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Final Report: Hydrogeologic Characterization and Stream Assessment at Franklin Creek State Park, Lee County, Illinois

Katharine L. Schleich, Jessica R. Ackerman, and Geoffrey E. Pociask

Wetlands Geology Section
Illinois State Geological Survey
Prairie Research Institute
University of Illinois at Urbana-Champaign

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One Natural Resources Way
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615 East Peabody Drive
Champaign, Illinois 61820-6964
http://www.isgs.illinois.edu/

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EXECUTIVE SUMMARY

In March 2018, the Wetlands Geology Section at the Illinois State Geological Survey (ISGS) began a study to characterize the hydrogeology and assess stream bank erosion at a parcel along Franklin Creek in Franklin Creek State Park, Lee County, Illinois at the request of the Illinois Department of Natural Resources (IDNR). The parcel, known as Site 5, was selected by IDNR for restoration under the Natural Resources Damage Assessment Program (NRDA). As part of the planning process the ISGS was asked to evaluate site conditions to inform potential options for habitat restoration (e.g., prairie, wetlands, stream). The purpose of this report is to identify the hydrogeologic conditions of the site and to recommend restoration strategies. The data presented in this report include descriptions of geologic materials, measurements of surface water levels, and groundwater levels, collected by the ISGS from March 2018 to December 2019.

Factors that indicate unfavorable conditions for wetland restoration at this site include: lack of sustained flooding or ponding at the site, lack of sustained seasonal high water-table within the root-zone, and presence of highly permeable geologic materials. During this study the observed period of inundation and saturation during the growing season was very brief over most of the site and sufficient to satisfy jurisdictional wetland hydrology criteria in only small portions of the north part of the site in 2019. Although the site generally does not show characteristic wetland hydrology, its position in the floodplain does facilitate some wetland and floodplain function near Franklin Creek and lower portions of the farm field.

Most if not all of the site is conducive to restoration of native vegetation through reforestation or prairie planting. Although Franklin Creek flooded portions of the site at least once in each growing season, these floods are generally brief, infrequent and cause relatively shallow inundation. Therefore the likelihood of damage to restoration plantings by floods is relatively low. The range of hydrology measured at the site suggests that a wide range of habitats could be restored.

The Franklin Creek stream channel shows characteristic meandering pattern typical of alluvial streams in Illinois. Site 5 similarly shows this characteristic pattern and channel migration rates within the historic range of variability. Likewise, recent bank erosion rates are of the same order of magnitude and within the historical range of channel migration rates. These findings suggest that more passive and less intensive stream restoration techniques are appropriate for restoring the riparian corridor and floodplain along Franklin Creek. Recent bank erosion rates measured at Site 5 and used to estimate future bank erosion could be used as guidelines for restoration planning in the near bank area of the riparian corridor.

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INTRODUCTION

In March 2018, the ISGS began water-level and stream-channel monitoring at a floodplain site (Site 5) in Franklin Creek State Park to assist the IDNR with restoration plans under the Natural Resources Damage Assessment Program. The proposed restoration site is located along Franklin Creek in Lee County, Illinois and covers approximately 8.8 hectares (ha) (21.8 acres [ac]) (Figure 1). It has previously been used for row-crop agriculture (i.e., corn and soybeans). The site is bordered on the west by Twist Road, on the north by IDNR property, on the east by Franklin Creek, and on the south by Old Mill Road.

Prior reports were submitted during this project. An initial assessment of the site based on a review of available file and online information as well as a one-day site visit was submitted in February 2017. At the request of IDNR, an interim report was also submitted in June 2018 to expedite planning discussions for site restoration. This report incorporates some elements of the previous reporting where appropriate. The focus of this final report is to provide a summary of observations of the range of hydrogeologic conditions during the monitoring period and provide analysis of bank erosion along Franklin Creek. Additionally, the overall monitoring project will provide a pre-restoration baseline of hydrogeologic and geomorphic conditions to assess the effects of restoration practices. Field observations presented here may not reflect long-term conditions at this site.

METHODS

In March 2018, monitoring wells and surface-water gauges equipped with electronic dataloggers were installed to measure groundwater levels at seven locations and surface-water levels at two locations on Franklin Creek (Figure 2). An additional monitoring well (Well 8) was installed in July 2018. A total of seven geologic borings were examined and described during the initial installation of monitoring wells. All boreholes were made using a bucket-type hand auger. Borings ranged from of 0.75 meters (m, 2.46 feet [ft]) to 1.95 m (6.40 ft). Geologic materials were observed and described during excavation of selected borings. Sediment texture, Munsell color, presence and type of redoximorphic features, soil and sedimentary structures, moisture content, and other features were recorded for most of the borings. The geologic profiles observed in the deeper borings provided the basis for the interpretations of the geology at the site.

A total of 11 wells were installed in eight locations at the site (Figure 2). Shallow (S) wells were designed to monitor saturation in the soil zone and were used to determine the extent of wetland hydrology at the site. Deeper wells were designed to monitor hydraulic potential at specific depths in deeper geologic units. Nested wells were installed at three locations to detect vertical ground-water gradients. Monitoring wells were constructed with 5-centimeter (cm) (2-inch [in]) diameter PVC casing and manufactured slotted screen. Screen slots for all wells are 0.025-cm (0.01-in) wide. The screened interval for shallow wells was approximately 45 to 75 cm (17 to 30 in). Screen lengths for deeper-wells ranged from approximately 17 to 117 cm (7 to 46 in). The depth of the screened interval for these wells was determined based on the geologic materials encountered in each boring. Sand was placed in each borehole so that the sand pack encompassed the entire screened interval. The boreholes were then sealed from the top of the sand pack to land surface using bentonite chips.

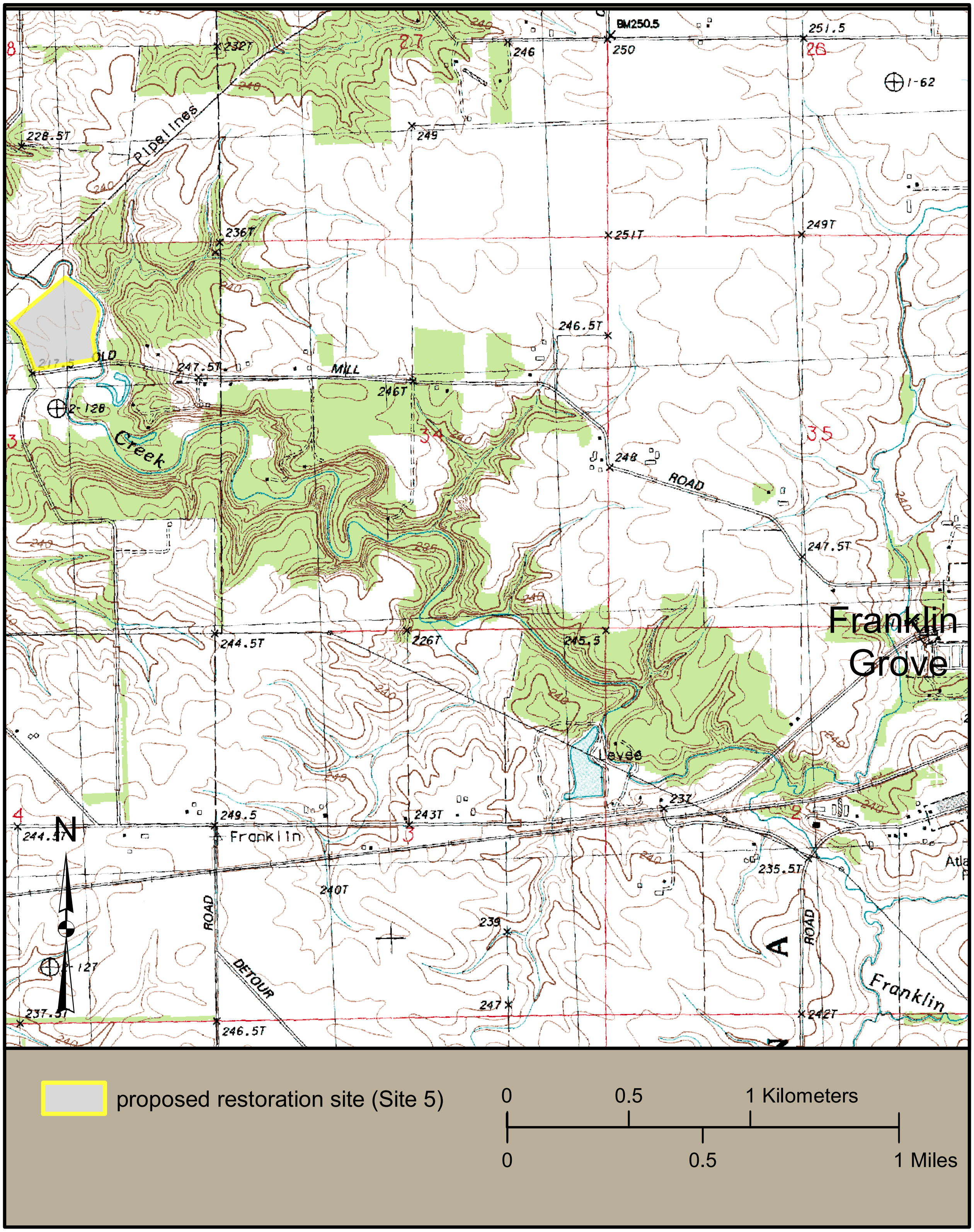

Figure 1. Location of the proposed restoration site, Site 5 at Franklin Creek State Park.
Map based on the Franklin Grove, IL, 7-5-Minute Series Topographic Quadrangle (USGS 1998).

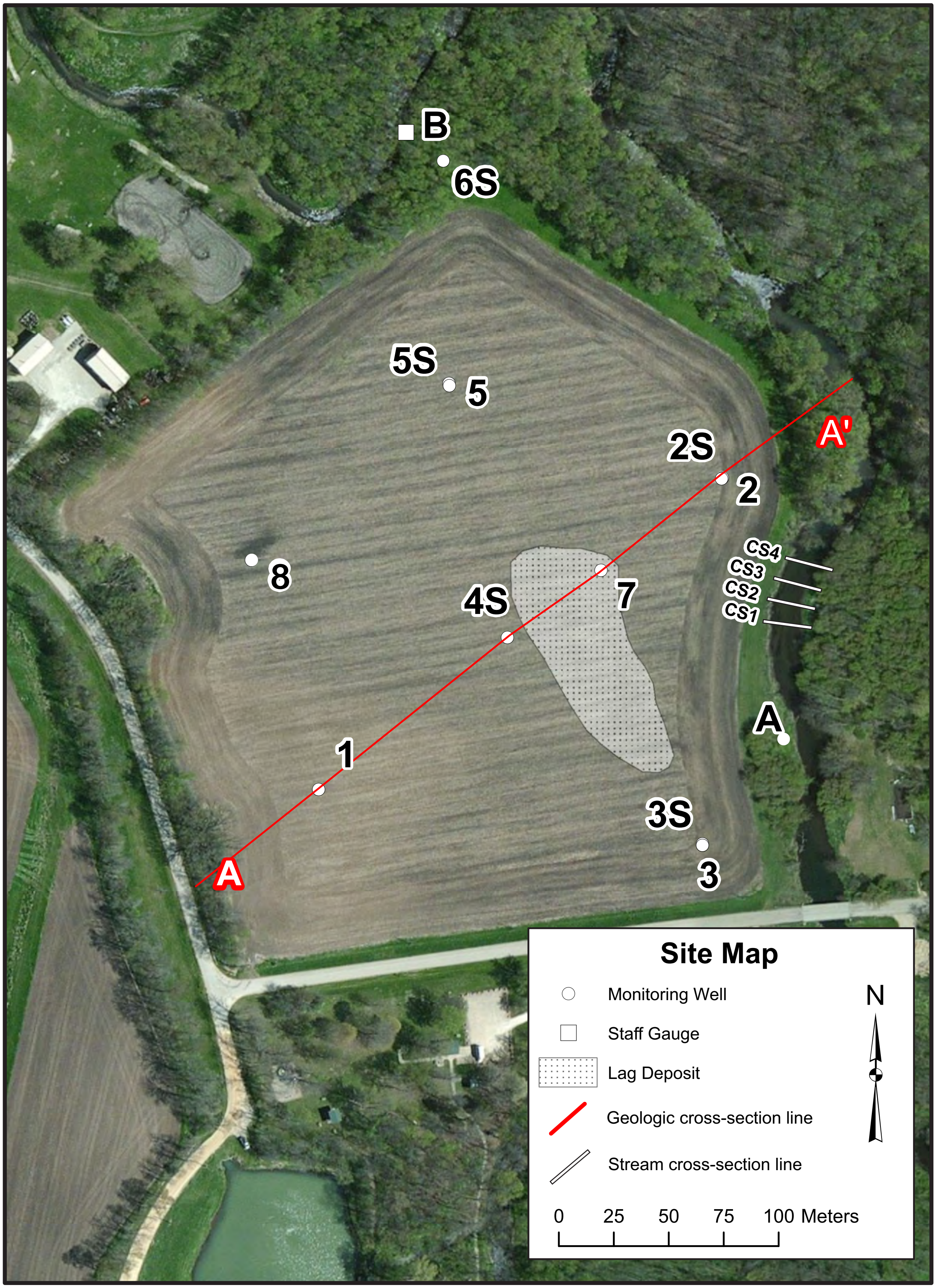

Figure 2. Monitoring wells, surface-water gauge locations, geologic cross section line (A-A'), and stream cross section lines at Franklin Creek State Park proposed restoration site. Approximate location of gravel lag deposit, at surface, between wells 4S and 7 shown as dotted polygon.

The depth to water in the wells was read manually with an electronic water-level meter at least quarterly and more frequently during the early growing season (March-May). These measurements were made relative to the top of the wells. To calculate the depth-to-water below land surface at each well location, the measured height of the well casing above land surface was subtracted from the measured depth to water from the top of the well. Groundwater elevations were calculated by subtracting the depth to water in the well from the elevation of the top of the well. Selected wells were instrumented with data loggers that recorded water levels at 1-hour intervals.

Surface-water data were collected at two locations in Franklin Creek using data loggers and staff gauges (Figure 2). Data loggers with pressure transducer sensors were used. Steel staff gauges were installed at logger locations to provide quality control and to provide water-level measurements in the event of logger failure. The staff gauges were read on the same schedule as the monitoring wells. Several times during the monitoring period, the staff gauges were knocked over in the stream as a result of flooding and/or ice. Data during the period when gages were laying in the stream bed after these events are still presented to provide information about frequency and magnitude of events, but it is denoted in the hydrographs that the absolute elevation data could not be validated.

The elevations of the monitoring wells, stage gauges, and land surface at each monitoring station were measured with GPS (Leica GPS1200 and Leica GS16 GNSS) equipment or with a Sokkia B1 Automatic Level. Site elevations were tied to the North American Vertical Datum of 1988 (NAVD 1988) using a benchmark established at the site with GPS equipment.

Historical aerial photography was used to evaluate background historical channel planform changes and channel migration rates at Franklin Creek State Park. Hard copies of historical aerial images were obtained from the University of Illinois Map and Geography Library (USDA 1958, 1964) and scanned to digital format (e.g. tif or jpg). Digital copies of 1939 aerial photography and orthophotography from 1999 and later were obtained from the Illinois Geospatial Clearinghouse (ISGS 2018a, 2018b, 2018c, 2018d). Photos from 1939 and scanned hardcopies were assigned a coordinate frame using the Georeferencing feature in Esri ArcGIS 10.5.1. Historical aerial photos were referenced using a minimum of 10 reference points per image and a maximum root mean square error (RMSE) threshold of 5 meters as standard. Of the images used for this analysis the range of RMSE was 2.043 to 2.865 meters.

Rectified historical imagery was then used to determine the change in position of Franklin Creek through time. The Planform Statistics Tool in the Stream Restoration Toolkit developed by the National Center for Earth-Surface Dynamics (NCED) at the University of Minnesota—Twin Cities was used to evaluate historical channel changes (Lauer 2006). An approximately 2-kilometer (km, 1.24-mile [mi]) segment of Franklin Creek within the current park boundaries from just upstream of Old Mill Road to downstream of Twist Road was evaluated to estimate historical background rates and types of channel migration. For each photo year, the streambanks of Franklin Creek were digitized in ArcMap 10.5.1 and these served as the input data for the analysis in the Planform Statistics Tool. The tool uses the position of the bank lines to interpolate a channel centerline. The channel centerlines were subsequently compared and used to calculate the total distance of channel movement between photo intervals. Distance of channel movement was then divided by the number of years between photos to estimate annual migration rate over the time period between photos along the length of the entire stream segment. The stream centerline paths for each year were discretized into 5-meter intervals in order to evaluate the differences in migration distances and rates along the entire length of channel segment and so that migration rates of selected meander bends through the segment could be compared.

To evaluate more recent stream channel changes at the restoration site, we established four stream channel cross sections in a meander bend in Franklin Creek at Site 5. The initial channel elevation measurements were taken on March 21, 2018 and repeat measurements were taken on October 4, 2018 and May 13, 2019. All measurements were taken using survey-grade GPS equipment. Elevation data were collected in Illinois State Plane West coordinates and referenced to North American Vertical Datum 1988 (NAVD88). Measurements were then compared to assess changes in channel morphology and evaluate net elevation change in the channel over the monitoring period.

To evaluate the recent erosion rates since 2009 the position of top of the left bank of the meander bend was located and measured with the survey-grade GPS during the March 21, 2018 field visit. These data were compared with the bank position interpreted from the 2009 LiDAR (ISGS, 2018e) elevations to determine an erosion rate at each cross section and two downstream locations within the bend at approximately 10 meter intervals. The bank erosion rates were then used to estimate bank position after 5, 10, and 20 years. Projected bank erosion distance was calculated by multiplying bank erosion rates at each cross section or downstream channel location by the specified time period. The estimated future bank position was drawn in ArcMap 10.5.1 by extending the erosion distance lines approximately orthogonal from the 2018 bank line. To represent future bank lines, the ArcMap arc line editing tool was used to trace a curved line that encompassed the three maximum estimated bank retreat distances among all the cross sections and downstream locations for each time interval.

