RIPARIAN ZONE HYDROLOGY AND HYDROGEOMORPHIC SETTING OF A GLACIATED VALLEY IN CENTRAL INDIANA

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ABSTRACT

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This study investigates the hydrological functioning of a riparian zone in central Indiana in a glaciated valley with concave topography (16% slope gradient) and ground water seeps on the valley walls. Unlike sites found in most riparian zone studies with lateral ground water inputs (Clement et al., 2003; Jordan et al., 1993; Blicher-Mathiesen and Hoffman, 1999; Hoffman et al., 2000), the site in this study is connected to thin, permeable upland sediments (≈2 m). The objectives of this research include: 1) understanding the influence of the hydrogeomorphic (HGM) setting on riparian hydrology (including determining the sources of water to the site), 2) determining how the HGM setting influences riparian zone water quality functioning, and 3) comparing the results from this site with conceptual models of riparian zone hydrologic functioning. Water chemistry and hydrometric data were collected over a 16-month period. Three factors influence riparian zone hydrological functioning at the site: 1) the nature of water contributions from upland sources, 2) riparian zone soil texture, and 3) the location of a preWisconsinan till unit. When the uplands are contributing water to the riparian zone a shallow water table is found near the hillslope and ground water flows from the hillslope to the stream. Conversely, when upland contributions cease a large water table drop occurs and ground water flows in a downvalley direction. Fine textured soils near the hillslope result in shallow water tables and small ground water fluxes. Hydrometric data, water chemistry, and statistical analyses suggest water from an intertill layer adjacent to the site is the primary source of water to the site. NO_3^- concentrations decreased in ground water flow in the riparian zone suggesting the site is removing nutrients. A preWisconsinan glacial till deposit at shallow depths in the riparian zone limits ground water flow to horizontal flow paths. Overall, the hydrologic functioning of the site agrees well with riparian zone conceptual models (Vidon and Hill, 2004a; Vidon and Hill, 2004b; Devito et al., 1996; Hill, 2000; Baker et al., 2001; Burt et al., 2002). The results of this study are important additions towards conceptualizing riparian zone hydrologic functioning.

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INTRODUCTION

Riparian zones provide habitat for wildlife, maintain plant species diversity, and act as a buffer between terrestrial and aquatic systems (Mitsch and Gosselink, 2000; Hefting et al., 2004). Because of their crucial position between upland and aquatic systems they are able to regulate energy, nutrient, and organic matter fluxes (Hefting et al., 2004). Riparian buffer zones have been used, particularly in the last 25 years, to mitigate the effects of nonpoint source pollutants on water quality, especially in small streams with over three quarters of total stream length in the United States accounted for by first, second, and third order streams (Lowrance et al., 1997; Hill, 1996; Puckett et al., 2002). Hydrologic and biogeochemical interactions in the nearstream zone are complex and the role of riparian zones as nutrient sinks is still unclear (Devito et al., 2000b; Cirmo and McDonnel, 1997; Hill, 1996; Burt et al., 2002; Lowrance and Sheridan, 2005; Angier et al., 2005).

Many studies have shown that in order to understand the biogeochemical functioning of riparian zones, we need to first understand how ground and surface water interact in these systems (Atekwana and Richardson, 2004; Hill, 2000; Vanek, 1991; Mulholland, 1992; Devito et al., 2000b; Puckett et al., 2002; Peterjohn and Correll, 1984; Lowrance et al., 1984; Hedin et al., 1998; Lowrance et al., 1997; Hefting et al., 2004; Vellidis et al., 2003; Vidon and Hill, 2004a; Cirmo and McDonnell, 1997). This involves characterizing riparian hydrological components such as ground water flow path, water table fluctuation, rates of ground movement, and sources of water to the riparian zone for riparian zones in many different hydrogeological settings. For example, a number of studies have looked at the mechanisms and riparian characteristics that are conducive to nutrient removal in nearstream zones (Dosskey, 2001; Hill, 1996; Puckett et al., 2002) and illustrated the importance that understanding of riparian zone hydrology plays in determining the behavior of contaminants in these settings (Peterjohn and Correl, 1984; Lowrance, 1998; Haycock and Pinay, 1993; Hill, 1996). The occurrence of denitrification has been linked to water table fluctuation, which influences the amount of oxygen available in the soil (Burt et al., 2002; Devito et al., 2000b; Gold et al., 2001; Hefting et al., 2004). Hefting et al. (2004) found that in sites where the average water table elevation was within 10 cm of the soil surface, ammonification was the main process occurring, whereas denitrification was the dominant process when the water table was between 10 and 30 cm below ground surface (BGS) and nitrification was the dominant process when water table was below 30 cm BGS. This emphasizes the importance of water table fluctuations in the riparian zone to nitrogen cycling. Results illustrating the importance of hydrology on nitrogen cycling in riparian zones have also been reported by Gold et al. (2002), Simmons et al. (1992), Haycock et al. (1993), Correll (1997) and others.

Understanding riparian hydrology is also important to understand the fate of many other chemicals in riparian systems. Biogeochemical processes relating to phosphorus are sensitive to redox conditions in the soil, which is strongly influenced by water table fluctuations and biological activity (Burt et al., 2004; Hite and Cheng, 1996). In a cropland and adjacent riparian forest, Peterjohn and Correll (1984) showed that 41% of phosphorous export from the riparian forest was via ground water flow, thus emphasizing the importance of riparian zone hydrology in influencing nutrient fluxes. They also showed that surface runoff was a dominant pathway of phosphorous flux between the cropland and riparian forest. Changes in ground water flowpath and water table elevation also influence dissolved organic carbon and dissolved oxygen patterns in riparian zones (Hill, 2000; Vidon and Hill, 2004a; Hinton et al., 1998). The fate of several additional parameters has been linked to riparian zone hydrology including ammonium (NH_4^+) (Hubbard and Lowrance, 1997; Peterjohn and Correll, 1984), sulfate (SO_4^{-2}) (Lowrance et al., 1984), dissolved organic nitrogen (Lowrance et al., 1984, Peterjohn and Correll, 1984), and some pesticides (Lowrance et al., 1997).

Recent research has emphasized the importance of the HGM setting (topography, soil texture, thickness of permeable upland and riparian zone sediments, etc.) at controlling riparian hydrology. For instance, shallow aquifers are more prone to surface water contamination than deep ground water sources (Stein et al., 2004), but can be more effective at removing NO_3^- due to increased contact between shallow ground water and surficial soils (Hill, 1996). Understanding the spatial and temporal variation in sources of water to riparian zones can also help determine the sensitivity of riparian systems to changes in precipitation and surface water contamination in upland areas. The relative contributions of various sources of water to riparian zones such as deep ground water, shallow ground water, upland soils, and overland flow have been studied during episodic precipitation events (McGlynn et al., 1999; Hill, 1993; Waddington et al., 1993); however, processes controlling the contributions of these various sources are still poorly understood (McGlynn et al., 1999; Peters et al., 1995; Angier et al., 2005). While many studies look at sources of water to the riparian zone during precipitation events (Rodhe, 1989; Dalzell et al., 2005; Waddington et al., 1993; Sklash and Farvolden, 1979; Pearce et al., 1986; Dunne, 1978), the study of temporal and spatial relationships between various sources of water to a riparian zone during an entire hydrological cycle is less common.

In addition, research has also emphasized the need to characterize the hydrological functioning of riparian zones in many different HGM settings (Correll, 1997; Lowrance et al., 1997; Cirmo and McDonnell, 1997; Hill, 2000; Vidon and Hill, 2004b). The most common HGM settings studied in the literature include riparian zones with large upland water storage and concave or flat topography (Cirmo and McDonnell, 1997; Devito et al., 2000a; Vidon and Hill, 2004b), and riparian zones with medium to small upland water storage with flat or steep convex topography (Lowrance, 1992; Lowrance et al., 1995; Mengis et al., 1999; Jordan et al., 1993; Puckett et al., 2002; Angier et al., 2005; Bosch et al., 1996; Maitre et al., 2003; Wigington et al., 2003).

In this study, we investigate a riparian zone located in an incised, glaciated till valley with ground water seeps located on the valley walls and a steep concave topography. Unlike sites found in the majority of riparian zone studies with lateral ground water inputs (Clement et al., 2003; Jordan et al., 1993; Blicher-Mathiesen and Hoffman, 1999; Hoffman et al., 2000), the site in this study is not connected to a large upland aquifer (> 6 m of permeable sediments). HGM settings similar to those found at the study site examined in this paper are common throughout the glaciated Midwest (Thompson et al., 1992). Nevertheless, reviews of riparian literature indicate a dearth of data from sites with a small upland aquifer (< 2 m of permeable upland sediments) linked to a riparian zone with medium to large ground water storage capacity and a steep concave topography.

The purpose of this study is to determine the influence of this specific type of HGM setting on riparian zone hydrological functioning. Presented first is the HGM setting of the site along with the temporal and spatial variation in water table fluctuations, ground water flow direction, and water chemistry at the site and how this relates to the sources of water to the riparian zone. A conceptual model linking the results of this study to the generalized HGM setting of the riparian zone is then presented. Specific research objectives include: 1) understanding the influence of the HGM setting on riparian hydrology (including determining the temporal and spatial distribution in sources of water to the riparian zone), 2) gaining insight towards the water quality functioning of this HGM setting, and 3) comparing the HGM setting of this site and its hydrological functioning to those found in the literature.

These objectives are significant because linking HGM settings to hydrology can help develop better predictive models of riparian zone functioning based on easily identifiable landscape features. These models are essential to further understanding of riparian water quality functions at the watershed and landscape scale (Rosenblatt et al., 2001). Through the use of widely available maps and data such as topographic maps, surficial geologic maps, well logs, and digital elevation models, sites can be classified based on their landscape features. If hydrologic functioning can be linked to specific landscape features, identifying sites with specific landscape characteristics will allow us to determine how that site is functioning from a hydrologic standpoint. This has positive implications from a watershed management viewpoint. Research at this site is also significant because understanding the influence of the HGM setting on riparian hydrology and determining the temporal and spatial distribution in sources of water to the riparian zone will provide insight towards the sensitivity of this particular HGM setting to potential changes in water quality.

STUDY SITE

The Scott Starling Nature Sanctuary (SSNS) study site (Figure 1) lies within the Fishback Creek watershed, which is located in central Indiana (6 km northwest of Indianapolis, Indiana). The watershed landscape is largely shaped by late Wisconsinan glaciations, which are responsible for the complex hydrogeological setting of the study site, which will be explained in the following paragraphs. The upper portion of the watershed is mainly agricultural with little topographic relief. The lower portion of the watershed, which has considerably more relief than the upper two-thirds of the watershed, includes the study site. Fishback Creek, the largest stream within the watershed, is underfit and runs through the study site and drains an area of 60 km^2 (Figure 2a) (Barr et al., 1996). Fishback Creek is incised in the lower portion of the watershed creating a glaciated valley with alluvial deposits and surficial soils—including a riparian zone—near the stream (Figure 2b). The Fishback Creek valley is a tributary valley and joins the larger Eagle Creek valley approximately 600 m downstream from SSNS (Figure 1). The area surrounding the study site has been preserved because of the unique geological, hydrological, and ecological characteristics it possesses making it a key resource for education (Barr et al., 1996). SSNS is especially important from an ecological standpoint due to high biological diversity along the riparian corridor in this part of the watershed (Barr et al., 1996).

Bedrock geology in the watershed consists of late Devonian to early Mississippian shales (Harrison, 1963). Overlying the bedrock surface is glacial till deposited during preWisconsinan and Wisconsinan glacial advances and retreats (Hartke et al., 1980). Till thickness is approximately 50-55 m in the upland areas and

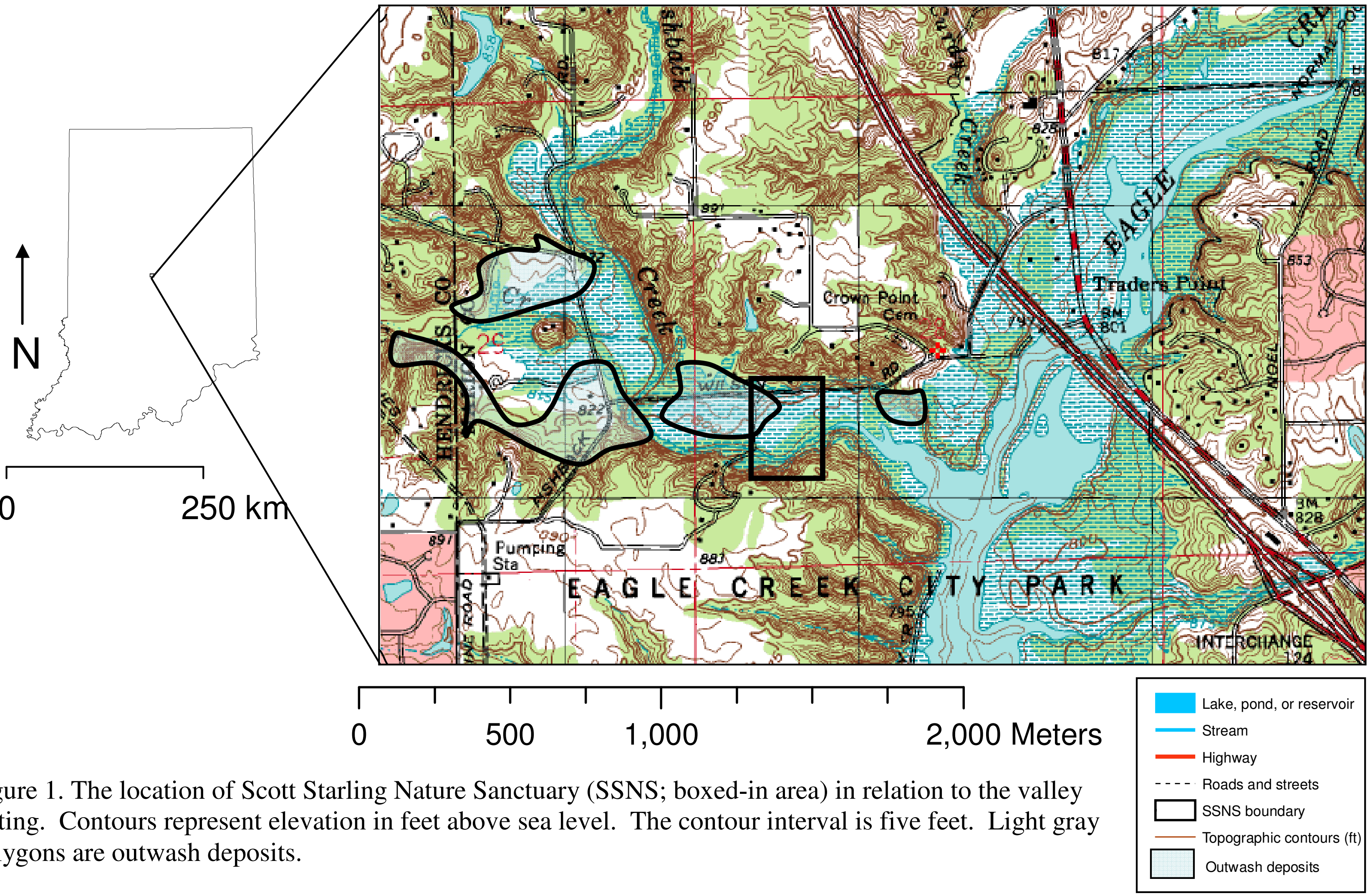


Figure 1. The location of Scott Starling Nature Sanctuary (SSNS; boxed-in area) in relation to the valley setting. Contours represent elevation in feet above sea level. The contour interval is five feet. Light gray polygons are outwash deposits.

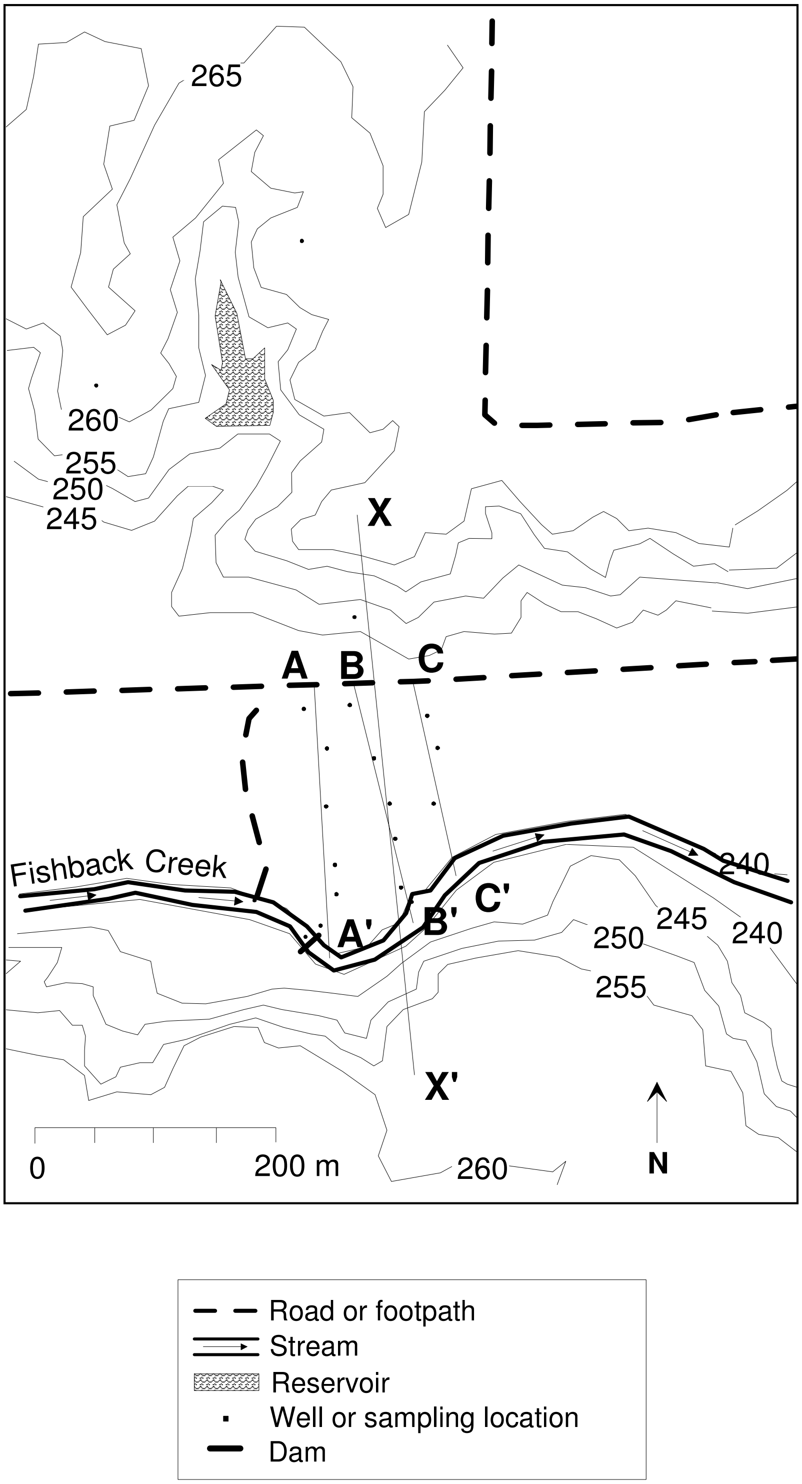


Figure 2a. Map of study site showing topography and location of transects. Contour lines are in meters.

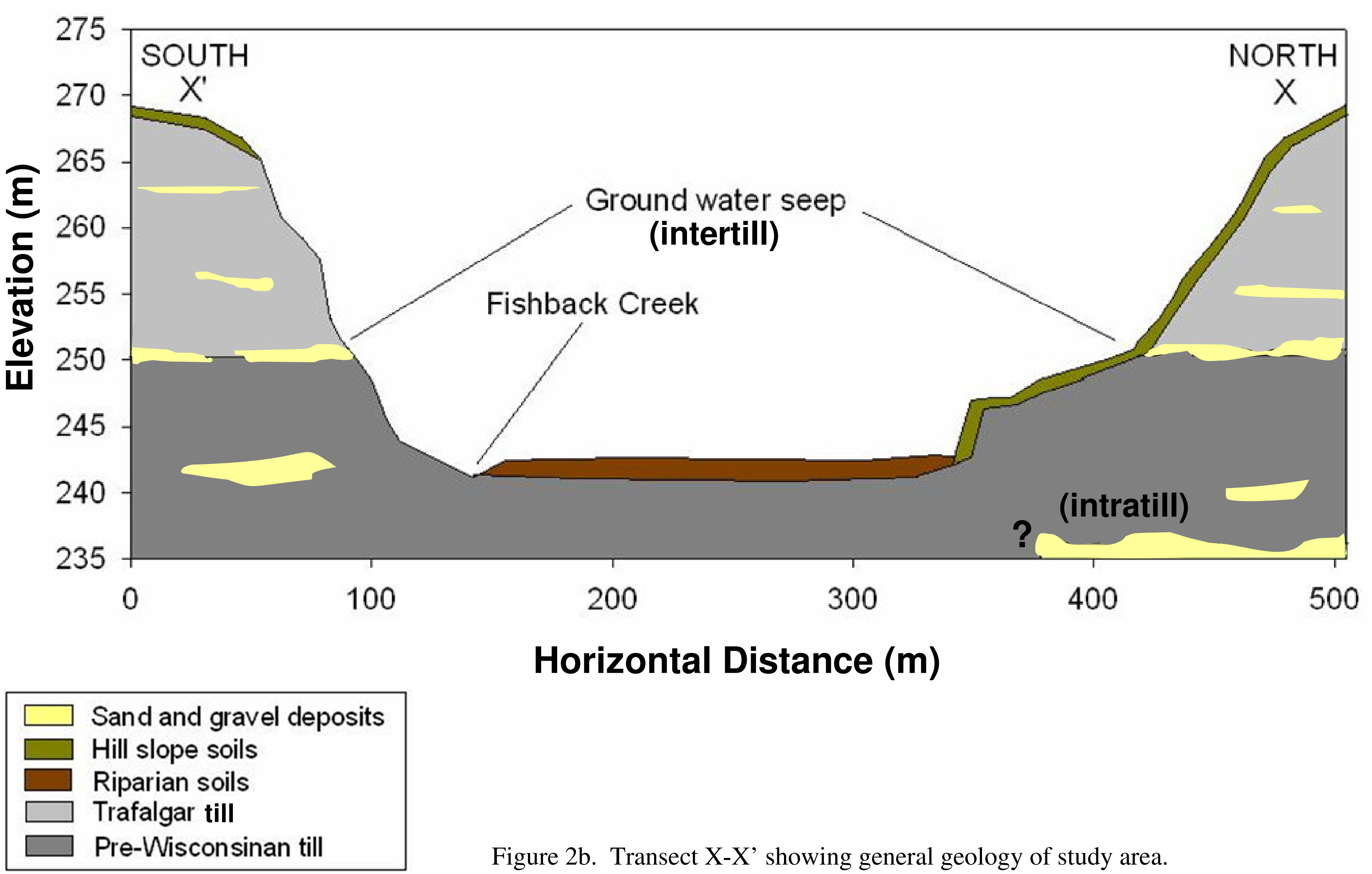


Figure 2b. Transect X-X’ showing general geology of study area.

approximately 20-25 m thick underlying alluvial deposits near the stream (Hartke et al., 1980). Two layers of till have been identified at the study site (Harrison, 1963). The highly compacted and poorly sorted lower till unit is an aquitard and is preWisconsinan in age and simply called preWisconsinan as no Illinoian drift has been positively identified in the area (Harrison, 1963). The lower preWisconsinan till unit forms the bed of Fishback Creek. The upper unit is Wisconsinan in age and called the Trafalgar till unit (Harrison, 1963). Harrison (1963) described typical till in this area as coarse silt to fine sand and high in carbonates due to high percentages of limestone and dolomite bedrock that were eroded by glacial meltwater streams. Both till units were incised by glacial meltwater outbursts during the Wisconsinan Epoch, resulting in the relatively steep topography found at the study site compared to the upper two-thirds of the watershed.

Both till units transmit minimal amounts of ground water, but contain unevenly distributed sand and gravel lenses that act as preferential flowpaths (Fleming et al., 2003). A variety of sand and gravel units are present at or just below the surface of the lower, preWisconsinan deposits, and are considered significant sources of water in areas of central Indiana (Figure 2b) (Fleming et al., 2003). Well logs indicate the presence of several relatively large sand and gravel bodies (average thickness of approximately 5 m) within the lower preWisconsinan till unit starting at approximately 10-12 m below the upper surface of the till (approximately 4-6 m below the riparian surface) (IDNR, water well record database). Several residential wells in the adjacent upland are finished in these sand and gravel layers (IDNR, water well record database). Henceforth, the sand and gravel layers within the lower preWisconsinan till unit will be referred to as intratill layers and water collected from these layers will be called intratill (IA) water. Within the upper Trafalgar till unit, small lenses of sand and gravel are commonly found, but are often too thin and discontinuous to be considered significant aquifers (Fleming et al., 2003). Field observations at the study site have confirmed the presence of a discontinuous sand and gravel unit located at the contact between the upper Trafalgar till unit and the lower preWisconsinan till unit (approximately 8 m above the riparian surface). Hereafter, the sand and gravel layer at the contact between the upper Trafalgar till unit and the lower preWisconsinan till unit will be referred to as the intertill layer and water collected from these deposits will be called intertill (IE) water. One explanation for the origin of these deposits is that they were deposited by water pouring off the retreating glacier (Barr et al., 1996; Harrison, 1963). The thickness of the intertill layer is unknown; however, field observations and work done by Harrison (1963) estimate the sand and gravel layer to be anywhere from 0.3-1 m thick. Ground water infiltrates then flows laterally across the upper surface of the preWisconsinan till unit—within the intertill layer—and discharges to the surface or shallow hillslope soils as it encounters a break in slope (Barr et al., 1996). These ground water seeps are believed to be an important source of water to the riparian zone and have been observed in a number of locations adjacent to and upstream from the study site.

Stream valleys located in central Indiana are often backfilled with extremely permeable outwash deposits (Barr et al., 1996; Tedesco et al., 2003). Field observations have confirmed the presence of at least one outwash deposit in the immediate vicinity of the study site and several in the lower part of the Fishback Creek watershed (Figure 1). Ground water seeps have been observed forming along the outer edges of these deposits.

In the area surrounding the study site, glacial till is covered by alluvial deposits and soils on the valley floor and shallow soils in the uplands (Figure 2b) (Barr et al., 1996). In upland areas surrounding the site the preWisconsinan till unit and the Trafalgar till unit are covered by a thin layer of soils with limited water storage capability and estimated to be 1.5 to 2 m in depth (IDNR, water well record database). On the valley floor the preWisconsinan till unit is capped by a thin layer of alluvium on which riparian zone soils have formed (1.2 to 2 m combined depth). Riparian zone soils are primarily loam and sandy loam in texture (L.R. Casey and B. Simpson, unpublished; Webber et al., 2003) and are estimated to have medium to large water storage capability. A more detailed description of riparian zone soils is presented in the "Results" chapter. Topography in the study area is characterized by the Fishback Creek valley which is bounded by steep bluffs and consists of a narrow floodplain on the south and west sides of the creek (Figures 2 and 3) (Tedesco et al., 2003). In contrast, a broad, gently sloping concave floodplain (approximately 190 m wide) with moderate to steeply sloping valley walls (16% slope approximately 220 m long) characterizes the north and east sides of the creek.

Annual precipitation at the site is 104 cm/yr with approximately 32.8 cm falling as rain during the wettest months of May, June, and July (Figure 4) (NOAA, climatological data). January, February, and October mark the driest months with a combined total of 19.4 cm of precipitation (rain and snow) typical of these three months. The mean annual temperature is 11.4 °C with a mean January temperature of -3.1 °C and a mean July temperature of 24.1 °C. Stream flow diminishes greatly from mid-summer through late fall.

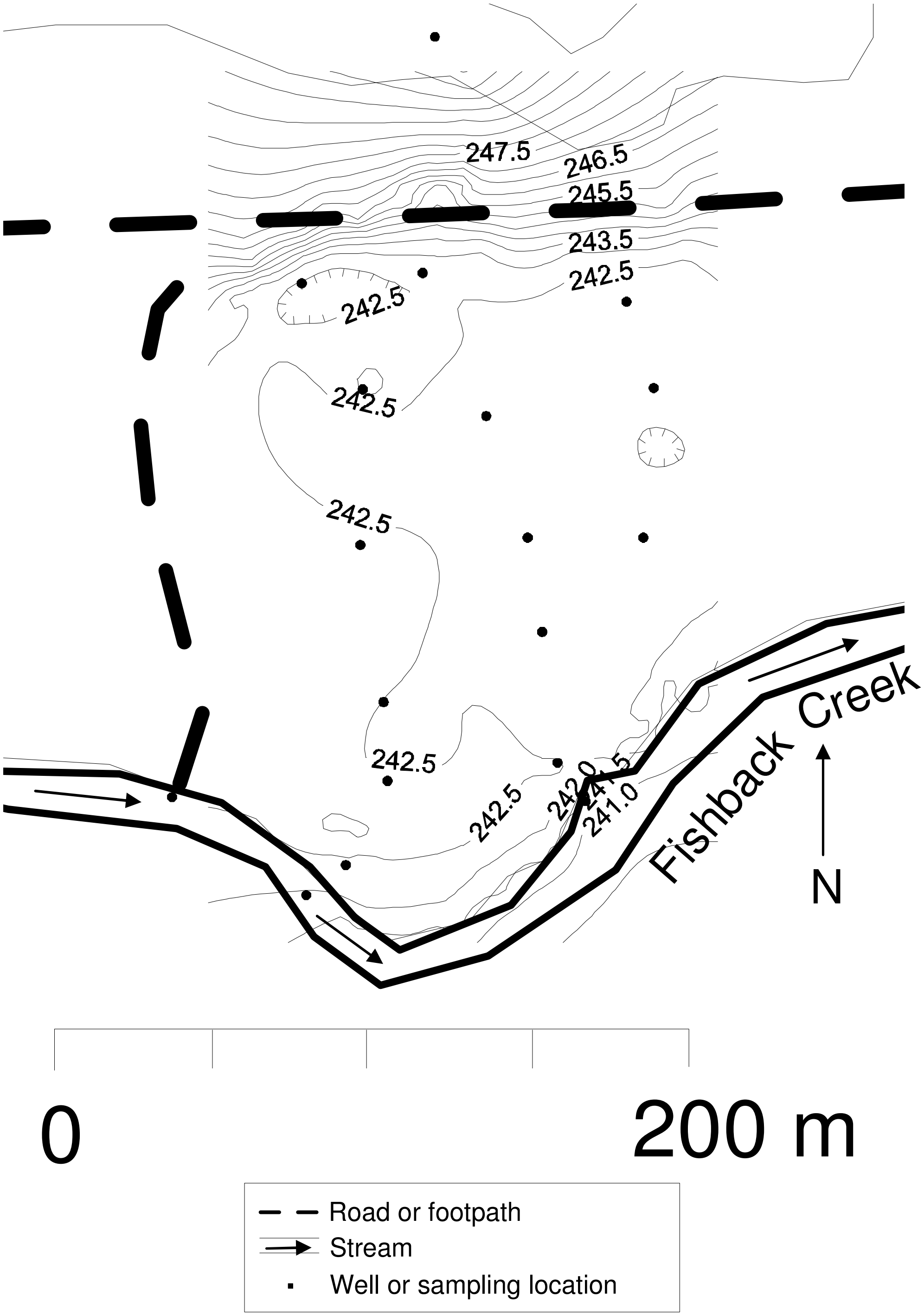


Figure 3. Detailed topography of the riparian zone and the lower portion of the hillslope. Contours are in meters. The contour interval is 0.50 m.

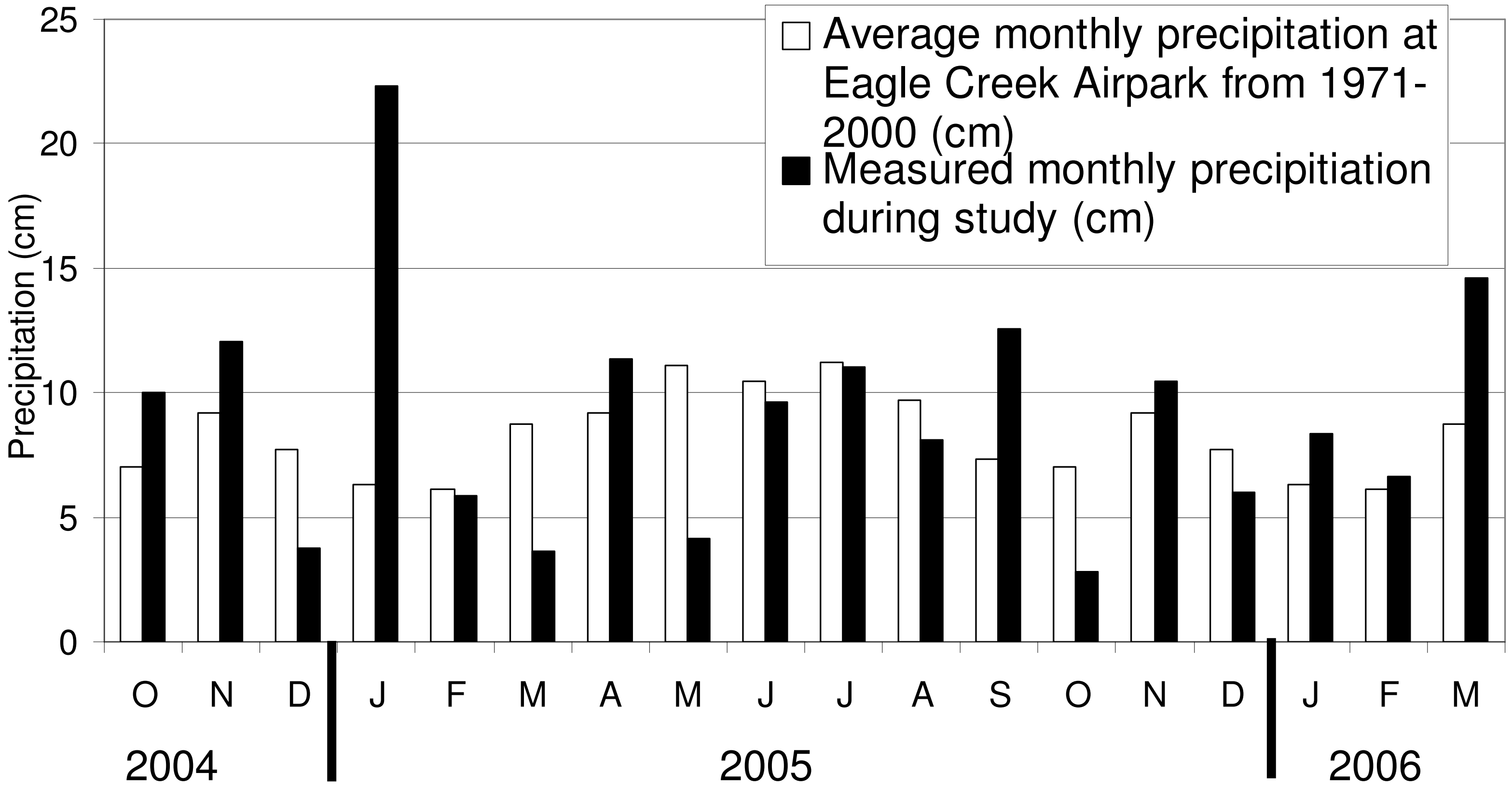


Figure 4. Average precipitation (1971-2000) and actual precipitation amounts recorded during the study.

METHODS

Site Hydrology

Soil textures were determined in the field using the feel method (Thien, 1979; NCSR, determination of soil texture). Soil results were also supplemented by results using dry sieving (Casey and Simpson, unpublished). Stratigraphy of surrounding areas was determined using sediment descriptions from residential well logs (IDNR, water well record database). Topography of the study site and a portion of the surrounding upland area were surveyed using a total station (TC 605L Surveying TPS, Leica Geosystems) with an error of +/- 2 mm. All total station elevations were taken relative to a bench mark located at the study site; therefore, all measurements were calculated in meters above sea level. For the remaining areas of the study site, topography was determined using five foot contours downloaded (IGS, reference downloads) and imported into Surfer (Golden Software, 1999).

A total of three transects of wells and piezometers were installed at the site perpendicular to stream flow. These transects are composed of a total of 15 monitoring wells (5 cm diameter, PVC, screened entire depth) and 42 piezometers (1.74 cm diameter, PVC, 20 cm screened interval) installed with a hand-auger (Figure 5; Table 1). Each of the 14 monitoring wells in the riparian zone is accompanied by three piezometers: at depths of 50 cm, 100 cm and > 100 cm or as deep as was possible (exact depth for the deepest piezometer in each nest listed in Table 1). Monitoring wells are labeled 1-14. Piezometer labels follow the monitoring well naming convention but have letters following them corresponding to depth. For example, the piezometer at a depth of 50 cm at well nest 4 is labeled 4a, the piezometer at 1 m depth is 4b, and the deepest

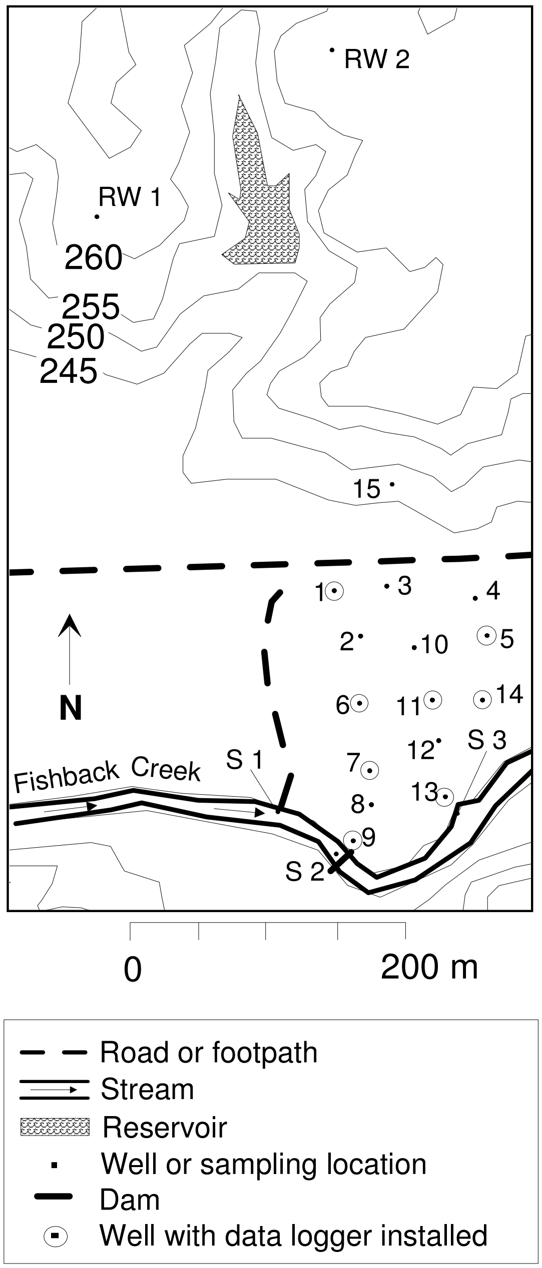


Figure 5. A map of the study site showing the sampling network. Well nests 1 though 14 consist of one monitoring well and three piezometers (50 cm, 100 cm, and >100cm depth). Well nests that are circled contain monitoring wells fitted with data loggers. Well 15 is finished in the sand and gravel layer located between the preWisconsinan and Trafalgar till units (intertill water). S 1, S 2, and S 3 represent stream stage measurement points. Stream samples were collected at S 2. RW 1 and RW 2 are residential wells in the upland that were sampled to collect water from the interbedded sand and gravel layer in the preWisconsinan till unit (intratill water).

Well Nest	Sample Name	Surface El. (m)	Riser Height (cm)	Riser El. (m)	Depth (cm)	Screened Interval (cm)	El. of Bottom of Well (m)
1	1	242.693	50	243.193	135	135	241.343
	1a	242.693	48	243.168	50	20	242.193
	1b	242.693	48	243.084	100	20	241.693
	1c	242.693	53	243.076	125	20	241.443
2	2	242.426	50	242.926	122	122	241.206
	2a	242.426	55	243.004	50	20	241.926
	2b	242.426	54	242.983	100	20	241.426
	2c	242.426	53	242.954	166	20	240.766
3	3	242.764	50	243.264	153	153	241.239
	3a	242.764	57	243.324	50	20	242.264
	3b	242.764	53	243.287	100	20	241.764
	3c	242.764	58	243.332	192	20	240.844
4	4	241.679	50	242.179	153	153	240.154
	4a	241.679	56	242.740	50	20	241.179
	4b	241.679	56	242.735	100	20	240.679
	4c	241.679	52	242.700	164	20	240.039
5	5	242.019	50	242.519	175	175	240.274
	5a	242.019	53	242.596	50	20	241.519
	5b	242.019	56	242.596	100	20	241.019
	5c	242.019	61	242.631	189	20	240.129
6	6	242.499	66	243.159	150	150	240.999
	6a	242.499	53	243.084	50	20	241.999
	6b	242.499	50	243.065	100	20	241.499
	6c	242.499	50	243.056	157	20	240.929
7	7	242.678	25	242.928	130	130	241.378
	7a	242.678	58	243.315	50	20	242.178
	7b	242.678	53	243.260	100	20	241.678
	7c	242.678	49	243.220	130	20	241.378
8	8	242.508	25	242.758	127	127	241.238
	8a	242.508	55	243.086	50	20	242.008
	8b	242.508	51	243.057	100	20	241.508
	8c	242.508	20	242.745	148	20	241.028
9	9	242.422	41	242.832	113	113	241.292
	9a	242.422	55	242.953	50	20	241.922
	9b	242.422	53	242.947	100	20	241.422
	9c	242.422	32	242.743	134	20	241.087
10	10	242.254	84	243.094	121	121	241.049
	10a	242.254	55	242.812	50	20	241.754
	10b	242.254	53	242.765	100	20	241.254
	10c	242.254	47	242.721	130	20	240.954
11	11	242.274	64	242.914	125	125	241.029
	11a	242.274	53	242.832	50	20	241.774
	11b	242.274	51	242.804	100	20	241.274
	11c	242.274	48	242.754	125	20	241.024
12	12	242.452	87	243.322	143	143	241.022
	12a	242.452	55	242.999	50	20	241.952

Table 1. Monitoring well and piezometer construction details.

Well Nest	Sample Name	Surface El. (m)	Riser Height (cm)	Riser El. (m)	Depth (cm)	Screened Interval (cm)	El. of Bottom of Well (m)
12	12b	242.452	52	242.970	100	20	241.452
	12c	242.452	52	242.960	150	20	240.952
13	13	242.823	16	242.983	132	132	241.508
	13a	242.823	56	242.565	50	20	242.323
	13b	242.823	52	242.916	100	20	241.823
	13c	242.823	49	242.874	141	20	241.413
14	14	242.228	71	242.938	160	160	240.628
	14a	242.228	50	242.745	50	20	241.728
	14b	242.228	49	242.757	100	20	241.228
	14c	242.228	50	242.733	173	20	240.498
15	15	250.821	50	251.321	75	75	250.071

Table 1. (continued)

piezometer is labeled 4c. An additional monitoring well (well 15) was placed on the valley wall upgradient from the riparian zone and was intended to collect water discharging from the intertill layer located at the contact between the two till units (referred to as intertill water, IE) (Figure 5). Well 15 also collects water from adjacent hillslope soils and from sand and gravel layers in the Trafalgar till besides the intertill layer at the base of the Trafalgar till unit. No piezometers were placed at well 15. A nylon mesh sleeve was placed over screened intervals to minimize obstruction of wells and piezometers by fine-grained particles. Holes were filled with sand along the screened intervals and a bentonite clay seal was applied near ground level to prevent contamination from surface runoff (Freeze and Cherry, 1979; Sanders, 1998). Two residential wells that are finished in interbedded sand and gravel layers within the lower, preWisconsinan till unit (intratill layers) were also sampled during riparian zone sampling in order to characterize water within the intratill deposits (referred to as intratill water, IA) (Figures 2b and 5). It is hypothesized that this layer is one potential source of water to the riparian zone. At the time of sampling (Table 2), water level was measured in each well and piezometer using an electric water level meter (estimated accuracy +/- 2 cm): water level was not measured in the residential wells. In addition, five YSI 600XL and one YSI 600 XLM data logging probes were installed in six wells in March 2005 and recorded water level at 15-minute intervals through March 2006 (Figure 5). Two additional YSI 600XL probes were installed in January 2006 and also recorded water level through March 2006. All YSI probes were calibrated for depth on each sampling date. Points of known elevation were established at three points along the stream using the total station (S 1, S 2, and S 3) (Figure 5). Stream stage was measured at each of the

Date	Wells, Piezometers, and Stream Sampled	Precipitation Sample	Post-Precipitation Event	Water Table Condition
10/24/2004	X	X		insufficient data
10/30/2004	X			insufficient data
11/6/2004	X			insufficient data
11/11/2004		X		insufficient data
12/21/2004	X			insufficient data
1/10/2005	X			insufficient data
2/11/2005	X			insufficient data
3/11/2005	X			high
3/29/2005	X			high
4/7/2005		X		high
4/14/2005	X			high
4/23/2005		X		high
4/26/2005		X		high
4/30/2005		X		high
5/2/2005	X			high
5/17/2005	X			high
6/2/2005	X			transitional
6/20/2005	X			transitional
7/11/2005	X	X		low
7/22/2005			X	low
8/1/2005	X			low
8/5/2005		X		low
8/18/2005	X			low
8/19/2005		X		low
8/30/2005		X		low
9/9/2005	X			low
9/19/2005		X		low
9/29/2005	X		X	low
10/20/2005		X		low
10/21/2005	X		X	low
11/10/2005	X			transitional
11/15/2005		X		transitional
12/1/2005	X	X		high
12/28/2005		X		high
12/29/2005	X		X	high
1/2/2006		X		high
1/11/2006	X		X	high
1/17/2006		X		high
1/28/2006		X		high
1/30/2006	X			high
2/16/2006		X		high
2/24/2006	X			high
3/9/2006		X		high
3/10/2006	X		X	high

Table 2. Study site sampling dates and type of sample(s) that were collected on each date. Post precipitation events area marked and the water table condition present during each sampling date is shown.

three points during each sampling event using a standard tape measure. Manual and data logger water table measurements were used to construct hydrographs for all monitoring wells for the entire study period. Hydrographs did not include dates where no measurable amounts of water were present. Surfer (Golden Software, 1999) was used to produce water table elevation maps for each sampling date. Ground water flow nets were created to characterize subsurface flow in the third dimension. Equipotential lines for flow nets were calculated by hand using triangulation (Cedergren, 1989). Saturated hydraulic conductivity (K_s) was measured for each well and piezometer using the Hvorslev water recovery method (Freeze and Cherry, 1979). Ground water fluxes in the riparian zone were calculated using Darcy's Law:

$$Q = K_s(\delta h/\delta l)A$$

where Q is the water flux (m^3/day), K_s is the saturated hydraulic conductivity (m/sec), $\delta h/\delta l$ is the hydraulic gradient between the two equipotential lines, and A is cross-sectional area (1 m wide x 2 m depth). In this study, Darcy's Law was applied assuming a one-dimensional form for homogenous media. A depth of 2 m was used as the depth to confining layer, marking the typical depth to the underlying till deposit. K_s values varied within each soil horizon so average K_s values for each piezometer cluster were used in flux calculations. Fluxes were calculated for one date from each flow regime (explained in "Results" section). Dates were chosen as those representative of typical water table conditions for the entire regime.

Water Quality

Samples were collected from all wells, piezometers, and Fishback Creek on 27 dates from October 2004 to February 2006 (Table 2). On six dates, samples were collected following precipitation events (≥ 0.5 cm of precipitation) (Table 2). Stream and ground water samples were collected from wells and piezometers using tygon tubing connected to a three-way stopcock and syringe and placed in 118 mL polypropylene containers (ASTM, 1996). Precipitation samples were collected approximately 5 km southeast of the study site in open sample containers fitted with a funnel on 20 dates from October 2004 to March 2006 (Table 2) as precipitation is also a potential source of water to the riparian zone. Samples were placed in a cooler at approximately 4 °C and transported back to the laboratory. Field blanks and field replicates were used to assure the quality of field and analytical methods. pH, specific conductance, temperature, oxidation-reduction potential, and dissolved oxygen content were measured in the field for monitoring wells and the stream using a YSI 600XLM multi-parameter probe and a Hanna HI 9142 dissolved oxygen sensor. Daily precipitation data for the study period was recorded at Eagle Creek Airpark, located 6.4 km from the study site, and downloaded from the National Climatic Data Center website (NOAA, climatological data, Indianapolis). In the well fitted with the YSI 600XLM data logger (well 1) pH, specific conductance, temperature, oxidation-reduction potential, and dissolved oxygen content was measured every 15 minutes. Specific conductance and temperature were measured every 15 minutes in wells fitted with the YSI 600XL data loggers (wells 2, 5, 7, 9, 11, 13, and 14). YSI probes were calibrated for water quality parameters at approximately six week intervals during deployment. Intertill water, intratill water, and precipitation samples each represent a potential source of water to the riparian zone and were characterized and treated as end members, or source water groups. All samples were filtered using a disposable GF/F 0.7-micron filter and frozen within 36 hours of sampling until further analysis. SiO_2, Cl^-, NO_2^-, NO_3^-, NH_3, SO_4^{-2}, and PO_4^{-3} concentrations were determined using a Konelab Photometric Analyzer using standard colorimetric methods (EPA Methods 370.1, 325.2, 354.1, 353.1, 350.1, 375.4, and 365.3, respectively) (Clesceri et al., 1998). Ca^{+2}, Mg^{+2}, K^+, and Na^+ concentrations were determined using a Dionex DX500 Ion Chromatograph using a CS15 Analytical Column and methansulfonic acid eluent. Laboratory replicates were run to determine instrument error (Table 3). Detection limits for the Konelab Photometric Analyzer and the Dionex Ion Chromatograph are listed in Tables 4a and 4b. Samples with concentrations below detection were assigned a value equal to one-half the detection limit (Boettner, 2002; Rickabaugh, 1999). Alkalinity was not determined in the field; therefore, alkalinity was estimated as a residual using a modified version of the method suggested by Rhoades (1982). Rhoades (1982) provided the following relationship:

$$\Sigma \{Ca^{+2} + Mg^{+2} + K^+ + Na^+\} = \Sigma \{\text{Alkalinity} + Cl^- + NO_3^- + SO_4^-\}$$

where the sum of major cations in meq/L equals the sum of major anions and alkalinity in meq/L. This method was originally designed to solve for SO_4^-; in this study SO_4^- is known and instead the equation was solved for alkalinity.

Data Analysis

Because it is unknown to what degree precipitation events influence inter- and intratill water chemistry, when determining the overall chemical signature to represent inter- and intratill water, samples collected on dates following precipitation events were discarded from inter- and intratill water data sets used for statistical analyses. Cluster analysis (CA) was used to confirm the presence of end members by determining if hypothesized end members are statistically dissimilar. Clusters were calculated in PAST

Parameter	Instrument	Laboratory or Field?	Instrument Error		
			N	Avg. Standard Deviation	Avg. % Standard
Temperature (℃)	YSI 600XLM Multi-parameter probe	Field	--	--	--
pH	YSI 600XLM Multi-parameter probe	Field	--	--	--
Specific conductivity	YSI 600XLM Multi-parameter probe	Field	--	--	--
Dissolved oxygen (mg/L)	Hanna HI 9142	Field	--	--	--
Oxidation reduction	YSI 600XLM Multi-parameter probe	Field	--	--	--
Cl^- (mg/L)	Konelab Photometric Analyzer	Laboratory	108	3.84	2.72
NO_2^- (mg/L)	Konelab Photometric Analyzer	Laboratory	103	0.01	11.29
NO_3^- (mg/L)	Konelab Photometric Analyzer	Laboratory	111	0.03	7.71
PO_4^{-3} (mg/L)	Konelab Photometric Analyzer	Laboratory	109	0.01	21.26
SO_4^{-2} (mg/L)	Konelab Photometric Analyzer	Laboratory	107	4.39	9.32
Ca^{+2} (mg/L)	Dionex Ion Chromatograph	Laboratory	305	3.92	5.38
K^+ (mg/L)	Dionex Ion Chromatograph	Laboratory	255	0.20	7.05
Mg^{+2} (mg/L)	Dionex Ion Chromatograph	Laboratory	305	2.36	7.72
Na^+ (mg/L)	Dionex Ion Chromatograph	Laboratory	305	3.00	6.12
NH_3 (mg/L)	Konelab Photometric Analyzer	Laboratory	108	0.01	3.18
SiO_2 (mg/L)	Konelab Photometric Analyzer	Laboratory	100	0.06	1.77

Table 3. Parameters measured, instrument used, location of analysis, and associated instrument error.

Ion Chromatograph

	Detection Limit (mg/L)
Na^+	0.848
Mg^{+2}	0.492
Ca^{+2}	1.296
K^+	0.800

Table 4a. Detection limits for the ion chromatograph.

Photometric Analyzer

	Detection Limit (mg/L)
Cl^-	0.327
NH_3	0.016
NO_2^-	0.004
NO_3^{-3}	0.327
PO_4^{-3}	0.003
SiO_2	0.013
SO_4^{-2}	0.064

Table 4b. Detection limits for the photometric analyzer.

(Hammer et al., 2001) using Ward's minimum variance method (Schot and van der Wal., 1992; Steinhorst and Williams, 1985; Seyhan et al., 1985). This method tends to join clusters with a small number of observations, which is relevant to the sample set used in this study (Schot and van der Wal, 1992). T-tests were used to determine if the 12 chemical parameters measured (anions, cations, SiO_2, NH_3; Table 3) varied significantly between high water table conditions and low water table conditions. T-tests compare the mean values of two sample sets to determine if they are statistically similar ($p > 0.05$).

Factor analysis, performed using the principal components analysis (PCA) method in SYSTAT 11.0 (Systat Software, 2004) was used to determine which variables and linear combinations of these variables explain the variation in the data set (Ashley and Lloyd, 1978; Seyhan et al., 1985; Stewart et al., 1993). Component loadings are used to determine which groups of parameters define linear relationships in the data set. High component loadings indicate a particular variable contributes significantly to the linear relationship explained by a component, irrespective of the sign (Davis, 2002). Whether a variable loads highly positive or highly negative indicates the nature of the relationship for those particular variables. For example, if you discover that one component has a high positive loading and another variable has a high negative loading, then abundant amounts of one would be associated with low levels of the other. Conversely, neutral loadings indicate that the parameter contributes little to the linear relationship explained by the component (Davis, 2002). Using PCA, if the same linear combinations of variables affecting a given source water group were found to influence a given riparian zone water sample, then it could be assumed that the source of that sample is that particular source water group or end member. Thus, insight is gained regarding the main sources of water to the riparian zone. Examination of the scree plot was used to determine the number of components considered significant (Hammer et al., 2001). PCA was performed on all samples collected and centroids were plotted for end members and riparian zone samples.

Classical discriminant analysis (DA) was performed in SYSTAT 11.0 (Systat Software, 2004) with the a priori assumption that all groups are equal. This analysis examined all variables and determined the best separation of samples based on data set variables (Stewart et al., 1993). The analysis was performed with all source water and riparian zone (treated as unknowns) samples included. DA grouped riparian zone samples with one of the three hypothesized end members based on water chemistry similarities thus providing insight into the temporal and spatial variations in the sources of water to different parts of the riparian zone.

Statistical analyses such as CA, DA, and PCA cannot handle missing data cells. Missing values before the 29 March, 2005 sampling date, as a result of analytical methods being refined, resulted in missing parameters for a number of samples. As a result, these samples were removed from the data set used for statistical analyses. In addition, because oxidation reduction potential and pH was not measured for piezometer samples these parameters were removed from the data set. Approximately 157 samples were removed and the final data set contained a total of 805 samples characterized by 12 parameters. To eliminate the dominance of parameters with larger measurement values in each analysis, all data were standardized by range to increase normality of data (Kinnear and Garnett, 1999).

RESULTS

Precipitation

During the 18 months the site was monitored, nine of those months were wetter than the 30-year average (Climatology of the United States, 2002) (Figure 4). Significant deviations (variation > 50%) from normal precipitation was recorded for seven of the 18 months. January and September 2005 and March 2006 were 254, 71, and 67% wetter than the 30-year average, respectively. The January deviation is accounted for by the 22.3 cm of precipitation received in January 2005. In contrast, December 2004 and March, May, and October 2005 were 52, 59, 63, and 60% drier than the 30-year normal. May 2005 through October 2005 marks a dry period characterized by several consecutive months with below normal precipitation amounts with September of that year being the exception (Climatology of the United States, 2002). Overall, the precipitation amounts were 6% wetter for the entire study period when compared to normals.

Hydrogeologic Setting of SSNS

Riparian zone soils range in texture from clay to gravel, but are primarily loam and sandy loam with large percentages of gravel (15-60%) in many locations. Figure 6 shows a map of surficial soils in the riparian zone. Soil profiles are provided for each well nest in Appendix A. In general, soil textures are finer grained near the slope bottom and at shallower depths. Conversely, the sand and gravel content increases near the stream and with increasing depth. Lenses of soil and alluvium with high sand and gravel percentages are prominent throughout the site, especially near the stream. Several piezometers (1c, 2c, 3c, 4c, 5c, 9b, 9c, 10b, 10c, and 11c) were finished in the preWisconsinan till underlying the riparian zone (Appendix A). A layer of high sand and

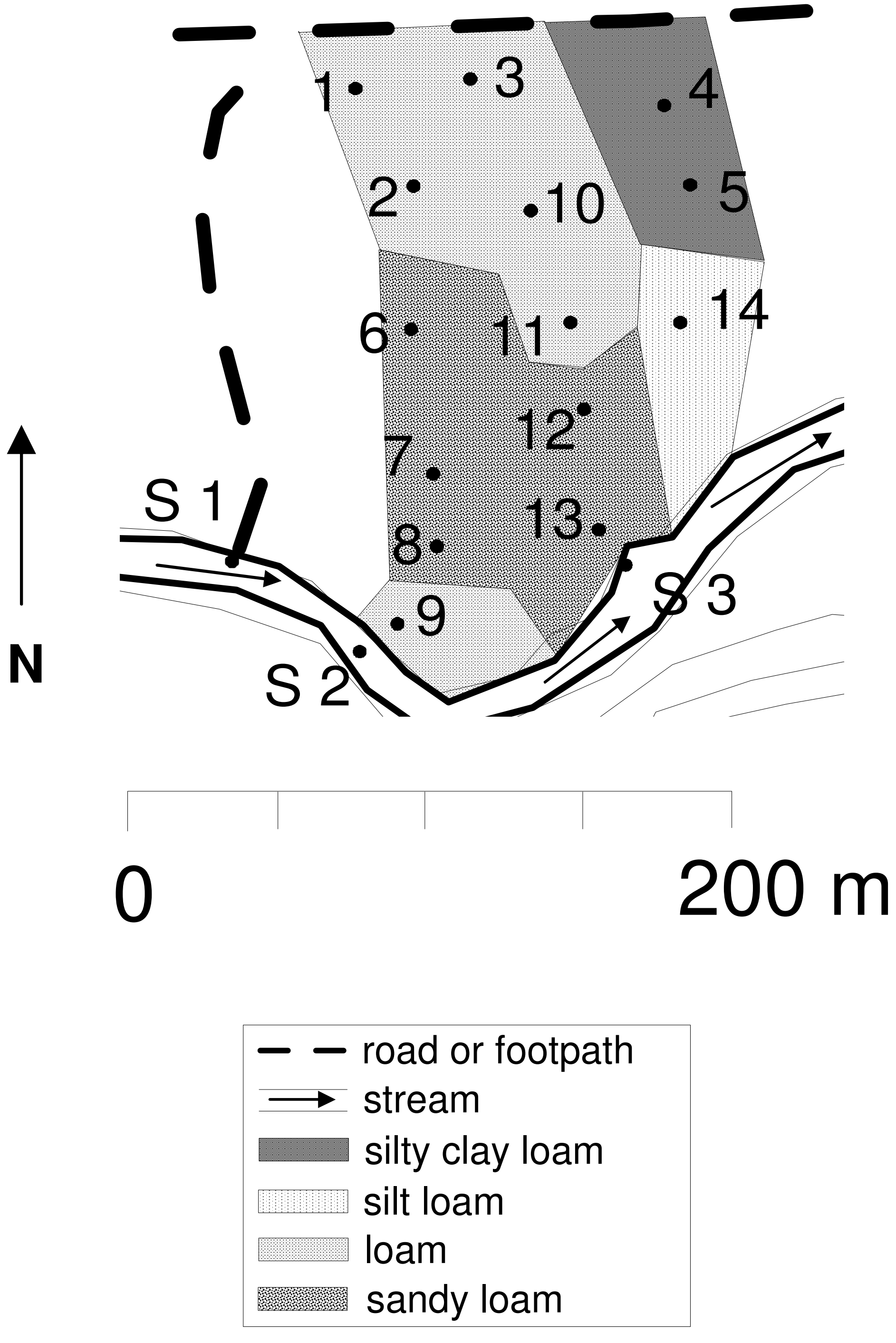


Figure 6. Riparian zone surficial soil textures. Black dots are well nest locations (1-14). S 1, S 2, and S 3 are stream stage measurement points.

gravel content that sits directly on the preWisconsinan till surface was found at piezometers 13c and 14c (refer to Appendix A). The layer with high sand and gravel content sitting on the till deposit was differentiated from the till itself using K_s results. Piezometers finished in till had K_s values one to three orders of magnitude lower than overlying alluvium and soils (0.29-13.08 cm/day) (Appendix A), while piezometers finished in the sand and gravel layer overlying the till had K_s values as high as > 600 cm/day. Overall, hydraulic conductivity (K_s) values range from 0.56 cm/day to > 600 cm/day with an average of 95 cm/day in the riparian soils at the study site. Generally, K_s values are higher near the stream and central portions of the study site, where sand and gravel content increases. For ten of the 14 piezometer nests, the intermediate (1 m) or shallow (50 cm) piezometer had the highest K_s value in the nest.

Water Table Fluctuations

Water levels were measured at approximately two-week intervals between October 2004 and March 2006 (Table 2; Appendix B). Water table conditions (and corresponding dates) were defined based on two factors; hydrograph shape and shallow ground water flow as illustrated in potentiometric surface maps. Three water table conditions were observed in riparian zone well hydrographs. Figure 7 shows a hypothetical hydrograph that resembles seasonal water table fluctuations at the study site along with the hydrograph from well 1. This figure illustrates how hydrographs were used to define high, low, and transitional water table conditions based on whether the hydrograph was rising or falling (transitional position), or relatively stable (high or low water table position). High water table conditions are defined as times when the water table is close to the ground surface (< 30 cm BGS in most wells) following the seasonal

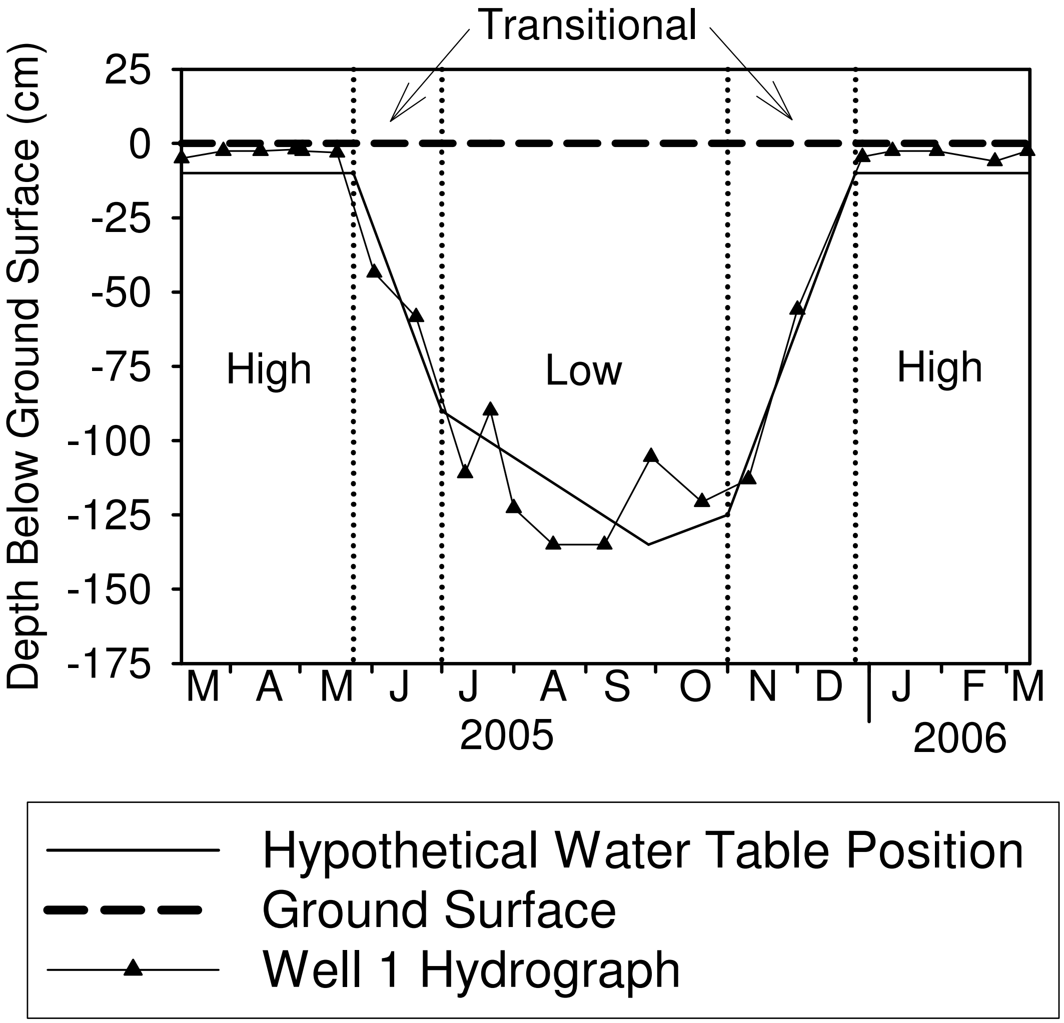
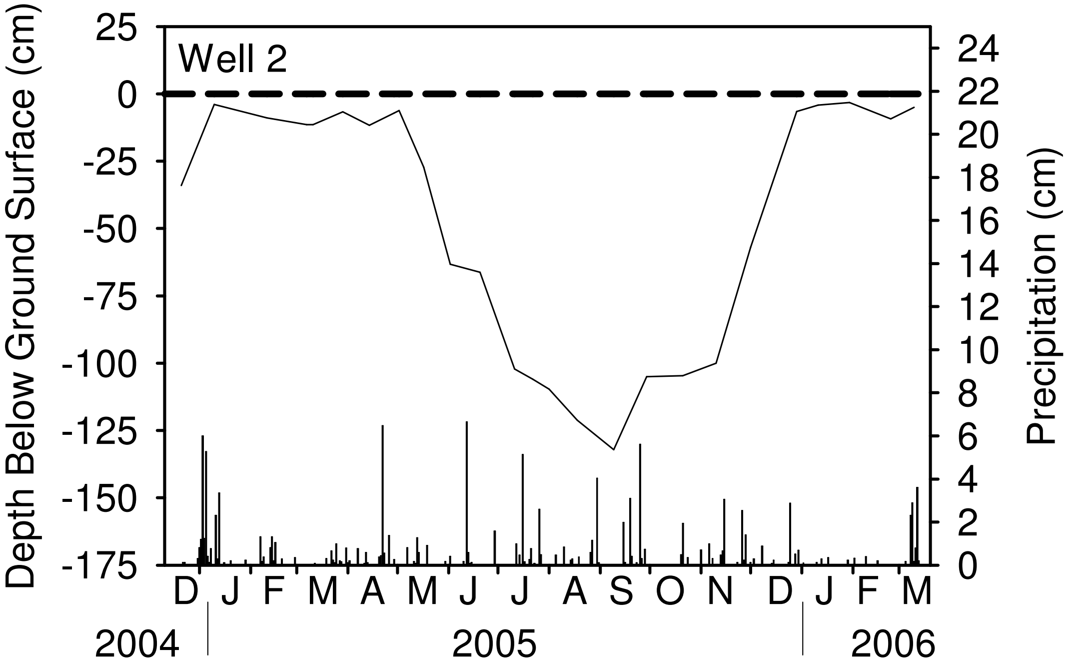


Figure 7. Hypothetical and actual hydrographs showing how the three water table conditions were defined using hydrograph data.

increase in water table elevation. High water table conditions occurred from mid-December to late May during the monitoring period. Low water table conditions are defined as periods when the water table is (> 60 cm BGS) following the seasonal drop in the water table (Figure 7). Low water table conditions occurred from early July to early November. A third transitional water table condition was defined to characterize periods when the riparian water table is shifting between high and low water table conditions.

Four hydrographs (Figure 8) were chosen as those representative of the study site to illustrate the temporal variation in water table behavior for different parts of the study site. The three water table conditions described above (Figure 7) are more easily distinguished in wells near the base of the hillslope. During high water table conditions no standing water was observed for areas near wells 6, 7, 8, 9, 12, 13, and 14 while five to 10 cm of standing water was commonly found in areas closer to the slope: near wells 1, 3, 4, 5, 10 (Appendix C). High water table conditions are well-defined in wells 2 and 5 (Figures 8a and 8b). During high water table conditions, the average depth to water was 40 cm below ground surface (BGS) for the entire riparian zone with a maximum of 15 cm above ground surface (AGS) recorded at well 3 and a minimum of 117 cm BGS measured at well 13 (Table 5). High water table conditions can also be observed in hydrographs for wells near the stream, such as wells 9 and 13 (Figures 8c and 8d), but it is less obvious. During low water table conditions, an average depth to water in the riparian zone of 122 cm BGS was calculated with a maximum of 54 cm BGS measured at well 10 and minimum of 192 cm BGS recorded at well 13 (Table 5). The large, seasonal rise and fall of the water table (rising and falling hydrograph limbs) as represented in the hydrographs illustrates transitional water table conditions (Figure 8). The average depth



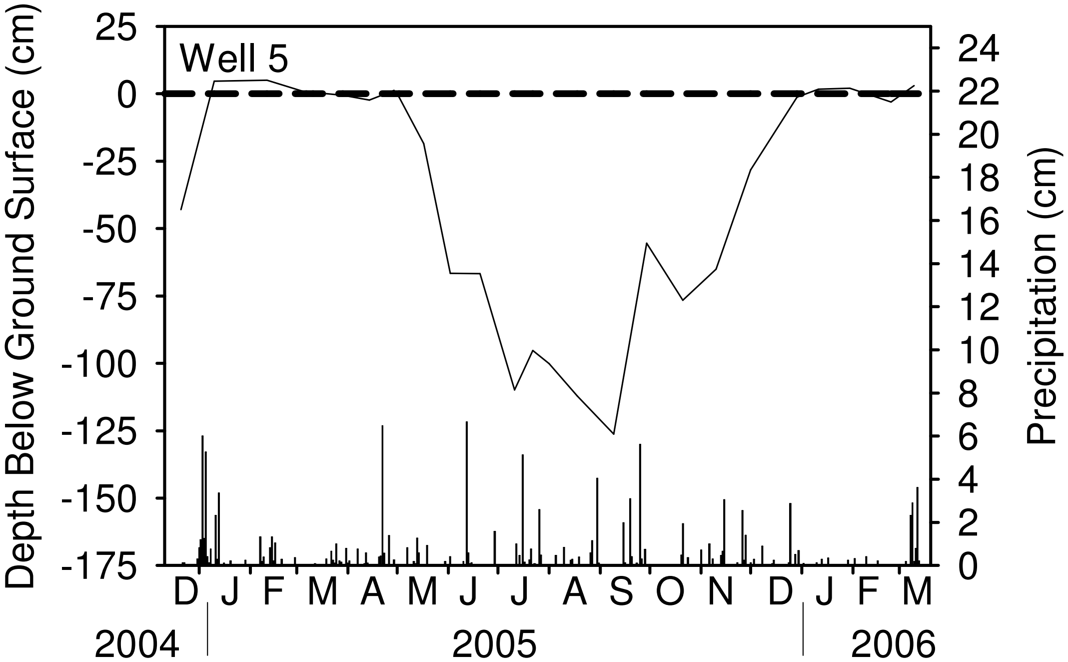
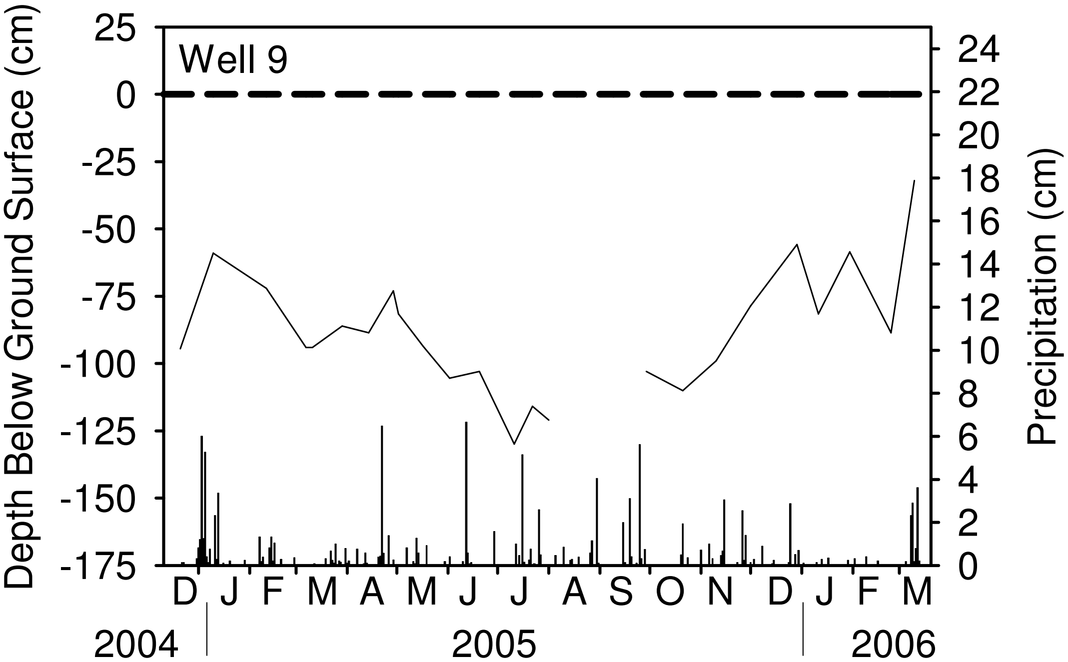


Figure 8a. Hydrographs for wells 2 and 5. The dashed line represents the ground surface. Daily precipitation is shown as columns on the x-axis.



