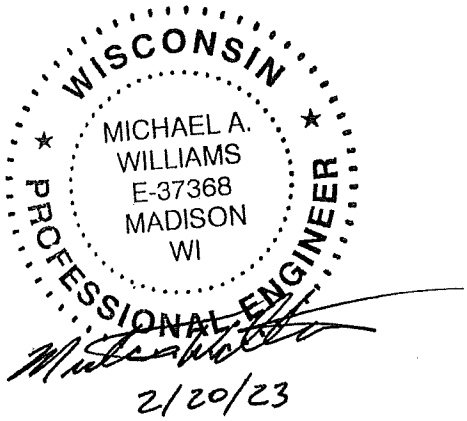
Report for
City of Manitowoc, Wisconsin

Stormwater Hydrology and Hydraulics Study



Prepared by:

STRAND ASSOCIATES, INC.®
910 West Wingra Drive
Madison, WI 53715
www.strand.com

February 2023

STRAND ASSOCIATES®
Excellence in Engineering
Since 1946

TABLE OF CONTENTS

This report summarizes the methodology and results of a study completed by Strand Associates, Inc.® (Strand) to develop a stormwater management plan for three watersheds in the City of Manitowoc (City). The three watersheds studied include L14–Lake Michigan (Red Arrow Discharge) Watershed, R22–Manitowoc (19th Street) Watershed, and LR1–Little Manitowoc River (Fenway Terrace) Watershed. The locations of each watershed area are shown on Exhibit 1. Each of these watersheds are predominantly fully developed urban watersheds having a highly interconnected storm sewer system that drains to the Little Manitowoc River, Manitowoc River, and Lake Michigan. Please note that all figures and tables referenced in this report are located in Appendix A and B, respectively.

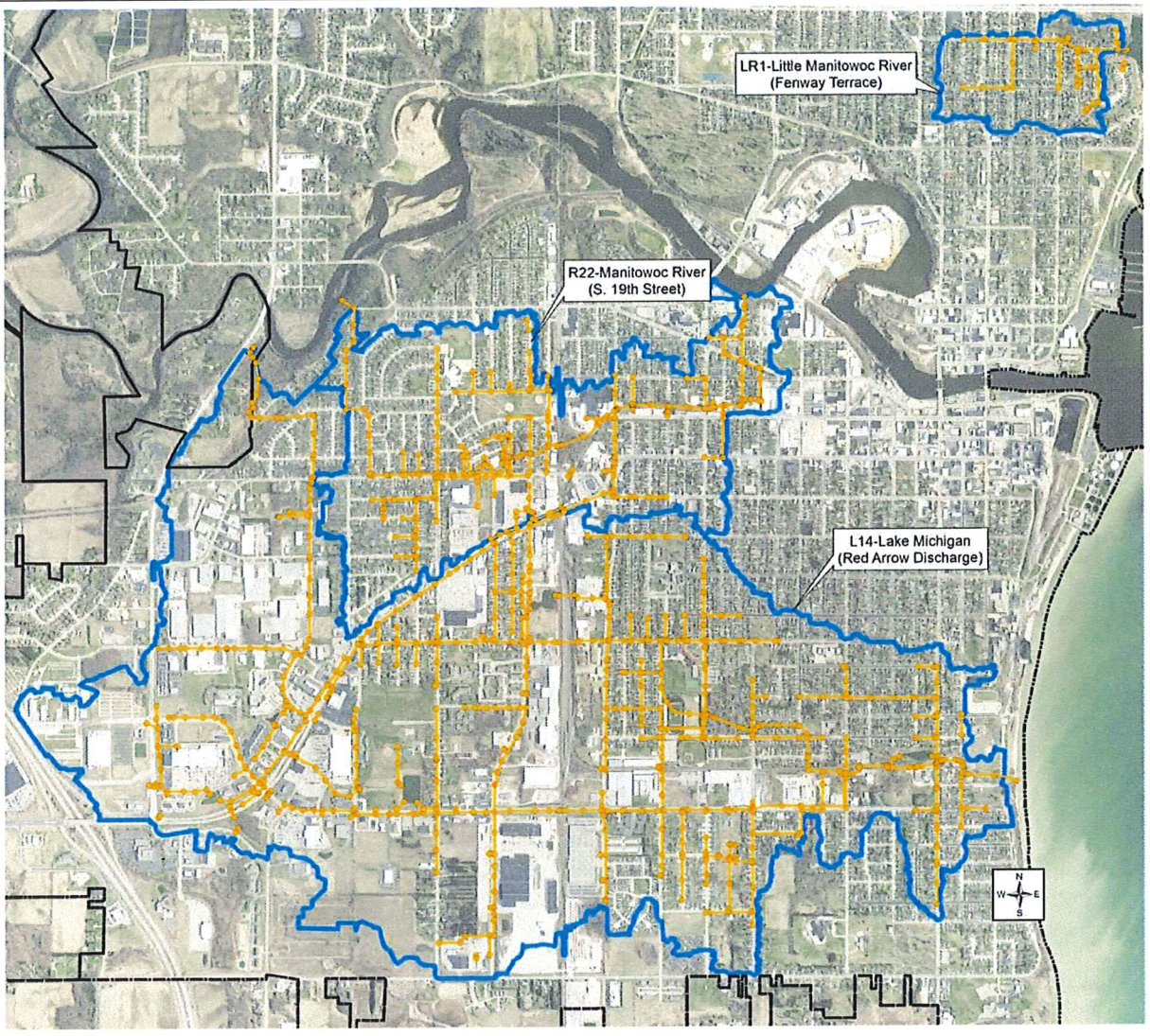


Exhibit 1 Watershed Locations

City staff have identified areas of repetitive flash flooding occurring at the following locations:

L14–Lake Michigan (Red Arrow Discharge)

1. 23rd Street from Division Street to Grand Avenue
2. 30th Street from Highway (Hwy) 42 to Division Street

R22–Manitowoc (South 19th Street) Watershed

1. Intersection of 29th Street and Mero Street
2. Intersection of Custer Street and 35th Street

LR1–Little Manitowoc River (Fenway Terrace) Watershed

1. Intersection of Pine Street and 5th Street

Figure 1 (Appendix C) shows the location of each of these flash flooding areas.

WATERSHED DESCRIPTION

The three watersheds studied are described in the following.

A. L14–Lake Michigan (Red Arrow Discharge)

As the largest of the three watershed studies (1,300 acres), the L14 watershed consists of a mixture of residential, industrial, commercial, and institutional land uses. Figure 1 shows the limits of this watershed as well as the storm sewer system and areas of flooding concern. The southwest area of the watershed appears to have some undeveloped land while the rest of the watershed is built out. While flooding occurs throughout the watershed in major storm events, there are two principal areas of flooding that were investigated as part of this project. The first area is located on South 30th Street between Calumet Avenue and Division Street.

The second area is located on 23rd Street between Division Street and Grand Avenue. It appears that this area floods because of an undersized downstream storm sewer system. The potential flooding in this area is estimated to create 6.5 acre-feet (ac-ft) of surface ponding. The incorporation of a stormwater detention basin (underground or traditional aboveground storage) to offset eliminated surface storage is preferred to minimize the potential of having to upsize the downstream storm sewer. A stormwater detention basin could be located just north of Rubick Field on school district lands or beneath the City-owned parking lot southeast of the Grand Avenue and South 23rd Street intersection, if an adequate storm sewer connection from the flooded area to the pond can be provided.

B. R22–Manitowoc (19th Street) Watershed

The R22 Manitowoc (19th Street) watershed encompasses 400 acres, consisting of a mixture of residential, commercial, and institutional land uses. The storm sewer system from this watershed outfalls to the Manitowoc River at the north end of 19th Street. Figure 1 shows the limits of this watershed as well

as the storm sewer system and areas of flooding concern. There are two specific areas of flooding in this watershed that City staff has identified. However, it is understood that other areas of flooding within the watershed also exist based on results of completed modeling. The first area of flooding concern is near the intersection of South 29th Street and Mero Street. It is Strand's understanding that the City is contemplating construction of a traditional or underground detention basin at the east end of Halvorsen Park (between Dale Street and Mero Street).

The second area of flooding concern is located at the intersection of 35th Street and Custer Street. It is Strand's understanding that a wet detention basin (Pond 134) on private property was proposed in the City's *2007 Stormwater Quality Plan*, at a location east of the 35th Street and Custer Street intersection. Assuming that there is not a constriction in the storm sewer system leading to the proposed pond, it appears that this pond would help to improve the flooding situation at the 35th Street and Custer Street intersection. Implementation of detention improvements at either flooded area would have a positive effect at the other flooding location, and vice versa, since the storm sewers downstream of these two locations are interconnected.

C. LR01–Little Manitowoc River (Fenway Terrace) Watershed

The LR01 Little Manitowoc (Fenway Terrace) watershed is 60 acres in size with a residential land use. This watershed outfalls to the Little Manitowoc River approximately 900 feet upstream of the river's mouth with Lake Michigan. Figure 1 shows the limits of this watershed as well as the storm sewer system and areas of flooding concern. Flows that exceed the capacity of the storm sewer system drain overland down Pine Street to the intersection of Pine Street and 5th Street, where it begins to flood. Excess stormwater then flows between homes located at 951 and 955 5th Street to a backyard low point to the north and through an easement to the east. The large volume of excess overland flow to this point appears to be caused by an undersized storm sewer system, lack of upstream inlets, and inlet clogging. The City has investigated options to route flow to Waldo Boulevard at both the Pine Street and Lincoln Boulevard and Pine Street and 6th Street intersections. However, there is concern that the Waldo Boulevard storm sewer does not have sufficient capacity to handle this additional flow. Through discussions with the City, it is Strand's understanding that a new storm sewer system along Waldo Boulevard was designed for a 10-year design storm under surcharged conditions that required bolt down castings. The diversion of a portion of the drainage area along Pine Street to Waldo Boulevard, while assisting in diverting water from the problem area, may exacerbate flooding along Waldo Boulevard.

HYDROLOGIC AND HYDRAULIC MODELING

Strand has developed an XPSWMM 2D computer model (Model) of the existing stormwater drainage systems for each studied watershed. Hydrologic input parameters of the contributing watersheds include subbasin drainage areas, runoff curve numbers (RCNs), times of concentration (Tc), and rainfall depths. RCNs were calculated by analyzing available soils (Figure 2 in Appendix C) and impervious area data (Figure 3 in Appendix C) in the studied watersheds. This information is summarized in Table 1. Hydraulic model input parameters including rim and invert elevations, pipe size, manning's "n" coefficients, length of pipe, and slope were incorporated into the model based on City provided geographical information system (GIS) information. Inlet capacity calculations were not incorporated into this modeling effort and the flooding shown on flood depth maps is based on pipe capacity only. This information is shown in

Table 2 in Appendix A. Figure 4 in Appendix C shows the modeled storm sewer along with the names of each structure.

Rainfall depths used for the hydrologic analysis were taken from National Oceanic and Atmospheric Administration Atlas 14 Precipitation Frequency Data Server. Appropriate Huff rainfall time distributions taken from *Bulletin 71, Rainfall Frequency Atlas of the Midwest*, Floyd A. Huff and James R. Angel, 1992, were applied for the analysis. Table 3 in Appendix A shows the 10 to 100-year frequency storm event rainfall depths from 1- to 24-hour duration storms.

