US Army Corps of Engineers®

Appendix F

Civil Design

South Pacific Division, Continuing Authorities Program
San Francisco District

Continuing Authorities Program (CAP), Section 103

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1 INTRODUCTION

This appendix documents the civil design for improving flood risk management (FRM) along San Bruno and Colma Creek in South San Francisco, CA. The purpose of the Lower Colma Creek Flood Risk Management Feasibility Study is to reduce flood damages to the wastewater treatment plant, City of South San Francisco and infrastructure due to fluvial flooding and sea lever rise in Lower Colma Creek. The study area includes the reach of the wastewater treatment plant and nearby Pump Station #4. This appendix summarizes the design and site considerations required for construction of project features, floodwalls, staging areas, real estate requirements, relocations and quantities developed for the alternatives analyzed for the Lower Colma Creek Flood Risk Management Feasibility Study. Design consideration information includes floodwalls and floodgates guidance, EM-1110-2-2000 Standard Practice for Concrete for Civil Works Structures and ER 1110-2-1150 Engineering and Design for Civil Works Projects.

1.1 PROJECT LOCATION AND BACKGROUND

San Bruno Creek also starts in San Bruno Mountain, and it flows to San Francisco Bay through a tide gate structure roughly 1,400 feet south of where Colma Creek meets San Francisco Bay (Figure 2). San Bruno Creek drains an area of roughly 4.5 square miles, collecting runoff from the City of San Bruno.

The lower reaches of Colma and San Bruno Creeks are heavily tidally influenced. During King or extreme tides on San Francisco Bay, drainage of the creeks is impeded, causing water levels to back up in the channels, potentially leading to overtopping the banks. With sea level change (SLC) increasing San Francisco Bay water levels, it is likely that San Bruno and Colma Creeks will more frequently overflow their banks and inundate surrounding areas due to more frequent high-water events on the Bay.

Flooding along the lower reaches of the Colma Creek and San Bruno Creek Project Area threatens the critical wastewater treatment plant and residential areas in South San Francisco and nearby San Bruno. 165,000 full time residents and the daily population of San Francisco International Airport rely on the plant. There have been no improvements to reduce flood risk in the area surrounding the plant. Flood risk is expected to increase over time due to the location in a low-lying area. Coastal storm risk flood events could cause disrupted wastewater treatment services and release of untreated raw sewage into the Bay. These events are likely to increase with a changing climate. Unpermitted discharges and mixing of contaminated water during flooding events could result in environmental degradation in the nearby sensitive habitat.

Project purpose: The purpose of this feasibility study in this project area is to explore flood risk management (FRM) measures to reduce present and future flood risk associated with sea-level change along San Bruno and Colma Creeks. The City will consider structural FRM measures that include (but are not limited to) traditional levees, seawalls, floodwalls, horizontal levees, and wetlands restoration. The feasibility study will also explore nonstructural FRM Measures, including elevation, flood proofing, and acquisition and relocation of critical infrastructure, land use planning policies, enhanced crisis management efforts, and flood insurance. In the development and selection of alternatives, the feasibility study will evaluate the potential for integrating natural and nature-based FRM measures to reduce flood risk and preserve or enhance environmental quality.

