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Vol. 1

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San Francisco – Oakland Bay Bridge
East Span Seismic Safety Project

Vol. 1 appendices

Final

Appendices

Environmental Impact Statement/ Statutory Exemption And Final Section 4(f) Evaluation

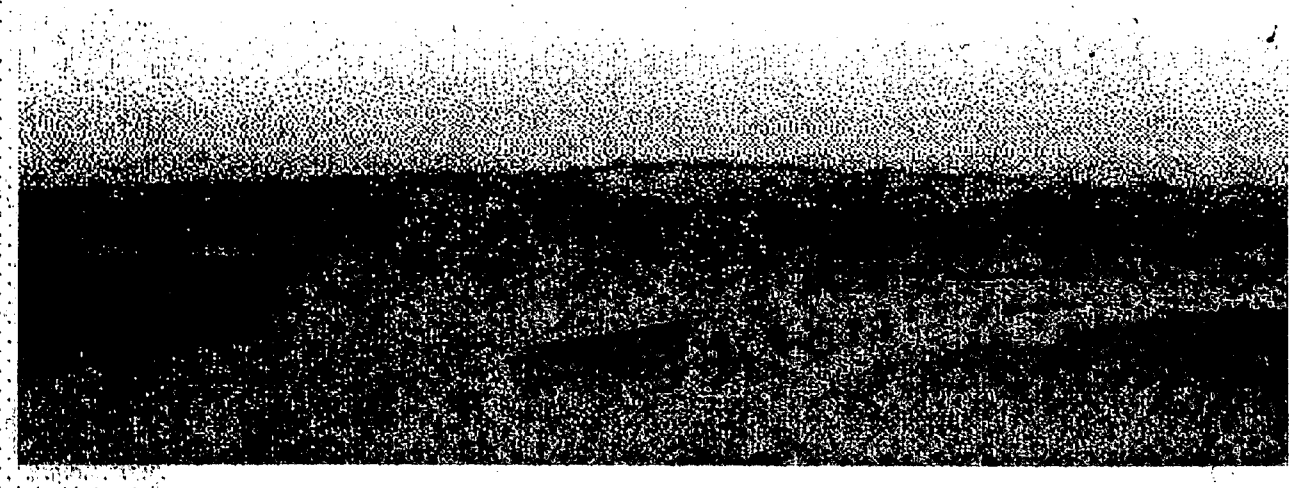
E, F, Gd

H

in the Notebook w/ main part of EIS

Volume 1 ~~Comments and Responses~~

Appendices only



May 8, 2001

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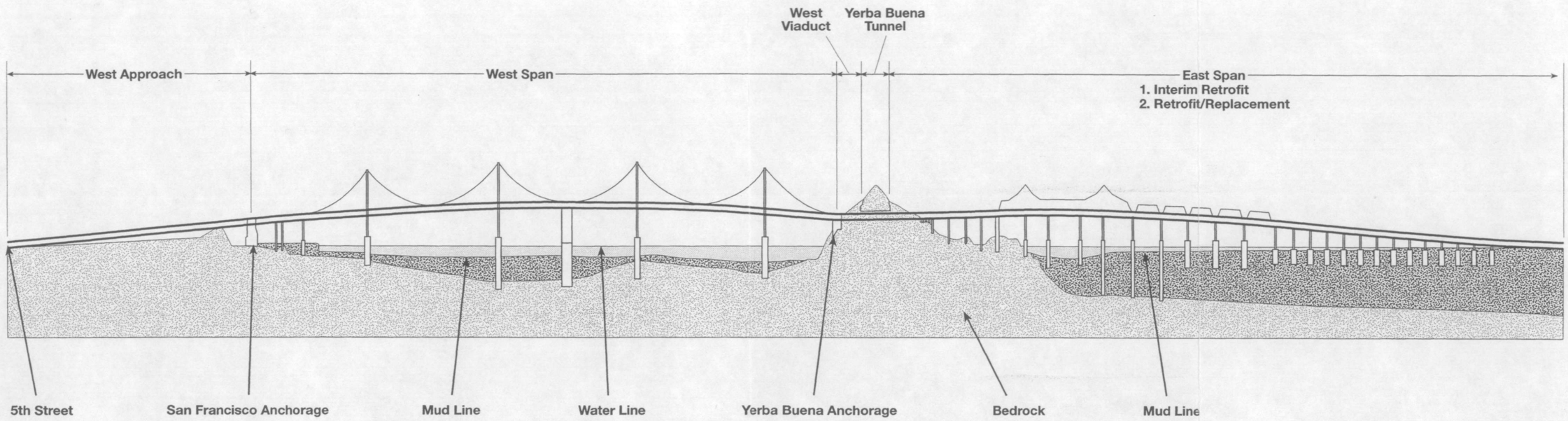
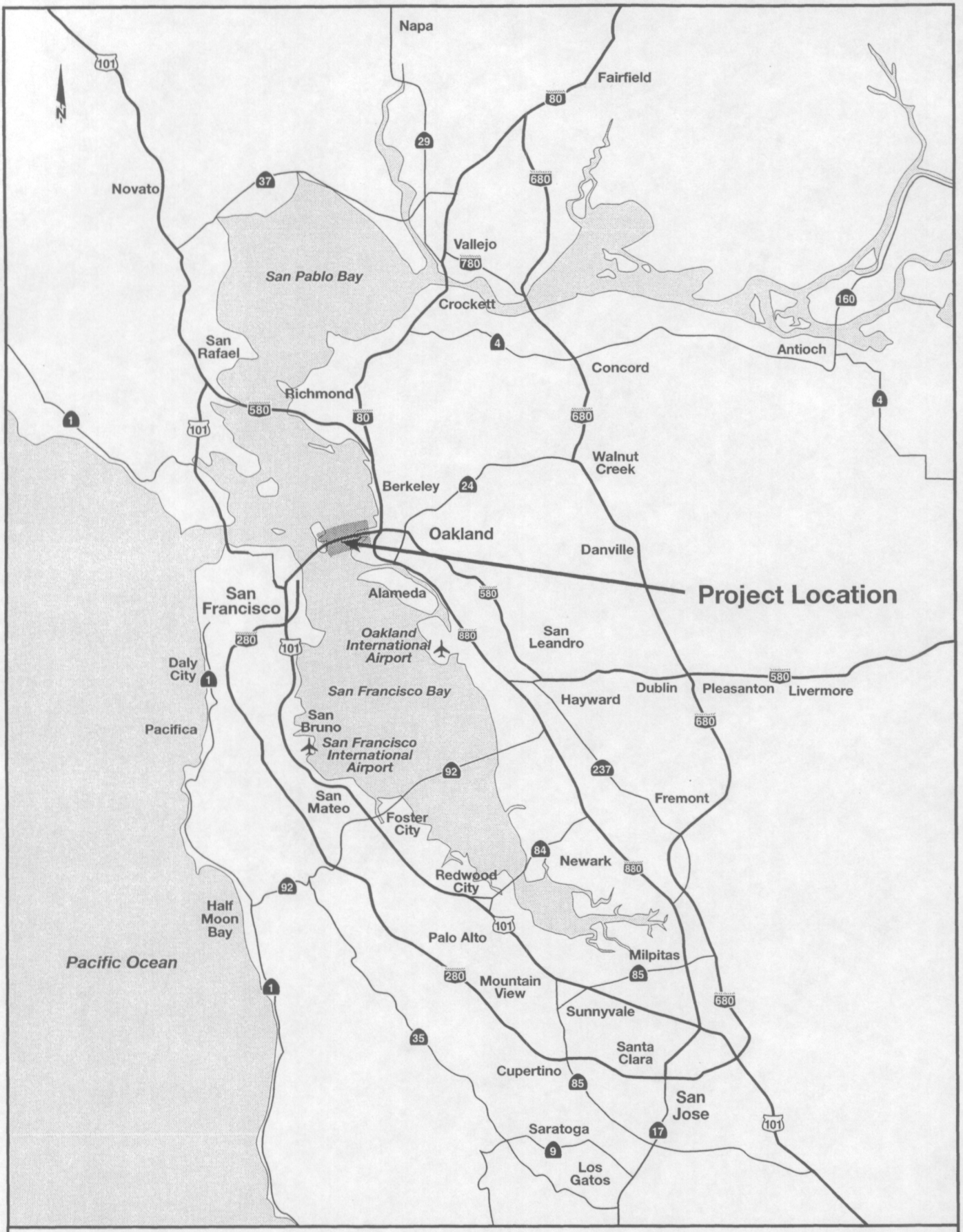


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

NO SCALE
VERTICAL EXAGGERATED

San Francisco–Oakland
Bay Bridge–Related Projects
Figure 1-1

4/25/01

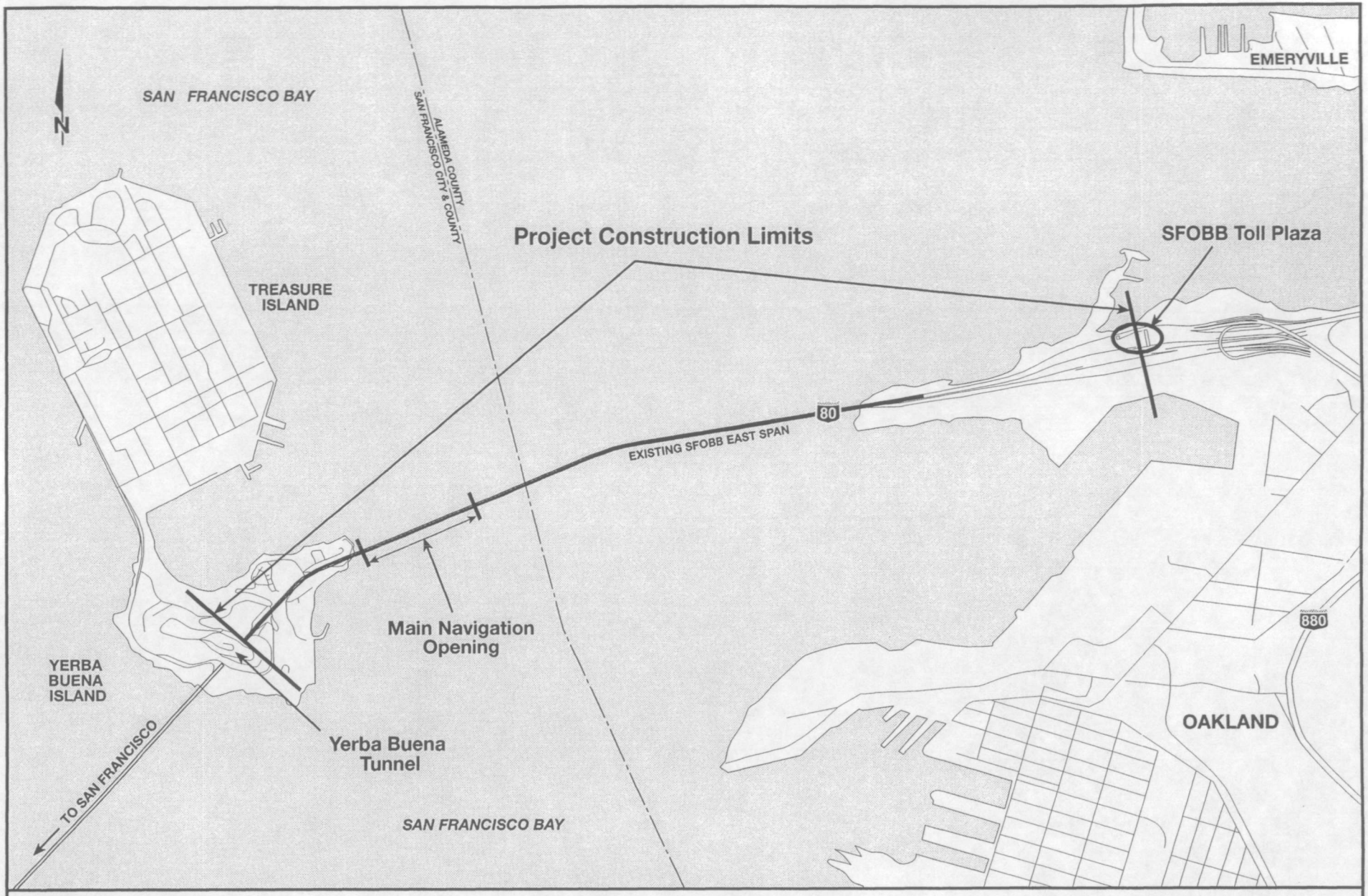


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Project Location

Figure 2-1

10/17/00



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

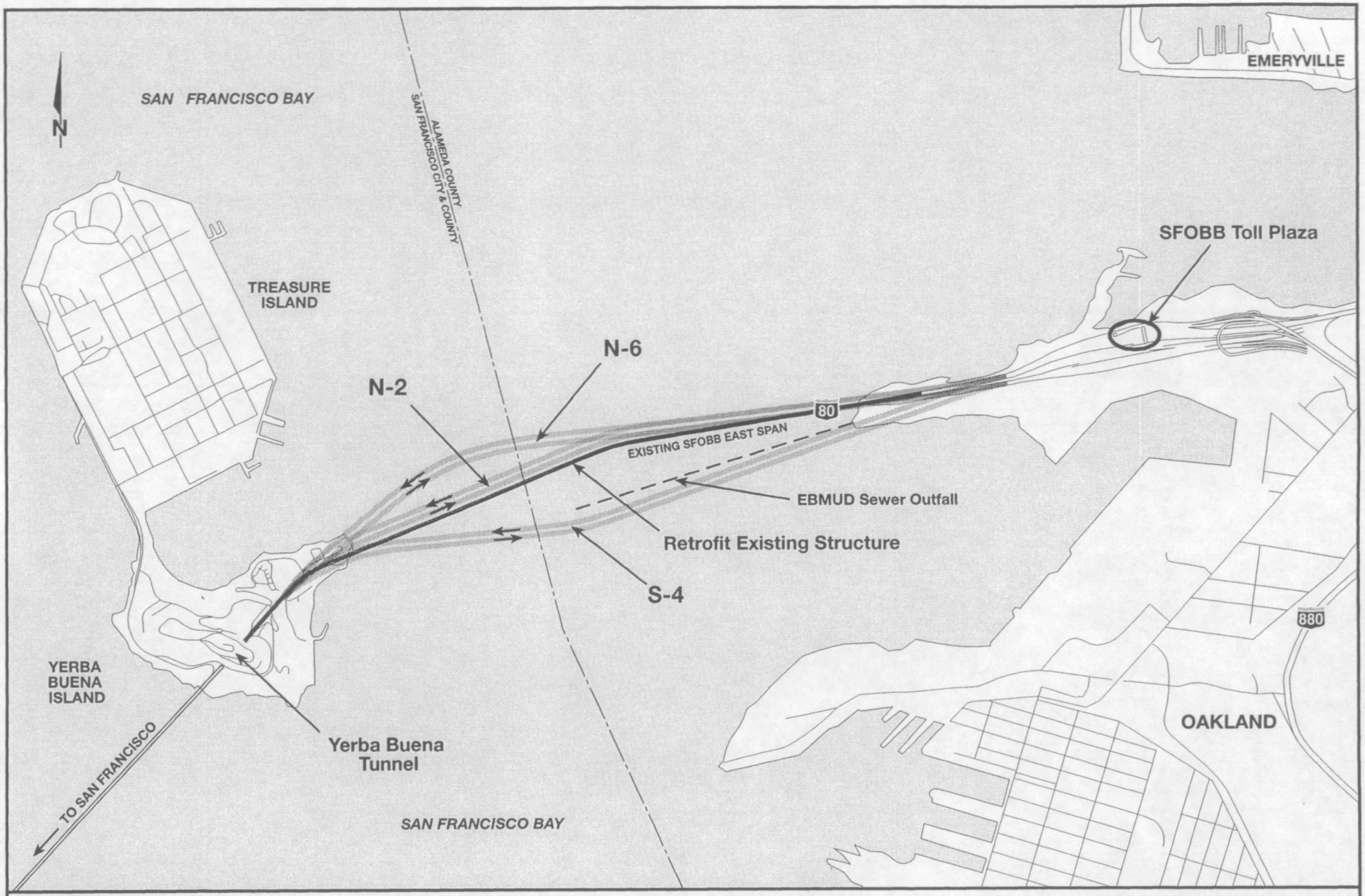
GRAPHIC SCALE 1:27,500

0 250 500 1000 m

Project Construction Limits

Figure 2-2

4/24/01



SFOBB EAST SPAN SEISMIC SAFETY PROJECT

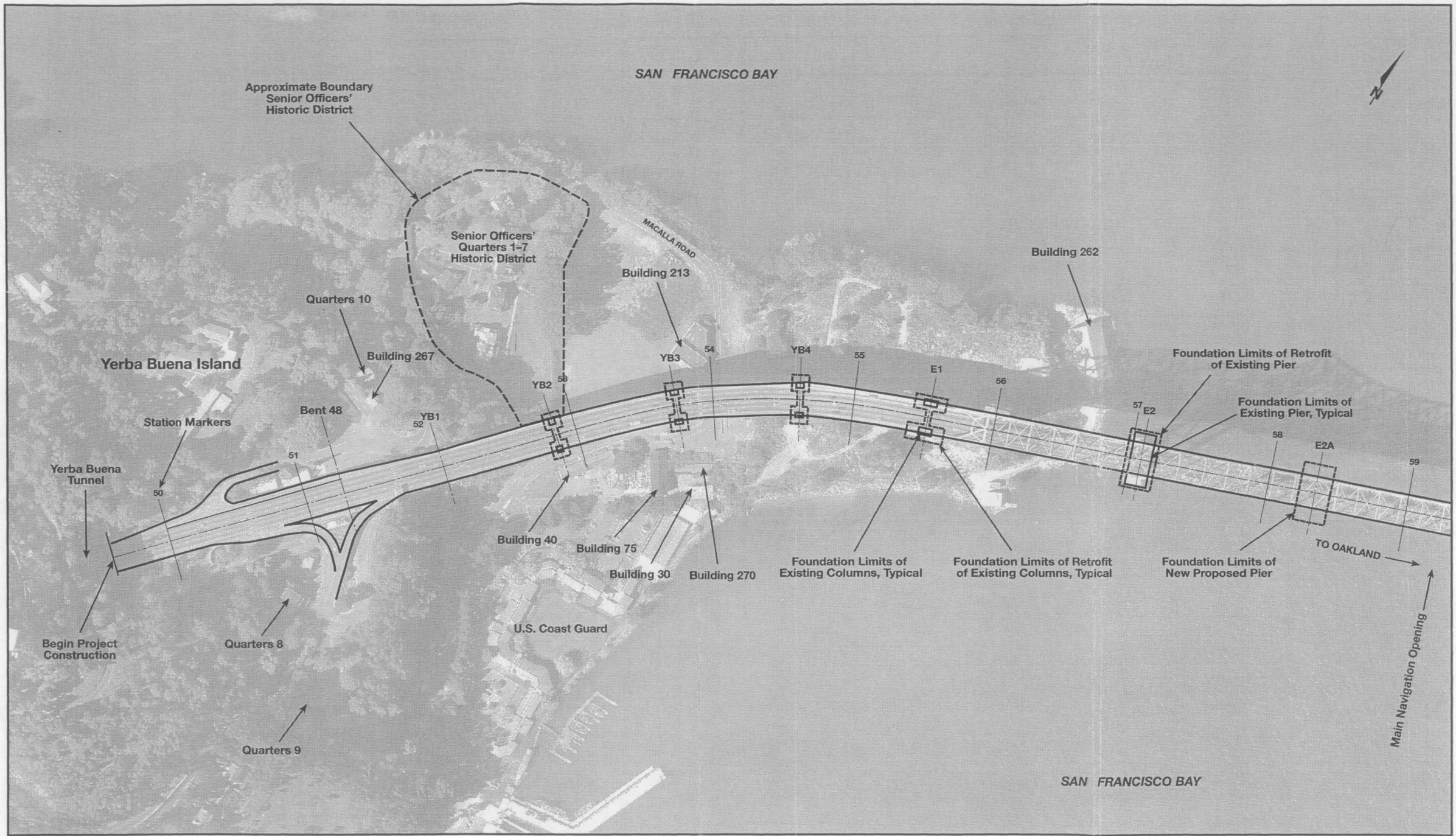
GRAPHIC SCALE 1:27,500

0 250 500 1000 m

Project Alternatives

Figure 2-3

9/4/00



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500
0 100 200 300 m

Retrofit Existing Structure Alternative
Figure 2-4.1

4/24/01

SAN FRANCISCO BAY

Main Navigation Opening

TO YERBA BUENA ISLAND

59 60 E2B 61 E3 62 E4 63 64 E5 65 66 E6 67 E7 68

Foundation Limits of Existing Pier, Typical

TO OAKLAND

Foundation Limits of New Proposed Pier

Foundation Limits of Retrofit of Existing Pier, Typical

SAN FRANCISCO BAY

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500
0 100 200 300 m

Retrofit Existing Structure Alternative

Figure 2-4.2

4/24/01

SAN FRANCISCO BAY

Foundation Limits of Existing Pier, Typical

TO YERBA BUENA ISLAND

E8 69 70 E9 71 E10 72 E11 73 E12 74 E13 75 E14 76 E15 77 E16 78 E17 79 E18

TO OAKLAND

Foundation Limits of Retrofit of Existing Pier, Typical

SAN FRANCISCO BAY

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

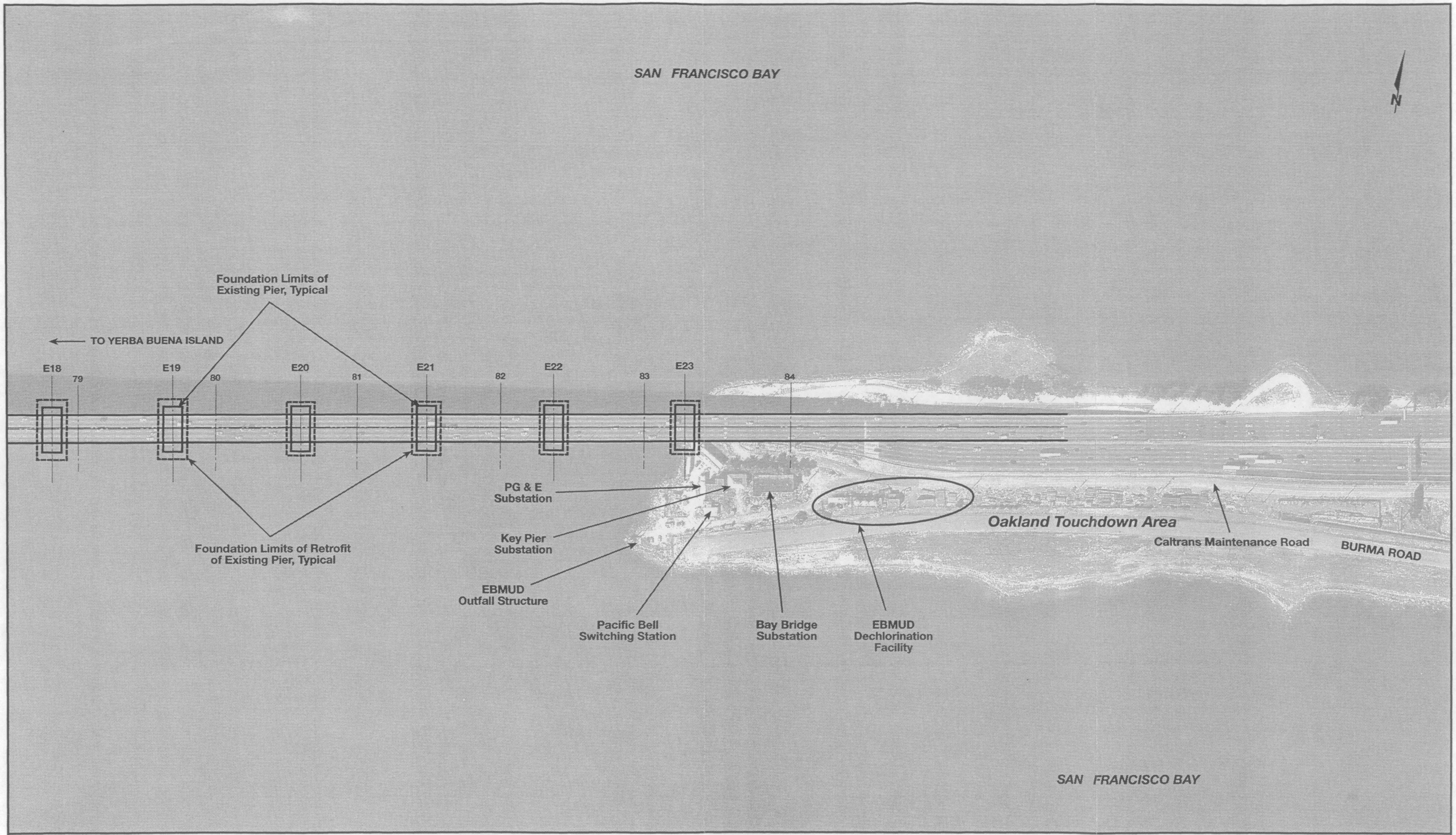
GRAPHIC SCALE 1:2,500

0 100 200 300 m

Retrofit Existing Structure Alternative

Figure 2-4.3

2/3/01



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

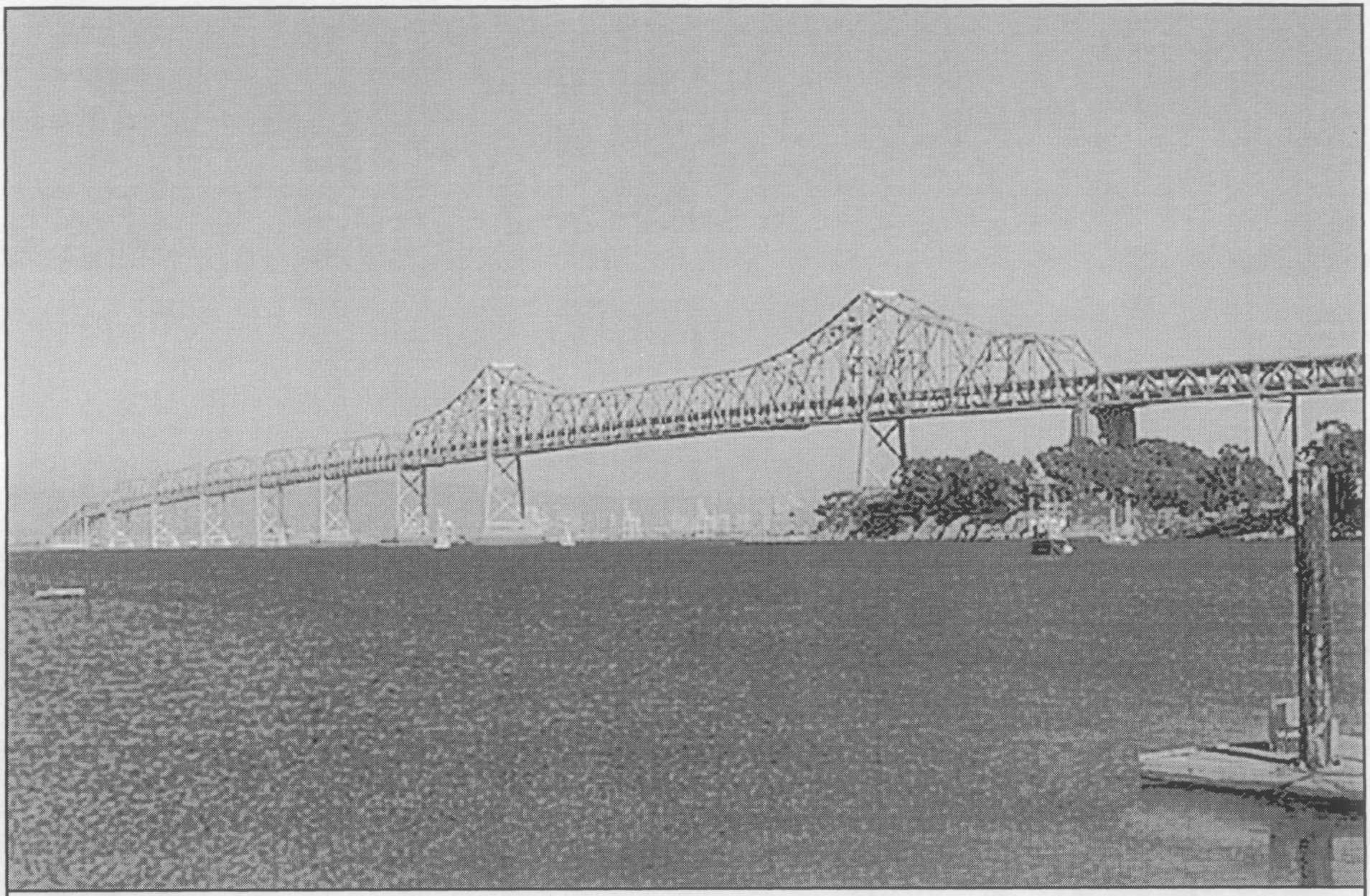
GRAPHIC SCALE 1:2,500

0 100 200 300 m

Retrofit Existing Structure Alternative

Figure 2-4.4

4/25/01

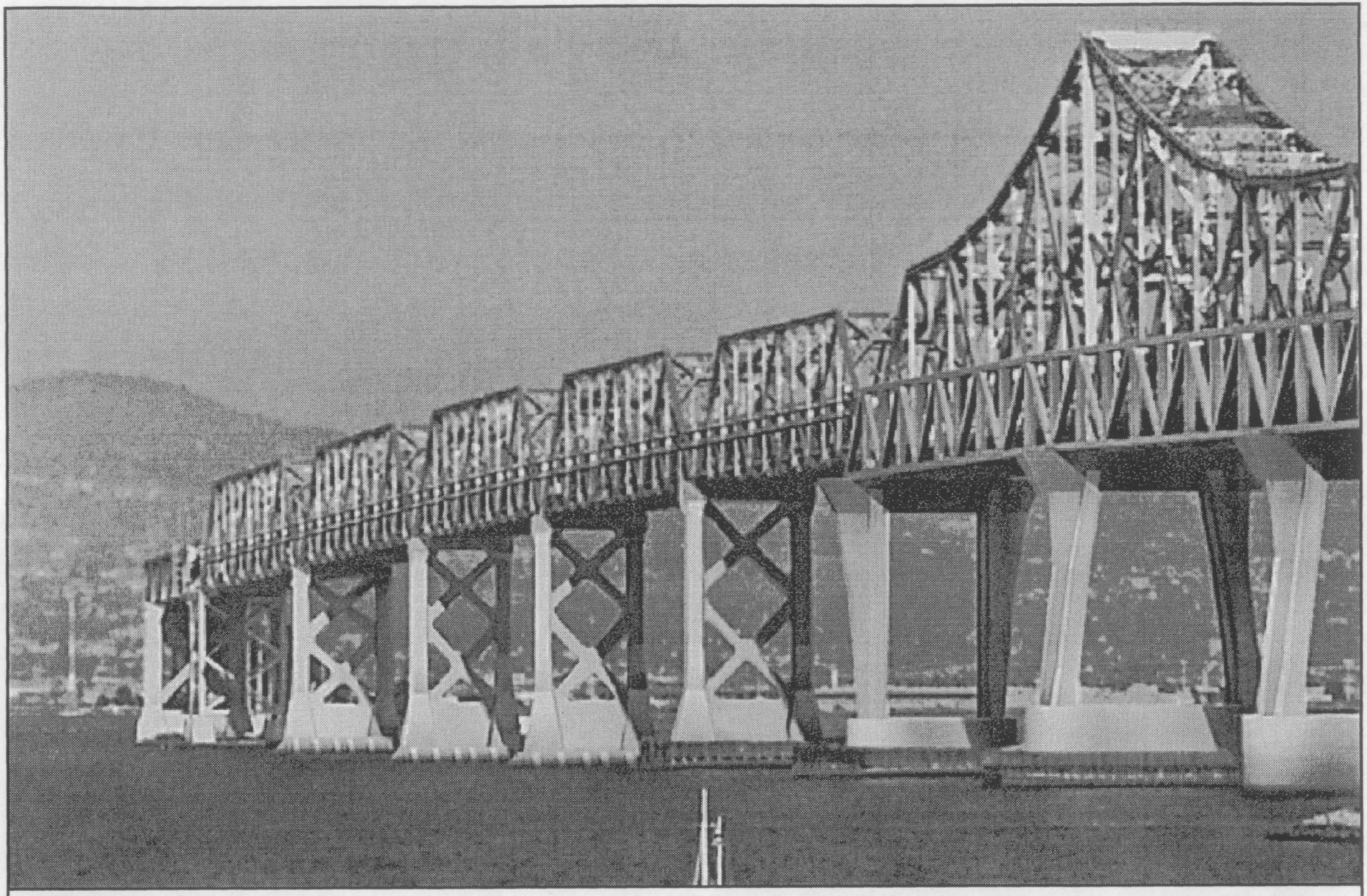


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

View of Existing Bridge
from Treasure Island Viewpoint

Figure 2-5

9/4/00



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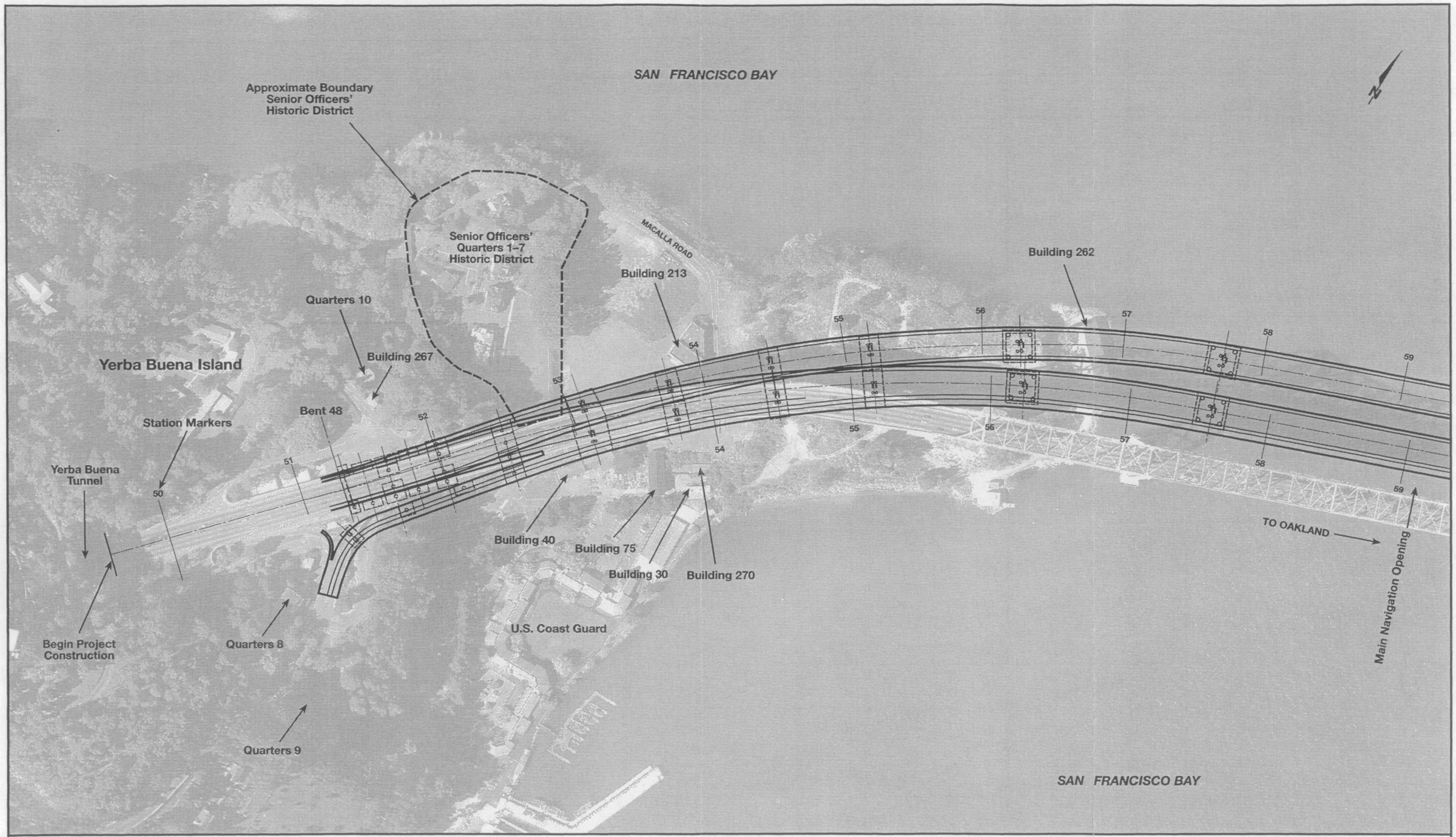
SEISMIC SAFETY
PROJECT

Photo Simulation Retrofit Existing Bridge Design
from Treasure Island Viewpoint

Figure 2-6

9/4/00



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

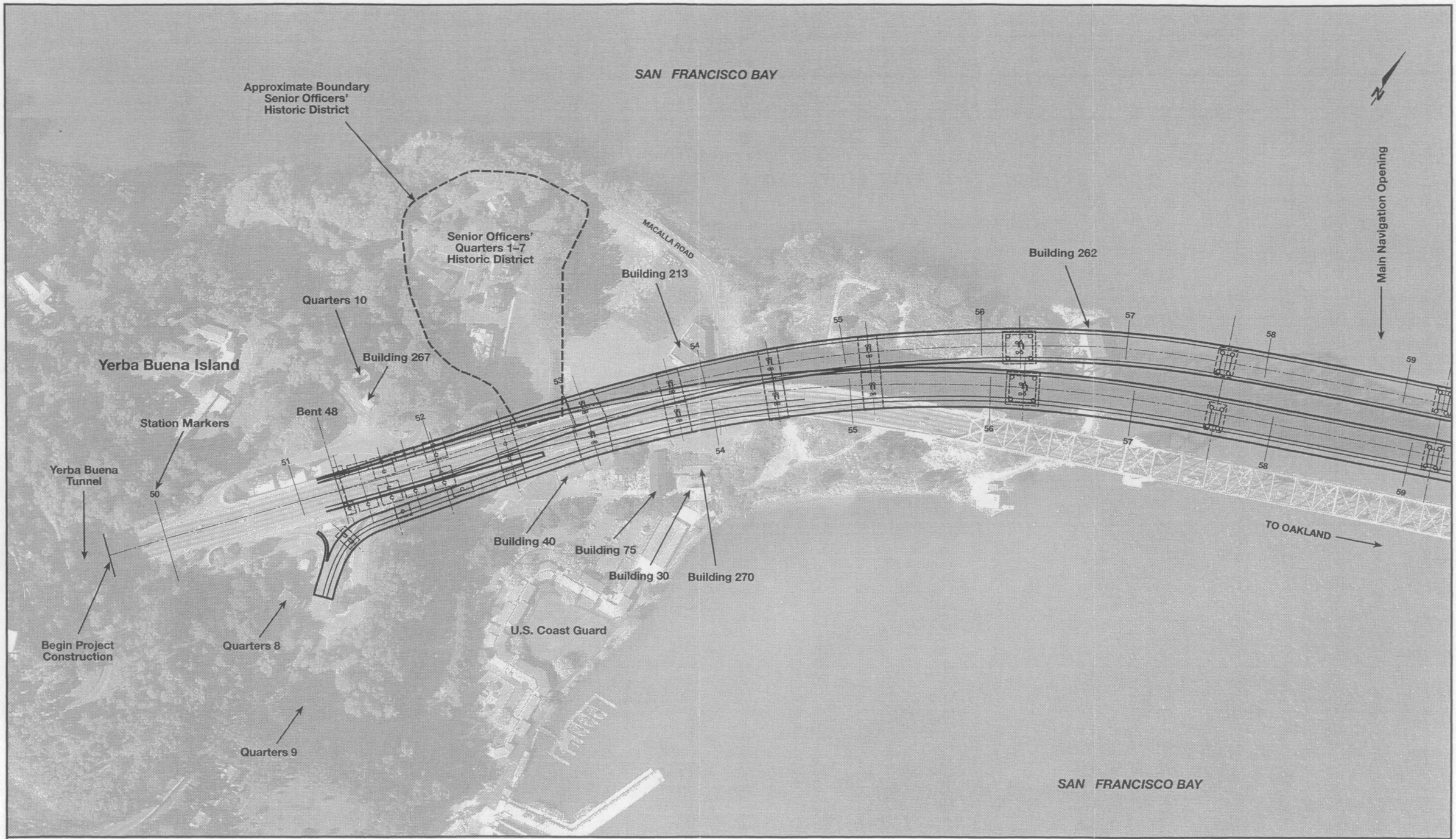
GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative N-2
Suspension/Cable-Stayed Structure Variation

Figure 2-7.1a

4/24/01



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative N-2
Skyway Structure Variation

Figure 2-7.1b

4/26/01

SAN FRANCISCO BAY

Main Navigation Opening

TO YERBA BUENA ISLAND

59 60 61 62 63 64 65 66 67 68 69

Proposed Foundation Limits–
Main Tower Support

TO OAKLAND

SAN FRANCISCO BAY

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500
0 100 200 300 m

Replacement Alternative N-2
Suspension Structure Variation

Figure 2-7.2a

4/24/01

SAN FRANCISCO BAY

N

Main Navigation Opening

TO YERBA BUENA ISLAND

59 60 61 62 63 64 65 66 67 68 69

Proposed Foundation Limits–
Main Tower Support

TO OAKLAND

SAN FRANCISCO BAY

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative N-2
Cable-Stayed Structure Variation

Figure 2-7.2b

4/24/01

SAN FRANCISCO BAY

Main Navigation Opening

59 60 61 62 63 64 65 66 67 68 69

SAN FRANCISCO BAY

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative N-2
Skyway Structure Variation
Figure 2-7.2c

4/24/01

SAN FRANCISCO BAY

N

TO YERBA BUENA ISLAND

TO OAKLAND

69 70 71 72 73 74 75 76 77 78

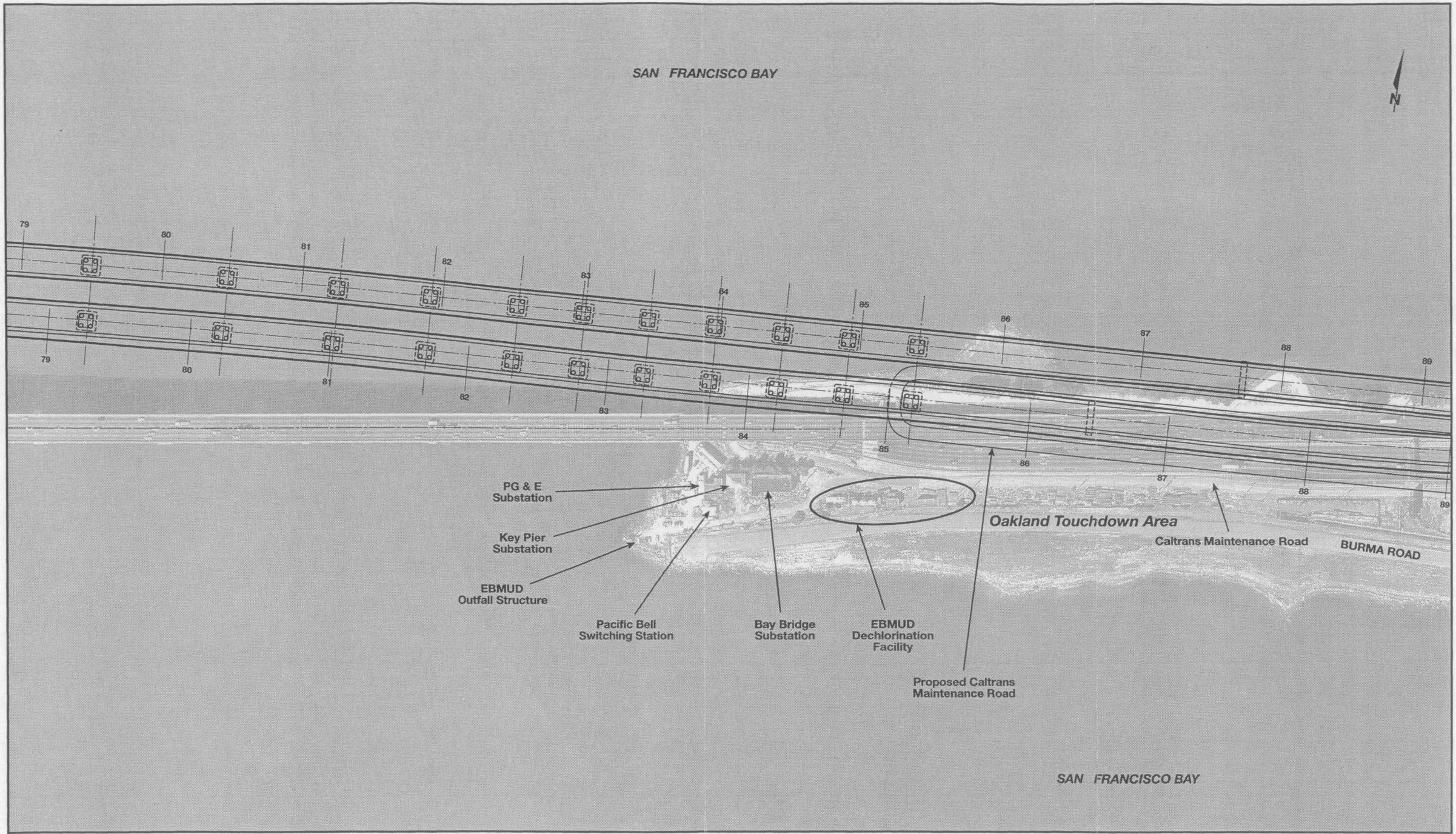
SAN FRANCISCO BAY

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500
0 100 200 300 m

Replacement Alternative N-2
All Design Variations
Figure 2-7.3

2/3/01



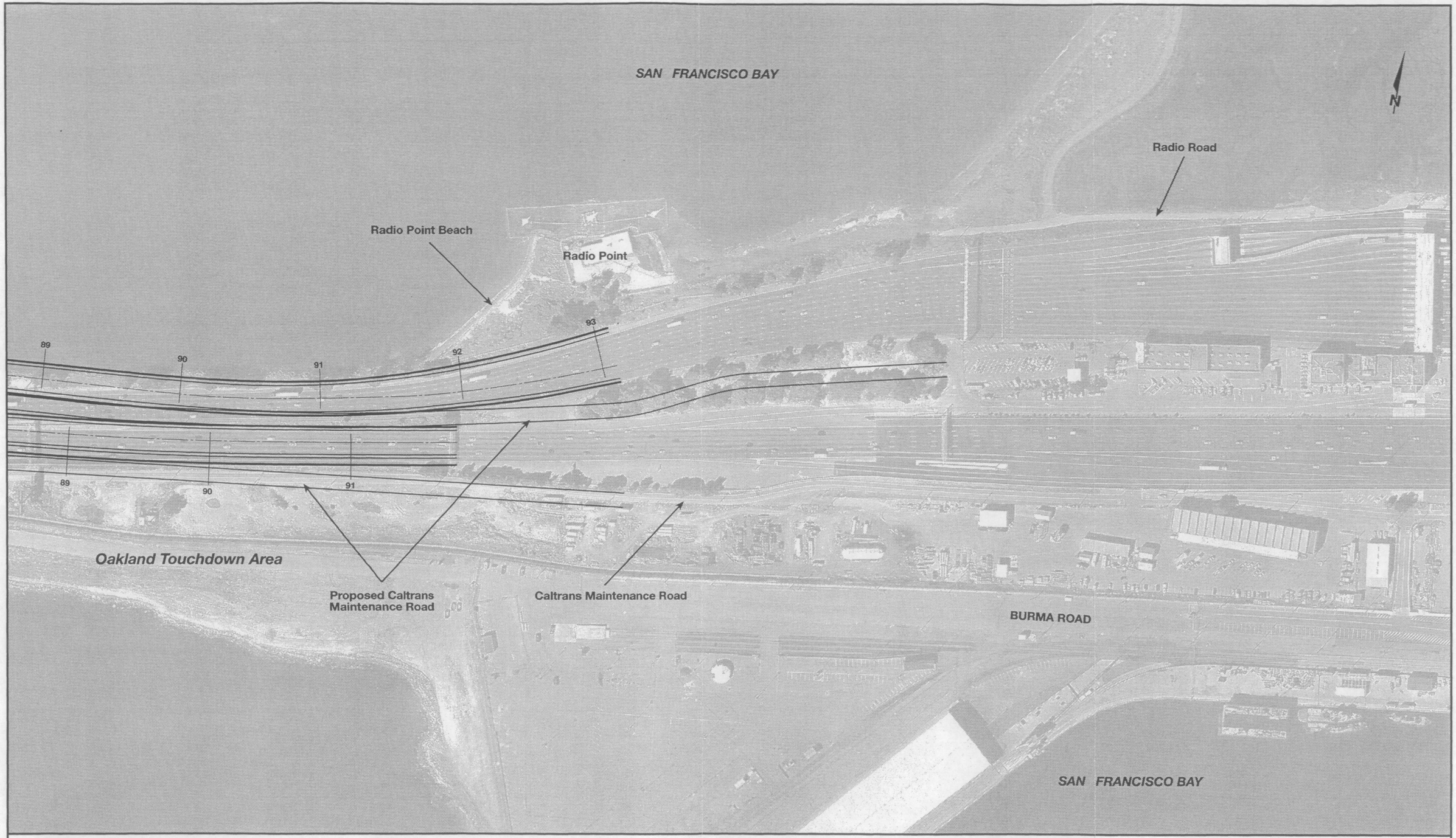
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative N-2
All Design Variations
Figure 2-7.4

4/26/01

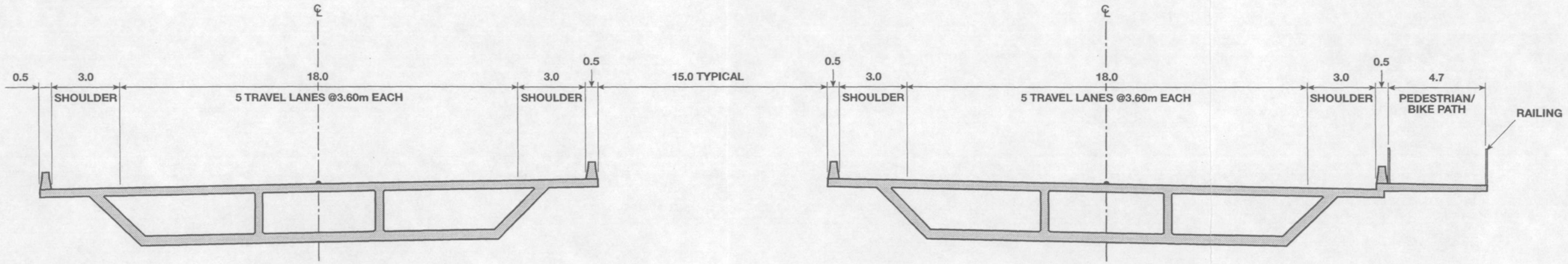


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500
0 100 200 300 m

Replacement Alternative N-2
All Design Variations
Figure 2-7.5

3/2/01



Westbound Roadway

Eastbound Roadway, with Pedestrian/Bike Path

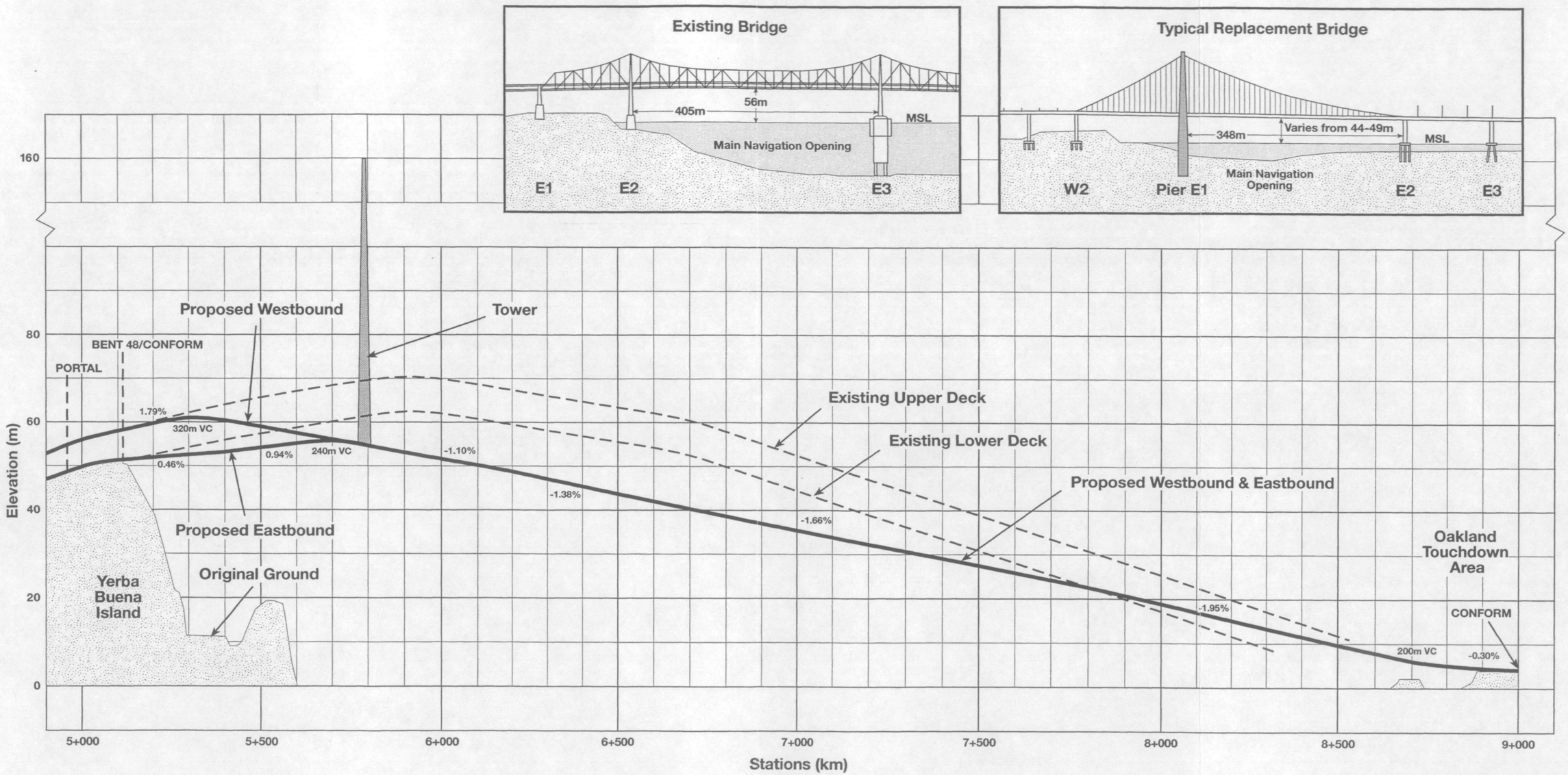
Note: Units in Meters

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Typical Cross Sections

Figure 2-8

2/3/01



Note: VC=Vertical Curve

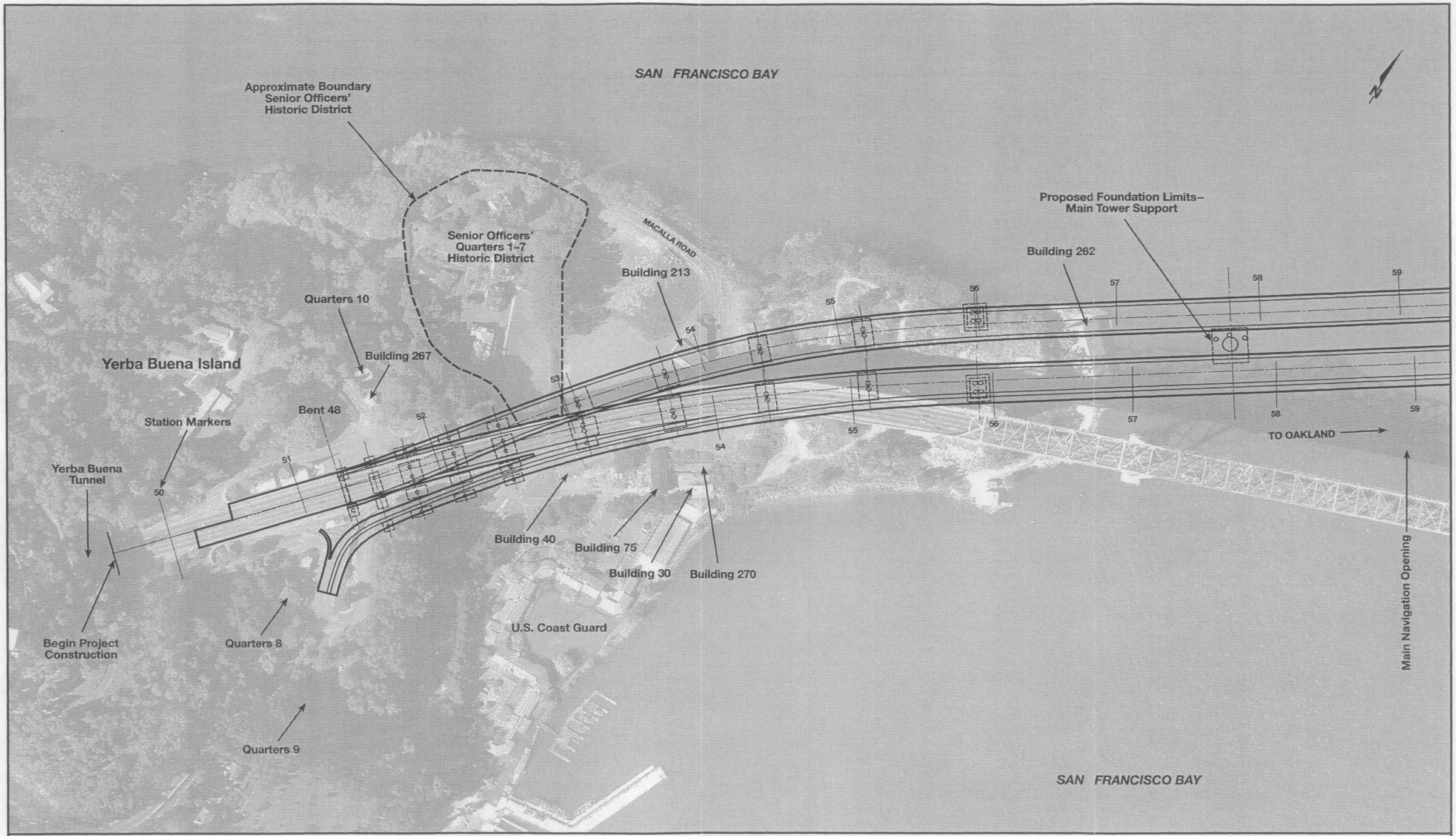
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

NO SCALE

Typical Profile for All Replacement Alternatives

Figure 2-9

4/25/01



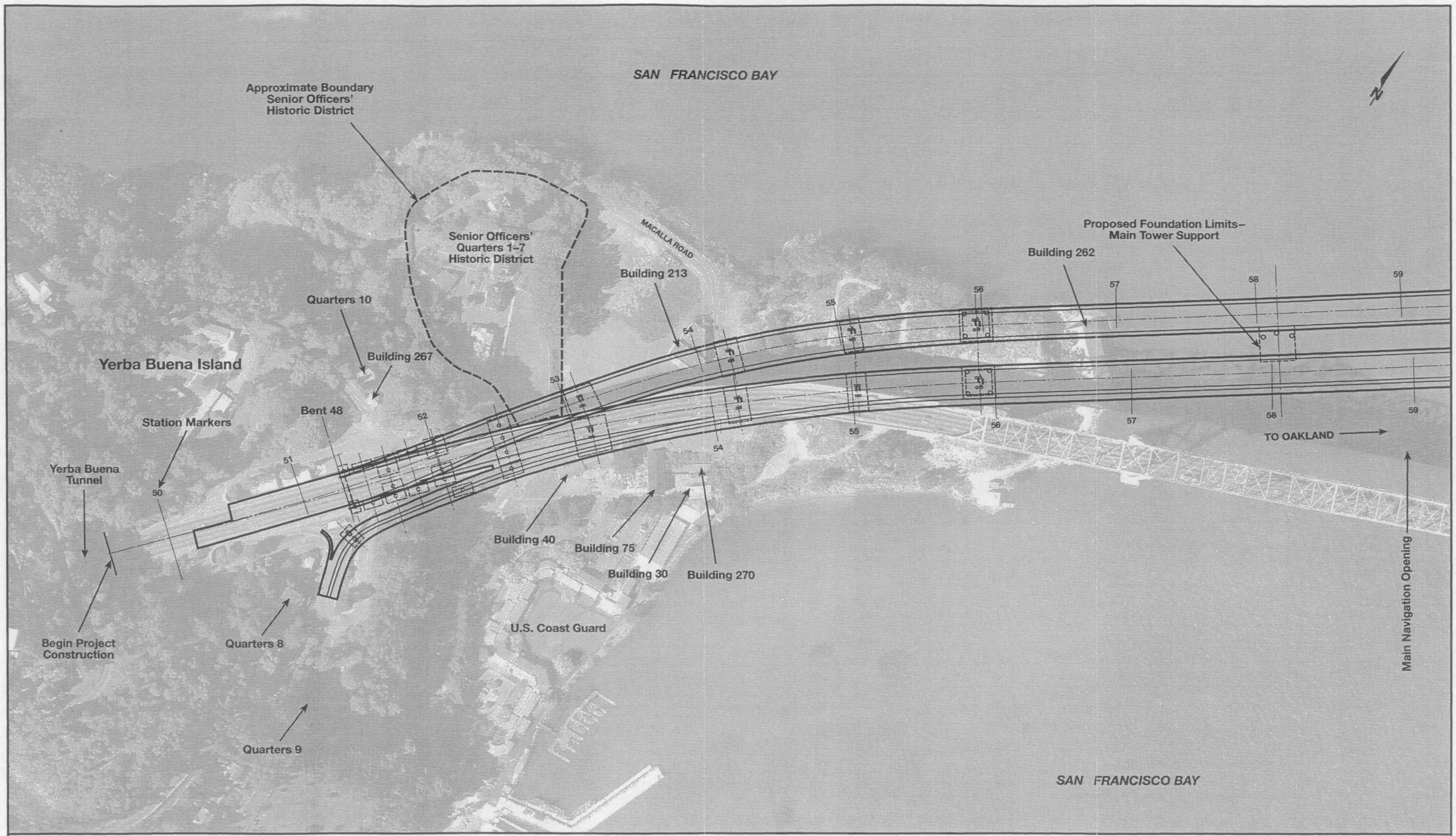
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative N-6
Suspension Structure Variation
Figure 2-10.1a

4/24/01



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

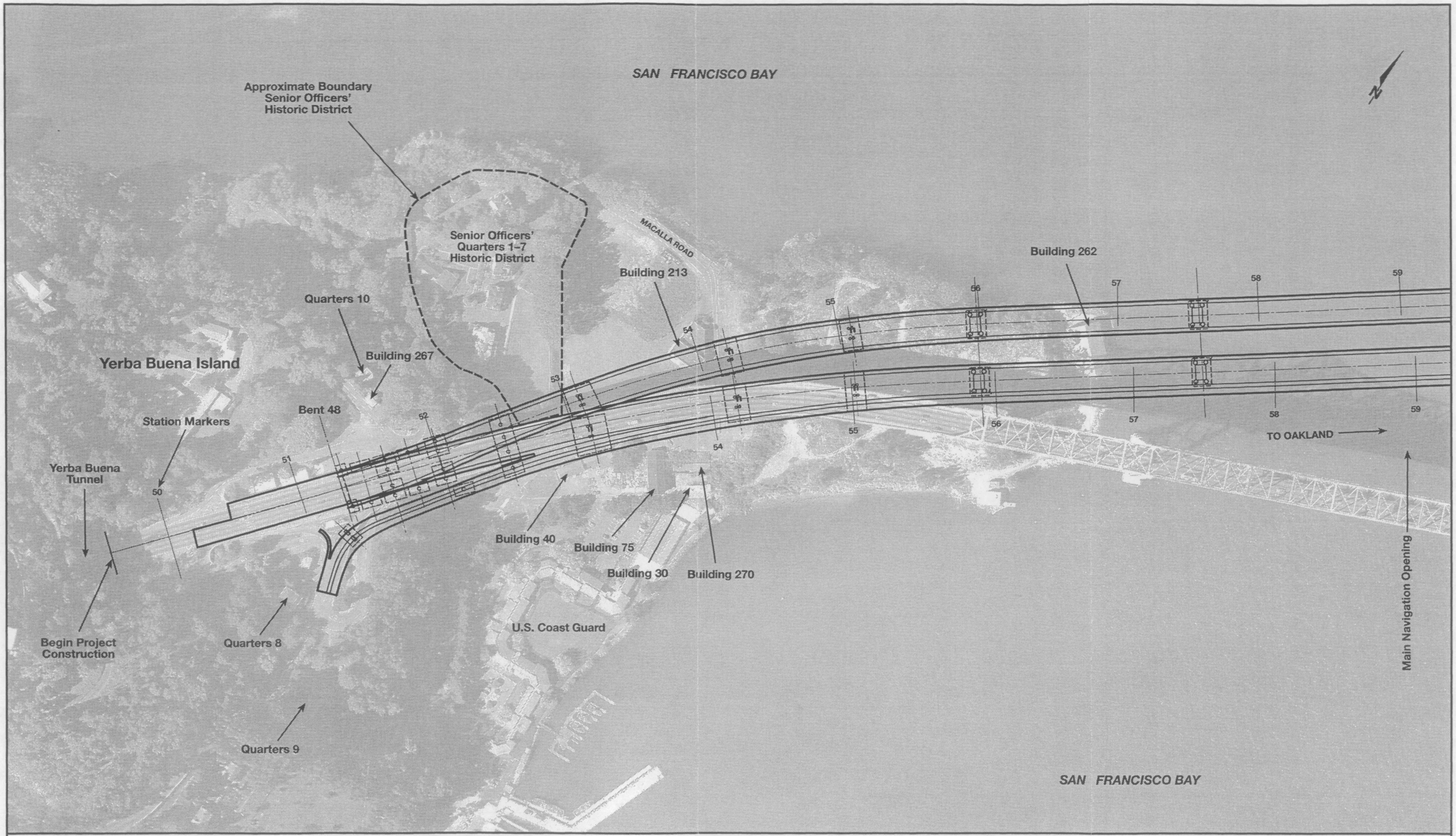
GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative N-6
Cable-Stayed Structure Variation

Figure 2-10.1b

4/24/01



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative N-6
Skyway Structure Variation
Figure 2-10.1c