A critical duration analysis was performed to estimate the storm duration generating the highest peak discharges and highest flood elevations at critical locations within the three watersheds. Based on the results of the critical duration analysis, the storm duration producing the highest flood elevations and peak flows under existing conditions was the 1-hour duration storm event for the R-22 Manitowoc River (19th Street) and L14-Lake Michigan (Red Arrow Discharge) watersheds. The LR-1 Little Manitowoc River (Fenway Terrace) watershed critical duration is the one-half-hour event. This critical duration analysis was completed as each of the alternatives were analyzed.

The three watersheds drain independently to the Little Manitowoc River, Manitowoc River, and Lake Michigan. For the R-22 Manitowoc River (19th Street) and LR01 Little Manitowoc River (Fenway Terrace) watershed, Strand proposes to use the calculated 10-year high-water elevations published in the Federal Emergency Management Agency (FEMA) effective flood information studies for the 100-year design storm runs.

Note that while the outfall for LR01 Little Manitowoc River (Fenway Terrace) watershed is near Lake Michigan, the regulatory riverine high-water elevations do not take into account fluctuating lake elevations. The L14-Lake Michigan (Red Arrow Discharge) watershed outfall is more dependent on the fluctuations of the normal water surface elevation of the lake. Strand will use the annual mean elevation calculated by the United States Army Corps of Engineers (USACE) along with the Lake Michigan water surface elevations from the Manitowoc County Flood Insurance Study. The FEMA and USACE information and elevations were incorporated as the tailwater condition in the XPSWMM model. The tailwater assumptions for each watershed outfall are shown in Table 4 in Appendix A.

MODEL CALIBRATION–JULY 14 TO 15, 2021, STORM EVENT

In an effort to validate the results of the of the existing conditions XPSWMM 2D model, the July 14 to 15, 2021, rainfall event was analyzed. One daily rain gage was located just east of the study watersheds near the wastewater treatment plant (WWTP). The rainfall recorded at this gage was 5.64 inches. Because this rainfall gage data was collected from a single location that was not geographically in proximity to the study watershed, Strand obtained NEXRAD special rainfall data from the National Climatic Data Center for the July 14 to 15, 2021, storm event.

A review of the NEXRAD figure showed a change of rainfall depths across the City. To account for this difference a rainfall hyetograph was collected at five locations (north, south, west, east, and central). In an effort to not over or underestimate the rainfall across the City, an average of these five hyetographs were used to calibrate the model. The five locations and their resulting hyetographs are shown on Figure 5. Review of the average rainfall data indicates approximately 5.15 inches and fell over a 12-hour

period, which equates to a slightly greater than 100-year return interval storm event. Based on the precalibrated modeling results, the estimated flood depths were generally higher than observed flood depths. The flood depth mapping from July 14 to 15, 2021, storm event are shown in Figure 6.

The following changes were made to calibrate the existing condition model:

1. The initial modeling effort used one composite RCN to represent the impervious and pervious area within each watershed. This was changed to three separate runoff inputs that include directly connected impervious area, unconnected impervious area, and pervious area. The unconnected impervious area is routed through the pervious area to take advantage of any remaining infiltration capacity.

2. Structure losses within the systems were modified to match a modeling approach created by the City of Madison, Wisconsin.

3. The pervious area runoff curve numbers were lowered by 15. This reduction generates less runoff to the system lowering flood depths. The impervious areas were not modified as part of the calibration process as the runoff from these surfaces will not change depending on underlying soils.

With the average rainfall hyetograph and the changes mentioned above, the model appears to be calibrated at several locations. The July 14 to 15, 2021, flood depth map shows the flood depths throughout the City and at each of the calibration points. Each calibration location is discussed in the following:

1. 23rd Street–Based on information provided by adjacent property owners and survey information provided by the City, the high-water elevation from the July 14 to 15, 2021, event was approximately 633.7 feet. The modeling results in this area show a high-water elevation of 633.78 feet.

2. 31st Street–Based on information provided by the owner at 1305 South 31st Street, there was approximately 1 foot of water surrounding their home. Strand's modeling results show this approximate 1 foot of flooding in the front and back yards of the home.

3. 35th Street and Custer Street–Flood depths and limits of flooding match City staff observations of the flooding.

4. 904 South 29th Street–Based on information provided by adjacent property owners, the stormwater was up to the home's foundation. The modeling results show the stormwater just touching the front of the house.

5. Sabbatical Brewery–Pictures provided by the City show barrels used for decoration by the brewery were pushed east to the tree line between the brewery and railroad. This would suggest that the stormwater was deep enough to float the barrels and the flow across the property was strong enough to push the barrels to the east. The modeling results show a flood depth at the tree line to be between 6 to 11 inches.

6. Pine Street and 5th Street Intersection - Flood depths and limits of flooding match City Staff observations of the flooding.

EXISTING CONDITIONS MODEL ANALYSIS

Using the calibrated existing condition model, Strand analyzed a 10-, 25-, 50-, and 100-year design storm event (1-hour duration storm for R22 and L14 and 0.5-hour duration storm for LR1). Estimated existing condition flooding depths for the 10-, 25-, 50-, and 100-year 1-hour design storms are depicted in Figures 7 to 10. Tables 5 and 6 in Appendix A show the peak runoff amounts from each watershed as well as the pipe flows under existing condition. The results of this modeling show that each of the flood problem areas begin to flood in the 10-year event. The flood problem areas in all three watersheds are attributed to lack of downstream conveyance capacity as well as lack of an adequate overland flow route.

DESIGN CRITERIA

Based on discussions with City staff, design criteria for proposed drainage improvements in the study area were established as follows:

- Use a maximum flood depth during the 100-year design storm within the studied areas of 6 inches to contain flooding within the right-of-way and to allow for emergency vehicles to pass through.
- In areas with an overland flow route, the storm sewer system shall be designed with a conveyance capacity of a 25-year design storm.
- In areas with a lack of an overland flow route, the storm sewer system shall be designed with a conveyance capacity of a 100-year design storm.
- In an effort to mitigate flooding, do not create other flooding problems within the watershed.

ALTERNATIVE ANALYSIS

Ten alternatives were analyzed as part of this alternative analysis. Each alternative is described in the following. Their respective figures are show in Appendix C and results tables are shown in Appendix A. Please note that potential sanitary and watermain conflicts and their resolution are incorporated into each alternative's opinion of probable construction cost (OPCC). Each alternative is composed of one or more new components used to mitigate flooding. Table 7 provides the flood depth in feet for each alternative at various locations in the watersheds.

A. L-14 (Lake Michigan Watershed–Red Arrow Discharge)

Potential solutions for L-14 have a goal of providing detention to reduce peak flows so that downstream mainline storm sewer will have capacity to convey the 100-year design storm and reduce flooding. During the existing condition analysis, it was noticed that a section of mainline storm sewer between 21st Street and 18th Street appeared to be undersized. Alternative 3 incorporates mainline storm sewer upgrades to address this issue. Alternative 4 was added to the study to provide a surface detention basin in lieu of the underground detention basin to provide flood mitigation while reducing the construction cost. The flood depth mapping for the 10-, 25-, 50-, and 100-year 1-hour design storms for each alternative listed in the following are depicted on Figures 21 to 36 in Appendix C.

1. Alternative 1

Alternative 1 incorporates a 17.9-ac-ft underground detention basin in the grass field between Rubick Field and Washington Jr. High School. It is assumed the underground detention basin would consist of modular precast concrete units (Storm Trap or equivalent). The Storm Trap preliminary layout is provided in Appendix D. The inside bottom of the structure is at elevation 624.5 feet and the inside top of the structure is elevation 630.0 feet. The inside top of the structure is at the approximate elevation of the curb and gutter at the low point on 23rd Street. The underground detention basin is connected to the storm sewer system along 23rd Street and outfalls to an existing storm sewer located on 21st Street. The storm sewer upgrades and underground layout are shown in Figure 11. After the installation of the underground structure, the ground surface can be graded similarly to how it is currently. Additional inlet capacity will be required at the low point on South 23rd Street. The watershed-wide critical duration analysis is the 1-hour event (same duration as existing conditions). During the 1-hour event the flooding at 30th Street is mitigated. However, the critical duration for the 30th Street detention basin is the 18-hour duration event with a high-water elevation of 631.49 feet during the 100-year 18-hour storm event creating approximately 1.49 feet of flooding in 23rd Street. The OPCC for this alternative is $13,336,300. The detailed OPCC is shown in Appendix B.

2. Alternative 2

Starting with the proposed flood mitigation upgrades considered in Alternative 1, Alternative 2 incorporates the expansion of the 30th Street detention basin as shown in Figure 12. The expansion of this detention basin provides an additional 8.8 ac-ft of storage volume for a total storage volume of 28.0 ac-ft. This alternative includes storm sewer upgrades at the low points on 30th Street, and through the easement connecting 31st Street and 32nd Street. Additional inlet capacity will be required at the low points on 30th, 31st, and 32nd Streets. The watershed-wide critical duration analysis is the 1-hour event (same duration as existing conditions). During the 1-hour event the flooding at 30th Street is mitigated. However, the critical duration for the 30th Street detention basin is the 18-hour duration event, with a high-water elevation of 638.41 feet during the 100-year 18-hour storm event creating approximately 0.36 feet of flooding in the street. The implementation of the added storage volume at 30th Street reduced the high-water elevation at 23rd Street to 631.32 feet reducing the flood depth by approximately 0.17 feet from Alternative 1. The OPCC for this alternative is $15,124,600. The detailed OPCC is shown in Appendix B.

3. Alternative 3

With Alternative 2 in place, Alternative 3 incorporates mainline storm sewer upgrades from South 21st Street to South 16th Street. The new storm sewer will run south on 21st Street to Grand Avenue and along Grand Avenue to a manhole just east of 16th Street as shown in Figure 13. The new storm sewer sizes range from 48-inch to 72-inch diameter. The existing storm sewer (from 21st Street to 16th Street) will be bulkheaded at 21st Street and only remain in service for local storm sewer systems' flow tying into it. The new large-diameter storm sewer on Grand Avenue will be at nearly the same elevation as the existing sanitary sewer creating potential conflicts with sanitary laterals on the south side of the road. A parallel sanitary sewer line will be installed from 21st Street to 20th Street and the sanitary sewer from 20th Street to a manhole

east of 18th Street will be lowered. There are also several locations within the project area where there is a potential for a water main conflict with the new storm sewer. These other utility updates are shown on Figure 13 and are included in the OPCC for Alternative 3. The watershed-wide critical duration analysis is the 1-hour event (same duration as existing conditions). During the 1-hour event the flooding at 23rd Street and 30th Street is mitigated; however, the critical duration for the 23rd Street and the 30th Street detention basin is the18-hour duration event. The 100-year 18-hour high-water elevation at 23rd Street is 629.59 feet which is lower than the roadway elevation. The 100-year high-water elevation at 30th Street is 638.19 feet which is 0.16 feet lower than Alternative 2 creating approximately 0.14 feet of flooding in the street. The OPCC for this alternative is $19,463,100. The detailed OPCC is shown in Appendix B.

