

**Pier 45 Drainage Improvements /
Herring Water Discharge Project
FINAL REPORT**

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Port of San Francisco

PIER 45 DRAINAGE IMPROVEMENTS / HERRING WATER DISCHARGE PROJECT

FINAL REPORT

EXECUTIVE SUMMARY

Aquatic Park is San Francisco's only public swimming beach on the San Francisco Bay. Breakwater structures provide calm waters for swimmers, but also restrict circulation. Routine water samples showed elevated levels of bacteria which was consistent with concerns about water quality raised by swimmers and other recreational users of the area. Directly adjacent to Aquatic Park is the Pier 45 fish processing operation. Water circulation between Pier 45 and Aquatic Park implicated the fish processing industry as a source of the bacteria loadings.

The Port of San Francisco applied for Clean Beaches Initiative grant funding for stormwater and fishing wastewater upgrades to the Port's Pier 45, the primary location for fish processing on San Francisco Bay (Figure 1). The upgrades provided for (1) capture and treatment of water generated during fishing boat unloading and (2) capture and treatment of wash-down water and stormwater from pier areas used by the fishing industry. This is known as the Pier 45 Drainage Improvements / Herring Water Discharge Project. Upon completion of the infrastructural upgrades, water quality was monitored for one year in the vicinity of Pier 45 and in Aquatic park. This data suggests water quality improvements in Aquatic Park that are attributable to the project. Specifically, there were notable improvements in the median and upper limits for e. coli and enterococci. Dissolved oxygen and biological oxygen demand were all well within acceptable limits.

INTRODUCTION

Pier 45 is located just 1,500 feet east of Aquatic Park, the City of San Francisco's only public swimming beach on San Francisco Bay. Operations at Pier 45 have direct and significant impacts on Aquatic Park, where 150 to 400 people swim on a daily basis (approximately 80,000 person-swims/year) and where additional people engage in rowing and kayaking. Additionally, the 12 million annual visitors to the Fisherman's Wharf area guarantee that improvements to water quality will positively influence public perception of Bay water quality.

The Port of San Francisco applied for Clean Beaches Initiative grant funding for stormwater and fishing wastewater upgrades to the Port's Pier 45, the primary location for fish processing on San Francisco Bay (Figure 1). The upgrades provide for (1) capture and treatment of water generated during fishing boat unloading and (2) capture and treatment of wash-down water and stormwater from pier areas used by the fishing industry.

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Between 2002-2004 Port staff conducted water quality monitoring at Aquatic Park that established baselines for several water quality parameters, including total and fecal coliform. Data show increasing bacteria counts moving south from Aquatic Beach towards Pier 45, with geometric means for Total Coliform, E. Coli and Enterococci collected during Herring Season (November to March) measuring two to three times higher than data collected during the rest of the year.

Port staff suspected that localized increases in Biological Oxygen Demand (BOD) associated with herring boat activities contribute to elevated bacteria counts between November and March. Additional fish wastes are washed into the Bay along with stormwater runoff from the west apron of Pier 45. Further, fish processing activities along the northern perimeter of Pier 45 attract gulls, other birds, and marine mammals, whose excretions contribute to bacterial loadings in the adjacent harbor and at Aquatic Park. Using funds provided through the Clean Beaches Initiative, the Port installed proposed the installation of infrastructure at the Pier 45 Fish Processing Facility to re-direct herring boat discharges and stormwater runoff to the San Francisco combined sewer system.

PROJECT GOALS

The primary objective of this project is to reduce postings at Aquatic Park such that water quality objectives are achieved during the Herring Season. Secondary objectives include year-round reduction of other pollutants associated with fish waste, including bacteria, biological oxygen demand and taste and odors. Since the Pier 45 Fish Processing facility is in continuous operation drainage improvements along the pier deck would yield water quality improvements throughout the year. The monitoring objective is to show a reduction in bacteria an postings at Aquatic Park. Commercial benefits include maintaining the viability of fish processing in the historic Fisherman's Wharf neighborhood, creating jobs for local fishermen, and maintaining the character of international tourist attraction in San Francisco.

PROJECT DESCRIPTION

Clean Beach Initiative grant funds were requested in the amount of \$1,548,645 for stormwater/industrial wastewater upgrades to address two separate sources of discharge at Pier 45:

- (1) seasonal herring water discharge from the Sheds B and D apron,
- (2) stormwater in the Sheds B and D apron area.