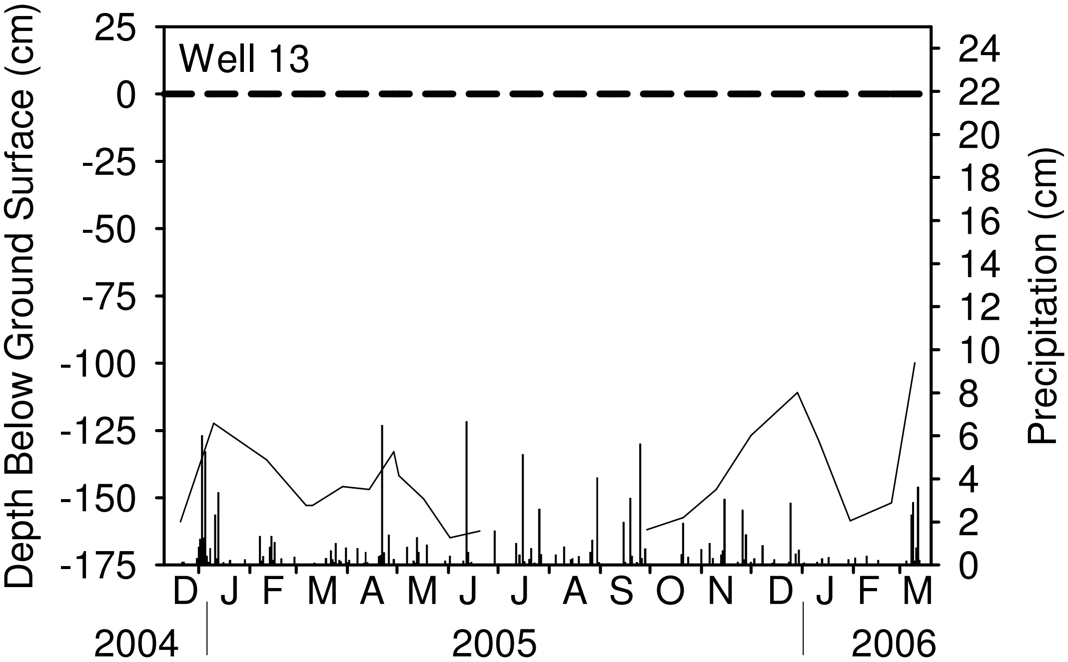


Figure 8b. Hydrographs for wells 9 and 13. The dashed line represents the ground surface. Daily precipitation is shown as columns on the x-axis.

All wells

	High	Low	Transitional	All
N	182	70	42	294
AVG (m)	-0.40	-1.22	-0.88	-0.66
MIN (m)	-1.17	-1.92	-1.31	-1.92
MAX (m)	0.15	-0.54	-0.34	0.15

Group 1 wells - 1,2,3,4,5,10, and 11

	High	Low	Transitional	All
N	91	35	21	147
AVG (m)	-0.11	-1.14	-0.71	-0.44
MIN (m)	-0.63	-1.92	-1.19	-1.92
MAX (m)	0.15	-0.54	-0.34	0.15

Group 2 wells - 7,8,9,12, and 13

	High	Low	Transitional	All
N	65	25	15	105
AVG (m)	-0.81	-1.33	-1.10	-0.97
MIN (m)	-1.17	-1.50	-1.31	-1.50
MAX (m)	-0.34	-1.03	-0.99	-0.34

Table 5. Water table statistics for Group 1, Group 2, and the entire riparian zone for different water table conditions. All measurements are in meters. Negative values are below the ground surface.

to water for all wells during the transitional season is 88 cm BGS. Hydrographs for all monitoring wells and the stream are shown in Appendix C (manual measurements only).

A spatial pattern is also represented in the well hydrographs. Hydrographs for wells near the base of the slope show the water table to be closer to the ground surface (Figure 9a). Wells near the base of the slope show fewer sharp peaks, especially during the high water table season. Hydrographs from wells 1, 2, 3, 4, 5, 10, and 11 (hereafter referred to as Group 1 wells) show water tables that fluctuate less than 15 cm during high water table conditions from December 2004 to May 2005 and again from December 2005 to March 2006 (note sampling ended in March 2006) (Figure 9a). The average depth to water for all dates is 44 cm BGS for Group 1 wells (Table 5). Group 1 well hydrographs display a larger, seasonal water table decline with the water level dropping an average of 104 cm during the transition from high water table conditions to low water table conditions and often dropping more than 115 cm. In contrast, hydrographs from wells 7, 8, 9, 12, and 13 (hereafter referred to as Group 2 wells) have sharper peaks throughout the monitoring period than hydrographs from Group 1 wells (Figure 9b). The average depth to water for all dates is 97 cm BGS for Group 2 wells. Group 2 wells generally experience a less dramatic seasonal decline with the water table dropping an average of 52 cm during the transition from the high water table season to the low water table season and rarely dropping more than 100 cm. In addition, hydrographs from Group 2 wells show a strong similarity to stream hydrographs in terms of the magnitude of seasonal water level decline and apparent sensitivity to precipitation (Figure 10).

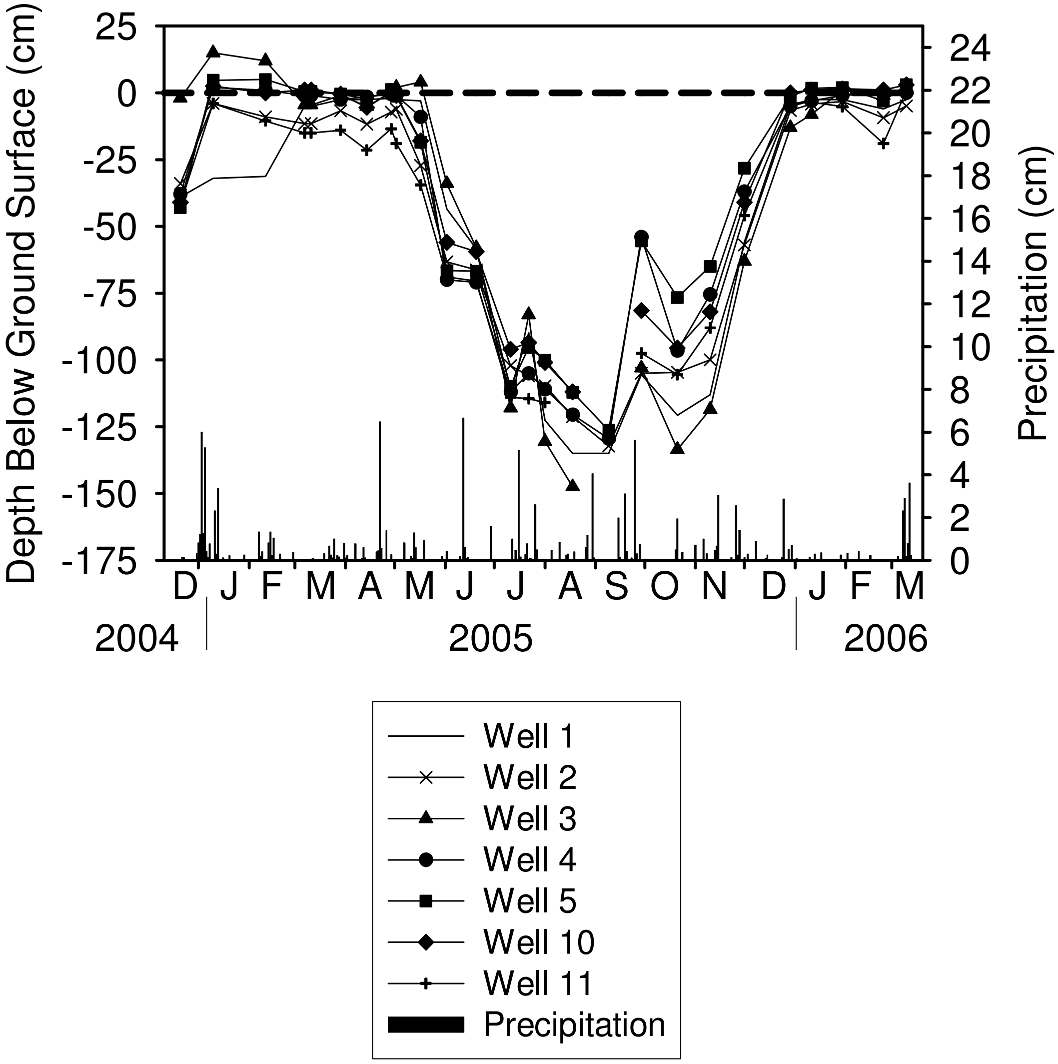


Figure 9a. Hydrographs from Group 1 wells (1, 2, 3, 4, 5, 10, and 11). All hydrographs were constructed using manual measurements at approximately two-week intervals.

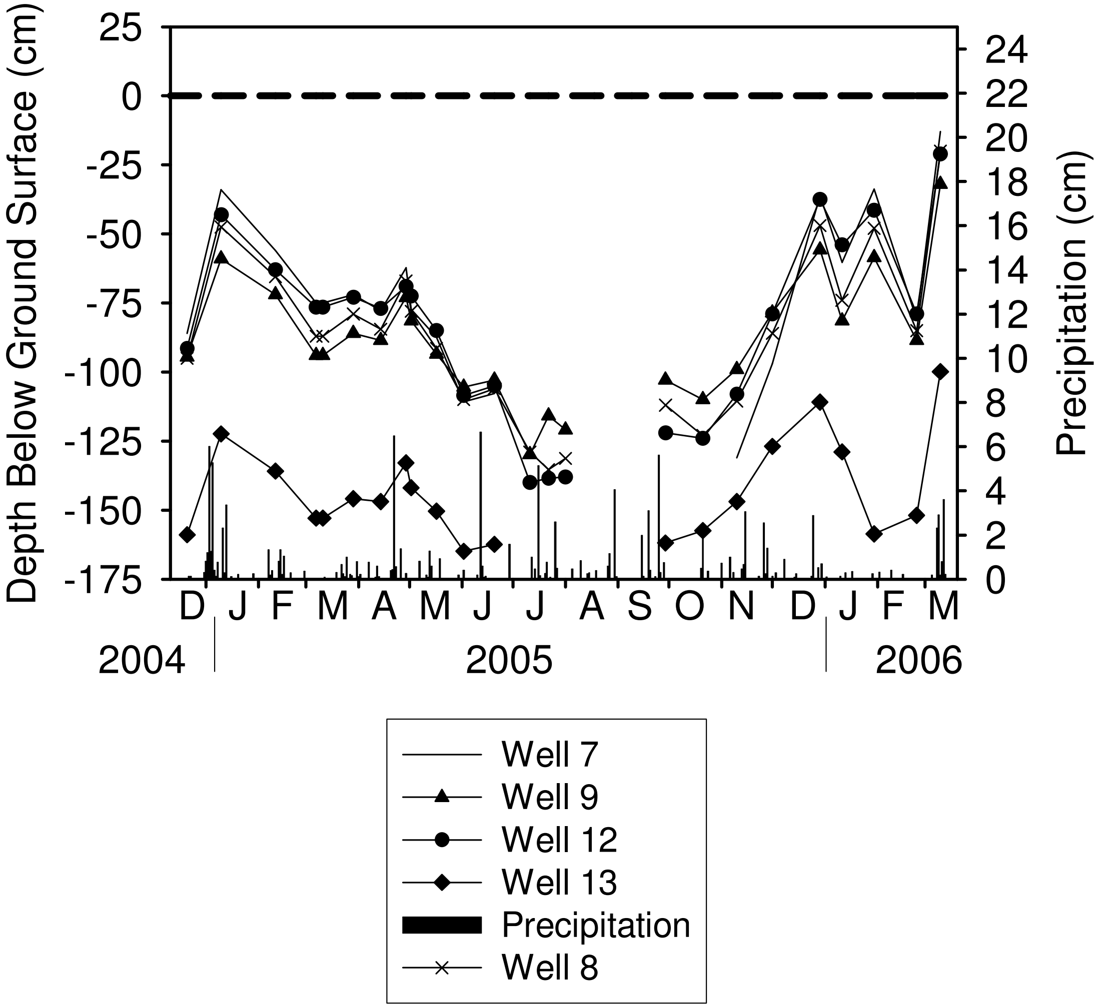


Figure 9b. Hydrographs from Group 2 wells (7, 8, 9, 12, and 13). All hydrographs were constructed using manual measurements at approximately two-week intervals.

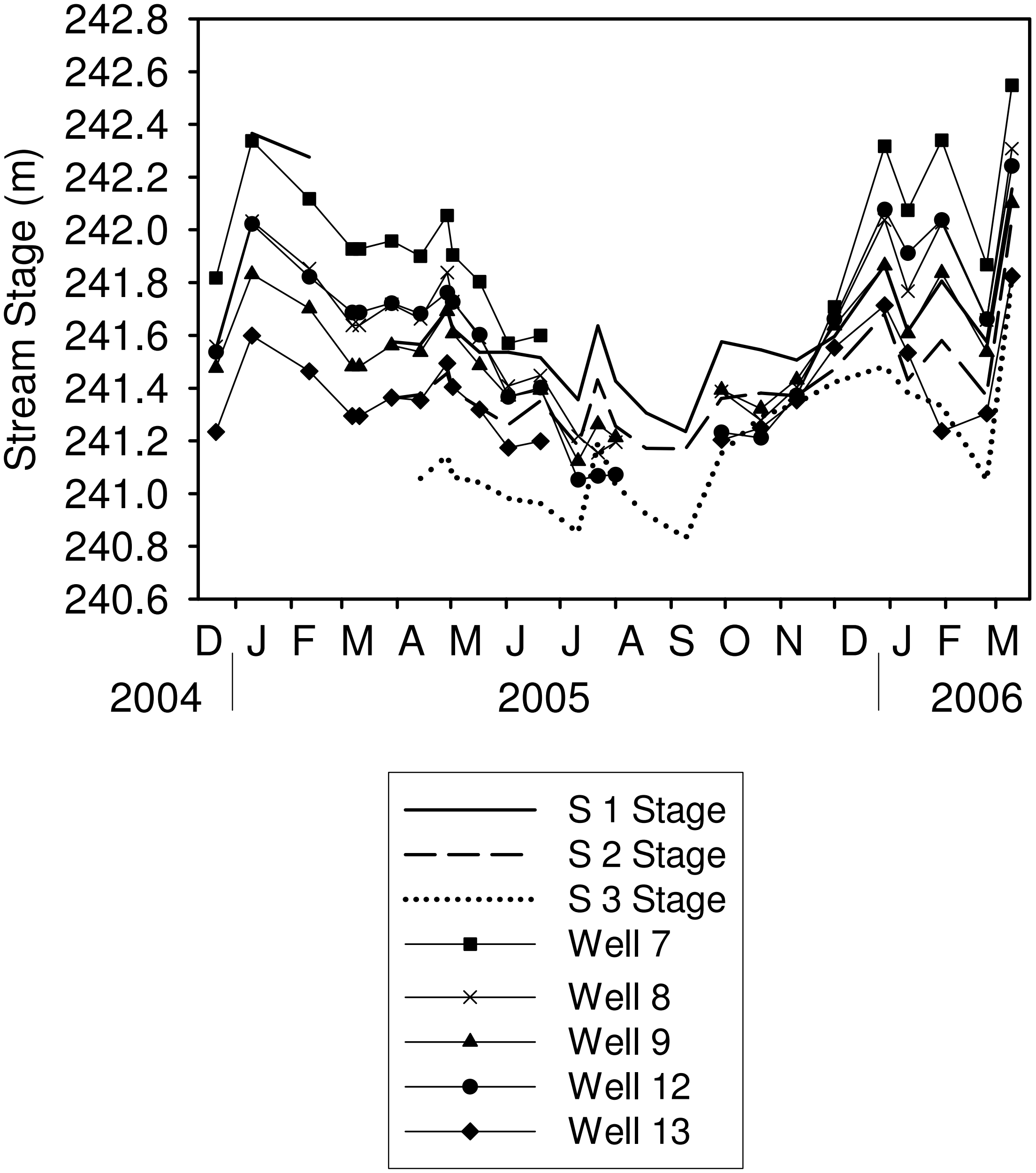


Figure 10. Graph comparing hydrographs from Group 2 wells to hydrographs measured at the three stream points. All hydrographs were constructed using manual measurements at approximately two-week intervals.

Ground Water Flow Paths

Hydraulic head measurements in piezometers indicated only minor vertical gradients with the average difference in water level for all piezometer nests for the entire study being 3 cm. Thus, equipotential lines were plotted for only one representative transect (A-A’) for three dates (one date during each of the three water table conditions) (Figure 11). Transect A-A’ is representative of conditions found in the entire riparian zone including transects B-B’ and C-C’ (Figure 2a). Flow nets illustrated ground water flow lines parallel to the ground surface throughout the year (Figure 11). During high and transitional water table seasons, flow from the hillslope to the stream is maintained (Figures 11a and 11b). Low water table condition flow nets illustrate the absence of large ground water gradients from the base of the slope to the stream (Figure 11c). As mentioned earlier, two distinct riparian zone water table conditions were observed in hydrographs and potentiometric surface maps, with the first one representing high water table conditions with ground water flowing from the slope to the stream, or roughly perpendicular to Fishback Creek (Figures 12a and 12f). High water table conditions were observed twice during this study: the first period starting in mid-March 2005 and going through mid-May 2005 and the second period starting late-December 2005 and going through mid-March 2006, when monitoring ended (Table 2). The second riparian zone ground water flow regime represents lowered water table conditions with ground water flowing downvalley or roughly parallel with the stream (Figures 12c and 12d). This flow pattern is observed from mid-July 2005 through late-October 2005 (Table 2). On several dates, ground water flow is neither dominantly perpendicular or parallel to the stream, but rather flows in an intermediate position that is neither in the stream or downvalley

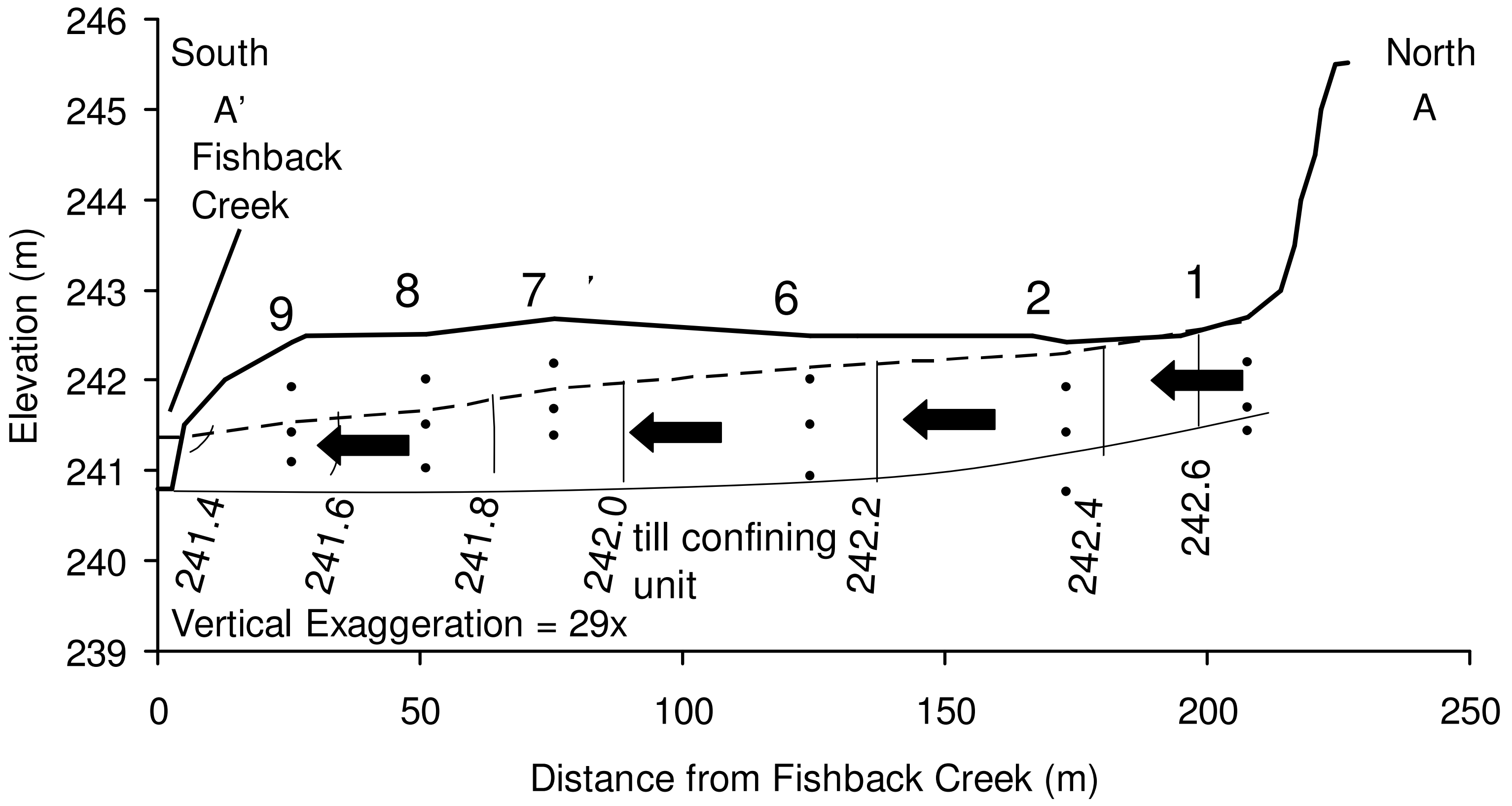


Figure 11a. Ground water flow net during high water table conditions for transect A-A' on 14 April 2005. Arrows indicate the direction of flow. Equipotential lines are labeled in meters with a 0.2 m contour interval. The dashed line is the position of the water table and the thick black line is the ground surface.

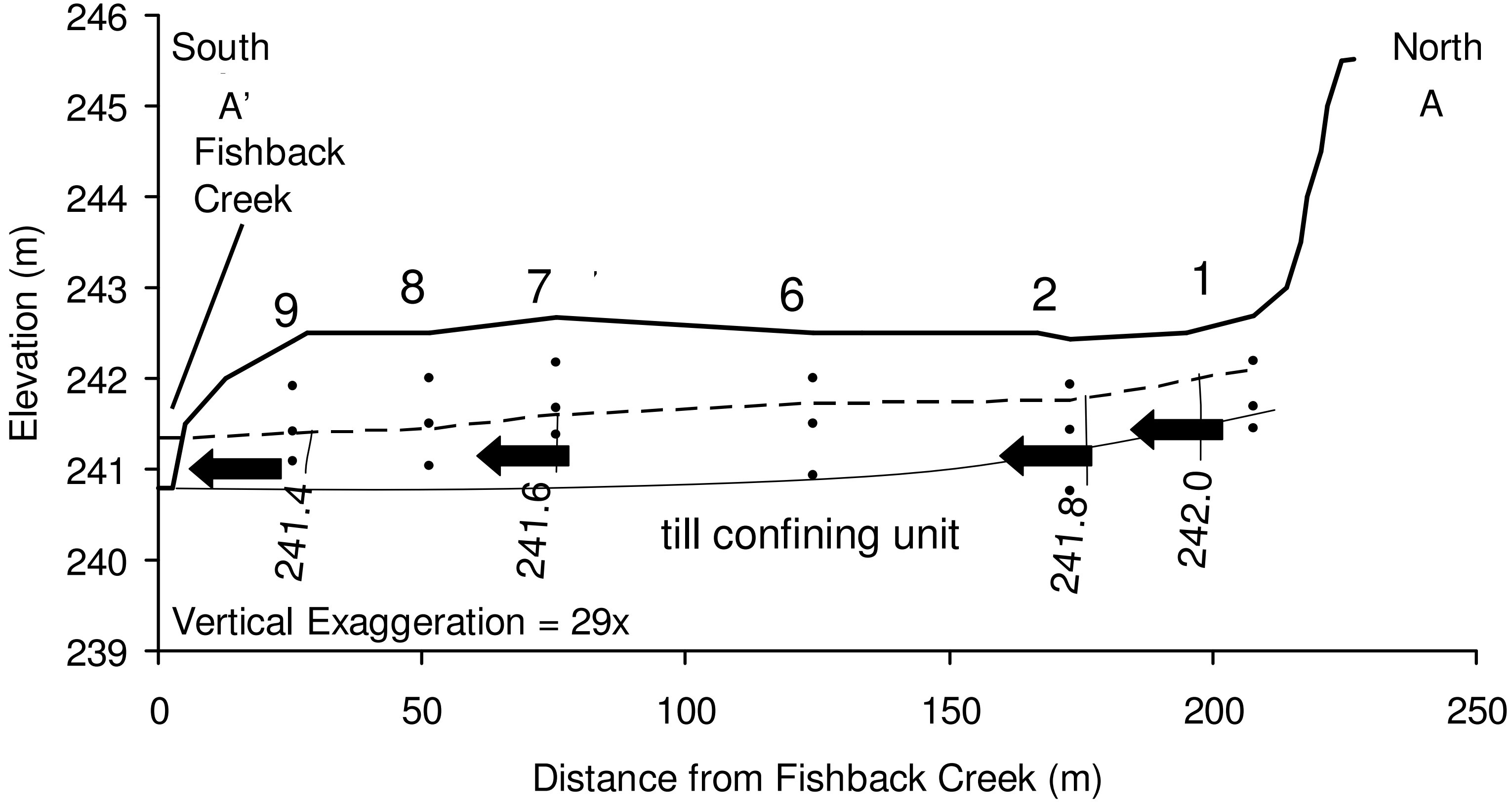


Figure 11b. Ground water flow net during transitional water table conditions for transect A-A' on 20 June 2005. Arrows indicate the direction of flow. Equipotential lines are labeled in meters with a 0.2 m contour interval. The dashed line is the position of the water table and the thick black line is the ground surface.

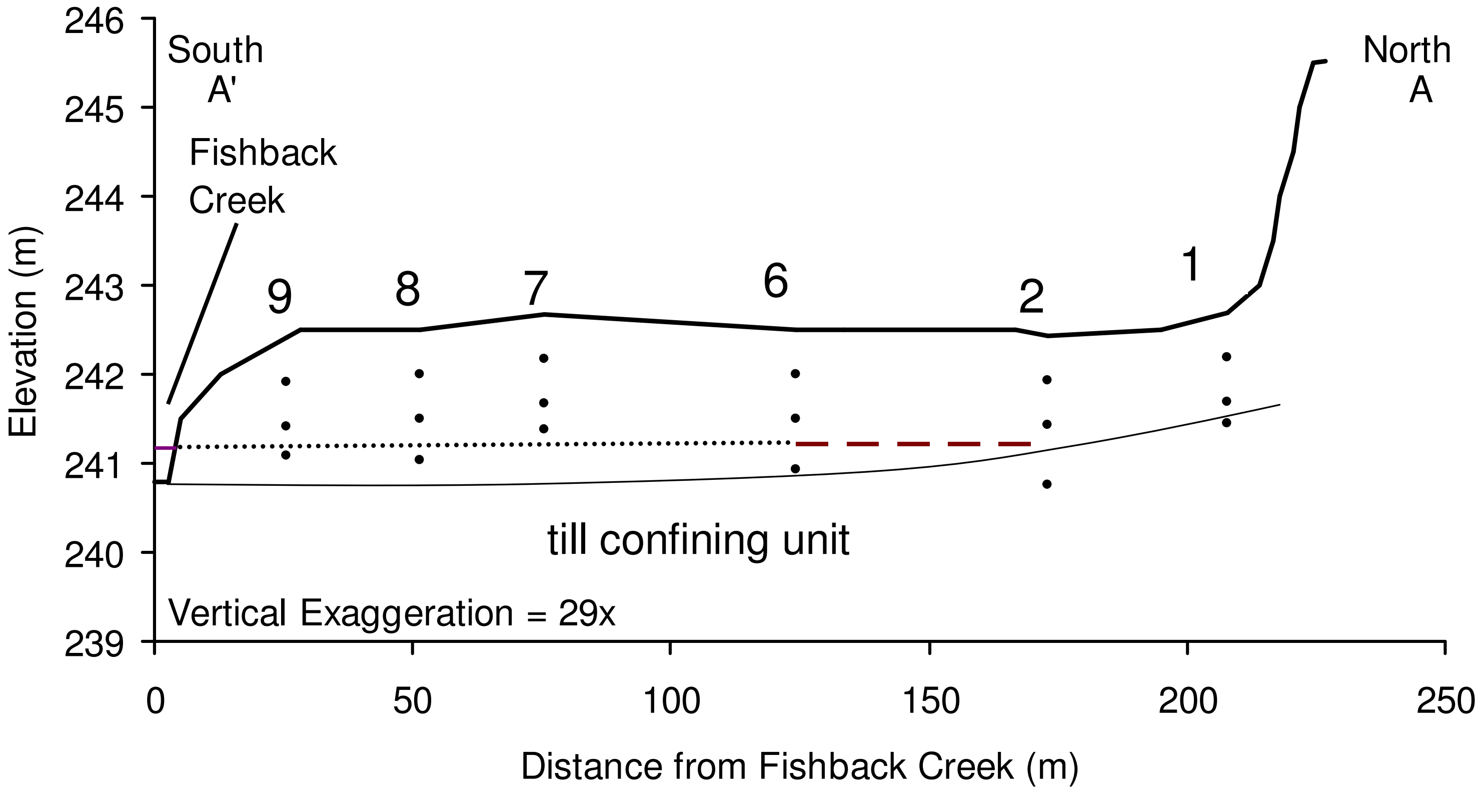


Figure 11c. Ground water flow net during low water table conditions for transect A-A’ on 18 August 2005. Arrows indicate the direction of flow. Equipotential lines are absent because the flow of ground water is eastward (out of the page). The dashed line is the position of the water table and the dotted line is the inferred water table position. The thick black line is the ground surface.

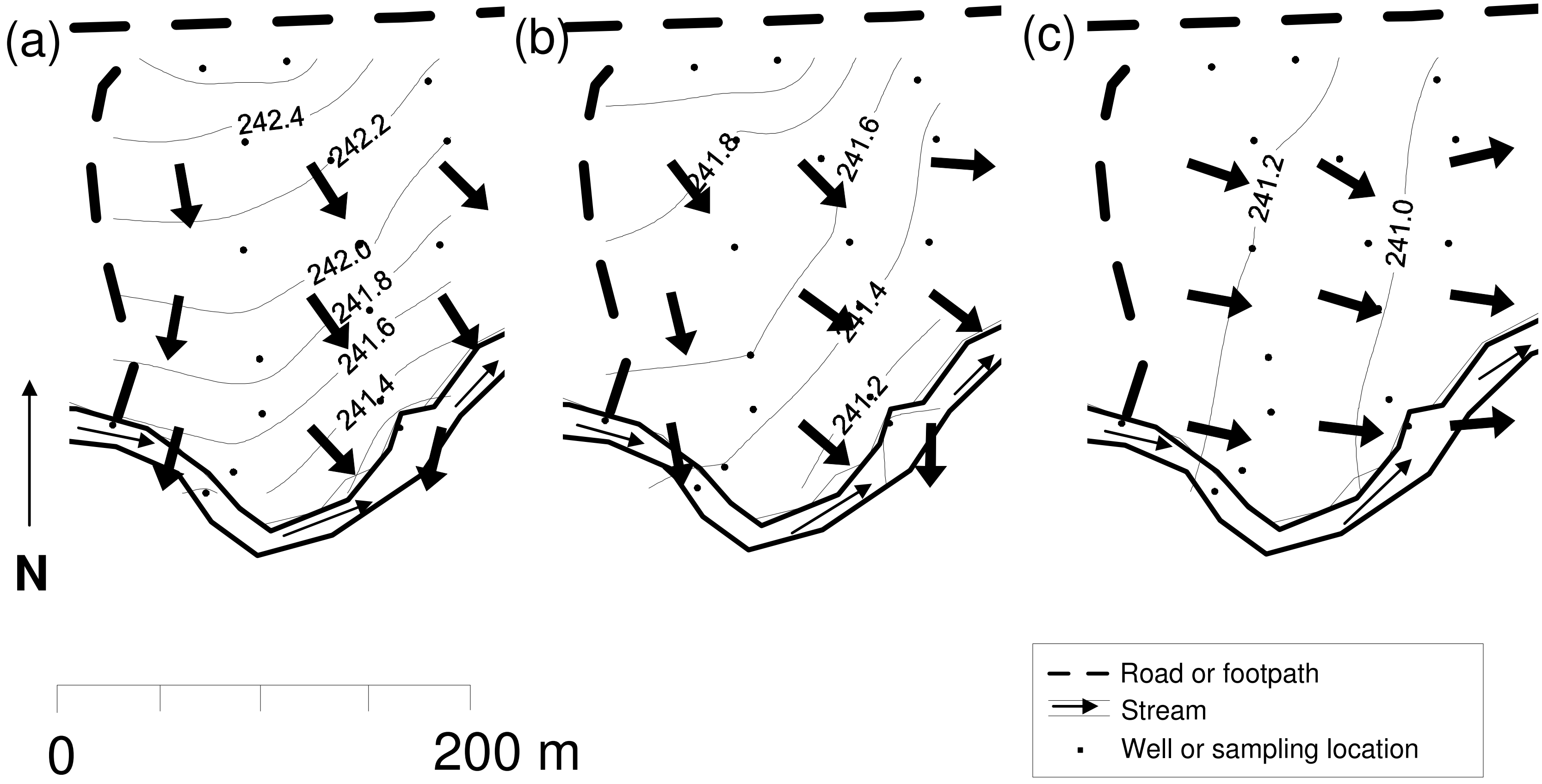


Figure 12a. Potentiometric surface maps for (a) 4-14-05 (high), (b) 6-20-05 (transitional), and (c) 8-18-05 (low). The contour interval is 0.20 m. Arrows indicate the direction of ground water flow. Black dots represent water sampling locations.

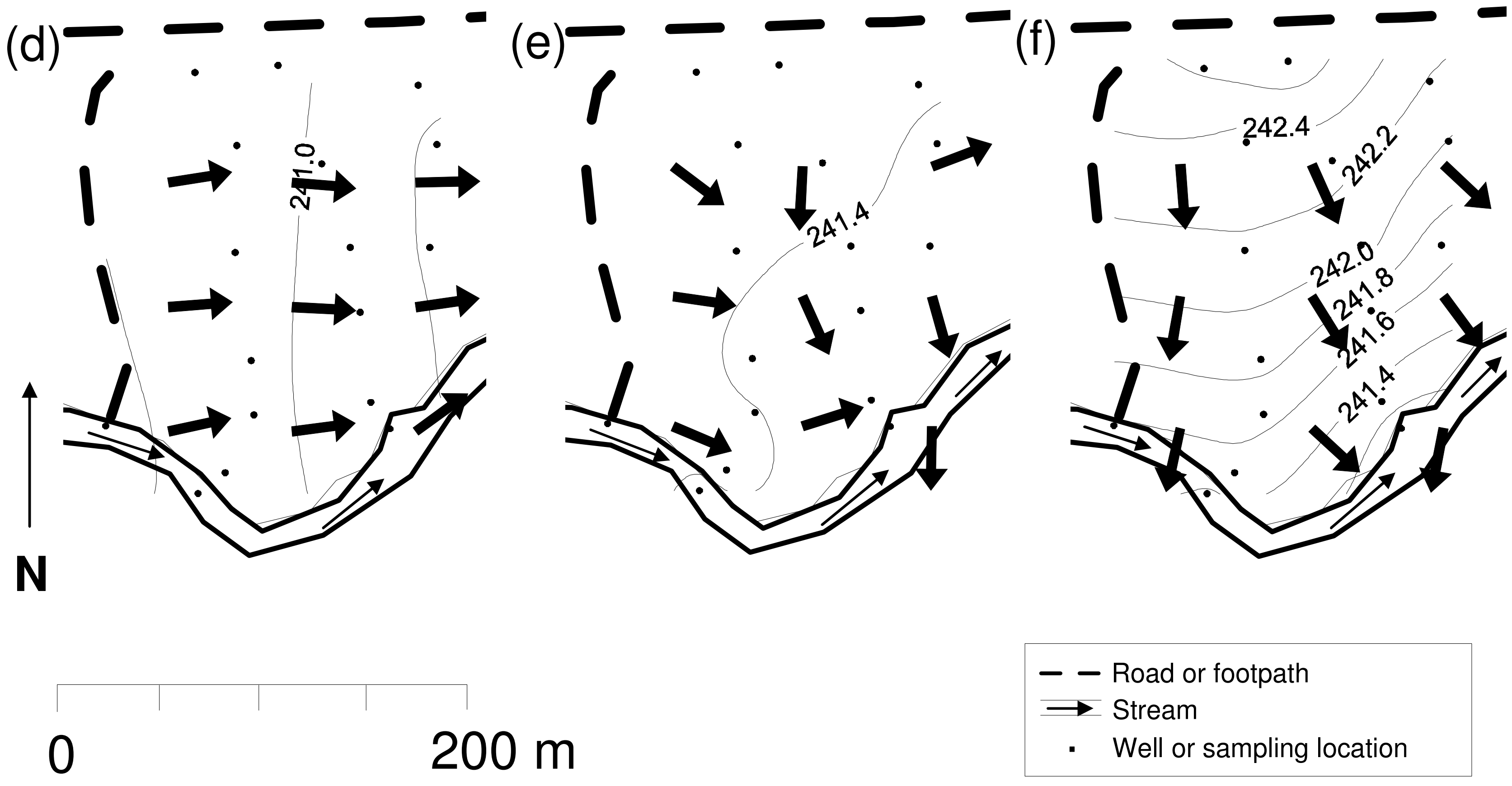


Figure 12b. Potentiometric surface maps for (d) 9-9-05 (low), (e) 11-10-05 (transitional), and (f) 2-24-06 (high). The contour interval is 0.20 m. Arrows indicate the direction of ground water flow. Black dots represent water sampling locations.

direction (Figures 12b and 12e). Direct flow from the stream to the riparian zone was not observed. However, flow lines indicate the stream may be infiltrating into riparian sediments near the stream in a downstream direction during low water table conditions. This is observed near wells 8 and 9 with water leaving the riparian zone near well 13 (Figures 12c and 12d). Potentiometric data collected prior to 11 March 2005 did not include all stream points and is not included in the discussion of data above.

Water table gradients from the hillslope to the stream vary seasonally. A major distinguishing feature of the potentiometric surface during high water table conditions is the increased gradient from the hillslope to the stream (Figure 11 and 12). Lower gradients are found during low and transitional water table conditions. Typical high water table condition gradients average 0.85 cm/m, while low water table condition gradients average 0.48 cm/m. During high water table conditions, the water table gradient approaches zero in the central portion of the riparian zone. An average gradient of 0.63 cm/m is typical of transitional water table conditions. Higher gradients are observed near the base of the slope and near the stream, except during low water table conditions when water table gradients are fairly uniform over the entire riparian zone. Ground water fluxes were calculated for two portions of the study site, the portion near the base of the slope (corresponding to Group 1 wells) and the portion near the stream (corresponding to Group 2 wells) for three dates (Table 6). The three dates chosen are typical of conditions found during each of the three water table conditions. Fluxes represent the movement of water from the hillslope to the stream, or parallel to the transects. The average ground water flux for the three dates is 5.8 L/day/m^{-1}, with high water table fluxes (14 April 2005) averaging 11.1 L/day/m^{-1} and transitional fluxes (20

			Date		
Transect	**Wells between which flux was calculated**	**General location**	**Ground water fluxes for 14 April 2005 (L/day/m^{-1})**	**Ground water fluxes for 20 June 2005 (L/day/m^{-1})**	**Ground water fluxes for 18 August 2005 (L/day/m^{-1})**
A-A'	1 and 2	base of slope	1.7	1.4	0.0
	7 and 9	near stream	3.7	1.7	0.0
B-B'	3 and 10	base of slope	11.8	6.6	0.0
	12 and 13	near stream	18.8	11.7	0.0
C-C'	4 and 5	base of slope	16.6	8.2	0.2
	5 and 14	near stream	13.7	1.8	1.7
		Average =	11.1	5.2	0.3

Table 6. Ground water fluxes (L/day/m^{-1}) for three dates. Ground water fluxes were calculated between well nests as indicated in the table for a 1 m wide (represented as m^{-1}) by 2 m section of riparian zone. The general riparian zone location is also shown.

June 2005) averaging 5.2 L/day/m^{-1}. The average flux for the low water table condition date (18 August 2005) is 0.3 L/day/m^{-1}. Ground water fluxes were higher for wells in transect C-C’ compared to wells in transects A-A’ and B-B’ for all dates, with transect A-A’ having fluxes one order of magnitude lower than fluxes in C-C’ for the 14 April 2005 date (Figure 2a; Table 6). In transects A-A’ and B-B’, fluxes were lower near the base of the slope (Group 1 wells) than near the stream (Group 2 wells), though often not an order of magnitude lower.

Ground and Surface Water Chemistry

A summary of water quality data is supplied in Table 7. Mean values for several water quality parameters varied greatly between end member groups (intertill water, intratill water, and precipitation), riparian zone samples, and stream water samples (Table 7; Appendix G). Alkalinity was highest in intratill water, although Ca^{+2} and Mg^{+2} were relatively low in that same group. The mean alkalinity for riparian zone samples was 238.40 mg/L, compared to 335.47 and 215.27 mg/L for intratill and intertill water, respectively. Intertill water has the highest specific conductance of the groups with a value of 1.115 mS/cm, compared to 0.645 mS/cm for intratill water and 0.947 mS/cm for riparian zone water. Cl^- varies two orders of magnitude between the intratill water, riparian zone water, and intertill water groups with the mean Cl^- value for intertill water being 131.43 compared to 3.03 and 93.12 mg/L for intratill water and intertill water, respectively. NO_3^- is one order of magnitude lower in intratill water than in the other groups where NO_3^- concentration varies between 0.29 and 0.49 mg/L except in the stream where the average NO_3^- concentration is 2.92 mg/L. Oxidation reduction potential also varied between water groups with mean values of 105.70, -14.31, 90.74, 59.03, and

	Sample Type or Location	Riparian zone		Ground water seeps		Residential wells		Fishback Creek		Precipitation	
	N (given as a range)	(159-724)		(13-19)		(24-35)		(13-20)		(12-18)	
		Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Parameter or Analyte	Temperature (°C)	11.27	4.95	12.46	5.21	14.63	4.05	13.43	7.12	--	--
	pH	7.11	0.22	7.00	0.13	7.67	0.16	8.07	0.29	7.09	0.97
	Conductivity (mS/cm C°)	0.947	0.217	1.115	0.163	0.645	0.015	0.621	0.096	0.027	0.017
	Diss. O_2 (mg/L)	2.37	1.97	2.13	0.78	1.26	0.85	8.41	3.33	9.41	3.10
	Oxidation reduction potential (mV)	90.74	121.26	105.70	69.35	-14.31	113.91	59.03	75.61	--	--
	Alkalinity (mg/L)	238.40	87.36	215.27	64.10	335.47	42.61	204.27	60.38	7.93	2.41
	Cl^- (mg/L)	93.12	43.81	131.43	35.22	3.03	0.32	53.65	12.35	0.94	0.46
	NO_2^- (mg/L)	0.023	0.044	0.011	0.011	0.017	0.031	0.022	0.016	0.009	0.008
	NO_3^- (mg/L)	0.41	2.30	0.29	0.17	0.09	0.10	2.92	2.51	0.49	0.43
	PO_4^{-3} (mg/L)	0.038	0.353	0.010	0.029	0.013	0.022	0.031	0.048	0.011	0.010
	SO_4^{2-} (mg/L)	34.66	42.97	32.15	15.18	0.46	0.42	29.82	11.92	1.76	1.68
	Ca^{+2} (mg/L)	67.89	24.68	69.52	20.00	46.41	8.87	60.80	11.50	2.30	0.93
	K^+ (mg/L)	1.26	0.62	0.71	0.93	1.22	0.15	1.59	0.27	0.45	0.21
	Mg^{+2} (mg/L)	30.26	8.99	39.46	9.11	27.94	5.90	26.79	11.13	0.35	0.43
	Na^+ (mg/L)	51.33	22.35	44.84	12.92	49.55	4.74	22.68	5.11	1.60	0.29
	NH^{+3} (mg/L)	0.19	0.35	0.09	0.04	0.80	0.38	0.09	0.04	0.59	0.43
	SiO_2 (mg/L)	3.31	1.42	4.01	1.48	4.79	1.37	1.77	0.89	0.01	0.00

Table 7. Water chemistry summary for all samples collected during monitoring period. Riparian zone samples included those collected from wells nests 1 through 14. Ground water seep samples were collected at well 15. Residential well samples represent water from interbedded sand and gravel layers in the lower pre-Wisconsinan till unit. The number of samples used to calculate each mean varies between parameters because several parameters were not measured in piezometer samples and residential well samples.

143.90 mV for intertill, intratill, riparian zone, stream, and precipitation water, respectively. Small variations in SO_4^{-2} concentration (< 5 mg/L) are observed between groups except for intratill water which had a mean value of 0.46 mg/L compared to 32.15, 34.66, and 29.82 mg/L for intertill, riparian zone, and stream water, respectively. Precipitation samples have the lowest values compared to other groups for all parameters. SO_4^{-2} is the exception as precipitation samples have a slightly greater SO_4^{-2} concentration than intratill water samples, but not the other groups (Table 7). NO_2^-, PO_4^{-3}, K^+, Mg^{+2}, and SiO_2, all show little variation between groups.

NO_3^-, PO_4^{-3}, and Cl^- were examined more closely to gain insight into the water quality functioning of the site. NO_3^- levels were typically highest in wells near the base of the slope during the monitoring period. The highest NO_3^- concentrations (> 15 mg/L) were found in transect B-B' near the base of the slope on four dates: 29 September 2005, 1 December 2005, 29 December 2005, and 11 January 2006 (results for 29 September 2005 and 29 December 2005 not shown). NO_3^-, PO_4^{-3}, and Cl^- concentrations were plotted for this transect for two dates (Figure 13). On all four dates, ground water NO_3^- decreased by over 97% in soils shallower than 100 cm between wells 3 and 10 (Figures 13a and 13d). Despite low NO_3^- concentrations (< 0.65 mg/L) in the deep piezometer in well nest 3, NO_3^- depletion was also observed in water traveling between well nest 3 and well nest 10. PO_4^{-3} concentrations were typically low during the four dates listed above with concentrations greater than 0.1 mg/L rarely measured (Figures 13b and 13e). PO_4^{-3} concentrations were relatively uniform along ground water flow paths on all four dates. Cl- concentrations were highest (> 100 mg/L) between well nests 10 and 11 for three of

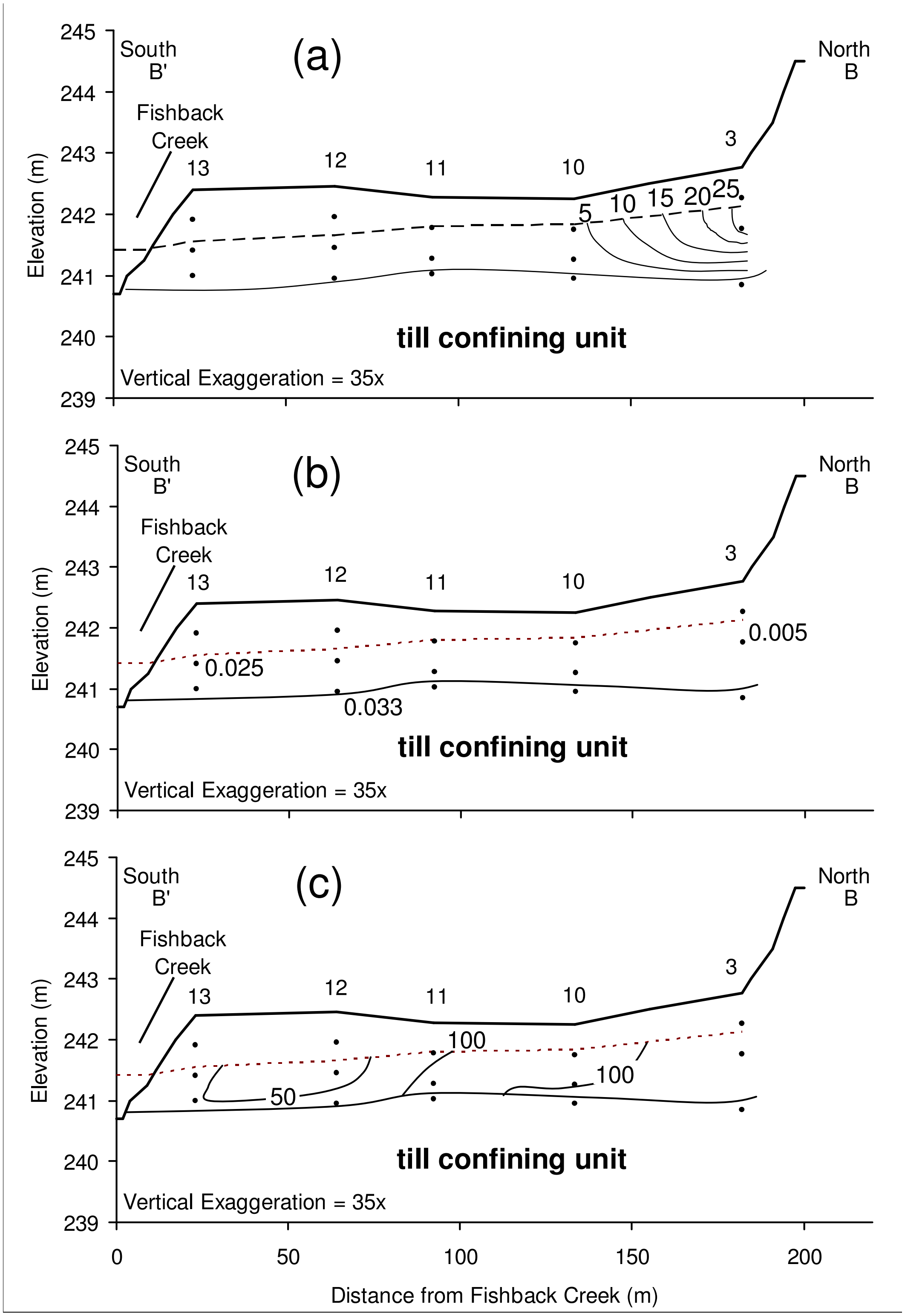


Figure 13. Ground water concentrations (mg/L) for NO_3^- (a), PO_4^{-3} (b), and Cl^- (c) as measured at transect B-B' on 1 December 2005. For PO_4^{-3}, only concentrations above the detection limit of 0.003 mg/L are shown.

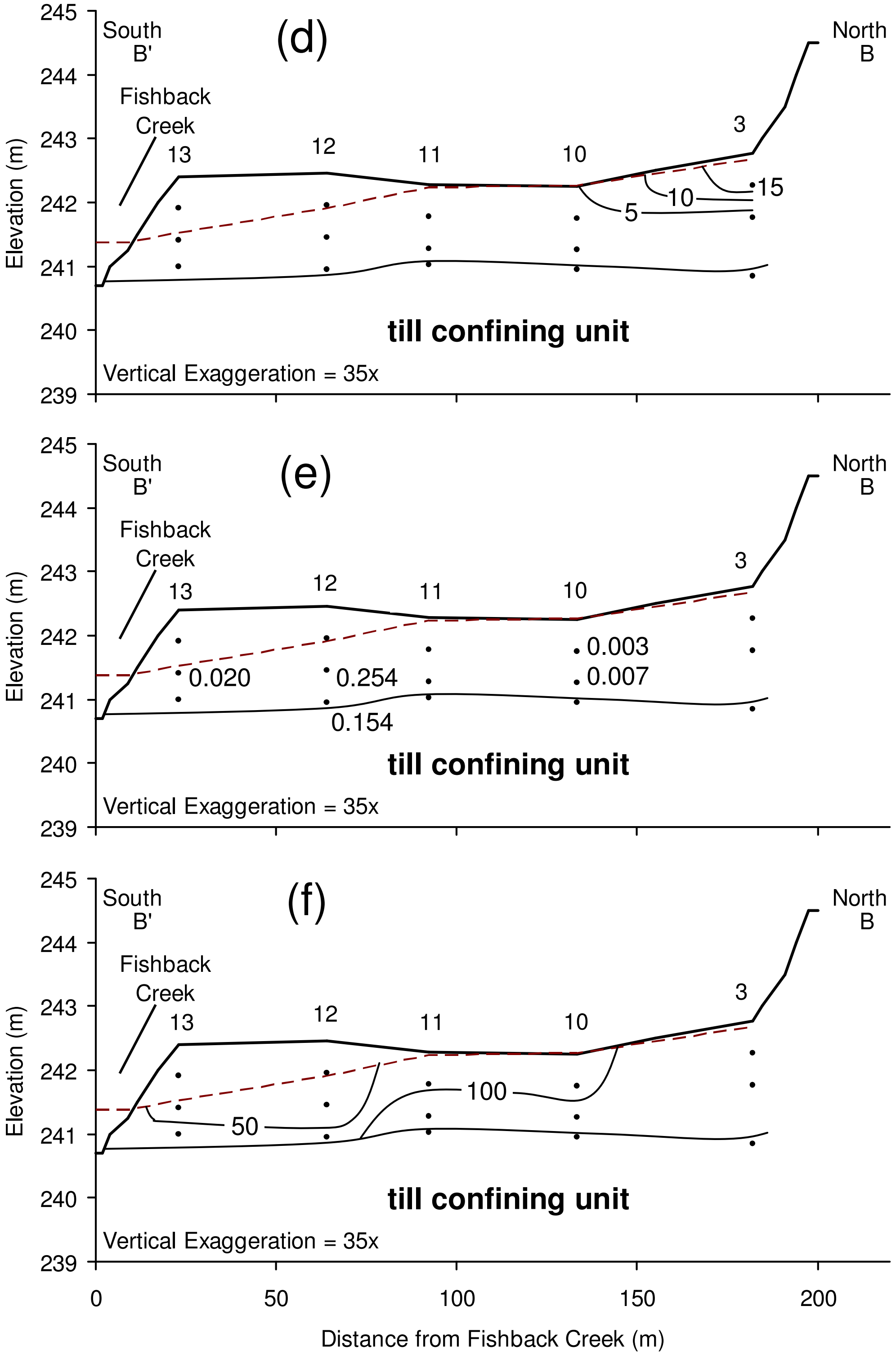


Figure 13 (continued). Ground water concentrations (mg/L) for NO_3^- (a), PO_4^{-3} (b), and Cl^- (c) as measured at transect B-B' on 11 January 2006. For PO_4^{-3}, only concentrations above the detection limit of 0.003 mg/L are shown.

the four dates and decreased near the base of the slope and near the stream (Figures 13c). Cl^- concentrations decreased uniformly along ground water flow paths on 11 January 2006 (Figure 13f).

Precipitation, intertill water, and intratill water were hypothesized as the three potential sources of water, or end members, to the riparian zone. Cluster analysis (CA) confirmed that the three hypothesized end members were statistically dissimilar from one another (Figure 14). Three distinct clusters formed, representing the intertill water samples, intratill water samples, and precipitation samples. T-tests showed no significant water chemistry variation between high and low water table conditions in the end members (Appendix H). In 34 of 36 t-tests performed, p was greater than 0.05, indicating there was no significant difference in means from samples collected during high water table conditions and means collected during low water table conditions. A seasonal variation was however observed in riparian zone water. For eight of 12 parameters tested (t-tests performed), p was less than 0.05, indicating a significant difference in riparian zone water chemistry between high and low water table conditions. PCA was used to determine the dominant processes affecting source water groups, Fishback Creek, and riparian zone samples. Examination of the scree plot shows that the plot of eigenvalues flattens out starting with the fourth component, suggesting the first three components should be considered significant (Figure 15) (Hammer et al., 2001). Therefore, only the first three components will be considered in this work. PCA results showed no overlap of 95% confidence intervals between end member centroids for components 1, 2, and 3 (Figure 16). Note that centroids represent the mean, or center, of

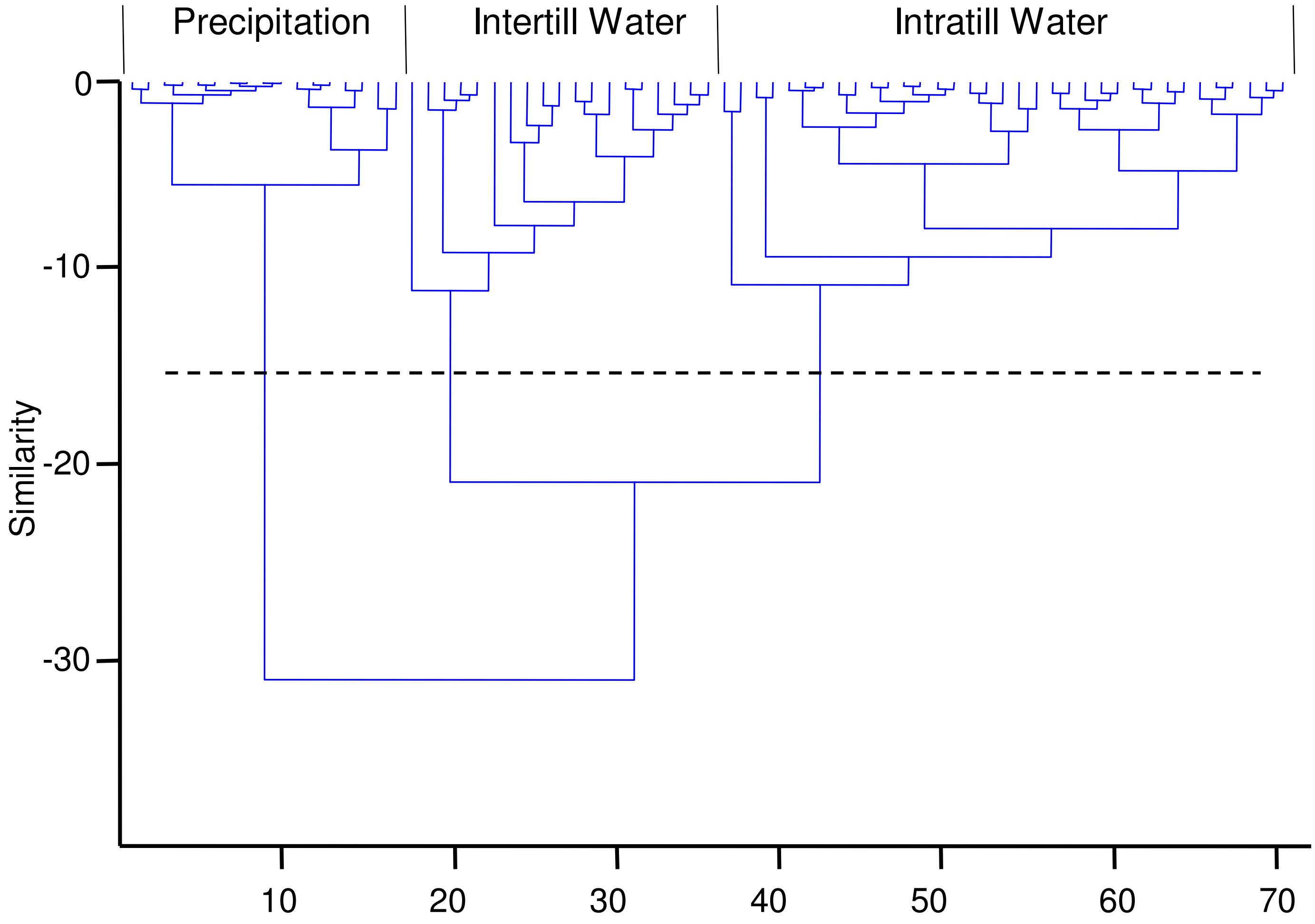


Figure 14. Dendogram showing results of cluster analysis for the three source water groups. Individual samples are represented by the end-point of each line (zero similarity). Due to space restrictions individual samples are not labeled. The horizontal dashed line represents where the dendogram can be cut-off to show the separation between the three groups.

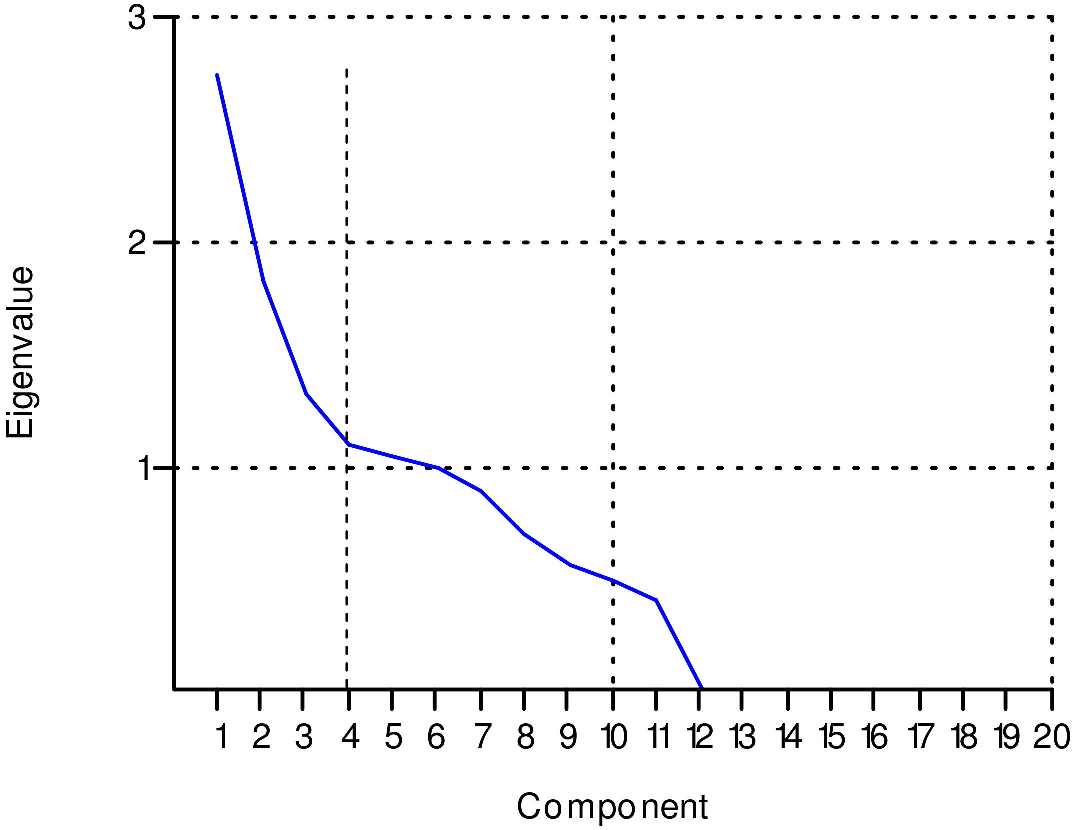


Figure 15. Scree plot from principle components analysis (PCA) illustrating the number of significant components. The vertical dashed line is drawn where the scree plot begins to flatten out. The components prior to the dashed line are considered significant.

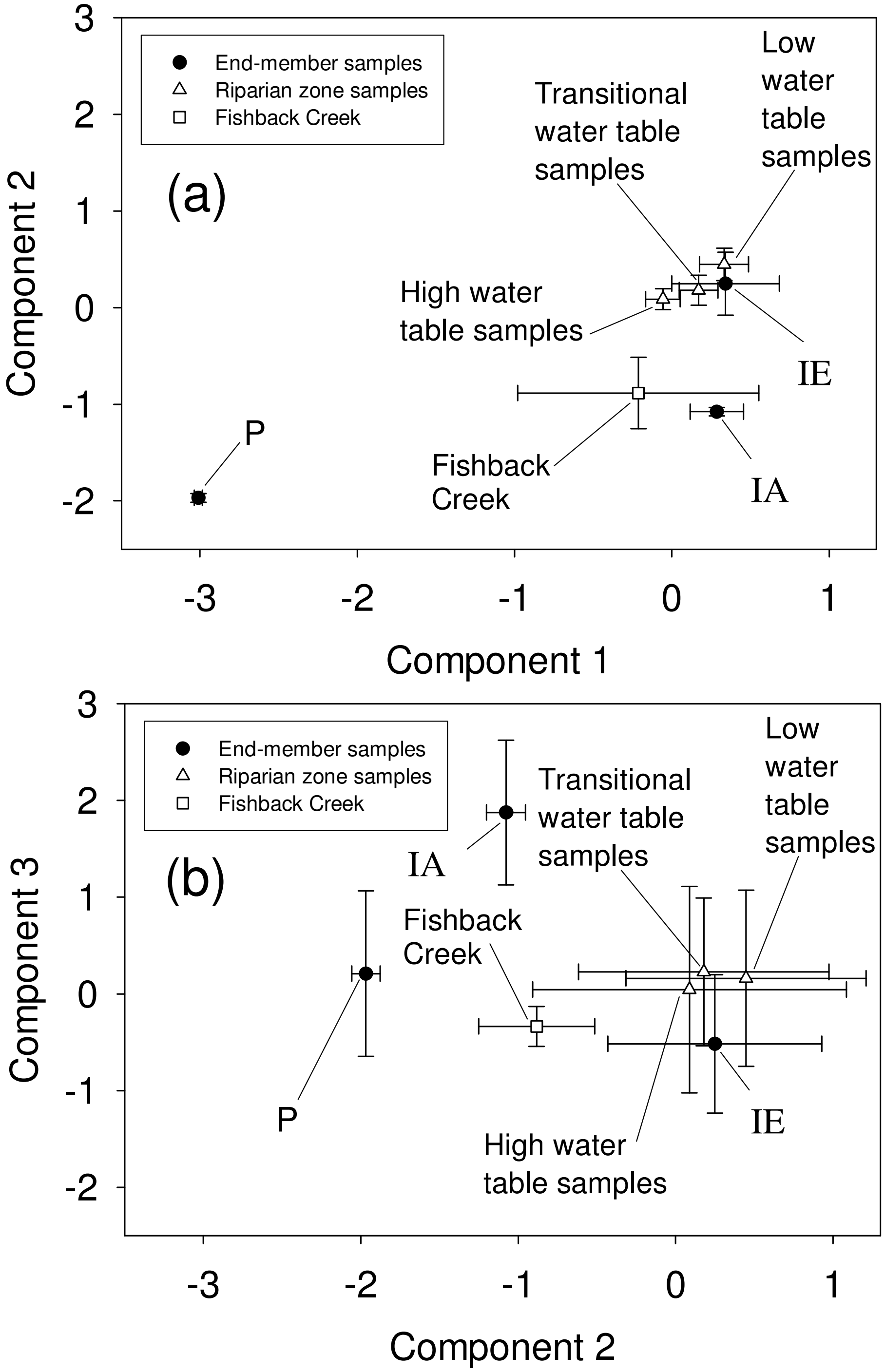


Figure 16. Plot of principle components analysis scores for Components 1 and 2 (a) and Components 3 and 4 (b). Points represent centroids which is the center or mean for that particular group of samples. Whiskers show 95% confidence intervals for each particular group of samples. The three end member groups are labeled as follows: P = precipitation samples; IE = intertill samples; and IA = intratill samples (water from the sand and gravel layer within the preWisconsinan till unit).

all the individual points making up that particular data set. For components 1 and 2, centroids representing intertill water and intratill water are relatively close to one another compared to their proximity to the centroid representing precipitation samples (Figure 16a). Centroids representing water collected during low water table conditions and transitional water table conditions plot within the 95% confidence interval of the intertill water centroid in the plot of component 1 versus component 2. The centroid representing samples collected during high water table conditions does not lie within the 95% confidence intervals of the intertill water centroid in component 1, but it does lie within the 95% confidence intervals of the intertill water centroid in component 2. The centroid representing samples collected during high water table conditions is pulled closer to the precipitation centroid along component 1 (Figure 16a). The plot of components 2 and 3 shows similar results with centroids for samples collected during high, low, and transitional water table conditions all plotting near to the intertill water end member centroid (Figure 16b).

Component loadings determine which groups of parameters define linear relationships in the data set. Component 1 shows high loadings for alkalinity, Ca^{+2}, Mg^{+2}, and SiO_2, and low loadings for PO_4^{-3}, SO_4^{-2}, NH_3, and NO_2^- (Figure 17a). Component 2 shows high loadings for Cl^-, Na^+, K^+, and SO_4^{-2}, and low loadings for NH_3, alkalinity, PO_4^{-3}, and NO_3^- (Figure 17b). Component 3 had high loadings for NH_3, SiO_2, K^+, and NO_2^-, and low loadings for NO_3^-, Cl^-, Ca^{+2}, and NO_2^- (Figure 17c). Components 1, 2, and 3 explain 19.9, 16.5, and 11.1% of the total variance in the data set, respectively.

DA was used to determine similarities between riparian zone samples and the three end member groups. DA results do not imply that if a sample is classified with an end member group that that sample has water chemistry that is statistically similar to the end member group. Rather, discriminant analysis determines which end member an unknown sample is most similar to for given end member choices. A plot of DA factor scores as centroids representing the source water groups shows no overlapping confidence intervals (Figure 18). Centroids representing all samples collected within each water table condition plot between the intertill water centroid and the intratill water centroid, but are much closer to the intertill sample centroid. Indeed, 77.6, 72.9, and 73.9% of all samples collected during high, transitional, and low water table conditions, respectively, were more similar to intertill water than the other end members represented (Figure 19). 15.6% of samples collected during high water table conditions grouped with the intratill water group compared to 26.2 and 25.0% during transitional and low water table conditions, respectively. Small percentages of samples collected within each regime grouped with precipitation water: 6.8, 0.9, and 1.1% for high, transitional, and low water table conditions, respectively. A sample-by-sample analysis of the spatial distribution of discriminant analysis results indicates that no consistent spatial pattern was observed in discriminant analysis results (Appendix I).

