



**DEFENCE CONSTRUCTION  
CANADA**

**Report for:**  
**Department of National Defence**  
**D Jetty Inspection**

**R E V I S E D**

**03133**  
**December 2003**



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Project No.: 03133

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Attention: Mr. D.C. Bonneau, A.Sc.T.

Reference: D Jetty Inspection  
Project No. ES 557 56  
Contract No. 22895

Dear Sirs:

Please find enclosed three copies of our Revised Report for the above referenced project.

We trust the report meets your immediate requirements. Please do not hesitate to contact us if you have any questions regarding the inspection findings, or if you require assistance in implementing the recommended remedial work.

Yours truly,

**WESTMAR CONSULTANTS INC.**



Alden J. Evans, P.Eng.

Manager

Port Infrastructure and Rehabilitation

AJE/tmw

Encl.

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Approved by:

  
Alden J. Evans, P.Eng.

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# **1 Introduction**

**Facility:** D Jetty, Esquimalt, BC

**Inspected by:** Westmar Consultants Inc.: Alden J. Evans, P.Eng.  
Victor Szabo, P.Eng.  
Murray Marquardt  
Ted Hill

Department of National Defence: Dan Bonneau, A.Sc.T.

**Date:** July 29, 2003, August 12 and 13, 2003

## **1.1 Purpose of Inspection**

The purpose of the inspection is to assess the general condition of the Department of National Defense's D Jetty facility located on the west side of the Esquimalt Harbour in Colwood. Based on the inspection findings, a prioritized program of repairs and continued monitoring will be developed.

## **1.2 Scope of Work**

The scope of the inspection work is summarized below:

- A detailed visual inspection of the concrete piles and pile caps to identify obvious mechanical damage and/or deterioration.
- A detailed visual underwater condition inspection to investigate the extent of any concrete cracking or spalling detected on the surface of the concrete piles.
- A detailed visual condition inspection of the timber fender system both above and below the waterline.
- A visual condition inspection of the coping wall and associated riprap slope protection.
- The preparation of a detailed report documenting all of the inspection findings.

Existing services and the topside portions of the superstructure were given a quick general inspection.

### **1.3 Reference Material**

The following reference material was made available prior to the inspection:

- *DND Drawings L-C260/5-9502/3-201 to L-C260/5-9502/3-204: Repairs to Jetty D - Plans, Sections and Details.*

### **1.4 Executive Summary**

The D Jetty facility is in a serviceable condition. The rate of deterioration of the concrete piles and pile caps appears to be slow, with only minor increases in the level of surface spalling and corrosion staining since the last inspection. The pile caps at the northeast corner of the facility have the most significant deterioration, and remedial measures are recommended to prevent the migration of the corrosion.

A summary of specific inspection observations related to the timber members is presented below:

- The bracing at the northeast corner of the facility is in poor condition resulting from marine borer infestation, and the replacement of 12 timber braces is recommended.
- There are 13 sections of fender logs which are either missing or have severe deterioration due to marine borer or limnoria infestation. Replacement is recommended.
- The fender log chain at Bent No. 14 is missing, and replacement is recommended.
- There are eight rubbing piles that require replacement, two rubbing piles that require the installation of resin plugs, and four rubbing piles that require new connection bolts.
- There is severe marine borer deterioration of 12 fender piles, and replacement is recommended.
- The northeast corner 4-pile dolphin has severe fungal decay in the tops of the piles, and replacement is recommended.

- There are seven locations where the securing chain and/or the eyebolt in the concrete pile cap is damaged, and replacement is recommended.
- There are five sections of the lower wale that have severe marine borer infestation, and replacement is recommended.

The D Jetty facility is currently being used as the lay down area for construction materials during the F Jetty Replacement project. Consequently, a detailed topside inspection could not be carried out. Furthermore, DND noted that damage to the guardrails, capping timbers, fender piles and fender logs has resulted by the ongoing construction activity. A detailed topside condition inspection is recommended after the contractor has demobilized.

Subject to an ongoing inspection and maintenance program, the remaining service life of the structure is estimated to exceed 10 years. The cost to implement the recommended repair work is in the order of \$105,000.

## 2 Description

The wharf consists of a laminated timber deck with an asphalt overlay, supported on reinforced concrete pile caps and piles. The general layout of the jetty is consistent with the details presented in *DND Drawing L-C260/5-9502/3-201*. Photographs of the structures are presented in *Appendix A*.

### 2.1 Reference System

The reference system for bent numbering and baylines is in accordance with *DND Drawing L-C260/5-9502/3-202*. For Unit 1, the pile caps are perpendicular to the north-south longitudinal axis of the structure, with the decking running in a parallel direction. For Unit 2, the pile caps are perpendicular to the longitudinal axis of the structure, with the longitudinal axis being east-west.

### 2.2 Unit 1 (East Face of Jetty)

- Deck Planking: 76 mm x 254 mm laminated timber spanning 1.8 m (maximum)
- Pile Caps: 400 mm x 800 mm reinforced concrete beams spanning 1.4 m (maximum)
- Piles: 400 mm hexagonal reinforced concrete piles

Lateral restraint is provided at the northeast corner of the structure by 203 mm x 254 mm horizontal timber wales located at approximately the low water elevation.

### 2.3 Unit 2 (North Face of Jetty)

- Deck Planking: 76 mm x 254 mm laminated timber spanning 3.8 m (maximum)
- Pile Caps: 400 mm x 800 mm reinforced concrete beams spanning 3.25 m (maximum)
- Piles: 400 mm hexagonal reinforced concrete piles



Lateral restraint is provided at the northeast corner of the structure by 203 mm x 254 mm horizontal timber wales located at approximately the low water elevation.

## 2.4 Fendering System

The fender system is of timber construction and consists of two fender piles complete with a rubbing pile and hollow rectangular rubber fender units, a top rubbing strip and a continuous wale. Lateral restraint is provided by horizontal timber chocks positioned between each pair of fender piles. Member geometry is summarized below:

- Rubbing Poles: Typically 355 mm diameter
- Fender Piles: Typically 355 mm diameter
- Fender Wale: 203 mm x 254 mm
- Top Rubbing Strip: 152 mm x 355 mm
- Timber Chocks: 152 mm x 355 mm
- Rubber Fenders: 254 mm x 254 mm

*Photograph Nos. 1 and 2 show the general arrangement of the structure.*

### 3 Inspection Results

The detailed inspection observations and related reference material are presented in the appendices as described below:

- *Appendix A* presents the inspection photographs.
- *Appendix B* presents the reference drawing.

