to be in poor condition.

Chemical treatment is recommended for the six wells in poor condition, I-70 Well 12A, I-64 Wells 8 and 9, Venice Well 4, and Missouri Avenue Wells 1 and 3. A video inspection of these wells to help detect excessive buildup of incrusting minerals also may be considered.

Table 2. Average Observed Specific Capacity of Dewatering Wells Based on Step Test Data from 143 Tests Since FY 84

Wells	*I-70*	*I-64*	*25th St.*	*Venice*	*MO Ave.*	*All sites*
All wells:						
Number of step tests	69	18	25	28	3	143
Average observed specific capacity, gpm/ft	71	92	94	76	66	78
Wells in good condition or posttreatment:						
Number of step tests	35	14	16	16	1	82
Average observed specific capacity, gpm/ft	96	105	119	99	100	102
Wells in poor condition or pretreatment:						
Number of step tests	34	4	9	12	2	61
Average observed specific capacity, gpm/ft	44	49	49	47	49	46

Since FY 84 (Phases 1-11), 143 step tests (including six drawdown tests) have been completed at all sites. The results are included in appendix C, and the observed specific capacity data are summarized in table 2. The average observed specific capacity for all 143 step tests (including the Missouri Avenue site) is about 78 gpm/ft. By excluding the results from 61 pretreatment step tests and other step tests that show wells in poor condition, the average observed specific capacity of 82 step tests is about 102 gpm/ft. The highest observed specific capacities are generally found at the 25th Street site, where 25 step tests have been completed. Observed specific capacities for all step tests at the 25th Street site averaged about 94 gpm/ft, 119 gpm/ft without nine pretreatment step tests. At the I-70, I-64, and Venice sites, respectively, 69, 18, and 28 step tests have been completed with average observed specific capacities of about 71, 92, and 76 gpm/ft. Without the pretreatment step tests and other step tests on wells in poor condition at these sites, the observed specific capacities were about 96, 105, and 99 gpm/ft, respectively. Averages for the Missouri Avenue site alone are not included here, as only the initial step test on each of the three wells at the Missouri Avenue site have been conducted.

Well Rehabilitation

Chemical Treatment Procedure

The specifications for the well rehabilitation work initially were developed in FY 86 by IDOT and the Water Survey based on chemical treatment practices in common use. Revisions to the specifications have been made periodically, based on results and experience from chemical treatment of the dewatering wells since 1986. Similar treatment procedures were used for all wells treated in FY 94, although adjustments occurred as specific conditions were encountered from day to day and from well to well. Table 3 summarizes the treatment procedure as required by IDOT specifications. The actual procedure used by the contractor, Layne-Western Company, Inc., varied in some instances, and the significant changes are noted in table 3.

Table 3. Outline of Typical Well Rehabilitation

Day 1

1. Pretreatment specific capacity test (contractor orifice tube, open to free discharge, used for flow measurements).
    a. Measurement of SWL (static water level) following 30 or more minutes of well inactivity.
    b. Measurement of PWL (pumping water level) and orifice piezometer tube following 60 or more minutes of pumping.

2. Polyphosphate application, 400 pounds, and displacement with 16,000 gallons water containing at least 500 ppm (mg/L) chlorine.
    a. Initial chlorination of well with 2,500 gallons water containing 500 ppm or more chlorine injected at a minimum rate of 750 gpm (actual rate: 2,000 gpm).
    b. Injection of polyphosphate solution at a minimum rate of 2,000 gpm (actual rate: 1,700 to 2,400 gpm) in two 1,800-gallon batches, each batch containing 200 pounds polyphosphate.
    c. Displacement injection of 16,000 gallons water chlorinated to at least 500 mg/L in 2,000-gallon batches at a minimum rate of 1,500 gpm (actual rate: 750 to 2,800 gpm).
    d. Time allowance for chemicals to react, 1 to 2 hours.
    e. Repeatedly surge and backflush well to loosen encrustants with multiple cycles (actual 7 to 20) of pumping well at high rates (actual: 1,200 to 1,600 gpm) to fill 2,000 gallon holding tank and pumping the contents of tank back into the well at high rates (actual rate: 2,400 to 3,000 gpm).

3. Pump to waste and check specific capacity.
    a. Pump continuously 6 or more hours to clear well of chemicals (actual time, when reported: 5.5 hours).
    b. Same procedure for specific capacity check as step 1 above.

Day 2

1. Acidization with 1,000 gallons 20° Baume-inhibited muriatic (hydrochloric) acid and displacement with 4,000 to 5,000 gallons water (not chlorinated).
    a. Pump 1,000 gallons of bulk-inhibited acid into well within 1 hour, 17 gpm minimum (actual rate: 56 to 500 gpm).
    b. Allowance time for acid to react, 1 hour.
    c. Injection of 4,000 to 5,000 gallons water at 1,000 to 2,000 gpm (actual rate: 1,700 to 2,450 gpm).
    d. Allowance for reaction, 2 to 3 hours.
    e. Repeatedly surge and backflush well to loosen encrustants with multiple cycles (actual 6 to 12) of pumping well at high rates (actual rates: 450 to 2,200 gpm) to fill 2,000 gallon holding tank and pumping the contents of tank back into the well at high rates (actual rate: 1,500 to 2,900 gpm).

Table 3. Continued

2. Pump to waste and check specific capacity.
   a. Pump continuously 3 hours or more (actual time: 16 hours) to clear well of acid.
   b. Same procedure for specific capacity check as Day 1, step 1.

Day 3

1. Polyphosphate application, 600 pounds, and displacement with 30,000 gallons water containing at least 500 ppm chlorine.

   Same procedure as Day 1, step 2, except three batch injections of 1,800 gallons (5,400 gallons total) with 200 pounds phosphate each in part b, and injection of 30,000 gallons in part c.

   Noted actual pumping rates and surging cycles for indicated steps of procedure.

   a. Initial chlorination: 1,600 to 3,100 gpm.
   b. Polyphosphate solution injections: 1,900 to 3,200 gpm.
   c. Displacements: 1,500 to 2,700 gpm.
   † Surging/backflushing actual cycles: 10 to 27; well to tank pumping rate: 1,000 to 1,500 gpm; tank to well pumping rate: 2,000 to 3,500 gpm).

2. Pump to waste and check specific capacity.
   a. Pump continuously 6 or more hours to clear well of chemicals (actual time: 17 to 67.5 hours).
   b. Same procedure for specific capacity check as Day 1, step 1.

Day 4 (Optional)

1. Polyphosphate application, 600 pounds, and displacement with 54,000 gallons water containing at least 500 ppm chlorine.

   Same procedure as Day 1, step 2, except three batch injections of 1,800 gallons (5,400 gallons total) with 200 pounds phosphate each in part b, and injection of 54,000 gallons in part c.

   Noted actual pumping rates and surging cycles for indicated steps of procedure.

   a. Initial chlorination: 2,100 gpm.
   b. Polyphosphate solution injections: 2,300 to 2,700 gpm.
   c. Displacements: 2,000 to 3,000 gpm.
   d. Surging/backflushing actual cycles: 17; well to tank pumping rate: 1,200 to 1,400 gpm; tank to well pumping rate: 2,400 to 3,100 gpm.

Table 3. Concluded

2. Pump to waste and check specific capacity.

   a. Pump continuously 6 or more hours to clear well of chemicals (actual time: 14 hours).
   b. Same procedure for specific capacity check as Day 1, step 1.

<u>Day 5</u> (Optional)

1. Polyphosphate application, 400 pounds, and displacement with 16,000 gallons water containing at least 500 ppm chlorine.

   Same procedure as Day 1, step 2.

2. Pump to waste and final specific capacity test.

   a. Pump continuously 6 or more hours to clear well of chemicals.
   b. Same procedure for specific capacity check as Day 1, step 1.

Figure 13 shows schematically the typical injection assembly/discharge apparatus used by the contractor for injecting solutions and acid into the wells, to pump spent solutions to waste, and to conduct drawdown pumping tests during the treatment work.

The well rehabilitation work was observed and documented by Water Survey staff. Field notes for each well treated in FY 94 are included in appendix D.

Chemical Treatment Results

The wells were selected for chemical treatment on the basis of data from the most recent Water Survey step tests and available Δh information (see section on "Piezometers"). Step tests completed for FY 92 for I-70 Well 2A and for FY 93 for I-70 Well 9A (both step tests delayed for reasons previously stated) indicated that these dewatering wells were in poor condition and should be chemically treated. Under a FY 94 IDOT contract, Layne-Western Company, Inc., chemically treated the two dewatering wells between July 12 and August 3, 1994.

The condition of I-70 Well 2A was previously checked during the initial step test on November 16, 1993, when the well was relatively new but in heavy use since its completion (about April 1993). The observed specific capacity of the well was only about 30 gpm/ft, the well loss about 8.5 percent, and the Δh about 14.0 feet. These results of the initial step test showed the well had surely deteriorated since its construction. The well was chemically treated in July 1994. The results of the posttreatment step test conducted for FY 94 on August 22, 1994, showed the observed specific capacity to be about 80 gpm/ft, the well loss to be about 3.7 percent, and the Δh to be an estimated 2.3 feet. Well 2A appears to be in fair condition, with an observed specific capacity about 83 percent of the average specific capacity of wells at the I-70 site in good condition.

The previous step test on I-70 Well 9A was conducted on May 12, 1994. The observed specific capacity of the well was about 78 gpm/ft, the well loss about 1.6 percent, and the Δh about 3.1 feet. The well was chemically treated in July and August 1994. The results of the posttreatment step test conducted for FY 94 on September 9, 1994, showed an observed specific capacity of about 100 gpm/ft and an estimated Δh value of about 1.6 feet. Well loss could not be determined from the collected data. Well 9A appears to be in good condition, with an observed specific capacity about 104 percent of the average observed specific capacity of wells at the I-70 site in good condition.

As indicated in table 3, the chemical treatment procedure required the treatment contractor to conduct 60-minute drawdown tests to measure the specific capacity after each successive treatment step. Table 4 summarizes these drawdown pumping test data collected as part of the field documentation during the chemical treatment of each dewatering well. Table 4 shows the measured specific capacity before treatment and after each step in the treatment process (polyphosphate or acid injection episode). The average specific capacity for both wells at each step in the treatment process is given at the end of table 4 along with an analysis of the improvement between steps. In general, the percentage improvement in specific capacity diminishes with each successive step of the treatment. This trend also has been noted in the

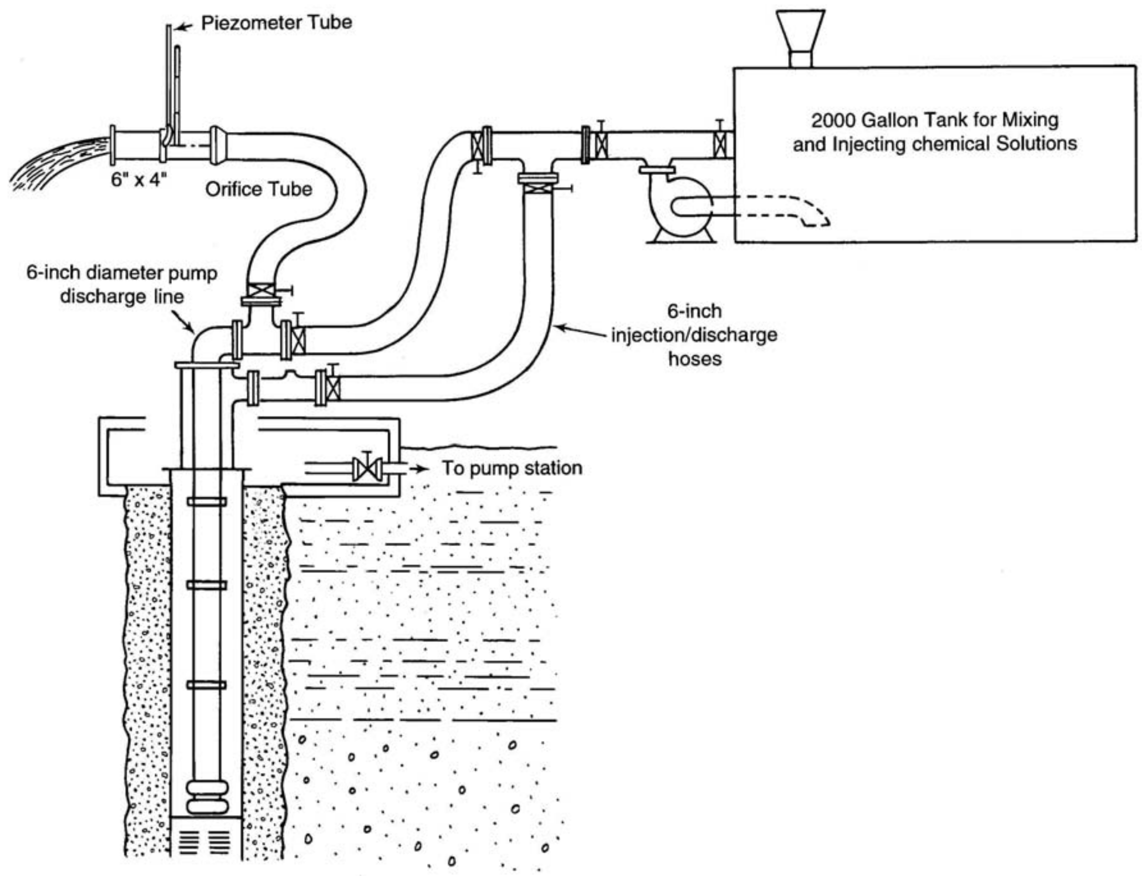

Figure 13. Schematic diagram of equipment used in well rehabilitation

Table 4. Drawdown Test Data Collected by Contractor During Well Rehabilitation

	Pretreatment	*1st PPP treatment*	*Acid treatment*	*2nd PPP treatment*	*3rd PPP treatment*	*4th PPP treatment*
<u>I-70 Well 2A</u>						
Date (1994)	7/12 p.m.	7/14 a.m.	7/15 a.m.	7/18 a.m.	7/19 a.m.	None
SWL	39.36	39.62	39.48	35.82	33.72	
PWL	58.89	50.00	48.66	44.51	42.16	
s	19.53	10.38	9.18	8.69	8.44	
Q	554	590	613	635	635	
Q/s	28.4	56.8	66.8	73.1	75.2	
<u>I-70 Well 9A</u>						
Date (1994)	7/27 a.m.	7/29 a.m.	8/2 a.m.	8/3 a.m.	None	None
SWL	36.08	35.47	36.46	36.82		
PWL	44.67	42.11	42.70	43.39		
s	8.59	6.64	6.24	6.57		
Q	600	597	603	659		
Q/s	69.9	89.9	96.6	100.3		
<u>Averages</u>						
Q/s	49.2	73.4	81.7	86.7		
ΔQ/s		24.2	8.3	5.0		
% increase over original Q/s		49.2	16.9	10.2		
% of total improvement		64.5	22.1	13.3		

Notes:
Total ΔQ/s = 37.5 gpm/ft (76 percent improvement over initial Q/s)
SWL - Static (nonpumping) water level, feet
PWL - Pumping water level, feet
s - Drawdown (PWL-SWL), feet
Q - Pumping rate, gpm
Q/s - Specific capacity, gpm/ft
PPP - Polyphosphate

results of the chemical treatment in some prior years. In FY 94 about 65 percent of the total improvement occurred with the first polyphosphate treatment and about 13 percent during the second polyphosphate treatment (following acidization). Based on the water level and pumping rate data collected by the contractor during the chemical treatment, the observed specific capacities for Wells 2A and 9A were about 78 and 105 percent, respectively, of the average observed specific capacity for wells in good condition at this site.

The trend of reduced improvement for successive treatment steps has been shown by the results of the treatment for each of the 9 years that this general well treatment procedure has been followed (one polyphosphate treatment, followed by a muriatic acid treatment, followed by up to three polyphosphate treatments). In these instances, about 76 to 96 percent of the improvement had occurred after the second polyphosphate treatment step.

Following recommendations presented in the FY 87 (Phase 4) report (Wilson et al., 1990), the chemical treatment specifications were modified to allow one polyphosphate treatment, followed by a muriatic acid treatment, followed by a polyphosphate treatment, and, if necessary, up to two additional polyphosphate treatments (table 3). Depending on the specific response of each well, it might be possible to eliminate these additional treatment steps if expectations for specific capacity have been achieved, thereby reducing the overall treatment cost. To do this, a target specific capacity for improvement is selected, based on the specific capacities observed during previous step tests and on the site average specific capacity for wells in good condition. Also, progress and results from each step in the rehabilitation work must be closely monitored in the field to verify significant improvement in specific capacity between treatment steps. During the FY 94 rehabilitation work, only one additional polyphosphate treatment was used on I-70 Well 2A and none on I-70 Well 9A.

Following the chemical treatments in FY 94, the Water Survey conducted step tests on each treated well to evaluate the condition of the well and the response to treatment; the tests also provided results for comparison with the contractor's drawdown tests conducted during the well treatment. Table 5 summarizes the results of these posttreatment step tests. The percentage improvement in I-70 Well 2A was the better of the two wells treated, with an increase of about 168 percent based on the step tests. The other well, I-70 Well 9A, had an increase of about 27 percent in observed specific capacity. However, compared to the average observed specific capacity of wells in good condition at the I-70 site, the chemical treatment of I-70 Well 9A achieved about 104 percent of the site average, but I-70 Well 2A was increased to only about 83 percent of site average.

A group of wells has now been rehabilitated in each of nine years for a total of 36 treatments on 29 wells (seven in FY 86, five in FY 87, four in FY 88, four in FY 89, five in FY 90, four in FY 91, three in FY 92, two in FY 93, and two in FY 94). Three contractors performed the treatments, one during the first two years (FY 86 and 87) and the fourth year (FY 89); a second in the third, fifth, sixth (FY 88, FY 90, and FY 91), and eighth years (FY 93); and the third during the seventh and ninth years (FY 92 and FY 94).

Table 5. Results of Chemical Treatment, FY 94 (Phase 11)

			Pretreatment		*Posttreatment*		
Site	*Well*		*Date*	*Q/s (gpm/ft)*	*Date*	*Q/s (gpm/ft)*	*% Change*
I-70	Well 2A	ISWS	11/16/93	29.7	08/22/94	79.7	+168
		LWC	07/12/94	28.4	07/19/94	75.2	+165
I-70	Well 9A	ISWS	05/12/94	78.3	09/09/94	99.8	+27
		LWC	07/27/94	69.9	08/03/94	100.3	+43
Average		ISWS		54.0		89.8	+66
		LWC		49.2		87.8	+79

Notes:
Q/s = Specific capacity, gpm/ft
ISWS = Illinois State Water Survey
LWC = Layne-Western Company, Inc.

Sand Pumpage Investigation

Field Procedure

Prior occurrences of sand pumpage from the dewatering wells have resulted in the standard practice of checking for the presence of sand in the discharge during each step test, unless precluded by site conditions and available equipment. To continue to address these concerns, the possibility of sand pumpage was investigated during 8 of the 11 step tests conducted on 11 wells in FY 94 (Phase 11). The other three wells, Missouri Avenue Wells 1, 2, and 3, are located where the site conditions prevent an appropriate location for the settling tank to be used.

During each step test, water is discharged from the orifice tube into a portable 1,000-gallon tank (see figure 14). Siphon tubes are used, as necessary, to help control the discharge from the tank. The tank itself acts as a sedimentation basin that, under ideal conditions, should allow sand with grain diameters of about 0.1 millimeter (mm) and larger to settle out at the design pumping rates of the wells (600 to 800 gpm). Usually 80 to 90 percent or more of the aquifer material in the screened interval of the wells exceeds the 0.1 mm grain size.

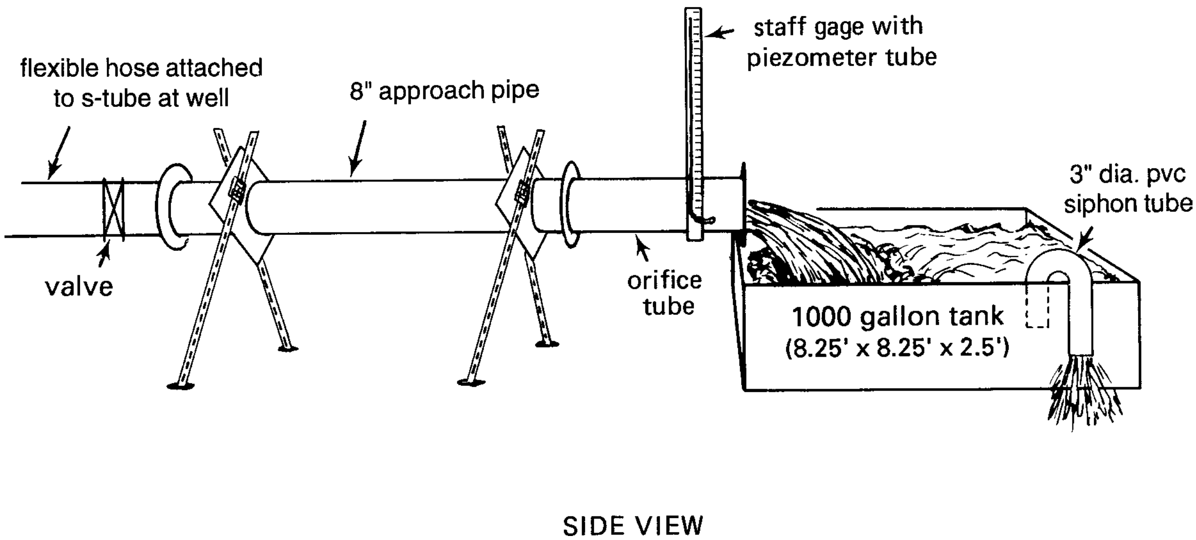

Figure 14. Sand pumpage test setup

Sand Sample Collection

Samples were collected following the step tests, whenever a sufficient amount of sediment remained in the tank to allow analysis of the grain size distribution. The samples were prepared and sieved at the Quaternary Materials Laboratory of the Illinois State Geological Survey. In all, three of the eight step tests in which the portable tank was used generated a sample large enough for collection. Appendix E contains the data for these sample analyses. The other three wells, Missouri Avenue Wells 1-3, could not be checked because site conditions do not allow a location for the tank where the discharge can be controlled to an appropriate storm drain. A discussion of the results for each well follows.

I-70 Well 2A:

No sand was observed in the tank following the FY 94 posttreatment step test on August 22, 1994. The previous FY 92 step test on Well 2A, conducted November 16, 1993, showed only a few grains of sand and a small amount of soft incrustation.

I-70 Well 9A:

Only a few grains of sand, if any, were observed in the tank following the FY 94 posttreatment step test on September 9, 1994. No sample was collected. No sand was observed following the pretreatment step test in FY 93, conducted on May 12, 1994.

I-70 Well 12A:

No sand was observed in the settling tank following the FY 94 condition assessment step test on August 2, 1995. A sediment sample with a very small amount of fine sand was collected following the previous step test on May 15, 1991. That sample is described in the report for FY 91 - Phase 8 (Sanderson and Olson, 1993).

I-64 Well 8:

Very fine sand, silt, and mud were observed in the portable tank following the FY 94 initial step test on this dewatering well, conducted on April 15, 1996. The sample collected was probably about 50 percent of the material in the settling tank. The results of the sieving of the sample are shown in figure 15. The sample is about 40 percent very fine sand and about 50 percent fine sand.

I-64 Well 9:

Fine sand with small particles of incrustation material was observed in the settling tank following the condition assessment step test on August 18, 1994. The sample collected probably represents about 60 to 70 percent of the material in the tank. The results of the sieving of the sample are shown in figure 16. As much as 85 percent of the sample is fine sand. The previous step test on this dewatering well on October 5, 1983 (FY 83-84, Phase 1), was conducted prior to the use of the portable tank.

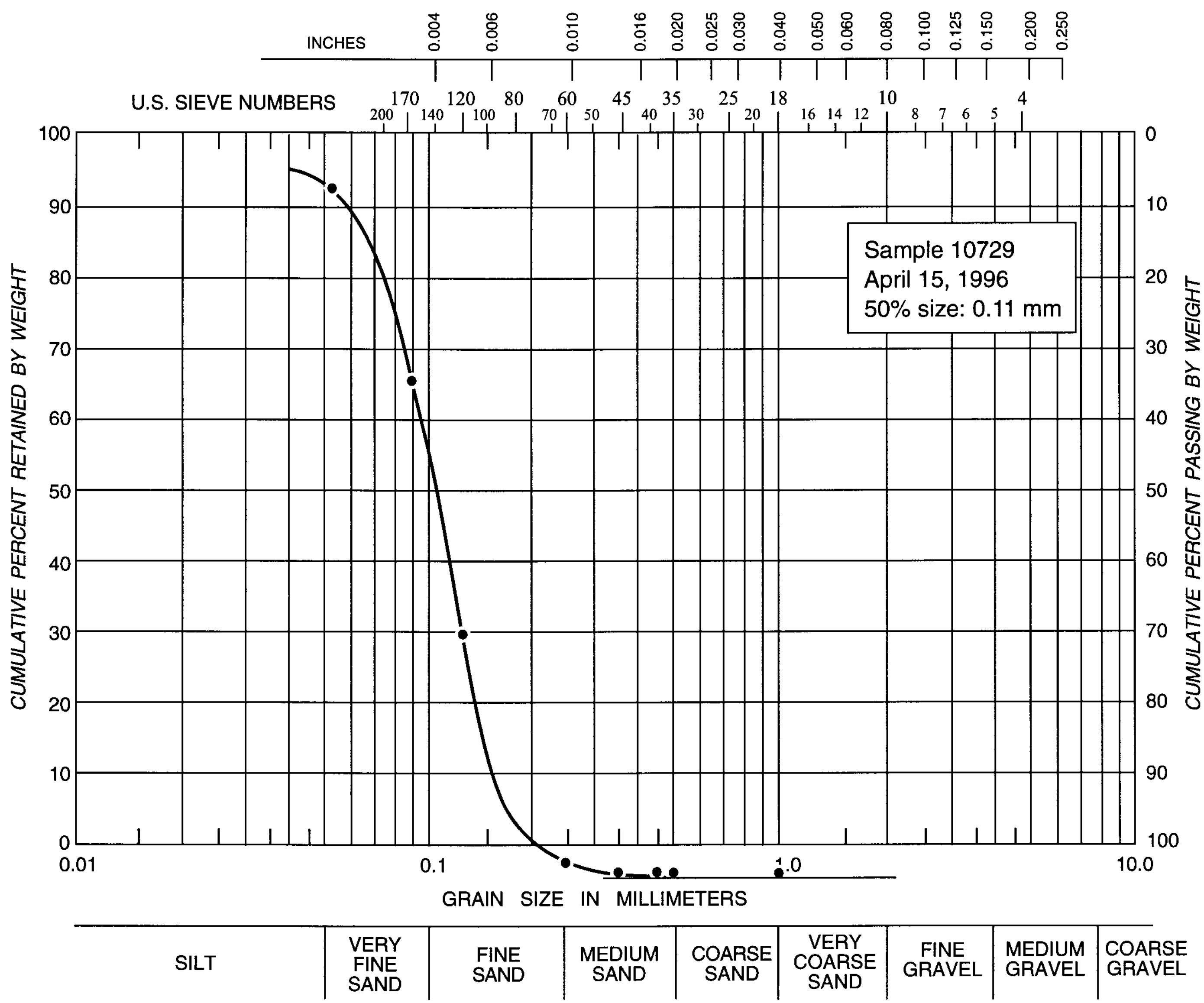

Figure 15. Sieve analysis of material pumped from I-64 Well 8 (04/15/96)

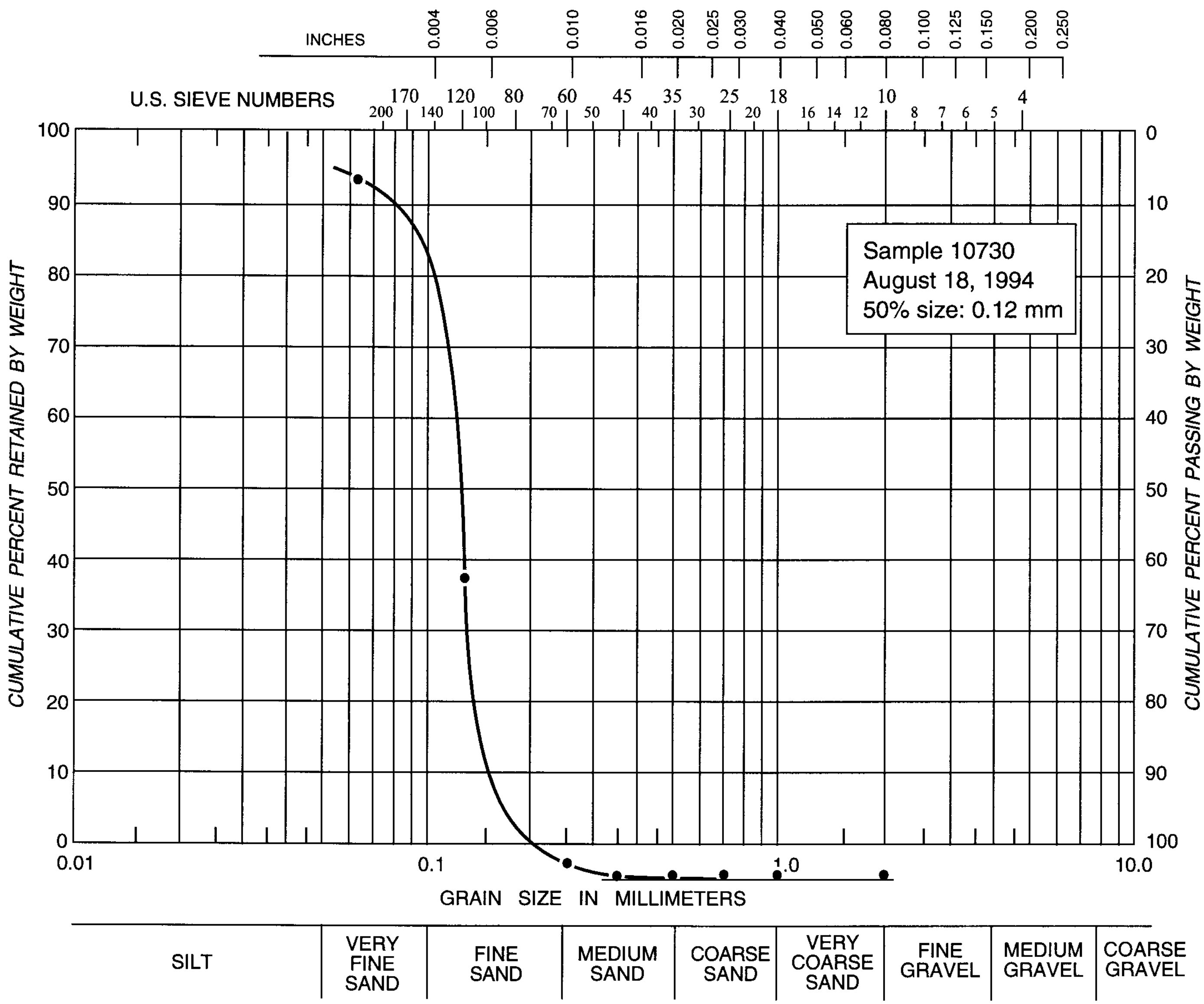

Figure 16. Sieve analysis of material pumped from I-64 Well 9 (08/18/94)

Venice Well 2:

No material was observed in the tank following the FY 94 condition assessment step test on June 21, 1994. A small amount of fine to very fine sand was detected in the settling tank after the FY 92 condition assessment step test on October 2, 1991.

Venice Well 3:

A small amount (less than 1 tablespoon) of fine sand was found in the settling tank following the FY 94 condition assessment step test conducted on July 1, 1994. No sample was collected. No sand was found in the FY 92 posttreatment step test conducted on December 16, 1991.

