Contract Report 540

# Dewatering Well Assessment for the Highway Drainage System at Four Sites in the East St. Louis Area, Illinois

## Phase 6

by Robert D. Olson, Steven D. Wilson, and Ellis W. Sanderson
Office of Ground-Water Resources Evaluation and Management

Prepared for the
Illinois Department of Transportation

November 1992

Illinois State Water Survey
Hydrology Division
Champaign, Illinois

A Division of the Illinois Department of Energy and Natural Resources

# DEWATERING WELL ASSESSMENT FOR THE HIGHWAY DRAINAGE SYSTEM AT FOUR SITES IN THE EAST ST. LOUIS AREA, ILLINOIS (FY 89 - PHASE 6)

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## ABSTRACT

In the East St. Louis vicinity, the Illinois Department of Transportation (IDOT) owns 48 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 four sites in the alluvial valley of the Mississippi River in an area known as the American Bottoms. At the dewatering sites, the alluvial deposits 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 a cooperative investigation has been conducted by IDOT and the Illinois State Water Survey 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. Six phases of the investigation have now been completed.

During FY 89 (Phase 6), 12 step tests were performed, the rehabilitation of four wells was reviewed, nine dewatering wells were investigated for sand pumpage during the step tests, and two replacement dewatering wells were constructed. Six wells (I-70 Wells 1 and 7A, I-64 Well 11, 25th Street Wells 2 and 5, and Venice Well 2) were step tested to assess their present condition. For these wells, the average specific capacity was 45.2 gallons per minute per foot (gpm/ft). All but I-64 Well 11 (specific capacity - 80.5 gpm/ft) are in poor condition and are recommended for rehabilitative treatment.

Post-treatment step tests were used to help document the rehabilitation of four dewatering wells (I-70 Wells 2, 5, 10, and 11) during FY 89 (Phase 6). Chemical treatments were used to restore the capacity of these four wells, and they were generally successful, as the improvement in specific capacity per well averaged about 61%. The average specific capacity for the four wells based on the post-treatment step tests was about 77.8 gpm/ft. Although there was good improvement in Well 10, it is still in relatively poor condition. As demonstrated in previous treatment episodes, most of the improvement from the treatment occurred very early in the treatment steps.

The sand pumpage investigation conducted during nine of the step tests revealed that only I-70 Well 11 is pumping sand, although the amount was small. Because the operation of this well has been severely limited, it should be retested after it has been repaired and pumped for several

months before other remedial measures are taken. It was also found that I-70 Well 2, which had previously pumped sand, apparently no longer does.

The two replacement dewatering wells (I-70 Well 8A for Well 8 and I-70 Well 9A for Well 9) were constructed based on design recommendations from the Water Survey. The average specific capacity resulting from the step tests on these wells was nearly 100 gpm/ft, slightly above average for this site, and $\Delta h$ measurements were low. Both wells appear to be in good hydraulic condition.

## INTRODUCTION

### Background

The Illinois Department of Transportation (IDOT) operates 48 high-capacity water wells at four 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 Interstate (I) 70/55 and I-64 was originally designed, ground-water levels were at lower elevations because of large withdrawals by the area's industries. Because of a combination of water conservation, production cutbacks, and conversion from ground water to river water as a source, ground-water withdrawals by industry have decreased at least 50% since 1970, and as a result, ground-water levels in many areas have recovered to early development levels. This exacerbates IDOT's need to dewater the areas of depressed highways.

### Scope of Study

The Illinois Department of Transportation first installed 12 dewatering wells in 1973, followed by an additional 30 in 1975. By 1977, the initial 12 wells were showing signs of loss of capacity. As a result, all 42 wells in use at that time were chemically treated to restore capacity. Although good results were obtained on most of the wells, routine monitoring by IDOT showed that deterioration problems were continuing to develop. Chemical treatment of isolated wells was made by IDOT personnel as required. In 1982, six more wells were installed. In October 1982, IDOT asked the Illinois State Water Survey to begin an investigative study of the dewatering wells to learn more about their condition, to determine efficient monitoring and operating procedures, and to determine suitable methods of rehabilitation.

The first phase of the work, begun in March 1983, included an assessment of the condition of 14 selected wells, a review of IDOT's monitoring program, a model study to outline efficient operating schemes, recommendations on wells to be treated, and recommendations for chemical treatment procedures.

Phase 2, begun in March 1984, included an assessment of the condition of 12 selected wells; testing of a non-invasive, portable flowmeter; and an initial study of the chemistry of the ground water as it moved toward an operating well.

Phase 3, begun in July 1985, included an assessment of the condition of six wells; demonstration of a non-invasive, portable flowmeter; a continued study of the ground-water chemistry; and documentation of the rehabilitation of seven dewatering wells, along with follow-up step tests.

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

Phase 5, begun in July 1987, 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-55/I-70.

Phase 6, begun in July 1988, included 12 step tests; review of the chemical treatment of four wells; evaluation of nine wells for possible sand pumpage; continuation of the investigation of the I-255 relief wells; and documentation of the installation of two replacement wells (I-70 Well 8A and I-70 Well 9A).

## 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 Ages. 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). Ground water generally flows from the bluffs toward the river, except where it is diverted by pumpage or drainage systems.

Detailed location maps of the four dewatering sites operated by IDOT are shown in figures 2 and 3. 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). The alluvial deposits are about 90 to 115 feet thick, meaning 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.

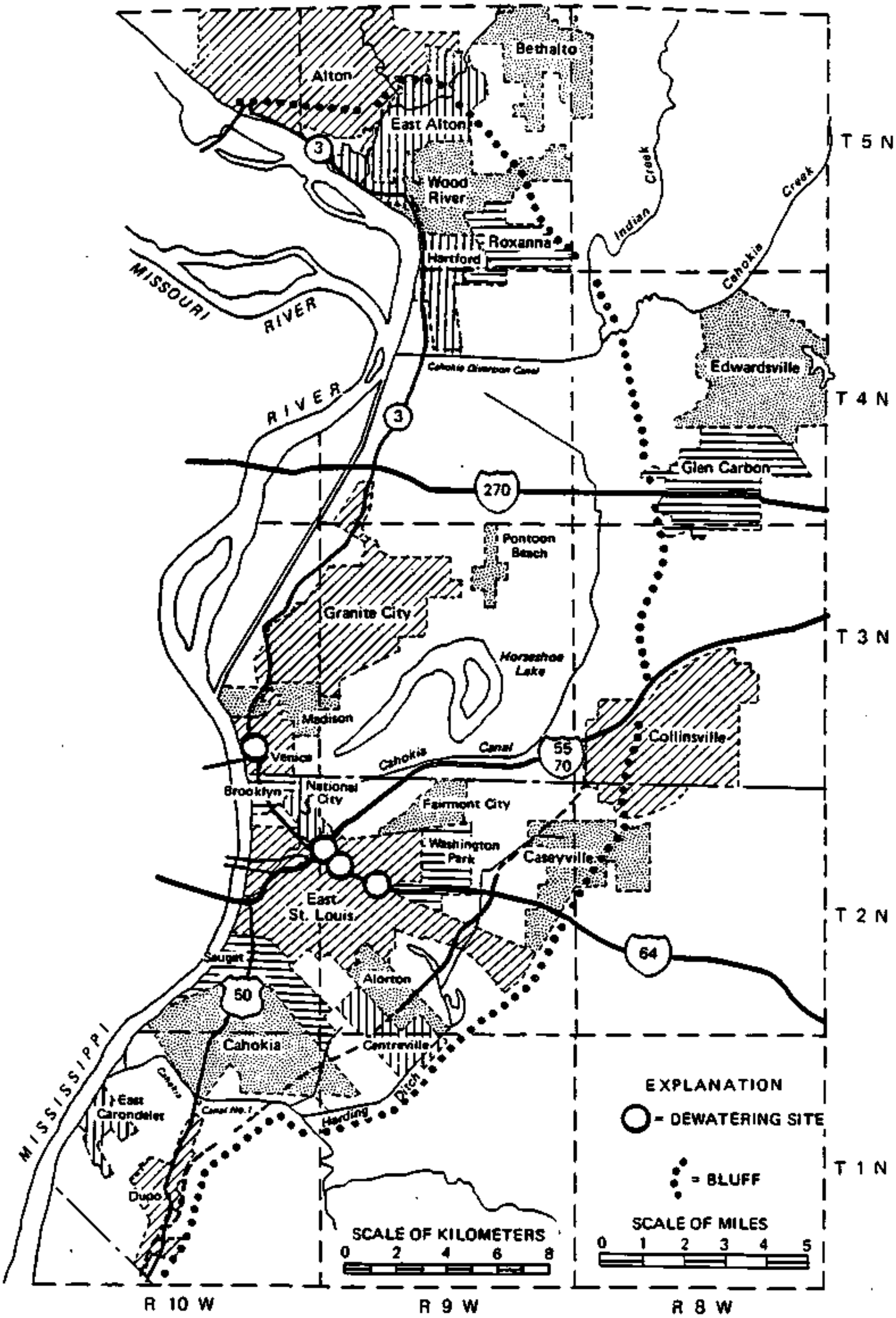



Figure 1. Location of the East St. Louis area

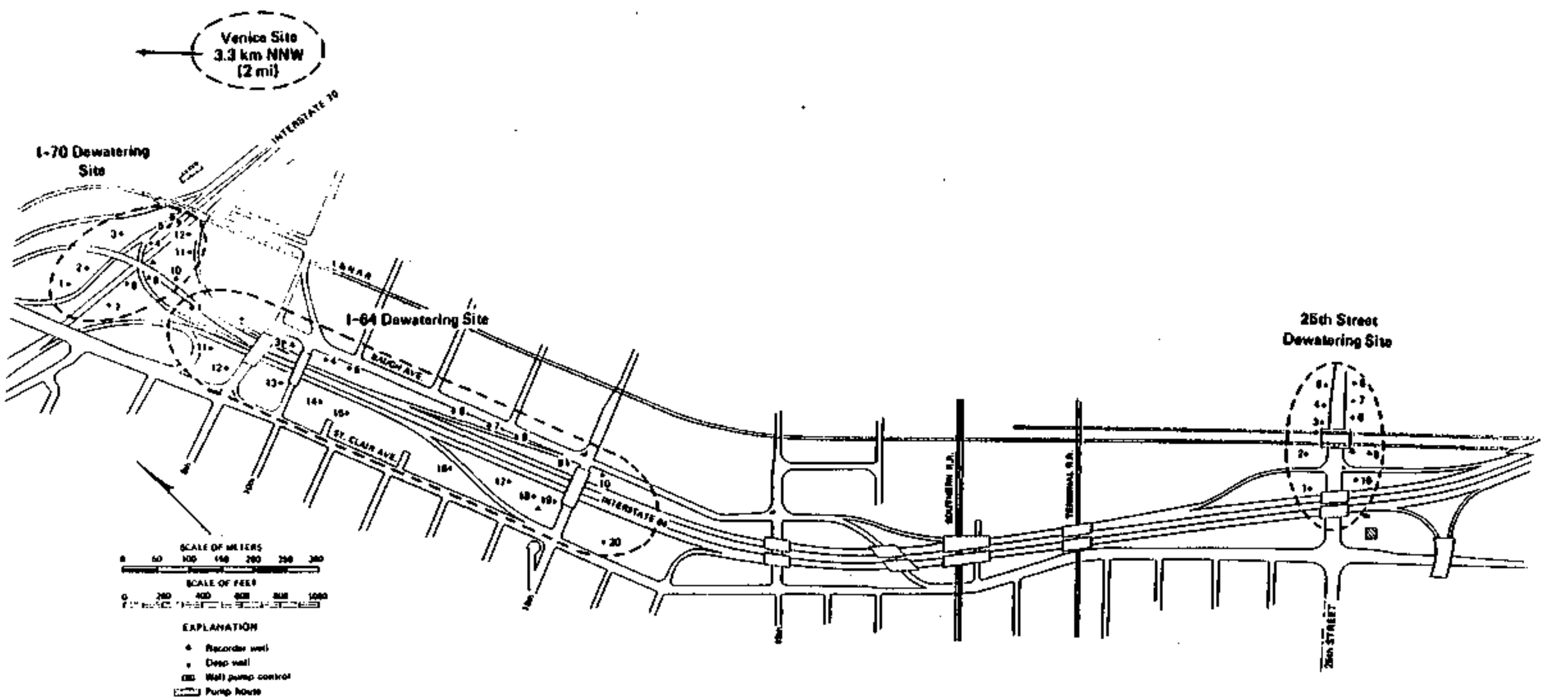



Figure 2. Locations of dewatering wells at the I-70 Tri-Level Bridge,
I-64, and 25th Street

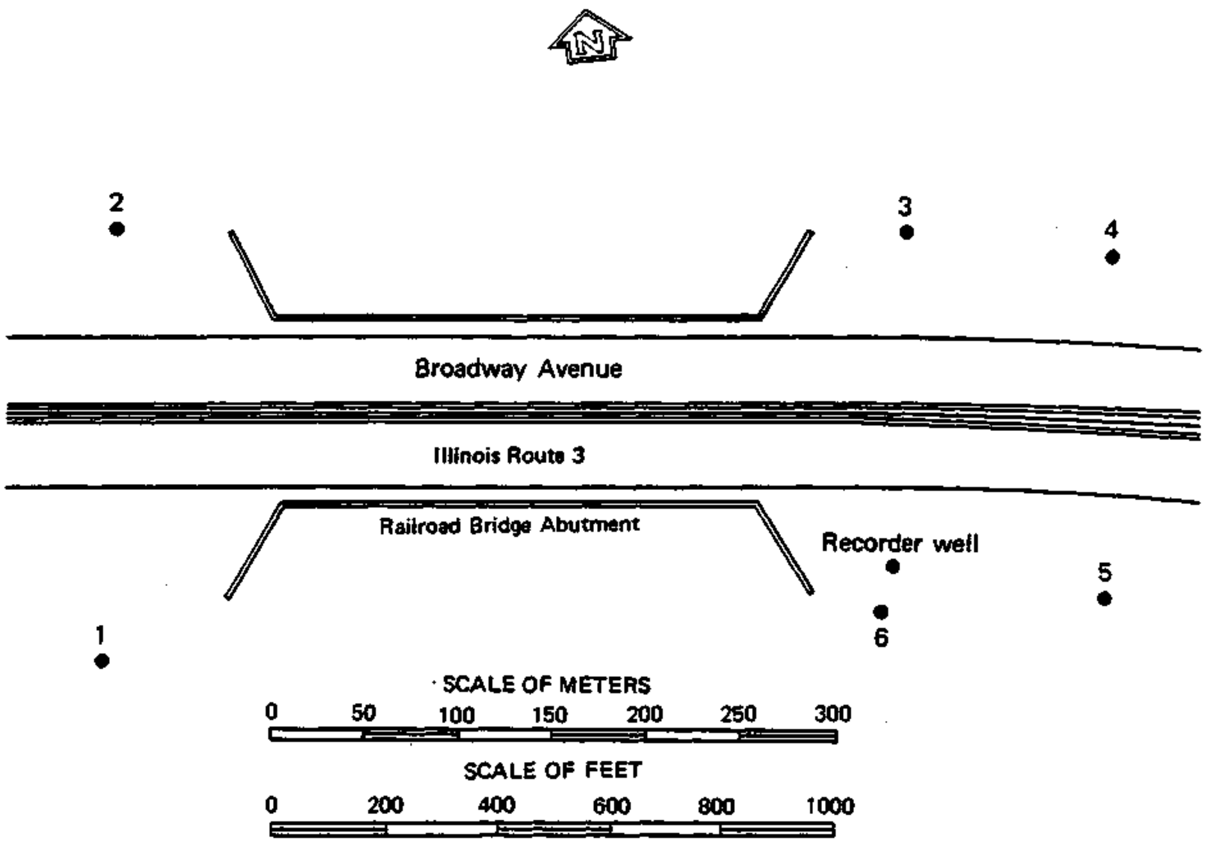



Figure 3. Locations of dewatering wells at the Venice Subway
(Illinois Route 3)

## Acknowledgments

This phase of the assessment of the condition of the highway dewatering well systems in the American Bottoms was funded by the Illinois Department of Transportation, Gregory W. Baise, Secretary. Special thanks are due Frank Opfer, Hydraulic Engineer, and Vic Modeer, Geotechnical Engineer, District 8, who reviewed and coordinated the investigation. The Maintenance Division pump crew under the supervision of Stan Gregowicz provided field support during the conduct of step-drawdown tests on the selected wells. Water Survey staff who ably assisted the authors with field data and water sample collection included Robert Kohlhase, Jeff Stollhans, Doug Kelly, Brian Kimpel, and Nita Hingsbn.

Analytical work was done by the Water Survey's former Analytical Chemistry Unit under the direction of Mark Peden, with Brian Kaiser, Lauren Sievers, and Linda Fox, performing the lab analyses. Manuscript editing was done by Laurie Talkington, and the illustrations were prepared by David Cox and Linda Hascall. Word processing was done by Pamela Lovett.

# HISTORICAL SUMMARY OF DEWATERING DEVELOPMENT

The eastbound lanes of Interstate 70 below the Tri-Level Bridge between St. Clair and Bowman Avenues in East St. Louis dip to an elevation of 383.5 ft msl, or approximately 32 feet below natural ground surface. At the time of highway design 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 was carried out in 1961-1962.

## Horizontal Drain System

A horizontal French drain system was designed for controlling the ground-water levels along an 800-foot reach of depressed highway. For highway construction, the excavation area was dewatered by pumping from seven wells 100 feet deep and 16 inches in diameter. The wells were equipped with 1800-gpm turbine pumps. The 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 construction dewatering system was turned off in the fall of 1962. The 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% of the filter sand was finer than the ¼-inch perforations in the drain pipes. As a result, when the construction dewatering system was turned off and ground-water levels rose above the drains, filter sand migrated through the holes into the drain pipes. After the filter sand migrated into the drain, the very fine "sugar" sand used as the pavement foundation was 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 construction dewatering system to lower the ground-water table. Since 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 3/8-inch-diameter holes on 3-inch centers, and surrounded with 6 inches of gravel and sand filter. 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 1200 to 2000 gpm, compared to a computed design flow of 4500 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 rise of 1 foot 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 was also observed. Depressions in the earth slopes immediately adjacent to the curb and gutter sections were noticed. 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 of the collector pipes (using a hydrojet at the rate of 100 gpm under a pressure of about 800 pounds per square inch), a significant amount of scale was removed from inside the mild steel 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 indicated a distressed condition requiring 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. A chemical analysis showed the extremely corrosive quality of the ground water as evidenced by:

- Extremely high concentrations of dissolved carbon dioxide, 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

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

## Individual Deep Well Systems

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 1972 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 ten deep wells equipped with 600-gpm pumps. An additional two wells were included to permit well rotation and maintenance. These 12 wells were constructed in 1973 and the new system placed in service in April 1974. The wells are 16-inch gravel-packed (42-inch borehole) wells averaging about 96 feet deep and are equipped with 60 feet of Layne stainless steel well screen. The pumps are 600-gpm capacity with 6-inch-diameter stainless steel (flanged coupling) column pipe.

A recorder well was included in the well dewatering system to monitor ground-water levels near the critical elevation of the highway. The well is 8 inches in diameter and is constructed of stainless steel casing and screen. 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. The purpose of these piezometers is to provide information on ground-water levels and to 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-55/70 northbound lanes was relocated, necessitating the abandonment of I-70 Well 12. At that time replacement Well 12A was constructed at a nearby location using components similar to those in the original wells. Also in the 1970s, the well screen in I-70 Well 7 reportedly failed, 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 (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 was also 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 were also designed and used in these wells as in I-70 Well 7A (covered later in this report).

The western terminal of Interstate 64 joins Interstate 70 at the Tri-Level Bridge site. A 2200-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. The wells were built in 1975 and are essentially identical to the original wells constructed for the Tri-Level Bridge site.

About 6200 feet southeast of the Tri-Level Bridge, at the East St. Louis 25th Street interchange with I-64, the street was designed to pass below the highway and adjacent railroad tracks. As a result, the 25th Street pavement would be about 3.5 feet below ground-water levels. Ten wells were installed at this site in 1975 to control ground-water levels. These wells are identical in design to the original I-70 wells. The 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 is 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 for monitoring the performance of each individual installation.

Approximately 2¼ miles north of the I-70 Tri-Level Bridge, Illinois Highway 3 passes beneath the N and W, ICG, 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 three to four months of continuous flood stage in the Mississippi River (about 2000 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 and are 16 inches in diameter with 50 feet of well screen. They 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.

Thus at present the highway dewatering operation in the American Bottoms consists of 48 individual dewatering wells fully penetrating the water-bearing sand and gravel aquifer. The wells are distributed at four sites as follows:

| | |
|---|---|
| I-70 (Tri-Level Bridge) | - 12 wells |
| I-64 | - 20 wells |
| 25th Street | - 10 wells |
| Venice (Route 3) | - 6 wells |

The wells are of similar construction, with 16-inch-diameter stainless steel casing and screen, and 6-inch-diameter stainless steel column pipe (figure 4). Each well is equipped with a 600-gpm submersible pump with bronze or stainless steel impellers, bowls, and jacket motors. The early experience with severe corrosion problems showed that corrosion-resistant materials are required to maximize service life. Five 8-inch recorder wells are available to monitor ground-water elevations near critical locations at the four sites. Each of the 48 wells has a 2-inch-diameter piezometer for monitoring individual well performance.

Usually, about one-third of the wells are in operation simultaneously. Total pumpage was estimated to be about 12.2 million gallons per day in 1988.

## DEWATERING SYSTEM MONITORING

When originally constructed, the well installations at I-70, I-64, and 25th Street included pitot-tube flow-rate meters. Reportedly, 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 erratic results were reported by the field crew. The six new installations at Venice include a venturi tube coupled to a bellows-type differential pressure indicator to measure the flow rate. Flow measurements from the venturi tube are reported to be accurate to within ±1% of full pipe flow rate, and the differential pressure indicators to within ±0.75% of the deflection. The bronze-lined

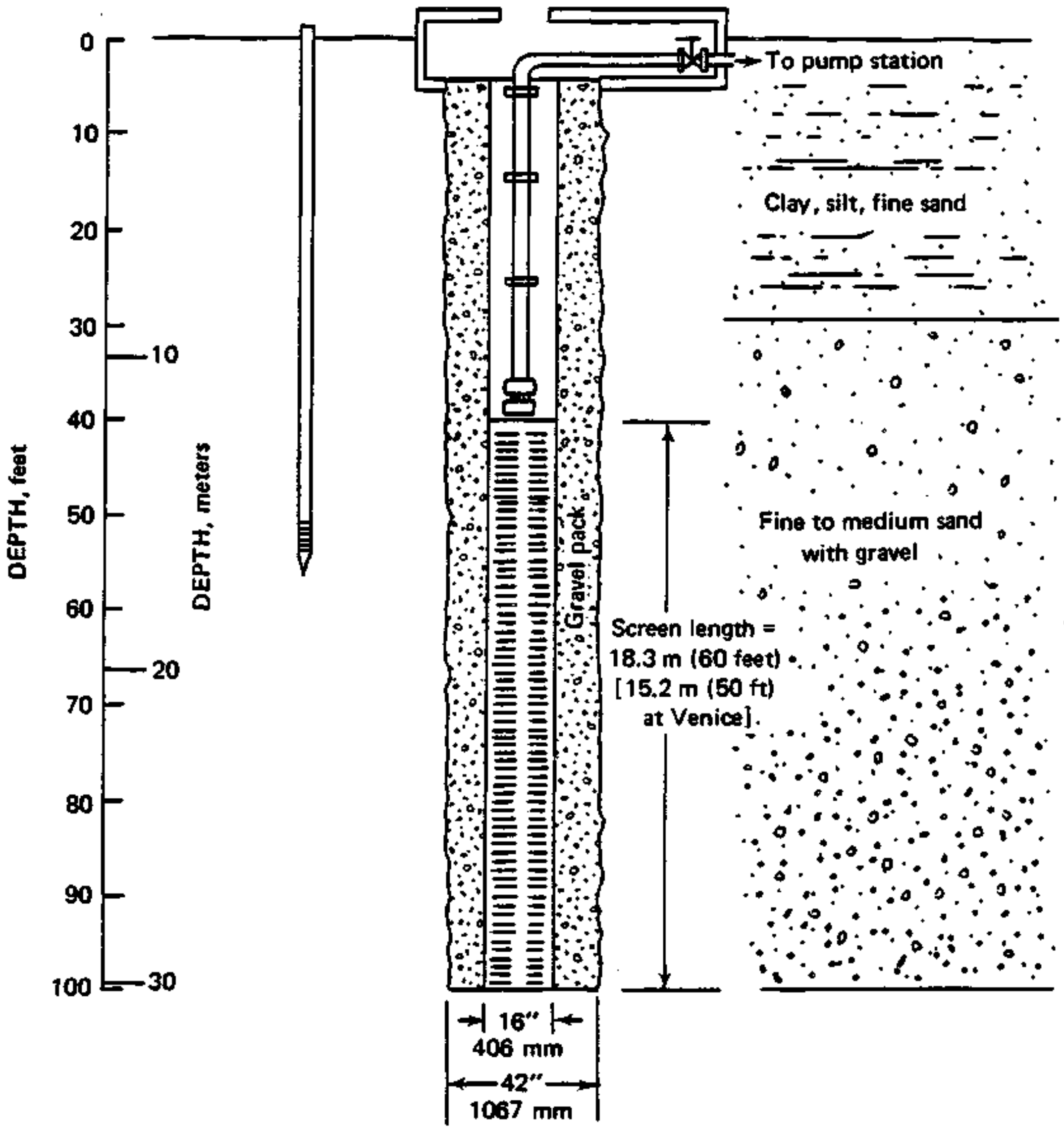



Figure 4. Typical features of a dewatering well

venturi tubes will probably remain unaffected over time by the quality of water pumped from these wells; however, the water comes in direct contact with the bellows in the differential pressure indicators via two ¼-inch water lines from the venturi tubes. The same corrosion and chemical deposition affecting the pitot tubes could, over time, cause obstructions in the water lines and/or water chambers or direct failure of the bellows. Operational problems have developed with some of the venturi instruments causing inaccurate flow measurements or inability to read the rate indicator.

Operational records have shown that wells are pumped for periods of about two to nine months and then left off for longer periods while another set of wells is operated. No standard sequence of pumping rotation is followed because of maintenance and rehabilitation requirements. Bar charts showing the periods of operation are prepared by IDOT for monitoring the accumulated hours of operation. Annual withdrawals currently are calculated on the basis of pumping time and estimated or measured pumping rates.

Water levels in the piezometer adjacent to each dewatering well are measured every two to four months. The pumping water-level in each operating well also is measured. These water-level data are reviewed by IDOT supervisors to monitor ground-water levels in relation to the pavement elevation and to assess the condition of individual dewatering wells. Water-level differences of 3 to 5 feet between the pumping wells and the adjacent piezometers usually are considered normal by IDOT. Greater differences are interpreted to indicate that well deterioration is occurring. Piezometer water levels also are superposed on drawings of longitudinal sections of the highway for visual comparison. This technique suggests probable errors in field measurements or a plugged piezometer when the water-level elevation for a given piezometer is not consistent with water levels in adjacent piezometers.

Finally, each dewatering well site includes an observation well equipped with a Leupold-Stevens water-level recorder. The recorder charts are changed monthly and are intended to provide a continuous record of water levels near the critical location at each dewatering site.

## INVESTIGATIVE METHODS AND PROCEDURES

### Well Loss

When a well is pumped, water is removed from the aquifer surrounding the well, and the water levels are lowered. The distance that the water level is lowered, whether within the well or in the surrounding aquifer, is referred to as drawdown, which under ideal conditions is a function of pumping rate, time, and the aquifer's hydraulic properties. Specific capacity, pumping rate divided by the drawdown in the pumped well following an established pumping period, is often used to describe well performance. However, because other non-ideal geohydrologic and hydraulic factors can affect the observed drawdown (particularly within the pumped well), the specific capacity may not provide the full well performance picture, especially when pumping rates change. Aquifer boundaries, spacial variation in aquifer thickness or hydraulic properties, interference from nearby wells, partial-penetration conditions, and well losses all can affect observed drawdowns. Well losses, usually associated only with the pumped well, are a reflection of the hydraulic efficiency of the well components and are the only non-ideal condition addressed in this report.

The observed drawdown in a pumped well is usually greater than that in the aquifer formation outside the borehole because of the well losses caused by the water moving from the fully penetrated aquifer into the well. The amount of well loss depends on the materials used and the job done in constructing the well. A limited amount of well loss is to be expected as 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 unacceptable well losses. In addition, well losses often reflect a deterioration in the condition of an existing well, especially if they are observed to increase with time.

Well losses are related to pumping rate and ideally are not a function of time. These losses are 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. In some cases, well loss occurs entirely under conditions of laminar flow; however, velocities may become sufficiently large that a change from laminar to turbulent flow occurs. Under these conditions the well-loss component of drawdown can rapidly become excessive, increasing in a nonlinear manner with increases in pumping rate.

Thus, 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 (and sometimes turbulent) flow head loss within the aquifer; and well loss ($s_w$) resulting from the turbulent (and sometimes laminar) flow of water into and inside the well, as shown in equation 1.

$$s_o = s_a + s_w \qquad (1)$$

Jacob (1947) devised a technique for separating the well losses from the 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:

$$s = BQ + CQ^2 \qquad (2)$$

where B is the formation loss coefficient at the well-aquifer interface per unit discharge, C is the well loss coefficient, and s is calculated well loss. 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

$$s = BQ + CQ^n \qquad (3)$$

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). This analysis requires a controlled pumping test, called a step drawdown test, 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 can be employed after first modifying equation 2 as:

$$s/Q = B + CQ \qquad (4)$$

After this modification, a plot of $s_o/Q$ versus Q can be prepared on arithmetic graph paper from data collected during a step drawdown test, with the observed drawdown, $s_o$, substituted for s. The slope of a line fitted to these data is equal to C, while the y-intercept is equal to B, as shown in figure 5. If the data do not fall on a straight line, but instead curve concavely upward, then Rorabaugh's method usually is suggested. The curvature of the plotted data indicates that the second-order relationship between Q and $s_o$ is not valid.

Occasionally the data plot may yield a line with zero or a negative slope, or be too random to provide a reasonable fit to one line. In these instances, the coefficients are immeasurable. Possible causes of this are: 1) turbulent well loss is negligible over the pumping rates tested; 2) inadequate data collection or test methods were employed during the test; 3) the hydraulic condition of the well is unstable, such as happens during well development; and 4) the contribution of water from the entire length of well screen over the range of test pumping rates is unequal, as might occur due to vertical heterogeneity of the aquifer materials.

If Rorabaugh's equation is used, then the 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 leads to:

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

A plot of $(s_o/Q)$ - B versus Q can be made on logarithmic graph paper from step test data, replacing s with $s_o$. Values of B are tested until the data fall on a straight line (figure 6). 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, the graphical procedure is facilitated if Q is plotted as cubic feet per second (cfs), and $(s_o/Q)$ - B is plotted as seconds per foot squared. It is also convenient (although not mandatory) to use these same units in the Jacob method.