4. Alternative 4

Starting with Alternative 3, Alternative 4 removes the Rubick Field underground detention basin and incorporates a traditional dry detention basin located in the open field north of Rubick Field as shown in Figure 14. The layout of the dry detention basin allows for a high school-sized football field to be placed in it. The basin has storm sewer on the west, south, and east sides to maximize available storage volume. This storm sewer is set at an elevation that is lower than the bottom of the proposed basin to allow smaller, more frequent storm events to drain around the dry basin. Larger and less frequent storm events will back up into the basin and drain down as the hydraulic grade line in the mainline system draws down. The bottom of the basin was laid out to have a 1.5 percent slope across the football field and a minimum 0.5 percent slope along the eastern and western edges for drainage back into the storm sewer. An accessible ramp could also be incorporated along the north side of the detention basin to allow for wheel chair access. The cost for this ramp was not included in this alternative. This alternative does not include the use of underdrain; however, it could be provided during final design of the detention basin. To allow for the additional storm sewer depth around the dry detention basin the downstream storm sewer system from 21st Street to just east of 18th Street was lowered from what is proposed in Alternative 3. This drop in pipe elevation created additional conflicts with the sanitary sewer and water main within the corridor as shown in Figure 14 in Appendix C. These utility updates are included in this alternatives OPCC. The watershed-wide critical duration analysis is the 1-hour event (same duration as existing conditions). During the 1-hour event, the flooding at 23rd Street and 30th Street is mitigated; however, the critical duration for the 23rd Street and the 30th Street detention basin is the 2-hour and 18-hour duration events, respectively. The 100-year 2-hour high-water elevation at 23rd Street is 629.54 feet which is lower than the roadway elevation. The 100-year 18-hour high-water elevation at 30th Street is 638.17 feet which is 0.15 feet lower than Alternative 2 creating approximately 0.13 feet of flooding in the street. The OPCC for this alternative is $9,975,400. The detailed OPCC is shown in Appendix B.

B. R-22 (Manitowoc River Watershed–South 19th Street Discharge)

Potential solutions for R-22 have a goal of providing detention volume to reduce peak flows so that downstream mainline storm sewer will have capacity to convey the 100-year design storm. The flood depth mapping for the 10-, 25-, 50-, and 100-year 1-hour design storms for each alternative listed in the following are depicted on Figures 37 to 48 in Appendix C.

1. Alternative 1

Alternative 1 incorporates a new wet detention basin located on the eastern side of Halvorson Park near the intersections of Mero Street and 29th Street. This wet detention basin will help with both regulatory water quality requirements as well as flood mitigation within the watershed. This detention basin will be served by local storm sewer systems as well as additional inlets near the low point of South 29th Street just north of Mero Street. The current detention basin layout shown on Figure 15 has a storage volume of 6.0 ac-ft. The watershed-wide critical duration analysis is the 1-hour event (same duration as existing conditions). During the 1-hour event, the flooding on 29th Street is mitigated; however, the critical duration for the new detention basin is the 18-hour duration event with a high-water elevation of 641.74 feet during the 100-year 18-hour storm event creating approximately 0.11 feet of flooding in 28th Street. The OPCC for this alternative is $1,415,700. The detailed OPCC is shown in Appendix B.

2. Alternative 2

Starting with the proposed Halvorson Park detention basin in Alternative 1, Alternative 2 incorporates a new wet detention basin located southeast of the intersection of Custer Street and Circle Drive. This new detention basin provides 10.8 ac-ft of storage volume. This wet detention basin will help with both regulatory water quality requirements as well as flood mitigation within the watershed. This alternative includes additional storm sewer capacity from the intersection of Custer Street and 35th Street. This storm sewer capacity can be achieved by replacing existing piping with a larger pipe or keeping the existing pipe in service and constructing a parallel pipe. With this detention basin and new storm sewer in place, the flooding in this area is effectively moved from the street to the basin mitigating flooding in the 100-year design storm. The current layout for this detention basin is shown on Figure 16. The watershed wide critical duration analysis is the 1-hour event (same duration as existing conditions). During the 1-hour event the flooding on Custer Street is mitigated; however, the critical duration for the new detention basin is the 12-hour duration event with a high-water elevation of 644.10 feet during the 100-year 12-hour storm event which also mitigates the flooding on Custer Street. The introduction of the Custer Street detention basin does not impact the Halvorson Park high-water elevation results as presented in Alternative 1. The OPCC for this alternative is $4,572,700. The detailed OPCC is shown in Appendix B.

3. Alternative 3

Starting with the proposed Halvorson Park detention basin in Alternative 1, Alternative 3 incorporates a new wet detention basin located between the two railroad tracks just north east of Custer Street and 29th Street. This new detention basin provides a storage volume of 11.1 ac-ft into the system. This wet detention basin will help with both regulatory water quality requirements as well as flood mitigation within the watershed. The detention basin layout is shown in Figure 17. This detention basin is downstream of the defined problem areas and was developed to lower the hydraulic grade line to allow the upstream storm sewer to drain more effectively. The watershed-wide critical duration analysis is the 1-hour event (same duration as existing conditions). The critical duration storm for the new detention basin is the 2-hour duration event with a high-water elevation of 633.35 feet during the 100-year, 2-hour storm event. Unfortunately,

the introduction of this detention basin into the modeling did not mitigate flooding in the watershed near the intersection of Custer Street and 35th Street or change the high-water elevation in the Halvorson Park detention basin as discussed in Alternative 1. The OPCC for this alternative is $3,615,400. The detailed OPCC is shown in Appendix B.

C. LR01 (Little Manitowoc River Watershed–Fenway Terrace Discharge)

Potential solutions for LR01 incorporate only conveyance options, given that locations for stormwater detention are not available within the watershed area. Alternatives for this location incorporate storm sewer upgrades as well as improved over land flow routes. Please note that all three options call for the replacement of the last two runs of storm sewer before the outfall to the Little Manitowoc River. While the size of these storm sewers will remain the same, the material changes from corrugated metal pipe to reinforced concrete pipe lowering the Manning's n value. The flood depth mapping for the 10-, 25-, 50-, and 100-year 0.5-hour design storms for each alternative listed in the following are depicted on Figures 49 to 60 in Appendix C.

1. Alternative 1

Alternative 1 upgrades the storm sewer from Pine Street to the outfall on Fenway Terrace to a 25-year design storm as shown in Figure 18. The specific pipe upgrades are shown in Figure 18. With these upgrades in place, the flooding for the 25-year design storm is mitigated; however, the 50-year and 100-year events continue to show ponding at the intersection of Pine Street and 5th Street. The OPCC for this alternative is $547,900. The detailed OPCC is shown in Appendix B.

2. Alternative 2

Alternative 2 starts with the storm sewer upgrades proposed in Alternative 1 and includes an improved overland flow route to direct surface flow from Pine Street to a point just south of the intersection of Fenway Terrace and River Court. The existing sidewalk connecting Pine Street and Fenway Terrace will be replaced with a 10-foot-wide path with curbing on each side. The grading on the north side of the new path shall be done to allow for 1 foot of flow through the path area. Fenway Street between Lawton Terrace and River Court will also be reconstructed. The south curb line will be constructed to only allow 6 inches of flooding in the low point at Lawton Terrace. A curb cut would be placed to allow water to flow to the south into the low-lying lands that drain to the river. The sidewalk along the south side of Fenway Terrace in this area will need to be removed or lowered to allow for drainage through the new overland flow route. If the City would like the sidewalk to remain in use without lowering it, a series of trench grates could be added at the location to allow flow under the sidewalk. These overland flow route updates are shown on Figure 19. The OPCC for this alternative is $722,700. The detailed OPCC is shown in Appendix B.

3. Alternative 3

Alternative 3 upgrades the storm sewer from Pine Street to the outfall on Fenway Terrace to a 100-year design storm. The specific pipe upgrades are shown in Figure 20. With these upgrades

in place, the flooding for the 100-year event is mitigated; however, there is a potential for clogged inlets or piping to continue to cause flooding at the intersection of Pine Street and 5th Street. The OPCC for this alternative is $860,200. The detailed OPCC is shown in Appendix B.

FUTURE CONDITION ANALYSIS

Incorporating a future condition analysis into the stormwater plan allows the City to understand how the recommended flood mitigation alternatives will function in a fully built out land development condition. In the three watersheds, 31 sites were identified and the hydrology for each site was determined based on land use mapping and the percent impervious area as established in the WinSLAMM standard land use files. The 31 future development sites incorporated as part of this effort are highlighted on Figure 61. Each undeveloped site within the community will be required to meet the City's stormwater ordinance for peak flow control. The additional stormwater runoff volume generated could cause downstream flooding to occur. A detention basin for each site was developed to mimic the peak flow reduction for the future site. These detention basins were then added to the recommended alternative modeling to understand the impacts of future development. Further discussion of the future condition analysis within each study watershed is provided in the following. Table 7 provides the flood depths in feet at various locations within the watersheds.

A. L14–Lake Michigan (Red Arrow Discharge)

The L14–Lake Michigan Watershed incorporates 28 open areas that have the potential to be developed in the future. Please note that some of these areas are identified as potential detention basin sites. While working through the future condition process it was not known which alternatives would be recommended. If an area is identified as a potential for future development along with a proposed detention basin the analysis was not modified and is considered to be a conservative analysis.

B. R22–Manitowoc (South 19th Street) Watershed

The R22–Manitowoc Watershed incorporates three open areas that have the potential to be developed in the future. Please note that some of these areas are identified as potential detention basin sites. While working through the future condition process, it was not known which alternatives would be recommended. If an area is identified as a potential for future development along with a proposed detention basin, the analysis was not modified and is considered to be a conservative analysis.

C. LR01–Little Manitowoc River (Fenway Terrace) Watershed

The LR1–Little Manitowoc River (Fenway Terrace) watershed is fully built out and, therefore, was not included in the future condition analysis.

As shown in Table 7, the future condition scenario creates a small rise within the recommended alternatives (L14 Alternative 4 and R22 Alternative 2 detention basins) of less than 2 inches in elevation. The flood resultant depth mapping is shown on Figures 62 to 65 in Appendix C. In this future condition analysis, the design goals for each flooding location continues to be met.

OPCC

The OPCCs in 2023 dollars for each alternative are summarized in Tables 8, 9, and 10 in Appendix A. Detailed OPCCs are available in Appendix B of this study. Please note that each OPCC includes addressing potential conflicts to the existing watermain and sanitary sewer system as well as surface restoration including sidewalk, roadways, and pervious area restoration. While inlet capacity calculations were not considered in this study, a coarse analysis was completed to generate a number of added inlets to be included in the OPCC. Inlet calculations for each alternative should be refined during the design of each recommended alternative. The OPCC's do not include potential land or easement acquisition costs if not currently owned by the City.