Combined with existing infrastructure, these upgrades provide for an integrated system to handle both types of water.

During winter herring season, herring are unloaded at Pier 45. Fish caught in the Bay are kept live in the hold of the fishing boats until they are unloaded at the pier. To unload the catch, large pumps are used which pump out the contents of the holds, water and herring alike. The fish are separated from the water and, traditionally, the water flows back into the Bay. This was identified as a priority environmental issue. The installation of a pumping manifold by the Project allows herring boats moored along the north end of Pier 45 to tie-in and discharge herring gurry to a sanitary sewer pump station located between the two Pier 45 fish processing sheds.

The aprons at Sheds B and D were originally designed to drain directly to the Bay via sheet flow off the edge of the pier aprons. The new stormwater collection system by the Project along the north deck of Pier 45 directs all stormwater runoff from this area to the City sewer system at the Pier 45 pump station. These drainage improvements along the Pier 45 north pier deck provide water quality enhancements year round. The Project includes upgrades to the existing sanitary sewer pump station at Pier 45 in order to create capacity for additional flows.

IMPLEMENTATION

In November, 2007 the project received a Class 1(b) Categorical Exemption under the California Environmental Quality Act as a minor modification to an existing facility that provides sewage or other public utility service. The San Francisco Bay Conservation and Development Commission (BCDC) approved the proposed work during its renewal in 2008 of the Port-wide maintenance permit M-77-17.

The project was bid in September, 2009 and the Port awarded the construction contract to the low bidder, A&B Construction, on November 10, 2009. The project achieved substantial completion on August 19, 2010. Final completion (testing and punch list completion) was completed in November, 2010. One year of water quality sampling followed completion.

PUBLIC OUTREACH

In 1996, the Port of San Francisco sponsored the formation of the Fisherman's Wharf Environmental Quality Advisory Committee (EQAC), to provide a forum for citizen input into environmental issues regarding the design and construction the new Hyde Street Harbor. Throughout design and construction of each of its fishing industry projects in the Fisherman's Wharf area, the Port has incorporated numerous environmentally friendly features, many of which exceeded local and state requirements. The Fisherman's Wharf EQAC served as a primary forum for public outreach for this project and provided significant input into the conceptual design of the stormwater and wastewater enhancements.

Additional support for the project was demonstrated during the application for funding. Letters of support for the project were submitted by the Dolphin Swimming And Boating Club, Inc., BCDC, as well as the San Francisco Board of Supervisors and the Mayor.

MONITORING AND PERFORMANCE

The monitoring program was intended to generate data that would help assess whether the new infrastructure resulted in water quality improvements in the vicinity of Aquatic Park. The results of this effort are summarized in *Appendix I – Monitoring Program for Pier 45 Drainage Improvements / Herring Water Discharge Project*.

LESSONS LEARNED

The Pier 45 Drainage / Herring Water Discharge Project underscores the benefits of a methodical and inclusive approach to protecting water quality. Concerns about water quality originated with recreational

users at Aquatic Park and were supported by sampling data from the area. Fish processors at Pier 45 were challenged to contain the gurry and other discharges from their operations along a pier apron that discharged directly into the San Francisco Bay. Although behavioral Best Management Practices (BMPs) could prevent some of the discharge, structural BMPs proved to be the more reliable solution. The infrastructure upgrades that tied the apron to the sanitary sewer system and facilitated the proper management of herring gurry, provided a reliable mechanism for eliminating these industrial waste discharges and the associated bacterial loadings.

The Clean Beaches Initiative grant funding was essential to achieving project goals. Local government funds are often limited and difficult to secure for all but the most urgent needs. The California State Water Resources Control Board's partnership with local government is valuable.

FUNDING

The American Recovery and Reinvestment Act of 2009 (ARRA) provided funding of \$1,548,645 through the State of California Clean Water State Revolving Fund ("CWSRF"). Expenditure of these funds is summarized in Table 1, American Recovery and Reinvestment Act of 2009 (ARRA) Invoice.

CONCLUSIONS

The Pier 45 Drainage / Herring Water Discharge Project was a successful water quality improvement project. An area of compromised water quality was identified at a recreational bayside beach and determined to be linked to high bacterial loadings. The cause of this pollution was linked to an adjacent industrial fish processing facility, which lacked sufficient infrastructure to ensure that industrial wastewater discharges were contained. A proposal was developed to install infrastructure upgrades that would direct these discharges to the sanitary sewer system. Funding was then secured through the SWRCB Clean Beaches Initiative grant program. Upon completion of the construction, a twelve month water quality monitoring program confirmed moderate improvements in the vicinity of the recreational beach.