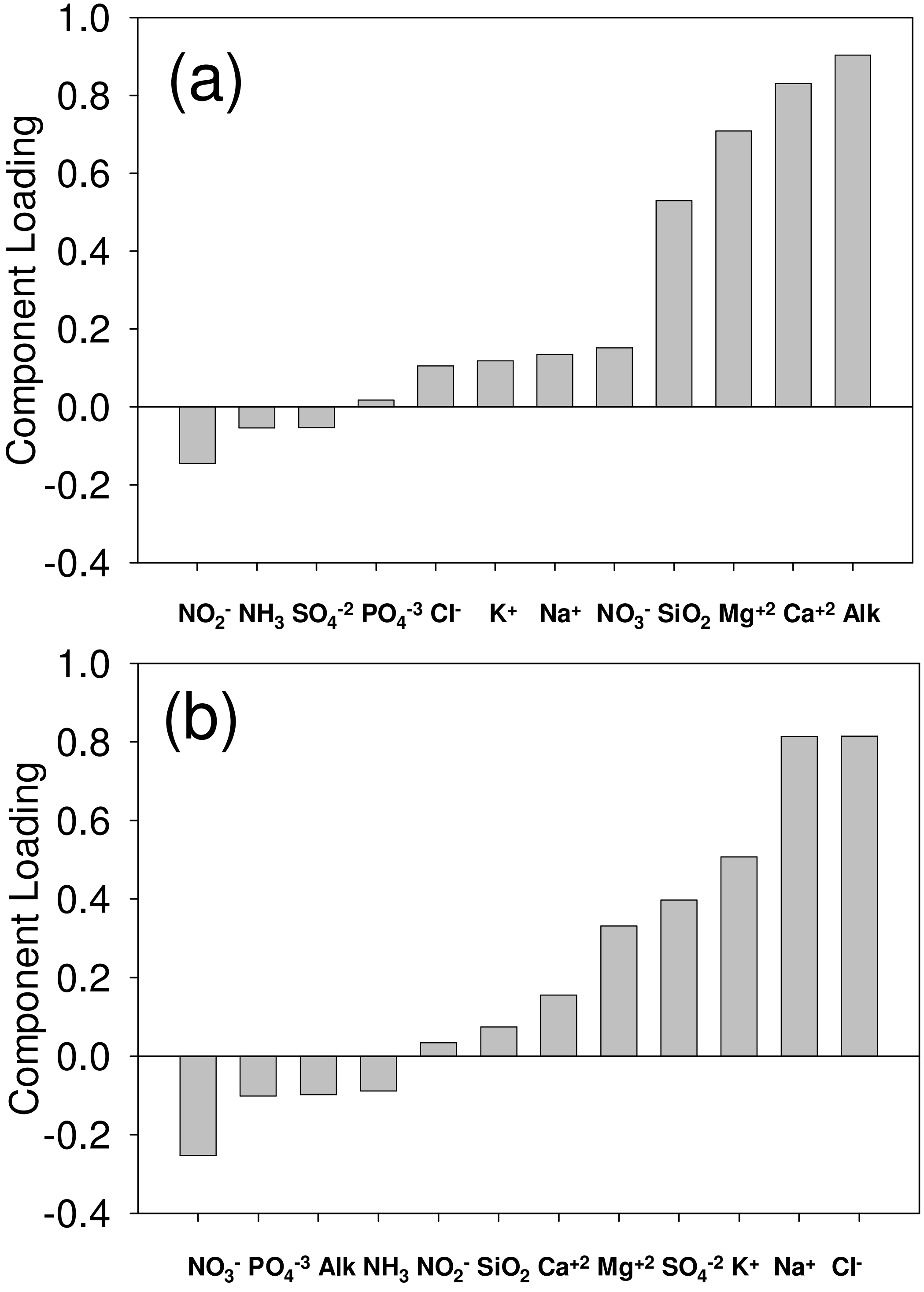


Figure 17. Principle components analysis (PCA) loadings for components 1 (a) and 2 (b). High positive and negative loadings indicate a particular variable contributes significantly to the linear relationship explained by a component (Davis, 2002). Neutral loadings suggest the variable contributes little to the linear relationship explained by the component (Davis, 2002).

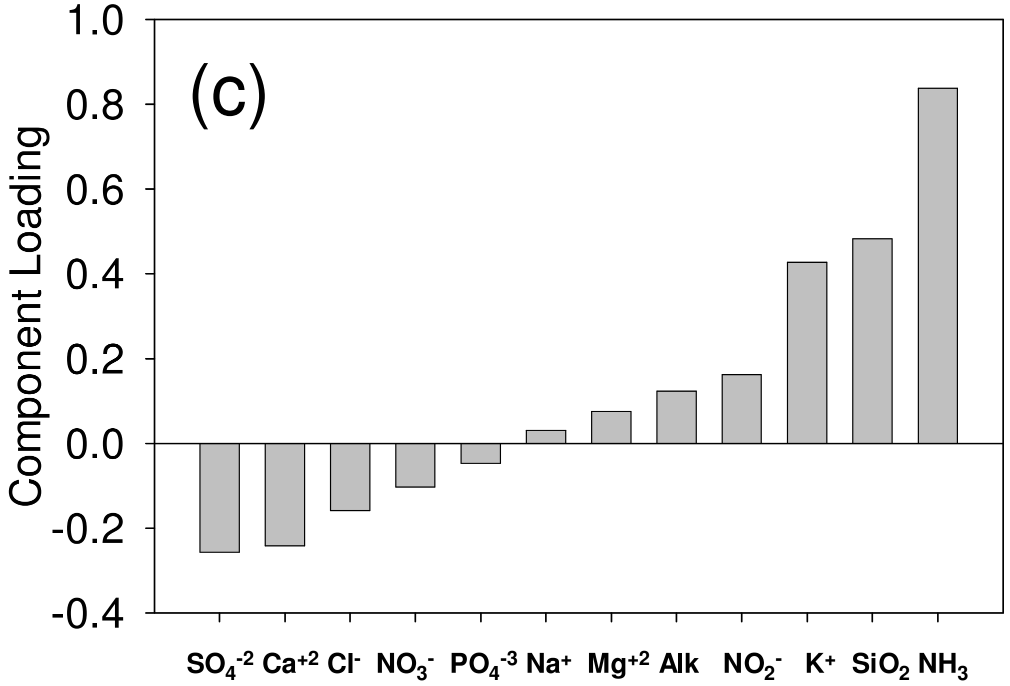


Figure 17 (continued). Principle components analysis (PCA) loadings for component 3 (c).

DISCUSSION

Influence of Hydrogeomorphic (HGM) Setting on Riparian Hydrology

Three main factors appear to influence observed ground water behavior at the study site: 1) the magnitude and seasonality of ground water inputs from upland areas adjacent to the site, 2) riparian zone soil texture, and 3) the location of the lower preWisconsinan till surface.

Riparian zones connected to local ground water flow systems often show a variety of ground water connections to upland areas, especially in terms of magnitude and seasonality (Devito et al., 1996; Buttle and Sami, 1992; Taylor and Pierson, 1985; Whiteley and Irwin, 1986). Hydrometric results from the site in this study suggest a seasonal variation in the connection between the riparian zone and permeable upland sediments. Riparian zone water table fluctuations reflect the seasonal nature of ground water contributions from the uplands. Group 1 wells are closer to the hillslope than Group 2 wells, which results in shallow water tables due to the increased influx of ground water from upslope areas during high water table conditions. For example, the average depth to water for Group 1 wells during high water table conditions is -11 cm and the average depth to water for Group 2 wells is -81 cm (Table 5; Figure 9). Devito et al. (1996) found shallow water tables at sites receiving ground water inputs from adjacent uplands. The influx of ground water from upland areas adjacent to SSNS also affects the response of the water table to precipitation. Group 1 well hydrographs suggest the water table in this portion of the riparian zone has a subdued response to precipitation inputs. A

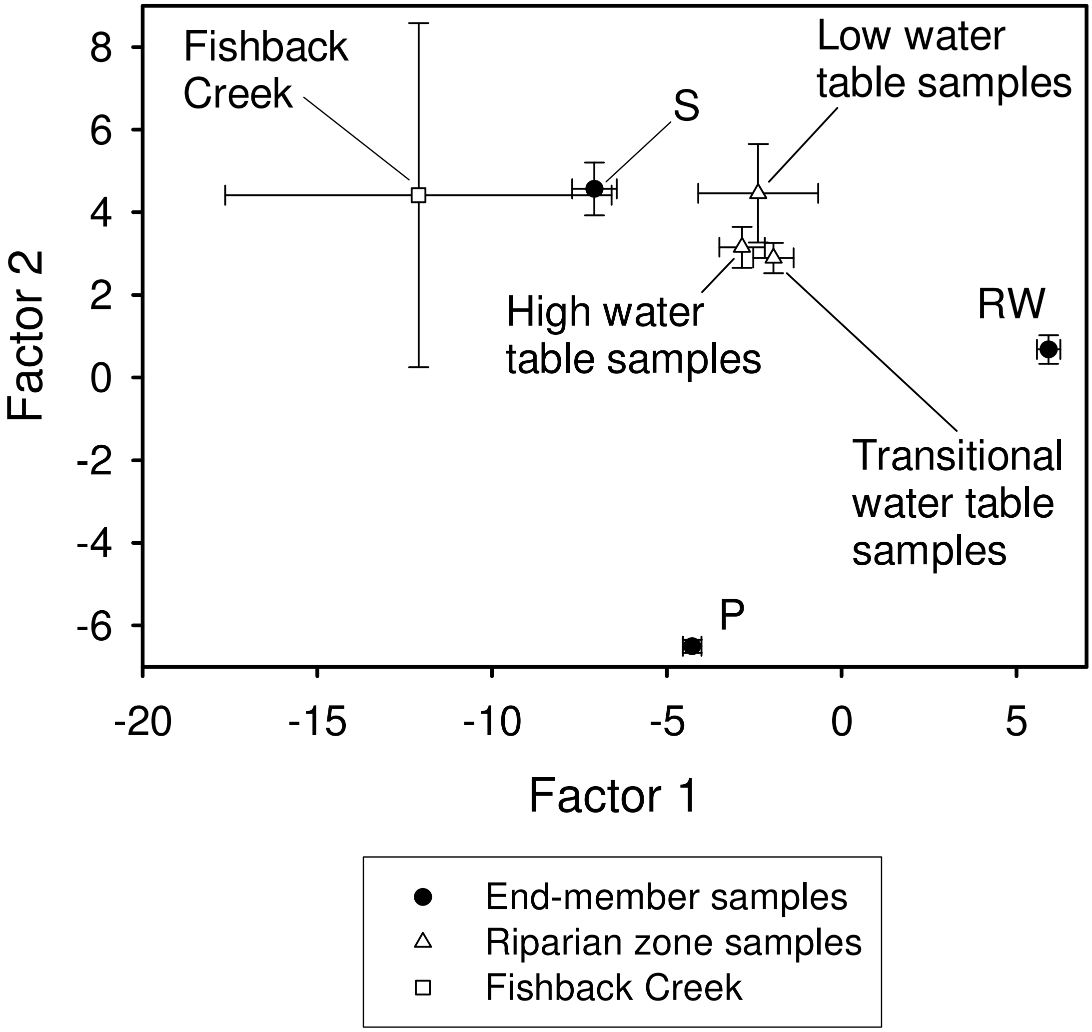


Figure 18. Plot of discriminant analysis scores for factors 1 and 2. Points represent centroids for that particular group of samples. Whiskers show 95% confidence intervals for each particular group of samples. The three end member groups are labeled as follows: P = precipitation samples; IE = intertill water samples; and IA = intratill water samples (water from the sand and gravel layer within the preWisconsinan till unit).

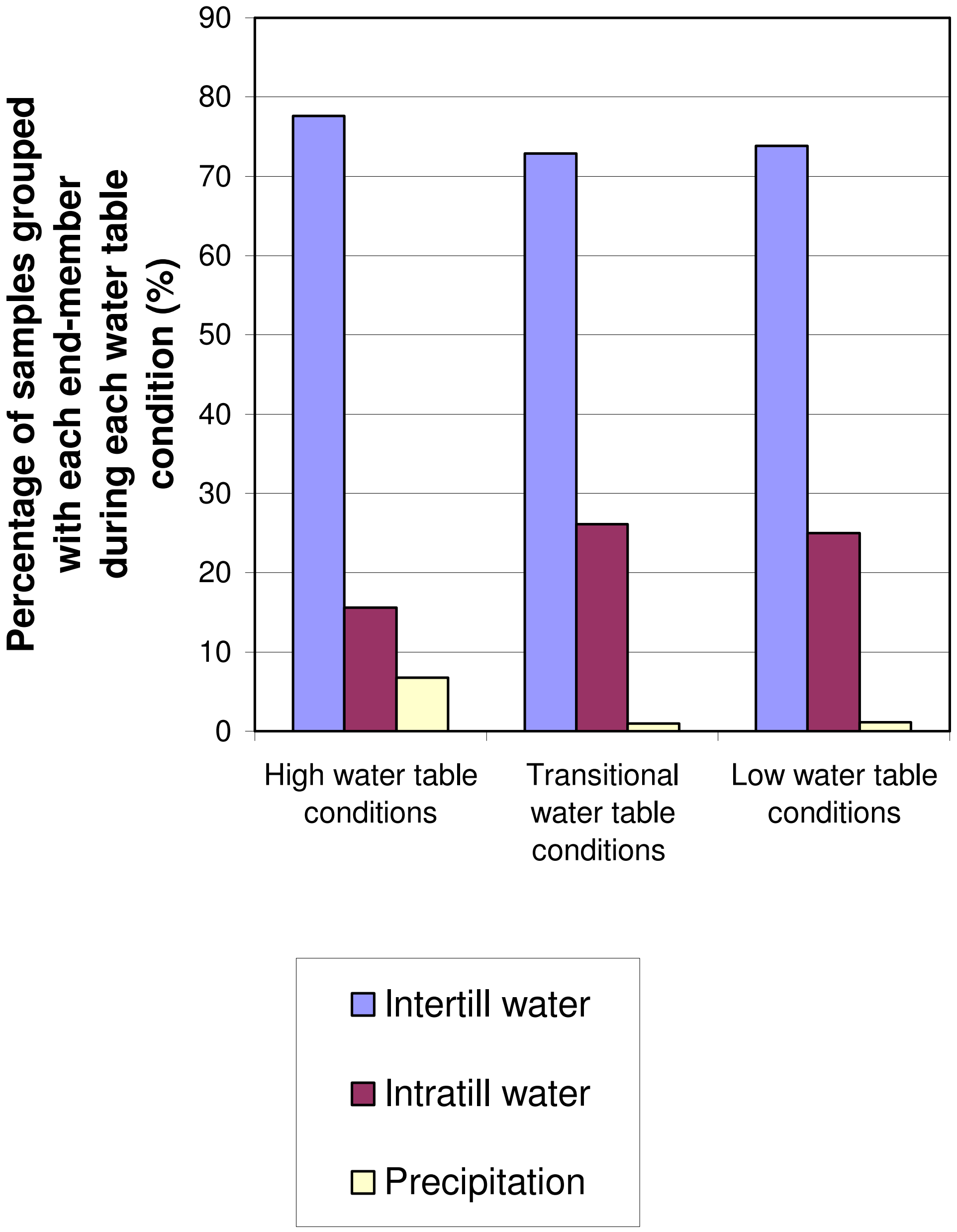


Figure 19. Percentage of samples grouped with each end member within each water table condition. For example, during high water table conditions approximately 78% of all samples collected were grouped with the intertill water group by discriminant analysis. 15% of high water table condition samples were classified as intratill water and 7% were classified as precipitation.

similar response to precipitation inputs was reported by McGlynn et al. (1999) who noted muted hydrograph responses in areas of the riparian zone that had high water tables due to the influx of water from the adjacent hillslope.

One feature also common to riparian zones with temporary connections with permeable upland sediments is a large water table decline during summer and fall months (Devito et al., 1996; Vidon and Hill, 2004b). This is displayed in hydrographs for Group 1 wells (Figure 9a) where the water table drops an average of 99 cm between high water table conditions and low water table conditions. Overall, the large water table decline observed in wells near the base of the hillslope is consistent with results from previous studies that suggest the absence of ground water inputs from the uplands contribute to the large water table drop during dry parts of the year (Devito et al., 1996; Vidon and Hill, 2004b; Bosche et al., 1994; Burt et al., 2004; McGlynn et al., 1999). The large water table decline during transitional and low water table conditions also suggest that the riparian zone is connected to a local source of water when the riparian zone–upland connection is present (Devito et al., 1996).

Potentiometric surface maps also illustrate the seasonality of upland ground water contributions. During high water table conditions, the flow of water from the hillslope to the stream is maintained (Figure 12; Appendix E). Well hydrographs and ground water flux data indicate that a sufficient amount of water is moving from the hillslope to the riparian zone during high water table conditions to maintain a potentiometric gradient from the base of the slope to the stream. As upland water contributions decrease during transitional water table conditions, the flow of water to the stream decreases and a downvalley gradient persists (Figure 12). Several studies have reported continuous flow of riparian zone ground water from the hillslope to the stream at sites with continuous connections with upland water sources (Devito et al., 2000a; Bosch et al., 1994; Vidon and Hill, 2004b). Also documented is the seasonal shift in the direction of riparian zone ground water flow at sites lacking a continuous riparian zone-upland connection (Puckett et al., 2002; Vidon and Hill, 2004b).

Ground water flux results also indicate the seasonality of the connection between the riparian zone and the upland. Vidon and Hill (2004b) found ground water fluxes to be a good indicator of riparian zone-upland connectivity. They found riparian zones connected to uplands with small permeable sediment depths (< 2 m) to have lower and more temporally variable ground water fluxes (Vidon and Hill, 2004b). At SSNS, during low water table conditions, water contributions from the adjacent uplands are small (ground water fluxes from 0.0 to 0.2 L/day/m^{-1}) making the water table gradient close to zero (Table 6; Figure 12). This results in little to no ground water flux in the lateral direction for much of the riparian zone during low water table periods. Conversely, during high water table conditions, the water table gradient is driven by ground water contributions from the uplands, resulting in much higher fluxes (1.7 to 18.8 L/day/m^{-1}).

Several studies have successfully linked the hydrologic connection between the riparian zone and adjacent uplands to the hydrogeologic setting of the area (Devito et al., 1996; Hinton et al., 1993; Vidon and Hill, 2004a; Vidon and Hill, 2004b). A major contributing factor for sites with a year-round riparian zone-upland connection is the nature of geologic deposits in adjacent uplands (Devito et al., 1996). At SSNS, upland permeable sediments include soils that have formed on top of the Trafalgar till unit as well as the sand and gravel layer at the contact between the lower preWisconsinan till unit and the overlying Trafalgar till (intertill layer) (Figure 2b). It is not known how much and at what rate water is transmitted through the Trafalgar till unit itself, but based on published hydraulic conductivities for glacial till it is estimated that the hydraulic conductivity of the Trafalgar till is between 8.64 x 10^{-6} and 17.28 cm/day (Domenico and Schwartz, 1990; Freeze and Cherry, 1979) making it behave as an aquitard when compared to the hydraulic conductivity of geologic materials surrounding it. The depth of upland soils was estimated to be < 2 m based on well logs (IDNR, water well record database) and the intertill layer was determined to be anywhere from 0.3-1 m thick based on field observations and work done by Harrison (1963). Therefore, the total depth of all permeable upland sediments is estimated to be between 1.8 and 3 m. Devito et al. (1996) found upland inputs absent during the summer months at a site where the upland permeable sediment depth was < 1 m. Conversely, they also found the riparian zone-upland connection to be permanent at a site with deeper upland sediments (1-3 m). Similarly, Vidon and Hill (2004b) found riparian zones that were connected to uplands with permeable sediment depths of 2-15 m had a permanent hydrological connection to the uplands and that when upland permeable sediment depths were < 2 m the connection was ephemeral. The intermittent riparian zone–upland connection observed at the site in this study suggests that in a setting similar to SSNS an upland permeable sediment depth of 1.8-3 m is not sufficient to maintain a continuous connection between the riparian zone and adjacent uplands.

The influence of riparian zone soil texture on riparian zone ground water behavior is well documented (Angier et al., 2005; McGlynn et al., 1999; Vidon and Hill, 2004b; Gold et al., 2001; Devito et al., 2000a; Puckett et al., 2002). In general, a strong correlation exists between well hydrograph behavior and riparian zone soil texture (Figures 6 and 9; Appendix C). Soil data (Figure 6; Appendix A) shows finer textured soils (mainly loams with patchy clay lenses) near the base of the slope than in the middle of the study site and near the stream (sandy loam with large amounts of gravel). Finer soil textures near the slope bottom (Group 1 wells) keeps the water table closer to the ground surface for longer durations throughout the year compared to Group 2 wells (Figure 9). The spatial variation in ground water fluxes can also be attributed to varying soil textures within the riparian zone. For transects A-A' and B-B', ground water fluxes are lower near the hillslope because loamy soil (Figure 6) with lower hydraulic conductivity (Appendix A) dominates near the hillslope, resulting in lower ground water fluxes compared to areas near the stream where sandy loam soils persist. Transect C-C' also shows coarser soil textures near the stream (silt loam) compared to soils near the hillslope (silty clay loam) but ground water fluxes are greater near the hillslope for this transect. One explanation for the higher ground water fluxes observed between wells 4 and 5 in transect C-C' might be the presence of a highly conductive (> 600 cm/day) layer at approximately 1 m depth near well 4 (Appendix A). Thus the combination of upland ground water contributions and riparian zone soil texture influence the direction, amount, and rate of water moving through the riparian zone.

The upper surface of the lower preWisconsinan till limits flow at depth in the riparian zone (Figures 2b and 11). Soil profiles and hydraulic conductivity results were used to determine the location of the preWisconsinan till layer (found at depths of 1.2-2 m in the riparian zone). The preWisconsinan glacial till unit is responsible for horizontal ground water flow (parallel to the ground surface) in the riparian zone, illustrating its control on shallow ground water movement (Figure 11). The presence of a shallow confining layer resulting in horizontal ground water flow is well documented (Devito et al., 1996; Devito et al., 2000a; Puckett et al., 2002; Mengis et al., 1999; Correll et al., 1992; Jordan et al., 1993; Puckett, 1999; Vidon and Hill, 2004b). The lower preWisconsinan till layer also underlies the intertill sand and gravel layer located between the two till units, marking the location of the ground water seeps on the valley walls (Figure 2b). In both places, the downward movement of water is restricted and water is forced to flow horizontally across the till surface until it discharges to the stream or surface soil layers, which was also suggested in earlier work in the Fishback Creek watershed by Barr et al. (1996). However, this work suggests the preWisconsinan till unit appears to affect flow throughout the lower portion of the Fishback Creek valley, not just in the intertill deposits. This is evidenced by the downvalley gradient observed during low water table conditions in potentiometric surface maps (Figure 12).

Sources of Water to the Riparian Zone

It was hypothesized that in addition to direct input from precipitation, two sources of water potentially contribute to the riparian zone: 1) intertill water (includes water from the intertill sand and gravel layer located approximately 8 m above the riparian zone surface, hillslope soils, and additional sand and gravel lenses within the Trafalgar till), and 2) intratill water (from interbedded sand and gravel layers approximately 4-6 m below the riparian surface). Water samples were collected to represent each hypothesized source of water to the riparian zone. Hydrometric and water chemistry data, as well as results of statistical analyses, were used to identify sources of water to the riparian zone.

Well logs from residential wells in the upland obtained from the Indiana Department of Natural Resources (IDNR, water well record database) indicate that the majority of residential wells in the upland are finished in intratill layers in the lower preWisconsinan till > 4 m below the riparian zone surface. The absence of vertical gradients in the riparian zone suggests that no upwelling of intratill water is occurring (Figure 11). Statistical analyses performed on water chemistry data also indicate that intratill water is not a major source of water to the riparian zone. Plots of PCA scores show lack of proximity between centroids representing riparian zone water samples and the centroid representing intratill water indicating they are influenced by different factors (Figure 16). DA has determined water from a number of wells in the riparian zone to be most similar in composition to intratill water (Figures 18 and 19; Appendix I), but overall the vast majority of riparian zone samples were not statistically similar, or even most similar, to intratill water. Water chemistry results support statistical analysis findings. For example, Cl^-, a conservative tracer, is one order of magnitude lower for intratill water (mean = 3.03 mg/L) compared to water from the riparian zone (mean = 93.12 mg/L) suggesting the two do not have a significant hydrologic connection. Specific conductivity, oxidation reduction potential, and SO_4^{-2} also vary greatly between intratill water and riparian zone water (Table 7). This suggests that riparian zone water chemistry is not affected by the same processes influencing intratill water and that the discharge of water directly from intratill layers is unlikely.

It is known that precipitation contributes water to the riparian zone as direct input and possibly via surface runoff during precipitation events, but PCA sample centroids (Figure 16) and DA results (Figures 18 and 19) suggest that precipitation is not a major source of water to the riparian zone. However, PCA and DA indicate that samples collected during high water table conditions are more influenced by precipitation than samples collected during low water table conditions, suggesting that during high water table conditions, precipitation contributes more. However, because the chemistry of precipitation can change quickly as it infiltrates and interacts with soils (Hornung et al., 1986; Hite and Cheng, 1996), knowing the exact contribution of precipitation to riparian zone water is difficult.

In contrast, both DA and PCA suggest that intertill water is the dominant source of water to the riparian zone throughout the year. DA results indicate that riparian water samples are most similar in composition to intertill water, because riparian zone sample centroids are closer to the intertill water centroid than they are to other end member centroids (Figure 18; Appendix I). This is true regardless of water table condition. For example, the percentage of samples collected during each water table condition that were classified as intertill water does not vary greatly suggesting that water with a similar composition to that collected from intertill layers is present in the riparian zone year-round (Figure 19). PCA analysis also indicates that similar processes are affecting riparian zone water and intertill water due to the close proximity of centroids representing riparian zone water samples and intertill samples (Figure 16).

PCA component loadings provide additional insight to water quality and source water at SSNS. Component loadings look at the water chemistry data set as a whole; therefore, interpretations must be made on the entire data set. However, since much of the data indicate that water with a chemical signature similar to intertill water dominates the riparian zone and since the overwhelming majority of the total number of samples collected were from the riparian zone (< 90%), one can conclude that component loadings apply in large part to intertill water also. Component loadings for PCA suggest that dissolution of carbonates and anthropogenic pollution are affecting water chemistry at the study site (Schot and van der Wal, 1992; Usunoff and Guzman-Guzman, 1989). Component 1 shows opposition between alkalinity (+0.9) and SO_4^{-2} (-0.05), which indicate that these ions are competing in reactions with Ca^{+2}: most likely dissolution and precipitation of calcite (Usunoff and Guzman-Guzman, 1989). Schot and van der Wal (1992) found high loadings for Ca^{+2}, Mg^{+2}, and alkalinity to suggest dissolution of carbonates is occurring. Dissolution of carbonates is likely to occur at the site as Harrison (1963) noted that till at the study site is typically high in carbonates. These findings suggest that intertill and riparian zone water is coming into contact with sediments high in carbonates somewhere along its flow path, such as glacial till. High loadings for parameters such as SO_4^{-2}, K^+, Na^+, and Cl^-, as observed in Component 2, have been linked to the infiltration of surface water of poor quality (Schot and van der Wal, 1992), septic effluent (Panno et al., 1999; Schot and van der Wal, 1992), and de-icing salt application (Panno et al., 1999). Elevated NO_3^- levels were recorded in water from wells near the base of the hillslope on several dates from 29 September 2005 until sampling ended. The elevated NO_3^- levels started being observed around the time the riparian zone–upland connection was restored. This is significant because it supports hydrometric data that indicates that water from upland sediments, where septic systems are installed, is supplying water to the riparian zone during high water table conditions.

Hydrometric results as presented in the first section of the discussion indicate that a seasonal connection exists between the riparian zone and upland water sources. Water chemistry and statistical analyses indicate that water with a similar composition to intertill water is found in riparian zone soils during high water table conditions. So it is concluded that during high water table conditions, when the riparian zone–upland connection is present, intertill water is the primary source of water to the riparian zone. The dominant source of water during low water table conditions is not as clear as ground water flow paths (Figure 12; Appendix E) and the connection between the riparian zone and upland water sources vary. DA analysis results indicate that riparian zone water during low water table conditions is most similar in composition to intertill water when compared to the chemical composition of the other two end members. One hypothesis to explain why riparian zone water retains the intertill water signature during low water table conditions is that there is an additional source of water in the Fishback Creek valley that contributes water to the riparian zone during low water table conditions that was not accounted for in the sampling regime used. Because a downvalley gradient persists during low water table conditions, yet riparian zone water is most similar in composition to intertill water, it is possible that an upstream (upvalley) water source similar in composition to intertill water is fueling the downvalley gradient observed during low water table conditions. Additional seeps located upstream from the study site at the contact between the preWisconsinan till and Trafalgar till could be discharging water into valley floor sediments and soils which then travel downvalley on the preWisconsinan surface. However, it is unknown if these seeps are producing enough water for this to occur or if the orientation of the preWisconsinan surface is appropriate at the watershed scale to facilitate such a downvalley flow of water. Further research is needed to understand the role of the additional seeps discussed above in influencing the hydrology of the Fishback Creek watershed.

Influence of Hydrogeomorphic (HGM) Setting on Water Quality Functioning

The HGM setting and resulting hydrology of this site suggest it is an important part of the landscape from a water quality point-of-view. Water table dynamics and soil wetness are critical components in ground water nutrient removal (Gold et al., 2001; Hefting et al., 2004). Water table position is important to nutrient removal functioning because high water tables enable nutrient-rich ground water to interact with shallow soil layers with elevated biogeochemical transformation rates (Gold et al., 2001). Organic carbon, plant roots, and living microbes are more abundant in shallow soils and help create situations conducive to nutrient removal, especially NO_3^- (Gold et al., 2001). Organic carbon amounts for soils at the site were not measured; however, water table fluctuation can be used as an indicator of nutrient removal potential of the site. Several studies have reported significant ground water denitrification at sites where the water table was within 1 m of the surface, but limited denitrification at sites with deeper water tables (Gold et al., 2001; Simmons et al., 1992; Starr and Gillham, 1993; Nelson et al., 1995; Gold et al., 1998). Hydrographs (Figure 9; Appendix C) and water table statistics from this study (Table 5) show high water tables as a result of poorly drained soils and increased upland inputs, especially near the base of the slope. This suggests that nutrients such as NO_3^- in water discharging into the riparian zone from upland sources is likely to be degraded as it flows through the riparian zone. Indeed, high NO_3^- concentrations do not persist across the riparian zone on four dates when high NO_3^- concentrations (often above 15 mg/L) were recorded in wells and piezometers near the base of the hillslope, suggesting efficient NO_3^- removal. On all four dates, ground water NO_3^- decreased by over 97% in soils shallower than 100 cm between well nests 3 and 10 (Figures 13a and 13d). Potentiometric surface maps (Appendix E) illustrate that ground water was flowing from the hillslope to the stream, or roughly parallel to the transect line, on all four dates. Similar results were found for transects A-A' and C-C' for the same dates. Cl^- concentrations, which can be used as an indicator of dilution along the ground water flowpath (Vidon and Hill, 2004a), suggest that dilution due to precipitation is possibly occurring; however, the lack of downward ground water flow and the lack of samples that were classified as precipitation using DA suggest that dilution is not a major factor influencing NO_3^- reduction in the riparian zone. A number of papers have reported subsurface NO_3^- reduction in the first 10-20 m upon entering the riparian zone (Lowrance et al., 1984; Peterjohn and Correl, 1984; Haycock and Pinay, 1993; Bohlke et al., 2002) while others have reported NO_3^- reduction over distances of > 100 m (Devito et al., 2000b). Vidon and Hill (2004a) indicate that a distance of 20 to 30 m for 90% of NO_3^- removal was estimated for sites with moderately to steeply sloping topography (> 5%), an upland permeable sediment depth of < 2 m, and a riparian permeable sediment depth of < 2 m. This suggests that sites with HGM characteristics similar to SSNS can be expected to reduce high nutrient concentrations, especially NO_3^-, when the site is receiving nutrient enriched water from upland sources when water is flowing from the hillslope to the stream. However, NO_3^- removal was observed on 29 September 2005 when the upland was not connected to the riparian zone and ground water flowed in a downvalley direction. A precipitation event the day prior to 29 September 2005 likely resulted in nutrient-rich runoff discharging into the riparian zone. Despite low water table conditions on 29 September 2005, > 99% of NO_3^- measured in well 3 (29.97 mg/L NO_3^-) was removed prior to reaching well 4 (0.05 mg/L NO_3^-). This suggests the ability of the site to reduce nuntrient concentration such as NO_3^- is not restricted to high water table conditions.

Topography has also been shown to affect the water quality functioning of riparian zones (Devito et al., 2000a; Vidon and Hill, 2004b). A concave riparian surface, similar to SSNS (Figures 3 and 11), typically increases the interaction between ground water and shallow soil horizons where denitrification and root uptake are common (Vidon and Hill, 2004a). This is illustrated by a high water table near the slope bottom for most of the year, which favors interaction between nutrient-rich ground water and organic-rich surface soil.

Increased residence time and nutrient removal have a positive relationship (Hill, 2000; Peterjohn and Correll, 1984; Cooper, 1990; Haycock and Pinay, 1993; Hill, 1996). Low hydraulic conductivities (Appendix A) as a result of finer textured soils near the base of the slope results in increased ground water residence time leading to a greater chance that NO_3^- will be removed from water discharging into the riparian zone. Shallow lateral ground water flow paths in the riparian zone also promote increased soil residence time (Devito et al., 2000b; Peterjohn and Correll, 1984; Cooper, 1990; Haycock and Pinay, 1993; Hill, 1996). As presented earlier, the presence of the upper surface of the preWisconsinan till unit at shallow depths underlying the riparian zone (Figure 2b) results in shallow lateral subsurface flow paths (Figure 11) that increases the amount of time that ground water is in contact with soil horizons containing organic carbon, plants roots, and microbes capable of reducing NO_3^- concentrations (Gold et al., 2001). The preWisconsinan till surface also prevents shallow ground water from the hillslope from bypassing shallow riparian soils via deep ground water flow paths as it travels through the riparian zone, thus increasing the ability of riparian soils to remove NO_3^- from ground water.

Although nutrient removal rates were not measured in this study, data suggests that SSNS is likely to actively remove nutrients from water discharging into Fishback Creek; however, riparian zone soil characteristics exist that have been shown to reduce nutrient removal ability. Indeed, highly conductive sand and gravel lenses were observed at several locations in the riparian zone at SSNS (Appendix A). Sand and gravel lenses have been shown to adversely influence NO_3^- removal by acting as conduits for ground water transport (Devito et al., 2000b; Angier et al., 2005; Haycock and Burt, 1993). Sand and gravel layers are often discontinuous and represent deposits left by laterally migrating stream channels which are common to riparian zone lithology in a number of settings (Devito et al., 2000b; Reineck and Singh, 1980). If the connectivity of sand and gravel deposits in the riparian zone is great enough, ground water can travel from the hillslope to the stream, bypassing riparian zone soils and essentially “short-circuiting” the ability of the riparian zone to reduce ground water nutrient concentrations (Hill, 1990; Brusch and Nilsson, 1993). However, this was not observed at SSNS.

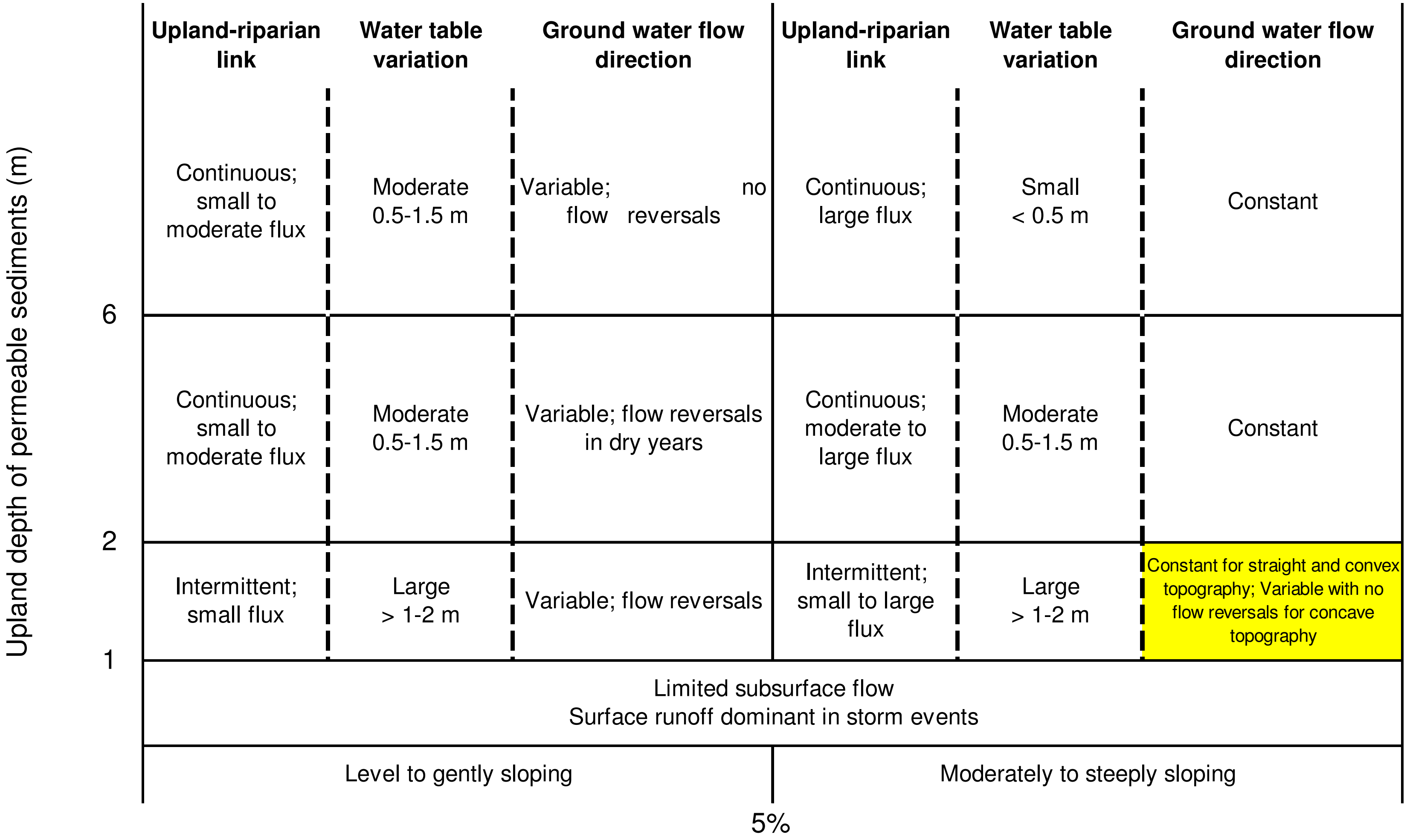
CONCEPTUAL MODEL

The riparian zone examined in this study represents a HGM setting uncommon to the literature but commonly found in the Midwest. This study shows that riparian zones in glaciated till valleys with ground water seeps on the valley wall and small upland permeable sediment depth (1.8-3 m) have intermittent connectivity between the upland and riparian zone. Topography of the riparian zone and surrounding uplands (relatively steep valley walls at a 16% slope and 220 m long) also influence the influx of upland ground water to the riparian zone and water quality functioning, but to a lesser extent. During low and high water table conditions, the site actively removes NO_3^- from shallow ground water flowing from the hillslope to the stream.

Correll (1997), Lowrance et al. (1997), Gold et al. (2001), and Hill (2000) found a significant relationship between landscape HGM setting and riparian hydrologic functioning. Recently, Vidon and Hill (2004b) discussed the relationship between riparian zone hydrology and HGM setting for seven riparian zone types ranging from riparian zones with thick upland aquifers and concave and flat topography to riparian zones with medium to thin upland aquifers and flat or steep convex topography. Reviews of riparian literature indicate a dearth of data from sites with a small upland aquifer (≈2 m of permeable upland sediments) linked to a riparian zone with medium to large ground water storage capacity and a steep concave topography; therefore, the work in this study includes an additional riparian zone type seldom mentioned in the literature. Generalizations about the hydrologic functioning of the site in this study were made which included linking upland permeable sediment depth and slope gradient to the duration of riparian zone-upland hydrologic connection, water table variation, and shallow ground water flow paths. These generalizations were tested against the conceptual models presented by Vidon and Hill (2004a) and Vidon and Hill (2004b) which is the culmination of work by several researchers (Devito et al., 1996; Hill, 2000; Baker et al., 2001; Burt et al., 2002). The hydrologic functioning of a site with HGM characteristics similar to SSNS was not researched by the authors listed above; therefore, they hypothesized the hydrologic functioning of sites similar to SSNS based on available data.

Results from this study suggest that at sites with small upland permeable sediment depth (1.8-3 m) and relatively steep valley walls (16% slope) a seasonally variable connection between the upland and riparian zone can be expected resulting in large water table fluctuations (> 1 m) which agrees with the model presented by Vidon and Hill (2004b). However, Vidon and Hill (2004b) hypothesized that sites similar to SSNS would have a constant ground water flow direction as a result of steep hillslope topography. Actual hydrologic functioning at SSNS illustrates a seasonally variable ground water flow direction in the riparian zone. It appears that at sites with upland permeable sediment depths of approximately 1.8-3 m, steep topography in the upland is not enough to maintain lateral flow throughout the year. The model presented by Vidon and Hill (2004b) was modified to accommodate these findings and is shown in Figure 20 (highlighted portion of figure shows modifications). The conceptual model presented by Vidon and Hill (2004a) emphasizes the connection between landscape features and NO_3^- removal in riparian zones in different settings. As mentioned previously, nutrient removal rates were not measured in this study making a comparison to the conceptual model presented by Vidon and Hill (2004a) difficult. Nevertheless, NO_3^- inputs at SSNS are intermittent and most common during the period of the year when recharge from the hillslope is the highest. This result is consistent with the conceptual model developed by Vidon and Hill (2004a). Although more data regarding NO_3^- removal at SSNS would be necessary to truly validate the conceptual model developed by Vidon and Hill (2004a) for SSNS, available data suggest that SSNS fits into the conceptual model well. Both conceptual models (Vidon and Hill, 2004a; Vidon and Hill, 2004b) were developed for use in temperate, mid-latitude climates and might require modifications for different climatic settings.

The conceptual model of riparian zone hydrological functioning presented in this report was devised in an attempt to use easily obtainable data (% slope, upland and riparian permeable sediment depth, surficial soils maps, etc.) to efficiently gain insight into the hydrological function of a number of sites in a variety of settings. In order for the conceptual model to be effective it must continue to be modified based on results from current and future riparian studies. This work has provided additional insight towards the hydrological functioning of one additional type of riparian zone. However, this study also illustrates the importance of individual site studies that provide data that is not widely available and quickly accessed. For instance, available soil maps would not have predicted the occurrence of layers of fine and coarse textured soils at depth in the riparian zone that have a significant influence on riparian zone hydrologic functioning at this site. Therefore, generalizations regarding riparian zone hydrologic functioning can be predicted by the conceptual model, but individual site hydrologic behavior may be difficult to evaluate.



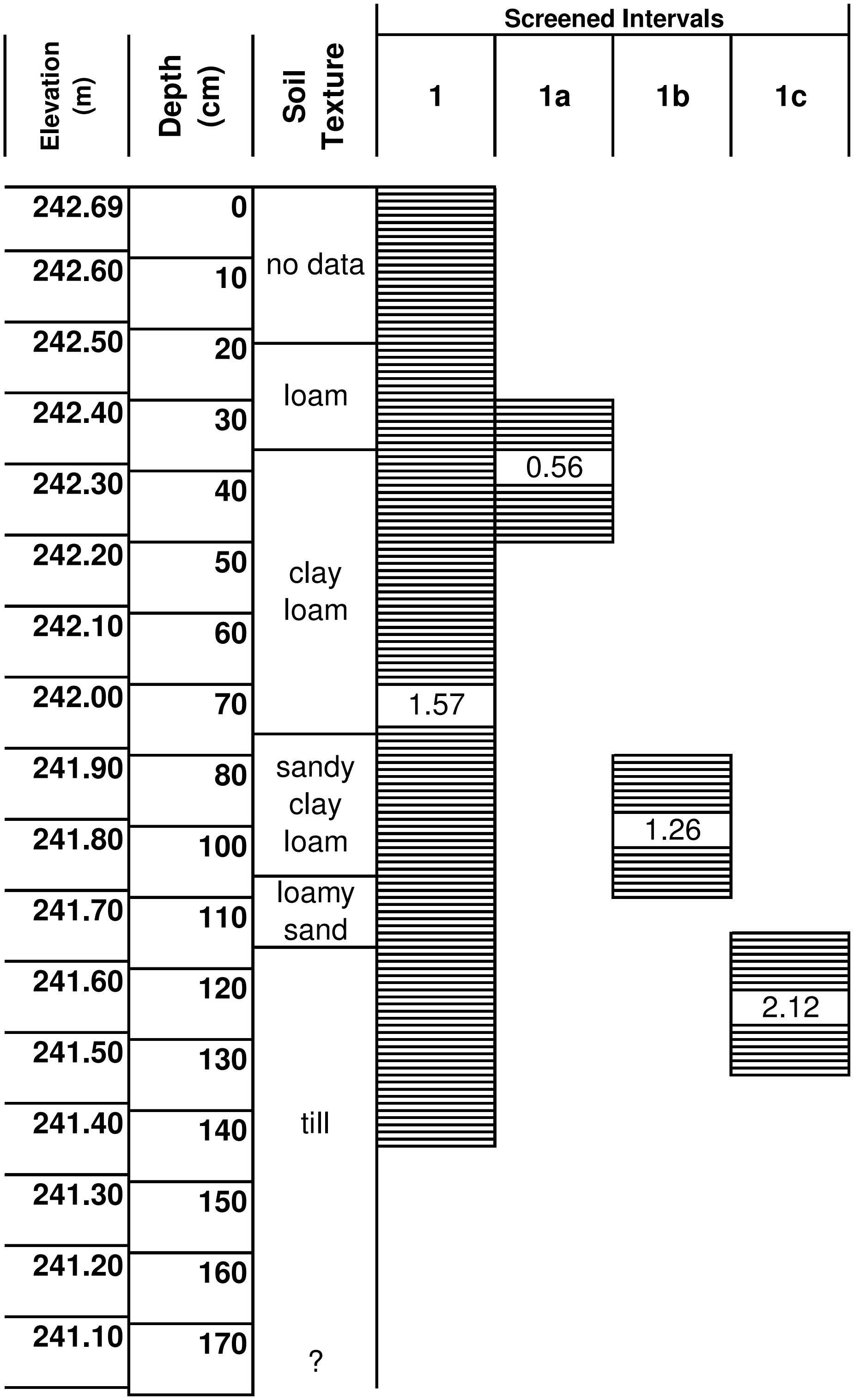
Upland depth of permeable sediments (m)	Upland-riparian link	Water table variation	Ground water flow direction	Upland-riparian link	Water table variation	Ground water flow direction
6	Continuous; small to moderate flux	Moderate 0.5-1.5 m	Variable; no flow reversals	Continuous; large flux	Small < 0.5 m	Constant
2	Continuous; small to moderate flux	Moderate 0.5-1.5 m	Variable; flow reversals in dry years	Continuous; moderate to large flux	Moderate 0.5-1.5 m	Constant
1	Intermittent; small flux	Large > 1-2 m	Variable; flow reversals	Intermittent; small to large flux	Large > 1-2 m	Constant for straight and convex topography; Variable with no flow reversals for concave topography
	Limited subsurface flow Surface runoff dominant in storm events					
	Level to gently sloping			Moderately to steeply sloping		

5%

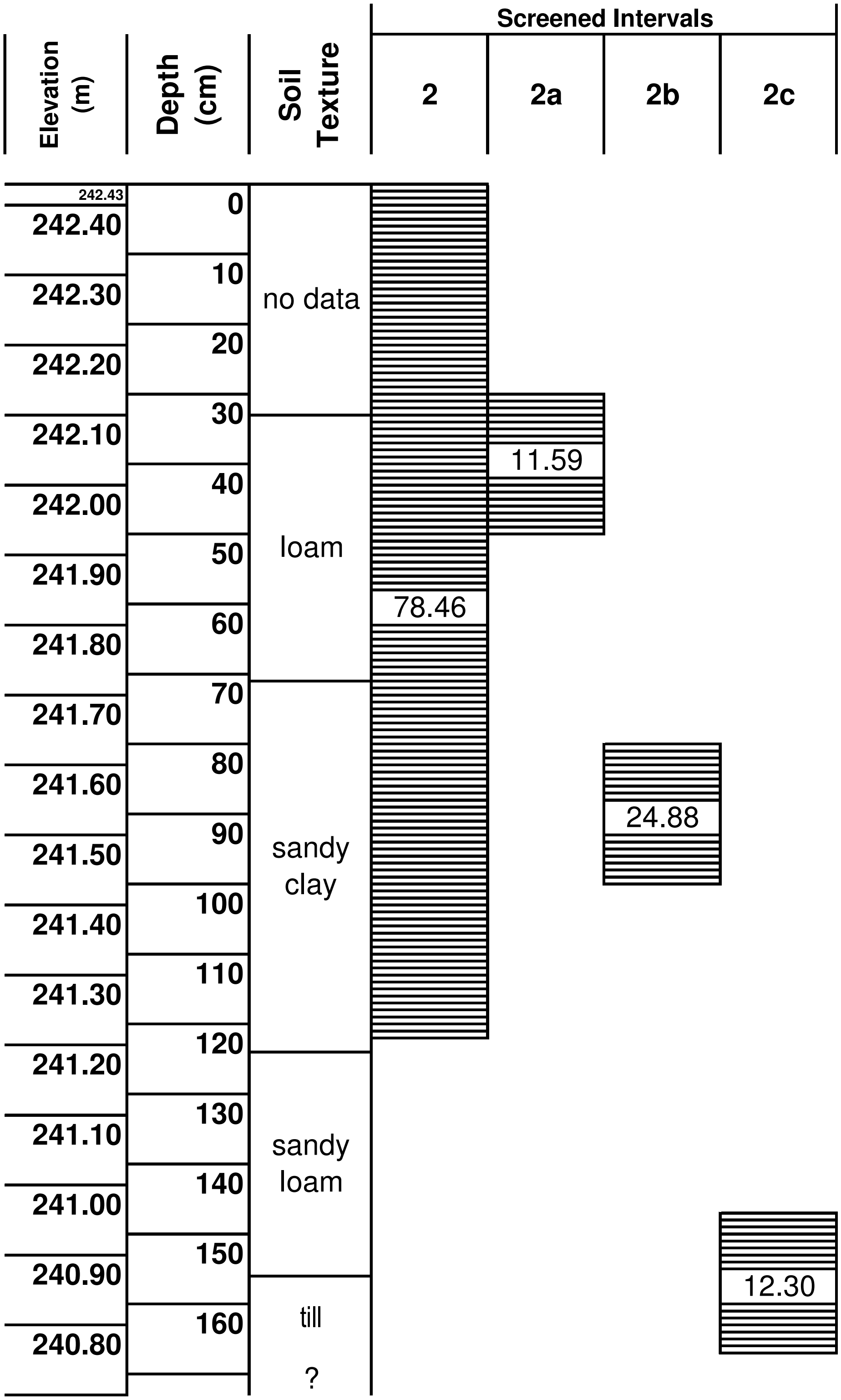
Figure 20. Conceptual model linking upland permable sediment depth (m) and slope gradient (%) to the duration of riparian zone - upland hydrologic connection, water table variation, and shallow ground water flow paths. The highlighted portion of the figure indicates modifications made to the original model proposed by Vidon and Hill (2004b).

CONCLUSIONS

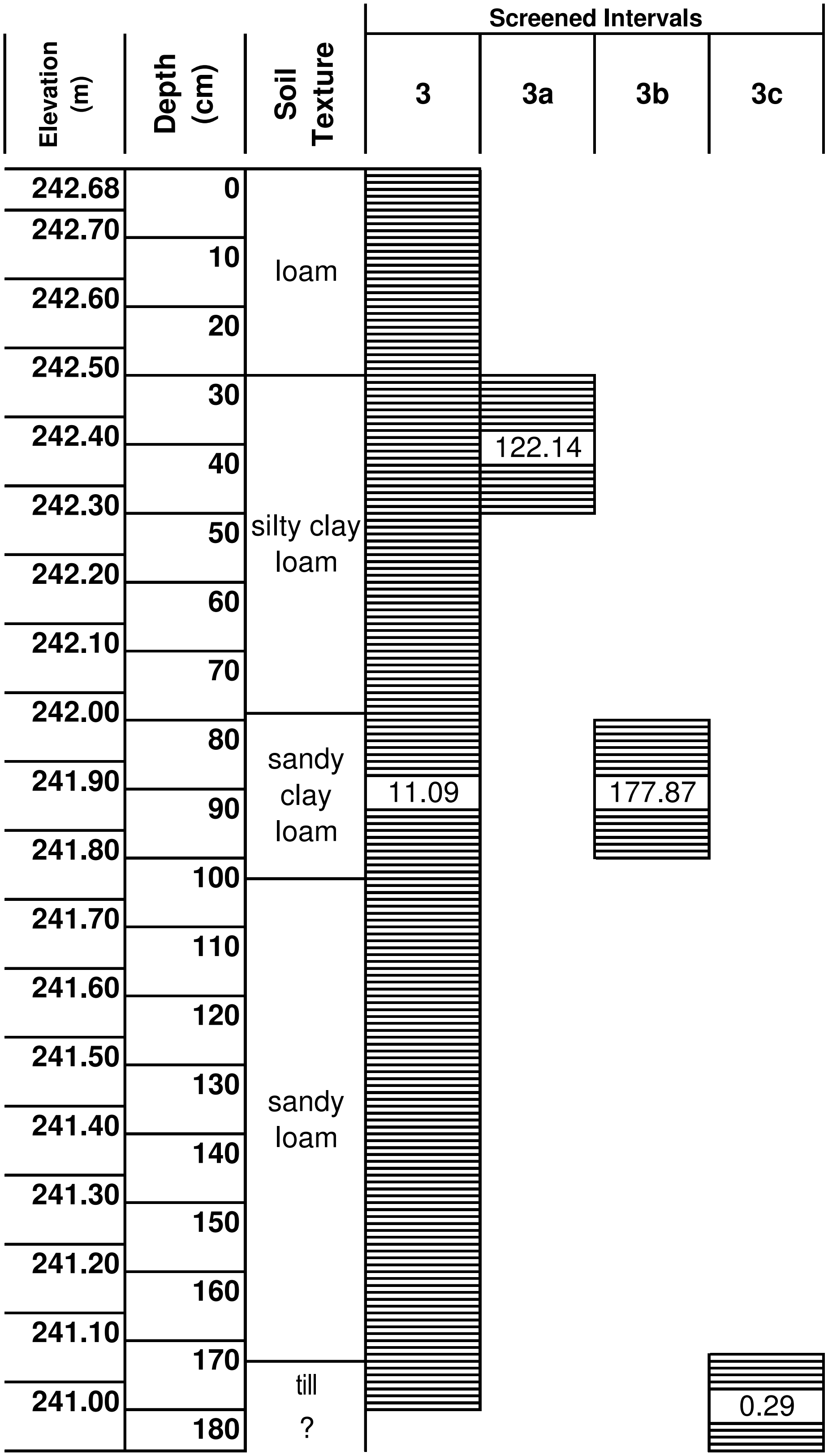
This work characterizes the hydrologic functioning of a site with features seldom found in the literature: a small upland permeable sediment depth (≈2 m) linked to a riparian zone with medium to large ground water storage capacity and a steep concave topography (16% slope; 220 m long). Three factors appear to influence riparian zone hydrological functioning at the site: 1) the seasonality and magnitude of contributions from upland water sources, 2) riparian zone soil texture, and 3) the location of the surface of the preWisconsinan till unit. The seasonal variation in upland water contributions to the riparian zone results in an elevated water table during high water table conditions near the base of the slope followed by a large water table decline when upland water contributions cease. The seasonal nature of upland water contributions also results in ground water flow from the hillslope to the stream during high water table conditions with a downvalley gradient being present when upland contributions are absent. Thus, intertill water from the adjacent uplands is the primary source of water during high water table conditions. Water with an intertill-like signature is also present in the riparian zone during low water table conditions despite limited contributions from upland water sources. Additional ground water seeps upstream from the site and low hydraulic conductivities resulting in seep water moving slowly through the riparian zone are two hypotheses to explain the presence of seep-like water during low water table conditions. The intermittent riparian zone–upland connection suggests the site receives water high in NO_3^- primarily during high water table conditions and potentially during precipitation events. NO_3^- was observed being actively removed in < 50 m from the base of the slope in shallow ground water flow in the riparian zone. Increased input from upland water sources during high water table conditions leads to a greater influx of ground water near the base of the slope, but finer textured soils near the base of the slope limit the rate at which water progresses into other parts of the riparian zone. Finer textured soils near the base of the slope with lower hydraulic conductivity also result in shallow water tables for most of the year compared to portions of the study site near the stream. In addition to soil texture distribution, the surface of the lower preWisconsinan till unit at shallow depths in the riparian zone is also responsible for limiting ground water flow to horizontal flow paths, increasing ground water residence times in shallow soil horizons (Vidon and Hill, 2004b; Devito et al., 1996; Devito et al., 2000b; Puckett et al., 2002; Mengis et al., 1999; Correll et al., 1992; Jordan et al., 1993; Puckett, 1999). Because the lower preWisconsinan till unit restricts the vertical movement of water, it prevents deeper ground water sources from discharging into the riparian zone limiting the site to local ground water flow. The preWisconsinan till surface also prevents shallow ground water from the hillslope from bypassing shallow riparian soils (via deep ground water flow paths) as it travels through the riparian zone, thus increasing the ability of riparian soils to remove NO_3^- from ground water. The results listed above are important additions towards conceptualizing riparian zone hydrologic functioning.



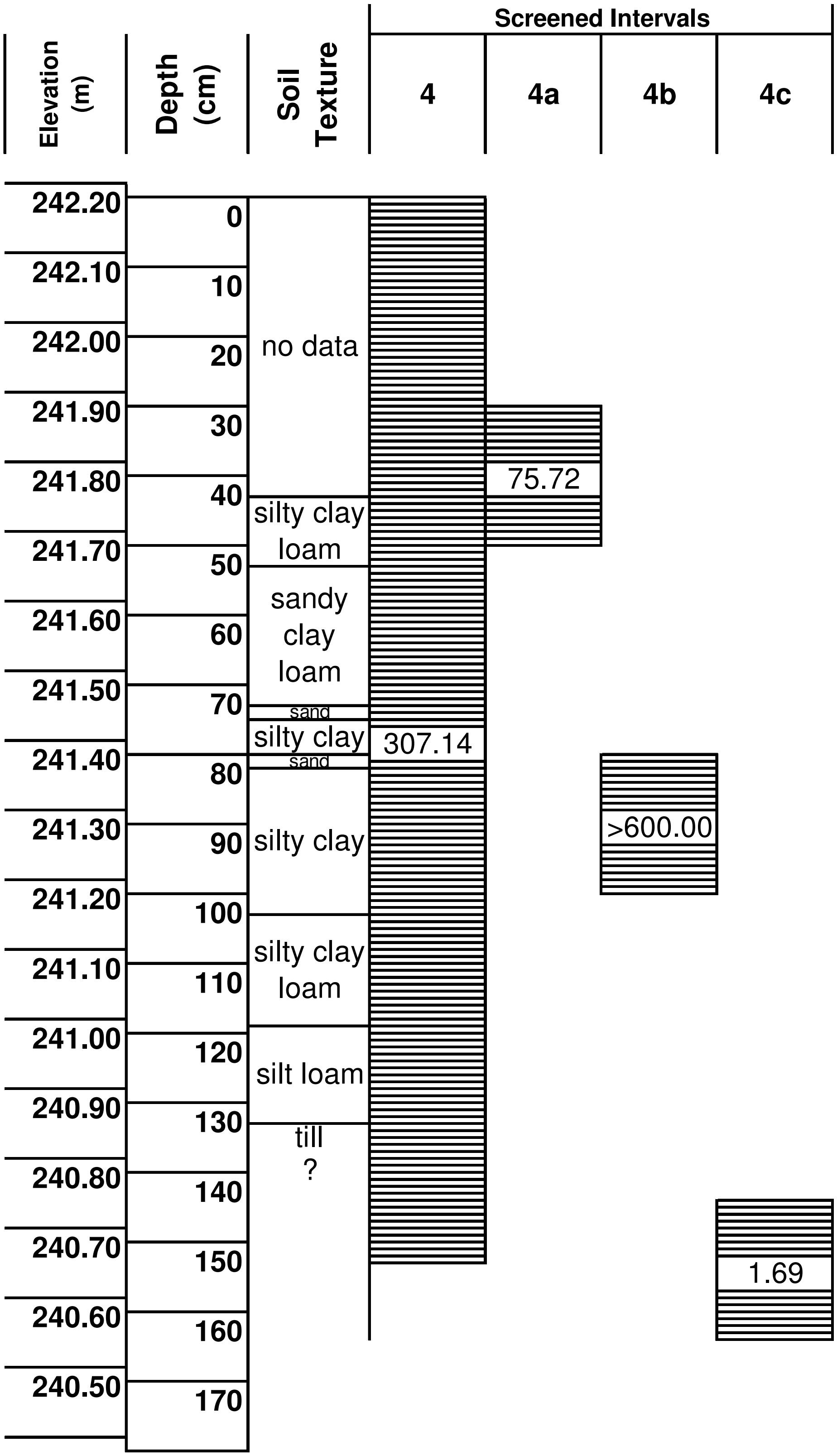
Appendix A. Soil profiles as recorded at wells 1 through 15. Elevation above sea level (m) is shown in the left column. Screened intervals for wells and piezometers are represented by the lined boxes in the right four columns. Hydraulic conductivity (cm/day) as measured in each well and piezometer is shown in the box representing the screened interval for each well.



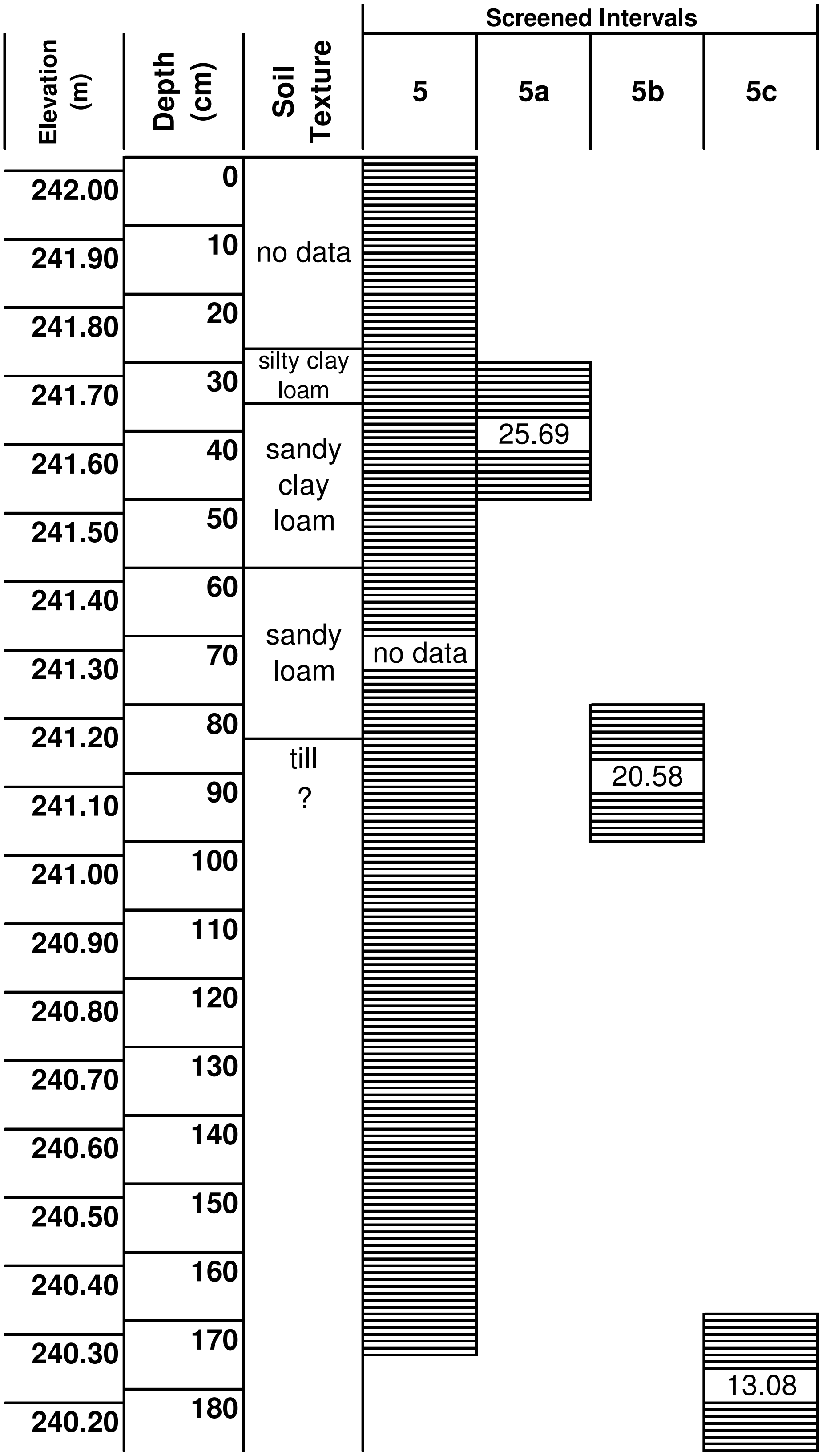
Appendix A (continued). Screened interval depths, soil profile, and hydraulic conductivities at well nest 2.



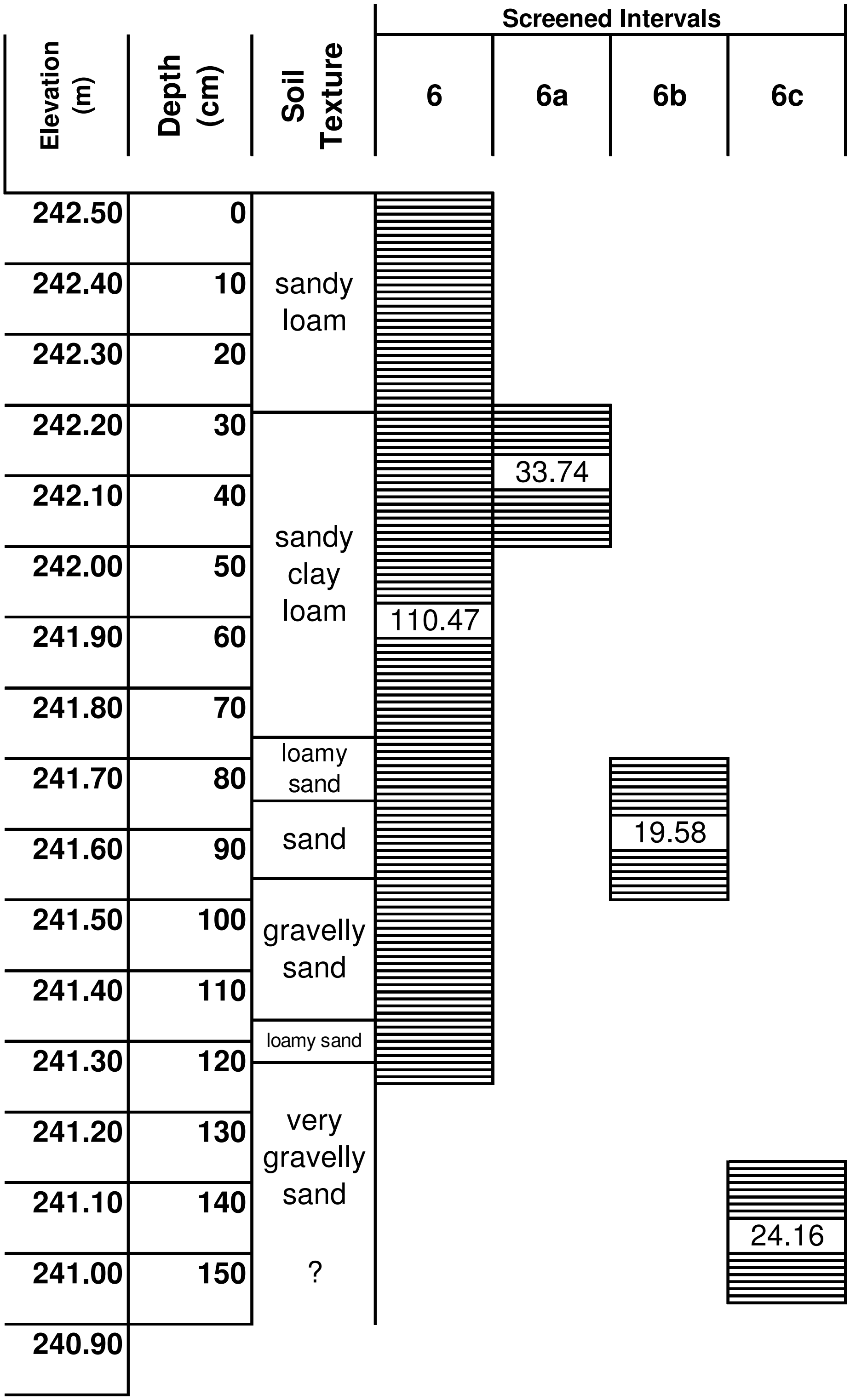
Appendix A (continued). Screened interval depths, soil profile, and hydraulic conductivities at well nest 3.



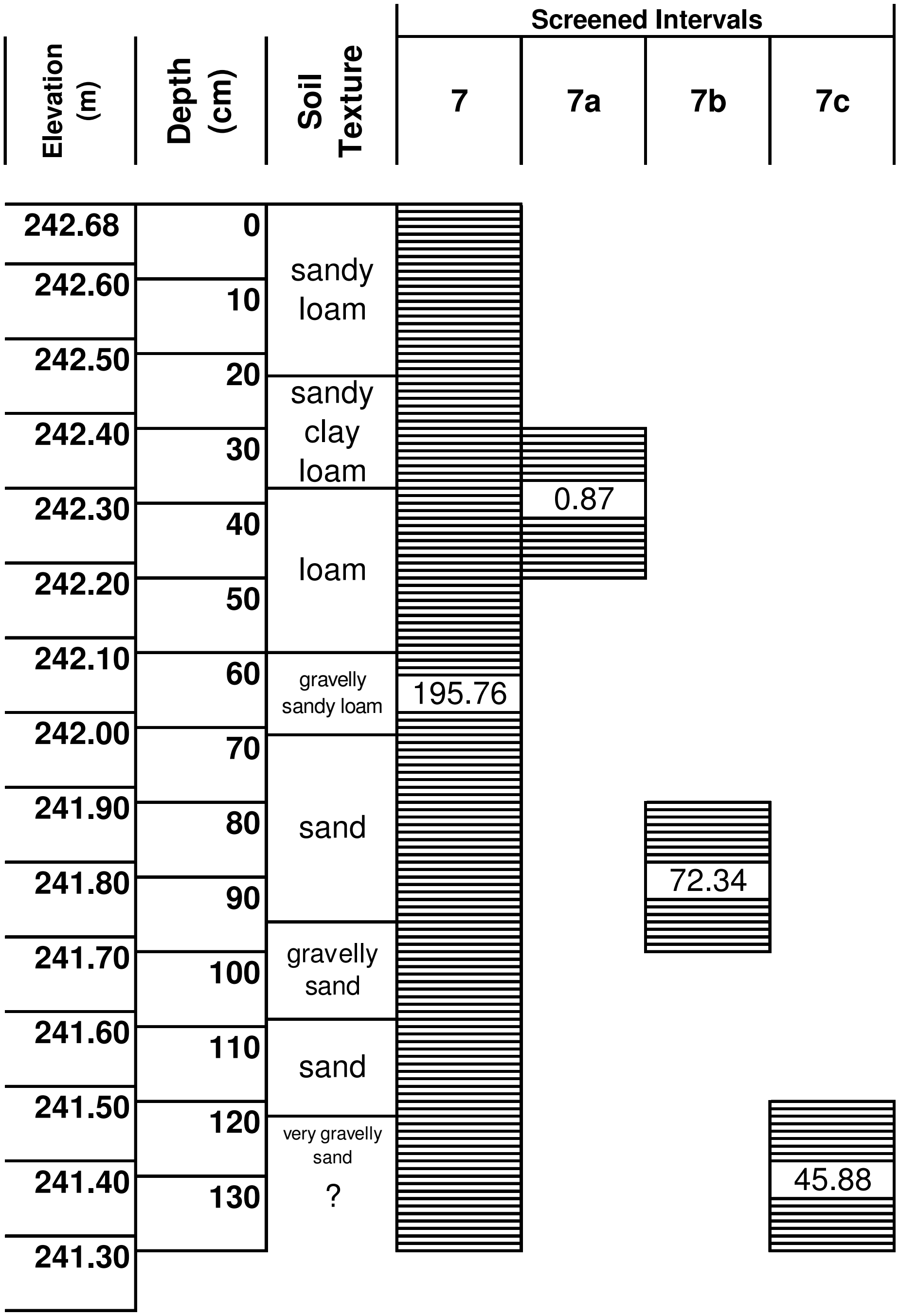
Appendix A (continued). Screened interval depths, soil profile, and hydraulic conductivities at well nest 4.



