City of Des Moines Marina Service Life Report
Des Moines, Washington
December 8, 2020

The engineering material and data contained in this report were prepared under the supervision and direction of the undersigned, whose seals as a registered professional engineer is affixed below.

12/8/2020

Shannon M. Kinsella, P.E.
Project Manager

ReidMiddleton

728 134th Street SW, Suite 200
Everett, WA 98204
File No. 242020.0102

Table of Contents

Figures and Tables

INTRODUCTION

The Des Moines Marina is in Des Moines, Washington. The Des Moines Marina provides moorage for approximately 840 vessels, with slips ranging in size from under 30 feet to larger end and side ties for boats up to 62 feet. The marina is owned and operated by the City of Des Moines. The main marina was constructed in the late 1960s and completed in 1970, with outer uncovered dock extensions on E to M Dock laterals added in around 1975. The marina consists of an offshore rubblemound breakwater and an interior moorage basin with a single marina entrance located on the north side of the facility, see Figure 1. A public fishing pier and timber breakwater are located near the marina entrance. The interior basin was built by construction of a timber seawall along the entire shoreline and dredging of the marina basin.

Overall marina facilities include guest and tenant moorage, a boat ramp, haulout facilities, fueling facilities, parking, upland storage, public access and restroom/shower facilities and upland service, retail and commercial business facilities, and a harbormaster office. The City of Des Moines began an assessment process in 2019 to determine the long-term goals for the marina. The process to date conducted by the City and other consultants has included community and stakeholder outreach and surveys, marketing and demand assessments, and other steps to inform the decision-making process for continued stewardship of the marina facility.

As part of the overall process, the City of Des Moines requested that Reid Middleton perform an evaluation to determine the estimated remaining design life of the inwater portions of the marina moorage dock facilities. The intent of the evaluation is to estimate when the inwater moorage facilities will require replacement to enable the City to plan effectively for replacement of the aging inwater facilities. The estimated design life remaining along with the planning work being conducted by others will assist the City in determining appropriate phasing and replacement timing for major capital rehabilitation projects for the marina facility. This report provides a summary of the estimated remaining life for the inwater moorage dock facilities at the marina.

Figure 1. Des Moines Marina.

BACKGROUND

The Des Moines Marina docks include fourteen main dock laterals starting with A Dock in the south and extending north to N Dock, see Figure 2. The boat ramp is located south of A Dock. The fuel dock and commercial dock are located north of N Dock. The inwater portions of the marina consist of a combination of uncovered and covered moorage floating docks anchored primarily with the original timber piling. The entire A Dock through D Dock and small portions of the outer sections on E Dock through N Dock are uncovered moorage. Most of the areas on E Dock through N Dock consist of covered moorage facilities.

The floating docks at the marina consist of a combination of timber floats with unencased flotation and modular concrete pontoon floats. The timber floats are in the covered moorage areas and on the uncovered sections of M and N Docks. The concrete docks at the marina consist of small (10- to 12-foot-long) modular concrete pontoons connected by a structural system of wood walers and thru-rods. The floating docks are anchored with timber piling, though replacement with steel piling has been done in limited areas. The covered moorage system consists of timber posts, steel truss framing, and corrugated roofing. Most of the floating dock, covered moorage structures, and piling are original construction.

In addition to routine maintenance, more extensive capital maintenance projects have been conducted through the years at the marina. These have included dredging, repairs to the timber seawall, and waler and thru-rod replacement on selected docks, which included waler replacement on A Dock to D Dock, approximately fifteen years ago, and on the outer uncovered section of docks on other laterals. Other capital improvement projects have included upgrades to the electrical system on M and N Docks and other minor electrical upgrades and improvement to the fuel float and new fuel lines and dispensers, water main improvements, and other inwater and upland projects. Approximately one hundred feet of the shoreward portion of J Dock, including the covered moorage structure, was replaced approximately five years ago following a fire at J Dock in 2013.

