

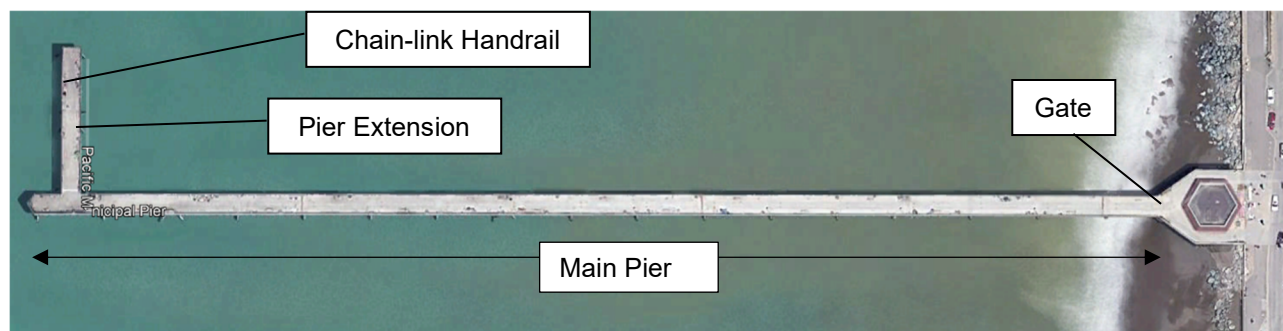
# Technical Memorandum

June 27, 2024

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<b>From</b>	Satish Chilka, PE	<b>Project No.</b>	12599413
<b>Project Name</b>	Pacifica Pier Condition Assessment		
<b>Subject</b>	Post Storm Condition Assessment – April 2024		

## 1. Introduction

The Pacifica Municipal Pier, located at 2100 Beach Blvd. Pacifica, CA 94044, is an L-shaped concrete pier supported on concrete piles (Figure 1.1). The pier functioned to support an outfall extending from Beach Boulevard into the ocean. The pier deck are prestressed concrete box girders with cast-in-place concrete handrails.



**Figure 1.1** Pacifica Municipal Pier Layout

GHD Inc. conducted a detailed condition assessment of the structure between April and August 2023. The Pier Extension has remained closed to public access since the collapse of handrails since January 2021. The assessment included the handrails, the exterior sides of the deck and piles above water line using an Unmanned Aerial Vehicle (UAV), piles below water line using Remote Operated Vehicle (ROV) and qualified divers, and deck delamination survey.

The overall condition ratings for different segments of the Pier were reported as following based on the observed conditions of individual components of the Pier. The assessment report (issued January 2024) recommended annual routine inspection of the structure to monitor the damages.

- Main Pier rated as Poor, from Abutment to Bent Q.
- Main Pier rated as Serious, from Bent Q to Bent R.
- Pier Extension rated as Serious.

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It was also recommended to close the Pier before and during anticipated storm events that subject the piles to high winds, swells and large waves and conduct a post-event assessment to identify any critical damages before re-opening the Pier. The City of Pacifica had closed the Pier in December 2023 due to high winds and large swells. After a high-level assessment of the handrails in January 2024, the City re-opened portion of the Main Pier and installed chain-link fence preventing access beyond Bent J (Figure 1.2).

GHD conducted another assessment in April 2024 utilizing a UAV to observe the piles. This memorandum summarizes the findings of the post-event (multiple storm events between December 2023 and February 2024) assessment.



**Figure 1.2** Chain-link Fence on Main Pier near Bent K

## 2. Methodology

The methodology was consistent with the condition assessment performed in previous years.

### 2.1 Observation methods

A visual observation of inside faces of concrete handrails and deck surfaces was performed by GHD's engineer Satish Chilka on April 18, 2024. A UAV operated by GHD's subconsultant New Age Aerial captured imagery of the exterior sides of the deck and the piles. The images were reviewed to assess current condition and identify areas of significant damage.

### 2.2 Damage Ratings

The observed conditions of the guardrails are categorized in conformance with ASCE 130: Waterfront Facilities Inspection and Assessment. For reinforced concrete elements, damage can be described as either minor, moderate, major, or severe as described in Table 2.1.