FIGURE 1

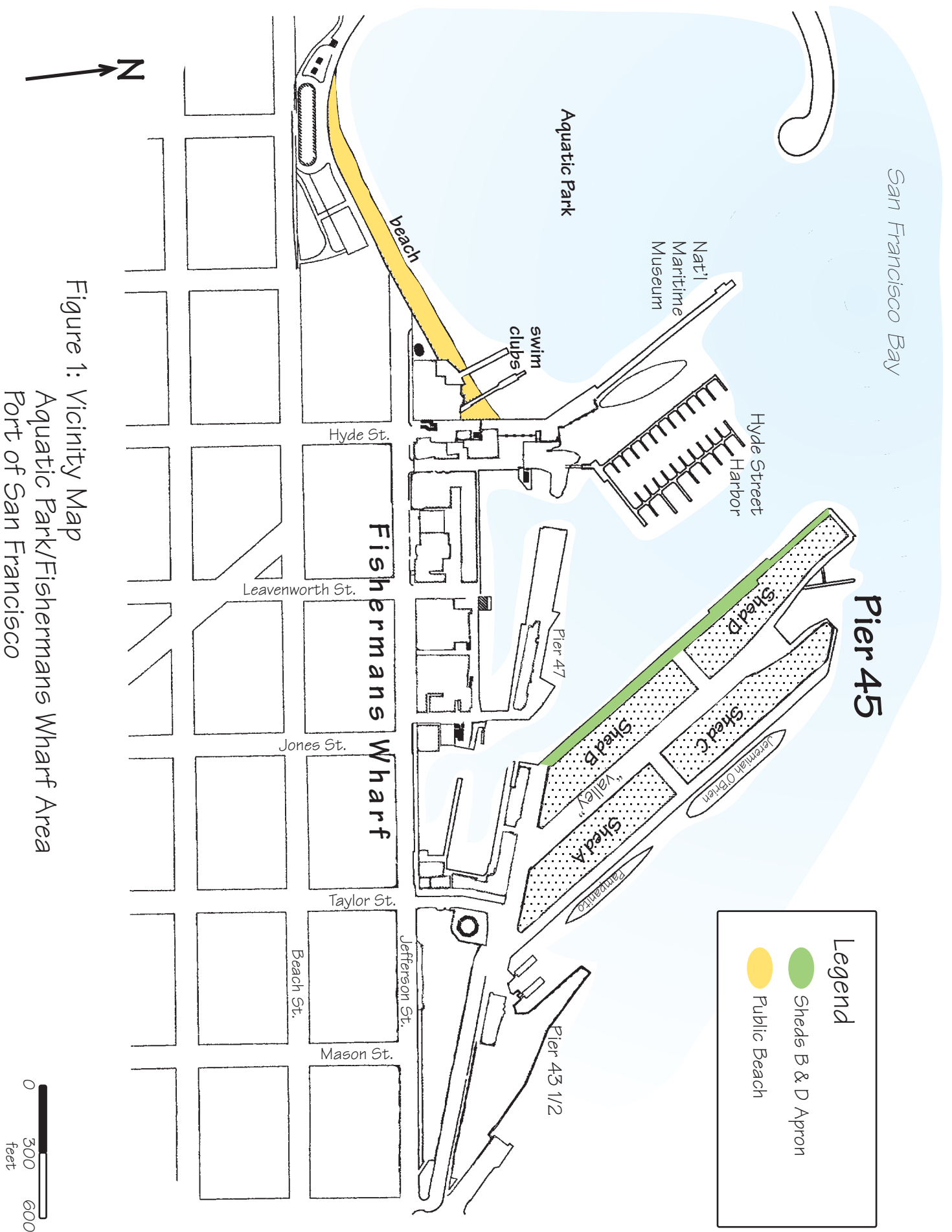


Figure 1: Vicinity Map
 Aquatic Park/Fishermans Wharf Area
 Port of San Francisco

TABLE 1

AMERICAN RECOVERY AND REINVESTMENT ACT OF 2009 (ARRA) INVOICE
 (Reference Instructions on following page - Failure to follow instructions may result in non-payment of invoice)
 THIS OFFICIAL INVOICE FORMAT MAY NOT BE MODIFIED

