PENDER HARBOUR & DISTRICT CHAMBER OF COMMERCE

## Pender Harbour Dock Management Plan

# Engineering Review

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## 1 INTRODUCTION

This review report was prepared by CWA Engineers Inc for the Pender Harbour & District Chamber of Commerce – Dock Management Plan Working Group.

The Province of British Columbia's Ministry of Forests, Lands, Natural Resources Operations and Rural Development (The Ministry) is currently in the process of implementing a new Dock Management Plan (DMP) in Pender Harbour. As part of the DMP, the Province has included Appendix 1 - Dock Construction and Maintenance Guidelines – Best Management Practices.

It is our understanding that the Guidelines have been largely based on the recommendations of the report *Impacts of Docks in Pender Harbour; Phase 2 Assessment* published by M.C Wright and Associates (MCW report) in March 2018.

Our review is based on the information presented in the DMP Appendix 1 and the MCW report.

The following commentary considers the implications of various aspects of the DMP and how they relate to the design and construction of docks in the region.

## 2 SCOPE OF REVIEW

This review focuses on aspects related to the structural design and performance of marine structures and facilities which includes safety for people and property, as well durability and long-term integrity. It does not specifically address environmental or legal implications other than how these relate in general to the practices of engineering and marine construction in BC.

The subject of this review is what is referred to in the DMP as a "Dock". In this context a Dock is a system of structures that provide private or public access to the ocean and moorage for small water craft.

A Dock consists of the following elements:

**A. Pier**

A dock may or may not have a pier. A pier is a fixed structure which provides access to the other dock structures. The pier may be a walkway, a vehicle access platform, or a deck structure.

**B. Ramp**

The ramp provides access directly from land or from the pier to the float. The ramp articulates with the tide to provide access at varying water levels. Typically the ramp is hinged at its upland support and rolls on the float; however, other arrangements exist in the harbor.

**C. Float(s)**

The dock may have a single float or multiple floats tied together. Floats are used for moorage of vessels, access to vessels, storage, or the support of other structures such as boat-houses.

**D. Float Restraint System**

The float restraint system keeps the floats in place. Commonly this is accomplished with piles, however there are other configurations used in the Pender Harbour area such as anchors and various forms of stiff-legs.

# 3 DESIGN CONSIDERATIONS

## 3.1 Code Compliance

In the design and construction of small craft marine facilities in BC, there are a number compliance related criteria that come into play. For the purposes of this review, the criteria fall into 3 categories:

**A. Environmental**

These considerations relate to the protection of the environment and are generally administered by agencies such as Fisheries and Oceans Canada (DFO), the Ministry of Forests, Lands, Natural Resource Operations and Rural Development.

Appendix 1 of the DMP appears to be intended to provide guidelines related to this criteria category only.

Environmental requirements are also governed by various other legislation such as The Fisheries Act.

**B. Operational**

These criteria relate to the operating considerations such as; vessel traffic and maritime safety. These aspects are generally administered by Transport Canada and compliance falls under the Navigation Protection Act.

**C. Safety of Occupancy**

These considerations relate to the physical design of the infrastructure to provide safety for the intended occupancy. Occupancy in this case includes people, and property.

In Canada there are no specific Compliance standards that govern the design requirements for safety and occupancy (Category C above) of small craft docks.

Safety of occupancy for infrastructure such as buildings and bridges are governed by relevant Federal or Provincial Codes or Design Standards.

Pender Harbour is in the Sunshine Coast Regional District (SCRD) which requires compliance with BC Building Code (BCBC) for all buildings, houses, and related structures. The BCBC is a comprehensive building standard that prescribes the specific requirements for the design and construction of all aspects of buildings including structural loading, strength, safety factors, serviceability, material quality, etc.

In a typical building related project an Owner will apply for a permit from the Building Authority, in this case the SCRD. A permit will be granted only if the design is in compliance with the BCBC. The Building Authority may also require sign-off or review by one or more Qualified Persons (QP). QP's in this case may include Architects, Professional Engineers, Geoscientists, etc.

As an example; if an owner is planning the addition of a deck to their house, the requirements are well defined per the BCBC. The design of the deck structure will need to withstand the prescribed design loadings in the BCBC; and the structural elements will be sized and configured according to the CSA related standards. Safety criteria such as the strength, size, and configuration of , guardrails, handrails, and stairs are also prescribed.

