

CONDITION ASSESSMENT OF LARGE DIAMETER CAST IRON OUTFALL PIPES UNDER PIERS 33 & 35 IN THE SAN FRANCISCO BAY

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BACKGROUND

- THE NORTH POINT FACILITY OUTFALL (OUTFALL) REHABILITATION PROJECT IS A PART OF THE SFPUC SEWER SYSTEM IMPROVEMENT PROGRAM (SSIP).
- THE NORTH POINT FACILITY AND OUTFALL WAS BUILT IN 1950 AND DIFFUSERS WERE ADDED TO THE OUTFALL IN THE 1970S IN ORDER TO MEET SECTION 402 OF THE 1972 CLEAN WATER ACT.
- THE OUTFALL DISCHARGES PRIMARY TREATED EFFLUENT FROM NORTH POINT FACILITY OUT TO SAN FRANCISCO BAY DURING WET WEATHER SEASONS.
- THE OUTFALL CONSISTS OF SUBTERRANEAN REINFORCED CONCRETE SEWER, FOUR 48" DIAMETER CAST IRON EFFLUENT PIPES AND DIFFUSERS SUSPENDED UNDER PIER 33 AND 35, AS SHOWN BELOW.
- SFPUC DESIRES TO MAINTAIN THE INTEGRITY AND FUNCTIONALITY OF THE NPO FOR ANOTHER 30 YEARS.

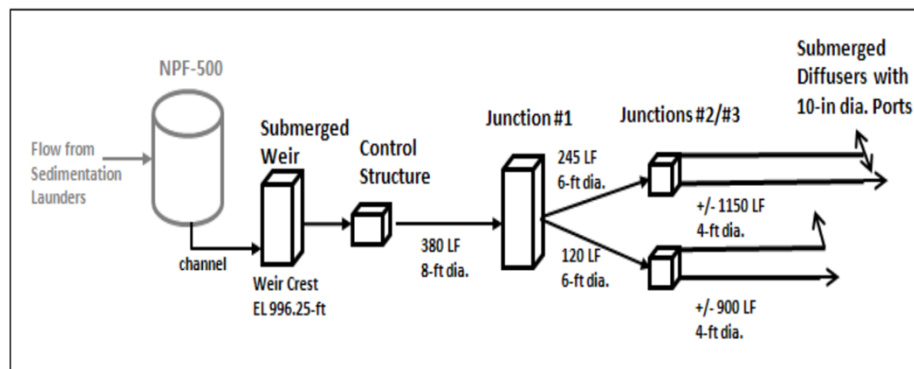


PURPOSE

- THIS INVESTIGATION WAS CONDUCTED FOR THE PURPOSE OF DETERMINING THE CURRENT CONDITION OF THE OUTFALLS ALONG WITH THEIR ASSOCIATED SUPPORT STRUCTURES
- TO DETERMINE IF THE FOUR (4) NPO PIPELINES AND THEIR CORRESPONDING SUPPORT SYSTEM ARE IN ADEQUATE CONDITION FOR CONTINUED USE FOR THE NEXT 30 YEARS.
- FURTHER, THIS STUDY WAS DONE TO DETERMINE THE NEED FOR ANY REPAIRS OR REPLACEMENT OF THE SUPPORT STRUCTURES AS WELL AS ANY NEED FOR COATING OR LINING REPAIRS, TO ENSURE THEIR INTEGRITY FOR AN ADDITIONAL 30 YEARS.

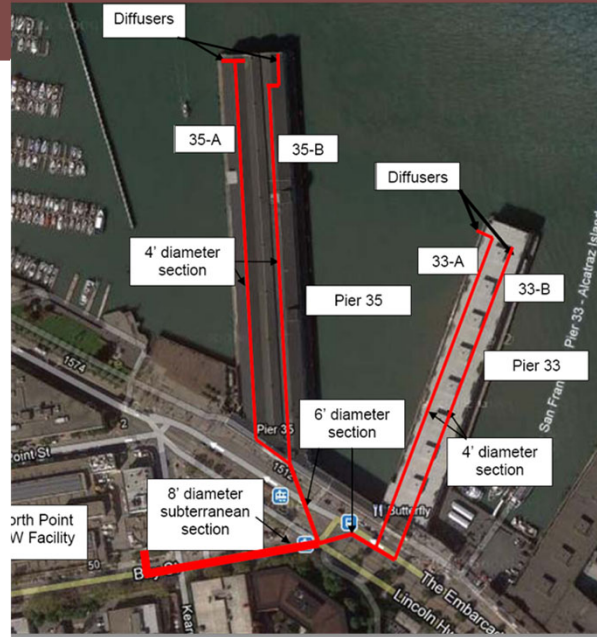


North Point Outfall schematic. (Courtesy of NPF Outfall System Rehabilitation Alternatives Analysis Report)



