RAMBØLL Bright ideas. Sustainable change.

CAPITAL ASSET RENEWAL PLAN 2070

PORT MILWAUKEE

AUGUST 2021

CONTENTS

Tables

Tables (Attached)

Figures

Maps (Attached)

Asset Renewal Plan Workbooks (Digital Files)

Appendices

A Coastal Management Framework

B Stakeholder Engagement Summary

1. INTRODUCTION

1.1 PURPOSE AND SCOPE OF PLAN

In 2020 Port Milwaukee began the process of establishing a Capital Asset Renewal Plan (CARP) to comprehensively address deficiencies in port facilities and infrastructure and establish a maintenance and replacement schedule. The CARP serves as a tool for Port Milwaukee to strategically plan significant improvements to port facilities and develop funding strategies for long-term asset repair and replacement.

This plan is developed to provide a high level, long-term action plan for asset renewal for a 50-year period and considers key factors influencing asset renewal planning at the port including the port's goals, stakeholder input, and long-term trends in coastal conditions and infrastructure resiliency to those conditions. The initial plan, developed in 2020/2021 timeframe, projects asset renewals through the year 2070. As part of a process of continuous improvement and update, the plan is intended to be updated at a regular interval and the planning period extended accordingly to maintain a 50-year planning horizon.

The scope of this CARP addresses port assets within the boundaries of its South Harbor Tract and North Harbor Tract (**Error! Reference source not found.** and Figure 2, respectively) including navigational areas within adjacent waterways.

Figure 1 - South Harbor Tract Boundary

Figure 2 - North Harbor Tract Boundary

Port infrastructure assets are organized into 10 primary categories. A description of the categories and types of assets included in the category is provided in Table 1.

Table 1 - Asset Category Description

Asset Category	Description
Buildings	The building asset category includes all terminals, warehouses, office buildings, and commercial structures owned by the port. Buildings in this asset category include both leased and non-leased structures. The category also includes some building structures associated with bare-ground lease arrangements whereby tenant has constructed and/or is responsible for their maintenance and renewal. Site features such as parking lots, walkways, and lighting associated with a particular building asset are included in this category.
Dockwalls	The dockwall asset category includes all port owned waterfront structures. These assets include steel sheet pile dockwalls as well as stone revetments, the liquid cargo pier, Russell Ave pier, and Pier Wisconsin.
Navigational Areas (Dredge Requirement)	The navigational area asset category consists of the maintained minimum water depths, or drafts, at the port's berths and channels. Drafts are maintained by the port through dredging. Depths within the federal harbor and channel maintained by US Army Corps of Engineers are not included in this category

Asset Category	Description
Fencing	The fencing asset category includes fencing and gates on the South Harbor Tract along roadways and surrounding port parcels. Fencing is largely security-type galvanized chain link fencing with 2 and 3 strand barbed wire.
Green Infrastructure & Public Spaces	Port assets in the green infrastructure category primarily include storm water management facilities and public waterfront access spaces. Public spaces include North Urban Park and waterfront access along the dockwall between the CDF and Liquid Cargo Pier. Additionally, waterside public space is available at the Lake Express dockwall and on Russell Avenue Pier. Kaszube's Park is not included since it is maintained by the City of Milwaukee.
Lighting	Lighting assets include area lights over Port rail and paved areas such as the City Heavy Lift Dock. Lighting associated with building sites is captured in the building asset category. Streetlights are maintained by another department of the City of Milwaukee.
Pavement and Roads	The pavement and roads category includes Port service drives in the South Harbor Tract as well as concrete and asphalt pavement areas not associated with building assets, such as the City Heavy Lift Dock.
Rail	The Rail asset category includes leased and non-leased rail, switches, crossings, and other rail system appurtenances.
Utilities	The utilities category includes port-owned and maintained water distribution system, sanitary sewer system, and storm sewer system.
Vehicles, Vessels, Cranes, and Other Equipment	Assets include in this category generally include fleet vehicles, workboats, survey boat, cranes, and mobile safety equipment.

Port assets located in the North Harbor Tract consist of dockwalls, navigational areas, public space, lighting, and utilities largely associated with Pier Wisconsin. The port does not have any building, rail, pavement, or road assets in the North Harbor Tract. Operations on the North Harbor Tract are primarily associated with lease agreements for the entities such as Henry Maier Festival Grounds, Lakeshore State Park, Discovery World, and Harbor House restaurant.

1.2 CONTEXT OF THE PLAN

1.2.1 Audit of Port Milwaukee Capital Assets

In September 2020, the City of Milwaukee conducted an audit of Port Milwaukee capital assets which concluded that the "identified internal controls in place over Port capital assets are sufficient and in the growth stage". The audit also produced several recommendations for improvement of Port Milwaukee capital asset management. The CARP was developed to support the Port in implementing the recommendations. Specifically, the CARP will:

- Reconcile Port assets lists and streamline annual asset updates to the City Comptroller.
- Review the Port's existing capital assets, and include assessment of the asset conditions, and infrastructure renewal budget, a maintenance and useful life schedule, and a coastal resilience framework appendix.
- Inform the development of a standard operating procedure to create a formalized workflow for the perpetual acquisition, recording, tracking, monitoring, maintenance, securing, reviewing, disposition, and physical inventory of Port assets. This procedure will likely include a preventative maintenance schedule for capital assets, as well as a maintenance verification form.

1.2.2 Relation to Port Milwaukee's Asset Management System

Port Milwaukee is working toward development of a comprehensive asset management system for coordinating and controlling maintenance and replacement activities on its assets and aligning those activities with the Port's goals and objectives. At the time of initial development of this capital asset renewal plan, a comprehensive asset management

system has not been established. Therefore, the CARP has been developed as a standalone plan, in the context of the Port's asset management tools existing at the time of initial plan development. The Port's existing asset management tools are described further in Section 1.3.3 of the plan. This plan includes a process of regular review and update envisioning its integration as a component to an overall asset management system developed at a future date. The Port's current asset management processes are separate from City of Milwaukee asset management systems and procedures and may remain so in the future.

1.2.3 Port Mission and Asset Renewal Objectives

A key aspect of asset management is to align renewal planning with organizational goals and objectives. Specifically, it is the *balancing of costs, opportunities, and risks against the desired performance of assets, to achieve the organizational objectives* (ISO 55000:2014(E), 2.4.1). For the purpose of informing this CARP, Port Milwaukee's goals and objectives related to asset renewal are presented through its Mission statement as stated below. Further asset renewal objectives established by Port Milwaukee are provided as well.

Port Mission and Vision:

- Strengthen the overall economic and social environment of the City of Milwaukee and the region by increasing international trade, business development, job creation, and public access to the waterfront.
- Continue to be a premier provider of domestic and international transportation and freight distribution services for commercial customers.
- Sustain Milwaukee as a water-centric city, where businesses thrive in a robust, Port-led maritime economy and where everyone can work, live and play through access to water-based commerce, recreation, and leisure.

Asset Renewal Objectives:

1. Position the Port for future growth.
2. Maintain assets in a state of good repair.

1.2.4 Stakeholders

The Port has many stakeholders with interest in long term planning for maintenance and replacement of Port assets. It is recognized by Port Milwaukee that engagement of stakeholders in the process of developing the capital asset renewal plan is key to realizing value in implementing the plan. Therefore, initial development and of the CARP and subsequent updates are to include stakeholder input. Organizational (internal) stakeholders include the Board of Harbor Commissioners and City of Milwaukee government. External stakeholders specific to the Port generally include the following:

- tenants,
- customers,
- community organizations,
- adjacent property owners,
- public recreational users, and
- state and federal government.

Stakeholder input was obtained as part of the asset renewal plan development. Details regarding stakeholder engagement is described in Section 1.3.2.

1.3 METHODOLOGY & APPROACH

This capital asset renewal plan was developed to align with fundamentals of asset management and asset management system as described by the International Organization for Standards (ISO) in their standards 55000/55001 which describes a risk-based asset management approach where the balancing of costs, opportunity, and risks are factored into asset management decisions. However, this capital asset renewal plan does not encompass all aspects of asset management envisioned by ISO. The primary elements of the ISO asset management system are described in Table 2 and include description of related components incorporated into this plan.

Table 2 - Comparison of CARP to ISO 55001 Standard for Asset Management Systems

ISO 55001 Asset Management System Element	Brief Description of ISO Asset Management System (AMS) Element	Related Components Incorporated in the Capital Asset Renewal Plan
Context of the Organization	Organization determines external and internal issues that are relevant to its purpose and those that affect its ability to achieve the intended outcomes of its AMS. Organization understands the needs and expectations of its stakeholders.	➢ Identification and alignment with Port mission and asset renewal planning objectives. ➢ Stakeholder engagement in plan development. ➢ Alignment of plan with City of Milwaukee Asset Management processes.
Leadership	Top management demonstrates leadership and commitment to the AMS, establishes asset management policy, and ensures responsibilities and authorities for relevant roles are assigned.	➢ Commitment to CARP development by Port leadership.
Planning	Organization takes action to address risks and opportunities and plan for achieving asset management objectives.	➢ A comprehensive risk-based decision framework has not been established for all Port assets. However, a level of risk is factored into asset renewal for water side assets through establishment of the Coastal Resiliency Framework prepared as a companion to this plan.
Support	Organization determines and provides resources necessary for establishment, implementation, maintenance, and continual improvement of the AMS. Organization determines competencies necessary for implementation of the AMS, provides awareness training, and plans for internal and external communications. Organization identifies information requirements to support its AMS and includes documented information including asset inventory, plans, procedures, and legal and regulatory requirements.	➢ The Capital Asset Renewal Plan provides documentation of information related to asset inventories, condition, and renewal planning for individual assets.
Operation	Organization plans, implements, and controls the AMS including outsourced activities. Implement management of change processes as they relate to risks associated with the AMS.	➢ No specific alignment with CARP identified.
Performance Evaluation	Organization monitors, measures, analyzes, and evaluates performance of its AMS, conducts internal audits, and provide management review at planned intervals.	➢ No specific alignment with CARP identified.

ISO 55001 Asset Management System Element	Brief Description of ISO Asset Management System (AMS) Element	Related Components Incorporated in the Capital Asset Renewal Plan
Improvement	Organization identifies non-conformity related to its AMS and implement corrective actions. A process of identifying potential failures in asset performance and conducting preventative action is performed. Organization should continually improve the suitability, adequacy, and effectiveness of its asset management and the asset management system.	➢ A process of regular review and update has been established in the CARP.

1.3.1 Coastal Management Framework

A Coastal Management Framework has been developed as a companion to this Capital Asset Renewal Plan. The purpose of this Coastal Management Framework is to identify the current and projected coastal processes affecting Port Milwaukee assets and provide a framework for long term strategic asset renewal planning and mitigating risks to vulnerable waterfront assets. The Coastal Management Framework is provided as Appendix A.

1.3.2 Stakeholder Engagement

Stakeholders were engaged in the CARP planning process through hosting stakeholder information meetings. Meetings were structured to provide stakeholders with an overview of the plan and development process and provide an opportunity to submit feedback. Two meetings were scheduled and hosted virtually on February 18 & 19, 2021. A list of stakeholder participants is provided in Appendix B.

1.3.3 Alignment with Port Asset Management Process

This plan has been developed to align with the following asset management process and tools existing at time of plan development.

- ***Asset Database***: Asset inventories and data managed in the Port Asset Database (PAD) were used to build inventories for this plan. The asset ID/name were used where available for consistency. The PAD does not contain a comprehensive list of all Port assets included in this plan. For this asset renewal plan, assets included were named and categorized in similar fashion as found in the asset database. The asset database was not updated as part of the process in preparing this plan. A separate, future process will be necessary to update the asset database to reflect assets and asset attributes covered in this plan.
- ***Maintenance Plans***: Some Port assets such as vehicles, vessels, cranes, compressors, and building systems, receive required routine maintenance which is planned in the Port's asset management process. These existing routine maintenance activities have largely been captured in the CARP however their inclusion is not exhaustive.
- ***City of Milwaukee Facility Development & Management (FDM) Facilities Condition Assessment Program (FCAP)***: A facilities condition assessment and capital improvement planning process was started by FDM for Port assets in 2012. That process was incomplete at the time of CARP development. However, this CARP was developed in a way that aligns with the FCAP method of budgeting maintenance and repairs across assets over time. This may aid in future expansion or development of the FCAP process into a component of Port Milwaukee's asset management system.

1.3.4 Organization of CARP

The CARP is organized to address Port assets in the 10 asset categories described in Table 1. Each section provides details related to the state of the infrastructure, level of service, and asset management strategies the methodology of which are detailed in Section 1.3.4.1, 1.3.4.2, and 1.3.4.3, respectively.

1.3.4.1 State of Infrastructure

The state of Port assets was determined for each asset category. The process involved the following primary steps:

- Identification of asset inventory to be included in the CARP,
- Evaluation of current asset condition and assigning a condition rating,
- Identification of repair and deferred maintenance needs, and
- Determination of current asset replacement costs.

Assets were inventoried for each of the 10 asset categories for inclusion into the CARP through review of the Port Asset Database and collaboration with Port staff. The set of assets included in the CARP are organized into the CARP Asset Inventory workbook. The specific Asset IDs used in the CARP Asset Inventory workbook are used throughout the plan for consistency and align with the asset descriptions used in the Port Asset Database.

The approach to evaluation of current asset conditions varies by asset category and is described in each section. Condition assessments were generally conducted using a combination of desktop study of existing asset data (age, materials of construction, repair history, etc.) and visual inspection. For each asset evaluated repairs and deferred maintenance needs were documented. In order to compare condition of assets within and across asset categories as well as provide measurable target for goals and defined level of service, assessed condition of assets are normalized into a five-point condition rating system from excellent to deficient (Figure 3) or a two-point rating as functional or nonfunctional (**Error! Reference source not found.**).

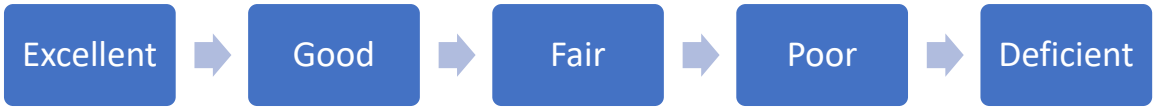

Figure 3 – Five-Point Asset Condition Rating System

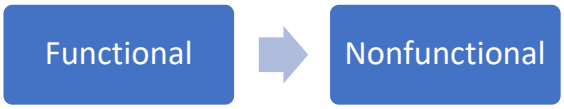

Figure 4 - Two-Point Asset Condition Rating System

A current replacement value (CRV) was estimated for each asset to provide a financial basis for comparing and evaluating costs of renewals. CRVs are prepared based on planning-level estimate and do not factor in depreciation. The CRV spreadsheet data is provided in the Asset Category Renewal Plans identified in Section 1.3.4.3.

1.3.4.2 Level of Service

Level of Service (LOS) is defined in ISO 55000 as the *parameters, or combination of parameters, which reflect social, political, environmental, and economic outcomes that the organization delivers. The parameters can include safety, customer satisfaction, quality, quantity, capacity, reliability, responsiveness, environmental acceptability, cost, and availability.* For the purpose of asset renewal planning identified in this plan, factors to be considered in establishing LOS targets for Port assets have been organized in 4 categories as described in Table 3.

Table 3 - Factors Considered for Establishing Level of Service

Factor	Consideration
Organizational Goals	Port Milwaukee's goals have a direct impact on the desired level of service provided by its assets. The Port's objectives related to asset renewal are translated to defining a level of service target for each asset category by maintaining assets in good state of repair. A condition rating based on a 5-point scale (deficient, poor, fair, good, excellent) is established to allow for comparison of asset condition to LOS and to other asset categories.
Stakeholder needs and expectations	Stakeholders include port tenants, community organizations, and the public. Each have needs and expectations of the level of service to be provided by Port assets.
Legislative / Regulatory Requirements	Legislative requirements include those ordinance or business plans required by City of Milwaukee. Regulatory requirements cover those legal requirements either by permit requirements, safety regulations, or building codes.
Financial Considerations	Financial considerations include constraints, budget, costs, etc.

1.3.4.3 Asset Renewal Strategies and Plan

For each asset category, high level renewal strategies are identified that support providing the desired level of service identified. Factors considered in establishing asset renewals strategies are described in Table 4. A target (or desired) level of service is identified for each of the asset categories evaluated based on the factors considered for establishing LOS.

Table 4 - Factors Considered in Establishing Asset Renewal Strategies

Factor	Consideration
Level of Service	What level of service does Port provide with its assets based on those factors considered as part of its renewal strategy?
Risk	What risks should be considered? How are they managed in Port asset renewals?
New Technologies	Are there new technologies that should be considered when planning asset replacements?
Growth	What future demands or increase in service levels will need to be addressed by Port assets?
Environmental Impact	Are there environmental impacts that should be considered in asset renewal strategies?

Rehabilitation and replacement projects are identified according to the strategies and mapped out through year 2070 (planning period). A workbook (*Asset Category Renewal Plan Workbook*) is created for each asset category where renewal activities are projected over the planning period. The Asset Category Renewal Plan Workbook includes the following worksheets:

- ***Summary***: Provides a rollup of renewal costs for assets in the category and includes a total. The Summary worksheet is referenced to the asset renewal plan worksheets and updates automatically. Changes to the summary table will only be required for structural changes in the asset renewal plan worksheet.
- ***Current Replacement Value (CRV)***: The current replacement value (2021) for each asset is estimated based on budget-level unit costs. The CRV is developed to provide a comparative value of the assets to the renewal costs.
- ***Asset Renewal Plan***: One or more asset plan worksheets are provided for each asset category based on their major sub-organizations. Each asset renewal plan follows a similar format that provides the following information:

Table 5 - Asset Renewal Plan Worksheet Guide

Column	Element	Description
B	Asset ID / Renewal Work	The asset description is provided in this field followed by details regarding the specific renewal work planned. Renewal work is intended to be detailed enough to provide a reasonable basis for the unit costs provided in Column E.
C-F	Capital Costs	Capital costs are developed on a unit cost basis. Unit costs are intended to be at a planning or budgetary level of detail and reflect present costs.
G	Total Renewal Cost Through 2070 (2021)	Total renewal cost is the sum of the renewals over the planning period including CRDM (Sum of Columns J-T). Since planned renewal costs are inflated by year, the total renewal costs reflect the present worth cost or the total amount relative to the value of the USD in 2021.The assume inflation rate is provided in cell K3 as a percent which is a referenced cell, adjustment of which will automatically update the spreadsheet.
H-I	Useful Life (UL) / Remaining Useful Life (RUL)	An estimate of useful life (UL) and remaining useful life (RUL) are provided for the assets or asset subsystems. For this plan, UL is defined as the estimated number of years the asset is likely to remain in service before it is obsolete, requires major repairs, or is no longer providing cost-effective service. The estimate of useful life is primarily based on professional judgment and industry standards. RUL is the estimated number of years remaining of the UL based on age, condition, exposure, and usage of the asset. Note that the estimated RUL is subjective and as a result can exceed the estimated UL. For instance, most steel sheet pile dock walls are given a UL of 100 years. However, the estimated RUL may exceed the UL when calculated from the date the wall was put in service.
J	Capital Repairs / Deferred Maintenance (CRDM)	Repairs and maintenance requirements that are needed or past due are placed in the CRDM category. These sometimes cover repairs to assets that are determined to be beyond their useful life.
K-T	5-Year Planning Bins for Renewal Costs	Identified renewal projects are placed out over the planning period based on remaining useful life or other renewal strategies. Capital costs are inflated at the rate referenced in cell K3. If a different inflation rate is desired, cell K3 can be updated with a new percentage and the changes will carry through the workbook. For renewal planning, 5-year planning bins are used to simplify the planning approach. As renewals approach the 5-10-year planning period, a detailed annual budget of renewal activities should be prepared in separate budgeting spreadsheet to aid in maintaining the streamlined approach of using 5-year planning bins.

2. BUILDINGS, TERMINALS, AND WAREHOUSES

STATE OF INFRASTRUCTURE

Inventory

Port Milwaukee has various maintenance and renewal responsibilities for building structures within its Buildings, Terminals, and Warehouses asset category. Building type and uses very from large warehouse facilities, commercial space, and office space. Some buildings are operated and maintained by Port tenants while others are occupied and maintained by Port. The delineation of maintenance responsibilities between Port and tenant are made in lease agreements which vary based on specific tenant and building. Some lease arrangements are structured as “bare ground” agreements whereby tenant erects building or uses existing buildings and are responsible for all renewals. Tenant erected structures may be required to be removed at the termination of the lease or transferred to Port where renewals may become Port responsibility at a future date. At the time of plan development there are 17 building structures for which Port has renewal responsibilities and 12 structures associated with bare ground lease arrangements. A summary of the buildings and current renewal responsibilities are summarized in Table 6.