SITE CHARACTERIZATION

Geographic Setting

The restoration site is located in the Rock River watershed and is within Chamberlin Creek-Franklin Creek catchment (HUC 070900050603). The site encompasses portions of the current floodplain of Franklin creek and higher valley terrace. Total relief at the site is approximately 6 m (20 ft). Franklin Creek flows through the site from southeast to northwest and drains into the Rock River approximately 6.4 km (4 mi) downstream. The site is situated within the alluvial deposits and glacial till common in the Rock River Hill Country of the Till Plains Section of Illinois physiographic provinces (Leighton et al. 1948).

Geology

Bedrock at the site and in the surrounding area are mapped as Prairie du Chien Group and Ancell Group (Kolata 2005). The Praire du Chien Group consists primarily of dolomite and interbedded sandstone and the Ancell Group is comprised of medium grained, well sorted, quartz sandstone. Surficial geology is mapped as Cahokia Alluvium while both Cahokia Alluvium and Glasford Formation are mapped in the surrounding area (Hansel and Johnson 1996, Nagy 1999) (Figure 3). Cahokia Alluvium consists of river and over bank deposits while the Glasford Formation is comprised of loam to clay loam glacial till. Wedron Formation, comprised of silty to clayey till, was also mapped in the surrounding area by Lineback (1979).

The geologic cross section in Figure 4 depicts deposits found at depth during the installation of the monitoring network. These materials are consistent with those described in the geologic mapping of the region. However, a deposit consisting of gravel with some cobble-sized material was found between wells 4S and 7 at 45 cm (1.48 ft) below surface (see Figure 2 for location). This deposit

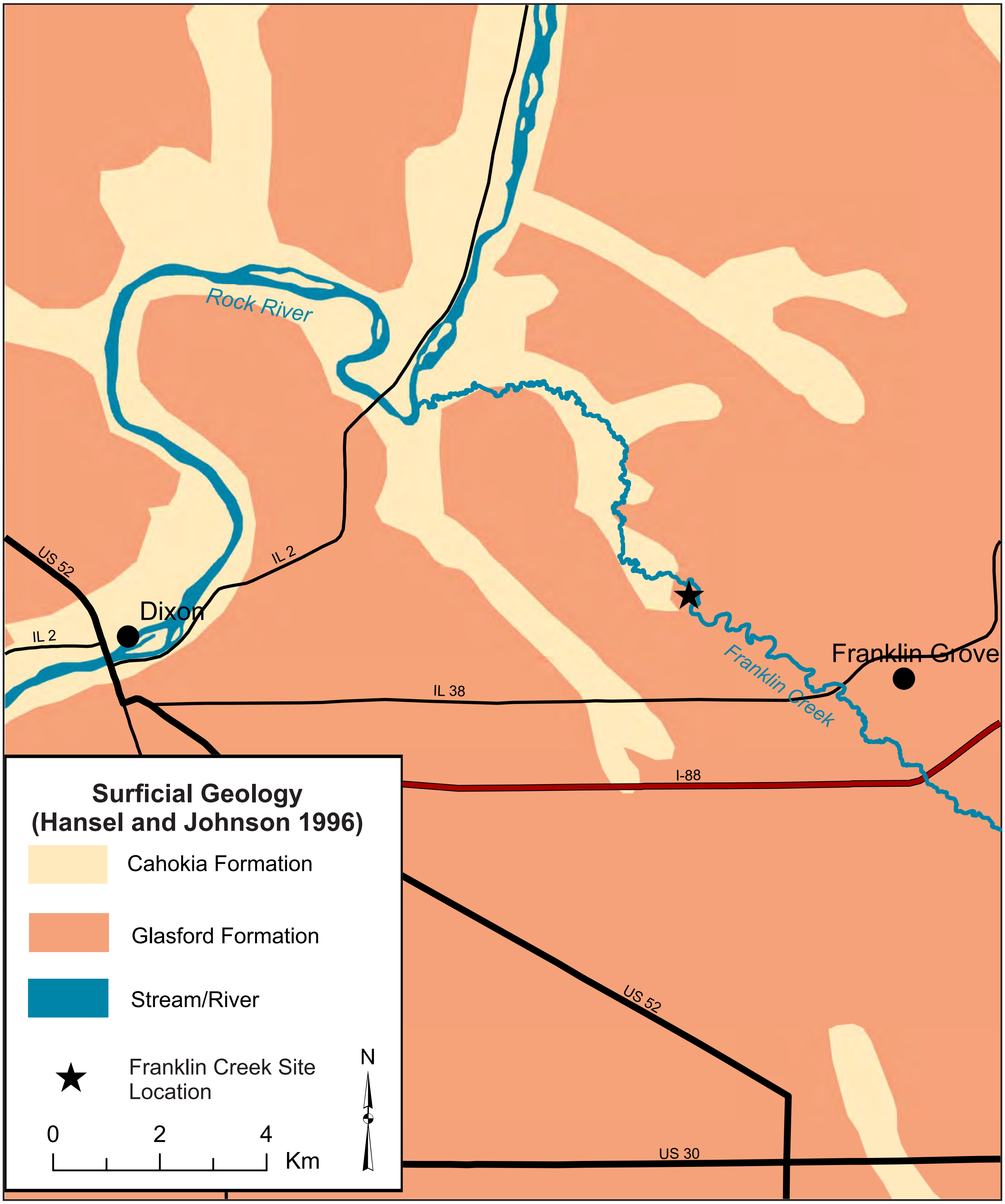

Figure 3. Surficial geology as mapped by Hansel and Johnson (1996) in the area surrounding the Franklin Creek field site.

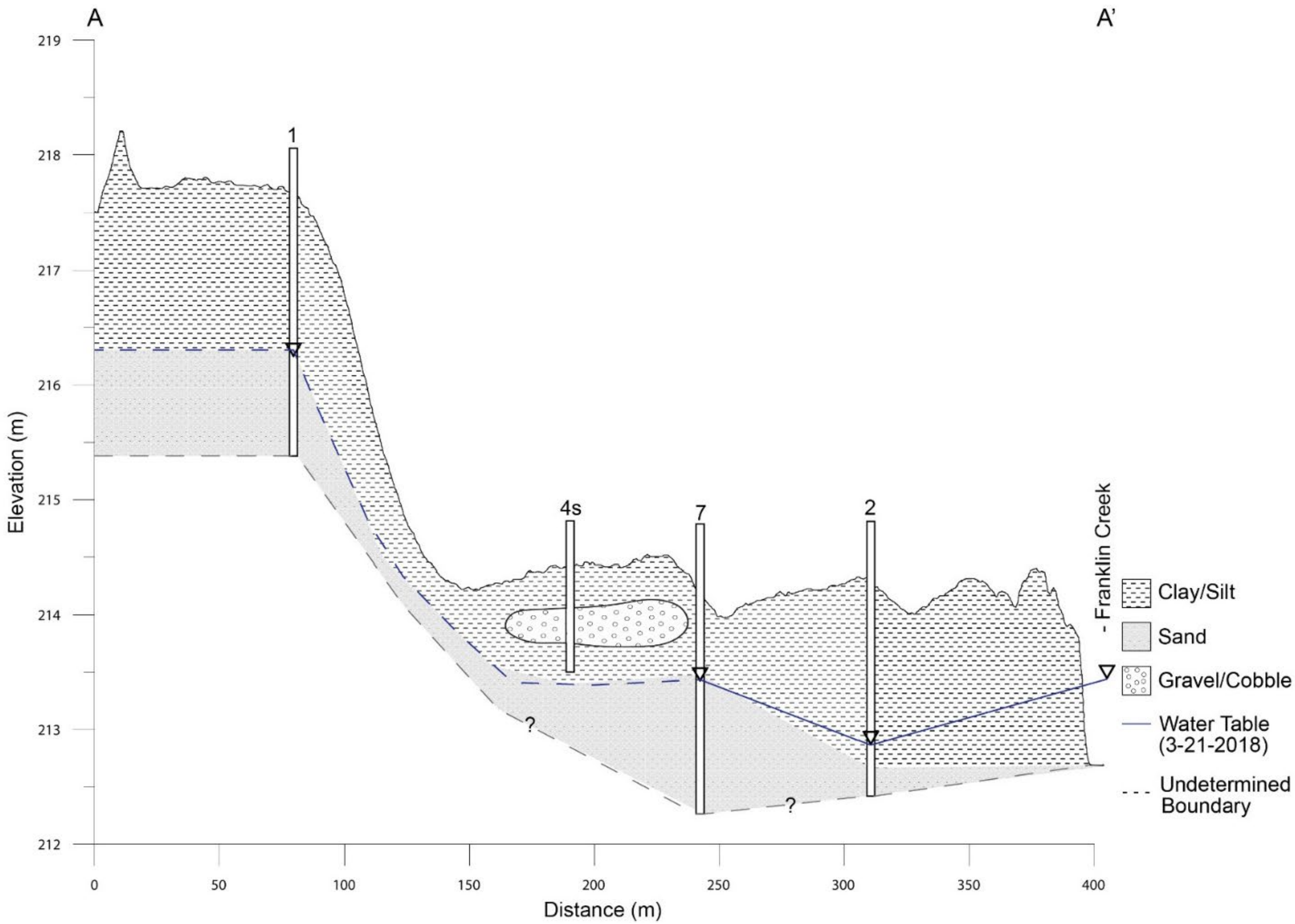

Figure 4. Geologic cross section at Franklin Creek State Park, Site 5. Well borings (1, 4s, 7 and 2) were made installing monitoring wells on March 19 and 20, 2018. See cross section location line (A-A') in Figure 2. Vertical exaggeration is 50.

appears to be a lag deposit but could also be a local bedrock high as much of the gravel and cobble material encountered was composed of sandstone similar to the local bedrock. The gravel layer could inhibit or preclude restoration or creation of wetlands due to the high permeability, and the potential for bedrock near the surface may prevent excavation.

Hydrology

Precipitation

Average annual precipitation at Dixon 1W Weather Station (NWS Coop #112348) is 38.40 in (97.54 cm) (MRCC 2019). The 30-year monthly averages show that most of the annual precipitation falls during the period May through August (Figure 5). Drier periods typically occur in late fall and winter (November-March) however both 2018 and 2019 saw seasonal peaks in February.

In 2018, precipitation amounts recorded at the Dixon 1W Weather Station were near normal levels. Annual precipitation totaled 39.32 in (99.87 cm) or 0.93 in. (2.34 cm) more than normal. However, exceedingly wet conditions prevailed during May and June, with precipitation amounts during this period at 168% of normal (Figure 5). Four large rainfall events occurred in May and June. The largest event, which the Dixon weather station recorded as 3.47 inches, occurred over June 9-10, 2018. However, radar estimates by the National Weather Service (NWS) indicated rainfall amounts as high as 5 inches near Franklin Creek State Park for this event. A 3.47-inch, 48-hr rainfall event would rank between a 1 and 2-year storm and a 5-inch, 48 hour event would rank as a 7-year rain event (Angel and Markus 2019).

Precipitation for 2019 at the Dixon 1W weather station has only been reported through May 2019 (Figure 5). For January through May 2019, precipitation totaled 26.69 in (67.79 cm) which is 13.16 in. above normal for that time period (33.43 cm). Precipitation in May 2019 was 137% of average for that month. The largest event was recorded as a 2.79-in rainfall that occurred over May 29-30, 2019.

Franklin Creek is located in Midwest Regional Climate Center’s (MRCC) Illinois Climate Division 1 which includes most of northwest Illinois. The Palmer Hydrologic Drought Index (PHDI) measures long-term duration and intensity of drought-inducing climate patterns across climate regions. The PHDI for the Illinois Climate Division 1 shows that 2019 has been a very moist to extremely moist year (Figure 6) (MRCC 2019). Division 1 has been experiencing normal or moist conditions since 2015.

Surface Water

Data from surface-water gauges on Franklin Creek show four distinct peaks in 2018 in response to precipitation events in May and June (Figure 7). The largest event occurred in early June and caused a 1.83-m (6.00-ft) increase in stage from base flow level at Gauge A and a 2.21-m (7.28-ft) increase at Gauge B. As of the June 14 site reading, water levels had been elevated for over four days, but the water level was receding.

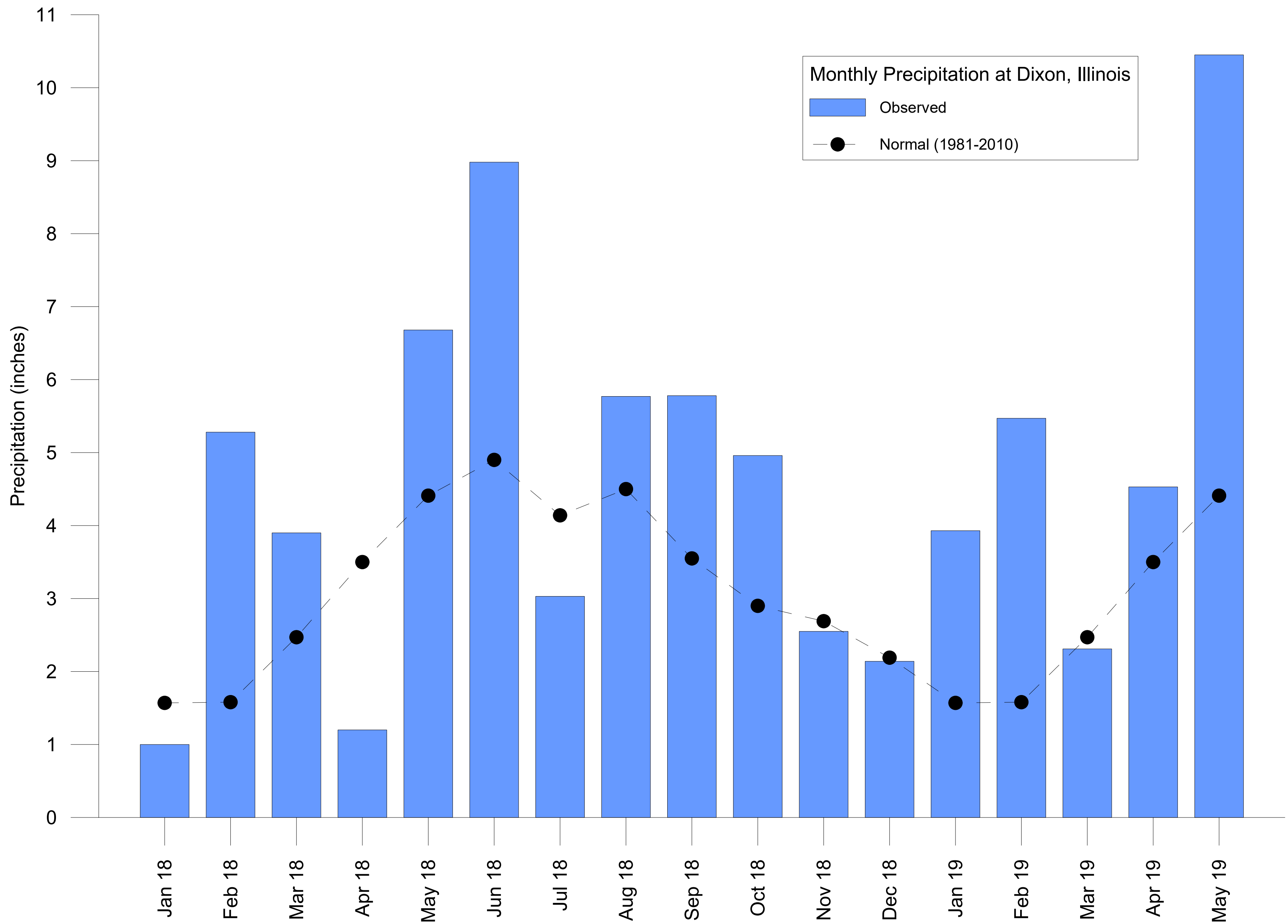

Figure 5. Monthly precipitation at Dixon 1W weather station (MRCC 2019).

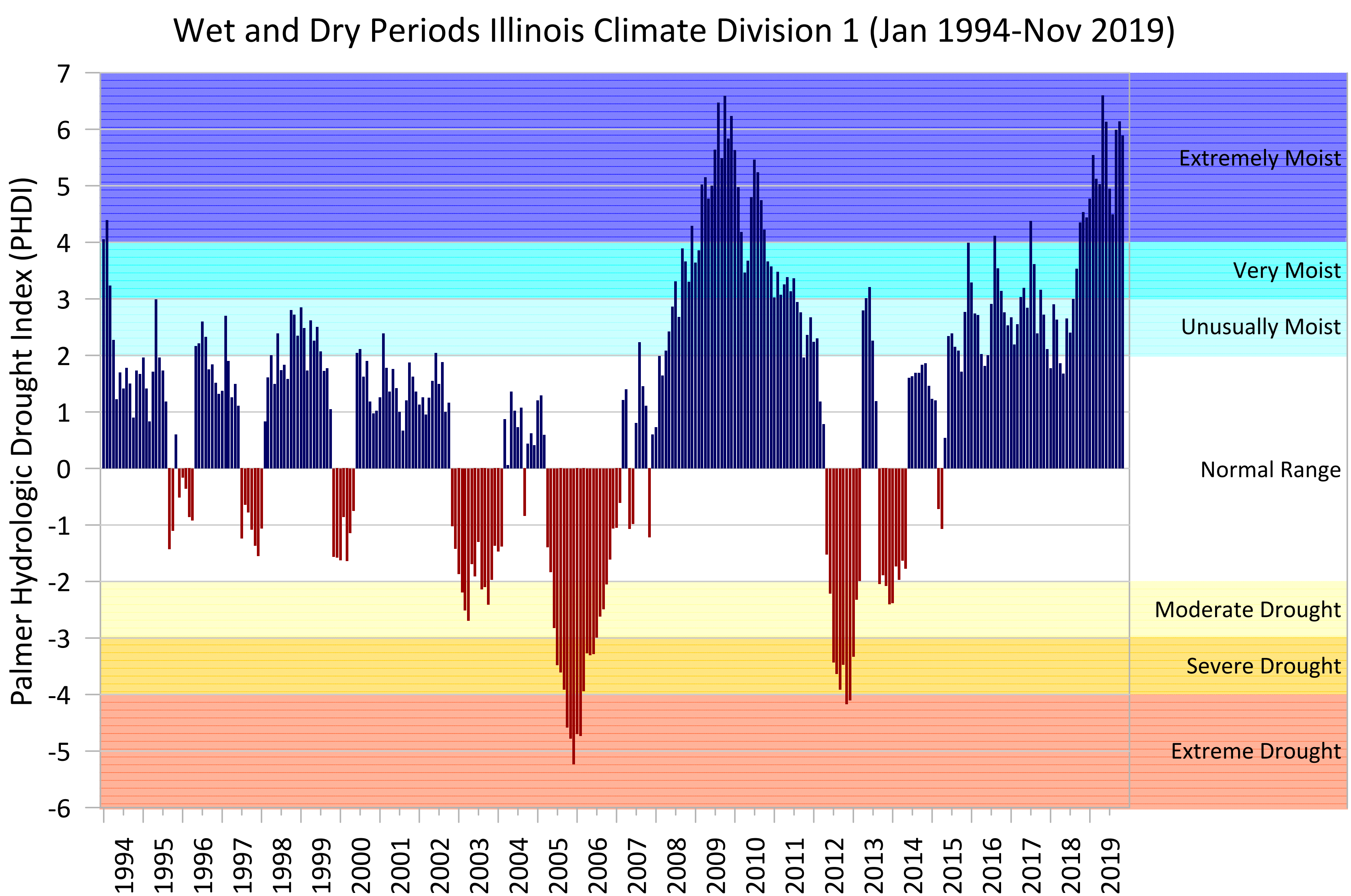

Figure 6. Palmer Hydrologic Drought Index showing long-term hydrologic patterns (duration and intensity dry and wet periods) in Illinois Climate Division 1 which covers northwest Illinois.

