MILAN BELTWAY, AIRPORT ROAD WETLAND COMPENSATION SITE: LEVEL II HYDROGEOLOGIC CHARACTERIZATION REPORT

Rock Island County, near Milan, Illinois
NW 1/4, NE 1/4, Section 19, T17N, R1W
(FAU 5822)

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Executive Summary

This is the level II hydrogeologic characterization report for the IDOT Airport Road wetland compensation site near Milan, Illinois. Data collection at this site began in Fall 1997 and is ongoing. Hydrologic alterations on the site include a levee, a pumping station, a gated culvert in the levee, and a drainage ditch. No drainage tile were found on the site, and there is no evidence of filling or excavation. Approximately 7.0 ha (17.3 ac) of the site satisfies the criteria for jurisdictional wetland hydrology in most years, while the remainder of the site rarely satisfies the criteria. The primary factor determining where or not wetland hydrology occurs appears to be topography. There is the potential to create about 3.0 ha (7.4 ac) of additional wetland. The only feasible hydrologic alteration likely to create wetland is excavation. It is recommended that the depth of excavation range from about 0.10 m (0.33 ft) to 0.40 m (1.31 ft).

Table of Contents

Figures

Tables

Introduction

This report was prepared by the Illinois State Geological Survey (ISGS) to provide the Illinois Department of Transportation (IDOT) with final conclusions regarding the hydrogeologic conditions of a wetland compensation site near the town of Milan in Rock Island Co., IL. The size of the study site is about 11.5 ha (28.4 ac), and it is located in the NW ¼, NE ¼, Section 19, T17N, R1W (Figure 1). The site is bounded by Airport Rd. on the south, commercial property on the west, a drainage ditch along I-280 on the north, and the levee of Case Creek on the east.

The purpose of this report is to provide IDOT with data regarding the hydrogeologic conditions of the study site and to make recommendations regarding restoration and/or creation of wetlands. Therefore, for convenience, the report presents conclusions and design recommendations first, followed by a discussion of the methods and supporting data. The supporting data include ground- and surface-water level data and precipitation data collected from September 1997 to December 2003, and geologic data collected during the installation of monitoring wells.

Data collection at the site is ongoing and will continue until terminated by IDOT. The data currently being collected will be used to compare the pre- and post-construction hydrology of the site and to determine the impact of hydrologic alterations on the area and duration of wetland hydrology.

Summary

The results of our investigation are as follows:

- Approximately 7.0 ha (17.3 ac) of the site satisfied the criteria (inundation/saturation > 12.5% of the growing season) for jurisdictional wetland hydrology for more than half the monitoring period (Figure 2). Therefore, about 4.5 ha (11.1 ac) are available for wetland restoration and/or creation.

- The primary factor affecting the occurrence of jurisdictional wetland hydrology on the site appears to be topography. The portion of the site that has jurisdictional wetland hydrology in most years (Figure 2) is generally at or below an elevation of 171.9 m (564.0 ft), while the remainder of the site is generally higher than that elevation.

- The primary sources of water for the site are direct precipitation, flooding from the I-280 drainage ditch, and runoff from Airport Rd and from the commercial property west of the site. The site is isolated from Case Creek and the Rock River by a network of levees, and the nearest source of upland runoff is about 2 miles south of the site (Figure 1).

- The hydrologic alterations on the site (Figure 2) include: a levee along Case Creek, a pumping station next to the levee with a discharge pipe into Case Creek, a culvert with a flapper valve in the levee, and a drainage ditch along I-280. No drainage tile were found on the site, and there is no evidence of filling or excavation.

- Hydric soils are mapped on about 65% of the site and include (Figure 3) the Wabash silty clay, Sawmill silty clay loam, and Montgomery silty clay loam. The remaining soil type mapped on the site is the non-hydric Coffeen silt loam.

- Construction of the Milan Beltway (Figure 4) will result in the loss of about 1.0 ha (2.5 ac) of wetland, and 0.7 ha (1.7 ac) of potential wetland compensation area, and will limit the area available for wetland restoration and/or creation to about 3.0 ha (7.4 ac). Construction of the beltway will isolate the site from the commercial property to the west, eliminating one source of runoff, but it will create another source of runoff from the slope of the approach ramp. Otherwise, the effects on the hydrology of the site will not be known until after the beltway is constructed.

- An anomaly in the surface-water hydrograph of the site suggests that the hydrology is being affected by something that causes surface-water to rapidly (~1 week) drain off the site, usually in June but sometimes as late as August. One possibility is a nearby high-capacity sump pump, perhaps on the commercial property west of the site.

- Rapid drainage also occurred on two occasions (August 9, 2000 and November 29, 2000) due to maintenance activities in the I-280 ditch. These activities breached a berm between the site and the ditch allowing water on the site to flow into the ditch.

Recommendations

The only alteration likely to result in the creation of additional wetland at this site is excavation. The Case Creek levee, and the culvert in the levee, are part of a flood control project (Stanley Consultants 1996) designed to protect the area between Case Creek and Mill Creek (Figure 1), therefore, it is unlikely that permission could be obtained to remove or alter either the levee or the culvert. Besides, monitoring of Case Creek reveals that, even if there were no levee, the creek would rarely flood the site.

Figure 4 shows the proposed area and depths of excavation. The recommended final land-surface elevation is 172.0 m (564.3 ft). In order to achieve this, a wedge-shaped body of sediment, ranging in thickness from 0.00 m at the northern edge to at least 0.40 m (1.31 ft) along Airport Rd. (Figure 4) would have to be removed. Ground-water data in the proposed area of excavation reveals that lowering land surface by the recommended amount would be sufficient to create jurisdictional wetland hydrology in most years.

The decommissioning of the pumping station on the site (Figure 2) may have already resulted in the creation of wetland. Therefore, it is recommended that a wetland assessment of the site be performed. The pumping station was installed in order to drain the portions of the site lower than the invert elevation (171.8 m) of the culvert in the Case Creek levee (Stanley Consultants 1996). The pump was shut down prior to the start of this investigation, therefore, its effect on the site cannot be quantified. However, the pump was still in operation when the potential of the site for wetland compensation was assessed by the ISGS (Fucciolo, et al. 1996). At that time, most of the site was a cornfield, and wetland vegetation was found only in the northwest corner (Figure 2). In addition, there were no NWI wetlands mapped on the site (Fucciolo, et al. 1996). Since then, wetland vegetation has expanded to cover about the northern half of the site (Figure 2).

Methods

A total of 24 monitoring wells were installed at 11 locations on or near the site (Figure 2). Details of well construction are shown in Appendix A. The shallow (S) wells and well RDS2 are screened within 1.0 m (3.2 ft) of land surface (Appendix A) and were used to determine the depth to saturation. If surface water is not present, then it is assumed that water levels measured in the wells show the position of the water table. If surface water is present, then it is assumed that sediments are saturated to ground surface.

The deep (D) and lower (L) wells were nested in order to determine if there were vertical hydraulic gradients. However, the well construction notes reveal that the screened intervals of most of these wells overlap (Appendix A), the only exceptions being 6D and 6L. Therefore, only those two wells are used to determine if there is a vertical hydraulic gradient. The others are used to determine the direction of horizontal ground-water flow.

Depth to ground water and ground- and surface-water elevation data are in Appendix B and Appendix C, respectively. Depth to ground water in the monitoring wells was measured biweekly in the spring (April, May, June), and monthly throughout the rest of the year. A data logger was installed at RDS2 in Fall 1998, and

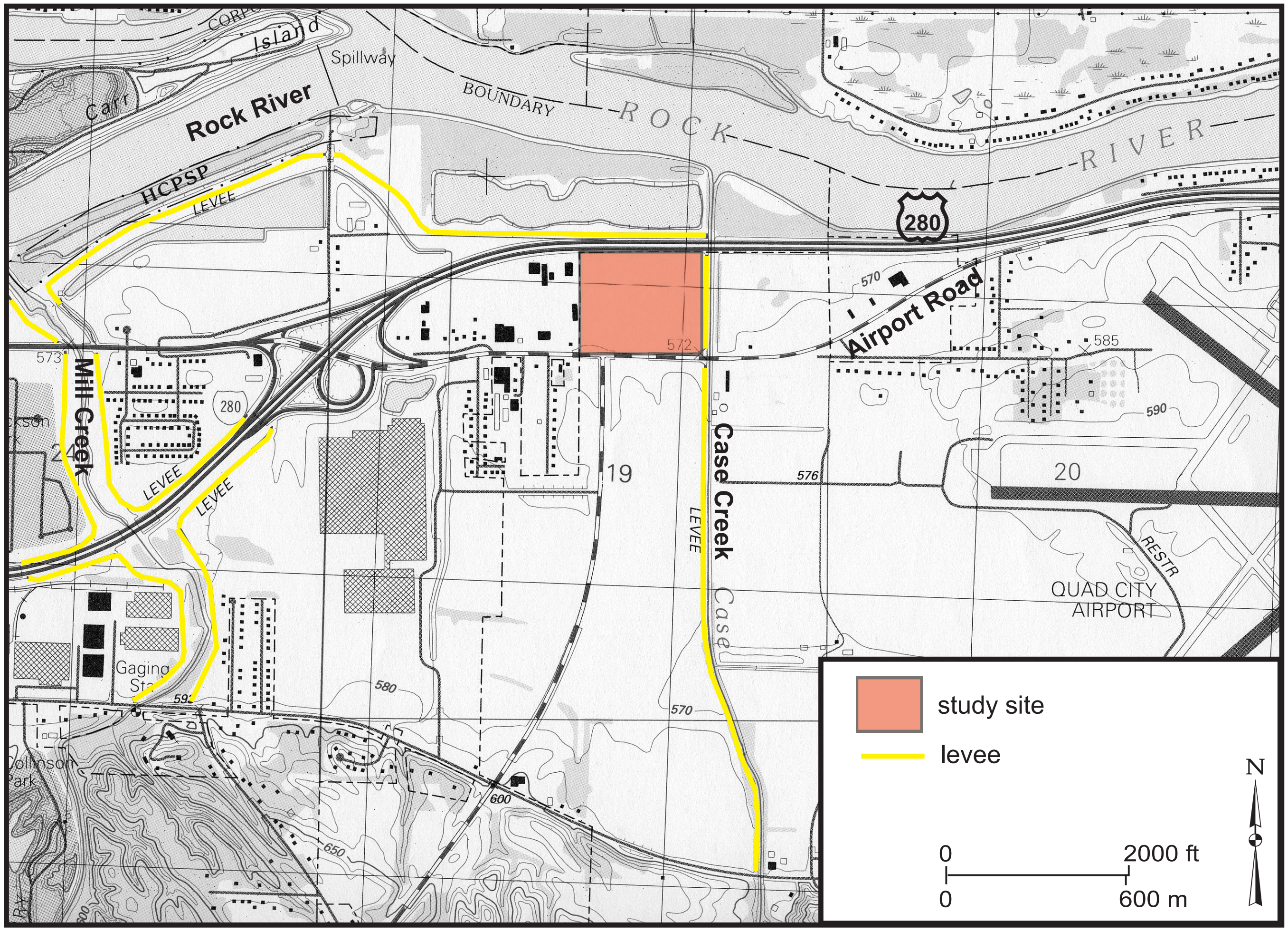

Figure 1: Site location map (U. S. Geological Survey 1992)

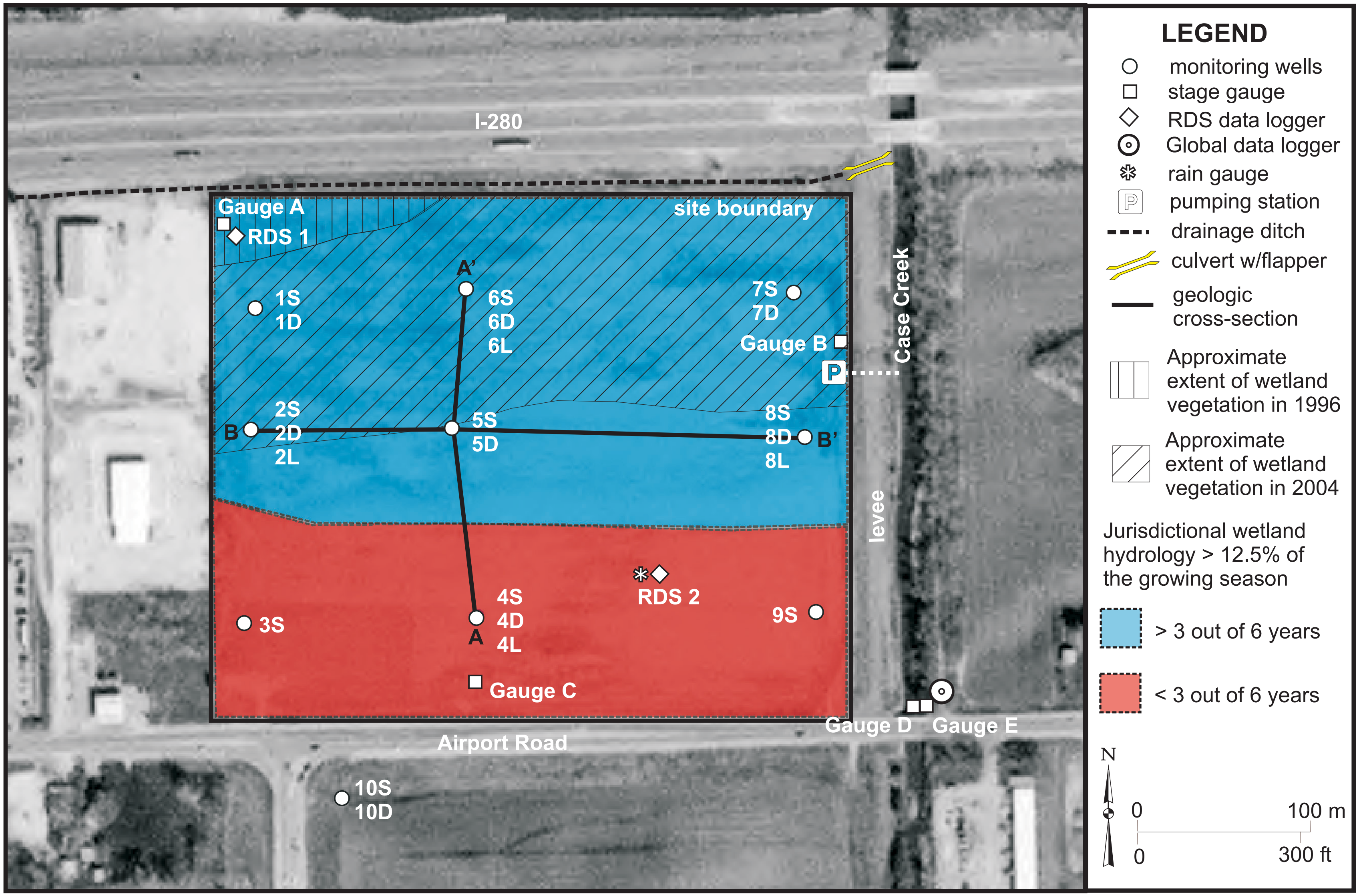

Figure 2: Monitoring network, hydrologic alterations, and wetland hydrology (Base map: U. S. Geological Survey 1998)

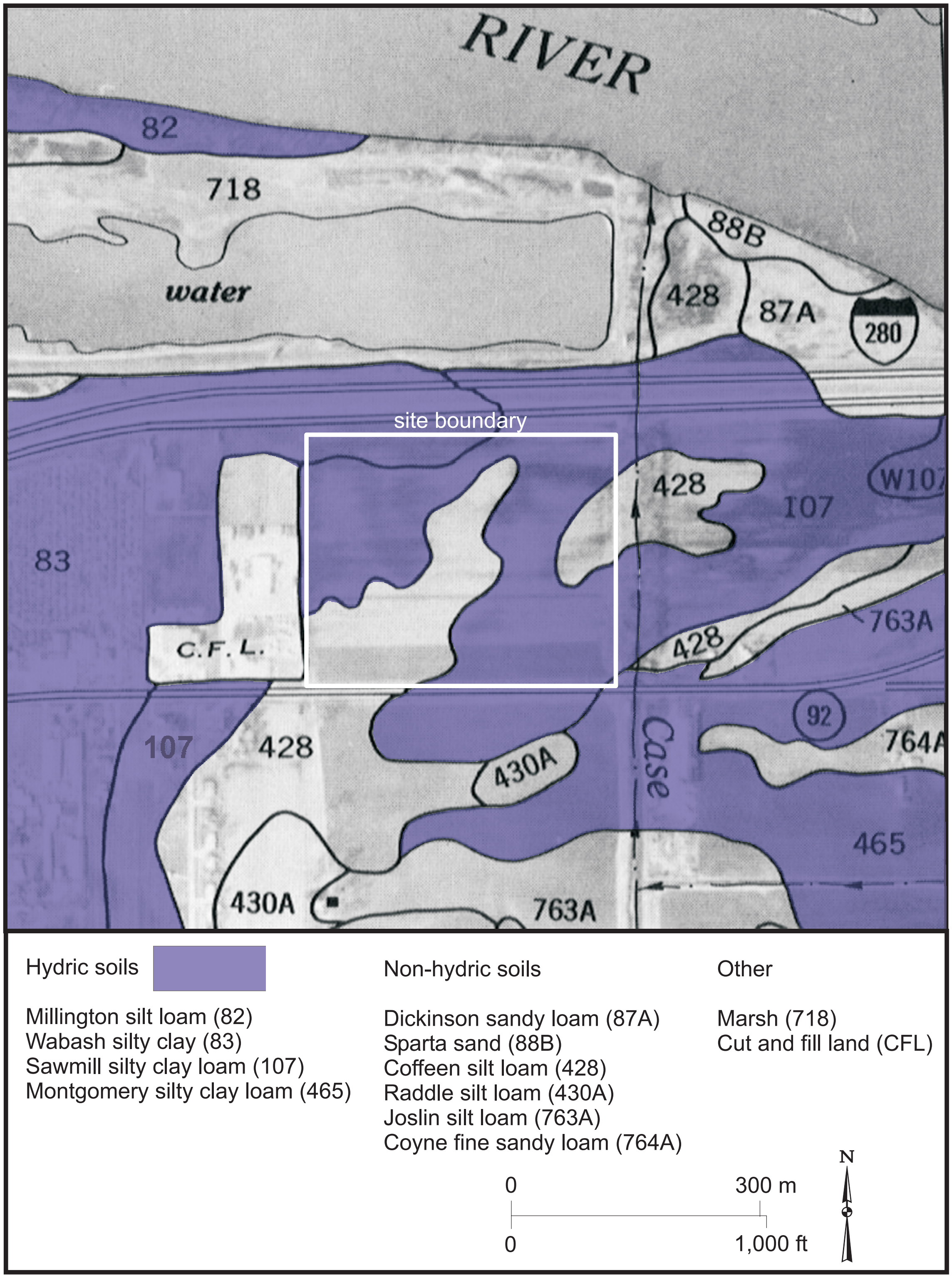

Figure 3: Soil types on the site and in the vicinity (U. S. Department of Agriculture 1977)