4/24/01

SAN FRANCISCO BAY

Main Navigation Opening

TO YERBA BUENA ISLAND

TO OAKLAND

59 60 61 62 63 64 65 66 67 68 69

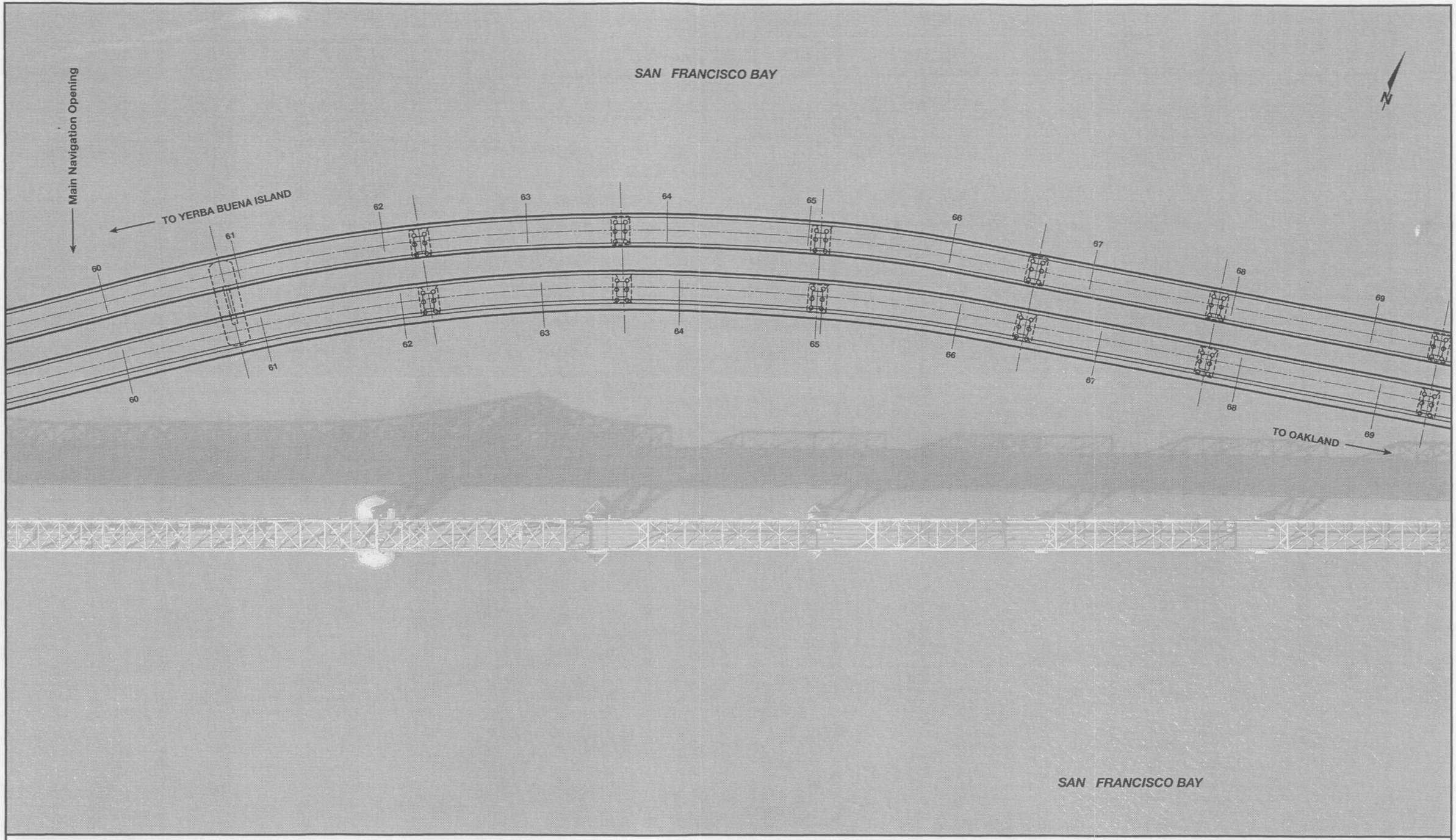
SAN FRANCISCO BAY

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500
0 100 200 300 m

Replacement Alternative N-6
Suspension Structure Variation
Figure 2-10.2a

4/24/01



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500
0 100 200 300 m

Replacement Alternative N-6
Cable-Stayed Structure Variation
Figure 2-10.2b

4/24/01

SAN FRANCISCO BAY

Main Navigation Opening

TO YERBA BUENA ISLAND

TO OAKLAND

59 60 61 62 63 64 65 66 67 68 69

SAN FRANCISCO BAY

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500
0 100 200 300 m

Replacement Alternative N-6
Skyway Structure Variation
Figure 2-10.2c

4/24/01

SAN FRANCISCO BAY

N

TO YERBA BUENA ISLAND

69 70 71 72 73 74 75 76 77 78 79

TO OAKLAND

SAN FRANCISCO BAY

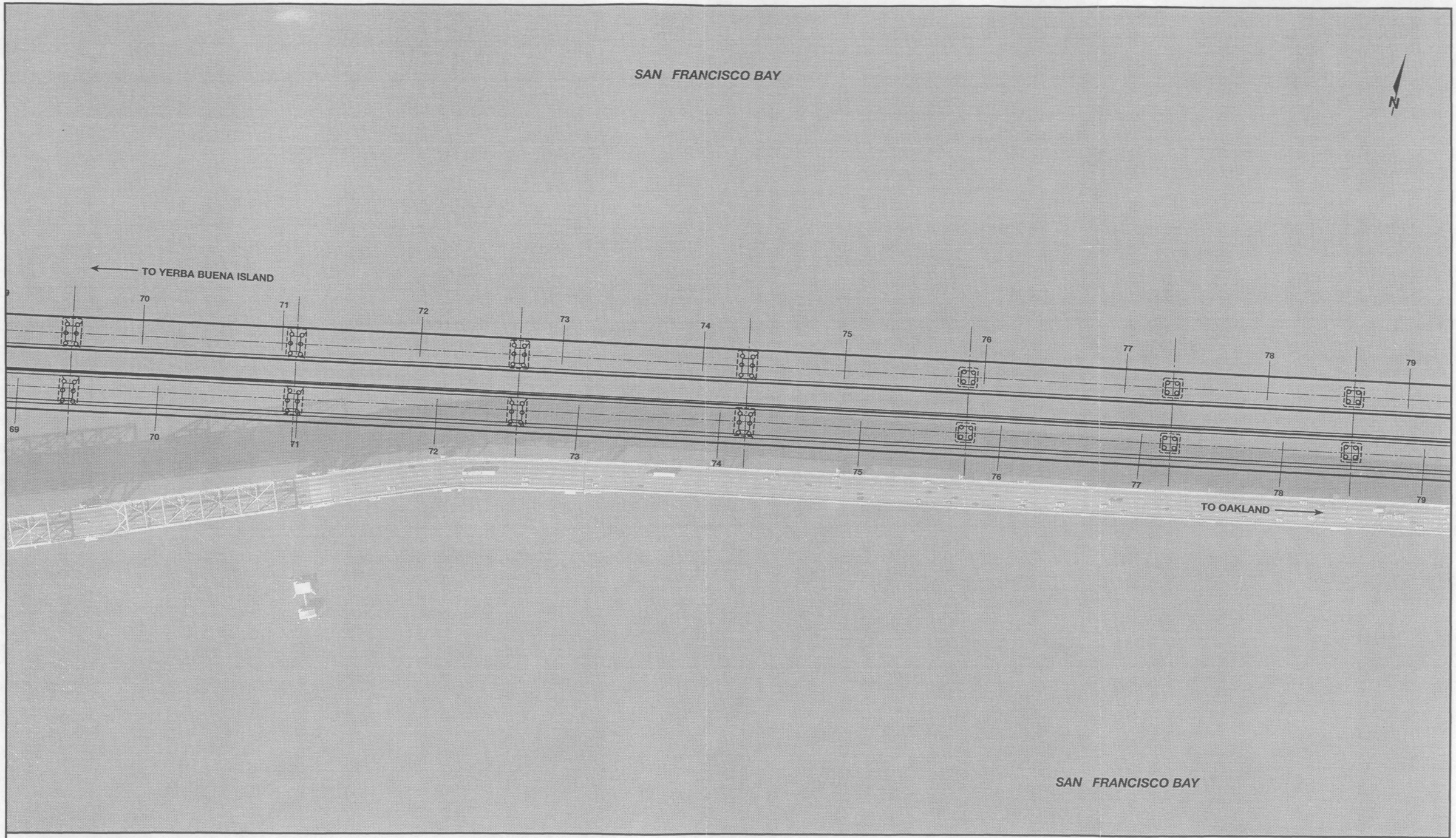
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500
0 100 200 300 m

Replacement Alternative N-6
Suspension/Skyway Structure Variation

Figure 2-10.3a

2/3/01



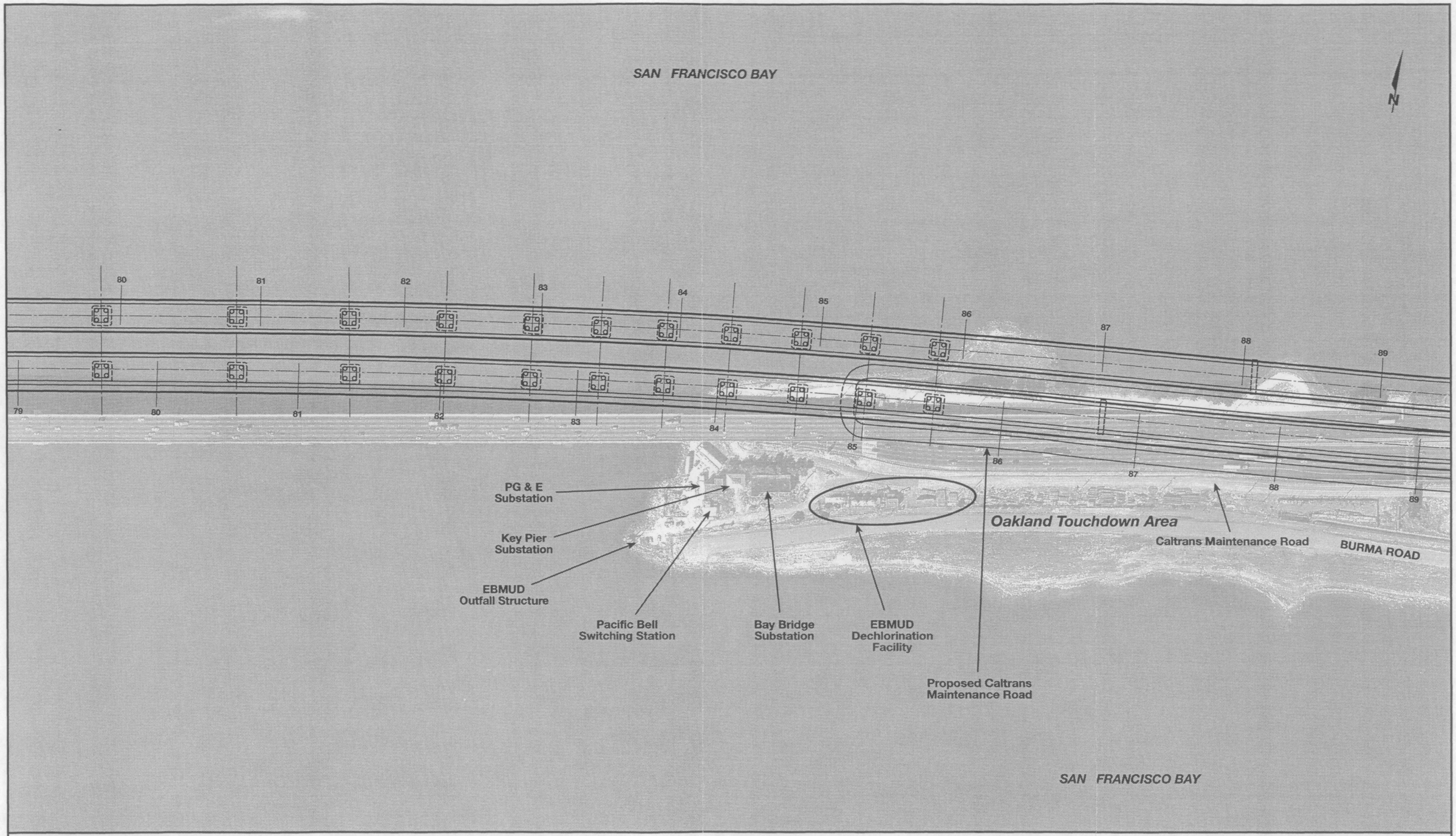
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500
0 100 200 300 m

Replacement Alternative N-6
Cable-Stayed Structure Variation

Figure 2-10.3b

2/3/01

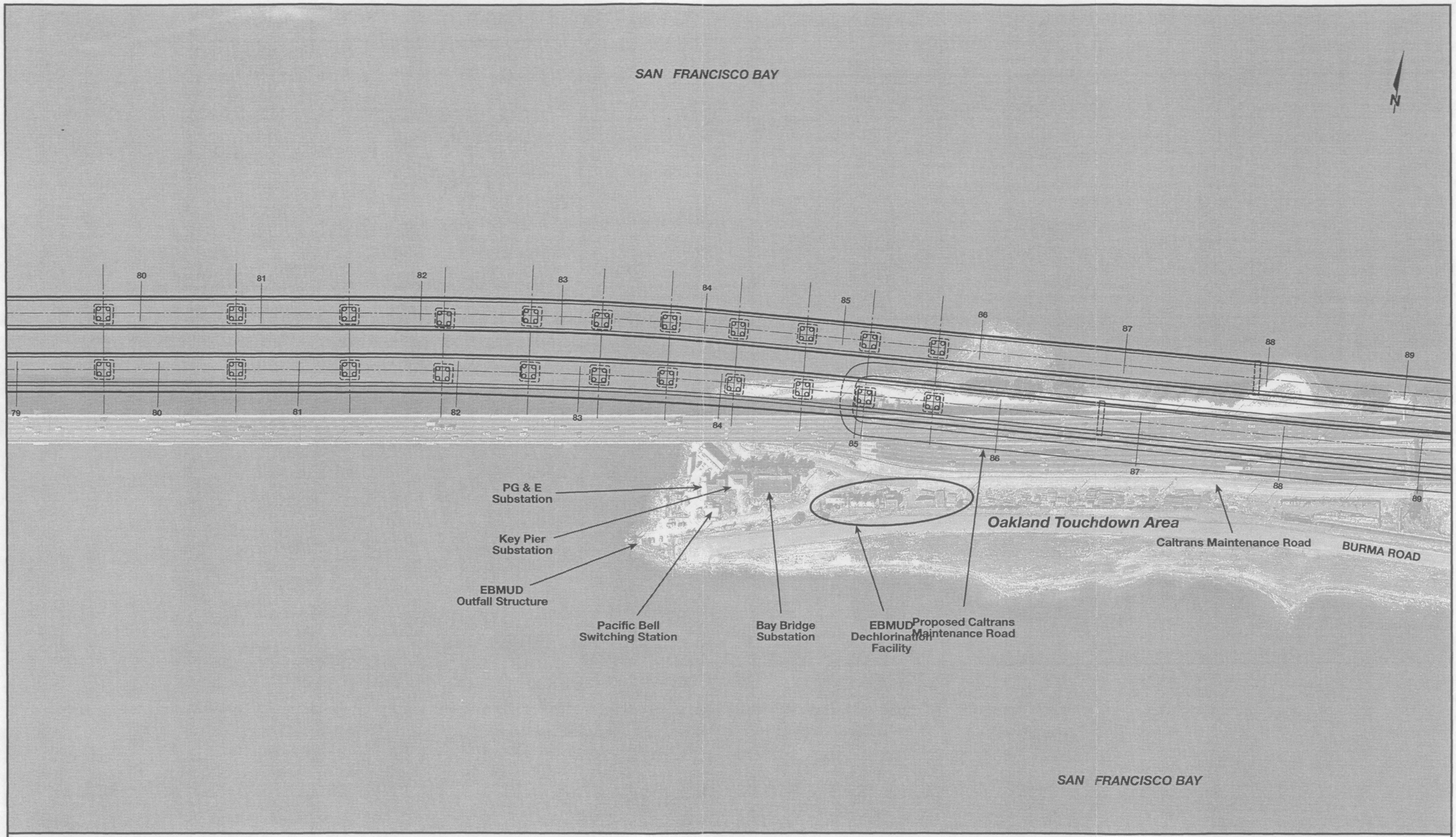


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500
0 100 200 300 m

Replacement Alternative N-6
Suspension/Skyway Structure Variation
Figure 2-10.4a

4/26/01



SFOBB EAST SPAN SEISMIC SAFETY PROJECT

GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative N-6 Cable-Stayed Structure Variation

Figure 2-10.4b

4/25/01

SAN FRANCISCO BAY

N

Radio Road

Radio Point Beach

Radio Point

90

91

92

92

89

90

91

92

Oakland Touchdown Area

Proposed Caltrans
Maintenance Road

Caltrans Maintenance Road

BURMA ROAD

SAN FRANCISCO BAY

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

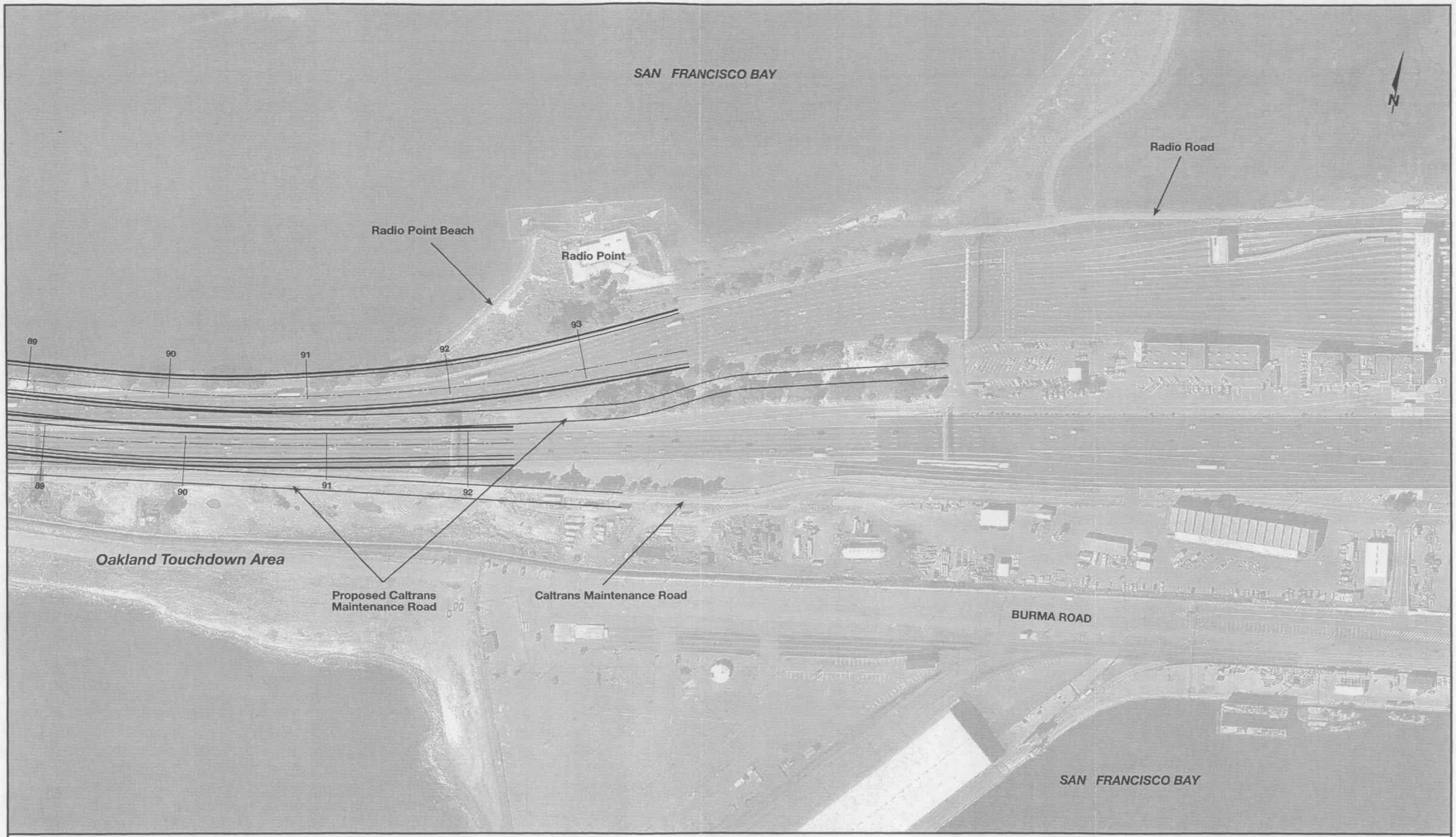
GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative N-6
Suspension/Skyway Structure Variation

Figure 2-10.5a

2/3/01



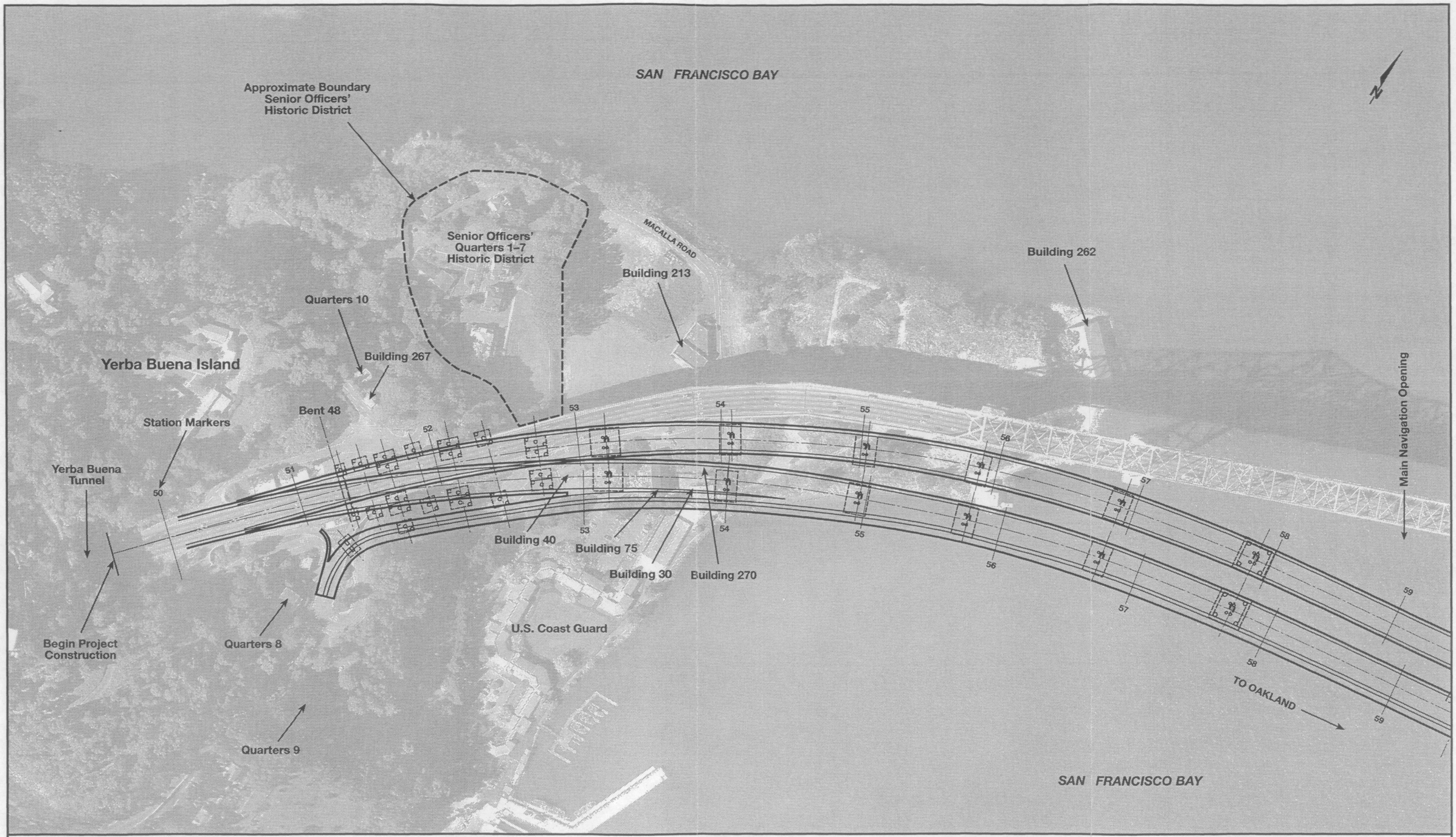
SFOBB EAST SPAN SEISMIC SAFETY PROJECT

GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative N-6
Cable-Stayed Structure Variation
Figure 2-10.5b

2/3/01



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

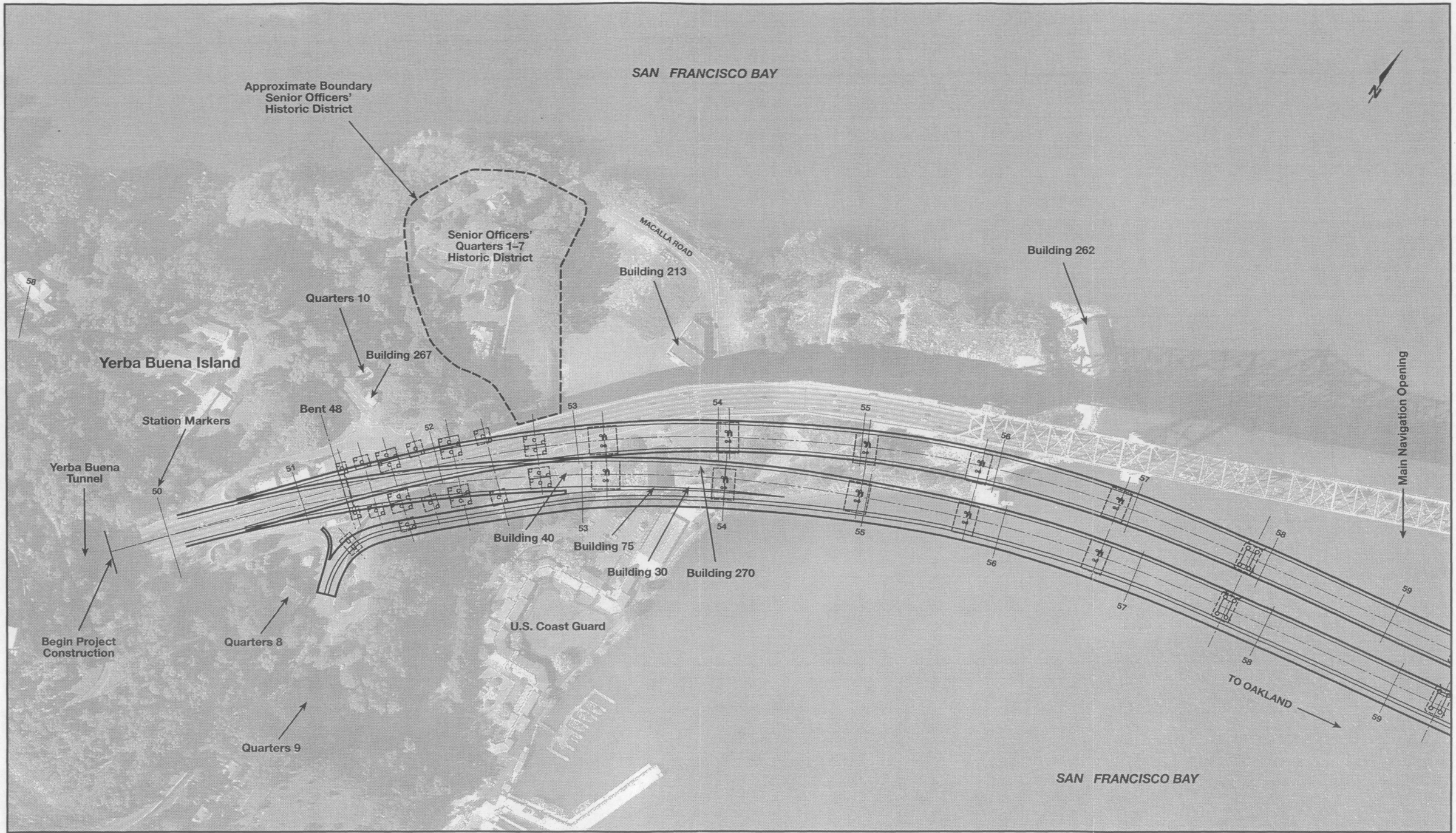
GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative S-4
Suspension Structure Variation

Figure 2-11.1a

4/25/01



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

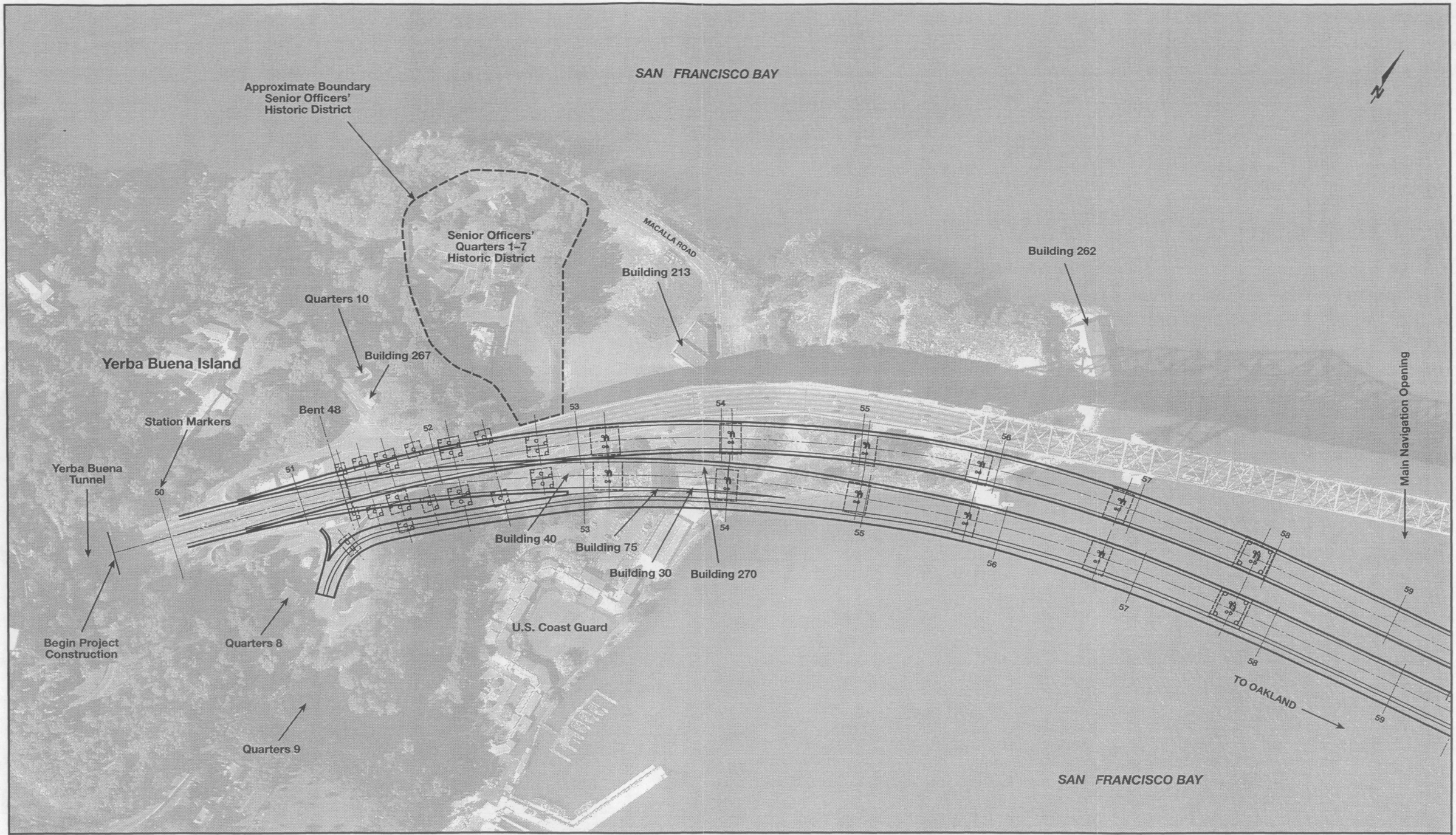
GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative S-4
Skyway Structure Variation

Figure 2-11.1b

4/25/01



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative S-4
Cable-Stayed Structure Variation
Figure 2-11.1c

4/25/01

SAN FRANCISCO BAY

N

TO YERBA BUENA ISLAND

58 59 60 61 62 63 64 65 66 67 68

Main Navigation Opening

Proposed Foundation Limits–
Main Tower Support

TO OAKLAND

SAN FRANCISCO BAY

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative S-4
Suspension Structure Variation

Figure 2-11.2a

4/25/01

SAN FRANCISCO BAY

N

TO YERBA BUENA ISLAND

Main Navigation Opening

Proposed Foundation Limits–
Main Tower Support

58 59 60 61 62 63 64 65 66 67 68

TO OAKLAND

SAN FRANCISCO BAY

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative S-4
Cable-Stayed Structure Variation

Figure 2-11.2b

4/25/01

SAN FRANCISCO BAY

N

TO YERBA BUENA ISLAND

Main Navigation Opening

58 59 60 61 62 63 64 65 66 67

TO OAKLAND

SAN FRANCISCO BAY

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

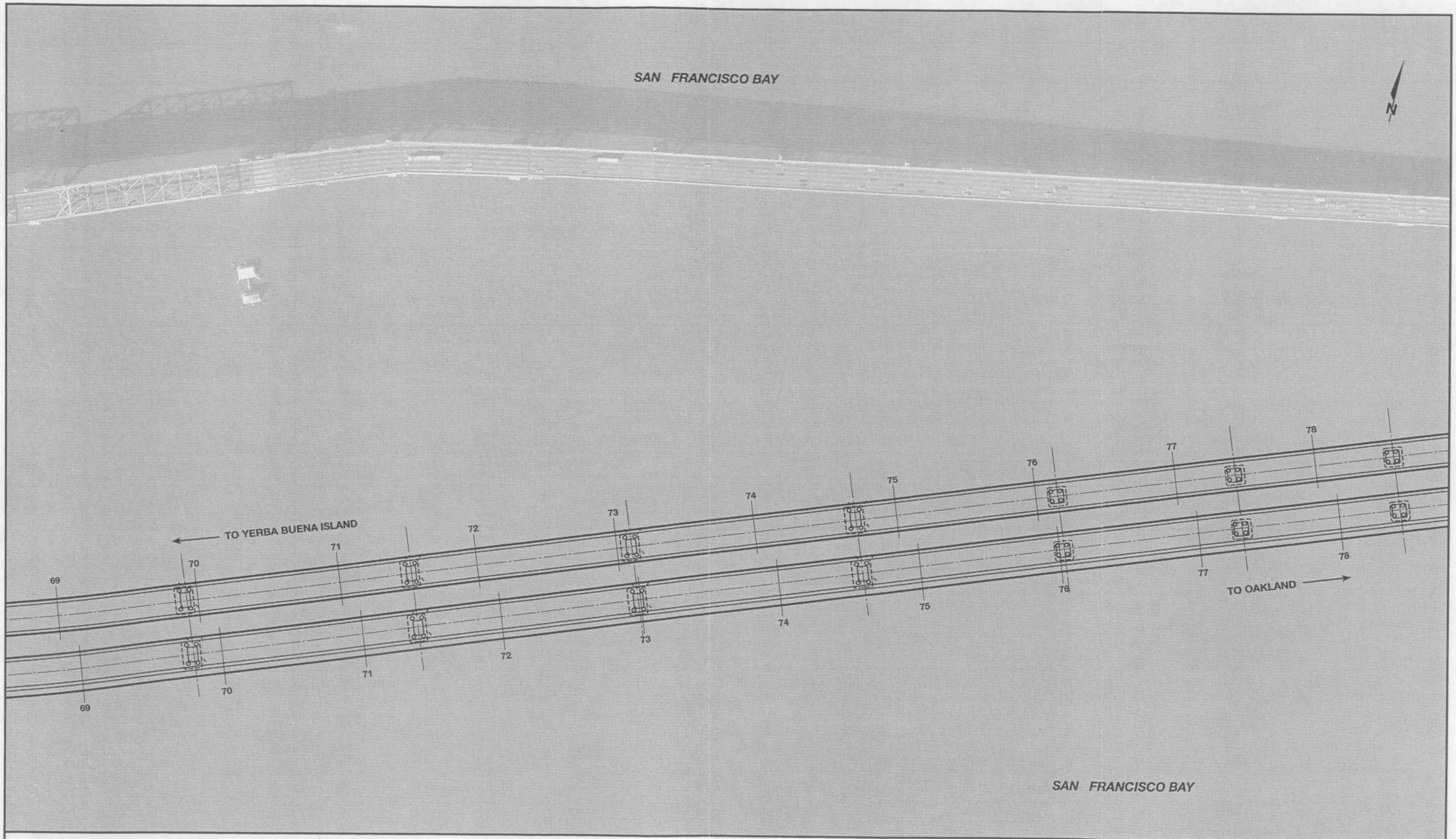
GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative S-4
Skyway Structure Variation

Figure 2-11.2c

4/25/01



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

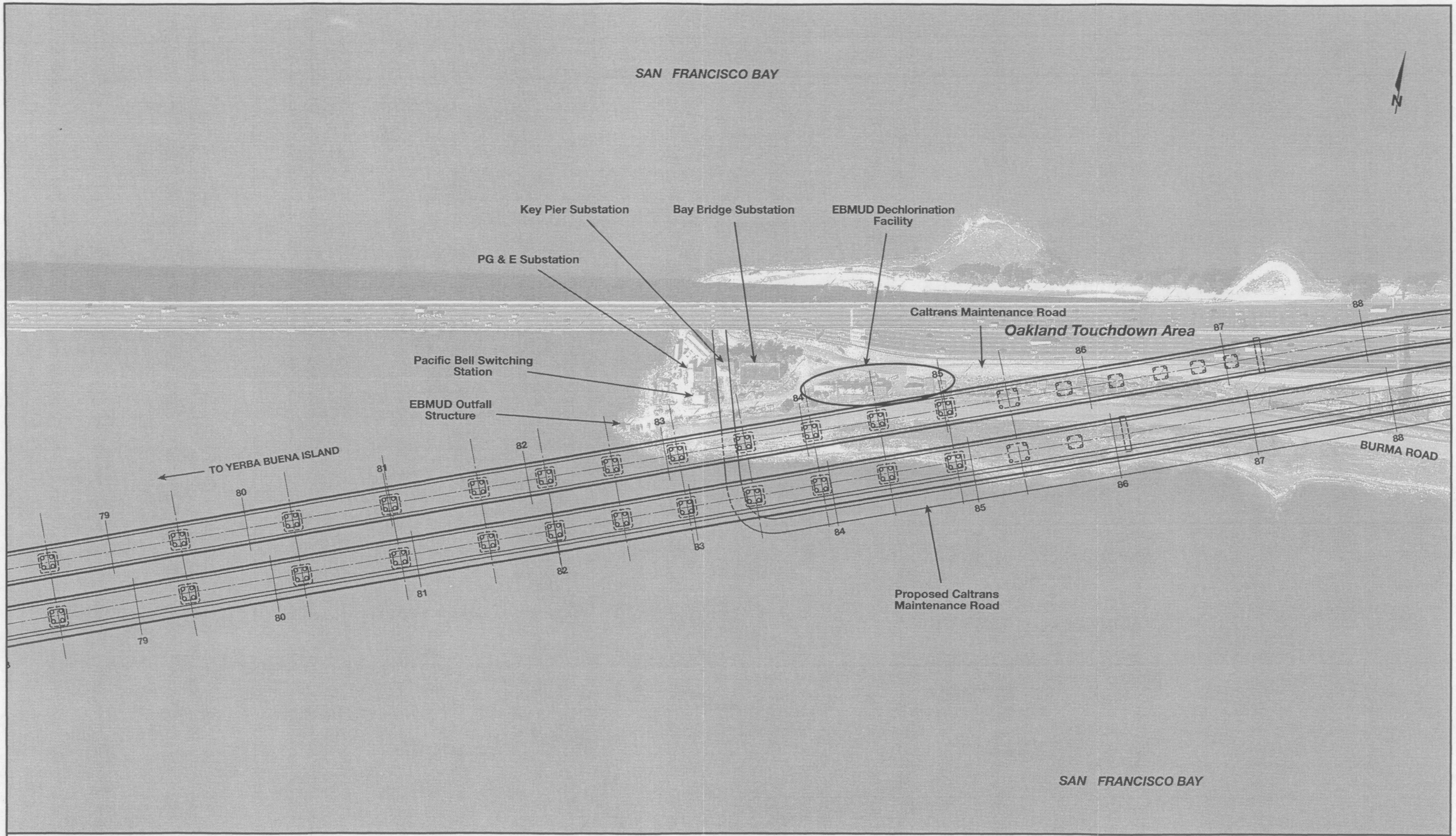
GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative S-4
All Design Variations

Figure 2-11.3

2/3/01



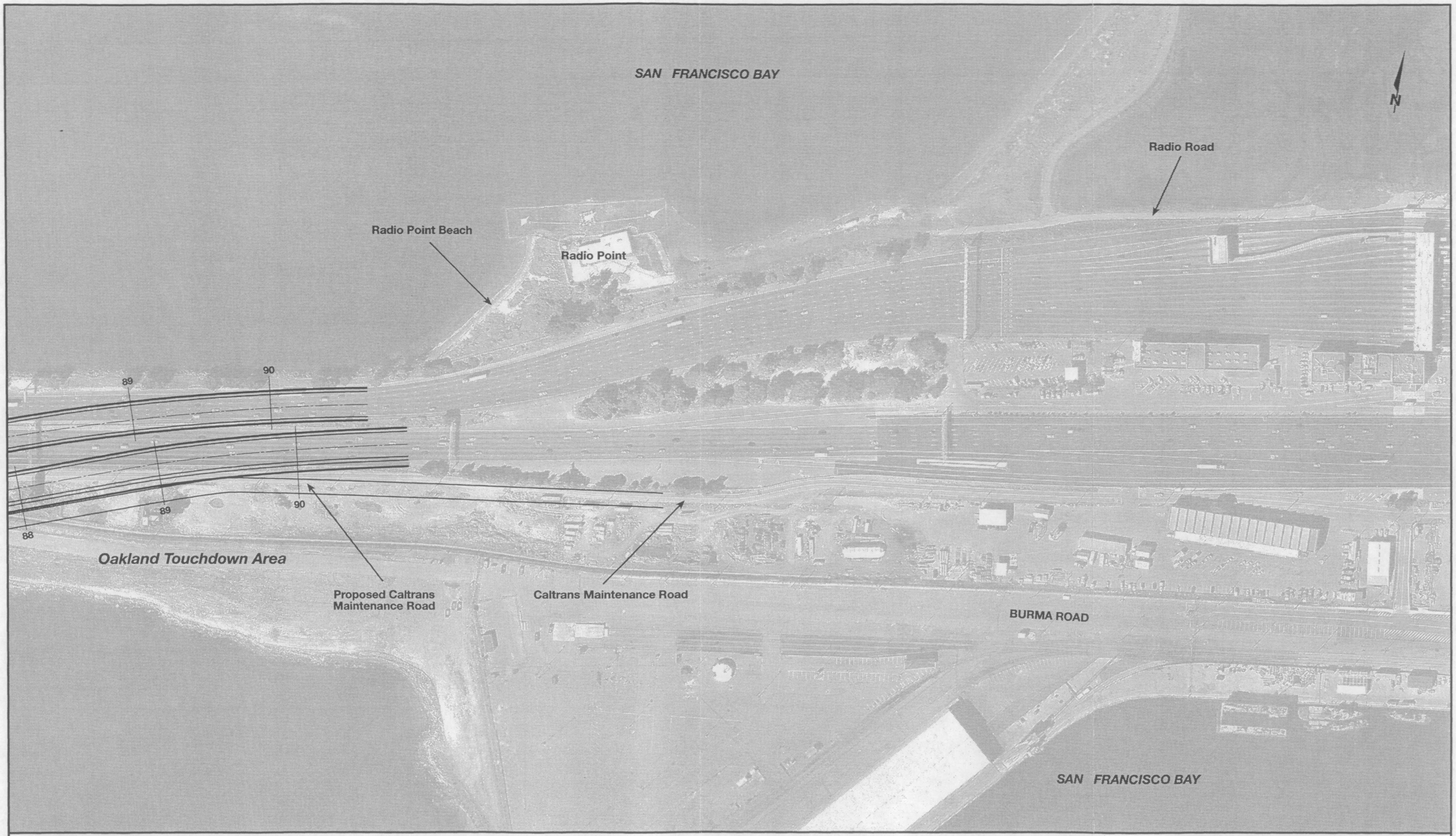
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,500
0 100 200 300 m

Replacement Alternative S-4
All Design Variations

Figure 2-11.4

4/25/01



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

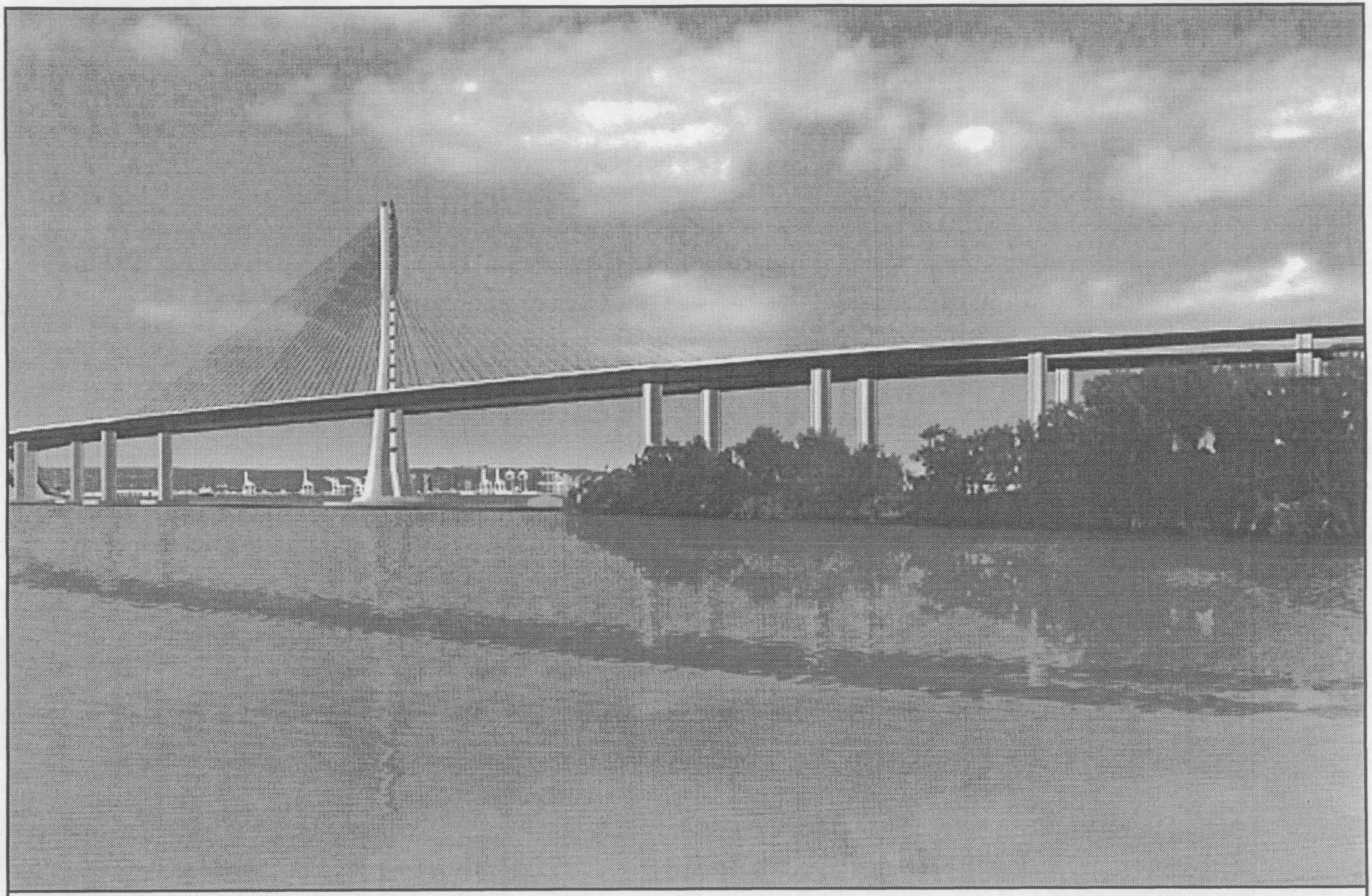
GRAPHIC SCALE 1:2,500

0 100 200 300 m

Replacement Alternative S-4
All Design Variations

Figure 2-11.5

2/3/01

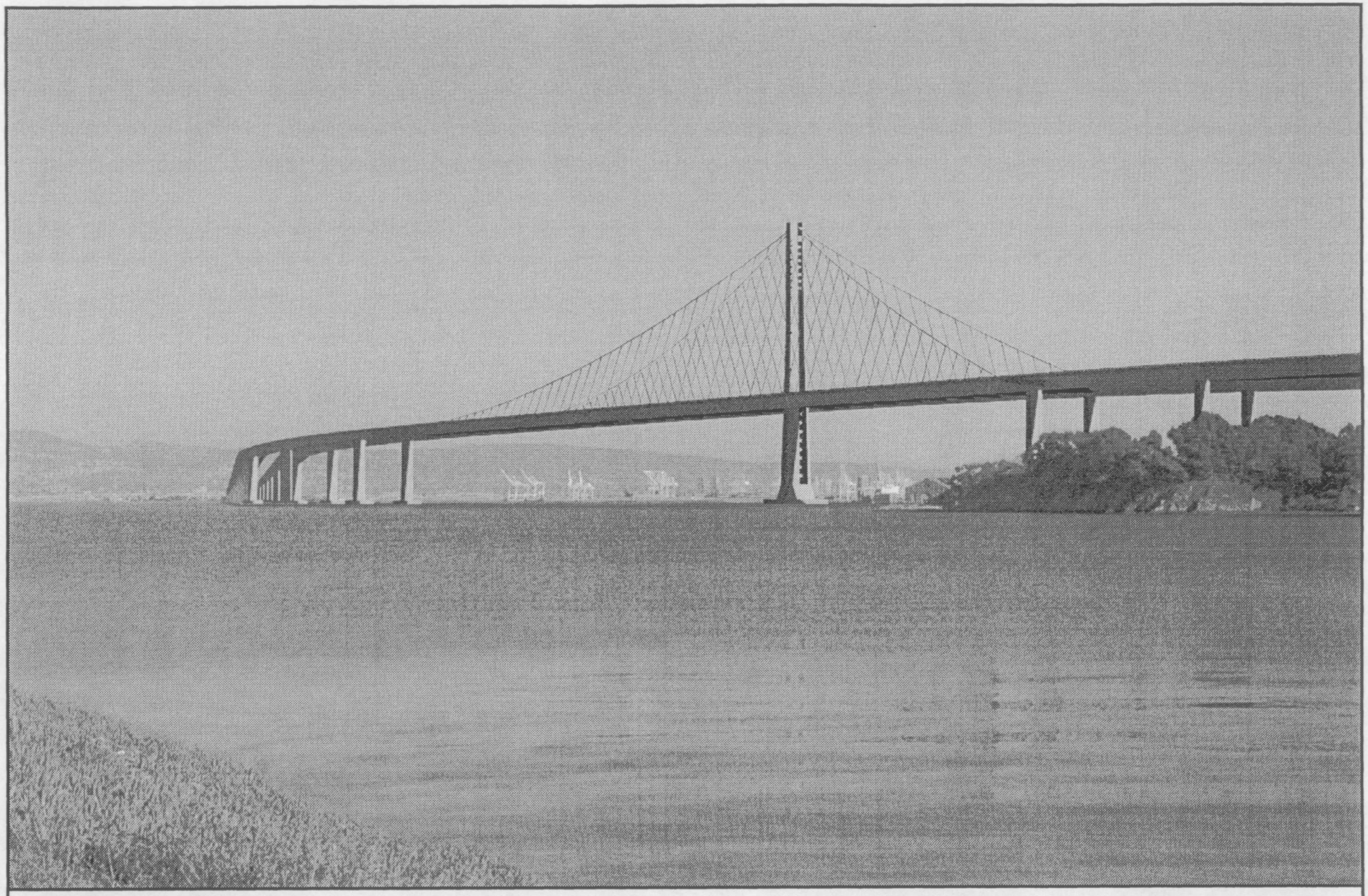


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Cable-Stayed Bridge Design

Figure 2-12

3/2/99

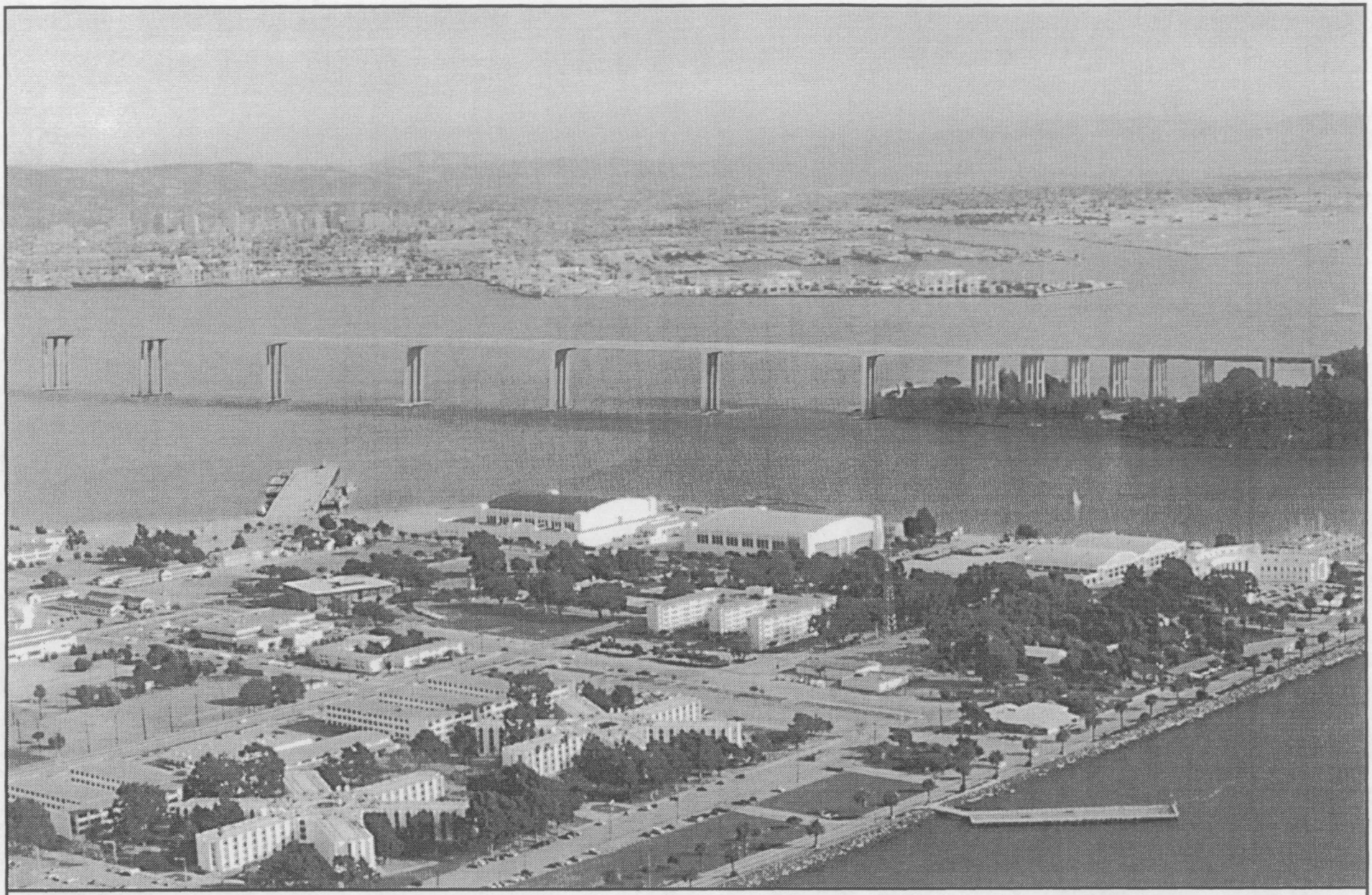


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Self Anchored Suspension Bridge Design

Figure 2-13

2/7/01

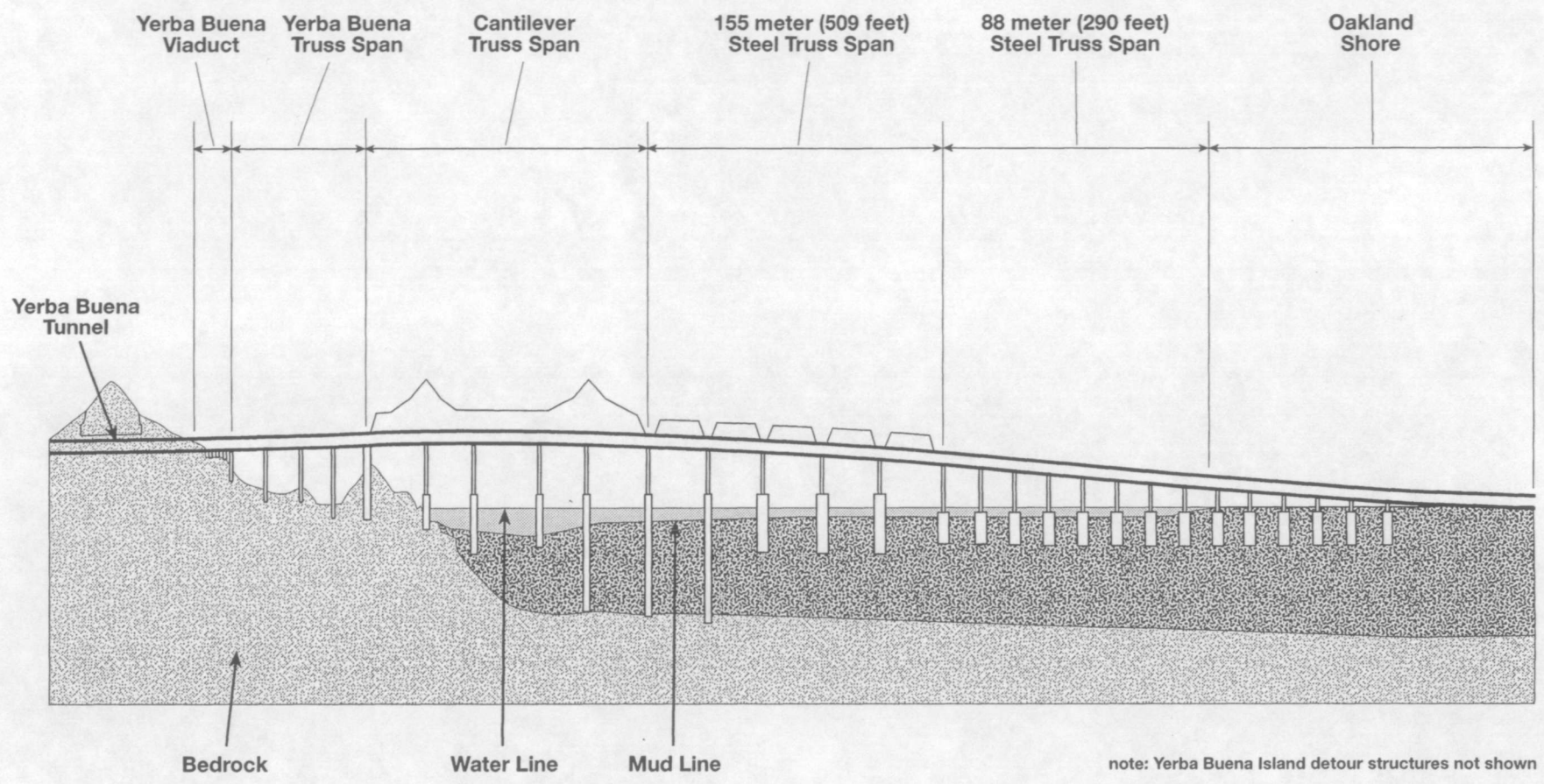


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Skyway Bridge Design

Figure 2-14

9/8/98

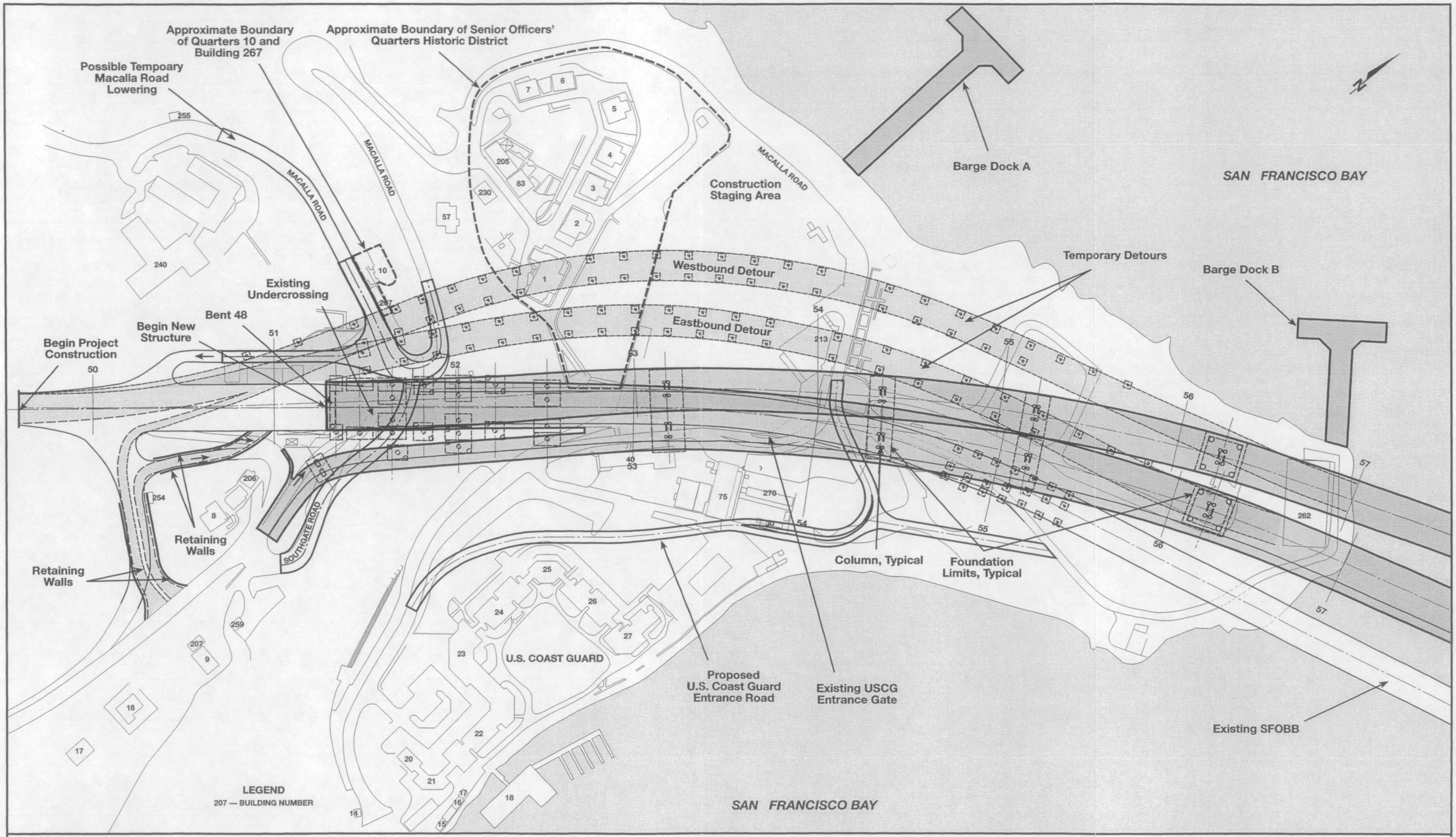


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

NO SCALE
VERTICAL EXAGGERATED

Major Components of Dismantling Activities

Figure 2-15



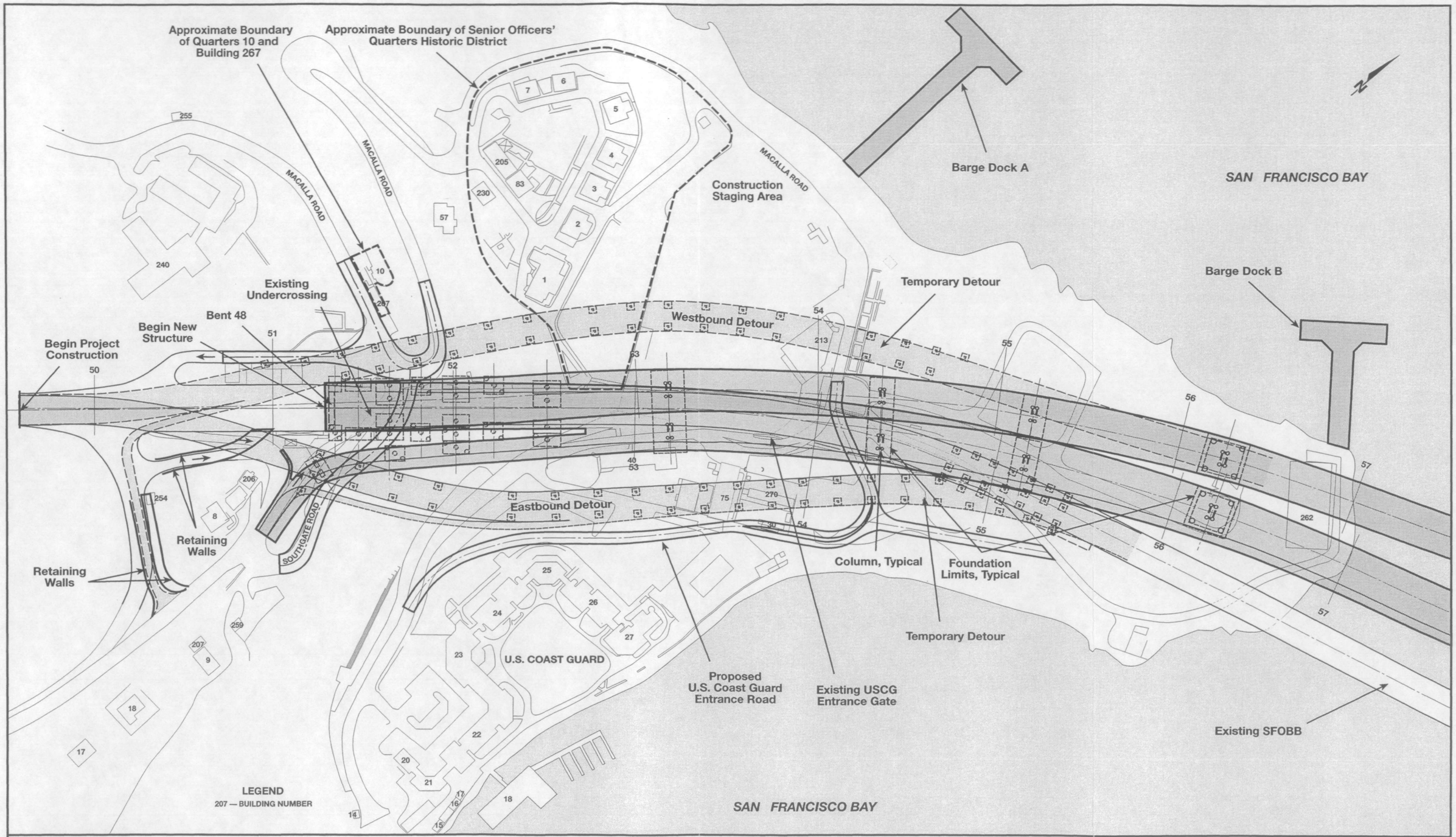
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,000
0 25 50 100 m

Foundation Construction Impact
Temporary Detours: North Option Replacement Alternative N-2