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**Table 2.1: Damage Rating for Reinforced Concrete Elements - ASCE 130**

Damage Rating	Existing Damage
Not Inspected	– Not inspected, inaccessible, or passed by
No Defects	– Good original hard surface, hard material, sound
Minor	<ul style="list-style-type: none"> <li>– Mechanical abrasion or impact spalls up to 1-in in depth</li> <li>– Occasional corrosion stains or small pop-out corrosion spalls</li> <li>– General cracks up to 1/16-in in width</li> </ul>
Moderate	<ul style="list-style-type: none"> <li>– Structural cracks up to 1/16-in in width</li> <li>– Corrosion cracks up to 1/4-in in width</li> <li>– Chemical deterioration: Random cracks up to 1/16-in in width; “Soft” concrete and/or rounding of corners up to 1-in deep</li> <li>– Mechanical abrasion or impact spalls greater than 1-in in depth</li> </ul>
Major	<ul style="list-style-type: none"> <li>– Structural cracks 1/16-in to 1/4-in in width and partial breakage (through section cracking with structural spalls)</li> <li>– Corrosion cracks wider than 1/4-in and open or closed corrosion spalls (excluding pop-outs)</li> <li>– Multiple cracks and disintegration of surface layer due to chemical deterioration</li> <li>– Mechanical abrasion or impact spalls exposing the reinforcing</li> </ul>
Severe	<ul style="list-style-type: none"> <li>– Structural cracks wider than 1/4-in or complete breakage</li> <li>– Complete loss of concrete cover due to corrosion of reinforcing steel with more than 30% of diameter loss for any main reinforcing bar</li> <li>– Loss of bearing and displacement at connections</li> <li>– Loss of concrete cover (exposed steel) due to chemical deterioration</li> <li>– Loss of more than 30% of cross-section due to any cause</li> </ul>

### 3. Condition Assessment

The pier has continued experiences high wind in a harsh marine environment. Continuous exposure to seawater or marine spray with recurring wet and dry conditions are detrimental to the concrete structure. Cracks in concrete allow seawater to access the reinforcement, initiating corrosion. As corrosion expands around the circumference of the reinforcement, the bond between concrete and reinforcement weakens and results in delamination. The progressive delamination eventually leads to concrete breaking off from the reinforcement i.e., spalling.

The revised damage ratings for the handrails are summarized in Table 3.1, and additional details, including ratings for the piles are provided in Attachment A. In previous assessments, the handrails on east side of the Pier Extension were miscounted as the joints between handrail panels were covered by plywood. The total count for handrails has been revised to 165 (from 164) to reflect recent observation.

**Table 3.1**      *Summary of Handrail Damage Ratings*

Assessment	Year 2024	Year 2022
No Damage	12	13
Minor Damage	27	29
Moderate Damage	28	29
Major Damage	57	56
Severe Damage	41	37

A few new damages were observed along the Pier after the seasonal storms between December 2023 and February 2024. The most notable damage occurred at the handrail between the Main Pier and Pier Extension as shown in Figure 3.1 and Figure 3.2.

The end of the Pier deck and the piles at Bent R were previously noted to have cracks and spall damage. These damages have increased in size and have exposed the underlying corroded reinforcements (Figure 3.3 and Figure 3.4). A large section of the abandoned outfall pile that previously extended several feet toward the water along the southern pile of Bent R and the steel bracket connecting to the pile were missing (Figure 3.4 and Figure 3.5).



**Figure 3.1**      *Handrail and Deck Slab between Main Pier and Pier Extension, View toward East*



**Figure 3.2** Handrail and Deck Slab between Main Pier and Pier Extension, View toward West



**Figure 3.3** Deck and Piles at Bent R, View toward East.





**Figure 3.4**      **Pile and Outfall Pipe at Bent R in April 2024**



**Figure 3.5**      **Pile and Outfall Pipe at Bent R in July 2023**

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A few large openings were noted along the handrails as shown in Figure 3.6 through Figure 3.11. These openings have resulted from loss of previously spalled concrete. These damages are not anticipated to impact the functionality of the handrails but the open spall, exposed reinforcement and size of the openings greater than 4-inches pose a hazardous condition.



**Figure 3.6**      *Handrail near Gate on South side of Pier*



**Figure 3.7**      *Handrail near Gate on North side of Pier*

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**Figure 3.8**      *Handrail #23, North side of Pier between Bent F and G*



**Figure 3.9**      *Handrail #39, North side of Pier near Bent K*

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**Figure 3.10**      **Handrail #41, #42, South side of Pier near Bent K**



**Figure 3.11**      **Handrail #41, North side of Pier near Bent K**

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The City had installed a chain-link fence to close access to the Pier Extension. The bottom of the fence panel was noted to have come off the connection.



