LAKE CHARLEVOIX WATERSHED
GREEN STORMWATER INFRASTRUCTURE

Boyne City

Green Stormwater Infrastructure

VISIONING REPORT

SUBMITTED TO

The City of Boyne City
319 North Lake Street
Boyne City, MI 49712

December 23, 2020

DRUMMOND CARPENTER
engineering + research

TIP OF THE MITT Watershed Council

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Project Introduction

This report summarizes the conceptual green stormwater infrastructure (GSI) visioning, community engagement, and modeling portions of the **Lake Charlevoix Communities: Increasing Capacity for Coastal Resilience** project. This project was grant funded, with funding provided by the Charlevoix County Community Foundation, and the Coastal Management Program, Water Resources Division, Michigan Department of Environment, Great Lakes, and Energy and the National Oceanic and Atmospheric Administration. The project is a collaboration between the Tip of the Mitt Watershed Council (TOMWC), Drummond Carpenter, and three municipalities within the Lake Charlevoix watershed. This project examined existing stormwater infrastructure in each of the three cities and highlighted opportunities to adopt new GSI practices. The project team selected areas for GSI consideration based on stormwater outlets to Lake Charlevoix, conditions of existing infrastructure, future planned improvements, and meetings with city officials. Locations of recommended GSI practices were then photographed and artistically rendered to show what a GSI practice could look like in that location. These graphics were used to help the public visualize different treatment options in context. They are not a guide to plant selection or the only configuration of a practice. Virtual public engagement during the project provided GSI educational material to the public and then surveyed the public regarding the rendered GSI concepts. The public surveys provide feedback regarding which applications each community favored as well as other comments and concerns.

Timeline

Charlevoix, Boyne City, and East Jordan all participated in initial site selection, virtual interim meetings, and a public visioning processes that followed a similar timeline (Figure 1). Drummond Carpenter and TOMWC representatives participated in three meetings per community partner to refine the conceptual plans and make sure the vision met municipal goals. All meetings after March 2020 were transitioned from in-person meetings to virtual meetings, including the public engagement process.

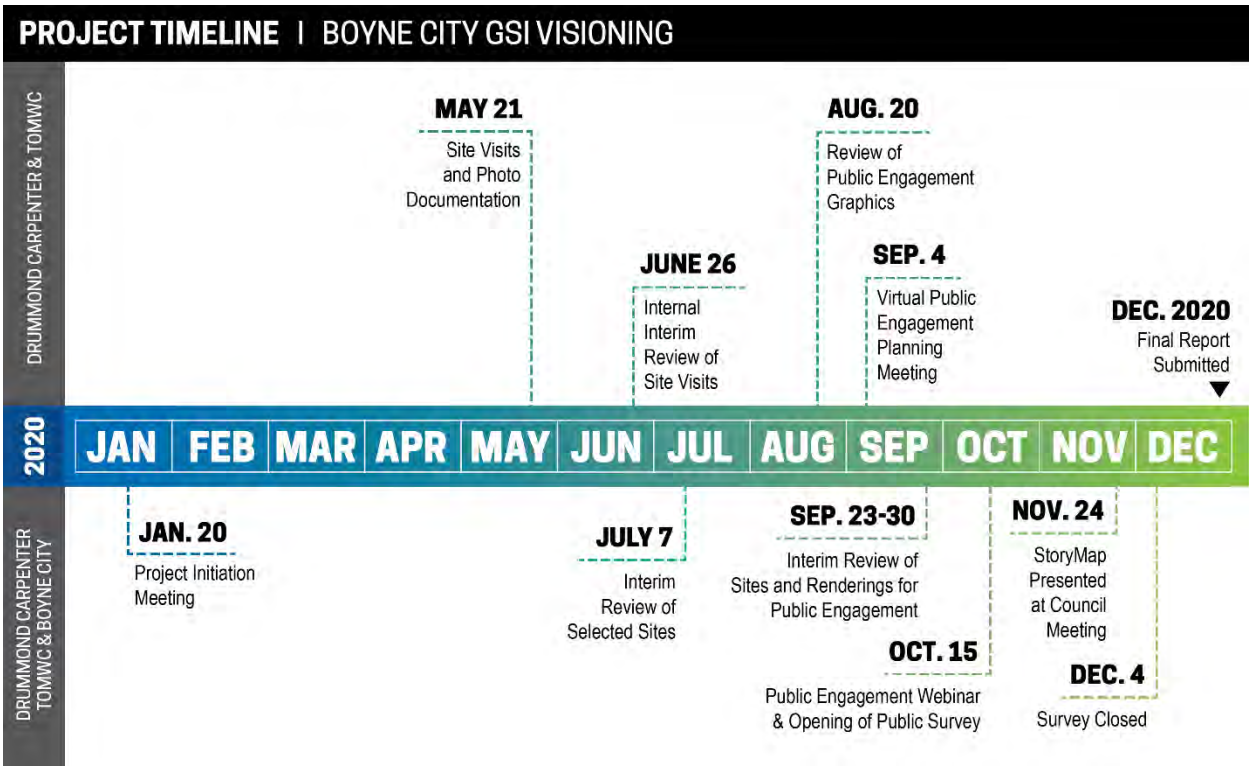

Figure 1 – Project Timeline

Green Stormwater Infrastructure

Green Stormwater Infrastructure (GSI) manages stormwater by mimicking natural processes such as infiltration and evapotranspiration and can help keep water resources clean and protect public health. These practices can prolong the life of existing stormwater infrastructure and enhance stormwater treatment prior to release into Lake Charlevoix.

GSI offers several advantages over traditional, engineered stormwater drainage approaches, including:

- **Addresses stormwater at its source** - GSI practices seek to manage rainfall where it falls, reducing or eliminating the need for detention ponds and flood controls.
- **Promotes groundwater recharge** - Many GSI techniques allow stormwater to infiltrate the earth, recharging groundwater aquifers.
- **Allows for more flexible site layouts** - Designs can incorporate stormwater management in a variety of open spaces and smaller landscaped areas.
- **Preserves streams and watersheds** - GSI practices reduce both pollutant loads and streambank erosion associated with peak flows because of greater infiltration.
- **Enhances aesthetics and public access/use** - Well-designed vegetated practices, such as rain gardens, should be visually appealing as well as functional.
- **Reduces costs** - GSI reduces the need for pipes, asphalt, detention basins, or other infrastructure traditionally needed to handle runoff. It can also reduce energy costs and increase potential developable land area.

Common GSI practices with definitions and photographic examples are in Appendix A.

Existing Conditions Assessment

Potential sites shown in Figure 2 were discussed at the Project Initiation meeting with Boyne City. These sites were visited on May 21 to evaluate potential for GSI practices and to photo document site conditions (see Appendix B for site visit notes). Sites were evaluated based on field observations of existing drainage patterns, existing infrastructure, signs of ponded water, and planned use. Water quality monitoring data from Lake Charlevoix stormwater outfalls was used to further inform focus areas within the community. Finally, Boyne City provided infrastructure and planning documents related to these sites.

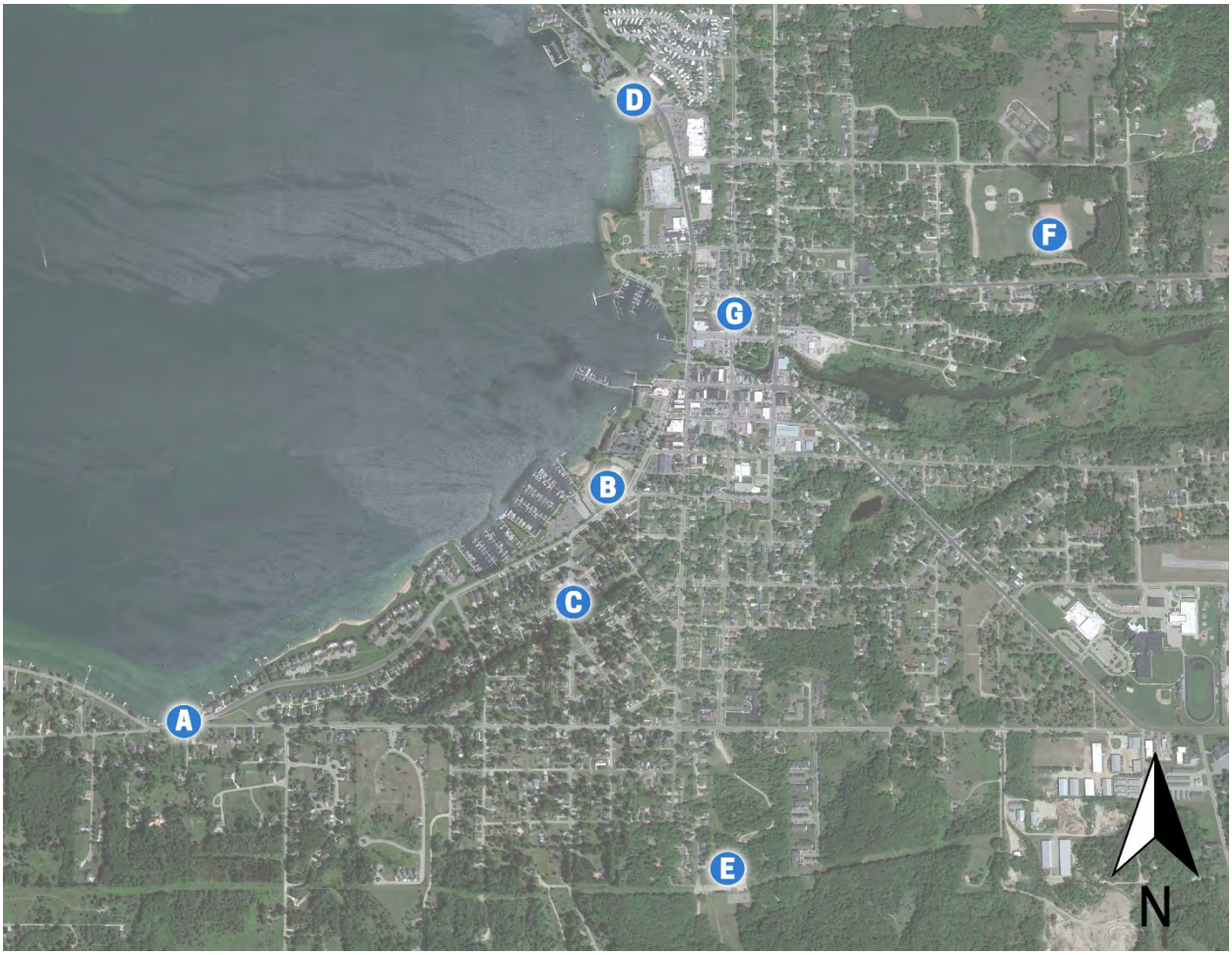

Figure 2 – Evaluated Site Locations

The files provided by Boyne City used for evaluating potential GSI sites included:

- **5 Year Recreation Pan Proposed Amendment – Marina/Harbor/Boat Launch** (RecreationPlan Amendment.pdf)
- **Avalanche Preserve Resource Inventory and Management Plan** (Avalanche.pdf) – *November, 2015*
- **City of Boyne City Master Plan 2015** (MasterPlan2015.pdf) – *October 13, 2015*
- **Boyne City Waterfront Master Plan 2006** (WaterfrontMasterPlan.pdf)
- **Boyne City Parking Study Final Report** (ParkingStudy.pdf) – *October, 2018*
- **Boyne City Recreation Plan 2015** (RecreationPlan.pdf)
- **Boyne City Michigan Cultural Economic Development Plan** (CED Plan.pdf) – *October 4, 2009*
- **Construction Plans for Boyne City Michigan Cedar Street and Terrace Street Reconstruction** (Terrace_Cedar_022619_FINAL-Secure.pdf) – *February 2019*
- **Development Plan and Tax Increment Financing Plan** (DDA Plan.pdf) – *March 9, 2010*
- **GIS Files** (stormwater and sewer infrastructure)
- **Storm Water Management Ordinance** (Ordinance.pdf)
- **Redevelopment Ready Communities® Community Assessment Report: City of Boyne City Evaluation Findings** (Redevelopment Ready Community.pdf) – *March, 2014*
- **Trail Town Master Plan: Capturing Trail Based Tourism in Boyne City and Boyne Falls** (TrailTown.pdf) – *August, 2014*

GSI Visioning

Feasibility of each proposed GSI location and practice type was evaluated using available information. Potential locations of GSI practices were discussed with city officials to determine which GSI retrofit opportunities should progress to further visioning and public surveys (Appendix B). A representative number of practices were artistically rendered to help the public visualize different treatment options in context of each site. Plants depicted in the renderings are listed in the *Lake Charlevoix Watershed Homeowner's Guide*[1]; however the renderings only show example plant pallets. It should be noted that not every viable or desired GSI practice was included in the visioning process and that other locations described in Appendix B are well suited for GSI implementation.

Public Engagement

An ESRI StoryMap, a website based immersive story platform, was created for the overall project[2] and each of the three communities involved. The overall project StoryMap was setup with background information on the project, links to the individual community StoryMaps, video recording of the public engagement webinar, Lake Charlevoix watershed background, and information on stormwater pollution and green stormwater infrastructure. StoryMaps for each community contained details for each site including maps, existing and artistically rendered images, and a brief description.

From October 15 to December 4, 2020, a public survey was hosted on the StoryMap for each community to gather input on public perception of GSI techniques and locations. Questions gauged the respondent's reaction to GSI practice locations, aesthetics, and overall concept as well as prioritization of practices. Appendix C contains a list of the questions, results, and all comments received through the survey. Thirty-one (31) participants submitted surveys for Boyne City. Majority of the public participation (20 votes) came immediately following Facebook posts by the City of Boyne City.

Stormwater Modeling & Cost Estimating

Stormwater modeling and a general cost estimate was performed for each of the rendered GSI practices. These analyses provide estimates of potential stormwater reductions each practice could achieve based on its contributing drainage area and size. The runoff reduction modeling and conceptual cost estimates are provided as a tool for stakeholders and municipal leadership to prioritize implementation.

Runoff Volume Calculations (Existing and Proposed)

Runoff volumes were calculated using the SCS Curve Number Method[3] for existing and proposed conditions. A 2-year 24-hour storm (approximately 2.2 inches of rainfall[4]) was used for the calculations. The 2-year 24-hour storm was selected because it is a common design storm used for green infrastructure design and represents about 99% of all rainfall events. Calculations were performed in an excel spreadsheet, *BC_Runoff Calculations_CN.xlsx*. The *BC_Runoff Calculations_CN.xlsx* spreadsheet

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[1] *Lake Charlevoix Watershed Homeowner's Guide* (Oct. 2016) pages 12-13 - Tip of the Mitt Watershed Council

[2] Lake Charlevoix GSI Visioning – ArcGIS StoryMaps (Dec 2020 Web Link: ***arcg.is/0iWbz5***)

[3] USDA SCS (Soil Conservation Service). (1986). "Urban Hydrology for Small Watersheds." SCS Technical Release No. 55. Washington, DC.

[4] NOAA (National Oceanic and Atmospheric Administration). (2013). "Precipitation-Frequency Atlas of the United States." Volume 8 Version 2.0. Silver Spring, MD.

could be manipulated for larger storm events by changing the precipitation value, but this should be done with caution since many design choices (such as bioretention size and curve number values) were based specifically on a 2-year 24-hour storm. Further detail and SCS curve number calculation details are included within the *BC_Runoff Calculations_CN.xlsx* spreadsheet.

Calculation Process:

- Drainage Areas
  Each site is broken into sub-drainage areas determined by common outlet points. The areas were determined through data provided by the municipalities, site visits, and google earth elevations. A GIS site plan of existing conditions was created in AutoCAD and used to determine the areas for calculations.

- Cover Type
  Cover type was determined from site visits and Google Earth aerial images[5].

- Soil Type
  Soil type was determined from USDA Web Soil Survey[6] for each sub-area. Each area's soil type is listed at the top of the *BC_Runoff Calculations_CN.xlsx* spreadsheet.

- CN Values
  The CN values were selected after determining the cover type and soil type. All CN values, excluding green infrastructure, are taken from SCS Method. CN values used in runoff calculations are listed in *Table 1 – CN Values*. Green infrastructure is assigned a CN Value of 100 because all water that lands on that area is accounted for in retention and subtracted at the end.

Table 1 – CN Values

Cover Type	CN Value
Impervious Surfaces	98
Soil – HSG D – Lawn	80
Green Infrastructure	100

Since each sub-area has multiple cover types, a composite CN value was determined for the sub-area:

$$CN=\Sigma(A_i*CN_i)/A$$

A_i=Surface Area of cover type (acres)
A=Surface Area Total (acres)
CN_i=Curve Number for Cover Type
CN=Composite Curve Number

[5] Google Earth 2020
[6] NRCS (Natural Resources Conservation Service). (2017). "Hydrologic Soils Map." Web Soil Survey, <http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm> (23 JUN. 2017).