Ongoing maintenance projects include continued replacement of waler and thru-rod systems on the outer end concrete dock sections, concrete and timber deck repairs, select flotation replacement and repairs, select pile removal or replacement for damaged or deteriorated piling, steel truss scraping and painting, utility system repairs, and other measures necessary to keep the marina facility in good safe working condition. These type of maintenance and additional capital repairs will be necessary to maintain the marina in safe operating condition and can be expected to increase as the marina facilities continue to age.

The following provides the results of the visual assessment and estimated remaining design life for the major structural components of the moorage system including floats, piling, and covered moorage structures. The assessment did not include any upland facilities, the boat ramp, timber breakwater, fishing pier, and haulout facilities. The assessment did not specifically include the seawall but general observations on the seawall are included in the report. The assessment did not include detailed assessment of the dock utility systems. It is assumed that a new utility system will be included when any dock replacement work is conducted.

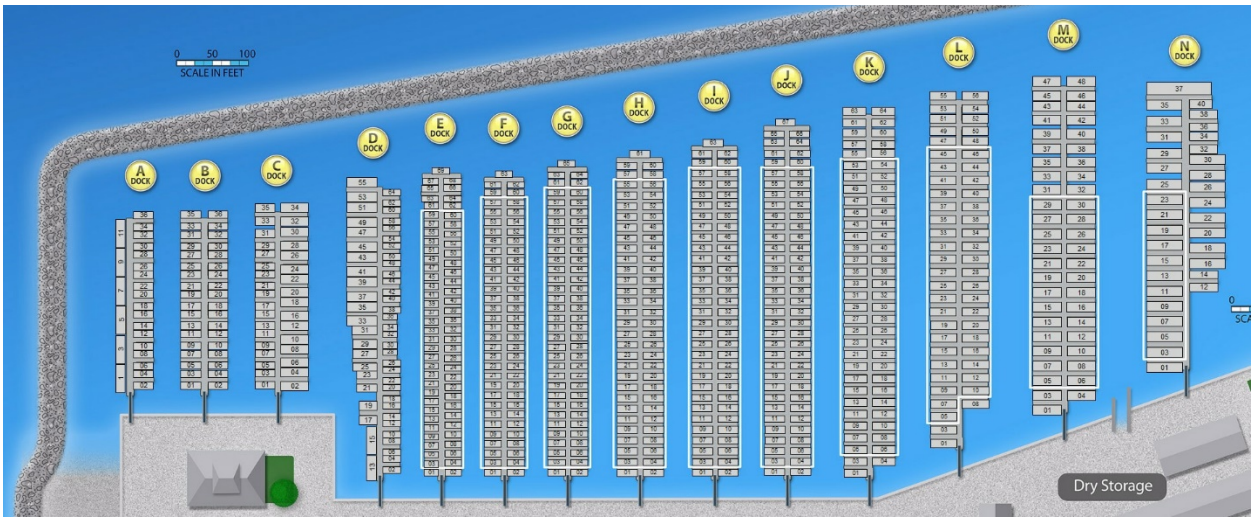

Figure 2. Dock Layout for Des Moines Marina.
(Source desmoinesmarina.com)

VISUAL ASSESSMENT – DOCK FACILITIES

To provide an estimated design life for the inwater facilities, Reid Middleton performed a visual walkthrough of the inwater dock facilities on September 25, 2020, along with marina maintenance staff, including Pat Wolfrom. The visual assessment included walking each of the docks starting with the commercial dock in the north and ending with D Dock in the south, including review of A to C Docks from the shore. The waterfront facilities visually assessed included gangways, floats, piling, covered roof structures, and general dock utilities.

