WATER POLLUTION REDUCTION PROJECTS

CITY OF OCONOMOWOC
WAUKESHA COUNTY, WISCONSIN
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INTRODUCTION

The City of Oconomowoc municipal separate storm sewer system (MS4) has water quality and quantity issues at several locations in the City. In particular, this study will focus on drainage basins near Thackeray Trail, Forest Street and Summit Avenue, all of which are in the proximity of downtown Oconomowoc. Storm water quality and pollutant mitigation will be the primary focus of this study. However, the ancillary benefits of storm water quantity management and flood mitigation will be addressed in this report alongside the water quality issues.

Several storm water facilities will be considered for implementation in the Summit Avenue basin (shown in Exhibit 1) which drains to Fowler Lake. With the recent realignment of Forest Street at Summit Avenue, opportunities exist to work with the hospital to modify their existing storm water facility or to provide separate best management practices to reduce flows and improve water quality. This study will also evaluate the effectiveness of storm water facilities and on-site treatment systems in other open areas that exist in this basin.

The Thackeray Trail basin is an area that has experienced flooding, ditch erosion and water quality problems for many years. The recent reconstruction of STH 67 and the STH 67 Bypass has intensified the situation, increasing the amount of storm water conveyed towards Thackeray Trail. Alternatives that will be evaluated in this basin will focus on capturing and treating storm water runoff closer to the source in order to avoid excess pollutants and flows from impacting downstream resources and properties. Possible alternatives include the construction of wet pond facilities and the reconstruction of Thackeray Trail. The latter project would seek to reduce pavement widths as well as to implement swale and storm water conveyance system improvements. The Thackeray Trail basin and corresponding proposed alternatives are shown in Exhibit 2.

Finally, the Forest Street basin (shown in Exhibit 3) was considered as a part of this study. There is frequent flooding in a low spot that exists in the residential area north of Forest Street, so the existing storm conveyance system was modeled and analyzed. In addition, two wet pond facilities were modeled near the outlet of the basin to achieve water quality benefits.

In addition to the alternatives summarized above, several smaller, on-site treatment alternatives were included in each of the basin analyses that could serve to improve water quality and lessen the impacts of large rain events in a specific area. These alternatives are summarized in Appendix B. Smaller practices that focus on collecting water from a particular property are varied and can be designed to remove much of the total suspended solids (TSS) and phosphorus (P) from storm water runoff. When used in combination with each other, many smaller practices can have a significant impact on improving the quality of runoff entering a particular water body. Also, capturing and retaining water on a site-by-site basis can prevent an inundation of water rushing downhill through each of the basins. On-site practices have the ability to slow and retain storm water, slowly releasing a smaller amount over a longer time period. It is important to know that a cooperative effort from both public and private entities is critical to a successful solution to runoff or flooding problems in an existing neighborhood or industrial area.

Expiration of Delayed Implementation Exemption

The issue of excess pollutants reaching local lakes, rivers and wetlands by way of MS4's is a result of urbanization practices over the past several decades. The mitigation of pollutants such as sediment and phosphorus was not considered in the design and development of buildings and properties until the latter part of the twentieth century. In Wisconsin, statewide regulations did not go into effect requiring post-construction storm water controls for new and redevelopment sites until 2004. This leaves the majority of municipalities in Wisconsin without storm water controls in developed areas.

The mitigation of pollutants that flow through MS4's will take significant time and financial commitment from municipalities. For this reason, it is important that communities implement projects in the most efficient and cost-effective ways possible. One way of achieving this goal is to implement post-construction storm water controls when private or public redevelopment projects occur. By adding storm water treatment facilities to road reconstruction projects, municipalities can save money rather than constructing a stand-alone water quality facility at a different time. This should be considered for projects that are required to implement storm water controls by state and federal regulations as well as minor reconstruction projects that may be exempt from those requirements.

An exemption from post-construction water quality requirements was given to municipalities permitted through the Wisconsin Department of Natural Resources (DNR's) MS4 program in the revised NR 151, Wisconsin Administrative Code, effective January 1, 2011.

> NR 151.242 (3) DELAYED IMPLEMENTATION. For municipalities that are regulated under subch. I of ch. NR 216 and for transportation facilities under the jurisdiction of the department of transportation for maintenance purposes that are located within municipalities regulated under subch. I of ch. NR 216, the highway reconstruction total suspended solids performance standard first applies January 1, 2017.

NR 151.242(3) encouraged municipalities to look at regional storm water practices to control runoff from roads rather than requiring practices to be designed and constructed with each individual project. However, this exemption expires at the end of 2016, so projects will need to incorporate storm water management practices into the design and construction if they do not meet a different exemption from post-construction storm water requirements.

Several alternatives proposed in this study are aligned with future road projects in the City of Oconomowoc. Small-scale practices, such as bioretention trenches and basins, are considered at a number of locations in the study area. Other storm water control concepts, such as permeable pavement, road narrowing, and neighborhood-wide rain garden or rain barrel programs are also proposed for evaluation on a site-by-site basis. Site conditions will need to be evaluated prior to determining which type of practice best suits the site, so the descriptions of these designs are conceptual in nature.

In order to help offset the additional cost of including storm water controls on a road reconstruction, projects may be eligible for grant funding for elements of the project that go beyond the minimum regulatory requirements. For example, a proposed project that includes a storm water facility that will control more pollution than is required for that site could be eligible for the difference between the required removal and the level of removal of the proposed facility. Grant funding can also be secured when road projects implement pollution controls even though that project meets exemptions from the need for such controls.

Project Approach

The following report will briefly summarize the methodology, results and recommendations of the basin analyses conducted by Ruekert & Mielke, Inc. (R/M). Each alternative will be designed to improve local stream/lake health while also moving the City closer to compliance with the recently released Total Maximum Daily Load (TMDL) requirements. In addition to the hydraulic analyses, regulatory and constructability concerns will be evaluated for each alternative and cost estimates will be included. As mentioned above, the location of future road projects will also be factored into the conceptual design and prioritization of proposed alternatives.

This study will address all of the work outlined in the Urban Nonpoint Source & Storm Water (UNPS&SW) Program Planning Grant. The recommended improvements will play a significant role in helping to reduce sediment, total suspended solids, phosphorous and heavy metals from reaching the City's water resources and ultimately the EPA 303(d)-listed Rock River. It is noted that the DNR Grant for this project is for water quality issues only. The City of Oconomowoc has invested above and beyond the minimum partner match for this project knowing that any flood analysis will not be covered by the Grant. The City of Oconomowoc acknowledges that any work specifically done to deal with flooding issues will not be submitted for reimbursement under the grant.

ANALYSIS

R/M used GIS technology to conduct a preliminary site investigation in each of the three basins included in this study in order to identify several locations where facilities could be constructed or on-site practices could be implemented. Several of the locations were taken from a previous storm water management study conducted in the area in 2008.

With the potential location of the facilities determined, the surrounding drainage basins were studied to determine the boundaries and hydrologic characteristics of the land contributing storm water runoff to the proposed alternative locations. The contributing area in each basin is a mix of commercial, industrial and densely populated residential land uses, leading to intense pollutant loadings that drain directly into the City's water resources. The drainage area delineations previously completed as part of the 2008 study were updated and sub-basins were also delineated within each basin to provide more detail of the contributing areas. These sub-basins were studied extensively to obtain all important hydrologic information, including flow paths and times of concentration, topographic and land use details, soils information, and historical precipitation data. This information was integrated into a baseline hydrograph model using the Hydraflow Hydrographs Extension for AutoCAD Civil 3D. The model yielded storm water volumes and peak rates of runoff in each of the sub-basins for the 2, 10 and 100-year storm events.

After the baseline model was established, several storm water facility configurations were analyzed for each of the three basins. The reduction in peak flows at the basin outlet was assessed for each of these configurations under varying storm events. In basins with more than one proposed facility, different combinations were analyzed producing an estimated peak flow reduction for each model setup.

Pollutant reductions were modeled for each proposed storm water facility on an individual basis. The Source Loading and Management Model (WinSLAMM Version 10.1) was used to calculate the probable pollutant loadings under existing land use conditions with no storm water controls and again with existing storm water controls (street sweeping, grass swales, detention ponds, infiltration facilities, etc.). Finally, the alternatives selected for evaluation were modeled using WinSLAMM to estimate average annual pollutant reductions as a result of the proposed alternatives.

For the smaller, on-site control measures, GIS technology was used to find locations with sufficient area where these practices could be installed. In addition, the City's road ratings and road construction schedule were considered in selecting areas for smaller storm water practices. Reconstruction of public roads and facilities gives the City the opportunity to redirect runoff to more beneficial areas or to install treatment practices that will improve water quality and slow the release of water during a rain event in a cost-effective manner. Also, as redevelopment opportunities arise on privately-owned parcels, some properties will have the potential to improve the water quality and drainage problems downstream by implementing these small-scale storm water management practices.

Summit Avenue Basin

The Summit Avenue basin has approximately 160 acres of total contributing area. This basin includes medium density residential neighborhoods, a large portion of the ProHealth Care Oconomowoc Memorial Hospital campus, and a sizeable amount of industrial land use near the outlet of the basin. The basin drains north to Fowler Lake, so it is considered part of the upstream portion of TMDL Reach 25 in this study.

The first storm water alternative considered in this basin was the "Hospital Pond", labeled "PA-3" in Exhibit 4. As mentioned in the introduction of this study, Forest Street was recently realigned north of the hospital campus, providing additional open area to augment the storage capacity of the existing pond. This facility would be a wet pond located south of the intersection of Forest Street and Summit Avenue and would be an enlargement of the existing hospital facility. The conceptual design is a trapezoidal shape approximately 1.0 acre in size with 300,000 ft^3 of total storage. The pond would reduce total suspended solids from the contributing drainage area by 68.7% and total phosphorus by 43.9%. This facility would require an agreement with the hospital as it would be combining with their storm water facility. A separate facility from the hospital could be constructed entirely within the City right-of-way; however, it would be smaller and produce less water quality benefits. There are no known special environmental conditions to be considered in the design process. This facility would have an estimated project cost of $236,000 and a total present worth of approximately $411,000.

The second wet pond alternative is the "Summit Avenue Pond", and is labeled "PA-2" in Exhibit 5. This facility is located across the street from the hospital on Forest Street. This particular facility was considered for implementation only to augment the storage of the Hospital Pond if the water quality and quantity effects were found to be significant; thus, the pond was only incorporated into the model in conjunction with PA-3. The conceptual design is conical, fitting the surrounding landscape, with approximately 2.2 acres of surface area and 570,000 ft^3 of total storage. The pond in conjunction with the Hospital Pond would reduce total suspended solids from the contributing drainage area by 41.3% and total phosphorus by 22.8%. This facility would require land acquisition, as the property is not owned by the City. There are no known special environmental conditions to be considered in the design process. These facilities would have a combined, estimated project cost of $686,000 and a total present worth of approximately $1,185,000.

Finally, the "Industrial Pond" is labeled "PA-1" in Exhibit 6 and is located east of Lyman Street near the railroad tracks. This facility is located near the outlet of the basin and receives significant flows. In addition, the area is prone to flooding because of surcharging from the lake. For this reason, the pond was conceptually designed with only water quality benefits in mind. The design also includes a cost for a basic pumping station to convey excess quantities of storm water to the lake. The Industrial Pond is a conical design, fitting the surrounding area which has wetlands in the northeast corner of the site, a shallow water table, and hydric soils. One other concern with the surrounding area is the unknown contents of the existing soil as much of this area is fill material. The pond is approximately 1.4 acres in size with 400,000 ft^3 of total storage. It would reduce total suspended solids from the contributing drainage area by 52.7% and total phosphorus by 31.8%. This facility would have an estimated project cost of $557,000 and a total present worth of approximately $1,152,000.

The results of the hydrograph model with respect to the outlet of the basin are summarized below in Table 1, showing several different pond combinations and three sizes of storm events.

Table 1 -- Peak Flow Reductions from the Summit Avenue Basin

Pond Configuration	2-Year Flow (cfs)	% Reduction	10-Year Flow (cfs)	% Reduction	100-Year Flow (cfs)	% Reduction
Existing Flow	121.0	0.0%	249.1	0.0%	450.0	0.0%
Hospital Pond Expansion	98.2	18.8%	212.8	14.6%	392.3	12.8%
Hospital Pond + Summit Avenue Pond	98.3	18.8%	212.2	14.8%	390.9	13.1%
Industrial Pond	43.5	64.0%	236.4	5.1%	444.9	1.1%
Hospital Pond + Industrial Pond	33.4	72.4%	182.1	26.9%	388.3	13.7%

The results in Table 1 show that fairly sizable peak flow reductions are attainable at the basin outlet. The most effective pond configuration includes the Hospital Pond and the Industrial Pond working in conjunction achieving peak flow reductions of approximately 72%, 27%, and 14% for 2-Year, 10-Year, and 100-Year storms, respectively.

The following list gives the location of several proposed on-site projects in the Summit Avenue basin which are also shown in Exhibit 1. When used in conjunction with each other, these projects would add additional reductions of pollutants reaching the downstream waters. Also, some practices may reduce the speed and quantity of storm water, reducing the frequency of flooding problems. Additional evaluation of site conditions would need to be completed prior to determining a final design on any of these projects.

- Pond at the North End of Dowd Court: There is a small pond (approximately 0.25 acres) at the north end of Dowd Court. The ownership of this pond should be reviewed, and potential modifications should be considered.

- Dry Pond West of Armour Court: There is a dry pond to the west of Armour Court which appears to drain the adjacent parking lots. This structure should be evaluated further to determine if it can be retrofitted into a storm water facility that could be used for water quality benefits.

- City Lot East of Houses on Lyman Street: Installation of storm sewer or grass swales could direct runoff from nearby streets to a storm water pond or infiltration basin on this parcel. Further investigation of site-specific conditions would need to be completed.

