San Francisco Bay Conservation and Development Commission
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September 12, 2024

TO: Engineering Criteria Review Board (ECRB) Members

FROM: Lawrence J. Goldzband, Executive Director (415/352-3653; larry.goldzband@bcdc.ca.gov)
Jenn Hyman, Senior Engineer (415/352-3670; jennifer.hyman@bcdc.ca.gov)
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SUBJECT: San Francisco International Airport – Shoreline Protection Project
San Mateo County – Second ECRB Meeting (BCDC Pre-Application)
(For Board consideration on September 25, 2024)

Project Name

SFO Shoreline Protection Program (San Francisco Bay Conservation and Development Commission (BCDC) Pre- Application)

Project Representatives

Applicant Representative
David Kim, PhD, Senior Environmental Planner, SFO

Project Design Team
ESA - Coastal Engineering
Terra Engineers Inc. - Geotechnical Consultants
COWI- Structural Consultants
Geosyntec – Geotechnical Consultants

Project Components Under Review

The safety of the following components of the SFO Shoreline Protection Program (project) are under review by the Engineering Criteria Review Board (ECRB):

- Steel sheet pile sea wall with outboard rock armoring of Class 4 riprap in Reaches 2-14.
- One area of sheet pile wall in an area of new Bay fill has geotechnical treatments including temporary earth surcharging, dredging soft Bay mud to reach depth of approximately 20 feet below MSL, and new wick drains (Reaches 7 and 8).
- Poured in place reinforced concrete sea wall with outboard rock armoring of Class 4

riprap in Reach 1 (Reach 15 is not included as it appears to not be located on Bay fill).

- Openings in the walls for roads with gates that would automatically rise up (or in one case be manually deployed) when flooding is predicted.
- Modifications to storm drain outfalls including rerouting of some storm drain pump station outfalls up and over the new sea walls with associated rock energy dissipators. Some storm drain outfalls will go through the new walls.
- Approximately 26 acres of fill in open Bay waters.

Purpose of this Meeting/Summary of First Meeting

The purpose of the meeting is to request the review and advice of the ECRB about the safety aspects of the sea wall design that could affect the public through impacts to the San Francisco Airport, a critical public facility. BCDC requests the assessment of the adequacy of the engineering criteria of the new sea wall (the project) which is the main focus of this review.

The authority to review and revise engineering criteria and any safety provisions is bestowed on the ECRB through the McAteer-Petris Act government section code 66605(e), which requires that all fill must be constructed "in accordance with sound safety standards which will afford reasonable protection to persons and property against the hazards of unstable geologic or soil conditions or of flood or storm waters." Additionally, the Bay Plan policies, especially policies Nos. 1 and 2 on the Safety of Fills, provide additional authority.

The ECRB first met on September 27, 2023 to review the safety aspects of the project. In that meeting, as summarized in the meeting comment letter attached dated November 2, 2023, the ECRB asked the applicant to return for another meeting to address a number of topics including derivation of design parameters, updated wall stability analysis, modeling an earthquake with a flood, corrosion, and wall design. BCDC staff sent an additional letter to the applicant asking for the following information to be addressed at the next ECRB meeting: possible increased flood risks from deep wall construction, land subsidence, wave reflection, and required Federal Emergency Management Administration (FEMA) reports (on the interior drainage system, riverine flooding, and operation and maintenance (O&M) plans for the stormwater system and wall system). Staff also asked SFO to discuss any existing seismographs on the property for the California seismic monitoring program or where a new monitoring station could be set up in anticipation of ECRB consideration of this issue.

One request from the ECRB in the first meeting was for the applicant to provide the results of a planned supplemental geotechnical investigation. SFO requested to be exempted from this request since they decided to have the supplemental investigation performed at a later date by the design-build team, who will not be under contract for some time. BCDC approved this request as there appears to be adequate geotechnical data currently to review the design criteria.