The visible structural components of major systems were viewed. Underwater inspection, material testing, and detailed inspections were not included in the scope and were not conducted. While a condition inspection was not performed, general condition of major infrastructure elements by dock were reviewed following general guidance and methods described in the ASCE *Manuals and Reports on Engineering Practice No. 130 (MOP 130), Waterfront Facilities Inspection and Assessment*. The following observation condition ratings from *MOP 130* are used in this report:

Good	No visible damage or only minor damage is noted. No repairs are required.
Satisfactory	Limited minor to moderate deterioration was observed. No repairs are required.
Fair	Primary elements are sound, but minor to moderate defects or deterioration are observed. Repairs are recommended, but the priority of the recommended repairs is low.
Poor	Advanced deterioration is observed on widespread portions of the structure. Repairs may need to be executed with moderate urgency.
Serious	Advanced deterioration or breakage may have affected the primary structural components significantly. Local failures are possible, and repairs should be carried out on a high-priority basis.
Critical	Extremely advanced deterioration or breakage has resulted in localized failure(s) of primary structural components. More widespread failures are possible or likely to occur, and repairs should be carried out on a high-priority basis.

This assessment was specifically for estimating remaining design life and was not a detailed inspection. Given the age of the facilities, periodic inspections should be performed in accordance with the ASCE MOP 130-2015, which recommends routine inspections at least every five years for these types of facilities.

The general condition of each structural element by dock lateral observed is summarized in Table 1. Photos of the various elements are included in Appendix A. The following provides a general summary by major structural element.

Timber Piling

Overall, the timber piling within the marina are in good condition given their age of approximately fifty years. The piling observed showed some abrasion damage but no widespread deterioration or marine borer damage. A small percentage of the piling (approximately 3 percent per maintenance staff) have deteriorated and have either been cut down to the mudline or removed and replaced with steel piling. The City expects to replace or remove a small number of additional piling, which will be identified through routine inspection and maintenance processes. Overall, the existing piling are anticipated to have a longer remaining service life than the existing timber float and covered roof system and are therefore not the critical element in estimating the remaining life of the overall moorage systems.

The existing pile hoops are in varying condition. Some are wood frames while others are steel pipe pile hoops. The pile hoops are an important element of the structural system and transfer the loads from the dock into the pile anchor system. The pile hoops should continue to be repaired as necessary but similar to the piling are not the critical element in estimating the remaining life of the overall system.

Timber Float System

The timber float systems within the marina are in poor to fair condition. The unencased flotation and timber framing and decking are showing signs of deterioration due to their age of approximately fifty years.

While most of the unencased flotation appears to be still intact, evidence of saturation and areas of loss of adhesion and separation of the flotation materials can be seen throughout the dock systems. Some of the deterioration is likely caused by mechanical means (impact from vessels, prop wash, and otter nesting) but it also appears that the flotation is deteriorating based on its age and loss of cohesion. Given the age of the flotation units, it is expected that this breakdown will accelerate. The unencased flotation is rated in poor condition. The encased flotation is generally newer and is rated in fair to good condition.

The timber float structures have been well maintained and appear to be in fair condition given their age. Most of the timber float systems have been protected from extreme weather by the covered moorage roof system. Areas of decking have been replaced under routine maintenance projects. The timber is showing its age, and it is likely that accelerated replacement of timber decking and repairs to the timber structure will be required due to increasing deterioration. As the timber ages, water intrusion increases the potential for rot and accelerates decay of the timbers. Due to the condition and age of the timber, the covered timber float structure and decking range in rate from poor to fair. The uncovered timber docks are rated as poor.

Concrete Float System

The concrete float systems within the marina are in fair to good condition. The decks of the concrete pontoons are in overall good condition. However, the concrete floats are starting to show some locations and evidence of delamination, spalling, and corroded and exposed

reinforcement. The City marina staff has implemented regular routine maintenance and capital projects to replace the structural component of the concrete float systems (waler and thru-rods) throughout the marina, which has and will continue to extend the life of the concrete dock system.

Covered Moorage Roof System

The covered moorage roof system is in poor to fair condition. There are areas where the timber support posts are damaged, and many are showing their age. There are also areas, particularly on the more exposed south sides of the moorage facilities, where there is corrosion of the steel truss members. While the City has a routine maintenance program to scrape and paint the steel truss members, the ongoing corrosion has reduced the thickness of the steel members and resulted in deteriorated conditions and aging of the steel trusses. The roof material is in generally fair condition, with some local areas of deterioration but overall no significant visual evidence of widespread deterioration. The covered moorage roof systems rate in overall poor condition primarily due to the age of the timber supports and corrosion of significant areas of the steel trusses.

