HARBOR DISTRICT RIVERWALK
DESIGN STANDARDS

March 5, 2020

City of Milwaukee

HARBOR DISTRICT
MILWAUKEE

STANDARDS PREPARED BY:

site landscape architecture urban design

Baird. Innovation Engineered.

STORMWATER SOLUTIONS ENGINEERING LLC

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Business Improvement District 51

Fund for Lake Michigan

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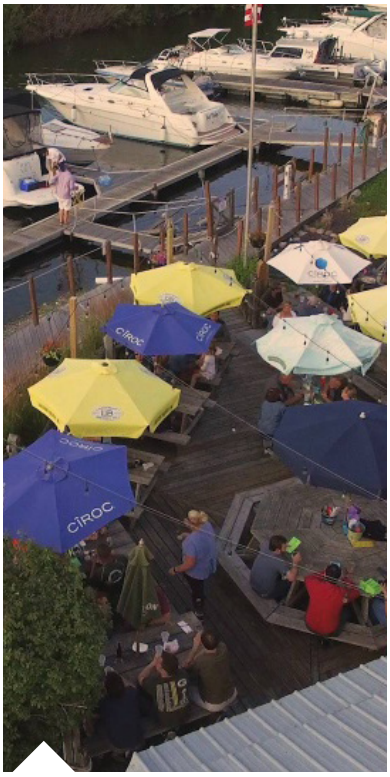
APPENDIX A1

01

INTRODUCTION



***Barnacle Buds**, Restaurant and Pub*

"The most important element to the Harbor District's unique identity and character is the water. The confluence of the three rivers as they meet and flow into Lake Michigan defines this part of the city. Yet, almost all of the Harbor District's nine miles of waterfront is off-limits to the public. Only at the Milwaukee County Boat Launch can one actually get to the water's edge."

- The Harbor District Water and Land Use Plan (WaLUP)

PROJECT BACKGROUND

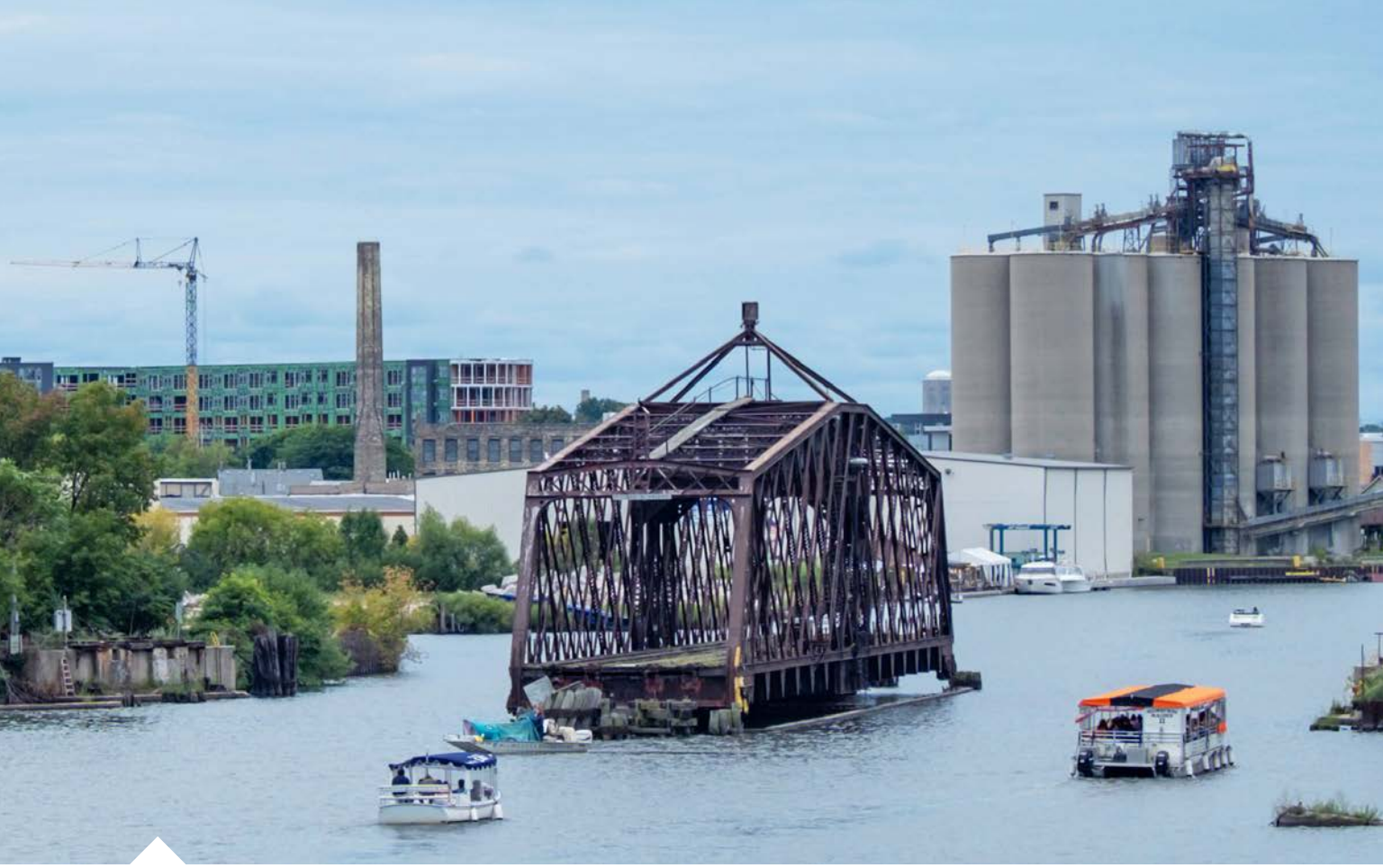
PURPOSE + GOALS OF THE PROJECT

While it once made sense to limit waterfront access to ships and factories to facilitate the growth of commerce in Milwaukee, the landscape of the economy and the city have changed dramatically. The Harbor District presents the opportunity to expand the Milwaukee RiverWalk system to develop a new type of working waterfront that helps to reestablish natural ecosystems, invites the public to explore and enjoy the water, and maintains the ability to utilize the waterways for commerce in the 21st century.

The Harbor District Riverwalk will extend the Milwaukee Riverwalk and invite the community to the water by establishing a public access network along the western shore of the Harbor District and along the banks of the Kinnickinnic River. This continuous Riverwalk will support the goals of the original RiverLink Guidelines adopted in 1992, including using the Riverwalk to reinforce the central roles of the River in Milwaukee:

+ The river as a scenic recreational corridor and urban amenity, a public gathering space, a place to observe or participate in recreational activities on the water;
+ The river as a natural resource, notably an undervalued resource undergoing cleanup that remains home to many users critical to Milwaukee's manufacturing and other key industries as well as a habitat for various species of plants, fish, and wildlife;
+ The river as a transportation corridor for ships, boats, and barges carrying raw materials as well as recreational users.

The City of Milwaukee created the Harbor District Riverwalk Site Plan Review Overlay Zone (SPROZ) and adopted initial Design Standards for Riverwalk development in 2019. Building on the initial SPROZ standards, the ideas generated during the 2015 Waterfront Innovations Design Charrette, and the recommendations in the WaLUP, DCD and HDI have developed these more detailed Harbor District Riverwalk Design Standards.



***Railroad Bridge**, photo by Jiajing Chen*

These standards are unique to the Harbor District and provide both the overall aesthetic vision and the specific Design Standards that will result in the successful development of the Harbor District Riverwalk.

Building off the initial SPROZ standards, the ideas generated during the 2015 Waterfront Innovations Design Charrette, and the recommendations in the WaLUP, DCD, and HDI have developed these more detailed Harbor District Riverwalk Design Standards. These standards will be unique to the Harbor District and will provide both the overall aesthetic vision and the specific Design Standards that will result in the successful development of the Harbor District Riverwalk.

PURPOSE OF THIS DOCUMENT

This document provides the requirements, design standards, and recommended best practices for the implementation of the Harbor District Riverwalk.

KEY TERMS

Path/Walk: The paved surface of either concrete or asphalt

Shoulder: Two foot (2') wide gravel area adjacent to the Path/Walk

Riverwalk Trail: Both the Path/Walk and Shoulder

Riverwalk Zone: The 15' or 25'minimum area that includes the Riverwalk Trail, landscaping, and amenities

Riverwalk Overlay Zone: The 50' area landward of riverward property lines that includes the Riverwalk Zone as well as the area beyond that may include buildings, parking, storage, etc.

Legal Boundary: When used in diagrams of this document, legal boundary may mean dock line or bulkhead line.

RIVERWALK OVERLAY ZONE

Overlay zones provide an opportunity to facilitate new development projects that are part of an integrated trail system, a themed district, a redevelopment project area, or master-planned neighborhood, which allows these projects to be more compatible with their neighbors, more pedestrian-friendly in design and scale, and more completely integrated in overall urban design.

The City of Milwaukee places a great emphasis on achieving its rivers' full potential and value to citizens, including the Kinnickinnic River with its connections to the Milwaukee and Menomonee Rivers. A continuous Riverwalk along both sides of the Kinnickinnic River, that connects to the City's existing Riverwalk system, expands river access, and ensures integrated urban design within the Harbor District will be a great amenity for the Milwaukee community.

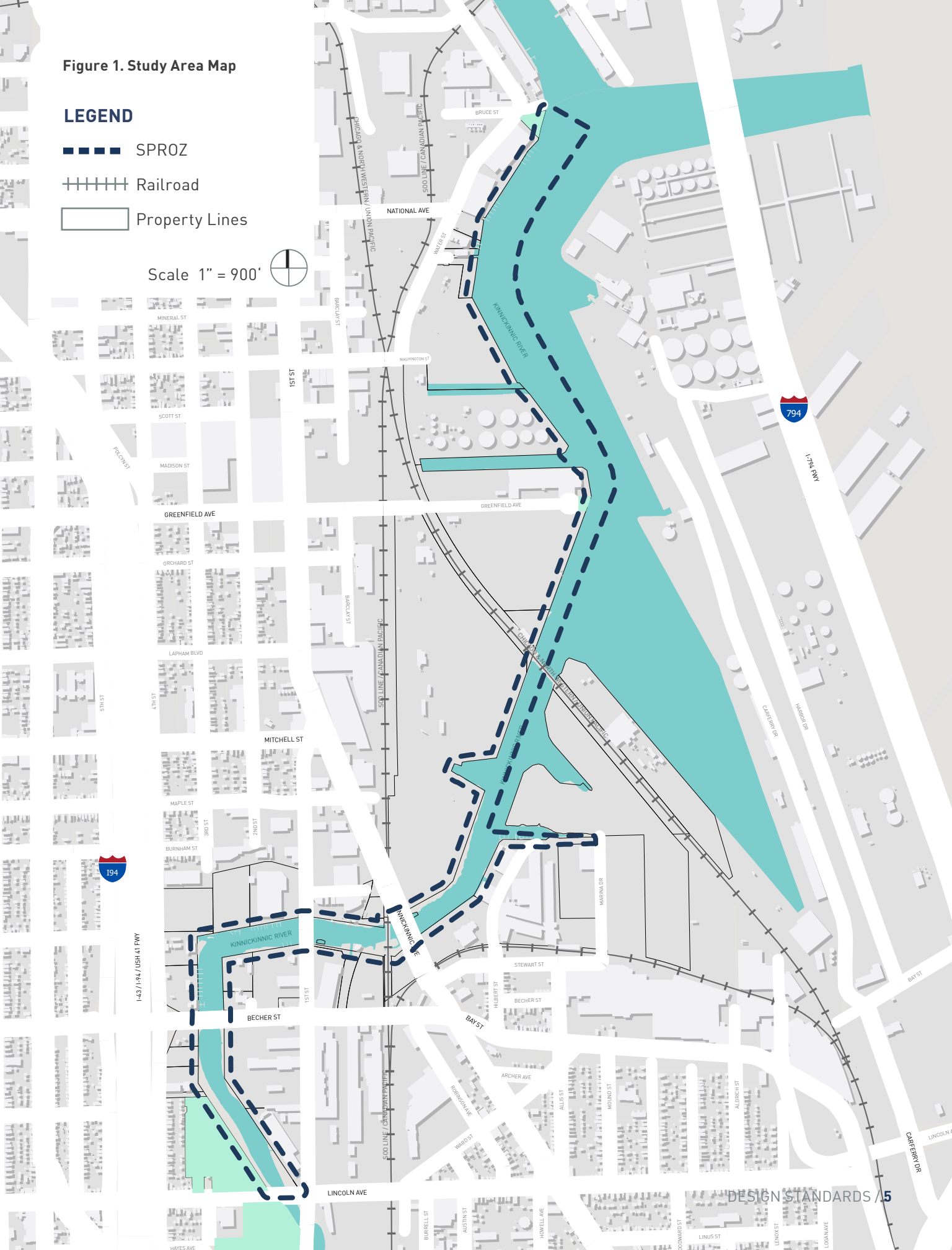
DEVIATIONS

For select sites or conditions that are not able to fully comply with the following standards, the property owner shall consult with a design professional and develop a proposal for a deviation that is consistent with the intent of these standards to the greatest extent practicable. Proposed deviations from these standards are subject to the review and approval by the City Plan Commission.

APPLICABILITY

The Harbor District Riverwalk Site Plan Review Overlay Zone (SPROZ) is located along the west side of the Kinnickinnic River from the confluence of the Milwaukee and Kinnickinnic Rivers south to Lincoln Avenue and along the eastern side of the Kinnickinnic River south of the South Channel of the Bay View Grand Trunk Wetland south to Lincoln Avenue. Within this overlay zone, the City Plan Commission must approve all projects located 50 feet landward of riverward property lines. For any property located within or partially within the overlay zone, a Riverwalk that complies with the requirements of this overlay zone shall be constructed at the time of any new construction or substantial improvement (as defined by Chapter 295-201 of the Zoning Code) of a principal structure on the property. This requirement shall apply even in cases where the principal structure itself is not located within the overlay zone. The property owner will be responsible for the ongoing maintenance and capital repairs of the Riverwalk

Figure 1. Study Area Map



RECOMMENDATIONS

Based on the number of regulations that impact waterfront development, early in the process of development in the Harbor District Riverwalk Site Plan Review Overlay Zone, developers should:

+ Obtain a property survey from a Professional Land Surveyor. The property survey should include the identification of any established bulkhead lines or the ordinary high watermark. The property survey should also show the location of the Riverwalk Overlay Zone and topography within and adjacent to the Riverwalk Overlay Zone.
+ Consult with the Wisconsin Department of Natural Resources (WI DNR) to identify any potential WI DNR and/or United States Army Corps of Engineers (USACE) waterway permits required for the proposed project.
+ Meet with Department of City Development staff to discuss the approval process, cost sharing available to assist with Riverwalk development and needed dockwall repair, owner required maintenance, and the associated development and easement agreements. Milwaukees's Riverwalk has been constructed as a public-private partnership under a cost sharing policy approved by the Common Council to support the design and construction of Riverwalk improvements. This arrangement facilitates the construction of a continuous network along the waterfront that provides significantly more value to both property owners and community than isolated waterfront improvements would on their own.

WORKING WATERFRONT

The City of Milwaukee and Harbor District, Inc. (HDI) aim to provide an active pedestrian realm within the Harbor District SPROZ while also accommodating the existing, and likely future, working waterfront that consists of many river-dependent uses. River-dependent uses are those uses and activities that can be carried out only on, in, or adjacent to a waterway. These uses include, but are not limited to:

+ Bulk material operations that ship or receive materials by barge;
+ Marinas;
+ Recreational and commercial boating facilities;
+ Waterfront dock and port facilities for commercial, cargo, or passenger uses;
+ Bridge abutments;
+ Waterfront recreational amenities such as kayak and canoe launches; and,
+ Other uses that require waterborne transportation on the river.

Existing river-dependent uses. The Harbor District SPROZ currently includes many river-dependent uses, which are an asset to the District and are likely to remain in the area for the long term.

New river-dependent uses. New river-dependent uses are appropriate and should be accommodated consistent with these Design Standards as the Riverwalk is developed.

Skipper Buds Marina,
photo by Jiajing Chen

Skipper Buds Marina,
photo by Jiajing Chen

Horny Goat Marina,
photo by Dan Adams

Harborfest Input Boards,
photo by Jiajing Chen

COMMUNITY ENGAGEMENT

Community engagement sessions were held during the development of these Design Standards with property owners within the SPROZ, targeted Harbor District stakeholder groups, as well as the public at large. Stakeholder input was structured to understand how a public Riverwalk might affect current business and industrial uses while public sessions looked to understand broader connections to the community, both physical and social. The planning team held a special engagement session that focused on water quality and aquatic and riverfront habitat creation efforts. All who attended were invited to give feedback on how the Harbor District Riverwalk system might look, including the aesthetics of furnishings and signage as well as materials. This input helped shape these design standards and is summarized in Appendix K on page A39.

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RIVERWALK TRAIL

PROPOSED TRAIL ROUTE

The Riverwalk Trail Route Map on page 11 outlines the proposed Riverwalk Trail route, distinguishing the primary and alternate routes.

The map also identifies multi-use segments of the Riverwalk, that shall provide access for pedestrians, cyclists and other active transit users (skateboards, in-line skates, etc.), and pedestrian-only routes. Pedestrian-only routes are later referred to as the "Urban Typology." The varying topography, working waterfront uses, and narrow setback conditions in some areas do not allow for bike access along the entire Riverwalk so pedestrian-only routes have been identified in strategic locations to respond to these constraints. There are existing and planned strong bicycle connections, both via on-street bike lanes and off-street multi-use trails through the Harbor District. Those sections of Harbor District Riverwalk that will allow bicycle access are meant to complement those existing routes by providing access to the water geared to more casual and family riders, and are not designed to serve as direct commuter routes.

PUBLIC ACCESS POINTS

The map also identifies the public access points located throughout the system. These access points connect the Riverwalk system to the existing street and pedestrian network. They also provide important nodes for pedestrian activity. Access points are to be located at highly-visible, highly-trafficked, and multi-modal areas.

Public access to the Riverwalk shall be designed to be accessible to the general public at all times and the Riverwalk shall be open to the public 24 hours a day at no charge, except as approved for working waterfront properties and except for such times as the Riverwalk must be closed for maintenance or repair or to avoid the acquisition of adverse or prescriptive rights. Signage and wayfinding shall be provided at public access points. As part of developing the vision for the Harbor District Riverwalk, potential concepts have also been developed to inform future planning for these public access points, which can be found in Appendix N on page A50.

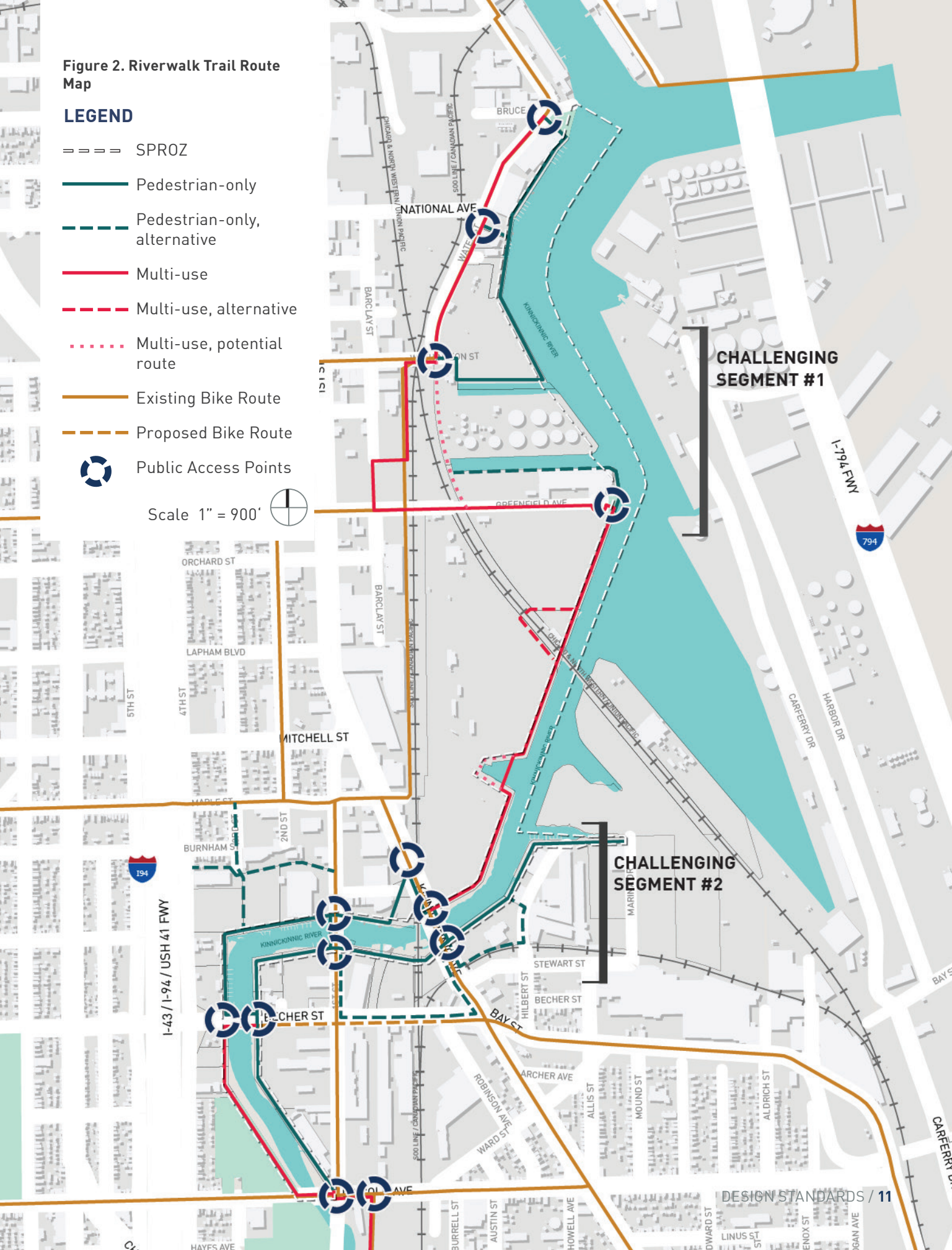
CHALLENGING SEGMENTS

In addition to public access points, the Riverwalk Trail Routing Map identifies two challenging segments of the Harbor District Riverwalk system. These segments are challenging due to the adjacent land uses, street network constraints, topographical change, and other factors that could limit the development of Riverwalk connections. Potential concepts for how the future Riverwalk can navigate these challenges are located in Appendix M on page A43.

ROUTING

The primary and alternative routings shown in Figure 2 are based on current conditions, site constraints, and potential future land use changes. While some segments are shown as being routed off of the river frontage, property owners carrying out a redevelopment project that triggers the applicability of the SPROZ will still need to comply with all applicable SPROZ requirements, including demonstrating business necessity or undue hardship if requiring a routing off of the waterfront.

Figure 2. Riverwalk Trail Route Map



03

DESIGN STANDARDS

OVERVIEW

The following Design Standards shall apply to Riverwalk development and all development that falls within the 50' Riverwalk Overlay Zone located in the SPROZ. Projects proposed within the SPROZ, and any requested deviations, shall be reviewed and approved by the City Plan Commission. In addition to the Design Standards included in this chapter, the document outlines several "Best Practices." While distinct from the required Design Standards, these Best Practices are encouraged in the development of the Harbor District Riverwalk.

ACCESS AND MARINE OPERATIONS

For marine-based businesses or users that require active use of the waterfront, Riverwalk segments should be designed to allow business operations along the waterfront in a manner that minimizes interference with public access to the Riverwalk and business operations. If business operations require temporary closures of the Riverwalk, a description of those circumstances requiring closure, and the anticipated frequency, shall be described in the development plan submitted to the City Plan Commission for approval. In areas where the development of a Riverwalk would create an undue hardship based on the safety, security, and operational needs of marine-based businesses, Riverwalk routing off of the waterfront and around a property or operational area may be considered for approval.

Disclaimer: These Design Standards represent design requirements for the development of the Harbor District Riverwalk. These standards present various concepts to consider for incorporation into each respective development, however, do not relieve the respective property owners and their design professionals from compliance with all local, State, and Federal codes, ordinances, and other regulatory requirements. The City of Milwaukee, HDI, and the authors of these standards assume no liability for finalized plans and subsequent construction. It is the responsibility of each design professional to use their judgment and knowledge as they apply the concepts presented herein.

SITE-SPECIFIC CONSIDERATIONS

While the standards outlined in the following sections are to be applied to each property within the Riverwalk Overlay Zone, each site comes with its unique existing conditions that will need to be considered and evaluated during the planning and design process.

Existing Seawalls. A thorough review of all existing seawalls on the property is recommended to understand where repair or replacement may be needed. Understanding the level of deterioration of existing tiebacks and dead-mans is the responsibility of the property owner.

Existing Concrete Bulkheads. Existing concrete bulkheads are not required to be removed, but should be incorporated into the Riverwalk Trail design or, at a minimum, accommodate the Design Standards set forth.