CONCLUSIONS AND RECOMMENDATIONS

A. L14–Lake Michigan (Red Arrow Discharge)

Alternatives 3 and 4 are the only two alternatives evaluated that meet the goal of mitigating flooding during the 100-year design storm. Alternative 3 incorporates the underground detention basin at Rubick Field which costs around $8,000,000 to $10,000,000 to construct. Alternative 4 incorporates a dry detention basin in lieu of an underground detention basin at Rubick Field which is significantly less costly. However, the field will be subject to potential flooding during rain events and may have water sitting in the basin for an extended period. With these considerations in mind, it is recommended to move forward with Alternative 4.

B. R22–Manitowoc (South 19th Street) Watershed

Alternative 1 mitigates the flooding observed by Sabbatical Brewing Company on 29th Street but does not reduce the flooding along Custer Street. Alternative 2 mitigates the flooding at both 29th Street and along Custer Street. Alternative 3 does not mitigate the flooding that is occurring along Custer Street. Therefore, it is recommended to move forward with Alternative 2.

C. LR1–Little Manitowoc River (Fenway Terrace) Watershed

The storm sewer Alternatives (1 and 3) are great options for reducing the potential for flooding on Pine Street and on Fenway Terrace. However, there is always the possibility of having a larger storm event than the storm sewer system design storm as well as the potential for clogged inlets or failed/clogged piping. If it is feasible to implement an overland flow route, it would mitigate the flooding if any of these potential scenarios occurred. It is recommended to move forward with Alternative 2 which incorporates the improved overland flow route.

FUNDING OPTIONS

Possible funding sources for implementation of flood mitigation measures are described herein.

A. Grants

Some of the more popular Wisconsin Department of Natural Resources (WDNR) grant programs include the Urban Nonpoint Source (UNPS) and Stormwater Grant, Healthy Lakes and Rivers Grant, Surface Water Restoration Grant, and Municipal Flood Control Grant. The WDNR UNPS Construction Grant and Municipal Flood Control Grant are likely the most appropriate for implementing a flood mitigation project. However, the UNPS construction grant will only cover portions of the pond design and construction that apply to water quality aspects of the project. Up to 50 percent of the design and construction of stormwater quality best management practices (BMP) could be covered up to a maximum of $150,000 for the UNPS Grant and $484,000 for the Municipal Flood Control Grant.

Another potential grant to consider is the FEMA Building Resilient Infrastructure and Communities (BRIC) grant which could cover up to 50 million dollars for design and construction of a project. This grant application will require a benefit cost analysis to be completed to show that project construction costs are justifiable. A smaller BRIC grant offered by the Wisconsin Emergency Management Team at WDNR was applied for in late 2022.

The Clean Water Fund (CWF) administered through the WDNR is also a funding option with current funding providing a 30 percent principal forgiveness loan and a 70 percent low interest loan. The principal forgiveness loan is received through a competitive process. An Intent to Apply (ITA) and Priority Evaluation Review Form (PERF) would need to be submitted to the WDNR.

B. Fees

Fees are another common means of funding stormwater management improvements. Fees are charges for services rendered. Many municipalities recover costs of constructing, designing, reviewing, and inspecting new developments through fees assessed to developers. Impact fees and special assessments transfer the cost of infrastructure improvements needed for private development direct to developers or property owners. User fees recover costs over the life of the project. An increasingly common type of user fee related to stormwater management is a stormwater utility. Formation of stormwater utilities enables municipalities to recover costs of stormwater management improvements based on the amount of stormwater "generated" by a land use.

C. Bonds

Large capital improvements projects, such as, major storm sewers or detention facilities may be funded through bonds or grants. Bonds are a mechanism to borrow capital for a project and distribute repayment over the life span of the project. A popular local bonding option is the CWF program. This is one of the subsidized loan programs included in the WDNR's Environmental Improvement Fund (EIF). The CWF provides loans to municipalities for wastewater treatment and urban stormwater projects. This program has historically been used extensively for wastewater treatment facility construction. Recent program modifications allow funds to be used for stormwater management improvements.

Most CWF projects receive a subsidized interest rate of 55 percent, 65 percent, or 70 percent of the EIF market interest rate. CWF wastewater projects that meet certain criteria may be eligible to receive a Hardship Financial Assistance, which may be in the form of a lower interest rate loan or include a grant.

Table 8 L14–Lake Michigan (Red Arrow Discharge) Alternative OPCC Summary

Watershed	Project Descriptions	OPCC
L14	Alternative 1	
	Rubick Field Underground Detention Basin	$13,336,300
	L14 Alternative 1 Total	**$13,336,300**
L14	Alternative 2	
	Rubick Field Underground Detention Basin	$13,336,300
	30th Street Detention Basin Expansion	$1,788,300
	L14 Alternative 2 Total	**$15,124,600**
L14	Alternative 3	
	Rubick Field Underground Detention Basin	$13,336,300
	30th Street Detention Basin Expansion	$1,788,300
	Grand Avenue Storm Sewer Upsizing	$4,338,500
	L14 Alternative 3 Total	**$19,463,100**
L14	Alternative 4	
	Rubick Field Dry Detention Basin	$3,749,700
	Grand Avenue Storm Sewer Upsizing (Paired with Rubick Dry Detention Basin)*	$4,437,400
	30th Street Detention Basin Expansion	$1,788,300
	L14 Alternative 4 Total	**$9,975,400**

*The Grand Avenue Storm Sewer Upsizing will need to be installed before the construction of the Rubick Field Dry Detention Basin.

Table 9 R22–Manitowoc (South 19th Street) Watershed Alternative OPCC Summary

Watershed	Project Descriptions	OPCC
R22	Alternative 1	
	Halvorsen Park Detention Basin	$1,415,700
	R22 Alternative 1 Total	**$1,415,700**
R22	Alternative 2	
	Halvorsen Park Detention Basin	$1,415,700
	Custer Street Detention Basin	$3,157,000
	R22 Alternative 2 Total	**$4,572,700**
R22	Alternative 3	
	Halvorsen Park Detention Basin	$1,415,700
	Railroad Detention Basin	$2,199,700
	R22 Alternative 3 Total	**$3,615,400**

Table 10 LR01–Little Manitowoc River (Fenway Terrace) Watershed Alternative OPCC Summary

Watershed	Project Descriptions	OPCC
LR01	Alternative 1	
	25-Year Storm Sewer Design	$547,900
	LR01 Alternative 1 Total	**$547,900**
LR01	Alternative 2	
	25-Year Storm Sewer Design with Overland Flow Route	$722,700
	LR01 Alternative 2 Total	**$722,700**
LR01	Alternative 3	
	100-Year Storm Sewer Design	$860,200
	LR01 Alternative 3 Total	**$860,200**

Strand Associates, Inc.

City of Manitowoc

Grand Avenue Storm Sewer Upsizing (Paired with Rubick Dry Detention Basin)

L14 - Lake Michigan Watershed

ENGINEER'S PLANNING LEVEL OPINION OF PROBABLE CONSTRUCTION COST

ITEM NO.	DESCRIPTION	Quantity	Units	Unit Price (2023)	Total Price
1	Mobilization/Demobilization	1	LS	$79,840.00	$79,850
2	Clearing and Grubbing	0.4	AC	$8,400.00	$3,350
3	Traffic Control	1	LS	$40,000.00	$40,000
4	Construction Layout	1	LS	$10,000.00	$10,000
5	Stone Tracking Pad	2	EA	$2,900.00	$5,800
6	Dust Control	1	LS	$2,350.00	$2,350
7	Inlet Protection	18	EA	$250.00	$4,500
8	Dewatering	1	LS	$15,000.00	$15,000
9	6-IN Salvaged Topsoil Placement (from project site)	333	SY	$3.35	$1,100
10	Erosion Control Revegetative Mat	333	SY	$2.55	$850
11	Turf Restoration - Seed and Fertilizer	333	SY	$1.70	$550
12	72-IN RCP Storm Sewer	863	LF	$635.00	$548,000
13	66-IN RCP Storm Sewer	1,191	LF	$580.00	$690,800
14	30-IN RCP Storm Sewer	117	LF	$180.00	$21,050
15	12-IN RCP Storm Sewer	500	LF	$74.00	$37,000
16	2'x3' Storm Sewer Inlet	18	EA	$2,350.00	$42,300
17	10-FT DIA Storm Sewer Manhole	4	EA	$20,600.00	$82,400
18	9-FT DIA Storm Sewer Manhole	5	EA	$17,600.00	$88,000
19	8-FT DIA Storm Sewer Manhole	5	EA	$15,100.00	$75,500
20	5-FT DIA Storm Sewer Manhole	1	EA	$3,800.00	$3,800
21	Pavement Removal	8,050	SY	$4.50	$36,250
22	Concrete Restoration (8-inch Reinforced Concrete)	8,050	SY	$102.00	$821,100
23	Sidewalk Removal	712	SY	$3.25	$2,300
24	Sidewalk Restoration	712	SY	$60.00	$42,750
25	Curb and Gutter Removal	2,584	LF	$6.75	$17,450
26	Curb and Gutter Restoration	2,584	LF	$25.00	$64,600
27	8-IN C900 PVC Water Main	87	LF	$236.62	$20,600
28	8-IN PVC Sanitary Sewer	904	LF	$97.46	$88,100
29	12-IN PVC Sanitary Sewer	923	LF	$165.00	$152,300
30	Sanitary Sewer Lateral Replacement	1,295	LF	$91.84	$118,950
31	4-FT DIA Sanitary Sewer MH	10	EA	$4,999.71	$50,000
32	Pipe Removal	4,240	LF	$26.00	$110,250
				Subtotal	$3,276,900
				35% Contingency and Technical Services Allowance	$1,146,915
				Construction Total	**$4,423,800**
				Geotech Borings & Report	$13,550
				SITE GRAND TOTAL	**$4,437,350**

Notes:

1. This planning level opinion of probable cost is based on limited data and the assumptions, herein. It should be refined in the future with site specific information.

Strand Associates, Inc.

