# Topeka Shiner Monitoring in Minnesota: 2015

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# Contents

## INTRODUCTION

The material presented in this report is the result of a stream monitoring survey for *Notropis topeka* (Topeka Shiner) in southwest Minnesota as per a contractual agreement between me, George R. Cunningham, and the Minnesota Department of Natural Resources (DNR) under **PO# 3000074815**.

*Notropis topeka* (Topeka Shiner) was historically widespread in smaller stream systems (1st through 3rd order) throughout the central portion of the tallgrass prairie biome of the United States. Since the 1970's, the species has exhibited widespread range contraction and is estimated to occur in only 10 to 15 percent of its historic geographic distribution (Tabor 2002, USFWS 2009). The decline of this species is the result of habitat loss resulting from the near complete conversion of the tallgrass prairie biome for agricultural purposes (Cross 1967; Eddy and Underhill 1974; Gelwicks and Bruenderman 1996; Pflieger 1997; Berg et al. 2004). Specifically, the conversion of the tallgrass prairie ecoregions from a perennial grassland systems with meandering, sinuous stream channels connected to their floodplains to a row crop agriculture landscape created stream conditions of ditched and straightened channels as well as down cut and degraded stream channels, resulting in widespread alteration of stream channels disconnected from their floodplains. Moreover, the construction of thousands of small flood control dams throughout the range of *N. topeka*, (combined with the conversion of the grassland ecoregions), has created pronounced functional changes to riverine ecosystem dynamics including: alterations to natural hydrographs, disruption of sediment dynamics and floodplain connectivity, increased turbidity, higher water temperatures, loss of aquatic vegetation, and introduced species (particularly sight feeding predators). In response to the rapid and dramatic decline in distribution and potential abundance of this species, the U.S. Fish and Wildlife Service (USFWS) designated the species as endangered under the Endangered Species Act of 1973 (Tabor 1998).

In 2004, the DNR began a presence/absence survey effort to monitor *N. topeka* populations in Minnesota at randomly selected sites within the federally designated critical habitat for the species in southwestern Minnesota. A protocol was established (Ceas and Anderson 2004) to conduct a presence/absence survey for this species at twenty (20) randomly selected 1-mile long stream segments from within the Big Sioux and Rock River drainages of southwestern Minnesota. Surveys were conducted annually from 2004 to 2010 by Ceas and continued in 2012 to 2014 with Nagle and Larson. This 2015 survey is a continuation of this monitoring process.

Analysis of data from the annual surveys conducted from 2004 to 2010 found *N. topeka* at an average of 76.4% of sites over this period (Nagle and Larson 2014). However, this percentage

dropped to 60% starting in 2010 and declined further in 2012 and 2013 (40% and 30% respectively), with a slight improvement observed in 2014 (Nagle and Larson 2014). Although the monitoring protocol used for this species is not designed to systematically evaluated population trends, a simply criteria to evaluate relative abundance indicates a decline of this species (Ceas and Larson 2010; Nagle and Larson 2014). Results from monitoring surveys conducted in 2015 are detailed in this report with a discussion regarding previous survey efforts and results.

## METHODS

Sampling methods for 2015 monitoring generally followed the previous methods by Ceas and Nagle.

### *Selection of Stream Segments*

For each year of *N. topeka* monitoring, 20 one-mile stream segments were selected at random from the federally designated *N. topeka* critical habitat within Minnesota, employing an ArcView extension program developed by the DNR. Final map files for the 2015 survey were provided to me by the DNR and overlaid on aerial imagery (**Appendix A**). The location of the 2015 stream segments are depicted in **Map 1**.

### *Landowner Contact*

Contact information for landowners was provided to me by the DNR. I followed up with land record searches for each county through their respective online landowner parcel databases since a number of landowners listed in the information provide to me did not have phone numbers; moreover, nearly one-quarter of the landowner names were not the current landowners listed in the DNR ownership file. Additionally, for those landowners without phone numbers, an Internet search of the person's name and address was conducted to find their phone numbers. Landowners were contacted via phone and asked permission to access their land. Those landowners that did not answer repeated calls were later asked in person to access their land by visiting their place of residence (most of the time this was near the stream segment). Nearly all the landowners agreed. However, access was denied to three of the originally-selected segments (212, 215, and 217), and therefore backup segments were used. Partial Segments were denied access, but the adjacent landowner allowed access so the stream was sampled. Interesting, some of the landowners who denied access did so because of the pending (now approved) legislation requiring buffer strips along streams that are public waters of Minnesota.

### *Selection of Sampling Sites*

Based on habitat preferences characterized in the literature and the experience of the surveyor, sample sites were identified within each randomly selected stream segment using aerial imagery. At each Segment, a brief reconnaissance was conducted to prioritize sampling of *N. topeka* habitat. Basic habitat descriptions and locality information for each of the 20 stream segments sampled are presented in **Table 1 of Appendix B**. The stream segments with sampled sites are depicted in aerial map in **Appendix A**. As noted in the maps, sampled sites included long reaches of the stream that were sampled in their entirety.

*Fish Sampling*

Presence/absence surveys were conducted for *N. topeka* shiners using 12' x 4' wall seines with 1/4" mesh during the week of 01 June to 05 June and again on 18 June 2015. Sampling efforts were focused on low-flow areas along the main channel boundary (MCB), in-channel pools, bend pools, deep undercut banks, backwaters, and off-channel ponds and oxbows. As with the previous survey monitoring efforts, sampling was not standardized nor was catch per unit effort calculated. Stream segments were sampled until a representative sample of suitable *N. topeka* habitat within a Segment had been surveyed. In the absence of *N. topeka*, a representative sample of all available pool type and undercut bank habitats were sampled within each Segment. In certain streams the entire length of that portion of the Segment where landowner permission was granted in one area but not in another was sampled for the species. This was done in Segments 203, 210, 213, 216. After a review of the draft survey report was submitted to the DNR, these partially surveyed Segments did not meet DNR's criteria for use in their long term analysis of *N. topeka* sampling. A decision was made to remove the original Segment 216 from consideration in the analysis and replace it with a backup stream segment that was sampled on 14 August 2015. On that same day, those reaches of Segments 203, 210, 213 that were not sampled during the first field survey were sampled.

Although no systematic population size estimate methodology was used in this presence/absence survey, a qualitative assessment of relative abundance of all fishes observed was made based on the professional judgment of the surveyor. The abundance categories are listed below and are based on the number of fish observed after all sampling within a Segment.

- Very Abundant = # of fish observed > 35 individuals
- Abundant = # of fish observed > 20 individuals
- Common = # of fish observed > 10 individuals
- Few = # of fish observed > 5 individuals
- Rare = # of fish observed < 5 individuals

## RESULTS

*N. topeka* was observed in 13 of the 20 one-mile stream segments sampled for this monitoring effort. Stream segments where this species was observed are listed in **Table 2 of Appendix B**. Specifically, this species was observed in Segments 202, 204 - 209, 211, 214, 216, and 218 – 220. Thus, 65% of the randomly selected stream segments were found to be occupied by *N. topeka*. This represents an increase in occupancy from data collected from 2012 – 2014 but still well below the occupancy percentage observed from 2004 – 2009 (**Figure 1**). Averaged over those first six (6) years of monitoring, *N. topeka* was present at just over 79% of randomly selected stream segments. Monitoring surveys conducted from 2010, 2012 and 2013 found the percentage of selected stream segments fell rapidly, with a slight increase in 2014. The 2015 monitoring effort demonstrated an increase in the percentage of stream segment occupancy from 2014. Averaging the percent of *N. topeka* occupancy from randomly selected stream segments from 2010 through 2015 reveals a 48% rate, far below the early years of the monitoring program.

As for the abundance of *N. topeka* at occupied stream segments, I observed six sites with rankings of *Common* or *Abundant* based on my criteria listed above. Three of these (206, 211, and 214 ranked as *Abundant*. Any comparison with previous surveys is difficult since different crew leaders and their definitions of *Common* or *Abundant* are not only different from my criteria, but they are defined differently between Ceas (2010) and Nagle (2014). **Figure 2** depicts the number of stream segment considered to be *Common* or *Abundant* for *N. topeka* across all survey years. The 2015 ranking effort is based on using the more conservative estimate of abundance of Ceas and Nagle on data I collected. Thus under this scenario, a slight increase in the number of stream segments with *Common* or *Abundant* measures was observed. However, this increase is still well below the measure observed in the early years of this monitoring program.

A total of 32 fish species and 1 hybrid were collected during the 2015 surveys. *Fundulus sciadicus* (Plains Topminnow), a Threatened species in Minnesota, was collected in two (2) stream segments (206-3 and 211-6). A list of fish species collected within each sample Segment is presented in **Table 2 of Appendix B**. Photographs of each stream segment, along with location sites of observed *N. topeka* and the respective fish, are in **Appendix C**.

### *Comments on Each Segment*

Segment 201 – This Segment is the extreme headwaters of the tributary, the lower reach is ditched, water depth was very shallow, several beaver dams were present in this lower reach, and aquatic macrophytes were abundant throughout the Segment. The substrate was composed

of silt and muck with pockets of cobble and gravel. An off-channel stock pond was sampled near the upper end of Segment, upstream of this feature the stream is nearly dry. The surrounding land use is pasture. **Map 1** in **Appendix A** depicts the sites sampled within the Segment. Nearly the entire ditched reach was sampled, and the remaining areas sampled were done so because they had the most amount of water present. This Segment is not *N. topeka* shiner habitat.

Segment 202 – This Segment flow through pasture but the surrounding uplands are all in row crop production, the stream flows along the base of lateral moraines. Some submergent vegetation was present throughout the Segment. *N. topeka* was collected in a channel border pool complex in site 202-3 and an off-channel dugout pool in 202-4.

Segment 203 – This Segment was sampled twice, on 03 June on the western ¼ and on 14 August in the remainder of the segment. I was very surprised we did not find *N. topeka* or *Fundulus sciadicus* at this site since the habitat consisted of long pools with abundant aquatic macrophytes and undercut banks. Good flow, heterogeneous substrate material, complex instream habitat, deeply undercut banks, abundant bend pools. The immediate floodplain is a semi-irrigated meadow. **Map 3** indicates the sites sampled within the Segment. This stream may have potential for oxbow restoration since the landowner experiences frequent flooding and the quality of the vegetation for cattle production is declining due to increased water levels.

Segment 204 – The eastern portion of this Segment has been previously ditched, it is fairly deep and wide in this reach. The land use in this reach is restored grassland with no evidence of grazing. The western portion of stream is heavily grazed pasture. A large wide pool is present just west of road culvert, the substrate was mostly silt with sand and gravel mix, and aquatic macrophytes were present throughout the Segment. *N. topeka* was collected in site 204-3.

Segment 205 – The eastern portion of the Segment is a degraded stream reach that has experienced repeated ditching activity and the row crop fields are too close to the stream resulting in eroded sediments to the system. But, *N. topeka* was found both in a channel pool at Site 205-3 and a stock pond immediate off the main channel (205-1). Several fish were collected that were similar in appearance to the *N. topeka* and *N. stramineus* that I have collected in South Dakota and Nebraska which appear to be a mix of these parentals, suggesting some sort of hybridization.

Segment 206 – Very nice looking stream, very good habitat heterogeneity with good fish diversity. Easily collected *N. topeka* in all seine hauls. *F. sciadicus* was collected at site 206-3.

Segment 207 – I was surprised to find *N. topeka* in this Segment given the proximity of this location to a reservoir and the presence of *Pomoxis nigromaculatus*. Surrounding land use is heavily grazed pasture and the substrate was composed of large boulder and cobble with a layer

of silt. *N. topeka* was collected in sites 207-1 and 207-3. Potential management issues may arise in the future with this Segment since the owner mentioned wanting to remove the large boulders in the floodplain for easier management of cattle.

Segment 208 – This Segment is a low gradient stream, slow moving current, fairly wide and deep with several large diameter side channel pools. The banks were well vegetated but erosion is present along the tight meander bends. The substrate was composed of silt, sand and gravel with patches of boulders; *N. topeka* was found in the lower reach within a big slow moving pool (208-1) and shallow side pools bordering the main channel (208-2).

Segment 209 – The Segment is an entrenched stream but with meandering bends, the stream banks were high relative to the surface water and nearly vertical and eroding. Springs sources were present within the floodplain. The substrate was mostly silt with patches of gravel and cobble and the land use is pasture used for haying. *N. topeka* was found at the margins of large pools and deep pools and meander bends, it was found in all sites except the riffles.

Segment 210 – The Segment is the extreme headwaters of this stream. This Segment was sampled once on 18 June immediately adjacent to the road crossing and then on 14 August within the remainder of the Segment. This Segment has little habitat complexity since it is ditched and is fed mostly by tile drainage from upstream. **Map 10** depicts the site locations sampled, the entire lower reach was sampled, however as the stream channel bends to the northeast it enters a linear Cattail wetland and the surface water disappears. This condition remains until the property boundary at site 210-3, then a small pool and channel appears as a result of tile drainage inflow. From this point and further upstream through the Segment, the stream was very shallow, narrow, and dominated by aquatic macrophytes. An off-channel dugout is present at site 210-4. No *N. topeka* were collected since this stream is poor habitat for the species.

Segment 211 – Although not exhibiting the same high quality as Segments 206 & 214, *N. topeka* was readily collected in each seine haul. Also, *F. sciadicus* was collected at site 211-6, a backwater wetland. The stream flows through pasture, grazing pressure was moderately high, erosion is evident from south of road, and row crop activity from the south and north is impacting this segment of stream. The stream banks are near vertical and eroding, old channel scars are present in the floodplain, and several spring sources are present within the sampled area. The substrate was composed of boulder, cobble with a mix of gravel and sand but a fair amount silt covered these materials. *N. topeka* abundant in segment.

