REPORT ON THE WOODEN BRIDGE,

MILNERTON LAGOON,

FOR THE MILNERTON MUNICIPALITY

SEPTEMBER 1994

WATERMEYER PRESTEDGE RETIEF
UNION CASTLE HOUSE
PIERHEAD
VICTORIA & ALFRED WATERFRONT
CAPE TOWN 8001
TEL: 4183830

REPORT ON THE WOODEN BRIDGE, MILNERTON LAGOON, FOR THE MILNERTON MUNICIPALITY, SEPTEMBER 1994

CONTENTS

WATERMEYER PRESTEDGE RETIEF
UNION CASTLE HOUSE
PIERHEAD
VICTORIA & ALFRED WATERFRONT
CAPE TOWN 8001
TEL: 4183830

1. INTRODUCTION

1.1 Terms of Reference

Milnerton Municipality Council resolved at its 9 June 1994 meeting "That Messrs. Watermeyer Prestedge Retief, Consulting Coastal, Ocean & Environmental Engineers, be commissioned to prepare a comprehensive report on the current status of the old Wooden Bridge as well as recommendations, including cost estimates, of any remedial works required at a consultancy fee not exceeding R23 800.". Mr D Barson, Assistant Town Engineer: Works, in his letter of 10 June 1994, further defined the scope of work for the report as follows:

* The detailed inspection of the Wooden Bridge structure both above and below water (in conjunction with assistance from the Town Engineer's Department).
* An evaluation of the results of the survey and information package already provided to allow the development of various options for remedial works.
* An assessment of the structural loadings on the Bridge and analysis of the structure including remedial options.
* The development of a design for the remedial work.
* The preparation of budget cost estimates for implementation of the remedial work.
* A report to Council giving recommendations concerning the future of the Bridge.

1.2 Description of Bridge

The bridge was built in 1904 and is constructed entirely of timber, connected by iron or steel bolts and gusset plates. Some repairs have been undertaken previously, namely replacement of some bolts and gusset plates and the handrailing.

The bridge comprises 21 pile bents with 4 piles per bent. Each pile group is arranged in a row across the width of the bridge and is braced against transverse forces with horizontal and diagonal members. In the longitudinal direction the pile groups are braced with diagonal members against the bridge deck. These longitudinal brace members also assist in propping the main deck beams and thereby transferring some of the vertical loads to the piles. The deck beams support transverse bearers which in turn support the roadway and footway decking.

2. BRIDGE INSPECTION

2.1 "As-built" Survey

Members of the Town Engineers department have undertaken a dimensional and level survey of the bridge. This information is recorded on Plan No R48.57, "WOODEN BRIDGE MILNERTON" and Figure 4.

2.2 Structural Inspection

2.2.1 Description:

A detailed structural inspection of the bridge has been undertaken by Watermeyer Prestedge Retief. At the time of the inspection the water level in the lagoon was low, at approximately + 0,5 m MSL, which enabled inspection of the portion of the piles in the "tidal" zone.

The inspection was limited to a visual surface assessment of the timber members, connecting bolts and steel work, and probing of the timber with a steel point. A few holes were drilled into timber members in order to provide some correlation between the surface appearance of the timber and its internal condition. The surface conditions varied over a wide range and the visual assessment of them was obviously subjective and so it was considered necessary to categorise the observations into a limited number of conditions. This gave continuity to the inspection and provided a basis for an overall objective assessment of the bridge.

The following items were assessed in the inspection:

(a) Missing members.

(b) Condition of timber members (eg. sound, decayed (rotten), split or loss of section).

(c) Condition of steel bolts and gusset plates (eg. sound, rusted, missing). Bolts or gusset plates that were found to be loose were considered unserviceable and recorded as missing.

The copy of the inspection record, Appendix A, is contained under separate cover to this report due to its size.

Figures 1 and 2 illustrate the transverse and longitudinal frames and give the member names referred to in this report. Figure 3 gives the numbering notation used for the frames, in the inspection and report.

A general photograph was taken of each transverse frame and close up photographs were taken of typical member and connection conditions. Due to the difficult lighting conditions beneath the deck the transverse frame photographs have only captured the lower portion of the transverse bracing and piles. The photograph record is contained in Appendix B.

2.2.2 Findings:

(a) Missing Members

Only one missing member was detected, a longitudinal diagonal on longitudinal frame 5D.

However, 16 bracing members have lost significant portions of their ends due to splitting or decay and have become detached from their connecting bolts, thereby rendering them unserviceable.

(b) Condition of timber members

The structural timber in the bridge is on average sound and in good condition. At some stage the entire bridge has been painted with a black bitumen-based coating which has helped preserve the timber. The deck top has been protected with a chip and spray wearing course. The bridge decking and handrails were found typically in good condition and so the inspection concentrated on the sub-structure which has defects requiring attention.

Examination of the timber/coating surfaces revealed the following general trends:

i) The chip and spray surfacing on the deck is competent and protecting the timber.
ii) The replacement handrails have not received the bitumen coating.
iii) The undersurfaces of the deck, deck beams, the upper horizontal, and the tops of the transverse diagonals and inner piles are sheltered from the weather and the paint is still in good condition and protecting the timber.
iv) The paint that has been exposed to the weather and/or the lagoon water on the remainder of the surfaces has deteriorated and largely disintegrated. Timber exposed above the normal water level has dried out causing surface cracking and splits. Those members that have been exposed to the lagoon waters have been subjected to alternate drying out and wetting making them susceptible to cracking and decay.
v) Pile timber that has been continually submerged has deteriorated very little.

Decay has occurred consistently in some locations throughout the bridge substructure. All these locations occur within the "tidal" zone, ie the area which is alternatively wetted and dried. These common incidences and the number of members affected are listed in Table 1 and summarised below.

vi) Piles: Occurrences of decay in the piles were noted from approximately 400 mm above the lower horizontal member centre line to 1200 mm below the centre line. At and above the horizontal member the decay has typically initiated around bolt holes and on the contact faces with adjacent members. Lower down decay would appear to have initiated around splits, cracks and possibly old marine borer holes in the wood on some piles and in a more overall manner on others. In these lower areas the decayed timber has largely been eroded by the river.