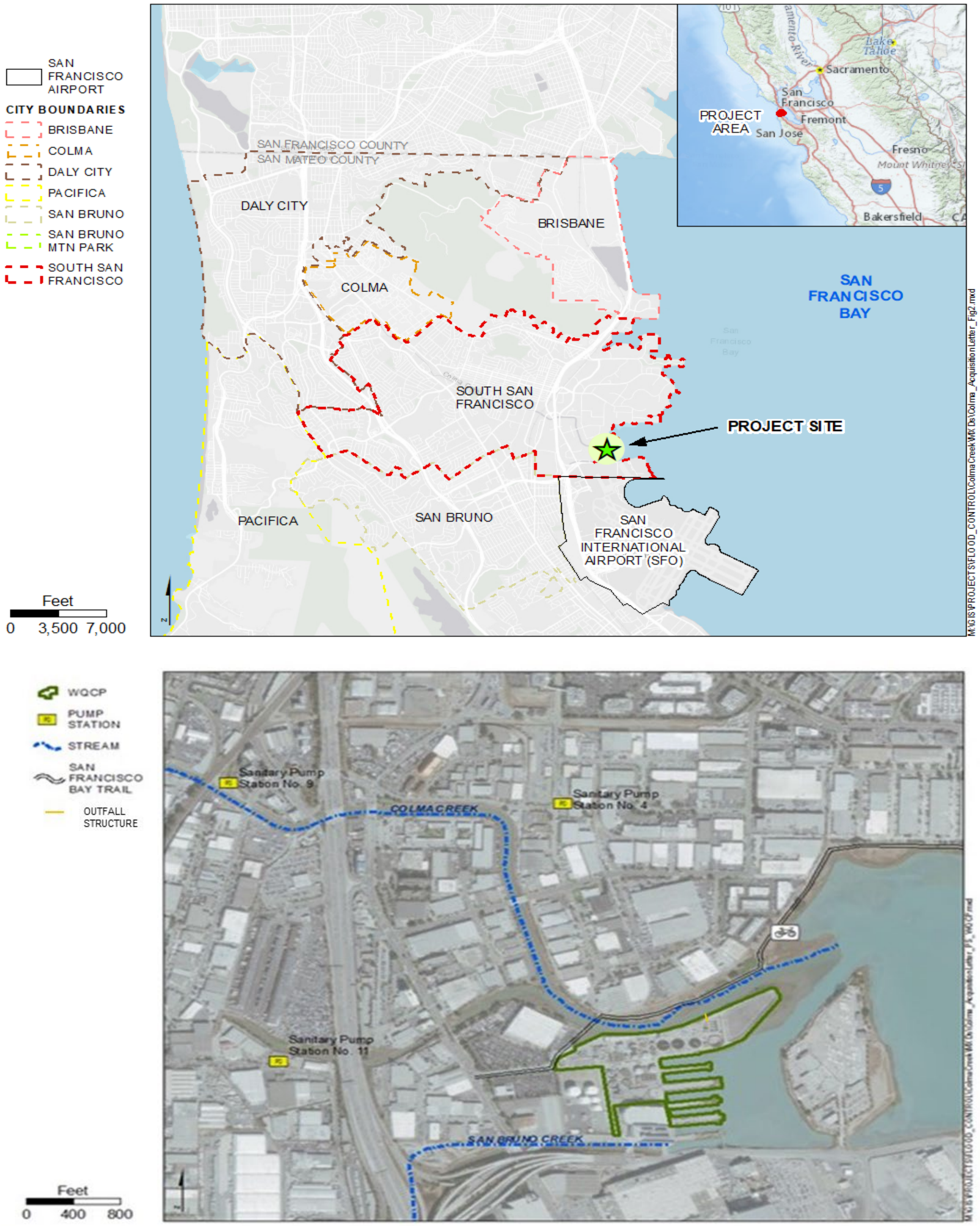


Figure 1-1. Study Area

1.2 PROJECT LIMIT AND COORDINATION

The project limit covers the footprint of the South San Francisco Water Quality Control Plant (WQCP) and Pump Station #4 (see Fig 1.1). The project delivery team (PDT) consisted of USACE San Francisco. Non-USACE team members include the City of South San Francisco and City of San Bruno.

2 GENERAL CONSIDERATIONS

2.1 TOPOGRAPHIC DATA

In the feasibility study of the project, the topographic data was obtained by extracting contour lines and a digital elevation model from Google Earth. Google appears to use a range of digital elevation model data sources to derive the terrain layer. The Digital Elevation Models were from the USGS National Elevation Dataset (NED). The detailed topographic survey will be performed in the PED phase. The elevations recorded will be in feet and referenced to the North American Vertical Datum of 1988 (NAVD88) and the horizontal datum is referenced to the North American Datum of 1983 (NAD83), and California State Plane Coordinate Zone III.

2.2 CLEARING, GRUBBING, AND STRIPPING

All areas, 4 feet wide along the floodwall alignment to either be excavated or native soil areas to be prepared to receive fill will be stripped of topsoil. This included the levee slopes. Other areas will be cleared and grubbed, including bush/shrub removal along the existing rock slopes. Stripping consists of the removal of weeds, grasses, and other vegetative materials, and the removal of surface soils. Wetlands will be avoided.

2.3 SHEETPILE WALLS AND CONCRETE FLOODWALLS

The proposed sheetpile walls along the wastewater treatment plant will include a concrete reinforced cap on top of sheetpile. According to the Geo-tech analysis, the walls are constructed by driving approximately 13' of prefabricated sections below the grades and extend approximately 3'to 4' above the grades, which depends on the ground elevations and embedded approximately 12" in the 2'x2' concrete cap. Depending on the soil conditions, the sections may be vibrated into ground instead of it being hammer driven. The full sheetpile wall is formed by connecting the joints of adjacent sheet pile sections in sequential installation.

The work of the concrete floodwalls at Pump Station #4 includes installation the wall foundation 2' below the grades and 2' of the wall above the grades.

Foundations and detailed information on sheetpile floodwall and ring concrete floodwall can be found in the Geo-tech appendix.