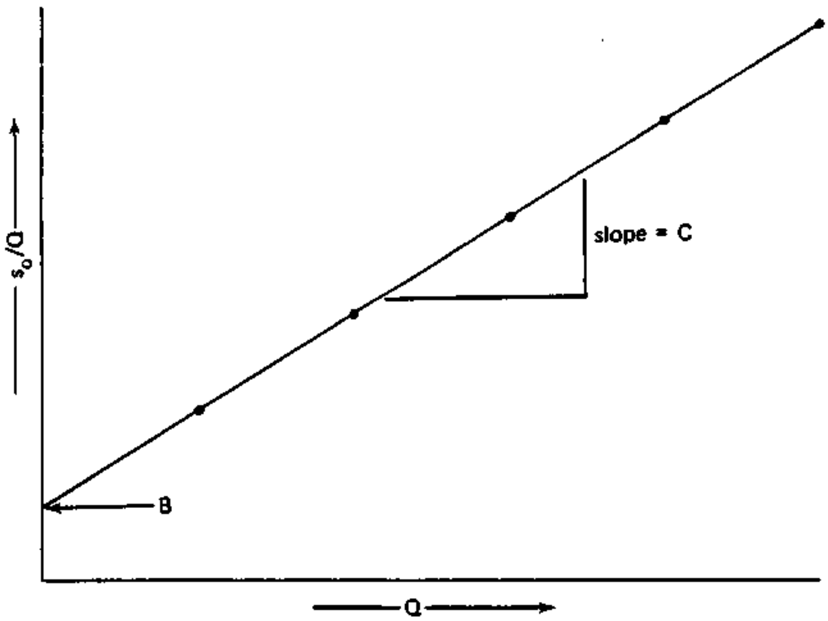



Figure 5. Graphical solution of Jacob's equation
for well-loss coefficient, C

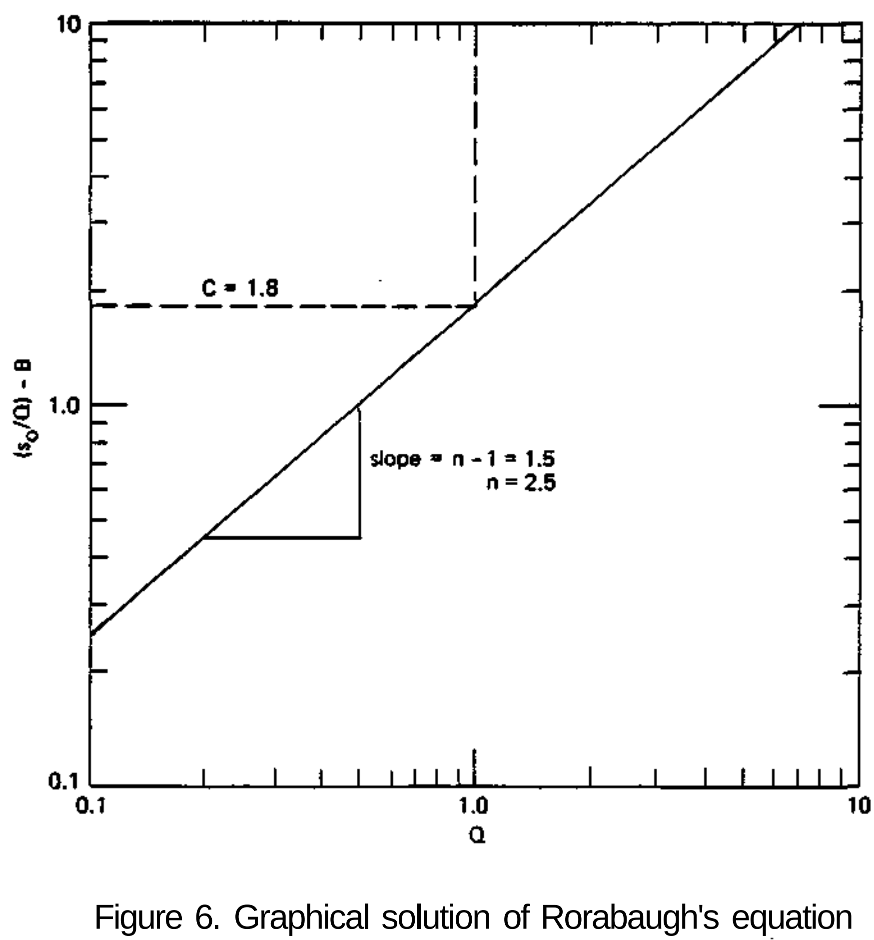



Figure 6. Graphical solution of Rorabaugh's equation
for well-loss coefficient, C, and exponent, n

## Step Test Procedure

The primary objective of a step drawdown test (or step test) is determination of 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 well is pumped successively at a number of selected pumping rates. Equally spaced pumping rates are selected 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.

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, the Water Survey's Micro-computer Data Acquisition System (referred to as McDAS) was used to collect the data. It can be set to read the data either at a selected frequency or logarithmically as conditions dictate. The logarithmic rate was used for the step tests, in which the readings progress from several per second at the start of the step to readings every two to three minutes at the end of each step. In this investigation, water levels were measured for 30 minutes per step. At the end of each 30-minute interval, the pumping rate was immediately changed, the water-level measurements reverted to the initial frequency again, and so on 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 7. Drawdowns for each step (shown as As,) 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 As, 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 $s_o/Q$ are equal to the sum of $\Delta S_i$ 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, piezometers have been drilled approximately 5 feet from the center line of each of the 48 IDOT dewatering wells 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 wells and those in the adjacent

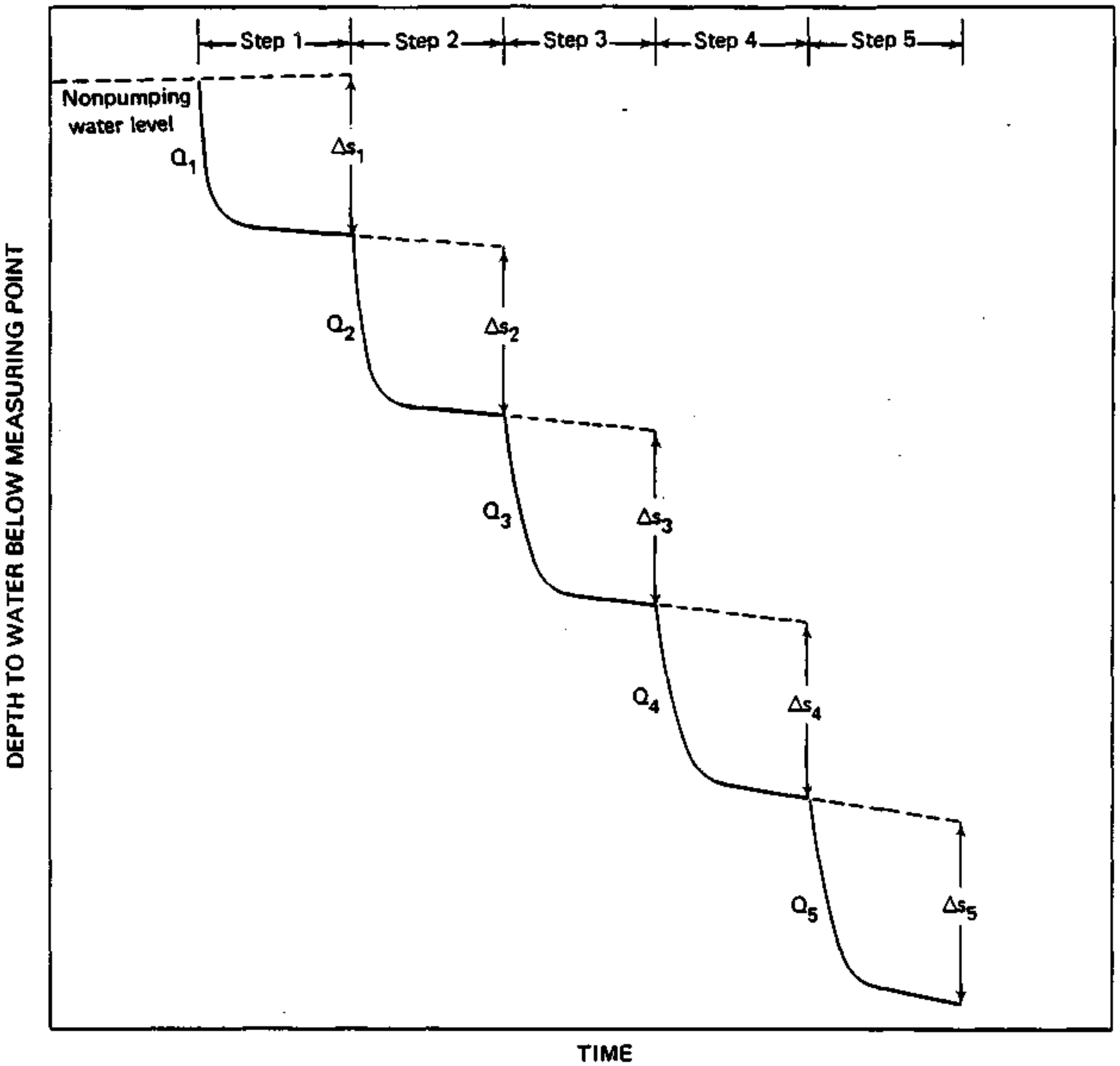



Figure 7. Relationship between time and water level during a five-step drawdown test

piezometers has been used Co help detect and track well deterioration problems.

Measuring piezometer water levels continously during each step test provides another means for checking whether turbulent well losses are occurring in the pumped well. The resultant Δh data are plotted over the large range of pumping rates. If turbulent losses exist within that range, the difference in heads should be nonlinear with increasing pumping rate. In addition, it can sometimes 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

### Well Selection

Twelve wells were step-tested in FY 89 (Phase 6). Four of these were post-treatment step tests on the four wells rehabilitated using chemical treatment during FY 89. Two of the step tests were conducted to establish the new condition of two replacement wells drilled during FY 89. The remaining six step tests were done to check the present condition of six wells and determine if well deterioration has taken place. The six wells were chosen based on the relative importance of their locations to the dewatering system and a review of IDOT's monitoring data, which suggested that capacity was declining. One of these wells, I-70 Well 1, had been chemically treated in 1985 to restore its capacity. Another step test was later added to the FY 89 (Phase 6) work to establish the pretreatment condition of I-70 Well 5. The well pump failed, however, in the early stages of the test, before enough data were collected to do the complete analysis.

The six wells step-tested to monitor their present condition were:

| | |
|---|---|
| I-70 | Well 1 |
| | Well 7A |
| I-64 | Well 11 |
| 25th St. | Well 2 |
| | Well 5 |
| Venice | Well 2 |

The four wells receiving post-treatment step tests were:

| | |
|---|---|
| I-70 | Well 2 |
| | Well 5 |
| | Well 10 |
| | Well 11 |

The two replacement wells were:

| | |
|---|---|
| I-70 | Well 8A |
| | Well 9A |

## Field Testing Procedure

Field work was conducted by Water Survey staff with the assistance of the IDOT Bureau of Maintenance pump crew under the supervision of Stan Gregowicz. The IDOT pump crew made all necessary pipe modifications and provided special piping adapters. This allowed the water from the pumped wells to be discharged through a flexible hose and orifice tube, provided by the Water Survey, to measure the flow rate. Discharge from the orifice tube was directed to nearby stormwater drains.

Orifice tubes are considered 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 steps as possible at 300 gpm or greater for each well. Prior to the start of each step test, the nonpumping water levels in the well and piezometer were measured with a steel tape. Pressure transmitters, coupled to the previously described McDAS field computer system for analog to digital conversion and data storage, were placed in the pumped well and piezometer to measure water levels during the step tests.

The step tests used to check the condition of the six wells (I-70 Wells 1 and 7A, I-64 Well 11, 25th Street Wells 2 and 5, and Venice Well 2) took place in the period during May through September 1989. The aborted step test on I-70 Well 5 was attempted in October 1988 shortly before its treatment. Treatment of the four rehabilitated wells (I-70 Wells 2, 5, 10, and 11) was completed in October and November 1988, and the post-treatment step tests followed in January and February 1989. The two replacement wells (I-70 Wells 8A and 9A) were not tested until October 1989 due to late arrival of the well pumps.

The data for the 12 step tests are included in Appendix A. Water samples were collected at the time of each test and analyzed for chemical/mineral content. The results from the analyses are summarized in table 3 and 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. This procedure breaks down the head losses into two components, the laminar losses from the formation and the turbulent losses from the well. To illustrate its use, the analysis of I-70 Well 10, tested on January 30, 1989, follows.

The test began at 12:16 p.m. at a rate of 370 gpm and ended at 2:16 p.m. at 250 gpm. The test had four steps, each 30 minutes in length, with pumping rate decrements of 40 gpm.

Data from the analysis are presented in table 1. Figure 8 is a plot of those data as $s_o/Q$ versus Q. As mentioned earlier, the Jacob method separates the well loss and the formation loss. A best-fit line is drawn through the graph (figure 8). The slope is the coefficient for well loss, C, and the y-intercept is the coefficient for formation loss, B. From the analysis, B and C were determined to be 7.32 $sec^2/ft$ and 0.975 $sec^2/ft^5$, respectively. Therefore, at 370 gpm (0.824 cfs), drawdown, s, becomes:

$$\begin{aligned} s &= BQ + CQ^2 \qquad (7) \\ &= 7.32(0.824) + 0.975(0.824)^2 \\ &= 6.03 + 0.66 \\ &= 6.69 \text{ ft} \end{aligned}$$

Table 1. I-70 Well 10 Step Test Data

| Step | Q-(gpm) | Q-(cfs) | $s_o$-(ft) | $s_o/Q$ | $CQ^2$ |
|---|---|---|---|---|---|
| 1 | 370 | 0.824 | 6.69 | 8.119 | 0.66 |
| 2 | 330 | 0.735 | 5.89 | 8.014 | 0.53 |
| 3 | 290 | 0.646 | 5.13 | 7.941 | 0.41 |
| 4 | 250 | 0.557 | 4.27 | 7.666 | 0.30 |

Q - flow rate
$s_o$ - observed drawdown

At 370 gpm, the calculated total drawdown (s) matches the observed drawdown ($s_o$), which was also 6.69 ft. This suggests a good correlation between theoretical and observed results. An estimate for drawdown and well loss at the design pumping rate of 600 gpm (1.337 cfs), obtained using equation 7, appears in table 2.

To verify the C value, a plot of $s_o$ versus Q is used (figure 9). When C = 0, equation 2 becomes s — BQ (the theoretical drawdown due to laminar formation losses), which would plot as a straight line through the origin. If $C \neq 0$, then the non-linear $CQ^2$ term will cause the line to curve upward increasingly as Q increases. The amount of displacement from the straight line is the amount of well loss at each pumping rate. In our case, $C \neq 0$. Using $s - CQ^2 - BQ$, and substituting $s_o$ for s, we should be able to subtract the $CQ^2$ from each value of observed drawdown, leaving the value of BQ. If our evaluation of C is correct, the BQ values should plot on a straight line through the origin. Each of these lines is plotted in figure 9. One is labeled $s_o$, and the other is labeled $s_o - CQ^2 = BQ$. As can be seen, the BQ line is a straight line through the origin, which verifies that C - 0.975, obtained from figure 8, is a good estimate for C.

The analysis indicates that there would be about 11.51 feet of drawdown if I-70 Well 10 were operated at the design rate of 600 gpm for 30 minutes, resulting in a specific capacity (pumping rate divided by drawdown) of about 52.1 gpm/ft. Turbulent well loss at the well would be

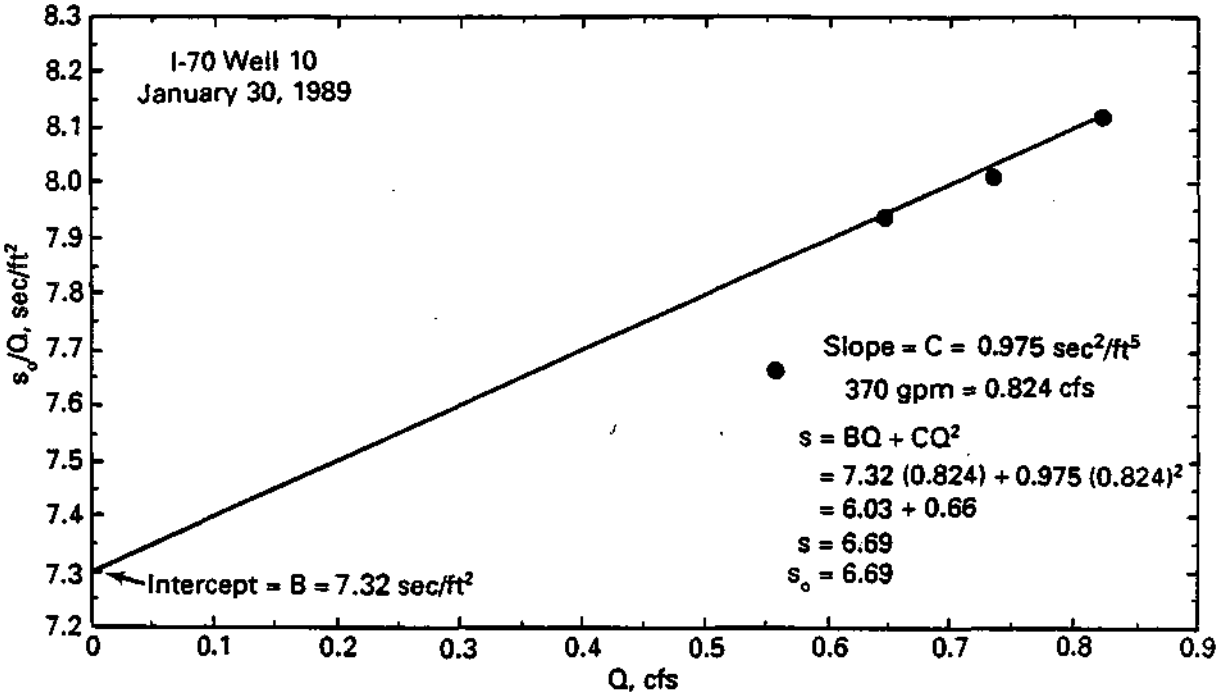



Figure 8. Graphical analysis, I-70 Well 10

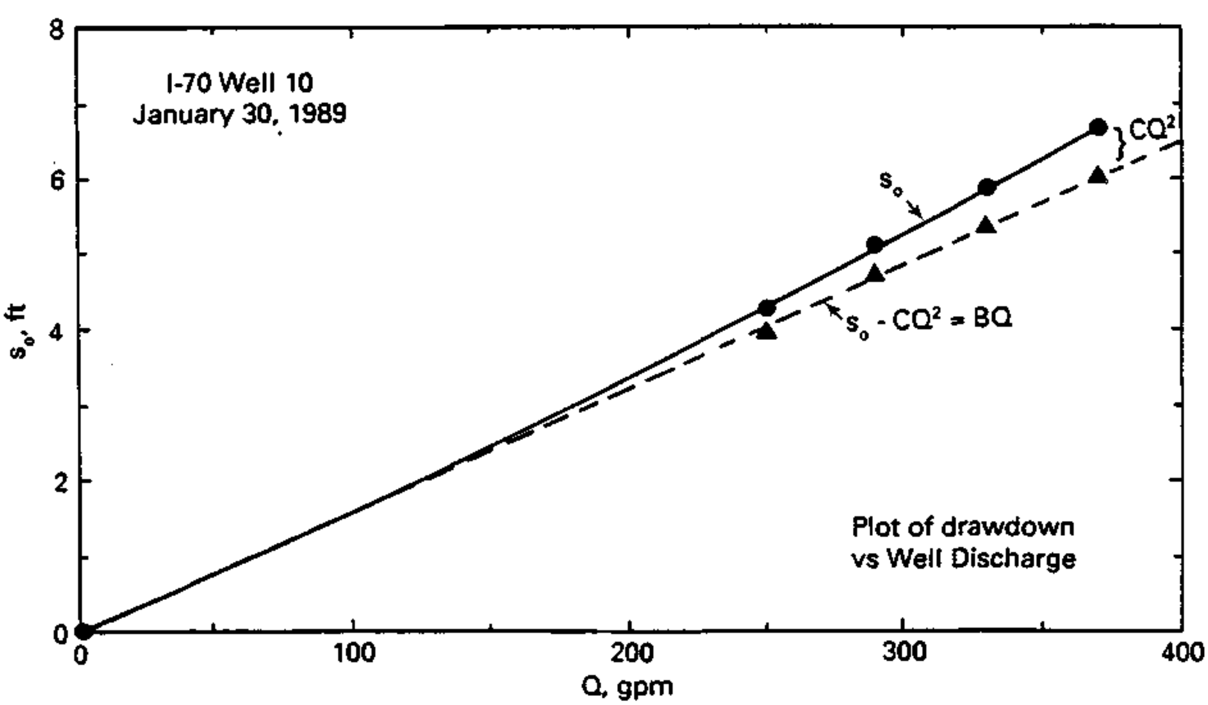



Figure 9. Drawdown versus well discharge, I-70 Well 10

Table 2. Results of Step Tests on IDOT Wells, FY 89 (Phase 6)

| Well | Date of test | Well loss @ 600 gpm (ft) | Drawdown @ 600 gpm (ft) | Well loss portion (%) | Specific capacity (gpm/ft) | $\Delta h$* @ 600 gpm (ft) | Remarks |
|---|---|---|---|---|---|---|---|
| I-70 | | | | | | | |
| No. 1 | 5/17/89 | 3.31 e | 14.68 e | 22.5 | 40.9 e | 8.5 e | $Q_{max}$ - 250 gpm |
| No. 2T | 2/1/89 | 0.19 e | 8.31 e | 2.3 | 72.2 e | P | $Q_{max}$ - 270 gpm, piezometer partially plugged |
| No. 5 | 10/13/88 | | 10.07 e | | 59.6 e | | Incomplete step test - pump stopped |
| No. 5T | 2/2/89 | 0.71 | 6.23 | 11.4 | 96.3 | P | $Q_{max}$ - 650+ gpm |
| No. 7A | 6/15/89 | 2.25 | 11.43 | 19.7 | 52.5 | 8.97 e | $Q_{max}$ - 520 gpm |
| No. 8A | 10/4/89 | ** | 6.10 | ** | 98.4 | 1.38 | $Q_{max}$ - 778 gpm |
| No. 9A | 10/3/89 | ** | 6.04 e | ** | 99.4 e | 1.72 e | $Q_{max}$ - 523 gpm |
| No. 10T | 1/30/89 | 1.74 e | 11.51 e | 15.1 | 52.1 e | 4.34 e | $Q_{max}$ - 370 gpm |
| No. 11T | 1/31/89 | 0.03 | 6.62 e | 0.5 | 90.6 e | P | $Q_{max}$ - 570 gpm, piezometer partially plugged |
| I-64 | | | | | | | |
| No. 11 | 6/16/89 | 0.52 | 7.45 e | 7.0 | 80.5 e | P | $Q_{max}$ - 505 gpm, |
| 25th St. | | | | | | | |
| No. 2 | 8/9/89 | ** | 10.3 e | ** | 58.3 e | -- | $Q_{max}$ - 550 gpm, $\Delta h$ elevation data not available |
| No. 5 | 5/16/89 | 0.47 e | 23.28 e | 0.02 | 25.8 e | 15.2 e | $Q_{max}$ - 352 gpm |

Table 2. Concluded

| Well | Date of test | Well loss @ 600 gpm (ft) | Drawdown @ 600 gpm (ft) | Well loss portion (%) | Specific capacity (gpm/ft) | Δh* @ 600 gpm (ft) | Remarks |
|---|---|---|---|---|---|---|---|
| Venice No. 2 | 9/5/89 | 12.49 e | 44.70 e | 27.9 | 13.4 e | 33.3 e | $Q_{max}$ - 200 gpm, water level below intake |

e-Estimate based on interpolated values adjusted to 600 gpm
*-Head difference between pumped well and adjacent piezometer
**-Coefficient immeasurable. Turbulent well loss negligible over the pumping rates tested.
T-Post-treatment step test
P-Piezometer plugged

about 1.74 feet or 15.1% of the total drawdown. This is a low specific capacity for the Tri-Level site and a moderate amount of well loss, indicating that the well is only in fair hydraulic condition.

Figure 10 shows Δh values at I-70 Well 10 for each step during the test. The projected Δh for I-70 Well 10 pumping 600 gpm is 4.34 ft or 0.78 ft per 100 gpm, which also suggests that the well is in fair condition. The apparently linear relationship implies that turbulent losses in the vicinity of the well are small and that most of this head difference is the result of laminar losses. This was corroborated by a plot of the drawdowns at the piezometer versus pumpage, which also showed a linear relationship.

The results of analyses performed on data gathered from the 12 step tests during FY 89 (Phase 6) are summarized in table 2. (A summary of the results from all of the step tests that have been conducted thus far are tabulated in Appendix C.) The average specific capacity for all 12 tests was 65.0 gpm/ft. For comparative purposes, the results are adjusted to 600 gpm, which is the design discharge rate for the wells.

Five of the six wells step-tested to assess their current state are in poor condition (I-70 Wells 1 and 7A, 25th Street Wells 2 and 5, and Venice Well 2). The specific capacities of these wells are low; 50% or less than the corresponding site averages. Also, for I-70 Wells 1 and 7A and Venice Well 2, well losses are a high percentage of the total drawdown (20% or higher), and Δh values are high. All five of these wells are canditates for chemical treatment.

The step test results can be compared to results from previous tests to document the temporal change in productivity of these wells. At I-70 Well 1, since the post-chemical treatment step test in 1985, the specific capacity has declined about 39% and Δh has more than doubled (both parameters are approaching the pretreatment values). In addition, the maximum test pumping rate (through the temporary discharge plumbing and orifice tube) has declined to 250 gpm, the lowest for any of the tests on this well to date. It is likely that the problem is related to the buildup of chemical encrustation in the pump and discharge piping, as was encountered during the treatment of this well in 1985. A thick buildup of the encrustation is also severely reducing the capacity of the discharge line exiting the pit and extending beyond for an unknown distance. Any rehabilitative work on Well 1 must address this problem as well. For I-70 Well 7A, a new well in 1987, less than two years of operation has resulted in a 27% decline in specific capacity and a four-fold increase in Δh. Well-loss comparisons cannot be made for either of these two wells because it could not be estimated for the earlier tests.

For 25th Street Well 2, the specific capacity has declined almost 50% since it was step-tested in 1983, but well loss and Δh data are unavailable for comparison. Surprisingly, 25th Street Well 5 has a very low specific capacity and high Δh, indicating its poor condition, but a very low well loss. The low well loss may be explained at least in part by the inability to pump the well for the test at a rate comparable to the usual operating rate. Since this is the first step test on Well 5, comparison with previous tests is not possible.

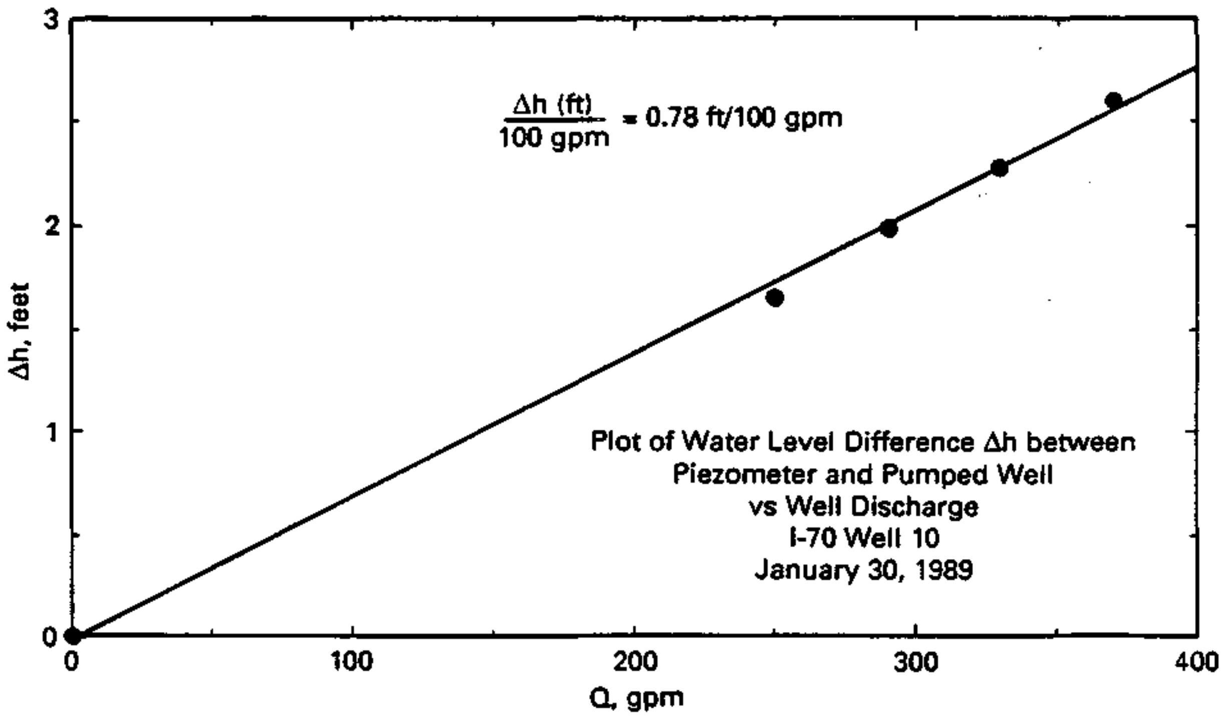



Figure 10. Water-level difference versus discharge, I-70 Well 10

In a period of about six years, since the 1983 step test, Venice Well 2 has experienced a dramatic decrease in specific capacity and increases of both well loss and Δh. Almost immediately after the step test began at about 400 gpm, the pump started breaking suction and had to be held to flow rates less than 200 gpm to keep water levels above the pump intake for the rest of the test. The results suggest that this well is in the poorest condition of those step-tested during FY 89 (Phase 6).

I-64 Well 11, the sixth step-tested well in this group, is in fair condition. Although its 80.5 gpm/ft specific capacity is below average for the site (100 gpm/ft), it compares favorably with the 83.1 gpm/ft specific capacity from the 1984 step test. In addition, well loss is relatively low, although it could not be estimated in 1984 for comparison. The piezometer was plugged at the time of the step test so Δh data also are not available to compare to the 1984 data. Treatment of this well is not warranted at this time, but its condition should be monitored, especially if it is pumped on a regular basis.

The replacement I-70 Wells 8A and 9A were tested soon after their final acceptance and met productivity expectations. The specific capacities averaged 98.9 gpm/ft, slightly above average for the site, and Δh measurements were low. Well loss could not be determined, probably because well development was taking place during both tests. The overall condition of these wells is the best of the 12 tested during FY 89 (Phase 6).

The post-treatment step tests of I-70 Wells 2, 5, 10, and 11 showed mixed results. The average specific capacity of the four wells is 77.8 gpm/ft. For Wells 2, 5, and 11, the well loss is low (4.7% average), and the specific capacity acceptably high (86.4 gpm/ft average), but there is no Δh information since the piezometers are now all plugged. The results compare favorably with those available from tests in prior years when the wells were in good condition. However, the maximum test pumping rate for Well 2 has declined from that in the previous test on 6/20/88 to about 270 gpm. This declining trend has been exhibited in each successive step test for this well from the 500 gpm rate during the first test on 7/19/83. When taking into account ground-water elevations, the decline appears to be related to the pump or column pipe. Well 11 also has major leaks in the discharge line exiting the well pit, and the connection to the well head must be repaired before the well can be placed back in operation.

I-70 Well 10 has moderate well loss and Δh, but the specific capacity after treatment remains much below that following a previous chemical treatment in 1985 as well as much below average for the I-70 site. The maximum test pumping rate has also declined noticeably from earlier tests. Both I-70 Wells 2 and 10 are candidates for additional rehabilitative measures. The "Well Rehabilitation" section of this report provides additional details about the condition of these wells and their response to treatment.

Seventy step tests have been completed at all sites since FY84 (Phases 1 through 6). The results of these step tests are presented in Appendix C. The average specific capacity for all 70 tests is 80.6 gpm/ft, down from the average of 86.5 gpm/ft for 58 tests at the end of

FY 88 (Phase 5). Twenty of the step tests followed chemical treatment, with the specific capacity averaging 99.3 gpm/ft. At I-70, I-64, 25th Street, and Venice, 36, 14, 10, and 10 tests have been completed, respectively, with average specific capacities of 75.8, 94.0, 74.6, and 85.1 gpm/ft. If the specific capacities from tests on wells in obviously poor condition are dropped from the computations, the site averages become 96.5, 100.0, 116.6, and 105.6 gpm/ft for I-70, I-64, 25th Street, and Venice, respectively.

## Evaluation of Ground-Water Quality

Eleven wells were sampled for analysis by the State Water Survey Analytical Laboratory. The results are reported in Appendix B. Analytical methods conformed to procedures presented in the 16th edition of Standard Methods for the Examination of Water And Wastewater (1985). Samples were preserved with acid for determining iron, calcium, and magnesium concentrations. The sample temperature was determined at each well site, and pH was determined in the laboratory immediately after transit of the samples. The ranges of concentrations and potential influence of each parameter are presented in table 3.