City of Manitowoc

Rubick Field Dry Detention Basin

L14 - Lake Michigan Watershed

ENGINEER'S PLANNING LEVEL OPINION OF PROBABLE CONSTRUCTION COST

ITEM NO.	DESCRIPTION	Quantity	Units	Unit Price (2023)	Total Price
1	Mobilization/Demobilization	1	LS	$67,500.00	$67,500
2	Clearing and Grubbing	1	AC	$8,400.00	$8,400
3	Traffic Control	1	LS	$10,000.00	$10,000
4	Construction Layout	1	LS	$7,500.00	$7,500
5	Stone Tracking Pad	2	EA	$2,900.00	$5,800
6	Dust Control	1	LS	$2,350.00	$2,350
7	Inlet Protection	13	EA	$250.00	$3,250
8	Silt Fence	1,340	LF	$3.50	$4,700
9	Straw Wattle/Silt Sock (Around Perimeter of Pond)	1,390	LF	$12.00	$16,700
10	Dewatering	1	LS	$15,000.00	$15,000
11	Parent Material Excavation and Off-Site Disposal	52,558	CY	$22.00	$1,156,300
12	6-IN Salvaged Topsoil Placement (50%)	11,045	SY	$3.35	$37,000
13	6-IN Hauled-in Topsoil Placement (50%)	11,045	SY	$8.00	$88,350
13	Medium Rip Rap	284	SY	$73.00	$20,750
13	Erosion Control Revegetative Mat	22,090	SY	$1.40	$30,950
14	Turf Restoration - Seed and Fertilizer	22,090	SY	$1.70	$37,550
15	Turf Reinforcement Mat for Emergency Spillway	267	SY	$23.00	$6,150
16	48-IN RCP Storm Sewer	1,367	LF	$350.00	$478,450
17	36-IN RCP Storm Sewer	543	LF	$240.00	$130,300
18	24-IN RCP Storm Sewer	489	LF	$130.00	$63,550
19	12-IN RCP Storm Sewer	200	LF	$74.00	$14,800
20	2'x3' Storm Sewer Inlet	37	EA	$2,350.00	$86,950
21	10-FT DIA Storm Sewer Manhole	2	EA	$20,600.00	$41,200
22	9-FT DIA Storm Sewer Manhole	1	EA	$17,600.00	$17,600
23	7-FT DIA Storm Sewer Manhole	3	EA	$6,500.00	$19,500
24	6-FT DIA Storm Sewer Manhole	3	EA	$8,900.00	$26,700
25	5-FT DIA Storm Sewer Manhole	1	EA	$3,800.00	$3,800
26	Pavement Removal	2,318	SY	$4.50	$10,450
27	Concrete Restoration (8-inch Reinforced Concrete)	2,318	SY	$102.00	$236,450
28	Sidewalk Removal	8	SY	$3.25	$50
29	Sidewalk Restoration	8	SY	$60.00	$500
30	Curb and Gutter Removal	1,391	LF	$6.75	$9,400
31	Curb and Gutter Restoration	1,391	LF	$25.00	$34,800
32	Pipe Removal	2,875	LF	$26.00	$74,750
				Subtotal	$2,767,500
				35% Contingency and Technical Services Allowance	$968,625
				Construction Total	**$3,736,100**
				Geotech Borings & Report	$13,550
				SITE GRAND TOTAL	**$3,749,650**

Notes:

1. This planning level opinion of probable cost is based on limited data and the assumptions, herein. It should be refined in the future with site specific information.

City of Manitowoc

30th St Detention Basin Expansion

L14 - Lake Michigan Watershed

ENGINEER'S PLANNING LEVEL OPINION OF PROBABLE CONSTRUCTION COST

ITEM NO.	DESCRIPTION	Quantity	Units	Unit Price (2023)	Total Price
1	Mobilization/Demobilization	1	LS	$32,065.00	$32,050
2	Clearing and Grubbing	0.25	AC	$8,400.00	$2,100
3	Traffic Control	1	LS	$2,500.00	$2,500
4	Construction Layout	1	LS	$2,500.00	$2,500
5	Stone Tracking Pad	1	EA	$2,900.00	$2,900
6	Dust Control	1	LS	$2,350.00	$2,350
7	Inlet Protection	52	EA	$250.00	$13,000
8	Silt Fence	465	LF	$3.50	$1,650
9	Straw Wattle/Silt Sock (Around Perimeter of Pond 2 feet above WSEL)	469	LF	$12.00	$5,650
10	Temporary Rock Check Dam at Outlet	1	EA	$1,000.00	$1,000
11	Dewatering	1	LS	$15,000.00	$15,000
12	Parent Material Excavation and Off-Site Disposal	23,939	CY	$22.00	$526,650
13	Medium Rip Rap	179	SY	$73.00	$13,050
14	Excavation for 2-FT Thick Clay Liner (Mechanical)	3,521	CY	$22.00	$77,450
15	2-FT Thick Clay Liner (Hauled In)	3,521	CY	$26.00	$91,550
16	6-IN Salvaged Topsoil Placement (from project site)	3,070	SY	$3.35	$10,300
17	Turf Reinforcement Mat for Emergency Spillway	267	SY	$23.00	$6,150
18	Detention Basin Native Seed Mix	1,937	SY	$3.00	$5,800
19	Erosion Control Revegetative Mat	1,937	SY	$2.55	$4,950
20	Native Plugs At Water's Edge (1 per lf around perimeter)	465	EA	$10.00	$4,650
21	Waterfowl Fence Around Pond Perimeter	465	LF	$6.50	$3,000
22	Turf Restoration - Seed and Fertilizer	1,132	SY	$1.70	$1,900
23	48-IN RCP Storm Sewer	278	LF	$350.00	$97,300
24	42-IN RCP Storm Sewer	269	LF	$165.00	$44,400
25	30-IN RCP Storm Sewer	186	LF	$180.00	$33,500
26	24-IN RCP Storm Sewer	91	LF	$130.00	$11,850
27	21-IN RCP Storm Sewer	15	LF	$83.00	$1,250
28	18-IN RCP Storm Sewer	111	LF	$80.00	$8,900
29	15-IN RCP Storm Sewer	15	LF	$75.00	$1,150
30	12-IN RCP Storm Sewer	176	LF	$74.00	$13,000
31	48-IN RCP Apron Endwall w/Pipe Gate and Cutoff Wall	1	EA	$5,500.00	$5,500
32	30-IN RCP Apron Endwall w/Pipe Gate and Cutoff Wall	2	EA	$3,750.00	$7,500
33	18-IN RCP Apron Endwall w/Pipe Gate and Cutoff Wall	1	EA	$2,750.00	$2,750
34	2'x3' Storm Sewer Inlet	52	EA	$2,350.00	$122,700
35	7-FT DIA Storm Sewer Manhole	2	EA	$6,500.00	$13,000
36	6-FT DIA Storm Sewer Manhole	1	EA	$8,900.00	$8,900
37	5-FT DIA Storm Sewer Manhole	1	EA	$3,800.00	$3,800
38	4-FT DIA Storm Sewer Manhole	2	EA	$2,850.00	$5,700
39	Pipe Removal	1,116	LF	$26.00	$29,000
40	Pavement Removal	500	SY	$4.50	$2,250
41	Concrete Restoration	500	SY	$82.00	$41,000
42	Sidewalk Removal	33	SY	$3.25	$100
43	Sidewalk Restoration	33	SY	$60.00	$2,000
44	Curb and Gutter Removal	395	LF	$6.75	$2,650
45	Curb and Gutter Restoration	395	LF	$25.00	$9,900
46	Outlet Control Structure Modification	1	LS	$10,000.00	$10,000
47	Native Vegetation Maintenance (3 Year)	0.40	AC	$26,000.00	$10,400
				Subtotal	$1,314,650
				35% Contingency and Technical Services Allowance	$460,128
				Construction Total	**$1,774,778**
				Geotech Borings & Report	$13,550
				SITE GRAND TOTAL	**$1,788,327**

Notes:

1. This planning level opinion of probable cost is based on limited data and the assumptions, herein. It should be refined in the future with site specific information.

Strand Associates, Inc.

City of Manitowoc

Halvorsen Park Detention Basin

R22 - Manitowoc Watershed

ENGINEER'S PLANNING LEVEL OPINION OF PROBABLE CONSTRUCTION COST

ITEM NO.	DESCRIPTION	Quantity	Units	Unit Price (2023)	Total Price
1	Mobilization/Demobilization	1	LS	$25,330.00	$25,350
2	Clearing and Grubbing	0.25	AC	$8,400.00	$2,100
3	Traffic Control	1	LS	$2,500.00	$2,500
4	Construction Layout	1	LS	$2,500.00	$2,500
5	Stone Tracking Pad	1	EA	$2,900.00	$2,900
6	Dust Control	1	LS	$2,350.00	$2,350
7	Inlet Protection	5	EA	$250.00	$1,250
8	Silt Fence	650	LF	$3.50	$2,300
9	Straw Wattle/Silt Sock (Around Perimeter of Pond 1 ft above WSEL)	933	LF	$12.00	$11,200
10	Temporary Rock Check Dam at Outlet	1	EA	$1,000.00	$1,000
11	Dewatering	1	LS	$15,000.00	$15,000
12	Parent Material Excavation and Off-Site Disposal	24,524	CY	$22.00	$539,550
13	Medium Rip Rap	227	SY	$73.00	$16,550
14	Excavation for 2-FT Thick Clay Liner	3,636	CY	$22.00	$80,000
15	2-FT Thick Clay Liner (Hauled In)	3,636	CY	$26.00	$94,550
16	6-IN Salvaged Topsoil Placement (from project site)	4,451	SY	$3.35	$14,900
17	Turf Reinforcement Mat for Emergency Spillway (10'x60')	267	SY	$23.00	$6,150
18	Detention Basin Native Seed Mix	3,256	SY	$3.00	$9,750
19	Erosion Control Revegetative Mat	3,256	SY	$2.55	$8,300
20	Native Plugs At Water's Edge (1 per lf around perimeter)	882	EA	$10.00	$8,800
21	Waterfowl Fence Around Pond Perimeter	882	LF	$6.50	$5,750
22	Turf Restoration - Seed and Fertilizer	1,194	SY	$1.70	$2,050
23	30-IN RCP Storm Sewer	87	LF	$180.00	$15,650
24	24-IN RCP Storm Sewer	245	LF	$130.00	$31,850
25	21-IN RCP Storm Sewer	80	LF	$83.00	$6,650
26	30-IN RCP Apron Endwall w/Pipe Gate and Cutoff Wall	1	EA	$3,750.00	$3,750
27	24-IN RCP Apron Endwall w/Pipe Gate and Cutoff Wall	3	EA	$3,300.00	$9,900
28	21-IN RCP Apron Endwall w/Pipe Gate and Cutoff Wall	1	EA	$3,000.00	$3,000
29	2'x3' Storm Sewer Inlet	10	EA	$2,350.00	$23,500
30	5-FT DIA Outlet Control Structure	1	EA	$10,000.00	$10,000
31	5-FT DIA Storm Sewer Manhole	1	EA	$3,800.00	$3,800
32	4-FT DIA Storm Sewer Manhole	4	EA	$2,850.00	$11,400
33	Pavement Removal	220	SY	$4.50	$1,000
34	Concrete Restoration	220	SY	$82.00	$18,050
35	Sidewalk Removal	56	SY	$3.25	$200
36	Sidewalk Restoration	56	SY	$60.00	$3,350
37	Curb and Gutter Removal	170	LF	$6.75	$1,150
38	Curb and Gutter Restoration	170	LF	$25.00	$4,250
39	8-IN C900 PVC Water Main	80	LF	$236.62	$18,800
40	Native Vegetation Maintenance (3 Year)	0.67	AC	$26,000.00	$17,500
				Subtotal	$1,038,600
				35% Contingency and Technical Services Allowance	$363,510
				Construction Total	**$1,402,110**
				Geotech Borings & Report	$13,550
				SITE GRAND TOTAL	**$1,415,660**

Notes:

1. This planning level opinion of probable cost is based on limited data and the assumptions, herein. It should be refined in the future with site specific information.
2. If deep well dewatering is necessary to install clay liner because of high groundwater, then dewatering cost would increase.

Strand Associates, Inc.

