2021 Little Manistee River Eroding Stream Bank Assessment

Carrieville (Kings Highway) Bridge to Old Stronach Rd. Bridge

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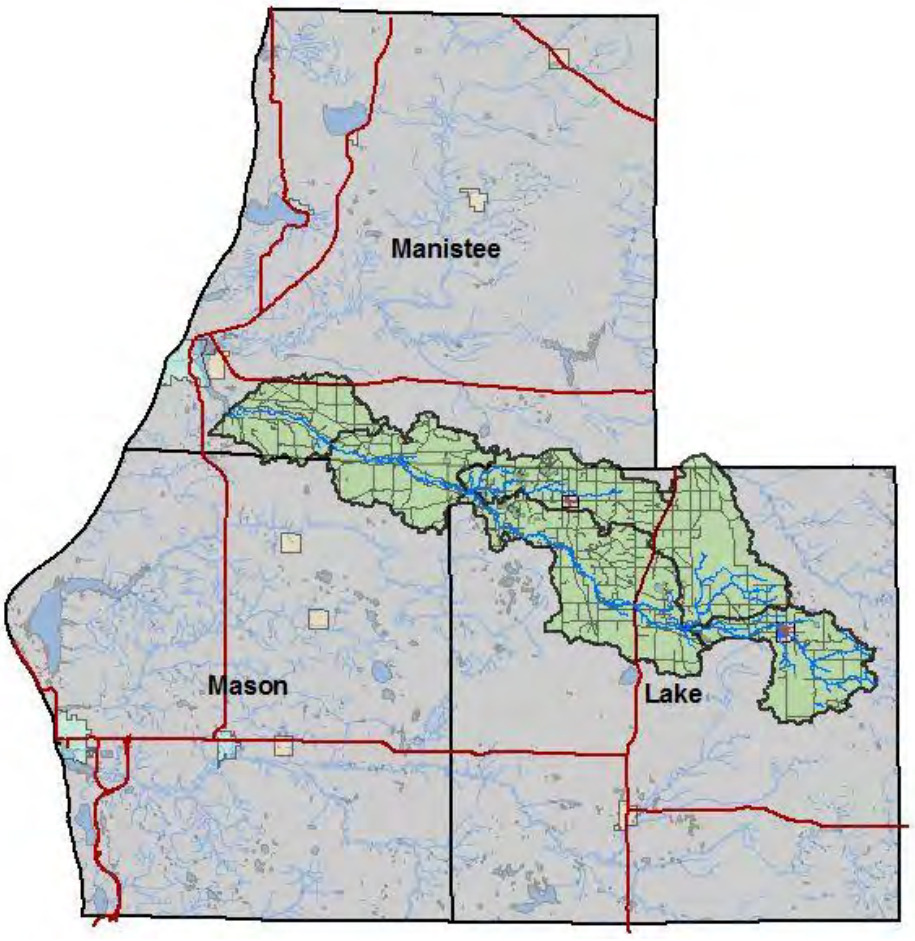

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Introduction

This report is an update to the "Little Manistee River Streambank Erosion Inventory" first performed in 1998 and subsequently updated in 2002 and 2011-2014. The purpose of the inventory is to identify erosion sites contributing excess sand sediment to the mainstem of the river, enabling partners to triage and then perform work to mitigate the erosion. This strategy utilized by the Little Manistee River Watershed Conservation Council (LMRWCC) addresses both the underlying cause and the condition of the erosion impairments including, but not limited to, excessive sand bedload, lack of instream wood for fish habitat, and loss of pool habitat.

In the past, bank stabilization efforts involved the use of fieldstone riprap to provide an armoring effect. However, this material does not serve as good habitat for fish and wildlife. A relatively recent technique implemented on the Little Manistee and other regional rivers to mitigate erosion is the installation of log jams at the interface between the river and the erosion site. These jams are constructed using whole trees, coarse wood debris, and logging slash that not only provide for erosion stabilization but result in benefits at both a reach and system-wide scale. Through their placement, log jams result in enhancement of the river fishery with wide-ranging adult trout especially benefitting and subsequently providing anglers with opportunities for catching adult trout in areas not proximal to any given project site*. Young age classes of both forage fish and salmonids also benefit in the physical separation from predatory adult fish and protection from high flow events*. The log jam structures address habitat-limiting factors called out in a 2015 Trout Unlimited habitat report** which concludes the Little Manistee River exhibits a paucity of instream large wood material. By supplying an absent component (wood) of rivers in wooded regions, ecosystem function is restored in the form of fish and wildlife cover as well as macroinvertebrate habitat and a reduction in bedload sediment.

Constructed log jam, Little Manistee River

The LMRWCC, through their work, is encouraging the development of sustainable fish and aquatic organism communities by providing a mosaic of habitats using large wood, a component of streams that's been shown in the peer-reviewed scientific literature to benefit aquatic biota***. Ecosystem functionality and geomorphic complexity go hand in hand as the large wood provides not only habitat for organisms but physical interaction with flowing water (resulting in the scour of bedload sand which is transported downstream) and a means to decrease energy during flood events.

The extent to which eroding sites must be treated, the toe is the most important due to the constant interaction between the water and bank or bluff. Because the sandy or sand/gravel material composing most of the sites provides important habitat for turtles (nesting and egg laying) and cavity nesting birds like kingfishers and bank swallows, it's not recommended the entire face of the site be stabilized. This may in fact not be necessary anyway as these surfaces can passively revegetate once the toe is stable (see page 108).

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Methods

Over the course of the 2020 and 2021 field seasons, a biologist from Conservation Resource Alliance (CRA) replicated the 2011-2014 survey. However, the sections from 6 Mile Bridge to the MDNR weir and Old Stronach Road Bridge to Manistee Lake were not surveyed based on prior years' data indicating this was not necessary. Due to the COVID pandemic and subsequent disruption to scheduling across the board at CRA, the survey was pushed to two seasons.

To minimize the amount of travel to and from sites, the river was surveyed downstream from M-37 with a canoe and camping gear to facilitate longer time spent in the field. Limitations posed by this method included the need to portage the canoe and gear around or over numerous log jams and channel spanning trees, especially between the Old Grade Campground and Indian Bridge. The section of river between Carrieville and M-37 was primarily hiked and waded as most of the channel is not suitable for canoe passage.

Because of the large number of site photos taken during the survey and the associated GPS coordinates, CRA felt the need for two complete trips from Carrieville to Old Stronach Bridge to assure accuracy prior to development of the final report. Field notes were recorded on each survey day and included site specific information as well as observations on river conditions, weather, riparian vegetation, and fish and wildlife. Site specific information included, but was not limited to, GPS coordinates, length and height of erosion, depth of water at bank toe, slope, material composition, location of site within the channel, channel substrate composition, and channel dimensions. An onsite call was made as to the severity (severe, moderate, minor) of the site based on observed conditions and professional judgement.

Results and Discussion

A breakdown of the river into the following sections help describe the results to follow:

Erosion Site Summary

River Section	Minor Sites	Moderate Sites	Severe Sites	Total Sites
Carrieville (Kings Highway) to M-37 Bridge	4	8	1	13
Old Grade Campground (M-37) to Spencer's Bridge	3	0	2	5
Spencer's Bridge to Indian Bridge	8	2	3	13
Indian Bridge to Johnson Bridge	1	3	7	11
Johnson Bridge to N. Granger Road	2	1	1	4
Fox Bridge to 18 Mile Bridge	1	0	1	2
18 Mile Bridge to 9 Mile Bridge	3	3	7	13
9 Mile Bridge to 6 Mile Bridge	8	6	16	30
6 Mile Bridge to Old Stronach Road Bridge	3	1	0	4
Total	33	24	38	95

Carrieville (Kings Highway) to M-37 Bridge

This section was evaluated by hiking, wading, and some paddling (lower section), necessitated by the difficulty posed by accumulations of coarse, medium, and large wood in the channel and the tunnel-like growths of tag alder.