Every pile has lost some of its cross-section below the lower horizontal whilst 16 (19%) of them have some decay above the member. The remaining lower section typically varies between 50% to 75% of the pile's original cross sectional area.

vii) Lower Horizontals: Twenty eight (67%) of the lower horizontal members have decayed timber at the connections, ie. around the bolt holes and behind the plate washers. This decay is not immediately apparent as it is covered by the stainless steel plate washer and it is highly likely that those members in which decay was not detected also have significant decay behind the washer. The decay has typically resulted in a loss of approximately 50% of the member at the connection. One member has lost the full section and is unserviceable.

viii) Longitudinal Diagonals: Sixty nine (41%) of the longitudinal diagonals have decayed at their lower connection, again around the bolt holes and behind the gusset plates. The damage varies from a split to a loss of up to 50% of the section over a typical length of 300 mm. Twenty four (14%) of the members have split at their top ends on the line of the bolts. Twenty seven (31%) of the diagonal support members have splits at their ends.

ix) Transverse Diagonals: Fifty three (42%) of the transverse diagonals have split or decayed around their single bolt connections.

(c) Condition of steel bolts and gusset plates

The lower horizontal members already have replacement stainless steel bolts and plate washers. They are in satisfactory condition with the exception of 5 (6%) nuts that are missing.

A number of the original gusset plates and bolts on the bottom connection of the longitudinal diagonals have already been replaced. The replacement plates were hot-dipped galvanised but the galvanising is typically approaching the end of its protective capacity. On some plates it has broken down completely and corrosion of the steel has commenced.

Fifty six (19%) of the gusset plates on the longitudinal diagonals and beams are missing or loose. The rest of the plates are extremely corroded and approaching the end of their serviceable life.

The transverse diagonals and upper horizontal are connected with the original single bolts. All of these bolts are corroded and sixty two (37%) of the diagonal and 9 (11%) of the upper horizontal bolts are missing or no longer serviceable. For the bolts that still appear serviceable it was not possible to determine the extent of corrosion on the bolt shank within the section. However, observation of one bolt that was missing its head showed advanced corrosion of the exposed end of the shank and a significant loss of cross-section. From this it could be inferred that all the bolts are approaching the end of their life.

2.3 Probe Survey

2.3.1 Description:

It was considered necessary to conduct a jet probe survey of the riverbed in order to gain some knowledge of the riverbed soils should any piling options be required.

The probes were done using a length of steel water pipe connected to the municipal fresh water supply. At each probe position the pipe was held vertically with the water jetting out of the bottom. The water flow disturbed the supporting soil and allowed the probe to sink into it. A subjective indication of the soil density and type was provided by the ease with which the probe sank. Those probes conducted on the exposed central sand bank in the lagoon allowed observation of the washings.

2.3.2 Findings:

The probes indicate that the riverbed at the bridge comprises a sand horizon, varying in thickness from 4 m to 7 m overlaying a clay layer of unknown thickness. At the level taken to be the top of clay there was a marked reduction in the rate at which the probe sank into the soil. At two positions the probe was sunk further (2,0 and 5,5 m) into the clay layer without encountering bedrock. The results of the survey are given in Figure 4.

2.4 Diver Survey

2.4.1 Description:

A diver survey was undertaken in order to ascertain the condition of the piles below the mudline at the deepest section of the lagoon. The sand was washed away locally around three piles using the jetting equipment from the probe survey (piles 3D, 5D and 7D). The diver was able to feel and probe the pile with a knife for approximately 500 mm below the riverbed.

2.4.2 Findings:

In all these piles the timber felt solid, hard and had retained it's original shape.

3. STRUCTUAL ANALYSIS OF BRIDGE

Structural calculations have been undertaken to determine the likely stresses that the bridge will experience.

The bridge was checked for the worst load combination of its self weight together with an extreme crowd loading over the full horizontal surface of the deck (5kPa) and a drag load from the river in flood applied to a frame in the deepest section.

It is difficult to accurately predict the drag load on the bridge. Hill Kaplan Scott (1994) (HKS) have estimated the 50 year flood flow in the river to be 550 m^3/s. Under a flow of this size it is likely that the mouth of the lagoon will scour open and for this condition HKS estimate the water level at the bridge to be + 2,5 m MSL. With a river bed scoured to 0,5 m below the present measured levels at the bridge the flow area is therefore 267 m^2 which gives a flow velocity of 2,06 m/s. However, a flow velocity of this magnitude would overstress the single bolt connections of the bridges transverse diagonal bracing, even in its original state. A tolerable flow velocity would be in the order of 0,9 m/s. For a flow area of 267 m^2 this would be equivalent to a flow rate of 240 m^3/s, which is close to an earlier estimate of the 50 year flow of 210 m^3/s (Beaumont (1980)). If a 1,0 m scour below the river bed was allowed then the flow rate would increase to 300 m^3/s.

For the 0,9 m/s flow it is considered that the bridge piles will be overstressed if they have been reduced to an equivalent section of less than 130 mm x 130 mm. It is estimated that all piles are at or below this capacity. The pile bents in the central sand bank, however, will not experience as much drag load as calculated because of the higher river bed, which will also support them at a higher level, giving a shorter vertical span and reduced bending moments.

Stresses in the deck and bearers from the 5kPa live load are satisfactory.

Any bracing members or joints which are not competent or serviceable would transfer their loads to adjacent members, thereby over stressing them.

4. SUMMARY AND OPTIONS

4.1 Summary of Findings

All of the bridges foundation piles have been weakened by loss of section below the level of the lower horizontal member. The worst cases of deterioration occur in the pile bents in the Western river channel on the island side of the bridge with a reduction in cross-sectional area of at least 50%. Strengthening of all of the bridge piles in the two side channels is needed while strengthening of those in the central sand bank could be postponed for as long as the sand level remains high.

The decking and its supporting beams are generally in good condition.

The transverse and longitudinal bracing members are generally in good condition except at the connection positions of the lower members. The combination of connecting bolt/gusset plate corrosion and decay of the timber around the bolt holes and behind the plates has substantially weakened the capacity of the members. Except for the stainless steel replacement bolts all connecting bolts and gusset plates are corroded and beyond repair. It is not possible to determine with any certainty how much longer the connections will last, or under what load intensity they will fail. All bolted connections therefore require attention, in particular the lower ones and those with missing components.

The timber paint coating has not been maintained in the past and has left timber exposed and accelerated decay of the lower members and drying out of the upper members. All exposed timber needs to be re-coated.

4.2 Remedial Work Options

4.2.1 Do Nothing Option

The first option is to undertake no remedial work on the bridge. It will continue to deteriorate and slowly come apart and there could be a sudden collapse with an incidence of high current loads or high deck loads. At some stage the bridge will have to be condemned and access to it stopped, followed by continued disintegration or demolition.

4.2.2 Repair Option

Repairs could be undertaken on the most obvious weaknesses i.e. replace the missing members and connections and strengthen or replace only the worst of the badly decayed members. Painting of the bridge would help preserve the timber. Repairs should be done according to the recommendations given in Section 5 below.