- Lake Country Estates Condominiums: Installation of infiltration trenches or permeable pavement around the edges of the existing parking lots could capture and treat runoff from this area, minimizing the pollutants and excess water flowing toward Fowler Lake. In addition, rain gardens constructed in the green space could receive runoff from parking areas or from rooftop downspouts.

- High Street: Infiltration trenches or bays on both sides of High Street could capture and treat the runoff originating on the road, as well as any water coming from private properties including rooftop, sidewalk and driveway runoff. Strategically placed rain garden bays to capture runoff may be an amenity for residents. The current pavement rating on this street is 4.

- Intersection of Charles Street and Lyman Street: Curb cuts can direct road runoff to an infiltration bay on the railroad side of S. Charles Street outside the railroad right-of-way.

- North End of Lapham Street: Install an infiltration or bioretention basin at the northern end of Lapham Street. This basin would capture and infiltrate runoff from streets and hard surfaces at 428 Lapham Street (west side of road) and 425 Lapham Street (east side of road).

- North End of Armour Road, West of Lapham Street: Strategically install infiltration trenches behind pavement to capture and treat runoff from Armour Road.

- Green Street Design and Infiltration Trenches around Private Parking Lots: In general, the Summit Avenue basin contains large amounts of impervious surfaces. It is recommended that business owners in the industrial portion of the basin be contacted and that practices designed to infiltrate runoff from their properties be discussed. Along these lines, the City should look for opportunities to replace impervious surfaces with pervious pavement (i.e. sidewalks, alleys, etc.).

- Neighborhood-Wide Rain Barrel Program: Based on the amount of medium density residential neighborhoods present in this basin, a rain barrel program may be effective in reducing local storm water from entering the system. This program may also enhance community education and involvement in the City's effort to achieve its storm water-related goals.

Thackeray Trail Basin

The Thackeray Trail basin has approximately 235 acres of total contributing area. This area includes a large amount of medium density residential neighborhoods, some commercial/industrial areas including a former gas station site and a car dealership, and segments of the ProHealth Care Oconomowoc Memorial Hospital and high school campuses. The campuses and the accompanying open area drain directly to the basin outlet and thus are not considered as a contributing area to any of the ponds in this basin's hydrograph analysis. The basin as a whole drains to the southeastern end of Thackeray Trail and is considered part of the downstream portion of TMDL Reach 25.

The first site-specific storm water facility alternative in this basin is the "Gas Station Pond", and is labeled "PA-4" in Exhibit 7. This potential facility is located near the split of STH 67 Bypass and Summit Avenue at the vacant lot of a former gas station. It receives flow from the neighborhoods north and west of the location including both major roadways. This facility would be a wet pond with a conceptual design that is a triangular in shape to fit the lot. It is approximately 0.95 acres in size with 425,000 ft^3 of total storage. The pond would reduce total suspended solids from the contributing drainage area by 68.4% and total phosphorus by 50.6%. This facility would require land acquisition, as the property was recently sold. Also, the site is suspected to have contaminated soils as a result of its former use as a gas station. This facility would have an estimated project cost of $665,000 (including additional costs for contaminated soil disposal) and a total present worth of approximately $991,000.

The other wet pond alternative in this basin is the "Whitman Park Pond", and is labeled "PA-5" in Exhibit 8. This facility is located near the outlet of the basin on the southwestern end of Thackeray Trail. This pond was conceptually designed with only water quality benefits in mind because of its location near the outlet and adjacent wetlands. The conceptual design is conical, fitting the surrounding landscape, with approximately 1.5 acres of surface area with 400,000 ft^3 of total storage. The pond would reduce total 38.8% suspended solids from the contributing drainage area by 56.8% and total phosphorus by 50.1%. Environmental conditions in this area are a significant concern as preliminary investigation shows that the proposed facility is adjacent to wetlands and the park contains hydric soils. Further investigation would need to be conducted before the design of this wet pond. This facility would have an estimated project cost of $301,000 and a total present worth of approximately $529,000.

The results of the hydrograph model with respect to the outlet of the basin at Thackeray Trail are summarized below in Table 2, showing several different pond combinations and three sizes of storm events.

Table 2 -- Peak Flow Reductions from the Thackeray Trail Basin

Pond Configuration	2-Year Flow (cfs)	% Reduction	10-Year Flow (cfs)	% Reduction	100-Year Flow (cfs)	% Reduction
Existing Flow	64.3	0.0%	143.2	0.0%	273.1	0.0%
Gas Station Pond	42.6	33.7%	100.9	29.5%	207.6	24.0%
Whitman Park Pond	31.5	51.0%	137.6	3.9%	272.3	0.3%
Gas Station + Whitman Park Pond	10.0	84.4%	60.8	57.5%	163.9	40.0%

Again, the results of the hydrograph analysis show that significant peak flow reductions are attainable at the basin outlet. The most effective pond configuration includes both the Gas Station and the Whitman Park Ponds. In combination, the ponds achieve peak flow reductions of approximately 84%, 58%, and 40% for 2-Year, 10-Year, and 100-Year storms, respectively.

As a part of the Thackeray Trail basin analysis, a conceptual design was made for the reconstruction of Thackeray Trail, which can be seen in Exhibit 9 (a) and (b). The road reconstruction would include the narrowing of the street and installation of curb and gutter on all sides of the boulevard. The street would contain a number of storm inlets to collect water that accumulates on the street itself and convey it to biofiltration facilities with underdrains on either side of the trail. The upstream flow contributions would be captured in a storm pipe and conveyed under the biofiltration facilities on the north side of the street to the outlet of the basin. Additional water quality reductions could also be achieved if permeable pavement was installed on the outside edges of the proposed street reconstruction. The reconstruction would reduce total suspended solids from the contributing drainage area by 82.4% and total phosphorus by 73.6%. The estimated project cost and total present worth of the reconstruction of Thackeray Trail are $2,792,000 and $3,555,000, respectively.

In addition to the conceptual design for Thackeray Trail itself, the following storm water practices (shown in Exhibit 2) should be considered for the Thackeray Trail basin:

- <u>Underground Storage at Safro Ford (1000 Summit Ave.):</u> Contaminated soils may make construction of a large pond at the former gas station site (1004 Summit Ave.) across the road quite costly. An underground storage system at the Safro Ford car dealership in conjunction with a smaller pond at the former gas station site may offer the same benefits pollutant reduction benefits at a lower cost. Further investigation of the existing soils at the Ford dealership will need to be done, as the DNR's information indicates contamination may have spread to this area.

- Permeable Pavement or Infiltration Trenches in the Lake Country Dentist Parking Lot: Rooftop drainage could be directed toward rain gardens to capture runoff, reducing the volume of water flowing toward Thackeray Trail. Parking lot runoff could be reduced by re-configuring the lots to include bio-retention islands, infiltration basins on the edges of the parking lots, or permeable pavement options in strategic areas of the lots.

- Permeable Pavement or Infiltration Trenches along the Parking Lot Edges and Rain Gardens to Receive Rooftop Runoff at Wilkinson Clinic: Less than 1.0 acre of the 3.6 acre lot is currently pervious. Infiltrating water on-site would reduce the amount of runoff contributing to the Thackeray Trail storm system. Rooftop runoff could be directed toward rain gardens to infiltrate rather than run across hard surfaces, picking up pollutants on the way to the Thackeray Trail storm system. Runoff from parking lots could be directed toward reconfigured parking lots, including islands with bioretention cells. Other parking lot alternatives include directing storm water toward the parking lot edges where infiltration cells could be installed, or toward strategic areas of permeable pavement.

- Infiltration Trenches or Green Street design along the East Side of Thackeray Trail: Rooftop water and runoff from Thackeray Trail immediately south of the intersection with Summit Avenue could be directed to infiltration or bioretention basins between the west side of the building and Silvernail Shopping Center parking lot. This option would improve water quality and reduce the amount of runoff reaching Thackeray Trail.

- Byron Drive, Whittier Lane and Emerson Drive: Curb cuts leading to infiltration bays or trenches in strategic locations on Byron Drive, Whittier Lane and Emerson Drive would allow for water to be captured and treated on site, reducing the amount of water reaching the downstream Thackeray Trail areas during a heavy rain event. Narrowing the roads would provide room for infiltration bays or trenches and reduce the amount of impervious surface. These streets are currently rated 3's or 4's in existing pavement ratings, and are being considered for an overlay project in the near future. Overflow pipes would direct excess water to the existing storm sewer underground during heavy rains or frozen ground rain events.

- Lowell Drive: Bioretention or infiltration trenches could be installed on the north side of Lowell Drive to capture rooftop runoff from the apartment buildings. Overflow pipes would direct excess water to the existing storm sewer underground during heavy rains or frozen ground rain events. These projects would reduce the amount of runoff getting to the Thackeray Drive storm system and Whitman Park.

- Hidden Ridge and Old Tower Road: This area includes a large subdivision without storm water controls. The goal would be to capture and treat storm water on-site and to reduce the amount of runoff reaching the Thackeray Trail system. This could be accomplished with the following strategies:
    - Capture runoff in center of cul-de-sacs with infiltration basins.
    - Install infiltration basins or trenches behind curbs with curb-cuts on alternating sides of the streets
    - Run a narrow, multi-basin infiltration system through the park area near the walking trail and direct runoff from Tanglewood Court toward basins. Overflow from cul-de-sac centers could flow under roads and toward outlots with walking trails leading off of each of the cul-de-sacs.

- Green Street Design and Infiltration Trenches around Private Parking Lots: The Thackeray Trail basin also contains large amounts of impervious surfaces. The City should look for opportunities to replace impervious surfaces with pervious pavement (i.e. sidewalks, alleys, etc.) or incorporate green street designs where appropriate.

- Neighborhood-Wide Rain Barrel or Rain Garden Program: Based on the amount of medium density residential neighborhoods present in this basin, a rain barrel or rain garden program may be effective in reducing local storm water from entering the system. This program may also enhance community education and involvement in the City's effort to achieve its storm water-related goals.

Forest Street Basin

The Forest Street basin has approximately 175 acres of total contributing area. This area includes mostly medium density residential neighborhoods with some open and wooded areas. The basin drains west towards the Oconomowoc River, so it is considered part of the downstream portion of TMDL Reach 25 in this study.

The first pond alternative in the Forest Street basin was the "Serve Facility Pond", and is labeled "PA-6" in Exhibit 10. The Serve Facility is to be constructed near the intersection of Forest Street and Main Street on the former Department of Public Works (DPW) yard. The storm water facility would be a wet pond located south of the proposed Serve Facility just west of Jean Street. The conceptual design is a triangular shape fitting the surrounding area which has wetlands directly to the west, a shallow water table, and hydric soils. These features make this proposed pond location uncertain, requiring further investigation of the soils and surrounding environmental corridors before design. The potential pond is approximately 1.0 acre in size with 460,000 ft^3 of total storage. The pond would reduce total suspended solids from the contributing drainage area by 58.4% and total phosphorus by 37.4%. This facility would have an estimated project cost of $441,000 and a total present worth of approximately $725,000.

The second wet pond alternative in this basin is the "Forest Street Pond", and is labeled "PA-7" in Exhibit 11. This facility is located on a City owned parcel on S. Worthington Street in an open area north of the DPW garage. For the purposes of this conceptual design, the pond was assumed to cover most of the open area. The pond shape is trapezoidal with a size of approximately 1.9 acres and 645,000 ft^3 of total storage. The pond would reduce total suspended solids from the contributing drainage area by 62.1% and total phosphorus by 43.8%. There are no known special environmental conditions to be considered in the design process. This facility would have an estimated project cost of $485,000 and a total present worth of approximately $847,000.

The results of the hydrograph model with respect to the outlet of the basin are summarized below in Table 3, showing several different pond combinations and three sizes of storm events.

Table 3 -- Peak Flow Reductions from the Forest Street Basin

Pond Configuration	2-Year Flow (cfs)	% Reduction	10-Year Flow (cfs)	% Reduction	100-Year Flow (cfs)	% Reduction
Existing Flow	47.3	0.0%	116.1	0.0%	232.4	0.0%
Forest Street Pond	20.0	57.7%	50.7	56.3%	189.8	18.3%
Serve Facility Pond	18.4	61.1%	54.7	52.9%	224.7	3.3%

Table 3 suggests that the most effective pond alternative is the Forest Street Pond achieving peak flow reductions of approximately 58%, 56%, and 18% for 2-Year, 10-Year, and 100-Year storms, respectively. However, note that both Forest Street basin alternatives are near the outlet of the basin, so the primary benefit of both ponds would be water quality-related. For this reason, it is recommended that only one of the two ponds be considered for design.

An additional step in the analysis of the Forest Street basin was to analyze the capacity of the existing storm water system in light of localized flooding issues in the basin. The system was modeled using Hydraflow Storm Sewer Extension for AutoCAD Civil 3D to determine if the existing pipes met current design standards. 4,424 feet of the existing system was inputted to the model along with information regarding the contributing area. Various storm sizes were simulated and flow through the system was evaluated. The initial modeling assessment of the system showed that the existing storm sewer system was significantly undersized given the approximate flows of the contributing area. In order to contain a 10-year storm within the system, 60-inch diameter pipes were required at a cost of approximately $1,023,000, making the effort cost-prohibitive. Alternatively, the entire system could be upsized to 48-inch pipes at a cost of approximately $712,000 to contain a 2-year storm.

An alternative scenario was also modeled using the storm water model in the Forest Street basin. In this scenario, the upstream section of the system prone to flooding was provided a dedicated storm pipe to convey the flows from that section independently from the existing system. The results of this analysis were more promising from a storm water management standpoint. The dedicated storm sewer could contain a 10-year storm with 36-inch pipe at a cost of $533,000, and a 100-year storm with 42-inch pipe at a cost of $622,000. These alternatives give the most cost-effective approach to alleviating the flooding issues in the Forest Street basin.