From: Kim von Blohn, Project Manager
 Port of San Francisco
 Pier 1
 San Francisco, CA 94111
 (415) 274-0256

To: **Barbara August, Program Analyst**
SWRCB/Division of Financial Assistance
1001 I Street, 17th Floor
Sacramento, CA 95814

SRF No.: C-06-6947-110
 SWRCB ARRA Agreement No: 06-303-550
 SWRCB PCA Number: 51610
 Invoice No.: PO6059-05
 Billing Period: 1/1/2011 to 11/30/2011
 Submittal Date: 12/12/2011

| ARRA FUNDS ONLY | | | | | ⑦ If Applicable: Match For This Reporting Period Only |
|----------------------------------|---------------------------------|---|--|--|---|
| Line Items | ④ Financing Agreement Allotment | ④ Previous Expenditures to Date (From previous invoice) | ⑤ Current Expenditures ARRA Funds Only | ⑥ Total Expenditures to Date + ⑤ = ⑥ | ⑧ % of Line Item Budget Spent to Date + Allotment = % |
| Personnel Services | \$0.00 | \$0.00 | \$0.00 | \$0.00 | 0.00% |
| Direct Project Expenses | \$0.00 | \$0.00 | \$0.00 | \$0.00 | 0.00% |
| Equipment | \$0.00 | \$0.00 | \$0.00 | \$0.00 | 0.00% |
| Professional/Consultant Services | \$32,301.00 | \$0.00 | \$32,301.00 | \$32,301.00 | 100.00% |
| Construction | \$1,516,344.00 | \$1,508,645.00 | \$7,699.00 | \$1,516,344.00 | 100.00% |
| Retention Withheld | (\$154,864.50) | (\$114,865.00) | \$114,865.00 | \$0.00 | |
| TOTALS | \$1,548,645.00 | \$1,508,645.00 | \$154,865.00 | \$1,548,645.00 | 100.00% |
| FOR STATE USE ONLY | | ⑨ Total Amount Due This Invoice | | ⑩ 10% Withheld (Retention) | |
| Date Reviewed by PA | | | | 10% of total grant award will be held until final report is submitted, approved, and project is 100% complete. | |
| Date to Accounting | | | | | |

Final Invoice Progress Report Rec'd.

RECIPIENT CERTIFICATION
 I certify that the costs shown in column '5' have been incurred and that these costs have been paid or will be paid within 30 days of receipt of the funds requested hereby. If such costs have not been paid within 30 days, funds received under this request will be returned to the State Water Resources Control Board (SWRCB). I certify that all prior funds received from this financing agreement have been disbursed within 30 days of receipt or have been returned to the SWRCB.
 In addition to the foregoing, where the Local Match Financing Agreements apply, I certify that the appropriate payment has been made with local funds that equate to at least the State match portion.
 I certify that all amounts on this invoice are costs incurred for the Project and represent only costs directly related to the Project, are specific to the Financing Agreement, and are within the approved scope of work. Documentation can be requested at any time for auditing purposes and such costs are justified and directly related to the Project.

Signature of the Authorized Representative: *[Signature]* Date: 12/15/11

STATE USE ONLY: APPROVAL FOR PAYMENT

Project Manager Signature: _____ Title: _____ Date: _____
 Reviewer Signature: _____ Title: _____ Date: _____
 Approval Signature: _____ Title: _____ Date: _____

COMMENTS

APPENDIX I

Monitoring Program for Pier 45 Drainage Improvements / Herring Water Discharge Project

**Prepared by:
Richard Berman
Port of San Francisco**

December 12, 2011

INTRODUCTION

This report provides a review and summary of water quality data in the vicinity of Pier 45 and Aquatic Park in San Francisco. The study data represents one year of sampling and laboratory analyses.

Historic water quality problems have been, in part, attributed to the Pier 45 Fish Processing Facility where several processors have operations on the western side of Pier 45 at Shed B and Shed D. Runoff from this pier apron previously drained directly into the San Francisco Bay and often carried wastes from the fish processing operations. The Pier 45 Drainage Project redirected drainage from this apron to the sanitary sewer, thus eliminating these discharges of fish processing wastes to the bay.

The purpose of the study is to determine whether there have been corresponding improvements in water quality, specifically in Aquatic Park.