Table 1. Visual Assessment of Dock Facilities.

Element	Description/Existing Condition	Rating
Docks A - D		
Concrete Float System	All docks, walers, and thru-rod systems updated.	Good
Timber Float System	Not Applicable.	
Timber Piling	Primarily original timber piling, approximately 3 percent of piling removed or replaced due to marine borer damage.	Fair
Covered Moorage System	Not Applicable.	
Utilities	Electrical system replaced approximately 15 years ago, basic potable water.	Good
Dock E		
Concrete Float System	Entire uncovered outer eight slips and end ties recently rebuilt.	Good
Timber Float System	Covered moorage, untreated-timber deck, creosote timber framing, unencased flotation in covered section.	Poor
Timber Piling	Primarily original timber piling, approximately 3 percent of piling removed or replaced due to marine borer damage.	Fair
Covered Moorage System	Timber support posts, posts show some camber from previous snow-load, non-galvanized steel truss that has been scraped and painted, corrosion of sections of truss members.	Poor

Table 1. Visual Assessment of Dock Facilities.

Element	Description/Existing Condition	Rating
Utilities	Electrical system original with some repairs, basic potable water.	Fair
Dock F		
Concrete Float System	Entire uncovered outer four slips and end ties	Fair
Timber Float System	Covered moorage, untreated-timber deck, creosote timber framing, unencased flotation in covered section.	Poor
Timber Piling	Primarily original timber piling, approximately 3 percent of piling removed or replaced due to marine borer damage	Fair
Covered Moorage System	Timber support posts, posts show some camber from previous snow-load, non-galvanized steel truss that has been scraped and painted, corrosion of sections of truss members.	Poor
Utilities	Electrical system original with some repairs, basic potable water.	Fair
Dock G		
Concrete Float System	Entire uncovered outer four slips and end ties.	Fair
Timber Float System	Covered moorage, untreated-timber deck, creosote timber framing, unencased flotation in covered section.	Poor
Timber Piling	Primarily original timber piling, approximately 3 percent of piling removed or replaced due to marine borer damage.	Fair
Covered Moorage System	Timber support posts, posts show some camber from previous snow-load, non-galvanized steel truss that has been scraped and painted, corrosion of sections of truss members, separate roof over north and south sides of dock.	Poor
Utilities	Electrical system original with some repairs, basic potable water.	Fair
Dock H		
Concrete Float System	Entire uncovered outer four slips and end ties.	Fair
Timber Float System	Covered moorage, untreated-timber deck, creosote timber framing, unencased flotation in covered section	Poor
Timber Piling	Primarily original timber piling, approximately 3 percent of piling removed or replaced due to marine borer damage.	Fair
Covered Moorage System	Timber support posts, posts show some camber from previous snow-load, non-galvanized steel truss that has been scraped and painted, corrosion of sections of truss members.	Poor

Table 1. Visual Assessment of Dock Facilities.

Element	Description/Existing Condition	Rating
Utilities	Electrical system original with some repairs, basic potable water.	Fair
Dock I		
Concrete Float System	Entire uncovered outer four slips and end ties.	Fair
Timber Float System	Covered moorage, untreated-timber deck, creosote timber framing, unencased flotation in covered section.	Poor
Timber Piling	Primarily original timber piling, approximately 3 percent of piling removed or replaced due to marine borer damage.	Fair
Covered Moorage System	Timber support posts, posts show some camber from previous snow-load, non-galvanized steel truss that has been scraped and painted, corrosion of sections of truss members, separate roof over north and south sides of dock.	Poor
Utilities	Electrical system original with some repairs, basic potable water.	Fair
Dock J		
Concrete Float System	Entire uncovered outer eight slips and end ties.	Fair
Grated Float System	Newer Float system in replaced covered moorage area.	Good
Timber Float System	Covered moorage, untreated-timber deck, creosote timber framing, unencased flotation in covered section.	Poor
Timber Piling	Primarily original timber piling, approximately 3 percent of piling removed or replaced due to marine borer damage.	Fair
Steel Piling	Piling in new float area.	Good
Original Covered Moorage System	Timber support posts, posts show some camber from previous snow-load, non-galvanized steel truss that has been scraped and painted, corrosion of sections of truss members, separate roof over north and south sides of dock.	Poor
New Covered Moorage System	Installed approximately 5 years ago.	Good
Utilities	Electrical system original with some repairs, basic potable water.	Fair
Dock K		
Concrete Float System	Entire uncovered outer eight slips and end ties, waler and thru-rod system rebuilt recently.	Good
Timber Float System	Covered moorage, untreated-timber deck, creosote timber framing, unencased flotation in covered section.	Poor