- Volume of Runoff

  Total areas and composite CN values for each sub-area were used to calculate the runoff with the SCS Method. The equation details are in *BC_Runoff Calculations_CN.xlsx* spreadsheet. The SCS Method generates runoff values which were multiplied by the sub-area's total area to obtain runoff volumes.

- Runoff Reductions
  Separate tabs are setup within the *BC_Runoff Calculations_CN.xlsx* spreadsheet for existing and proposed (*New*) conditions. The differences between the New tab and Existing tab are that cover types are changed for the green infrastructure and storage volumes added. Storage volumes for green infrastructure are quantified in *BC_Runoff Calculations_CN.xlsx* and listed in the Storage column. Areas that are retained for a 2-year 24-hour storm, like rain barrels or bioretention areas, are accounted for as reductions after the runoff from that drainage area is calculated (see *BC_Runoff Calculations_CN.xlsx* spreadsheet). The *New* tab also has a summary of before and after runoff amounts and the reductions in each sub-area.

Reduction Percentages for Individual BMPs

Reductions and sizing for each green infrastructure treatment are calculated in the *BC_ReductionPercentages.xlsx* spreadsheet. Calculations use the runoff values for each drainage area that were calculated in the *BC_RunoffCalculations.xlsx* spreadsheet. The spreadsheet is divided into a tab for each GSI treatment type. If adequate space was available, the GSI practice was sized for a 2-year 24-hour storm. In some cases, a larger storm volume could be contained (i.e. more than 100% capture of a 2-year 24-hour storm) but capture percentage was set at 100%.

Conceptual Cost Estimate

A conceptual cost estimate was determined based on GSI projects in Michigan. Estimates for this project are based on an average cost per square foot of treatment surface of the envisioned design. For some practice types, like bioretention and permeable pavers, the practice type can have a wide range of costs dependent on infrastructure and aesthetic requirements. For these practice types high and low complexity costs are listed. Each practice was assigned either a low or high complexity cost based on the location and anticipated difficulty of installation and design. Surveyed drainage areas, design complexity, and further site details will influence the engineered design and result in lower or higher project costs.

Appendix A – Green Stormwater Infrastructure Practices

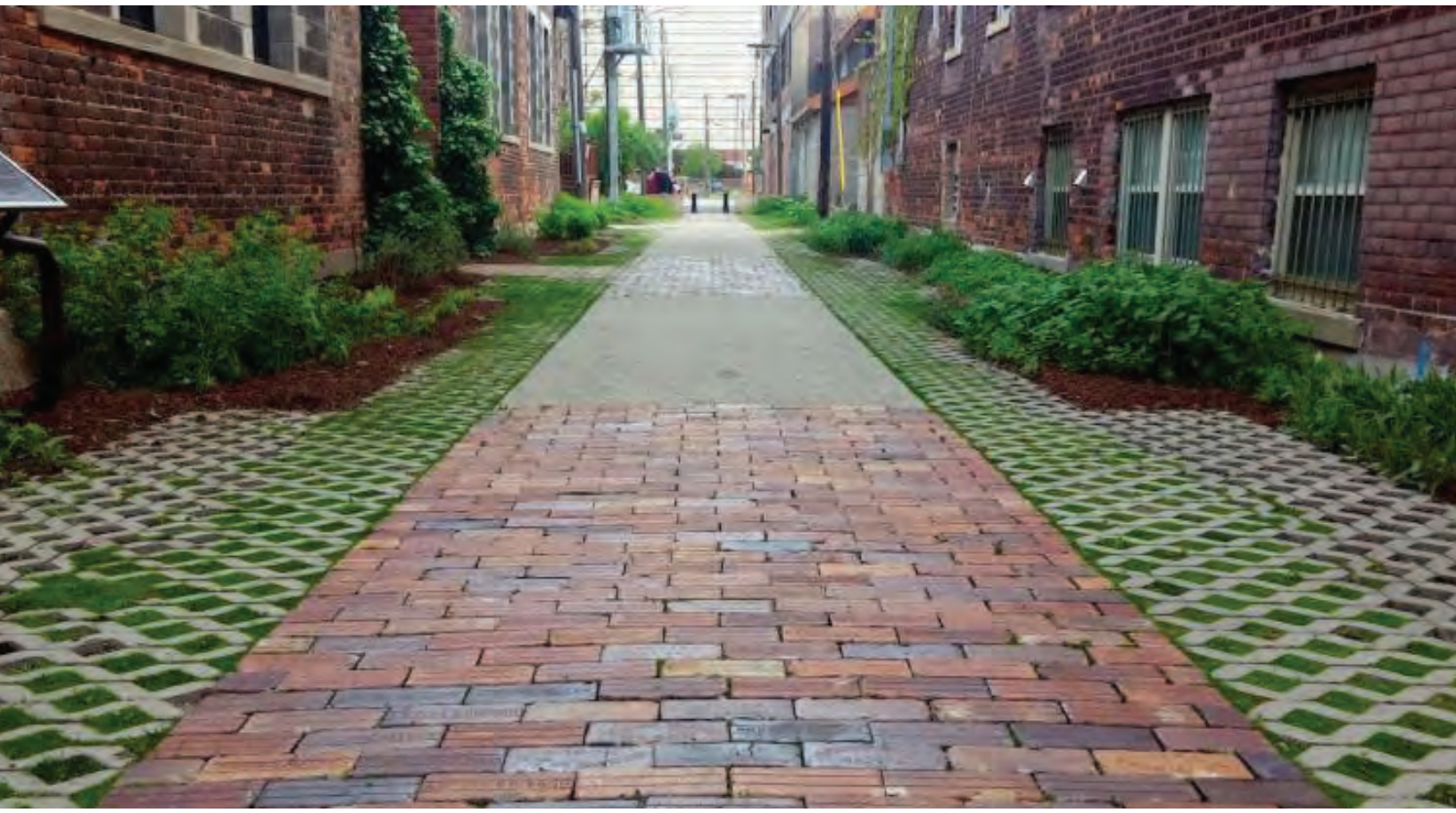
RAIN GARDEN / BIORETENTION

A Rain Garden or **Bioretention Cell** is a shallow depression area in the landscape that captures and treats stormwater runoff in an amended planting soil mix. The depression (or ponding area) allows water to pool for a short time (less than 24 hours) after a rainfall and then slowly absorb into the soil and vegetation.

Native plants are typically used because of their deep roots, hardiness, and ability to provide habitat for native species.

GREEN ALLEYS

Green Alleys and low traffic roads incorporate permeable pavers and underground stormwater storage to help intercept, filter and infiltrate stormwater before it drains into stormwater catch basins. Pedestrian alleys can also feature stormwater planter boxes, which are similar to raised bioretention beds.



POROUS PAVEMENT

Porous Pavement is a stormwater management technique that combines storage and infiltration with a structural pavement.

Porous pavement can consist of permeable asphalt, porous concrete or interconnected concreate paver blocks that are underlain by a storage reservoir.

NATIVE LANDSCAPING

Native Landscaping uses native plants instead of turf grass or other higher maintenance non-native landscaping features.

Native landscaping performs similar to a rain garden but without the ponding and enhanced underground storage areas.

BIOSWALE

A **Bioswale** (or bioretention swale) is a a naturalized swale that has the additional component of bioretention planting mix and/ or a stone sub-basin to promote additional storage and infiltration.

Bioswales reduce runoff volume and increase water quality, while also providing conveyance of excess runoff. The use of pretreatment control measures such as filter strips or other sediment capturing devices can reduce sediment accumulation in the swale.

NATIVE PRAIRIE

A **Native Prairie** is a large scale naturalized grassland area that utilizes deep fertile soil, a cover of tall coarse grasses, flowers and other native prairie plants to absorb stormwater runoff from the surrounding areas.

Native prairie also provides habitat for native species.

NATIVE SHORELINES

Native Shorelines, also known as a riparian buffer, consist of a mix of native trees, shrubs, and herbaceous plants along a lake or river shoreline. Riparian buffers provide many benefits to the lake ecosystem, including shoreline stabilization and erosion control, habitat for shoreline-dependent species, infiltration of runoff, and filtration of pollutants such as sediments, nutrients, and chemicals.

Native shorelines can be divided into different zones that include varying vegetation to enhance the quality of the body of water they are adjacent to. It is important to note turf grass does not provide the same benefits that a mix of native vegetation does and is not considered an adequate buffer.

TREE BOX FILTERS

Tree Box Filters Tree box filters help to effectively manage stormwater by providing areas where water can collect, undergo filtration, and either naturally seep into the ground, be absorbed by the tree, or be transferred to storm drains. They are typically pre-cast or cast-in-place concrete structures that can be set adjacent to structural pavements. The boxes are then filled with loose, filtering soils, which allow urban trees to thrive by providing space for an extensive root system.

STREET TREES

Street Trees play a significant role in the urban hydrologic cycle through tree canopy interception of precipitation, promoting increased infiltration along root paths, removal of water from the soil by roots, and release of water back into the atmosphere through evaporation and transpiration.

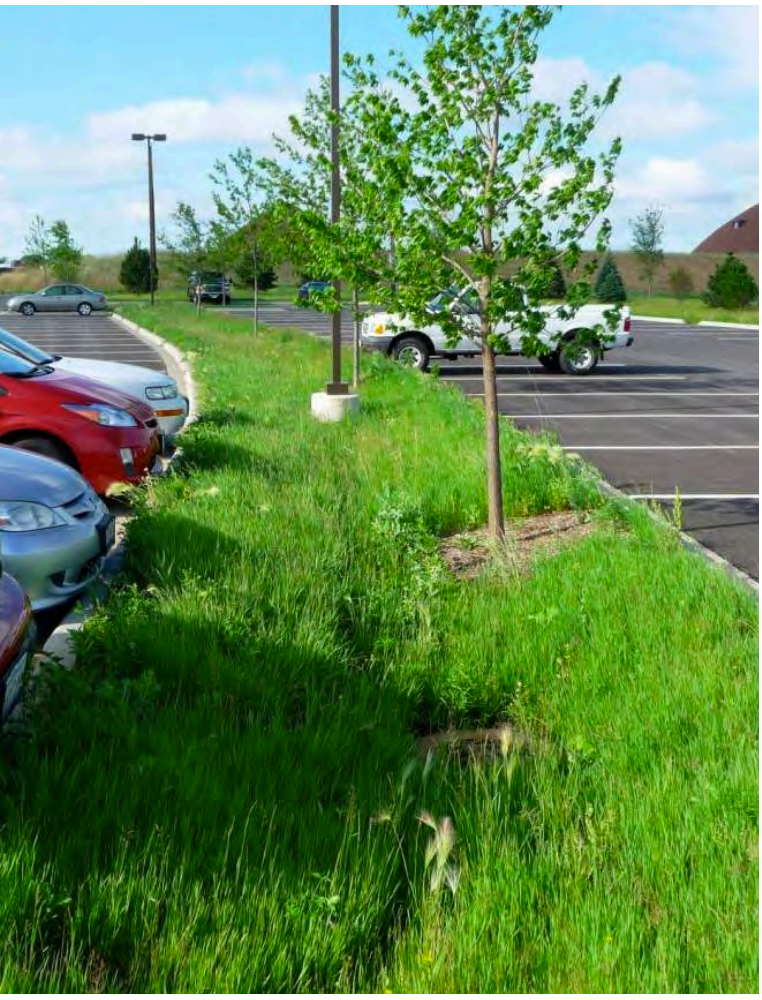
Mature street trees are an extremely valuable resource when it comes to stormwater management and should be designated to remain on site and protected during all construction activities whenever possible.

STORMWATER TREATMENT WETLANDS

Stormwater Treatment Wetlands are engineered, shallow-water ecosystems designed to treat stormwater runoff. Commonly implemented in low-lying areas, stormwater wetlands are well suited to areas along river corridors where water tables are already higher.

Stormwater treatment wetlands provide flood and nutrient control benefits by storing nutrients and slowly releasing water over several days. They also provide excellent plant and wildlife habitat and can be designed as public amenities with trails or platforms for wildlife viewing.

NATURALIZED SWALE



A **Naturalized Swale** is a stormwater drainage swale or "ditch" that incorporates native landscaping instead of mowed turf grass.

The swale can be vegetated with a combination of grasses, shrubs, and/or trees designed to slow, filter, and possibly store or infiltrate stormwater runoff.

CISTERN

Cisterns are structures designed to intercept and store stormwater runoff from rooftops.

Stormwater is typically reused for irrigation or other water needs thereby reducing potable water consumption.

VEGETATED ROOF

Vegetated roofs, or green roofs, are conventional rooftops that include a thin covering of vegetation allowing the roof to function more like a vegetated surface that provides both filtration and infiltration of runoff, but also provides other co-benefits including increased biodiversity and environmental cooling.

The overall thickness of the vegetated roof may range from 2 to 6 inches, typically containing multiple layers consisting of waterproofing, synthetic insulation, non-soil engineered growth media, fabrics, synthetic components, and foliage.

Appendix B – Meeting Minutes (Project Initiation and Site Visits)

Project Initiation Meeting – January 28, 2020

Drummond Carpenter, PLLC
Traverse City, MI
Tel 920.362.4265
RPieschek@DrummondCarpenter.com

28 January 2020

General Meeting Agenda for Tip of the Mitt Watershed Council GSI Visioning 2020 Project

Meeting:
Monday, January 20, 2020
2:00 pm – 2:30 pm - Boyne City

Attendees: Jennifer Buchanan (Tip of the Mitt), Ashley Soltysiak (Tip of the Mitt), Don Carpenter (Drummond Carpenter, Rachel Pieschek (Drummond Carpenter), Mike Cain (Boyne City)

Meeting Minutes:

- Overview of Green Stormwater Infrastructure (GSI) visioning process
    - Drummond Carpenter's past visioning projects with the Clinton River Watershed Council WaterTowns program and Elk Rapids (example work products provided separately).
    - Deliverables & Timeline
        - Community engagement meeting
            - Target timeframe will be sometime in the last two weeks of August
            - Location at City Hall
        - Site visits in May or June (when snow is cleared)

- Existing Stormwater Treatment locations
    A. Underground infiltration tanks for downtown area
    B. Schools stormwater is treated onsite in ponds that infiltrate well
    C. Cedar and Terrace streets have been recently redone with swales and storm drains for overflow
    D. Veterans memorial has a 7+ year old permeable paver installation
    E. There is a private development that has some concrete/grass pavers – Specific location was not discussed. **Where is this?**

- Discussion of potential locations for GSI visioning – numbers are labeled on pdf map
    - (1) Tannery Beach
        - This location has been subject of previously unsuccessful grant applications
        - Outfall location is here for Marshall and Anderson Roads, treatment would likely need to be upstream
        - Potential groundwater contamination
    - (2) Outfall in Marina
        - Treatment upstream of this outfall at location 3 or along streets
    - (3) Road Triangles
        - Two triangles of ROW created by the roads
        - These could be potential GI locations
    - (5) Boat Launch
        - Areas is mostly pavement
        - This site is in consideration for reconstruction with some permeable pavement
    - (6) Avalanche Park

        - There is a lot of documentation available for this park, including a park plan
    - (7) Rotary Park
        - Some gravel parking lots that could use improvement
        - Park is often wet
    - (8) New Mixed-use development
        - Redevelopment on a large part of this block for mixed-use
        - Streets in this area could also be evaluated for GI solutions
        - Some interest in inverting bumpout areas around street parking that are currently raised and produce runoff
    - Other locations discussed and dismissed:
        - Downtown stormwater goes to infiltration tanks that may be underwater
        - Schools treat stormwater on site with retention ponds
        - City parking lots are in good shape and have been recently redone.