Table 3. Range of Concentrations and Potential Influence of Common Dissolved Constituents

| Parameter | Concentration, mg/l Min. | Concentration, mg/l Max. | Potential Influence |
|---|---|---|---|
| Iron (Fe) | 6.0 | 23.8 | Major - incrustative |
| Calcium (Ca) | 137.0 | 231.0 | Major - incrustative |
| Magnesium (Mg) | 37.6 | 59.9 | Minor - incrustative |
| Sodium (Na) | 15.7 | 251.0 | Neutral |
| Silica ($SiO_2$) | 28.6 | 33.7 | Minor - incrustative |
| Nitrate ($NO_3$) | < 0.1 | 1.6 | Neutral |
| Chloride (Cl) | 23.8 | 128.0 | Moderate - corrosive |
| Sulfate ($SO_4$) | 181.0 | 928.0 | Major - corrosive |
| Alkalinity (as $CaCO_3$) | 346.0 | 501.0 | Major - incrustative |
| Hardness (as $CaCO_3$) | 502.0 | 780.0 | Major - incrustative |
| Total dissolved solids | 688.0 | 1816.0 | Major - corrosive |
| pH | 7.0 | 8.0 | Major - incrustative |

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 samples previously analyzed and reported for wells in the nearby area.

## Well Rehabilitation

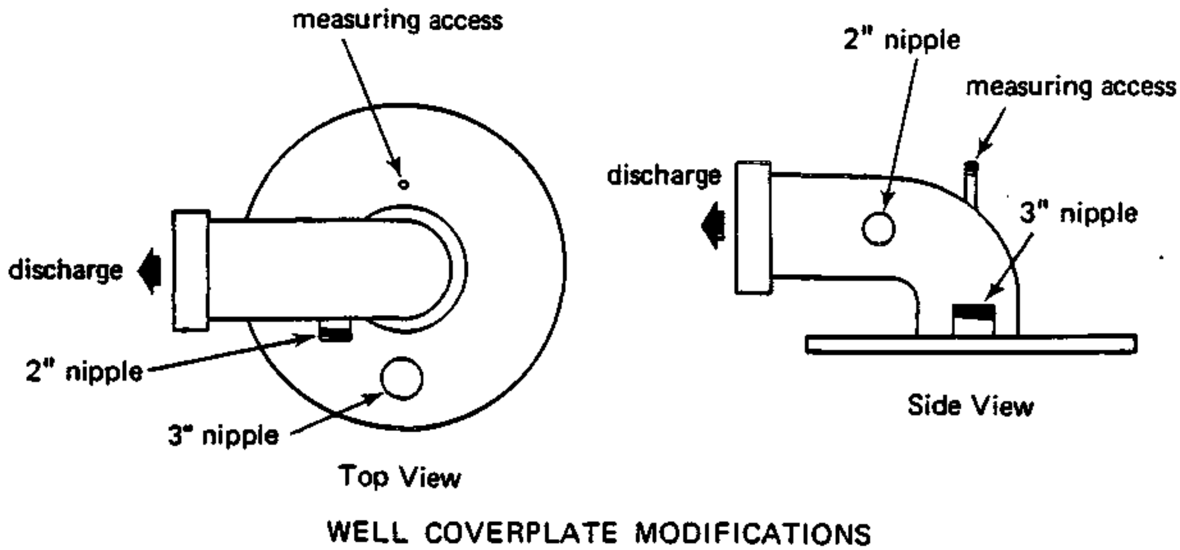
The chemical treatment of four dewatering wells (I-70 Wells 2, 5, 10 and 11) during FY 89 (Phase 6) was carried out by Aylor Aqua Services, Inc., in the period from October 5 to November 19, 1988. The wells had been recommended for chemical treatment in the Phase 5 report (Wilson et al., 1991) based on the results from the step tests and the available Δh data collected by IDOT. IDOT personnel observed and documented the rehabilitation work. The documentation field notes for each treated well are in Appendix D.

Similar treatment procedures were used for all of the wells, as required by IDOT specifications, although adjustments occurred as specific conditions were encountered from day to day and from well to well. The treatment consisted of a series of injections/displacements of phosphate or acid solutions, all conducted at high pumping rates. The chemicals in combination with the surging action caused by the high pumping rates helps loosen, break down, and remove chemical encrustations or other materials that are reducing the hydraulic efficiency of the wells. All four wells had been previously treated in 1985 or 1986 using nearly the same procedure. They are the first IDOT dewatering wells to receive this extensive treatment a second time. Table 4 summarizes the specified treatment procedure and notes significant changes in the actual procedure used by the contractor.

Figure 11 schematically depicts the typical injection assembly/ discharge apparatus used for injecting chemical solutions (except for the acid) into the wells, pumping spent solutions to waste, and conducting pumping tests. Figure 12 illustrates the typical assembly used for acidization. Modifications to the well heads made during previous well treatment contracts were utilized for injecting the solutions.

Table 5 summarizes the pumping test data collected during the field documentation as part of the specified scope of work for the treatment of each well. It contains an estimate of specific capacity prior to the start of treatment and following each step in the treatment process (phosphate or acid injection). The average specific capacity for all of the wells at each step in the treatment process is given at the end of the table, along with an analysis of the improvement between steps. The analysis shows that more than 80% of the total improvement occurred by the time the second step of treatment (acidization) was completed, with only a small amount of improvement during the final three phosphate applications. Improvement was about equal between the first phosphate application and acidization. This trend diverges from that noted in the treatments during prior years, when substantial improvements occurred through the second phosphate application, before dramatically tapering off. This finding provides additional support for the scheme to reduce total treatment costs by eliminating unecessary steps, which was presented in the Phase 5 report.

Following chemical treatment, the Water Survey performed step tests on each of the rehabilitated wells to evaluate their condition and response to treatment as well as to verify the results from the specific capacity tests conducted during the treatment. The results of these step tests are shown in table 2 and also appear in Appendix C, along with results from step tests conducted previously on the wells. Table 6 contains a comparison of pre- and post-treatment specific capacity data for the Water Survey step tests and the treatment pumping tests.



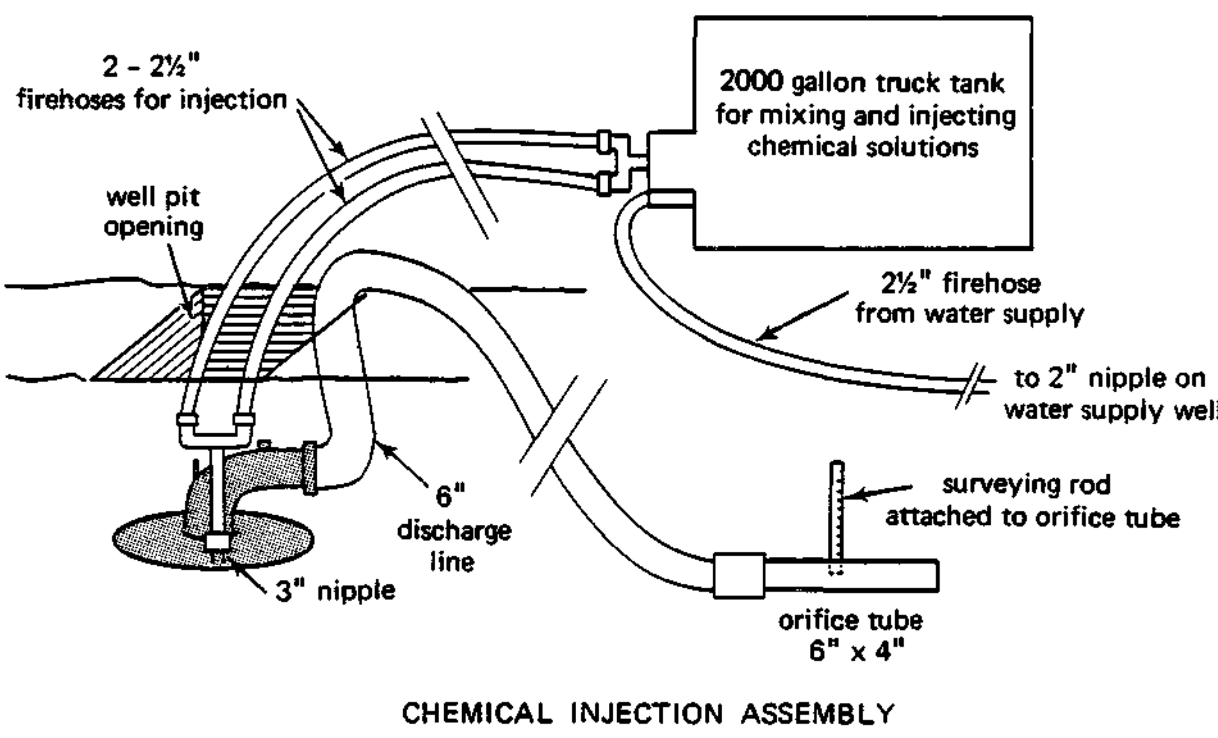




Figure 11. Injection assembly and discharge apparatus

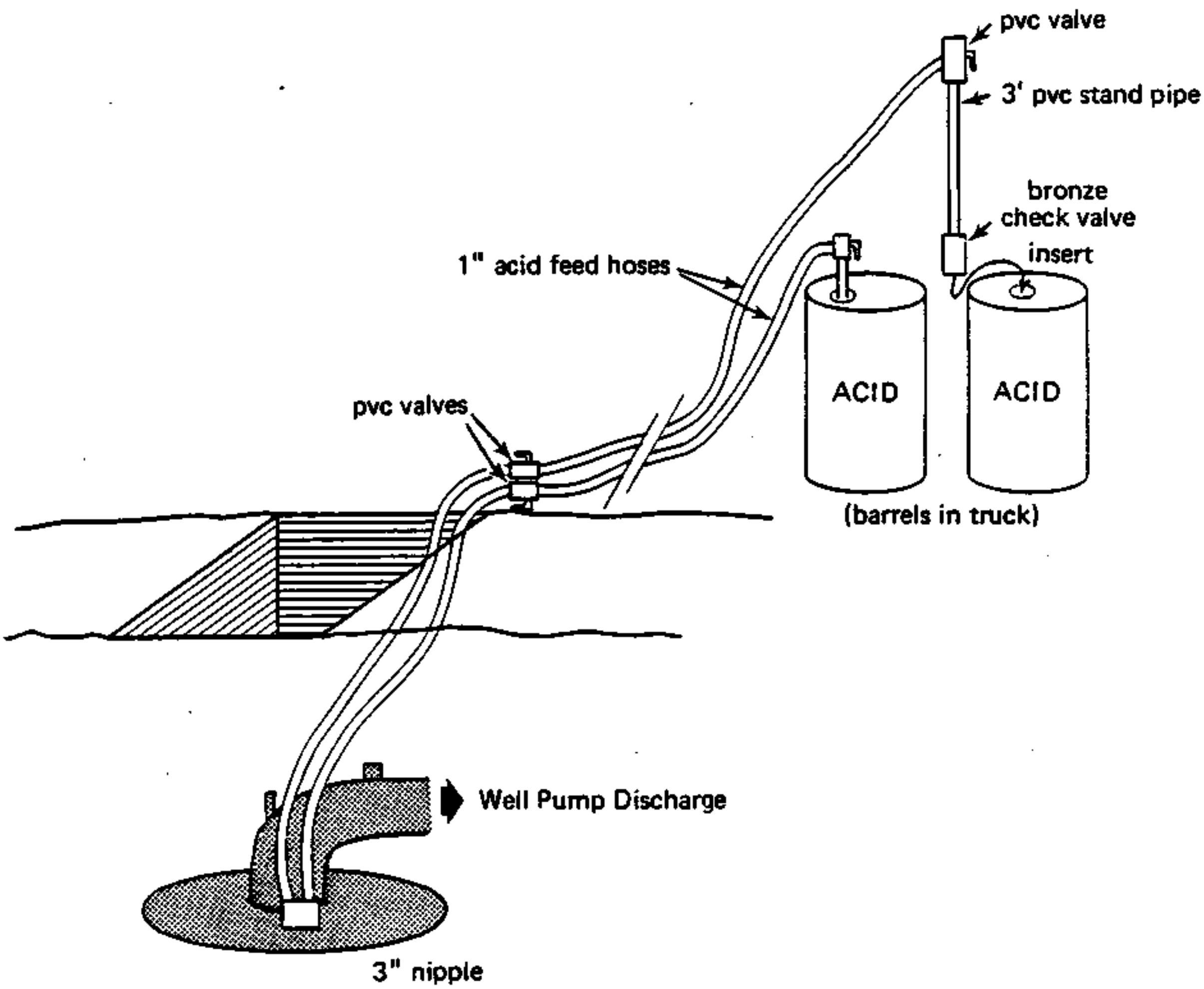



Figure 12. Acidization assembly

## Table 4. 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 lbs., and displacement with 16,000 gallons water containing at least 500 ppm (mg/l) chlorine.

    a. Initial chlorination of well using a minimum of 2500 gallons water containing 500 ppm or more chlorine injected at a minimum rate of 750 gpm (actual rates from less than 300 gpm to 1000 gpm). Rates less than 750 gpm occurred only in a few instances, usually in the early stages of treatment, when wells were unable to accept higher rates without overflowing.
    b. Injection of polyphosphate solution at a minimum rate of 2000 gpm (actual, 480 to 2040 gpm) in two 1800-gallon batches, each batch containing 200 lbs. polyphosphate and at least 500 ppm chlorine. Rates substantially less than 2000 gpm occurred usually when wells were unable to accept higher rates without overflowing.
    c. Injection of 16,000 gallons water chlorinated to 500 ppm at a minimum rate of 1500 gpm in batches of at least 2000 gallons (the few reported injection rates varied from 150 to 200 gpm).
    d. Time allowance for chemicals to react, 60 or more minutes.

3. Pump to waste and check specific capacity.

    a. Pump 6 or more hours to clear well of chemicals.
    b. Same procedure as step 1 above.

Day 2

1. Acidization with 1000 gallons (150% of screen volume) 20° Baume inhibited muriatic (hydrochloric) acid and displacement with 4000 to 5000 gallons water (not chlorinated).

    a. Pump/siphon 1000 gallons of acid (18 55-gallon drums used) into well -- injection period not to exceed 1 hour (17 gpm minimum).
    b. Allowance time for acid to react, 1 hour (actual, 1 to 2 hours).
    c. Injection of 4000 to 5000 gallons (actual 5,000 gallons) water at rates from 1000 to 2000 gpm (actual rate not specified in field notes).
    d. Allowance for reaction, 2 hours or more (actual, 1 to 2 hours).

Table 4. Concluded

2. Pump to waste and check specific capacity.

   a. Pump 3 hours or more to clear well of acid.
   b. Same procedure as Day 1, step 1 above.

Day 3

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

   Same procedure as Day 1, step 2 above, except 3 batch injections of 1800 gallons (5400 gallons total) with 200 lbs. phosphate each in part b, and injection of 30,000 gallons in part c.

2. Pump to waste and check specific capacity.

   a. Pump 6 or more hours to clear well of chemicals.
   b. Same procedure as Day 1, step 1 above.

Day 4

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

   Same procedure as Day 1, step 2 above, except 3 batch injections of 1800 gallons (5400 gallons total) with 200 lbs. phosphate each in part b, and injection of 54,000 gallons in part c.

2. Pump to waste and check specific capacity.

   a. Pump 6 or more hours to clear well of chemicals.
   b. Same procedure as Day 1, step 1 above.

Day 5

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

   Same procedure as Day 1, step 2 above.

2. Pump to waste and final specific capacity test.

   a. Pump 6 or more hours to clear well of chemicals.
   b. Same procedure as Day 1, step 1 above.

Table 5. Pumping Test Data Collected before Treatment and after Each Treatment Step

| | Pretreatment | 1st PPP treatment | Acid treatment | 2nd PPP treatment | 3rd PPP treatment | 4th PPP treatment |
|---|---|---|---|---|---|---|
| I-70 Well 2 | | | | | | |
| | 11/14/88 | 11/15/88 | 11/16/88 | 11/17/88 | 11/18/88 | 11/19/88 |
| SWL | 35.2 | 34.5 | 35.8 | 35.0 | 35.0 | 36.7 |
| PWL | 41.0 | 40.4 | 40.6 | 40.7 | 40.8 | 42.3 |
| DD | 5.8 | 5.9 | 4.8 | 5.7 | 5.8 | 5.6 |
| Flow | 316 | 339 | 361 | 372 | 383 | 372 |
| Q/s | 54.5 | 57.5 | 75.2 | 65.3 | 66.0 | 66.4 |
| I-70 Well 5 | | | | | | |
| | 11/9/88 | 11/10/88 | 11/11/88 | 11/12/88 | 11/13/88 | 11/14/88 |
| SWL | 13.6 | 12.4 | 12.6 | 11.4 | 11.3 | 11.2 |
| PWL | 23.0 | 22.1 | 21.2 | 19.0 | 19.6 | 18.9 |
| DD | 9.4 | 9.7 | 8.6 | 7.6 | 8.3 | 7.7 |
| Flow | 584 | 644 | 644 | 632 | 650 | 650 |
| Q/s | 62.1 | 66.4 | 74.9 | 83.2 | 78.3 | 84.4 |
| I-70 Well 10 | | | | | | |
| | 10/15/88 | 10/17/88 | 10/18/88 | 10/19/88 | 10/20/88 | 10/21/88 |
| SWL | 31.2 | 30.9 | 31.0 | 31.0 | 31.0 | 31.0 |
| PWL | 45.3 | 39.4 | 38.7 | 38.1 | 38.3 | 38.5 |
| DD | 14.1 | 8.5 | 7.7 | 7.1 | 7.3 | 7.5 |
| Flow | 185 e | 280 e | 361 | 372 | 383 | 393 |
| Q/s | 13.1 e | 32.9 | 46.9 | 52.4 | 52.5 | 52.4 |
| I-70 Well 11 | | | | | | |
| | 10/5/88 | 10/7/88 | 10/11/88 | 10/12/88 | 10/14/88 | 10/15/88 |
| SWL | 23.2 | 23.1 | 22.7 | 22.6 | 22.8 | 22.7 |
| PWL | 32.0 | 31.2 | 30.6 | 30.8 | 30.6 | 30.0 |
| DD | 8.8 | 8.1 | 7.9 | 8.2 | 7.8 | 7.3 |
| Flow | 596 | 632 | 602 | 590 | 632 | 614 |
| Q/s | 67.7 | 78.0 | 76.2 | 72.0 | 81.0 | 84.1 |

Table 5. (Concluded)

| Averages | | | | | | |
|---|---|---|---|---|---|---|
| Q/s | 49.4 | 58.7 | 68.3 | 68.2 | 69.5 | 71.8 |
| ΔQ/s | 9.3 | 9.6 | -0.1 | 1.3 | 2.3 | |
| % Increase over initial Q/S | 18.8 | 19.4 | - | 2.6 | 4.7 | |
| % of total improvement | 41.5 | 42.9 | - | 5.8 | 10.3 | |

SWL - static water level (ft)
PWL - pumped water level (ft)
DD - drawdown (ft)
e - estimate, rate too low for accurate orifice tube measurement
Flow - flow rate (gpm)
Q/s - specific capacity (gpm/ft)
PPP - polyphosphate

Table 6. Results of Chemical Treatment

| Site | Well | | Pretreatment Date | Pretreatment Q/s (gpm/ft) | Post-treatment Date | Post-treatment Q/s (gpm/ft) | Δ% | % Change |
|---|---|---|---|---|---|---|---|---|
| I-70 | | | | | | | | |
| | 2 | ISWS | 6/20/88 | 50.1 | 2/1/89 | 72.2 | 22.1 | +44 |
| | | AASI | 11/14/88 | 54.5 | 11/19/88 | 66.4 | 11.9 | +22 |
| | 5 | ISWS | 10/13/88 | 59.6 | 2/2/89 | 96.3 | 36.7 | +62 |
| | | AASI | 11/9/88 | 62.1 | 11/14/88 | 84.4 | 22.3 | +36 |
| | 10 | ISWS | 8/13/87 | 31.6 | 1/30/89 | 52.1 | 20.5 | +65 |
| | | AASI | 10/15/88 | 13.1 | 10/21/88 | 52.4 | 39.3 | +300 |
| | 11 | ISWS | 8/12/87 | 51.9 | 1/31/89 | 90.6 | 38.7 | +75 |
| | | AASI | 10/5/88 | 67.7 | 10/15/88 | 84.1 | 16.4 | +24 |
| Average | | ISWS | | 48.3 | | 77.8 | 29.5 | +61 |
| | | AASI | | 49.4 | | 71.8 | 22.4 | +45 |

ISWS = Illinois State Water Survey
AASI = Aylor Aqua Services, Inc.
Q/s = specific capacity

As discussed earlier in the "Results of Step Tests" section of this report and further exemplified in table 6, the chemical treatment generally was successful in improving the condition of the wells. Following treatment, well losses were reasonably low and the specific capacities, although still below the site average for wells in good condition, were improved on the average approximately 61% (about 30 gpm/ft). Somewhat of an exception to this is I-70 Well 10, which still has a moderate amount of well loss and low specific capacity, even though there was a good amount of improvement in both specific capacity and $\Delta h$. For the other wells, the specific capacity was improved to about the level expected.

As previously noted, the chemical treatment has not solved the declining pumping rate problem for I-70 Well 2. Since the well is in good condition, a problem likely remains in the pump or discharge pipe. These components should be pulled and inspected for mechanical problems or blockage. Such activities were not included in the current well treatment contract.

A review of the specific capacity data from the tests conducted by the contractor only shows a 45% improvement during treatment (table 6). A partial explanation for this is that the post-treatment specific capacities from the step tests for all but I-70 Well 10 were greater than those reported at the end of treatment. This was also the trend following previous chemical treatment contracts. It implies that improvement usually continues for some time following treatment. Curiously, the pretreatment specific capacities from the step tests are lower than those collected immediately before treatment, again with the exception of I-70 Well 10. The time between these step tests and when the actual treatment began probably factors into this observation.

A group of wells has now been rehabilitated in each of four years (7 in 1985, 5 in 1986, 4 in 1987, and 4 in 1988) for a total of 20 chemical treatments. Two different contractors have performed the treatments, one in 1985, 1986, and 1988 and the other in 1987. The results obtained by each contractor have been similar, although the second contractor may not have treated a sufficient number of wells to enable a fair comparison.

As previously stated, these are the first wells to be treated a second time. In all cases the rehabilitation work was completed by the same contractor. Based on the comparison of step-test results for these wells in Appendix C, the first treatment was more successful for two of the wells, the second treatment produced better results for one well, and in one case the results of both treatments were about the same. The average specific capacity was 86.2 gpm/ft after the first treatment and 77.8 gpm/ft after the second treatment. The average improvement in specific capacity was 42.2 gpm/ft after the first treatment and 29.5 gpm/ft after the second. The limited sample of results for the treatment work suggests that the response to treatment was better the first time than the second, although the explanation for this is presently unclear. Most probably a few more wells will need to be retreated before the topic can be adequately addressed.

Follow-up step tests to monitor long-term performance of wells treated in the previous two phases of work show that once improved with phosphate/acid treatment and placed back into operation, the condition of the wells begins to decline again. Thus, the presently used treatment methods do not offer a permanent improvement in the condition of the wells. This suggests that wells located in areas critical to the operation of the dewatering system will probably need to be treated periodically to keep their performance at a satisfactory level. Analysis of the routinely collected water-level data and step test results will continue to be critical in deciding when treatment should be scheduled. The continuing pattern of declining well capacity noted above and the less than ideal response of some wells to the chemical treatments points to the need to explore other well treatment technology that may offer longer lasting results or more cost-effective methods.

## Sand Pumpage Investigation

Nine wells were investigated for sand pumpage during FY 89 (Phase 6): I-70 Wells 1, 2, 5, 7A, 8A, 9A and 11, I-64 Well 11, and 25th Street Well 5. During the step tests on these wells, water from the orifice tube was discharged into a portable 1000-gallon tank (figure 13). Siphon tubes were used as necessary to help control the discharge from the tank. The tank serves as a sedimentation basin that should allow sand with minimum grain diameters of no more than 0.1 mm to settle out at the design pumping rate of the wells (approximately 600 gpm). Usually 80 to 90% or more of the aquifer material in the screened interval of the wells exceeds the 0.1 mm grain size.

Of the nine wells investigated, only I-70 Well 11 yielded enough sand in the tank during the step tests to allow collection of a sample for sieve analysis. A handful of material accumulated in the tank during the test, and it visually consisted of about 50% sand and 50% encrustation chips. The sieve analysis data for this sample with the chips removed are plotted in figure 14 and appear in Appendix E. The sand is similar to that from most of the other sand-producing wells that have been investigated, with the major fraction of the sand being very fine. Based on the gravel pack originally recommended for use in the I-70 wells (see Phase 4 report), the sand could easily migrate through the gravel pack to the well screen and into the well. Review of the sieve data suggests that zones of fine material in the upper aquifer, above about elevation 340 to 350 feet msl, may be the source of the sand. At these elevations, the top 10 to 20 feet of well screen and an even longer interval of the gravel pack would be opposite this suspect source material. It is also conceivable (but unlikely) that the sand is piping through a small hole in the well casing or screen.

Another factor to consider for this well is that since being treated, it has not been possible to pump Well 11 into the system because of leaks in the well pit discharge line. Thus, development may still occur, eliminating the sand pumpage once the well has been repaired and operated for a while. The well should be monitored closely for signs of settlement (none are currently apparent) after it is placed back into operation and the discharge retested for sand once the well has been pumped for several

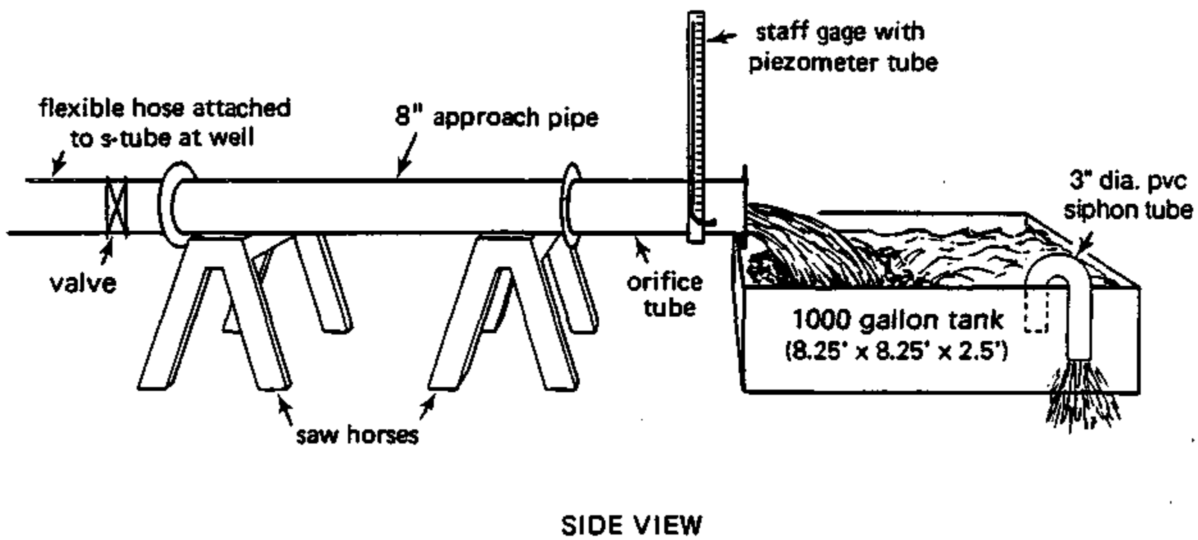



Figure 13. Sand pumpage test setup

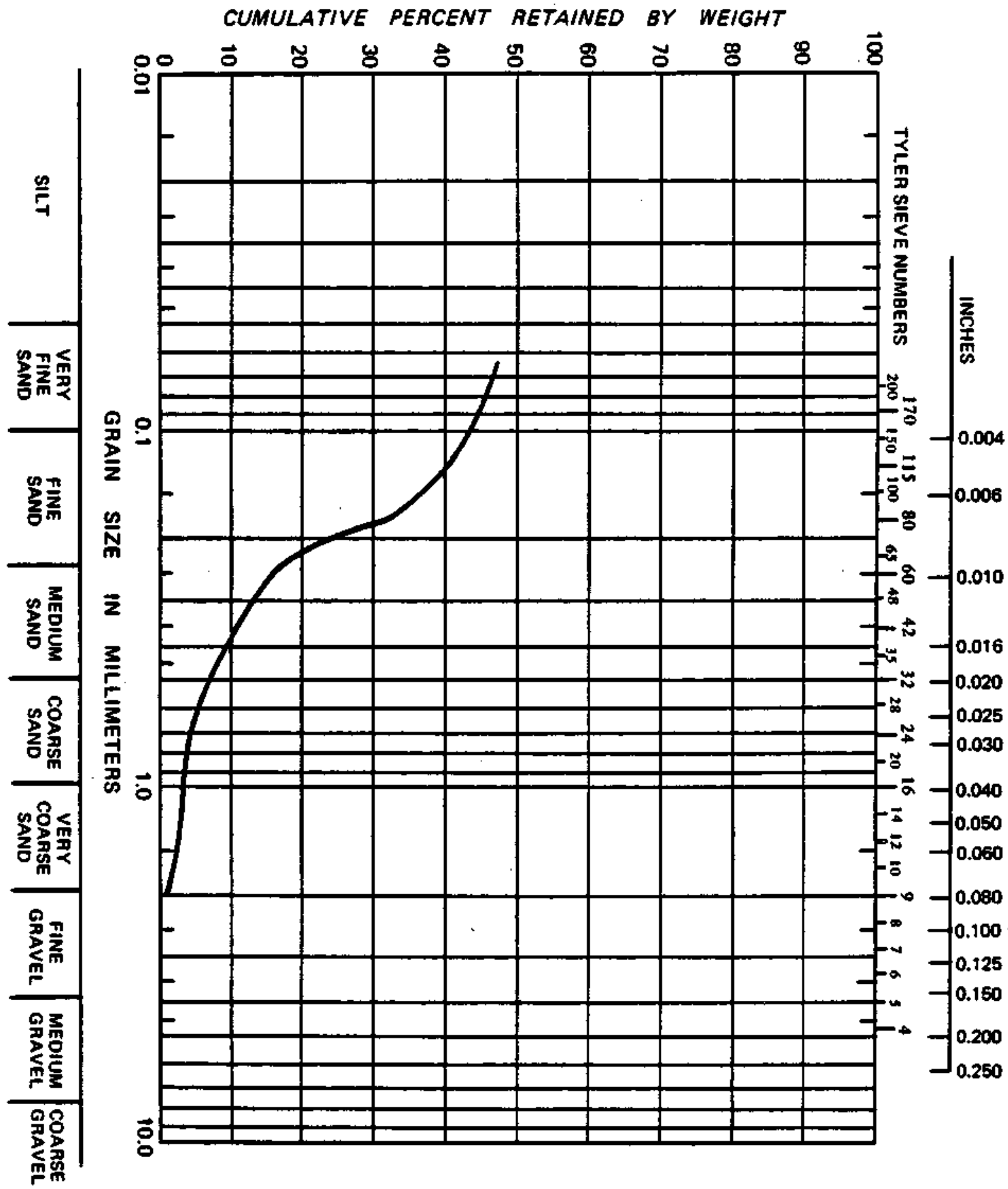



Figure 14. Sieve analysis for sand pumped from I-70 Well 11

months. Additional measures such as video inspection under pumping conditions or insertion of a liner opposite problem areas of the well casing/screen can be considered should the symptom persist.

The other eight wells yielded either insignificant trace amounts of sand or none at all while being step-tested. Interestingly, I-70 Well 2 had produced a small amount of sand during the step test conducted prior to treatment, and it was collected for grain size analysis (see the Phase 5 report for these results). There are at least two plausible explanations as to why the discharge from this well is now apparently sand-free following treatment. Either the treatment may have caused the sand to be effectively developed out of the discharge or the 95 gpm decline in pumping rate from the pretreatment to post-treatment step test may have lowered the entrance velocity below the threshold necessary to pump the sand. This issue can be reexamined after the normal well pumping rate is restored and the well discharge checked for sand.