Segment 212 – The original segment was not sampled because the landowner denied permission. In the backup Segment, the current was fast and the water column depth was 1.5 m or greater. The substrate was compacted silt, semi-hard pan with patches of gravel. Off-channel sloughs

were present but contained too little water to maintain fish, they were very shallow and essentially palustrine wetlands. The surrounding land use is pasture. **Map 17** depicts the site locations sampled. This stream, Flandreau Creek, is a system where *N. topeka* has probably never been very common and is rarely collected in this system in South Dakota. I believe this is because of its geophysical position related to glacial activity. Although the area occupied by both the Rock River and Flandreau Creek are imbedded in subglacial tunnel valleys, the thick glacial deposits of the Flandreau drainage are compacted within a steeper elevation gradient (Patterson 1997). This relationship between elevation gradient and glacial deposits most likely explains the more linear dimension and lack of backwater sloughs and off-channel habitats of Flandreau Creek to other similarly sized stream systems in southwestern Minnesota.

Segment 213 – This Segment was sampled twice, once on 05 June for the reach of stream east of the road crossing and on 14 August for the western reach of stream. The entire 1 mile stream segment was sampled. The reach east of the road is ditched, but the western reach of the segment has natural meanders. On the eastern reach a good buffer exists on the north side of the stream but the buffer on the south side is of poor quality. This ditched reach of stream possessed a great deal of habitat complexity with shoal pools, riffles, side channels within the main channel, as well as deep undercut banks along the margin of channel. The substrate was composed of cobble, gravel and sand, very little silt. Many nest beds of *Campostoma anomalum* and *Luxilus cornutus* were present throughout eastern reach. The reach west of the road had deep undercut banks, bend pools, channel runs, and riffles. The substrate was cobble, gravel and sand with some silt. No *N. topeka* were collected in this Segment.

Segment 214 – Access was denied to this stream segment south of the road crossing, which made up 95% of the Segment. However, north of the road access was granted. A decision was made to survey immediately outside the designated segment given the proximity of this Segment to a tributary 250 m upstream and good habitat upstream within Beaver Creek. *N. topeka* was abundant in this portion of the stream. A second sampling effort on 18 June 2014 was done to comply with the monitoring protocol criteria of only sampling within the designated Segment. The uppermost portion of the designated Segment was sampled and within several minutes and two (2) short seine hauls *N. topeka* was collected (214-1).

Segment 215 – The original segment was not sampled because the landowner denied permission. The backup Segment is located at the extreme headwaters of the stream. Oddly, the water temperature was noticeably much warmer than the other sampled streams. The appearance of terrestrial vegetation in the stream channel indicates this stream may go dry in hot summers and possible winter kill from lack of depth and cool water inflows. The substrate was silt and sand with patches of gravel and cobble. The surrounding land use is pasture

dominated by Reed Canary Grass. **Map 18** depicts the site locations sampled. This Segment does not offer suitable habitat for *N. topeka*.

Segment 216 – Access was only granted on eastern one-quarter of the original stream segment. Because of lack of access to the remainder of the Segment, itt was replaced with a backup Segment. The backup Segment flows through heavily grazed pasture, erosion is evident all along the stream banks, the row crop activity is very close to the stream in places, and old mining borrow pits are located to the north of the stream in the eastern two-thirds of the Segment. A significant amount of silt and muck were noted in all habitat types covering the larger substrate materials within the stream, deep muck was present in pool habitats. The water was turbid, with a greenish brown tint, lots of cyanobacteria. After extensive effort, one (1) *N. topeka* was collected in a pool below a cobble road crossing in the stream.

Segment 217 – The original segment was not sampled because the landowner denied permission. The backup Segment is an entrenched stream channel with vertical eroding banks, little to no connection with the floodplain, and very old channel scars in the floodplain are now disconnected from the stream channel even under high flows. The water temperature was uncharacteristically warm compared to other sampled stream Segments (except 215). The substrate was composed of silt, sand and gravel. The stream morphology is a series of long glide pools, bend pools and several riffles, with the stream channel is fairly wide. Given the stream bed degradation of this stream, it does not offer suitable *N. topeka* habitat. **Map 19** depicts the site locations sampled.

Segment 218 – This stream is the main channel of the Rock River, and at the time of sampling, the stream flow was fast and bend pools were too deep sample. The stream channel is entrenched at this location but meanders within the bedform. The eroded banks are nearly vertical and evidence of frequent flooding exits by the presence of debris lines in the riparian forest and sand deposits in surrounding field. Large quantities of woody debris were present within the stream channel. The current was swift and the bend pools were deep, thus much of the stream segment was too dangerous to cross making sampling difficult. The sampling effort was confined to shoal margins and shallow pools and the sampling reach including a side pool and all habitats upstream for approximately 120 m. The substrate was sand, gravel and cobble. As with Segments 205 & 216, a hybrid type *N. stramineus x N. topeka* was collected, but one (1) *N. topeka* was collected from a side pool [218] (see site photo in **Appendix C)**.

Segment 219 – This stream was the only one that possessed the true off-channel slough habitat typically associated with *N. topeka* in southwest Minnesota, Iowa, and portions of South Dakota. This off-channel habitat was located slightly east and north of the designated sampling Segment.

The margins of this backwater possessed abundant aquatic macrophytes, the substrate was silt and muck, and *N. topeka* were present this area (219-1). This area was seined as part of a pre-construction monitoring effort with the USFWS. One (1) additional *N. topeka* was observed on the southern end of the stream segment (219-5). This Segment has an entrenched stream channel and vertical eroded banks, but the stream meanders within an entrenched bedform. Beaver dams were present as well as gravel shoals; the substrate was composed of silt, sand. The surrounding land use is pasture.

Segment 220 – This Segment flows adjacent to lateral moraines however the uplands are all in row crop production. The Segment had well vegetated stream banks, some areas of erosion along the bluff line were observed. The stream channel meanders through pasture within the immediate floodplain and old channel scars are present. The middle part of stream channel is cobble, gravel, and sand while the margins are silt, the banks were undercut. *N. topeka* was collected from a side pool (220-1) and a cobble riffle (220-3).

## DISCUSSION

The results of this most recent survey indicate an increase in the detection presence on *N. topeka* in southwest Minnesota. A definite increase in occupancy in randomly selected stream segments is evident over the years of 2014 and 2015, however the percentage is still well below that of the early years of sampling under this monitoring program. Not surprisingly, the number of sites with more abundant numbers of this species having been observed increased, but again, this is far below the earlier years of surveying.

The explanation for this perceived increase is hard to deduce, however, an examination of stream flow gauge data depicts an extended high flood flow period throughout the month of July 2014 which may have created favorable conditions for young of the year recruitment and winter survival of all age classes. As for the years just prior to 2014, the years 2012 and 2013 where extremely dry during the latter part of the growing seasons, and in 2012 the winter flow conditions were extremely low. Thus, the results of Nagle and Larson (2014) may be a reflection of the 2012 and 2013 flow years, while the 2015 results are a reflection of the flow conditions of 2014. Although beyond the scope of this most recent survey effort, an examination of stream flow gauge data over the last 15 years may indicate a reason for the steady decline of *N. topeka* in Minnesota. Data from these years seem to indicate a much lower stream discharge in the late fall and winter months. These lower discharges could create conditions of extreme low flows that would dry off-channel habitats and lower pool deeps in the main channel and channel

borders. Given the low winter temperatures in that region, ice could form to the substrate creating lethal winter conditions for fish species. I suggest a hydrologist examine the longer term flow regimes in the gauge record of streams in southwest Minnesota to determine if such patterns have indeed changed over time.

Although sampling effort is not part of the sampling protocol for this long-term monitoring survey, the effort needed during 2015 to detect *N. topeka* was minimal at most stream segments where the species was observed. I have experience surveying for this species in Nebraska, Iowa, South Dakota, and some in Kansas, and similar to sampling in South Dakota, finding *N. topeka* in southwest Minnesota requires far less effort than in Nebraska and Iowa. Unfortunately without a catch per unit effort metric, making definitive statements about declines or increases is difficult.

As cautious as I am about making definitive statement about *N. topeka* percent occupancy and abundance changes about over time, the reality is the landscape of southwest Minnesota has changed significantly since 2000 when I participated in some reconnaissance sampling for this species with a group of colleagues. My observations, as well as Farm Service Agency data, indicate a number of land parcels that were once native grasslands or cattle pastures have been converted to row crop agriculture. Moreover, a number of parcels have had grassed waterways and buffer strips removed, have had tile drainage systems added to the fields, and the number of hog confinement facilities has increased dramatically. An example of such changes is stream segment *2*14. In recent years, this landowner has added tile drainage and removed grassed waterways in row crop field and narrowed the buffer strips adjacent to stream. Collectively, these land management changes within *N. topeka* watersheds leads to, and will continue to exacerbate over time, fundamental changes to stream dynamics (e.g. sediment, flow regimes, channel morphology, floodplain connectivity, and excess nutrient loading) that I believe has and will continue to negatively affect this species. As these stream systems experience flashier flow regimes in one part of the year and dry conditions in another portion of the year due to both changes on the landscape and climate change induced effects, the stream channels will lose connectivity with their floodplains and experience channel degradation, all of which will result in the loss of *N. topeka* preferred habitat.

*Hybridization*

An interesting aspect of this sampling effort was the collection of fish that appear to be a mix of *N. topeka* and *N. stramineus* genomes. These hybrid fish were found in three localities: Segment 205, 216, and 218. As mentioned previously, I have observed these hybrid types in both South Dakota and Nebraska, invariably the streams from whence these fish were collected are degraded streams or they are the lower order reaches of streams with previous *N. topeka*

collections. Specifically, streams akin to Segment 205 and 216 have become semi-entrenched streams with little connection to their associated floodplains. These streams, and similar ones in other States in have sampled, no longer have off channel habitats, their larger substrate material is covered in sediment, and instream habitat complexity is compromised. As for Segment 218, it is a lower order stream reach that has become semi-entrenched, experiences significant bank erosion, possesses habitat more similar to the larger stream it is connected with but whose upper reach still, or did until recently, have *N. topeka* as part of the fish community. As a result of this degradation, prime habitat for *N. topeka* in this stream system is very rare or nonexistent. So without appropriate spawning habitat, the two closely related species of *N. topeka* and *N. stramineus* are forced to share the same habitat and presumably the results is hybridization.

As for the appearance of these hybrids, **Appendix D** depicts three photographs of fish with **Photo A** representing a *N. stramineus x N. topeka* hybrid, **Photo B** representing a *N. topeka* with possibly a small component of *N. stramineus* genes, and **Photo C** representing a typical *N. topeka*. The fish in **Photo A** does not demonstrate the typical diamond shaped scales of *N. stramineus* but the more oval shape of *N. topeka*. In addition, the scale margins above the lateral line are darkened by melanophores, creating an etched-like appearance typical of what you see in abundance in **Photo C**. Also, the body of this fish is much deeper than a typical *N. stramineus*. But, this fish does not possess a chevron in the caudal peduncle, its snout is more pointed and its larger eye diameter is more typical of *N. stramineus*, plus its dorsal strip widens before the dorsal fish as in *N. stramineus*. **Photo B** is a *N. topeka* but the weak chevron, very slightly pointed snout, and an occasional diamond shaped scale suggests a hint of *N. stramineus* genome present. In **Photo C** the much more rounded snout, small eye diameter, complete chevron mark, and a scale margin etched pattern due to dense melanophores are all typical of *N. topeka*.

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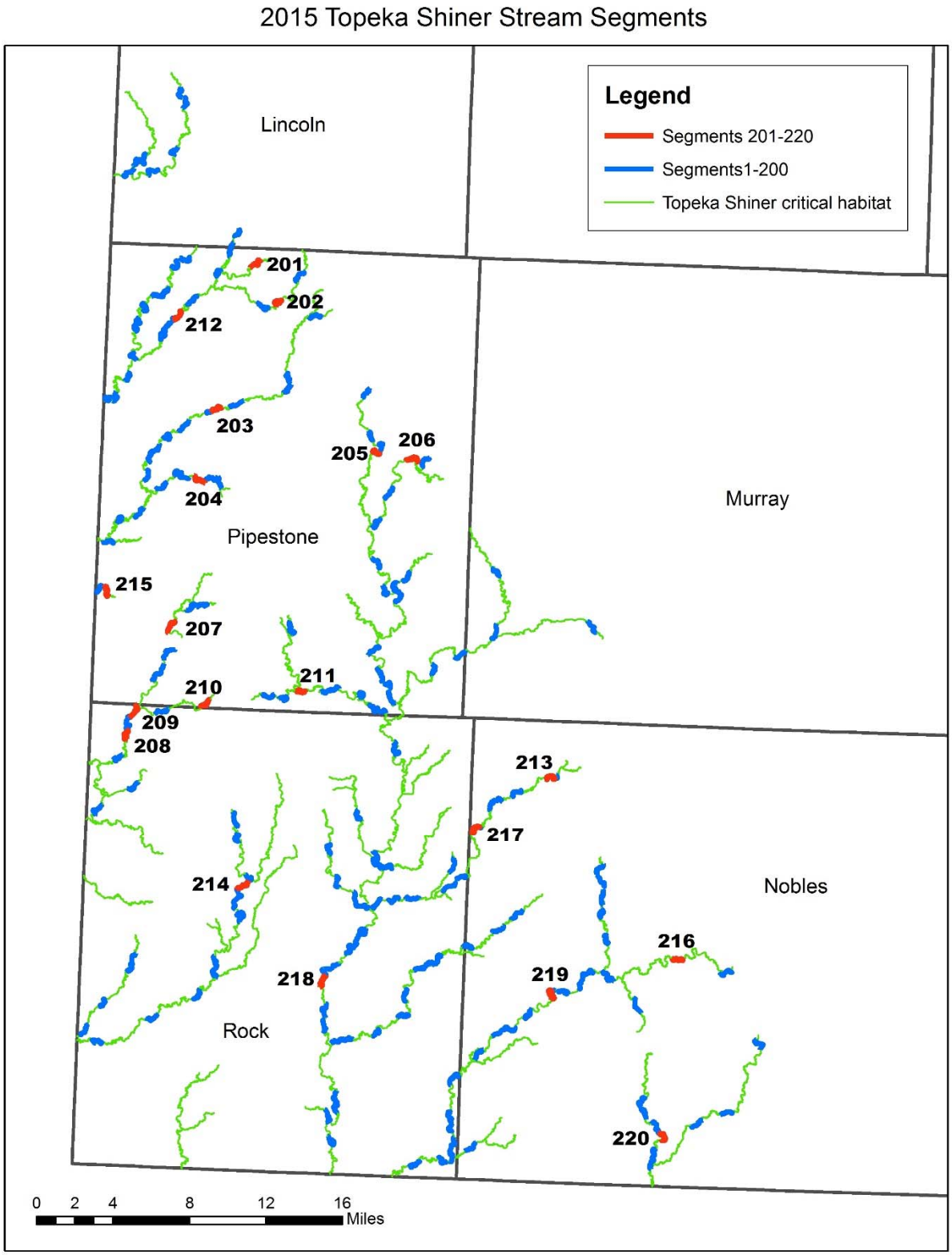