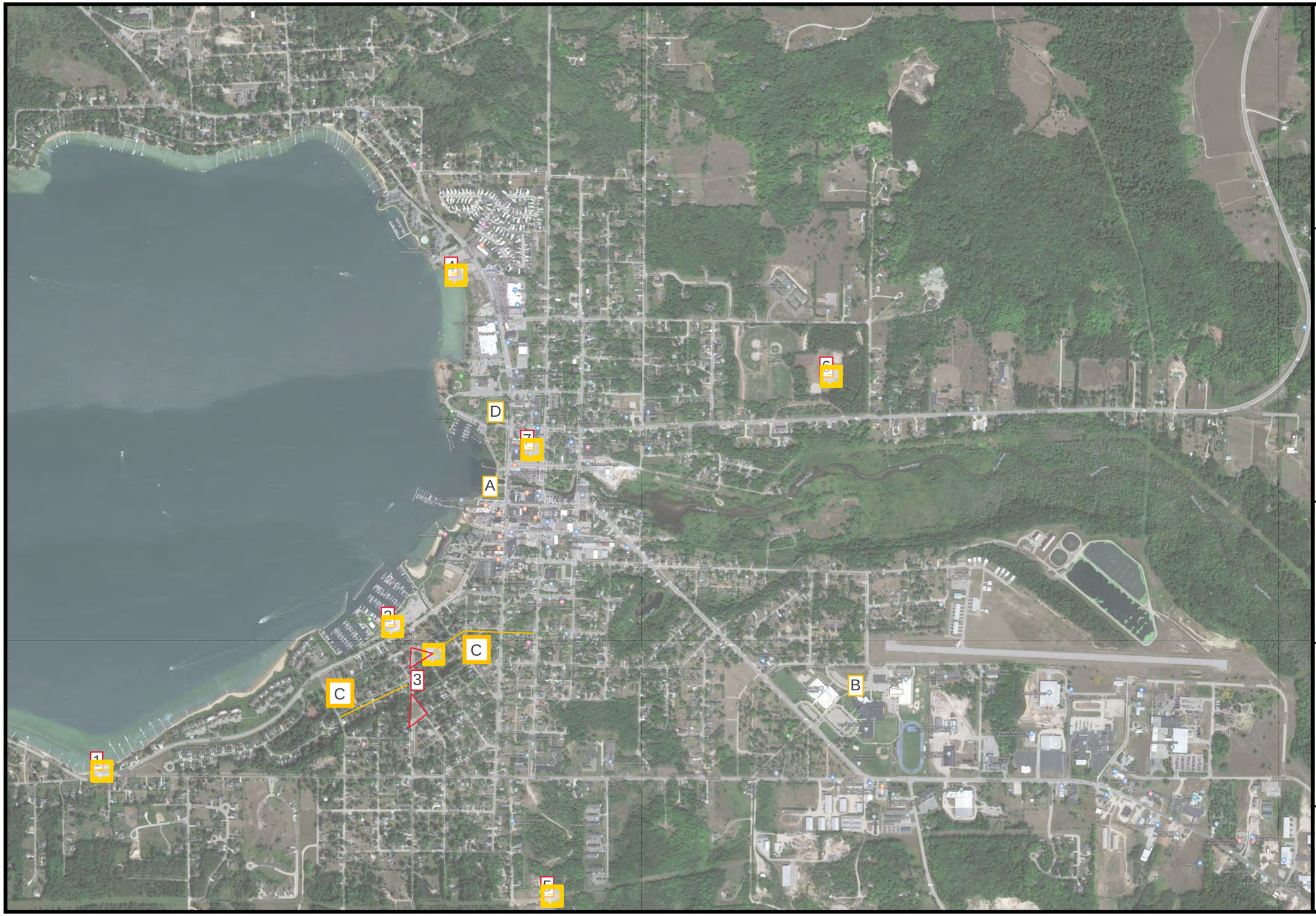
Data Requests
Scott McPherson (Planner/Zoning Administrator) is contact for GIS files.

GIS Data Requests

- Underground infrastructure GIS layers – specifically stormwater (storm sewers, inlets, catch basins, manholes, drainage districts, etc) but other infrastructure (water and sanitary sewer) that would influence design would be helpful.
- Roads
- Lidar/topography
- Publicly owned parcel maps
- Locations of existing stormwater treatment (like the underground storage tanks near downtown, permeable pavers at Veteran's Memorial, swales on Cedar and Terrace streets, etc.).

Other Documentation Requested:

- Most recent Master Plan
- C2AE documentation or contact to learn more about the underground storage for downtown
- Any plans or information regarding the new mixed-use development on North side of the river



Tip of the Mitt Watershed Council

GSI Visioning 2020
Boyne City

Legend:

Notes:

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DRUMMOND CARPENTER
engineering + research

Appendix B – Meeting Minutes (Project Initiation and Site Visits)

Site Visit Notes

Drummond Carpenter, PLLC
Traverse City, MI
Tel 920.362.4265
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BOYNE CITY SITE VISIT NOTES

On 21 May 2020, Don Carpenter and Rachel Pieschek conducted a field visit of the sites discussed in the 20 January 2020 Lake Charlevoix GSI Visioning Project meeting. This document is a status update on the visioning process and contains questions (**Bolded in Blue**) for the municipality that are answered at the interim meeting in the next section. It is based on the site visit and interim meetings with TOMWC.

Site Notes:

1. Tannery Beach
    a. Stormwater outlet for local pipe network was submerged so treatment must happen upstream of the outlet.
    b. Are there contamination issues at this site? It was mentioned as a possibility in the project initiation meeting, but it is not listed as a contaminated site in the MDEQ database. What is the likelihood of issues at this site and should we include it in visioning?
    c. There is a catch basin on edge of road in the parking lot that could be a shallow bioretention/stormwater wetland retrofit and treat road runoff.
    d. Additional bioretention could be provided for road runoff with curb cuts and bioswales.
    e. Shoreline erosion was observed and shoreline on both sides of park are riprapped. Possibilities include leaving more vegetated buffer with designated access points (similar to river in downtown, image below). This would not reduce stormwater but could reduce erosion - especially during periods of highwater.

Figure 1 – Example of limited shoreline access (behind the sculpture) in Boyne City

    f. Recommendations at Tannery Beach are similar to April 2006 Waterfront Master Plan for this area with slight relocation of the bioretention/wetland area. It is also similar to previous grant application by TOTM watershed council, with the exclusion of permeable pavers. Due to high water levels permeable pavers were not recommended in this location.

2. Peninsula Beach Park
    a. Contributing areas upstream of this outfall are discussed under Section 3 - Road Triangles.
    b. Outfall at the marina was not inspected due to the marina being private property. Instead the adjacent Peninsula Beach Park was visited.
        i. Peninsula Beach Park was not discussed in the project initiation meeting. Are there any reasons we should exclude it from this visioning process? Some of our plans could be incorporated into the design from April 2006 Waterfront Master Plan, but the parking lot recommendation does not exist on that plan.
        ii. There already is a small swale along the parking lot. It could be enhanced with plants to increase infiltration.
        iii. More treatment could be achieved by a larger bioretention practice between swale and beach. Runoff from this parking lot is already being partially treated by the swale and overland flow before it gets to the beach.
        iv. Center of parking turn-around could be recessed for more treatment of stormwater. Soils around and inside the turn-around are being driven on – possibly by lawn service trailer. This could be addressed by reinforcing the edges with interlocking concrete pavers, but that would mostly be for aesthetics with little stormwater benefit (Example in Figure 2).

Figure 2 – Reinforced Pavement Edge Example

        v. Parking lot on east end of park has a catch basin and could be retrofitted with bioretention. This treatment likely would reduce parking by one spot but would provide treatment for stormwater piped directly to the lake.

vi. Bioengineering to reduce shoreline erosion is recommended near the marina.

3. Road Triangles
    a. North triangle – This parcel is owned by the city but feels like it is part of the adjacent residence since there is no longer a road separating it. **Can we propose practices in this location without upsetting the homeowner? Does the city or homeowner maintain the parcel?** There is a catch basin adjacent to the parcel and stormwater could be directed into bioretention practices at this location.
    b. South triangle – opportunity to treat stormwater in this parcel and make it into a stormwater park. There is some elevation change on the site, so stepped bioretention practices would be envisioned. There is potential at this site to treat a some of the neighborhood stormwater and not just the adjacent street runoff.
    c. Streetside opportunities – wide right of ways can be made into swales with overflows
        i. Recommendations for treatment are similar to what the city has done on Cedar and Terrace Street with swales.
4. Boat Launch
    a. At our project initiation meeting, there was discussion that the city is considering using some permeable pavement when reconstructing. Permeable pavement or pavers would infiltrate some runoff, but high water tables could limit infiltration rates. With water tables as high as they currently are, permeable pavers would likely be ineffective on this site.
    b. Parking lot sheet flows to boat ramp and grass (SW corner). This corner could use naturalized sections of shoreline – similar to Figure 1 with defined access points and the rest naturalized if access is needed. This would provide additional treatment for parking lot runoff and help reinforce the soil near shore.
    c. A swale in the green space between the boat launch and next parcel to treat road runoff from the north. There is a nearby outlet that could be tapped into or it could connect straight to the lake with a bridge for pedestrian access.
    d. Are there plans of expanding parking at the boat launch? If so, what is the plan – so we can plan non-conflicting infrastructure.
    e. We did not discuss the adjacent parcel (Open Space Park) at the project initiation, but we agree with TOTM comments on the plans. Permeable pavers or bioswales to treat parking lot runoff and naturalized shoreline buffers will help reduce stormwater impacts on the site.
        i. In addition to previous plan comments by TOTM, we also recommend a swale/bioretention along road in the ROW between park and Lake Street to treat stormwater runoff from the roadway.
5. Avalanche Preserve
    a. The 2015 recreation plan and Avalanche park plan include a stormwater retention wetland. **Since this (Figure 3) is already included in the existing plans should we do any alternative recommendations for Avalanche Preserve? Or should we incorporate these GSI concepts into our recommendations?** We could envision other ideas including underground infiltration chambers for this area if surface techniques are no longer desired.

Figure 3 – 2015 Recreation Plan for Avalanche Preserve (Stormwater management circled in lime green)

b. Alternative options: Currently there are two catch basins on west end of parking lot. An infiltration system could be used in this location with pretreatment to address sediment issues from gravel/dirt parking lot.

c. Currently there are large mowed areas that could be native prairie/naturalized. **Are the areas marked on the Avalanche site map in the appendix mowed all year or just short because it is spring? What is the lighted area used for (note on appendix site map)?**

d. Large grass area could be used for a larger stormwater treatment practice – large bioretention or retention basin. This would be similar to 2015 Recreation plan, but not dependent on redoing the parking layout.

6. Rotary Park

a. Stormwater on this site is likely retained on site since there was no visible stormwater collection system and multiple areas of shallow ponding. Suggested improvements are targeted towards reducing standing water issues but will do little to improve Lake Charlevoix water quality since runoff is already retained on the site. **Do we still want to proceed with recommendations for this site?**

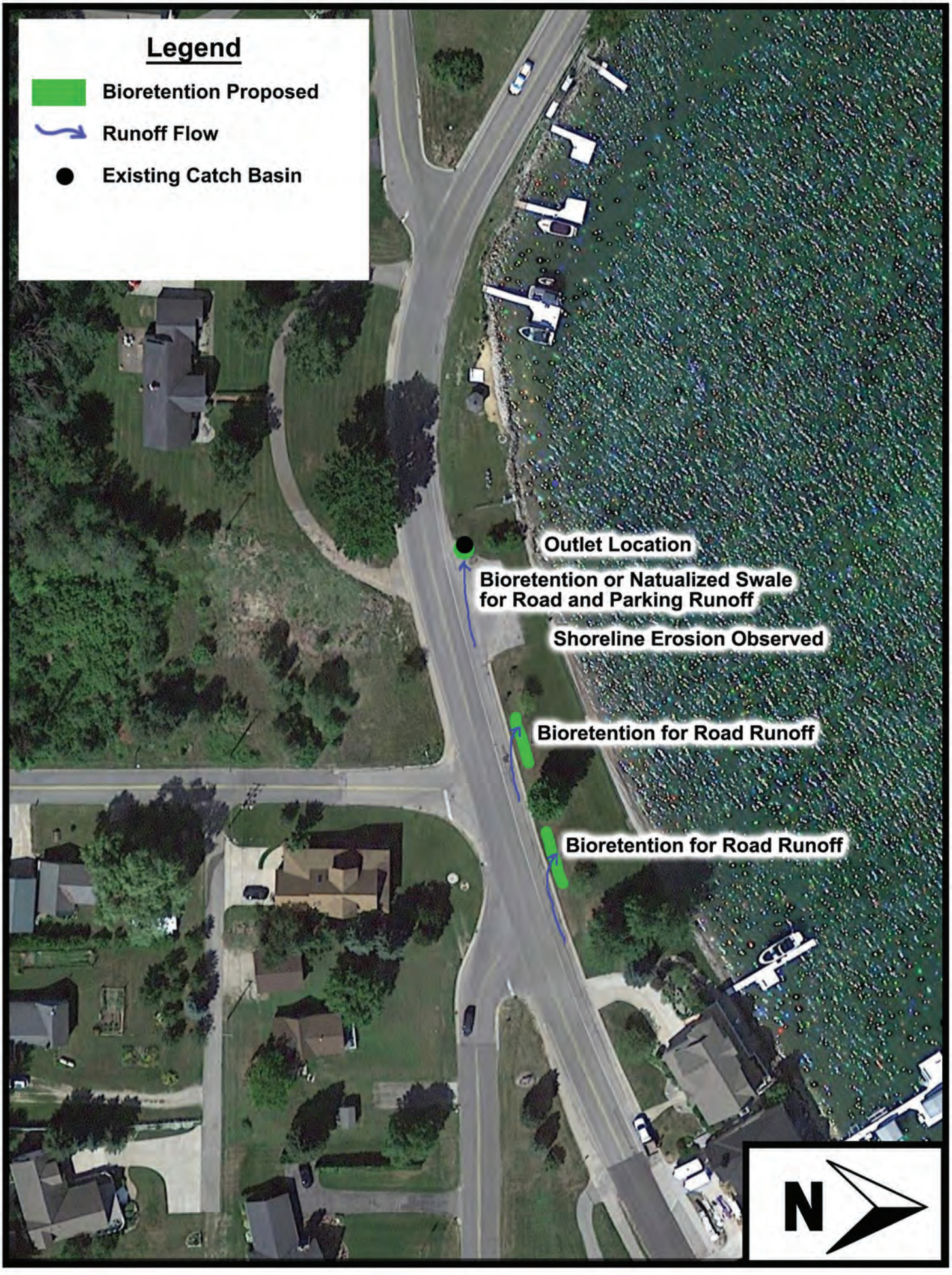
b. Edges of gravel parking lots could be enhanced with a 4 ft concrete interlocking paver reinforced parking.

c. Along with pavers, a shallow swale along the edge would help divert water from parking and native plants can help infiltrate stormwater. There is very little depth to the water table at this site.

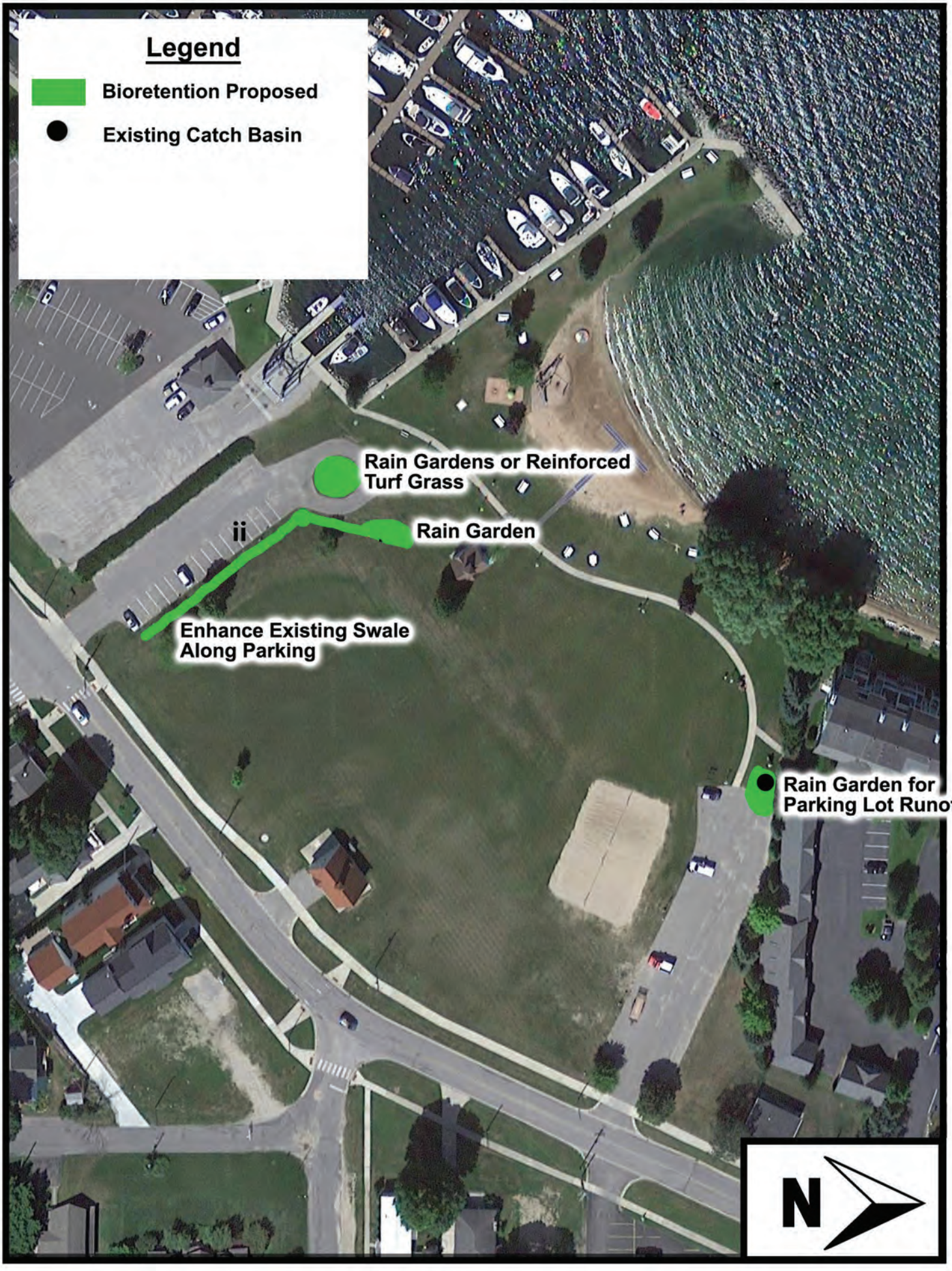
d. We recommend naturalizing areas in front of park where it is very wet and currently is mowed.