The general condition of the various elements of the facility are described below. Members with damage or deterioration, and the recommended repair options are referenced in and follow, the general descriptions.

#### 3.1 Topsides

The D Jetty facility is currently being used as the lay down area for construction materials during the F Jetty Replacement project. Consequently, a detailed topside inspection could not be carried out. Furthermore, DND noted that damage to the guardrails, capping timbers, fender piles, and fender logs has resulted by the ongoing construction activity. A detailed topside condition inspection is recommended after the contractor has demobilized.

The nail-laminated deck beneath the asphalt appears to be in a serviceable condition. There is no evidence of water leakage through the decking.

#### 3.2 Pile Caps

The pile caps are generally in a serviceable condition. Typically, there is minor deterioration of the concrete with localized areas of surface spalling and exposed reinforcement, and mechanical damage at the offshore ends of the pile caps.

The severe deterioration of the pile cap soffit at Bent No. 3 (adjacent to Bayline G) and at Bent No. 1 (adjacent to Bayline B) has resulted in the bottom leg of the shear reinforcement (stirrups) being exposed. The extent of the deterioration does not appear to have increased since the 1997 inspection program.

Specific areas of pile cap damage are summarized in *Table 3.2* on the following page.

**TABLE 3.2: D Jetty - Pile Cap Damage**

Bent No.	Pile	Description of Damage
1	A-B	Concrete spalling on soffit of cap with exposed reinforcement in a 1.3 m long x 0.4 m wide x 50 mm deep section between Piles A and B ( <i>Photograph No. 3</i> ).
2	A	Minor surface spalling of concrete with exposed reinforcement steel.
3	A	Minor surface spalling of concrete with exposed reinforcement steel.
	C	Minor surface spalling of concrete with exposed reinforcement steel.
	G	Concrete spalling on soffit of pile cap with exposed reinforcement in a 300 mm x 150 mm x 50 mm deep section ( <i>Photograph No. 4</i> ).
22	A	Spalling on outside corner with exposed reinforcement steel (impact at berth face).
24	C-B	Minor surface spalling of concrete with exposed reinforcement steel (four bars visible) ( <i>Photograph No. 5</i> ).
	E	Minor surface spalling of concrete with exposed reinforcement steel.
	F	Minor surface spalling of concrete with exposed reinforcement steel (three bars visible).
25	B-C	Minor surface spalling of concrete with exposed reinforcement steel.
29	B-C	Minor surface spalling of concrete with exposed reinforcement steel.
35	A	Surface spalling of concrete on the offshore end of the pile cap resulting from mechanical impact ( <i>Photograph No. 6</i> ). This deterioration was first identified during the 2003 inspection program.
36	B	Minor surface spalling of concrete with exposed reinforcement steel. This deterioration was first identified during the 2003 inspection program.
	C	Minor surface spalling of concrete with exposed reinforcement steel ( <i>Photograph No. 7</i> ). This deterioration was first identified during the 2003 inspection program.
38	E-F	Minor efflorescence on the east side of the pile cap. This deterioration was first identified during the 2003 inspection program.
2A	A	Pile cap has a 0.6 m long x 0.3 m wide x 10 mm deep spall on the corner.
4A	E	Pile cap has a 100 mm diameter x 25 mm deep spall.
14A	A	Pile cap has a 300 mm x 300 mm x 12 mm deep spall on the corner.
53A	C	Pile cap has minor spalling with rust staining and exposed reinforcement steel between Piles C and D.

### 3.3 Piles

The piles are generally in a serviceable condition. There is typically hairline cracking, minor surface spalling, and rust staining at the pile/pile cap interface. There is also evidence of previous repairs being carried out at the tops of the piles.

The underwater inspection identified similar hairline cracking with associated V-shaped surface spalling. There is no evidence of exposed reinforcement in the submerged portion of the piles, although there is minor rust staining at spall locations in Pile Nos. 26-A and 26A-D.

The condition of the piles and the extent of deterioration does not appear to have increased since the 1997 inspection program.

### 3.4 Bracing

The bracing is located at the northeast corner of the jetty and consists of 200 mm x 254 mm timber horizontal wales spanning between the piles in both the longitudinal and transverse directions. The bracing is supported/connected to the piles by steel collars bolted to the piles. The extent of the bracing is presented in *Figure 1* below.