**Figure 3.12** Chain-link Fence between Main Pier and Pier Extension

Although the extent of spalling has increased on some of the piles along Bent R and under the Pier Extension, these piles were previously assigned a Severe damage rating. The damage ratings have not changed. A summary of the pile damage ratings is shown in Figure 3.13.

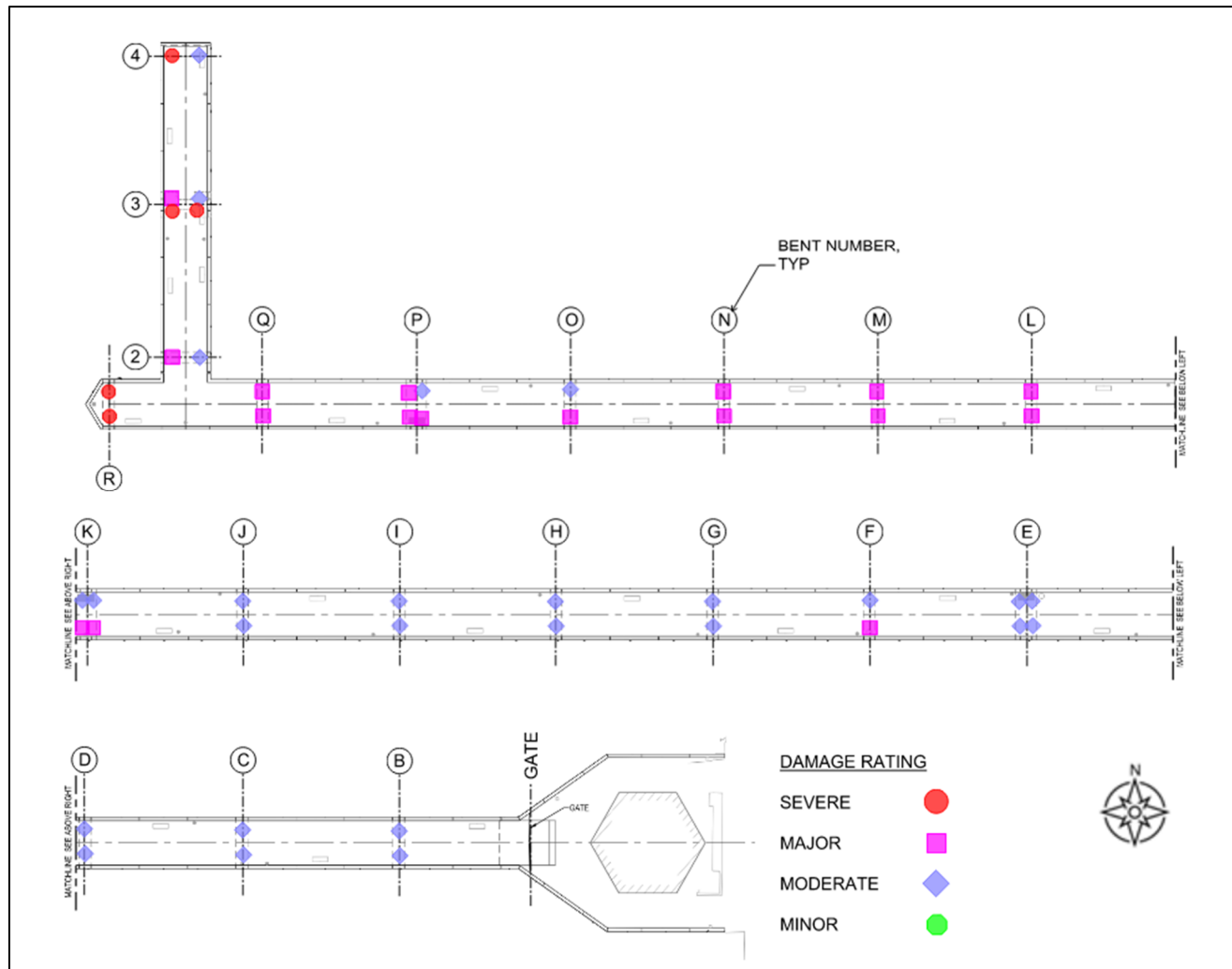


Figure 3.13 Damage Ratings – Piles, Above Water Observations 2024

## 4. Conclusions and Recommendations

The offshore end of the Main Pier and the Pier Extension are exposed to most severe impacts from the storm events. The damaged piles along Bent R, Bent 3 and Bent 4 are recommended for repairs in the near term. The open spalls on these piles have increased in size and exposed more of the underlying corroded reinforcement. Although the piles and deck are not subject to heavy loads during non-storm season, these conditions will worsen over time and pose a significant risk to the stability of the structure.