Table 6 - Port Building Renewal Responsibility

Lease Buildings with Shared Renewal Responsibilities	Non-Leased Buildings with Full Renewal Responsibility	Bare Ground Lease Buildings with No Current Renewal Responsibilities
TERMINAL #2 BUILDING	POLE BUILDING #1	ST. MARY'S WAREHOUSE BUILDING
TERMINAL #3 BUILDING	POLE BUILDING #2	ST. MARY'S PROCESSING BUILDING
TERMINAL #3A BUILDING	PORT ADMINISTRATION BUILDING	ST. MARY'S OFFICE BUILDING
TERMINAL #4 BUILDING	SEAMAN'S CLUB BUILDING	LAFARGE MAINTENANCE BUILDING
TERMINAL #4A BUILDING		LAFARGE RAIL LOADING BUILDING
TERMINAL #5 BUILDING		CARGILL WAREHOUSE BUILDING
BRADFORD #1 BUILDING		US OIL OFFICE BUILDING
BRADFORD #2 BUILDING		US OIL MAINTENANCE BUILDING
LAKE EXPRESS BUILDING		US OIL MECHANICAL BUILDING
MILWAUKEE BULK TERMINALS BUILDING		SOUTH HARBOR OFFICE BUILDING
COMPASS MINERALS OFFICE BUILDING		SOUTH HARBOR CANOPY STRUCTURE
PORTLAND TRUCKING BUILDING		SOUTH HARBOR MECHANICAL BUILDING
SEA SCOUTS BUILDINGS		

Current Replacement Value

Current replacement value of the 17 buildings is estimated to total $53,496,000. A summary chart indicating the replacement values is provided below. The Port’s two large terminal buildings (#3 and #4) represent nearly 40% of the asset category value.

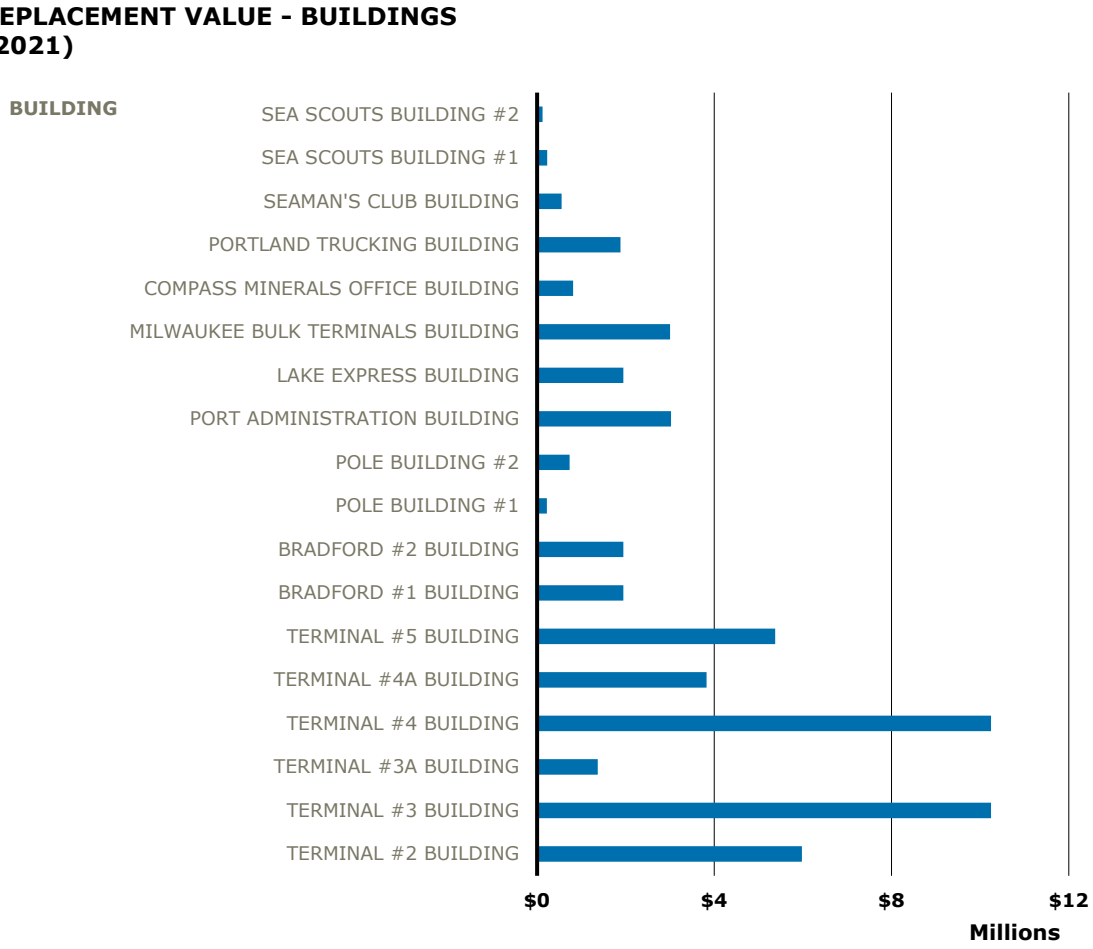

Figure 5 - Building CRV Summary

Condition Assessment

Building condition assessment were completed by visual inspection, review of existing building plans and records, and discussion with port and tenant representatives. An inspection record is completed for each building that covers major building systems including its exterior, interior, mechanical, electrical, and plumbing (MEP), safety, and site. Condition of building systems are then rated based on remaining useful life.

An industry recognized method for comparing the relative condition of a group of facilities overt time uses the calculated Facility Condition Index (FCI). The FCI is the sum of the maintenance, repairs, and replacement costs (renewals) of a facility divided by its current replacement value. Renewal costs used in calculating the FCI cover a given period of time.

$$Facility\ Condition\ Index = \frac{Renewal\ Costs}{Current\ Replacement\ Value}$$

For evaluating condition of Port facilities, an FCI covering a 5-year period is used which aligns with that asset renewal plan worksheets that are structured around 5-year planning bins. A standard is not established for FCI however based on a reasonably accepted approach that considers facilities with and FCI of less than 0.05 as being in good condition, the following condition rating (Table 7) is established for Port buildings based on the 5-point scale developed for all port asset categories.

Table 7 - Building Asset Condition Rating

Condition Rating	Excellent	Good	Fair	Poor	Deficient
Facility Condition Index (FCI)	<0.05	0.05-0.10	0.10-0.15	0.15-0.20	>0.20

Current Condition

Table 8 provides a summary of building condition using the FCI condition rating. FCI was calculated from the sum of the capital repairs and deferred maintenance (CRDM) added to the renewal costs projected through 2025. An average FCI and rating are provided as well.

Table 8 - Building Current Condition Summary

Asset ID	Replacement Value (2021)	CRDM + Renewal Through 2025	FCI	Condition Rating
TERMINAL #2 BUILDING	$5,978,468	$373,000	0.06	Good
TERMINAL #3 BUILDING	$10,246,500	$932,000	0.09	Good
TERMINAL #3A BUILDING	$1,372,000	$0	0.00	Excellent
TERMINAL #4 BUILDING	$10,246,500	$18,000	0.00	Excellent
TERMINAL #4A BUILDING	$3,828,000	$23,000	0.01	Fair/Good
TERMINAL #5 BUILDING	$5,376,000	$336,000	0.06	Good
BRADFORD #1 BUILDING	$1,950,000	$139,000	0.07	Good
BRADFORD #2 BUILDING	$1,950,000	$139,000	0.07	Good
POLE BUILDING #1	$224,000	$38,000	0.17	Poor
POLE BUILDING #2	$735,000	$0	0.00	Excellent
PORT ADMINISTRATION BUILDING	$3,024,000	$4,000	0.00	Excellent
LAKE EXPRESS BUILDING	$1,950,000	$0	0.00	Excellent
MILWAUKEE BULK TERMINALS BUILDING	$3,004,400	$81,400	0.03	Excellent
COMPASS MINERALS OFFICE BUILDING	$815,000	$167,000	0.20	Poor
PORTLAND TRUCKING BUILDING	$1,886,000	$989,925	0.52	Deficient
SEAMAN'S CLUB BUILDING	$554,200	$136,124	0.25	Deficient
SEA SCOUTS BUILDING #1	$230,000	$23,580	0.10	Fair/Good
SEA SCOUTS BUILDING #2	$126,000	$45,500	0.36	Deficient
TOTAL / AVERAGE	**$53,496,068**	**$3,445,529**	**0.11**	**Fair**

Based on the average FCI Port buildings are currently found to be in fair condition with several Port building assets considered in good condition or better representing over 90% of the total building replacement value.

The FCI does not entirely tell the story of the building condition in a few cases. Brief observations regarding the condition rating for a few of the buildings is provided here:

- Buildings with shared maintenance responsibilities such as Milwaukee Bulk Terminals Building, do not have all the cost accounted for in the renewal plan and therefore skew the FCI toward a better condition rating.
- Terminal Building #4A: This steel framed, metal-sided building is being used by tenant for processing of salt products. The corrosive environment caused by the salt and operations has led to a sever corrosion to the building. All repairs and maintenance to rectify the current condition of the building are not accounted for in the renewal plan, skewing the FCI condition rating to fair/good. The actual building condition is very poor for the reasons mentioned.

Assumptions

- Estimates of remaining useful life (RUL) made for building systems assumes Port is tracking and performing customary maintenance on building systems to ensure full life cycle of assets is achieved.
- Some major renewals for mechanical, plumbing, and electrical building systems have not been captured in the condition assessments and the renewal plan for these building components will need to be developed and included in subsequent plan updates.

LEVEL OF SERVICE

Table 9 - Level of Service Factors for Building Assets

LOS Factor	Performance Indicator, Target, and Other Considerations
Organizational Goals	To align with Port asset renewal objective of maintaining assets in state of good repair, a LOS target for building assets is established to maintain an average 5-year FCI of 0.10 or less.
Stakeholder expectations and considerations	Maintain building assets to meet tenant expectation for reliable and safe for performance. Maintain buildings in a state of good repair and fit for occupancy.
Legislative / Regulatory Requirements	Several legislative and regulatory requirements will mandate level of service for building assets including federal, state, and local building codes, OSHA, ADA, fire protection and safety systems.
Economic Considerations	Port expenditures on renewals for leased buildings is balanced with shared maintenance responsibilities between Port and its tenants based on individual lease agreements.

RENEWAL STRATEGIES & PLAN

Considerations of factors influencing renewal strategies for building assets is provided in Table 10.

Table 10 - General Renewal Strategy Considerations for Building Assets

Renewal Strategy Factor	Considerations
Level of Service	Maintaining 5-year FCI at 0.10 or less will ensure organizational goals and stakeholder expectations are met.
Risks	Determine coastal risks associated with high lake levels and flood risks and plan for mitigating renewals. Allow for buildings with excellent condition ratings to have maintenance and repairs deferred while still maintaining targeted level of service. Continue mitigating project funding risks through proactive grant application and seeking new funding opportunities.
New Technologies	Plan for electric vehicle technologies and the inclusion of charging station infrastructure at Port facilities such as the Port Administration Building. Continue to explore new building technologies around energy efficiency and/or alternative energy.
Growth	Align building replacements with growth plans and projections.
Environmental Impacts	Meet or exceed environmental requirements for redevelopment projects. Incorporate existing building technologies around energy efficiency and/or alternative energy.

Asset Renewal Plan

For the building asset category, the Asset Renewal Plan Workbook is organized by building. A worksheet is provided for each building that separates renewals by major building system (exterior, interior, MEP, Safety, and Site). A building-specific renewal summary is provided as Table 11.

Table 11 - Building Specific Renewal Summary

Building Asset	Renewal Summary
TERMINAL #2 BUILDING	Entire building system to be included in renewal plan. Major renewals include roofing, siding, corrosion protection of steel members, and rail dock rehabilitation.
TERMINAL #3 BUILDING	Entire building system to be included in renewal plan. Major renewals include roofing, windows, and corrosion protection of steel members.
TERMINAL #3A BUILDING	Former refrigeration building. Shows signs of age but is functioning well for use as mechanical garage. Major renewals include rehabilitation of corroded structural members and corrosion protection.
TERMINAL #4 BUILDING	Entire building system to be included in renewal plan. Major renewals include roofing, windows, corrosion protection of steel members, and steel column footing rehabilitation.
TERMINAL #4A BUILDING	Building is likely beyond suitability for other warehouse uses. No specific renewal plan identified.
TERMINAL #5 BUILDING	Entire building system to be included in renewal plan. Major renewals include roofing, siding, and asphalt floor replacement.
BRADFORD #1 BUILDING	Entire building system to be included in renewal plan. Major renewals include door replacement, siding, and roofing.
BRADFORD #2 BUILDING	Entire building system to be included in renewal plan. Major renewals include door replacement, siding, and roofing.
POLE BUILDING #1	Sheet metal siding and roof are aged. Plan for roof replacement.
POLE BUILDING #2	New building. Potential heating project.
PORT ADMINISTRATION BUILDING	Plan for major renewals of roof, windows, siding, general interior renovations, etc.
LAKE EXPRESS BUILDING	Plan for major renewals of roof, windows, siding, etc. Consider adding permanent maintenance storage and refrigeration unit. Address settlement issues in site walkways.
MILWAUKEE BULK TERMINALS BUILDING	Plan for major renewals of interior paved floor, window replacement, and exterior brick repair.
COMPASS MINERALS OFFICE BUILDING	Interior and site elements in fair condition. Renewal plan to include replacement or rehabilitation of exterior systems, including roof, brick, and windows.
PORTLAND TRUCKING BUILDING	Interior and site elements in fair condition. Tenant indicates planned renovations for interior and site, including paving. Renewal plan to include replacement or rehabilitation of exterior systems, including roof, brick, and windows. Also include pavement replacement.
SEAMAN'S CLUB BUILDING	Significant renovations required to place back into service as office space. Renewal plan to include roof replacement and securing window openings.
SEA SCOUTS BUILDINGS	Plan for new roof and windows.

Assumptions

Assumptions for building renewal strategies include:

- Building use will not change significantly from current or past use of buildings.

3. DOCKWALLS

STATE OF INFRASTRUCTURE

Inventory

The port's waterfront infrastructure can be considered the backbone of its operation, the working line between its waterborne and land-based transportation services. The dockwall asset category contains all waterfront infrastructure types within the ports area of responsibility which primarily includes steel sheet pile bulkheads, stone revetments, piers, and docks. The port's dockwall inventory is delineated into 33 segments of similar construction and use and are divided into three areas: North Harbor Tract, South Harbor Tract – West, and South Harbor Tract – East.

Current Replacement Value

Current replacement value of Port's dockwall assets are estimated to total $77,030,000. A summary chart indicating the replacement values by dockwall segment is provided below.

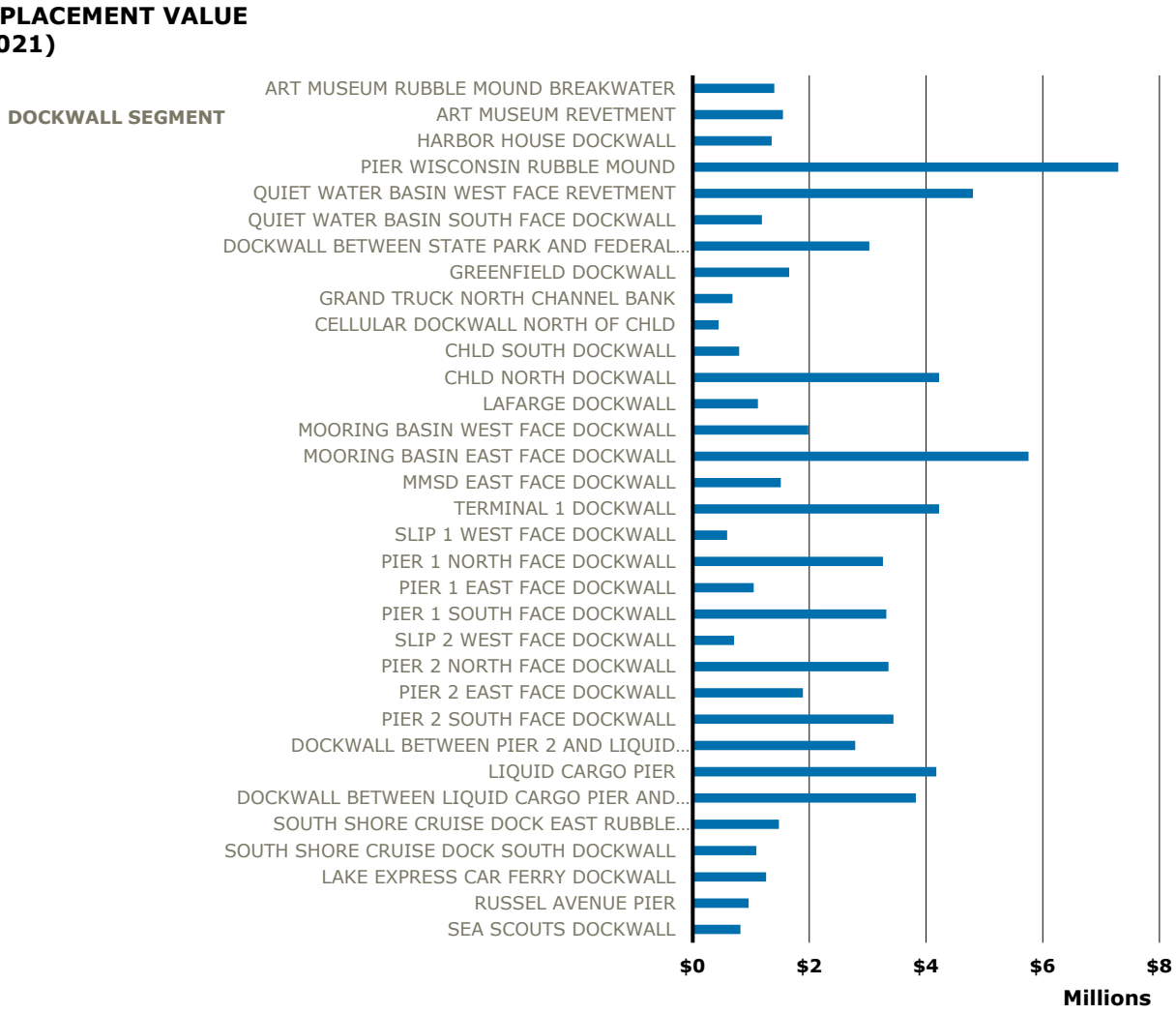

Figure 6 - Dockwall CRV Summary

Condition Assessment

Dockwall assets were inspected using a combination of field observation and high-resolution drone imagery captured at an oblique angle to the dockwall. All inspection were conducted above the water line and results of inspections were documented in an inspection report for each segment. Port construction drawings and inspection records were utilized to determine form, materials, and age of the entire dockwall structure. Dockwall condition assessment followed guidelines provided in the Waterfront Facilities Inspection and Assessment Manual published by the American Society of Civil Engineers (ASCE).

A condition rating based on remaining useful life (RUL) has been established for dockwalls as shown in Table 12.

Table 12 - Dockwall Asset Condition Rating

Condition Rating	Excellent	Good	Fair	Poor	Deficient
Remaining Useful Life (RUL)	>60	20-60	10-20	<10	Beyond Useful Life

Current Condition

Freshwater dockwall assets of steel and concrete typically have a useful life of over 100 years. Port Milwaukee dockwalls are no exception with some dockwalls built in the 1930s still in service today and in good condition. The freshwater environment of Lake Michigan they sit in is much less corrosive than seawater environments where the same steel structures would have half the life. However, some impacts to steel dockwalls from bulk salt use at the port were observed where salt laden runoff appeared to be accelerating corrosion of piles in areas.

A summary of the dockwall condition by length and asset type is provided in Table 13.