Environmental Conditions. Projects with contaminated soils will require a Phase I and II Environmental Assessment to determine the extent of the contamination. Management plans are required.

***Harbor View Plaza during Harborfest 2019**, photo by Jiajing Chen*

Geotechnical Information. To most appropriately design the Riverwalk Trail cross-section, each property owner and their design team is responsible for understanding the site's geotechnical conditions. This information is necessary to appropriately design the below-grade systems that will support paths and structures along the Riverwalk.

Wildlife Habitats. The Harbor District and its partners have worked to create a more connected wildlife habitat environment along the Kinnickinnic River through the use of fish hotels and other improvements. Each property owner should have a basic understanding of the wildlife context of their site and consider incorporating both land-based and aquatic habitat improvements and measures that will accomplish the larger City of Milwaukee and Harbor District goals.

RIVERWALK ZONE

The Riverwalk Zone is the 15' or 25' minimum area that includes the Riverwalk Trail, landscaping, and amenities. The Riverwalk Zone is located adjacent to the river, within the 50' Riverwalk Overlay.

IMPROVEMENTS OR STRUCTURES PERMITTED IN THE RIVERWALK ZONE

+ Paved or unpaved walkways;
+ Projections from buildings outside the Riverwalk Zone but within the 50' Overlay Zone, including, but not limited to, awnings, canopies, windows, balconies, and overhangs, provided the projection does not impede the 8' wide, unobstructed pedestrian zone;
+ Shade structures;
+ Railings and low architectural seatwalls;
+ Site furnishings;
+ Signage and wayfinding; and,
+ Riverwalk amenities.
+ Buildings or structures installed by government agencies, provided for public use, or accessory structures required to support working waterfront uses.

IMPROVEMENT OR STRUCTURES NOT PERMITTED IN THE RIVERWALK ZONE

+ All other buildings or structures, except for those listed as permitted;
+ Overhead utilities; and,
+ Private yards, patios, terraces, or decks.

WIDTH AND SETBACK

Required trail typology is determined by the system map on page 11 as well as the land use adjacent to the Riverwalk being developed. Segments identified on the system map as being accessible by bicycles, or those Riverwalk segments adjacent to non-pedestrian activated 1st floor uses shall be constructed following the Multi-Use Typology. These segments shall be at least 25 feet wide with a 12-foot wide unobstructed corridor. Riverwalk segments adjacent to pedestrian activated first floor uses that are not identified as

Figure 3. Trail Typology Matrix

	Riverwalk Zone	*Min. Path/Walk*	*Unobstructed Corridor*	*Adjacent Land Uses*
Multi-Use Typology	25'	14'*	12'	Non-Pedestrian Activated 1st Floor
Urban Typology	15'	12'	12'/8'**	Pedestrian Activated 1st Floor

**The 14' minimum may include a minimum 12' paved path with two 2' decomposed aggregate shoulders.*
***The min. unobstructed corridor width for an Urban Typology is 12'; however, the width of the unobstructed corridor may be reduced to 8' to allow for placement of seating, tables, landscaping, and site furnishings within the Riverwalk Path as long as the 12' minimum unobstructed corridor is maintained for at least 70% of the length of the Riverwalk segment.*

part of the bicycle network shall be constructed following the Urban Typology, and shall be at least 15 feet wide and include a 12-foot Riverwalk Trail with a minimum 8-foot wide, unobstructed corridor where no objects such as benches, planters, tables, and chairs are located.

The City of Milwaukee recognizes that the dimensions of the Riverwalk Zone may adjust based on the physical characteristics and development constraints for each property. As such, the Riverwalk Path width may need to adjust to accommodate the varying Riverwalk Zone dimensions.

Figure 3. Trail Typology Matrix on page 17 outlines the characteristics of the two trail typologies - Multi-use and Urban - which are distinguished by their setback and minimum trail width.

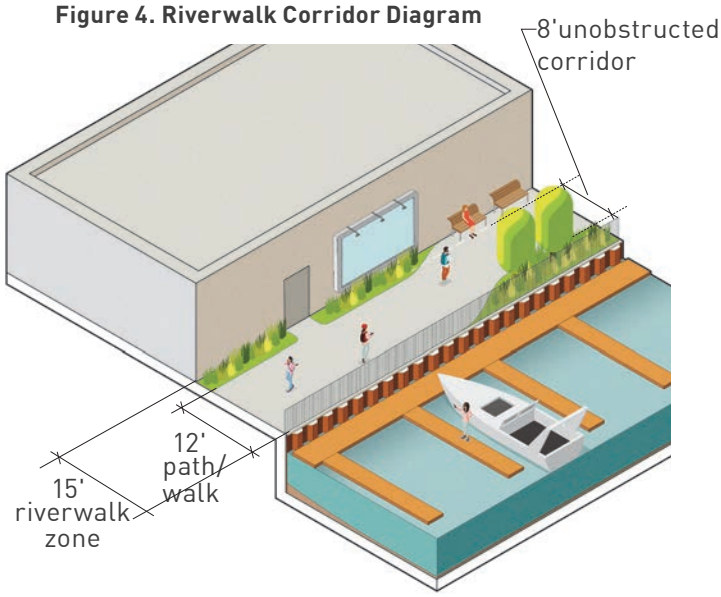
DESIGN STANDARDS

Codes and Compliance. The Riverwalk Trail shall have no more than a zero (0) to five (5) percent longitudinal slope and no more than a 1.5% cross-slope to comply with all relevant and current codes, standards, and regulations. These include, but are not limited to, the Americans with Disabilities Act (ADA), American Association of State Highway and Transportation Officials (AASHTO) Standards for multi-use paths, the City of Milwaukee Zoning Code, and other applicable City and County ordinances.

Natural Features. The Riverwalk Trail should minimize impacts to sensitive wildlife habitats and natural areas/features through careful design and alignment including, but not limited to, floodplain, wetlands, established trees, and identified aquatic habitat.

Path Transitions. As the setback and path width adjust to accommodate specific site characteristics, the path should transition gradually, unless abrupt shifts are part of the overall design intent. In the majority of cases, however, there should not be sudden or abrupt changes in path width at the property line.

Figure 4. Riverwalk Corridor Diagram



ADJACENT LAND USES

The required Riverwalk typology and resulting width of the Riverwalk Zone is determined in part by the land uses adjacent to the Riverwalk in order to create a pedestrian-friendly environment along the Riverwalk and improve safety for all users. Different land uses may require additional considerations for Riverwalk development, such as a need for buffer zones and screening, or placement of different types of amenities.

LAND USES WITH PEDESTRIAN ACTIVATED FIRST FLOORS

Urban Typology (15-foot Riverwalk Zone). In locations where the Riverwalk is adjacent to a pedestrian-activated multi-family residential or commercial use (as defined below), the Riverwalk Zone shall have a minimum width of 15 feet.

Multi-Family Residential Uses. This includes residential buildings with activated first floors areas, such as common areas, amenity space, townhouse-style units (with appropriate separation). Parking levels adjacent to the Riverwalk within a multi-family residential use are not considered a pedestrian-activated use for determining the minimum with of the Riverwalk Zone.

Commercial Uses. This includes retail, office, restaurant, hospitality, and other uses where active first-floor uses face the Riverwalk. Marina uses adjacent to the waterfront are also considered an active first-floor use. Parking levels adjacent to the Riverwalk within a commercial development are not considered a pedestrian activated use for determining the minimum width of the Riverwalk Zone.

LAND USES WITH NON-PEDESTRIAN ACTIVATED FIRST FLOORS

Multi-Use Typology (25-foot Riverwalk Zone). In all locations where a pedestrian activated first floor use is not present, the Riverwalk Zone shall have a minimum width of 25 feet. Non-pedestrian activated uses include: manufacturing, transportation, storage and wholesale trade uses, parking lots, storage yards, and other similar uses. Due to lack of activation, these uses require a wider Riverwalk Zone in order to create a safe and pedestrian-friendly environment.

Exceptions. Should one of these building types with more passive use create an activated uses on the first floor adjacent to the Riverwalk, such as a café, gallery, showroom or other similar space, then the use may classified as pedestrian activated and thus only require a minimum 15-foot wide Riverwalk Zone. Larger buffers between the path and adjacent uses are encouraged.

The flex space between the Riverwalk Zone boundary and the Riverwalk Trail should include a landscape buffer, via either plantings or berms. Pedestrian safety and security should be a priority throughout the Riverwalk, but especially in segments next to potentially conflicting land uses, such as manufacturing. Clear boundaries between the public and private realm are required when buildings and infrastructure are directly adjacent to the Riverwalk Zone. When a large buffer zone between buildings/ infrastructure and the Riverwalk Zone exists, the landscape should transition between the two uses.

***Pedestrian Activated Use**, Third Ward Riverwalk*

***Pedestrian Activated Use**, Michels Development*

***Non-Pedestrian Activated Use**, St. Mary's Cement*

RIVER EDGE CONDITIONS

There are three typical conditions along the Harbor District Riverwalk. These conditions present different constraints and considerations for Riverwalk Trail construction.

The three typical conditions are:

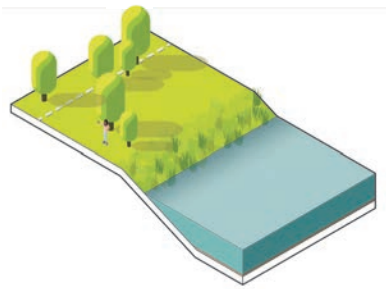
+ Soft Edge;
+ Hard Edge; and,
+ River-Dependent Uses.

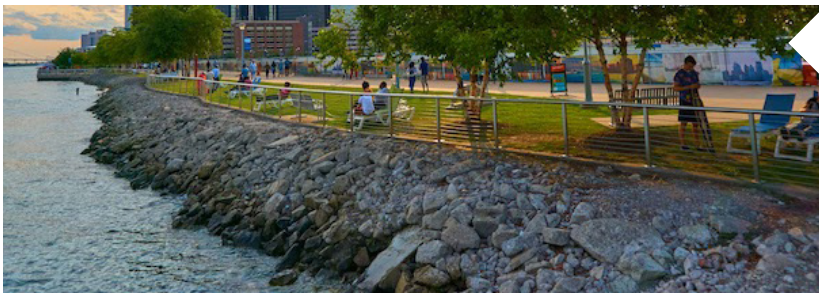
As the Riverwalk develops, site owners may elect to reconstruct the river edge and provide alternative conditions that promote wildlife habitat, direct access to the water, stormwater management, and erosion control.

SOFT EDGE (NATURALIZED)

This edge condition features a naturalized, graded slope and vegetation. While dock walls likely exist to some extent along soft edges, they are mostly covered and hidden by vegetation. These slopes are prime opportunities for direct access to the water's edge, aquatic and upland habitat measures, and stormwater management features.

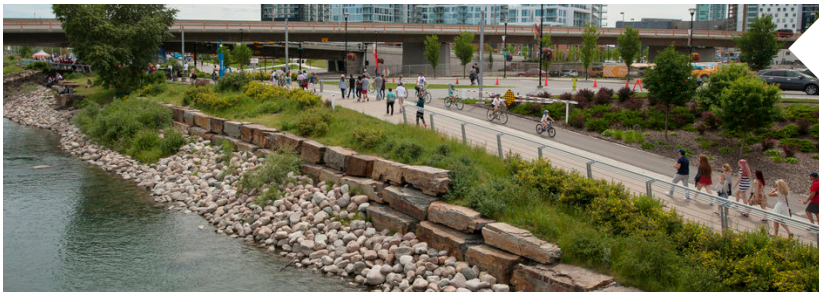
Figure 5. Soft or Naturalized Edge Condition





***Naturalized River Edge With Boulder**, Detroit Riverwalk*

***Vegetated River Edge**, The New District Of Hammarby Sjöstad (Hammarby Waterfront), Stockholm, Sweden*



***Mixed Type Naturalized River Edge**, Riverwalk East Village At Downtown Calgary, Alberta, Canada.*

HARD EDGE (METAL SHEET PILE, CONCRETE BULKHEAD)

These edge conditions feature metal sheet pile dock walls or concrete bulkheads. Examples are shown in Figure 6 and Figure 7. For Riverwalk segments along these edge conditions, overlooks or railings may be appropriate. These conditions also provide opportunities for recreational water features, such as a kayak or canoe launch or pier.

Figure 6. Metal Sheet Pile

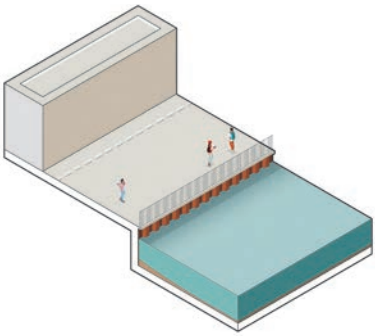
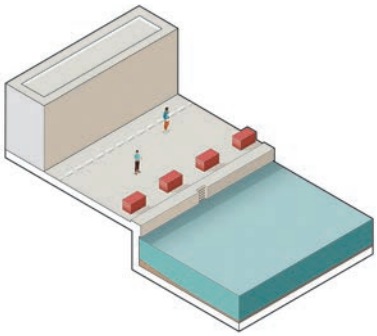
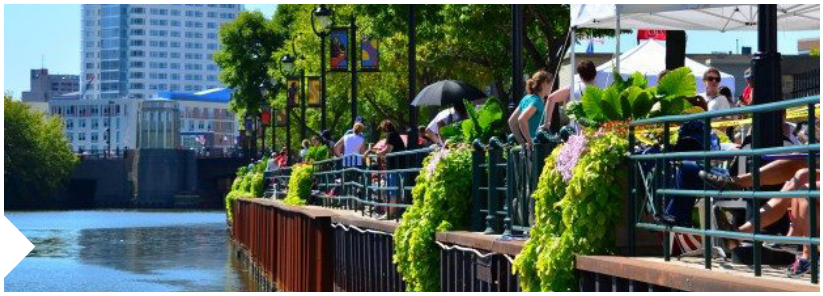


Figure 7. Concrete Bulkhead



***Boardwalk River Edge**, Wilmington, North Carolina Riverwalk*



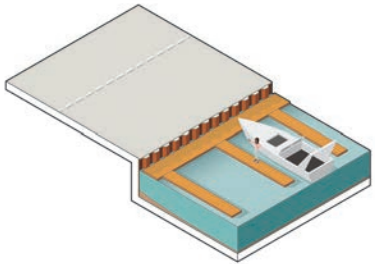
***Open Space At Metal Sheet Pile River Edge**, Milwaukee Riverwalk*

***Riverwalk At Metal Sheet Pile River Edge**, Historic Third Ward Riverwalk, Milwaukee*

RIVER-DEPENDENT USE (MARINA, PIER, DOCKS, ETC.)

A defining feature of the Harbor District is the working waterfront that includes piers, marinas, and docking facilities, for both commercial and recreational purposes. For some of these river-dependent uses, alternative routes may need to be considered for 24-hour connectivity, while also allowing for river-dependent uses and business operations to occur. Riverwalk Trail segments adjacent to river-dependent uses will require railings or other barrier methods to enhance pedestrian safety and delineate between the public and private areas. The placement of the trail, either directly along the river's edge or within a distance (that includes a buffer between the uses) will be dependent upon the public or private nature of the river-dependent use. An example of this edge condition is illustrated in Figure 8.

Figure 8. Marina / Pier



***St. Mary's Cement**, Milwaukee, Wisconsin*

***Docks at Riverwalk**, Milwaukee Riverwalk*

***Horny Goat Marina**, Milwaukee, Wisconsin*

ALTERNATIVE EDGE (STONE OUTCROPPING, OVERLOOKS)

Alternative edge treatments are encouraged along the Riverwalk. These treatments may serve to not only improve the resiliency of the river's edge, but also provide active, unique user experiences along the Riverwalk Trail. Examples of alternative edge treatments that may be appropriate for this Riverwalk include the stone outcropping revetments or overlooks. Alternative edge treatments may require approval by Wisconsin DNR.

Figure 9. Overlooks

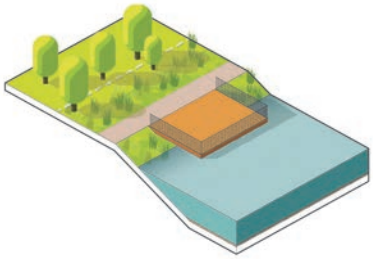
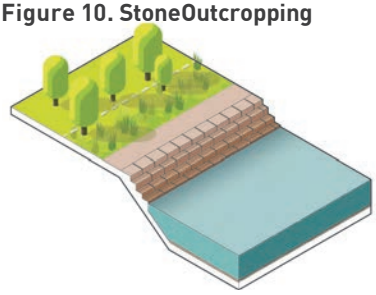


Figure 10. StoneOutcropping



Stone Outcropping with Boulder Seating, *Thunder Bay Waterfront, Ontario, Canada*

Boardwalk Overlook, *Point Cook, Victoria, Australia Boardwalk*

Stone Outcropping, *Royal Botanic Gardens, Victoria, Australia*

TRAIL TYPOLOGIES

Two primary trail typologies will make up the Harbor District Riverwalk:

+ Multi-Use Typology; and
+ Urban Typology (pedestrian-only).

Figure 2. Riverwalk Trail Route Map on page 11 identifies segments of the Riverwalk that shall allow bicycle access and be constructed according to the Multi-Use Typology. Riverwalk segments adjacent to non-pedestrian activated first floor uses must also be constructed following the multi-use typology as described on page 18. Both typologies consist of the following components:

Riverwalk Zone: This dimension will be a minimum of either 25 feet or 15 feet.

Riverwalk Path: A minimum 12-foot wide Riverwalk Path is required. In areas allowing bicycle access, a 14-foot wide Riverwalk Path is required that shall be striped to accommodate two lanes of at least 6-feet in width, one lane in either direction.

Flex Zone. This zone occurs on the landward side of the Riverwalk Path. The adjacent land use conditions will determine specific elements in this zone. This zone may include seating and gathering areas, landscape buffers or berms, fencing, stormwater management features, or other elements that are deemed appropriate.

Buffer Zone. This zone occurs on the riverside of the Riverwalk Path. If the path occurs within three feet of the river edge, the buffer zone shall include a railing. If there is a buffer zone greater than three (3) feet,or the Riverwalk is adjacent to a boat docking or a marine operations area, no railing is required. If this zone is adjacent to a soft/natural edge, the buffer should be designed to minimize erosion and improve stormwater management.

See Multi-Use Typology on page 26 and Urban Typology on page 27 for specific design criteria.

***Multi-use trail**, Reed Street Yards*

MULTI-USE TYPOLOGY

The Multi-Use Riverwalk Typology shall be utilized in segments allowing bicycle access and requires a minimum 25-foot Riverwalk Zone. This typology shall also be used next to land uses with low activation. This typology has a variety of layouts appropriate within the 25-foot Riverwalk Zone. Examples can be found below and in Appendix E on page A15 Alternative Trail Typologies on page A15. This typology may include up to two additional features in the 25-foot Riverwalk Zone in addition to the Riverwalk Path: a flex zone and buffer zone. The division of space between the flex and buffer zones may vary to respond to site conditions and design goals and to accommodate landscaping and other Riverwalk amenities.

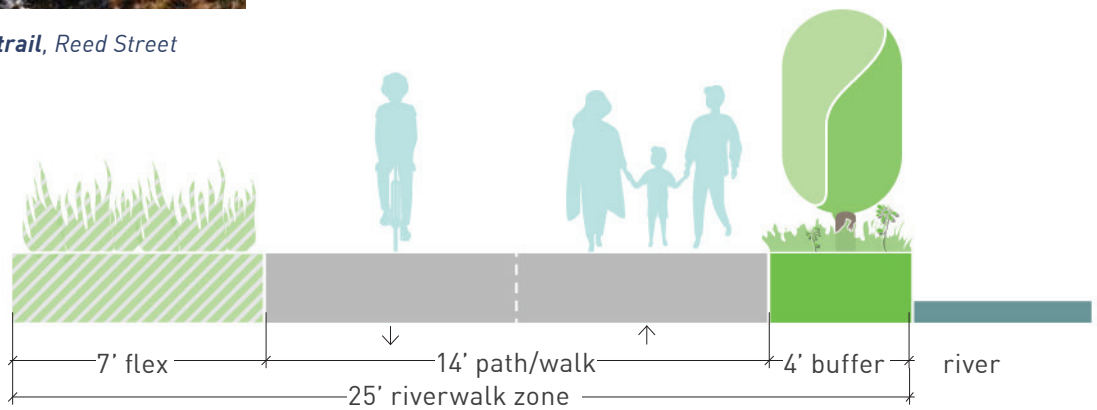


Figure 11. Multi Use Typology, 16' Path

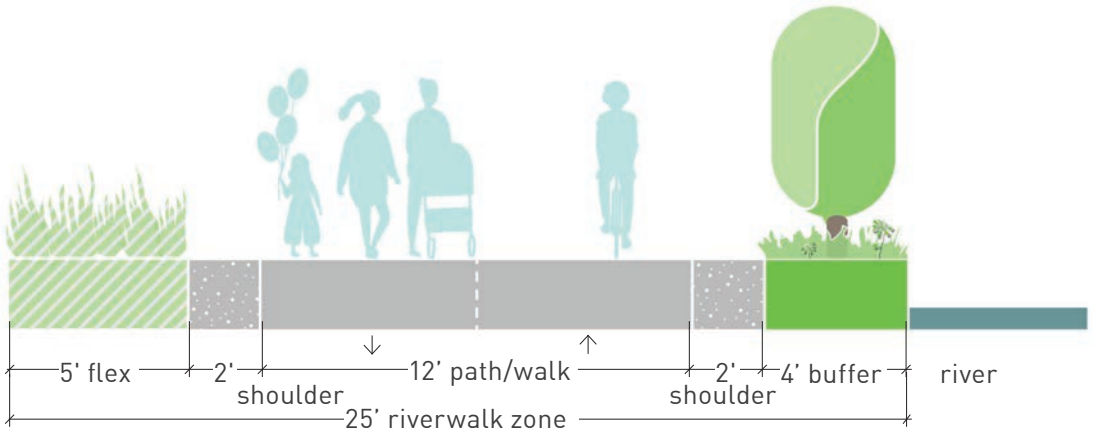
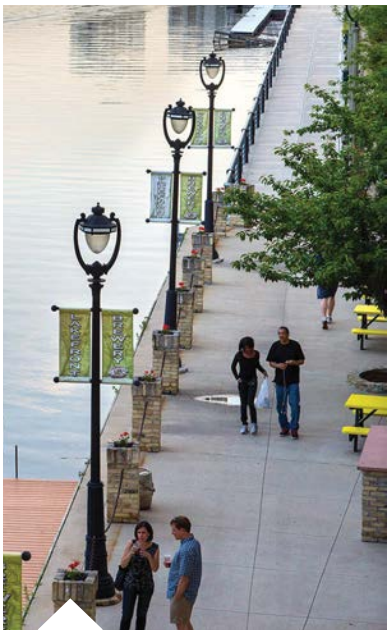


Figure 12. Multi Use Typology, 12' Path with 2' Shoulders

URBAN TYPOLOGY

The Urban Riverwalk Typology shall be utilized in those segments that do *not* allow for bicycle access and that are adjacent to pedestrian-activated first-floor uses. This urban riverwalk typology requires a minimum 15-foot wide Riverwalk Zone. This typology is appropriate for uses adjacent to land uses with high activation, including multi-family and commercial land uses. This typology includes a 12-foot wide Riverwalk Path. A railing is required along the riverside of the path unless a buffer zone of at least three (3) feet is provided between the path and water edge or Riverwalk is adjacent to boat docking or a marine operation area.