Table 1. Visual Assessment of Dock Facilities.

Element	Description/Existing Condition	Rating
Timber Piling	Primarily original timber piling, approximately 3 percent of piling removed or replaced due to marine borer damage.	Fair
Covered Moorage System	Timber support posts, posts show some camber from previous snow-load, non-galvanized steel truss that has been scraped and painted, corrosion of sections of truss members, separate roof over north and south sides of dock.	Poor
Utilities	Electrical system original with some repairs, basic potable water.	Fair
Dock L		
Concrete Float System	Entire uncovered outer eight slips and end ties, waler and thru-rod systems have not been updated.	Fair
Timber Float System	Covered moorage, untreated-timber deck, creosote timber framing, unencased flotation in covered section.	Poor
Timber Piling	Primarily original timber piling, approximately 3 percent of piling removed or replaced due to marine borer damage.	Fair
Covered Moorage System	Timber support posts, non-galvanized steel truss that has been scraped and painted, corrosion of sections of truss members, separate roof over north and south sides of dock.	Poor
Utilities	Electrical system original with some repairs, basic potable water.	Fair
Dock M		
Concrete Float System	Outer four slips and end ties recently rebuilt.	Good
Timber Float System	Untreated-timber deck, creosote timber framing, unencased flotation in covered section, replaced flotation in uncovered portion with encased flotation.	Poor
Timber Piling	Primarily original timber piling, approximately 3 percent of piling removed or replaced due to marine borer damage	Fair
Covered Moorage System	Timber support posts, non-galvanized steel truss that has been scraped and painted, corrosion of sections of truss members, separate roof over a portion of the north and south sides of dock.	Poor
Utilities	Electrical system upgraded, basic potable water.	Good
Dock N		
Concrete Float System	Not Applicable.	Fair
Timber Float System	Untreated-timber deck, creosote timber framing, unencased flotation in covered section, replaced flotation in uncovered portion with encased flotation.	Poor

Table 1. Visual Assessment of Dock Facilities.

Element	Description/Existing Condition	Rating
Timber Piling	Primarily original timber piling, approximately 3 percent of piling removed or replaced due to marine borer damage.	Fair
Covered Moorage System	Timber support posts, non-galvanized steel truss that has been scraped and painted, corrosion of sections of truss members, this roof is a single span over a portion of the main walk and south side of the dock.	Poor
Utilities	Electrical system upgraded, basic potable water.	Good
Fuel Float		
Concrete Float System	Installed in the 1980s.	Good
Concrete Piling	Installed in the 1980s.	Good
Fuel Dispensers, Tanks System	Installed approximately 15 years ago, with further updates planned.	Good
Fuel Lines	New lines installed recently.	Good
Fuel Bldg.	Wood construction, installed in 1980s.	Fair
Other Utilities	Sanitary sewer and potable water.	Good
Commercial Dock		
Concrete Float System	All open moorage, side ties, newer than original docks.	Good
Timber Piling	One piling replaced, others original timber.	Good
Utilities	Potable water.	Good
Miscellaneous		
Original Gangways	Steel truss framing with various decking.	Fair
Two Newer Gangways at Guest/Commercial Dock	Aluminum gangways installed approximately 8 years ago, in good overall condition, though some wear of nonslip surfacing.	Good
Seawall	Timber with some concrete bag and other miscellaneous repairs.	Poor
Guest Gathering Floats	Newer concrete floats and canopies.	Good