It is recommended that additional storm water management methods be explored by the City to alleviate the storm water issues in this area. The following alternatives (shown in Exhibit 3) should be considered for the Forest Street basin:

- Westover Street, Adjacent to Westover Park: Curb cuts can direct runoff from Westover Street to an infiltration basin in the right-of-way on the east side of the park. Pitching the road slightly to the west to direct sheet flow toward the curb cuts would prevent this runoff from flowing directly to the storm sewer inlets, minimizing the amount of water flowing through the storm sewer system during a rain event and allowing the pollutants to be filtered out in the infiltration trench. This street is also being considered for an overlay project in the next 5-10 years.

- Green Street Design along Forest Street Near Roosevelt Field Park: Cars currently park along the north and the south sides of Forest Avenue to access the park facilities. This wider street cross section produces more runoff than an average street cross section. Pitching the road to the north or the south would allow runoff to flow into infiltration or bio-retention bays and trenches and help mitigate this increased amount of runoff. An alternative would be the installation of permeable pavers or asphalt to allow runoff to soak in, rather than flow toward the nearest storm sewer inlet. An overflow pipe would direct excess runoff to the storm sewer to avoid flooding issues.

- Southeast Corner of Roosevelt Park: An infiltration basin could be located at the southeast corner of Roosevelt Park to take on runoff flowing west from Forest Street and south from Main Street. This would improve water quality in the Oconomowoc River by capturing runoff (and pollutants) at the source, as well as by reducing the amount of water flowing through the existing storm sewer system during rain events. An infiltration basin can be designed and configured with plants and bridges over a multiple-cell structure to enhance the entry way to the park from the parking area. This street is also being considered for a reconstruction project in the next 5 years.

- Green Street Design with Infiltration Trench along North Side of Bolson Drive: The apartment complexes located north of Bolson Drive and south of Frederick Court contain mostly impervious surfaces where rain and melting snow cannot soak into the ground. Infiltration trenches along the road would receive road runoff from the adjacent streets and possibly from apartment building roof tops and parking areas, depending on the size of the trenches. Overflow standpipes connected to existing storm sewer system would allow runoff during large rain events or during frozen ground conditions to flow to the storm system to prevent flooding issues. Bolson Drive and Frederick Court are both listed as 3's on the pavement rating rankings, and are also being considered for a reconstruction project in the next 5 years.

- Neighborhood-Wide Rain Barrel/Rain Garden Program: Based on the amount of medium density residential neighborhoods present in this basin, a rain barrel or rain garden program may be effective in reducing local storm water from entering the system. This program may also enhance community education and involvement in the City's effort to achieve its storm water-related goals.

SUMMARY AND RECOMMENDATIONS

Table 4 below summarizes the cost information related to each of the recommended alternatives. Appendix C breaks down the cost formulation for each of the site-specific alternatives in more detail for reference.

Table 4 – Present Worth Cost Estimates for Recommendations

Watershed	Component Description	Project Cost	Incremental Annual O & M Cost	Present Worth Cost
Summit Avenue Basin	PA-1 (Industrial Pond)	$557,090	$18,400	$1,151,829
	PA-3 (Hospital Pond)	$236,218	$5,950	$410,505
	On-Site Alternatives	-	-	-
Thackeray Trail Basin	PA-4 (Gas Station Pond)	$665,366	$8,250	$991,483
	Thackeray Trail Reconstruction	$2,792,463	$3,350	$3,555,457
	On-Site Alternatives	-	-	-
Forest Street Basin	PA-7 (Forest Street Pond)	$484,703	$12,450	$846,995
	Storm Sewer Relief (42-inch)	$622,402	$1,000	$797,369
	On-Site Alternatives	-	-	-

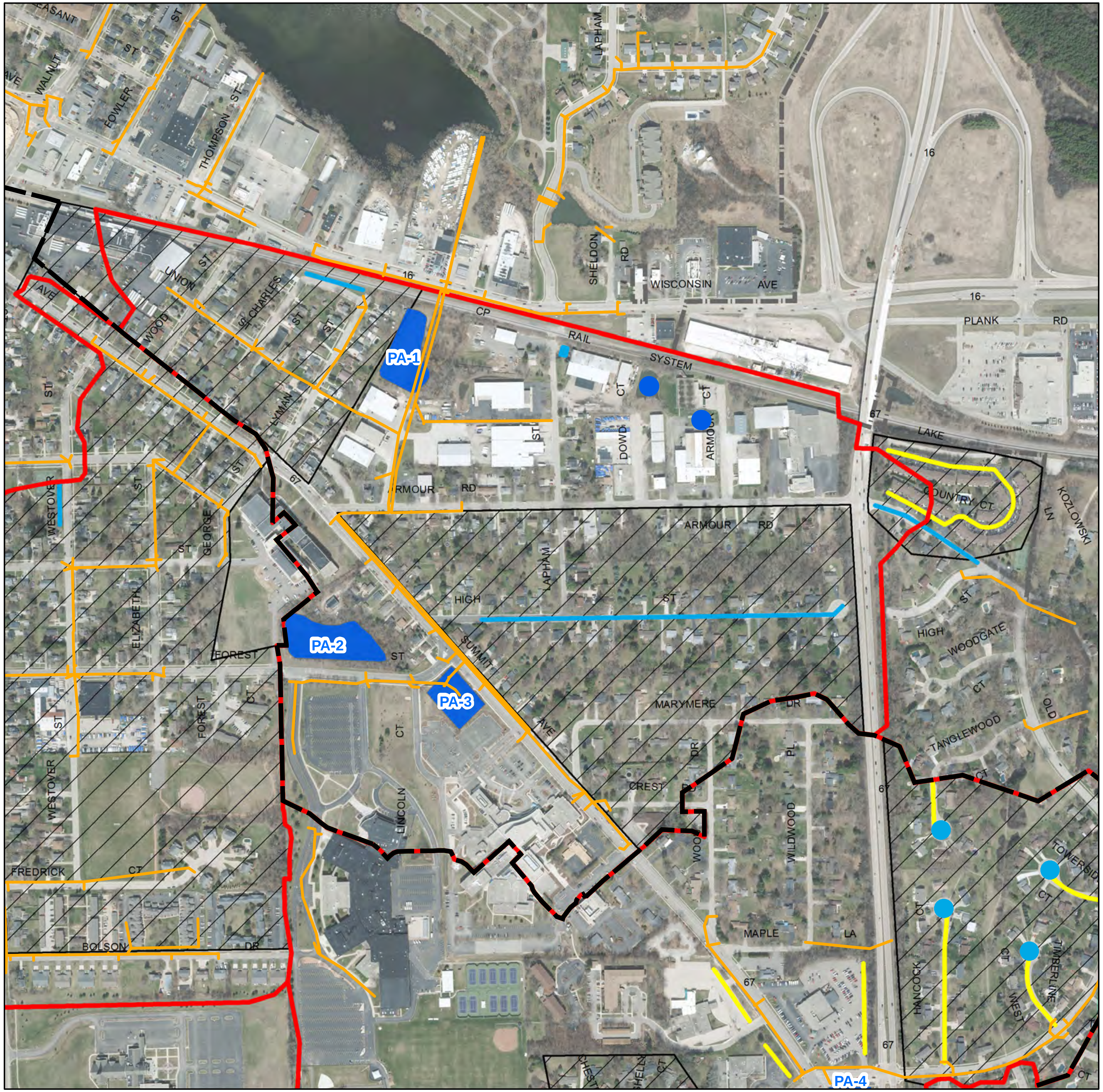
The recommended set of site-specific alternatives for the Summit Avenue basin is the Hospital Pond in combination with the Industrial Pond. This combined set of alternatives provides the most significant peak flow reductions in the basin while also giving water quality benefits at two locations in the basin before discharging to Fowler Lake. The Summit Avenue Pond did not provide any notable peak flow reductions because of its proximity to the Hospital Pond. It is also recommended that the smaller, on-site alternatives shown in Exhibit 1 and described above be implemented in recommended areas around the basin.

For the Thackeray Trail basin, it is recommended that two of the site-specific alternatives be explored in more depth: the Gas Station Pond and the Thackeray Trail Reconstruction. In combination, these two alternatives could simultaneously alleviate storm water quantity and quality issues facing the Thackeray Trail area. The Gas Station Pond would consistently cut down peak flow rates to Thackeray Trail for a variety of storm sizes. Consequently, the conceptual design for the Thackeray Trail Reconstruction alternative could be downsized, saving money on that project. In addition to addressing flooding issues facing Thackeray Trail, the recommended alternatives could provide substantial water quality benefits. The drawbacks of the recommended alternatives include the sizeable capital costs involved in each of the projects; however, the benefits of the recommendation could outweigh the cost when both water quality and quantity benefits are evaluated. Other drawbacks include questions about the ownership of the gas station site and the possible soil contamination at the site. Both of these issues need to be investigated and evaluated before design of the Gas Station Pond can proceed. It is important to note that underground storage at the adjacent car dealership could provide similar benefits to the area if this option is deemed more advantageous than the Gas Station Pond alternative. In addition, it is recommended that the numerous opportunities for smaller-scale storm water management alternatives in this basin be explored. In particular, the alternatives highlighted in the northeast portion of the basin could reduce flows to Thackeray Trail and provide water quality benefits. The Whitman Park Pond is not recommended in this study because of concerns regarding the environmental impact of facility construction at that site. It is likely that a storm water facility could not be constructed because of the adjacent wetlands and existing hydric soils.

The Forest Street Pond is the most effective storm water solution available in the Forest Street basin. The City already owns the lot, and significant water quality benefits are attainable with this facility. In light of the proximity of the two proposed ponds in this basin as well as the environmental impact concerns associated with the Serve Facility Pond, this alternative is not recommended for design. The results of the storm water analysis revealed that a dedicated storm sewer for the upstream portion of the system could divert sizeable flows from the existing system to reduce flooding. It is recommended that a dedicated 42-inch pipe be installed which can contain 100-year storm flows from the upstream portion of the Forest Street basin. In addition to the storm sewer relief alternative, the implementation of the other proposed alternatives in the Forest Street basin is recommended. There is a large amount of medium density residential neighborhoods in the area, so rain barrel and/or rain garden program could be particularly effective. In addition, the amount of smaller alternatives in the Forest Park Street area could provide additional water quality benefits to the basin.

APPENDIX A

PROPOSED ALTERNATIVE EXHIBITS



Life comes NATURALLY here

Water Pollution Reduction Project
Summit Avenue Basin
Exhibit 1

Legend

- Storm Water Pond / Infiltration Basin
- Permeable Pavement
- Bioretention / Infiltration Basin
- Rain Barrel / Rain Garden Program
- Proposed Alternative
- Drainage Area
- Existing Storm Sewer
- Upper/Lower Reachshed Boundary
- Oconomowoc Boundary - City Limits

N
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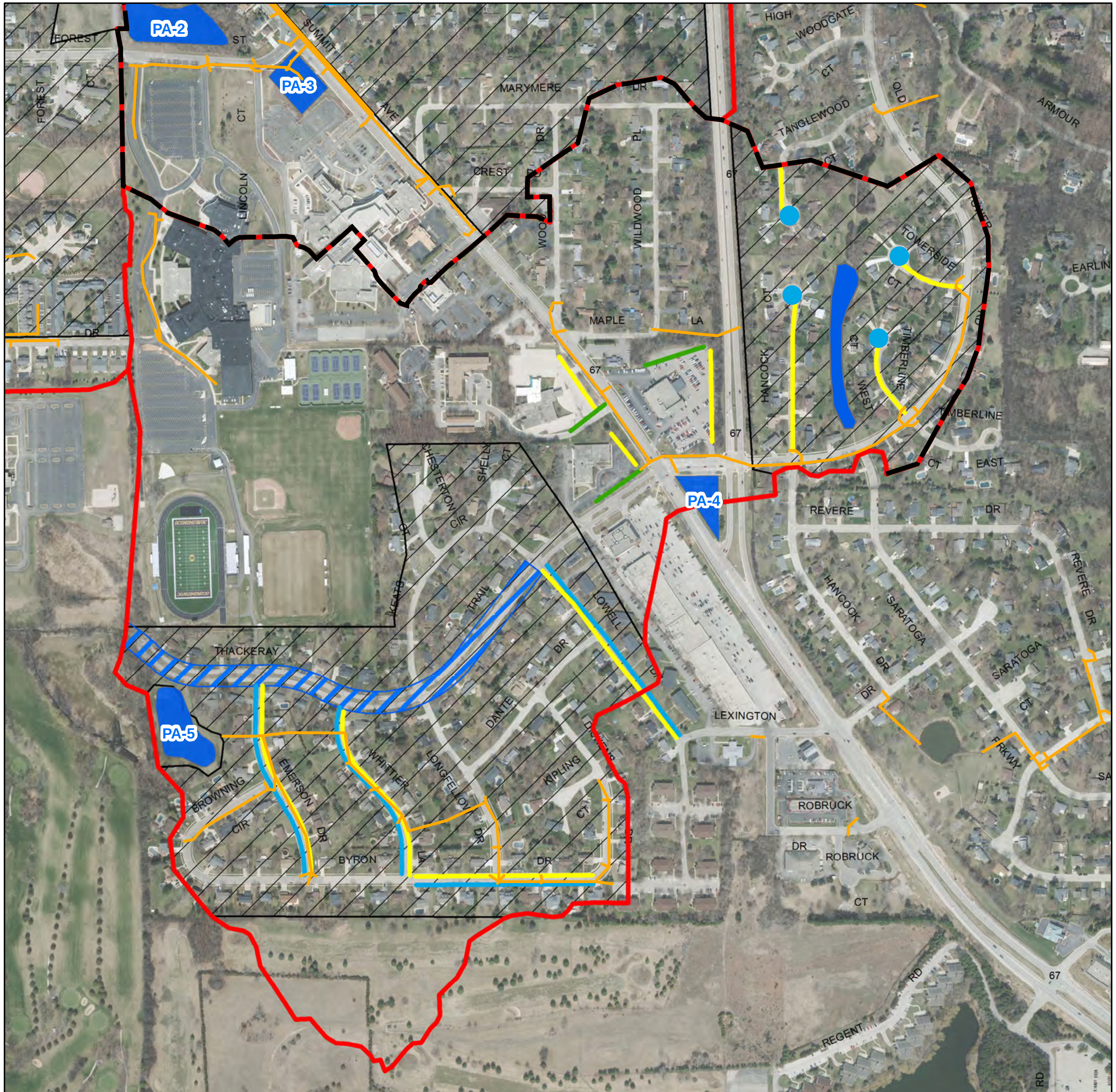
0 250 500 1,000 1,500
Feet