Table 13 - Dockwall Current Condition Summary by Length (feet)

Condition Rating	Excellent >60 years RUL	Good 20-60 years RUL	Fair 10-20 years RUL	Poor <10 years RUL	Deficient Beyond Useful Life
North Harbor Tract					
Revetment or Rubble Mound	1,542	2,398	0	0	0
SSP Bulkhead, Dockwall or Pier	0	2,046	0	0	0
South Harbor Tract – East					
Cellular SSP Dockwall	0	1,151	0	0	0
Pile Supported Deck Pier	0	1,054	0	0	0
Revetment or Rubble Mound	0	369	0	0	0
SSP Bulkhead, Dockwall or Pier	0	6,265	5,517	0	0
South Harbor Tract – West					
Cellular SSP Dockwall	0	444	0	0	0
Revetment or Rubble Mound	0	0	0	0	684
SSP Bulkhead, Dockwall or Pier	0	4,263	2,878	0	0
Total	1,542	17,991	8,395	0	684

Note:
Asset lengths in linear feet.

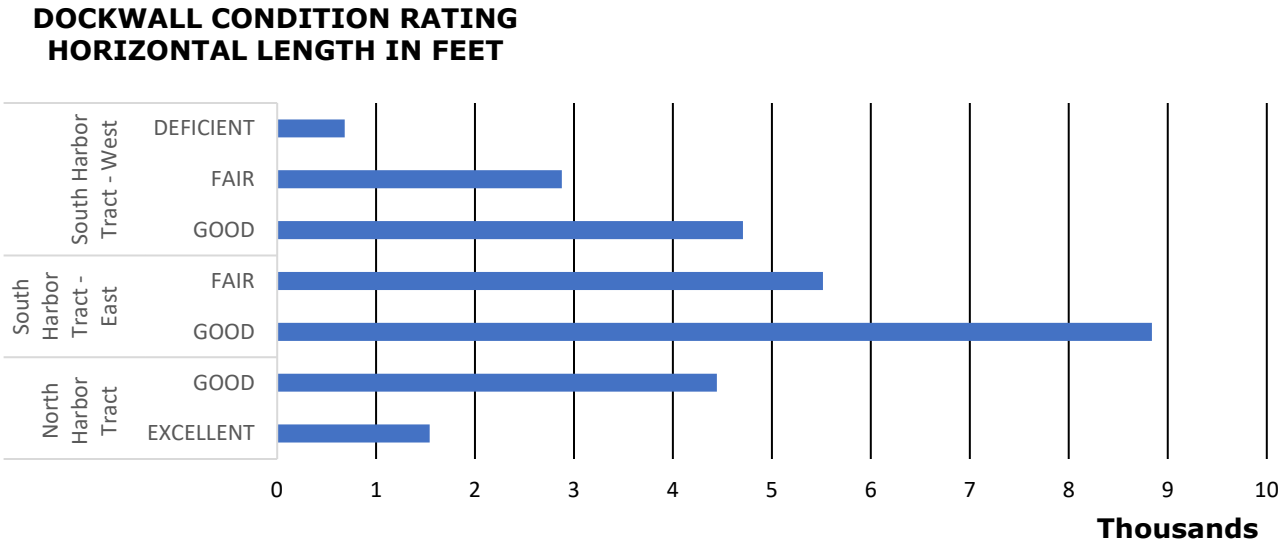

Figure 7 - Dockwall Current Condition Summary

Assumptions

- Remaining useful life estimated based on age of asset and estimated useful life of asset material. Useful life estimated to be 100 years for all materials, except for the pile supported deck pier, which was estimated to be 75 years.

LEVEL OF SERVICE

Table 14 - Level of Service Factors for Dockwall Assets

LOS Factor	Performance Indicator, Target, and Other Considerations
Organizational Goals	To align with Port asset renewal objective of maintaining assets in state of good repair, the LOS target for dockwall assets is to maintain a RUL of 20 years or more.
Stakeholder expectations and considerations	Maintain dockwalls to meet tenant expectation for reliable and safe performance. Maintain dockwalls to meet public expectations for reliable and safe access.
Legislative / Regulatory Requirements	Milwaukee City Code of Ordinances US Coast Guard
Economic Considerations	Limits of available finances for dockwall replacement and maintenance require careful planning and phased approach for major replacement and renewal efforts. LOS is limited to access to state and federal grant and annual capital budget.

RENEWAL STRATEGIES & PLAN

Table 15 - General Renewal Strategy Considerations for Dockwall Assets

Renewal Strategy Factor	Considerations
Level of Service	Maintaining dockwall assets according to targeted level of service based on remaining useful life will ensure stakeholder LOS expectations are met.

Renewal Strategy Factor	Considerations
Risks	Evaluate coastal risks associated with high lake levels and flood risks and plan for mitigation when renewing dockwall assets. Deterioration rates and RUL uncertainty present risk for failure of dockwall prior to planned replacement perform detailed assessment that include underwater inspection and testing to improve RUL prediction. Identify and manage risks related to salt exposure on dockwalls and excessive corrosion.
New Technologies	Consider operational changes to reduce accelerated deterioration Consider new materials for sheet pile walls (i.e., vinyl, composite, fiberglass)
Growth	No Current dockwall renewals are planned to accommodate projected growth or expansion of port services. Consider growth needs when replacing dockwalls. Renewals relative to dockwalls near the pending DMMF should be deferred.
Environmental Impacts	None identified

Asset Renewal Plan

For the dockwall asset category, the Asset Renewal Plan Workbook is organized by dockwall segment. A separate worksheet is provided for the North Harbor Tract, South Harbor Tract-East, and South Harbor Tract-West that contain the dockwall segments located in those areas. A dockwall-specific renewal summary is provided below in Table 16. Total renewal costs estimated for dockwalls through 2070 is about $9.77M.

Table 16 - Dockwall Segment Specific Renewal Summary

Dockwall Asset	Renewal Summary
SEA SCOUTS DOCKWALL	Monitor wall and anchorages. Monitor future dockside uses to restrict surcharges. Replace with dockwall of similar design draft depth at end of useful life.
RUSSEL AVENUE PIER	Monitor pier fill and deck for loss of material. Plan for deck rehab project in next 5-years to ensure public use is maintained until structure is replaced. Some point repairs to SSP and anchorages may be required. Replace with pier of similar geometry and use. Upgrade public safety features such as railing and ladders.
LAKE EXPRESS CAR FERRY DOCKWALL	The cellular SSP wall system is roughly halfway through its useful life. Some localized reinforcement or rehabilitation of the cellular SSP system may be required to maximize RUL.
SOUTH SHORE CRUISE DOCK SOUTH DOCKWALL	The cellular SSP wall system is roughly halfway through its useful life. Some localized reinforcement or rehabilitation of the cellular SSP system may be required to maximize RUL. The concrete dockwall segment should either be rehabilitated if commercial docking is to continue or removed/modified to accommodate other uses. Fender repairs are recommended.
SOUTH SHORE CRUISE DOCK EAST RUBBLE MOUND DIKE	Overall, structure is functional and can be considered about halfway through its useful life before major rehabilitation of the system and supplementing the stone with new will be required.
DOCKWALL BETWEEN LIQUID CARGO PIER AND CDF	Replace broken safety ladders. Monitor other safety ladders and replace when required. Monitor the SSP checking for deformations and defects, with aim to replace at end of RUL. Consider replacement with SSP bulkhead of shorter wall height if wall will not serve as docking wall. A portion of this dockwall may need to be replaced due to planned expansion of the CDF.
LIQUID CARGO PIER	[Renewal plan for segment not complete]
DOCKWALL BETWEEN PIER 2 AND LIQUID CARGO PIER	Monitor safety ladders and replace when required. Monitor the SSP checking for deformations and defects, with aim to replace at end of RUL. Consider replacement with SSP bulkhead of shorter wall height if wall will not serve as docking wall.
PIER 2 SOUTH FACE DOCKWALL	Perform detailed evaluation of Pier 2 SSP RUL by 2030 to refine timing for planned replacement. Dockwall is designed for 39 ft wall height. Ability to add additional 1-2 ft. of dredge depth without reinforcement or rehab is likely feasible - will require additional engineering evaluation to determine. Fender system may need to be replaced before dockwall.

Dockwall Asset	Renewal Summary
PIER 2 EAST FACE DOCKWALL	Same renewal approach as Pier 2 North/South Face Dockwalls. East face is outfitted with rubber fender and steel/concrete pile cap/curb assembly. Continued use of east face for docking should be evaluated which will factor into replacement of the east dockwall and fenders.
PIER 2 NORTH FACE DOCKWALL	Same renewal approach as Pier 2 South Face Dockwall.
SLIP 2 WEST FACE DOCKWALL	Plan for replacement at end of useful life. A replacement wall may be able to be shorter and less costly if planned operations at the end of the slip facilitate it. Considerations for enhancing or expanding wave protection should be incorporated into the wall replacement.
PIER 1 SOUTH FACE DOCKWALL	Same renewal approach as Pier 1 North Face Dockwall.
PIER 1 EAST FACE DOCKWALL	Same renewal approach as Pier 1 North/South Face Dockwalls. Use of east face for docking should be evaluated which will factor into replacement of the east dockwall and fenders.
PIER 1 NORTH FACE DOCKWALL	Perform detailed evaluation of Pier 1 SSP RUL by 2030 to refine timing for planned replacement. Dockwall is designed for 36 ft wall height. Ability to add additional 1-2 ft. of dredge depth without reinforcement or rehab is likely not feasible without reinforcing - will require additional engineering evaluation to determine. Look to hold out on replacement of fenders with dockwall replacement.
SLIP 1 WEST FACE DOCKWALL	Plan for replacement at end of useful life. A replacement wall may be able to be shorter and less costly if planned operations at the end of the slip facilitate it. Considerations for enhancing or expanding wave protection should be incorporated into the wall replacement.
TERMINAL 1 DOCKWALL	Begin long-term process for planning replacing 1930s SSP dockwalls starting with the segment along Terminal 1. Replacement options can consider placement of new anchor wall forward of existing.
MMSD EAST FACE DOCKWALL	[Renewal plan for segment not complete]
MOORING BASIN EAST FACE DOCKWALL	[Renewal plan for segment not complete]
MOORING BASIN WEST FACE DOCKWALL	Monitor the SSP checking for deformations and defects, with aim to replace at end of RUL. Plan for upgrade of fender system that will need to be salvaged and reinstalled with new SSP dockwall.
LAFARGE DOCKWALL	[Renewal plan for segment not complete]
CHLD SOUTH DOCKWALL / SMALL BOAT SLIP SEGMENT	Monitor the SSP checking for deformations and defects, with aim to replace at end of RUL. Consider closing off and filling slip if no long-term use planned.
CHLD SOUTH DOCKWALL / 264 FT SEGMENT NORTH OF SMALL BOAT SLIP	Monitor the SSP checking for deformations and defects, with aim to replace at end of RUL. Future replacements/rehabs should consider increasing height of wall and top of wall elevations.
CHLD NORTH DOCKWALL / 1,193 FT PRIMARY SEGMENT OF CHLD	Monitor the SSP checking for deformations and defects, with aim to replace at end of RUL. Future replacements/rehabs should consider increasing height of wall and top of wall elevations.
CHLD NORTH DOCKWALL / 215 FT SEGMENT AT NORTH END OF CHLD	Monitor the SSP checking for deformations and defects, with aim to replace at end of RUL. Future replacements/rehabs should consider increasing height of wall and top of wall elevations.
CELLULAR DOCKWALL NORTH OF CHLD	[Renewal plan for segment not complete]
GRAND TRUCK NORTH CHANNEL BANK	[Renewal plan for segment not complete]
GREENFIELD DOCKWALL	[Renewal plan for segment not complete]
DOCKWALL BETWEEN STATE PARK AND FEDERAL PIER	Monitor the SSP checking for deformations and defects, with aim to replace at end of RUL. Consider replacement with SSP bulkhead of shorter wall height if wall will not serve as docking wall. Tube steel railing will likely need to be rehabilitated before end of dockwall RUL.
QUIET WATER BASIN SOUTH FACE DOCKWALL	Monitor the SSP checking for deformations and defects, with aim to replace at end of RUL. Consider replacement with SSP bulkhead of shorter wall height if wall will not serve as docking wall. Reinforced concrete cap can likely make it to

Dockwall Asset	Renewal Summary
	dockwall full replacement provided it is adequately maintained (grouted/sealed).
QUIET WATER BASIN WEST FACE REVETMENT	Limestone is weathered but has sufficient lifespan remaining to be reworked for rehabilitation of revetement in the future when needed. Since the shoreline is protected within the quiet water basin, the stone size and gradation required for protection can likely be served through reworking the existing stone with minor supplementation for the filter layer (geotextile or aggregate). The renewal approach should include reworking the revetment section in segments as needed.
PIER WISCONSIN RUBBLE MOUND	Due to current age and condition of Pier Wisconsin, major renewals for concrete, stone, and steel components have not been planned through year 2070. Replacement of rubber fenders at end of useful life is planned. Rehabilitation of the concrete roadway, curbs, and steel catwalks should be monitored and included in the renewal plan worksheet in later updates when deterioration rates of these components become more apparent.
HARBOR HOUSE DOCKWALL	Monitor the SSP checking for deformations and defects, with aim to replace at end of RUL. Consider replacement with SSP bulkhead of shorter wall height if wall will continue non-docking service. Tube steel railing will likely need to be rehabilitated before end of dockwall RUL.
ART MUSEUM REVETMENT	Monitor configuration of stone revetment and rework/supplement as necessary to provide protection from direct wave action under the walkway. Eastern edge of walkway has corrosion staining, spawling, and cracking indicating potential exposure of the rebar. A preventative maintenance project is recommended to repair and protect the eastern edge of the concrete from continued deterioration.
ART MUSEUM RUBBLE MOUND BREAKWATER	No major renewal activities planned for next 50-year period due to the current age and nature of the structure.

Assumptions

- Most dockwall renewals planned assumed full replacement of dockwall asset at or near end of useful life. Some dockwalls may benefit from major rehabilitation at end of useful life to extend its service cost effectively. Assuming full replacement of a dockwall ensures the high-end planning-level costs are identified. It is assumed that Port will evaluate major renewal requirements for dockwalls as they near end of useful life to determine feasibility and cost-benefit of rehabbing a structure over replacement.

4. NAVIGATIONAL AREAS

STATE OF INFRASTRUCTURE

Inventory

The navigational areas asset category includes areas outside of the federally maintained channel that require minimum water depths to allow for vessel navigation and access within Port Milwaukee. The US Army Corps of Engineers maintains depths of the Milwaukee harbor and channel. Port Milwaukee maintains its berth facilities to -27 ft (IGLD 85) which is the depth maintained for the St. Lawrence Seaway and Great Lakes Navigation system. Other areas within Port Milwaukee are maintained to -17 ft (IGLD 85).

The areas identified as navigational area assets maintained to -27 ft (IGLD 85) include:

- Slip 1
- Slip 2
- Slip 3
- Liquid Cargo Pier
- City Heavy Lift Dock
- Municipal Mooring Basin
- Greenfield Dock

The areas identified as navigational area assets maintained to -17 ft (IGLD 85) include:

- Pier Wisconsin
- Maritime Basin & Entrance
- South Shore Cruise Dock / Lake Express Car Ferry Dock
- Grand Trunk Slip

Current Replacement Value

Due to the limited availability of historical dredging data within Port Milwaukee, a current replacement value was not developed for navigational areas. A CRV could be developed in the future based on historic dredging frequency and volume or a modeled rate of sedimentation over the planning period.

Condition Assessment

Recent bathymetric data for the navigational areas, and detailed dredging history for the Port were unavailable for review at the time of this condition assessment. Limited historic dredging data and interviews with Port staff indicate that Port draft areas have historically required little maintenance dredging and are currently operational. A two-level condition rating system was utilized for this assessment to identify navigational assets as Functional or Nonfunctional in meeting their required LOS. For example, navigational areas with top of sediment elevations above minimum draft requirements would be considered Nonfunctional. A more detailed rating system could be developed in the future based on top of sediment elevation relative to target draft depths if routine bathymetric surveys were conducted.

Current Condition

Regular dredging of Port berths is not required. Sedimentation rates are low due, in part, to the sediment transport protection provided by the federal breakwater and the regular dredging by USACE in the federal harbor and channel that reduce feed material that would otherwise be available for settlement in Port berth facilities. Port staff indicate that all navigational areas are currently operational. Therefore, current condition ratings for navigational areas are all considered to be functional.

LEVEL OF SERVICE

Table 17 - Level of Service Factors for Navigational Area Assets

LOS Factor	Performance Indicator, Target, and Other Considerations
Organizational Goals	Maintain berth areas in good, functional condition. Commercial berthing areas dredged to Seaway depth with current (less than 5 years old) soundings for all berthing locations. Maintain target depths in navigational areas across 100% of area.
Stakeholder expectations and considerations	Maintain current dredge depths (e.g., 27 feet for Seaway max) Provide drafts for projected low lake levels.
Legislative / Regulatory Requirements	None identified.
Economic Considerations	None identified.

RENEWAL STRATEGIES & PLAN

Table 18 - General Renewal Strategy Considerations for Navigational Area Assets

Renewal Strategy Factor	Considerations
Level of Service	Maintain level of service. Consider system approach with dockwalls (dockwalls may need to be modified or changed during replacement to accommodate change in level of service.) Providing LOS based on projected use. Implement routine hydrographic survey program for navigational areas to define conditions and achieve targeted level of service.

Renewal Strategy Factor	Considerations
Risks	Evaluate coastal risks associated with low lake levels and plan for mitigating renewals.
New Technologies	None identified.
Growth	No specific growth-related renewal strategies associated with navigational areas are identified.
Environmental Impacts	Incorporate plans for beneficial reuse of dredged material when maintaining navigational areas.

Asset Renewal Plan

An asset renewal plan workbook was created for navigational areas, however there is not enough data available to provide a cost forecast at this time. Renewal costs would consist of periodic maintenance dredging and sediment disposal. Current bathymetric data for navigational areas, detailed historic dredging records and/or sedimentation rate modeling would be needed to provide accurate planning for navigational area assets. The Port is currently planning to establish a routine hydrographic survey program and dredging record keeping to improve dredge planning.

5. FENCING

STATE OF INFRASTRUCTURE

Inventory

The fencing asset category includes perimeter and security fencing and gates, on the South Harbor Tract. Fencing was inventoried along roadways and surrounding Port parcels. Most of the fencing is 6 or 8-foot-high chain link security fencing with barbed wire on top. Decorative steel picket security fence was identified at the Lake Express Terminal, CDF fence line, and the Port Administration Building. In total, the inventory includes about 44,950 lineal feet of fence.

Current Replacement Value

Current replacement value of Port's fencing assets is estimated to total $2,623,000.

Condition Assessment

Fencing condition assessment was completed by visual inspection. All sections of fencing and gates were visually inspected for damage and functionality. The extent of corrosion and vegetation on fencing was also noted. A condition rating based on remaining useful life (RUL) has been established for fencing as represented in Table 19 below.

Table 19 - Fencing Asset Condition Rating

Condition Rating	Excellent	Good	Fair	Poor	Deficient
Remaining Useful Life (RUL)	>20	10-20	3-10	<3	Beyond Useful Life

Current Condition

Overall, the steel picket fencing is in good to excellent condition. The chain link fencing is serviceable, with most of it in fair too good condition, however some sections deficient and beyond its useful life.

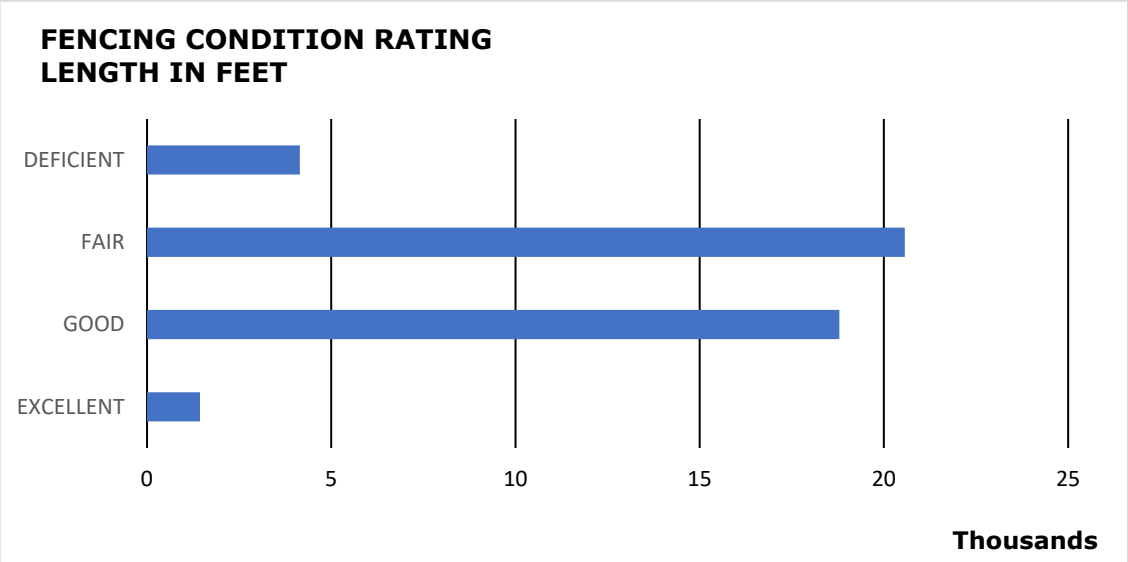

Figure 8 - Fencing Current Condition Summary by Length

Assumptions

- Remaining useful life is estimated based on the current condition of the asset.
- Assets with no signs of wear or damaged were assumed to have a maximum useful life of 25 years.
- Repairs and renewals were not considered to significantly extend useful life.