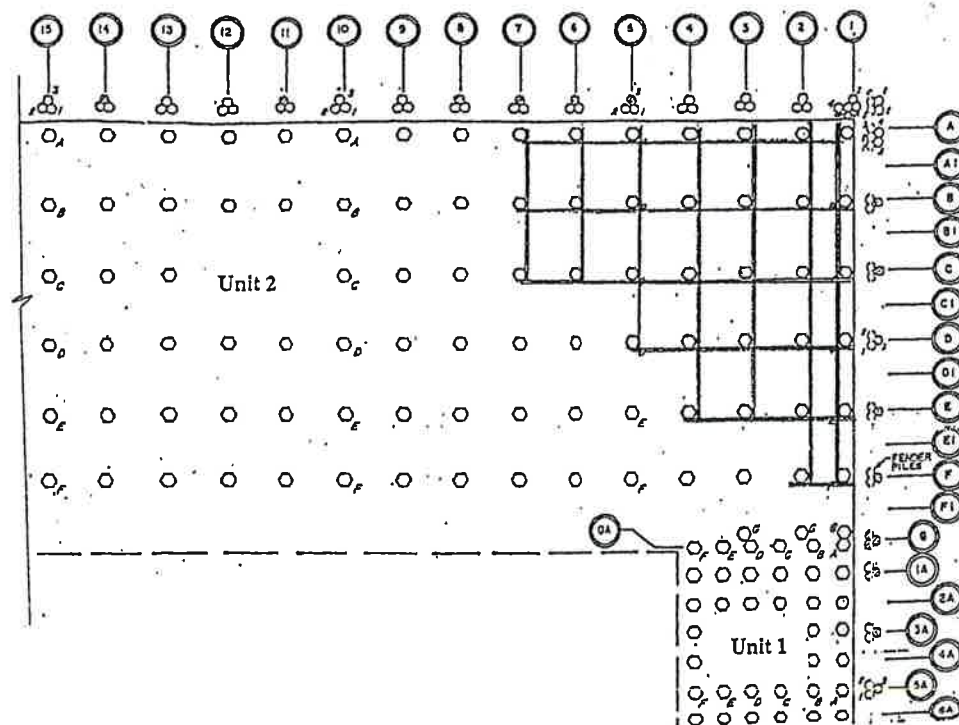


FIGURE 1: D-Jetty - Bracing Arrangement

The bracing is generally in a serviceable condition, although there has been an increase in the observed deterioration due to marine borer attack. Specific areas of bracing damage are summarized in *Table 3.4* below:

**TABLE 3.4: D Jetty - Bracing Damage**

Brace No.	Description	Recommendation
1B - 7B	Brace has a 10% MBC at Pile No. 1B.	Monitor.
1C - 7C	Brace has a 10% MBC at Pile No. 1C.	Monitor.
1D - 5D	Brace has a 75% MBC at Pile No. 1D.	Replace brace.
1E - 4E	Brace has a 75% MBC at Pile No. 1E.	Replace brace.
1A - 1F	Brace has multiple 10% MBC's between Pile Nos. 1B and 1F.	Monitor.
1F - 2F	Brace has a 100% MBC at Pile No. 2F.	Replace brace.
1E - 4E	Brace has a 25% MBC at Pile No. 2E.	Monitor.
1D - 5D	Brace has a 50% MBC at Pile No. 2D.	Replace brace.
2A - 2F	Brace has multiple 10% MBC's between Pile Nos. 2D and 2F and a 100% MBC at Pile No. 2F.	Replace brace.
1C - 7C	Brace has a 25% MBC at Pile No. 2C.	Monitor.
2A - 2F	Brace has a 25% MBC between Pile Nos. 2A and 2D.	Replace brace.
1E - 3E	Brace has a 25% MBC at Pile No. 3E.	Monitor.
3A - 3E	Brace has a 50% MBC at Pile No. 3E.	Replace brace.
1E - 4E	Brace has a 100% MBC between Pile Nos. 3E and 4E.	Replace brace.
4A - 4E	Brace has a 75% MBC at Pile No. 4E.	Replace brace.
1C - 7C	Brace has a 90% MBC at Pile No. 4C.	Replace brace.
1A - 7A	Brace has a 25% MBC at Pile No. 2A, and a 10% MBC at Pile No. 4A.	Monitor.
1B - 7B	Brace has a 25% MBC at Pile No. 7B.	Monitor.
6A - 6C	Brace has 50-75% CSL due to MBC along the entire length.	Replace brace.
7A - 7C	Brace has 25-50% CSL due to MBC along the entire length.	Replace brace.

Redundant brace support collars are either still attached, partially attached, or resting on the mudline on the remainder of the piles.

### 3.5 Fendering System

#### 3.5.1 Fender Logs

The fender logs are generally in a serviceable condition. Specific inspection observations are presented in *Table 3.5.1* below:

**TABLE 3.5.1: Fender Log Damage**

Bent	Description	Recommendation
1-14	Fender logs are missing.	Replace fender logs.
14-17	East fender log chain is missing.	Replace fender chain.
18 - 21	Fender log is missing.	Replace fender log.
22 - 25	Fender log has 25% CSL due to limnoria infestation.	Monitor.
26 - 28	Fender log has 75% CSL due to limnoria infestation.	Replace fender log.
29 - 31	Fender log has 25% CSL due to limnoria infestation.	Monitor.
32 - 34	Fender log is missing.	Replace fender log.
35 - 37	Fender log has 10% CSL due to limnoria infestation.	Monitor.
A - C	Fender log is missing.	Replace fender log.
D - F	Fender log has 25% CSL due to limnoria infestation.	Monitor.
G - 5A	Fender log has 75% CSL due to limnoria infestation.	Replace fender log.
5A - 13A	Fender log is missing.	Replace fender log.



### 3.5.2 Rubbing Piles

The rubbing piles are generally in a serviceable condition. Specific piles requiring remedial work are presented in *Table 3.5.2* below:

**TABLE 3.5.2: Damage to Rubbing Piles**

Bent	Observation	Recommendation
A	OBH in the upper ITZ on the north pile; 90% MBC in the lower ITZ on the south pile.	Replace south pile and install resin plug in north pile.
B	Lower connection bolt is loose.	Install lower connection bolts.
3A	50% CSL in intertidal zone due to abrasion.	Replace pile.
9A	Pile is fractured.	Replace pile.
19A	Pile is fractured.	Replace pile.
25A	90% MBC at lower bolt connection ( <i>Photograph No. 8</i> ); bolt is missing and pile has failed.	Replace pile.
33A	Pile is fractured.	Replace pile.
43A	Lower connection bolt is loose.	Install lower connection bolts.
47A	Pile has 50% CSL due to abrasion and 75% CSL due to limnoria infestation.	Replace pile.
55A	OBH in the lower ITZ.	Install resin plugs.
17	25% CSL due to mechanical damage ( <i>Photograph No. 9</i> ).	Monitor.
18	Upper connection bolt has failed.	Replace upper connection bolts.
21	10% CSL due to limnoria in the ITZ.	Monitor.
25	5% MBC in the upper ITZ.	Monitor.
28	5% MBC in the upper ITZ.	Monitor.
29	5% MBC at lower bolt connection.	Monitor.
30	Upper connection bolt is loose.	Replace upper connection bolts.
33	25% CSL at the upper bolted connection due to fungal decay ( <i>Photograph No. 10</i> ).	Replace pile.