Project Description

SFO has submitted pre-application materials to BCDC for their Shoreline Protection Program. In this project, SFO is proposing to install a new shoreline protection system around the Airport

for flood protection against a 100-year flood and would incorporate protection from 3.5 feet of future sea-level rise, to eliminate the probability of substantial inundation at the Airport through approximately 2085. The shoreline protection system has been divided into 15 reaches, as shown in Figure 1 below.

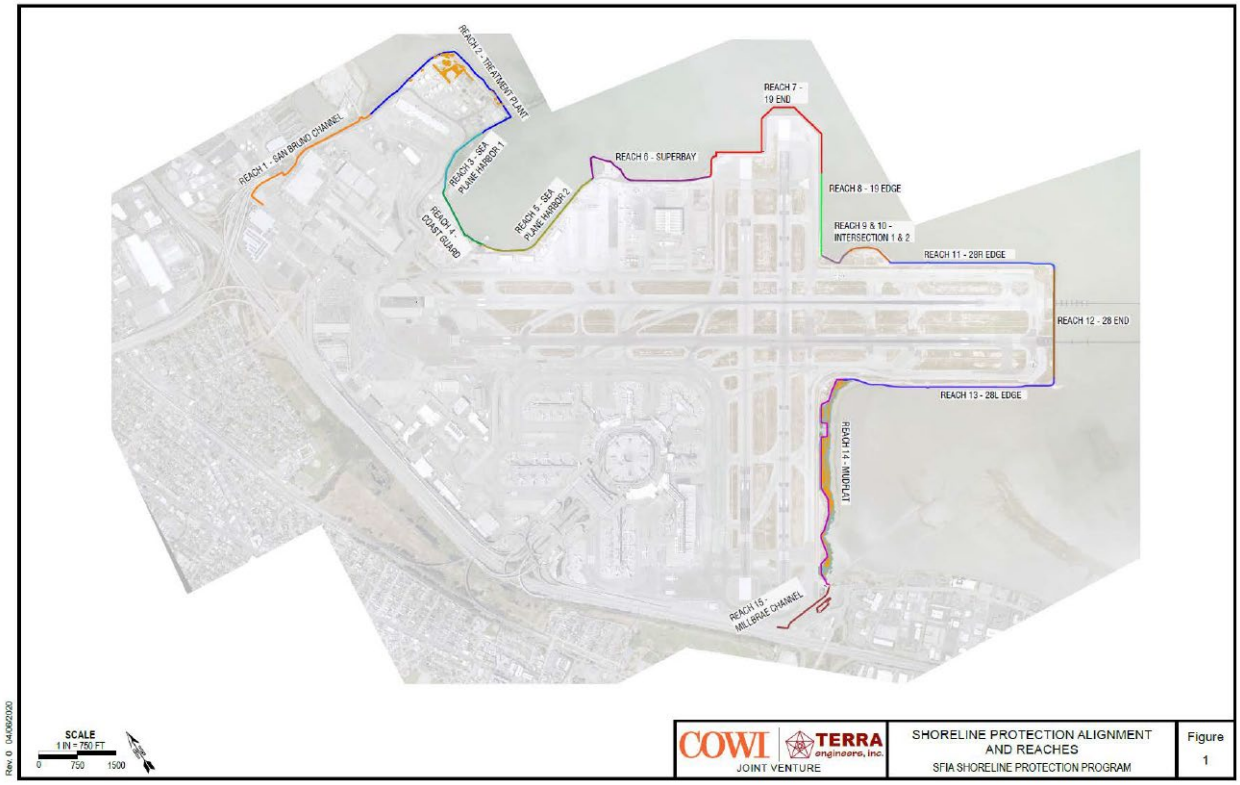

Figure 1. Map of the SFO Shoreline protection System showing Reaches 1-15 (Terra Engineers 2020)

The proposed project would remove the existing shoreline protection features and construct a new shoreline protection system approximately 7.6 miles long. The floodwall would primarily be constructed of steel sheet piles. On the two inland ends of the floodwall (Reaches 1 and 15) the sheet piles transition to reinforced concrete walls. The steel sheet piles would be driven to a maximum depth of approximately 79 feet and the tops of proposed wall elevations range from 16 – 20.2 feet NAVD88. Armor rock revetments are proposed in tandem with the walls to dissipate wave energy and prevent sediment scour. Aspects of the project design are required to comply with Federal Aviation Agency (FAA) regulations. SFO is also pursuing FEMA accreditation for the project. An application is being prepared for a Conditional Letter of Map Revision (CLOMR) to remove the airport from the coastal floodplain as a result of this project.