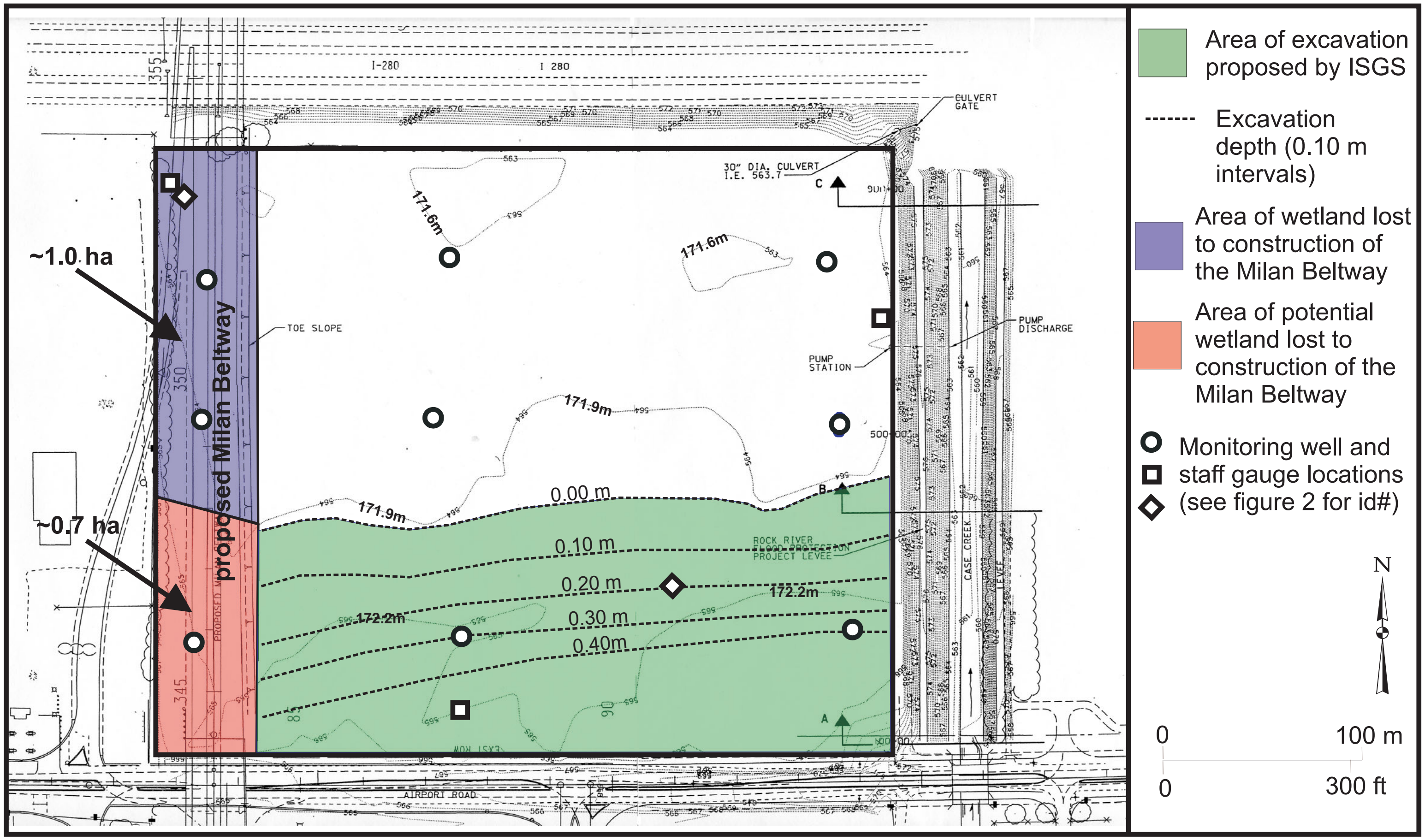

Figure 4: Proposed alterations (Base map: Stanley Consultants 1996)

was programmed to record depth to ground water in 3-hour intervals. Ground-water elevations were calculated by subtracting the depth to water measured from the top of the well casing from the elevation of the top of the well casing.

In addition to the monitoring wells, three staff gauges (A, B, and C) and a data logger (RDS1) were installed on the site in order to monitor surface-water inundation. The stage of Case Creek was monitored by a staff gauge (E) and a data logger (Global) installed in the creek, and by stage measurements from the guard rail of the bridge over the creek (D). The staff gauges were read on the same schedule as the monitoring wells. The on-site data logger (RDS1) was installed in February 1998, and was programmed to record surface-water depth in 3-hour intervals. The data logger in Case Creek (Global) was installed in April 2000, and recorded creek stage in 1-hour intervals until June 2001.

A tipping-bucket rain gauge equipped with a data logger was installed on the site in August 2000. Precipitation was generally recorded from March to December. The data collected with the on-site rain gauge were supplemented with daily precipitation data recorded at the Weather Service Office at the Moline Airport (Station# 115751), which is located near the site (figure 1). These data were obtained from the Midwestern Regional Climate Center (Midwestern Regional Climate Center 2004) at the Illinois State Water Survey (ISWS). The precipitation data were used to determine the effect of monthly, seasonal, and annual precipitation trends on surface- and ground-water levels and wetland hydrology.

Temperature data for Moline, IL were obtained from the National Water and Climate Center (NWCC). These data were used to determine the length of the growing season for the region, and from this the number of days of inundation/saturation needed to satisfy the criteria for jurisdictional wetland hydrology. The growing season (Environmental Laboratory 1987) is the period between the last occurrence of 28°F air temperature in the spring and the first occurrence in the fall. According to the data, the median length (5 out of 10 years) of the growing season for the region is 193 days, with a starting date on April 11 and an ending date on October 21 (National Water and Climate Center 2004).

The most recent guidance from the U.S. Army Corp of Engineers (Environmental Laboratory 1987) states that inundation and/or saturation for at least 5% of the growing season is sufficient to satisfy the criterion for jurisdictional wetland hydrology. However, this is only if the hydric soil and wetland vegetation criteria are also satisfied. General observations of soil and vegetation conditions by the ISGS are not sufficient to use the most recent guidance, therefore, the ISGS uses the criterion which states that, in order to conclusively satisfy the criteria for jurisdictional wetland hydrology, inundation and/or saturation must occur for at least 12.5% of the growing season. At this site, 12.5% of the growing season is about 24 days.

The elevations of the staff gauges, monitoring wells, and data loggers were measured from a benchmark that was established on site by the ISGS relative to the National Geodetic Vertical Datum of 1929. A Sokkia B-1 automatic level and a fiberglass extending rod were used to measure elevations on the site. In addition, the geographic locations of the staff gauges, water-level meters and monitoring wells were determined using a Trimble Pro XR/XRS receiver and TSC1 Asset Surveyor. In order to increase position accuracy, the locations were differentially corrected using the Trimble Pathfinder software.

Climate

Total precipitation during the monitoring period (September 1997 to December 2003) was 591.6 cm (232.9 in.), which was 103% of normal for the period. The wettest year was 1998 and the driest year was 2003 (Table 1). Seasonally, spring was mostly above normal, fall was mostly below normal, summer tended to be closest to normal, and winter was the most variable.

Figure 5 shows monthly precipitation recorded at the Moline airport during the monitoring period. The wettest months during the period were October 1998 (272% of normal) and May 2001 (226% of normal), and the driest months were September 2002 (6% of normal) and November 2002 (10% of normal). There were several extended periods (> 2 months) of either above or below normal precipitation. The driest periods were October 1997 to December 1997 (53% of normal), and November 2001 to March 2002 (62% of normal). The wettest periods were January 1998 to April 1998 (159% of normal), and August 1998 to November 1998 (153% of normal). The driest overall period, despite near normal precipitation in October 2002, was September 2002 to March 2003 (39% of normal).

Year	1998	1999	2000	2001	2002	2003
Winter	178	93	92	120	71	44
Spring	122	121	121	118	111	92
Summer	91	81	100	99	92	91
Fall	149	47	69	86	49	89
Annual	127	89	100	106	86	83

Table 1: Annual and seasonal precipitation (percent of normal)

Geology

Bedrock surface maps (Anderson 1980, Herzog et al. 1994) show that bedrock in the vicinity of the site is at an elevation of about 167.6 m (550.0 ft). The bedrock is mapped as the Middle Devonian, Cedar Valley Formation (Willman 1967, Willman et al. 1975). Outcrops of this formation are found west of the site along the lower reach of Mill Creek (Figure 1). The Cedar Valley Formation is dominantly limestone and dolomite, but also contains argillaceous layers and beds of shale (Savage and Udden 1922).

Glacial drift in the vicinity of the site is generally less than 7.6 m (25.0 ft) thick (Piskin and Bergstrom 1975). The sediments mapped in the area include the Cahokia Formation (Fm.), the Henry Fm., and Silurian/Devonian bedrock (Anderson 1980, Berg and Kempton 1988, Lineback 1979). The geologic map (Figure 6) shows that the northwestern half of the site is underlain by < 6 m (19.7 ft) of Cahokia Fm. alluvium over Silurian/Devonian bedrock, while the southeastern half of the site is underlain by < 6 m of Cahokia Fm. alluvium, over > 6 m of Henry Fm. sand and gravel, over Silurian/Devonian bedrock.

Geologic samples collected during the installation of monitoring wells (Appendix D) reveal that the sediments at the site consist of clayey to sandy alluvium, over sand and sand and gravel, all overlying bedrock (Figure 7 and Figure 8). The sequence of finer-grained sediments over sand and gravel was also seen in exposures in the east bank of Case Creek. The bedrock encountered in the borings is likely a shaly or argillaceous bed of the Cedar Valley Formation. The unconsolidated deposits are up to 3.5 m (11.5 ft) thick, and the elevation of the top of the bedrock ranges from about 168.3 m (552.2 ft) to about 169.5 m (556.1 ft). The finer-grained sediments are likely Cahokia Formation alluvium, while the coarse-grained sediments below the Cahokia may be a coarse facies of that formation or deposits of the Henry Formation. Most of these sediments are likely deposited by the Rock River, however, cross-section B-B' (Figure 8) reveals that the clayey silt on the east side of the site may have been deposited by Case Creek.

Soils

The soils mapped on the site (Figure 4) include the Wabash silty clay (83), the Sawmill silty clay loam (107), the Montgomery silty clay loam (465), and the Coffeen silt loam (428). The Coffeen soil forms from silty alluvium on bottom lands, the Wabash soil from clayey alluvium on bottom lands, the Sawmill soil from silty alluvium in depressions on bottom lands, and the Montgomery soil from black and grayish clayey deposits on terraces (U. S. Department of Agriculture 1977).

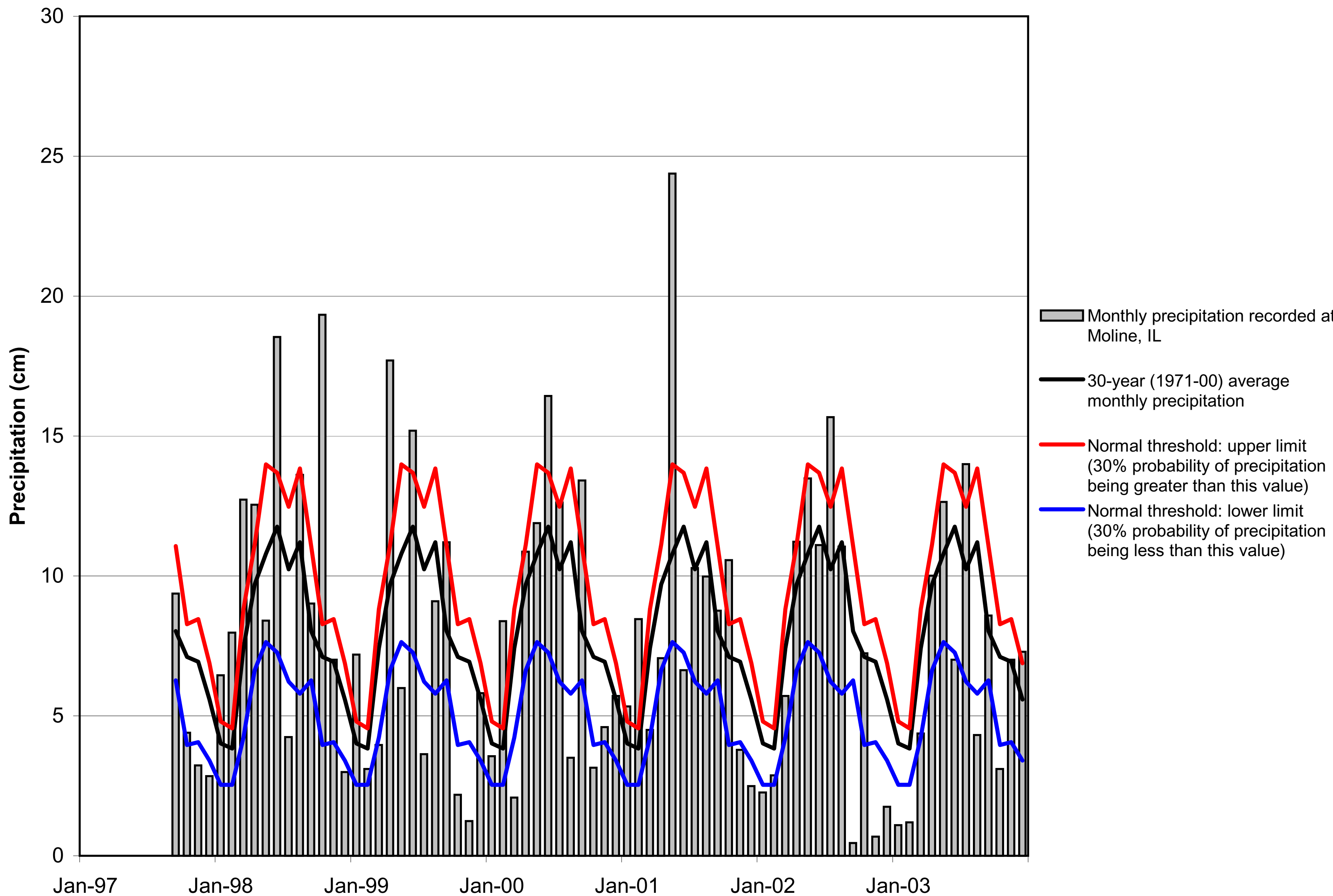

Figure 5: Monthly precipitation (Midwestern Regional Climate Center 2004)

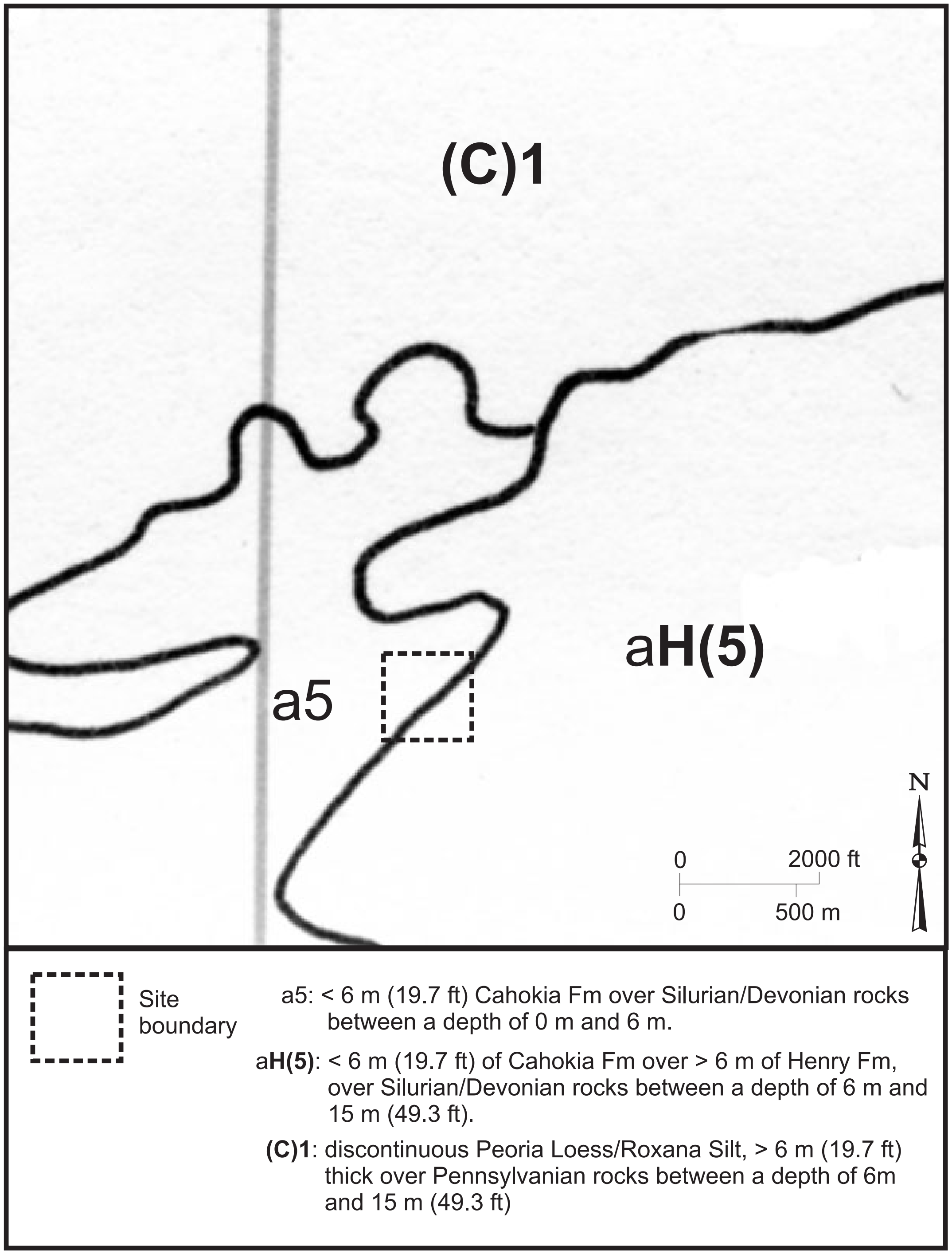

Figure 6: Geologic map (Source: Berg and Kempton 1988)