Date: December, 2105

Ruekert·Mielke



Water Pollution Reduction Project
Thackeray Trail Basin
Exhibit 2

Legend

- Storm Water Pond / Infiltration Basin
- Permeable Pavement
- Underground Storage Trenches
- Bioretention / Infiltration Basin
- Rain Barrel / Rain Garden Program
- Proposed Alternative
- Drainage Area
- Existing Storm Sewer
- Upper/Lower Reachshed Boundary
- Oconomowoc Boundary - City Limits

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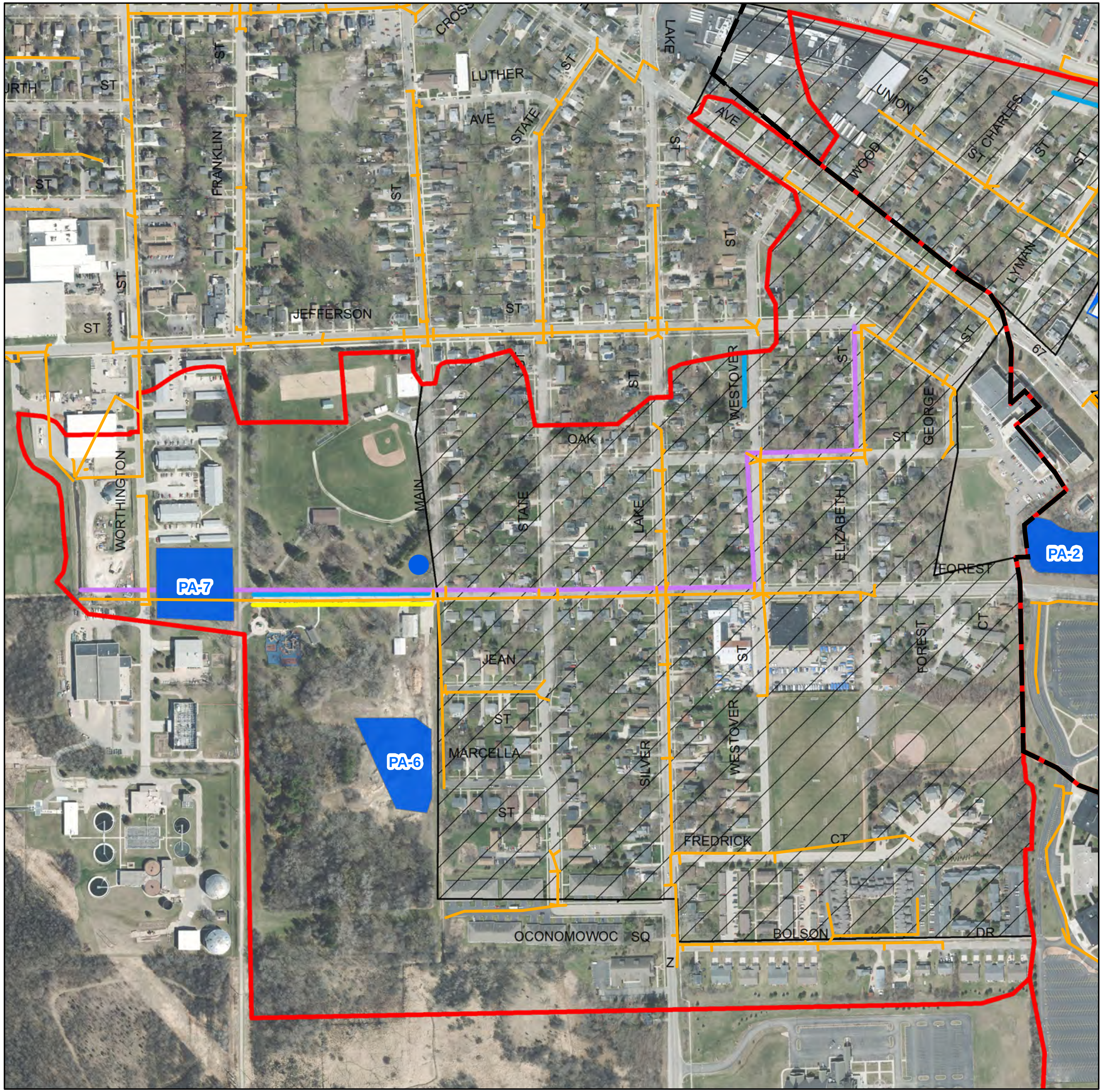
Feet

Date: December, 2105

Ruekert · Mielke



Life comes NATURALLY here

Water Pollution Reduction Project
Forest Street Basin
Exhibit 3

Legend

- Storm Water Pond / Infiltration Basin
- Permeable Pavement
- Underground Storage Trenches
- Bioretention / Infiltration Basin
- Dedicated Upstream Relief Storm Sewer (42")
- Rain Barrel / Rain Garden Program
- Proposed Alternative
- Drainage Area
- Existing Storm Sewer
- Upper/Lower Reachshed Boundary
- Oconomowoc Boundary - City Limits

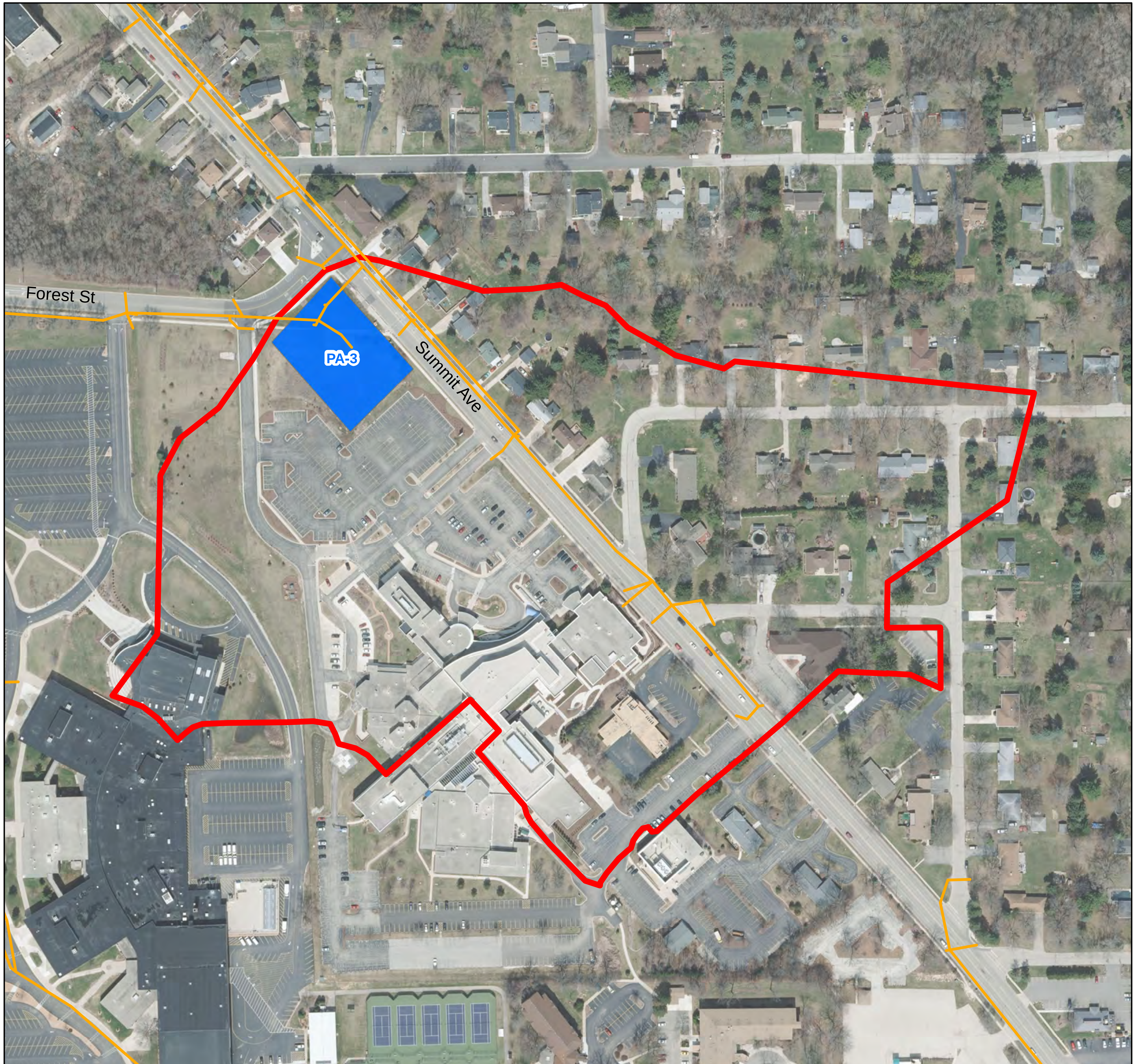
N W E S

0 200 400 800 1,200

Feet

Date: December, 2105

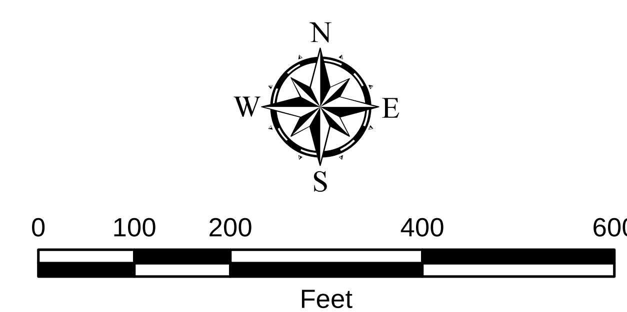
Ruekert·Mielke



Proposed Wet Detention Alternative PA-3 Oconomowoc River (Upstream) Reachshed Exhibit 4

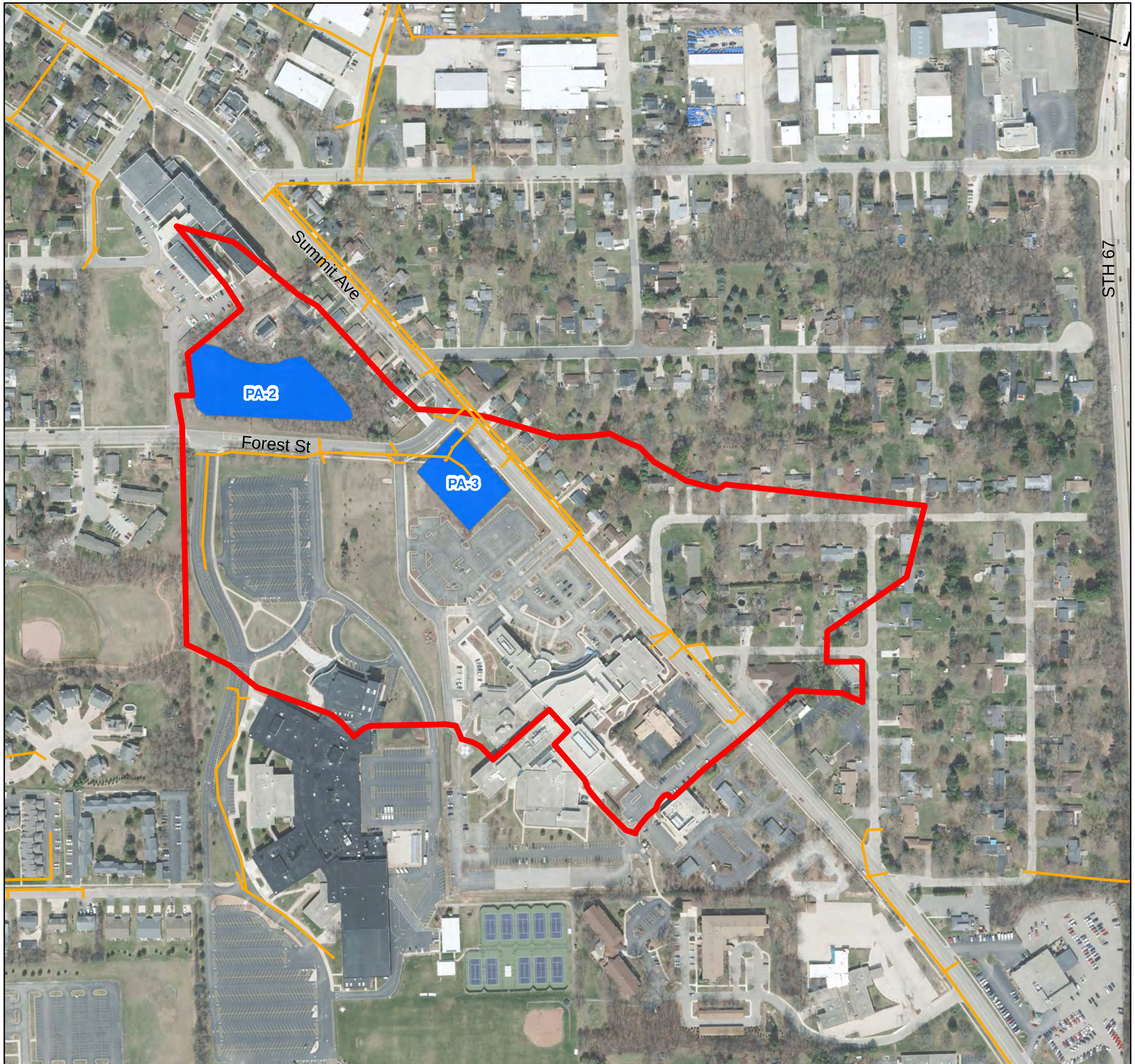
Legend

- Existing Storm Sewer
- Proposed Alternative
- Drainage Area to Proposed Alternative