In order to form a continuous, closed flood protection system, one more segment of flood protection is likely required along the western perimeter of the airport boundary just east of Highway 101. This could be addressed as part of a future South San Francisco and Millbrae shoreline protection project, or by the Airport as an additional Reach 16. While

the Airport has prepared a conceptual design of a flood protection system along the western perimeter, this segment is not included in this project.

SFO may seek to modify the proposed design in the future for additional sea level rise by installing a new taller reinforced concrete cap beam. This option is not under consideration at this time and is expected to require a permit amendment, wall condition assessment, updated stability analyses, and ECRB review if and when it is proposed in the future.

Project Design Considerations

SFO is currently mapped as being in the FEMA 100-year floodplain. In addition to flooding directly from the Bay, flooding can also come from the San Bruno Channel north of the airport and the Millbrae Channel south of the airport. Flooding could also result from groundwater rise at the site caused by sea level rise.

Federal Aviation Administration requirements limit the maximum wall crest in certain reaches to avoid penetrating critical airspace surfaces. In Reach 7, at the end of Runway 19, this restriction has resulted in the shift in alignment of the new sea wall 215 feet farther into the Bay from the existing shoreline.

Aircraft bird strikes are a serious safety concern and therefore the project was designed to minimize wildlife attractants. Therefore, no nature-based solutions, which may attract birds to the airport were included in the plans.

The project includes a relocation and widening of the vehicle service road (VSR) in places around the perimeter of the airport to improve emergency access.

SFO currently has a stormwater control system with 91 miles of piping and 19 pump stations. Some stormwater discharges to the Bay while other stormwater is pumped to an onsite combined sewer/stormwater treatment system with treated water discharged to the Bay, in compliance with the SFO NPDES permit from the RWQCB. Besides collecting rainwater, the storm drain system may also collect and treat shallow groundwater where it infiltrates into leaky pipes. Groundwater at the airport is currently around 1 to 4 ft NAVD88 and ground surface elevations are as low as 7 to 8 ft NAVD88 in some areas. Emergent groundwater is anticipated to be an issue in the future, as groundwater levels in the shoreline rise in direct proportion to sea level rise in the Bay. In the future, the existing stormwater system will continue to mitigate surface water flooding and intercept and pump out groundwater. The deep sheet pile walls may mute tidal effects on groundwater levels with the project, although it will also contain rainwater within it.

The geotechnical report describes the local geology, seismic design criteria, liquefaction and design details. Stability modeling indicates the sheet piles (in the reaches except where dredging is required) should be installed deep into the layer below the young bay mud, up to

depths of approximately 79 feet. In Reaches 7 and 8, at the end of Runway 19, where Bay fill will be placed to locate the new sea wall 215 feet from the existing shoreline, special geotechnical treatments are recommended. This will require dredging prior to construction of a perimeter rock dike in the Bay, filling the area between the rock dike and the current shoreline, preloading the filled area with a temporary earth cover and installing wick drains to expedite consolidation of the young bay mud, and deep vibratory compaction of the fill.