PROJECT STUDY - WATER QUALITY DATA

SAMPLING LOCATIONS

One year of post-construction monitoring was conducted at four locations as follows:

- Location 1** - Pier 45 west apron between Shed B and Shed C.
- Location 2** - Hyde Street Harbor at Floating Dock.
- Location 3 (Bay-210)** - Aquatic Park, at end of pier.
- Location 4 (Bay-211)** - Aquatic Park, near shoreline.

HISTORIC COMPARISONS

Locations 3 and 4 correspond well to historic sampling locations Bay-210 and Bay-211, respectively. Comparison of the project data to historic data will refer to this correspondence. In other words, project data from Location 3 will be compared to historic data at Bay-210 and project data from Location 4 will be compared to historic data at Bay-211. Historic data represents sampling events from January 2007 through October 2010.

FIGURE 1: Water Sampling Locations at Pier 45 and Aquatic Park



SAMPLING and ANALYSIS

Samples were collected for one year, beginning in November 2010. Appendix A contains the chain of custody for each sampling event. Samples were analyzed for several pollutants (see Table-1). Beach closings at Aquatic Park are often due to high bacteria counts in the water. This study tested for three bacterial analytes: Total Coliform, E.Coli, and Enterococci. The original monitoring plan for the project cited EPA – 1604 as the bacteriological test method. At the recommendation of the laboratory director and to ensure comparative value with historical data and the ongoing shoreline monitoring program, the bacteriological test method was changed to EPA approved methodology SM 9223 Q-tray.

Dissolved oxygen and Biological Oxygen Demand (BOD-5) are typical indicators of the health of an aquatic ecosystem. Temperature and pH are also standard indicators of the ecosystem.

TABLE – 1 ANALITICAL PARAMETERS

| Analytical Parameter | Frequency | Methodology | PROJECT ACTION LIMIT |
|----------------------|-----------|----------------|--------------------------|
| Total Coliform | Weekly | SM 9223 Q-tray | Median<240/100mL |
| | | | Upper Limit = 10,000 MNP |
| E. Coli | Weekly | SM 9223 Q-tray | 235/100mL |
| Enterococci | Weekly | SM 9223 Q-tray | 104/100mL |
| pH | Weekly | SM 4500H+B | 6.0 – 9.0 |
| Temperature | Weekly | SM 2550B | None |
| Dissolved Oxygen | Weekly | SM 4500-O G | <5.0 mg/L |
| BOD-5 | Monthly | SM 5210B | None |
| | | | |

TOTAL COLIFORM

Total Coliform is one of the primary bacterial analytes. It is an indicator of a “group of closely related, mostly harmless bacteria that live in soil and water as well as the gut of animals. The extent to which Total Coliforms are present in the source water can indicate the general quality of that water and the likelihood that the water is fecally contaminated.” (Drinking Water Pathogens and Their Indicators: A Reference Resource, US EPA, October 27, 2011).

Table 2 provides the summary data on Total Coliform. The standard unit of measure is the most probable number (MPN)/100mL. 48 samples were taken from each of the four locations in the study. The San Francisco Basin Plan (Basin Plan) for the San Francisco Regional Water Quality Control Board lists two water quality objectives that are included as Project action limits for total Coliform:

- 1) A median of 240 MPN/100 mL of water
- 2) An upper limit of 10,000 MPN/100mL in any one sample.

Values above these limits indicate unacceptable water quality due to concentrations of Total Coliforms.

The median of samples from Location 1 was **466** MPN/100 mL, which exceeded the action limit of 240 MPN/100mL. (NOTE: **Numbers in red** indicate values that exceeded the Project action limit or Basin Plan water quality objective). The median from Location 4 was **251**, which also exceeded the action limit, but by a smaller amount. The medians at Location 2 and Location 3 as well as the upper limits at Locations 1-4 were below the action levels. The number of individual samples that exceeded the median action limit is listed in the column ‘Individual

Exceedances’. The column ‘Below Detection’ shows the number of samples that were below the detection limit of the laboratory. For purposes of calculating averages, these are treated as zeroes.

