CHRISTCHURCH CITY COUNCIL

GOVERNORS BAY JETTY STRUCTURE CONDITION ASSESSMENT

CONSULTANTS NZ LIMITED

49 Crownhill Street
PO Box 151
New Plymouth 4340

Telephone 06 7512310
Fax 06 7512310
Email: ocel@clear.net.nz

OCEL House
276 Antigua Street
PO Box 877
Christchurch 8140
Telephone 03 3790444
Fax 03 3790333
Email: mail@ocel.co.nz

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INTRODUCTION

The scope of the work under the first stage of this project is:

- to inspect and report on the condition of pile caps, corbels and beams based on detailed assessment of condition on a component by component basis
- to inspect and report on the decking and handrail systems and proposed remedial options
- to compile a summary of repair options for the wharf in conjunction with CCC
- to review costs and benefits of the proposed options and establish a likely ongoing maintenance assessment requirement and costs.

Subsequent discussion resulted in the incorporation of the assessment of pile condition to compare it with the inspection carried out in 2011. The pile assessment was carried out with the assistance of Brent McKay of Maintenance Management Services Limited who undertook the detailed pile inspection for the OPUS assessment of 2011.

BACKGROUND

The Governors Bay jetty at its present site appears to have been constructed around 1900 as a replacement for the older structure at the end of Sandy Bay Road which was originally built in the 1860's.

We have been unable to find definitive history of the present jetty, although it is likely to have been extended more than once to its present 300 m length as the bay has gradually infilled. The bed of the bay comprises fine soft mud which is understood to have risen 0.8 m over the last century, with the present situation of the low water mark being some 40 m beyond the outer landing which is 300 m from shore. Access to this landing by water is thus limited both by accessible draft, and time, over each tide. The inshore landing is accessible only to dinghy sized vessels at higher tide levels.

First stage of jetty circa 1900

The jetty has obviously been repaired a number of times over its life, with many piles having been replaced adjacent to the originals and bolted to the caps or the decaying piles they replace. In many cases this has resulted in a less sound structural configuration in relation to both lateral and vertical load resistance. The inshore 185 m of decking has been replaced, and some beams have been supported with the addition of

'doublers' installed beside the 'original'. In many cases construction and repair has been done using timber recovered from other structures.

The motivation for the current inspection was to update the knowledge of the condition of the jetty which was inspected in detail 17 February 2011 and reported on by Opus. Subsequently there were a number of significant earthquake events, and a detailed inspection of the piles carried out in July 2011 by Maintenance Management Services Limited. This pile assessment increased the number of piles considered nonviable or requiring replacement from 19 nominated by Opus following their February inspection to 49. The jetty has remained closed since the 2011 inspections with no maintenance, and continuing deterioration. This current inspection was carried out 3 years later than the previous one.

INSPECTION PROCEDURE

Inspection was carried out from beneath the structure at low tide, and from the deck. Individual assessment of each pile was undertaken including the removal of marine growth to expose areas of potential deterioration in the tidal zone, and observation of the pile to cap connections which in many cases comprised the bolting of replacement piles adjacent to the original connection but with no, or limited, timber to timber bearing support. Caps were observed visually from below and soundness tested with a geologist's hammer where condition was doubtful. Beams and corbels were inspected from below, and all beams were drilled vertically from the deck to provide an indication of soundness. This process involved drilling into the beam from above using a 10 mm auger bit. Beams were drilled at approximately midspan and between deck planks to a penetration depth where sound timber was produced by the auger, and the depth recorded.

Decking and handrails were observed and conditions recorded. A photographic record of the substructure inspections was also recorded.

INSPECTION RESULTS

Detailed inspection results are summarised in the following pictorial spreadsheet format which provides a summary of the observations and the distribution over the structure of components requiring attention or replacement. A selection of the photographic record is also included. Several areas were found that are considered unsafe, and our inspection confirms that the closure of the structure was and remains justified.

Issues that lead to components meeting criteria for replacement are generally as follows:

Piles

Piles on a structure such as this are required to carry vertical and lateral loads. While the inshore section of the wharf to the inner landing, and at the outer landing, was initially provided with bracing within the piled frames, the majority of the structure is unbraced, with lateral loads originally resisted by portal frame action and requiring fixity at the pile to cap joints. In many cases the original bracing has become ineffective due to deterioration of connections either at the brace ends or in the piles, with lateral resistance now being provided by cantilever action of the piles fixed into the seabed. Deterioration of piles near bed level which, is the most commonly observed deterioration, reduces the bending and shear capacity of the pile section. Where piles are assessed as having lost greater than 50% of original section through the effects of worms and other fauna, and general deterioration, or have substantial splits affecting load transfer from the caps, they are considered inadequate for service and designated as requiring replacement. Many were observed with holes through the full section which have been enlarged by marine organisms to create cavities in the pile section.

It is important to point out in relation to piles that the build-up of sediment within the bay potentially conceals earlier deterioration in the older piles that remain. One explanation of the structural settlement that has occurred in the outer piles is that the pile has failed at a cavity below bed level and thus not observable, with the top section dropping to sit on the embedded end.

Pile Caps

Pile caps have been considered on a similar basis. Most of the original caps were connected to piles with a mortise and tenon joint with mortise cut from the cap. This provided a timber to timber load path and rotational fixity in the joint provided by the close fit of the components. In some of the caps the mortise holes have now enlarged, and the caps have split at the ends resulting from the proximity of the mortise and the drilling of the vertical beam securing bolts. Some have split both horizontally and vertically at the ends. As a result of these defects, and the fact that very few of the original piles that were connected in this manner remain, the fixity within the pile to cap joint is tenuous, and in many cases shear transfer from cap to pile is limited to bolts through split timbers.