Figure 2-1. Sheetpile Floodwall

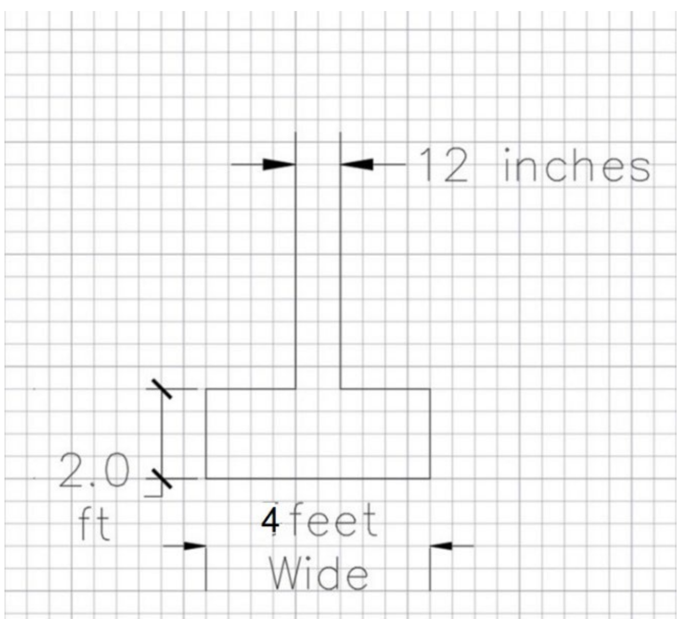


Figure 2-2. Ring concrete floodwall at Pump Station #4

2.4 ALIGNMENT AND STATIONING

The stations will be set at 100-foot intervals along the centerline of the floodwall following standardized notation norms and procedures.

2.5 UTILITIES

Unnecessary utility relocations are avoided. Accurate utility information is available to the designers early enough in the development of a project to design around many potential conflicts. The existing drain pipes penetrate the new floodwall. Concrete grout is applied outside drain pipe along the circular hole of the floodwall serving as a "Ring gasket" to seal and clamp the pipe to the floodwall. The existing outfall pipes for the wastewater treatment plant and the site to drain remain functional regardless of the new floodwall in place.

However, there are several known utilities in the wastewater treatment plant that cross or are in close proximity to the floodwall alignment that may need to be modified during the north and south floodwall construction (See Plate 2).

Table 2-1. Utilities potentially affected by the floodwalls

Item	Known Utility	Location	Owner
1	48"-D Storm Drain outfall	North wall, N1A	City of S. San Francisco
2	30"-D Storm Drain culvert	North wall, N1A	City of S. San Francisco
3	High voltage Cable	South wall, 2S	City of S. San Francisco
4	Abandoned Jet Fuel Line	South wall, 2S	Shell Oil

2.6 KNOWN LOWER COLMA CREEK FLOOD EVENTS

Periodic flooding occurs in South San Francisco but is generally confined to certain areas along Colma Creek north of the project site. The water levels in Colma Creek are highly influenced by both tidal action and storm events. The project site is located within a 1% annual exceedance probability (AEP) floodplain, colloquially referred to as the 100-year floodplain, designated by the Federal Emergency Management Agency (FEMA; 2012). The FEMA maps reviewed in a recent flood study (Carollo Engineers, 2010) indicate that the 1% AEP event occurring at high tide would raise water levels to 9.7 feet above mean sea level. The Maintenance Building at the project site lies at an elevation of approximately 12.82 feet (Carollo Engineers, 2010). While the water level is not regularly monitored in the stretch of the creek bordering the project site, near-flooding conditions have been observed outside the Maintenance Building (Carollo Engineers, 2010). As recently as October 13, 2009, the water level was measured to be 1.6 feet above the 1% AEP flood level (11.3 feet above mean sea level), which is approximately 1.5 feet below the Maintenance Building's foundation elevation. The project site is not substantially higher than potential flooding events.

2.7 CONSTRUCTION ACCESS – HAUL ROUTES, ACCESS RAMPS AND STAGING AREAS

The PDT has identified a staging area and access haul route (See Figure 3.2) throughout the project that are strategically positioned.

2.8 REAL ESTATE REQUIREMENTS

The Non-Federal Sponsor is responsible for the procurement of all lands, easements, relocations, rights-of-way, and disposal areas (LERRD) necessary for the construction, operation, and maintenance of the project.

Temporary construction easements and staging / stockpiling areas will also be required for this project. Materials to be disposed of will be hauled to a landfill or other areas to be identified during the design phase of the project.

Maps and detailed information on easements and affected properties can be found in the Real Estate appendix.

2.9 OPERATION AND MAINTENANCE

The Inspection of Completed Works (ICW) program is an O&M program that provides for USACE inspections of federally constructed flood risk management projects. A draft O&M manual will be developed preceding a project's final design state and used by the counties and the USACE to ensure that the project is maintained to USACE standards. Annual and periodic 5-year ICW inspections will be performed for the Lower Colma Creek Project which will be based on the O&M manual requirements and current USACE maintenance standards. The O&M manual will provide a detailed description of the management activities for the floodwall, channel, vegetation, sediment, debris, bank erosion, concrete surfaces, and other activities to provide the design flood conveyance of the TSP.

3 PROJECT DESIGN ALTERNATIVES AND SELECTED PLAN

3.1 FINAL ARRAY OF ALTERNATIVES

A wide range of features were considered and evaluated to reduce flood risk in the project area. The two structural alternatives, Alternative 1 and Alternative 2, differ in the level of protection and cost. Below is the final array of alternatives that were analyzed.