### 3.5.3 Fender Piles

The fender piles, and connections, are generally in a serviceable condition. Specific areas requiring remedial action are presented in *Table 3.5.3* below:

**TABLE 3.5.3: Damage to Timber Fender Piles**

Bent	Pile No.	Observation	Recommendation
1A	2	Connection/restraint chain between concrete pile cap and timber fender piles is loose ( <i>Photograph No. 11</i> ).	Resecure restraint chain.
5A	2	Fender pile has an OBH in the ITZ.	Install resin plug.
7A	1	Upper connection has failed.	Replace upper connection bolts.
9A	1	Connection/restraint chain between concrete pile cap and timber fender piles and the eyebolt in the pile cap are missing; pile has two OBH's in the ITZ.	Install additional eyebolts and restraint chains. Install two resin plugs.
	2	Connection/restraint chain between concrete pile cap and timber fender piles and the eyebolt in the pile cap are missing.	Install additional eyebolts and restraint chains.
17A	-	Eyebolt in pile cap is missing.	Replace eyebolt.
18A	2	Upper connection is loose.	Replace upper connection bolts.
19A	-	Fendering is fractured.	Replace two piles.
21A	2	100% MBC in the upper ITZ ( <i>Photograph No. 12</i> ).	Replace pile.
23A	2	5% MBC in the upper ITZ.	Monitor.
25A	1	25% MBC in the upper ITZ.	Replace pile.
	2	50% MBC in the upper ITZ.	Replace pile.
27A	2	10% MBC in an OBH in the upper ITZ.	Monitor
33A	2	10% MBC in an OBH in the upper ITZ and fractured top 2.5 m.	Monitor.
41A	-	There is a fender log jammed beneath the dock.	Remove debris.



Bent	Pile No.	Observation	Recommendation
45A	---	Eyebolt in pile cap is missing.	Replace eyebolt.
A	---	Eyebolt in pile cap is missing.	Replace eyebolt.
B	---	Eyebolt in pile cap is missing.	Replace eyebolt.
	2	10% MBC in an OBH in the upper ITZ.	Monitor.
C	1	10% MBC in an OBH in the upper ITZ.	Monitor.
D	2	Eyebolt in pile cap is missing.	Replace eyebolt.
G	2	Connection/restraint chain between concrete pile cap and timber fender piles and the eyebolt in the pile cap are broken.	Install additional restraint chains.
Northeast Corner Dolphin	---	The 4-pile turning dolphin has 90% CSL due to fungal decay in the top 1.0 m of three of the four piles ( <i>Photograph No. 13</i> ).	Replace turning dolphin.
1	1	90% MBC in an OBH in the upper ITZ.	Replace pile.
	2	75% MBC in an OBH in the upper ITZ ( <i>Photograph No. 14</i> ).	Replace pile.
	3	75% MBC in an OBH in the upper ITZ.	Replace pile.
6	2	5 mm wide split in the bottom 1.0 m.	Monitor.
19	1	Fender pile has an OBH in the ITZ.	Install resin plug.
21	---	Connection/restraint chain between concrete pile cap and timber fender piles and the eyebolt in the pile cap are broken.	Install additional restraint chains.
25	1	Minor splitting at the mudline.	Monitor.
28	1	75% MBC in the upper ITZ.	Replace pile.
29	1	Minor splitting at the mudline.	Monitor.
31	1	Minor splitting at the mudline.	Monitor.
36	1	Pile is fractured.	Replace pile.
	2	Fender pile has an OBH in the ITZ.	Install resin plug.
37	2	50% MBC in the lower ITZ.	Replace pile.
38	2	Fender pile ends approximately 150 mm above mudline, possibly due to scour.	Replace pile.

### 3.5.4 Top Rubbing Strip

The top rubbing strip is generally in a serviceable condition. A detailed condition inspection should be completed as discussed in *Section 3.1*.

### 3.5.5 Timber Chocks

The timber chocks are in a serviceable condition. Specific inspection observations are presented in *Table 3.5.5* below:

**TABLE 3.5.5: Timber Chock Damage**

Bent	Description	Recommendation
14 - 15	Fender chock is fractured.	Replace fender chock.
19 - 20	Fender chock is split ( <i>Photograph No. 16</i> ).	Replace fender chock.
24 - 25	Fender chock is fractured.	Replace fender chock.
33 - 34	Fender chock is fractured.	Replace fender chock.
37 - 38	Fender chock is fractured ( <i>Photograph No. 15</i> ).	Replace fender chock.
F - G	Fender chock is split.	Replace fender chock.
19A - 21A	Fender chock is missing.	Replace fender chock.

### 3.5.6 Fender Wale

The fender wale is in a serviceable condition. Specific inspection observations are presented in *Table 3.5.6* below:

**TABLE 3.5.6: Timber Chock Damage**

Bent	Description	Recommendation
25 - 28	Fender wale has 25% CSL due to limnoria infestation in the end 1.0 m.	Replace fender wale.
37 - 38	Fender wale has 75% CSL due to marine borer infestation in the end 300 mm.	Monitor fender wale.
A - C	Fender wale is missing.	Replace fender wale.
E - G	Fender wale has 25% CSL due to limnoria infestation.	Replace fender wale.
1A - 5A	Fender wale has 25% CSL due to limnoria infestation.	Replace fender wale.

### 3.5.7 Rubber Fenders

The rubber fenders are in a serviceable condition.

## 3.6 Slope Protection

The riprap slope protection appears to be working effectively. Typical slopes are in the order of 45 degrees. The exposed coping wall piles are an indication of previous down slope migration of the riprap. Attempts to stabilize the slope have been carried out by pouring concrete at the top of the slope beneath the coping wall. There does not appear to have been any recent significant movement.

## 3.7 Coping Wall

The coping wall is in a serviceable condition. As identified in the 1997 Inspection Report, a down slope movement of the riprap has exposed the tops of the timber piles. There is no evidence of additional slope movement since the 1997 inspection program.