LEVEL OF SERVICE

Table 20 - Level of Service Factors for Fencing Assets

LOS Factor	Performance Indicator, Target, and Other Considerations
Organizational Goals	Maintain fence in good condition as measured by estimated remaining useful life. Provide boundary definition of Port areas through perimeter fencing. Provide physical deterrent to unauthorized entry into secured areas. Security fences and gates are installed and used primarily to define the perimeter of protected areas, restricted areas, controlled areas, entry control/access control points, installation perimeters, and to define parcel boundaries. Fencing should provide a physical and psychological deterrent to entry and preventing unauthorized personnel from entering a protected area.
Stakeholder expectations and considerations	Port provides and maintains functional perimeter security through construction and maintenance of fencing. Fencing egress points are reliable and easy to use.
Legislative / Regulatory Requirements	Homeland security, U.S. Customs Foreign Trade Zone
Economic Considerations	None identified.

RENEWAL STRATEGIES & PLAN

Table 21 - General Renewal Strategy Considerations for Fencing Assets

Renewal Strategy Factor	Considerations
Level of Service	Maintain or improve level of service Establish fencing standard to ensure continued unification in type. Evaluate inclusion of gate automation into renewals
Risks	Some fencing segments do not have well defined function while most may be considered critical assets. A method for prioritizing important fence segments based on function would be beneficial to renewal planning.
New Technologies	None identified.
Growth	Expansion of secured port areas should be considered during fencing renewals.
Environmental Impact	No renewal strategies are identified that consider environmental impacts of fencing.

Asset Renewal Plan

An asset renewal plan workbook is developed for fencing and is organized by segment. Renewals for gates are included in the associated fence segment and primarily assume an in-kind replacement. The primary renewal strategy capture in the plan is full replacement at end of estimated useful life. Reuse of fencing components like posts and gates during replacements is not considered in the renewal plan. Total renewal costs estimated for fencing through 2070 is about $9.77M.

Assumptions

- Current fencing types and locations assumed to meet the current regulatory requirements and tenant needs.

6. GREEN INFRASTRUCTURE AND PUBLIC SPACES

STATE OF INFRASTRUCTURE

Inventory

Port assets in the green infrastructure and public spaces category include a stormwater management facility and public waterfront access spaces as follows:

- North Urban Park (North Harbor Tract)
- Public Waterfront
    - Russell Avenue Pier and Walkway*
    - Park space adjacent to Lake Express
    - Pier Wisconsin (North Harbor Tract)*
    - Area adjacent to dockwalls between CDF and Liquid Cargo Pier*
- Stormwater Pond (Parcel C)
- Grand Trunk Wetlands

*Maintenance costs included in Dockwalls and Pavement asset categories.

Kaszube's Park is maintained by the City of Milwaukee and is not considered an asset of the Port. The Grand Trunk Wetlands area is managed in coordination with the Department of Community Development (DCD). Public spaces along dockwalls with no other significant infrastructure are included in the Dockwall and Pavement asset categories. This includes the Russell Avenue pier and walkway, Pier Wisconsin, and the dockwall between the CDF and Liquid Cargo Pier.

Current Replacement Value

Current replacement value of Port's green infrastructure and public spaces assets are estimated to total $396,000. Note that replacement value does not include the value of land.

Condition Assessment

Green infrastructure and public spaces condition assessments were completed by visual inspection and discussion with Port staff. The stormwater management facility was assessed for sufficient capacity and operating condition to appropriately manage stormwater needs. Other areas of green infrastructure and public spaces were assessed for ease of public access, vegetation growth, and condition of any public amenities present. Since these assets have differing maintenance and replacement requirements, a two-level condition rating system was utilized that identifies the assets as Functional or Nonfunctional in fulfilling the service they are providing. The following provide examples of conditions considered nonfunctional:

- Public space assets in need of significant repair or where public access is hindered would be considered Nonfunctional.
- Stormwater management facilities not meeting water management needs would be considered Nonfunctional.

Current Condition

Current condition ratings for green infrastructure and public space assets were all determined to be functional. No major repairs or maintenance requirements were observed. A condition summary was prepared to document the assessment.

LEVEL OF SERVICE

Table 22 - Level of Service Factors for Green Infrastructure and Public Space Assets

LOS Factor	Performance Indicator, Target, and Other Considerations
Organizational Goals	Maintain green infrastructure in functional condition.
Stakeholder expectations and considerations	Public expects accessibility maintained or improved.
Legislative / Regulatory Requirements	Stormwater Management Facility: Meet WDNR maintenance requirements.
Economic Considerations	Maintain effective stormwater management to protect other Port assets.

RENEWAL STRATEGIES & PLAN

Table 23 - General Renewal Strategy Considerations for Green Infrastructure and Public Space Assets

Renewal Strategy Factor	Considerations
Level of Service	Maintain in functional condition. Improve public access were
Risks	Public access to waterfront areas requires Port security tools to maintain safety of other Port assets.
New Technologies	Consider use of green technologies (i.e., rain gardens) in future stormwater management planning.
Growth	Consider inclusion of additional green infrastructure and public spaces in any future expansion plans.
Environmental Impacts	Work with City to maintain and improve wetland habitat area at Grand Trunk. Look for opportunities to implement proposed green infrastructure solutions identified by Harbor District Inc. in their Port Milwaukee Storm Water and Green Infrastructure Plan (2020).

Asset Renewal Plan

An asset renewal plan workbook was developed for this asset category. Renewals generally include maintenance activities for the stormwater management facility and Lake Express public access facilities. Total renewal costs estimated for these facilities through 2070 is about $1.6M.

Assumptions

- Only mowing and minor maintenance included in current renewal plans. Stormwater management facility to be monitored for functionality and condition of pond liner periodically inspected.

7. LIGHTING

STATE OF INFRASTRUCTURE

Inventory

Port assets in the lighting category include lights that are independent of street lighting and building or parking area lighting. The inventory includes seven floodlight clusters on poles. Three flood light poles are located in the City Heavy Lift Dock area and four are located in the Intermodal Yard. All inventoried lights serve to illuminate work areas. Streetlights and flood lights mounted on street light poles are assumed to be managed by the City of Milwaukee DPW, not the Port. Existing asset data for lights indicating age, model, and type were not available. The asset inventory data was derived from what could be inferred at ground level during the inspection.

Current Replacement Value

Current replacement value of Port's lighting assets is estimated to total $14,000 which represents a small portion of the Port's asset portfolio.

Condition Assessment

Lighting condition assessments were completed by visual inspection from the ground during daylight hours. Due to limitations for accessing lighting fixtures they were not closely inspected.

A condition rating based on remaining useful life (RUL) has been established for lighting as presented int Table 24.

Table 24 - Lighting Asset Condition Rating

Condition Rating	Excellent	Good	Fair	Poor	Deficient
Remaining Useful Life (RUL)	>15	10-15	3-10	<3	Beyond Useful Life

Current Condition

All support poles were found to be in good condition. The lights were assumed to be in working condition. Overall, each lighting asset was assumed to have three-quarters of their useful life remaining (or about 15 years) since installation or renewal dates are not available.

Assumptions

- Light fixtures were assumed to be in working condition. Lighting was inspected only during daylight hours.
- Lighting wattage assumed to fulfill working and safety needs for illuminated areas.
- Per Port guidance – flood lights mounted on city maintained light poles assumed to be maintained by city.

LEVEL OF SERVICE

Table 25 - Level of Service Factors for Lighting Assets

LOS Factor	Performance Indicator, Target, and Other Considerations
Organizational Goals	Maintain lighting in good working condition as measured by estimated remaining useful life. Provide level of illumination to clearly identify persons or objects and create a safer work environment as well as a psychological deterrent to criminal activity in the area. Security lighting should provide a level of illumination to clearly identify persons or objects and create a safer work environment as well as psychological deterrent to criminal activity in the area.
Stakeholder expectations and considerations	Provide security Provide security and illumination of dock/yard to provide for safe and efficient operation during hours of darkness. Provide reliable lighting as part of overall Port security plan.
Legislative / Regulatory Requirements	Align replacements with City standards
Economic Considerations	None identified.

RENEWAL STRATEGIES & PLAN

Table 26 - General Renewal Strategy Considerations for Lighting Assets

Renewal Strategy Factor	Considerations
Level of Service	Maintain level of service.
Risks	Some value on operational safety with function lights on CHLD. Maybe none identified.
New Technologies	Factor energy efficiencies into replacements (e.g., LED). Consider opportunities for incorporating renewable energy sources (e.g., solar).
Growth	Expansion of secured port areas should be considered during lighting renewals.
Environmental Impacts	Incorporate lighting designed to improve energy efficiency and reduce light pollution when replacing.

Asset Renewal Plan

For the lighting asset category, the Asset Renewal Plan Workbook is organized by light pole and provides a unit cost for replacement of the entire light and pole structure. Replacement frequency is based on assumed age of current lighting assets. The assumed RUL is provided as a placeholder in the renewal plan workbook to program replacement costs over the 50-year planning horizon for each light. These can be refined in subsequent plan update when additional asset information is available. Total renewal costs currently estimated for lighting renewals through 2070 is about $49,000.

Assumptions

- Lighting wattage and placement assumed to fulfill working and safety needs for illuminated areas.
- Assumes Port will have need to replace each light asset at the end of its useful life.

8. PAVEMENT AND ROADS

STATE OF INFRASTRUCTURE

Inventory

The Port's pavement and roads asset category includes roadways, pavement areas, and walkways in the South Harbor Tract. Roadway assets are primarily service roads. The City of Milwaukee maintains public roadways within the Port boundaries. Roadways sections are typically asphalt with no curb and limited shoulder. Some concrete pavement roadway sections are present. Roadway sections in the South Harbor Tract do not include sidewalks. Pavement areas included in this asset category are those generally not associated with a building asset such as the City Heavy Lift Dock. A complete list of the pavement and road assets included in this category are provided in Table 27 below.

Table 27 - Pavement and Roadway Assets

ASSET ID	ASSET TYPE
HIGH-WIDE ROUTE	Roadway
SOUTH HARBOR DRIVE EXTENDED	Roadway
LAKE EXPRESS DRIVE	Roadway
HARBOR-BAY DR ACCESS ROAD	Roadway
WEST TURNING BASIN SERVICE ROAD	Roadway
HARBOR-LINCOLN DR SOUTH ACCESS ROAD	Roadway
EAST TURNING BASIN ACCESS ROAD	Roadway
SOUTH CARFERRY DR.	Roadway
SOUTH CARFERRY DR ACCESS ROAD	Roadway
CAR FERRY-HARBOR DR ACCESS ROAD	Roadway
HARBOR-LINCOLN DR NORTH ACCESS ROAD	Roadway
CITY HEAVY LIFT DOCK SERVICE ROAD	Roadway
CITY HEAVY LIFT DOCK PAVEMENT	Pavement Area
CITY HEAVY LIFT DOCK CONCRETE APRON	Pavement Area
TERMINAL 1 PAVEMENT	Pavement Area
TERMINAL 1 CONCRETE APRON	Pavement Area
SOUTH SLIP 1 WEST APRON	Pavement Area
SOUTH SLIP 2 WEST APRON	Pavement Area
SOUTH SLIP 3 WEST APRON	Pavement Area
SOUTH SHORE CRUISE DOCK PAVEMENT	Pavement Area
LAKE EXPRESS WEST PARKING LOT	Parking Lot
LAKE EXPRESS EAST PARKING LOT	Parking Lot
KASZUBE'S PARK LOT	Parking Lot
RUSSELL AVENUE PIER ACCESS WALKWAY	Walkway
LAKE EXPRESS WALKWAY	Walkway

Current Replacement Value

Current replacement value of pavement and road assets are estimated to total $6,048,740. About 70% of this total replacement value is comprised of the Terminal 1 Pavement area and City Heavy Lift Dock area replacement values at $1.5M and $2.8M respectively.

Condition Assessment

Pavement and road assets were inspected visually using both in-person and drone imagery tools. Observed pavement surface conditions were rated using the Pavement Surface Evaluation and Rating (PASER) method developed by the Transportation Information Center at the University of Wisconsin-Madison. The PASER manual is used to describe types of defects and provides a simple system to visually rate pavement. PASER manuals are available to assist in rating asphalt, concrete, and gravel road surfaces. The PASER system also employs a five-point condition rating that aligns with the scheme used throughout this CARP. A summary of the condition rating based PASER rating is provided in Table 28 below.

Table 28 – Pavement and Road Asset Condition Rating

Condition Rating	Excellent	Good	Fair	Poor	Deficient
PASER Rating	8-10	6-7	4-5	2-3	1

Current Condition

Pavement and road assets exhibited the range of conditions from poor to excellent. Pavement condition rating by asset type and total area is provided in Figure 9. A summary of the pavement condition assessments is provided as attachment to the CARP. Current pavement conditions are generally spread across the lifecycle, with most of the pavement area rated as good to fair. About 188,000 SF of pavement is considered in poor condition (~17%).

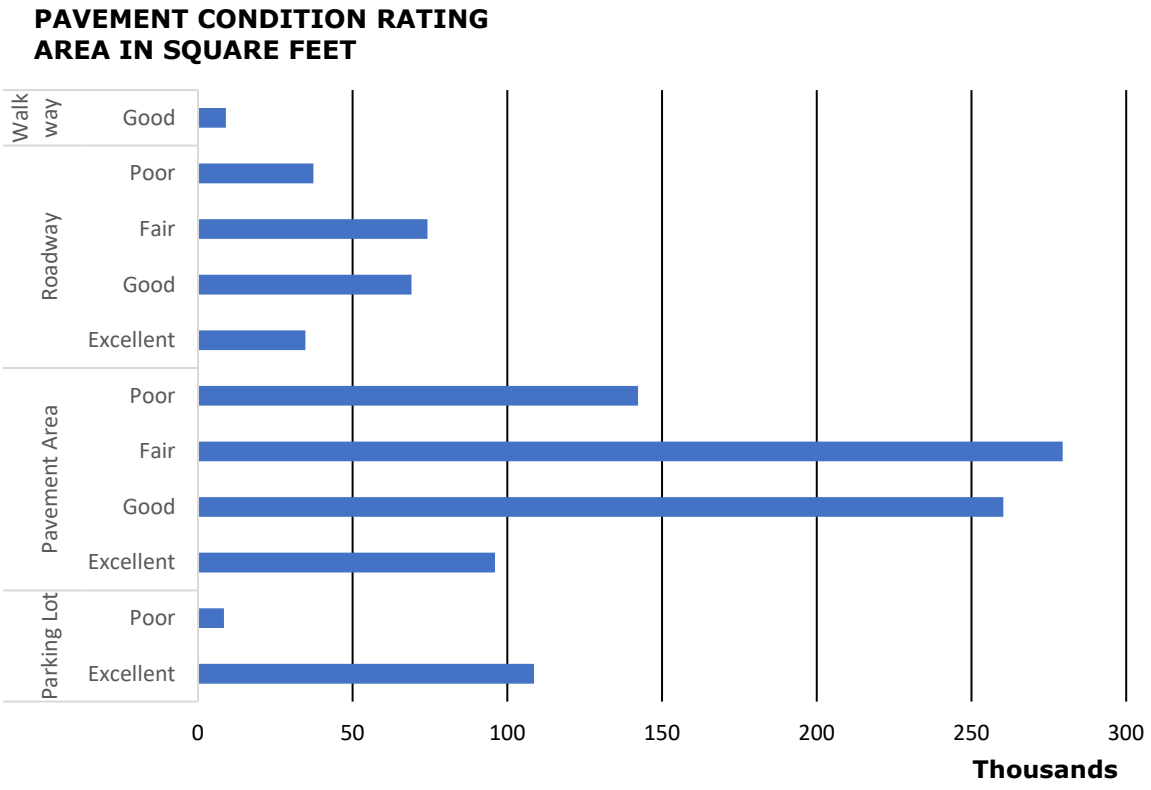

Figure 9 - Pavement Current Condition Summary

LEVEL OF SERVICE

Table 29 - Level of Service Factors for Pavement and Road Assets

LOS Factor	Performance Indicator, Target, and Other Considerations
Organizational Goals	Maintain in good condition as defined by PACER rating of 6-7.
Stakeholder expectations and considerations	Port tenants expected pavement inventory provides safe and reliable traveling surface for large freight vehicles.
Legislative / Regulatory Requirements	Meet maintenance standards of WisDOT and City of Milwaukee DPW.
Economic Considerations	Align renewals with City Public Works Department renewals for island roadways to achieve cost efficiencies. Optimize renewals to maximize pavement lifecycle.

RENEWAL STRATEGIES & PLAN

Table 30 - General Renewal Strategy Considerations for Pavement and Road Assets

Renewal Strategy Factor	Considerations
Level of Service	Maintain or improve level of service Improve stormwater drainage or other to maximize pavement lifecycle. Align with other regional Port best management practices (BMPs).
Risks	Failure of roadway assets may increase risk to public safety and port commercial activity. Maintaining defined level of service will reduce risks.
New Technologies	Consider use of alternative pavement options.
Growth	Plan for heavier vehicles use and cranes when renewing pavements
Environmental Impacts	Consider some storm water pavement solutions in defined areas. Evaluate reduced energy materials (lower carbon footprint).

Asset Renewal Plan

The asset renewal plan for pavements and roads includes recommended maintenance and replacements based on current condition and estimated remaining useful life. Renewals are arranged by asset and broken into subsections where distinct repair areas are identified. High interest, poor condition, areas identified as Harbor-Lincoln Dr North Access Road, South Slip 1 West Apron and Terminal 1 Pavement area. Total renewal costs estimated for rail renewals through 2070 is about $9.2M.

Assumptions

- Pavement sections have been assumed based on experience with similar. Information such as thickness and type of granular base and pavement not available in current Port asset data.
- Routine maintenance of pavements including patching and sealing are performed.

9. RAIL

STATE OF INFRASTRUCTURE

Inventory

The Port has over 10 miles of rail identified in the asset inventory with a little more than a third of that under leased service. The asset inventory was obtained from the Port Asset Database (PAD) and is organized into track segments and switches. At the time of plan development, digital mapping data of rail assets was not available and was not developed for the CARP. Locational and length data for rail inventories were derived from the Track Inventory Map (Sheet R-1) prepared by Via Rail Logistics, LLC (2012). The 2012 inventory map and PAD had some discrepancies

between them and as compared to the conditions observed in the field likely due to age of the data. Discrepancies identified are noted as appropriate in the Capital Asset Renewal Plan Workbook. Future work to digitize rail asset inventories will aid in managing rail asset renewal plans and future updates.

Current Replacement Value

Current replacement value of rail assets is estimated to total $25,000,000.

Condition Assessment

A detailed inspection of rail assets was performed in 2020 by Volkmann Railroad Builders on behalf of Port Milwaukee. Several recommendations for priority repairs were made by Volkman (April 13, 2020 letter to Brian Kasprzyk). The Volkman inspections and findings, which utilized a standard inspection form and were performed by qualified inspectors, serve as the basis for the condition assessment performed for this initial CARP. The Volkman rail inspection findings and repair recommendations were evaluated and summarized into a data table (Milwaukee Rail Asset Inventory and Condition Assessment Summary.xlsx). An estimated remaining useful life (RUL) for each rail asset was determined based on the inspection results and estimated age. A 5-point condition rating based on RUL has been established for rail assets as shown in Table 31.