Venice Well 4:

A large amount of sand was found in the tank following the FY 94 condition assessment step test on May 11, 1994. A quart size sample bag was collected; this represents most of the material in the tank. About 80 percent of the sample is fine sand, as shown by the graphical analysis of the sieving data in figure 17. Pre- and posttreatment step tests for FY 91, conducted on December 6, 1990, and September 17, 1991, also resulted in sand samples in the settling tank. The amount of sample from the posttreatment step test was less than that found from the pretreatment step test, and both samples were much smaller in volume than that collected during the FY 94 step test. The grain size of the sand fraction of all three samples is comparable. Sanderson and Olson (1993) suggested in the FY 91-Phase 8 report that the grain size of the gravel pack installed in Venice Well 4, if comparable to Venice Well 1, may be allowing the aquifer sand to migrate through the gravel pack.

Missouri Avenue Site:

The location of the dewatering wells and the configuration of the highways at this site preclude the use of the portable tank to check for the presence of pumped material.

Sand Pumpage Results

The results of the tests for sand pumpage from the dewatering wells have yielded interesting information. In previous years, the chemical treatment conducted on some of the dewatering wells to restore production rates appears to have influenced the tendency for these wells to pump sand. In these instances the treatment process may cause sufficient disturbance of the gravel pack and native aquifer material to allow the well either to pump sand for some period of time after treatment or to pump sand of a somewhat coarser grain size than is pumped in routine operation. This does not appear to be the case with two wells (I-70 Wells 2A and 9A) chemically treated for FY 94 because neither posttreatment step test showed sand in the tank.

Sand may be pumped from Venice Well 4 on a continuing basis in routine operation. As indicated, the gravel pack selected for use in this well was likely inappropriate for the grain size of the aquifer present at the well site. No conclusion can be reached on whether the chemical treatment of Venice Well 4 in January and February 1991 exacerbated the sand pumping situation.

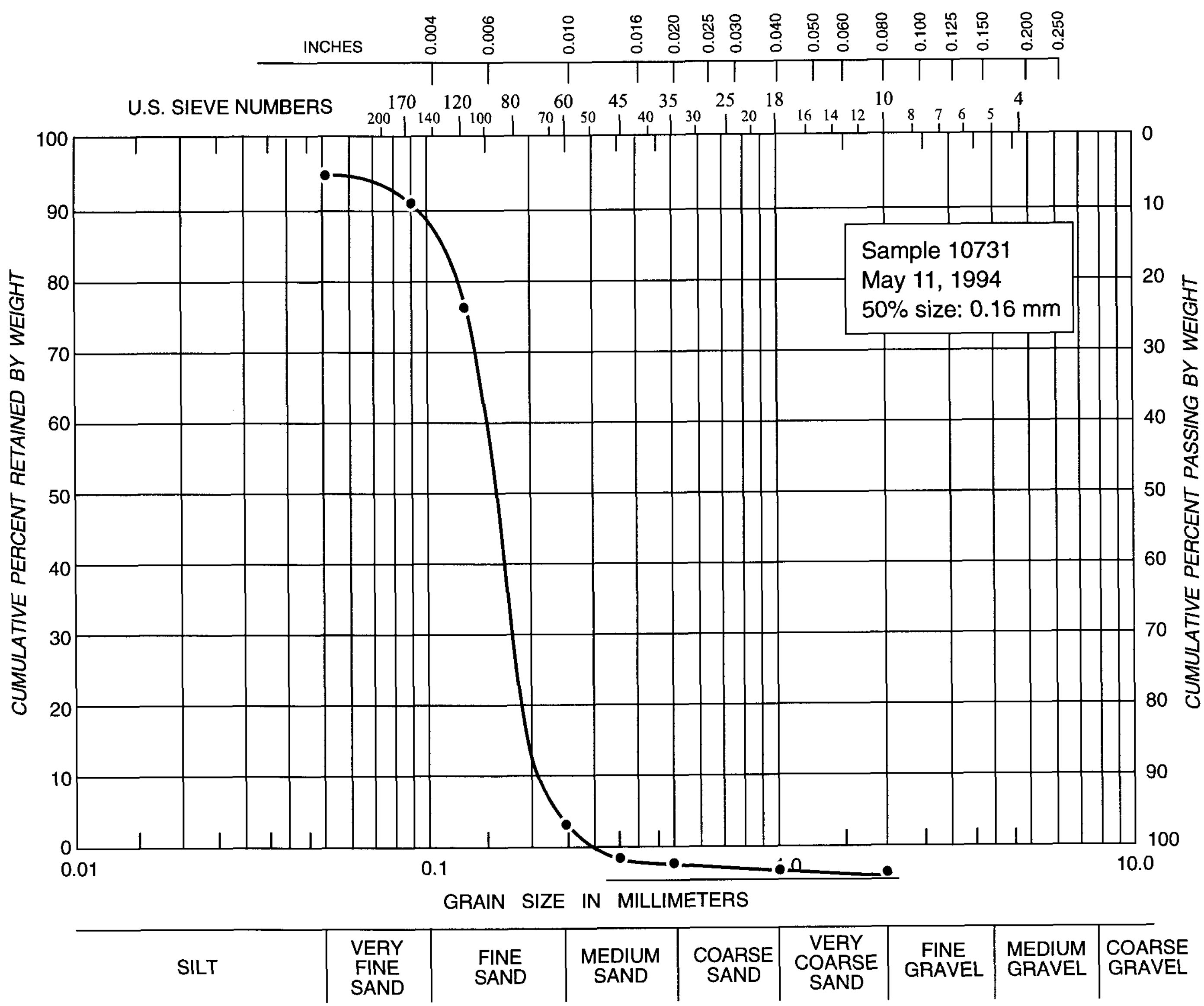

Figure 17. Sieve analysis of material pumped from Venice Well 4 (05/11/94)

Since sand pumpage tests began in FY 87 (Phase 4), a total of 40 dewatering wells have been checked for sand pumpage. Twenty-one of these wells have pumped an amount of sand judged to be significant during at least one step test; five of these wells have been abandoned and replaced with new wells. (Three additional wells have been replaced that exhibited settlement or other symptoms indicative of excess sand pumpage.) Sand has been pumped on at least one occasion in nine of 20 different dewatering wells tested at the I-70 site (23 wells have existed), three of four wells tested at the I-64 site, three of eight wells tested at the 25th Street site, and six of eight wells tested at the Venice site. Of the 12 new/replacement dewatering wells built since FY 87, four wells have pumped sand when checked during 6 of 13 step tests on those four wells.

Evaluation of Ground-Water Quality

The Water Survey's Office of Analytical and Water Treatment Services analyzed water samples collected during all 11 step tests. Appendix B reports the results. Analytical methods used conform to the latest procedures certified by the U.S. Environmental Protection Agency (1979). The sample temperature was determined at each well site, and pH of samples was determined in the laboratory. Table 6 presents the range of concentrations and potential influence of the major water quality parameters analyzed.

Although the ground-water samples vary in water chemistry, generally the ground water can be described as highly mineralized, very hard, and alkaline, with unusually high concentrations of soluble iron. The water quality is consistent with that of previously analyzed samples from the dewatering wells.

Table 6. Range of Concentrations and Potential Influence of Common Dissolved Constituents, FY 94 (Phase 11)

	Concentration, mg/L		
Parameter	*Minimum*	*Maximum*	*Potential influence*
Iron (Fe)	7.16	21.04	Major - incrustative
Manganese (Mn)	0.51	1.32	Major - incrustative
Calcium (Ca)	152	295	Major - incrustative
Magnesium (Mg)	38.7	73.7	Minor - incrustative
Sodium (Na)	37.0	558	Neutral
Silica (SiO_2)	23.8	38.4	Minor - incrustative
Nitrate (NO_3)	< 0.02	0.53	Neutral
Chloride (Cl)	43.9	389	Moderate - corrosive
Sulfate (SO_4)	194	1438	Major - corrosive
Alkalinity (as $CaCO_3$)	338	545	Major - incrustative
Hardness (as $CaCO_3$)	538	1039	Major - incrustative
Total dissolved solids	811	2821	Major - corrosive
pH	7.2	8.0	Major - incrustative

A total of 139 water samples have been analyzed since our studies began in FY 84 (Phase 1). Appendix F contains results from all of the analyses, grouped according to site and summarized in table 7. There appear to be few important differences between the sites in terms of these water-quality parameters. Iron concentration is indicated to be higher in the water from the I-64 and Venice sites, and the water from the I-64 and 25th Street sites contains more dissolved minerals; however, these trends probably do not matter much from a practical standpoint because the concentrations are already very high at all locations.

Nuisance Bacteria Sampling

Nuisance bacteria (e.g., iron bacteria, sulfate-reducing bacteria, etc.) that inhabit wells, gravel packs, and the aquifer matrix often produce well-plugging biofilms, as well as an environment favorable for chemical deposition and corrosion processes. To explore the possibility that such nuisance bacteria might be present in the dewatering wells, the Biological Activity Reaction Test (BART), developed by Droycon Bioconcepts, Inc., Regina, Saskatchewan, Canada, was run on water samples collected from the well discharge at the time of the step tests. The BART tests are customized to detect three general classes of nuisance bacteria commonly associated with problems in wells: iron-related bacteria (IRB), slime-forming bacteria (SLYM), and sulfate-reducing bacteria (SRB). The BART system was previously used during FY 90 to identify the presence of nuisance bacteria in the I-255 Detention Pond relief wells and in conjunction with 14 step-tested dewatering wells during FY 91 (Sanderson et al., 1993), 16 step-tested dewatering wells during FY 92 (Olson and Sanderson, 1997), and 12 step-tested dewatering wells during FY 93 (Sanderson and Olson, 1998).

The testing protocol requires placing a water sample in the test vial for examination over a period of days, and documenting any reactions that may occur. The bacterial population or activity in the water sample is inversely related to the length of time before reactions occur. Reaction types and patterns of occurrence depend on the dominant bacterial groups present in the water (Cullimore, 1990). Thus, the type and size of the bacterial community can be inferred from this reaction signature. Multiple sets of samples collected at time intervals of pumping are recommended for detailed analysis of the bacterial activity (Mansuy et al., 1990).

The BART samples were collected during 11 step tests on 11 dewatering wells for FY 94, all using the same procedure. Because the purpose was to simply determine whether nuisance bacteria are present in the wells, only one sample set, consisting of IRB, SLYM, and SRB samples was collected for each step-tested well. Samples were collected from the orifice tube discharge, usually in sequence with the other water samples being collected for analysis of the dissolved constituents, near the end of the test.

The results for most of the BART samples indicated high to moderate amounts of nuisance bacteria activity in the discharge water from the wells. Generally, the SRB tests appeared to show positive reactions somewhat later than the IRB and SLYM tests. In all but three wells, the tests showed high-to-moderate bacterial activity. Bacterial activity was indicated as low by only one IRB test, one SLYM test, and two SRB tests. In only one instance (the SLYM and SRB tests for Missouri Avenue Well 3) did more than one test in a sample set indicate low

Table 7. Ground-Water Chemical Quality Summary, FY 84-FY 94 (Phases 1-11)

Site		*Iron*	*Manganese*	*Calcium*	*Magnesium*	*Sodium*	*Silica*	*Nitrate*	*Chloride*	*Sulfate*	*Alkalinity**	*Hardness**	*TDS*
I-70	Average	11.86	0.77	191	45.3	77.5	32.3	0.43	98	305	418	663	1,053
	Minimum	2.97	0.44	131	35.2	26.2	20.0	<0.02	39	151	316	507	736
	Maximum	18.84	1.49	239	63.8	230.0	38.0	3.7	234	694	593	834	1,642
	No. of samples	67	51	67	67	67	58	36	67	67	67	67	67
I-64	Average	16.51	0.57	236	58.9	152.1	33.8	0.5	115	617	457	834	1,558
	Minimum	12.30	0.47	202	44.3	29.8	30.5	<0.1	41	350	412	725	974
	Maximum	21.04	0.70	295	74.1	558.0	35.8	2.3	390	1,438	545	1,039	2,821
	No. of samples	17	8	17	17	17	15	8	17	17	17	17	17
25th St.	Average	12.18	0.58	177	51.0	123.6	34.2	0.1	34	520	397	651	1,235
	Minimum	4.50	0.36	123	35.4	14.2	31.2	<0.1	21	122	331	467	612
	Maximum	22.90	0.82	250	73.1	314.0	39.4	0.2	49	1,171	477	898	2,335
	No. of samples	24	20	24	24	24	17	10	24	24	24	24	24
Venice	Average	17.27	0.56	207	50.3	41.4	32.9	0.2	60.8	329	433	724	1,022
	Minimum	8.28	0.39	180	42.2	28.9	24.4	<0.02	25	218	387	635	878
	Maximum	25.7	0.76	261	61.2	65.1	39.6	0.8	124	490	476	890	1,241
	No. of samples	28	21	28	28	28	24	12	28	28	28	28	28
MO Ave.	Average	10.42	1.07	226	50.5	65.7	28.9	0.20	82.2	306	472	772	1,081
	Minimum	7.16	0.99	205	40	59	23.8	<0.02	70.4	254	398	676	925
	Maximum	12.82	1.18	243	65.3	72.4	32.2	0.53	88.9	348	521	875	1,168
	No. of samples	3	3	3	3	2	3	3	3	3	3	3	3

Notes: All concentration units are in mg/L
*Reported as $CaCO_3$
TDS = total dissolved solids

bacterial activity for a well. The results were similar to those reported since FY 91, the first year that these tests were used on the step-tested dewatering wells.

There continues to be little correlation between the indication of well conditions from the step tests and reaction response signatures from the BART samples. The BART samples collected from the wells in the poorest hydraulic condition showed similar response patterns in a comparable time frame to samples collected from wells in very good condition.

The BART samples were collected during the pre- and posttreatment step tests on the two wells that received chemical treatment during FY 94 (although the pretreatment step tests were conducted in previously reported fiscal years). For I-70 Well 2A, there was little difference in the reaction signature that occurred before and after treatment; however, in Well 9A the reactions for the posttreatment samples occurred somewhat sooner, indicating more aggressive populations for all three classes of bacteria. It is unclear whether any meaningful conclusions can be drawn at this time from such a small data set. When compared to the BART results from all of the nontreated wells, results for the 11 wells treated, beginning with FY 91, fall within the same range of high-to-moderate bacterial activity.

The BART samples have been collected near the end of the step tests, after many well casing and screen volumes of water have been pumped, so it is assumed that the water sampled is being derived totally from the aquifer. Therefore, the rapid bacterial activity usually observed suggests that there is substantial biomass development within the well casing and screen that is slowly sloughing off during the step test pumping on most of the wells, or a significant population of the bacteria is present in the aquifer, or both.

When taking into consideration that all of the dewatering wellheads are located in pits that can be readily subjected to contamination from pit seepage or spill water, the high degree of nuisance bacteria activity is not that surprising. Although nuisance bacteria can be present in ground water, most of these types of bacteria are ubiquitous in the surface environment. The use of sanitary wellheads and using precautions such as disinfection after performing maintenance activities on the wells are good preventative measures for keeping the wells free of bacterially induced problems.

CONCLUSIONS AND RECOMMENDATIONS

Construction of New Wells

Four wells were constructed at the new Missouri Avenue dewatering site during June, July, and August 1993. Three of the wells (Wells 1-3) are equipped with 1,200 to 1,500 gpm capacity submersible pumps. The fourth well (Well 2-93) is capped and remains as an alternate if Well 3 becomes inoperable. Water Survey step tests indicated that Wells 1 and 3 are in poor hydraulic condition. However, the initial condition of the wells is unknown as there was considerable delay before the step testing could be done.

The use of above ground wellheads and pump discharge at the Missouri Avenue dewatering site has eliminated access and sanitary problems associated with the well pits that are used at the other dewatering sites. However, the diameter and the installed well screens of these wells are inadequate for the intended pumping rates, according to Water Survey well design criteria and experience. These criteria and the experience gained with the design and operation of other dewatering wells suggest that the present operating rates are about 50 to 100 percent too high. The initial position of the pump intakes within the screened interval in the wells also may be a contributing factor to well deterioration, because the resulting turbulence and pressure drop cause changes in water chemistry and deposition of minerals. In addition, there is minimal annular space between the edges of flanges and the well casing in Wells 2 and 3, making physical measurement of water levels very difficult. Regular measurements of the ground-water levels in these wells are important, as the step tests conducted and described earlier show that these wells also are susceptible to significant deterioration problems and loss of production capacity.

If new wells are added at the Missouri Avenue site, it is recommended that longer well screens be installed and that the well casing and screen be at least 20 inches in diameter for individual rates of 1,200 gpm or more. Actual well design should be based on sieve data of formation samples collected from a test hole at the dewatering well location.

Condition of Wells

Results of the step tests conducted to assess the condition of eight existing and new wells show that Missouri Avenue Well 2 probably is in good condition, with an observed specific capacity near the average of wells in good condition at all other sites. Venice Wells 2 and 3 are in fair condition, with observed specific capacities about 67 to 69 percent of the average observed specific capacities of wells in good condition at the Venice site and with Δh values of 4.4 and 5 feet.

Several wells are in poor condition: I-70 Well 12A, I-64 Wells 8 and 9, and Venice Well 4, with observed specific capacities about 22 to 57 percent of the average observed specific capacities of wells in good condition at the respective sites. Missouri Avenue Wells 1 and 3 also appear to be in poor condition, with observed specific capacities about one-half of the average observed specific capacity of wells in good condition at all other sites. Chemical treatment is recommended to improve the condition of these six wells. Underwater video inspection of these wells for excessive buildup of incrusting minerals also should be considered.

On the basis of data collected by the contractor at the time of treatment, I-70 Wells 2A and 9A appear to have been restored to fair to good condition. Posttreatment step-test data for I-70 Well 2A suggest only a fair condition, with an observed specific capacity about 83 percent of the average for wells in good condition at the I-70 site. The posttreatment step-test data for I-70 Well 9A confirm the acceptable condition, with an observed specific capacity of about 104 percent of the average observed specific capacity for wells in good condition at this site and a Δh value of only 1.6 feet.

Well Rehabilitation

Chemical treatments used to restore well capacity in FY 94 (Phase 11) were moderately successful. Drawdown data collected during treatment by the contractor indicate that an average increase in observed specific capacity of the two wells was about 79 percent, but the Water Survey step-test data show improvement of about 66 percent. Posttreatment observed specific capacities of I-70 Wells 2A and 9A are about 83 percent and 104 percent of the average observed specific capacity of wells in good condition at the I-70 site.

The change in chemical treatment specifications made in FY 90 to provide for optional polyphosphate treatment steps after the second application reduced the total number of polyphosphate treatments applied to I-70 Wells 2A and 9A. The optional third polyphosphate treatment step was omitted for I-70 Well 9A, and the optional fourth polyphosphate treatment step was dropped at both of the treated wells on the basis of the field observations made at the time of the treatment.

Sand Pumpage Investigation

Discharge from eight dewatering wells was tested for sand pumpage during eight step tests. For the three step tests on Missouri Avenue Wells 1, 2, and 3, the discharge could not be checked because of site conditions. Sediment collected after three of the step tests on the eight wells was visually inspected for the presence of sand and gravel pack and sieved for the grain-size distribution.

Results of the tests for sand pumpage from the dewatering wells for this and prior years have yielded interesting information. It appears that the chemical treatment of some wells to restore production capacity may influence the tendency for a dewatering well to pump sand. In some instances it appears that the treatment may cause sufficient disturbance of the gravel pack and native aquifer material to allow the well either to pump sand for some period of time after treatment or to pump sand of a somewhat coarser grain size than is pumped in routine operation. However, neither of the dewatering wells treated during FY 94 (Phase 11) yielded a sample of sand during the posttreatment step tests.

It appears that sand is being pumped from Venice Well 4 on a continuing basis in routine operation. As indicated, the gravel pack selected for use in this well was likely inappropriate for the aquifer grain size present at the well site. No conclusion can be reached on whether the chemical treatment of Venice Well 4 in January and February 1991 exacerbated the sand pumping situation.

It is recommended that testing for the presence of sand in the discharge be continued during future step tests. This will continue to allow a qualitative assessment of the sand pumpage problem. It is possible that some of the wells produce sand occasionally because of well development, as might occur immediately after an idle well is restarted. This can be verified as more wells are repeatedly checked during the step tests.

Nuisance Bacteria Sampling

The BART samples were collected during 11 step tests on 11 dewatering wells in FY 94, all using the same procedure. Results from this limited testing in FY 91-FY 94 can be considered only preliminary. Even though the relatively high level of nuisance bacteria identified in the dewatering wells represents a significant potential for causing well plugging, the data clearly show that even wells in good condition contain the bacteria. It also appears that chemical treatments used to rehabilitate the wells do not eliminate the nuisance bacteria from the wells. Widespread bacteria in the wells sampled might mean that they are indigenous to the ground water, or that they are being regularly introduced into the wells from some other source. In either case, the problems associated with their presence will need to be managed on a continual basis. It is recommended that more background data be collected using the BART sets as additional dewatering wells are step tested. Although the use of BART sets for more detailed analysis of some of the wells probably is not warranted now, it may be considered in the future.

Future Investigations

A program of continued investigation of the condition of the dewatering wells is recommended. Measuring the difference between water levels in a well and the adjacent piezometer will continue to be an important first step in determining whether a well is a candidate for future step tests or treatment. In addition, if a well is pumping sand, this indicates a potentially major problem with the well. A sand pumpage investigation is recommended as a standard part of each step test.

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Appendix A

Step Test Data
FY 94 (Phase 11)

I-70	**Well 2A**	**8/22/94**
	Well 9A	**9/9/94**
	Well 12A	**8/2/95**
I-64	**Well 8**	**4/15/96**
	Well 9	**8/18/94**
Venice	**Well 2**	**6/21/94**
	Well 3	**7/1/94**
	Well 4	**5/11/94**
MO Ave.	**Well 1**	**2/10/95**
	Well 2	**2/16/95**
	Well 3	**2/16/95**

DEWATERING WELL DATA
Posttreatment Step Test

	Well No. I-70 W2A	Piezometer No. I-70 P2A
Date Drilled:	2/6/92	1992
Casing		
Top elevation:	408	na
Diameter:	16-in. SS	2-in. PVC
Length (ft):	55	na
Screen		
Bottom elevation:	303	na
Diameter:	16-in. SS	2-in. PVC
Length, lower (ft):	30	3
Slot size, lower:	0.055-in.	na
Length, upper (ft):	20	-
Slot size, upper:	0.020-in.	-
Measuring Point Elevation:	na	na
Nonpumping Water Level		
Depth below temp. MP (ft):	38.94	-
Height of temp. MP (ft):	4.37	-
Depth below perm. MP (ft):	34.57	39.04
Elevation:	-	-
Date of Step Test:	8/22/94	-
Water Sample		
Time:	4:04 pm	-
Temperature:	59.2°F	-
Laboratory No.:	227955	-
Distance and Direction to Piezometer from PW:		7.0 ft north
Time PW Off Before Step Test:		Not recorded

Notes: SWS 8-in. dia. orifice tube w/plate No. 4, Omnidata datalogger, sand tank
No sand observed in tank following step test
na-information not available

SWS Crew: E. Sanderson, R. Olson, S. Ralston

WATER-LEVEL MEASUREMENTS
I-70 Well No. 2A
Posttreatment Step Test

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
08/22/94						
01:28 pm	0	38.94				Dropline measurement
01:29 pm	0		39.04			Dropline measurement
01:45 pm	0					Omnidata logging started
01:46 pm	0	38.94	39.04			Water-level trend
01:47 pm	0	38.95	39.11			
01:48 pm	0	38.95	39.19			
01:49 pm	0	38.95	39.23			
01:50 pm	0	38.95	39.29			
01:51 pm	0	38.95	39.34			
01:52 pm	0	38.95	39.33			
01:53 pm	0	38.95	39.36			
01:54 pm	0	38.95	39.40			
01:55 pm	0	38.95	39.43			
01:56 pm	0	38.95	39.45			
01:57 pm	0	38.95	39.45			
01:58 pm	0	38.95	39.44			
01:59 pm	0	38.94	39.43			
02:00 pm	0	38.95	39.43			Pump On
02:01 pm	1	44.94	43.38	2.45	525	Step 1; Max Q
02:02 pm	2	45.07	43.58	2.23	500	
02:03 pm	3	44.80	43.47			
02:04 pm	4	44.86	43.50			
02:05 pm	5	44.89	43.53			
02:06 pm	6	44.91	43.55			
02:07 pm	7	44.93	43.58			
02:08 pm	8	44.99	43.61			
02:09 pm	9	45.02	43.66			
02:10 pm	10	45.02	43.70			
02:11 pm	11	45.01	43.63			
02:12 pm	12	45.03	43.56	2.23	500	
02:13 pm	13	45.09	43.60			
02:14 pm	14	45.14	43.72			
02:15 pm	15	45.12	43.77			
02:16 pm	16	45.14	43.77			
02:17 pm	17	45.18	43.80			
02:18 pm	18	45.12	43.82			
02:19 pm	19	45.19	43.83			
02:20 pm	20	45.21	43.84	2.22	500	
02:21 pm	21	45.17	43.85			
02:22 pm	22	45.17	43.83			
02:23 pm	23	45.16	43.77			
02:24 pm	24	45.17	43.79			

WATER-LEVEL MEASUREMENTS
I-70 Well No. 2A (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
02:25 pm	25	45.24	43.84			
02:26 pm	26	45.20	43.88			
02:27 pm	27	45.19	43.93			
02:28 pm	28	45.19	43.96			
02:29 pm	29	45.25	43.94	2.22	500	
02:30 pm	30	45.22	43.89			Reduce rate
02:31 pm	1	44.66	43.47	1.80	450	Step 2
02:32 pm	2	44.65	43.41			
02:33 pm	3	44.64	43.38			
02:34 pm	4	44.66	43.37			
02:35 pm	5	44.64	43.36			
02:36 pm	6	44.64	43.36			
02:37 pm	7	44.64	43.36			
02:38 pm	8	44.61	43.34			
02:39 pm	9	44.64	43.35			
02:40 pm	10	44.62	43.34	1.80	450	
02:41 pm	11	44.64	43.31			
02:42 pm	12	44.67	43.29			
02:43 pm	13	44.66	43.32			
02:44 pm	14	44.68	43.31			
02:45 pm	15	44.63	43.27			
02:46 pm	16	44.63	43.26			
02:47 pm	17	44.65	43.26			
02:48 pm	18	44.67	43.26			
02:49 pm	19	44.65	43.33			
02:50 pm	20	44.68	43.38			
02:51 pm	21	44.65	43.40			
02:52 pm	22	44.65	43.42	1.80	450	
02:53 pm	23	44.66	43.43			
02:54 pm	24	44.72	43.43			
02:55 pm	25	44.67	43.42			
02:56 pm	26	44.69	43.40			
02:57 pm	27	44.67	43.39			
02:58 pm	28	44.67	43.38			
02:59 pm	29	44.70	43.38	1.80	450	
03:00 pm	30	44.66	43.39	1.80	450	Reduce rate
03:01 pm	1	44.11	43.01	1.41	400	Step 3
03:02 pm	2	44.09	43.00			
03:03 pm	3	44.08	43.00			
03:04 pm	4	44.09	43.01			
03:05 pm	5	44.07	43.01			
03:06 pm	6	44.08	43.01			
03:07 pm	7	44.06	43.00			

WATER-LEVEL MEASUREMENTS
I-70 Well No. 2A (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
03:08 pm	8	44.06	43.00			
03:09 pm	9	44.09	43.00			
03:10 pm	10	44.07	43.04	1.41	400	
03:11 pm	11	44.08	43.05			
03:12 pm	12	44.07	43.08			
03:13 pm	13	44.06	43.08			
03:14 pm	14	44.07	43.06			
03:15 pm	15	44.07	43.04			
03:16 pm	16	44.09	43.01			
03:17 pm	17	44.09	43.02			
03:18 pm	18	44.07	43.02			
03:19 pm	19	44.09	43.03			
03:20 pm	20	44.10	43.04			
03:21 pm	21	44.09	43.05			
03:22 pm	22	44.07	43.06			
03:23 pm	23	44.11	43.07			
03:24 pm	24	44.07	43.07	1.41	400	
03:25 pm	25	44.08	43.08			
03:26 pm	26	44.09	43.09			
03:27 pm	27	44.09	43.10			
03:28 pm	28	44.08	43.11			
03:29 pm	29	44.10	43.10	1.41	400	
03:30 pm	30	44.09	43.11			Reduce rate
03:31 pm	1	43.54	42.75	1.09	350	Step 4
03:32 pm	2	43.52	42.74			
03:33 pm	3	43.53	42.73			
03:34 pm	4	43.53	42.72			
03:35 pm	5	43.51	42.72			
03:36 pm	6	43.52	42.71			
03:37 pm	7	43.51	42.71			
03:38 pm	8	43.51	42.71	1.09	350	
03:39 pm	9	43.52	42.72			
03:40 pm	10	43.50	42.72			
03:41 pm	11	43.51	42.73			
03:42 pm	12	43.49	42.73			
03:43 pm	13	43.51	42.73			
03:44 pm	14	43.50	42.77			
03:45 pm	15	43.50	42.78			
03:46 pm	16	43.50	42.76			
03:47 pm	17	43.50	42.74	1.09	350	
03:48 pm	18	43.50	42.73			
03:49 pm	19	43.50	42.72			
03:50 pm	20	43.50	42.73			

WATER-LEVEL MEASUREMENTS
I-70 Well No. 2A (Concluded)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
03:51 pm	21	43.51	42.73			
03:52 pm	22	43.50	42.73			
03:53 pm	23	43.52	42.76			
03:54 pm	24	43.51	42.78			
03:55 pm	25	43.51	42.78			
03:56 pm	26	43.51	42.75			
03:57 pm	27	43.51	42.76			
03:58 pm	28	43.52	42.77			
03:59 pm	29	43.50	42.76	1.09	350	
04:00 pm	30	43.51	42.74			Reduce rate
04:01 pm	1	42.93	42.35	0.78	300	Step 5
04:02 pm	2	42.89	42.31			
04:03 pm	3	42.87	42.30			
04:04 pm	4	42.87	42.30			Water samples collected,
04:05 pm	5	42.86	42.30			T=59.2°F
04:06 pm	6	42.86	42.30			
04:07 pm	7	42.86	42.30			BART samples collected
04:08 pm	8	42.86	42.30			
04:09 pm	9	42.86	42.30			
04:10 pm	10	42.86	42.30			
04:11 pm	11	42.86	42.30			
04:12 pm	12	42.86	42.30	0.78	300	
04:13 pm	13	42.85	42.30			
04:14 pm	14	42.86	42.31			
04:15 pm	15	42.86	42.32			
04:16 pm	16	42.85	42.33			
04:17 pm	17	42.85	42.34			
04:18 pm	18	42.85	42.35	0.78	300	
04:19 pm	19	42.85	42.35			
04:20 pm	20	42.85	42.34			
04:21 pm	21	42.85	42.31			
04:22 pm	22	42.85	42.29			
04:23 pm	23	42.85	42.28			
04:24 pm	24	42.85	42.28			
04:25 pm	25	42.84	42.28	0.78	300	
04:26 pm	26	42.85	42.31			
04:27 pm	27	42.85	42.32			
04:28 pm	28	42.85	42.32			
04:29 pm	29	42.85	42.33			
04:30 pm	30	42.85	42.32			End of step test

DEWATERING WELL DATA
Posttreatment Step Test

	Well No. I-70 W9A	Piezometer No. I-70 P9A
Date Drilled:	4/5/89	4/13/89
Casing		
Top elevation:	402.8	407.52
Diameter:	16-in. SS	2-in. PVC
Length (ft):	40.9	na
Screen		
Bottom elevation:	301.9	na
Diameter:	16-in. SS	2-in. PVC
Length, lower (ft):	40	3
Slot size, lower:	0.055-in.	na
Length, upper (ft)	20	-
Slot size, upper:	0.020-in.	-
Measuring Point Elevation:	404.05	407.52
Nonpumping Water Level		
Depth below temp. MP (ft):	36.24	-
Height of temp. MP (ft):	3.80	-
Depth below perm. MP (ft):	32.44	36.17
Elevation:	371.61	371.35
Date of Step Test:	9/9/94	-
Water Sample		
Time:	11:55 am	-
Temperature:	59.7°F	-
Laboratory No.:	227970	-
Distance and Direction to Piezometer from PW:		6.0 ft east
Time PW Off Before Step Test:		Not recorded