***The minimum unobstructed corridor width for an Urban Typology is 12'; however, the width of the unobstructed corridor may be reduced to 8' to allow for placement of seating, tables, landscaping and site furnishings within the Riverwalk Path as long as the 12' minimum unobstructed corridor is maintained for at least 70% of the length of the Riverwalk segment.*



Lakefront Brewery trail,
Milwaukee Riverwalk

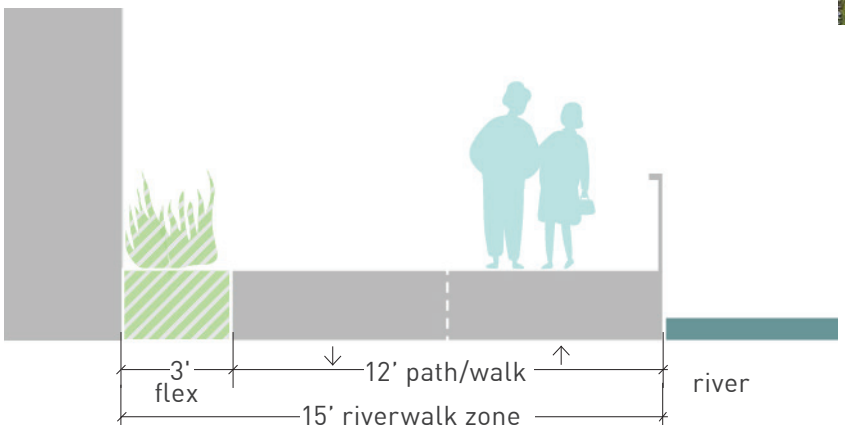


Figure 13. Urban Typology - A

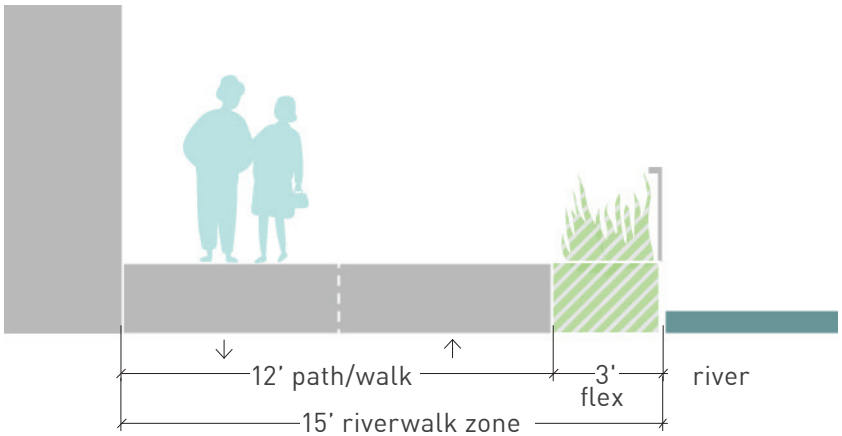


Figure 14. Urban Typology - B

ALTERNATIVE TRAIL TYPOLOGIES

Additional trail typologies can be found in the Appendix. These typologies can be used along the Riverwalk where some specific constraints and conditions cannot accommodate one of the two typical trail typologies identified previously, or where site owners want to acheive a more dynamic riverwalk experience.

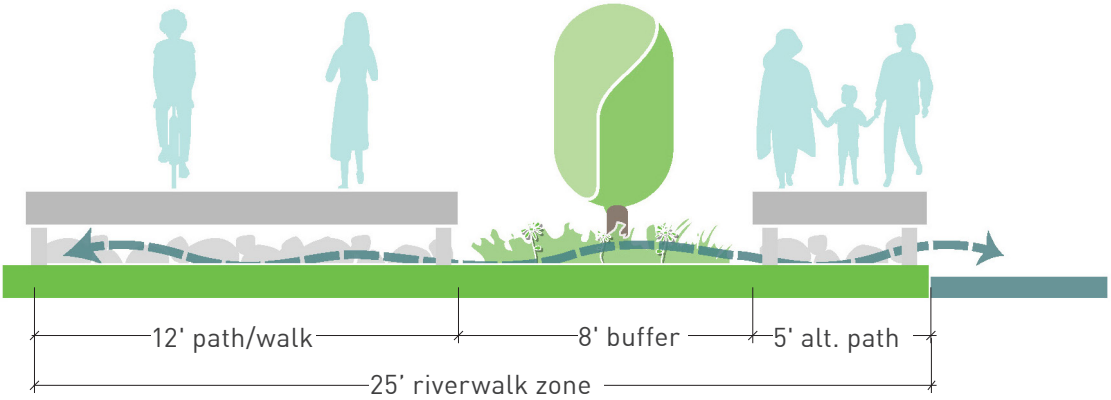


Figure 15. Alternate Trail Typology - Raised Boardwalks

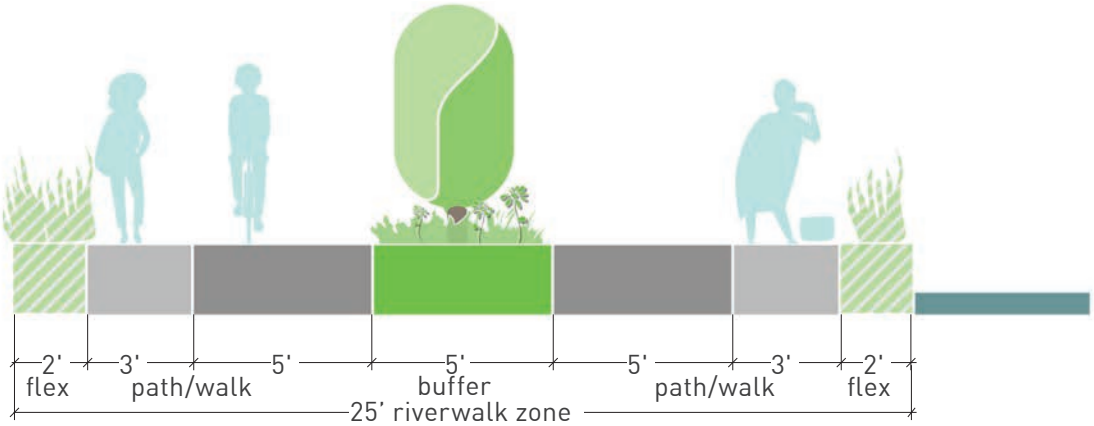


Figure 16. Alternate Trail Typology - Separated Bike and Pedestrian Paths

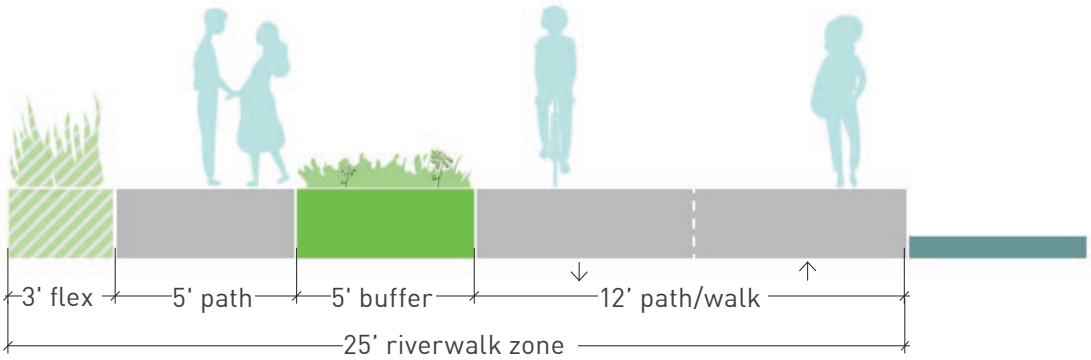


Figure 17. Alternate Trail Typology - Multi-Use Trail with Secondary Route

Boardwalk Adjacent to Landscape,
Shanghai Houtan Park

Multi Use Trail,
Green Bay Riverwalk

Presqu'ile Rollet Park Riverwalk,
Rouen, France

PUBLIC RIGHT-OF-WAY CONNECTIONS

Public right-of-way connections serve to connect the Riverwalk Trail back to the street network and are designed to support connectivity, ease of access, accessibility, and safety.

DESIGN STANDARDS

Width Public right-of-way connections should be a minimum of 12' wide, and connect directly to the Riverwalk and sidewalk along the public right-of-way. Signage and wayfinding shall be provided where these connectors meet the street network.

Screening. For connectors adjacent to industrial or residential land uses or parking lots, screening and buffering shall be provided. Outdoor storage areas should be avoided along connectors; however, when they occur, they should be screened from view.

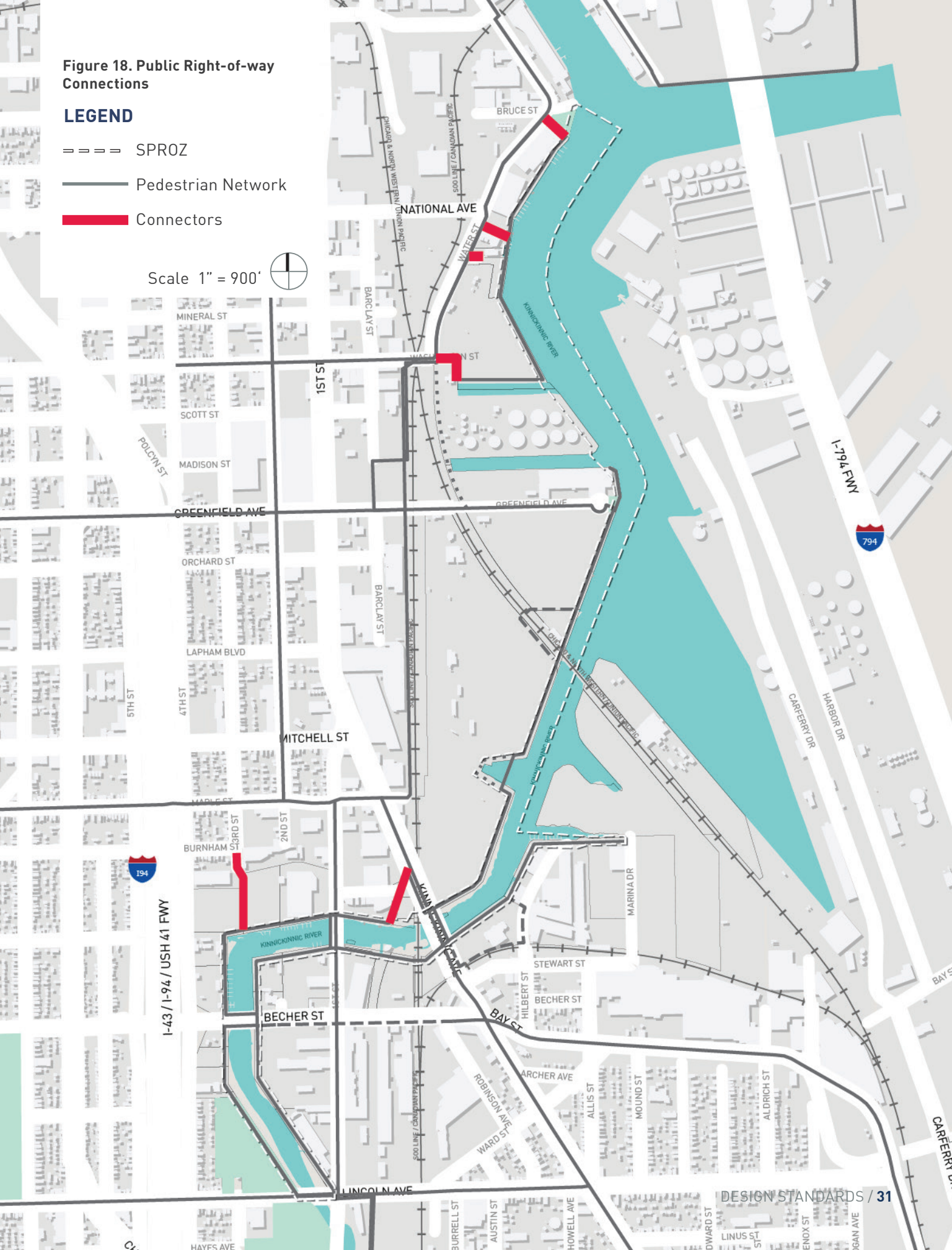
Materials. Public right-of-way connections shall be constructed of materials similar to those of the adjacent Riverwalk Trail. A shoulder is not required, except when adjacent to or making a connection from an urban to a multi-use typology with a shoulder.

Transitions. Width adjustments shall be gradual. Abrupt or sudden shifts between the connector and Riverwalk Trail are not permitted.

Visibility. Connectors should be designed so as to avoid blind corners, sharp corners, steep slopes, or other issues that impede pedestrian and cyclist safety and security.

***Harbor View Plaza**, photo by Jiajing Chen*

Figure 18. Public Right-of-way Connections



***Lakefront Brewery**,*
Milwaukee Riverwalk

PAVEMENT MATERIALS

Riverwalk Trail construction shall consist of paving materials that ensure adequate strength, accessibility, and safety to users, including emergency vehicles. All Riverwalk segments are required to be inclusive and accessible. ADA ramps shall connect public walkways and points of public access to the Riverwalk and must include railings and lighting. The following materials are suitable for bicycle, pedestrian, and shared-use paths. Whenever possible, paving materials should comply with green infrastructure and stormwater management objectives. All paving materials should utilize neutral colors, primarily in gray or earth-tones.

PAVEMENT REQUIREMENTS

Primary Materials shall be used for the primary Riverwalk Path.

Secondary Materials are permitted for secondary paths or alternate routes as well as plaza and gathering space along the Riverwalk.

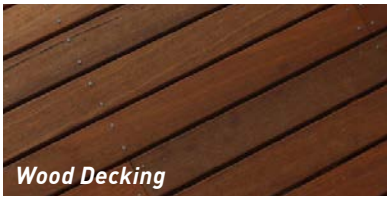
Supplementary / Accent Materials are permitted for plazas and gathering spaces along the Riverwalk. These materials shall not be used for the primary route of travel. ADA accessibility should be considered when designing gathering spaces.

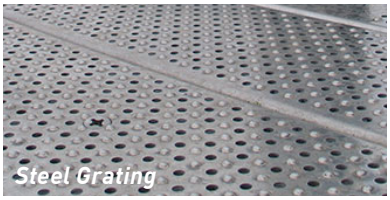
Figure 19. Pavement Materials

Materials	Poured-in-Place Concrete	Wood Decking	Steel Grating	Asphalt*	Decomposed Aggregate	Permeable Pavers	Wood Block Pavers
Primary	X	X	X*	X †	X‡		
Secondary	X	X	X	X	X		
Supplemental / Accent	X	X	X	X	X	X	X

**Steel grating may be used as a primary material only in transition zones such as bridges or over-water segments.*
†Asphalt is a primary material for the Multi-Use Typology, but is not permitted as a primary material for the Urban Typology.
‡ Decomposed aggregate may be used as a primary material for the 2' shoulders alongside trail in the Multi-Use Typology

Concrete


Wood Decking


Steel Grating

Asphalt

Decomposed Aggregate

Permeable Pavers Wood Block Pavers

DESIGN STANDARDS

The design criteria on the following page are based on industry best practices, however, as each site has unique sub-grade conditions, each property/building owner, developer, and/or design professional will be required to design the pathway(s) per individual site conditions.

Concrete. 4000 psi, air-entrained Portland cement concrete with tooled or saw cut joints and light broom finish. Thickness shall be 5" unless otherwise indicated, sat atop a 4" compacted aggregate base.

Wood Decking. Decking shall be FSC-certified Ipe or other sustainable alternatives that provide similar durability or aesthetic qualities such as Cumaru, Black locust, or similar species. Acetylated or Polymerized wood/kemobnization may also be appropriate so long as the implementation of such wood results in a consistent aesthetic along the Riverwalk.

Steel Grating. A steel grating pathway should be comprised of non-slip, durable, anti-corrosion galvanized carbon welded bar grating or press locked steel grating.

Asphalt. Hot mix asphalt per WisDOT specification, section 460. Asphalt shall have a 1.75" surface course of No. 4 LT 58-28 S, a 2.25" binder course of No. 3 LT 58-28 S, and a 10" compacted aggregate base course.

Decomposed Aggregate. Provide high quality decomposed aggregate materials consisting of sound, angular, durable stone particles, free from clay lumps, organic material, frozen materials, or other deleterious substances. The aggregate mix shall comply with ASTM C136, and blends of coarse sand and rock dust are not acceptable. Aggregate shall be contained using 3/16" thick by 4" deep steel metal edging with overlapping joints. The edging shall be installed per manufacturer's instructions.

Permeable Pavers. Permeable pavers should comply with the Wisconsin Department of Natural Resources Technical Standards. This includes compliance with the recommendations published by the Interlocking Concrete Pavement Institute, Brick Industry Association, or National Concrete Masonry Association.

Wood Block Pavers. Wood block pavers shall use wood species appropriate for in-ground applications, and be sealed to increase durability and longevity of the pavement material.

SITE FURNISHINGS AND LIGHTING

Appropriate furnishings and fixtures shall be provided throughout the length of the Riverwalk to make it attractive and functional for users.

Site furnishings should prioritize environmentally and socially responsible choices that are easily maintained and fit within the context of the Riverwalk, as well as create a unified aesthetic for the Riverwalk. Aesthetic and material choices demonstrated in this section were selected through a comprehensive community engagement process, and aim to embody the industrial, rustic Harbor District brand.

The property owner shall maintain site furnishings, including trash receptacles and lighting. Final furnishings and materials are subject to review and approval by the City Plan Commission.

SITE FURNISHING DESIGN STANDARDS

Accessibility. The design and placement of all furnishings and amenities shall be compliant with all applicable ADA requirements.

Benches. Benches/seating shall be included in every Riverwalk segment, and no more than 200 feet apart.

Tables and Chairs. Tables and chairs are encouraged throughout the Riverwalk, especially at public access points which are encouraged to feature larger seating and gathering areas. Other examples of appropriate placement include parks, unique viewing areas, and plazas. These sites should be strategically located along the Riverwalk.

Trash and Recycling Receptacles. Trash receptacles shall be placed along with tables and seating areas.

Railings and Guardrails. Railings along naturalized/soft edging shall be installed at the discretion of site owners and design professionals. Site conditions will dictate the need for railings along soft/naturalized conditions. Along hard or River-Dependent use edge conditions, railings or guardrails are required where pathways are located within three feet of the water's edge, except where the Riverwalk is adjacent to boat docking or a marine operation area. The standard for all railing or guardrails shall be black powder coated steel. Railing and guardrails to be fabricated from steel tube and shall be consistent in design and appearance with adjacent sections.

Fencing. While fencing is not required as a standard, owners may place fencing at the landside edge of the 25-foot Riverwalk Zone (or further inland) if they so desire. The standard for fencing is not limited to a single design type, however quality and durable materials are required and will be approved by the City Plan Commission. As a baseline, fencing can be in black-painted iron or aluminum vertical picket fencing, with a dark green mesh privacy screen if desired, which must be located on the landside of the metal fencing. Steel framed fencing with wood slats are also acceptable. Chain-link fencing or barbed wire are not permitted.

Materials. In general, furnishings and site elements along the Riverwalk shall be constructed of durable materials using recycled or FSC-certified wood planks, weathering steel, and concrete. The palette should be cohesive in material, color, and aesthetic.

Figure 20. Preferred Site Furnishing Products

Element	Specification
Bench	Rough and Ready T6 Benches (R&R-L6-300 and R&R-L-BR1_154) by Streetlife
Table(s)	Drifter Picnic Sets (DB-PS-L3-500-PC and DB-PS-L3-300-PC) by Streetlife
Bollard	Moka Bollard by Metalco or Bright Bollards by Streetlife
Bicycle Racks	CorTen Bicycle Racks by Streetlife
Trash / Recycling Receptacle	Victor Stanely Steelsite Series SDC-36 in black
Railings	The standard for all railing or guardrails shall be black powder coated steel. Railing and guardrails to be fabricated from steel tube and shall be consistent in design and appearance with adjacent sections.

Accent site furnishings to be made of weathering steel or concrete

***Tandem Light Straight Series**,*
Structura Lighting

Preferred Products. Recommended furnishings for the Riverwalk are listed in Figure 20 on page 35. Equivalent products that align with the Harbor District Riverwalk aesthetic identity may be proposed for approval by the City Plan Commission.

Foundations. Furnishings shall be surface-mounted to a concrete foundation. Foundation to be designed per the site's soil conditions and local codes. Installation to follow the manufacturer's instructions.

LIGHTING DESIGN STANDARDS

Product. For pedestrian lights, Tandem Light Straight Series pole with A16-BP18R, mast arm mount light fixture from Structura, or approved equal. For bollards, Moka Bollard by Metalco or Bright Bollards by Streetlife.

Pole Height. Preferred pole height is 17.5'. Avoid abrupt changes in fixture height between properties.

Fixture Height. Height for pedestrian light fixtures is less than 20 feet with a maximum allowable light fixture height of 20 feet. The primary fixture shall be located on the path-facing side side of the pole.

Finish and Color. Pole and fixture finish shall be Light Grey. Base panel materials shall be weathering steel.

Color. LED bulbs should provide warm white light with a color temperature of 3000K and below. The light color should emit a warmer light color and less blue (cool) light. Cool blue light is more harmful to many animal species.

Foundation. Pole to be placed upon a foundation designed per the site's soil conditions and local codes.

Additional Features. Timers and dimmer switches should be incorporated into fixtures, and when possible, lights should be turned off when not in use.

Light Levels. Provide adequate light levels for pedestrian safety and security considering visibility, continuous illumination of vehicular use and other areas, avoidance of dark or un-illuminated areas, etc. Light levels at the property lines should not exceed 1 footcandles (Fc) adjacent to active properties, while light levels should not exceed 0.5 Fc at non-active property lines. Light levels and uniformity ratios should not exceed recommended values, per Illuminating Engineering Society of North America (IESNA) RP-33 or 20. For more information see: darkskysociety.org/handouts/LightingPlanGuidelines.pdf

Dark Sky. Luminaries should be dark-sky compliant and be equipped with shields so that light does not shine into adjacent residential or institutional areas or negatively affect wildlife. Specifications and/or product data sheets, specifically highlighting the color temperature, light fixture height, and shield is required for review and approval.

BEST PRACTICES

Design. Integrate seating with landscape design.

Seating Options. Provide a variety of seating options throughout the Riverwalk Trail. Consider a mix of fixed, movable, bench, table/chair, and platform seating to provide a variety of experiences for a diverse user group. Provide opportunities for both individual and group seating. The site owner shall consider universal seating options to accommodate multi-generational use and seating for those with mobility constraints.

Security Lighting. If you must have security lighting, use motion sensors and avoid projecting onto adjacent properties.

Brand and Identity. Consider ways to incorporate the Harbor District brand aesthetic of 'Gritty, Green, Real' into the various site furnishing elements along the Riverwalk.

LANDSCAPING

DESIGN STANDARDS

Required landscaped areas. At least 10% of the total square footage of the required Riverwalk Zone must consist of landscape elements as described in this section. In addition to ground plantings, permanent raised planters can be included when determining compliance with this standard. All required landscaping elements shall be properly maintained and replaced as necessary to achieve compliance with this standard and as required by Chapter 295-405-1-f of the Zoning Code.

Plant Sourcing and Selection. Plants should be nursery-grown and legally harvested. Native or adapted species should be used in all instances, with an effort to achieve plant species diversity. Plant species exceptions may be made for species whose ranges are nearby and may move into the region due to climate change. Owners and designers should consider the site and region's natural communities, and promote and support a long-term, stable ecosystem through the plant selection and design. Plants should be selected based on the appropriateness of each unique ecological zone or community. See Appendix I on page A22 Full Plant List on page A22 for full preferred plant list.

Aesthetics. Aesthetics should relate to the surrounding context, and plants should be selected to promote seasonal interest. Planting along the riverbank should be naturalistic. Four-season interest should be considered when selecting plants.

Invasive Species. Exotic and invasive species shall not be permitted along the Riverwalk. Exotic plants are those not native to the United States, while invasive species are those considered both non-native and fast-growing, able to spread to the point of disrupting native and natural plant communities or ecosystems.

Disturbance. To the extent possible, owners should minimize site disturbance and re-vegetate disturbed areas with native and adapted species. Owners shall provide erosion and sediment control measures for all areas disturbed during the construction process. The riverbank should not be developed or disturbed except for environmental restoration, landscaping, nature paths, restoration of the existing dock wall, or for new marina activities. When the riverbank is disturbed, care should be taken to re-vegetate and stabilize the edge in ways that manage erosion control, sediments, and stormwater runoff.

Turf Grass. No turf grass shall be installed within the 15-foot or 25-foot Riverwalk Zones.

Tree Placement. There shall be one shade tree per 40 feet of Riverwalk frontage. Trees are not required to be placed at regular intervals and can be placed in groupings to comply with this requirement. For the Multi-use Typology, trees shall be placed along the Riverwalk Path/Walk at least three feet from the pavement on the landward side of the Path/Walk. Naturalized placement of trees is encouraged. For the Urban Typology, trees may be incorporated into the Riverwalk Trail design through tree grates or stormwater infiltration planters. If site constraints cause a hardship condition that cannot accommodate tree placement within the Riverwalk Zone, CPC may approve a landscape plan that places the required trees elsewhere within the 50' Overlay.

Tree Spacing. Each tree shall be provided with a four (4) foot width of exposed soil at the ground surface.

Tree Soil Requirement. If soil quality is of particular concern, soil chemistry tests should be conducted to inform any mitigation needed.

Soil compaction should be evaluated to determine the need for tilling or soil amendment.

Tree Soil Volume. A minimum of 24 inches of engineered soil media layer depth.

BEST PRACTICES

Tree Protection and Removal. To the extent possible, mature, healthy, native trees shall be preserved. Dead, diseased, invasive, or hazardous trees should be removed.

Planting / Habitat Preservation. To the extent possible, existing planting and habitat areas should be preserved.

SIGNAGE AND WAYFINDING

All Riverwalk signage placed within the SPROZ shall be reviewed and approved by the City Plan Commission (CPC). Signage is also recommended for locations outside the SPROZ to draw users to the Riverwalk and reinforce the Harbor District Riverwalk brand identity.