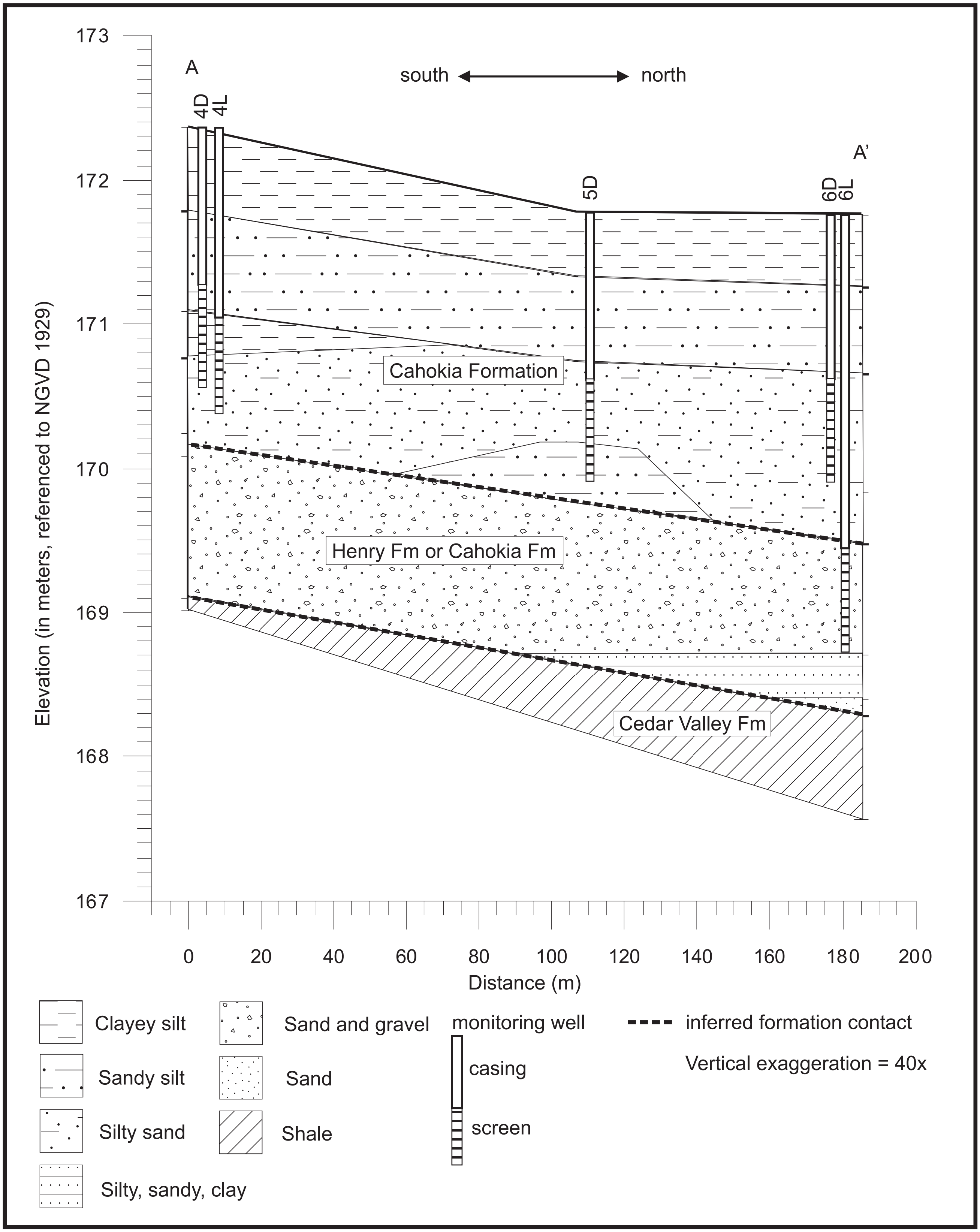

Figure 7: Cross-section A-A'

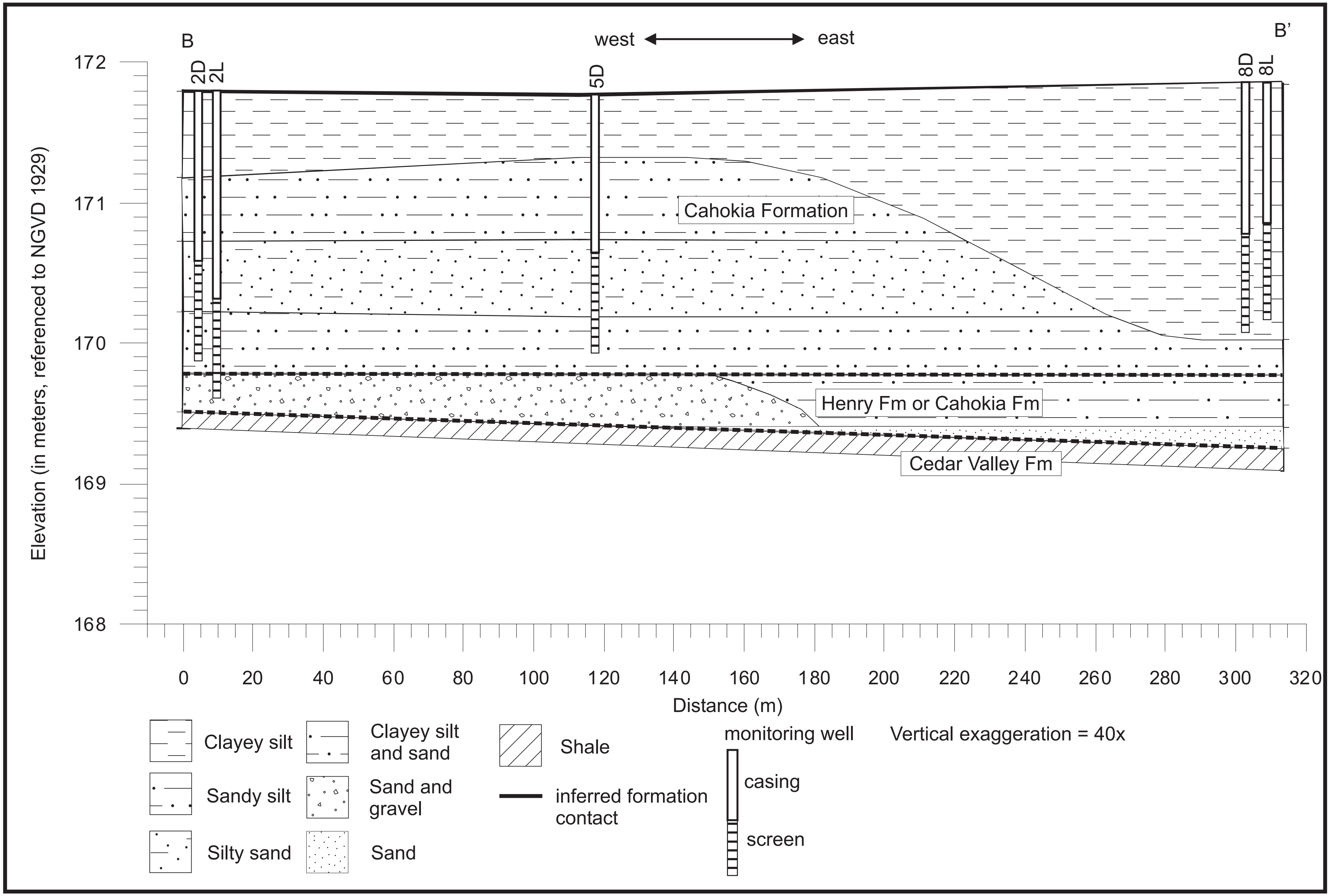

Figure 8: Cross-section B-B'

The Montgomery, Sawmill, and Wabash soils are all on the state list of hydric soils in Illinois (U. S. Department of Agriculture 1991), and the county list of hydric soils in Rock Island County (U. S. Department of Agriculture 1995a). The Coffeen soil is non-hydric, nor does it normally contain inclusions of hydric soil (U. S. Department of Agriculture 1995b).

Table 2 shows the hydraulic properties and textures of the soils. The hydric soils are poorly or very poorly drained, have a seasonal high water table within 0.3 m (1.0 ft) of ground surface, and have a least one layer in which the permeability is moderately slow to very slow (≤ 0.5 cm/hr [0.2 in/hr]). The non-hydric soil is somewhat poorly drained, the seasonal high water table ranges from 0.3 m (1.0 ft) to 0.9 m (2.9 ft) below ground surface, and one layer within the soil has a rapid permeability (≥ 15.2 cm/hr [6.0 in/hr]).

Soil type	Permeability		Texture	Seasonal high water table (m)	Drainage class
	depth (cm)	permeability (cm/hr)			
Coffeen	0-112 112-124 124-175	1.5-5.1 15.2-51.0 1.5-5.1	silt loam sand sandy clay loam	0.3-0.9	somewhat poorly
Sawmill	0-152	0.5-5.1	silty clay loam	0.0-0.3	poorly
Montgomery	0-35 35-162 162-188	1.5-5.1 <0.5 1.5-5.1	silty clay loam clay silty clay loam	0.0-0.3	very poorly
Wabash	0-102 102-160	<0.1 0.1-5.1	silty clay clay loam	0.0-0.3	very poorly

Table 2: Soil properties (U.S. Department of Agriculture 1977)

The permeabilities listed in Table 4 are based on the textures of representative soil profiles (U.S. Department of Agriculture 1977, U.S. Department of Agriculture 2003). However, Appendix D reveals that sediment texture at the site is coarser than the representative soil profiles. In addition, there are likely macro-pores present in the sediments at the site. Therefore, it is likely that the permeability of the soils at the site are higher than for the representative profiles.

Hydrology

Figure 9 and Figure 10 are representative hydrographs of ground-water elevation and depth to ground water, respectively. The hydrographs show that ground-water levels tend to be highest in the winter and spring, and lowest in the summer and fall. Figure 9 also shows that there is no appreciable vertical hydraulic gradient, indicating that no ground-water discharge is occurring. Figure 10 shows that wetland hydrology due to saturation and/or inundation usually occurs for long durations in the spring.

Figure 11 is a representative hydrograph of on-site flooding. The most widespread and persistent flooding (RDS1, gauge A, and gauge B) occurs in the northern portion of the site in the winter and spring, and is the result of precipitation and likely runoff from the property to the west (Figure 2). Flooding also occurs occasionally at gauge C (Figure 10, Appendix C), likely as the result of runoff from Airport Rd. However, the area of flooding is not widespread, because visual observations at the site reveal that gauge C is located in a small, shallow, closed depression.

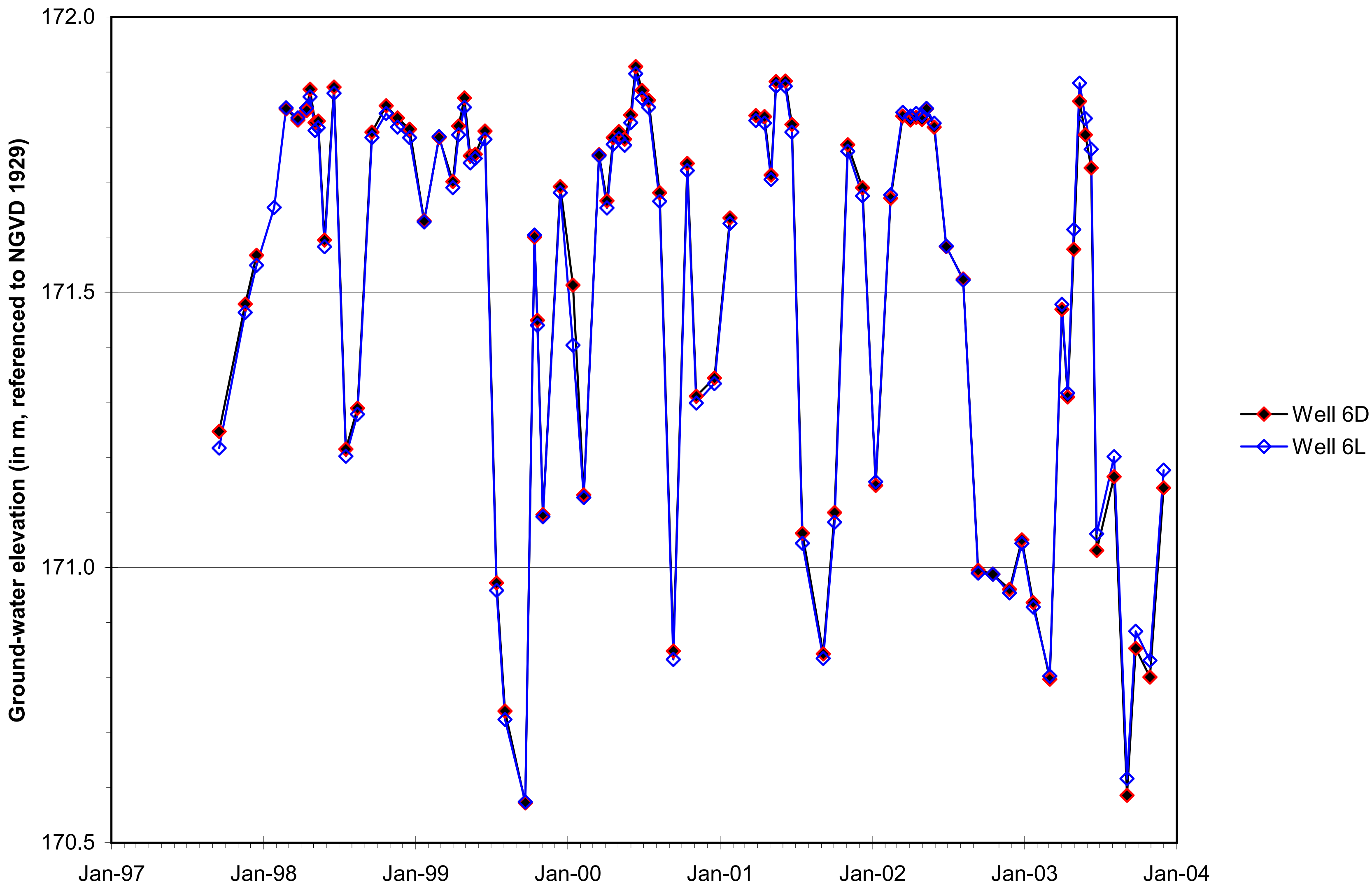

Figure 9: Ground-water elevations at wells 6D and 6L

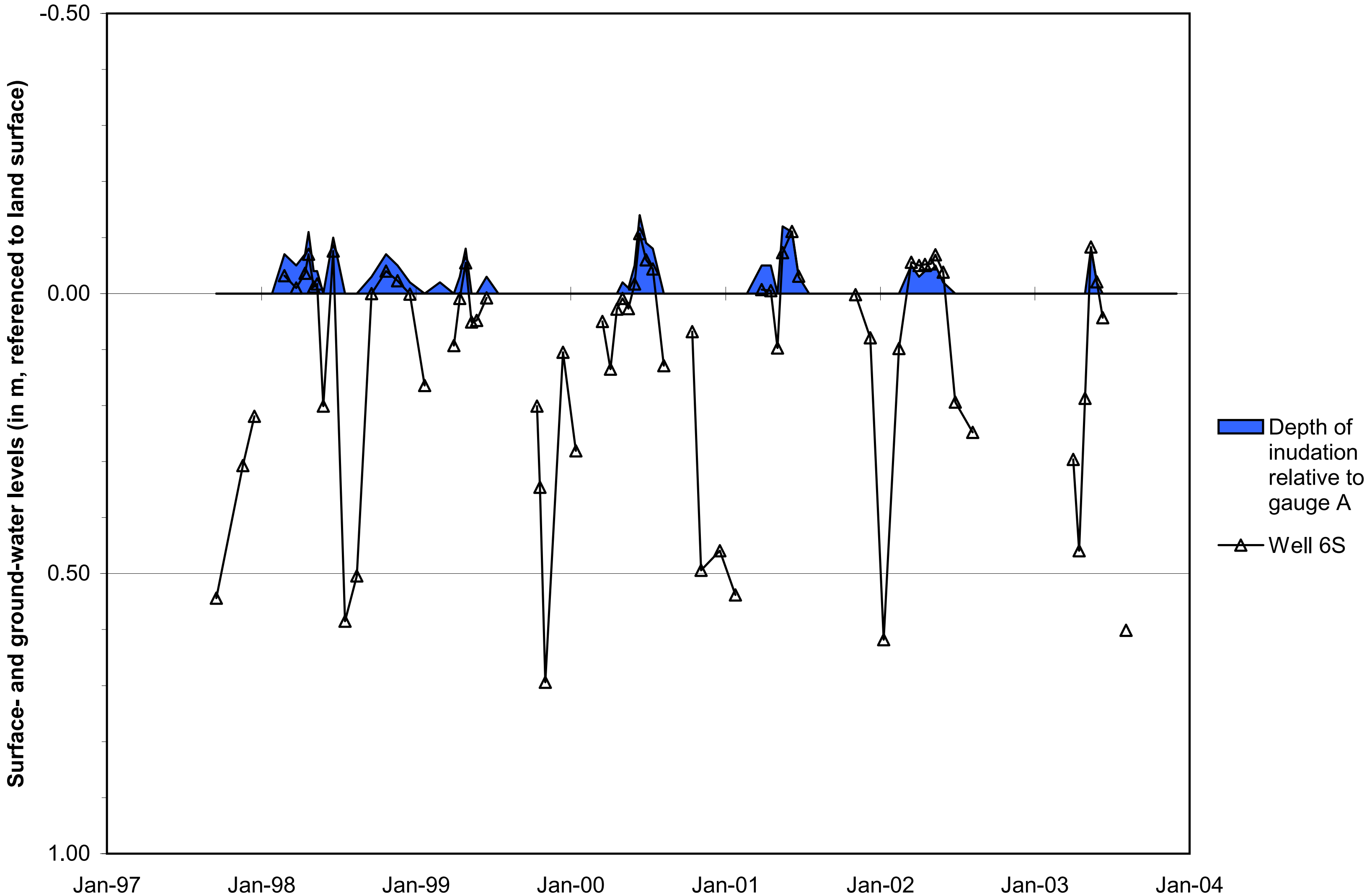

Figure 10: Depth to ground water and depth of inundation at well 6S

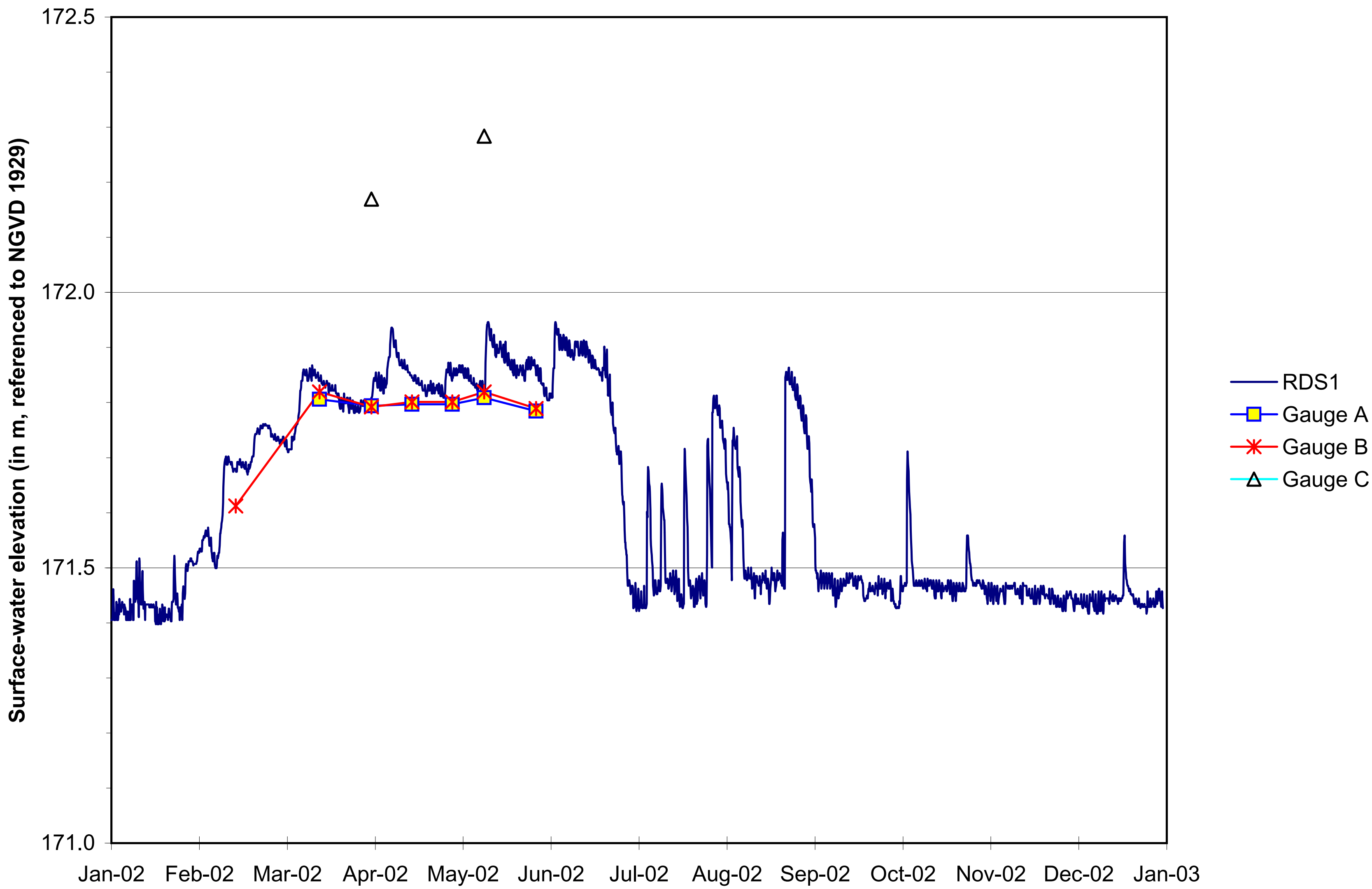

Figure 11: On-site surface-water elevation in 2002

Figure 12 is a hydrograph of water levels in Case Creek. The site is isolated from Case Creek by a levee (Figure 1). The figure shows that the water level in the creek was high enough to flood the lower portion of the site, as represented by land surface elevation at well cluster 6, on only five occasions, and high enough to flood most of the site, as represented by land surface elevation at well 9, on only one occasion. The data reveal that the duration of flooding would have been brief. In the lower portion of the site, the longest period of flooding would only have been about 10 days, while the longest period over most of the site would only have been about 3 days. In any event, using Case Creek as a water source is impractical due to offsite flooding concerns.