The City should continue to limit public access to the offshore end of the Main Pier and the Pier Extension until the piles, handrails and deck are repaired. Moving the current chain-link fence from Bent K to a location between Bent N and Bent P (last fish cleaning station) will be appropriate to prevent access to these areas. The large gaps in the handrails should be boarded to reduce risk of injury from exposed reinforcement and rough concrete surfaces.

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It is also recommended to remove the remaining portion of the outfall pipe under the deck near Bent R and prevent the pipe from falling into the water and potentially damaging the underside of the deck if the connection bracket is pulled out.

The City of Pacifica should continue to undertake annual condition assessment of the handrails and above deck components until the handrails are repaired, as necessary. The pier should be closed to public when high wind and wave conditions are anticipated in the area. The handrail panels should be visually checked before opening the pier.

## 5. Limitations

*This technical memorandum has been prepared by GHD for City of Pacifica. It is not prepared as, and is not represented to be, a deliverable suitable for reliance by any person for any purpose other than stated. It is not intended for circulation or incorporation into other documents in parts. The matters discussed in this memorandum are limited to those specifically detailed in the memorandum and are subject to any limitations or assumptions specially set out.*

*The opinions, conclusions and any recommendations in this memorandum are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.*

*Investigations undertaken in respect of this memorandum are constrained by the site conditions and location of the structural components limiting visual and physical access. As a result, not all relevant site features and conditions may have been identified in this memorandum.*

### Accessibility of documents

*If this Technical Memorandum is required to be accessible in any other format this can be provided by GHD upon request and at an additional cost if necessary.*

**Attachment A:** Field Notes – Damage Ratings April 2024.



Client

City of Pacifica

Job Number

12599413

Sheet

1

Project

Pacifica Pier Condition Assessment

Sheets By

SC

Date

05/15/2024

Subject

Post Storm (2024) Assessment

Checked By

Date

LEGEND

PANEL ID INFO

- N/S/E/W
- SIDE OF PIER (NORTH/SOUTH/EAST/WEST)
- #
- PANEL COUNT FROM ENTRANCE OF PIER (Negative # indicates panels shoreside of the gate)
- S
- SHORT PANEL
- A
- ABUTMENT WALL

REPORT ITEM

- RAT

DAMAGE RATING
- ND

NO DAMAGE
- MN

MINOR DAMAGE
- MD

MODERATE DAMAGE
- MJ

MAJOR DAMAGE
- SV

SEVERE DAMAGE
- MC(##)

MINOR CRACK NOT EXCEEDING 1/16" (TOTAL LENGTH OF CRACK, INCHES)
- MS(##x##)