**Map 1.** Overview of 2015 stream segments selected for *N. topeka* monitoring.

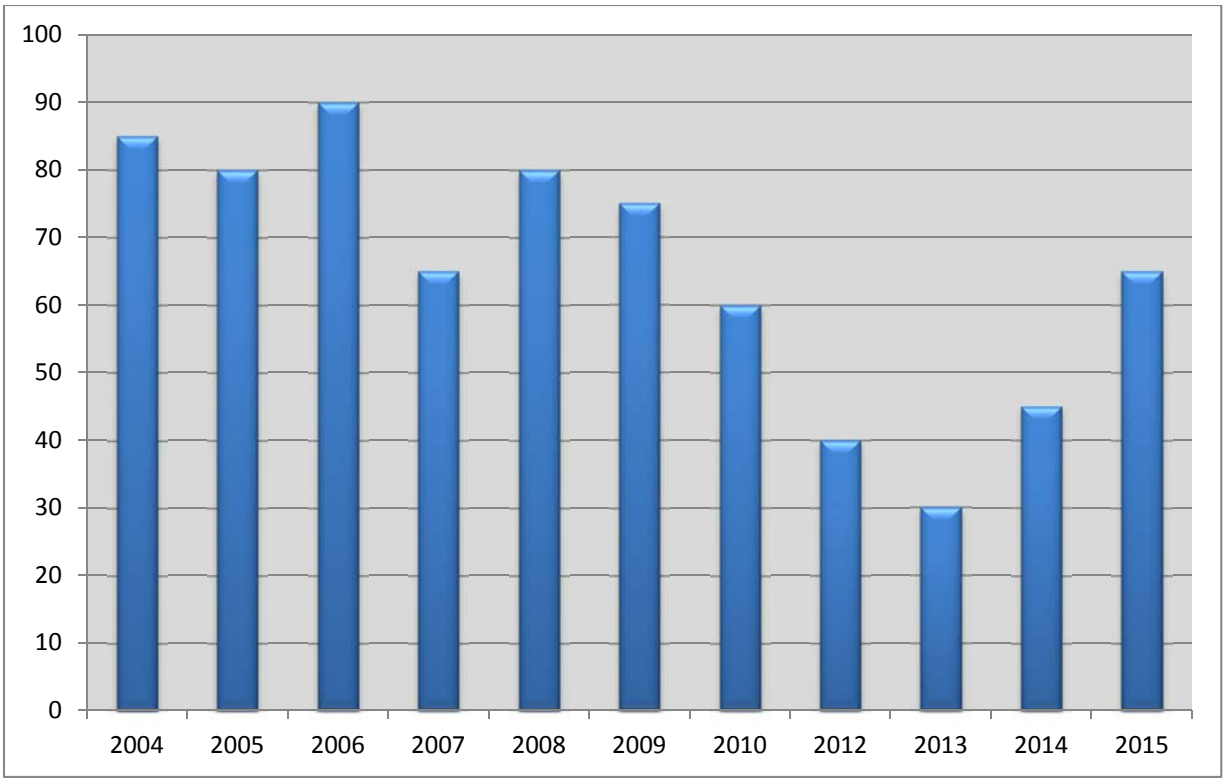



**Figure 1.** Percentage of randomly selected stream segments with *N. topeka*, 2004-2015.

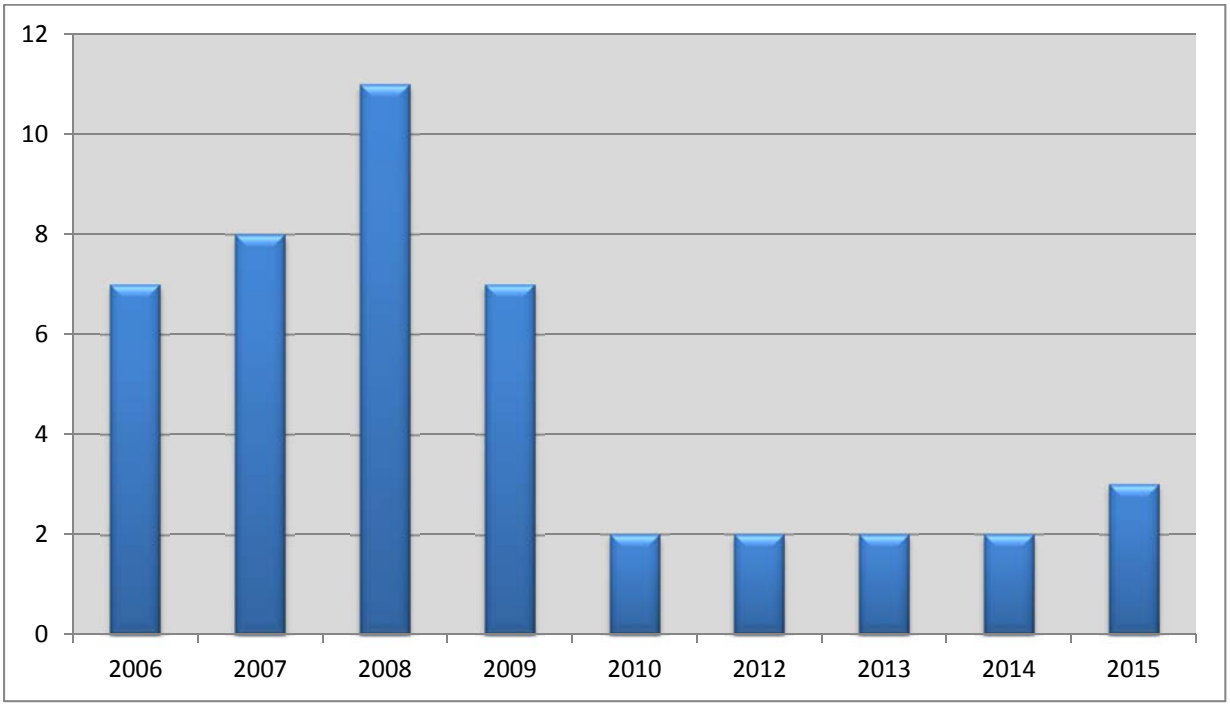
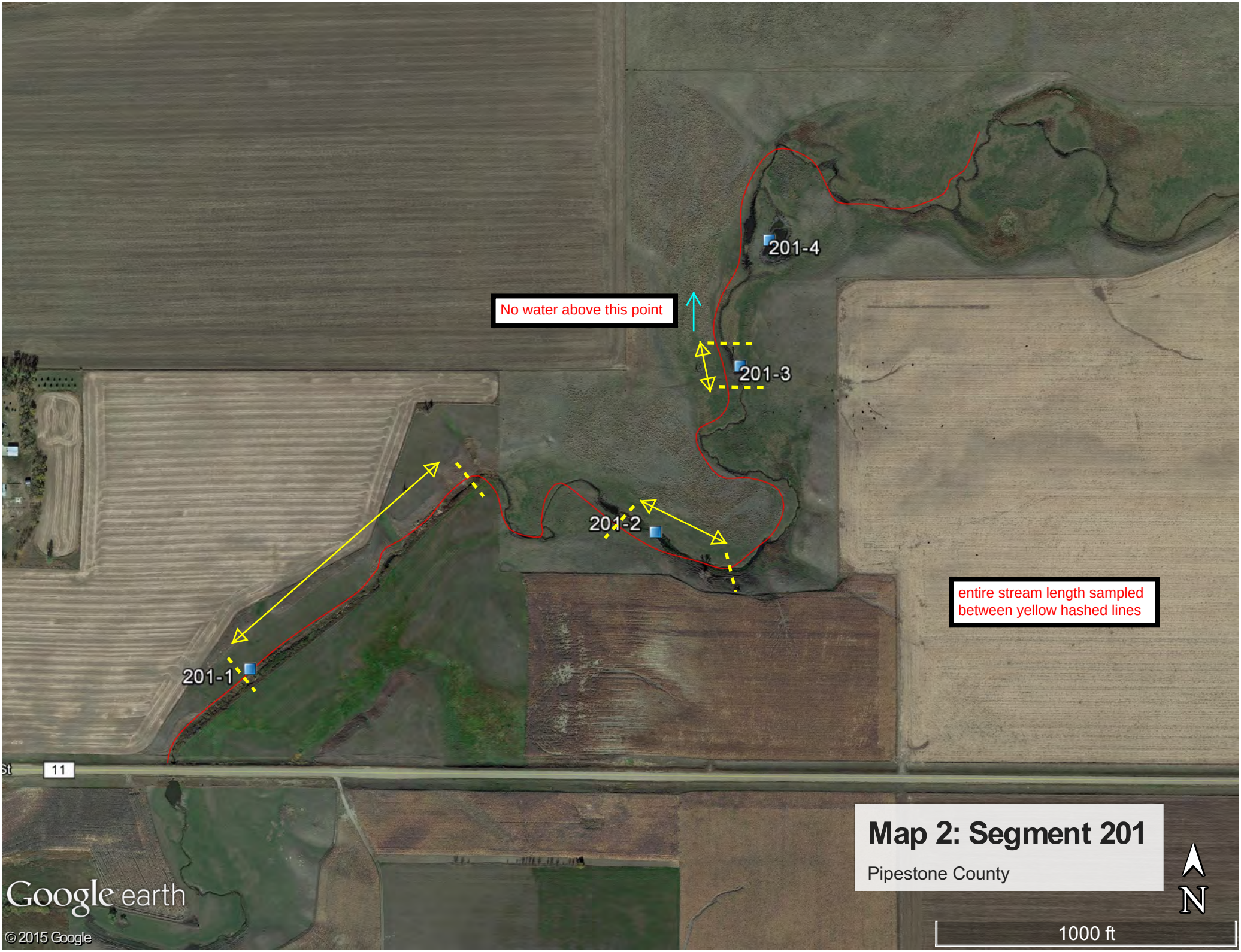


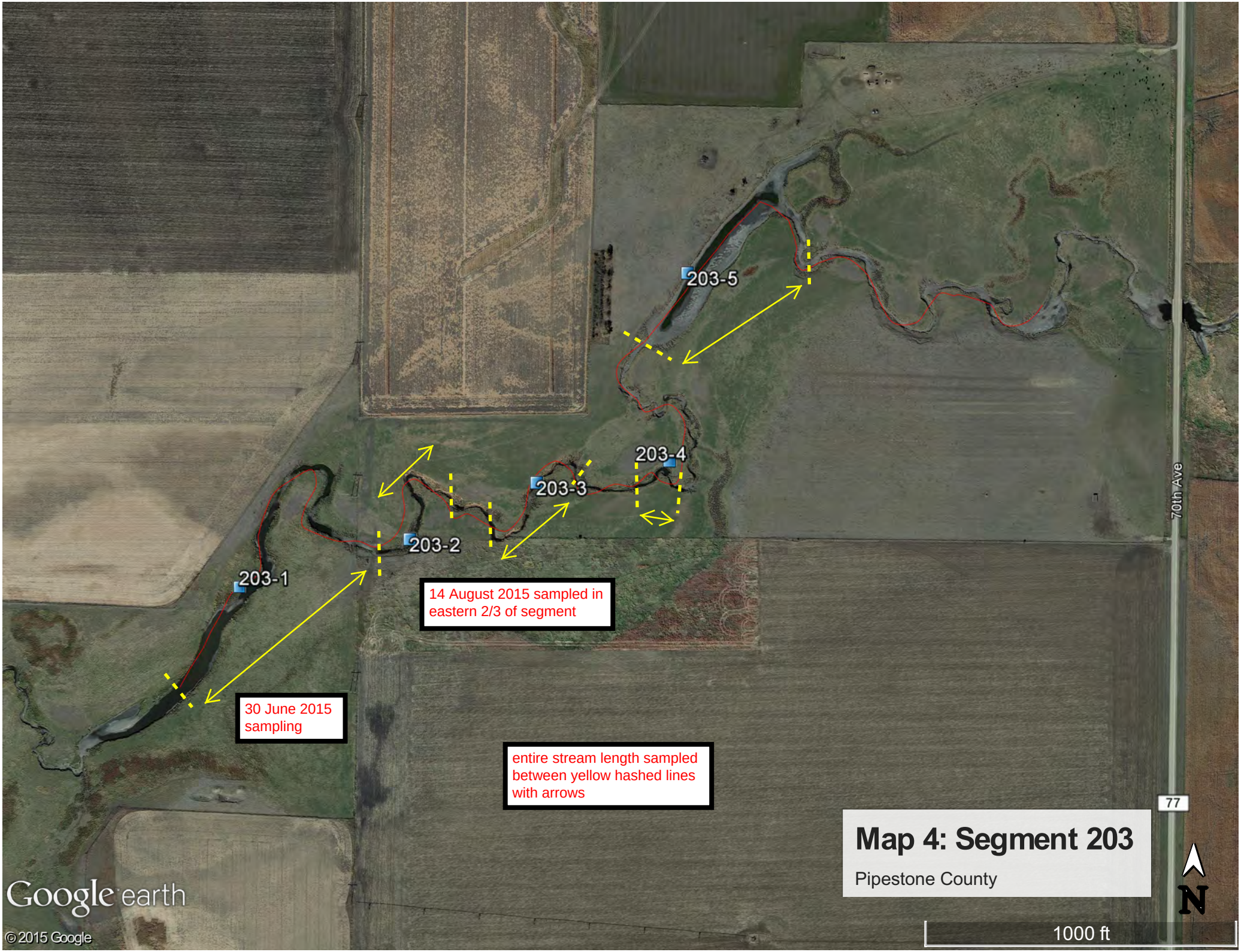

**Figure 2.** Number of sites where *N. topeka* was considered Abundant or Common, 2006-2015. The abundance measure is based on Ceas' and Nagle's definitions.