Pile/Pile Cap Connections

The steel hardware (bolts, washers and straps), particularly where used to connect piles to caps, is in many cases significantly rusted and impossible to assess in terms of reliable remaining capacity. Where the caps are supported on the ends of, or are checked in to piles to provide timber to timber support and simply retained in place by the bolt combinations, the remaining integrity of bolts is less important than in the many instances where replacement piles have been driven beside caps with little or no attempt to provide timber to timber support, leaving the bolts alone to transfer the vertical loadings in shear. The repair process should address this issue in providing more reliable load transfer from caps to piles. This needs to be considered on a case by case basis depending on pile position (which will vary with the installation of replacement piles) and cap condition.

Beams

Deck beams span between the caps supporting the decking, and apart from the inshore 25 m of jetty, the spans between pile centrelines are in the range 7.5 to 8 m. This is a relatively long span for timber members in a structure of this type, and results in relatively large bending moments and deflections under moderate loads. The beams on adjacent spans are jointed over timber corbels, a method common on railway bridges to achieve jointing over a narrow cap while maintaining beam alignment (ie avoiding having to lap and offset consecutive beams). In our assessment the use of these corbels does not effectively reduce the beam span, as the corbel/cap system will rotate with higher loadings on a single span. Over the width of the wharf, beam sets comprise two 350x200 members and two 350x100 members on the outsides.

Design live loading for such public areas of structures are nominated in the New Zealand Building Code, AS 3692 Guidelines for Design of Marinas, SNZ HB 8630:2004 Tracks and outdoor visitor structures, all stipulating a distributed live loading of 4 kPa. This loading is challenging for this structure, and while there is limited potential for imposition of such a load on Governors Bay Jetty, it is clearly established as the design requirement.

Structural assessment and design is based on reliance on a sound known member cross section. With new materials this is a basic procedure, but where there is deterioration of indeterminate and variable degree, and where the species of timber is unknown and variable in terms of establishing appropriate stress capacities, the process becomes less certain and requires the assumption of member parameters. Analysis on this basis using mid range values for hardwood characteristic bending stress (36 MPa) and elastic modulus (12000 MPa), shows that the original member sizes provided in the jetty construction, if in sound timber, are appropriate for supporting the deck and a live loading of 4 kPa as nominated. That is with bending moments less than design member bending capacity, and deflections below code guidelines. Deterioration of the members reduces their adequacy however, with, for example, the loss of 100 mm from the top of the cross section of a 350 mm deep beam doubling the bending stresses in the section for the same applied load, or effectively halving the load capacity of the beam. Assessment of beams with a 50 mm loss of section under the same 4 kPa loading indicates the bending moments in the reduced section are of adequate design capacity, but deflections are well above design guidelines. In other words this small loss of cross section (14% of the beam depth) is

enough to increase the beams' deflection to well beyond recommended limits. With 80 mm loss of depth the beams' bending capacity reduces to below that required to carry the design load, and further increases deflections to 150% of those of 50 mm loss of section. Beyond 80 mm loss of section the beams are clearly inadequate in both bending capacity and deflection. We note that deflections are a serviceability issue, and assessments here are based on the upper end of the standard range at span/150, the acceptable deflection based on the beam span.

Beams were inspected visually from below the structure, and also drilled to assess the possibility of hidden decay. Vertical holes were drilled with a 10 mm auger bit into the top of the deck beams. Each beam on the structure was drilled at about mid span (where bending stresses are highest under imposed vertical load) with measured penetration to sound timber, judged by the presence of clean timber in the auger flights, and firm drilling load. The presence of unsound material established in this manner is not obvious from the sides of the beams, nor is the lateral extent of the rot or the width of the remaining timber shell. For structural assessment the depth of the cross section has been reduced by the penetration measured.

Because it is considered that a single exploratory drill hole may not be representative along the beam (it may be that deterioration at deck spike positions is worse), but cannot be better than the drilled position, beams where unsound timber is identified to 50 mm depth or greater have been nominated as requiring replacement. This is based on the likely ongoing deterioration of the members and the 4 kPa loading requirement which may appear conservative but is consistent with the appropriate design code requirements. Discussion of the option of only replacing beams with 80 mm or more deterioration is present further on.

Other faults observed in the beams included rot, longitudinal splitting, deterioration of sections exposed due to drilling for bolts, and the expansion of bolts and steel fittings through rusting, particularly in the outer 350 x 100 members which tend to warp and are more vulnerable because of the aspect ratio.

Stairs and Landings

Stairs and landings their stringers and supports are in a generally poor state and require substantial replacement.

Decking

Decking and handrails were visually assessed, the inshore 185 m of deck being replaced with pine timber, the seaward section is elderly hardwood showing various degrees of aging, to the extent that there is a 2 m section missing altogether at about 260 m from the shore.

Requirements for Upgrading

In summary, the items assessed as unserviceable and requiring replacement include:

63 piles
103 beams total with greater than 50 mm decay, 88 with greater than 80 mm decay (ie is fewer)
5 caps
24 corbels
200 linear m of decking (3.3 m wide)
Various handrail timbers
Stair stringers, supports and treads
Fixing hardware including bolts, nuts, washers, tie rods, and flat bar

The spreadsheets included in Appendices 1 and 3 summarise the inspection results. They are produced twice at different scales to show the distribution of defects, and to allow the details to be legible. The spreadsheet has been prepared to diagrammatically represent the jetty components laid out as pile bents with caps between, and

beam spans. Coloured items represent components requiring replacement as identified in the key on each sheet. The full colour coded spreadsheet is plotted with the wharf outline in the appendix to show diagrammatically the distribution of repairs proposed. Refer to the A4 prints for text detail.

REPAIR REQUIREMENTS

The amount of improvement identified as required is substantial, and is beyond piecemeal independent repairs. Thus a concerted approach is considered appropriate to make economical and practical use of the set up and mobilisation costs.