This section was found to have **13** eroding stream banks which necessitated evaluation. In general terms, this section was low gradient, and primarily sand bottomed. The channel is quite sinuous resulting in relatively deep pools on the outside of meander bends.

Because of the low-lying country between M-37 and the Merriville ORV trail, it's not necessary to survey this section as no banks are susceptible to erosion. However, the upper section, closer to the campground is typified by relatively high sandy banks and bluffs.

Carrieville is also the upstream limit of the US Forest Service-administered *Wild and Scenic Study River* which terminates at the MDNR weir near Stronach. In recent years, the Forest Service has required a "Section 7" analysis of any stabilization or habitat enhancement in the corridor regardless of land ownership.

Old Grade (M-37) to 9 Mile Bridge

This section was evaluated via canoe and was found to have 4**8** eroding stream banks which necessitated evaluation.

Due to the relative similarities of the channel and landscape between M-37 and the 9 Mile Bridge, the discrete river sections as broken down in Table 1 have been combined for this portion of the report. The river channel alternates between a sand substrate and a mix of sand, gravel, clay, and in the vicinity of the Indian Club, boulders.

As was noted in the prior survey, the segment from "Trapper Dan's Landing" to the settlement in the vicinity of Pomeroy Springs exhibited a paucity of large wood more notable than the rest of the river. In addition, the channel exhibits both a lack of large wood and a high width-to-depth ratio along with a comparatively high volume of sand bedload.

This section had a relatively high concentration of riverfront homes with little or no riparian buffer at the water's edge and expansive mown lawns, especially in the vicinity of Pomeroy Springs.

Tall, eroding bluffs and banks were documented during the survey but the most striking resource issue continues to be the lack of channel complexity due at least in part to the paucity of large wood and log jams coupled with the amount of sand bed load. That said, it's important to recognize that the gradient through this section is comparatively low and therefore is depositional in nature and it can be expected that sand deposition would occur here.

9 Mile Bridge to 6 Mile Bridge

This section was evaluated via canoe and was found to have **30** eroding stream banks and bluffs which necessitated evaluation.

This high gradient section is where a majority of the tall, sandy and severely eroding bluffs are located. The current bearing banks and bluffs on the outside of the meander bends are exposed to a high amount of energy; this condition coupled with the sand dominated geology provides a high volume of sediment to the channel. Because the river drops in elevation at a very high rate, the material is transported downstream to a point where the hydraulic competency lessens (at approximately the 6 Mile Bridge) and the sediment drops out of suspension. As a result, any gravel substrate present over time has become laden with sand bedload.

Many of the sites requiring stabilization in this section are on U.S. Forest Service managed lands and therefore any stabilization efforts are subject to analysis under the *National Environmental Policy Act* (NEPA) in addition to Section 7 of the *Wild and Scenic Rivers Act*.

6 Mile Bridge to MDNR Weir

This section was evaluated via canoe during the previous survey and was found to have **no** erosion sites which necessitated evaluation for treatment. Nor were there any sites that were in imminent possibility of erosion.

As noted above, the gradient is markedly less dramatic here than in the prior section and as a result, the current-bearing sites were nonexistent. However, there was a relatively high quantity of submerged wood in the form of whole trees and rootwads which help offset the homogenous nature of a sand bed channel.

MDNR Weir to Old Stronach Rd. Bridge

This section was evaluated via canoe and was found to have 4 eroding stream banks which necessitated work. The only high bluffs encountered were just above the Old Stronach Road Bridge. During previous surveys, these sites were noted as erosion sites but for the purposes of this current survey, their condition is not a concern from a resource standpoint. Site LM#92-2021 was stabilized and protected with a constructed log jam during the writing of this report and a photo of the site post-construction appears in the introduction. Because the site falls outside of the jurisdiction of the Wild and Scenic Study River corridor, a Section 7 analysis was unnecessary.

The channel through this section is primarily underlain with sand, gravel generally being expressed in the bottom of deep holes on the outside bends.

Acknowledgements

This assessment was generously funded by the Little Manistee River Watershed Conservation Council, a citizen-based advocacy organization with a strong and effective presence in the Little Manistee River watershed.

Carrieville (Kings Highway) to M-37 Bridge

LM#1-2021
44.03456, -85.72323

dimensions: 6’ l x 4’ h
river right
depth at toe: 3’
moderate
substrate: sand
owner: MDNR

LM#2-2021
44.03405, -85.72340

dimensions: 8’ l x 8’ h
river left
depth at toe: 2’
minor
substrate: sand
owner: MDNR

LM#3-2021
44.03411, -85.72511

dimensions: 50’ l x 4’ h
river right
depth at toe: .5’
minor
substrate: sand
owner: MDNR

LM#3 (downstream)

LM#4-2021
44.03434, -85.72540

dimensions: 50’ l x 4’ h
river right
depth at toe: .5’
moderate
substrate: sand
owner: MDNR

LM#4-2021 (downstream)

LM#5-2021
44.03498, -85.72604

dimensions: 10’ l x 3.5’ h
river left
depth at toe: .5’
moderate
substrate: sand, medium gravel
owner: MDNR

LM#6-2021
44.03561, -85.72720

dimensions: 20’ l x 5’ h
river left
depth at toe: 2.5’
moderate
substrate: sand
owner: MDNR

LM#7-2021
44.03569, -85.72728

dimensions: 20’ l x 5’ h
river left
depth at toe: .5’
moderate
substrate: sand
owner: MDNR

LM#8-2021
44.03461, -85.73061

dimensions: 6’ l x 7’ h
river left
depth at toe: .5’
moderate
substrate: sand
owner: MDNR

LM#9-2021
44.03499, -85.73139

dimensions: 10’ l x 10’ h
river right
depth at toe: 2’
severe
substrate: sand, gravel
owner: MDNR

LM#10-2021
44.03519, -85.73207

dimensions: 122’ l x 4’-10’ h
river right
depth at toe: .5’
moderate
substrate: sand, gravel
owner: MDNR

LM#10-2021 (cont.)

LM#10-2021 (cont.)

LM#11-2021
44.03504, -85.73323

dimensions: 6’ l x 5’ h
river left
depth at toe: 1’
minor
substrate: sand
owner: MDNR

LM#12-2021
44.03522, 85.73569

dimensions: 6’ l x 5’ h
river left
depth at toe: 2.5’
minor
substrate: sand
owner: MDNR

LM#13-2021
44.04666, -85.82535

dimensions: 4’ l x 2’ h
river right
depth at toe: 4’
moderate
substrate: sand
owner: MDNR

M-37 to Spencer Bridge

LM#14-2021
44.06048, -85.85301

dimensions: 10’ l x 6’ h
river right
depth at toe: 1’
minor
substrate: sand
owner: USFS

LM#15-2021
44.06042, -85.85333

dimensions: 12’ l x 8’ h
river right
depth at toe: 2.5’
minor
substrate: sand
owner: USFS

LM#16-2021
44.06221, -85.85563

dimensions: 160’ l x 12’ h
river right
depth at toe: inches to 3’
severe
substrate: gravel
owner: USFS

LM#17-2021
44.06124, -85.86974

dimensions: 50’ l x 12’ h
river right
depth at toe: 2”- 3’
severe
substrate: medium to small gravel, sand
owner: Private

LM#18-2021
44.06273, -85.87586

dimensions: 65’ l x 6’ h
river right
depth at toe: inches to 2.5’
minor
substrate: sand, vegetation
owner: Private