7. Mixed use development (edge of downtown)/bump-outs
    a. Redevelopment with new construction was in progress on North Street and Lake Street, so only the right of way was evaluated.
    b. Nearby Streets
        i. Bumpout areas could be converted to bioretention and future bumpouts can incorporate bioretention and overflow catch basins. Many existing bumpouts have CBs adjacent to them and could be retrofitted.
        ii. Wide ROWs on roads without on-street parking could have swales to treat road runoff.
        iii. Bumpout recommendations and swales do not match the April 2006 Waterfront Master Plan, but could be complimentary to the plan.
    c. Green Alleys
        i. These were not discussed at the project initiation meetings, but there are alleys in this area that could be green alley opportunities – including stormwater planters and permeable pavers.
    d. Public parking lot – briefly discussed at project initiation meeting and dismissed, but there are adjacent opportunities.
        i. This is labeled a brownfield site on the EGLE website (Accessed 2 Jun 2020) – so infiltration practices may not be feasible depending on what contamination remains at the site.
        ii. Based on elevation from Boyne City GIS, there is good elevation difference between the river and surrounding areas.
            1. Parking CBs rim elevation: 587.64’
            2. Grass inlet rim: 588.21’
            3. Grass inlet pipe invert: 584.21’ (estimated)
            4. Outlet in river: 579.2’
        iii. Permeable paver retrofits around catch basins in parking lot
        iv. Bioretention on grass treating parking lot runoff