Table 31 - Rail Asset Condition Rating

Condition Rating	Excellent	Good	Fair	Poor	Deficient
Years Remaining Useful Life (RUL)	>40	25-40	10-25	<5	Beyond Useful Life

Current Condition

Overall condition of rail system is serviceable. About half of the rail inventory is rated as good or better based on estimated remaining useful life. Some poor and deficient track segments are identified (combined for about 27%). Details of the condition for each track segment are identified in the summary worksheet (Milwaukee Rail Asset Inventory and Condition Assessment Summary.xlsx). An overview of the condition rating by track type (leased / non-leased) is provided in Figure 10.

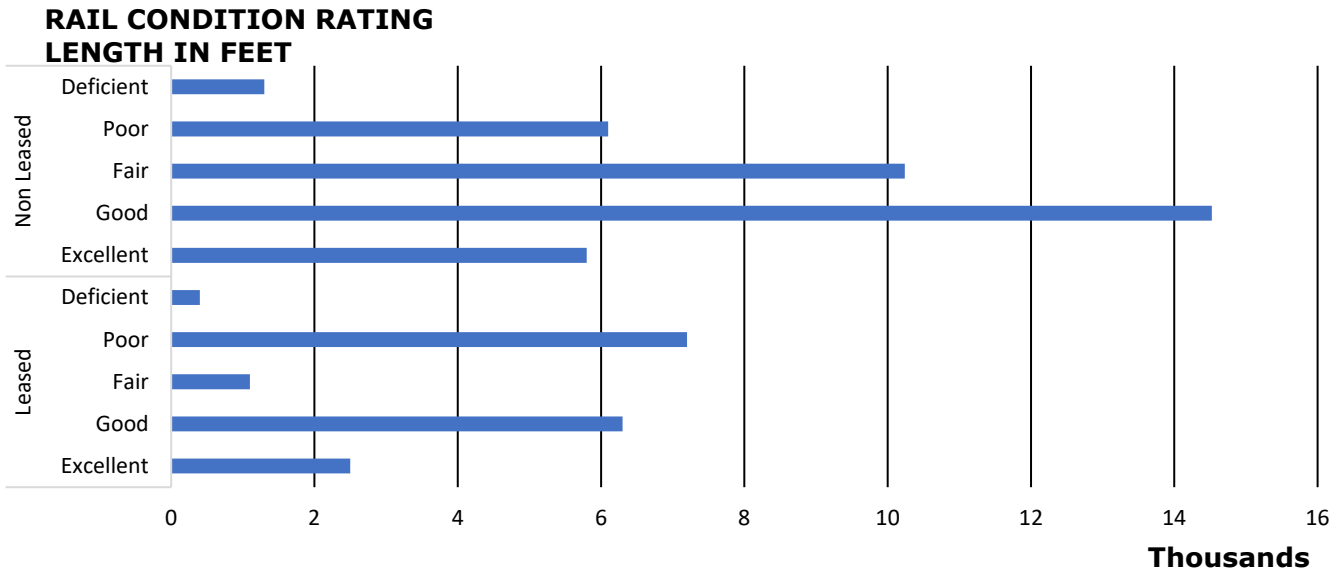

Figure 10 – Rail Current Condition Summary

Assumptions

- Estimated remaining useful life for rail assets was derived from condition reports where possible. When not possible, judgment has been made based on available information.

LEVEL OF SERVICE

Table 32 - Level of Service Factors for Rail Assets

LOS Factor	Performance Indicator, Target, and Other Considerations
Organizational Goals	Maintain in good condition as defined by remaining useful life of greater than 25 years.
Stakeholder expectations and considerations	Maintain rail to meet tenant expectation for reliable and safe performance.
Legislative / Regulatory Requirements	Railway requirements/regulations FRA, OCR, Class 1 Standards
Economic Considerations	Leverage state/federal funding to supplement renewal costs.

RENEWAL STRATEGIES & PLAN

Table 33 - General Renewal Strategy Considerations for Rail Assets

Renewal Strategy Factor	Considerations
Level of Service	Maintain level of service Upgrade rail to 115 lb. weight and switches (Samson). Raise railyards and switches above road grade to prevent roadway runoff and silting in of switches at road grade crossings.
Risks	Categorize track area/segments into priority areas based on condition and use. Evaluate coastal factors associated with risk to flooding of rail assets and operations. Manage grant funding risks through implementation of CARP.
New Technologies	None identified.
Growth	Expand rail system to accommodate Ag Export Project.
Environmental Impacts	None identified.

Asset Renewal Plan

The asset renewal plan workbook developed for the rail asset category is organized by track segment. Switch renewals are included with an associated track segment. Total renewal costs estimated for rail renewals through 2070 is about $44.7M.

Due to the pending rail improvement projects stemming from the ag export project and the dated rail a significant update to the rail inventory and renewal planning will likely be required for the next comprehensive plan update.

Assumptions

- Renewal planning for switches assumed that all switches required upgrade to Samson type.
- Renewal planning for tracks assumed that those not currently 115 lb. class, or where track size was not indicated in inspection report, are required to be upgraded.

10. UTILITIES

STATE OF INFRASTRUCTURE

Inventory

Port Milwaukee utility asset category includes water distribution, storm sewer, and sanitary sewer systems across the South Harbor Track and water distribution, sanitary sewer, and dry fire line fire suppression systems across the North Harbor Track Municipal Pier. These systems support water and sewer system requirements of the port and tenant operations across the entire port.

South Harbor Track utility assets, overall system piping lengths:

- Water Distribution, approximately 6.8 miles
- Sanitary Sewer, approximately 3 miles
- Storm Sewer, approximately 2.6 miles

North Harbor Track Municipal Pier utility assets, overall system piping lengths:

- Water Distribution, approximately 0.2 miles
- Sanitary Sewer, approximately 0.2 miles
- Dry Fire Line, approximately 0.2 miles

Current Replacement Value

Current replacement value of Port's utility assets is estimated to total $8,299,350. Figure 11 below shows current replacement value per system.

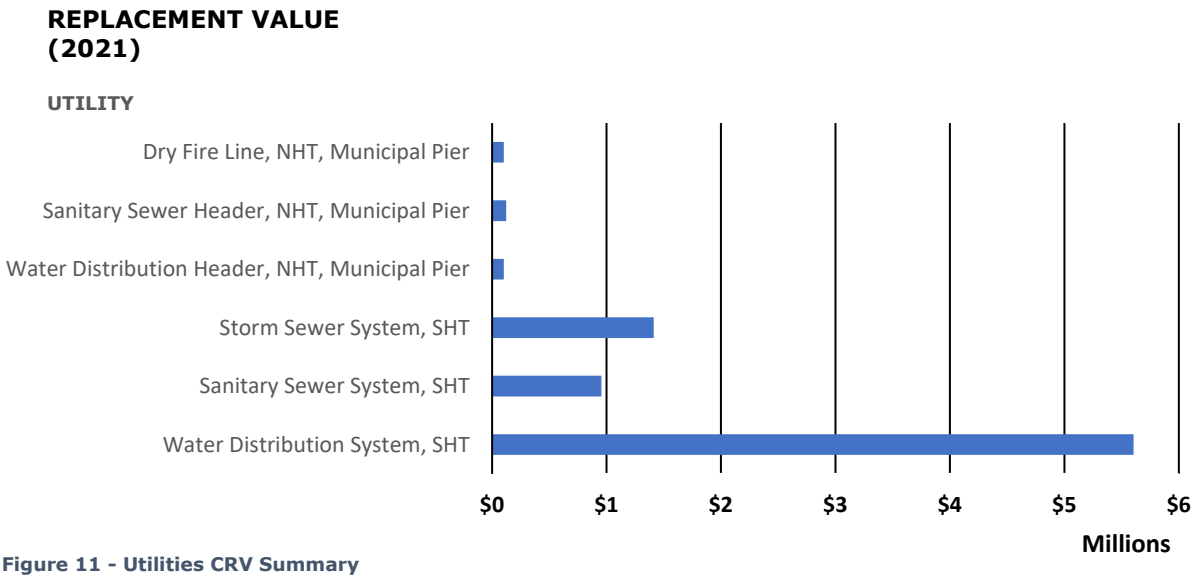

Figure 11 - Utilities CRV Summary

Condition Assessment

The condition assessments and renewal strategy for Port Milwaukee's utility systems including water distribution, sanitary sewer, storm sewer and dry fire line piping systems were based on a desktop analysis using the guidelines of the American Water Works Association (AWWA), Manual of Water Supply Practices, M77 "Condition Assessments of Water Mains".

Utilities were organized into system sections, these sections included the similar piping, valve, hydrant, etc. assets that are located within that area of the system. Within each system section, the assets were organized by size and installation date associated with the pipe in the system; size and date information were based on notes within the utility drawings provided by the Port.

The data used for the desktop analysis was taken from utility service drawings of the South Harbor Tract, Drawing No. C1-1-46 with annotations revised 5-4-1996, and North Harbor Tract, Municipal Pier Breakwater, Drawing C107A revised 6-30-2004 as well as the mid-90's era Port of Milwaukee Infrastructure Report, Sections 7 and 8 for the water distribution system and sewer systems respectively.

The condition assessments were based on the system age and material of construction and is an assumption of conditions derived from the limited data available; detailed historical information regarding system breaks and leaks, system outage repair, and system maintenance was not available.

Existing water system piping material was assumed to be ductile iron pipe. The industry standard life expectancy of buried ductile iron pipe utility systems is 100 years per the Ductile Iron Pipe Research Association (DIPRA) and AWWA.

Existing sanitary and storm sewer piping was assumed to be clay pipe. Although the industry standard life expectancy of modern vitrified clay pipe utility systems is over 100 years per the National Clay Pipe Institute (NCPI), there exist many critical variations in the historical standards for the manufacture and installation of old clay (non-vitrified) piping, therefore the conservative estimate for life expectancy of 60 years is used.

These industry standards were used as the assumed effective useful life (EUL) when assessing the water and dry fire system conditions. EUL is shown simply as the useful life (UL) within the Asset Renewal Plan Worksheets for all utility systems.

The condition rating listed for the utility systems is based on remaining useful life (RUL) of the component in years, derived from the EUL and the component age, as shown below.

$$Remaining\ Useful\ Life\ (RUL) = \ Effective\ Usefull\ Life\ (EUL) - Component\ Age$$

Table 34 - Utility Asset Condition Rating

Condition Rating	Excellent	Good	Fair	Poor	Deficient
Years Remaining Useful Life (RUL)	>50	20-50	10-20	<10	Beyond Useful Life

Current Condition

The current conditions of Port Milwaukee's utility systems show the majority of the systems are well into their remaining useful life. Significant costs for replacement of portions of water and sewer systems could potentially be required within the near future as well as increased replacement costs across most of the systems over the next 50 years. Considering the industry described effective useful life of between 60 and 100 years and the average ages of the Ports current utility systems as described below.

The average age of the current Port Milwaukee utility systems:

- SHT Water distribution system average age 52 years
- SHT Sanitary sewer average age 54 years
- SHT Storm sewer average age 56 years
- NHT Water, sewer and fire line average age 17 years

Figure 12 below shows the existing utility sytems piping lengths per condition rating for each system.

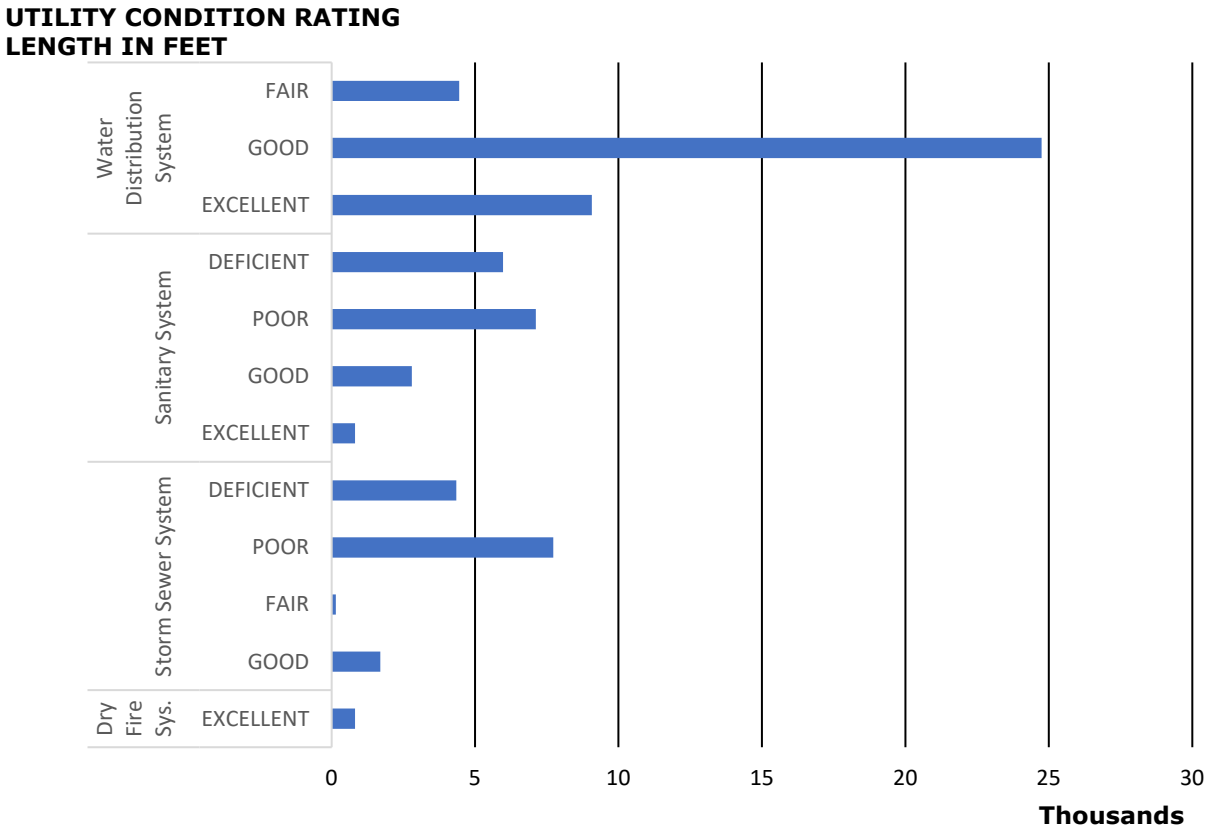

Figure 12 - Utility Current Condition Summary by System Type

Assumptions

- Assumed existing sewer (sanitary and storm) systems are clay pipe with an effective useful life of 60 years.
- Sanitary Sewer system piping to be replaced with PVC Pipe, SDR 35, gasketed flanged sealed joints, with an effective useful life of 100 years.
- Storm Sewer system piping to be replaced with reinforced concrete pipe, un-gasketed soil tight joints, with an effective useful life of 100 years.
- Assumed existing water systems are ductile iron (DI) pipe with mechanical joints with an effective useful life of 100 years, to be replaced with same.
- Replacement of pipes to include excavating, trenching, backfill only as required for pipe size, and paving with typical asphalt or concrete; additional cost may be incurred for high strength reinforced or sealed concrete surface.
- Existing storm sewer system includes new buried storm drawings along S. Carferry Dr, replacing culverts as city piping, not within Port sewer system scope.
- Assuming all piping on NHT Municipal Pier is ductile iron DI Class 50 piping.
- Additional detailed analysis will be required for recommended actions to improve coastal resiliency, specifically concerning the storm sewer system.

LEVEL OF SERVICE

Table 35 - Level of Service Factors for Utility Assets

LOS Factor	Performance Indicator, Target, and Other Considerations
Organizational Goals	Maintain utility systems in good condition as defined by remaining useful life of 20 years or better.
Stakeholder expectations and considerations	Storm Sewer: Provide functional storm water drainage to minimize ponding and standing water in operational areas. Look for opportunities to include BMPs and GI in storm sewer system renewals. Sanitary Sewer: Functional and safe sanitary sewerage disposal. Water Distribution: Provide water and sewer systems as required by port and tenant operations.
Legislative / Regulatory Requirements	Storm Sewer: MS4 permit requirements. SWMP requirements. Sanitary Sewer: City of Milwaukee inspection and maintenance requirements. MMSD discharge permit (NOI) Water Distribution System: Operate and maintain system in accordance with state and federal requirements for drinking water systems.
Economic Considerations	Industry drivers for utility system operational changes should be considered. System capacity changes could be affected due to industry demands.

RENEWAL STRATEGIES & PLAN

Table 36 - General Renewal Strategy Considerations for Utility Assets

Renewal Strategy Factor	Considerations
Level of Service	Maintain or improve level of service. All utility systems will require additional inspections both internal and external to the system to provide a deeper insight into the systems' conditions beyond the desktop analysis completed. Plan improvements based on coastal resiliency factors associated with flooding risk relative to storm sewer infrastructure.
Risks	Utility assets are inherently risky due to their buried nature. Regular inspection and maintenance of buried utility assets should be performed to minimize risk of unexpected failures. Regular inspection program.
New Technologies	Consider operational changes to reduce accelerated deterioration. Additional
Growth	Water Distribution: Plan improvements to system capacity and operations based on future growth to shipping tonnage and cruise industry business demand.
Environmental Impacts	Weather exposure or corrosive underground conditions could accelerate system deterioration.

Asset Renewal Plan

The asset renewal plan for utilities including water distribution, storm sewer, sanitary sewer systems and dry fire line fire suppression system includes recommended inspections and maintenance as described below and listed in the Utilities Asset Renewal Plan Workbook. Inspections are recommended per the guidelines of American Water Works Association (AWWA), Manual of Water Supply Practices, M77 "Condition Assessments of Water Mains".

Documentation of all current and recent maintenance, system breaks and leaks, both minor and major outages for all utility systems is recommended and will allow for further review and analysis of utility system conditions. The analysis of this data will indicate high risk or problem areas in the system, and along with the remaining useful life, help guide future decisions on where investments are needed for utility system maintenance, repair, and expansion.

Buried piping systems shall be replaced on a partial section phased base as necessary based on the age of the system and as necessary to reduce the operational impact of leads and breaks.

Maintenance should be performed on system components, including but not limited to valves, hose connections, pumps, hydrants, etc. in accordance with the original equipment manufacturers' recommendations.

Assumptions

- Recommended strategy includes a combination of review of recent historical system breaks and leaks and periodic system inspections in the near- and long-term future.
- Additional visual and electronic inspections of piping, valve, hydrant, and connection components will be required to determine the system conditions, maintenance plans and future replacement budget and scheduling needs.
- Additional inspections are recommended per the guidelines of American Water Works Association (AWWA), Manual of Water Supply Practices, M77 "Condition Assessments of Water Mains".

11. VEHICLES, VESSELS, CRANES, AND OTHER EQUIPMENT

STATE OF INFRASTRUCTURE

Inventory

Port Milwaukee equipment category includes cranes, waterborne vessels, vehicles, power and compressed air equipment, emergency response equipment and security equipment. These items are used across the Port properties supporting all operations of the port and its clients and tenants. The list below summarizes the asset types within the equipment category.

- Fleet vehicles, Quantity (9)
- Vessels, Quantity (3)
- Cranes, Quantity (6)
- Forklifts, Quantity (3)
- Tractors, Quantity (3)
- Power & Compressed Air, Quantity (6)
- Boom Lifts, Quantity (2)
- Emergency Response & Security Equipment, Quantity (23), including light towers, gates, message centers, modular trailers, and oil booms.

Current Replacement Value

Current replacement value of Port's equipment assets is estimated to total $17,675,000. Figure 13 below shows current replacement values by equipment category.