Spencer Bridge to Indian Bridge

LM#19-2021
44.06620, -85.88358

dimensions: 15’ l x 3’ h
river right
depth at toe: 4’
severe
substrate: sand
owner: MDNR (or Lake County Road Commission)

LM#20-2021
44.07051, -85.88240

dimensions: 16’ l x 20’ h
river right
depth at toe: 1” to 1.5’
minor
substrate: sand, small gravel
owner: Private

LM#21-2021
44.07073, -85.88660

dimensions: 140’ l x 12’ h
river left
depth at toe: 2’- 3’
minor
substrate: small-medium gravel, sand
owner: Private

LM#22-2021
44.07310, -85.88529

dimensions: 15’ l x 9’ h
river right
depth at toe: 3’
minor
substrate: sand, submerged wood
owner: Private

LM#23-2021
44.07567, -85.88647

dimensions: 12’ l x 8’ h
river right
depth at toe: 1’-2’
minor
substrate: small-medium gravel
owner: Private

LM#24-2021
44.07888, -85.88983

dimensions: 60’ l x 18’ h
river left
depth at toe: 1’-2’
moderate
substrate: sand, fieldstone
owner: Private

LM#25-2021
44.08048, -85.89095

dimensions: 10’ l x 12’ h
river right
depth at toe: 2’- 3’
severe
substrate: sand
owner: Private

LM#26-2021
44.08197, -85.89217

dimensions: 80’ l x 19’ h
river right
depth at toe: 4’
severe
substrate: sand
owner: Private

LM#27-2021
44.08242, -85.89562

dimensions: 10’ l x 5’ h
river right
depth at toe: 3.5’
minor
substrate: sand
owner: Private

LM#28-2021
44.08271, -85.89648

dimensions: 5’ l x 8’ h
river right
depth at toe: 3’
minor
substrate: sand
owner: Private

LM#29-2021
44.08471, -85.89833

dimensions: 40’ l x 20’ h
river right
depth at toe: 2’
minor
substrate: cobble, gravel, sand
owner: Private

LM#30-2021
44.08448, -85.89880

dimensions: 100’ l x 10’-18’ h
river right
depth at toe: 2.5’
minor
substrate: sand, vegetation
owner: Private

LM#31-2021
44.08775, -85.90228

dimensions: 15’ l x 10’ h
river left
depth at toe: 4.5’
moderate
substrate: sand, medium gravel
owner: Private

Indian Bridge to Johnson Bridge

LM#32-2021
44.09069, -85.90736

dimensions: 70’ l x 10’ h
river right
depth at toe: 2’
moderate
substrate: medium gravel, sand
owner: Private

LM#33-2021
44.09183, -85.90710

dimensions: 65’ l x 15’ h
river right
depth at toe: 3’
severe
substrate: sand
owner: Private

LM#34-2021
44.09406, -85.91064

dimensions: 65’ l x 8’ h
river left
depth at toe: 4.5’
severe
substrate: small-medium gravel
owner: USFS

LM#35-2021
44.09680, -85.91067

dimensions: 15’ l x 8’ h
river left
depth at toe: 4’
severe
substrate: sand
owner: USFS

LM#36-2021
44.09985, -85.91238

dimensions: 10’ l x 6’ h
river right
depth at toe: 1’
severe
substrate: sand, gravel
owner: USFS

LM#37-2021
44.10181, -85.91402

dimensions: 45’ l x 20’ h
river left
depth at toe: 5’
minor
substrate: gravel
owner: USFS

LM#38-2021
44.10224, -85.91378

dimensions: 35’ l x 20’ h
river left
depth at toe: 4’
severe
substrate: sand, medium gravel
owner: USFS

LM#39-2021
44.10224, -85.91379

dimensions: 60’ l x 20’ h
river left
depth at toe: 4’
severe
substrate: sand, medium gravel
owner: USFS

LM#40-2021
44.10282, -85.91203

dimensions: 10’ l x 6’ h
river right
depth at toe: 4’
moderate
substrate: sand, medium gravel, boulders
owner: USFS

LM#41-2021
44.10302, -85.91206

dimensions: 15’ l x 8’ h
river right
depth at toe: 3’
moderate
substrate: sand, gravel
owner: USFS

LM#42-2021
44.10361, -85.91603

dimensions: 10’ l x 6’ h
river right
depth at toe: 2.5’
severe
substrate: sand, gravel
owner: USFS

Johnson Bridge to North Granger Road Bridge

LM#43-2021
44.11154, -85.93953

dimensions: 25’ l x 6’ h
river left
depth at toe: 1’
minor
substrate: medium-small gravel
owner: Private

LM#44-2021
44.11220, -85.93949

dimensions: 40’ l x 12’ h
river left
depth at toe: 3’
moderate
substrate: fine, medium, coarse gravel
owner: Private

LM#45-2021
44.11246, -85.95420

dimensions: 30’ l x 12’ h
river left
depth at toe: 6’
severe
substrate: sand, coarse gravel, cobble
owner: USFS

LM#46-2021
44.11575, -85.97102

dimensions: 15’ l x 4’ h
river left
depth at toe: 4’
minor
substrate: sand
owner: Private

Fox Bridge to 18 Mile Bridge

LM#47-2021
44.14169, -86.01369

dimensions: 10’ l x 5’ h
river left
depth at toe: 6’
minor
substrate: sand
owner: Private

LM#48-2021
44.14634, -86.01687

dimensions: 30’ l x 12’ h
river right
depth at toe: 2.5’
severe
substrate: sand
owner: Private

18 Mile Bridge-9 Mile Bridge

LM#49-2021
44.14890, -86.03338

dimensions: 120’ l x 30’ h
river left
depth at toe: 4’
severe
substrate: sand
owner: Private

LM#50-2021
44.14987, -86.04291

dimensions: 50’ l x 8’ h
river left
depth at toe: 3’
minor (trending toward severe due to adjacent home)
substrate: sand
owner: Private

LM#51-2021
44.15369, -86.04763

dimensions: 25’ l x 10’ h
river right
depth at toe: 8’-10’
severe
substrate: unknown
owner: Private

LM#52-2021
44.15506, -86.05917

dimensions: 18’ l x 8’ h
river left
depth at toe: 3’
moderate
substrate: sand
owner: USFS

LM#53-2021
44.15427, -86.06400

dimensions: 16’ l x 8’ h
river left
depth at toe: 2’
minor
substrate: sand
owner: USFS

LM#54-2021
44.15545, -86.06768

dimensions: 20’ l x 4’ h
river left
depth at toe: 3’
minor
substrate: sand
owner: USFS

LM#55-2021
44.15604, -86.07442

dimensions: 65’ l x 12’ h
river left
depth at toe: 5’
severe
substrate: sand
owner: Private

LM#56-2021
44.15796, -86.07480

dimensions: 30’ l x 20’ h
river right
depth at toe: 2’
severe
substrate: sand
owner: USFS

LM#57-2021
44.15827, -86.07536

dimensions: 40’ l x 25’ h
river right
depth at toe: 4’
severe
substrate: sand
owner: USFS

LM#58-2021
44.16262, -86.08240

dimensions: 50’ l x 20’
river right
depth at toe: 2’-3’
moderate
substrate: sand
owner: USFS

LM#59-2021
44.16609, -86.08598

dimensions: 45’ l x 15’ h
river right
depth at toe: 3’
severe
substrate: submerged wood, sand
owner: Private

LM#60-2021
44.16669, -86.08622

dimensions: 60’ l x 15’ h
river right
depth at toe: 3’
severe
substrate: sand
owner: Private

LM#61-2021
44.16809, -86.09155

dimensions: 10’ l x 6’ h
river left
depth at toe: 3’
minor
substrate: sand
owner: Private