Date: December, 2015

Ruekert · Mielke



Life comes NATURALLY here

Proposed Wet Detention Alternative PA-2 & PA-3 Oconomowoc River (Upstream) Reachshed Exhibit 5

Legend

- Existing Storm Sewer
- Proposed Alternative
- Drainage Area to Proposed Alternative
- Oconomowoc Boundary - City Limits

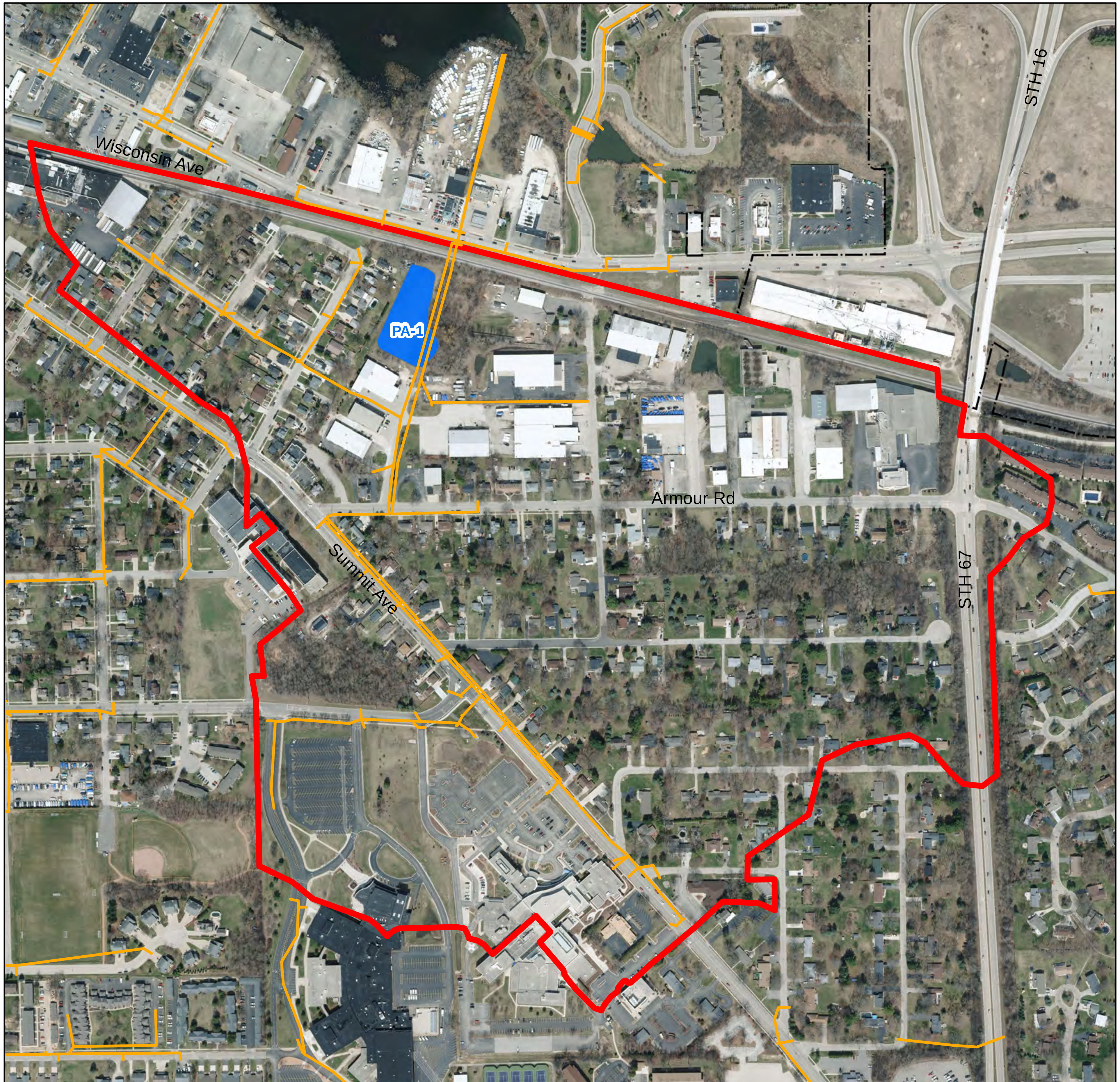
N W E S

0 150 300 600 900

Feet

Date: December, 2015

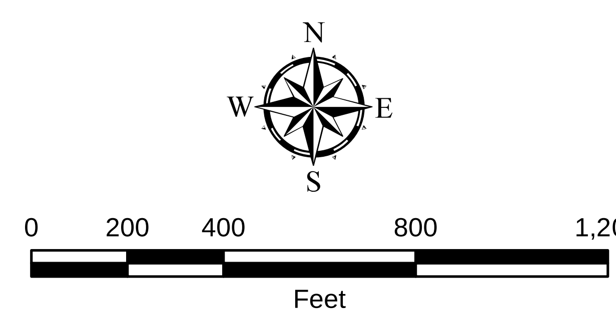
Ruekert · Mielke



Proposed Wet Detention Alternative PA-1 Oconomowoc River (Upstream) Reachshed Exhibit 6

Legend

- Existing Storm Sewer
- Proposed Alternative
- Drainage Area to Proposed Alternative
- Oconomowoc Boundary - City Limits



Date: December, 2015

Ruekert·Mielke

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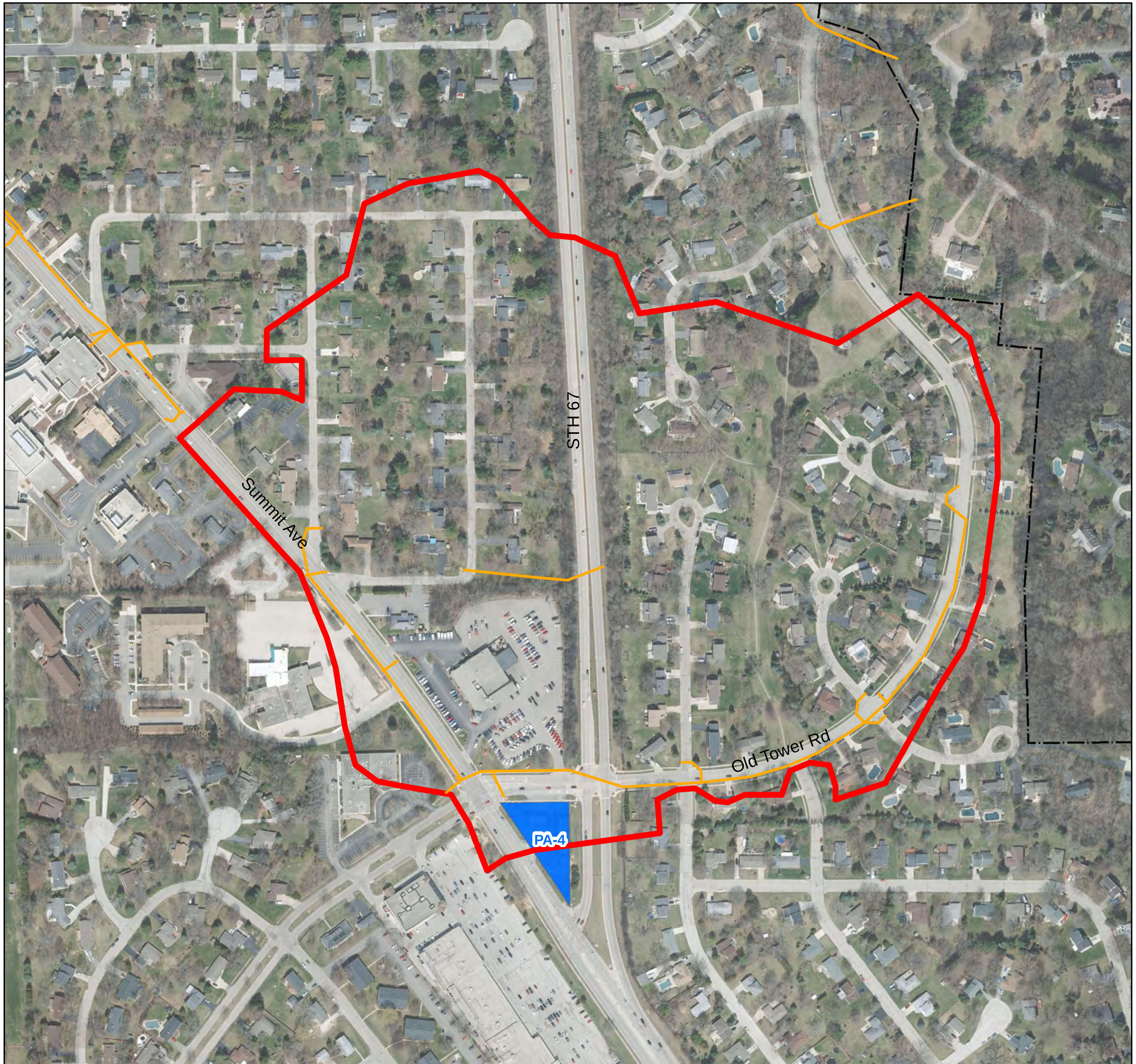

Life comes NATURALLY here

Proposed Wet Detention Alternative PA-4 Oconomowoc River (Downstream) Reachshed Exhibit 7

Legend

- Existing Storm Sewer
- Proposed Alternative
- Drainage Area to Proposed Alternative
- Oconomowoc Boundary - City Limits

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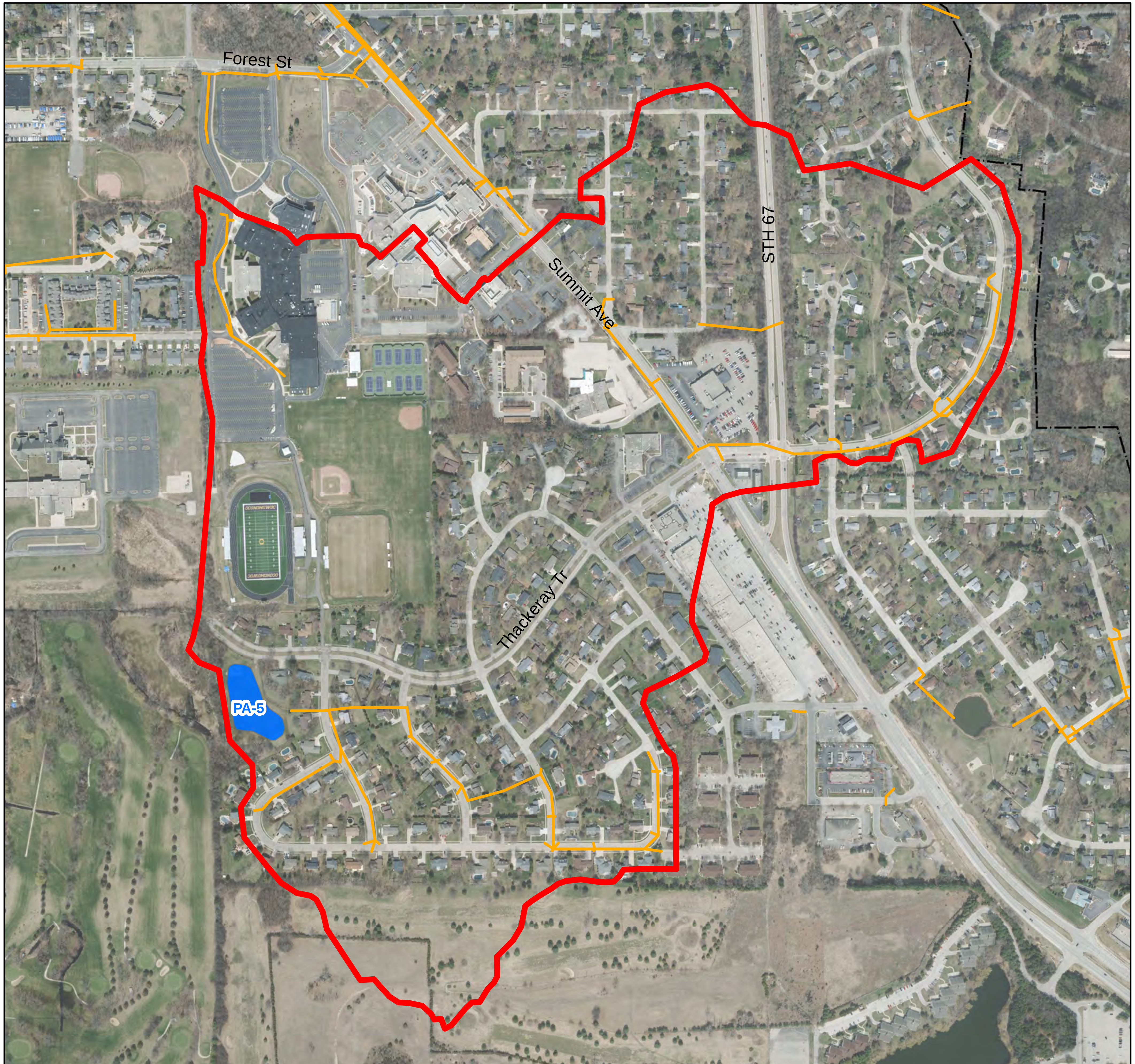
Feet