Comparison of the project data to historic data suggests there has been an improvement in the water quality at Aquatic Park. Location 3 corresponds to the historic sampling location, Bay-210. The median for Location 3 (139) is only slightly lower than the historic median at Bay-210 (142), but the upper limit at Location 3 (880) is well below the historic upper limit at Bay-210 (2,481). A similar pattern can be found between Location 4 and Bay-211. The median exceeds the action limit (240) in both the project data at Location 4 (251) and historic data at Bay-211 (374) but the project median was lower than historic median at this sampling location. A notable improvement appears when comparing the upper limit. The upper limit of the project data (1,989 MPN/100mL) was well below the action limit of 10,000 MPN/100mL. The historic upper limit (17,329 MPN /100mL) is well above the action limit.

Overall, the data indicate an improvement in concentrations of Total Coliforms that might, in part, be explained by the Pier 45 Drainage project. If waste from the fish processing operations were the only source of Total Coliforms, then it would be reasonable to expect decrease in this concentration with distance from Pier 45. The concentrations at Location 4 / Bay-211 are anomalous to such a conclusion.

TABLE – 2 TOTAL COLIFORM

| UNITS | MPN/100mL | | n | INDIVIDUAL EXCEEDANCES | | BELOW DETECTION | |
|---------------------|---------------------------|---------------|-----|------------------------|----|-----------------|----|
| | Median | Upper Limit | | Count | % | Count | % |
| Location 1 | 466 | 6,131 | 48 | 18 | 38 | 3 | 6 |
| Location 2 | 227 | 3,654 | 48 | 7 | 15 | 1 | 2 |
| Location 3 | 139 | 880 | 48 | 10 | 21 | 4 | 8 |
| Location 4 | 251 | 1,989 | 48 | 16 | 33 | 1 | 2 |
| | | | | | | | |
| Bay 210 | 142 | 2,481 | 219 | 37 | 17 | 30 | 11 |
| Bay 211 | 374 | 17,329 | 235 | 77 | 33 | 13 | 4 |
| ACTION LIMIT | <240/ 100mL | 10,000 | | | | | |

E. COLI

E. Coli is one of the primary bacterial analytes. Escherichia coli (E. coli) are members of a large group of bacterial germs that inhabit the intestinal tract of humans and other warm-blooded animals (mammals, birds). They are a primary indicator fecal coliform contamination in water.

Table 3 provides the summary data for E. Coli. 48 samples were taken from each of the four locations in the study. The Basin Plan lists the following water quality objective that is included as a Project action limit for E.Coli:

- 1) Any value above of 235 MPN/100 mL of water

Any value above this limit indicates unacceptable water quality due to concentrations of E.Coli.

The median of samples from Locations 1-4 were all below the action limit of 235 MPN/100mL. The highest values at each location exceeded this action limit. The 'Exceedances' column shows the number of individual samples that exceeded the median action limit. The column 'Below Detection' shows the number of samples that were below the detection limit of the laboratory. For purposes of calculating averages, these are treated as zeroes.

Comparison of the project data to historic data suggests an improvement in the concentrations of E.Coli at Aquatic Park. The median for Location 3 (45) is less than the historic median at Bay-210 (61). Similarly, the upper limit at Location 3 (594) is less than the historic upper limit at Bay-210 (1,274). At Location 4 and Bay-211 the medians are below the action limit (137) and (189), respectively. The Upper Limit for the project data at Location 4 is 1,850 compared to (8,164) at Bay-211.

The data for E.Coli suggest a slight improvement in concentrations of E.Coli, although the elevated concentrations at Location 4 / Bay-211 suggest a source of contamination other than Pier 45 fish processing activities.

TABLE – 3 E.COLI

| UNITS | MPN / 100mL | | n | INDIVIDUAL EXCEEDANCES | | BELOW DETECTION | |
|------------|-------------|-------------|-----|------------------------|----|-----------------|----|
| | Median | Upper Value | | Count | % | COUNT | % |
| Location 1 | 176 | 6,131 | 48 | 3 | 6 | 11 | 23 |
| Location 2 | 42 | 464 | 48 | 1 | 2 | 10 | 21 |
| Location 3 | 45 | 594 | 48 | 2 | 4 | 19 | 40 |
| Location 4 | 137 | 1,850 | 48 | 6 | 13 | 10 | 21 |
| Bay 210 | 61 | 1,274 | 273 | 11 | 4 | 92 | 34 |

| | | | | | | | |
|-------------------------|---------------------------|-------|-----|----|----|----|----|
| Bay 211 | 189 | 8,164 | 303 | 57 | 19 | 42 | 14 |
| ACTION LIMIT | <235/ 100mL | -- | | | | | |

ENTEROCOCCI

Enterococci is a routinely included in water quality assessments for bacterial contamination. Table 4 provides the summary data for Enterococci. The standard unit of measure is the Number/100mL. 46 samples were available for Location 1 and 48 samples were for Locations 2-4. The Basin Plan lists the following water quality objective that is included as a Project action limit for Enterococci:

- 1) Any value above of 104 MPN/100 mL of salt water

Any value above this limit indicates unacceptable water quality due to concentrations of Enterococci. Additionally, the Basin Plan also has a water quality objective of a median of 35/100mL for Enterococci. Even though this is not an action limit for the project, it is included for reference.