City of Manitowoc

Custer St Detention Basin

R22 - Manitowoc Watershed

ENGINEER'S PLANNING LEVEL OPINION OF PROBABLE CONSTRUCTION COST

ITEM NO.	DESCRIPTION	Quantity	Units	Unit Price (2023)	Total Price
1	Mobilization/Demobilization	1	LS	$56,670.00	$56,650
2	Clearing and Grubbing	0.25	AC	$8,400.00	$2,100
3	Traffic Control	1	LS	$5,000.00	$5,000
4	Construction Layout	1	LS	$2,500.00	$2,500
5	Stone Tracking Pad	1	EA	$2,900.00	$2,900
6	Dust Control	1	LS	$2,350.00	$2,350
7	Inlet Protection	15	EA	$250.00	$3,750
8	Silt Fence	1,354	LF	$3.50	$4,750
9	Straw Wattle/Silt Sock (Around Perimeter of Pond 1 ft above WSEL)	1,404	LF	$12.00	$16,850
10	Temporary Rock Check Dam at Outlet	1	EA	$1,000.00	$1,000
11	Dewatering	1	LS	$15,000.00	$15,000
12	Parent Material Excavation and Off-Site Disposal	37,055	CY	$22.00	$815,200
13	Medium Rip Rap	93	SY	$73.00	$6,800
14	Excavation for 2-FT Thick Clay Liner	5,163	CY	$22.00	$113,600
15	2-FT Thick Clay Liner (Hauled In)	5,163	CY	$26.00	$134,250
16	6-IN Salvaged Topsoil Placement (from project site)	6,982	SY	$3.35	$23,400
17	Turf Reinforcement Mat for Emergency Spillway (10'x40')	267	SY	$23.00	$6,150
18	Detention Basin Native Seed Mix	5,244	SY	$3.00	$15,750
19	Erosion Control Revegetative Mat	5,244	SY	$2.55	$13,350
20	Native Plugs At Water's Edge (1 per lf around perimeter)	1,354	EA	$10.00	$13,550
21	Waterfowl Fence Around Pond Perimeter	1,354	LF	$6.50	$8,800
22	Turf Restoration - Seed and Fertilizer	1,738	SY	$1.70	$2,950
23	8-FT x 3-FT RCP Box with Angles	801	LF	$866.00	$693,650
24	42-IN RCP Storm Sewer	124	LF	$165.00	$20,450
25	18-IN RCP Storm Sewer	50	LF	$80.00	$4,000
26	24-IN RCP Storm Sewer	162	LF	$130.00	$21,050
27	8-FT x 3-FT RCP Apron Endwall w/Gate and Cutoff Wall	1	EA	$12,000.00	$12,000
28	42-IN RCP Apron Endwall w/Pipe Gate and Cutoff Wall	1	EA	$4,900.00	$4,900
29	24-IN RCP Apron Endwall w/Pipe Gate and Cutoff Wall	1	EA	$3,300.00	$3,300
30	2'x3' Storm Sewer Inlet	9	EA	$2,350.00	$21,150
31	5-FT DIA Outlet Control Structure	1	EA	$10,000.00	$10,000
32	5-FT DIA Storm Sewer Manhole	1	EA	$4,300.00	$4,300
33	6-FT DIA Storm Sewer Manhole	1	EA	$8,900.00	$8,900
34	8'x3' Storm Sewer Access Manhole	6	EA	$4,000.00	$24,000
35	8'x3' Storm Sewer Manhole Structure	1	EA	$25,000.00	$25,000
36	Pavement Removal	1,460	SY	$4.50	$6,550
37	Concrete Restoration	1,460	SY	$82.00	$119,700
38	Sidewalk Removal	44	SY	$3.25	$150
39	Sidewalk Restoration	44	SY	$60.00	$2,650
40	Curb and Gutter Removal	820	LF	$6.75	$5,550
41	Curb and Gutter Restoration	820	LF	$25.00	$20,500
42	Pipe Removal	801	LF	$26.00	$20,850
43	Native Vegetation Maintenance (3 Year)	1.08	AC	$26,000.00	$28,150
				Subtotal	$2,323,450
				35% Contingency and Technical Services Allowance	$813,208
				Construction Total	**$3,136,658**
				Geotech Borings & Report	$20,325
				SITE GRAND TOTAL	**$3,156,982**

Notes:

1. This planning level opinion of probable cost is based on limited data and the assumptions, herein. It should be refined in the future with site specific information.
2. If deep well dewatering is necessary to install clay liner because of high groundwater, then dewatering cost would increase.

Strand Associates, Inc.

City of Manitowoc

25-Year Storm Sewer Design With Overland Flow Route

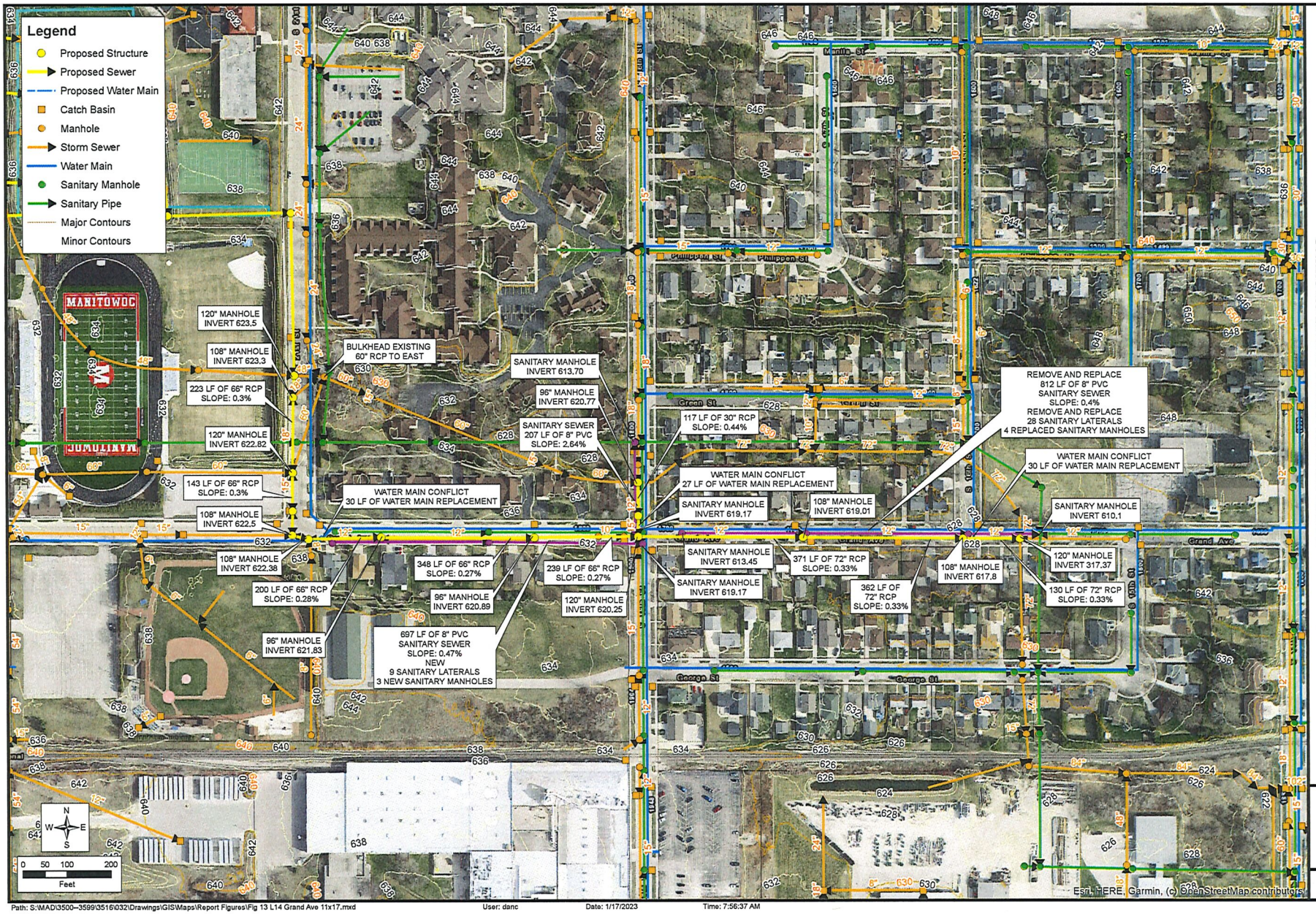
LR01 - Little Manitowoc River Watershed

ENGINEER'S PLANNING LEVEL OPINION OF PROBABLE CONSTRUCTION COST

ITEM NO.	DESCRIPTION	Quantity	Units	Unit Price (2023)	Total Price
1	Mobilization/Demobilization	1	LS	$12,935.00	$12,935
2	Clearing and Grubbing	0.15	AC	$8,400.00	$1,250
3	Traffic Control	1	LS	$2,500.00	$2,500
4	Construction Layout	1	LS	$2,500.00	$2,500
5	Stone Tracking Pad	1	EA	$2,900.00	$2,900
6	Dust Control	1	LS	$2,350.00	$2,350
7	Inlet Protection	32	EA	$250.00	$8,000
8	Silt Fence	500	LF	$3.50	$1,750
9	Dewatering	1	LS	$10,000.00	$10,000
10	Parent Material Excavation and Off-Site Disposal	333	CY	$34.00	$11,350
11	6-IN Salvaged Topsoil Placement (from project site)	1,183	SY	$3.35	$3,950
12	Erosion Control Revegetative Mat	1,183	SY	$2.55	$3,000
13	Turf Restoration - Seed and Fertilizer	1,183	SY	$1.70	$2,000
14	48-IN RCP Apron Endwall w/Pipe Gate and Cutoff Wall	1	EA	$5,500.00	$5,500
15	48-IN RCP Storm Sewer	139	LF	$350.00	$48,650
16	38x60-IN RCP Storm Sewer	338	LF	$203.00	$68,600
17	27-IN RCP Storm Sewer	152	LF	$112.00	$17,000
18	18-IN RCP Storm Sewer	113	LF	$80.00	$9,050
19	12-IN RCP Storm Sewer	97	LF	$74.00	$7,200
20	2'x3' Storm Sewer Inlet	17	EA	$2,350.00	$38,900
21	8-FT DIA Storm Sewer Manhole	2	EA	$15,100.00	$30,200
22	5-FT DIA Storm Sewer Manhole	5	EA	$3,800.00	$19,000
23	Pavement Removal	1,962	SY	$4.50	$8,850
24	Concrete Restoration	1,962	SY	$82.00	$160,900
25	Sidewalk Removal	139	SY	$3.25	$450
26	Sidewalk Restoration	139	SY	$60.00	$8,350
27	Curb and Gutter Removal	845	LF	$6.75	$5,700
28	Curb and Gutter Restoration	845	LF	$25.00	$21,150
29	Pipe Removal	629	LF	$26.00	$16,350
				Subtotal	$530,335
				35% Contingency and Technical Services Allowance	$185,617
				Construction Total	**$715,952**
				Geotech Borings & Report	$6,775
				SITE GRAND TOTAL	**$722,727**

Notes:

1. This planning level opinion of probable cost is based on limited data and the assumptions, herein. It should be refined in the future with site specific information.