## I-70 Well 8A and 9A Construction

Two replacement wells were drilled by Luhr Bros., Inc., at the I-70 dewatering site. The Water Survey made well screen and gravel pack design recommendations for the wells based upon data from the original site borings, the washed samples collected from I-70 Well 7A, and a new boring near the site of Well 9A. In addition, the construction was observed and documented by ISWS staff. Appendix F contains the documentation notes.

The drilling began April 5, 1989, on Well 9A, and the work was completed on the second well, 8A, on April 14. The wells were not inspected and brought on-line until September 20, 1989, due to a delay in the delivery of the permanent pumps. The well construction report forms and the sieve analysis results from the washed samples collected by the driller appear in Appendix G.

Each well has a total of 60 feet of 16-inch-diameter Johnson continuous-slot stainless steel well screen. For Well 8A, the lower 30 feet of screen has 55-slot openings (0.055-inch) and the upper 30 feet of screen has 25-slot openings (0.025-inch). In Well 9A, the lower 40 feet of screen is 55-slot and the upper 20 feet of screen is 20-slot openings (0.020-inch).

Material from the Northern Gravel Company, Muscatine, IA, was specified for gravel packing the annulus between the bore hole and the well screen. In each well, Northern pack material No. 1 (Type A in the specs) was to be placed from the bore hole bottom to about 5 feet above the top of the lower (55-slot) screen section. In Well 8A, Northern pack material No. 0 (Type B) was to be placed on top of the No. 1 material to about 5 feet above the top of the upper (25-slot) screen section. For Well 9A, Northern pack material No. 00 (Type C) was to be used on top of the No. 1 pack opposite the 20-slot screen.

Two noteworthy potential problems arose at I-70 Well 8A during construction. First, large cobbles encountered near the bottom of the bore hole (figure 15) severely restricted additional penetration by the

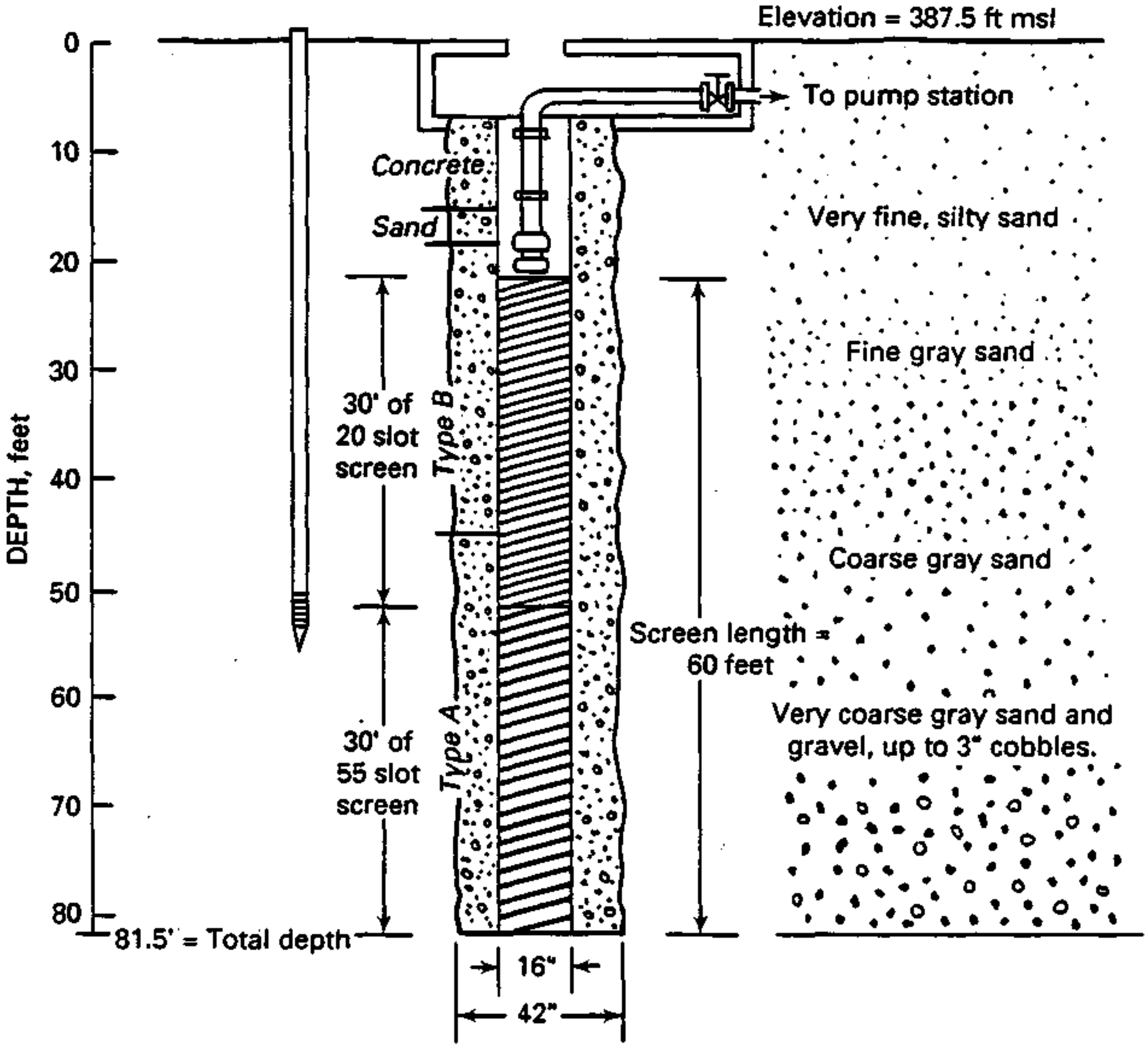



Figure 15. I-70 Well 8A construction features

drag bit, and eventually, drilling was terminated with the total depth about 4 feet short of the target elevation. This caused the screened interval and gravel packs to be shifted up 4 feet higher than specified. Secondly, the bore hole wall apparently caved in during the placement of the upper Type B gravel pack. Measurements indicated that about 84 feet of native material may have filled in the bore hole from 18½ to 27 feet below land surface and is now against the well screen. The cave-in occurred in the time between the placement of two loads of Type B gravel pack. Collectively these actions result in a significant risk for sand pumpage from Well 8A.

In Well 9A, the finer Type C gravel pack was placed to a point about 26 feet above the top of the upper well screen (figure 16). Although this brings the gravel pack in contact with fine-grained material in the upper part of the aquifer, there should be minimum risk of sand pumpage.

After each well was drilled, it was pumped and surged to develop out the fines and cuttings, thereby improving the hydraulic efficiency. The drilling contractor estimated the pumping rate from each well at about 1000 gpm. Using the calculated drawdowns from the water-level measurements collected during well development, I-70 Well 8A had an approximate specific capacity of 98 gpm/ft and Well 9A about 94 gpm/ft.

The post construction step tests conducted October 3 and 4, 1989, showed I-70 Well 8A to have a specific capacity of 98.4 gpm/ft and Well 9A a specific capacity of 99.4 gpm/ft. Well losses could not be determined because some well development probably was still occurring. The $\Delta h$ measurements were low, suggesting that well losses also are low. Although the bore hole wall of I-70 Well 8A may have caved in as described above, no sand was observed in the settling tank following the step test.

## Condition of Relief Wells at Two I-255 Detention Ponds

IDOT maintains two stormwater detention ponds with 39 relief wells southeast of the intersection of I-255 and I-55/I-70. As part of the FY 88 (Phase 5) work, IDOT requested that the Water Survey assist in a preliminary investigation of the condition of the relief wells. Periodic inspection and testing had been recommended in the original design specifications that were prepared for the relief well system. However, access to the well-heads located about 10 feet below land surface at the bottom of the vaults was found to be restricted by the presence of water, limiting the inspection to visual observations from the vault manhole at ground level. Results of the visual inspection of four relief wells, two at the north pond and two at the south pond, appear in the Phase 5 report (Wilson et al., 1991).

Although the visual inspection did not reveal any obvious evidence that the condition of the four relief wells might be in jeopardy, a more thorough investigation was recommended as a precaution. The investigation was to include: visual inspection of the vault floor, well-head check valve, and well casing; collection of water samples to check for the presence of nuisance bacteria using a recently developed test; and other measurements/tests as might be deemed appropriate on four wells. To allow

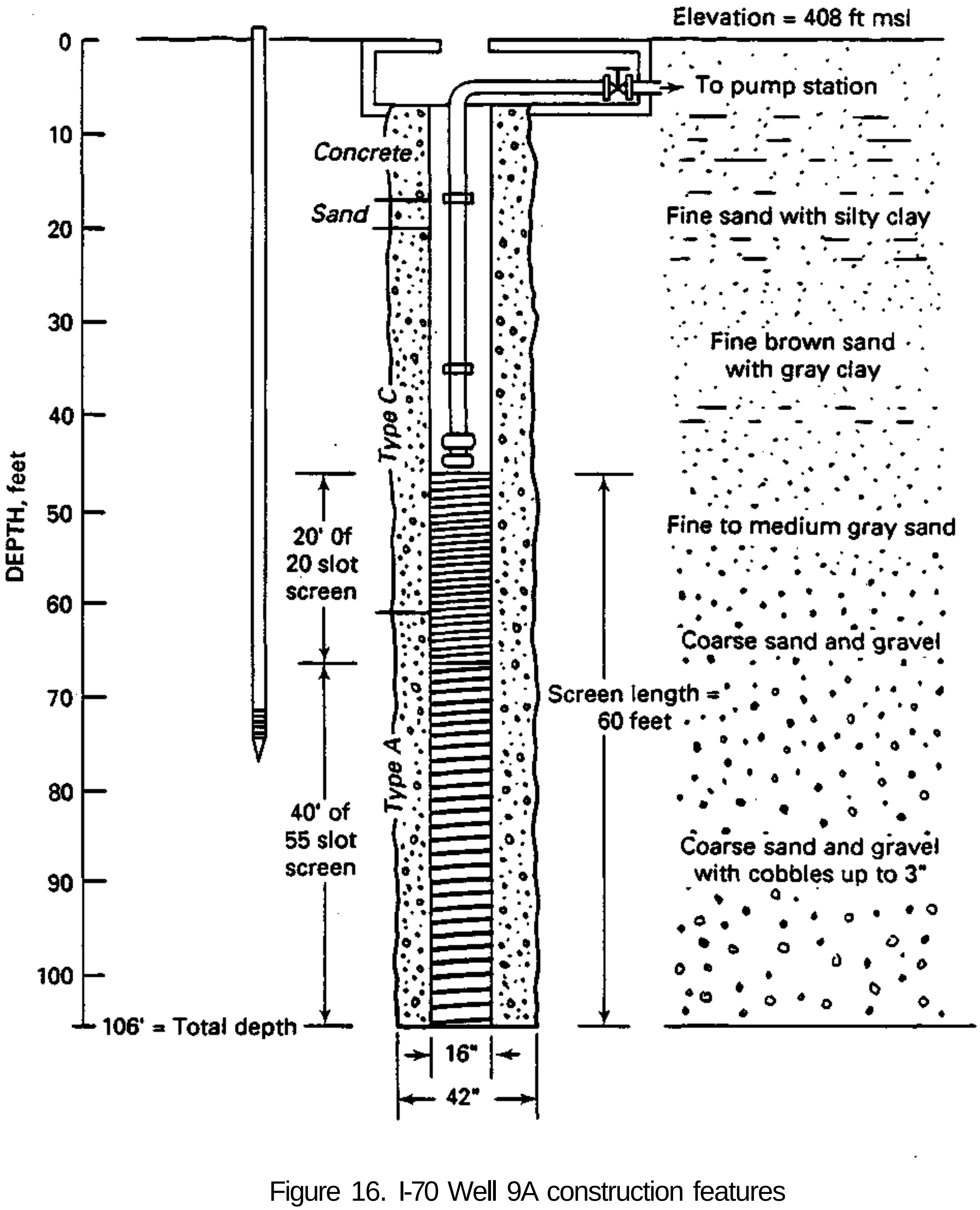



Figure 16. I-70 Well 9A construction features

access to the well heads for this work, the detention ponds were to be pumped down and inflatable plugs installed in the vault outlet pipes. Since all of the arrangements for well-head access could not be made by the time the work for FY 89 (Phase 6) concluded, the investigation was extended into FY 90 (Phase 7). At which time it might also be possible to video inspect some of the wells.

## CONCLUSIONS AND RECOMMENDATIONS

### Condition of Wells

Step tests were conducted on six wells to assess their present condition. These tests show that I-70 Wells 1 and 7A, 25th Street Wells 2 and 5, and Venice Well 2 are in poor condition. The specific capacities of these five wells range from about 13 to 58 gpm/ft and well loss is 20% or higher in most of the wells. All five of these wells are candidates for rehabilitation using chemical treatment. For I-70 Well 1, the rehabilitative work must also address its plugged discharge line to be worthwhile. I-64 Well 11 is in fair condition with low well loss but with a specific capacity (about 81 gpm/ft) that is lower than the average for this dewatering site. Rehabilitation of this well is unnecessary at this time.

The replacement I-70 Wells 8A and 9A are in good condition with specific capacities of nearly 100 gpm/ft, which is slightly above the site average. Well losses could not be determined from the step-test results probably because the wells were still developing during the tests.

The step tests on wells following chemical treatment showed that I-70 Wells 2, 5, and 11 are in good condition with low well losses (5% average) and acceptably high specific capacities (86 gpm/ft average) that are somewhat below the site average. However, the maximum test pumping rate for I-70 Well 2 continued its decline from earlier tests to 270 gpm and needs to be addressed before the well can become an effective component of the dewatering system. I-70 Well 10 has moderate well loss and $\Delta h$, but the specific capacity after treatment remains much below that following a previous chemical treatment in 1985, as well as much below the site average. The pumping rate for this well has also declined. Additional rehabilitative treatment appears warranted for I-70 Well 10, and the pumping components for both Wells 2 and 10 should be inspected for mechanical problems or blockage. Finally, leaks in the discharge line exiting the well pit at I-70 Well 11 must be repaired before this well can be placed back into permanent operation.

Four of the step-tested wells (I-70 Wells 2, 5, and 11 and I-64 Well 11) had piezometers that were plugged. They are important parts of the step tests as well as the monitoring program; therefore, we recommend that they either be rehabilitated or replaced.

## Well Rehabilitation

The chemical treatments used to restore well capacity in FY 89 (Phase 6) were generally successful. The average increase in specific capacity from treatment of the four wells was about 61% (approximately 30 gpm/ft). Well losses were reasonably low following treatment for I-70 Wells 2, 5, and 11, and the specific capacities were improved to about the level expected, although they were still below the site average for wells in good condition. Even though there was good improvement in I-70 Well 10, its condition is still relatively poor, and the well would probably benefit from additional treatment, perhaps using different or more aggressive methods. A video inspection of the well is warranted to help locate problem areas in the well. To help document the treatment effectiveness, it is recommended that future treatment contracts should include provisions to conduct pre- and post-treatment video inspections.

The chemical treatment also did little to improve the low pumping rates of Wells 2 and 10. Future treatment contracts should include options to address any problems in the well pumping equipment that may be discovered during the rehabilitation work.

These four wells are the first to be treated a second time using essentially identical procedures both times. The response to treatment based on averaged values was somewhat better the first time than the second, although individually, the results were mixed. This trend should be examined in greater detail as more wells are retreated.

A review of the specific capacity data for the individual treatment steps indicates that more than 80% of the total improvement had occurred by the time the acidization step was completed, with only a small amount of improvement evident during the final three phosphate applications. A, similar trend of diminished returns from each succeeding treatment step has been noted from the previous rehabilitation work, but the drop-off in response has usually been after later treatment steps. It is not known whether this phenomenon is related to the repeat aspect of the treatments. Nonetheless, it continues to support the idea that the treatment specifications should be modified to allow elimination of unnecessary steps as was presented in the Phase 5 report, thereby increasing the efficiency and reducing the overall cost of the chemical treatment.

The presently used chemical treatment methods have not proven to be a permanent solution to the declining condition of the dewatering wells. Long-term monitoring of 16 previously treated wells shows that once improved and placed back into operation, the condition of the wells usually begins to decline. Thus it appears that the frequently used wells will need to be treated periodically. The routinely collected water-level data and step tests results provide necessary data to make decisions for scheduling chemical treatment for the wells. Also, the limited response of some of the wells to chemical treatment implies that one standard treatment method cannot always be used for rehabilitating the dewatering wells. Other well treatment technology should be explored which may offer better, more cost-effective results.

## Sand Pumpage Investigation

The discharge from nine wells was tested for sand pumpage during the step tests. A significant amount of sand was detected in only the discharge from I-70 Well 11, but the amount was small. In addition, there is little visual evidence of settlement around the well at land surface. The grain size distribution shows that the majority of the sand is very fine and could easily migrate through the gravel pack into the well. The sand may be originating from zones of fine material in the upper aquifer (above elevations 340 to 350 ft msl), which is opposite the top 10 to 20 feet of well screen, and from an even longer interval of gravel pack. Since it has not been possible to pump this well into the dewatering system following treatment because of a leaky discharge line in the well pit, there is a chance that regular well operation will redevelop the well to eliminate the sand pumpage. Before any other measures are taken, it is first recommended that the well be retested after it has been repaired and pumped for several months. If the symptom still persists, the well should be video inspected before considering the course of remediation to pursue.

I-70 Well 2, which had yielded sand when last step-tested in FY 88 (Phase 5), apparently no longer pumps sand. The pumping rate was about 94 gpm lower than the previous test, which may have reduced the entrance velocity into the well enough to stop sand migration. This issue should be revisited and the discharge checked again for the presence of sand if the pumping rate can be restored.

## Well Construction

I-70 Wells 8A and 9A, as constructed, appear to be in good hydraulic condition. However, the inability to drill to the required depth as occurred during the construction of Well 8A is a potential problem. Future well drilling contractors should be made aware of this problem when bidding on the work and required to have on hand the equipment necessary to handle this situation. If this is not possible, adjustments in the length of the well screen may be necessary in the field immediately before setting the screen. It is also recommended that a fully penetrating boring with samples collected for grain size analysis be done at the site of any new or replacement well before finalizing the design (as was done for Well 9A).

## Future Investigations

A program of continued investigation of the condition of the dewatering wells using step tests is recommended. Measuring the difference between water levels in the piezometer and the adjacent well will continue to be important for determining which wells should be step-tested or treated. In addition, since the pumpage of sand has been identified in some of the wells and continues to be a cause for concern, we recommend that the well discharge be checked for sand during each step test.

To help provide more insight as to the mortality of the dewatering wells, we propose an expanded monitoring effort for at least one of the two replacement wells. This effort would consist of a regularly (yearly) scheduled step test to document the condition of the well as it is used.

Five wells have been recommended for rehabilitative treatment during FY 90. The presently used chemical treatment method has not proven to be an all-inclusive or permanent solution to the declining condition of the dewatering wells. Therefore, we recommend exploring other well treatment technology that may offer better results and/or be more cost-effective.

The investigation of the four detention pond relief wells will continue as soon as the well vaults have been modified to allow access into the well heads. The wells will then be inspected and pumped to collect water samples for use in the nuisance bacteria tests.

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## Appendix A.

### Step Test Data

| | | |
|---|---|---|
| I-70 | Well 1 | 5/17/89 |
| | Well 2 | 2/1/89 |
| | Well 5 | 2/2/89 |
| | Well 7A | 6/15/89 |
| | Well 8A | 10/4/89 |
| | Well 9A | 10/3/89 |
| | Well 10 | 1/30/89 |
| | Well 11 | 1/31/89 |
| I-64 | Well 11 | 6/16/89 |
| 25th St. | Well 2 | 8/9/89 |
| | Well 5 | 5/16/89 |
| Venice | Well 2 | 9/5/89 |

## DEWATERING WELL DATA

| | Well No. I-70 Wl | Piezometer No. I-70 Pl |
|---|---|---|
| Date Drilled: | 1973 | 1973 |
| **Casing** | | |
| Top elevation: | 409.7 ft | 416.1 ft |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 45.0 | na |
| **Screen** | | |
| Bottom elevation: | 304.71 ft | na |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 60 ft | 3 ft |
| Slot size: | 0.080-in. | na |
| Measuring Point Elevation: | 410.80 | 416.10 |
| **Nonpumping Water Level** | | |
| Depth below temp. MP: | 35.01 ft | - |
| Length of temp. MP extension: | 5.80 | - |
| Depth below perm. MP: | 29.21 | 34.74 ft |
| Elevation: | 381.59 | 381.36 |
| Date of Step Test: | 5/17/89 | - |
| **Water Sample** | | |
| Time: | 1:02 PM | - |
| Temperature: | 60° F | - |
| Laboratory No.: | 223086 | - |
| Distance and Direction to Piez. from PW: | | 9.44 ft SW |
| Time PW Off Before Step Test: | | na |

Notes: SWS 8-in. dia. orifice tube w/plate No. 2
Data collected with McDAS

WATER LEVEL MEASUREMENTS
Well I-70 No. 1

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| 9:20 AM | | | 34.74 | | | Steel tape measurements |
| 9:36 | | 35.01 | | | | |
| 10:18 | | | | | | Pump not working |
| 11:03 | | | | | | Pump running backward |
| 11:08 | | | | | | Only pumps 250 gpm changed to Plate 2 |
| 11:27 | 0 | 35.01 | 35.83 | | | Start Step 1 |
| | 1 | 39.36 | 35.91 | 4.43 | 240 | Max Q |
| | 2 | 39.51 | 35.91 | | | |
| | 3 | 39.59 | 35.96 | | | |
| | 4 | 39.66 | 36.00 | 4.33 | 237 | |
| | 5 | 39.71 | 36.03 | | | |
| | 6 | 39.73 | 36.05 | | | Discharge water reddish- |
| | 7 | | | 4.30 | 236 | brown |
| | 8 | 39.78 | 36.08 | | | |
| | 10 | 39.83 | 36.11 | | | |
| | 11 | | | 4.27 | 235 | |
| | 12 | 39.84 | 36.12 | | | |
| | 14 | 39.87 | 36.13 | | | |
| | 16 | 39.88 | 36.14 | 4.25 | 235 | |
| | 20 | 39.89 | 36.16 | | | |
| | 25 | 39.92 | 36.17 | | | |
| | 28 | | | 4.21 | 234 | |
| | 29 | 39.92 | 36.17 | | | |
| | 30 | 39.92 | 36.17 | | | |
| 11:58 | 1 | 39.24 | 36.00 | 3.05 | 199 | Step 2 |
| | 2 | 39.22 | 35.99 | | | |
| | 3 | 39.21 | 35.99 | | | |
| | 4 | 39.21 | 35.98 | | | |
| | 5 | 39.21 | 35.98 | | | |
| | 6 | 39.21 | 35.99 | | | |
| | 8 | 39.21 | 35.99 | | | Collected BART samples |
| | 10 | 39.21 | 35.97 | | | |
| | 12 | 39.20 | 35.97 | | | |
| | 13 | | | 3.05 | 199 | |
| | 14 | 39.20 | 35.98 | | | |
| | 16 | 39.20 | 35.97 | | | |
| | 20 | 39.20 | 35.97 | | | |
| | 22 | | | 3.06 | 199 | |
| | 25 | 39.20 | 35.98 | | | |
| | 26 | | | 3.06 | 199 | |
| | 29 | 39.20 | 35.98 | | | |
| | 30 | 39.19 | 35.98 | | | |
| 12:28 PM | 1 | 38.28 | 35.74 | 1.73 | 149 | Step 3 |

WATER LEVEL MEASUREMENTS (Continued)
Well I-70 No. 1

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| | 2 | 38.24 | 35.72 | | | |
| | 3 | 38.21 | 35.71 | | | |
| | 4 | 38.20 | 35.70 | | | |
| | 5 | 38.19 | 35.69 | | | |
| | 6 | 38.18 | 35.68 | | | |
| | 8 | 38.17 | 35.68 | | | |
| | 10 | 38.15 | 35.67 | | | |
| | 12 | 38.15 | 35.66 | | | |
| | 13 | | | 1.74 | 150 | |
| | 14 | 38.15 | 35.66 | | | |
| | 16 | 38.15 | 35.66 | | | |
| | 20 | 38.15 | 35.66 | | | |
| | 25 | 38.14 | 35.65 | | | |
| | 26 | | | 1.74 | 150 | |
| | 29 | 38.15 | 35.65 | | | |
| | 30 | 38.14 | 35.65 | | | |
| 12:58 | 1 | 37.21 | 35.41 | 0.77 | 99 | Step 4 |
| | 2 | 37.16 | 35.38 | | | |
| | 3 | 37.13 | 35.37 | | | Collected water sample |
| | 4 | 37.11 | 35.36 | | | Bottle #B89051502; |
| | 5 | 37.11 | 35.35 | | | Temp 60° F |
| | 6 | 37.09 | 35.34 | | | |
| | 8 | 37.08 | 35.33 | | | |
| | 10 | 37.08 | 35.33 | | | |
| | 12 | 37.06 | 35.32 | | | |
| | 14 | 37.06 | 35.32 | | | |
| | 16 | 37.05 | 35.32 | | | |
| | 17 | | | 0.77 | 99 | |
| | 20 | 37.05 | 35.32 | | | |
| | 25 | 37.05 | 35.31 | | | |
| | 26 | | | 0.77 | 99 | |
| | 29 | 37.05 | 35.32 | | | |
| | 30 | 37.05 | 35.32 | | | |

## DEWATERING WELL DATA

| | Well No. I-70 W2 | Piezometer No. I-70 P2 |
|---|---|---|
| Date Drilled: | 1973 | 1973 |
| **Casing** | | |
| Top elevation: | - | 414.6 ft |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | - | na |
| **Screen** | | |
| Bottom elevation: | 307.36 ft | na |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 60 ft | 3 ft |
| Slot size: | 0.080-in. | na |
| Measuring Point Elevation: | 406.5 | 414.6 |
| **Nonpumping Water Level** | | |
| Depth below temp. MP: | 39.48 ft | - |
| Length of temp. MP extension: | 8.45 | - |
| Depth below perm. MP: | 31.03 | 38.89 ft |
| Elevation: | 375.47 | 375.71 |
| Date of Step Test: | 2/1/89 | - |
| **Water Sample** | | |
| Time: | 12:14 PM | - |
| Temperature: | 59.5° F | - |
| Laboratory No.: | 222892 | - |
| Distance and Direction to Piez. from PW: | | 6.25 ft west |
| Time PW Off Before Step Test: | | na |
| Wells in Operation at Site at Time of Step Test:* | | na |

Notes: SWS 8-in. dia. orifice tube w/plate No. 2
Well chemically treated 11/14/88-11/19/88
Piezometer is partially plugged
Data collected with McDAS

SWS Crew: Wilson, Stollhans, Olson

* Operation based upon IDOT records

WATER LEVEL MEASUREMENTS
Well I-70 No. 2

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| 8:55 AM | | 39.47 | | | | Steel tape measurements |
| 9:03 | | 39.48 | | | | |
| 9:05 | | | 38.89 | | | |
| 9:36 AM | | 39.48 | 38.89 | | | Start test |
| 9:38 | | | | | | Stop test |
| 10:06 | 0 | 39.48 | 39.04 | | | Only pumping 300 gpm; |
| | 1 | 41.31 | 39.06 | 1.49 | 138 | start over with plate |
| | 2 | 41.27 | 39.09 | | | No. 2; piezometer is |
| | 3 | 41.28 | 39.10 | | | partially plugged |
| | 4 | 41.30 | 39.12 | | | |
| | 5 | 41.30 | 39.13 | | | |
| | 6 | 41.34 | | 1.52 | 140 | |
| | 8 | 41.37 | | | | |
| | 10 | 41.38 | 39.21 | 1.51 | 139 | |
| | 12 | 41.38 | | | | |
| | 14 | 41.39 | | | | |
| | 16 | 41.40 | | | | |
| | 20 | 41.40 | 39.37 | | | |
| | 23 | | | 1.50 | 139 | |
| | 25 | 41.41 | | | | |
| | 29 | 41.42 | | | | |
| | 30 | 41.42 | 39.50 | | | |
| 10:37 | 1 | 41.91 | | 2.50 | 180 | Step 2 |
| | 2 | 41.92 | | | | |
| | 3 | 41.92 | | | | |
| | 4 | 41.93 | | | | |
| | 5 | 41.94 | | | | |
| | 6 | 41.94 | | | | |
| | 8 | 41.95 | | | | |
| | 10 | 41.95 | 39.66 | | | |
| | 12 | 41.94 | | | | |
| | 13 | | | 2.48 | 179 | |
| | 14 | 41.94 | | | | |
| | 16 | 41.95 | | | | |
| | 20 | 41.96 | 39.80 | | | |
| | 25 | 41.96 | | 2.48 | 179 | |
| | 29 | 41.97 | 39.91 | | | |
| | 30 | 41.97 | | | | |
| 11:07 | 1 | 42.46 | | | | Step 3 |
| | 2 | 42.47 | | | | |
| | 3 | 42.48 | | | | |
| | 4 | 42.49 | | 3.72 | 220 | |
| | 5 | 42.49 | | | | |
| | 6 | 42.50 | | | | |

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

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| | 8 | 42.51 | | | | |
| | 10 | 42.52 | 40.07 | 3.73 | 220 | |
| | 12 | 42.52 | | | | |
| | 14 | 42.52 | | | | |
| | 16 | 42.52 | | 3.73 | 220 | |
| | 20 | 42.53 | 40.20 | | | |
| | 25 | 42.53 | | | | |
| | 28 | | | 3.72 | 220 | |
| | 29 | 42.53 | 40.31 | | | |
| | 30 | 42.54 | | | | |
| | 1 | 43.02 | | 5.21 | 260 | Step 4 |
| | 2 | 43.04 | | | | |
| | 3 | 43.04 | | | | |
| | 4 | 43.05 | | | | |
| | 5 | 43.05 | | 5.21 | 260 | |
| | 6 | 43.06 | | | | |
| | 8 | 43.07 | | | | |
| | 9 | | | 5.21 | 260 | |
| | 10 | 43.06 | 40.46 | | | |
| | 12 | 43.07 | | | | |
| | 14 | 43.07 | | 5.19 | 260 | |
| | 16 | 43.07 | | | | |
| | 20 | 43.08 | 40.59 | | | |
| | 25 | 43.10 | | | | |
| | 29 | 43.09 | 40.70 | 5.19 | 260 | |
| | 30 | 43.10 | | | | |
| 12:07 PM | 1 | 43.22 | | 5.62 | 270 | Step 5 |
| | 2 | 43.22 | | | | Wide open |
| | 3 | 43.22 | | | | Water samples collected, |
| | 4 | 43.23 | | 5.62 | 270 | Bottle #s C-89012703 |
| | 5 | 43.24 | | 5.62 | 270 | (standard) and |
| | 6 | 43.24 | | | | C-89012707 (preserved) |
| | 8 | 43.24 | | 5.62 | 270 | Temp - 59.5° F |
| | 10 | 43.24 | 40.81 | | | |
| | 12 | 43.25 | | | | |
| | 14 | 43.25 | | | | |
| | 16 | 43.23 | | | | |
| | 20 | 43.18 | 40.92 | | | |
| | 25 | 43.16 | | | | |
| | 26 | | | 5.62 | 270 | |
| | 27 | | | 5.63 | 271 | |
| | 29 | 43.15 | | | | |
| | 30 | 43.15 | 40.99 | 5.63 | 271 | |