9 Mile Bridge to 6 Mile Bridge

LM#62-2021
44.17007, -86.10600

dimensions: 10’ l x 6’ h
river left
depth at toe: 3’
minor
substrate: sand, medium gravel
owner: USFS

LM#63-2021
44.17054, -86.10658

dimensions: 20’ l x 10’ h
river left
depth at toe: 3’
moderate
substrate: sand, wood
owner: USFS

LM#64-2021
44.17327, -86.10602

dimensions: 6’ l x 6’ h
river right
depth at toe: 3’
severe
substrate: sand
owner: Private

LM#65-2021
44.17337, -86.11163

dimensions: 12’ l x 2’ h
river right
depth at toe: 3’
severe
substrate: sand, some gravel
owner: Private

LM#66-2021
44.16893, -86.11646

dimensions: 8’ l x 5’ h
river left
depth at toe: 1.5’
minor
substrate: sand, medium gravel
owner: Private

LM#67-2021
44.17026, -86.11784

dimensions: 10’’ l x 8’ h
river left
depth at toe: 3’
minor
substrate: sand, coarse gravel
owner: Private

LM#68-2021
44.17180, -86.11626

dimensions: 100’ l x 5’ h
river right
depth at toe: 3’
moderate
substrate: coarse gravel
owner: Private

LM#68-2021 (cont.)

LM#68-2021 (cont.)

LM#69-2021
44.17217, -86.11787

dimensions: 30’ l x 4’ h
river left
depth at toe: 3.5’
minor
substrate: various sized gravel
owner: Private

LM#70-2021
44.17279, -86.11891

dimensions: 120’ l x 30’ h
river right
depth at toe: 1’-5’
severe
substrate: sand, wood
owner: USFS

LM#70-2021 (upstream view)

LM#71-2021
44.17253, -86.11926

dimensions: 100’ l x 20’ h
river right
depth at toe: 6’
severe
substrate: sand, medium and coarse gravel, cobble (fieldstone)
owner: USFS

LM#71-2021 upstream view

LM#72-2021
44.17134, -86.11994

dimensions: 40’ l x 8’ h
river right
depth at toe: 10’
severe
substrate: unknown
owner: USFS

LM#73-2021
44.17249, -86.12099

dimensions: 65’ l x 25’ h
river right
depth at toe: 8’
severe
substrate: unknown
owner: USFS

LM#73-2021 (closeup of prior fieldstone stabilization effort)

LM#74-2021
44.17287, -86.12207

dimensions: 40’ l x 15’ h
river right
depth at toe: 3’
severe
substrate: gravel
owner: USFS

LM#75-2021
44.17275, -86.12230

dimensions: 40’ l x 8’ h
river right
depth at toe: 3.5’
severe
substrate: gravel
owner: USFS

LM#76-2021
44.17204, -86.12429

dimensions: 25’ l x 15’ h
river right
depth at toe: 2.5’
minor
substrate: gravel
owner: USFS

LM#77-2021
44.17204, -86.12449

dimensions: 50’ l x 12’ h
river right
depth at toe: 2.5’
severe
substrate: gravel
owner: USFS

LM#78-2021
44.17141, -86.12701

dimensions: 50’ l x 15’ h
river right
depth at toe: 4’
severe
substrate: gravel
owner: USFS

LM#79-2021
44.17144, -86.13126

dimensions: 40’ l x 35’ h
river right
depth at toe: 1’
severe
substrate: gravel
owner: USFS

LM#80-2021
44.17383, -86.13348

dimensions: 45’ l x 3’ h
river right
depth at toe: 5’
moderate
substrate: gravel, cobble (fieldstone)
owner: Private

LM#81-2021
44.17423, -86.13521

dimensions: 20’ l x 10’ h
river right
depth at toe: 1.5’
moderate
substrate: gravel, wood
owner: Private

LM#82-2021
44.17426, -86.13592

dimensions: 5’ l x 5’ h
river right
depth at toe: 3’
minor
substrate: sand, gravel
owner: Private

LM#83-2021
44.17419, -86.13862

dimensions: 25’ l x 6’ h
river left
depth at toe: 3’
severe
substrate: gravel
owner: USFS

LM#84-2021
44.17476, -86.13882

dimensions: 15’ l x 5’ h
river right
depth at toe: 2’
moderate
substrate: sand, gravel
owner: USFS

LM#85-2021
44.17503, -86.13828

dimensions: 18’ l x 4’ h
river right
depth at toe: 3’
minor
substrate: sand, gravel
owner: Private

LM#86-2021
44.17566, -86.14111

dimensions: 130’ l x 3’ h
river left
depth at toe: 3’
moderate
substrate: sand, gravel
owner: USFS

LM#87-2021
44.17735, -86.14570

dimensions: 35’ l x 6’ h
river right
depth at toe: 5’
severe
substrate: gravel, cobble (fieldstone)
owner: USFS

LM#88-2021
44.17735, -86.14850

dimensions: 15’ l x 4’ h
river left
depth at toe: 3.5’
minor
substrate: sand, gravel
owner: Private

LM#89-2021
44.17673, -86.15128

dimensions: 20’ l x 25’ h
river right
depth at toe: 2.5’
severe
substrate: sand, gravel
owner: USFS

LM#90-2021
44.17615, -86.15361

dimensions: 40’ l x 8’ h
river left
depth at toe: 3’
severe
substrate: sand
owner: Private

LM#91-2021
44.17911, -86.16132

dimensions: 45’ l x 15’ h
river right
depth at toe: 4’
severe
substrate: sand, gravel
owner: USFS

Passive bluff stabilization through benign neglect (Site #79-2011/2014).

Site #79 in 2011

Weir to Old Stronach Bridge

LM#92-2021
44.20363, -86.20378

dimensions: 20’ l X 7’ h
river right
depth at toe: 6’
minor
substrate: sand
owner: Private

LM #93-2021
44.20692, -86.22277

dimensions: 60’ l x 3’-5’ h
river right
depth at toe: 1’
minor
substrate: sand
owner: USFS

LM#94-2021
44.20821, -86.23972

dimensions: 100’ l x 4.5’ h
river left
depth at toe: 4’
minor
substrate: sand
owner: USFS and/or Private

LM#95-2021
44.20850, -86.24171

dimensions: 70’ l x 4.5’ h
river left
depth at toe: 2.5’
moderate
substrate: sand
owner: Private

Minor Sites

ID	Latitude	Longitude	County	Ownership
LM#2-2021	44.03405	-85.72340	Lake	MDNR
LM#3-2021	44.03411	-85.72511	Lake	MDNR
LM#4-2021	44.03434	-85.72540	Lake	MDNR
LM#11-2021	44.03504	-85.73323	Lake	MDNR
LM#12-2021	44.03522	-85.73569	Lake	MDNR
LM#14-2021	44.06048	-85.85301	Lake	USFS
LM#15-2021	44.06042	-85.85333	Lake	USFS
LM#18-2021	44.06273	-85.87586	Lake	Private
LM#20-2021	44.07051	-85.88240	Lake	Private
LM#21-2021	44.07073	-85.88660	Lake	Private
LM#22-2021	44.07310	-85.88529	Lake	Private
LM#23-2021	44.07567	-85.88647	Lake	Private
LM#27-2021	44.08242	-85.89562	Lake	Private
LM#28-2021	44.08271	-85.89648	Lake	Private
LM#29-2021	44.08471	-85.89833	Lake	Private
LM#30-2021	44.08448	-85.89880	Lake	Private
LM#37-2021	44.10181	-85.91402	Lake	USFS
LM#37-2021	44.10181	-85.91402	Lake	USFS
LM#43-2021	44.11154	-85.93953	Lake	Private
LM#46-2021	44.11575	-85.97102	Lake	Private
LM#47-2021	44.14169	-86.01369	Lake	Private
LM#50-2021	44.14987	-86.04291	Lake	Private
LM#53-2021	44.15427	-86.06400	Lake	USFS
LM#54-2021	44.15545	-86.06768	Lake	USFS
LM#61-2021	44.16809	-86.09155	Lake	Private
LM#62-2021	44.17007	-86.10600	Manistee	USFS
LM#66-2021	44.16893	-86.11646	Manistee	Private
LM#67-2021	44.17026	-86.11784	Manistee	Private
LM#69-2021	44.17217	-86.11787	Manistee	Private
LM#76-2021	44.17204	-86.12429	Manistee	USFS
LM#85-2021	44.17503	-86.13828	Manistee	Private
LM#88-2021	44.17735	-86.14850	Manistee	Private
LM#92-2021	44.20363	-86.20378	Manistee	Private
LM#93-2021	44.20692	-86.22277	Manistee	USFS
LM#94-2021	44.20821	-86.23972	Manistee	Private