REMAINING USEFUL SERVICE LIFE

Typically, timber structures and floats along the waterfront are assumed to have an approximately 25-year useful service life, and concrete structures and floats are assumed to have an approximately 50-year useful service life. Steel structures can have a wide range of service life expectancy depending on their resistance to corrosion, which is based on original metal thicknesses and the presence of corrosion inhibitors such as galvanizing, coatings, and anode systems. Steel systems are estimated to have a service life of 15 to over 50 years depending on design thickness and allowance for corrosion, corrosion rates, and applied protective measures.

The general estimated useful service life can be exceeded if the systems are protected from weather by roof structures; are not subject to mechanical damage, biological deterioration, and overloading; and are properly maintained with routine repairs. Evidence of the value provided by protection from rain and weather can be seen in the fact that the roof trusses are more deteriorated on the south side of the dock systems where there is more exposure to weather and salt spray from southerly storm conditions. For the Des Moines Marina, the covered roof structures and routine maintenance have extended the life of the existing dock structures beyond what would have been a typically estimated service life.

A summary of the remaining useful service life for the marina by dock is provided below. The overall estimated remaining service life is based on the lowest rated element for the structural systems of the dock. For the covered docks, that is the timber floats and roof structure. Note that the estimate of service life remaining assumes continued proper maintenance and routine repair of the systems and does not account for extreme events. Interim utility system upgrades may be necessary to maintain safe and operable utility systems until the dock structural systems and associated utility systems are replaced. Other non-structural improvements may be implemented by the City prior to the end of the estimated service life such as American with Disabilities Act (ADA) accessibility improvements, utility upgrades, and provision for additional amenities to provide higher levels of services for tenants and users.

Table 2. Dock Facilities – Estimated Service Life Remaining.

Item	Estimated Service Life Remaining
Docks A - D	15-25 years
Docks E to I	10-15 years
Dock J	10-15 years, 30 years for newer section
Docks K and L	10-15 years
Dock M	10 years
Dock N	10 years
Guest Party Docks	25-30 years
Fuel Float	20-25 years
Commercial Dock	25 years
Seawall	5-15 years
Gangways	10-15 years

With the exception of the newer elements, such as the new J Dock section, steel piling, and guest party docks and gangways, the majority of the existing piers, floats, piling, roof structures, and gangways are approximately 35 to 50 years old. Most timber float systems and roofs are at the 50-year mark. This would generally be the limit for general structures in a marine environment. However, even with their advanced age, the dock systems at Des Moines Marina still have some useful service life remaining due to the protection provided by the covered roof structures and the continued maintenance that has been performed.

Given the overall age of the marina elements, ongoing maintenance requirements will likely increase significantly over time. As timber deteriorates, it becomes less dense and the rate of saturation and rotting increases. As steel components corrode and become thinner, the more significant corrosion becomes and the ability to continue to extend the life of the structures by scraping and painting measures decreases.

Repairs to replace substantial float components, particularly for the concrete float modules, walers, thru-rods, utilities, pile hoops, decking, etc., can extend the life of the concrete float systems. While repairs to some selected locations of the concrete floats (such as the extensions on F, G, H, I, J, and L Docks) may be beneficial, repairs of the entire concrete float systems and timber float systems are not recommended and would not be cost efficient. Repairs and component replacement will not be cost effective for the existing timber floats and roof structures given their age, overall conditions, and potential for increased rates of deterioration. Therefore, complete replacement of the timber floats and roof systems is likely to be more cost effective over substantial repairs to these structures.

The piling were noted to have mainly abrasion damage and are anticipated to outlive the existing float system. However, the existing treated timber piling should be replaced as part of the overall dock replacement work for configuration, life cycle, and environmental purposes. New utility systems and appurtenances should also be installed as new dock laterals are constructed to meet current code and operation requirements.