MINOR SPALLING (APPROX. AREA, INCHES)
- CR

CRACKING WITH LOSS OF EFFECTIVE CONCRETE AREA AT SUPPORT
- SP

SPALLING WITH LOSS OF EFFECTIVE CONCRETE AREA AND REINFORCEMENT COVER
- B

BOTTOM CONNECTION DAMAGED
- E

DAMAGE LOCATED AT EDGE OF PANEL
- FW/FH

DAMAGE SPREAD ACROSS FULL WIDTH / HEIGHT
- X#

NUMBER OF INSTANCES OF DAMAGE
- TSP

THROUGH SPALL / SECTION LOSS
- BIN

TRASH RECEPTACLE IN THE VICINITY
- BENCH

CONCRETE BENCH IN THE VICINITY
- LIGHT

LIGHT POLE IN THE VICINITY
- STN

FISH CLEANING STATION IN THE VICINITY
- WATER

WATER FOUNTAIN IN THE VICINITY
- PLY

PLYWOOD / TIMBER BOARD COVERING HANDRAIL
- SENS

SENSOR EQUIPMENT INSTALLED BY OTHERS



SUMMARY

TOTAL	NO DAMAGE	12
	MINOR	27
	MODERATE	28
	MAJOR	57
	SEVERE	41



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**MAIN PIER STRUCTURE - REVISED RATINGS APRIL 2024**

	PIER SIDE - S				PIER SIDE - N			
PANEL ID	INSIDE	OUTSIDE	RAT	REMARK	INSIDE	OUTSIDE 2	RAT	REMARK
-5A		SP	MN		CR(90)	FW-SP	SV	
-4A	CR, B	SP	MD		CR	SP	MJ	B
-3A	CR	SPX2	MD			SP	MJ	B
-2A	CR(60)	SP(24X30)	MJ	B, 11'-2" (INSIDE)	CR(48)	SP	SV	11'-2" (INSIDE), EXPOSED REBAR / RUST AT EXTERIOR
-1A	E-SP	SP(3)	MJ	B	CR(30)	E-SPX2	SV	MJ-SV, EXPOSED REBAR / RUST AT EXTERIOR
0A	MC, CR, TSP	FW-SP	SV	GATE LOCATED 4' FROM END	CR(60)	E-SP	MJ	GATE LOCATED 4' FROM END
1	MS(18X10)X2	TSP @ FULL HEIGHT ON CAFÉ END	SV	MJ-MD, STEEL BRACKET (7'-11")		TSP @ BOTTOM CORNER NEAR #2	SV	STEEL BRACKET (8'-3")
2	42" CR	E-MC	MN	VERTICAL	MC(42)	CR	MN	
3			ND				ND	
4S			ND			SP	MD	MD-MN
5			MN	DECK DAMAGED	MC(42)		MN	
6			ND	BENCH			ND	
7	MS(12X4)		MN	BIN	MS		MD	MD-MN
8S	MS		MJ	MD-MJ, LIGHT		MC	MN	
9	MC(90), MS	SP	MJ	MD-MJ, LARGE OPENING		MS(12X18)X2	MJ	MD-MJ, B, BIN
10		CR, SP	MJ	MD-MJ, ENDS, SENS		MS(12X12)	MD	BENCH
11	HZ-CR	MS	MJ	MD-MJ, EXPOSED REBAR / RUST AT EXTERIOR TOP	MS, MC(90)	MS	MD	MD-MN
12S			ND			MS	MD	MD-MN
13		MS(12X24)	MD	SPALLING CONCENTRATED NEAR ANCHORS, EXPOSED REBAR / RUST AT EXTERIOR TOP, BIN	MC(42)	MC	MD	MD-MN
14			MN	BENCH	SP	MC	SV	SV-MJ, ENDS S/C LOSS
15	MC(90)		MN	CR IN DECK	MS(18X6), MC		MJ	MJ-MD
16S			ND	LIGHT			ND	CLEANING STA W/ SPALLING
17	CR(42)		MD	CORRODED DECK	MS, MC(30)	SP	MJ	BIN
18		MS(12X12)	MD		MC, SP	MS	MJ	MJ-MD, BENCH
19	TSP @ TOP	MS(6X12)X2	SV	MINOR SECTION LOSS	SP(24X8)	MS	SV	SV-MJ
20S		MS	MN	WATER	MS		MN	MN-ND, BIN
21		SP, MC(42)	MJ	MJ-MD, BIN		MS	MD	MN-MD, B