The median of samples at Location 1 (76) exceeded the water quality objective of < 35/100mL. The medians from Locations 2-4 were all below the action limit. The upper limit for Locations 1 (2,247) and Location 4 (259) exceeded the action limit of 104/100mL for an individual sample.

Comparison of the project data to historic data suggests improvement in the concentrations of Enterococci at Aquatic Park. The median for Location 3 (9) is lower than the historic median at Bay-210 (17) and both are below the water quality objective. The upper limit at Location 3 (85) was below the action limit (104) but Bay-210 (1,274) exceeded this limit. The median at Location 4 (25) was below the water quality objective but Bay-211 (80) was above. The Upper Limits for Location 4 (259) Bay-211 (8,164) were both above the action limit, although historic value was much higher. The percent of individual exceedances was smaller than for the historic data. The percent of values below detection was higher than for historic data. Both trends suggest an improvement in the water quality as measured by Enterococci.

Again, the data for Enterococci suggest a slight improvement in water quality at Aquatic Park and the elevated concentrations are still evident at Location 4 / Bay-211, which is the farthest sampling location from the Pier 45 Drainage Project.

TABLE – 4 ENTEROCOCCI

| UNITS | MPN | MPN | | EXCEEDANCES | | BELOW DETECTION | |
|---------------------|-----------------|----------------|-----|-------------|--------|-----------------|----|
| | | | | MEASURE | Median | Upper Value | n |
| Location 1 | 76 | 2,247 | 46 | 4 | 9 | 21 | 46 |
| Location 2 | 10 | 63 | 48 | 0 | 0 | 30 | 63 |
| Location 3 | 9 | 85 | 48 | 0 | 0 | 29 | 60 |
| Location 4 | 25 | 259 | 48 | 3 | 6 | 22 | 46 |
| | | | | | | | |
| Bay 210 | 17 | 1,274 | 273 | 11 | 4 | 92 | 34 |
| Bay 211 | 80 | 8,164 | 303 | 57 | 19 | 42 | 14 |
| ACTION LIMIT | <35/ * 100mL | <104/ 100mL | | | | | |

* The Project action limit for Enterococci is only for a single value at or above 104/100mL. The standard of <35/100mL for the median value is a water quality objective in the Basin Plan, but is not an action limit for this project. It is included for reference only.

DISSOLVED OXYGEN

Dissolved oxygen is an indicator of the ecological health of the aquatic environment. A minimum concentration of 5 mg/L is a common standard but higher concentrations are preferred. Table 5 provides the summary data for Dissolved Oxygen.

Project data strongly suggest that the waters in Aquatic Park have healthy levels of dissolved oxygen. 120 Samples were taken at each of the four project sampling locations. Median concentrations at Locations 1-4 ranged from 9.4 to 9.9 mg/L. The lowest value was 6.3 and there were no samples that had a concentration below the action level of 5.0 mg/L. There is no historic data on dissolved oxygen for comparison.

TABLE – 5 DISSOLVED OXYGEN

| UNITS | mg/L | | n | EXCEEDANCES | |
|---------------------|---------------------|-----------|-----|-------------|----|
| | Average | Low Value | | Count | % |
| Location 1 | 9.4 | 7.9 | 120 | 0 | 0 |
| Location 2 | 9.6 | 6.3 | 120 | 0 | 0 |
| Location 3 | 9.7 | 8.3 | 120 | 0 | 0 |
| Location 4 | 9.9 | 8.9 | 120 | 0 | 0 |
| Bay 210 | -- | -- | -- | -- | -- |
| Bay 211 | -- | -- | -- | -- | -- |
| ACTION LIMIT | <5.0 mg/L | -- | | | |

BIOLOGICAL OXYGEN DEMAND

Biological Oxygen Demand (BOD) is a measure of the dissolved oxygen that is used by microorganisms in a body of water. Aerobic bacterial activity naturally consumes oxygen. Organic pollutants can result in very high levels of aerobic bacterial activity with a high demand for oxygen, resulting in a reduction of dissolved oxygen to levels that can be harmful to fish and other aquatic species. Biological Oxygen Demand is generally a concern at levels of 5.0 mg/L or higher. Table 6 provides the summary data for Biological Oxygen Demand.