DEWATERING WELL DATA

| | Well No. I-70 W5 | Piezometer No. I-70 P5 |
|---|---|---|
| Date Drilled: | 1973 | 1973 |
| **Casing** | | |
| Top elevation: | 385.3 ft | 391.1 ft |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 21.4 | na |
| **Screen** | | |
| Bottom elevation: | 303.91 ft | na |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 60 ft | 3 ft |
| Slot size: | 0.080-in. | na |
| Measuring Point Elevation: | 385.9 | 391.1 |
| **Nonpumping Water Level** | | |
| Depth below temp. MP: | 16.32 ft | - |
| Length of temp. MP extension: | 5.3 | - |
| Depth below perm. MP: | 11.02 | 16.13 ft |
| Elevation: | 374.88 | 374.97 |
| Date of Step Test: | 2/2/89 | - |
| **Water Sample** | | |
| Time: | 11:40 AM | - |
| Temperature: | 55° F | - |
| Laboratory No.: | 222891 | - |
| Distance and Direction to Piez. from PW: | | 6.5 ft east |
| Time PW Off Before Step Test: | | na |
| Wells in Operation at Site at Time of Step Test:* | | na |

Notes: SWS 8-in. dia. orifice tube w/plate No. 4
Well chemically treated 11/9/88-11/14/88
Piezometer is partially plugged
Test data collected with McDAS

SWS Crew: Wilson, Stollhans, Olson

* Operation based upon IDOT records

WATER LEVEL MEASUREMENTS
Well I-70 No. 5

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| 9:04 AM | 0 | 16.32 | 16.13 | | | |
| 9:25 | 0 | 16.32 | 16.18 | | 650 | Pump on |
| | 1 | 22.95 | 16.19 | | | Step 1 |
| | 2 | 22.86 | 16.20 | 3.80 | 650 | |
| | 3 | 22.88 | 16.21 | | | Cold rainy day |
| | 4 | 22.91 | 16.22 | | | |
| | 5 | 22.93 | 16.23 | | | |
| | 6 | 22.95 | 16.24 | | | |
| | 7 | | | 3.81 | 650 | |
| | 8 | 22.98 | 16.26 | | | Piezometer responds |
| | 10 | 22.99 | 16.28 | | | very slowly, nearly |
| | 12 | 23.01 | | | | plugged |
| | 14 | 23.03 | | | | |
| | 16 | 23.04 | | | | |
| | 20 | 23.08 | | | | |
| | 23 | | | 3.80 | 650 | |
| | 25 | 23.10 | | | | |
| | 28 | | | 3.80 | 650 | |
| | 29 | 23.13 | | | | |
| | 30 | 23.14 | 16.38 | 3.80 | 650 | |
| 9:56 | 1 | 22.63 | | 3.22 | 600 | Step 2 |
| | 2 | 22.61 | | | | |
| | 3 | 22.62 | | | | |
| | 4 | 22.62 | | | | |
| | 5 | 22.62 | | | | |
| | 6 | 22.63 | | | | |
| | 8 | 22.64 | | | | |
| | 10 | 22.64 | | | | |
| | 12 | 22.65 | | 3.22 | 600 | |
| | 14 | 22.66 | | | | |
| | 16 | 22.67 | | | | |
| | 20 | 22.69 | | | | |
| | 25 | 22.69 | | | | |
| | 27 | | | 3.22 | 600 | |
| | 29 | 22.71 | 16.47 | | | |
| | 30 | 22.71 | | 3.22 | 600 | |
| 10:26 | 1 | 22.22 | | 2.71 | 550 | Step 3 |
| | 2 | 22.21 | | 2.71 | 550 | |
| | 3 | 22.21 | | | | |
| | 4 | 22.21 | | | | |
| | 5 | 22.22 | | | | |
| | 6 | 22.22 | | | | |
| | 8 | 22.22 | | | | |
| | 10 | 22.22 | | | | |

WATER LEVEL MEASUREMENTS (Continued)
Well I-70 No. 5

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| | 12 | 22.22 | | | | |
| | 14 | 22.23 | | | | |
| | 16 | 22.24 | | 2.70 | 550 | |
| | 20 | 22.24 | | | | |
| | 25 | 22.25 | | | | |
| | 28 | | | 2.70 | 550 | |
| | 29 | 22.26 | 16.51 | | | |
| | 30 | 22.26 | | 2.70 | 550 | |
| 10:56 | 1 | 21.75 | | 2.22 | 500 | Step 4 |
| | 2 | 21.73 | | | | |
| | 3 | 21.73 | | | | |
| | 4 | 21.73 | | | | |
| | 5 | 21.73 | | | | |
| | 6 | 21.73 | | | | |
| | 8 | 21.72 | | | | |
| | 10 | 21.72 | | | | |
| | 12 | 21.73 | | | | |
| | 14 | 21.73 | | | | |
| | 16 | 21.74 | | | | |
| | 17 | | | 2.21 | 500 | |
| | 20 | 21.74 | | | | |
| | 25 | 21.73 | | | | |
| | 26 | | | 2.21 | 500 | |
| | 29 | 21.74 | 16.50 | | | |
| | 30 | 21.73 | | 2.21 | 500 | |
| 11:26 | 1 | 21.24 | | 1.81 | 450 | Step 5 |
| | 2 | 21.25 | | 1.81 | 450 | |
| | 3 | 21.26 | | | | |
| | 4 | 21.25 | | | | |
| | 5 | 21.25 | | | | |
| | 6 | 21.25 | | | | |
| | 8 | 21.24 | | | | |
| | 10 | 21.24 | | | | |
| | 12 | 21.24 | | | | |
| 11:39 | 14 | 21.25 | | | | Water samples collected, |
| | 15 | | | 1.81 | 450 | Bottle #s D-89012708 |
| | 16 | 21.25 | | | | (preserved), and |
| | 20 | 21.25 | | | | D-89012704 (standard) |
| | 25 | 21.25 | | | | |
| | 28 | | | 1.81 | 450 | |
| | 29 | 21.24 | | | | Temp - 55° F ? |
| | 30 | 21.24 | 16.49 | 1.81 | 450 | |

## DEWATERING WELL DATA

| | Well No. I-70 W7A | Piezometer No. I-70 P7A |
|---|---|---|
| Date Drilled: | 11/86 | 12/86 |
| **Casing** | | |
| Top elevation: | - | - |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 19.9 ft | na |
| **Screen** | | |
| Bottom elevation: | - | na |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 60 ft | 3 ft |
| Slot size: | 0.080-in. | na |
| Measuring Point Elevation: | 390.17 | - |
| **Nonpumping Water Level** | | |
| Depth below temp. MP: | - | - |
| Length of temp. MP extension: | - | - |
| Depth below perm. MP: | 9.61 ft | 9.69 ft |
| Elevation: | 380.56 | - |
| Date of Step Test: | 6/15/89 | - |
| **Water Sample** | | |
| Time: | None taken | - |
| Temperature: | - | - |
| Laboratory No.: | - | - |
| Distance and Direction to Piez. from PW: | | 5.2 ft E |
| Time PW Off Before Step Test: | | na |
| Wells in Operation at Site at Time of Step Test:* | | na |

Notes: SWS 8-in. dia. orifice tube w/plate No. 4
Test data collected with McDAS using updated software

SWS Crew: S. Wilson, D. Kelly, N. Hingson

* Operation based upon IDOT records

WATER LEVEL MEASUREMENTS
Well I-70 No. 7A

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| 7:51 AM | | | 9.69 | | | Steel tape measurements |
| 8:25 | | 9.61 | | | | |
| 9:00 | 0 | 9.61 | 9.79 | | | Step 1 |
| | 1 | 21.21 | 15.26 | 3.65 | 638 | $Q_{max}$ |
| | 2 | 21.27 | 15.25 | | | |
| | 3 | 20.84 | 12.10 | | | |
| | 4 | 20.66 | 12.02 | | | |
| | 5 | | | 3.20 | 598 | |
| | 6 | 20.73 | 12.12 | | | |
| | 12 | 20.89 | 12.21 | | | |
| | 16 | | | 3.16 | 594 | |
| | 20 | | 12.26 | | | |
| | 22 | 20.99 | | | | |
| | 25 | | | 3.16 | 594 | |
| 9:30 | 30 | 21.04 | 12.29 | | | |
| | 1 | 20.10 | 11.86 | 2.67 | 547 | Step 2 |
| | 3 | 20.04 | 11.81 | | | |
| | 8 | | | 2.67 | 547 | |
| | 13 | 20.03 | 11.76 | | | |
| | 22 | | | 2.68 | 548 | |
| | 23 | 20.05 | 11.80 | | | |
| | 28 | | | 2.68 | 548 | |
| 10:00 | 30 | 20.06 | 11.82 | | | |
| | 1 | 19.25 | 11.38 | 2.23 | 500 | Step 3 |
| | 2 | 19.20 | 11.36 | | | |
| | 8 | 19.16 | 11.31 | | | |
| | 15 | | | 2.24 | 501 | |
| | 18 | 19.16 | 11.28 | | | |
| | 26 | | | 2.25 | 502 | |
| | 28 | 19.18 | 11.30 | | | |
| 10:30 | 30 | 19.18 | 11.31 | | | |
| | 1 | 18.15 | 10.73 | 1.78 | 448 | Step 4 |
| | 6 | 18.04 | 10.67 | | | |
| | 16 | 18.02 | 10.64 | 1.78 | 448 | |
| | 26 | 18.03 | 10.65 | | | |
| 11:00 | 30 | 18.03 | 10.66 | | | |
| | 1 | 17.11 | 10.10 | 1.43 | 402 | Step 5 |
| | 5 | 17.05 | 10.06 | | | |
| | 12 | | | 1.43 | 402 | |
| | 15 | 17.05 | 10.02 | | | |
| | 25 | 17.04 | 10.03 | | | |
| 11:30 | 30 | 17.04 | 10.04 | | | |
| | 1 | 16.04 | 9.44 | 1.06 | 347 | Step 6 |
| | 3 | 15.97 | 9.42 | | | |

WATER LEVEL MEASUREMENTS (Continued)
Well I-70 No. 7A

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| | 12 | | | 1.06 | 347 | |
| | 15 | 15.94 | 9.35 | | | |
| | 23 | 15.92 | 9.36 | | | |
| | 30 | 15.91 | 9.37 | | | |

## DEWATERING WELL DATA

| | Well No. I-70 W8A | Piezometer No. I-70 P8A |
|---|---|---|
| Date Drilled: | April 1989 | April 1989 |
| **Casing** | | |
| Top elevation: | - | - |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | - | na |
| **Screen** | | |
| Bottom elevation: | - | na |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | - | 3 ft |
| Slot size: | 0.080-in. | na |
| Measuring Point Elevation: | 387.46 | - |
| **Nonpumping Water Level** | | |
| Depth below temp. MP: | - | - |
| Length of temp. MP extension: | - | - |
| Depth below perm. MP: | 7.71 ft | 11.78 ft |
| Elevation: | 379.75 | - |
| Date of Step Test: | 10/4/89 | - |
| **Water Sample** | | |
| Time: | 2:37 PM | - |
| Temperature: | 61° F | - |
| Laboratory No.: | 223203 | - |
| Distance and Direction to Piez. from PW: | | 6.4 ft E |
| Time PW Off Before Step Test: | | na |
| Wells in Operation at Site at Time of Step Test:* | | na |

Notes: SWS 8-in. dia. orifice tube w/plate No. 4
Test data collected with McDAS

* Operation based upon IDOT records

WATER LEVEL MEASUREMENTS
Well I-70 No. 8A

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| 10:48 AM | | 7.71 | | | | Steel tape measurements |
| 11:00 | | | 11.78 | | | |
| 11:37 | 0 | 7.71 | 11.78 | 5.46 | 778 | Start, wide open, $Q_{max}$ |
| | 1 | 14.51 | 16.80 | | | Step 1 |
| | 2 | 14.62 | 16.98 | 5.08 | 750 | Using plate No. 4 |
| | 3 | 14.70 | 17.01 | | | |
| | 4 | 14.75 | 17.09 | | | |
| | 5 | 14.83 | 17.16 | 5.06 | 749 | |
| | 6 | 14.87 | 17.21 | | | |
| | 8 | 14.96 | 17.28 | | | |
| | 10 | 15.02 | 17.35 | 5.03 | 747 | |
| | 12 | 15.07 | 17.39 | | | |
| | 14 | 15.10 | 17.42 | | | |
| | 16 | 15.13 | 17.48 | | | |
| | 17 | | | 5.02 | 746 | |
| | 20 | 15.16 | 17.51 | | | |
| | 25 | 15.18 | 17.53 | | | |
| | 28 | 15.19 | 17.52 | 5.01 | 745 | |
| | 30 | 15.20 | 17.53 | 5.01 | 745 | |
| 12:08 PM | 1 | 14.83 | 17.26 | 4.41 | 700 | Step 2 |
| | 2 | 14.81 | 17.26 | | | |
| | 3 | 14.81 | 17.24 | | | |
| | 4 | 14.81 | 17.26 | | | |
| | 5 | 14.82 | 17.25 | | | |
| | 6 | 14.82 | 17.25 | 4.43 | 701 | |
| | 8 | 14.82 | 17.26 | | | |
| | 10 | 14.82 | 17.26 | | | |
| | 12 | 14.82 | 17.26 | | | |
| | 14 | 14.83 | 17.28 | | | |
| | 16 | 14.84 | 17.28 | | | |
| | 18 | | | 4.42 | 701 | |
| | 20 | 14.85 | 17.29 | | | |
| | 24 | | | 4.41 | 700 | |
| | 25 | 14.85 | 17.30 | | | |
| | 29 | 14.86 | 17.31 | | | |
| | 30 | 14.86 | 17.31 | | | |
| 12:38 | 1 | 14.40 | 16.98 | 3.80 | 650 | Step 3 |
| | 2 | 14.39 | 16.97 | 3.80 | 650 | |
| | 3 | 14.38 | 16.96 | | | |
| | 4 | 14.38 | 16.96 | | | |
| | 5 | 14.38 | 16.96 | | | |
| | 6 | 14.38 | 16.94 | | | |
| | 8 | 14.38 | 16.96 | | | |
| | 10 | 14.38 | 16.95 | | | |

WATER LEVEL MEASUREMENTS (Continued)
Well I-70 No. 8A

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| | 12 | 14.38 | 16.96 | | | |
| | 14 | 14.38 | 16.96 | | | |
| | 16 | 14.39 | 16.96 | | | |
| | 20 | 14.39 | 16.96 | | | |
| | 25 | 14.40 | 16.97 | 3.79 | 650 | |
| | 28 | 14.41 | 16.97 | | | |
| | 30 | 14.41 | 16.98 | | | |
| 1:08 | 1 | 13.98 | 16.67 | 3.22 | 599 | Step 4 |
| | 2 | 13.97 | 16.65 | | | |
| | 3 | 13.95 | 16.64 | | | |
| | 4 | 13.95 | 16.64 | | | |
| | 5 | 13.95 | 16.63 | | | |
| | 6 | 13.95 | 16.64 | | | |
| | 8 | 13.94 | 16.63 | | | |
| | 10 | 13.95 | 16.63 | | | |
| | 12 | 13.94 | 16.63 | | | |
| | 14 | 13.94 | 16.63 | | | |
| | 16 | 13.95 | 16.64 | | | |
| | 20 | 13.94 | 16.64 | | | |
| | 23 | | | 3.22 | 599 | |
| | 25 | 13.95 | 16.64 | | | |
| | 29 | 13.96 | 16.64 | 3.22 | | |
| | 30 | 13.96 | 16.65 | | | |
| 1:38 | 1 | 13.51 | 16.32 | 2.70 | 550 | Step 5 |
| | 2 | 13.48 | 16.31 | | | |
| | 3 | 13.49 | 16.31 | | | |
| | 4 | 13.48 | 16.30 | | | |
| | 5 | 13.48 | 16.30 | | | |
| | 6 | 13.46 | 16.29 | | | |
| | 8 | 13.47 | 16.28 | | | |
| | 10 | 13.47 | 16.29 | | | |
| | 12 | 13.46 | 16.28 | | | |
| | 14 | 13.46 | 16.28 | | | |
| | 15 | | | 2.70 | 550 | |
| | 16 | 13.47 | 16.29 | | | |
| | 20 | 13.46 | 16.29 | | | |
| | 29 | 13.48 | 16.29 | 2.69 | 549 | |
| 2:07 | 1 | 13.00 | 15.96 | 2.22 | 499 | Step 6 |
| | 2 | 12.99 | 15.92 | | | |
| | 3 | 12.99 | 15.93 | | | Water sample collected, |
| | 4 | 12.97 | 15.92 | | | Bottle #s 89092903 and |
| | 5 | 12.98 | 15.92 | | | 89092904; T=61° F |
| | 6 | 12.98 | 15.92 | | | |
| | 8 | 12.96 | 15.91 | | | |

WATER LEVEL MEASUREMENTS (Continued)
Well I-70 No. 8A

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| | 10 | 12.96 | 15.91 | | | |
| | 12 | 12.96 | 15.90 | | | |
| | 14 | 12.96 | 15.91 | | | |
| | 16 | 12.95 | 15.90 | | | |
| | 18 | | | 2.20 | 497 | |
| | 20 | 12.95 | 15.90 | | | |
| | 23 | | | 2.20 | 497 | |
| | 25 | 12.95 | 15.90 | | | |
| | 28 | 12.93 | 15.89 | | | |
| | 30 | 12.95 | 15.90 | | | |

# DEWATERING WELL DATA

| | Well No. I-70 W9A | Piezometer No. I-70 P9A |
|---|---|---|
| Date Drilled: | April 1989 | April 1989 |
| **Casing** | | |
| Top elevation: | - | - |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | - | na |
| **Screen** | | |
| Bottom elevation: | - | na |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | - | 3 ft |
| Slot size: | 0.080-in. | na |
| Measuring Point Elevation: | 407.85 | 407.52 |
| **Nonpumping Water Level** | | |
| Depth below temp. MP: | 28.37 ft | - |
| Distance to perm. MP: | 3.80 | - |
| Depth below perm. MP: | 32.17 ft | 32.09 ft |
| Elevation: | 375.68 | 375.43 |
| Date of Step Test: | 10/3/89 | - |
| **Water Sample** | | |
| Time: | 3:02 PM | - |
| Temperature: | 61° F | - |
| Laboratory No.: | 223202 | - |
| Distance and Direction to Piez. from PW: | | 6.0 ft E |
| Time PW Off Before Step Test: | | na |
| Wells in Operation at Site at Time of Step Test:* | | na |

Notes: SWS 8-in. dia. orifice tube w/plate No. 4
Test data collected with McDAS

* Operation based upon IDOT records

WATER LEVEL MEASUREMENTS
Well I-70 No. 9A

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| 12:05 PM | | 28.37 | | | | |
| 12:09 | | | 32.09 | | | |
| 12:30 | 0 | 28.37 | 32.07 | 2.44 | 523 | Start, $Q_{max}$ |
| | 1 | 33.15 | 35.39 | | | Step 1 |
| | 2 | 33.27 | 35.51 | | | |
| | 3 | 33.11 | 35.43 | 2.22 | 499 | |
| | 4 | 33.13 | 35.45 | | | |
| | 5 | 33.16 | 35.47 | | | |
| | 6 | 33.17 | 35.49 | | | |
| | 8 | 33.21 | 35.51 | | | |
| | 10 | 33.23 | 35.55 | | | |
| | 12 | 33.26 | 35.57 | | | |
| | 14 | 33.29 | 35.60 | 2.22 | 499 | |
| | 16 | 33.30 | 35.60 | | | |
| | 20 | 33.33 | 35.63 | | | |
| | 25 | 33.34 | 35.66 | 2.21 | 498 | |
| | 29 | 33.32 | 35.66 | 2.21 | 498 | |
| | 30 | 33.32 | 35.66 | | | |
| 1:01 | 1 | 32.95 | 35.42 | 1.81 | 451 | Step 2 |
| | 2 | 32.93 | 35.39 | 1.81 | 451 | |
| | 3 | 32.94 | 35.40 | | | |
| | 4 | 32.94 | 35.41 | | | |
| | 5 | 32.93 | 35.39 | | | |
| | 6 | 32.94 | 35.40 | | | |
| | 8 | 32.94 | 35.40 | | | |
| | 10 | 32.95 | 35.41 | | | |
| | 12 | 32.95 | 35.42 | | | |
| | 14 | 32.94 | 35.41 | 1.81 | 451 | |
| | 16 | 32.96 | 35.41 | | | |
| | 20 | 32.96 | 35.43 | | | |
| | 25 | 32.96 | 35.44 | | | |
| | 28 | 32.97 | 35.44 | 1.81 | 4.51 | |
| | 30 | 32.97 | 35.43 | | | |
| 1:31 | 1 | 32.52 | 35.15 | 1.42 | 400 | Step 3 |
| | 2 | 32.50 | 35.12 | 1.43 | 402 | |
| | 3 | 32.49 | 35.12 | | | |
| | 4 | 32.50 | 35.12 | | | |
| | 5 | 32.50 | 35.11 | | | |
| | 6 | 32.48 | 35.11 | | | |
| | 8 | 32.49 | 35.11 | | | |
| | 10 | 32.50 | 35.11 | | | |
| | 12 | 32.49 | 35.11 | | | |
| | 14 | 32.51 | 35.13 | | | |
| | 16 | 32.49 | 35.12 | | | |

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

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| | 20 | 32.53 | 35.13 | | | |
| | 25 | 32.52 | 35.14 | 1.43 | 402 | |
| | 29 | 32.51 | 35.13 | | | |
| | 30 | 32.53 | 35.15 | | | |
| 2:01 | 1 | 32.09 | 34.84 | 1.09 | 352 | Step 4 |
| | 2 | 32.06 | 34.82 | | | |
| | 3 | 32.03 | 34.80 | | | |
| | 4 | 32.00 | 34.80 | | | |
| | 5 | 32.01 | 34.79 | | | |
| | 6 | 32.02 | 34.79 | | | |
| | 8 | 32.00 | 34.80 | | | |
| | 10 | 32.03 | 34.79 | | | |
| | 12 | 32.01 | 34.79 | | | |
| | 13 | | | 1.10 | 353 | |
| | 14 | 32.01 | 34.79 | | | |
| | 16 | 32.01 | 34.80 | | | |
| | 20 | 32.03 | 34.80 | | | |
| | 23 | | | 1.10 | 353 | |
| | 25 | 32.04 | 34.81 | | | |
| | 29 | 32.04 | 34.81 | | | |
| | 30 | 32.04 | 34.81 | | | |
| 2:31 | 1 | 31.53 | 34.47 | 0.79 | 300 | Step 5 |
| | 2 | 31.54 | 34.48 | | | |
| | 3 | 31.55 | 34.46 | | | |
| | 4 | 31.52 | 34.46 | | | |
| | 5 | 31.52 | 34.46 | | | |
| | 6 | 31.52 | 34.45 | | | |
| | 8 | 31.51 | 34.44 | | | |
| | 10 | 31.51 | 34.44 | | | |
| | 12 | 31.52 | 34.44 | | | |
| | 14 | 31.50 | 34.44 | | | |
| | 15 | | | 0.79 | 300 | |
| | 16 | 31.51 | 34.45 | | | |
| | 20 | 31.52 | 34.45 | | | |
| | 25 | 31.53 | 34.45 | | | |
| | 29 | 31.57 | 34.49 | 0.80 | 302 | |
| | 30 | 31.58 | 34.50 | | | |
| 3:01 | 1 | 31.00 | 34.12 | 0.54 | 249 | Step 6 |
| | 2 | 31.00 | 34.08 | | | Collected water samples, |
| | 3 | 31.00 | 34.10 | | | Bottle #s 89092901 and |
| | 4 | 30.99 | 34.08 | | | 89092902; Temp. = 61° F |
| | 5 | 30.99 | 34.08 | | | |
| | 6 | 30.98 | 34.08 | | | |
| | 8 | 30.97 | 34.06 | | | |

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

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| | 10 | 30.98 | 34.07 | | | |
| | 12 | 30.96 | 34.07 | | | No sediment in sand tank |
| | 14 | 30.97 | 34.07 | | | |
| | 16 | 30.97 | 34.07 | | | |
| | 20 | 30.98 | 34.06 | 0.53 | 246 | |
| | 25 | 30.96 | 34.06 | | | |
| | 29 | 30.96 | 34.06 | 0.51 | 242 | |
| | 30 | 30.96 | 34.05 | 0.51 | 242 | |

## DEWATERING WELL DATA

| | Well No. I-70 W10 | Piezometer No. I-70 P10 |
|---|---|---|
| Date Drilled: | - | - |
| **Casing** | | |
| Top elevation: | 400.8 ft | 409.8 ft |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 37.4 | na |
| **Screen** | | |
| Bottom elevation: | 303.43 ft | na |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 60 ft | 3 ft |
| Slot size: | 0.080-in. | na |
| Measuring Point Elevation: | 401.5 | 409.8 |
| **Nonpumping Water Level** | | |
| Depth below temp. MP: | 35.58 ft | - |
| Length of temp. MP extension: | 8.80 | - |
| Depth below perm. MP: | 26.78 | 35.03 ft |
| Elevation: | 374.72 | 374.77 |
| Date of Step Test: | 1/30/89 | - |
| **Water Sample** | | |
| Time: | 1:51 PM | - |
| Temperature: | 60° F | - |
| Laboratory No.: | 222889 | - |
| Distance and Direction to Piez. from PW: | | 5.8 ft SE |
| Time PW Off Before Step Test: | | na |

Notes: SWS 8-in. dia. orifice tube w/plate No. 4
Well chemically treated 10/15/88-10/21/88
Test data collected with McDAS

SWS Crew: Wilson, Stollhans, Kimpel

WATER LEVEL MEASUREMENTS
Well I-70 No. 10

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| 11:35 AM | | 35.58 | 35.05 | | | Steel tape readings |
| 11:40 | | | 35.03 | | | |
| 12:16 PM | 0 | 35.58 | 35.03 | | | Step 1 |
| | 1 | 41.87 | 38.26 | 1.20 | 369 | Pump on |
| | 2 | 41.99 | 38.85 | | | |
| | 3 | 42.05 | 38.98 | | | |
| | 4 | 42.08 | 39.03 | | | |
| | 5 | 42.11 | 39.05 | | | |
| | 6 | 42.17 | 39.08 | | | |
| 12:24 | 8 | 42.20 | 39.11 | 1.20 | 369 | |
| | 10 | 42.20 | 39.12 | | | |
| | 12 | 42.22 | 39.13 | | | |
| | 14 | 42.22 | 39.13 | | | |
| | 15 | | | 1.20 | 369 | |
| | 16 | 42.24 | 39.14 | | | |
| | 20 | 42.23 | 39.14 | | | |
| | 21 | | | 1.19 | 368 | |
| | 25 | 42.26 | 39.16 | 1.20 | 369 | |
| | 29 | 42.27 | 39.16 | | | |
| 12:46 | 30 | 42.27 | 39.16 | 1.20 | 370 | |
| 12:47 | 1 | 41.54 | 38.85 | 0.96 | 330 | Step 2 |
| | 2 | 41.52 | 38.74 | | | |
| | 3 | 41.53 | 38.72 | 0.96 | 330 | |
| | 4 | 41.51 | 38.72 | | | |
| | 5 | 41.52 | 38.72 | | | |
| | 6 | 41.52 | 38.72 | 0.96 | 330 | |
| | 8 | 41.51 | 38.71 | | | |
| | 10 | 41.52 | 38.72 | | | |
| | 12 | 41.53 | 38.72 | | | |
| | 14 | 41.52 | 38.73 | 0.96 | 330 | |
| | 16 | 41.53 | 38.73 | | | |
| | 20 | 41.53 | 38.73 | | | |
| | 23 | | | 0.96 | 330 | |
| | 25 | 41.52 | 38.72 | | | |
| | 29 | 41.52 | 38.73 | | | |
| | 30 | 41.52 | 38.73 | 0.96 | 330 | |
| 1:17 | 1 | 40.82 | 38.36 | 0.74 | 290 | Step 3 |
| | 2 | 40.78 | 38.29 | | | |
| | 3 | 40.76 | 38.28 | | | |
| | 4 | 40.76 | 38.27 | | | |
| | 5 | 40.76 | 38.27 | | | |
| | 6 | 40.77 | 38.27 | 0.74 | 290 | |
| | 8 | 40.78 | 38.27 | | | |
| | 10 | 40.76 | 38.26 | | | |

WATER LEVEL MEASUREMENTS (Continued)
Well I-70 No. 10

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| | 12 | 40.75 | 38.26 | | | |
| | 14 | 40.76 | 38.25 | | | |
| | 15 | | | 0.74 | 290 | |
| | 16 | 40.75 | 38.26 | | | |
| | 20 | 40.76 | 38.26 | | | |
| | 25 | 40.75 | 38.26 | | | |
| | 27 | | | 0.74 | 290 | |
| | 29 | 40.75 | 38.26 | | | |
| | 30 | 40.75 | 38.26 | 0.74 | 290 | |
| 1:47 | 1 | 39.96 | 37.85 | 0.54 | 248 | Step 4 |
| | 2 | 39.94 | 37.79 | | | |
| | 3 | 39.92 | 37.78 | | | |
| | 4 | 39.92 | 37.77 | | | |
| 1:51 | 5 | 39.92 | 37.76 | 0.53 | 246 | Collected water sample, |
| | 6 | 39.92 | 37.76 | | | Bottle #s A-89012705 |
| | 8 | 39.92 | 37.76 | | | (preserved), A-89012701 |
| | 10 | 39.92 | 37.75 | | | (standard); Temp.=60° F |
| | 12 | 39.91 | 37.75 | | | |
| | 14 | 39.91 | 37.75 | | | |
| | 16 | 39.91 | 37.75 | 0.53 | 246 | |
| | 20 | 39.90 | 37.75 | | | |
| | 24 | | | 0.53 | 246 | |
| | 25 | 39.90 | 37.75 | | | |
| | 29 | 39.89 | 37.74 | | | |
| | 30 | 39.90 | 37.74 | 0.53 | 246 | |

# DEWATERING WELL DATA

| | Well No. I-70 Wll | Piezometer No. I-70 Pll |
|---|---|---|
| Date Drilled: | - | - |
| Casing | | |
| Top elevation: | 396.1 ft | 403.2 ft |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 32.0 | na |
| Screen | | |
| Bottom elevation: | 304.14 ft | na |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 60 ft | 3 ft |
| Slot size: | 0.80-in. | na |
| Measuring Point Elevation: | 396.9 | 403.2 |
| Nonpumping Water Level | | |
| Depth below temp. MP: | 28.04 ft | - |
| Length of temp. MP extension: | 5.8 | - |
| Depth below perm. MP: | 22.24 | 28.60 ft |
| Elevation: | 374.66 | 374.60 |
| Date of Step Test: | 1/31/89 | - |
| Water Sample | | |
| Time: | 1:48 PM | - |
| Temperature: | 59° F | - |
| Laboratory No.: | 222890 | - |
| Distance and Direction to Piez. from PW: | | 5.2 ft West |
| Time PW Off Before Step Test: | | na |
| Wells in Operation at Site at Time of Step Test:* | | na |

Notes: SWS 8-in. dia. orifice tube w/plate No. 4
Well chemically treated 10/5/88-10/15/88
Test data collected with McDAS
Piezometer is partially plugged