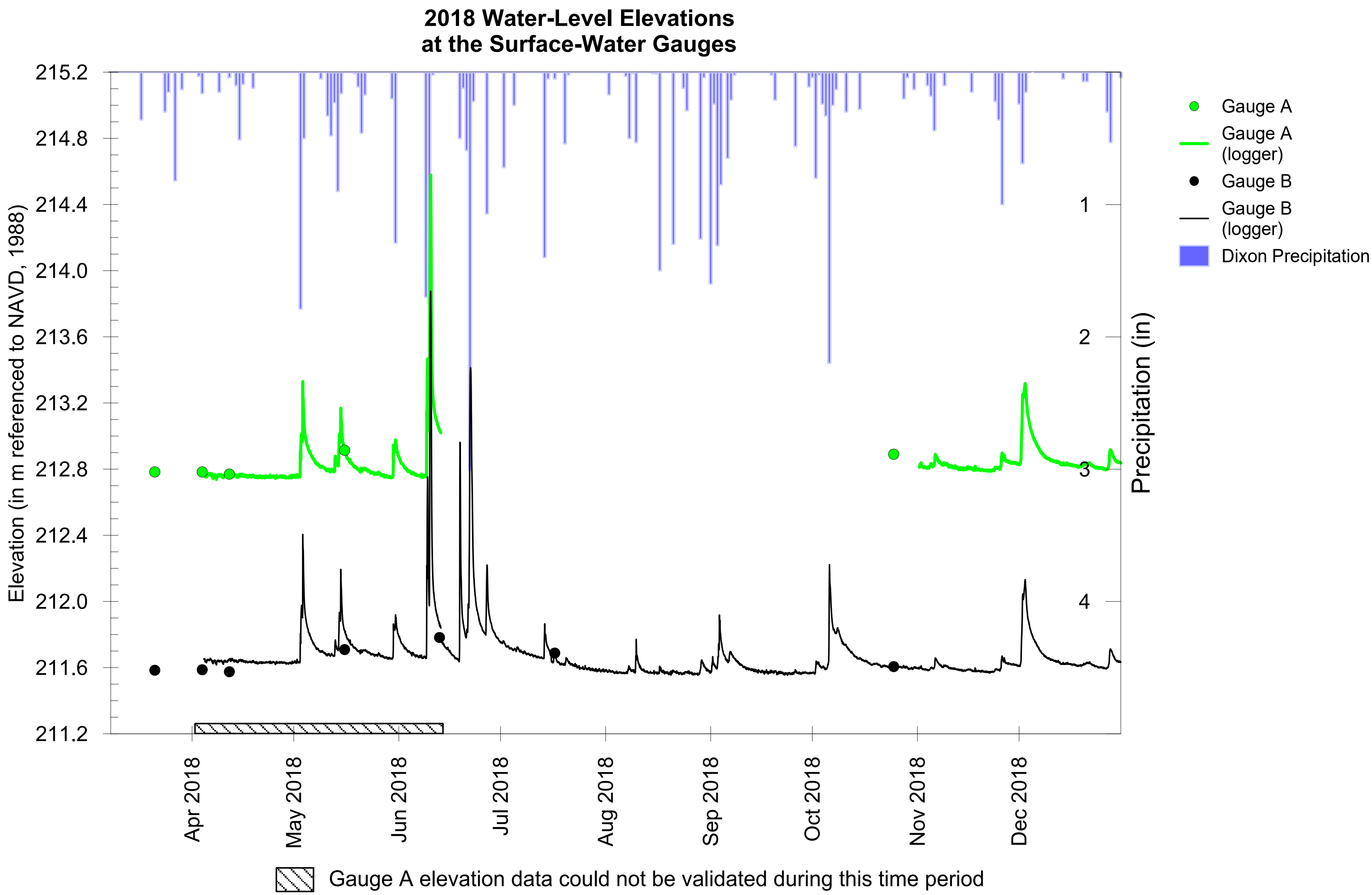

Figure 7. Water-level elevation, manual staff gauge readings at surface water monitoring locations and daily precipitation from Dixon 1W weather station (MRCC 2018).

In 2019, data from surface-water gauges on Franklin Creek in 2019 show five distinct peaks in response to precipitation events between February and May (Figure 8). The largest event occurred in late May after several smaller peaks leading to a 2.23-m (7.31-ft) increase in stage from base flow level at Gauge B. Gauge A was not operational during this event.

The site is subject to flooding from Franklin Creek, although the period of inundation for individual flooding events is usually brief, typically around one day. Based on logger data and field observations in 2018, well 6S flooded seven times. However water levels were only high enough to flood portions of the farmed field on two occasions. In 2019, well 6S flooded five times and portions of the farmed field were flooded on three of those occasions. It is important to note that above average precipitation was observed in the spring of both 2018 and 2019, and it is not likely that the site would flood at that frequency during a spring with average or below average precipitation.

Groundwater

2018

Water level data from monitoring wells in 2018 are shown in Figures 9 and 10. Six monitoring wells (2, 2S, 5, 5S, 6S and 7) showed inundation but only for a brief period during the June 10, 2018 flood event. Well 6S, which is located in a National Wetlands Inventory (NWI) mapped wetland, showed about three days of inundation (U.S. Fish and Wildlife Service 2016). However, the longest inundated period in the farmed field was about 18 hours at wells 5 and 5S. Field observations made at the site on June 14, 2018, indicated signs of flooding between Gauge B and well 6S. Vegetation was pushed down in the area and covered with silt.

Saturation, when water-levels are within the root-zone, considered here as within 30 cm (1ft) of land surface, was more wide-spread on-site. The same wells that showed inundation also showed saturation, but saturation occurred at an increased frequency and duration. Well 6S showed the longest period of saturation at three days. Within the farmed field, the longest saturated period in 2018 was at wells 5 and 5S for two days.

The highest water level elevation from wells showing saturation was used to estimate the maximum extent of saturation during the 2018 growing season. Figure 11 shows the extent of saturation during the June 10, 2018 rain event. Even though this shows a large saturation extent, it was only during a rain event when the site received at least 3.47 inches, and with a rather short saturation duration (18 hours at most). This is not an indication of long-term saturation, but gives a good idea of the extent of root-zone saturation which could limit restoration plantings with species with higher moisture requirements.

2019

Water level data from monitoring wells are shown in Figures 12 and 13. Wells 2, 2S, 5, 5S, 6S, 7, and 8 were inundated during a flood event on May 30, 2019 that resulted from a storm that produced 2.79 inches of rain at Dixon. While inundation generally lasted less than a day during this event, wells 6S and 8 remained inundated for over three days. Figure 14 shows the maximum water depth across the site during the May 30 event and was calculated using the water-level elevation from the wells showing saturation.

Franklin Creek Hydrogeological Assessment

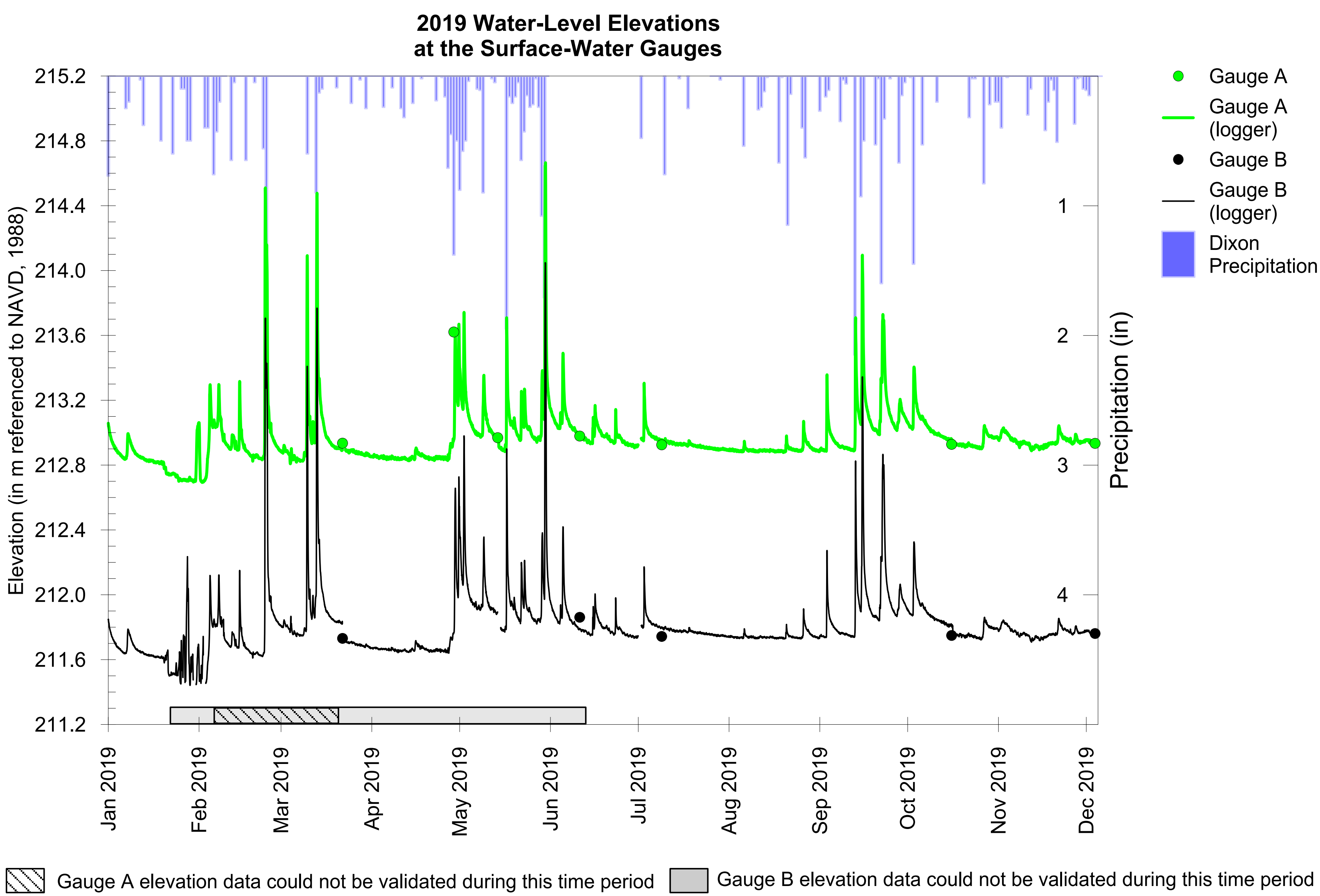

Figure 8. Water-level elevation, manual staff gauge readings at surface water monitoring locations and daily precipitation from Dixon 1W weather station (MRCC 2019).

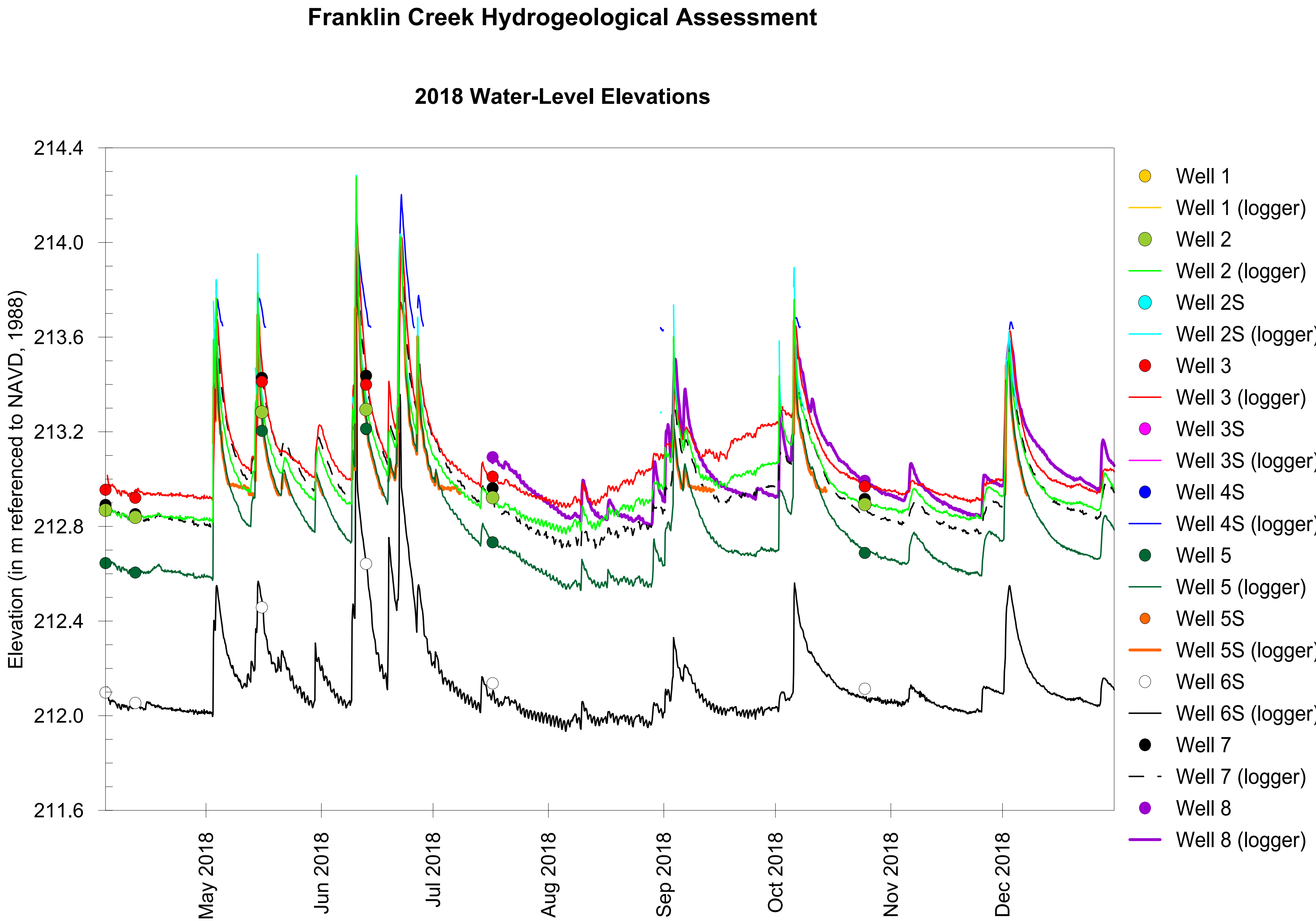

Figure 9. 2018 groundwater level elevations logged and manually measured at monitoring wells.

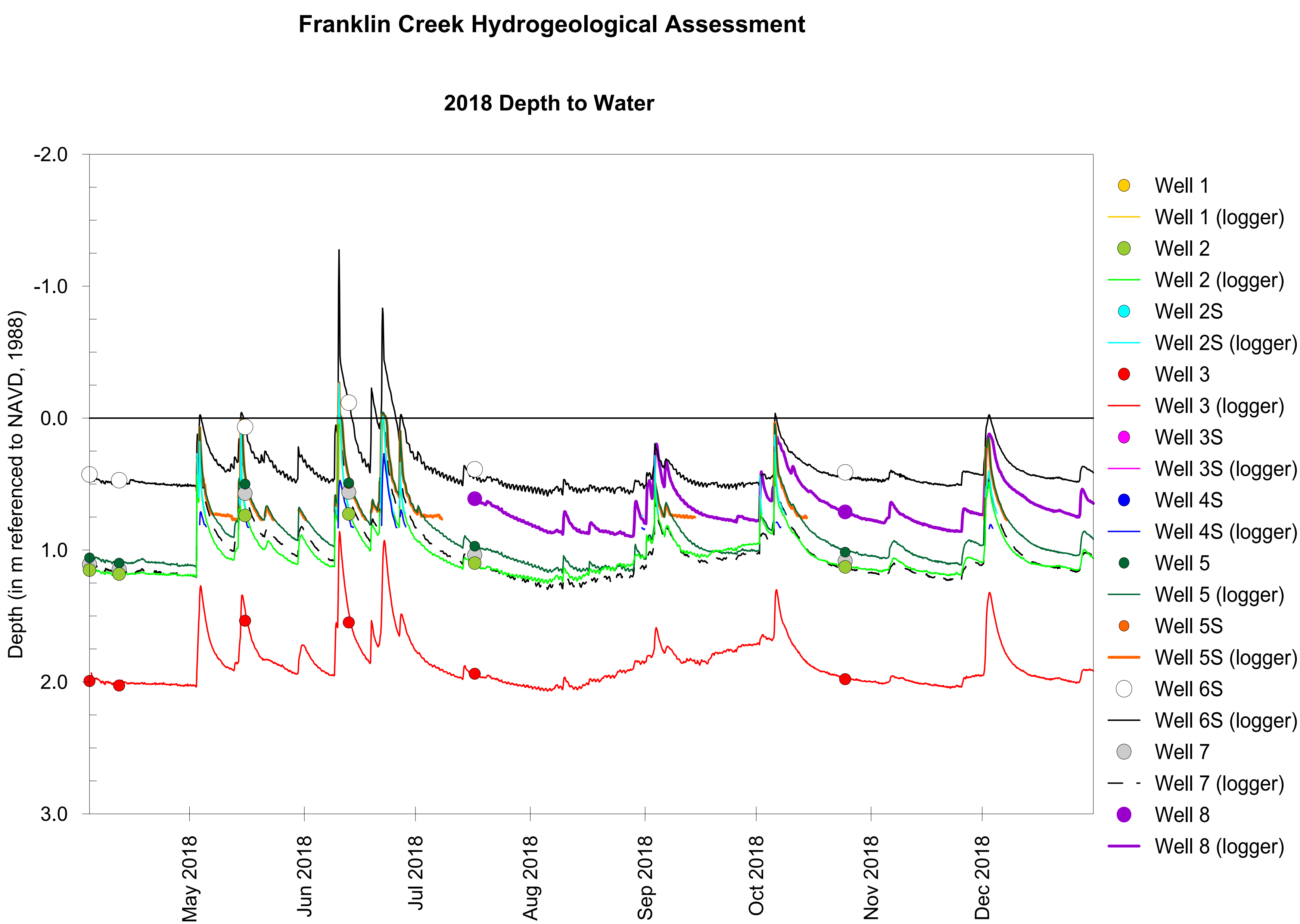

Figure 10. 2018 depth to groundwater levels logged and manually measured at monitoring wells.