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22	MS	MS,CR	MJ	MD-MJ, ENDS, BENCH		SP	MJ	MD-MJ
23	MC(30)	MS	MJ	MD-MJ	CR, FW-MC	SP, TSP	SV	SV, EXPOSED REBAR / RUST AT EXTERIOR
24S		MS	MD	DECK DAMAGE, LIGHT	HZ CR		MJ	EXPOSED REBAR / RUST AT EXTERIOR
25		MS	MN	BIN	SP	SP	SV	SV-MJ @ INTERIOR, EXPOSED REBAR / RUST AT EXTERIOR
26		SP	MJ	MJ-MD	SP	SP	MJ	MJ-MD, BENCH
27		MC	MD		MC		MN	ND-MN
28S	SP NEAR #27		MN	MN-ND, NO JOINT GAP W/ #27	CORNER SPALL NEAR #29		ND	NO JOINT GAP W/ #27
29			ND	STEEL BRACKET LOST			MN	ND-MN, CORRODED STEEL BRACKET, BIN
30	VERT CR	SP @ TOP CORNER	MD	MN-MD, BENCH		END LAND - SPALL	MJ	MD-MJ
31		SP	MN		E-SP	MS,SP	MJ	MD-MJ
32S		SP	MD	LIGHT		MC,MS	MJ	MJ-MD
33	MC	FH-SP	MJ	MJ-MD, BIN	E-SP	SP	SV	SV-MJ, ENDS
34	E-SP,CR	HZ CR AT TOP, RUST STAINS	SV	ROUGH SURFACE	CR(300), SP	FH-CR	SV	OFFSET WITH #33, BENCH, ROUGH SURFACE, SEVERAL HZ CRACKS ON EXTERIOR
35	MC(30)	TSP @ 34-35, PLY INSTALLED	MN	DECK CRACK		FH-SP	MJ	SPALL AT TOP CORNER EXT NEAR #36
36S		MC(42)	MN			CR	MD	WATERSIDE BASE DAMAGED
37	MC(42), SP		MD	MN-MD	SP	MC	SV	BIN
38	MC(42)		MJ	MD-MJ, BIN, BARRICADE	SP, PLY @ 37-38	SP	SV	BARRICADE
39	MC(42)	MS	MJ	EXPOSED REBAR / RUST AT EXTERIOR TOP,	TSP @ BOTTOM CORNER NEAR #38	SP	MJ	SP AT ENDS
40S			MN	ND-MN. LIGHT			ND	STN
41	SP	SP	SV	DECK DAMAGE, EXPOSED REBAR / RUST AT EXTERIOR TOP	SP(24X12), TSP	E-SP,CR	SV	SV-MJ, DECK DAMAGE MD
42	E-SP, FW-SP	TSP	SV	THROUGH SPALL AT ENDS	E-SP	TSP @ BOTTOM CORNER NEAR #43	SV	MJ-SV, ENDS, BENCH
43	MC(42)	SP	MJ	MJ-MD	E-SP		MJ	MJ-MD
44S		E-SP	SV	SV-MJ, WATER			MN	
45		E-SP	MJ	MD-MJ, BIN		E-SP	MJ	RUST AT CONNECTIONS
46			ND	BENCH	FW-SP	SP	SV	
47	MC		MD	MN-MD			SV	SV-MJ
48S			MN	LIGHT			MN	ND-MN



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49		E-SP	MJ	MD-MJ, ENDS		E-SP	SV	SV-MJ, ENDS, BIN
50	MS(12X24)X2	E-SP	MJ	MD-MJ		E-SP	SV	SV-MJ, BENCH
51	SP @ CORNER		MD	MN-MD		E-SP	MJ	MD-MJ
52S		SP	MJ	MD-MJ		SP	MJ	MD-MJ
53	CR(42)	SP	MJ	CORRODED DECK, CR AT JT ALONG DECK, BIN	CR	MS	SV	SV-MJ, MD - DECK DAMAGE
54			MD	MN-MD, BENCH		E-MS	MJ	MJ-MD, RUST AT CONNECTION
55		SP	MJ	MD-MJ, EXPOSED REBAR / RUST AT MID-PANEL		E-SP	MJ	MJ-MD
56S		MS	MN	LIGHT, SV SPALL AT DECK EXT SIDE	FW-CR	FW-CR	MD	CRACK AT JT ALONG DECK
57		E-SP	SV	SV-MJ		SP	MJ	MD-MJ, BIN
58	CR	E-SP	SV	SV-MJ, ENDS		E-SP	MJ	BENCH
59	CR(42)		MD	MN-MD, STEEL BRACKET MISSING	CR	E-SP	SV	MJ-SV, STEEL BRACKET, SPALL AT CONNECTION
60S	CR		MN	STN	CR	FW-CR	MJ	MD-MJ
61	CR(42)		MJ	MD-MJ, DECK DAMAGE, BIN	MC(42)	MS	MJ	MD-MJ
62		MS	MJ	MD-MJ		CR,MS	MJ	AT MID-PANEL
63	MC(60)	MS	MJ	MD-MJ		SP	MJ	MD-MJ
64S			MN	MJ SPALL AT DECK EXT SIDE			MN	MN-ND
65, L-SHAPE @ N		E-SP	SV	SV-MJ	SP, TSP @ TOP CORNER AT N/S PIER		SV	DAMAGE CONCENTRATED AT CORNER, BIN
66		FH-SP	MJ	MJ-MD, BIN, SENSOR				OPEN BAY, DECK DAMAGE
67		E-SP	MD	BENCH	CR		MD	BIN
68	CR, SP	FW-SP	SV	SV-MJ, END/CORNER WALL, LIGHT, EXPOSED REBAR / RUST AT MID HT	CR, SP	FW-SP	SV	END/CORNER WALL, BIN, SUPPORTS STEEL POLE BRACKET, EXPOSED REBAR / RUST AT EXTERIOR
SUBTOTAL		NO DAMAGE	7	SUBTOTAL		NO DAMAGE	5	
		MINOR	17			MINOR	9	
		MODERATE	15			MODERATE	10	
		MAJOR	24			MAJOR	27	
		SEVERE	11			SEVERE	22	