Signage and wayfinding elements are integral to communicating the Harbor District Brand, which is outlined in the 2019 Harbor District Branding and Identity Deployment Guidelines and Plan. The **Gritty. Green. Real.** brand is based on the Harbor District's juxtaposing mix of old and new, high- and low-tech, historical remnants, and new development.

OVERVIEW

Identity Signage. Identity and/or Directional Signage shall be provided where the multi-use path intersects with streets or other public access points. This type of signage provides navigation help and reassurance for visitors along the path and at key destinations.

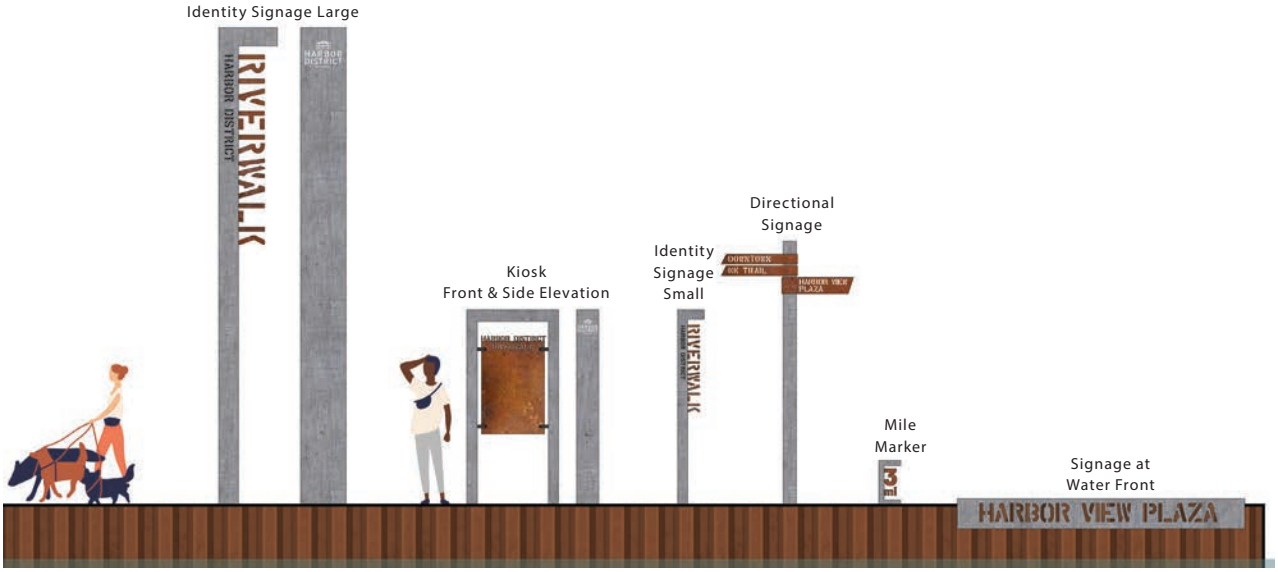
Informational / Kiosk: Provides information to users about the Riverwalk's features and destinations. The sign content may include maps, directional guidance, and educational messages on the river's history and ecology.

Mile Markers. Mile markers may be located along the multi-use path to identify how far the user is from a beginning point, which the City of Milwaukee will dictate based on the other segments of the Milwaukee Riverwalk system.

Directional Signage. Directional signage is generally used to provide people with information about where a path or roadway goes and how far it is to a travel destination.

Mounting. Signage shall be surface mounted to a concrete footing using durable, corrosion-resistant fittings. These footings shall be designed per the sign manufacturer's recommendations and based on the site's soil conditions and local codes.

Figure 21. Signage Family



BEST PRACTICES

ADA Guidelines. The signage program shall be designed in compliance with signage regulations defined by the Americans with Disabilities Act of 1990. Those regulations are quite involved and beyond the scope of this reference document. Additionally, signage design shall reference and comply with the 1992 Society for Environmental Graphic Design (SEGD) White Paper on ADA. This has become the standard reference for designers.

DESIGN STANDARDS

Placement and Orientation. Signage along the Riverwalk shall be placed on the land-side of the path and orientated perpendicular to the path or adjacent hardscape area. For Riverwalk identity signage located outside of the Riverwalk Zone, such as the Public Access Points, signage placement and location shall be dictated by context and surroundings. Signage placements within the SPROZ shall be reviewed and approved by the City Plan Commision (CPC). Placement in the public right-of-way requires coordination and approval from the Department of Public Works.For minor signage adjustments and replacements, or future installation of additional signage types depicted in Figure 21 in addition to those proposed at the time of inital application, CPC approval is not required. Additional information regarding placement of specific sign types is detailed in Figure 22 on page 42.

Materials. Signage shall be constructed of durable, corrosion-resistant materials. Signs structures shall be composed of steel frames, sealed to protect the material's intrinsic aesthetics and provide a maintainable surface.

Content Panel Materials. Content panels shall be constructed of weathering steel. Major text elements shall be full reliefs/cut outs while major content such as the overview map and destination directory shall be made of corrosion-resistant powder-coated steel or aluminum with high-resolution graphics fused into the panel using UV-resistant inks. Content imagery should be a seamless, continuous image. Panels shall be no less than 1/16" and no more than 1/4" thick.

Mounting. Signage shall be surface mounted to a concrete footing using durable, corrosion-resistant fittings. These footings shall be designed per the sign manufacturer's recommendations and based on the site's soil conditions and local codes.

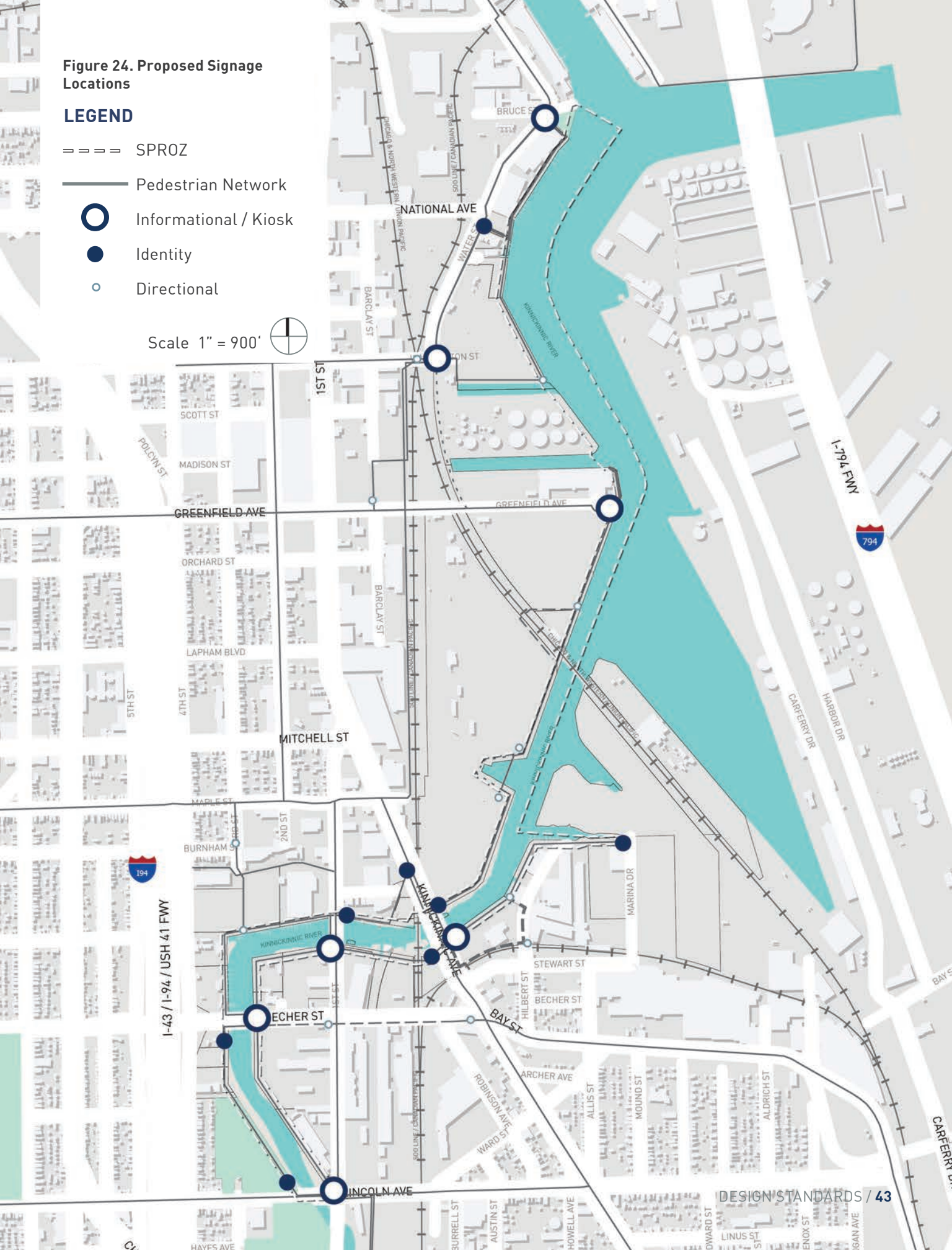
Figure 22. Signage Placement and Orientation

Signage	*Standard*
Informational / Kiosk	Informational signage is recommended to be placed along the Riverwalk at primary access points and other major pedestrian and bicycle access points. At a minimum, these signs should be placed where the Riverwalk Zone intersects with major street connections (arterial streets) such as (1) Bruce Street, (2) Greenfield Avenue, (3) Kinnickinnic Avenue, (4) Becher Street, and (5) Lincoln Avenue. Kiosks are encouraged to be located within a five- to ten-minute walk. There shall be, at minimum, five feet of clearance around all sides of the informational/kiosk signs. Any site furnishings (e.g., benches, tables, trash receptacles, etc.) shall be located outside of the five-foot clearance area around the sign. Signage shall be located in the landscape, at minimum two feet from the sidewalk or adjacent hardscape.
Identity	Identity and/or Directional signage shall be placed along the Riverwalk at Primary Access Points and other major pedestrian and bicycle access points. At minimum, Identity signs shall be placed where the street network intersects with the Riverwalk Zone such as (1) Bruce Street, (2) National Avenue, (3) Washington Street, (4) Greenfield Avenue, (5) Kinnickinnic Avenue, (6) Marina Drive, (7) 1st Street, (8) Becher Street, and (9) Lincoln Avenue. Signage shall be located in the landscape, at minimum two feet from the sidewalk or adjacent hardscape.
Directional	Directional signage may be placed along the Riverwalk Path, within a 1/2-mile of the identified destination.
Mile Markers	Mile markers may be located every 1/10 or 1/4-mile.

Figure 23. Signage Content

Signage	*Standard*
Informational / Kiosk	Signs shall include an overview map, destination-wayfinding, and a directory of key destinations along the Riverwalk. Up to five destinations should be included in the wayfinding portion of the content panel. Appropriate destinations include major intersections, parks and open spaces, area institutions, and neighborhoods. Directional arrows should be placed adjacent to the descriptive text and orientated at one of the four cardinal directions (north, south, east, or west). The directional arrow should not be oriented in the true direction, but simply up, down, right, or left. The overview map shall include a plan view of the Harbor District / Kinnickinnic River and show the street grid, rail lines, parks and open spaces, and other riverwalk segments (where appropriate). Labels shall be provided for all major map elements, including street names, parks, and open spaces, and the river branches.
Identity	Identity signage shall identify the Riverwalk.
Directional	Directional signage should contain one destination per sign panel. Appropriate destinations include major intersections, parks and open spaces, area institutions, and neighborhoods. (e.g., Harbor View Plaza). The name of specific developments should not be included in the directional signage as the names of developments may change over time.
Mile Markers	Mile markers shall identify the distance from the confluence of the Milwaukee and Kinnickinnic Rivers. Additional mile markers may indicate jogging loops on larger development sites.

Figure 24. Proposed Signage Locations



STORMWATER MANAGEMENT

The Harbor District is located within the Milwaukee Metropolitan Sewerage District (MMSD) and is riparian to the Kinnickinnic River and Lake Michigan Estuary.

Stormwater runoff on many sites is directed into the MMSD combined sewer system (CSS). Riparian properties, or sites that lack stormwater or sewer infrastructure altogether, drain directly to the surface waters. Capturing stormwater that drains to the CSS provides storage during heavy rain events that may otherwise overtax the system and lead to combined sewer overflows (CSOs). Capturing and treating stormwater from riparian properties, or those draining directly to surface waters within the Harbor District will help improve water quality in the adjacent waterways. Future development projects within the Harbor District are regulated under Wisconsin Department of Natural Resources (WDNR) Chapters NR216 and NR 151 of the Wisconsin Administrative Code (WAC), Chapter 13 of the MMSD Regulations, and/or Chapter 120 of the City of Milwaukee Code of Ordinances to control stormwater runoff quantity and quality. MMSD Chapter 13 added requirements for green infrastructure for projects at a small threshold (5,000 square feet) of new impervious surface.

The vision for the Harbor District is to capture and treat the first 15,000,000 gallons of stormwater – the first 1/2-inch of rainfall – through innovative and effective infrastructure. To improve water quality, provide green space, improve urban habitat, and reconnect the community to the historical and cultural significance of water in the Harbor District area, best-suited stormwater BMPs are going to be positioned along existing drainage areas and low lying topography especially in riparian and separate storm sewer system.

DESIGN STANDARDS

Stormwater runoff within the Harbor District shall be managed on both future development properties and within the Harbor District Riverwalk Zone (15 or 25-foot buffer of trails, shoulder, vegetation, pedestrian seating, or access). Figure 25. Green Infrastructure Options on page 45 outlines a list of green infrastructure improvements that could be best suited for each zone – the Riverwalk, Future Development Properties, and the Roadways. Additional information can be found in the Appendix L on page A41.

Under 5,000 square feet of new impervious area. If the development of a Riverwalk segment is completed as part of a project that does not meet the size thresholds to trigger the Stormwater and Green Infrastructure requirements of either City of Milwaukee Chapter 120 or MMSD Chapter 13, then the Riverwalk shall incorporate a minimum of one green infrastructure menu item within the 15-foot or 25- foot Riverwalk Zone. For sites with topographic or other constraints that make it difficult to incorporate green infrastructure into the Riverwalk Zone, owners may consider placing menu items outside of the Riverwalk Zone but still within the 50-foot Overlay Zone.

Path Pitch/Slope. The pavement surface of the Riverwalk shall be pitched or sloped toward the adjacent buffer area to capture runoff in green infrastructure. No stormwater shall drain directly into the River without first being filtered through a

Figure 25. Green Infrastructure Options

	Greenway/Vegetated Buffer	*Bioswales*	*Wetlands*	*Rain Gardens*	*Native Landscape*	*Removal of Structures/Paving*	*Pervious Pavements/Pavers*	*Green/Blue Roofs*	*Disconnect /Redirect Downspouts*	*Underground/Aboveground Storage*
Riverwalk Overlay Zone										
Riverwalk Zone	X	X								
Future Development Properties										
Areas of Low Topography			X	X	X					
Existing Drainage Ditches		X	X							
Existing Property Features						X	X	X	X	X
New Property Features		X					X	X		X
Roadways										
Adjacent Roadways		X					X			

vegetated buffer.

See Appendix L for additional guidance on stormwater management on the Harbor District Riverwalk.

BEST PRACTICES

Salt/Deicing. Property owners and property managers are encouraged to refrain from the use of salt/deicing chemicals along the Riverwalk to prevent runoff and protect water quality.

UPLAND AND AQUATIC HABITAT

DESIGN STANDARDS

Habitat Requirements. Riverwalk design must incorporate at least one upland habitat opportunity from the list below. An applicant who elects to provide an aquatic wildlife habitat element described in this chapter along the river at their property is exempt from the requirement to construct an upland habitat element. Applicants must demonstrate how they will comply with this requirement at the time of plan submittal. For Riverwalk segments with greater than 600 linear feet of river frontage, selected elements must be installed with a frequency of not less than one per 600 feet (i.e., a 700 foot Riverwalk segment could install at least two bat boxes, or one bat box and one birdhouse).

Upland Wildlife Habitat. Upland wildlife habitats create and enhance wildlife habitats for avian species, mammals, reptiles, amphibians, and other terrestrial animals. Native trees reduce flooding and the heat island effect, increase property values, promote safety, and provide social and health benefits to humans and animals alike. Native plants are hardier than non-natives, as they've adapted over time to local conditions and do not require pesticides, fertilizers, or watering. This reduced maintenance is good for the environment and saves time and money. Upland wildlife habitat improvements shall be selected from the following list:

- Increase landscaped areas.
- Butterfly or pollinator gardens.
- Bat boxes.
- Birdhouses or nest boxes.

***Habitat Hotel**, Harbor District, Inc.*

Increase landscaped areas. Double the amount of landscaped area throughout the Riverwalk zone from the required 10% (see landscaping section) of the total square footage to a minimum of 20% of total square footage.

Butterfly or pollinator gardens. Gardens should follow the Southern Wisconsin Butterfly Association's best practices including choosing a location that receives at least 6 hours of full sun a day, including both caterpillar food plants and species that provide nectar for butterflies, having a dense natural planting layout, and avoiding pesticides and herbicides. More information available at https://www.naba.org/chapters/nabawba.

Bat boxes. Boxes should follow the Bat Conservation International best practices including mounting to buildings or other large concrete or wooden structures (not poles) if possible, mounting between 10 and 20 feet above the ground, and choosing a location that receives at least 6 hours of full sun a day. More information available at http://www.batcon.org/resources/getting-involved/bat-houses.

Birdhouses or nest boxes. Houses and/or boxes should follow NestWatch's best practices including using untreated wood, having a sloped roof that overhangs the box entrance, including drainage holes in the bottom of the box, walls that are at least ¾" thick, and do not include perches at the box entrance. More information can be found at https://nestwatch.org/learn/all-about-birdhouses/features-of-a-good-birdhouse/. To design a house/box for specific species go to https://nestwatch.org/learn/all-about-birdhouses/right-bird-right-house/.

BEST PRACTICE

Aquatic Wildlife Habitat. Aquatic habitats are in-stream improvements that create places for aquatic wildlife to live, find food, and hide from predators. Aquatic wildlife habitat improvements are encouraged along the Riverwalk. These improvements also clean and filter water and can provide food and shelter for avian and other terrestrial or semi-aquatic species as well. These include:

+ Fish habitat hotels.
+ Waterside planters.
+ Waterfowl connections from water to land.
+ Naturalized edge with seawall/sheet pile.
+ Enhance existing sheet pile/artificial wetland.
+ Dormant woody cuttings and livestaking.
+ Coir logs.
+ Vegetated geogrids.
+ Perforated dockwalls to connect in-stream water to wetland behind dockwall.

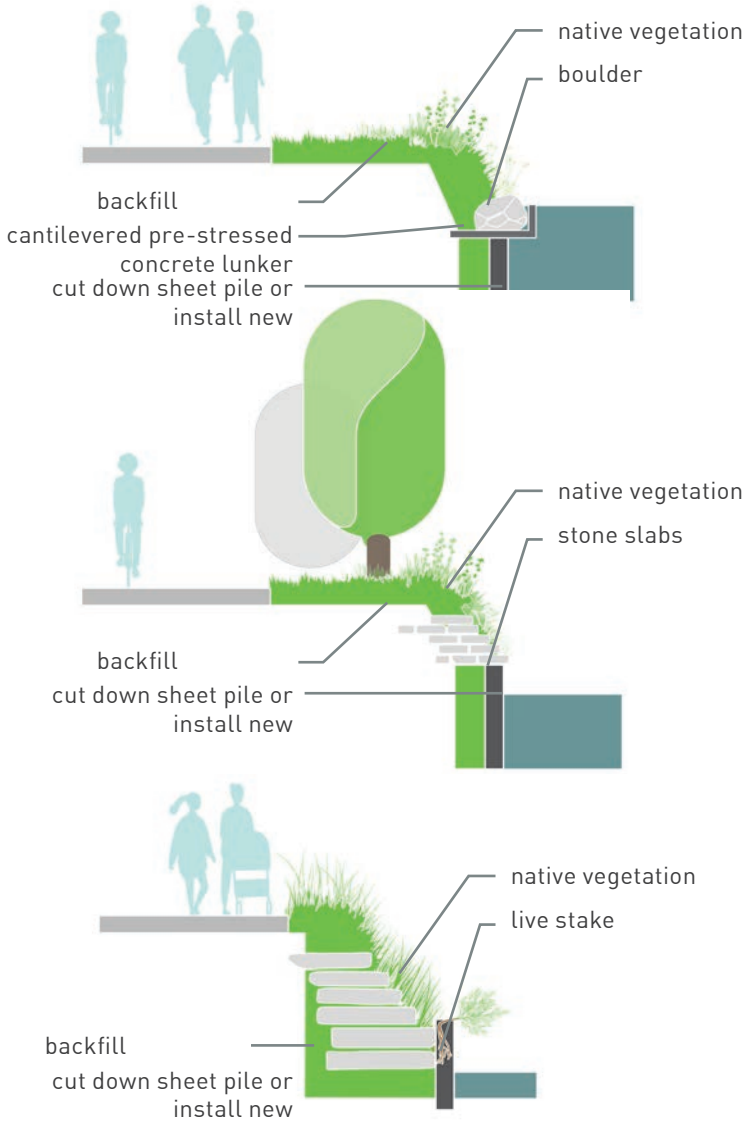
Fish habitat hotels. Habitat Hotels are underwater habitats retrofitted for steel sheet piling consisting of a 12' long pole mounted to the top of a dockwall with baskets and shelves attached to the pole below water. They provide multiple vertical layers of habitat including underwater plants, hiding places for fish, and food for fish, and mimic the habitat that might be found along more naturalized river shorelines. If Riverwalk construction requires the installation of new sheet metal dockwall, brackets for habitat hotels are encouraged to be installed on the dockwall prior to dockwall installation. For further information regarding Habitat Hotels, contact Harbor District, Inc.

Waterside planters. Native vegetation planted adjacent to a dockwall that hangs over into the water and provides shelter and food for fish.

Waterfowl connections from water to land. Provide ramped connections that allow waterfowl to travel from the water to the land. Typical sheet metal dockwal and most riprap water's edges make travel between water and land nearly impossible for waterfowl. Sloped edges and/or ramps will provide a safe space for waterfowl to travel between habitats.

Naturalized edge with seawall / sheet pile. This application is useful for sites with limited setback distances and provides the opportunity to utilize the existing seawall. The seawall can be cut down or replaced by a shortened sheet pile. Once cut, the slope would need to be re-graded and/or backfilled to create a more natural slope and planted with native or adapted vegetation. This application would require the planting of native forbs or grasses to strengthen and stabilize the edge and enhance the aesthetics of the application. Additionally, a cantilevered truss, constructed on top of the cut seawall or sheet pile, can be planted, creating a small artificial wetland.

Figure 26. Naturalized Edge with Seawall / Sheet PIle

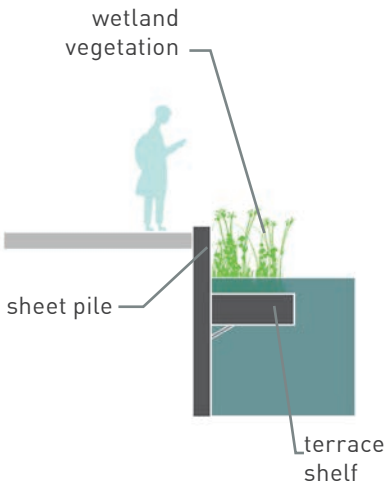


Enhance existing sheet Pile / artificial wetland.
A naturalized edge can also be achieved without removing the sheet pile. Anchoring native plants and shrubs in strategic locations in and around the sheet piling, outside of the navigation channel, can create the appearance of a natural edge without removing the sheet piling.

This terrace or shelf functions as a narrow riparian wetland, sustaining emergent wetland vegetation such as cattails, sedges, arrowhead, and irises. The new wetland habitat will attract wildlife, including insects, crayfish, snails, shorebirds, fish, and more. Anchored by a boulder, the reconstructed river bank above the waterline can be re-vegetated with native plants, gradually blending into the river edge.

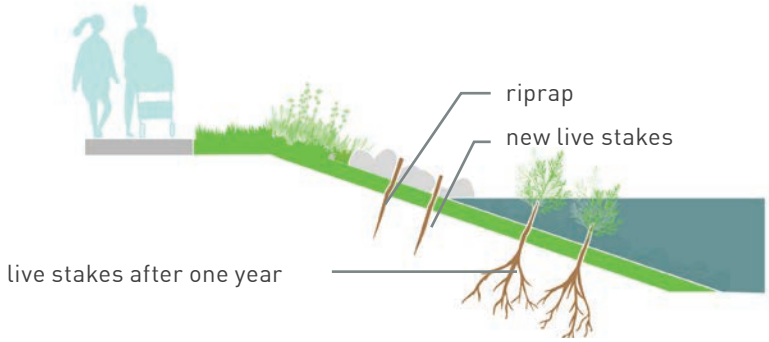
Overhanging vegetation at the river bank also serves to provide cover for wildlife adjacent to the water's edge. This type of riverbank restoration project can serve as an excellent interpretive river site to illustrate the natural and cultural aspects of the river.