Assessment of the cost and method to undertake the repairs outlined has been carried out in conjunction with Brent McKay of Maintenance Management Services Limited. Mr McKay's company has significant experience and specialised equipment for maintenance work of the type and extent required.

In considering the extent and cost of repairs it is necessary to understand the issues related to gaining access for repair, and providing the structural support required to enable equipment such as pile drivers to operate. In particular this project requires the handling, placement and driving of timber piles, and the replacement of substantial 8 m beams, both of which are major structural components of the existing jetty, but which require exposure by removal of other jetty components such as decking and handrails. The condition and means of fixing of some of these components, particularly decking and handrails, is such that it is likely that damage will occur necessitating the additional supply of and fixing replacement items. The potential for exposing more defects as repairs progress and as the structure is opened up to closer inspection is moderate, and the inclusion of a reasonable contingency for budgeting is recommended. The durability of materials is a major consideration in reducing future maintenance, and given that the cost of materials is a small proportion of the total repair cost, estimates are based on the use of treated hardwood timber for piles and beams, and treated pine for decking.

The location and nature of the jetty structure is very restrictive in providing working access. The narrow deck and relatively long spans limit the size and mobility of construction plant that could be used from the jetty, and require that the structure is progressively repaired to safely support this gear, which because of the structure's capacity will not be adequate to handle and pitch piles. Alternative access from an independent work platform would be provided from a barge, although this is awkward as the full length of the jetty "dries" at low tide. The soft seabed conditions do not allow any vehicular access at low tide, and the limited draft tidal nature of the site over the full length of the jetty makes access from the water time consuming and requires careful management to ensure efficiency of resources. To set up a barge with a pile driver will allow one pile to be driven before the barge can be moved on the next high tide. The barge can sit on the seabed as the tide retreats, but cannot be moved until there is draft available. It is also expected that in some cases temporary support of deck spans and caps from the seabed will be required as components are removed and replaced. The nature of the seabed is such that careful assessment is required to develop a suitable approach for providing such support on a temporary basis. Given also that many of the piles have been duplicated already, the installation of a third pile at any location is problematic with pile placement to avoid the remains of earlier components requiring careful consideration. This issue also has the potential to affect the regular appearance of the structure in terms of positioning and alignment of piles.

Access also relates to the ability to deliver equipment and materials to site, and to dispose of removed/recovered materials to waste. This process will be required to handle a significant amount of material. It has been assumed that the road around the shoreline and back to the main road could be re-opened to allow trucks to operate without having to turn at the bottom of the hill where space is inadequate, this may require construction of a new culvert to replace the bridge on the roadway. There are other issues related to the ability of the access road down the hill to support and provide truck access necessary, given the bridging and retaining walls. These aspects require further assessment. For safety reasons it is expected that the road would have to be closed to public access, and some provisions made in relation to the school.

It is noted that there is significant work required to expose and provide access for replacement of defective components, particularly beams and piles. Given the effort required, consideration needs to be given to the fact that unrenewed components will not have the same life expectancy and may be subject to accelerated

deterioration. For this reason if repair is to proceed, it would be prudent to carry out as much work as possible when the components are accessible.

REPAIR COSTS

Programming and duration of the work is the greatest variable in terms of establishing overall costing. Materials can be reasonably measured and costed. On the basis of the construction constraints outlined above an overall allowance of five days per bent is considered reasonable to cover site set up and demobilisation, offsite storage, preparation and handling of materials, dismantling and exposure of main structural components, piling, member replacement, securing and connections, and restoration of deck and hand railing. Thus for 45 bents a total of 225 working days is allowed, and has been applied to time related rates for labour and construction plant. Labour then becomes the greatest time related cost component. A construction team comprising two teams of 3 working on the jetty (on adjacent span and pile bent), a skipper/barge operator, a truck driver delivering and removing materials from site, and 2 men at an off site assembly yard preparing and prefabricating components for delivery.

A summary of estimated costs is set out below assuming 225 working days.

Site Establishment and Labour	
Fences	
Office	
Insurance	
Environmental controls	
Labour 10 men	
	$1,600,000
Plant and Equipment	
Pile driver	
Vehicles small	
Fork truck	
Hand tools	
Punt	
Boat	
Truck	
	$634,500
Materials	
Disposal of removed timber	
Piles	
Beams	
Caps	
Decking 200 x 50 H5 x 3.2 m	
Corbels	
Hand rail bolts/fixings	
Hand rails 100 x 50 H5	
Posts 100 x 100 1.5 m	
Stair stringers	
Stair treads	
Ss 24 mm rod	
Ss 24 mm nuts	
Ss 24 mm washers	
Ss 24 mm sq washers	
Ss 100 x 12 mm flat bar	
	$496,500
	$2,731,000
Contingency 15%	410,000
TOTAL ESTIMATE	$3,141,000

FUTURE MAINTENANCE

The proposed remedial work replaces approximately half of the structural components of the existing jetty. Successful and objective implementation of the work identified is expected to result in minimal maintenance costs over the next 10 years. However, the remaining 50% of the structure will by then be in the order of 30 to 40 years old, and beginning to deteriorate at an accelerated rate as is characteristic of these structures. The difficulty of gaining access to repair and replace these components will again arise and needs to be addressed when considering the initial scope of work.

Prediction of the cost of such maintenance ten years out is unrealistic, particularly as the work required will be influenced by how well the initial repair work is carried out. Based roughly on the estimate for the repairs identified an annual budget allowance beyond ten years would not be less than $20,000 per year. This figure would need to be put aside as a sinking fund to allow for planned piling replacement and maintenance.