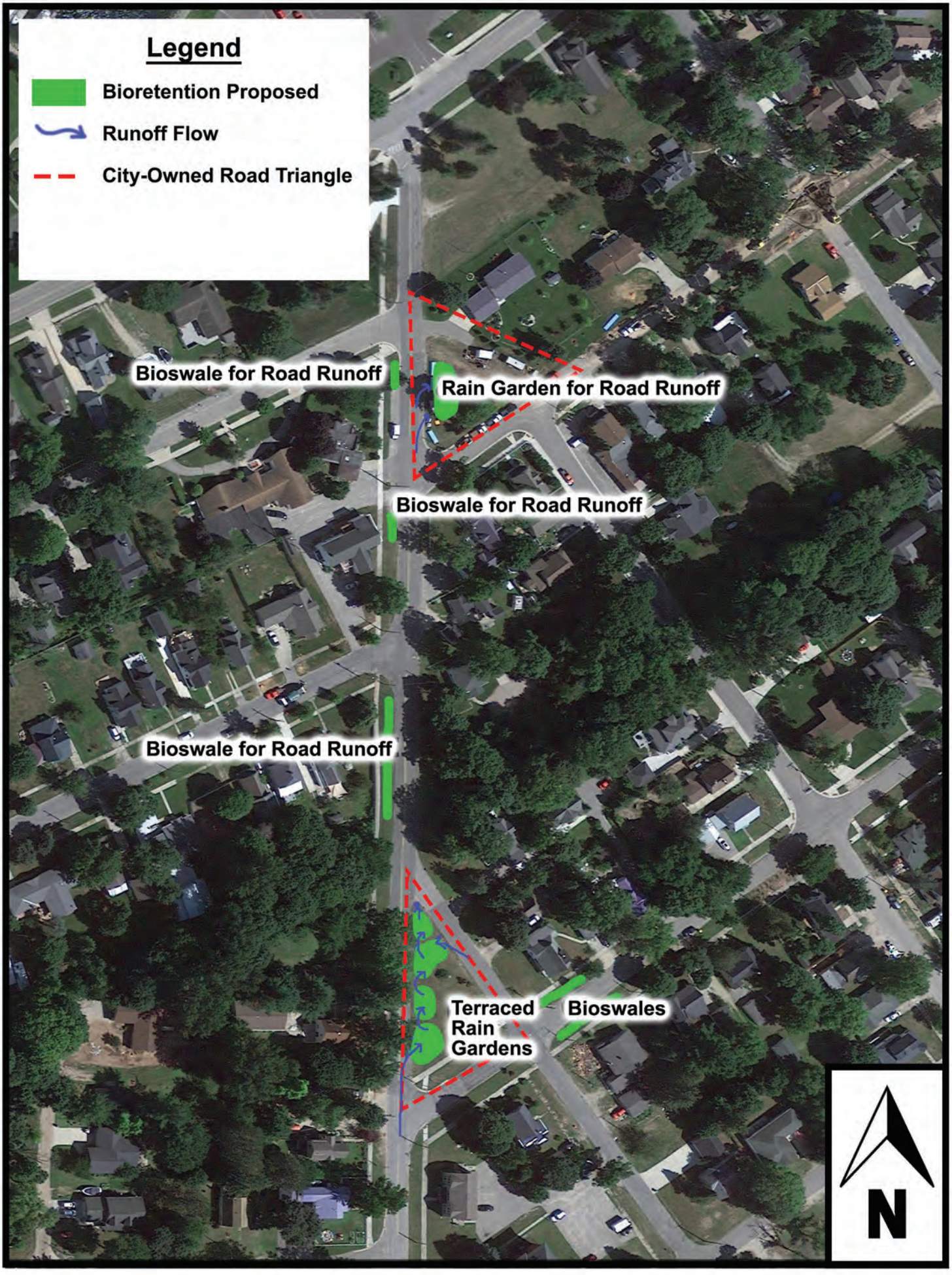
BOYNE CITY 1 - TANNERY BEACH



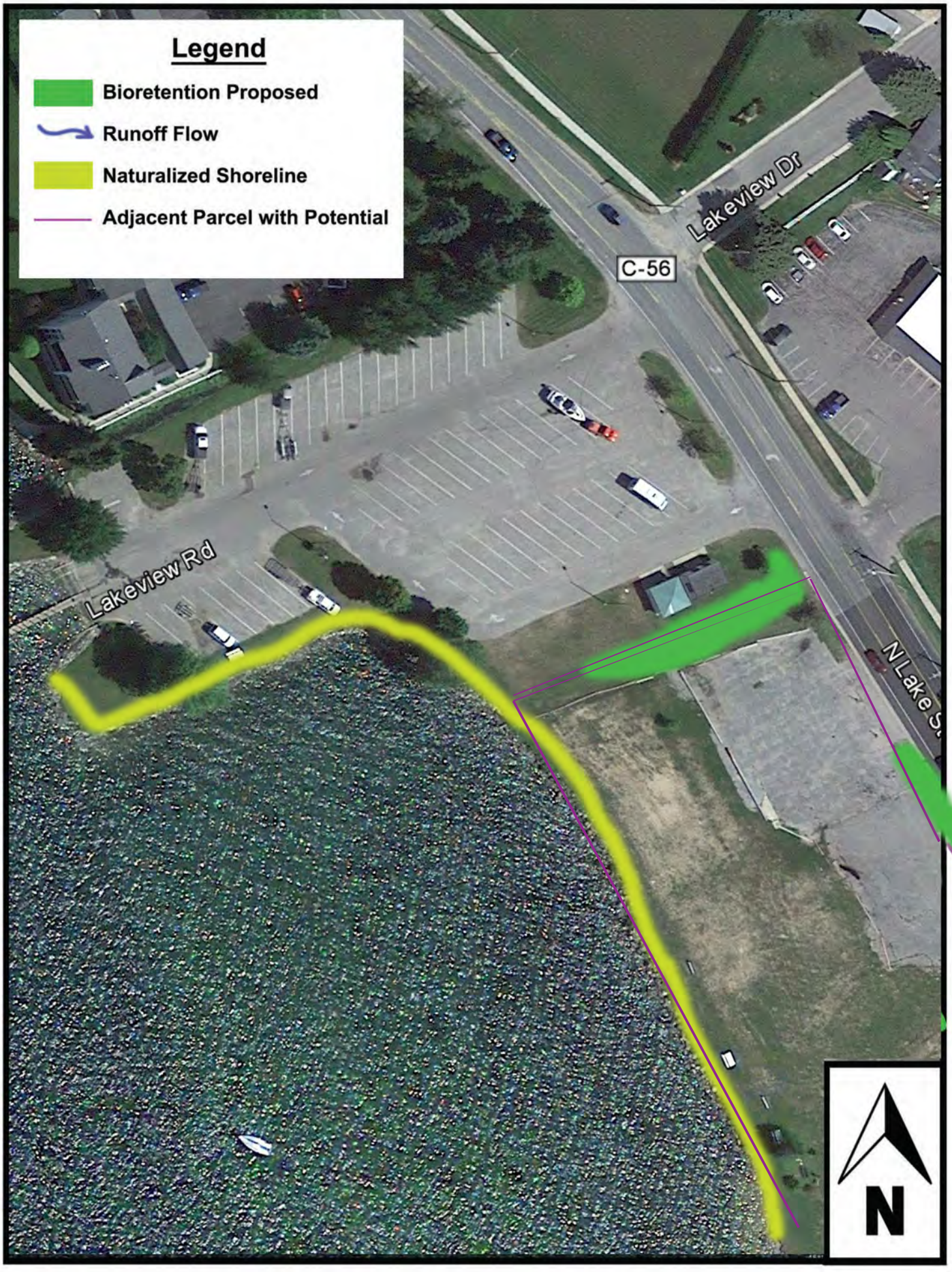
BOYNE CITY 2 - PENINSULA BEACH PARK



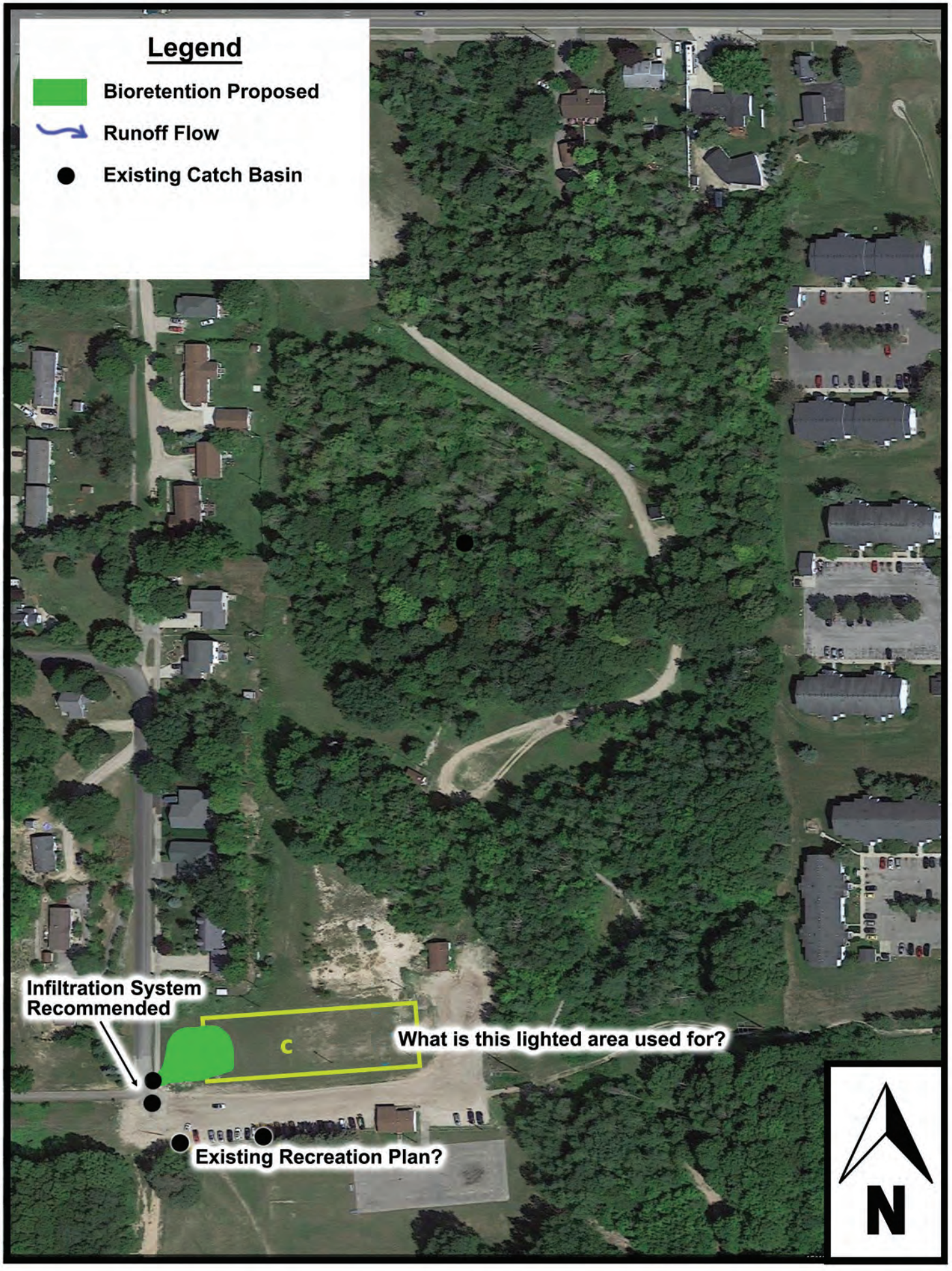
BOYNE CITY 3 - ROAD TRIANGLES



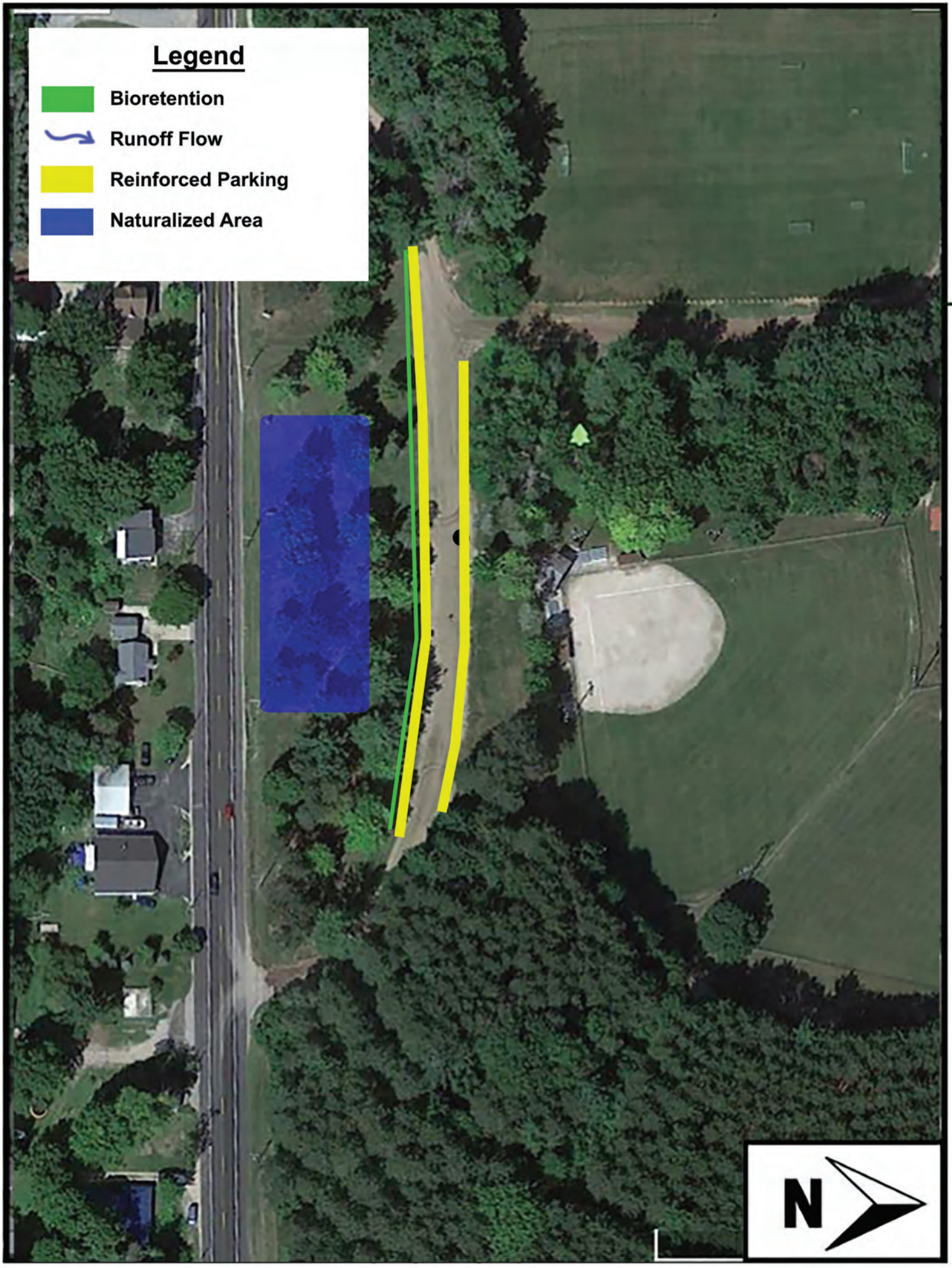
BOYNE CITY 4 - BOAT LAUNCH



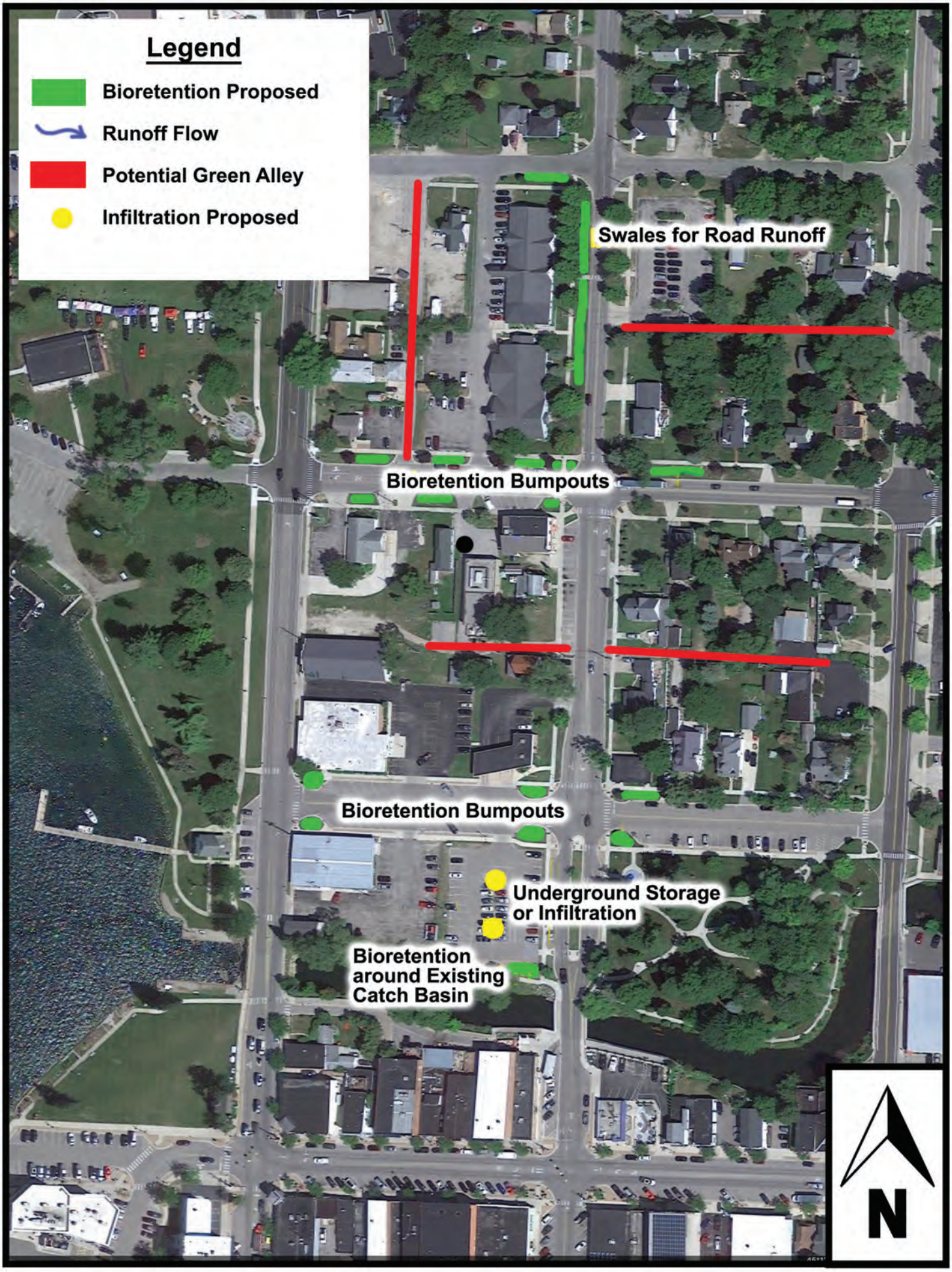
BOYNE CITY 5 - AVALACHE PRESERVE (ENTRANCE, LOT + BUILDINGS)



BOYNE CITY 6 - ROTARY PARK



BOYNE CITY 7 - DOWNTOWN DEVELOPMENT



Appendix B – Meeting Minutes (Project Initiation and Site Visits)

City Responses to Site Visit Notes – July 7, 2020

At the interim meeting on July 7, 2020 the questions generated during site evaluations were answered. The questions are copied from the site visit notes and their responses listed below each question. Context for these answers are listed in the previous section.

1. b. Are there contamination issues at this site? It was mentioned as a possibility in the project initiation meeting, but it is not listed as a contaminated site in the MDEQ database. What is the likelihood of issues at this site and should we include it in visioning?
   There is no city knowledge of any contamination issues at this site and it can be included in visioning.
2. i. Peninsula Beach Park was not discussed in the project initiation meeting. Are there any reasons we should exclude it from this visioning process? Some of our plans could be incorporated into the design from April 2006 Waterfront Master Plan, but the parking lot recommendation does not exist on that plan.
   Go ahead and continue with visioning this site.
3. a. Can we propose practices in this location without upsetting the homeowner? Does the city or homeowner maintain the parcel?
   This site can be visioned, it is city land. Further engagement with adjacent property owners can be engaged later if the design is taken further.
4. d. Are there plans of expanding parking at the boat launch? If so, what is the plan – so we can plan non-conflicting infrastructure.
   Boat launch site and adjacent parcel are in process of redesign and other than the comments on the plans, this site will not be taken further in the visioning process.
   e. We did not discuss the adjacent parcel (Open Space Park) at the project initiation, but we agree with TOTM comments on the plans. Permeable pavers or bioswales to treat parking lot runoff and naturalized shoreline buffers will help reduce stormwater impacts on the site.
   See previous answer, the design will not go further in the visioning process. The site however is a good candidate for GSI.
5. a. Since this (Site visit notes - Figure 3) is already included in the existing plans should we do any alternative recommendations for Avalanche Preserve? Or should we incorporate these GSI concepts into our recommendations?
   This site has gone through multiple iterations of plans. When a plan is decided GSI should be incorporated, but it will not be taken further visioning as part of this project.
   c. Are the areas marked on the Avalanche site map in the appendix mowed all year or just short because it is spring? What is the lighted area used for (note on appendix site map)?
   This site is not going through further visioning as part of this project.
6. a. Do we still want to proceed with recommendations for this site?
   Yes, go continue the visioning process. If further upgrades at the site occur it would likely be connected to the drainage system.

Appendix C – Survey Results

Residents of Boyne City were invited to participate in a Green Stormwater Infrastructure (GSI) visioning process. The survey was available online from October 15 to December 4, 2020. Participants viewed a brief description, photo, and artistic renderings of the design as it would appear in that location. After scrolling through green infrastructure locations, participants completed a survey designed to gather community input regarding green stormwater infrastructure and the potential designs.

Thirty-one (31) people participated in the Boyne City GSI survey and the date of survey participation is shown in Figure C-1.

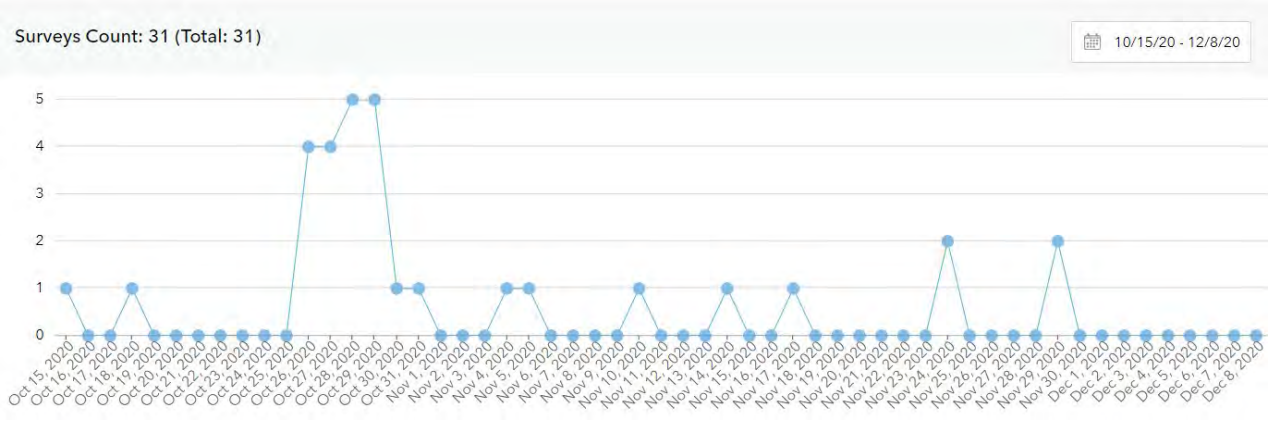


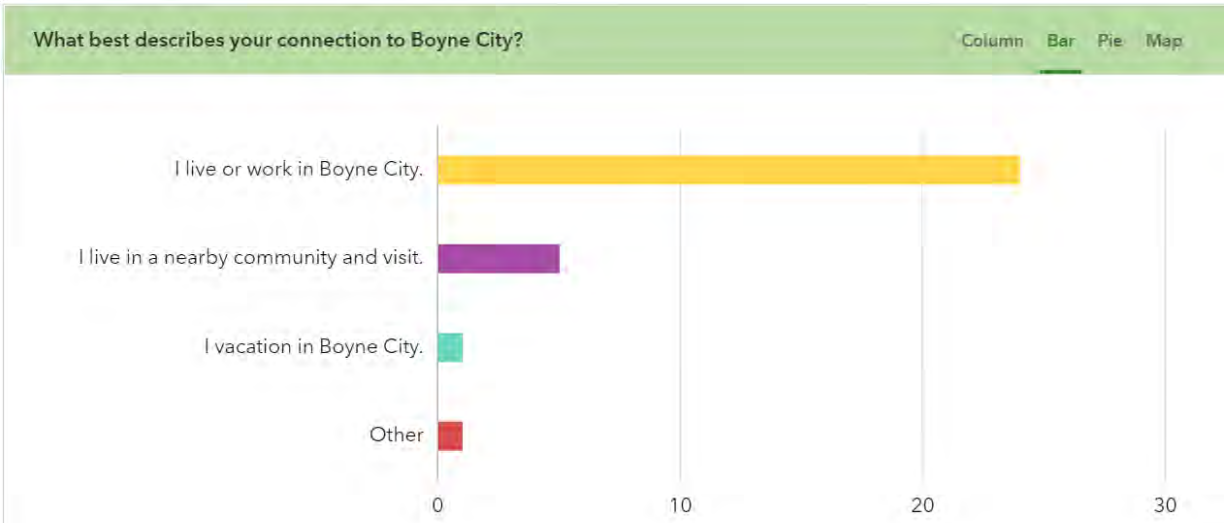
Figure C - 1: Survey Participation by Date

Question 1: What best describes your connection to Boyne City?

The first survey question helped determine how participants were connected to Boyne City. The question was a drop-down list including the responses:

- I live or work in Boyne City.
- I live in a nearby community and visit.
- I vacation in Boyne City.
- Other – Fill in a text response.

Results are shown in Figure C-2. The one respondent who selected "Other" as an answer wrote: "Live in Advance 8 months of year".



Hide table | Other response | Empty categories | Sort

Answers	Count	Percentage
I live or work in Boyne City.	24	77.42%
I live in a nearby community and visit.	5	16.13%
I vacation in Boyne City.	1	3.23%
Other	1	3.23%

Answered: 31 Skipped: 0

Figure C - 2: Survey Responses to Question 1

Questions 2 through 9: Rate the GSI Concepts

Survey respondents were asked to "Please rate the GSI concepts to help us understand public preferences" for the eight concepts (Figure C-3) proposed for Boyne City. The survey included Figure C-3 embedded and followed by the questions where respondents were asked to indicate the answer that best expressed their opinion of each proposed practice:

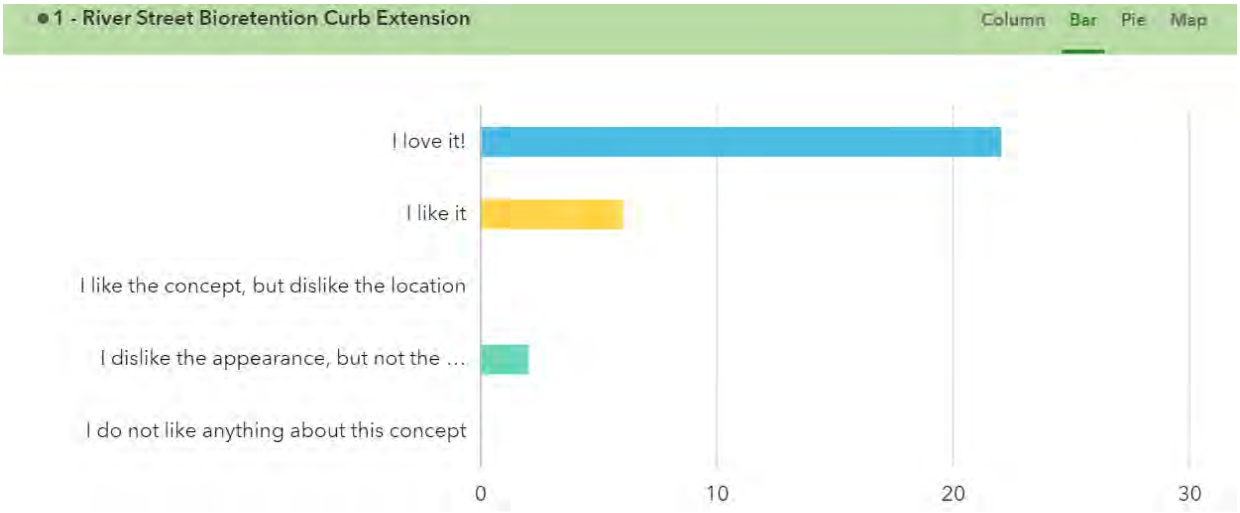
- I love it!
- I like it.
- I like the concept, but dislike the location.
- I dislike the appearance, but not the concept.
- I do not like anything about this concept.

Responses for each concept are shared in Figures C-4 to C-11.

Figure C - 3: Figure from Survey for Questions 2 through 9

Question 2: Practice 1 – River Street Bioretention Curb Extension

Respondent instructions for this question were, "Please rate the GSI concepts to help us understand public preferences". Responses are shown in Figure C-4.