The results of the 1997 baseline survey to document the exposed lengths were verified during the current inspection program, and are presented in *Table 3.7* below:

**TABLE 3.7:** Exposed Length of Coping Wall Piles

Bent No.	Length of Exposed Pile (m)
1 - 3	No exposed piles
4 - 10	1
10 - 14	0.5
14 - 20	0.3
20 - 28	0.15 - 0.3
28 - 30	0.3
30 - 33	0.15
0A - 3A	0.6
3A - 5A	0.3
5A - 11A	0.15 - 0.3

Bent No.	Length of Exposed Pile (m)
11A - 15A	0.3
15A - 18A	0.6 - 1.0
18A - 25A	1
25A - 28A	0.3
28A - 32A	0.6
32A - 35A	1
35A - 39A	No exposed piles
39A - 41A	0.6
41A - 55A	No exposed piles

## 4 Residual Life Estimates

### 4.1 Timber

An estimate of the residual life of each structural element is an essential part of the long term planning and maintenance process. The estimates presented below are based on the following assumptions:

- Where creosote or salt-treated timber has been examined for the presence of decay and is found to be sound, an estimated life in excess of 8 to 10 years is deemed appropriate.
- Where some evidence of decay has been found, but very limited in extent, the element can be assumed to have a residual life in the order of 3 to 7 years.
- Where an element has a weakened cross-section due to decay, the residual life should be taken as negligible, and the element should be considered unreliable for structural loads.
- Where individual bracing members are damaged, the level of redundancy within the entire system is assessed before making recommendations for repairs/replacement.
- Residual life should be established for each major class of elements in the structure, i.e., decking, bull rail, handrails, stringers, pile caps, piles and bracing, and for individual elements within these classes where replacement of the deficient individuals is practical.

It is important to note that these are approximate estimates. Fungal decay (rot) and marine borer attack will spread quickly once established in the structure and where conditions are favorable.

- |                   |                                |
|-------------------|--------------------------------|
| • Fender Logs:    | 8 to 10 years, except as noted |
| • Rubbing Piles:  | 3 to 7 years, except as noted  |
| • Fender Piles:   | 3 to 7 years, except as noted  |
| • Timber Chocks:  | 8 to 10 years, except as noted |
| • Rubber Fenders: | 8 to 10 years                  |
| • Cross Bracing:  | 3 to 5 years, except as noted  |

## 4.2 Concrete Piles

The cracking and minor spalling of the concrete piles is caused by overloading, and is attributable to the following:

- Excessive pile driving during construction. The initial damage which is often hairline cracking in the top section of the pile goes unnoticed at the time of installation. This is common in concrete piles, and experience with similar structures has demonstrated that the damage does not become apparent for a number of years.
- Vessel berthing loads which exceed the energy absorption capabilities of the fender system. Berthing forces are transferred into the structure and are typically dissipated in bending at the pile cap/pile interface. The damage observed in the top section of the piles is typically more severe in the three bents adjacent to the berth face.
- It is common practice to construct pile caps wider than the pile diameter to allow for some degree of construction tolerance during pile driving. However, the D Jetty pile caps are the same size as the piles and in order to minimize pile misalignment during driving, it is probable that the contractor may have pulled the piles into position. Excessive stresses generated by pulling will result in overloading at the mudline. *Photograph Nos. 9 and 10* are typical examples of piles which are not in alignment with the cap. A reduction in cover to the reinforcement steel is probable with piles that are out of alignment, and the continued monitoring of these locations for rust staining and mechanical damage is recommended.

There is concern that the intermittent wetting of the piles will eventually initiate corrosion of the reinforcement causing the cracks to increase in number and size, eventually leading to spalling.

The immediate repairs to the concrete piles is not recommended at this time. The piles are in a serviceable condition considering the age of the structure (constructed in 1954). The continued monitoring of the condition of the piles, both above and below the waterline, is strongly recommended. A prioritized program of concrete rehabilitation should be implemented when the extent of cracking/deterioration reaches a stage that may compromise the structural stability of the jetty.

A service life in excess of 10 years can be expected for the concrete piles.

### 4.3 Concrete Pile Caps

The localized areas of reinforcement steel on the vertical faces of the pile caps is attributed to insufficient cover. Hammer sounding in the vicinity of the exposed reinforcement to identify the extent of delamination and possible internal corrosion of the steel indicated that the extent of corrosion appears to be localized, and confined to the area of steel that is visible on the surface. The exposed reinforcement is typically 150 mm in length and the section loss due to corrosion deterioration is minimal (>5%).

Of immediate concern are the pile caps that exhibit severe spalling and exposed reinforcement. Located on the soffit of the members the damage is attributed to insufficient concrete cover resulting in the corrosion of the shear reinforcement. Section loss in the steel is in the order of 10 to 15% of the original bar diameter. Since the pile caps in shear is one of the governing factors with respect to jetty loading, remedial work consisting of the removal of delaminating concrete, cleaning of the steel and resealing the pile cap using a concrete patching system is recommended. In the event that there is severe section loss of the reinforcement steel, additional bars may be required to be drilled into the cap.

Upon completion of the recommended repairs, a service life in excess of 10 years can be expected for the concrete pile caps.

### 4.4 Slope Protection

The riprap slope protection appears to be working effectively. Although there is evidence of previous down slope movement, the slope appears to be stable. There is concern that the piles adjacent to the coping wall are retaining some of the riprap. *Photograph Nos. 16, 17 and 18* are typical of the conditions at D Jetty. The piles do not show evidence of distress; however, future inspection programs should include a detailed examination of these piles to ensure that they are not being overloaded.

A service life of five to eight years can be expected for the slope protection structures.



## 5 Summary and Recommendations

The D Jetty facility is generally in a serviceable condition, although repairs/maintenance work is required in order to maintain the facility in a safe and operational condition.