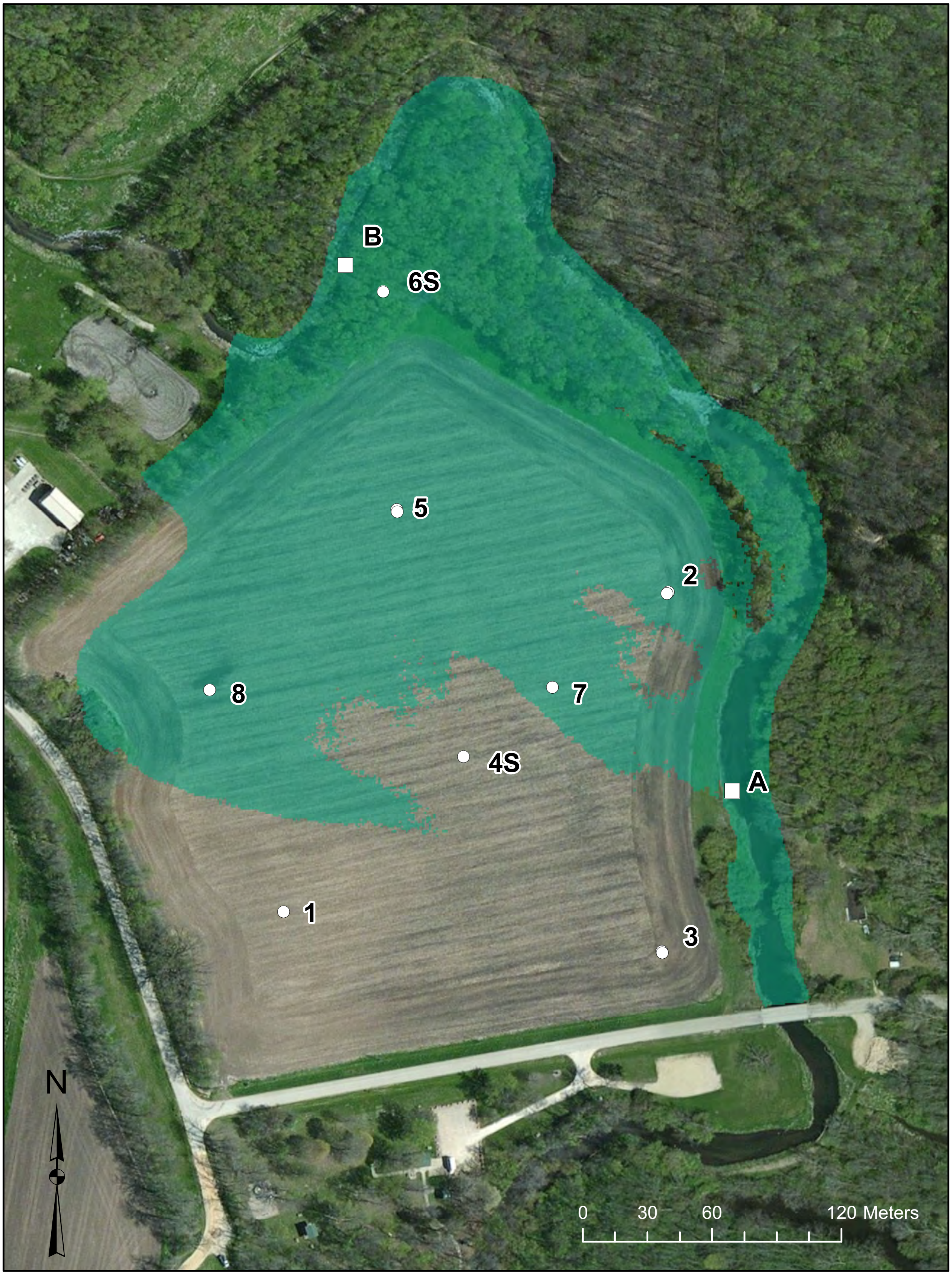

Figure 11. Approximate maximum saturation area based on groundwater levels within 30 cm of ground-surface during the June 9-10, 2018 precipitation and flood event.

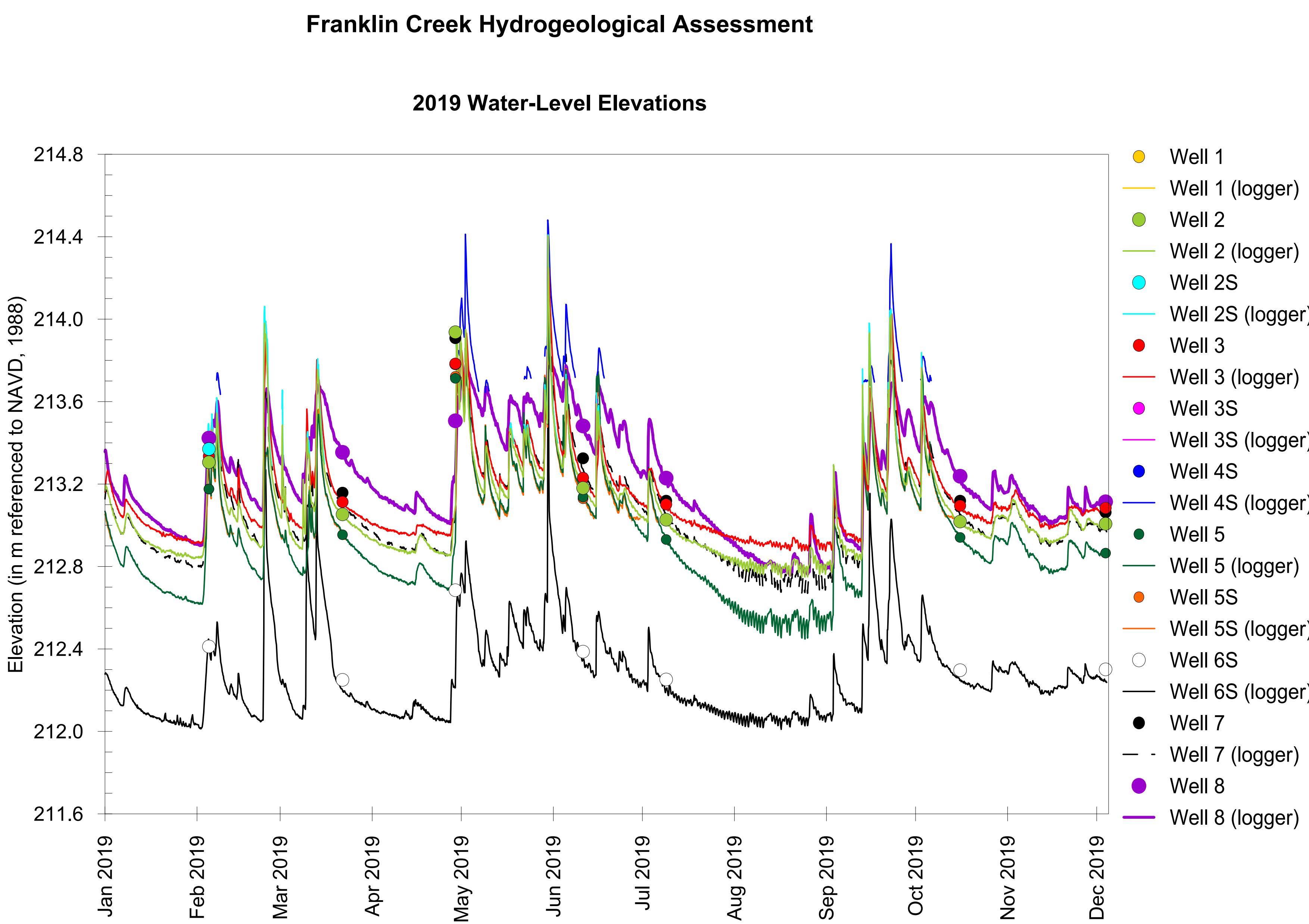

Figure 12. 2019 groundwater level elevations logged and manually measured at monitoring wells.

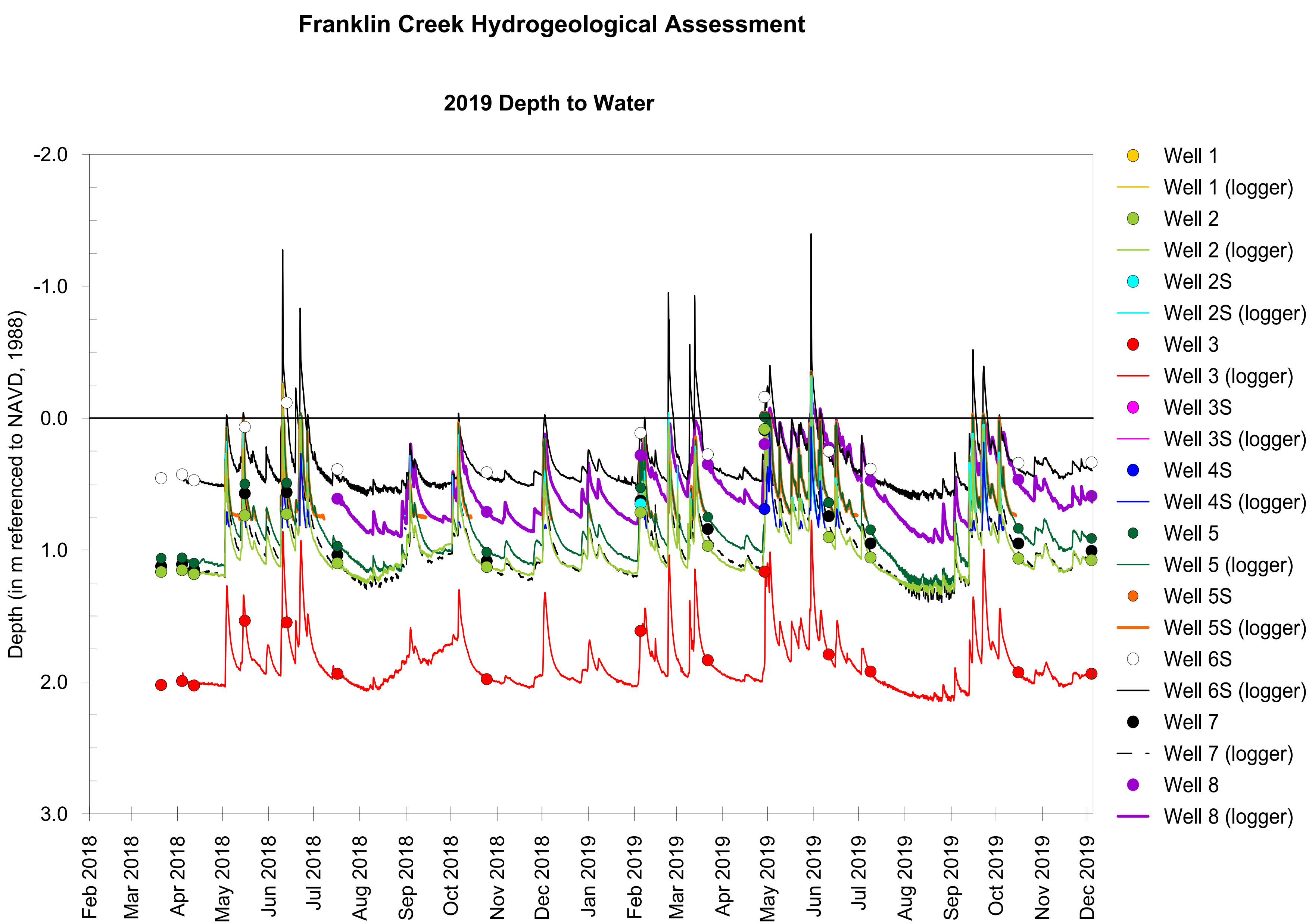

Figure 13. 2019 Depth to groundwater levels logged and manually measured at monitoring wells.

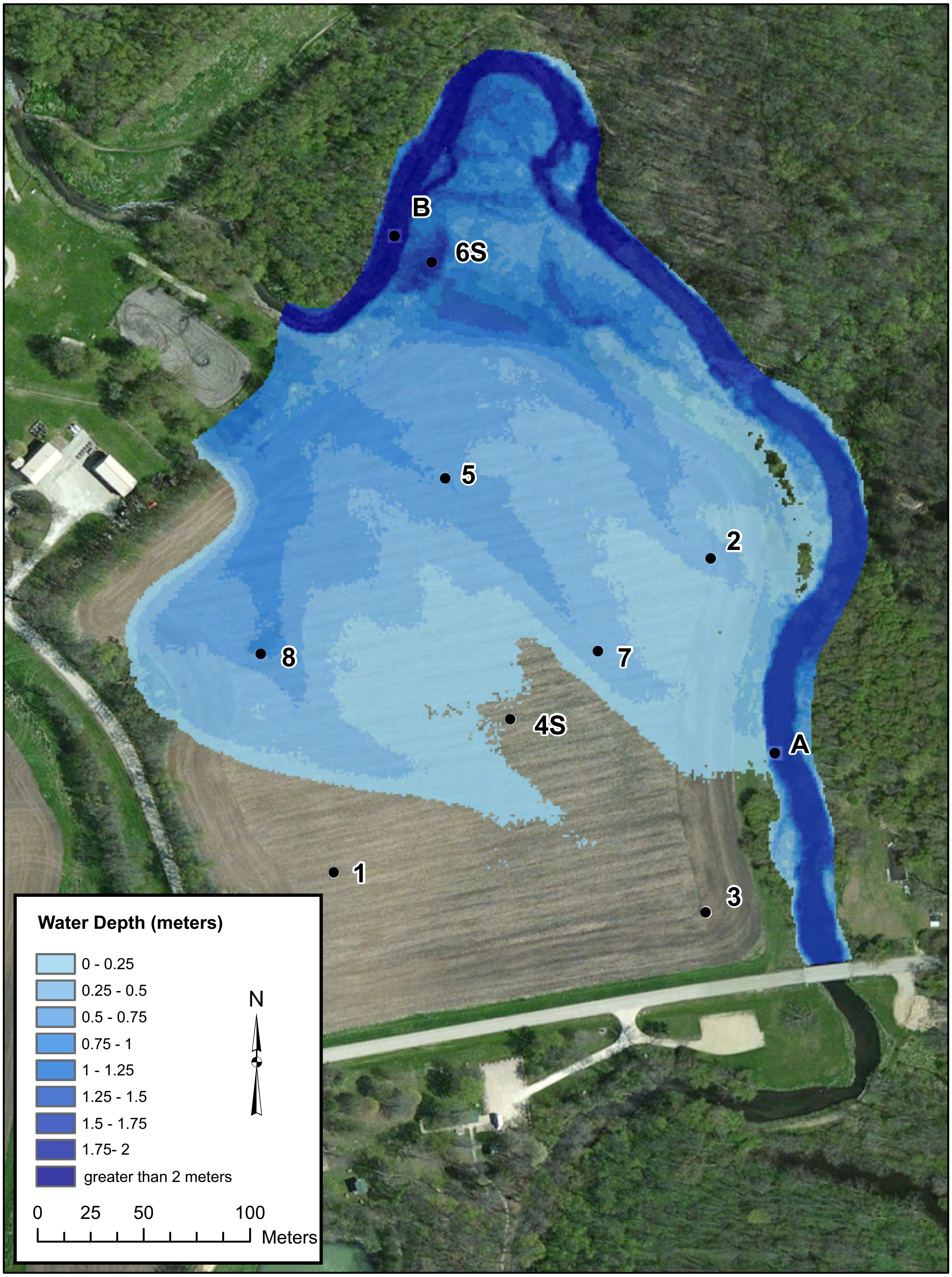

Figure 14. Approximate maximum flood inundation depth during the May 30, 2019 flood event.

The maximum extent of saturation during the May 30, 2019 event is shown in Figure 15. Saturation was evident in all wells that were inundated, and was also evident in Well 4S. Saturation occurred at an increased frequency and duration as compared to inundation. Wells 6S and 8 had the longest periods of saturation. Well 6S was saturated over 25 days and well 8 was saturated over 28 days. The increased frequency of precipitation events likely led to the extended period of saturation seen in 2019 in contrast to the shorter saturation period seen in 2018 as a result of one large precipitation and flood event.

Wetland Hydrology

According to the Army Corps of Engineers regulatory definition (Environmental Laboratory 1987, U.S. Army Corps of Engineers [USACE] 2010), an area must be saturated or inundated for a minimum of 14 consecutive days to satisfy characteristics for wetland hydrology. The site was evaluated for wetland hydrology in both 2018 and 2019. No part of the site met the wetland hydrology standard in 2018 and a small portion of the site met the criteria in 2019. Figure 16 shows the depth to water during the 2019 peak 14-day hydroperiod. While wells 6S and 8 were the only wells that sustained water levels within the wetland hydrology range for the full 14 days, other areas on site had lower water levels or were saturated for shorter periods of time.