If the project involves a dock, however, the specific Code requirements are not clear. Docks are not buildings so the BCBC does not strictly apply. They are, however, structures that support occupancy so the design must legally meet a minimum standard for safety and durability.

In the absence of a specific prescriptive Code, Building Authorities and Regulators must rely on QP's to ensure that the design is fit for purpose and safe. In BC the involvement of a QP is a legal requirement under the Engineers and Geoscientists Act. In fact, the Act specifically includes "wet docks, dry docks, and floating docks" under the definition of *the practice of professional engineering*.

Professional Engineers who practice design of marine facilities will use their judgment and expertise in combination with other available and related codes or standards. There are numerous guidelines and standards available for reference that marine structure designers may use including:

- American Society of Civil Engineers, "Planning and Design Guidelines for Small Craft Harbours"
- Unified Facilities Criteria "Design: Small Craft Berthing Facilities"
- Tobiasson, B.O., Kollmeyer, R.C., "Marinas and Small Craft Harbours"
- PIANC – Guidelines for marina design
- BCBC British Columbia Building Code
- CSA S6 Canadian Bridge Code
- CSA 086 Engineered design in wood.
- CSA S16 Design of steel structures
- CSA S157 Strength design in aluminum

Such standards are typically used to develop the configuration of facilities, the structural design criteria, the structural design loadings, and to calculate/determine the strength and stability of the structural system.

## 3.2 Code vs Best Practices

As discussed above, Codes are prescriptive and specific. They are considered by designers and QP's to prescribe specific requirements, or rules, that cannot be deviated from without demonstrated cause. Codes are developed by committees of engineers, architects, building authorities, academics and other QP's and are regularly improved and upgraded.

A Best Practices Guideline is usually considered as either a summary of the current state of industry practice, or a statement of intention. Designers and QP's generally consider a Best Practices Guideline as a suggestion of intent rather than a strict requirement.

## 3.3 Requirements to Upgrade.

Codes, standards, and relevant legislation that govern buildings, structures, and facilities are subject updates on a regular basis. The BC Building Code for example, was initially adopted in 1970 and is presently on its 7th edition.

Each time that a Code is updated, many building regulations and requirements change. In no circumstances, however, is there a required mandatory upgrade of all existing buildings, structures, or facilities to meet the new requirements. This is the case for all facilities, leased or owned, including; buildings, schools, hospitals, bridges, etc. Mandatory compliance with a new Code or Standard is only applied to new construction, or to projects involving existing facilities where certain trigger criteria are met. Triggers as they apply to buildings generally fall into two categories:

1. A change in occupancy; for example, changing a warehouse to an apartment building.
2. A major renovation or reconfiguration. This category is more subjective and most municipalities have a detailed formula to evaluate trigger criteria. Typically, this would apply to an addition, changes to a major structural system, etc. This does not apply to routine maintenance or the replacement of damaged or worn out components in-kind.

The language in the DMP is unclear, however, Article 6.4 and 6.5 may suggest that the Ministry is requiring an upgrade as a condition of future tenure renewal. If this is the case, we would consider this highly unprecedented in the industry and that this would place an unreasonable burden on the affected property owners.

## 3.4 Design Loadings and Strength Requirements

Loadings that may be considered for the structural design of docks include:

- Dead Loads; the self weight of the structures and permeant utilities or fixtures
- Occupancy live loads; people, storage, vehicles, etc
- Snow loads
- Wind loads

- Current loads
- Mooring loads
- Berthing loads
- Loads from the restraint system such as piling or anchor forces
- Waves generated by wind
- Waves generated by passing vessels
- Seismic loads

All structures that are part of a dock system must be designed to safely perform under the assessed loading conditions. The loading conditions will consist of various combinations of the above listed loads.

It should be noted, that each dock structure at a particular location is different and must be evaluated independently. For example, an identical shaped float at two different locations may have different wave or wind exposures, different angles of current attack, different mooring loads, different live loads, different utility loads, etc.