This would be a short term solution and would require a regular and ongoing program of inspections and repairs.

4.2.3 Bridge Renovation Option

In order to maximise the future life span of the bridge systematic renovation of all members and connections should be undertaken. The renovations could be done in one go or in phases as funds permit.

The recommended remedial works for the renovation are detailed in Section 5 below.

5. RECOMMENDED REMEDIAL WORKS

5.1 Splice Piles

It is recommended that the piles should be strengthened over the tidal zone. The most appropriate form of strengthening for reasons of aesthetics and ease of construction is to splice extra timber across the weakened area. The splice should consist of two half size timbers (ie. 150 x 100 mm section), one on the upstream face and one on the downstream. The splice timbers should be connected by drilling and bolting as illustrated in Figure 5. In order to make the splice less obtrusive the outermost splice timber is shown extended to the underside of the deck bearers. Some piles already have splices, presumably done during the original construction.

The lower connections will have to be constructed by divers and will require excavation around the piles situated in the sand bar and the eastern channel. Removal of one of the lower horizontals will be necessary at each pile bent to enable insertion of the splice timbers.

5.2 Replacement of missing or damaged members

The number of members that require replacement can be minimised by revised gusset plate details, see section 5.3 below. However, the following replacement members are still required where excessive decay or loss of section has occurred.

(a)	Longitudinal diagonal	1	No.
(b)	Transverse diagonal	6	No.
(c)	Lower horizontal	35	No.
(d)	Upper horizontal	2	No.

5.3 Replacement of Gusset Plates

Figure 6 illustrates the recommended revised replacement gusset plates. It is considered that plates larger than the originals be used with bolt positions that straddle the old bolt holes in order to avoid splits, oversize holes and old bolts that are difficult to extract.

In time all gusset plates will require replacement. Initially missing plates and all the lower gusset plates will have to be replaced, concurrently with pile splicing. Sequencing of the remedial works is discussed further in section 5.5 below.

5.4 Timber Coating

All exposed timber surfaces need re-coating with a bitumen based product in order to maintain preservation of the timber. Weathered surfaces will require scraping down and a full coat treatment whilst the undersides of the deck should suffice with re-touching. Where possible paint should be flooded into splits, cracks, old bolt holes and gaps between members. All surfaces should be coated before reattaching members, gusset plates or adding splice members. Uncoated timber between members or beneath gusset plates is susceptible to water ingress and subsequent decay. A common observed origin of decay is in the timber around the bolt holes and hence, if possible, new holes should be flooded with paint before bolting.

5.5 Sequence of Remedial Works

It is considered that items (a) to (e) below are necessary as a minimum first phase of work followed by (f) and (g) and lastly (h).

(a) Splice piles in west and east channels and concurrently replace associated lower gusset plates. (Pile bents 1 to 8 and 14 to 21)

The lower gusset plates will have to be replaced with the pile splicing operation. The old inner pile plates have to be removed to enable splicing of the piles and the outer pile plates will become inaccessible if covered by the outer pile splice.

(b) Replace missing or badly damaged members throughout bridge.

(c) Replace missing upper and beam gusset plates throughout bridge.

(d) Replace missing brace member bolts throughout bridge.

(e) Paint entire bridge.

The painting operation will have to be done in parallel with all remedial work as noted in 5.4 above.

(f) Replace remaining gusset plates.

(g) Replace remaining bolts.

Replacement of gusset plates and bracing bolts which are corroded but still serviceable and providing tight connections could be delayed. Touching up of the paint coating will be required with (f) and (g) above and also (h) below.

(h) Splice piles in central sandbank area. (Pile bents 9 to 13)

The piles in the sand bank area are less exposed to flood current forces and generally the piles are in better condition than on either side. Work on these members could therefore be delayed to a time when there is less of a sand bank than there is at present.

5.6 Materials

5.6.1 Timber

It is recommended that timber used for replacement and splice members be a suitable hardwood. In recent years imported balau and keruing timbers have been used in local harbour and marine structures. However, two local commercially grown timbers have been identified which will be suitable for marine structures. Turpentine (Syncarpia Glomulifera), and Ironbark (Eucalyptus Paniculata) both of Australian origin are grown in the Eastern Transvaal and are available from Sabie Hardwood.

5.6.2 Connecting bolts and gusset plates.

All replacement steelwork should be protected by a duplex system of hot dip galvanising (to the "heavy duty" specification of SABS 763) and a compatible paint coating. The coating system must be applied to all surfaces under factory conditions before installation and should be re-coatable to allow touching up of mechanical damage during installation. Nuts and bolts should be coated before installation and their exposed threads, and damage to the heads and nuts coated after installation. The bolts and plate washers of the underwater pile splice connection should preferably be made from stainless steel as it will not be possible to maintain them after installation.

5.6.3 Timber coating

The paint recommended by a.b.e industrial products (Pty) Ltd is their "Ravenol" black bituminous paint. It is recommended that the paint first be tested on a portion of the bridge to confirm its suitability before undertaking the full remedial works.

5.7 Cost of Remedial Works

5.7.1 Material Costs

The material costs given below are estimated without VAT. If the materials are sourced by a contractor then a mark-up of at least 10% could be applied to these costs.

(a) Timber

It is recommended that a stock of 10 m³ of syncarpia timber be purchased (sufficient for all splices and replacements) even if bridge renovations are staggered. Costs including delivery to Milnerton would be R2 745/m³ or R27 450 in total.

(b) Bolts for pile splices

The cost of supplying a set of bolts for splicing the piles in one pile bent is estimated to be R1 800/bent. The supply cost of the first phase (pile bents 1 to 8 and 14 to 21) would therefore be R28 800 and the second phase (pile bents 9 to 13) would be R9 000.

(c) Gusset plates and bolts

The estimated supply cost of replacement gusset plates and bolts is R2 300/bent, giving a total cost for the bridge of R48 300.

(d) Bracing member bolts

The estimated supply cost of replacement bolts for the bracing member connections is R500/bent or R10 500 for the whole bridge.

(e) Timber coating

It is estimated that approximately 900 m² of the bridge requires repainting. The cost of "Ravenol" paint to cover this area is R3 500.

5.7.2 Labour Costs

It is difficult to estimate labour costs for an unusual renovation job of this nature. Some work could certainly be undertaken departmentally at a lower cost and less risk than with an outside contractor.

It is felt that it should first be determined how much of the work and sourcing of materials could be undertaken departmentally and how much should be done by outside contractors. Once there is a clearer idea of the scope of the work then contractors could be approached for help in estimating the remaining costs.