OPTIONS FOR COST REDUCTION

The obvious first option for reducing this cost is to exclude replacement of the beams showing section depth reduction of 50 to 80 mm. This would reduce the number of beams to be replaced by 15. Inspection of the spatial distribution of these beams however, shows that in only two cases does the exclusion of work on these beams result in deck span sections requiring no intervention – on the rest, there are beams with greater loss of section that require replacement and exposure of all beams on that span. On this basis the reduction in cost by excluding those beam replacement is minimal (but real).

The second option would be to use decayed beams to double up providing a double width beam with improved bending capacity. This process would provide material savings, but would require exposure and assessment of the beams on a component by component basis. It would result in an increase in the dead load of the structure, and introduce further future issues related to component life.

Further options for limiting expenditure and allowing the jetty to be reopened are likely to require careful consideration of future life and costs in conjunction with utility, but do exist. For example, it would be possible to abandon part of the outer structure and focus on a shorter nearshore section. This option has not been pursued at this stage.

DO NOTHING

The do nothing option in this case would effectively abandon the jetty in its current state of closure. To exclude public access (which is not effectively done with the present barrier system) for safety purposes, the removal of the nearshore spans should be considered. A sum of $30,000 should be allowed to do this.

This option would lead to the slow deterioration of the structure.

DEMOLITION

Removal of the structure would involve the same basic difficulties identified in relation to repairs. Access, both on the structure itself, and for disposal of materials is a major constraint. The indicative cost of demolition and removal of all components including piles is $800,000 considering these aspects. Partial demolition (as has been done at the old jetty) would reduce this cost.

CONCLUSIONS

Governors Bay Jetty is in a poor state of repair and its current closure on safety grounds is justified.

Inspection has revealed an extensive range of repairs is required to restore structural adequacy, most of which are difficult to access both within the structure, and for appropriate pile driving and construction plant. The site is

restricted also in terms of road access and limited in terms of establishing site facilities and materials handling and storage.

The estimated cost of completing the repairs identified is $3.2 million, including a contingency that should cover additional problems exposed during the repair process. It is also recommended that if repairs are to be undertaken that consideration is to given to optimising the amount of work done while the basic structural components are exposed.

There are other options that could be considered at lower cost, but would require community discussion. They have not been pursued in detail.

APPENDIX 1

Inspection Summary Spreadsheets

GOVERNORS BAY WHARF - DIAGRAMMATIC PRESENTATION OF THE RESULTS OF DETAILED INSPECTION April 2014

Bent No		S pile	Cap, bracing, corbels (on bent lines)				N pile	Deck
			Beam	Beam	Beam Drilled depth to sound timber	Beam		
0 Abutment	Shoreline	Rectangular pile in rock abutment, condition unknown		310x200 Cap Hollow 1m from ends			Rectangular pile in rock abutment, condition unknown	
			250x125 span 2 bents	250x125 span 2 bents	250x125 span 2 bents	250x125 span 2 bents		
Bent 1		350x200 hardwood 50% wasted at bed	Caps typ 350x210 ok				350x200 hardwood 80 dia hole thru mid height	
			250x125 span 2 bents ok	250x125 span 2 bents 80	250x125 span 2 bents 100	250x125 span 2 bents 80		
Bent 2		Piles concrete jacketed to bed	Cap ok				Piles concrete jacketed to bed	
			ok	Beams lapsplice over cap, all bolted to cap 50	50	ok		
Bent 3		Hardwood round outside steel frame. Necked at bed, 50% cavity 600 up	cap ok, rusted steel cross brace				Hardwood round outside steel frame. Split frm top, cavity thru 100x50 mid height	
Bent 4		Hardwood round outside steel frame. Necked at bed, 75% cavity 600 up	cap ok, rusted steel cross brace				Hardwood round outside steel frame. Necked at bed, 50% cavity 600 up	
			ok	Beams lapsplice over cap, all bolted to cap 100	ok	90		
Bent 5		Large cavity mid height, 80% wasted, vertical splits to top	cap ok, rusted steel cross brace				Large cavity mid height, 80% wasted, vertical splits to top	
Bent 6		Large cavity mid height, 80% wasted, vertical splits to top, bearing part only	cap ok, rusted steel cross braces broken thru				Large cavity mid height, 80% wasted, vertical splits to top	
			50	100	ok	ok		
Bent 7	Hardwood round with fender post to outside, ok	Large cavity wasted 750 above bed, 80%		Diagonal brace wasted at bed level, ? Horiz brace probed 800 below bed			Large cavity wasted 750 above bed, 80%	
			60	80	80	ok		

KEY

- Piles requiring replacement
- Beams requiring replacement
- Caps, braces or corbels requiring replacement
- Extent of hardwood decking
- Extent of pine decking