The Board will review the following reports recently submitted by SFO, some of which were specifically prepared to respond to ECRB comments:

1. SFO Response to Comments from ECRB on the September 27, 2023 Meeting, August 9, 2024
2. Terra Engineers Inc., SFO Shoreline Protection Program Supplemental Analyses Preliminary Geotechnical Report, prepared for ESA, August 5, 2024
3. Telamon Engineering Consultants Inc, and AECOM, Volume I: San Francisco International Airport Shoreline Protection Program Conceptual Design Development Report, March 30, 2018 (provides conceptual design alternatives)
4. COWI, Earthquake and Flooding Memo, SFO-SPP, August 4, 2024
5. Geosyntec Consultants, Screening-level Evaluation of Groundwater Conditions with Sea Level Rise and Implementation of the Proposed Shoreline Protection Program at SFO, August 5, 2024
6. Geosyntec Consultants, SFO Shoreline Protection Program – Subsidence Assessment, July 31, 2024
7. ESA, San Francisco International Airport Shoreline Protection Program – Coastal Hydraulic Technical Report, December 2021 (presents results of wave reflection analysis)
8. Lotus Water prepared for COWI, Riverine Flooding Analysis Technical Memorandum, January 21, 2024 (for San Bruno Creek and Millbrae Canal)
9. HNTB Corporation, San Francisco International Airport Interior Drainage Study, February 2021 revised August 2023
10. COWI, SFO Shoreline Protection Program Operations and Maintenance Manual (undated)
11. Pathways Climate Institute, SFO Coastal Flood Hazard Study, Floodplain Mapping Considerations, January 31, 2024 (proposed updated FEMA floodplain mapping)
12. COWI, SFO No-Rise Study, August 2023 (modeling of near-field storm surge redistribution)
13. Geosyntec Consultants, SFO Shoreline Protection Program, Strong Motion Instrumentation, July 31, 2024
14. COWI and Terra Engineers Inc. Joint Venture, SFO Shoreline Protection Program,

Plans and Sections (Conceptual Design Development), July 19, 2023 (same set as presented for the 2023 meeting)

Staff Questions to the Board

BCDC staff requests that the Board review the content provided and advise on the following:

1. Are the scenarios and design criteria in the geotechnical stability analyses appropriate for the site hazards and conditions and site criticality?
2. Are current and future flooding risks (i.e. from groundwater, coastal and riverine flooding, and sea level rise) addressed adequately based on the references and the nature of the project?
3. Has the applicant demonstrated that adverse impacts to adjacent properties from the project have been minimized in the design?
4. In light of the critical nature of the airport, what future plan reviews or monitoring programs would you recommend BCDC require of the applicant to enhance the future safety of the project in light of its projected 60-year estimated lifespan and future sea level rise? Monitoring could include:
    - Design-build phase submittals
    - Corrosion monitoring
    - Interior drainage system function
    - Passive barrier function
    - Storms/waves and sea level rise
    - Emergency preparation or response systems
    - Others?
5. Are there any other design and physical concerns that have not been addressed?

Bay Plan Policies

The project raises issues related to Bay Plan policies on topics including Safety of Fills, Shoreline Protection and Climate Change. The following policies are relevant for the Board's review:

Safety of Fills

The policies on the Safety of Fills seek to reduce risk of life and damage to property for projects that require construction on fill in San Francisco Bay. The following policies (paraphrased below) apply:

1. **Policy No. 1**. The Commission has appointed and empowered the ECRB to:
    a. Establish and revise safety criteria for Bay fills and structures thereon,
    b. Review projects for the adequacy of their specific safety provisions and make recommendations concerning these provisions, and

c. Prescribe an inspection system to assure placement and maintenance of fill according to approved designs.

2. **Policy No. 2**. Even if fill may be permissible, no fill or building should be constructed if hazards cannot be overcome adequately for the intended use in accordance with the criteria prescribed by the ECRB.

3. **Policy No. 3** requires the installation of strong-motion seismographs on all future major landfills with the guidance of and recommendations by the California Geological Survey, for purposes of data comparison and evaluation.

4. **Policy No. 4** Adequate measures should be provided to prevent damage from sea level rise and storm activity that may occur on fill or near the shoreline over the expected life of a project. The Commission may approve fill that is needed to provide flood protection for existing projects and uses. New projects on fill or near the shoreline should either:

   a. Be set back from the edge of the shore so that the project will not be subject to dynamic wave energy,

   b. Be built so the bottom floor level of structures will be above a 100-year flood elevation that takes future sea level rise into account for the expected life of the project,

   c. Be specifically designed to tolerate periodic flooding, ***or***

   d. Employ other effective means of addressing the impacts of future sea level rise and storm activity.