Moderate Sites

ID	Latitude	Longitude	County	Ownership
LM#1-2021	44.03456	-85.72323	Lake	MDNR
LM#5-2021	44.03498	-85.72604	Lake	MDNR
LM#6-2021	44.03561	-85.72720	Lake	MDNR
LM#7-2021	44.03569	-85.72728	Lake	MDNR
LM#8-2021	44.03461	-85.73061	Lake	MDNR
LM#10-2021	44.03519	-85.73207	Lake	MDNR
LM#13-2021	44.04666	-85.82535	Lake	MDNR
LM#24-2021	44.07888	-85.88983	Lake	Private
LM#31-2021	44.08775	-85.90228	Lake	Private
LM#32-2021	44.09069	-85.90736	Lake	Private
LM#40-2021	44.10282	-85.91203	Lake	USFS
LM#41-2021	44.10302	-85.91206	Lake	USFS
LM#44-2021	44.11220	-85.93949	Lake	Private
LM#52-2021	44.15506	-86.05917	Lake	USFS
LM#58-2021	44.16262	-86.08240	Lake	USFS
LM#63-2021	44.17054	-86.10658	Manistee	USFS
LM#68-2021	44.17180	-86.11626	Manistee	Private
LM#80-2021	44.17383	-86.13348	Manistee	Private
LM#81-2021	44.17423	-86.13521	Manistee	Private
LM#82-2021	44.17426	-86.13592	Manistee	Private
LM#84-2021	44.17476	-86.13882	Manistee	USFS
LM#86-2021	44.17566	-86.14111	Manistee	USFS
LM#95-2021	44.20850	-86.24171	Manistee	Private