A summary of the recommended repair/maintenance work, an estimate of the associated costs, and the recommended time frame to implement the repair work is presented below:

Description	Time Frame to Implement Repairs	Estimated Cost
Repair two (2) areas of pile cap with shotcrete.	2003/2004	\$20,000
Replace 12 timber braces.	2003/2004	10,000
Replace 13 fender logs.	2003/2004	13,000
Replace one (1) fender log chain, complete with anchor block.	2003/2004	2,500
Replace eight (8) rubbing piles.	2006/2008	4,000
Install two (2) resin plugs in the rubbing piles.	2003/2004	500
Replace connection bolts on two (2) rubbing piles.	2003/2004	1,000
Replace 12 fender piles.	2003/2004	18,000
Replace 4-pile turning dolphin at northeast corner.	2003/2004	5,000
Replace five (5) sections of fender wales.	2003/2004	3,500
Miscellaneous connection chain and eyebolt repairs.	2003/2004	2,000
<b>Subtotal</b>		<b>\$79,500</b>
Contingency and Engineering (30%)		23,500
<b>Total Estimated Cost</b>		<b>\$103,000</b>

In reviewing the estimated costs, it is important to note the following:

- Contractor mobilization has not been included. We have assumed that the repair work would be carried out in conjunction with other pile driving activities in Esquimalt Harbour.

- The estimate is based on in-house experience with similar projects and on budget price quotations from local contractors and suppliers.
- The estimate is based on mid 2003 cost levels and does not allow for escalation.
- The estimates do not include GST (if applicable).
- It is recommended that a contingency allowance of 25% of the total estimated cost is included to cover undefined items. This contingency is not a reflection of the accuracy of the estimate, but covers items of work that will have to be performed, and elements of cost that will be incurred, but which are not explicitly detailed or described due to the level of engineering and estimating that has been completed to date.



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## ***APPENDIX A***

### *Site Photographs*



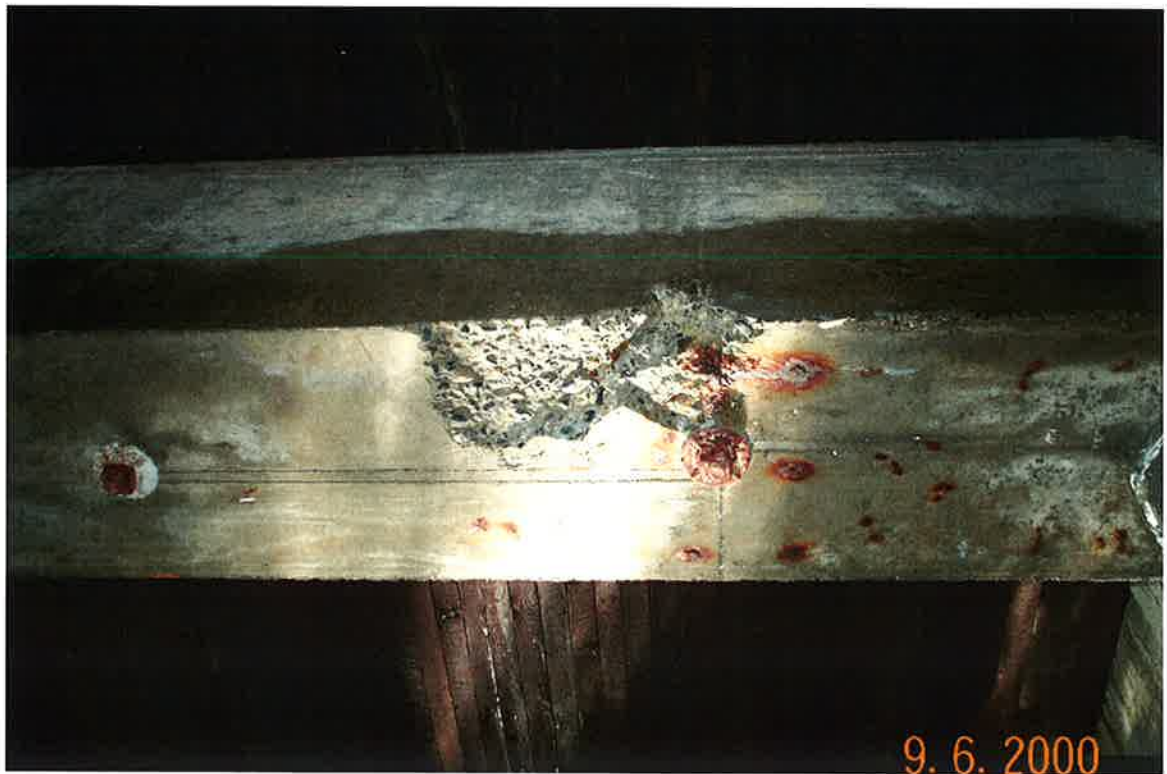
**Photograph No. 1:** General view of the east berth.