While a detailed visual assessment of the existing seawall was not conducted, the overall condition of the seawall was observed. Given the deterioration of the timber seawall, it is likely that significant seawall repairs or major renovation and replacement of sections of the seawall will need to be made within the next five to ten years. It is recommended that a detailed inspection of the seawall be conducted if one has not been done recently and consideration for seawall repairs and replacement be included in the overall planning for stewardship of the marina.

EXTREME EVENTS

Extreme events may impact the facilities, including inwater structures at the Des Moines Marina. Extreme events include fires, heavy wet snowstorms, windstorms, tsunamis, earthquakes, impacts from large vessels, and other unique events. The estimated remaining service life identified in Table 2 does not include considerations for extreme events. These extreme events can cause immediate irreparable damage requiring complete replacement of all or portions of a marina facility. There is a risk that any of these extreme events could occur and require replacement of portions of the inwater infrastructure at Des Moines Marina prior to the end of the estimated service life identified in Table 2.

Fire

Fires can be very devastating and cause significant damage at a marina facility. While fires can cause extensive damage at any marina facility even at uncovered moorage due to the combustibles associated with vessels, fire impacts can be greater in facilities with wooden docks and older covered moorage systems. The timber docks and timber support posts provide additional combustible material, and the covered roof structure can trap heat and spread smoke, heat, and flames sideways. The fire at J Dock at the Des Moines Marina in 2013 demonstrates the significant amount of damage that can occur from a fire event and the complete replacement of the impacted dock structure that could be required. Des Moines should continue to employ and enforce operational and control measures to minimize the potential for fires at the existing marina facility.

While codes related to fire protection in marinas can vary greatly by jurisdiction, many modern covered moorage facilities include a variety of measures such as burn out panels or full burnout roofing material, drop vents, draft curtains, separating covered roof sections with open moorage slips, and sometimes fire sprinkler systems that can reduce the potential for fire to spread within a covered moorage system. Covered moorage dock systems that are replaced at the marina should meet current code and implement measures to reduce the risk of and impacts from fire.

Heavy Snow

Heavy vertical loads from extreme snow events can cause collapse of covered moorage structures. This was very evident in December of 1996 when the City of Edmonds and Port Orchard Marina roof structures and floating dock systems collapsed under extreme snow loads. The City of Des Moines Marina staff shoveled snow from the covered moorage roofs during the extreme snow event in December of 1996 and have shoveled snow from the roofs on multiple other occasions during snow events to prevent the roof and floating moorage system from collapse.

The City of Des Moines staff shovel snow off the roofs when approximately six inches of snow falls. The estimated remaining service life of the covered moorage facilities assumes that these shoveling operations will continue. There is a risk that it will not be possible to respond effectively to an extreme snow event, particularly one with heavy snow over a short period or wet conditions, which tend to make the snow heavier, resulting in irreparable damage to the

marina infrastructure that would require replacement of dock systems prior to the end of their estimated service life.

While it is difficult to predict exactly how each dock lateral would respond to extreme snow events, the impacts will likely vary across the marina. The existing roofs at the marina have a relatively flat slope and do not shed snow as easily as steeper roofs. The addition of snow on the roofs adds a vertical load that must be counteracted by the additional upward buoyancy force. The buoyancy force is proportional to the additional volume of float in the water as the float sinks into the water. The more float area there is under a given area of roof the more reserve buoyancy force is available to support snow loads on the roof. Therefore, docks with closely spaced fingers such as E, F, and G (20- and 24-foot slips) would have more reserve buoyancy and may be less likely to collapse under snow loads than the large slips which have less float area under a given roof area. The larger the slips sizes, the greater the spacing between finger floats and the less finger area in the water. Thus, H through J Docks (28-foot slips) may be more likely to sink than E through G Docks. The larger finger spacing on K (32 feet), L (36 feet), and M (40 feet) Docks, with the least amount of reserve buoyancy, may be more susceptible to sinking. N Dock has a unified roof and additional buoyancy may be provided by the connected uncovered portions of floating dock, which would suggest that N Dock has a lower likelihood of collapse from snow loads.