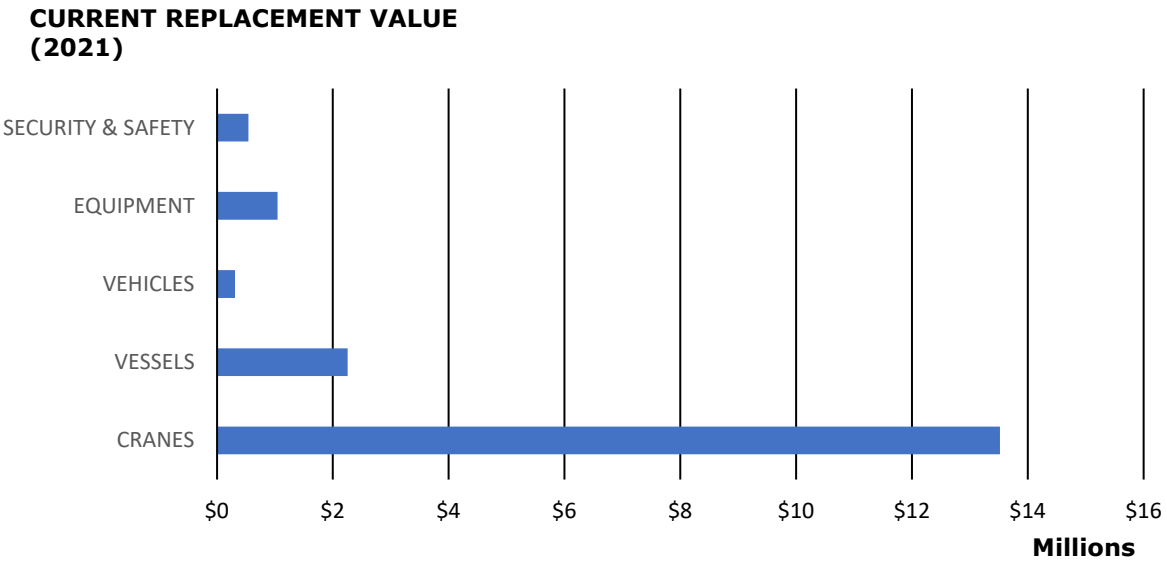

Figure 13 - Equipment CRV Summary

Condition Assessment

Condition assessment of the Port's equipment assets included a desktop analysis of the equipment's age, current operational status, available historical maintenance records, and current operational needs of the Port. Interviews were held with Port Engineering and Operations staff to review the conditions and current use of each major piece of equipment; the information gained through these discussions supplemented the desktop analysis.

The condition rating of each piece of equipment is based on the % of remaining useful life (% RUL). This allows the normalized evaluation of condition across various types of equipment with a range of estimated useful lives (UL).

Table 37 - Equipment Asset Condition Rating

Condition Rating	Excellent	Good	Fair	Poor	Deficient
% Remaining Useful Life (%RUL)	>90	40-90	20-40	<20	Beyond Useful Life

Current Condition

Figure 14 below shows the distribution of equipment items across condition ratings, with 80% of the equipment items in either excellent or good condition. There are 9 items of equipment that are in either poor or deficient condition. These items of highest concern for the Port are listed below and should be inspected further to determine a more accurate evaluation of remaining useful life and identify what maintenance actions are required to bring these assets back into operation as required by port operations.

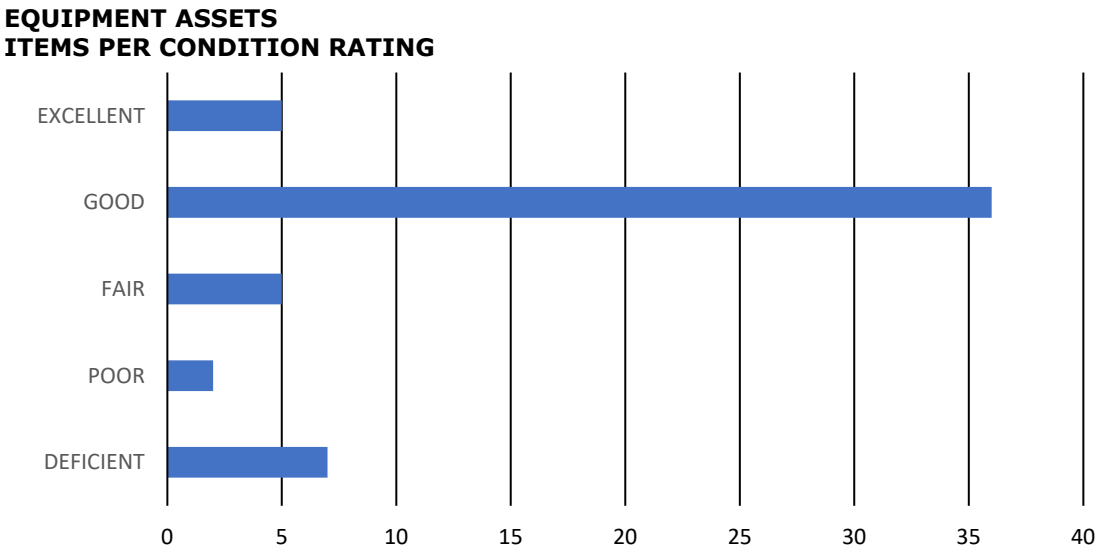

Figure 14 – Equipment Current Condition Summary

Table 38 - High Interest Equipment Assets (Deficient and Poor Condition Ratings)

ASSET ID	ASSET TYPE	MANUFACTURER	PURCHASE YEAR	CONDITION RATING	Renewal Approach Summary
Mastercraft Forklift 6000#	FORKLIFT	MASTERCRAFT INDUSTRIAL EQUIPMENT	?	DEFICIENT	Original purchase year of this forklift is unknown. Inspection is required for continued operation but the condition rating may be acceptable for continued use.
Dodge Caravan (2010)	VEHICLE	DODGE	2010	DEFICIENT	Condition rating based on useful life and recommended vehicle interval replacement strategy. Vehicles to be replaced every 5 to 10 years based on use.
Dodge Ram 3500 Reg Cab DRW Dump (2007)	VEHICLE	DODGE	2009	DEFICIENT	Condition rating based on useful life and recommended vehicle interval replacement strategy. Vehicles to be replaced every 5 to 10 years based on extent of use.
GMC Sierra 2500 Reg Cab SRW 4x4 (2009)	VEHICLE	GMC	2009	DEFICIENT	Condition rating based on useful life and recommended vehicle interval replacement strategy. Vehicles to be replaced every 5 to 10 years based on use.
Ingersoll-Rand (Air Compressor, Trailerable)	COMPRESSOR	INGERSOLL-RAND	1985	DEFICIENT	Estimated age, Compressor to be inspected and preventative maintenance performed per OEM recommendations as required for continued use.

ASSET ID	ASSET TYPE	MANUFACTURER	PURCHASE YEAR	CONDITION RATING	Renewal Approach Summary
70 TON GANTRY CRANE / #09	CRANE	CLYDE	1952	DEFICIENT	No planned operation at this time. Crane is not certified. No plans to recertify.
Sullair 185 CFM Compressor / Towable (2015)	COMPRESSOR	SULLAIR	2015	DEFICIENT	Currently out of service. Evaluate if asset is required for future port operations. Maintenance required per original equipment manufacturer to return to service.
90 TON BUCYRUS ERIE TRUCK CRANE / #18	CRANE	BUCYRUS-ERIE	1980	POOR	Continue to maintain crane operational, continued load testing for recertification. Future higher capacity and rough terrain capability replacement to be considered in the future.
Jeep Patriot Latitude (2012)	VEHICLE	JEEP	2013	POOR	Condition rating based on useful life and recommended vehicle interval replacement strategy. Vehicles to be replaced every 5 to 10 years based on use.

Assumptions

- The condition rating is based on percent of remaining useful life of each equipment item. The specific condition of each equipment item can be evaluated with further inspection as required to determine future maintenance and replacement.

LEVEL OF SERVICE

Table 39 - Level of Service Factors for Equipment Assets

LOS Factor	Performance Indicator, Target, and Other Considerations
Organizational Goals	Maintain assets in state of good repair as defined by having a percent remaining useful life of greater than 40%. Provide the equipment required to support Port operations.
Stakeholder expectations and considerations	Tenants and clients expect safe and efficient Port operations using applicable and sufficient vehicles and equipment.
Legislative / Regulatory Requirements	Maintain vehicles, vessels, cranes, and equipment in accordance with the applicable industry codes and standards as well as original equipment manufacturer (OEM) recommendations.
Economic Considerations	Consider the environmental and economic impacts and feasibilities of electric vehicles and renewable energies in the future as applicable.

RENEWAL STRATEGIES & PLAN

Table 40 - General Renewal Strategy Considerations for Equipment Assets

Renewal Strategy Factor	Considerations
Level of Service	Maintain level of service.
Risks	Various asset types within equipment may have various renewal strategy factors. Vehicles are recommended to be evaluated for new technologies while existing cranes can be maintained following current industry standards and practices.
New Technologies	Plan for transition to electric vehicle fleet within the current 50-year renewal planning period. Estimated time horizon is by 2030/2040.
Growth	Consider if growth of Port operations for shipping and cruise industry traffic requires additional equipment capacity.

Asset Renewal Plan

The asset renewal plan for the Port's equipment including vehicles, vessels, cranes, and emergency and security equipment, etc. is listed in the Equipment Asset Renewal Plan Workbook. This plan focuses on standard preventative maintenance as described by the applicable industry standards. Cranes and vehicles shall be inspected and certified in accordance with their applicable requirements. The majority of the equipment is good or excellent operating condition and can continue to be maintained and operated in accordance with the Port's current operations.

The items listed in poor condition, including the 90 Ton Bucyrus Crane #18 and Jeep Patriot Latitude Vehicle are still operational, it is recommended that these be maintained and evaluated for further operation past their useful life as required.

The items listed in deficient condition, specifically the Sullair Compressor and 70-ton Gantry Crane #09 are out of service with no planned operation, it is recommended that the Port review these assets for use as needed in the future. Vehicles shown as deficient, beyond their useful life, may still be operational and can be evaluated for further service and maintained or replaced as required.

Assumptions

- The renewal strategies may vary for each asset type within the equipment category and each asset type should be reviewed individually as required during the Port's future asset management strategy development.
- Emergency response equipment and security equipment is protected and stored when not in use, it can be periodically inspected and maintained as required and may be used beyond its listed useful life.

12. RENEWAL SUMMARY

This CARP serves as a tool for Port Milwaukee to strategically plan significant improvements to port facilities and develop funding strategies for long-term asset repair and replacement. It provides a high level, long-term action plan for asset renewal for a 50-year period and considers key factors influencing asset renewal planning at the Port including the Port's goals, stakeholder input, and long-term trends in coastal conditions and infrastructure resiliency to those conditions. This initial plan, developed in 2020/2021, projects asset renewals through the year 2070. This section summarizes the renewal plan financial information presented for each asset category to provide a complete picture of the Port's infrastructure and renewal need. Values provided in this section are based on the condition assessment and renewal planning completed in 2020/2021.

12.1 CURRENT REPLACEMENT VALUE

The current replacement value (CRV) of Port assets by category is provided in Figure 15.

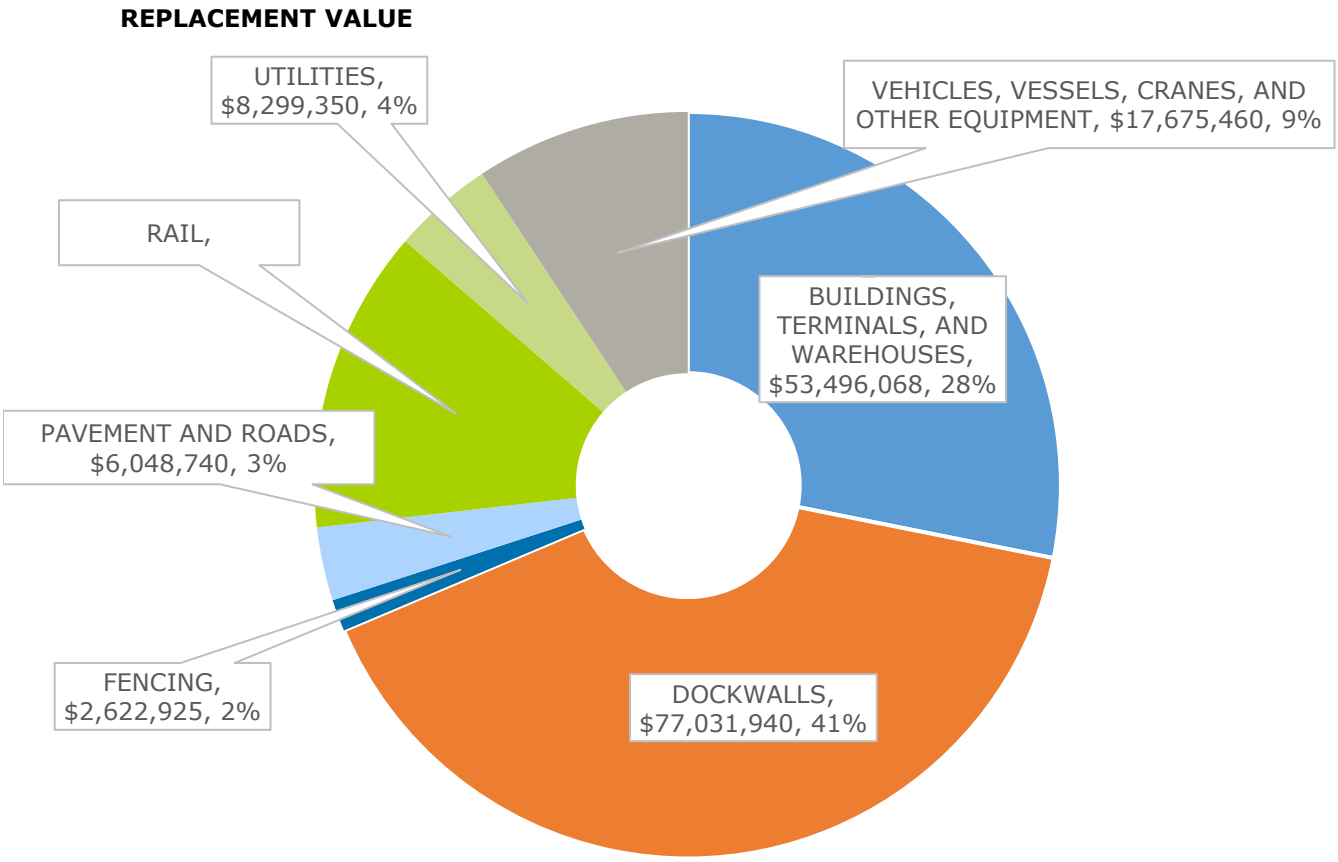

Figure 15 - Current Replacement Value by Asset Category

Dockwall and building assets have the largest share of replacement value representing about 70% of the total asset value followed by rail and equipment at 13% and 9%, respectively. Dockwalls and buildings are long-life assets with relatively high replacement costs. Overall renewal strategy for these assets requires well-planned lifecycle management to optimize their service life. Renewal planning and funding levels should generally follow the relative percentages indicated with dockwalls, buildings, and rail assets receiving the larger shares of renewal funding.

12.2 CURRENT AND PLANNED RENEWAL NEED

A summary of the current and planned renewal needs based on the plans presented in the individual asset category sections is provided in Figure 16. Current renewal need is represented by the capital repairs and deferred maintenance (CRDM) category. Planned needs are the projected renewals per 5-year planning bin. Renewal data represented in Figure 16 is based on the current costs of renewal work that is inflated at an annual rate (in this case 2.2%) to provide a comparison of costs over the planning period relative to today's dollar. Similar to the total CRV relative to each category, the renewal cost over the next 50-year planning period is seen to be primarily influenced by dockwall, building, and rail system renewals. The total renewal need across all categories is about $204M (million) with an average renewal of about $20M every 5-years or a little less than $4M annually. Peaks in the total renewal cost can be flattened by phasing the large renewal project across a longer period. A linear trend line is applied to the data (dashed) which generally shows an increasing renewal cost of about $2M every 5-years. A portion of this is attributable to the inflation factored into the renewal cost projections.

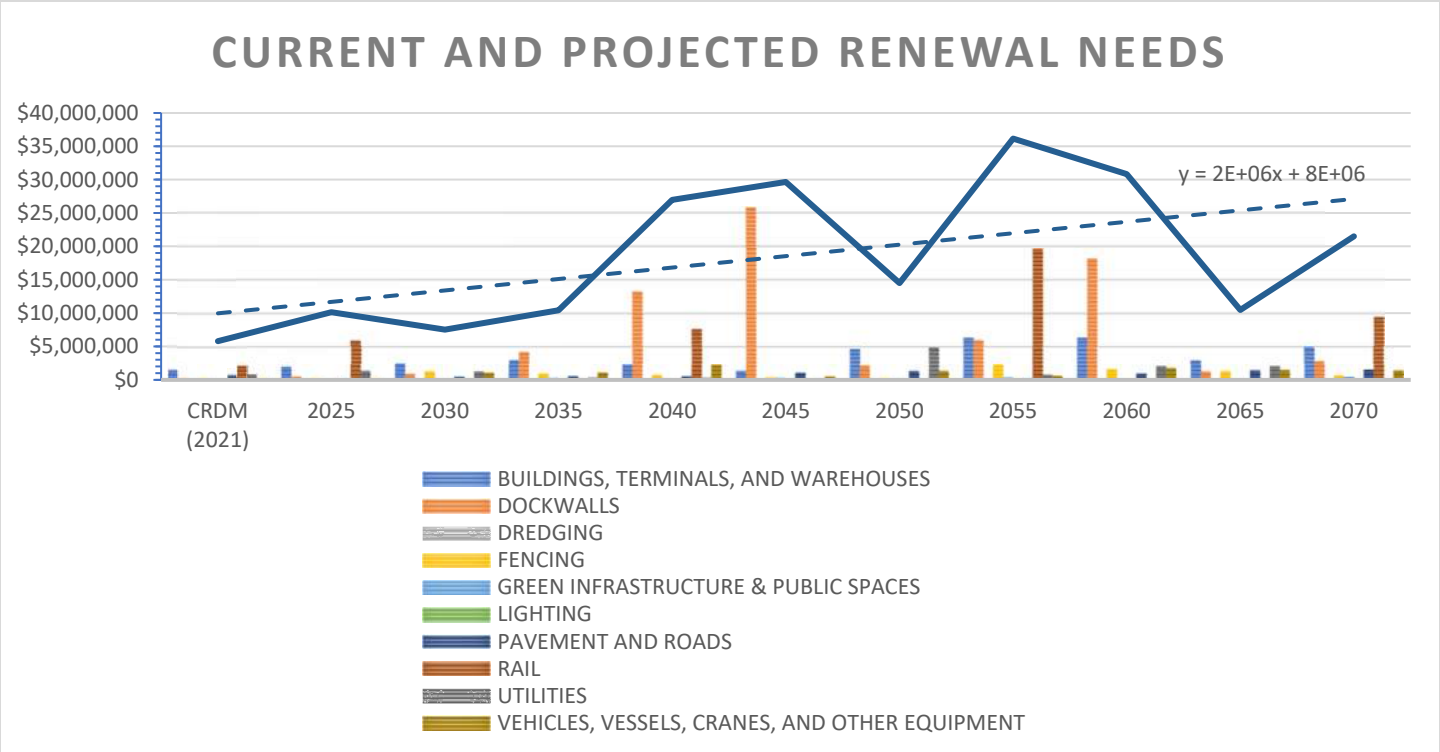

Figure 16 - Current and Projected Renewal Needs

The total 50-year renewal costs by asset category including percent of total are presented in Figure 17.