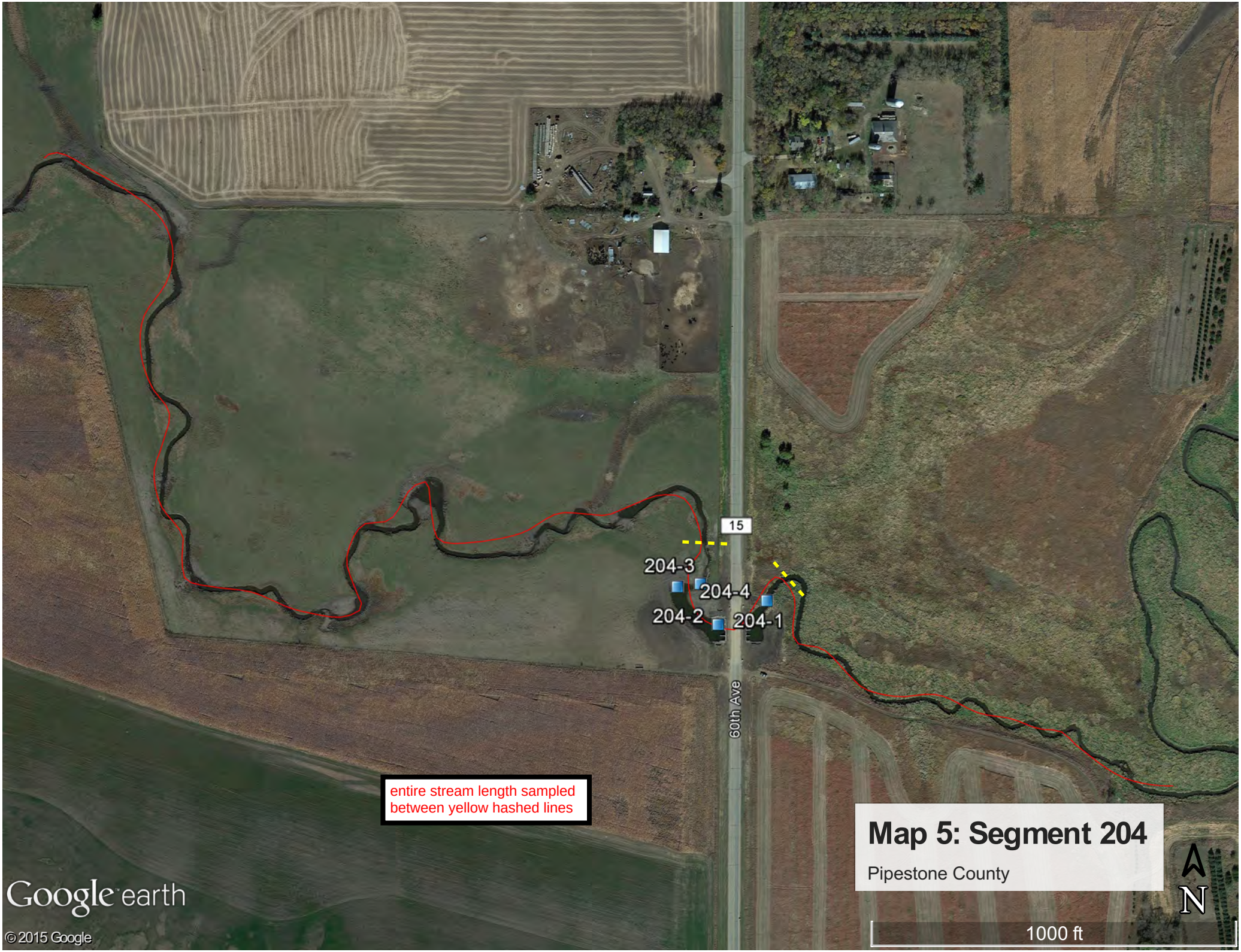
# Appendix A

Maps 2-21. Aerial images of each randomly selected 1-mile stream segment for 2015.


201-4
No water above this point
201-3
201-2
entire stream length sampled between yellow hashed lines
201-1
11
Map 2: Segment 201
Pipestone County
N
1000 ft
Google earth
© 2015 Google


202-4
202-3
202-2
202-1
entire stream length sampled between yellow hashed lines
10
Map 3: Segment 202
Pipestone County
N
1000 ft
Google earth
© 2015 Google


203-5
203-4
203-3
203-2
203-1
70th Ave
77
14 August 2015 sampled in eastern 2/3 of segment
30 June 2015 sampling
entire stream length sampled between yellow hashed lines with arrows
Map 4: Segment 203
Pipestone County
N
1000 ft
Google earth
© 2015 Google

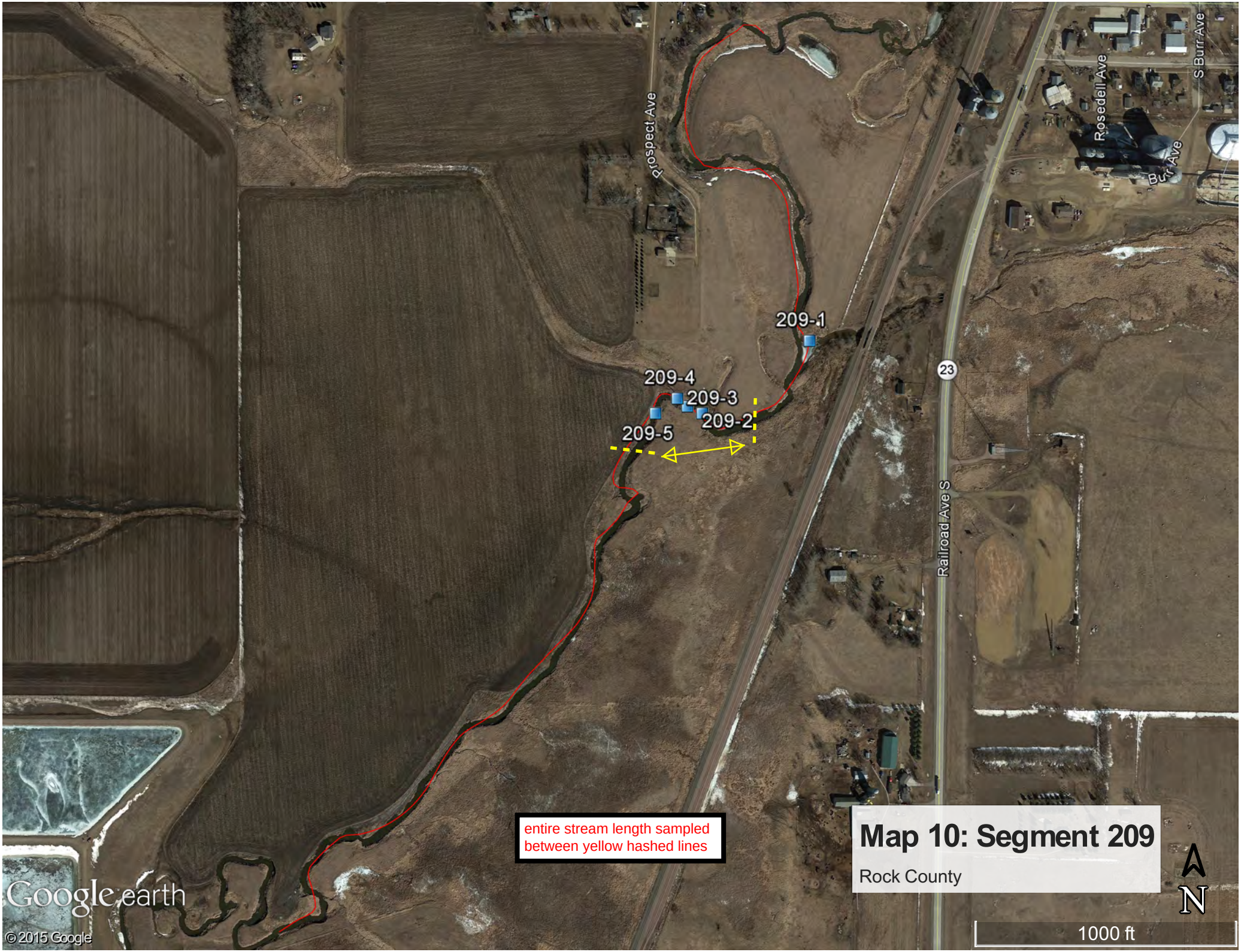

15
204-3
204-4
204-2
204-1
60th Ave
entire stream length sampled
between yellow hashed lines
Map 5: Segment 204
Pipestone County
N
1000 ft
Google earth
© 2015 Google

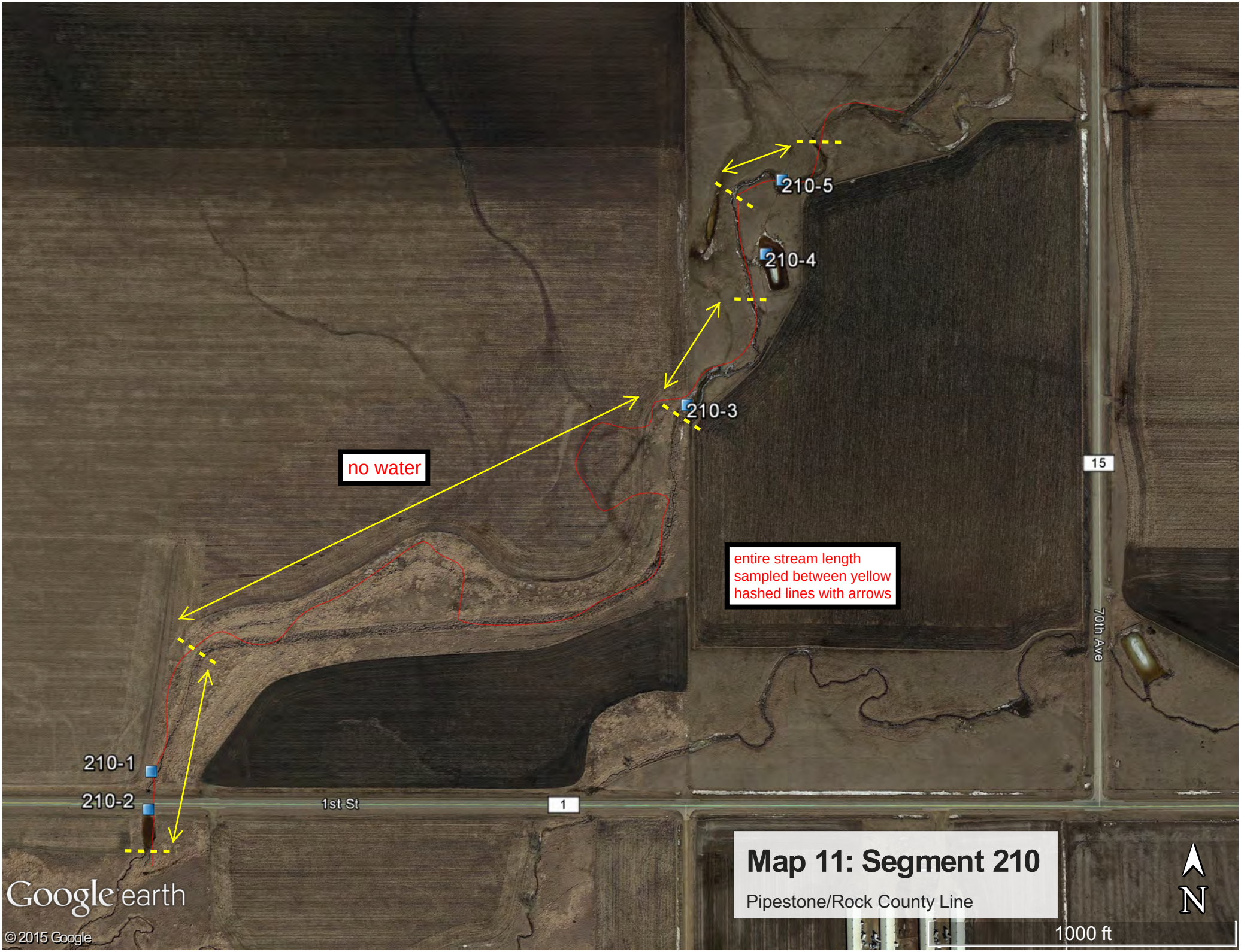

150th Ave
205-1
205-2
205-3
entire stream length sampled
between yellow hashed lines
Map 6: Segment 205
Pipestone County
N
900 ft
Google earth
© 2015 Google