	PILE BENT		1				2				3				4				5				6			
	PILE		A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
	MEMBER	CONDITION																								
1	PILE	DECAY ABOVE LOW. HORIZ.			X			X	X		X															
2	LOWER HORIZONTAL	DECAY AROUND BOLT		L				IL	IL		I	IL	IL	I					I	I	I	I	I	I	L	I
3	UPPER HORIZONTAL	ALL OR PART MISSING													I											
4	LOWER HORIZONTAL	ALL OR PART MISSING					IL							L												
5	TRANSVERSE DIAGONAL	ALL OR PART MISSING						IB	IB							IB										IT
6	LONGITUDINAL DIAGONAL	ALL OR PART MISSING																				I				
7	LONGITUDINAL DIAGONAL	DECAY/SPLIT BOTTOM END	L	I			IL	L	I	IL	I	IL		IL			L		L		I			I	IL	
8	LONGITUDINAL DIAGONAL	SPLIT AT TOP END					I				I													L		L
9	LONG. DIAG. SUPPORT	SPLIT AT END									I							L	IL			IL		L		L
10	TRANS. DIAG. ISLAND SIDE	DECAY OR SPLIT AT END												T	B			T	B		B	T				
11	TRANS. DIAG. LAND SIDE	DECAY OR SPLIT AT END										B		B			B	B			B	B			B	
12	LOWER GUSSET PL'S	MISSING OR LOOSE												X								X				
13	UPPER GUSSET PL'S	MISSING OR LOOSE					L				I	IL	IL	IL		I	IL		L			IL		L		L
14	BEAM GUSSET PL'S	MISSING OR LOOSE					X					X	X				X	X	X	X		X		X	X	X
15	LOWER HORZ. S.S. BOLTS	MISSING								I																
16	UPPER HORIZ. BOLTS	MISSING OR LOOSE																								
17	TRANS. DIAG. BOLTS	MISSING OR LOOSE						B	B	T	B	B	B	BT	B	B	B	BT	B	BT	B			B		BT

	PILE BENT		7				8				9				10				11				12			
	PILE		A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
	MEMBER	CONDITION																								
1	PILE	DECAY ABOVE LOW. HORIZ.		X																	X					
2	LOWER HORIZONTAL	DECAY AROUND BOLT					I	I	I	I	L	IL	L		I	L	L	L		I		I	IL	IL	I	
3	UPPER HORIZONTAL	ALL OR PART MISSING																								
4	LOWER HORIZONTAL	ALL OR PART MISSING													L							L				L
5	TRANSVERSE DIAGONAL	ALL OR PART MISSING																								
6	LONGITUDINAL DIAGONAL	ALL OR PART MISSING																								
7	LONGITUDINAL DIAGONAL	DECAY/SPLIT BOTTOM END			IL		I		IL			I	IL		L	I			I	I	IL	I	IL	L	I	L
8	LONGITUDINAL DIAGONAL	SPLIT AT TOP END						L		L		IL						I				I				
9	LONG. DIAG. SUPPORT	SPLIT AT END												L						L		IL				IL
10	TRANS. DIAG. ISLAND SIDE	DECAY OR SPLIT AT END	B				B			T						B				B			B	T		T
11	TRANS. DIAG. LAND SIDE	DECAY OR SPLIT AT END			B				TB			B				B								B	B	B
12	LOWER GUSSET PL'S	MISSING OR LOOSE																								
13	UPPER GUSSET PL'S	MISSING OR LOOSE					I	L		IL		IL	IL	L								IL				I
14	BEAM GUSSET PL'S	MISSING OR LOOSE			X	X		X	X	X		X	X				X									
15	LOWER HORZ. S.S. BOLTS	MISSING													L		L			L		L				
16	UPPER HORIZ. BOLTS	MISSING OR LOOSE																	X	X	X	X	X	X	X	X
17	TRANS. DIAG. BOLTS	MISSING OR LOOSE			B	B		B	B	T		B				B	BT	BT						B	B	BT

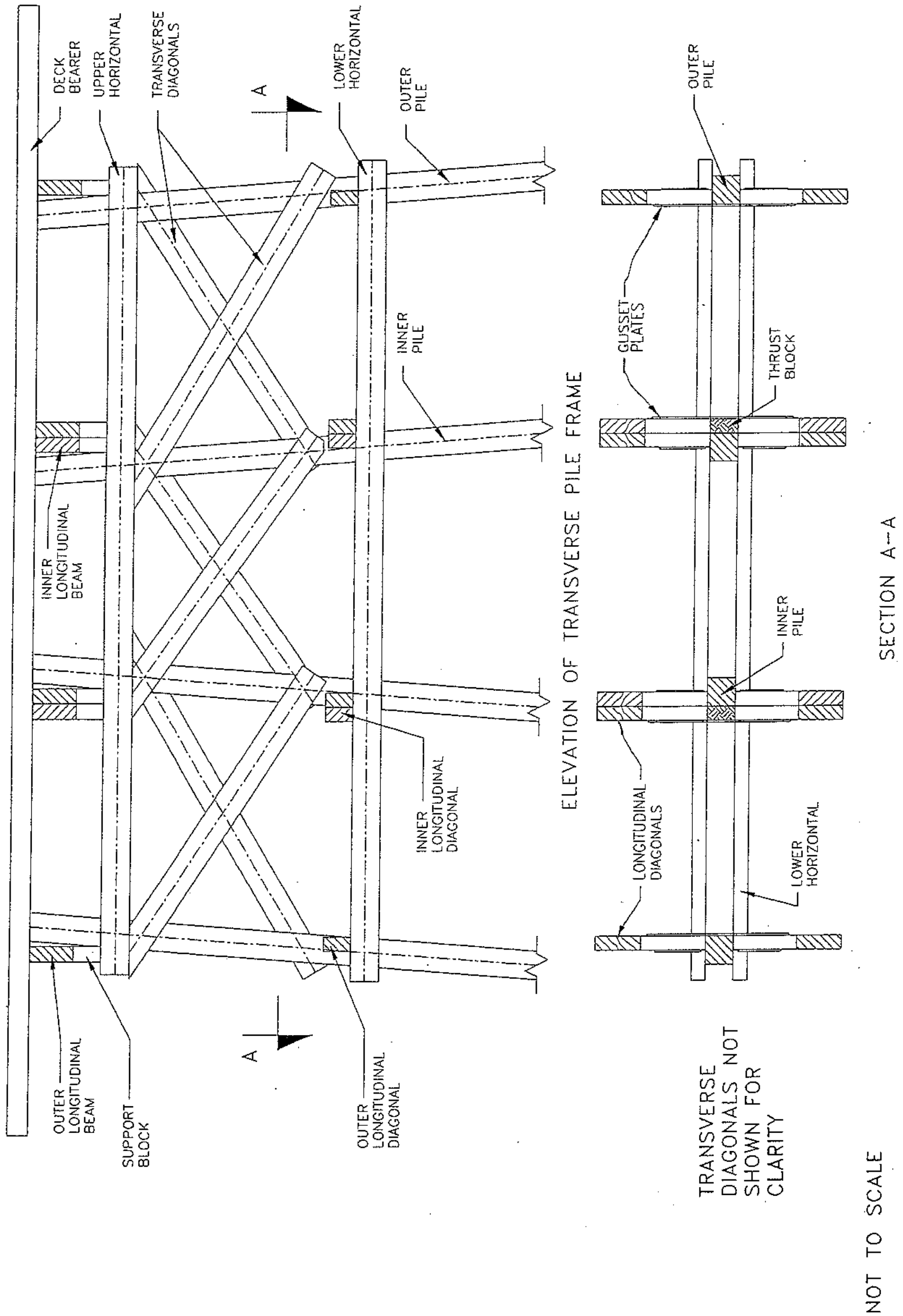
KEY:
X=OCCURRENCE
I=OCCURRENCE ON ISLAND SIDE OF PILE BENT
L=OCCURRENCE ON LANDWARD SIDE OF PILE BENT
B=OCCURRENCE ON BOTTOM END OF MEMBER
T=OCCURRENCE ON TOP END OF MEMBER