PROJECT AREA

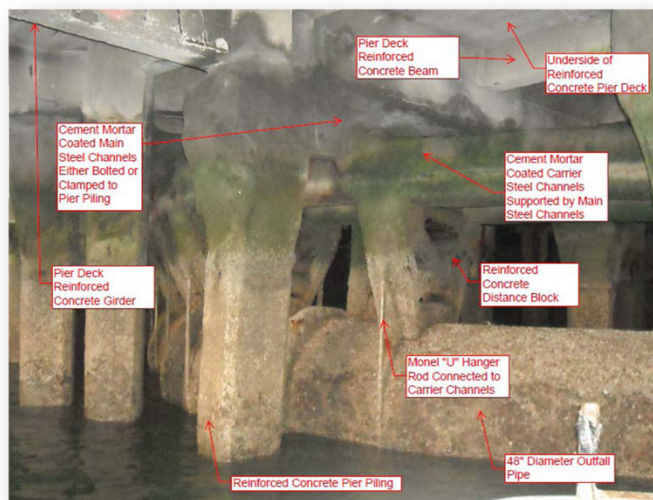
PIERS 33 & 35 SAN FRANCISCO



OUTFALL PIPE & SUPPORTS

PROFILE OF CAST IRON
PIPE AND SUPPORT
FRAMING UNDER PIER.

(COURTESY OF NPF
OUTFALL SYSTEM
REHABILITATION
ALTERNATIVES
ANALYSIS REPORT)



EXTERNAL INSPECTIONS

EXTERNAL INSPECTIONS WERE CONDUCTED DURING LOW TIDE AS THE OUTFALL PIPES ARE TOTALLY SUBMERGED DURING HIGH TIDE.



MARINE GROWTH REMOVAL

REMOVAL OF MARINE GROWTH AND MORTAR COATING TO PERFORM INSPECTION ON EXTERIOR OF OUTFALL PIPELINE.



EXTERNAL VISUAL INSPECTION

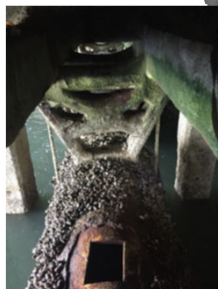
- MARINE GROWTH & MORTAR COATING WAS REMOVED
- 1/6TH – 1/8TH INCH LAYER OF GRAPHITIZATION WAS FOUND
- NO SIGNIFICANT PITTING WAS OBSERVED
- THE PIPES WERE FOUND TO BE IN FAIR EXTERNAL CONDITION



CALIBRATION BLOCK

Due to the complex crystalline metallurgy of cast iron, there are no calibration blocks that can be purchased to properly calibrate the UT meter for proper testing.

A piece of abandoned section of 33 B South was removed to construct a calibration block for the UT equipment



INTERNAL VISUAL INSPECTION WITH DIVER'S ASSISTANCE

- DIVERS WORKED ON THE DIRECTIONS OF OUR TEAM
- OUR TEAM VIEWED THE PROGRESS VIA DIVER WORN VIDEO CAMERAS
- DIVERS CHECKED FOR:
 - SEDIMENT & DEBRIS LEVEL
 - DEGREE & EXTENT OF CORROSION
 - PIPE JOINT GAP DISTANCE
 - CONDITION OF MORTAR LINING
 - IDENTIFY CORRODED AREAS TO BE UT TESTED FROM THE OUTSIDE
- A SIGNAL TRANSMITTER PINPOINTED THE LOCATION OF DIVERS FOR UT TESTING FROM OUTSIDE
- THE PIPE INTERIOR SURFACES WERE FOUND TO HAVE SIGNIFICANT CORROSION AND PITTING AS WELL AS LOSS OF MORTAR LINING



INTERIOR GRAPHITIZATION

GRAPHITIZATION
VISIBLE ON INTERIOR
OF OUTFALL PIPELINE



ULTRASONIC THICKNESS (UT) TESTING

WALL THICKNESS WAS MEASURED FROM THE EXTERIOR OF THE PIPE BECAUSE EXPOSURE TO SEA WATER WAS CAUSING THE PIPE TO CORRODE MORE RAPIDLY FROM EXTERIOR.