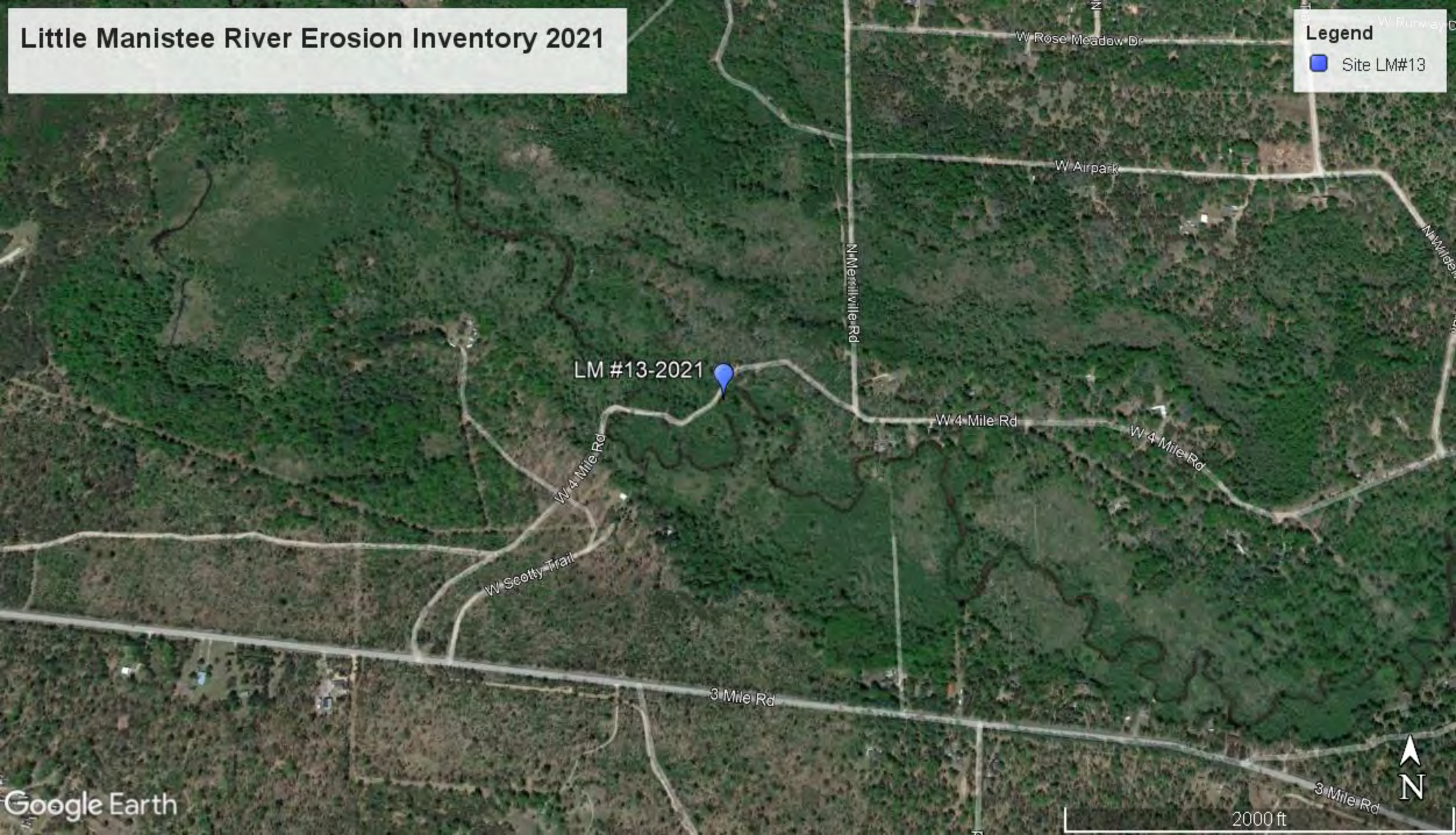
Severe Sites

ID	Latitude	Longitude	County	Ownership
LM#9-2021	44.03499	-85.73139	Lake	MDNR
LM#16-2021	44.06221	-85.85563	Lake	USFS
LM#17-2021	44.06124	-85.86974	Lake	Private
LM#19-2021	44.06620	-85.88358	Lake	Lake Co. Road Commission
LM#25-2021	44.08048	-85.89095	Lake	Private
LM#26-2021	44.08197	-85.89217	Lake	Private
LM#33-2021	44.09183	-85.90710	Lake	Private
LM#34-2021	44.09406	-85.91064	Lake	Private
LM#35-2021	44.09680	-85.91067	Lake	Private
LM#36-2021	44.09985	-85.91238	Lake	Private
LM#38-2021	44.10224	-85.91378	Lake	USFS
LM#39-2021	44.10224	-85.91379	Lake	USFS
LM#42-2021	44.10361	-85.91603	Lake	USFS
LM#45-2021	44.11246	-85.95420	Lake	USFS
LM#48-2021	44.14634	-86.01687	Lake	Private
LM#49-2021	44.14890	-86.03338	Lake	Private
LM#51-2021	44.15369	-86.04763	Lake	Private
LM#55-2021	44.15604	-86.07442	Lake	Private
LM#56-2021	44.15796	-86.07480	Lake	USFS
LM#57-2021	44.15827	-86.07536	Lake	USFS
LM#59-2021	44.16609	-86.08598	Lake	Private
LM#60-2021	44.16669	-86.08622	Lake	Private
LM#64-2021	44.17327	-86.10602	Manistee	Private
LM#65-2021	44.17337	-86.11163	Manistee	Private
LM#70-2021	44.17279	-86.11891	Manistee	USFS
LM#71-2021	44.17253	-86.11926	Manistee	USFS
LM#72-2021	44.17134	-86.11994	Manistee	USFS
LM#73-2021	44.17249	-86.12099	Manistee	USFS
LM#74-2021	44.17287	-86.12207	Manistee	USFS
LM#75-2021	44.17275	-86.12230	Manistee	USFS
LM#77-2021	44.17204	-86.12449	Manistee	USFS
LM#78-2021	44.17141	-86.12701	Manistee	USFS
LM#79-2021	44.17144	-86.13126	Manistee	USFS
LM#83-2021	44.17419	-86.13862	Manistee	USFS
LM#87-2021	44.17735	-86.14570	Manistee	USFS
LM#89-2021	44.17673	-86.15128	Manistee	USFS
LM#90-2021	44.17615	-86.15361	Manistee	Private
LM#91-2021	44.17911	-86.16132	Manistee	USFS

Appendix A

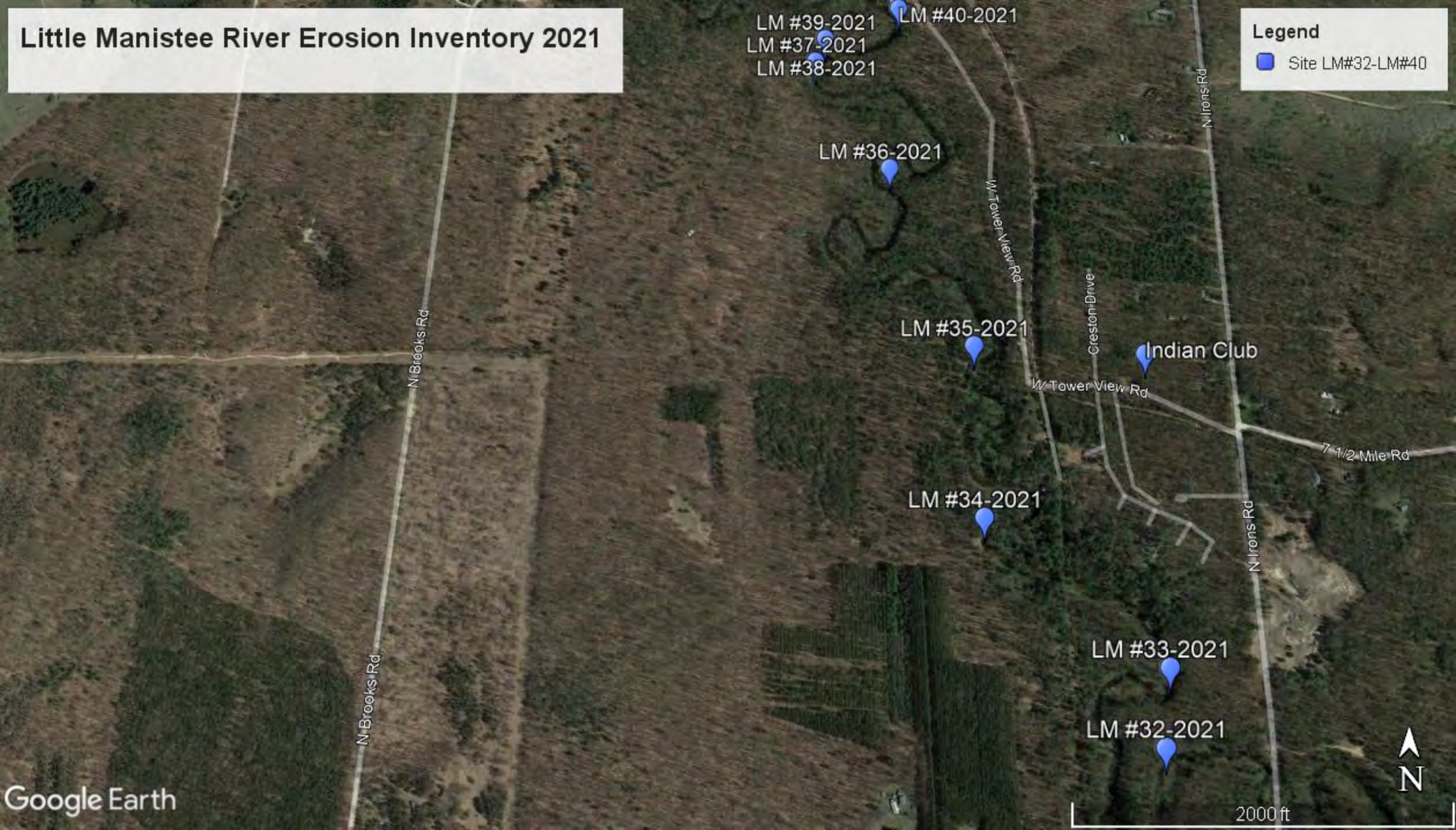
Overview Mapping


Little Manistee River Erosion Inventory 2021
Legend
Site LM#1-LM#12
Carrieville MDNR Campground
LM #12-2021
LM #11-2021
LM #10-2021
LM #9-2021
LM #8-2021
LM #7-2021
LM #6-2021
LM #5-2021
LM #4-2021
LM #3-2021
LM #2-2021
LM #1-2021
N Kings Hwy
E A Ave
E F Ave
E Ecker
Google Earth
1000 ft
N