Figure 2-16.1

4/4/01



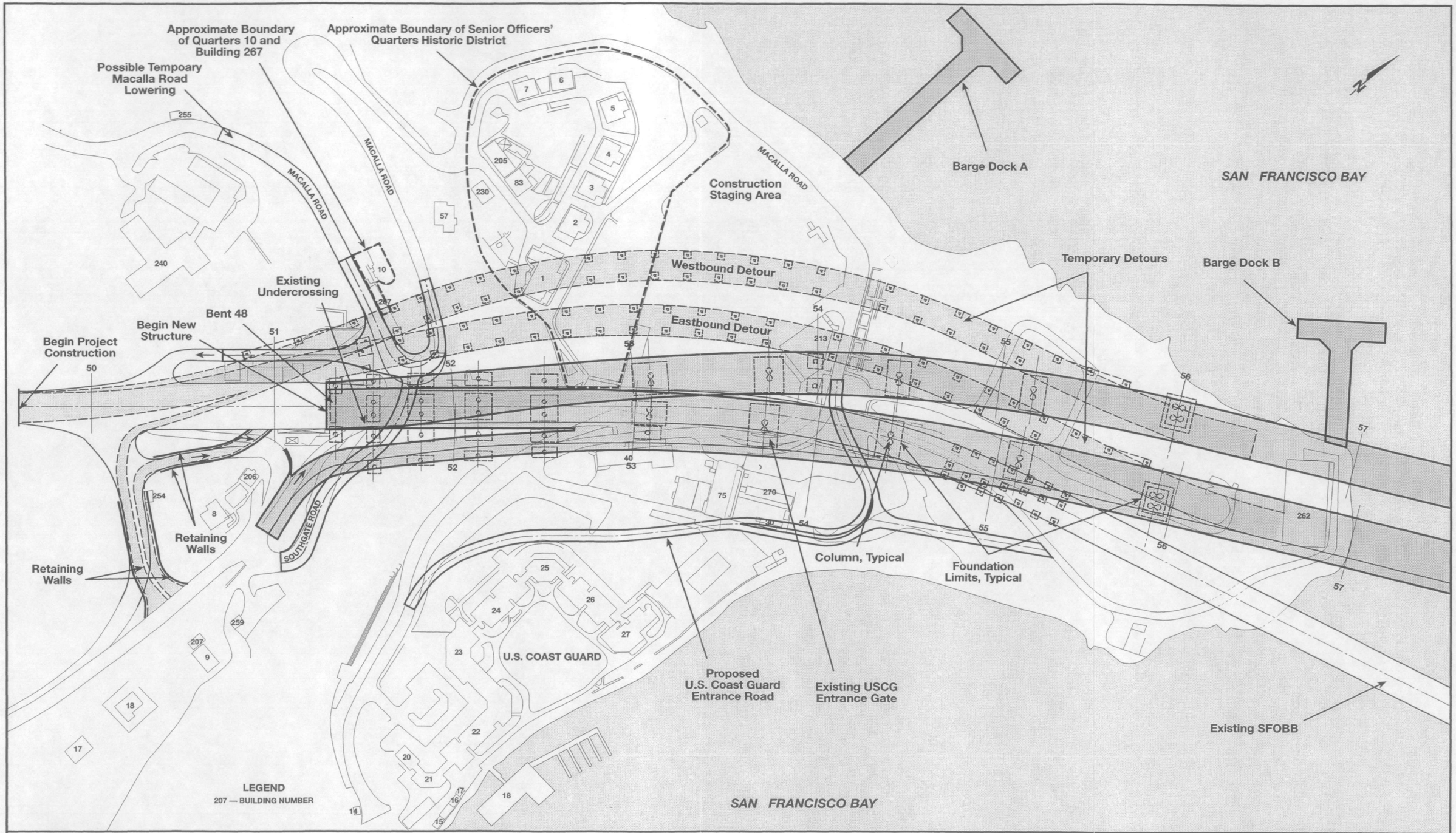
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,000
0 25 50 100 m

Foundation Construction Impact
Temporary Detours: North-South Option Replacement Alternative N-2

Figure 2-16.2

4/4/01



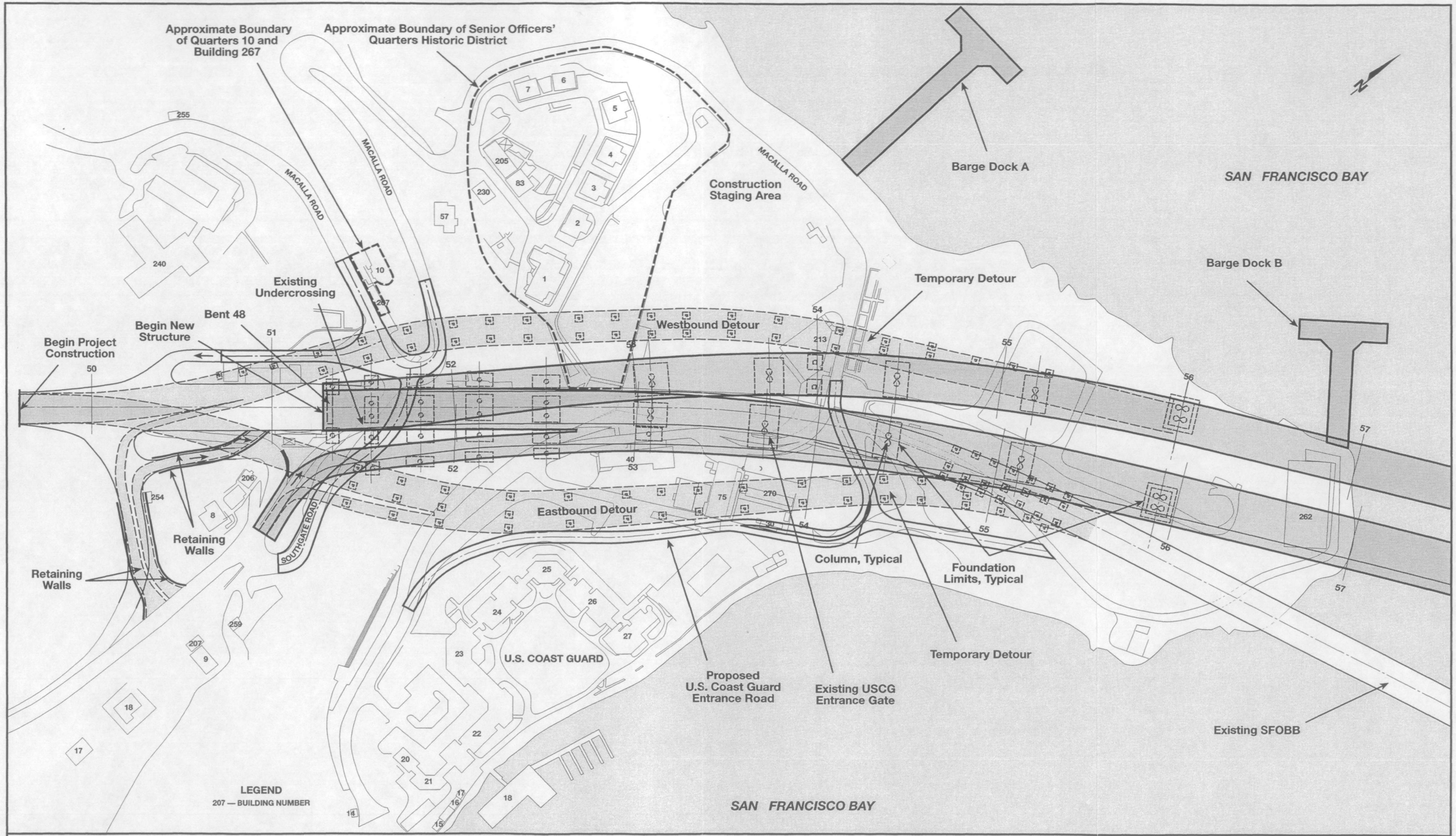
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,000
0 25 50 100 m

Foundation Construction Impact
Temporary Detours: North Option Replacement Alternative N-6

Figure 2-17.1

4/4/01



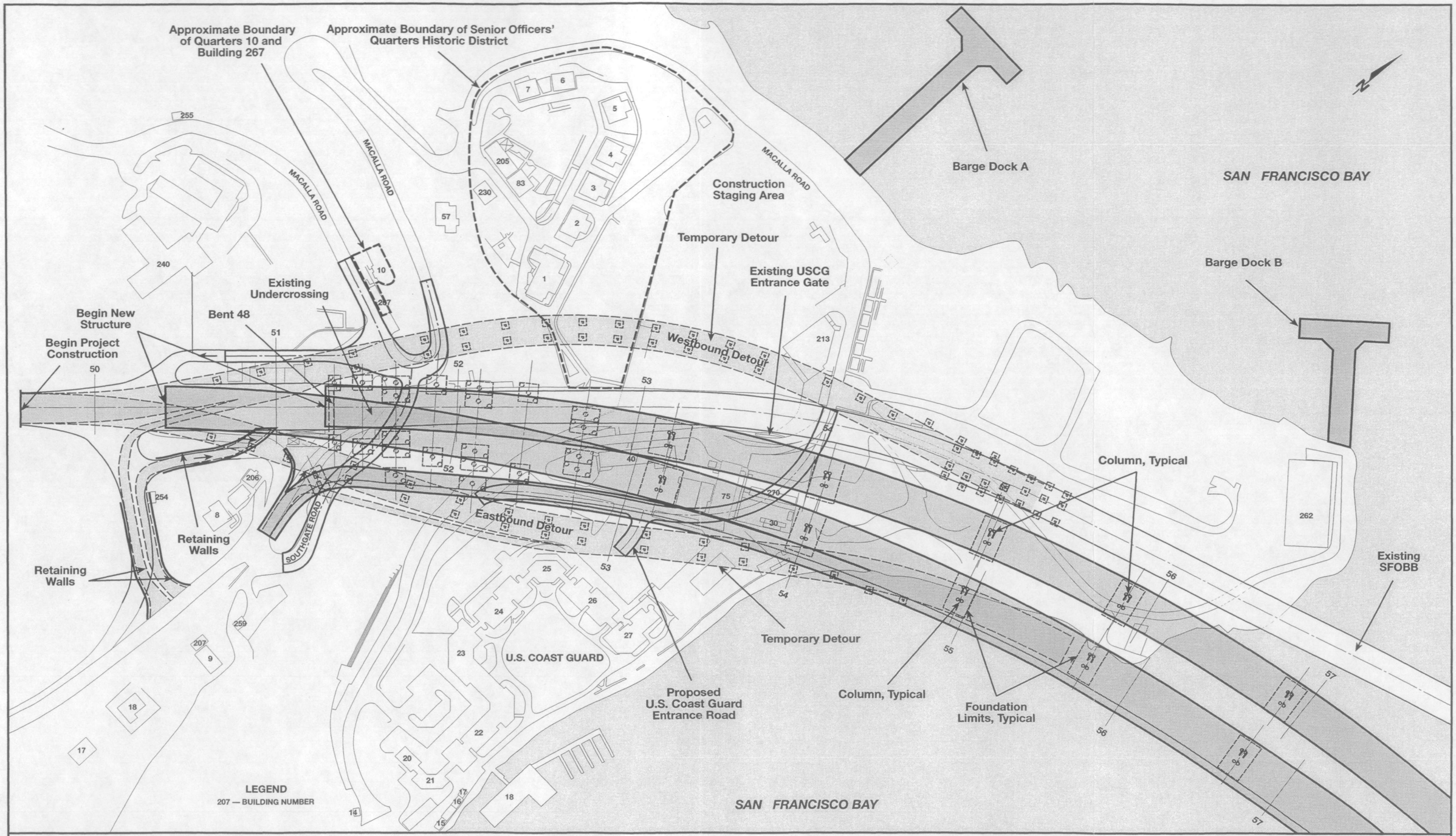
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:2,000
0 25 50 100 m

Foundation Construction Impact
Temporary Detours: North-South Option Replacement Alternative N-6

Figure 2-17.2

4/4/01

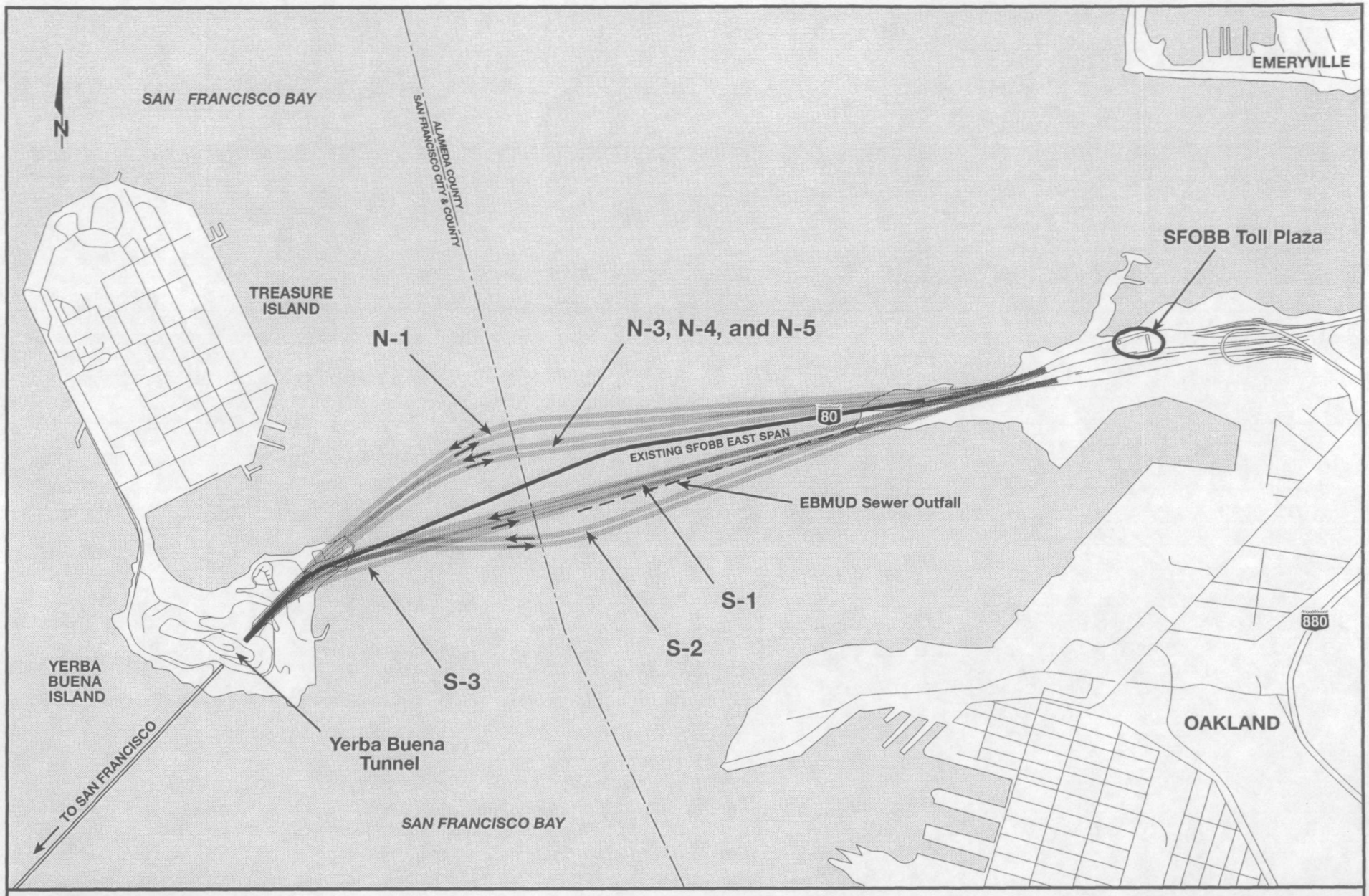


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Foundation Construction Impact
Temporary Detours: North-South Option Replacement Alternative S-4

Figure 2-18

4/4/01



SFOBB EAST SPAN SEISMIC SAFETY PROJECT

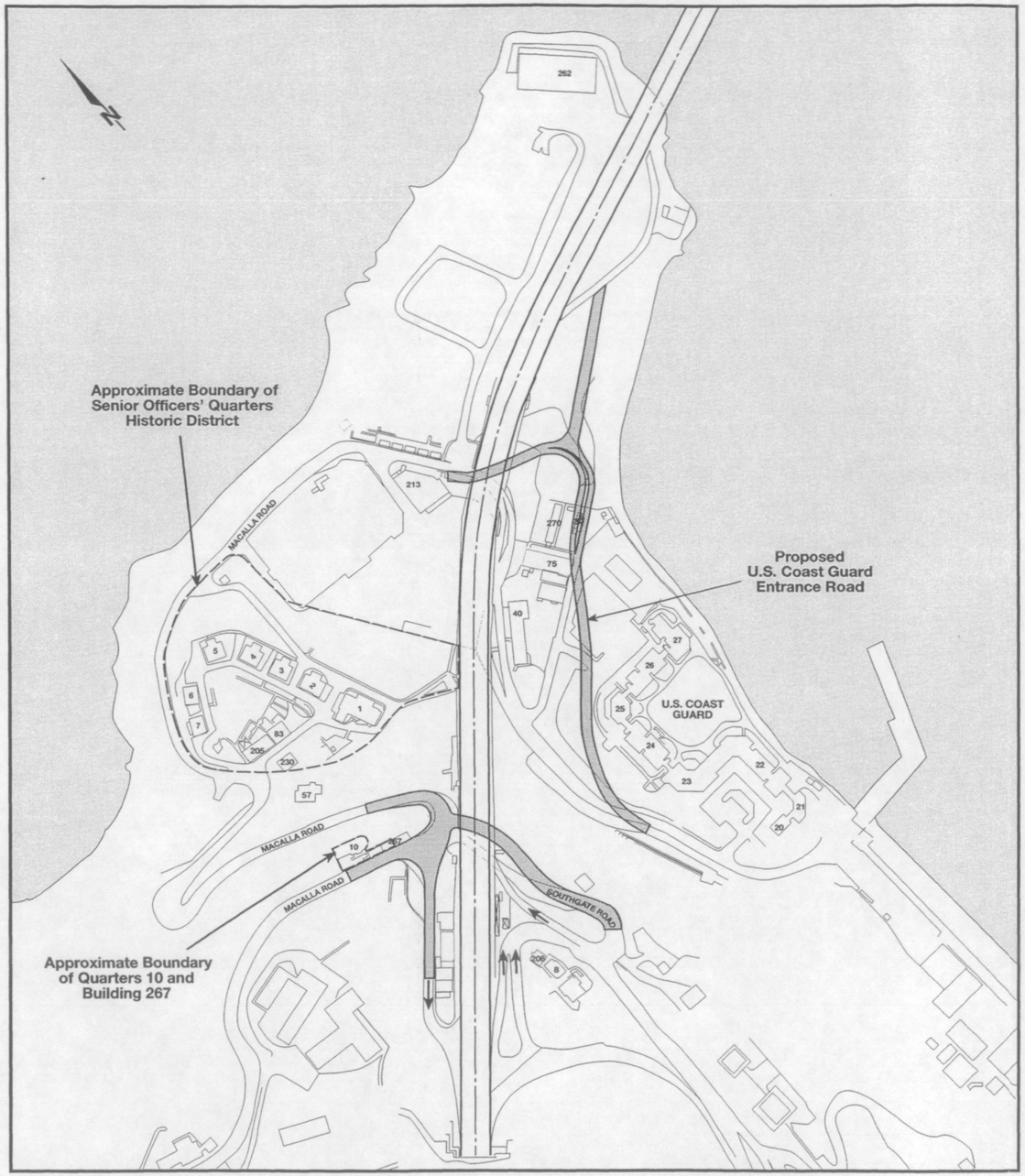
GRAPHIC SCALE 1:27,500

0 250 500 1000 m

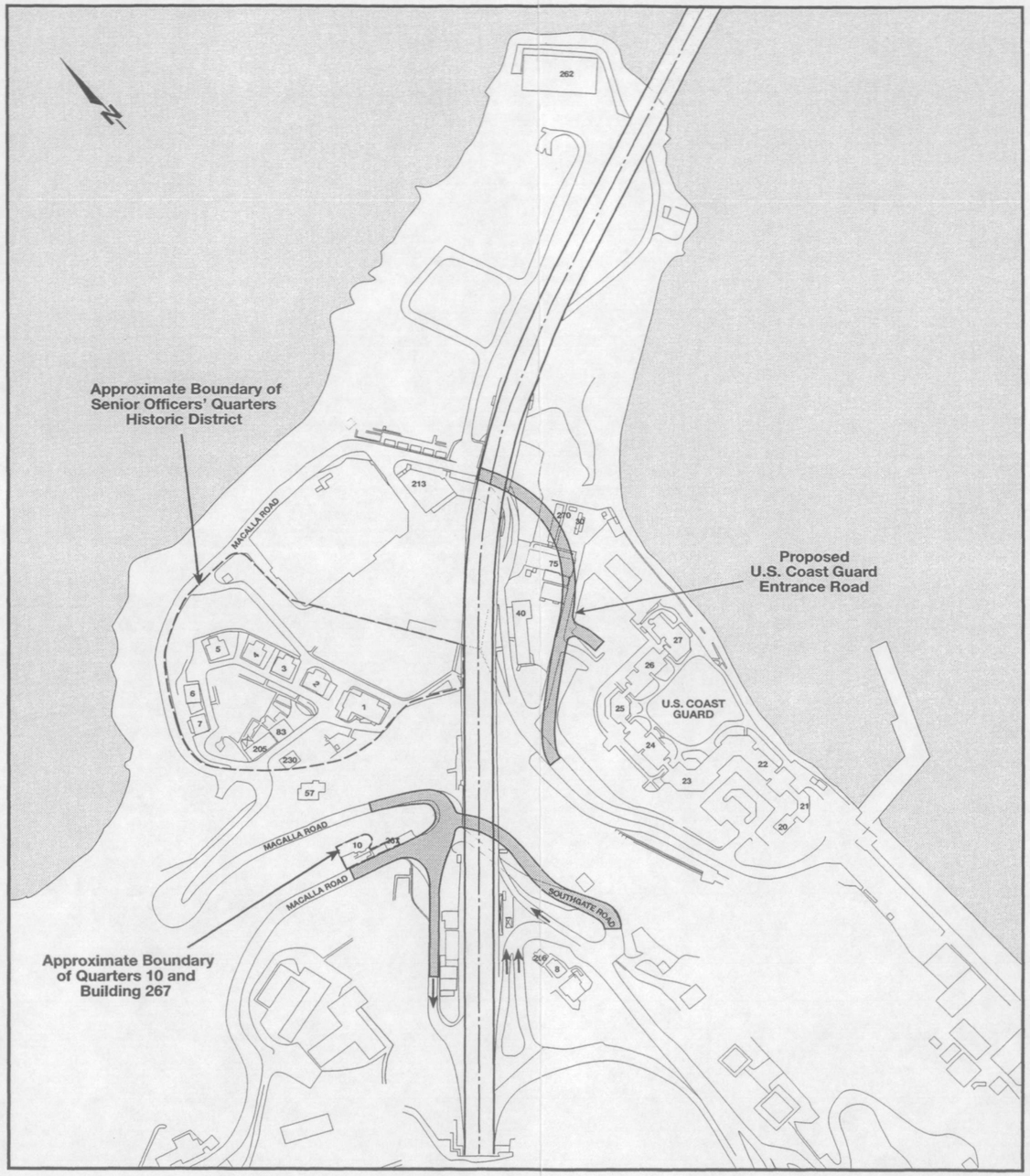
Replacement Alternatives Considered and Withdrawn

Figure 2-19

2/3/01



Replacement Alternatives N-2 and N-6



Replacement Alternative S-4

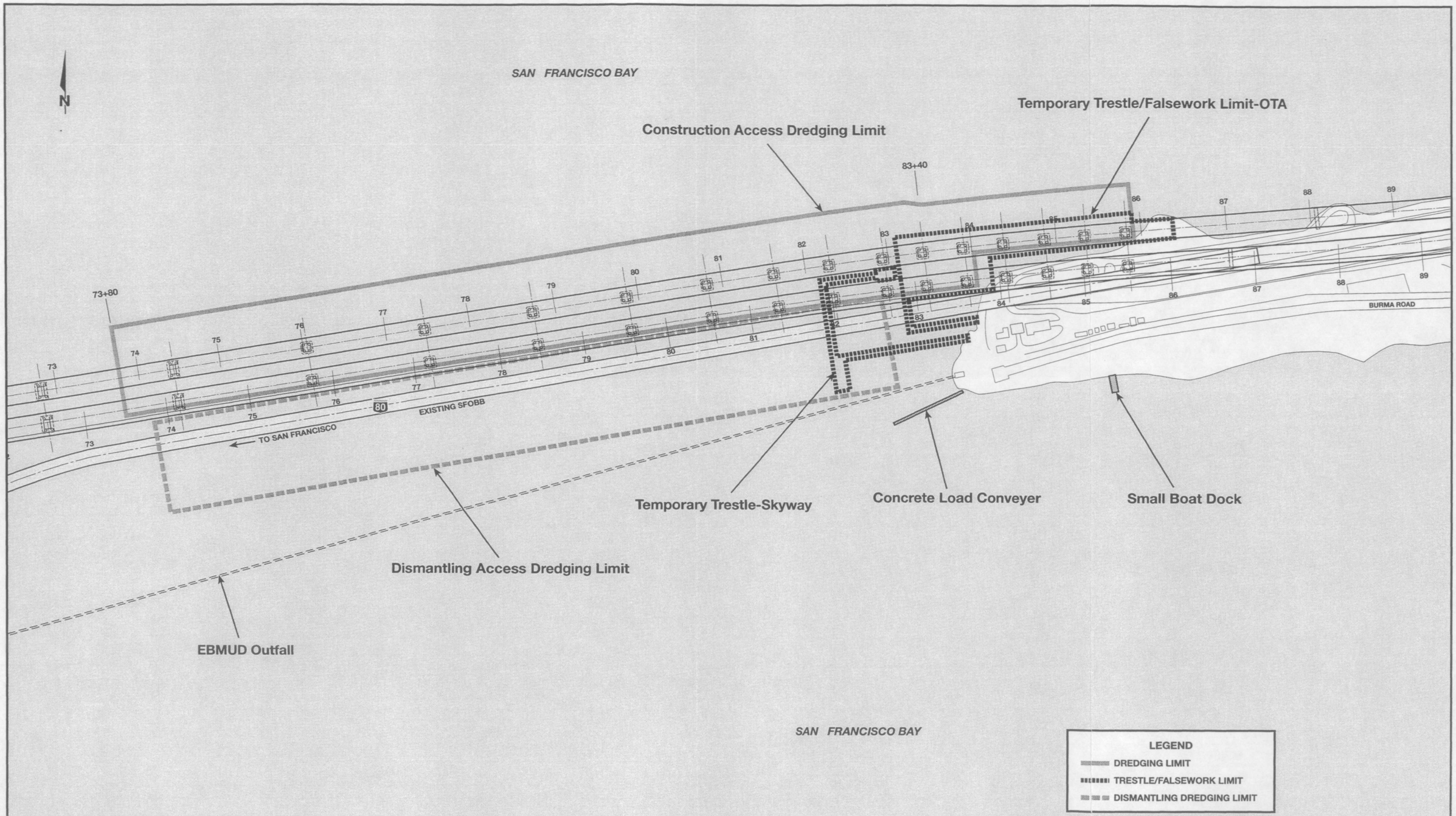
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:3,500
0 25 50 m

Potential Roadway Modifications For Replacement Alternatives

Figure 2-20

4/12/01

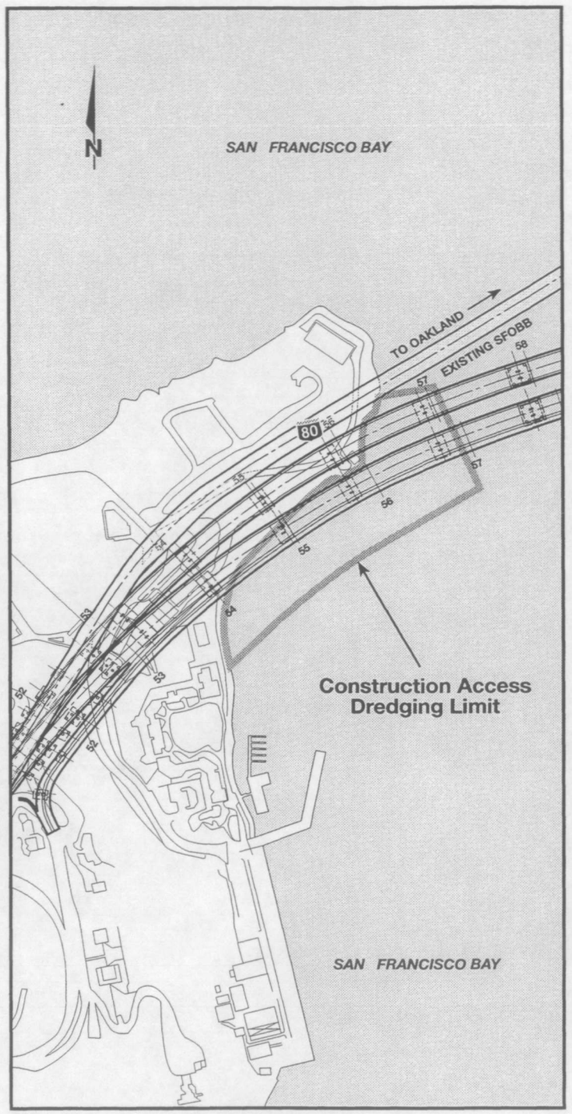


SFOBB EAST SPAN SEISMIC SAFETY PROJECT

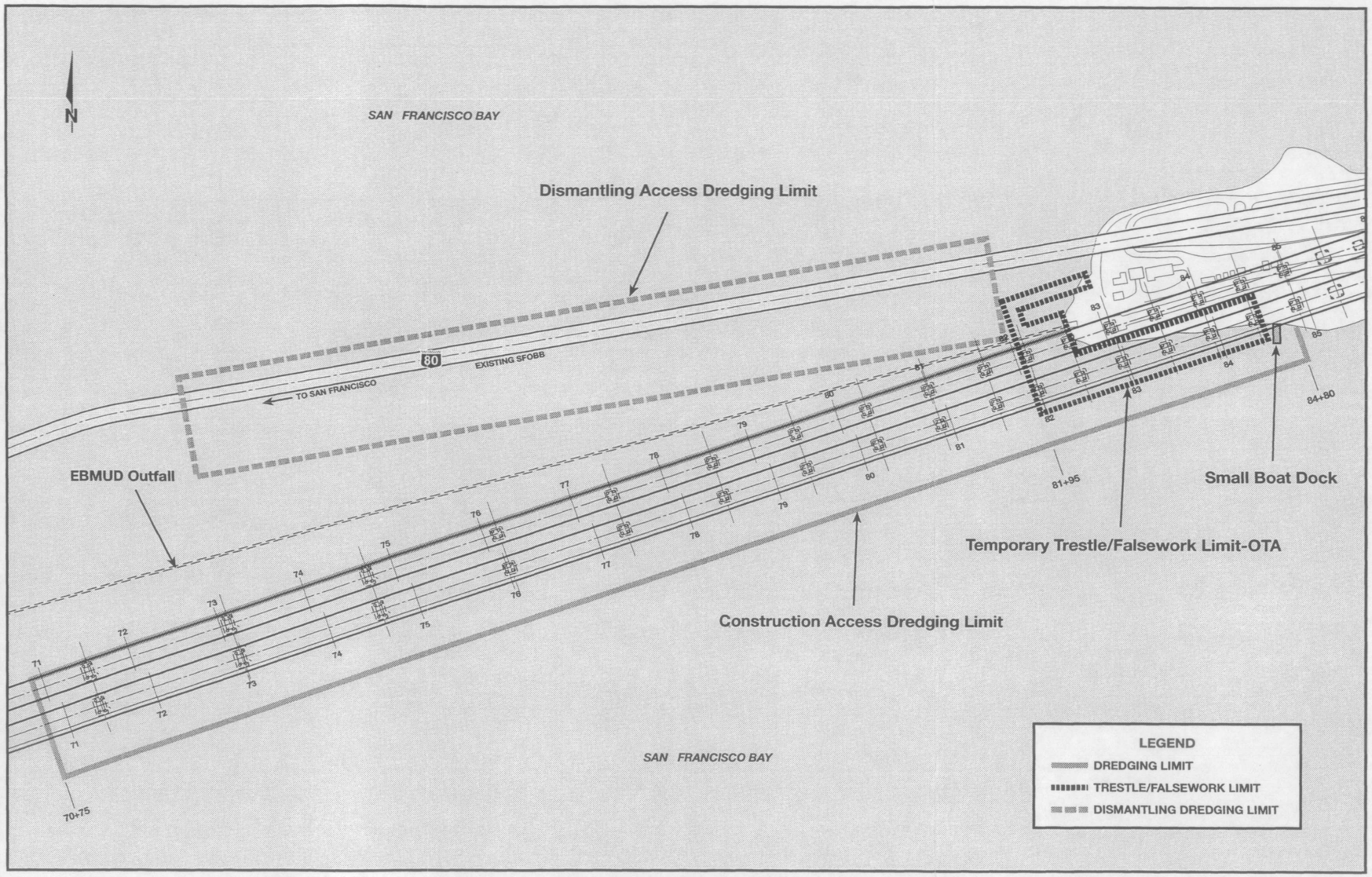
GRAPHIC SCALE 1:6,000
0 50 100 150 m

Construction Dredging and Trestle Limits-
Replacement Alternatives N-2 and N-6
Figure 2-21

4/4/01



Yerba Buena Island



Oakland Touchdown Area

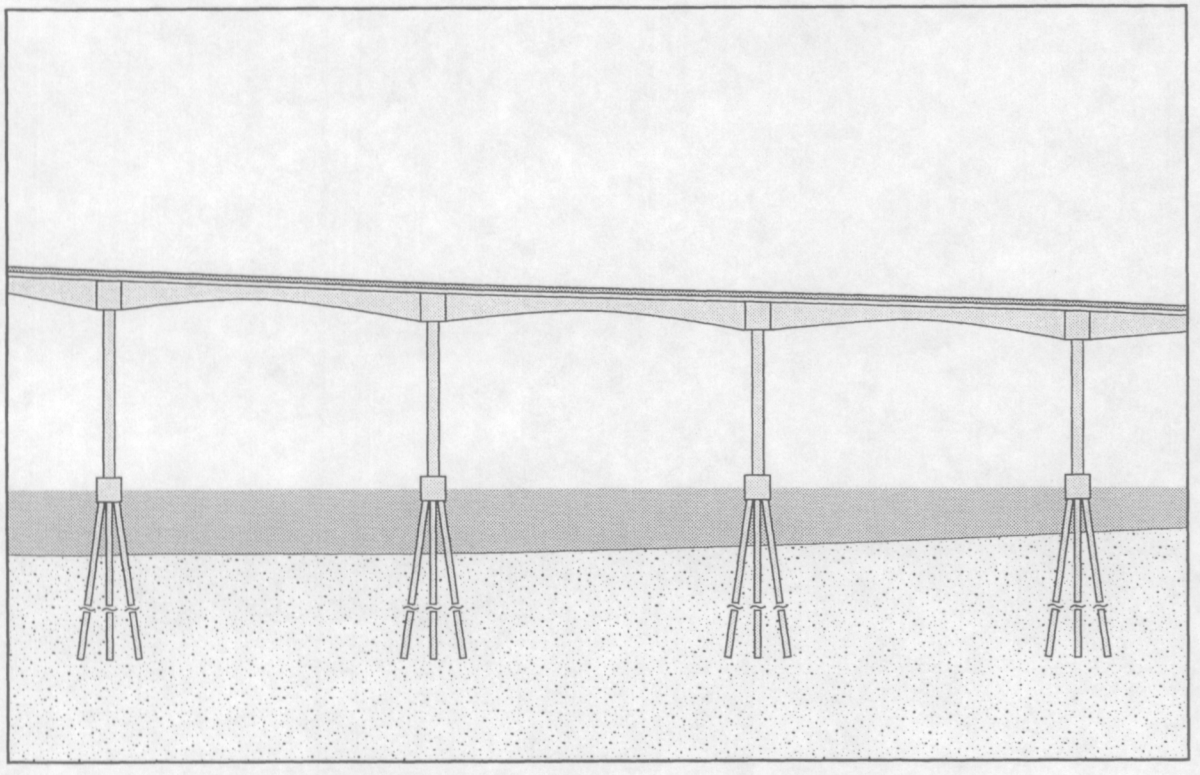
SFOBB EAST SPAN SEISMIC SAFETY PROJECT

GRAPHIC SCALE 1:7,000
0 50 10 150 m

Construction Dredging and Trestle Limits-Replacement Alternative S-4

Figure 2-22

4/4/



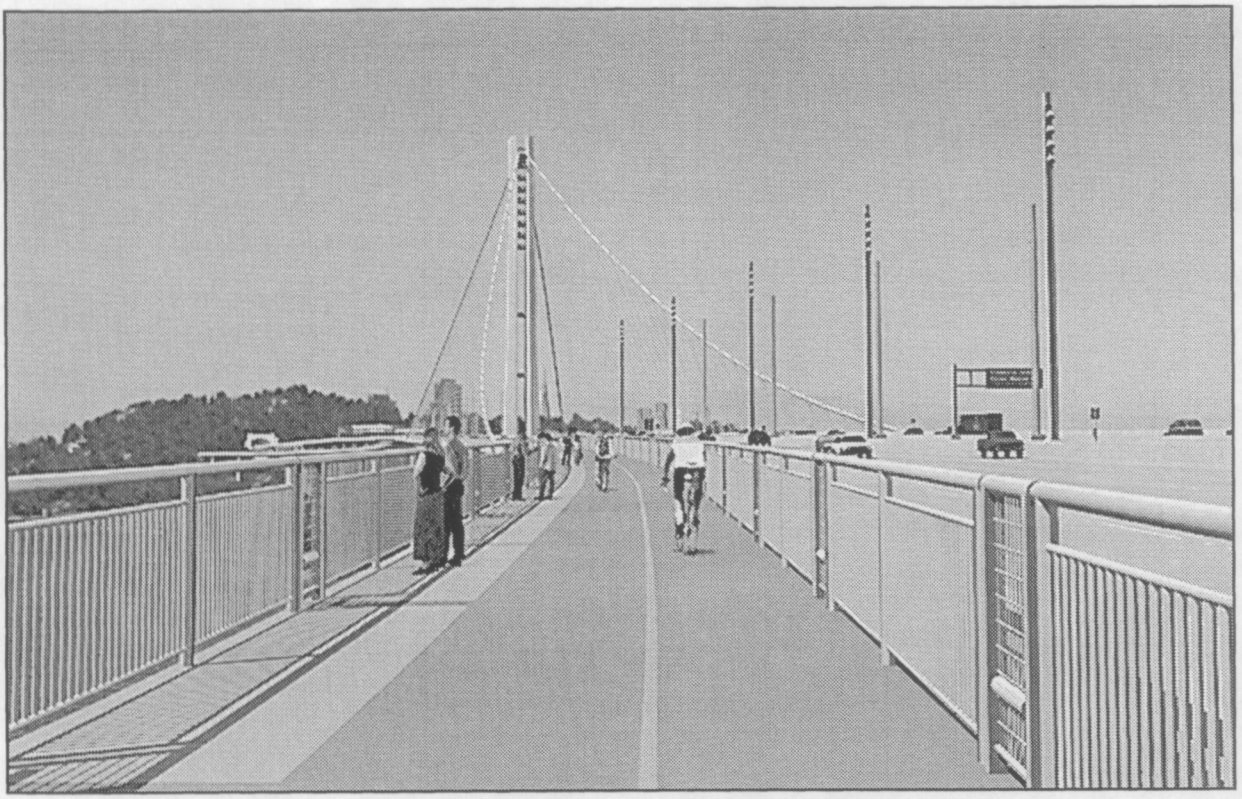
Not to Scale

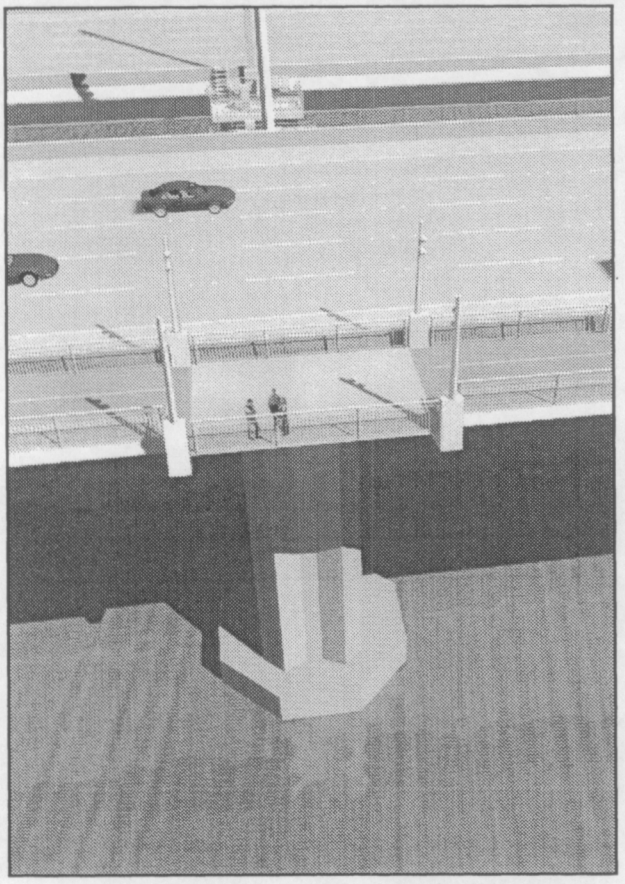
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Typical Frame for Haunched Concrete Girders on Skyway Structure

Figure 2-23

2/7/01

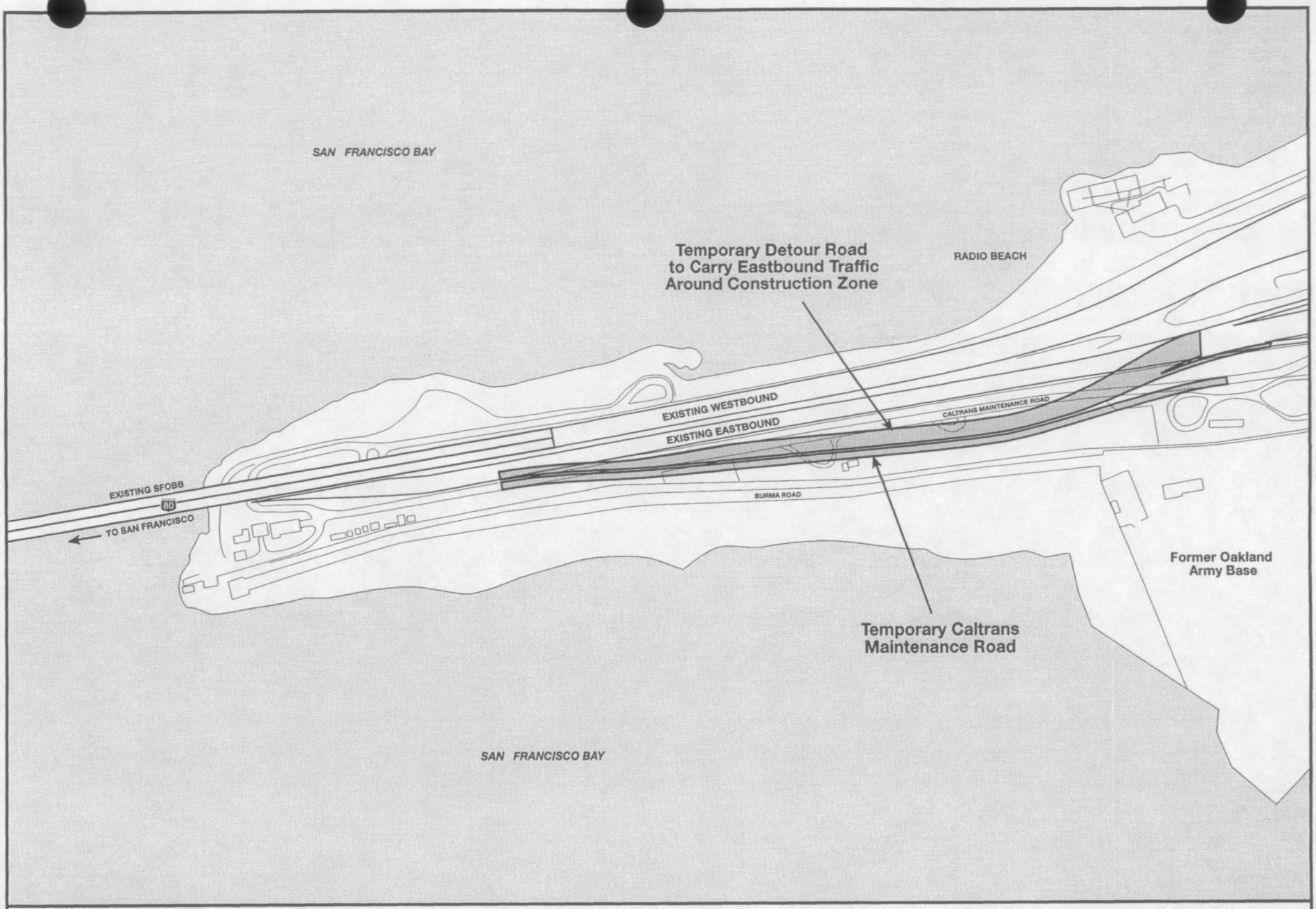




SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Visual Simulations of Bicycle and Pedestrian Path and Belvederes

Figure 2-24



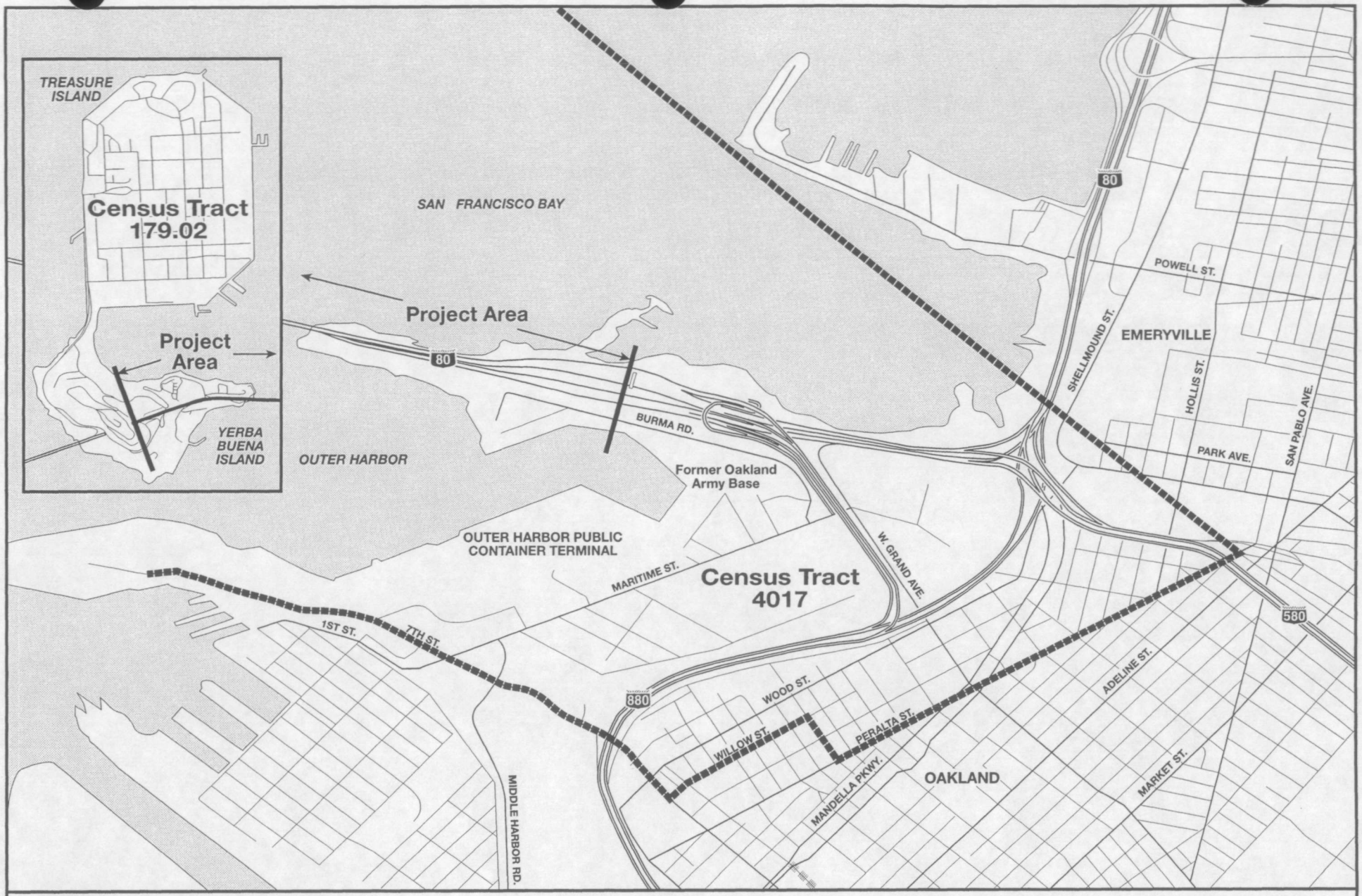
SFOBB EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:4,000

0 50 100 150 m

Temporary Roadways
Oakland Touchdown Area
Figure 2-25

2/7/01



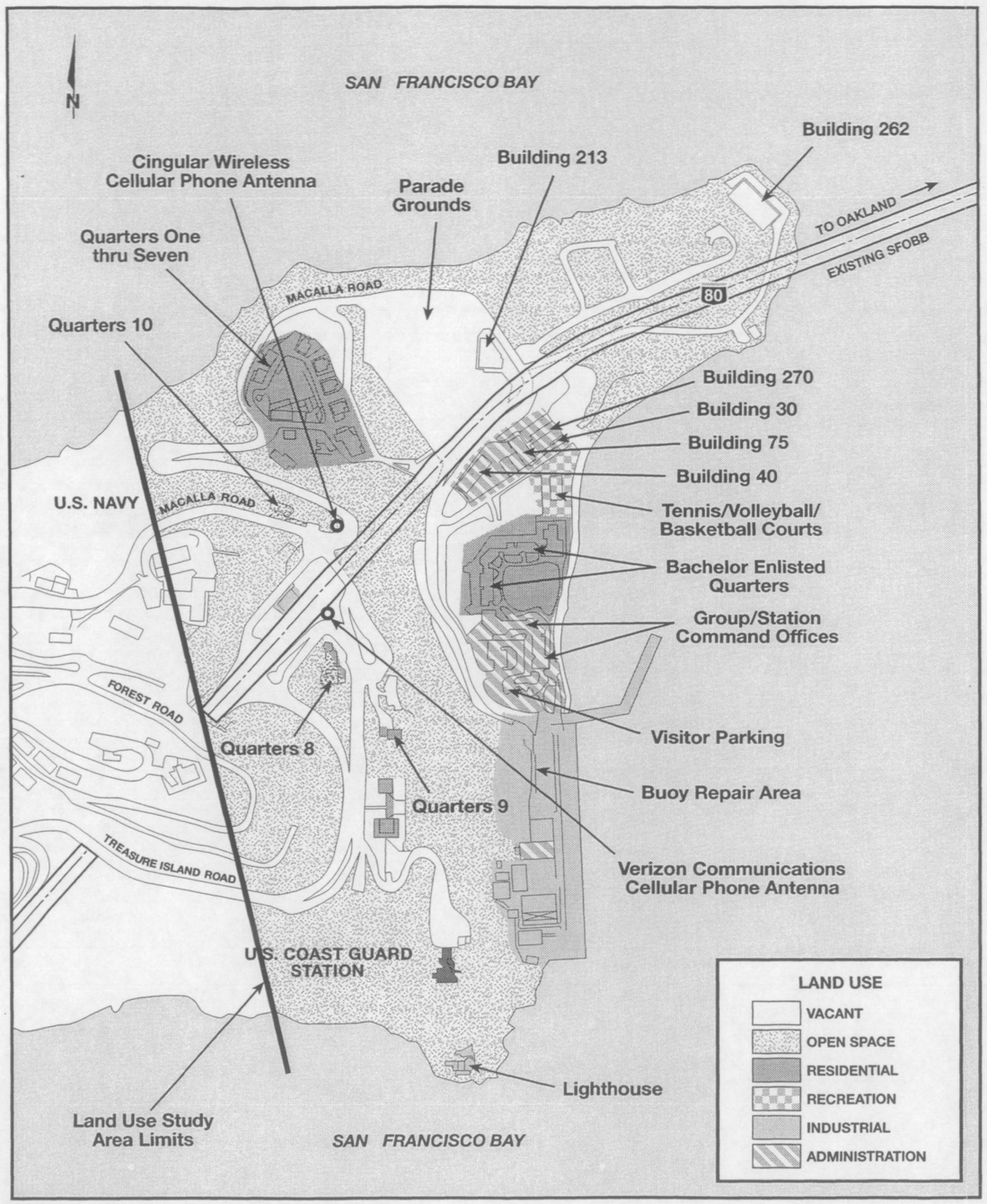
SFOBB EAST SPAN SEISMIC SAFETY PROJECT

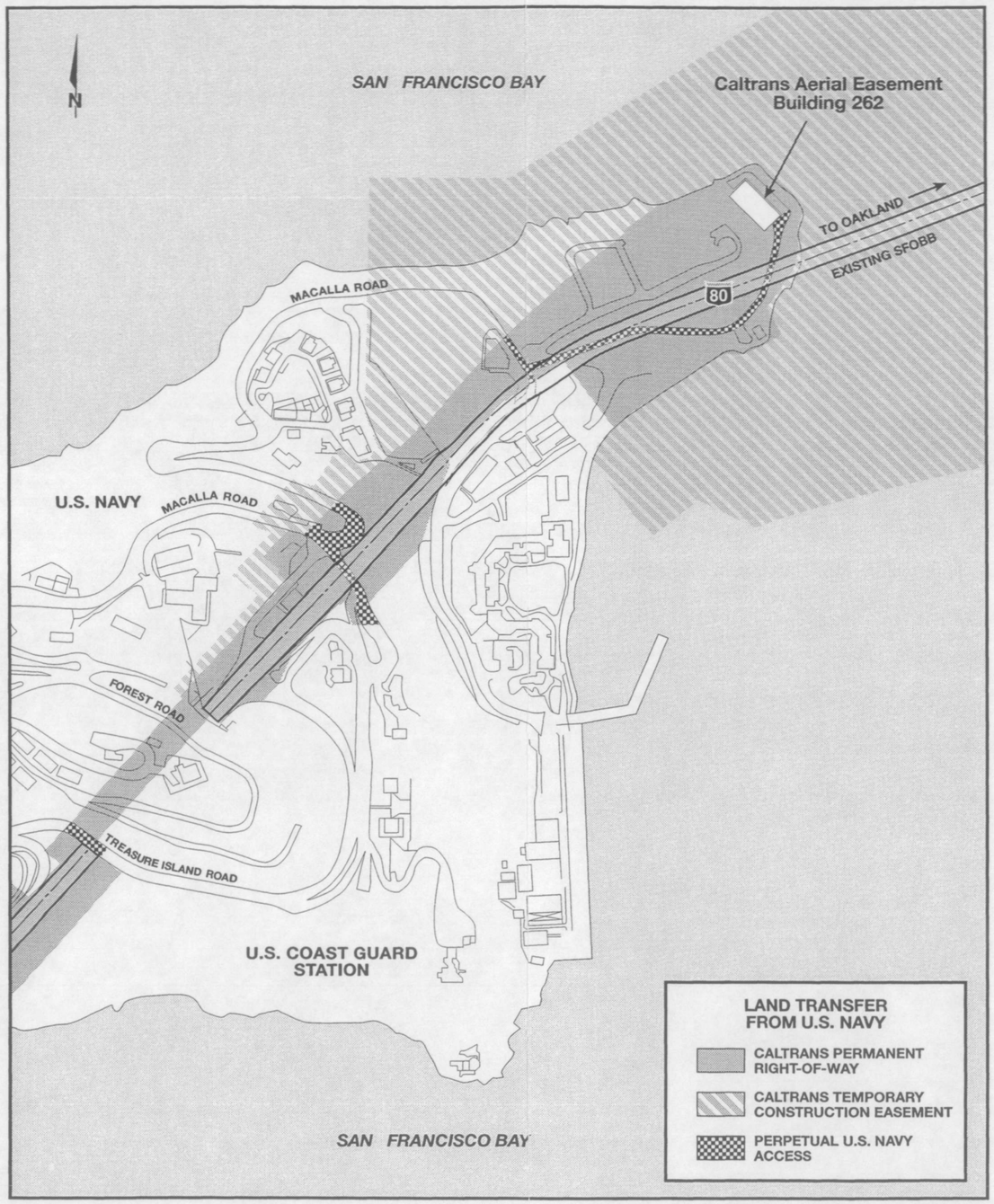
NO SCALE

Census Tracts

Figure 3-1

2/3/01





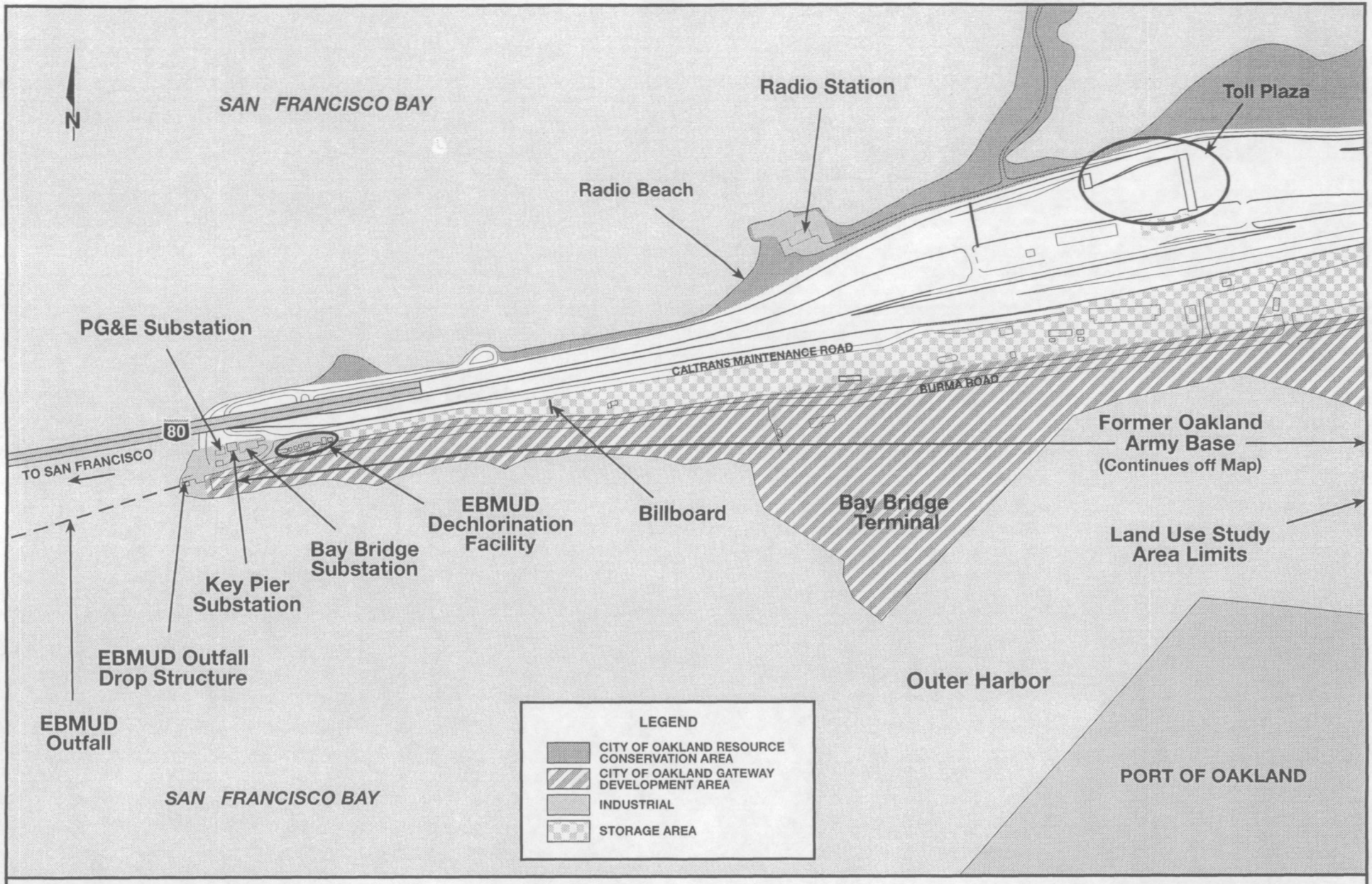
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:5,000
0 100 200 300 m

Existing Land Uses & Land Transfer
Yerba Buena Island

Figure 3-2

4/12/01



SFOBB EAST SPAN SEISMIC SAFETY PROJECT

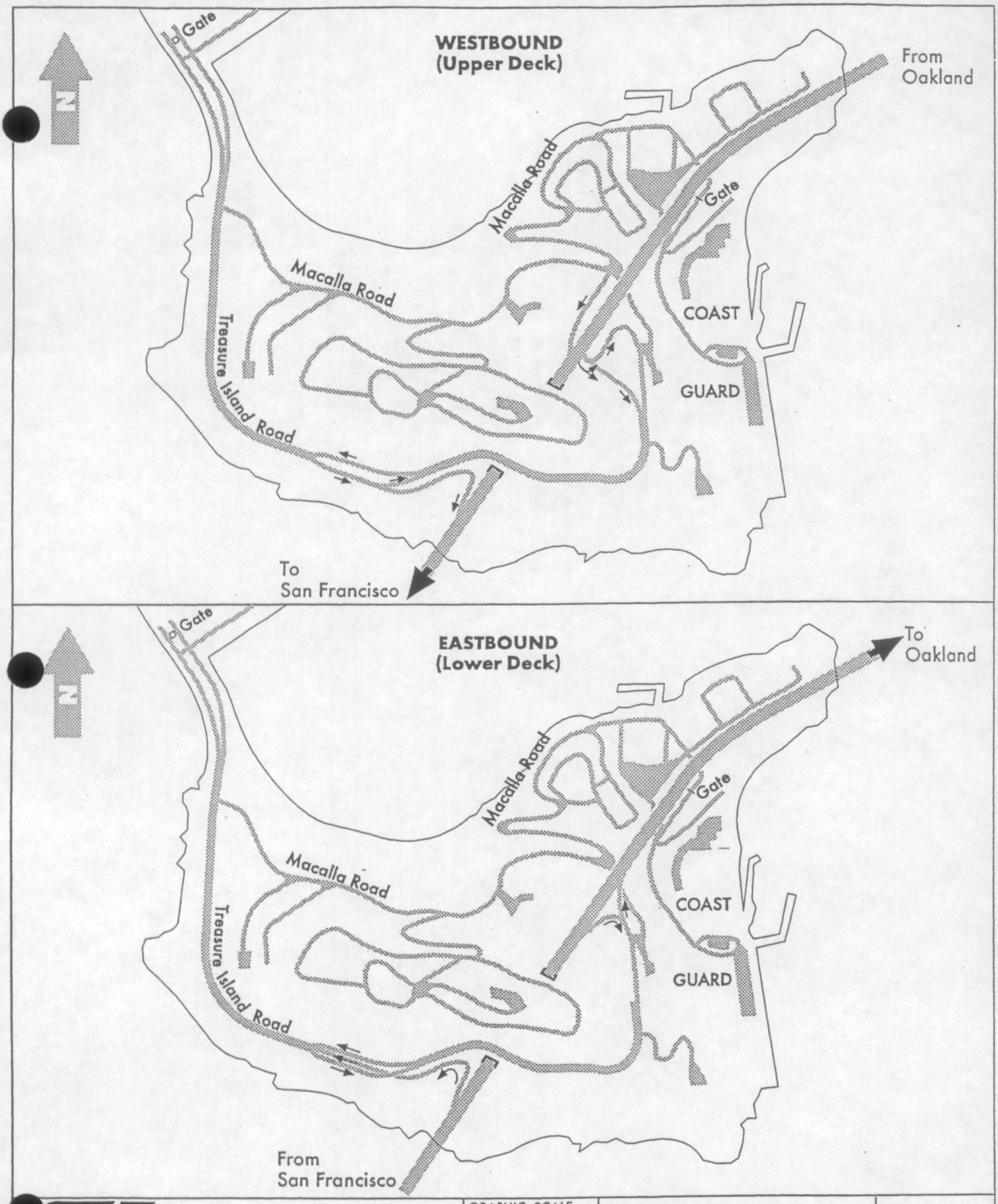
GRAPHIC SCALE 1:8,000

0 50 100 200 m

Existing Land Uses
Oakland Touchdown Area

Figure 3-3

4/5/01

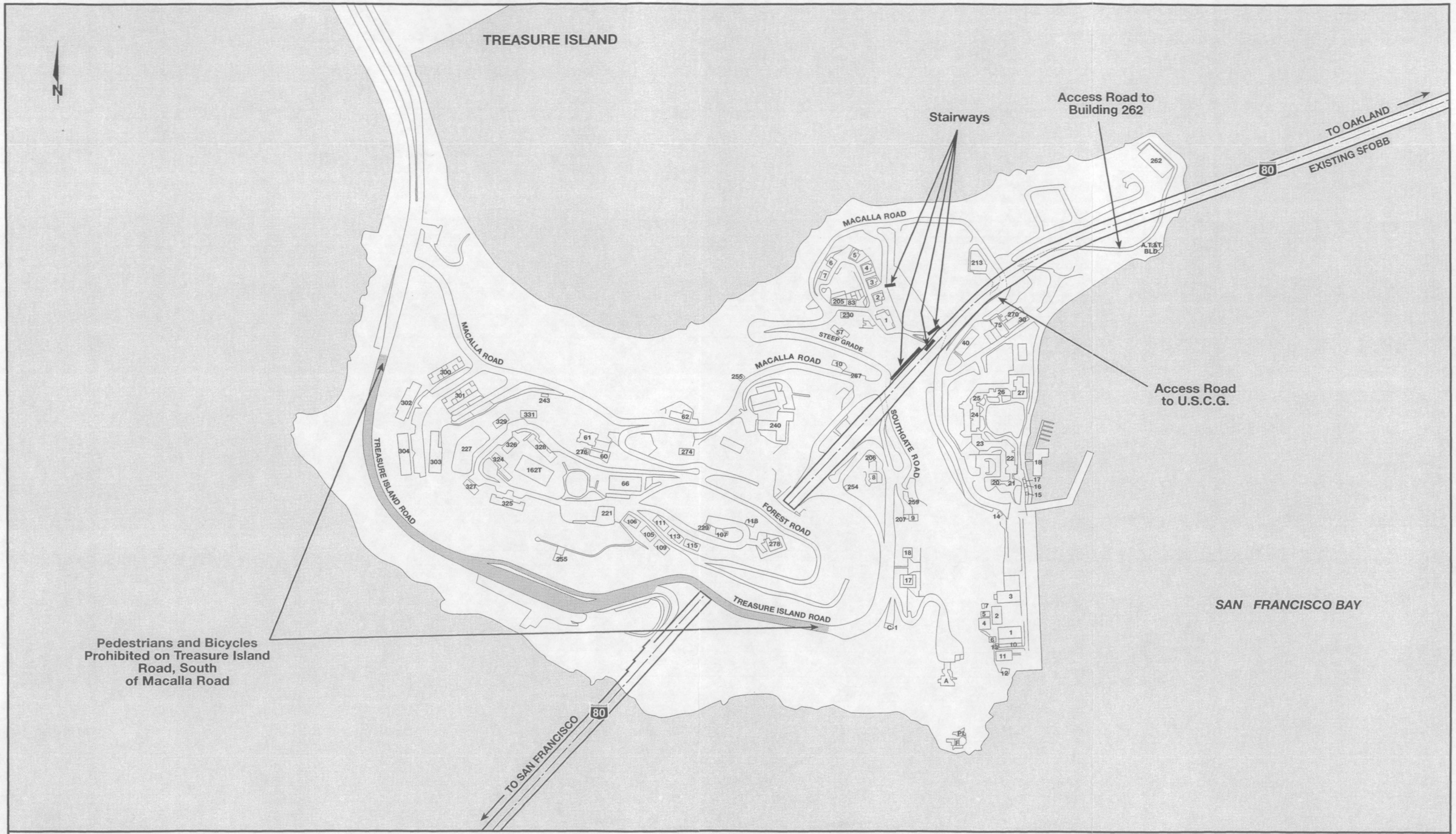


SFOBB EAST SPAN SEISMIC SAFETY PROJECT

GRAPHIC SCALE
0 100m 200m

Yerba Buena Island
Existing SFOBB Ramps

FIGURE 3-4



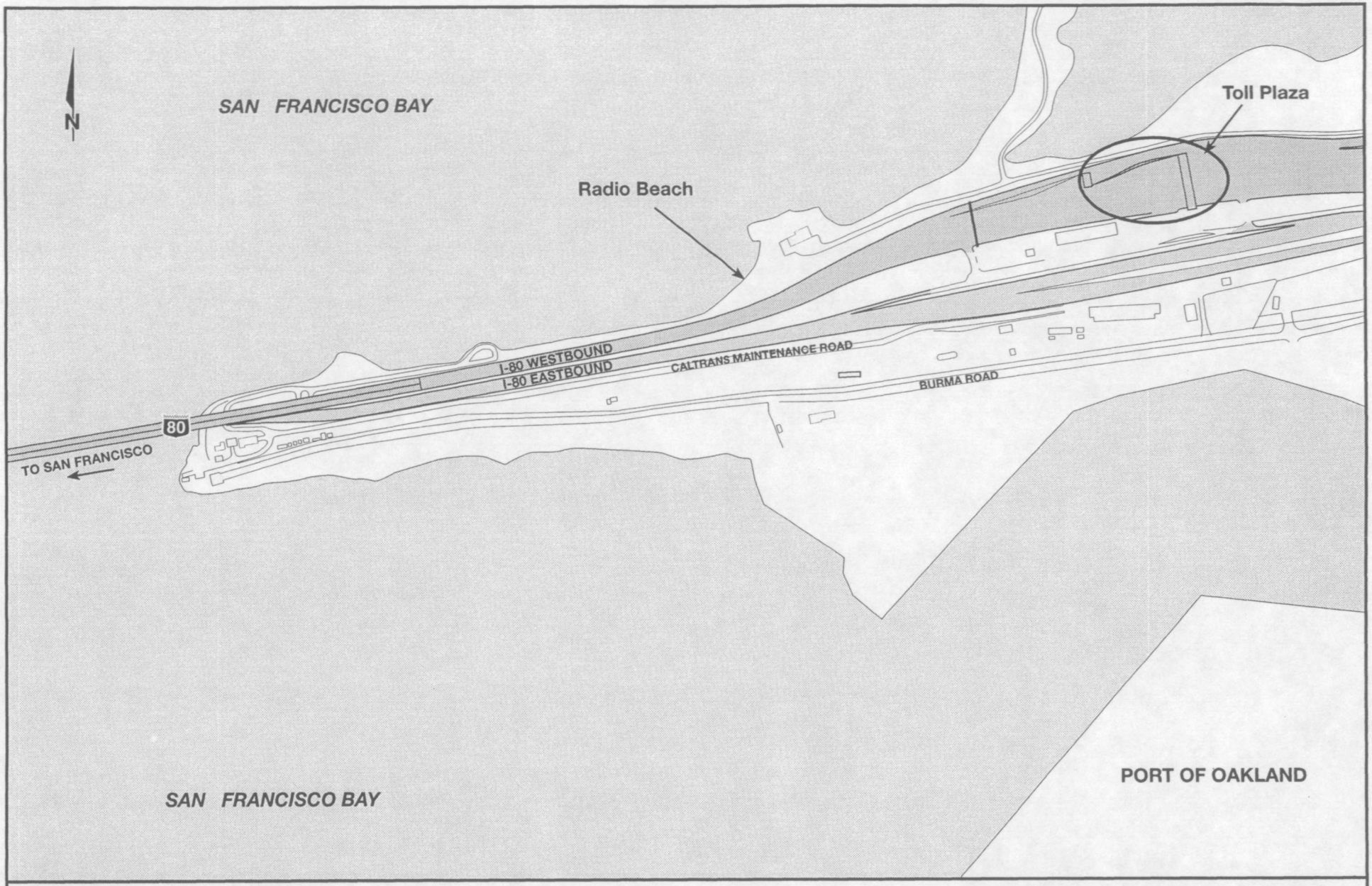
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:5,000
0 100 200 300 m