Date: December, 2015

Ruekert · Mielke



Life comes NATURALLY here

Proposed Wet Detention Alternative
PA-5 Oconomowoc River (Downstream) Reachshed
Exhibit 8

Legend

- Existing Storm Sewer
- Proposed Alternative
- Drainage Area to Proposed Alternative
- Oconomowoc Boundary - City Limits

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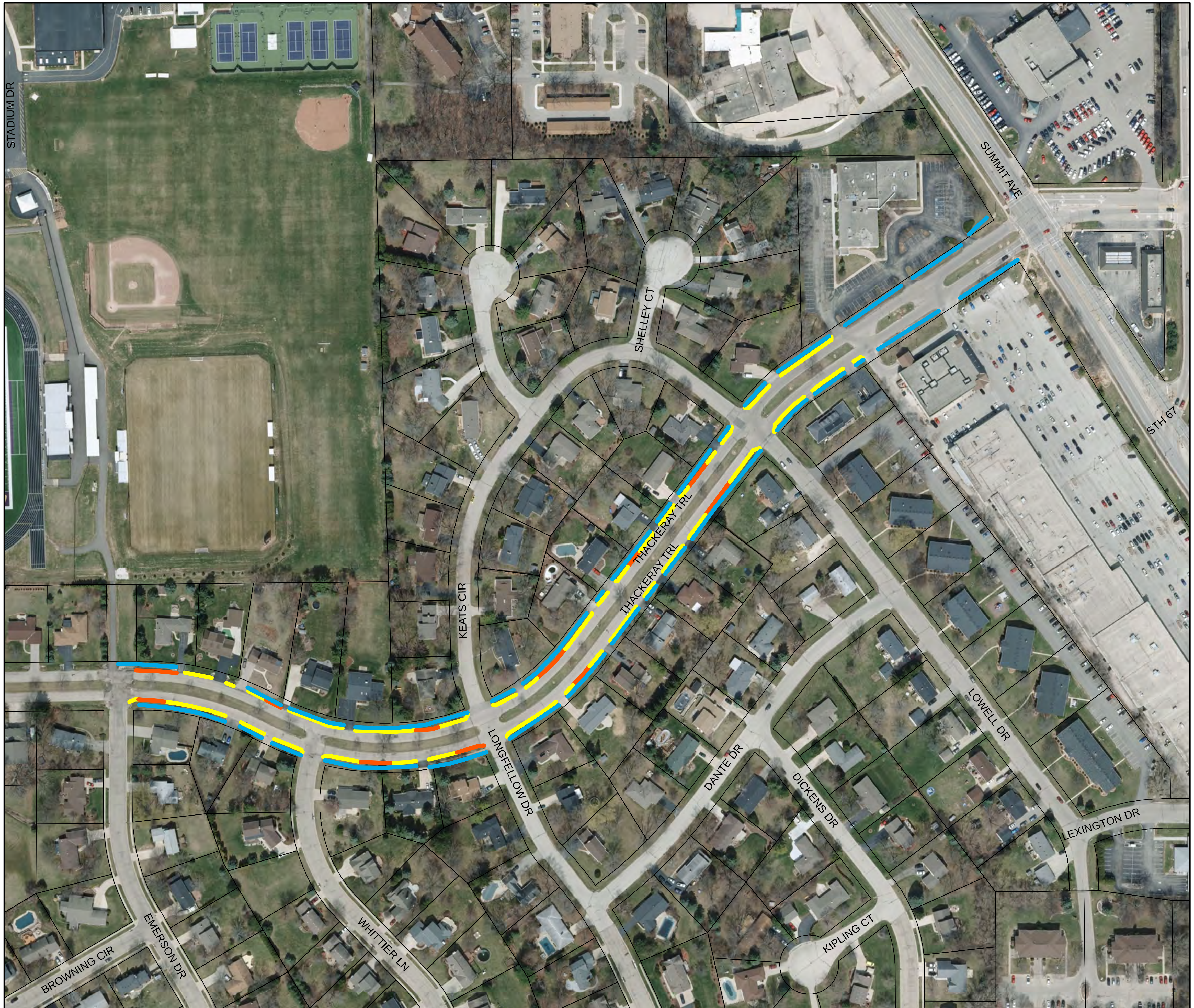
Feet

Date: December, 2015

Ruekert · Mielke



OCONOMOWOC

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Thackeray Trail Proposed Biofiltration Exhibit 9(a)

Legend

- Curb Extension
- Bioretention / Infiltration Basin
- Permeable Pavement

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Feet

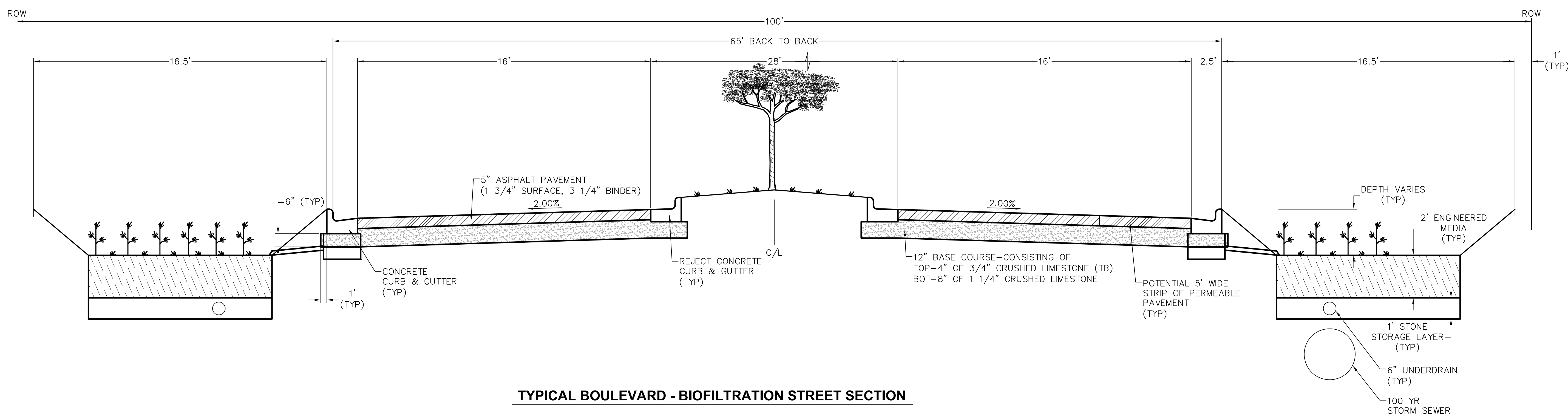
Date: December, 2015

Ruekert · Mielke

EXHIBIT 9(b)

THACKERY TRAIL POTENTIAL BIOFILTRATION CROSS SECTION

CITY OF OCONOMOWOC
WAUKESHA COUNTY, WISCONSIN



TYPICAL BOULEVARD - BIOFILTRATION STREET SECTION

DATE: DECEMBER 2015

SOURCE: R|M
BASEMAP SOURCE: WAUKESHA PARKS & LAND USE

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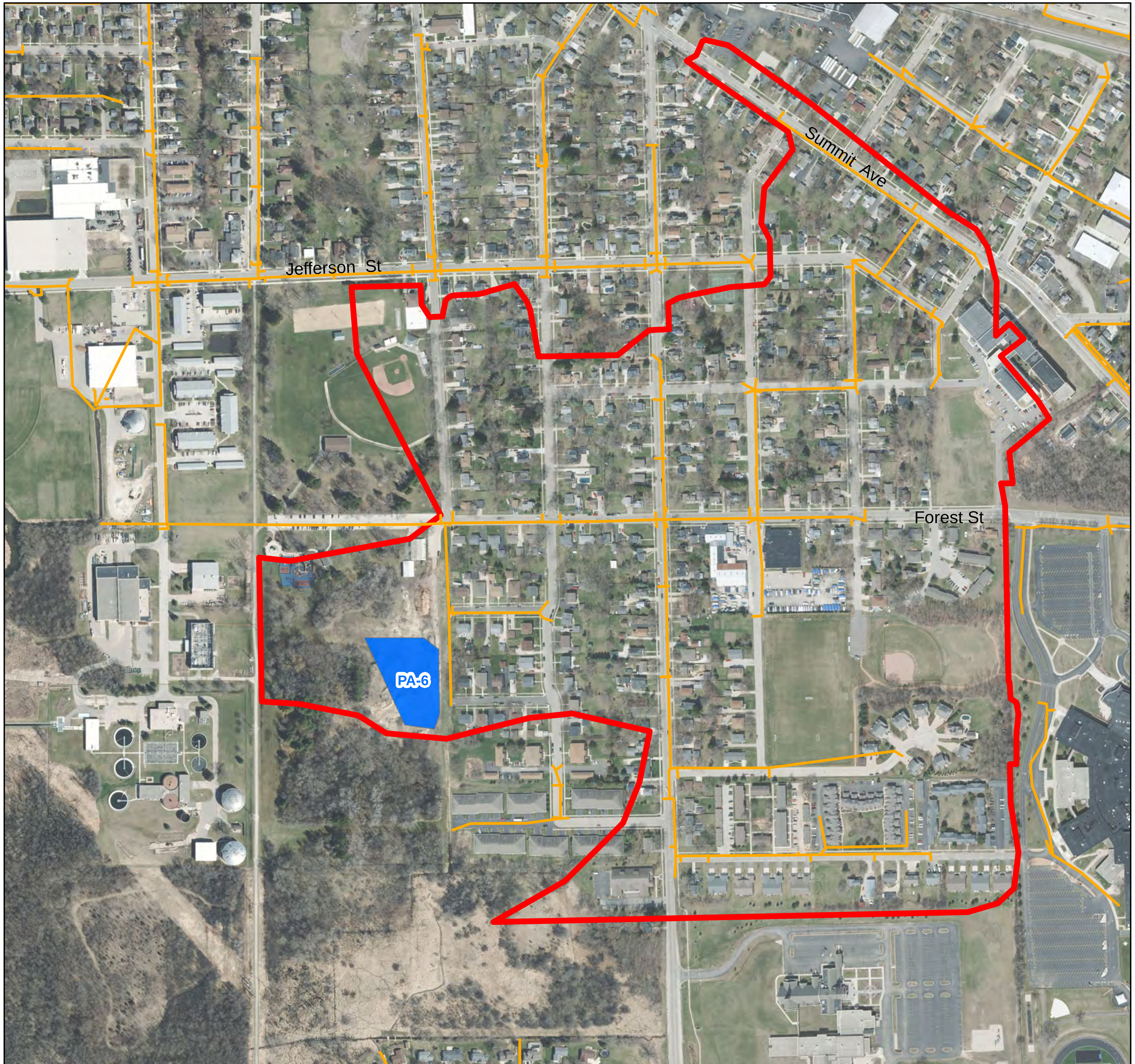
engineering solutions for a working world



OCONOMOWOC
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Proposed Wet Detention Alternative
PA-6 Oconomowoc River
(Downstream) Reachshed
Exhibit 10

Legend

- Existing Storm Sewer
- Proposed Alternative
- Drainage Area to Proposed Alternative

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Feet

Date: December, 2015

Ruekert · Mielke

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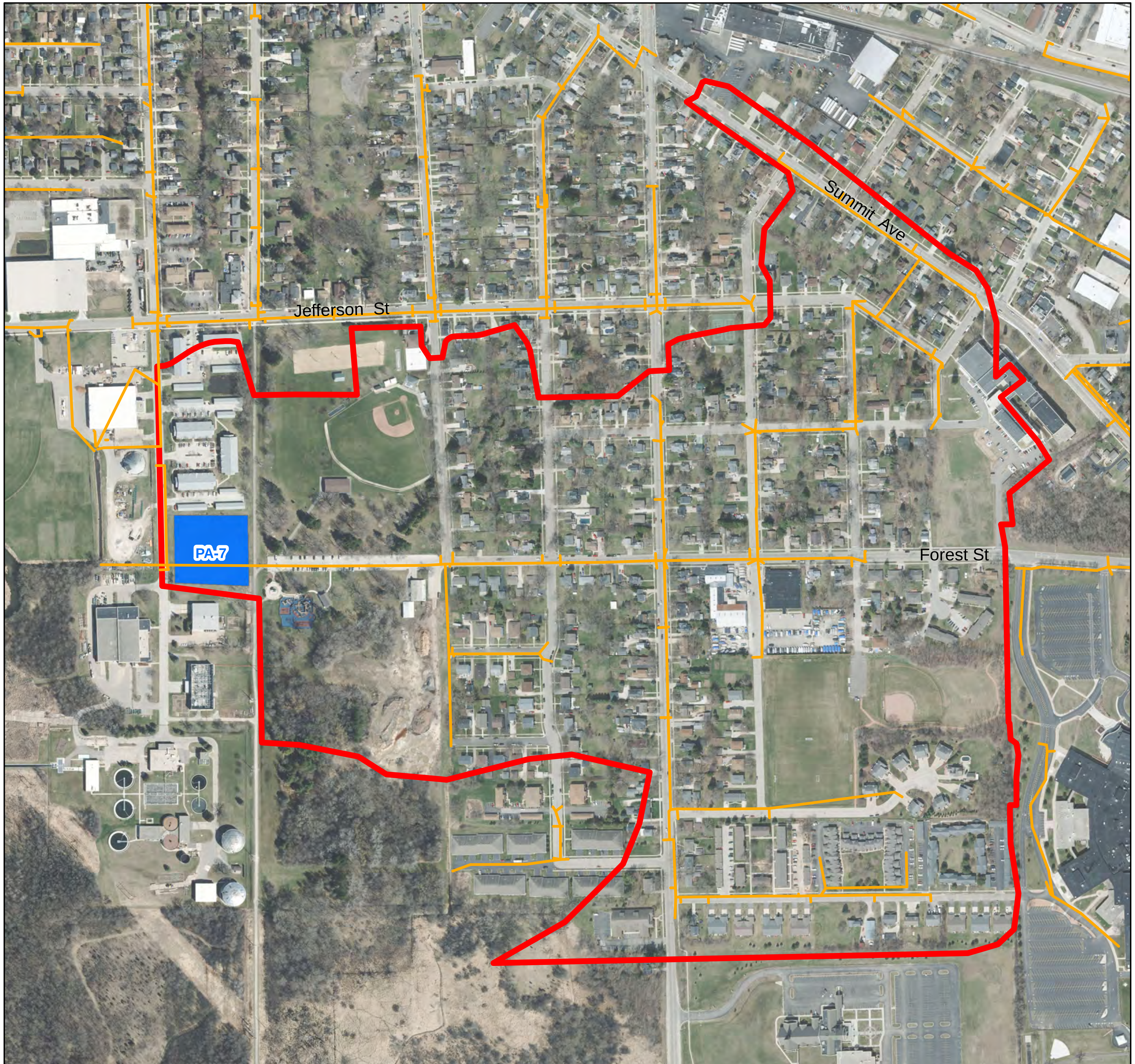