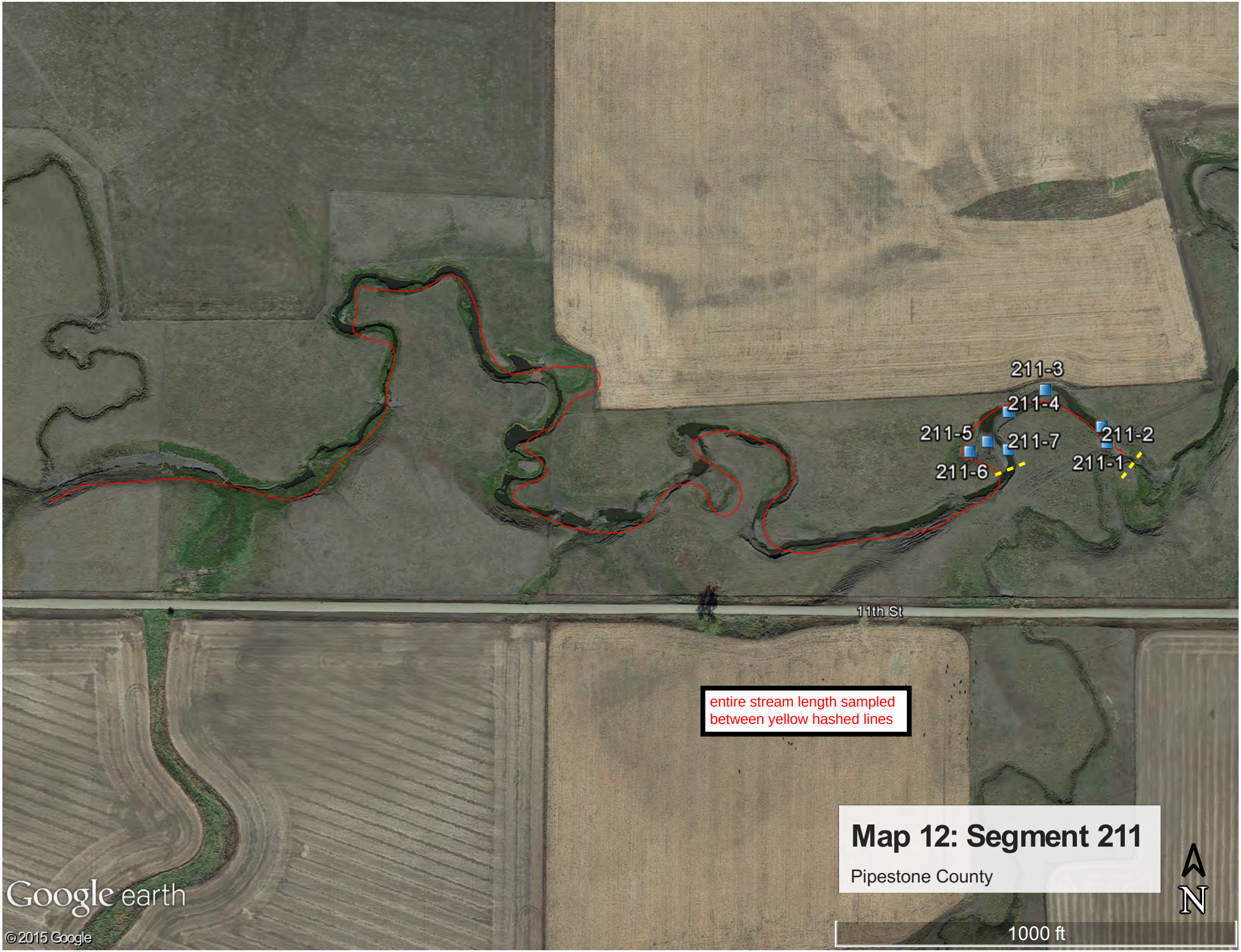

206-2
206-1
206-3
entire stream length sampled between yellow hashed lines
Map 7: Segment 206
Pipestone County
N
1000 ft
Google earth
© 2015 Google


207-3
207-2
207-1
54
23
Mabel St
Bertha Ave
Ihlen
Jessica St
Holman St
S Waldo St
Judd St
20
2
41st St
entire stream length sampled between yellow hashed lines
Map 8: Segment 207
Pipestone County
N
1000 ft
Google earth
© 2015 Google

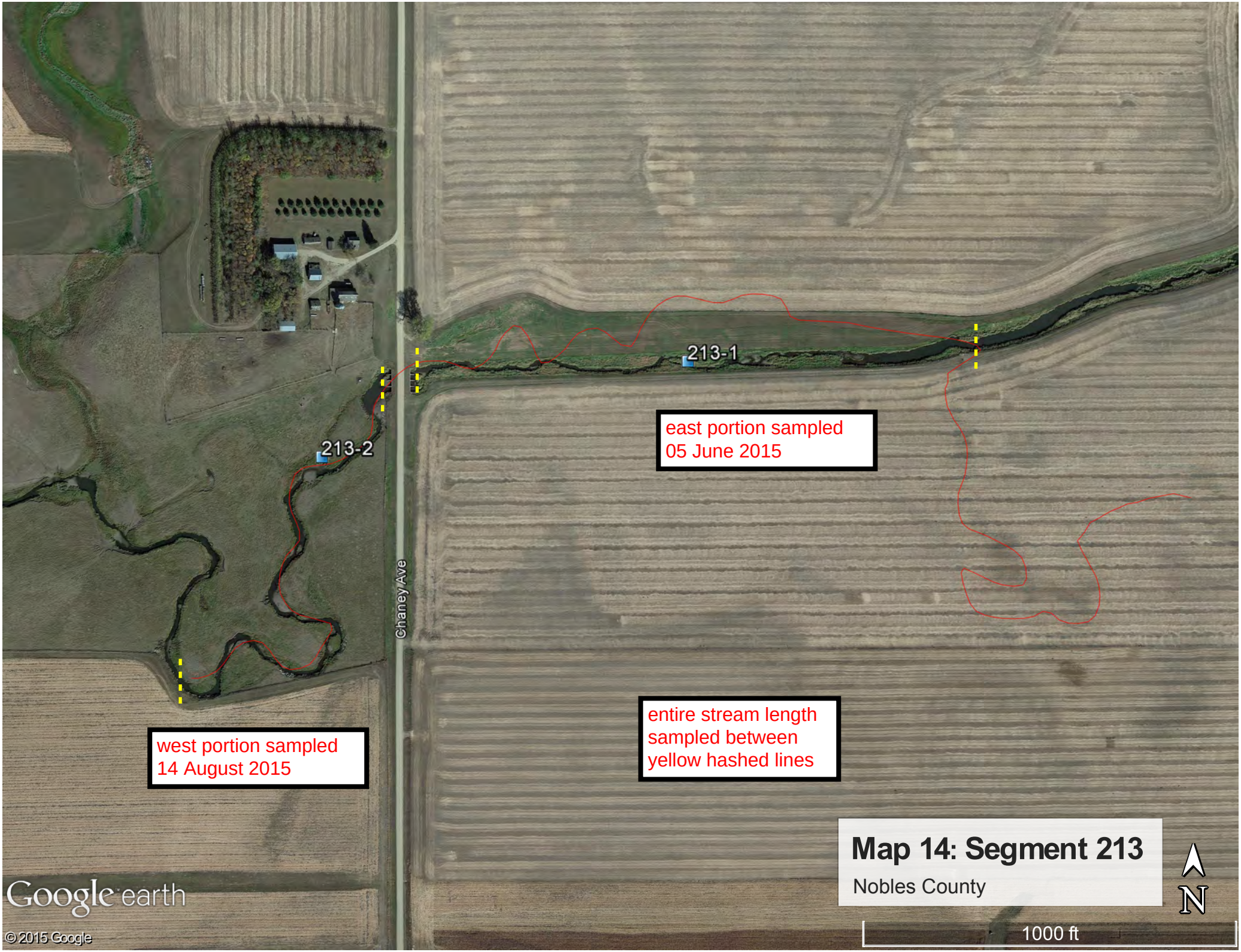

208-2
208-1
entire stream length sampled
between yellow hashed lines
Map 9: Segment 208
Rock County
N
1000 ft
Google earth
© 2015 Google

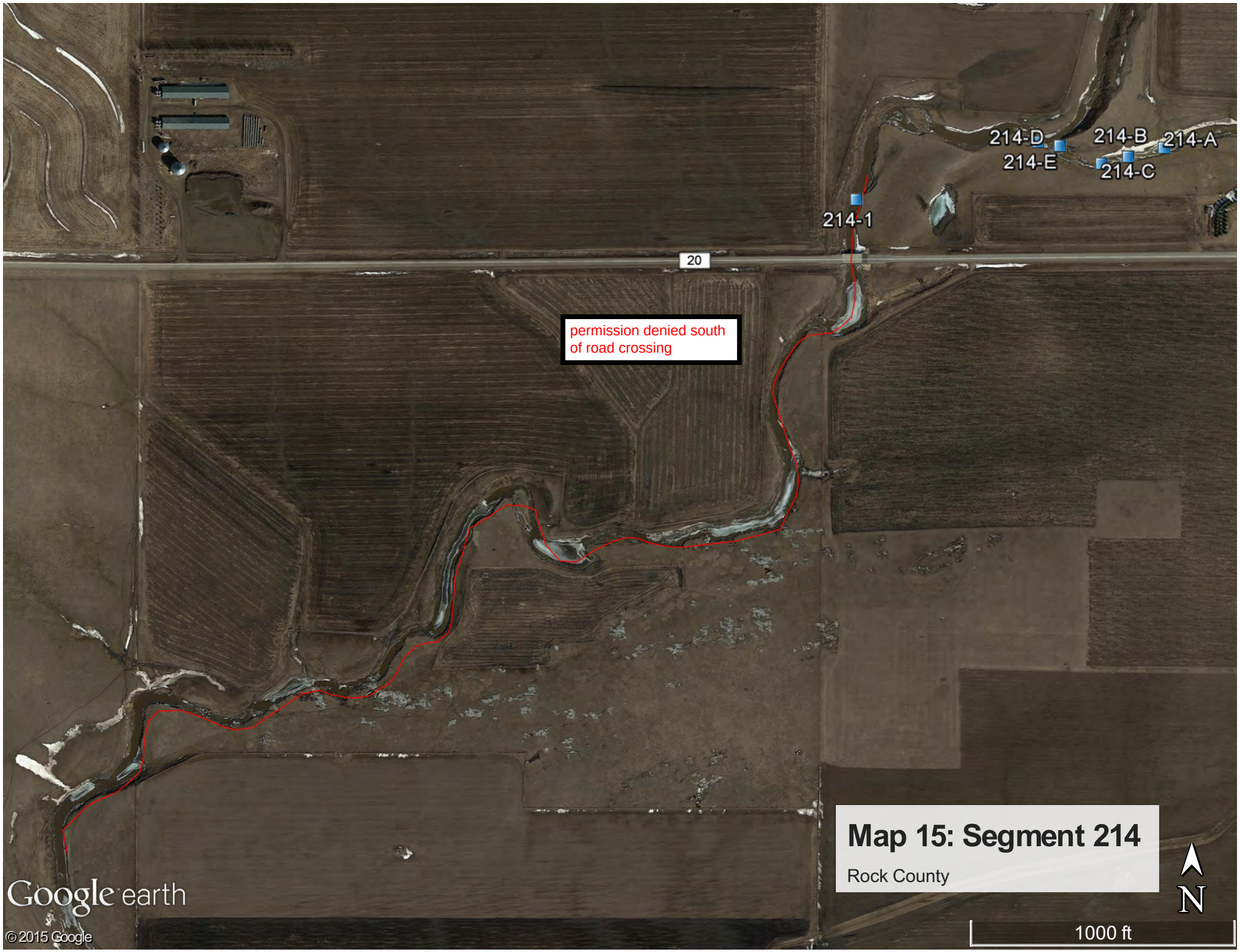

Prospect Ave
Rosedell Ave
S Burr Ave
Burr Ave
Railroad Ave S
23
209-1
209-4
209-3
209-2
209-5
entire stream length sampled
between yellow hashed lines
Map 10: Segment 209
Rock County
N
1000 ft
Google earth
© 2015 Google