Figure 13 and Figure 14 are maps showing ground-water flow and on-site flooding typical of spring, and summer and fall. Both figures show that ground-water flows towards the north and northeast, and that it likely discharges into Case Creek. The obvious difference is the lack of on-site flooding in the summer and fall. Despite near normal precipitation in most years (Table 1), inundation in the summer generally only occurs for brief periods following precipitation events (Figure 11). This is likely mostly due to high rates of evaporation and transpiration, which, in Illinois (Neely and Heister 1987), are at a maximum in the summer, but occur at much lower rates in the spring and are negligible in the winter.

Generally, about two-thirds of the site satisfies jurisdictional wetland hydrology in most years (Figure 2). Yearly estimates (Table 3) reveal that, over the course of the monitoring period, the area has ranged from 5.1 ha (12.6 ac) in 2003 to 9.7 ha (24.0 ac) in 2001. The factors that affect the size of the area include, but are likely not limited to: soil type, geology, hydrologic alterations, precipitation, topography, and anthropogenic effects. The first three factors create the conditions favorable for wetland hydrology, in that, alluvial deposits (Figure 6) result in a slow infiltration rate which promotes saturation and inundation, while the hydrologic alterations prevent the runoff of water into Case Creek.

Year	1998	1999	2000	2001	2002	2003
Acres	19.4	23.0	19.6	24.0	20.6	12.6
Hectares	7.8	9.3	7.9	9.7	8.3	5.1

Table 3: Estimated areas of jurisdictional wetland hydrology (Fucciolo et. al. 1999, 2000, 2001, 2002, 2003)

Precipitation data reveals that the area of jurisdictional wetland hydrology is affected by variations in seasonal precipitation. The smallest area of jurisdictional wetland hydrology (2003) occurred in a year in which winter precipitation was well below normal and spring precipitation was slightly below normal (Table 1), while the largest area of jurisdictional wetland hydrology (2001) occurred in a year in which winter and spring precipitation were both above normal.

Variations in seasonal precipitation alone cannot account for all of the variation in the size of the area of jurisdictional wetland hydrology. If so, then it would be expected that the largest area of jurisdictional wetland hydrology would have been in 1998, because winter and spring precipitation that year (Table 1) were both greater than in 2001. However, table 3 shows that the area was slightly smaller than in 2000.

The factor that limited the area of jurisdictional wetland hydrology in 1998 to 7.8 ha., and likely the primary factor limiting the area in every year is topography. Elevational surveying by the ISGS and Stanley Consultants reveals that the portion of the site that satisfies the criteria for jurisdictional wetland hydrology in most years (Figure 2) is at or below an elevation of 171.9 m (Figure 4), while the portion that does not satisfy the criteria in most years is higher. Table 4 shows that, in the lower portion of the site, jurisdictional wetland hydrology occurred at each monitoring well every year during the monitoring period, while in the higher portion of the site, jurisdictional wetland hydrology rarely occurred.

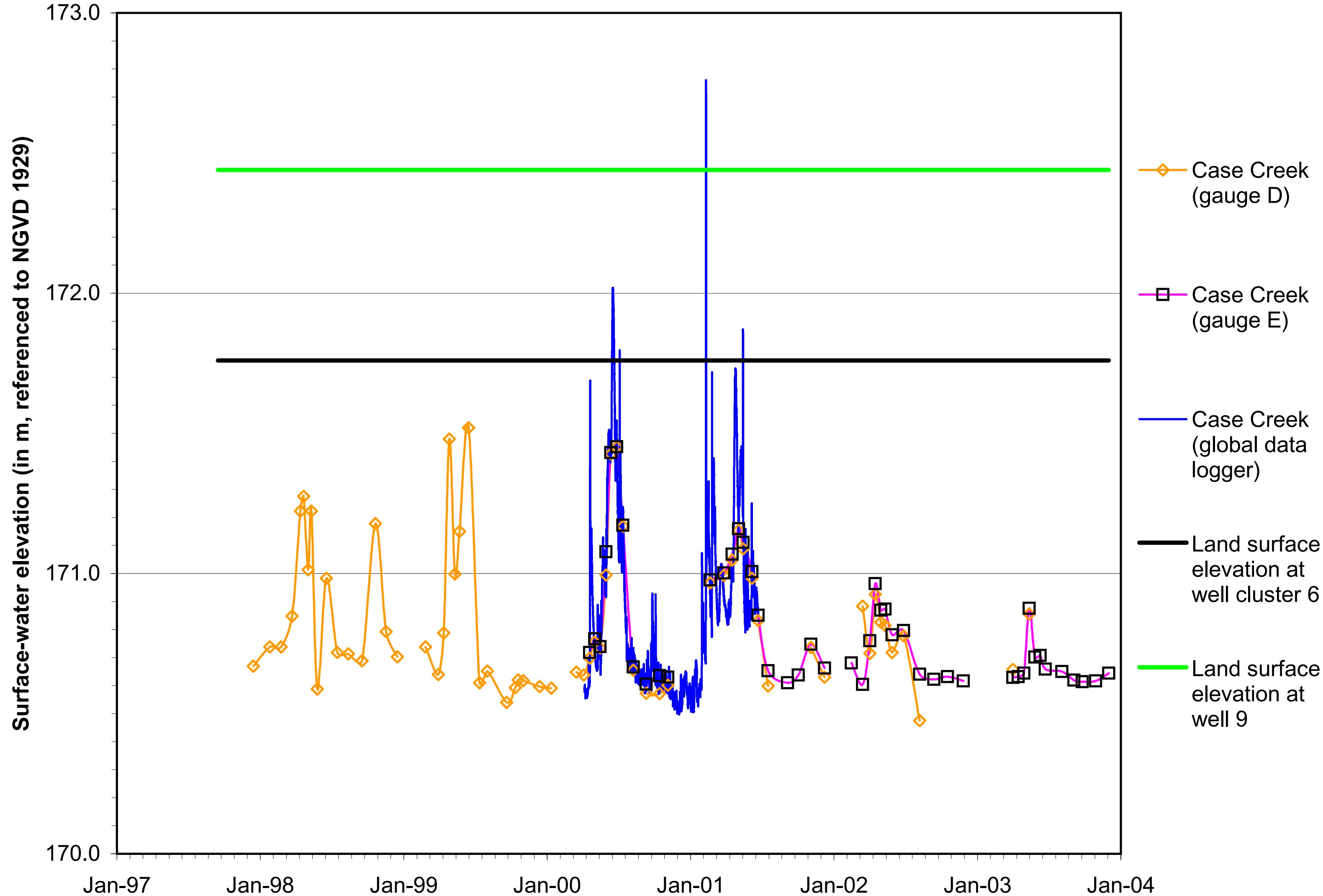

Figure 12: Surface-water elevations in Case Creek

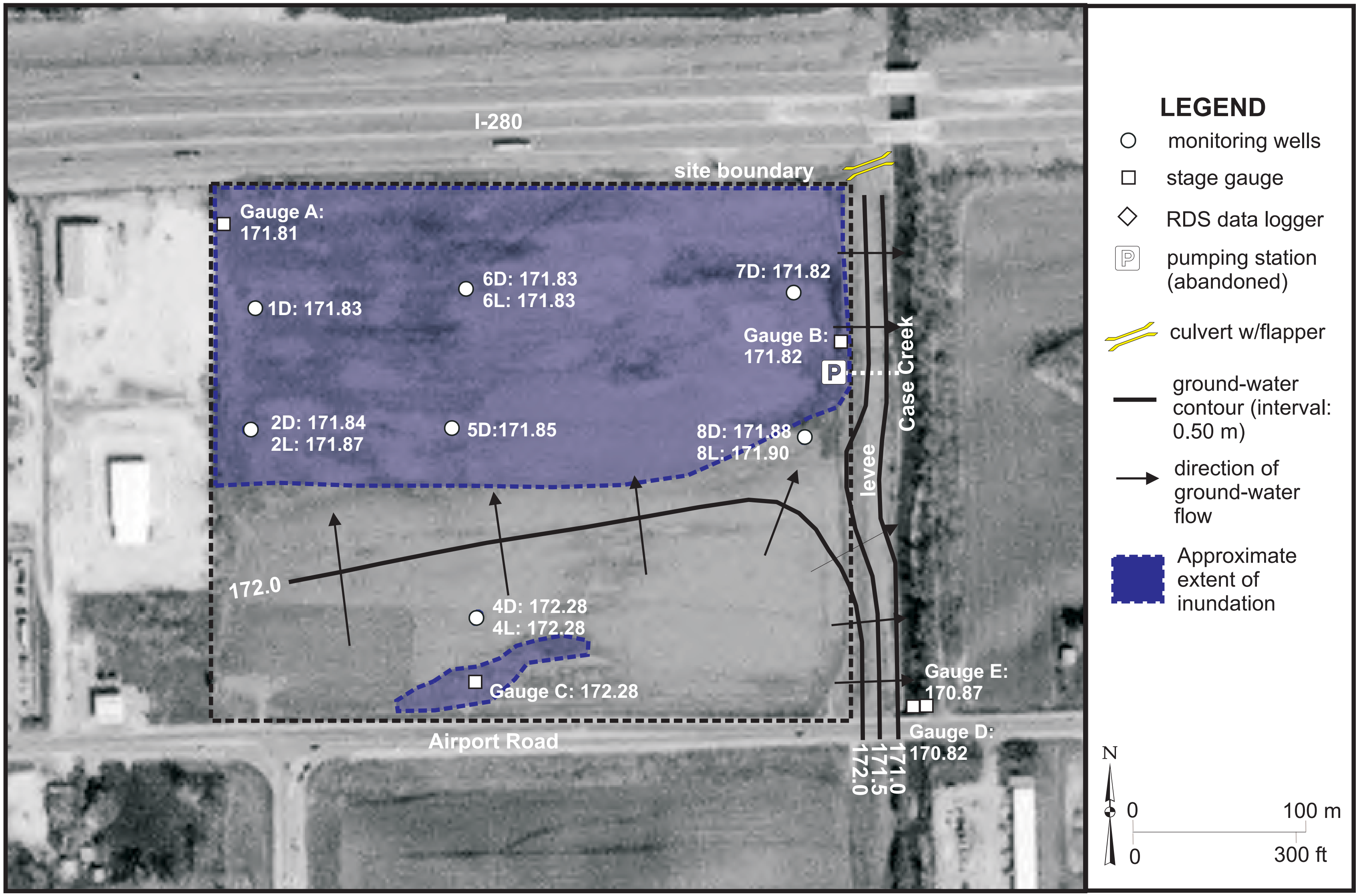

Figure 13: Ground-water flow and on-site flooding typical of spring (water levels recorded on 5/11/2002)

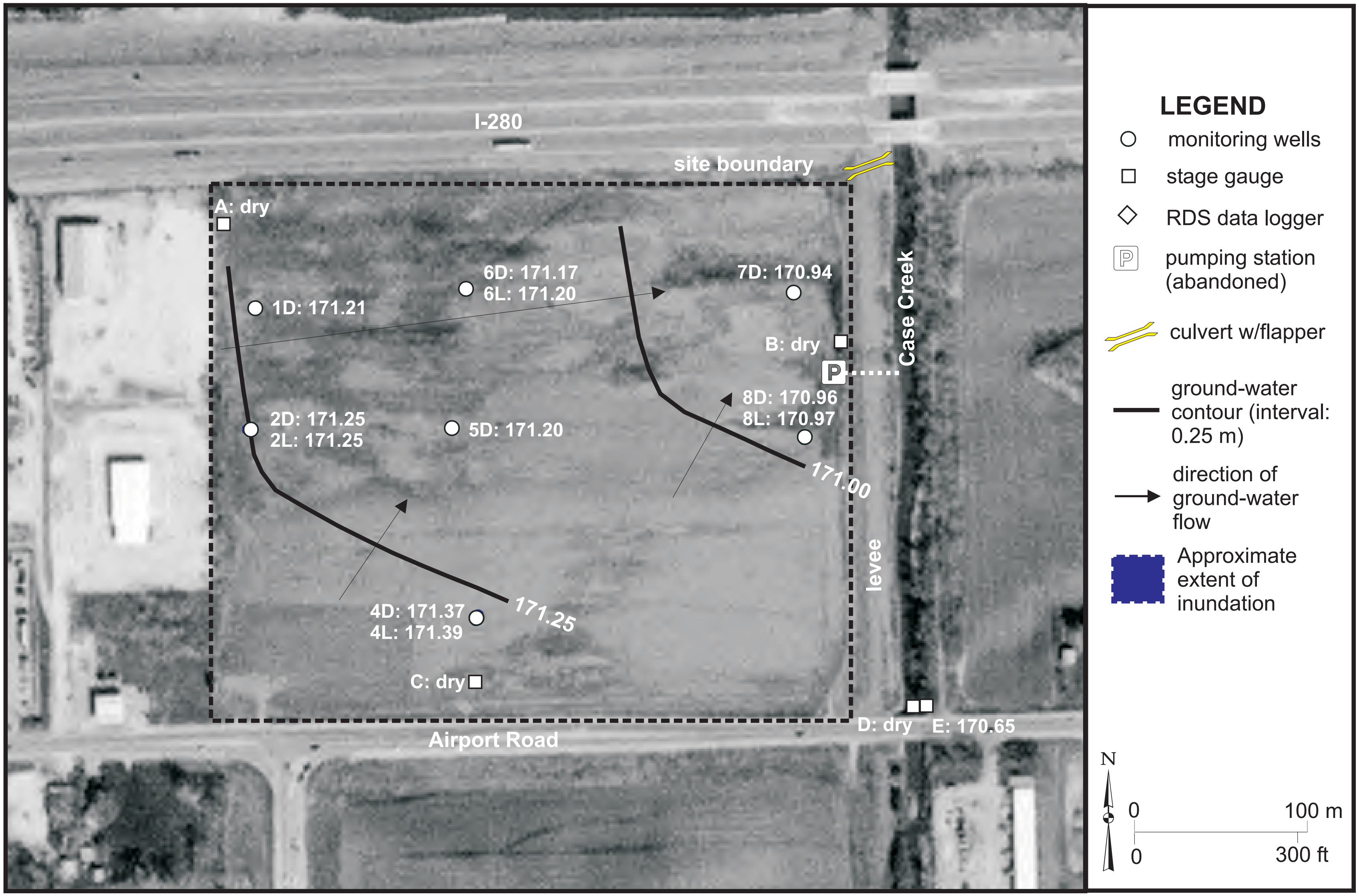

Figure 14: Ground-water flow typical of summer and fall (water levels recorded on 8/4/2003)

Year	Land surface below 171.9 m						Land surface higher than 171.9 m			
	1S	2S	5S	6S	7S	8S	3S	4S	9S	RDS2
1998	15.6	15.6	35.4	35.4	15.6	15.6	1.0	0.0	5.2	
1999	33.8	33.8	33.8	33.8	33.8	33.8	8.3	0.0	0.5	7.8
2000	61.4	61.4	61.4	61.4	61.4	47.9	22.9	6.8	6.8	5.7
2001	37.0	37.0	37.0	37.0	37.0	20.3	12.0	0.5	12.0	10.9
2002	24.5	24.5	24.5	60.9	24.5	24.5	15.1	0.5	0.5	6.8
2003	22.4	22.4	22.4	22.4	22.4	14.5	0.5	0.0	0.0	9.9

Table 4: Longest periods of saturation/inundation (percent of growing season)

The anthropogenic factors affecting jurisdictional wetland hydrology appear to be caused by both recurring and isolated events. Figure 11 shows that rapid dewatering occurred in June 2002, and that inundation afterward occurred for only brief periods. Surface-water data reveals that this rapid dewatering occurs every year, usually in June, but also as late as August. It is not likely that the dewatering is caused by evaporation and transpiration alone, because it generally takes only about 1 week for the site to dry out. One possible cause for this recurring event is dewatering from a sump pump near the site, perhaps on the commercial property to the west (Figure 1). On the other hand, rapid dewatering occurred on two occasions in 2000 (August 9 and November 29) due to maintenance activities in the I-280 ditch (Keith Carr, pers. comm.), that breached a berm between the ditch and the site.

The only options for restoring/creating wetland on the site are excavation and decommissioning the pumping station (Figure 2). There are no drainage ditches or drain tiles on the site. The Case Creek levee and culvert are part of a flood control project, therefore, it is unlikely that permission could be obtained to either alter or remove them, nor would it significantly increase the area of jurisdictional wetland hydrology.

The pumping station on the site was decommissioned prior to the start of the investigation. Therefore, its effect on the hydrology of the site cannot be quantified. However, during the initial site evaluation (Fucciolo et. al 1996), it was found that most of the site was under cultivation, and that wetland vegetation was confined to the northwest corner (Figure 2). In addition, none of the site was mapped as wetland by the NWI (Fucciolo et. al. 1996). Since then, wetland vegetation has expanded to cover approximately the northern half of the site (Figure 2).

Water-level data reveals that, in order to create wetland hydrology, the portion of the site that does not satisfy the criteria for jurisdictional wetland hydrology in most years (Figure 2) should be excavated to an elevation of about 172.0 m (564.3 ft). The excavation would be in the form of a wedge, with the depth of excavation ranging from 0.0 m along the northern edge to at least 0.4 m (1.3 ft) along Airport Rd. (Figure 4). Table 5 and Figure 15 show the effect of lowering the ground elevation to 172.0 m on the period of saturation at wells 4S, 9S, and RDS2:

- At well RDS2, lowering ground surface by 0.2 m (0.6 ft) results in saturation for periods long enough to satisfy the criteria for jurisdictional wetland hydrology in five out of five years.
- At well 4S, lowering ground surface by 0.40 m (1.3 ft) results in periods of saturation long enough to satisfy the criteria for jurisdictional wetland hydrology in four out of five years.
- At well 9S, lowering ground surface by 0.40 m (1.3 ft) results in periods of saturation long enough to satisfy the criteria for jurisdictional wetland hydrology in three out of three years.