Notes: SWS 8-in. dia. orifice tube w/plate No. 4; Omnidata datalogger w/transmitters; 50-ft flexible hose; 1,000-gal settling tank
Only a few, if any, grains of sand in tank following test
na-information not available

SWS Crew: R. Olson, E. Sanderson

WATER-LEVEL MEASUREMENTS
I-70 Well No. 9A
Posttreatment Step Test

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
09/09/94						
10:10 am	0		36.17			Dropline measurement
10:12 am	0	36.24				Dropline measurement
10:34 am	0	36.24	36.17			Omnidata logging started
10:35 am	0	36.24	36.17			Water-level trend
10:36 am	0	36.24	36.18			
10:37 am	0	36.23	36.18			
10:38 am	0	36.24	36.18			
10:39 am	0	36.24	36.19			
10:40 am	0	36.23	36.18			
10:41 am	0	36.23	36.18			
10:42 am	0	36.23	36.19			
10:43 am	0	36.23	36.19			
10:44 am	0	36.23	36.19			
10:45 am	0	36.23	36.19			Pump On
10:46 am	1	40.93	39.53	2.35	515	Step 1; Max Q
10:47 am	2	40.97	39.58			
10:48 am	3	41.04	39.65	2.23	500	
10:49 am	4	41.01	39.65			
10:50 am	5	41.02	39.66			
10:51 am	6	41.03	39.67			
10:52 am	7	41.05	39.69			
10:53 am	8	41.07	39.71	2.23	500	
10:54 am	9	41.09	39.73			
10:55 am	10	41.10	39.73			
10:56 am	11	41.10	39.73			
10:57 am	12	41.11	39.75			
10:58 am	13	41.13	39.76			
10:59 am	14	41.13	39.77			
11:00 am	15	41.15	39.78			
11:01 am	16	41.16	39.78			
11:02 am	17	41.16	39.79			
11:03 am	18	41.16	39.80	2.23	500	
11:04 am	19	41.19	39.81			
11:05 am	20	41.18	39.82			
11:06 am	21	41.19	39.83			
11:07 am	22	41.20	39.83			
11:08 am	23	41.20	39.83			
11:09 am	24	41.20	39.84			
11:10 am	25	41.21	39.85			
11:11 am	26	41.20	39.82	2.23	500	
11:12 am	27	41.23	39.85			
11:13 am	28	41.23	39.85			

WATER-LEVEL MEASUREMENTS
I-70 Well No. 9A (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
11:14 am	29	41.23	39.85			
11:15 am	30	41.24	39.87	2.23	500	Reduce rate
11:16 am	1	40.81	39.57	1.80	450	Step 2
11:17 am	2	40.79	39.56			
11:18 am	3	40.79	39.56			
11:19 am	4	40.78	39.56			
11:20 am	5	40.78	39.55			
11:21 am	6	40.79	39.55			
11:22 am	7	40.79	39.57	1.80	450	
11:23 am	8	40.79	39.56			
11:24 am	9	40.80	39.57			
11:25 am	10	40.81	39.57			
11:26 am	11	40.80	39.57			
11:27 am	12	40.80	39.57	1.80	450	
11:28 am	13	40.81	39.58			
11:29 am	14	40.81	39.58			
11:30 am	15	40.82	39.57			
11:31 am	16	40.81	39.59			
11:32 am	17	40.81	39.59			
11:33 am	18	40.82	39.59			
11:34 am	19	40.82	39.59			
11:35 am	20	40.83	39.60			
11:36 am	21	40.83	39.60			
11:37 am	22	40.83	39.60	1.80	450	
11:38 am	23	40.83	39.60			
11:39 am	24	40.83	39.60			
11:40 am	25	40.83	39.61			
11:41 am	26	40.84	39.61			
11:42 am	27	40.84	39.62			
11:43 am	28	40.84	39.62			
11:44 am	29	40.84	39.62			
11:45 am	30	40.85	39.62	1.80	450	Reduce rate
11:46 am	1	40.43	39.33	1.42	400	Step 3
11:47 am	2	40.40	39.30			
11:48 am	3	40.40	39.29			
11:49 am	4	40.40	39.29	1.42	400	
11:50 am	5	40.40	39.29			
11:51 am	6	40.40	39.29			
11:52 am	7	40.40	39.29			
11:53 am	8	40.40	39.29			
11:54 am	9	40.40	39.29			
11:55 am	10	40.40	39.30	1.42	400	Water sample collected,
11:56 am	11	40.41	39.30			T=59.7°F

WATER-LEVEL MEASUREMENTS
I-70 Well No. 9A (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
11:57 am	12	40.42	39.31			
11:58 am	13	40.41	39.31			
11:59 am	14	40.41	39.31			
12:00 pm	15	40.42	39.31			
12:01 pm	16	40.41	39.31	1.42	400	
12:02 pm	17	40.42	39.32			
12:03 pm	18	40.42	39.31			
12:04 pm	19	40.42	39.31			
12:05 pm	20	40.41	39.30			
12:06 pm	21	40.41	39.31	1.42	400	
12:07 pm	22	40.42	39.33			
12:08 pm	23	40.43	39.34			
12:09 pm	24	40.43	39.35			
12:10 pm	25	40.43	39.34			
12:11 pm	26	40.43	39.35			
12:12 pm	27	40.43	39.35			
12:13 pm	28	40.44	39.35			
12:14 pm	29	40.43	39.34			
12:15 pm	30	40.44	39.34	1.42	400	Reduce rate
12:16 pm	1	39.97	39.00	1.08	350	Step 4
12:17 pm	2	39.96	39.00			
12:18 pm	3	39.96	38.99			
12:19 pm	4	39.95	39.00			
12:20 pm	5	39.95	39.00			
12:21 pm	6	39.96	39.01			
12:22 pm	7	39.95	39.01			
12:23 pm	8	39.95	38.99			
12:24 pm	9	39.96	38.99	1.08	350	
12:25 pm	10	39.95	38.98			
12:26 pm	11	39.96	38.99			
12:27 pm	12	39.96	39.00			
12:28 pm	13	39.96	39.01			
12:29 pm	14	39.96	39.01			
12:30 pm	15	39.95	39.01	1.08	350	
12:31 pm	16	39.96	39.01			
12:32 pm	17	39.95	39.01			
12:33 pm	18	39.96	39.01			
12:34 pm	19	39.96	39.00			
12:35 pm	20	39.95	39.00			
12:36 pm	21	39.96	39.00			
12:37 pm	22	39.96	38.99			
12:38 pm	23	39.94	38.97			
12:39 pm	24	39.96	39.00	1.08	350	

WATER-LEVEL MEASUREMENTS
I-70 Well No. 9A (Concluded)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
12:40 pm	25	39.96	39.01			
12:41 pm	26	39.95	39.01			
12:42 pm	27	39.96	39.02			
12:43 pm	28	39.96	39.01			
12:44 pm	29	39.96	39.01			
12:45 pm	30	39.97	39.02	1.08	350	Reduce rate
12:46 pm	1	39.52	38.70	0.79	300	Step 5
12:47 pm	2	39.51	38.69			
12:48 pm	3	39.51	38.69			
12:49 pm	4	39.51	38.69			
12:50 pm	5	39.50	38.69			
12:51 pm	6	39.51	38.68			
12:52 pm	7	39.50	38.68			
12:53 pm	8	39.50	38.69			
12:54 pm	9	39.50	38.68			
12:55 pm	10	39.50	38.69			
12:56 pm	11	39.51	38.69			
12:57 pm	12	39.50	38.69			
12:58 pm	13	39.50	38.68			
12:59 pm	14	39.50	38.68			
01:00 pm	15	39.50	38.68	0.79	300	
01:01 pm	16	39.50	38.67			
01:02 pm	17	39.51	38.68			
01:03 pm	18	39.50	38.68			
01:04 pm	19	39.50	38.67			
01:05 pm	20	39.50	38.67			
01:06 pm	21	39.51	38.68			
01:07 pm	22	39.50	38.68			
01:08 pm	23	39.50	38.69			
01:09 pm	24	39.51	38.69			
01:10 pm	25	39.50	38.69	0.79	300	
01:11 pm	26	39.51	38.70			
01:12 pm	27	39.51	38.69			
01:13 pm	28	39.50	38.67			
01:14 pm	29	39.50	38.68			
01:15 pm	30	39.50	38.67	0.79	300	End of step test

DEWATERING WELL DATA
Condition Assessment Step Test

	Well No. I-70 W12A	Piezometer No. I-70 P12A
Date Drilled:	1980	1980
Casing		
Top elevation:	403.12	na
Diameter:	16-in. SS	2-in. PVC
Length (ft):	na	na
Screen		
Bottom elevation:	na	na
Diameter:	16-in. SS	2-in. PVC
Length (ft):	60	3
Slot size:	0.080-in.	na
Measuring Point Elevation:	391.5	395.8
Nonpumping Water Level		
Depth below temp. MP (ft):	15.19	-
Height of temp. MP (ft):	4.4	-
Depth below perm. MP (ft):	10.79	15.17
Elevation:	380.71	380.63
Date of Step Test:	8/2/95	-
Water Sample		
Time:	11:44 am	-
Temperature:	58.8°F	-
Laboratory No.:	228882	-
Distance and Direction to Piezometer from PW:		6.0 ft NW
Time PW Off Before Step Test:		Not recorded

Notes: SWS 8-in. dia. orifice tube w/plate No. 4
Water level data collected w/Hermit datalogger
na-information not available

SWS Crew: R. Olson, B. Coulson

WATER-LEVEL MEASUREMENTS
I-70 Well No. 12A
Condition Assessment Step Test

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
08/02/95						
09:46 am	0		15.17			Dropline measurement
09:48 am	0	15.19				Dropline measurement
10:25 am	0	15.19	15.19			Hermit logging started
10:26 am	0	15.19	15.20			Water-level trend
10:27 am	0	15.20	15.20			
10:28 am	0	15.20	15.20			
10:29 am	0	15.20	15.19			
10:30 am	0	15.19	15.19			
10:31 am	0	15.19	15.19			
10:32 am	0	15.19	15.18			
10:33 am	0	15.19	15.20			
10:34 am	0	15.19	15.19			
10:35 am	0	15.19	15.19			
10:36 am	0	15.19	15.20			
10:37 am	0	15.19	15.18			
10:38 am	0	15.19	15.19			
10:39 am	0	15.19	15.19			
10:40 am	0	15.18	15.17			Pump On
10:41 am	1	24.28	17.93	2.38	517	Step 1; Max Q
10:42 am	2	24.11	17.98	2.24	501	
10:43 am	3	24.14	18.01			
10:44 am	4	24.18	18.05			
10:45 am	5	24.23	18.07			
10:46 am	6	24.23	15.37			
10:47 am	7	24.22	13.98			
10:48 am	8	24.24	13.28			
10:49 am	9	24.27	12.26			
10:50 am	10	24.28	12.48			
10:51 am	11	24.30	11.67			
10:52 am	12	24.32	9.57			Well dischargewater ponding
10:53 am	13	24.33	9.57			nearby
10:54 am	14	24.34	9.57	2.24	501	Water flowing into
10:55 am	15	24.31	9.57			piezometer
10:56 am	16	24.29	9.57			Piezometer plugged
10:57 am	17	24.28	9.57			
10:58 am	18	24.28	9.57			
10:59 am	19	24.30	9.57			
11:00 am	20	24.29	9.57			
11:01 am	21	24.31	9.57			
11:02 am	22	24.29	9.57			
11:03 am	23	24.30	9.57	2.24	501	Small amount of water
11:04 am	24	24.33	9.57			flowing into well;
11:05 am	25	24.36	9.57			piezometer submerged

WATER-LEVEL MEASUREMENTS
I-70 Well No. 12A (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
11:06 am	26	24.36	9.57			
11:07 am	27	24.39	9.57			
11:08 am	28	24.39	9.57	2.24	501	
11:09 am	29	24.39	9.57			
11:10 am	30	24.40	9.57	2.23	500	Reduce rate
11:11 am	1	23.46	9.57	1.80	450	Step 2
11:12 am	2	23.46	9.57			
11:13 am	3	23.45	9.57			
11:14 am	4	23.46	9.57			
11:15 am	5	23.46	9.57			
11:16 am	6	23.46	9.57			
11:17 am	7	23.46	9.57			
11:18 am	8	23.48	9.57			
11:19 am	9	23.48	9.57	1.80	450	
11:20 am	10	23.49	9.57			
11:21 am	11	23.47	9.57			
11:22 am	12	23.50	9.57			
11:23 am	13	23.50	9.57			
11:24 am	14	23.49	9.57	1.80	450	
11:25 am	15	23.50	9.57			
11:26 am	16	23.49	9.57			
11:27 am	17	23.49	9.57			
11:28 am	18	23.51	9.57			
11:29 am	19	23.50	9.57			
11:30 am	20	23.51	9.57	1.80	450	
11:31 am	21	23.51	9.57			
11:32 am	22	23.51	9.57			
11:33 am	23	23.51	9.57			
11:34 am	24	23.51	9.57			
11:35 am	25	23.52	9.57			
11:36 am	26	23.52	9.57			
11:37 am	27	23.52	9.57			
11:38 am	28	23.54	9.57			
11:39 am	29	23.53	9.57	1.80	450	
11:40 am	30	23.53	9.57	1.80	450	Reduce rate
11:41 am	1	22.59	9.57			Step 3
11:42 am	2	22.59	9.57	1.41	399	
11:43 am	3	22.59	9.57			
11:44 am	4	22.60	9.57			Water sample collected,
11:45 am	5	22.58	9.57	1.41	399	T=58.8°F
11:46 am	6	22.58	9.57			
11:47 am	7	22.59	9.57			
11:48 am	8	22.58	9.57			
11:49 am	9	22.59	9.57			

WATER-LEVEL MEASUREMENTS
I-70 Well No. 12A (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
11:50 am	10	22.59	9.57			
11:51 am	11	22.58	9.57			
11:52 am	12	22.58	9.57			
11:53 am	13	22.60	9.57			BART samples collected
11:54 am	14	22.59	9.57			
11:55 am	15	22.60	9.57	1.41	399	
11:56 am	16	22.59	9.57			
11:57 am	17	22.60	9.57			
11:58 am	18	22.60	9.57			
11:59 am	19	22.60	9.57			
12:00 pm	20	22.60	9.57			
12:01 pm	21	22.59	9.57			
12:02 pm	22	22.60	9.57			
12:03 pm	23	22.60	9.57			Ponded water subsiding
12:04 pm	24	22.60	9.57	1.41	399	Water no longer flowing into
12:05 pm	25	22.63	9.57			well and piezometer
12:06 pm	26	22.62	9.57			
12:07 pm	27	22.62	9.57			
12:08 pm	28	22.62	9.57	1.41	399	
12:09 pm	29	22.58	9.57			
12:10 pm	30	22.59	9.57	1.41	399	Reduce rate
12:11 pm	1	21.71	9.57	1.08	350	Step 4
12:12 pm	2	21.69	9.57			
12:13 pm	3	21.70	9.57			
12:14 pm	4	21.68	9.57			
12:15 pm	5	21.68	9.57			
12:16 pm	6	21.69	9.57			
12:17 pm	7	21.70	9.57			
12:18 pm	8	21.69	9.57			
12:19 pm	9	21.69	9.57			
12:20 pm	10	21.69	9.57			
12:21 pm	11	21.70	9.57			
12:22 pm	12	21.70	9.57			
12:23 pm	13	21.70	9.57	1.08	350	Starting to rain & storm
12:24 pm	14	21.70	9.67			
12:25 pm	15	21.70	10.01			
12:26 pm	16	21.71	10.30			
12:27 pm	17	21.70	10.63			
12:28 pm	18	21.71	10.91			
12:29 pm	19	21.71	11.18			
12:30 pm	20	21.71	11.47	1.08	350	
12:31 pm	21	21.71	11.72			
12:32 pm	22	21.70	11.99			
12:33 pm	23	21.70	12.23			

WATER-LEVEL MEASUREMENTS
I-70 Well No. 12A (Concluded)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
12:34 pm	24	21.70	12.44			
12:35 pm	25	21.70	12.68			
12:36 pm	26	21.71	12.87			
12:37 pm	27	21.70	13.07			
12:38 pm	28	21.69	13.28			
12:39 pm	29	21.71	13.42			
12:40 pm	30	21.71	13.61	1.08	350	Reduce rate
12:41 pm	1	20.80	13.75	0.79	300	Step 5
12:42 pm	2	20.80	13.90			
12:43 pm	3	20.78	14.05			
12:44 pm	4	20.79	14.18			
12:45 pm	5	20.79	14.31			
12:46 pm	6	20.77	14.45			
12:47 pm	7	20.79	14.56			
12:48 pm	8	20.79	14.69	0.79	300	Raining harder
12:49 pm	9	20.78	14.80			
12:50 pm	10	20.78	14.91			
12:51 pm	11	20.78	15.03			
12:52 pm	12	20.78	15.11			
12:53 pm	13	20.77	15.24			
12:54 pm	14	20.78	15.35			
12:55 pm	15	20.77	15.45			
12:56 pm	16	20.77	15.53			
12:57 pm	17	20.78	15.65			
12:58 pm	18	20.77	15.70			
12:59 pm	19	20.77	15.81			
01:00 pm	20	20.78	15.87			
01:01 pm	21	20.77	15.94			
01:02 pm	22	20.77	16.02			
01:03 pm	23	20.76	16.09			
01:04 pm	24	20.78	16.11	0.79	300	
01:05 pm	25	20.78	16.15			
01:06 pm	26	20.77	16.22			
01:07 pm	27	20.77	16.27			
01:08 pm	28	20.77	16.32			
01:09 pm	29	20.78	16.35			
01:10 pm	30	20.78	16.40	0.79	300	End of step test

DEWATERING WELL DATA
Condition Assessment Step Test

	Well No. I-64 W8	Piezometer No. I-64 P8
Date Drilled:	4/21/75	1975
Casing		
Top elevation:	395.95	404.9
Diameter:	16-in. SS	2-in. PVC
Length (ft):	35.0	na
Screen		
Bottom elevation:	300.58	na
Diameter:	16-in. SS	2-in. PVC
Length (ft):	60.4	na
Slot size:	0.080-in.	na
Measuring Point Elevation:	396.7	404.9
Nonpumping Water Level		
Depth below temp. MP (ft):	19.58	-
Height of temp. MP (ft):	8.8	-
Depth below perm. MP (ft):	10.78	Plugged
Elevation:	395.92	-
Date of Step Test:	4/15/96	-
Water Sample		
Time:	1:46 pm	-
Temperature:	62.1°F	-
Laboratory No.:	229408	-
Distance and Direction to Piezometer from PW:		4.3 ft west
Time PW Off Before Step Test:		Not recorded

Notes: SWS 8-in. dia. orifice tube w/plate No. 4, manual data collection, sand tank not used
na-information not available

SWS Crew: R. Olson, E. Sanderson

WATER-LEVEL MEASUREMENTS
I-64 Well No. 8
Condition Assessment Step Test

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
04/15/96						
11:43 am	0	19.58				Dropline measurement
11:55 am	0	19.58				Hermit logging started
11:56 am	0	19.58				Water-level trend
11:57 am	0	19.57				Piezometer plugged
11:58 am	0	19.57				
11:59 am	0	19.57				
12:00 pm	0	19.58				
12:01 pm	0	19.57				
12:02 pm	0	19.57				
12:03 pm	0	19.57				
12:04 pm	0	19.57				
12:05 pm	0	19.57				
12:06 pm	0	19.57				
12:07 pm	0	19.57				
12:08 pm	0	19.57				
12:09 pm	0	19.57				
12:10 pm	0	19.57				
12:11 pm	0	19.57				
12:12 pm	0	19.57				
12:13 pm	0	19.57				
12:14 pm	0	19.57				
12:15 pm	0	19.57				
12:16 pm	0	19.57				
12:17 pm	0	19.57				
12:18 pm	0	19.57				
12:19 pm	0	19.57				
12:20 pm	0	19.57				Pump On
12:21 pm	1	20.60				Extremely low rate
12:22 pm	2	20.49				
12:23 pm	3	20.48				
12:24 pm	4	20.49				
12:25 pm	5	20.49				
12:26 pm	6	20.47				
12:27 pm	7	20.50				
12:28 pm	8	20.50				
12:29 pm	9	20.49				
12:30 pm	10	20.48				
12:31 pm	11	20.47				
12:32 pm	12	19.94				Pump Off
12:33 pm	0	19.56				Checking pump rotation
12:34 pm	0	19.59				
12:35 pm	0	19.59				
12:36 pm	0	19.59				

WATER-LEVEL MEASUREMENTS
I-64 Well No. 8 (Continued)

Hour	Time (min)	Adjusted depth to water in well (ft)	Adjusted depth to water in piezometer (ft)	Orifice tube piez. (ft)	Pumping rate (gpm)	Remarks
12:37 pm	0	19.59				
12:38 pm	0	19.58				
12:39 pm	0	19.58				
12:40 pm	0	20.53				Pump On
12:41 pm	1	26.64		1.70	435	Step 1; Max Q
12:42 pm	2	26.02				
12:43 pm	3	25.98		1.45		
12:44 pm	4	26.01		1.54		
12:45 pm	5	25.81		1.42	400	
12:46 pm	6	25.81				
12:47 pm	7	25.85		1.42	400	
12:48 pm	8	25.86				
12:49 pm	9	25.86				
12:50 pm	10	25.81				
12:51 pm	11	25.81				
12:52 pm	12	25.90				
12:53 pm	13	25.80				
12:54 pm	14	25.82		1.41	400	Adjust rate
12:55 pm	15	25.84		1.43	400	
12:56 pm	16	25.94				
12:57 pm	17	25.90				
12:58 pm	18	25.92				
12:59 pm	19	26.04				
01:00 pm	20	26.05				
01:01 pm	21	26.03		1.43	400	
01:02 pm	22	26.01				
01:03 pm	23	26.12				
01:04 pm	24	26.21				
01:05 pm	25	26.31				
01:06 pm	26	26.41				
01:07 pm	27	26.42				
01:08 pm	28	26.37		1.42	400	
01:09 pm	29	26.45				
01:10 pm	30	26.50		1.42	400	Reduce rate
01:11 pm	1	25.74		1.08	350	Step 2
01:12 pm	2	25.74				
01:13 pm	3	25.75		1.07		Adjust rate
01:14 pm	4	25.84		1.09	350	
01:15 pm	5	25.86				
01:16 pm	6	25.84				
01:17 pm	7	25.91				
01:18 pm	8	25.87				
01:19 pm	9	25.94		1.09	350	
01:20 pm	10	26.00				

WATER-LEVEL MEASUREMENTS
I-64 Well No. 8 (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
01:21 pm	11	26.03				
01:22 pm	12	26.05				
01:23 pm	13	26.06				
01:24 pm	14	26.08				
01:25 pm	15	26.07				
01:26 pm	16	26.02				
01:27 pm	17	25.99				
01:28 pm	18	26.01				
01:29 pm	19	26.13				
01:30 pm	20	26.13		1.08	350	
01:31 pm	21	26.04				
01:32 pm	22	26.14				
01:33 pm	23	26.13				
01:34 pm	24	26.09				
01:35 pm	25	26.13		1.08	350	
01:36 pm	26	26.10				
01:37 pm	27	26.21				
01:38 pm	28	26.11				
01:39 pm	29	26.21				
01:40 pm	30	26.27		1.09	350	Reduce rate
01:41 pm	1	25.52		0.79	300	Step 3
01:42 pm	2	25.50				
01:43 pm	3	25.42				
01:44 pm	4	25.49				
01:45 pm	5	25.42				
01:46 pm	6	25.54				Water sample collected,
01:47 pm	7	25.43				T=62.1°F
01:48 pm	8	25.54				
01:49 pm	9	25.43				
01:50 pm	10	25.55				BART samples collected
01:51 pm	11	25.45		0.79	300	
01:52 pm	12	25.57				
01:53 pm	13	25.49				
01:54 pm	14	25.45				
01:55 pm	15	25.55				
01:56 pm	16	25.55				
01:57 pm	17	25.49				
01:58 pm	18	25.59				
01:59 pm	19	25.49				
02:00 pm	20	25.55				
02:01 pm	21	25.61		0.79	300	
02:02 pm	22	25.51				
02:03 pm	23	25.54				
02:04 pm	24	25.63				

WATER-LEVEL MEASUREMENTS
I-64 Well No. 8 (Concluded)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
02:05 pm	25	25.61		0.79	300	
02:06 pm	26	25.63				
02:07 pm	27	25.55				
02:08 pm	28	25.55				
02:09 pm	29	25.55				
02:10 pm	30	25.57		0.79	300	End of step test

DEWATERING WELL DATA
Condition Assessment Step Test

	Well No. I-64 W9	Piezometer No. I-64 P9
Date Drilled:	4/17/75	1975
Casing		
Top elevation:	390.85	397.35
Diameter:	16-in. SS	2-in. PVC
Length (ft):	30.0	na
Screen		
Bottom elevation:	300.55	na
Diameter:	16-in. SS	2-in. PVC
Length (ft):	60	3
Slot size:	0.080-in.	na
Measuring Point Elevation:	391.4	397.0
Nonpumping Water Level		
Depth below temp. MP (ft):	8.88	-
Height of temp. MP (ft):	6.0	-
Depth below perm. MP (ft):	2.88	8.20
Elevation:	388.52	388.80
Date of Step Test:	8/18/94	-
Water Sample		
Time:	2:10 pm	-
Temperature:	59.2°F	-
Laboratory No.:	227956	-
Distance and Direction to Piezometer from PW:		4.6 ft south
Time PW Off Before Step Test:		Not recorded

Notes: SWS 8-in. dia. orifice tube w/plate No. 4
Omnidata datalogger w/ trasmitters
50-ft flexible hose, 1,000-gal portable tank
Very fine sand w/incrustation particles in tank following step test
Sand sample collected
na-information not available

SWS Crew: M. Anliker, E. Sanderson, R. Olson (part-time)

WATER-LEVEL MEASUREMENTS
I-64 Well No. 9
Condition Assessment Step Test

Hour	Time (min)	Adjusted depth to water in well (ft)	Adjusted depth to water in piezometer (ft)	Orifice tube piez. (ft)	Pumping rate (gpm)	Remarks
08/18/94						
12:35 pm	0		8.20			Dropline measurement
12:36 pm	0	8.88				Dropline measurement
12:51 pm	0	8.88	8.20			Onmidata logging started
12:52 pm	0	8.89	8.22			Water-level trend
12:53 pm	0	8.89	8.28			
12:54 pm	0	8.89	8.33			
12:55 pm	0	8.88	8.35			
12:56 pm	0	8.88	8.35			
12:57 pm	0	8.87	8.33			
12:58 pm	0	8.87	8.35			
12:59 pm	0	8.86	8.37			
01:00 pm	0	8.86	8.37			Pump On
01:01 pm	1	28.11	12.39	~2.0	470	Step 1; Max Q
01:02 pm	2	28.85	12.96			
01:03 pm	3	27.95	12.88	1.81	450	
01:04 pm	4	28.06	12.93			
01:05 pm	5	28.11	12.97			
01:06 pm	6	28.13	12.99	1.82	450	
01:07 pm	7	28.17	13.00			
01:08 pm	8	28.25	13.02			
01:09 pm	9	28.27	13.09			
01:10 pm	10	28.28	13.11			
01:11 pm	11	28.31	13.09			
01:12 pm	12	28.37	13.07	1.81	450	
01:13 pm	13	28.42	13.09			
01:14 pm	14	28.44	13.13			
01:15 pm	15	28.45	13.20			
01:16 pm	16	28.45	13.23			
01:17 pm	17	28.46	13.25			
01:18 pm	18	28.47	13.26			
01:19 pm	19	28.49	13.27	1.81	450	
01:20 pm	20	28.48	13.24			
01:21 pm	21	28.51	13.25			
01:22 pm	22	28.51	13.25			
01:23 pm	23	28.52	13.25			
01:24 pm	24	28.52	13.27			
01:25 pm	25	28.52	13.27			
01:26 pm	26	28.54	13.23			
01:27 pm	27	28.55	13.21			
01:28 pm	28	28.55	13.21			
01:29 pm	29	28.55	13.20	1.80	449	
01:30 pm	30	28.55	13.21			Reduce rate
01:31 pm	1	26.59	12.89	1.42	400	Step 2

WATER-LEVEL MEASUREMENTS
I-64 Well No. 9 (Continued)

Hour	Time (min)	Adjusted depth to water in well (ft)	Adjusted depth to water in piezometer (ft)	Orifice tube piez. (ft)	Pumping rate (gpm)	Remarks
01:32 pm	2	26.48	12.84			
01:33 pm	3	26.47	12.81			
01:34 pm	4	26.47	12.79	1.42	400	
01:35 pm	5	26.45	12.81			
01:36 pm	6	26.42	12.79			
01:37 pm	7	26.41	12.75			
01:38 pm	8	26.42	12.74			
01:39 pm	9	26.42	12.74	1.42	400	
01:40 pm	10	26.43	12.76			
01:41 pm	11	26.43	12.79			
01:42 pm	12	26.42	12.80			
01:43 pm	13	26.42	12.78			
01:44 pm	14	26.42	12.78			
01:45 pm	15	26.43	12.79			
01:46 pm	16	26.44	12.80			
01:47 pm	17	26.44	12.84	1.42	400	
01:48 pm	18	26.43	12.81			
01:49 pm	19	26.44	12.79			
01:50 pm	20	26.44	12.78			
01:51 pm	21	26.44	12.81			
01:52 pm	22	26.44	12.77			
01:53 pm	23	26.44	12.78			
01:54 pm	24	26.44	12.78			
01:55 pm	25	26.47	12.79	1.42	400	
01:56 pm	26	26.46	12.79			
01:57 pm	27	26.47	12.78			
01:58 pm	28	26.46	12.75			
01:59 pm	29	26.47	12.77			
02:00 pm	30	26.47	12.82	1.42	400	Reduce rate
02:01 pm	1	24.42	12.42	1.09	350	Step 3
02:02 pm	2	24.42	12.36			
02:03 pm	3	24.43	12.36			
02:04 pm	4	24.43	12.35			
02:05 pm	5	24.44	12.35	1.10	352	Adjust rate
02:06 pm	6	24.43	12.32			
02:07 pm	7	24.42	12.32			
02:08 pm	8	24.43	12.33			
02:09 pm	9	24.42	12.32	1.09	350	
02:10 pm	10	24.43	12.28			Water sample collected,
02:11 pm	11	24.45	12.30			T=59.2°F
02:12 pm	12	24.45	12.30			BART samples collected
02:13 pm	13	24.45	12.34			
02:14 pm	14	24.44	12.36			
02:15 pm	15	24.44	12.34			
02:16 pm	16	24.40	12.31	1.09	350	