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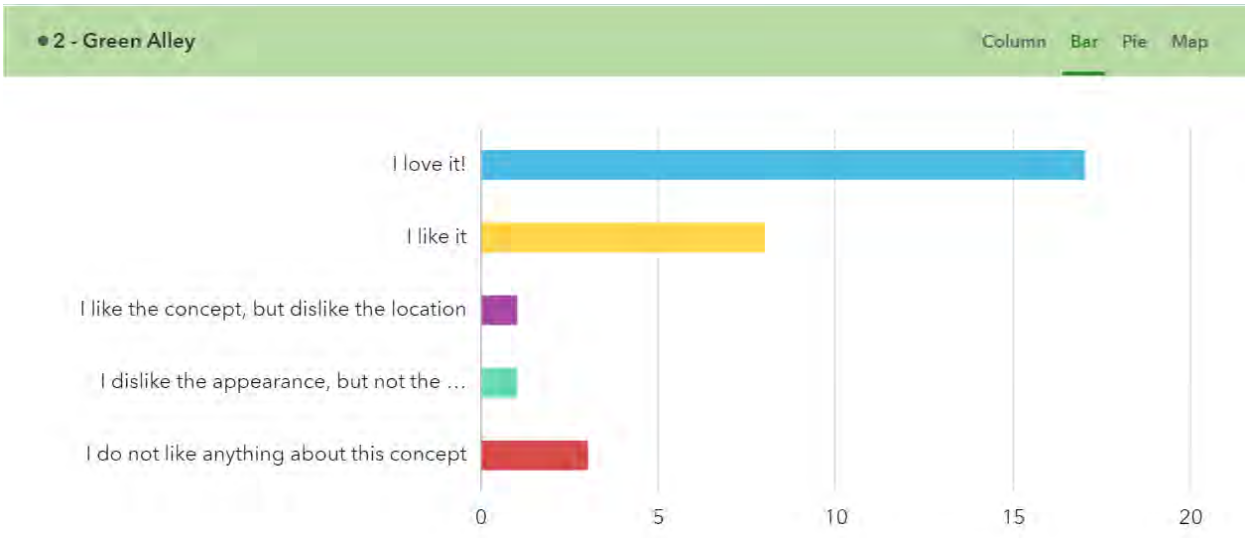
Answers	Count	Percentage
I love it!	22	70.97%
I like it	6	19.35%
I like the concept, but dislike the location	0	0%
I dislike the appearance, but not the concept	2	6.45%
I do not like anything about this concept	0	0%

Answered: 30 Skipped: 1

Figure C - 4: Survey Responses to Question 2

Question 3: Practice 2 – Green Alley

Respondent instructions for this question were, "Please rate the GSI concepts to help us understand public preferences". Responses are shown in Figure C-5.



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Sort

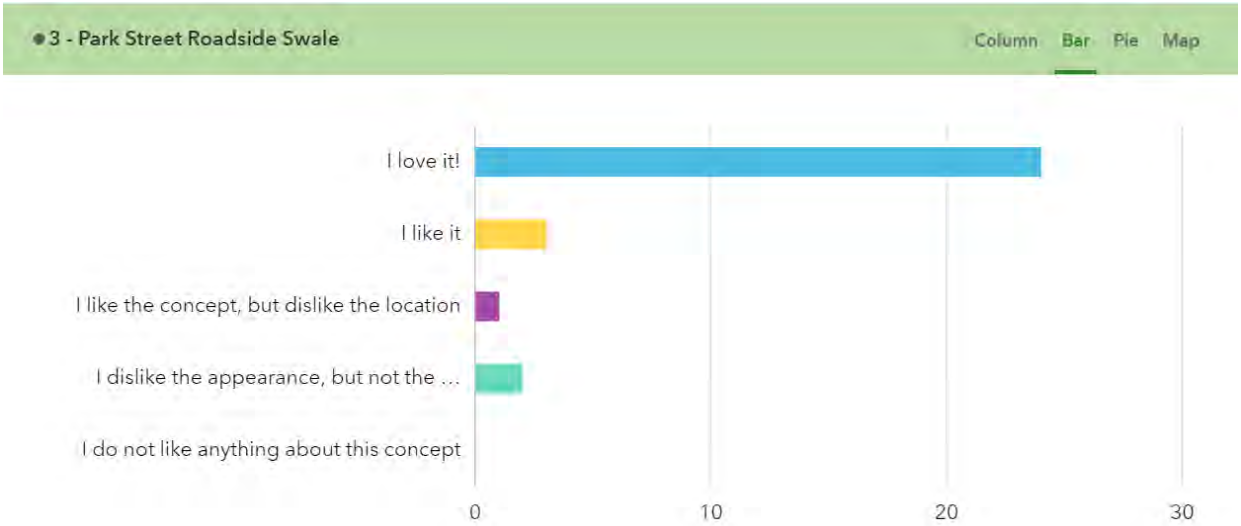
Answers	Count	Percentage
I love it!	17	54.84%
I like it	8	25.81%
I like the concept, but dislike the location	1	3.23%
I dislike the appearance, but not the concept	1	3.23%
I do not like anything about this concept	3	9.68%

Answered: 30 Skipped: 1

Figure C - 5: Survey Responses to Question 3

Question 4: Practice 3 – Park Street Roadside Swale

Respondent instructions for this question were, "Please rate the GSI concepts to help us understand public preferences". Responses are shown in Figure C-6.



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Empty categories Sort

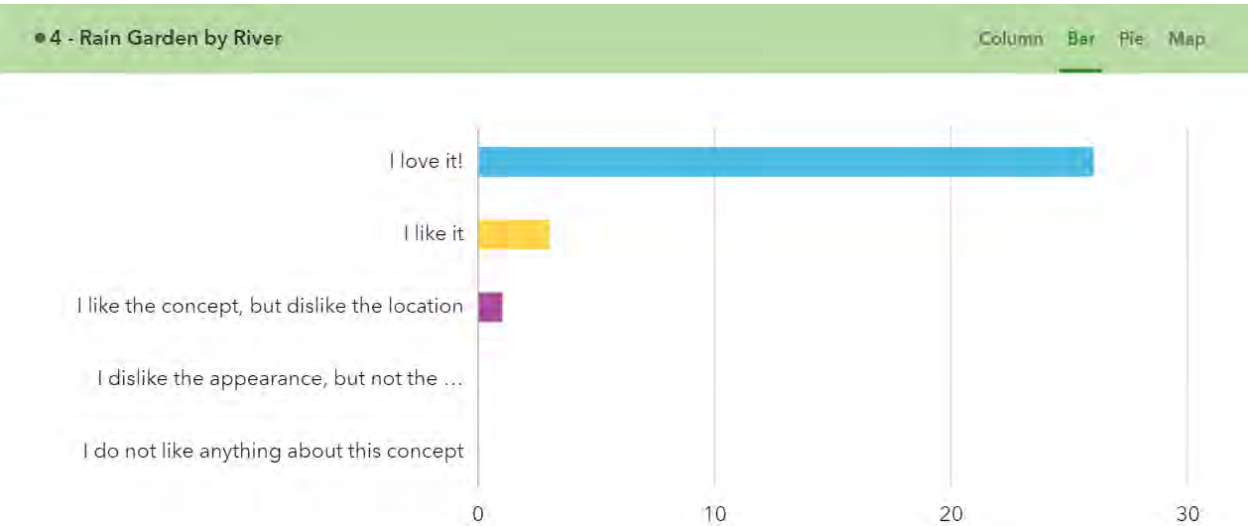
Answers	Count	Percentage
I love it!	24	77.42%
I like it	3	9.68%
I like the concept, but dislike the location	1	3.23%
I dislike the appearance, but not the concept	2	6.45%
I do not like anything about this concept	0	0%

Answered: 30 Skipped: 1

Figure C - 6: Survey Responses to Question 4

Question 5: Practice 4 – Rain Garden by River

Respondent instructions for this question were, "Please rate the GSI concepts to help us understand public preferences". Responses are shown in Figure C-7.



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Sort

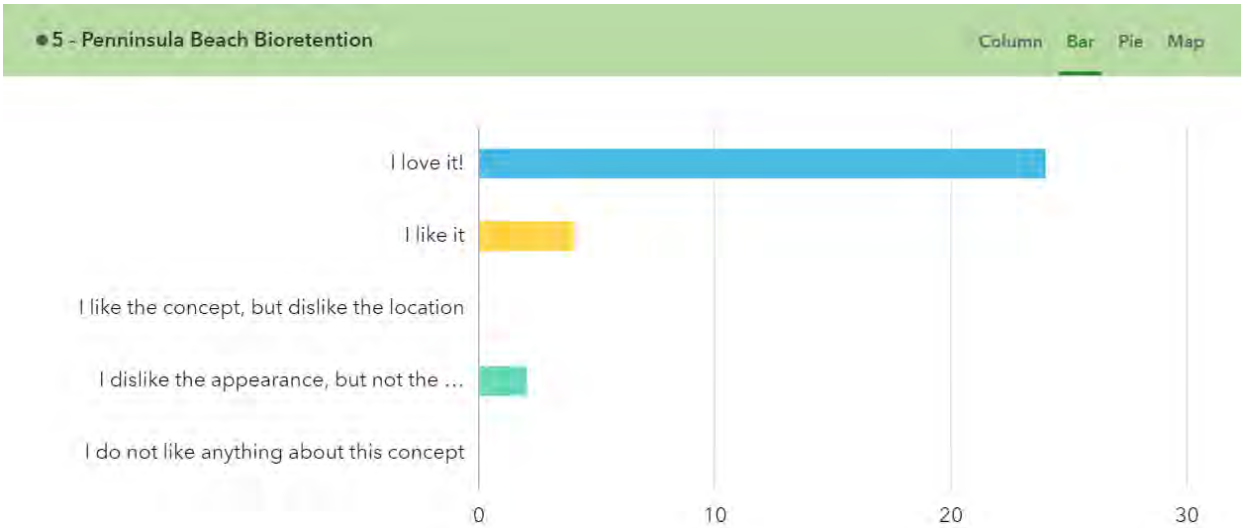
Answers	Count	Percentage
I love it!	26	83.87%
I like it	3	9.68%
I like the concept, but dislike the location	1	3.23%
I dislike the appearance, but not the concept	0	0%
I do not like anything about this concept	0	0%

Answered: 30 Skipped: 1

Figure C - 7: Survey Responses to Question 5

Question 6: Practice 5 – Peninsula Beach Bioretention

Respondent instructions for this question were, "Please rate the GSI concepts to help us understand public preferences". Responses are shown in Figure C-8.



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Empty categories Sort

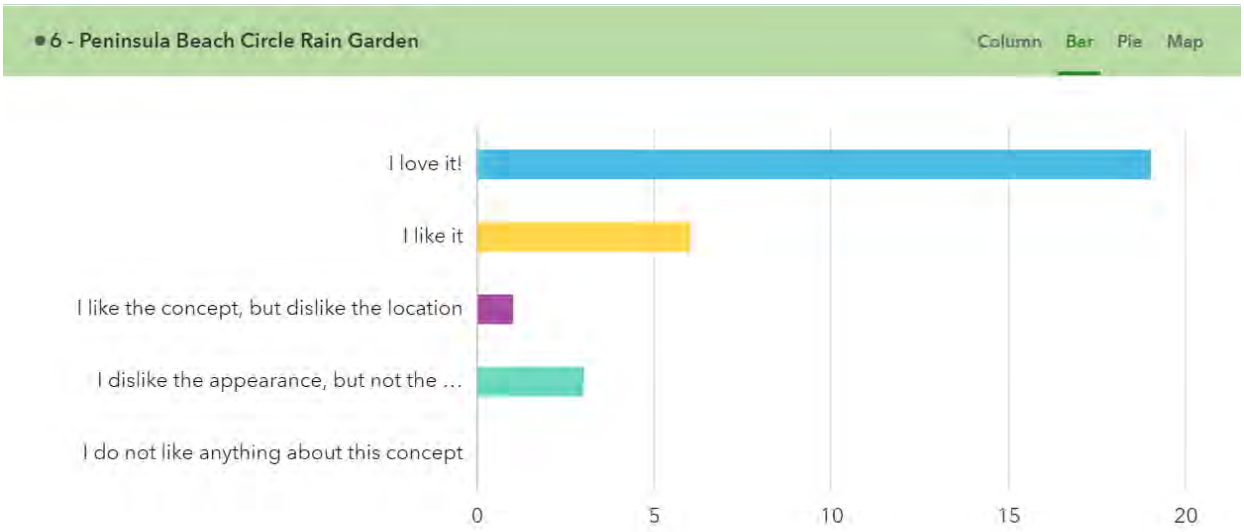
Answers	Count	Percentage
I love it!	24	77.42%
I like it	4	12.9%
I like the concept, but dislike the location	0	0%
I dislike the appearance, but not the concept	2	6.45%
I do not like anything about this concept	0	0%

Answered: 30 Skipped: 1

Figure C - 8: Survey Responses to Question 6

Question 7: Practice 6 – Peninsula Beach Circle Rain Garden

Respondent instructions for this question were, "Please rate the GSI concepts to help us understand public preferences". Responses are shown in Figure C-9.



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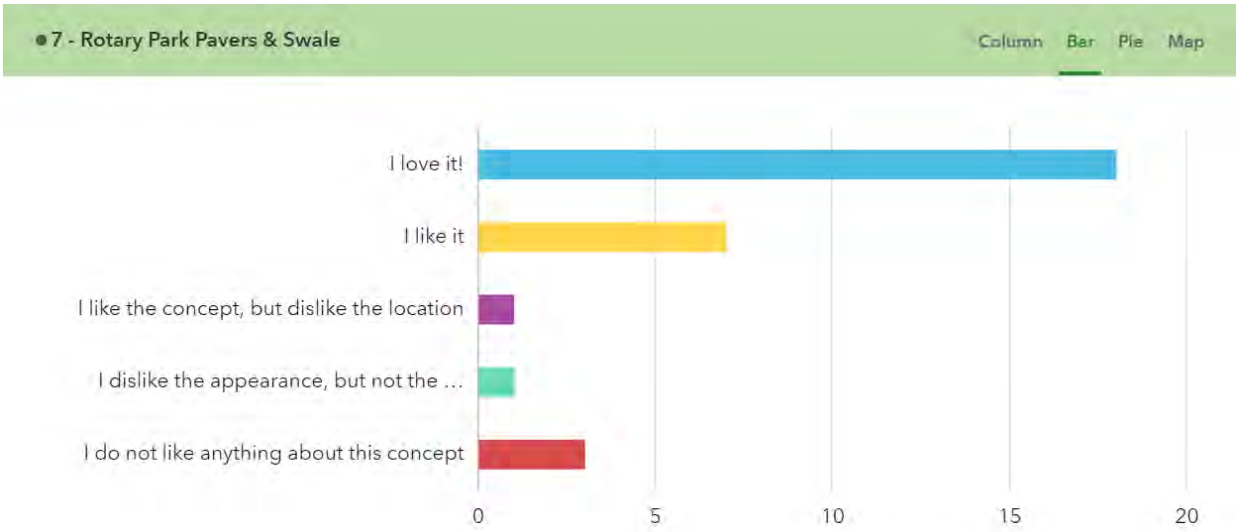
Answers	Count	Percentage
I love it!	19	61.29%
I like it	6	19.35%
I like the concept, but dislike the location	1	3.23%
I dislike the appearance, but not the concept	3	9.68%
I do not like anything about this concept	0	0%

Answered: 29 Skipped: 2

Figure C - 9: Survey Responses to Question 7

Question 8: Practice 7 – Rotary Park Pavers & Swale

Respondent instructions for this question were, "Please rate the GSI concepts to help us understand public preferences". Responses are shown in Figure C-10.