Streets and Pedestrian Facilities
Yerba Buena Island

Figure 3-5

2/3/01



SFOBB EAST SPAN SEISMIC SAFETY PROJECT

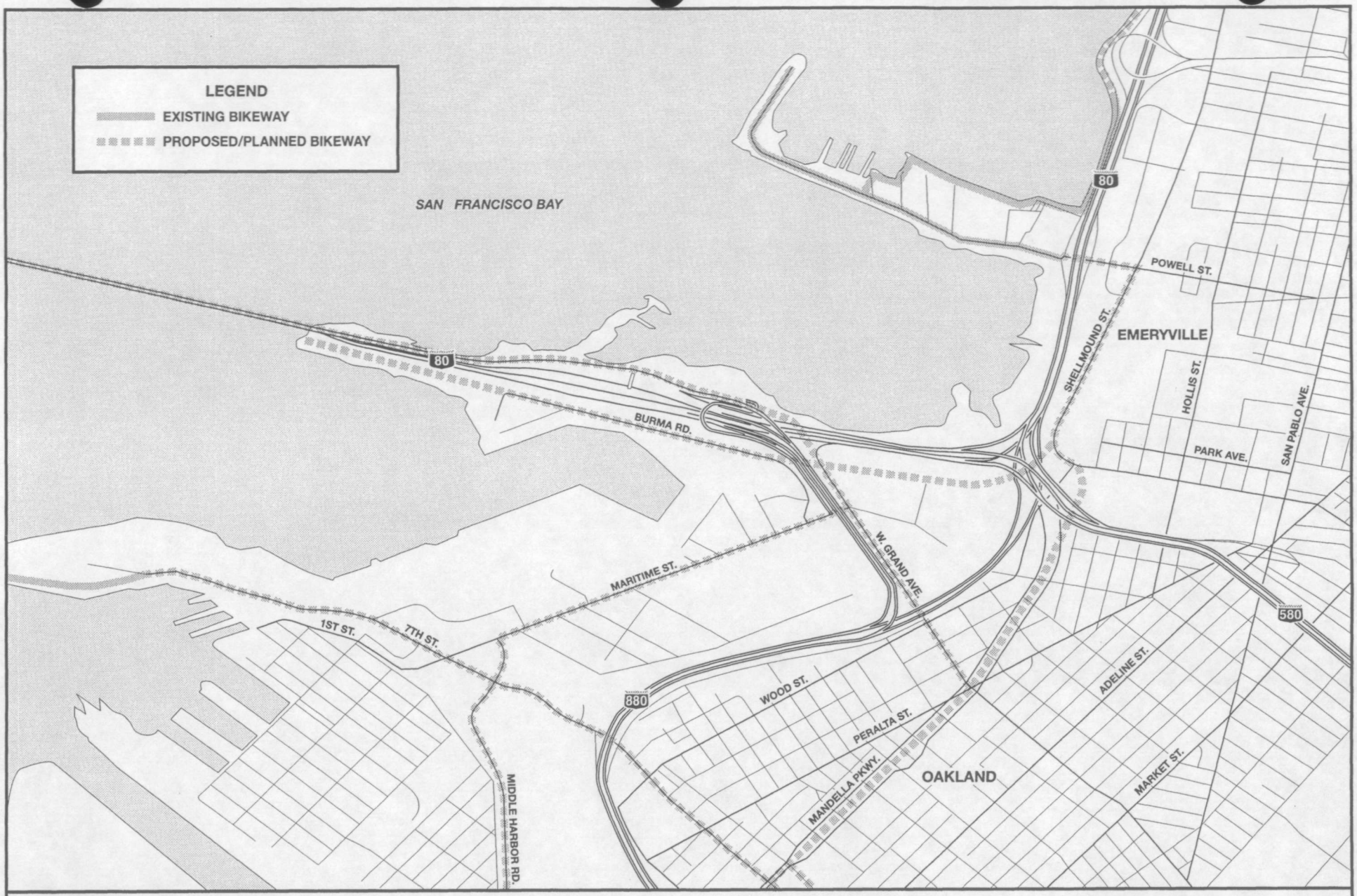
GRAPHIC SCALE 1:8,000

0 50 100 200 m

Existing Streets and Pedestrian Facilities Oakland Touchdown Area

Figure 3-6

2/7/01



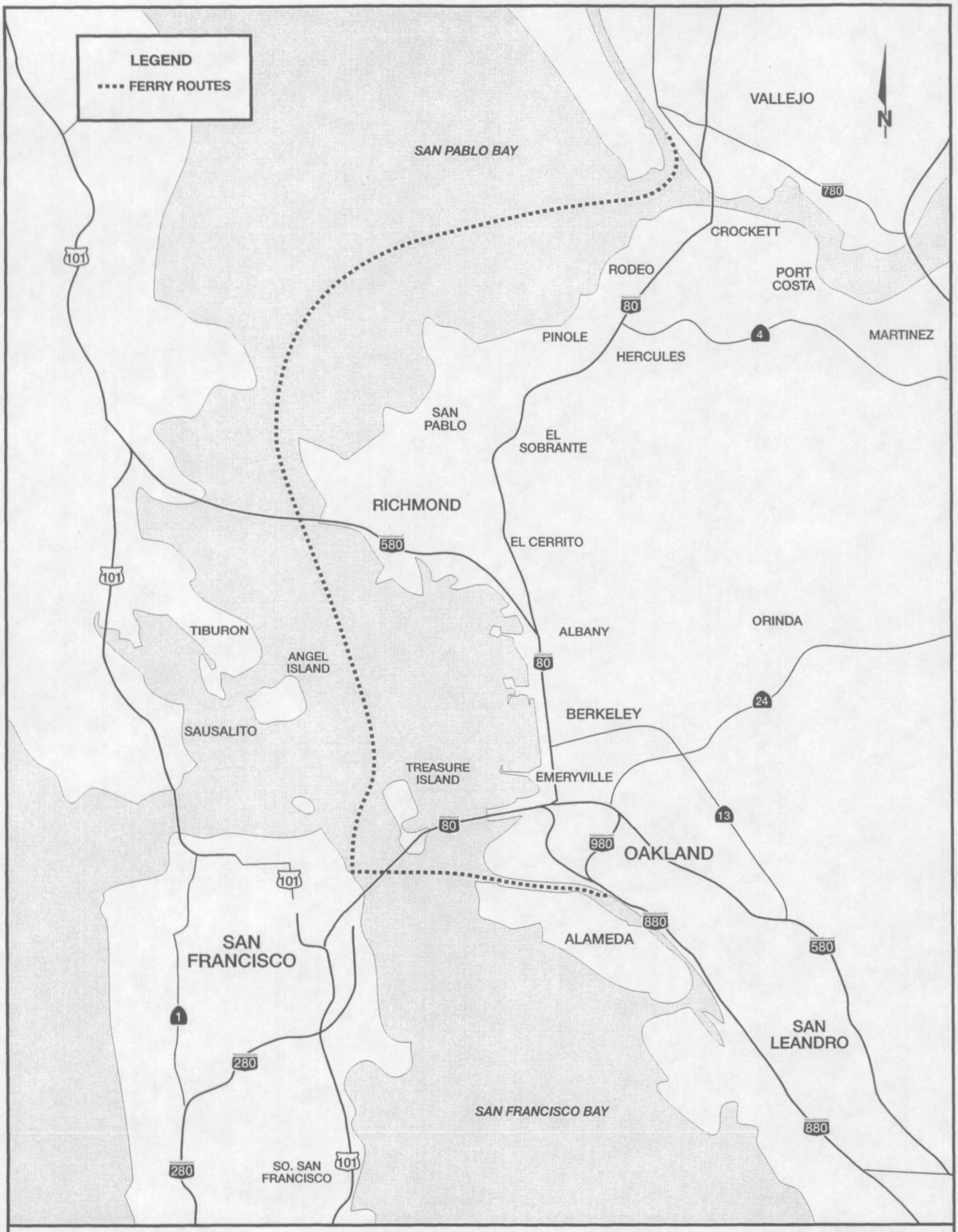
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

NO SCALE

Bay Trails and Bikeways

Figure 3-7

12/13/00



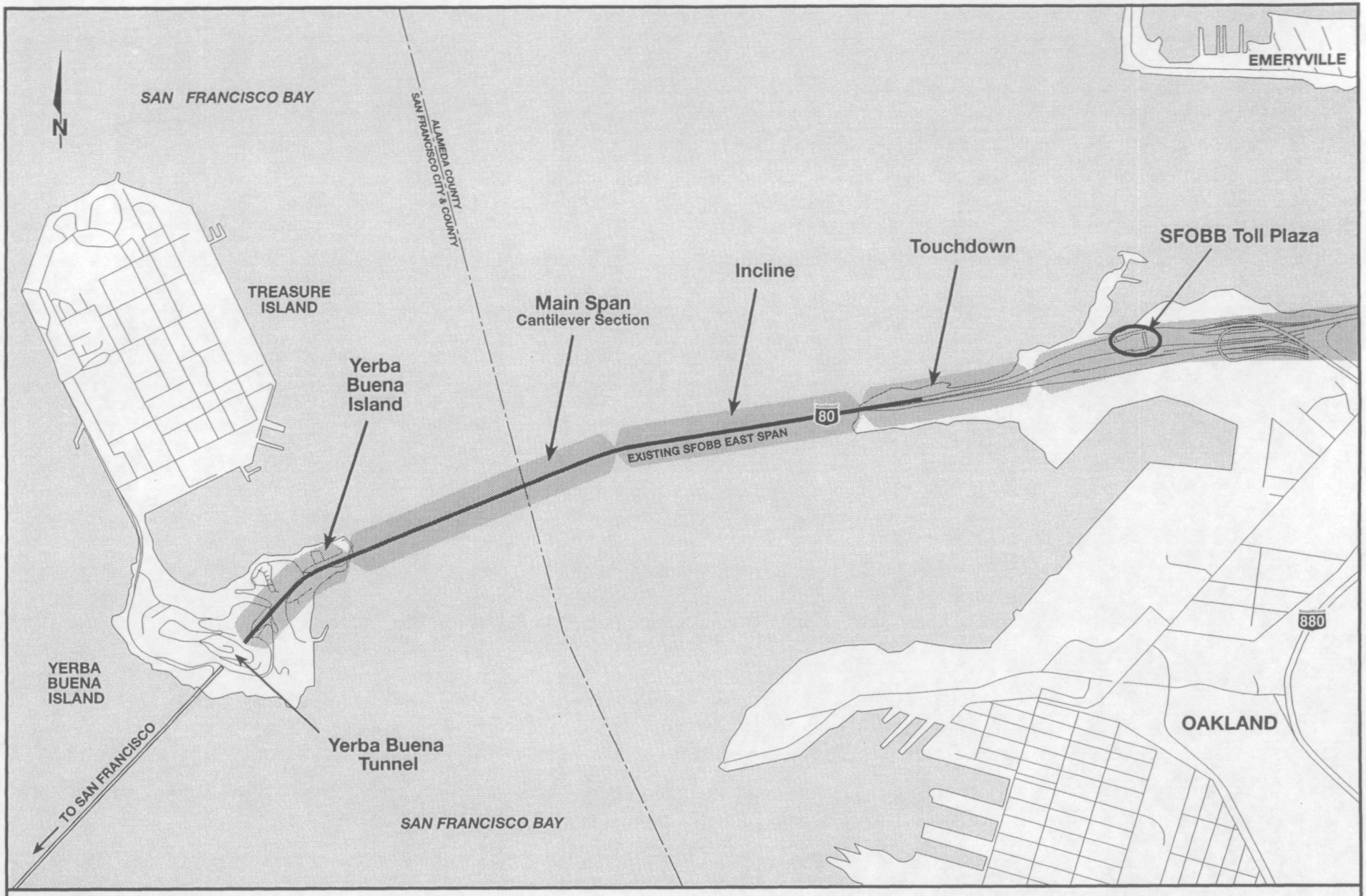
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

NO SCALE

Visual Context

Figure 3-8

2/28/00



SFOBB EAST SPAN SEISMIC SAFETY PROJECT

GRAPHIC SCALE 1:27,500

0 250 500 1000 m

Location of Landscape Units

Figure 3-9

9/28/98

Yerba Buena Island

Main Span (cantilever section)

Incline

Oakland Touchdown Area

Toll Plaza

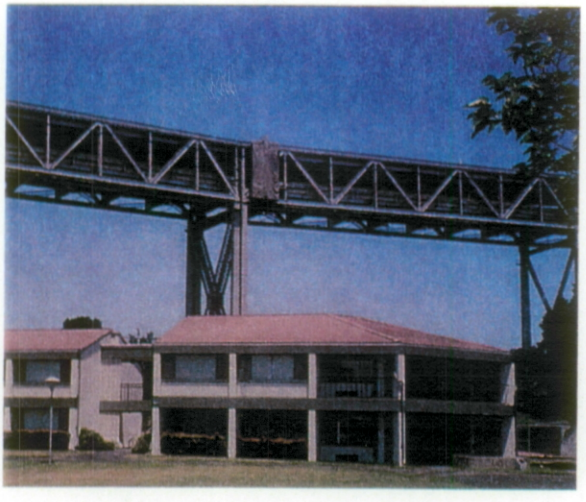
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Landscape Units

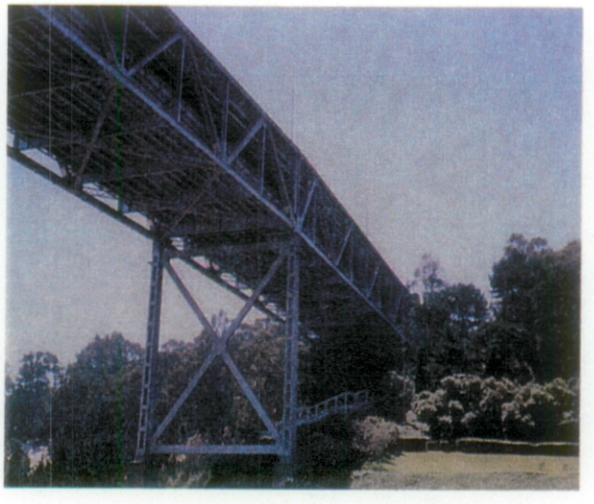
Figure 3.10.a

R1—Older Residential

01—Marsh/Estuary



R2—High Density Residential



02—Woodland

H1—Historic Structures

03—The Bay

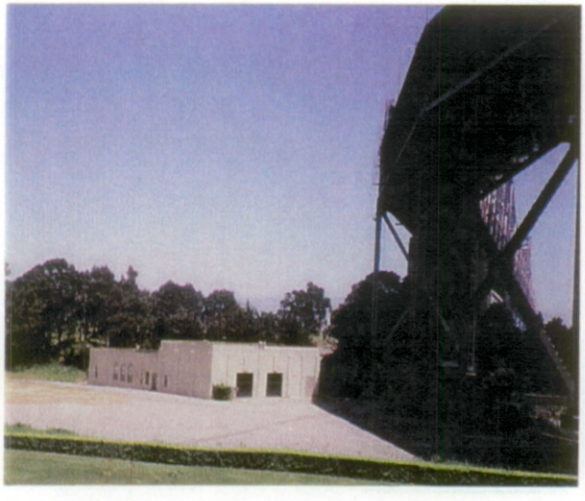
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Image Types

Figure 3-10b

M1—US Army

I1—Light Industrial



M2—US Navy

I2—Port Facilities

M3—Toll Plaza

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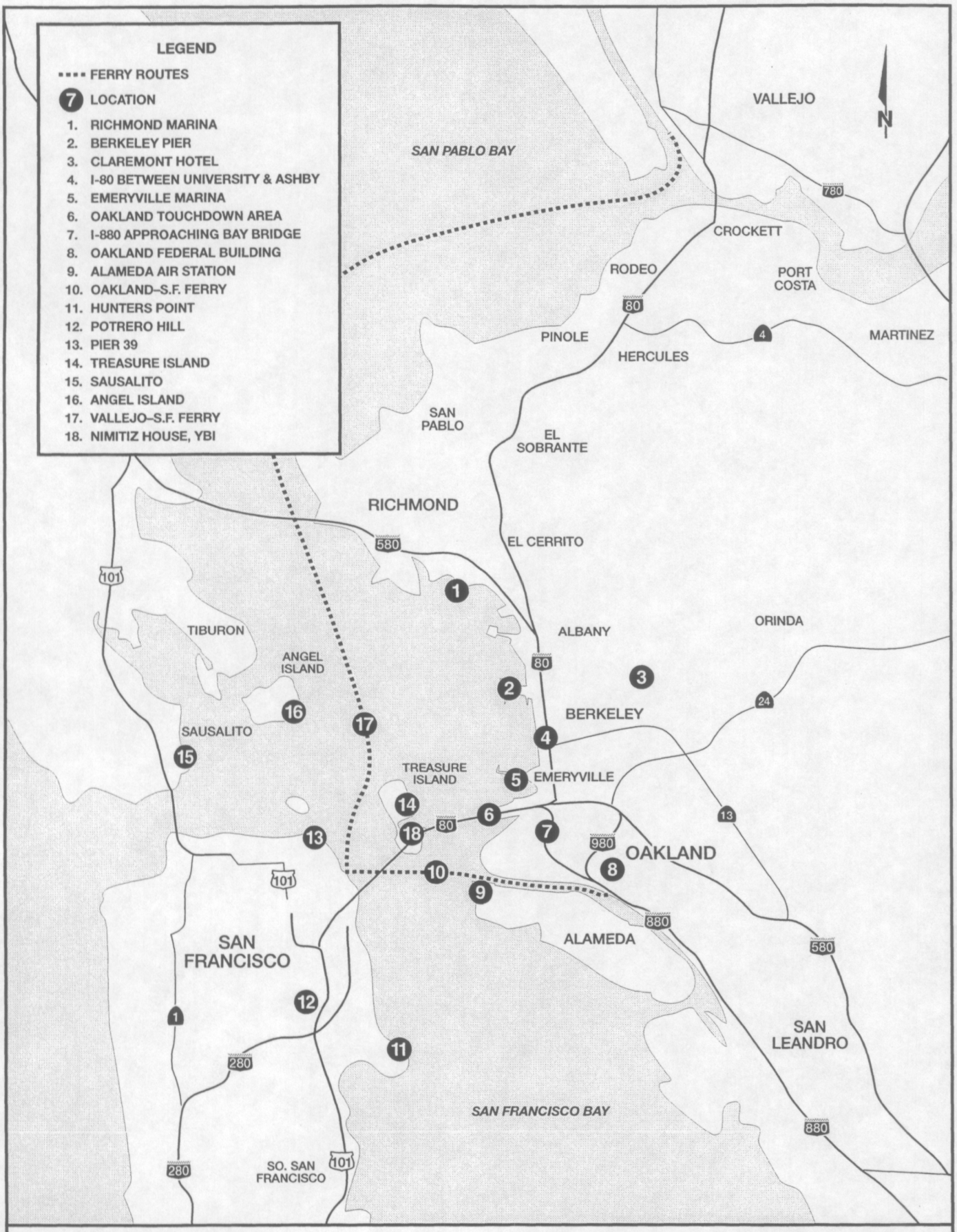
EAST SPAN
SEISMIC SAFETY
PROJECT

Image Types

Figure 3-10c



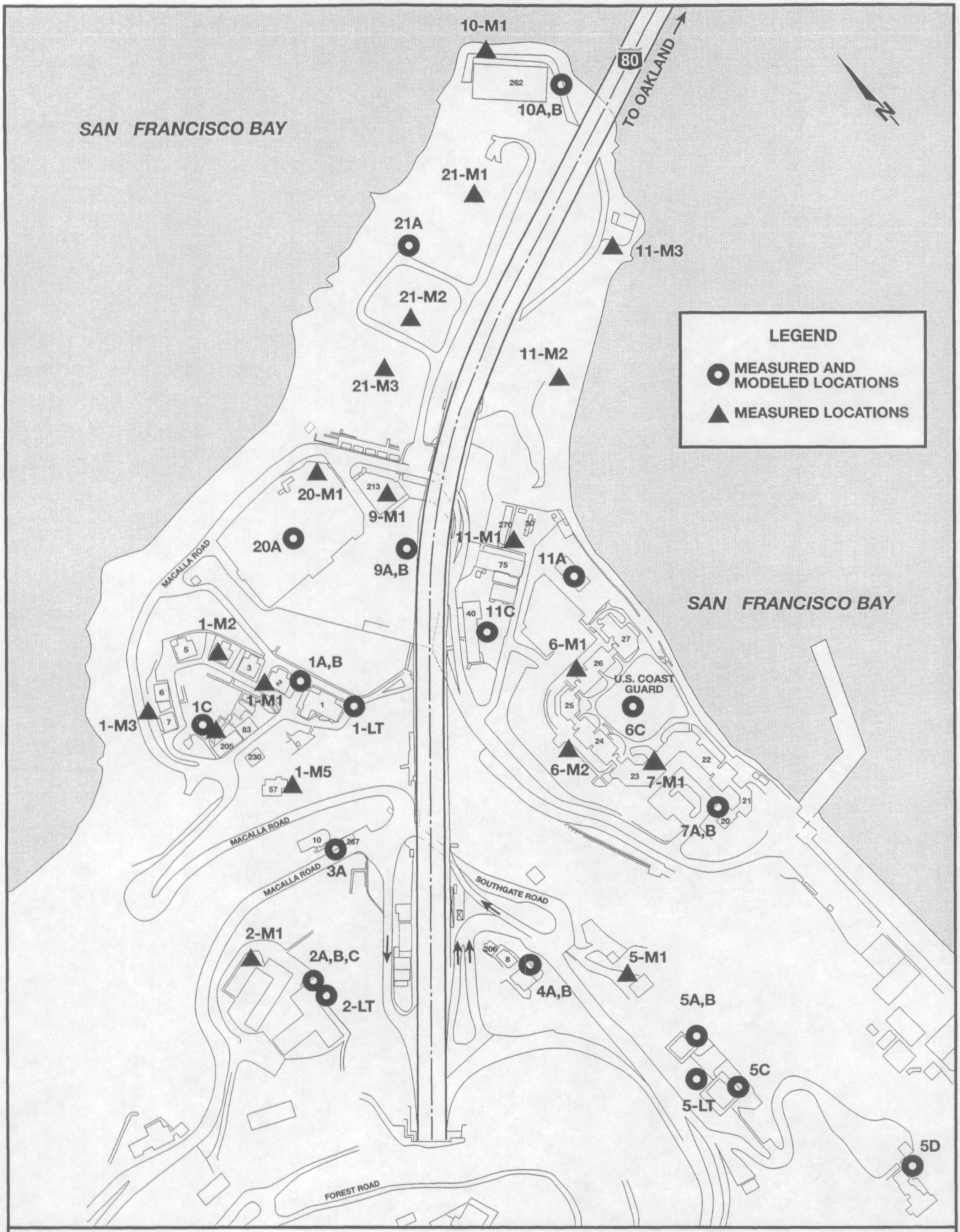
SFOBB EAST SPAN SEISMIC SAFETY PROJECT

NO SCALE

Visual Assessment Viewpoint Locations

Figure 3-11

2/28/00



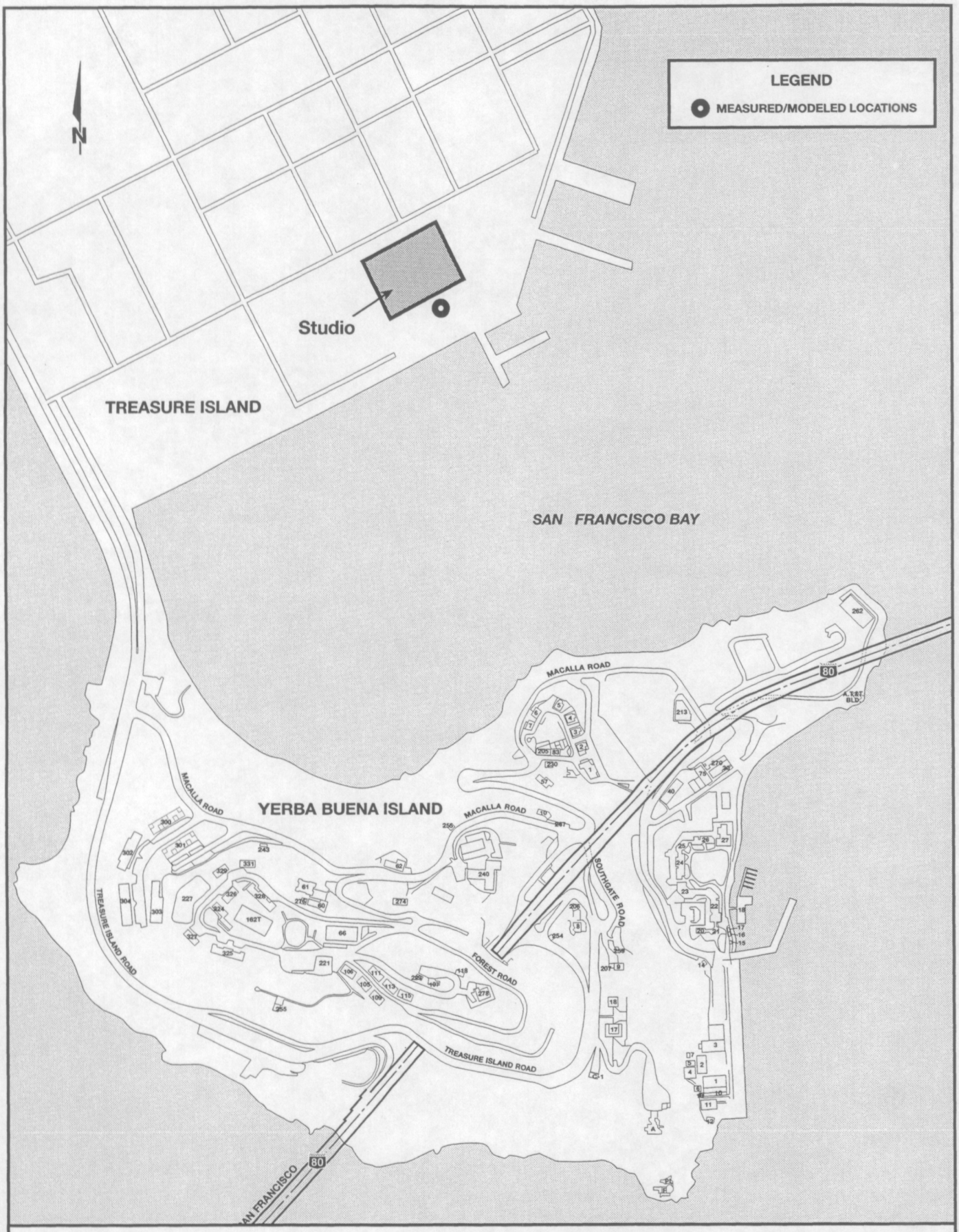
SFOBB EAST SPAN SEISMIC SAFETY PROJECT

GRAPHIC SCALE 1:3,500

0 25 50 m

Noise Measurement and Modeling Locations–Yerba Buena Island

Figure 3-12



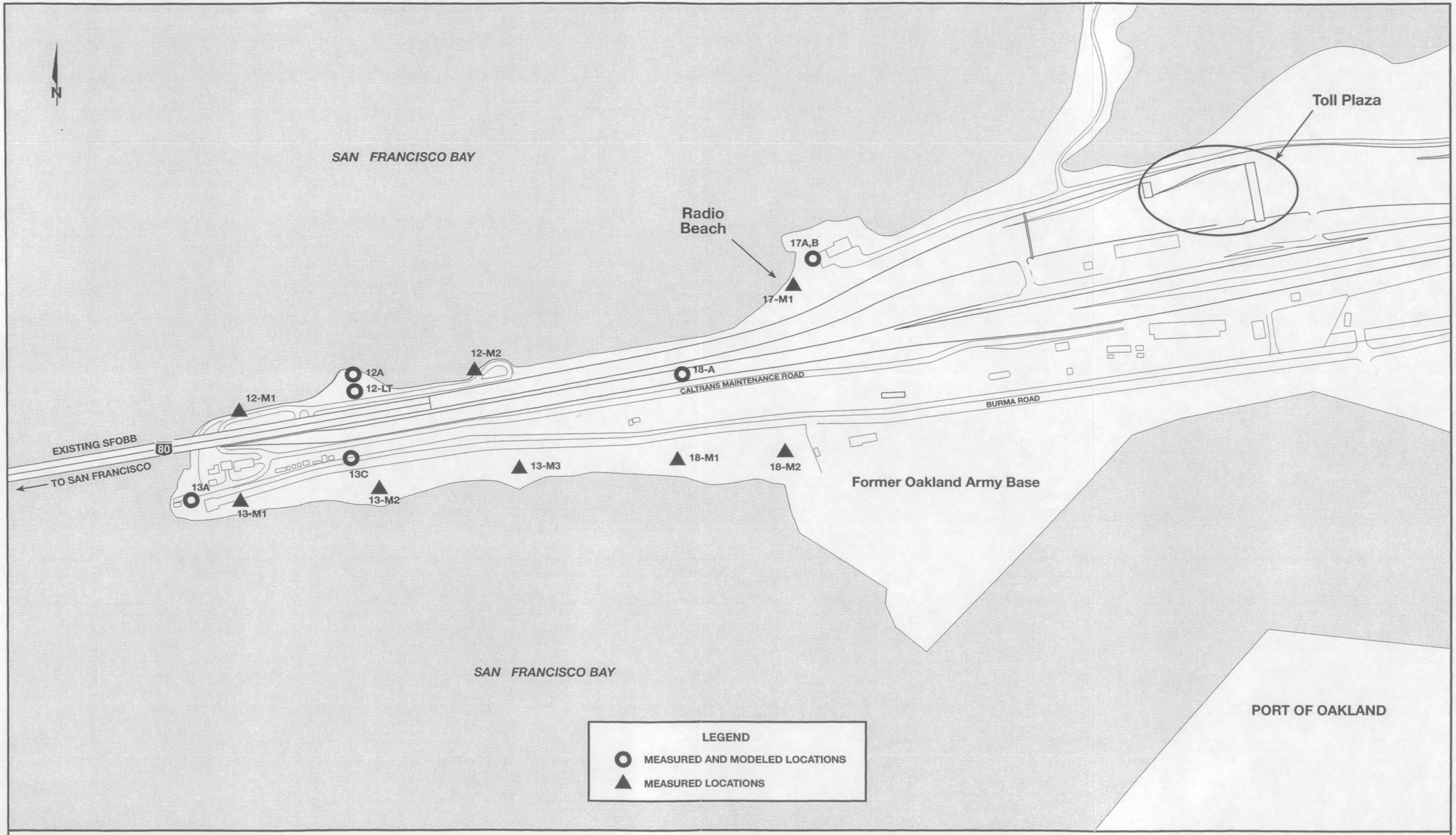
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:6,000

0 100 200 m

Noise Measurement and Modeling Locations – Treasure Island

Figure 3-13

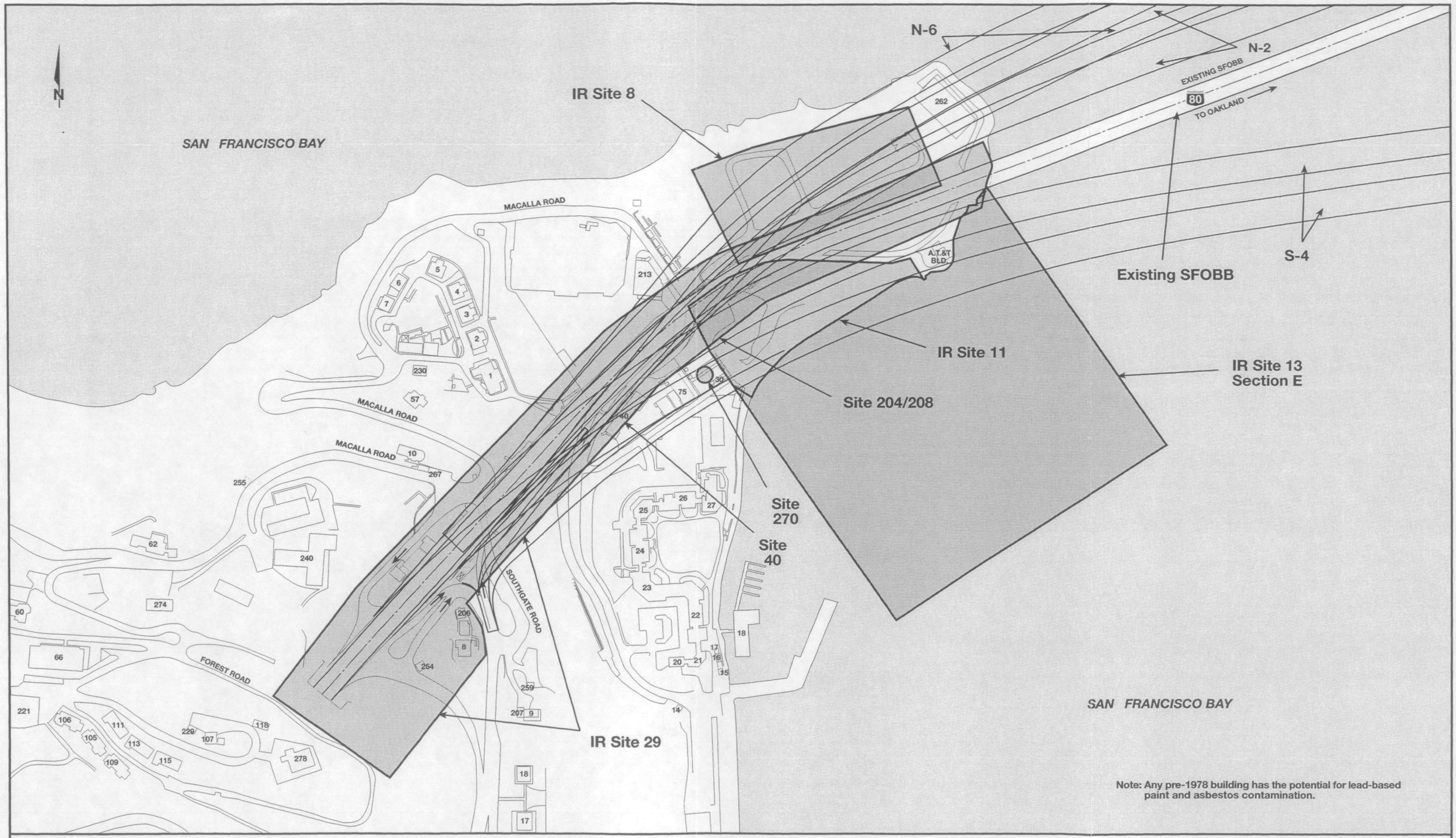


SFOBB EAST SPAN SEISMIC SAFETY PROJECT

Noise Measurement and Modeling Locations–Oakland Touchdown Area

Figure 3-14

2/3/01

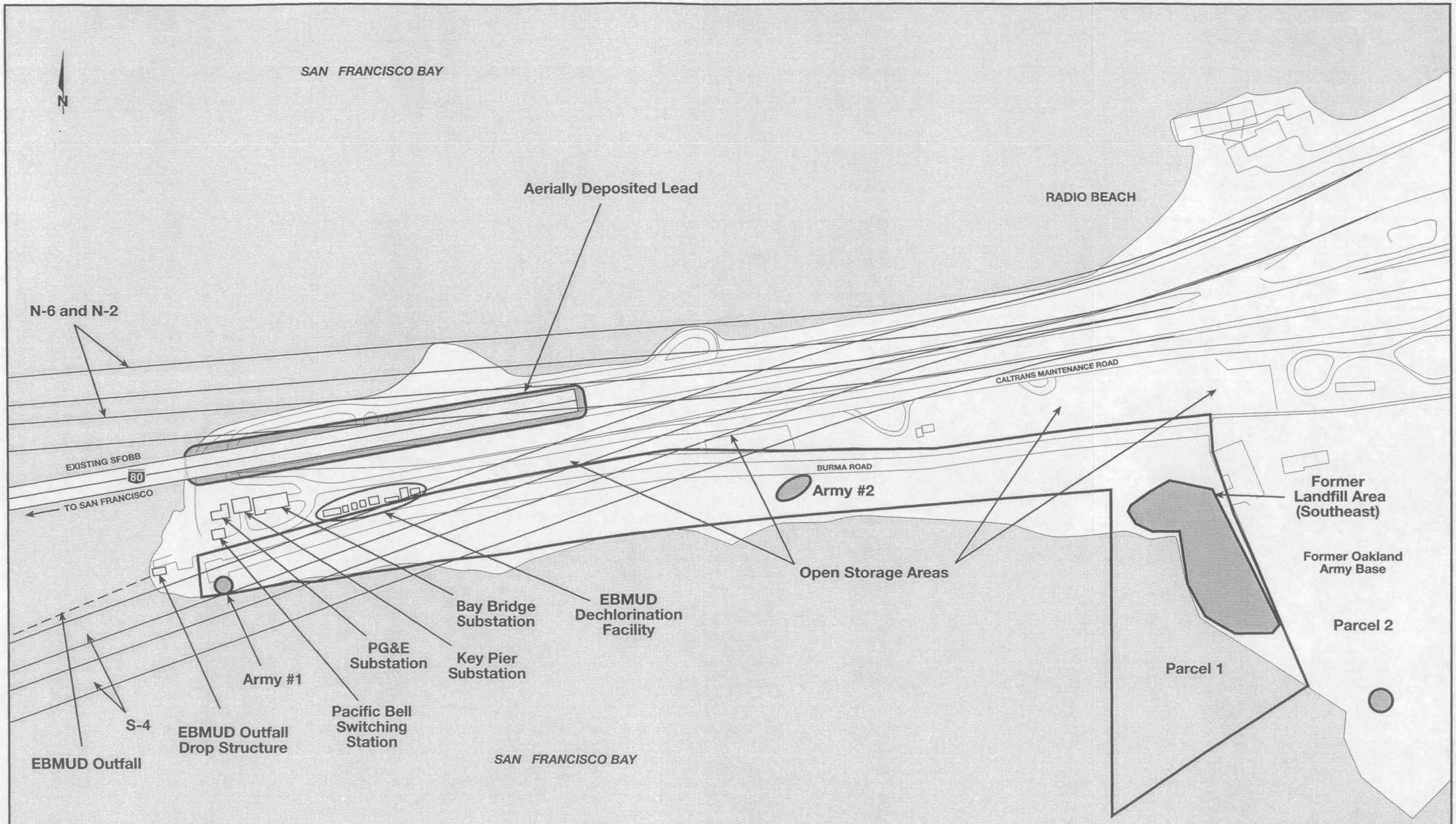


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Potential Contaminant Sources
Yerba Buena Island

Figure 3-15a

7/5/00

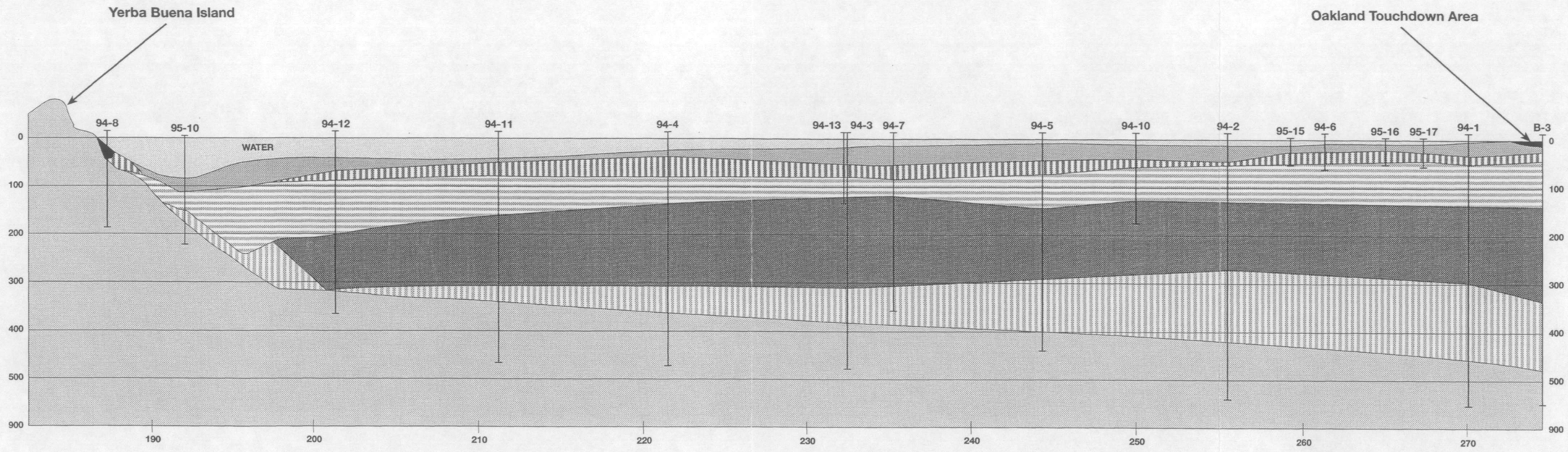


SFOBB EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:4,000
0 50 100 150 m

Potential Contaminant Sources
Oakland Touchdown Area
Figure 3-15b

4/25/01



PROFILE

STATIONING INTERVAL = 1000 FEET

VERTICAL EXAGGERATION = 3

ELEVATIONS REFER TO THE MEAN LOWER LOW WATER DATUM OF 1933 ((MLLW))

LEGEND

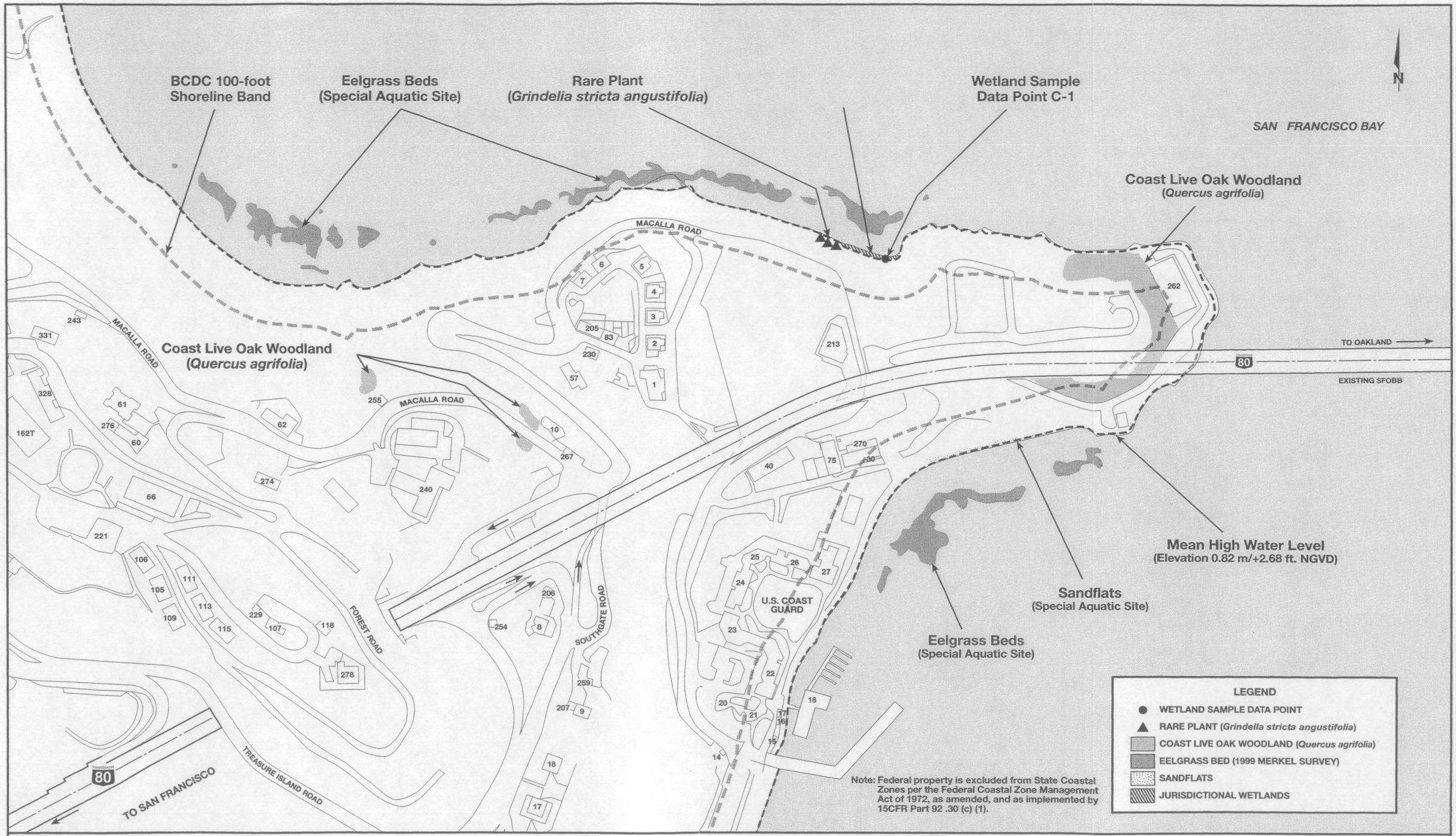
- FILL
- YOUNG BAY MUD
- MERRITT/POSEY/SAN ANTONIO FORMATION
- YERBA BUENA MUD (OLD BAY MUD)
- UPPER ALAMEDA FORMATION
- LOWER ALAMEDA FORMATION
- FRANCISCAN BEDROCK

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Geologic Profile of the Project Area

Figure 3-16

2/3/01



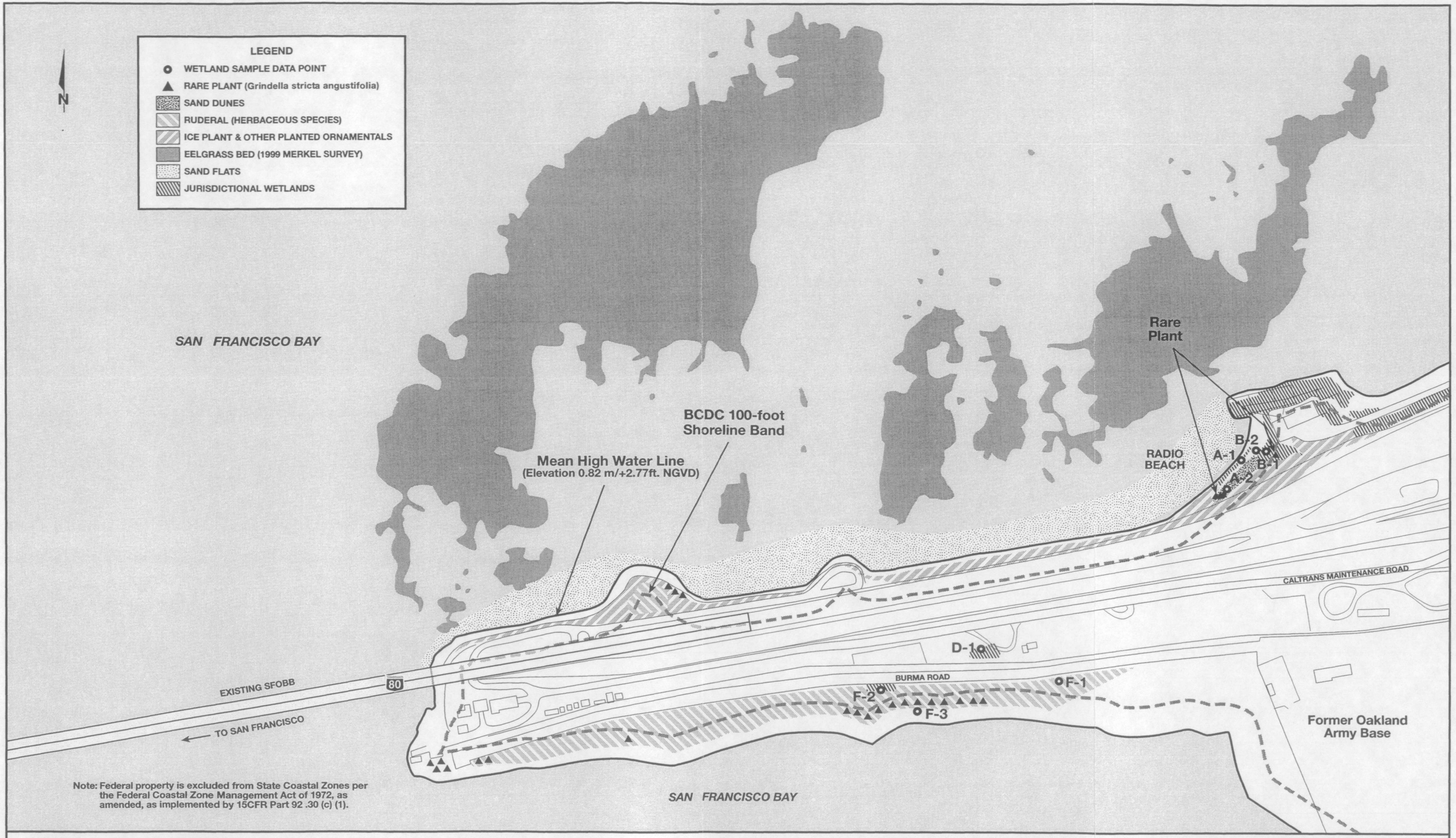
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:3,000
0 100 200 300 m

Biological Resources
Yerba Buena Island

Figure 3-17

4/5/01



Note: Federal property is excluded from State Coastal Zones per the Federal Coastal Zone Management Act of 1972, as amended, as implemented by 15CFR Part 92 .30 (c) (1).

SFOBB EAST SPAN SEISMIC SAFETY PROJECT

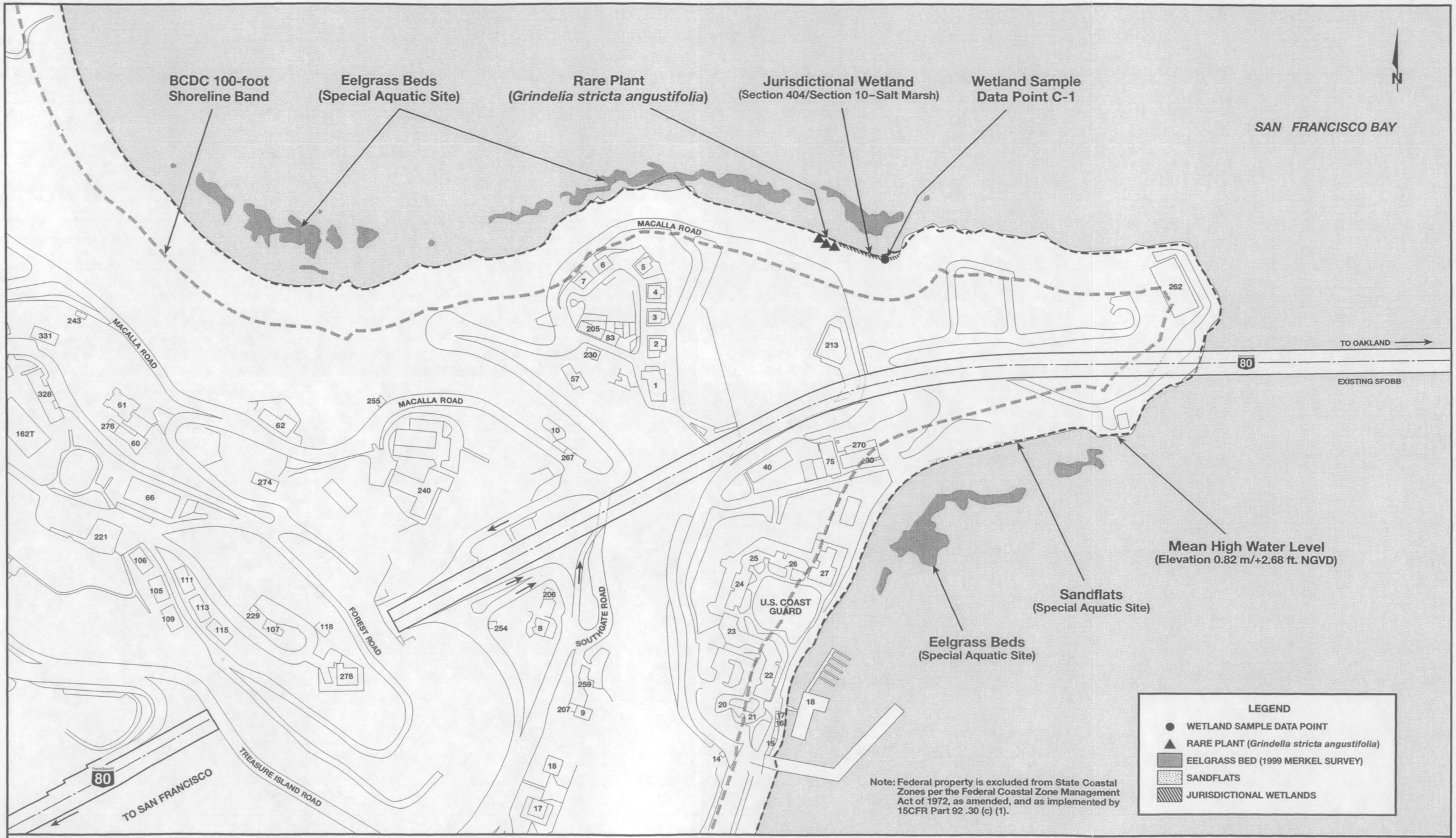
GRAPHIC SCALE 1:5,000

0 50 100 150 m

Biological Resources
Oakland Touchdown Area

Figure 3-18

4/5/01



Note: Federal property is excluded from State Coastal Zones per the Federal Coastal Zone Management Act of 1972, as amended, and as implemented by 15CFR Part 92 .30 (c) (1).

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

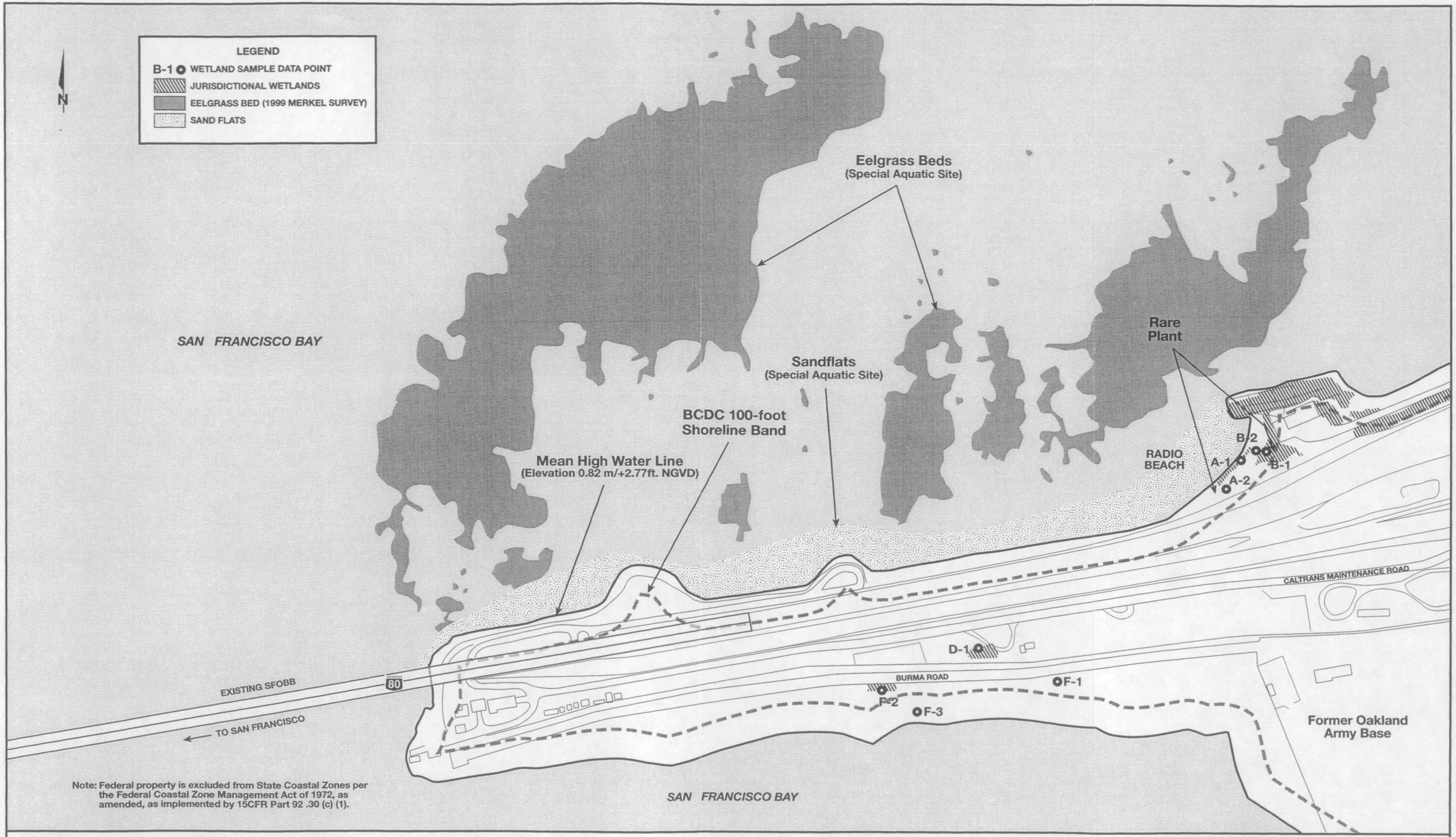
GRAPHIC SCALE 1:3,000

0 100 200 300 m

Wetlands and Special Aquatic Sites Yerba Buena Island

Figure 3-19

4/25/01



Note: Federal property is excluded from State Coastal Zones per the Federal Coastal Zone Management Act of 1972, as amended, as implemented by 15CFR Part 92 .30 (c) (1).