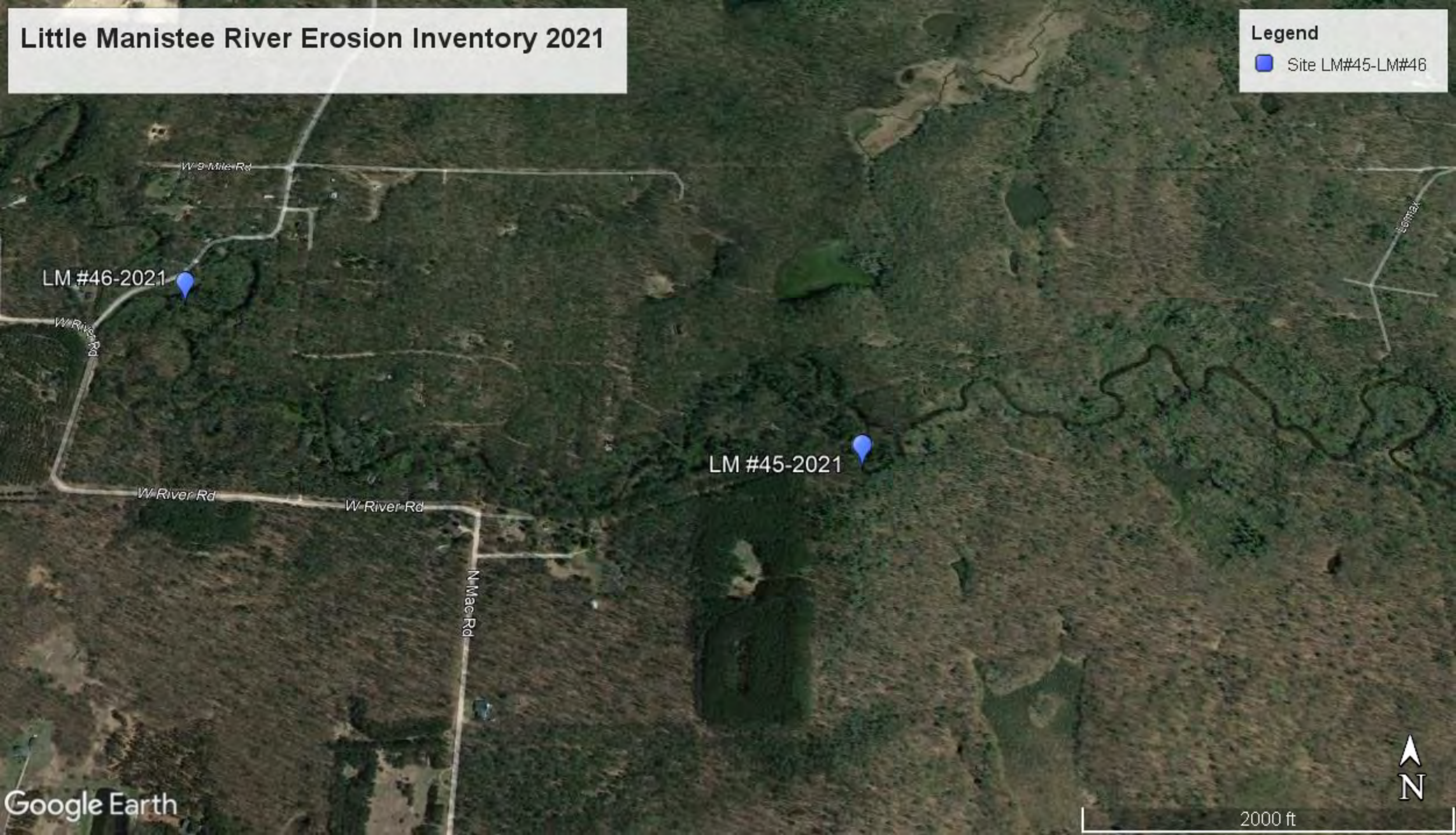

Little Manistee River Erosion Inventory 2021
Legend
Site LM#13
LM #13-2021
W Rose Meadow Dr
W Airpark
N Merrillville Rd
W 4 Mile Rd
W 4 Mile Rd
W 4 Mile Rd
W Scotty Trail
3 Mile Rd
3 Mile Rd
N
2000 ft
Google Earth


Little Manistee River Erosion Inventory 2021
Legend
Site LM#14-LM#23
LM #23-2021
6 Mile Road
LM #22-2021
LM #21-2021
LM #20-2021
LM #19-2021
LM #18-2021
LM #17-2021
LM #16-2021
LM #14/15-2021
Old Grade Campground
37
N
Google Earth
3000 ft


Little Manistee River Erosion Inventory 2021
Legend
Site LM#23-LM#31
LM #31-2021
LM #30-2021
LM #29-2021
LM #28-2021
LM #27-2021
LM #26-2021
LM #25-2021
LM #24-2021
LM #23-2021
N Irons Rd
N Timber Dr
6 Mile Rd
N
2000 ft
Google Earth


Little Manistee River Erosion Inventory 2021
Legend
Site LM#32-LM#40
LM #39-2021
LM #40-2021
LM #37-2021
LM #38-2021
LM #36-2021
LM #35-2021
Indian Club
LM #34-2021
LM #33-2021
LM #32-2021
N Brooks Rd
N Brooks Rd
W Tower View Rd
W Tower View Rd
Creston Drive
N Irons Rd
N Irons Rd
7 1/2 Mile Rd
N
2000 ft
Google Earth


Little Manistee River Erosion Inventory 2021
Legend
Site LM#37-LM#44
LM #44-2021
LM #43-2021
Wayward Ct
N Johnson Rd
Little Manistee River
W Tower View Rd
Homestead Rd
N Johnson Rd
W Tower View Rd
W 8 Mile Rd
W 8 Mile Rd
LM #42-2021
LM #41-2021
LM #40-2021
LM #39-2021
LM #37-2021
LM #38-2021
N Irons Rd
N
2000 ft
Google Earth


Little Manistee River Erosion Inventory 2021
Legend
Site LM#45-LM#46
W 9 Mile Rd
LM #46-2021
W River Rd
LM #45-2021
W River Rd
W River Rd
N Mac Rd
Lomax
Google Earth
N
2000 ft


Little Manistee River Erosion Inventory 2021
Legend
Site LM#47-LM#50
LM #50-2021
LM #49-2021
LM #48-2021
LM #47-2021
Riverside Dr
Riverside Dr
W 11 Mile Rd
W 11 Mile Rd
E Koenig Rd
N River Rd
N Steelhead Dr
W River Rd
11 Mile Rd
Google Earth
2000 ft
N


Little Manistee River Erosion Inventory 2021
Legend
Site LM#51-LM#57
LM #56-2021
LM #57-2021
LM #55-2021
LM #54-2021
LM #52-2021
LM #53-2021
LM #51-2021
E Pomeray Springs Rd
Riverside Dr
Fir 8861
Riverside Dr
Riverside Dr
River Dr Ranch
N
2000 ft
Google Earth


Little Manistee River Erosion Inventory 2021
Legend
Site LM#58-LM#65
LM #65-2021
LM #64-2021
LM #63-2021
LM #62-2021
LM #61-2021
LM #60-2021
LM #59-2021
LM #58-2021
9 Mile Bridge Rd
S Skorelas Rd
Pomeroy Springs Rd
Tank Creek
Indian Trails Dr
RiverView Dr
Pine Dr
White Pine Rd
S County Line Rd
Riverside Dr
N Campbell Rd
Chaloon Dr
Campbell Rd
Frd 5040
Google Earth
2000 ft
N


Little Manistee River Erosion Inventory 2021
Legend
Site LM#65-LM#78
9 Mile Bridge Rd
9 Mile Bridge Rd
9 Mile Bridge Rd
LM #65-2021
LM #74-2021
LM #75-2021
LM #73-2021
LM #70-2021
LM #71-2021
LM #69-2021
LM #68-2021
LM #77-2021
LM #76-2021
LM #78-2021
LM #72-2021
LM #67-2021
LM #66-2021
County Line Rd
S County Line Rd
S County Line Rd
S County Line Rd
5038
N
1000 ft
Google Earth


Little Manistee River Erosion Inventory 2021
Legend
Site LM#76-LM#86
LM #86-2021
LM #84-2021
LM #85-2021
LM #81-2021
LM #82-2021
LM #83-2021
LM #80-2021
LM #79-2021
LM #76-2021
LM #77-2021
LM #78-2021
Red Arrow Rd
9 Mile Bridge
County Line Rd
County Line Rd
N
1000 ft
Google Earth


Little Manistee River Erosion Inventory 2021
Legend
Site LM#77-LM#86
LM #86-2021
LM #84-2021
LM #85-2021
LM #82-2021
LM #83-2021
LM #81-2021
LM #80-2021
LM #77-2021
LM #78-2021
LM #79-2021
S County Line Rd
S County Line Rd
Google Earth
N
1000 ft


Little Manistee River Erosion Inventory 2021
Legend
Site LM#86-LM#91
6 Mile Bridge Rd
6 Mile Bridge Rd
North Little Manistee River Drive
6 Mile Bridge Rd
North Little Manistee River Drive
North Little Manistee River Drive
6 Mile Bridge Rd
LM #91-2021
LM #89-2021
LM #88-2021
LM #87-2021
LM #90-2021
LM #86-2021
N
2000 ft
Google Earth