**Photograph No. 2:** General view of the north berth.



**Photograph No. 3:** Exposed, rusted reinforcing steel along Bent No. 1, between Piles A and B.

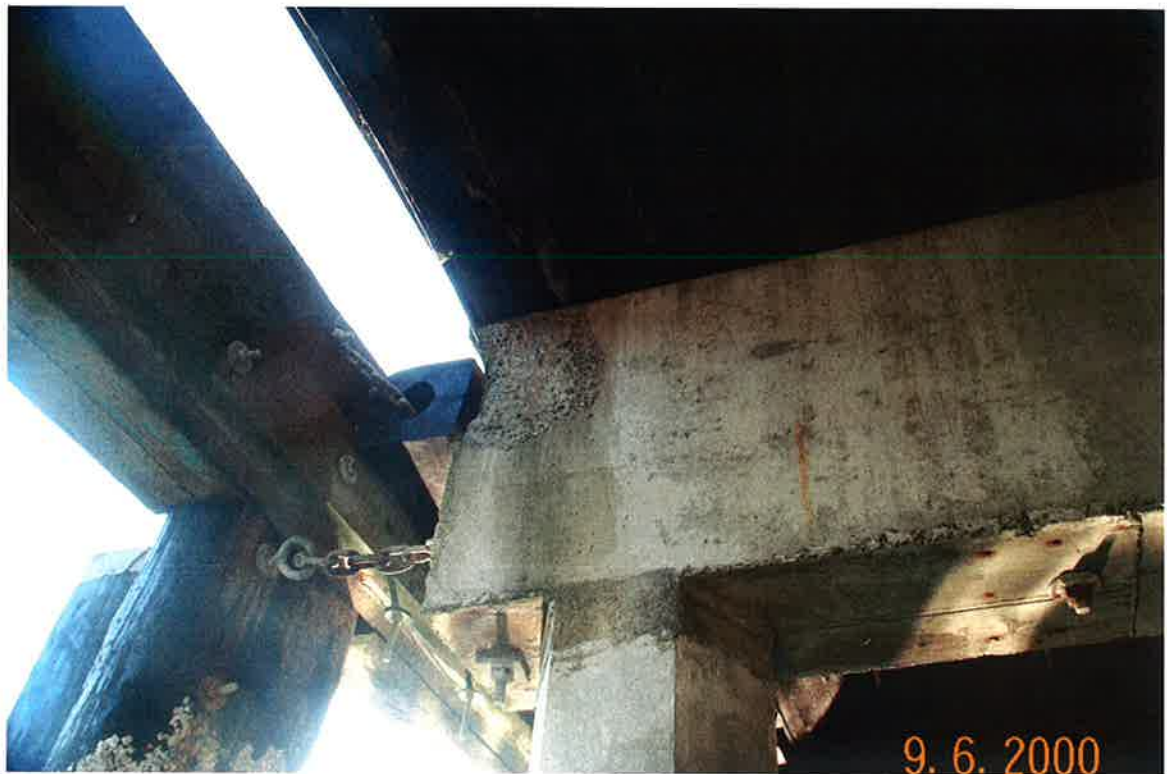


**Photograph No. 4:** Spalling on pile cap corner at Pile No. 3G.





**Photograph No. 5:** Exposed, rusted reinforcement at Pile No. 24C.



**Photograph No. 6:** Spalling resulting from impact at Pile No. 35A.



**Photograph No. 7:** Exposed, rusted reinforcement at Pile No. 36C.



**Photograph No. 8:** Rub pile has severe marine borer infestation, and as a result the lower connection has failed.

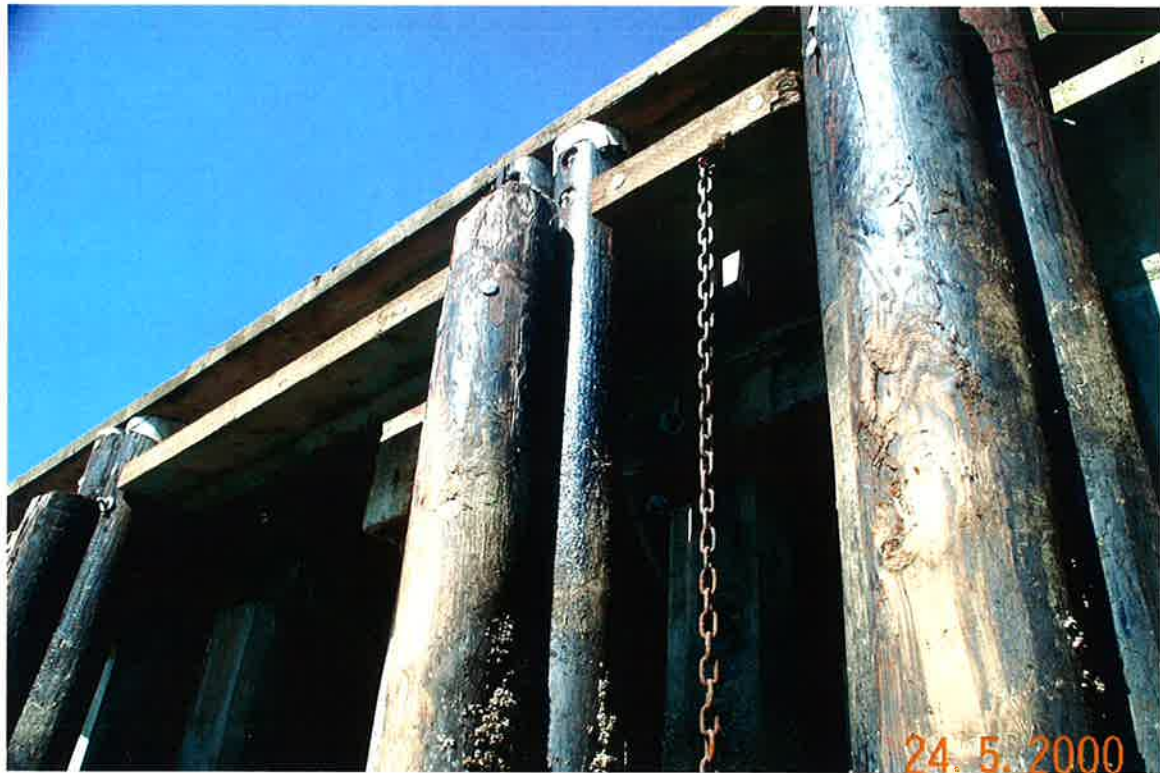




**Photograph No. 9:** Fungal decay and mechanical damage at the top of the rub pile.



**Photograph No. 10:** Fungal decay in the top of the rub pile at Bent No. 33.



**Photograph No. 11:** Eyebolt is missing at Bent No. 1A.



**Photograph No. 12:** Severe marine borer damage to Fender Pile No. 21A-2.





**Photograph No. 13:** Fungal decay in the tops of the 4-pile mooring dolphin at the northeast corner of the facility.



**Photograph No. 14:** Severe marine borer damage to Fender Pile No. 1-3.





**Photograph No. 15:** Chock No. 37-38 is fractured.



**Photograph No. 16:** Chock No. 19-20 is split.

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***APPENDIX B***

*Reference Drawing*



PF76-96/97-7754

NO	DATE	REVISION	REVISION	BY

SCALE - ÉCHELLE  
N.T.S.