SWS Crew: Wilson, Stollhans, Kimpel

* Operation based upon IDOT records

WATER LEVEL MEASUREMENTS
Well I-70 No. 11

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| 10:28 AM | | 28.04 | 28.60 | | | Steel tape measurements |
| 11:08 | 0 | 28.04 | 28.60 | | | Static water level |
| | 1 | 33.90 | 28.73 | 2.87 | 566 | Step 1 |
| | 2 | 34.02 | 28.80 | | | |
| | 3 | 34.07 | 28.85 | | | |
| | 4 | 34.10 | 28.92 | | | |
| | 5 | 34.12 | 28.98 | | | |
| | 6 | 34.13 | 29.04 | | | |
| | 8 | 34.15 | 29.17 | | | |
| | 10 | 34.18 | 29.27 | | | |
| | 12 | 34.19 | 29.42 | 2.85 | 565 | |
| | 14 | 34.20 | 29.50 | | | |
| | 16 | 34.22 | 29.61 | | | |
| | 18 | | | 2.85 | 565 | |
| | 20 | 34.25 | 29.84 | | | |
| | 24 | | | 2.85 | 565 | |
| | 25 | 34.27 | 30.06 | | | |
| | 29 | 34.28 | 30.22 | | | |
| | 30 | 34.28 | 30.23 | 2.85 | 565 | |
| 11:39 | 1 | 33.81 | 30.29 | 2.40 | 519 | Step 2 |
| | 2 | 33.80 | 30.33 | | | |
| | 3 | 33.80 | 30.36 | | | |
| | 4 | 33.81 | 30.40 | | | |
| | 5 | 33.80 | 30.44 | | | |
| | 6 | 33.81 | 30.46 | | | |
| | 8 | 33.82 | 30.54 | 2.40 | 519 | |
| | 10 | 33.81 | 30.60 | | | |
| | 12 | 33.83 | 30.66 | | | |
| | 14 | 33.83 | 30.73 | | | |
| | 16 | 33.84 | 30.77 | | | |
| | 17 | | | 2.40 | 519 | |
| | 20 | 33.85 | 30.90 | | | |
| | 25 | 33.86 | 31.03 | | | |
| | 27 | | | 2.40 | 519 | |
| | 29 | 33.87 | 31.12 | | | |
| | 30 | 33.87 | 31.14 | 2.40 | 519 | |
| 12:09 PM | 1 | 33.28 | 31.18 | 1.95 | 468 | Step 3 |
| | 2 | 33.25 | 31.19 | | | |
| | 3 | 33.23 | 31.21 | | | |
| | 4 | 33.24 | 31.23 | | | |
| | 5 | 33.24 | 31.24 | | | |
| | 6 | 33.25 | 31.26 | | | |
| | 7 | | | 1.93 | 466 | |
| | 8 | 33.25 | 31.30 | | | |

WATER LEVEL MEASUREMENTS (Continued)
Well I-70 No. 11

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| | 10 | 33.25 | 31.33 | | | |
| | 12 | 33.25 | 31.36 | | | |
| | 14 | 33.26 | 31.39 | | | |
| | 16 | 33.26 | 31.42 | | | |
| | 17 | | | 1.93 | 466 | |
| | 20 | 33.25 | 31.50 | | | |
| | 25 | 33.27 | 31.55 | 1.93 | 466 | |
| | 29 | 33.27 | 31.61 | | | |
| | 30 | 33.27 | 31.62 | 1.93 | 466 | |
| 12:39 | 1 | 32.81 | 31.63 | 1.57 | 421 | Step 4 |
| | 2 | 32.78 | 31.64 | | | |
| | 3 | 32.78 | 31.65 | | | |
| | 4 | 32.78 | 31.65 | | | |
| | 5 | 32.78 | 31.66 | | | |
| | 6 | 32.79 | 31.67 | | | |
| | 8 | 32.78 | 31.69 | | | |
| | 9 | | | 1.57 | 421 | |
| | 10 | 32.78 | 31.71 | | | |
| | 12 | 32.79 | 31.72 | | | |
| | 14 | 32.80 | 31.74 | | | |
| | 16 | 32.80 | 31.75 | | | |
| | 20 | 32.81 | 31.78 | 1.57 | 421 | |
| | 25 | 32.81 | 31.82 | | | |
| | 27 | | | 1.57 | 421 | |
| | 29 | 32.82 | 31.84 | | | |
| | 30 | 32.82 | 31.84 | 1.57 | 421 | |
| 1:09 | | | | 1.19 | 367 | Step 5 No data |
| 1:39 | | | | 0.90 | 320 | Step 6 - No data, computer disk full |
| 1:48 | | | | | | Water sample collected, Bottle #s B-89012706 (preserved), B-89012702 (standard); Temp.-59° F Sand sample collected |
| 2:08 | | | | | | End of test |

DEWATERING WELL DATA

| | Well No. I-64 Wll | Piezometer No. I-64 Pll |
|---|---|---|
| Date Drilled: | V2/75 | V2/75 |
| Casing | | |
| Top elevation: | 396.02 | - |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 31.23 | na |
| Screen | | |
| Bottom elevation: | 304.52 | na |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 60.27 | 3 ft |
| Slot size: | 0.080-in. | na |
| Measuring Point Elevation: | 397.0 | 402.32 |
| Nonpumping Water Level | | |
| Depth below temp. MP: | 21.94 ft | - |
| Length of temp. MP extension: | 5.8 | - |
| Depth below perm. MP: | 16.14 | - |
| Elevation: | 380.86 | Plugged |
| Date of Step Test: | 6/16/89 | - |
| Water Sample | | |
| Time: | 11:20 AM | - |
| Temperature: | - | - |
| Laboratory No.: | 223066 | - |
| Distance and Direction to Piez. from PW: | | 5 ft NE |
| Time PW Off Before Step Test: | | na |
| Wells in Operation at Site at Time of Step Test:* | | na |

Notes: SWS 8-in. dia. orifice tube w/plate No. 4
Test data collected with McDAS using updated software

* Operation based upon IDOT records

# WATER LEVEL MEASUREMENTS
Well I-64 No. 11

| 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 |
|---|---|---|---|---|---|---|
| 8:35 AM | | 21.94 | | | | Piezometer plugged |
| 8:54 | 0 | 21.91 | | | | |
| | 1 | 27.52 | | 2.27 | 505 | Step 1 |
| | 2 | 27.70 | | | | |
| | 4 | 27.79 | | | | |
| | 14 | 27.95 | | | | |
| | 24 | 28.03 | | | | |
| 9:24 | 30 | 28.06 | | | | |
| | 1 | 27.35 | | 1.77 | 446 | Step 2 |
| | 3 | 27.32 | | | | |
| | 13 | 27.34 | | | | |
| | 20 | | | 1.73 | 441 | |
| | 23 | 27.54 | | | | |
| | 27 | 27.55 | | | | |
| | 28 | | | 1.79 | 449 | |
| 9:54 | 30 | 27.56 | | | | |
| | 1 | 27.35 | | 1.44 | 403 | Step 3 |
| | 4 | 27.00 | | | | |
| | 7 | 27.00 | | | | |
| | 11 | 27.00 | | | | |
| | 14 | | | 1.44 | 403 | |
| | 15 | 27.00 | | | | |
| | 19 | 27.00 | | | | |
| | 23 | 27.01 | | | | |
| | 27 | 27.00 | | | | |
| | 28 | | | 1.44 | 403 | |
| 10:24 | 30 | 27.00 | | | | |
| | 1 | 26.66 | | 1.05 | 345 | Step 4 |
| | 2 | 26.24 | | | | |
| | 6 | 26.22 | | | | |
| | 10 | 26.21 | | | | |
| | 13 | | | 1.02 | 340 | |
| | 14 | 26.16 | | | | |
| | 18 | 26.15 | | | | |
| | 19 | | | 1.00 | 337 | |
| | 22 | 26.15 | | | | |
| | 26 | 26.15 | | | | |
| 10:54 | 30 | 26.15 | | | | |
| | 1 | | | 0.78 | 298 | Step 5 |
| | 4 | 25.63 | | | | Water sample collected, |
| | 7 | 25.63 | | | | Bottle # 89061201 |
| | 11 | 25.62 | | | | |
| | 15 | 25.62 | | | | |
| | 19 | 25.62 | | | | |

WATER LEVEL MEASUREMENTS (Continued)
Well I-64 No. 11

| 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 |
|---|---|---|---|---|---|---|
| | 23 | 25.62 | | | | |
| | 27 | 25.62 | | 0.77 | 296 | |
| 11:24 | 30 | 25.62 | | | | Pump off |

## DEWATERING WELL DATA

| | Well No. 25th St. W2 | Piezometer No. 25th St. P2 |
|---|---|---|
| Date Drilled: | 7/16/75 | 1975 |
| Casing | | |
| Top elevation: | 393.50 ft | 401.80 |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 31.89 | na |
| Screen | | |
| Bottom elevation: | 301.58 | na |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 60 ft | 3 ft |
| Slot size: | 0.080-in. | na |
| Measuring Point Elevation: | 394.60 | 401.80 |
| Nonpumping Water Level | | |
| Depth below temp. MP: | 14.84 ft | - |
| Length of temp. MP extension: | 8.20 | - |
| Depth below perm. MP: | 6.64 | 13.91 ft |
| Elevation: | 387.96 | 387.89 |
| Date of Step Test: | 8/9/89 | - |
| Water Sample | | |
| Time: | 3:45 PM | - |
| Temperature: | 60° F | - |
| Laboratory No.: | 223142 | - |
| Distance and Direction to Piez. from PW: | | 5 ft South |
| Time PW Off Before Step Test: | | na |
| Wells in Operation at Site at Time of Step Test:* | | na |

Notes: SWS 8-in. dia. orifice tube w/plate No. 4
Test data collected using McDAS

* Operation based upon IDOT records

WATER LEVEL MEASUREMENTS
Well 25th St. No. 2

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| 12:17 PM | | 14.84 | | | | |
| 12:27 | | | 13.91 | | | |
| 12:55 | 0 | 14.84 | | | | Pump on |
| | 1 | 24.12 | | | | Step 1 |
| | 2 | 24.30 | | 2.74 | 554 | |
| | 3 | 24.28 | | | | |
| | 4 | 24.28 | | | | Transducer in piezometer |
| | 5 | 24.29 | | | | dewatered |
| | 6 | 24.29 | 24.73 | | | Measured 2 ft of cable |
| | 8 | 24.29 | | 2.78 | 558 | and lowered transducer; |
| | 10 | 24.30 | 24.76 | | | actual correction = |
| | 12 | 24.29 | | | | 1.59 ft |
| | 14 | 24.30 | | | | |
| | 16 | 24.29. | 24.76 | | | |
| | 18 | 24.30 | | 2.79 | 559 | |
| | 21 | 24.32 | 24.83 | | | |
| | 24 | 24.32 | | | | |
| | 26 | 24.33 | 24.86 | 2.80 | 560 | |
| | 30 | 24.33 | 24.84 | | | Adjust rate |
| 1:26 | 1 | 23.37 | | 2.24 | 501 | Step 2 |
| | 2 | 23.06 | | 2.21 | 498 | |
| | 3 | 23.26 | | | | |
| | 4 | 23.27 | | | | |
| | 5 | 23.29 | 23.76 | | | |
| | 6 | 23.30 | | | | |
| | 8 | 23.31 | | 2.22 | 499 | |
| | 10 | 23.31 | 23.81 | | | |
| | 12 | 23.32 | | | | |
| | 14 | 23.34 | | | | |
| | 16 | 23.33 | 23.85 | | | |
| | 20 | 23.34 | 23.86 | 2.22 | 499 | |
| | 24 | 23.34 | 23.86 | | | |
| | 27 | 23.34 | | 2.23 | 500 | |
| | 29 | 23.35 | 23.89 | | | |
| | 30 | | | | | Adjust rate |
| 1:56 | 1 | 22.40 | | | | Step 3 |
| | 2 | 22.89 | | | | |
| | 3 | 22.93 | | 1.78 | 448 | |
| | 4 | 22.42 | | | | |
| | 5 | 22.39 | 22.86 | 2.20 | 497 | Readjusted rate due to |
| | 6 | 22.79 | | | | twist in pipe |
| | 8 | 23.31 | | 1.81 | 451 | |
| | 10 | 22.50 | 22.98 | | | |
| | 12 | 22.50 | | | | |

WATER LEVEL MEASUREMENTS (Continued)
Well 25th St. No. 2

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| | 14 | 22.51 | | | | |
| | 16 | 22.52 | 23.02 | | | |
| | 19 | 22.52 | | 1.80 | 450 | |
| | 23 | 22.53 | 22.99 | 1.81 | 451 | |
| | 29 | 22.54 | | | | |
| | 30 | 22.55 | 23.05 | | | Adjust rate |
| 2:26 | 1 | 21.63 | | 1.40 | 398 | Step 4 |
| | 2 | 21.60 | | | | |
| | 3 | 21.60 | | | | |
| | 4 | 21.60 | | | | |
| | 5 | 21.62 | 22.01 | | | |
| | 6 | 21.61 | | | | |
| | 8 | 21.62 | | | | |
| | 11 | 21.63 | 22.06 | 1.43 | 402 | |
| | 13 | 21.64 | | | | |
| | 16 | 21.65 | 22.08 | | | |
| | 20 | 21.65 | 22.08 | | | |
| | 25 | 21.66 | 22.05 | | | |
| | 28 | 21.66 | | 1.45 | 405 | |
| | 30 | 21.67 | 22.10 | | | Adjust rate |
| | 1 | 20.60 | | 1.05 | 345 | Step 5 |
| | 2 | 20.57 | | | | |
| | 3 | 20.57 | | | | |
| | 4 | 20.58 | | | | |
| | 5 | 20.58 | 20.90 | | | |
| | 6 | 20.58 | | | | |
| | 8 | 20.59 | | | | |
| | 10 | 20.59 | 20.91 | | | |
| | 12 | 20.60 | | 1.07 | 348 | |
| | 14 | 20.59 | | | | |
| | 16 | 20.60 | 20.91 | | | |
| | 20 | 20.60 | 20.92 | | | |
| | 25 | 20.61 | 20.93 | | | |
| | 29 | 20.61 | | | | |
| | 30 | 20.62 | 20.92 | | | Adjust rate |
| 3:26 | 1 | 19.80 | | 0.79 | 300 | Step 6 |
| | 2 | 19.76 | | | | |
| | 3 | 19.75 | | | | Collected water sample; |
| | 4 | 19.75 | | | | Temp.=60° F; Bottle #s |
| | 5 | 19.75 | 19.97 | | | A89080701 and A89080704 |
| | 6 | 19.75 | | | | |
| | 8 | 19.75 | | | | |
| | 10 | 19.75 | 19.95 | | | |
| | 12 | 19.75 | | | | |

WATER LEVEL MEASUREMENTS (Continued)
Well 25th St. No. 2

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (from) | Remarks |
|---|---|---|---|---|---|---|
| | 14 | 19.75 | | | | |
| | 16 | 19.75 | 19.96 | | | |
| | 20 | 19.75 | 19.97 | 0.80 | 302 | |
| | 25 | 19.76 | 19.95 | | | |
| | 29 | 19.76 | | | | |
| | 30 | 19.77 | 19.93 | | | |

## DEWATERING WELL DATA

| | Well No. 25th St. W5 | Piezometer No. 25th St. P5 |
|---|---|---|
| Date Drilled: | 7/21/75 | - |
| **Casing** | | |
| Top elevation: | 395.63 ft | - |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 28.27 | na |
| **Screen** | | |
| Bottom elevation: | 307.36 ft | na |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 60 ft | 3 ft |
| Slot size: | 0.080-in. | na |
| Measuring Point Elevation: | 396.20 | 404.13 |
| **Nonpumping Water Level** | | |
| Depth below temp. MP: | 16.84 ft | - |
| Length of temp. MP extension: | 8.30 | - |
| Depth below perm. MP: | 8.54 | 16.15 ft |
| Elevation: | 387.66 | 387.98 |
| Date of Step Test: | 5/16/89 | - |
| **Water Sample** | | |
| Time: | 2:53 PM | - |
| Temperature: | 59° F | - |
| Laboratory No. : | 223085 | - |
| Distance and Direction to Piez. from PW: | | 5.0 ft South |
| Time PW Off Before Step Test: | | |
| Wells in Operation at Site at Time of Step Test:* | | na |

Notes: SWS 8-in. dia. orifice tube w/plate No. 4
Test data collected using McDAS

SWS Crew: Steve Wilson and Bob Olson

* Operation based upon IDOT records

WATER LEVEL MEASUREMENTS
Well 25th St. No. 5

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| 9:40 AM | | | 16.15 | | | Steel tape measurements |
| 11:43 | | 16.83 | | | | |
| 11:45 | | 16.84 | | | | |
| 12:15 PM | | | | | | Started test but immediately stopped when orifice tube fell over |
| 12:30 | | | | | | Start-Stop--rate too low for plate 4 |
| 12:55 | 0 | 16.84 | 16.15 | | | Start pump |
| 12:56 | 1 | 29.10 | 20.38 | | | Step 1 |
| | 2 | 30.48 | 21.65 | | | Using Plate No. 3 |
| | 3 | 30.33 | 21.62 | 3.03 | 352 | |
| | 4 | 30.32 | 21.61 | | | Gaseous at first - $H_2S$ |
| | 5 | 30.32 | 21.61 | | | |
| | 6 | 30.33 | 21.61 | | | |
| | 7 | | | 3.04 | 352 | |
| | 8 | 30.33 | 21.61 | | | |
| | 10 | 30.34 | 21.63 | | | |
| | 12 | 30.33 | 21.63 | | | |
| | 14 | 30.34 | 21.63 | | | |
| | 16 | 30.35 | 21.64 | | | |
| | 20 | 30.35 | 21.65 | | | |
| | 21 | | | 3.03 | 352 | |
| | 25 | 30.35 | 21.66 | | | |
| | 29 | 30.36 | 21.65 | 3.03 | 352 | |
| | 30 | 30.37 | 21.66 | | | |
| 1:26 | 1 | 28.56 | 21.05 | 2.19 | 300 | Step 2 |
| | 2 | 28.32 | 20.89 | | | |
| | 3 | 28.30 | 20.88 | | | |
| | 4 | 28.32 | 20.88 | | | |
| | 5 | 28.31 | 20.88 | | | |
| | 6 | 28.30 | 20.88 | | | |
| | 8 | 28.31 | 20.87 | | | |
| | 10 | 28.32 | 20.88 | | | |
| | 12 | 28.32 | 20.89 | | | |
| | 14 | 28.32 | 20.89 | | | |
| | 16 | 28.32 | 20.88 | | | |
| | 19 | | | 2.20 | 301 | |
| | 20 | 28.32 | 20.88 | | | |
| | 25 | 28.32 | 20.89 | | | |
| | 27 | | | 2.20 | 301 | |
| | 28 | 28.33 | 20.89 | | | |
| | 30 | 28.34 | 20.89 | | | |

WATER LEVEL MEASUREMENTS (Continued)
Well 25th St. No. 5

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| 1:56 | 1 | 26.66 | 20.31 | 1.51 | 250 | Step 3 |
| | 2 | 26.50 | 20.18 | | | |
| | 3 | 26.47 | 20.17 | | | |
| | 4 | 26.47 | 20.18 | | | |
| | 5 | 26.46 | 20.17 | | | |
| | 6 | 26.46 | 20.17 | | | |
| | 8 | 26.47 | 20.18 | | | |
| | 10 | 26.47 | 20.17 | | | |
| | 12 | 26.46 | 20.16 | | | |
| | 14 | 26.47 | 20.17 | | | |
| | 16 | 26.46 | 20.17 | | | |
| | 20 | 26.45 | 20.18 | | | |
| | 22 | | | 1.49 | 249 | |
| | 25 | 26.44 | 20.16 | | | |
| | 29 | 26.45 | 20.17 | 1.49 | 249 | |
| | 30 | 26.45 | 20.17 | | | |
| 2:26 | 1 | 24.87 | 19.66 | | | Step 4 |
| | 2 | 24.51 | 19.42 | 0.95 | 200 | |
| | 3 | 24.51 | 19.40 | | | |
| | 4 | 24.47 | 19.40 | | | Water sample collected, |
| | 5 | 24.49 | 19.39 | | | Bottle #39051501, |
| | 6 | 24.50 | 19.39 | | | Temp. - 59° F |
| | 8 | 24.50 | 19.40 | 0.95 | 200 | |
| | 10 | 24.49 | 19.40 | | | |
| | 12 | 24.50 | 19.40 | | | |
| | 14 | 24.50 | 19.40 | | | |
| | 16 | 24.50 | 19.39 | | | |
| | 20 | 24.50 | 19.38 | | | |
| | 25 | 24.51 | 19.40 | | | |
| | 28 | 24.50 | 19.38 | 0.95 | 200 | |
| | 30 | 24.50 | 19.38 | | | |

DEWATERING WELL DATA

| | Well No. Venice W2 | Piezometer No. Venice P2 |
|---|---|---|
| Date Drilled: | 1982 | 1982 |
| Casing | | |
| Top elevation: | 405.3 ft | 410.30 ft |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 28.9 | na |
| Screen | | |
| Bottom elevation: | 325.5 ft | na |
| Diameter: | 16-in. SS | 2-in. PVC |
| Length: | 50.9 ft | 3 ft |
| Slot size: | 0.080-in. | na |
| Measuring Point Elevation: | 405.55 | 410.30 |
| Nonpumping Water Level | | |
| Depth below temp. MP: | 22.78 ft | - |
| Length of temp. MP extension: | 5.40 | - |
| Depth below perm. MP: | 17.38 | 22.11 ft |
| Elevation: | 388.17 | 388.19 |
| Date of Step Test: | 9/5/89 | - |
| Water Sample | | |
| Time: | 12:45 PM | - |
| Temperature: | 60.5° F | - |
| Laboratory No.: | 223165 | - |
| Distance and Direction to Piez. from PW: | | 6.1 ft West |
| Time PW Off Before Step Test: | | na |
| Wells in Operation at Site at Time of Step Test:* | | na |

Notes: SWS 8-in. dia. orifice tube w/plate No. 4
Sand tank not used because of low Q
Test data collected using McDAS

* Operation based upon IDOT records

WATER LEVEL MEASUREMENTS
Well Venice No. 2

| Hour | Time fmin) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| 10:36 AM | | 22.79 | | | | Steel tape measurements |
| 10:44 | | | 22.12 | | | |
| 10:46 | | | 22.11 | | | |
| 10:50 | | 22.78 | | | | |
| 11:05 | 0 | | | | | Start test - Plate 4 |
| 11:06 | | | | | | Stop. Orifice tube fell over |
| 11:17 | 0 | 22.78 | | | | Start test |
| 11:23 | 6 | | | 0.35 | 200 | Stop test, change to orifice plate 2 |
| 11:40 | 0 | 22.78 | 22.56 | | | Start test - Step 1 |
| | 1 | 35.61 | 23.79 | | | Using Plate No. 2 |
| | 2 | 35.59 | 23.91 | | | Breaking suction, |
| | 3 | 34.22 | 23.85 | 3.05 | 199 | adjusting rate |
| | 4 | 34.62 | 23.90 | | | |
| | 5 | 34.51 | 23.93 | | | |
| | 6 | 34.50 | 23.94 | | | |
| | 7 | | | 3.05 | 199 | |
| | 8 | 34.63 | 23.98 | | | |
| | 10 | 34.62 | 24.00 | | | |
| | 12 | 34.63 | 24.01 | | | |
| | 14 | 34.67 | 24.02 | | | |
| | 15 | | | 3.02 | 197 | |
| | 16 | 34.70 | 24.01 | | | |
| | 20 | 34.69 | 24.02 | | | |
| | 23 | | | 3.01 | 197 | |
| | 25 | 34.68 | 24.07 | | | |
| | 28 | 34.72 | 24.07 | | | |
| | 30 | 34.71 | 24.06 | | | Adjust rate |
| 12:11 PM | 1 | 32.31 | 23.86 | 1.76 | 151 | Step 2 |
| | 2 | 31.87 | 23.80 | | | |
| | 3 | 31.72 | 23.80 | | | |
| | 4 | 31.69 | 23.77 | | | |
| | 5 | 31.66 | 23.77 | | | |
| | 6 | 31.63 | 23.76 | | | |
| | 8 | 31.65 | 23.75 | 1.75 | 150 | |
| | 10 | 31.60 | 23.73 | | | |
| | 12 | 31.58 | 23.72 | | | |
| | 14 | 31.55 | 23.72 | | | |
| | .16 | 31.55 | 23.70 | | | |
| | 20 | 31.51 | 23.69 | 1.71 | 148 | |
| | 25 | 31.55 | 23.69 | | | |
| | 28 | | | 1.72 | 149 | |
| | 29 | 31.58 | 23.69 | | | |

WATER LEVEL MEASUREMENTS (Continued)
Well Venice No. 2

| Hour | Time (min) | Adjusted depth to water in well (ft) | Depth to water in piezometer (ft) | Orifice tube piez. (ft) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|---|
| | 30 | 31.55 | 23.69 | | | Adjust rate |
| 12:41 | 1 | 29.30 | 23.49 | 0.80 | 101 | Step 3 |
| | 2 | 28.75 | 23.42 | | | |
| | 3 | 28.65 | 23.38 | | | |
| | 4 | 28.67 | 23.36 | | | Water sample collected, |
| | 5 | 28.64 | 23.36 | | | Bottle #s 89081401 and |
| | 6 | 28.62 | 23.35 | | | 89081403; Temp. = |
| | 8 | 28.60 | 23.34 | 0.79 | 101 | 60.5° F; water clear |
| | 10 | 28.59 | 23.34 | | | |
| | 12 | 28.54 | 23.32 | | | |
| | 14 | 28.57 | 23.32 | | | |
| | 16 | 28.56 | 23.32 | | | |
| | 20 | 28.58 | 23.30 | | | |
| | 23 | | | 0.78 | 100 | |
| | 25 | 28.56 | 23.28 | | | |
| | 29 | 28.55 | 23.28 | | | |
| | 30 | 28.54 | 23.29 | | | |

# Appendix B.

## Results from Chemical Analysis of Dewatering Well Water Samples

Appendix B. Chemical Quality of Ground Water at IDOT Dewatering Sites

| Site | I-70 | I-70 | I-70 | I-70 |
|---|---|---|---|---|
| Well No. | 1 | 2 | 5 | 8A |
| Date Collected | 5/17/89 | 2/1/89 | 2/2/89 | 10/4/89 |
| Laboratory No. | 223086 | 222892 | 222891 | 223203 |
| Iron (Fe), mg/l | 6.02 | 10.60 | 7.73 | 10.59 |
| Manganese (Mn), mg/l | 1.40 | 0.61 | 1.07 | 0.95 |
| Calcium (Ca), mg/l | 177.0 | 160.0 | 175.0 | 208.0 |
| Magnesium (Mg), mg/l | 37.6 | 45.0 | 38.2 | 42.7 |
| Sodium (Na), mg/l | 118.0 | 68.9 | 124.0 | 72.4 |
| Copper (Cu), mg/l | ND | <0.05 | <0.05 | <0.05 |
| Potassium (K), mg/l | ND | 7.5 | 10.0 | ND |
| Silica ($SiO_2$), mg/l | 28.6 | 28.9 | 30.0 | 30.8 |
| Zinc (Zn), mg/l | ND | <0.15 | <0.15 | <0.15 |
| Fluoride (F), mg/l | 0.6 | 0.7 | 0.8 | 0.7 |
| Nitrate ($NO_3$), mg/l | 1.6 | 0.2 | <0.1 | <0.1 |
| Chloride (Cl), mg/l | 85.0 | 128.0 | 113.0 | 103.0 |
| Sulfate ($SO_4$), mg/l | 347.0 | 261.0 | 305.0 | 322.0 |
| Alkalinity (as $CaCO_3$), mg/l | 479 | 395 | 495 | 457 |
| Hardness (as $CaCO_3$), mg/l | 596 | 584 | 594 | 695 |
| Total dissolved minerals, mg/l | 1046 | 967 | 1099 | 1055 |
| Dissolved Non-Volatile Organic Carbon (as C), mg/l | ND | 6.41 | 5.72 | ND |
| Turbidity (lab), NTU | 63 | 100 | 80 | 60 |
| Color, PCU | 8 | 5 | 3 | 5 |
| Odor | None | None | None | None |
| pH (lab) | 7.4 | 7.4 | 7.3 | 7.2 |
| Temperature, °F | 60.0 | 59.5 | 55.0 | 61.0 |

HC - hydrocarbon

< - Below detection limit (i.e., <1.0 = les than 1.0 mg/l)

ND - Not determined/Information not available

Appendix B. (Continued)

| Site | I-70 | I-70 | I-70 | I-64 |
|---|---|---|---|---|
| Well No. | 9A | 10 | 11 | 11 |
| Date Collected | 10/3/89 | 1/30/89 | 1/31/89 | 6/16/89 |
| Laboratory No. | 223202 | 222889 | 222890 | 223066 |
| Iron (Fe), mg/l | 10.90 | 11.42 | 9.11 | 15.00 |
| Manganese (Mn), mg/l | 0.67 | 0.56 | 0.55 | 0.56 |
| Calcium (Ca), mg/l | 231.0 | 189.0 | 154.0 | 215.0 |
| Magnesium (Mg), mg/l | 49.6 | 47.0 | 43.0 | 54.5 |
| Sodium (Na), mg/l | 41.0 | 38.8 | 39.9 | 44.3 |
| Copper (Cu), mg/l | <0.05 | <0.05 | <0.05 | ND |
| Potassium (K), mg/l | ND | 8.2 | 7.1 | ND |
| Silica ($SiO_2$), mg/l | 33.5 | 33.7 | 32.6 | 33.4 |
| Zinc (Zn), mg/l | <0.15 | <0.15 | <0.15 | ND |
| Fluoride (F), mg/l | 0.8 | 0.8 | 0.6 | 0.7 |
| Nitrate ($NO_3$), mg/l | <0.1 | <0.1 | <0.1 | <0.1 |
| Chloride (Cl), mg/l | 63.1 | 63.1 | 73.0 | 59.8 |
| Sulfate ($SO_4$), mg/l | 378.0 | 354.0 | 300.0 | 376.0 |
| Alkalinity (as $CaCO_3$), mg/l | 466 | 436 | 346 | 501 |
| Hardness (as $CaCO_3$), mg/l | 780 | 665 | 561 | 761 |
| Total dissolved minerals, mg/l | 1099 | 1024 | 889 | 1198 |
| Dissolved Non-Volatile Organic Carbon (as C), mg/l) | ND | 4.93 | 4.39 | 3.52 |
| Turbidity (lab), NTU | 60 | 95 | 95 | 120 |
| Color, PCU | 5 | 5 | 3 | 15 |
| Odor | None | HC | HC | None |
| pH (lab) | 7.0 | 7.2 | 7.2 | 8.0 |
| Temperature, °F | 61.0 | 60.0 | 59.0 | ND |

HC - hydrocarbon

< - Below detection limit (i.e., <1.0 - less than 1.0 mg/l)

ND - Not determined/Information not available

Appendix B. (Concluded)

| Site | 25th St. | 25th St. | Venice |
|---|---|---|---|
| Well No. | 2 | 5 | 2 |
| Date Collected | 8/9/89 | 5/16/89 | 9/5/89 |
| Laboratory No. | 223142 | 223085 | 223165 |
| Iron (Fe); mg/l | 8.11 | 8.93 | 23.80 |
| Manganese (Mn), mg/l | 0.52 | 0.57 | 0.60 |
| Calcium (Ca), mg/l | 205.0 | 137.0 | 199.0 |
| Magnesium (Mg), mg/l | 59.9 | 38.9 | 50.9 |
| Sodium (Na), mg/l | 251.0 | 15.7 | 39.6 |
| Copper (Cu), mg/l | ND | ND | ND |
| Potassium (K), mg/l | 8.0 | ND | ND |
| Silica ($SiO_2$), mg/l | ND | 32.1 | 32.6 |
| Zinc (Zn), mg/l | ND | ND | ND |
| Fluoride (F), mg/l | 1.2 | 0.3 | 0.7 |
| Nitrate ($NO_3$), mg/l | 0.2 | <0.1 | <0.1 |
| Chloride (Cl), mg/l | 36.8 | 23.8 | 49.8 |
| Sulfate ($SO_4$), mg/l | 928.0 | 181.0 | 328.0 |
| Alkalinity (as $CaCO_3$), mg/l | 451 | 369 | 470 |
| Hardness (as $CaCO_3$), mg/l | 758 | 502 | 706 |
| Total dissolved minerals, mg/l | 1816 | 688 | 1002 |
| Dissolved Non-Volatile Organic Carbon (as C), mg/l | ND | 1.96 | ND |
| Turbidity (lab), NTU | 95 | 82 | 115 |
| Color, PCU | 15 | 8 | 17 |
| Odor | Musty | None | None |
| pH (lab) | 7.9 | 7.5 | 7.0 |
| Temperature, °F | 60.0 | 59.0 | 60.5 |

HC - hydrocarbon

< - Below detection limit (i.e., <1.0 - less than 1.0 mg/l)

ND - Not determined/Information not available

Appendix C.