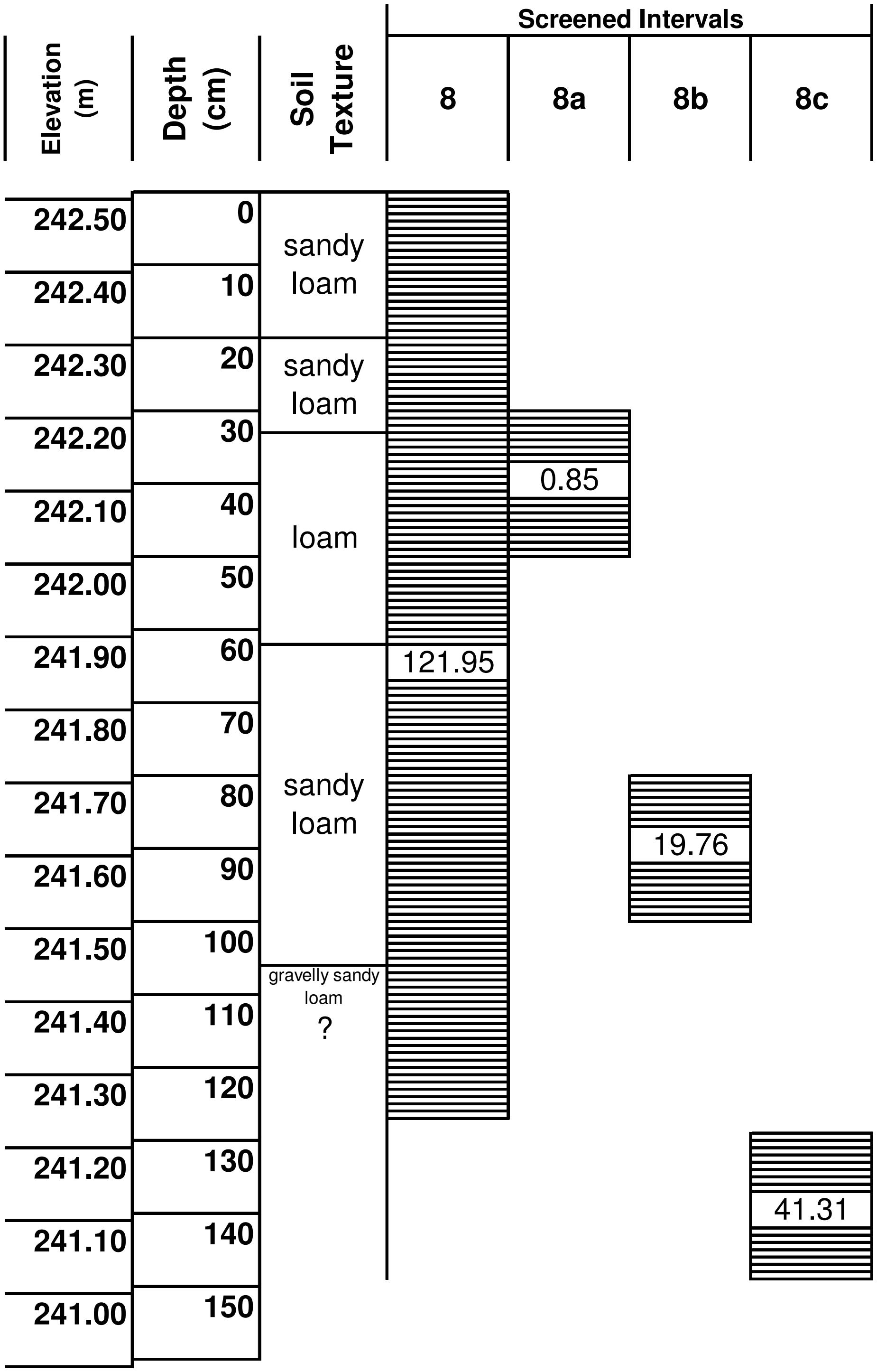
Appendix A (continued). Screened interval depths, soil profile, and hydraulic conductivities at well nest 5.



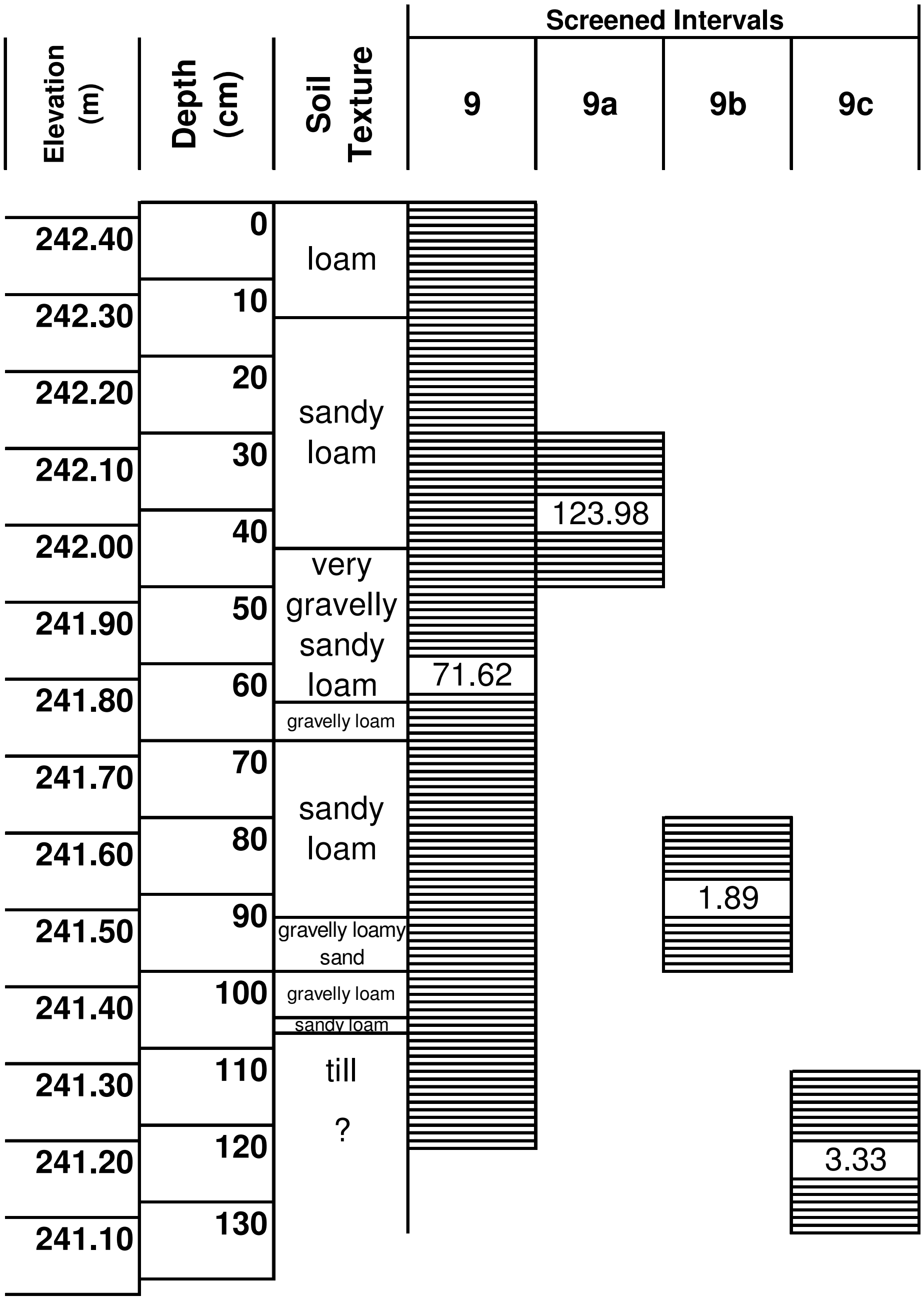
Appendix A (continued). Screened interval depths, soil profile, and hydraulic conductivities at well nest 6.



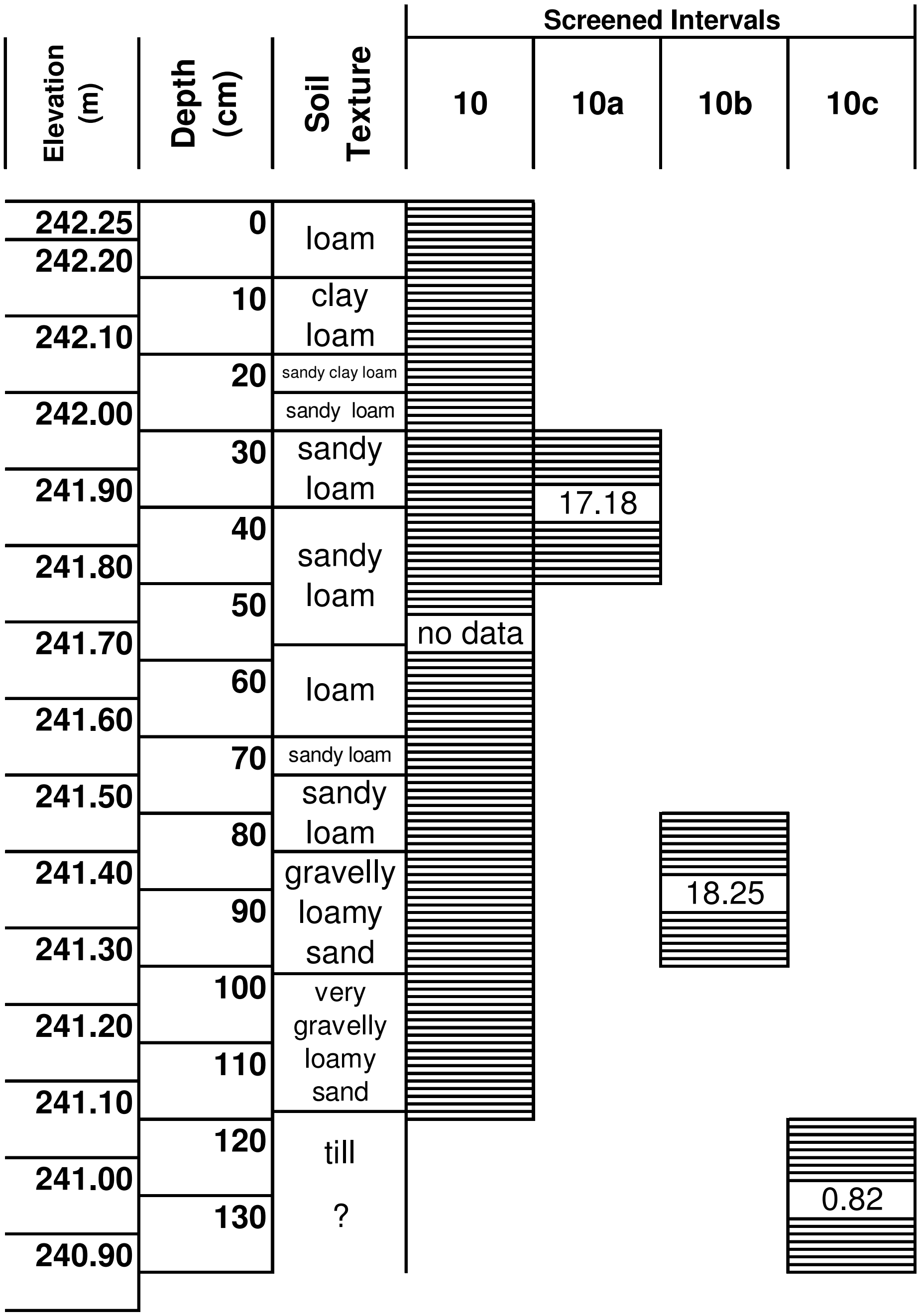
Appendix A (continued). Screened interval depths, soil profile, and hydraulic conductivities at well nest 7.



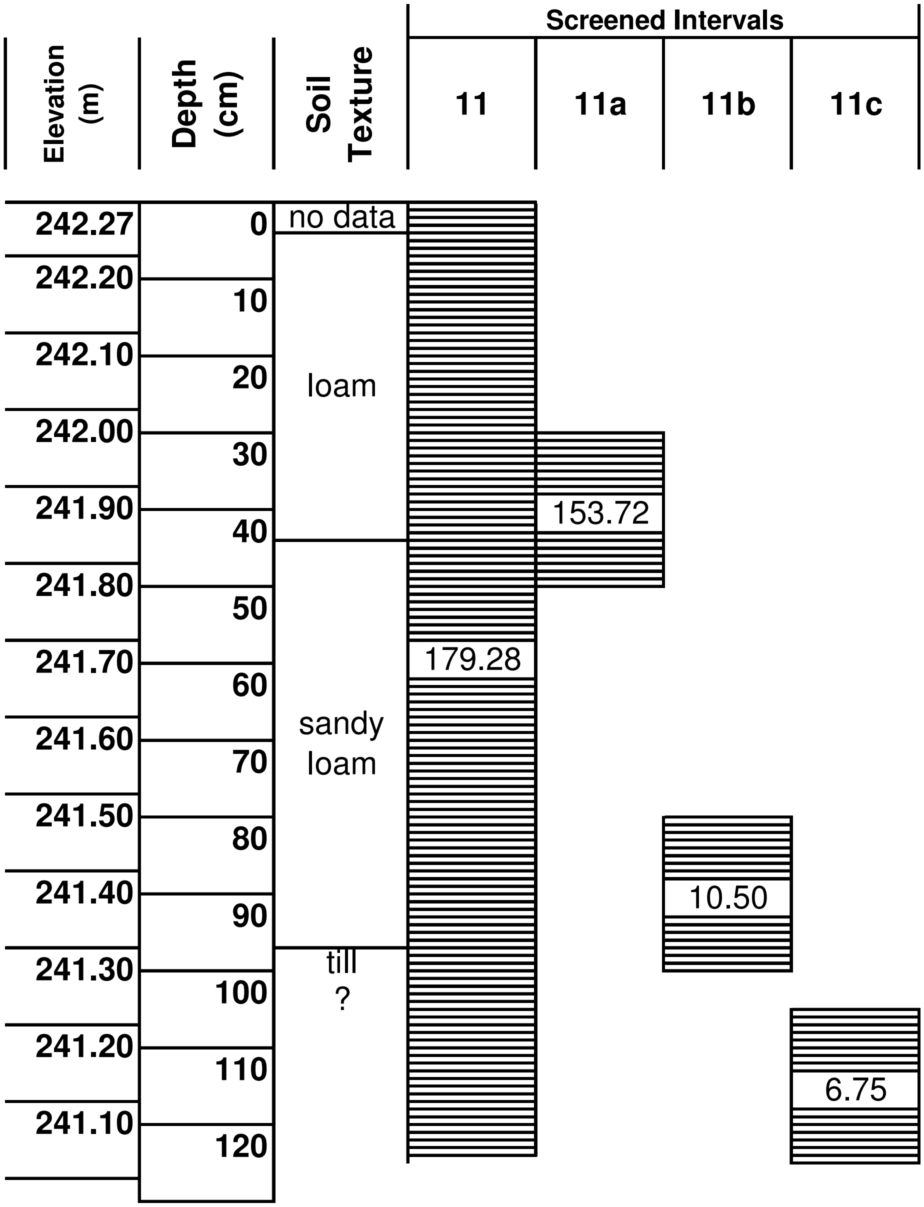
Appendix A (continued). Screened interval depths, soil profile, and hydraulic conductivities at well nest 8.



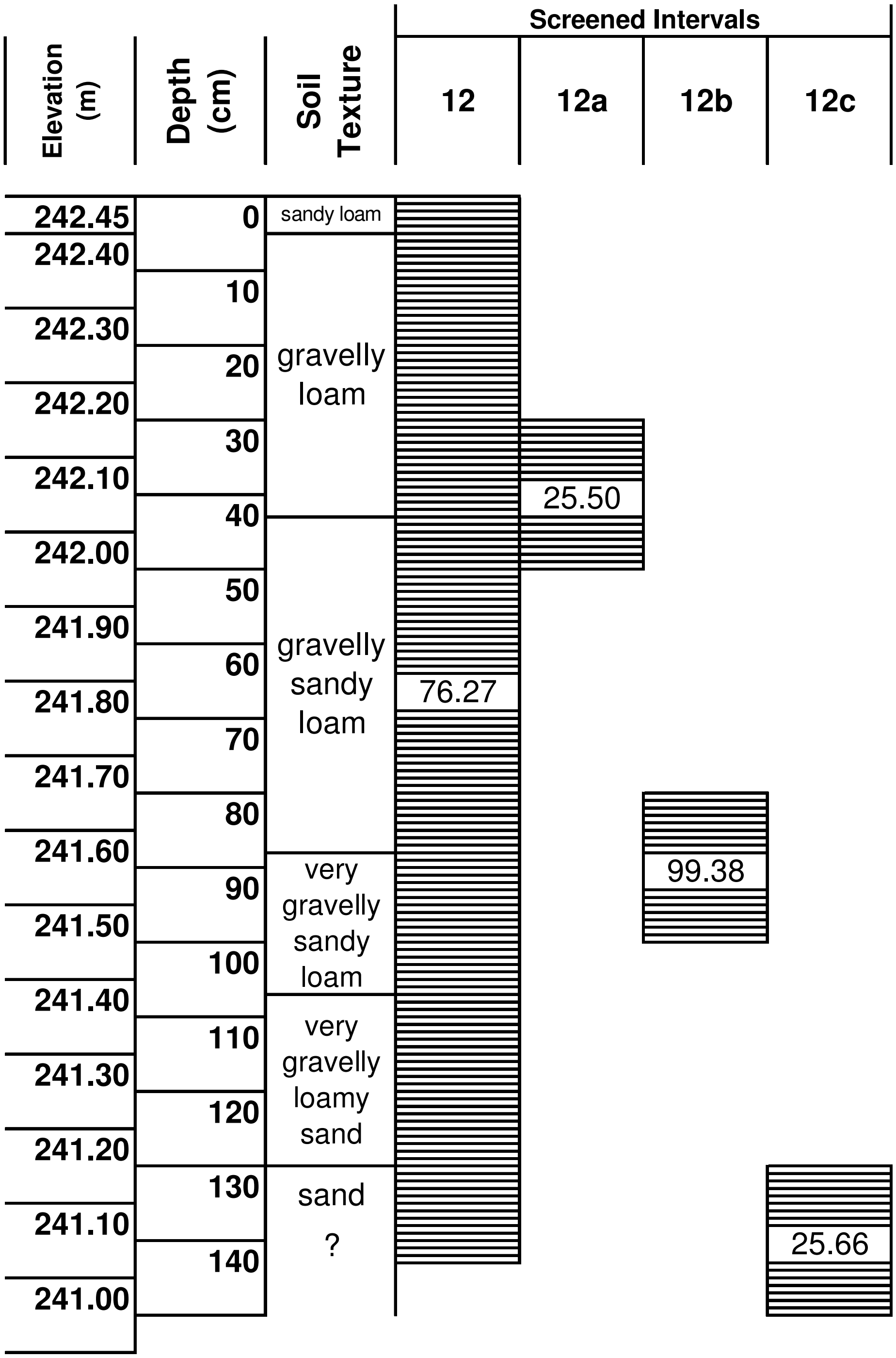
Appendix A (continued). Screened interval depths, soil profile, and hydraulic conductivities at well nest 9.



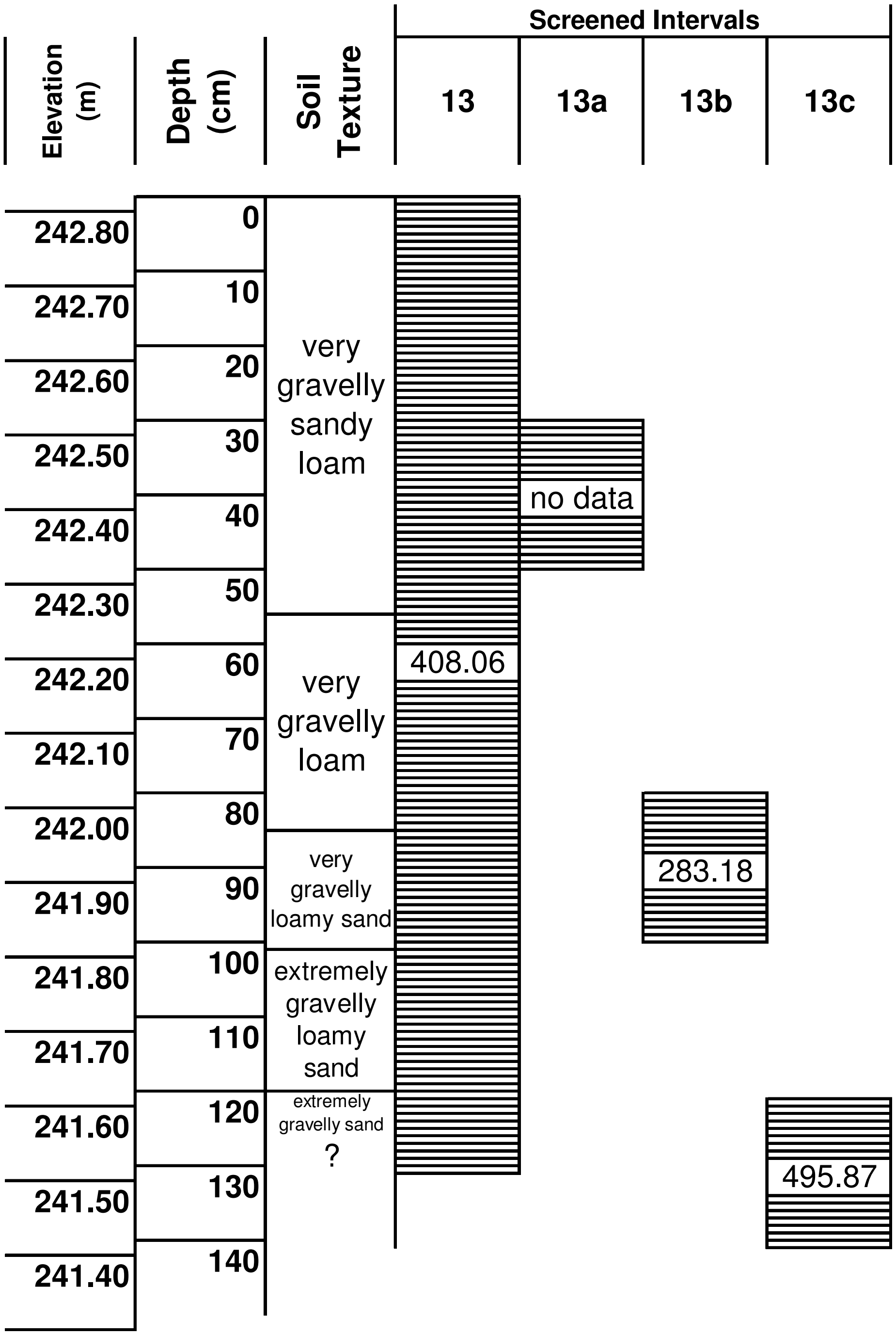
Appendix A (continued). Screened interval depths, soil profile, and hydraulic conductivities at well nest 10.



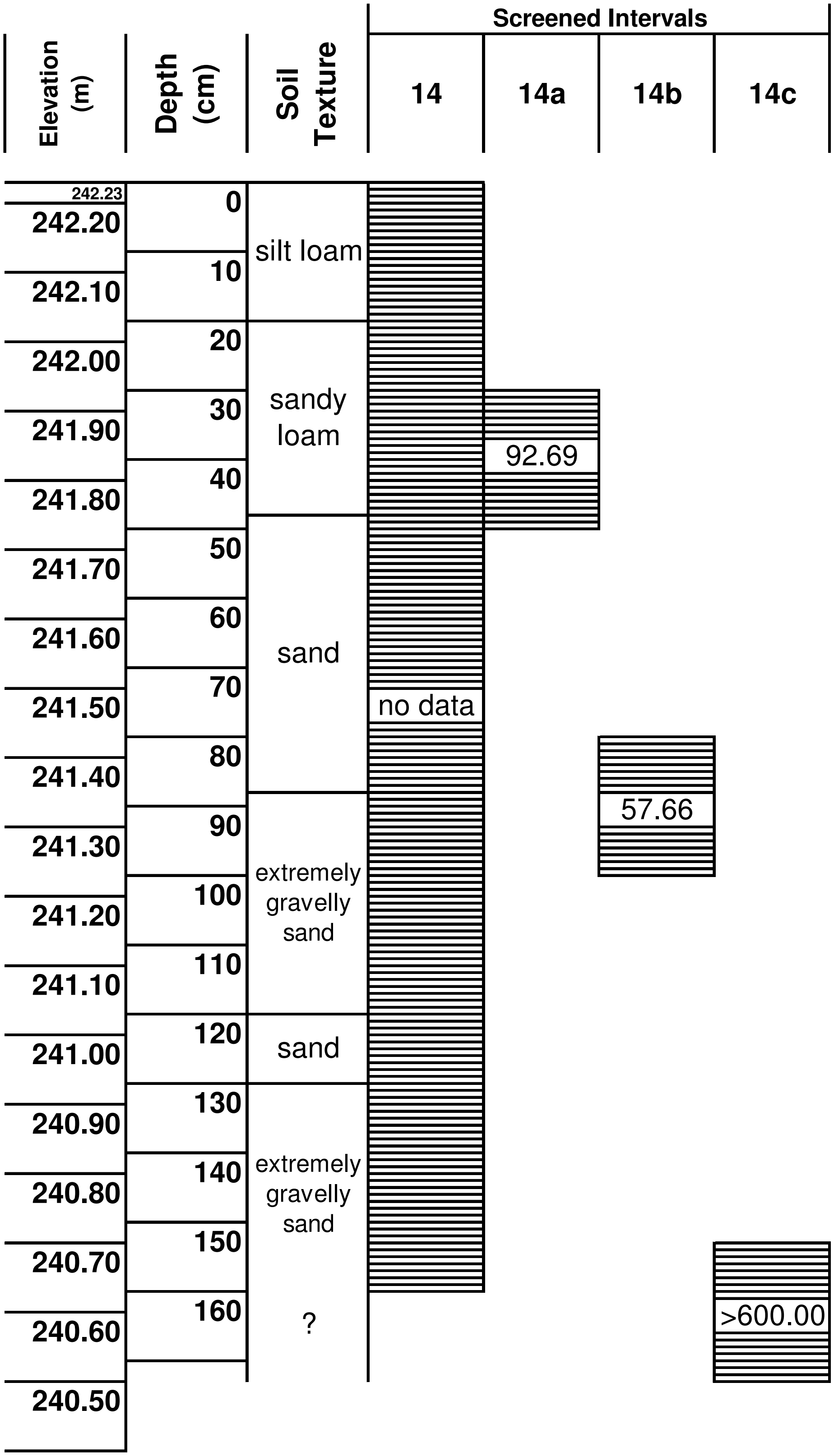
Appendix A (continued). Screened interval depths, soil profile, and hydraulic conductivities at well nest 11.



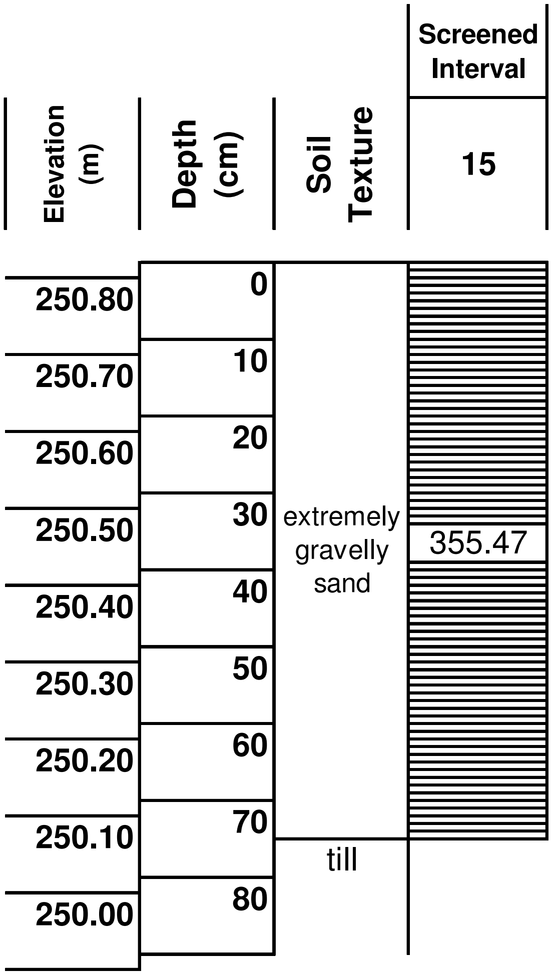
Appendix A (continued). Screened interval depths, soil profile, and hydraulic conductivities at well nest 12.



Appendix A (continued). Screened interval depths, soil profile, and hydraulic conductivities at well nest 13.



Appendix A (continued). Screened interval depths, soil profile, and hydraulic conductivities at well nest 14.



Appendix A (continued). Screened interval depths, soil profile, and hydraulic conductivities at well nest 15.

Well or Piezometer	12/21/2004	1/10/2005	2/11/2005	3/7/2005	3/11/2005	3/29/2005
1	242.303	242.373	242.380	242.643	242.643	242.668
1a				242.618	242.618	242.668
1b				242.654	242.654	242.674
1c				242.646	242.646	242.666
2	242.086	242.386	242.336	242.311	242.311	242.359
2a			242.392	242.369	242.369	242.359
2b			242.388	242.368	242.368	242.353
2c			242.063	242.049	242.049	242.359
3	242.744	242.914	242.884	242.719	242.719	242.754
3a			242.761	242.759	242.759	242.759
3b			242.763	242.757	242.757	242.762
3c			242.690	242.692	242.692	242.687
4	241.799	242.199	242.189	242.169	242.169	242.154
4a			242.180	242.190	242.190	242.180
4b			242.180	242.175	242.175	242.175
4c				242.195	242.195	242.185
5	241.589	242.066	242.069	242.024	242.024	242.014
5a			242.146	242.026	242.026	242.016
5b			242.036	242.026	242.026	242.016
5c			242.071	242.031	242.031	242.021
6	242.014	242.479	242.314	242.234	242.234	242.214
6a			242.316	242.229	242.229	242.214
6b			242.320	242.240	242.240	242.215
6c			242.324	242.241	242.241	242.221
7	241.818	242.338	242.118	241.928	241.928	241.958
7a						
7b				241.935	241.935	241.970
7c				241.930	241.930	241.970
8	241.558	242.033	241.853	241.638	241.638	241.718
8a						
8b				241.657	241.657	241.727
8c				241.650	241.650	241.725
9	241.477	241.832	241.702	241.482	241.482	241.562
9a						
9b				241.517	241.517	241.587
9c				241.523	241.523	241.588
10	241.844	242.279	242.254	242.264	242.264	242.249
10a				242.277	242.277	242.262
10b				242.275	242.275	242.255
10c				242.261	242.261	242.266
11	241.859	242.234	242.169	242.124	242.124	242.134
11a			242.160	242.202	242.202	242.127
11b			242.169	242.159	242.159	242.119
11c				242.164	242.164	242.124
12	241.537	242.022	241.822	241.687	241.687	241.722

Appendix B. Manual water level measurements for monitoring wells, piezometers, and the stream.

Well or Piezometer	12/21/2004	1/10/2005	2/11/2005	3/7/2005	3/11/2005	3/29/2005
12a			241.927			
12b			241.848	241.705	241.705	241.745
12c			241.460	241.190	241.190	241.735
13	241.234	241.599	241.464	241.294	241.294	241.364
13a						
13b			241.479			
13c			240.849	240.694	240.694	241.359
14	241.463	241.893	241.783	241.748	241.748	241.738
14a			241.795	241.765	241.765	241.755
14b			241.807	241.772	241.772	241.757
14c			241.503	241.463	241.463	241.753
15				250.811	250.811	250.776
S 1		242.366	242.276			241.576
S 2						241.361
S 3						

Appendix B. (continued)

Well or Piezometer	4/14/2005	4/29/2005	5/2/2005	5/17/2005	6/2/2005	6/20/2005
1						
1a	242.668	242.673	242.668	242.663	242.258	
1b	242.664	242.669	242.684	242.664	242.264	242.109
1c	242.656	242.666	242.576	242.656	242.256	242.101
2						
2a	242.309	242.354	242.364	242.154		
2b	242.308	242.373	242.353	242.168	241.793	241.763
2c	242.309	242.374	242.354	242.164	241.794	241.764
3	242.714	242.764	242.784	242.804	242.424	242.184
3a	242.804	242.764	242.764	242.754	242.434	
3b	242.752	242.752	242.762	242.747	242.417	242.217
3c	242.682	242.692	242.692	242.672	242.282	242.102
4	242.164	242.174	242.169	242.089	241.479	241.469
4a	242.180	242.190	242.180	242.110	241.690	
4b	242.165	242.185	242.180	242.095	241.490	241.470
4c	242.175	242.200	242.185	242.105	241.490	241.470
5						
5a	241.996	242.031	242.006	241.831		
5b	241.936	242.031	242.016	241.836	241.356	241.356
5c	242.011	242.036	242.016	241.836	241.361	241.361
6	242.144	242.274	242.194	242.034	241.729	241.729
6a	242.154	242.274	242.194	242.054		
6b	242.150	242.275	242.195	242.040	241.730	241.730
6c	242.156	242.276	242.201	242.041	241.736	241.731
7						
7a						
7b	241.900	242.055	241.905	241.800		
7c	241.900	242.060	241.950	241.800	241.570	241.600
8	241.663	241.838	241.728	241.593	241.408	241.448
8a						
8b	241.667	241.837	241.727	241.602		
8c	241.670	241.840	241.615	241.595	241.405	241.455
9						
9a						
9b	241.537	241.692	241.607	241.487		
9c	241.548	241.693	241.398	241.493	241.368	241.393
10	242.199	242.259	242.244	242.074	241.694	241.659
10a	242.212	242.272	242.262	242.087		
10b	242.210	242.265	242.250	242.080	241.690	241.665
10c	242.236	242.261	242.251	242.126	241.741	241.731
11	242.059	242.139	242.084	241.929	241.584	241.569
11a	242.062	242.132	242.097	241.942		
11b	242.054	242.124	242.079	241.929	241.584	241.564
11c	242.059	242.129	242.084	241.929	241.589	241.636
12	241.682	241.762	241.727	241.602	241.367	241.402

Appendix B. (continued)

Well or Piezometer	4/14/2005	4/29/2005	5/2/2005	5/17/2005	6/2/2005	6/20/2005
12a						
12b	241.700	241.830	241.740	241.620		
12c	241.690	241.820	241.730	241.610	241.370	241.405
13	241.354	241.494	241.404	241.319	241.174	241.199
13a						
13b		241.514	241.424			
13c	241.349	241.489	241.394	241.294	241.164	241.194
14						
14a	241.720	241.805	241.735			
14b	241.722	241.807	241.737	241.612	241.302	241.327
14c	241.713	241.793	241.783	241.608	241.288	241.313
15	250.746		250.811	250.706		250.701
S 1	241.566	241.696	241.626	241.536	241.536	241.516
S 2	241.376	241.456	241.391	241.326	241.261	241.351
S 3	241.057	241.144	241.062	241.042	240.982	240.962

Appendix B. (continued)

Well or Piezometer	7/11/2005	7/22/2005	8/1/2005	8/18/2005	9/9/2005	9/29/2005
1						241.638
1a						
1b	241.584	241.794				241.724
1c	241.586	241.786	241.466			241.636
2		241.366				241.376
2a						
2b						
2c	241.404	241.409	241.329	241.214	241.104	241.404
3	241.584	241.934	241.459	241.289		241.734
3a						
3b		241.892				
3c	241.542	241.772	241.437			241.692
4	241.059	241.129	241.069	240.974	240.884	241.639
4a						
4b						241.650
4c	241.060	241.170	241.090	240.995	240.950	241.660
5						241.464
5a						
5b						241.486
5c	240.921	241.066	241.021	240.901	240.756	241.491
6	241.374	241.339	241.299	241.199	241.099	241.314
6a						
6b						
6c	241.376	241.346	241.306	241.206		241.326
7						
7a						
7b						
7c						
8	241.218					241.388
8a						
8b						
8c	241.110	241.155	241.195			241.390
9						241.693
9a						
9b						
9c	241.123	241.263	241.213			241.393
10	241.294	241.319	241.244	241.134		241.439
10a						
10b	241.325					241.445
10c	241.401					241.421
11	241.134	241.129	241.114			241.299
11a						
11b						
11c	241.144	241.139	241.124			241.304
12	241.052	241.067	241.072			241.232

Appendix B. (continued)

Well or Piezometer	7/11/2005	7/22/2005	8/1/2005	8/18/2005	9/9/2005	9/29/2005
12a						
12b						
12c						241.240
13						241.204
13a						
13b						
13c						241.209
14					240.778	241.332
14a						
14b						241.332
14c	240.983	241.028	241.033	240.933	240.783	241.323
15	250.466		250.521	250.456	250.401	250.751
S 1	241.356	241.636	241.426	241.306	241.236	241.576
S 2	241.181	241.431	241.256	241.171	241.171	241.361
S 3	240.852	241.192	241.032	240.922	240.832	241.152

Appendix B. (continued)

Well or Piezometer	10/21/2005	11/10/2005	12/1/2005	12/29/2005	1/11/2006	1/30/2006
1	241.486	241.563	242.134	242.648	242.668	242.668
1a				242.648	242.668	242.668
1b			242.134	242.644	242.654	242.674
1c	241.486	241.561	242.126	242.646	242.656	242.666
2	241.379	241.426	241.856	242.360	242.384	242.394
2a				242.374	242.384	242.394
2b		241.458	241.903	242.363	242.383	242.393
2c	241.344	241.454	241.904	242.384	242.389	242.404
3	241.429	241.579	242.134	242.634	242.684	242.774
3a				242.634	242.694	242.769
3b			242.137	242.637	242.687	242.762
3c	241.422	241.552	242.102	242.592	242.632	242.682
4	241.214	241.424	241.809	242.129	242.149	242.169
4a			241.830	242.150	242.170	242.180
4b	241.230	241.435	241.835	242.145	242.165	242.185
4c	241.235	241.440	241.830	242.160	242.175	242.190
5	241.253	241.369	241.736	242.006	242.036	242.039
5a				242.036	242.036	242.026
5b	241.256	241.396	241.736	242.041	242.036	242.036
5c	241.266	241.406	241.741	242.031	242.041	242.041
6	241.329	241.419	241.829	242.379	242.349	242.429
6a				242.384	242.354	242.444
6b			241.845	242.385	242.365	242.445
6c	241.336	241.756	241.836	242.396	242.356	242.446
7		241.368	241.708	242.317	242.075	242.340
7a				242.295		242.340
7b				242.290	242.075	242.310
7c			241.740	242.290	242.070	242.310
8	241.278	241.403	241.648	242.038	241.768	242.028
8a				242.146		242.086
8b			241.667	242.107	241.777	242.057
8c	241.320	241.420	241.665	242.055	241.785	242.045
9	241.322	241.432	241.637	241.865	241.607	241.837
9a						
9b			241.637	241.867	241.607	241.837
9c	241.328	241.413	241.593	241.863	241.603	241.833
10	241.299	241.434	241.844	242.254	242.264	242.269
10a				242.272	242.277	242.282
10b		241.445	241.865	242.285	242.280	242.275
10c	241.261	241.421	241.861	242.281	242.281	242.281
11	241.219	241.394	241.814	242.234	242.239	242.222
11a				242.252	242.252	242.222
11b		241.394	241.814	242.244	242.244	242.204
11c	241.234	241.409	241.774	242.244	242.244	242.209
12	241.212	241.372	241.662	242.077	241.912	242.037

Appendix B. (continued)

Well or Piezometer	10/21/2005	11/10/2005	12/1/2005	12/29/2005	1/11/2006	1/30/2006
12a				242.099		
12b			241.690	242.090	241.925	242.050
12c	241.220	241.380	241.680	242.080	241.915	242.045
13	241.249	241.354	241.554	241.714	241.534	241.237
13a						
13b			241.574	241.734	241.569	241.664
13c	241.254	241.364	241.554	241.704	241.554	241.654
14	241.247	241.392	241.667	241.906	241.905	241.897
14a				241.910	241.905	
14b	241.247	241.392	241.667	241.917	241.907	241.897
14c	241.243	241.383	241.663	241.903	241.893	241.883
15	250.701	250.676	250.746	250.781	250.751	250.821
S 1	241.546	241.506	241.596	241.866	241.616	241.806
S 2	241.381	241.371	241.471	241.681	241.431	241.581
S 3	241.292	241.342	241.422	241.482	241.382	241.332

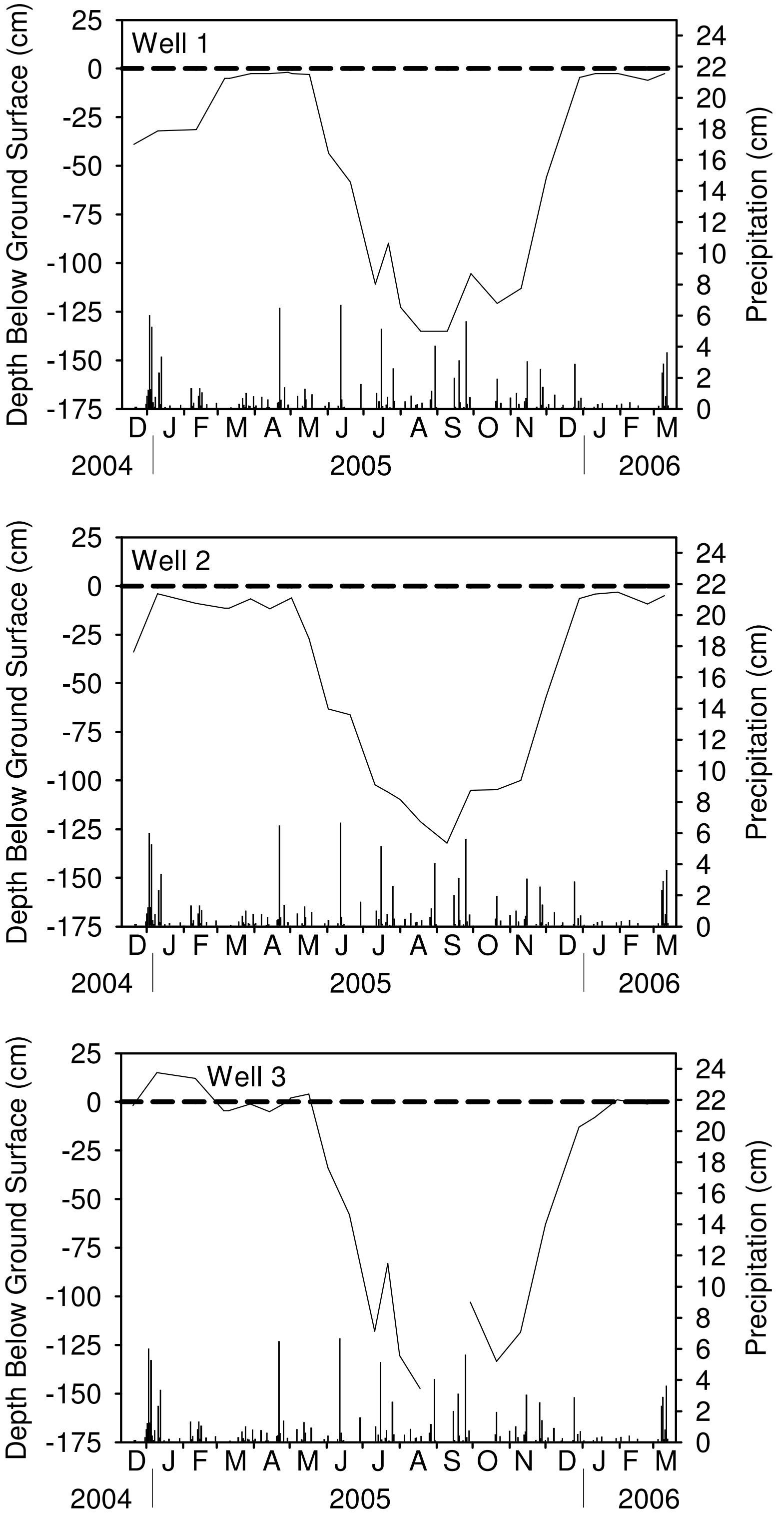
Appendix B. (continued)

Well or Piezometer	2/24/2006	3/10/2006
1	242.633	242.668
1a	242.668	242.668
1b	242.634	242.674
1c	242.576	242.656
2	242.333	242.376
2a	242.334	242.369
2b	242.333	242.403
2c	242.334	242.414
3	242.754	242.774
3a	242.764	242.774
3b	242.767	242.767
3c	242.692	242.692
4	242.179	242.179
4a	242.180	242.130
4b	242.235	242.245
4c	242.170	242.195
5	241.989	242.049
5a	242.001	242.046
5b	242.001	242.056
5c	242.006	242.061
6	242.169	242.529
6a	242.164	242.534
6b	242.180	242.545
6c	242.186	242.556
7	241.868	242.548
7a		242.545
7b	241.915	242.550
7c	241.920	242.540
8	241.658	242.308
8a		242.456
8b	241.677	242.317
8c	241.675	242.315
9	241.537	242.102
9a		242.103
9b	241.547	242.132
9c	241.543	242.113
10	242.264	242.284
10a	242.252	242.297
10b	242.240	242.305
10c	242.231	242.321
11	242.084	242.284
11a	242.082	242.282
11b	242.064	242.264
11c	242.064	242.274
12	241.662	242.242

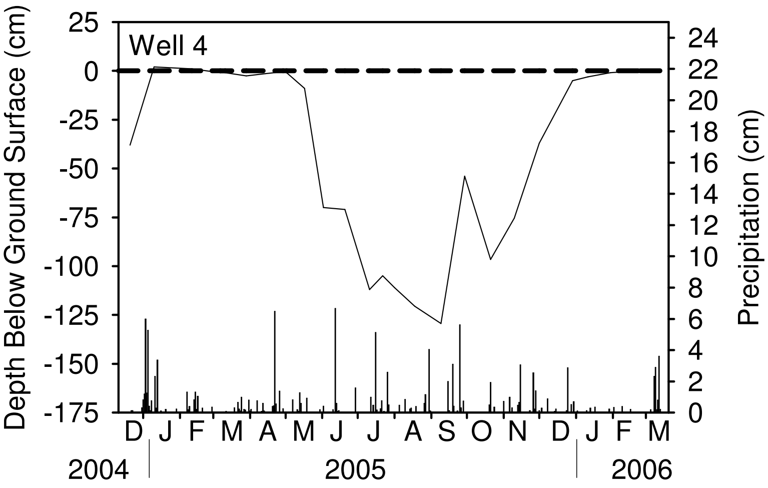
Appendix B. (continued)

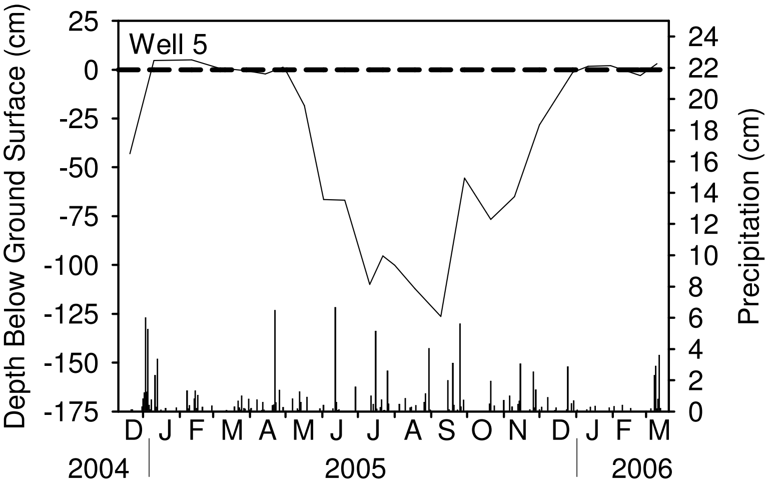
Well or Piezometer	2/24/2006	3/10/2006
12a		242.279
12b	241.680	242.255
12c	241.670	242.245
13	241.304	241.824
13a		
13b		241.824
13c	241.304	241.814
14	241.663	242.028
14a		242.025
14b	241.677	242.047
14c	241.673	242.033
15	250.771	250.821
S 1	241.576	242.156
S 2	241.371	242.041
S 3	241.052	241.816

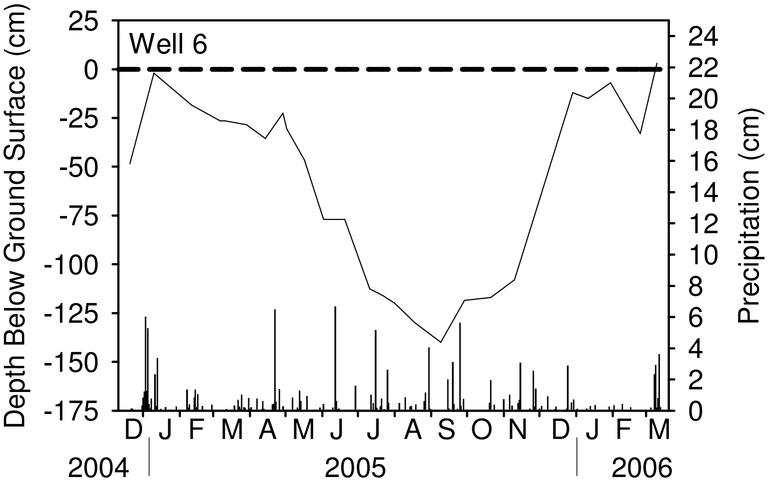
Appendix B. (continued)



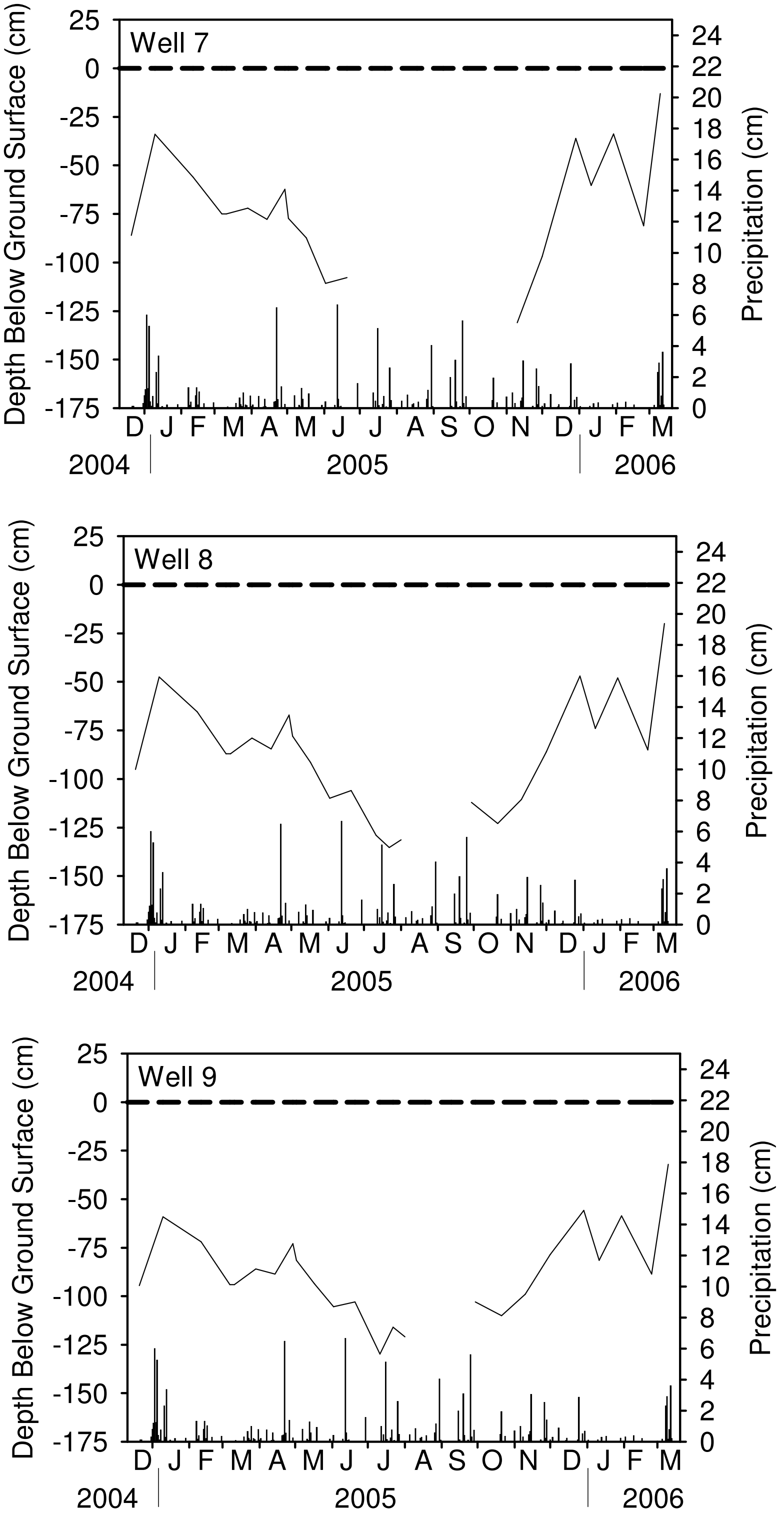
Appendix C. Well and stream hydrographs. Hydrographs for wells 1, 2, and 3 (using manual measurements only). Dashed line represents the ground surface. Daily precipitation is shown as columns on the x-axis.



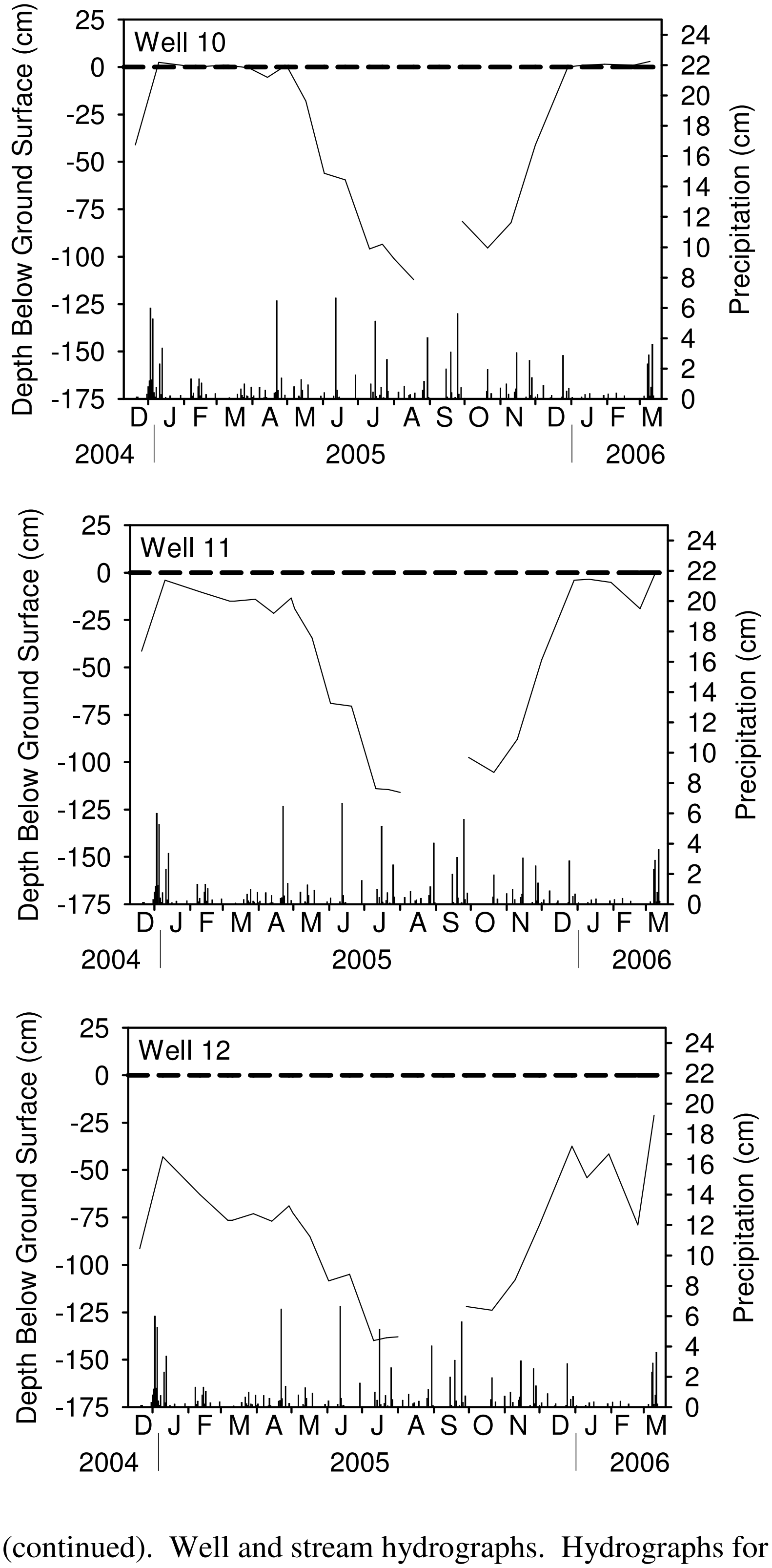




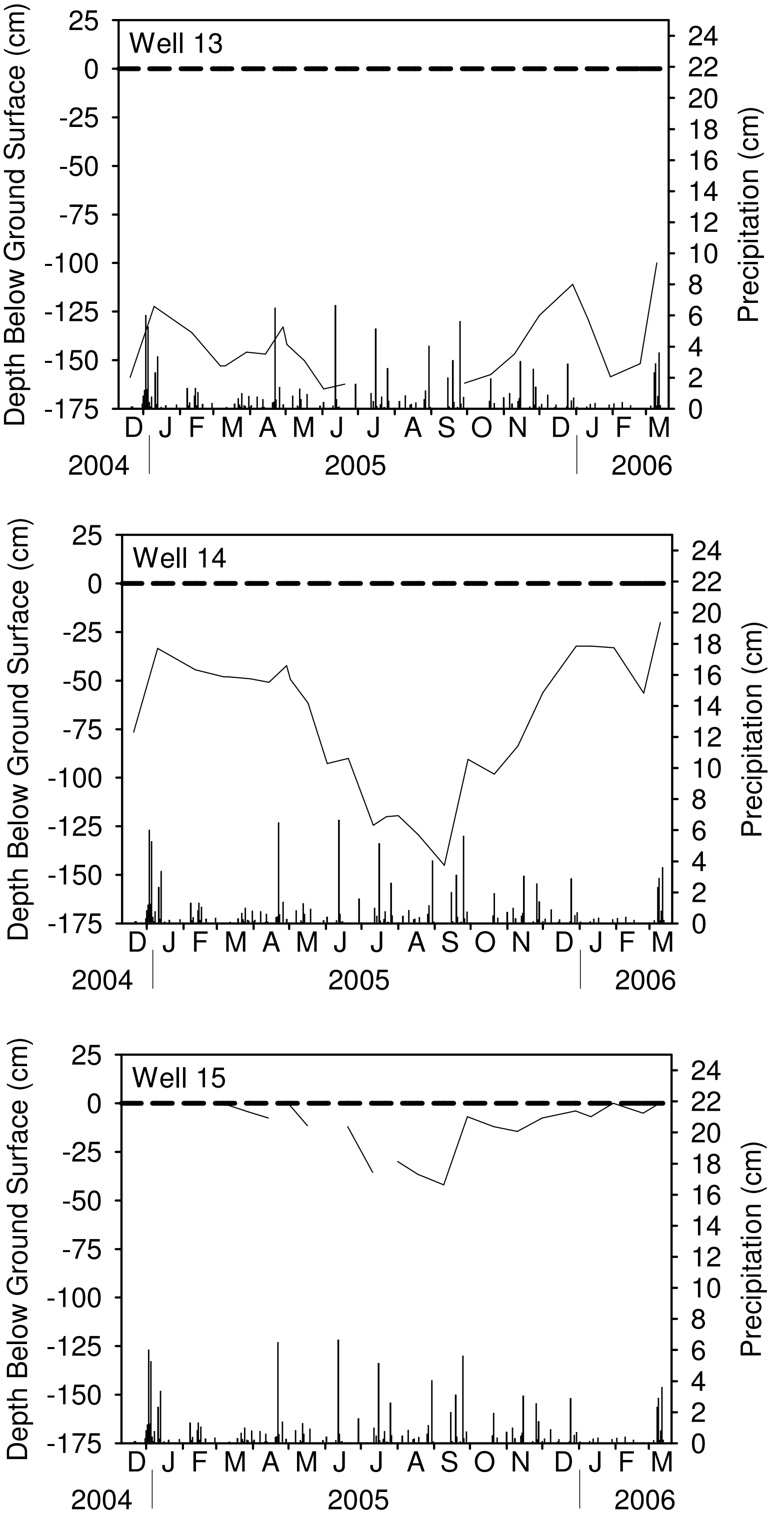
Appendix C (continued). Well and stream hydrographs. Hydrographs for wells 4, 5, and 6 (using manual measurements only). Dashed line represents the ground surface. Daily precipitation is shown as columns on the x-axis.



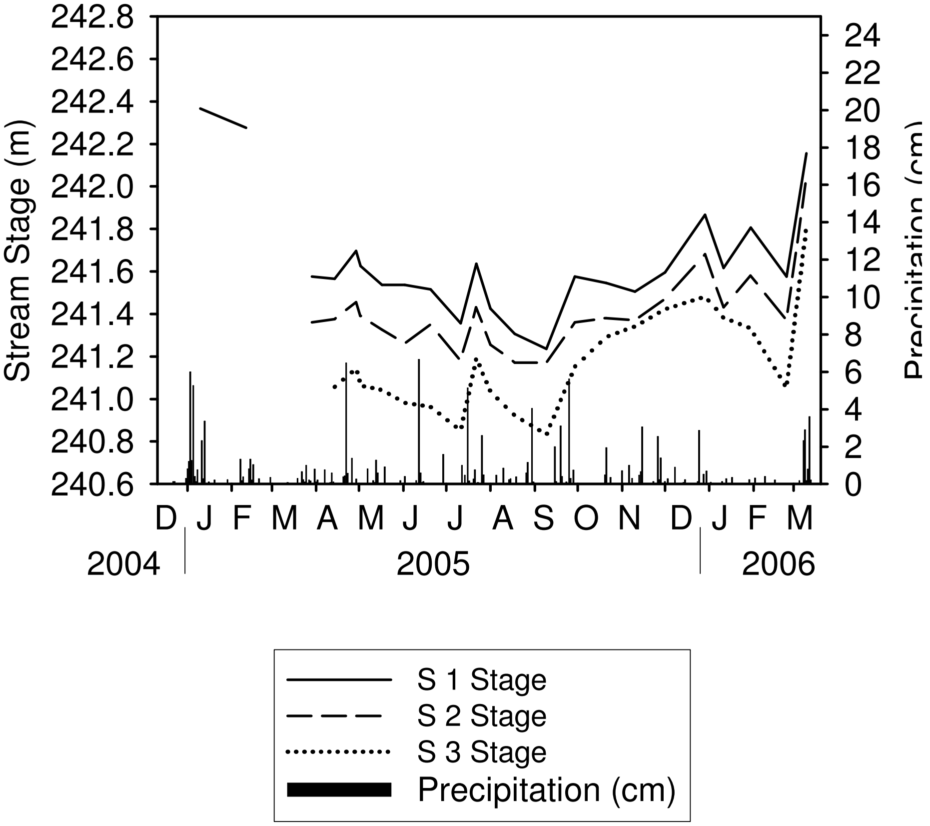
Appendix C (continued). Well and stream hydrographs. Hydrographs for wells 7, 8, and 9 (using manual measurements only). Dashed line represents the ground surface. Daily precipitation is shown as columns on the x-axis.



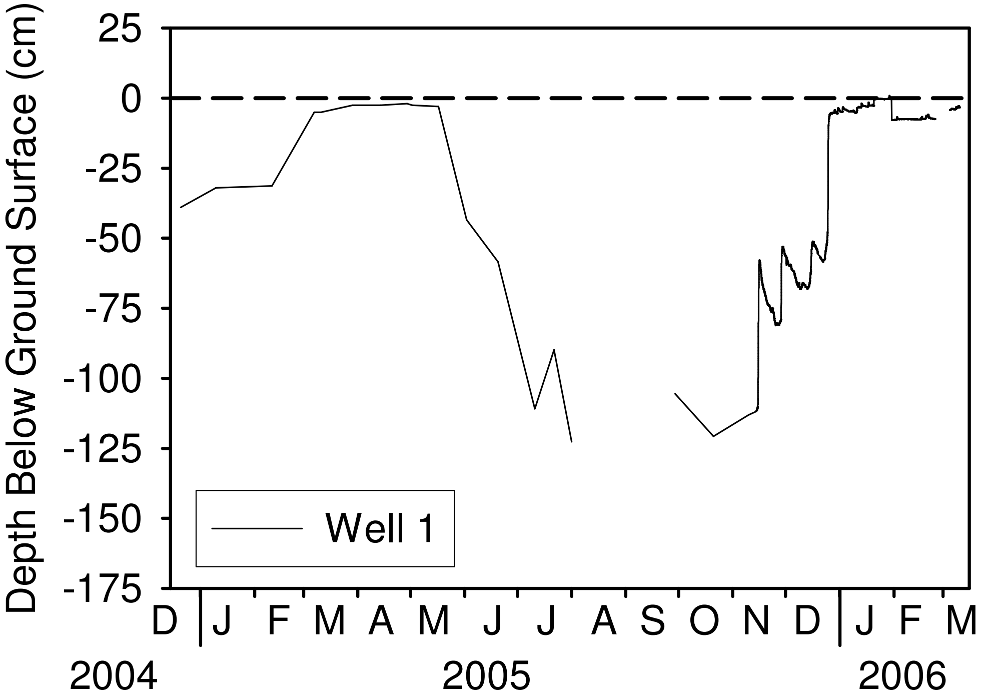
Appendix C (continued). Well and stream hydrographs. Hydrographs for wells 10, 11, and 12 (using manual measurements only). Dashed line represents the ground surface. Daily precipitation is shown as columns on the x-axis.

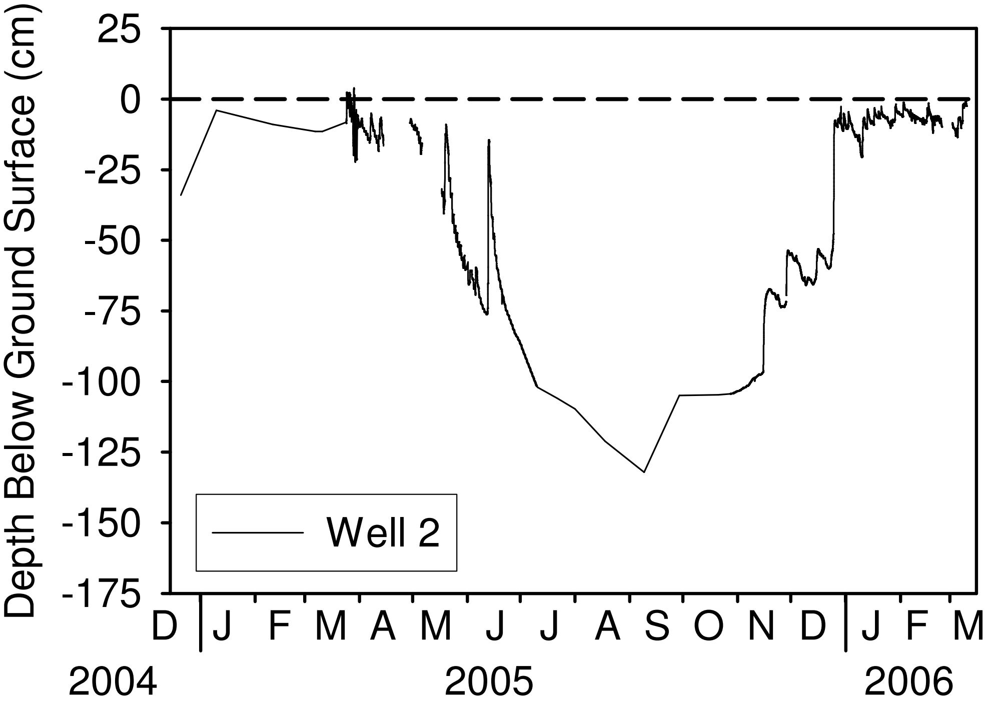


Appendix C (continued). Well and stream hydrographs. Hydrographs for wells 13, 14, and 15 (using manual measurements only). Dashed line represents the ground surface. Daily precipitation is shown as columns on the x-axis.

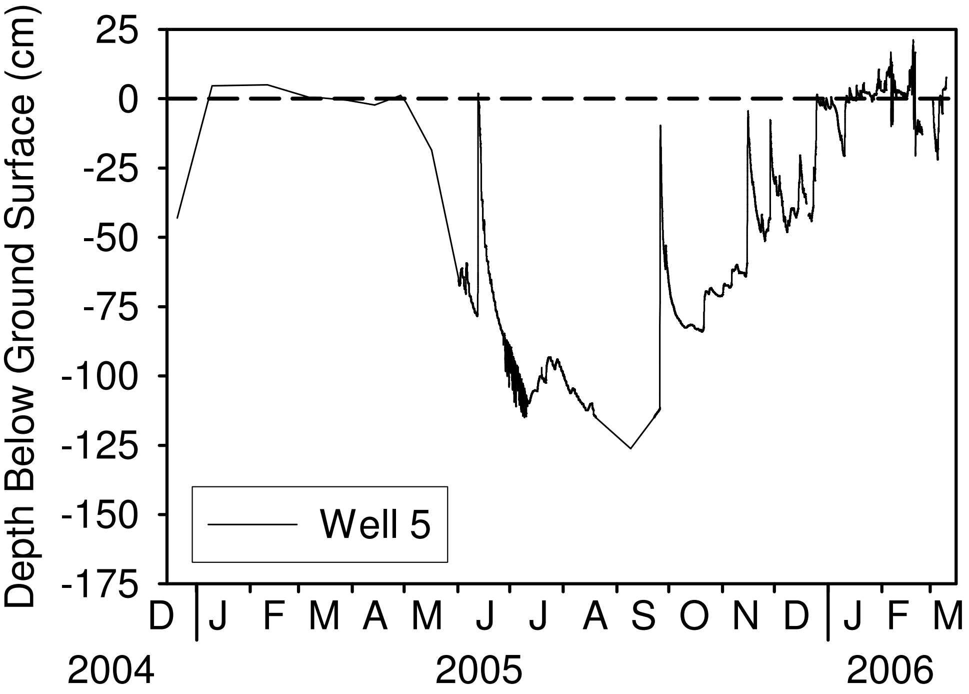


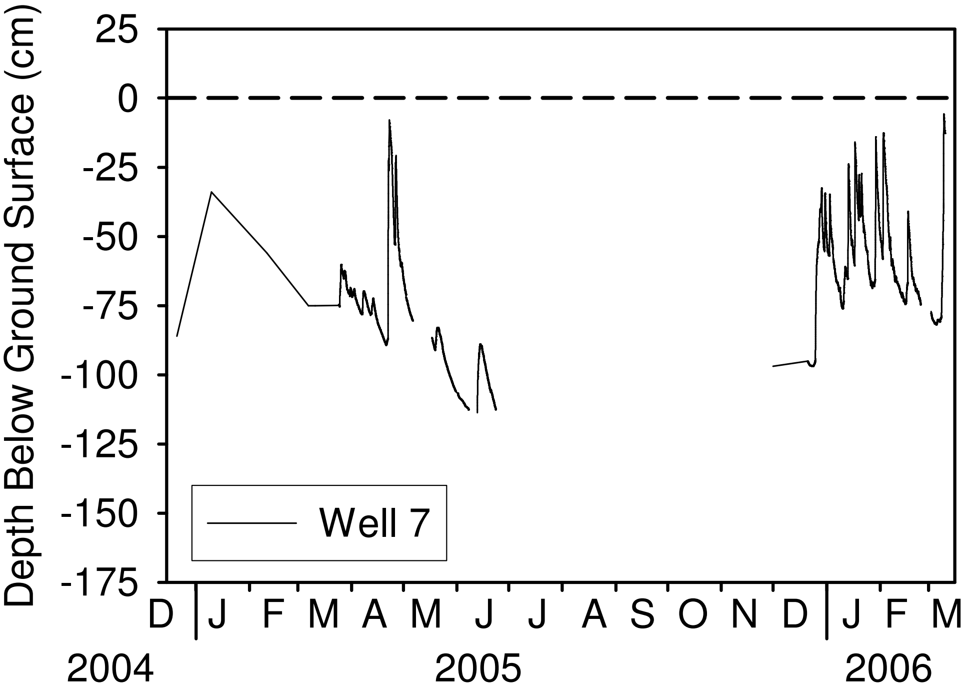
Appendix C (continued). Well and stream hydrographs. Hydrographs for Fishback Creek at points S 1, S 2, and S 3. Daily precipitation is shown as columns on the x-axis.