Stream Assessment

Franklin Creek Watershed

The catchment of Franklin Creek covers approximately 38 square miles upstream of its confluence with Chamberlain Creek, near the Rock River at Grand Detour (USGS 2019). According to the USDA-NASS (2007), the primary land cover type is row crops of corn and soybeans which makes up 65.5% of the land cover in the watershed. However, there is also appreciable forest, wetland, and grassland areas which cover with 24.4% of the watershed. Developed land accounts for 9.1% and consists mainly of the village of Franklin Grove and roadways (Figure 17). While agriculture remains the overwhelming land use in upperpart of the watershed, evidence from historical aerial photographs indicates that forest cover has expanded and matured, at least within the Franklin Creek valley in the state park (see Figure 18). Sediment delivery to Franklin creek has likely decreased over time with development of forest cover the riparian corridor at the park and in lower parts of the watershed.

Historical channel migration (1939-2010)

Franklin Creek channel migration between 1939 and 2010 shows that change in channel position was consistent and gradual with two notable exceptions (Figure 18). Channel migration rates along the entire channel segment ranged from near 0 to 25.83 m/yr (84.74 ft/yr). However, for most intervals rates ranged between 0 and 1.41 m/yr (4.63 ft/yr)(Table 1). Lower rates were associated with gradual lateral and downstream migration associated with typical stream meandering. Higher migration rates were atypical and associated with abrupt channel cutoff or channelization.

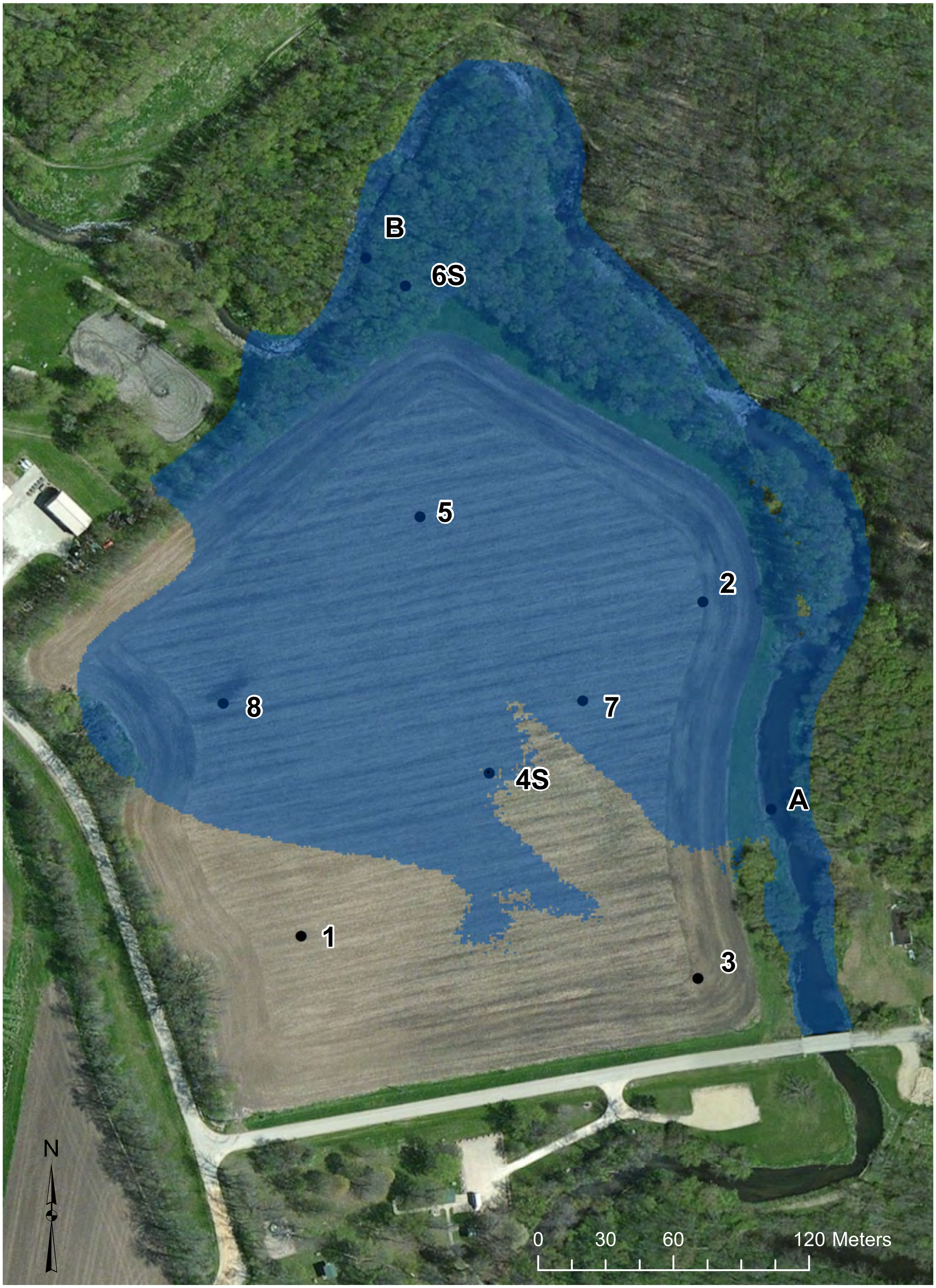

Figure 15. Approximate maximum saturation area based on groundwater levels within 30 cm of ground-surface during the May 30, 2019 precipitation and flood event.

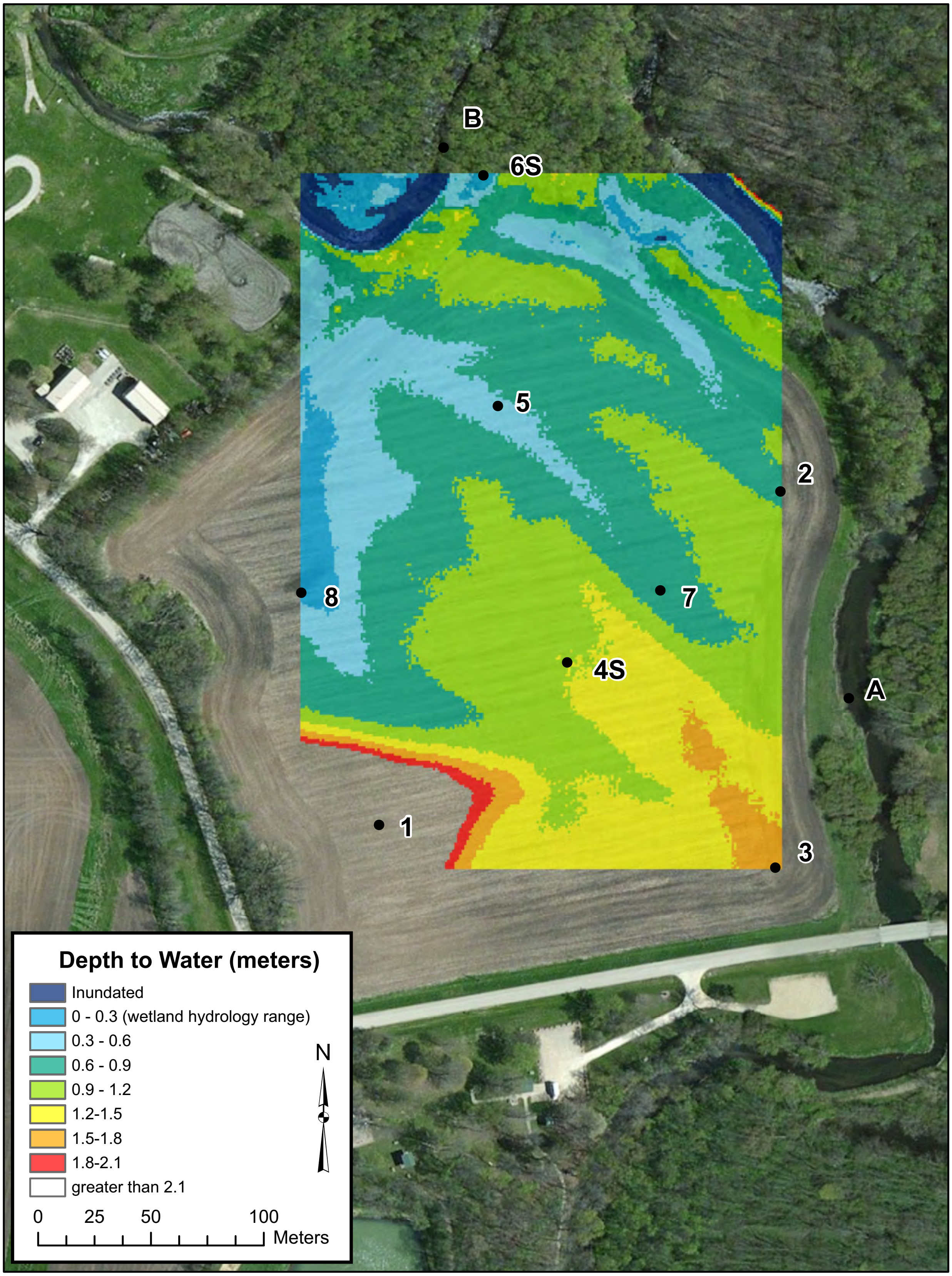

Figure 16. Approximate depth to water during the 2019 maximum 14-day hydroperiod. Areas with a depth to water less than 0.3 m would meet the USACE Midwest Regional Supplement's criteria for wetland hydrology.

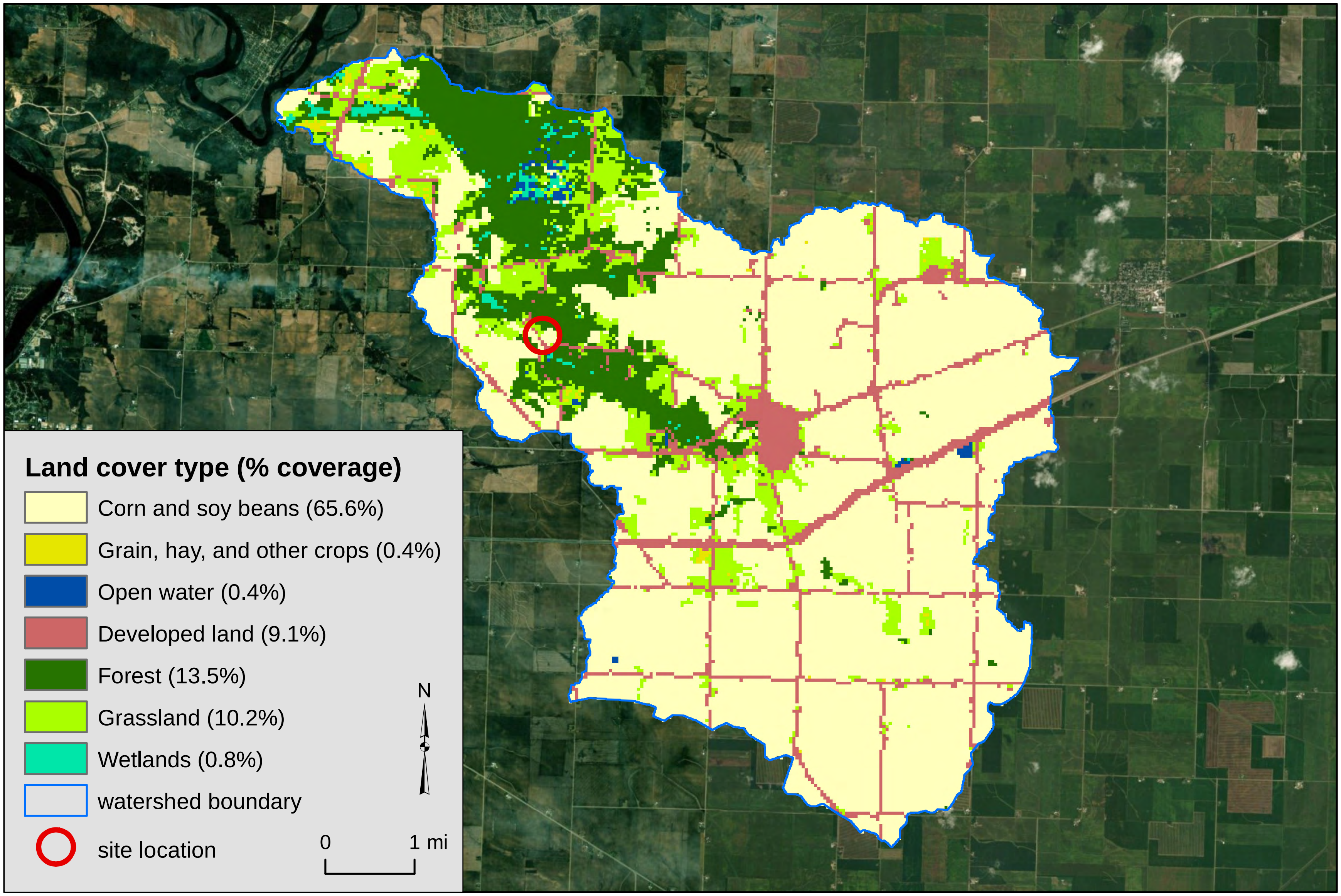

Figure 17. Franklin Creek Watershed landcover. Land cover types were generalized from USDA-NASS (2007) data.

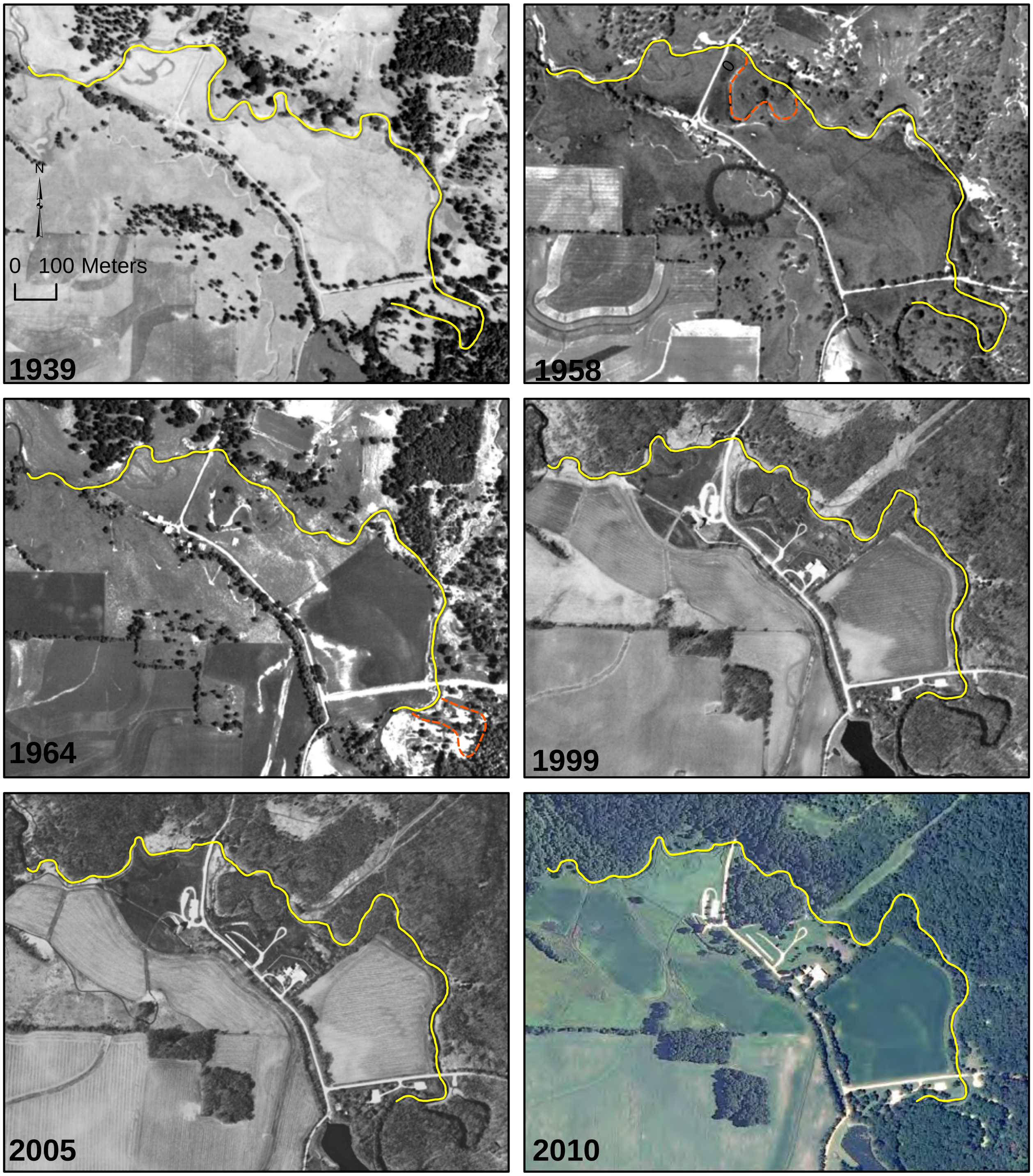

Figure 18. Photo sequence of historical aerial photography used for stream migration analysis. Channel centerlines for each year are are shown as solid yellow lines. Channel cutoffs are shown as dashed orange lines. Scale and orientation are shown in the 1939 photo.

During the 1939-58 interval, a 195-m (640-ft) channel segment was cut off immediately upstream Twist Road Bridge. During the 1958-64 interval, a 320-m (1050-ft) channel segment was cut off immediately upstream of the Old Mill Road Bridge. These cutoffs likely increased sediment mobility and migration rates immediately downstream by increasing the channel gradients, although this cannot be determined directly from aerial photo evidence.

Channel migration rates under 1 m/yr (3 ft/yr) were much more common than higher rates. Rates greater than 1 m/yr (3 ft/yr) were most often found in more pronounced (i.e. higher amplitude) meander bends (Figure 19). Therefore, we evaluated six selected bends along the creek segment, including the subject bend of this study located at Site 5, to compare higher historical migration rates among meander bends (Figure 19, Table 1). During each interval, including the most recent, Bend 2 showed neither the highest nor the lowest migration rate. This indicates that, as least until 2010, Bend 2 was migrating at a rate that was within the range of variability for the selected bends within the Franklin Creek State Park and that the rate and mode (i.e., lateral and downstream) of migration is consistent with the natural stream processes at the park.