Little Manistee River Erosion Inventory 2021
Legend
Site LM#92-LM#95
Little River Road
LM #95-2021
LM #94-2021
LM #93-2021
LM #92-2021
Old Stronach Road
MDNR Little Manistee Weir
N
Google Earth
4000 ft

Appendix B

Land Ownership

2021 Little Manistee Erosion Survey Addendum: Property Ownership

Minor Sites

ID	Latitude	Longitude	County	Ownership
LM#2-2021	44.03405	-85.72340	Lake	MDNR
LM#3-2021	44.03411	-85.72511	Lake	MDNR
LM#4-2021	44.03434	-85.72540	Lake	MDNR
LM#11-2021	44.03504	-85.73323	Lake	MDNR
LM#12-2021	44.03522	-85.73569	Lake	MDNR
LM#14-2021	44.06048	-85.85301	Lake	USFS
LM#15-2021	44.06042	-85.85333	Lake	USFS
LM#18-2021	44.06273	-85.87586	Lake	Nyla Rampa
LM#20-2021	44.07051	-85.88240	Lake	Indian Club
LM#21-2021	44.07073	-85.88660	Lake	Indian Club
LM#22-2021	44.07310	-85.88529	Lake	Indian Club
LM#23-2021	44.07567	-85.88647	Lake	Indian Club
LM#27-2021	44.08242	-85.89562	Lake	Indian Club
LM#28-2021	44.08271	-85.89648	Lake	Indian Club
LM#29-2021	44.08471	-85.89833	Lake	Indian Club
LM#30-2021	44.08448	-85.89880	Lake	Indian Club
LM#37-2021	44.10181	-85.91402	Lake	USFS
LM#43-2021	44.11154	-85.93953	Lake	Edward J. Nickels
LM#46-2021	44.11575	-85.97102	Lake	John H. Miller
LM#47-2021	44.14169	-86.01369	Lake	Janette Klaiss or John G. Mayer
LM#50-2021	44.14987	-86.04291	Lake	Jeffrey W. Laprad
LM#53-2021	44.15427	-86.06400	Lake	USFS
LM#54-2021	44.15545	-86.06768	Lake	USFS
LM#61-2021	44.16809	-86.09155	Lake	Anne M. Eardley Trust
LM#62-2021	44.17007	-86.10600	Manistee	USFS
LM#66-2021	44.16893	-86.11646	Manistee	Philip Lemmer
LM#67-2021	44.17026	-86.11784	Manistee	Susan M. Latham
LM#69-2021	44.17217	-86.11787	Manistee	Susan M. Latham
LM#76-2021	44.17204	-86.12429	Manistee	USFS
LM#85-2021	44.17503	-86.13828	Manistee	Steve L. and Marianne Moore
LM#88-2021	44.17735	-86.14850	Manistee	Steve Brickman
LM#92-2021	44.20363	-86.20378	Manistee	Jay Flaherty
LM#93-2021	44.20692	-86.22277	Manistee	USFS
LM#94-2021	44.20821	-86.23972	Manistee	Little Manistee River, LLC or USFS

Moderate Sites

ID	Latitude	Longitude	County	Ownership
LM#1-2021	44.03456	-85.72323	Lake	MDNR
LM#5-2021	44.03498	-85.72604	Lake	MDNR
LM#6-2021	44.03561	-85.72720	Lake	MDNR
LM#7-2021	44.03569	-85.72728	Lake	MDNR
LM#8-2021	44.03461	-85.73061	Lake	MDNR
LM#10-2021	44.03526	-85.73270	Lake	MDNR
LM#13-2021	44.04666	-85.82535	Lake	MDNR
LM#24-2021	44.07888	-85.88983	Lake	Indian Club
LM#31-2021	44.08775	-85.90228	Lake	Indian Club
LM#32-2021	44.09069	-85.90736	Lake	Indian Club
LM#40-2021	44.10282	-85.91203	Lake	USFS
LM#41-2021	44.10302	-85.91206	Lake	USFS
LM#44-2021	44.11220	-85.93949	Lake	Daniel J. Kamstra
LM#52-2021	44.15506	-86.05917	Lake	USFS
LM#58-2021	44.16262	-86.08240	Lake	USFS
LM#63-2021	44.17054	-86.10658	Manistee	USFS
LM#68-2021	44.17180	-86.11626	Manistee	Daniel J. and Janelle V. Antes
LM#80-2021	44.17383	-86.13348	Manistee	Corrine J. Lloyd
LM#81-2021	44.17423	-86.13521	Manistee	Steve L. and Marianne Moore
LM#82-2021	44.17426	-86.13592	Manistee	Griffith Holdings, LLC
LM#84-2021	44.17476	-86.13882	Manistee	USFS
LM#86-2021	44.17566	-86.14111	Manistee	USFS
LM#95-2021	44.20850	-86.24171	Manistee	Scott and June A. Phillips

Severe Sites

ID	Latitude	Longitude	County	Ownership
LM#9-2021	44.03499	-85.73139	Lake	MDNR
LM#16-2021	44.06221	-85.85563	Lake	USFS
LM#17-2021	44.06124	-85.86974	Lake	Robert P. Umlor or Scott Van Singel
LM#19-2021	44.06620	-85.88358	Lake	MDNR or Lake County Road Commission
LM#25-2021	44.08048	-85.89095	Lake	Indian Club
LM#26-2021	44.08197	-85.89217	Lake	Indian Club
LM#33-2021	44.09183	-85.90710	Lake	Indian Club
LM#34-2021	44.09406	-85.91064	Lake	Indian Club
LM#35-2021	44.09680	-85.91067	Lake	Indian Club
LM#36-2021	44.09985	-85.91238	Lake	Indian Club
LM#38-2021	44.10224	-85.91378	Lake	USFS
LM#39-2021	44.10224	-85.91379	Lake	USFS
LM#42-2021	44.10361	-85.91603	Lake	USFS
LM#45-2021	44.11246	-85.95420	Lake	USFS
LM#48-2021	44.14634	-86.01687	Lake	Luann Judis
LM#49-2021	44.14890	-86.03338	Lake	Jeffrey Styers
LM#51-2021	44.15369	-86.04763	Lake	Robert E. Kendall
LM#55-2021	44.15604	-86.07442	Lake	John F. Quertermus
LM#56-2021	44.15796	-86.07480	Lake	USFS
LM#57-2021	44.15827	-86.07536	Lake	USFS
LM#59-2021	44.16609	-86.08598	Lake	James B. Flowers
LM#60-2021	44.16669	-86.08622	Lake	Lawrence M. Opalka
LM#64-2021	44.17327	-86.10602	Manistee	Al Bufka Real Estate Co., LLC
LM#65-2021	44.17337	-86.11163	Manistee	Howard D. Vaas et al.
LM#70-2021	44.17279	-86.11891	Manistee	USFS
LM#71-2021	44.17253	-86.11926	Manistee	USFS
LM#72-2021	44.17134	-86.11994	Manistee	USFS
LM#73-2021	44.17249	-86.12099	Manistee	USFS
LM#74-2021	44.17287	-86.12207	Manistee	USFS
LM#75-2021	44.17275	-86.12230	Manistee	USFS
LM#77-2021	44.17204	-86.12449	Manistee	USFS
LM#78-2021	44.17141	-86.12701	Manistee	USFS
LM#79-2021	44.17144	-86.13126	Manistee	USFS
LM#83-2021	44.17419	-86.13862	Manistee	USFS
LM#87-2021	44.17735	-86.14570	Manistee	USFS
LM#89-2021	44.17673	-86.15128	Manistee	USFS
LM#90-2021	44.17615	-86.15361	Manistee	Frank D. Moser
LM#91-2021	44.17911	-86.16132	Manistee	USFS