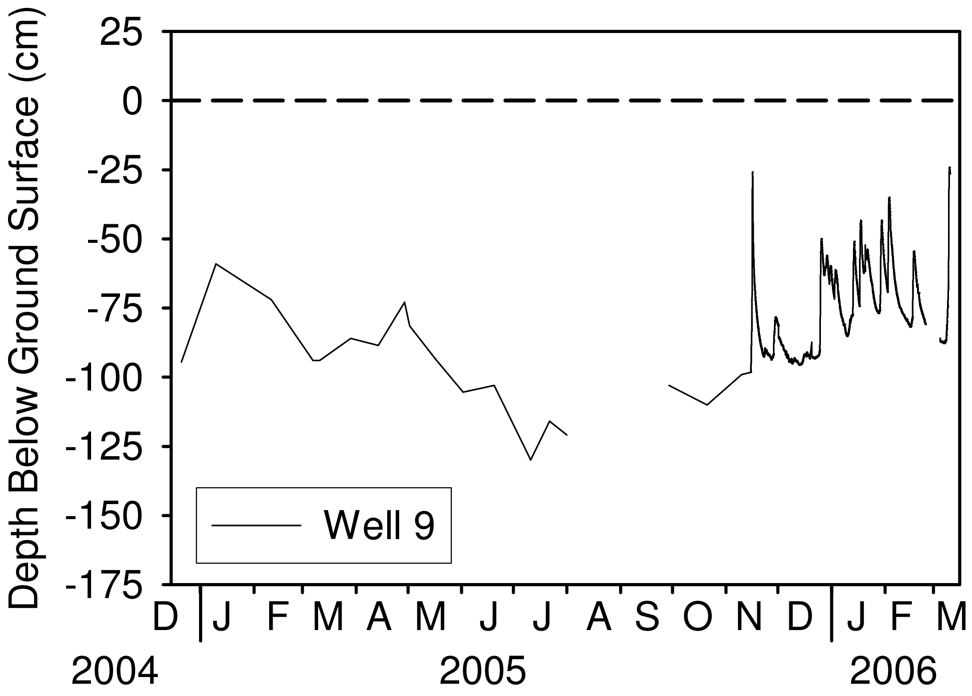


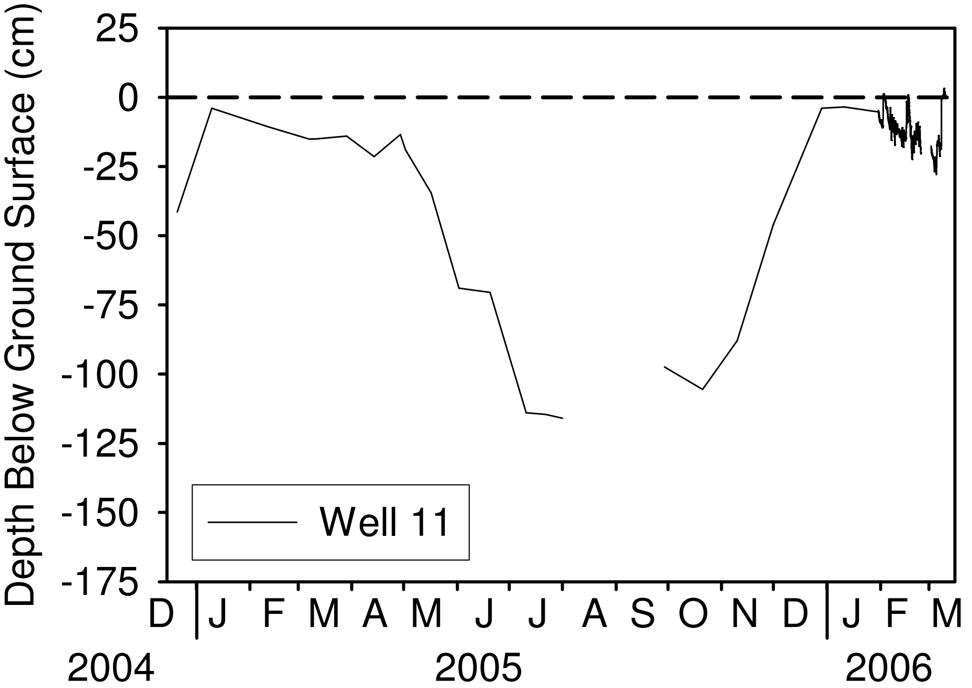
Appendix D. Hydrographs for wells fitted with data loggers (wells 1 and 2). Manual water table measurements were used when no data logger data was available. Water table (cm below ground surface) is represented by the solid black line. The ground surface is the dashed, horizontal black line.



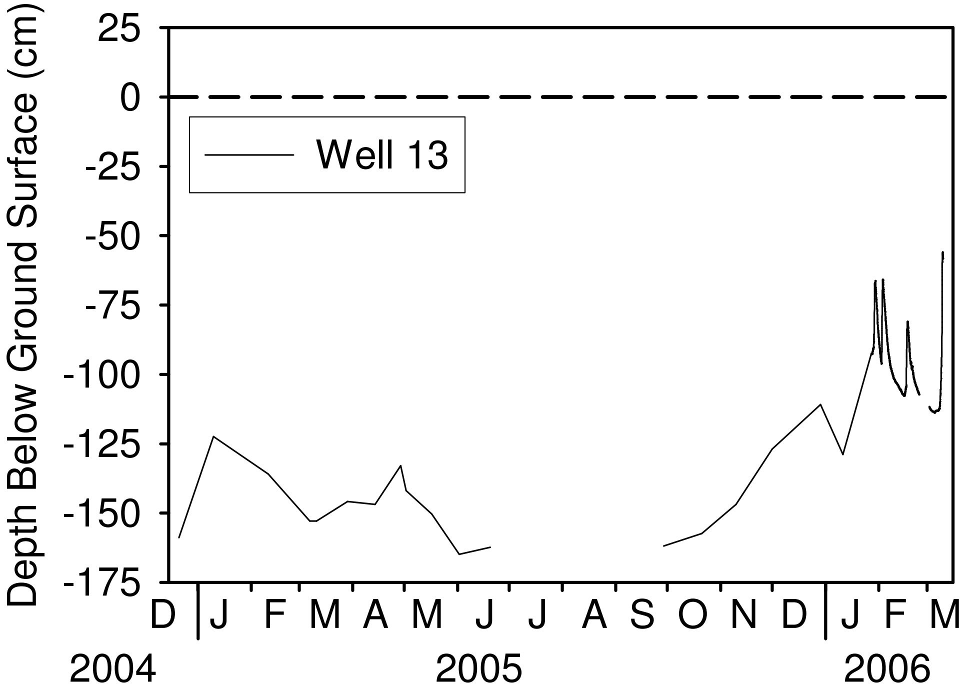


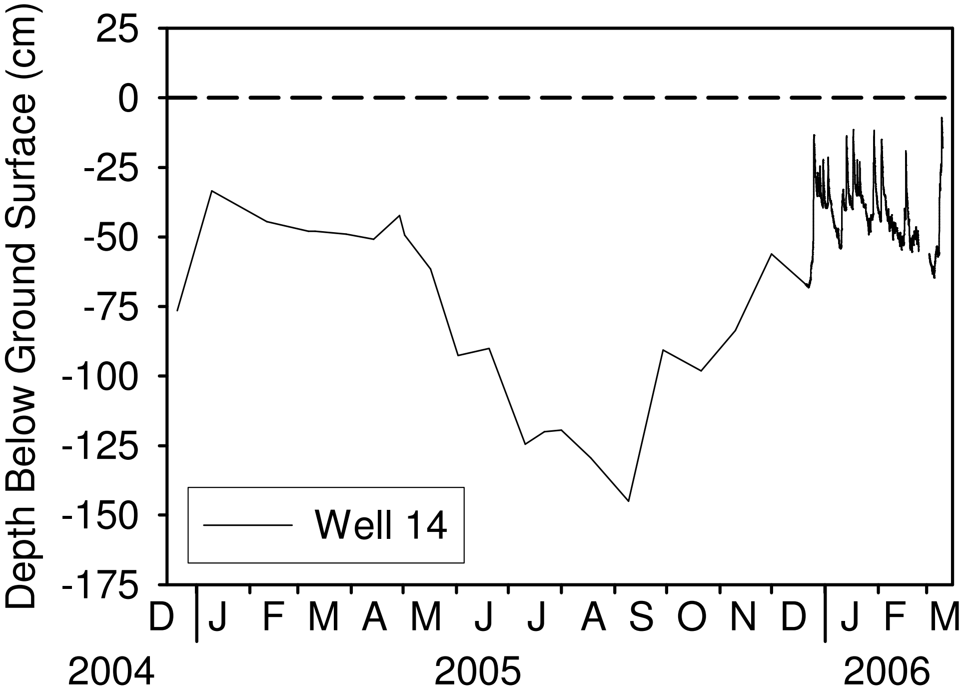
Appendix D (continued). Hydrographs for wells fitted with data loggers (wells 5 and 7). Manual water table measurements were used when no data logger data was available. Water table (cm below ground surface) is represented by the solid black line. The ground surface is the dashed, horizontal black line.



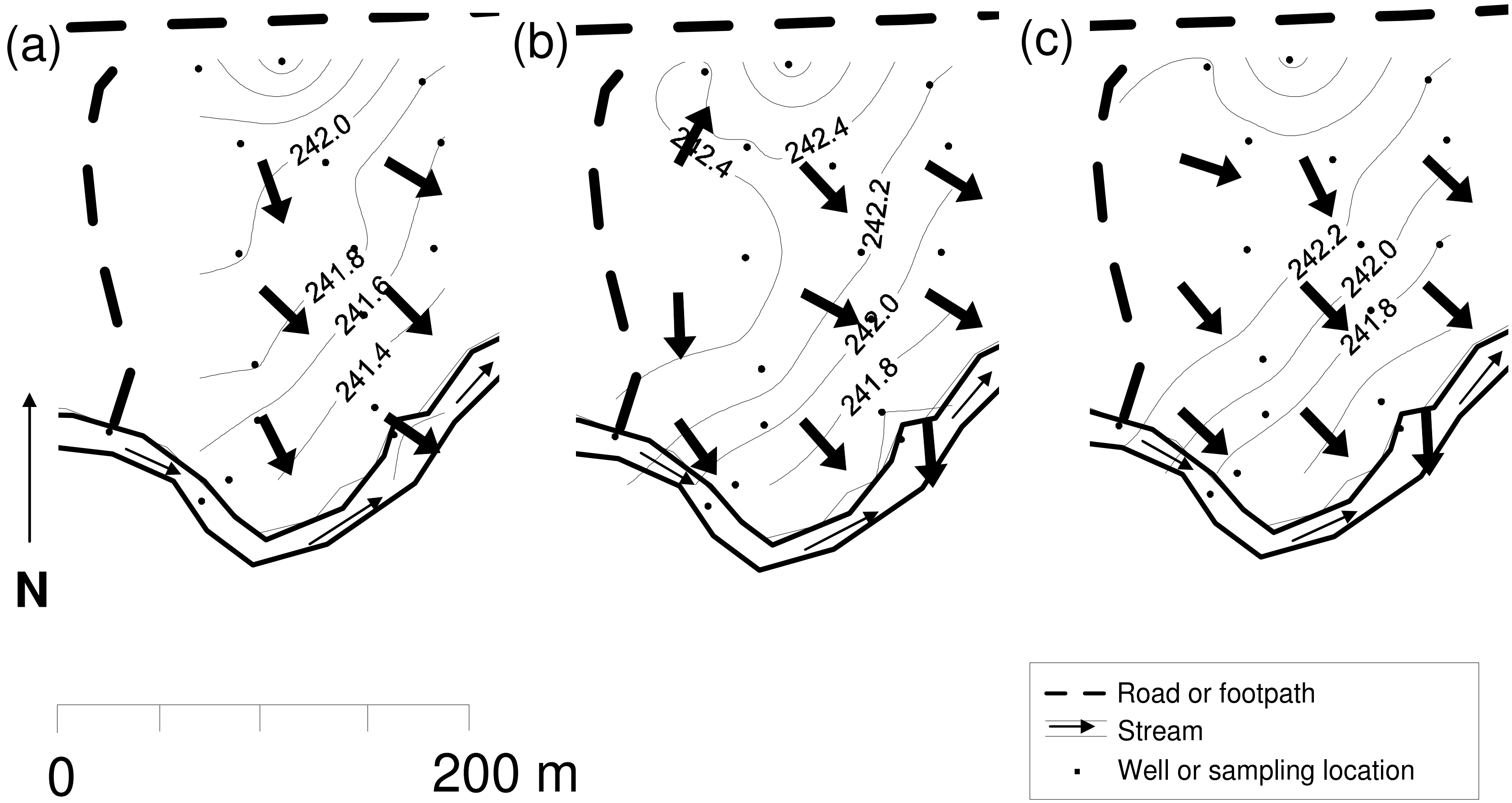


Appendix D (continued). Hydrographs for wells fitted with data loggers (wells 9 and 11). Manual water table measurements were used when no data logger data was available. Water table (cm below ground surface) is represented by the solid black line. The ground surface is the dashed, horizontal black line.

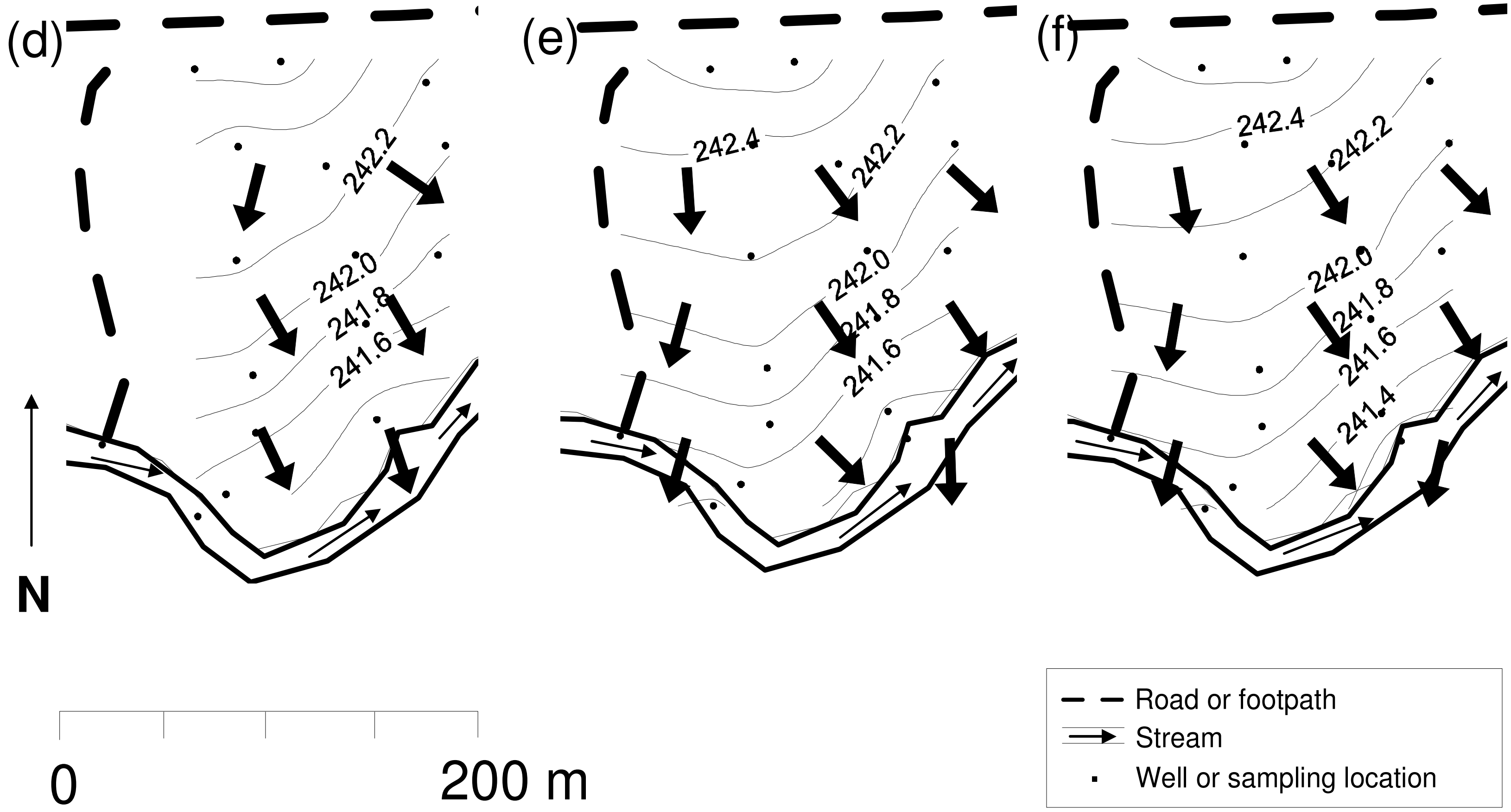




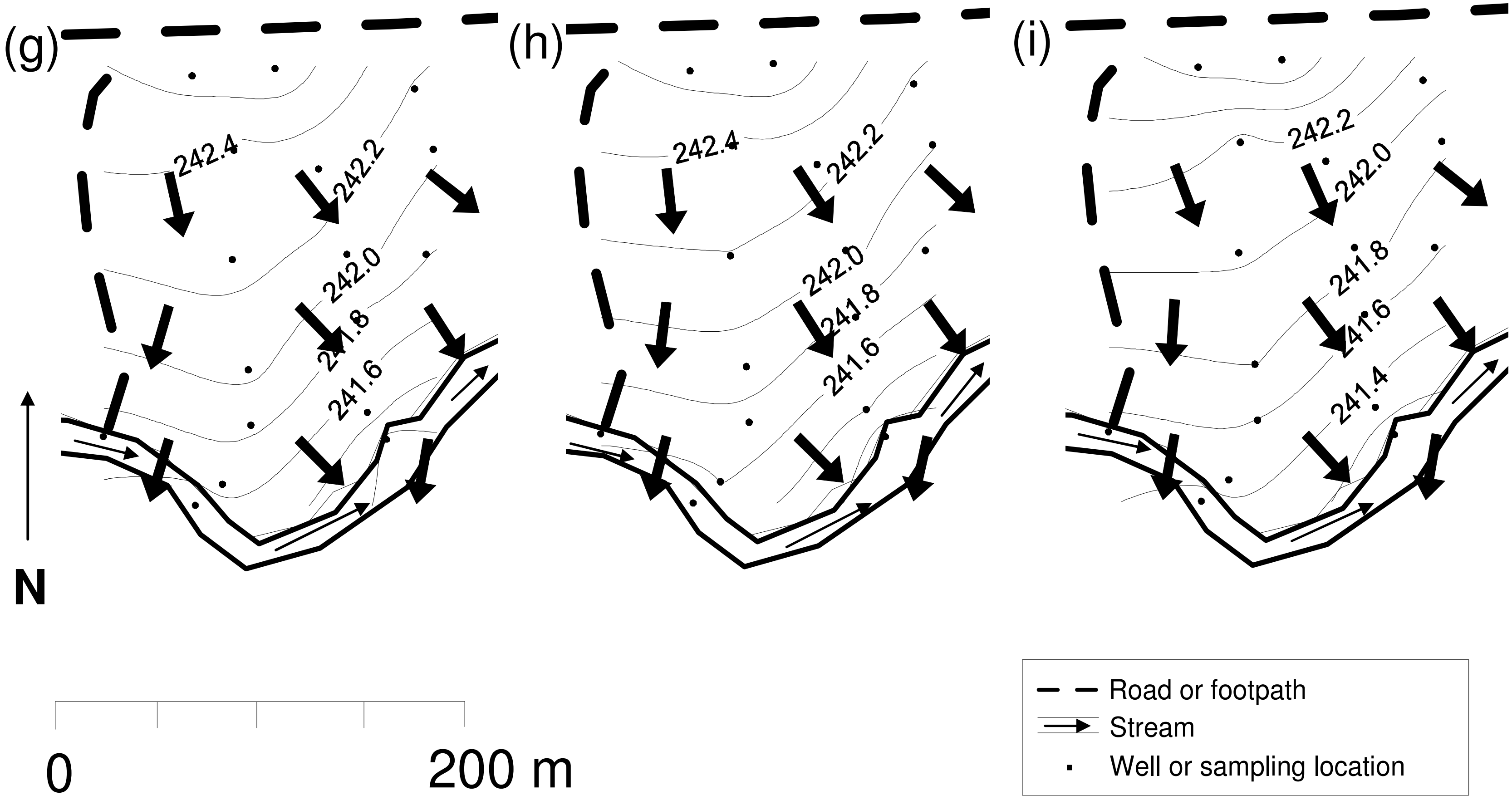
Appendix D (continued). Hydrographs for wells fitted with data loggers (wells 13 and 14). Manual water table measurements were used when no data logger data was available. Water table (cm below ground surface) is represented by the solid black line. The ground surface is the dashed, horizontal black line.



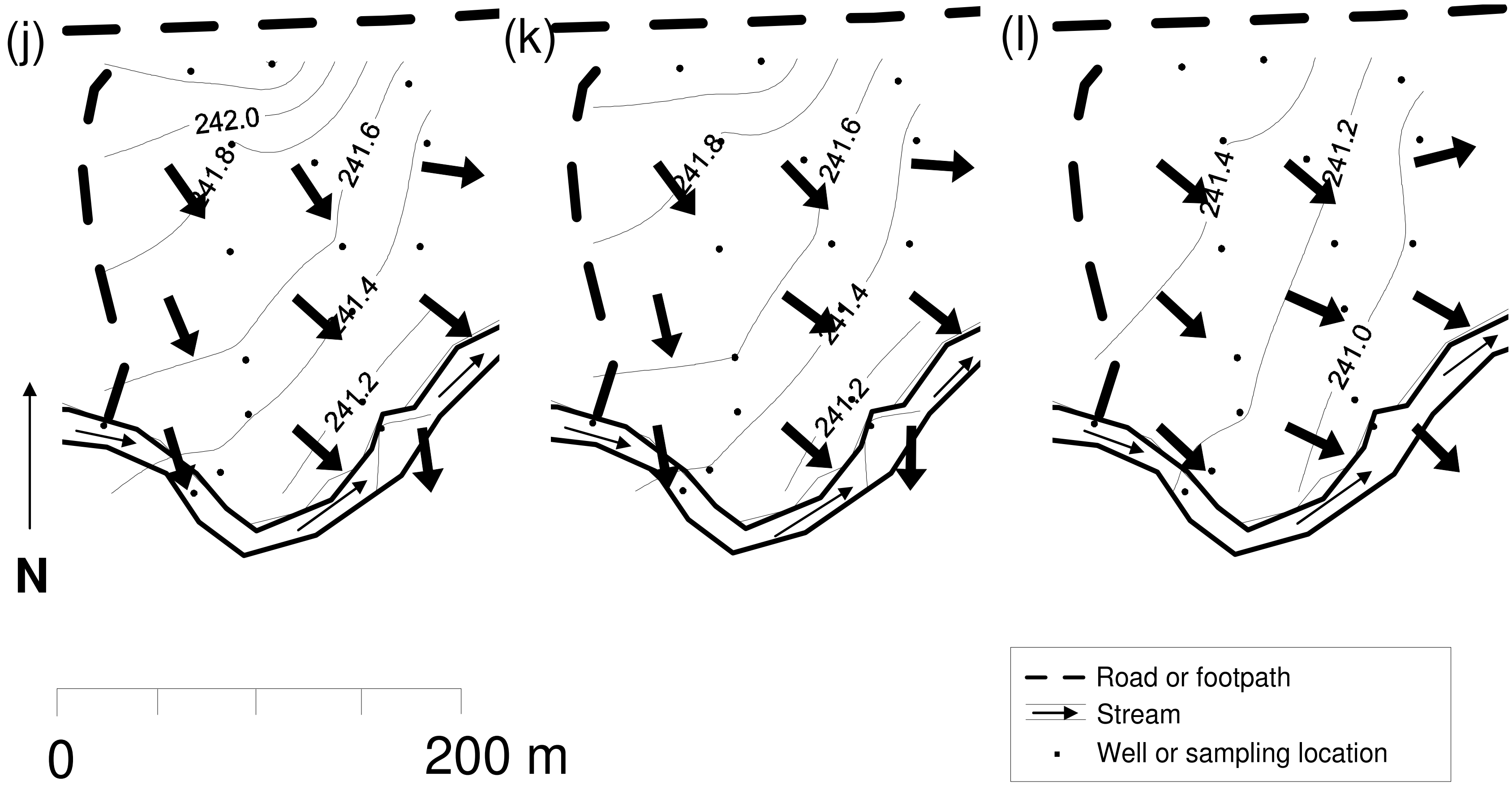
Appendix E. Potentiometric surface maps for (a) 12-21-04, (b) 1-10-05, and (c) 2-11-05. The contour interval is 0.20 m. Arrows indicate the direction of ground water flow. Black dots represent water sampling locations.



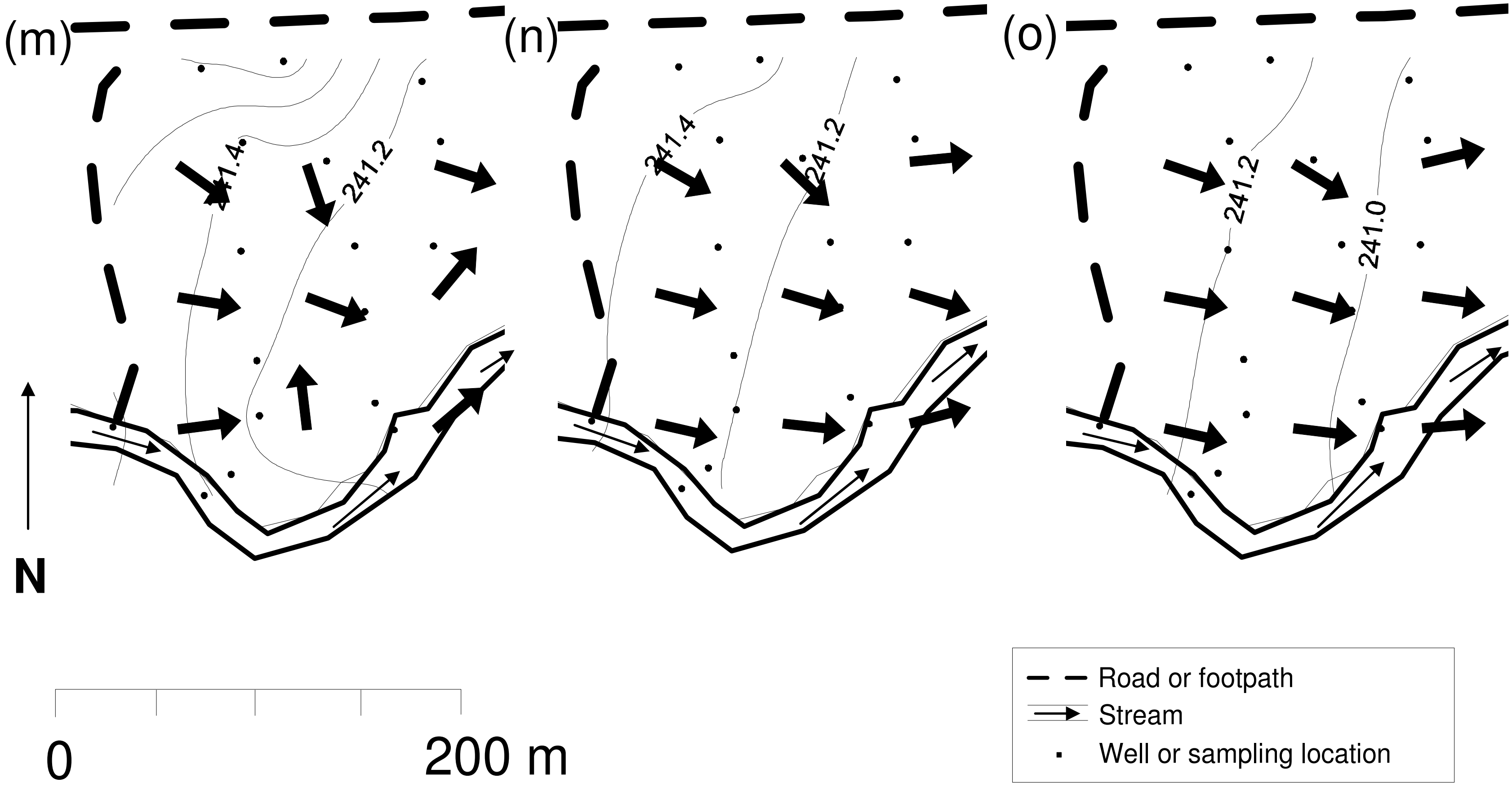
Appendix E (continued). Potentiometric surface maps for (d) 3-11-05, (e) 3-29-05, and (f) 4-14-05. The contour interval is 0.20 m. Arrows indicate the direction of ground water flow. Black dots represent water sampling locations.



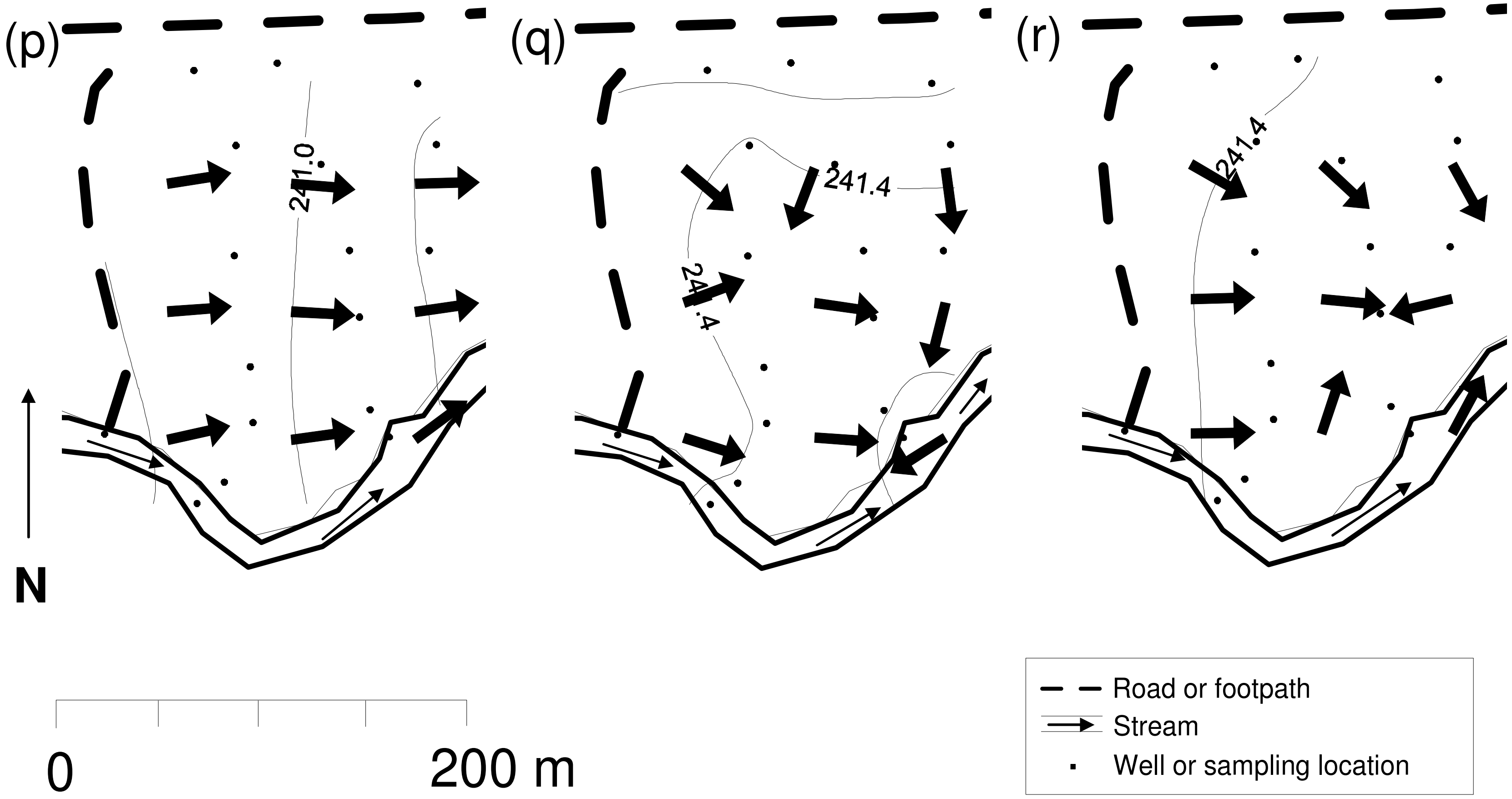
Appendix E (continued). Potentiometric surface maps for (g) 4-29-05, (h) 5-2-05, and (i) 5-17-05. The contour interval is 0.20 m. Arrows indicate the direction of ground water flow. Black dots represent water sampling locations.



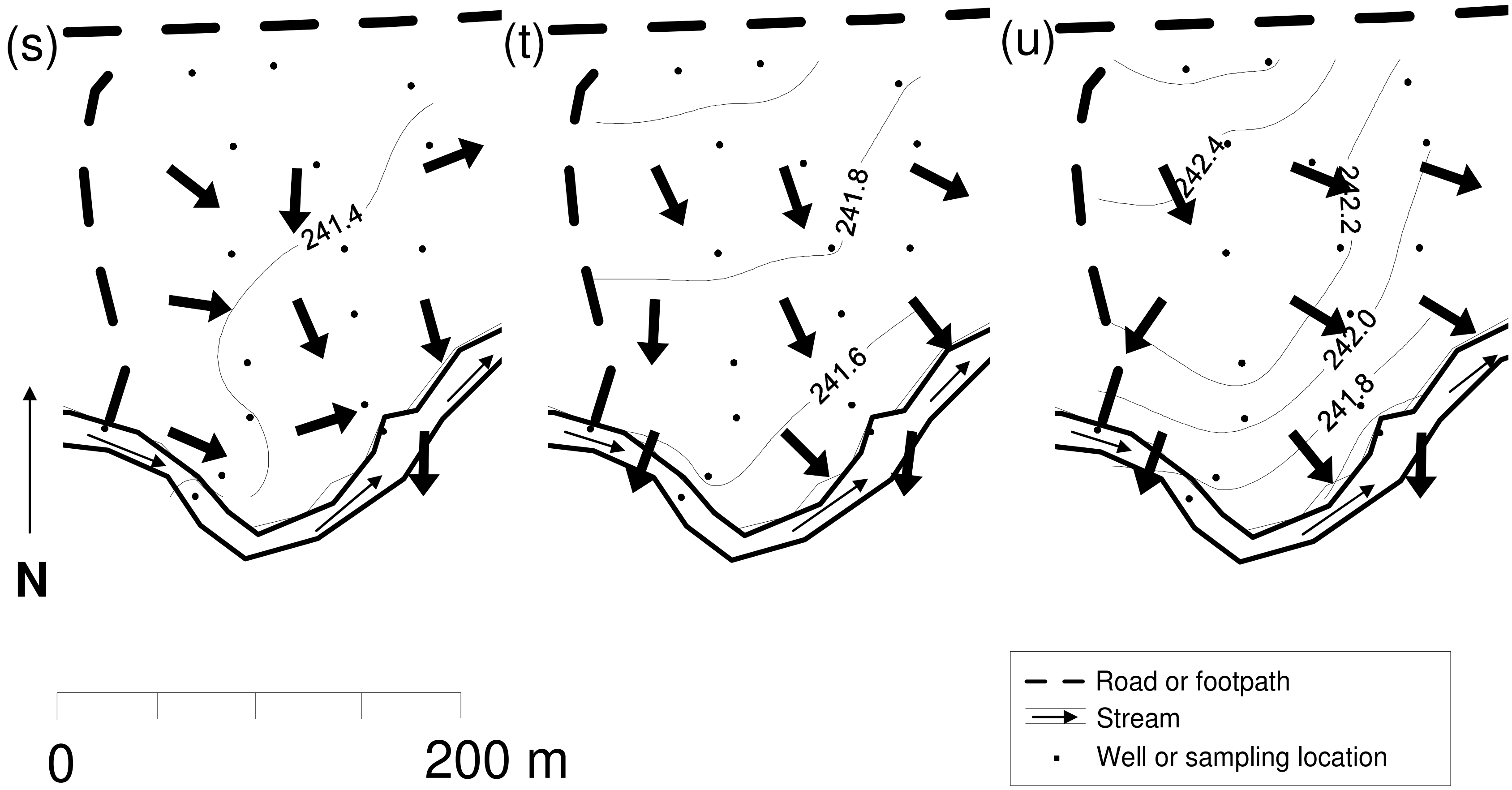
Appendix E (continued). Potentiometric surface maps for (j) 6-2-05, (k) 6-20-05, and (l) 7-11-05. The contour interval is 0.20 m. Arrows indicate the direction of ground water flow. Black dots represent water sampling locations.



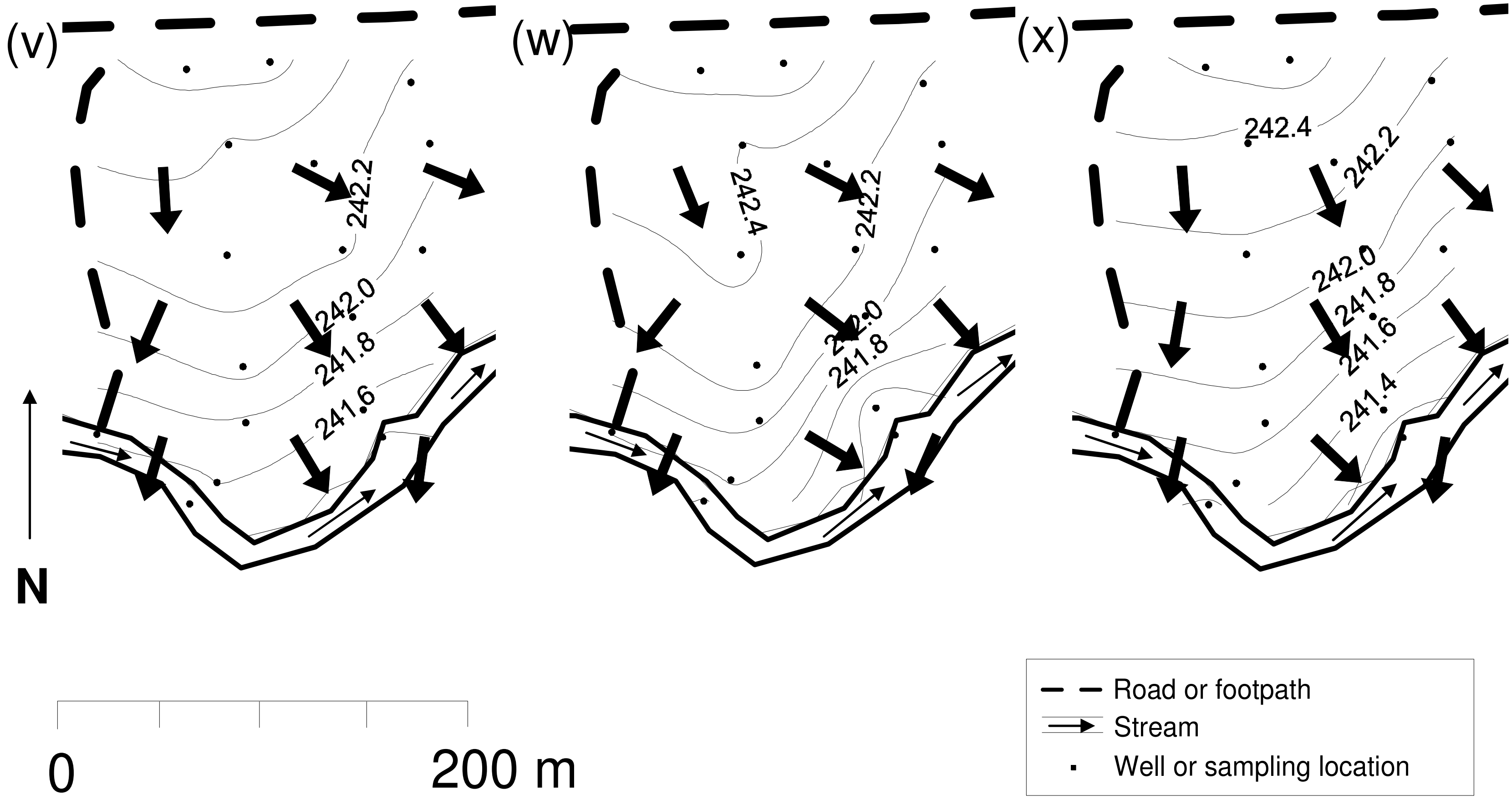
Appendix E (continued). Potentiometric surface maps for (m) 7-22-05, (n) 8-1-05, and (o) 8-18-05. The contour interval is 0.20 m. Arrows indicate the direction of ground water flow. Black dots represent water sampling locations.



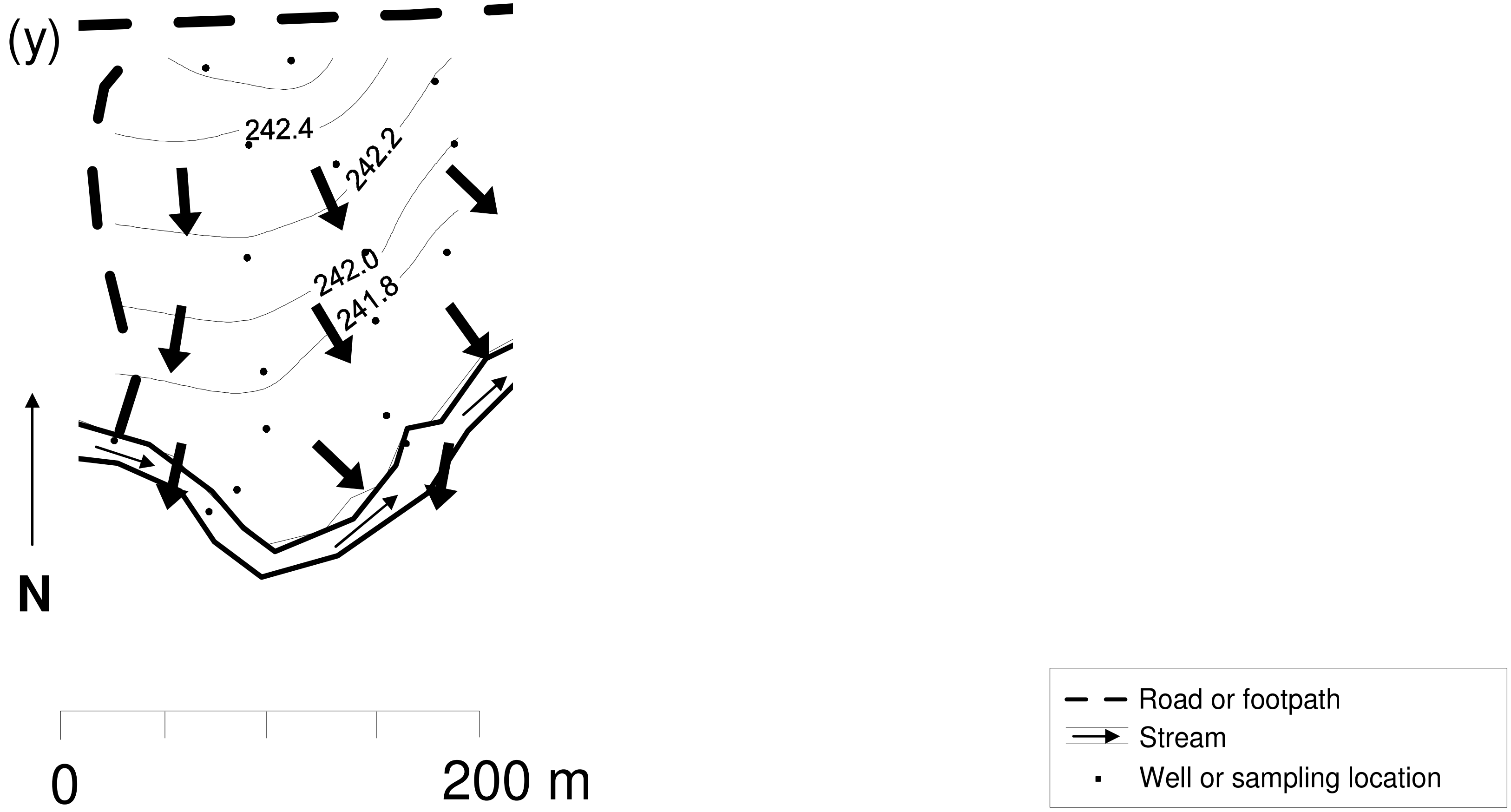
Appendix E (continued). Potentiometric surface maps for (p) 9-9-05, (q) 9-29-05, and (r) 10-21-05. The contour interval is 0.20 m. Arrows indicate the direction of ground water flow. Black dots represent water sampling locations.



Appendix E (continued). Potentiometric surface maps for (s) 11-10-05, (t) 12-1-05, and (u) 12-29-05. The contour interval is 0.20 m. Arrows indicate the direction of ground water flow. Black dots represent water sampling locations.



Appendix E (continued). Potentiometric surface maps for (v) 1-11-06, (w) 1-30-06, and (x) 2-24-06. The contour interval is 0.20 m. Arrows indicate the direction of ground water flow. Black dots represent water sampling locations.



Appendix E (continued). Potentiometric surface mas for (y) 3-11-06. The contour interval is 0.20 m. Arrows indicate the direction of ground water flow. Black dots represent water sampling locations.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
10/24/2004	Fishback	11.18	7.70	0.616			52.43		0.03	27.30	
10/24/2004	MW01	13.44	7.38	1.094						18.74	
10/24/2004	MW02	13.44	7.38	1.094			127.99		0.03	32.93	
10/24/2004	MW03	15.31	7.18	1.089			84.71		0.03	47.11	
10/24/2004	MW04w						111.01		0.03	19.45	
10/24/2004	Prec.								0.03		
10/24/2004	6	13.26	7.18	1.135			95.12		0.03		
10/24/2004	10	14.73	7.01	1.096			111.62		0.03	28.20	
10/24/2004	14	14.46	7.00	1.060			108.06		0.03	24.95	
10/30/2004	Fishback	19.64	7.46	0.736			58.95		0.03	28.40	
10/30/2004	MW01	15.60	7.25	0.570							
10/30/2004	MW02	14.73	7.31	1.073			130.60		0.03	34.08	
10/30/2004	MW03	15.87	7.30	1.040			79.71		0.03	51.66	
10/30/2004	MW04w	14.73	7.20	1.148			123.78		0.03	27.62	
10/30/2004	6	15.02	7.10	1.113			107.19		0.03	36.66	
10/30/2004	10	15.42	7.17	1.100			111.79		0.03	25.55	
10/30/2004	14	14.90	7.10	1.088			110.12		0.03	27.31	
11/6/2004	Fishback	9.03	7.77	0.690			64.35		0.03	34.04	
11/6/2004	MW01	14.51	7.00	1.130			96.62		0.03	52.47	
11/6/2004	MW02	14.40	7.21	1.049			126.11		0.03	34.90	
11/6/2004	MW03	15.33	7.07	1.146			81.01		0.03	104.39	
11/6/2004	MW04e	14.76	7.12	1.124			164.03		0.03	58.50	
11/6/2004	MW04w	14.59	7.10	1.130			150.51		0.03	52.02	
11/6/2004	MW05e	14.07	7.31	0.888							
11/6/2004	MW05w	14.13	7.18	0.147							
11/6/2004	6	14.06	6.99	1.040			96.91		0.03	38.02	

Appendix F. Water chemistry results for all samples collected. Sampling locations labeled MW-- are monitoring wells from previous studies at the same locations used in the current study. New wells were installed for the current study.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
10/24/2004	Fishback	68.14	22.19	4.11	31.10			
10/24/2004	MW01							
10/24/2004	MW02	100.20	31.14	3.15	74.57			
10/24/2004	MW03	111.64	34.87	1.53	49.33			
10/24/2004	MW04w	111.36	33.91	1.07	75.14			
10/24/2004	Prec.	3.07	2.40	0.27	1.61			
10/24/2004	6	105.16	30.63	6.57	64.32			
10/24/2004	10	117.17	33.24	1.86	72.76			
10/24/2004	14	117.15	33.36	2.96	66.57			
10/30/2004	Fishback	77.82	24.63	3.88	35.84			
10/30/2004	MW01							
10/30/2004	MW02	106.11	29.33	2.69	73.13			
10/30/2004	MW03	123.96	36.73	1.56	50.59			
10/30/2004	MW04w	115.18	36.41	1.59	81.72			
10/30/2004	6	113.25	31.65	5.68	68.32			
10/30/2004	10	117.21	33.06	1.65	70.44			
10/30/2004	14	111.76	31.81	2.81	63.61			
11/6/2004	Fishback	74.89	25.05	4.47	39.56			
11/6/2004	MW01	132.14	37.50	2.36	71.25			
11/6/2004	MW02	100.68	26.98	2.40	70.46			
11/6/2004	MW03	140.36	40.85	1.59	49.04			
11/6/2004	MW04e	98.95	30.13	1.44	78.75			
11/6/2004	MW04w	109.38	33.31	1.01	81.53			
11/6/2004	MW05e							
11/6/2004	MW05w							
11/6/2004	6	113.20	31.69	4.50	63.75			

Appendix F (continued). Water chemistry results for all samples collected. Sampling locations labeled MW-- are monitoring wells from previous studies at the same locations used in the current study. New wells were installed for the current study.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
11/6/2004	8	12.54	7.01	0.976			50.70		0.03	35.94	
11/6/2004	10	14.84	7.02	0.952			81.45		0.03	25.58	
11/6/2004	11	14.70	7.08	0.973			101.78		0.03	29.50	
11/6/2004	12	14.20	7.08	1.090			84.81		0.03	94.94	
11/6/2004	13	14.13	6.89	1.068							
11/6/2004	14	14.13	6.89	1.068			106.92		0.03	27.88	
11/11/2004	Prec.	7.55	8.54	0.008					0.03		
12/21/2004	Fishback	0.29	7.89	0.844			76.74		0.03	58.75	
12/21/2004	MW01	6.59	7.30	1.112			134.76		0.03	65.24	
12/21/2004	MW02	7.76	7.43	1.071			138.33		0.03	42.79	
12/21/2004	MW03	8.72	7.26	1.133			93.52		0.03	61.96	
12/21/2004	MW04e	6.64	7.23	1.102			134.29		0.03	74.43	
12/21/2004	MW04w	7.94	7.27	1.107			136.14		0.03	69.51	
12/21/2004	MW05e	6.36	7.29	1.063			128.15		0.03	51.86	
12/21/2004	MW05w	5.69	7.50	1.026			122.93		0.03	53.86	
12/21/2004	6	8.26	7.30	0.797			86.70		0.03	38.11	
12/21/2004	7	7.92	7.34	0.798			61.46		0.03	31.53	
12/21/2004	8	7.68	7.11	0.779			21.30		0.03	26.98	
12/21/2004	9	9.32	6.86	1.170			78.72		0.03	20.99	
12/21/2004	10	7.16	7.17	0.959			92.03		0.03	34.26	
12/21/2004	11	7.21	7.26	0.978			129.29		0.03	42.06	
12/21/2004	12	7.20	7.19	0.903			92.65		0.03	36.50	
12/21/2004	13	8.24	7.13	0.898			64.04		0.03	38.93	
12/21/2004	14	7.73	7.18	0.955			111.40		0.03	37.67	
1/10/2005	Fishback	4.17	7.56	0.276		68.7	41.22		5.46	35.12	

Appendix F (continued). Water chemistry results for all samples collected. Sampling locations labeled MW-- are monitoring wells from previous studies at the same locations used in the current study. New wells were installed for the current study.

Date	**Sampling Location**	**Ca^{+2} (mg/L)**	**Mg^{+2} (mg/L)**	**K^{+} (mg/L)**	**Na^{+} (mg/L)**	**Alkalinity (mg/L)**	**NH^{+3} (mg/L)**	**SiO$_2$ (mg/L)**
11/6/2004	8	125.68	36.46	1.38	31.35			
11/6/2004	10	107.91	30.13	1.27	53.67			
11/6/2004	11	87.85	29.70	2.51	66.42			
11/6/2004	12	119.24	37.48	2.21	55.66			
11/6/2004	13							
11/6/2004	14	116.80	35.23	2.62	61.23			
11/11/2004	Prec.	3.88	2.40	0.31	1.84			
12/21/2004	Fishback	49.81	34.49	1.49	33.21			
12/21/2004	MW01	50.49	40.34	1.17	69.73			
12/21/2004	MW02	45.16	33.57	1.87	81.49			
12/21/2004	MW03	39.30	45.93	0.77	49.75			
12/21/2004	MW04e	38.66	37.74	0.08	82.72			
12/21/2004	MW04w	44.04	37.92	0.27	81.80			
12/21/2004	MW05e	38.90	36.20	0.50	74.60			
12/21/2004	MW05w	43.91	35.92	0.61	70.78			
12/21/2004	6	37.32	26.70	2.72	48.38			
12/21/2004	7	31.88	31.90	0.16	38.44			
12/21/2004	8	21.70	37.83	0.40	16.80			
12/21/2004	9	46.32	49.90	0.52	37.61			
12/21/2004	10	33.19	35.76	0.51	45.84			
12/21/2004	11	32.30	32.97	1.40	63.08			
12/21/2004	12	20.42	29.08		38.44			
12/21/2004	13	28.72	35.75	0.25	35.26			
12/21/2004	14	50.34	32.34	2.19	58.73			
1/10/2005	Fishback	49.81	20.99	1.89	17.10			

Appendix F (continued). Water chemistry results for all samples collected. Sampling locations labeled MW-- are monitoring wells from previous studies at the same locations used in the current study. New wells were installed for the current study.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
1/10/2005	MW01	6.54	7.08	1.094		76.2	127.10		0.03	63.09	
1/10/2005	MW02	6.59	7.21	1.048		71.6	127.11		0.11	44.44	
1/10/2005	MW03	8.22	7.30	1.157		83.3	91.99		0.29	63.51	
1/10/2005	MW04e	6.28	7.14	1.155		91.1	143.67		0.03	62.94	
1/10/2005	MW04w	6.48	7.17	1.154		90.4	154.65		0.03	67.39	
1/10/2005	MW05e	4.81	7.30	0.997		86.7	121.34		0.03	55.11	
1/10/2005	MW05w	5.33	7.29	0.937		91.2	103.20		0.02	53.95	
1/10/2005	6	4.66	7.23	0.426		81.0	28.79		0.03	17.22	
1/10/2005	7	4.99	7.50	0.162		77.8	40.72		0.06	27.12	
1/10/2005	8	5.36	7.03	0.766		89.1	13.47		0.03	20.85	
1/10/2005	9	6.89	6.96	0.852		88.8	47.70		0.03	42.51	
1/10/2005	10	5.92	7.15	1.003		93.5	99.17		0.03	50.90	
1/10/2005	11	5.43	7.16	0.980		94.0	121.15		0.03	42.39	
1/10/2005	12	5.95	7.34	0.551		90.4	64.78		0.18	35.58	
1/10/2005	13	6.81	7.14	0.830		94.3	48.02		0.03	31.86	
1/10/2005	14	6.07	7.16	0.853		97.2	101.94		0.03	40.14	
1/10/2005	Surf. Wtr	4.86	7.25	0.931		70.1	110.27		1.44	50.68	
2/11/2005	Fishback		7.52	0.610		286.3	53.91		0.03	40.62	
2/11/2005	MW01	4.27	6.95	1.113		293.0	128.96		0.03	71.81	
2/11/2005	MW02	4.43	6.99	1.033		299.7	68.95		0.03		
2/11/2005	MW03	8.14	7.25	1.117		266.7	93.68		0.03	59.31	
2/11/2005	MW04e	1.01	7.05	0.926		215.7	99.80		0.03	46.72	
2/11/2005	MW04w	1.50	7.12	0.960		242.4	100.66		0.03	45.79	
2/11/2005	MW05e	1.38	7.14	0.741		89.5	102.80		0.03	44.98	
2/11/2005	MW05w	1.14	7.25	0.645		215.7	93.30		0.03	46.03	
2/11/2005	Rich Peine	8.68	7.51	0.336		-30.1	6.89		0.03		
2/11/2005	2										

Appendix F (continued). Water chemistry results for all samples collected. Sampling locations labeled MW-- are monitoring wells from previous studies at the same locations used in the current study. New wells were installed for the current study.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
1/10/2005	MW01	36.70	41.06	1.59	70.04			
1/10/2005	MW02	40.15	32.32	1.75	76.12			
1/10/2005	MW03	35.90	47.38	1.37	49.47			
1/10/2005	MW04e	39.01	38.51	1.18	85.89			
1/10/2005	MW04w	47.46	40.56	1.24	89.21			
1/10/2005	MW05e	34.54	34.30	1.28	73.89			
1/10/2005	MW05w	41.40	30.67	1.37	62.29			
1/10/2005	6	45.86	19.97	2.77	30.81			
1/10/2005	7	31.14	26.98	1.20	26.53			
1/10/2005	8	25.00	35.76	0.40	12.89			
1/10/2005	9	49.15	34.77	1.64	26.33			
1/10/2005	10	37.88	38.40	1.32	50.13			
1/10/2005	11	43.27	33.63	1.60	64.36			
1/10/2005	12	35.26	31.84	1.22	34.48			
1/10/2005	13	60.21	31.64	0.40	27.90			
1/10/2005	14	33.18	32.17	1.79	53.92			
1/10/2005	Surf. Wtr	38.48	38.27	2.45	59.93			
2/11/2005	Fishback	40.87	14.77	1.18	12.90			
2/11/2005	MW01							
2/11/2005	MW02							
2/11/2005	MW03							
2/11/2005	MW04e	66.78	31.10	0.40	68.98			
2/11/2005	MW04w	43.66	32.71	0.40	71.81			
2/11/2005	MW05e	51.66	29.13	1.23	71.02			
2/11/2005	MW05w	54.63	29.96	1.19	58.09			
2/11/2005	Rich Peine	50.57	27.98	1.11	46.93			
2/11/2005	2	70.88	30.25	1.33	76.91			

Appendix F (continued). Water chemistry results for all samples collected. Sampling locations labeled MW-- are monitoring wells from previous studies at the same locations used in the current study. New wells were installed for the current study.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
2/11/2005	2a						80.92		0.03	74.02	
2/11/2005	2b						87.97		0.03	42.55	
2/11/2005	2c						100.68		0.03	38.41	
2/11/2005	3										
2/11/2005	3a						67.82		0.03	37.09	
2/11/2005	3b						67.43		0.03	34.78	
2/11/2005	4										
2/11/2005	4a						88.48		0.03	50.26	
2/11/2005	4b						105.64		0.03	54.56	
2/11/2005	5a						97.44		0.03	49.06	
2/11/2005	5b						106.39		0.03	51.94	
2/11/2005	5c						112.52		0.03	47.39	
2/11/2005	6	2.84	7.00	0.399		305.8	45.97		0.03	25.67	
2/11/2005	6a						23.22		0.03	113.66	
2/11/2005	6b						66.88		0.03	48.77	
2/11/2005	6c						73.17		0.03	42.42	
2/11/2005	7	4.11	7.03	0.644		302.6	39.61		0.03	26.55	
2/11/2005	8	3.14	6.87	0.698		310.8	26.50		0.03	25.28	
2/11/2005	9	5.18	6.93	0.828		312.8	29.07		0.03	42.11	
2/11/2005	10	2.79	7.34	1.013		284.1	108.01		0.03	45.44	
2/11/2005	11	3.19	7.07	0.923		279.8	113.52		0.03	41.96	
2/11/2005	11a						84.49		0.03	43.90	
2/11/2005	11b						98.62		0.03	44.65	
2/11/2005	12	3.69	7.00	0.759		275.1	34.86		0.03	29.57	
2/11/2005	12a										
2/11/2005	12b						19.20		0.03	41.80	
2/11/2005	12c						48.86		0.03	30.77	
2/11/2005	13	4.93	7.03	0.814		229.4	35.35		0.03	42.46	
2/11/2005	13a										

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
2/11/2005	2a	45.37	24.67	1.46	114.10			
2/11/2005	2b	48.60	33.80	1.78	71.34			
2/11/2005	2c	46.23	32.01	2.01	67.23			
2/11/2005	3	59.80	41.40	1.20	44.90			
2/11/2005	3a	51.55	33.30	1.70	50.60			
2/11/2005	3b	55.46	33.07	1.82	54.38			
2/11/2005	4	52.58	28.66	1.46	66.63			
2/11/2005	4a	63.42	31.06	1.53	73.44			
2/11/2005	4b							
2/11/2005	5a	40.34	33.60	1.29	56.31			
2/11/2005	5b	44.76	31.93	1.37	58.29			
2/11/2005	5c	57.68	35.75	1.56	62.52			
2/11/2005	6	41.26	13.29	1.44	19.38			
2/11/2005	6a	49.38	18.79	1.24	43.13			
2/11/2005	6b	41.16	23.72	1.75	52.22			
2/11/2005	6c	58.38	25.57	1.82	57.17			
2/11/2005	7	64.66	24.84	0.40	23.23			
2/11/2005	8	60.22	26.79	0.40	12.89			
2/11/2005	9	74.10	24.69	1.20	16.52			
2/11/2005	10	52.20	25.41	1.26	44.86			
2/11/2005	11	51.61	29.51	1.25	57.31			
2/11/2005	11a	48.87	29.75	0.40	34.57			
2/11/2005	11b	53.47	28.58	1.20	38.75			
2/11/2005	12	57.34	21.55	0.40	22.10			
2/11/2005	12a	59.64	23.08	0.40	17.36			
2/11/2005	12b	48.67	29.66	1.31	22.54			
2/11/2005	12c							
2/11/2005	13	58.56	27.32	1.18	24.48			
2/11/2005	13a	68.85	32.94	1.52	15.26			

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
2/11/2005	13b						23.43		0.03	28.54	
2/11/2005	13c						46.20		0.03	30.42	
2/11/2005	14	4.79	7.06	0.857		217.0	90.07		0.03	39.38	
2/11/2005	14a						14.12		0.03	21.09	
2/11/2005	14b						54.61		0.03	45.24	
2/11/2005	14c						86.89		0.03	38.89	
2/11/2005	Tom Peine	10.23	7.63	0.634		-74.6					
3/11/2005	Fishback	1.48	7.96	0.677		144.2	69.21		0.03	53.65	
3/11/2005	Rich Peine	9.35	7.70	0.638		-46.3	7.18				
3/11/2005	1	4.57	7.20	1.193		-41.5	127.27		0.03	41.13	
3/11/2005	1a						121.17		0.03	37.56	
3/11/2005	1b						138.20		0.03	64.88	
3/11/2005	1c						139.24		0.03	64.88	
3/11/2005	2	3.08	7.24	1.024		105.2	135.15		0.03	76.41	
3/11/2005	2a						137.32		0.03	123.80	
3/11/2005	2b						136.92		0.03	59.22	
3/11/2005	2c						138.95		0.03	49.35	
3/11/2005	3	7.31	7.45	0.890		43.7	79.35		0.03	41.40	
3/11/2005	3a						74.48		0.03	37.33	
3/11/2005	3b						74.36		0.03	38.44	
3/11/2005	3c						110.66		0.03	24.74	
3/11/2005	4	3.37	7.21	1.070		43.8	156.99		0.03	49.43	
3/11/2005	4a						154.38		0.03	51.43	
3/11/2005	4b						155.97		0.03	52.92	
3/11/2005	4c						170.53		0.03	53.57	
3/11/2005	5	2.47	7.35	1.043		23.8	119.85		0.03	66.22	
3/11/2005	5a						108.00		0.03	81.21	
3/11/2005	5b						129.79		0.03	55.17	

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
2/11/2005	13b	51.87	25.65	1.31	26.29			
2/11/2005	13c							
2/11/2005	14	52.15	29.80	1.37	48.84			
2/11/2005	14a	75.77	19.35	0.40	5.01			
2/11/2005	14b	43.95	22.10	1.36	23.11			
2/11/2005	14c	46.99	21.56	1.26	31.27			
2/11/2005	Tom Peine	37.13	25.47	1.24	48.72			
3/11/2005	Fishback	49.68	27.59	1.32	26.19			
3/11/2005	Rich Peine	47.42	28.84	1.17	48.27			
3/11/2005	1	56.38	38.51	1.43	81.28			
3/11/2005	1a	74.60	37.23	1.53	57.13			
3/11/2005	1b	66.06	40.56	1.36	65.87			
3/11/2005	1c	75.76	38.28	1.45	61.34			
3/11/2005	2	59.27	29.61	1.25	72.83			
3/11/2005	2a	49.06	28.35	1.37	128.00			
3/11/2005	2b	51.63	31.03	1.46	72.12			
3/11/2005	2c	56.55	32.01	1.51	66.49			
3/11/2005	3	55.77	32.24	1.29	48.53			
3/11/2005	3a	47.17	31.98	1.29	47.69			
3/11/2005	3b	70.18	31.06	1.30	46.62			
3/11/2005	3c	51.35	41.88	1.48	50.30			
3/11/2005	4	61.85	34.44	0.40	76.39			
3/11/2005	4a	62.36	32.88	0.40	72.49			
3/11/2005	4b	71.97	33.41	0.40	73.19			
3/11/2005	4c	47.44	35.50	1.19	74.36			
3/11/2005	5	65.63	29.28	1.20	85.69			
3/11/2005	5a	57.07	36.72	0.40	70.49			
3/11/2005	5b	67.15	33.03	0.40	61.91			

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
3/11/2005	5c						134.34		0.03	54.97	
3/11/2005	6	4.09	7.24	0.705		132.3	77.53		0.03	46.52	
3/11/2005	6a						26.93		0.03	61.25	
3/11/2005	6b						72.21		0.03	43.55	
3/11/2005	6c						84.93		0.03	41.70	
3/11/2005	7	4.61	7.27	0.772		135.7	54.64		0.03	35.44	
3/11/2005	7b						45.05		0.03	86.36	
3/11/2005	7c						50.08		0.03	35.44	
3/11/2005	8	3.66	7.16	0.706		138.1	35.51		0.03	27.05	
3/11/2005	8b						39.64		0.03	390.79	
3/11/2005	8c						29.36		0.03	69.63	
3/11/2005	9	5.02	6.97	0.914		144.3	43.22		0.03	32.44	
3/11/2005	9b						42.03		0.03	38.13	
3/11/2005	9c						46.88		0.03	20.78	
3/11/2005	10	3.72	7.73	0.835		53.9	107.40		0.03	57.60	
3/11/2005	10a						114.91		0.03	70.23	
3/11/2005	10b						110.87		0.03	56.97	
3/11/2005	10c						100.95		0.03	57.90	
3/11/2005	11	3.06	7.25	0.903		73.0	132.01		0.03	48.43	
3/11/2005	11a						103.79		0.03	44.61	
3/11/2005	11b						125.63		0.03	47.18	
3/11/2005	11c						129.64		0.03	47.46	
3/11/2005	12	4.97	7.15	0.840		76.2	96.40		0.03	37.74	
3/11/2005	12b						13.42		0.03	59.10	
3/11/2005	12c						83.09		0.03	37.29	
3/11/2005	13	4.75	7.14	0.730		75.2	51.22		0.03	31.65	
3/11/2005	13c						51.06		0.03	33.01	
3/11/2005	14	4.98	7.28	0.841		85.6	96.24		0.03	46.18	
3/11/2005	14a						12.38		0.03	18.64	

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO$_2$ (mg/L)
3/11/2005	5c	64.98	33.27	1.20	60.41			
3/11/2005	6	63.69	26.84	1.82	45.69			
3/11/2005	6a	59.50	22.95	1.17	19.30			
3/11/2005	6b	58.29	26.98	1.71	46.59			
3/11/2005	6c	47.82	28.28	1.79	50.10			
3/11/2005	7	42.51	31.16	0.40	30.39			
3/11/2005	7b	38.67	17.33	1.30	52.04			
3/11/2005	7c	45.59	31.24	0.40	25.39			
3/11/2005	8	58.20	31.26	0.40	16.86			
3/11/2005	8b							
3/11/2005	8c	41.00	34.07	1.40	54.01			
3/11/2005	9	63.83	34.14	0.40	20.68			
3/11/2005	9b	29.54	28.94	1.21	48.85			
3/11/2005	9c							
3/11/2005	10	49.68	31.13	1.13	49.06			
3/11/2005	10a	39.90	34.00	1.12	56.53			
3/11/2005	10b	46.11	32.79	1.14	45.93			
3/11/2005	10c	44.29	33.26	0.40	47.81			
3/11/2005	11	38.31	27.65	1.18	54.42			
3/11/2005	11a	46.81	30.68	0.40	35.16			
3/11/2005	11b	38.64	24.05	0.40	38.99			
3/11/2005	11c	32.46	36.44	1.30	55.78			
3/11/2005	12	24.90	13.58	0.40	18.56			
3/11/2005	12b	35.47	20.21	0.40	16.93			
3/11/2005	12c	31.53	33.13	1.17	35.35			
3/11/2005	13	51.17	27.38	0.40	25.58			
3/11/2005	13c	40.90	27.44	0.40	26.76			
3/11/2005	14	35.72	28.13	1.25	45.57			
3/11/2005	14a	58.08	19.46	0.40	5.20			

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
3/11/2005	14b						54.54		0.03	58.17	
3/11/2005	14c						96.02		0.03	44.32	
3/11/2005	15	5.54	7.34	0.826		57.9	73.38		0.03	44.75	
3/11/2005	Surf. Wtr	3.99	7.65	0.699		37.2	103.90		0.03	36.78	
3/11/2005	Tom Peine	9.43	7.72	0.633		-94.2					
3/29/2005	Fishback	8.77	8.23	0.695	9.9	-78.4	61.94	0.020	3.57	32.41	0.002
3/29/2005	Rich Peine	11.75	7.78	0.629	2.3	-53.7	2.70	0.002	0.01	0.03	0.010
3/29/2005	1	9.86	7.09	1.123	1.8	-13.7	140.74	0.240	0.21	13.40	0.010
3/29/2005	1a				0.9		173.51	0.130	0.21	12.17	0.010
3/29/2005	1b				0.5		208.53	0.140	0.20	31.65	0.002
3/29/2005	1c				0.0		261.30	0.040	0.07	37.52	0.013
3/29/2005	2	7.37	7.12	1.090	2.1	-15.4	146.39	0.110	0.08	77.67	0.002
3/29/2005	2a				0.9		163.65	0.200	0.23	116.63	0.002
3/29/2005	2b				0.0		212.14	0.140	0.08	48.70	0.003
3/29/2005	2c				0.0		216.34	0.040	0.07	26.69	0.003
3/29/2005	3	9.35	7.39	0.848	1.2	-31.0	114.81	0.160	0.48	17.29	0.004
3/29/2005	3a				1.9		99.68	0.160	0.46	16.56	0.004
3/29/2005	3b				2.8		76.54	0.620	1.15	15.52	0.050
3/29/2005	3c				1.7		166.22	0.130	0.18	12.22	0.003
3/29/2005	4	7.81	7.13	1.089	1.4	-16.4	154.17	0.200	0.18	22.68	0.004
3/29/2005	4a				2.4		201.49	0.020	0.14	22.93	0.005
3/29/2005	4b				0.8		241.91	0.010	0.12	25.28	0.005
3/29/2005	4c				1.5		183.44	0.020	0.13	25.84	0.005
3/29/2005	5	6.93	7.25	1.022	0.5	-22.7	128.55	0.020	0.12	31.09	0.004
3/29/2005	5a				2.1		156.57	0.020	0.15	30.60	0.005
3/29/2005	5b				1.1		143.62	0.020	0.14	23.94	0.004
3/29/2005	5c				0.2		142.52	0.210	0.17	31.40	0.004
3/29/2005	6	7.01	7.10	0.744	0.0	-14.3	117.95	0.150	0.18	15.33	0.004

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
3/11/2005	14b	36.95	20.96	0.40	34.84			
3/11/2005	14c	49.45	26.89	1.39	45.16			
3/11/2005	15	43.82	30.35	0.40	35.47			
3/11/2005	Surf. Wtr	31.76	26.71	1.60	50.62			
3/11/2005	Tom Peine	34.46	28.89	1.26	54.60			
3/29/2005	Fishback	35.95	28.82	1.28	26.99	144.69	0.08	0.91
3/29/2005	Rich Peine	30.17	28.46	1.24	48.43	295.65	0.54	3.77
3/29/2005	1	33.41	33.65	1.41	78.94	182.52	0.07	6.25
3/29/2005	1a	52.48	39.37	1.42	59.03	165.49	0.02	2.95
3/29/2005	1b	49.39	41.94	1.46	67.39	116.90	0.05	4.98
3/29/2005	1c	43.78	40.41	1.55	62.74	6.18	0.32	2.58
3/29/2005	2	51.73	29.58	1.32	94.86	171.34	0.05	1.76
3/29/2005	2a	31.01	28.87	1.31	115.90	97.30	0.13	2.37
3/29/2005	2b	36.68	29.92	1.47	66.60	11.20	0.18	3.68
3/29/2005	2c	44.04	30.89	1.60	64.94	47.23	0.17	4.06
3/29/2005	3	35.92	32.50	1.28	43.66	139.52	0.09	4.30
3/29/2005	3a	39.25	30.41	1.37	43.87	161.94	0.18	2.67
3/29/2005	3b	43.79	31.17	1.46	44.95	211.46	0.22	4.33
3/29/2005	3c	36.84	39.42	1.37	47.66	112.10	0.35	6.02
3/29/2005	4	41.79	35.94	0.40	79.96	185.22	0.15	2.36
3/29/2005	4a	34.77	32.26	1.19	68.92	62.71	0.14	3.63
3/29/2005	4b	54.58	32.56	0.40	70.21	55.77	0.11	3.47
3/29/2005	4c	37.99	34.48	1.16	70.82	106.45	0.13	5.58
3/29/2005	5	47.39	32.75	1.22	78.18	210.89	0.12	3.53
3/29/2005	5a	38.14	38.65	1.21	72.79	161.30	0.13	2.73
3/29/2005	5b	43.21	34.17	1.22	63.55	160.66	0.14	3.04
3/29/2005	5c	38.92	32.21	1.19	59.22	125.96	0.09	2.76
3/29/2005	6	42.75	31.21	2.05	51.42	166.98	0.12	2.87