Figure 27. Artificial Wetland



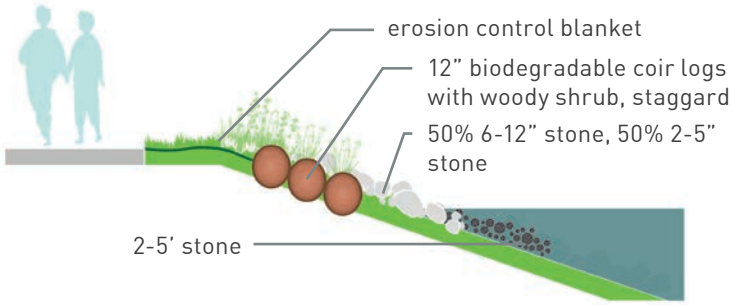
Dormant woody cuttings and livestaking. Some of the most common bioengineering techniques for naturalizing shorelines include live staking and planting dormant woody cuttings. This involves inserting dormant native tree cuttings into the existing riverbank. This method can only be implemented on natural sloped shoreline areas.

Figure 28. Dormant Woody Cuttings and Livestaking



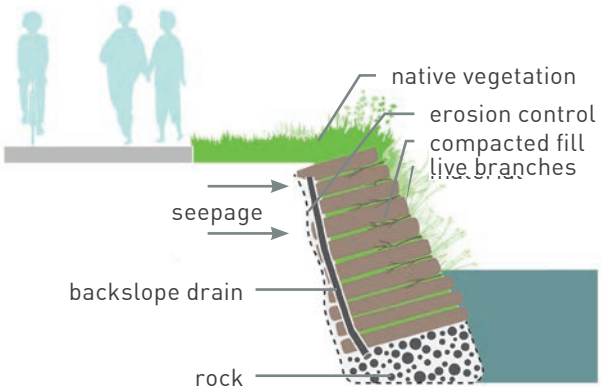
Coir Logs. An application that helps to promote riverbank establishment and deter erosion is coir logs. These coconut fiber wrapped rolls are placed at various locations throughout the slope to serve as a buffering medium to contain and protect a degrading slope and serve as a growing medium for plants. This method can only be implemented on natural sloped shoreline areas.

Figure 29. Coir Logs



Vegetated Geogrids. Vegetated geogrids involve installing dormant cuttings and native plantings layered between erosion control fabric and compacted fill materials. The toe of the geogrid is stabilized by lunkers, boulders, or rock fill while the top is planted with native plantings. This application not only provides bank stabilization but also serves as fish habitat and cover.

Figure 30. Vegetated Geogrids



Perforated dockwalls to connect in-stream water to wetland behind dockwall. Dockwalls can be modified to allow river water to flow to designated habitat areas on the land side of the dockwall. These wetland habitat areas would include native riparian and emergent plants.

Increase Biodiversity. As habitat opportunities are developed, the site owner and designers should aim to increase the number of plant species in the habitat area to provide food and shelter for a variety of animals, including mammals, birds, fish, and insects. Species should be selected to provide consistent food sources (e.g., flowers that bloom at different times of the year). Plants should also be selected to provide a diversity of habitat layers: canopy, sub-canopy, shrub, and ground layer, including mammals, birds, fish, and insects. Increasing biodiversity increases ecosystem resiliency and provide aesthetic benefits.

Placement. Terrestrial habitats should not be placed directly adjacent to busy pedestrian areas such as the path/walk or seating areas; however, aquatic habitats could be incorporated below pedestrian boardwalks or overlooks.

Connectivity. Habitat placement should aim to connect existing habitats and close gaps between them. Terrestrial habitats should connect to other site features, such as landscaping, trees and green infrastructure.

50' OVERLAY, BUILDINGS AND SITES

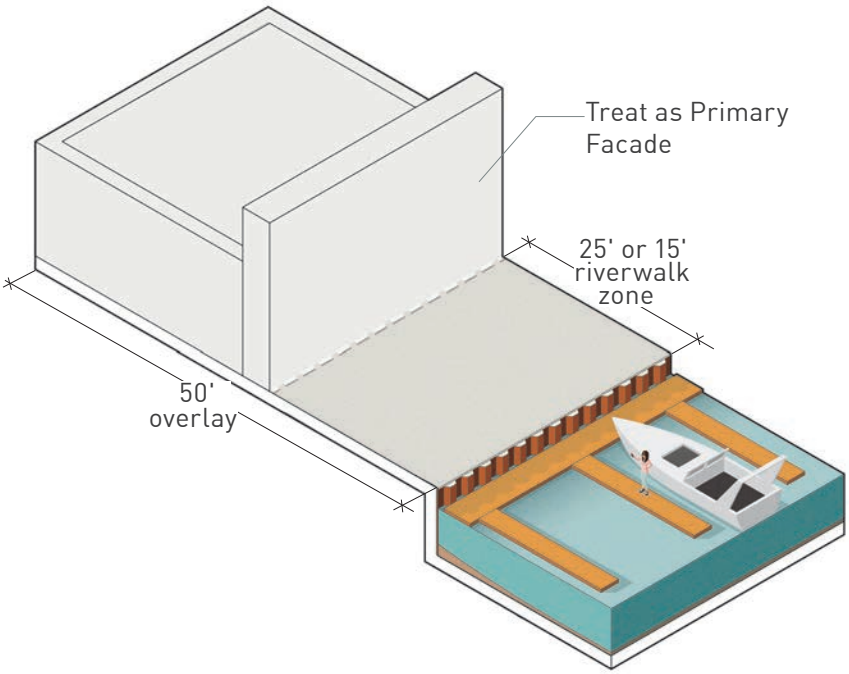
The Harbor District Riverwalk Site Plan Review Overlay Zone regulates buildings and site components within 50 feet landward of an existing dock wall or ordinary high watermark. This section of the document describes the regulations that apply to buildings, uses, or site elements outside of the Riverwalk Zone but within the 50-foot Riverwalk Overlay Zone.

DESIGN STANDARDS

Placement and Orientation. Within the 50-foot Riverwalk Overlay Zone, both principal and accessory structures are permitted. Buildings and structures are prohibited within the Riverwalk Zone section, except for structures provided for public use. The river-facing façade of buildings within the Overlay Zone should be designed and treated as a principal façade and should feature the same design elements, materials, building articulation, relief, and other architectural considerations as street-facing façades.

Existing conditions which do not comply with the following standards should move towards compliance at time of additions and substantial improvement of an existing facility of existing facility.

Figure 31. 50-Foot Overlay Zone



Harbor View Design Concept,
WaLUP

Massing and Articulation. Architectural features may consist of fenestration with transparent glazing, wall modulation, decorative pilasters, horizontal banding, scoring, reveals, decorative panels, and / or articulation of functional elements. Building facades and opaque fencing within the Overlay Zone shall not be blank or unarticulated. Clerestory windows may be used if internal functions do not allow for large areas of glazing.

Scale. Consider stepping back the massing of buildings frontage along the river to create an environment with a pedestrian-friendly scale, increase sunlight access, and create multiple levels of interest. This is a key consideration for land uses with high activation. Long uninterrupted walls beyond 100 feet in length shall have off-sets of at least 2 feet, or other means to create a pedestrian-friendly condition.

Glazing Requirements. When a Riverwalk Zone is allowed to be reduced to a 15-foot width due to an adjacent "pedestrian activated land use," then the Riverwalk level of the building is required to have 60% glazing (measured in a linear manner, consistent in method with 295-605-2-i-3 of the Commercial District chapter) or an equivalent level of wall articulation. At least one pedestrian entrance from the pedestrian activated use shall connect to the Riverwalk.

Façade Materials. High quality façade materials are encouraged, and certain façade materials such as metal building walls, concrete masonry units and simulated stucco products are restricted per requirements found in Commercial Districts, Section 295-605-2-i-6. for façade walls, both parallel and perpendicular to the river, that occur in the 50-foot Riverwalk Overlay Zone.

Site Elements. Private patios and decks are permitted and encouraged in the overlay area outside the required minimum Riverwalk Zone. Patio and deck surfaces should be finished quality materials that are consistent with materials permitted in the Riverwalk Zone area. Any necessary retaining walls should be finished quality materials such as poured-in-placed concrete or finished quality masonry matching the building. Dry stack block retaining wall systems are not permitted.

Required Landscaping. In the case of site features such as parking lots, storage yards, and trash collection areas being located in the 50' Riverwalk Overlay, they shall follow the same landscaping requirements as would be required by ordinance if the condition were along the primary street frontage of a property (Landscape and Screening Requirements per Subchapter 4 Section 295-405 of the Zoning Code of Ordinances). The landscaping that is located in the Riverwalk Zone or in the public right-of-way area is not counted toward this requirement.

Fencing. For uses required by Chapter 295-405 of the Zoning Code to provide landscaping and screening from public streets, the landward edge of the Riverwalk Path shall be treated in the same manner as a primary street property line when determining landscaping and screening requirements. Any fencing required to comply with the requirements of 295-405 shall be placed outside of the minimum required Riverwalk Zone. For security and containment purposes, fencing abutting a Riverwalk can be erected along the Riverwalk using decorative metal. Chain link and barbed wire are not permitted.

Storage Yards, Loading Docks and Dumpster Areas. Service areas containing outdoor storage yards, loading docks, and dumpster areas that face the Riverwalk shall be screened using wing walls, or opaque screening or fencing.

Lighting. Lighting in the overlay zone shall follow requirements and standards of those set forth in the 25' Riverwalk Zone area for permitted fixtures. No high level flood lights are permitted adjacent to the Riverwalk Trail area, including at outdoor storage yards and parking lots.

Signage. Within all signage categories (wall, free-standing, roof, etc), Type A signage is required for all signs located in the Riverwalk Overlay Zone. These requirements include individual letter wall signs, monument style free-standing signs, and other features associated with higher quality signage as found in Section 295-407 of the Zoning Code of Ordinances. If a free-standing monument sign is located in the Riverwalk Overlay, the design shall be compatible with the character of signs found on page 40.

04

APPENDIX

APPENDIX

APPENDIX A A4

Previous/Related Planning Documents

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Other Regulatory Requirements

APPENDIX C A8

Design Water Levels

APPENDIX D A11

System wide Planning

APPENDIX E A15

Alternative Trail Typologies

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Connectors

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In The Water

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Full Plant List

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Open Space And Recreation

APPENDIX K A39

Community Engagement Overview

APPENDIX L A41

Stormwater Details

APPENDIX M A43

Challenging Segments Concepts

APPENDIX N A50

Public Access Points Concepts

APPENDIX O A53

Sources

APPENDIX A

PREVIOUS/RELATED PLANNING DOCUMENTS

The City of Milwaukee and Harbor District, Inc. have completed several plans and studies that impact and provide recommendations relevant to the Harbor District Riverwalk and its surrounding areas. Relevant plans, research, and charrettes include:

- Milwaukee Riverlink Guidelines, 1992
- ReFresh Milwaukee Sustainability Plan, 2013
- Waterfront Innovations Design Charrette, 2015
- Watermarks Document by City as a Living Laboratory, 2015
- Harbor District Water and Land Use Plan (WaLUP), 2017
- Kinnickinnic Watershed Green Infrastructure Plan, 2018

MILWAUKEE RIVERLINK GUIDELINES, 1992

The City of Milwaukee developed the Riverlink Guidelines in 1992 to set forth the vision and initial guidelines for the development of Milwaukee's Riverwalk system along the Milwaukee River from the North Avenue Dam south to the confluence of the Milwaukee and Kinnickinnic Rivers at Bruce Street.

https://city.milwaukee.gov/Designguidelines/MilwaukeeRiver.htm

REFRESH MILWAUKEE SUSTAINABILITY PLAN, 2013

Milwaukee's Sustainability Plan was adopted in 2013 and identified the redevelopment of the Harbor District as one of two priority projects to demonstrate Milwaukee's comprehensive approach to environmental sustainability. ReFresh Milwaukee set goals for improved habitat opportunities, water quality, and stormwater management within the Harbor District.

http://refreshmke.com/

WATERFRONT INNOVATIONS DESIGN CHARETTE, 2015

In 2015, Harbor District Inc. hosted a design charette that brought four internationally recognized design teams together to develop concepts showcasing how the waterfront throughout the Harbor District could be reimagined to provide improved public access, restored natural habitat, and bring environmental and economic benefits to the Harbor District.

https://harbordistrict.org/resources/

WATERMARKS: AN ATLAS OF WATER AND THE CITY OF MILWAUKEE, 2016

City as Living Laboratory, led by artist Mary Miss is working with the City of Milwaukee and other local partners to implement the Watermarks public art project. Watermarks will be developed at a series of locations throughout the city activated by community partners. The Harbor District, the confluence of the city's three rivers, is the starting point of a multi-layered, incremental project that will be implemented over time in neighborhoods throughout the city.

https://www.cityaslivinglab.org/watermarks

HARBOR DISTRICT WATER AND LAND USE PLAN (2018)

The City of Milwaukee and Harbor District Inc. collaborated to create the Harbor District Water and Land Use Plan (WaLUP), which was adopted as part of the City of Milwaukee's Comprehensive Plan in 2018. The WaLUP was developed through extensive community engagement and established a long-term vision for the future of the Harbor District. Improved public access to the waterfront and the extension of the Milwaukee Riverwalk into the Harbor District were identified as catalytic projects to achieve the goals of the plan.

https://city.milwaukee.gov/AreaPlans/HarborDistrict

KINNICKINNIC RIVER WATERSHED: GREEN INFRASTRUCTURE PLAN (2018)

The Milwaukee Metropolitan Sewerage District developed the Kinnickinnic River Green Infrastructure Plan to identify goals for the installation of stormwater management and other green infrastructure in the KK River watershed, including improvements that can be made along the River itself.

https://www.freshcoastguardians.com/resources/our-plans

APPENDIX B

OTHER REGULATORY REQUIREMENTS

CITY OF MILWAUKEE (CHAPTER 120)

The City of Milwaukee's Chapter 120 ordinance (Ch. 120) regulates the quality and quantity of the runoff into receiving bodies of waters storm sewers or drainage facilities, or onto driveways, sidewalks, parking lots or other areas that drain into the drainage system. A stormwater management plan (SWMP) addressing stormwater runoff must be submitted and approved if your site meets the criteria set by the City. A SWMP is required under any of the following scenarios: (1) Development or redevelopment activities cause a land disturbing activity of 1 acre or more. (2) Development or redevelopment activities cause the cumulative area of all land disturbing activities at a property to be 1 acre or more over a 3-year period. (3) Development or redevelopment activities cause an increase of 0.5 acres or more of impervious area.

Ch. 120 provides guidance on peak runoff release rate calculations, the runoff release rate requirement, runoff discharge quality control requirement, and green infrastructure requirement for the development. Documents to Download for a Storm Water Management Plan can be found here:

https://city.milwaukee.gov/stormwatermanagement/Document-Downloads-for-Storm-W.htm#.XaYV5W5Fyzk

MILWAUKEE METROPOLITAN SEWERAGE DISTRICT (CHAPTER 13)

Chapter 13 (Ch. 13) applies to all users of the sewerage system and all governmental units within the sewer service area, including the Kinnickinnic River Estuary that is in the Harbor District's River Walk proposed Site Plan Review Overlay Zone (SPROZ). Runoff management is required for any development or redevelopment if: (1) will add one-half acre or more of impervious surface. (2) Development or redevelopment activities will disturb two acres or more but will not add one-half acre or more of impervious surface. In addition, green infrastructure is required for development and redevelopments with new impervious surface of 5,000 square feet but less than 21,780.

Ch. 13 provides guidance on Site Development Stormwater Runoff Management Plans and Green Infrastructure Plans along with sizing calculations. MMSD's rules and supporting documentation can be found here:

https://www.mmsd.com/government-business/rules-regulations/rules

WISCONSIN DEPARTMENT OF NATURAL RESOURCES (NR 151 AND NR 216)

Construction projects that disturb one acre or more of land through clearing, grading, excavating, or stockpiling of fill, require permit coverage regulated by the DNR.

The standards in NR 151 were developed to protect water quality by minimizing the amount of sediment and other non-point source pollutants that enter the waterways. Subchapter III, Non-Agricultural Performance Standards, encompasses the construction and post-construction erosion and storm water management for new development and redevelopment areas, as well as certain requirements for developed urban areas. NR 151 provides design requirements for total suspended solids, peak discharge rate, infiltration, and protective areas. This standard is implemented and enforced through storm water construction permits issued by the DNR through NR 216.

The Wisconsin Pollutant Discharge Elimination System (WPDES) is administered under the authority of NR 216 and regulates the discharge of stormwater. Landowners must develop a Stormwater Management Plan and an Erosion Control Plan describing the BMPs that will be used on-site and submit a Water Resource Application for Project Permits (WRAPP) and Notice of Intent (NOI) prior to land disturbing activities. More information on stormwater regulations can be found here:

https://dnr.wi.gov/topic/stormwater/learn_more/regulations.html

The principal agencies concerned with permitting will be the Wisconsin Department of Natural Resources (WI DNR), Wisconsin Department of Transportation (WisDOT), and the United States Army Corps of Engineers (USACE), though other regulatory agencies should be engaged during the design stage of Riverwalk development. Relevant agencies for the Harbor District include but are not limited to the following:

+ Federal Emergency Management Agency (FEMA)
+ US Coast Guard (USCG)
+ US Environmental Protection Agency (USEPA)
+ US Fish and Wildlife Service (USFWS)
+ Wisconsin Coastal Management Program / Wisconsin Sea Grant
+ City of Milwaukee
+ Milwaukee Metropolitan Sewerage District (MMSD)

Activities that will likely involve permitting with these authorities include:

+ In-channel Fill and Placement of Structures – Activities which impact the channel of the Kinnickinnic may require a permit from the USACE under the Section 404 permit as required by the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899. Wisconsin State Statutes Chapter 30 provides detail on the requirements pertaining to permits needed for activities such as enclosures, dredging, grading on the shoreline bank, and development of piers and wharves.
+ Dredging / Removal of Material from a Streambed – A federal permit from the USACE will be needed, which for large dredging projects will require a full public interest review, and which for small dredging projects, a letter of permission is needed. State regional and general permits from the WDNR for navigable waters.
+ Stormwater Discharge – A Storm Water Discharge Permit may be required from the WDNR.

APPENDIX C

DESIGN WATER LEVELS

CONTEXT

In establishing the Milwaukee Harbor District Riverwalk Design Standards, it was desired that future developers be given an understanding of water levels on the Kinnickinnic River to provide them guidance in determining the base elevation for future Riverwalk segments. This desire arose from the potential that future Riverwalk segments might be subject to flooding during periods of high water levels on Lake Michigan, during rises in the Kinnickinnic's flow due to snowmelt or stormwater, or during a storm-driven seiche event that can move Lake Michigan water into the Milwaukee Estuary and rapidly raise water levels on the Kinnickinnic (also known as a meteotsunami). This memorandum summarizes the return period for water levels on Lake Michigan (including Milwaukee Harbor) and the Kinnickinnic River, and its flow rates.

METHODOLOGY

This is an analysis of water level data to determine probability of exceedance for varying still water levels in the vicinity of the project area. Figure 33 provides a description of the U.S. Geological Survey (USGS) water level gauges that were used in the analysis. Figure 32 shows the location of these USGS gauges.

Figure 32. Location of Study Gauges

Figure 33. Summary of Available Data

Gauge	Period of Record	Lat/Long	Authority	Datum
USGS Kinnickinnic Gauge @ S 11th Street, Milwaukee, WI (ID No. 04087159)	08/18/1977– 08/12/2017	42°59'51"N 87°55'35"W	USGS	NAVD88
USGS Milwaukee River Mouth Gauge, Milwaukee, WI (ID No. 04087170)	10/01/2017– 11/01/2019	43°01'28"N 87°53'54"W	USGS	NAVD88
USACE Gauge - Lake Michigan at Milwaukee (ID No. 9087057 / 9087058)	08/01/1899 – 11/01/2019	43° 0'7.80"N 7°53'15.68"W	USACE	IGLD85

WATER LEVEL ANALYSIS

The short (two-year) record of water levels at the USGS Milwaukee River mouth gauge precludes use of said data for an Extreme Value Analysis .

The daily averages of the data for the USGS Milwaukee River mouth gauge was compared to the USACE daily average water level data for Lake Michigan. This comparison showed a strong correlation between the values, which indicates water levels in the harbor and for the lake are comparable. The largest recorded difference was 0.37 ft (4.48 in) with a mean difference of 0.05 ft (0.6 in). Figure 2.2 shows the relationship between the Milwaukee River mouth gauge and the Lake Michigan levels.

Analysis of 43,167 data points taken as daily readings for Lake Michigan water levels (1900-present) was used to produce 'best estimates' of water level exceedance probabilities. Return period estimates for water levels are shown below in Table 2.2.

The water level analysis was conducted by filtering the data to annual maxima. Figure 2.3 shows the probability of exceedance estimated for various water levels measured in feet from the IGLD85 datum. The best statistical distribution fit for the series of annual maxima was determined to be the normal distribution.

Figure 34. Relationship of Water Level Data Curves between Milwaukee River Mouth and Lake Michigan

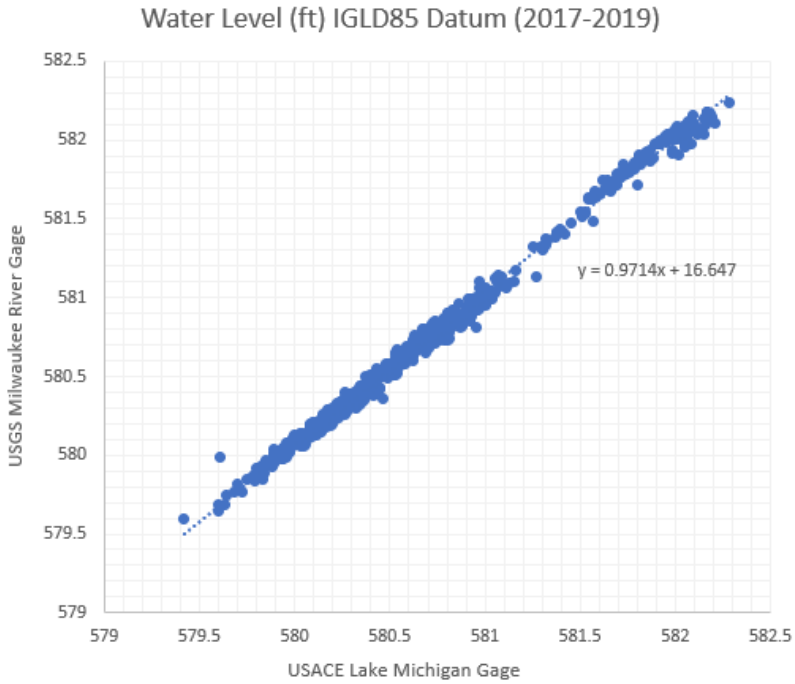


Figure 35. Summary of Return Periods for Design Water Levels

Return Period	Best Estimate - Water Level (Feet) IGLD 85	95% Confidence Limit	5% Confidence Limit
200	582.87	583.31	582.56
100	582.57	582.99	582.27
50	582.18	582.58	581.95
20	581.57	582.05	581.47
10	581.15	581.53	581.03
5	580.76	580.94	580.52
2	579.79	579.87	579.49

KINNICKINNIC RIVER ANALYSIS

The scope of this project did not attempt to delineate how far upriver the Kinnickinnic River is estuarine. It is possible that during a freshet , the south of the project site may experience water levels significantly above those estimated for the harbor section.

There are existing models of the river that could be used alongside stage/discharge data for the gauge located upriver from the project site to estimate design water levels with more precision. Table 2.3 outlines estimated stage and discharge exceedance probabilities for the USGS gauge located upriver (based on a 34-year annual maximum series).

CONCLUSIONS

Water level fluctuations can be estimated to range from 579.79 ft IGLD85 to 582.87 ft IGLD85 based upon an analysis of non-extreme values. Site conditions may vary and exceed this range due to extreme circumstances (or a combination of multiple such circumstances). More complex analyses shall be conducted to determine extreme water levels during detailed design of future Riverwalk development shoreline infrastructure.