WATER-LEVEL MEASUREMENTS
I-64 Well No. 9 (Concluded)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
02:17 pm	17	24.39	12.29			
02:18 pm	18	24.40	12.31			
02:19 pm	19	24.41	12.35			
02:20 pm	20	24.40	12.38			
02:21 pm	21	24.41	12.33			
02:22 pm	22	24.41	12.32			
02:23 pm	23	24.41	12.34			
02:24 pm	24	24.40	12.30	1.10	352	
02:25 pm	25	24.39	12.29			
02:26 pm	26	24.40	12.29			
02:27 pm	27	24.42	12.33			
02:28 pm	28	24.41	12.33			
02:29 pm	29	24.41	12.32	1.10	352	
02:30 pm	30	24.42	12.31			Reduce rate
02:31 pm	1	22.41	11.91	0.79	300	Step 4
02:32 pm	2	22.26	11.84			
02:33 pm	3	22.24	11.81			
02:34 pm	4	22.23	11.79			
02:35 pm	5	22.22	11.79			
02:36 pm	6	22.23	11.81	0.79	300	
02:37 pm	7	22.22	11.81			
02:38 pm	8	22.21	11.78			
02:39 pm	9	22.21	11.78			
02:40 pm	10	22.22	11.80			
02:41 pm	11	22.21	11.86			
02:42 pm	12	22.21	11.84			
02:43 pm	13	22.20	11.78			
02:44 pm	14	22.21	11.75	0.79	300	
02:45 pm	15	22.22	11.73			
02:46 pm	16	22.22	11.75			
02:47 pm	17	22.21	11.78			
02:48 pm	18	22.20	11.77			
02:49 pm	19	22.19	11.76	0.79	300	
02:50 pm	20	22.20	11.76			
02:51 pm	21	22.19	11.76			
02:52 pm	22	22.20	11.77			
02:53 pm	23	22.19	11.74			
02:54 pm	24	22.19	11.72			
02:55 pm	25	22.19	11.73			
02:56 pm	26	22.20	11.77	0.79	300	
02:57 pm	27	22.19	11.75			
02:58 pm	28	22.19	11.72			
02:59 pm	29	22.19	11.73	0.79	300	
03:00 pm	30	22.19	11.74			End of step test

DEWATERING WELL DATA
Condition Assessment Step Test

	Well No. Venice W2	Piezometer No. Venice P2
Date Drilled:	1982	1982
Casing		
Top elevation:	405.3	410.3
Diameter:	16-in. SS	2-in. PVC
Length (ft):	28.9	na
Screen		
Bottom elevation:	325.5	na
Diameter:	16-in. SS	2-in. PVC
Length (ft):	50.9	3
Slot size:	0.080-in.	na
Measuring Point Elevation:	405.55	410.30
Nonpumping Water Level		
Depth below temp. MP (ft):	18.64	-
Height of temp. MP (ft):	5.4	-
Depth below perm. MP (ft):	13.24	18.06
Elevation:	392.31	392.24
Date of Step Test:	6/21/94	-
Water Sample		
Time:	3:08 pm	-
Temperature:	58.6°F	-
Laboratory No.:	227790	-
Distance and Direction to Piezometer from PW:		6.1 ft west
Time PW Off Before Step Test:		Not recorded

Notes: SWS 8-in. dia. orifice tube w/plate No. 4; 1,000-gal portable settling tank; 50-ft 6-in. dia. flexible hose
Omnidata datalogger w/transmitters
No sand in tank following step test
na-information not available

SWS Crew: R. Olson, M. Anliker

WATER-LEVEL MEASUREMENTS
Venice Well No. 2
Condition Assessment Step Test

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
06/21/94						
01:26 pm	0	18.64				Dropline measurement
01:28 pm	0		18.06			Dropline measurement
01:41 pm	0	18.64	18.06			Omnidata logging started
01:42 pm	0	18.64	18.05			Water-level trend
01:43 pm	0	18.64	18.04			
01:44 pm	0	18.64				Piezometer transmitter not
01:45 pm	0	18.64				secure; readings not reliable
01:46 pm	0	18.64				
01:47 pm	0	18.64				
01:48 pm	0	18.64				
01:49 pm	0	18.64				
01:50 pm	0	18.64				
01:51 pm	0	18.64				
01:52 pm	0	18.64				
01:53 pm	0	18.63				
01:54 pm	0	18.63				
01:55 pm	0	18.64				
01:56 pm	0	18.64				
01:57 pm	0	18.63				
01:58 pm	0	18.64				
01:59 pm	0	18.64				
02:00 pm	0	20.47				Pump On
02:01 pm	1	27.97		5.00	745	Step 1; Max Q
02:02 pm	2	27.88		4.41	700	
02:03 pm	3	28.05				
02:04 pm	4	28.20				
02:05 pm	5	28.29				
02:06 pm	6	28.37				
02:07 pm	7	28.41		4.40		Adjust rate
02:08 pm	8	28.48		4.41	700	
02:09 pm	9	28.52				
02:10 pm	10	28.56				
02:11 pm	11	28.60				
02:12 pm	12	28.64				
	12.5		23.07			Dropline measurement
02:13 pm	13	28.67	23.07			Piezometer readings adjusted
02:14 pm	14	28.70	23.10			for slippage of transmitter
02:15 pm	15	28.72	23.12			
02:16 pm	16	28.77	23.15	4.41	700	
02:17 pm	17	28.78	23.17			
02:18 pm	18	28.80	23.20			
02:19 pm	19	28.82	23.22			
02:20 pm	20	28.84	23.24			

WATER-LEVEL MEASUREMENTS
Venice Well No. 2 (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
02:21 pm	21	28.86	23.26			
02:22 pm	22	28.87	23.27			
02:23 pm	23	28.88	23.29			
02:24 pm	24	28.90	23.30			
02:25 pm	25	28.92	23.32	4.41	700	
02:26 pm	26	28.93	23.33			
02:27 pm	27	28.95	23.35			
02:28 pm	28	28.97	23.37			
02:29 pm	29	28.98	23.38			
02:30 pm	30	28.99	23.39	4.41	700	Reduce rate
02:31 pm	1	28.42	23.16	3.80	650	Step 2
02:32 pm	2	28.40	23.14			
02:33 pm	3	28.39	23.13			
02:34 pm	4	28.39	23.13	3.80	650	
02:35 pm	5	28.39	23.14			
02:36 pm	6	28.40	23.14			
02:37 pm	7	28.40	23.15			
02:38 pm	8	28.41	23.15			
02:39 pm	9	28.42	23.16			
02:40 pm	10	28.43	23.17			
02:41 pm	11	28.43	23.17	3.79		Adjust rate
02:42 pm	12	28.46	23.19	3.80	650	
02:43 pm	13	28.45	23.19			
02:44 pm	14	28.45	23.19			
02:45 pm	15	28.46	23.19			
02:46 pm	16	28.46	23.20			
02:47 pm	17	28.48	23.21			
02:48 pm	18	28.48	23.21			
02:49 pm	19	28.49	23.22			
02:50 pm	20	28.50	23.23	3.80	650	
02:51 pm	21	28.51	23.23			
02:52 pm	22	28.51	23.24			
02:53 pm	23	28.52	23.24			
02:54 pm	24	28.52	23.25			
02:55 pm	25	28.52	23.26			
02:56 pm	26	28.52	23.26	3.79	650	
02:57 pm	27	28.53	23.26			
02:58 pm	28	28.55	23.27			
02:59 pm	29	28.55	23.27			
03:00 pm	30	28.55	23.28			Reduce rate
03:01 pm	1	27.96	23.03	3.23	600	Step 3
03:02 pm	2	27.93	23.00			
03:03 pm	3	27.91	22.99			
03:04 pm	4	27.92	22.99			

WATER-LEVEL MEASUREMENTS
Venice Well No. 2 (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
03:05 pm	5	27.91	22.98			
03:06 pm	6	27.92	22.99			
03:07 pm	7	27.91	22.98			
03:08 pm	8	27.92	22.98			Water sample collected
03:09 pm	9	27.92	22.99	3.23	600	T=58.6°F
03:10 pm	10	27.92	22.99			
03:11 pm	11	27.93	22.99			
03:12 pm	12	27.93	22.99			
03:13 pm	13	27.93	22.99			
03:14 pm	14	27.93	22.99			
03:15 pm	15	27.93	22.99			
03:16 pm	16	27.94	23.00	3.23	600	
03:17 pm	17	27.94	23.00			
03:18 pm	18	27.94	23.00			
03:19 pm	19	27.95	23.00			
03:20 pm	20	27.94	23.01			
03:21 pm	21	27.95	23.01			
03:22 pm	22	27.95	23.01	3.23	600	
03:23 pm	23	27.95	23.01			
03:24 pm	24	27.95	23.01			
03:25 pm	25	27.95	23.01			
03:26 pm	26	27.95	23.01			
03:27 pm	27	27.97	23.02			
03:28 pm	28	27.96	23.01			
03:29 pm	29	27.97	23.02	3.23	600	
03:30 pm	30	27.97	23.02			Reduce rate
03:31 pm	1	27.38	22.76			Step 4
03:32 pm	2	27.36	22.74	2.70	550	
03:33 pm	3	27.34	22.72			
03:34 pm	4	27.34	22.71			
03:35 pm	5	27.33	22.70			
03:36 pm	6	27.33	22.70			
03:37 pm	7	27.31	22.69			
03:38 pm	8	27.32	22.69			
03:39 pm	9	27.31	22.68			
03:40 pm	10	27.31	22.68	2.70	550	BART samples collected
03:41 pm	11	27.31	22.68			
03:42 pm	12	27.31	22.68			
03:43 pm	13	27.31	22.68			
03:44 pm	14	27.32	22.68			
03:45 pm	15	27.31	22.68			
03:46 pm	16	27.31	22.67			
03:47 pm	17	27.32	22.67			
03:48 pm	18	27.31	22.68	2.70	550	

WATER-LEVEL MEASUREMENTS
Venice Well No. 2 (Concluded)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
03:49 pm	19	27.32	22.67			
03:50 pm	20	27.31	22.67			
03:51 pm	21	27.31	22.67			
03:52 pm	22	27.32	22.67			
03:53 pm	23	27.32	22.67			
03:54 pm	24	27.32	22.67			
03:55 pm	25	27.32	22.67			
03:56 pm	26	27.33	22.67	2.70	550	
03:57 pm	27	27.32	22.67			
03:58 pm	28	27.32	22.67			
03:59 pm	29	27.31	22.67			
04:00 pm	30	27.33	22.67	2.70	550	Reduce rate
04:01 pm	1	26.73	22.42	2.23	500	Step 5
04:02 pm	2	26.70	22.39			
04:03 pm	3	26.69	22.37			
04:04 pm	4	26.68	22.36			
04:05 pm	5	26.68	22.35			
04:06 pm	6	26.67	22.34			
04:07 pm	7	26.66	22.33			
04:08 pm	8	26.66	22.33	2.23	500	
04:09 pm	9	26.68	22.34			
04:10 pm	10	26.67	22.32			
04:11 pm	11	26.67	22.32			
04:12 pm	12	26.67	22.32			
04:13 pm	13	26.67	22.32			
04:14 pm	14	26.66	22.32	2.23	500	
04:15 pm	15	26.67	22.32			
04:16 pm	16	26.67	22.31			
04:17 pm	17	26.67	22.31			
04:18 pm	18	26.66	22.31			
04:19 pm	19	26.67	22.31			
04:20 pm	20	26.66	22.31			
04:20 pm	20		22.39			Dropline measurement
04:21 pm	21	26.64				Dropline measurement
04:21 pm	21	26.66	22.31			
04:22 pm	22	26.66	22.30	2.23	500	
04:23 pm	23	26.66	22.31			
04:24 pm	24	26.66	22.31			
04:25 pm	25	26.66	22.31	2.25	502	
04:26 pm	26	26.67	22.31			
04:27 pm	27	26.66	22.31			
04:28 pm	28	26.66	22.30			
04:29 pm	29	26.65	22.30			
04:30 pm	30	26.66	22.30	2.25	502	End of step test

DEWATERING WELL DATA
Condition Assessment Step Test

	Well No. Venice W3	Piezometer No. Venice P3B
Date Drilled:	1982	1990
Casing		
Top elevation:	402.3	408.4
Diameter:	16-in. SS	2-in. PVC
Length (ft):	26.7	na
Screen		
Bottom elevation:	324.7	na
Diameter:	16-in. SS	2-in. PVC
Length (ft):	50.9	3
Slot size:	na	na
Measuring Point Elevation:	402.55	408.4
Nonpumping Water Level		
Depth below temp. MP (ft):	17.03	-
Height of temp. MP (ft):	6.0	-
Depth below perm. MP (ft):	11.03	15.49
Elevation:	391.52	392.91
Date of Step Test:	7/1/94	-
Water Sample		
Time:	10:57 am	-
Temperature:	59.4°F	-
Laboratory No.:	227791	-
Distance and Direction to Piezometer from PW:		7.1 ft east
Time PW Off Before Step Test:		Not recorded

Notes: SWS 8-in. dia. orifice tube w/plate No. 4; 1,000-gal portable tank; 50-ft 6-in. dia. flexible hose
Omnidata datalogger w/transmitters
Very little sand (<1 Tbs) in tank following step test
No sample collected
na-information not available

SWS Crew: R. Olson, E. Sanderson

WATER-LEVEL MEASUREMENTS
Venice Well No. 3
Condition Assessment Step Test

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
07/01/94						
08:59 am	0	17.03				Dropline measurement
09:03 am	0		15.49			Dropline measurement
09:16 am	0	17.03	15.49			Omnidata logging started
09:17 am	0	17.03	15.49			Water-level trend
09:18 am	0	17.03	15.48			
09:19 am	0	17.03	15.48			
09:20 am	0	17.03	15.48			
09:21 am	0	17.03	15.48			
09:22 am	0	17.03	15.48			
09:23 am	0	17.03	15.48			
09:24 am	0	17.03	15.48			
09:25 am	0	17.03	15.48			
09:26 am	0	17.02	15.48			
09:27 am	0	17.03	15.48			
09:28 am	0	17.03	15.48			
09:29 am	0	17.03	15.48			
09:30 am	0	17.03	15.48			Pump On
09:31 am	1	27.80	19.89	5.26	760	Step 1; Max Q
09:32 am	2	27.41	19.87	5.09		
09:33 am	3	27.56	19.96			
09:34 am	4	27.69	20.06	5.08	750	
09:35 am	5	27.80	20.13			
09:36 am	6	27.85	20.16			
09:37 am	7	27.91	20.22			
09:38 am	8	27.96	20.25			
09:39 am	9	28.00	20.28			
09:40 am	10	28.02	20.30			
09:41 am	11	28.06	20.34			
09:42 am	12	28.09	20.36	5.05		Adjust rate
09:43 am	13	28.17	20.40	5.09	750	
09:44 am	14	28.18	20.41			
09:45 am	15	28.21	20.43			
09:46 am	16	28.22	20.45			
09:47 am	17	28.24	20.45	5.08	750	
09:48 am	18	28.26	20.48			
09:49 am	19	28.28	20.49			
09:50 am	20	28.30	20.51			
09:51 am	21	28.30	20.51			
09:52 am	22	28.33	20.52			
09:53 am	23	28.33	20.54			
09:54 am	24	28.35	20.55	5.08	750	
09:55 am	25	28.37	20.56			

WATER-LEVEL MEASUREMENTS
Venice Well No. 3 (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
09:56 am	26	28.38	20.58			
09:57 am	27	28.39	20.59			
09:58 am	28	28.41	20.60			
09:59 am	29	28.43	20.61			
10:00 am	30	28.43	20.62	5.08	750	Reduce rate
10:01 am	1	27.75	20.36	4.42	700	Step 2
10:02 am	2	27.74	20.35			
10:03 am	3	27.74	20.35			
10:04 am	4	27.74	20.35	4.42	700	
10:05 am	5	27.74	20.35			
10:06 am	6	27.75	20.36			
10:07 am	7	27.76	20.37			
10:08 am	8	27.77	20.37			
10:09 am	9	27.77	20.38			
10:10 am	10	27.79	20.39			
10:11 am	11	27.79	20.39	4.41	700	
10:12 am	12	27.80	20.40			
10:13 am	13	27.80	20.40			
10:14 am	14	27.81	20.41	4.41	700	
10:15 am	15	27.82	20.42			
10:16 am	16	27.82	20.42			
10:17 am	17	27.82	20.42			
10:18 am	18	27.83	20.43			
10:19 am	19	27.84	20.43	4.41	700	
10:20 am	20	27.84	20.44			
10:21 am	21	27.85	20.44			
10:22 am	22	27.85	20.45			
10:23 am	23	27.86	20.45			
10:24 am	24	27.87	20.46	4.41	700	
10:25 am	25	27.87	20.46			
10:26 am	26	27.88	20.46			
10:27 am	27	27.88	20.47			
10:28 am	28	27.88	20.47			
10:29 am	29	27.89	20.48			
10:30 am	30	27.89	20.48	4.41	700	Reduce rate
10:31 am	1	27.22	20.22	3.80	650	Step 3
10:32 am	2	27.21	20.21			
10:33 am	3	27.20	20.21			
10:34 am	4	27.20	20.20			
10:35 am	5	27.19	20.20			
10:36 am	6	27.19	20.20			
10:37 am	7	27.19	20.20			
10:38 am	8	27.20	20.21			

WATER-LEVEL MEASUREMENTS
Venice Well No. 3 (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
10:39 am	9	27.20	20.21	3.79	650	
10:40 am	10	27.21	20.21	3.80	650	
10:41 am	11	27.22	20.22			
10:42 am	12	27.23	20.22			
10:43 am	13	27.23	20.22			
10:44 am	14	27.23	20.22			
10:45 am	15	27.23	20.23			
10:46 am	16	27.24	20.23			
10:47 am	17	27.23	20.23			
10:48 am	18	27.23	20.23			
10:49 am	19	27.24	20.23			
10:50 am	20	27.24	20.24			
10:51 am	21	27.24	20.24	3.80	650	
10:52 am	22	27.24	20.24			
10:53 am	23	27.24	20.24			
10:54 am	24	27.25	20.24			
10:55 am	25	27.25	20.25			
10:56 am	26	27.25	20.25			
10:57 am	27	27.26	20.25			Water sample collected,
10:58 am	28	27.26	20.25			T=59.4°F
10:59 am	29	27.26	20.25			
11:00 am	30	27.26	20.25	3.80	650	Reduce rate
11:01 am	1	26.58	19.99	3.23	600	Step 4
11:02 am	2	26.57	19.98			
11:03 am	3	26.56	19.97			
11:04 am	4	26.55	19.96			
11:05 am	5	26.54	19.96			
11:06 am	6	26.54	19.96			
11:07 am	7	26.56	19.96	3.23	600	
11:08 am	8	26.56	19.96			
11:09 am	9	26.56	19.97			
11:10 am	10	26.56	19.97			
11:11 am	11	26.56	19.97			
11:12 am	12	26.56	19.97			
11:13 am	13	26.57	19.97	3.22	600	BART samples collected
11:14 am	14	26.56	19.97			
11:15 am	15	26.56	19.97			
11:16 am	16	26.53	19.96			
11:17 am	17	26.54	19.96			
11:18 am	18	26.54	19.96			
11:19 am	19	26.54	19.96			
11:20 am	20	26.54	19.96			
11:21 am	21	26.54	19.96			

WATER-LEVEL MEASUREMENTS
Venice Well No. 3 (Concluded)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
11:22 am	22	26.54	19.96			
11:23 am	23	26.54	19.96			
11:24 am	24	26.54	19.96			
11:25 am	25	26.54	19.96	3.23	600	
11:26 am	26	26.54	19.96			
11:27 am	27	26.55	19.97			
11:28 am	28	26.55	19.97			
11:29 am	29	26.55	19.97			
11:30 am	30	26.55	19.97	3.23	600	Reduce rate
11:31 am	1	25.86	19.69	2.69		Step 5
11:32 am	2	25.86	19.70	2.70	550	
11:33 am	3	25.85	19.68			
11:34 am	4	25.85	19.68			
11:35 am	5	25.85	19.68			
11:36 am	6	25.84	19.68			
11:37 am	7	25.84	19.68			
11:38 am	8	25.84	19.68			
11:39 am	9	25.83	19.67			
11:40 am	10	25.84	19.67			
11:41 am	11	25.83	19.67			
11:42 am	12	25.84	19.67			
11:43 am	13	25.83	19.67			
11:44 am	14	25.83	19.65			
11:45 am	15	25.83	19.67	2.70	550	
11:46 am	16	25.83	19.67			
11:47 am	17	25.83	19.67			
11:48 am	18	25.83	19.67			
11:49 am	19	25.83	19.67			
11:50 am	20	25.83	19.67			
11:51 am	21	25.84	19.67			
11:52 am	22	25.83	19.67			
11:53 am	23	25.84	19.67			
11:54 am	24	25.83	19.67			
11:55 am	25	25.83	19.67	2.69	550	
11:56 am	26	25.83	19.67			
11:57 am	27	25.84	19.67			
11:58 am	28	25.84	19.67			
11:59 am	29	25.83	19.67			
12:00 pm	30	25.83	19.66	2.69	550	End of step test

DEWATERING WELL DATA
Condition Assessment Step Test

	Well No. Venice W4	Piezometer No. Venice P4
Date Drilled:	1982	1982
Casing		
Top elevation:	402.8	407.93
Diameter:	16-in. SS	2-in. PVC
Length (ft):	24.4	na
Screen		
Bottom elevation:	327.5	na
Diameter:	16-in. SS	2-in. PVC
Length (ft):	50.9	3
Slot size:	na	na
Measuring Point Elevation:	403.05	407.93
Nonpumping Water Level		
Depth below temp. MP (ft):	11.13	-
Height of temp. MP (ft):	5.0	-
Depth below perm. MP (ft):	6.13	11.36
Elevation:	396.92	396.57
Date of Step Test:	5/11/94	-
Water Sample		
Time:	3:36 pm	-
Temperature:	59.0°F	-
Laboratory No.:	227661	-
Distance and Direction to Piezometer from PW:		7.6 ft west
Time PW Off Before Step Test:		Not recorded

Notes: SWS 8-in. dia. orifice tube w/plate No. 4; 50-ft 6-in. diameter hose
1,000-gal settling tank
Sand sample collected from tank following step test
Water level data collected w/Omnidata datalogger
na-information not available

SWS Crew: R. Olson, M. Anliker

WATER-LEVEL MEASUREMENTS
Venice Well No. 4
Condition Assessment Step Test

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
05/11/94						
12:34 pm	0	11.13				Dropline measurement
12:35 pm	0		11.36			Dropline measurement
12:57 pm	0	11.13	11.36			Omnidata logging started
12:58 pm	0	11.13	11.43			Water-level trend
12:59 pm	0	11.13	11.45			
01:00 pm	0	11.14	11.50			
01:01 pm	0	11.12	11.49			
01:02 pm	0	11.13	11.51			
01:03 pm	0	11.13	11.56			
01:04 pm	0	11.12	11.55			
01:05 pm	0	11.13	11.56			
01:06 pm	0	11.13	11.60			
01:07 pm	0	11.12	11.60			
01:08 pm	0	11.12	11.58			
01:09 pm	0	11.13	11.57			
01:10 pm	0	11.12	11.58			
01:11 pm	0	11.12	11.58			
01:12 pm	0	11.12	11.55			
01:13 pm	0	13.74	12.73			
01:14 pm	0	11.13	11.62			
01:15 pm	0	11.15	11.66			Pump On
01:16 pm	1	17.86	11.77			Pump Off; Orifice tube turned over
01:17 pm	0	11.29	11.72			
01:18 pm	0	11.02	11.74			
01:19 pm	0	11.19	11.73			
01:20 pm	0	11.18	11.72			
01:21 pm	0	11.17	11.70			
01:22 pm	0	11.16	11.75			
01:23 pm	0	11.15	11.77			
01:24 pm	0	11.15	11.78			
01:25 pm	0	11.15	11.78			
01:26 pm	0	11.14	11.77			
01:27 pm	0	11.15	12.85			
01:28 pm	0	11.14	11.58			
01:29 pm	0	11.13	11.60			
01:30 pm	0	11.13	11.62			
01:31 pm	0	11.13	11.69			
01:32 pm	0	11.14	11.70			
01:33 pm	0	11.13	11.74			
01:34 pm	0	11.12	11.62			
01:35 pm	0	11.13	11.67			
01:36 pm	0	11.13	11.71			

WATER-LEVEL MEASUREMENTS
Venice Well No. 4 (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
01:37 pm	0	11.12	11.67			
01:38 pm	0	11.12	11.67			
01:39 pm	0	11.12	11.67			
01:40 pm	0	11.12	11.70			
01:41 pm	0	11.12	11.73			
01:42 pm	0	11.12	11.72			
01:43 pm	0	11.12	11.72			
01:44 pm	0	11.12	11.69			
01:45 pm	0	11.12	11.67			
01:46 pm	0	11.11	11.66			
01:47 pm	0	11.12	11.66			
01:48 pm	0	11.11	11.67			
01:49 pm	0	11.11	11.67			
01:50 pm	0	11.09	11.58			
01:51 pm	0	11.10	11.45			
01:52 pm	0	11.12	11.50			
01:53 pm	0	11.12	11.65			
01:54 pm	0	11.11	11.72			
01:55 pm	0	11.11	11.75			
01:56 pm	0	11.11	11.75			
01:57 pm	0	11.10	11.70			
01:58 pm	0	11.10	11.65			
01:59 pm	0	11.11	11.61			
02:00 pm	0	11.10	11.68	5.28	760	Pump On
02:01 pm	1	26.72	11.79	5.08	750	
02:02 pm	2	26.86	11.86			
02:03 pm	3	26.96	11.93			
02:04 pm	4	27.10	12.02	5.04		Adjust rate
02:05 pm	5	27.18	12.07	5.08	750	
02:06 pm	6	27.24	12.12	5.06		Adjust rate
02:07 pm	7	27.31	12.16	5.08	750	
02:08 pm	8	27.37	12.22			
02:09 pm	9	27.43	12.31	5.08	750	
02:10 pm	10	27.47	12.35			
02:11 pm	11	27.49	12.35			
02:12 pm	12	27.53	12.40			
02:13 pm	13	27.58	12.50			
02:14 pm	14	27.61	12.59	5.08	750	
02:15 pm	15	27.65	12.64			
02:16 pm	16	27.66	12.71			
02:17 pm	17	27.69	12.75	5.08	750	
02:18 pm	18	27.71	12.77			
02:19 pm	19	27.71	12.83			
02:20 pm	20	27.74	12.88	5.08	750	

WATER-LEVEL MEASUREMENTS
Venice Well No. 4 (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
02:21 pm	21	27.76	12.91			
02:22 pm	22	27.78	12.96			
02:23 pm	23	27.80	12.96			
02:24 pm	24	27.83	12.99	5.08	750	
02:25 pm	25	27.85	13.06			
02:26 pm	26	27.84	13.11			
02:27 pm	27	27.87	13.14			
02:28 pm	28	27.88	13.19	5.06		
02:29 pm	29	27.90	13.25			
02:30 pm	30	27.90	13.30	5.06		Reduce rate
02:31 pm	1	26.86	13.34	4.41	700	Step 2
02:32 pm	2	26.82	13.36			
02:33 pm	3	26.83	13.38	4.41	700	
02:34 pm	4	26.85	13.41	4.41	700	Train passing
02:35 pm	5	26.85	13.48			
02:36 pm	6	26.86	13.54			Piezometer partially plugged;
02:37 pm	7	26.87	13.56			note water levels still
02:38 pm	8	26.88	13.55	4.41	700	declining
02:39 pm	9	26.90	13.58			
02:40 pm	10	26.92	13.57			
02:41 pm	11	26.94	13.60			
02:42 pm	12	26.95	13.64			
02:43 pm	13	26.94	13.68			
02:44 pm	14	26.94	13.68			
02:45 pm	15	26.95	13.67	4.41	700	
02:46 pm	16	26.96	13.71			
02:47 pm	17	26.99	13.73			
02:48 pm	18	26.99	13.79			
02:49 pm	19	27.00	13.83			
02:50 pm	20	26.99	13.88	4.41	700	
02:51 pm	21	27.02	13.90			
02:52 pm	22	27.00	13.95			
02:53 pm	23	27.02	13.97	4.41	700	
02:54 pm	24	27.02	14.00			
02:55 pm	25	27.05	14.07			
02:56 pm	26	27.04	14.07			
02:57 pm	27	27.05	14.09			
02:58 pm	28	27.06	14.07			
02:59 pm	29	27.06	14.10	4.41	700	
03:00 pm	30	27.07	14.12			Reduce rate
03:01 pm	1	25.99	14.13	3.80	650	Step 3
03:02 pm	2	25.96	14.18			
03:03 pm	3	25.95	14.19			
03:04 pm	4	25.98	14.19			

WATER-LEVEL MEASUREMENTS
Venice Well No. 4 (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
03:05 pm	5	25.99	14.21			Piezometer partially plugged;
03:06 pm	6	25.96	14.23	3.80	650	note water levels still
03:07 pm	7	25.99	14.26			declining
03:08 pm	8	25.98	14.26			
03:09 pm	9	25.98	14.27			
03:10 pm	10	25.98	14.27			
03:11 pm	11	25.97	14.26			
03:12 pm	12	25.99	14.31			
03:13 pm	13	25.99	14.34	3.80	650	
03:14 pm	14	26.01	14.41			
03:15 pm	15	25.99	14.42			
03:16 pm	16	26.01	14.44			
03:17 pm	17	26.00	14.46			
03:18 pm	18	26.00	14.50			
03:19 pm	19	26.02	14.53			
03:20 pm	20	25.99	14.57	3.80	650	
03:21 pm	21	26.01	14.56			
03:22 pm	22	26.00	14.52			
03:23 pm	23	26.01	14.53			
03:24 pm	24	26.02	14.56			
03:25 pm	25	26.05	14.56			
03:26 pm	26	26.03	14.59	3.80	650	
03:27 pm	27	26.03	14.62			
03:28 pm	28	26.04	14.65			
03:29 pm	29	26.06	14.65			
03:30 pm	30	26.07	14.68	3.80	650	Reduce rate
03:31 pm	1	24.92	14.70			Step 4
03:32 pm	2	24.93	14.69	3.23	600	
03:33 pm	3	24.93	14.68			
03:34 pm	4	24.93	14.67			
03:35 pm	5	24.93	14.67			
03:36 pm	6	24.94	14.67	3.23	600	Water sample collected,
03:37 pm	7	24.94	14.70			T=59.0°F
03:38 pm	8	24.96	14.74			
03:39 pm	9	24.95	14.75			
03:40 pm	10	24.97	14.76			Piezometer partially plugged;
03:41 pm	11	24.96	14.76			note water levels still
03:42 pm	12	24.96	14.78			declining
03:43 pm	13	24.96	14.80			
03:44 pm	14	24.93	14.77			
03:45 pm	15	24.97	14.75			
03:46 pm	16	24.98	14.82	3.22		
03:47 pm	17	24.99	14.88	3.23	600	
03:48 pm	18	24.99	14.92			

WATER-LEVEL MEASUREMENTS
Venice Well No. 4 (Concluded)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
03:49 pm	19	24.98	14.93			
03:50 pm	20	25.01	14.93	3.23	600	BART samples collected
03:51 pm	21	25.01	14.93			
03:52 pm	22	25.00	14.92	3.23	600	
03:53 pm	23	24.99	14.96			
03:54 pm	24	25.02	15.00			
03:55 pm	25	24.99	15.01			
03:56 pm	26	25.01	14.99			
03:57 pm	27	25.00	14.99			
03:58 pm	28	24.98	14.99	3.23	600	
03:59 pm	29	24.99	14.88			
04:00 pm	30	25.00	14.88	3.23	600	Reduce rate
04:01 pm	1	23.88	14.96			Step 5
04:02 pm	2	23.87	14.99	2.70	550	
04:03 pm	3	23.87	14.93			
04:04 pm	4	23.89	14.90			
	4	23.51				Dropline measurement
04:05 pm	5	23.91	14.92			(through 3-in hole)
04:06 pm	6	23.90	14.97			
04:07 pm	7	23.90	14.96	2.70	550	
04:08 pm	8	23.89	14.96			
	8		14.72			Dropline measurement
04:09 pm	9	23.90	15.02			
04:10 pm	10	23.91	15.12	2.70	550	
04:11 pm	11	23.90	15.18			
04:12 pm	12	23.90	15.20			
04:13 pm	13	23.90	15.15			
04:14 pm	14	23.91	15.15			
04:15 pm	15	23.94	15.22			
04:16 pm	16	23.92	15.25	2.70	550	
04:17 pm	17	23.91	15.23			
04:18 pm	18	23.91	15.22			
04:19 pm	19	23.91	15.20			
04:20 pm	20	23.89	15.18			
04:21 pm	21	23.90	15.20			
04:22 pm	22	23.91	15.17	2.70	550	
04:23 pm	23	23.92	15.18			
04:24 pm	24	23.93	15.19			
04:25 pm	25	23.92	15.15			
04:26 pm	26	23.91	15.17			
04:27 pm	27	23.91	15.12	2.70	550	
04:28 pm	28	23.93	15.10			
04:29 pm	29	23.92	15.09			
04:30 pm	30	23.93	15.08			End of step test