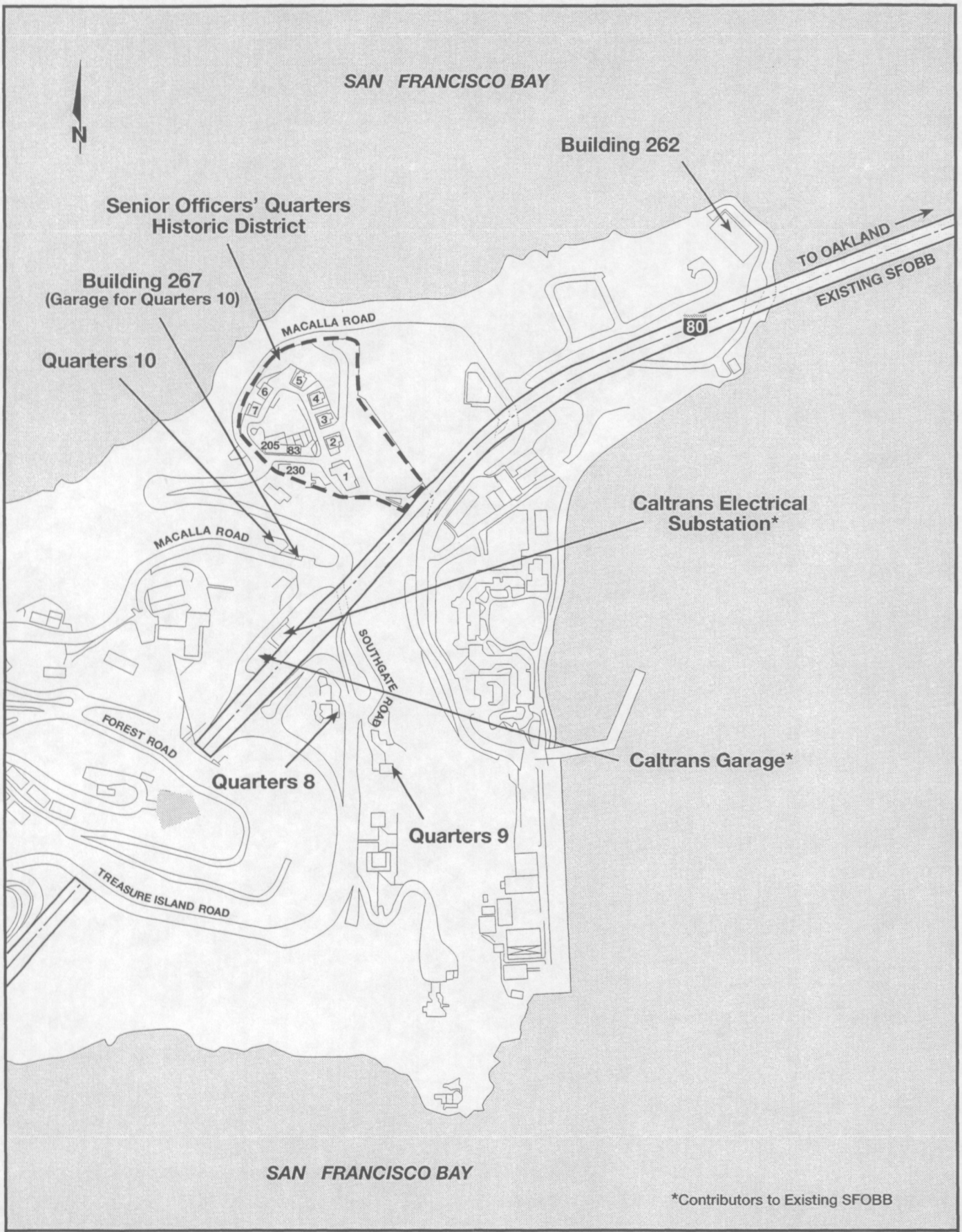
SFOBB EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:5,000
0 50 100 150 m

Wetlands and Special Aquatic Sites
Oakland Touchdown Area

Figure 3-20

4/25/01



SFOBB EAST SPAN SEISMIC SAFETY PROJECT

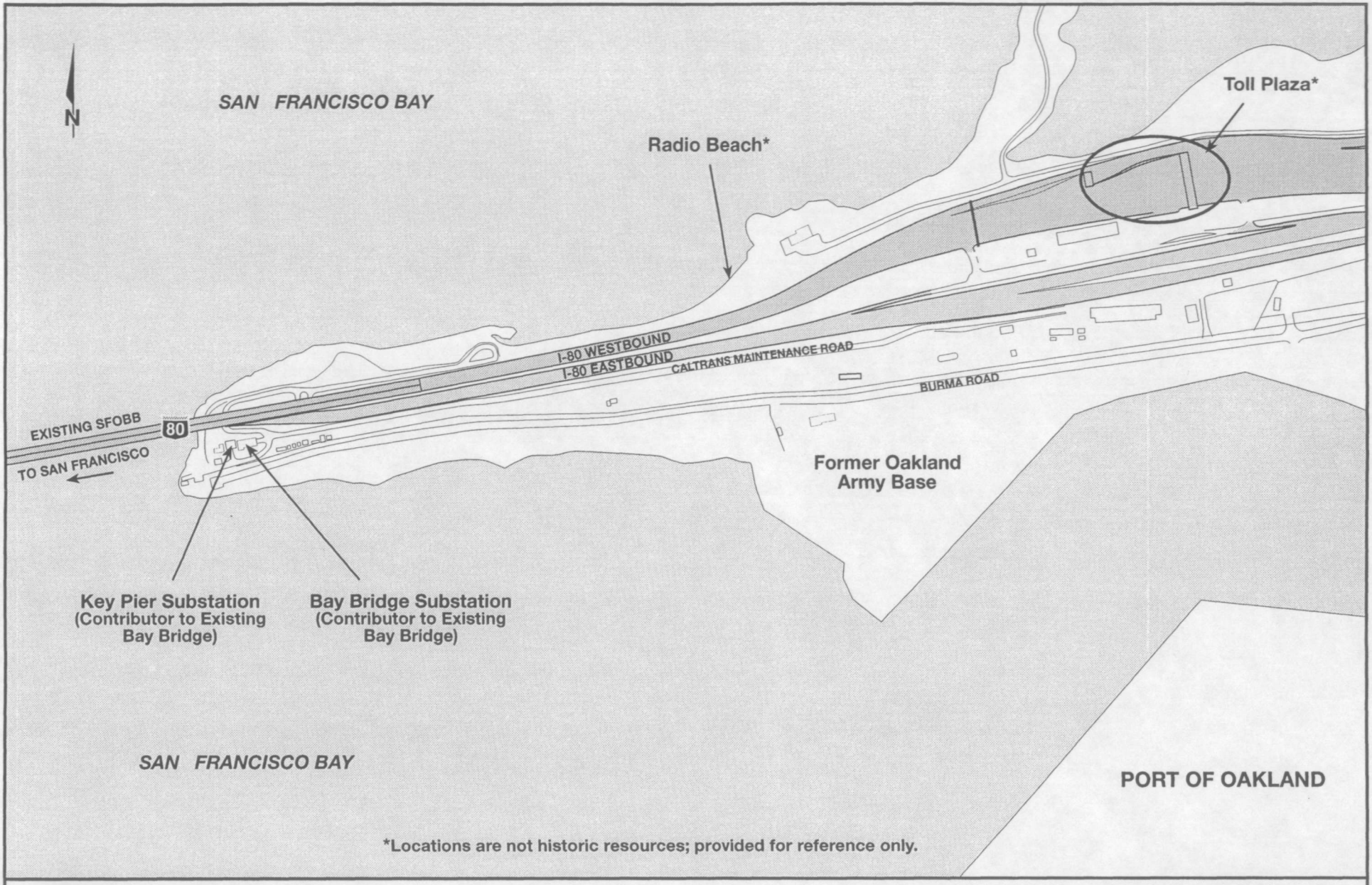
GRAPHIC SCALE 1:5,000

0 100 200m

Historic Resources Yerba Buena Island

Figure 3-21

9/10/00

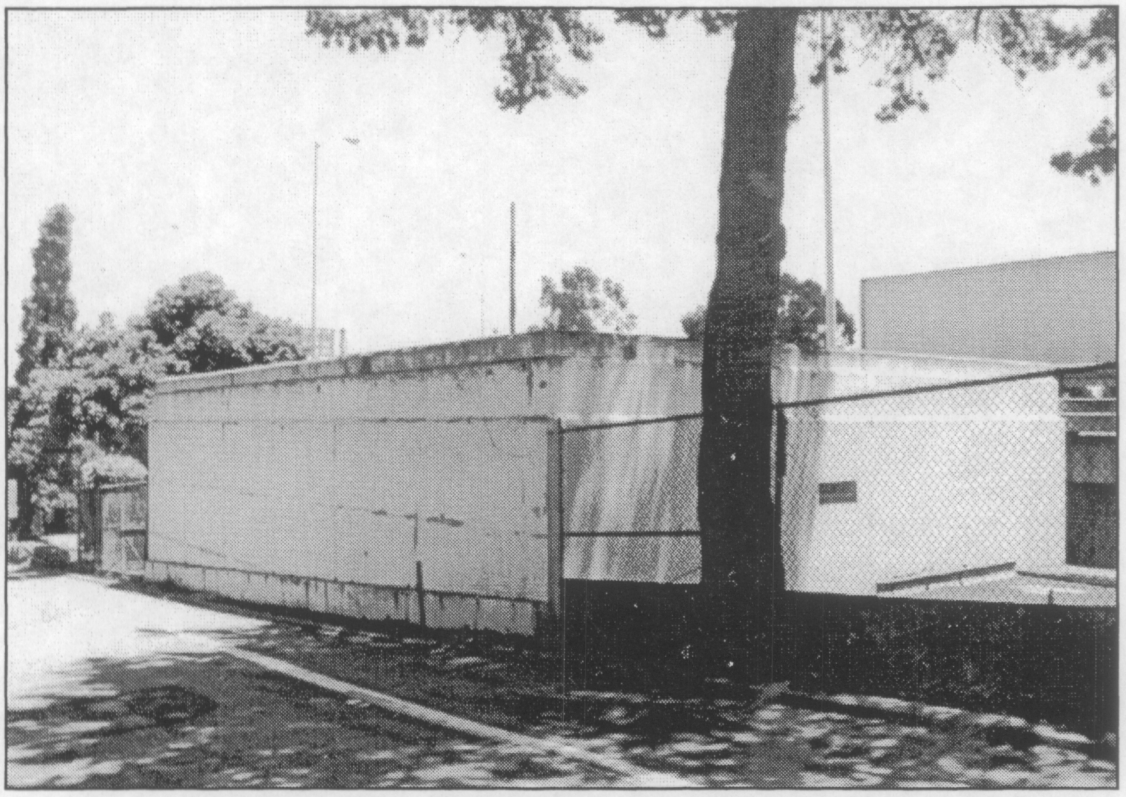


SFOBB EAST SPAN
SEISMIC SAFETY
PROJECT

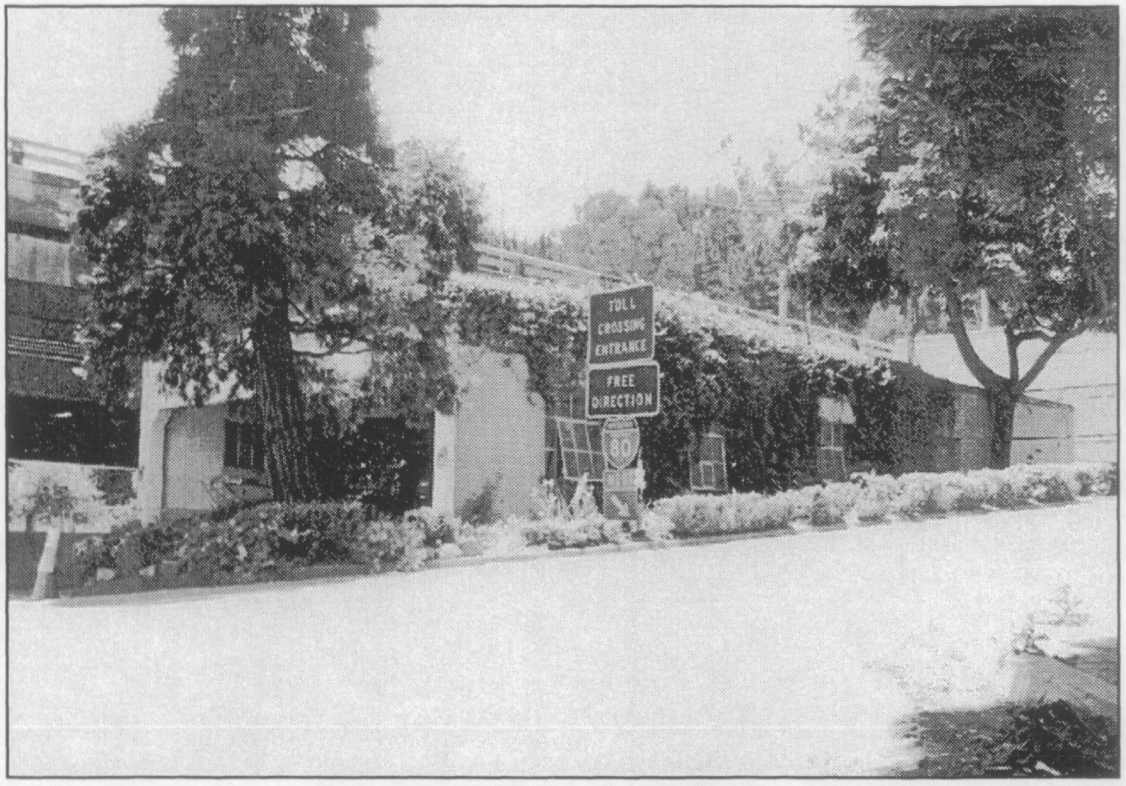
GRAPHIC SCALE 1:8,000
0 50 100 200 m

Historic Resources–
Oakland Touchdown Area
Figure 3-22

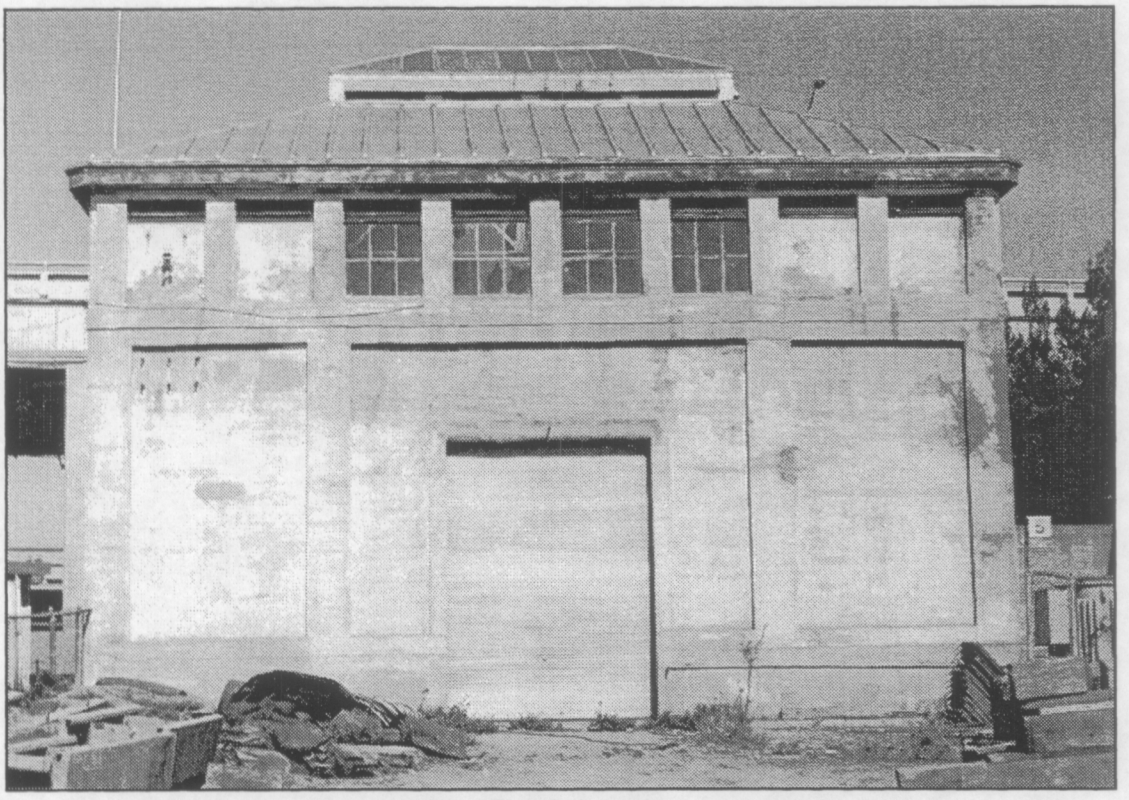
4/12/01



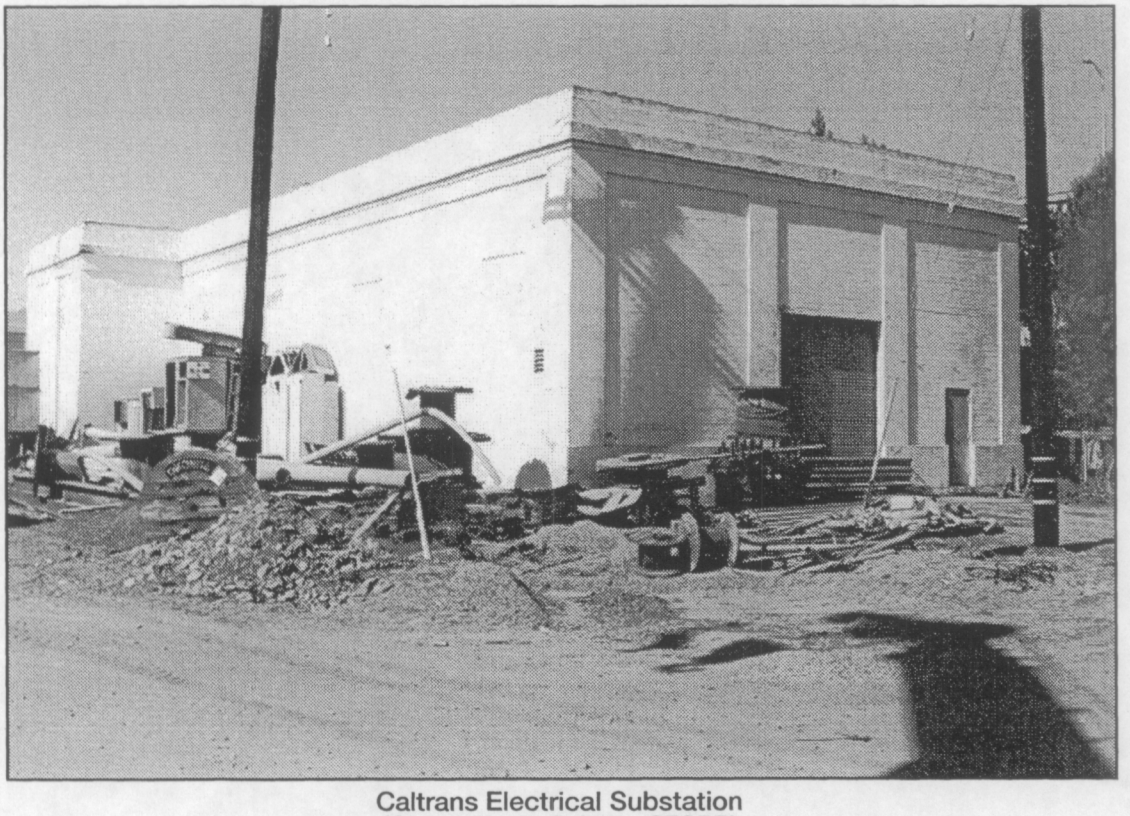
Caltrans Substation
(Contributor to Existing SFOBB)



Caltrans Garage and Substation
(Contributor to Existing SFOBB)



Key Pier Substation
(Individually Eligible and Contributor to Existing SFOBB)



Caltrans Electrical Substation
(Contributor to Existing SFOBB)

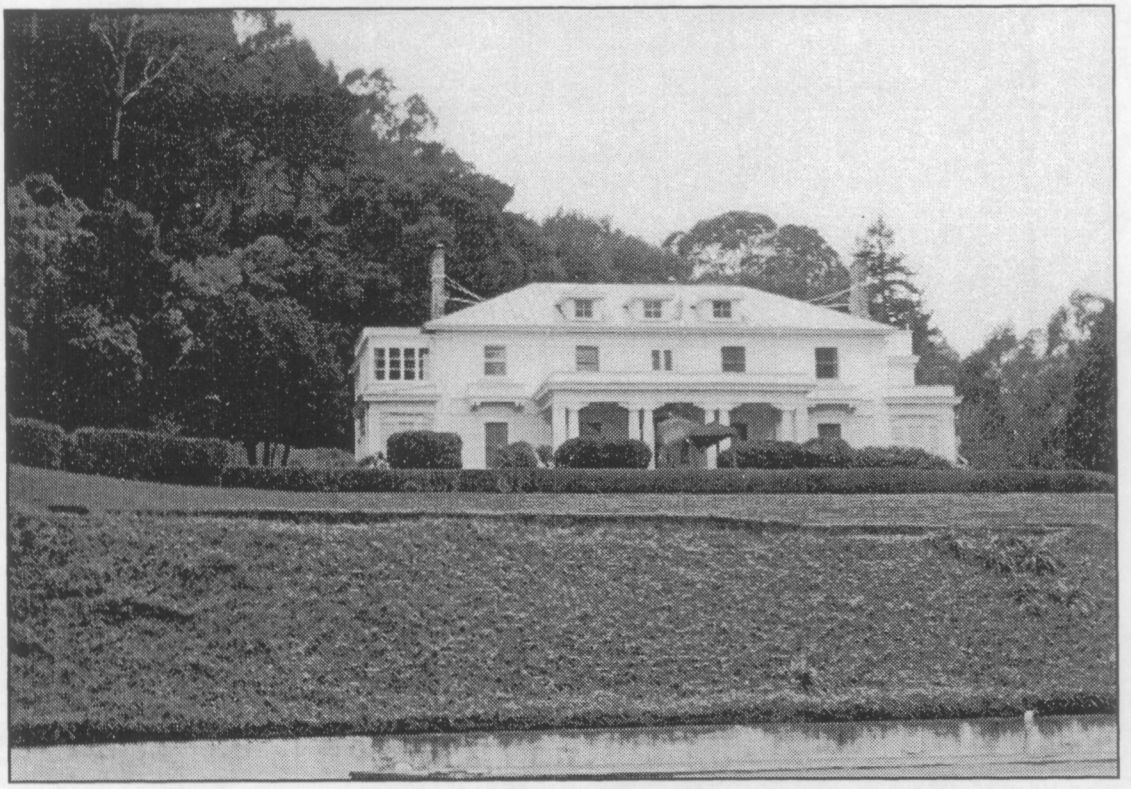
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Historic Resources: Caltrans Electrical Substation and Key Pier Substaion–Oakland Touchdown Area

Figure 3-24

2/4/01

Senior Officers' Quarters Historic District
(from left to right, Quarters 1-4; Quarters 5-7 are out of view to the northwest)



Quarters 1

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

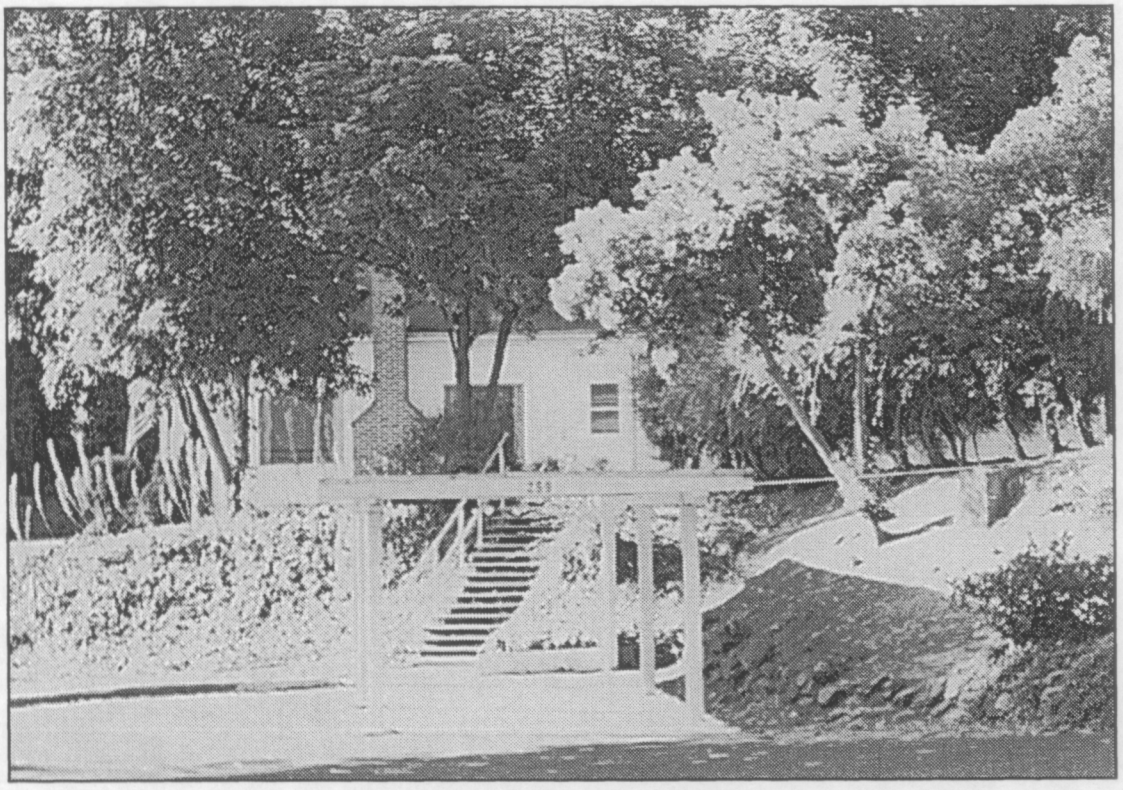
Historic Resources: Senior Officers' Quarters Historic District
and Quarters 1–Yerba Buena Island

Figure 3-25

9/10/00

Quarters 8

Quarters 9

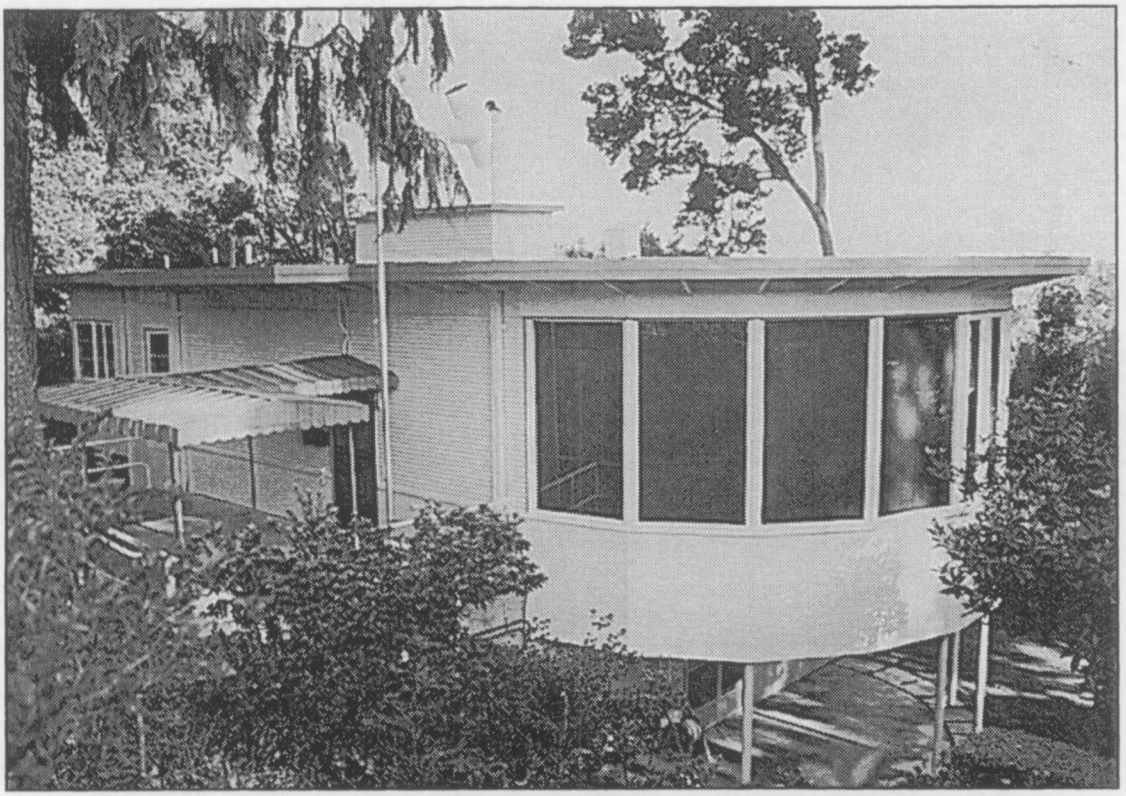


Quarters 9

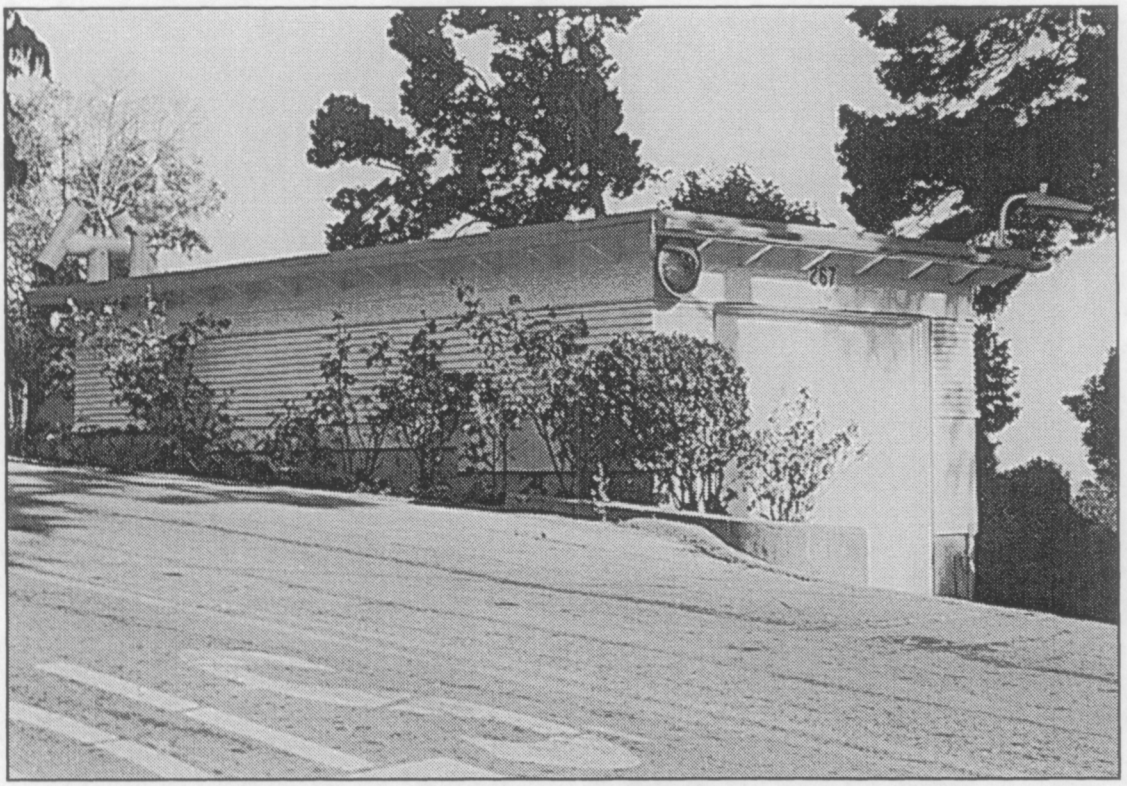
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Historic Resources: Quarters 9
–Yerba Buena Island

Figure 3-27



Quarters 10

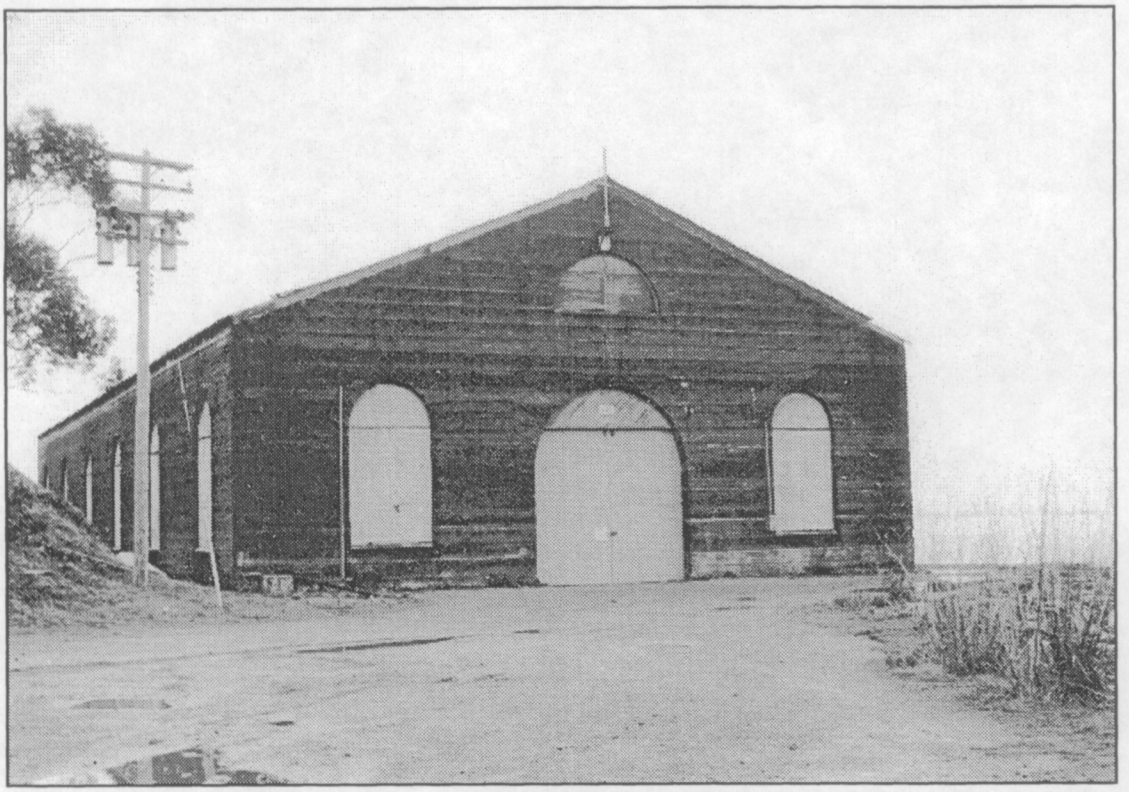


Building 267

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Historic Resources: Quarters 10 and Garage
(Building 267)–Yerba Buena Island

Figure 3-28



Building 262

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Historic Resources: Building 262
–Yerba Buena Island

Figure 3-29

2/4/01

SAN FRANCISCO BAY

MACALLA ROAD

MACALLA ROAD

SOUTHGATE ROAD

TO OAKLAND

SAN FRANCISCO BAY

LEGEND

- ELECTRICAL (HIGH RISK)
- TELEPHONE
- GAS (HIGH RISK)
- SEWER
- WATER

SFOBB EAST SPAN SEISMIC SAFETY PROJECT

GRAPHIC SCALE 1:5,000

0 50 100 150 m

Existing Major Utilities
Yerba Buena Island

Figure 3-30a

4/25/01

SAN FRANCISCO BAY

N

TO SAN FRANCISCO

BURMA ROAD

LEGEND

- ELECTRICAL (HIGH RISK)
- TELEPHONE
- GAS (HIGH RISK)
- SEWER
- WATER

SAN FRANCISCO BAY

SFOBB EAST SPAN
SEISMIC SAFETY
PROJECT

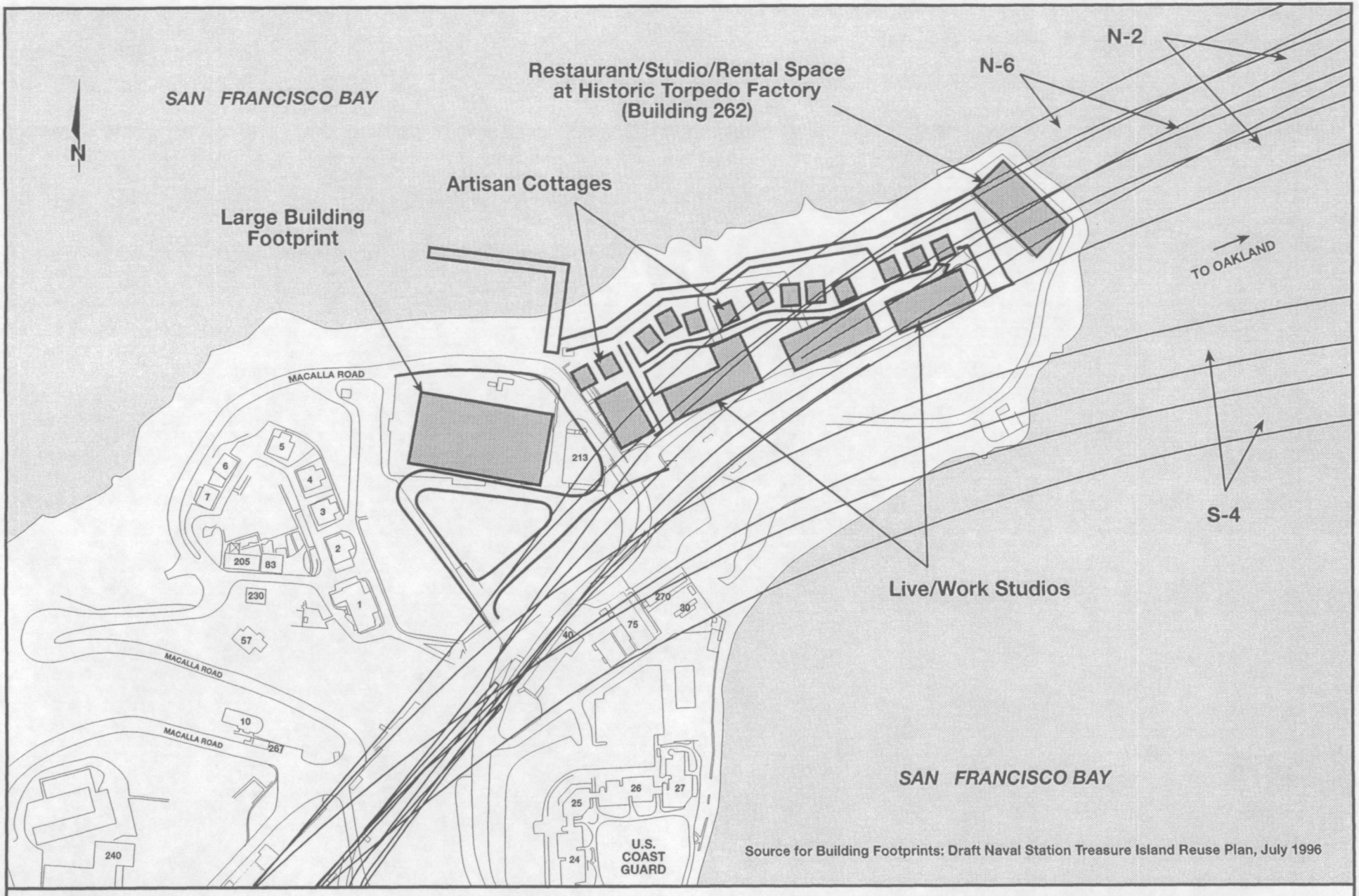
GRAPHIC SCALE 1:5,000

0 50 100 150 m

Existing Major Utilities
Oakland Touchdown Area

Figure 3-30b

4/25/01



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:3,000

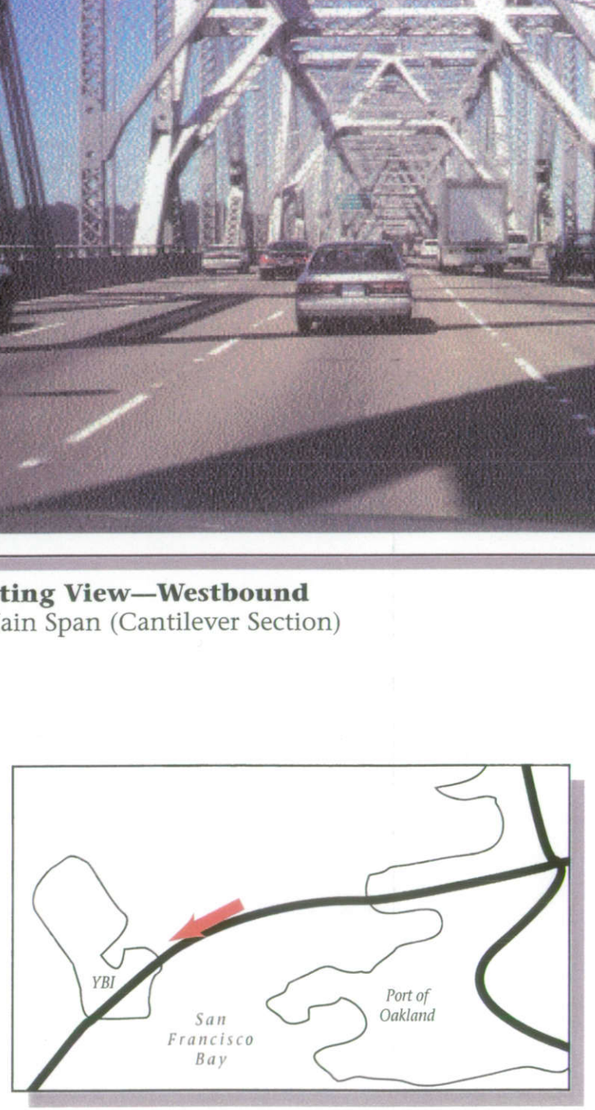
0 25 50 100 m

Potential Project Impacts on Development Scenarios–Yerba Buena Island

Figure 4-1

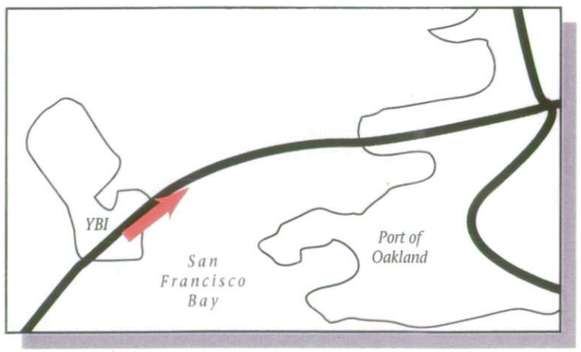
2/5/01

Existing View—Westbound
In Main Span (Cantilever Section)



Simulation of Proposed Project
Westbound View in Main Span (Self-Anchored Suspension Section)

Existing View—Eastbound
Just East of YBI Tunnel



Simulation of Proposed Project
Eastbound View Just East of YBI Tunnel

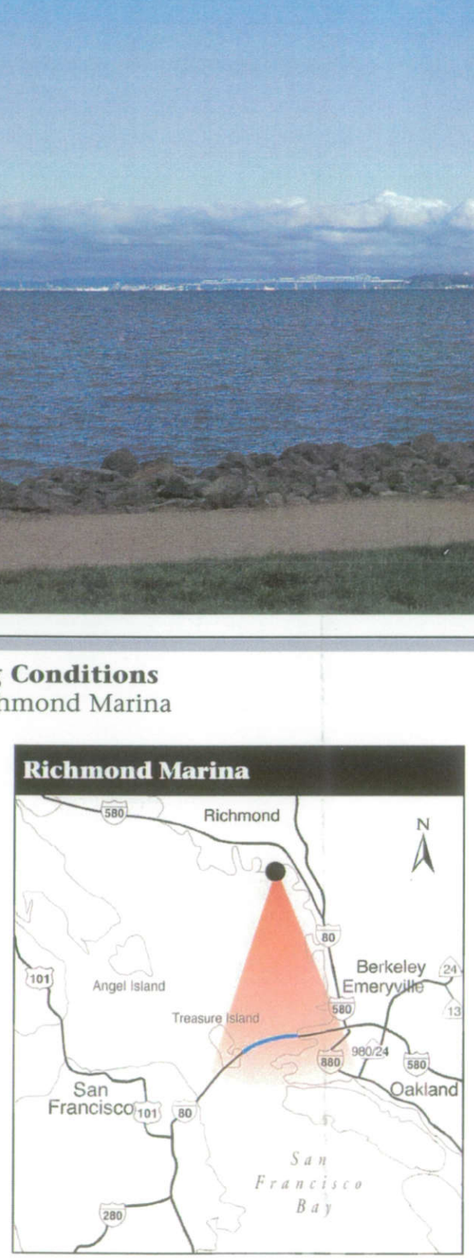
Existing View—Eastbound
In Decline Section

Simulation of Proposed Project
Eastbound View In Decline Section

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Figure 4-3b

Existing Conditions
From Richmond Marina

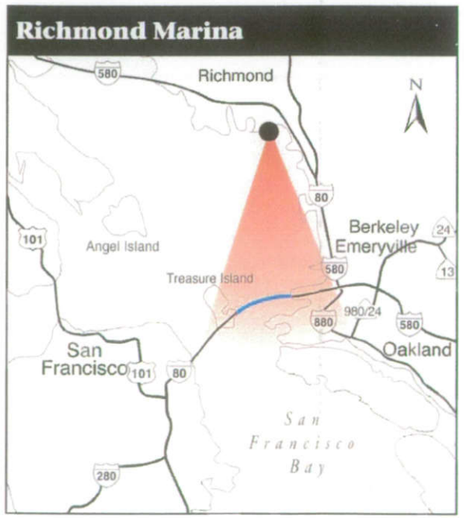


Simulation of Proposed Project
Replacement Alternative N-6 Skyway Design Variation

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

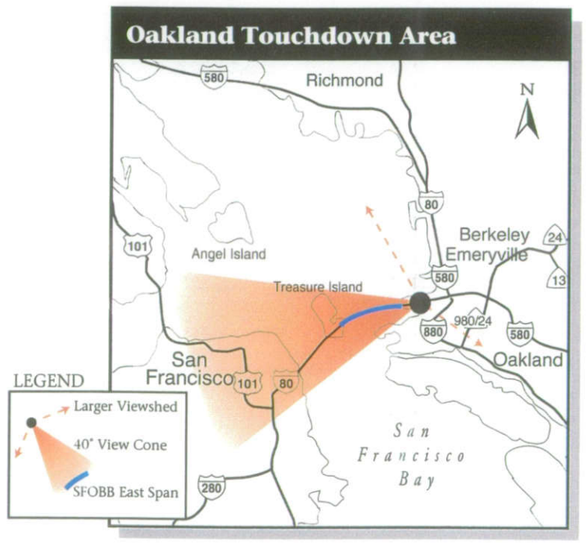
Figure 4-4

Existing Conditions
From Richmond Marina



Simulation of Proposed Project
Replacement Alternative N-6, Self-Anchored Suspension Design Variation

Existing Conditions
From Oakland Touchdown Area

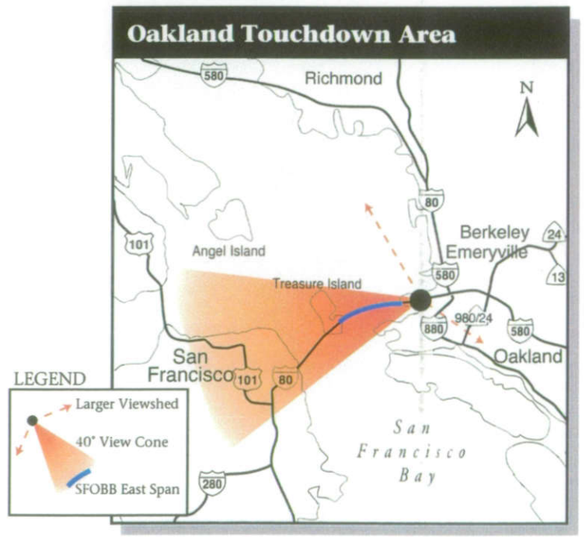


Simulation of Proposed Project
Replacement Alternative N-6, Skyway Design Variation

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Figure 4-6

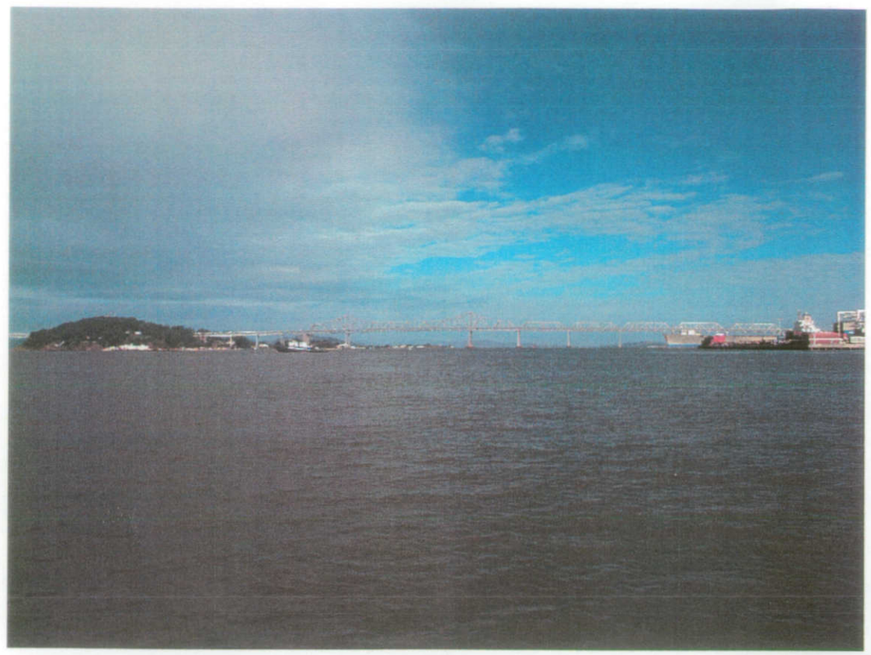
Existing Conditions
From Oakland Touchdown Area



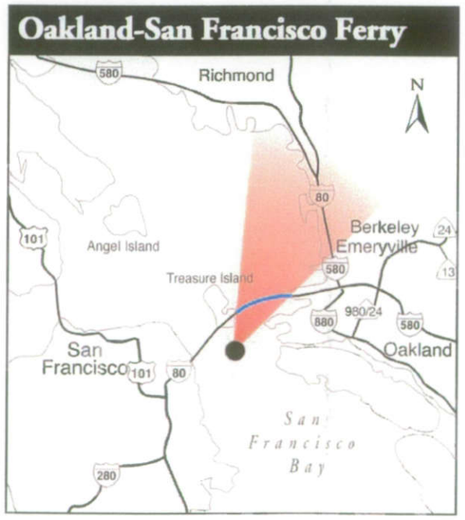
Simulation of Proposed Project
Replacement Alternative S-4, Self-Anchored Suspension Design Variation

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Figure 4-7



Existing Conditions
From Oakland-San Francisco Ferry

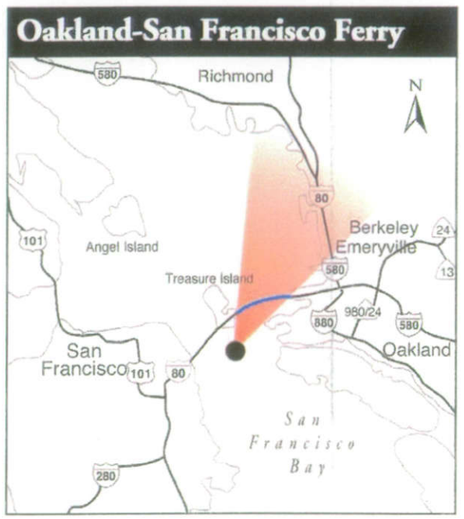


Simulation of Proposed Project
Replacement Alternative S-4, Skyway Design Variation

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Figure 4-8

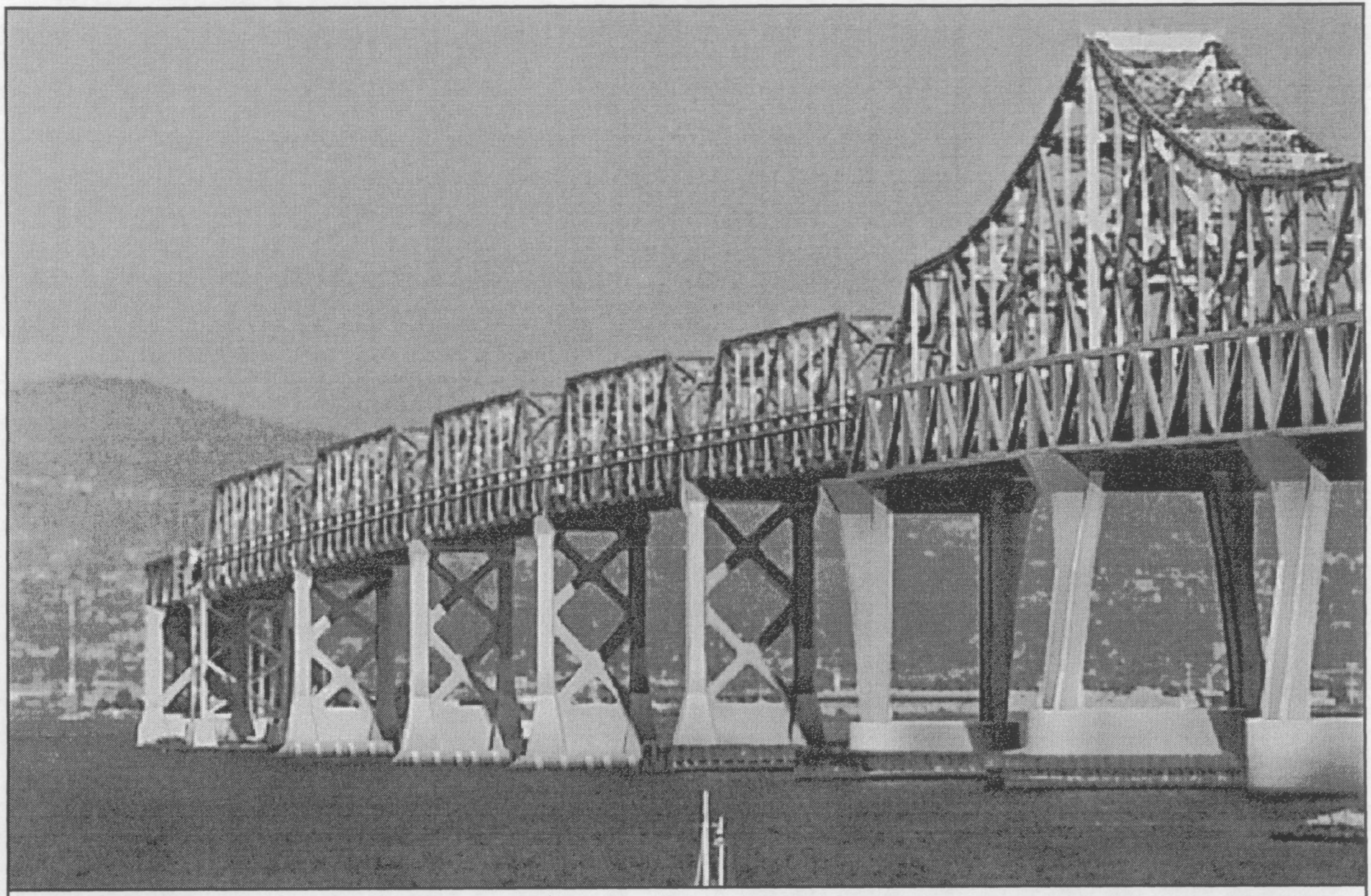
Existing Conditions
From Oakland-San Francisco Ferry



Simulation of Proposed Project
Replacement Alternative S-4, Cable-Stayed Design Variation

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Figure 4-9



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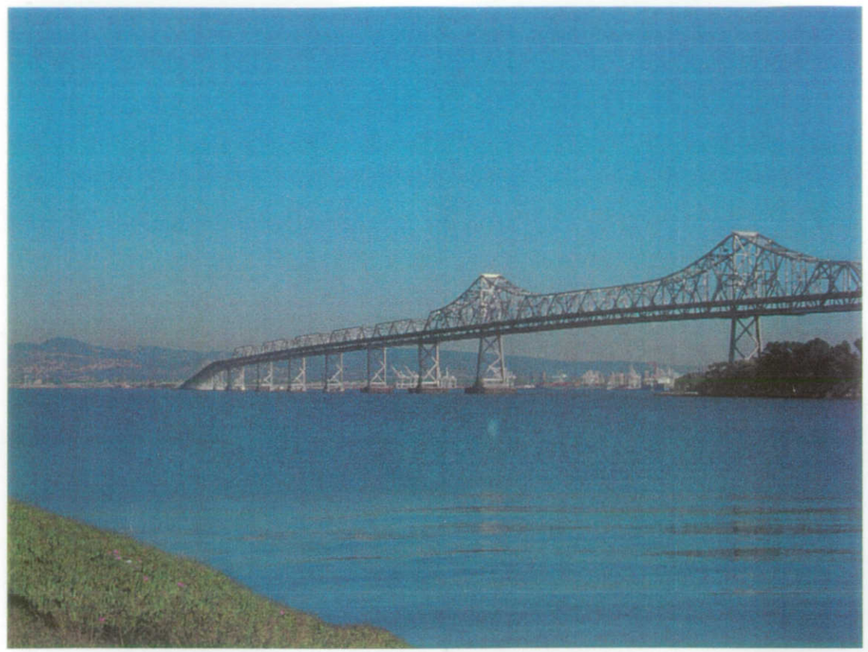
SEISMIC SAFETY
PROJECT

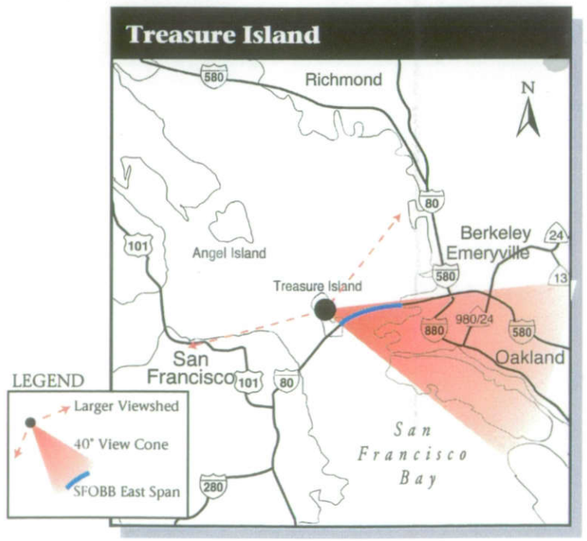
Photo Simulation Retrofit Existing Bridge Design
from Treasure Island Viewpoint

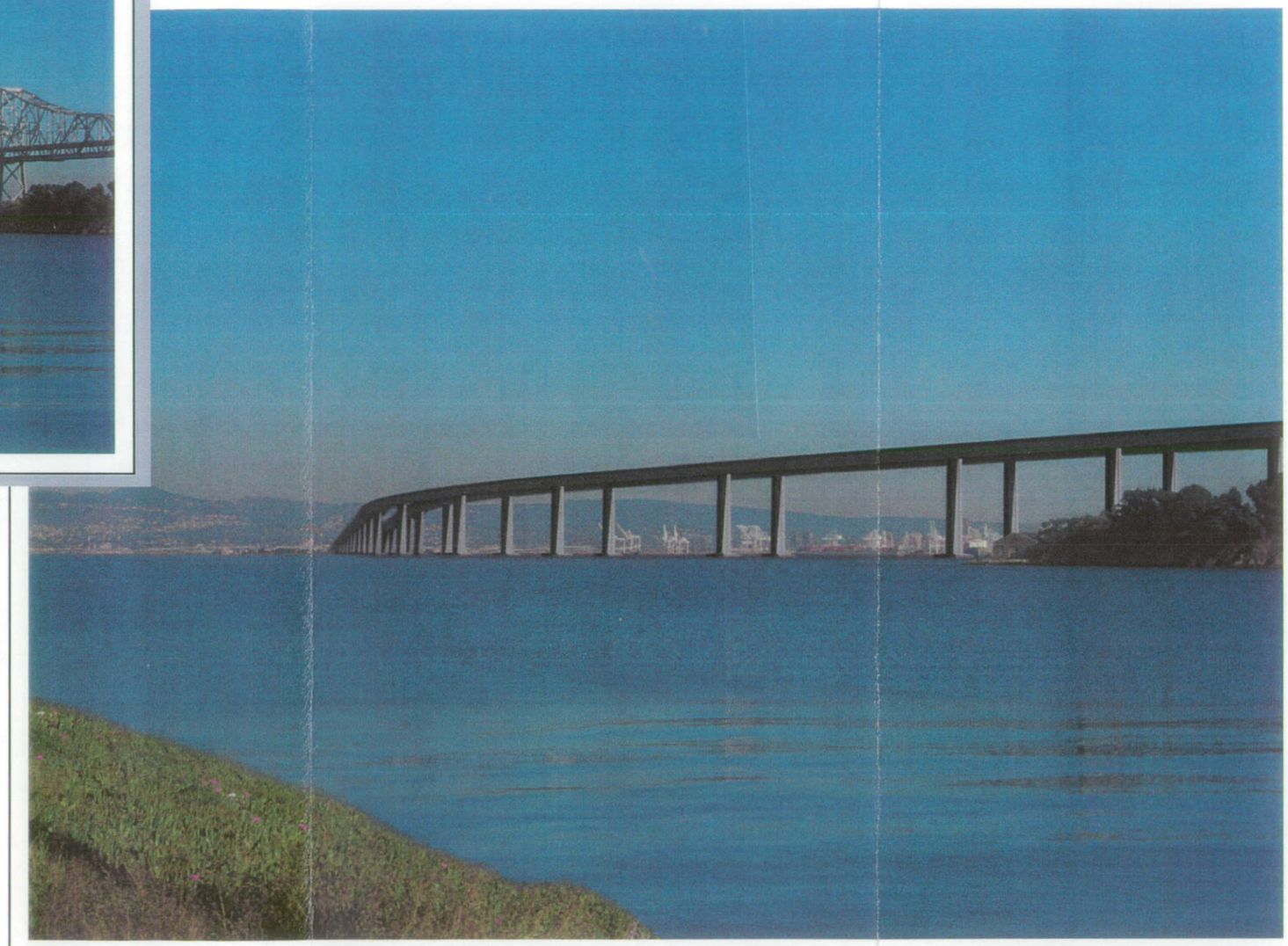
Figure 4-10

9/4/00



Existing Conditions
From Treasure Island

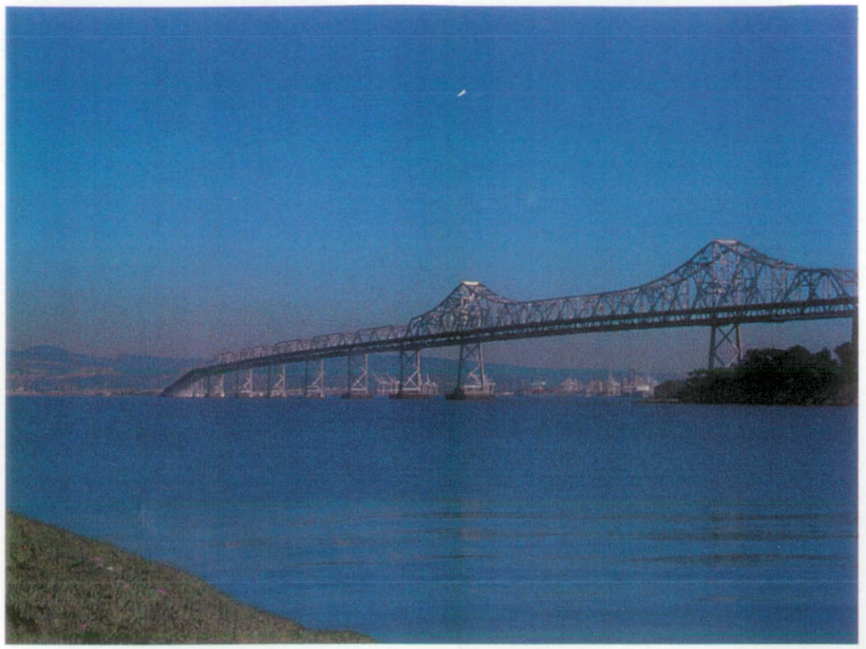




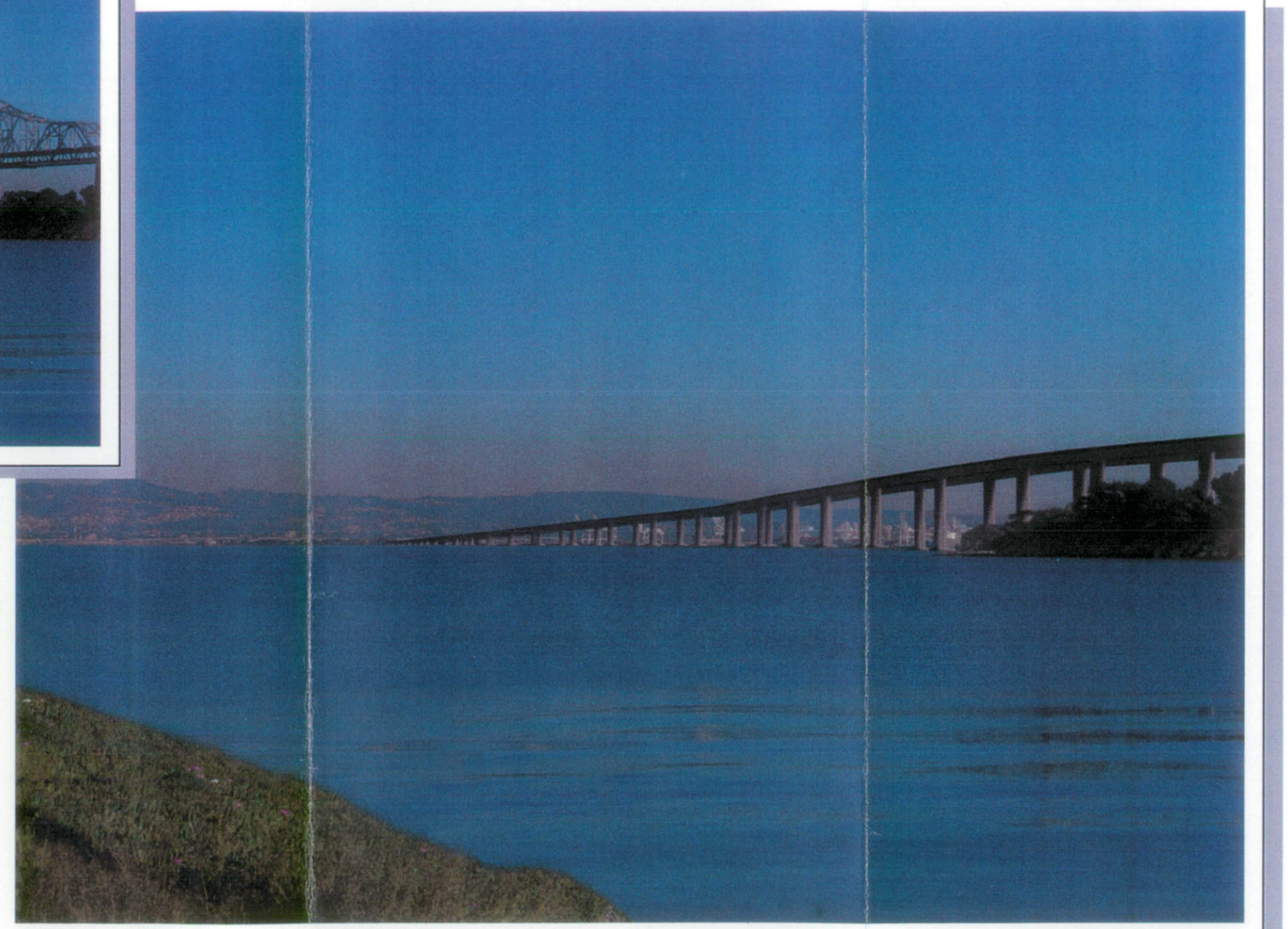
Simulation of Proposed Project
Replacement Alternative N-6, Skyway Design Variation

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

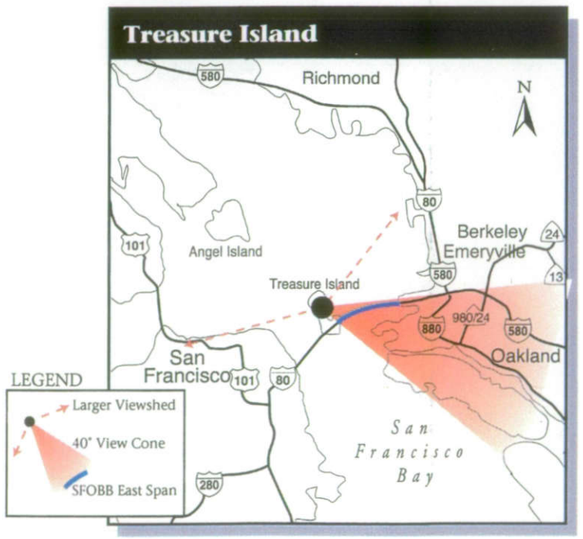
Figure 4-11



Existing Conditions
From Treasure Island



Simulation of Proposed Project
Replacement Alternative S-4, Skyway Design Variation



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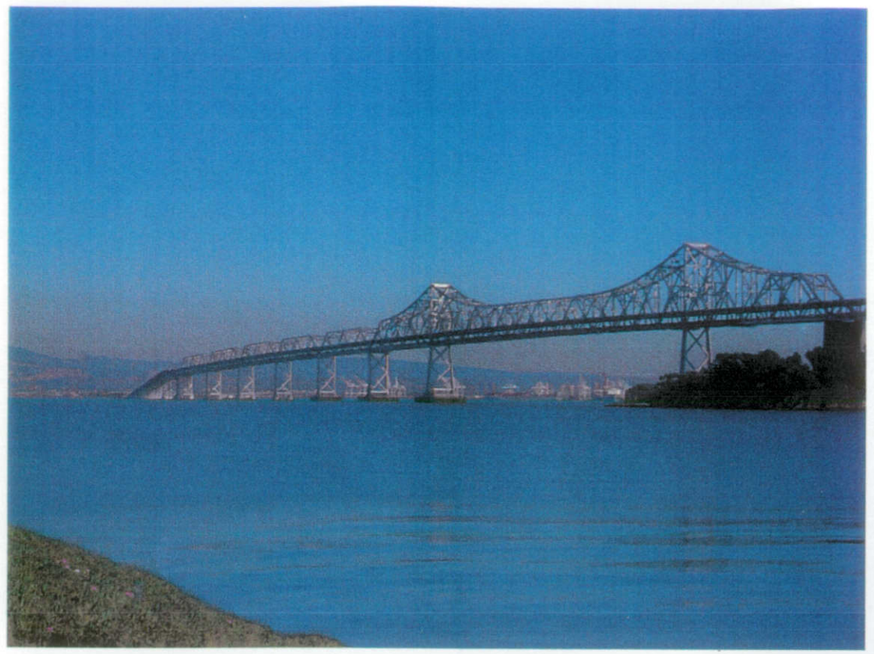
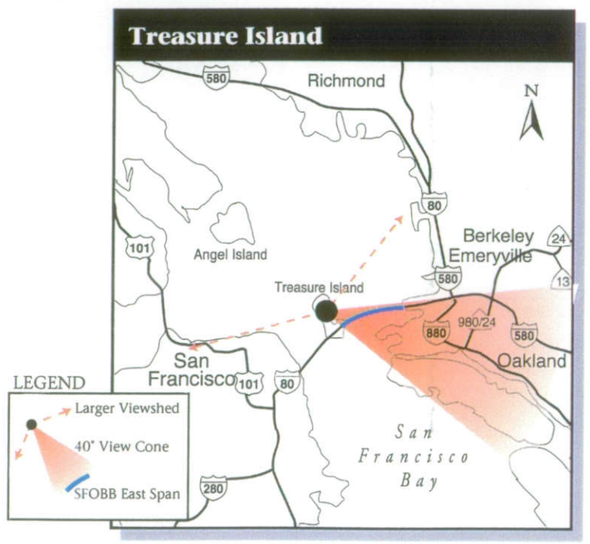
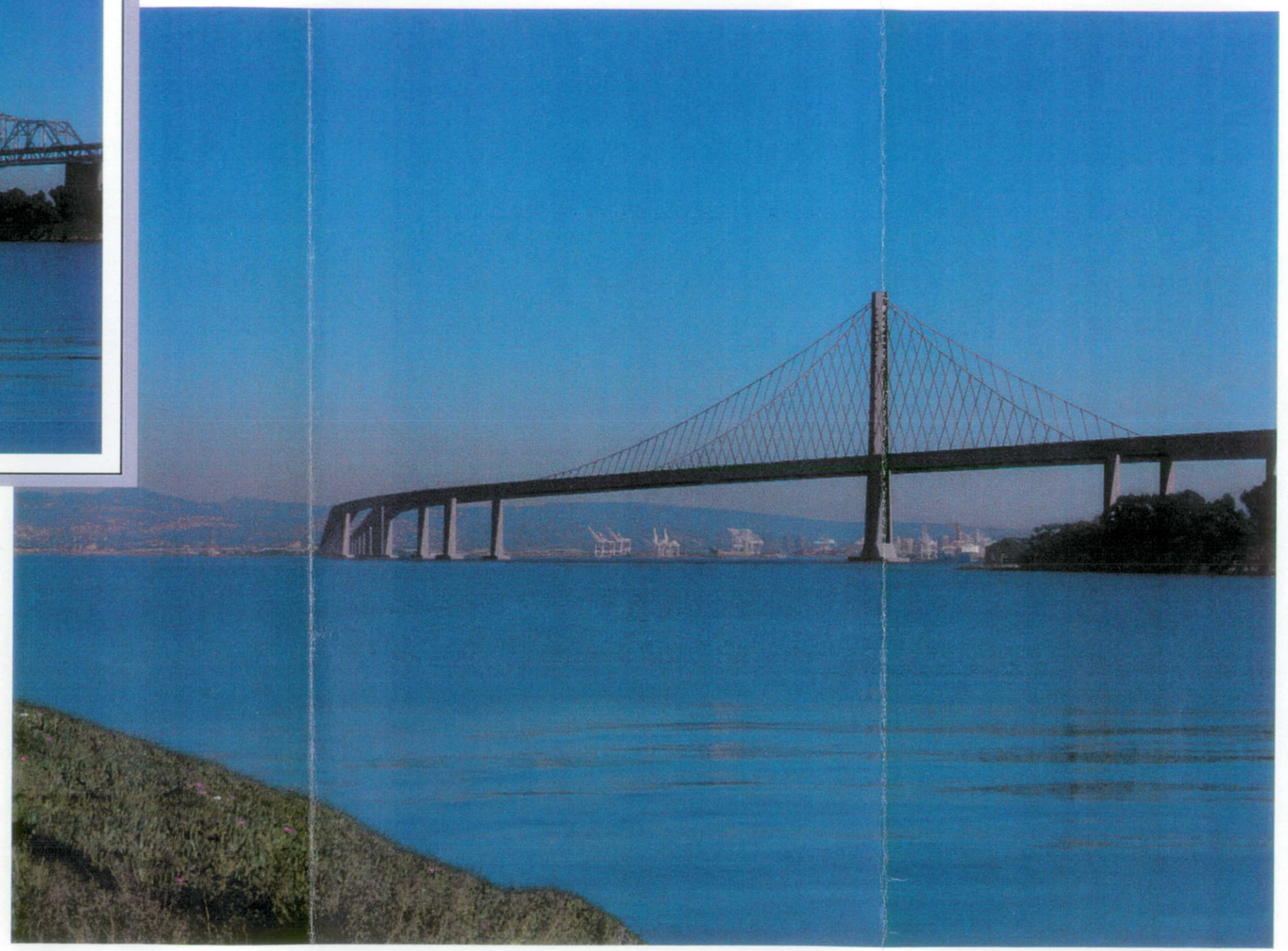
SEISMIC SAFETY
PROJECT