GOVERNORS BAY WHARF - DIAGRAMMATIC PRESENTATION OF THE RESULTS OF DETAILED INSPECTION April 2014

Bent No		S pile	Cap, bracing, corbels (on bent lines)				N pile	Deck
			Beam	Beam	Beam Drilled depth to sound timber	Beam		
Bent 8	Outer pile broken at bed and swinging off stair stringer	Pile has 80% cavity at 700 above bed		Cap cantilevers to broken pile, has horiz cracks and reduced to half section			Pile has 4 holes, 80% cavity 700 above bed	
Inshore Landing	inside 300x250 stair stringer split, reduced to half section		ok	80	100+	50		
Bent 9	Short 300sq pile supporting stair, 100x60 slot at bed, fender post 50% wasted at bed	pile 60% wasted at bed	Cap 300x250 ok				Pile 75 % cavity at brace connection height	
	Steps and stringer need replacing, handrails u/s		100	100+	80	ok		
Bent 10		Pile has hole at mid height, hollow and split up to cap	Start of lower caps, 200x200 corbels and long spans 8m nom	Timber cross brace disconnected, wasted at seabed.	3 corbels need replacement		Pile non viable, large cavity	
			outer beams 350x100 ok	Southern inner beam rotten over corbel check and midspan 80	100	outer beams 350x100 100+		
Bent 11		Pile hollow and split, 90% wasted		Cap has some decay round bolt hole mid length. High tide mark halfway up cap	Inner N corbel needs replacement		Pile hollow and split, 90% wasted	
			ok	ok	ok	ok		
Bent 12		Pile has 2 holes at mid height, 75% cavity	Cap ok				Pile has hole at mid height, 50% cavity and split to top. May have moved along cap 200mm	
			Outer beam has horiz split mid height full length ok	beam split at corbel notch ok	100	Beam with horiz split full length, and at outer corbel notch ok		
Bent 13		Pile has 2 holes at mid height and bed level, 75% cavity		Cap hollowed out at ends - u/s	2 corbels need replacement		Pile u/s split vertically	
			Outer beam has horiz split mid height full length ok	ok	ok	Beam peeling midspan u/s see above		
Bent 14		Orig pile 350x250 rect 75% wasted no connection at top, additional 250x150 25% wasted at bed, bolted to cap with ea support bracket		Cap has 75 dia central hole 750 deep into N end	N inside corbel hollowed and split		Pile 350x200, sq hole at mid height, 30% cavity	

KEY

- Piles requiring replacement
- Beams requiring replacement
- Caps, braces or corbels requiring replacement
- Extent of hardwood decking
- Extent of pine decking

GOVERNORS BAY WHARF - DIAGRAMMATIC PRESENTATION OF THE RESULTS OF DETAILED INSPECTION April 2014

Bent No	S pile	Cap, bracing, corbels (on bent lines)				N pile	Deck
		Beam	Beam	Beam Drilled depth to sound timber	Beam		
Bent 15		ok	ok	ok	beam u/s split ok		
	Pile new 200 dia round pine, badly fitting notch (40mm), single bolt to cap		Cap has lrge mortise hole at bolted connection, and split to end - u/s			Orig Pile wasted at bed, added 250x150 supported by bolts only, no bearing	
		o/s beam badly split at support ok	ok	60	ok		
Bent 16	Pile hollowed at seabed and split over length, 70% cavity	Cap ok				Orig Pile wasted at bed, added 250x150 supported by bolts only to cap, no bearing. Reduced pile section due to chamfer, pile 20% wasted	
		beam horiz splitting, peeling to outside at midspan, pine doubler over short section ok	ok	100	Beam horiz splits full width both ends ok		
Bent 17	Orig pile 350x250 rect 75% wasted no connection at top, additional 250x150 sound, bolted to cap with ea support bracket	Cap split s end				Orig Pile wasted at bed, added 250x150 supported by bolts only to cap, no bearing. New pile sound	
		ok	beam horiz split mid span ok	100+	beam poor condition ok		
Bent 18	Orig pile 350x250 rect 75% wasted no connection at top, additional 250x150 15% wasted at bed, bolted to cap with ea support bracket	Cap ok				New pine pile bolted to side of cap, single rusted bolt, no bearing	
		ok	100	100	beam poor condition ok		
Bent 19	Orig pile removed, additional 250x150 50% cavity at bed, bolted to cap with ea support bracket	Cap ok		1 corbel to be replaced		Orig Pile 90% wasted at bed.	
		ok	50	100	100+		
Bent 20	New 300 treated hardwood, single bolt to cap, imperfect notch at cap	Bent leaning south	Cap ok	1 corbel hollowed, u/s		Orig Pile 50% wasted at bed.	

KEY

- Piles requiring replacement
- Beams requiring replacement
- Caps, braces or corbels requiring replacement
- Extent of hardwood decking
- Extent of pine decking

GOVERNORS BAY WHARF - DIAGRAMMATIC PRESENTATION OF THE RESULTS OF DETAILED INSPECTION April 2014

Bent No		S pile	Cap, bracing, corbels (on bent lines)				N pile	Deck
			Beam	Beam	Beam Drilled depth to sound timber	Beam		
Bent 21		Original pile gone, rectangular pile bolted to cap, no bearing. 20% wasted at bed, pile has vertical split.	ok	beam split 100+	70	ok	Orig Pile wasted at bed, added 250x150 supported by bolts only to cap, no bearing. Reduced pile section at bed, pile 50% wasted	
			Cap ok					
Bent 22		New 200 dia pine pile, single bolt to cap, 40mm seat only	25	100	ok	beam poor condition, split ok	Orig Pile wasted at bed, added 250x150 supported by bolts only to cap, no bearing. Pile 20% wasted at bed.	
			Bent and piles leaning south	Cap ok				
Bent 23		New 200 dia pine pile, single bolt to cap, 40mm seat only	ok	80	20	ok	Orig Pile wasted at bed, added 250x150 supported by bolts only to cap, no bearing. Pile 80% wasted at bed.	
			Cap ok					
Bent 24	attachment	New 200 dia pine pile, has slipped off notch and sitting on bolt below. No connection to cap, unsafe condition.	ok	100	100	beam poor condition ok	Pile split down centre with hollowing. u/s	
			Cap ok					
Bent 25		Elderly pile 70% wasted, cap has moved off notch, single bolt connection	ok	100+	20	beam poor condition, horizontal splits ok	Orig Pile split full height, steel dowell exposed. u/s	
			Cap ok					
Bent 26		Old pile 80% wasted, new pile but cap not sitting on notch, single bolt in shear	40	40	80	25	Orig Pile wasted at bed, added 250x150 supporting cap on ea bracket. Reduced pile section at bed, pile 50% wasted	
			Cap ok					

KEY

- Piles requiring replacement
- Beams requiring replacement
- Caps, braces or corbels requiring replacement
- Extent of hardwood decking
- Extent of pine decking