Table 1. Historical maximum channel migration rates in meander bends at Franklin Creek State Park. Bend 2 (values in bold) is located at the proposed restoration Site 5.

Bend	***Channel migration rate per photo interval***									
	1939-58		*1958-64*		*1964-99*		*1999-2005*		*2005-10*	
	m/y	ft/yr	m/y	ft/yr	m/y	ft/yr	m/y	ft/yr	m/y	ft/yr
1	0.37	1.21	n/a	n/a	0.44	1.44	0.72	2.36	0.32	1.05
2*	**0.09**	**0.30**	**1.53**	**5.02**	**0.37**	**1.21**	**0.37**	**1.21**	**0.69**	**2.26**
3	0.55	1.80	2.63	8.63	0.62	2.03	1.25	4.10	2.63	8.63
4	0.44	1.44	0.6	1.97	0.69	2.26	1.23	4.04	0.55	1.80
5	n/a	n/a	n/a	n/a	0.44	1.44	1.35	4.43	1.41	4.63
6	0.57	1.87	1.1	3.61	0.4	1.31	0.52	1.71	0.35	1.15

The movement of the point of maxim channel migration within each bend were also mapped to evaluate bend movement over time (Figure 20). This analysis indicates that while meander bends erode laterally the location of maximum migration along the bank also moves downstream over time. This finding is consistent with the observation that, within meandering alluvial channels, bends tend to move laterally and downstream along the valley due to the differences erosion and deposition rates along the channel (Knighton 1998).

Channel characteristics and channel changes at Site 5 (2009-2019)

Repeat cross section measurements of Franklin Creek (Figures 21 and 22a-d) show the channel ranged from 2.04 to 2.34 m (6.69 to 7.68 ft) deep. No major channel changes occurred within the cross sections during the March 2018 to May 2019 channel monitoring period, however minor channel adjustments were evident (Figures 22a-d). Changes in elevation were evaluated, with positive changes indicating channel deposition and negative changes indicating erosion at each station point along the cross section.

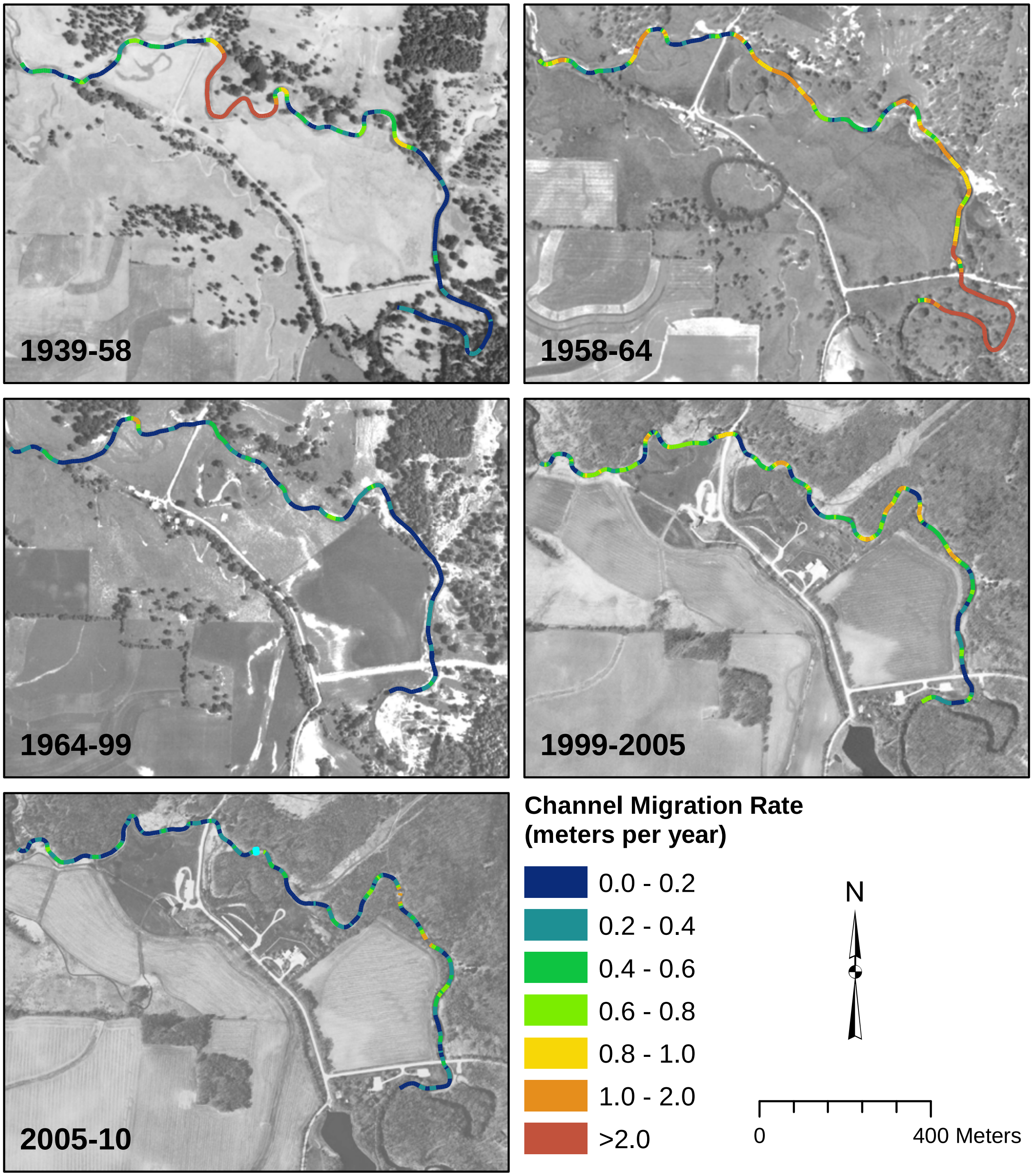

Figure 19. Channel migration rates along Franklin Creek at Franklin Creek State Park between 1939 and 2010. Backgound photos are the earlier year in the sequence.

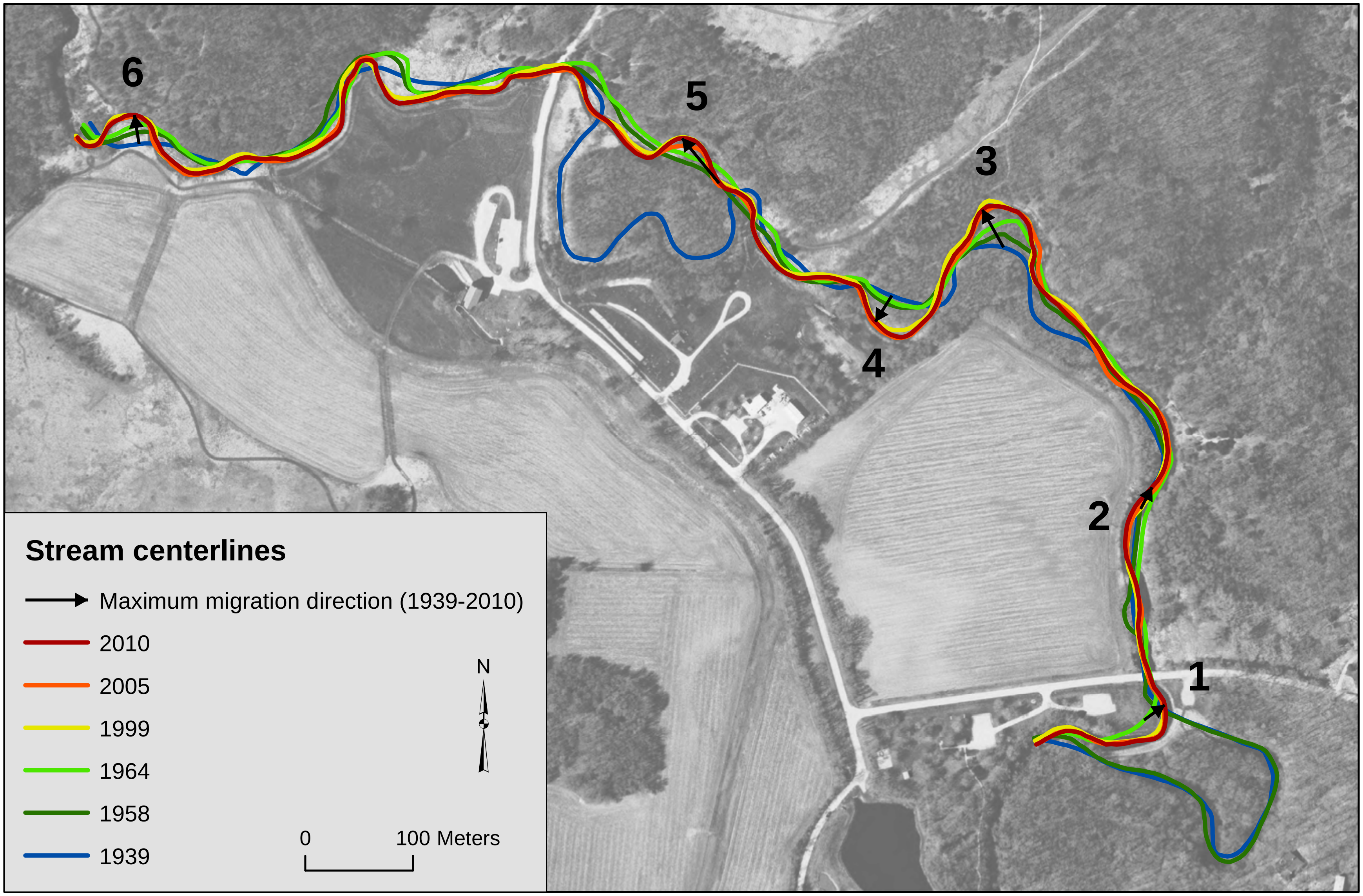

Figure 20. Overlay of stream channel centerlines from each year in the photo sequence. Background layer is the 2005 DOQ imagery (ISGS 2019). Bold black numbers indicate stream bends that were selected for the historical migration analysis. Bend 2 is the subject bend for proposed stream restoration.

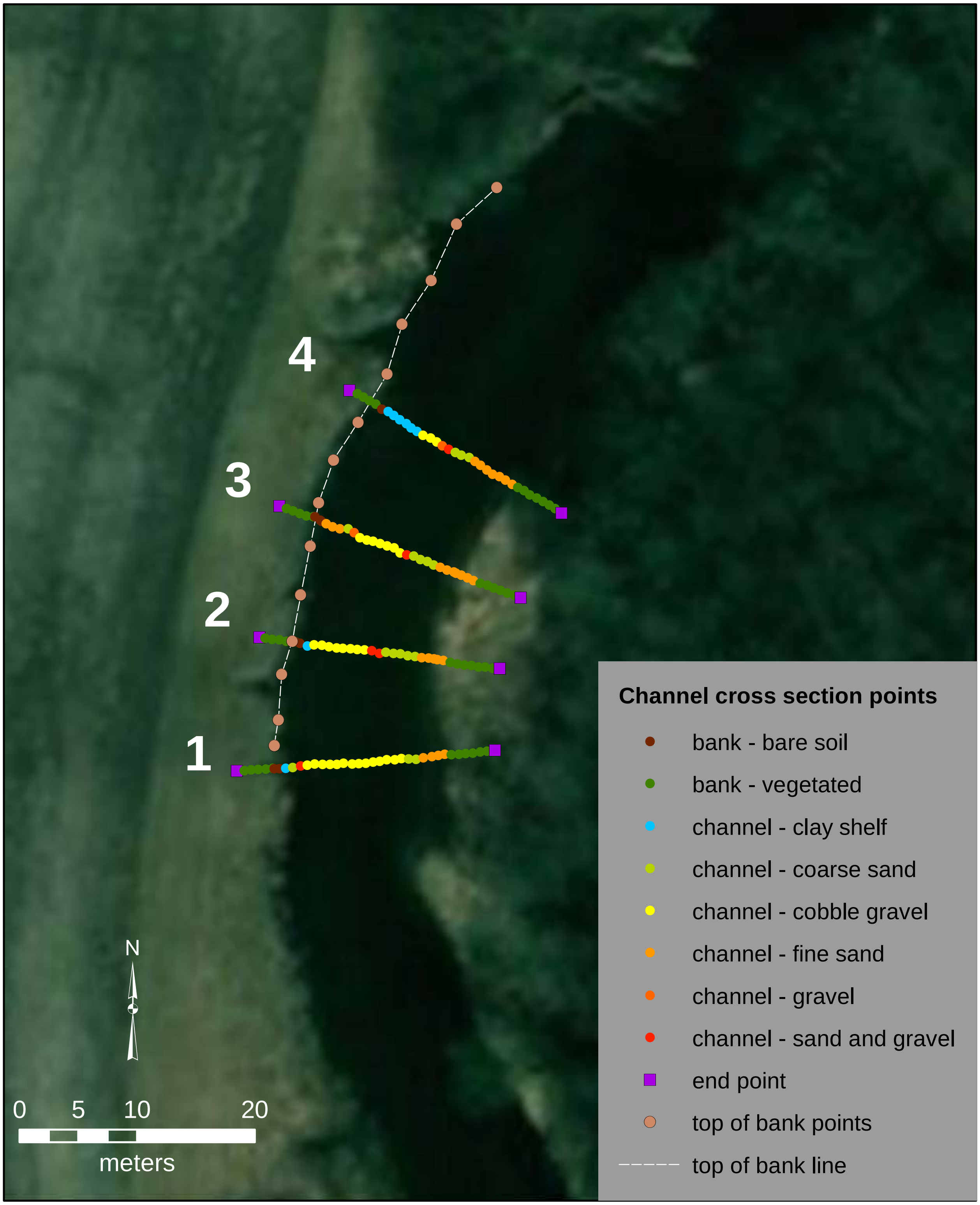

Figure 21. Cross section and bankline data point locations from March 2018. Cross section points were qualitatively categorized according to general grain size characteristics and vegetation cover. Cross sections are labeled 1 through 4 upstream to downstream corresponding with Figures 22a-d.

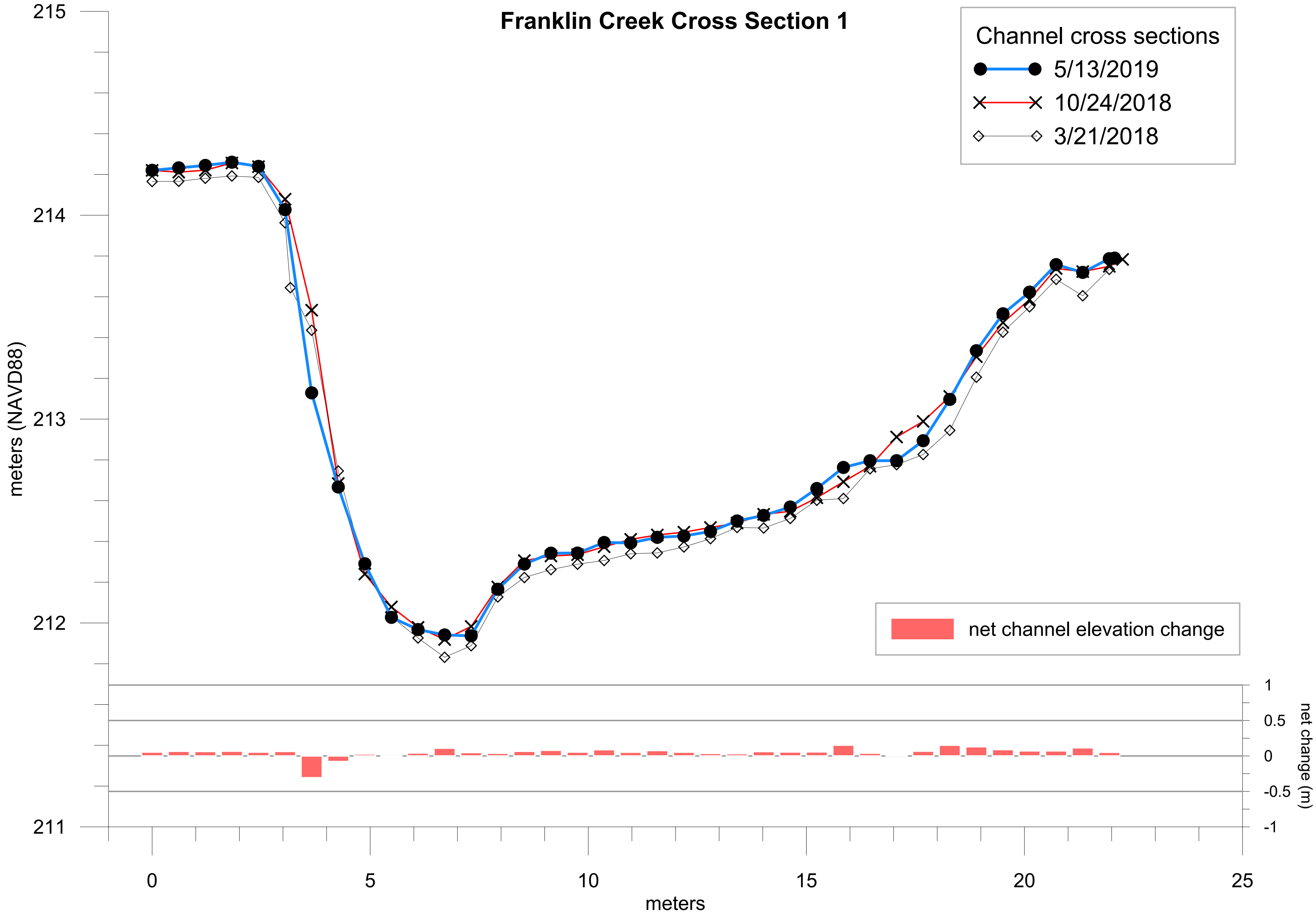

Figure 22a. Repeat channel cross section measurements of Franklin Creek channel at Site 5, cross section 1. The bar graph at the bottom of the figure shows the net change in channel elevation between March 21, 2018 and May 13, 2019.