Alternative Plan 1: The north wall in Alternative 1 increases the minimum elevation to flood from 10.5 ft on the north side to 11.74 ft on the south side. This offers protection from any event that results in an extreme tide elevation of 11.74 ft or less. 1% AEP flood risk reduction with floodwall installation consisting of approximately 1,996 feet of the sheetpile wall with reinforced concrete cap along the north perimeter of the wastewater treatment plant plus ring floodwall at pump station 4, with flood warning system.

LOWER COLMA CREEK ALT - FLOODWALL 1A & B (N)

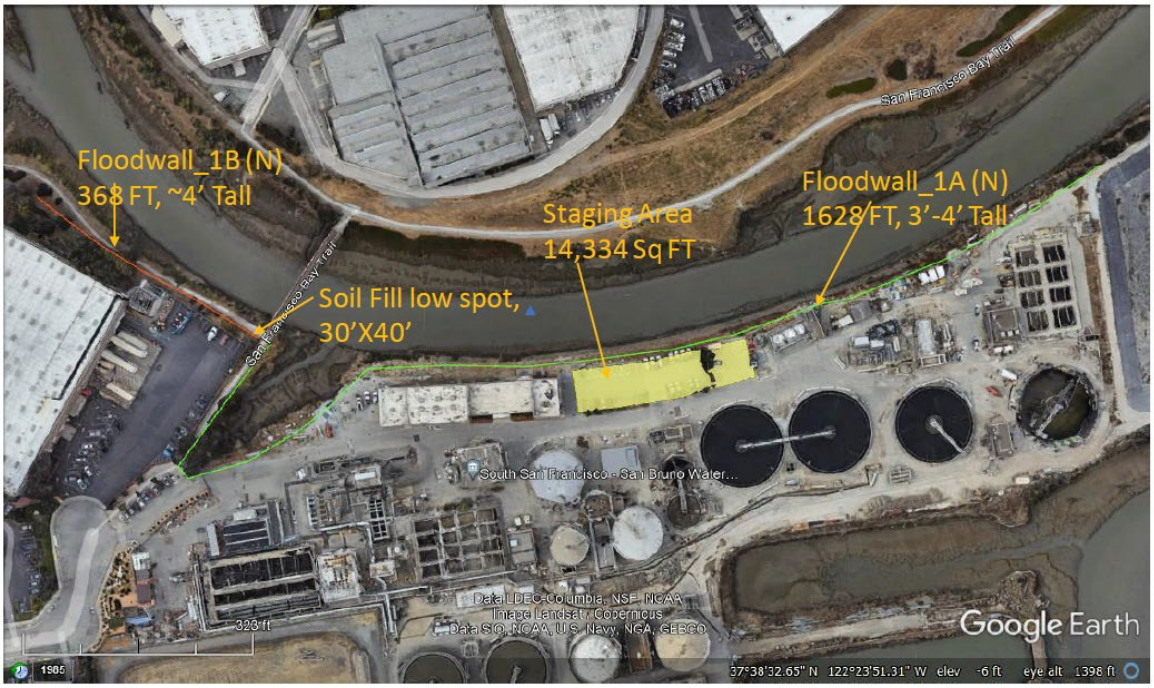


Figure 3-1. Alternative Plan 1

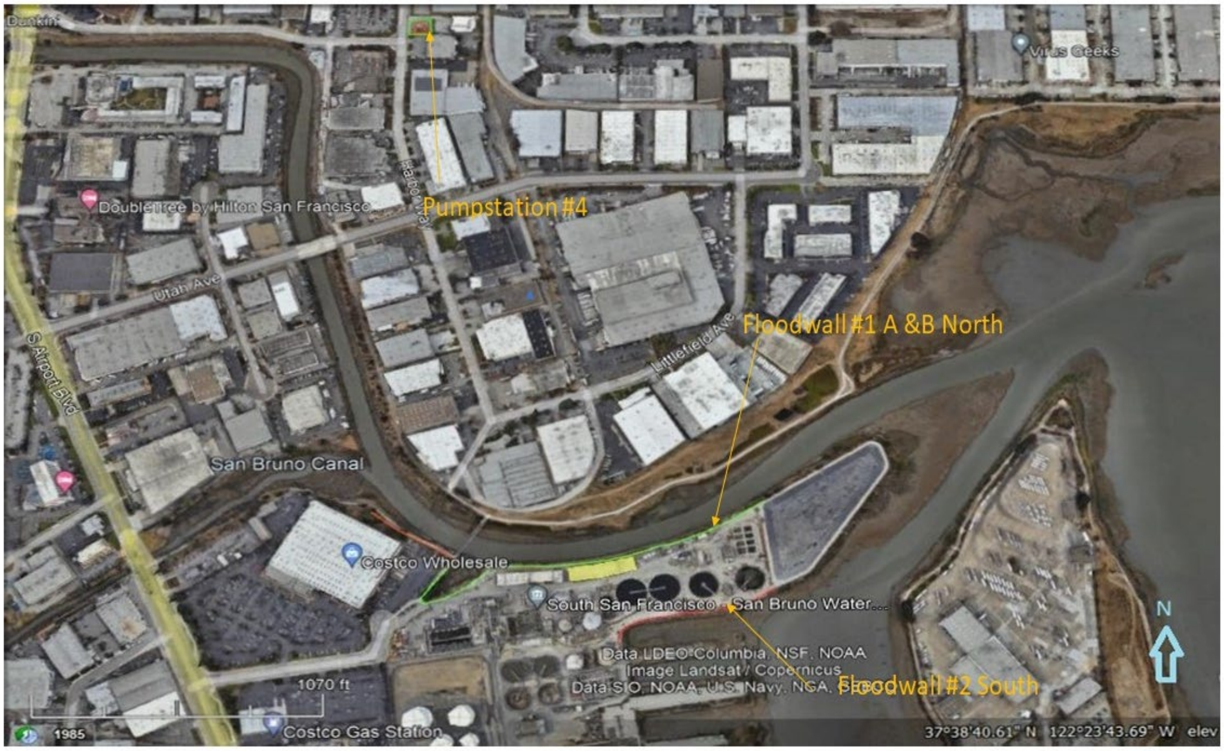
Alternative Plan 2: The north plus the south floodwall in Alternative 2 that increases the minimum elevation to flood from 11.74 ft on the south side to 13 ft on the west side due to overland flooding. Protection up to 13 ft covers most scenarios. 0.2% AEP flood risk protection with floodwall installation consisting of approximately 2,660 feet of the sheetpile wall with reinforced concrete cap along the north and south perimeter of the wastewater treatment plant plus ring floodwall at pump station 4, with flood warning system.

Alternative Plan 3 (Nonstructural only): Floodproofing 23 buildings at the main WQCP and ring floodwall at pump station 4, with flood warning system, plus raising critical access in place, and providing elevated emergency exits for plant operator.

3.2 TENTATIVELY SELECTED PLAN

The Tentatively Selected Plan (TSP) milestone was held in March 2022, where it was determined that Alternative 2 was the TSP. Alternative 2 is the NED Plan with the highest net NED benefits and was found to have a higher benefit to cost ratio than Alternative 1. However, both alternatives were found to have positive benefit to cost ratios. Alternative 2 is also the comprehensive benefit plan that maximizes comprehensive benefits. After incorporating feedback from the comment period on the Draft Report, Alternative 2 was confirmed as the agency preferred plan.