THE AVERAGE THICKNESS OF THE PIPE 1.45" WITH A MINIMUM THICKNESS OF 0.98"



(UT) TESTING

LOCATIONS OF MAXIMUM INTERNAL CORROSION WERE LOCATED BY DIVERS WORKING ON THE INTERIOR OF THE FLOODED PIPE

THESE AREAS WERE IN TURN LOCATED ON THE EXTERIOR OF THE PIPE WHERE WALL THICKNESS WAS MEASURED USING THE CALIBRATED UT EQUIPMENT



ULTRASONIC THICKNESS (UT) TESTING RESULTS

Ultrasonic Thickness Testing North Point Outfall Pipelines			
Outfall Pipeline	Minimum Thickness	Maximum Thickness	Average Thickness
33A North	0.98"	1.57"	1.41"
33B South	1.30"	1.56"	1.47"
35A North	1.10"	1.65"	1.48"
35B South	1.35"	1.54"	1.45"



INSPECTION OF PIPE SUPPORT STRUCTURES

- THE SUPPORT STRUCTURES:
 - DISTANCE BLOCKS
 - PREFORMED REINFORCED CONCRETE BLOCKS
 - LONGITUDINAL BEAMS
 - STEEL C-CHANNELS COVERED WITH REINFORCED CONCRETE COATING
 - TRANSVERS BEAMS
 - STEEL C-CHANNELS COVERED WITH REINFORCED CONCRETE COATING
 - ALLOY 400 (MONEL) HANGER RODS
 - SOLID MONEL ROD HANGERS

INSPECTION OF PIPE SUPPORT STRUCTURERS

- THE SUPPORT STRUCTURES:
- DISTANCE BLOCKS
 - DELAMINATION TESTING
 - TESTING PERFORMED PER ASTM C4580
 - PHENOLPHTHALEIN TESTING
 - PINK COLOR IS ACTIVATED AT A PH OF 8.4
- THE DISTANCE BLOCKS WERE FOUND TO BE IN GOOD CONDITION
- TRANSVERS & LONGITUDINAL BEAMS
 - STEEL MESH & CONCRETE COATING WAS REMOVED AT SELECTED LOCATIONS TO INSPECT UNDERLYING STEEL
 - THE UNDERLYING STEEL BEAMS WERE FOUND TO BE IN FAIR CONDITION. FURTHER INVESTIGATION AND RECOATING WAS RECOMMENDED
- ALLOY 400 (MONEL) HANGER RODS
 - SOLID MONEL ROD HANGERS
 - THE ROD HANGERS WERE FOUND TO BE IN EXCELLENT CONDITION



(UT) TESTING

**PIER 33 B SOUTH PIPE
LONGITUDINAL BEAM
BAY 48.**

**CORROSION IS
OCCURRING ON THE
EMBEDDED C-CHANNELS
AS SHOWN AT THIS
LOCATION**



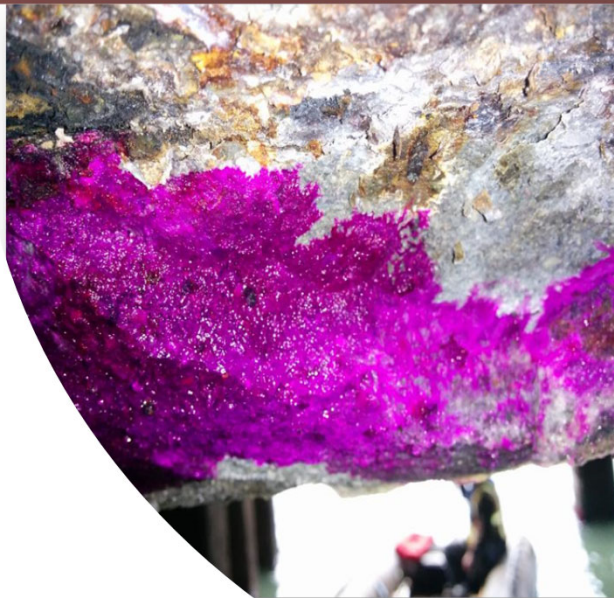
STEEL BEAMS

SEVERE CORROSION EVIDENT ON LONGITUDINAL AND TRANSVERSE BEAMS OF OUTFALL 35 A NORTH, BAY 3X. THESE BEAMS WERE ORIGINALLY COATED WITH COAL TAR EPOXY SYSTEM