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
3/29/2005	6a				3.0		30.46	0.170	0.20	20.52	0.004
3/29/2005	6b				1.0		124.30	0.190	0.21	23.08	0.003
3/29/2005	6c				0.0		134.56	0.200	0.19	24.42	0.003
3/29/2005	7	9.74	7.19	0.754	6.3	-21.0	89.71	0.170	0.18	15.79	0.004
3/29/2005	7b				3.6		62.81	0.220	0.33	62.29	0.004
3/29/2005	7c				4.3		50.48	0.120	0.29	19.55	0.004
3/29/2005	8	6.15	7.08	0.722	2.4	-13.2	57.49	0.120	0.11	13.01	0.003
3/29/2005	8b				3.7		21.34	0.510	0.47	373.15	0.003
3/29/2005	8c				2.0		27.53	0.160	0.18	65.78	0.003
3/29/2005	9	8.84	6.94	0.925	1.6	-5.0	64.53	0.130	0.13	15.12	0.003
3/29/2005	9b				2.9		36.29	0.120	0.13	10.53	0.003
3/29/2005	9c				1.1		33.95	0.010	0.04	20.08	0.002
3/29/2005	10	7.63	7.33	0.878	1.6	-27.0	100.20	0.002	0.01	39.61	0.010
3/29/2005	10a				2.1		85.28	0.010	0.06	34.87	0.010
3/29/2005	10b				0.7		96.96	0.002	0.03	31.68	0.002
3/29/2005	10c				1.0		92.36	0.010	0.06	50.58	0.010
3/29/2005	11	6.60	7.18	0.959	0.0	-18.9	115.34	0.002	0.01	33.43	0.002
3/29/2005	11a				1.3		84.12	0.010	0.05	26.53	0.002
3/29/2005	11b				1.1		120.87	0.010	0.05	32.97	0.002
3/29/2005	11c				1.0		109.62	0.010	0.04	26.06	0.002
3/29/2005	12	6.82	7.13	0.777	2.1	-16.1					
3/29/2005	12b				2.8		5.54	0.010	0.07	11.73	0.010
3/29/2005	12c				1.2		79.01	0.010	0.04	26.72	0.010
3/29/2005	13	6.56	7.10	0.758	2.5	-14.2	50.70	0.010	0.03	26.60	0.010
3/29/2005	13c				1.9		47.22	0.010	0.05	23.54	0.002
3/29/2005	14	6.87	7.14	0.835	0.1	-16.4	84.71	0.002	0.01	30.03	0.010
3/29/2005	14a				3.4		11.76	0.002	0.03	11.00	0.010
3/29/2005	14b				0.9		57.68	0.010	0.06	32.30	0.002
3/29/2005	14c				0.2		84.07	0.002	0.01	31.17	0.002

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
3/29/2005	6a	42.75	23.68	0.40	16.93	176.86	0.12	3.29
3/29/2005	6b	36.15	26.28	1.64	43.12	94.52	0.12	3.67
3/29/2005	6c	38.71	29.84	1.91	51.55	118.41	0.15	3.89
3/29/2005	7	37.79	29.22	0.40	31.38	140.06	0.11	4.19
3/29/2005	7b	26.36	26.86	1.17	70.09	176.38	0.09	3.47
3/29/2005	7c	46.78	34.67	1.23	30.34	235.17	0.13	2.69
3/29/2005	8	47.22	33.82	0.40	19.21	204.53	0.13	2.14
3/29/2005	8b	35.81	41.85	1.19	199.52	277.67	0.13	1.78
3/29/2005	8c	27.58	30.71	1.17	45.15	187.34	0.13	3.34
3/29/2005	9	68.25	34.92	0.40	21.22	253.77	0.11	2.61
3/29/2005	9b	53.16	37.09	0.40	21.36	269.98	0.10	7.05
3/29/2005	9c	44.64	29.20	1.20	24.37	217.35	0.30	2.91
3/29/2005	10	61.33	30.14	1.18	47.45	199.29	0.08	2.51
3/29/2005	10a	56.98	33.10	1.17	53.85	240.45	0.12	1.83
3/29/2005	10b	52.09	32.26	1.19	44.97	192.37	0.12	2.67
3/29/2005	10c	50.01	29.45	1.21	49.93	173.22	0.08	1.95
3/29/2005	11	44.95	31.55	1.27	62.93	183.07	0.07	2.13
3/29/2005	11a	46.67	33.51	0.40	36.76	188.60	0.11	1.14
3/29/2005	11b	57.08	30.23	1.17	51.77	176.11	0.10	2.58
3/29/2005	11c	45.43	33.38	1.43	57.41	195.71	0.12	1.71
3/29/2005	12							
3/29/2005	12b	28.76	22.24	0.40	9.14	163.63	0.08	2.23
3/29/2005	12c	34.96	34.56	1.28	38.98	176.65	0.18	2.21
3/29/2005	13	51.78	27.39	1.15	28.67	206.62	0.11	2.51
3/29/2005	13c	42.93	28.83	1.22	30.90	203.47	0.11	2.48
3/29/2005	14	45.91	30.13	1.38	48.71	195.57	0.09	2.46
3/29/2005	14a	47.56	22.01	0.40	7.29	197.67	0.09	2.09
3/29/2005	14b	48.09	20.90	1.26	36.77	172.64	0.13	1.75
3/29/2005	14c	44.70	29.47	1.40	48.68	189.51	0.09	2.30

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
3/29/2005	15	8.80	7.09	0.874	2.1	-14.0	91.04	0.010	0.24	30.49	0.010
3/29/2005	Surf. Wtr	8.28	7.43	0.942		-33.3	95.01	0.010	0.11	33.00	0.010
3/29/2005	Tom Peine	11.20	7.76	0.640	1.0	-52.2	3.32	0.002	0.01	0.03	0.010
4/7/2005	Prec.	15.91	7.76	0.061	9.8	68.9	1.04	0.004	0.40	1.84	0.016
4/14/2005	Fishback	15.04	8.42	0.646	10.6		53.62	0.049	2.39	60.09	0.004
4/14/2005	Rich Peine	16.85	7.84	0.662	1.6		2.67	0.140	0.14	1.08	0.006
4/14/2005	1	9.95	7.15	1.223	0.0		121.54	0.010	0.02	11.66	0.010
4/14/2005	1a				0.7		123.43	0.010	0.03	20.22	0.010
4/14/2005	1b				0.0		130.19	0.010	0.02	37.00	0.010
4/14/2005	1c				0.0		115.85	0.010	0.05	53.58	0.010
4/14/2005	2	9.92	7.23	1.100	2.1		136.64	0.020	0.05	57.86	0.010
4/14/2005	2a				2.4		140.37	0.010	0.11	127.19	0.010
4/14/2005	2b				0.9		116.50	0.010	0.04	33.65	0.010
4/14/2005	2c				0.2		127.96	0.010	0.03	32.26	0.010
4/14/2005	3	13.73	7.53	0.859	2.5		66.99	0.010	0.21	24.23	0.010
4/14/2005	3a				2.7		70.75	0.190	0.61	26.44	0.010
4/14/2005	3b				1.3		61.41	0.170	0.51	17.51	0.010
4/14/2005	3c				1.3		87.18	0.010	0.03	12.31	0.010
4/14/2005	4	13.45	7.12	1.136	2.3		162.96	0.010	0.01	34.45	0.002
4/14/2005	4a				3.6		160.27	0.010	0.08	33.79	0.010
4/14/2005	4b				1.5		167.22	0.010	0.04	41.73	0.010
4/14/2005	4c				1.0		144.29	0.010	0.01	33.50	0.002
4/14/2005	5	12.17	7.16	1.041	1.5		109.42	0.010	0.01	25.87	0.002
4/14/2005	5a				4.4		85.77	0.010	0.05	20.80	0.002
4/14/2005	5b				1.2		116.28	0.010	0.04	31.68	0.002
4/14/2005	5c				1.5		111.92	0.010	0.04	31.23	0.010
4/14/2005	6	11.56	7.03	0.701	1.3		152.88	0.010	0.01	36.89	0.010

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
3/29/2005	15	41.29	34.47	0.40	34.43	159.98	0.08	4.24
3/29/2005	Surf. Wtr	42.35	29.96	1.64	53.65	179.33	0.09	2.46
3/29/2005	Tom Peine	35.21	27.15	1.32	51.96	309.74	0.69	5.14
4/7/2005	Prec.	2.43	0.25	0.40	2.08	8.38	0.54	0.01
4/14/2005	Fishback	59.13	29.21	1.26	25.82	185.44	0.18	0.27
4/14/2005	Rich Peine	50.42	27.73	1.18	47.48	339.74	0.42	6.68
4/14/2005	1	51.04	33.37	1.51	81.01	259.33	0.07	5.84
4/14/2005	1a	83.06	35.88	1.41	58.56	289.03	0.12	2.67
4/14/2005	1b	67.23	38.99	1.43	64.33	247.89	0.11	3.66
4/14/2005	1c	76.51	40.77	1.58	65.51	284.08	0.23	3.76
4/14/2005	2	73.65	28.26	1.39	75.95	214.10	0.15	2.38
4/14/2005	2a	54.27	27.99	1.38	111.23	163.83	0.20	3.30
4/14/2005	2b	35.67	30.89	1.58	72.18	175.81	0.15	1.36
4/14/2005	2c	41.81	32.66	1.58	70.79	180.67	0.12	2.52
4/14/2005	3	81.33	31.18	1.42	41.41	303.41	0.07	2.99
4/14/2005	3a	68.95	31.26	1.44	43.21	268.61	0.15	4.05
4/14/2005	3b	50.24	29.95	1.36	40.71	233.56	0.11	2.67
4/14/2005	3c	39.40	41.28	1.44	49.95	242.94	0.32	3.49
4/14/2005	4	44.67	33.87	1.19	78.64	157.73	0.06	3.00
4/14/2005	4a	37.30	32.18	1.32	70.59	119.42	0.31	2.39
4/14/2005	4b	59.10	32.09	1.16	70.73	155.53	0.13	2.82
4/14/2005	4c	67.30	32.65	1.21	69.62	216.95	0.26	2.43
4/14/2005	5	57.24	30.71	1.20	70.94	243.87	0.09	2.15
4/14/2005	5a	44.13	37.69	1.19	69.17	274.64	0.19	2.00
4/14/2005	5b	45.76	33.31	1.24	65.96	199.36	0.13	2.35
4/14/2005	5c	46.69	33.29	1.27	63.29	202.44	0.16	2.55
4/14/2005	6	45.48	30.89	2.46	52.76	104.42	0.13	2.88

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
4/14/2005	6a						24.07	0.010	0.03	24.36	0.010
4/14/2005	6b				1.6		85.33	0.010	0.01	25.43	0.010
4/14/2005	6c				0.9		110.87	0.010	0.03	35.20	0.010
4/14/2005	7	10.83	7.19	0.800	2.8		69.32	0.010	0.03	30.75	0.010
4/14/2005	7b				1.8		46.98	0.010	0.08	41.82	0.010
4/14/2005	7c						46.82	0.010	0.06	26.76	0.010
4/14/2005	8	10.02	7.05	0.768	1.8		35.50	0.010	0.01	21.25	0.010
4/14/2005	8b				2.0		38.06	0.010	0.06		0.010
4/14/2005	8c						37.82	0.020	0.07	31.56	0.020
4/14/2005	9	9.96	6.96	0.910	2.0		39.86	0.020	0.04	18.75	0.002
4/14/2005	9b						32.81	0.010	0.11	0.48	0.002
4/14/2005	9c				1.2		32.04	0.020	0.05	16.89	0.002
4/14/2005	10	12.12	7.24	0.916	2.1		81.56	0.020	0.05	38.36	0.010
4/14/2005	10a				1.7		93.45	0.020	0.06	88.69	0.010
4/14/2005	10b				0.7		93.85	0.020	0.10	39.43	0.002
4/14/2005	10c				1.5		86.94	0.020	0.07	61.22	0.002
4/14/2005	11	12.11	7.12	0.872	2.7		100.82	0.020	0.06	39.39	0.010
4/14/2005	11b				1.8		102.73	0.020	0.10	31.45	0.002
4/14/2005	11c				1.6		112.40	0.020	0.05	33.29	0.010
4/14/2005	12	10.05	7.09	0.847	0.4		91.22	0.020	0.10	28.96	0.010
4/14/2005	12b				1.8		7.06	0.010	0.20	8.75	0.010
4/14/2005	12c						94.25	0.010	0.09	23.49	0.010
4/14/2005	13	9.50	7.06	0.769	2.7		46.00	0.039	0.14	39.82	0.009
4/14/2005	13c				2.3		48.85	0.035	0.16	36.54	0.003
4/14/2005	14	11.36	7.15	0.869	1.1		79.93	0.026	0.12	45.34	0.004
4/14/2005	14a						29.15	0.036	0.14	25.31	0.004
4/14/2005	14b				0.5		61.33	0.036	0.14	49.02	0.004
4/14/2005	14c				1.7		78.45	0.028	0.13	48.36	0.004
4/14/2005	15	12.70	7.10	0.919	2.0		91.85	0.026	0.31	49.14	0.003

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
4/14/2005	6a						0.09	3.34
4/14/2005	6b	39.50	27.45	2.14	43.52	162.10	0.08	2.42
4/14/2005	6c	39.30	28.51	2.14	49.37	132.46	0.21	3.64
4/14/2005	7	56.63	29.49	1.21	33.30	206.89	0.08	3.11
4/14/2005	7b	37.52	30.51	3.30	57.28	238.22	0.07	3.86
4/14/2005	7c	33.89	31.45	1.26	26.36	179.05	0.50	2.98
4/14/2005	8	41.98	34.91	1.92	20.96	224.35	0.09	3.16
4/14/2005	8b	40.24	32.41	1.31	227.08		0.29	4.17
4/14/2005	8c	85.07	30.98	1.54	41.89	346.70	0.28	2.71
4/14/2005	9	100.61	34.21	1.18	21.48	364.44	0.09	3.11
4/14/2005	9b	63.94	45.99	0.40	22.81	352.26	0.08	6.59
4/14/2005	9c	46.11	31.75	1.47	21.73	232.17	0.30	3.73
4/14/2005	10	48.32	32.29	1.28	47.94	204.40	0.07	2.55
4/14/2005	10a	45.11	30.23	1.52	49.60	122.59	0.33	2.40
4/14/2005	10b	56.94	33.01	1.24	47.09	208.51	0.18	2.80
4/14/2005	10c	65.41	28.62	1.29	52.21	209.85	0.13	2.26
4/14/2005	11	45.90	27.65	1.33	55.96	168.51	0.08	3.77
4/14/2005	11b	46.36	31.62	1.25	57.15	194.03	0.08	2.47
4/14/2005	11c	45.89	31.36	1.39	54.52	170.72	0.67	2.55
4/14/2005	12	27.15	16.23	1.20	27.05	35.96	0.08	2.52
4/14/2005	12b	59.26	19.87	0.40	6.88	225.97	0.14	2.89
4/14/2005	12c	35.85	30.25	1.24	35.93		0.15	3.12
4/14/2005	13	74.83	26.65	1.24	29.98	256.85	0.23	4.14
4/14/2005	13c	60.07	26.53	1.24	30.07	219.07	0.23	2.64
4/14/2005	14	77.64	29.19	1.44	48.38	261.01	0.19	3.17
4/14/2005	14a	36.00	13.28	0.40	11.07	101.47	0.23	3.02
4/14/2005	14b	40.20	24.44	1.54	40.55	153.44	0.29	3.67
4/14/2005	14c	38.99	28.80	1.45	50.77	167.05	0.17	3.77
4/14/2005	15	48.29	32.70	0.40	28.35	136.27	0.20	5.75

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
4/14/2005	Surf. Wtr	9.67	8.14	0.894	9.6		87.16	0.033	0.57	45.04	0.004
4/14/2005	Tom Peine	10.76	7.70	0.652	1.5		2.85	0.130	0.13	0.82	0.008
4/23/2005	Prec.						0.61	0.004	0.48	1.66	0.021
4/26/2005	Prec.						0.33	0.002	0.16	1.41	0.008
4/30/2005	Prec.	19.24	5.85	0.058	4.1		2.43	0.005	1.52	6.48	0.040
5/2/2005	Fishback	10.39	8.58	0.645	12.4		54.35	0.043	3.86	35.96	0.004
5/2/2005	Rich Peine	14.52	7.86	0.648	0.3		2.56	0.018	0.05	0.54	0.005
5/2/2005	1	10.94	7.23	1.128	0.8		105.21	0.031	0.14	42.69	0.004
5/2/2005	1a				4.1		107.50	0.029	0.15	30.10	0.004
5/2/2005	1b				4.8		106.60	0.011	0.14	49.93	0.004
5/2/2005	1c				2.3		114.09	0.039	0.12	51.43	0.004
5/2/2005	2	10.19	7.22	1.088	2.0		112.66	0.029	0.12	54.16	0.004
5/2/2005	2a				5.4		112.89	0.037	0.15	101.03	0.004
5/2/2005	2b				4.8		92.03	0.031	0.21	43.84	0.005
5/2/2005	2c				2.5		91.47	0.029	0.18	43.71	0.006
5/2/2005	3	11.11	7.52	0.857	1.6		74.92	0.027	0.23	43.79	0.005
5/2/2005	3a						53.96	0.044	0.70	34.11	0.005
5/2/2005	3b				1.1		65.28	0.144	0.42	38.93	0.007
5/2/2005	3c				0.7		70.65	0.034	0.17	23.51	0.007
5/2/2005	4	11.11	7.17	1.166	1.9		154.52	0.033	0.15	50.29	0.004
5/2/2005	4a				1.6		89.94	0.038	0.15	39.67	0.310
5/2/2005	4b				1.9		104.07	0.033	0.13	48.40	0.633
5/2/2005	4c				5.5		104.85	0.038	0.23	53.69	0.044
5/2/2005	5	10.34	7.19	1.081	1.3		99.25	0.028	0.13	41.67	0.004
5/2/2005	5a				3.6		97.66	0.040	0.19	13.85	0.005

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
4/14/2005	Surf. Wtr	31.11	28.55	1.55	54.37	145.09	0.18	3.24
4/14/2005	Tom Peine	30.60	25.89	1.27	51.60	291.77	0.36	7.26
4/23/2005	Prec.	1.67	0.25	0.40	1.81		0.46	0.01
4/26/2005	Prec.	1.80	0.25	0.40	1.70	7.64	0.21	0.01
4/30/2005	Prec.	3.96	0.25	1.32	1.67	4.74	1.39	0.01
5/2/2005	Fishback	35.15	25.28	1.37	20.83	121.58	0.08	0.76
5/2/2005	Rich Peine	43.46	26.15	1.20	45.20	311.84	0.50	4.20
5/2/2005	1	38.13	34.87	1.44	67.53	194.46	0.20	5.89
5/2/2005	1a	72.59	37.95	1.33	60.37	287.33	0.25	5.91
5/2/2005	1b	83.31	37.89	1.40	66.68	308.31	0.19	6.37
5/2/2005	1c	67.64	35.68	1.42	61.93	237.62	0.22	6.06
5/2/2005	2	68.94	37.39	1.38	89.08	306.14	0.13	3.31
5/2/2005	2a	60.97	24.31	1.48	105.77	219.67	0.24	4.09
5/2/2005	2b	44.63	24.97	1.46	58.36	167.34	0.24	2.63
5/2/2005	2c	38.34	23.45	1.43	50.67	129.54	0.48	2.82
5/2/2005	3	54.20	30.67	1.34	36.54	191.25	0.22	4.27
5/2/2005	3a	45.16	23.20	1.45	31.21	165.70	0.17	4.41
5/2/2005	3b	44.99	27.86	1.43	35.95	173.92	0.25	4.57
5/2/2005	3c	45.53	33.75	1.61	41.46	220.53	0.71	5.82
5/2/2005	4	46.34	34.95	3.77	79.46	166.69	0.16	4.16
5/2/2005	4a	62.77	30.45	2.06	64.78	256.79	2.41	3.85
5/2/2005	4b	78.78	31.22	1.51	66.84	274.20	0.91	4.23
5/2/2005	4c	65.96	25.83	1.35	53.36	184.65	1.23	4.09
5/2/2005	5	45.47	40.43	1.24	81.46	275.20	0.20	3.85
5/2/2005	5a	56.01	36.44	1.21	62.47	274.94	0.33	5.11

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
5/2/2005	5b				1.5		107.00	0.023	0.14	60.02	0.004
5/2/2005	5c				0.9		93.44	0.028	0.17	43.35	0.004
5/2/2005	6	11.07	7.05	0.799	1.2		83.85	0.028	0.13	39.91	0.005
5/2/2005	6a				1.0		29.18	0.038	0.14	67.95	0.019
5/2/2005	6b				0.9		91.18	0.032	0.14	39.95	0.073
5/2/2005	6c				3.1		90.22	0.038	0.17	42.57	0.005
5/2/2005	7	11.11	7.21	0.810	2.7		57.54	0.027	0.14	42.43	0.004
5/2/2005	7b				3.9		32.66	0.035	0.17	49.15	0.003
5/2/2005	7c				1.3		48.04	0.045	0.15	36.96	0.045
5/2/2005	8	10.35	7.09	0.772	1.6		41.48	0.024	0.13	38.93	0.005
5/2/2005	8b						7.06	0.041	0.16	985.29	0.223
5/2/2005	8c				1.2		32.79	0.042	0.16	53.12	0.004
5/2/2005	9	9.82	7.02	0.984	1.6		28.66	0.028	0.16	35.69	0.042
5/2/2005	9b						23.05	0.035	0.13	12.95	0.005
5/2/2005	9c				0.7		33.87	0.026	0.13	28.82	0.004
5/2/2005	10	11.33	8.00	1.002	5.5		91.87	0.029	0.15	36.86	0.004
5/2/2005	10a				4.1		77.32	0.043	0.24	42.92	0.014
5/2/2005	10b				0.9		87.47	0.023	0.14	37.36	0.004
5/2/2005	10c				1.5		71.28	0.032	0.25	51.25	0.004
5/2/2005	11	11.06	7.16	0.898	1.7		87.27	0.032	0.18	37.12	0.005
5/2/2005	11a				3.9		82.56	0.038	0.14	27.21	0.022
5/2/2005	11b				0.9		95.55	0.052	0.16	40.89	0.035
5/2/2005	11c				0.8		93.57	0.053	0.01	35.82	0.006
5/2/2005	12	10.14	7.15	0.775	1.6						
5/2/2005	12b						6.46	0.029	0.22	6.94	0.008
5/2/2005	12c				1.2		74.05	0.027	0.19	30.56	0.005
5/2/2005	13	9.29	7.12	0.792	1.2		42.93	0.021	0.13	33.92	0.008
5/2/2005	13c				1.3		46.82	0.120	0.12	20.34	0.004
5/2/2005	14	10.52	7.19	0.872	1.4		87.07	0.170	0.05	34.95	0.003

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
5/2/2005	5b	50.20	30.88	1.22	59.05	168.84	0.12	4.50
5/2/2005	5c	49.39	27.36	1.21	55.49	181.05	0.16	3.38
5/2/2005	6	53.48	30.52	1.44	43.78	196.26	0.06	4.05
5/2/2005	6a	54.26	29.32	1.24	36.39	224.81	0.71	4.86
5/2/2005	6b	58.00	25.60	1.98	40.50	170.31	0.34	4.06
5/2/2005	6c	63.28	26.70	1.98	48.10	203.29	0.23	3.02
5/2/2005	7	69.15	29.38	0.40	30.52	234.99	0.05	3.58
5/2/2005	7b	35.52	26.93	1.15	59.40	232.85	0.07	3.92
5/2/2005	7c	63.62	29.10	1.47	26.34	231.30	1.53	4.32
5/2/2005	8	55.97	32.91	0.40	22.97	226.50	0.06	3.74
5/2/2005	8b	37.10	34.23	1.27	232.37	-296.05	0.43	4.72
5/2/2005	8c	51.10	32.17	1.12	40.61	248.07	0.58	4.41
5/2/2005	9	108.40	43.41	0.40	19.45	414.37	0.06	4.66
5/2/2005	9b	72.20	36.43	1.27	22.35	334.38	0.03	7.47
5/2/2005	9c	56.12	34.14	1.25	22.29	252.83	0.50	4.61
5/2/2005	10	49.34	36.48	1.18	59.62	236.42	0.04	2.28
5/2/2005	10a	38.37	27.15	1.21	44.22	151.27	0.68	2.70
5/2/2005	10b	48.65	29.32	0.40	42.96	173.64	0.32	4.78
5/2/2005	10c	36.05	26.27	1.24	43.77	140.77	0.29	3.96
5/2/2005	11	40.04	32.83	0.40	50.52	183.56	0.03	4.12
5/2/2005	11a	55.08	31.13	1.40	37.42	203.86	2.81	4.45
5/2/2005	11b	59.95	26.48	1.26	48.33	187.82	0.79	3.70
5/2/2005	11c	50.51	30.75	1.33	54.15	202.79	1.65	3..7
5/2/2005	12							
5/2/2005	12b	31.57	17.09	1.18	8.49	152.60	0.41	2.28
5/2/2005	12c	38.42	26.36	1.19	35.01	145.63	0.21	3.89
5/2/2005	13	75.63	27.82	1.27	28.11	270.11	0.03	5.15
5/2/2005	13c	44.65	23.95	1.25	25.05	178.69	0.10	1.94
5/2/2005	14	45.19	28.42	1.41	46.09	172.40	0.07	2.51

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (℃)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
5/2/2005	14a				3.4		17.22	0.026	0.06	11.84	0.004
5/2/2005	14b				1.0		60.39	0.032	0.08	25.02	0.003
5/2/2005	14c				0.8		76.81	0.017	0.06	29.51	0.003
5/2/2005	15	10.20	7.24	0.867	2.4		78.75	0.018	0.56	28.42	0.004
5/2/2005	Surf. Wtr	12.34	7.24	0.990	-1.6		118.36	0.021	0.06	23.02	0.006
5/2/2005	Tom Peine	11.80	7.83	0.645	0.5		2.98	0.017	0.06	1.05	0.009
5/17/2005	Fishback	16.34	8.32	0.651	10.4		55.94	0.029	4.04	35.61	0.005
5/17/2005	Rich Peine	14.89	7.72	0.636	0.4						
5/17/2005	1	12.18	7.00	1.170	1.9		110.10	0.017	0.06	7.10	0.004
5/17/2005	1a				2.3		117.53	0.076	0.12	12.36	0.005
5/17/2005	1b				1.7		124.09	0.027	0.06	34.34	0.009
5/17/2005	1c				1.2		108.38	0.019	0.06	34.33	0.003
5/17/2005	2	13.21	7.07	1.062	2.4		126.59	0.012	0.06	42.35	0.010
5/17/2005	2a				3.2		117.70	0.006	0.05	61.98	0.004
5/17/2005	2b				1.4		104.35	0.007	0.06	28.23	0.004
5/17/2005	2c				4.5		112.92	0.006	0.06	31.20	0.003
5/17/2005	3	14.09	7.37	0.862	1.8		77.34	0.006	0.06	27.74	0.005
5/17/2005	3a				1.7		71.99	0.007	0.10	22.89	0.004
5/17/2005	3b				2.2		70.34	0.007	0.09	23.95	0.007
5/17/2005	3c				0.8		86.47	0.006	0.06	10.98	0.005
5/17/2005	4	13.36	6.97	1.228	1.9		142.47	0.005	0.06	22.88	0.004
5/17/2005	4a				1.3		137.45	0.008	0.08	5.59	0.005
5/17/2005	4b				1.6		139.34	0.007	0.07	26.05	0.302
5/17/2005	4c				1.1		134.99	0.005	0.05	29.71	0.005
5/17/2005	5	13.44	7.06	1.058	1.0		105.50	0.020	0.05	27.27	0.004
5/17/2005	5a				0.8		95.02	0.029	0.06	0.36	0.029
5/17/2005	5b				1.1		98.87	0.007	0.06	24.29	0.005
5/17/2005	5c				1.4		107.45	0.007	0.06	34.47	0.004

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
5/2/2005	14a	52.95	24.35	1.16	10.42	219.89	0.14	2.94
5/2/2005	14b	36.78	18.52	1.33	33.15	130.51	0.28	2.54
5/2/2005	14c	31.17	23.80	1.44	40.94	127.55	0.09	2.12
5/2/2005	15	48.66	26.84	0.40	25.90	147.62	0.07	3.76
5/2/2005	Surf. Wtr	44.96	26.46	1.49	46.80	133.81	0.10	2.91
5/2/2005	Tom Peine	35.43	18.31	1.20	35.77	237.85	0.41	6.11
5/17/2005	Fishback	65.32	26.80	1.35	22.19	204.09	0.11	1.01
5/17/2005	Rich Peine							
5/17/2005	1	75.33	39.32	1.64	80.09	363.52	0.06	5.48
5/17/2005	1a	54.74	36.40	1.55	59.94	240.05	0.10	5.69
5/17/2005	1b	42.42	22.60	1.38	41.01	78.96	0.15	5.66
5/17/2005	1c	66.92	24.98	1.36	45.24	181.34	0.18	5.68
5/17/2005	2						0.15	3.30
5/17/2005	2a	55.10	21.12	1.30	95.70	203.72	0.12	3.65
5/17/2005	2b	61.01	23.05	1.33	70.47	225.56	0.82	3.47
5/17/2005	2c	48.23	27.42	1.51	59.48	172.75	0.19	3.54
5/17/2005	3	53.20	33.76	1.38	38.96	220.27	0.07	4.05
5/17/2005	3a	65.01	24.61	1.35	31.08	207.49	0.09	4.48
5/17/2005	3b	69.53	22.16	1.31	28.23	203.65	0.17	4.48
5/17/2005	3c	100.17	32.81	1.38	42.46	345.80	0.46	6.29
5/17/2005	4	52.53	33.08	0.40	81.98	221.31	0.09	4.87
5/17/2005	4a	34.74	40.98	1.55	82.13	236.26	2.84	4.90
5/17/2005	4b	52.80	25.07	1.37	56.80	136.09	1.79	4.74
5/17/2005	4c	60.77	23.55	1.19	54.54	147.36	0.57	5.04
5/17/2005	5	58.95	19.33	0.40	43.14	143.80	0.12	3.51
5/17/2005	5a	51.65	47.04	1.73	79.15	362.50	5.54	5.69
5/17/2005	5b	34.45	33.36	1.51	66.94	206.06	1.16	4.19
5/17/2005	5c	67.01	26.48	1.24	53.45	206.60	0.28	4.57

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
5/17/2005	6	11.75	7.04	1.071	1.9		113.24	0.007	0.60	30.57	0.006
5/17/2005	6a						93.78	0.009	0.06	24.52	0.009
5/17/2005	6b				1.1		119.27	0.005	0.05	27.60	0.097
5/17/2005	6c				1.8		121.32	0.005	0.06	30.27	0.104
5/17/2005	7	14.09	7.02	0.839	3.8		64.92	0.005	0.06	28.55	0.007
5/17/2005	7c				1.8		55.01	0.009	0.07	12.10	0.181
5/17/2005	8	13.78	6.93	0.755	1.3		37.71	0.002	0.06	22.88	0.010
5/17/2005	8c				2.9		35.46	0.008	0.06	40.53	0.011
5/17/2005	9	12.44	6.83		1.4		37.80	0.004	0.06	17.11	0.006
5/17/2005	9c				2.1		35.85	0.007	0.07	9.88	0.390
5/17/2005	10	14.62	7.16	0.865	1.1		77.89	0.004	0.06	32.79	0.006
5/17/2005	10a				1.2		94.89	0.019	0.08	20.70	0.005
5/17/2005	10b				1.1		81.17	0.007	0.06	21.33	0.004
5/17/2005	10c				1.4		77.91	0.002	0.05	33.17	0.068
5/17/2005	11	14.49	7.05	0.938	1.0		105.98	0.002	0.05	30.71	0.006
5/17/2005	11a						75.58	0.004	0.06	21.55	0.005
5/17/2005	11b				1.0		102.77	0.003	0.05	29.93	0.011
5/17/2005	11c				0.9		109.36	0.002	0.06	25.23	0.004
5/17/2005	12	12.36	6.99	0.896	1.1		81.36	0.018	0.07	23.39	0.008
5/17/2005	12b						24.75	0.007	0.06	7.80	0.096
5/17/2005	12c						86.91	0.005	0.06	20.97	0.011
5/17/2005	13	11.35	6.89	0.775	1.0		57.03	0.005	0.05	18.12	0.005
5/17/2005	13c				1.3		61.97	0.008	0.12	22.86	0.004
5/17/2005	14	11.58	6.97	0.866	1.3		83.28	0.002	0.06	33.42	0.005
5/17/2005	14b				0.7		69.62	0.008	0.08	23.59	0.005
5/17/2005	14c				0.8		80.91	0.004	0.06	31.86	0.005
5/17/2005	15	12.46	7.01	0.909	2.0		85.68	0.002	0.32	34.40	0.004
5/17/2005	Surf. Wtr	14.14	7.65	0.860	6.9		77.78	0.004	0.28	30.09	0.013
5/17/2005	Tom Peine	13.06	7.60	0.635	0.8		3.17	0.002	0.06	0.65	0.012

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
5/17/2005	6	64.10	32.21	1.78	51.42	214.65	0.13	3.94
5/17/2005	6a						1.38	4.54
5/17/2005	6b	77.10	24.98	2.07	42.71	193.64	0.77	3.45
5/17/2005	6c	91.32	31.23	2.21	56.81	280.06	0.20	3.84
5/17/2005	7	73.70	35.34	1.21	41.78	300.59	0.11	3.84
5/17/2005	7c	89.49	29.67	1.43	27.34	316.33	0.78	4.64
5/17/2005	8	53.60	27.75	0.40	20.63	216.34	0.10	3.50
5/17/2005	8c	81.30	26.67	1.18	37.37	303.29	0.58	4.62
5/17/2005	9	95.45	33.84	0.40	21.86	354.48	0.10	4.08
5/17/2005	9c	64.77	27.05	1.25	18.10	252.50	0.65	5.64
5/17/2005	10	57.94	26.73	1.22	37.96	194.72	0.08	3.94
5/17/2005	10a	68.63	33.06	1.24	52.02	266.69	1.01	3.83
5/17/2005	10b	62.24	31.86	1.27	46.40	252.35	0.32	4.06
5/17/2005	10c	46.00	28.09	1.50	46.83	189.69	0.75	4.23
5/17/2005	11	53.42	27.08	1.31	51.46	176.89	0.11	3.87
5/17/2005	11a	52.68	24.69	1.29	43.65	200.65	0.92	3.77
5/17/2005	11b	76.51	22.24	1.29	41.22	197.67	0.68	4.00
5/17/2005	11c	59.58	29.43	1.37	53.78	208.04	0.54	4.46
5/17/2005	12	81.81	29.56	1.29	49.92	296.99	0.11	3.96
5/17/2005	12b	74.82	24.67	1.64	26.64	305.21	0.87	5.29
5/17/2005	12c	39.63	19.63	1.20	26.18	93.66	0.44	4.65
5/17/2005	13	82.74	27.42	1.24	28.38	283.39	0.08	4.40
5/17/2005	13c	51.89	25.62	1.33	28.41	187.17	0.13	3.61
5/17/2005	14	77.46	29.99	1.55	50.52	276.36	0.06	3.81
5/17/2005	14b	77.62	22.94	1.39	41.54	257.52	0.45	4.48
5/17/2005	14c	53.08	18.23	1.29	30.73	128.67	0.14	3.87
5/17/2005	15	43.91	28.65	0.40	26.00	127.63	0.10	4.96
5/17/2005	Surf. Wtr	66.36	24.11	1.47	42.52	218.00	0.09	3.80
5/17/2005	Tom Peine	46.96	27.11	1.36	51.93	338.42	0.67	6.35

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
6/2/2005	Fishback	17.95	8.14	0.675	8.8		57.89	0.029	1.34	34.44	0.002
6/2/2005	Rich Peine	14.69	7.69	0.633	0.1		3.20	0.004	0.07	0.03	0.009
6/2/2005	1	13.70	7.02	1.127	1.1		108.62	0.002	0.06	18.03	0.004
6/2/2005	1a				3.1		108.89	0.018	0.08	8.25	0.007
6/2/2005	1b				1.4		111.73	0.008	0.07	25.33	0.009
6/2/2005	1c				1.2		118.53	0.002	0.06	22.77	0.043
6/2/2005	2	14.50	7.10	1.049	0.9		107.84	0.002	0.06	34.47	0.005
6/2/2005	2b				2.8		105.57	0.002	0.05	15.90	0.004
6/2/2005	2c				0.8		114.68	0.002	0.07	25.09	0.002
6/2/2005	3	14.86	7.17	0.892	0.8		90.64	0.008	0.09	37.94	0.002
6/2/2005	3a				1.7		95.72	0.006	0.08	30.72	0.002
6/2/2005	3b				2.1		86.65	0.006	0.25	20.65	0.002
6/2/2005	3c				0.2		74.10	0.007	0.07	4.32	0.007
6/2/2005	4	14.37	6.88	1.224	0.3		139.81	0.005	0.07	17.16	0.002
6/2/2005	4b				0.8		137.15	0.005	0.07	18.89	0.002
6/2/2005	4c				0.0		128.94	0.002	0.07	13.69	0.002
6/2/2005	5	14.13	7.03	1.030	0.4		93.28	0.002	0.08	20.28	0.010
6/2/2005	5b				0.5		96.23	0.004	0.06	14.40	0.002
6/2/2005	5c				0.7		107.30	0.002	0.06	24.39	0.005
6/2/2005	6	13.28	7.04	1.119	0.3		141.55	0.004	0.07	25.45	0.002
6/2/2005	6b						110.99	0.005	0.07	16.98	0.003
6/2/2005	6c				1.0		89.18	0.004	0.07	14.67	0.002
6/2/2005	7	14.11	7.10	0.881	1.3		53.36	0.004	0.06	21.12	0.002
6/2/2005	7c						58.34	0.005	0.07	4.30	0.002
6/2/2005	8	13.88	6.99	0.797	2.0		42.62	0.004	0.06	19.93	0.002
6/2/2005	8c				0.8		43.21	0.011	0.07	16.73	0.002
6/2/2005	9	12.55	6.87	0.896	0.9		25.28	0.003	0.07	9.41	0.002
6/2/2005	9c				0.2		29.80	0.006	0.08	7.58	0.002
6/2/2005	10	14.62	7.09	0.892	1.0		67.19	0.005	0.07	23.87	0.002

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO$_2$ (mg/L)
6/2/2005	Fishback	68.35	29.18	1.35	21.79	221.25	0.11	1.53
6/2/2005	Rich Peine	50.71	27.54	1.34	53.03	352.53	0.37	5.13
6/2/2005	1	108.15	36.92	1.76	71.92	408.67	0.60	5.41
6/2/2005	1a	73.72	23.28	1.28	39.53	205.22	0.13	6.01
6/2/2005	1b	51.93	32.47	1.56	58.92	209.39	0.38	5.10
6/2/2005	1c	55.86	36.74	2.51	64.69	243.60	0.27	5.89
6/2/2005	2	77.87	20.21	1.33	47.93	195.45	0.33	4.10
6/2/2005	2b	72.59	29.44	1.67	65.80	282.19	0.98	15.90
6/2/2005	2c	69.54	27.29	1.48	58.25	226.57	0.18	3.38
6/2/2005	3	93.32	29.59	1.58	36.62	269.00	0.09	4.43
6/2/2005	3a	52.72	31.69	1.40	48.19	201.62	0.09	4.94
6/2/2005	3b	62.66	31.29	1.42	37.36	224.36	0.15	4.39
6/2/2005	3c	96.01	32.50	1.45	42.33	358.34	0.50	6.40
6/2/2005	4	84.14	31.27	1.99	74.51	288.24	0.15	3.24
6/2/2005	4b	98.19	35.88	1.46	78.15	351.55	0.45	5.16
6/2/2005	4c	60.62	36.15	1.35	77.63	274.56	1.01	4.32
6/2/2005	5	80.20	30.82	1.54	78.21	346.46	0.16	1.88
6/2/2005	5b	68.53	30.04	1.41	62.72	282.25	0.46	3.75
6/2/2005	5c	61.03	32.55	1.32	65.21	253.09	0.62	3.41
6/2/2005	6	86.35	28.15	2.20	52.46	222.10	0.15	2.88
6/2/2005	6b	61.32	33.54	2.54	58.10	246.49	0.52	2.57
6/2/2005	6c	90.92	35.22	2.41	64.03	373.24	0.24	2.87
6/2/2005	7	101.31	34.39	1.78	39.56	385.57	0.13	2.91
6/2/2005	7c						0.33	4.25
6/2/2005	8	98.00	35.49	0.40	26.22	367.43	0.11	3.44
6/2/2005	8c	76.11	35.98	1.20	35.57	338.63	0.24	4.47
6/2/2005	9	90.78	37.84	1.38	22.32	387.26	0.08	3.73
6/2/2005	9c	81.62	34.55	1.26	21.90	345.27	0.34	4.91
6/2/2005	10	99.02	33.93	1.26	46.61	370.23	0.10	3.38

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
6/2/2005	10b				1.5		71.60	0.045	0.09	13.54	0.002
6/2/2005	10c				1.8		61.80	0.016	0.09	11.79	0.011
6/2/2005	11	14.46	7.05	1.007	0.8		103.45	0.005	0.07	22.12	0.002
6/2/2005	11b				1.2		102.03	0.006	0.08	22.13	0.002
6/2/2005	11c				0.7		88.94	0.006	0.08	18.16	0.002
6/2/2005	12	13.79	7.04	0.929	0.3		107.07	0.009	0.08	24.92	0.002
6/2/2005	12c						91.79	0.009	0.08	17.00	0.008
6/2/2005	13	12.59	6.80	0.825	2.7		71.99	0.005	0.07	19.78	0.002
6/2/2005	13c				2.9		82.66	0.007	0.07	21.75	0.004
6/2/2005	14	13.39	6.98	0.916	0.4		85.20	0.004	0.07	20.14	0.002
6/2/2005	14b						80.97	0.007	0.08	15.44	0.002
6/2/2005	14c				0.4		92.46	0.005	0.07	24.37	0.002
6/2/2005	15	13.83	7.02	0.943	2.0		91.63	0.005	0.24	30.02	0.002
6/2/2005	Tom Peine	14.16	7.68	0.641	1.2		2.82	0.005	0.07	0.03	0.003
6/20/2005	Fishback	19.95	8.22	0.640	8.6	14.2	44.76	0.013	4.93	31.58	0.017
6/20/2005	Rich Peine	21.02	7.62	0.645	0.9	-130.0	3.05	0.006	0.06	0.58	0.007
6/20/2005	1	16.73	6.94	1.087	0.4	-130.5	112.03	0.002	0.05	23.42	0.002
6/20/2005	1b				1.3		108.29	0.021	0.08	21.89	0.012
6/20/2005	1c				1.1		126.63	0.004	0.05	25.09	0.133
6/20/2005	2	17.93	6.91	1.102	0.4	-87.4	119.06	0.002	0.06	34.22	0.002
6/20/2005	2b				2.5		97.76	0.005	0.08	22.43	0.002
6/20/2005	2c				2.4		99.55	0.004	0.07	23.92	0.002
6/20/2005	3	16.10	7.09	0.953	1.0	-119.0	92.99	0.007	0.05	34.21	0.009
6/20/2005	3b				3.5		95.68	0.005	0.06	22.04	0.358
6/20/2005	3c				1.1		77.21	0.007	0.15	6.20	0.005
6/20/2005	4	16.23	6.80	1.175	1.7	-54.0	138.79	0.006	0.06	27.43	0.002
6/20/2005	4b				1.8		127.36	0.014	0.07	24.03	0.001
6/20/2005	4c				1.5		124.98	0.002	0.04	16.19	0.002

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
6/2/2005	10b	76.91	31.67	1.25	46.66	310.27	0.21	4.02
6/2/2005	10c	72.93	30.39	1.56	47.96	313.95	0.45	3.84
6/2/2005	11	93.94	34.30	1.43	71.75	364.65	0.11	2.75
6/2/2005	11b	51.60	31.00	1.34	55.60	212.05	0.51	3.14
6/2/2005	11c	47.37	29.69	1.43	54.33	216.07	0.56	3.03
6/2/2005	12	54.92	32.58	1.39	62.61	232.16	0.21	3.30
6/2/2005	12c	64.79	29.25	1.48	43.12	230.59	1.09	3.45
6/2/2005	13	84.92	30.48	1.27	34.37	291.66	0.17	3.08
6/2/2005	13c	76.29	30.39	1.33	35.05	254.21	0.19	2.66
6/2/2005	14	65.41	29.76	1.64	53.72	263.57	0.11	2.86
6/2/2005	14b						0.25	3.04
6/2/2005	14c	50.48	27.29	1.56	46.59	185.85	0.23	2.87
6/2/2005	15	75.17	35.83	0.40	32.76	246.17	0.11	3.67
6/2/2005	Tom Peine	49.26	27.99	1.27	48.32	340.96	1.19	6.61
6/20/2005	Fishback	74.47	27.79	1.40	16.63	238.25	0.09	3.03
6/20/2005	Rich Peine	54.07	29.47	1.23	50.94	363.81	0.26	4.74
6/20/2005	1	54.37	32.21	1.79	63.56	226.44	0.26	5.08
6/20/2005	1b	54.15	29.25	2.28	58.38	209.85	0.16	5.48
6/20/2005	1c	38.03	28.62	1.47	56.98	133.56	0.17	4.64
6/20/2005	2	54.69	30.47	1.47	67.76	207.61	0.14	2.79
6/20/2005	2b	36.73	30.52	1.97	52.98	173.79	0.14	3.03
6/20/2005	2c	45.71	30.50	1.72	60.37	207.79	0.08	3.77
6/20/2005	3	52.98	31.10	1.59	37.23	176.43	0.18	4.81
6/20/2005	3b	65.66	32.57	2.11	37.75	224.27	0.74	4.85
6/20/2005	3c	44.59	31.53	1.36	42.22	219.20	0.34	4.36
6/20/2005	4	66.54	35.33	7.47	79.83	270.36	0.09	3.35
6/20/2005	4b	58.07	32.85	1.65	71.16	232.35	0.34	5.06
6/20/2005	4c	36.33	33.81	1.28	70.54	191.78	0.24	3.67

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
6/20/2005	5	17.76	7.01	0.947	0.6	-130.2	90.37	0.005	0.05	31.06	0.002
6/20/2005	5b				1.2		85.42	0.008	0.05	14.52	0.002
6/20/2005	5c				1.6		96.85	0.005	0.05	17.19	0.008
6/20/2005	6	15.95	6.96	1.136	1.7	-92.3	143.23	0.006	0.05	25.53	0.002
6/20/2005	6b						138.24	0.009	0.09	33.47	0.008
6/20/2005	6c				0.9		130.23	0.017	0.08	24.48	0.002
6/20/2005	7	17.33	6.95	0.903	2.6	11.7	69.39	0.005	0.06	33.93	0.002
6/20/2005	7c				1.4		79.49	0.008	0.07	21.05	0.002
6/20/2005	8	16.83	6.80	0.688	1.6	-10.0	45.98	0.004	0.05	19.08	0.002
6/20/2005	8c				1.1		46.77	0.031	0.18	15.39	0.001
6/20/2005	9	16.18	6.76	0.920	1.0	0.0	40.25	0.004	0.04	14.78	0.002
6/20/2005	9c				1.2		37.22	0.029	0.13	11.93	0.002
6/20/2005	10	17.80	6.93	0.891	1.6	-40.3	80.24	0.264	0.58	28.97	0.002
6/20/2005	10b				0.8		82.31	0.084	0.12	18.52	0.234
6/20/2005	10c				0.5		99.20	0.006	0.05	26.33	0.015
6/20/2005	11	16.95	6.87	0.951	0.9	31.4	98.72	0.005	0.05	26.33	0.002
6/20/2005	11b				1.2		75.35	0.022	0.08	19.49	0.002
6/20/2005	11c				1.0		96.67	0.005	0.06	21.76	0.002
6/20/2005	12	16.27	6.90	0.928	0.9	14.0	100.73	0.004	0.04	23.48	0.002
6/20/2005	12c				0.8		94.99	0.007	0.04	22.38	0.015
6/20/2005	13	14.53	6.79	0.909	1.5	-7.7	93.30	0.006	0.05	23.64	0.002
6/20/2005	13c				2.1		79.71	0.007	0.05	20.06	0.002
6/20/2005	14	15.89	6.95	0.959	1.6	-1.9	98.29	0.005	0.05	24.15	0.002
6/20/2005	14b				3.9		81.36	0.006	0.05	25.65	0.002
6/20/2005	14c				1.0		85.54	0.006	0.05	20.97	0.002
6/20/2005	15	16.26	6.93	0.974	2.0	57.6	126.37	0.005	0.20	31.03	0.002
6/20/2005	Tom Peine	17.85	7.59	0.646	1.3	-105.5	3.28	0.010	0.05	0.56	0.004
7/11/2005	Fishback	22.63	7.80	0.618	3.3	21.5	61.54	0.010	0.09	31.40	0.011

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
6/20/2005	5	51.06	27.20	1.26	61.14	214.16	0.16	3.23
6/20/2005	5b						2.09	3.72
6/20/2005	5c	45.08	32.34	1.40	67.57	239.89	0.23	2.44
6/20/2005	6	49.45	33.09	2.57	69.15	184.69	0.14	2.55
6/20/2005	6b	54.56	23.52	2.00	46.41	106.56	0.30	4.28
6/20/2005	6c	43.45	29.54	2.19	57.58	148.79	0.21	2.93
6/20/2005	7	51.21	32.61	1.18	37.58	212.10	0.12	4.05
6/20/2005	7c	78.50	35.36	1.31	35.87	287.13	0.21	4.41
6/20/2005	8	81.19	28.32	0.40	22.05	282.98	0.16	4.03
6/20/2005	8c	68.62	32.51	1.17	31.18	292.29	0.15	4.97
6/20/2005	9	67.03	36.02	0.40	22.80	293.55	0.10	4.88
6/20/2005	9c	56.52	30.76	1.25	20.19	248.22	0.17	5.01
6/20/2005	10	52.21	32.74	1.25	45.08	220.68	0.09	3.77
6/20/2005	10b	54.37	30.16	1.27	44.66	222.73	0.16	4.69
6/20/2005	10c	55.19	32.11	1.80	48.65	210.65	0.22	3.60
6/20/2005	11	67.29	25.86	1.27	48.57	215.00	0.23	3.61
6/20/2005	11b	70.34	22.58	1.23	43.07	237.15	0.14	2.60
6/20/2005	11c	67.19	31.58	1.40	59.57	270.07	0.30	3.26
6/20/2005	12	62.88	27.83	1.24	49.57	214.39	0.15	4.07
6/20/2005	12c	29.83	27.37	2.02	43.33	126.58	0.30	3.22
6/20/2005	13	56.76	31.55	1.22	37.85	199.18	0.14	3.34
6/20/2005	13c	48.41	32.89	1.28	37.29	205.62	0.15	2.57
6/20/2005	14	40.39	31.49	1.72	55.83	190.28	0.16	3.86
6/20/2005	14b	58.85	29.12	1.56	47.70	231.04	0.19	4.41
6/20/2005	14c	72.52	26.07	1.57	47.02	250.13	0.15	2.20
6/20/2005	15	64.18	36.85	4.45	34.91	182.80	0.13	5.18
6/20/2005	Tom Peine	54.48	28.46	1.24	53.68	366.36	0.73	6.00
7/11/2005	Fishback	65.31	27.16	1.71	25.50	212.92	0.09	1.74

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
7/11/2005	Prec.	24.07	7.75	0.015		145.5	1.19	0.009	0.15	2.32	0.003
7/11/2005	Rich Peine	21.65	7.53	0.646	0.9	-129.8	3.16	0.007	0.04	0.57	0.043
7/11/2005	1	17.83	6.89	1.113	2.4	-132.8	112.81	0.006	0.04	12.65	0.003
7/11/2005	1c				1.2		129.36	0.007	0.04	13.57	0.002
7/11/2005	2	19.85	7.01	0.577		-128.8	106.43	0.006	0.05	29.80	0.002
7/11/2005	2c				1.2		107.26	0.006	0.05	21.67	0.002
7/11/2005	3	18.01	6.93	0.949	1.8	-69.3	92.74	0.011	0.07	25.88	0.002
7/11/2005	3c						85.44	0.100	0.71	13.24	0.004
7/11/2005	4	17.51	6.73	1.179	1.3	-67.9	144.11	0.008	0.05	16.14	0.014
7/11/2005	4c				0.8		138.22	0.019	0.08	25.49	0.002
7/11/2005	5	18.86	6.91	1.010	0.3	-103.9	104.51	0.007	0.05	23.75	0.002
7/11/2005	5c				2.6		103.87	0.097	0.15	21.17	0.003
7/11/2005	6	17.80	6.93	1.152	0.7	-97.9	163.73	0.008	0.03	31.90	0.004
7/11/2005	6c				2.6		140.18	0.007	0.04	23.55	0.324
7/11/2005	10	19.06	6.97	0.978	1.7	-89.8	143.88	0.006	0.04	24.49	0.001
7/11/2005	11	18.58	6.95	0.918	0.9	-54.3	110.39	0.010	0.04	27.84	0.007
7/11/2005	11c						97.30	0.007	0.05	18.45	0.002
7/11/2005	12				2.5		95.83	0.010	0.05	25.47	0.002
7/11/2005	14	17.18	6.85	1.062	1.3	-9.5	110.66	0.006	0.04	26.27	0.162
7/11/2005	14c				1.6		107.02	0.009	0.05	25.39	0.060
7/11/2005	15	19.71	6.93	1.032	1.0	49.0	126.05	0.011	0.16	31.18	0.005
7/11/2005	Tom Peine	19.18	7.53	0.642	1.4	-104.8	3.01	0.008	0.05	0.60	0.012
7/22/2005	Fishback	23.11	7.93	0.458	6.7		36.84	0.006	0.54	21.80	0.085
7/22/2005	1				0.4		106.03	0.002	0.04	33.13	0.002
7/22/2005	1b				2.3		108.99	0.012	0.05	43.76	0.008
7/22/2005	1c				0.9		111.16	0.010	0.04	24.95	0.002
7/22/2005	2	19.74	7.00	1.070	2.1		103.27	0.002	0.04	25.53	0.002
7/22/2005	2c				0.9		99.87	0.002	0.04	19.87	0.002

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
7/11/2005	Prec.	1.95	0.25	0.40	1.86	6.21	0.36	0.01
7/11/2005	Rich Peine	54.81	29.48	1.23	50.81	365.22	0.31	5.32
7/11/2005	1	97.44	36.76	2.62	69.16	376.07	0.29	6.10
7/11/2005	1c	80.06	24.72	1.48	51.70	219.31	0.25	5.87
7/11/2005	2	87.65	31.95	1.57	72.45	328.76	0.17	3.83
7/11/2005	2c	72.21	43.11	2.55	66.09	330.88	0.19	4.21
7/11/2005	3	83.41	35.60	1.53	42.36	291.05	0.15	6.65
7/11/2005	3c	83.31	30.24	1.62	41.45	289.74	0.42	6.60
7/11/2005	4	103.55	33.43	1.20	76.22	343.31	0.15	5.81
7/11/2005	4c	94.73	35.99	1.70	77.47	333.75	0.25	5.11
7/11/2005	5	87.00	27.39	1.30	62.75	295.92	0.21	4.16
7/11/2005	5c	92.48	29.66	1.39	59.75	315.96	0.43	4.25
7/11/2005	6	101.27	33.24	2.68	73.55	288.84	0.13	4.36
7/11/2005	6c	73.61	34.48	2.70	71.92	262.80	0.22	3.95
7/11/2005	10	82.39	33.67	1.40	60.08	248.25	0.17	3.20
7/11/2005	11	90.36	35.10	1.53	62.90	324.12	0.12	4.27
7/11/2005	11c	77.42	33.61	1.40	61.41	310.53	0.18	4.48
7/11/2005	12						0.13	4.06
7/11/2005	14	77.24	35.71	1.86	63.88	297.43	0.14	3.57
7/11/2005	14c	72.31	33.00	1.90	58.53	268.61	0.16	3.83
7/11/2005	15	80.67	39.70	1.15	40.05	242.96	0.14	5.03
7/11/2005	Tom Peine	54.55	28.67	1.29	55.70	372.20	0.76	5.32
7/22/2005	Fishback	49.31	16.25	1.81	20.56	161.79	0.07	2.68
7/22/2005	1	88.73	34.75	2.68	67.32	330.34	0.46	3.47
7/22/2005	1b	73.16	26.98	1.40	53.76	213.04	0.11	4.11
7/22/2005	1c	65.69	30.53	1.44	60.11	239.44	0.19	3.28
7/22/2005	2	78.27	32.69	1.61	71.59	315.48	0.20	4.29
7/22/2005	2c	76.78	37.81	2.44	65.49	331.33	0.51	5.04

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
7/22/2005	6	17.90	6.95	1.168	0.9		144.58	0.004	0.04	27.48	0.002
7/22/2005	6c				3.4		138.01	0.012	0.12	24.82	0.118
7/22/2005	8c						44.05	0.008	0.06	4.99	0.002
7/22/2005	9c						49.16	0.007	0.07	17.25	0.002
8/1/2005	Fishback	24.21	8.29	0.581	8.1	95.2	37.73	0.008	1.68	28.12	0.046
8/1/2005	Rich Peine	20.18	7.75	0.632	0.8	-151.3	2.73	0.002	0.04	0.03	0.002
8/1/2005	1				0.4		113.16	0.002	0.04	27.66	0.002
8/1/2005	2				0.3		118.11	0.007	0.09	27.74	0.022
8/1/2005	2c				1.0		106.28	0.004	0.04	17.83	0.002
8/1/2005	3	19.56	6.92	0.830	1.1	-33.5	66.17	0.010	0.87	52.50	0.027
8/1/2005	3c						84.56	0.062	0.36	18.96	0.004
8/1/2005	4	18.55	7.00	1.158	1.8	-160.0	117.81	0.021	0.06	14.40	0.002
8/1/2005	4c				0.5		90.83	0.032	0.07	16.32	0.002
8/1/2005	5	19.95	7.03	1.061	1.3	-103.0	95.08	0.008	0.05	21.37	0.002
8/1/2005	5c				0.2		95.32	0.012	0.05	17.48	0.002
8/1/2005	6	20.04	6.99	1.151	0.4	-76.5	147.04	0.007	0.06	26.04	0.002
8/1/2005	6c				1.2		135.85	0.020	0.06	20.96	0.002
8/1/2005	8c				2.0		56.55	0.009	0.05	8.07	0.002
8/1/2005	9c						42.94	0.005	0.04	9.54	0.002
8/1/2005	10	20.56	7.02	1.016	0.9	-116.0	65.47	0.004	0.16	19.53	0.005
8/1/2005	11	20.18	7.01	1.067	2.0	-37.9	120.47	0.007	0.06	29.64	0.002
8/1/2005	12	19.75	7.01	0.527	1.9	22.2	86.17	0.008	0.08	19.57	0.002
8/1/2005	14	18.64	6.95	1.029	0.7	-2.1	103.27	0.004	0.04	27.02	0.065
8/1/2005	14c				1.3		94.45	0.004	0.04	23.37	0.002
8/1/2005	15	20.39	6.90	1.097	2.5	122.8	120.29	0.004	0.12	30.08	0.002
8/1/2005	Tom Peine	19.20	7.70	0.637	1.1	-123.8	3.06	0.006	0.04	0.03	0.002
8/5/2005	Prec.						1.07	0.004	1.46	4.54	0.023

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
7/22/2005	6	69.03	31.00	2.42	67.21	216.62	0.12	2.99
7/22/2005	6c	94.76	33.50	2.51	70.92	311.15	0.20	4.59
7/22/2005	8c	71.26	34.99	1.17	27.60	316.12	0.21	7.18
7/22/2005	9c	98.98	36.05	1.42	26.72	368.09	0.15	4.89
8/1/2005	Fishback	70.10	25.41	1.58	17.53	235.84	0.08	3.51
8/1/2005	Rich Peine	48.32	30.05	1.31	51.40	353.98	0.74	4.91
8/1/2005	1	85.97	35.12	3.21	68.13	323.05	0.55	4.22
8/1/2005	2	72.20	27.29	1.68	66.90	244.70	0.40	4.24
8/1/2005	2c	53.53	37.99	2.15	67.89	271.95	0.46	3.71
8/1/2005	3	76.20	30.44	1.61	36.81	248.90	0.11	5.92
8/1/2005	3c	73.39	30.40	1.98	40.16	258.89	2.13	6.58
8/1/2005	4	103.92	37.50	1.18	81.70	411.82	0.19	5.10
8/1/2005	4c	76.88	37.26	1.29	76.39	368.00	0.20	4.52
8/1/2005	5	57.30	34.53	1.35	69.85	282.48	0.24	3.68
8/1/2005	5c	77.50	35.54	1.24	63.78	327.41	0.20	3.17
8/1/2005	6	60.91	35.28	2.78	78.50	236.99	0.13	4.58
8/1/2005	6c	92.54	33.82	3.28	72.60	318.87	1.99	4.65
8/1/2005	8c	122.18	42.88	2.08	39.96	482.98	0.48	6.61
8/1/2005	9c	94.51	38.18	1.30	27.54	384.20	0.22	6.48
8/1/2005	10	97.56	34.47	1.32	65.32	416.46	0.10	3.53
8/1/2005	11	53.34	36.16	1.68	66.80	228.61	0.08	3.19
8/1/2005	12	94.28	33.81	1.37	58.67	361.95	0.09	4.74
8/1/2005	14	52.92	35.07	1.83	61.52	238.69	0.06	4.58
8/1/2005	14c	54.00	34.93	1.84	60.47	254.90	0.08	2.47
8/1/2005	15	74.22	41.32	0.40	45.50	253.71	0.09	3.00
8/1/2005	Tom Peine	52.04	28.82	1.35	55.48	366.69	0.64	4.91
8/5/2005	Prec.	4.70	0.25	0.40	1.31	8.65	1.83	0.01

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (℃)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
8/18/2005	Fishback	23.10	8.06	0.608	8.6	52.3	57.79	0.006	0.07	34.49	0.008
8/18/2005	Rich Peine	19.30	7.78	0.634	2.6	-150.4	2.76	0.004	0.03	0.03	0.004
8/18/2005	2c						120.91	0.007	0.04	21.91	0.002
8/18/2005	3	19.72	6.99	0.913	4.7	-49.9	78.38	0.022	0.10	35.84	0.002
8/18/2005	4	8.78	7.04	1.150	0.2	-151.3	119.49	0.014	0.05	11.51	0.002
8/18/2005	4c						106.15	0.110	0.35	22.47	0.002
8/18/2005	5	19.85	7.07	1.075		-114.6	105.70	0.009	0.04	21.35	0.002
8/18/2005	5c				0.2		97.93	0.007	0.07	19.50	0.002
8/18/2005	6	19.29	7.07	1.165	1.2	-101.7	145.93	0.005	0.03	23.50	0.002
8/18/2005	6c						163.87	0.011	0.09	29.25	0.017
8/18/2005	10	20.15	7.01	1.045	0.7	-99.0	103.91	0.004	0.03	24.00	0.005
8/18/2005	14	18.58	6.95	1.073	0.6	-3.3	108.31	0.005	0.03	27.39	0.002
8/18/2005	14c						103.02	0.006	0.04	26.08	0.002
8/18/2005	15	20.38	6.91	1.174	1.6	102.8	137.28	0.006	0.32	32.85	0.002
8/18/2005	Tom Peine	19.56	7.77	0.646	2.9	-127.7	3.18	0.004	0.05	0.03	0.009
8/19/2005	Prec.	23.08	6.04	0.018	8.4	24.3	0.63	0.006	0.27	0.77	0.012
8/30/2005	Prec.	12.44	6.36	0.011	11.4	132.9	0.87	0.002	0.09	0.03	0.002
9/9/2005	Fishback	20.32	7.51	0.533	0.3		54.16	0.002	0.06	4.06	0.009
9/9/2005	Rich Peine	20.72	7.35	0.638	0.3		2.90	0.002	0.04	0.03	0.003
9/9/2005	2c						115.99	0.002	0.04	23.42	0.002
9/9/2005	4	19.28	6.67	0.958	2.8		116.16	0.002	0.04	11.65	0.061
9/9/2005	4c						97.74	0.005	0.24	10.53	0.002
9/9/2005	5c						102.62	0.010	0.14	20.15	0.003
9/9/2005	6	18.89	6.79	1.148	18.4		156.11	0.004	0.07	22.36	0.002
9/9/2005	14	18.94	6.74	1.023	10.2		109.93	0.002	0.04	26.73	0.003
9/9/2005	14c						107.11	0.002	0.11	27.14	0.015

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
8/18/2005	Fishback	55.06	22.76	1.51	22.11	163.65	0.11	0.91
8/18/2005	Rich Peine	49.82	25.80	1.13	44.38	324.69	1.01	5.47
8/18/2005	2c	82.35	29.70	1.59	57.07	260.58	0.15	4.47
8/18/2005	3	93.43	28.79	1.29	34.12	279.67	0.22	6.44
8/18/2005	4	82.57	31.41	0.40	67.40	301.99	0.15	4.74
8/18/2005	4c	71.14	23.81	1.32	48.80	209.92	0.19	5.66
8/18/2005	5	95.14	29.43	1.19	58.59	316.28	0.24	4.85
8/18/2005	5c	72.54	25.66	1.17	46.28	230.39	0.16	4.33
8/18/2005	6	80.58	31.58	2.26	70.29	256.60	0.20	3.73
8/18/2005	6c	93.77	30.76	2.16	67.93	249.50	0.15	5.36
8/18/2005	10	61.17	28.82	0.40	55.13	220.18	0.08	3.47
8/18/2005	14	94.45	33.12	1.57	59.68	322.64	0.09	4.60
8/18/2005	14c	80.86	32.22	1.58	57.06	288.15	0.16	3.67
8/18/2005	15	94.23	30.59	0.40	36.98	213.97	0.08	6.05
8/18/2005	Tom Peine	44.48	22.50	1.16	43.74	295.81	0.80	5.79
8/19/2005	Prec.	2.46	0.25	0.40	1.70	9.43	0.35	0.01
8/30/2005	Prec.	1.71	0.25	0.40	1.60	7.94	0.30	0.01
9/9/2005	Fishback	55.01	19.45	1.57	25.88	195.04	0.06	0.85
9/9/2005	Rich Peine	60.96	29.81	1.12	52.89	387.33	1.03	3.40
9/9/2005	2c	63.56	33.26	1.71	68.33	258.40	0.10	2.70
9/9/2005	4	37.32	35.00	0.40	75.71	226.34	0.16	4.68
9/9/2005	4c	78.13	30.43	1.12	63.99	311.93	0.14	3.98
9/9/2005	5c	41.68	34.15	0.40	64.53	219.67	0.08	3.21
9/9/2005	6	68.06	32.64	2.31	76.47	230.01	0.17	3.50
9/9/2005	14	40.36	33.86	1.60	65.18	201.02	0.05	3.55
9/9/2005	14c	35.13	34.02	1.63	64.87	191.46	0.09	2.81

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
9/9/2005	15	19.89	6.89	1.173	0.6		139.64	0.002	0.20	30.16	0.002
9/9/2005	Tom Peine	18.85	7.53	0.637	0.3		3.78	0.002	0.05	0.03	0.012
9/19/2005	Prec.	17.52	8.24	0.026	3.2		0.71	0.002	0.18	0.03	0.002
9/29/2005	Fishback	16.37	8.07	0.564	8.4		45.37	0.016	3.74	29.35	0.064
9/29/2005	Rich Peine	15.52	7.63	0.629	1.2		2.83	0.002	0.04	0.03	0.107
9/29/2005	1	17.83	7.08	1.283	1.5		148.03	0.002	0.05	74.16	0.009
9/29/2005	1c				1.9		114.39	0.027	0.17	152.26	0.017
9/29/2005	2				2.5		126.97	0.002	0.13	3.72	0.002
9/29/2005	2c				1.0		135.57	0.013	0.12	30.65	0.002
9/29/2005	3	18.24	7.07	1.223	1.7		86.54	0.036	29.97	75.45	0.002
9/29/2005	3c				0.8		96.96	0.026	0.65	4.73	0.002
9/29/2005	4	18.03	7.03	1.165	2.1		184.36	0.002	0.05	41.60	0.004
9/29/2005	4b				3.0		193.51	0.008	0.05	21.33	0.010
9/29/2005	4c				1.0		124.74	0.016	0.13	12.37	0.002
9/29/2005	5	17.98	7.10	1.076	3.4		154.55	0.002	0.05	4.81	0.005
9/29/2005	5b				2.0		157.24	0.024	0.16	24.44	0.006
9/29/2005	5c				1.1		109.45	0.006	0.05	23.55	0.002
9/29/2005	6	17.88	7.03	1.054	1.0		153.02	0.002	0.06	31.09	0.002
9/29/2005	6c				0.9		166.15	0.008	0.10	25.98	0.002
9/29/2005	8	17.14	7.03	0.825	2.8		38.23	0.002	0.05	29.94	0.002
9/29/2005	8c				1.7		46.34	0.002	0.13	25.68	0.015
9/29/2005	9	18.05	6.88	1.402	0.7		89.25	0.002	0.05	39.59	0.002
9/29/2005	9c				1.4		59.42	0.010	0.10	30.84	0.002
9/29/2005	10	18.00	7.19	0.906	1.5		98.82	0.002	0.08	34.54	0.002
9/29/2005	10b				2.4		98.09	0.002	0.05	19.70	0.004
9/29/2005	10c						56.41	0.066	2.73	62.25	0.166
9/29/2005	11	17.33	7.22	0.870	3.9		108.94	0.002	0.05	34.86	0.005

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO$_2$ (mg/L)
9/9/2005	15	72.39	40.37	0.40	56.83	242.47	0.09	4.42
9/9/2005	Tom Peine	46.17	20.94	0.40	42.10	288.20	0.69	4.83
9/19/2005	Prec.	1.98	0.25	0.40	1.08	7.64	0.40	0.01
9/29/2005	Fishback	55.19	20.62	1.63	18.23	166.71	0.05	2.74
9/29/2005	Rich Peine	34.97	25.05	1.21	45.09	285.92	0.86	3.91
9/29/2005	1	110.71	34.60	1.38	62.43	270.27	0.08	3.45
9/29/2005	1c	69.58	27.15	1.27	58.59	94.38	0.11	3.55
9/29/2005	2	51.38	26.71	1.33	65.86	200.09	0.10	2.17
9/29/2005	2c	44.16	30.82	1.51	67.02	161.52	0.18	3.42
9/29/2005	3	76.78	41.24	1.28	41.54	228.58	0.07	3.91
9/29/2005	3c	52.28	34.97	1.31	41.06	223.21	0.61	5.51
9/29/2005	4	57.48	26.46	0.40	66.17	93.37	0.11	3.13
9/29/2005	4b	54.87	32.93	0.40	82.38	156.94	0.08	3.73
9/29/2005	4c	44.72	37.53	1.16	77.69	247.65	0.08	4.20
9/29/2005	5	76.00	25.93	0.40	56.64	197.08	0.06	2.35
9/29/2005	5b	70.87	24.64	0.40	56.71	154.80	0.07	3.22
9/29/2005	5c	39.43	32.95	1.11	60.87	188.92	0.06	2.38
9/29/2005	6	75.40	29.87	2.24	67.07	211.65	0.11	2.25
9/29/2005	6c	47.58	32.53	2.26	71.27	149.05	0.09	2.47
9/29/2005	8	51.95	28.14	0.40	24.02	213.15	0.16	2.51
9/29/2005	8c	47.78	27.61	0.40	49.15	248.15	0.06	4.70
9/29/2005	9	66.50	47.54	0.40	35.54	272.34	0.08	4.75
9/29/2005	9c	51.27	37.97	0.40	24.21	221.43	0.09	4.91
9/29/2005	10	53.59	30.04	1.17	54.71	202.51	0.06	3.08
9/29/2005	10b	79.09	24.62	0.40	58.28	267.17	0.07	2.21
9/29/2005	10c	88.77	23.67	1.99	25.36	229.84	0.41	2.89
9/29/2005	11	53.69	25.30	1.27	54.21	167.69	0.06	1.92