## 4 COMMENTARY ON APPENDIX 1 – DOCK CONSTRUCTION AND MAINTENANCE GUIDELINES – BEST MANAGEMENT PRACTICES

Appendix 1 appears to be an intent to provide a framework to be used by designers of docks in the area. All of the subject matter is environmentally motivated and deals with the perceived protection of habitat. The Appendix does, however, state a number of prescriptive requirements that would have a direct affect on the strength, stability, safety, and performance of dock structures.

**Clause 8.3**

***The bottom for all floats must be a minimum of 1.5 meters above the sea bed during the lowest tide. Dock height above lowest water level must be increased if deep draft vessels are to be moored at the dock. The Dock and the vessel to be moored at the Dock must not come to rest on the foreshore sea bed during the lowest tide of the year.***

The requirement for a 1.5m minimum clearance is a clearly stated as a minim criterion. If this criterion is met, then the float will not lie on the seabed regardless of the moored vessel,

In an initial installation it is reasonable to require the design to meet the anticipated vessel draft requirements.

In the future life of the dock, however, the draft of a given vessel moored at the dock may or may not be in the control of the owner and becomes a matter of operating practice and not physical design.

The intent of the statement is understood but is this clause suggesting that a float actually has to be raised if the moored boat rests on the sea-bed? Once a dock is built with a certain water depth it is usually not practical to increase the depth.

The requirement for a given vessel not grounding at low tide is a separate issue from the float design and should be treated as such. This is an issue of operation and not design.

More reasonable wording should simply state that vessels may not ground at low tide and not that the float has to be raised.

**Clause 8.4**

***The size of all docks should be minimized. Access ramps, walkways or docks should be a minimum of 1.0 meter above the highest high water mark of the tide. Access ramps and walkways should not exceed a maximum of 1.2 meters. Docks should not exceed a minimum of 1.5 meters.***

This clause deals with three design parameters: The dock height, the ramp and walkway widths, and the float width.

**Dock height**

The statement that access ramps, walkways, or docks must be a minimum of 1 m above the high-water ramp is ambiguous. The presumed intent is that fixed structures over or near the water should clear the highest tide by 1.0m. Definition is required, however, to differentiate between what comprises an access ramp, a walkway, and a dock. An articulated access ramp joining the shore to a float for example, cannot be 1.0m above the water at the float end unless the float has a very high freeboard.

**Ramp and walkway widths**

The statement that access ramps and walkways should not exceed 1.2 m can also only be taken as a suggested intent. The use of the word “should” is noted so it is assumed that this is not an absolute requirement. It is further assumed that in this context the definition of an access ramp is the articulating portion of the structure and a walkway would be a fixed structure.

Assuming that the 1.2 m is the overall dimension (out to out) of the ramp or walkway, the actual clear walking space will be 1.2 m less the width the structural elements. Articulating ramps usually consist of two trusses with a walking surface between. Newer ramps are typically constructed form rectangular or square tube sections with dimensions ranging from 100 to 150 mm. The clear walking space would therefore be reduced to 1.0m to 0.9m respectively.

While 0.9m is generally an adequate width of a pedestrian only walkway or ramp, other operational requirements may require a wider platform. Many piers and related structures are much wider to provide access for vehicles, storage, or other special needs.

It should also be noted that the BCBC requires that handicap access ramps have a minimum clear width of 1.5m.

The width of a ramp or walkway structure may also be governed by the structural design. Longer span structures need to be wider for lateral stability. For example, a 30m long ramp will need to be wider than a 10m long ramp just from a structural strength perspective.

The width of a ramp or a walkway must be evaluated on an individual basis. If a long ramp is required due to the geometry of the specific site, then a wider ramp may be needed for stability and strength. Also, if for example a series of pile supported fixed walkways are required; the spans of the walkways should be maximized and wider walkways may be more appropriate. Longer spans require less support locations which may translate into fewer piles in the water.

**Float width**

The clause states that docks should not be wider than 1.5 m. The use of the word dock is inconsistent in this document, however, it is assumed that in this context it is referring to the floats. The width of a float must also be assessed individually for strength and stability. The float shape, it's use, and its exposure must be considered. Pender Harbour is a very active boating area and there are many locations that are routinely subject to repeated wave action from passing boats. Also, much of the harbour is exposed to strong winds and currents. Narrow floats may not perform as well as wider floats when subject to waves, wind, and currents. Further, landing an articulating ramp on a 1.5 m float may not be practical or safe for many configurations; for example, if the ramp is perpendicular to the float.

