Wheeler Drain Assessment

Prepared For:

Hess Lake Improvement Board

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August 22, 2022

INTRODUCTION

At the request of the Hess Lake Improvement Board, Streamside Ecological Services, Inc. (SES) reviewed historical documents and other existing information, and conducted a site inspection, to assess the stability of the Wheeler Drain. The overall purpose of this effort was to provide a professional opinion regarding causes of instability and recommendations for future management.

BACKGROUND

The Wheeler Drain, a tributary to Hess Lake, is located in Grant and Ashland Townships in southern Newaygo County, MI (Figure 1). The drain has a very interesting history that is relevant to the present-day function of the drain. Originally, prior to 1916, the Wheeler Drain flowed easterly into what was called Rice Lake. The Rice Lake outlet was to the Rogue River (Part of the larger Grand River watershed), which flowed into Kent County. In 1916, the Wheeler Drain was re-routed to flow north into Hess Lake; the construction included crossing a natural watershed divide that separates the Grand and Muskegon River watersheds. This watershed divide is located in the area of E. 104th St and E. 108th St. At the time, the work was considered to be necessary to drain wetlands for agricultural and residential development. It is doubtful that much deliberation was given to the long-term impacts of such a project, which would have been a fairly common project during the turn of the century.

In 1949, excessive erosion of the drain was resulting in negative impacts to downstream property and resources. A Michigan Department of Conservation memo described the excessive erosion of sandy soils and downstream transport of light material. The soil was deposited at the outlet of the drain, in Hess Lake, where it formed a delta resulting in what was claimed to be damage to about 50 cottages. Since that time, the erosion of the Wheeler Drain has been the subject of debate and multiple engineering and improvement efforts.

Several attempts have been made over the years to stabilize the drain channel through in-channel work or hydrologic modification. Rock grade control structures (e.g. riffles, check dams) are visible throughout much of the drain and offline detention/wetland sediment traps have been constructed in at least four locations. While these efforts have undoubtedly resulted in improved stability and water quality, the on-going erosion issues are testament to the consequences of the original construction through a sandy watershed divide and the severity of instability.

FIELD INSPECTION

On June 13, 2022, SES conducted an on-site inspection of the Wheeler Drain. The inspection began at the origin of the drain, near the Sycamore Ave. crossing, and continued downstream to Hess Lake. From Sycamore Ave. to E. 108th St. the drain and surrounding landscape were observed from the vehicle and short walks from road crossings; the entire drain was walked from E. 108th St. down to Hess Lake. This was a decision that was made based upon the relative stability of the upper portion of the drain and the instability of the lower portion.

From Sycamore Ave. to E. 108th St., the Wheeler Drain is typical of most agricultural drains. It is relatively low slope, low energy, has vegetated banks and is quite stable. Surrounding lands are a mix of residential,