LOWER COLMA CREEK TSP – LOCATION MAP FOR NORTH FLOODWALL, SOUTH FLOODWALL, AND PUMPSTATION #4



LOWER COLMA CREEK TSP - FLOODWALLS 1A, 1B (N) & 2(S)

LOWER COLMA CREEK TSP – FLOODWALL AT PUMPSTATION #4

Figure 3-2. Tentatively Selected Plan (Alternative 2)

3.3 CIVIL QUANTITY ESTIMATES

Earthwork construction quantity estimates for excavation, stockpiling and backfill were calculated utilizing the average end area method, which were based on the topographic information of Google Earth by extracting contour lines and a digital elevation model. (see paragraph 2.1 Topographic Data). Additional construction quantity estimates included reinforcing steel rebar tonnage for floodwall construction, utility modifications and slope protection concrete caps, traffic control, and construction fencing.

Cross sections were used in determining quantities of cut and fill in the construction design. The original ground cross sections were plotted and compared to the as constructed cross sections, the volume was computed. Swell is usually in the 15% to 20% range, whereas shrinkage is in the 10% to 15% range, were considered.

Table 3.1: Estimated Quantities of Floodwall Construction

	Task	**Estimated Quantity**	**Unit of Measure**
1	MOBILIZATION AND DEMOBILIZATION	1	Job
2	STORM WATER POLLUTION PREVENTION PLAN	1	Job
3	PRE-AND-POST CONSTRUCTION SURVEY	1	Job
4	CLEARING AND GRUBBING	1	Job
5	CONTROL OF WATER	1	Job
6	TRAFFIC CONTROL	1	Job
7	CONSTRUCTION TRAILER	1	EA
8	CONCRETE REMOVAL & SITE DEMOLITION	1	Job
9	TRENCH EXCAVATION	121	CY
10	SAWCUTTING	650	LF
11	CONCRETE T-WALL AT PUMPSTATION 4	115	CY
12	FLOODGATE & STOPLOGS	30	LF
13	CONCRETE FORMING AT PUMPSTATION 4	325	LF
14	#4 REBAR FOR PUMPSTION 4	4,343	LB
15	6' TALL CHAIN LINK FENCE AND STREET-END-BARRICADE	1	Job
16	6' TALL TEMPORARY CONSTRUCTION FENCE AND RAIL	400	LF
17	SHEETPILE WALL (S)	9,960	SF
18	CONCRETE CAP (S)	222	CY
19	#4 REBAR FOR SOUTH WALL	7,097	LB
20	CONCRETE FORMING (S)	7,968	SF
21	SHEETPILE WALL (N)	29,925	SF
22	CONCRETE CAP (N)	665	CY
23	#4 REBAR FOR NORTH WALL	21,323	LB
24	CONCRETE FORMING (N)	23,940	SF
25	Utility Modification	1	Job