GOVERNORS BAY WHARF - DIAGRAMMATIC PRESENTATION OF THE RESULTS OF DETAILED INSPECTION April 2014

Bent No	S pile	Cap, bracing, corbels (on bent lines)				N pile	Deck
		Beam	Beam	Beam Drilled depth to sound timber	Beam		
Bent 27		beam poor condition, split horizontally ok	Beam has hole at midspan 60	100	beam poor condition, split at corbel 30		
	Old pile gone, rect hw bolted to side of cap with ea bracket. 2 bolts. Vertical splits starting to rot.	Cap ok				Orig Pile 80% wasted at bed. New pine 200 sed, cap not bearing on pile. One bolt to cap, one to old pile	
Bent 28		ok	ok	beam has splits and bulges top sides 60	beam poor condition, horiz splits 30		
	Added rect pile with ea bearing bracket, 2 bolts to cap. Vertical split beginning to hollow - monitor	Cap ok				Added rect pile with ea bearing bracket, 2 bolts to cap. 95% wasted at bed.	
Bent 29		ok	beam splits to one side 50	beam splits to one side ok	30		
	New rect hw pile added, no check, 1 bolt to cap 2 to old u/s pile, 70% wasted at bed	Cap marginal		2 corbels to replace		New rect hw pile added, no check, 2 bolts to cap 1 to old u/s pile, 80% wasted at bed	
Bent 30		60	30	100+	20		Pine Decking Landward Hardwood decking seaward
	New 200 dia pine pile, single bolt to cap, 40mm seat only		Cap split s end - cap has been replced but is not connected. Has nearly rotated off pile			Orig Pile wasted at bed, added 250x150 supported by bolts only to cap, no bearing. Pile 80% wasted at bed.	
Bent 31		ok	100	100	ok		
	New 300 dia hw pile, 80 mm check and bolt to both cap and beam	Cap ok		4 corbels to replace		New 300 dia hw pile, 80 mm check and bolt to both cap and beam	
Bent 32		ok	100	new beam fitted ok	100		Deck drops to north
	New 200 dia pine pile, single bolt to cap, 40mm seat only	Cap ok				New rect hw pile added, no check, 1 bolt to cap 2 to old u/s pile, 50% wasted. Pile has settled.	
Bent 33		ok	100+	100	100+		Deck drops to north
	Orig Pile split, hollow u/s	Cap ok		2 corbels to replace		New rect hw pile added, no check, 100% wasted	
Bent 34		30	70	100+	70		
	New rect hw pile added, no check, 2 bolts,ok	Cap ok		2 corbels to replace		Orig Pile 80% wasted at bed	

KEY

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GOVERNORS BAY WHARF - DIAGRAMMATIC PRESENTATION OF THE RESULTS OF DETAILED INSPECTION April 2014

Bent No	S pile	Cap, bracing, corbels (on bent lines)				N pile	Deck
		Beam	Beam	Beam Drilled depth to sound timber	Beam		
Bent 35		100	100+	60 to 100	beam poor condition 30		
	New rect hw pile added, no check, 70% wasted		Cap ok	2 corbels to replace		Pile 200 sed pine, no bolt, check or bearing to cap. 2 bolts to old wasted pile	
Bent 36		80	beam split vertically 100+	70	beam poor condition 100		
	New 200 dia pine pile, single bolt to cap, no bearing at check		Cap ok	1 corbel to replace		New rect hw pile added, no check, 70% wasted	
Bent 37		120	100+	doubler ok	Split at corbel ok		Handrails missing S side
	Orig Pile 50% hollowed, full height		Cap ok	corbels ok		Orig Pile vertical split full height - u/s	
Bent 38		30	90	100	100		
	Orig Pile 50% wasted at bed		Cap ok, 1 corbel to replace	1 corbel to replace		Orig Pile 90% wasted at bed	
Bent 39		ok	100	100	ok		Deck drops to S
	Replaced 230 hw checked to cap, good bearing, single bolt (LPC) Pile is low.		Cap ok, lower to south			Orig Pile 60% wasted at bed	
Bent 40		50	new hw doubler full span ok	80	beam poor condition 100		Deck drops to S
	Rect pile bolted to side of cap. No bearing 2 bolts, 60% wasted, vertical split		Cap ok			Rect pile bolted to side of cap. No bearing 2 bolts, 30% wasted	
Bent 41		100+	100	60	80		Deck drops to N, no decking for 2m
	New 200 dia pine pile, single bolt to cap plus bolt to outside beam		cap ok			Pile lower, ?settled. 250x150, no check, 1 bolt to cap, 2 to old pile. Pile 50% wasted at bed. Pile is low.	
Bent 42		100 split	100	100+	beam poor condition 100 split		
	New hw pile, single bolt, no bearing to check		Cap ok, outside corbels marginal	Diag brace ok		New hw pile, single bolt	
	80 doubler, splay to steps	80 pine doubler	100+	100 doubler	40		

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GOVERNORS BAY WHARF - DIAGRAMMATIC PRESENTATION OF THE RESULTS OF DETAILED INSPECTION April 2014

Bent No			S pile	Cap, bracing, corbels (on bent lines)				N pile	Deck
				Beam	Beam	Beam Drilled depth to sound timber	Beam		
Bent 43		Rect hw pile, 90 % wasted, no bearing to cap	Rect hw pile, 70 % wasted.					Rect hw pile, 70 % wasted.	
			15	60	100	100	10		
Bent 44	New stair pile, single bolt.	New hw pile single bolt	New 200 sed pine checked, single bolt					New hw pile inside old pile. Checked to cap (LPC)	
Seaward landing			20	100+	100+	100	20		
Bent 45	300 hw checked into inside cap, good condition (?LPC)	330x200 hw pile 90% wasted at bed	330x200 hw pile 90% wasted at bed		Double caps checked in to piles ok	Cross bracing in end frame connected to old outer piles at bed - joints totally ineffective		Pile new pine 200 sed checked into inside cap, no eff bearing, single bolt.	