Figure 4-12

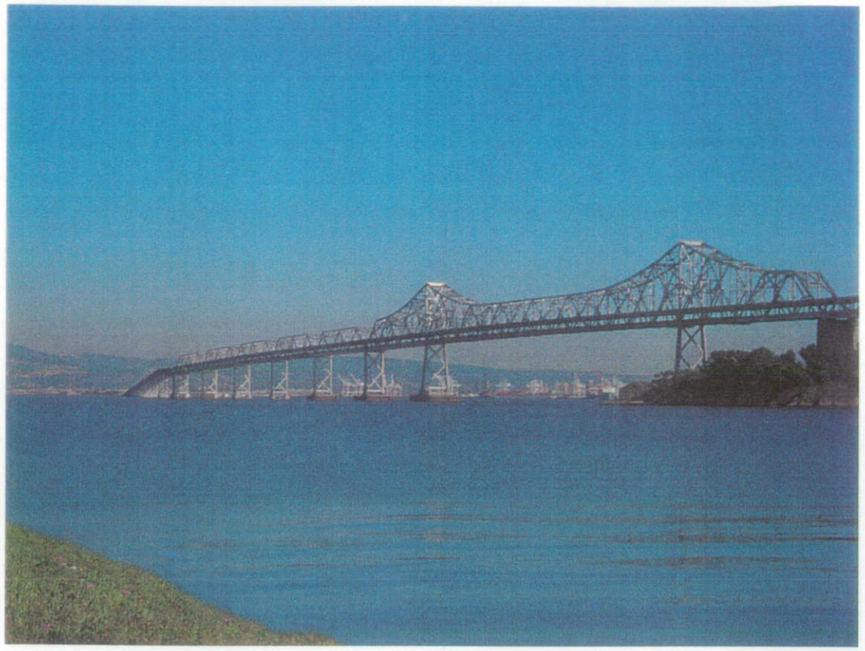


Existing Conditions
From Treasure Island

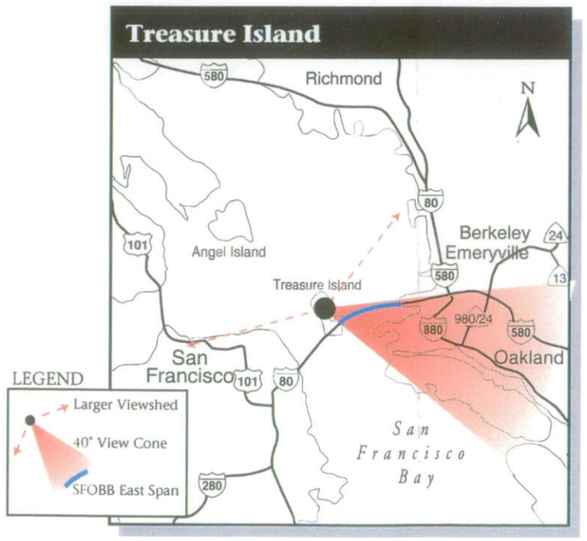




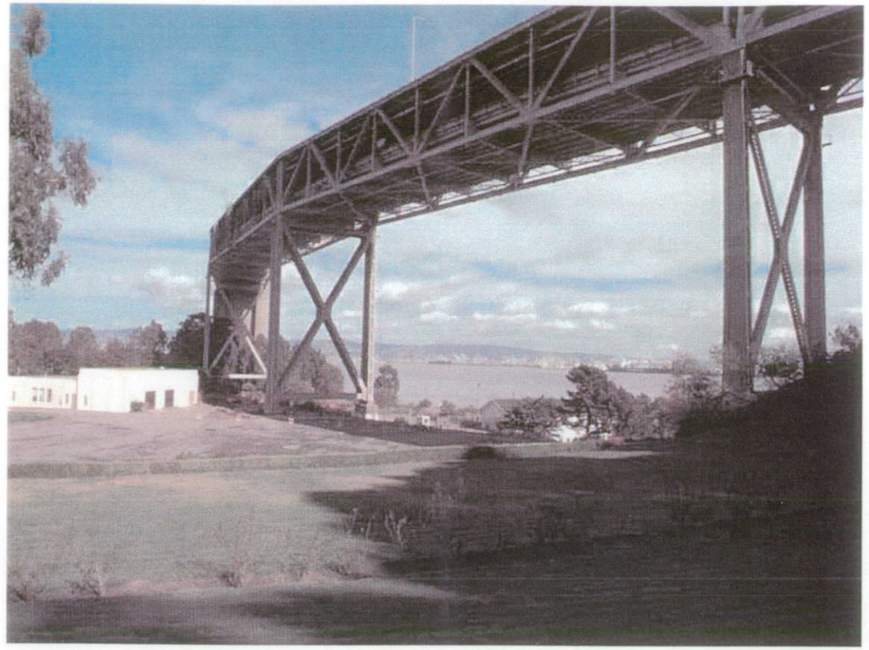
Simulation of Proposed Project
Replacement Alternative N-6, Self-Anchored Suspension Design Variation



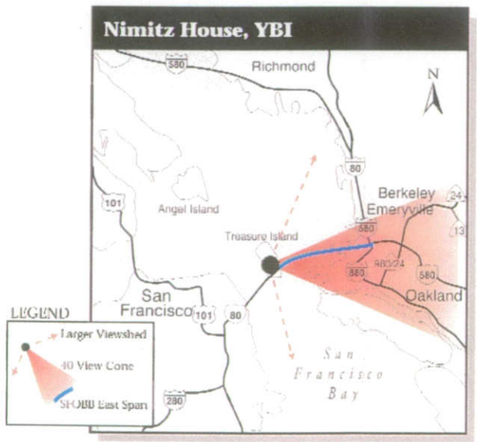
Existing Conditions
From Treasure Island

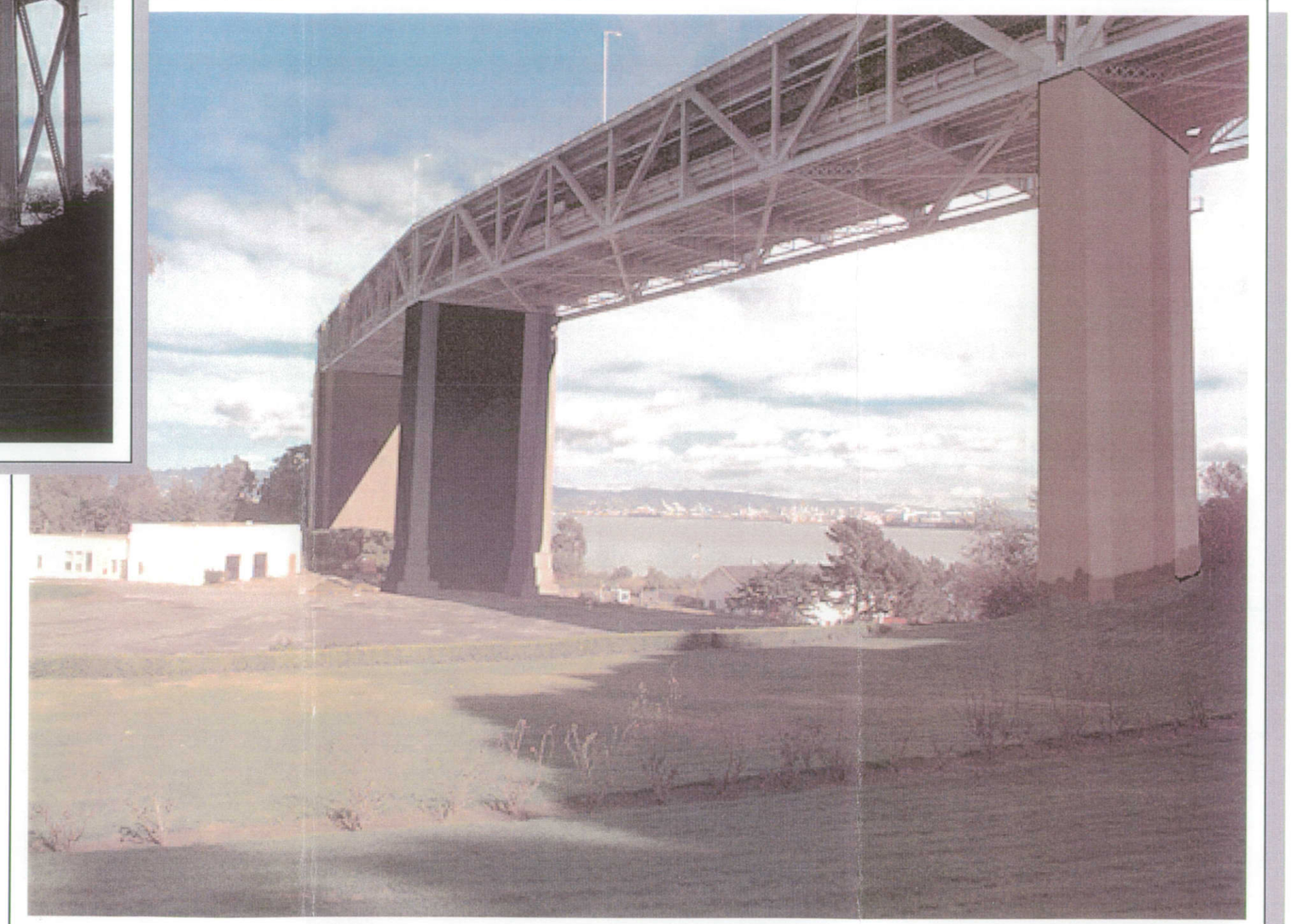


Simulation of Proposed Project
Replacement Alternative S-4, Self-Anchored Suspension Design Variation



Existing Conditions
View From Nimitz House (Quarters 1), YBI





Simulation of Proposed Project
Retrofit Alternative

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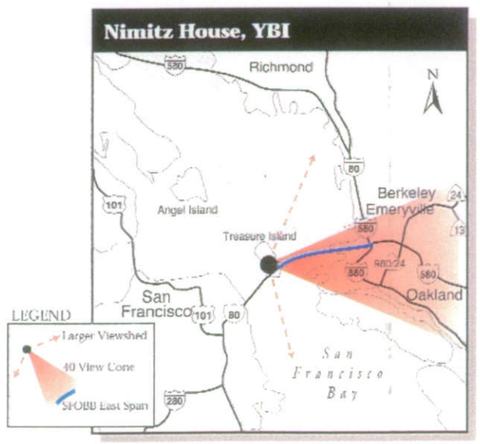
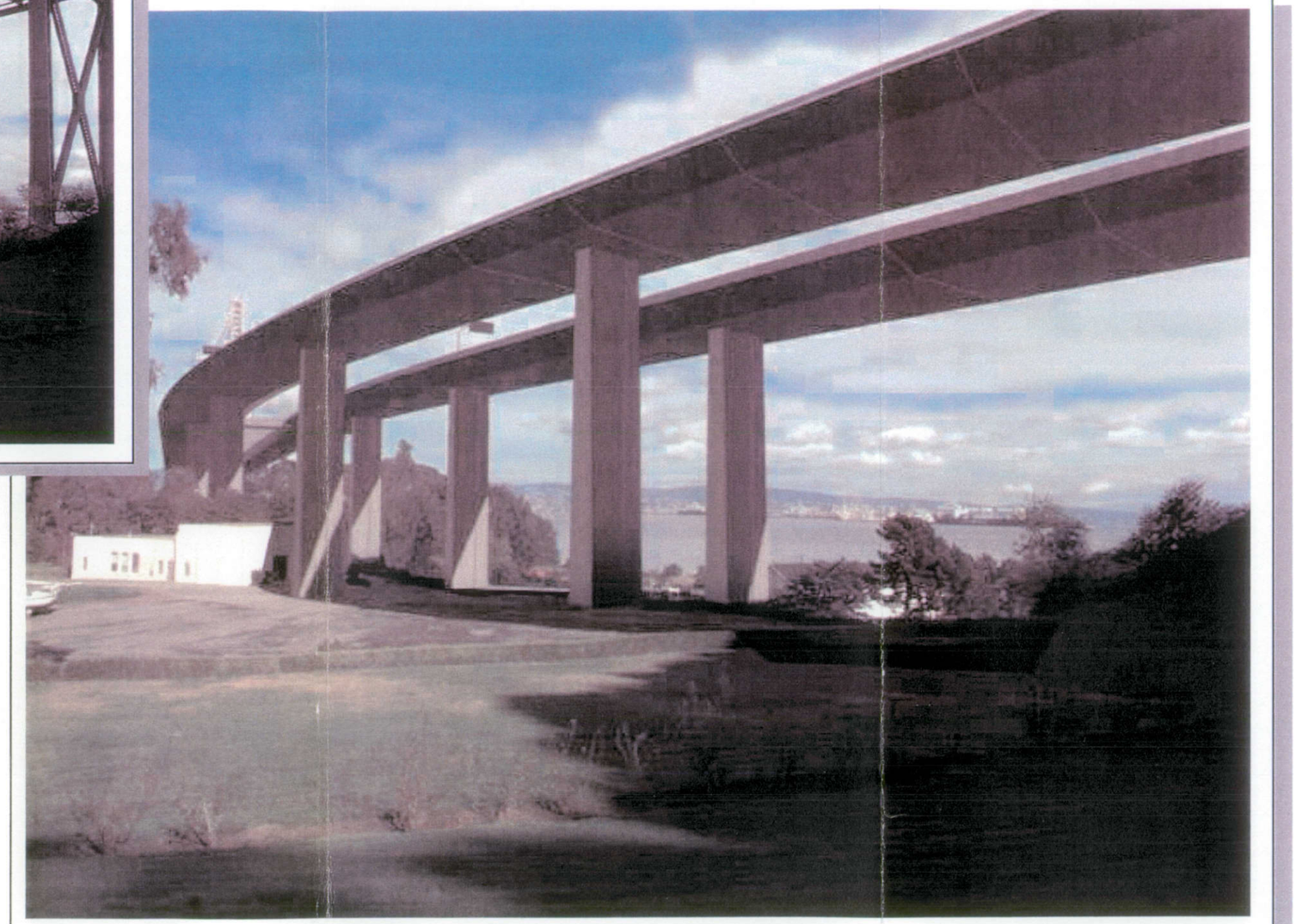
PROJECT

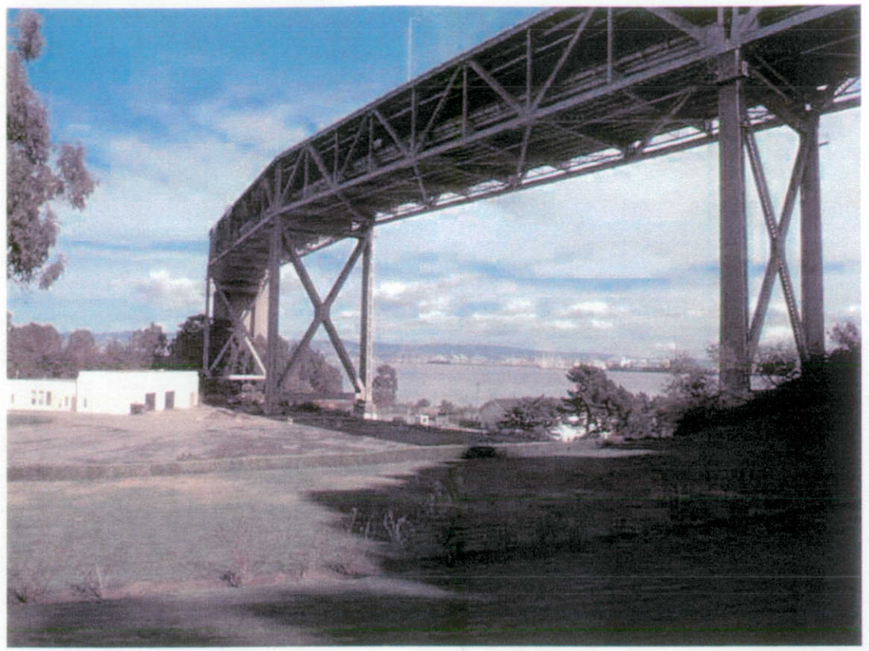
Figure 4-15a

Existing Conditions
View From Nimitz House (Quarters 1), YBI

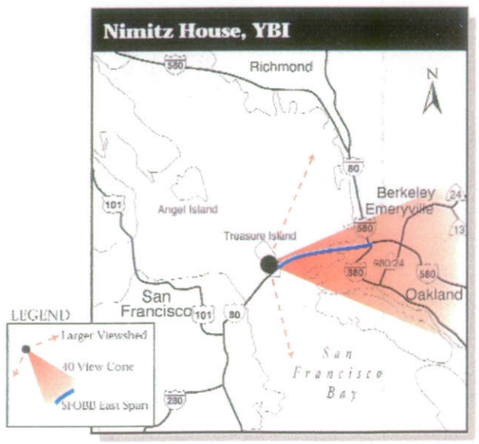


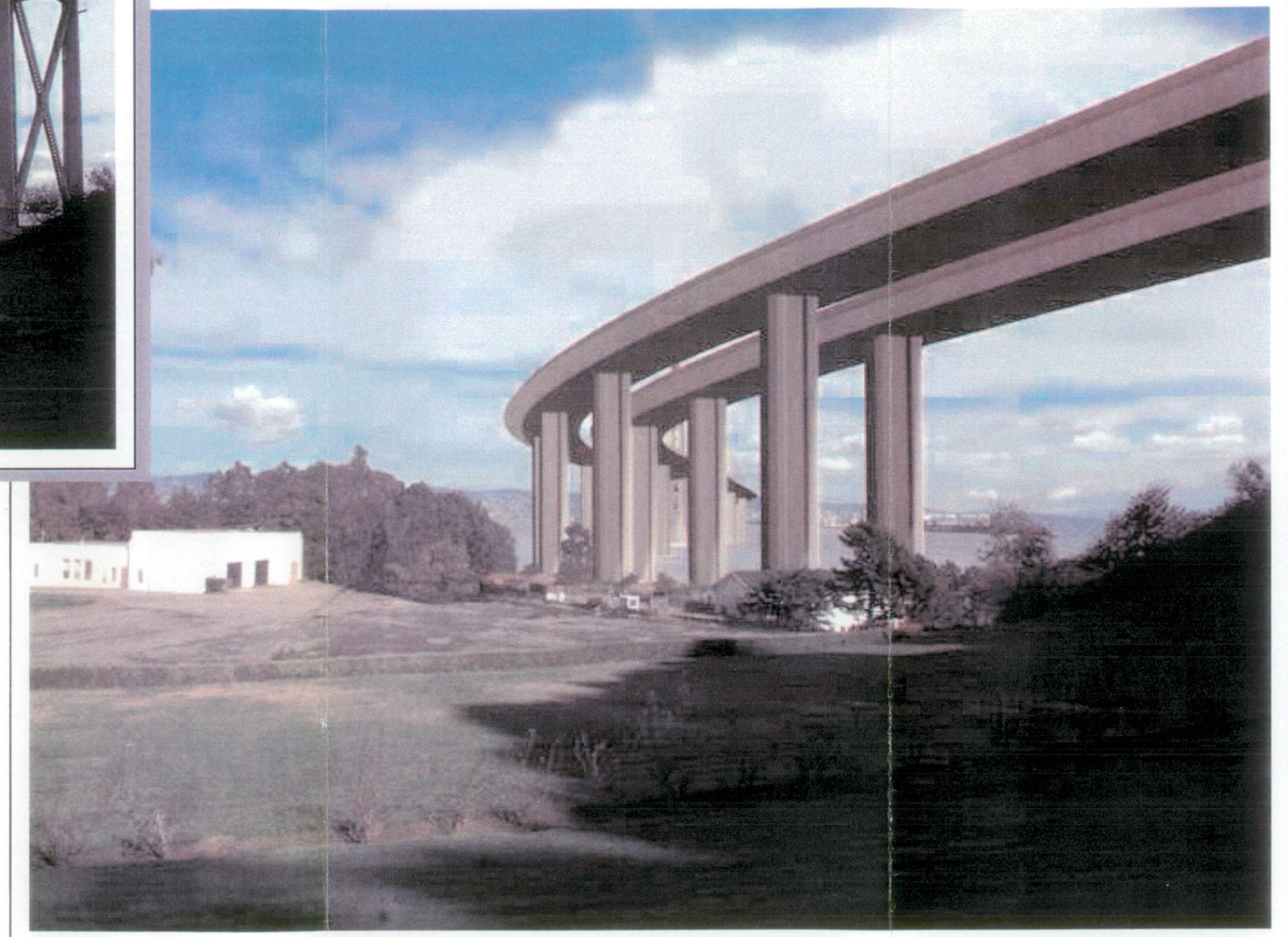


Simulation of Proposed Project
Replacement Alternative N-6, Self-Anchored Suspension Design Variation

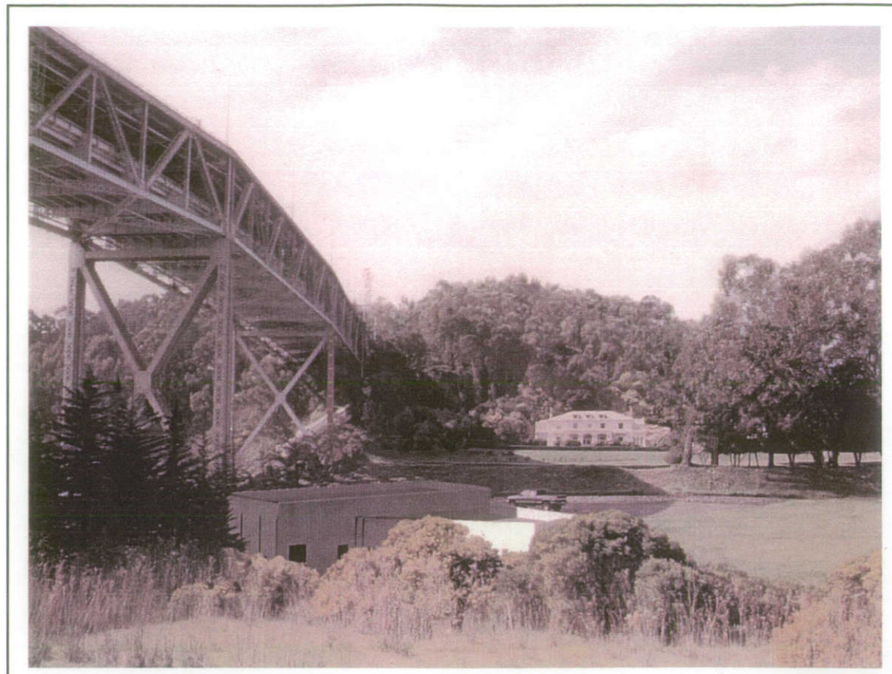


Existing Conditions
View From Nimitz House (Quarters 1), YBI

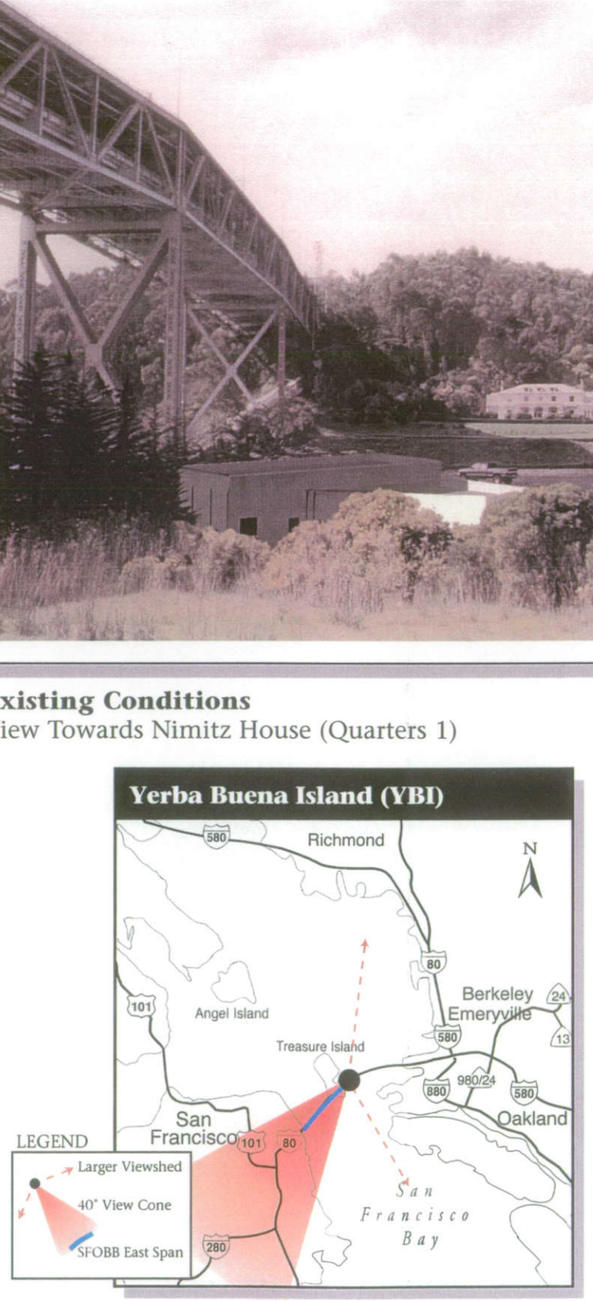




Simulation of Proposed Project
Replacement Alternative S-4, Self-Anchored Suspension Design Variation



Existing Conditions
View Towards Nimitz House (Quarters 1)



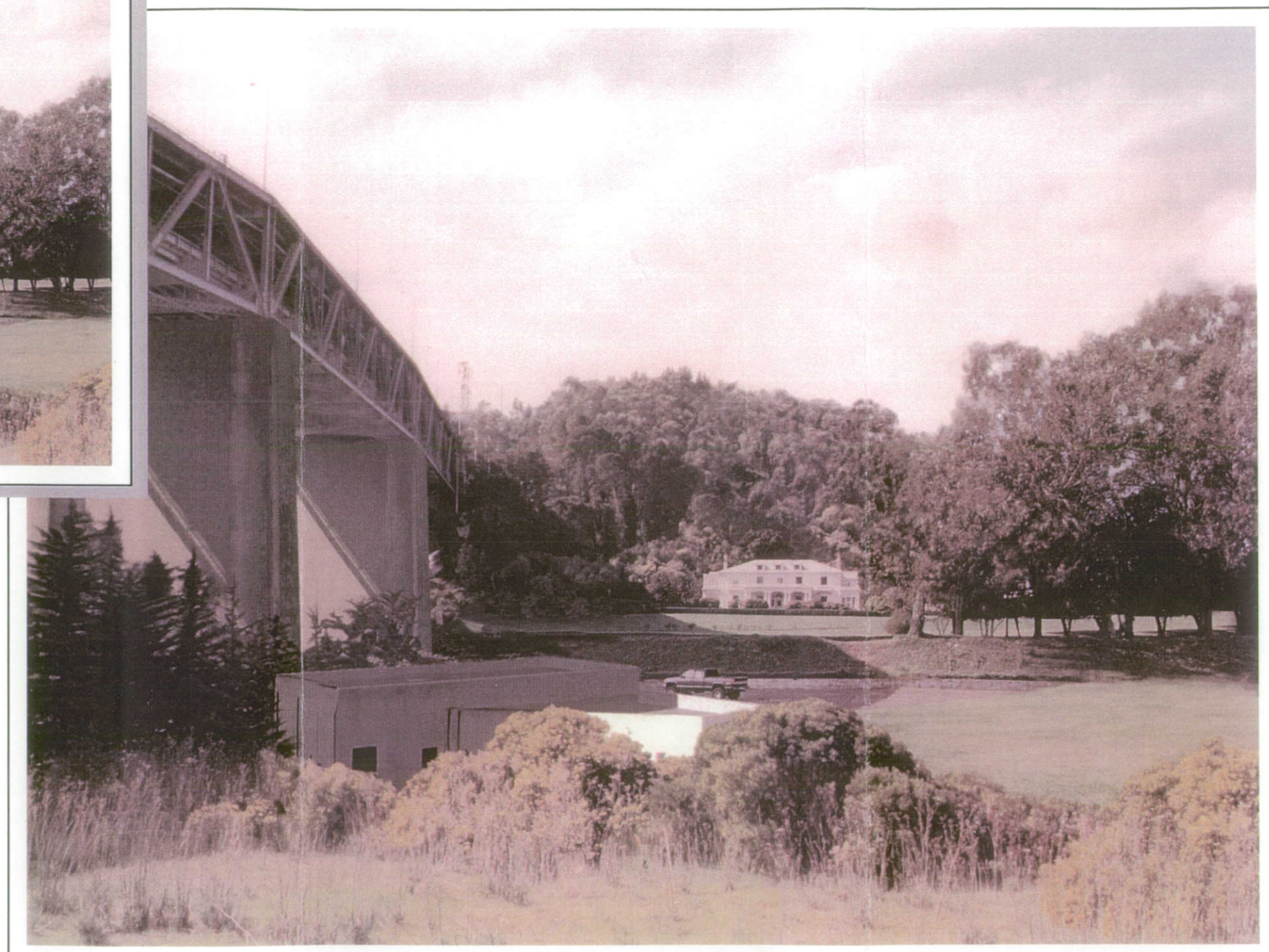
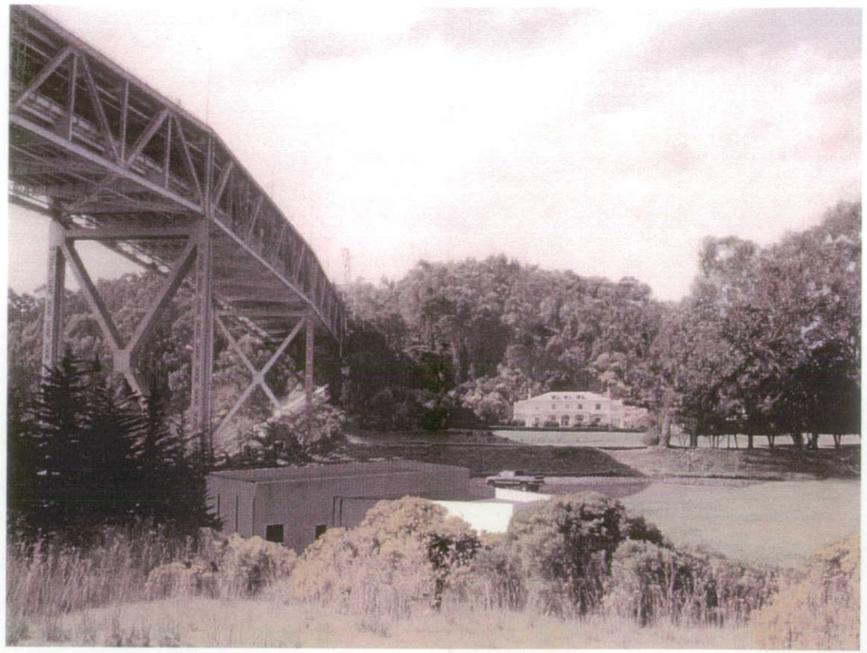
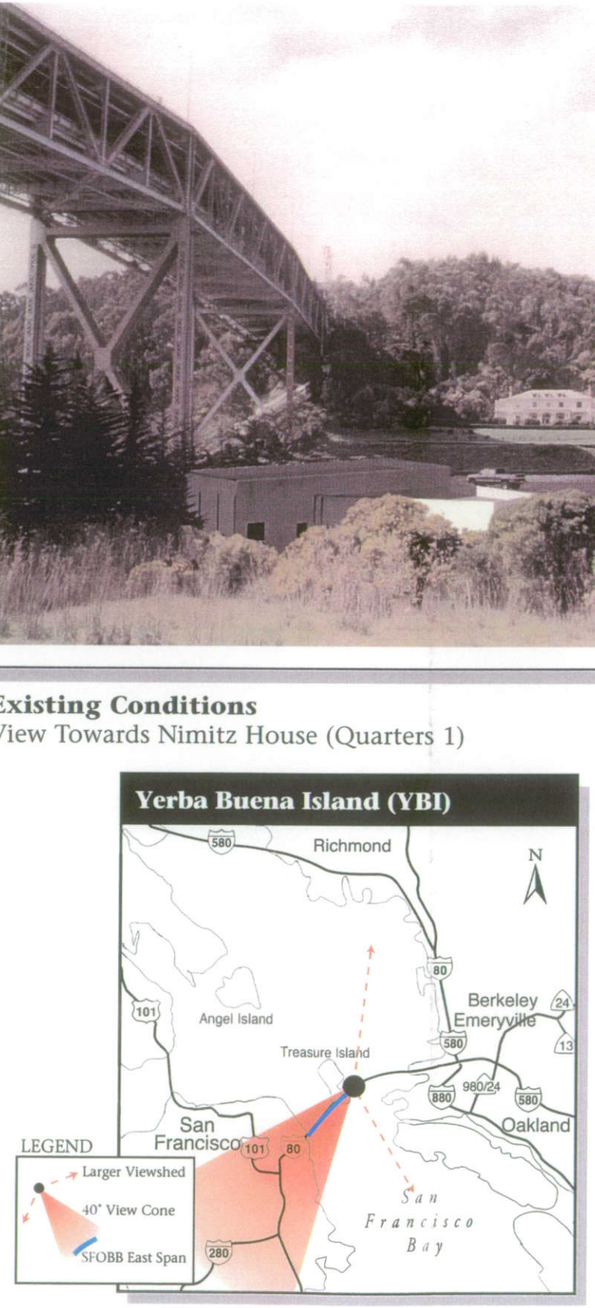


Photo Simulation View towards Nimitz House (Quarters 1), YBI
Retrofit Alternative



Existing Conditions
View Towards Nimitz House (Quarters 1)



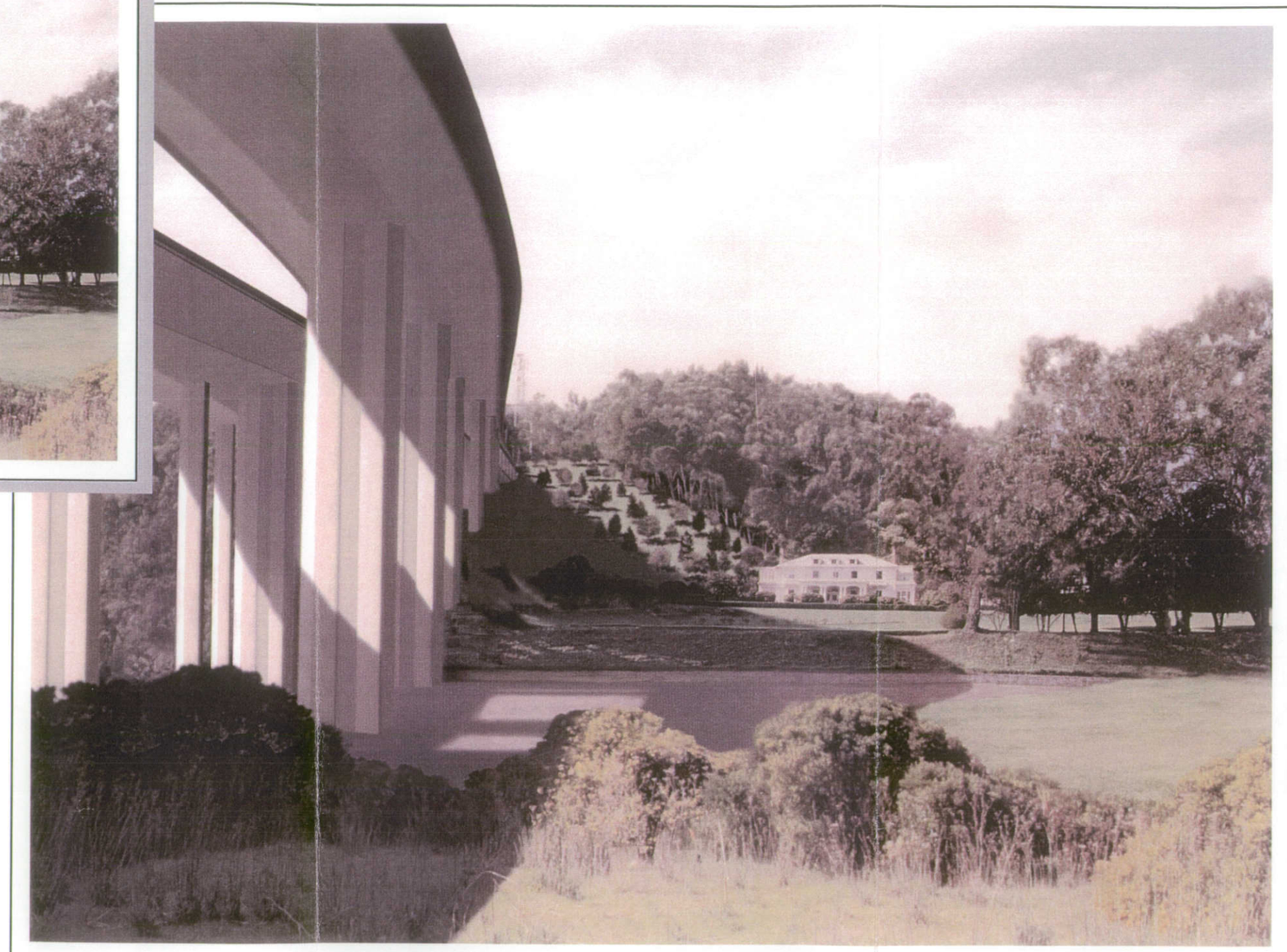
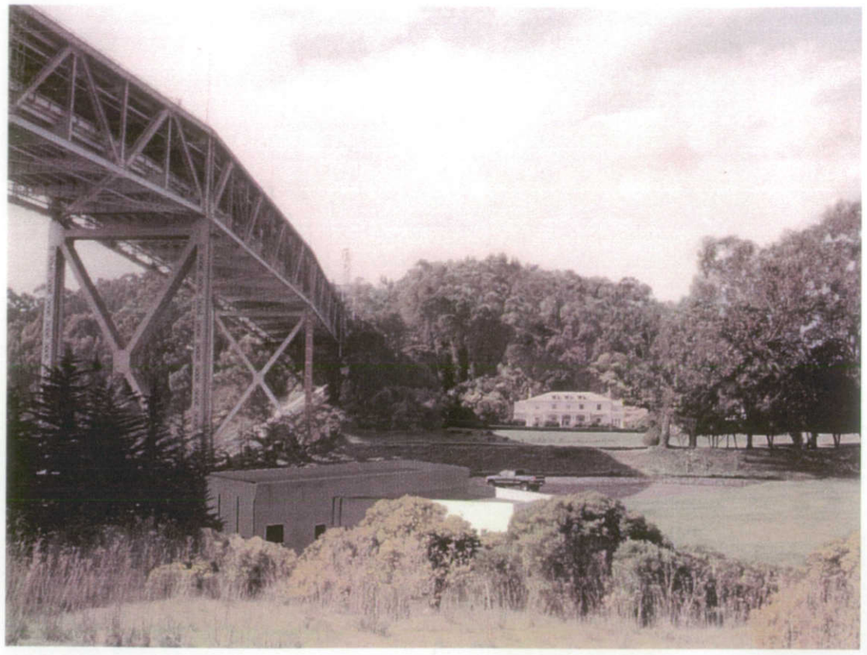
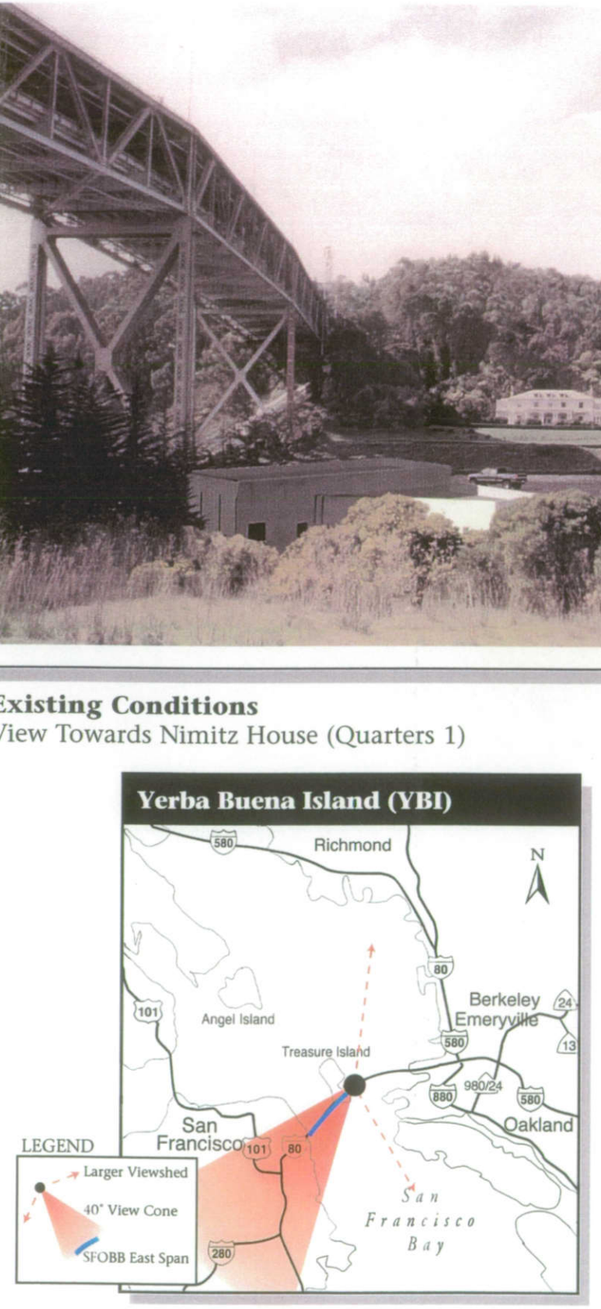


Photo Simulation View towards Nimitz House (Quarters 1), YBI
Replacement Alternative N-6 Self-Anchored Suspension Bridge Design Variation



Existing Conditions
View Towards Nimitz House (Quarters 1)



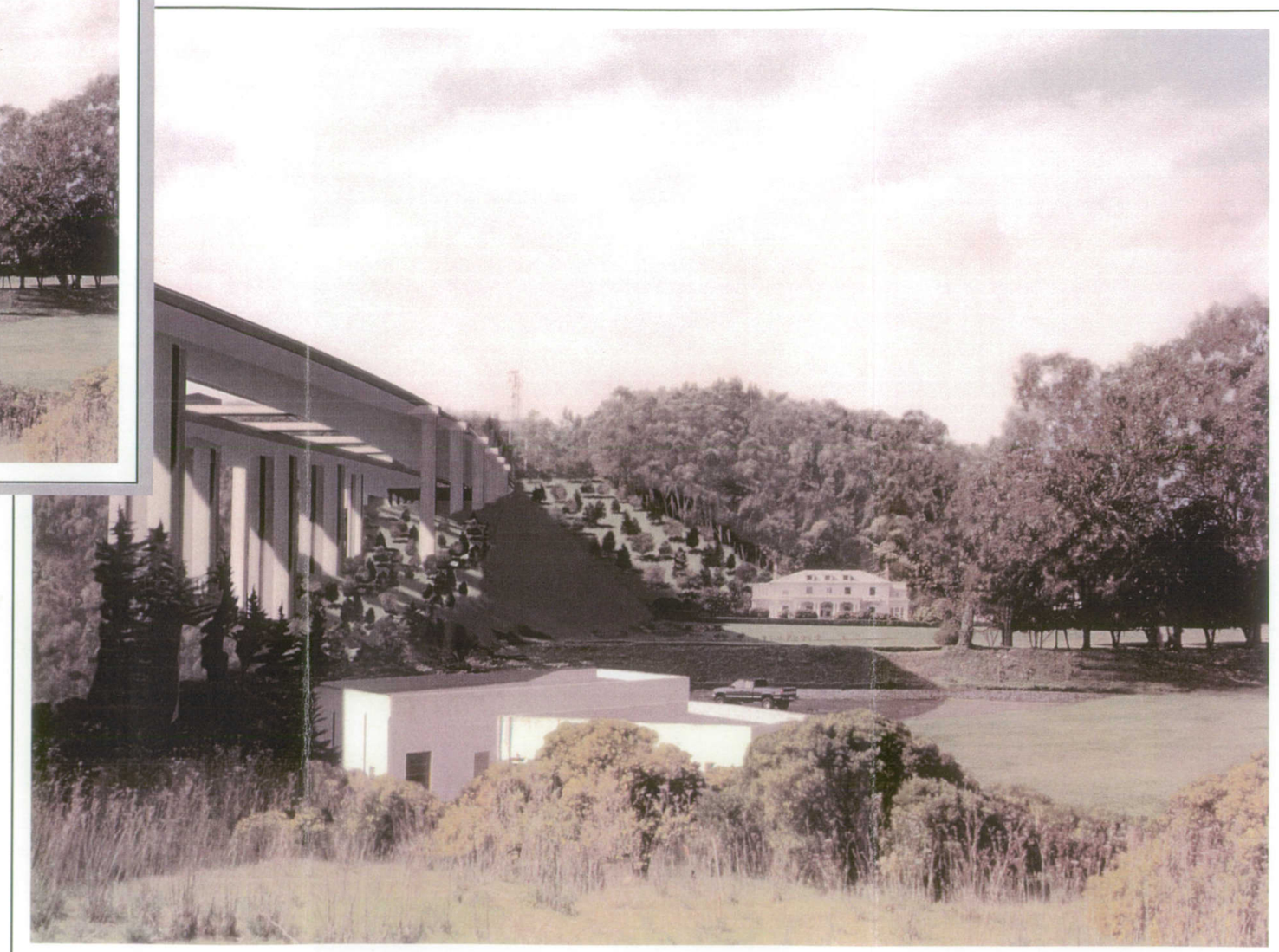


Photo Simulation View towards Nimitz House (Quarters 1), YBI
Replacement Alternative S-4 Self-Anchored Suspension Bridge Design Variation

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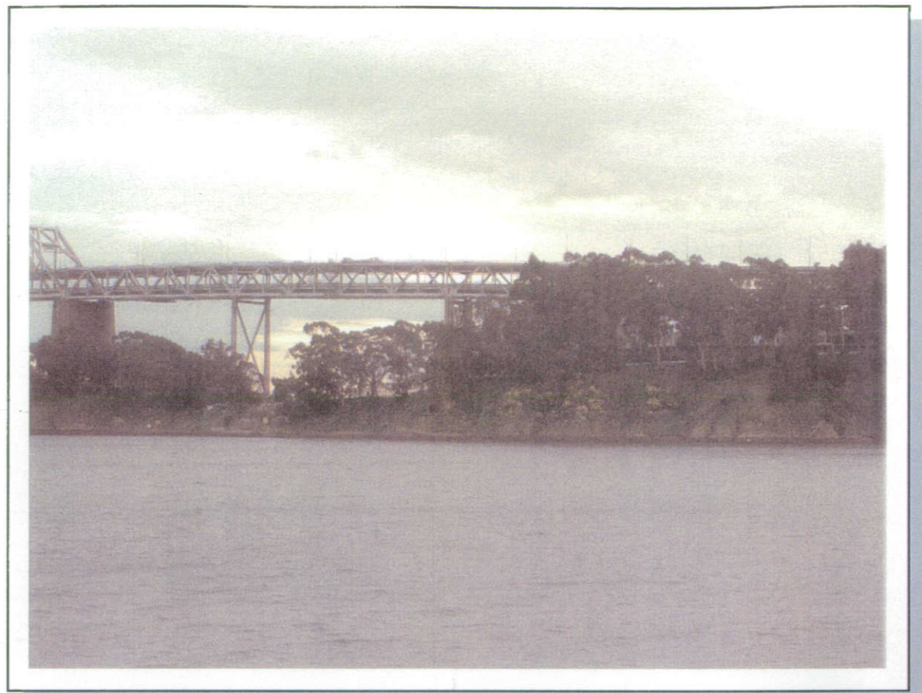
EAST SPAN
SEISMIC SAFETY
PROJECT

Figure 4-16c



Existing Conditions
From Clipper Cove

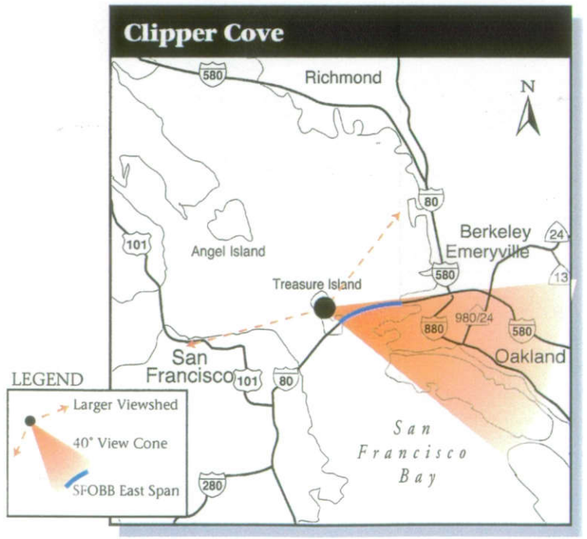


Photo Simulation View from Clipper Cove
Retrofit Alternative

Existing Conditions
From Clipper Cove

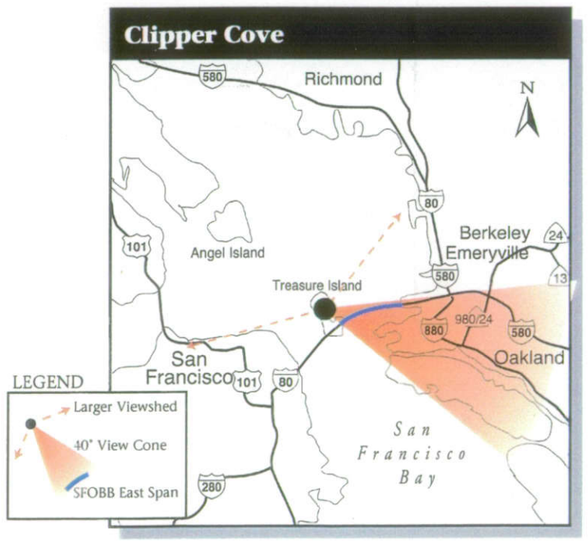


Photo Simulation View from Clipper Cove
Replacement Alternative N-6 Self-Anchored Suspension Bridge Design Variation

Existing Conditions
From Clipper Cove

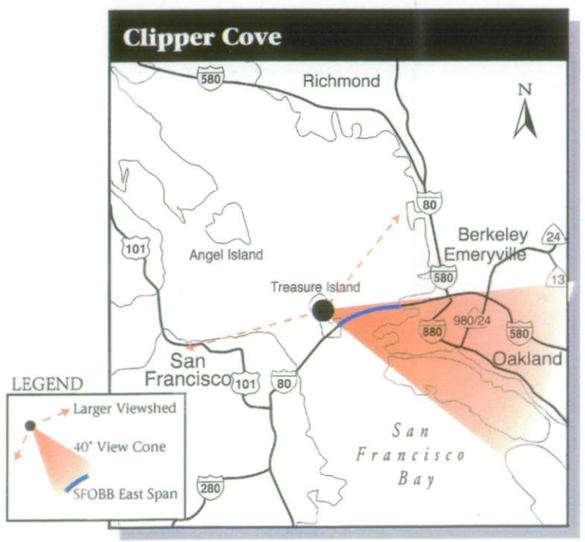
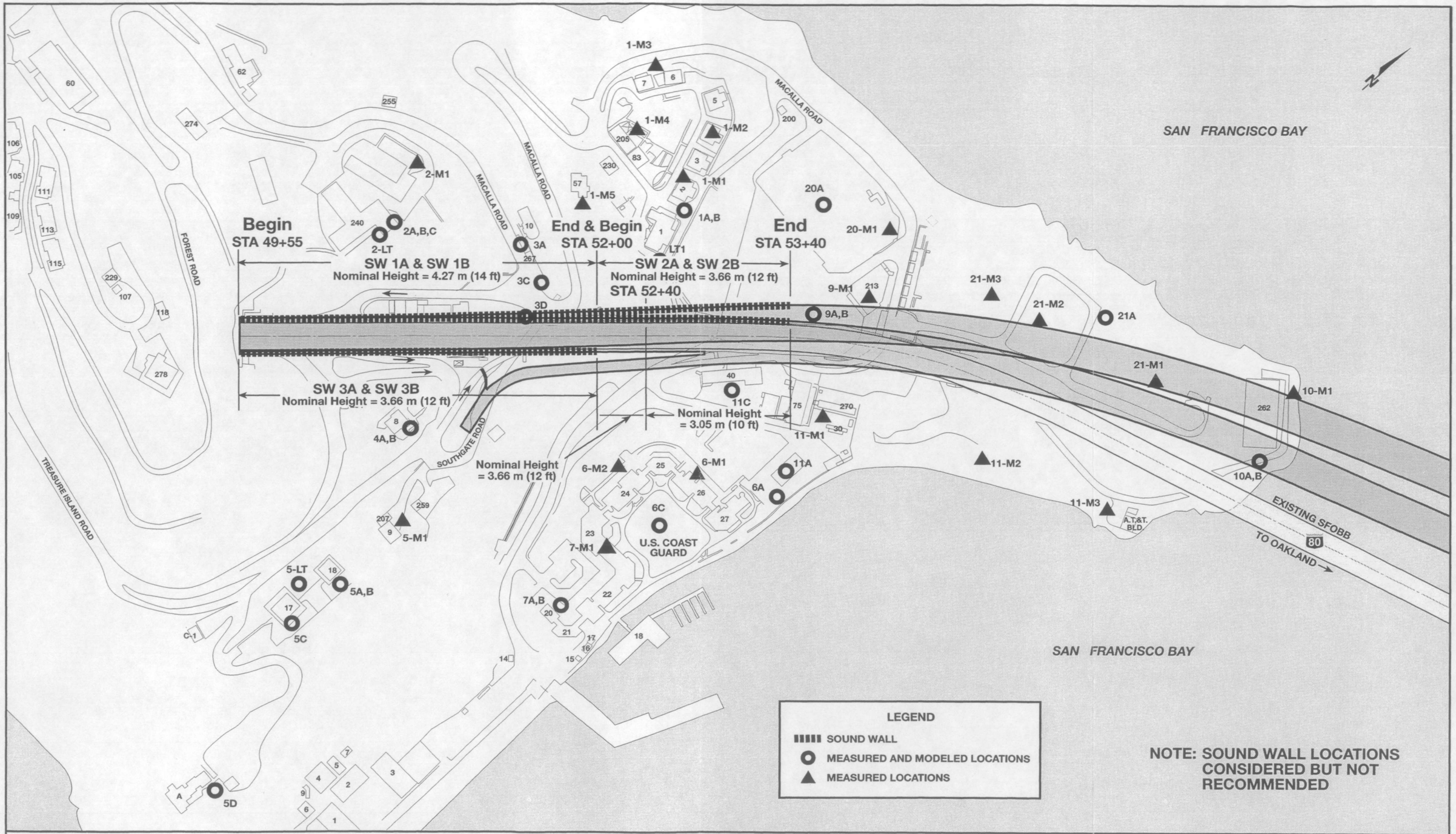


Photo Simulation View from Clipper Cove
Replacement Alternative S-4 Self-Anchored Suspension Bridge Design Variation

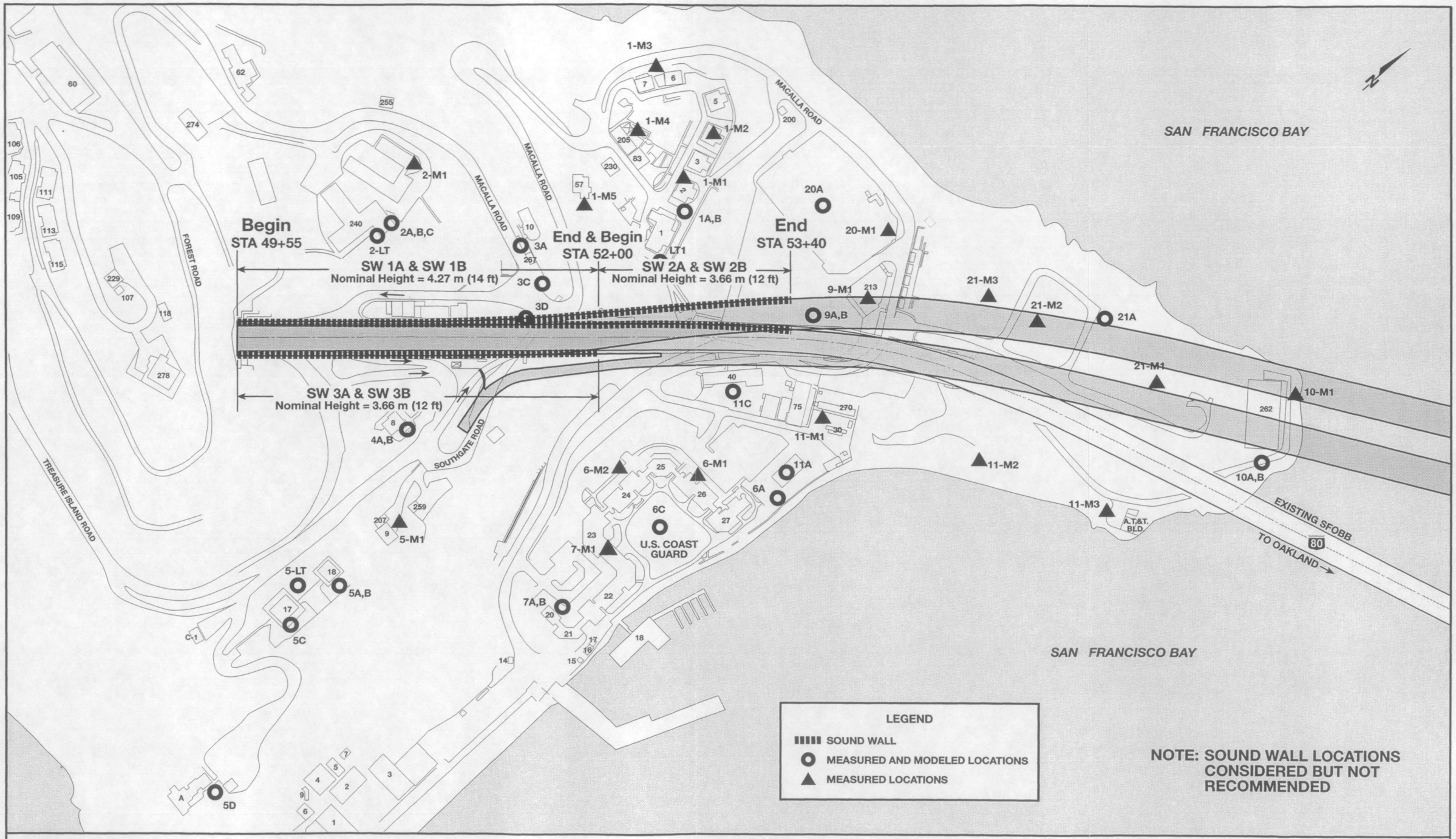


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Sound Wall Locations & Heights–
Replacement Alternative N-2–Yerba Buena Island

Figure 4-18

2/6/01



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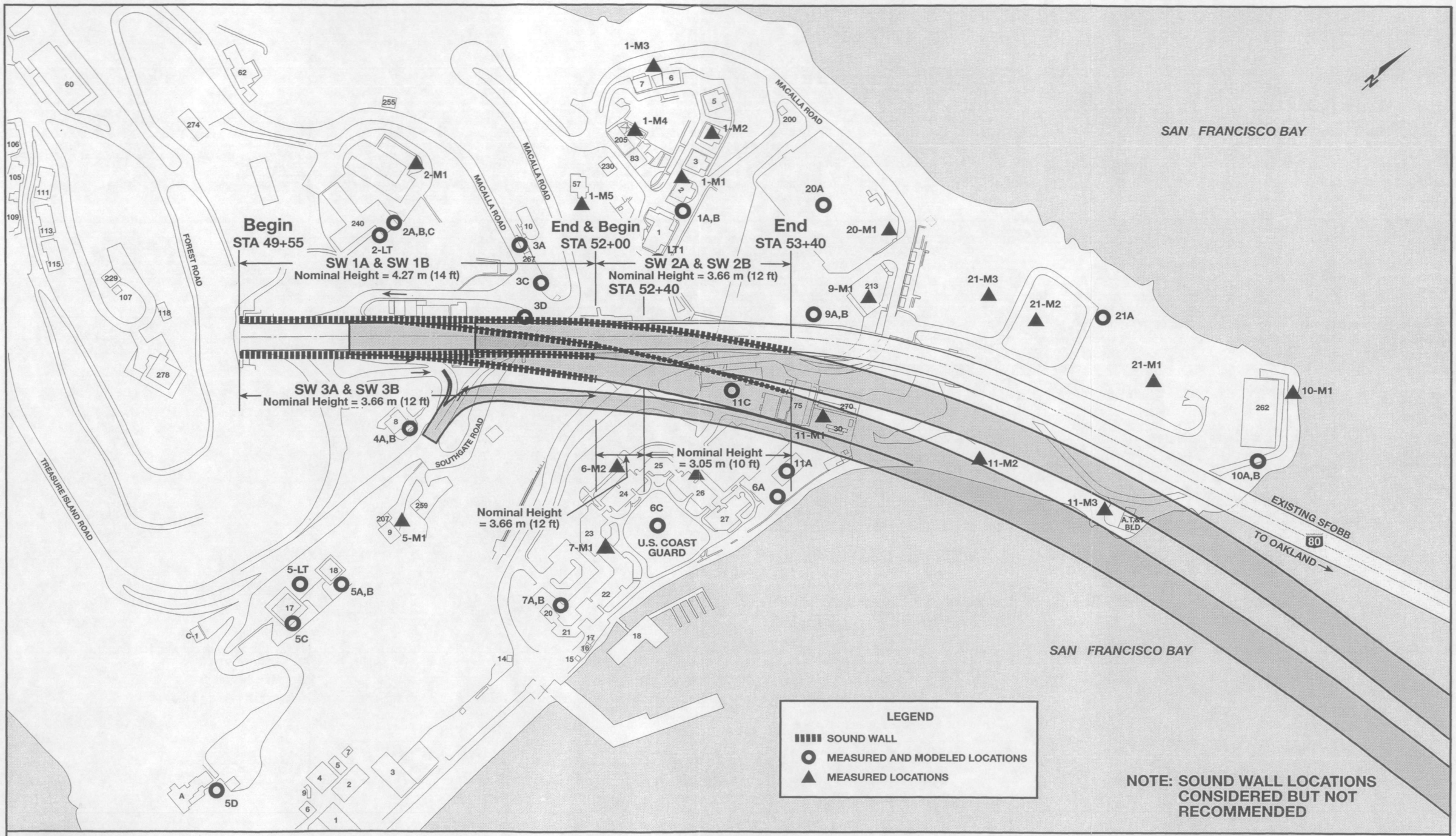
PROJECT

Sound Wall Locations & Heights–
Replacement Alternative N-6–Yerba Buena Island

Figure 4-19

2/6/01



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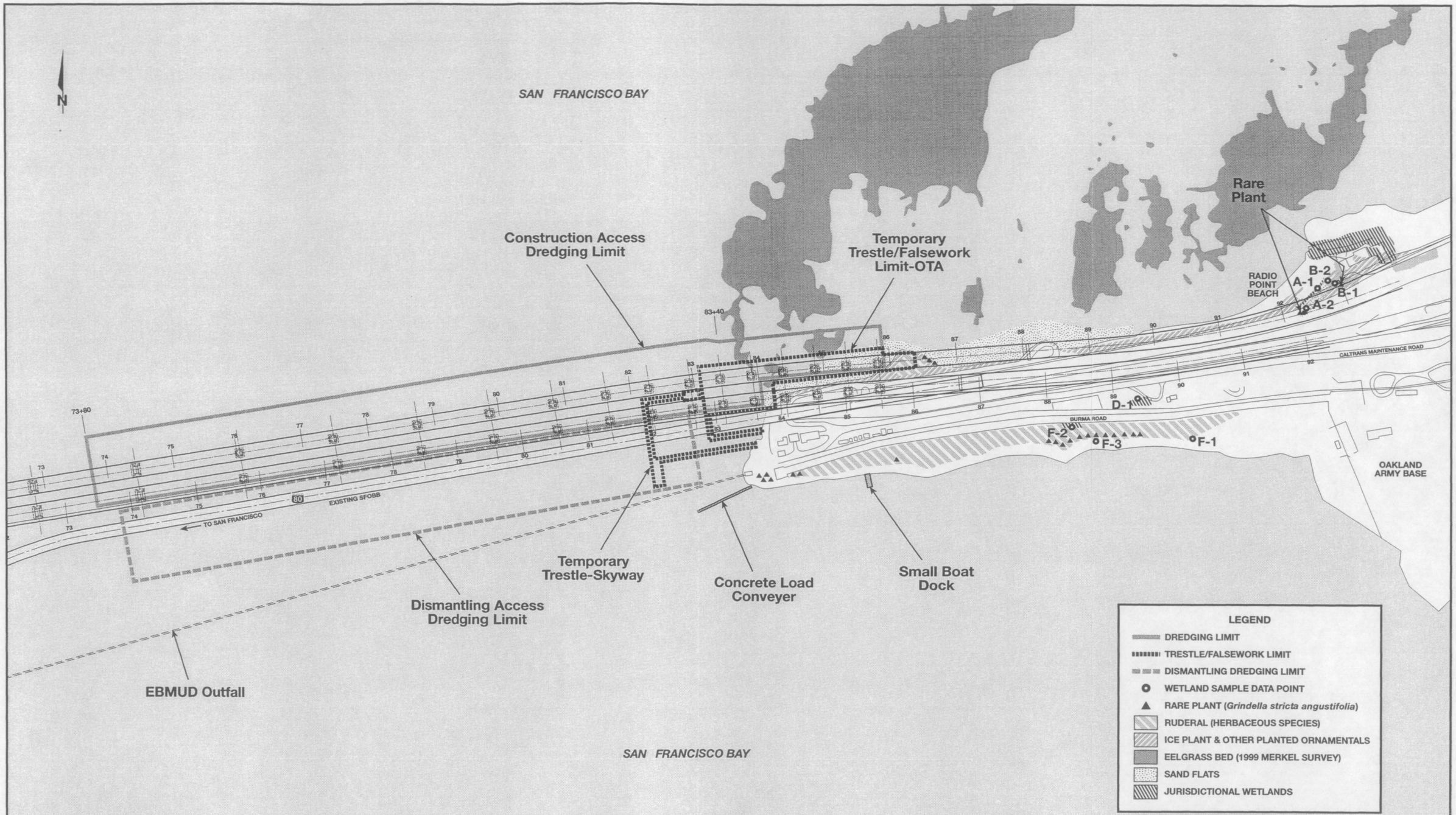
SEISMIC SAFETY
PROJECT