Step Test Results,
Phases 1 through 6

# Appendix C. Results of Step Tests on IDOT Wells

| Well | Date of test | Well loss @ 600 gpm (ft) | Drawdown @ 600 gpm (ft) | Well loss portion (%) | Specific capacity (gpm/ft) | Δh* @ 600 gpm (ft) | Remarks |
|---|---|---|---|---|---|---|---|
| 1-70 | | | | | | | |
| No. 1 | 8/15/84 | ** | 18.1 e | ** | 33.1 e | 12.8 e | $Q_{max}$ = 328 gpm |
| No. IT | 8/14/85 | ** | 8.89 e | ** | 67.5 e | 3.3 e | $Q_{max}$ = 390 gpm |
| No. 1 | 5/17/89 | 3.31 e | 14.68 e | 22.5 | 40.9 e | 8.5 e | $Q_{max}$ = 250 gpm |
| No. 2 | 7/19/83 | ** | 11.9 e | ** | 50.4 e | 7.9 e | $Q_{max}$ = 500 gpm |
| No. 2T | 8/15/85 | ** | 8.32 e | ** | 72.1 e | P | $Q_{max}$ = 410 gpm |
| No. 2 | 6/20/88 | ** | 11.98 e | ** | 50.1 e | P | $Q_{max}$ = 365 gpm |
| No. 2T | 2/1/89 | 0.19 e | 8.31 e | 2.3 | 72.2 e | P | $Q_{max}$ = 270 gpm. piezometer partially plugged |
| 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 | $Q_{max}$ = 610 gpm |
| No. 3T | 1/14/87 | 0.82 | 6.09 | 13.5 | 98.5 | 2.40 | $Q_{max}$ = 620 gpm |
| No. 4 | 8/16/84 | 0.07 | 9.33 | 0.8 | 64.3 | P | |
| No. 4T | 1/8/87 | ** | 5.89 | ** | 101.9 | P | $Q_{max}$ = 660 gpm |
| No. 5 | 7/10/84 | 0.89 | 6.53 | 13.6 | 91.9 | 2.11 | $Q_{max}$ = 740 gpm |
| No. 5T | 1/13/87 | ** | 7.98 | ** | 75.2 | 4.76 | $Q_{max}$ = 665 gpm |
| No. 5T | 2/2/89 | 0.71 | 6.23 | 11.4 | 96.3 | P | $Q_{max}$ = 650+ gpm |
| No. 6 | 7/19/85 | 0.23 | 5.39 | 4.3 | 111.3 | P | $Q_{max}$ = 625 gpm |
| No. 7 | 6/30/83 | 1.88 | 18.55 | 10.1 | 32.3 | 15.0 | Piezometer at 7.5 ft |
| No. 7A | 7/23/87 | ** | 8.39 | ** | 71.5 | 2.13 | $Q_{max}$ = 770 gpm |
| No. 7A | 6/15/89 | 2.25 | 11.43 | 19.7 | 52.5 | 8.97 e | $Q_{max}$ = 520 gpm |
| No. 8 | 8/1/84 | 2.68 | 13.54 | 19.8 | 44.3 | 9.94 | $Q_{max}$ = 625 gpm |
| No. 8T | 12/5/85 | 0.07 | 6.83 | 1.0 | 87.8 | 2.21 | $Q_{max}$ = 750 gpm |
| No. 8 | 6/22/88 | ** | 12.62 | ** | 47.5 e | 8.22 | $Q_{max}$ = 600 gpm |
| No. 8A | 10/4/89 | ** | 6.10 | ** | 98.4 | 1.38 | $Q_{max}$ = 778 gpm |
| No. 9 | 6/28/84 | ** | 9.46 | ** | 63.4 | 5.94 | $Q_{max}$ = 630 gpm |
| No. 9A | 10/3/89 | ** | 6.04 e | ** | 99.4 e | 1.72 e | $Q_{max}$ = 523 gpm |
| No. 10 | 7/31/84 | 5.97 e | 16.93 e | 35.3 | 35.4 e | P | $Q_{max}$ = 480 gpm |
| No. 10T | 9/4/85 | 0.66 | 6.61 e | 10.0 | 90.8 | P | $Q_{max}$ = 490 gpm |
| No. 10 | 8/13/87 | 1.07 | 18.98 e | 5.6 | 31.6 e | 10.4 e | $Q_{max}$ = 390 gpm |
| No. 10T | 1/30/89 | 1.74 e | 11.51 e | 15.1 | 52.1 e | 4.34 e | $Q_{max}$ = 370 gpm |

Appendix C. Continued

| Well | Date of test | Well loss @ 600 gpm (ft) | Drawdown @ 600 gpm (ft) | Well loss portion (%) | Specific capacity (gpm/ft) | Δh* @ 600 gpm (ft) | Remarks |
|---|---|---|---|---|---|---|---|
| 1-70 (Cont'd) | | | | | | | |
| No. 11 | 8/2/84 | 1.58 e | 15.55 e | 10.2 | 38.6 e | 13.35 e | $Q_{max}$ = 555 gpm |
| No. 11T | 9/5/85 | ** | 5.63 | ** | 106.6 | P | |
| No. 11 | 8/12/87 | ** | 11.56 e | ** | 51.9 e | P | $Q_{max}$ = 550 gpm |
| No. 11T | 1/31/89 | 0.03 | 6.62 e | 0.5 | 90.6 e | P | $Q_{max}$ = 570 gpm, piezometer partially plugged |
| 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 | $Q_{max}$ = 450 gpm |
| No. 12 AT | 11/16/87 | 1.45 | 2.36 | 61.4 | 254.2 | P | $Q_{max}$ = 750 gpm |
| 1-64 | | | | | | | |
| No. 1 | 7/21/87 | ** | 4.13 | ** | 145.3 | 0.85 | $Q_{max}$ = 660 gpm |
| No. 2 | 7/25/85 | 0.09 | 5.32 e | 1.7 | 112.8 | 5.22 | $Q_{max}$ = 550 gpm |
| No. 3 | 6/26/84 | 0.52 | 10.73 e | 4.8 | 55.9 e | P | $Q_{max}$ = 525 gpm |
| No. 3T | 6/21/88 | 0.68 e | 5.68 e | 12.0 e | 105.6 e | P | $Q_{max}$ = 555 gpm |
| No. 4 | 7/15/85 | 0.66 | 4.40 | 15.0 | 136.4 | P | |
| No. 9 | 10/5/83 | 0.37 | 6.22 | 5.9 | 96.5 | 2.3 | |
| No. 10 | 7/11/84 | ** | 7.46 | ** | 80.4 | 2.73 | $Q_{max}$ = 605 gpm |
| No. 11 | 8/14/84 | ** | 7.22 e | ** | 83.1 e | 3.2 e | $Q_{max}$ = 520 gpm |
| No. 11 | 6/16/89 | 0.52 | 7.45 e | 7.0 | 80.5 e | P | $Q_{max}$ = 505 gpm |
| No. 12 | 7/18/85 | 0.17 | 6.22 e | 2.8 | 96.5 | 1.62 e | $Q_{max}$ = 590 gpm |
| No. 13 | 7/12/84 | ** | 6.44 | ** | 93.2 | 2.65 | $Q_{max}$ = 600 gpm |
| No. 15 | 6/29/83 | 0.73 | 9.94 | 7.3 | 60.4 | 4.6 | |
| No. 15T | 8/13/85 | 0.71 | 7.24 | 9.8 | 82.9 | 2.97 | $Q_{max}$ = 615 gpm |
| No. 15 | 7/22/87 | 0.84 e | 6.94 e | 12.1 e | 86.5 e | 2.52 | $Q_{max}$ = 570 gpm |
| 25th St. | | | | | | | |
| 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 | | $Q_{max}$ = 550 gpm, Δh elevation data not available |

Appendix C. Continued

| Well | Date of test | Well loss @ 600 gpm (ft) | Drawdown @ 600 gpm (ft) | Well loss portion (%) | Specific capacity (gpm/ft) | Δh* @ 600 gpm (ft) | Remarks |
|---|---|---|---|---|---|---|---|
| 25th St. (Cont'd) | | | | | | | |
| No. 3 | 9/6/85 | 0.03 | 4.89 | 0.6 | 122.7 | 1.75 | |
| No. 5 | 5/16/89 | 0.47 e | 23.28 e | 0.02 | 25.8 e | 15.2 e | $Q_{max}$ = 352 gpm |
| No. 6 | 6/27/84 | 0.14 | 9.44 | 1.5 | 63.6 | P | $Q_{max}$ = 775 gpm |
| No. 6T | 1/7/87 | 0.23 | 4.38 | 5.3 | 137.0 | P | $Q_{max}$ = 775 gpm |
| No. 8 | 6/15/83 | 0.11 | 4.70 | 2.3 | 127.7 | 1.5 | |
| No. 9 | 6/25/86 | ** | 5.55 e | ** | 110.4 | 2.04 e | $Q_{max}$ = 520 gpm |
| No. 10 | 7/26/85 | ** | 9.56 | ** | 62.8 | 3.59 | |
| No. 10T | 11/18/87 | 0.43 | 6.24 | 6.9 | 96.2 | 2.06 | $Q_{max}$ = 800 gpm |
| Venice | | | | | | | |
| No. 1 | 11/30/83 | 2.29 | 18.33 e | 12.5 | 32.7 | 10.9 e | $Q_{max}$ = 500 gpm |
| No. 1T | 12/4/85 | 0.39 | 7.89 | 4.9 | 74.5 | 2.33 | $Q_{max}$ = 870 gpm |
| 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 | $Q_{max}$ = 200 gpm, water level below intake |
| No. 3 | 11/28/83 | ** | 9.20 | ** | 65.2 | 4.2 | |
| No. 3T | 1/6/87 | 0.35 | 7.60 | 4.6 | 78.3 | P | $Q_{max}$ = 775 gpm |
| No. 4 | 12/1/83 | 0.39 | 5.15 | 7.6 | 116.5 | 2.3 | |
| No. 5 | 11/15/83 | 0.16 | 4.98 | 3.2 | 120.5 | 1.9 | |
| No. 6 | 11/29/83 | 0.16 | 7.82 | 2.0 | 76.7 | 6.1 | |
| No. 6T | 11/17/87 | 3.18 | 4.13 | 77.0 | 145.3 | 2.61 | $Q_{max}$ = 800 gpm |

e-Estimate based on interpolated values adjusted to 600 gpm
*-Head difference between pumped well and adjacent piezometer
**-Coefficient immeasurable. Turbulent well loss negligible over the pumping rates tested.
T-Indicates step test after chemical treatment
P-Piezometer plugged or partially plugged

# Appendix D.

## Chemical Treatment Field Data

## WELL REHABILITATION FIELD NOTES

WELL SITE: I-70 Well No. 2 OBSERVER: Al Brown, IDOT

CONTRACTOR: Aylor Aqua Services, Inc. Dyersburg, TN (Deryl Aylor)

MEASURING POINT:

MEASURING EQUIP.: Contractor's 6x5 in. orifice tube, electric dropline

1. SPECIFIC CAPACITY TEST DATE: 11/14/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate* (gpm) | Remarks |
|---|---|---|---|---|---|
| 12:30 | 35.2 | | 6½ | 316 | Static water level-pump on |
| | 41.0 | 5.8 | | | Pumping water level |

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.

* All pumping rates from 6x5 in. orifice table, Layne and Bowler, Inc., Orifice Tables.

60 min. specific capacity: 54.5 gpm/ft

2. 400 LBS POLYPHOSPHATE APPLICATION DATE: 11/14/88

A. INITIAL CHLORINATION

Quantity: 2500 gal Strength: 500 mg/L (ppm)

Injection rate: 800 gpm

B. POLYPHOSPHATE INJECTION, 400 lbs total

| | Batch 1 | Batch 2 |
|---|---|---|
| Phosphate (lbs.): | 200 | 200 |
| Quantity $H_2O$ (gal): | 1800 | 1800 |
| Injection rate: | | |

C. DISPLACEMENT, 16,000 gallons chlorinated water (500 mg/l)

| Time - initial/complete | Quantity (gal) | 0 (gpm) |
|---|---|---|
| 2:30 PM/4:00 PM | 16,250 | |

D. PUMPED TO WASTE

Time - initial: 5:00 PM
- complete: 11:00 PM

Q: 339 gpm Quantity: 122,040 gal

3. SPECIFIC CAPACITY TEST DATE: 11/15/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 10:20AM | 34.5 | | 7.5 | 339 | SWL - Pump on |
| | 40.4 | 5.9 | | | |

60 min. specific capacity: 57.5 gpm/ft

4. ACIDIZATION - INHIBITED MURIATIC ACID DATE: 11/15/88

A. ACID INJECTION

Acid strength: 20° baume Quantity: 1000 gal

Time - initial: 1:15 PM
- complete: 2:15 PM

B. DISPLACEMENT, 5,000 gallons nonchlorinated water

Quantity: 5,000 gal

Time - initial: 3:15 PM
- complete: 3:45 PM

C. PUMPED TO WASTE

Time - initial: 5:45 PM
- complete: 9:45 PM

Q: 393 gpm Quantity: 94,320 gal

5. SPECIFIC CAPACITY TEST DATE: 11/16/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 7:30AM | 35.8 | | 10 | 393 | SWL - Pump on |
| | 40.6 | 4.8 | 8.5 | 361 | |

60 min. specific capacity: 75.2 gpm/ft

6. 600 LBS POLYPHOSPHATE APPLICATION DATE: 11/16/88

A. INITIAL CHLORINATION

Quantity: 2500 gal Strength: 500 mg/l (ppm)

Injection rate:

B. POLYPHOSPHATE INJECTION, 600 lbs total

| | Batch 1 | Batch 2 | Batch 3 |
|---|---|---|---|
| Phosphate (lbs): | 200 | 200 | 200 |
| Quantity $H_2O$ (gal): | 1800 | 1800 | 1800 |
| Injection rate: | | | |

C. DISPLACEMENT, 30,000 gallons chlorinated water (500 mg/l)

Time - initial: 11:00 AM
- complete: 2:15 PM

Quantity: 30,000 gal Q: gpm

Comments: 12 tanks, 2500 gal each inj ected

D. PUMPED TO WASTE

Time - initial: 3:15 PM
- complete: 9:15 PM

Q: 383 gpm Quantity: 137,880 gal

7. SPECIFIC CAPACITY TEST DATE: 11/17/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 8:00AM | 35.0 | | 9.5 | 383 | Static water level-pump on |
| 9:00AM | 40.7 | 5.7 | 9.0 | 372 | Pumping water level |

60 min. specific capacity: 65.3 gpm/ft

8. 600 LBS POLYPHOSPHATE APPLICATION DATE: 11/17/88

A. INITIAL CHLORINATION

Quantity: 2500 gal Strength: 500 mg/l (ppm)

Injection rate:

B. POLYPHOSPHATE INJECTION, 600 lbs total

| | Batch 1 | Batch 2 | Batch 3 |
|---|---|---|---|
| Phosphate (lbs): | 200 | 200 | 200 |
| Quantity $H_2O$ (gal): | 1800 | 1800 | 1800 |
| Injection rate: | | | |

C. DISPLACEMENT, 54,000 gallons chlorinated water (500 mg/l)

Time - initial: 11:15 AM
- complete: 4:45 PM

Quantity: gal Q: gpm

D. PUMPED TO WASTE

Time - initial: 5:45 PM
- complete: 11:45 PM

Q: 383 gpm Quantity: 137,880 gal

9. SPECIFIC CAPACITY TEST DATE: 11/18/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 10:00AM | 35.0 | | 8.5 | 361 | Static water level-pump on |
| 11:00AM | 40.8 | 5.8 | 9.5 | 383 | Pumped well level |

60 min. specific capacity: 66.0 gpm/ft

10. 400 LBS POLYPHOSPHATE APPLICATION — DATE: 11/18/88

A. INITIAL CHLORINATION

Quantity: 2500 gal — Strength: 500 mg/l (ppm)

Injection rate:

B. POLYPHOSPHATE INJECTION, 400 lbs total

| | Batch 1 | Batch 2 |
|---|---|---|
| Phosphate (lbs): | 200 | 200 |
| Quantity $H_2O$ (gal): | 1800 | 1800 |
| Injection rate: | | |

C. DISPLACEMENT, 16,000 gallons chlorinated water (500 mg/l)

Time - initial:
- complete:

Quantity: 16,250 gal — Q: gpm

D. PUMPED TO WASTE

Time - initial: 2:45 PM
- complete: 6:45 PM

Q: 372 gpm — Quantity: 89,280 gal

11. SPECIFIC CAPACITY TEST — DATE: 11/19/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 8:15AM | 22.8 | | 8.5 | 361 | Static water level-pump on |
| 9:15AM | 42.3 | | 9.0 | 372 | Pumped well level |
| 9:45AM | 36.7 | 5.6 | | | Static well level |

60 min. specific capacity: 66.4 gpm/ft

# WELL REHABILITATION FIELD NOTES

WELL SITE: I-70 Well No. 5 OBSERVER: Al Brown, IDOT

CONTRACTOR: Aylor Aqua Services, Inc. Dyersburg, TN (Deryl Aylor)

MEASURING POINT:

MEASURING EQUIP.: Contractor's 6x5 in. orifice tube, electric dropline

## 1. SPECIFIC CAPACITY TEST DATE: 11/9/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate* (gpm) | Remarks |
|---|---|---|---|---|---|
| 12:30 | 13.6 | | | | Static water level-pump on |
| | 23.0 | 9.4 | 23.0 | 584 | Pumping water level |

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.

* All pumping rates from 6x5 in. orifice table, Layne and Bowler, Inc., Orifice Tables.

60 min. specific capacity: 62.1 gpm/ft

## 2. 400 LBS POLYPHOSPHATE APPLICATION DATE: 11/9/88

A. INITIAL CHLORINATION

Quantity: 2500 gal Strength: 500 mg/L (ppm)

Injection rate: Unable to maintain 750 gpm. Well would not allow injection at this rate.

B. POLYPHOSPHATE INJECTION, 400 lbs total

| | Batch 1 | Batch 2 |
|---|---|---|
| Phosphate (lbs): | 200 | 200 |
| Quantity $H_2O$ (gal): | 1800 | 1800 |
| Injection rate: | | |

C. DISPLACEMENT, 16,000 gallons chlorinated water (500 mg/l)

| Time - initial/complete | Quantity (gal) | Q (gpm) |
|---|---|---|
| 3:00 PM/5:30 PM | | |

Comments: 6+ batches

D. PIMPED TO WASTE

Time - initial: 6:30 PM
- complete: 12:30 PM

Q: 644 gpm    Quantity: 231,840 gal

3. SPECIFIC CAPACITY TEST    DATE: 11/10/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 7:20AM | 12.4 | | 28.0 | 644 | SWL - Pump on |
| | 22.1 | 9.7 | | | |

60 min. specific capacity: 66.4 gpm/ft

4. ACIDIZATION - INHIBITED MURIATIC ACID    DATE: 11/10/88

A. ACID INJECTION

Acid strength: 20° baume    Quantity: 1000 gal

Time - initial: 12:20 PM
- complete: 1:20 PM

B. DISPLACEMENT, 5,000 gallons nonchlorinated water

Quantity: 5000 gal

Time - initial: 3:20 PM
- complete: 4:00 PM

Comments: 2 truck loads

C. PUMPED TO WASTE

Time - initial: 5:00 PM (11/10/88) and 8:00 AM (11/11/88)
- complete: 5:15 PM***(11/10/88) and 11:45 AM (11/11/88)

Q: 644 gpm    Quantity: 154,560 gal

Comments: ***Pump discharge foaming too much; breaker kicked off. Getting too dark to fix--will pump in AM instead.

5. SPECIFIC CAPACITY TEST DATE: 11/11/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 12:15AM | 12.6 | | | | SWL - Pump on |
| 1:15PM | 21.2 | 8.6 | 28.0 | 644 | |

60 min. specific capacity: 74.9 gpm/ft

6. 600 LBS POLYPHOSPHATE APPLICATION DATE: 11/11/88

A. INITIAL CHL0RINATION

Quantity: 2500 gal Strength: 500 mg/l (ppm)

Injection rate: 900 gpm

B. POLYPHOSPHATE INJECTION, 600 lbs total

| | Batch 1 | Batch 2 | Batch 3 |
|---|---|---|---|
| Phosphate (lbs): | 200 | 200 | 200 |
| Quantity $H_2O$ (gal): | 1800 | 1800 | 1800 |
| Injection time (sec): | 54 | 53 | 55 |
| Injection rate (gpm): | 2000 | 2038 | 1964 |

C. DISPLACEMENT, 30,000 gallons chlorinated water (500 mg/l)

Time - complete: 4:30 pm

Quantity: 30,000 gal Q:

Comments: 12 tanks, 2500 gal each, injected

D. PUMPED TO WASTE

Time - initial: 5:30 PM
- complete: 11:30 PM

Q: 638 gpm Quantity: 229,680 gal

## WELL REHABILITATION -- I-70 Well No. 5 (Continued)

7. SPECIFIC CAPACITY TEST DATE: 11/12/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 7:20AM | 11.4 | | 27.5 | 638 | SWL-pump on |
| | 19.0 | 7.6 | 27.0 | 632 | |

60 min. specific capacity: 83.2 gpm/ft

8. 600 LBS POLYPHOSPHATE APPLICATION DATE: 11/12/88

A. INITIAL CHLORINATION

Quantity: 2500 gal Strength: 500 mg/l (ppm)

Injection rate: 850 gpm

B. POLYPHOSPHATE INJECTION, 600 lbs total

| | Batch 1 | Batch 2 | Batch 3 |
|---|---|---|---|
| Phosphate (lbs): | 200 | 200 | 200 |
| Quantity $H_2O$ (gal): | 1800 | 1800 | 1800 |
| Injection time (sec): | 56 | 55 | 56 |
| Injection rate (gpm): | 1929 | 1964 | 1929 |

C. DISPLACEMENT, 54,000 gallons chlorinated water (500 mg/l)

Time - initial: 12:00 PM
- complete: 5:45 PM

Quantity: 54,000 gal Q:

Comments: 21.6 tanks @ 2500 gal each

D. PUMPED TO WASTE

Time - initial: 6:45 PM (11/12)
- complete: 12:45 AM (11/13)

Q: 650 gpm Quantity: 234,000 gal

WELL REHABILITATION -- I-70 Well No. 5 (Continued)

9. SPECIFIC CAPACITY TEST DATE: 11/13/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 7:20AM | 11.3 | | 28.5 | 650 | SWL-pump on |
| | 19.6 | 8.3 | 28.5 | 650 | |

60 min. specific capacity: 78.3 gpm/ft

10. 400 LBS POLYPHOSPHATE APPLICATION DATE: 11/13/88

A. INITIAL CHLORINATION

Quantity: 2500 gal Strength: 500 mg/l (ppm)

Injection rate:

B. POLYPHOSPHATE INJECTION, 400 lbs total

| | Batch 1 | Batch 2 |
|---|---|---|
| Phosphate (lbs): | 200 | 200 |
| Quantity $H_2O$ (gal): | 1800 | 1800 |
| Injection time (sec): | 55 | 55 |
| Injection rate (gpm): | 1964 | 1964 |

C. DISPLACEMENT, 16,000 gallons chlorinated water (500 mg/1)

Time - initial: 10:30 AM
- complete: 12:00 PM

Quantity: 16,250 gal Q: 181 gpm

Comments: 6½ tanks, 2500 gal each, injected

D. PUMPED TO WASTE

Time - initial: 1:00 PM
- complete: 7:00 PM

Q: 650 gpm Quantity: 234,000 gal

11. SPECIFIC CAPACITY TEST DATE: 11/14/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 7:30AM | 11.2 | | 28.5 | 650 | SWL-pump on |
| | 18.9 | 7.7 | 28.5 | 650 | |

60 min. specific capacity: 84.4 gpm/ft

WELL REHABILITATION FIELD NOTES

WELL SITE: I-70 Well No. 10 OBSERVER: Al Brown, IDOT

CONTRACTOR: Aylor Aqua Services, Inc., Dyersburg, TN (Deryl Aylor)

MEASURING POINT:

MEASURING EQUIP.: Contractor's 6x5 in. orifice tube, electric dropline

1. SPECIFIC CAPACITY TEST DATE: 10/15/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate* (from) | Remarks |
|---|---|---|---|---|---|
| 9:10AM | 31.2 | | | | Static water level-pump on |
| 9:20 | 45.1 | | * | | |
| 9:30 | 44.5 | | * | | |
| 10:10 | 45.3 | 14.1 | * | | |

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.

* Unable to read accurately. Piezometer tube reads approximately 1 to 2 inches. Estimate pumping rate at 150 to 220 gpm. This well supplied about 150 gpm during the treatment of Well #11 last week.

60 min. specific capacity: 10.6 gpm/ft @ 150 gpm
15.6 gpm/ft @ 220 gpm

2. 400 LBS POLYPHOSPHATE APPLICATION DATE: 10/15/88

A. INITIAL CHLORINATION

Quantity: 2500 gal Strength: 500 mg/L (ppm)

Injection rate: Unable to maintain 300 gpm injection as water backs up in well.

Time - initial: 10:10 AM
- complete: 10:15 AM

B. POLYPHOSPHATE INJECTION, 400 lbs total

| | Batch 1 | Batch 2 |
|---|---|---|
| Phosphate (lbs.): | 200 | 200 |
| Quantity $H_2O$ (gal): | 1800 | 1800 |
| Injection rate (gpm): | 570 | 480 |

C. DISPLACEMENT, 17,500 gallons chlorinated water (500 mg/l)

| Time - initial/complete | 0 (gpm) | Quantity (gal) |
|---|---|---|
| 10:50 AM/1:10 PM | | 17,500 |

Comments: 7 batches @ 2500 gal each. Unable to maintain injection pumping rate as water backs up in well.

D. PUMPED TO WASTE

Time - initial: 2:15 PM
- complete: 8:15 PM

Q: 250 gpm Quantity: 90,000 gal

3. SPECIFIC CAPACITY TEST DATE: 10/17/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 8:00AM | 30.9 | | 2.5 | <280 | SWL - Pump on |
| 9:05 | 39.4 | 8.5 | 2.5 | | |

60 min. specific capacity: undetermined

4. ACIDIZATION - INHIBITED MURIATIC ACID DATE: 10/17/88

A. ACID INJECTION

Acid strength: 20° baume Quantity: 1000 gal

Time - initial:
- complete:

B. DISPLACEMENT, 5,000 gallons nonchlorinated water

Quantity: 5,000 gal

Time - initial: 2:15 PM
- complete: 2:50 PM

C. PUMPED TO WASTE

Time - initial: 3:50 PM
- complete: 7:50 PM

Q: Quantity:

5. SPECIFIC CAPACITY TEST DATE: 10/18/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 7:40AM | 31.0 | | 8.5 | 361 | SWL - Pump on |
| 8:43 | 38.7 | 7.7 | 8.5 | 361 | |

60 min. specific capacity: 46.9 gpm/ft

6. 600 LBS POLYPHOSPHATE APPLICATION DATE: 10/18/88

A. INITIAL CHLORINATION

Quantity: 2500 gal Strength: 500 mg/l (ppm)

Time - initial: 9:30 AM
- complete:

Injection rate: 800 gpm

B. POLYPHOSPHATE INJECTION, 600 lbs total

| | Batch 1 | Batch 2 | Batch 3 |
|---|---|---|---|
| Phosphate (lbs): | 200 | 200 | 200 |
| Quantity $H_2O$ (gal): | 1800 | 1800 | 1800 |
| Injection rate: | | | |

C. DISPLACEMENT, 30,000 gallons chlorinated water (500 mg/l)

Time - initial: 12:13 PM
- complete: 2:45 PM

Quantity: Q: gpm

D. PUMPED TO WASTE

Time - initial: 3:45 PM
- complete: 9:45 PM

Q: 372 gpm Quantity: 133,920 gal

7. SPECIFIC CAPACITY TEST DATE: 10/19/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 7:30AM | 31.0 | | 9 | 372 | SWL-pump on |
| | 38.1 | 7.1 | 9.0 | 372 | Pumping water level |

60 min. specific capacity: 52.4 gpm/ft

8. 600 LBS POLYPHOSPHATE APPLICATION DATE: 10/19/88

A. INITIAL CHLORINATION

Quantity: 2500 gal Strength: 500 mg/l (ppm)

Injection rate: 800 gpm

B. POLYPHOSPHATE INJECTION, 600 lbs total

| | Batch 1 | Batch 2 | Batch 3 |
|---|---|---|---|
| Phosphate (lbs): | 200 | 200 | 200 |
| Quantity $H_2O$ (gal) : | 1800 | 1800 | 1800 |
| Time (sec) | 57 | 55 | 57 |
| Injection rate (gpm): | 1895 | 1964 | 1895 |

C. DISPLACEMENT, 54,000 gallons chlorinated water (500 mg/l)

Time - initial: 9:25 AM
- complete: 2:00 PM

Quantity: 55,000 gal Q: 200 gpm

D. PUMPED TO WASTE

Time - initial: 3:00 PM
- complete: 9:00 PM

Q: 383 gpm Quantity: 137,880 gal

9. SPECIFIC CAPACITY TEST DATE: 10/20/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 7:45AM | 31.0 | | 9.5 | 383 | SWL-pump on |
| 8:50AM | 38.3 | 7.3 | 9.5 | 383 | |

60 min. specific capacity: 52.5 gpm/ft

10. 400 LBS POLYPHOSPHATE APPLICATION DATE: 10/20/88

A. INITIAL CHLORINATION

Quantity: 2500 gal Strength: 500 mg/l (ppm)

Injection rate: 750 gpm

B. POLYPHOSPHATE INJECTION, 400 lbs total

| | Batch 1 | Batch 2 |
|---|---|---|
| Phosphate (lbs): | 200 | 200 |
| Quantity $H_2O$ (gal): | 1800 | 1800 |
| Time (sec) | 55 | 54 |
| Injection rate (gpm): | 1964 | 2000 |

C. DISPLACEMENT, 16,000 gallons chlorinated water (500 mg/l)

Time - initial: 9:30 AM
- complete: 10:50 AM

Quantity: 16,000 gal Q: 200 gpm

Comments: 1 hr 20 mins total injection time. Approximately 7 tanks, 2500 gal each, injected.

D. PUMPED TO WASTE

Time - initial:
- complete:

Q: Quantity:

11. SPECIFIC CAPACITY TEST DATE: 10/21/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 7:45AM | 31.0 | | 10 | 393 | SWL-pump on |
| 8:45AM | 38.5 | 7.5 | 10 | 393 | |

60 min. specific capacity: 52.4 gpm/ft

## WELL REHABILITATION FIELD NOTES

WELL SITE: I-70 Well No. 11 OBSERVER: Al Brown, IDOT

CONTRACTOR: Aylor Aqua Services, Inc. Dyersburg, TN (Deryl Aylor)

MEASURING POINT:

MEASURING EQUIP.: Contractor's 6x5 in. orifice tube, electric dropline

1. SPECIFIC CAPACITY TEST DATE: 10/5/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate* (gpm) | Remarks |
|---|---|---|---|---|---|
| 8:54 | 23.20 | | | | Static level |
| 9:01 | | | | | Start pumping |
| 10:19 | 32.00 | 8.8 | 24 | 596 | 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.

* All pumping rates from 6x5 in. orifice table, Layne and Bowler, Inc., Orifice Tables.