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APPENDIX 2

Selection of Photographs

Northern Pile Bent 4

Outer stair support Bent 8

Split Brace at inner landing

Cavity in beam at Bent 10

Split outer beam Span 11-12

Split pile Bent 13

Hollow corbel Bent 14

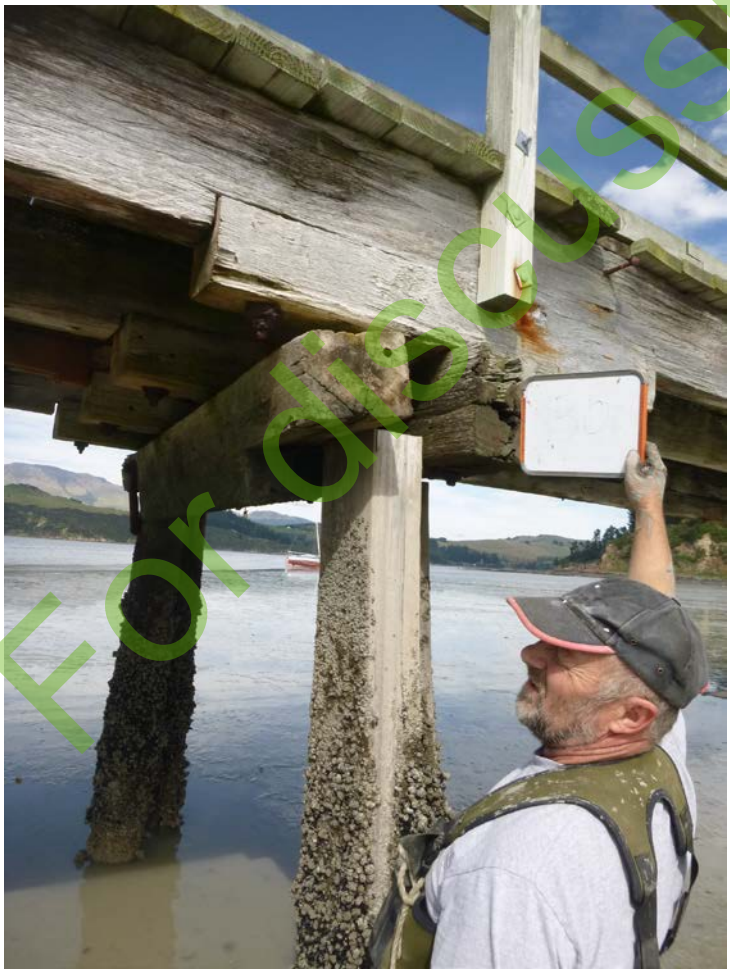
Outer beam Bent 14

Pile at Bent 19

Corbel bent 20

Pile at Bent 21

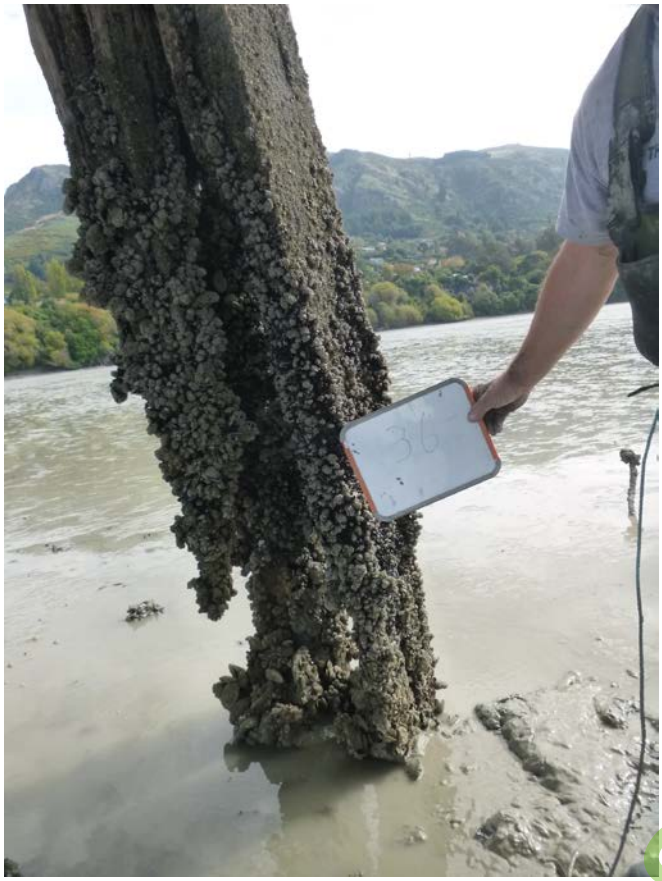
Cap precarious on new pile Bent 24



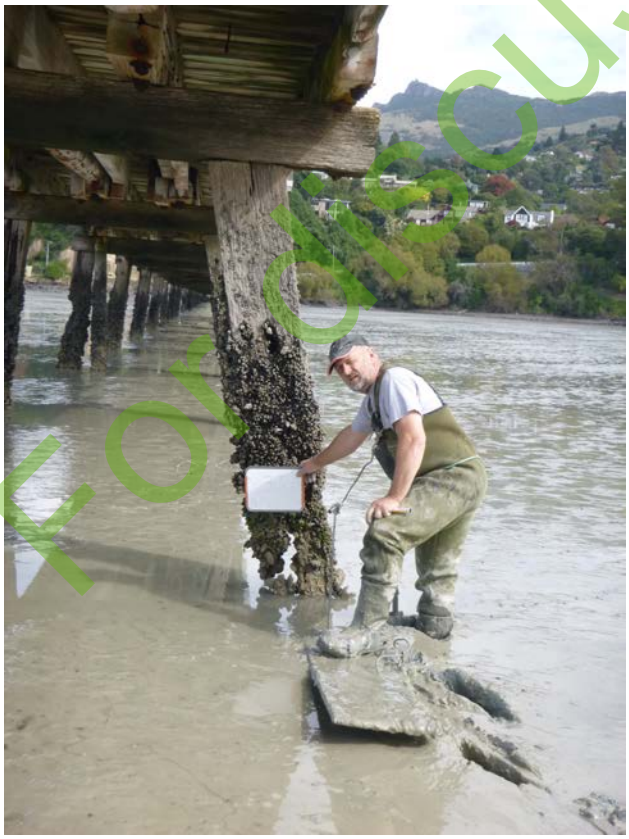
Replacement cap bent 30 about to fall out