Sound Wall Locations & Heights–
Replacement Alternative S-4–Yerba Buena Island

Figure 4-20

2/6/01



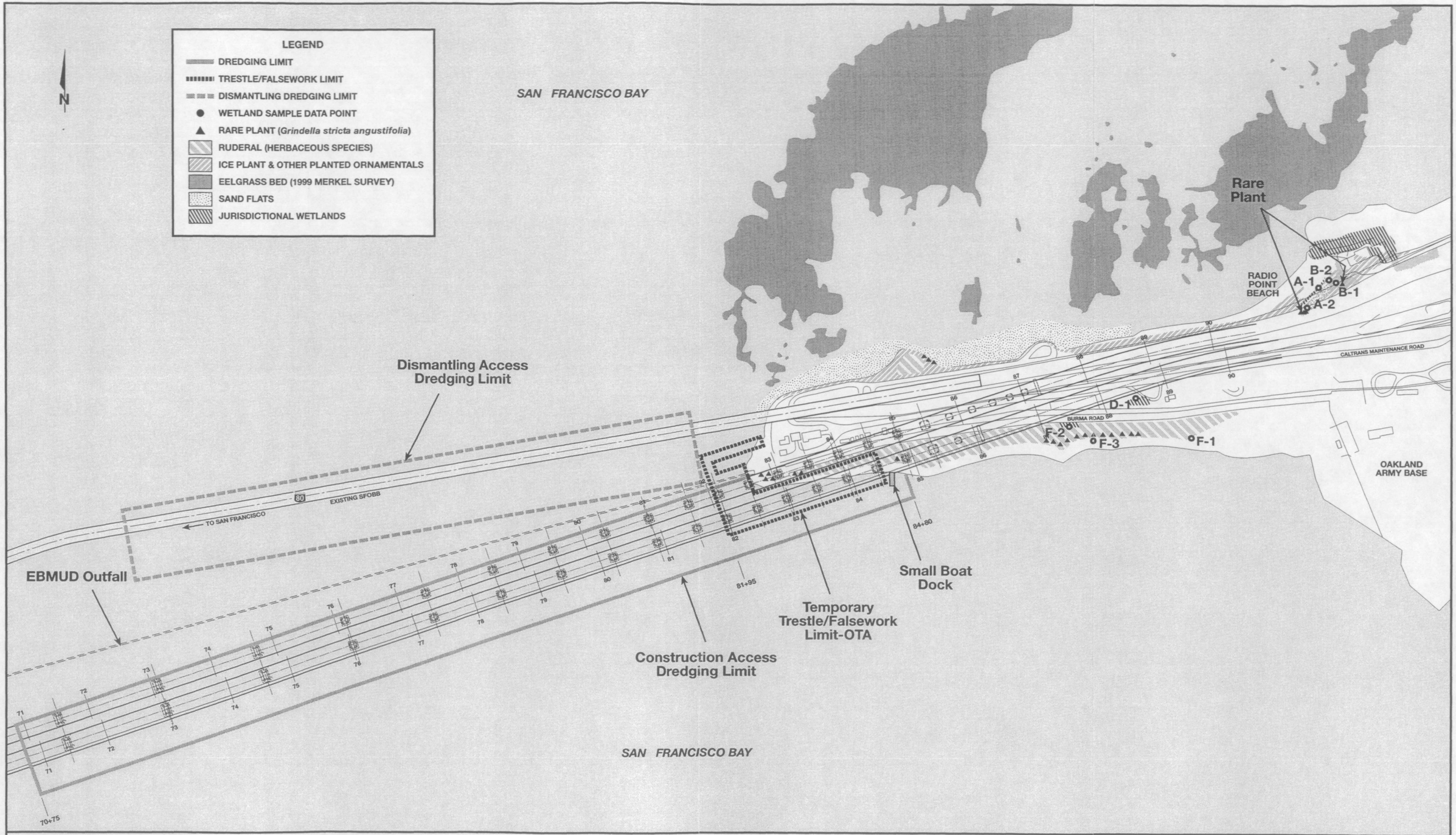
SFOBB EAST SPAN SEISMIC SAFETY PROJECT

GRAPHIC SCALE 1:6,000
0 50 100 150 m

Impacts to Natural Resources-Replacement Alternatives N-2 and N-6 at the Oakland Touchdown Area

Figure 4-21

4/25/01



SFOBB EAST SPAN SEISMIC SAFETY PROJECT

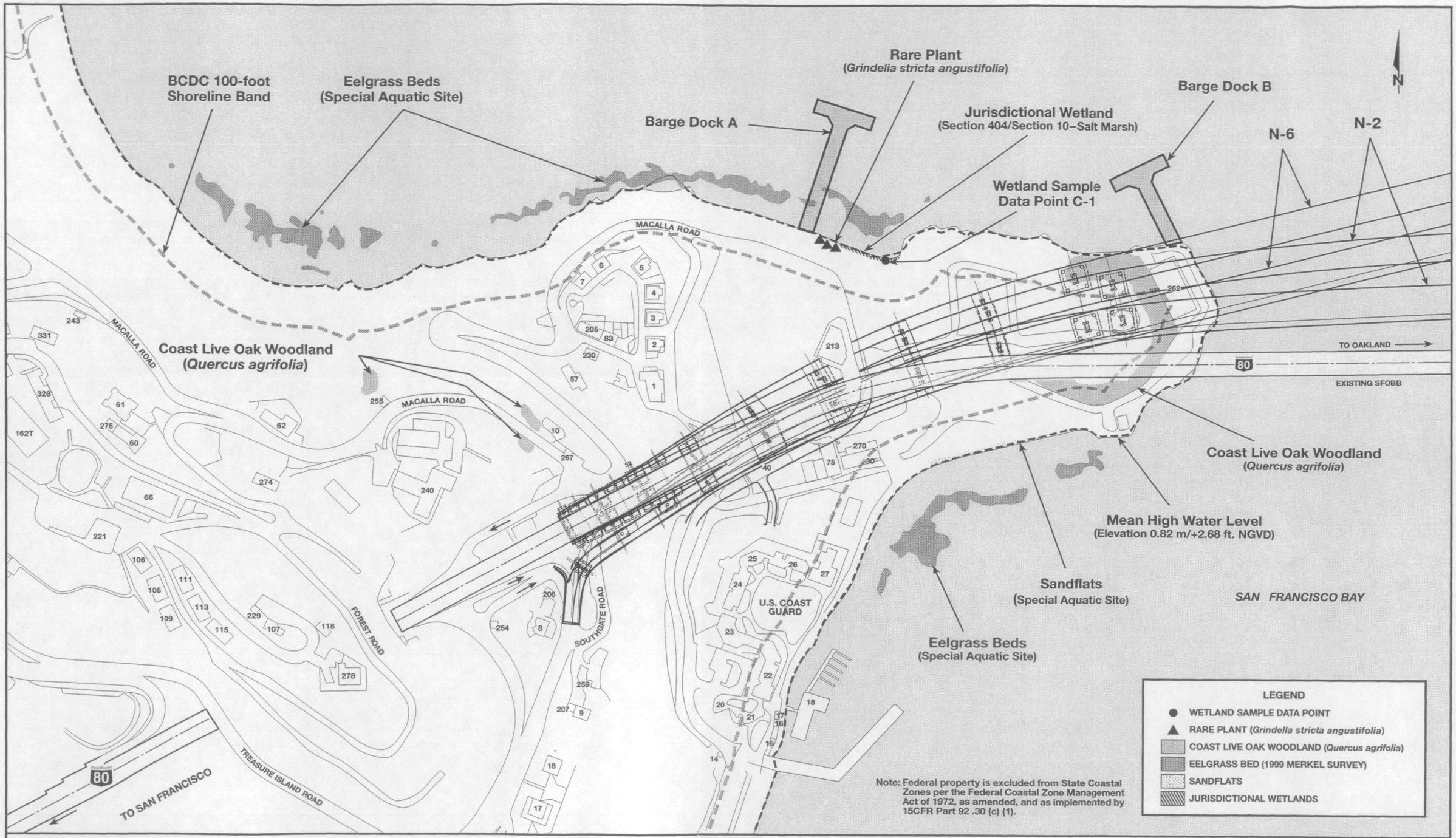
GRAPHIC SCALE 1:6,000

0 50 100 150 m

Impacts to Natural Resources- Replacement Alternative S-4 at the Oakland Touchdown Area

Figure 4-22

4/12/01



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

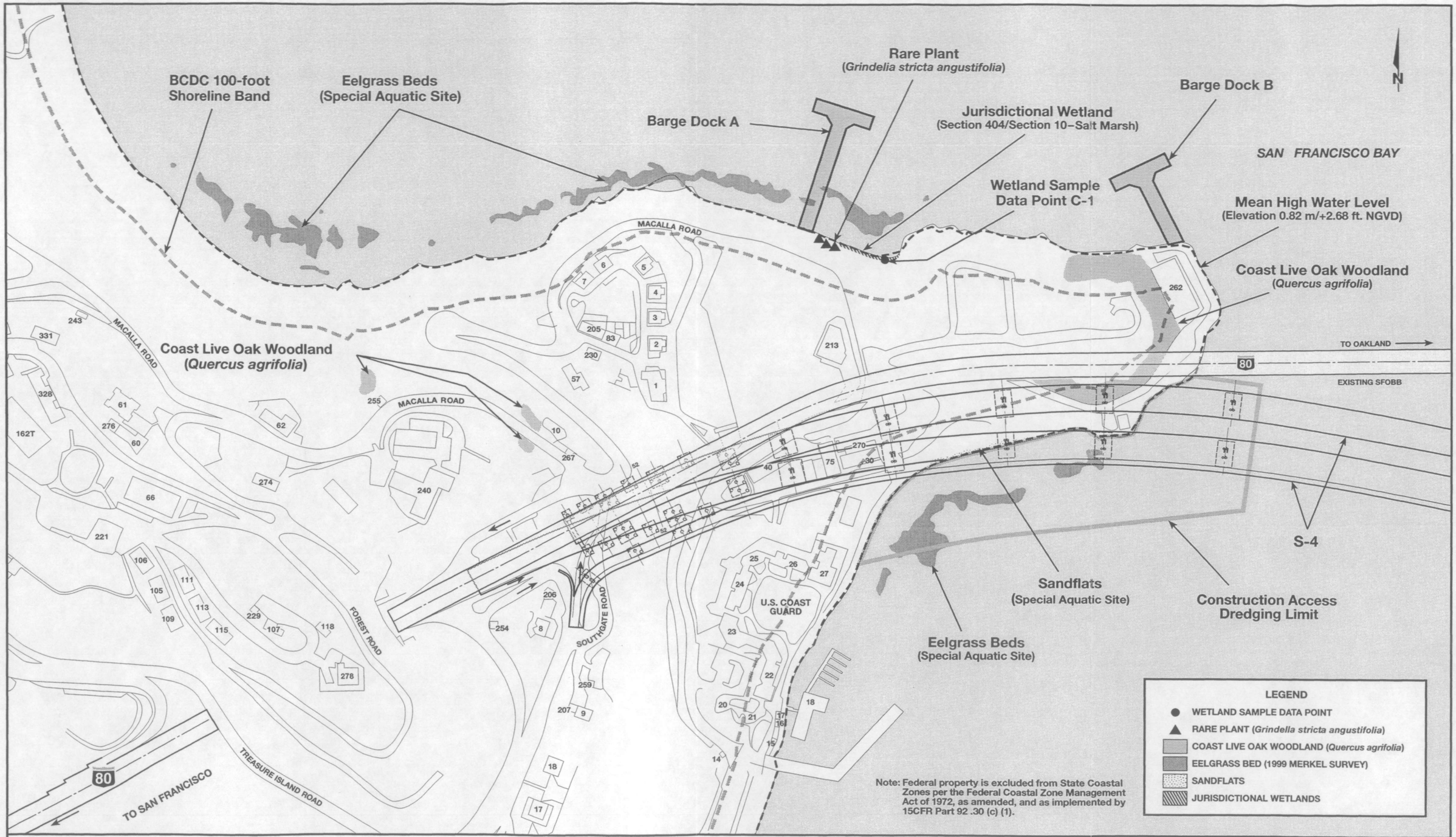
GRAPHIC SCALE 1:3,000

0 100 200 300 m

Impacts to Natural Resources-Replacement Alternatives N-2 and N-6 at Yerba Buena Island

Figure 4-23

4/5/01

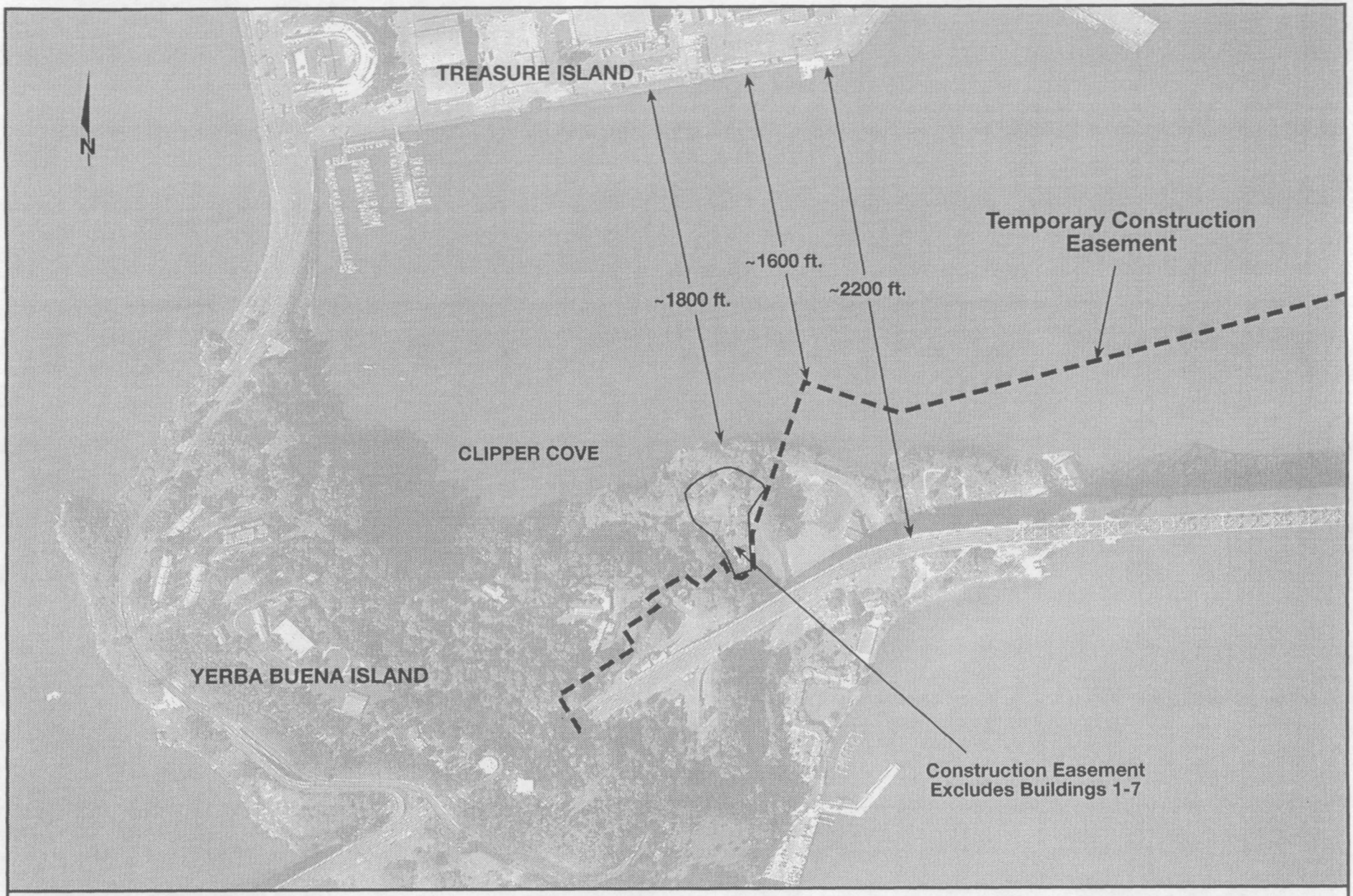


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Impacts to Natural Resources-Replacement Alternative S-4 at Yerba Buena Island

Figure 4-24

4/25/01



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EAST SPAN
SEISMIC SAFETY
PROJECT

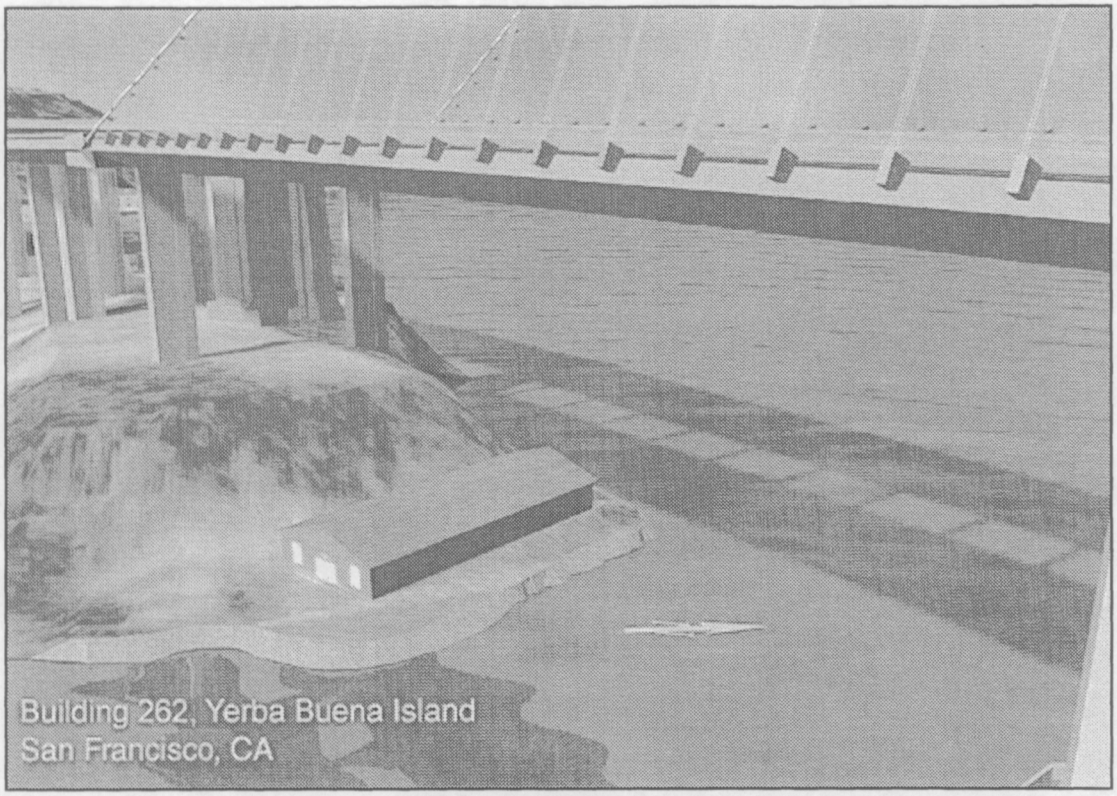
GRAPHIC SCALE 1:20,000

0 250 500 1000 m

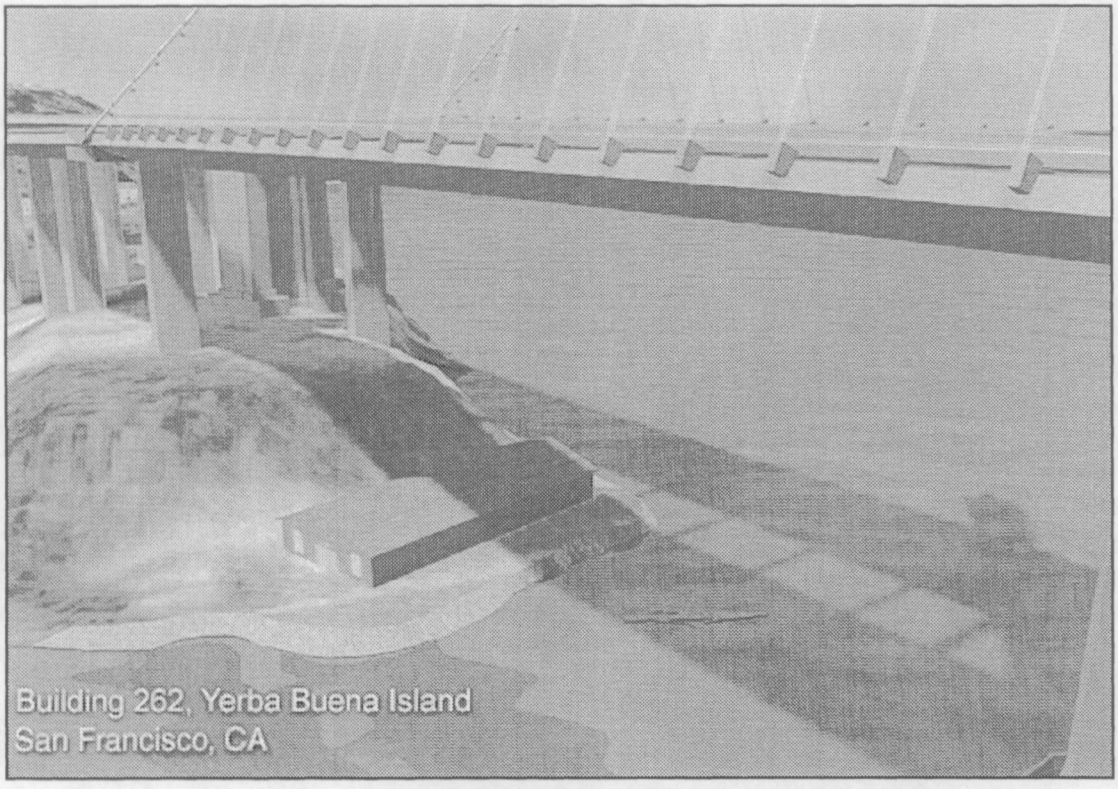
Construction Area

Figure 4-25

4/9/01



Spring Equinox, 12:00 PM



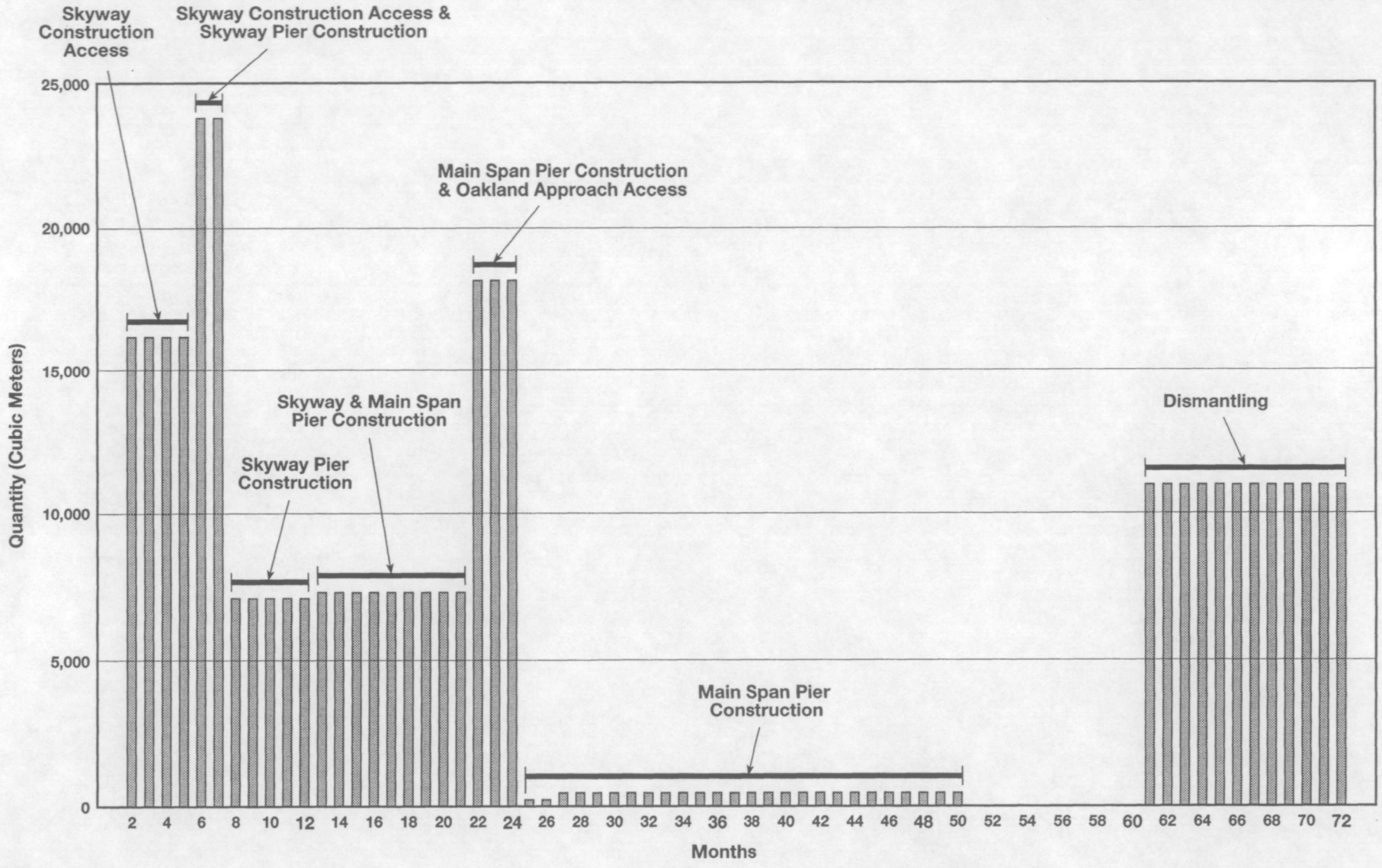
Summer Solstice, 12:00 PM

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Shadow Simulation, Replacement Alternative N-6
Building 262 (Torpedo Building), Yerba Buena Island

Figure 4-26

4/9/01

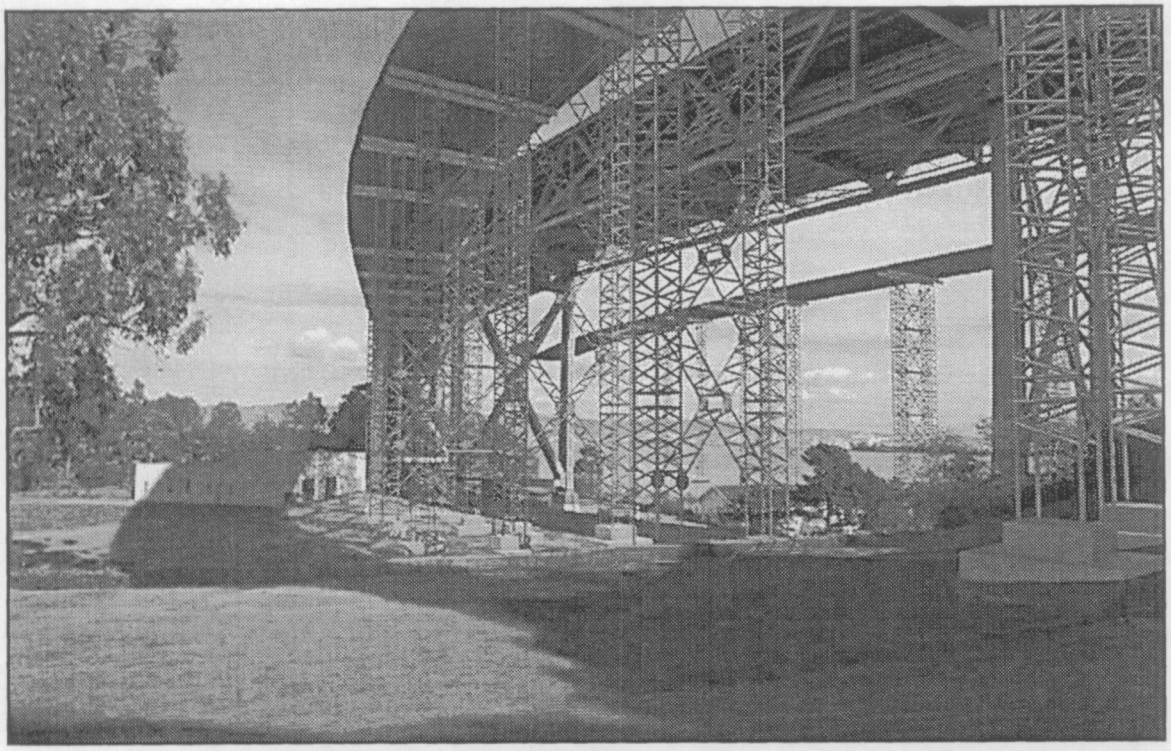


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

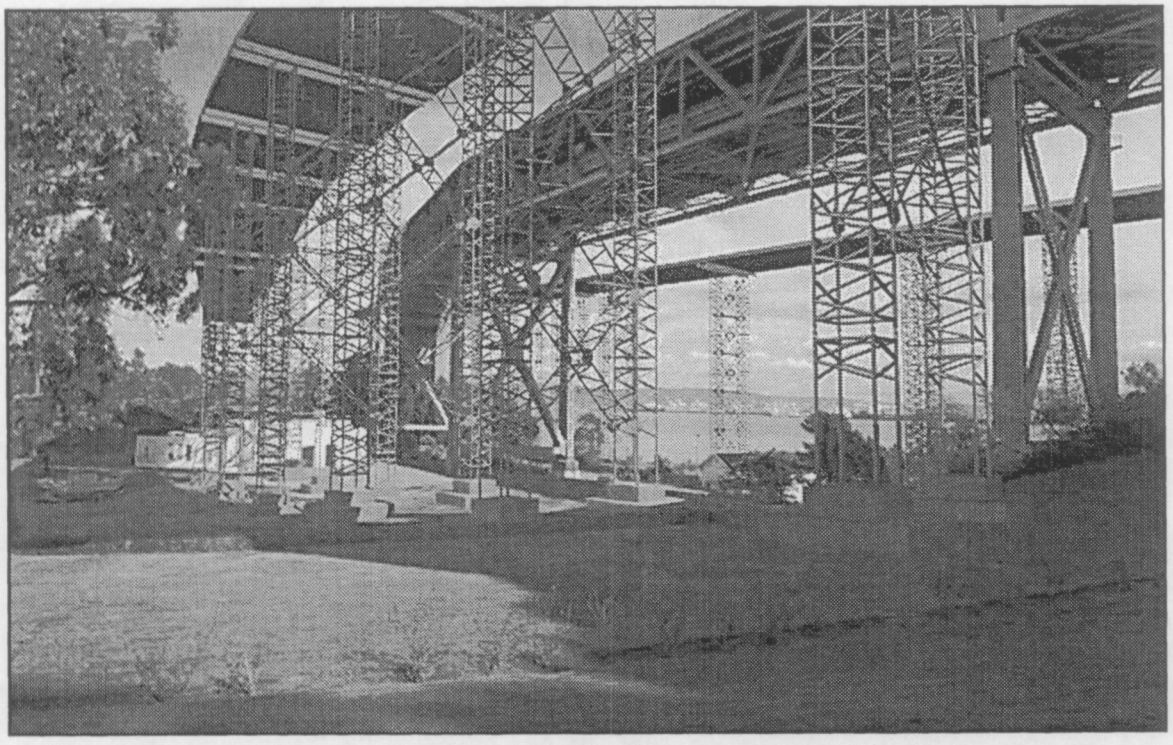
Anticipated Monthly Dredging Volumes–
Construction and Dismantling of East Span

Figure 4-27

3/10/01



View from Nimitz House of North-South Detour Structures–Replacement Alternative S-4



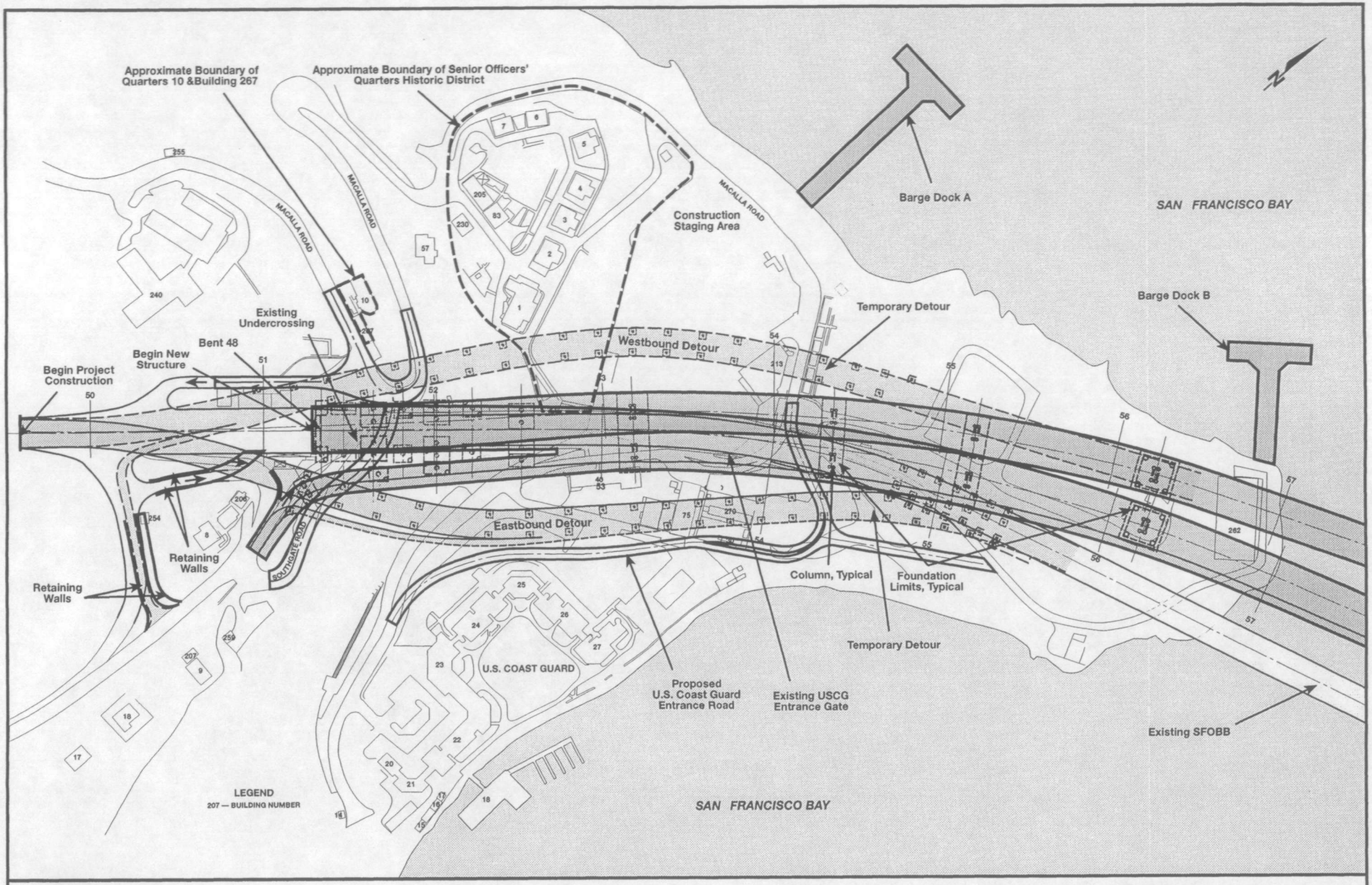
View Nimitz House of North-South Detour Structures–Replacement Alternatives N-2/N-6

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Simulated Views of the North-South
Detour Structures–Yerba Buena Island

Figure 4-28

3/10/01



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:3,000

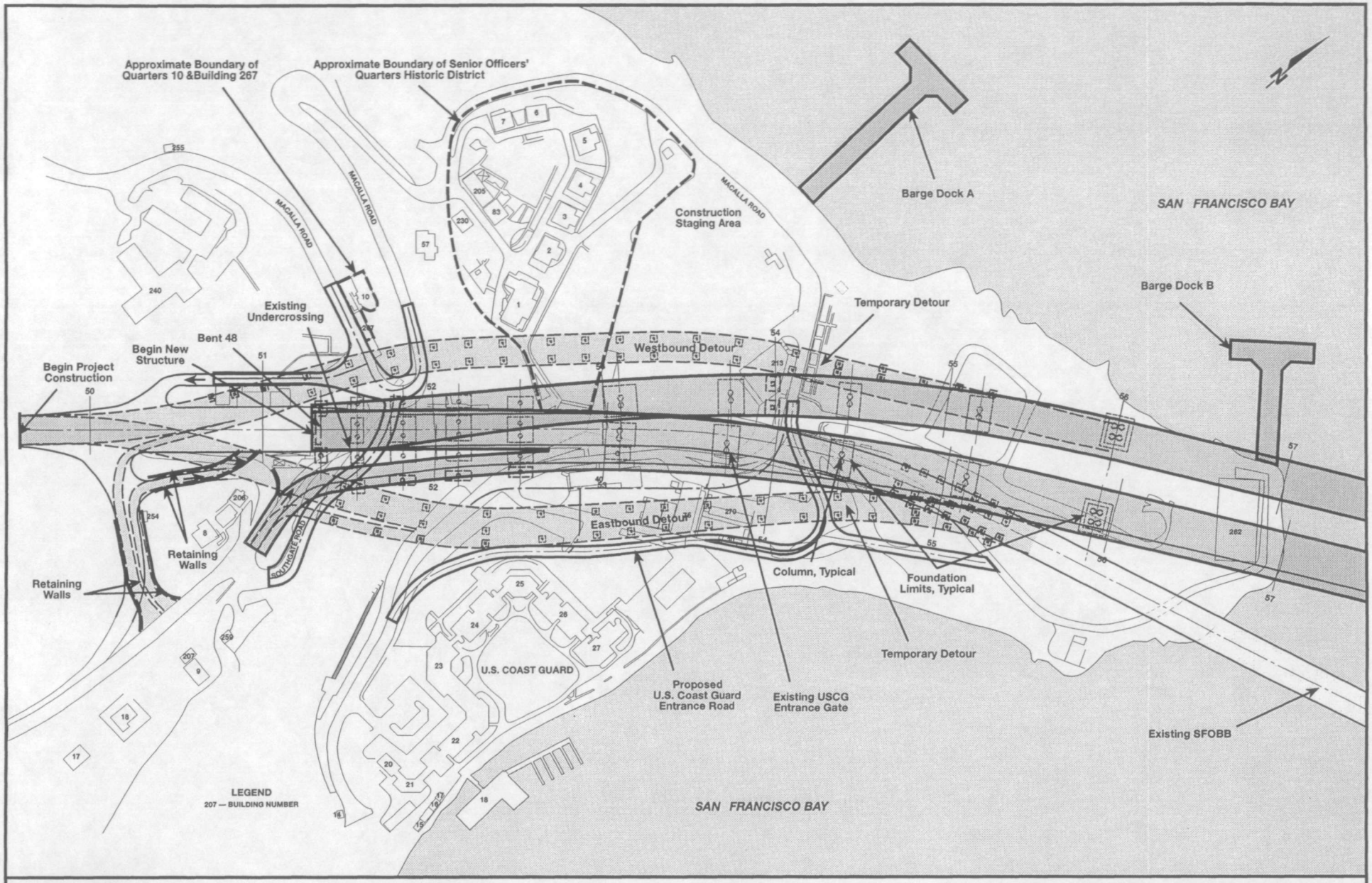
0 25 50 100 m

Foundation Construction Impact

Temporary Detours: North-South Option Replacement Alternative N-2

Figure 6-1

4/5/01



SFOBB EAST SPAN SEISMIC SAFETY PROJECT

GRAPHIC SCALE 1:3,000

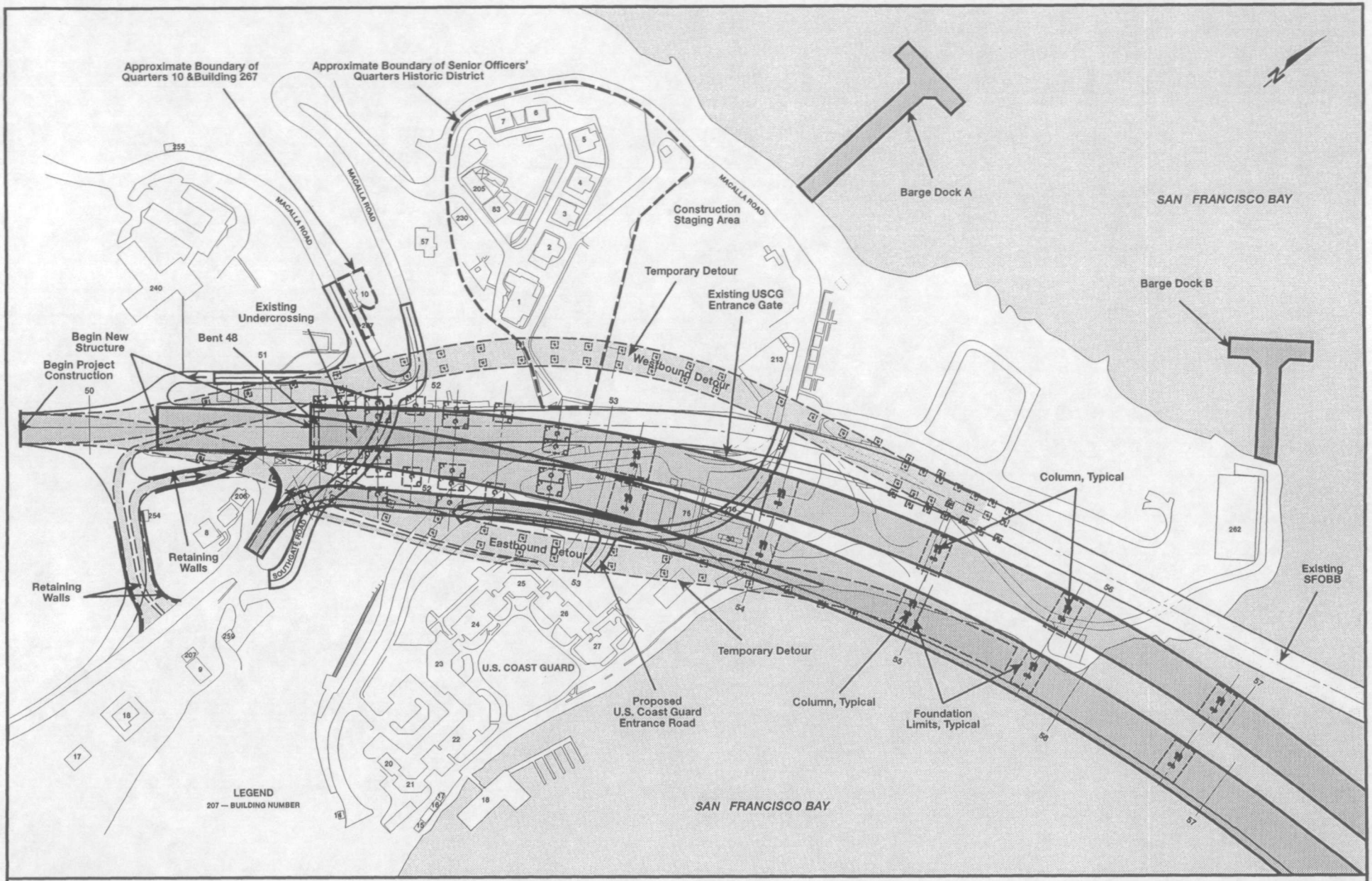
0 25 50 100 m

Foundation Construction Impact

Temporary Detours: North-South Option Replacement Alternative N-6

Figure 6-2

4/5/01



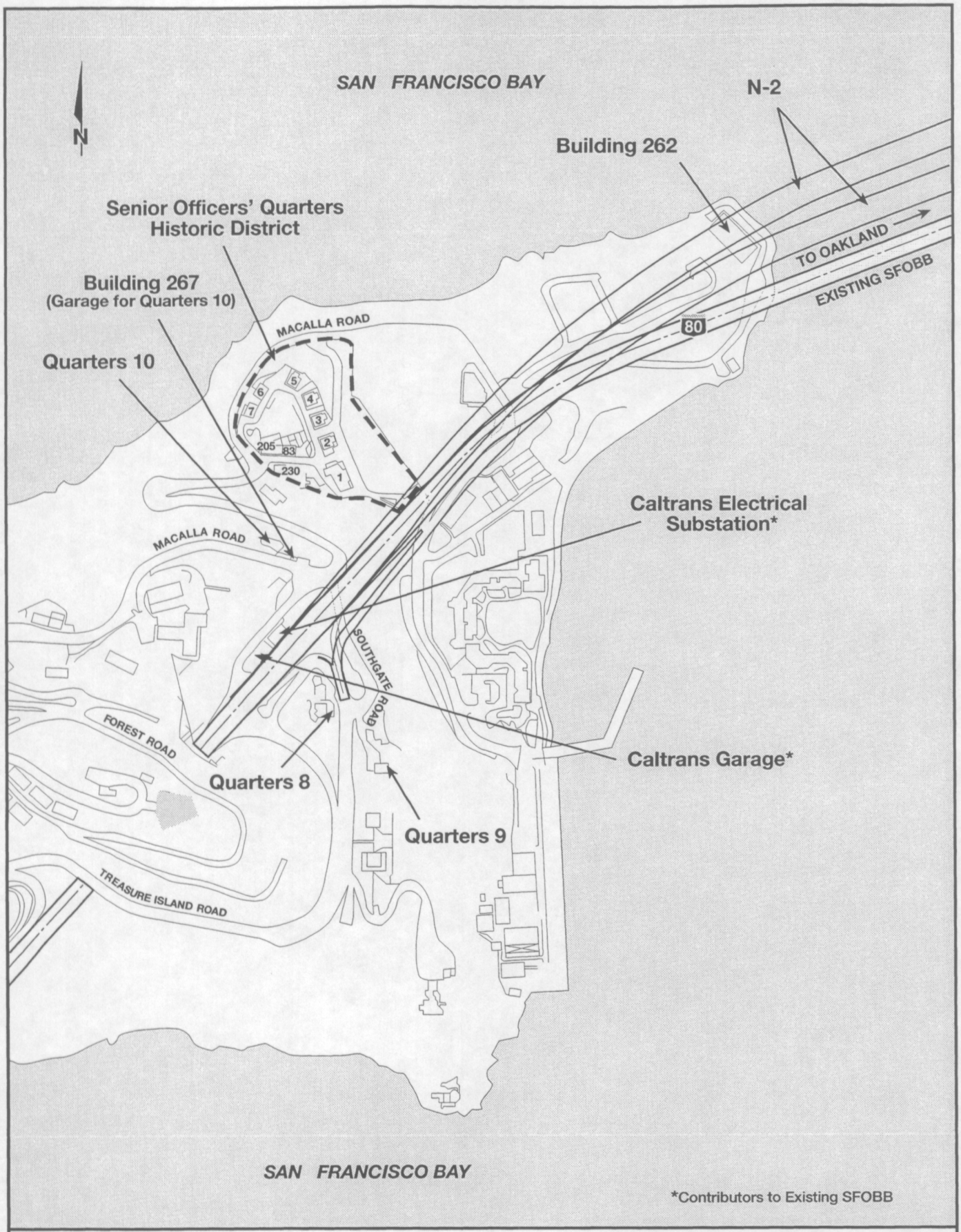
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:3,000
0 25 50 100 m

Foundation Construction Impact
Temporary Detours: North-South Option Replacement Alternative S-4

Figure 6-3

4/12/01

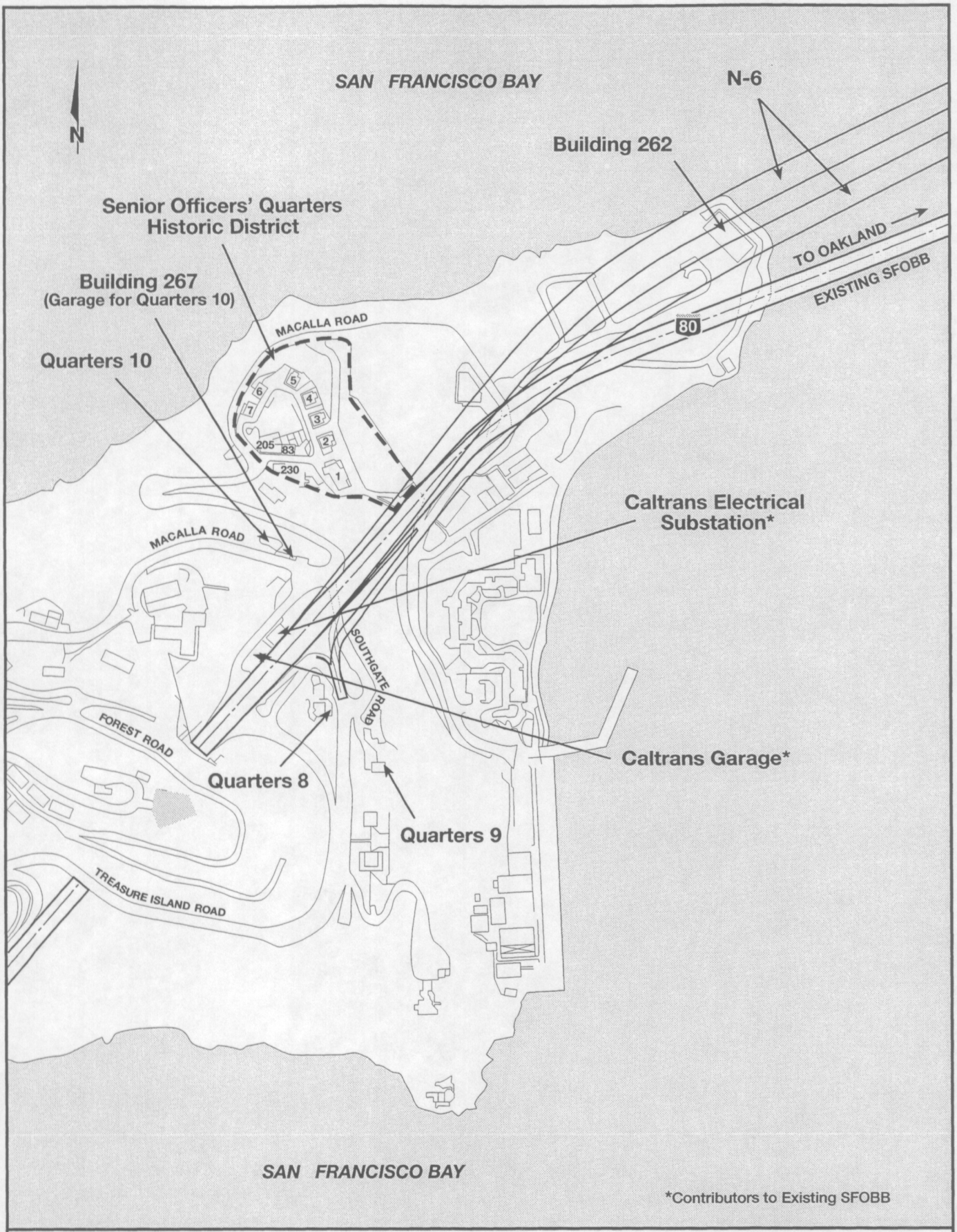


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:5,000
0 100 200m

Historic Resources–Yerba Buena Island
Replacement Alternative N-2
Figure 6-4

3/10/01

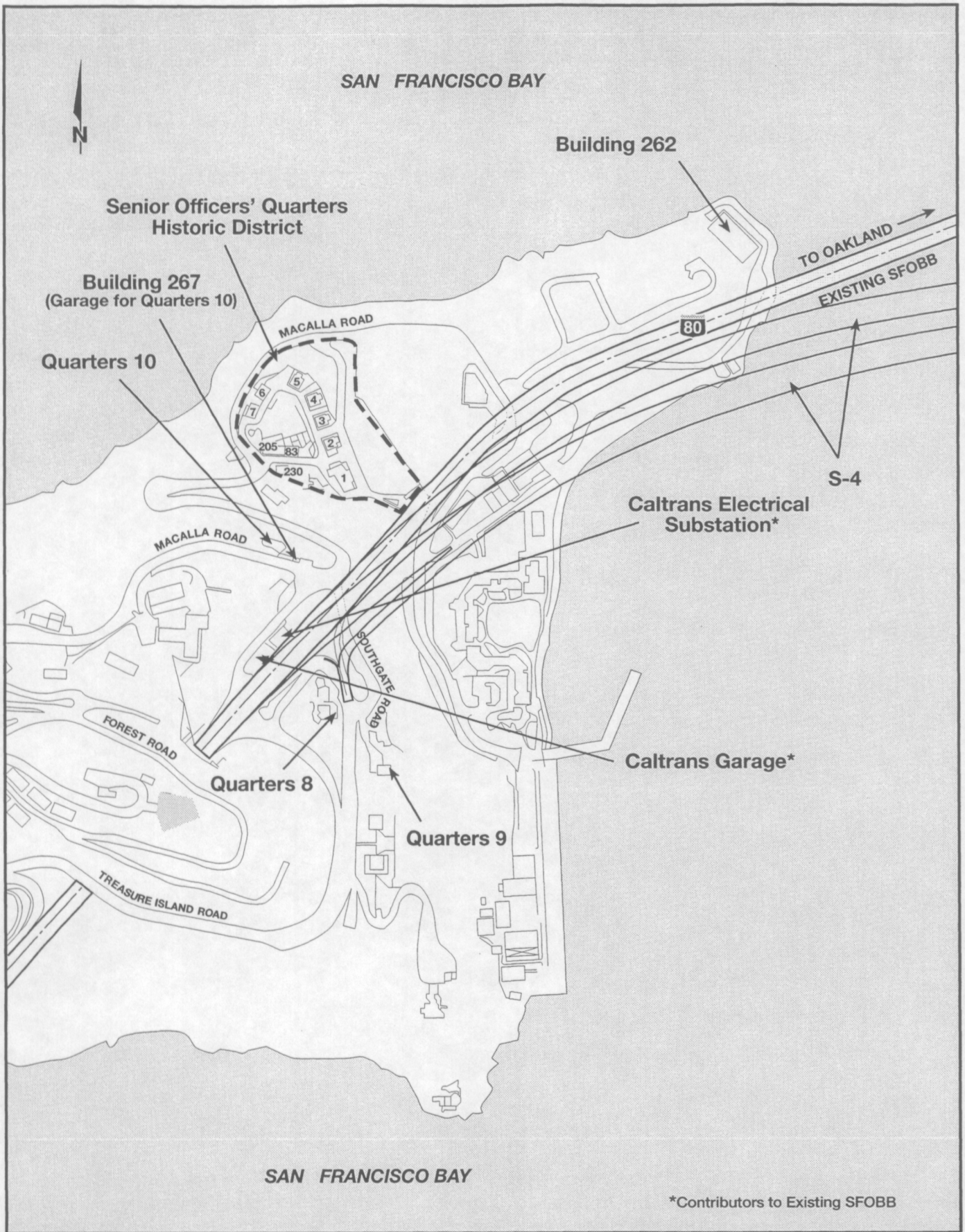


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:5,000
0 100 200m

Historic Resources–Yerba Buena Island
Replacement Alternative N-6
Figure 6-5

3/10/01

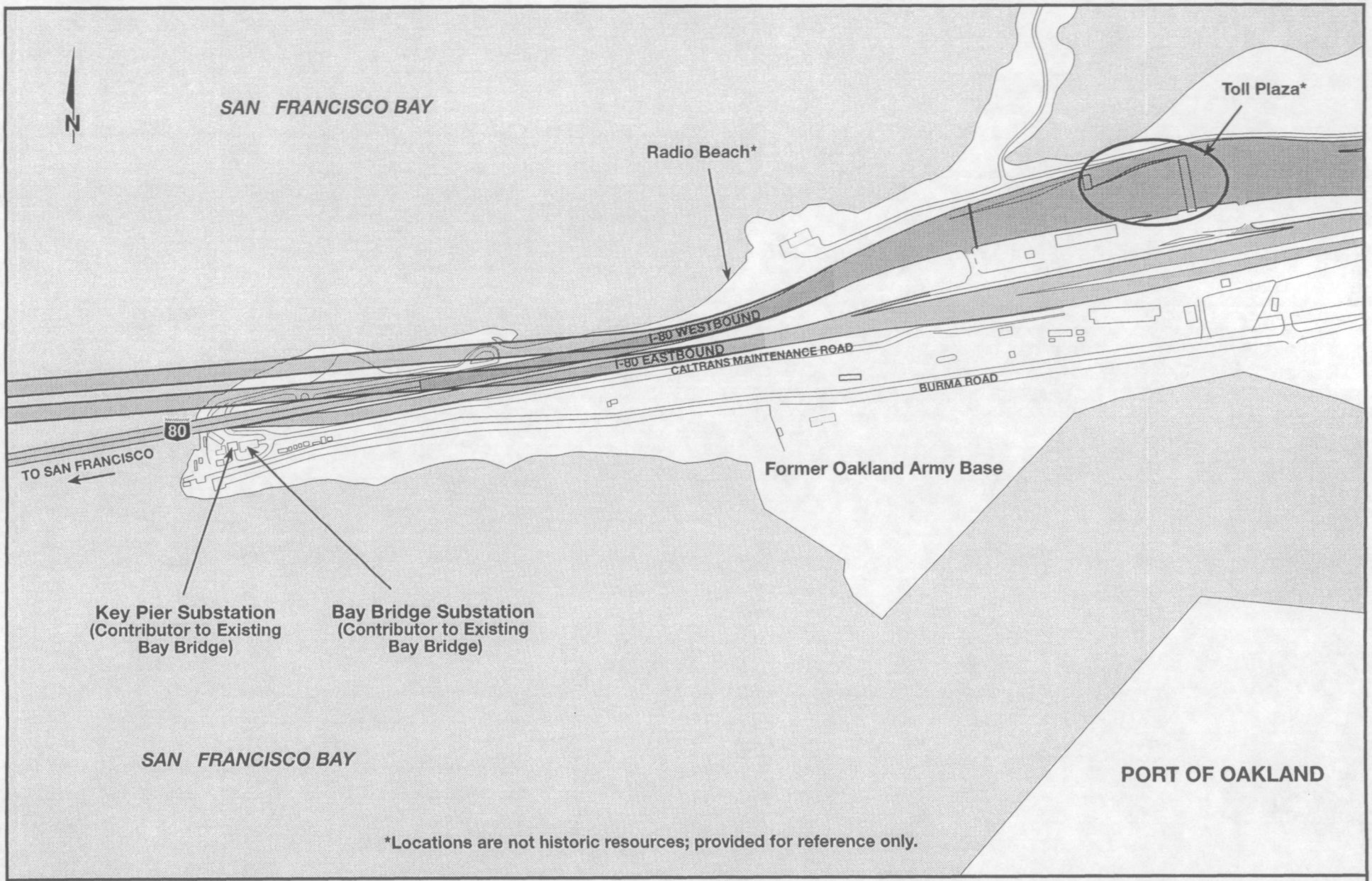


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:5,000
0 100 200m

Historic Resources–Yerba Buena Island
Replacement Alternative S-4
Figure 6-6

3/10/01



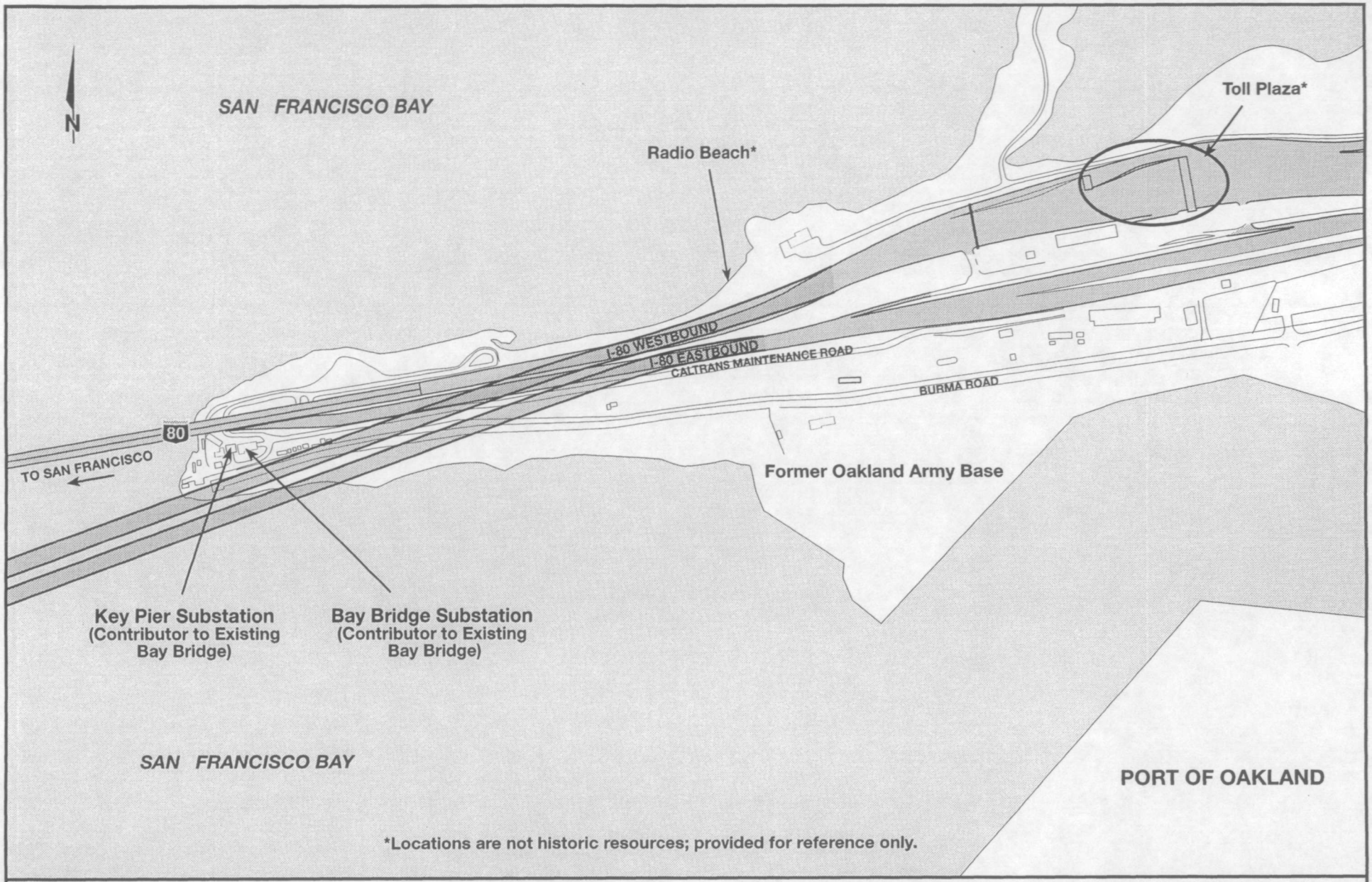
SFOBB EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:8,000
0 50 100 200 m

Historic Resources–Oakland Touchdown Area
North Replacement Alternatives

Figure 6-7

4/12/01



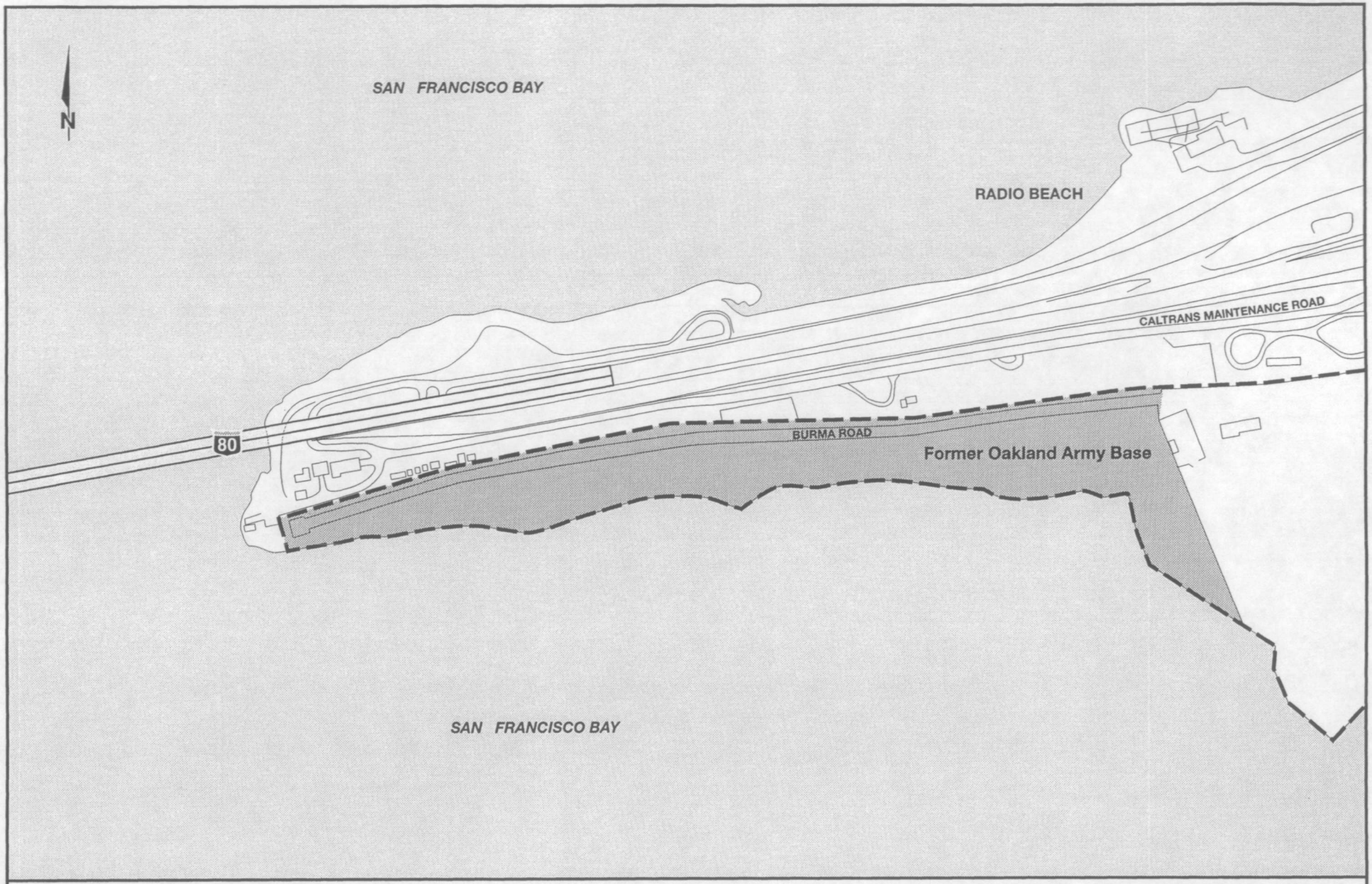
SFOBB EAST SPAN SEISMIC SAFETY PROJECT

GRAPHIC SCALE 1:8,000
0 50 100 200 m

Historic Resources–Oakland Touchdown Area
Replacement Alternative S-4

Figure 6-8

4/12/01



SFOBB EAST SPAN SEISMIC SAFETY PROJECT

GRAPHIC SCALE 1:7,000

0 50 100 150 m

Oakland Army Base Property for Proposed Gateway Park

Figure 6-9

3/10/01

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EAST SPAN
SEISMIC SAFETY
PROJECT

View of Existing Bridge
from Treasure Island Viewpoint

Figure 6-10

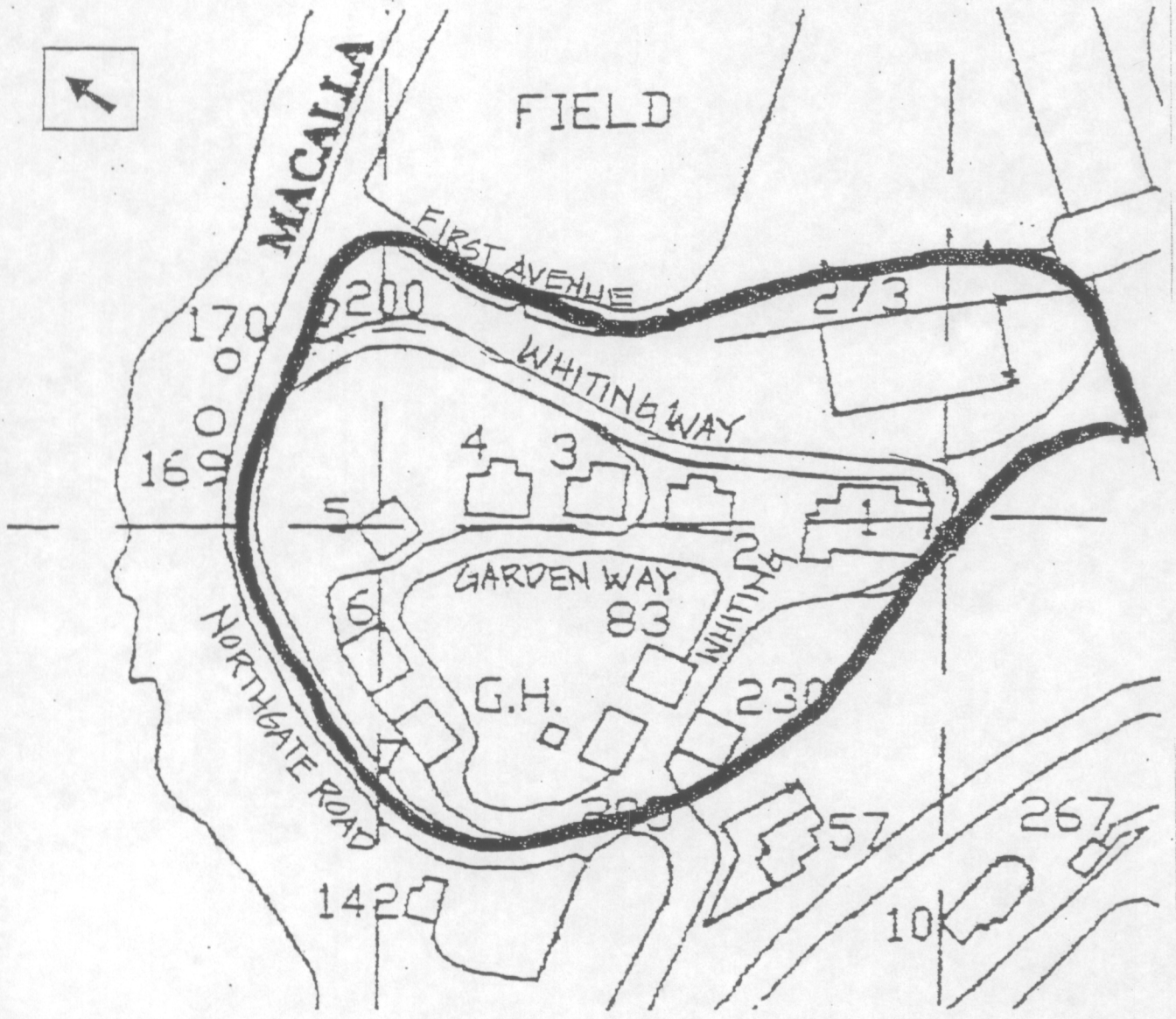
10/3/01

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Photo Simulation Retrofit Existing Bridge Design
from Treasure Island Viewpoint

Figure 6-11

3/10/01



Source: Map of District Boundary for Senior Officers' Quarters Historic District, Prepared by U.S. Navy, January 1997.