DEWATERING WELL DATA
Initial Step Test

	Well No. MO Ave. W1	Piezometer No. -
Date Drilled:	1993	
Casing		
Top elevation:	408.72	
Diameter:	12-in.	
Length (ft):	34.7	
Screen		
Bottom elevation:	331.0	
Diameter:	12-in. SS	
Length (ft):	40	
Slot size:	0.050-in	
Measuring Point Elevation:	408.72	
Nonpumping Water Level		
Depth below temp. MP (ft):	-	
Height of temp. MP (ft):	-	
Depth below perm. MP (ft):	24.62	
Elevation:	384.10	
Date of Step Test:	2/10/95	
Water Sample		
Time:	1:05 pm	
Temperature:	61.9°F	
Laboratory No.:	228405	
Distance and Direction to Piezometer from PW:		No Piezometer
Time PW Off Before Step Test:		Not recorded

Notes: SWS 8-in. dia. orifice tube w/plate No. 5, manual data collection, sand tank not used

SWS Crew: R. Olson, E. Sanderson

WATER-LEVEL MEASUREMENTS
MO Ave. Well No. 1
Initial Step Test

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
02/10/95						
09:32 am	0	24.65				Dropline measurements
10:05 am	0	24.63				Water-level trend
10:43 am	0	24.62				
10:49 am	0	24.62				
10:53 am	0	24.58				
10:54 am	0	24.62				
10:55 am	0					Pump On
10:57 am	2			~5.5	1260	Maximum rate
10:58 am	3			~5.3	1240	
10:59 am	4	35.5				
11:00 am	5	35.47		~5.35	1250	Readings range from 5.0-5.5
11:02 am	7			~5.35	1250	
11:04 am	9			~5.35	1250	Water-level measurements
11:05 am	10	35.5		~5.35	1250	erratic. Due to cascading
11:07 am	12	35.94		~5.35	1250	water?
11:09 am	14	36		~5.35	1250	"
11:11 am	16	35.5				"
11:13 am	18	36.06		~5.25	1240	"
11:15 am	20	37.1		~5.2	1220	"
11:17 am	22	37.15		~5.2	1220	"
11:19 am	24			~5.2	1220	
11:20 am	25	37.4				"
11:21 am	26	38.35		~5.2	1220	"
11:23 am	28	37.25		~5.2	1220	"
11:24 am	29	36.94		~5.2	1220	"
11:25 am	30	36.3		~5.2	1220	Reduce rate
11:26 am	1					Step 2
11:28 am	3			4.4	1130	Readings range from
11:29 am	4			4.4	1130	4.35-4.45
11:31 am	6			4.4	1130	
11:32 am	7	37.25				
11:33 am	8			4.4	1130	
11:34 am	9	37.75				
11:37 am	12	35.55				
11:39 am	14	35.55				
11:41 am	16	35.57		4.4	1130	
11:43 am	18	35.55		4.4	1130	
11:45 am	20	35.65		4.4	1130	
11:47 am	22	35.54		4.4	1130	
11:49 am	24	35.53		4.4	1130	
11:51 am	26	35.54		4.38	1128	
11:53 am	28	35.6		4.38	1128	
11:54 am	29			4.38	1128	

WATER-LEVEL MEASUREMENTS
MO Ave. Well No. 1 (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
11:55 am	30	35.58				Reduce rate
11:58 am	3			~3.4		Step 3
11:59 am	4			~3.7	1045	
12:00 pm	5	35.56				
12:01 pm	6	35.55		3.75	1050	
12:03 pm	8	35.58		3.72	1047	
12:05 pm	10	35.57				
12:07 pm	12	35.6				
12:10 pm	15	35.55				
12:11 pm	16			3.72	1047	
12:15 pm	20	35.75		3.72	1047	
12:18 pm	23	35.6				
12:19 pm	24			3.7	1045	
12:20 pm	25	35.69				
12:21 pm	26			3.7	1045	
12:23 pm	28			3.7	1045	
12:24 pm	29	35.63				
12:25 pm	30	35.63		3.7	1045	Reduce rate
12:26 pm	1					Step 4
12:27 pm	2	35.63				Reducing rate to get good
12:28 pm	3			2.35	840	water-level readings in
12:29 pm	4			2.35	840	pumped well
12:30 pm	5	35.53		2.35	840	Reduce rate
12:31 pm	6	35.55		1.8	735	
12:32 pm	7	35.56		1.8	735	
12:33 pm	8	35.52				
12:34 pm	9	35.53		1.78	730	
12:35 pm	10	35.52		1.78	730	Reduce rate
12:36 pm	11	32.38				Start drawdown test
12:37 pm	12	32.13		0.48	385	
12:38 pm	13			0.45	372	Adjust rate up
12:40 pm	15	33.62				
12:41 pm	16			0.68	455	
12:42 pm	17	33.45				
12:43 pm	18			0.67	453	
12:45 pm	20	33.38				
12:51 pm	26			0.67	453	
12:53 pm	28	33.39				
12:55 pm	30	33.38		0.67	453	
12:57 pm	32	33.38				
01:03 pm	38	33.38				
01:05 pm	40	33.37		0.67	453	Water sample collected
01:10 pm	45	33.36				T=61.9°F
01:14 pm	49					BART samples collected

WATER-LEVEL MEASUREMENTS
MO Ave. Well No. 1 (Concluded)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
01:15 pm	50			0.66	450	
01:17 pm	52	33.37				
01:21 pm	56			0.66	450	
01:25 pm	60			0.66	450	
01:27 pm	62	33.37				
01:30 pm	65	33.37		0.66	450	End of test

DEWATERING WELL DATA
Initial Step Test

	Well No. MO Ave. W2	Piezometer No. -
Date Drilled:	1993	
Casing		
Top elevation:	417.63	
Diameter:	16-in. SS	2-in. PVC
Length (ft):	78.5	na
Screen		
Bottom elevation:	309.1	na
Diameter:	16-in. SS	2-in. PVC
Length (ft):	30	3
Slot size:	0.050-in.	na
Measuring Point Elevation:	417.63	
Nonpumping Water Level		
Depth below temp. MP (ft):	-	
Height of temp. MP (ft):	-	
Depth below perm. MP (ft):	34.89	
Elevation:	382.94	
Date of Step Test:	2/16/95	-
Water Sample		
Time:	11:08 am	-
Temperature:	59.5°F	-
Laboratory No.:	228437	-
Distance and Direction to Piezometer from PW:		No Piezometer
Time PW Off Before Step Test:		Not recorded

Notes: SWS 8-in. dia. orifice tube w/plate No. 5, manual data collection, sand tank not used
na-information not available

SWS Crew: R. Olson, E. Sanderson, M. Anliker

WATER-LEVEL MEASUREMENTS
MO Ave. Well No. 2
Initial Step Test

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
02/16/95						
08:28 am	0	35.27				Dropline measurements
08:54 am	0	35.06				Water-level trend
09:06 am	0	34.99				
09:13 am	0	34.96				
09:15 am	0	34.95				Pump On
	0.5					Pump Off to adjust
09:26 am		34.90				orifice tube
09:30 am	0	34.89				Pump On
09:31 am	1					Step 1
09:32 am	2	48.85		~7.2	1450	Maximum rate
09:33 am	3			7.15	1445	
09:34 am	4	48.95		7.12	1442	
09:35 am	5	49.00				Readings range from 5.0-5.5
09:36 am	6			7.10	1440	
09:37 am	7					
	7.5	49.08				
09:38 am	8			7.08	1429	
09:39 am	9					Adjust rate
09:40 am	10	49.17		7.15	1445	Readings from about 7.13-7.18
09:41 am	11					
09:42 am	12	49.22		7.15	1445	
09:45 am	15	49.23				
09:46 am	16			7.15	1445	
09:47 am	17	49.26				
09:49 am	19	49.27				
09:50 am	20			7.15	1445	
09:51 am	21	49.28				
09:53 am	23	49.29				
09:54 am	24			7.15	1445	
09:55 am	25	49.30				
09:56 am	26			7.15	1445	
09:57 am	27	49.32				
09:58 am	28			7.15	1445	
09:59 am	29	49.32		7.15	1445	
10:00 am	30	49.31				Reduce rate
10:01 am	1	48.40		6.24	1344	Step 2
10:02 am	2			6.24	1344	
10:03 am	3	48.39				
10:05 am	5	48.38		6.23	1343	
10:07 am	7	48.39				
10:08 am	8			6.24	1344	
10:09 am	9	48.41				

WATER-LEVEL MEASUREMENTS
MO Ave. Well No. 2 (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
10:11 am	11	48.41				
10:12 am	12			6.23	1343	
10:13 am	13	48.41				
10:14 am	14			6.23	1343	
10:15 am	15	48.42				
10:17 am	17	48.41				
10:18 am	18			6.23	1343	
10:19 am	19	48.43				
10:21 am	21	48.44				
10:22 am	22			6.24	1344	
10:23 am	23	48.44				
10:26 am	26	48.45		6.24	1344	
10:28 am	28	48.45		6.24	1344	
10:29 am	29			6.23	1343	
	29.5	48.45				
10:30 am	30			6.24	1344	Reduce rate
10:31 am	1	47.49		5.34	1250	Step 3
10:32 am	2			5.35	1250	
10:33 am	3	47.49				
10:34 am	4			5.35	1250	
10:35 am	5	47.49				
10:37 am	7	47.49		5.35	1250	
10:39 am	9	47.48				
10:42 am	12	47.49				
10:44 am	14	47.48		5.35	1250	Readings from about 5.32-5.37
10:45 am	15					
10:47 am	17	47.49				
10:49 am	19	47.49				
10:51 am	21	47.49				
10:53 am	23	47.49				
10:54 am	24			5.34	1250	
10:55 am	25	47.50				
10:57 am	27	47.50				
10:58 am	28			5.34	1250	
10:59 am	29	47.50		5.35	1250	
11:00 am	30	47.50		5.34	1250	Reduce rate
11:01 am	1	46.50		4.50	1145	Step 4
11:02 am	2			4.50	1145	
11:03 am	3	46.49				
11:04 am	4			4.51	1147	
11:05 am	5	46.49				
11:07 am	7	46.48				

WATER-LEVEL MEASUREMENTS
MO Ave. Well No. 2 (Concluded)

Hour	Time (min)	Adjusted depth to water in well (ft)	Adjusted depth to water in piezometer (ft)	Orifice tube piez. (ft)	Pumping rate (gpm)	Remarks
11:08 am	8					Water sample collected,
11:09 am	9	46.47				T=59.5°F
11:11 am	11	46.49				
11:13 am	13	46.48		4.51	1147	
11:15 am	15	46.48				
11:17 am	17	46.48				
11:19 am	19	46.49		4.51	1147	BART samples collected
11:21 am	21	46.48				
11:23 am	23	46.49		4.51	1147	
11:25 am	25	46.48				
11:27 am	27	46.49				
11:28 am	28	46.47		4.51	1147	
11:29 am	29	46.48		4.51	1147	
11:30 am	30	46.49		4.51	1147	Reduce rate
11:31 am	1	45.55				Step 5
11:32 am	2			3.77	1052	
11:33 am	3	45.49		3.76	1051	
11:35 am	5	45.48		3.76	1051	Readings from about 3.74-3.78
11:36 am	6					
11:40 am	10	45.48		3.76	1051	
11:44 am	14	45.48		3.76	1051	
11:47 am	17	45.48				
11:49 am	19	45.48		3.76	1051	
11:51 am	21	45.47				
11:53 am	23	45.47				
11:55 am	25	45.47		3.76	1051	
11:57 am	27	45.46				
11:59 am	29	45.47		3.76	1051	
12:00 pm	30	45.47		3.76	1051	End of step test

DEWATERING WELL DATA
Initial Step Test

	Well No. MO Ave. W3	Piezometer No. TW 2-93
Date Drilled:	1993	1993
Casing		
Top elevation:	415.44	415.48
Diameter:	16-in. SS	12-in.
Length (ft):	69	-
Screen		
Bottom elevation:	316.4	331.0
Diameter:	16-in. SS	12-in.
Length (ft):	30	-
Slot size:	0.050-in.	-
Measuring Point Elevation:	415.44	415.48
Nonpumping Water Level		
Depth below temp. MP (ft):	-	
Height of temp. MP (ft):	-	
Depth below perm. MP (ft):	32.58	32.58
Elevation:	382.86	382.90
Date of Step Test:	2/16/95	-
Water Sample		
Time:	2:27 pm	-
Temperature:	60.0°F	-
Laboratory No.:	228438	-
Distance and Direction to Piezometer from PW:		11.5 ft west
Time PW Off Before Step Test:		Not recorded

Notes: SWS 8-in. dia. orifice tube w/plate No. 5, manual data collection, sand tank not used

SWS Crew: R. Olson, E. Sanderson, M. Anliker

WATER-LEVEL MEASUREMENTS
MO Ave. Well No. 3
Initial Step Test

Hour	Time (min)	Adjusted depth to water in well (ft)	Adjusted depth to water in piezometer (ft)	Orifice tube piez. (ft)	Pumping rate (gpm)	Remarks
02/16/95						
12:27 pm	0	32.67				Slope indicator dropline
12:33 pm	0		32.62			
12:37 pm	0	32.61				
12:38 pm	0		32.60			
12:44 pm	0	32.58				
12:45 pm	0		32.58			Pump On
12:46 pm	1					Adjusting rate
12:47 pm	2	49.30		~4.7	1170	Step 1; Maximum rate
12:48 pm	3		37.15			
12:49 pm	4			4.53	1151	
12:50 pm	5	49.47				
12:51 pm	6		37.18			
12:52 pm	7			4.53	1151	
12:53 pm	8	49.38				
12:54 pm	9		37.25			
12:56 pm	11	49.60	37.27			
12:57 pm	12			4.52	1149	Readings range from
12:59 pm	14	49.83				4.49-4.55
01:00 pm	15		37.31	4.52	1149	
01:01 pm	16	49.70				
01:03 pm	18	49.62	37.33			
01:05 pm	20	49.42		4.51	1147	
01:07 pm	22		37.36			
01:08 pm	23	49.60				
01:09 pm	24			4.51	1147	
01:10 pm	25		37.36			
01:13 pm	28	49.86		4.50	1145	
01:14 pm	29	49.43	37.37	4.50	1145	
01:15 pm	30			4.50	1145	Reduce rate
01:16 pm	1	49.50		3.78	1053	Step 2
01:17 pm	2		37.02	3.75	1050	Adjust rate
01:18 pm	3	49.38				Readings range from
01:19 pm	4		37.00	3.78	1053	4.35-4.45
01:20 pm	5	49.60				
01:21 pm	6		37.01	3.78	1053	
01:22 pm	7	49.52				
01:23 pm	8			3.77	1051	
01:25 pm	10	49.60	37.01			
01:27 pm	12	49.55	37.01			
01:31 pm	16	49.75	37.01	3.77	1051	
01:34 pm	19	49.55	37.01			
01:35 pm	20			3.77	1051	

WATER-LEVEL MEASUREMENTS
MO Ave. Well No. 3 (Continued)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
01:37 pm	22	49.45				
01:38 pm	23		37.02			
01:39 pm	24			3.77	1051	
01:40 pm	25	49.55				
01:41 pm	26		37.02	3.77	1051	
01:43 pm	28	49.55		3.77	1051	
01:44 pm	29		37.02			
01:45 pm	30	49.50		3.77	1051	Reduce rate
01:46 pm	1			3.02	944	Step 3
01:47 pm	2	49.42		3.02	944	
01:48 pm	3		36.56			
01:50 pm	5	49.07				
01:51 pm	6		36.55	3.01	942	
01:53 pm	8			3.01	942	
01:55 pm	10	49.40	36.54			
01:57 pm	12			3.01	942	
02:00 pm	15	49.60				
02:01 pm	16		36.55			
02:05 pm	20			3.01	942	
02:06 pm	21		36.53			
02:09 pm	24	49.55				
02:11 pm	26			3.01	942	
02:13 pm	28	49.40		3.01	942	
02:14 pm	29		36.53			
02:15 pm	30	49.45		3.01	942	Reduce rate
02:16 pm	1	49.40				Step 4
02:18 pm	3	47.73		~2		Adjusting rate
02:19 pm	4			2.45	852	Cascading water
02:21 pm	6			2.45	852	influencing water-level
02:22 pm	7	49.40				measurements in pumped
02:23 pm	8		36.14			well?
02:25 pm	10	49.35				Adjust rate
02:27 pm	12	49.33		2.45	852	Water sample collected,
02:29 pm	14			2.45	852	T=60.0°F
02:31 pm	16		36.13			
02:34 pm	19	49.55				
02:35 pm	20			2.44	851	
02:39 pm	24	49.45	36.70			
02:43 pm	28	49.60		2.44	851	
02:45 pm	30	49.60		2.44	851	BART samples collected
02:46 pm	1					Step 5
02:47 pm	2	43.17				Setting rate to get good
02:49 pm	4	48.84		1.22	606	readings in pumped well

WATER-LEVEL MEASUREMENTS
MO Ave. Well No. 3 (Concluded)

Hour	*Time (min)*	*Adjusted depth to water in well (ft)*	*Adjusted depth to water in piezometer (ft)*	*Orifice tube piez. (ft)*	*Pumping rate (gpm)*	*Remarks*
02:50 pm	5	44.85	35.70	1.22	606	
02:52 pm	7	44.86				
02:54 pm	9	44.89	35.70	1.22	606	
02:57 pm	12	44.90				
02:59 pm	14		35.71			
03:00 pm	15	44.91				
03:01 pm	16			1.22	606	
03:02 pm	17	44.91				
03:03 pm	18		35.70			
03:05 pm	20	44.90				
03:08 pm	23		35.70			
03:09 pm	24	44.89				
03:11 pm	26	44.88		1.22	606	
03:14 pm	29	45.40		1.22	606	BR turned on Well 2 pump
03:15 pm	30	45.57	36.47	1.22	606	End of step test

Appendix B

Chemical Quality of Ground Water from Dewatering Wells
FY 94 (Phase 11)

Appendix B. Chemical Quality of Ground Water from Dewatering Wells FY 94 (Phase 11)

Site	I-70	I-70	I-70	I-64
Well No.	2A	9A	12A	8
Section Location T2N, R9W, St. Clair Co.	7.7b	7.7b	7.7b	18.4g
Date Collected	08/22/94	09/09/94	08/02/95	04/15/96
Laboratory No.	227955	227970	228882	229408
Iron (Fe), mg/L	12.54	17.41	10.71	21.04
Manganese (Mn), mg/L	1.32	0.70	0.63	0.70
Calcium (Ca), mg/L	216	233	152	295
Magnesium (Mg), mg/L	45.8	55.4	38.7	73.7
Sodium (Na), mg/L	208	137	46.2	487
Silica (SiO_2), mg/L	31.8	-	34.2	35.8
Fluoride (F), mg/L	0.3	0.2	0.2	0.3
Nitrate (NO_3), mg/L	0.05	<0.02	<0.02	<0.02
Chloride (Cl), mg/L	234	82.7	82.7	370
Sulfate (SO_4), mg/L	354	521	194	1438
Aluminum (Al), mg/L	0.018	0.053	0.03	0.19
Arsenic (As), mg/L	<0.11	<0.11	<0.11	<0.11
Barium (Ba), mg/L	0.11	0.09	0.08	0.11
Beryllium (Be), mg/L	<0.003	<0.003	<0.003	<0.003
Boron (B), mg/L	1.01	0.78	0.35	0.67
Cadmium (Cd), mg/L	<0.017	<0.017	<0.017	<0.017
Chromium (Cr), mg/L	0.020	0.019	<0.007	0.009
Copper (Cu), mg/L	<0.007	<0.007	<0.01	<0.01
Lead (Pb), mg/L	<0.066	<0.066	<0.066	<0.066
Nickel (Ni), mg/L	<0.031	<0.031	<0.031	<0.031
Potassium (K), mg/L	10.0	8.3	5.2	8.0
Selenium (Se), mg/L	<0.18	<0.18	<0.18	<0.18
Silver (Ag), mg/L	<0.014	<0.014	<0.014	<0.014
Zinc (Zn), mg/L	<0.02	0.10	<0.02	<0.02
Alkalinity (as $CaCO_3$), mg/L	507	497	338	514
Hardness (as $CaCO_3$), mg/L	727	809	538	1039
Total dissolved minerals, mg/L	1435	1332	811	2821
Turbidity (lab), NTU	116	124	116	234
Color, PCU	7	7	5	7
Odor	Musty	Musty	Musty	Musty
pH (lab)	7.2	7.6	7.6	8.0
Temperature, °F	59.2	60	58.8	62.1

Notes:

< = below detection limit (i.e., <1.0 = less than 1.0 mg/L)
mg/L = milligrams per liter
\- = concentration not determined

Appendix B. (Continued)

Site	I-64	Venice	Venice	Venice
Well No.	9	2	3	4
Section Location		Madison Co.		
T2N, R9W,		T3N,R10W		
St. Clair Co.	18.4g	35.4g	35.3g	35.3g
Date Collected	08/18/94	06/21/94	07/01/94	05/11/94
Laboratory No.	227956	227790	227791	227661
Iron (Fe), mg/L	16.12	18.54	16.96	18.4
Manganese (Mn), mg/L	0.55	0.76	0.51	0.52
Calcium (Ca), mg/L	240	213	198	195
Magnesium (Mg), mg/L	57.5	44.2	50.9	48.6
Sodium (Na), mg/L	558	37.0	46.1	43.6
Silica (SiO_2), mg/L	-	37.8	-	38.4
Fluoride (F), mg/L	0.8	0.2	0.2	0.3
Nitrate (NO_3), mg/L	<0.02	<0.02	<0.02	<0.02
Chloride (Cl), mg/L	389	43.9	46.5	71.9
Sulfate (SO_4), mg/L	951	227	289	245
Aluminum (Al), mg/L	0.024	<0.017	<0.017	0.02
Arsenic (As), mg/L	<0.11	0.11	<0.11	<0.11
Barium (Ba), mg/L	0.09	0.17	0.14	0.14
Beryllium (Be), mg/L	<0.003	-	-	-
Boron (B), mg/L	0.72	1.52	0.79	0.80
Cadmium (Cd), mg/L	<0.017	<0.017	<0.017	<0.017
Chromium (Cr), mg/L	<0.018	0.014	<0.007	<0.007
Copper (Cu), mg/L	<0.007	<0.01	<0.01	<0.01
Lead (Pb), mg/L	<0.066	<0.066	<0.066	<0.066
Nickel (Ni), mg/L	<0.031	<0.031	<0.031	<0.031
Potassium (K), mg/L	9.5	4.85	4.25	5.6
Selenium (Se), mg/L	<0.18	<0.18	<0.18	<0.18
Silver (Ag), mg/L	<0.014	<0.014	<0.014	<0.014
Zinc (Zn), mg/L	<0.02	<0.02	<0.02	<0.02
Alkalinity (as $CaCO_3$), mg/L	545	454	389	424
Hardness (as $CaCO_3$), mg/L	835	713	703	686
Total dissolved minerals, mg/L	2624	878	957	971
Turbidity (lab), NTU	174	227	193	245
Color, PCU	10	6	8	6
Odor	Musty	None	None	None
pH (lab)	7.2	7.2	7.3	7.6
Temperature, °F	59.2	58.6	59.4	59.0

Notes:

< = below detection limit (i.e., <1.0 = less than 1.0 mg/L)
mg/L = milligrams per liter
\- = not determined/information not available

Appendix B. (Concluded)

Site	MO Ave.	MO Ave.	MO Ave.
Well No.	1	2	3
Section Location T2N, R10W, St. Clair Co.	13.7g	13.7g	13.7g
Date Collected	02/10/95	02/16/95	02/16/95
Laboratory No.	228405	228437	228438
Iron (Fe), mg/L	7.16	11.27	12.82
Manganese (Mn), mg/L	0.99	1.18	1.03
Calcium (Ca), mg/L	205	243	231
Magnesium (Mg), mg/L	40.0	65.3	46.2
Sodium (Na), mg/L	59.0	-	72.4
Silica (SiO_2), mg/L	23.8	30.8	32.2
Fluoride (F), mg/L	0.4	0.4	0.3
Nitrate (NO_3), mg/L	0.53	0.06	<0.02
Chloride (Cl), mg/L	88.9	87.3	70.4
Sulfate (SO_4), mg/L	254	348	317
Aluminum (Al), mg/L	0.066	<0.017	<0.017
Arsenic (As), mg/L	-	<0.11	<0.11
Barium (Ba), mg/L	0.13	0.14	0.15
Beryllium (Be), mg/L	<0.003	<0.003	<0.003
Boron (B), mg/L	0.68	1.13	1.25
Cadmium (Cd), mg/L	-	<0.017	<0.017
Chromium (Cr), mg/L	<0.007	<0.007	0.010
Copper (Cu), mg/L	-	<0.007	<0.007
Lead (Pb), mg/L	0.42	<0.066	<0.066
Nickel (Ni), mg/L	0.046	<0.031	<0.031
Potassium (K), mg/L	6.1	6.3	8.1
Selenium (Se), mg/L	-	<0.18	<0.18
Silver (Ag), mg/L	-	<0.015	<0.015
Zinc (Zn), mg/L	-	<0.02	<0.02
Alkalinity (as $CaCO_3$), mg/L	398	497	521
Hardness (as $CaCO_3$), mg/L	676	875	766
Total dissolved minerals, mg/L	925	1168	1149
Turbidity (lab), NTU	81.9	139	157
Color, PCU	8	7	6
Odor	None	None	None
pH (lab)	7.7	7.6	7.6
Temperature, °F	61.9	59.5	60.0

Notes:
< = below detection limit (i.e., <1.0 = less than 1.0 mg/L)
mg/L = milligrams per liter
\- = concentration not determined/information not available

Appendix C

Results of Step Tests on Dewatering Wells
FY 84 - FY 94 (Phases 1-11)

Appendix C. Results of Step Tests on Dewatering Wells
FY 84 - FY 94 (Phases 1-11)

Well	*Date of test*	*Well loss at 600 gpm (ft)*	*Drawdown at 600 gpm (ft)*	*Well loss portion (%)*	*Observed specific capacity (gpm/ft)*	*Δh* at 600 gpm (ft)*	*Observed Q_{max} (gpm)*	*Remarks*
I-70								
No. 1	8/15/84	**	18.1 e	**	33.1 e	12.8 e	328	Pretreat
No. 1	8/14/85	**	8.89 e	**	67.5 e	3.3 e	390	Posttreat
No. 1	5/17/89	3.31 e	14.68 e	22.5	40.9 e	8.5 e	250	
No. 1A	4/26/95	0.92	14.98 e	6.1	40.8	8.7 e	445	New well, initial test
No. 2	7/19/83	**	11.9 e	**	50.4 e	7.9 e	500	Pretreat
No. 2	8/15/85	**	8.32 e	**	72.1 e	P	410	Posttreat
No. 2	6/20/88	**	11.98 e	**	50.1 e	P	365	Pretreat
No. 2	2/1/89	0.19 e	8.31 e	2.3	72.2 e	P	270	Posttreat; Piezometer partially plugged
No. 2A	11/16/93	1.78 e	20.82 e	8.5	29.7	14.0 e	438	New well, initial test
No. 2A	8/22/94	0.28	7.59	3.7	79.7	2.3 e	525	Posttreat
No. 3	6/28/83	**	8.53	**	70.9	5.65		
No. 3	6/24/86	1.11	7.47	14.9	80.3	3.64	610	Pretreat
No. 3	1/14/87	0.82	6.09	13.5	98.5	2.40	620	Posttreat
No. 3	12/11/89	0.46	13.4 e	3.4	44.9	7.3 e	530	Pretreat
No. 3	4/17/90	4.8 e	8.7 e	54.5	84.0	2.9 e	440	Posttreat
No. 3A	10/29/93	1.34 e	15.25 e	8.8	40.0	7.7 e	540	New well, initial test
No. 4	8/16/84	0.07	9.33	0.8	64.3	P		Pretreat
No. 4	1/8/87	**	5.89	**	101.9	P	660	Posttreat
No. 4	5/11/95	**	6.70	**	89.7	P	685	
No. 5	7/10/84	0.89	6.53	13.6	91.9	2.11	740	
No. 5	1/13/87	**	7.98	**	75.2	4.76	665	Posttreat

Appendix C. (Continued)

Well	*Date of test*	*Well loss at 600 gpm (ft)*	*Drawdown at 600 gpm (ft)*	*Well loss portion (%)*	*Observed specific capacity (gpm/ft)*	*Δh* at 600 gpm (ft)*	*Observed Q_{max} (gpm)*	*Remarks*
I-70 (Continued)								
No. 5	2/2/89	0.71	6.23	11.4	96.3	P	650+	Posttreat
No. 5	10/14/93	1.19 e	13.67 e	8.7	44.8	P	500	
No. 6	7/19/85	0.23	5.39	4.3	111.3	P	625	
No. 6	8/1/90	--	--	--	16.1		145	
No. 6	10/29/91	0.19	4.93	3.8	121.7	--	750	Posttreat; Piezometer buried
No. 6	5/12/95	**	6.72	**	89.3	2.5	610	
No. 7	6/30/83	1.88	18.55	10.1	32.3	15.0		Replaced 11/86
No. 7A	7/23/87	**	8.39	**	71.5	2.13	770	
No. 7A	6/15/89	2.25	11.43	19.7	52.5	8.97 e	520	
No. 7A	6/27/90	6.8 e	26.7 e	25.3	24.6	13.2 e	425	Pretreat
No. 7A	8/6/91	0.32	8.58	3.7	69.9	1.4	625	Posttreat
No. 7A	5/5/94	0.54 e	11.1 e	4.8 e	54.5	2.9 e	465	
No. 8	8/1/84	2.68	13.54	19.8	44.3	9.94	625	Pretreat
No. 8	12/5/85	0.07	6.83	1.0	87.8	2.21	750	Posttreat
No. 8	6/22/88	**	12.62	**	47.5 e	8.22	600	
No. 8A	10/4/89	**	6.10	**	98.4	1.38	778	
No. 8A	10/1/91	0.29	11.61	2.5	51.7	6.4	620	
No. 8A	12/17/92	0.17 e	9.8 e	1.2 e	61.1	5.3 e	590	Pretreat
No. 8A	3/16/94	0.27 e	7.9 e	3.4 e	76.0	2.5 e	588	Posttreat
No. 9	6/28/84	**	9.46	**	63.4	5.94	630	
No. 9A	10/3/89	**	6.04 e	**	99.4 e	1.72 e	523	
No. 9A	6/26/90	0.4 e	6.2 e	6.3	97.1	2.1 e	575	

Appendix C. (Continued)