TABLE 1
OCCURRENCES OF STRUCTURAL DETERIORATION

	PILE BENT		13				14				15				16				17				18				19				20				21				TOTAL	TOTAL IN	%
	PILE		A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	OCCUR.	BRIDGE	OCCUR.
	MEMBER	CONDITION																																							
1	PILE	DECAY ABOVE LOW. HORIZ.	X	X														X				X		X						X		X			X	X	X		16	84	19
2	LOWER HORIZONTAL	DECAY AROUND BOLT	IL	L	L			I	I	I	IL	L		IL					I	I	I	I	I	L	IL		I	I	I		IL	IL	IL	I	I		I	I	28	42	67
3	UPPER HORIZONTAL	ALL OR PART MISSING							I																														2	42	5
4	LOWER HORIZONTAL	ALL OR PART MISSING																					L										I						8	42	19
5	TRANSVERSE DIAGONAL	ALL OR PART MISSING								LB							LB																						6	126	5
6	LONGITUDINAL DIAGONAL	ALL OR PART MISSING																																					1	168	1
7	LONGITUDINAL DIAGONAL	DECAY/SPLIT BOTTOM END						L	I	I	I			I	L	L			IL	IL	IL			IL	IL	L	IL		IL	L			I	IL		IL	IL		69	168	41
8	LONGITUDINAL DIAGONAL	SPLIT AT TOP END			I	I		I					I					I				I			L	L		L				IL				I		IL	24	168	14
9	LONG. DIAG. SUPPORT	SPLIT AT END		I		L												IL	L			IL	IL				IL					L	L	I	IL			IL	27	88	31
10	TRANS. DIAG. ISLAND SIDE	DECAY OR SPLIT AT END				T				T	B			T				T								T	B	B	T	T			B	T					26	63	41
11	TRANS. DIAG. LAND SIDE	DECAY OR SPLIT AT END				B			B	B				B			B	B			B								B	B				B			B	B	27	63	43
12	LOWER GUSSET PL'S	MISSING OR LOOSE																																					2	84	2
13	UPPER GUSSET PL'S	MISSING OR LOOSE				I												I				I						L											32	126	25
14	BEAM GUSSET PL'S	MISSING OR LOOSE											X				X	X																					22	84	26
15	LOWER HORZ. S.S. BOLTS	MISSING																																					5	84	6
16	UPPER HORIZ. BOLTS	MISSING OR LOOSE																X																					9	84	11
17	TRANS. DIAG. BOLTS	MISSING OR LOOSE		BT	BT	B			BT	B	B						B			B		B	B	T	B	BT		BT	B	B		B	BT	T		BT			62	168	37

KEY:
X=OCCURRENCE
I=OCCURRENCE ON ISLAND SIDE OF PILE BENT
L=OCCURRENCE ON LANDWARD SIDE OF PILE BENT
B=OCCURRENCE ON BOTTOM END OF MEMBER
T=OCCURRENCE ON TOP END OF MEMBER