BOD results are indicative of a healthy aquatic environment. There were 10 or fewer samples from each of the four sampling locations. Every sample measured less than 5.0 mg/L. There is no historic data on biological oxygen demand for comparison.

TABLE – 6 BIOLOGICAL OXYGEN DEMAND

| UNITS | mg/L | mg/L | |
|---------------------|-----------|------------|----|
| MEASURE | Average | High Value | n |
| Location 1 | <5.0 | <5.0 | 10 |
| Location 2 | <5.0 | <5.0 | 8 |
| Location 3 | <5.0 | <5.0 | 9 |
| Location 4 | <5.0 | <5.0 | 8 |
| Bay 210 | -- | -- | -- |
| Bay 211 | -- | -- | -- |
| ACTION LIMIT | -- | -- | |

TEMPERATURE and pH

Temperature data varies seasonally. Summary results are provided in Table - 7.

TABLE – 7 TEMPERATURE

| UNITS | C ⁰ | C ⁰ | |
|-------------------------|----------------|----------------|-----|
| MEASURE | Low | High | N |
| Location 1 | 10.3 | 19.4 | 120 |
| Location 2 | 9.2 | 19.5 | 120 |
| Location 3 | 9.0 | 17.5 | 120 |
| Location 4 | 9.6 | 18.6 | 120 |
| | | | |
| Bay 210 | 9 | 20 | 129 |
| Bay 211 | 9 | 21 | 151 |
| ACTION LIMIT | -- | -- | |

The acceptable project range for pH is 6.0 to 9.0 and summary results are provided in Table - 8. The project included 127 samples for Locations 1, 2, and 4 and 126 samples for Location 3. The median at each Locations 1-3 was 7.8 and at Location 4 it was 7.9, well within the acceptable range of pH for this water body. All individual sample results were within the acceptable range of 6.0 to 9.0. There is no historical data on pH for comparison.

TABLE – 8 pH

| UNITS | pH | pH | pH | |
|-------------------------|---------|------|------|-----|
| MEASURE | Average | Low | High | N |
| Location 1 | 7.8 | 7.23 | 8.28 | 127 |
| Location 2 | 7.8 | 6.04 | 8.34 | 127 |
| Location 3 | 7.8 | 6.01 | 8.77 | 126 |
| Location 4 | 7.9 | 7.42 | 8.38 | 127 |
| | | | | |
| Bay 210 | -- | -- | | -- |
| Bay 211 | -- | -- | | -- |
| ACTION LIMIT | -- | 6.0 | 9.0 | |

CONCLUSION

The project tested water samples from four locations, two near Pier 45 and two in Aquatic Park. Project samples were collected between November 2010 and November 2011. Bacteriological tests were performed for Total Coliform, E.Coli, and Enterococci. Samples were also tested for Dissolved Oxygen, Biological Oxygen Demand, Temperature and pH.

Location 1, which is the closest to Pier 45 fish processing activities, showed elevated values for Total Coliform and Enterococci. Values for the other water quality parameters were at acceptable levels. Location 2 and Location 3 had no project data that exceeded Project action values or Basin Plan water quality objectives. Location 4, which is the farthest sampling location from Pier 45 showed elevated values for Total Coliform and Enterococci. Values for the other parameters were within acceptable ranges.

Comparisons of Project data with corresponding historic data suggest that the Pier 45 Drainage Project has improved the water quality at Aquatic Park. When Project data and historic data both exceeded the standard, as with Enterococci at Location 4/Bay-211, the historic exceedance (8,164) was much larger than that of the Project (259). Enterococci also showed a lower percentage of exceedances and higher percentage of 'below detection' values than the historic data.

Data from the Project show moderate improvements in bacteriological results when compared to the historic data. Although there was no corresponding historical BOD data, the Project results suggest that the Pier 45 Drainage Project is maintaining healthy levels of aerobic bacterial activity.

APPENDICES

- APPENDIX A – Chain of Custody Records
- APPENDIX B – Project Data
- APPENDIX C – Historic Data