Well	*Date of test*	*Well loss at 600 gpm (ft)*	*Drawdown at 600 gpm (ft)*	*Well loss portion (%)*	*Observed specific capacity (gpm/ft)*	*Δh* at 600 gpm (ft)*	*Observed Q_{max} (gpm)*	*Remarks*
I-70 (Continued)								
No. 9A	4/26/91	**	5.95 e	--	100.8	2.7 e	535	
No. 9A	7/23/92	0.24 e	7.8 e	3.1	78.7	2.9 e	525	
No. 9A	5/12/94	0.13 e	7.7 e	1.6 e	78.3	3.1 e	470	
No. 9A	9/9/94	**	5.9 e	**	99.8	1.6 e	515	Posttreat
No. 10	7/31/84	5.97 e	16.93 e	35.3	35.4 e	P	480	Pretreat
No. 10	9/4/85	0.66	6.61 e	10.0	90.8	P	490	Posttreat
No. 10	8/13/87	1.07	18.98 e	5.6	31.6 e	10.4 e	390	Pretreat
No. 10	1/30/89	1.74 e	11.51 e	15.1	52.1 e	4.34 e	370	Posttreat
No. 10	2/7/91	--	19.3 e	--	31.1	P	270	Pretreat; Drawdown test only
No. 10	8/8/91	0.95	9.4 e	10.0	65.2	P	450	Posttreat
No. 10	8/1/95	**	6.2 e	**	57.9	P	455	
No. 11	8/2/84	1.58 e	15.55 e	10.2	38.6 e	13.35 e	555	Pretreat
No. 11	9/5/85	**	5.63	**	106.6	P		Posttreat
No. 11	8/12/87	**	11.56 e	**	51.9 e	P	550	Pretreat
No. 11	1/31/89	0.03	6.62 e	0.5	90.6 e	P	570	Posttreat; Piezometer partially plugged
No. 11A	10/28/93	0.40 e	16.09 e	2.5	37.6	12.5 e	474	New well, initial test
No. 12A	6/16/83	0.20	3.82	5.2	157.1	P		
No. 12A	7/30/86	**	13.3 e	**	45.1	P	450	Pretreat
No. 12A	11/16/87	1.45	2.36	61.4	254.2	P	750	Posttreat
No. 12A	5/15/91	1.09	4.7 e	23.2	132.6	2.0 e	520	
No. 12A	8/2/95	0.68	11.2 e	6.1	54.3	P	517	

Appendix C. (Continued)

Well	*Date of test*	*Well loss at 600 gpm (ft)*	*Drawdown at 600 gpm (ft)*	*Well loss portion (%)*	*Observed specific capacity (gpm/ft)*	*Δh* at 600 gpm (ft)*	*Observed Q_{max} (gpm)*	*Remarks*
I-70 (Continued)								
No. 13	4/25/91	0.47	7.57 e	6.2	79.9	2.9 e	560	New well, initial test
No. 13	4/25/95	**	20.1 e	**	29.9	4.4 e	208	Drawdown test
No. 14	12/20/90	0.13	5.93	2.2	100.5	3.0	750	New well, initial test
No. 14	6/22/94	**	16.0 e	**	34.0	14.6 e	396	
No. 15	10/15/93	2.95 e	14.88 e	19.8	41.5	9.1 e	545	New well, initial test
I-64								
No. 1	7/21/87	**	4.13	**	145.3	0.85	660	
No. 1	9/24/91	0.12	4.33	2.8	138.6	P	630	
No. 2	7/25/85	0.09	5.32 e	1.7	112.8	5.22	550	
No. 3	6/26/84	0.52	10.73 e	4.8	55.9 e	P	525	Pretreat
No. 3	6/21/88	0.68 e	5.68 e	12.0 e	105.6 e	P	555	Posttreat
No. 4	7/15/85	0.66	4.40	15.0	136.4	P		
No. 8	4/15/96	2.19	11.0 e	19.9	57.9	P	435	
No. 9	10/5/83	0.37	6.22	5.9	96.5	2.3		
No. 9	8/18/94	**	26.2 e	**	22.9	19.7 e	470	
No. 10	7/11/84	**	7.46	**	80.4	2.73	605	
No. 11	8/14/84	**	7.22 e	**	83.1 e	3.2 e	520	
No. 11	6/16/89	0.52	7.45 e	7.0	80.5 e	P	505	
No. 12	7/18/85	0.17	6.22 e	2.8	96.5	1.62 e	590	
No. 13	7/12/84	**	6.44	**	93.2	2.65	600	

Appendix C. (Continued)

Well	*Date of test*	*Well loss at 600 gpm (ft)*	*Drawdown at 600 gpm (ft)*	*Well loss portion (%)*	*Observed specific capacity (gpm/ft)*	*Δh* at 600 gpm (ft)*	*Observed Q_{max} (gpm)*	*Remarks*
I-64 (Continued)								
No. 14	8/3/90	0.31	4.71 e	6.5	128.2	P	585	Initial test
No. 15	6/29/83	0.73	9.94	7.3	60.4	4.6		Pretreat
No. 15	8/13/85	0.71	7.24	9.8	82.9	2.97	615	Posttreat
No. 15	7/22/87	0.84 e	6.94 e	12.1 e	86.5 e	2.52	570	
25th St.								
No. 1	8/11/89	1.0 e	3.6 e	27.2	184.7	P	375	
No. 1	9/4/91				31.6	P	235	Drawdown test only
No. 2	7/20/83	0.54	5.69	9.5	105.4	1.1		
No. 2	8/9/89	**	10.3 e	**	58.3 e	--	550	Pretreat; Δh elevation data not available
No. 2	4/18/90	0.45	4.87	9.3	120.4	0.6	795	Posttreat
No. 3	9/6/85	0.03	4.89	0.6	122.7	1.75		
No. 3	9/7/89	0.80 e	14.9 e	5.4	40.9	4.5 e	560	Pretreat
No. 3	12/19/90	0.28	10.29	2.7	58.1	3.0	650	Pretreat
No. 3	5/14/91	0.17	5.59	3.0	106.5	0.9	780	Posttreat
No. 4	8/2/90	1.86	10.87	17.1	55.2	--	635	Initial test
No. 4	11/19/91	0.62	4.75	13.1	119.9	P	840	Posttreat
No. 4	7/24/92	**	6.24	**	98.8	P	820	
No. 5	5/16/89	0.47 e	23.28 e	0.02	25.8 e	15.2 e	352	Pretreat
No. 5	4/19/90	**	4.92	**	122.0	1.0	790	Posttreat
No. 6	6/27/84	0.14	9.44	1.5	63.6	P	775	Pretreat
No. 6	1/7/87	0.23	4.38	5.3	137.0	P	775	Posttreat

Appendix C. (Continued)

Well	*Date of test*	*Well loss at 600 gpm (ft)*	*Drawdown at 600 gpm (ft)*	*Well loss portion (%)*	*Observed specific capacity (gpm/ft)*	*Δh* at 600 gpm (ft)*	*Observed Q_{max} (gpm)*	*Remarks*
25th St. (Continued)								
No. 6	2/8/91	**	4.96	**	122.5	1.9	810	
No. 7	3/21/91	1.56	5.15	30.3	110.8	P	735	Initial test
No. 8	6/15/83	0.11	4.70	2.3	127.7	1.5		
No. 8	4/24/91	--	13.2 e	--	45.5	9.5 e	255	Drawdown test only
No. 8	11/15/93	**	6.23	**	96.3	4.81	620	Posttreat
No. 9	6/25/86	**	5.55 e	**	110.4	2.04 e	520	
No. 9	9/18/91	0.66 e	5.10 e	12.9	117.6	1.8 e	580	
No. 10	7/26/85	**	9.56	**	62.8	3.59		Pretreat
No. 10	11/18/87	0.43	6.24	6.9	96.2	2.06	800	Posttreat
Venice								
No. 1	11/30/83	2.29	18.33 e	12.5	32.7	10.9 e	500	Pretreat
No. 1	12/4/85	0.39	7.89	4.9	74.5	2.33	870	Posttreat
No. 1	9/6/89	0.81	6.94	11.7	85.1	1.9	740	
No. 1	3/29/94	2.9	17.4	16.6	34.5	P	680	
No. 2	11/17/83	0.05	4.70	1.0	127.7	1.2		
No. 2	9/5/89	12.49	44.70 e	27.9	13.4 e	33.3 e	200	Pretreat; Water level below intake
No. 2	5/8/90	**	6.34	**	94.7	2.4	730	Posttreat
No. 2	10/2/91	1.30	6.14	21.1	92.8	2.3	780	
No. 2	6/21/94	**	9.0	**	67.6	4.37	745	
No. 3	11/28/83	**	9.20	**	65.2	4.2		Pretreat
No. 3	1/6/87	0.35	7.60	4.6	78.3	P	775	Posttreat

Appendix C. (Continued)

Well	*Date of test*	*Well loss at 600 gpm (ft)*	*Drawdown at 600 gpm (ft)*	*Well loss portion (%)*	*Observed specific capacity (gpm/ft)*	*Δh* at 600 gpm (ft)*	*Observed Q_{max} (gpm)*	*Remarks*
Venice (Continued)								
No. 3	12/5/90	**	9.54	**	62.9	6.1	700	
No. 3	12/16/91	**	6.26 e	**	97.2	2.3	840	Posttreat
No. 3	7/1/94	**	9.2	**	65.8	5.03	760	
No. 4	12/1/83	0.39	5.15	7.6	116.5	2.3		
No. 4	12/6/90	--	30.0 e	--	20.0	26.0 e	262	Pretreat; Drawdown test only
No. 4	9/17/91	0.66	5.86	11.3	102.4	2.7	795	Posttreat
No. 4	5/11/94	**	13.5	**	44.7	P	760	
No. 5	11/15/83	0.16	4.98	3.2	120.5	1.9		
No. 5	12/7/89	4.3 e	13.7 e	31.4	43.8	9.6 e	500	Pretreat
No. 5	5/2/90	**	5.38	**	109.7	1.6	740	Posttreat
No. 5	3/24/92	0.73	5.28	13.8	110.5	P	760	
No. 6	11/29/83	0.16	7.82	2.0	76.7	6.1		Pretreat
No. 6	11/17/87	3.18	4.13	77.0	145.3	2.61	800	Posttreat
No. 6A	3/20/91	1.89	6.84 e	27.6	78.6	3.7	900	New well, initial test
No. 6A	6/23/94	**	9.9	**	61.5	6.1	825	
No. 7	2/27/91	**	7.48	**	80.2	4.1	895	New well, initial test
No. 7	5/4/94	**	17.5	**	35.2	13.9 e	845	

Appendix C. (Concluded)

Well	*Date of test*	*Well loss at 600 gpm (ft)*	*Drawdown at 600 gpm (ft)*	*Well loss portion (%)*	*Observed specific capacity (gpm/ft)*	*Δh* at 600 gpm (ft)*	*Observed Q_{max} (gpm)*	*Remarks*
MO Ave.								
No. 1†	2/10/95	**	11.7 e	**	51.4		1,260	
No. 2	2/16/95	0.06	5.92 e	1.0	100.1	9.1	1,450	
No. 3‡	2/16/95	**	12.9 e	**	46.7		1,170	

Notes:

* Head difference between pumped well and adjacent piezometer.

** Coefficient immeasurable. Turbulent well loss negligible over the pumping rates tested.

† Drawdown test only (450 gpm). Cascading H_2O interfered with W.L. measurement.

‡ Drawdown test only; cascading H_2O interfered with W.L. measurement. Δh calculated with W.L. data from Well 2-93 at 606 gpm.

e-Estimate based on interpolated values adjusted to 600 gpm.

P-Piezometer plugged or partially plugged.

Appendix D

Well Rehabilitation Field Notes
FY 94 (Phase 11)

Appendix D. Well Rehabilitation Field Notes

WELL SITE: I-70 Well 2A　　　　OBSERVER: Robert Olson

CONTRACTOR: Layne-Western Company, Inc.

MEASURING POINT: At temporary wellhead approximately 2.0 ft above lsd

MEASURING EQUIPMENT: Layne 6x5 in. orifice tube, steel tape

1. SPECIFIC CAPACITY TEST　　　　DATE: 7/12/94

Time	Depth (ft)	Drawdown (ft)	Piezo-meter tube (in.)	Pumping rate (gpm)	Remarks
1:02 PM	39.29				SWL--steel tape
1:18					Start pump--running backwards
1:22	39.30				Start pump--hose leaking–Off
1:27	39.36				SWL
1:27:30			22.0	584	Pump On
1:47	58.65		20.0	557	
2:18	58.77		19.5	550	
2:30	58.89	19.53	19.75	554	PWL

Notes: All specific capacity tests--static water level (SWL) measured after minimum 30 min. period of well inactivity. Minimum period of pumpage for drawdown measurements is 60 min.

60 min. specific capacity: 28.4 gpm/ft

Comments: Pulled existing pump, assembled and set treatment wellhead and pump

2. 400 LB POLYPHOSPHATE APPLICATION　　　　DATE: 7/13/94

A. INITIAL CHLORINATION

Quantity: 1,800 gal
1,200 gal

Strength: 5 gal in 2,000 gal of water

Time - initial: 10:10 AM
- complete: 10:20 AM

Injection rate: 2,000 gpm

Comments: VERTEX 10% sodium hypochlorite solution is chlorine source for treatment of I-70 Wells 2A and 9A. It takes approximately 1 min. to empty 2,000 gal tank; some leakage between wellhead and pump head.

B. POLYPHOSPHATE INJECTION, 400 lb total

	Batch 1	Batch 2
Phosphate:	200 lb	200 lb
Quantity H_2O:	2,000 gal	2,000 gal
Time - initial:	10:27:30 AM	10:33:45 AM
- complete:	10:28:35 AM	10:34:55 AM
Injection rate:	1,846 gpm	1,714 gpm

Comments: Used food grade sodium tripolyphosphate by Monsanto: Nutrifos; Granular light dense 088. H_2O coming out seal at well head flange.

C. DISPLACEMENT, 16,000 gal chlorinated water (500 mg/L)

Time - initial/complete	Quantity (gal)	Q (gpm)
10:43:52/10:44:52 AM	2,000	2,000
10:51:52/10:53:45	2,000	1,062
10:59:50/11:01:35	2,000	1,143
11:11:55/11:13:53	2,000	1,017
11:15:07/11:17:45	2,000	759
11:53:15/11:54:23	2,000	1,765
12:01:10/12:02:33 PM	2,000	1,446
12:08:34/12:10:25	2,000	1,081

Comments: I-70 Well 3A is supplying make-up water for displacements. It takes about 7 min. to fill the 2,000 gal treatment rig tank. Much leakage around flange at wellhead. By third injection, water in pit draining out discharge line. Delay after 5th displacement until another 55 gal drum of chlorine could be obtained.

D. SURGING - Tank to well injections only reported

Time - initial/complete	Quantity (gal)	Q (gpm)
1:15 PM/NA	2,000	
1:30/NA	2,000	
1:40/NA	2,000	
2:09:15/2:10:03 PM	2,000	2,500
2:29:05/2:29:55	2,000	2,400
2:34:55/2:35:44	2,000	2,449
2:43:35/2:46:25	2,000	706*

Comments: 2,000 gal treatment rig tank pumped full from Well 2A, then injected back into well. Well 2A fills rig tank in about 95 sec.

*Rate when full rig tank allowed to back siphon into Well 2A.

E. PUMPED TO WASTE

Time - initial: 2:48 PM
- complete: 8:10 PM

Q - initial: 570 gpm (21.0 inches)
- complete: 594 gpm (22.75 inches)

Quantity: 187,000 gal

3. SPECIFIC CAPACITY TEST — DATE: 7/14/94

Time	Depth (ft)	Drawdown (ft)	Piezo-meter tube (in.)	Pumping rate (gpm)	Remarks
2:48 PM			21.0	570	7/13
8:10 PM			22.75	590	7/13
7:55 AM	50.00		22.5	590	PWL - Pump Off
8:24 AM	39.58				
8:26 AM	39.62	10.38			SWL

60 min. specific capacity: 56.8 gpm/ft

Comment: 28.5 gpm/ft increase (100.4%)

4. ACIDIZATION - INHIBITED MURIATIC ACID — DATE: 7/14/94

A. ACID INJECTION

Acid strength: 20° Baume
VERTEX acid

Quantity: 1,000 gal

Time - initial: 8:28 AM
- complete: 8:46 AM

Q: 56 gpm

Comment: None

B. DISPLACEMENT, 5,000 gal nonchlorinated water

Time - initial/complete	Quantity (gal)	Q (gpm)
9:50:11/9:51:11 AM	2,000	2,000
9:59:30/10:00:23	2,000	2,264
10:04:15/10:04:50	1,000	1,714

Comment: None

C. SURGING - Tank to well injections only reported

Time - initial/complete	Quantity (gal)	Q (gpm)
12:14:15/12:15:35 PM	2,000	1,500
12:27:00/12:28:00	2,000	2,000
12:40:40/12:41:45	2,000	1,846
1:14:07/1:15:11	2,000	1,875
1:55:10/1:56:15	2,000	1,846
2:38:33/2:39:40	2,000	1,791

Comments: Began surging activity at 12:05 PM. Well pump gas locked at first. It took until 12:13:50 to fill tank the first time.

D. PUMPED TO WASTE

Time - initial: 2:42 PM - Start pumping into system
- complete: 8:14 AM on 7/15

Q: 613 gpm Quantity: 645,000 gal

Comments: Outlet manhole accepts discharge from Wells 1A and 2A. Well 1A outlet position is low enough to possibly allow backflow into the well.

5. SPECIFIC CAPACITY TEST DATE: 7/15/94

Time	Depth (ft)	Drawdown (ft)	Piezometer tube (in.)	Pumping rate (gpm)	Remarks
7:57 AM	48.61	9.13	24.25	613	PWL
8:12	48.66	9.18	24.25	613	PWL
8:14					Pump Off
8:34	39.64				
8:44	39.48				SWL

60 min. specific capacity: 66.8 gpm/ft

Comment: 9.9 gpm/ft increase (17.5%)

6. 600 LB POLYPHOSPHATE APPLICATION DATE: 7/15/94

A. INITIAL CHLORINATION

Quantity: 2,000 gal Strength: 500 ppm

Time - initial: 8:45:05 AM Injection rate: 1,600 gpm
- complete: 8:46:20 AM

B. POLYPHOSPHATE INJECTION, 600 lb total

	Batch 1	Batch 2	Batch 3
Phosphate:	200 lb	200 lb	200 lb
Quantity H_2O:	2,000 gal	2,000 gal	2,000 gal
Time - initial:	8:54:10 AM	9:02:33 AM	9:10:45 AM
- complete:	8:55:13 AM	9:03:29 AM	9:11:39 AM
Injection rate:	1,905 gpm	2,143 gpm	2,222 gpm

Comment: None

C. DISPLACEMENT, 30,000 gallons chlorinated water (500 mg/L) - in tank batches of 2,000 gal each

Time - initial/complete	Q (gpm)
9:19:50/9:20:52 AM	1,791
9:29:27/9:30:23	2,143
9:38:17/9:39:13	2,143
9:46:58/9:47:57	2,034
9:55:52/9:56:47	2,182
10:04:49/10:05:50	1,967
10:13:30/10:14:39	1,739
10:23:16/10:24:14	2,069
10:32:25/10:33:30	1,846
10:41:42/10:42:44	1,935
10:51:35/10:52:37	1,935
11:00:40/11:01:41	1,967
11:09:47/11:10:42	2,182
11:18:33/11:19:23	2,400
11:27:18/11:28:15	2,105

Comment: One 55 gal drum sodium hypochlorite used with every 5 displacements (10,000 gal water).

D. SURGING - Cycles of 2,000 gal each

Well to tank time - initial/complete	Q (gpm)	Tank to well time - initial/complete	Q (gpm)
12:34:40/12:36:20 PM	1,200	12:37:04/12:37:55 PM	2,353
12:53:15/12:54:55	1,200	12:55:34/12:56:33	2,034
1:02:15/1:03:47	1,304	1:04:18/1:05:11	2,264
1:21:47/1:23:25	1,224	1:24:02/1:24:57	2,182
1:40:35/1:42:11	1,250	1:42:50/1:43:44	2,222
1:55:52/1:57:26	1,277	1:57:57/1:58:47	2,400
2:12:35/2:14:03	1,364	2:15:45/2:16:34	2,449
2:35:00/2:36:32	1,304	2:36:58/2:37:50	2,308
2:44:55/2:46:25	1,333	2:46:45/2:47:36	2,353
2:51:02/2:52:45	1,165	2:53:05/2:54:00	2,182

E. PUMPED TO WASTE

Time - initial: 2:58 PM (7/15/94)
- complete: 8:25 AM (7/18/94)

Q: 635 gpm (26.0 inches) Quantity: 2,570,000 gal

Comments: The electrical control box along I-55/I-70 northbound was hit by a vehicle over the weekend and knocked out all the wells under its control. The recorder shows water levels rising rapidly.

7. SPECIFIC CAPACITY TEST DATE: 7/18/94

Time	Depth (ft)	Drawdown (ft)	Piezometer tube (in.)	Pumping rate (gpm)	Remarks
8:25 AM	44.51		26.0	635	PWL - Pump Off
8:55	35.82	8.69			SWL

60 min. specific capacity: 73.1 gpm/ft

Comment: 6.3 gpm/ft increase (9.4%)

8. 600 LB POLYPHOSPHATE APPLICATION — DATE: 7/18/94

A. INITIAL CHLORINATION

Quantity: 2,000 gal — Strength: 500 mg/L

Time - initial: 10:30:18 AM — Injection rate: 2,105 gpm
- complete: 10:31:15 AM

B. POLYPHOSPHATE INJECTION, 600 lb total

	Batch 1	Batch 2	Batch 3
Phosphate:	200 lb	200 lb	200 lb
Quantity H_2O:	2,000 gal	2,000 gal	2,000 gal
Time - initial:	10:38:15 AM	10:46:19 AM	10:54:11 AM
- complete:	10:39:04 AM	10:47:12 AM	10:54:55 AM
Injection rate:	2,449 gpm	2,264 gpm	2,727 gpm

C. DISPLACEMENT, 54,000 gal chlorinated water (500 mg/L) - in tank batches of 2,000 gal each

Time - initial/seconds	Q (gpm)
11:02:39 AM / 55	2,182
11:10:35 / 49	2,449
11:19:03 / 47	2,553
11:27:32 / 46	2,609
11:36:40 / 54	2,222
11:45:00 / 55	2,182
11:54:00 / 55	2,182
12:03:00 PM / 55	2,182
12:11:50 / 52	2,308
12:21:47 / 58	2,069
12:30:10 / 45	2,667
12:38:35 / 57	2,105
12:47:05 / 40	3,000
12:54:05 / 60	2,000
1:03:50 / 60	2,000
1:12:45 / 58	2,069
1:20:45 / 45	2,667
1:29:26 / 61	1,967

Comment: None

D. SURGING - Cycles of 2,000 gal each

Well to tank time - initial/seconds	Q (gpm)	Tank to well time - seconds	Q (gpm)
3:40 PM / 90	1,333	50	2,400
3:46 / 87	1,379	45	2,667
3:54 / 85	1,412	42	2,857
4:03 / 91	1,319	43	2,791
4:07 / 89	1,348	44	2,727
4:18 / 87	1,379	39	3,077
4:30 / 88	1,364	43	2,791
4:39 / 90	1,333	42	2,857
4:47 / 85	1,412	42	2,857
4:56 / 89	1,348	41	2,927
5:01 / 95	1,263	40	3,000
5:07 / 92	1,304	40	3,000
5:13 / 97	1,237	44	2,727
5:17 / 85	1,412	46	2,609
5:22 / 95	1,263	40	3,000
5:27 / 90	1,333	41	2,927
5:33 / 85	1,412	42	2,857

Comment: A 55 gal drum of sodium hypochlorite is being used with about every 6 displacements.

E. PUMPED TO WASTE

Time - initial: 5:36 PM (7/18/94)
- complete: 7:40 AM (7/19/94)

Q: 635 gpm

Quantity: 536,000 gal

9. SPECIFIC CAPACITY TEST

DATE: 7/19/94

Time	Depth (ft)	Drawdown (ft)	Piezo-meter tube (in.)	Pumping rate (gpm)	Remarks
7:40 AM	42.16		26.0	635	PWL - Pump Off
8:18	33.72	8.44			SWL

60 min. specific capacity: 75.2 gpm/ft

Comment: 2.2 gpm/ft increase (3.0%), treatment concluded

Well Rehabilitation Field Notes

WELL SITE: I-70 Well 9A OBSERVER: Robert Olson

CONTRACTOR: Layne-Western Company, Inc.

MEASURING POINT: Access hole in temporary wellhead, approximately 2.6 ft above pit cover

MEASURING EQUIPMENT: Layne 6x5 in. orifice tube, steel tape

1. SPECIFIC CAPACITY TEST DATE: 7/27/94

Time	Depth (ft)	Drawdown (ft)	Piezo-meter tube (in.)	Pumping rate (gpm)	Remarks
8:02 AM	36.08				SWL
8:11			25.0	622	Pump On
8:33			23.5	603	
9:12	44.67	8.59	23.25	600	PWL

Note: All specific capacity tests--static water level (SWL) measured after minimum 30 min. period of well inactivity. Minimum period of pumpage for drawdown measurements is 60 min.

60 min. specific capacity: 69.9 gpm/ft

Comments: An attempt was made to begin polyphosphate application, but the supply well (I-64 Well 1) would cut out so treatment was delayed until 7/28 when hose could be attached to I-70 Well 13 for supply. About 2,500 gal of chlorinated water was pumped into the well on 7/27.

2. 400 LB POLYPHOSPHATE APPLICATION DATE: 7/28/94

A. INITIAL CHLORINATION

Quantity: 1,000 gal Strength: 500 mg/L

Time - initial: 8:17:50 AM Injection rate: 2,000 gpm
- complete: 8:18:20 AM

B. POLYPHOSPHATE INJECTION, 400 lb total

	Batch 1	Batch 2
Phosphate:	200 lb	200 lb
Quantity H_2O:	2,000 gal	2,000 gal
Time - initial:	8:21:43 AM	8:31:07 AM
- complete:	8:22:32 AM	8:32:00 AM
Injection rate:	2,449 gpm	2,264 gpm

C. DISPLACEMENT, 16,000 gal chlorinated water (500 mg/L)

Time - initial/complete	Quantity (gal)	Q (gpm)
8:41:00/8:41:43 AM	2,000	2,791
8:50:21/8:51:10	2,000	2,449
9:00:02/9:00:53	2,000	2,353
9:09:28/9:10:17	2,000	2,449
9:19:00/9:19:53	2,000	2,264
9:28:23/9:29:14	2,000	2,353
9:37:25/9:38:24	2,000	2,034
9:46:46/9:47:38	2,000	2,308

Comment: None

D. SURGING - Cycles of 2,000 gal each

Well to tank time - initial/complete	Q (gpm)	Tank to well time - seconds	Q (gpm)
11:09:22/11:10:35 AM	1,644	40	3,000
11:14:02/11:15:40	1,224	43	2,791
11:19:00/11:20:43	1,165	42	2,857
11:25:15/11:26:49	1,277	43	2,791
11:31:39/11:33:21	1,176	40	3,000
11:37:00/11:38:40	1,200	41	2,927
11:42:13/11:43:50	1,237	42	2,857
11:47:38/11:49:13	1,263	43	2,791
11:53:09/11:54:49	1,200	44	2,727
11:59:23 AM /12:01:07 PM	1,154	45	2,667
12:05:51/12:07:27	1,250	40	3,000
12:16:22/12:17:54	1,304	43	2,791
12:24:29/12:26:11	1,176	44	2,727
12:32:20/12:34:00	1,200	41	2,927
12:39:23/12:40:58	1,263	41	2,927
12:48:27/12:50:05	1,224	40	3,000
12:56:45/12:58:20	1,263	44	2,727
1:04:28/1:06:08	1,200	44	2,727
1:11:54/1:13:31	1,237	41	2,927

Well to tank time - initial/complete	Q (gpm)	Tank to well time - seconds	Q (gpm)
1:19:32/1:21:06 PM	1,277	43	2,791
1:26:19/1:27:59	1,200	43	2,791
1:33:59/1:35:37	1,224	44	2,727
1:39:54/1:41:34	1,200	41	2,927
1:46:41/1:48:17	1,250	43	2,791
1:54:17/1:55:58	1,188	43	2,791

Comment: Foam blowing out of wellhead measuring point hole between surgings.

E. PUMPED TO WASTE

Time - initial: 2:00 PM (7/28/94)
- complete: ?*

Q - initial: 647 gpm (27.0 inches) Quantity: ?
- complete:

Comment: *Pumping stopped during the night as a fuse was blown.

3. SPECIFIC CAPACITY TEST DATE: 7/29/94

Time	Depth (ft)	Drawdown (ft)	Piezo-meter tube (in.)	Pumping rate (gpm)	Remarks
8:18 AM	35.47				SWL
9:28			23.5	603	Pump On
9:45	42.03		23.0		
9:59	42.11	6.64	23.0	597	Stopped the test short because acid was delivered and waiting in tank

60 min. specific capacity: 89.9 gpm/ft

Comment: 20 gpm/ft increase (29%)

4. ACIDIZATION - INHIBITED MURIATIC ACID DATE: 7/29/94

A. ACID INJECTION

Acid strength: 20° Baume Quantity: 1,000 gal

Time - initial: 10:05 AM Q: 500 gpm
- complete: 10:07 AM

B. DISPLACEMENT, 5,000 gal nonchlorinated water

Time - initial/complete	Quantity (gal)	Q (gpm)
11:07:07/11:07:56 AM	2,000	2,449
11:18:00/11:18:59	2,000	2,034
11:24:05/11:24:35	1,000	2,000

C. SURGING - Cycles of 2,000 gal each

Well to tank time - initial/complete	Q (gpm)	Tank to well time - initial/complete	Q (gpm)
1:25/2:05 PM	Pump gas locking	1:33:23/1:34:34 PM	1,690
1:36:38/1:40:41	494	1:41:00/1:41:57	2,105
1:45:32/1:49:55	456	1:50:00/1:51:04	1,875
1:53:07/1:56:14	642	1:56:30/1:57:17	2,553
1:59:58/2:02:36	759	2:02:53/2:03:37	2,727
2:06:27/2:09:11	732	2:09:23/2:10:08	2,667
2:12:10/2:14:08	1,017	2:14:26/2:15:10	2,727
2:16:13/2:18:18	960	2:18:32/2:19:13	2,927
2:21:50/2:22:45	2,182	2:22:58/2:23:40	2,857
2:25:04/2:26:02	2,069	2:26:13/2:26:56	2,791
2:29:15/2:31:14	1,008	2:31:30/2:32:13	2,791
2:33:32/2:35:30	1,017	2:35:43/2:36:24	2,927

Comment: None

D. PUMPED TO WASTE

Time - initial: 2:38 PM (7/29)
- complete: time unknown (8/1)

Q: 635 gpm (26 inches) Quantity:

Comments: Pump broke down after 35 min. of pumpage. Pump was pulled and repaired on Monday (8/1). Pump was turned on and resumed at 23.5-24 in. (603-610 gpm) for an unknown period of time.

5. SPECIFIC CAPACITY TEST DATE: 8/2/94

Time	Depth (ft)	Drawdown (ft)	Piezo-meter tube (in.)	Pumping rate (gpm)	Remarks
8:00 AM			15.25		
8:12			19.50		
8:18			24.50		
8:28			23.50	603	
8:45	42.70		23.50	603	PWL
8:55					Pump Off
9:25	36.46	6.24			SWL

60 min. specific capacity: 96.6 gpm/ft

Comment: 6.7 gpm/ft increase (7%)

6. 600 LB POLYPHOSPHATE APPLICATION DATE: 8/2/94

A. INITIAL CHLORINATION

Quantity: 2,000 gal Strength: 500 mg/L

Time - initial: 9:26:13 AM Injection rate: 3,077 gpm
- complete: 9:26:52 AM

B. POLYPHOSPHATE INJECTION, 600 lb total

	Batch 1	Batch 2	Batch 3
Phosphate:	200 lb	200 lb	200 lb
Quantity H_2O:	2,000 gal	2,000 gal	2,000 gal
Time - initial:	9:35:03 AM	9:43:36 AM	9:52:11 AM
- complete:	9:35:50 AM	9:44:14 AM	9:52:56 AM
Injection rate:	2,553 gpm	3,158 gpm	2,667 gpm

C. DISPLACEMENT, 30,000 gal chlorinated water (500 mg/L) - in tank batches of 2,000 gal each

Time - initial/complete	Q (gpm)
10:00:23/10:01:12 AM	2,449
10:09:26/10:10:12	2,609
10:18:21/10:19:10	2,449
10:27:25/10:28:09	2,727
10:36:13/10:37:00	2,553

Time - initial/complete	Q (gpm)
10:44:56/10:45:45 AM	2,449
10:53:53/10:54:43	2,353
11:03:06/11:03:56	2,400
11:12:14/11:13:02	2,500
11:21:15/11:22:04	2,449
11:30:20/11:31:40	1,500
11:39:27/11:40:18	2,353
11:48:30/11:49:20	2,400
11:57:24/11:58:12	2,500
12:06:14/12:07:11 PM	2,105

Comments: One 55 gal drum of sodium hypochlorite used with every five to six displacements.