Figure 36. Probability of Exceedance for Milwaukee Harbor Water Levels (ft)

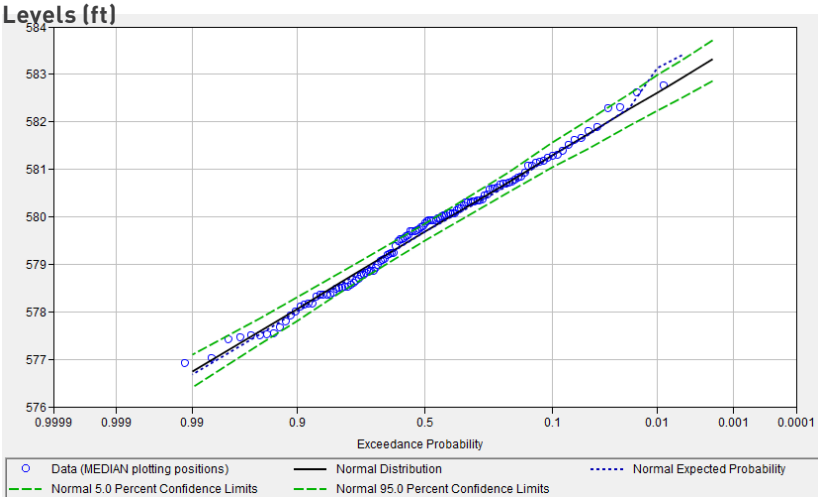


Figure 37. Probability of Exceedance for Milwaukee Harbor Water Levels (ft)

% Chance Exceedance (in a given year)	Flow (CFS)	Gauge Height (ft)
1.0	9527.3	14.16
2.0	8415.0	13.93
5.0	7002.2	13.58
10.0	5961.6	13.27
20.0	4921.2	12.90
50.0	3441.3	12.18

APPENDIX D

SYSTEM WIDE PLANNING

The first step the planning team accomplishing during this process was a review of the existing conditions along the Harbor District. The existing conditions review provided a snapshot in time of the Harbor District and provides the framework within which the planning team will work to develop the detailed Riverwalk design standards.

STUDY AREA OVERVIEW

The study area includes all 43 properties located within the Harbor District Riverwalk Site Plan Review Overlay Zone (SPROZ, overlay zone). The overlay zone requires the construction of a Riverwalk segment for any new development or major redevelopment of a river fronting property in the Harbor. The overlay zone includes all waterfront parcels on the western shore of the Inner Harbor and waterfront parcels on both sides of the Kinnickinnic River between the Union Pacific rail swing bridge and Lincoln Avenue. Within the overlay zone, City Plan Commission approval would be required for all projects located 50 feet landward of an existing dock wall or ordinary high watermark. For any property located within or partially within the overlay zone, a Riverwalk that complies with the requirements of this overlay zone shall be constructed at the time of any new construction or substantial improvement of a principal structure on the property. This requirement shall apply even in cases where the principal structure itself is not located within the zone.

Overall, there are 43 properties or more than 200 acres of land within the overlay zone. This also includes nearly 4.5 miles of waterfront. The development of a Riverwalk within a 25' setback equates to the opportunity of 13.2 acres of public use within the study area.

The planning team sub-divided the study area into three sub-districts. These zones mirror those of the Harbor District WaLUP sub-districts. They are as follows:

+ North / Harbor View Sub-District
+ Center / East Greenfield Ave and Grand Trunk Sub-District
+ South / Lower Kinnickinnic River Sub-District

The diagrams on the following pages outline the open space, access, and habitat opportunities within the study area.

Study Area
25' Zone
Park
Water
Rail
Proposed River Walk
Existing Trail
Public Access Point
Boardwalk / Overlook
Habitat Opportunity
Public Space Opportunity
Direct Water Access
Parking Opportunity
BRUCE ST
SOO LINE / CANADIAN PACIFIC
NATIONAL AVE
KINNICKINNIC RIVER
GREENFIELD AVE

Study Area
25' Zone
Park
Water
Rail
Proposed River Walk
Existing Trail
Public Access Point
Boardwalk / Overlook
Pedestrian Bridge
Habitat Opportunity
Public Space Opportunity
Direct Water Access
Parking Opportunity
River Dependent Use
GREENFIELD AVE
BARCLAY ST
SOO LINE / CANADIAN PACIFIC
CHICAGO NORTH WESTERN / UNION PACIFIC
KINNICKINNIC RIVER
MARINA DR
STEWART ST
HILBERT ST
BECHER ST
BAY ST

BURNHAM ST
3RD ST
2ND ST
KINNICKINNIC RIVER
BECHER ST
1ST ST
LINCOLN
Study Area
25' Zone
Park
Water
Rail
Proposed River Walk
Existing Trail
Public Access Point
Boardwalk / Overlook
Habitat Opportunity
Public Space Opportunity
Direct Water Access
Parking Opportunity

APPENDIX E

ALTERNATIVE TRAIL TYPOLOGIES

In addition to the trail typologies presented in Chapter 3 of the Design Standards document, the planning team developed alternative trail typology cross-sections to assist property owners with trail design. The following cross-sections may be appropriate in various areas of the Riverwalk where property owners aim to go above and beyond the standards set forth in Chapter 3.

Figure 38. Multi Use Typology, 14' Path

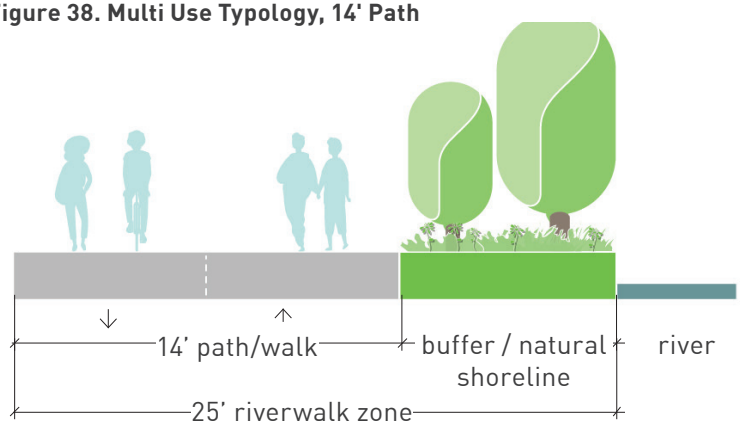


Figure 39. Multi Use Typology, 12' Path with river side alternative or secondary path.

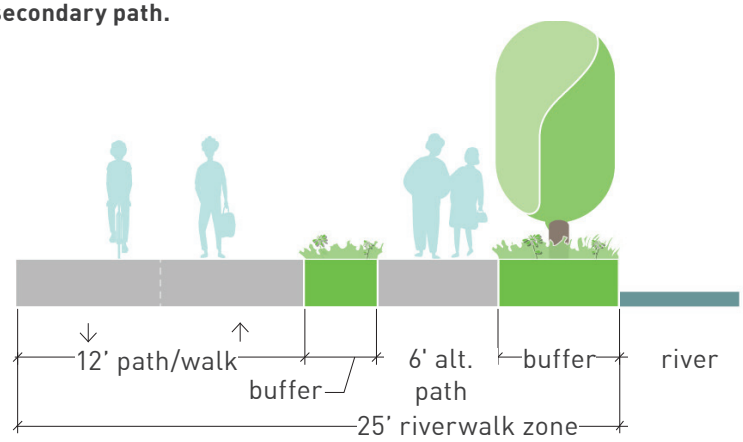


Figure 40. Multi Use Typology, 14' Path with river side alternative or secondary path.

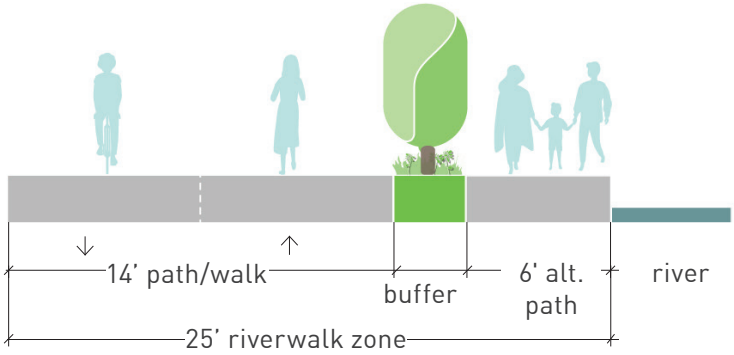


Figure 41. Multi Use Typology, Separated Bike and Pedestrian Paths

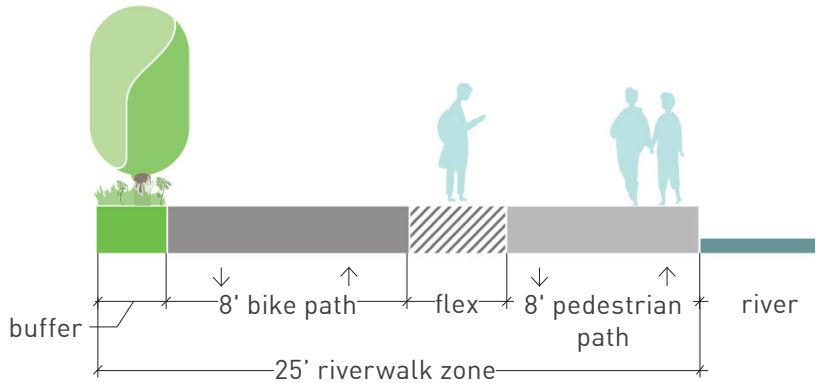


Figure 42. Urban Typology, Boardwalk / Cantilever

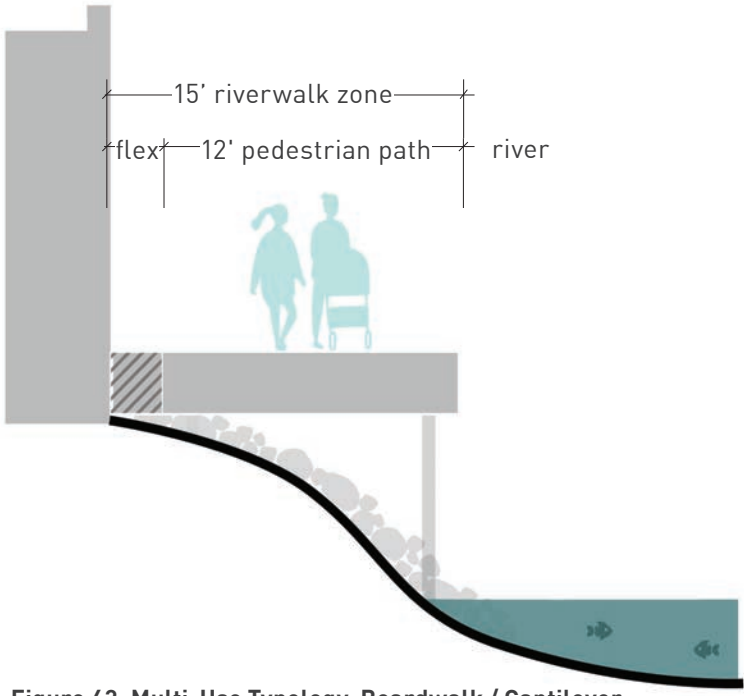
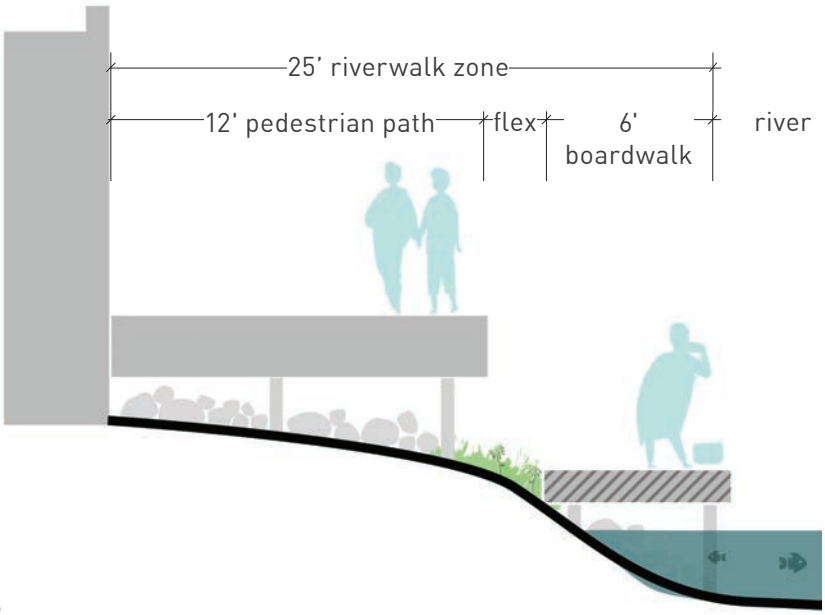


Figure 43. Multi-Use Typology, Boardwalk / Cantilever



APPENDIX F
CONNECTORS

Street Network, Crosswalks. Pedestrian connections between the Riverwalk and street network should be constructed with pedestrian safety and security as the highest priority. At-grade crossings shall follow the AASHTO standards. Additional branding and wayfinding elements, such as crosswalk designs, are encouraged to create a clear visual connection and enhance the sense of place and Riverwalk identity.

Street Network, Mid-Block Connections. Pedestrian connections between the Riverwalk and street network should be constructed with pedestrian safety and security as the highest priority, especially when done at mid-block locations. At-grade crossings shall follow the AASHTO standards. Additional branding and wayfinding elements, such as crosswalk designs, are encouraged to create a clear visual connection and enhance the sense of place and Riverwalk identity. Raised medians, pedestrian refuge islands, and bump outs are encouraged on streetscapes that allow for them. Mid-block connections shall have appropriate signage signaling per the Manual on Uniform Traffic Control Devices (MUTCD).

APPENDIX G
IN THE WATER

FLOATING BOARDWALKS

Future floating boardwalk applications in the Harbor District shall generally consist of over-water public walkways that are designed to withstand the environmental conditions (i.e. water level fluctuation, wind/wave conditions, ice, etc.) and may also be designed to accommodate additional uses or applications (i.e. vessel dockage and floating wetlands or submerged ecological improvements – fish hotels). Floating boardwalks may incorporate numerous amenities (i.e. lighting, benches, overhead structures, signage, etc.).

No matter the application, all floating boardwalk structures shall meet local, state, and federal regulatory requirements as required for the proposed project site location. This includes meeting regulatory and environmental permitting in addition to designing project components to meet the minimum standard of care of engineering practice. The recommendations herein focus upon marine and coastal aspects and the standard of care related to the design of floating river boardwalks. Environmental and regulatory permitting aspects are not discussed in detail but are mentioned in concert with their relation to the design. In order to meet the standard of care of industry practice, the floating boardwalks shall be designed to meet minimum requirements stated within the currently adopted version of ASCE 7 Minimum Design Loads for Buildings and Other Structures.

The design of marine structures require a unique set of conditions compared to land-based structures, including, to name some of the most critical aspects, the proposed project site exposure to wind, waves, currents, ice loads, as well as recreational and commercial vessel traffic within the site vicinity. ASCE 7's primary emphasis is on the design of land-based structures and thus supplemental recommendations for marine structures is often useful.

Types of Anchorage for Floating Structure. Floating boardwalks are comprised of two primary structural elements: the floating boardwalk itself, and the anchorage of the floating boardwalk. There are generally two categories of anchorage systems used for floating structures, where the floating structure is fixed to the river bottom using cables extending from the floating structure to some type of anchor at the river bottom – often the anchor is typically some type of dead weight "clump-type" block for floating structures of this scale, or alternatively, the floating structure is held in place using guide piles which the floating structure slides vertically along as water levels fluctuate.

Cable Anchor Systems. For cable anchorage as it relates to a floating boardwalk, in order for the boardwalk to remain (relatively) in-place, there must be cables extending from the perpendicular axis to the direction the boardwalk extends such that there is sufficient lateral restraint to lateral loading from waves, ice, wind, etc. The extent of the perpendicular footprint due to the cables projecting beyond the width of the floating boardwalk will depend primarily upon water depth (as well as the magnitude of lateral loading, among others), but a reasonable first approximation would be 1:1 or 1:2 such that the cable anchorage footprint width perpendicular would be two to four times the water depth. Due to the relatively shallow waterway width within the proposed area within the Kinnickinnic River area, as well as the prevalent use of hard waterfront structures (primarily steel bulkhead walls), there is limited room for a cable anchorage system, and therefore cable anchorage systems are not recommended to be considered by future developers.

Piled Anchor Systems. Piled anchor systems for floating boardwalks are recommended due to the geometrical restraints within the project vicinity which negate the practical use of cable anchorage systems. Pile supported anchor systems require that the piles are vertical (plumb) such that the floating system may rise and fall during fluctuations in water elevations by sliding unrestrained vertically along the pile. Thus, each individual pile acts as a cantilever beam and must achieve fixity below mudline for the system to be stable.

Landside Connections. Connections between any floating structure and the adjacent land must be designed on a site-specific basis to establish the necessary landside foundation, appropriate transition connection (particularly if any utilities are being carried from the landside to the floating structure) which meets ADA-compliant accessibility guidelines mentioned previously, and which do not negatively impact other uses in the project area, such as berthing vessels or conducting maintenance operations within the Kinnickinnic.

Safety Considerations. Safety considerations for floating boardwalk elements are consistent with those previously noted in Figure 52. Summary of Recommended Safety Amenities on page A38.

APPENDIX H
UNDERBRIDGE CONNECTIONS

Where bridges and abutments are barriers to connectivity, underbridge connections may be necessary to maintain a cohesive, connective Riverwalk system. Per the City of Milwaukee RiverLink ordinance, underbridge connections are allowed only if there is a minimum of seven (7) feet of clearance between the top of the walking surface and underside of bridge.

The results of this analysis are summarized in the following table, Figure 44. Underbridge Dimensions on page A21. For the Kinnickinnic Avenue and South 1st Street Bridges, these bridges have an arched shape to their bottom structure, and as such, the clearance at the abutments is lower than at the center span. The West Becher Street Bridge is flat along its bottom and across its span, while the West Lincoln Avenue Bridge is flat along its bottom, and the west abutment of the span is at a higher elevation than the east abutment. This work is only an estimate and does not include changes during construction nor settlement. For a more accurate determination, a professional land surveyor should be involved with deck elevation measurements. Furthermore, these clearances are determined only for conceptual consideration, and actually constructing the Riverwalk under any of these bridges will involve further engineering. At this time, only one bridge along the Harbor District Riverwalk Trail provides enough clearance for an underbridge connection.

Figure 44. Underbridge Dimensions

	Clearance Location	Clearance from +0.0 ft.	Clearance from 8/2019 WL (+1.79 ft.)	Clearance from 100-year high water level (+3.7 ft.)
Kinnickinnic Avenue	At Center Span	+11.00 ft	+9.21	+7.3
Bascule Bridge	At Abutment	+5.22 ft.	+3.43	+1.52
South 1st Street	At Center Span	+12.6	+10.81	+8.9
Bascule Bridge	At Abutment	+4.6	+2.81	+0.9
West Becher Street	At Center Span	+10.0	+8.21	+6.3
Bridge	At Abutment	+5.0	+3.21	+1.3
West Lincoln	At Center Span	+13.0	+11.21	+9.3
Avenue Bridge	At Abutment	+14.0	+12.21	+10.3

It has been noted that other Riverwalk Design Guidelines in the City of Milwaukee use an under-bridge clearance minimum of 7.0 ft. As such, it would appear that only the West Lincoln Avenue Bridge has sufficient under-bridge clearance at its abutments to include a continuous Riverwalk. For the remaining three bridges, under-bridge clearance of greater than 7.0 ft. is achievable at the center span and potentially nearby. However, as the Riverwalk pushes further out into the river channel, further issues will be encountered, such as impacts to navigation, issues with constructability, and so forth.

Underbridge connections should adhere to AASHTO standards, be adequately illuminated, and provide continuous safety railing for a minimum of 20 feet on approaches to the underbridge from the Riverwalk Trail. Underbridge connections may require additional permitting considerations and coordination with regulatory agencies.

APPENDIX I

FULL PLANT LIST

P: Preferred

GTW: Used in the Grand Trunk Wetland Restoration Plan

Upland

Scientific Name	Common Name	Location	
		P	GTW
Trees			
Acer saccharum	Sugar Maple		
Acer x freemanii 'Autumn Blaze'	Autumn Blaze Maple	X	X
Alnus rugosa	Speckled Alder		
Betula nigra	River Birch		X
Celtis occidentalis	Hackberry	X	X
Gleditsia triacanthos inermis	Thornless Honeylocust	X	
Gymnocladus dioicus	Kentucky Coffeetree	X	
Liriodendron tulipifera	Tulip Tree		
Quercus alba	White Oak		X
Quercus bicolor	Swamp White Oak	X	X
Quercus macrocarpa	Bur Oak	X	X
Tilia americana	American Linden	X	
Tsuga canadensis	Canadian Hemlock		

Ornamental Trees			
Amelanchier laevis	Allegheny serviceberry		
Amelanchier canadensis	Shadblow Serviceberry	X	
Amelanchier x grandiflora	Apple Serviceberry		
Carpinus betulus	European Hornbeam	X	
Carpinus caroliniana	Blue Beech, Musclewood, American Hornbeam		
Cercis canadensis	Redbud	X	
Crataegus punctata	Dotted Hawthorn		
Crataegus crusgalli inermis	Thornless Cockspur Hawthron	X	
Crataegus mollis	Downy Hawthorn	X	
Crataegus phaenopyrum	Washington Hawthorn		
Hamamelis virginiana	American Witchhazel	X	
Ostrya virginiana	Ironwood, Eastern Hophornbeam		

Scientific Name	Common Name	Location	
		P	GTW
Shrubs			
Aronia melanocarpa	Black Chokeberry		
Ceanothus americanus	New Jersey Tea	X	
Cornus racemosa	Gray Dogwood	X	
Cornus sericea cultivars	Redtwig Dogwood	X	
Cornus stolinifera	Red-osier Dogwood		X
Corylus americana	American Hazelnut, Filbert	X	X
Hamamelis virginiana	Witch Hazel		X
Hypericum kalmianum	St. John's wort		
Ilex verticillata varieties	Common Winterberry		X
Juniperus horizontalis var.	Spreading Juniper varieties		
Juniperus virginiana var.	Eastern Red Cedar varieties	X	
Physocarpus opulifolius	Common Ninebark	X	
Potentilla friuticosa	Potentilla	X	
Rhus aromatica 'Gro-Low'	Gro-Low Sumac	X	
Rhus glabra	Smooth Sumac		
Rhus typhinia	Staghorn Sumac	X	
Sambucus canadensis	Elderberry		X
Symphoricarpos albus	Common Snowberry		
Thuja occidentalis varieties	Arborvitae varieties		
Viburnum dentatum	Arrow-Wood Viburnum	X	
Viburnum lentago	Nannyberry	X	
Viburnum prunifolium	Blackhaw Viburnum	X	
Viburnum trilobum	American Cranberrybush	X	

Scientific Name	Common Name	Location	
		P	GTW
Grasses, Sedges, and Rushes			
Andropogon gerardi	Big Bluestem	X	X
Bromus pubescens	Woodland Brome		X
Carex gracillima	Graceful Sedge		X
Carex hirtifolia	Hairy Sedge		X
Carex pensylvanica	Penn Sedge		X
Elymus canadensis	Nodding Wild Rye		X
Elymus patula	Bottle Brush Grass		X
Elymus vilosus	Silky Wild Rye		X
Elymus virginicus	Virginia Wild Rye	X	
Koeleria cristata	June Grass		
Panicum virgatum	Switch Grass	X	X
Schizachyrium scoparium	Little Blue Stem	X	X
Sorgastrum nutans	Indian Grass	X	X
Forbs and Others			
Actaea pachypoda	White Banberry		X
Allium tricoccum	Wild Leek		X
Anemone cylindrica	Thimbleweed		
Anemone quinquefolia	Woodland Anemone		X
Aquilegia canadensis	American Columbine	X	
Asclepias tuberosa	Butterfly Weed	X	X
Aster azureus	Sky Blue Aster	X	X
Aster laevis	Smooth Blue Star	X	X
Aster nova-angliae 'Purple Dome'	Purple Dome New England Aster	X	
Aster novae-angliae	New England Aster	X	
Bouteloua curtipendula	Side-Oats Grama	X	
Caulophyllum thalictroides	Blue Cohosh		X
Chasmanthium latifolium	Northern Sea Oats		
Chelone glabra	Turtlehead	X	
Claytonia virginica	Spring Beauty		X
Coreopsis tripteris	Tall Coreopsis		
Dalea purpurea	Purple Prairie Clover		X
Desmodium illinoense	Illinois Tick Trefoil	X	X
Echinacea purpurea cultivars	Purple Coneflower	X	
Erythronium albidum	White Trout Lily		X
Eupatorium maculatum	Spotted Joe Pye Weed	X	
Eutrochim purpureum	Purple Joe-Pye-Weed		X
Filipendula rubra	Queen of the Prairie		
Geranium maculatum	Wild Geranium		X
Helenium autumnale	Common Sneezeweed	X	
Hydrophyllum virginianum	Virginia Waterleaf		X
Lespedeza capitata	Round-Headed Bush Clover		X