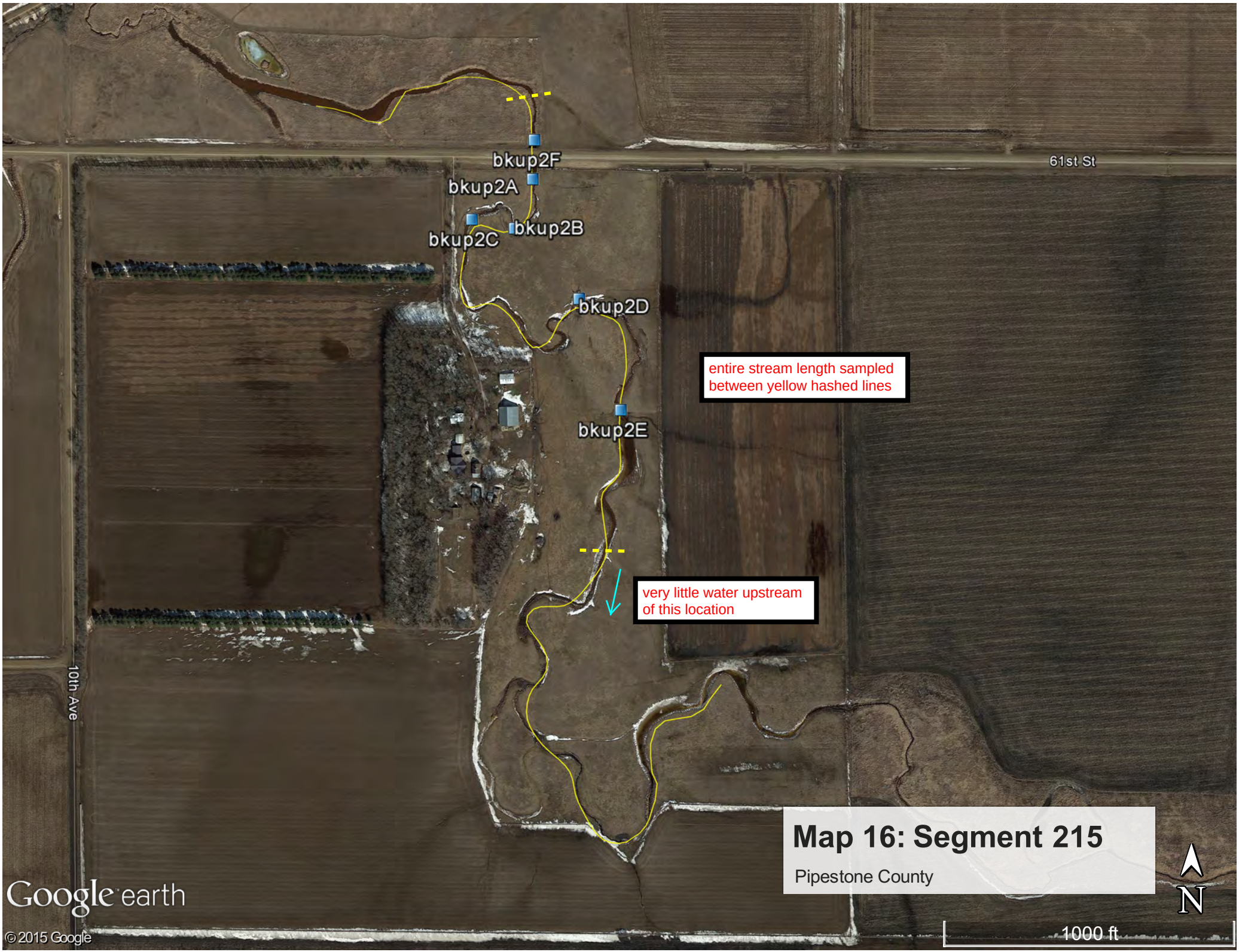

210-5
210-4
210-3
210-1
210-2
no water
entire stream length sampled between yellow hashed lines with arrows
15
70th Ave
1st St
1
Map 11: Segment 210
Pipestone/Rock County Line
N
1000 ft
Google earth
© 2015 Google


211-3
211-4
211-5
211-7
211-2
211-6
211-1
11th St
entire stream length sampled
between yellow hashed lines
Map 12: Segment 211
Pipestone County
N
1000 ft
Google earth
© 2015 Google

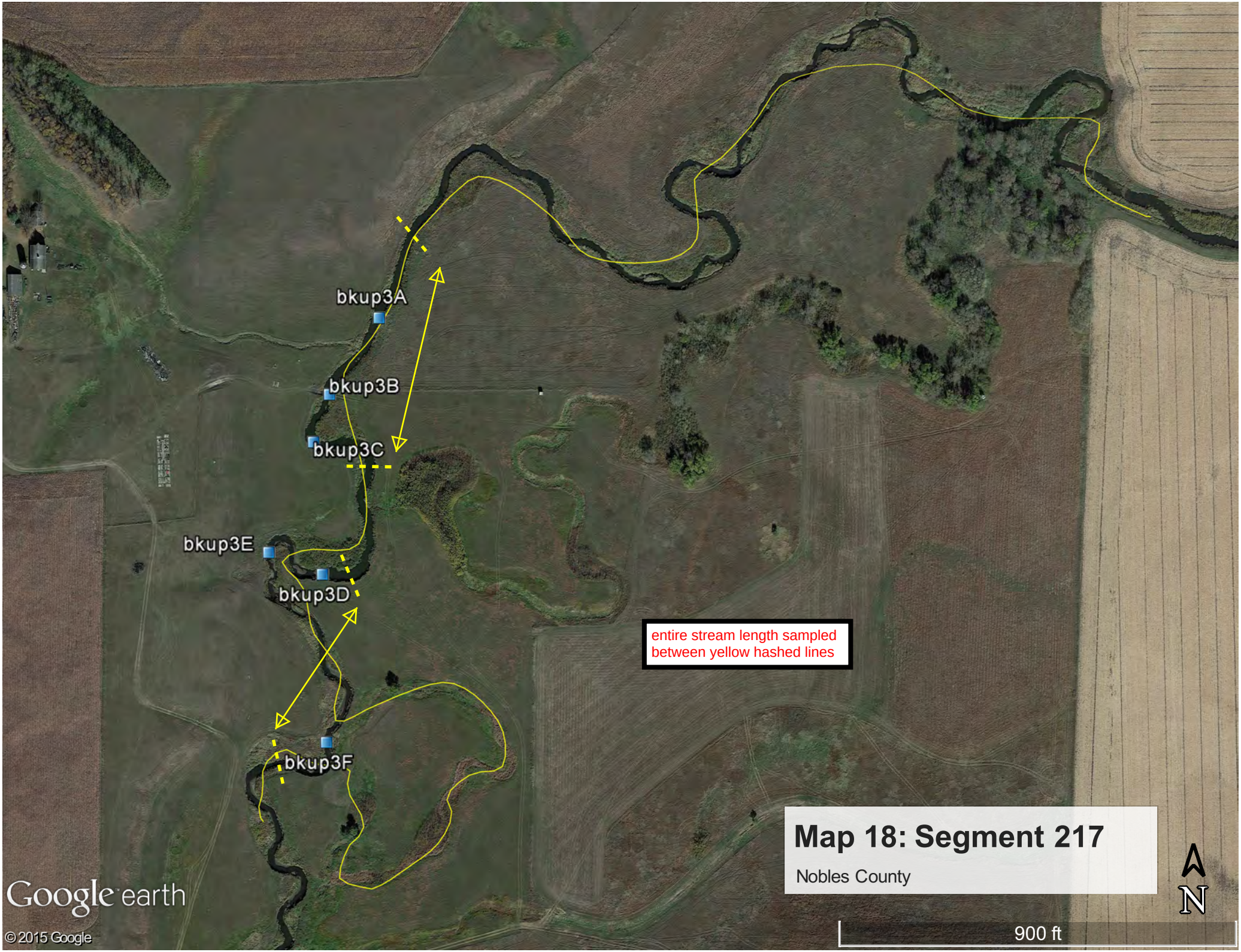

bkup1F
bkup1G
bkup1E
bkup1B
bkup1D
bkup1A
bkup1C
entire stream length sampled between yellow hashed lines
Map 13: Segment 212
Pipestone County
N
1000 ft
Google earth
© 2015 Google


213-1
213-2
Chaney Ave
east portion sampled
05 June 2015
west portion sampled
14 August 2015
entire stream length
sampled between
yellow hashed lines
Map 14: Segment 213
Nobles County
N
1000 ft
Google earth
© 2015 Google

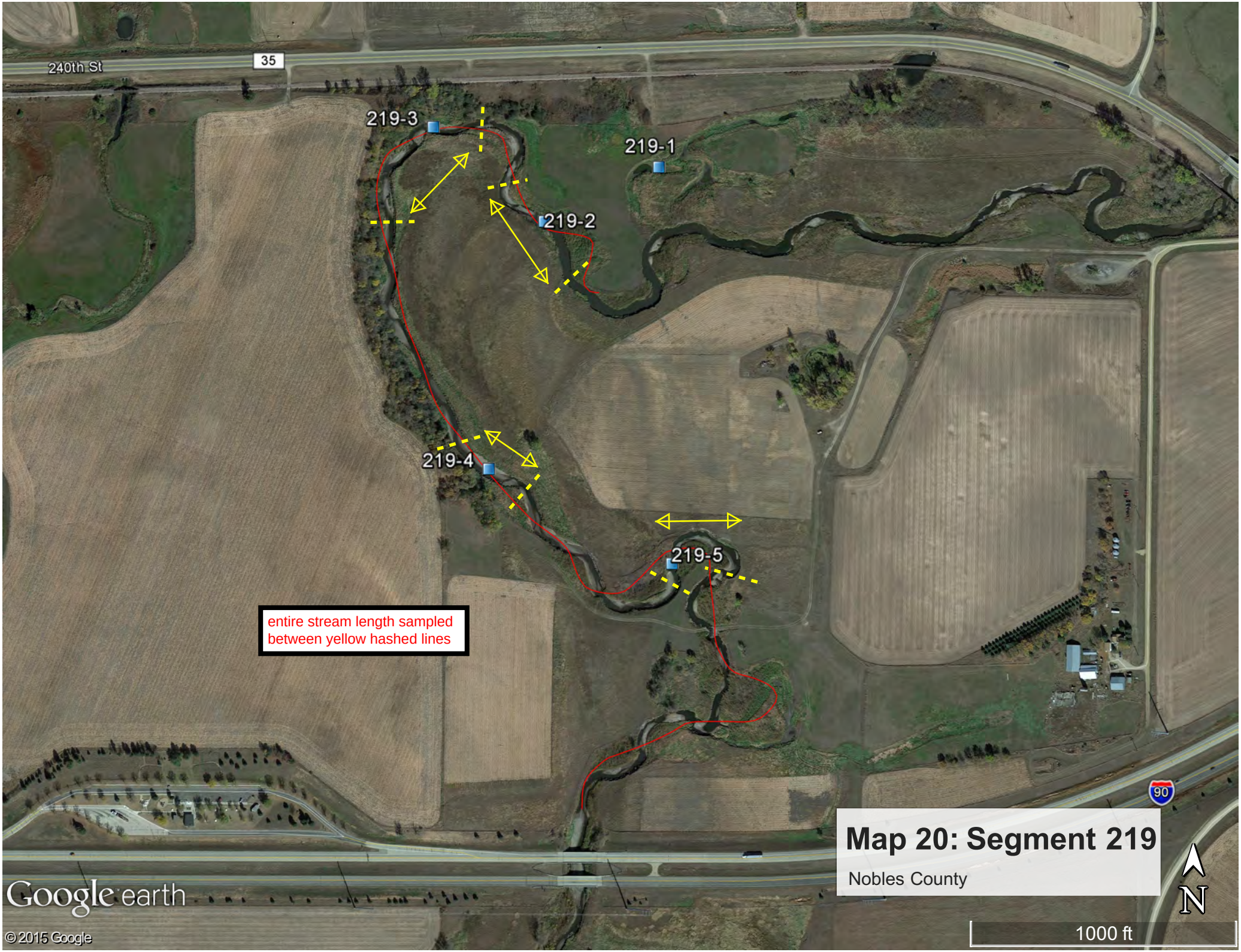

214-D
214-B
214-A
214-E
214-C
214-1
20
permission denied south of road crossing
Map 15: Segment 214
Rock County
N
1000 ft
Google earth
© 2015 Google

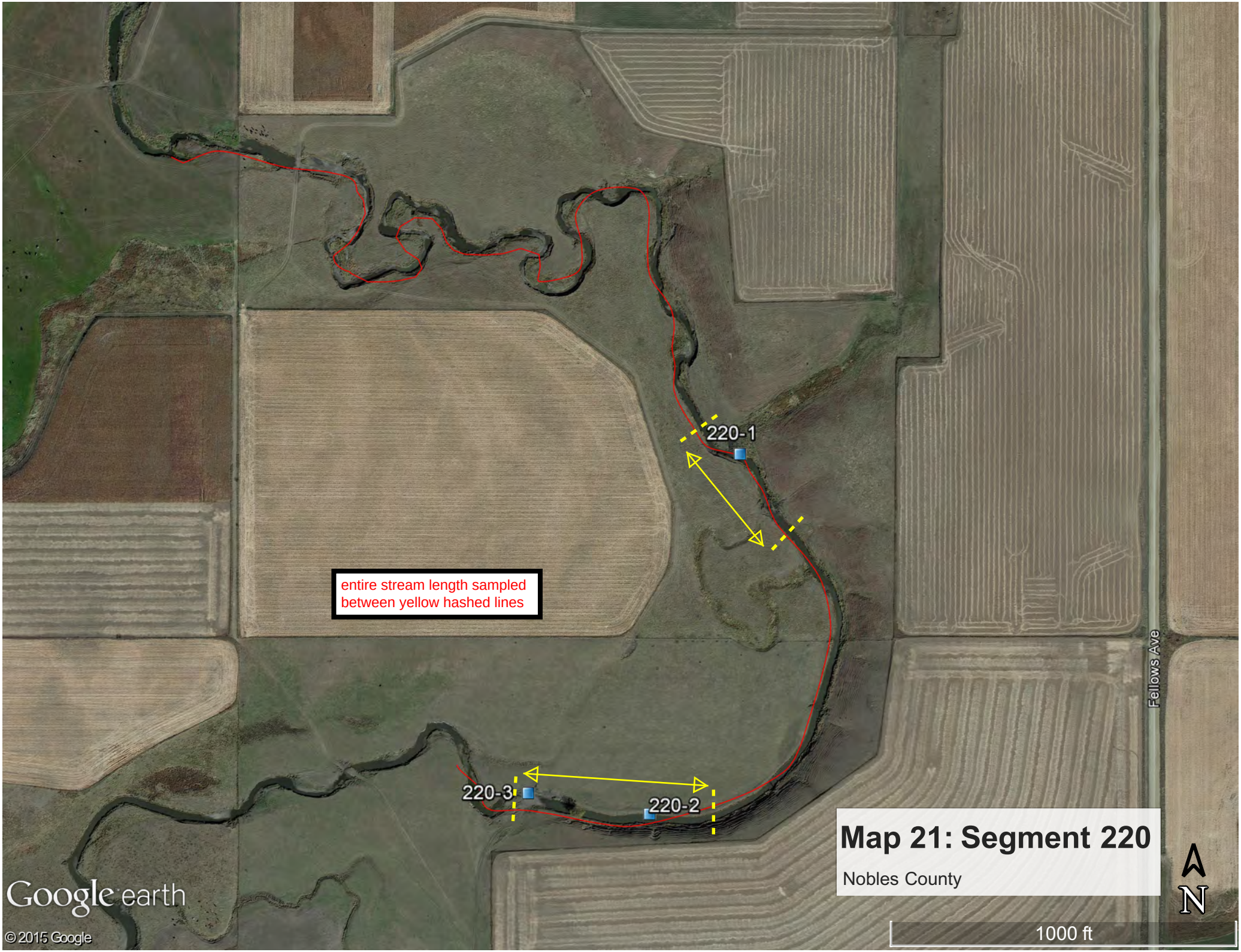

bkup2F
bkup2A
bkup2B
bkup2C
bkup2D
bkup2E
61st St
10th Ave
entire stream length sampled between yellow hashed lines
very little water upstream of this location
Map 16: Segment 215
Pipestone County
N
1000 ft
Google earth
© 2015 Google


220th St
bkup4
60
Fellows Ave
entire length of stream sampled between yellow hashed lines
Map 17: Segment 216
Nobles County
N
1000 ft
Google earth
© 2015 Google


bkup3A
bkup3B
bkup3C
bkup3E
bkup3D
bkup3F
entire stream length sampled
between yellow hashed lines
Map 18: Segment 217
Nobles County
N
900 ft
Google earth
© 2015 Google


E Meade Ct
E Hatting St
Rock River Dr
218
entire right (eastern) stream length sampled between yellow hashed lines
Map 19: Segment 218
Rock County
N
1000 ft
Google earth
© 2015 Google


240th St
35
219-3
219-1
219-2
219-4
219-5
entire stream length sampled
between yellow hashed lines
90
Map 20: Segment 219
Nobles County
N
1000 ft
Google earth
© 2015 Google


220-1
220-2
220-3
entire stream length sampled
between yellow hashed lines
Fellows Ave
Map 21: Segment 220
Nobles County
N
1000 ft
Google earth
© 2015 Google

# Appendix B

Table 1. Stream segment descriptions and sampling site location data for 2015.