D. SURGING - Cycles of 2,000 gal each

Well to tank time - initial/complete	Q (gpm)	Tank to well time - initial/complete	Q (gpm)
1:09:45/1:11:48 PM	976	1:11:32/1:12/11 PM	3,077
1:13:53/1:15:30	1,224	1:15:55/1:16:37	2,857
1:17:46/1:19:19	1,290	1:19:38/1:20:15	3,243
1:22:17/1:23:58	1,188	1:24:16/1:24:57	2,927
1:26:27/1:28:02	1,263	1:28:20/1:29:01	2,927
1:30:30/1:32:03	1,290	1:32:21/1:33:00	3,077
1:34:45/1:36:23	1,224	1:36:42/1:37:21	3,077
1:39:00/1:40:20	1,500	1:40:49/1:41:26	3,243
1:43:27/1:45:02	1,263	1:45:18/1:45:56	3,158
1:48:34/1:49:58	1,429	1:50:14/1:50:53	3,077
1:52:35/1:53:53	1,538	1:54:09/1:54:49	3,000
1:56:43/1:58:22	1,212	1:58:43/1:59:19	3,333
2:00:59/2:02:29	1,333	2:02:46/2:03:20	3,529
2:05:25/2:07:00	1,263	2:07:18/2:07:59	2,927
2:10:07/2:11:35	1,364	2:11:55/2:12:33	3,158
2:14:04/2:15:37	1,290	2:15:53/2:16:43	2,353
2:18:35/2:20:12	1,237	2:20:28/2:21:08	3,000
2:23:14/2:24:51	1,237	2:25:07/2:25:47	3,000
2:27:51/2:29:27	1,250	2:29:43/2:30:23	3,000
2:32:20/2:33:59	1,212	2:34:20/2:34:59	3,077
2:36:20/2:37:57	1,237	2:38:19/2:39:01	2,857
2:41:05/2:42:30	1,412	2:42:51/2:43:31	3,000
2:44:40/2:46:20	1,200	2:46:38/2:47:16	3,158
2:48:41/2:50:36	1,043	2:51:00/2:51:45	2,667
2:53:05/2:54:31	1,395	2:54:58/2:55:37	3,077
2:58:05/2:59:39	1,277	2:59:59/3:00:40	2,927
3:03:05/3:04:52	1,121	3:05:07/3:05:50	2,791

E. PUMPED TO WASTE

Time - initial: 2:10 PM (8/2/94)
- complete: 7:45 AM (8/3/94)

Q - initial: 665 gpm (28.5 inches)   Quantity: 700,000 gal
- complete: 659 gpm (28.0 inches)

7. SPECIFIC CAPACITY TEST   DATE: 8/3/94

Time	Depth (ft)	Drawdown (ft)	Piezo-meter tube (in.)	Pumping rate (gpm)	Remarks
7:45 AM			28.0	659	
7:50	43.39				PWL
7:54					Pump Off
8:21	36.82	6.57			SWL

60 min. specific capacity: 100.3 gpm/ft

Comments: 3.67 gpm improvement (3.8%), treatment concluded

Appendix E

Sieve Data for Material Pumped from Dewatering Wells FY 94 (Phase 11)

Appendix E. Sieve Data for Material Pumped from Dewatering Wells (Cumulative Percent Retained)

Site	*I-64*	*I-64*	*Venice*
Well	*8*	*9*	*4*
Date collected	04/15/96	08/18/94	05/11/94
Sample no.	PS 10729	PS 10730	PS 10731
Sample wt (gm)	212.83	42.26	161.51
U.S. Sieve No./ Sieve opening (mm)			
10 (2.000)	0.02	0.12	0.50
18 (1.000)	0.11	0.43	1.00
25 (0.710)	-	0.52	-
35 (0.500)	0.17	0.57	2.50
45 (0.355)	0.55	0.69	2.79
60 (0.250)	2.11	2.06	7.70
120 (0.125)	34.55	42.33	81.49
170 (0.090)	70.53	-	95.66
230 (0.063)	96.77	98.30	99.62
Pan	99.97	99.88	99.95
Specific gravity	2.51	2.50	2.55

Appendix F

Chemical Quality Data
FY 84 - FY 94 (Phases 1-11)

Appendix F. Chemical Quality Data, FY 84-FY 94 (Phases 1-11)

I-70 Site

Well	*Date*	*Lab No.*	*Iron*	*Manganese*	*Calcium*	*Magnesium*	*Sodium*	*Silica*	*Nitrate*	*Chloride*	*Sulfate*	*Alkalinity**	*Hardness**	*TDS*
1	08/15/84	220249	10.20		201	45.0	124.0	29.8	3.7	136	320	480	687	1203
1	08/14/85	221273	10.98		218	48.0	112.0	23	2.9	140	360	488	741	1279
1	05/17/89	223086	6.02	1.40	177	37.6	118.0	28.6	1.6	85	347	479	596	1046
1A	04/26/95	228642	11.33	1.49	232	48.7	182	33.3	0.20	192	369	510	779	1446
2	07/19/83	218825	11.90		180	40.0	127.0	31.4		131	290	464	614	1105
2	08/15/85	221272	5.55		182	42.4	124.0	20		140	360	464	628	1159
2	06/20/88	222598	11.20	1.20	177	40.0	110.0	30.9	0.4	138	246	465	606	1088
2	02/01/89	222892	10.60	0.61	160	45.0	68.9	28.9	0.2	128	261	395	584	967
2A	11/16/93	227238	14.00	1.35	228	49.6	176	36.9	0.03	200	299	482	773	1308
2A	08/22/94	227955	12.54	1.32	216	45.8	208	31.8	0.05	234	354	507	727	1435
3	06/28/83	218685	14.40		224	52.2	112.0	32.8		198	307	440	774	1238
3	06/24/86	221686	14.80	0.86	162	40.0	180.0	31.6		230	300	444	569	1250
3	01/14/87	221954	8.70	0.81	211	40.8	99.0	31.6		154	266	416	694	1074
3	12/11/89	223290	7.57	0.76	162	38.8	33.2	32		69	222	385	564	826
3	04/17/90	223481	6.11	0.71	156	35.2	45.2			87	188	369	534	834
3A	10/29/93	227203	12.83	0.83	175	41.0	38.5	35.0	<0.02	53.1	175	374	605	877
4	08/17/84	220250	9.20		197	46.2	62.8	29.7	0.7	125	247	408	632	982
4	01/08/87	221949	6.90	0.95	219	40.0	33.6	29.6	0.9	79	221	369	711	854
4	05/11/95	228699	13.18	0.83	153	38.1	26.2	34.8	<0.02	73.6	153	349	538	743
5	07/10/84	220112	11.60		148	37.2	29.3	32		84	169	336	524	775
5	01/13/87	221953	7.50	0.88	187	38.8	33.2	31.1	1.2	83	195	360	626	787
5	02/02/89	222891	7.73	1.07	175	38.2	124.0	30		113	305	495	594	1099
5	10/14/93	227164	13.36	0.54	163	43.4	61.7	37.1	0.3	106	151	404	585	883
6	08/01/90	223646	10.80	0.44	152	40.5	55.5		0.3	58	242	355	546	858
6	10/29/91	225019	11.52	0.47	158	40.7	55.0	30.7	<0.1	81.0	218	363	562	839
6	05/12/95	228701	11.91	0.45	153	41.2	54.6	30.4	<0.02	64.9	192	386	551	832
7	06/30/83	218687	12.10		189	41.8	51.7	31.1		77	285	367	643	936
7A	07/23/87	222215	8.30	0.63	152	36.8	50.8	33.8		98	244	355	531	926
7A	06/27/90	223575	10.70	0.87	220	49.2	78.9			76	403	461	751	1198
7A	08/06/91	224511	12.10	0.79	196	43.0	77.9	34.1		98	304	429	666	1075
7A	05/05/94	227595	11.66	0.85	197	41.4	59.5	31.7	0.02	93.5	279	413	662	1005
8	08/01/84	220187	13.50		210	44.5	69.6	30.4		89	332	438	707	1076
8	12/05/85	221485	12.20		193	43.2	65.8	29.8		87	310	412	659	1011
8	06/22/88	222600	15.50	0.80	210	46.5	43.2	31		57	317	451	715	1089
8A	10/04/89	223203	10.59	0.95	208	42.7	72.4	30.8		103	322	457	695	1055
8A	10/01/91	224907	12.70	1.03	201	42.9	104.0	27.0	<0.1	144	317	447	678	1198
8A	12/17/92	226432	14.26	0.84	228	49.8	47.0	36.4	<0.1	67.0	302	441	774	1044
8A	03/16/94	227449	11.54	0.73	194	40.4	48.1	35.3	0.04	73.8	267	374	650	897
9	06/28/84	220091	12.20		178	43.4	81.5	32.2	0.4	108	320	376	623	1082
9A	10/03/89	223202	10.90	0.67	231	49.6	41.0	33.5		63	378	466	780	1099
9A	06/26/90	223574	16.60	0.70	232	54.9	230.0			71	694	522	805	1642
9A	04/26/91	224140	15.24	0.59	224	50.8	40.8	37.2		58	356	440	768	1112
9A	07/23/92	226027	16.96	0.60	232	55.5	76.6	36.4	0.3	64.0	441	477	807	1238
9A	05/12/94	227662	16.6	0.68	239	54.9	51.8	35.7	<0.02	66.5	422	462	822	1218
9A	09/09/94	227970	17.41	0.70	233	55.4	137		<0.02	82.7	521	497	809	1332
10	07/31/84	220186	13.10		202	51.2	47.9	33.3		67	332	424	715	1042
10	09/04/85	221318	16.10		234	58.4	50.4			57	450	432	824	1181
10	08/13/87	222254	11.30	0.60	218	54.4	44.4	36.5	0.2	68	376	424	768	1132
10	01/30/89	222889	11.42	0.56	189	47.0	38.8	33.7		63	354	436	665	1024
10	02/07/91	223980	12.65	0.54	225	56.6	60.4			73	455	424	794	1242
10	08/08/91	224512	14.20	0.54	198	50.4	65.4	35.7		78	399	388	701	1150
10	08/01/95	228881	15.04	0.58	213	52.3	114	37.3	<0.02	71	442	454	746	1280
11	08/02/84	220188	13.10		169	43.0	47.5	31.8		72	270	362	599	893
11	09/05/85	221319	15.90		204	53.3	65.4			57	420	396	728	1127
11	08/12/87	222253	9.00	0.50	170	44.8	55.6	28.6	0.2	102	271	349	608	930
11	01/31/89	222890	9.11	0.55	154	43.0	39.9	32.6		73	300	346	561	889
11A	10/28/93	227202	13.04	0.48	175	44.7	34.3	37.2	<0.02	38.7	192	399	620	912

Appendix F. Chemical Quality Data (Continued)

Fluoride	*Aluminum*	*Arsenic*	*Barium*	*Beryllium*	*Boron*	*Cadmium*	*Chromium*	*Copper*	*Lead*	*Mercury*	*Nickel*	*Potassium*	*Selenium*	*Silver*	*Zinc*	*Well*
																1
																1
																1
0.3	<0.017	<0.11	0.11	<0.003	1.07	<0.017	<0.007	<0.007	<0.066		<0.031	9.2	<0.18	<0.014	<0.02	1A
																2
																2
																2
																2
0.4	0.02	<0.11	0.12		1.03	<0.017	0.02	<0.01	<0.063		<0.031	12.6	<0.18	<0.014	<0.02	2A
0.3	0.018	<0.11	0.11	<0.003	1.01	<0.017	0.020	<0.007	<0.066		<0.031	10.0	<0.18	<0.014	<0.02	2A
																3
																3
																3
																3
																3
0.3	0.02	<0.11	0.08		0.1	<0.017	<0.007	<0.01	<0.063		<0.031	9.8	<0.18	<0.014	<0.02	3A
																4
																4
0.3	0.03	<0.11	0.07	<0.003	0.20	<0.017	<0.007	<0.007	<0.066		<0.031	3.4	<0.18	<0.014	<0.02	4
																5
																5
																5
0.3	<0.017	<0.11	0.10		0.10	<0.017	0.01	<0.01	<0.063		<0.031	5.9	<0.18	<0.014	<0.02	5
																6
0.3												7.8				6
0.5	0.04	<0.11	0.09	<0.003	0.34	<0.017	<0.007	<0.007	<0.066		<0.031	6.0	<0.18	<0.014	<0.02	6
																7
																7A
																7A
																7A
0.2	<0.017	<0.11	0.12		0.62	<0.017	<0.01	<0.01	<0.066		<0.031	9.0	<0.18	<0.014	<0.02	7A
																8
																8
																8
																8A
0.5																8A
0.7	0.03	<0.11	0.11		0.84	<0.017	<0.007	<0.006	<0.063		<0.031	10.4	<0.18	<0.014	<0.02	8A
0.3	0.03	<0.11	0.10		0.79	<0.017	0.009	<0.01	<0.063		<0.031	8.0	<0.18	<0.014	<0.02	8A
																9
																9A
																9A
																9A
0.7	0.027	<0.11	0.088		0.76	<0.017	<0.007	<0.006	<0.066	<0.05	<0.031	10.1	<0.18	<0.014	<0.02	9A
0.3	0.02	<0.11	0.09		0.98	<0.017	0.008	<0.01	<0.066		0.060	8.5	<0.18	<0.014	<0.02	9A
0.2	0.053	<0.11	0.09	<0.003	0.78	<0.017	0.019	<0.007	<0.066		<0.031	8.3	<0.18	<0.014	0.10	9A
																10
																10
																10
																10
																10
																10
0.2	0.09	<0.11	0.09	<0.003	0.65	<0.017	<0.007	<0.007	<0.066		<0.031	6.5	<0.18	<0.014	<0.02	10
																11
																11
																11
																11
0.4	0.02	<0.11	0.10		0.17	<0.017	<0.007	<0.01	<0.063		<0.031	10.2	<0.18	<0.014	<0.02	11A

Appendix F. Chemical Quality Data (Continued)

Well	*Date*	*Lab No.*	*Iron*	*Manganese*	*Calcium*	*Magnesium*	*Sodium*	*Silica*	*Nitrate*	*Chloride*	*Sulfate*	*Alkalinity**	*Hardness**	*TDS*
12A	06/16/83	218640	13.80		167	46.6	49.4	30.7		67	350	352	608	971
12A	07/30/86	221717	18.10	0.69	172	47.0	86.0	34.4		185	250	360	622	1050
12A	11/16/87	222342	8.50	0.50	158	43.6	62.5	27.3		113	222	316	574	816
12A	05/15/91	224201	11.84	0.48	131	43.8	92.4	33.4	0.2	158	224	341	507	987
12A	08/02/95	228882	10.71	0.63	152	38.7	46.2	34.2	<0.02	82.7	194	338	538	811
13	04/25/91	224138	9.72	0.46	147	37.0	33.2	36.8	0.1	39	184	322	519	736
13	04/25/95	228641	14.29	0.75	213	50.4	123.0	38.0	0.08	73.2	412	491	739	1257
14	12/20/90	223933	8.36	0.97	166	38.7	42.9	26.9	0.6	77	220	368	573	835
14	06/22/94	227793	2.97	1.37	206	47.2	59.8		0.46	83.9	285	422	708	1031
15	10/15/93	227163	18.84	0.75	229	63.8	111	34.4	0.2	140	265	593	834	1234
		Average	11.86	0.77	191	45.3	77.5	32.3	0.43	98	305	418	663	1053
		Minimum	2.97	0.44	131	35.2	26.2	20.0	<0.02	39	151	316	507	736
		Maximum	18.84	1.49	239	63.8	230.0	38.0	3.7	234	694	593	834	1642
		No. of samples	67	51	67	67	67	58	36	67	67	67	67	67

I-64 Site

Well	*Date*	*Lab No.*	*Iron*	*Manganese*	*Calcium*	*Magnesium*	*Sodium*	*Silica*	*Nitrate*	*Chloride*	*Sulfate*	*Alkalinity**	*Hardness**	*TDS*
1	07/21/87	222213	12.30	0.47	221	57.6	40.4	31.9		61	411	456	788	1183
1	09/24/91	224847	16.00	0.53	235	57.3	229	35.1	<0.1	73.0	685.0	504	822	1708
2	07/25/85	221219	16.60		228	56.8	33.1	35.6		50	410	428	802	1098
3	06/26/84	220089	20.00		227	61.8	87.1	33		55	625	428	821	1448
3	06/21/88	222599	18.40	0.60	258	62.0	64.8	33.4	0.4	64	516	461	899	1439
6	07/21/83	218827	17.60		225	60.3	85.4	33.8		45	580	424	809	1323
8	04/15/96	229408	21.04	0.70	295	73.7	487	35.8	<0.02	370	1438	514	1039	2821
9	10/05/83	219087	12.90		202	53.8	29.8	32.9	0.3	41	350	412	725	974
9	08/18/94	227956	16.12	0.55	240	57.5	558		<0.02	389	951	545	835	2624
10	07/11/84	220113	18.70		277	74.1	222.0	32.8		390	636	424	998	1997
11	08/14/84	220248	15.90		220	54.1	45.6	35.2	0.3	61	358	448	771	1111
11	06/16/89	223066	15.00	0.56	215	44.3	44.3	33.4		60	376	501	761	1198
13	07/12/84	220114	15.80		204	53.3	29.8	34.7	2.3	50	361	412	729	1080
14	08/03/90	223648	12.35	0.52	213	47.5	269.0		0.3	61	713	512	727	1762
15	06/29/83	218686	20.00		260	60.8	75.2	35.4		57	585	416	899	1388
15	08/13/85	221271	17.90		254	62.4	119.0	30.5		59	710	420	890	1580
15	07/22/87	222214	14.00	0.60	243	64.0	166.0	33.6		62	787	456	870	1750
		Average	16.51	0.57	236	58.9	152.1	33.8	0.5	115	617	457	834	1558
		Minimum	12.30	0.47	202	44.3	29.8	30.5	<0.1	41	350	412	725	974
		Maximum	21.04	0.70	295	74.1	558.0	35.8	2.3	390	1438	545	1039	2821
		No. of samples	17	8	17	17	17	15	8	17	17	17	17	17

Appendix F. Chemical Quality Data (Continued)

Fluoride	*Aluminum*	*Arsenic*	*Barium*	*Beryllium*	*Boron*	*Cadmium*	*Chromium*	*Copper*	*Lead*	*Mercury*	*Nickel*	*Potassium*	*Selenium*	*Silver*	*Zinc*	*Well*
																12A
																12A
																12A
																12A
0.2	0.03	<0.11	0.08	<0.003	0.35	<0.017	<0.007	<0.01	<0.066		<0.031	5.2	<0.18	<0.014	<0.02	12A
																13
0.3	0.048	<0.11	0.13	<0.003	0.83	<0.017	<0.007	<0.007	<0.066		<0.031	6.1	<0.18	<0.014	<0.02	13
																14
0.3	<0.017	<0.11	0.07		0.62	<0.017	<0.007	<0.01	<0.066		<0.031	6.08	<0.18	<0.014	<0.02	14
0.3	<0.017	<0.11	0.14		0.51	<0.017	0.01	<0.01	<0.063		<0.031	8.5	<0.18	<0.014	<0.02	15
0.3	0.03	<0.11	0.10	<0.003	0.62	<0.017	0.01					8.1	<0.18	<0.014		
0.2	<0.017		0.07		0.10		<0.007	<0.006	<0.063		<0.031	3.4			<0.02	
0.7	0.09		0.14		1.07		0.02	<0.01	<0.066		0.060	12.6			0.10	
21	19	19	19	8	19	19	19	19	19	1	19	20	19	19	19	

Fluoride	*Aluminum*	*Arsenic*	*Barium*	*Beryllium*	*Boron*	*Cadmium*	*Chromium*	*Copper*	*Lead*	*Mercury*	*Nickel*	*Potassium*	*Selenium*	*Silver*	*Zinc*	*Well*
																1
1.0																1
																2
																3
																3
																6
0.3	0.19	<0.11	0.11	<0.003	0.67	<0.017	0.009	<0.01	<0.066		<0.031	8.0	<0.18	<0.014	<0.02	8
																9
0.8	0.024	<0.11	0.09	<0.003	0.72	<0.017	<0.018	<0.007	<0.066		<0.031	9.5	<0.18	<0.014	<0.02	9
																10
																11
																11
																13
																14
																15
																15
																15
3	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2	

Appendix F. Chemical Quality Data (Continued)

25th Street Site

Well	*Date*	*Lab No.*	*Iron*	*Manganese*	*Calcium*	*Magnesium*	*Sodium*	*Silica*	*Nitrate*	*Chloride*	*Sulfate*	*Alkalinity**	*Hardness**	*TDS*
1	02/11/89	223141	8.50	0.66	166	46.8	120.0		0.2	34	548	415	607	1226
1	09/04/91	224802	15.10	0.55	200	55.7	262.0	34.0	<0.1	28.9	850	419	728	1777
2	08/09/89	223142	8.10	0.52	205	59.9	251.0		0.2	37	928	451	758	1816
2	04/18/90	223480	5.40	0.39	240	68.8	226.0			35	972	451	882	1891
3	09/06/85	221320	17.90		222	61.9	143.0			38	680	404	808	1484
3	09/07/89	223167	14.90	0.62	246	66.9	254.0	32.1		47	939	474	889	1925
3	05/14/91	224200	22.90	0.72	179	73.1	314.0	35.7		49	1171	477	747	2335
3	12/19/90	223932	18.30	0.69	239	65.2	220.0	31.2		33	911	449	864	1911
4	08/02/90	223647	14.90	0.62	250	66.8	276.0		0.1	39	944	457	898	2032
4	11/19/91	225122	9.04	0.56	175	47.3	75.0	36.4	<0.1	34	353	397	631	993
4	07/24/92	226026	17.69	0.64	234	61.4	261	35.1	<0.1	44	902	475	836	1880
5	05/16/89	223085	8.90	0.57	137	38.9	15.7	32.1		24	181	369	502	688
5	04/19/90	223479	4.90	0.49	129	35.4	16.5			23	160	360	467	661
6	06/27/84	220090	10.50		132	38.0	14.2	34		24	176	334	486	663
6	01/07/87	221948	8.40	0.36	152	38.0	15.2	33.3		26	167	334	536	644
6	02/08/91	223981	9.30	0.39	139	39.2	15.1			32	201	331	508	683
7	03/21/91	224038	12.20	0.45	145	43.1	22.3	33.4		48	191	331	539	738
8	06/15/83	218639	9.10		124	38.7	16.6	33.4		21	185	356	469	659
8	04/24/91	224139	11.90	0.78	134	39.1	17.4	38.1	0.2	31	122	351	495	612
8	11/15/93	227237	12.19	0.70	152	44.8	22.7	39.4	0.03	41.9	155	360	564	682
9	06/25/86	221687	18.90	0.82	123	42.0	17.5	32.5		21	190	352	480	688
9	09/18/91	224803	12.20	0.54	156	45.8	58.6	34.0	<0.1	28.9	325	369	578	911
10	07/26/85	221220	16.50		193	53.6	179.0	33.9		30	660	412	702	1408
10	11/18/87	222344	4.50	0.50	176	52.5	153.0	32.7	0.2	39	571	406	655	1332
		Average	12.18	0.58	177	51.0	123.6	34.2	0.1	34	520	397	651	1235
		Minumum	4.50	0.36	123	35.4	14.2	31.2	<0.1	21	122	331	467	612
		Maximum	22.90	0.82	250	73.1	314.0	39.4	0.2	49	1171	477	898	2335
		No. of samples	24	20	24	24	24	17	10	24	24	24	24	24

Appendix F. Chemical Quality Data (Continued)

Fluoride	*Aluminum*	*Arsenic*	*Barium*	*Beryllium*	*Boron*	*Cadmium*	*Chromium*	*Copper*	*Lead*	*Mercury*	*Nickel*	*Potassium*	*Selenium*	*Silver*	*Zinc*	*Well*
																1
0.8																1
																2
																2
																3
																3
																3
																3
																4
0.4																4
1.1	0.029	<0.11	0.117		0.22	<0.017	<0.007	<0.006	<0.066	<0.05	<0.031	9.4	<0.18	<0.014	<0.02	4
																5
																5
																6
																6
																6
																7
																8
																8
0.4	0.04	<0.11	0.09		0.08	<0.017	0.02	<0.01	<0.063		<0.031	6.0	<0.18	<0.014	<0.02	8
																9
0.3																9
																10
																10
0.6	0.035	<0.11	0.10		0.15	<0.017					<0.031	7.7	<0.18	<0.014	<0.02	
0.3	0.029		0.09		0.08							6				
1.1	0.04		0.117		0.22							9.4				
5	2	2	2	0	2	2	2	2	2	1	2	2	2	2	2	

Appendix F. Chemical Quality Data (Continued)

Well	*Date*	*Lab No.*	*Iron*	*Manganese*	*Calcium*	*Magnesium*	*Sodium*	*Silica*	*Nitrate*	*Chloride*	*Sulfate*	*Alkalinity**	*Hardness**	*TDS*
Venice Site														
1	11/30/83	219239	25.70		256	61.2	38.3	26.7		66	465	444	890	1241
1	12/04/85	221486	17.80		226	60.8	36.8	33		59	460	420	814	1169
1	09/06/89	223166	17.36	0.55	220	53.6	35.2	31.4		43	372	475	769	1114
1	03/29/94	227474	18.40	0.65	207	47.0	32.6	36.5	<0.02	36.4	330	417	710	955
2	11/17/83	219213	21.60		261	54.2	30.1	31.8	0.8	42	440	476	874	1195
2	09/05/89	223165	23.80	0.60	199	50.9	39.6	32.6		50	328	470	706	1002
2	05/08/90	223505	15.10	0.66	193	44.9	35.8			44	297	462	666	970
2	10/02/91	224908	17.20	0.65	193	42.2	34.9	30.8	<0.1	53.1	273	445	655	984
2	06/21/94	227790	18.54	0.76	213	44.2	37.0	37.8	<0.02	43.9	227	454	713	878
3	11/28/83	219237	20.10		216	51.7	65.1	26.6	0.3	79	325	472	752	1097
3	01/06/87	221947	15.30	0.56	253	52.0	39.2	34.3		55	343	469	845	1060
3	12/05/90	223911	17.10	0.55	194	46.7	49.5	37.9		57	218	461	676	972
3	12/16/91	225267	8.28	0.39	182	46.9	34.0	39.6	<0.1	73.6	249	399	647	890
3	07/01/94	227791	16.96	0.51	198	50.9	46.1		<0.02	46.5	289	389	703	957
4	12/01/83	219241	20.70		208	52.8	50.0	25.3	0.6	86	330	424	735	1054
4	12/06/90	223912	10.93	0.52	196	47.9	40.9	34.6		62	284	417	686	950
4	09/17/91	224804	15.00	0.45	180	45.2	44.5	32.3		85	311	400	635	999
4	05/11/94	227661	18.4	0.52	195	48.6	43.6	38.4	<0.02	71.9	245	424	686	971
5	11/15/83	219212	20.30		224	55.8	38.5	31.8		65	380	428	788	1104
5	12/07/89	223289	11.00	0.52	185	50.6	44.7	31.6		68	313	425	670	990
5	05/02/90	223504	15.10	0.58	187	50.9	50.2			74	314	443	676	1011
5	03/24/92	225674	17.60	0.56	198	50.9	47.7	34.9	0.1	124	490	418	703	982
6	11/29/83	219238	22.70		226	56.0	38.1	24.4		62	410	402	794	1138
6	11/17/87	222343	9.60	0.40	196	55.4	41.3	33.8		55	419	387	717	1087
6A	03/20/91	224037	15.40	0.48	184	48.2	45.6	33.2		62	284	400	657	958
6A	06/23/94	227792	18.94	0.55	201	48.6	53.2		<0.02	77.1	243	440	701	991
7	02/27/91	224009	18.08	0.72	223	46.7	38.4	34.4		25	300	432	748	1000
7	05/04/94	227594	16.61	0.64	188	42.9	28.9	34.7	<0.02	35.8	262	426	645	892
		Average	17.27	0.56	207	50.3	41.4	32.9	0.2	60.8	329	433	724	1022
		Minimum	8.28	0.39	180	42.2	28.9	24.4	<0.02	25	218	387	635	878
		Maximum	25.7	0.76	261	61.2	65.1	39.6	0.8	124	490	476	890	1241
		No. of samples	28	21	28	28	28	24	12	28	28	28	28	28
Missouri Avenue Site														
1	02/10/95	228405	7.16	0.99	205	40.0	59.0	23.8	0.53	88.9	254	398	676	925
2	02/16/95	228437	11.27	1.18	243	65.3		30.8	0.06	87.3	348	497	875	1168
3	02/16/95	228438	12.82	1.03	231	46.2	72.4	32.2	<0.02	70.4	317	521	766	1149
		Average	10.42	1.07	226	50.5	65.7	28.9	0.20	82.2	306	472	772	1081
		Minimum	7.16	0.99	205	40	59	23.8	<0.02	70.4	254	398	676	925
		Maximum	12.82	1.18	243	65.3	72.4	32.2	0.53	88.9	348	521	875	1168
		No. of samples	3	3	3	3	2	3	3	3	3	3	3	3

Notes:

TDS - Total dissolved solids

All chemical concentration data units are in mg/L

* - Reported as calcium carbonate ($CaCO_3$)

Appendix F. Chemical Quality Data (Concluded)

Fluoride	*Aluminum*	*Arsenic*	*Barium*	*Beryllium*	*Boron*	*Cadmium*	*Chromium*	*Copper*	*Lead*	*Mercury*	*Nickel*	*Potassium*	*Selenium*	*Silver*	*Zinc*	*Well*
																1
																1
																1
0.2	0.1	<0.11	0.14		1.43	<0.017	0.013	<0.01	<0.066		<0.031	7.8	<0.18	<0.014	<0.02	1
																2
																2
																2
0.4																2
0.2	<0.017	0.11	0.17		1.52	<0.017	0.014	<0.01	<0.066		<0.031	4.85	<0.18	<0.014	<0.02	2
																3
																3
																3
0.3																3
0.2	<0.017	<0.11	0.14		0.79	<0.017	<0.007	<0.01	<0.066		<0.031	4.25	<0.18	<0.014	<0.02	3
																4
																4
																4
0.3	0.02	<0.11	0.14		0.80	<0.017	<0.007	<0.01	<0.066		<0.031	5.6	<0.18	<0.014	<0.02	4
																5
																5
																5
0.5																5
																6
																6
																6A
0.2	0.018	<0.11	0.16		0.86	<0.017	<0.007	<0.01	<0.066		<0.031	5.70	<0.18	<0.014	<0.02	6A
																7
0.3	0.02	<0.11	0.12		0.64	<0.017	0.008	<0.01	<0.066		<0.031	7.07	<0.18	<0.014	<0.02	7
0.3	0.03		0.145		1.0067	<0.017	0.008	<0.01	<0.066		<0.031	5.88	<0.18	<0.014	<0.02	
0.2	0		0.12		0.64		<0.007					4.25				
0.5	0.1		0.17		1.52		0.014					7.8				
9	6	6	6	0	6	6	6	6	6	0	6	6	6	6	6	
0.4	0.066		0.13	<0.003	0.68		<0.007		0.42		0.046	6.1				1
0.4	<0.017	<0.11	0.14	<0.003	1.13	<0.017	<0.007	<0.007	<0.066		<0.031	6.3	<0.18	<0.015	<0.02	2
0.3	<0.017	<0.11	0.15	<0.003	1.25	<0.017	0.010	<0.007	<0.066		<0.031	8.1	<0.18	<0.015	<0.02	3
0.4	0.02		0.14	<0.003	1.02	<0.017		<0.007	<0.066			6.83	<0.18	<0.015	<0.02	
0.3	<0.017		0.13		0.68							6.1				
0.4	0.066		0.15		1.25		0.01					8.1				
3	3	2	3	3	3	2	3	2	3	0	3	3	2	2	2	