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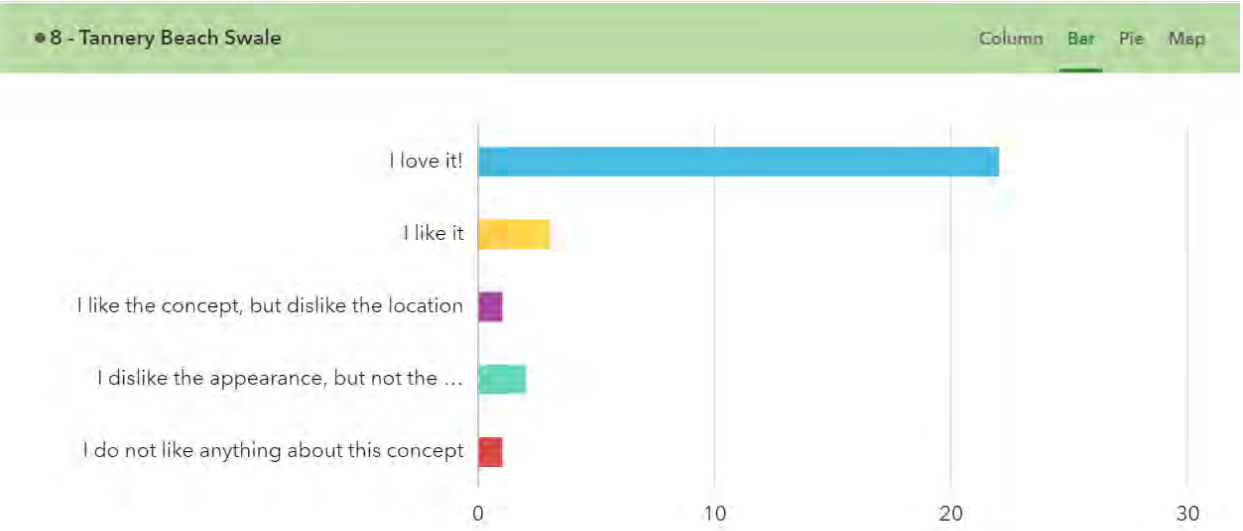
Answers	Count	Percentage
I love it!	18	58.06%
I like it	7	22.58%
I like the concept, but dislike the location	1	3.23%
I dislike the appearance, but not the concept	1	3.23%
I do not like anything about this concept	3	9.68%

Answered: 30 Skipped: 1

Figure C - 10: Survey Responses to Question 8

Question 9: Practice 8 – Tannery Beach Swale

Respondent instructions for this question were, "Please rate the GSI concepts to help us understand public preferences". Responses are shown in Figure C-11.



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Sort

Answers	Count	Percentage
I love it!	22	70.97%
I like it	3	9.68%
I like the concept, but dislike the location	1	3.23%
I dislike the appearance, but not the concept	2	6.45%
I do not like anything about this concept	1	3.23%

Answered: 29 Skipped: 2

Figure C - 11: Survey Responses to Question 9

Question 10: Drag and Drop Ranked Choice

Respondents were asked to "drag and drop rank the concepts in order of what you want to see implemented". Figure C-12 shows a screenshot of the survey for question 10. The question may have appeared different depending on what device was used to access the survey.

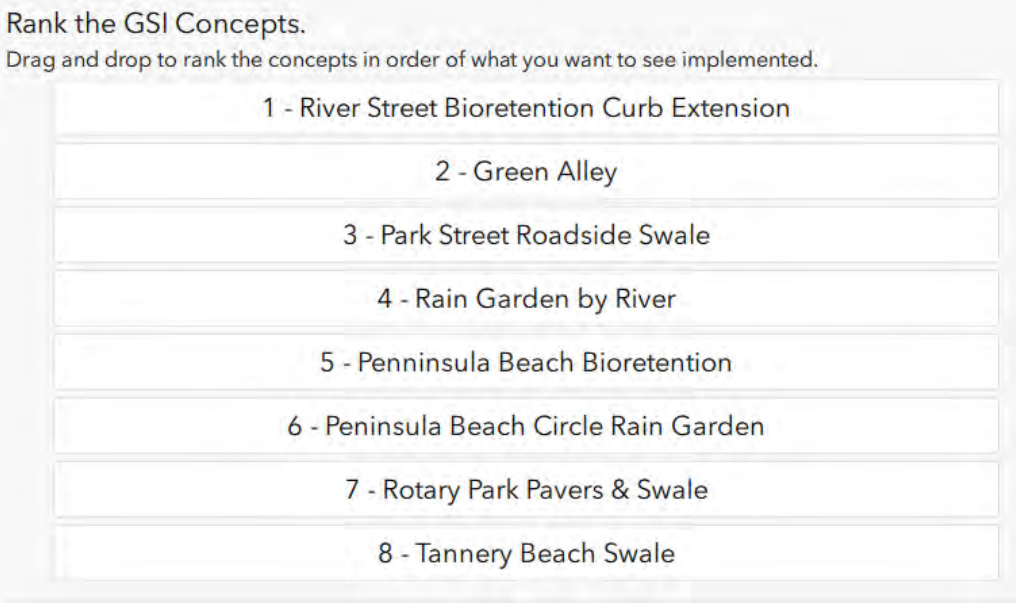


Figure C - 12: Screenshot of Survey Question 10

Due to a user difficulty with the phone-based version of the survey, many users did not answer the question and the resulting order was submitted as "1,2,3,4,5,6,7,8". Due to the known user difficulty, any results that did not modify rank order in the survey were removed before evaluating the data. The ranked choice voting results were weighted based on the number of votes for 1st place, 2nd place, 3rd place, etc. and the resulting ranked order is:

- 5 - Peninsula Beach Bioretention
- 4 - Rain Garden by River
- 1 - River Street Bioretention Curb Extension
- 3 - Park Street Roadside Swale
- 8 - Tannery Beach Swale
- 6 - Peninsula Beach Circle Rain Garden
- 2 - Green Alley
- 7 - Rotary Park Pavers and Swale

The number of times each practice received a 1st, 2nd, 3rd, etc rank is listed in the Table C-1:

Table C-1 – Number of Results for Each Practice Ranking

RANK	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth
1 - River Street Bioretention Curb Extension	5	4	3	5	2	3	2	1
2 - Green Alley	2	3	4	1	2	3	4	6
3 - Park Street Roadside Swale	3	3	3	7	4	2	1	2
4 - Rain Garden By River	6	4	4	4	1	1	3	2
5 - Peninsula Beach Bioretention	6	4	4	3	2	4	1	1
6 - Peninsula Beach Circle Rain Garden	0	5	2	1	6	4	5	2
7 - Rotary Park Pavers and Swale	1	0	0	3	3	5	8	5
8 - Tannery Beach Swale	2	2	5	1	5	3	1	6

Question 11: Concept 3 - Aesthetics

Respondents were asked "Which of these proposed versions do you aesthetically prefer?" for Concept 3 (Figure C-13). Figure C-13 was embedded in the survey and shows the practice rendered with three different plant pallets. Version 3C was the overwhelming preferred choice from the survey results with 22 of 30 votes cast (Figure C-14).

Figure C - 13: Survey Image for Question 11

Figure C - 14: Survey Responses to Question 11

Question 12: Concept 3 - Text

Respondents were then asked, “Why did you select that version of Concept 3 as your preference?”. Six respondents did not answer this question. Responses are recorded verbatim below grouped by which version of the practice they chose.

Text responses for Proposed 3A:

1. Less cost and upkeep. Also the amount of maple leaves that fall there might be too much to deal with?
2. As a residential area, risk of bees to those that may be allergic
3. Low maintenance. I like them all. I actually prefer 3A but I'm not sure what commitment the Boyne Area Medical Center would have to maintenance.

Text responses for Proposed 3B:

1. I like the look of the mulch with minimal landscaping
2. Lower maintenance and less noise
3. Am Master Gardener and prefer easy to maintain planting. Love flowers but they need too much maintenance including clean up. Some grasses absorb much water.
4. Recommend a design with a low maintenance cost to the city.

Text responses for Proposed 3C:

1. Native plants and informal arrangement, larger native shrubs and trees would improve concept
2. If it is planted with plants that encourage and support the bee population I think that would be very beneficial. The other version with mulch looks like it would be too high maintenance.
3. 3C looks more natural and beneficial to wildlife and pollinators. Beautiful!
4. Lots of flowers
5. Lots of flowers
6. The addition of color makes it more pleasing to the eye. Takes eyes away from the swale.
7. Who doesn't love flowers? And hopefully better for bees and butterflies.
8. Prefer natural/native vegetation
9. I like to see native plantings
10. Simply looks for eye appealing. If the functionality is the same the eye appeal is what I would go for
11. Visually appealing
12. Most full looking vegetation
13. Lower maintenance, beneficial ecological aspects
14. More plantings and color
15. Like the color variance
16. Perennial Flowers are a wonder way to add color to these spaces
17. I like wildflowers and I would like to see more natural plants and look around.
18. Good for beneficial insects and birds, easy to maintain, beautiful

Question 13: Concept 8 - Aesthetics

Respondents were asked “Which of these proposed versions do you aesthetically prefer?” for Concept 8 (Figure C-15). Figure C-15 was embedded in the survey and shows the practice rendered with two different plant pallets. Responses were split evenly between the two (Figure C-16).

Figure C - 15: Survey Image for Question 13

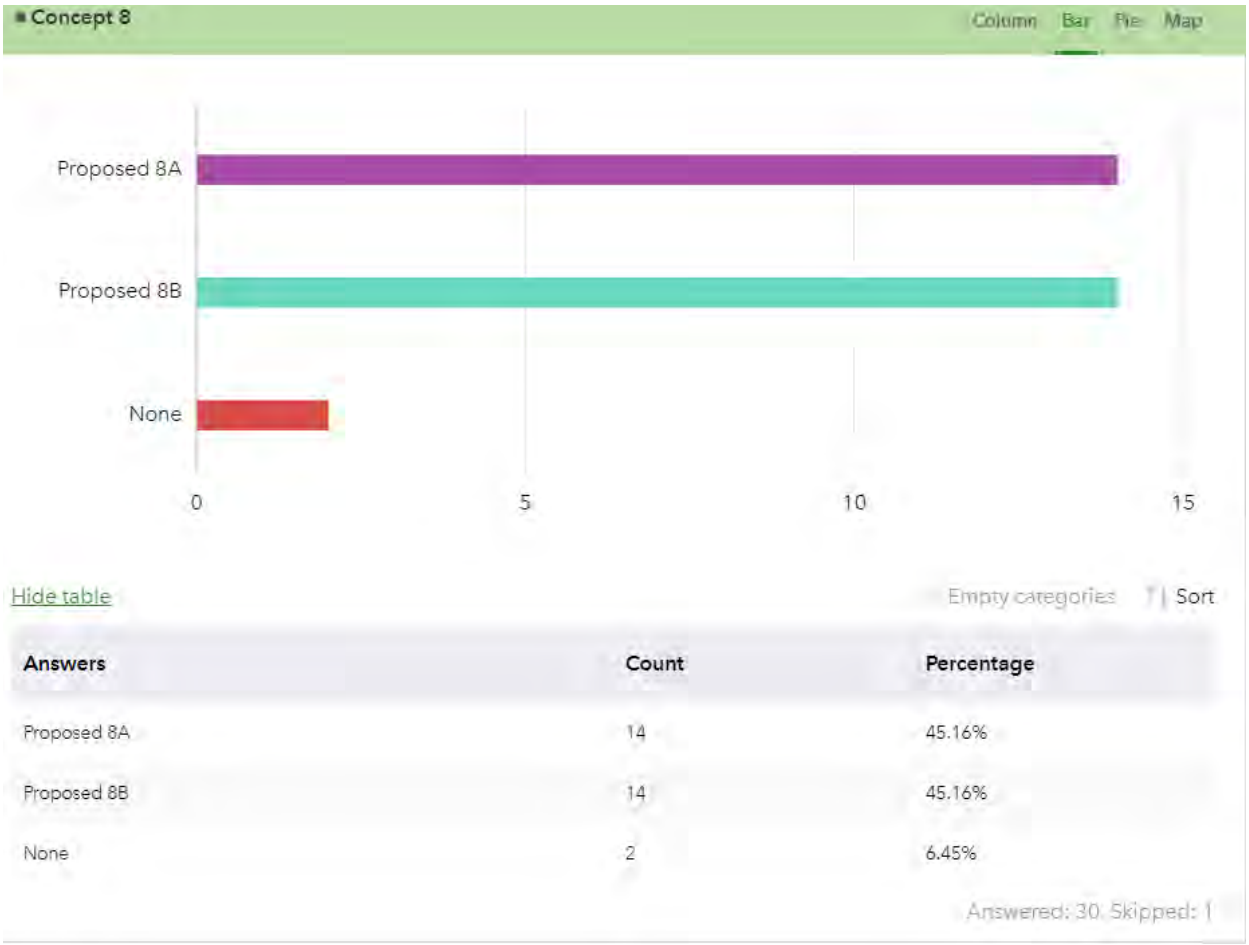


Figure C - 16: Survey Responses to Question 13

Question 14: Concept 8 - Text

Respondents were then asked, “Why did you select that version of Concept 8 as your preference?”. Seven respondents did not answer this question. Responses are recorded verbatim below grouped by which version of the practice they chose.

Text responses for Proposed 8A:

1. It seems out of place and takes away from the lakeview
2. Design doesn't fit the locality
3. Style it up in high traffic areas
4. Both concepts looks great. Actually I rate them as equals.
5. Perennials and grasses easy to maintain than bushes which need yearly pruning.
6. Will need to be salt tolerant and pushed further back off the edge of the road.
7. 8A looks like it might not detract from the view of the lake.
8. Color scheme
9. Less visual obstruction of the shoreline
10. To me is looks for appealing as a lake front piece of property with this landscaping vs the 8B
11. Low maintenance

Text responses for Proposed 8B:

1. I like the color the plants add, but both of these versions are beautiful.
2. I think the bushes give us a nice look all year
3. More natural appearance
4. Looks more natural, less maintenance
5. Like look better
6. Most full looking vegetation
7. More aesthetically pleasing, though either is great.
8. They both look nice, but bushes provide some height and may be less maintenance?
9. Like the grasses, seems softer
10. More bushes than grass
11. More color
12. I like the color of the flowers.
13. The bushes might get too tall and block more of the view. Also potentially requires more maintenance if bushes need trimming/pruning.

Questions 15-16: Additional GSI Questions

Question 15: Do you want to see more Green Stormwater Infrastructure (GSI) in Boyne City?

Most respondents strongly agree that they would like to see more GSI in Boyne City (22 respondents of 30) and another 7 responded they agree. Only one respondent strongly disagrees with wanting to see more GSI in Boyne City (Figure C-17).

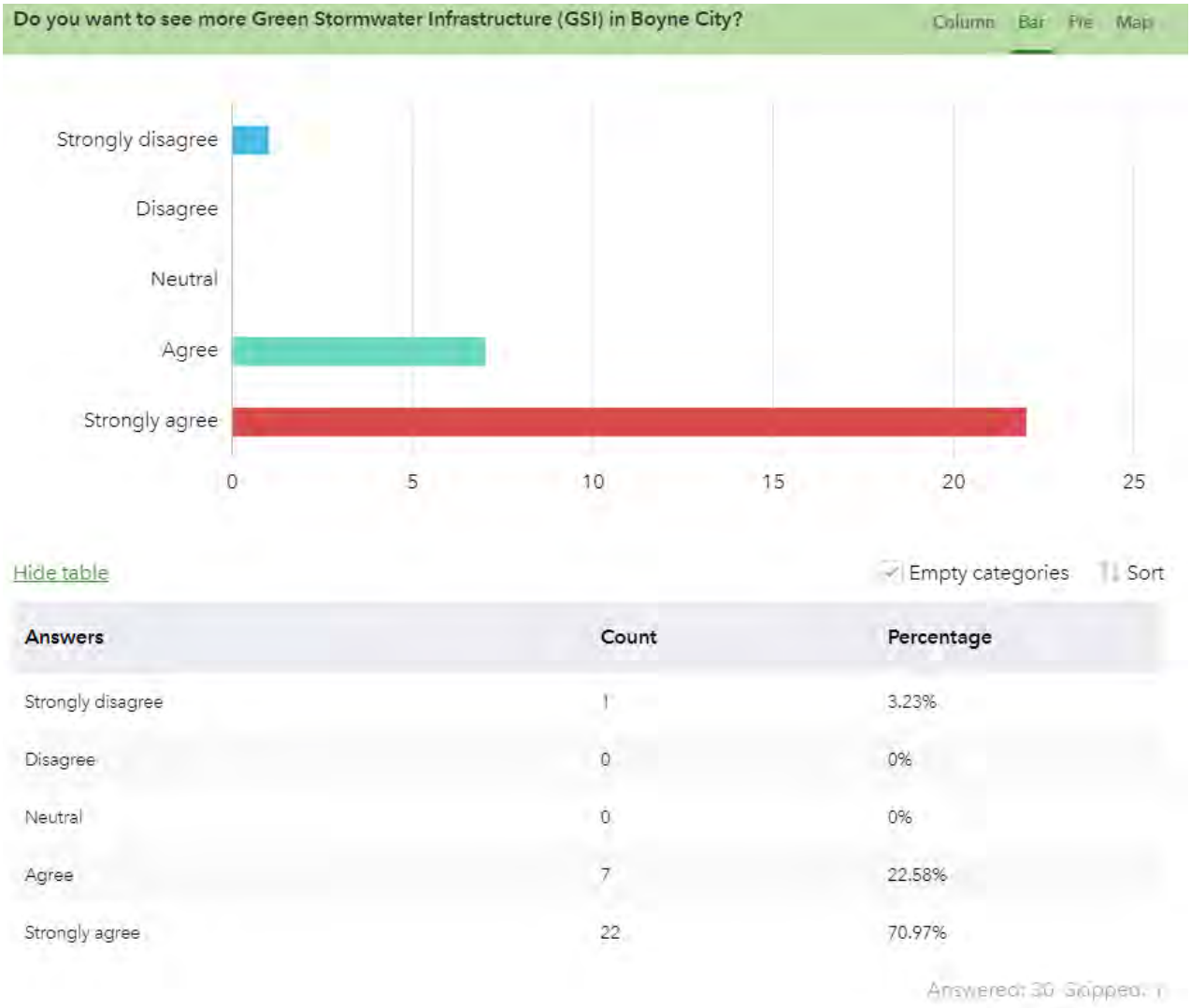
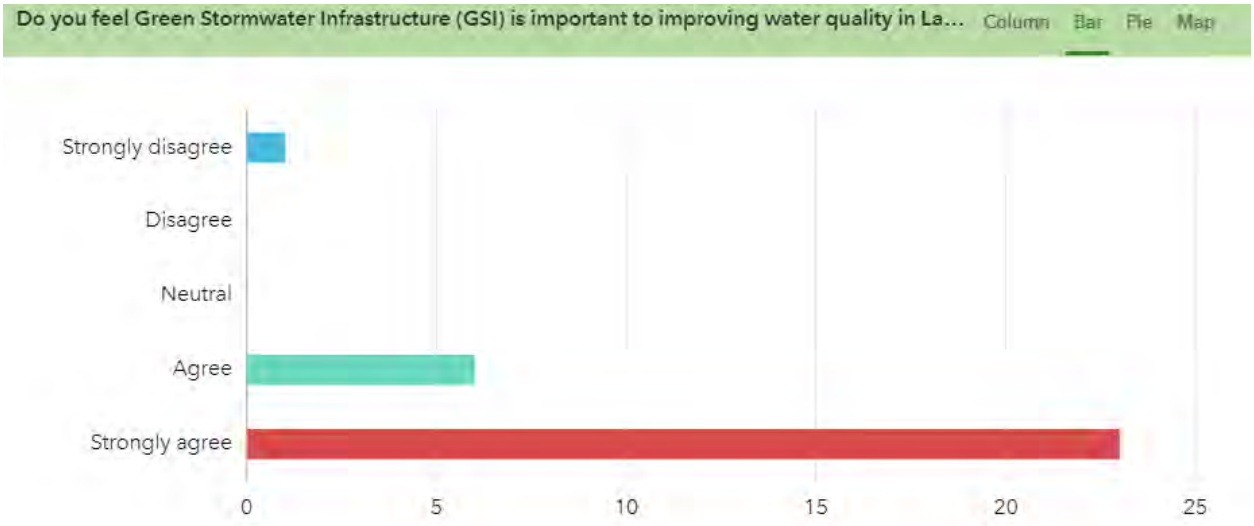