   Rights-of-way for levees or other structures protecting inland areas from tidal flooding should be sufficiently wide on the upland side to allow for future levee widening to support additional levee height so that no fill for levee widening is placed in the Bay.

Shoreline Protection Policies

The following policies of Shoreline Protection (paraphrased below) apply:

1. **Policy No. 1** New shoreline protection projects and the maintenance or reconstruction of existing projects and uses should be authorized if:

   (a) the project is necessary to provide flood or erosion protection for

   (i) existing development, use or infrastructure, or

   (ii) proposed development, use or infrastructure that is consistent with other Bay Plan policies;

   (b) the type of the protective structure is appropriate for the project site, the uses to be protected, and the causes and conditions of erosion and flooding at the site;

   (c) the project is properly engineered to provide erosion control and flood protection for the expected life of the project based on a 100-year flood event that takes future sea level rise into account;

(d) the project is properly designed and constructed to prevent significant impediments to physical and visual public access;

(e) the protection is integrated with current or planned adjacent shoreline protection measures; and

(f) adverse impacts to adjacent or nearby areas, such as increased flooding or accelerated erosion, are avoided or minimized.

2. **Policy No. 4** Authorized protective projects should be regularly maintained according to a long-term maintenance program to assure that the shoreline will be protected from tidal erosion and flooding and that the effects of the shoreline protection project on natural resources during the life of the project will be the minimum necessary.

Dredging Policies
The Bay Plan Dredging policies apply to this project, but are not related to project design safety and so are not repeated here.

Climate Change Policies
The Bay Plan Climate Change policies apply to the proposed project:

2. **Policy No. 2** When planning shoreline areas or designing larger shoreline projects, a risk assessment should be prepared by a qualified engineer and should be based on the estimated 100-year flood elevation that takes into account the best estimates of future sea level rise and current flood protection and planned flood protection that will be funded and constructed when needed to provide protection for the proposed project or shoreline area. A range of sea level rise projections for mid-century and end of century based on the best scientific data available should be used in the risk assessment. Inundation maps used for the risk assessment should be prepared under the direction of a qualified engineer. The risk assessment should identify all types of potential flooding, degrees of uncertainty, consequences of defense failure, and risks to existing habitat from proposed flood protection devices.
3. **Policy No. 3**- To protect public safety and ecosystem services, within areas that a risk assessment determines are vulnerable to future shoreline flooding that threatens public safety, all projects—other than repairs of existing facilities, small projects that do not increase risks to public safety, interim projects and infill projects within existing urbanized areas—should be designed to be resilient to a mid-century sea level rise projection. If it is likely the project will remain in place longer than mid-century, an adaptive management plan should be developed to address the long-term impacts that will arise based on a risk assessment using the best available science-based projection for sea level rise at the end of the century.

Subtidal Areas Policies

The Bay Plan includes the following Subtidal Area policies relevant to the proposed project:

1. **Policy No. 1**: Any proposed filling or dredging project in the subtidal area should be thoroughly evaluated to determine the local and Bay-wide effects of the project on: (b) tidal hydrology and sediment movement; … and (e) the Bay's bathymetry. Projects in the subtidal areas should be designed to minimize and, if feasible, avoid harmful effects.

Airports Policies

The Bay Plan Airports policies apply to the proposed project:

1. **Policy No. 2b** Airports for general aviation can and should be at inland sites whenever possible. Expansion of existing general aviation airports should be permitted on Bay fill only if no feasible alternative is available.