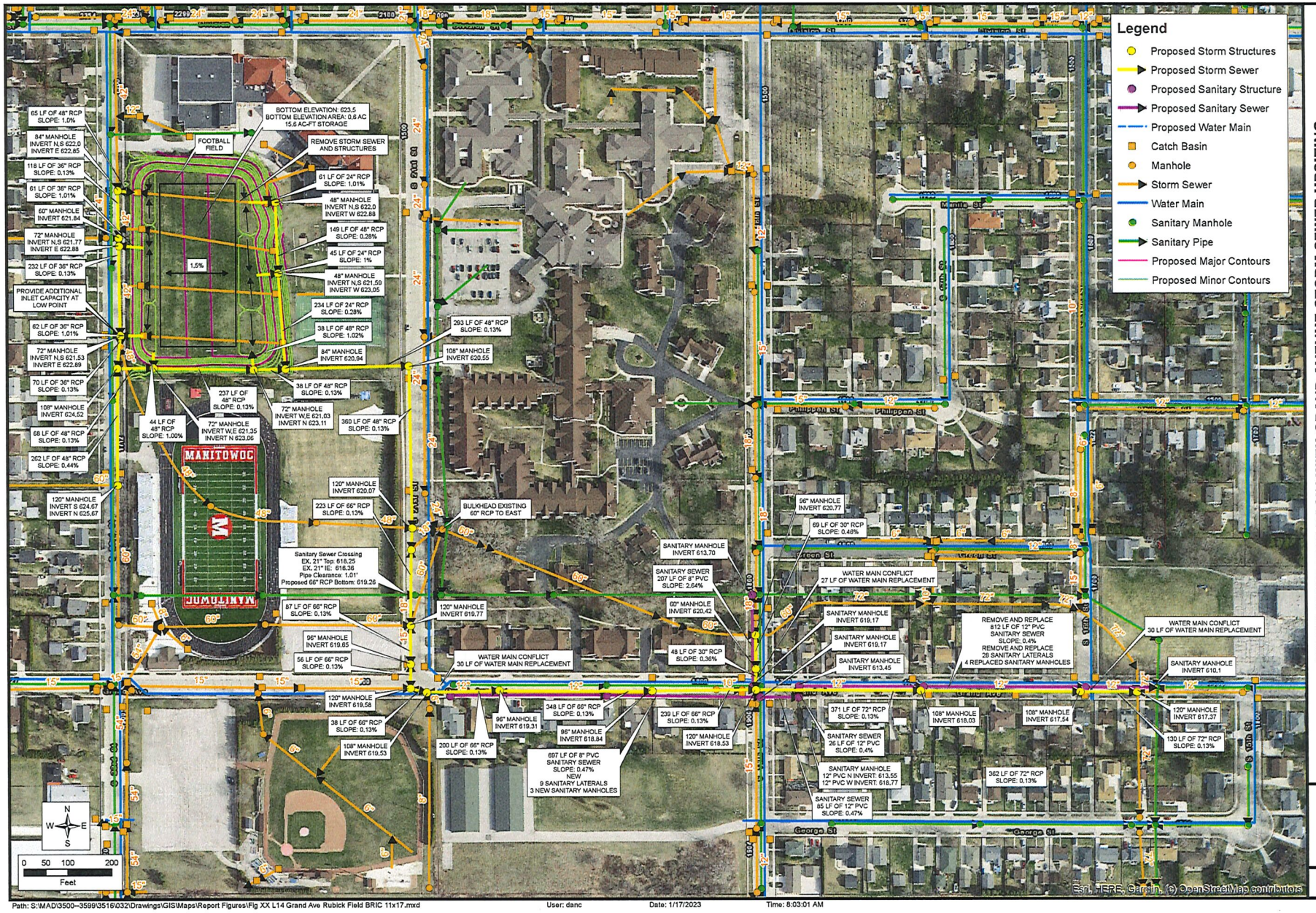
GRAND AVENUE STORM SEWER UPSIZING
L14 - LAKE MICHIGAN WATERSHED

STORMWATER HYDROLOGY AND HYDRAULICS STUDY
CITY OF MANITOWOC
MANITOWOC COUNTY, WISCONSIN

STRAND ASSOCIATES®

FIGURE 13
3516.032

Path: S:\MAD\3500–3599\3516\032\Drawings\GIS\Maps\Report Figures\Fig 13 L14 Grand Ave 11x17.mxd User: danc Date: 1/17/2023 Time: 7:56:37 AM



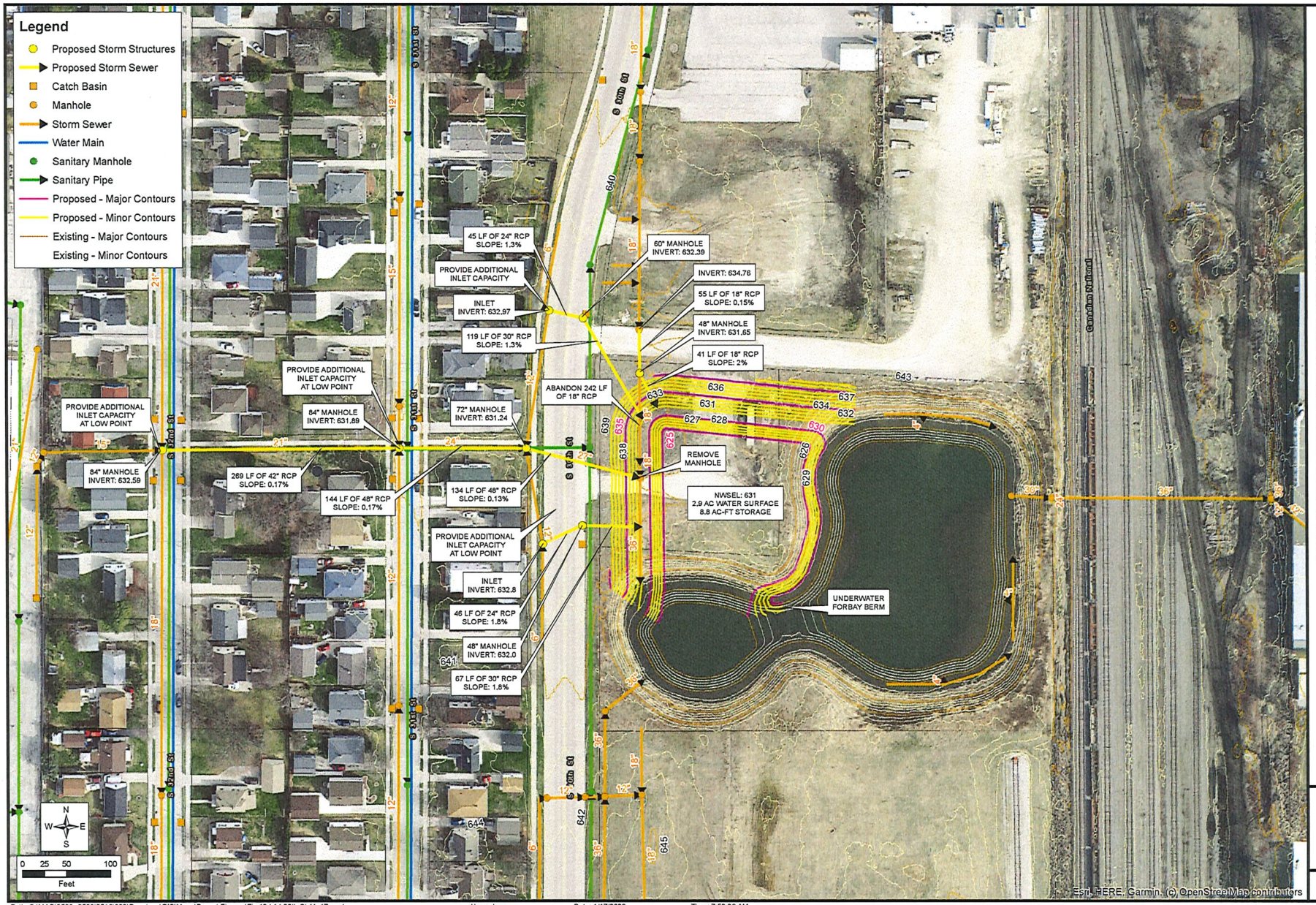
RUBIC FIELD DRY BASIN WITH GRAND AVENUE STORM SEWER UPSIZING
L14 - LAKE MICHIGAN WATERSHED

STORMWATER HYDROLOGY AND HYDRAULICS STUDY
CITY OF MANITOWOC
MANITOWOC COUNTY, WISCONSIN

STRAND ASSOCIATES

FIGURE 14
3516.032

Path: S:\MAD\3500–3599\3516\032\Drawings\GIS\Maps\Report Figures\Fig XX L14 Grand Ave Rubick Field BRIC 11x17.mxd User: danc Date: 1/17/2023 Time: 8:03:01 AM

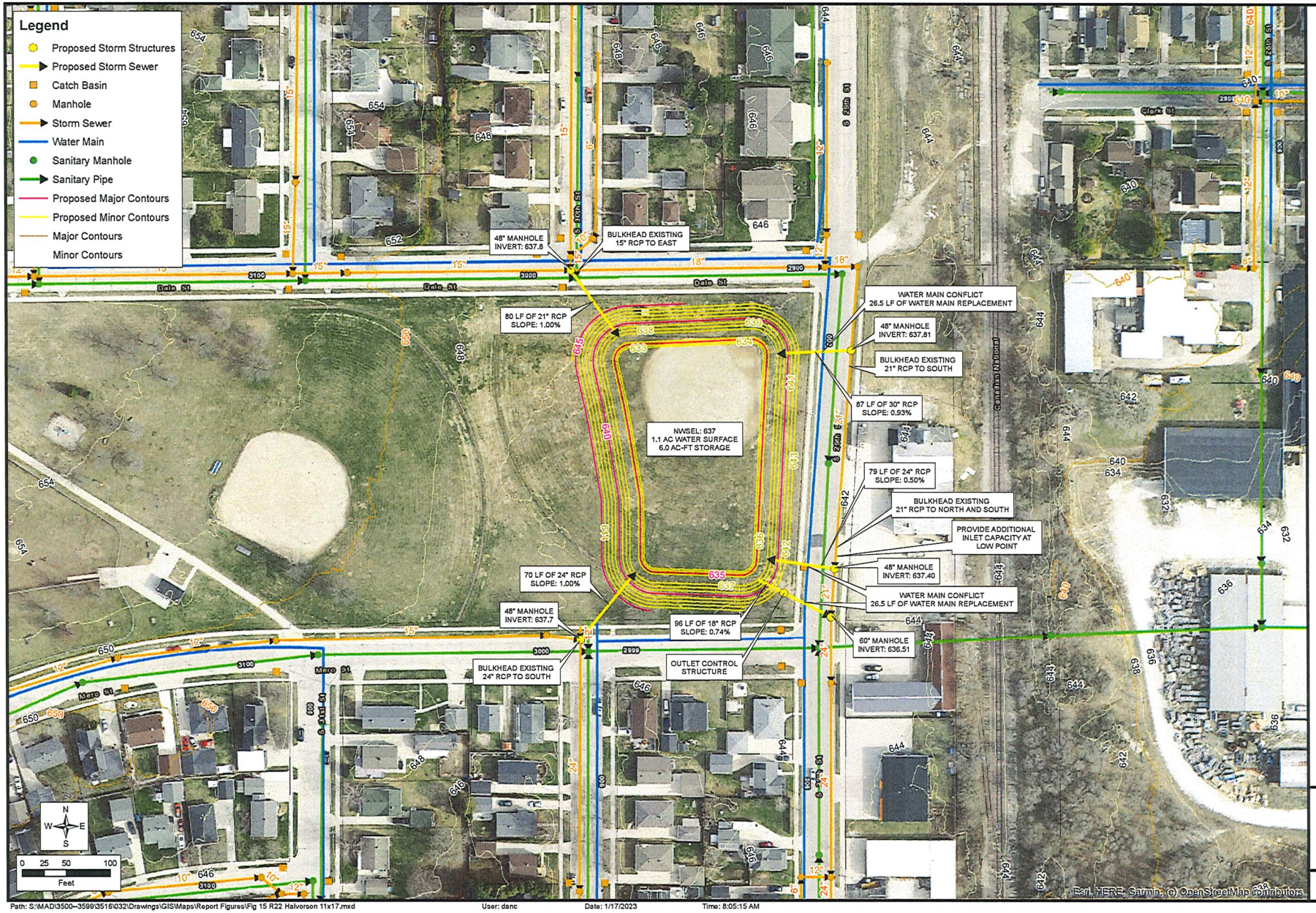


30TH STREET DETENTION BASIN EXPANSION
L14 - LAKE MICHIGAN WATERSHED
STORMWATER HYDROLOGY AND HYDRAULICS STUDY
CITY OF MANITOWOC
MANITOWOC COUNTY, WISCONSIN