Life comes NATURALLY here

Proposed Wet Detention Alternative
PA-7 Oconomowoc River
(Downstream) Reachshed
Exhibit 11

Legend

- Existing Storm Sewer
- Proposed Alternative
- Drainage Area to Proposed Alternative

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0 200 400 800 1,200

Feet

Date: December, 2015

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APPENDIX B

ON-SITE TREATMENT ALTERNATIVE CUT SHEETS AND LOCATION SUMMARY

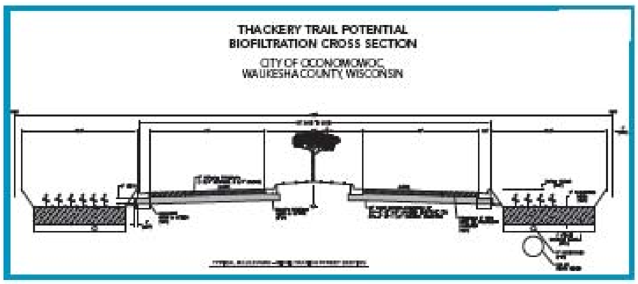
CURBED STREET WITH BIORETENTION TRENCH

BIORETENTION TRENCHES

Bioretention trenches allow road runoff to soak into the ground, instead of flowing through storm pipes to the nearest creek, lake or wetland. Water quickly infiltrates through a filtering soil layer via the long rooted, native plantings. This minimizes the amount of pollution washing off the streets and into the local waterways, and minimizes downstream flooding impact by capturing storm water where it falls.

Studies have shown that neighborhoods with green infrastructure practices such as infiltration trenches and traffic calming street designs are desirable to residents, with social, environmental and economic benefits associated with these improvements.

Infiltration basins behind curb cuts



Biofiltration with Underdrain at Bottom

COST ESTIMATES

- Excavation
- Plantings (salt tolerant recommended)
- Soil amendments
- Retaining wall / riprap materials
- Underdrain

MAINTENANCE

Like any utility structure, maintenance is needed to ensure proper functioning over time. Vegetation will need to be watered, thinned, cut or replaced over time, especially during the first couple years as plantings become established. Inspections and maintenance should occur at regular intervals and after heavy rain events. Debris will need to be removed from overflow pipes to prevent clogging.

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NO CURB INFILTRATION BAY

NO CURB INFILTRATION BAY

Infiltration trenches allow road runoff to soak into the ground, instead of flowing through storm pipes to the nearest creek, lake or wetland. Water quickly infiltrates through a filtering soil layer via a variety of long rooted, native plantings. This minimizes the amount of sediment, nutrients and other pollution washing off the streets and into the local waterways. Infiltration trenches also reduce impacts from flooding as water soaks into the ground where it falls, minimizing the amount of water that flows downstream.

Residents usually look favorably upon green infrastructure practices such as infiltration trenches with native plantings and traffic calming street designs. These measures provide positive social, economic and environmental impacts to a community.

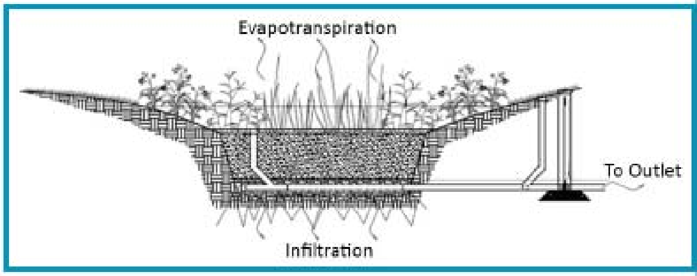
Cross section without underdrain

COST ESTIMATES

- Excavation
- Plantings (salt tolerant recommended)
- Soil amendments / mulch
- Retaining wall / riprap materials
- Underdrain (optional)

MAINTENANCE

The infiltration bay should be watered and weeded, especially in the first 2-3 years while plants become established and during periods of drought. Any plants that die off should be pruned or removed. Mulch may need to be replaced over time or after excessive rain events.



Biofiltration with Underdrain at Bottom

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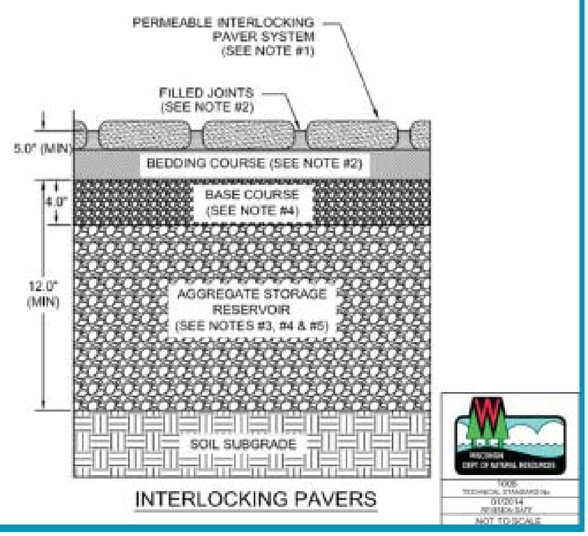
PERMEABLE PAVEMENT

PERMEABLE PAVEMENT SYSTEMS

Permeable concrete, asphalt or pavers allow rain or snow melt to soak into sidewalks, trails, parking areas, or center lanes of alleys. Runoff from adjacent hard surfaces can also be directed to these permeable systems. Water runs through the pores in the pavement to the storage layer below which drains within 72 hours. An underdrain can enhance drainage of the storage layer.

Permeable pavement systems that infiltrate into soils below receive 100% pollutant removal credit; systems with underdrains receive 55% TSS and 35% phosphorus credit, based on specifications in the Wisconsin Department of Natural Resources' Technical Standard 1008. Proper installation is critical; most manufacturers of permeable products have specific installation instructions that should be followed closely.

FIGURE 1. CRITERIA FOR UNDERDRAIN DISCHARGE AND INFILTRATION PRETREATMENT CREDITS



Wolf Paving
Porous Asphalt Parking Lot.

COST ESTIMATES

- Approximately $10/sq. ft. (from MMSD Green Infrastructure Plan, April 2013)
- Excavation/grading
- Aggregate for storage reservoir
- Asphalt / concrete / pavers
- Filler for joints between pavers (if applicable)

MAINTENANCE

Regular maintenance of permeable pavement systems is critical.

- Prevent clogging by removing organics such as leaves and seeds; do not use sand as an anti-icing practice.
- Occasional sweeping with a vacuum assisted sweeper is recommended
- Filler material between pavers may need to be replaced.
- Regular inspections should be documented

GREEN INFRASTRUCTURE

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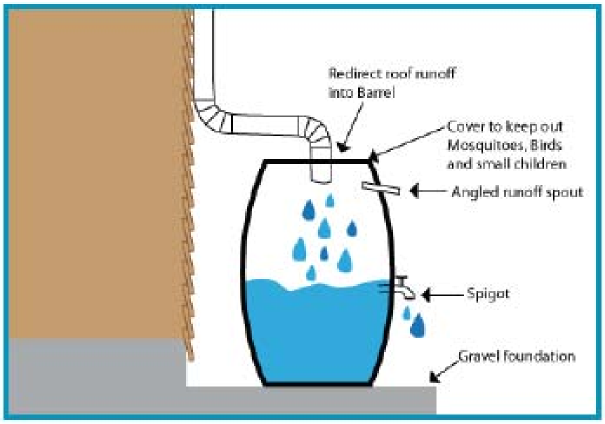
RAIN BARRELS

RAIN BARREL PROGRAMS

A community-wide rain barrel program can bring attention to water quality and drainage problems in a community. Rain barrels can reduce the amount of roof top water flowing into the storm sewer, reducing the impacts of flooding and pollution in waterways downstream. Residents and businesses that install rain barrels can water gardens and lawns with this water.

An engaged community can implement a successful rain barrel program by offering local workshops, on-site demonstrations, and reduced prices for rain barrels through cost sharing. Communities can support local businesses by partnering with hardware stores, nurseries, and other businesses to sell barrels. Different sizes, colors and shapes of rain barrels can also be purchased at retail stores, online, and through the Waukesha County Parks and Land Use Department.



Water captured in barrels can be used later to water gardens and lawns.

COST ESTIMATES

Retail prices typically start around $100 per barrel and can go up, depending on the features. Some do-it-yourself models can be purchased for a lower price. Community or grant related cost-sharing can lower the price of the barrels.

MAINTENANCE

- Barrels should be taken inside during winter months
- Use water within 5-7 days of rain events to prevent algae and mosquito larvae from developing
- A screen or mesh over any inlets for water will prevent mosquitoes from getting inside to lay larvae

GREEN INFRASTRUCTURE

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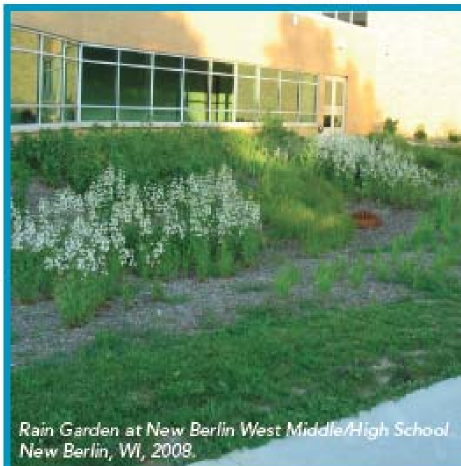
RAIN GARDENS

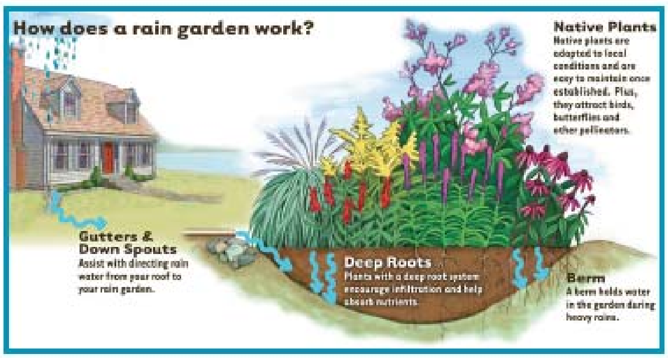
NEIGHBORHOOD RAIN GARDEN PROGRAMS

Rain gardens are small gardens set in the ground that receive water from downspouts and swales. Native plants typically have longer root systems, which enhances infiltration, and are more accustomed to fluctuations in rainy and dry weather patterns. By taking on water from rooftops and other hard surfaces, rain gardens promote infiltration and groundwater recharge, as well as minimize the impacts of pollutants and excess rain water on the local rivers, lakes and wetlands.

Rain garden programs can be marketed toward particular neighborhoods or areas of a city through local rain garden workshops, demonstration sites, discounted or cost-shared plantings, partnerships with local businesses to make plants and materials available, and volunteer programs to assist property owners with installation.



Rain Garden at New Berlin West Middle/High School New Berlin, WI, 2008.



COST ESTIMATES

- Excavation
- Plantings (native / wet mesic mixes)
- Soil amendments / mulch
- Downspout extensions
- Riprap / rock (at end of downspout extension into rain garden)

MAINTENANCE

The plantings in the rain garden should be watered and weeded, especially in the first 2-3 years and in periods of drought. Plants that spread may need to be thinned, to prevent a particular species from taking over the whole garden. Additional rock may be needed over time at the end of the down spout to prevent scouring.

GREEN INFRASTRUCTURE

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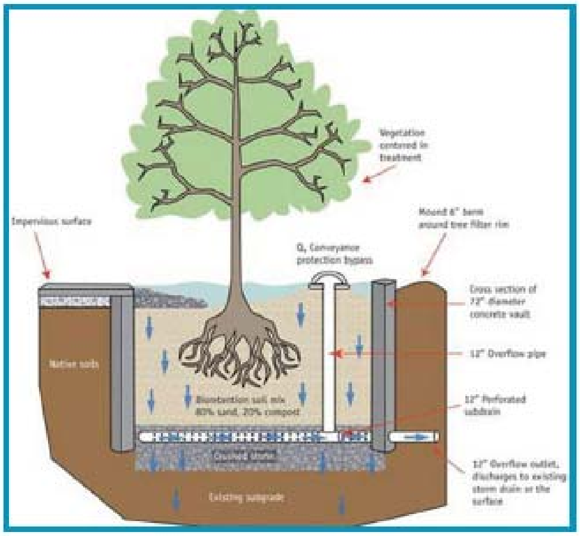
STORM WATER TREES

INSTALLATION OF TREE PLANTERS

Tree planters can be installed along roads to capture road and sidewalk runoff, allowing for infiltration and evapotranspiration of the water. Excess flows enter the storm system under the planter. Trees and vegetation on city blocks improve air & water quality, provide shade, and cool hard surfaces. Trees and vegetation beautify downtown areas, enhancing daily activities for everyone in the area.