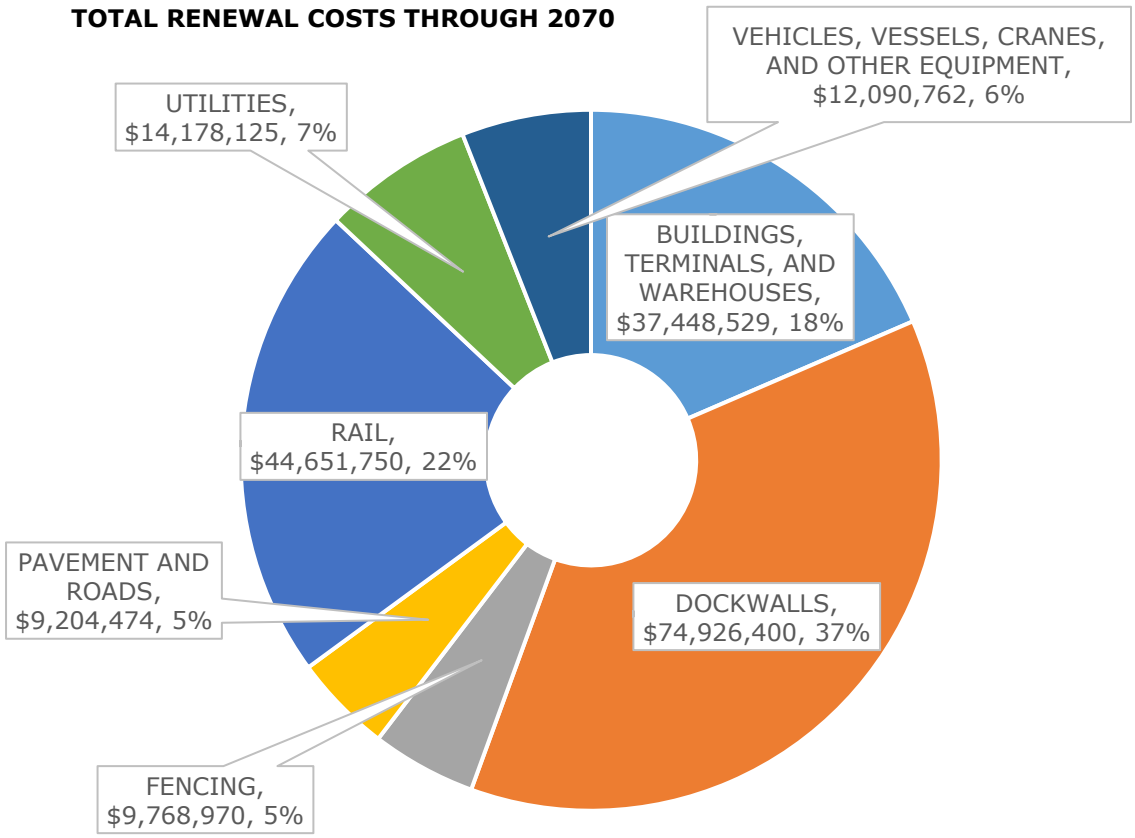

Figure 17 - Total 50-Year Renewal Need by Asset Category

13. CONTINUOUS IMPROVEMENT AND UPDATE

This Capital Asset Renewal Plan has been developed as a stand-alone plan that forms a part of the Port's overall asset management processes and tools. At the time of initial plan development, the Port did not have a comprehensive asset management system established. Implementation of an asset management system at a future date will likely incorporate elements of this renewal plan. Until replaced or otherwise made obsolete, this plan will require regular update of the asset renewal scheduling and to refine strategies.

13.1 COMPREHENSIVE PLAN UPDATE

A comprehensive plan update frequency of 5 years is recommended. This frequency will align with the structure of the asset renewal plan worksheets and is infrequent enough to not be overly burdensome to Port staff and resources. More or less frequent plan updates may be schedule for specific asset categories. Figure 18 identifies the general flow of activities envisioned during a comprehensive plan update.

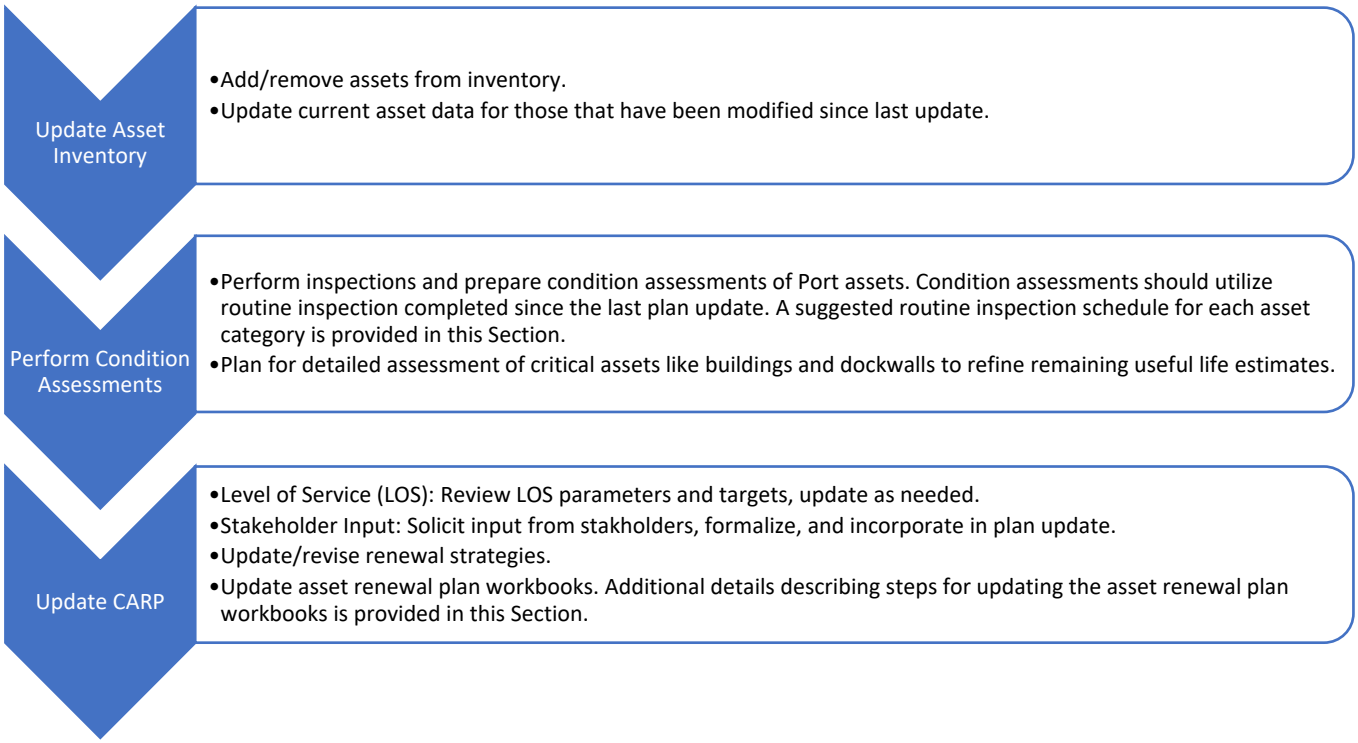

Figure 18 - Comprehensive Plan Update Steps

13.2 UPDATE TO ASSET RENEWAL PLAN WORKBOOKS

Updates to the asset renewal plan to renewal plan workbooks will generally include the following steps:

- Extend planning period 5-years by adding a 5-year bin at end of worksheet. Workbook formulas and reference will need to be checked and updated.
- Add new assets to the plan worksheet by copy an existing asset plan and inserting.
- Add/adjust/shift projected renewal costs and add the renewal costs not completed to CRDM category as appropriate. Check and update estimated unit costs and quantities.
- Update current replacement value by checking and updating unit costs and quantities. Add new assets to CRV worksheets.
- Update summary table by ensuring existing table references are correct and adding new asset lines and references.

13.3 ROUTINE INSPECTION SCHEDULE

A suggested routine inspection schedule by asset category is presented in Table 41 below. A routine inspection of port assets will allow for effective inventory tracking and maintenance planning as well as supporting comprehensive updates to the CARP.

Table 41 – Suggested Routine Inspection Schedule

Asset Category	Inspection Frequency	Inspection Tasks
Buildings, Terminals, and Warehouses	Annual	Visual inspection, tenant interviews
Dockwalls	Biannual	Visual inspection from shore, and from water (boat or drone) as needed. Diver inspection, as needed.
Navigational Areas	Biannual	Bathymetric survey
Fencing	Biannual	Visual inspection
Green Infrastructure and Public Spaces	Biannual	Visual inspection
Lighting	Quarterly	Visual inspection, customer/tenant interviews
Pavement and Roads	Annual	Visual inspection
Rail	Biannual	Visual inspection
Utilities	Annual, as opportunity permits	Visual inspection (internal and external) as accessible, customer/tenant interviews
Vehicles, Vessels, Cranes, and Other Equipment	Quarterly	Visual and mechanical inspection

14. ASSET MANAGEMENT SYSTEM RECOMMENDATIONS

The following section provides recommendations for establishing an asset management system (AMS) at Port Milwaukee. The primary purpose of this Capital Asset Renewal Plan is to provide the Port with a framework for planning major rehabilitation and replacement of port infrastructure, facilities, and equipment. At the time of plan development, Port Milwaukee does not have a comprehensive AMS and is seeking to establish one. This CARP would serve as a plan component under such a system and has been developed within that context.

As indicated in Section 1, this CARP has been developed as a stand-alone plan incorporating the Port's asset management process, tools, and procedures existing at the time of plan development. The CARP has also been developed to align with fundamentals of AMS as envisioned by the International Organization for Standards (ISO) in their standards 55000/55001. A summary of the ISO AMS elements is provided in Table 2. The recommendations provided here are tailored to expand the existing Port asset management processes and this CARP toward a robust AMS that is appropriately scaled to Port Milwaukee.

14.1 OVERVIEW OF RECOMMENDED AMS

The recommended AMS will provide a formalized workflow for the perpetual acquisition, recording, tracking, monitoring, maintenance, securing, reviewing, and physical inventory of Port assets. At a high level, the AMS recommended for Port Milwaukee will consist of two primary components:

(1) the written management system policies, process, and procedures, and
(2) the asset data management system.

The written management system elements would follow the plan-do-check structure of the ISO asset management system. The data management component would be a GIS-based data platform that will provide capabilities for interfacing with other business systems and stakeholders such as City of Milwaukee.

Note that GIS software in and of itself is not a complete asset management system, rather it's a modern, adapted, interactive look into asset data through a geospatial lens. Building a complete geospatial inventory of assets is a foundational step for successful asset management and attribution of GIS features with critical metadata is a required component of any complete asset management strategy. These recommended AMS components are described in further detail in the following sections.

14.2 ASSET MANAGEMENT SYSTEM POLICIES, PROCESS, AND PROCEDURES

All management systems described by ISO (quality, environmental, safety, etc.) have the same general top down, plan-do-check structure which works well when appropriately tailored to the size and needs of the organization. An ISO envisioned AMS system for Port Milwaukee would likely consist of the following main elements:

- Establishment of a formal Asset Management Policy endorsed by Port/City leadership.
- Establishment of a Strategic Asset Management Plan outlining objectives and the Port's approach to asset management.
- Identification of internal AMS champion(s) and assignment of responsibilities and authorities as appropriate for implementation.
- Development of AMS procedures that will include at minimum:
    - Asset data management,
    - Management of change,
    - AMS performance evaluations (to include a quarterly verification and recording schedule to ensure consistency in capital asset management), and
    - Internal audit and management review.
- Establishment of a risk-based decision framework: One such local example is the framework described in MMSD's 2050 Strategic Plan that systematically identifies and mitigates risks tied to defined level of service for District assets.
- Development and continued improvement of a Capital Asset Renewal Plan.

Some of these recommended AMS elements, such as management of change procedures, management review process, and corrective action procedures may already be implemented by Port for other systems and can be expanded and/or combined to support this element of the Port's AMS. A consultant or other external partner with experience may be required to help develop and structure an appropriately scaled AMS for Port Milwaukee. However, like any organizational management system, an externally developed AMS will need to be fully embraced and managed by the organization for it to be sustainable and successful.

14.3 ASSET DATA MANAGEMENT

The recommended asset data management tool for Port Milwaukee will be a GIS-based system. GIS-based systems are the state-of-the-art technology for a wide variety of world-class ports throughout North America and Europe, including Port of Rotterdam, Netherlands, Port of New Orleans, LA, Port of Anchorage, AK, Port of Beaumont, TX, Port of Houston, TX to name a few. Successful models leverage current geospatial technologies to inventory and manage assets and inform stakeholders in real-time. These systems are dynamic and scalable and can support a wide array of port management services including parcel/lease/tenant maps, daily workorder operations, facility maintenance and repair, dredging operations, and safety/security. These systems can facilitate effective internal communication as well as drive public engagement. Data privacy and security are of utmost importance and are forefront in the delivery of this technology.

The maritime / port GIS solutions vary and there is no single system for use in managing port assets. Ports who use GIS-based asset data management tools each have unique approaches and operational circumstances. As such, there is no one size fits all solution. Implementing a GIS-based solution allows Port Milwaukee flexibility to adapt Port-specific needs but will essentially require building the system from the ground up. The recommended model of an implementation strategy would include the following steps:

- GIS Needs Assessment,
- Conceptual Data-Model Design,
- Gap Analysis, and
- Delivery of a Geospatial Model.

Through conducting individual and/or group interviews, GIS data designers could gain a thorough understanding of Port of Milwaukee operational and business needs, while retrieving and documenting critical institutional knowledge. A long-term consulting relationship to help maximize the build-out, maintenance, and delivery of these GIS services will likely be required. Optionally, the GIS-consultant could function in an advisory role to help train Port staff in leveraging this technology to maximize their individual benefit on a daily basis, toward self-performing long-term maintenance.

There is a wealth of current resources available to Port Milwaukee from local GIS systems implemented by County and City of Milwaukee as well as MMSD and SWRPC. However, it is understood that these systems and communication between departments is highly fragmented. Another facet of this recommended strategy would include reaching out to various leaders within the community to help bring people, systems, and data together. Additionally, there are other industry collaborators willing to share their data model, such as the Port of Houston, TX which could help begin the process of implementing of building a GIS asset data management solution.

Other out-of-the-box software packages that are designed for asset management can be considered. However, a GIS-based approach will likely be more versatile, scalable, and accessible for Port Milwaukee’s needs. By building a representative digital twin, all concerned stakeholders will be able to access timely and relevant information through a common and easy-to-use mapping interface. Following the first phase of developing a GIS-based asset data management system, Port Milwaukee may wish to reassess it's need for additional asset management capabilities that are not typically found in the GIS ecosystem, such as financial planning and temporal prediction tools.

APPENDIX A
COASTAL MANAGEMENT FRAMEWORK

APPENDIX B
STAKEHOLDER ENGAGEMENT SUMMARY

Prepared for
Port Milwaukee

Date
August 2021

CAPITAL ASSET RENEWAL PLAN
COASTAL MANAGEMENT FRAMEWORK

RAMBOLL Bright ideas. Sustainable change.

CAPITAL ASSET RENEWAL PLAN
COASTAL MANAGEMENT FRAMEWORK

Project name	**Capital Asset Renewal Plan / Coastal Management Framework**
Recipient	**Port Milwaukee**
Version	**Final**
Date	**August 2021**
Description	**Coastal Management Framework Prepared as Supplement to Capital Asset Renewal Plan**

Ramboll
234 W. Florida Street
Fifth Floor
Milwaukee, WI 53204
USA

T 414-837-3607
F 414-837-3608
https://ramboll.com

CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

1. INTRODUCTION

Port Milwaukee developed a Capital Asset Renewal Plan (CARP) in 2021 that covered an initial planning horizon of 50-years, or through year 2070. The CARP is a component of the Port's overall asset management system and is planned for regular update and improvement. This Coastal Management Framework was developed as a companion to the CARP.

1.1 Purpose

The purpose of this Coastal Management Framework is to identify the current and projected coastal processes affecting Port Milwaukee assets and provide a framework for long term strategic asset renewal planning and mitigation of risks to vulnerable waterfront assets.

1.2 Scope

The scope of this Coastal Management Framework includes:

- Assess Lake Michigan coastal processes affecting Port Milwaukee and identify vulnerable assets.
- Evaluate historic data as well as available studies and reports to determine predictive planning parameters for key coastal factors (i.e. likely high and low water levels for Lake Michigan) over the renewal planning period.
- Provide high level guidance for planning asset management strategies that incorporate coastal protection and resiliency specific to Port Milwaukee assets impacted by Lake Michigan.

2. COASTAL PROCESSES IMPACTING PORT ASSETS

Coastal processes of the Great Lakes affect maintenance and replacement planning of waterfront facilities. Port Milwaukee waterfront assets are primarily affected by Lake Michigan water levels, storm surge, and wave action. Port Milwaukee is situated within the protection area of the federal breakwater of Milwaukee Harbor and therefore the coastal process of long-shore sediment transport is not a major factor in Port asset renewal planning and is not considered here. The Milwaukee Harbor breakwater also serves to dampen the impacts of wave action on Port assets. Wave heights experienced at the Port facilities are reduced by the presence of the breakwater from what they would otherwise be if the breakwater were not present. Long term asset planning should assume continued protection being provided by the breakwater structure. Many factors influence lake levels, including precipitation, evaporation, anthropogenic uses (diversion, consumption, etc.), and water level regulation structures. Air temperature, wind, and barometric pressure also influence water level as well as storm surge and wave heights in the Great Lakes. Long term trends of a changing climate also play a role in those factors affecting lake levels, storm surge, and wave heights. Lake seiche also has a minor influence on lake levels. Seiche are typically caused when strong winds and rapid changes in atmospheric pressure push water from one side of the lake to the other. The typical height of lake seiche is on the order of inches and has a typical duration of minutes to hours.

Lake levels vary as the result of annual and decadal evaporation and rainfall cycles, as well as anthropogenic activities, as described in Section 2.1. Coastal flooding is primarily the result of

storm-induced surge and waves, as described in Section 2.2. Tidal forces on the Great Lakes is only 1 to 2 inches (Melby, 2012), and therefore are not a significant consideration for coastal resiliency. Anthropogenic diversions also have a small impact on the Great Lakes system (IA Report, 2018).

2.1 Water Levels

Lake levels are a complex balance between input and output from the Great Lakes basin, mainly driven by precipitation and evaporation. Short-term water level fluctuations occur during storm events as well as seasonally. Lake levels vary seasonally with the lowest levels in the winter and highest in the summer. Long-term fluctuations occur over a period of years where continuous wet and cold years cause water levels to rise and consecutive warm and dry years cause water levels to decline. A long-term rebounding of the earth's crust following retreat of the glaciers in the last ice age, known as glacial isostatic adjustment (GIA), also plays a role in long-term water level trends.

2.2 Storm Surge and Waves

Storm events not only result in an increase in precipitation affecting the overall lake level, but also cause storm surge and wave inundation that affect the coast. Storm surge can be defined as: "High winds blowing in a specific direction can develop significant shear stress on the water surface producing large waves. The shear stresses, combined with pressure differentials, can cause water to pile up on the shoreline" (Melby, 2012). The degree of impacts of storm surge and wave inundation depends on the overall lake level, ice cover present and storm conditions (i.e. wind speed, direction, duration, and barometric pressure). Storm surge is an added height above lake level. For the Milwaukee area, a storm surge of 2 feet would be considered an extreme event. An additional 2 feet of water on top of a low or average lake elevation will have less potential impact on structures than a 2-foot surge on top of a high lake level condition.

3. PROJECTED COASTAL FACTORS FOR ASSET RENEWAL PLANNING

This section summarizes information derived from available studies and reports used for projecting long-term coastal conditions most likely to be experienced by Port Milwaukee assets. Coastal processes evaluated primarily include long term projections of lake levels, storm surge, and storm driven wave heights. A recommended planning range for lake elevations is provided.

All water levels are referenced to the most recent datum, IGLD85 (likely to be updated soon – see *Effect of Isostatic Rebound* discussion in Section 3.1). The nearest National Oceanic and Atmospheric Administration (NOAA) water level gage to Port Milwaukee is Milwaukee Station No. 9087057.

3.1 Lake Levels

The best available studies and data were reviewed to predict future Lake Michigan water level changes for Milwaukee. This includes seasonal and long-term fluctuations based on evaluation of historic data, as well as predictions of water level changes under future climate change models. Summaries for Lake Michigan water levels are provided in tables in below.

Table 1 - Lake Michigan Water Levels (Lake-Wide)

Summary of Lake-Wide Levels (ft, IGLD 85)
➢ Seasonal fluctuations average 12 to 20 inches with low water in the winter and higher water levels in summer.[1]
➢ Monthly water levels vary 2-3 feet above or below the long-term monthly average. [1]
➢ Annual average water levels range 6.5 feet over recorded time. [1]
➢ Several year periods of high or low levels are normal feature of Great Lakes water levels dynamics but are difficult to predict. [1]
➢ Lake Michigan Low Water Datum (LWD) Elevation of 1985 is 577.5
➢ All-time record high lake level is 582.35 (Monthly, 1918-2020) [2]
➢ All-time record low lake level is 576.02 (Monthly, 1918-2020) [2]

Table References:

1. Great Lakes Water Levels Integrated Assessment Report (2018)
2. The Great Lakes Dashboard

Table 2 -Lake Michigan Water Levels Near Milwaukee, Melby (2012)

Summary of Lake Levels Near Milwaukee (ft, IGLD 85)
➢ Highest recorded lake level is 583.4 (1838)
➢ Long-term Lake Michigan lake level statistics: o Mean of Monthly Averages - 579.2 o Max. of Monthly Averages - 583.3 o Min. of Monthly Averages - 575.9 o Standard deviation of monthly averages - 1.3
➢ 100-year return lake level (1% exceedance) - 583.3
➢ 500-year return lake level (0.2% exceedance) - 583.8

Climate change is predicted to raise air temperatures, however current studies are uncertain regarding how long-term changes in regional climate will affect future water levels in the Great Lakes. Numerous studies have projected changes in the Great Lakes water levels under alternative climate scenarios. The Great Lakes Water Level Dashboard maintained by NOAA's Great Lakes Environmental Research Laboratory provides projected water levels from four different studies [Angel (2010), Hayhoe (2010), Lofgren (2011), MacKay (2012)]. Each study uses similar climate predictive base models with varying temperature and precipitation scenarios. The water level predictions of all the models through year 2070 are summarized in Table 3. Of the studies, the highest and lowest modeled lake levels were found in Lofgren's work which are referenced.