In the example of a marina facility, narrow floats are often used effectively, however, they are all part of a larger system of floats that works together for stability and strength. A single float used at an exposed private residence may need to be wider.

The size of the vessel to be moored will also dictate the size of the float required. Floats are usually designed with the piles located at either end of the float and not at its mid-span. This is so that the boat's rigging does not foul on the pilings while at the berth; or maneuvering to or from the berth. This is especially true for sail boats. Since the float must effectively span the width between the piles, longer floats need to be wider for strength. Also, longer floats that accommodate larger vessels will see higher loadings. A float for an 80ft vessel for example, will need to be wider than the float for a 30ft vessel.

The other consideration for the width of the float is the method of restraint. If piling is used an assessment of the number and configuration of piles will be required. The number and configuration will depend on many things such as the design loadings, the geotechnical conditions, and the water depth. In shallower water with good driving conditions single vertical piles may work. A float can be anchored to vertical piles using metal hoops attached to the outer perimeter. In deeper water or in areas where driving conditions prohibit full strength embedment into the seabed, pile clusters, known as dolphins, may be appropriate. Dolphin

arrangements (especially in deeper water) often require the piles to be battered into "tripod" shaped clusters. It may not be possible to anchor floats to a batter pile dolphin using hoops. This type of configuration often uses pile wells, or holes, in the center of the float for restraint. This arrangement requires a wider float and would not be possible with a 1.5m float.

The width of ramps, fixed walkways, and floats cannot be designed on the basis of a "one size fits all" criteria. Due diligence must be given to the principals of engineering as well as the configuration and use.

It should also be noted, that the BCBC prescribes that a minimum of 1.5m be provided for a wheel-chair to make a full turn. The prescribed float width would barely meet this criteria, and may infact put wheelchair users in danger. If a 1.5m float had bull-rails, as many wood floats do, the clear width would be less the width of the rails and the minimum turning criteria would not be met.

**Clause 8.5**

***All improvements should be a minimum of 5 meters from the side property line (6.0 meters if adjacent to a dedicated public beach access or park) and at least 10 meters from any existing dock or structures, consistent with Federal requirements under Transport Canada's Navigable Waters Protection Act.***

It is noted that this clause refers to compliance with the *Navigable Waters Protection Act*, however, this Act was replaced the *Navigation Protection Act* in 2014. The clearances sited in this clause refer to an amendment order to the legislation in 2009 to allow for pre-approval of small docks and boathouses in order to reduce back-log for applications. If the design of the proposed dock meets the criteria, a review by Transport Canada would not be required. It does not specifically imply that other clearances would not be accepted upon review.

Depending on the specifics of a dock or adjacent dock configurations, smaller clearances should be acceptable if they do not impede navigation corridors. Design guidelines for small craft marinas which include fairways and multiple adjacent structures are typically built with much tighter spatial restrictions and still allow for safe navigation.

**Clause 8.6**

***Docks must be constructed to allow light penetration under the structure and used decking materials must allow for minimum of 43% open space allowing for light penetration to the water surface. Light transmitting materials may be made of various materials shaped in the form of grids, grates, and lattices for light penetration.***

This clause is very onerous and may be difficult to achieve in any practical manner. It only refers to the "dock" so it is assumed that it is meant to apply to piers, ramps, and floats. It is also noted, that in this clause the word "must" is used indicating mandatory compliance.

The clause calls for a very specific 43% light penetration and that some form of grating is to be used. We note that the MCW report provides two product examples: ThruFlow, and FibreGrate. The 43% coincides with the Legacy Series ThruFlow grating product. This suggests that the 43% criterion has been selected on the basis of a specific manufacturer's product.

In reviewing a number of other grating products available on the market, we found that the percent of open space ranges from 20% to 70%. Generally, gratings with larger open space have deeper cross bars spaced farther apart. To achieve a higher open space will generally result in larger holes in the grating.

It is important to note that, decking and grating do not serve the same structural purpose. Grating is used to support vertical loads only. Decking is used to support vertical loads, and, to act as a diaphragm to transmit lateral and torsional loads; and to prevent racking. Structures that use grating require a separate lateral bracing system. Also, the vertical load carrying capacity of grating is limited to pedestrian level loading only. Most grating products cannot be used for larger loads or any motor-vehicles.