Attachment: Letter from J. Hyman, BCDC to David Kim, SFO, Summary of September 27, 2023 ECRB Meeting Comments, November 2, 2023

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Transmitted via electronic mail only

November 2, 2023

ATTN: David Kim, PhD
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Email: David.t.kim@flysfo.com

SUBJECT: San Francisco International Airport (SFO) Shoreline Protection Project - Summary of September 27, 2023 ECRB Meeting Comments (BCDC Pre-Application)

Dear David Kim,

This letter summarizes the comments from the Engineering Criteria Review Board (ECRB) on aspects of the SFO Shoreline Protection Project (SPP) presented by the project team at the September 27, 2023 ECRB meeting. In addition to the materials presented by the SFO team at the ECRB meeting, the meeting discussion brought up some additional aspects of the project including:

- Studies are being done for the FEMA certification on riverine flooding from adjacent surface and storm water discharges. Preliminary results show some flooding that may need to be addressed with a future Reach 16 project.
- The seismic design criteria call for the wall to not fail in an earthquake, but repairable damage is allowed. Seismic modeling indicates the potential for sheet pile interlock breakage at corners of the sheet pile wall, which should be repairable. Openings in the wall could be temporarily blocked with sandbags.
- SFO expects that the system that pumps out and treats stormwater from the airport will need to be upsized and upgraded in the future to address groundwater emergence and other accumulation of water from within the sea walls. The performance of the storm drain system is also being modeled for FEMA certification. FEMA is requiring an operation and maintenance (O&M) plan for the stormwater system.
- The project will be bid as a design-build contract, so a new engineer will be hired to further develop and finalize the design.
- Additional cone penetrometer testing (CPT) is planned to gather geotechnical data and possibly add ground improvements or specify thicker steel. It is not known if this additional investigation will be done by the current engineering team or the design-build team.

- Groundwater is currently very shallow at the site now, about 3 feet below grade.
- Loads from flooding will govern over (are estimated to be greater than) those from seismic loading.

The ECRB's comments are as follows:

1) The 2D PLAXIS modeling of seismic site response/lateral displacements was done at Reach 6 which was assumed to be the critical area due to the thickest layer of Young Bay Mud (YBM) observed. This may not be the area with the strongest ground motions; however, thicker YBM can attenuate strong ground motion. Please perform additional analyses that include other sections to evaluate ground motions for a variety of subsurface profiles, and to evaluate which section(s) may be critical from the perspective of slope stability and seismic performance.
2) There may be other sea wall design approaches besides a steel sheet pile wall that could better serve to hold back Bay water when it rises above an elevation of around 8.3 – 8.6 feet NAVD88 (ground surface) in the future. A levee with a sheet pile wall on top comes to mind like at Foster City. Please provide your alternatives analysis report for review.
3) Fill for the airport came from the San Bruno mountains and it may contain lots of rock fragments, making it difficult to drive the sheet piles. (This comment is for information only.)
4) Corrosion is important to address since it can weaken the steel wall. According to the design team, corrosion of the steel sheet piles is being addressed by a coating system. Analysis of corrosion rates in the design to date rely on published numbers when corrosion rates are site specific. Provide a monitoring program to measure actual corrosion rates at the site so coating maintenance can be timed appropriately.
5) Provide analysis of scenarios with both earthquake and flooding.
6) In an emergency event such as a flood or earthquake, the ability for the airport to get back into operation is expected to depend on the operation of the stormwater pumping system. Therefore, provide information on how the pumping system is powered, if backup power is available, and present what measures will be taken to have a resilient stormwater pumping system in the project. At what elevation have the backup power systems been placed (compared to tides and flood levels)?
7) The ECRB requested that SFO come back for a future meeting, following the supplemental geotechnical investigation, to present the updated interpretation of the subsurface geology, derivation of design parameters, wall stability analysis, and other issues raised above. In the next ECRB meeting, please also address the issues listed below.

Please do not hesitate to contact me with any questions at 415-352-3670 or Jennifer.hyman@bcdc.ca.gov or permit analyst Rowan Yelton at 415-352-3613 or rowan.yelton@bcdc.ca.gov.

Sincerely,

DocuSigned by:
Jennifer Hyman
5C47B567FFDB4FB...

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JH/mm