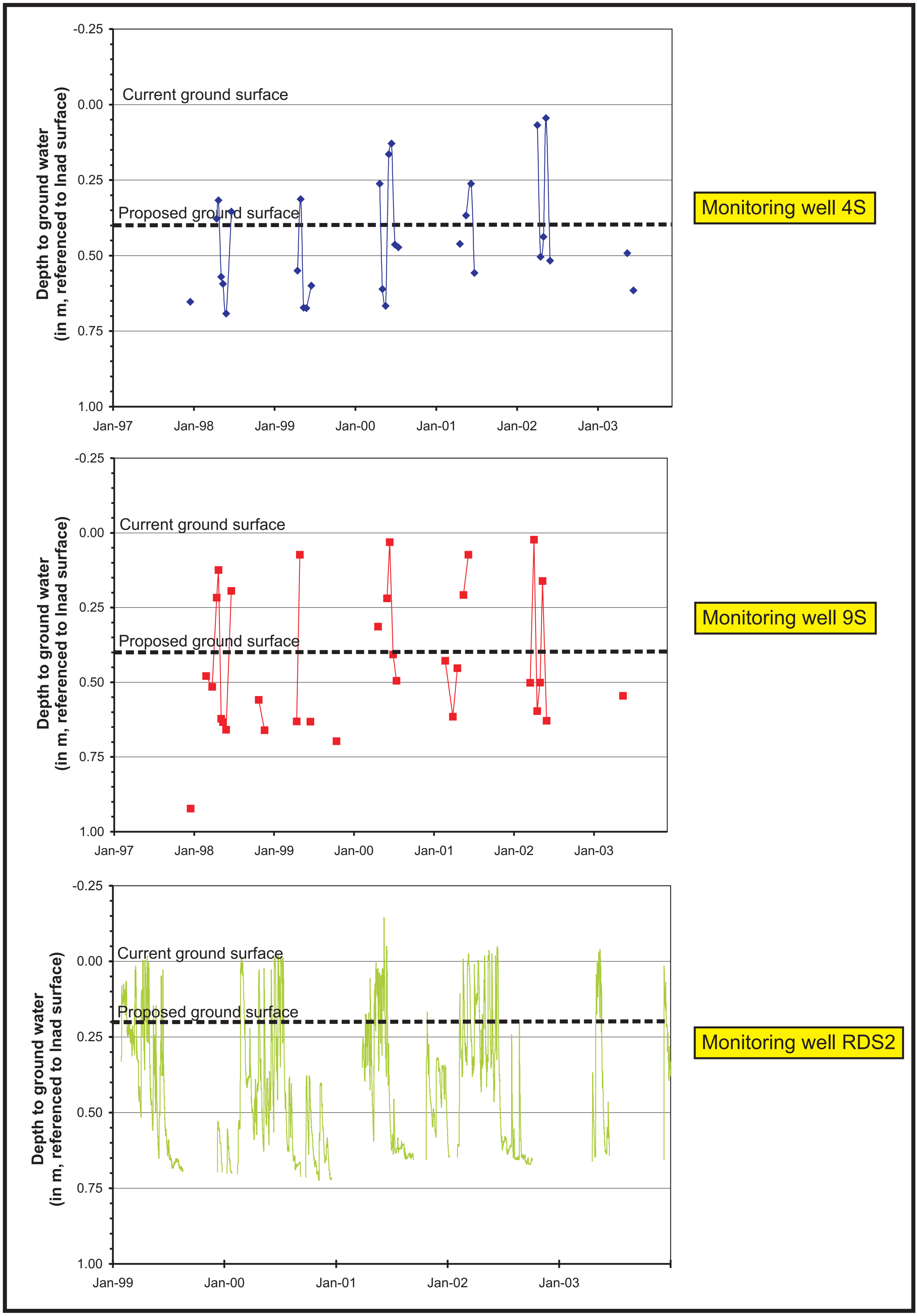

Figure 15: Effect of excavation on saturation at monitoring wells 4S, 9S, and RDS2

Well#	Land surface elevation (m)		Period of saturation (% of growing season)					
			1998	1999	2000	2001	2002	2003
RDS2	Current	172.2		7.8	5.7	10.9	6.8	9.9
	Proposed	172.0		14.1	20.8	27.6	36.4	13.5
4S	Current	172.4	0.0	0.0	6.8	0.5	0.5	insufficient data
	Proposed	172.0	15.6	8.3	22.9	20.3	24.5	insufficient data
9S	Current	172.4	5.2	0.5	6.8	12.0	0.5	insufficient data
	Proposed	172.0	35.4	insufficient data	22.9	insufficient data	24.5	insufficient data

Table 5: Effect of proposed alteration on periods of saturation at wells 4S, 9S, and RDS2

Though the portion of the site that currently has jurisdictional wetland hydrology in most years is lower than 172.0 m (546.3 ft), Table 5 shows that the proposed excavation is sufficient to result in jurisdictional wetland hydrology in most years. Ground-water data reveals that shallower excavation does not result in jurisdictional wetland hydrology, while deeper excavation only increases a period of saturation that is already long enough to satisfy the jurisdictional criteria.

Conclusions

The results of our investigation are as follows:

- Approximately 7.0 ha (17.3 ac) of the site satisfied the criteria (inundation/saturation > 12.5% of the growing season) for jurisdictional wetland hydrology for more than half the monitoring period (Figure 2). Therefore, about 4.5 ha (11.1 ac) are available for wetland restoration and/or creation.

- The primary factor affecting the occurrence of jurisdictional wetland hydrology on the site appears to be topography. The portion of the site that has jurisdictional wetland hydrology in most years (Figure 2) is generally at or below an elevation of 171.9 m (564.0 ft), while the remainder of the site is generally higher than that elevation.

- The primary sources of water for the site are direct precipitation, flooding from the I-280 drainage ditch, and runoff from Airport Rd and from the commercial property west of the site. The site is isolated from Case Creek and the Rock River by a network of levees, and the nearest source of upland runoff is about 2 miles south of the site (Figure 1).

- The hydrologic alterations on the site (Figure 2) include: a levee along Case Creek, a pumping station next to the levee with a discharge pipe into Case Creek, a culvert with a flapper valve in the levee, and a drainage ditch along I-280. No drainage tile were found on the site, and there is no evidence of filling or excavation.

- Hydric soils are mapped on about 65% of the site and include (Figure 3) the Wabash silty clay, Sawmill silty clay loam, and Montgomery silty clay loam. The remaining soil type mapped on the site is the non-hydric Coffeen silt loam.

- Construction of the Milan Beltway (Figure 4) will result in the loss of about 1.0 ha (2.5 ac) of wetland,

and 0.7 ha (1.7 ac) of potential wetland compensation area, and will limit the area available for wetland restoration and/or creation to about 3.0 ha (7.4 ac). Construction of the beltway will isolate the site from the commercial property to the west, eliminating one source of runoff, but it will create another source of runoff from the slope of the approach ramp. Otherwise, the effects on the hydrology of the site will not be known until after the beltway is constructed.

- An anomaly in the surface-water hydrograph of the site suggests that the hydrology is being affected by something that causes surface-water to rapidly (~1 week) drain off the site, usually in June but sometimes as late as August. One possibility is a nearby high-capacity sump pump, perhaps on the commercial property west of the site.

- Rapid drainage also occurred on two occasions (August 9, 2000 and November 29, 2000) due to maintenance activities in the I-280 ditch. These activities breached a berm between the site and the ditch allowing water on the site to flow into the ditch.

- The only alteration likely to result in the creation of additional wetland at this site is excavation. The Case Creek levee, and the culvert in the levee, are part of a flood control project (Stanley Consultants 1996) designed to protect the area between Case Creek and Mill Creek (Figure 1), therefore, it is unlikely that permission could be obtained to remove or alter either the levee or the culvert. Besides, monitoring of Case Creek reveals that, even if there were no levee, the creek would rarely flood the site.

- Figure 4 shows the proposed area and depths of excavation. The recommended final land-surface elevation is 172.0 m (564.3 ft). In order to achieve this, a wedge-shaped body of sediment, ranging in thickness from 0.00 m at the northern edge to at least 0.40 m (1.31 ft) along Airport Rd. (Figure 4) would have to be removed. Ground-water data in the proposed area of excavation reveals that lowering land surface by the recommended amount would be sufficient to create jurisdictional wetland hydrology in most years.

- The decommissioning of the pumping station on the site (Figure 2) may have already resulted in the creation of wetland. Therefore, it is recommended that a wetland assessment of the site be performed. The pumping station was installed in order to drain the portions of the site lower than the invert elevation (171.8 m) of the culvert in the Case Creek levee (Stanley Consultants 1996). The pump was shut down prior to the start of this investigation, therefore, its effect on the site cannot be quantified. However, the pump was still in operation when the potential of the site for wetland compensation was assessed by the ISGS (Fucciolo, et al. 1996). At that time, most of the site was a cornfield, and wetland vegetation was found only in the northwest corner (Figure 2). In addition, there were no NWI wetlands mapped on the site (Fucciolo, et al. 1996). Since then, wetland vegetation has expanded to cover about the northern half of the site (Figure 2).

Acknowledgements

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Appendix A: Well construction information

Well Construction Information	1S	1D	2S	2D	2L	3S	4S	4D	4L
Total length of well (m)	1.84	2.33	1.84	2.34	3.09	1.84	1.87	2.34	3.05
Screen length (m)	0.24	0.72	0.24	0.71	0.69	0.24	0.24	0.71	0.69
Depth of borehole (m) *	0.77	1.92	0.75	1.99	2.26	0.76	0.75	1.87	2.11
Bentonite seal - top (m) *	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sand pack - top (m) *	0.30	0.92	0.30	0.91	1.22	0.30	0.30	0.76	1.77
Sand pack - bottom (m) *	0.77	1.92	0.75	1.99	2.26	0.76	0.75	1.87	2.11
Depth to top of screen (m) *	0.49	1.16	0.47	1.22	1.49	0.48	0.46	1.10	1.33
Depth to bottom of screen (m) *	0.73	1.88	0.71	1.93	2.18	0.72	0.70	1.81	2.02

* referenced to land surface

Well Construction Information	5S	5D	6S	6D	6L	7S	7D	8S	8D
Total length of well (m)	1.84	2.33	1.84	2.33	3.82	1.85	2.32	1.84	2.32
Screen length (m)	0.25	0.72	0.25	0.72	0.69	0.25	0.71	0.24	0.71
Depth of borehole (m) *	0.75	1.90	0.77	1.92	3.07	0.80	1.82	0.75	1.85
Bentonite seal - top (m) *	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sand pack - top (m) *	0.30	0.95	0.30	0.84	1.83	0.30	0.90	0.30	0.80
Sand pack - bottom (m) *	0.75	1.90	0.77	1.92	3.07	0.80	1.82	0.75	1.85
Depth to top of screen (m) *	0.46	1.13	0.48	1.14	2.31	0.51	1.06	0.47	1.09
Depth to bottom of screen (m) *	0.71	1.85	0.73	1.86	3.00	0.76	1.77	0.71	1.80

* referenced to land surface

Well Construction Information	8L	9S	10S	10D	RDS2
Total length of well (m)	2.68	1.84	1.96	2.44	1.72
Screen length (m)	0.70	0.25	0.35	0.75	0.28
Depth of borehole (m) *	1.78	0.75	0.93	1.98	0.90
Bentonite seal - top (m) *	0.00	0.00	0.00	0.00	0.00
Sand pack - top (m) *	0.53	0.30	0.37	0.75	0.26
Sand pack - bottom (m) *	1.78	0.75	0.93	1.98	0.90
Depth to top of screen (m) *	1.01	0.46	0.54	1.19	0.45
Depth to bottom of screen (m) *	1.71	0.71	0.89	1.94	0.73

* referenced to land surface

Appendix B: Depths to ground-water

Well	9/16/97	11/18/97	12/15/97	1/26/98	2/24/98	3/24/98	4/14/98	4/22/98	5/4/98	5/12/98	5/27/98
1S	0.58	0.33	***0.25***	***0.20***	***0.02***	***0.05***	***0.03***	***0.00***	***0.10***	***0.09***	0.34
1D	0.59	0.35	***0.26***	frozen	***0.02***	***0.04***	***0.03***	***-0.02***	***0.07***	***0.06***	0.31
2S	0.51	***0.20***	***0.11***	frozen	***-0.07***	***-0.04***	***-0.05***	***-0.07***	***0.01***	***0.03***	0.35
2D	0.56	**0.25**	***0.15***	frozen	***-0.04***	***-0.02***	***-0.03***	***-0.05***	***0.03***	***0.06***	0.37
2L	0.56	***0.26***	***0.17***	***0.14***	***-0.03***	***-0.02***	***-0.02***	***-0.03***	***0.04***	***0.06***	0.37
3S	dry	0.45	0.36	0.36	***0.08***	***0.18***	***0.02***	dry	0.30	0.33	0.59
4S	dry	dry	0.65	0.64	0.42	0.47	0.38	0.32	0.57	0.59	0.69
4D	0.92	0.78	0.71	0.65	0.43	0.49	0.39	0.33	0.56	0.58	0.78
4L	0.98	0.82	0.75	0.70	0.47	0.53	0.41	0.34	0.62	0.65	0.84
5S	0.48	***0.22***	***0.09***	frozen	***-0.09***	***-0.08***	***-0.09***	***-0.14***	***-0.08***	***-0.06***	***0.27***
5D	***0.16***	***0.27***	***0.14***	frozen	***-0.04***	***-0.03***	***-0.04***	***-0.07***	***0.00***	***0.02***	0.35
6S	0.54	0.31	***0.22***	frozen	***-0.03***	***-0.01***	***-0.04***	***-0.07***	***-0.01***	***-0.02***	***0.20***
6D	0.53	***0.30***	***0.21***	frozen	***-0.05***	***-0.03***	***-0.05***	***-0.07***	***-0.01***	***-0.01***	***0.21***
6L	0.61	0.36	***0.27***	***0.17***	***-0.01***	***0.01***	***-0.01***	***-0.04***	***0.02***	***0.02***	***0.24***
7S	0.63	0.42	0.37	frozen	***-0.05***	***-0.03***	***-0.05***	***-0.07***	***0.00***	***0.00***	0.32
7D	0.64	0.43	0.38	***0.24***	***-0.06***	***-0.03***	***-0.05***	***-0.09***	***-0.01***	***-0.02***	0.31
8S	dry	0.41	0.31	***0.25***	***0.02***	***0.07***	***0.00***	***-0.02***	***0.13***	***0.14***	0.43
8D	0.65	0.40	0.30	***0.22***	***-0.01***	***0.03***	***-0.04***	***-0.03***	***0.12***	***0.12***	0.42
8L	**	0.51	0.41	0.34	***0.10***	***0.14***	***0.07***	***0.01***	***0.17***	***0.18***	0.49
9S	dry	dry	0.92	dry	0.48	0.52	***0.22***	***0.12***	0.62	0.63	0.66
10S	**	dry	0.84	0.81	0.56	0.56	0.47	0.40	0.63	0.64	0.80
10D	**	1.22	1.15	0.80	0.54	0.55	0.48	0.39	0.61	0.62	0.78

*	not yet installed
**	not measured
***	destroyed
-	indicates water above land surface
BR	indicates bad reading
U	indicates upper monitoring well
D	indicates middle monitoring well
L	indicates lower monitoring well
S	indicates soil-zone monitoring well
SR	indicates shallow replacement soil-zone monitoring well
bold	depth values $\leq$ 0.304 m

Appendix B: continued

Well	6/19/98	7/17/98	8/14/98	9/18/98	10/22/98	11/18/98	12/17/98	1/21/99	2/26/99	3/31/99	4/14/99
1S	***-0.01***	0.66	0.47	***0.09***	***0.03***	***0.05***	***0.08***	***0.25***	***0.07***	***0.18***	***0.06***
1D	***-0.03***	0.64	0.46	***0.08***	***0.01***	***0.03***	***0.05***	frozen	***0.05***	***0.16***	***0.04***
2S	***-0.07***	0.61	0.39	***0.02***	***-0.04***	***-0.03***	***-0.01***	***0.14***	***-0.02***	***0.22***	***-0.04***
2D	***-0.04***	0.64	0.42	***0.05***	***-0.01***	***0.00***	***0.02***	***0.17***	***0.03***	***0.26***	***0.00***
2L	***-0.03***	0.63	0.42	***0.05***	***-0.01***	***0.00***	***0.03***	***0.17***	***0.03***	***0.26***	***0.00***
3S	***0.04***	dry	dry	0.42	***0.23***	***0.29***	0.31	0.46	***0.24***	0.44	***0.28***
4S	0.35	dry	dry	0.63	0.52	0.54	0.55	0.65	0.51	dry	0.55
4D	0.36	0.93	1.08	0.63	0.51	0.53	0.54	0.64	0.50	0.71	0.54
4L	0.38	0.99	1.14	0.70	0.58	0.60	0.61	0.71	0.57	0.78	0.61
5S	***-0.15***	0.51	0.46	***-0.05***	***-0.11***	***-0.10***	***-0.09***	***0.03***	***-0.08***	***0.18***	***-0.05***
5D	***-0.07***	0.59	0.54	***0.03***	***-0.04***	***-0.02***	***0.00***	***0.11***	***0.00***	***0.20***	***-0.05***
6S	***-0.08***	0.58	0.50	***0.00***	***-0.04***	***-0.02***	***0.00***	***0.16***	frozen	***0.09***	***0.01***
6D	***-0.07***	0.59	0.51	***0.01***	***-0.04***	***-0.02***	***0.01***	***0.17***	***0.02***	***0.08***	***-0.02***
6L	***-0.04***	0.62	0.54	***0.04***	***-0.01***	***0.02***	***0.04***	***0.19***	***0.04***	***0.11***	***0.01***
7S	***-0.07***	0.64	0.70	***0.03***	***-0.04***	***-0.01***	***0.02***	***0.30***	***0.06***	***0.16***	***0.00***
7D	***-0.07***	0.62	0.69	***0.02***	***-0.05***	***-0.03***	***0.01***	***0.25***	***0.01***	***0.17***	***0.00***
8S	***-0.03***	0.63	dry	***0.24***	***0.02***	***0.08***	***0.15***	***0.26***	***0.07***	0.31	***0.09***
8D	***-0.02***	0.64	0.81	***0.24***	***0.02***	***0.08***	***0.14***	***0.23***	***0.06***	0.31	***0.09***
8L	***0.02***	0.68	0.86	0.31	***0.08***	***0.15***	***0.20***	0.31	***0.14***	0.36	***0.14***
9S	***0.19***	dry	dry	dry	0.56	0.66	dry	dry	dry	dry	0.63
10S	0.42	dry	dry	dry	0.59	0.61	0.74	dry	0.82	dry	0.68
10D	0.40	1.07	1.35	1.07	0.57	0.59	0.72	0.95	0.79	0.88	0.70

*	not yet installed
**	not measured
***	destroyed
-	indicates water above land surface
BR	indicates bad reading
U	indicates upper monitoring well
D	indicates middle monitoring well
L	indicates lower monitoring well
S	indicates soil-zone monitoring well
SR	indicates shallow replacement soil-zone monitoring well
bold	depth values $\leq$ 0.304 m