Typically structures that use grating consist of steel or aluminum framing with lateral bracing; or where torsional loadings are not expected. Grating is harder to use with wood framed structures as the installation of effective lateral bracing is inherently more difficult. This is why wood frame construction typically utilizes decking or sheathing for stability.

Using grating as opposed to decking on a wood float in Pender Harbour would not be advisable. Floats in the ocean are subject to a high degree of lateral loading and torsional twisting, especially in exposed locations. Designing an affective and robust bracing system for wood floats is not considered practical.

Effective light penetration through a float would be small even if it was fully covered in grating. The timber substructure combined with the floatation billets would block a large portion of any light that penetrates the grating. A properly designed float for the Pender Harbour region needs to have adequate freeboard for the conditions, and needs to support its self weight in addition to the worst-case occupancy or snow load; and maintain a safe and functional freeboard. This typically requires floatation in excess of 50% of the plan area of the float.

Grated floats may be suitable for light duty environment such as a lake or very protected cove, however, they would not be appropriate for the majority of Pender Harbour.

We note that small craft harbour facilities owned and operated by the Department of Fisheries and Oceans do not use grating. Wood decking is the standard form of construction for piers, ramps, and floats.

The practicality of grated structures with large openings in a residential application should also be questioned. Grating may present a number of safety hazards for pedestrians. Grating could be hazardous for persons wearing shoes with heels, people in bare feet (especially small

children or toddlers). Tripping and falling on a grated surface may be more dangerous. Also, things dropped or spilled may fall through the grating into the water.

**Clause 8.7**

*Docks should be aligned in a north-south direction to the maximum extent that is practicable.*

From the perspective of a safe and effective dock design, the requirement to orient a dock in a North-South direction in Pender Harbour would only work in a limited number of locations. The orientation of a dock float is a very important consideration for the performance, safety, and cost of any installation.

When locating a dock float there are generally three main criteria that are considered:

1. Current. Pender Harbour experiences approximately 5m of tide which results in significant currents in many areas of the harbour.

   A float should always be oriented parallel to the current for the following reasons:

   - It reduces excessive side loading from current on the float and the float restraints.
   - It allows for safe berthing and de-berthing of vessels. Berthing or de-berthing with a cross current presents a very unsafe situation which can result in damage to the vessel, the dock as well as present a risk of injury. This is also true for the operation of smaller craft such as kayaks.
   - Vessels moored at the dock are less likely to sustain damage. Cross currents will push the boat into the dock which will cause wear on the hull, damage to fenders, and potentially the dock structure.

Each dock location needs to be assessed individually, however, where currents are present they typically find a way to run parallel to the shore. In these areas, therefore, it is usually advisable to orient the dock parallel to the shoreline.

2. Water Depth

It is generally desirable to locate the moorage side (s) of a float at a consistent water depth. This makes the dock easier and safer to operate as the available draft for boats is consistent along the length of the float. Also, the pilings are of similar lengths which makes for a more efficient structure.

Typically, constant contours, and, therefore water depths are found parallel to the shore-line.

3. Water lease and Navigation

For reasons of economy, a dock float is usually located as close to shore as possible and also parallel if possible. This reduces the costs of the access walkways and anchorage. It also reduces the size of the water lease required.

Docks located closer to shore also present less risk to navigation.

Water lease boundaries are typically parallel to the property boundaries. The shape and orientation of the water lease will also dictate the configuration of the dock structures, as they must fit within the boundaries.

A quick view of the satellite image of Pender Harbour shows that the large majority of floats are in-fact oriented parallel to the shore, especially in the channels subject to tidal currents.

## 5 SUMMARY COMMENTS AND RECCOMENDATIONS

### DMP Guideline Requirements

The specific design requirements outlined in Appendix 1 of the DMP as they relate to the size, shape, configuration, and light transparency of docks appear for the most part to originate from the MCW report. In reviewing the MCW report we note that these recommendations are based on literature review of other studies which are referenced in Appendix 2.