3.4 CONSTRUCTION DURATION ESTIMATES

The estimated duration of the construction for the floodwall and utility modification is 12 months. The daily production rate of the sheetpile wall construction is approximately 30 feet. The following assumptions should be considered as far as the construction schedules are concerned.

- Construction activities must be schedules according to project phase narrative.
- Single crews will be mobilized for each independent activity.
- Utility construction in plans set is not included in these rates.
- Weather delays are not accounted for in these rates.

Sheetpile installation will occur from land therefore an in-water work window is not proposed. However, if work in the creek is needed, construction would be limited to 6 months in a year due to environmental restrictions. Therefore, it is expected that the construction would occur during two construction seasons.

3.5 CONSTRUCTION EQUIPMENT AND SEQUENCE

The construction equipment will include, but not limited to, concrete saw cutter, front-end loader with 2 CY bucket, 10 CY dump truck, hydraulic excavator with 1.5 CY bucket, sheepsfoot soil compactor, 3,000-gallon water tank and hydraulic hammers.

The proposed construction sequence is as follows:

1. A loader will remove vegetation and rock from the top of the bank and will stockpile materials in the staging area or load directly into a dump truck. Start work at South floodwall 2, begin removing vegetation from the 4’ wide work zone alone the alignment and use hydraulic hammers drive sheet piles to its final elevations.
2. Move the same equipment to Floodwall 1 N and Floodwall 2-N; repeat the same process as Item 1. The hydraulic excavator excavates the trench to gain an access at Floodwall 1-N for manually seal the intersection of the floodwall and storm drainpipe.
3. Install a cast-in-place reinforced concrete bulkhead cap to structurally tie the tops of the sheet piles together and to provide corrosion protection for the reinforcing and prestressing steel that extend from the tops of the piles.
4. At the low spots near the bridge location, excavate slope toe and prep soil sub-base prior to placing imported clay. Import clay from staging area to the site. Dump truck will unload clay at the top of bank and the loader will move clay into the low spots adjacent to the bridge. Final placement of the clay will be placed by the excavator. The remaining slope above the levee will be compacted using compaction equipment or a dozer is the slope isn’t very steep.
5. Hydroseed slope.
    - This activity might be done last when all construction is nearly complete.
    - Additional measures could be needed if the final slope is steep. May need to use an erosion control netting/blanket. Wire netting could be used if the slope is steeper than or equal to 1.5H:1V slope.

6. Move excavator and loader over to Pump Station #4. Excavator will start construction from the top and will remove sawcut concrete slab and excess soil along the alignment. A loader will remove concrete out of the sawcut areas. Dump trucks will remove concrete/excess soil to the staging area or to the landfill.
7. Construct the concrete formwork of the T walls, setting rebar and pour concrete.

3.6 TRAFFIC CONTROL

The Belle Air Rd Lane right next to the Costco Gas station is expected to need traffic control when the construction equipment goes in and out of the plant through the access roads. During the floodwall construction, a concrete truck is expected to be parked on the Belle Air Rd Lane or Costco parking lot right next to the creek while concrete is pumped to the creek.

3.7 ACRONYMS AND ABBREVIATIONS

AEP - Annual Exceedance Probability

CFS – Cubic Feet per Second

CY – Cubic Yard

DEM - Digital Elevation Model

FRM – Flood Risk Management

ICW – Inspection of Completed Works

LF – Linear Feet

LB - Pound

LERRD – Lands, Easements, Relocations, Rights-of-way, and Disposal Area

NAD – North American Datum

NAVD – North American Vertical Datum

O&M – Operation and Maintenance

PDT – Project Delivery Team

PED – Preconstruction Engineering and Design

NED – National Economic Development

RW – Retaining Wall

SF – Square Feet

STA – Station

TSP – Tentatively Selected Plan

USACE – U.S. Army Corps of Engineers

WQCP – Water Quality Control Plant

3.8 REFERENCES

- Lower Colma creek H&C engineering appendix, Detail project report, March 2022
- Staff Summary sheet – Lower Colma CAP 103 RP Execution sheet
- ER 1105-2-101_Risk Assessment for Flood Risk Management, July 2019
- EM1112-2-2503 Design of Sheet pile retaining Structures, June 1990
- EM 1110-2-2902 Conduits, Pipes and Culverts associated with Levee, Dec 2020