Table 2. List of Fish Species Collected at all stream segments in 2015.

**Table 1. Locations of the 20 stream segments sampled in 2015, corresponding sampling sites within each segment, whether *N. topeka* present, and a brief habitat description for each segment.**

| Segment | Stream | County | Township | Range | Section | Habitat Type | Site Number | Latitude | Longitude | TS found | Date |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 201 | Trib. to Flandreau Creek | Pipestone | 108 | 45 | 6 | main channel | 201-1 | 44.183695 | -96.303742 | | 04-Jun-15 |
| | | | | | | main channel | 201-2 | 44.184989 | -96.298548 | | |
| | | | | | | crossing pool | 201-3 | 44.186523 | -96.297549 | | |
| | | | | | | stock pond | 201-4 | 44.187549 | -96.297278 | | |
| Extreme headwaters of tributary, several beaver dams, lower reach is straighten very narrow width and shallow throughout; aquatic macrophytes abundant; substrate composed of silt and muck with pockets of cobble and gravel; off channel stock pond sample near upper end of segment; surrounding landuse is pasture. | | | | | | | | | | | |
| 202 | Trib. to Flandreau Creek | Pipestone | 108 | 45 | 17 | culvert pool | 202-1 | 44.153982 | -96.276502 | | 04-Jun-15 |
| | | | | | | main channel | 202-2 | 44.154692 | -96.276516 | | |
| | | | | | | channel border pool | 202-3 | 44.15574 | -96.277037 | Yes | |
| | | | | | | off channel dugout | 202-4 | 44.1562 | -96.277108 | Yes | |
| At the time of sampling the terrestrial bank vegetation was partially flooded, some submergent veg. was present; appearance indicates that during the latter part of summer stream flows maybe minimal and water is confined to the deeper channel runs; flow is slow, turbid conditions, depth 1-1.5 m, mean wide approx. 3m; stream flows through a steep valley with surrounding landuse as pasture. | | | | | | | | | | | |
| 203 | N.B of Pipestone Creek | Pipestone | 107 | 46 | 14 | glide pool/run and main channel | 203-1 | 44.07333 | -96.339141 | | 3-Jun-15 |
| | | | | | | channel border pools/main channel | 203-2 | 44.073894 | -96.337068 | | 14-Aug-15 |
| | | | | | | channel border pools/main channel | 203-3 | 44.074405 | -96.335525 | | 14-Aug-15 |
| | | | | | | channel border pools | 203-4 | 44.074612 | -96.333902 | | 14-Aug-15 |
| | | | | | | glide pool/run channel border pool | 203-5 | 44.076264 | -96.333712 | | 14-Aug-15 |
| Stream flows through what appears to be a subirrigated meadow, very well vegetated stream banks, vegetated uncut banks, abundant aquatic macrophytes; substrate is cobble and gravel with a layer of sand and silt, cobble riffes, low gradient profile with larger reaches of slow, wide glide pools, 0.75 to 1m deep; number of fishes very high. | | | | | | | | | | | |
| 204 | Pipestone Creek | Pipestone | 106 | 46 | 2, 3 | glide pool/run | 204-1 | 44.020223 | -96.347631 | | 18-Jun-15 |
| | | | | | | culvert pool | 204-2 | 44.020003 | -96.347985 | | |
| | | | | | | pool | 204-3 | 44.020376 | -96.348531 | Yes | |
| | | | | | | riffle | 204-4 | 44.020454 | -96.348227 | | |
| East portion has been previously ditched, 1m deep, 4m wide; vegetated banks, some bank erosion evident, landuse is restored grassland, no evidence of grazing; west portion of stream is heavily grazed, landuse is pasture; large wide pool just west of road culvert, 1 to 1.5 m deep; clear to slightly turbid; substrate is mostly silt with sand and gravel mix; aquatic macrophytes present. | | | | | | | | | | | |

**Table 1. Continued**

| Segment | Stream | County | Township | Range | Section | Habitat Type | Site Number | Latitude | Longitude | TS found | Date |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 205 | Rock River | Pipestone | 107 | 44 | 29 | off channel dugout | 205-1 | 44.045814 | -96.164459 | Yes | 5-Jun-15 |
| | | | | | | main channel | 205-2 | 44.0460907 | 96.164295 | | |
| | | | | | | channel border pool | 205-3 | 44.045721 | -96.161706 | Yes | |
| Previously ditched segment of stream, continued ditch maintenance evident by spoil piles adjacent to the stream; row crop agriculture nearly to stream bank, fair amount of erosion from crop fields, just a narrow grass strip adjancent to the stream; slow current, turbid conditions; substrate is muck and silt; 0.75 to 1 m deep, 1.5 to 2 m wide; off channel cattle pond adjacent to stream east of road - *N. topeka* present in it. | | | | | | | | | | | |
| 206 | East Branch of Rock River | Pipestone | 107 | 44 | 28 | main channel | 206-1 | 44.042798 | -96.128983 | Yes | 5-Jun-15 |
| | | | | | | riffle | 206-2 | 44.042943 | -96.129277 | Yes | |
| | | | | | | glid pool | 206-3 | 44.042473 | -96.13044 | Yes | |
| Very nice stream segment, flows through moraine hills, stream meanders with long glide pools, abundant aquatic macrophytes along margins of glide pools, boulder and cobble riffles present; slow to moderate velocity; nearly clear; cobble, gravel substrate with a thin layer of silt, boulder also present; 0.5 to <1m deep, 3 to 4 m wide; surrounding landuse is pasture. *N. topeka* found is all habitat types. | | | | | | | | | | | |
| 207 | Split Rock Creek | Pipestone | 105 | 46 | 9 | main channel | 207-1 | 43.90886 | -96.374132 | Yes | 1-Jun-15 |
| | | | | | | bend pool | 207-2 | 43.912616 | -96.3693 | | |
| | | | | | | channel border pool | 207-3 | 43.913316 | -96.36979 | Yes | |
| Stream banks well vegetated, slow current; deep pools 1.5m, 2-3 m in width; surrounding landuse is pasture, site is only a short distance from large impoundement lake; substrate is boulders, cobble and silt. | | | | | | | | | | | |
| 208 | Split Rock Creek | Rock | 104 | 47 | 12 | channel border pool | 208-1 | 43.823355 | -96.415511 | Yes | 2-Jun-15 |
| | | | | | | channel border pool | 208-2 | 43.82565 | -96.415033 | Yes | |
| Low gradient stream reach, slow moving current; depth 0.75 to 1 m deep, 3-4 m wide, some large diameter side channel pools; vegetated banks but erosion present along the tight meander bends; silt, sand and gravel substrate with patches of boulders; *N. topeka* found in big slow moving and shallow side pools bordering the main channel. | | | | | | | | | | | |
| 209 | Split Rock Creek | Rock | 104 | 46 | 6 | channel border pool | 209-1 | 43.845544 | -96.404493 | Yes | 2-Jun-15 |
| | | | | | | channel margin | 209-2 | 43.844825 | -96.405806 | Yes | |
| | | | | | | riffle | 209-3 | 43.845031 | -96.406104 | | |
| | | | | | | main channel pool | 209-4 | 43.845055 | -96.406171 | Yes | |
| | | | | | | bend pool | 209-5 | 43.845021 | -96.406505 | Yes | |
| Entrenched stream but with meandering bends, high banks, nearly vertical and eroding; springs sources present in floodplain; very turbid and moderate flow; substrate is mostly silt with patches of gravel and cobble; landuse is pasture used for haying; *N. topeka* found at the margins of large pools and deep pools and meander bends; 1 to 1.5 m deep, 3-4 m wide, very large pool just west of the railroad bridge. | | | | | | | | | | | |

**Table 1. Continued**

| Segment | Stream | County | Township | Range | Section | Habitat Type | Site Number | Latitude | Longitude | TS found | Date |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pipestone | 105 | 46 | 35 | main channel | 210-1 | 43.849072 | -96.338691 | | |
| 210 | Trib. to Split Rock Creek | Rock | 104 | 46 | 3 | culvert pool | 210-2 | 43.848735 | -96.338724 | | 18-Jun-15 |
| | | Pipestone | 105 | 46 | 35 | pool | 210-3 | 43.852462 | -96.332072 | | 14-Aug-15 |
| | | | | | | dug out pool | 210-4 | 43.853783 | -96.33114 | | 14-Aug-15 |
| | | | | | | pool | 210-5 | 43.854442 | -96.330937 | | 14-Aug-15 |
| Headwater stream that has been previously ditched, source of water is tile drainage, only a narrow strip of grass separates the stream from surrounding row crop field; large segment of stream dominated by Cattails was without water; water temp was cold and clear; 0.75 to 1 m wide and 0.5 m deep, except large deep pool south of the road; only 3 species of fish collected. Not *N. topeka* habitat. | | | | | | | | | | | |
| 211 | Poplar Creek | Pipestone | 105 | 45 | 27 | spring seep pool | 211-1 | 43.864074 | -96.229864 | Yes | 1-Jun-15 |
| | | | | | | pool | 211-2 | 43.864233 | -96.229835 | Yes | |
| | | | | | | main channel border | 211-3 | 43.864542 | -96.230446 | Yes | |
| | | | | | | channel border pool | 211-4 | 43.864362 | -96.230797 | Yes | |
| | | | | | | channel border pool | 211-5 | 43.864109 | -96.230989 | Yes | |
| | | | | | | channel border pool | 211-6 | 43.864073 | -96.231189 | Yes | |
| | | | | | | main channel border | 211-7 | 43.864053 | -96.230762 | Yes | |
| Stream flows through pasture, grazing pressure moderately high, erosion evident from south of road, row crop activity from the south and north impacting this segment of stream; eroded vertical banks, old channel scars present in the floodplain; several backwater marshes with *F. sciadicus* present; substrate boulder, cobble with a mix of gravel and sand but a fair amount silt cover these materials; slighty turbid; >1m deep, 3-4 m wide; *N. topeka* abundant in segment. | | | | | | | | | | | |
| 212 | Flandreau Creek | Pipestone | 108 | 46 | 21 | bend pool | bkup1A | 44.141779 | -96.381979 | | 4-Jun-15 |
| | | | | | | bend pool | bkup1B | 44.142282 | -96.382308 | | |
| | | | | | | bend pool | bkup1C | 44.141775 | -96.380874 | | |
| | | | | | | channel border pool | bkup1D | 44.142158 | -96.379623 | | |
| | | | | | | pool | bkup1E | 44.142956 | -96.378604 | | |
| | | | | | | bend pool | bkup1F | 44.145188 | -96.376463 | | |
| | | | | | | off channel slough | bkup1G | 44.144345 | -96.379422 | | |
| Current was fast and depth was 1.5 m or greater, turbid water conditions; substrate is compacted silt, semi-hard pan with patches of gravel; off channel slough were present but contained too little water to maintain fish, very shallow, essentially palustrine wetlands; surrounding landuse is pasture. | | | | | | | | | | | |