Appendix 2 references studies on the East Coast of the US. References are made to South Carolina, Massachusetts, Connecticut, Alabama, and Florida. There are no references to any studies in the Pacific North West. It is important to note that the tidal range in different geographical regions is highly variable. In the Pender Harbour area the range is approximately 16 ft; in South Carolina it is 5.5 ft, in Massachusetts it is 10 ft, in Alabama it is 1.5ft.

The literature reference to using grating for light penetrations on structures appears to come from Florida. We note that in Florida, the tide variations are small docks in that region often do not use floats. Since the tide range is low, boats are tied directly to pilings. The boats are tied between the piles and do not rest against the dock. The access walkways over the water are fixed directly to the piles as well and do not float. These types of structures are not in contact with water or with moored boats. They are therefore not subject the constant forces from currents, waves, berthing, and mooring. Using grating as a deck for this type of fixed structure would be much more feasible than using it on a float. Also, the light penetration would not be blocked by the flotation billets.

Areas with lower tidal fluctuations also have less tide driven currents. Mandating the orientation of docks in a N-S direction would also be more feasible in these regions as current would be less of a factor.

### Permitting and Compliance

The Ministry has published the DMP as a requirement for a Tenure application. This implies the following:

- The Ministry will be taking on the role of a Building Authority as it applies to the design and construction of docks in Pender Harbour.
- The Ministry will be reviewing and approving proposed designs and dock construction projects.
- The Ministry will be enforcing compliance in some manner.

- *Appendix 1-Best Management Practices* of the DMP sets out guidelines that designers, owners, and constructors are expected to use for this approval and compliance process.

As design professionals we have some significant concerns with this process. Appendix 1 is a short 2 page list with some simplistic statements of intention. In our opinion, this guideline is ambiguous, inconsistent in its language, and does not address any issues surrounding occupancy, safety, and integrity. Further, the guideline may actually compromise safety of individual installations if followed literally. If the Ministry is to be the Building Authority, they will be taking on the related liability and should be setting a much more comprehensive standard that addresses all aspects of design.

With due respect to the anticipated environmental benefits of this plan, we question its technical validity, its practicality, and its ultimate cost-benefit if it is imposed across the Harbour.

If fully enacted, this guideline will set a significant precedent for the design of dock facilities in the region and it is therefore critical that it has been fully vetted and consideration be given to all design aspects, not just environmental. We understand that the Ministry is already considering imposing similar regulations Province wide.

**Recommendations**

We would suggest that the Ministry consider the following recommendations:

1 The guideline should only apply to new docks, or to substantial reconfigurations of existing facilities. It is noted that the MCW report states that their recommendations should apply to "new applications for private docks or replacements/upgrades". Upgrade of an existing facility should not be a requirement for tenure renewal. Also, the definition of replacements/upgrades needs to be clarified. Maintenance of an existing dock, or the replacement with a new float in kind, should not trigger a required upgrade to comply with all aspects of the guideline. This requirement would effectively penalize owners for keeping their exiting docks in good repair.

2 The guideline should reference compliance with an appropriate marine structures design standard and/or should require that the design be reviewed and approved by a Qualified Person.

3 Clause 8.3: The requirement to raise the deck height for deep draft vessels should be removed. The clause should reference the minimum 1.5m under-keel clearance for the floats and separately state that moored vessels are not permitted to ground at low tide.

4 Clause 8.4: The requirements for 1.2 m wide ramps and 1.5m wide floats should be relaxed as a suggested target only. The designer/QP needs to reserve the ability to make the structures wider for safety, strength, and stability, function, and handicap access.

5 Clause 8.5: The requirement for 5m, 6m, and 10m setbacks should be stated as a suggested target only to minimize the impact on navigation, however, a mechanism for reviewing each specific location should be allowed. There are a large number of existing docks in the Harbour that would not meet these criteria and have safely been in service for decades.

6 Clause 8.6: The requirement for grating with 43% light penetration on floats should be removed. The use of grating on ramps or fixed piers can reasonably be achieved, however, the use grating on wood floats in Pender Harbour is not considered advisable. Also, the requirement to minimise shading should be reviewed in the context of each specific location (ie) whether or not the dock is in-fact in or near a critical habitat area.

7 Clause 8.7: The requirement for a North-South orientation should be removed. This is not a practical or reasonable requirement for the Pender Harbour region.