PLATE 1

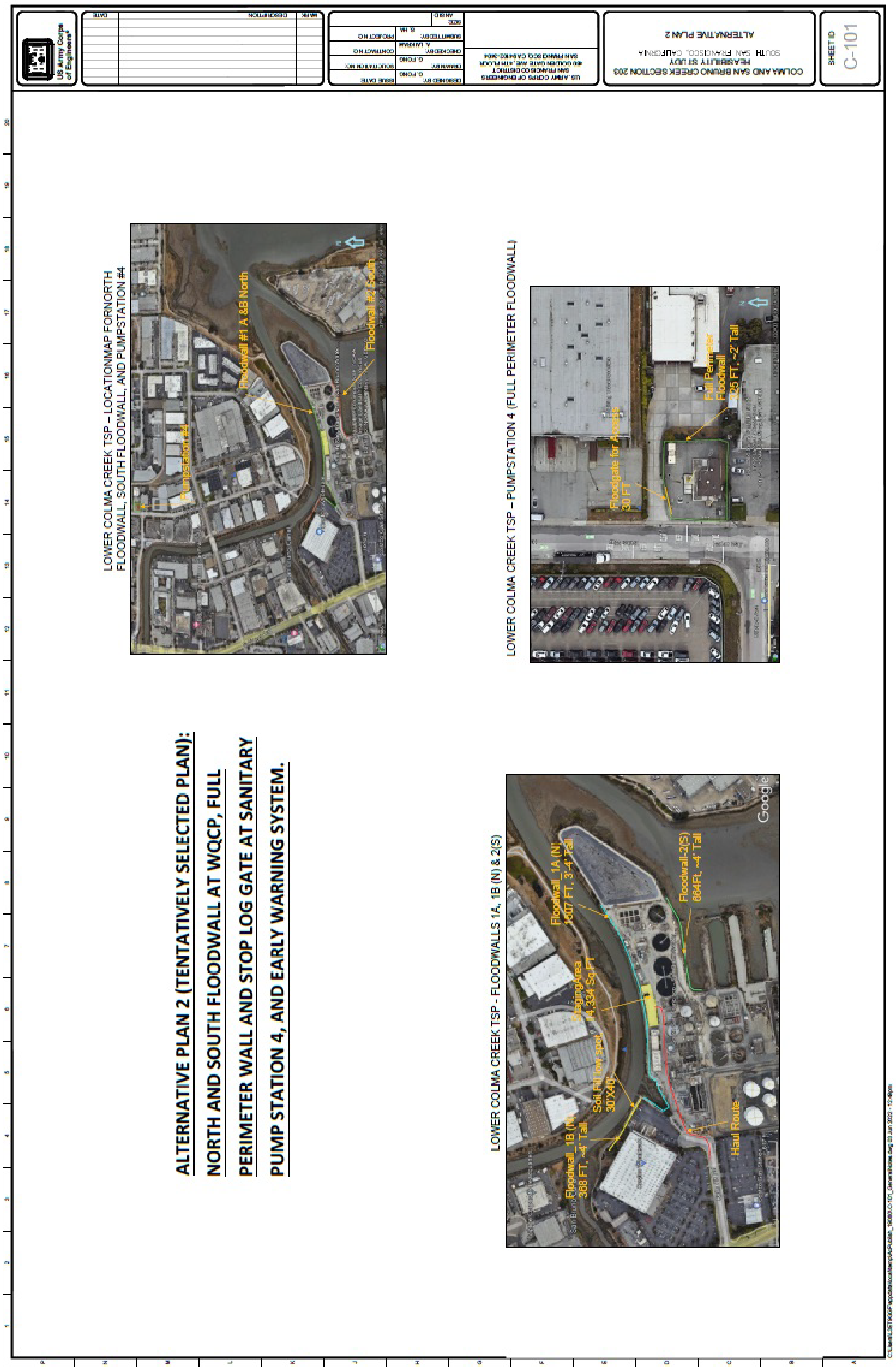

ALTERNATIVE PLAN 2 (TENTATIVELY SELECTED PLAN):
NORTH AND SOUTH FLOODWALL AT WQCP, FULL
PERIMETER WALL AND STOP LOG GATE AT SANITARY
PUMP STATION 4, AND EARLY WARNING SYSTEM.
LOWER COLMA CREEK TSP – LOCATIONMAP FORNORTH
FLOODWALL, SOUTH FLOODWALL, AND PUMPSTATION #4
Floodwall #1 A &B North
Floodwall #2 South
Pumpstation #4
LOWER COLMA CREEK TSP – PUMPSTATION 4 (FULL PERIMETER FLOODWALL)
Floodgate for Access
30 FT
Full Perimeter
Floodwall
325 FT, ~2' Tall
LOWER COLMA CREEK TSP - FLOODWALLS 1A, 1B (N) & 2(S)
Floodwall_1A (N)
1307 FT, 3'-4' Tall
Floodwall-2(S)
664Ft, ~4' Tall
Staging Area
Soil Fill low spot
30'X40'
Floodwall_1B (N)
388 FT, ~4' Tall
Haul Route
Google
COLMA AND SAN BRUNO CREEK SECTION 203
FEASIBILITY STUDY
SOUTH SAN FRANCISCO, CALIFORNIA
ALTERNATIVE PLAN 2
SHEET ID
C-101
US Army Corps
of Engineers