Table 3 – Summary of Long-Term Projected Lake Levels Through 2070, IGLD 85

	HIGH	LOW
Highest and Lowest Modeled Lake Levels	581.55 (Lofgren, CGCM3-EA)	572.44 (Lofgren, GFDL20-TA)
Average Lake Levels from all Models Reviewed	579.25 (Range: 577.71 to 581.55)	577.5 (Range: 572.44 to 579.4)

Based on the summary of predicted lake levels provided in Table 3, a few observations can be made:

- The average of the modeled low lake levels is 577.5 which coincides with the current elevation of low water datum IGLD 85. This would suggest a prediction of typical low lake levels through 2070 as has been historically experienced.
- The low water elevation of 572.44 predicted by Lofgren is a very low lake level and if experienced in the future would have wider implications on operation and maintenance of the Great Lakes Navigation System. Other changes to the system would likely be required in addition to dredging slips and channels to accommodate Seaway maximum depths at this low elevation.
- The highest projected monthly average (581.55) is below both the record high level for the lake-wide basin (582.35) and the maximum monthly averages observed near Milwaukee (583.3). This would suggest that asset planning for lake levels above those historically experienced at Port Milwaukee can be limited at this time with low risk.

Overall, long term lake levels are predicted to remain relatively stationary over the next 50 years. Any deviation from long term averages would like trend downward due to change in climate conditions. Based on the model projections through year 2070, and not considering the extreme low lake level of 572.44 predicted by Lofgren, the following table provides a reasonable planning range for monthly average lake level over the 50-year planning period.

Table 4 - Recommended Planning Range for Lake Levels

	HIGH	LOW
Planning Range for Monthly Average Lake Level Through Year 2070, IGLD 85	582	576

A summary of projected and planning water levels presented here are summarized together in Figure 1.

Effect of Isostatic Rebound and Adjustment to International Great Lakes Datum

The International Great Lakes Datum (IGLD) is planned for an update in the coming years. The need for the update is in part due to the long-term phenomena of a rebounding earth crust in the Great Lakes basin following retreat of the glaciers at the end of the last ice age. The process, referred to as glacial isostatic adjustment (GIA), is a slow process that has the overall effect of tilting the basin southward. Therefore, long term changes in water levels due to GIA will favor

higher water levels in the southern portion of the lakes and lower lake levels in the northern areas (Great Lakes Water Levels Integrated Assessment Report [2018]). For Port Milwaukee, which is located within the southern zone of the Great Lakes, the estimated rate of lowering earth is about 5.5 inches per century. The result of GIA for Port Milwaukee will likely trend toward higher lake levels. However, average lake levels may be offset by the predicted lowering of water due to factors identified in this planning document. The overall net effect of raising and lowering factors over the next 50-100 years may be negligible. For the next 50-year planning period, Port may consider a negligible impact and therefore limited asset planning as it relates to GIA and adjustment of IGLD.

3.2 Precipitation

Current global climate models have difficulty estimating future changes in precipitation patterns and rainfall intensity. However, climate change, resulting in increased air temperatures, will likely increase the frequency and intensity of severe storms. Annual average precipitation will likely increase or remain nearly stable, as the warmer temperatures will lead to less precipitation falling as snow, and more falling as rain. This will increase the intensity of precipitation during rainfall events, even if total averaged annual rainfall remains stable (Great Lakes Coastal Resilience Planning Guide, 2013).

3.3 Storm Surge

High surge events that raise the water level at Port Milwaukee are caused by strong storms with high winds and atmospheric pressure variations. Strong storm conditions typically occur in late spring and winter, with surge levels usually around 1.5 to 2 feet (Melby, 2012). A figure excerpt from Melby below shows the calculated probability of storm surge height (ft) for Milwaukee. A storm surge with a 2% probability (50-year return period) is around 2 feet.

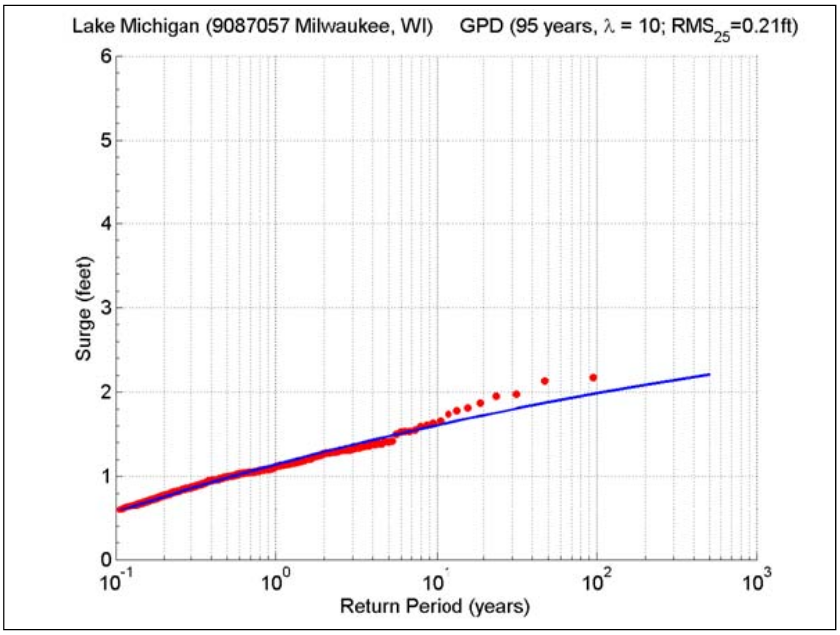

Figure 67. Milwaukee surge PDS empirical distribution and best fit using GPD.

There appears to be little correlation between surge height and lake levels. For coastal planning purposes, Port Milwaukee should consider storm surges around 2 feet in height will be experienced over the planning period.

3.4 Wave Heights and Runup

For assets on the outer harbor, wave breaking, wave setup, wave runup and wave overtopping are also considerations in total water level. Below is a summary of the ten most significant storm events and their resulting wave conditions for a beach profile near Milwaukee (Melby, 2012).

Table 5 - Wave Runup Data Example (Melby, 2012)

Table 24. Wave runup results for top 10 storms for beach profile near Milwaukee gage.

Year	Month	Surge (ft)	Offshore H_{m0} (ft)	Nearshore H_{m0} (ft)	CSHORE $R_{2\%}$ (ft)	Total Water Level (ft, IGLD85)
1987	3	2.13	14.11	9.25	5.81	588.2
1987	12	1.95	16.40	9.62	6.09	587.6
1990	12	1.78	14.11	9.24	6.04	586.5
1985	3	1.61	10.83	7.27	4.11	586.9
1971	12	1.52	9.19	6.95	3.58	585.5
1974	2	1.24	19.03	9.48	6.80	585.5
1984	2	1.03	19.03	9.62	6.31	585.1
1973	12	0.96	16.73	9.11	5.79	585.3
1987	12	1.95	16.40	9.62	6.09	587.6
1993	4	1.36	16.40	9.62	6.33	586.6

The calculated wave runup results shown in Table 5 is for a beach profile transect into Milwaukee Harbor. The model results do not account for the presence of the federal breakwater but are still informative. The actual wave runup will be less than the modeled result due to the dampening effect of the breakwater. The runup elevation accounts for a beach or shallow slope profile at the shoreline, in this case 1:33. Most of Port Milwaukee's waterfront exposed to offshore waves is constructed of vertical face dockwalls. Runup and wave interaction with these structures will differ. Specifically, dockwalls such as those on South Piers 1 and 2, with relatively deep water depths in front of them may experience wave heights similar to those represented in the fifth column of Table 5 (Nearshore, Hmo (ft)), not accounting for effects of the breakwater. As can be seen in the table, wave heights on the order of 6 to 9.5 ft at the dockwalls may have been experienced during these modeled storm events.

For this evaluation, it is a reasonable assumption that a maximum 9-foot wave could potentially interact with the piers. The specifics of how a 9-foot wave interacts with the piers in these cases will depend on the wave angle and orientation of the dockwall. Waves tend to be almost fully reflected by vertical dockwall structures. However, when large non-breaking waves encounter a dockwall, they may be in some instances reflected up along the dockwall allowing for water to overtop the structure. The general dock elevations for South Pier 1 & 2 are 589 to 590 so it would be expected for these 9-foot wave scenarios to overtop the piers during high lake level conditions (582 + 9 = 591). Any additional lake level due to storm surge would certainly

exacerbate the amount of wave overtopping. Of course, as stated prior, it is expected that the federal breakwater provides some level of reduction to the wave heights experienced at the piers to those indicated in Table 5. Historical observations indicate that conditions do arise where the dockwalls along the east side of the Port's south harbor tract are overtopped by storm-driven wave events during high lake level conditions. For Port asset planning purposes, it is recommended that Port consider wave heights of at least 590 will be experienced on its eastern dockwalls and runup and overtopping of dockwalls will occur during major storm events.

4. VULNERABLE ASSETS

Port Milwaukee waterfront assets are susceptible to damage, wear, and being rendered inoperable or reduced in function by effects of coastal processes. A summary of vulnerable assets and specific negative impacts from coastal processes is provided in Table 6.

Table 6 - Asset Vulnerabilities

Asset	Coastal Process	Vulnerabilities
Buildings		
Terminal #2 Building	Wave Runup and Overtopping Dockwall	Damage to south face overhead doors due to wave forces.
Terminal #3 Building	Wave Runup and Overtopping Dockwall	Damage to north face overhead doors due to wave forces particularly at northwest corner of building where geometry of Slip 2 focuses wave energy. During winter condition, ice buildup inhibits use of apron alongside building in northwest corner.
Terminal #4 Building	Wave Runup and Overtopping Dockwall	Damage to south face overhead doors due to wave forces.
Dockwalls		
South Pier 1 & Terminal 1 Dockwalls	Low Water Levels	South Pier 1 dockwalls and Terminal 1 Dockwall were constructed in 1930s and designed for -25 ft dredge depth. An additional 5 ft depth (-30 ft) was dredged in 1950s to accommodate Seaway max depth. Low water levels may require dredging to maintain navigational depth. Wall stability is a factor to consider if additional dredge depths are required.
Navigational Areas (Dredging)		
Slip 1	Low Water Levels	Dredging to maintain navigational depth. (~8,500 CY per foot of dredging)
Slip 2	Low Water Levels	Dredging to maintain navigational depth. (~10,500 CY per foot of dredging)

Asset	Coastal Process	Vulnerabilities
Slip 3	Low Water Levels	Dredging to maintain navigational depth. (~11,900 CY per foot of dredging)
Liquid Cargo Pier (North & South Slips)	Low Water Levels	Dredging to maintain navigational depth. Pier has slips on both sides. Vulnerability may be limited to dredging north side only to maintain use. (~24,600 CY per foot of dredging)
City Heavy Lift Dock (CHLD)	Low Water Levels	Dredging to maintain navigational depth. (~3,400 CY per foot of dredging)
Municipal Mooring Basin	Low Water Levels	Low water levels may require dredging to maintain navigational depth More extreme precipitation/storm events may cause more upland erosion, leading to increased sedimentation
Fencing		
Fenceline and Gates, East Side of Lincoln Memorial Drive	Wave Runup and Overtopping Dockwall	Damage to fence and gates due to wave overtopping of dockwalls and inland flooding.
Green Infrastructure & Public Spaces		
Gravel Apron / Public Space Adjacent to Dockwall Between Confined Disposal Facility (CDF) and Slip 3.	Wave Runup and Overtopping Dockwall	Erosion of gravel surface and loss of public use from wave overtopping
Pavement and Roads		
South Pier 1 – East Asphalt Pavement	Wave Runup and Overtopping Dockwall	Damage and excessive wear of asphalt pavements from wave overtopping and erosion.
South Pier 2 – East Asphalt Pavement	Wave Runup and Overtopping Dockwall	Damage and excessive wear of asphalt pavements from wave overtopping and erosion.
Slip 1 - Asphalt Apron West of Slip 1	Wave Runup and Overtopping Dockwall	Damage and excessive wear of asphalt pavements from wave overtopping and erosion.
Slip 2 - Asphalt Apron West of Slip 2	Wave Runup and Overtopping Dockwall	Damage and excessive wear of asphalt pavements from wave overtopping and erosion.
Slip 3 - Asphalt Apron West of Slip 3	Wave Runup and Overtopping Dockwall	Damage and excessive wear of asphalt pavements from wave overtopping and erosion.
City Heavy Lift Dock Asphalt Apron	High Lake Levels	Flooding in low areas of CHLD.

Asset	Coastal Process	Vulnerabilities
Rail		
Piers 1 and 2	Wave Runup and Overtopping Dockwall	Ice cover from wave overtopping may damage rails
Utilities		
Storm Sewers	High Lake Levels and Storm Surge	Flooding of upland low areas through storm sewer inlets during high lake level and storm surge conditions.

5. MITIGATION AND RENEWAL STRATEGIES

Mitigation and renewal strategies to address vulnerabilities of assets described in Section 4 are presented below and shown on Figure 2. These strategies are presented at a high level as alternatives and are intended to provide guidance for planning major repairs and renewals for port assets with vulnerabilities to coastal processes. These strategies should be regularly reviewed and updated with new data as it becomes available.

5.1 Wave Runup and Overtopping

Terminal Buildings (#2, #3, #4)

Terminals buildings #2, #3, and #4 are positioned relatively close to the dockwall which leaves the buildings susceptible to wave runup and overtopping conditions. Each building has a concrete foundation wall extending above grade that serves to protect the structure from damage caused by wave action on the piers. However, overhead door assemblies, particularly those toward the western end of the piers, are susceptible to damage from overtopping wave action. Some overhead door openings on the west end of Terminal building #2 have been barricaded with timbers for wave protection.

Mitigation alternatives include the following:

- Raise dockwall cap height during rehabilitation or replacement.
- Install flood resilient door systems.
- Change building use plan to permanently remove western overhead doors on the dockside of the terminal and close openings. Construct concrete wall across opening, ~3 feet high to provide continuation of flood protection.

Some protection of the western most doors may be provided by installation of wave protection structure such as wave-return wall, barrier, or wave energy dissipation (i.e. stone structure). Such structure would be limited to the western end of the pier where they would not interfere with the normal dockside use and operations.

Asphalt Pavements

Several locations associated with South Piers 1 & 2 and Slips 1, 2, & 3 have asphalt pavement installed directly adjacent to the dockwall where it is susceptible to wave overtopping and damage. The reinforced concrete aprons running alongside the piers provide a reasonable level of

protection from the erosive and damaging forces of wave overtopping and freeze/thaw cycling as compared to the asphalt pavement aprons found adjacent to the Ports dockwalls. Particularly since the concrete aprons are integrally tied into the sheet pile cap which provides a solid interface between dockwall and apron that protects against the erosive forces of overtopping wave action. Further, asphalt aprons behind the dockwall are in locations that are most susceptible to wave runup and overtopping due to their orientation to the primary wind-wave direction (east) associated with high wave conditions. Specifically, this refers to the aprons at the east end of South Piers 1 & 2 and west end of Slips 1, 2, & 3.

Mitigation alternatives include the following:

- Construct reinforced concrete apron integrated into pile cap.
- Raise dockwall cap height.
- Construct wave protection structures such as wave-return wall, barrier wall, or wave energy dissipation structure (i.e. large stone mound system).

Gravel and Public Spaces Areas

The Port's dockwall segments between the Confined Disposal Facility and South Pier 2 have a gravel apron behind them that is vulnerable to erosion from waves overtopping the dockwall. A portion of these dockwall segments are also available to public use and therefore are also susceptible to loss of use by the public resulting from wave damage. A section of the dockwall between the CDF and Liquid Cargo Pier will receive additional protection from planned expansion of the CDF. Any planned mitigations in this area should account for this planned future work.

Mitigation alternatives include the following:

- Construct wave protection in front of the dockwall such as a stone rubble mound. These sections of dockwall are not used operationally and therefore may be able to accommodate such protection without interfering in Port use.
- Raise dockwall height.
- Install resilient ground cover behind the dockwall such as apron of riprap stone. Material may need to be underlain with geosynthetic fabric or other separation material. Size should be large enough to resist erosion from overtopping waves while still providing a functional surface for maintenance vehicle and public fishing access.

5.2 Flooding

Fencing (East Side of Lincoln Memorial Drive)

The Port has a long line of security fencing running on the east side of Lincoln Memorial Drive that is susceptible to damage from coastal flooding under extreme events. The fenceline is primarily galvanized chain link fence. Some segments of the fenceline are required for security of Port operations. Other sections of the fence toward its southern end may potentially be eliminated with adjustment to operations.

Mitigation alternatives include the following:

- Construct flood resilient fencing during replacement.
- Eliminate fence in areas where not operationally required.
- Frequency of occurrence and relative damage repair costs are low. Consider maintaining fence as-is and replace when damaged.

Storm Sewers

During high lake level conditions combined with storm surge events, storm sewer outfalls into Lake Michigan with low inland catchment areas can become flooded from backflow through the system. A few locations have been identified during the high-water conditions of 2019/2020 where this problem exists.

Mitigation alternatives for these conditions include:

- Installation of flood protection devices on storm sewer outfalls such as elastomeric duckbill assemblies or flap gates.

Two outfalls that could be targeted initially include the storm sewer outfall serving the Milwaukee Bulk Terminals lot and an outfall serving the City Heavy Lift Dock. Both outfalls are identified on Figure 2.

5.3 Low Water Conditions

Low water conditions exacerbate the need for dredging. The projected low water level used for planning (576) may require additional dredging to maintain Seaway max depths. This amounts to an additional 1 to 1.5 feet of dredge depth which should be readily accommodated by the South Pier 2 dockwalls and those at the CHLD and Municipal Mooring Basin. The dockwall associated with Terminal 1 and South Pier 1 are already dredged lower than their design height and therefore will require additional analysis before deepening to determine what, if any, bracing our reinforcement to the wall may be required to ensure stability. When replacing the wall, design should account for lower planned water levels.

5.4 Increased Precipitation Intensity/Frequency

Under any lake water level conditions, climate change is likely to cause more intense rain precipitation events. For these conditions, the following asset renewal strategies should be considered:

- Storm sewer capacity should be evaluated and potentially increased
- Sedimentation of upstream eroded material should be monitored and dredging frequency potentially increased.

6. REFERENCES

Angel and Kunkel. (2010). The response of Great Lakes water levels to future climate scenarios with an emphasis on Lake Michigan-Huron. Journal of Great Lakes Research, 36: 51-58.

Great Lakes Coastal Resilience Planning Guide. Climate & Environment. (2013). National Oceanic and Atmospheric Administration (NOAA). Available at: http://greatlakesresilience.org/climate-environment

Great Lakes Dashboard. Great Lakes Environmental Research Laboratory (GLERC). National Oceanic and Atmospheric Administration (NOAA). Available at: https://www.glerl.noaa.gov/data/dashboard/GLD_HTML5.html

Great Lakes Water Levels Integrated Assessment Report (2018). Graham Sustainability Institute. University of Michigan.

Hayhoe K, et al. (2010). Regional climate change protections for Chicago and US Great Lakes. Journal of Great Lakes Research, 36: 7-21.

Lofgren B.M. et al. (2011). Effects of using air temperatures as a proxy for potential evapotranspiration in climate change scenarios of Great Lakes basin hydrology. Journal of Great Lakes Research, DOI 10.1016/j.jglr.2011.09.006.

MacKay and Seglenieks. (2012). On the simulation of Laurentian Great Lakes water levels under projections of global climate change. Climatic Change. DOI 10.1007/s10584-012-0560-z.

Melby J, et al, (2012). Wave Height and Water Level Variability on Lakes Michigan and St. Clair. Coastal and Hydraulic Laboratory. US Army Corps of Engineers. ERDC/CHL TR-12-23.