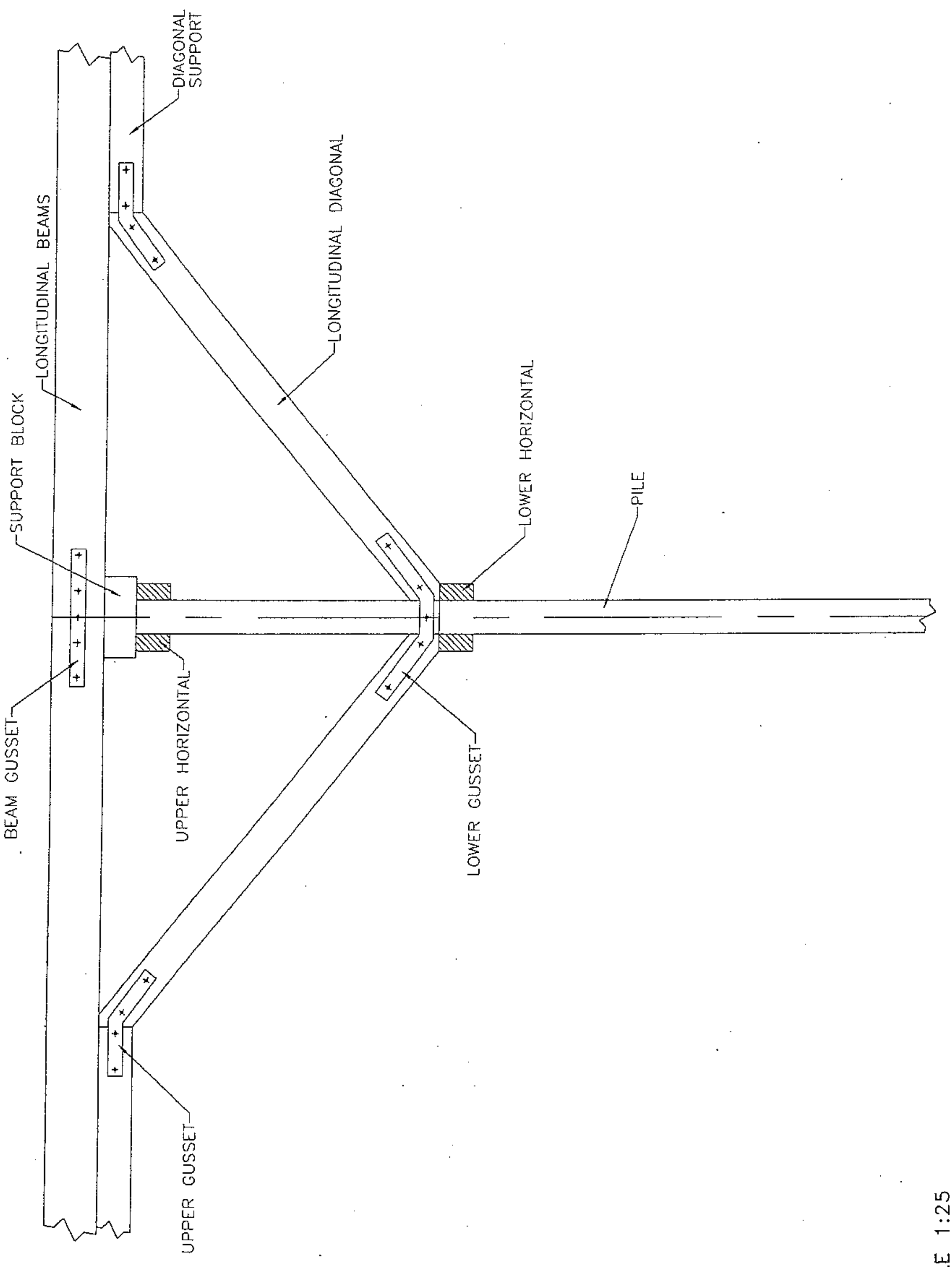
TABLE 1 (CONTINUED)
OCCURRENCES OF STRUCTURAL DETERIORATION



Drawn CSS	Project	MILNERTON WOODEN BRIDGE INSPECTION	Figure No.
Checked	Title		
Date AUG 94		TRANSVERSE FRAME	1
Ref.			