**Table 1. Continued**

| Segment | Stream | County | Township | Range | Section | Habitat Type | Site Number | Latitude | Longitude | TS found | Date |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 213 | Champepadan Creek | Nobles | 104 | 43 | 14 | all habitat types | 213-1 | 43.807032 | -95.969285 | | 5-Jun-15 |
| | | | 104 | 43 | 15 | all habitat types | 213-2 | 43.806173 | -95.973793 | | 14-Aug-15 |
| Stream segment east of the road is ditched but western portion of the segment has natural meanders; on the eastern segment there is a good buffer on the north side of stream but poor buffer on the south side; stream is 5-8 m wide, 0.5 to 1.5 m depths; cobble, gravel shoals present, shoal pools, riffles, side channels within main channel, as well as deep undercut banks along margin of channel; moderate flow, clear water; substrate cobble, gravel and sand, very little silt; many nest beds present throughout sampled reach. Segment west of the road with deep undercut bannks, bend pools, substrate cobble, gravel and sand, some silt. Nearly the entire stream segment was sampled. | | | | | | | | | | | |
| 214 | Beaver Creek | Rock | 103 | 45 | 18 | main channel border | 214-1 | 43.718783 | -96.281873 | Yes | 18-Jun-15 |
| | | | | | | side channel | 214-A | 43.719412 | -96.277639 | Yes | 1-Jun-15 |
| | | | | | | pool | 214-B | 43.719338 | -96.278016 | Yes | |
| | | | | | | side channel | 214-C | 43.71931 | -96.278312 | Yes | |
| | | | | | | riffle | 214-D | 43.719471 | -96.278997 | Yes | |
| | | | | | | pool | 214-E | 43.719484 | -96.279205 | Yes | |
| On 01 June 2014 a portion of Beaver Cr. immediatedly outside the designated segment was sampled given the proximity of very good habitat and a tributary confluence. A second sampling on 18 June was conducted in the upper most portion of the designated reach to remain true to the sampling protocol. Area outside designated reach: flow stream along the base of a bluff, boulders present along bluff and major part of stream substrate with a mix of cobble and gravel; the small side channels within the main channel composed of sand/gravel substrate with fine layer of silt; 1.5 - 2 m wide and 0.5 - 0.75m deep; valley is grazing land with row crop on top of bluff; *N. topeka* abudant. Area with in designated segment a long glide pool with undercut, well vegetated banks; substrate cobble, gravel with some silt, occasional boulders; 8 m wide and 1 - 1.5 m deep; 1 *N. topeka* collected after 2 short seine hauls with little effort. | | | | | | | | | | | |
| 215 | Trib. to Pipestone Creek | Pipestone | 105 | 47 | 1 | main channel | bkup2A | 43.936285 | -96.442304 | | 18-Jun-15 |
| | | | | | | bend pool | bkup2B | 43.935956 | -96.442546 | | |
| | | | | | | main channel border | bkup2C | 43.936054 | -96.443099 | | |
| | | | | | | pool | bkup2D | 43.935294 | -96.441694 | | |
| | | | | | | pool | bkup2E | 43.934218 | -96.441097 | | |
| | | | 106 | 47 | 36 | culvert pool | bkup2F | 43.936742 | -96.442297 | | |
| Headwater stream, 0.5 - 0.7 deep and 0.5 - 1 m wide; water temp was much warmer than other sampled streams; appears stream may go dry in hot summers, possible winter kill from lack of depth and cool water inflows; slow moving current and turbid; silt and sand substrate with patches of gravel and cobble; surrounding landuse is a reed canary grass pasture. Not *N. topeka* habitat. | | | | | | | | | | | |
| 216 | East Branch of Kanaranzi Creek | Pipestone | 102 | 42 | 1,2 | all habitat types | entire western half | | | | 14-Aug-15 |
| | | | | | | pool below rock ramp | bkup4 | 43.67178 | -95.830712 | Yes | |
| Stream flows through pasture, grazing pressure moderately high, erosion evident all along the stream banks, row crop activity is very close to the stream in places; old mining borrow pits to the north of the stream in Section 1; significant amount of silt and muck in the stream, in the runs, glides, and pool habitats the muck was deep; water was turbid, greenish brown tint, lots of cyanobacteria; stream was 3-5 m wide, less than 0.5 m deep in most places, pools were less than 1m deep. | | | | | | | | | | | |

**Table 1. Continued**

| Segment | Stream | County | Township | Range | Section | Habitat Type | Site Number | Latitude | Longitude | TS found | Date |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 217 | Champepadan Creek | Nobles | 104 | 43 | 31 | glide run/pool | bkup3A | 43.765856 | -96.04881 | | 18-Jun-15 |
| | | | | | | riffle | bkup3B | 43.765319 | -96.049255 | | |
| | | | | | | bend pool | bkup3C | 43.765012 | -96.049393 | | |
| | | | | | | channel border pool | bkup3D | 43.764193 | -96.04922 | | |
| | | | | | | bend pool | bkup3E | 43.764292 | -96.049781 | | |
| | | | | | | channel border pool | bkup3F | 43.763219 | -96.049283 | | |
| Entrenched stream segment, vertical eroding banks, little to no connection with the floodplain, very old channel scars in floodplain; warm water temp. and turbid conditions; substrate is silt, sand and gravel; stream morphology is a series of long glide pools, bend pools and several riffles; 4 - 6 m wide and 0.5 - 1 m deep. Not *N. topeka* habitat | | | | | | | | | | | |
| 218 | Rock River | Rock | 102 | 45 | 11, 14 | side pool | 218 | 43.646301 | -96.199067 | Yes | 2-Jun-15 |
| Entrenched stream channel, vertical eroded banks but stream meanders within entrenched bedform, evidence of frequent flooding, debris lines in riparian forest and sand deposits in surrounding field, large quantities woody debris, current is swift and bend pools deep, much of the stream was too dangerous to cross making sampling difficult, sampling effort confined to shoal margins and shallow pools, sampling reach including side pool and all habitat upstream for apprioximately 120 m; substrate was sand, gravel and cobble; turbid conditions. | | | | | | | | | | | |
| 219 | Kanaranzi Creek | Nobles | 102 | 43 | 11, 14 | off channel slough | 219-1 | 43.644833 | -95.960089 | Yes | 3-Jun-15 |
| | | | | | | main channel | 219-2 | 43.644199 | -95.961708 | | |
| | | | | | | beaver dam side channels | 219-3 | 43.645165 | -95.96325 | | |
| | | | | | | main channel border | 219-4 | 43.641565 | -95.962329 | | |
| | | | | | | channel border pool | 219-5 | 43.640609 | -95.959859 | Yes | |
| Entrenched stream channel, vertical eroded banks but stream meanders within entrenched bedform, gravel shoals present as well as beaver dams; current was fast and water was turbid; surrounding landuse is pasture; substrate is silt, sand and gravel; 4-5 m wide and 0.5 - 1 m deep. Off channel slough present, it is slightly east and north of the designated sampling segment; margin with aquatic macrophytes; substrate silt and muck; *N. topeka* present in off channel slough. | | | | | | | | | | | |
| 220 | Little Rock Creek | Nobles | 101 | 42 | 23 | channel border pool | 220-1 | 43.537805 | -95.838571 | Yes | 3-Jun-15 |
| | | | | | | main channel border | 220-2 | 43.534944 | -95.83941 | | |
| | | | | | | riffle | 220-3 | 43.53508 | -95.840809 | Yes | |
| Well vegetated stream banks, some areas of erosion along bluff line; meandering channel through pasture, old channel scars present; middle part of channel is cobble, gravel and sand while the margins are silt; banks undercut; heavy rain the night before and during the morning increased turbidity; depth 0.5 - 0.75, width 4 - 5 m. *N. topeka* collected from side pool and a cobble riffle. | | | | | | | | | | | |

**Table 2. Complete List of Fish Species Captured at Segments 201-220 for Sampling Year 2015.**

| Species | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Cyprinus carpio* | | | X (r) | | | X (r) | X (f) | X (r) | | | | | | | | | | | | |
| *Campostoma anomalum* | | X (va) | X (va) | X (f) | | X (a) | | | X (r) | | | X (r) | X (a) | X (f) | | X (a) | X (a) | X (a) | X (va) | X (f) |
| *Chrosomus erythrogaster* | | | | | | | | | | | | | | | | | | | X (r) | |
| *Cyprinella lutrensis* | | | X (f) | X (c) | | X (c) | X (r) | X (c) | X (c) | | X (c) | | | X (a) | | | | X (f) | X (c) | X (f) |
| *Hybognathus hankinsoni* | X (f) | X (r) | | | X (r) | | | | | | X (r) | X (r) | X (r) | X (c) | | | | X (r) | X (f) | X (r) |
| *Luxilus cornutus* | X (r) | X (va) | X (va) | X (a) | X (r) | X (c) | | X (c) | X (c) | | X (a) | X (va) | X (va) | | | X (a) | X (c) | | X (c) | X (c) |
| *L. cornutus x S. atromaculatus* | | | | | | | | | | | | | | | | | | | | X (r) |
| *Notropis dorsalis* | | X (r) | X (c) | X (r) | X (c) | | X (a) | X (c) | X (a) | | X (c) | X (f) | X (a) | X (c) | | X (va) | X (a) | X (va) | X (va) | X (a) |
| *Notropis stramineus* | | | X (a) | X (f) | X (r) | X (f) | X (a) | | X (a) | | X (c) | X (r) | X (a) | X (a) | X (r) | X (a) | X (va) | X (va) | X (va) | X (a) |
| ***Notropis topeka*** | | **X (r)** | | **X (r)** | **X (r)** | **X (a)** | **X (r)** | **X (c)** | **X (c)** | | **X (a)** | | | **X (a)** | | **X (r)** | | **X (r)** | **X (c)** | **X (f)** |
| *Pimephales notatus* | | X (a) | X (f) | X (c) | X (f) | | | X (a) | X (c) | | X (a) | X (f) | X (c) | | | X (a) | X (r) | X (c) | X (c) | X (c) |
| *Pimephales promelas* | X (va) | X (a) | X (a) | X (a) | X (a) | X (c) | X (va) | X (c) | X (a) | X (a) | X (a) | X (a) | X (c) | X (va) | X (va) | X (a) | X (c) | | X (c) | X (c) |
| *Rhinichthys atratulus* | | X (r) | X (a) | | | | | | | | X (r) | X (r) | X (va) | | | X (a) | X (c) | X (c) | X (f) | |
| *Semotilus atromaculatus* | X (c) | X (c) | X (va) | X (c) | X (c) | X (f) | X (f) | X (a) | X (c) | | X (c) | X (a) | X (va) | X (c) | X (c) | X (va) | X (va) | X (a) | X (a) | X (a) |
| *Catostomus commersoni* | | X (c) | X (va) | | X (c) | X (c) | X (r) | X (c) | X (f) | | X (c) | X (f) | X (va) | X (f) | X (r) | X (a) | X (c) | X (c) | X (c) | X (a) |
| *Carpiodes carpio* | | | | | | | | | | | | | | X (r) | | | | | | |
| *Moxostoma erythrurum* | | | | | | | | | | | | | | X (r) | | | | | | |
| *Ameiurus melas* | | X (r) | | | X (c) | | X (c) | | | | | | X (f) | | | X (c) | | | | |
| *Ameiurus natilis* | | | | | | | | | X (r) | | | | | | | | | | | |
| *Noturus gyrinus* | | X (r) | X (r) | X (r) | | | X (r) | | X (r) | | X (r) | | | X (r) | | | | | | |
| *Noturus flavus* | | | | | | | | X (r) | X (r) | | | | | | | | X (r) | | | X (r) |
| *Esox lucius* | | | | | X (r) | | | X (r) | | | | | X (r) | | | | | | | |
| *Fundulus sciadicus* | | | | | | X (r) | | | | | X (f) | | | | | | | | | |
| *Culaea inconstans* | X (c) | X (c) | X (c) | | X (r) | | | | X (r) | X (a) | | X (c) | X (r) | | | | | | | |
| *Micropterus salmoides* | | | | | | | | | | | X (r) | | | | | | | | | |
| *Lepomis cyanellus* | | X (r) | X (r) | X (f) | X (r) | X (f) | | X (r) | X (f) | | X (a) | X (r) | | X (f) | | | | X (r) | X (r) | |
| *Lepomis macrochirus* | | | | | | | | | | | X (f) | | X (r) | X (a) | | X (r) | | | | |
| *Lepomis humilis* | | X (r) | | | X (r) | | X (a) | X (a) | X (a) | | X (a) | | X (f) | | | X (a) | | | X (r) | X (f) |
| *Pomoxis nigromaculatus* | | | | | | | X (r) | | | | | | | | | | | X (f) | X (f) | |
| *Etheostoma exile* | X (r) | X (r) | | X (r) | X (r) | X (r) | | | | | X (r) | | | | | | | X (f) | X (f) | |
| *Etheostoma nigrum* | X (r) | X (f) | X (c) | X (f) | X (r) | X (c) | | X (f) | X (f) | | | X (r) | X (a) | X (r) | | X (va) | X (f) | | | X (c) |
| *Perca flavescens* | | | | | | | | | | | | | | | | | | | X (f) | |
| *Percina maculata* | | | X (f) | | | X (f) | | | | | | | X (r) | | | | X (r) | | | X (c) |

Abundance Categories:

*va* Very Abundant > 35 individuals

*a* Abundant > 20 individuals

*c* Common > 10 individuals

*f* Few > 5 individuals

*r* Rare < 5 individuals

# Appendix C

Photographs of Habitat and Fish.

## APPENDIX C: PHOTOGRAPHS OF HABITATS & FISH

Stream photographs for Segments with no *N. topeka* collected are representative stream habitat for the 1-mile stream segments. Stream photographs for those Segments with *N. topeka* are the actual stream sites inhabited by *N. topeka*. The yellow outlined areas on these photographs represent the exact location where the species was captured. Voucher photographs of *N. topeka* from the actual site of capture are included.

**Segment 201**

No *N. topeka* collected.

**Segment 202-3**

**Segment 202-4**

**Segment 203**

No *N. topeka* collected.

**Segment 204-3**

**Segment 205-1**

**Segment 205-3**

**Segment 206-1**

**Segment 206-3**

**Segment 207-1**

**Segment 208-1**

**Segment 209-2**

**Segment 210**

No *N. topeka* collected.

**Segment 210**

Tile drain flow as the source of water in Segment 210. No *N. topeka* collected.

**Segment 211-1**

**Segment 212**

No *N. topeka* collected.

**Segment 213**

Eastern ditched portion. No *N. topeka* collected.

Western unchannelized portion. No *N. topeka* collected.

**Segment 214-1**

**Segment 214-B**

**Segment 215**

No *N. topeka* collected.

**Segment 216**

**Segment 217**

No *N. topeka* collected.

**Segment 218**

**Segment 219-1**

10 *N. topeka* collected – no photos taken

**Segment 219-5**

**Segment 220-1**

**Segment 220-3**

# Appendix D

Photographs of Potential Hybrid Fish.

A

B

C

**APPENDIX D – POTENTIAL HYBRIDS**