PLATE 2

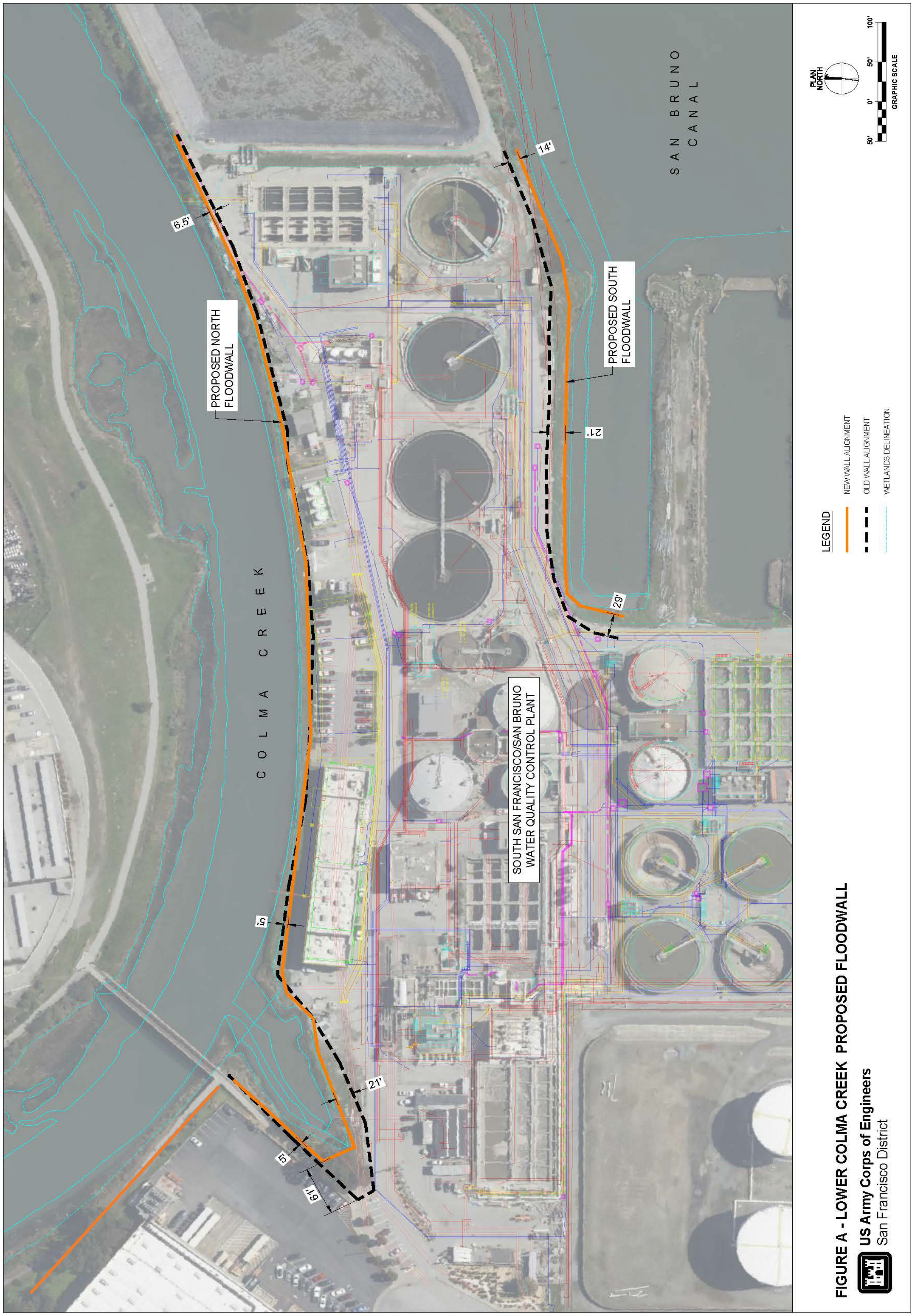


FIGURE A - LOWER COLMA CREEK PROPOSED FLOODWALL
US Army Corps of Engineers
San Francisco District
LEGEND
NEW WALL ALIGNMENT
OLD WALL ALIGNMENT
WETLANDS DELINEATION
PLAN NORTH
GRAPHIC SCALE
50'
0'
50'
100'
SAN BRUNO CANAL
COLMA CREEK
PROPOSED NORTH FLOODWALL
PROPOSED SOUTH FLOODWALL
SOUTH SAN FRANCISCO/SAN BRUNO WATER QUALITY CONTROL PLANT
6.5'
14'
21'
29'
5'
21'
5'
61'