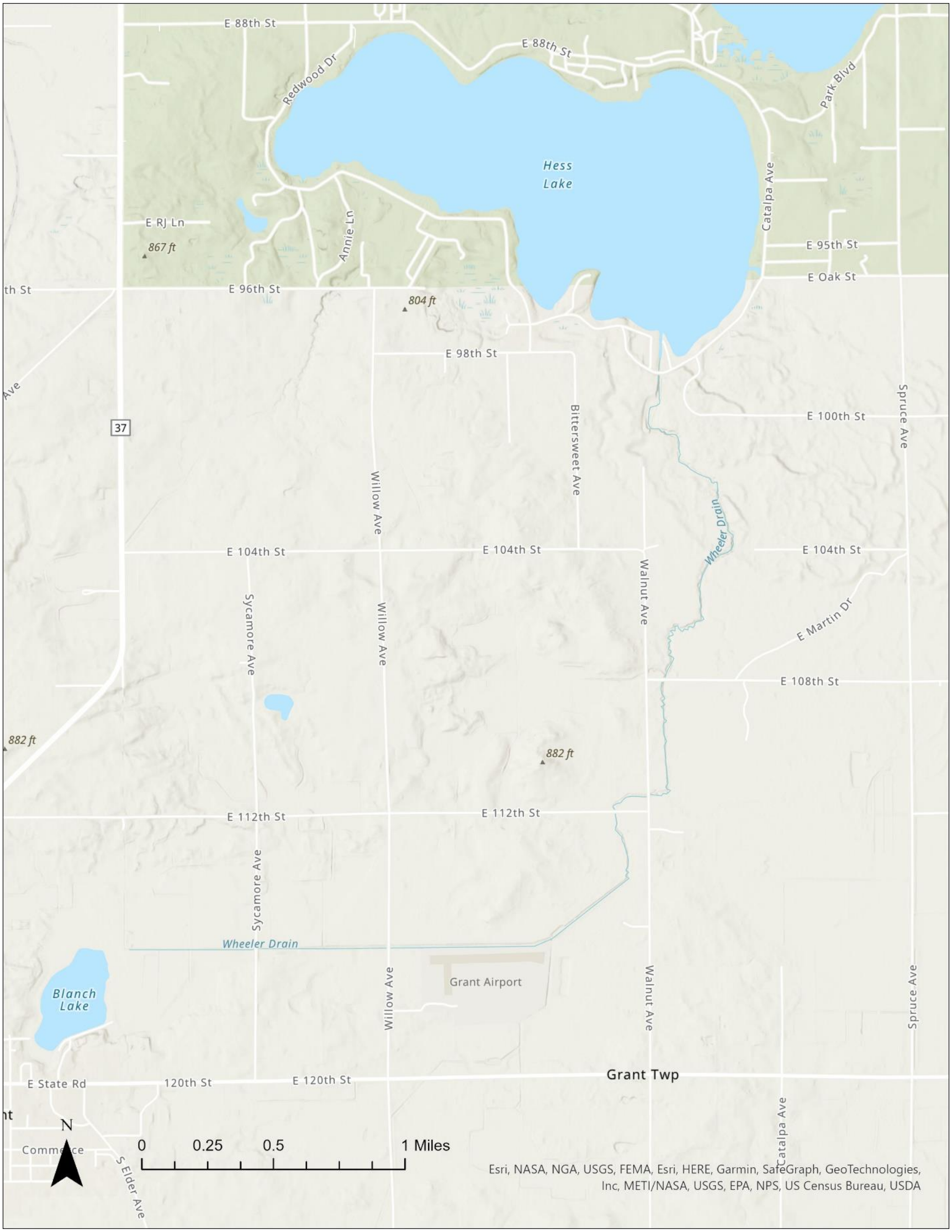

Figure 1. Location of the Wheeler Drain in Newaygo County, MI.

forest and, predominantly, agricultural. The croplands likely contribute a supply of sediment and nutrients to the drain, since little buffer exists along the field edges; the bottom of the drain is covered in fine sediments and dense aquatic vegetation grows along this entire reach. However, a surprising amount (though a minority) of the cropland was fallow and covered in dense herbaceous vegetation.

The culvert under E. 108^{th} St. is severely perched and the drain spills approximately 12 to 18 inches into a plunge pool. This crossing pretty well defines the upper limit of the major instability of the drain. Downstream of E. 108^{th} St. the Wheeler Drain flows through sandy soils and begins a relatively drastic descent to Hess Lake. This reach was completely constructed as part of the 1916 project; the landscape is not alluvial (was not formed by running water) and is not naturally capable of resisting the erosive forces of flowing water.

The first approximately 1,800 feet of drain downstream of E. 108^{th} St. flows through open land, with bare sand, herbaceous vegetation and sparse shrubs bordering the drain. Bank erosion is present and quite significant in concentrated areas, but not severe, overall. Several constructed rock riffles have been relatively successful at holding the streambed grade and preventing continued downcutting, but the entire reach is incised with little to no functional floodplain. The drain banks are +/-6 feet in height, consist primarily of sand and are vegetated with annual grasses and ferns. Potential for future erosion and sediment input is substantial.

About 1,800 feet downstream of E. 108^{th} St. the drain turns to the north and flows to Hess Lake. Here, the drain enters a wooded corridor, where it remains until it reaches the sediment basins upstream of Hess Lake. The wooded corridor has a heavy canopy of oaks, white pine and other mixed species. Banks are steep and bank heights increase significantly and exceed ten to fifteen feet in many locations. Sand is the dominant soil type and the drain is severely incised, with no floodplain access. The drain meanders from one eroded bank to the next and dozens of trees have been undermined and fallen into the channel, further exacerbating bank erosion. Efforts to install rock grade control have been mostly unsuccessful, as evidenced by remains of failed structures that collapsed or were laterally bypassed. This condition prevails all the way to the sediment basin. Potential for future erosion is extreme.