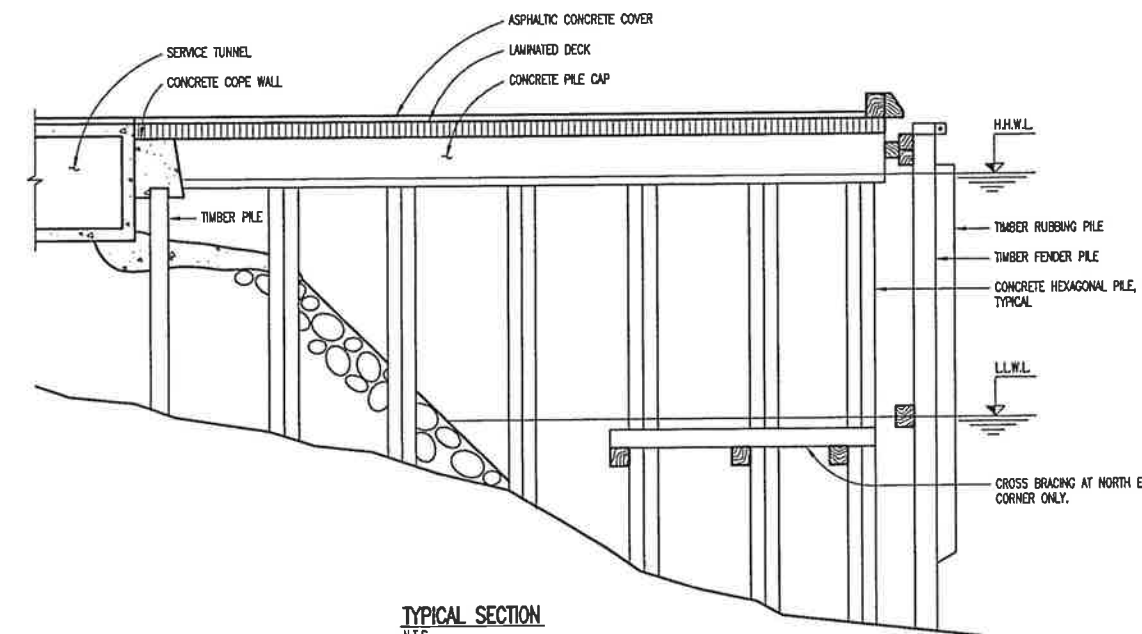
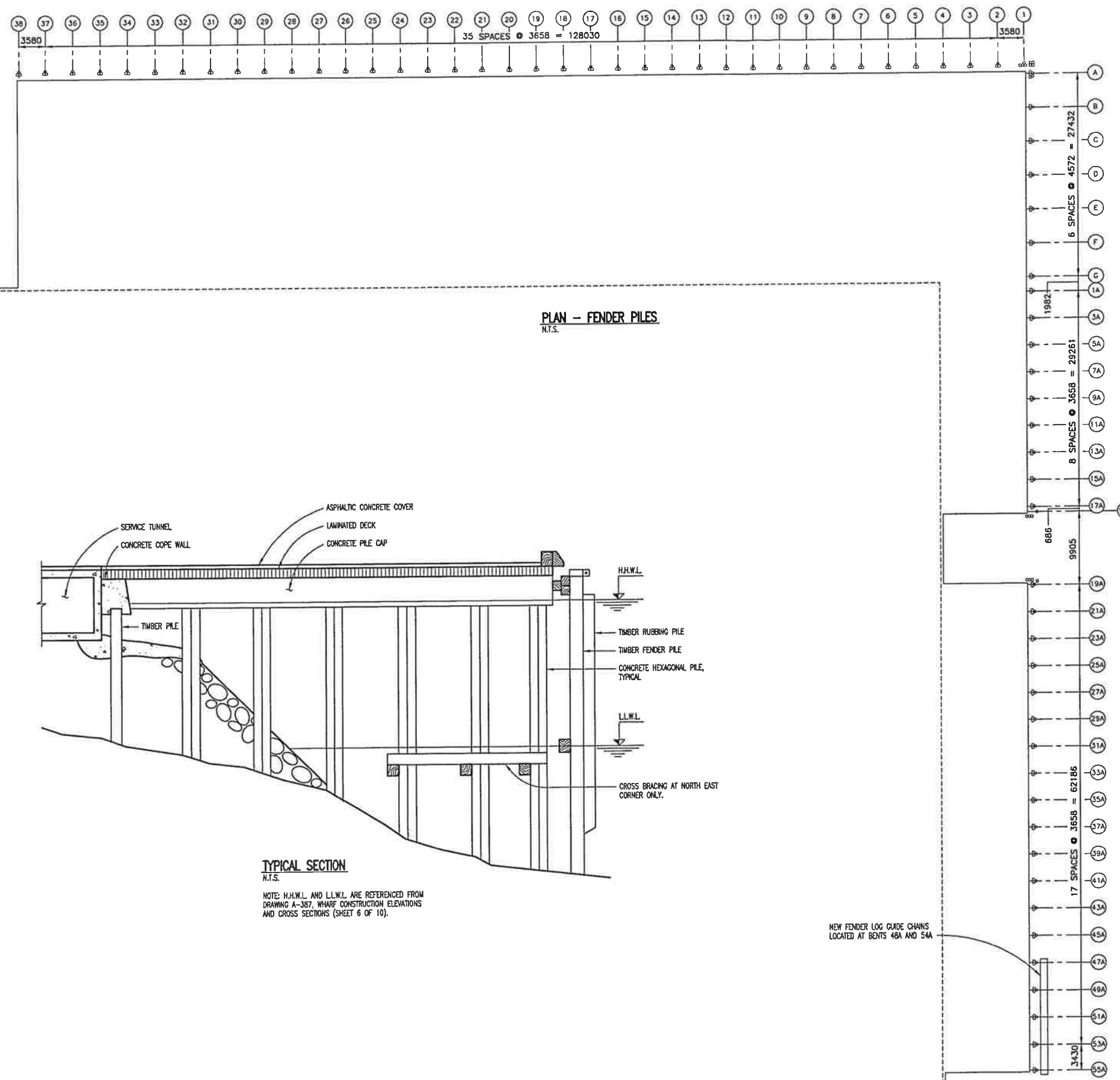
PROJECT - PROJET  
CFB ESQUIMALT (ESQUIMALT DOCKYARD) B.C.

JETTY INSPECTION - 2003

DATE  
NOV19/03

SUBJECT - SUJET  
D-JETTY INSPECTION

DESIGNED ÉLÉVÉ	CONFERENCED - ASSURÉ
DRAWN Dessin	
CHECKED Vérifié	
COORDINATOR	APPROVED BY - APPROUVÉ PAR



PRELIMINARY  
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