WATERMEYER PRESTEDGE RETIEF

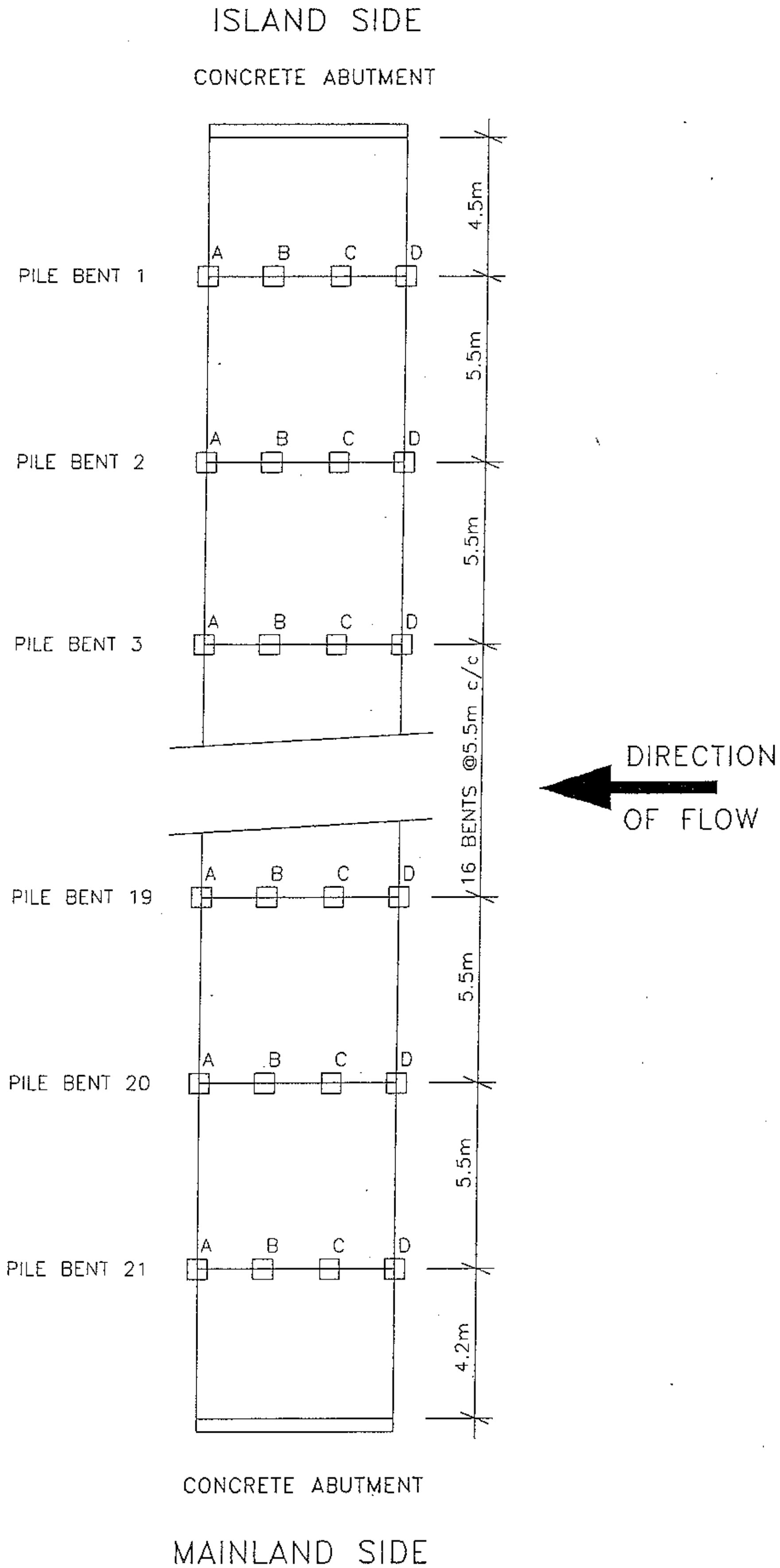
CONSULTING COASTAL, OCEAN AND ENVIRONMENTAL ENGINEERS



SCALE 1:25

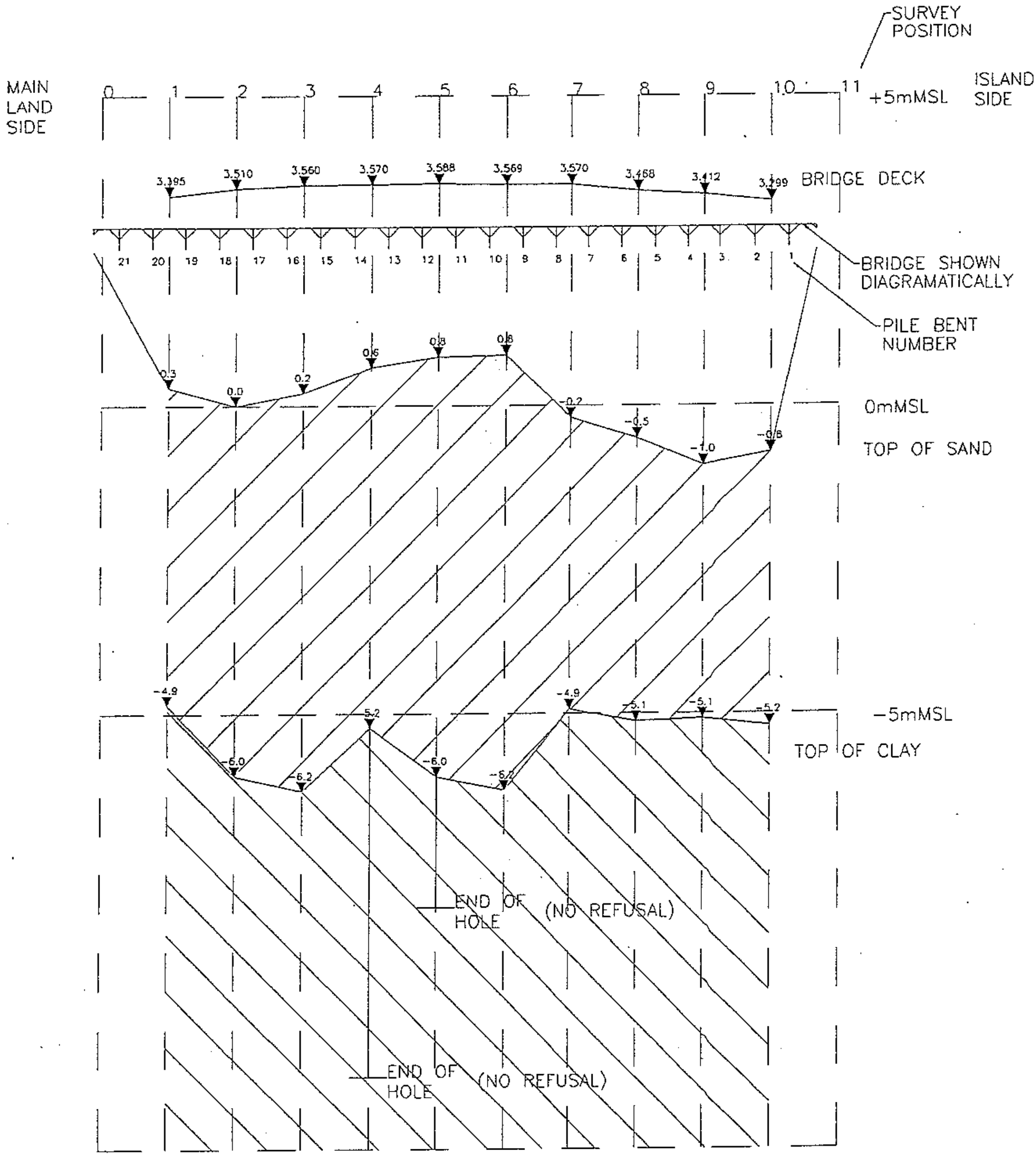
Drawn CSS	Project	MILNERTON WOODEN BRIDGE INSPECTION	Figure No.
Checked	Title	LONGITUDINAL FRAME	2
Date AUG 94			
Ref.			

WATERMEYER PRESTEDGE RETIEF
CONSULTING COASTAL, OCEAN AND ENVIRONMENTAL ENGINEERS



Drawn CSS	Project MILNERTON WOODEN BRIDGE INSPECTION	Figure No.
Checked	Title BRIDGE FRAME NUMBERING	3
Date AUG 94		
Ref.		

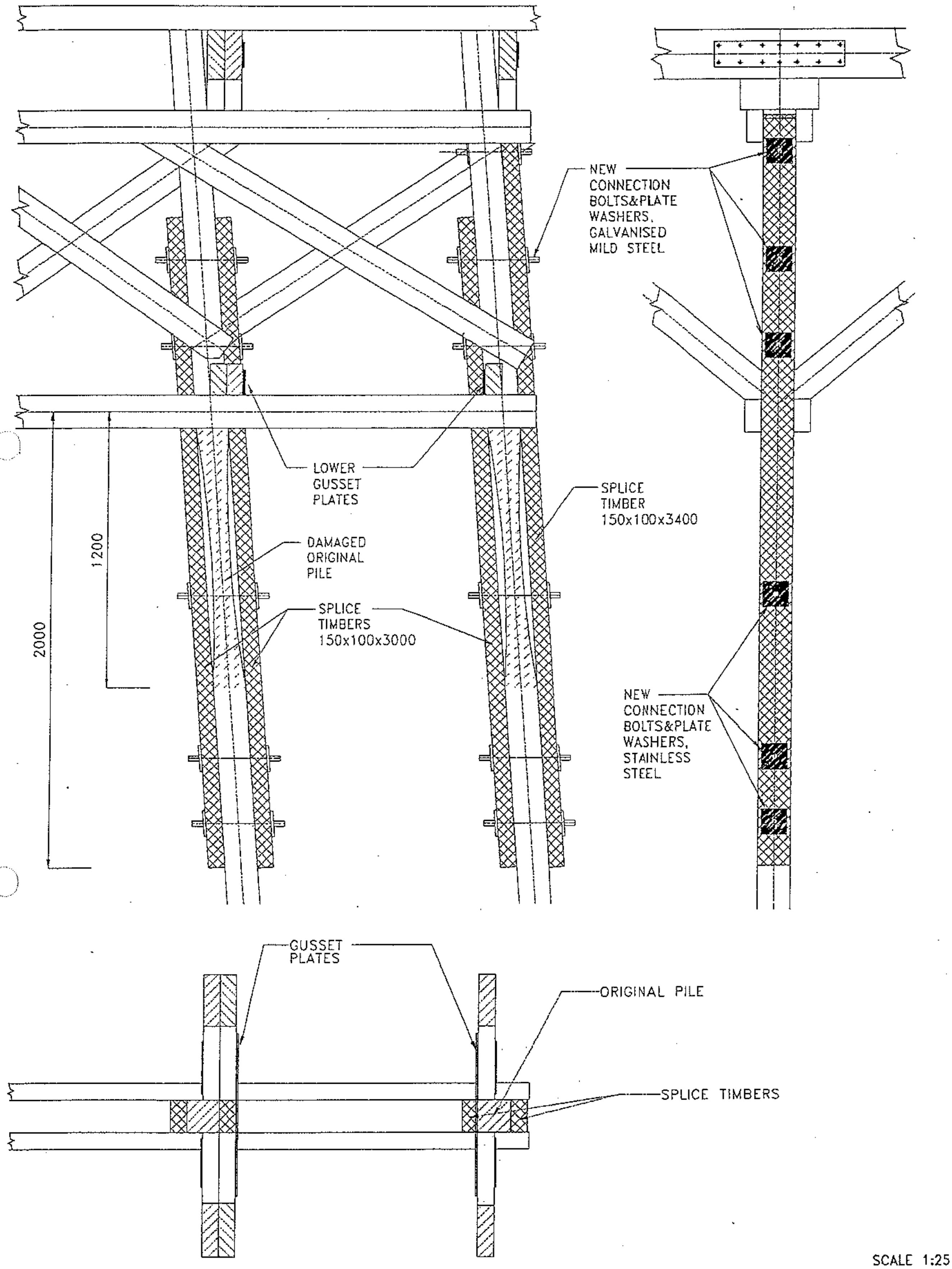
WATERMEYER PRESTEDGE RETIEF
CONSULTING COASTAL, OCEAN AND ENVIRONMENTAL ENGINEERS