60 min. specific capacity: 67.7 gpm/ft

2. 400 LBS POLYPHOSPHATE APPLICATION DATE: 10/6/88

A. INITIAL CHLORINATION

Quantity: 2500 gal Strength: Used 12 lbs dry chlorine

Injection rate: 770 gpm

Time - initial: 1:17:10 PM
- complete: 1:20:25

B. POLYPHOSPHATE INJECTION, 400 lbs total

| | Batch 1 | Batch 2 |
|---|---|---|
| Phosphate (lbs.): | 200 | 200 |
| Quantity $H_2O$ (gal) : | 1800 | 1800 |
| Time - initial: | 1:47 PM | 2:11 PM |
| - complete: | 1:48 | 2:12 |
| Injection rate (gpm): | 1800 | 1800 |

C. DISPLACEMENT, 16,000 gallons chlorinated water (500 mg/1)

| Time - initial/complete | Quantity (gal) | Q (gpm) |
|---|---|---|
| /4:30 PM | | |

D. PUMPED TO WASTE

Time - initial: 5:30 PM (10/6/88) and 7:00 AM (10/7/88)
- complete: 9:30 PM (10/6/88) and 9:00 AM (10/7/88)

Q: 596 gpm (10/6/88) Quantity: 143,040 gal (10/6/88)
632 gpm (10/7/88) 75,840 gal (10/7/88)
218,880 total gal

3. SPECIFIC CAPACITY TEST DATE: 10/7/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 6:58AM | 23.1 | | 26 | 620 | Static level - Pump on |
| 8:06AM | 31.2 | 8.1 | 27 | 632 | Pumped level |

60 min. specific capacity: 78.0 gpm/ft

4. ACIDIZATION - INHIBITED MURIATIC ACID DATE: 10/7/88

A. ACID INJECTION

Acid strength: 20° baume Quantity: 1000 gal

Time - initial: 12:00 PM
- complete: 1:00 PM

B. DISPLACEMENT, 5,000 gallons nonchlorinated water

Time - initial: 2:00 PM
- complete: 2:15 PM

C. PUMPED TO WASTE

Time - initial: 4:15 PM (10/7/88) and 2:30 PM (10/11/88)
- complete: 6:15 PM (10/7/88) and 4:30 PM (10/11/88)

Q: 602 gpm (10/7/88) Quantity: 144,480 gal
602 gpm (10/11/88)

5. SPECIFIC CAPACITY TEST DATE: 10/11/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 2:27PM | 22.7 | | | | SWL - Pump on |
| 3:00PM | | | 25 | 602 | |
| 3:45PM | 30.6 | 7.9 | 25 | 602 | |

60 min. specific capacity: 76.2 gpm/ft

6. 600 LBS POLYPHOSPHATE APPLICATION DATE: 10/12/88

A. INITIAL CHL0RINATI0N

Quantity: 2500 gal Strength: 500 mg/l (ppm)

Injection rate: 1000 gpm

B. POLYPHOSPHATE INJECTION, 600 lbs total

| | Batch 1 | Batch 2 | Batch 3 |
|---|---|---|---|
| Phosphate (lbs): | 200 | 200 | 200 |
| Quantity $H_2O$ (gal): | 1800 | 1800 | 1800 |
| Time (sec): | 61 | 63 | 59 |
| Injection rate: | 1770 | 1714 | 1830 |

C. DISPLACEMENT, 30,000 gallons chlorinated water (500 mg/l)

Comments: Twelve 2500 gal batches injected.

D. PUMPED TO WASTE

Time - initial: 2:15 PM
- complete: 8:30 PM

Q: 608 gpm Quantity: 228,000 gal

7. SPECIFIC CAPACITY TEST DATE: 10/12/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 8:25AM | 22.6 | | 25 | 608 | SWL - Pump on |
| 9:00AM | 30.8 | 8.2 | 23.5 | 590 | |

60 min. specific capacity: 72.0 gpm/ft

8. 600 LBS POLYPHOSPHATE APPLICATION DATE: 10/13/88

A. INITIAL CHLORINATION

Quantity: 2500 gal Strength: 500 mg/l (ppm)

Injection rate: 750 gpm

B. POLYPHOSPHATE INJECTION, 600 lbs total

| | Batch 1 | Batch 2 | Batch 3 |
|---|---|---|---|
| Phosphate (lbs): | 200 | 200 | 200 |
| Quantity $H_2O$ (gal): | 1800 | 1800 | 1800 |
| Time (sec): | 57 | 56 | 53 |
| Injection rate (gpm): | 1895 | 1929 | 2038 |

C. DISPLACEMENT, 54,000 gallons chlorinated water (500 mg/l)

Time - initial: 9:00 AM
- complete: 3:10 PM

Quantity: 55,500 gal Q: 150 gpm

D. PUMPED TO WASTE

Time - initial: 4:10 PM
- complete: 10:15 PM

Q: 632 gpm Quantity: 230,680 gal

9. SPECIFIC CAPACITY TEST DATE: 10/14/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 8:15AM | 22.8 | | 27 | 632 | SWL - Pump on |
| 9:15AM | 30.6 | 7.8 | | | |

60 min. specific capacity: 81.0 gpm/ft

10. 400 LBS POLYPHOSPHATE APPLICATION DATE: 10/14/88

A. INITIAL CHLORINATION

Quantity: 2500 gal Strength: 500 mg/l (ppm)

Injection rate: 750 gpm

B. POLYPHOSPHATE INJECTION, 400 lbs total

| | Batch 1 | Batch 2 |
|---|---|---|
| Phosphate (lbs): | 200 | 200 |
| Quantity $H_2O$ (gal): | 1800 | 1800 |
| Injection rate: | | |

C. DISPLACEMENT, 16,000 gallons chlorinated water (500 mg/l)

Time - initial:
- complete: Finished at 11:48 AM

Quantity: 17,500 gal Q: gpm

Comments: Seven tanks @ 2500 gal each injected

D. PUMPED TO WASTE

Time - initial: 1:00 PM
- complete: 7:00 PM

Q: 626 gpm Quantity: 225,360 gal

11. SPECIFIC CAPACITY TEST DATE: 10/15/88

| Time | Depth (ft) | Drawdown (ft) | Piez. tube (in.) | Pumping rate (gpm) | Remarks |
|---|---|---|---|---|---|
| 7:15AM | 22.7 | | 24.5 | 602 | SWL - Pump on |
| 8:20AM | 30.0 | 7.3 | 25.5 | 614 | |

60 min. specific capacity: 84.1 gpm/ft

## Appendix E.

## I-70 Well 11 Sand Pumpage Test Sieve Data

Appendix E. I-70 Well 11 Sand Pumpage Test Sieve Data
(cumulative % retained)

| Sieve diameter (mm) | I-70 Well 11 |
|---|---|
| 2.00 | 1.63 |
| 1.00 | 3.01 |
| 0.710 | 4.71 |
| 0.500 | 7.72 |
| 0.355 | 11.78 |
| 0.250 | 17.91 |
| 0.180 | 32.6 |
| 0.125 | 40.04 |
| 0.063 | 46.81 |

Appendix F.

I-70 Wells 8A and 9A Construction Notes

## Appendix F. I-70 Wells 8A and 9A Construction Notes

Note: These notes are combined in chronological order, since work was being done on both wells at times.

Mon., March 27. 1989

2:45 pm Arrived at site for Well 9A (15). Luhr Bros. equipment is on site except for the well screen. Pit construction is in progress. Presence of CMP drainage pipe and unexpected electrical cable has slowed progress. They anticipate finishing the site preparation tomorrow and begin drilling at 7 am on Wednesday.

Tues., March 28

8:00 am Morning began with rain. The work is delayed. As rain slows down, work proceeds. Rig is being set up and the surface casing installed.

2:00 pm The site superintendent has decided not to drill Wednesday because of a stormy forecast. All that is left for today is setting up I-70 Well 10 for the supply well.

Wed., April 5

7:00 am Arrived at site. The Luhr Bros. crew began preparing the rig for operation.

7:45 IDOT engineer Al Brown arrived on site. Pit is nearly full. Wells 8 and 10 are being used as the source. Well 10 is the main supply. The Well 8 hose is being run across the exit ramp. Al Brown will not allow this to continue. They will try to run the hose under the trilevel.

8:05 Drilling began.

8:28 Added first 10-ft section of drill stem. Began drilling.

8:45 Drilling was stopped to level rig. Now leveled, continued drilling.

9:02 Drilling stopped. They cut off the drill bit edges to reduce the diameter to 42 inches.

9:12 Resume drilling.

9:35 Added second 10-ft section of drill stem, drilling continued.

9:58 Added third 10-ft section of drill stem, drilling continued.

10:22 Added fourth 10-ft section of drill stem, drilling continued.

10:41 Added fifth 10-ft section of drill stem, drilling continued. Screen has arrived on site. There are three 20-ft sections. Two are 55 slot, one is 20 slot.

11:03 Added sixth 10-ft section of drill stem, drilling continued.

11:34 Added seventh 10-ft section of drill stem, drilling continued.

11:48 Pause in drilling to allow supply well (No. 10) to catch up.

| | |
|---|---|
| 12:14 pm | Added eighth 10-ft section of drill stem, drilling continued. |
| 12:31 | Pause in drilling to allow pit to fill. |
| 1:05 | Resume drilling. |
| 1:15 | Added ninth 10-ft section of drill stem, drilling continued. |
| 2:00 | Coarse cobbles encountered from 95 to 98 ft, approximately 1-2 inches in diameter. |
| 2:05 | Drilling stopped. Total depth from land surface is 104.7 ft. All but the last foot of the ninth section was used. |
| 2:40 | Depth is 106 ft from surveyed wood plug at 408 msl. Bottom of well at 408-106 - 302 MSL. |
| 2:55 | They are preparing the three sections of screen for welding. |
| 3:05 | The driller is welding the first two sections of screen together. |
| 3:37 | The centering guide has been welded to the bottom of the second section. |
| 3:55 | The third section of screen has been welded on. They are preparing to weld a 20-ft section of stainless steel casing to the screen. The 20-ft casing is actually four 5-ft sections already welded together. |
| 4:10 | The 20-ft casing has been welded on. |
| 4:25 | The gravel pack has arrived - 2 trucks. |
| 4:35 | A 15-ft section of stainless steel casing is being welded on. |
| 4:55 | A 3.75-ft section of stainless steel casing has been welded on. |
| 5:15 | To obtain the proper depth, an 8-ft section of carbon steel pipe was temporarily welded to the top of the stainless steel casing. |
| 5:44 | Two 6-inch diameter stainless steel sections of pipe are being set on both sides of the well casing. A 4-inch spacer was welded between the temporary 16-inch well casing and the 6-inch pipe to allow correct positioning. |
| 6:15 | The first truckload of gravel pack is being unloaded into the borehole. Approximately 10 yards per truckload, 2.01 tons/yard. Northern No. 1 (Type A) gravel: sample collected. |
| 6:35 | First truck has been unloaded. 408-79 (steel tape) - 329 ft MSL to gravel pack. |
| 6:42 | Second truck of Type A gravel is being unloaded. Elevation to pack is now 347.1 ft MSL. Only % of the truckload was used. |
| 6:55 | The third truckload of pack is being unloaded, Northern No. 00 (Type C) gravel. Elevation of pack is 384 ft MSL. Target elevation is 388 ft MSL. |
| 7:20 | Unloaded fourth truckload until target elevation was reached. |
| 7:45 | A 20-ft length of 36 inch diameter steel pipe is being inserted in the borehole down to the gravel pack to prevent the upper portion from caving in. |

Thurs., April 6

| | |
|---|---|
| 8:00 am | Arrived at site. Drill crew is preparing to surge and bail material from 16-inch diameter well casing. The surge block is approximately 8 inches in diameter and 10 ft long. |
| 8:45 | Surging is completed. |
| 9:00 | Bailer has replaced the surge clock on the wireline to pull additional fines through the screen and remove material that has collected. Depth to bottom is now 107.4 ft. This is 0.1 ft less than yesterday. |
| 9:20 | The surge block has replaced the bailer for further action. |
| 9:35 | The bailer has replaced the surge block for final bailing of the fines. |
| 10:00 | Preparing the pump and column pipe to be used to develop the well. |
| 1:15 pm | The nonpumping water level is approximately 30.5 ft below land surface. |
| 1:45 | Started pumping well to waste. They plan on pumping until the effluent is clear. |
| 1:50 | The pumping water level is about 40.4 ft below land surface. The pumping rate is 1000 gpm. |
| 2:45 | Water has cleared, turned off pump. The water level just before shut off was 41.2 ft below land surface. |

Fri., April 7

| | |
|---|---|
| 8:45 am | Arrived on site. They are waiting on delivery of the bentonite/cement grout to pour the plug on top of the gravel pack. |
| 9:20 | Cement truck arrived. The cement:bentonite ratio is 30:1. |
| 9:50 | Pumping cement into the well hole. |
| 10:05 | Completed pouring cement. Cemented to 8 ft below land surface. |
| 10:20 | Removed the 36-inch diameter support pipe now that the cement has been poured. |
| 10:35 | The crew began preparing the Well 8A site for drilling on Monday. The driller plans to wait an hour before backfilling No. 9A to allow the cement to set up. |

Mon., April 10

| | |
|---|---|
| 7:15 am | Arrived at site. Well 10 is being used to fill the pit along with No. 8 for drilling No. 8A. |
| 8:00 | Began drilling I-70 No. 8A. |
| 8:04 | There is a seep developing along the pipe to the mud pit. The drill crew is scooping sand to fill it back up. |
| 8:15 | Added first 10-ft section of drill stem, drilling continued. |
| 8:25 | A small hose has burst on the rig. It will take about 5 minutes to fix. |
| 8:35 | Added second 10-ft section of drill stem, drilling continued. |
| 8:45 | The well screen has arrived. There are two 20-ft sections and two 10-ft sections. There is 30 ft of 55 slot screen and 30 ft of 25 slot screen. |

| | |
|---|---|
| 8:51 | Added third 10-ft section of drill stem, drilling continued. |
| 9:09 | Added fourth 10-ft section of drill stem, drilling continued. |
| 9:25 | Added fifth 10-ft section of drill stem, drilling continued. |
| 9:49 | Added sixth 10-ft section of drill stem, drilling continued. |
| 10:01 | The walls of the mudpit have caved in some, exposing an electric line. They are using a backhoe to clean out the pit. |
| 10:07 | Water to the pit from Well 10 isn't keeping up. They began pumping from No. 8 to help. Al Brown mentioned earlier that No. 8 was not to be used while drilling. This was pointed out to the drill crew. |
| 10:18 | Added seventh 10-ft section of drill stem, drilling continued. |
| 10:25 | Drilling stops periodically to allow the pit to fill. |
| 11:10 | Added eighth 10-ft section of drill stem, drilling continued. |
| 11:47 | Progress has slowed considerably due to large cobbles. Some are 3 inches in diameter. |
| 1:19 pm | Still using eighth section of drill stem. Progress has only been a few feet in the last 2 hours. |
| 2:51 | Added ninth 10-ft section of drill stem, drilling continued. |
| 3:00 | It has taken almost 3 hours to drill one foot. The bottom elevation is now at 306 ft above MSL. This is about 4 ft above the target depth. Because of the size of the boulders, it was decided to stop. |
| 3:20 | The screens are being prepared for welding. |
| 3:41 | The first two sections of screen have been welded together. |
| 3:48 | The centering guide is to be attached to the top of the second section of screen. It is too big and must be cut. Each ring is welded on separately. |
| 3:55 | The 20-ft section of 25 slot screen is being welded to the 30-ft section of 55 slot screen. |
| 4:13 | Welding last 10-ft section of 25 slot screen. |
| 4:30 | Welding 14.85 ft of stainless steel casing to the screen. The total length of screen is 61.4 ft (because of welding ring), so top of casing is at 306+61.4+14.85 - 382.25 ft above MSL. |
| 4:50 | Spot welding temporary steel pipe to top of stainless steel casing. |
| 5:02 | The first truckload of gravel pack, Type A, begins to unload, sample taken. |
| 5:17 | During the unloading of the first truck, the well casing was swaying back and forth. |
| 5:19 | Depth to pack after first truck, 71 ft. |
| 5:20 | The second truck broke a U-joint while backing up to the well. |
| 5:30 | Using a bulldozer, the second truck has been backed up to the well. The driller fixed the U-joint so the bed could be raised. |
| 5:35 | Unloading second truck of Type A gravel pack, sample taken. |
| 5:52 | Depth after second truckload is 45 ft. |
| 6:02 | The third truck of Type B gravel pack (Northern No. 0) has been unloaded, sample collected. Depth is now at 27 feet. |

6:04 A second measurement was taken. Depth now only 18½ ft. There may have been some wall failure or cave-in. If so, there is 8½ ft of native material replacing the gravel pack. Top of screen is about 21.5 ft deep.

6:08 Placing 36-inch diameter pipe in the borehole to protect from cave-ins. The drill crew is shoveling excess pack into the well. The excess pack is both Type A & Type B.

Tues., April 11

8:30 am Arrived at site. Surging has begun. The temporary well casing was cut off about 1 ft above land surface.

9:00 Measured well with steel tape. About 2 ft of sediment has accumulated. They began bailing well.

9:10 Reattached surge block. Surging well a second time.

9:42 Stopped surging, attached bailer.

9:46 Finished bailing.

9:50 Began setting up pumping equipment.

11:20 Began pumping, water is cloudy. NPWL - 12 ft 8 inches (12.67 ft).

11:25 PWL - 22 ft 10 inches (22.83 ft)

11:40 Began preparing Well 9A for the pit installation.

12:20 pm At Well 9A the well casing was cut off to the proper height.

12:30 The backhoe is filling the mudpit at Well 9A.

12:52 The water level at Well 8A is now 23.9 ft.

12:55 The concrete box for No. 9A arrived.

1:00 Shut off pump at No. 8A. Pumped 100,000 gallons in 98 minutes or 1020 gpm.

1:13 They have set the pit box for Well 9A. Now they are preparing the top.

1:15 Before placing the top of the pit box the crew applied some black 2-sided cement tape to help waterproof the pit box.

1:18 Pit box is complete. Al Brown noted that the steps are missing in the box.

1:26 The drill crew is dismantling the pump and pipe assembly at No. 8A in preparation for the cement grout plug on top of the gravel pack.

2:30 They began installing the 6-inch diameter pipes in the well. The pipes allow the addition of gravel pack, if necessary.

2:35 The pipes are 4 ft too long. They are being removed and taken to be cut off to the proper length.

3:15 The cement grout has arrived.

3:48 The supervisor is back with the 6-inch pipes cut to the correct length. They are being installed.

4:11 Pipes are now in place. They are putting 2 ft of sand down before the concrete grout is poured.

4:18 The cement truck has backed up to the well. The driver added a bag of bentonite to the cement and is mixing it in. The drill crew has set up a pump, hooked into a 55 gallon barrel, to pump the grout into the well.

4:22 They began pouring the grout.

4:41 The cement grout is in place. The drill crew is pulling the 36-inch diameter pipe from the well.

Weds., April 12

Dug the hole for installation of the concrete pit box at Well 8A. Spent the majority of the day working on the discharge line at Well 9A.

Thurs., April 13

8:15 am Arrived at site. The drill crew is just now moving the rig over to No. 9A to drill the piezometer well. Apparently the battery was stolen from the rig last night. The driller mentioned that the concrete box for Well 8A should be here between 10 am and noon today.
9:00 Rig is in place at No. 9A to drill the piezometer well. A portable mud pit is being used. They are adding Revert to the drilling fluid.
9:15 They are having trouble priming the drilling system.
10:15 Have begun drilling. Using the rotary drill rig.
10:35 Added first section of drill stem.
11:00 Added second section of drill stem. Still having a problem keeping the system primed.
11:20 Added third section of drill stem.
11:30 Box for No. 8A has arrived. The supervisor and another crew member are helping set the box and top.
11:35 Added fourth section of drill stem.
11:48 Added fifth section of drill stem.
12:15 pm Added sixth section of drill stem.
12:20 Stopped drilling. They have encountered some large rocks.
12:27 At Well 8A they've realized the box isn't set correctly. The well isn't directly under the opening as it should be.
12:54 Added seventh section of drill stem.
1:14 Added eighth section of drill stem.
1:26 Stopped drilling, began disassembly of drill stem.
1:41 Began setting piezometer (3-ft screen).
1:53 Piezometer is in place.
1:59 Tube is 83 ft long. Six feet will be cut off leaving the well 77 feet deep.
2:06 Cut hole in bottom of 55 gallon barrel of gravel pack. Gravel pack is pouring into the annulus. Took sample.
2:40 Finished unloading second barrel of gravel pack. The rest of the hole will be filled with sand.

Fri., April 14

8:50 am Arrived at site. The drill crew is placing the top on the pit box at No. 8A. When complete, they will set up the rig to drill the No. 8A piezometer.
10:35 Started drilling. Using Revert® in the drilling fluid.
10:45 Added second section of drill stem.
10:59 Added third section of drill stem.
11:05 Began putting piezometer pieces together, 3 ft screen.
11:10 Added fourth section of drill stem.
11:20 Added fifth section of drill stem.
11:30 Added sixth section of drill stem.

| | |
|---|---|
| 12:00 pm | Finished drilling. Drilled fast so some rocks are above the bit. May have problem getting pipe out. |
| 12:30 | Circulating mud through system to try and clean out bore hole. |
| 12:51 | Began removing drill stem pipes. |
| 1:05 | Began setting piezometer. Top of box is at 387.75± so piezometer at target 330 ft bottom elevation will be 57.75 feet long. |
| 1:13 | Piezometer won't fill up with water from hole. Casing is floating up so using water hose to fill piezometer. Piezometer casing is now 63 ft long. Six feet must be removed to set top at land surface. |
| 1:27 | Waiting on gravel pack. |
| 1:29 | Gravel pack arrived. |
| 1:48 | Finished pouring first barrel of pack. |
| 1:54 | Finished pouring second barrel of pack. |
| 2:00 | Leaving site. Piezometer installation is complete. |

Appendix G.

I-70 Wells 8A and 9A IDPH Construction Reports

and Sieve Analysis Results of Washed Samples

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

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1. Type of Well
   - a. Bored____ Hole Diam. 42 in. Depth 86 ft
     Buried Slab: Yes___ No X
   - b. Driven____ Drive Pipe Diam.____in. Depth____ft
   - c. Drilled X Finished in Drift____ XXX Rock____
   - d. Grout:

| (KIND) | FROM (Ft.) | TO (Ft.) |
|---|---|---|
| Cement & Bentonite | 8 | 16 |
| | | |
| | | |

2. Well furnishes water for human consumption? Yes___ No X
3. Date well drilled 4/10/89
4. Permanent pump installed? Yes ___ Date________ No X
   Manufacturer________ Type________
   Location________
   Capacity ______gpm. Depth of setting________ft.
5. Well top sealed? Yes___ No X Type________
6. Pitless adapter installed? Yes___ No X
   Manufacturer________ Model No.________
   How attached to casing?________
7. Well disinfected? Yes___ No X
8. Pump and equipment disinfected Yes___ No X

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. Disclosure of this information is mandatory. This form has been approved by the Forms Management Center.

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

GEOLOGICAL AND WATER SURVEYS WELL RECORD

9. Driller Kennedy License No. 102000833
10. Well Site Address I-64 & I-70
11. Property Owner State of Illinois Well No. 8A
12. Permit No. IDOT Date Issued________
13. Location: County St. Clair
    IDOT Well No. 8A
    Sec.____
    Twp.____
    Rge.____
    Show location in section plat
14. Water from 12 at depth 86 ft
    to____ft
15. Casing and Liner Pipe

| Diam.(in) | Kind and Weight | From (ft) | To (ft) |
|---|---|---|---|
| 16 | 304 Stainless | 6 | 21 |
| | | | |
| | | | |
| | | | |

16. Screen: Diam. 16 in, Length 30' ~~ft~~ (30'), Slot Size 25 (55)
17. Size hole below casing____in. 18. Ground Elev. 388 ft msl.
19. Static level 12 ft below casing top which is 0 ft. above ground level. Pumping level 23.9 ft, pumping 1000 gpm for 1 hours.

| 20. Earth Materials Passed Through | Depth of Top | Depth of Bottom |
|---|---|---|
| Very Fine Silty Brown Sand | 0 | 10 |
| Very Fine Silty Gray Sand | 10 | 15 |
| Fine Gray Sand | 15 | 30 |
| Coarse Gray Sand | 30 | 55 |
| Very Coarse Gray Sand & Gravel to 3" Cobbles | 55 | 86 |

Continue on separate sheet if necessary.

Signed [redacted] Date [redacted]

IL[redacted]0126

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. 42 in. Depth 106 ft
      Buried Slab: Yes___ No X
   b. Driven____ Drive Pipe Diam.____in. Depth 0 ft
   c. Drilled X Finished in Drift____ In Rock____
   d. Grout:

| (KIND) | FROM (Ft.) | TO (Ft.) |
|---|---|---|
| Cement & Bentonite | 8 | 16 |
| | | |
| | | |

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2. Well furnishes water for human consumption? Yes___ No X
3. Date well drilled 4/5/89
4. Permanent pump installed? Yes ___ Date__________ No___
   Manufacturer__________ Type______
   Location__________
   Capacity ______gpm. Depth of setting__________ft.
5. Well top sealed? Yes___ No X Type________
6. Pitless adapter installed? Yes___ No X
   Manufacturer__________ Model No.______
   How attached to casing?__________
7. Well disinfected? Yes___ No X
8. Pump and equipment disinfected Yes___ No___

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.

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

IL482-0126

GEOLOGICAL AND WATER SURVEYS WELL RECORD

9. Driller Kennedy License No. 102000833
10. Well Site Address I-64 & I-70
11. Property Owner State of Illinois Well No. 9A
12. Permit No. IDOT Date Issued______
13. Location: County St. Clair
    IDOT Well No. 9A
    Sec.____
    Twp.____
    Rge.____
    Show location in section plat
14. Water from 30.45 at depth 108 ft to______ft
15. Casing and Liner Pipe

| Diam.(in) | Kind and Weight | From (ft) | To (ft) |
|---|---|---|---|
| 16 | 304 Stainless | 5 | 42.8 |
| | | | |
| | | | |
| | | | |

16. Screen: Diam. 16 (16) in, Length 20 ft (40'), Slot Size 20 (55)
17. Size hole below casing____in. 18. Ground Elev. 108 ft msl.
19. Static level 30.45 ft below casing top which is 0 ft. above ground level. Pumping level 41 ft, pumping 1000 gpm for 1 hours.

| 20. Earth Materials Passed Through | Depth of Top | Depth of Bottom |
|---|---|---|
| Silty Fine Sand With Clay Lenses | 0 | 14 |
| Gray Silty Clay | 14 | 22 |
| Fine Brown Sand | 22 | 25 |
| Heavy Gray Clay | 25 | 27 |
| Fine Brown Sand | 27 | 36 |
| Gray Clay | 36 | 41 |
| Fine Gray Sand | 41 | 52 |
| Medium Gray Sand | 52 | 56 |
| Coarse Sand & Gravel 1" | 56 | 66 |
| Coarse Sand & Gravel 3" Cobbles | 66 | 106 |

Continue on separate sheet if necessary.

Signed William R. Gardner Date April 13, 1989
William R. Gardner, Project Engineer

Appendix G. Sieve Results of I-70 Well 8A Washed Samples
(Cumulative percent retained)

| Depth | Standard Sieve | ,5" | ,.375" | #4 | #10 | #16 | #30 | #40 | #50 | #100 | #200 | PAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0-5 | | | | 0 | 0.5 | 1.5 | 4.9 | 7.5 | 11.0 | 37.8 | 77.3 | 100 |
| 5-10 | | | 0 | 0.2 | 0.8 | 1.6 | 7.0 | 18.3 | 48.8 | 74.0 | 89.6 | 100 |
| 10-15 | | | 0 | 0.4 | 2.0 | 4.4 | 10.1 | 12.8 | 15.3 | 25.0 | 55.3 | 100 |
| 15-20 | | | 0 | 0.2 | 0.5 | 1.0 | 2.1 | 3.2 | 7.6 | 76.8 | 97.5 | 100 |
| 20-25 | | | | | | 0 | 0.3 | 1.7 | 11.5 | 88.3 | 98.5 | 100 |
| 25-30 | | | | 0 | 0.4 | 0.6 | 2.8 | 7.5 | 19.3 | 91.0 | 98.7 | 100 |
| 30-35 | | | | | 0.2 | 0.7 | 4.4 | 13.6 | 38.0 | 90.4 | 99.4 | 100 |
| 35-40 | | | | | | 0 | 0.1 | 0.6 | 3.4 | 69.4 | 98.6 | 100 |
| 40-45 | | 1.7 | 1.7 | 3.2 | 9.7 | 21.6 | 50.6 | 58.7 | 64.4 | 87.8 | 99.1 | 100 |
| 45-50 | | 0 | 1.1 | 2.3 | 13.9 | 25.4 | 48.9 | 64.2 | 77.3 | 86.3 | 98.5 | 100 |
| 50-55 | | | 0 | 3.6 | 10.9 | 19.8 | 44.3 | 58.6 | 71.7 | 98.7 | 99.5 | 100 |
| 55-60 | | 0 | 1.0 | 3.1 | 6.7 | 14.3 | 43.0 | 55.1 | 59.3 | 88.6 | 97.3 | 100 |
| 60-65 | | | 0 | 0.4 | 2.9 | 7.7 | 30.1 | 69.3 | 97.2 | 99.4 | 99.6 | 100 |
| 65-70 | | 0 | 2.3 | 8.0 | 25.5 | 37.3 | 48.1 | 64.4 | 86.2 | 92.8 | 97.4 | 100 |
| 70-75 | | | 0 | 3.3 | 22.8 | 50.1 | 88.0 | 95.0 | 97.6 | 99.3 | 99.7 | 100 |
| 75-80 | | 4.9 | 5.5 | 12.7 | 23.0 | 33.5 | 63.3 | 85.4 | 96.1 | 99.2 | 99.7 | 100 |
| 80-85 | | 2.3 | 2.8 | 5.1 | 9.4 | 12.5 | 27.1 | 47.6 | 89.6 | 99.6 | 100.0 | 100 |

Appendix G. Sieve Results of I-70 Well 9A Washed Samples
(Cumulative percent retained)

| Depth | Standard Sieve | .75" | .5" | .375" | #4 | #10 | #16 | #30 | #40 | #50 | #100 | #200 | PAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12-22 | | | | | | | | 0 | 0 | 0 | 0.4 | 1.7 | 100 |
| 22-25 | | | | | | | | 0 | 0 | 0 | 4.2 | 53.3 | 100 |
| 25-27 | | | | | | | | 0 | 0 | 0 | 1.3 | 5.7 | 100 |
| 27-31 | | | | | | | | 0 | 0 | 0 | 17.7 | 84.2 | 100 |
| 31-36 | | | | | | | | 0 | 0 | 0.6 | 47.5 | 93.9 | 100 |
| 36-41 | | | | | | | | 0 | 0 | 0.4 | 2.3 | 9.8 | 100 |
| 41-46 | | | | | | | | 0 | 0 | 0.8 | 71.2 | 95.1 | 100 |
| 46-52 | | | | | | | 0 | 0 | 0.2 | 6.7 | 87.9 | 96.8 | 100 |
| 52-56 | | | | | 0 | 1.1 | 3.7 | 11.0 | 15.6 | 32.6 | 77.1 | 95.5 | 100 |
| 56-60 | | | 0 | 0.7 | 7.8 | 30.2 | 47.8 | 77.4 | 89.1 | 94.9 | 97.6 | 98.0 | 100 |
| 60-66 | | | 2.4 | 2.4 | 6.2 | 18.0 | 30.0 | 60.6 | 78.4 | 92.8 | 98.4 | 98.6 | 100 |
| 66-71 | | | 3.8 | 5.8 | 12.0 | 31.4 | 46.2 | 70.6 | 83.0 | 90.2 | 98.3 | 99.2 | 100 |
| 71-76 (1) | | | 0 | 4.5 | 18.1 | 33.4 | 43.5 | 67.6 | 82.1 | 89.6 | 98.4 | 99.7 | 100 |
| 71-76 (2) | | | 0 | 0 | 4.3 | 15.4 | 29.0 | 66.3 | 87.5 | 92.6 | 99.0 | 99.8 | 100 |
| 71-76 (3) | | | 0 | 1.9 | 1.9 | 2.9 | 4.4 | 9.8 | 33.8 | 89.2 | 99.3 | 99.6 | 100 |
| 76-81 | | | 4.9 | 9.2 | 20.1 | 40.7 | 57.9 | 88.7 | 97.8 | 98.9 | 99.8 | 99.9 | 100 |
| 81-91 | | | | 0 | 0.7 | 1.3 | 2.2 | 24.6 | 62.4 | 98.7 | 99.4 | 89.8 | 100 |
| 91-96 | | 12.4 | 24.1 | 33.7 | 51.2 | 60.1 | | 73.1 | 81.5 | 92.6 | 99.2 | 99.7 | 100 |