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
9/29/2005	11c				3.5		121.17	0.005	0.08	2.83	0.002
9/29/2005	12	17.51	7.09	0.977	3.0		141.64	0.005	0.07	27.23	0.107
9/29/2005	12c				3.6		124.59	0.008	0.38	15.08	0.021
9/29/2005	13	16.52	6.95	1.075	2.0		84.81	0.002	0.07	56.36	0.002
9/29/2005	13c				2.8		56.85	0.002	0.05	24.48	0.002
9/29/2005	14	17.32	7.03	0.995	1.5		104.91	0.002	0.04	28.76	0.002
9/29/2005	14b						69.46	0.002	0.05	26.92	0.002
9/29/2005	14c				1.4		110.33	0.002	0.05	27.75	0.009
9/29/2005	15	17.30	7.14	1.265	2.5		171.96	0.002	0.23	11.40	0.002
9/29/2005	Tom Peine	15.08	7.76	0.635	0.8		3.50	0.004	0.04	0.03	0.005
10/20/2005	Prec.	21.41	7.15	0.017		118.2	0.70	0.002	0.27	0.03	0.002
10/21/2005	Fishback	11.34	8.10	0.695	6.4	92.4	65.42	0.027	0.24	31.93	0.022
10/21/2005	Prec.				10.3						
10/21/2005	Rich Peine	16.17	7.84	0.643		-6.5	2.62	0.015	0.17	0.03	0.016
10/21/2005	1	15.70	6.72		1.5		128.42	0.008	0.09	53.27	0.002
10/21/2005	2				1.1		126.11	0.008	0.17	32.25	0.002
10/21/2005	2c				1.2		148.14	0.004	0.07	17.39	0.002
10/21/2005	3	16.07	7.18	1.178	1.8	126.9	93.08	0.004	1.50	59.97	0.028
10/21/2005	3c						91.80	0.014	1.09	10.27	0.013
10/21/2005	4	15.71	7.13	1.180	2.7	149.7	152.48	0.006	0.07	14.34	0.002
10/21/2005	4c				1.0		152.71	0.007	0.11	28.32	0.002
10/21/2005	5	15.24	7.14	1.088	1.2	149.6	132.61	0.005	0.07	29.63	0.002
10/21/2005	5b				2.2		145.01	0.011	0.08	18.55	0.002
10/21/2005	5c				1.2		115.15	0.007	0.09	17.40	0.002
10/21/2005	6	15.17	7.13	1.106	1.8	44.0	160.17	0.005	0.09	0.20	0.002
10/21/2005	6c				1.8		158.07	0.007	0.21	0.03	0.002
10/21/2005	8		7.03		2.3	106.9	36.66	0.004	0.91	25.40	0.029

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^+ (mg/L)	Na^+ (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
9/29/2005	11c	50.57	31.34	1.23	57.74	208.48	0.06	2.04
9/29/2005	12	65.41	38.16	0.40	71.56	248.18	0.08	3.27
9/29/2005	12c	48.04	33.57	1.34	56.81	191.62	0.11	3.86
9/29/2005	13	61.23	36.61	1.15	45.10	224.77	0.07	1.93
9/29/2005	13c	57.92	26.44	1.17	26.75	207.40	0.07	2.14
9/29/2005	14	72.31	27.48	1.53	49.30	224.88	0.05	2.04
9/29/2005	14b	64.39	28.01	1.29	45.01	249.55	0.09	3.64
9/29/2005	14c	78.95	27.96	1.55	53.64	246.31	0.07	2.72
9/29/2005	15	78.04	38.45	0.40	54.36	217.20	0.06	2.84
9/29/2005	Tom Peine	36.58	24.47	1.27	49.45	296.33	0.86	4.50
10/20/2005	Prec.	1.80	0.25	0.40	1.94	9.00	0.39	0.01
10/21/2005	Fishback	63.46	25.49	2.05	30.06	284.37	0.03	1.30
10/21/2005	Prec.							
10/21/2005	Rich Peine	28.38	26.86	1.22	48.37	205.57	0.99	3.15
10/21/2005	1	63.79	41.15	2.48	68.08	243.19	0.12	2.60
10/21/2005	2	43.35	27.43	1.42	63.72	149.92	0.10	2.09
10/21/2005	2c	39.57	30.63	1.62	68.55	148.86	0.39	2.46
10/21/2005	3	62.63	40.70	1.49	43.46	225.32	0.07	3.19
10/21/2005	3c	52.01	35.78	1.48	42.67	230.74	0.48	5.85
10/21/2005	4	40.09	34.38	0.40	73.76	172.48	0.07	2.71
10/21/2005	4c	38.64	36.48	1.14	76.63	169.77	0.09	5.31
10/21/2005	5	47.39	32.36	1.13	62.54	171.01	0.07	2.01
10/21/2005	5b	39.63	35.02	1.12	63.91	159.59	0.21	2.59
10/21/2005	5c	87.12	31.73	1.15	60.29	300.09	0.12	3.01
10/21/2005	6	69.81	29.79	2.24	68.94	223.49	0.07	2.25
10/21/2005	6c	48.50	31.39	2.32	70.42	183.24	0.09	1.96
10/21/2005	8	64.49	29.75	0.40	21.78	252.42	0.06	2.48

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
10/21/2005	8c				0.9		47.22	0.006	0.10	27.04	0.002
10/21/2005	9		7.04		2.6	100.7	65.99	0.004	0.10	16.35	0.002
10/21/2005	9c				1.3		66.78	0.010	0.15	34.89	0.002
10/21/2005	10	15.40	7.22	0.841	1.0	124.0	96.55	0.004	0.08	27.58	0.002
10/21/2005	10c						83.68	0.002	0.09	33.29	0.002
10/21/2005	11	15.04	7.28	0.999	3.2	127.3	140.05	0.004	0.10	32.78	0.012
10/21/2005	11c				3.3		128.61	0.004	0.08	0.03	0.002
10/21/2005	12	15.07	7.11	0.812	1.9	118.3	58.26	0.008	0.08	22.40	0.011
10/21/2005	12c				4.7		100.22	0.023	0.37	0.03	0.002
10/21/2005	13	14.66	6.98	1.062	1.9	132.7	66.63	0.018	0.17	0.03	0.002
10/21/2005	13c				1.6		60.10	0.024	0.22	33.34	0.006
10/21/2005	14	15.17	7.03	1.033	1.7	158.1	100.62	0.018	0.18	29.29	0.011
10/21/2005	14c				0.9		103.13	0.015	0.19	30.20	0.011
10/21/2005	15	13.60	7.00	1.299	2.2	104.7	141.96	0.018	0.65	0.03	0.014
10/21/2005	Tom Peine	15.80	7.81	0.638	1.9	-68.3	2.95	0.019	0.17	0.03	0.019
11/10/2005	Fishback	9.41	8.04	0.798	7.0	61.1	64.49	0.016	0.17	0.03	0.019
11/10/2005	Rich Peine	15.03	7.78	0.669	1.0	66.3	2.41	0.024	0.18	0.03	0.005
11/10/2005	1	13.69	6.94	1.373	1.2	60.4	97.90	0.026	0.19	37.60	0.012
11/10/2005	1c				2.8		119.07	0.036	0.24	9.04	0.009
11/10/2005	2	13.59	7.33	1.076	2.2	66.6	83.80	0.024	0.23	23.23	0.009
11/10/2005	2c				1.0		151.08	0.025	0.19	13.19	0.008
11/10/2005	3	15.02	7.15	1.300	2.7	70.7	78.06	0.012	0.24	31.39	0.014
11/10/2005	3c						69.72	0.036	0.95	2.22	0.013
11/10/2005	4	13.82	7.16	1.262	2.0	-8.4	140.46	0.014	0.18	0.23	0.221
11/10/2005	4b				1.8		119.89	0.018	0.20	34.87	0.011
11/10/2005	4c				1.4		137.71	0.022	0.21	0.03	0.148
11/10/2005	5	13.01	7.18	1.145	1.0	17.6	86.71	0.013	0.18	19.63	0.010
11/10/2005	5b				1.3		139.57	0.025	0.47	12.93	0.006

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
10/21/2005	8c	44.08	35.18	0.40	36.43	239.80	0.08	2.51
10/21/2005	9	66.24	39.87	1.20	31.80	290.02	0.07	3.93
10/21/2005	9c	52.69	39.12	1.15	25.90	219.70	0.16	3.86
10/21/2005	10	35.92	31.76	1.23	57.69	182.50	0.07	2.38
10/21/2005	10c	44.63	30.56	0.40	56.93	208.78	0.07	3.46
10/21/2005	11	45.34	28.37	1.41	61.45	133.62	0.06	1.73
10/21/2005	11c	70.49	31.36	1.33	59.54	254.75	0.09	2.72
10/21/2005	12	50.73	28.16	0.40	34.65	212.88	0.08	3.64
10/21/2005	12c	38.07	33.61	1.44	54.01	210.98	0.11	2.82
10/21/2005	13	61.67	38.40	0.40	42.91	311.74	0.05	2.04
10/21/2005	13c	57.53	33.16	1.21	33.17	234.11	0.06	2.21
10/21/2005	14	41.13	31.00	1.53	58.02	185.85	0.05	2.37
10/21/2005	14c	61.78	31.58	1.58	58.35	236.08	0.07	2.16
10/21/2005	15	50.32	44.75	0.40	54.21	227.40	0.04	2.10
10/21/2005	Tom Peine	50.43	26.62	1.24	52.97	348.00	1.09	3.79
11/10/2005	Fishback	75.51	28.29	1.97	30.71	283.11	0.03	1.54
11/10/2005	Rich Peine	46.06	25.72	1.17	46.05	319.01	1.42	2.78
11/10/2005	1	119.07	42.78	2.33	69.24	449.58	0.12	2.65
11/10/2005	1c	92.36	38.19	1.62	66.70	357.36	0.12	2.99
11/10/2005	2	84.51	27.95	2.13	65.45	328.55	0.09	2.16
11/10/2005	2c	43.96	32.48	1.66	78.05	188.30	0.10	2.97
11/10/2005	3	70.90	43.29	1.43	46.71	315.61	0.02	2.33
11/10/2005	3c	57.59	36.41	1.44	41.73	284.83	0.58	3.67
11/10/2005	4	73.77	34.74	0.40	77.12	296.56	0.04	2.09
11/10/2005	4b	56.55	37.90	1.14	84.63	277.18	0.05	2.19
11/10/2005	4c	72.32	36.91	0.40	82.30	317.35	0.07	3.45
11/10/2005	5	88.09	30.79	1.15	59.47	334.59	0.06	1.20
11/10/2005	5b	103.65	37.75	0.40	68.27	352.46	0.05	2.56

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
11/10/2005	5c				0.8		112.45	0.031	0.26	23.45	0.007
11/10/2005	6	13.57	7.04	1.123	1.9	77.0	133.95	0.016	0.19	0.03	0.006
11/10/2005	6c				1.3		136.28	0.020	0.28	28.65	0.008
11/10/2005	7						46.88	0.021	6.52	17.93	0.016
11/10/2005	8	12.38	7.03	0.899	3.7	91.6	31.13	0.024	0.19	21.42	0.008
11/10/2005	8c				1.0		30.10	0.025	0.31	15.25	0.007
11/10/2005	9	13.88	6.80	1.086	1.2	64.4	49.41	0.018	0.18	11.28	0.006
11/10/2005	9c				1.7		53.60	0.018	0.31	23.65	0.217
11/10/2005	10	13.27	7.28	0.927	1.2	64.7	69.11	0.026	0.28	24.73	0.007
11/10/2005	10b				2.3		96.89	0.024	0.19	0.03	0.005
11/10/2005	11	13.18	7.18	1.025	3.5	61.2	118.82	0.030	0.24	32.72	0.005
11/10/2005	11b						93.72	0.020	0.18	29.48	0.004
11/10/2005	11c				1.4		118.91	0.023	0.24	0.03	0.023
11/10/2005	12	13.35	7.13	0.901	3.5	56.1	70.82	0.023	0.20	16.93	0.006
11/10/2005	12c				1.6		97.24	0.031	0.36	33.56	0.005
11/10/2005	13	13.16	6.93	1.023	2.4	51.7	53.16	0.026	0.19	22.50	0.002
11/10/2005	13c				1.9		56.39	0.023	0.30	30.36	0.002
11/10/2005	14	13.26	7.00	1.083	1.2	42.6	103.11	0.028	0.19	28.60	0.004
11/10/2005	14b						104.51	0.026	0.23	29.98	0.002
11/10/2005	14c				0.9		56.65	0.031	0.22	33.04	0.003
11/10/2005	15	12.73	6.91	1.352	2.3	12.0	141.96	0.024	0.59	0.03	0.002
11/10/2005	Tom Peine	12.79	7.77	0.670	1.8	217.9	3.14	0.027	0.21	0.03	0.011
11/15/2005	Prec.	14.45	7.26	0.019	7.4	198.6	0.69	0.016	0.29	0.03	0.004
12/1/2005	Fishback	3.01	8.47	0.723	2.8	24.4	48.15	0.015	5.86	33.83	0.011
12/1/2005	Prec.						1.52	0.012	0.89	1.84	0.014
12/1/2005	Rich Peine	14.90	7.84	0.666	0.5	-130.0	2.53	0.005	0.09	0.87	0.002
12/1/2005	1	10.34	7.15	1.283	4.3	59.2	128.53	0.020	0.20	49.19	0.017

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
11/10/2005	5c	41.56	32.26	1.22	60.81	187.12	0.11	3.02
11/10/2005	6	52.86	30.59	2.21	65.75	214.57	0.03	1.90
11/10/2005	6c	49.04	31.86	2.32	70.48	187.51	0.13	2.64
11/10/2005	7	58.75	25.97	1.66	20.82	210.90	0.06	3.53
11/10/2005	8	71.21	34.08	0.40	24.10	304.64	0.49	1.84
11/10/2005	8c	86.31	35.72	0.40	31.97	374.01	0.06	2.74
11/10/2005	9	65.11	35.27	1.24	27.45	287.42	0.11	3.51
11/10/2005	9c	60.09	37.46	0.40	25.82	260.07	0.18	3.62
11/10/2005	10	51.62	29.24	1.21	47.17	229.90	0.05	2.02
11/10/2005	10b	82.78	28.80	0.40	50.52	298.76	0.06	3.05
11/10/2005	11	75.23	28.93	1.38	59.65	236.53	0.04	2.87
11/10/2005	11b	56.25	31.32	1.22	58.99	236.18	0.04	2.13
11/10/2005	11c	45.69	32.79	1.29	58.48	209.90	0.05	1.68
11/10/2005	12	58.44	31.47	0.40	35.96	236.49	0.04	1.87
11/10/2005	12c	46.98	33.93	1.33	53.00	201.49	0.10	2.15
11/10/2005	13	57.82	36.75	0.40	37.88	279.97	0.05	1.84
11/10/2005	13c	54.05	33.22	1.20	32.23	231.92	0.05	2.28
11/10/2005	14	43.66	32.75	1.60	58.76	198.27	0.04	2.61
11/10/2005	14b	81.02	32.01	1.60	58.84	285.25	0.07	2.47
11/10/2005	14c	87.62	29.77	1.29	43.56	323.20	0.07	3.30
11/10/2005	15	56.70	43.50	0.40	55.18	240.36	0.04	2.76
11/10/2005	Tom Peine	47.85	26.58	1.24	53.04	341.27	1.22	3.87
11/15/2005	Prec.	1.56	0.25	0.40	1.14	6.64	0.12	0.01
12/1/2005	Fishback	64.75	25.93	1.41	20.40	206.66	0.07	2.34
12/1/2005	Prec.	2.54	0.25	0.40	1.86	7.10	0.67	0.01
12/1/2005	Rich Peine	43.18	28.17	1.27	51.45	332.84	0.40	3.05
12/1/2005	1	101.32	41.26	1.41	78.71	363.12	0.07	1.52

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
12/1/2005	1b				5.6		130.30	0.027	0.35	65.68	0.007
12/1/2005	1c				1.8		130.98	0.029	0.38	44.65	0.003
12/1/2005	2	9.39	7.44	0.992	1.6	36.8	120.20	0.032	0.45	32.70	0.002
12/1/2005	2b						119.76	0.025	0.26	0.03	0.002
12/1/2005	2c						150.23	0.022	0.20	26.46	0.002
12/1/2005	3	11.22	7.27	1.327	3.6	296.4	96.99	0.029	14.12	34.00	0.002
12/1/2005	3b				3.8		94.99	0.033	25.26	42.62	0.005
12/1/2005	3c				0.9		87.86	0.033	0.35	1.56	0.002
12/1/2005	4	9.32	7.27	1.267	4.0	339.7	150.70	0.034	0.20	16.09	0.002
12/1/2005	4a				4.6		94.78	0.036	0.22	32.16	0.009
12/1/2005	4b				1.8		123.90	0.024	0.19	3.19	0.033
12/1/2005	4c				3.0		117.14	0.024	0.20	3.96	0.002
12/1/2005	5	8.91	7.19	1.094	1.3	316.2	121.21	0.034	0.26	0.03	0.084
12/1/2005	5b				1.0		143.82	0.040	0.22	0.03	0.002
12/1/2005	5c				0.0		112.55	0.037	0.20	23.87	0.002
12/1/2005	6	9.81	7.08	1.099	1.7	62.2	143.21	0.026	0.20	0.03	0.008
12/1/2005	6b						107.07	0.037	0.26	0.03	0.003
12/1/2005	6c						113.20	0.030	0.38	32.03	0.002
12/1/2005	7	9.51	7.34	0.796	3.1	76.8	62.82	0.029	0.25	29.95	0.002
12/1/2005	7c						64.45	0.030	0.33	33.26	0.002
12/1/2005	8	8.25	7.17	0.862	2.5	96.6	29.30	0.018	0.21	22.62	0.002
12/1/2005	8b						7.89	0.032	0.25	137.36	0.006
12/1/2005	8c						34.96	0.004	0.14	16.54	0.002
12/1/2005	9	9.80	6.94	1.574	0.7	-21.2	94.88	0.004	0.10	103.96	0.007
12/1/2005	9b						121.00	0.005	0.09	124.63	0.002
12/1/2005	9c						52.49	0.007	0.26	20.24	0.177
12/1/2005	10	8.24	7.25	0.982	1.8	294.2	83.62	0.004	0.13	30.04	0.002
12/1/2005	10b				1.2		102.30	0.006	0.12	74.87	0.002
12/1/2005	10c				0.9		82.67	0.036	0.15	26.72	0.002

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
12/1/2005	1b	65.94	34.81	1.37	70.93	211.38	0.04	1.87
12/1/2005	1c	95.15	37.32	1.47	69.41	312.40	0.06	2.54
12/1/2005	2	51.63	15.20	1.25	36.20	67.75	0.03	1.57
12/1/2005	2b	47.36	19.85	1.48	56.21	154.91	0.10	1.41
12/1/2005	2c	48.45	21.58	1.36	54.75	90.91	0.09	2.50
12/1/2005	3	66.64	34.86	1.29	36.25	206.69	0.04	2.00
12/1/2005	3b	66.54	36.74	1.34	38.07	203.06	0.07	2.24
12/1/2005	3c	55.51	23.22	1.66	27.99	171.27	0.84	4.33
12/1/2005	4	64.98	28.37	0.40	64.58	190.45	0.04	1.55
12/1/2005	4a	67.30	21.14	0.40	51.56	200.26	0.05	1.38
12/1/2005	4b	65.28	23.02	0.40	51.41	191.76	0.02	1.51
12/1/2005	4c	56.29	22.30	0.40	49.84	171.67	0.07	2.80
12/1/2005	5	44.68	21.54	0.40	43.50	123.91	0.03	1.94
12/1/2005	5b	45.30	17.80	0.40	35.15	60.17	0.03	2.45
12/1/2005	5c	36.51	15.31	0.40	28.60	33.01	0.07	2.50
12/1/2005	6	45.74	16.23	1.35	28.33	42.01	0.02	1.49
12/1/2005	6b	37.61	10.77	1.28	19.39	30.69	0.14	2.66
12/1/2005	6c	41.56	11.24	1.32	22.12	6.39	0.03	2.74
12/1/2005	7	48.66	13.75	0.40	18.30	98.32	0.02	2.22
12/1/2005	7c	45.73	15.66	0.40	19.12	94.87	0.03	1.34
12/1/2005	8	49.30	17.82	0.40	11.74	157.40	0.03	2.29
12/1/2005	8b	26.29	17.14	1.21			0.04	3.06
12/1/2005	8c	44.00	21.48	0.40	23.16	182.52	0.08	1.85
12/1/2005	9	76.96	31.02	0.40	27.22	137.31	0.09	2.18
12/1/2005	9b	68.34	26.37	0.40	28.88	41.90	0.09	2.18
12/1/2005	9c	53.19	15.89	0.40	13.03	131.43	0.11	2.85
12/1/2005	10	32.67	9.06	0.40	12.79	-2.25	0.07	1.75
12/1/2005	10b	72.86	29.85	1.14	61.50	217.64	0.13	1.46
12/1/2005	10c	51.66	20.57	1.27	30.74	137.51	0.19	2.12

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
12/1/2005	11	10.21	7.26	0.929	4.6	247.7	103.52	0.005	0.10	48.15	0.015
12/1/2005	11b				2.8		110.04	0.005	0.13	48.66	0.002
12/1/2005	11c				1.9		117.08	0.005	0.13	47.60	0.002
12/1/2005	12	9.38	7.24	0.917	3.6	143.7					
12/1/2005	12b				5.1		4.53	0.004	0.12	79.33	0.002
12/1/2005	12c				4.2		79.62	0.004	0.21	24.82	0.033
12/1/2005	13	9.49	7.02	1.013	1.6	72.0	61.02	0.006	0.10	27.11	0.002
12/1/2005	13b				3.5		64.21	0.007	0.24	47.75	0.025
12/1/2005	13c				1.1		60.21	0.006	0.12	30.63	0.002
12/1/2005	14	9.44	7.03	1.073	1.1	313.7	103.09	0.007	0.09	30.03	0.002
12/1/2005	14b				3.0		22.56	0.006	0.12	51.41	0.002
12/1/2005	14c				2.0		98.78	0.007	0.24	30.84	0.002
12/1/2005	15	6.86	7.00	1.340	1.3	80.3	135.90	0.004	0.26	51.76	0.002
12/1/2005	Tom Peine	9.63	7.81	0.679	0.9	-90.8	3.04	0.005	0.09	0.70	0.002
12/28/2005	Prec.	18.43	6.53	0.033	10.3	203.2	1.22	0.008	0.94	3.61	0.002
12/29/2005	Fishback	4.71	7.70	0.550	10.2	136.9	52.16	0.033	7.55	28.26	0.058
12/29/2005	Rich Peine	13.00	7.53	0.641	0.5	93.7	2.86	0.007	0.07	1.09	0.002
12/29/2005	1	5.37	7.20	1.076	4.2	173.0	96.60	0.007	4.44	97.08	0.041
12/29/2005	1a				5.0		110.49	0.009	0.38	88.46	0.027
12/29/2005	1b				4.8		127.71	0.009	0.18	70.56	0.002
12/29/2005	1c				1.4		128.59	0.010	0.14	80.74	0.008
12/29/2005	2	4.80	7.52	0.747	5.1	160.4	86.52	0.007	0.20	75.59	0.011
12/29/2005	2a				2.7		69.65	0.007	0.13	103.91	0.170
12/29/2005	2b				1.8		122.22	0.006	0.09	41.30	0.002
12/29/2005	2c				0.9		142.29	0.007	0.09	31.76	0.108
12/29/2005	3	5.91	7.18	0.960	3.2	166.8	79.58	0.007	19.01	121.49	0.010
12/29/2005	3a				2.0		68.39	0.018	26.61	90.95	0.070

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
12/1/2005	11	59.83	18.15	0.40	32.13	98.16	0.07	1.26
12/1/2005	11b	38.78	16.32	0.40	28.18	19.73	0.08	2.20
12/1/2005	11c	46.93	13.83	0.40	24.99	14.07	0.08	1.57
12/1/2005	12	61.98	17.79	0.40	30.21			
12/1/2005	12b	51.85	16.02	0.40	49.36	214.22	0.07	0.98
12/1/2005	12c	65.63	22.24	1.20	34.49	193.59	0.10	1.07
12/1/2005	13	48.50	29.26	0.40	29.64	192.15	0.07	2.16
12/1/2005	13b	61.37	28.40	1.43	30.30	197.34	0.07	2.73
12/1/2005	13c	55.88	27.03	0.40	27.52	194.19	0.06	1.94
12/1/2005	14	52.04	28.90	1.46	50.71	184.27	0.08	2.14
12/1/2005	14b	65.32	19.20	0.40	63.88	296.18	0.07	1.47
12/1/2005	14c	58.14	29.34	1.62	54.22	214.25	0.12	2.25
12/1/2005	15	68.13	39.77	0.40	52.18	201.97	0.06	2.63
12/1/2005	Tom Peine	37.93	22.63	1.30	47.15	287.09	0.32	2.71
12/28/2005	Prec.	1.96	0.25	0.40	1.39	3.19	1.08	0.01
12/29/2005	Fishback	58.32	20.61	1.78	15.63	157.50	0.13	2.33
12/29/2005	Rich Peine	37.27	26.60	1.26	47.69	302.73	0.83	2.67
12/29/2005	1	83.93	31.43	1.82	62.67	236.52	0.07	1.56
12/29/2005	1a	77.90	32.01	1.28	64.79	220.45	0.07	1.49
12/29/2005	1b	68.72	28.86	1.30	58.40	165.25	0.08	1.41
12/29/2005	1c	83.18	31.41	1.40	62.69	209.46	0.08	1.87
12/29/2005	2	43.26	11.49	1.26	61.84	90.46	0.07	1.20
12/29/2005	2a	38.10	9.64	1.22	84.68	113.71	0.09	1.83
12/29/2005	2b	55.14	23.94	1.32	69.36	173.29	0.10	1.46
12/29/2005	2c	53.79	27.81	1.43	70.46	169.82	0.09	2.16
12/29/2005	3	70.75	24.40	1.17	25.74	80.37	0.07	1.95
12/29/2005	3a	100.40	33.82	1.32	33.43	251.48	0.08	1.62

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
12/29/2005	3b				5.0		86.34	0.011	26.03	79.33	0.019
12/29/2005	3c				0.5		86.95	0.013	0.24	0.81	0.002
12/29/2005	4	6.15	6.99	1.258	4.4	186.5	154.18	0.009	0.09	73.54	0.012
12/29/2005	4a				5.3		124.43	0.009	0.10	83.82	0.008
12/29/2005	4b				1.8		164.57	0.008	0.08	71.99	0.004
12/29/2005	4c				2.0		137.83	0.009	0.11	71.02	0.002
12/29/2005	5	4.91	7.11	0.853	2.4	186.2	86.69	0.010	0.09	49.67	0.007
12/29/2005	5a				10.5		71.72	0.009	0.09	59.45	0.039
12/29/2005	5b				1.7		133.96	0.011	0.08	40.10	0.002
12/29/2005	5c				2.9		102.27	0.013	0.13	22.74	0.002
12/29/2005	6	3.78	7.55	0.158	6.7	152.1	3.82	0.008	0.08	0.03	0.092
12/29/2005	6a				6.7		3.70	0.009	0.12	0.07	0.037
12/29/2005	6b				0.4		11.76	0.009	0.08	2.11	0.014
12/29/2005	6c				3.6		128.52	0.012	0.16	33.08	0.002
12/29/2005	7	4.55	7.46	0.268	6.6	150.7	54.53	0.007	0.09	34.64	0.002
12/29/2005	7a				6.8		13.22	0.011	0.09	12.38	0.002
12/29/2005	7b				7.7		4.74	0.012	0.08	100.06	0.002
12/29/2005	7c				3.6		32.18	0.010	0.11	101.27	0.002
12/29/2005	8	4.22	7.19	0.267	7.4	157.8	1.12	0.008	0.15	5.53	0.002
12/29/2005	8b				7.2		3.75	0.008	0.14	58.13	0.011
12/29/2005	8c				0.9		21.64	0.006	0.09	12.75	0.031
12/29/2005	9	6.44	6.77	1.151	4.7	162.0	51.96	0.006	0.08	35.51	0.002
12/29/2005	9b				4.3		48.81	0.015	0.11	112.68	0.011
12/29/2005	9c				0.0		47.30	0.008	0.07	21.06	0.031
12/29/2005	10	4.25	7.37	0.701	4.7	163.2	79.31	0.011	0.14	39.68	0.002
12/29/2005	10a				4.9		67.94	0.010	0.21	87.02	0.008
12/29/2005	10b				0.6		111.46	0.013	0.10	71.94	0.104
12/29/2005	10c				1.5		84.09	0.010	0.08	26.54	0.002
12/29/2005	11	5.05	6.98	1.035	3.6	170.4	45.78	0.009	0.08	21.52	0.010

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
12/29/2005	3b	97.31	40.22	1.29	41.56	275.10	0.09	1.88
12/29/2005	3c	40.45	37.54	1.48	43.53	228.39	0.57	3.37
12/29/2005	4	78.59	28.06	2.94	71.38	176.58	0.08	2.03
12/29/2005	4a	80.60	32.29	1.31	75.20	236.50	0.09	1.39
12/29/2005	4b	64.48	39.62	1.15	88.76	211.40	0.08	1.86
12/29/2005	4c	68.01	35.69	1.28	82.19	228.64	0.09	2.28
12/29/2005	5	56.22	27.98	1.33	46.63	184.56	0.07	2.24
12/29/2005	5a	75.38	23.22	1.62	56.19	244.91	0.08	2.56
12/29/2005	5b	115.43	39.48	1.21	78.00	391.15	0.10	2.22
12/29/2005	5c	62.33	17.93	0.40	34.03	135.87	0.10	2.53
12/29/2005	6	20.70	5.75	1.99	4.68	82.43	0.11	2.03
12/29/2005	6a	12.37	2.93	1.19	19.09	80.56	0.12	0.93
12/29/2005	6b	21.70	4.04	0.40	15.16	85.44	0.09	1.68
12/29/2005	6c	56.76	24.60	1.81	52.56	143.72	0.08	2.14
12/29/2005	7	34.24				35.28	0.05	1.71
12/29/2005	7a		11.26	0.40	7.39	116.78	0.09	1.86
12/29/2005	7b	46.01	17.35	0.40	19.06	117.29	0.07	1.56
12/29/2005	7c	56.25	20.71	0.40	42.94	168.63	0.05	1.71
12/29/2005	8						0.07	0.96
12/29/2005	8b	38.73	13.57	0.40	101.78	308.62	0.04	1.61
12/29/2005	8c	48.46	34.61	0.40	30.90	287.32	0.06	2.11
12/29/2005	9	82.53	39.34	0.40	32.28	328.38	0.05	2.55
12/29/2005	9b	91.86	25.44	0.40	30.95	215.56	0.08	2.20
12/29/2005	9c	83.75	37.17	0.40	26.41	331.33	0.12	2.38
12/29/2005	10	72.54	21.79	1.80	38.71	204.02	0.07	2.97
12/29/2005	10a	63.52	18.48	0.40	59.31	177.54	0.08	0.90
12/29/2005	10b	78.77	28.93	0.40	59.45	213.15	0.10	1.51
12/29/2005	10c	63.73	32.47	1.24	45.83	247.73	0.23	2.20
12/29/2005	11	41.98	12.40	1.27	47.21	173.15	0.07	2.15

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
12/29/2005	11a				7.2		70.28	0.013	0.14	51.59	0.023
12/29/2005	11b				3.2		112.37	0.010	0.08	37.37	0.002
12/29/2005	11c				3.4		118.56	0.011	0.08	40.72	0.002
12/29/2005	12	4.77	7.37	0.429	7.0	152.7					
12/29/2005	12a				7.3		5.19	0.007	0.07	26.25	0.003
12/29/2005	12b				6.8		7.06	0.016	0.11	77.93	0.006
12/29/2005	12c				6.4		95.31	0.013	0.16	29.13	0.002
12/29/2005	13	6.44	6.85	0.951	2.8	165.2	54.54	0.011	0.11	34.90	0.020
12/29/2005	13b				4.8		38.31	0.012	0.24	58.24	0.018
12/29/2005	13c				5.0		63.00	0.013	0.40	27.48	0.002
12/29/2005	14	4.71	6.99	0.774	5.3	190.9	44.08	0.010	0.12	24.49	0.002
12/29/2005	14a				6.5		2.52	0.011	0.09	6.61	0.002
12/29/2005	14b				3.6		14.32	0.009	0.11	26.74	0.002
12/29/2005	14c				3.6		119.47	0.009	0.08	29.62	0.002
12/29/2005	15	5.91	6.95	1.310	3.7	160.0	225.41	0.009	0.29	45.94	0.002
12/29/2005	Tom Peine	8.16	7.50	0.631	0.4	24.5	3.58	0.013	0.06	1.05	0.002
1/2/2006	Prec.	10.55	6.20	0.011	11.0	175.9	0.55	0.021	0.41	0.03	0.012
1/11/2006	Fishback	4.98	7.74	0.751	11.5	104.7	90.33	0.011	3.39	35.92	0.002
1/11/2006	1	6.39	7.08	1.075	1.8	144.7	119.59	0.012	0.83	82.69	0.017
1/11/2006	1a				3.4		126.98	0.009	0.16	68.19	0.002
1/11/2006	1b				2.6		130.88	0.009	0.10	59.78	0.002
1/11/2006	1c				2.0		152.54	0.013	0.08	63.42	0.002
1/11/2006	2	5.57	7.35	0.636	2.1	136.1	84.07	0.009	0.14	59.21	0.003
1/11/2006	2a				1.9		71.79	0.013	0.10	82.71	0.079
1/11/2006	2b				2.6		148.99	0.010	0.07	40.98	0.002
1/11/2006	2c				1.1		171.90	0.010	0.07	34.90	0.002
1/11/2006	3	6.68	6.96	1.146	1.8	149.4	166.85	0.008	1.65	77.14	0.002

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
12/29/2005	11a	77.42	25.14	0.40	40.83	233.07	0.08	1.56
12/29/2005	11b	80.56	31.12	1.19	52.92	248.35	0.08	1.54
12/29/2005	11c	72.96	26.96	1.27	49.82	193.39	0.11	1.34
12/29/2005	12	48.94	16.45	0.40	20.27			
12/29/2005	12a	37.02	12.04	0.40	65.56	250.47	0.06	1.38
12/29/2005	12b	61.78	20.47	0.40	61.48	281.61	0.07	1.68
12/29/2005	12c	50.69	33.32	1.31	49.94	209.12	0.09	1.85
12/29/2005	13	91.28	35.90	2.23	29.10	328.40	0.08	1.88
12/29/2005	13b	90.04	31.94	1.52	36.92	323.60	0.08	2.28
12/29/2005	13c	92.51	30.59	1.29	29.96	305.91	0.09	2.27
12/29/2005	14	93.31	25.66	1.23	24.42	305.51	0.10	1.17
12/29/2005	14a	29.27	5.97	1.20	26.71	146.81	0.08	1.80
12/29/2005	14b	66.25	15.71	0.40	60.68	314.52	0.07	1.48
12/29/2005	14c	54.86	31.03	1.50	55.48	187.81	0.07	1.38
12/29/2005	15	60.39	42.51	0.40	66.37	104.50	0.07	2.08
12/29/2005	Tom Peine	46.36	23.50	1.27	48.06	312.52	0.63	3.14
1/2/2006	Prec.	2.49		0.40	1.12	9.00	0.39	0.01
1/11/2006	Fishback	79.69	29.18	1.44	33.23	225.59	0.08	1.18
1/11/2006	1	89.21	33.80	1.99	65.35	251.02	0.08	1.94
1/11/2006	1a	83.13	29.67	1.31	61.16	214.09	0.07	1.69
1/11/2006	1b	59.19	31.27	1.34	60.42	162.61	0.07	2.12
1/11/2006	1c	72.23	35.89	1.43	69.51	199.75	0.09	1.62
1/11/2006	2	44.89	12.16	1.22	65.66	126.16	0.09	1.29
1/11/2006	2a	38.64	10.90	1.30	89.15	149.36	0.08	2.48
1/11/2006	2b	64.01	19.99	1.28	56.35	113.32	0.11	1.30
1/11/2006	2c	54.38	32.17	1.53	77.31	159.36	0.08	2.87
1/11/2006	3	70.40	39.80	1.31	48.50	129.65	0.08	2.05

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
1/11/2006	3a				1.9		121.47	0.018	18.22	76.66	0.002
1/11/2006	3b				2.0		143.51	0.012	4.48	78.54	0.002
1/11/2006	3c				1.5		102.27	0.020	0.16	3.72	0.002
1/11/2006	4	6.47	7.03	0.851	3.0	149.9	95.78	0.012	0.10	46.27	0.009
1/11/2006	4a				4.0		153.25	0.011	0.09	59.66	0.029
1/11/2006	4b				2.7		163.59	0.013	0.17	65.78	0.002
1/11/2006	4c				1.3		176.70	0.009	0.06	69.50	0.002
1/11/2006	5	5.47	6.89	0.959	0.8	156.6	129.43	0.014	0.09	49.88	0.002
1/11/2006	5a				5.1		111.65	0.010	0.09	51.30	0.004
1/11/2006	5b				4.4		127.51	0.012	0.06	41.76	0.002
1/11/2006	5c				1.3		133.05	0.013	0.07	25.71	0.002
1/11/2006	6	5.24	7.14	0.363	2.7	136.3	42.22	0.006	0.06	19.94	0.002
1/11/2006	6a				4.6		15.64	0.007	0.10	34.83	0.006
1/11/2006	6b				4.4		90.92	0.009	0.07	31.60	0.002
1/11/2006	6c				1.0		150.63	0.008	0.11	34.49	0.002
1/11/2006	7	6.06	7.18	0.743	5.0	138.6	82.64	0.008	0.07	26.29	0.002
1/11/2006	7b				7.0		17.30	0.008	0.06	64.24	0.186
1/11/2006	7c				4.5		72.55	0.008	0.06	25.92	0.002
1/11/2006	8	5.81	6.88	0.672	1.2	140.3	22.92	0.009	0.06	19.28	0.002
1/11/2006	8b				4.6		9.85	0.009	0.08	90.59	0.008
1/11/2006	8c				1.8		25.39	0.006	0.06	19.28	0.186
1/11/2006	9	7.14	6.67	1.261	0.7	128.5	87.72	0.007	0.19	44.44	0.002
1/11/2006	9b						94.35	0.007	0.06	100.69	0.002
1/11/2006	9c						61.86	0.008	0.06	30.16	0.002
1/11/2006	10	6.24	6.87	1.000	1.6	152.7	114.10	0.006	0.08	34.60	0.002
1/11/2006	10a				3.0		93.05	0.019	0.12	51.05	0.003
1/11/2006	10b				1.9		110.76	0.011	0.10	58.00	0.007
1/11/2006	10c				1.3		117.10	0.017	0.09	32.09	0.002
1/11/2006	11	5.84	6.89	0.958	3.6	153.4	112.31	0.007	0.06	33.93	0.002

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
1/11/2006	3a	85.39	39.53	1.35	42.24	203.55	0.09	1.53
1/11/2006	3b	94.86	36.86	1.30	42.56	194.88	0.11	1.87
1/11/2006	3c	52.04	37.38	1.45	42.85	230.56	0.98	3.22
1/11/2006	4	62.73	22.43	1.50	61.11	200.41	0.08	1.77
1/11/2006	4a	63.68	34.41	1.29	79.05	195.76	0.13	1.28
1/11/2006	4b	65.32	34.92	1.23	79.34	181.52	0.24	1.97
1/11/2006	4c	57.20	37.78	1.31	85.61	164.48	0.15	2.15
1/11/2006	5	88.18	30.58	1.30	56.98	237.01	0.09	1.89
1/11/2006	5a	70.75	25.17	1.47	53.88	188.31	0.08	2.75
1/11/2006	5b	57.43	28.85	1.26	56.49	163.18	0.09	2.28
1/11/2006	5c	64.88	32.65	1.21	60.92	215.90	0.09	2.61
1/11/2006	6	51.24	18.15	1.23	23.35	174.61	0.05	1.76
1/11/2006	6a	35.04	11.86	0.40	23.85	130.26	0.09	2.03
1/11/2006	6b	58.50	18.24	1.46	35.74	139.47	0.08	1.66
1/11/2006	6c	74.29	30.21	2.09	64.07	203.34	0.06	2.08
1/11/2006	7	48.46	27.08	0.40	31.61	157.70	0.07	1.12
1/11/2006	7b	61.98	22.99	0.40	36.70	238.08	0.08	1.52
1/11/2006	7c	71.72	25.92	0.40	30.75	223.78	0.05	1.61
1/11/2006	8	82.50	33.19	0.40	13.72	320.55	0.06	1.94
1/11/2006	8b	30.35	14.66	1.21	170.02	399.36	0.04	2.76
1/11/2006	8c	75.98	33.09	0.40	26.06	326.92	0.06	2.42
1/11/2006	9	79.80	46.17	0.40	34.05	293.68	0.06	2.47
1/11/2006	9b	86.66	43.86	1.17	45.75	259.90	0.08	2.73
1/11/2006	9c	88.34	36.55	0.40	26.10	309.58	0.10	2.85
1/11/2006	10	63.34	34.93	1.31	45.69	205.89	0.06	2.04
1/11/2006	10a	60.37	20.65	0.40	56.22	173.99	0.09	1.51
1/11/2006	10b	75.12	23.75	0.40	51.13	180.31	0.17	1.69
1/11/2006	10c	56.49	32.46	1.24	44.33	173.95	0.23	2.17
1/11/2006	11	59.92	23.80	1.31	63.29	193.13	0.06	1.60

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
1/11/2006	11a				3.4		98.55	0.011	0.07	35.06	0.002
1/11/2006	11b				2.9		141.38	0.011	0.06	38.27	0.002
1/11/2006	11c				3.1		123.89	0.010	0.05	35.38	0.002
1/11/2006	12	5.49	7.08	0.534	7.2	142.2					
1/11/2006	12b				6.5		2.97	0.009	0.06	62.22	0.254
1/11/2006	12c				1.3		81.73	0.014	0.06	26.10	0.154
1/11/2006	13	6.84	6.68	0.918	3.5	158.4	67.28	0.002	0.06	23.84	0.102
1/11/2006	13b				4.0		34.93	0.002	0.13	32.48	0.027
1/11/2006	13c				0.5		64.19	0.002	0.07	21.98	0.002
1/11/2006	14	5.78	6.79	0.833	3.5	157.9	58.95	0.002	0.05	23.58	0.002
1/11/2006	14a				6.4		3.15	0.002	0.06	16.71	0.002
1/11/2006	14b				5.1		9.43	0.005	0.07	19.41	0.002
1/11/2006	14c				1.9		108.28	0.002	0.07	30.71	0.249
1/11/2006	15	6.16	6.93	1.281	2.1	132.5	176.54	0.002	0.19	53.78	0.002
1/11/2006	Surf. Wtr	5.07	7.48	0.961	3.9	134.9	90.58	0.007	0.38	34.16	0.014
1/17/2006	Prec.	21.05	7.88	0.020	9.4	105.7	0.99	0.009	0.31	2.53	0.012
1/28/2006	Prec.	10.00	5.53	0.017	14.3	180.6	0.85	0.031	0.71	1.37	0.002
1/30/2006	Fishback	5.60	7.69	0.543	7.5	104.0	39.02	0.063	9.23	27.37	0.032
1/30/2006	Rich Peine	13.06	7.24	0.695	0.9	136.4	2.86	0.038	0.46	1.03	0.002
1/30/2006	1	6.74	6.89	1.119	1.4	34.1	129.26	0.009	0.09	64.65	0.021
1/30/2006	1a				1.6		114.20	0.012	0.10	52.55	0.009
1/30/2006	1b				2.5		98.53	0.045	0.46	46.07	0.003
1/30/2006	1c				2.5		103.89	0.053	0.44	58.13	0.003
1/30/2006	2	5.43	7.41	0.775	3.5	85.1	84.88	0.041	0.44	53.03	0.002
1/30/2006	2a				2.2		111.31	0.080	0.46	49.50	0.014
1/30/2006	2b				4.2		115.75	0.062	0.43	40.56	0.002

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
1/11/2006	11a	66.41	31.70	0.40	53.87	238.37	0.07	0.91
1/11/2006	11b	74.46	31.17	1.15	52.96	191.47	0.06	1.83
1/11/2006	11c	75.55	30.51	1.26	58.00	230.29	0.07	1.25
1/11/2006	12	65.62	21.08	0.40	16.63			
1/11/2006	12b	54.31	18.49	0.40	65.62	285.61	0.05	0.96
1/11/2006	12c	77.41	37.18	1.27	48.05	309.69	0.07	2.28
1/11/2006	13	92.25	35.15	0.40	31.07	323.18	0.07	2.20
1/11/2006	13b	114.39	34.60	1.42	15.33	379.97	0.07	2.46
1/11/2006	13c	87.45	35.69	1.16	32.91	324.82	0.08	1.41
1/11/2006	14	81.94	28.19	1.26	33.15	286.59	0.07	1.74
1/11/2006	14a	72.55	15.90	0.40	20.92	270.77	0.07	1.31
1/11/2006	14b	49.56	18.43	1.15	60.63	299.48	0.08	1.26
1/11/2006	14c	77.24	28.29	1.43	51.78	238.55	0.09	1.32
1/11/2006	15	71.51	44.14	0.40	58.44	182.61	0.06	1.93
1/11/2006	Surf. Wtr	84.90	34.85	2.17	55.13	314.49	0.08	2.35
1/17/2006	Prec.	3.68	0.25	0.40	1.49	9.64	0.60	0.01
1/28/2006	Prec.	2.05	0.25	0.40	1.65	7.00	0.25	0.01
1/30/2006	Fishback	60.34	21.21	1.78	19.32	191.15	0.07	2.31
1/30/2006	Rich Peine	51.34	28.57	1.25	52.39	355.91	1.40	2.93
1/30/2006	1	89.34	33.58	1.73	62.73	250.13	0.07	2.37
1/30/2006	1a	86.55	30.53	1.31	60.19	258.44	0.04	2.27
1/30/2006	1b	77.43	33.85	1.40	65.42	289.40	0.04	1.58
1/30/2006	1c	78.95	34.44	1.45	68.39	282.00	0.04	2.21
1/30/2006	2	60.40	17.34	1.25	66.74	193.63	0.04	1.24
1/30/2006	2a	59.30	17.71	1.18	87.83	204.50	0.06	1.40
1/30/2006	2b	64.91	25.44	1.36	65.88	205.88	0.08	1.72

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
1/30/2006	2c				1.2		119.85	0.066	0.43	37.13	0.002
1/30/2006	3	7.39	7.20	1.040	2.6	127.7	116.33	0.055	1.12	39.99	0.002
1/30/2006	3a				2.2		115.19	0.039	1.77	41.55	0.002
1/30/2006	3b				2.2		115.85	0.036	1.13	40.67	0.002
1/30/2006	3c				0.5		78.82	0.064	0.53	6.51	0.002
1/30/2006	4	5.16	7.21	1.070	3.9	122.2	139.57	0.052	0.42	42.26	0.015
1/30/2006	4a				3.5		129.98	0.064	0.47	44.52	0.004
1/30/2006	4b				1.1		186.07	0.067	0.45	60.88	0.002
1/30/2006	4c				1.5		143.59	0.030	0.41	63.96	0.107
1/30/2006	5	4.92	7.43	0.906	5.1	118.6	97.84	0.070	0.44	37.55	0.002
1/30/2006	5a				2.9		84.83	0.071	0.50	34.92	0.007
1/30/2006	5b				1.3		99.55	0.057	0.43	34.12	0.431
1/30/2006	5c				1.8		99.50	0.052	0.44	23.56	0.002
1/30/2006	6	4.85	7.21	0.323	2.7	100.0	26.78	0.063	0.48	12.59	0.042
1/30/2006	6a				1.8		22.97	0.053	0.49	35.46	0.003
1/30/2006	6b				2.3		87.96	0.048	0.45	37.87	0.002
1/30/2006	6c				3.8		100.74	0.060	0.46	33.67	0.002
1/30/2006	7	5.30	7.44	0.315	6.2	96.4	11.25	0.051	0.51	8.49	0.005
1/30/2006	7a				4.6		5.53	0.042	0.45	117.08	0.005
1/30/2006	7b				6.9		12.06	0.066	0.46	59.23	0.002
1/30/2006	7c				5.4		63.11	0.049	0.44	27.03	0.002
1/30/2006	8	4.63	7.35	0.282	6.2	101.5	1.22	0.062	0.46	0.87	0.002
1/30/2006	8b				5.8		1.80	0.031	0.43	49.32	0.002
1/30/2006	8c				1.3		25.72	0.053	0.46	20.60	0.002
1/30/2006	9	6.24	6.89	1.004	2.9	120.4	37.72	0.039	0.45	30.80	0.002
1/30/2006	9b				1.7		42.18	0.048	0.47	63.78	0.002
1/30/2006	9c				0.0		33.49	0.050	0.46	20.31	0.002
1/30/2006	10	4.94	7.41	0.956	4.1	124.2	100.92	0.061	0.46	38.98	0.113
1/30/2006	10a				3.1		95.58	0.050	0.48	46.55	0.002

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
1/30/2006	2c	65.27	31.87	1.55	73.14	247.10	0.07	1.94
1/30/2006	3	88.35	33.94	1.34	51.80	267.94	0.04	2.23
1/30/2006	3a	86.08	29.37	1.29	42.04	221.64	0.04	2.19
1/30/2006	3b	91.41	33.84	1.31	51.14	273.70	0.04	2.44
1/30/2006	3c	60.56	38.75	1.31	43.65	288.89	0.80	3.28
1/30/2006	4	86.82	34.34	1.57	71.99	275.39	0.04	2.30
1/30/2006	4a	74.14	28.66	1.33	63.01	211.65	0.09	1.64
1/30/2006	4b	86.86	35.85	0.40	82.45	217.91	0.07	2.28
1/30/2006	4c	81.04	37.71	1.25	84.18	272.59	0.14	2.54
1/30/2006	5	78.83	28.44	1.77	52.67	253.13	0.06	2.65
1/30/2006	5a	70.61	23.14	1.41	45.25	215.25	0.08	2.33
1/30/2006	5b	85.92	29.99	1.24	58.84	290.51	0.07	2.32
1/30/2006	5c	94.48	30.50	1.21	56.67	320.98	0.12	2.34
1/30/2006	6	38.14	12.98	2.80	12.16	127.26	0.04	2.69
1/30/2006	6a	45.76	16.15	0.40	24.30	164.34	0.04	2.16
1/30/2006	6b	69.90	23.66	1.54	40.65	198.40	0.06	1.78
1/30/2006	6c	81.00	27.88	1.64	49.68	249.56	0.05	1.81
1/30/2006	7	30.73	9.43	0.40	6.98	106.06	0.04	1.80
1/30/2006	7a	35.13	12.42	1.18	45.48	109.18	0.05	3.10
1/30/2006	7b	55.31	20.78	0.40	34.01	219.02	0.09	1.93
1/30/2006	7c	71.62	26.47	1.15	31.48	240.13	0.06	1.84
1/30/2006	8	19.87	7.28	0.40	14.70	109.03	0.06	1.42
1/30/2006	8b	36.19	12.61	0.40	92.42	289.67	0.06	2.24
1/30/2006	8c	77.76	29.04	0.40	22.51	305.04	0.06	1.96
1/30/2006	9	112.65	33.82	1.21	26.20	393.36	0.03	2.60
1/30/2006	9b	126.09	39.30	1.25	38.27	435.12	0.04	2.83
1/30/2006	9c	91.78	31.83	0.40	22.56	340.95	0.07	2.19
1/30/2006	10	82.03	25.80	1.57	47.90	233.62	0.04	2.59
1/30/2006	10a	83.07	28.36	0.40	59.23	269.75	0.05	2.46

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
1/30/2006	10b				1.1		101.24	0.042	0.48	50.06	0.002
1/30/2006	10c				1.7		89.54	0.042	0.93	30.62	0.002
1/30/2006	11	5.05	7.12	0.931	1.9	129.4	98.57	0.052	0.44	36.71	0.002
1/30/2006	11a				3.9		108.80	0.041	0.44	40.00	0.002
1/30/2006	11b				2.8		108.31	0.035	0.43	37.37	0.002
1/30/2006	11c				1.7		108.63	0.056	0.45	38.74	0.002
1/30/2006	12	6.14	7.04	0.581	5.5	126.2					
1/30/2006	12b				6.4		3.05	0.053	0.43	26.58	0.002
1/30/2006	12c				1.8		72.31	0.032	0.43	23.78	0.002
1/30/2006	13	6.03	6.91	0.861	2.6	128.2	39.93	0.050	0.48	34.02	0.002
1/30/2006	13b				2.5		11.46	0.046	0.50	48.68	0.031
1/30/2006	13c				1.7		59.93	0.035	0.43	21.91	0.002
1/30/2006	14	5.15	7.10	0.702	1.9	125.2	71.73	0.041	0.43	25.47	0.002
1/30/2006	14b				4.4		10.90	0.047	0.46	12.56	0.002
1/30/2006	14c				0.6		84.64	0.030	0.41	28.28	0.002
1/30/2006	15	7.00	6.77	1.101	1.4	113.5	116.14	0.043	0.53	33.01	0.002
1/30/2006	Surf. Wtr	6.62	7.60	1.071	6.7	118.8	86.99	0.029	1.28	32.66	0.002
1/30/2006	Tom Peine	8.10	7.28	0.631	1.4	95.8	3.20	0.039	0.46	1.02	0.002
2/16/2006	Prec.	12.46	8.81	0.056	11.2	192.1	1.02	0.002	0.19	1.94	0.004
2/24/2006	Fishback	3.78	8.35	0.668	13.9	207.3	56.19	0.002	2.83	37.42	0.006
2/24/2006	Rich Peine	12.89	7.78	0.643	0.9	162.0	2.87	0.002	0.03	0.92	0.085
2/24/2006	1	5.92	7.24	1.119	1.8	238.8	120.82	0.002	0.05	57.99	0.002
2/24/2006	1a				1.9		118.84	0.002	0.06	54.75	0.020
2/24/2006	1b				3.9		137.17	0.002	0.06	67.03	0.019
2/24/2006	1c				3.6		143.48	0.002	0.05	72.50	0.014
2/24/2006	2	4.03	7.48	0.878	2.6	235.4	112.20	0.002	0.03	67.05	0.003
2/24/2006	2a				1.7		138.57	0.046	0.03	64.86	0.210

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
1/30/2006	10b	91.96	28.21	0.40	52.44	264.92	0.06	2.11
1/30/2006	10c	91.73	32.72	1.24	44.70	303.56	0.13	1.89
1/30/2006	11	80.19	27.67	1.49	60.11	269.10	0.05	2.30
1/30/2006	11a	84.09	30.48	0.40	58.99	268.70	0.04	1.66
1/30/2006	11b	82.24	33.87	0.40	63.95	292.28	0.04	1.78
1/30/2006	11c	85.64	32.23	1.35	65.75	297.25	0.05	1.81
1/30/2006	12	46.55	15.14	0.40	23.93			
1/30/2006	12b	54.99	17.72	0.40	51.02	289.44	0.05	1.44
1/30/2006	12c	59.40	33.73	1.26	41.26	251.38	0.06	2.18
1/30/2006	13	106.51	34.21	1.55	22.76	366.08	0.05	3.25
1/30/2006	13b	112.86	33.70	1.61	31.54	423.88	0.10	2.80
1/30/2006	13c	69.62	32.17	1.19	32.02	269.69	0.04	1.96
1/30/2006	14	73.61	29.77	1.48	49.03	286.81	0.04	1.97
1/30/2006	14b	66.36	19.21	1.19	42.42	309.73	0.10	1.71
1/30/2006	14c	92.04	31.78	1.56	57.45	338.40	0.04	1.81
1/30/2006	15	97.25	42.32	1.49	56.88	343.94	0.07	3.15
1/30/2006	Surf. Wtr	85.10	36.63	2.08	57.36	332.93	0.05	2.30
1/30/2006	Tom Peine	49.72	28.03	1.32	57.35	360.07	1.34	3.66
2/16/2006	Prec.	2.06	2.06	0.40	1.90	14.67	0.89	0.01
2/24/2006	Fishback	71.63	71.63	1.38	26.09	411.69	0.09	1.44
2/24/2006	Rich Peine	55.40	55.40	1.17	48.79	468.91	1.78	7.20
2/24/2006	1	122.27	35.59	1.57	61.06	355.74	0.09	5.35
2/24/2006	1a	111.63	32.26	1.36	56.84	312.10	0.06	4.82
2/24/2006	1b	121.43	35.20	1.43	65.77	329.57	0.16	5.31
2/24/2006	1c	122.86	34.24	1.45	68.00	319.49	0.08	5.50
2/24/2006	2	73.38	19.40	1.21	66.56	181.22	0.07	2.96
2/24/2006	2a	79.79	21.18	1.18	89.48	219.13	0.08	3.87

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
2/24/2006	2b				3.2		136.93	0.002	0.01	59.65	0.034
2/24/2006	2c				1.7		130.26	0.002	0.01	51.42	0.002
2/24/2006	3	7.15	7.56	1.045	3.1	243.0	138.51	0.002	1.13	38.17	0.010
2/24/2006	3a				1.7		135.41	0.002	1.09	36.38	0.011
2/24/2006	3b				3.6		129.52	0.007	0.90	40.17	0.022
2/24/2006	3c				1.8		110.37	0.006	1.23	14.83	0.024
2/24/2006	4	1.32	7.42	1.043	2.1	319.0	182.20	0.002	0.03	52.48	0.009
2/24/2006	4a				4.6		181.39	0.002	0.03	53.84	0.009
2/24/2006	4b				1.4		193.44	0.002	0.01	54.00	0.006
2/24/2006	4c				0.6		215.88	0.002	0.01	59.07	0.002
2/24/2006	5	2.94	7.51	1.101	3.3	319.6	153.13	0.002	0.27	46.60	0.013
2/24/2006	5a				4.5		124.85	0.002	0.03	40.90	0.011
2/24/2006	5b				3.7		127.94	0.002	0.01	39.31	0.002
2/24/2006	5c				1.8		126.49	0.002	0.01	40.01	0.002
2/24/2006	6	4.82	7.30	0.811	1.9	242.5	87.85	0.002	0.01	29.93	0.002
2/24/2006	6a				3.7		43.97	0.006	0.03	39.46	0.011
2/24/2006	6b				2.9		73.34	0.002	0.01	31.74	0.005
2/24/2006	6c				1.9		117.85	0.002	0.04	38.61	0.202
2/24/2006	7	5.51	7.45	0.774	5.9	236.7	55.35	0.002	0.01	29.34	0.002
2/24/2006	7b				6.7		17.48	0.002	0.01	22.17	0.002
2/24/2006	7c				4.8		58.10	0.002	0.01	28.73	0.065
2/24/2006	8	4.93	7.42	0.673	3.3	234.7	15.78	0.002	0.01	20.64	0.002
2/24/2006	8b						15.58	0.007	0.12	53.17	0.047
2/24/2006	8c				1.5		31.31	0.002	0.03	20.66	0.004
2/24/2006	9	6.18	7.09	1.124	1.2	212.5	51.16	0.002	0.01	38.81	0.002
2/24/2006	9b				3.5		54.08	0.002	0.01	42.80	0.022
2/24/2006	9c				1.5		40.84	0.002	0.03	23.63	0.002
2/24/2006	10	1.60	7.74	1.093	6.2	250.5	150.03	0.002	0.01	50.18	0.202
2/24/2006	10a				2.7		107.71	0.002	0.08	43.34	0.009

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
2/24/2006	2b	111.96	31.22	1.48	68.46	303.49	0.15	4.85
2/24/2006	2c	118.16	32.72	1.57	73.45	354.17	0.09	5.12
2/24/2006	3	113.70	32.85	1.34	52.32	298.52	0.07	5.93
2/24/2006	3a	113.56	32.65	1.35	49.64	297.81	0.07	5.75
2/24/2006	3b	110.53	33.05	1.37	51.93	301.41	0.20	5.79
2/24/2006	3c	135.54	39.98	1.38	44.80	430.03	0.55	7.73
2/24/2006	4	116.49	36.35	6.03	79.25	308.81	0.09	4.51
2/24/2006	4a	109.48	32.97	1.85	71.34	254.60	0.08	3.77
2/24/2006	4b	119.73	37.64	1.43	84.99	311.39	0.09	4.53
2/24/2006	4c	110.16	36.56	1.29	82.73	241.01	0.11	6.11
2/24/2006	5	116.30	33.01	1.53	57.70	288.90	0.09	6.11
2/24/2006	5a	87.30	25.51	1.35	48.05	210.43	0.08	4.53
2/24/2006	5b	103.89	29.37	1.22	56.72	283.80	0.08	5.38
2/24/2006	5c	122.95	36.19	1.23	67.60	384.47	0.06	4.96
2/24/2006	6	84.62	25.77	1.19	36.29	242.68	0.08	4.19
2/24/2006	6a	59.43	19.94	0.40	23.57	179.10	0.08	4.72
2/24/2006	6b	79.48	23.61	1.47	37.20	241.88	0.08	4.27
2/24/2006	6c	100.52	28.98	1.74	52.51	279.90	0.08	4.68
2/24/2006	7	99.26	30.85	0.40	31.02	334.18	0.07	4.34
2/24/2006	7b	68.99	21.90	0.40	16.60	251.27	0.07	3.77
2/24/2006	7c	89.60	27.02	0.40	29.67	288.01	0.07	4.21
2/24/2006	8	87.34	27.68	0.40	13.62	318.39	0.13	4.38
2/24/2006	8b	64.16	19.33	1.44	117.83	420.54	0.07	5.86
2/24/2006	8c	94.79	31.71	0.40	26.26	359.15	0.11	4.69
2/24/2006	9	177.21	43.67	0.40	34.12	584.38	0.10	5.97
2/24/2006	9b	175.02	39.61	1.18	35.26	557.40	0.12	6.71
2/24/2006	9c	129.53	36.34	0.40	24.39	444.33	0.20	5.89
2/24/2006	10	121.91	35.15	1.54	59.49	316.19	0.11	5.71
2/24/2006	10a	107.92	30.48	1.24	57.85	325.20	0.15	4.34

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (℃)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
2/24/2006	10b				3.7		113.56	0.002	0.03	47.10	0.002
2/24/2006	10c				2.6		103.30	0.002	0.09	38.87	0.002
2/24/2006	11	3.42	7.32	0.984	1.2	251.1	130.12	0.002	0.01	39.45	0.002
2/24/2006	11a				2.0		120.74	0.002	0.01	41.59	0.003
2/24/2006	11b				3.3		145.31	0.002	0.01	46.05	0.002
2/24/2006	11c				2.2		130.83	0.002	0.03	45.32	0.004
2/24/2006	12	5.30	7.22	0.854	3.2	229.6	24.17	0.002	0.04	23.04	0.002
2/24/2006	12b				5.9		5.05	0.002	0.01	16.16	0.002
2/24/2006	12c				5.3		82.78	0.002	0.03	30.46	0.002
2/24/2006	13	5.17	7.13	0.830	1.8	209.2	63.76	0.002	0.01	28.85	0.002
2/24/2006	13c				2.2		63.07	0.002	0.04	31.02	0.002
2/24/2006	14	4.53	7.27	0.935	1.7	317.0	105.28	0.002	0.03	41.13	0.002
2/24/2006	14b				3.6		57.93	0.002	0.03	28.13	0.002
2/24/2006	14c				1.9		98.85	0.002	0.03	36.71	0.002
2/24/2006	15	5.16	7.36	1.214	3.0	231.7	150.83	0.002	0.01	54.79	0.131
2/24/2006	Surf. Wtr	7.29	7.60	1.061	7.8	222.8	103.76	0.002	0.30	35.23	0.003
2/24/2006	Tom Peine	7.07	7.85	0.650	2.1	97.4	3.30	0.002	0.01	0.91	0.005
3/9/2006	Prec.	13.46	7.94	0.015	12.5	180.9	0.46	0.016	0.17	1.19	0.014
3/10/2006	Fishback	7.62	7.73	0.381	12.7	-68.2	35.23	0.041	2.86	22.31	0.213
3/10/2006	Rich Peine	11.38	7.55	0.629	3.6	146.2	3.47	0.012	0.06	0.82	0.003
3/10/2006	1	7.03	6.92	1.051	1.2	121.7	110.71	0.013	0.08	41.96	0.021
3/10/2006	1a						124.83	0.006	0.08	41.24	0.015
3/10/2006	1b						164.92	0.006	0.07	51.70	0.325
3/10/2006	1c						149.69	0.006	0.08	59.64	0.006
3/10/2006	2	6.16	7.20	0.783	3.7	162.7	97.22	0.014	0.09	52.14	0.008
3/10/2006	2a						140.86	0.014	0.06	56.82	0.017
3/10/2006	2b						162.34	0.008	0.06	53.55	0.004

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
2/24/2006	10b	112.73	31.02	0.40	54.50	318.92	0.14	4.38
2/24/2006	10c	125.46	36.07	1.28	49.31	384.34	0.13	5.30
2/24/2006	11	109.26	32.44	1.26	64.53	323.61	0.10	4.09
2/24/2006	11a	107.92	32.87	0.40	61.37	325.12	0.14	3.72
2/24/2006	11b	84.83	84.83	1.32	59.27	438.64	0.15	4.43
2/24/2006	11c	77.49	77.49	1.32	60.24	413.37	0.11	4.46
2/24/2006	12	65.03	65.03	0.40	18.60	412.95	0.12	4.10
2/24/2006	12b	52.74	52.74	0.40	28.92	388.27	0.10	3.25
2/24/2006	12c	78.27	78.27	1.27	43.94	466.32	0.18	4.61
2/24/2006	13	64.36	64.36	0.40	20.69	351.12	0.23	4.90
2/24/2006	13c	72.66	72.66	0.40	28.45	421.60	0.19	4.80
2/24/2006	14	90.34	90.34	1.51	50.26	517.38	0.16	4.72
2/24/2006	14b	84.99	84.99	1.22	35.24	529.28	0.13	4.57
2/24/2006	14c	71.24	71.24	1.54	55.71	416.58	0.12	4.44
2/24/2006	15	71.50	71.50	0.40	31.03	270.73	0.16	7.22
2/24/2006	Surf. Wtr	71.68	71.68	1.65	43.65	387.77	0.09	4.38
2/24/2006	Tom Peine	41.35	41.35	1.20	40.19	356.86	1.51	7.22
3/9/2006	Prec.	0.65	0.25	0.40	1.43	4.20	0.41	0.02
3/10/2006	Fishback	53.87	14.74	2.27	13.99	152.90	0.16	3.03
3/10/2006	Rich Peine	64.00	29.53	1.24	53.06	392.64	0.66	5.48
3/10/2006	1	119.17	34.21	1.46	58.44	367.36	0.07	3.74
3/10/2006	1a	118.31	33.89	1.37	59.69	347.35	0.10	3.36
3/10/2006	1b	132.56	37.54	1.41	65.88	343.50	0.11	4.07
3/10/2006	1c	134.22	37.06	1.43	69.86	368.10	0.10	4.12
3/10/2006	2	70.60	18.39	1.20	64.59	202.45	0.06	2.22
3/10/2006	2a	92.15	24.56	0.40	82.62	253.41	0.08	2.68
3/10/2006	2b	111.29	30.54	1.43	70.02	272.84	0.11	3.28

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
3/10/2006	2c						153.74	0.005	0.06	49.01	0.002
3/10/2006	3	7.95	7.27	1.023	4.2	237.4	150.26	0.007	1.25	32.66	0.021
3/10/2006	3a						149.38	0.008	1.23	32.52	0.015
3/10/2006	3b						147.77	0.017	1.27	32.18	0.014
3/10/2006	3c						121.00	0.012	0.40	19.57	0.002
3/10/2006	4	5.00	7.11	1.104	2.7	292.7	200.23	0.008	0.06	49.84	0.291
3/10/2006	4a						148.06	0.009	0.08	44.67	0.010
3/10/2006	4b						207.58	0.010	0.06	51.20	0.022
3/10/2006	4c						193.17	0.009	0.06	51.45	0.002
3/10/2006	5	6.47	7.59	0.813	8.5	298.7	115.04	0.006	0.05	30.61	0.019
3/10/2006	5a						131.87	0.012	0.11	32.83	1.790
3/10/2006	5b						151.82	0.006	0.05	45.15	0.069
3/10/2006	5c						151.54	0.009	0.06	45.67	0.004
3/10/2006	6	5.58	6.96	0.774	2.5	176.2	99.71	0.009	0.05	30.84	0.009
3/10/2006	6a						57.92	0.019	0.08	27.73	1.913
3/10/2006	6b						85.61	0.009	0.05	29.37	0.084
3/10/2006	6c						127.72	0.011	0.08	33.67	0.002
3/10/2006	7	6.02	7.07	0.192	10.4	184.2	10.20	0.013	0.09	1.28	0.089
3/10/2006	7a						11.08	0.039	0.11	5.62	9.035
3/10/2006	7b						14.86	0.031	0.05	32.30	0.022
3/10/2006	7c						63.72	0.009	0.05	26.74	0.412
3/10/2006	8	4.64	7.20	0.108	12.5	195.0	0.96	0.033	0.05	1.34	0.231
3/10/2006	8a						2.88	0.044	0.09	4.21	0.086
3/10/2006	8b						2.62	0.034	0.08	49.02	0.043
3/10/2006	8c						34.77	0.005	0.04	20.14	0.005
3/10/2006	9	5.81	7.01	0.729	8.9	208.6	21.56	0.009	0.07	23.73	0.064
3/10/2006	9a						8.07	0.006	0.14	16.65	0.186
3/10/2006	9b						25.20	0.007	0.06	42.86	0.319
3/10/2006	9c						46.45	0.007	0.04	20.64	0.119

Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO_2 (mg/L)
3/10/2006	2c	109.11	30.04	1.49	70.40	283.13	0.11	3.58
3/10/2006	3	115.19	32.93	1.31	54.50	296.35	0.10	4.13
3/10/2006	3a	114.02	32.76	1.34	52.38	289.52	0.09	4.08
3/10/2006	3b	110.83	32.82	1.33	52.80	285.33	0.09	4.09
3/10/2006	3c	145.30	42.37	1.32	47.11	449.94	0.37	6.08
3/10/2006	4	110.74	34.93	0.40	77.79	255.09	0.08	3.33
3/10/2006	4a	96.31	29.12	0.40	63.67	243.82	0.10	2.66
3/10/2006	4b	108.51	34.51	1.22	77.53	236.91	0.12	3.28
3/10/2006	4c	105.19	34.70	0.40	76.27	245.69	0.13	4.14
3/10/2006	5	91.78	25.84	1.58	48.94	249.73	0.06	4.35
3/10/2006	5a	88.60	25.21	1.27	48.45	208.81	0.09	3.60
3/10/2006	5b	111.49	31.41	0.40	61.67	280.94	0.08	3.66
3/10/2006	5c	115.78	33.04	1.20	63.33	302.93	0.08	3.86
3/10/2006	6	91.07	26.29	1.38	39.94	251.39	0.07	3.20
3/10/2006	6a	63.87	21.46	0.40	28.48	196.59	0.07	5.06
3/10/2006	6b	94.25	28.87	1.33	39.68	290.65	0.05	4.95
3/10/2006	6c	105.22	29.50	1.93	56.80	294.85	0.08	4.39
3/10/2006	7	27.61	8.23	0.40	5.69	99.75	0.06	5.45
3/10/2006	7a	30.93	10.05	1.14	46.57	185.52	0.01	9.12
3/10/2006	7b	59.94	19.07	0.40	27.54	233.90	0.05	3.88
3/10/2006	7c	98.48	29.13	0.40	30.24	313.66	0.09	3.63
3/10/2006	8	13.59	4.05	0.40	9.55	68.71	0.09	2.12
3/10/2006	8a	21.10	7.35	1.11	38.34	159.13	0.06	6.00
3/10/2006	8b	43.60	13.84	0.40	104.41	338.66	0.04	5.75
3/10/2006	8c	104.46	31.11	0.40	26.90	377.87	0.08	3.88
3/10/2006	9	117.33	24.02	1.51	25.34	393.63	0.05	5.43
3/10/2006	9a	105.06	13.92	1.40	83.50	474.05	0.01	5.46
3/10/2006	9b	130.29	28.09	1.29	29.92	426.93	0.08	3.92
3/10/2006	9c	129.81	35.11	0.40	22.76	431.40	0.11	4.27

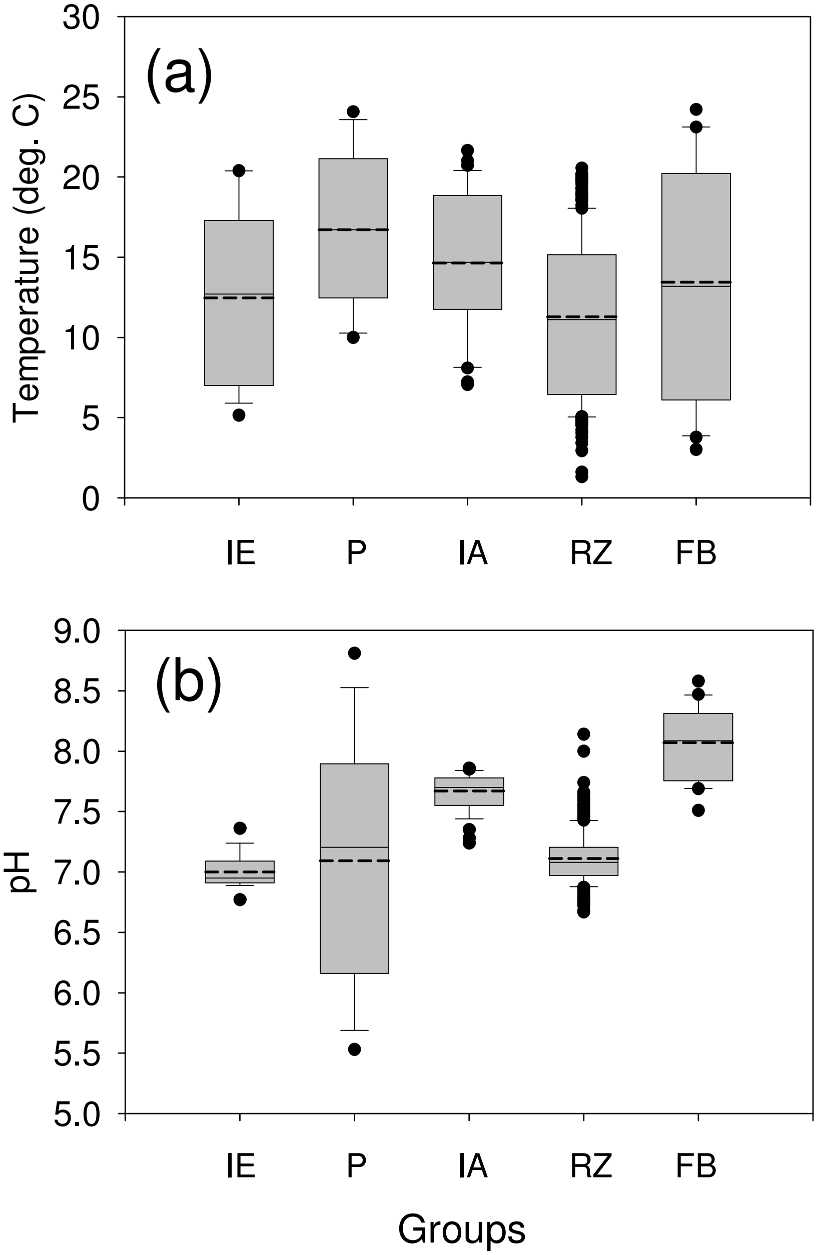
Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Temperature (°C)	pH	Conductivity (mS/cm C°)	Diss. O_2 (mg/L)	Oxidation reduction potential (mV)	Cl^- (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{-3} (mg/L)
3/10/2006	10	5.90	7.03	0.944	1.5	236.9	112.75	0.010	0.04	52.22	0.097
3/10/2006	10a						105.10	0.007	0.10	34.91	0.060
3/10/2006	10b						121.75	0.010	0.05	49.96	0.032
3/10/2006	10c						117.89	0.010	0.07	45.58	0.043
3/10/2006	11	5.53	7.04	1.047	1.5	232.8	130.56	0.013	0.05	33.38	0.070
3/10/2006	11a						148.90	0.009	0.04	41.44	0.007
3/10/2006	11b						136.26	0.009	0.05	41.59	0.007
3/10/2006	11c						172.73	0.012	0.05	45.30	0.004
3/10/2006	12	6.20	7.66	0.243	11.8	216.8	2.55	0.046	0.06	4.03	0.009
3/10/2006	12a						2.36	0.021	0.06	2.54	0.013
3/10/2006	12b						1.84	0.007	0.04	9.20	0.002
3/10/2006	12c						99.51	0.015	0.05	29.94	0.029
3/10/2006	13	5.04	6.96	0.707	7.9	220.0	39.37	0.011	0.98	27.10	0.002
3/10/2006	13b						11.39	0.014	0.15	33.32	0.024
3/10/2006	13c						71.28	0.007	0.06	23.71	0.002
3/10/2006	14	5.50	7.14	0.592	8.5	301.3	21.46	0.010	0.05	13.86	0.048
3/10/2006	14a						3.40	0.026	0.06	0.69	0.011
3/10/2006	14b						45.11	0.012	0.05	17.39	0.002
3/10/2006	14c						107.51	0.010	0.05	34.11	0.008
3/10/2006	15	7.33	6.93	1.067	3.8	221.2	147.95	0.019	0.11	32.34	0.002
3/10/2006	Surf. Wtr	7.07	7.63	1.042	10.4	240.2	91.49	0.007	0.13	33.54	0.011
3/10/2006	Tom Peine	7.24	7.60	0.632	3.4	41.2	3.53	0.008	0.05	0.82	0.006

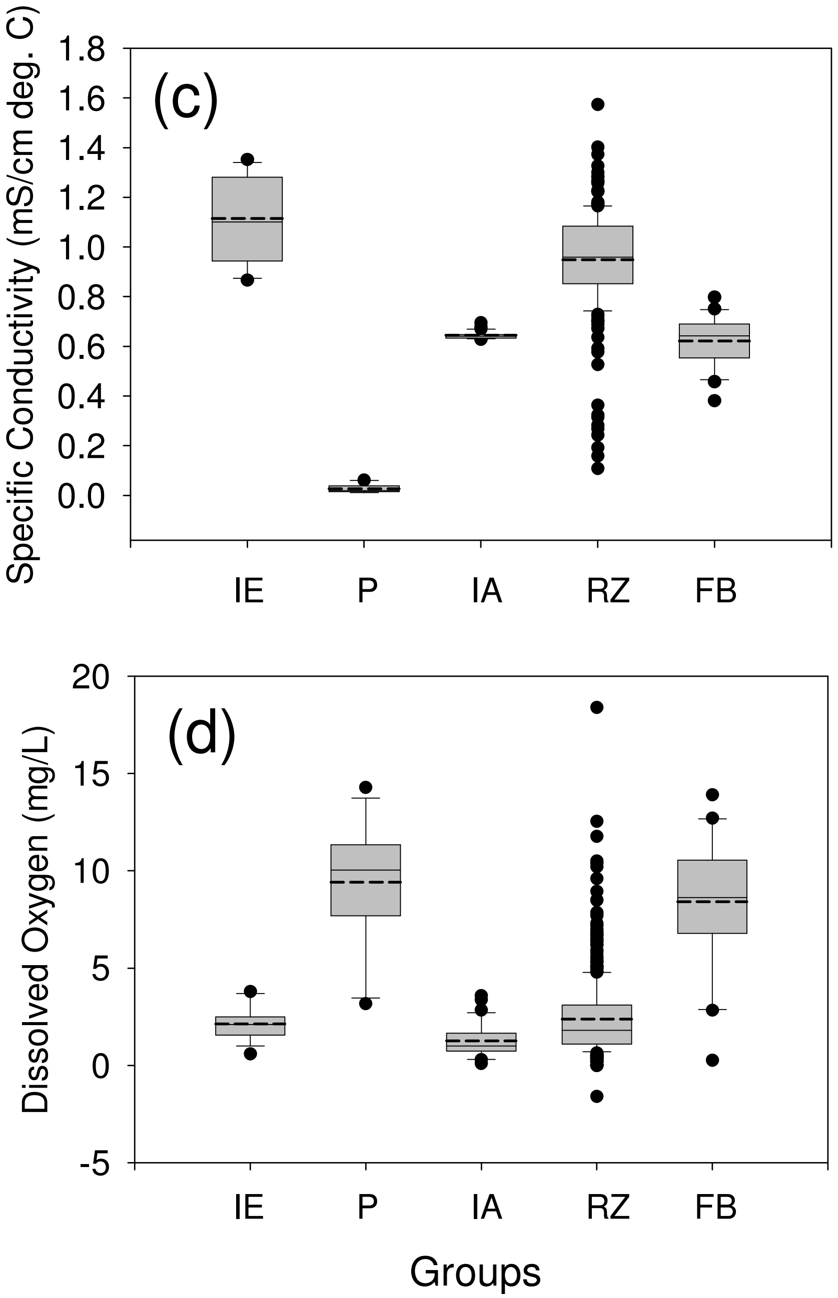
Appendix F (continued). Water chemistry results for all samples collected.