Appendix B: continued

Well	4/28/99	5/12/99	5/24/99	6/16/99	7/14/99	8/3/99	9/21/99	10/13/99	10/20/99	11/2/99	12/14/99
1S	***0.00***	***0.12***	***0.16***	***0.09***	dry	dry	dry	***0.30***	0.41	dry	***0.15***
1D	***-0.02***	***0.10***	***0.13***	***0.07***	0.86	1.00	1.12	***0.28***	0.40	0.72	***0.13***
2S	***-0.07***	***0.12***	***0.04***	***0.00***	dry	dry	dry	0.43	0.44	0.63	***-0.01***
2D	***-0.04***	***0.14***	***0.08***	***0.03***	0.81	0.95	1.12	0.46	0.47	0.66	***0.03***
2L	***-0.05***	***0.16***	***0.07***	***0.04***	0.81	0.95	1.12	0.47	0.48	0.66	***0.02***
3S	***-0.09***	0.50	0.44	0.34	dry	dry	dry	dry	dry	dry	0.36
4S	0.31	0.67	0.67	0.60	dry	dry	dry	dry	dry	0.76	0.67
4D	0.32	0.65	0.67	0.59	1.05	1.28	1.54	0.99	1.02	1.12	0.66
4L	0.34	0.75	0.73	0.66	1.25	1.35	1.61	1.04	1.08	1.18	0.73
5S	***-0.09***	***0.05***	***0.07***	***-0.02***	0.66	dry	dry	0.40	0.41	0.61	***0.07***
5D	***-0.08***	***0.07***	***0.08***	***0.00***	0.72	0.97	1.18	0.41	0.42	0.62	***0.09***
6S	***-0.05***	***0.05***	***0.05***	***0.01***	dry	dry	dry	***0.20***	0.35	0.69	***0.11***
6D	***-0.07***	***0.03***	***0.03***	***-0.01***	0.81	1.04	1.21	***0.18***	0.33	0.69	***0.09***
6L	***-0.04***	***0.06***	***0.05***	***0.02***	0.84	1.07	1.22	***0.19***	0.36	0.71	***0.12***
7S	***-0.06***	***0.06***	***0.08***	***0.00***	dry	dry	dry	BR	0.55	dry	***0.22***
7D	***-0.06***	***0.05***	***0.09***	***0.00***	0.87	1.15	1.46	BR	0.56	0.81	***0.24***
8S	***-0.03***	***0.18***	***0.27***	***0.13***	dry	dry	dry	0.70	dry	dry	0.32
8D	***-0.03***	***0.18***	***0.26***	***0.13***	0.80	1.08	1.47	0.68	0.72	0.89	0.32
8L	***0.01***	***0.22***	***0.30***	***0.18***	0.83	1.12	1.50	0.73	0.76	0.93	0.37
9S	***0.07***	dry	dry	0.63	dry	dry	dry	0.70	dry	dry	dry
10S	0.42	0.77	0.76	0.65	dry	dry	dry	dry	dry	dry	dry
10D	0.43	0.77	0.77	0.67	1.28	1.55	1.85	1.34	1.38	1.49	1.28

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BR	indicates bad reading
U	indicates upper monitoring well
D	indicates middle monitoring well
L	indicates lower monitoring well
S	indicates soil-zone monitoring well
SR	indicates shallow replacement soil-zone monitoring well
bold	depth values $\leq$ 0.304 m

Appendix B: continued

Well	1/13/00	2/8/00	3/16/00	4/4/00	4/19/00	5/2/00	5/16/00	5/31/00	6/12/00	6/27/00	7/13/00
1S	***0.29***	dry	***0.13***	***0.20***	***0.04***	***0.07***	***0.09***	***0.02***	***-0.05***	***0.00***	***0.02***
1D	***0.28***	0.67	***0.09***	***0.17***	***0.01***	***0.03***	***0.05***	***-0.01***	***-0.08***	***-0.04***	***-0.02***
2S	***0.16***	0.53	***0.08***	***0.19***	***-0.08***	***-0.01***	***0.02***	***-0.08***	***-0.12***	***-0.07***	***-0.06***
2D	***0.19***	0.56	***0.11***	***0.22***	***-0.06***	***0.01***	***0.04***	***-0.07***	***-0.10***	***-0.06***	***-0.05***
2L	***0.18***	0.56	***0.11***	***0.22***	***-0.04***	***0.02***	***0.05***	***-0.06***	***-0.10***	***-0.04***	***-0.03***
3S	0.45	dry	0.38	0.48	***0.00***	0.37	0.42	***-0.01***	**0.00**	**0.17**	**0.23**
4S	dry	dry	0.60	dry	***0.26***	0.61	0.67	***0.16***	***0.13***	0.46	0.47
4D	0.76	0.96	0.61	0.74	***0.28***	0.61	0.66	***0.18***	***0.16***	0.46	0.47
4L	0.82	1.03	0.67	0.80	***0.30***	0.69	0.74	***0.21***	***0.16***	0.53	0.55
5S	***0.20***	0.50	***0.02***	***0.18***	***-0.11***	***0.05***	***0.08***	***-0.11***	***-0.15***	***-0.11***	***-0.10***
5D	***0.22***	0.52	***0.04***	***0.19***	***-0.09***	***0.02***	***0.08***	***-0.11***	***-0.14***	***-0.10***	***-0.09***
6S	***0.28***	dry	***0.05***	***0.13***	***0.03***	***0.01***	***0.03***	***-0.02***	***-0.11***	***-0.06***	***-0.04***
6D	***0.27***	0.65	***0.02***	***0.11***	***-0.01***	***-0.02***	***-0.01***	***-0.05***	***-0.14***	***-0.09***	***-0.08***
6L	0.39	0.67	***0.05***	***0.14***	***0.03***	***0.02***	***0.03***	***-0.01***	***-0.10***	***-0.05***	***-0.04***
7S	0.42	dry	***0.07***	***0.29***	***0.03***	***0.01***	***0.04***	***0.02***	***-0.12***	***-0.07***	***-0.05***
7D	0.43	0.75	***0.06***	***0.29***	***0.03***	***0.01***	***0.04***	***0.01***	***-0.12***	***-0.08***	***-0.06***
8S	0.41	dry	***0.21***	0.36	***-0.01***	***0.21***	***0.28***	***-0.02***	***-0.06***	***-0.02***	***0.00***
8D	0.41	0.76	***0.20***	0.36	***0.00***	***0.21***	***0.28***	***-0.01***	***-0.06***	***-0.02***	***0.00***
8L	0.46	0.80	***0.27***	0.42	***0.03***	***0.27***	0.34	***0.02***	***-0.01***	***0.03***	***0.05***
9S	dry	dry	dry	dry	0.31	dry	dry	***0.22***	***0.03***	0.41	0.50
10S	dry	dry	0.87	dry	0.74	0.73	0.78	0.32	***0.26***	0.56	0.60
10D	1.28	1.36	0.82	0.95	0.69	0.68	0.73	***0.28***	***0.22***	0.52	0.55

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BR	indicates bad reading
U	indicates upper monitoring well
D	indicates middle monitoring well
L	indicates lower monitoring well
S	indicates soil-zone monitoring well
SR	indicates shallow replacement soil-zone monitoring well
bold	depth values $\leq$ 0.304 m

Appendix B: continued

Well	8/8/00	9/10/00	10/14/00	11/4/00	12/18/00	1/24/01	2/20/01	3/27/01	4/17/01	5/3/01	5/15/01
1S	***0.12***	dry	***0.14***	0.54	0.52	***0.28***	frozen	***0.06***	***0.07***	***0.23***	***0.00***
1D	***0.09***	0.75	***0.10***	0.50	0.49	***0.24***	frozen	frozen	***0.04***	***0.19***	***-0.03***
2S	***-0.01***	dry	***0.09***	0.42	0.39	frozen	frozen	***-0.01***	***-0.02***	0.31	***-0.06***
2D	***0.00***	0.73	***0.11***	0.43	0.41	***-0.14***	frozen	***-0.02***	***-0.04***	0.31	***-0.07***
2L	***0.01***	0.74	***0.11***	0.45	0.43	***0.19***	frozen	***-0.02***	***-0.03***	0.31	***-0.08***
3S	0.32	dry	0.48	0.64	0.60	0.38	frozen	***0.24***	***0.12***	0.53	***0.08***
4S	0.66	dry	dry	dry	dry	0.67	0.46	0.52	0.46	dry	0.37
4D	0.65	1.23	0.74	0.90	0.84	0.70	0.46	0.52	0.47	0.76	0.38
4L	0.74	1.30	0.81	0.98	0.91	0.75	0.53	0.59	0.51	0.82	0.40
5S	***0.06***	dry	***0.15***	0.40	0.34	frozen	frozen	***-0.07***	***-0.09***	***0.22***	***-0.12***
5D	***0.07***	0.85	***0.17***	0.42	0.35	frozen	***-0.10***	***-0.06***	***-0.08***	***0.23***	***-0.11***
6S	***0.13***	dry	***0.07***	0.49	0.46	0.54	frozen	***-0.01***	***-0.01***	***0.10***	***-0.07***
6D	***0.09***	0.92	***0.04***	0.46	0.43	***0.14***	frozen	***-0.05***	***-0.05***	***0.06***	***-0.11***
6L	***0.13***	0.96	***0.08***	0.50	0.46	***0.17***	frozen	***-0.01***	***-0.01***	***0.09***	***-0.08***
7S	***0.30***	dry	***0.13***	0.62	0.56	0.37	frozen	frozen	***-0.02***	***0.11***	***-0.09***
7D	***0.30***	1.14	***0.14***	0.62	0.56	0.38	frozen	frozen	***-0.01***	***0.12***	***-0.08***
8S	0.31	dry	0.36	0.62	0.51	frozen	frozen	***0.08***	***0.06***	0.40	***0.00***
8D	0.31	1.04	0.36	0.62	0.50	frozen	frozen	***0.05***	***0.03***	0.37	***-0.03***
8L	0.37	1.09	0.42	0.68	0.56	0.38	frozen	***0.13***	***0.10***	0.45	***0.04***
9S	dry	dry	dry	dry	dry	dry	0.43	0.62	0.45	dry	***0.21***
10S	dry	***	***	***	***	***	***	***	***	***	***
10D	1.07	***	***	***	***	***	***	***	***	***	***

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D	indicates middle monitoring well
L	indicates lower monitoring well
S	indicates soil-zone monitoring well
SR	indicates shallow replacement soil-zone monitoring well
bold	depth values $\leq$ 0.304 m

Appendix B: continued

Well	6/6/01	6/22/01	7/17/01	9/5/01	10/2/01	11/3/01	12/8/01	1/9/02	2/14/02	3/15/02	4/2/02
1S	***-0.03***	***0.07***	dry	dry	dry	***0.10***	***0.19***	dry	***0.16***	***0.02***	***0.00***
1D	***-0.03***	***0.07***	0.78	0.96	0.74	***0.10***	***0.19***	0.72	***0.19***	***0.04***	***0.02***
2S	***-0.04***	***0.06***	0.70	dry	0.65	***0.07***	0.36	0.59	***-0.01***	***-0.03***	***-0.05***
2D	***-0.07***	***0.07***	0.70	0.90	0.67	***0.07***	***0.10***	0.60	***0.01***	***-0.02***	***-0.03***
2L	***-0.08***	***0.07***	0.71	0.90	0.67	***0.08***	***0.10***	0.59	***-0.01***	***-0.04***	***-0.06***
3S	***0.02***	0.38	dry	dry	dry	0.41	0.39	0.67	***0.23***	***0.15***	***-0.01***
4S	***0.26***	0.56	dry	dry	dry	0.61	0.61	dry	0.51	0.46	***0.07***
4D	***0.28***	0.56	0.93	1.24	1.11	0.61	0.63	0.83	0.52	0.46	***0.10***
4L	***0.30***	0.65	1.00	1.32	1.18	0.69	0.70	0.91	0.59	0.54	***0.14***
5S	***-0.11***	***-0.02***	0.62	dry	0.62	***0.04***	***0.05***	0.48	***-0.05***	***-0.08***	***-0.10***
5D	***-0.12***	***-0.02***	0.63	0.86	0.63	***0.03***	***0.05***	0.49	***-0.03***	***-0.06***	***-0.08***
6S	***-0.11***	***-0.03***	dry	dry	dry	***0.00***	***0.08***	0.62	***0.10***	***-0.06***	***-0.05***
6D	***-0.12***	***-0.04***	0.70	0.92	0.66	***-0.01***	***0.07***	0.61	***0.09***	***-0.06***	***-0.05***
6L	***-0.10***	***-0.02***	0.73	0.94	0.69	***0.01***	***0.10***	0.61	***0.09***	***-0.06***	***-0.05***
7S	***-0.10***	***-0.01***	dry	0.71	dry	***0.04***	***0.29***	0.70	***0.18***	***-0.05***	***-0.03***
7D	***-0.11***	***-0.01***	0.79	1.13	0.83	1.04	***0.29***	0.71	***0.19***	***-0.05***	***-0.03***
8S	***-0.06***	***0.13***	dry	dry	dry	***0.18***	***0.21***	0.59	***0.04***	***-0.12***	***-0.06***
8D	***-0.06***	***0.14***	0.71	1.04	0.89	***0.19***	***0.23***	0.60	***0.06***	***0.09***	***-0.05***
8L	***-0.01***	***0.20***	0.76	1.08	0.93	***0.25***	***0.28***	0.64	***0.12***	***0.14***	***-0.02***
9S	***0.07***	dry	dry	dry	dry	dry	dry	dry	dry	0.50	***0.02***
10S	***	***	***	***	***	***	***	***	***	***	***
10D	***	***	***	***	***	***	***	***	***	***	***

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***	destroyed
-	indicates water above land surface
BR	indicates bad reading
U	indicates upper monitoring well
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S	indicates soil-zone monitoring well
SR	indicates shallow replacement soil-zone monitoring well
bold	depth values ≤ 0.304 m

Appendix B: continued

Well	4/16/02	4/30/02	5/11/02	5/29/02	6/27/02	8/7/02	9/12/02	10/17/02	11/26/02	12/26/02	1/22/03
1S	***0.02***	***0.02***	***-0.01***	***0.05***	0.33	0.32	dry	dry	dry	dry	dry
1D	***0.05***	***0.04***	***0.01***	***0.06***	0.32	0.32	0.84	0.81	0.84	0.74	0.89
2S	***-0.02***	***-0.03***	***-0.05***	***0.00***	0.39	***0.29***	dry	dry	dry	dry	dry
2D	***0.00***	***-0.02***	***-0.04***	***0.01***	0.40	***0.30***	0.76	0.75	0.79	0.71	0.84
2L	***-0.02***	***-0.04***	***-0.06***	***-0.01***	0.42	0.31	0.78	0.76	0.81	0.72	0.86
3S	***0.29***	***0.12***	***-0.02***	0.33	0.63	0.51	dry	dry	dry	dry	dry
4S	0.50	0.44	***0.04***	0.52	dry	0.66	dry	dry	dry	dry	dry
4D	0.51	0.45	***0.07***	0.52	0.78	0.74	1.06	1.27	1.32	1.30	1.33
4L	0.59	0.51	***0.14***	0.60	0.82	0.78	1.10	1.30	1.36	1.33	1.37
5S	***-0.06***	***-0.08***	***-0.10***	***-0.05***	0.34	0.34	0.70	dry	dry	dry	dry
5D	***-0.05***	***-0.06***	***-0.09***	***-0.04***	0.35	0.35	0.72	0.77	0.81	0.74	0.83
6S	***-0.05***	***-0.05***	***-0.07***	***-0.04***	***0.19***	***0.25***	dry	dry	dry	dry	dry
6D	***-0.06***	***-0.05***	***-0.07***	***-0.04***	***0.18***	***0.24***	0.77	0.78	0.81	0.72	0.83
6L	***-0.05***	***-0.05***	***-0.06***	***-0.04***	***0.23***	***0.29***	0.83	0.83	0.86	0.77	0.89
7S	***-0.04***	***-0.04***	***-0.05***	***-0.02***	0.40	0.51	dry	dry	dry	dry	dry
7D	***-0.04***	***-0.05***	***-0.05***	***-0.01***	0.41	0.53	0.93	1.04	1.07	1.01	1.10
8S	***0.03***	***-0.02***	***-0.06***	***0.07***	0.46	0.48	dry	dry	dry	dry	dry
8D	***0.04***	***-0.01***	***-0.05***	***0.07***	0.47	0.50	0.86	1.07	1.13	1.09	1.16
8L	***0.10***	***0.04***	***-0.02***	***0.14***	0.52	0.55	0.90	1.12	1.17	1.13	1.20
9S	0.60	0.50	***0.16***	0.63	dry	dry	dry	dry	dry	dry	dry
10S	***	***	***	***	***	***	***	***	***	***	***
10D	***	***	***	***	***	***	***	***	***	***	***

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U	indicates upper monitoring well
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S	indicates soil-zone monitoring well
SR	indicates shallow replacement soil-zone monitoring well
bold	depth values $\leq$ 0.304 m

Appendix B: continued

Well	3/3/03	4/1/03	4/15/03	4/29/03	5/13/03	5/27/03	6/10/03	6/23/03	8/4/03	9/4/03	9/25/03
1S	dry	0.34	0.52	***0.30***	***0.02***	***0.13***	***0.08***	dry	0.64	dry	dry
1D	1.00	0.35	0.53	***0.30***	***0.03***	***0.13***	***0.10***	0.81	0.65	1.16	0.75
2S	dry	***0.30***	0.44	***0.23***	***-0.05***	***0.18***	***0.02***	dry	0.55	dry	dry
2D	0.95	0.31	0.45	***0.23***	***-0.05***	***0.18***	***0.03***	0.69	0.55	1.07	0.75
2L	0.97	0.33	0.47	***0.23***	***-0.05***	***0.17***	***0.03***	0.69	0.55	1.06	0.74
3S	dry	0.61	0.65	0.51	***0.18***	0.50	***0.26***	dry	dry	dry	dry
4S	dry	dry	dry	dry	0.49	dry	0.62	dry	dry	dry	dry
4D	1.40	0.97	0.92	0.78	0.49	0.74	0.62	0.99	1.00	1.44	1.41
4L	1.44	1.01	0.96	0.78	0.49	0.74	0.64	0.98	0.99	1.44	1.39
5S	dry	0.37	0.43	***0.22***	***-0.08***	***0.20***	***0.01***	0.65	0.57	dry	dry
5D	0.96	0.38	0.43	***0.22***	***-0.08***	***0.20***	***0.01***	0.66	0.57	1.11	0.96
6S	dry	***0.30***	0.46	***0.19***	***-0.08***	***-0.02***	***0.04***	dry	0.60	dry	dry
6D	0.97	***0.30***	0.46	***0.18***	***-0.09***	***-0.03***	***0.03***	0.73	0.59	1.17	0.91
6L	1.01	0.34	0.50	***0.14***	***-0.12***	***-0.06***	***0.00***	0.70	0.56	1.14	0.87
7S	dry	0.51	0.59	0.44	***-0.07***	***0.03***	***0.19***	dry	dry	dry	dry
7D	1.19	0.52	0.61	0.45	***-0.07***	***0.03***	***0.19***	0.90	0.84	1.52	1.47
8S	dry	dry	dry	0.43	***0.00***	0.41	***0.19***	dry	dry	dry	dry
8D	1.25	0.62	0.65	0.43	***0.01***	0.41	***0.20***	0.85	0.89	1.43	1.52
8L	1.30	0.69	0.70	0.44	***0.01***	0.42	***0.21***	0.84	0.89	1.42	1.51
9S	dry	dry	dry	dry	0.55	dry	dry	dry	dry	dry	dry
10S	***	***	***	***	***	***	***	***	***	***	***
10D	***	***	***	***	***	***	***	***	***	***	***