Hardwood replacement pile, checked and bolted, but only bolt supporting cap

Original pile, Bent 32



Pile Bent 36



Pile Bent 38

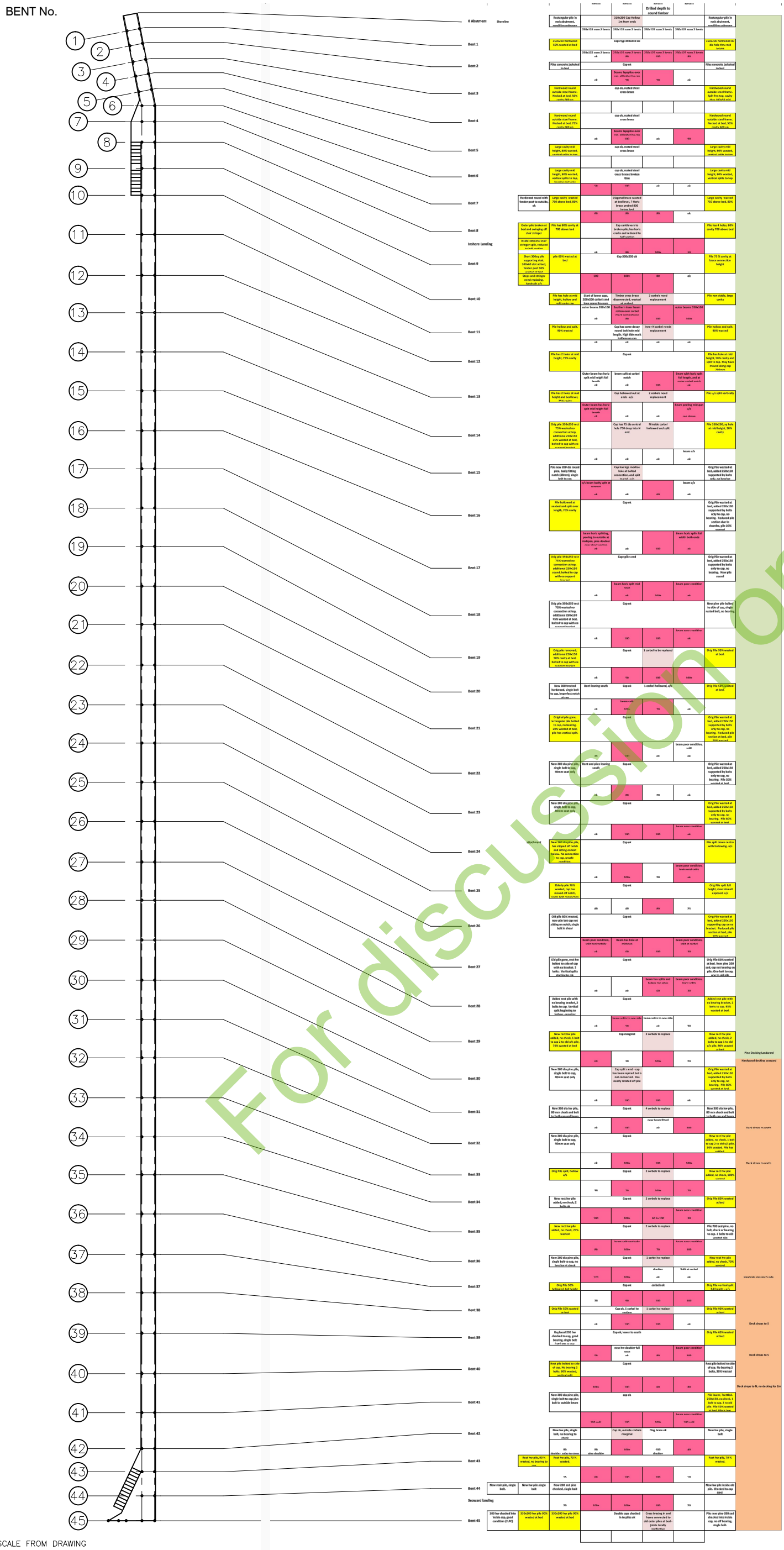
View inshore at Bent 40, settles to south

Stair stringer outer landing

Outer deck section

APPENDIX 3

Diagrammatic Representation of Distribution of Repairs



KEY

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DO NOT SCALE FROM DRAWING

	Drawn	PN
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	Traced	
–	Approved	
Amendments	Date	23/06/14

OCEL CONSULTANTS NZ LIMITED
272–276 Antigua Street
PO Box 877
Christchurch
Tel (03) 3790444
Fax (03) 3790333
49 Crown Hill Street
PO Box 151
New Plymouth
Tel (067) 512310
Fax (067) 512310

CHRISTCHURCH CITY COUNCIL
GOVERNORS BAY JETTY
DIAGRAMMATIC DEPICTION OF
REPAIR REQUIREMENTS

Scale (A3)	ACAD Filename
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Drawing No.	Rev.
DR–140110–001	2