Date	Sampling Location	Ca^{+2} (mg/L)	Mg^{+2} (mg/L)	K^{+} (mg/L)	Na^{+} (mg/L)	Alkalinity (mg/L)	NH^{+3} (mg/L)	SiO$_2$ (mg/L)
3/10/2006	10	114.74	32.65	1.25	43.81	304.14	0.07	3.78
3/10/2006	10a	107.37	29.75	1.19	54.48	325.76	0.10	2.71
3/10/2006	10b	119.76	32.76	0.40	59.12	339.09	0.09	3.25
3/10/2006	10c	128.97	35.92	1.29	54.53	376.19	0.22	3.88
3/10/2006	11	107.94	29.94	1.46	63.08	312.74	0.05	3.05
3/10/2006	11a	116.04	34.04	0.40	64.80	318.05	0.10	2.94
3/10/2006	11b	115.95	33.31	1.20	67.27	338.90	0.09	2.98
3/10/2006	11c	109.78	30.59	1.31	64.58	251.22	0.15	3.28
3/10/2006	12	28.84	8.69	0.40	25.27	155.37	0.07	3.58
3/10/2006	12a	0.65	8.88	0.40	41.78	123.57	0.07	2.46
3/10/2006	12b	63.68	17.03	0.40	20.51	262.07	0.07	2.28
3/10/2006	12c	107.86	31.03	1.25	46.53	328.20	0.10	3.64
3/10/2006	13	104.99	26.00	1.25	17.18	323.59	0.09	4.37
3/10/2006	13b	93.45	21.23	1.46	82.80	451.88	0.05	6.76
3/10/2006	13c	106.32	28.92	0.40	32.53	330.49	0.09	3.36
3/10/2006	14	95.41	22.68	1.21	23.52	339.52	0.07	2.70
3/10/2006	14a	91.69	21.59	1.20	23.10	364.04	0.09	2.53
3/10/2006	14b	103.84	21.20	0.40	31.99	334.90	0.06	3.17
3/10/2006	14c	105.51	29.22	1.40	50.37	307.84	0.09	3.45
3/10/2006	15	124.01	35.58	0.40	61.52	347.92	0.09	5.45
3/10/2006	Surf. Wtr	103.64	30.48	1.80	50.51	332.28	0.06	3.35
3/10/2006	Tom Peine	61.53	28.60	1.32	58.40	394.31	0.69	5.60

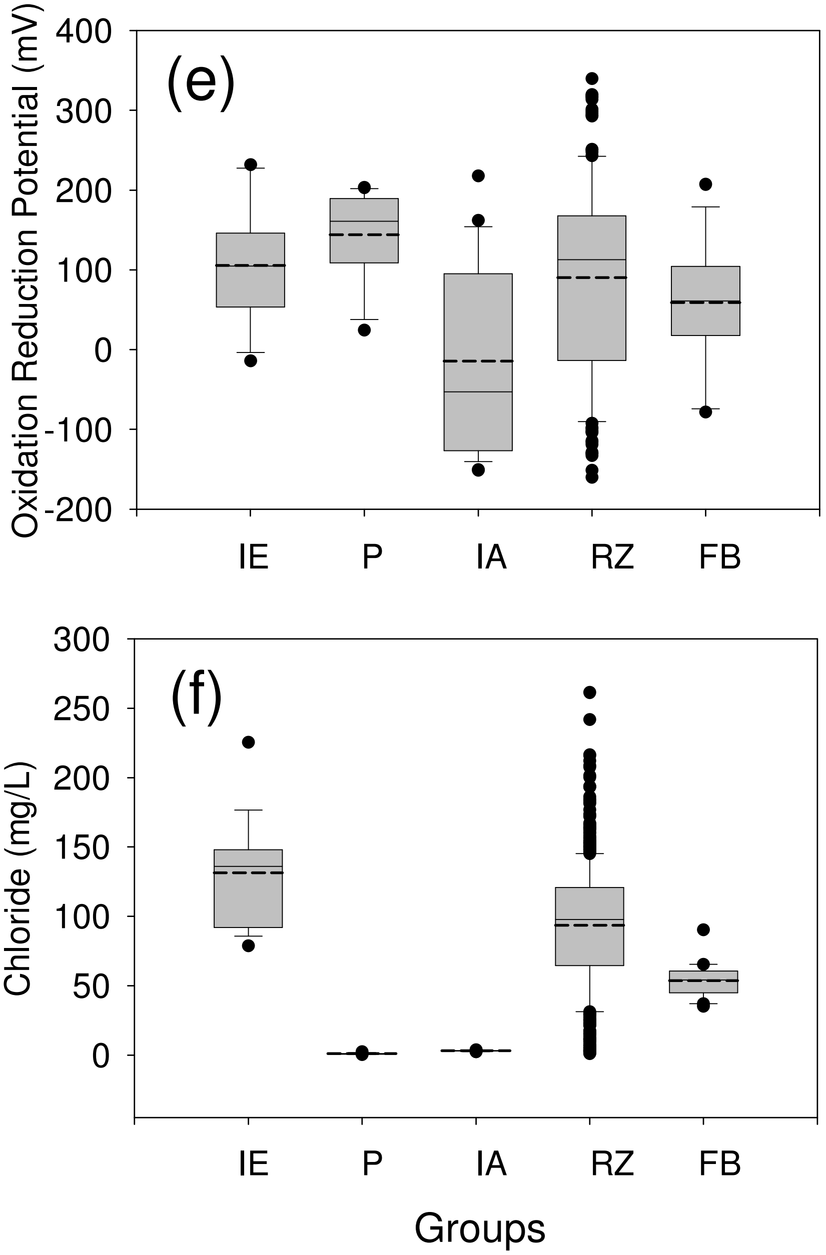
Appendix F (continued). Water chemistry results for all samples collected.



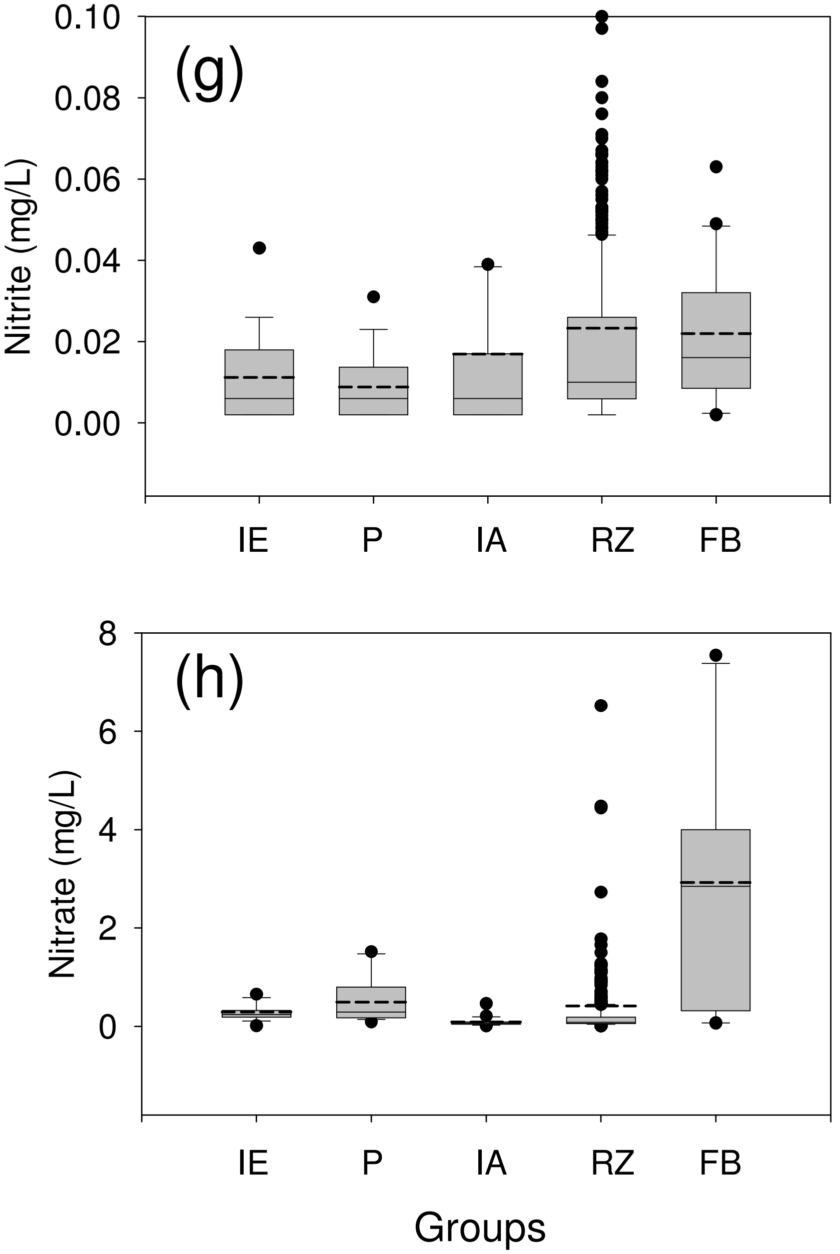
Appendix G. Box plots comparing water chemistry results for temperature (a) and pH (b) for all dates. The bottom and top of the box represent the 25th and 75th percentiles, respectively, for each data set. The bottom and top whiskers represent the 10th and 90th percentiles, respectively. The solid line within each box is the median and the dashed line is the mean. Outliers are plotted as points outside of the whiskers representing the 10th and 90th percentiles. Sample group labels: IE = intertill water; P = precipitation; IA = intratill water; RZ = riparian zone samples; and FB = Fishback Creek. Temperature values for precipitation are not shown because the sample was collected after the event making temperature readings simply a reflection of air temperature.



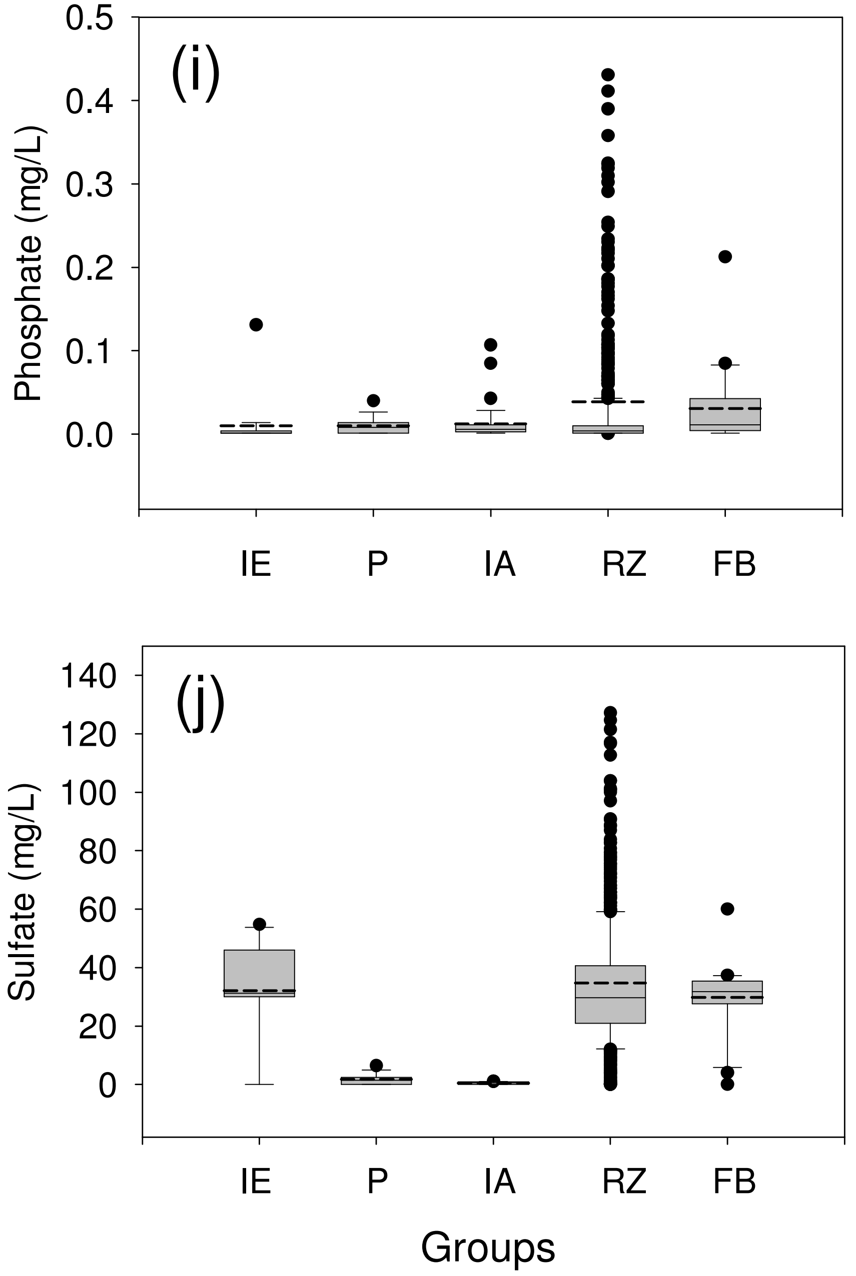
Appendix G (continued). Box plots comparing water chemistry results for specific conductivity (c) and dissolved oxygen (d) for all dates. The bottom and top of the box represent the 25th and 75th percentiles, respectively, for each data set. The bottom and top whiskers represent the 10th and 90th percentiles, respectively. The solid line within each box is the median and the dashed line is the mean. Outliers are plotted as points outside of the whiskers representing the 10th and 90th percentiles. Sample group labels: IE = intertill water; P = precipitation; IA = intratill water; RZ = riparian zone samples; and FB = Fishback Creek.



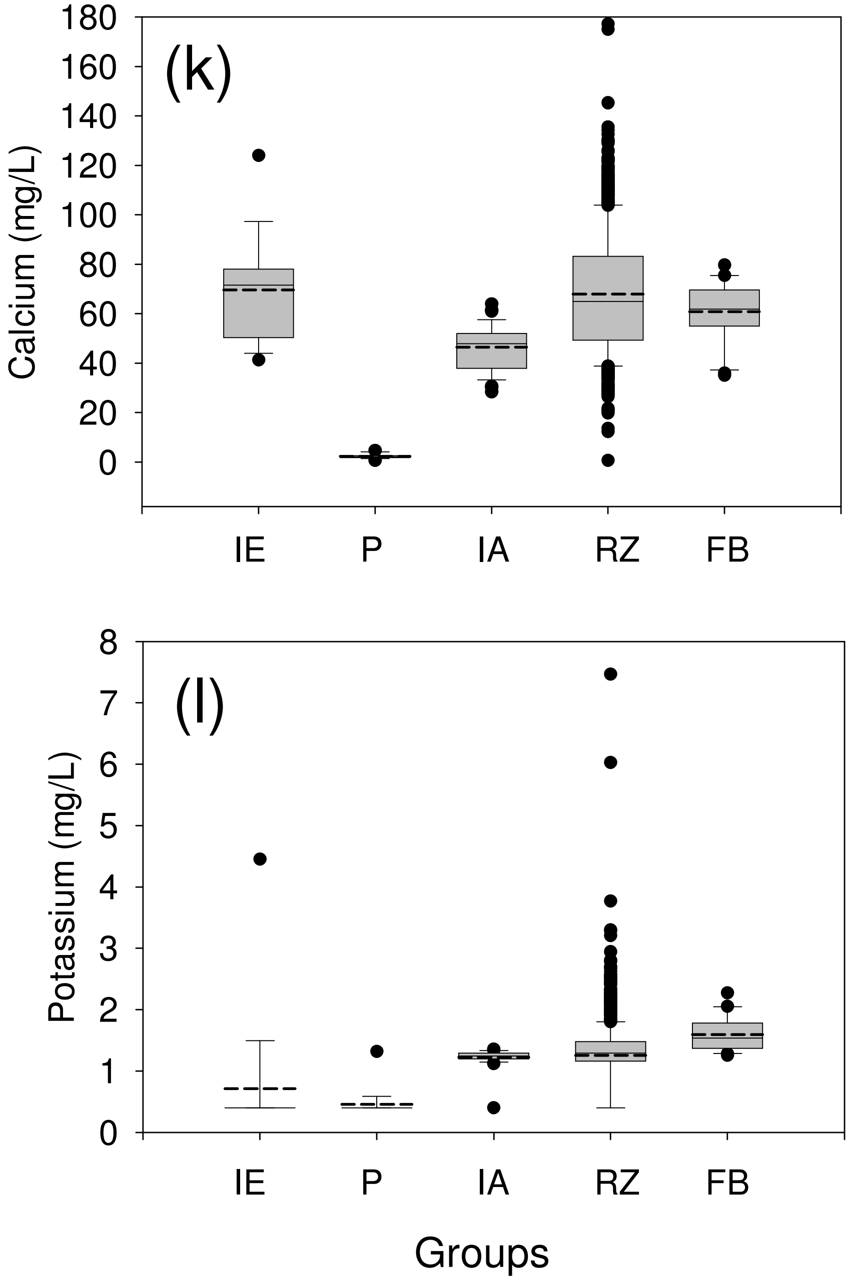
Appendix G (continued). Box plots comparing water chemistry results for oxidation reduction potential (e) and chloride (f) for all dates. The bottom and top of the box represent the 25th and 75th percentiles, respectively, for each data set. The bottom and top whiskers represent the 10th and 90th percentiles, respectively. The solid line within each box is the median and the dashed line is the mean. Outliers are plotted as points outside of the whiskers representing the 10th and 90th percentiles. Sample group labels: IE = intertill water; P = precipitation; IA = intratill water; RZ = riparian zone samples; and FB = Fishback Creek.



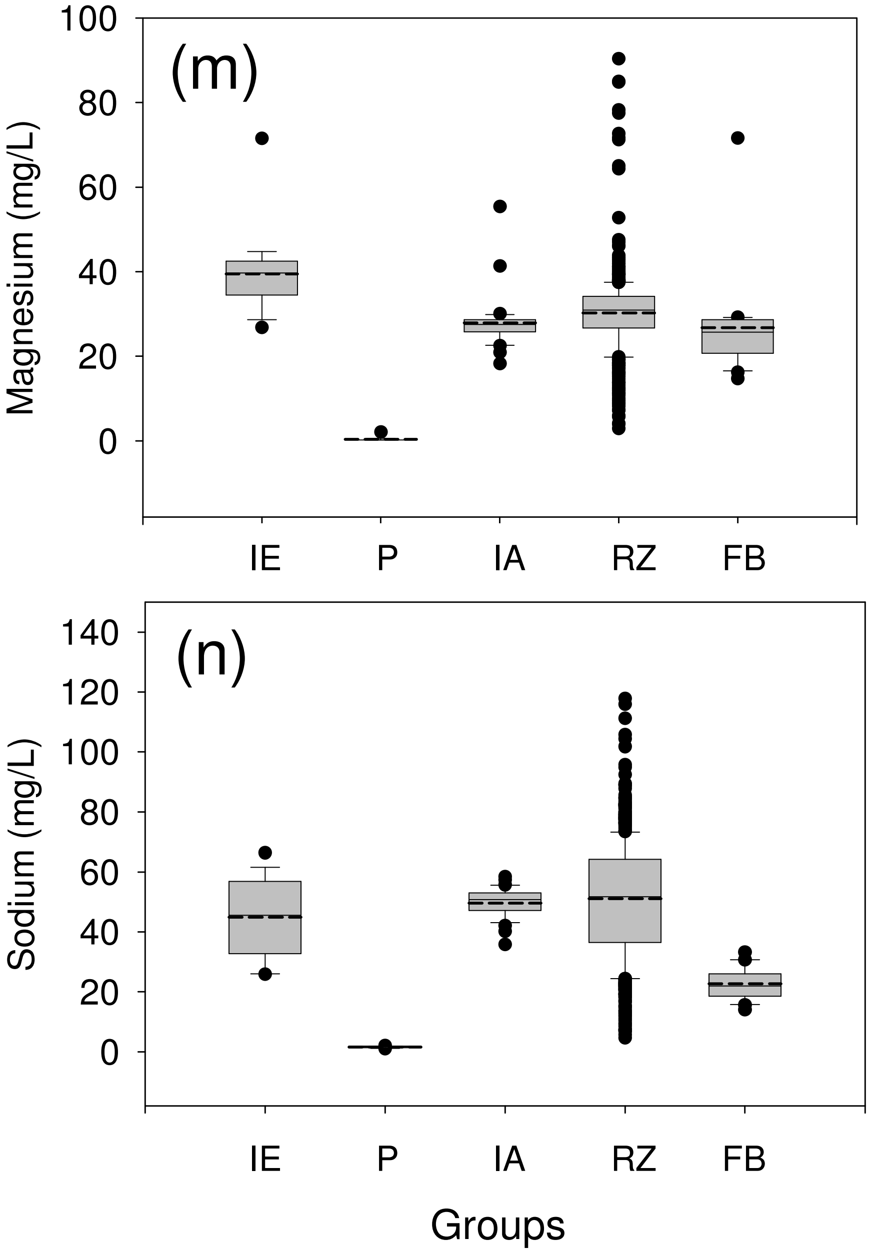
Appendix G (continued). Box plots comparing water chemistry results for nitrite (g) and nitrate (h) for all dates. The bottom and top of the box represent the 25th and 75th percentiles, respectively, for each data set. The bottom and top whiskers represent the 10th and 90th percentiles, respectively. The solid line within each box is the median and the dashed line is the mean. Outliers are plotted as points outside of the whiskers representing the 10th and 90th percentiles. Sample group labels: IE = intertill water; P = precipitation; IA = intratill water; RZ = riparian zone samples; and FB = Fishback Creek.



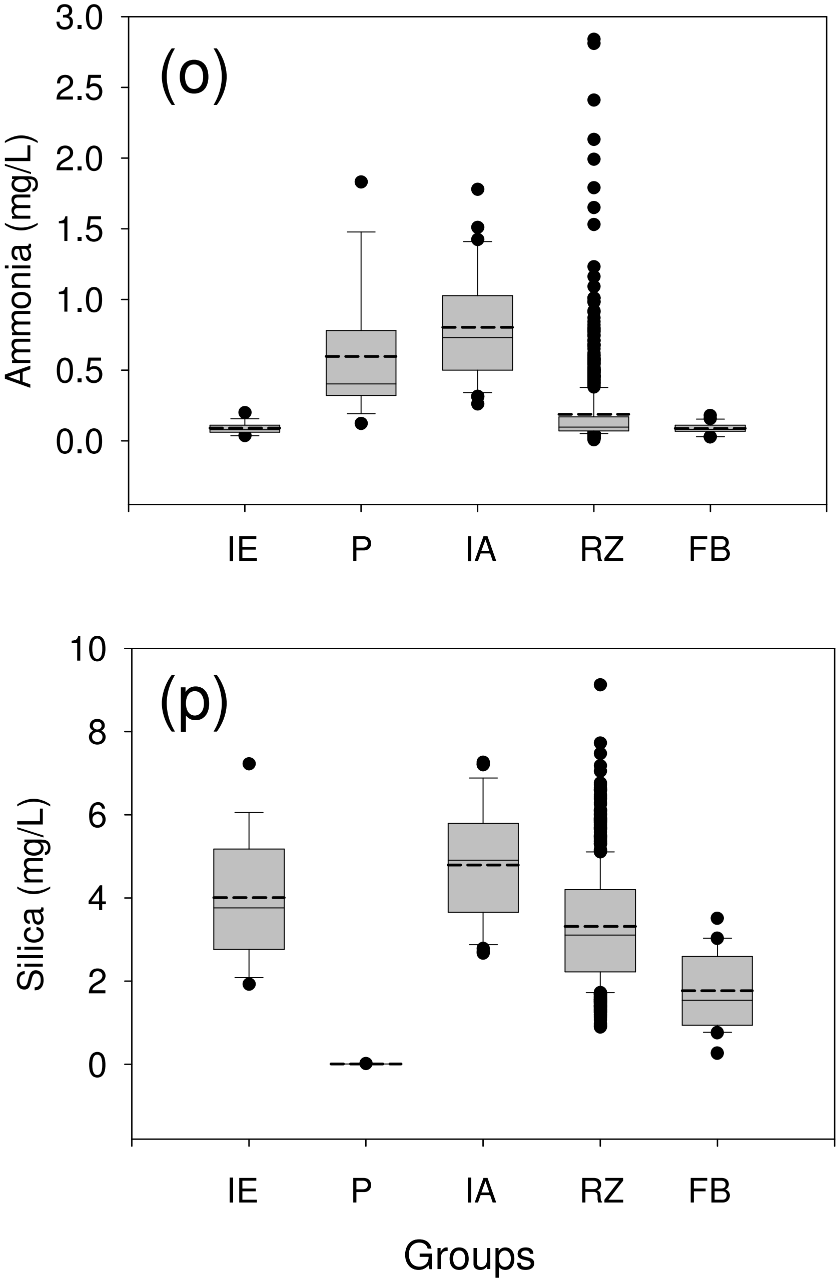
Appendix G (continued). Box plots comparing water chemistry results for phosphate (i) and sulfate (j) for all dates. The bottom and top of the box represent the 25th and 75th percentiles, respectively, for each data set. The bottom and top whiskers represent the 10th and 90th percentiles, respectively. The solid line within each box is the median and the dashed line is the mean. Outliers are plotted as points outside of the whiskers representing the 10th and 90th percentiles. Sample group labels: IE = intertill water; P = precipitation; IA = intratill water; RZ = riparian zone samples; and FB = Fishback Creek.



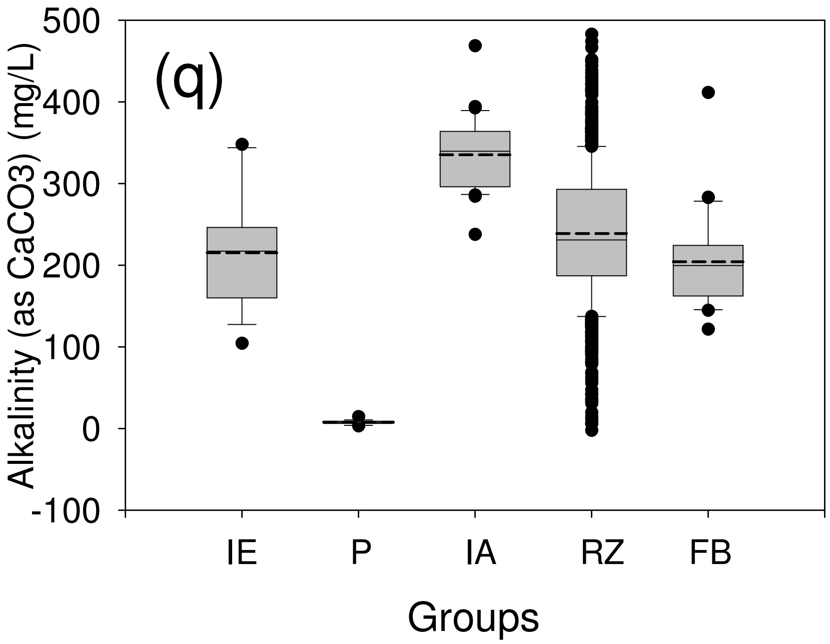
Appendix G (continued). Box plots comparing water chemistry results for calcium (k) and potassium (l) for all dates. The bottom and top of the box represent the25th and 75th percentiles, respectively, for each data set. The bottom and top whiskers represent the 10th and 90th percentiles, respectively. The solid line within each box is the median and the dashed line is the mean. Outliers are plotted as points outside of the whiskers representing the 10th and 90th percentiles. Sample group labels: IE = intertill water; P = precipitation; IA = intratill water; RZ = riparian zone samples; and FB = Fishback Creek.



Appendix G (continued). Box plots comparing water chemistry results for magnesium (m) and sodium (n) for all dates. The bottom and top of the box represent the 25th and 75th percentiles, respectively, for each data set. The bottom and top whiskers represent the 10th and 90th percentiles, respectively. The solid line within each box is the median and the dashed line is the mean. Outliers are plotted as points outside of the whiskers representing the 10th and 90th percentiles. Sample group labels: IE = intertill water; P = precipitation; IA = intratill water; RZ = riparian zone samples; and FB = Fishback Creek.



Appendix G (continued). Box plots comparing water chemistry results for ammonia (o) and silica (p) for all dates. The bottom and top of the box represent the 25th and 75th percentiles, respectively, for each data set. The bottom and top whiskers represent the 10th and 90th percentiles, respectively. The solid line within each box is the median and the dashed line is the mean. Outliers are plotted as points outside of the whiskers representing the 10th and 90th percentiles. Sample group labels: IE = intertill water; P = precipitation; IA = intratill water; RZ = riparian zone samples; and FB = Fishback Creek.



Appendix G (continued). Box plots comparing water chemistry results for alkalinity (q) for all dates. The bottom and top of the box represent the 25th and 75th percentiles, respectively, for each data set. The bottom and top whiskers represent the 10th and 90th percentiles, respectively. The solid line within each box is the median and the dashed line is the mean. Outliers are plotted as points outside ofthe whiskers representing the 10th and 90th percentiles. Sample group labels: IE = intertill water; P = precipitation; IA = intratill water; RZ = riparian zone samples; and FB = Fishback Creek.

		Groups Being Compared			
Test #	**Parameter**	**First Data Set (high water table conditions)**	**Second Data Set (low water table conditions)**	**p value**	**Statistically Similar (p > 0.05)?**
1	SiO_2	IE	IE	0.92276	YES
2	SiO_2	P	P	0.42383	YES
3	SiO_2	IA	IA	0.95835	YES
4	SiO_2	RZ	RZ	4.24×10^{-8}	NO
5	SiO_2	FB	FB	0.46357	YES
6	Cl^-	IE	IE	0.13785	YES
7	Cl^-	P	P	0.50111	YES
8	Cl^-	IA	IA	0.48802	YES
9	Cl^-	RZ	RZ	0.00525	NO
10	Cl^-	FB	FB	0.99136	YES
11	NO_2^-	IE	IE	0.27374	YES
12	NO_2^-	P	P	0.10744	YES
13	NO_2^-	IA	IA	0.14361	YES
14	NO_2^-	RZ	RZ	0.01156	NO
15	NO_2^-	FB	FB	0.04780	NO
16	SO_4^{-2}	IE	IE	0.14147	YES
17	SO_4^{-2}	P	P	0.32575	YES
18	SO_4^{-2}	IA	IA	0.04328	NO
19	SO_4^{-2}	RZ	RZ	0.00046	NO
20	SO_4^{-2}	FB	FB	0.11036	YES
21	NO_3^-	IE	IE	0.26564	YES
22	NO_3^-	P	P	0.50334	YES
23	NO_3^-	IA	IA	0.16474	YES
24	NO_3^-	RZ	RZ	0.33147	YES
25	NO_3^-	FB	FB	0.00928	NO
26	PO_4^{-3}	IE	IE	0.44275	YES
27	PO_4^{-3}	P	P	0.34635	YES
28	PO_4^{-3}	IA	IA	0.95631	YES
29	PO_4^{-3}	RZ	RZ	0.79794	YES
30	PO_4^{-3}	FB	FB	0.29908	YES
31	Alkalinity	IE	IE	0.36501	YES
32	Alkalinity	P	P	0.68225	YES
33	Alkalinity	IA	IA	0.46394	YES
34	Alkalinity	RZ	RZ	3.85×10^{-6}	NO
35	Alkalinity	FB	FB	0.88384	YES

Appendix H. Results of t-tests testing for seasonal variation between samples collected during high and low water table conditions. IE = intertill water; P = precipitation; IA = intratill water; RZ = riparian zone water; FB = Fishback Creek.

		Groups Being Compared			
Test #	**Parameter**	**First Data Set (high water table conditions)**	**Second Data Set (low water table conditions)**	**p value**	**Statistically Similar ($p > 0.05$)?**
36	NH_3	IE	IE	0.84283	YES
37	NH_3	P	P	0.87445	YES
38	NH_3	IA	IA	0.84921	YES
39	NH_3	RZ	RZ	0.54224	YES
40	NH_3	FB	FB	0.57526	YES
41	Ca^{+2}	IE	IE	0.09410	YES
42	Ca^{+2}	P	P	0.89485	YES
43	Ca^{+2}	IA	IA	0.01205	NO
44	Ca^{+2}	RZ	RZ	0.00018	NO
45	Ca^{+2}	FB	FB	0.51901	YES
46	Mg^{+2}	IE	IE	0.85798	YES
47	Mg^{+2}	P	P	0.45500	YES
48	Mg^{+2}	IA	IA	0.52666	YES
49	Mg^{+2}	RZ	RZ	0.07827	YES
50	Mg^{+2}	FB	FB	0.34205	YES
51	K^+	IE	IE	0.90520	YES
52	K^+	P	P	0.45769	YES
53	K^+	IA	IA	0.13092	YES
54	K^+	RZ	RZ	2.27 x 10^{-7}	NO
55	K^+	FB	FB	0.07822	YES
56	Na^+	IE	IE	0.27584	YES
57	Na^+	P	P	0.77108	YES
58	Na^+	IA	IA	0.63672	YES
59	Na^+	RZ	RZ	0.00019	NO
60	Na^+	FB	FB	0.87804	YES

Source water groups (IE, P, IA)	# of t-tests indicating water chemistry between high and low water table conditions is statistically similar =	34
	# of t-tests indicating water chemistry between high and low water table conditions is statistically different =	2

Riparian zone samples	# of t-tests indicating water chemistry between high and low water table conditions is statistically similar =	4
	# of t-tests indicating water chemistry between high and low water table conditions is statistically different =	8

Appendix H. (continued)

Location	Date	Group	Predicted
15	3/29/2005	IE	IE
15	4/14/2005	IE	IE
15	5/2/2005	IE	IE
15	5/17/2005	IE	IE
15	6/2/2005	IE	IE
15	6/20/2005	IE	IE
15	7/11/2005	IE	IE
15	8/1/2005	IE	IE
15	8/18/2005	IE	IE
15	9/9/2005	IE	IE
15	9/29/2005	IE	IE
15	10/21/2005	IE	IE
15	11/10/2005	IE	IE
15	12/1/2005	IE	IE
15	12/29/2005	IE	IE
15	1/11/2006	IE	IE
15	1/30/2006	IE	IE
15	2/24/2006	IE	IE
15	3/10/2006	IE	IE

Location	Date	Group	Predicted
P	4/7/2005	P	P
P	4/26/2005	P	P
P	4/30/2005	P	P
P	7/11/2005	P	P
P	8/5/2005	P	P
P	8/19/2005	P	P
P	8/30/2005	P	P
P	9/19/2005	P	P
P	10/20/2005	P	P
P	11/15/2005	P	P
P	12/1/2005	P	P
P	12/28/2005	P	P
P	1/2/2006	P	P
P	1/17/2006	P	P
P	1/28/2006	P	P
P	2/16/2006	P	P
P	3/9/2006	P	P

Appendix I. Discriminant analysis results for each sample. End-members are shown seperately from all other samples. The column labeled "Group" is the designation given to the sample prior to running the discriminant analysis. The column labeled "Predicted" is the end-member the sample was grouped with by discriminant analysis.

Location	Date	Group	Predicted
RW 1	3/29/2005	IA	IA
RW 1	4/14/2005	IA	IA
RW 1	5/2/2005	IA	IA
RW 1	5/17/2005	IA	IA
RW 1	6/2/2005	IA	IA
RW 1	6/20/2005	IA	IA
RW 1	7/11/2005	IA	IA
RW 1	8/1/2005	IA	IA
RW 1	8/18/2005	IA	IA
RW 1	9/9/2005	IA	IA
RW 1	9/29/2005	IA	IA
RW 1	10/21/2005	IA	IA
RW 1	11/10/2005	IA	IA
RW 1	12/1/2005	IA	IA
RW 1	12/29/2005	IA	IA
RW 1	1/30/2006	IA	IA
RW 1	2/24/2006	IA	IA
RW 1	3/10/2006	IA	IA
RW 2	3/29/2005	IA	IA
RW 2	4/14/2005	IA	IA
RW 2	5/2/2005	IA	IA
RW 2	6/2/2005	IA	IA
RW 2	6/20/2005	IA	IA
RW 2	7/11/2005	IA	IA
RW 2	8/1/2005	IA	IA
RW 2	8/18/2005	IA	IA
RW 2	9/9/2005	IA	IA
RW 2	9/29/2005	IA	IA
RW 2	10/21/2005	IA	IA
RW 2	11/10/2005	IA	IA
RW 2	12/1/2005	IA	IA
RW 2	12/29/2005	IA	IA
RW 2	1/30/2006	IA	IA
RW 2	2/24/2006	IA	IA
RW 2	3/10/2006	IA	IA

Appendix I. (continued)

Location	Date	Group	Predicted
Fishback	3/29/2005	--	IE
1	3/29/2005	--	IA
1a	3/29/2005	--	IE
1b	3/29/2005	--	IE
1c	3/29/2005	--	IE
2	3/29/2005	--	IA
2a	3/29/2005	--	IA
2b	3/29/2005	--	IE
2c	3/29/2005	--	IE
3	3/29/2005	--	IE
3a	3/29/2005	--	IE
3b	3/29/2005	--	P
3c	3/29/2005	--	IE
4	3/29/2005	--	IE
4a	3/29/2005	--	IE
4b	3/29/2005	--	IE
4c	3/29/2005	--	IE
5	3/29/2005	--	IA
5a	3/29/2005	--	IE
5b	3/29/2005	--	IE
5c	3/29/2005	--	IE
6	3/29/2005	--	IE
6a	3/29/2005	--	P
6b	3/29/2005	--	IE
6c	3/29/2005	--	IE
7	3/29/2005	--	IE
7b	3/29/2005	--	IA
7c	3/29/2005	--	IE
8	3/29/2005	--	IE
8b	3/29/2005	--	IA
8c	3/29/2005	--	IA
9	3/29/2005	--	IE
9b	3/29/2005	--	IE
9c	3/29/2005	--	IE
10	3/29/2005	--	IE
10a	3/29/2005	--	IE
10b	3/29/2005	--	IE
10c	3/29/2005	--	IE
11	3/29/2005	--	IE
11a	3/29/2005	--	IE
11b	3/29/2005	--	IE
11c	3/29/2005	--	IE
12b	3/29/2005	--	P
12c	3/29/2005	--	IE
13	3/29/2005	--	IE
13c	3/29/2005	--	IE
14	3/29/2005	--	IE
14a	3/29/2005	--	P
14b	3/29/2005	--	IE
14c	3/29/2005	--	IE
Surf. Wtr	3/29/2005	--	IE

Appendix I. (continued)

Location	Date	Group	Predicted
Fishback	4/14/2005	--	IE
1	4/14/2005	--	IA
1a	4/14/2005	--	IE
1b	4/14/2005	--	IE
1c	4/14/2005	--	IE
2	4/14/2005	--	IE
2a	4/14/2005	--	IA
2b	4/14/2005	--	IA
2c	4/14/2005	--	IA
3	4/14/2005	--	IE
3a	4/14/2005	--	IE
3b	4/14/2005	--	IE
3c	4/14/2005	--	IE
4	4/14/2005	--	IE
4a	4/14/2005	--	IE
4b	4/14/2005	--	IE
4c	4/14/2005	--	IE
5	4/14/2005	--	IA
5a	4/14/2005	--	IA
5b	4/14/2005	--	IE
5c	4/14/2005	--	IE
6	4/14/2005	--	IE
6b	4/14/2005	--	IE
6c	4/14/2005	--	IE
7	4/14/2005	--	IE
7b	4/14/2005	--	IA
7c	4/14/2005	--	IE
8	4/14/2005	--	IE
8c	4/14/2005	--	IE
9	4/14/2005	--	IE
9b	4/14/2005	--	IE
9c	4/14/2005	--	IE
10	4/14/2005	--	IE
10a	4/14/2005	--	IE
10b	4/14/2005	--	IE
10c	4/14/2005	--	IE
11	4/14/2005	--	IE
11b	4/14/2005	--	IE
11c	4/14/2005	--	IE
12	4/14/2005	--	IE
12b	4/14/2005	--	P
13	4/14/2005	--	IE
13c	4/14/2005	--	IE
14	4/14/2005	--	IE
14a	4/14/2005	--	P
14b	4/14/2005	--	IE
14c	4/14/2005	--	IE
Surf. Wtr	4/14/2005	--	IE

Appendix I. (continued)

Location	Date	Group	Predicted
Fishback	5/2/2005	--	IE
1	5/2/2005	--	IA
1a	5/2/2005	--	IE
1b	5/2/2005	--	IE
1c	5/2/2005	--	IE
2	5/2/2005	--	IA
2a	5/2/2005	--	IA
2b	5/2/2005	--	IA
2c	5/2/2005	--	IE
3	5/2/2005	--	IE
3a	5/2/2005	--	IE
3b	5/2/2005	--	IE
3c	5/2/2005	--	IE
4	5/2/2005	--	IA
4a	5/2/2005	--	IA
4b	5/2/2005	--	IA
4c	5/2/2005	--	IA
5	5/2/2005	--	IA
5a	5/2/2005	--	IA
5b	5/2/2005	--	IE
5c	5/2/2005	--	IE
6	5/2/2005	--	IE
6a	5/2/2005	--	IA
6b	5/2/2005	--	IE
6c	5/2/2005	--	IE
7	5/2/2005	--	IE
7b	5/2/2005	--	IA
7c	5/2/2005	--	P
8	5/2/2005	--	IE
8b	5/2/2005	--	IA
8c	5/2/2005	--	IA
9	5/2/2005	--	IE
9b	5/2/2005	--	IE
9c	5/2/2005	--	IE
10	5/2/2005	--	IE
10a	5/2/2005	--	IE
10b	5/2/2005	--	IE
10c	5/2/2005	--	IE
11	5/2/2005	--	IE
11a	5/2/2005	--	IA
11b	5/2/2005	--	IE
11c	5/2/2005	--	0
12b	5/2/2005	--	P
12c	5/2/2005	--	IE
13	5/2/2005	--	IE
13c	5/2/2005	--	P
14	5/2/2005	--	IE
14a	5/2/2005	--	P
14b	5/2/2005	--	P
14c	5/2/2005	--	IE
Surf. Wtr	5/2/2005	--	IE

Appendix I. (continued)

Location	Date	Group	Predicted
Fishback	5/2/2005	--	IE
1	5/2/2005	--	IA
1a	5/2/2005	--	IE
1b	5/2/2005	--	IE
1c	5/2/2005	--	IE
2	5/2/2005	--	IA
2a	5/2/2005	--	IA
2b	5/2/2005	--	IA
2c	5/2/2005	--	IE
3	5/2/2005	--	IE
3a	5/2/2005	--	IE
3b	5/2/2005	--	IE
3c	5/2/2005	--	IE
4	5/2/2005	--	IA
4a	5/2/2005	--	IA
4b	5/2/2005	--	IA
4c	5/2/2005	--	IA
5	5/2/2005	--	IA
5a	5/2/2005	--	IA
5b	5/2/2005	--	IE
5c	5/2/2005	--	IE
6	5/2/2005	--	IE
6a	5/2/2005	--	IA
6b	5/2/2005	--	IE
6c	5/2/2005	--	IE
7	5/2/2005	--	IE
7b	5/2/2005	--	IA
7c	5/2/2005	--	P
8	5/2/2005	--	IE
8b	5/2/2005	--	IA
8c	5/2/2005	--	IA
9	5/2/2005	--	IE
9b	5/2/2005	--	IE
9c	5/2/2005	--	IE
10	5/2/2005	--	IE
10a	5/2/2005	--	IE
10b	5/2/2005	--	IE
10c	5/2/2005	--	IE
11	5/2/2005	--	IE
11a	5/2/2005	--	IA
11b	5/2/2005	--	IE
11c	5/2/2005	--	0
12b	5/2/2005	--	P
12c	5/2/2005	--	IE
13	5/2/2005	--	IE
13c	5/2/2005	--	P
14	5/2/2005	--	IE
14a	5/2/2005	--	P
14b	5/2/2005	--	P
14c	5/2/2005	--	IE
Surf. Wtr	5/2/2005	--	IE

Appendix I. (continued)

Location	Date	Group	Predicted
Fishback	6/2/2005	--	IE
1	6/2/2005	--	IA
1a	6/2/2005	--	IE
1b	6/2/2005	--	IA
1c	6/2/2005	--	IA
2	6/2/2005	--	IE
2b	6/2/2005	--	IA
2c	6/2/2005	--	IE
3	6/2/2005	--	IE
3a	6/2/2005	--	IE
3b	6/2/2005	--	IE
3c	6/2/2005	--	IE
4	6/2/2005	--	IE
4b	6/2/2005	--	IE
4c	6/2/2005	--	IA
5	6/2/2005	--	IA
5b	6/2/2005	--	IA
5c	6/2/2005	--	IA
6	6/2/2005	--	IE
6b	6/2/2005	--	IE
6c	6/2/2005	--	IA
7	6/2/2005	--	IE
8	6/2/2005	--	IE
8c	6/2/2005	--	IE
9	6/2/2005	--	IE
9c	6/2/2005	--	IE
10	6/2/2005	--	IE
10b	6/2/2005	--	IE
10c	6/2/2005	--	IA
11	6/2/2005	--	IE
11b	6/2/2005	--	IE
11c	6/2/2005	--	IA
12	6/2/2005	--	IE
12c	6/2/2005	--	IE
13	6/2/2005	--	IE
13c	6/2/2005	--	IE
14	6/2/2005	--	IE
14c	6/2/2005	--	IE

Appendix I. (continued)

Location	**Date**	**Group**	**Predicted**
Fishback	6/20/2005	--	IE
1	6/20/2005	--	IA
1b	6/20/2005	--	IA
1c	6/20/2005	--	IA
2	6/20/2005	--	IE
2b	6/20/2005	--	IE
2c	6/20/2005	--	IA
3	6/20/2005	--	IE
3b	6/20/2005	--	IA
3c	6/20/2005	--	IE
4	6/20/2005	--	IA
4b	6/20/2005	--	IA
4c	6/20/2005	--	IA
5	6/20/2005	--	IA
5c	6/20/2005	--	IA
6	6/20/2005	--	IE
6b	6/20/2005	--	IE
6c	6/20/2005	--	IE
7	6/20/2005	--	IE
7c	6/20/2005	--	IE
8	6/20/2005	--	IE
8c	6/20/2005	--	IE
9	6/20/2005	--	IE
9c	6/20/2005	--	IE
10	6/20/2005	--	IE
10b	6/20/2005	--	IA
10c	6/20/2005	--	IE
11	6/20/2005	--	IE
11b	6/20/2005	--	IE
11c	6/20/2005	--	IE
12	6/20/2005	--	IE
12c	6/20/2005	--	IE
13	6/20/2005	--	IE
13c	6/20/2005	--	IE
14	6/20/2005	--	IA
14b	6/20/2005	--	IE
14c	6/20/2005	--	IE

Appendix I. (continued)

Location	Date	Group	Predicted
Fishback	7/11/2005	--	IE
1	7/11/2005	--	IA
1c	7/11/2005	--	IE
2	7/11/2005	--	IA
2c	7/11/2005	--	IE
3	7/11/2005	--	IE
3c	7/11/2005	--	IE
4	7/11/2005	--	IE
4c	7/11/2005	--	IE
5	7/11/2005	--	IE
5c	7/11/2005	--	IE
6	7/11/2005	--	IE
6c	7/11/2005	--	IA
10	7/11/2005	--	IE
11	7/11/2005	--	IE
11c	7/11/2005	--	IE
14	7/11/2005	--	IA
14c	7/11/2005	--	IE

Location	Date	Group	Predicted
Fishback	7/22/2005	--	P
1	7/22/2005	--	IA
1b	7/22/2005	--	IE
1c	7/22/2005	--	IE
2	7/22/2005	--	IA
2c	7/22/2005	--	IA
6	7/22/2005	--	IE
6c	7/22/2005	--	IA
8c	7/22/2005	--	IE
9c	7/22/2005	--	IE

Appendix I. (continued)

Location	Date	Group	Predicted
Fishback	8/1/2005	--	IE
1	8/1/2005	--	IA
2	8/1/2005	--	IA
2c	8/1/2005	--	IA
3	8/1/2005	--	IE
3c	8/1/2005	--	IA
4	8/1/2005	--	IA
4c	8/1/2005	--	IA
5	8/1/2005	--	IA
5c	8/1/2005	--	IE
6	8/1/2005	--	IA
6c	8/1/2005	--	IA
8c	8/1/2005	--	IE
9c	8/1/2005	--	IE
10	8/1/2005	--	IA
11	8/1/2005	--	IE
12	8/1/2005	--	IE
14	8/1/2005	--	IA
14c	8/1/2005	--	IE

Appendix I. (continued)

Location	Date	Group	Predicted
Fishback	8/18/2005	--	IE
2c	8/18/2005	--	IE
3	8/18/2005	--	IE
4	8/18/2005	--	IE
4c	8/18/2005	--	IE
5	8/18/2005	--	IE
5c	8/18/2005	--	IE
6	8/18/2005	--	IE
6c	8/18/2005	--	IE
10	8/18/2005	--	IE
14	8/18/2005	--	IE
14c	8/18/2005	--	IE

Location	Date	Group	Predicted
Fishback	9/9/2005	--	P
2c	9/9/2005	--	IE
4	9/9/2005	--	IA
4c	9/9/2005	--	IE
5c	9/9/2005	--	IA
6	9/9/2005	--	IE
14	9/9/2005	--	IA
14c	9/9/2005	--	IA

Appendix I. (continued)

Location	Date	Group	Predicted
Fishback	9/29/2005	--	IE
1	9/29/2005	--	IE
1c	9/29/2005	--	IE
2	9/29/2005	--	IE
2c	9/29/2005	--	IE
3	9/29/2005	--	IE
3c	9/29/2005	--	IE
4	9/29/2005	--	IE
4b	9/29/2005	--	IE
4c	9/29/2005	--	IA
5	9/29/2005	--	IE
5b	9/29/2005	--	IE
5c	9/29/2005	--	IE
6	9/29/2005	--	IE
6c	9/29/2005	--	IE
8	9/29/2005	--	IE
8c	9/29/2005	--	IA
9	9/29/2005	--	IE
9c	9/29/2005	--	IE
10	9/29/2005	--	IE
10b	9/29/2005	--	IE
10c	9/29/2005	--	IE
11	9/29/2005	--	IE
11c	9/29/2005	--	IE
12	9/29/2005	--	IA
12c	9/29/2005	--	IE
13	9/29/2005	--	IE
13c	9/29/2005	--	IE
14	9/29/2005	--	IE
14b	9/29/2005	--	IE
14c	9/29/2005	--	IE

Appendix I. (continued)

Location	Date	Group	Predicted
Fishback	10/21/2005	--	IE
1	10/21/2005	--	IE
2	10/21/2005	--	IE
2c	10/21/2005	--	IE
3	10/21/2005	--	IE
3c	10/21/2005	--	IE
4	10/21/2005	--	IE
4c	10/21/2005	--	IA
5	10/21/2005	--	IE
5b	10/21/2005	--	IE
5c	10/21/2005	--	IE
6	10/21/2005	--	IE
6c	10/21/2005	--	IE
8	10/21/2005	--	IE
8c	10/21/2005	--	IE
9	10/21/2005	--	IE
9c	10/21/2005	--	IE
10	10/21/2005	--	IE
10c	10/21/2005	--	IA
11	10/21/2005	--	IE
11c	10/21/2005	--	IE
12	10/21/2005	--	IE
12c	10/21/2005	--	IE
13	10/21/2005	--	IE
13c	10/21/2005	--	IE
14	10/21/2005	--	IE
14c	10/21/2005	--	IE

Appendix I. (continued)

Location	Date	Group	Predicted
Fishback	11/10/2005	--	IE
1	11/10/2005	--	IE
1c	11/10/2005	--	IE
2	11/10/2005	--	IA
2c	11/10/2005	--	IA
3	11/10/2005	--	IE
3c	11/10/2005	--	IE
4	11/10/2005	--	IA
4b	11/10/2005	--	IA
4c	11/10/2005	--	IA
5	11/10/2005	--	IE
5b	11/10/2005	--	IE
5c	11/10/2005	--	IE
6	11/10/2005	--	IE
6c	11/10/2005	--	IE
7	11/10/2005	--	IE
8	11/10/2005	--	IE
8c	11/10/2005	--	IE
9	11/10/2005	--	IE
9c	11/10/2005	--	P
10	11/10/2005	--	IE
10b	11/10/2005	--	IE
11	11/10/2005	--	IE
11b	11/10/2005	--	IE
11c	11/10/2005	--	IE
12	11/10/2005	--	IE
12c	11/10/2005	--	IE
13	11/10/2005	--	IE
13c	11/10/2005	--	IE
14	11/10/2005	--	IE
14b	11/10/2005	--	IE
14c	11/10/2005	--	IE

Appendix I. (continued)

Location	**Date**	**Group**	**Predicted**
Fishback	12/1/2005	--	IE
1	12/1/2005	--	IE
1b	12/1/2005	--	IE
1c	12/1/2005	--	IE
2	12/1/2005	--	IE
2b	12/1/2005	--	IE
2c	12/1/2005	--	IE
3	12/1/2005	--	IE
3b	12/1/2005	--	IE
3c	12/1/2005	--	IE
4	12/1/2005	--	IE
4a	12/1/2005	--	IE
4b	12/1/2005	--	IE
4c	12/1/2005	--	IE
5	12/1/2005	--	P
5b	12/1/2005	--	IE
5c	12/1/2005	--	IE
6	12/1/2005	--	IE
6b	12/1/2005	--	P
6c	12/1/2005	--	IE
7	12/1/2005	--	IE
7c	12/1/2005	--	IE
8	12/1/2005	--	P
8c	12/1/2005	--	P
9	12/1/2005	--	IE
9b	12/1/2005	--	IE
9c	12/1/2005	--	P
10	12/1/2005	--	P
10b	12/1/2005	--	IE
10c	12/1/2005	--	IE
11	12/1/2005	--	IE
11b	12/1/2005	--	IE
11c	12/1/2005	--	IE
12b	12/1/2005	--	IA
12c	12/1/2005	--	IE
13	12/1/2005	--	IE
13b	12/1/2005	--	IE
13c	12/1/2005	--	IE
14	12/1/2005	--	IE
14b	12/1/2005	--	IA
14c	12/1/2005	--	IE

Appendix I. (continued)

Location	Date	Group	Predicted
Fishback	12/29/2005	--	IE
1	12/29/2005	--	IE
1a	12/29/2005	--	IE
1b	12/29/2005	--	IE
1c	12/29/2005	--	IE
2	12/29/2005	--	IA
2a	12/29/2005	--	IA
2b	12/29/2005	--	IE
2c	12/29/2005	--	IA
3	12/29/2005	--	IE
3a	12/29/2005	--	IE
3b	12/29/2005	--	IE
3c	12/29/2005	--	IE
4	12/29/2005	--	IE
4a	12/29/2005	--	IE
4b	12/29/2005	--	IE
4c	12/29/2005	--	IE
5	12/29/2005	--	IE
5a	12/29/2005	--	IA
5b	12/29/2005	--	IE
5c	12/29/2005	--	IE
6	12/29/2005	--	P
6a	12/29/2005	--	P
6b	12/29/2005	--	P
6c	12/29/2005	--	IE
7	12/29/2005	--	P
7a	12/29/2005	--	P
7b	12/29/2005	--	IE
7c	12/29/2005	--	IE
8b	12/29/2005	--	IA
8c	12/29/2005	--	IE
9	12/29/2005	--	IE
9b	12/29/2005	--	IE
9c	12/29/2005	--	IE
10	12/29/2005	--	IE
10a	12/29/2005	--	IA
10b	12/29/2005	--	IE
10c	12/29/2005	--	IE
11	12/29/2005	--	IA
11a	12/29/2005	--	IE
11b	12/29/2005	--	IE
11c	12/29/2005	--	IE
12a	12/29/2005	--	IA
12b	12/29/2005	--	IA
12c	12/29/2005	--	IE
13	12/29/2005	--	IE
13b	12/29/2005	--	IE
13c	12/29/2005	--	IE
14	12/29/2005	--	S
14a	12/29/2005	--	P
14b	12/29/2005	--	RW
14c	12/29/2005	--	S

Appendix I. (continued)

Location	Date	Group	Predicted
Fishback	1/11/2006	--	IE
1	1/11/2006	--	IE
1a	1/11/2006	--	IE
1b	1/11/2006	--	IE
1c	1/11/2006	--	IE
2	1/11/2006	--	IA
2a	1/11/2006	--	IA
2b	1/11/2006	--	IE
2c	1/11/2006	--	IE
3	1/11/2006	--	IE
3a	1/11/2006	--	IE
3b	1/11/2006	--	IE
3c	1/11/2006	--	IE
4	1/11/2006	--	IE
4a	1/11/2006	--	IE
4b	1/11/2006	--	IE
4c	1/11/2006	--	IE
5	1/11/2006	--	IE
5a	1/11/2006	--	IE
5b	1/11/2006	--	IE
5c	1/11/2006	--	IE
6	1/11/2006	--	P
6a	1/11/2006	--	P
6b	1/11/2006	--	IE
6c	1/11/2006	--	IE
7	1/11/2006	--	IE
7b	1/11/2006	--	IA
7c	1/11/2006	--	IE
8	1/11/2006	--	IE
8b	1/11/2006	--	IA
8c	1/11/2006	--	P
9	1/11/2006	--	IE
9b	1/11/2006	--	IE
9c	1/11/2006	--	IE
10	1/11/2006	--	IE
10a	1/11/2006	--	IE
10b	1/11/2006	--	IE
10c	1/11/2006	--	IE
11	1/11/2006	--	IE
11a	1/11/2006	--	IE
11b	1/11/2006	--	IE
11c	1/11/2006	--	IE
12b	1/11/2006	--	IA
12c	1/11/2006	--	IA
13	1/11/2006	--	IE
13b	1/11/2006	--	IE
13c	1/11/2006	--	IE
14	1/11/2006	--	IE
14a	1/11/2006	--	P
14b	1/11/2006	--	IA
14c	1/11/2006	--	P
Surf. Wtr	1/11/2006	--	IE

Appendix I. (continued)

Location	Date	Group	Predicted
Fishback	1/30/2006	--	IE
1	1/30/2006	--	IE
1a	1/30/2006	--	IE
1b	1/30/2006	--	IE
1c	1/30/2006	--	IE
2	1/30/2006	--	IA
2a	1/30/2006	--	IA
2b	1/30/2006	--	IE
2c	1/30/2006	--	IE
3	1/30/2006	--	IE
3a	1/30/2006	--	IE
3b	1/30/2006	--	IE
3c	1/30/2006	--	IE
4	1/30/2006	--	IE
4a	1/30/2006	--	IE
4b	1/30/2006	--	IE
4c	1/30/2006	--	IA
5	1/30/2006	--	IE
5a	1/30/2006	--	IE
5b	1/30/2006	--	IA
5c	1/30/2006	--	IE
6	1/30/2006	--	P
6a	1/30/2006	--	IE
6b	1/30/2006	--	IE
6c	1/30/2006	--	IE
7	1/30/2006	--	P
7a	1/30/2006	--	IA
7b	1/30/2006	--	IE
7c	1/30/2006	--	IE
8	1/30/2006	--	P
8b	1/30/2006	--	IA
8c	1/30/2006	--	IE
9	1/30/2006	--	IE
9b	1/30/2006	--	IE
9c	1/30/2006	--	IE
10	1/30/2006	--	IE
10a	1/30/2006	--	IE
10b	1/30/2006	--	IE
10c	1/30/2006	--	IE
11	1/30/2006	--	IE
11a	1/30/2006	--	IE
11b	1/30/2006	--	IE
11c	1/30/2006	--	IE
12b	1/30/2006	--	IA
12c	1/30/2006	--	IE
13	1/30/2006	--	IE
13b	1/30/2006	--	IE
13c	1/30/2006	--	IE
14	1/30/2006	--	IE
14b	1/30/2006	--	IA
14c	1/30/2006	--	IE
Surf. Wtr	1/30/2006	--	IE

Appendix I. (continued)

Location	Date	Group	Predicted
Fishback	2/24/2006	--	IE
1	2/24/2006	--	IE
1a	2/24/2006	--	IE
1b	2/24/2006	--	IE
1c	2/24/2006	--	IE
2	2/24/2006	--	IE
2a	2/24/2006	--	IA
2b	2/24/2006	--	IE
2c	2/24/2006	--	IE
3	2/24/2006	--	IE
3a	2/24/2006	--	IE
3b	2/24/2006	--	IE
3c	2/24/2006	--	IE
4	2/24/2006	--	IE
4a	2/24/2006	--	IE
4b	2/24/2006	--	IE
4c	2/24/2006	--	IE
5	2/24/2006	--	IE
5a	2/24/2006	--	IE
5b	2/24/2006	--	IE
5c	2/24/2006	--	IE
6	2/24/2006	--	IE
6a	2/24/2006	--	IE
6b	2/24/2006	--	IE
6c	2/24/2006	--	IA
7	2/24/2006	--	IE
7b	2/24/2006	--	IE
7c	2/24/2006	--	IE
8	2/24/2006	--	IE
8b	2/24/2006	--	IA
8c	2/24/2006	--	IE
9	2/24/2006	--	IE
9b	2/24/2006	--	IE
9c	2/24/2006	--	IE
10	2/24/2006	--	IE
10a	2/24/2006	--	IE
10b	2/24/2006	--	IE
10c	2/24/2006	--	IE
11	2/24/2006	--	IE
11a	2/24/2006	--	IE
11b	2/24/2006	--	IE
11c	2/24/2006	--	IE
12	2/24/2006	--	IE
12b	2/24/2006	--	IE
12c	2/24/2006	--	IE
13	2/24/2006	--	IE
13c	2/24/2006	--	IE
14	2/24/2006	--	IE
14b	2/24/2006	--	IE
14c	2/24/2006	--	IE
Surf. Wtr	2/24/2006	--	IE

Appendix I. (continued)

Location	Date	Group	Predicted
Fishback	3/10/2006	--	P
1	3/10/2006	--	IE
1a	3/10/2006	--	IE
1b	3/10/2006	--	IA
1c	3/10/2006	--	IE
2	3/10/2006	--	IA
2a	3/10/2006	--	IE
2b	3/10/2006	--	IE
2c	3/10/2006	--	IE
3	3/10/2006	--	IE
3a	3/10/2006	--	IE
3b	3/10/2006	--	IE
3c	3/10/2006	--	IE
4	3/10/2006	--	IA
4a	3/10/2006	--	IE
4b	3/10/2006	--	IE
4c	3/10/2006	--	IE
5	3/10/2006	--	IE
5a	3/10/2006	--	IA
5b	3/10/2006	--	IE
5c	3/10/2006	--	IE
6	3/10/2006	--	IE
6a	3/10/2006	--	IA
6b	3/10/2006	--	IE
6c	3/10/2006	--	IE
7	3/10/2006	--	P
7a	3/10/2006	--	IA
7b	3/10/2006	--	P
7c	3/10/2006	--	P
8	3/10/2006	--	P
8a	3/10/2006	--	IA
8b	3/10/2006	--	IA
8c	3/10/2006	--	IE
9	3/10/2006	--	IE
9a	3/10/2006	--	IA
9b	3/10/2006	--	P
9c	3/10/2006	--	IE
10	3/10/2006	--	IE
10a	3/10/2006	--	IE
10b	3/10/2006	--	IE
10c	3/10/2006	--	IE
11	3/10/2006	--	IE
11a	3/10/2006	--	IE
11b	3/10/2006	--	IE
11c	3/10/2006	--	IE
12	3/10/2006	--	P
12a	3/10/2006	--	IA
12b	3/10/2006	--	P
12c	3/10/2006	--	IE
13	3/10/2006	--	IE
13b	3/10/2006	--	IA
13c	3/10/2006	--	IE
14	3/10/2006	--	P
14a	3/10/2006	--	P
14b	3/10/2006	--	IE
14c	3/10/2006	--	IE
Surf. Wtr	3/10/2006	--	IE

Appendix I. (continued)

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