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-	indicates water above land surface
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SR	indicates shallow replacement soil-zone monitoring well
bold	depth values $\leq$ 0.304 m

Appendix B: continued

Well	10/29/03	12/1/03
1S	dry	0.66
1D	0.88	0.66
2S	dry	0.51
2D	0.83	0.53
2L	0.83	0.53
3S	dry	dry
4S	dry	dry
4D	1.50	1.08
4L	1.49	1.06
5S	dry	0.54
5D	0.96	0.55
6S	dry	dry
6D	0.96	0.61
6L	0.93	0.58
7S	dry	dry
7D	1.42	0.80
8S	dry	dry
8D	1.53	0.98
8L	1.52	0.98
9S	dry	dry
10S	***	***
10D	***	***

*	not yet installed
**	not measured
***	destroyed
-	indicates water above land surface
BR	indicates bad reading
U	indicates upper monitoring well
D	indicates middle monitoring well
L	indicates lower monitoring well
S	indicates soil-zone monitoring well
SR	indicates shallow replacement soil-zone monitoring well
bold	depth values $\leq$ 0.304 m

Appendix C: Ground-water elevations

Well	9/16/97	11/18/97	12/15/97	1/26/98	2/24/98	3/24/98	4/14/98	4/22/98	5/4/98	5/12/98	5/27/98
1S	171.26	171.51	171.59	171.63	171.82	171.79	171.81	171.86	171.77	171.78	171.52
1D	171.26	171.50	171.59	frozen	171.83	171.81	171.83	171.86	171.77	171.78	171.53
2S	171.24	171.55	171.64	frozen	171.82	171.79	171.80	171.86	171.79	171.76	171.44
2D	171.24	171.54	171.64	frozen	171.83	171.81	171.82	171.87	171.79	171.76	171.45
2L	171.24	171.54	171.63	171.66	171.83	171.82	171.82	171.86	171.78	171.76	171.45
3S	dry	171.60	171.69	171.69	171.97	171.87	172.03	dry	171.79	171.77	171.51
4S	dry	dry	171.68	171.70	171.91	171.86	171.95	172.05	171.80	171.78	171.68
4D	171.42	171.56	171.63	171.69	171.91	171.85	171.95	172.03	171.80	171.78	171.58
4L	171.42	171.57	171.64	171.70	171.93	171.86	171.98	172.08	171.80	171.77	171.58
5S	171.26	171.52	171.65	frozen	171.84	171.82	171.83	171.86	171.80	171.78	171.45
5D	171.63	171.52	171.65	frozen	171.83	171.82	171.83	171.87	171.80	171.78	171.45
6S	171.23	171.47	171.56	frozen	171.81	171.79	171.81	171.86	171.80	171.81	171.59
6D	171.25	171.48	171.57	frozen	171.83	171.81	171.83	171.87	171.81	171.81	171.60
6L	171.22	171.46	171.55	171.65	171.84	171.82	171.84	171.86	171.79	171.80	171.58
7S	171.14	171.35	171.40	frozen	171.81	171.80	171.82	171.86	171.78	171.79	171.46
7D	171.14	171.35	171.39	171.54	171.83	171.81	171.83	171.86	171.78	171.79	171.46
8S	dry	171.43	171.52	171.59	171.82	171.77	171.84	171.90	171.75	171.73	171.45
8D	171.18	171.42	171.52	171.61	171.84	171.80	171.86	171.89	171.74	171.73	171.43
8L	**	171.42	171.52	171.59	171.83	171.79	171.86	171.89	171.73	171.72	171.41
9S	dry	dry	171.48	dry	171.92	171.89	172.18	172.32	171.82	171.81	171.78
10S	**	dry	172.17	172.20	172.45	172.45	172.53	172.63	172.40	172.39	172.22
10D	**	171.78	171.85	172.20	172.46	172.45	172.52	172.62	172.39	172.39	172.22
Gauge											
A	dry	dry	dry	frozen	171.83	171.81	171.83	171.87	171.80	171.80	171.69
B	171.10	dry	frozen	flooded	flooded	flooded	flooded	**	171.79	171.79	dry
C	dry	172.42	172.22	frozen	172.23	dry	172.24	172.27	172.24	172.24	dry
D	**	**	170.67	170.74	170.74	170.85	171.22	171.28	171.01	171.22	170.59
E	*	*	*	*	*	*	*	*	*	*	*

*	not yet installed
**	not measured
***	destroyed
BR	indicates bad reading
U	indicates upper monitoring well
D	indicates middle monitoring well
L	indicates lower monitoring well
S	indicates soil-zone monitoring well
SR	indicates shallow replacement soil-zone monitoring well

Appendix C: continued

Well	6/19/98	7/17/98	8/14/98	9/18/98	10/22/98	11/18/98	12/17/98	1/21/99	2/26/99	3/31/99	4/14/99
1S	171.87	171.20	171.39	171.77	171.83	171.82	171.79	171.61	171.79	171.66	171.79
1D	171.87	171.20	171.38	171.77	171.83	171.81	171.79	frozen	171.79	171.66	171.79
2S	171.86	171.18	171.41	171.77	171.83	171.82	171.80	171.66	171.81	171.55	171.81
2D	171.86	171.18	171.40	171.77	171.83	171.82	171.80	171.65	171.79	171.55	171.81
2L	171.86	171.19	171.40	171.77	171.83	171.82	171.79	171.65	171.79	171.55	171.81
3S	172.06	dry	dry	171.68	171.86	171.81	171.79	171.64	171.86	171.65	171.80
4S	172.01	dry	dry	171.73	171.85	171.83	171.82	171.72	171.85	dry	171.81
4D	172.00	171.43	171.28	171.73	171.85	171.83	171.82	171.72	171.86	171.64	171.81
4L	172.05	171.43	171.29	171.72	171.85	171.83	171.82	171.71	171.86	171.65	171.81
5S	171.87	171.21	171.27	171.77	171.83	171.82	171.81	171.70	171.81	171.57	171.81
5D	171.87	171.21	171.26	171.77	171.84	171.82	171.81	171.69	171.80	171.57	171.81
6S	171.87	171.21	171.29	171.79	171.83	171.82	171.79	171.63	frozen	171.70	171.78
6D	171.87	171.22	171.29	171.79	171.84	171.82	171.80	171.63	171.78	171.70	171.80
6L	171.86	171.20	171.28	171.78	171.83	171.80	171.78	171.63	171.78	171.69	171.79
7S	171.85	171.15	171.09	171.76	171.82	171.79	171.77	171.49	171.73	171.62	171.79
7D	171.85	171.16	171.09	171.76	171.83	171.80	171.77	171.52	171.77	171.62	171.79
8S	171.91	171.25	dry	171.64	171.86	171.79	171.73	171.62	171.81	171.54	171.76
8D	171.88	171.22	171.04	171.61	171.83	171.77	171.71	171.62	171.79	171.54	171.75
8L	171.88	171.22	171.04	171.59	171.82	171.76	171.70	171.60	171.76	171.53	171.74
9S	172.25	dry	dry	dry	171.88	171.78	dry	dry	dry	dry	171.78
10S	172.61	dry	dry	dry	172.44	172.42	172.28	dry	172.21	dry	172.30
10D	172.60	171.93	171.66	171.93	172.44	172.42	172.29	172.05	172.21	172.12	172.30
Gauge											
A	171.86	dry	dry	171.79	171.83	171.81	171.78	frozen	171.78	171.73	171.79
B	171.86	dry	dry	171.79	171.83	171.80	171.78	dry	171.77	171.66	171.79
C	172.27	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry
D	170.98	170.72	170.71	170.69	171.18	170.79	170.70	frozen	170.74	170.64	170.79
E	*	*	*	*	*	*	*	*	*	*	*

*	not yet installed
**	not measured
***	destroyed
BR	indicates bad reading
U	indicates upper monitoring well
D	indicates middle monitoring well
L	indicates lower monitoring well
S	indicates soil-zone monitoring well
SR	indicates shallow replacement soil-zone monitoring well

Appendix C: continued

Well	4/28/99	5/12/99	5/24/99	6/16/99	7/14/99	8/3/99	9/21/99	10/13/99	10/20/99	11/2/99	12/14/99
1S	171.85	171.73	171.69	171.76	dry	dry	dry	171.55	171.44	dry	171.70
1D	171.85	171.73	171.69	171.76	170.96	170.83	170.71	171.55	171.43	171.10	171.69
2S	171.85	171.65	171.73	171.77	dry	dry	dry	171.34	171.33	171.15	171.78
2D	171.85	171.66	171.73	171.77	171.00	170.85	170.69	171.34	171.33	171.14	171.78
2L	171.85	171.65	171.74	171.77	171.00	170.86	170.69	171.34	171.33	171.15	171.78
3S	172.17	171.58	171.64	171.74	dry	dry	dry	dry	dry	dry	171.72
4S	172.05	171.69	171.69	171.76	dry	dry	dry	dry	dry	171.60	171.70
4D	172.03	171.70	171.67	171.76	171.30	171.07	170.81	171.36	171.33	171.23	171.69
4L	172.08	171.68	171.69	171.76	171.17	171.08	170.81	171.38	171.34	171.24	171.69
5S	171.85	171.71	171.68	171.77	171.09	dry	dry	171.36	171.34	171.15	171.69
5D	171.85	171.70	171.69	171.77	171.05	170.80	170.58	171.36	171.34	171.15	171.68
6S	171.85	171.74	171.75	171.79	dry	dry	dry	171.59	171.45	171.10	171.69
6D	171.85	171.75	171.75	171.79	170.97	170.74	170.57	171.60	171.45	171.10	171.69
6L	171.84	171.74	171.74	171.78	170.96	170.72	170.57	171.60	171.44	171.09	171.68
7S	171.85	171.73	171.70	171.78	dry	dry	dry	BR	171.23	dry	171.56
7D	171.85	171.73	171.70	171.78	170.91	170.63	170.32	BR	171.23	170.97	171.55
8S	171.88	171.67	171.58	171.72	dry	dry	dry	171.16	dry	dry	171.53
8D	171.87	171.67	171.58	171.72	171.04	170.76	170.37	171.16	171.13	170.95	171.53
8L	171.88	171.66	171.58	171.71	171.05	170.77	170.39	171.15	171.12	170.95	171.52
9S	172.34	dry	dry	171.78	dry	dry	dry	171.71	dry	dry	dry
10S	172.57	172.22	172.23	172.33	dry	dry	dry	dry	dry	dry	dry
10D	172.56	172.23	172.22	172.33	171.72	171.45	171.15	171.66	171.62	171.51	171.72
Gauge											
A	171.84	171.74	171.76	171.79	dry	dry	dry	171.66	dry	dry	171.68
B	171.84	171.72	171.74	171.79	dry	dry	dry	dry	dry	dry	dry
C	172.26	172.22	dry	dry	dry	dry	dry	dry	dry	dry	dry
D	171.48	171.00	171.15	171.52	170.61	170.65	170.54	170.59	170.62	170.62	170.60
E	*	*	*	*	*	*	*	*	*	*	*

*	not yet installed
**	not measured
***	destroyed
BR	indicates bad reading
U	indicates upper monitoring well
D	indicates middle monitoring well
L	indicates lower monitoring well
S	indicates soil-zone monitoring well
SR	indicates shallow replacement soil-zone monitoring well

Appendix C: continued

Well	1/13/00	2/8/00	3/16/00	4/4/00	4/19/00	5/2/00	5/16/00	5/31/00	6/12/00	6/27/00	7/13/00
1S	171.56	dry	171.73	171.66	171.82	171.79	171.77	171.84	171.91	171.86	171.84
1D	171.55	171.16	171.73	171.65	171.81	171.78	171.77	171.83	171.90	171.86	171.84
2S	171.62	171.25	171.70	171.59	171.86	171.79	171.76	171.86	171.90	171.85	171.84
2D	171.62	171.25	171.70	171.59	171.87	171.80	171.77	171.88	171.91	171.87	171.86
2L	171.62	171.25	171.69	171.58	171.85	171.79	171.76	171.87	171.91	171.85	171.84
3S	171.63	dry	171.69	171.59	172.08	171.70	171.66	172.08	172.08	171.91	171.84
4S	dry	dry	171.75	dry	172.09	171.74	171.69	172.19	172.23	171.89	171.88
4D	171.59	171.39	171.74	171.61	172.07	171.74	171.69	172.17	172.19	171.89	171.88
4L	171.60	171.39	171.75	171.62	172.12	171.73	171.68	172.22	172.26	171.89	171.88
5S	171.56	171.26	171.72	171.57	171.85	171.69	171.67	171.86	171.90	171.85	171.85
5D	171.55	171.25	171.72	171.57	171.85	171.74	171.67	171.86	171.90	171.86	171.85
6S	171.51	dry	171.75	171.66	171.77	171.79	171.77	171.81	171.90	171.86	171.84
6D	171.51	171.13	171.75	171.67	171.78	171.79	171.78	171.82	171.91	171.87	171.85
6L	171.40	171.13	171.75	171.65	171.77	171.78	171.77	171.81	171.90	171.85	171.84
7S	171.36	dry	171.72	171.50	171.76	171.78	171.75	171.77	171.90	171.86	171.84
7D	171.36	171.03	171.72	171.49	171.75	171.77	171.75	171.77	171.90	171.86	171.84
8S	171.44	dry	171.64	171.49	171.86	171.64	171.57	171.87	171.91	171.87	171.85
8D	171.44	171.09	171.64	171.48	171.85	171.64	171.56	171.86	171.90	171.86	171.84
8L	171.43	171.08	171.63	171.48	171.86	171.63	171.56	171.88	171.91	171.87	171.85
9S	dry	dry	dry	dry	172.11	dry	dry	172.20	172.39	172.01	171.92
10S	dry	dry	172.14	dry	172.26	172.28	172.23	172.68	172.75	172.45	172.41
10D	171.71	171.64	172.14	172.01	172.28	172.28	172.23	172.69	172.75	172.45	172.41
Gauge											
A	frozen	frozen	171.75	171.68	171.75	171.78	171.77	171.81	171.90	171.85	171.84
B	dry	dry	171.74	dry	171.72	171.77	171.75	171.76	171.90	171.86	171.84
C	dry	dry	dry	dry	172.25	dry	dry	172.28	172.28	dry	dry
D	170.59	frozen	170.65	170.64	170.70	170.76	170.73	170.99	171.43	171.45	171.17
E	*	*	*	*	170.72	170.77	170.74	171.08	171.43	171.45	171.17

*	not yet installed
**	not measured
***	destroyed
BR	indicates bad reading
U	indicates upper monitoring well
D	indicates middle monitoring well
L	indicates lower monitoring well
S	indicates soil-zone monitoring well
SR	indicates shallow replacement soil-zone monitoring well

Appendix C: continued

Well	8/8/00	9/10/00	10/14/00	11/4/00	12/18/00	1/24/01	2/20/01	3/27/01	4/17/01	5/3/01	5/15/01
1S	171.74	dry	171.72	171.32	171.34	171.58	frozen	171.80	171.79	171.63	171.86
1D	171.73	171.07	171.72	171.32	171.33	171.58	frozen	frozen	171.78	171.63	171.85
2S	171.79	dry	171.69	171.36	171.39	frozen	frozen	171.79	171.80	171.47	171.84
2D	171.80	171.07	171.70	171.37	171.40	171.95	frozen	171.82	171.84	171.50	171.88
2L	171.79	171.07	171.70	171.36	171.38	171.62	frozen	171.83	171.84	171.50	171.88
3S	171.75	dry	171.59	171.44	171.47	171.69	frozen	171.83	171.96	171.54	172.00
4S	171.70	dry	dry	dry	dry	171.69	171.90	171.83	171.89	dry	171.99
4D	171.69	171.12	171.61	171.45	171.51	171.65	171.89	171.83	171.88	171.59	171.97
4L	171.68	171.12	171.61	171.44	171.51	171.67	171.90	171.84	171.91	171.61	172.02
5S	171.69	dry	171.59	171.35	171.41	frozen	frozen	171.82	171.84	171.53	171.87
5D	171.69	170.91	171.59	171.34	171.41	frozen	171.86	171.82	171.84	171.52	171.87
6S	171.67	dry	171.73	171.30	171.34	171.26	frozen	171.80	171.80	171.70	171.87
6D	171.68	170.85	171.73	171.31	171.34	171.64	frozen	171.82	171.82	171.71	171.88
6L	171.67	170.83	171.72	171.30	171.33	171.63	frozen	171.81	171.81	171.71	171.87
7S	171.49	dry	171.66	171.17	171.22	171.42	frozen	frozen	171.81	171.68	171.88
7D	171.49	170.64	171.65	171.16	171.22	171.40	frozen	frozen	171.79	171.66	171.86
8S	171.54	dry	171.49	171.23	171.34	frozen	frozen	171.77	171.79	171.45	171.85
8D	171.53	170.80	171.48	171.22	171.34	frozen	frozen	171.80	171.82	171.47	171.87
8L	171.53	170.81	171.47	171.22	171.34	171.51	frozen	171.77	171.80	171.45	171.86
9S	dry	dry	dry	dry	dry	dry	171.99	171.80	171.97	dry	172.21
10S	dry	***	***	***	***	***	***	***	***	***	***
10D	171.89	***	***	***	***	***	***	***	***	***	***
Gauge											
A	171.67	dry	171.74	dry	frozen	frozen	frozen	171.81	171.81	171.73	171.88
B	dry	dry	171.67	dry	frozen	frozen	frozen	171.83	171.83	171.72	171.90
C	dry	dry	dry	dry	frozen	frozen	172.24	dry	dry	dry	172.24
D	170.66	170.57	170.57	170.60	frozen	frozen	170.97	170.99	171.05	171.15	171.09
E	170.67	170.61	170.64	170.63	frozen	frozen	170.98	171.00	171.07	171.16	171.11

*	not yet installed
**	not measured
***	destroyed
BR	indicates bad reading
U	indicates upper monitoring well
D	indicates middle monitoring well
L	indicates lower monitoring well
S	indicates soil-zone monitoring well
SR	indicates shallow replacement soil-zone monitoring well