Modern covered moorage design works to address snow loads by a combination of measures such as steeper roof slopes to promote shedding of snow from the roofs and higher freeboard floats to provide additional reserve buoyancy for snow loads. Any covered moorage systems reconstructed at the Des Moines Marina should include measures to address snow loading.

Windstorm, Tsunami, Earthquake, and Vessel Impacts

Other extreme events that could require replacement of dock facilities at Des Moines prior to the estimated end of service life include windstorms, tsunamis, earthquakes, and vessel impacts. These events can cause extreme lateral, uplift, and impact loads on the infrastructure causing irreparable damage. Windstorms can pull up and destroy covered moorage roof material, particularly roof material that is held in place with older fasteners. Tsunamis can cause extensive damage to floating dock systems such as the complete destruction of the Crescent City Marina. Earthquakes can cause lateral movement of soils that damage pile systems. Vessel impacts due to operational error and due to vessels that break moorage lines during extreme windstorm, tsunami, and other extreme events have caused severe damage to marina infrastructure.

ENVIRONMENTAL REGULATIONS CONSIDERATIONS

The existing inwater dock system was designed per the environmental regulations and codes in place at the time of the design and construction. These regulations, design standards, and related codes have changed over time and differ from when the docks were originally constructed. Any major reconstruction or replacement of the dock facilities will be required to meet current regulations including environmental requirements.

Permitting and environmental regulations include a variety of considerations and primarily focus on protection of inwater habitat, endangered species, and water quality. Measures such as minimizing overwater coverage, use of grating and light penetration materials, and limits on the use of treated wood are required to protect nearshore habitat and listed species. Evolving permitting regulations may impact the City's ability to effectively maintain and repair the existing covered moorage, open moorage, seawall, and other inwater and shoreline infrastructure. Environmental considerations and regulation requirements could potentially reduce the overall estimated remaining life of the marina infrastructure. For example, if unencased flotation is required to be replaced, replacing all the timber dock's unencased flotation would not be cost effective given the overall limited remaining service life of the existing timber docks. The City should consider that evolving regulatory requirements and environmental considerations could impact the potential schedule for replacement versus continued repair of the existing marina infrastructure.

CONCLUSION

The City of Des Moines Marina was constructed in the late 1960s and early 1970s, with some minor expansion in the 1980s. The inwater facility consists of a variety of concrete and timber floating dock structures anchored primarily with timber piling. Six of the dock laterals at the marina are uncovered concrete pontoon with wood waler dock structures. The remaining ten dock laterals are primarily timber docks with unencased flotation and timber and steel truss covered moorage roofs.

The City is in the process of an assessment for determining how to proceed with continued stewardship of the marina. As part of that process, the City requested Reid Middleton perform a visual assessment and provide estimated remaining service life for the major inwater elements at the marina. While some of the inwater elements such as the concrete dock structures and piling have significant remaining life with routine maintenance, other marina elements, in particular the timber floats with covered roof structures, are nearing the end of their service life.

The timber floats and covered roof structures are 50 years old and approaching the end of their useful service life. Overall deterioration is expected to accelerate given the age of the systems. The covered moorage and timber float systems are estimated to have approximately 10 to 15 years of useful service life remaining. The concrete floats have approximately 15 to 25 years of useful service life remaining. These estimates assume that the continued proper repairs and maintenance of all system components will be performed and that some interim improvements such as ADA accessibility, service, and amenity upgrades may be implemented.

The estimated remaining service life does not consider extreme events and potential changing environmental regulations. Extreme events may include fire, heavy snow and windstorms, and other catastrophic events. An extreme event may result in the need for immediate replacement of infrastructure at the marina. Changing regulations and environmental considerations may make earlier replacement for portions of the inwater infrastructure at the marina more desirable or cost effective.

APPENDIX: SITE PHOTOGRAPHS

ReidMiddleton

728 134th Street SW, Suite 200
Everett, WA 98204-5322
(425) 741-3800
www.reidmiddleton.com
File No. 242020.012