DISCUSSION

The function of streams (and drains) is to transport the water and sediment supplied by their watershed. A stable stream is able to complete this function without degrading or aggrading and maintains its pattern, profile and dimension over time. In the case of the Wheeler Drain, the historic excavation of a channel through a watershed divide was ill-advised, at best. The drain is able to transport a portion of the sediment load downstream, where it deposits in Hess Lake, but there is such a large volume of sand that the drain is in a continual state of adjustment as it tries to reach an equilibrium between sediment supply and the ability to transport it. The anticipated channel evolution or succession scenario (how the stream will adjust over time to find stability) that will naturally occur within the Wheeler Drain involves the channel meandering through the sandy soils and gradually transporting the sediments downstream. The drain will continue to meander, erode, headcut, deposit and transport until the valley is wide enough for a floodplain to form within the bottom and the slope is reduced to a degree that the bed material can resist the erosive forces of the water, or the bed cuts to a more resistant soil layer. Only once a floodplain is formed and vegetated will the channel become stable. This adjustment will, without a doubt, continue for decades or centuries.

A large part of stream restoration or stabilization is understanding the natural channel succession scenarios and the volume of water and sediment supplied by the watershed. Then, the channel geometry can be adjusted. There are three general approaches to stabilizing a channel: 1) Creating an appropriately-sized channel at the historic floodplain elevation; 2) Creating floodplain at the existing streambed elevation or; 3) Using erosion-resistant materials to "lock" a channel into place (e.g. rock riprap, steel piling, bio-engineering, etc.).

Frankly, it is the professional opinion of SES that none of these options are suitable for the Wheeler Drain. First, there is no historic floodplain since the drain was excavated at great depth through the watershed divide. In lieu of utilizing historic floodplain, the premise to elevate the drain bed to create floodplain in the surrounding landscape would be extremely expensive and prone to failure; the soils are not compatible and there is too much elevation change between E. 108th St. and Hess Lake (steep streams and sandy soils are not well-suited). Second, creating functional floodplain near the elevation of the existing channel would involve massive volumes of excavation (hundreds of thousands of cubic yards) and the soils are still not compatible for creating a stable channel and floodplain. Third, stabilizing in place using rock or other erosion-resistant materials is costly with a very high risk of failure. The drain has cut deep into the landscape resulting in all of the erosive flows being contained within the banks. The drain is too steep for the erosion-prone soils. Many of the past attempts at grade control have failed as a result of the site conditions.

Relocation of the Wheeler Drain to its original route and course, prior to the 1916 construction work, is theoretically a good alternative. This would eliminate the surety of continued erosion of the drain between E. 108th St. and Hess Lake, a source of sediment and nutrients to Hess Lake, and the expenses associated with engineering studies and attempted stabilization. It would also restore the historic flow route to the Rogue River. However, the planning, land acquisition, engineering, legal, permitting, etc. would be expensive and difficult, if not impossible.

All of this being said, the best alternative for drain management may be increased upstream detention of flood flows and continual and consistent maintenance of the drain within the problem reach and the sediment basins. Specifically, the more water that can be detained upstream of E. 108th St, the less erosive flows pass through the problem area. As well, trees and debris should be selectively removed from the channel. Care should be taken to leave trees in place that promote bank protection and increase roughness near the banks; ideally, the center of the channel should be open for flow but the banks armored with trees and debris. Large tree sections (10-inch diameter or more) can be used to protect banks, centralize flows and to encourage deposition by anchoring them into suitable locations and at appropriate angles. This work will not be a long-term solution, the overall risk of bank failure will remain high and the drain will continue to transport large volumes of sediment downstream, but this alternative may offer a low-cost alternative for possibly significant improvements. Finally, although not a solution to drain stabilization, regular, continued maintenance and clean-out of the sediment basin upstream of Hess Lake should be continued to reduce the volume of sediment and nutrient transport to Hess Lake.