Appendix C: continued

Well	6/6/01	6/22/01	7/17/01	9/5/01	10/2/01	11/3/01	12/8/01	1/9/02	2/14/02	3/15/02	4/2/02	
1S	171.87	171.77	dry	dry	dry	171.74	171.65	dry	171.68	171.83	171.85	
1D	171.87	171.77	171.07	170.88	171.10	171.74	171.65	171.13	171.65	171.80	171.82	
2S	171.84	171.74	171.11	dry	171.15	171.74	171.44	171.21	171.81	171.83	171.86	
2D	171.87	171.73	171.10	170.90	171.13	171.73	171.70	171.20	171.79	171.82	171.84	
2L	171.88	171.73	171.10	170.90	171.14	171.73	171.70	171.22	171.82	171.85	171.87	
3S	172.07	171.71	dry	dry	dry	171.68	171.70	171.42	171.86	171.94	172.10	
4S	172.08	171.79	dry	dry	dry	171.74	171.73	dry	171.83	171.88	172.28	
4D	172.07	171.79	171.41	171.11	171.24	171.73	171.72	171.51	171.82	171.88	172.25	
4L	172.13	171.78	171.42	171.11	171.24	171.73	171.73	171.51	171.83	171.89	172.29	
5S	171.88	171.79	171.14	dry	171.14	171.73	171.71	171.28	171.81	171.85	171.86	
5D	171.88	171.78	171.13	170.90	171.14	171.73	171.71	171.27	171.80	171.83	171.85	
6S	171.87	171.79	dry	dry	dry	171.76	171.68	171.15	171.67	171.82	171.81	
6D	171.88	171.81	171.06	170.84	171.10	171.77	171.69	171.15	171.67	171.82	171.81	
6L	171.87	171.79	171.04	170.84	171.08	171.76	171.68	171.16	171.68	171.83	171.82	
7S	171.87	171.78	dry	171.06	dry	171.73	171.48	171.07	171.58	171.82	171.80	
7D	171.88	171.78	170.98	170.64	170.94	170.73	171.48	171.06	171.58	171.82	171.80	
8S	171.89	171.70	dry	dry	dry	171.64	171.61	171.24	171.78	171.95	171.89	
8D	171.89	171.69	171.12	170.79	170.94	171.64	171.60	171.23	171.77	171.74	171.88	
8L	171.90	171.69	171.13	170.80	170.95	171.63	171.60	171.24	171.77	171.74	171.90	
9S	172.34	dry	dry	dry	dry	dry	dry	dry	dry	171.91	172.39	
10S	***	***	***	***	***	***	***	***	***	***	***	
10D	***	***	***	***	***	***	***	***	***	***	***	
Gauge												
A	171.87	171.79	dry	dry	dry	171.75	171.67	frozen	frozen	171.81	171.79	
B	171.87	171.79	dry	dry	dry	171.73	dry	dry	171.61	171.82	171.79	
C	172.27	dry	dry	dry	dry	dry	dry	dry	dry	dry	172.17	
D	170.98	170.83	170.60	nearly dry		nearly dry		170.74	170.63	frozen	frozen	170.88
	170.72											
E	171.01	170.85	170.65	170.61	170.64	170.75	170.66	frozen	170.68	170.60	170.76	

*	not yet installed
**	not measured
***	destroyed
BR	indicates bad reading
U	indicates upper monitoring well
D	indicates middle monitoring well
L	indicates lower monitoring well
S	indicates soil-zone monitoring well
SR	indicates shallow replacement soil-zone monitoring well

Appendix C: continued

Well	4/16/02	4/30/02	5/11/02	5/29/02	6/27/02	8/7/02	9/12/02	10/17/02	11/26/02	12/26/02	1/22/03
1S	171.82	171.83	171.86	171.80	171.52	171.53	dry	dry	dry	dry	dry
1D	171.79	171.80	171.83	171.78	171.53	171.53	171.00	171.04	171.01	171.10	170.96
2S	171.82	171.83	171.86	171.80	171.41	171.51	dry	dry	dry	dry	dry
2D	171.80	171.82	171.84	171.79	171.40	171.50	171.04	171.05	171.01	171.10	170.96
2L	171.83	171.84	171.87	171.82	171.39	171.50	171.04	171.05	171.00	171.09	170.96
3S	171.80	171.97	172.11	171.76	171.45	171.57	dry	dry	dry	dry	dry
4S	171.84	171.91	172.30	171.83	dry	171.67	dry	dry	dry	dry	dry
4D	171.83	171.90	172.28	171.82	171.55	171.59	171.27	171.07	171.01	171.03	171.00
4L	171.83	171.92	172.28	171.83	171.56	171.60	171.28	171.08	171.02	171.05	171.01
5S	171.83	171.84	171.86	171.82	171.44	171.44	171.09	dry	dry	dry	dry
5D	171.82	171.82	171.85	171.80	171.43	171.44	171.07	171.01	170.97	171.04	170.95
6S	171.82	171.82	171.83	171.80	171.57	171.52	dry	dry	dry	dry	dry
6D	171.82	171.81	171.83	171.80	171.58	171.52	171.00	170.99	170.96	171.05	170.94
6L	171.83	171.82	171.83	171.81	171.58	171.52	170.99	170.99	170.95	171.04	170.93
7S	171.81	171.81	171.82	171.79	171.33	171.21	dry	dry	dry	dry	dry
7D	171.81	171.82	171.82	171.78	171.31	171.19	170.80	170.69	170.65	170.71	170.62
8S	171.80	171.85	171.89	171.76	171.38	171.36	dry	dry	dry	dry	dry
8D	171.79	171.84	171.88	171.76	171.37	171.34	170.98	170.77	170.72	170.75	170.68
8L	171.78	171.85	171.90	171.75	171.37	171.34	171.00	170.78	170.72	170.76	170.69
9S	171.82	171.91	172.25	171.79	dry	dry	dry	dry	dry	dry	dry
10S	***	***	***	***	***	***	***	***	***	***	***
10D	***	***	***	***	***	***	***	***	***	***	***
Gauge											
A	171.80	171.80	171.81	171.78	dry	dry	dry	dry	dry	dry	dry
B	171.80	171.80	171.82	171.79	dry	dry	dry	dry	dry	dry	dry
C	dry	dry	172.28	dry	dry	dry	dry	dry	dry	dry	dry
D	170.93	170.83	170.82	170.72	170.78	170.48	dry	dry	dry	frozen	frozen
E	170.96	170.87	170.87	170.78	170.80	170.64	170.62	170.63	170.62	frozen	frozen

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Appendix C: continued

Well	3/3/03	4/1/03	4/15/03	4/29/03	5/13/03	5/27/03	6/10/03	6/23/03	8/4/03	9/4/03	9/25/03
1S	dry	171.50	171.32	171.57	171.85	171.73	171.78	dry	171.22	dry	dry
1D	170.84	171.50	171.32	171.56	171.83	171.73	171.77	171.05	171.21	170.70	171.11
2S	dry	171.51	171.36	171.57	171.85	171.62	171.77	dry	171.25	dry	dry
2D	170.85	171.49	171.35	171.57	171.85	171.62	171.77	171.11	171.25	170.73	171.05
2L	170.84	171.48	171.34	171.57	171.85	171.63	171.77	171.11	171.25	170.74	171.06
3S	dry	171.47	171.43	171.59	171.92	171.60	171.83	dry	dry	dry	dry
4S	dry	dry	dry	dry	171.88	dry	171.76	dry	dry	dry	dry
4D	170.93	171.37	171.42	171.59	171.88	171.63	171.75	171.38	171.37	170.93	170.96
4L	170.94	171.37	171.42	171.59	171.89	171.64	171.74	171.39	171.39	170.93	170.98
5S	dry	171.41	171.36	171.56	171.86	171.58	171.77	171.12	171.20	dry	dry
5D	170.83	171.40	171.35	171.55	171.85	171.58	171.76	171.12	171.20	170.66	170.82
6S	dry	171.47	171.31	171.57	171.84	171.78	171.72	dry	171.16	dry	dry
6D	170.80	171.47	171.31	171.58	171.85	171.79	171.73	171.03	171.17	170.59	170.85
6L	170.80	171.48	171.32	171.61	171.88	171.82	171.76	171.06	171.20	170.62	170.88
7S	dry	171.22	171.13	171.34	171.85	171.75	171.59	dry	dry	dry	dry
7D	170.53	171.20	171.12	171.33	171.85	171.75	171.59	170.88	170.94	170.26	170.31
8S	dry	dry	dry	171.43	171.86	171.45	171.67	dry	dry	dry	dry
8D	170.59	171.22	171.19	171.42	171.84	171.44	171.66	171.01	170.96	170.42	170.33
8L	170.60	171.21	171.19	171.41	171.84	171.43	171.65	171.02	170.97	170.43	170.34
9S	dry	dry	dry	dry	171.89	dry	dry	dry	dry	dry	dry
10S	***	***	***	***	***	***	***	***	***	***	***
10D	***	***	***	***	***	***	***	***	***	***	***
Gauge											
A	dry	dry	dry	dry	171.84	171.78	171.69	dry	dry	dry	dry
B	dry	dry	dry	dry	171.84	171.76	dry	dry	dry	dry	dry
C	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry
D	frozen	170.66	dry	dry	170.86	dry	dry	dry	dry	dry	dry
E	frozen	170.63	170.63	170.64	170.88	170.70	170.71	170.66	170.65	170.62	170.61

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Appendix C: continued

Well	10/29/03	12/1/03
1S	dry	171.21
1D	170.98	171.20
2S	dry	171.28
2D	170.97	171.27
2L	170.97	171.27
3S	dry	dry
4S	dry	dry
4D	170.88	171.29
4L	170.88	171.31
5S	dry	171.24
5D	170.82	171.23
6S	dry	dry
6D	170.80	171.15
6L	170.83	171.18
7S	dry	dry
7D	170.36	170.98
8S	dry	dry
8D	170.33	170.88
8L	170.33	170.88
9S	dry	dry
10S	***	***
10D	***	***
Gauge		
A	dry	dry
B	dry	dry
C	dry	dry
D	dry	dry
E	170.62	170.64

*	not yet installed
**	not measured
***	destroyed
BR	indicates bad reading
U	indicates upper monitoring well
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Appendix D: Geologic logs

Borehole: **1D**
Drilled by: **Hand auger**
Location: **NW ¼, NE ¼ Section 19, T17N, R1W, Rock Island Co., IL**

Depth (m)	**Description**
0.00-0.45	Clayey sand, black (10YR2/1); no mottles; slightly sticky and plastic, friable high organic content, roots to 0.25 m; weak granular structure; gradational lower boundary.
0.45-0.68	Silty sand, very dark gray (10YR3/1); no mottles; less organic material than above; massive structure; sand is very fine, well-sorted, rounded, quartz sand; clear lower boundary.
0.68-1.00	Silty sand, dark grayish brown (10YR4/2); common, fine, brownish yellow (10YR6/8) mottles; slightly sticky and plastic; firm; massive structure; sand is fine, rounded, quartz sand; gradational lower boundary.
1.00-1.52	Silty sand, grayish brown (10YR5/2); fine to medium, common, prominent, yellowish brown (10YR5/8) mottles; not sticky, slightly plastic; friable; massive structure; sand is fine, well-sorted, sub-rounded quartz sand; higher sand content than above.
1.52-1.92	Silty sand, gray (10YR5/1); many, large, prominent, brownish yellow (10YR6/8) mottles; not sticky or plastic; slightly cohesive (forms balls); massive structure; sand is fine, well-sorted, rounded, quartz sand.

Borehole: **2D**
Drilled by: **Hand auger**
Location: **NW ¼, NE ¼ Section 19, T17N, R1W, Rock Island Co., IL**

Depth (m)	**Description**
0.00-0.56	Clayey silt, black (10YR2/1); no mottles; very sticky and plastic; very fine, weak, subangular blocky structure; clear lower boundary.
0.56-0.61	Clayey silt, dark gray (10YR4/1); fine, rounded, quartz sand; slightly plastic; firm; massive structure.
0.61-1.07	Sandy silt, gray (10YR5/1); common, fine, prominent, mottles; slightly sticky and plastic; massive structure; sand is fine, rounded, well-sorted, quartz sand; clear lower boundary.
1.07-1.57	Silty sand, gray (10YR6/1); brownish yellow (10YR6/8) mottles; not sticky or plastic; forms balls; massive structure; sand is fine, rounded, well-sorted, quartz sand, clear lower boundary.
1.57-1.99	Sandy silt, gray (10YR5/1); common, fine, distinct, yellowish brown (10YR5/6) mottles; slightly sticky and plastic; firm; massive structure.

Appendix D: continued

Borehole: **2L**
Drilled by: **Hollow-stem auger**
Location: **NW ¼, NE ¼ Section 19, T17N, R1W, Rock Island Co., IL**

Depth (m)	**Description**
0.00-0.76	no sample
0.76-1.22	no sample
1.22-1.52	no sample
1.52-1.98	Sandy silt; not sticky or plastic; sand is fine, well-sorted, subrounded.
1.98-2.28	no sample, shale encountered at 2.28 m, gray, fresh, very hard, split spoon was broken trying to conduct blow test.

Borehole: **4D**
Drilled by: **Hollow-stem auger**
Location: **NW ¼, NE ¼ Section 19, T17N, R1W, Rock Island Co., IL**

Depth (m)	**Description**
0.00-0.58	Clayey silt, very dark gray (10YR3/1); no mottles; plastic and sticky; firm; fine, moderate, subangular blocky structure.
0.58-0.79	Sandy silt, dark gray (10YR4/1); no mottles; slightly plastic and sticky; firm; massive structure; gradational lower boundary.
0.79-1.27	Sandy silt, dark gray (10YR4/1); many, fine, distinct, yellowish brown (10YR5/8) mottles; slightly plastic and sticky; firm; massive structure.
1.27-1.60	Clayey silt, light brownish gray (2.5YR6/2); common, medium, distinct, yellowish brown (10YR5/8) mottles; very plastic and sticky; firm; massive structure; abrupt lower boundary.
1.60-1.75	Silty, clayey, sand, gray (2.5Y5/1); common, fine, prominent, yellowish brown (10YR5/8) mottles; slightly sticky and plastic; firm; massive structure; sand is fine, rounded, and well-sorted.
1.75-1.90	Silty sand, brown (10YR5/3); common, fine, distinct, yellowish brown (10YR5/6) mottles; not sticky or plastic; friable; massive structure; sand is fine, rounded, and well-sorted.

Appendix D: continued

Borehole:	**4L**
Drilled by:	**Hollow-stem auger**
Location:	**NW ¼, NE ¼ Section 19, T17N, R1W, Rock Island Co., IL**

Depth (m)	**Description**
0.00-0.76	no sample
0.76-1.16	no recovery
1.16-1.22	Clayey silt, dark gray (10YR4/1); common, fine, distinct, yellowish brown (10YR5/6) mottles; sticky and plastic; firm; massive structure.
1.22-1.52	no sample
1.52-1.98	Silty sand, gray (10YR6/1) with 2-3 cm thick sand lenses; common, medium, distinct, yellowish brown (10YR5/6) mottles; black MnO nodules; sand is fine, rounded, well-sorted.
1.98-2.28	no sample
2.28-2.74	Sand and gravel, grayish brown (10YR5/2); very poorly-sorted; fine to medium sand, gravel, and pebbles; sub-rounded.
2.74-3.26	Sand with gravel, gray (10YR5/1); moderately-sorted; sub-rounded; shale fragments.
3.26-3.35	Shale, gray, hard.

Borehole:	**5D**
Drilled by:	**Hand auger**
Location:	**NW ¼, NE ¼ Section 19, T17N, R1W, Rock Island Co., IL**

Depth (m)	**Description**
0.00-0.44	Clayey silt, black (10YR2/1); no mottles; very sticky and plastic; weak, fine, subangular blocky structure; no clay films; diffuse lower boundary.
0.44-0.80	Sandy silt, very dark gray (10YR3/1); no mottles; slightly plastic and sticky; firm; massive structure.
0.80-1.02	Sandy silt, grayish brown (2.5Y5/2); common, fine, distinct, yellowish brown (10YR5/8) mottles; plastic and sticky; firm; massive structure.
1.02-1.58	Silty sand, grayish brown (2.5Y5/2); common, medium, prominent, yellowish brown (10YR5/8) mottles; not sticky or plastic; friable; massive structure; sand is fine, rounded, and well-sorted.
1.58-1.90	Sandy silt, light grayish brown (2.5Y6/2); common, medium, distinct, yellowish brown (10YR5/8) mottles; slightly sticky and plastic; friable.

Appendix D: continued

Borehole: **6D**
Drilled by: **Hand auger**
Location: **NW ¼, NE ¼ Section 19, T17N, R1W, Rock Island Co., IL**

Depth (m)	Description
0.00-0.50	Clayey silt, black (10YR2/1); no mottles; sticky and plastic; firm; fine, weak, subangular blocky structure; diffuse lower boundary.
0.50-1.10	Sandy silt, dark gray (2.5YR4/1); few to common, fine, distinct, yellowish brown (10R5/8) mottles; slightly sticky and plastic; friable; massive; gradational lower boundary.
1.10-1.92	Silty sand, gray (10YR5/1); many, medium, distinct, yellowish brown (10YR5/6) mottles; not sticky or plastic; slightly cohesive; massive; percentage of sand increases with depth; sand is fine, rounded, well-sorted.

Borehole: **6L**
Drilled by: **Hollow-stem auger**
Location: **NW ¼, NE ¼ Section 19, T17N, R1W, Rock Island Co., IL**

Depth (m)	Description
0.00-0.76	no sample
0.76-1.22	Sandy, silty, clay, very dark gray (10YR3/1); no mottles; weak subangular blocky structure.
1.22-1.52	no sample
1.52-1.98	no sample
1.98-2.28	no sample
2.28-2.74	Sand and gravel, dark gray (10YR4/1); very poorly sorted, medium sand to coarse gravel and pebbles; slightly cohesive; not sticky or plastic; shell fragments.
2.74-3.05	no sample
3.05-3.20	Sand and gravel as above
3.20-3.35	Silty, sandy, clay, black (10YR2/1); massive structure; wood fragments; possible peat layer?
3.35-3.47	Sand, dark gray (10YR4/1); moderately-sorted, sub-rounded, with weathered shale and shell fragments.
3.47-4.19	Shale, greenish gray (5G5/1); very hard; dry.

Appendix D: continued

Borehole: **7D**
Drilled by: **Hand auger**
Location: **NW ¼, NE ¼ Section 19, T17N, R1W, Rock Island Co., IL**

Depth (m)	**Description**
0.00-0.59	Clayey silt, black (2.5YR2.5/1) grading to very dark gray (2.5Y4/2) at 0.43 m; dry to moist; soft; massive; gradational lower boundary.
0.59-1.82	Silty sand, dark gray (10YR4/1) grading to gray (2.5Y6/1) at 1.35 m; common, fine, distinct, brownish yellow (10YR6/8) mottles; saturated; soft; massive structure; silt content decreases from about 50% at the top to 10% at the bottom of the sample; sand is very fine - medium, poorly-sorted; subangular to rounded.

Borehole: **8D**
Drilled by: **Hand auger**
Location: **NW ¼, NE ¼ Section 19, T17N, R1W, Rock Island Co., IL**

Depth (m)	**Description**
0.00-0.64	Clayey silt, black (2.5Y2.5/1); no mottles; dry to moist; slightly stiff; massive structure; gradual lower boundary.
0.64-1.34	Clayey silt, dark gray (5Y4/1); common to many, distinct, olive (5YR4/3) grading to olive yellow (2.5Y6/8) mottles; saturated; slightly stiff; massive structure; gradual lower boundary.
1.34-1.82	Clayey silt, gray (5Y6/1); many, medium, distinct, strong brown (7.5YR5/8) mottles; moist to wet; slightly stiff; massive structure; non-calcareous; sharp lower contact.
1.82-1.85	Sand, fine-medium, with ~10% silt, grayish brown (2.5YR5/2); poorly-sorted; subangular to rounded; massive.

Appendix D: continued

Borehole: **8L**
Drilled by: **Hollow-stem auger**
Location: **NW ¼, NE ¼ Section 19, T17N, R1W, Rock Island Co., IL**

Depth (m)	**Description**
0.00-0.76	no sample
0.76-1.22	Clayey silt, gray (10YR6/1); fine, common, distinct, yellowish brown (10YR5/6) mottles; slightly sticky and plastic; firm; massive structure.
1.22-1.52	no sample
1.52-1.68	Clayey silt, gray (10YR6/1); fine, common, distinct, yellowish brown (10YR5/6) mottles; slightly sticky and plastic; firm; massive structure.
1.68-1.98	Silty sand, gray (10YR6/1); common, fine, distinct, yellowish brown (10YR5/6) mottles; not sticky or plastic; very friable; massive structure.
1.98-2.28	no sample
2.28-2.44	Clayey silt and sand
2.44-2.59	Sand, brown; fine, well-sorted, rounded.