ClientCity of Pacifica

Job Number12599413

Sheet5

ProjectPacifica Pier Condition Assessment

Sheets BySC

Date05/15/2024

SubjectPost Storm (2024) Assessment

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Date

PIER N/S EXTENSION - (REVISED RATINGS APRIL 2024)								
	PIER SIDE - W				PIER SIDE - E			
PANEL ID	INSIDE	OUTSIDE	RAT	REMARK	INSIDE	OUTSIDE 2	RAT	REMARK
1S		SP @ BOTTOM CORNER	SV	NEW PANEL, EXTENSIVE SPALL NEAR MAIN PIER	MC	CR	MD	HZ CR AT EXTERIOR TOP
2	CR(42)	SP, E-SP	MJ	EXPOSED REBAR / RUST AT EXTERIOR	MC(42)	E-SP	SV	S/C LOSS AT TOP CORNERS
3	VERT CR, SP		MD			MC(30)	MJ	BENCH, EXPOSED REBAR / RUST AT EXTERIOR
4			SV	PARTIAL COLLAPSE, DAMAGE DUE TO ADJ COLLAPSE			MN	BIN
5S			SV	COLLAPSE	SP	SP	MJ	BENCH
6			SV	COLLAPSE	CR	E-SP	SV	BENCH
7			SV	COLLAPSE		E-SP	MJ	BIN
8	SP	FW-SP	SV	DAMAGE DUE TO ADJ COLLAPSE		E-SP	MJ	
9		MS	MD	L-SHAPED ENDPANEL		SP(24X12)X2	MJ	ENDPANEL, EXPOSED REBAR FULL HEIGHT ON CORNER
SUBTOTAL		NO DAMAGE	0	SUBTOTAL		NO DAMAGE	0	
		MINOR	0			MINOR	1	
		MODERATE	2			MODERATE	1	
		MAJOR	1			MAJOR	5	
		SEVERE	6			SEVERE	2	



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**Pile Damage Rating - Above Water Line (April 2024)**

Pile Location	Damage Rating
Bent B - N	MD
Bent B - S	MD
Bent C - N	MD
Bent C - S	MD
Bent D - N	MD
Bent D - S	MD
Bent E - NE	MD
Bent E - SE	MD
Bent E - NW	MD
Bent E - SW	MD
Bent F - N	MD
Bent F - S	MJ
Bent G - N	MD
Bent G - S	MD
Bent H - N	MD
Bent H - S	MD
Bent I - N	MD
Bent I - S	MD
Bent J - N	MD
Bent J - S	MD
Bent K - NE	MD
Bent K - SE	MJ
Bent K - NW	MD
Bent K - SW	MJ
Bent L - N	MJ
Bent L - S	MJ
Bent M - N	MJ

**Water Level at approximately +2 ft (MLLW)**

Pile Location	Damage Rating
Bent M - S	MJ
Bent N - N	MJ
Bent N - S	MJ
Bent O - N	MD
Bent O - S	MJ
Bent P - NE	MD
Bent P - SE	MJ
Bent P - NW	MJ
Bent P - SW	MJ
Bent Q - N	MJ
Bent Q - S	MJ
Bent R - N	SV
Bent R - S	SV
Bent 2 - E	MD
Bent 2 - W	MJ
Bent 3 - NE	MD
Bent 3 - SE	SV
Bent 3 - NW	MJ
Bent 3 - SW	SV
Bent 4 - E	MD
Bent 4 - W	SV

**Pile Location Descriptor**

N - North Side  
S - South Side  
E - East Side  
W - West Side