STRAND ASSOCIATES

FIGURE 12
3516.032

Path: S:\MAD\3500–3599\3516\032\Drawings\GIS\Maps\Report Figures\Fig 12 L14 30th St 11x17.mxd User: danc Date: 1/17/2023 Time: 7:52:26 AM



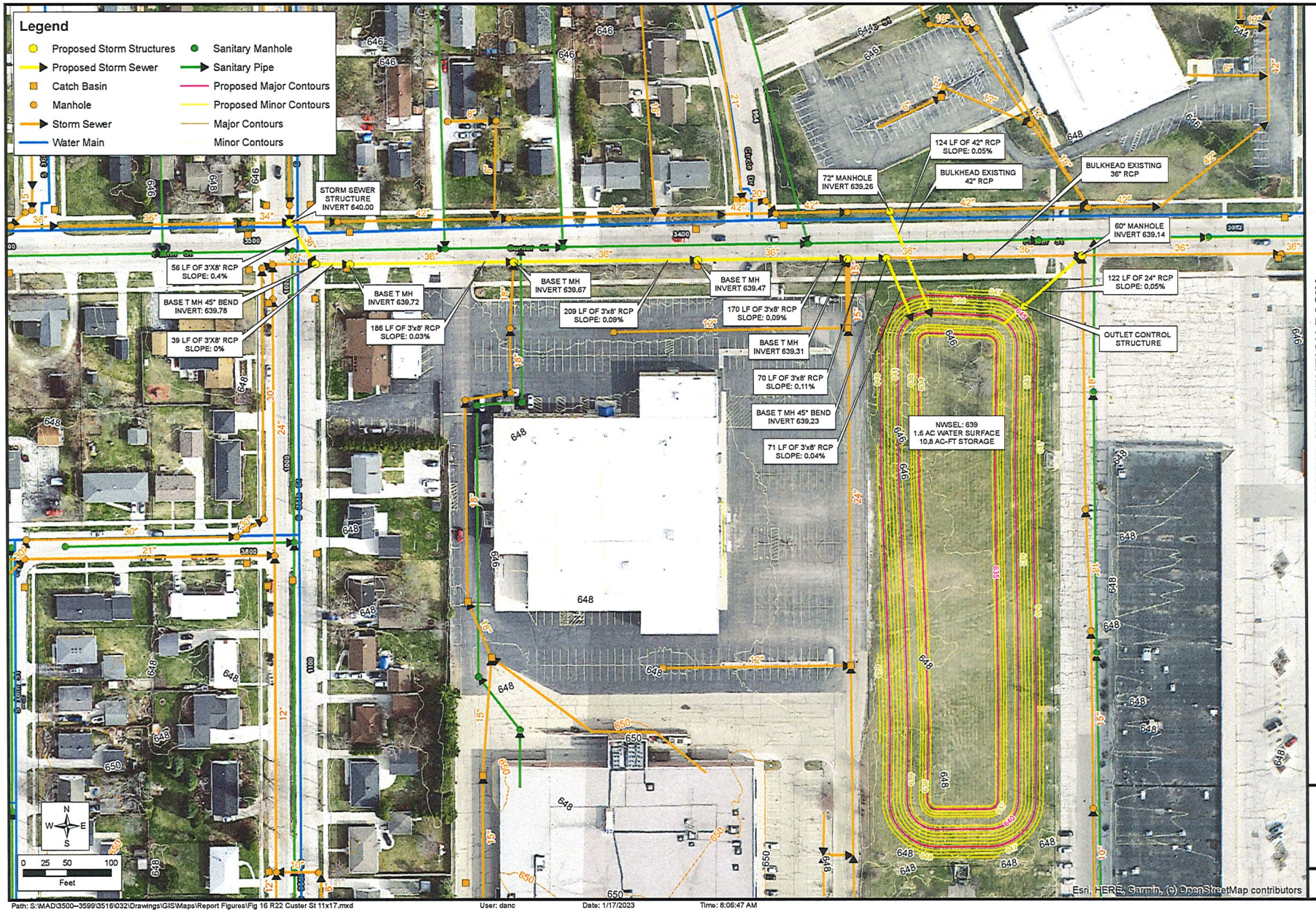
HALVORSEN PARK DETENTION BASIN
R22 - MANITOWOC WATERSHED

STORMWATER HYDROLOGY AND HYDRAULICS STUDY
CITY OF MANITOWOC
MANITOWOC COUNTY, WISCONSIN

STRAND ASSOCIATES

FIGURE 15
3516.032

Path: S:\MAD\3500–3599\3516\032\Drawings\GIS\Maps\Report Figures\Fig 15 R22 Halvorson 11x17.mxd User: danc Date: 1/17/2023 Time: 8:05:15 AM



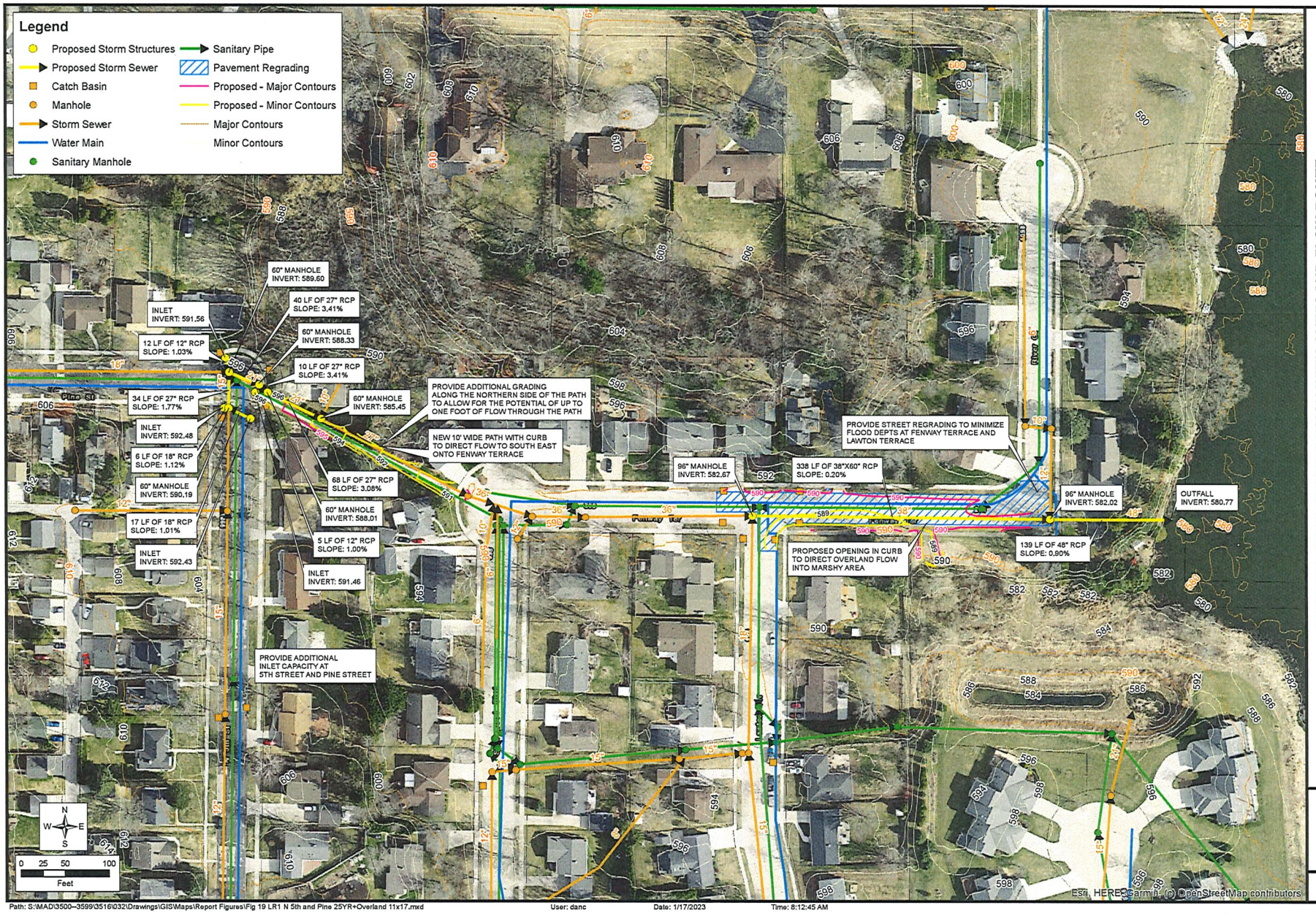
CUSTER ST DETENTION BASIN
R22 - MANITOWOC WATERSHED

STORMWATER HYDROLOGY AND HYDRAULICS STUDY
CITY OF MANITOWOC
MANITOWOC COUNTY, WISCONSIN

STRAND ASSOCIATES

FIGURE 16
3516.032

Path: S:\MAD\3500–3599\3516\032\Drawings\GIS\Maps\Report Figures\Fig 16 R22 Custer St 11x17.mxd User: danc Date: 1/17/2023 Time: 8:06:47 AM



25-YEAR STORM SEWER DESIGN WITH OVERLAND FLOW ROUTE
LR01 - LITTLE MANITOWOC RIVER WATERSHED

STORMWATER HYDROLOGY AND HYDRAULICS STUDY
CITY OF MANITOWOC
MANITOWOC COUNTY, WISCONSIN

STRAND ASSOCIATES®

FIGURE 19
3516.032

Path: S:\MAD\3500--3599\3516\032\Drawings\GIS\Maps\Report Figures\Fig 19 LR1 N 5th and Pine 25YR+Overland 11x17.mxd User: danc Date: 1/17/2023 Time: 8:12:45 AM