Appendix G

Dewatering Well Ground-Water Levels and Operation

FY 94 (Phase 11)

Appendix G. Dewatering Well Ground-Water Levels and Operation, FY 94 (Phase 11)

I-70 Site

			August 31, 1993		*Oct 28-29, 1993*		*December 16, 1993*		*March 16, 1994*		*April 27, 1994*		*June 30, 1994*	
Well Piez	*MP Elev*	*Temp MP*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*
W 1A	*			Off?		Off		On		?		Off		Off
P 1A	*		41.88		36.32		35.04		36.64		34.04		37.82	
W 2A	*			On		On	35.64	Off		?		Off		Off?
P 2A	*		45.86		40.56				40.78		34.14		41.86	
W 3A	*		50.60	On	29.55	Off	49.59	On	51.92	On	50.35	On	51.83	On
P 3A	*		42.58		29.42		39.25		39.72		37.65		38.84	
W 4	389.1	396.6	369.9	Off	375.6	Off	373.2	Off	373.7	Off	375.9	Off	374.0	Off
P 4			Piezometer destroyed by new concrete footing for road sign.											
W 5	385.9	391.1	371.1	Off	365.8	On	364.0	On	363.1	On	365.2	On	364.2	On
P 5	391.1				Plugged		Plugged		Plugged		Plugged		Plugged	
W 6	386.6	391.7	373.6	Off	377.6	Off	375.7	Off	376.3	Off	377.3	Off	377.1	Off
P 6	391.9													
W 7A	*		26.67	On	11.69	Off	12.02	Off	10.69	Off	17.80	On	22.54	On
P 7A	*		24.46								16.76		19.45	
W 8A	*		25.44	On	18.26	On	18.36	On	8.99	Off	8.92	Off	12.20	Off
P 8A	*		22.21		14.58		15.12		9.24				12.36	
W 9A		407.8	360.3	On	377.2	Off	375.6	Off	376.9	Off	377.8	Off	368.1	On
P 9A	407.5		366.2	5.9									370.8	2.7
W 10	401.5	410.2		?		Off		?		?		?		?
P 10	409.8		Plugged		Plugged		Plugged		Plugged		Plugged		Plugged	

Appendix G. (Continued)

I-70 Site

			August 31, 1993		*Oct 28-29, 1993*		*December 16, 1993*		*March 16, 1994*		*April 27, 1994*		*June 30, 1994*	
Well Piez	*MP Elev*	*Temp MP*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*
W 11A	*			On	24.20	Off	44.70	On	45.28	On	45.01	On	45.27	On
P 11A	*		36.30		28.23		33.50		32.11		30.60		31.36	
W 12A		395.8	370.1	On	374.4	On	371.9	On	371.1	On	371.3	On	369.8	On
P 12A	395.8		372.3	2.2	375.5	1.1	373.4	1.5	373.6	2.5	374.2	2.9	373.7	3.9
W 13	397.0	407.0	361.0	On	365.2	On	361.2	On	360.6	On	361.0	On	360.3	On
P 13	407.2		367.2	6.2	372.9	7.7	370.6	9.4	372.5	11.9	373.7	12.7	372.5	12.2
W 14	382.5	391.0	362.30	On	367.4	On	364.0	On	363.4	On	371.9	On	363.8	On
P 14	390.8		369.20	6.9	374.0	6.6	371.2	7.2	372.0	8.6	374.9	3.0	372.9	9.1
W 15				On	27.82	On	33.70	On	35.90	On	34.85	On	35.90	On
P 15			23.09		19.17		21.19		20.32		19.18		18.91	
RW	390.6		369.1		377.0						376.8		373.6	

Appendix G. (Continued)

I-64 Site (Westbound)

			August 31, 1993		*October 28, 1993*		*December 16, 1993*		*March 17, 1994*		*April 27, 1994*		*June 30, 1994*	
Well Piez	*MP Elev*	*Temp MP*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*
W 1	399.7	407.6	375.3	Off	381.0	Off	379.5	Off	380.2	Off	386.6	Off	379.1	Off
P 1	406.6													
W 2	397.1	402.1	380.1	Off	384.1	Off	383.0	Off	383.1	Off	383.2	Off	382.9	Off
P 2	401.5													
W 3	394.6	402.1	382.4	Off	385.8	Off	384.9	Off	384.7	Off	384.6	Off	384.7	Off
P 3	400.0													
W 4	394.0	400.2	383.8	Off	386.9	Off	386.2	Off	385.7	Off	385.5	Off	385.7	Off
P 4	399.4													
W 5	396.5	401.1	385.3	Off	388.0	Off	387.5	Off	386.7	Off	386.2	Off	386.7	Off
P 5	400.2													
W 6	394.3	400.2	386.6	Off	389.0	Off	388.7	Off	384.5	On	383.6	On	382.9	On
P 6	399.9								385.4	0.9	384.9	1.3	385.2	2.3
W 7	392.2	398.0	387.3	Off	389.5	Off	389.2	Off	387.6	Off	387.0	Off	387.6	Off
P 7	397.6												387.8	
W 8	396.7	405.5	385.4	On	389.4	Off	389.5	Off	386.2	On	385.4	On	385.6	On
P 8	404.9		Plugged				Plugged		Plugged		Plugged		Plugged	
W 9	391.4	397.4	373.7	On	374.5	On	373.2	On	370.2	On	367.5	On	367.2	On
P 9	397.0		384.9	11.2	386.7	12.2	386.6	13.4	384.6	14.4	383.8	16.3	383.8	16.6
W 10	395.4	404.7	389.0	Off	390.6	Off	390.8	Off	389.9	Off	389.4	Off	390.0	Off
P 10	404.6													
RW 1	403.0		383.1		386.1						384.9		385.3	

Appendix G. (Continued)

I-64 Site (Eastbound)

Well Piez		MP Elev	Temp MP	August 31, 1993 GW Elev	August 31, 1993 Pump Δh	October 28, 1993 GW Elev	October 28, 1993 Pump Δh	December 16, 1993 GW Elev	December 16, 1993 Pump Δh	March 17, 1994 GW Elev	March 17, 1994 Pump Δh	April 27, 1994 GW Elev	April 27, 1994 Pump Δh	June 30, 1994 GW Elev	June 30, 1994 Pump Δh
W	11	397.0	402.8	379.5	Off	383.9	Off	382.9	Off	383.1	Off	383.1	Off	382.5	Off
P	11	402.5													
W	12	395.2	401.6	381.7	Off	385.3	Off	384.4	Off	384.4	Off	384.3	Off	384.2	Off
P	12	401.5													
W	13	394.3	399.1	383.7	Off	386.8	Off	386.1	Off	385.8	Off	385.5	Off	385.7	Off
P	13	399.1													
W	14	396.0	400.5	385.0	Off	387.8	Off	387.2	Off	386.6	Off	386.2	Off	386.6	Off
P	14	399.7													
W	15	395.1	400.5	386.4	Off	388.9	Off	388.5	Off	387.3	Off	386.8	Off	387.3	Off
P	15	399.7													
W	16	393.7	399.8	387.3	Off	389.5	Off	389.3	Off	387.8	Off	387.2	Off	387.8	Off
P	16	398.8													
W	17	392.1	398.0	387.7	Off	389.8	Off	389.9	Off	382.4	On	382.1	On	382.3	On
P	17	397.8								Plugged		Plugged		Plugged	
W	18	391.3	396.6	387.8	Off	389.7	Off	389.9	Off	388.2	Off	387.6	Off	388.4	Off
P	18	396.4													
W	19	391.8	397.0	388.3	Off	390.0	Off	390.2	Off	388.9	Off	388.4	Off	389.1	Off
P	19	397.0													
W	20	395.4	405.3	390.1	Off	391.5	Off	391.7	Off	390.9	Off	390.4	Off	391.1	Off
P	20	404.7													
RW	2	398.2		388.1		389.7						387.9		388.7	

Appendix G. (Continued)

25th Street Site

Well Piez	MP Elev	Temp MP	*August 31, 1993* GW Elev	Pump Δh	*October 28, 1993* GW Elev	Pump Δh	*December 16, 1993* GW Elev	Pump Δh	*March 17, 1994* GW Elev	Pump Δh	*April 27, 1994* GW Elev	Pump Δh	*June 30, 1994* GW Elev	Pump Δh
W 1	399.7	407.4	390.1	Off	390.5	Off	392.1	Off	391.8	Off	392.1	Off	386.5	On
P 1	407.3												389.2	2.7
W 2	394.6	402.8	388.5	Off	388.7	Off	390.7	Off	390.1	Off	390.4	Off	389.4	Off
P 2	401.9		388.4											
W 3	390.4	400.3	379.0	On	379.3	On	381.0	On	380.4	On	380.3	On	378.4	On
P 3	400.2		380.9	1.9	381.3	2.0	383.3	2.3	382.5	2.1	382.4	2.1	380.8	2.4
W 4	392.4	401.6	378.9	On	379.0	On	380.8	On	379.3	On	379.3	On	377.0	On
P 4	401.5		Plugged		Plugged		Plugged		Plugged		Plugged		Plugged	
W 5	396.2	404.2	387.3	Off	387.7	Off	389.6	Off	388.9	Off	389.3	Off	384.4	On
P 5	403.8												385.4	1.0
W 6	396.5	405.4	387.5	**	387.8	**	389.8	**	389.2	**	389.6	**	388.6	**
P 6	404.5													
W 7	392.6	402.9	378.7	On	378.6	On	379.5	On	379.2	On	379.5	On	378.9	On
P 7	402.0		Plugged		Plugged		Plugged		Plugged		Plugged		Plugged	
W 8	390.8	401.0	382.6	On	Leaking	On	389.2	Off	384.5	On	384.6	On	383.5	On
P 8	400.5		384.1	1.5	384.6				390.1	5.6	390.4	5.8	385.8	2.3
W 9	409.4	414.5	381.2	On	381.1	On	382.8	On	382.0	On	382.2	On	382.2	On
P 9	414.7		386.4	5.2	386.8	5.7	388.8	6.0	388.2	6.2	388.5	6.3	388.1	5.9
W 10	398.6	407.5	390.3	Off	390.6	Off	392.4	Off	392.0	Off	392.3	Off	391.3	Off
P 10	406.1													
RW	401.4		388.2		388.5						390.2		389.4	

Appendix G. (Continued)

Venice Site

			August 31, 1993		*October 28, 1993*		*December 16, 1993*		*March 1, 1994*		*April 28, 1994*		*July 1, 1994*	
Well Piez	*MP Elev*	*Temp MP*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*
W 1	405.6	411.6	385.1	On	386.6	On	384.4	On	380.3	On	383.1	On	381.0	On
P 1	411.2		Plugged				Plugged		Plugged		Plugged		Plugged	
W 2	405.6	411.0	395.4	On	396.1	Off	388.3	On	383.7	On	387.3	On	384.8	On
P 2	410.3		396.2	0.8			390.2	1.9	386.2	2.5	390.6	3.3	388.1	3.3
W 3	402.6	408.6	391.0	On	388.7	On	385.5	On	389.4	Off	392.6	Off	391.6	Off
P 3	408.4		395.7	4.7	393.9	5.2	390.9	5.4						
W 4	403.1	408.1	391.8	On	389.7	On	386.8	On	381.0	On	384.2	On	382.1	On
P 4	407.2		394.2	2.4	392.4	2.7	389.8	3.0	386.9	5.9	389.4	5.2	389.3	7.2
W 5	401.1	407.4	394.4	On	Leaking	On	390.0	On	386.7	On	389.6	On	387.4	On
P 5	407.2		395.4	1.0	393.6		391.0	1.0	387.7	1.0	Flooded		389.2	1.8
W 6A	400.8	408.4	397.4	Off	392.7	On?	389.3	On	384.7	On	387.9	On	385.7	On
P 6A	408.6		Damaged		394.0	1.3	391.2	1.9	387.9	3.2	391.4	3.5	388.5	2.8
W 7	399.3	407.5	384.9	On	379.2	On	374.9	On	370.5	On	371.5	On	369.0	On
P 7	409.1		391.7	6.8	390.1	10.9	387.1	12.2	383.5	13.0	386.6	15.1	384.8	15.8
RW	407.3		396.8		394.1				388.3		391.3		390.8	

Appendix G. (Concluded)

Missouri Avenue Site

			September 1, 1993		*December 16, 1993*		*March 17, 1993*		*April 27, 1994*		*June 30, 1994*	
Well Piez	*MP Elev*	*Temp MP*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*	*GW Elev*	*Pump Δh*
W 1	408.72				359.7	On	373.2	On	373.3	On	373.0	On
W 2	417.63				370.0	On	387.1	Off	388.8	Off	379.2	On
W 3 P 2-93	415.44				362.9	On	364.3	On	365.5	On	364.9	On
OW 1	416.75		386.0		380.7		387.2		388.9		385.0	
OW 2	418.67		385.6		381.5		385.4		387.2		385.1	
OW 3	402.49				384.4		388.7		390.6		387.6	

Notes:
GW Elev = ground-water elevation
MP Elev = measuring point elevation
OW = observation well
P or piez = piezometer
Pump = pump operation status
RW = recorder well
Temp MP = elevation of temporary measuring point
W = well
? Status uncertain/not verified
* Measuring point elevations not available; depths to water recorded
** Pump removed from well
Δh = difference in ground-water elevation between well and piezometer

Appendix H

Missouri Avenue Dewatering Wells:
Sieve Data for Aquifer Samples,
Gravel Pack Specifications, and
Well Construction Reports

Appendix H. Missouri Avenue Dewatering Wells: Sieve Data for Aquifer Samples, Gravel Pack Specification, and Well Construction Reports

Test Boring

Location: At I-55/I-64/I-70 westbound lanes; Sta 17+15; O/S 48' LT.B.L.
near SW corner, SW 1/4, Section 12, T.2 N., R.10 W., St. Clair County

Drilled by IDOT Bureau of Materials on June 7, 1993

Elevation (ft-msl)	*Depth (ft)*	*IDOT Driller's Log*
416.0-396.5	0.0-19.5	No samples
396.5-376.5	19.5-39.5	Brown fine-grained silty sand
376.5-374.0	39.5-42.0	Brown fine to coarse sand
374.0-359.5	42.0-56.5	Brown fine silty sand
359.5-347.0	56.5-69.0	Brown fine- to medium-grained silty sand
347.0-343.0	69.0-73.0	Gray and brown fine to coarse sand
343.0-339.5	73.0-76.5	Gray fine-grained silty sand
339.5-325.5	76.5-90.5	Gray fine to coarse sand with some gravel and cobbles
325.5-312.6	90.5-103.4	Gray fine to medium sand

Aquifer Material Samples Sieved by IDOT Bureau of Materials

		Sample	*U.S. Sieves, #/opening size, in mm*										
Elevation	*Depth*	*weight*	*#8*	*#16*	*#20*	*#30*	*#40*	*#50*	*#60*	*#70*	*#100*	*#200*	*Pan*
(ft-msl)	*(ft)*	*(g)*	*2.38*	*1.19*	*0.840*	*0.595*	*0.420*	*0.297*	*0.250*	*0.210*	*0.149*	*0.074*	
			(Cumulative Percent Retained)										
396.5-376.5	19.5-39.5	725.4	0.15	0.35	0.51	1.05	4.22	18.45	30.16	56.51	80.31	94.00	100
376.5-374.0	39.5-42.0		Sample not sieved										
374.0-359.5	42.0-56.5	662.1	0.35	0.83	1.66	3.82	11.98	31.02	42.32	67.56	86.38	94.64	100
359.5-347.0	56.5-69.0	619.8	2.47	8.20	13.54	24.01	43.39	59.84	69.09	75.15	87.21	94.43	100
347.0-343.0	69.0-73.0	714.6	15.09	22.73	41.51	55.01	70.70	81.65	85.80	87.81	92.64	96.00	100
343.0-339.5	73.0-76.5	659.0	0.06	0.23	0.58	1.56	5.33	16.86	35.68	53.16	72.87	90.52	100
339.5-325.5	76.5-90.5	1026.1	4.78	16.13	25.66	39.65	53.44	68.76	82.58	88.76	96.00	97.80	100
325.5-312.6	90.5-103.5	670.1	1.15	4.39	9.51	21.82	45.62	65.78	74.66	82.94	90.27	95.18	100

Colorado Silica Sand, Inc., Gravel Pack Material 8x16

Material Specifications

	U.S. Sieves					
Sieve number	*#6*	*#8*	*#10*	*#12*	*#14*	*#16*
Opening size, mm	*3.36*	*2.38*	*2.00*	*1.68*	*1.41*	*1.19*
	(Cumulative Percent Retained)					
Average	0	7	20	40	90	98
Range	0	0-10	5-35	35-85	80-98	95-100

Note: Above material used as gravel pack in Missouri Avenue Site Wells 2 (Well 4-93) and 3 (Well 3-93)

White & Pink Copies:
Ill. Dept. of Public Health
Yellow Copy: Well Contractor
Golden Copy: Well Owner

Well Construction Report

THIS FORM MUST BE COMPLETED WITHIN 30 DAYS
OF WELL COMPLETION AND SENT TO
THE ILLINOIS DEPARTMENT OF PUBLIC HEALTH
DIVISION OF ENVIRONMENTAL HEALTH
525 WEST JEFFERSON STREET
SPRINGFIELD, ILLINOIS 62761

1. Type of Well
   a. Bored____ Hole Diam. 36 in. Depth 75 ft
      Buried Slab: Yes___ No ✓
   b. Driven____ Drive Pipe Diam.____in. Depth____ft
   c. Drilled ✓ Finished in Drift 75 FT In Rock____
   d. Grout:

(KIND)	FROM (Ft.)	TO (Ft.)
CEMENT	25 FEET	2 FT ABOVE L.S.

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2. Well furnishes water for human consumption? Yes___ No ✓
3. Date well drilled AUG. 1993
4. Permanent pump installed? Yes ✓ Date AUG. 93 No___
   Manufacturer CROWN Type SUBM.
   Location 10 FT WITHIN THE SCREEN INTERVAL
   Capacity 1200 gpm. Depth of setting 60 ft.
5. Well top sealed? Yes ✓ No___ Type FLANGE & GASKET (CEMENT)
6. Pitless adapter installed? Yes___ No ✓
   Manufacturer N/A Model No. N/A
   How attached to casing?____
7. Well disinfected? Yes ✓ No___
8. Pump and equipment disinfected Yes ✓ No___

0000832 ✓

IMPORTANT NOTICE

This State Agency is requesting disclosure of information that is necessary to accomplish the statutory purpose as outlined under Public Act 85-0863. Disclosiure of this information is mandatory. This form has been approved by the Forms Management Center.

~~P 298107~~

PRESS FIRMLY WITH BLACK PEN OR TYPE
Do Not Use Felt Pen

CO# 29189 ✓

IL482-0126

P 297830

GEOLOGICAL AND WATER SURVEYS WELL RECORD

9. Driller JEFF STOLLHANS C/O LAYNE WESTERN License No. 102-003837
10. Well Site Address MISSOURI AVE & 55/70
11. Property Owner IL. DEPT. OF TRANSPORT. Well No. 1-93
12. Permit No. 023463 Date Issued 10/5/93
13. Location: EAST ST. LOUIS, IL County ST. CLAIR
    INTERSECTION OF MISSOURI AVE 55/70 - SOUTH EAST CORNER
    Sec. 13
    Twp. 2N
    Rge. 10W

Show location in section plat

14. Water from SAND & GRAVEL at depth 50 ft to 75 ft

15. Casing and Liner Pipe

Diam.(in)	Kind and Weight	From (ft)	To (ft)
12"	STEEL CASING .375 WALL 49.56#/FT	50	+2
12"	STAINLESS STEEL WIREWRAP SCREEN	75	50

16. Screen: Diam. 12 in, Length 25 FT, Slot Size 50 ABOVE L.S.
17. Size hole below casing 30 in. 18. Ground Elev. 2 ~~ft msl.~~
19. Static level 19 ft below casing top which is 2 ft. above ground level. Pumping level 40 ft, pumping 1200 gpm for 8 hours.

20. Earth Materials Passed Through	Depth of Top	Depth of Bottom
TOP SOIL	0	3
FINE SAND W/ CLAY SEAMS	3	17
FINE TO MEDIUM SAND	17	47
MED. SAND W/ FINE GRAVEL	47	75

Continue on separate sheet if necessary.

Signed [signature] Date 9-24-97

White & Pink Copies: Ill[illegible]ot. of Public Health
Yello[illegible]opy: Well Contractor
Golden Copy: Well Owner

Well Construction Report

THIS FORM MUST BE COMPLETED WITHIN 30 DAYS
OF WELL COMPLETION AND SENT TO
THE ILLINOIS DEPARTMENT OF PUBLIC HEALTH
DIVISION OF ENVIRONMENTAL HEALTH
525 WEST JEFFERSON STREET
SPRINGFIELD, ILLINOIS 62761

1. Type of Well BORE HOLE
   a. Bored ____ Hole Diam. 36 in. Depth 76 ft
      Buried Slab: Yes ___ No ___
   b. Driven ____ Drive Pipe Diam. ____ in. Depth ____ ft
   c. Drilled ✓ Finished in Drift 76 FT In Rock ____
   d. Grout:

(KIND)	FROM (Ft.)	TO (Ft.)
CEMENT	24 FT	2 FT ABOVE L.S.

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2. Well furnishes water for human consumption? Yes ___ No ✓
3. Date well drilled AUG. 93
4. Permanent pump installed? Yes ✓ Date AUG. 93 No ___
   Manufacturer CROWN Type SUBM.
   Location SETTING 71 FT (5FT FROM T.D.)
   Capacity 1500 gpm. Depth of setting 71 FT ft.
5. Well top sealed? Yes ✓ No ___ Type CEMENT (ANNULUS)
6. Pitless adapter installed? Yes ___ No ✓ FLANGED WELL HEAD
   Manufacturer N/A Model No. N/A
   How attached to casing? N/A
7. Well disinfected? Yes ✓ No ___
8. Pump and equipment disinfected Yes ✓ No ___

0000833

IMPORTANT NOTICE

This State Agency is requesting disclosure of information that is necessary to accomplish the statutory purpose as outlined under Public Act 85-0863. Disclosiure of this information is mandatory. This form has been approved by the Forms Management Center.

P-298108

PRESS FIRMLY WITH BLACK PEN OR TYPE
Do Not Use Felt Pen

CO# 29190

IL482-0126

GEOLOGICAL AND WATER SURVEYS WELL RECORD

9. Driller JEFF STOLLHANS c/o LAYNE WESTERN License No. 102-003837
10. Well Site Address MISSOURI AVE & 55/70
11. Property Owner IL. DEPT. OF TRANS. Well No. 2-93
12. Permit No. 023464 Date Issued 10/5/93
13. Location: EAST ST. LOUIS, IL County ST. CLAIR
    INTERSECTION OF MISSOURI AVE 55/70 - NORTH EAST CORNER OF INTERSECTION
    Sec. 13 Twp. 2N Rge. 10W
    Show location in section plat
14. Water from SAND AND GRAVEL at depth 50 ft to 76 ft
15. Casing and Liner Pipe

Diam. (in)	Kind and Weight	From (ft)	To (ft)
16"	STAINLESS STEEL CASING .25 WALL 42.05 lb/FT	51	+2
16"	STAINLESS STEEL WIRE WRAP SCREEN	76	51

16. Screen: Diam. 16 in, Length 25 FT, Slot Size 50
17. Size hole below casing 36 in. 18. Ground Elev. 2 ft msl.
19. Static level 18 ft below casing top which is 2 ft. above ground level. Pumping level 41 ft, pumping 1,200 gpm for 8 hours.

20. Earth Materials Passed Through	Depth of Top	Depth of Bottom
TOP SOIL	0	2
SAND W/ SOME SILT	2	15
FINE TO MED. SAND	15	48
FINE SAND TO MED. GRAVEL	48	76

Continue on separate sheet if necessary.

Signed Jeffry K Stollhans Date 9-24-97

White & Pink Copies: Ill. Dept. of Public Health
Yellow Copy: Well Contractor
Golden Copy: Well Owner

Well Construction Report

THIS FORM MUST BE COMPLETED WITHIN 30 DAYS
OF WELL COMPLETION AND SENT TO
THE ILLINOIS DEPARTMENT OF PUBLIC HEALTH
DIVISION OF ENVIRONMENTAL HEALTH
525 WEST JEFFERSON STREET
SPRINGFIELD, ILLINOIS 62761

1. Type of Well
   a. Bored____ Hole Diam. 36 in. Depth 99 ft
      Buried Slab: Yes___ No ✓
   b. Driven____ Drive Pipe Diam.____in. Depth____ft
   c. Drilled ✓ Finished in Drift 99 FT In Rock____
   d. Grout:

(KIND)	FROM (Ft.)	TO (Ft.)
CEMENT	28	2 FT ABOVE

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2. Well furnishes water for human consumption? Yes___ No ✓
3. Date well drilled JULY 1993
4. Permanent pump installed? Yes ✓ Date JULY 93 No___
   Manufacturer CROWN Type____
   Location 1 FT ABOVE SCREEN
   Capacity 1200 gpm. Depth of setting 68 FT ft.
5. Well top sealed? Yes ✓ No___ Type FLANGED WELL HEAD
6. Pitless adapter installed? Yes___ No___ CEMENT ANNULUS
   Manufacturer N/A Model No.____
   How attached to casing? N/A
7. Well disinfected? Yes ✓ No___
8. Pump and equipment disinfected Yes ✓ No___

0000834 ✓

IMPORTANT NOTICE

This State Agency is requesting disclosure of information that is necessary to accomplish the statutory purpose as outlined under Public Act 85-0863. Disclosiure of this information is mandatory. This form has been approved by the Forms Management Center.

~~P-298109~~

PRESS FIRMLY WITH BLACK PEN OR TYPE
Do Not Use Felt Pen

00# 29191

IL482-0126

P29782?

GEOLOGICAL AND WATER SURVEYS WELL RECORD

9. Driller JEFF STOLLHANS c/o LAYNE WESTERN License No. 102-003837
10. Well Site Address MO. AVE. E. ST. LOUIS
11. Property Owner IL DEPT. OF TRANS. Well No. 3-93
12. Permit No. 023465 Date Issued 10/5/93
13. Location: INTERSECTION OF MISSOURI AVE AND 55/70 NORTH EAST CORNER EAST ST. LOUIS, IL
    County ST. CLAIR
    Sec. 13
    Twp. 2N
    Rge. 10W
    Show location in section plat
14. Water from SAND & GRAVEL at depth 50 ft to 99 ft

15. Casing and Liner Pipe

Diam. (in)	Kind and Weight	From (ft)	To (ft)
16"	STAINLESS STEEL CASING 0.25 WALL 42.05 lb/FT	69	2 FT ABOVE L.S.
16"	STAINLESS STEEL WIRE WRAP SCREEN	69	99

16. Screen: Diam. 16 in, Length 30 FT, Slot Size 50
17. Size hole below casing 36 in. 18. Ground Elev. 2 ft ~~msl~~ ABOVE L.S.
19. Static level 25 ft below casing top which is 2 ft. above ground level. Pumping level 52 ft, pumping 1200 gpm for 8 hours.

20. Earth Materials Passed Through	Depth of Top	Depth of Bottom
TOP SOIL	0	2
SAND W/ CLAY	2	20
FINE SAND	20	54
MEDIUM SAND W/ GRAVEL	54	71
MEDIUM GRAVEL W/ SAND	71	99

Continue on separate sheet if necessary.

Signed [signature] Date 9-24-97

White & Pink Copies: Ill. Dept. of Public Health
Yellow Copy: Well Contractor
Golden Copy: Well Owner

Well Construction Report

THIS FORM MUST BE COMPLETED WITHIN 30 DAYS
OF WELL COMPLETION AND SENT TO
THE ILLINOIS DEPARTMENT OF PUBLIC HEALTH
DIVISION OF ENVIRONMENTAL HEALTH
525 WEST JEFFERSON STREET
SPRINGFIELD, ILLINOIS 62761

GEOLOGICAL AND WATER SURVEYS WELL RECORD

9. Driller JEFF STOLLHANS c/o LAYNE WESTERN License No. 102-003837
10. Well Site Address MO. AVE. E. ST. LOUIS
11. Property Owner IL. DEPT. OF TRANS. Well No. 4-93
12. Permit No. 023466 Date Issued 10/5/93
13. Location: County ST. CLAIR
Sec. 13
Twp. 2N
Rge. 10W

Show location in section plat

1. Type of Well
   a. Bored____ Hole Diam. 36 in. Depth 108.5 ft
      Buried Slab: Yes___ No___
   b. Driven____ Drive Pipe Diam.____in. Depth____ft
   c. Drilled ✓ Finished in Drift 108.5 In Rock____
   d. Grout:

(KIND)	FROM (Ft.)	TO (Ft.)
CEMENT	20	2 FT ABOVE

14. Water from SAND & GRAVEL at depth 50 ft to 108.5 ft

15. Casing and Liner Pipe			
Diam.(in)	Kind and Weight CASING	From (ft)	To (ft)
16"	STAINLESS STEEL .25 WALL 42.05 lb/FT	78.5	~~78.5~~ 2 FT
16"	STAINLESS STEEL SCREEN	78.5	108.5

2. Well furnishes water for human consumption? Yes___ No ✓
3. Date well drilled JULY 1993
4. Permanent pump installed? Yes ✓ Date JULY 1993 No___
   Manufacturer CROWN Type SUBM.
   Location 13.5 FT INTO SCREENED INTERVAL
   Capacity 1200 gpm. Depth of setting 92 FT ft.
5. Well top sealed? Yes ✓ No___ Type FLANGED WELDED HEAD
6. Pitless adapter installed? Yes___ No ✓
   Manufacturer N/A Model No. N/A
   How attached to casing? N/A
7. Well disinfected? Yes ✓ No___
8. Pump and equipment disinfected Yes ✓ No___

16. Screen: Diam. 16 in, Length 30 Ft, Slot Size 50
17. Size hole below casing 36 in. 18. Ground Elev. 2 ft ~~msl~~. ABOVE L.S
19. Static level 25 ft below casing top which is 2 ft. above ground level. Pumping level 40 ft, pumping 1200 gpm for 8 hours.

20. Earth Materials Passed Through	Depth of Top	Depth of Bottom
TOP SOIL	0	2
CLAYEY - SAND W/ SMALL GRAVEL	2	24
SAND W/ SMALL GRAVEL	24	74
GRAVEL W/ SOME SAND	74	108.5

Continue on separate sheet if necessary.

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0000835 ✓

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This State Agency is requesting disclosure of information that is necessary to accomplish the statutory purpose as outlined under Public Act 85-0863. Disclosiure of this information is mandatory. This form has been approved by the Forms Management Center.

PRESS FIRMLY WITH BLACK PEN OR TYPE CO# 29192 ✓
Do Not Use Felt Pen

~~P-29810~~ 010

IL482-0126

P297823

Signed [signature] Date 9-24-97

Illinois State
WATER
Survey (1895)

ILLINOIS
DEPARTMENT OF
NATURAL
RESOURCES

ILLINOIS