Center for Neighborhood Technology, IL
Chicago's south side.



COST ESTIMATES

- Planter(s)
- Excavation
- Trees / Plantings (salt tolerant recommended)
- Soil amendments / mulch
- Underdrain / Pipe
- Stone for aggregate layer

GREEN INFRASTRUCTURE

MAINTENANCE

Trees require watering and care, especially in the first few years. Pruning may be needed depending on the species and the location. The planter should be inspected on a routine basis for any wear or needed repairs; the overflow pipe should remain free of debris to prevent clogging. Routine inspections should be documented.

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Location	Underground Storage	Bio-Retention Basins	Infiltration Bays/Trenches	Curb Extensions	Permeable Pavement	Street Narrowing	Rain Barrel Program	Rain Garden Program	Storm Water Pond	Infiltration Basin
Summit Avenue Basin										
North of Dowd Court									X	
West of Armour Court									X	X
City Lot East of Lyman Street									X	X
Lake Country Estates Condos		X	X		X		X	X		
High Street		X	X							
Intersection of Lyman and Charles Streets			X							
North End of Lapham Street		X	X							
Armour Road, West of Lapham Street			X							
High Street Neighborhood							X	X		
Wood St. - Union St. Neighborhood							X	X		
Thackeray Trail Basin										
Safro Ford 1000 Summit Avenue	X				X					
Lake Country Dentist 888 Thackeray Trail	X	X			X					
Wilkinson Clinic 915 Summit Avenue	X	X			X					
Thackeray Trail between Summit Ave. & Keats Circle		X	X	X	X	X				
Byron Drive, Whittier Lane & Emerson Drive		X	X		X					
Lowell Drive		X	X							
Hidden Ridge Subdivision		X	X		X		X	X	X	X
Thackeray Trail Neighborhood							X	X		
Forest Street Basin										
Westover Park (Westover Street)		X	X							
Roosevelt Field Park (Forest Avenue)		X	X		X					
Roosevelt Field Park (Southeast)			X							X
Bolson Drive		X	X							
Forest Street Neighborhood							X	X		
All 3 Basins										
Various Private Parking Lots	X	X	X		X					
Parking Lots in Parks		X	X		X					
Sidewalks across Residential Driveways					X					

APPENDIX C

COST INFORMATION

City of Oconomowoc
Economic Analysis of Proposed Alternative #1
Construct New Wet Detention Facility

Description: Construct New Wet Detention Facility

i= 4.625% Item Description	Unit	Unit Price	Initial Quantity	Initial Cost	Annual Incremental O & M	Serv. Life
Outlet Structure	E.A.	$ 3,000.00	1.0	$ 3,000.00		50
Wet Detention Facility Construction	C.Y.	$ 20.00	14954.5	$ 299,090.37	$ 7,500.00	50
Inlet/Outlet Storm Sewer	L.F.	$ 100.00	50.0	$ 5,000.00	$ 450.00	50
Pumping Station (Electrical/Mechanical)	L.S.	$ 150,000.00	1.0	$ 150,000.00	$ 10,000.00	25
Pumping Station (Structural)	L.S.	$ 100,000.00	1.0	$ 100,000.00	$ 450.00	50
Totals				$ 557,090.37	$18,400.00	
Present Worth Factor (50-year)					19.3668	
Present Worth Factor (25-year)					14.6393	
Present Worths				$ 557,090.37	$ 455,466.48	

Summary of Estimated Present Worth Costs

Total Estimated Construction Cost	$ 557,090.37
Legal, Engineering, & Contingencies (25%)	139,272.59
Subtotal - Estimated Project Cost	$ 696,362.96
Present Worth of O&M (50 Year)	455,466.48
Total Present Worth	**$ 1,151,829.45**

City of Oconomowoc
Economic Analysis of Proposed Alternative #2
Construct New Wet Detention Facility

Description: Construct New Wet Detention Facility

i= 4.625% Item Description	Unit	Unit Price	Initial Quantity	Initial Cost	Annual Incremental O & M	Serv. Life
Outlet Structure	E.A.	$ 3,000.00	1.0	$ 3,000.00		50
Wet Detention Facility Construction	C.Y.	$ 20.00	21008.1	$ 420,161.48	$10,500.00	50
Inlet/Outlet Storm Sewer	L.F.	$ 100.00	270.0	$ 27,000.00	$ 450.00	50
Totals				$ 450,161.48	$10,950.00	
Present Worth Factor					19.3668	
Present Worths				$ 450,161.48	$ 212,066.32	

Summary of Estimated Present Worth Costs

Total Estimated Construction Cost	$ 450,161.48
Legal, Engineering, & Contingencies (25%)	112,540.37
Subtotal - Estimated Project Cost	$ 562,701.85
Present Worth of O&M (50 Year)	212,066.32
Total Present Worth	**$ 774,768.17**

City of Oconomowoc
Economic Analysis of Proposed Alternative #3
Construct New Wet Detention Facility

Description: Construct New Wet Detention Facility

i= 4.625% Item Description	Unit	Unit Price	Initial Quantity	Initial Cost	Annual Incremental O & M	Serv. Life
Outlet Structure	E.A.	$ 3,000.00	1.0	$ 3,000.00		50
Wet Detention Facility Construction	C.Y.	$ 20.00	10910.9	$ 218,217.78	$ 5,500.00	50
Inlet/Outlet Storm Sewer	L.F.	$ 100.00	150.0	$ 15,000.00	$ 450.00	50
			Totals	$ 236,217.78	$5,950.00	
			Present Worth Factor		19.3668	
			Present Worths	$ 236,217.78	$ 115,232.38	

Summary of Estimated Present Worth Costs

Total Estimated Construction Cost	$ 236,217.78
Legal, Engineering, & Contingencies (25%)	59,054.44
Subtotal - Estimated Project Cost	$ 295,272.22
Present Worth of O&M (50 Year)	115,232.38
Total Present Worth	**$ 410,504.60**

City of Oconomowoc
Economic Analysis of Proposed Alternative #4
Construct New Wet Detention Facility

Description: Construct New Wet Detention Facility

i= 4.625% Item Description	Unit	Unit Price	Initial Quantity	Initial Cost	Annual Incremental O & M	Serv. Life
Outlet Structure	E.A.	$ 3,000.00	1.0	$ 3,000.00		50
Wet Detention Facility Construction (Contaminated Soil Removal)	C.Y.	$ 40.00	15684.1	$ 627,365.93	$ 7,800.00	50
Inlet/Outlet Storm Sewer	L.F.	$ 100.00	350.0	$ 35,000.00	$ 450.00	50
			Totals	$ 665,365.93	$8,250.00	
			Present Worth Factor		19.3668	
			Present Worths	$ 665,365.93	$ 159,775.99	

Summary of Estimated Present Worth Costs

Total Estimated Construction Cost	$ 665,365.93
Legal, Engineering, & Contingencies (25%)	166,341.48
Subtotal - Estimated Project Cost	$ 831,707.41
Present Worth of O&M (50 Year)	159,775.99
Total Present Worth	**$ 991,483.40**

City of Oconomowoc
Economic Analysis of Proposed Alternative #5
Construct New Wet Detention Facility

Description: Construct New Wet Detention Facility

i= 4.625% Item Description	Unit	Unit Price	Initial Quantity	Initial Cost	Annual Incremental O & M	Serv. Life
Outlet Structure	E.A.	$ 3,000.00	1.0	$ 3,000.00		50
Wet Detention Facility Construction	C.Y.	$ 20.00	14788.7	$ 295,774.07	$ 7,400.00	50
Inlet/Outlet Storm Sewer	L.F.	$ 100.00	25.0	$ 2,500.00	$ 450.00	50
		Totals		$ 301,274.07	$7,850.00	
		Present Worth Factor			19.3668	
		Present Worths		$ 301,274.07	$ 152,029.28	

Summary of Estimated Present Worth Costs

Total Estimated Construction Cost	$ 301,274.07
Legal, Engineering, & Contingencies (25%)	75,318.52
Subtotal - Estimated Project Cost	$ 376,592.59
Present Worth of O&M (50 Year)	152,029.28
Total Present Worth	**$ 528,621.87**

City of Oconomowoc
Economic Analysis of Thackeray Trail Reconstruction
Construct New Cross-Section Including Biofiltration

Description: Construct New Cross-Section Including Biofiltration

i= 4.625% Item Description	Unit	Unit Price	Initial Quantity	Initial Cost	Annual Incremental O & M	Serv. Life
Plant Plugs	S.F.	$ 3.00	13851.0	$ 41,553.00	$ 2,800.00	50
6-Inch Underdrain	L.F.	$ 25.00	5500.0	$ 137,500.00		50
Standpipe Outlet Structure	E.A.	$ 400.00	32.0	$ 12,800.00		50
Engineered Cross-Section Material	C.Y.	$ 70.00	1539.0	$ 107,730.00	$ 550.00	50
Biofiltration Area Construction	C.Y.	$ 20.00	5144.0	$ 102,880.00		50
Full Depth Road Reconstruct (32' wide)	L.F.	$ 300.00	5500.0	$ 1,650,000.00		50
Concrete Curb and Gutter	L.F.	$ 20.00	11000.0	$ 220,000.00		50
100-Year Storm Pipe (48-inch)	L.F.	$ 160.00	2750.0	$ 440,000.00		50
72" Storm Manhole	E.A.	$ 4,000.00	10.0	$ 40,000.00		50
Storm Inlet	E.A.	$ 2,000.00	20.0	$ 40,000.00		50
			Totals	$ 2,792,463.00	$3,350.00	
			Present Worth Factor		19.3668	
			Present Worths	$ 2,792,463.00	$ 64,878.74	

Summary of Estimated Present Worth Costs

Total Estimated Construction Cost	$ 2,792,463.00
Legal, Engineering, & Contingencies (25%)	698,115.75
Subtotal - Estimated Project Cost	$ 3,490,578.75
Present Worth of O&M (50 Year)	64,878.74
Total Present Worth	**$ 3,555,457.49**

City of Oconomowoc
Economic Analysis of Proposed Alternative #6
Construct New Wet Detention Facility

Description: Construct New Wet Detention Facility

i= 4.625% Item Description	Unit	Unit Price	Initial Quantity	Initial Cost	Annual Incremental O & M	Serv. Life
Outlet Structure	E.A.	$ 3,000.00	1.0	$ 3,000.00		50
Wet Detention Facility Construction	C.Y.	$ 20.00	16969.0	$ 339,379.26	$ 8,500.00	50
Inlet/Outlet Storm Sewer	L.F.	$ 100.00	990.0	$ 99,000.00	$ 450.00	50
Totals				$ 441,379.26	$8,950.00	
Present Worth Factor					19.3668	
Present Worths				$ 441,379.26	$ 173,332.74	

Summary of Estimated Present Worth Costs

Total Estimated Construction Cost	$ 441,379.26
Legal, Engineering, & Contingencies (25%)	110,344.81
Subtotal - Estimated Project Cost	$ 551,724.07
Present Worth of O&M (50 Year)	173,332.74
Total Present Worth	**$ 725,056.82**

City of Oconomowoc
Economic Analysis of Proposed Alternative #7
Construct New Wet Detention Facility

Description: Construct New Wet Detention Facility

i= 4.625% Item Description	Unit	Unit Price	Initial Quantity	Initial Cost	Annual Incremental O & M	Serv. Life
Outlet Structure	E.A.	$ 3,000.00	1.0	$ 3,000.00		50
Wet Detention Facility Construction	C.Y.	$ 20.00	23960.1	$ 479,202.96	$ 12,000.00	50
Inlet/Outlet Storm Sewer	L.F.	$ 100.00	25.0	$ 2,500.00	$ 450.00	50
Totals				$ 484,702.96	$12,450.00	
Present Worth Factor					19.3668	
Present Worths				$ 484,702.96	$ 241,116.50	

Summary of Estimated Present Worth Costs

Total Estimated Construction Cost	$ 484,702.96
Legal, Engineering, & Contingencies (25%)	121,175.74
Subtotal - Estimated Project Cost	$ 605,878.70
Present Worth of O&M (50 Year)	241,116.50
Total Present Worth	**$ 846,995.20**

City of Oconomowoc
Economic Analysis of Forest Street Storm Sewer Relief
Construct Dedicated Storm Sewer Relief Pipe

Description: Construct Dedicated Storm Sewer Relief Pipe

i= 4.625% Item Description	Unit	Unit Price	Initial Quantity	Initial Cost	Annual Incremental O & M	Serv. Life
42-Inch RCP CL3 Storm w/ Granular Backfill	L.F.	$ 140.00	4424.3	$ 619,402.00	$ 500.00	50
42-Inch RCP End Section	E.A.	$ 3,000.00	1.0	$ 3,000.00	$ 500.00	50
			Totals	$ 622,402.00	$1,000.00	
			Present Worth Factor		19.3668	
			Present Worths	$ 622,402.00	$ 19,366.79	

Summary of Estimated Present Worth Costs

Total Estimated Construction Cost	$ 622,402.00
Legal, Engineering, & Contingencies (25%)	155,600.50
Subtotal - Estimated Project Cost	$ 778,002.50
Present Worth of O&M (50 Year)	19,366.79
Total Present Worth	**$ 797,369.29**