Figure C - 17: Survey Responses to Question 15

Question 16: Do you feel Green Stormwater Infrastructure (GSI) is important to improving water quality in Lake Charlevoix?

Only one respondent strongly disagreed that GSI is important to improving water quality in Lake Charlevoix. The other 29 people who responded selected Agree or Strongly Agree (Figure C-18).



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Empty categories Sort

Answers	Count	Percentage
Strongly disagree	1	3.23%
Disagree	0	0%
Neutral	0	0%
Agree	6	19.35%
Strongly agree	23	74.19%

Answered: 30 Skipped:

Figure C - 18: Survey Responses to Question 16

Question 17: Do you have any additional comments you would like to share with us?"

Nine participants provided the below answers. Answers are provided verbatim.

1. There needs to be more education to residents to keep our drains clean, whether this is done by the city or residents. Also, people need to be educated on the danger of cigarette butts going into our waterways. More cigarette butt receptacles are needed.
2. I love these ideas... These projects would beautify the city and protect our waters... I am in full support!
3. Whatever the solution, we need to be cognizant of wind from the lake and if the planting will be maintainable. Also the cost to maintain, will this be volunteer like Charlevoix had stated with the Petunia plantings when that was prominent?
4. This looks like a great way to work with the stormwater runoff as well as beautify our city.
5. No
6. As a former downstate resident and science teacher, it is amazing to see the different approaches two different communities can place on maintaining a healthy ecosystem. Greenbelts, GSI projects, and other eco-friendly improvements are always great!
7. When these improvements are made, it will be important to provide training for those who will be responsible for maintaining the gardens. Maintenance will be important for functionality and aesthetics. Thank you for your good work.
8. Would like to see more of this in Veterans Park and the new Open Space property when that gets developed.
9. Thanks for your efforts. I hope these concepts become reality very soon.

Appendix D – Proposed GSI Practices

BOYNE CITY GSI VISIONING | SITE 1

1 River Street Bioretention Curb Extension

Rain gardens, also known as bioretention basins, reduce the volume of and treat stormwater runoff using amended soils and native vegetation. They can be aesthetically pleasing and also provide valuable habitat for birds, butterflies and many beneficial insects. Curb extensions that are typically found at intersections are ideal locations.

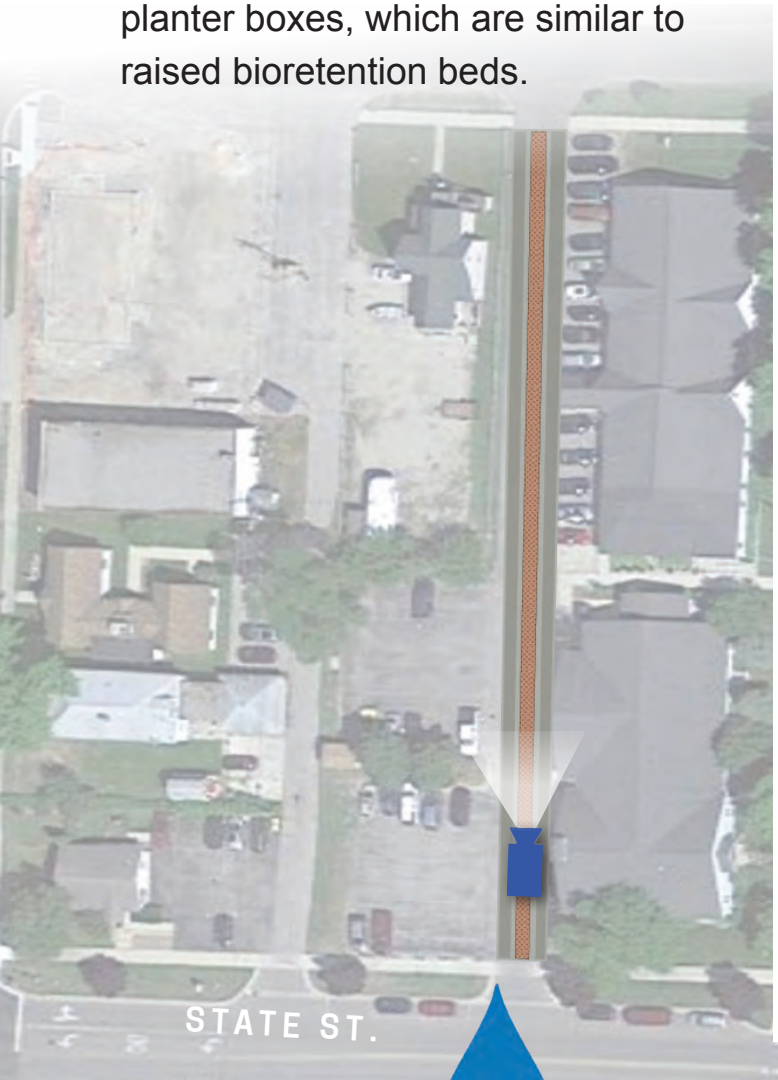
RUNOFF REDUCTION 65%

COST ESTIMATE | $ 22,300

BOYNE CITY GSI VISIONING | SITE 2

2 | Green Alley

Alleys and low traffic roads can incorporate permeable pavers and underground stormwater storage to help intercept, filter and infiltrate stormwater before it drains into stormwater catch basins. Pedestrian alleys can also feature stormwater planter boxes, which are similar to raised bioretention beds.



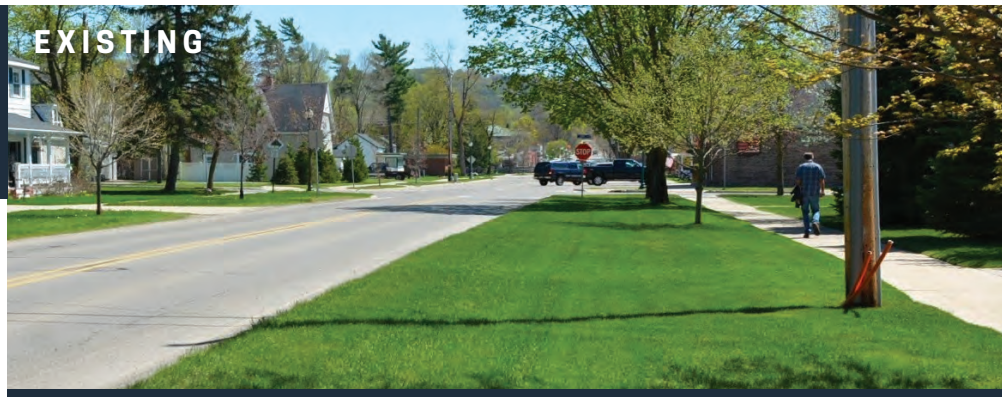
RUNOFF REDUCTION 100%

COST ESTIMATE | $ 57,600

BOYNE CITY GSI VISIONING | SITE 3

3 Park Street Roadside Swale

Bioswales are linear, shallow, vegetated channels that convey stormwater from one point to another -- oftentimes to a nearby rain garden or catch basin. Swales can be mowed turf grass, but vegetation with deeper roots helps to trap additional pollutants, reduce the velocity of stormwater runoff, and encourage infiltration.



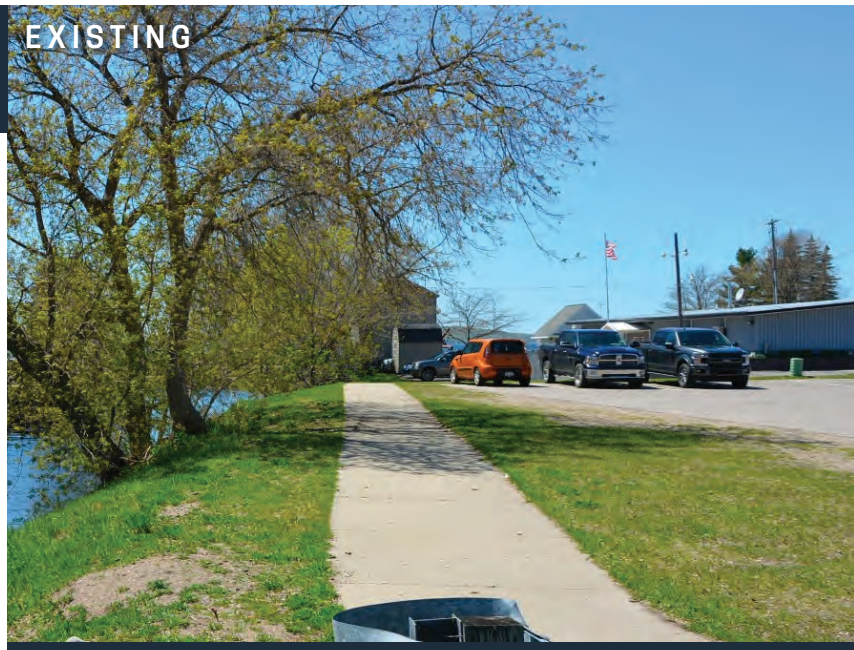
RUNOFF REDUCTION 100%

COST ESTIMATE | $ 36,300

BOYNE CITY GSI VISIONING | SITE 4

4 | Rain Garden

Rain gardens reduce the volume of and treat stormwater runoff using amended soils and native vegetation. They can be aesthetically pleasing and also provide valuable habitat for birds, butterflies and many beneficial insects. Rain gardens that intercept runoff from parking lots before discharging into adjacent lakes and streams.



RUNOFF REDUCTION 100%

COST ESTIMATE | $ 11,800

BOYNE CITY GSI VISIONING | SITE 5

5 | Peninsula Beach Bioretention

Rain gardens that intercept runoff from parking lots before discharging into adjacent lakes and rivers are particularly beneficial and can beautify parking areas. In locations like this, gravel boarders can catch sediment before it clogs the planting beds.

FRONT ST.

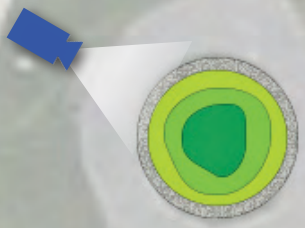
RUNOFF REDUCTION 100%

COST ESTIMATE | $ 16,500

BOYNE CITY GSI VISIONING | SITE 6

6 River Street Bioretention Curb Extension

Turf grass areas that are underutilized or serve no other function are good candidates for conversion to native planting areas and rain gardens.



FRONT ST.

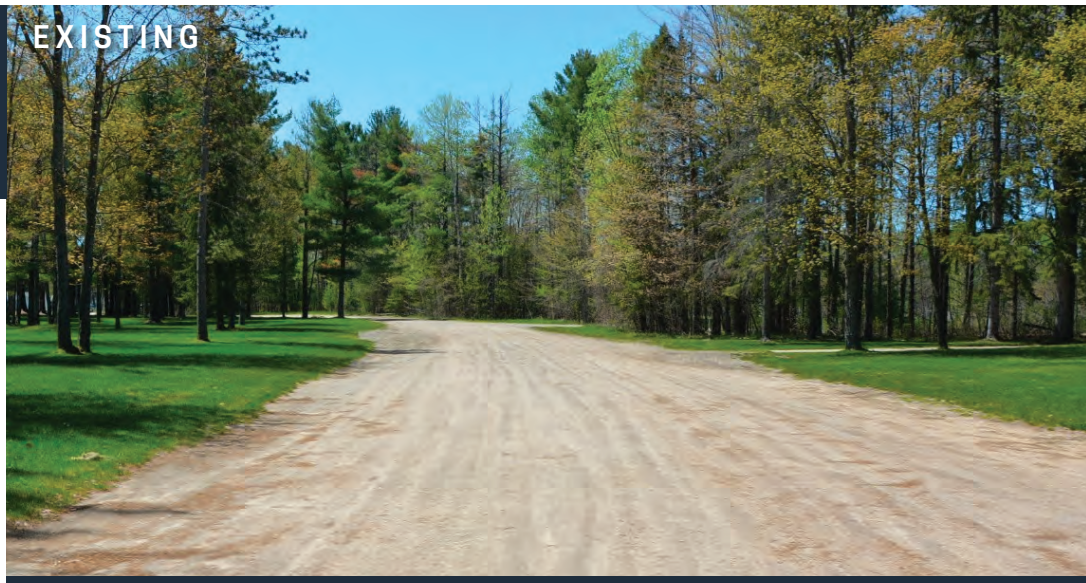
RUNOFF REDUCTION 100%

COST ESTIMATE | $ 17,400

BOYNE CITY GSI VISIONING | SITE 7

7 Rotary Park Pavers & Swale

If the Rotary Parking lots are modified to impervious surfaces, stormwater runoff will need to be managed. Practices such as pavers or bioswales are potential practices.



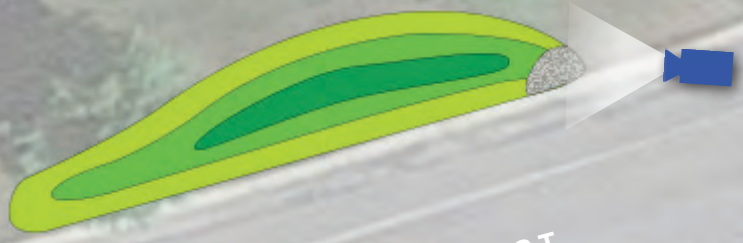
RUNOFF REDUCTION 100%

COST ESTIMATE | $ 264,500

BOYNE CITY GSI VISIONING | SITE 8

8 | Tannery Beach Swale

Roadside bioswales are linear, shallow, vegetated channels that convey stormwater from the pavement to adjacent waterbodies. They capture pollutants, reduce the velocity of stormwater runoff, and encourage infiltration.



FRONT ST.

W. DIVISION ST.

RUNOFF REDUCTION 100%

COST ESTIMATE | $ 25,100