PHENOLPHTHALEIN TESTING

PHENOLPHTHALEIN TESTING ON LONGITUDINAL BEAM ALONG BROKEN SIDE. THE DEEP RED COLOR IS INDICATIVE OF HIGH PH, NON-CARBONATED CONCRETE



CONCLUSIONS & RECOMMENDATIONS

- AVERAGE PIPE THICKNESS OF 1.45 INCHES
- IMPLIES CATEGORY OF A CLASS B PIPE UNDER THE AWWA STANDARDS
- BASED ON THIS THE OUTFALL PIPELINES WOULD BE RATED FOR 200-FOOT OF HEAD OR 86 POUNDS OF PRESSURE (PSI), WHICH GREATLY EXCEEDS THE REPORTED MAXIMUM OPERATING PRESSURES FOR THESE PIPELINES (I.E. 16-FOET OF HEAD OF 7 PSI
- THE PIPE IS IN GOOD CONDITION AND CAN BE UTILIZED FOR ADDITIONAL 30 YEARS AFTER INTERNAL LINING AND EXTERNAL CATHODIC PROTECTION
- THE PIPE SUPPORTS WILL NEED COATING AND REPAIRS



CATHODIC PROTECTION FEASIBLY STUDY

- ELECTRICAL CONTINUITY TESTING
 - PIPES WERE FOUND TO BE ELECTRICALLY CONTINUOUS THOUGHT THE LENGTH OF EACH PIPE. NO BONDING WAS REQUIRED EXCEPT AT THE DUCTILE IRON DIFFUSERS
- CATHODIC PROTECTION (CP) CURRENT REQUIREMENT TESTING
 - CURRENT WAS APPLIED UTILIZING A SIMULATED CP SYSTEM CONSISTING OF A TEST RECTIFIER AND STEEL RODS SUBMERGED IN THE SEA WATER.
 - A PIPE-TO-WATER POTENTIAL PROFILE WAS OBTAINED FROM A BOAT UTILIZING A HIGH IMPEDANCE VOLTMETER AND SILVER CHLORIDE REFERENCE ELECTRODE
 - 100 MV POLARIZATION WAS ACHIEVED WITH THE APPLICATION OF 10 AMPERES OF CURRENT.
 - CP IS FEASIBLE AND WOULD BE A GOOD OPTION OF EXTENDING THE LIFE OF THE PIPE

FOLLOW UP

- CATHODIC PROTECTION SYSTEM
 - CATHODIC PROTECTION SYSTEM CONSISTING OF ALUMINUM (GALVULUM III) ANODES WAS DESIGNED
 - TWO 300-LB ANODES PER SLED. TOTAL OF 3 SLEDS PER PIPE
 - THE SYSTEM WAS INSTALLED AND IS OPERATING SATISFACTORILY
- PIPE INTERNAL LINING
 - ORIGINAL THOUGHT PRIOR TO THE INVESTIGATION WAS TO INSTALL A STRUCTURAL LINER INSIDE THE PIPE
 - SINCE THE PIPE WERE FOUND TO BE STRUCTURALLY SOUND, NON-STRUCTURAL LINING WAS RECOMMENDED AND APPLIED TO THE PIPE







AIR BAG TO THE RESCUE

**THE AIR BAG FLOATED
THE SLED. DIVERS THEN
PULLED THE SLED UNDER
THE PIER AND SANK THE
SLED ALONG SIDE THE
PIPELINE.**



EPOXY LINING

- Pipes were coated with 100% solids epoxy system.
- Product application was completed by an automated spraying machine.
- Coating mix ratio, temperature, application pressure, film thickness and adhesion were monitored and recorded by onsite NACE inspectors.



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