Scientific Name	Common Name	Location	
		P	GTW
Liatris aspera	Rough Blazing Star	X	X
Liatris spicata	Blazing Star	X	
Monarda fistulosa	Wild Bergamot	X	X
Monarda punctata	Horse Mint		
Oxmorhiza claytonii	Sweet Cicely		X
Phlox divaricata	Wild Blue Phlox		X
Podophyllum peltatum	May Apple		X
Prenanthes alba	White Rattlesnake Root		X
Pycanthemum virginianum	Common Mountain Mint	X	
Ratibida pinnata	Yellow Coneflower	X	X
Rudbeckia hirta	Black Eyed Susan	X	X
Sanguinaria canadensis	Bloodroot		X
Silphium integrifolium	Rosin Weed	X	X
Silphium laciniatum	Compass Plant	X	X
Silphium terebinthinaceum	Prairie Dock	X	X
Smilicina racemos	False Solomon Seal		X
Solidago flexicaulis	Zig Zag Goldenrod		X
Solidago nemoralis	Old-Field Goldenrod	X	
Solidago rigida	Stiff Goldenrod	X	X
Solidago speciosa	Showy Goldenrod	X	X
Sporobolus heterolepsis	Prairie Dropseed	X	
Thalictrum dioicum	Early Meadow Rue		X
Tradescantia ohioensis	Spiderwort	X	X
Uvularia grandifolia	Large Belwort		X
Verbena hastata	Blue Vervain	X	
Veronia fasciculata	Common Ironweed	X	

Vines			
Amphicarpa bractaeta	Hog Peanut		X
Celastrus scandens	Bittersweet		
Parthenocissus quinquefolia	Virginia Creeper		

Groundcovers			
Asarum canadensis	Wild Ginger	X	

P: Preferred

GTW: Used in the Grand Trunk Wetland Restoration Plan

Riparian / Riverbank

Scientific Name	Common Name	Location	
		P	GTW
Trees			
Betula nigra	River Birch		
Gymnocladus dioicus	Kentucky Coffeetree	X	
Nyssa sylvatica	Blackgum		
Platanus occidentalis	Sycamore		X
Quercus bicolor	Swamp White Oak	X	
Ornamental Trees			
Amelanchier laevis	Allegheny serviceberry		
Amelanchier canadensis	Shadblow Serviceberry	X	
Shrubs			
Amelanchier arborea	Juneberry		
Amorpha fruticosa	False Indigo		
Aronia melanocarpa	Black Chokeberry		
Ceanothus americanus	New Jersey Tea		
Cephalanthus occidentalis	Common Buttonbush		X
Cornus racemosa	Gray Dogwood		
Cornus sericea cultivars	Redtwig Dogwood	X	
Hypericum kalmianum	St. John's wort	X	
Ilex verticillata varieties	Common Winterberry		
Potentilla friuticosa	Potentilla	X	
Rhus glabra	Smooth Sumac		
Rhus typhinia	Staghorn Sumac	X	
Sambucus canadensis	Elderberry		
Viburnum dentatum	Arrow-Wood Viburnum	X	
Viburnum lentago	Nannyberry	X	
Viburnum prunifolium	Blackhaw Viburnum	X	
Viburnum trilobum	American Cranberrybush	X	
Elymus canadensis	Canada Wild Rye	X	
Panicum virgatum	Switchgrass	X	
Spartina pectinata	Prairie Cord Grass		
Grasses, Sedges, and Rushes			
Carex muskingumensis	Palm Sedge		
Carex stipita	Fox Sedge	X	
Elymus canadensis	Nodding Wild Rye		X
Elymus virginicus	Virginia Wild Rye	X	
Panicum virgatum	Switch Grass	X	X
Forbs and Others			
Allium cernuum	Nodding Wild Onion	X	
Amorpha canescens	Lead Plant		X

Scientific Name	Common Name	Location	
		P	GTW
Aquilegia canadensis	American Columbine		
Asclepias incarnata	Swamp Milkweed	X	
Asclepias syriaca	Common Milkweed		X
Asclepias tuberosa	Butterfly Milkweed	X	X
Aster azureus	Heath Aster		X
Aster laevis	Smooth Blue Aster	X	X
Aster lanceolatus	Panicled Aster	X	
Aster nova-angliae 'Purple Dome'	Purple Dome New England Aster	X	
Aster novae-angliae	New England Aster	X	
Baptista leucantha	Wild White Indigo		X
Bidens frondosa	Common Beggarsticks		
Chasmanthium latifolium	Northern Sea Oats		
Chelone glabra	Turtlehead	X	
Dalea purpurea	Purple Prairie Clover		X
Desmodium canadense	Canada Tick Trefoil		X
Dodecatheon meadia	Shooting Star		X
Echinacea pallida	Pale Purple Coneflower		X
Echinacea purpurea cultivars	Purple Coneflower	X	
Eryngium maculatum	Rattlesnake Master		X
Eupatorium maculatum	Spotted Joe Pye Weed	X	
Euthamia graminfolia	Grass Leaf Goldenrod		X
Filipendula rubra	Queen of the Prairie		
Gaura biennis	Biennial gaura		X
Glyceria striata	Fowl Mana Grass	X	
Helenium autumnale	Common Sneezeweed	X	
Helianthus helianthoides	False Sunflower		X
Helianthus lateriflorus	Showy Sunflower		X
Helianthus occidentalis	Western Sunflower		X
Juncus effusus	Common Rush		
Lespedeza capitata	Prairie Bush Clover		X
Liatris aspera	Rough Blazing Star	X	X
Ratibida pinnata	Yellow Coneflower	X	X
Rudbeckia hirta	Black-eyed Susan	X	X

P: Preferred

GTW: Used in the Grand Trunk Wetland Restoration Plan

Emergent			
Scientific Name	Common Namev	Location	
		P	GTW
Shrubs			
Cephalanthus occidentalis	Common Buttonbush		
Salix discolor	Pussy Willow		X
Grasses, Sedges, and Rushes			
Carex comosa	Bristly Sedge	X	
Carex frankii	Frank's Sedge		
Carex lacustris	Common Lake Sedge	X	X
Carex lurida	Bottlebrush Sedge	X	
Carex stricta	Common Tussock Sedge	X	
Carex trichocarpa	Harry Fruited Sedge	X	
Carex vulpinoidea	Brown Fox Sedge	X	
Glyceria striata	Fowl Manna Grass	X	
Juncus effusus	Common Rush		
Scirpus acutus	Hard-Stemmed Bulrush		
Scirpus atrovirens	Dark Green Rush		
Scirpus fluviatilis	River Bulrush	X	
Spartina pectinata	Prairie Cord Grass	X	
Sparganium eurycarpum	Great Bur Reed	X	
Forbs and Others			
Acorus calamus	Sweet Flag	X	
Alisma plantago-aquatica	Water Plantain		X
Alisma subcordatum	Common Water Plantain		
Asclepias incarnata	Marsh Milkweed		X
Eleocharis acicularis	Creeping Spike Rush	X	
Eleocharis obtusa	Blunt Spike Rush		
Glyceria striata	Fowl Mana Grass	X	
Iris virginica shrevei	Blue Flag Iris	X	X
Juncus effusus	Common Rush		X
Leersia oryzoides	Rice Cut Grass	X	X
Lobelia cardinalis	Cardinal Flower	X	
Lobelia siphilitica	Great Blue Lobelia	X	
Mimulus ringens	Monkey Flower		
Pontederia cordata	Pickerel Weed		
Sagittaria latifolia	Common Arrowhead	X	X
Scripus cyperinus	Woolgrass		X
Scripus fluviatilis	River Bulrush		X
Scripus validus	Soft Stem Bulrush		X
Sparganium americanum	American Bur-reed		X
Sparganium eurycarpum	Giant Bur-reed		X

P: Preferred

GTW: Used in the Grand Trunk Wetland Restoration Plan

Submergent			
Scientific Name	Common Namev	Location	
		P	GTW
Grasses, Sedges, and Rushes			
Calamagrostis canadensis	Canada Blue Joint Grass		X
Carex bebbii	Bebb's Sedge		X
Carex lurida	Bottlebrush Sedge		X
Carex intumenscens	Greater Bladder Sedge		X
Carex lupulina	Hop Sedge		X
Carex scoparia	Pointed Broom Sedge		X
Carex stipata	Awl Fruited Sedge		X
Carex vulpinoidea	Brown Fox Sedge		X
Elymus virginicus	Virginia Wild Rye		X
Panicum virgatum	Switchgrass		X
Scirpus atrovirens	Dark Green Rush		X
Scripus cyperinus	Woolgrass		X
Spartina pectinata	Prairie Cord Grass		X
Forbs and Others			
Asclepias incarnata	Marsh Milkweed		X
Eupatorium perfoliatum	Boneset		X
Euthamia graminifolia	Grass Leaf Goldenrod		X
Eutrochium maculatum	Joe Pye-weed		X
Iris virginica shrevei	Blue Flag Iris	X	X
Lobelia cardinalis	Cardinal Flower	X	X
Lobelia siphilitica	Great Blue Lobelia	X	X
Mimulus ringens	Monkey Flower		X
Potamogeton natans	Common Pondweed		
Potamogeton nodosus	Long-leaved Pondweed		
Solidago riddellii	Reddell's Goldenrod		X
Symphyotrichum lanceolatum	Panical Aster		X
Symphyotrichum novae-angliae	New England Aster		X
Symphyotrichum puniceum	Swamp Aster		X
Vallisneria americana	Eel Grass		
Verbena hastata	Bler Vervain		X
Floating Aquatics			
Nelumbo lutea	American Lotus		X
Nuphar advena	Yellow Water Lily		
Nymphaea ordata	American White Water Lily		X

APPENDIX J

OPEN SPACE AND RECREATION

WATER-BASED RECREATION

Broadly, water-based recreation is split into two categories: water-dependent and water-enhanced activities.

Harbor District Riverwalk will undoubtedly play host to both sets of activities, often simultaneously and throughout the year.

- Water-dependent activities are those in which water is essential to conducting the activity (i.e. fishing, boating, kayaking, canoeing, sailing, etc.).
- Water-enhanced activities are those in which water is not required in order to participate in the activity, but in which it greatly contributes to the recreationist's overall experience (i.e. biking and walking along bodies of water, viewing scenery, and studying nature, etc.).

To understand the best practices for water-dependent recreation in the Harbor District, it is appropriate to consider the Kinnickinnic waterfront in the project area as a public waterfront (or modified recreational marina). The foundation of a marina operation is built off the infrastructure and design of the marina basin and docking system. At the same time, the Harbor District can be considered a working waterfront. Working waterfronts provide critical access for water-dependent activities of an entirely different sort – those which are commercial in nature. In the Harbor District, these range from bulk freight shipping on Great Lakes freighters to small watercraft maintenance and storage, charter fishing, and the work of maintenance vessels such as barges and dredges. As land uses evolve, it might be expected that yet-unknown economic activities will arrive and further change the uses of the waterfront.

While structurally similar to a marina, working waterfronts nonetheless differs in the important aspect that there will be water-based uses whose space is used for industrial and commercial activity, and water-based user who use the space for recreational purposes, and there may be conflicts of use between the two. Reconciling these conflicts is necessary to the degree possible, and therefore, best practices for water-based recreation can be separated into three categories: infrastructure, accessibility, and safety.

Infrastructure. Best practices for infrastructure as they relate to water-based recreation concern vessel slip layout, aisle widths, freeboard height of dockage, vertical clearances necessary for vessels (air draught), as well as prescriptive guidance on engineering and design performance for future Riverwalk developers. Requirements related to dredging for underkeel clearance or channel width are omitted here, as control over this is the purview of state and federal authorities.

Vessel Slip Layout. Although developing a traditional marina in the Harbor District is not likely based on spatial constraints and conflicting vessel operations (i.e. commercial, recreational, etc.), marina design standards are also applicable to the development of small dockage areas for recreational vessels. Optimal dock layout and design balances appropriate slip mix with maximum use of suitable harbor space. Appropriate fairway widths between docks and other harbor structures optimize the use of space in the Kinnickinnic River, as other potential harbor amenities and existing uses (i.e. floating boardwalks, ecological improvements, commercial shipping, etc.) also require water area within the Kinnickinnic.

An example of existing dockage along the Milwaukee River is shown in below. Future dockage slips in the Harbor District will likely consist of a single row of finger piers (perpendicular to the bulkhead) near the water's edge (to minimize impacts on the navigable waterway, similar to that shown below). The spacing between finger piers (or slip width) is variable based on vessel size. Slip width is determined according to the formula that:

+ Double slips = 2 x beam of the widest vessels served + clearance for obstructions, fendering, etc.; and
+ Single slip = the beam of the widest vessel served + clearance for environment conditions, fendering, etc.

Areas where implementing in-water improvements (further into the waterway) may find it feasible to utilize additional piers to increase dockage capacity. For this scenario, an aisle (or fairway) is the unobstructed waterway between berthing areas (as defined by the end of the boat or finger pier, whichever has the smaller clearance) serving as the interior harbor boat circulation system. Minimum clear aisle widths between ends of finger piers are established as 1.5x to 1.75x the longest boat served, as detailed in Figure 46. Typical Boat Slip Arrangement on page A32

In addition, Figure 45. Marina Planning Ratios (ASCE 50) on page A32 includes relevant density guidance for structuring vessel slip layouts based on type, and Figure 47. Typical Schedule for Boat Slip Dimensions (ASCE 50) on page A33 includes schedules for slip length versus berth width, truncated from the Planning and Design Guidelines for Small Craft Harbors, 3rd Edition (ASCE 50) with respect to slip lengths given the limitations on vessel berth lengths (i.e. ~60' maximum length for recreational vessel) in the Kinnickinnic.

***Existing Dockage along Milwaukee River**, Milwaukee*

Figure 46. Typical Boat Slip Arrangement

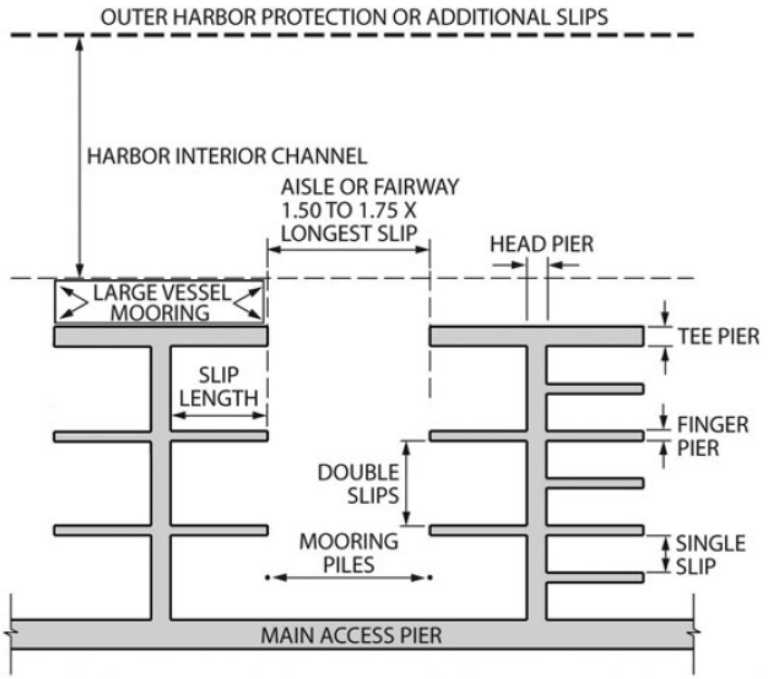


Figure 45. Marina Planning Ratios (ASCE 50)

Item	Density	Assumptions
Wet Slip (in water)	15-25 boats/acre	Includes entrances, aisles, turning areas, and maneuvering 35-40 ft average boat length
Dry Stack (on land)	80-100 boats/acre	Includes buildings, maneuvering, and parking
Auto-Trailer Parking (on land)	25-30 auto trailers/acre	Includes parking, maneuvering, and relevant landscaping
Auto-only Parking (on land)	80-100 autos/acre	Includes parking, aisles, and relevant landscaping
Winter Storage (on land)	55-65 boats/acre	Includes storage, aisles, and maneuvering 35-40 ft average boat length

Figure 47. Typical Schedule for Boat Slip Dimensions (ASCE 50)

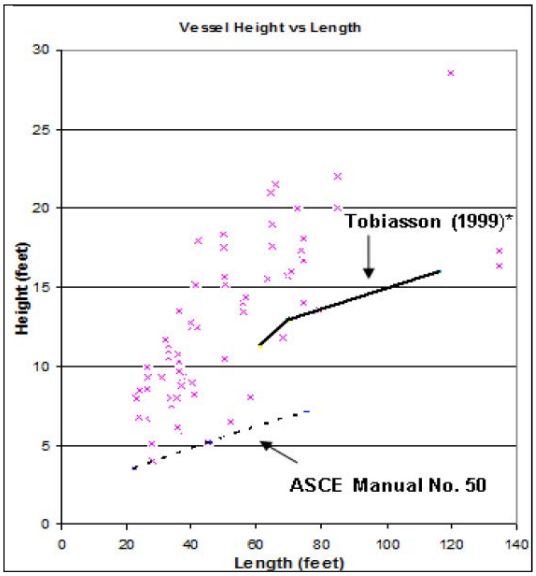
Slip Length (ft)	Finger Pier Width (ft)	Single Slip Clear Width (ft)	Double Slip Clear Width (ft)
30	3 to 4	14	29
35	4	16	32
40	4 to 5	18	35
45	4 to 5	19	39
50	5 to 6	20	41
55	5 to 6	22	43
60	5 to 6	23	45

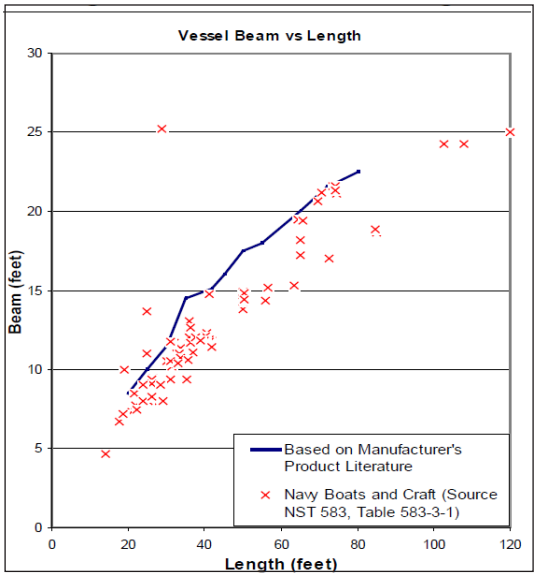
Vertical Clearances. Small craft recreational vessels include both motorized and non-motorized vessels (i.e. canoe, kayak, etc.) Figure 48. Left Image, Vessel Height vs Length; Right Image, Vessel Beam vs Length (UFC, 2009) on page A34, extracted from the U.S. Department of Defense Manual (Unified Facilities Criteria, Design: Small Craft Berthing Facilities)) displays typical height above the water line, referred to as air draught, in relation to vessel length as well as length/beam (UFC, 2009).

Figure 48 shows that the air draught for 40 ft to 50 ft long vessels (not including sail boats) range from approximately 5 ft (ASCE 50) to 10 ft (Tobiasson). Any Riverwalk construction impeding on the air space above the navigable channel of the Kinnickinnic should consider these vessel clearances.

Prescriptive Guidance for Future Development. In order to confirm the development suitability of a waterfront site, it is customary to perform a series of site investigations and analyses prior to undertaking detailed planning and design activities. All available information on the site, including property information, environmental regulatory review, local wind and wave data, topographic, bathymetric and other natural features mapping, utilities, streets and other built improvements, and subsurface conditions should be collected and organized. More detailed studies may be required during development, including environmental/geotechnical investigations, infrastructure capacity study, wind, wave, and water level analyses, and a search for appropriate materials of construction and cost analysis.

Figure 48. Left Image, Vessel Height vs Length; Right Image, Vessel Beam vs Length (UFC, 2009)





Accessible Routes. The primary source for guidance on accessibility comes from the Americans with Disabilities Act – Sections 235 and 1003, which pertain to Recreational Boating Facilities, supplemented with others generally. Sections 206.2.10 and 1003.2 of the 2010 Standards require an accessible route to all boating facilities, including boat slips and boarding piers at boat launch ramps. Section 1003.2.1 provides a list of exceptions – restated below - applicable to structures such as gangways, transition plates, floating piers, and structures containing combinations of these elements that are affected by water level changes. Because of water level fluctuations, it may be difficult to provide accessible routes to all accessible boating facilities, including boat slips and boarding piers at boat launch ramps.

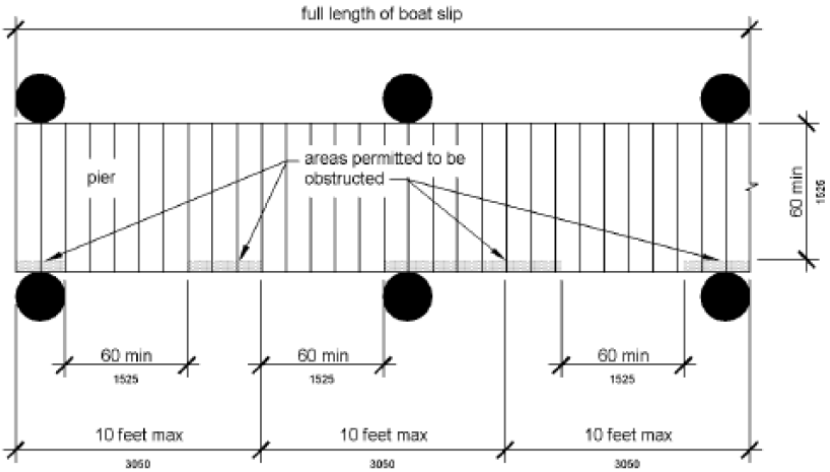
Figure 49. Accessible Boat Slip Requirements

Total Number of Boat Slips Provided in Facility	Minimum # of Required Accessible Boat Slips
1 to 25	1
26 to 50	2
51 to 100	3

The exceptions for accessible routes contained in section 1003.2 of the 2010 Standards modify the requirements of Chapter 4 of the ADA, and state:

1. Where an existing gangway or series of gangways is replaced or altered, an increase in the length of the gangway shall not be required to comply with 1003.2 unless required by 202.4 (Alterations Affecting Primary Function Areas).
2. Gangways shall not be required to comply with the maximum rise of 30 inches specified in 405.6.
3. Where the total length of a gangway or series of gangways serving as part of a required accessible route is 80 feet minimum, gangways shall not be required to comply with the provision of ramps with the least possible running slope, accompanied by stairs where possible, as specified in 405.2.
4. Where facilities contain fewer than 25 boat slips and the total length of the gangway or series of gangways serving as part of a required accessible route is 30 feet minimum, gangways shall not be required to comply with 405.2.
5. Where gangways connect to transition plates, landings specified by 405.7 shall not be required.
6. Where gangways and transition plates connect and are required to have handrails, handrail extensions shall not be required. Where handrail extensions are provided on gangways or transition plates, the handrail extensions shall not be required to be parallel with the ground or floor surface.
7. The cross slope specified in 403.3 and 405.3 for gangways, transition plates, and floating piers that are part of accessible routes shall be measured in the static position.
8. Changes in level complying with 303.3 and 303.4 shall be permitted on the surfaces of gangways and boat launch ramps.

Figure 50. Boat Slip Clearance

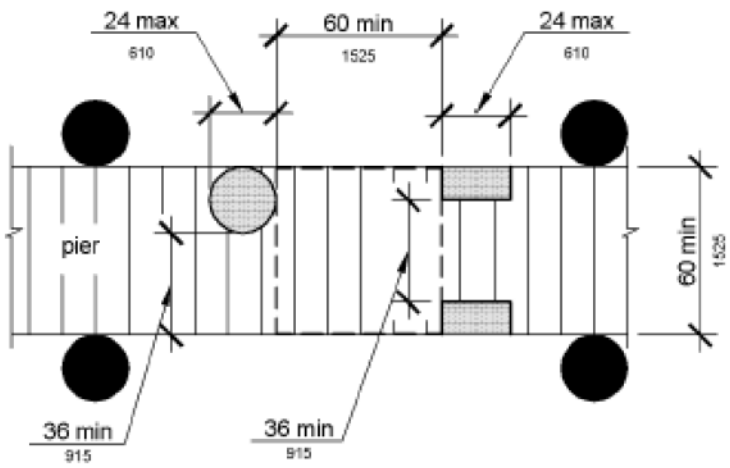


Boat Slips. Boat slips complying with 1003.3.1 shall provide accessible boat slips at a ratio in accordance with Figure 49. Accessible Boat Slip Requirements on page A35, which is truncated from the full list based on the size of facilities present in the Harbor District. Where the number of boat slips is not identified (i.e. continuous side-tie floating pier or vertical edge), each 40 feet of boat slip edge provided along the perimeter of the pier shall be counted as one boat slip for the purpose of this requirement. Accessible boat slips must be dispersed among various types (lengths) of slips provided.

For vessel access, boat slips shall provide an unobstructed, clear space (minimum of 60 inches in length) between dock obstructions (i.e. pilings, railings, etc.) every 10 feet along the slip edge (at a minimum), as shown in Figure 50. Boat Slip Clearance on page A36. Slips shall be a minimum of 60 inches wide; however, reduced widths shall be permitted to be 36 inches wide (minimum) for a length of 24 inches (maximum), provided that multiple 36 inch wide segments are separated by segments that are 60 inches wide by 60 inches long (minimum), as shown in Figure 51. Clear Pier Space Reduction at Boat Slips (ADA) on page A37. If desired, edge protection shall be permitted at the continuous clear openings, provided that it is 4 inches high (maximum) and 2 inches wide (maximum).