SCALE: HORIZONTAL 1:100
VERTICAL 1:10

Drawn CSS	Project MILNERTON WOODEN BRIDGE INSPECTION	Figure No.
Checked	Title RIVER BED AND SOIL PROFILE AT BRIDGE	4
Date AUG 94		
Ref.		

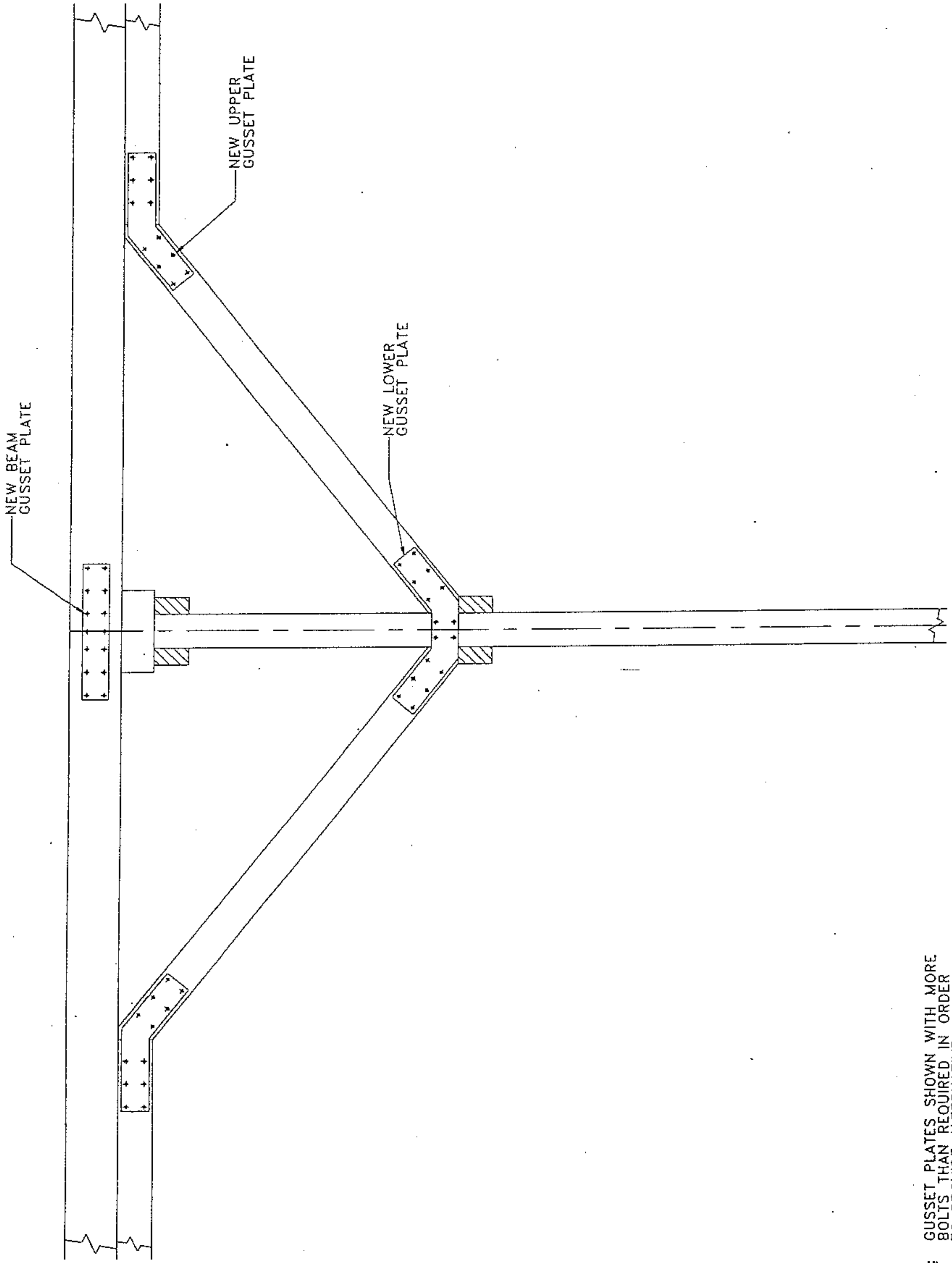
WATERMEYER PRESTEDGE RETIEF
CONSULTING COASTAL, OCEAN AND ENVIRONMENTAL ENGINEERS



Drawn CSS	Project MILNERTON WOODEN BRIDGE INSPECTION	Figure No.
Checked	Title	
Date AUG 94	PILE SPLICE	5
Ref.		

WATERMEYER PRESTEDGE RETIEF
CONSULTING COASTAL, OCEAN AND ENVIRONMENTAL ENGINEERS

SCALE 1:25



NOTE: GUSSET PLATES SHOWN WITH MORE BOLTS THAN REQUIRED IN ORDER TO PROVIDE ALTERNATIVE BOLT POSITIONS

Drawn CSS	Project	MILNERTON WOODEN BRIDGE INSPECTION	Figure No.
Checked	Title		
Date AUG 94		NEW GUSSET PLATES	6
Ref.			

WATERMEYER PRESTEDGE RETIEF

CONSULTING COASTAL, OCEAN AND ENVIRONMENTAL ENGINEERS