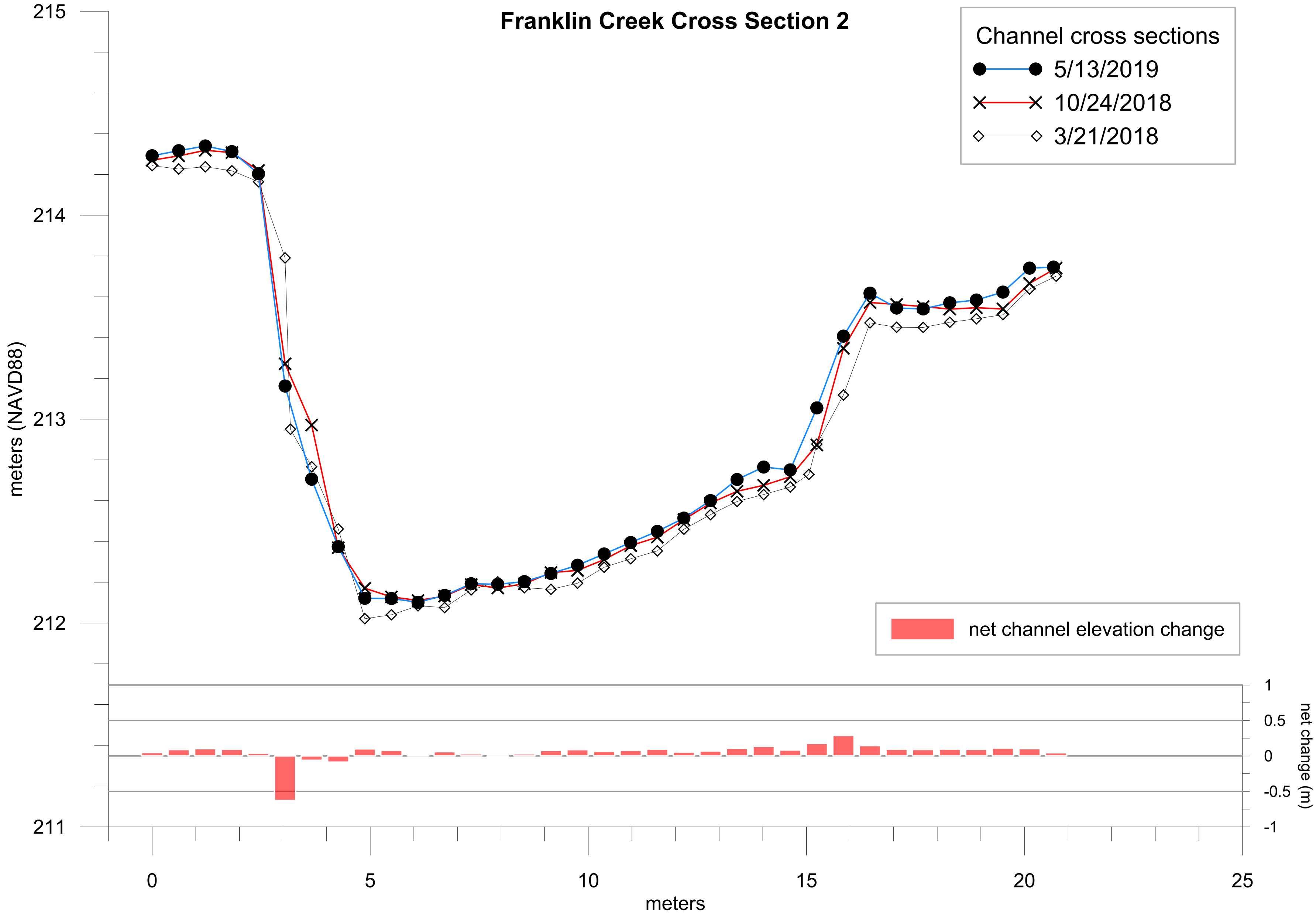

Figure 22b. Repeat channel cross section measurements of Franklin Creek channel at Site 5, cross section 2. The bar graph at the bottom of the figure shows the net change in channel elevation between March 21, 2018 and May 13, 2019.

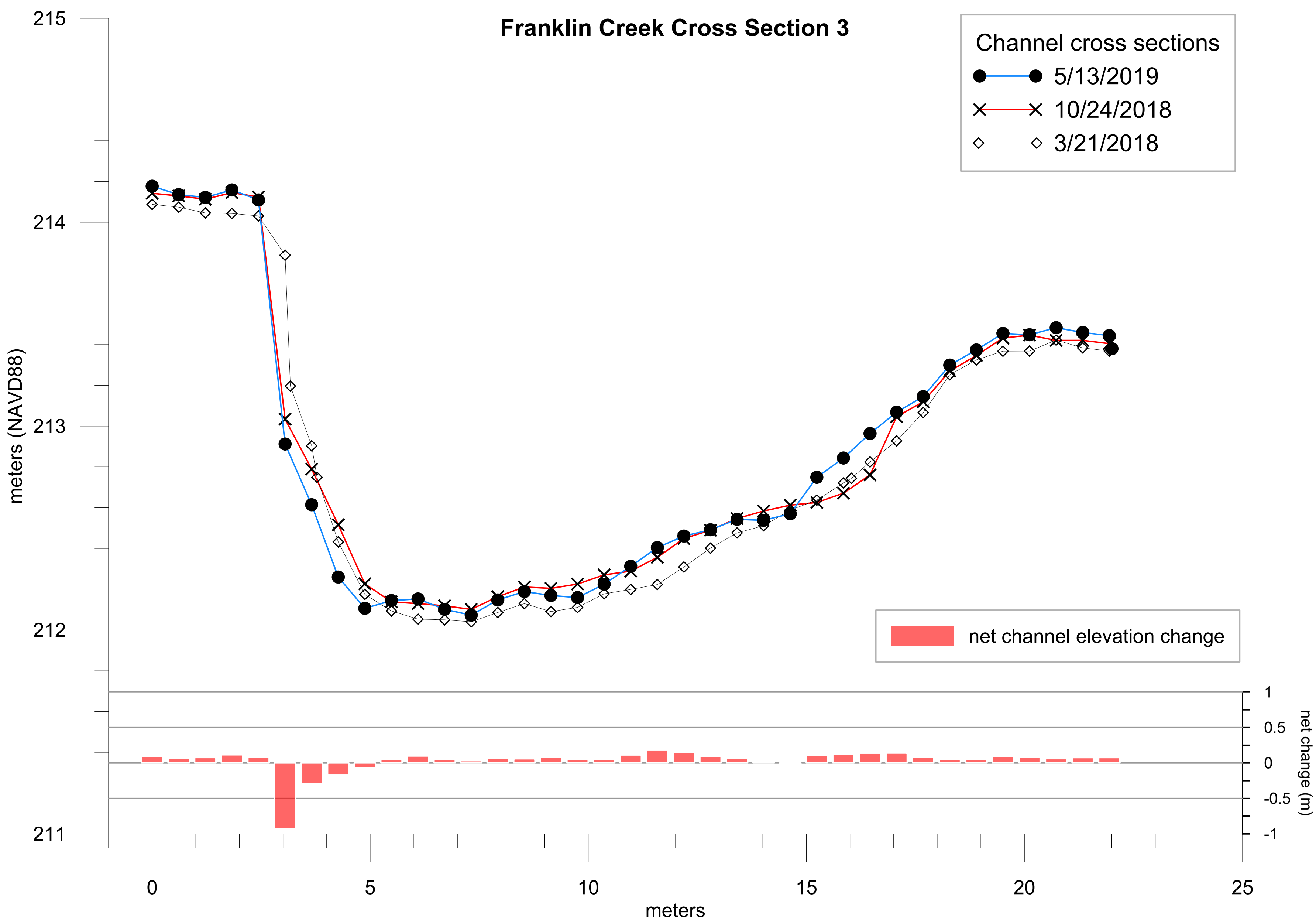

Figure 22c. Repeat channel cross section measurements of Franklin Creek channel at Site 5, cross section 3. The bar graph at the bottom of the figure shows the net change in channel elevation between March 21, 2018 and May 13, 2019.

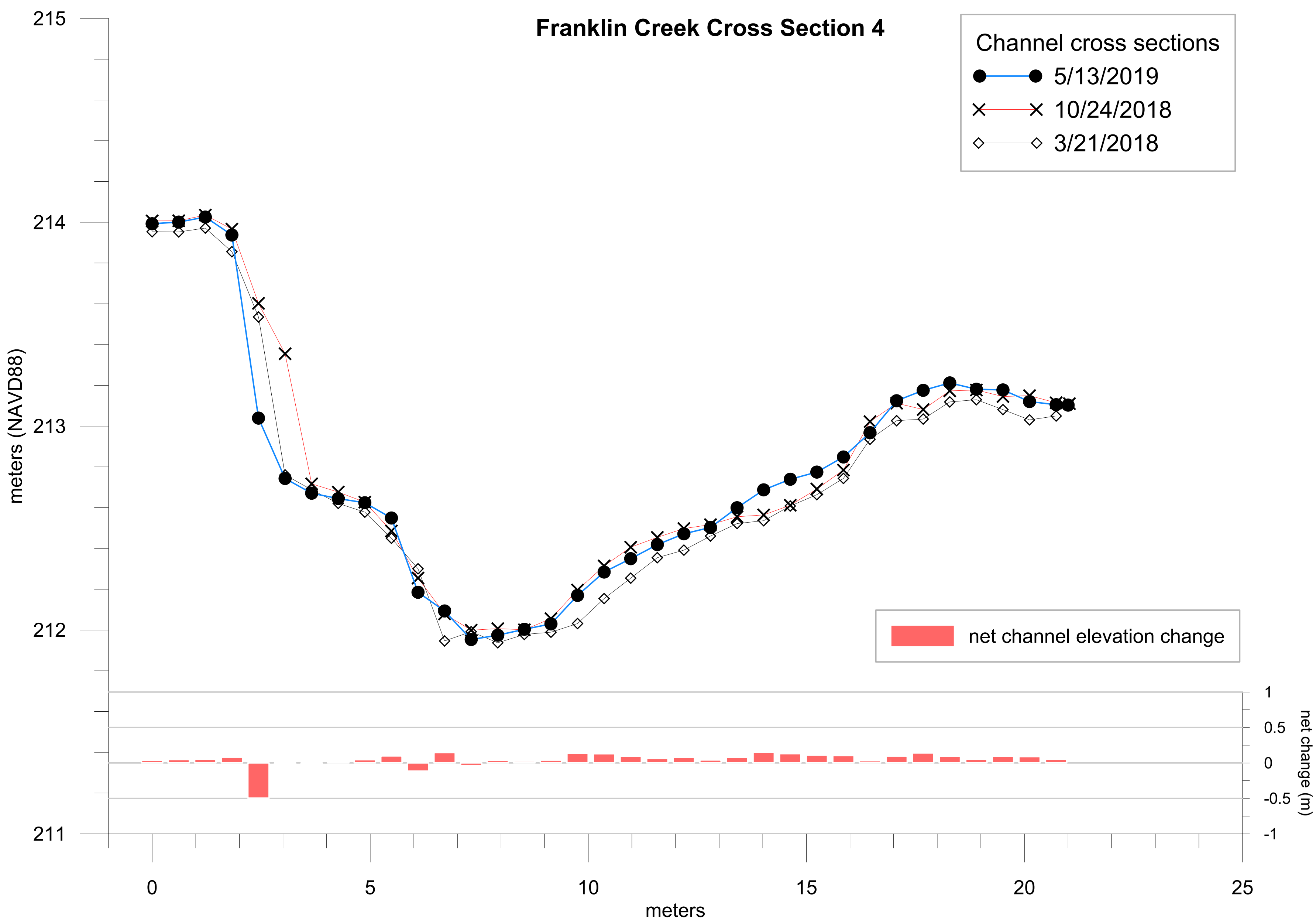

Figure 22d. Repeat channel cross section measurements of Franklin Creek channel at Site 5, cross section 4. The bar graph at the bottom of the figure shows the net change in channel elevation between March 21, 2018 and May 13, 2019.

Among the cross sections, the maximum (vertical) erosion per measurement point location was 0.93 m (3.05 ft) in cross section 3 and the maximum deposition measured was 0.29 m (0.95 ft) in cross section 2. All portions of the point bar (right bank) and most of the channel bed showed either no erosion or net deposition. Only those areas of the channel bed closest to the left bank showed net erosion in cross sections 1, 2, and 3. Cross section 4 showed some slight erosion in the center part of the channel.

Bank materials along the left bank consist of past river deposits (alluvium) composed of silt loam at the surface to slightly more than 1 m below the top of bank underlain by more dense clayey materials. These clay-rich deposits extend to an undetermined depth but do appear in the bed of the channel at cross section 4 and just downstream (Figure 22d, Figure 23). We were not able to characterize the morphology of the downstream most portion of the bend due to a deep scour hole that prevented measurement of a cross section in this location. Coarser deposits are located in the channel bed and consist of cobble, gravel, and coarse to medium sand. The point bar along the right bank is partly vegetated but recent sand and silt deposits were evident.

The cross sections 1, 2 and 3 reflect typical pronounced bar-pool topography and channel asymmetry associated with alluvial meander bends (Knighton 1998); a point bar along the right bank composed of finer grained sediments with the deeper part of the channel (i.e., pool) along center of the channel and toward the left bank with coarser grained materials. Cross section 4, however, is atypically symmetrical for the position in the bend. The more symmetrical channel shape in cross section 4 reflects the presence of a clay-rich deposit forming a shelf that protrudes into the channel slightly below base flow water level. The resistance of the clay shelf coupled with point bar deposition and growth along the opposite bank constricts stream flow and likely increases local stream velocity and turbulence near the bed and left bank (Figure 24).

Table 2. Net lateral erosion distance and net annual bank erosion rates along the left bank (cutbank) at Site 5, between March 21, 2018 and May 2019.

	Top of bank				**Bank face**			
Cross Section	**Net lateral erosion**		**Erosion rate**		**Net lateral erosion**		**Erosion rate**	
	m/yr	ft/yr	m/yr	ft/yr	m/yr	ft/yr	m/yr	ft/yr
1	0.00	0.00	0.00	0.00	0.30	0.98	0.26	0.85
2	0.00	0.00	0.00	0.00	0.37	1.21	0.32	1.05
3	0.48	1.57	0.41	1.35	0.62	2.03	0.53	1.74
4	0.00	0.00	0.00	0.00	0.54	1.77	0.46	1.51

Comparison of the 2009 LiDAR elevations and the March 2018 bank line measured on-site with GPS shows bank retreat over this period throughout Bend 2 at Site 5. Total bank retreat ranged from 2.54 m at cross section 2 in the upstream portion of the bend to 5.85 m at location 6 in the downstream portion of the bend (Table 3). The corresponding erosion rates ranged from 0.28 m/y to 0.65 m/yr. The future position of the bank line was estimated based on these recent bank erosion rates and is shown in Figure 25. The approach we used to estimate future channel erosion does not account for the likely downstream movement of the location of maximum channel migration (see the white arrow in Figure 25) and cannot account for future changes in watershed conditions or climate patterns.

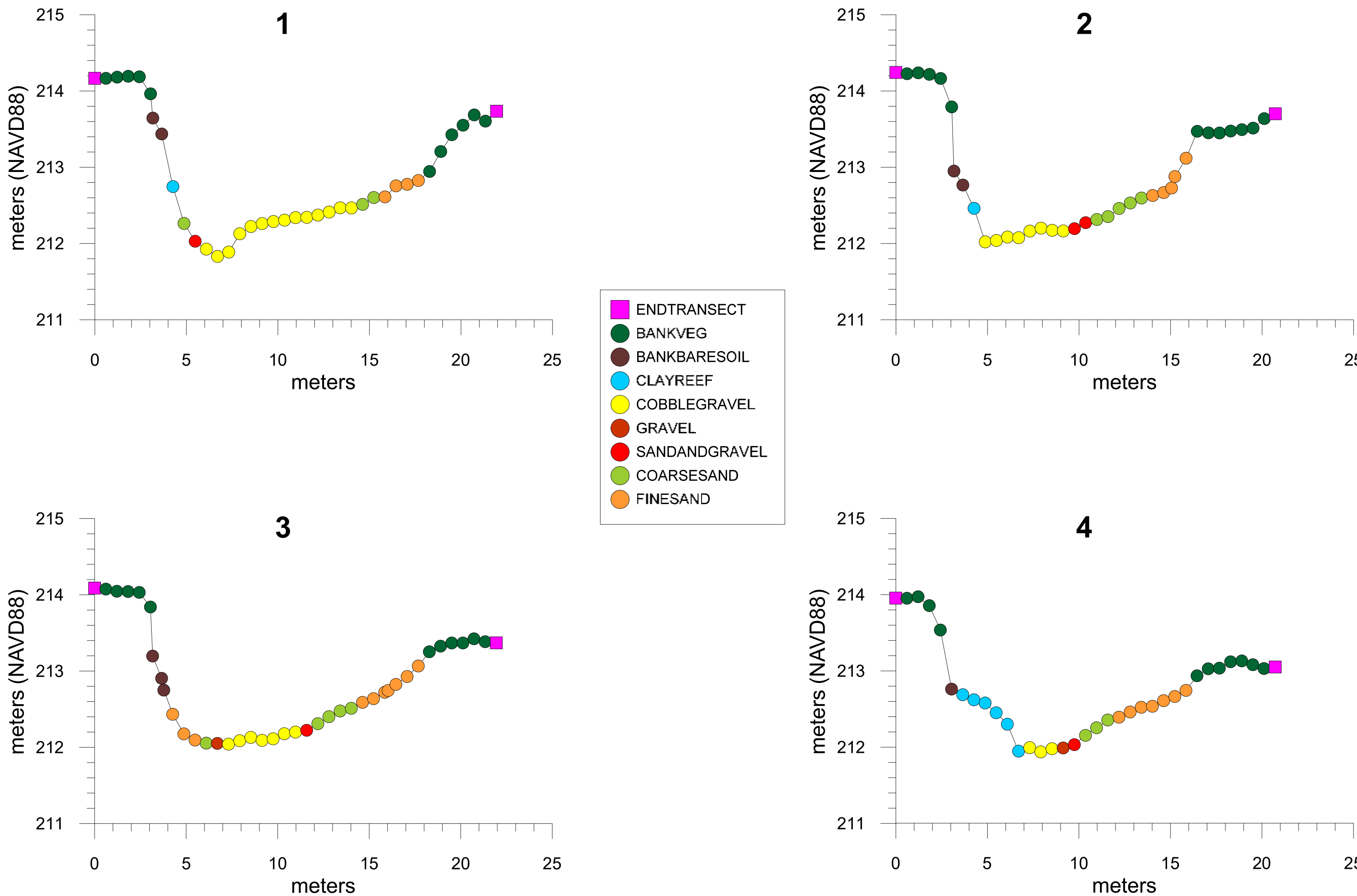

Figure 23. Channel cross sections of Franklin Creek at Site #5. Cross section numbers 1-4 are upstream to downstream and correspond to the map in Figure 2.