Boarding Piers. Where boarding piers are provided at boat launch ramps, at least 5% of boarding piers (or at least one boarding pier) must be 60 inches wide (minimum) for entire length of boarding pier and be served by an ADA compliant accessible route. Where accessible route serving floating boarding pier or skid pier is located within boat launch ramp, portion of accessible route within boat launch ramp are not required to comply with ramp provisions. Accessible routes serving floating boarding piers are permitted to use gangways exceptions for alterations, maximum rise, landings, handrail extensions, cross slope, and platform lifts. Maximum 1V:12H slope does not apply where total length of gangways serving as part of an accessible route is at least 30 feet.

Figure 51. Clear Pier Space Reduction at Boat Slips (ADA)



Gangways. Articulated gangways are the most widely used method of access from land or fixed piers to floating structures. Minimum gangway requirements generally include:

- Widths of 36 inches clear, 48 inches preferred.
- Widths of 72 inches for high-traffic areas and where cart access to the floating structures occurs.
- Accessible gangways, where required per ADA, shall have a maximum slope of 1V:12H. However, gangway (or series of gangways) does not have to be longer than 80 feet. Similarly, if the gangway is servicing fewer than 25 slips, the maximum gangway length is 30 feet.
- Upper/guard rail heights of 42-45 inches above the deck.
- Handrail height of 34-36 inches above the deck.
- Maximum slope of 1V:3H at design low water level.
- Walking surface to be nonskid when wet.

Gangways are typically hinged at the landside connection and include rollers or skids on the floating structure end. The design of the gangway should consider existing shoreline structures and grades, and the freeboard of the floating structures, and the gangway geometry should be such that the gangway remains operations at extreme water levels (both high and low).

Figure 52. Summary of Recommended Safety Amenities

Type of Safety Amenity	Active/Passive	Recommendation for Inclusion in Development
Signage for Usage Conflict	Passive	High
Operation Barriers for Usage Conflict Zones	Active	Necessary (Where installation does not negatively impact economic uses of waterfront; High recommendation otherwise)
Life Rings (Throw Buoys)	Active	High (90 foot maximum spacing, per USCG)
Emergency Access Ladders (along bulkhead, fixed piers, and floating docks)	Active	High (400 foot maximum spacing, per UFC)
Overhead and Edge Lighting	Passive	Necessary
High Visibility Striping/Signage	Passive	Moderate

Safety. Broadly speaking, it can be understood that safety concerns for the water-based recreation along the Riverwalk will occur either between individual users and infrastructure, or between different users. Because the scale and form of the future Riverwalk development is not known, safety amenities to mitigate these risks of conflict are summarized generally in Figure 52. Summary of Recommended Safety Amenities on page A38.

APPENDIX K

COMMUNITY ENGAGEMENT OVERVIEW

STAKEHOLDER FEEDBACK

The targeted stakeholder groups, which included local business and property owners, developers, City of Milwaukee staff, Milwaukee County Parks employees, and representatives from MMSD (Milwaukee Metropolitan Sewerage District), recognized the following key items:

+ The current Komatsu development will help to set the tone for the future Riverwalk expansion. It is critical that this piece establish the expectations for aesthetics, public access, and habitat creation.
+ Some river dependent uses are not compatible with public access at all while others see the need for times where access may be restricted. It is important to allow businesses to continue to operate safely. In the case where public access could not occur, alternate paths which re-route the public from the water front, to connect again on the other side, will be explored.
+ The existing Milwaukee County Boat Launch is not ideal as the ramp is steep and rough waves enter the Harbor from Lake Michigan right at this point. Parking is inefficient.
+ Pedestrian crossings of railroad lines and City streets should be carefully considered.
+ Links to existing and future bike paths should be included in the design.

HABITAT FEEDBACK

Representatives from the DNR and the UWM School of Freshwater Sciences discussed overall Inner Harbor and Milwaukee and Kinnickinnic River water quality, and the potentials for creating habitats within the District. The following key points were made:

+ Large gaps cannot exist between habitat sites. Habitats should be distributed throughout the Inner Harbor to allow species to move between the Rivers and the Lake.
+ Habitats can vary in size and materials. By applying a range of techniques and scales, Inner Harbor business and recreational activities could continue while also allowing for an increase in plant and animal populations.
+ Aquatic habitats may include lunkers, habitat hotels attached to dock walls, fish curtains, and floating vegetation mats.
+ Upland habitats may include wildlife-attracting vegetation, and boxes and nests along the Riverwalk.

PUBLIC FEEDBACK

Public engagement sessions were held on 2 occasions to engage on conversation about the design and aesthetics of the Harbor District Riverwalk system. The public largely favored furniture and signage with an obvious industrial look. These were the key takeaways:

+ Furniture should look industrial in character. Large wood pieces mixed with metals were favored, as the wood helps to soften or warm the metal materials.
+ People favored larger signage with an easily identifiable brand at entry points to the Riverwalk.
+ Directional signage that is easy to read is very important. While some commented that color is easy to read, many felt that simplicity in materials that would age well was appropriate.
+ Including mile markers along the Riverwalk routes along with occasional full-system maps was a popular idea. People stated that they would like to see the entire system and also indicators of where they are along the route.
+ Most people favored asphalt and decomposed aggregate as the primary trail materials. Permeable paving and distinct paving patterns at key places along the Riverwalk were noted as important.

APPENDIX L
STORMWATER DETAILS

The list below identifies the types of green infrastructure that could be best suited for each zone – the River Walk, Future Development Properties, and the Roadways.

River Walk

+ Greenways/Vegetated Buffers (see landscaping standards)
+ Stormwater Trees
+ Bioswales (along higher elevation and/or urbanized areas)

Future Development Properties

Areas of Low Topography

+ Constructed Wetlands
+ Rain Gardens
+ Stormwater Trees
+ Native Landscaping

Existing Drainage Ditches

+ Bioswales
+ Constructed Wetlands

Existing Property Features (Buildings/Pavement)

+ Removal of Structures and/or Paving and replacement with amended soil and native landscaping
+ Retrofit with Pervious Pavement/Pavers
+ Bioswale buffers at edge of parking lots

Future Development Properties (cont.)

+ *Retrofit to Green/Blue Roofs*
+ *Enhance Existing Stormwater BMPs with Native Plantings*
+ *Disconnect Downspouts from Sewer System into green infrastructure*
+ *Redirect Downspouts into green infrastructure*
+ *Addition of water quality planters like StormGUARDen™ at downspouts*

New Property Features (Buildings/Pavement)

+ *Green/Blue Roofs*
+ *Pervious Pavers or Pavement*
+ *Bioswales*
+ *Stormwater Trees*
+ *Underground/aboveground storage (i.e. rainwater cistern)*
+ *Soil Amendments for any landscaped area*

Adjacent Roads

+ *Bioswales*
+ *Pavers (best suited in parking lanes, bike lanes, or pedestrian walkways)*
+ *Stormwater Trees*

DESIGN STANDARDS

Stormwater runoff from the walkway surfaces should be managed through vegetated buffers, bioswales, or stormwater trees as a means quality control before it reaches the surface water. Future developments within the Harbor District shall conform to the local regulations and implement stormwater BMPs appropriately, prioritizing the use of green infrastructure. Future development properties may have low topography, drainage ditches, buildings, or parking lots where stormwater BMPs could be implemented or existing stormwater features that could be improved to enhance water quality and urban riparian and aquatic habitat. Stormwater runoff from the roads within and adjacent to the Harbor District could be reconstructed to include bioswales, pavers, or stormwater trees within the right of ways, medians, or bike, parking or pedestrian paths.

Figure 53. Green Infrastructure

	Greenway/Vegetated Buffer	*Bioswales*	*Wetlands*	*Rain Gardens*	*Native Landscape*	*Removal of Structures/Paving*	*Pervious Pavements/Pavers*	*Green/Blue Roofs*	*Disconnect /Redirect Downspouts*	*Underground/Aboveground Storage*
Riverwalk Overlay Zone										
Riverwalk Zone	X	X								
Future Development Properties										
Areas of Low Topography			X	X	X					
Existing Drainage Ditches		X	X							
Existing Property Features						X	X	X	X	X
New Property Features		X					X	X		X
Roadways										
Adjacent Roadways		X					X			

DESIGN CRITERIA

Technical design guidelines have been developed by the WDNR, MMSD, and UW Extension for designers and developers for various Green Infrastructure stormwater management practices. Prior to designing and implementing GI at a site, designers should review the Wisconsin Department of Natural Resources (WDNR) Conservation Practice Standards (CPS) section titled "Site Evaluation for Stormwater Infiltration (Section 1002)" for additional details related to green infrastructure strategy siting considerations. For various GI practices, below is a list of guidance documents for design reference:

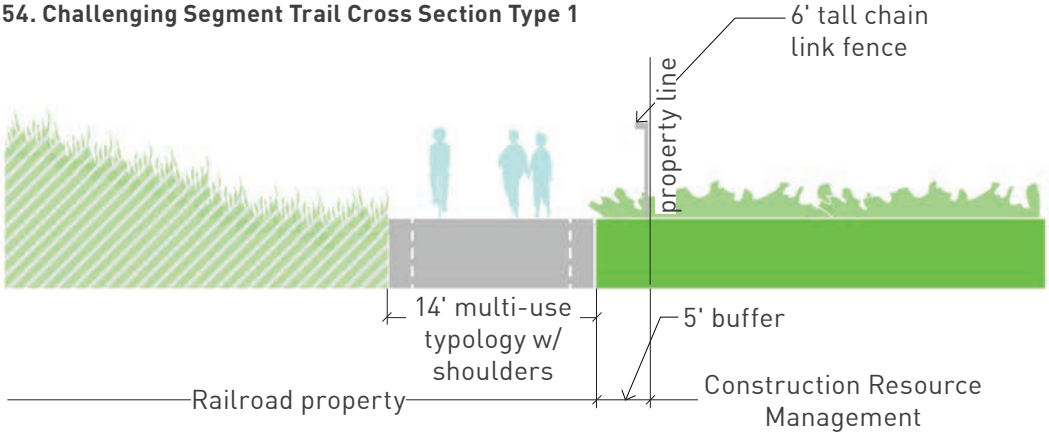
+ Wisconsin Department of Natural Resources Storm Water Post-Construction Technical Standards
+ The Wisconsin Storm Water Manual (G3691-5)
+ Milwaukee Metropolitan Sewerage District Green Infrastructure Standard Specifications and Plan Templates Report: Section 5.3Wisconsin Department of Natural Resources Storm Water Post-Construction Technical Standards: Bioretention for Infiltration (1004) https://dnr.wi.gov/topic/stormwater/documents/1004Bioretention.pdf
+ Milwaukee Metropolitan Sewerage District Green Infrastructure Standard Specifications and Plan Templates Report: Section 2.3

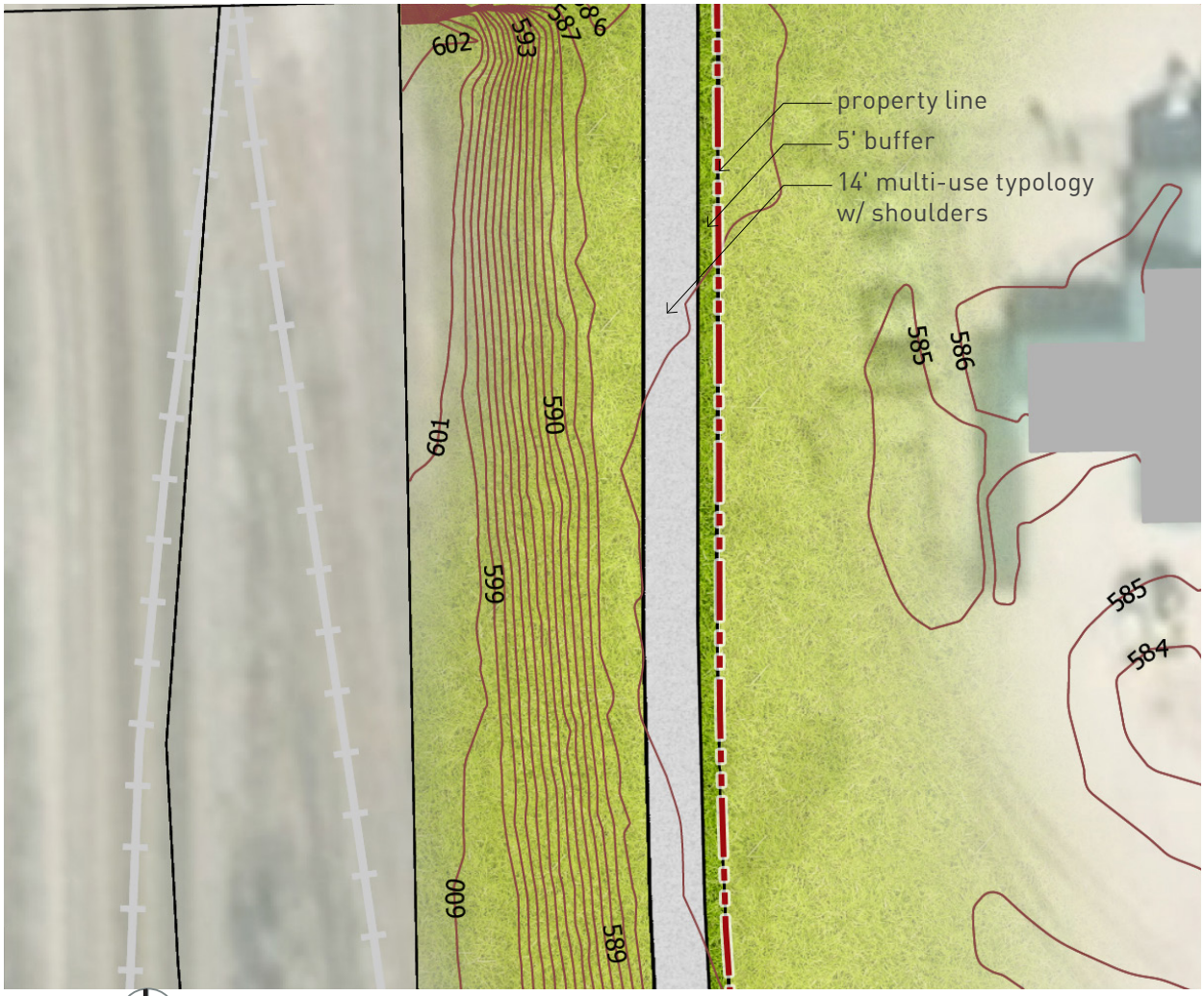
Wisconsin Department of Natural Resources "Rain Garden: How to for Homeowners" manual for additional design considerations.

APPENDIX M

CHALLENGING SEGMENTS CONCEPTS

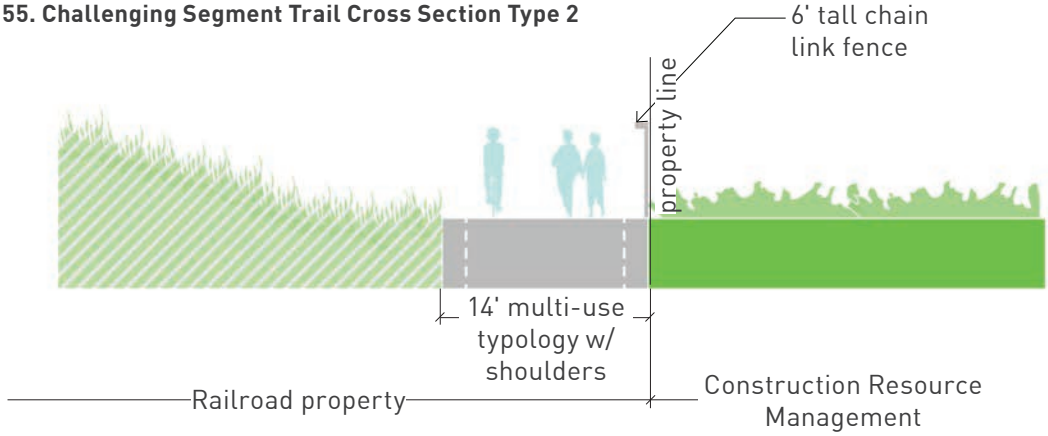
Figure 54. Challenging Segment Trail Cross Section Type 1

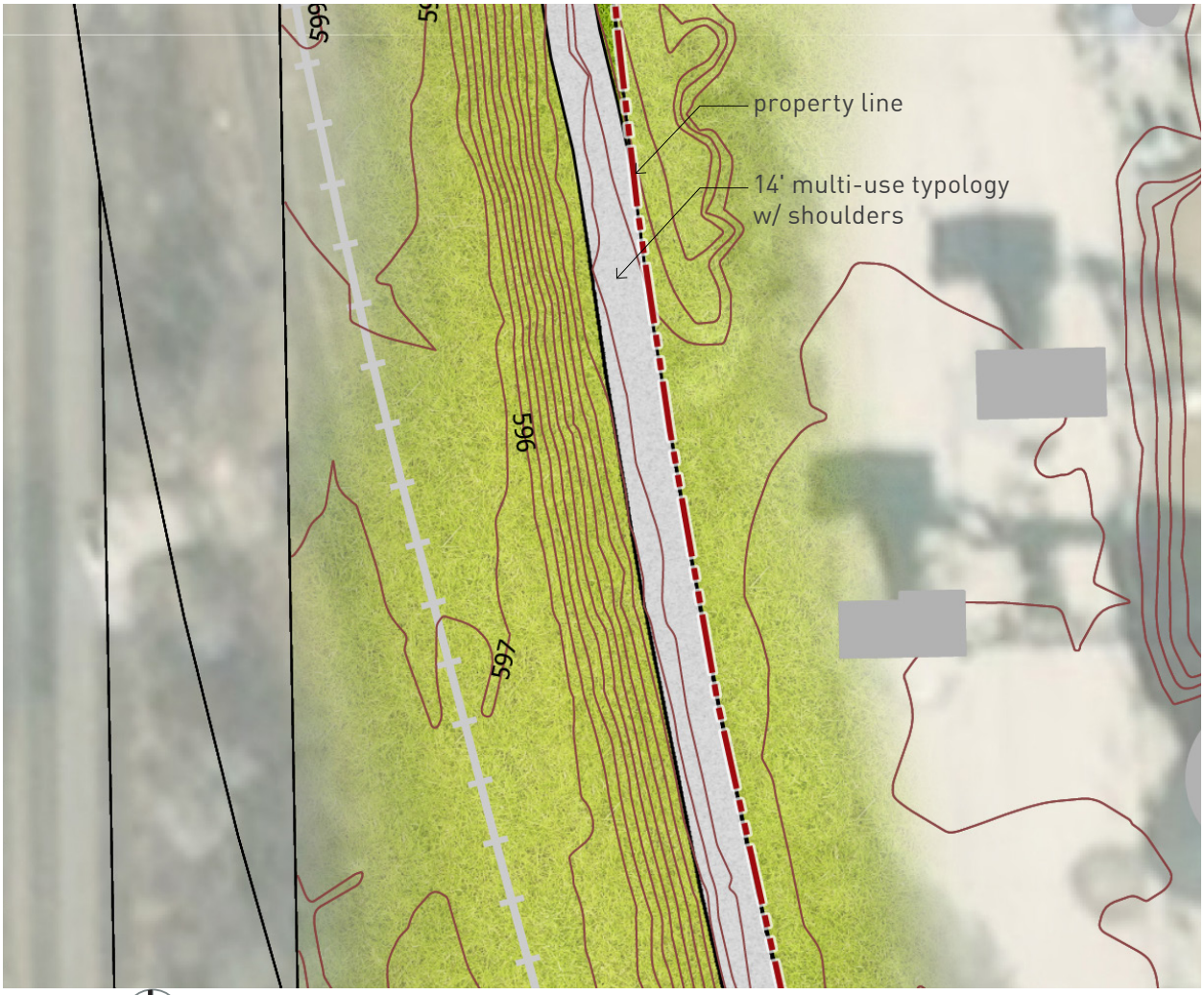




Scale 1" = 60'

Figure 55. Challenging Segment Trail Cross Section Type 2





Scale 1" = 60'

Figure 56. Challenging Segment Boardwalk Concept

Figure 57. Challenging Segment 1

Scale 1" = 100'

Figure 58. Challenging Segment 2

Placemaking
Kinnickinnic River
Habitat Opportunity
Shoreline Armoring
Identity Signage
Enhanced Crosswalk
Parking
Enhanced Crosswalk
Identity and
Wayfinding Signage
Ramp
Space
Alternative Route

APPENDIX N

PUBLIC ACCESS POINTS CONCEPTS

Figure 59. Bruce Street Boat Launch

Figure 60. MMSD (Becher & 4th)

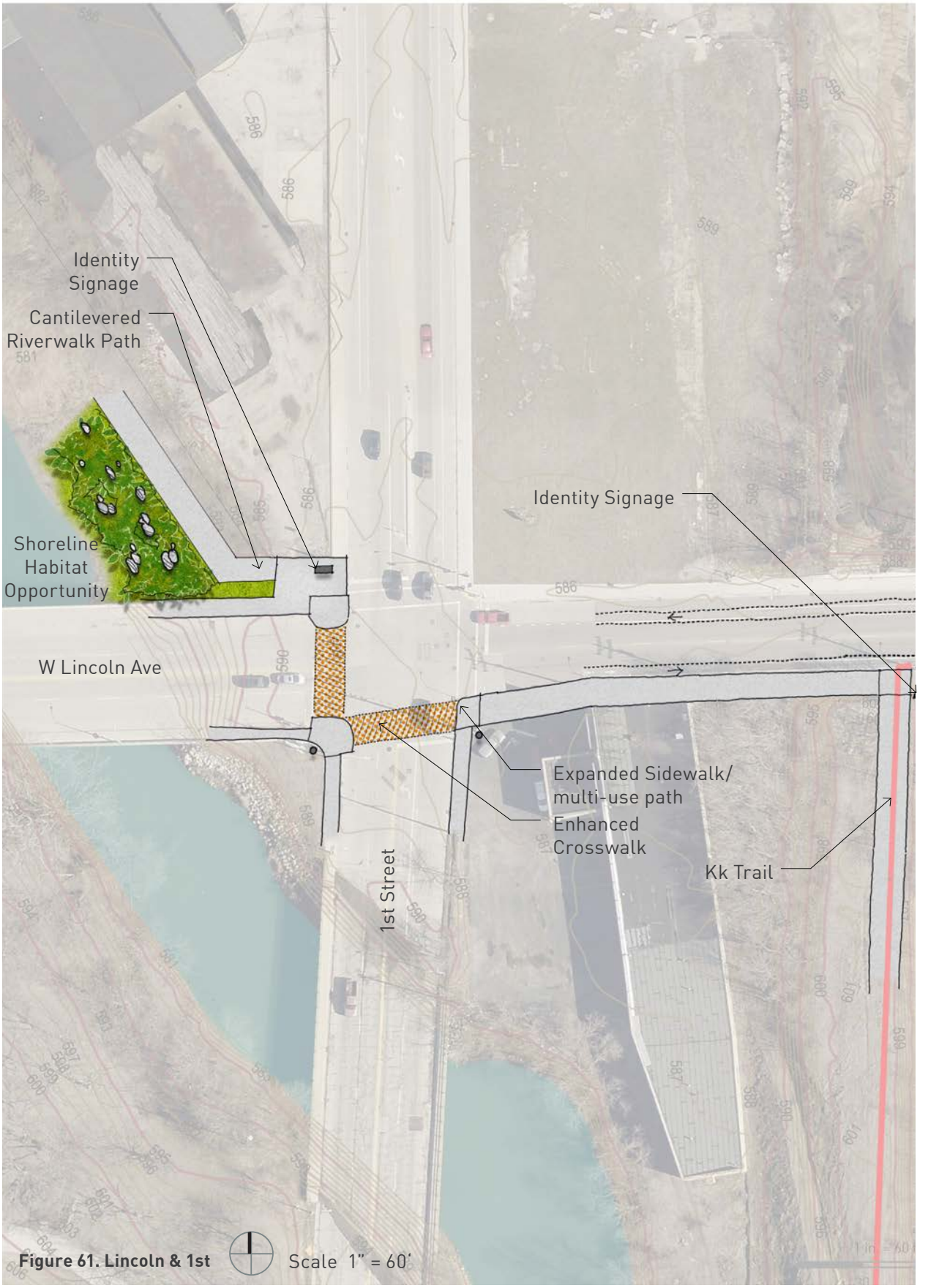


Figure 61. Lincoln & 1st

APPENDIX O
SOURCES

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MMSD GI Standard Specifications Plan Templates Report: https://www.freshcoastguardians.com/application/files/9715/0411/5614/MMSD_GI_Specs_and_Plan_Template_Report.FINAL.012717.pdf

Wisconsin Storm Water Manual: https://dnr.wi.gov/topic/stormwater/documents/StormwaterManual2-TechnicalDesign.pdf