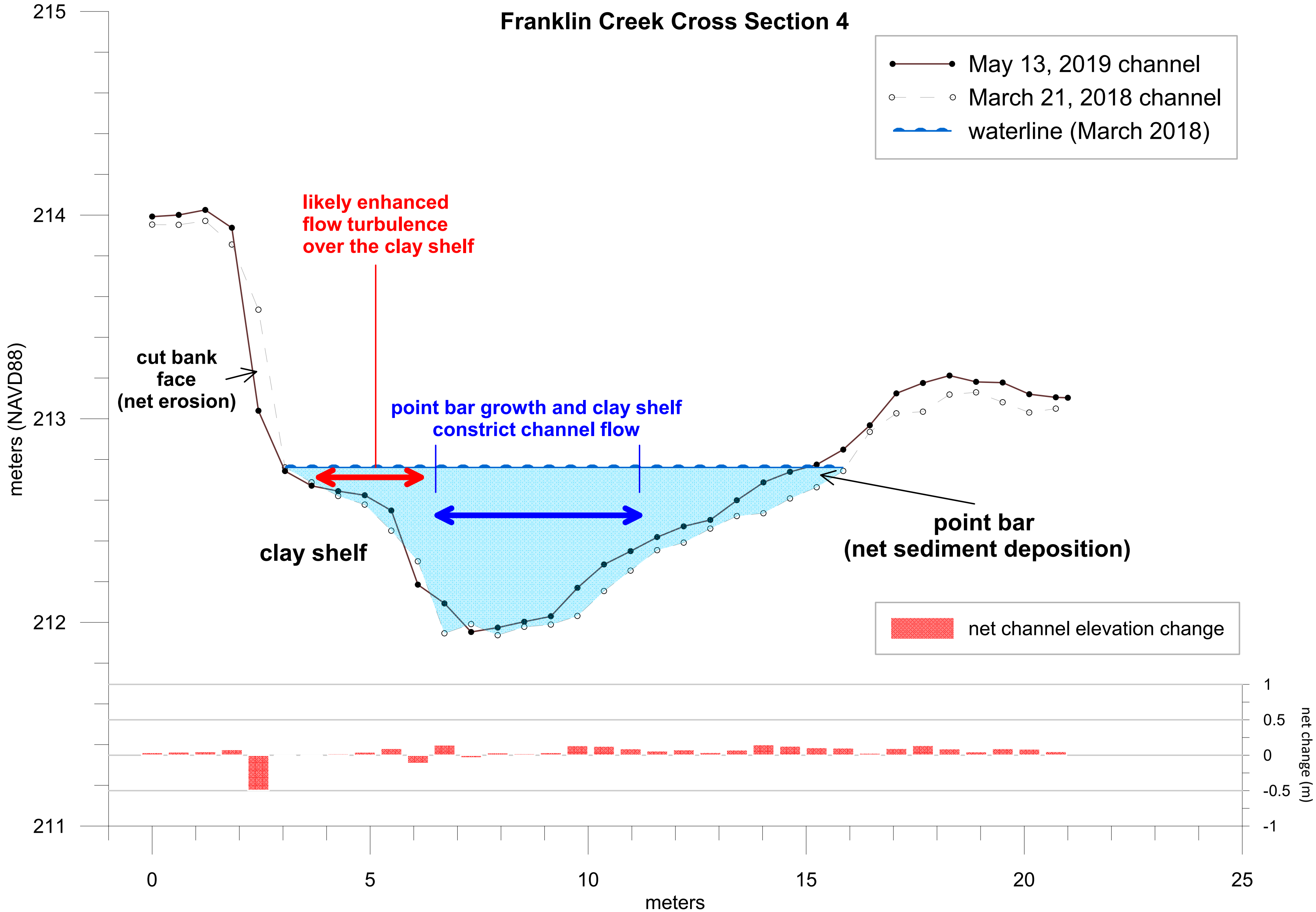

Figure 24. Likely effects of the point bar aggradation and the resistant clay layer on flow at cross section 4, Site 5, Franklin Creek State Park. Flow constriction likely enhances bank erosion downstream of cross section 4.

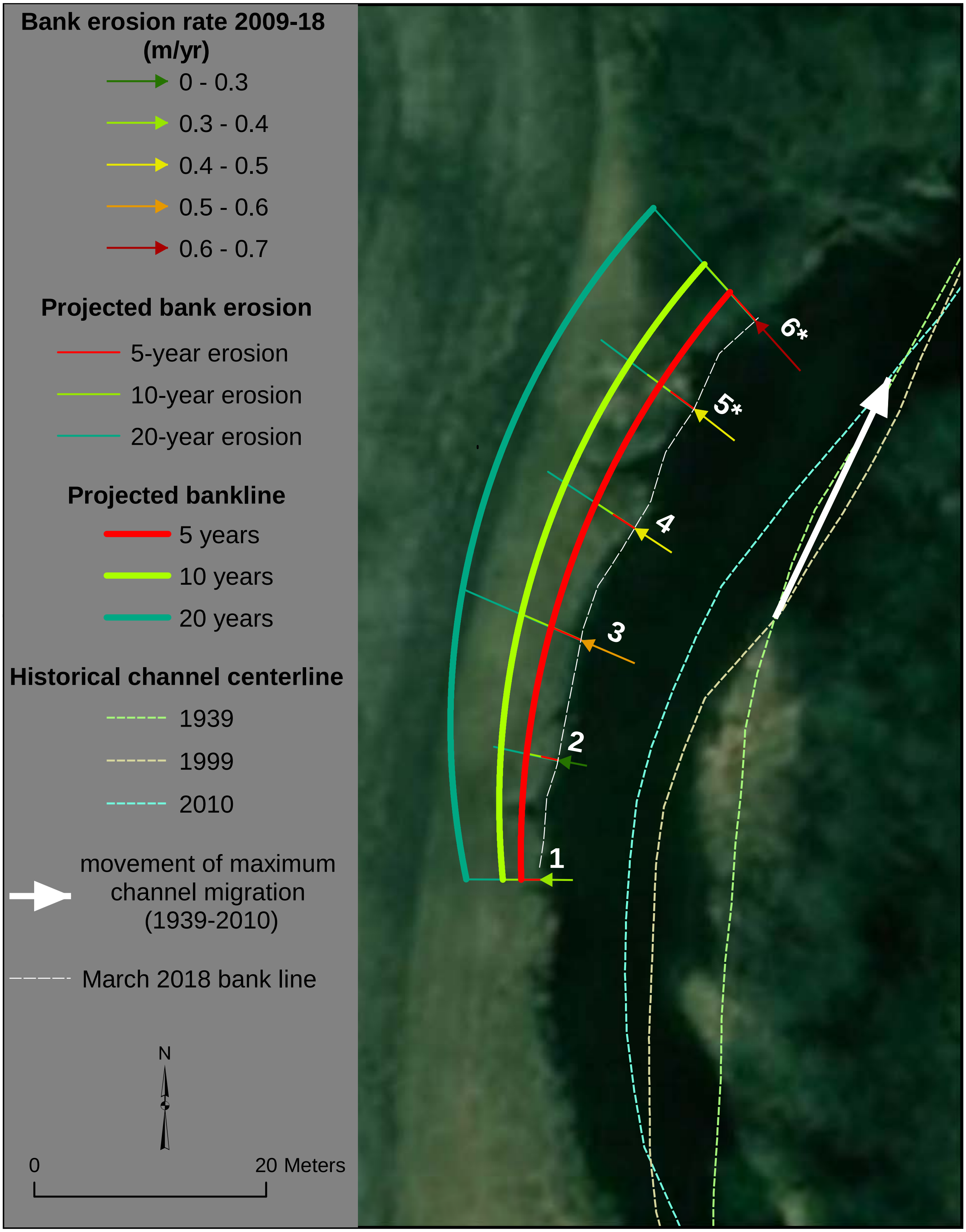

Figure 25. Projected bankline erosion at 5- 10- and 20-year intervals at Site 5. Projections were estimated using 2009-2018 erosion rates. Representation of the projected banklines are based on the maximum rates from this time period. Labels 1 through 4 correspond with measured channel cross sections locations 5 and 6 are assigned measurement locations with no corresponding cross section.

Also, the projection was based on current maximum erosion rates and therefore may overestimate the future erosion that could take place. Nonetheless, based on the assumption of erosion rates of similar magnitude to current and historical rate this provides a guideline for the range expected erosion to inform restoration activities. Based on the projection, the streambank margin at the 5 years threshold is expected to range from approximately 1.6 m at the upstream end to 3.25 meters at the downstream end. The margin at the 10 and 20 years would range from 3.2 m to 6.5 m, and 6.3 m to 13 m, respectively.

Table 3. Bank retreat distance and erosion rates at Site 5, 2009-2019. Distances and rates are based on a comparison of a March 2018 bank line survey and the position of the bank line in the 2009 LiDAR for Lee County.

	Total bank retreat (2009-18)		**Annual bank erosion rate**	
Cross Section	m	ft	m/yr	ft/yr
1	2.84	9.32	0.32	1.05
2	2.53	8.30	0.28	0.92
3	5.00	16.40	0.56	1.84
4	3.80	12.47	0.42	1.38
5*	4.43	14.53	0.49	1.61
6*	5.85	19.19	0.65	2.13

*only bank line position was measured, a full cross section could not be measured due to a deep scour hole in the channel.

Discussion: Franklin Creek channel changes and approaches for stream restoration

Assessment of long-term (1939-2010) channel planform changes along Franklin Creek shows that the direction of channel migration was lateral and down valley. The range of migration rates in meander bends was from near zero up to 2.63 m/yr (8.63 ft/yr). Comparison of the position of the bank in 2009 based on LiDAR topography and 2018 based on spot measurements shows that recent erosion occurred at rates ranging from 0.28 to 0.65 m/yr (0.92 to 2.13 ft/yr) which are within the range of historical rates (see Tables 1 and 3).

Detailed repeat cross sections show channel erosion and deposition in response to hydrologic events and seasonal hydrologic patterns. Overall, changes were relatively small in magnitude showing centimeter scale adjustments and some within measurement error. Nevertheless, the cross-section measurements mostly indicate no change or slight increases in sediment deposition in the channel bed and along the right bank. This suggests that sediment supply is in balance or slightly in excess of the capacity of the current flow regime.

Cross-sections also show that the position of the top of the bank line did not change between March 2018 and May 2019, however, there were indications of erosion from the cut bank face. This may reflect the process of bank mass failure, which often happens in episodes. As the bank face and bed is eroded more gradually and directly by channel flow, the top of the bank is undermined but remains intact until it becomes unstable and falls into the channel. This bank failure process tends to occur at higher rates where the banks have shallow rooted or little to no vegetation. Cross-section 4 shows atypical channel symmetry for its position within the meander bend. The shape of the channel at this cross-section indicates the presence of a resistant clay rich deposit in the bed and banks. The clay-rich deposit along with active deposition on the point bar constricts flow in the downstream portion of Bend 2. The flow constriction likely causes local increases in stream flow velocity and turbulence near the bed and banks. This effect is likely enhanced at higher stream stages leading to increased erosion of less resistant material around the clay deposit and just downstream. This effect is particularly evident from the deep scour hole observed in the downstream portion of the bend and the bank failure immediately downstream.

During the 2018-2019 monitoring period, precipitation was at or above normal in most months. Therefore, channel changes observed in the repeat cross section measurements happened during overall wetter than normal conditions. However, the wetter conditions yielded only four flood events at bank full or higher. Further, the Palmer Hydrologic Drought Index shows above normal to extremely moist conditions have prevailed in the region since early 2015 suggesting that stream flow would also have been above normal during this period. While higher erosion rates would be expected with increased stream flow, recent lateral erosion rates show no departure from historical background migration rates. The obvious erosion that is occurring in Bend 2 appears to be a local effect from a resistant geologic deposit and not related to infrastructure (Old Mill Bridge) or other abrupt change to watershed conditions. Unless substantial changes watershed landscape or land use, sediment supply, stream discharge, or climatic conditions occur, channel migration can be expected to continue with similar patterns and rates.

The goal of the IDNR restoration project is restoring and improving native habitat along Franklin Creek and floodplain for the benefit of the larger Rock River watershed. One objective under this goal is to prevent sediment from getting into Franklin Creek. Under this goal a variety of restoration approaches and techniques could be implemented among them could be:

1) Allowing active bank erosion, cease farming and mowing, and allowing natural revegetation of the near-bank riparian corridor.
2) Allowing active bank erosion, cease farming and mowing, and replanting the near-bank riparian corridor with relatively fast growing deep rooted woody vegetation.
3) Reshaping and replanting the bank and near-bank riparian corridor with relatively fast growing deep rooted woody vegetation.
4) Hardening the bank with riprap or local native stone and replanting the near-bank riparian corridor with relatively fast growing deep rooted woody vegetation.
5) Channel reconfiguration and bank hardening to address protection of infrastructure, drastic erosion caused by sediment or hydrologic imbalance.

Corresponding consideration should be taken into account based on observations from this study. Simply allowing active bank erosion without active replanting may not establish desirable species or deep rooted vegetation that could slow bank erosion and improve near-bank habitat within the riparian corridor. For example, zoned replanting of native species using the projected bank erosion as a guideline (see Figure 25) may be more desirable for restoring the near bank area than a completely passive approach. Regardless of any work directly on the stream bank, cessation of farming and restoration of the field to native vegetation is likely to reduce delivery of sediment that is currently produced by runoff from the field to Franklin Creek.

Any work to the bank or channel itself has the potential to release additional sediment to the channel and disrupt existing channel morphology and flow patterns which could lead to unwanted upstream and downstream changes. Further, reconfiguring the channel could disrupt the existing habitat within the stream. However, bank reshaping that would facilitate establishment of fast-growing, deep-rooted native vegetation could be utilized to slow future bank erosion. Hardening of the channel bed or banks is likely to have a similar effect to the resistant clay deposit. Adding resistant material (i.e., rock, riprap, concrete) to the channel is likely to result in enhanced turbulence and unwanted erosion to less resistant material around and downstream of hardened structures. Moreover, more intensive channel manipulation appears to be unwarranted given the evidence provided by the observed hydrology, channel morphology and rates of erosion.

A number of factors not considered in this discussion and outside of the scope of this study include project costs, policy regarding particular species or habitat types, and other possible IDNR policies that may be pertinent to the project.

CONCLUSIONS AND RECOMMENDATIONS

Geologic materials, groundwater supply, and flood duration and frequency are not conducive to extensive wetland restoration. However, small areas of ponding are evident from secondary hydrologic indicators suggesting that re-establishing native vegetation may result in small wetland areas within existing small depressions at the site, and support wet prairie species in lower elevation areas of the field at Site 5 that flood and show a high water table within the root zone.

Despite above normal levels of precipitation in 2018 and 2019, no areas on site met the criteria for wetland hydrology in 2018 and only two of the eight monitoring wells met the criteria in 2019. Precipitation in the last two years has been above average for this area, so inundation and saturation descriptions in this report are not indicative of a normal year. Under normal precipitation conditions, lower water table and less potential for wetland hydrology can be expected.

Given the infrequent flooding, depth to water table, and existence of a gravel lag deposit, we do not recommend excavation to create wetland areas. A large amount of excavation, ranging from 0.6 to 1.0 m (2.0 to 3.3 ft) based on the 2019 high water table, would be required to intercept the water table and/or capture floodwater on a more frequent basis in order to establish widespread hydrology characteristic of wetland habitat. The amount of excavation required to produce wetland hydrology would remove the native soil and the possibility of utilizing the existing seed bank within the existing soils.

Most, if not all, of the site is conducive to restoration of native vegetation through reforestation or prairie planting. Although Franklin Creek flooded portions of the site five times during the study, these floods are generally brief and cause relatively shallow inundation (maximum inundation measured in the field at Site 5 was 0.36 m [1.20 ft]). Therefore, the likelihood of tree plantings being damaged by flood inundation (or erosion, or ice rafting) is relatively low. The range of hydrology from near wetland conditions (where high water table was detected within the upper 30 cm of the soil in the north and northeast portions) to dry (where the seasonal high water table was relatively deep or not detected) suggests that a wide range of habitats could be restored and appropriate species could be planted based on the specific hydrologic conditions.

Comparison of historical channel migration rates and recent bank erosion at the site suggest that more passive and less intensive stream restoration techniques are appropriate for restoring the riparian corridor and floodplain along Franklin Creek. Recent erosion rates measured at Site 5 and used to estimate future bank erosion could be used as guidelines for restoration planning in the near bank area of the riparian corridor.

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APPENDIX: SITE PHOTOS

A1. Photo of restoration site, looking northeast. Photo taken February 21, 2017.

A2. Soil boring from initial site evaluation on February 21, 2017.

A3. Shells found in soil borings on February 21, 2017.

A3. Organic material found in soil borings on February 21, 2017.

A4. Stream bank near Gauge A during the March 21, 2018.

A5. Franklin Creek near Gauge B on the April 29, 2019 site visit.

A6. Well 6 during the April 29, 2019 site visit.

A7. Ponding on the farmed field during the April 29, 2019 site visit. Photo is looking southwest towards well 8.

A8. Rivulet near Gauge A during the April 29, 2019 site visit.

A9. Undercutting of bank near Gauge A taken during the May 13, 2019 site visit.

A10. Corn stubble around Wells 5 and 5S during the June 11, 2019 site visit.