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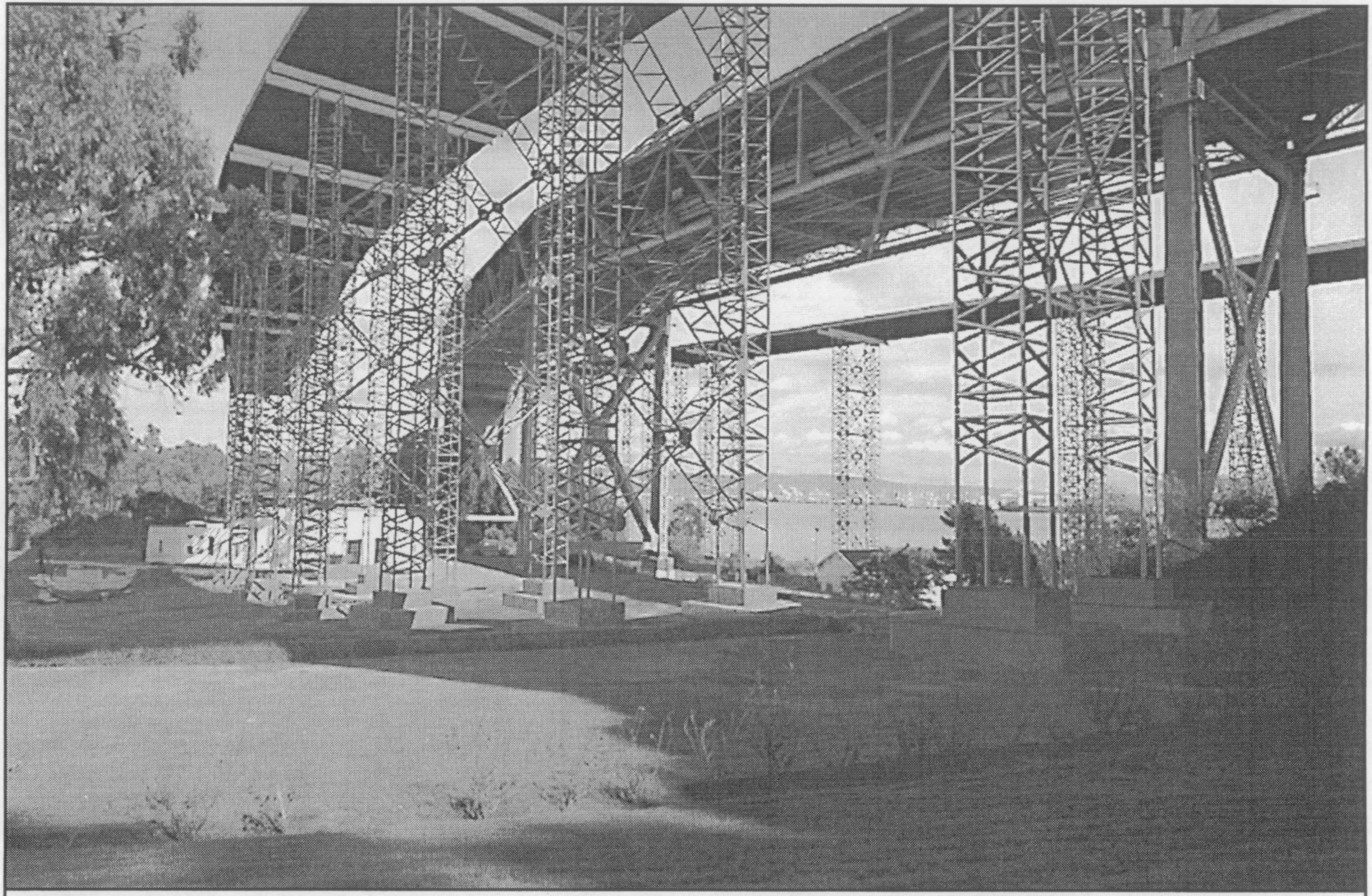
PROJECT

Senior Officers' Quarters
Historic District Boundary

Figure 6-12



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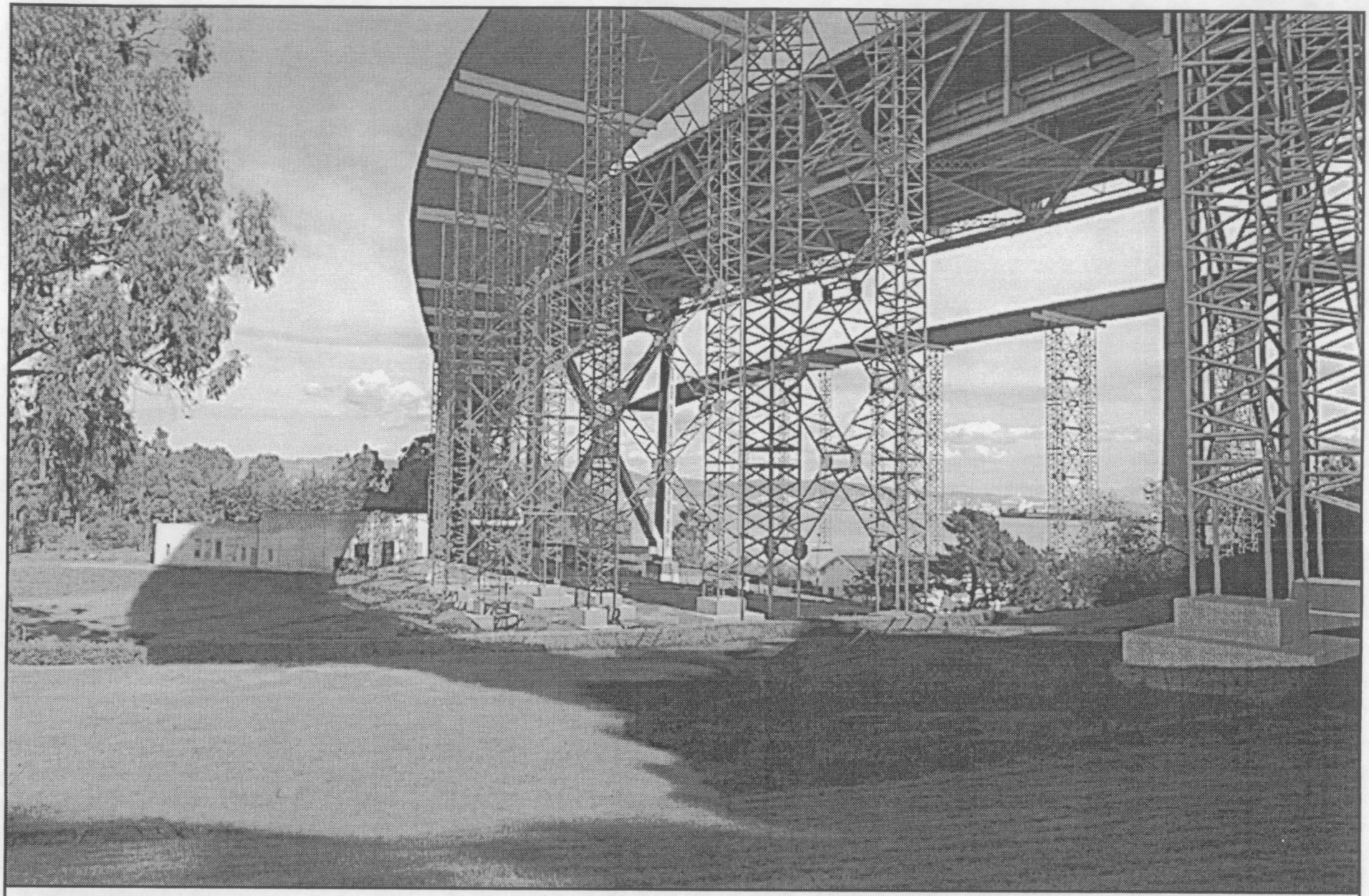
EAST SPAN
SEISMIC SAFETY
PROJECT

Photo Simulation of Temporary Detours
North Replacement Alternatives–View from Quarters 1

Figure 6-13

3/10/01



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EAST SPAN
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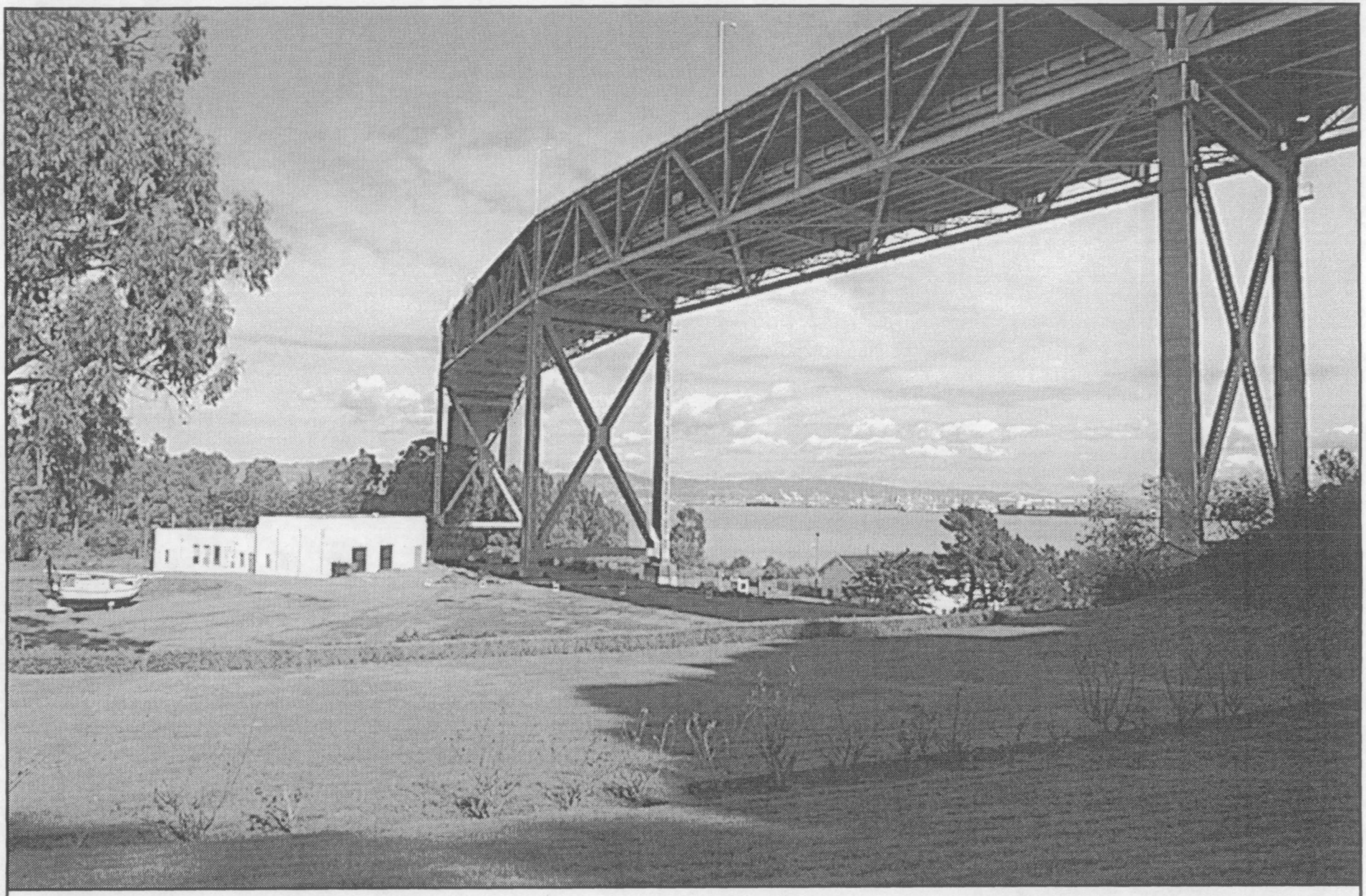
PROJECT

Photo Simulation of Temporary Detours
Replacement Alternative S-4–View from Quarters 1

Figure 6-14

3/10/01



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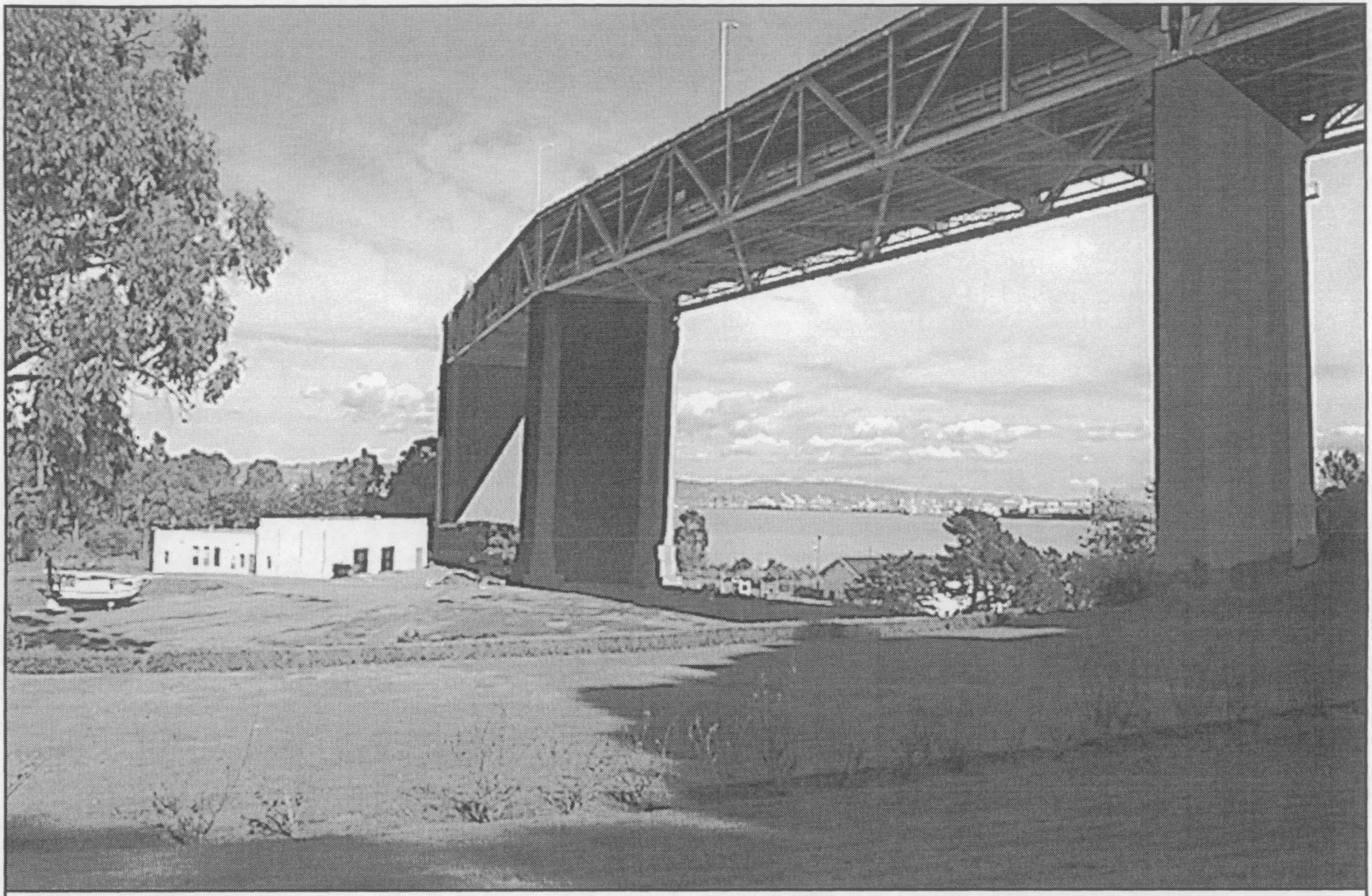
EAST SPAN
SEISMIC SAFETY
PROJECT

Existing View from Quarters 1

Figure 6-15

3/10/99



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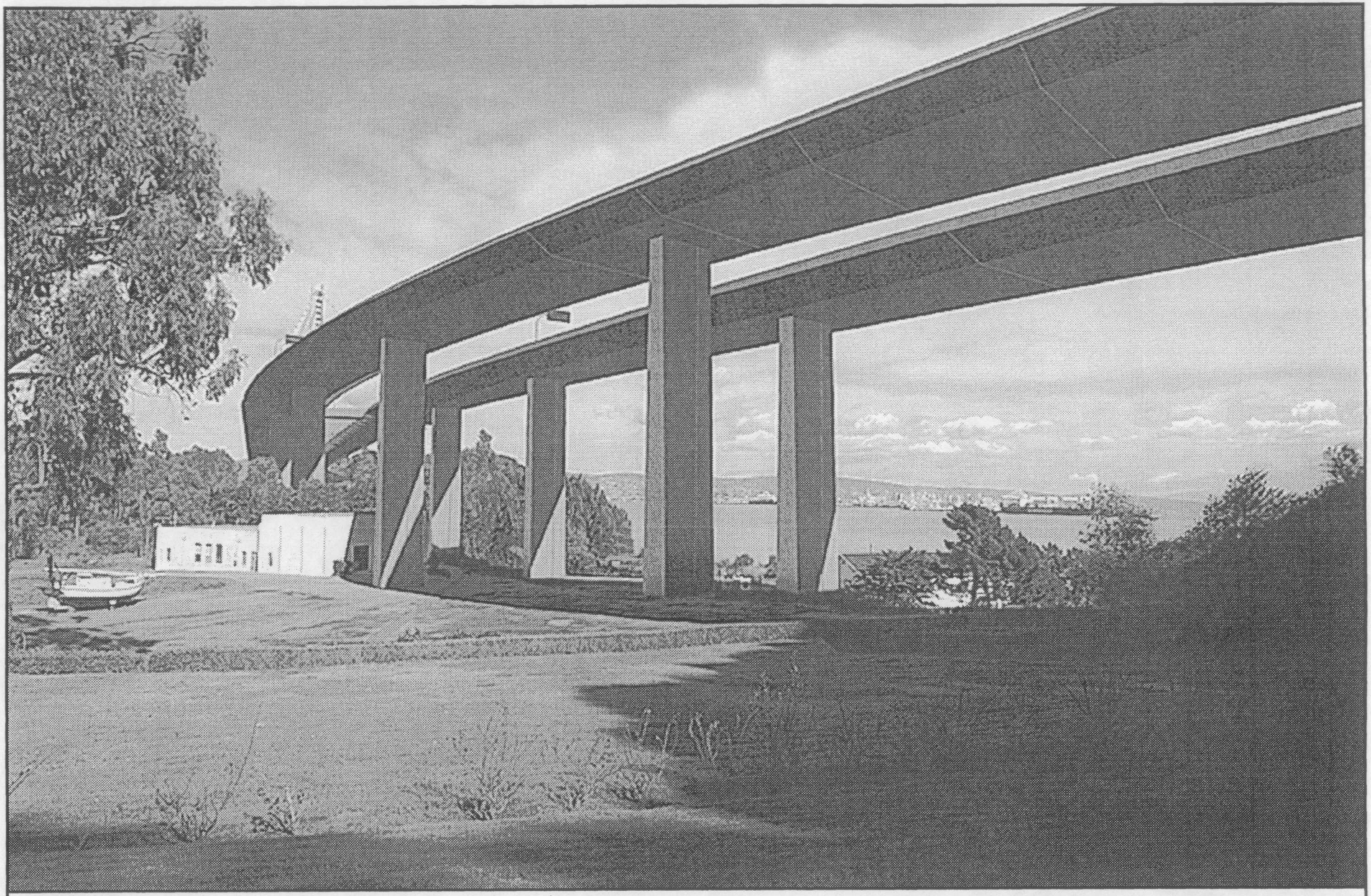
SEISMIC SAFETY
PROJECT

**Photo Simulation, Retrofit Existing Bridge Design–
View from Quarters 1**

Figure 6-16

3/10/01

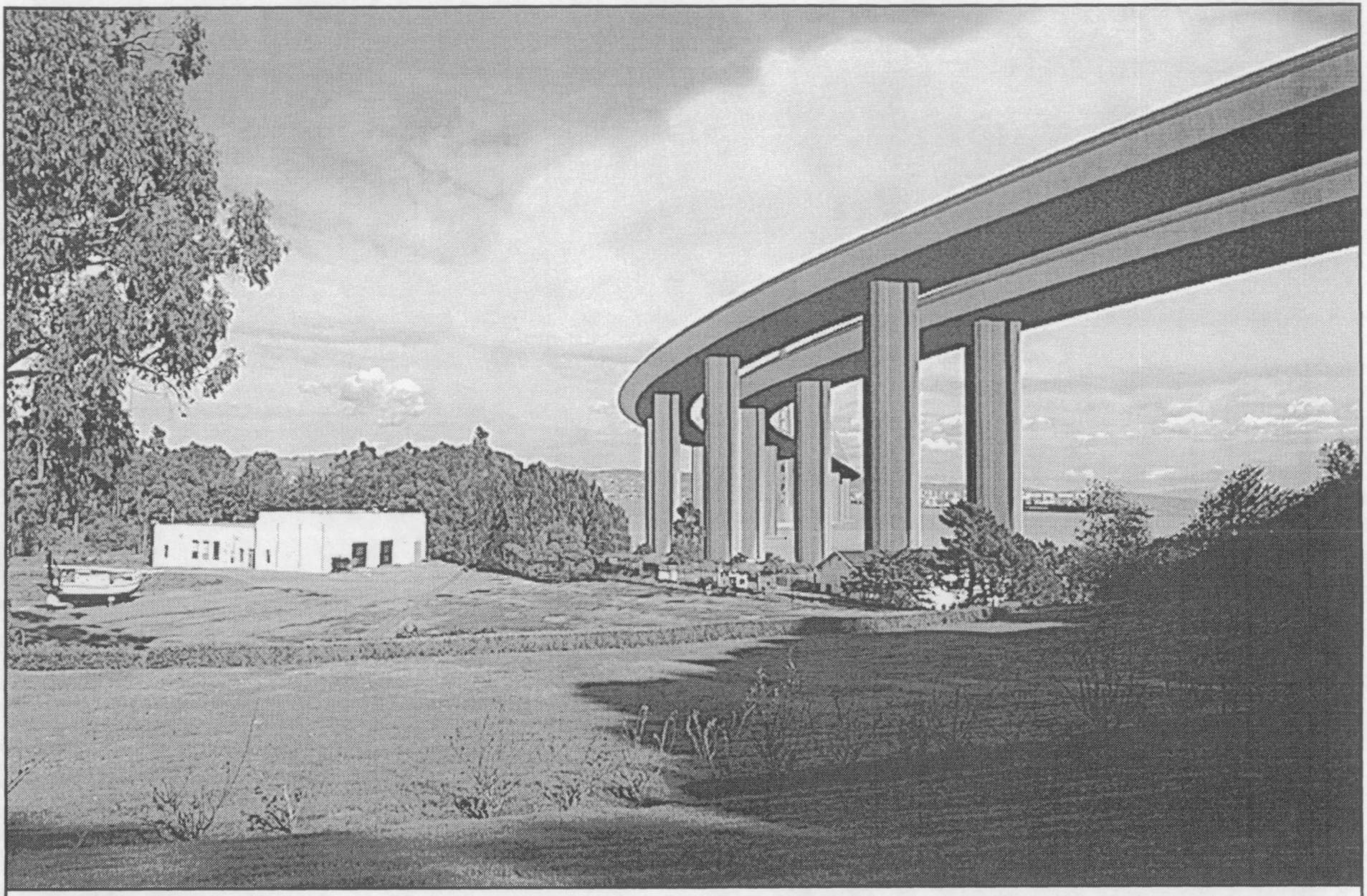


SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Photo Simulation of North Replacement Alternatives–View from Quarters 1

Figure 6-17

3/10/01



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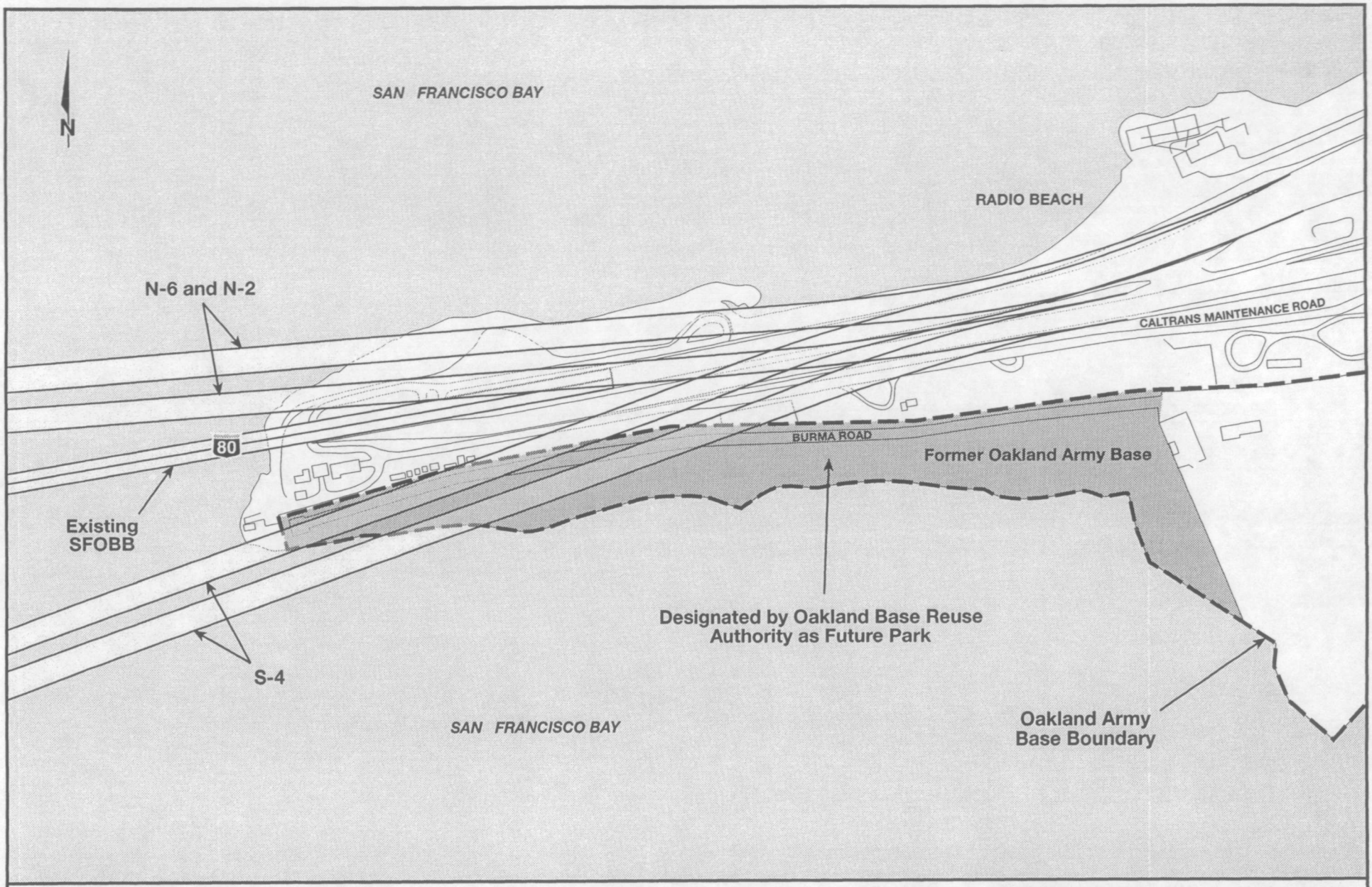
SEISMIC SAFETY
PROJECT

Photo Simulation of Replacement
Alternative S-4–View from Quarters 1

Figure 6-18

3/10/01



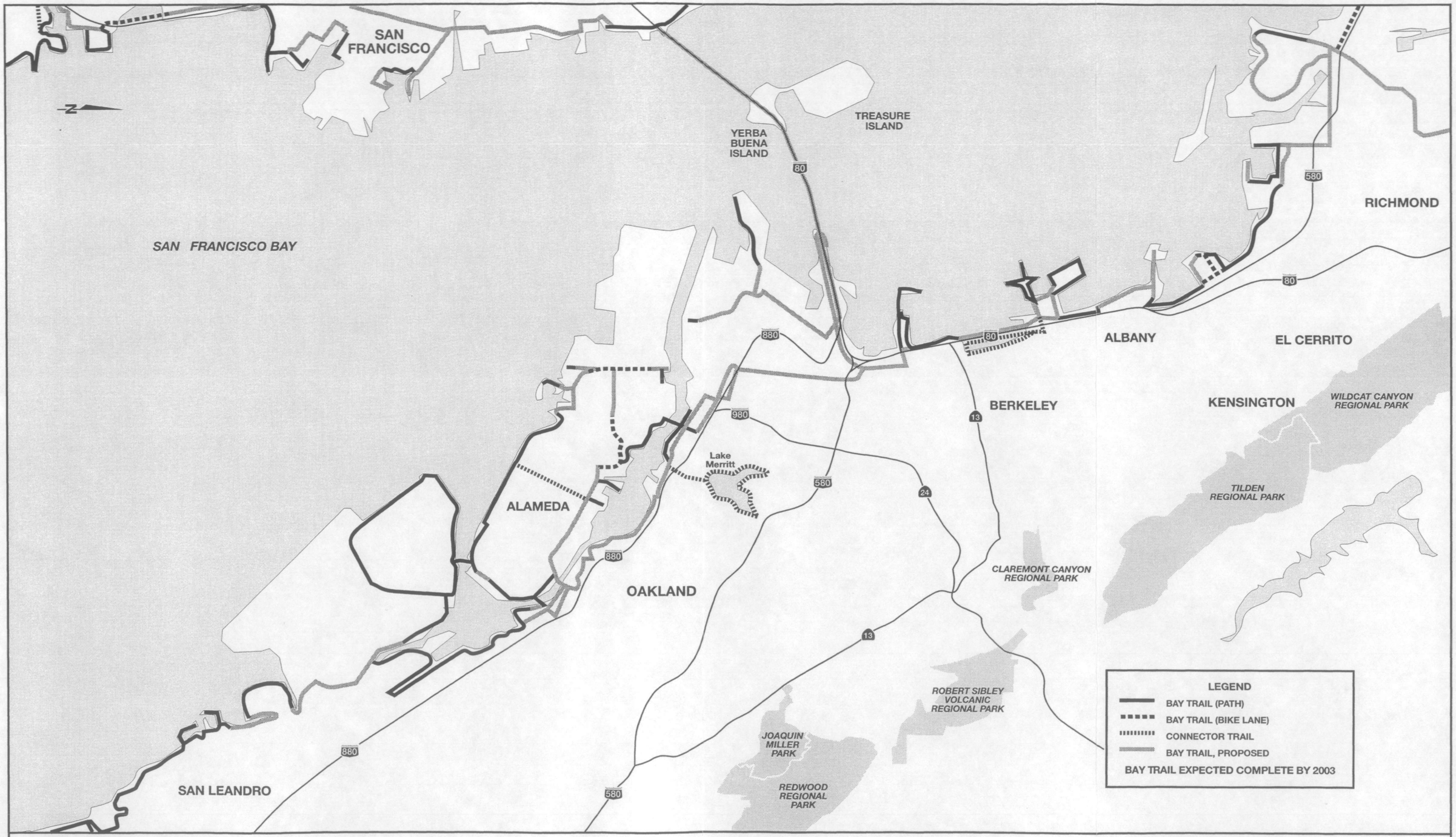
SFOBB EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:7,000
0 50 100 150 m

Build Alternatives in Relation
to Proposed Gateway Park

Figure 6-19

3/10/01



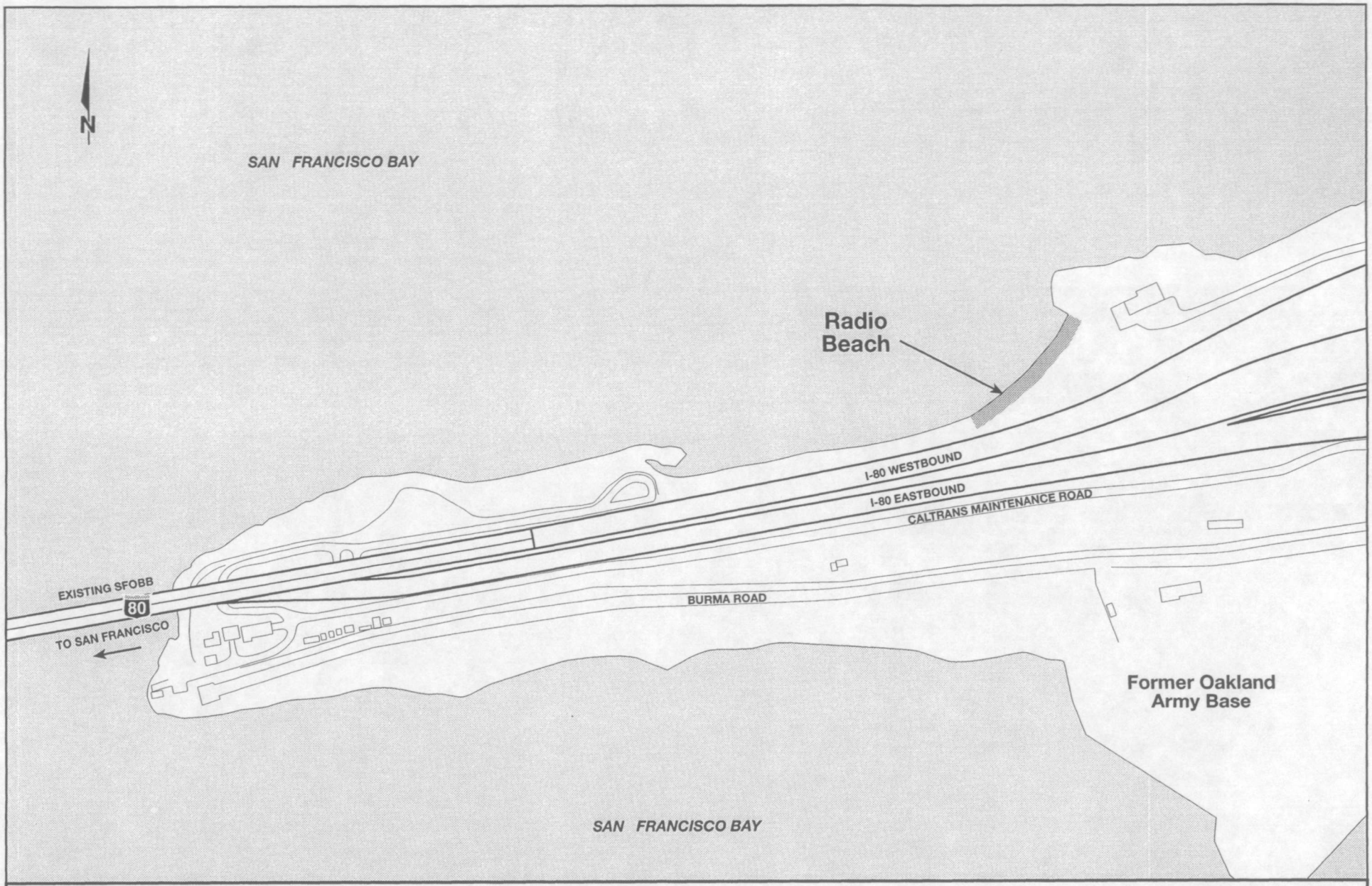
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

NO SCALE

ABAG Bay Trail-Central East Bay

Figure 6-20

3/10/01



SFOBB EAST SPAN SEISMIC SAFETY PROJECT

GRAPHIC SCALE 1:5,000

0 50 100 200 m

Radio Beach

Figure 6-21

3/10/01

APPENDIX B
LIST OF PREPARERS

APPENDIX B
LIST OF PREPARERS

Caltrans District 4 - Environmental Evaluation Team

Annie Amundsen, Landscape Associate. M.L.A. Landscape Architecture; 3 years of experience in landscape architecture.

Allen Baradar, R.E.A., P.E., Senior Transportation Engineer. B.S. Metallurgical Engineering; 8 years experience in environmental engineering (hazardous waste, water quality, dredging, and regulatory compliance).

Clive Endress, Senior Landscape Architect. B.S. Landscape Architecture; 22 years experience in visual analysis.

Rachel Falsetti, P.E., Office Chief - SFOBB Specifications and Estimates. B.S. Civil Engineering; 15 years experience in bridge management, design, and construction.

Nick Fiorentinos, Right-of-Way Agent. B.A. Speech and Communication Studies; 10 years of experience in right-of-way activities.

Michael Flake, P.E., Senior Transportation Engineer. B.S. Civil Engineering; 8 years experience in environmental engineering, including water quality and hazardous waste analyses.

Andrew Hope, Associate Environmental Planner. M.A. Architecture; 12 years experience in architectural history and historic preservation.

Jeffrey Jensen, Associate Environmental Planner. M.A. Urban Planning, B.A. Public Policy; 10 years experience in environmental planning.

John Krause, Environmental Planner. B.S. Natural Sciences; 3 years experience in land use planning and land management.

Bev McIntosh, Associate Biologist. M.A. Biogeography, B.A. Geography; 25 years practicing biology and teaching physical geography.

Mara Melandry, Environmental Manager. M.Phil. Anthropology, B.A. Anthropology; 27 years experience in environmental planning with a specialty in historic preservation.

Saba Mohan, Transportation Engineer, M.S. Civil Engineering; 5 years experience in civil engineering.

John Mook, P.E., Senior Bridge Engineer, B.S. Mechanical Engineering; 12 years experience in construction, design, maintenance, and budgeting.

Marilee Mortenson, Senior Environmental Planner. B.S. Geology; 9 years experience in environmental planning.

Kristin Opbroek, Landscape Associate. B.S. Landscape Architecture; 3 years experience in landscape architecture.

Rod Oto, P.E., Senior Transportation Engineer. B.S. Civil Engineering; 20 years experience in traffic operations.

Janet Pape, Senior Environmental Planner/Archaeologist. M.A. Cultural Resource Management; 19 years experience in California archaeology.

Mark Shindler, Senior Right-of-Way Agent. B.S. Business Management; 15 years of experience in Right-of-Way activities.

Charles Smith, P.E., Environmental Engineer, B.S. Civil Engineering; 7 years experience in hazardous waste management.

Don Stratton, Associate Right-of-Way Agent. B.S. Business; 20 years experience in right-of-way and performing housing/relocation studies.

Vong Toan, P.E., Structural Oversight Engineer; M.S. Civil Engineering; 18 years experience in design and construction.

Mike Whiteside, P.E., Assistant Structure Contract Manager. B.S. Civil Engineering; 13 years experience in design, construction, and management of bridge projects.

Victor Zeuzem, P.E., Senior Environmental Engineer. A.A. Civil Engineering; 15 years in air quality, traffic noise, and energy analyses.

Parsons Brinckerhoff Quade & Douglas, Inc.

Mark Aikawa, P.E., Civil Engineering Manager. B.S. Civil Engineering; 12 years experience on highway and rail projects.

Patricia Berryhill, Afilliate Natural Resource Consultant, B.S. Natural Resource Conservation; 12 years experience in environmental planning.

Helise Cohn, Senior Transportation Planner. M.S. Civil Engineering (pending), B.S. Mathematics; 11 years experience in transportation planning.

Timothy K. Dougherty, P.E., Civil and Environmental Consultant Team Manager. B.S. Construction Engineering Technology; 22 years of highway engineering design and heavy construction experience.

Ivy Edmonds-Hess, Lead Environmental Planner. B.S. Meteorology; 11 years experience in environmental planning and air quality analysis.

Elizabeth Heffner, Associate Transportation and Environmental Planner. B.A. Geography; 2 years experience in environmental and transportation planning.

Edward Heyd, Associate Environmental Planner. B.A. History; 1 year of experience in environmental planning.

Ken Jong, P.E., former Civil and Environmental Consultant Team Manager. B.S. Civil Engineering; 17 years experience in transportation engineering and project management.

Susan Killen, Senior Supervising Planner. M.Ed. Education, B.A. Art/Education; 20 years experience in environmental planning and the preparation of Major Investment Studies.

Robert Malone, Associate Environmental Planner. Master of Regional Planning, B.S. Management; 2 years experience in environmental/transportation planning and geographic information system (GIS) applications.

Brady Nadell, P.E., Civil Engineer. B.S. Civil Engineering; 8 years experience in civil/highway design.

Stephen Noack, Lead Environmental Planner. M.S. Urban and Regional Planning; 23 years experience in environmental planning.

Rita Poon, Administrative Assistant. B.A. Liberal Studies; 14 years experience.

Shadde Rosenblum, Transportation Planner. Master of Urban and Regional Planning, B.A. International Studies; 3 years experience in environmental/transportation planning.

Jones & Stokes Associates, Inc.

Mike Davis, Environmental Manager. M.A. Urban and Regional Planning, B.A. Geography; 20 years experience in environmental and transportation planning.

Public Affairs Management

Scott Steinwert, Principal Environmental Planner. B.A. Biology; 13 years experience in community and environmental planning.

Steve Wertheim, Assistant Planner. B.A. Public Policy; 4 years experience in environmental planning and public involvement.

Kay Wilson, President. M.A. Regional & Community Planning, B.A. Political Science; 31 years experience in community and environmental planning.

URS Greiner

Vance Bente, Senior Consultant. M.A. Anthropology; 26 years experience in cultural resources management.

Laura Cholodenko, Staff Biologist. B.A. Environmental Studies; 5 years experience in wildlife management and research.

Sean Dexter, Senior Staff Archaeologist. B.A. Anthropology; 10 years of experience in cultural resource management/environmental planning.

Steve Kellogg, Associate Scientist. M.A. Biology, B.S. Biology; 27 years of experience in environmental impact statements and biological assessments.

Steve Leach, Wetlands Biologist. M.S. Botany, B.S. Geography; 10 years of experience in biological assessments.

Corinna Lu, Biologist. M.A. Geography, B.S. Biology; 3 years experience in wildlife biology.

William Martin, Senior Water Quality Scientist. B.S. Oceanography; 15 years experience with biological impact assessments and water quality and marine resource issues.

Sally Morgan, Senior Scientist. M.A. Anthropology; 25 years experience in cultural resources management and Section 106 compliance.

Jeff Zimmerman, Senior Environmental Planner. B.S. Conservation of Natural Resources; 20 years of experience in environmental planning.

APPENDIX C
DISTRIBUTION LIST

APPENDIX C
DISTRIBUTION LIST

ELECTED OFFICIALS

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The Honorable Barbara Boxer
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The Honorable Dianne Feinstein
U.S. Senate
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San Francisco, CA 94105

U.S. House of Representatives

The Honorable Anna Eshoo
U.S. House of Representatives
698 Emerson Street
Palo Alto, CA 94301

The Honorable Doug Ose
U.S. House of Representatives
722-B Main Street
Woodland, CA 95695

The Honorable Mike Honda
U.S. House of Representatives
3550 Stevens Creek Boulevard
Campbell, CA 95117

The Honorable Nancy Pelosi
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San Francisco, CA 94102

The Honorable Tom Lantos
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San Mateo, CA 94402

The Honorable Fortney Pete Stark
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The Honorable Barbara Lee
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The Honorable Ellen Tauscher
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The Honorable Zoe Lofgren
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The Honorable Michael Thompson
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The Honorable George Miller
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The Honorable Liz Figueroa
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California State Assembly
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Alameda County Board of Supervisors
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Alameda County Board of Supervisors
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Supervisor, District 3
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Mr. Warren Slocum
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Mayor, City of San Francisco
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Mayor, City of Emeryville
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Emeryville, CA 94608

The Honorable Shirley Dean
Mayor, City of Berkeley
2180 Milvia Street
Berkeley, CA 94704-1308

The Honorable James Spering
Mayor, City of Suisun City
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Suisun City, CA 94585

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Mayor, City of Alameda
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Director of Housing
U.S. Department of Housing and Urban Development
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San Francisco, CA 94102-3448

Mr. James Beall, Jr.
MTC Chairperson
Santa Clara County Supervisor
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San Jose, CA 95110

METROPOLITAN TRANSPORTATION COMMISSION (continued)

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MTC Vice Chairperson
City of San Pablo Councilmember
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San Pablo, CA 94806

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MTC Commissioner
Contra Costa County Supervisor
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MTC Commissioner
Napa County Supervisor
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Napa, CA 94559-3082

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MTC Commissioner
U.S. Department of Transportation
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Bay Conservation and Development
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APPENDIX D
DEFINITIONS AND ACRONYMS

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DEFINITIONS

Abutment - A stone, concrete, brick, or timber structure supporting the end of a span.

Advisory Council on Historic Preservation (ACHP) - An independent federal agency that provides a forum for influencing federal policy, programs, and activities as they affect historic and archaeological resources in communities and on public lands nationwide.

Alluvial - Resulting from the operations of water, including floodplains, lakes, rivers, and fans at the foot of mountain slopes.

Anchorage - An assemblage of material designed to hold in correct position the anchor span of a cantilever bridge or the end of a suspension span cable.

Attainment area - An area that meets air quality standards.

Attenuation - The reduction of noise.

San Francisco Bay Regional Water Quality Control Board (RWQCB) - An agency with the California Environmental Protection Agency that is responsible for regulating pollutants to protect the water resources of the Bay Area.

Bay mud - Soft to stiff silty clay with some shell fragments that is found in the Bay. It is generally unsuitable for structure foundations.

Bedrock - Solid rock that underlies all soil, sand, clay, gravel, and loose material on the earth's surface.

Bent - A bridge support column founded on land.

Biological opinion - A document that is the product of formal consultation, stating the opinion of the USFWS on whether or not a federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

Bracing - A system of tension or compression members that supports a truss or frame.

Cable - The part of a bridge that has the function of receiving the bridge floor loads and transmitting them to the towers and the anchorages.

Cable-stayed span - A span that involves steel cables that connect towers directly to support the bridge deck.

California Department of Fish and Game (CDFG) - The state agency that manages California's wildlife and plant resources.

California Department of Transportation (Caltrans) - Responsible for planning, designing, building, operating, and maintaining California's state highway system.

Candidate species - Any species of fish, wildlife, or plant which has been determined to be candidates for listing under Section 4 of the Endangered Species Act of 1973 (amended).

Cantilever span - A general term applying to a bridge having a superstructure of the cantilever type (supported at one end only).

Coastal Zone Management Act (CZMA) - The CZMA regulates development in coastal areas to protect the unique resources in such areas.

Cofferdam - A temporary water-tight enclosure built in the water and pumped dry to expose the bottom so that construction of piers can be undertaken.

Column - A supporting pillar.

Contaminant source - A facility that treats, stores, or disposes of hazardous waste, uses hazardous substances, or stores petroleum products on site.

Cultural resources - Archaeological and historic resources eligible for or listed on the National Register of Historic Places. Cultural resources include buildings, sites, districts, structures, or objects having historical, architectural, archaeological, cultural, or scientific importance.

Cumulative impact - The impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions.

Day-Night Equivalent Sound Level (Ldn) - A 24-hour equivalent sound level with a 10 dB penalty assessed to noise events occurring at night (10:00 p.m. to 7:00 a.m.).

dBA - A sound level in decibels, measured with a sound level meter having metering characteristics and frequency weighting specified in American National Standard Specifications for sound level meters (ANSI S1.4-1971). It is common to refer to numerical units of an A-weighted sound level as "dBA."

Deck - The portion of a bridge that provides direct support for vehicular, bicycle, and/or pedestrian traffic.

Draft Environmental Impact Statement (DEIS) - A draft report that analyzes potential environmental impacts of a proposed project in compliance with NEPA.

Dredged Material Management Office (DMMO) - An interagency coordination group, consisting of the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the San Francisco Bay Conservation and Development Commission, the State Lands Commission, and the Regional Water Quality Control Board, that determines the suitability of in-Bay disposal for dredged materials.

Edge truss - Horizontal trusswork that is extended from the base of a lower deck to the bottom of an upper deck.

Endangered species - Any species of wildlife or plant which has been determined to be endangered under Section 4 of the Endangered Species Act of 1973 (amended). This definition is adopted from the USFWS, Section 7 regulations, 51 FR 19926.

Equivalent Sound Level (L_{eq}) - A measure of sound energy over a period of time, or a sound level which, in a stated period of time, would contain the same acoustical energy as the time-varying sound during the same period.

Expansion joint - A joint designed to provide means for expansion and contraction movements produced by temperature changes, loadings, or other means.

4 (f) resources - Resources protected by Section 4(f) of the Department of Transportation Act. These include public park and recreation lands, wildlife and waterfowl refuges, and historic sites eligible or listed on the National Register.

Falsework - A temporary wooden or metal framework built to support a structure under construction until that structure is self-supporting.

Federal Aviation Administration (FAA) - The federal agency that issues and enforces regulations and standards related to the manufacture, operation, certification, and maintenance of aircraft.

Federal Highway Administration (FHWA) - The federal agency that coordinates highway transportation programs in cooperation with states and other partners. It provides federal financial assistance to the States to construct and improve the National Highway System, urban and rural roads, and bridges.

Federal Transit Administration (FTA) - The federal agency that provides financial and technical assistance to local transit systems. It also assists in the development of local and regional traffic reduction programs.

Fill - Earth used to create embankments or to raise low-lying areas in order to bring them to grade. Under the Clean Water Act (ACOE jurisdiction), fill is defined as material used for the primary purpose of replacing an aquatic area with dry land, or a change in the bottom elevation of a water body. Under the McAteer-Petris Act (BCDC jurisdiction), fill is defined as any solid, pile-supported, floating, cantilevered, or

suspended material that is placed bayward of the Mean High Tide Line, or the +1.5-meter (5.0-foot) contour line where marshlands are present.

Final Environmental Impact Statement (FEIS) - A document that responds to comments received on the DEIS and provides updated information that has become available after publication of the DEIS.

Floodplain - The part of the ground surface inundated with water on a recurring basis, usually associated with the one percent recurrence interval (100-year) flow.

Footing - The enlarged, or spread-out, lower portion of a substructure, which distributes the structure load either to the earth or to supporting piles.

Foundation - The supporting material upon which the substructure portion of a bridge is placed.

Franciscan Formation - Regional bedrock that is approximately 90 to 160 million years old. It is composed of sandstone and shale and is generally highly weathered.

General Plan - A document that contains policies used to implement the goals of a community.

Geomorphic - Of the earth's surface configuration.

Girder - A horizontal beam used as a main support for a structure.

Grade - A slope or gradual incline.

Groundwater - Water beneath the earth's surface between saturated soil and rock that supplies wells and springs.

Haunched girder - An arched beam used between support piers.

High Occupancy Vehicle (HOV) - Vehicles occupied by two (sometimes three) or more persons such as carpools and buses.

High Occupancy Vehicle Lane (HOV Lane) - A system of exclusive lanes signed and striped for use by vehicles with multiple occupants (two or more or three or more persons). HOV lanes are designed on roadways to reduce traffic congestion, improve safety, reduce fuel consumption, and improve air quality.

Historic American Building Survey (HABS) - Founded by the National Park Service to document and archive significant historic architectural works.

Historic American Engineering Record (HAER) - Founded to document and archive significant engineering and industrial sites.

Inundation - The act of covering with water.

Isolator bearing - A bearing developed to protect structures against earthquake damage. Under seismic loading, the bearing becomes more flexible. This allows it to isolate the structure from the effects of earthquake motion.

Landscape unit - A geographically distinct portion of an area that has a particular visual character.

Lateral bracing - A horizontal bracing assemblage on a structure. Its function is to help the structure resist wind, lateral vibration, and traffic movement tending to produce lateral movement and deformation.

Lattice work - A structure made of lattices that is used to secure another structure in place.

Least Environmentally Damaging Practicable Alternative (LEDPA) - This designation is identified under the Federal Clean Water Act Section 404 (b)(1) alternatives evaluation process. The Section 404 (b)(1) process requires ACOE and EPA to make a determination of the LEDPA for any action involving discharge of dredge or fill material into waters of the U.S.

Level of Service (LOS) - The operating level of an intersection or roadway segment can be described using the term Level of Service. Level of Service is a qualitative description of operation based on delay and maneuverability. It can range from "A" representing free flow conditions to "F" representing gridlock.

Lifeline - A connection that provides for post-earthquake relief access linking major population centers, emergency relief routes, emergency supply and staging centers, and intermodal links to major distribution centers.

Liquefaction - The loss of strength that can occur in loose, saturated soil during or following seismic shaking. This condition can produce a number of ground effects, including lateral spreading, boils, ground lurching, and settlement of fill material.

Maintenance area - An area that had previously been designated a non-attainment area, but now meets applicable air quality standards.

Marine Mammal Protection Act - Provides for the protection and conservation of marine mammal species.

Maximum Credible Earthquake (MCE) - The largest earthquake reasonably capable of occurring based on current geological knowledge.

Metamorphic - Pertaining to an alteration in composition, texture, or structure of rock masses caused by great heat and/or pressure.

Metropolitan Transportation Commission (MTC) - The transportation planning, coordinating, and financing agency for the nine-county San Francisco Bay

Area. It functions both as the region's metropolitan transportation planning agency (RTPA) and as the region's metropolitan planning organization (MPO)—state and federal designations, respectively.

Migratory Bird Treaty Act of 1918 - Reflects agreements involving the United States, Great Britain (for Canada), Mexico, Japan, and the former Soviet Union to protect migratory bird populations.

Mitigation - Measures taken to minimize adverse environmental impacts. Mitigation could reduce the magnitude and extent of an impact from a level of significance to a level of insignificance.

National Environmental Policy Act (NEPA) - The United States' basic national charter for protection of the environment. It establishes policy, sets goals, and provides means for carrying out the policy.

National Geodetic Vertical Datum (NGVD) - A fixed surface reference established by the U.S. Coast and Geodetic Survey in 1929 as the datum to which relief features and elevation data are referenced.

National Historic Preservation Act of 1966 - The primary federal law pertaining to protection of cultural resources, referred to as Section 106.

National Marine Fisheries Service (NMFS) - The part of the National Oceanic and Atmospheric Administration that oversees the Administration's programs which support the domestic and international conservation and management of living marine resources.

National Register eligible - Cultural resources eligible for inclusion on the National Register of Historic Places.

National Register of Historic Places - A federal listing of historic resources protected under the National Historic Preservation Act of 1966.

Navigation channel - An area of water used for marine vessel travel under bridges.

Non-attainment area - An area that does not meet air quality standards.

Noise Abatement Criteria - Noise level standards above which noise reducing actions should be considered.

Outfall - The place where a sewer, drain, or stream discharges into adjacent water.

Pier - A structure composed of stone, concrete, brick, steel or wood and built in shaft or block-like form to support the ends of the spans of a multi-span superstructure at an intermediate location between its abutments.

Pile - A rod or shaft-like linear member driven into the earth as a foundation or support for a structure.

Pile cap - The topmost portion of a pier. On rigid frame piers, the term applies to the beam across the column tops.

Portal - The clear unobstructed space of a through bridge forming the entrance to the structure.

Profile - refers to the rise in roadway elevation.

Record of Decision - A public document that explains the reasons for a project decision and summarizes any mitigation measures that will be incorporated in the project.

Right-of-way - Land, property, or interest therein, acquired for infrastructure such as a highway, railbed, pipeline, electric power lines, or telephone facilities. The land has been set aside as an easement or in fee, either by agreement or by condemnation.

Riparian - An aquatic or terrestrial ecosystem that is associated with bodies of water, such as streams, lakes, or wetlands, or is dependent upon the existence of perennial, intermittent, or ephemeral surface or subsurface water drainage. Riparian areas are usually characterized by dense vegetation and an abundance and diversity of wildlife.

Riprap - Brickbats, stones, blocks of concrete or other materials deposited upon shores to prevent erosion and scour by water flow.

Rock-wedge Failure - A movement or sliding of rock mass, possibly including overlying soil, along existing discontinuities such as fractures or joints within the rock fabric.

Safety Evaluation Event (SEE) - An earthquake that generates the largest motions expected to occur at a site within an established time interval. For the East Span Project, the time interval is 1,500 years.

San Francisco Bay Conservation and Development Commission (BCDC) - The state agency responsible for protecting and enhancing the San Francisco Bay. Two of its mandates are to prevent the unnecessary filling of the San Francisco Bay and to increase public access to and along the Bay shoreline. BCDC is also the federally designated state coastal management agency for the San Francisco Bay segment of the California coastal zone authorized under the federal Coastal Zone Management Act.

Sediment Sampling and Analysis - The process of evaluating the physical, chemical, and biological make-up of potential dredged sediment.

Self-anchored suspension bridge - A suspension bridge where cables are anchored in the bridge deck itself, eliminating the need for traditional anchorage structures.

Shoal - A place in a body of water where the water is particularly shallow.

Silt - A sedimentary material consisting of fine mineral particles in size between sand and clay.

Skyway span - A span that is supported from under the bridge deck by piers.

Special status species - Any species of fish, wildlife, or plant that is officially listed as rare, threatened, endangered, or candidate for rare, threatened, or endangered species listing under the state or federal Endangered Species Acts.

Spit - A narrow point of land extending into a body of water.

State Implementation Plan (SIP) - A plan for attaining national ambient air quality standards required by the Clean Air Act.

State Office of Historic Preservation - The state agency that assists private citizens, private institutions, local governments, and state and federal agencies in the identification, evaluation, protection, and enhancement of properties significant in California history and archaeology; also responsible for reviewing federal undertakings that affect cultural resources on or eligible for the National Register of Historic Places.

Stress - An applied force or system of forces that tends to strain or deform a body.

Substructure - The abutments, piers, or other constructions built to support the span or spans of a bridge. The superstructure is supported by the substructure; the substructure is placed on the foundations.

Superelevation - The transverse inclination of the roadway surface within a horizontal curve. The purpose of superelevation is to provide a means of resisting or overcoming the centrifugal forces of vehicles in transit.

Superstructure - The entire portion of the bridge structure that primarily receives and supports highway, railway or other traffic loads. It is supported by the substructure.

Surface runoff - Water that runs off streets and land and enters a body of water.

Suspension bridge - A span in which cables are draped from towers and connected to anchorages on either end of the bridge, and the bridge deck is supported by vertical connections to the cables.

Tectonic - Pertaining to structural deformations in the earth's surface.

Temporary structure - A structure that is used to support a permanent structure that is temporarily unable to support itself.

Tower - A pier or frame serving to support the cables of a bridge.

Traffic Management Plan - A plan to manage traffic during construction of projects to reduce congestion.

Trestle - A timber, reinforced concrete, or steel structure, usually consisting of many short spans, used to support a temporary or permanent bridge or used temporarily to construct a permanent bridge.

Truss - A jointed structure having an open built web construction so arranged that the frame is divided into a series of triangular figures.

Tsunamis - Seismically induced sea waves that are generated when large subsea earth or rock masses are displaced during earthquakes or very large landslides.

U.S. Army Corps of Engineers (ACOE) - Federal agency with jurisdiction over waters of the U.S.

U.S. Coast Guard (USCG) - Federal agency with jurisdiction over navigable waterways.

U.S. Environmental Protection Agency (EPA) - The federal agency responsible for maintaining environmental quality, including air quality, noise, and hazardous waste management.

U.S. Fish and Wildlife Service (USFWS) - The federal agency that administers the federal Endangered Species Act and is involved in protection of fish and wildlife habitat, including wetland areas.

Viaduct - A series of spans or arches used to carry a road or railroad over a wide valley or over other roads or railroads.

Visual dominance - The contrast between a project and its setting, described in terms of vegetation, landform, and structural changes.

Visual image type - An area that exhibits a fairly homogeneous visual quality. Types that are present in the SFOBB study area include recreational, industrial, institutional/military, historical, and open space.

Watershed - the point of high ground dividing two different drainage systems.

Waterway - The available width for the passage of water beneath a bridge.

Wetlands - According to regulations of the U.S. Army Corps of Engineers, wetlands are areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, under normal conditions, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, and similar areas and are subject to protection under Executive Order 11990 and Section 404 of the Clean Water Act.

ACRONYMS

AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
AATC	Advanced Automatic Train Control
ABAG	Association of Bay Area Governments
AC Transit	Alameda-Contra Costa Transit District
ACHP	Advisory Council on Historic Preservation
ACOE	U.S. Army Corps of Engineers
ADEIS	Administrative Draft Environmental Impact Statement
ADT	Average Daily Traffic
AHC	Ad Hoc Committee on Seismic Ground Motions
APE	Area of Potential Effect
ASR	Archaeological Survey Report
BAAQMD	Bay Area Air Quality Management District
BART	Bay Area Rapid Transit District
BATA	Bay Area Toll Authority
BCDC	San Francisco Bay Conservation and Development Commission
BEQ	Bachelor Enlisted Quarters
BMPs	Best Management Practices
BPAC	Bicycle/Pedestrian Advisory Committee
BRAC	Base Realignment and Closure
CAA	Federal Clean Air Act
Caltrans	California Department of Transportation
CARB	California Air Resources Board
CCAA	California Clean Air Act
CCSF	City and County of San Francisco
CDFG	California Department of Fish and Game
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
CHP	California Highway Patrol
CIH	Certified Industrial Hygienist
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Survey
CO	Carbon Monoxide
CSHC	California Streets and Highways Code
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
CZMP	Coastal Zone Management Plan
dB	Decibel
dBA	A-weighted decibel
dBA L_{eq}	A-weighted decibel equivalent sound level
DDT	Dichlorodiphenyltrichloroethane
DEIR	Draft Environmental Impact Report

DEIS	Draft Environmental Impact Statement
DMMO	Dredged Material Management Office
DMMP	Dredged Material Management Plan
DTSC	California Department of Toxic Substance Control
EA	Environmental Assessment
EB	Eastbound
EBMUD	East Bay Municipal Utility District
EBRPD	East Bay Regional Park District
EDAP	MTC Bay Bridge Design Task Force Engineering and Design Advisory Panel
EFH	Essential Fish Habitat
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Environmentally Sensitive Areas
ESU	Evolutionary Significant Unit
FAA	Federal Aviation Administration
FCWA	Federal Clean Water Act
FEIS	Final Environmental Impact Statement
FHWA	Federal Highway Administration
FISC	Fleet and Industrial Supply Center
FSTIP	Federal Statewide Transportation Improvement Program
FTA	Federal Transit Administration
ha	Hectare or hectares
HAER	Historic American Engineering Record
HASR	Historic Architecture Survey Report
HCM	Highway Capacity Manual
HOV	High Occupancy Vehicle
HPSR	Historic Property Survey Report
HTL	High Tide Line
HUD	Department of Housing and Urban Development
HWCL	Hazardous Waste Control Law
I	Interstate
IR	Installation Restoration
ISTEA	Intermodal Surface Transportation Efficiency Act
JIT	Joint Intermodal Terminal
km	Kilometer or kilometers
kph	Kilometers per hour
KV	Kilovolt
LEDPA	Least Environmentally Damaging Practicable Alternative
L_{10}	Noise level equaled or exceeded 10% of the time
L_{eq}	Equivalent Sound Level
L_{max}	Maximum Level
LPAB	Landmarks Preservation Advisory Board
LRT	Light Rail Transit
LTMS	Long-Term Management Strategy
LUST	Leaking Underground Storage Tank
m	Meter or meters
MCE	Maximum Credible Earthquake

mg/L	Milligrams per Liter
mg/m^3	Milligrams per Cubic Meter
MHTL	Mean High Tide Line
MHW	Mean High Water
mi	Mile or Miles
MIS	Major Investment Study
MLLW	Mean Lower Low Water
MLW	Mean Low Water
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
mph	Miles per hour
MPO	Metropolitan Planning Organization
MPRSA	Marine Protection, Research, and Sanctuaries Act
MSL	Mean Sea Level
MTC	Metropolitan Transportation Commission
MTL	Mean Tide Level
MUNI	San Francisco Municipal Railway
NAAQS	National Ambient Air Quality Standards
NAC	Noise Abatement Criteria
NAHC	Native American Heritage Commission
NEPA	National Environmental Policy Act
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOD	Notice of Determination
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRHP	National Register of Historic Places
NSTI	Naval Station Treasure Island
NUAD	Not Suitable for Unconfined Aquatic Disposal
O&M	Operations and Maintenance
OARB	Oakland Army Base
OBRA	Oakland Army Base Reuse Authority
OES	Office of Emergency Services
OSHA	Occupational Safety and Health Administration
PAH	Polyaromatic Hydrocarbon or Polynuclear Aromatic Hydrocarbon
PA/SI	Preliminary Assessment/Site Investigation
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
PDT	Project Development Team
PG&E	Pacific Gas and Electric Company
PIDP	Pile Installation Demonstration Project
$PM_{2.5}$	Particulate Matter with an Aerodynamic Diameter less than 2.5 Micrometers
PM_{10}	Particulate Matter with an Aerodynamic Diameter less than Ten Micrometers
ppm	Parts per Million
ROD	Record of Decision

RCRA	Resource Conservation and Recovery Act
RMP	Regional Monitoring Program
RTP	Regional Transportation Plan
RTPA	Regional Transportation Planning Agency
RWQCB	San Francisco Bay Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SAR	Sediment Sampling and Analysis Report
SARA	Superfund Amendments and Reauthorization Act
SCPBRG	Santa Cruz Predatory Bird Research Group
SEE	Safety Evaluation Event
SF-11	San Francisco In-Bay Disposal Site at Alcatraz
SF – DODS	San Francisco Deep Ocean Disposal Site
SFEI	San Francisco Estuary Institute
SFFD	San Francisco Fire Department
SFOBB	San Francisco-Oakland Bay Bridge
SFWD	San Francisco Water Department
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SUAD	Suitable for Unconfined Aquatic Disposal
SVOC	Semi-Volatile Organic Compound
SWPPP	Storm Water Pollution Prevention Plan
TCE	Temporary Construction Easement
TEA-21	Transportation Equity Act for the 21st Century
TI	Treasure Island
TIDA	Treasure Island Development Authority
TIP	Transportation Improvement Program
TMP	Traffic Management Plan
TPH	Total Petroleum Hydrocarbons
TRPH	Total Recoverable Petroleum Hydrocarbons
TSCA	Toxic Substance Control Act
ug/m^3	Micrograms per Cubic Meter
ug/L	Micrograms per Liter
USC	United States Code
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compound
VTS	Vessel Traffic Service
WB	Westbound
WWTP	Wastewater Treatment Plant
YBI	Yerba Buena Island

APPENDIX I
RELOCATION ASSISTANCE INFORMATION

APPENDIX I
RELOCATION ASSISTANCE INFORMATION

I IMPORTANT RELOCATION ASSISTANCE INFORMATION

The following explanation is general in nature and is not intended to be a complete statement of Federal and State relocation laws and regulations. Any questions concerning relocation should be addressed to Caltrans Right-of-Way.

Any persons to be displaced will be assigned to a relocation advisor, who will work closely with each displacee in order to see that all payments and benefits are fully utilized and that all regulations are observed, thereby avoiding the possibility of displacees jeopardizing or forfeiting any of their benefits or payments. At the time of the first written offer to purchase, owner-occupants are given a detailed explanation of the State's relocation services. Tenant occupants of properties to be acquired are contacted soon after the first written offer to purchase and also are given a detailed explanation of the Caltrans Relocation Program. To avoid loss of possible benefits, no individual, family, business, farm, or nonprofit organization should commit to purchase or rent a replacement property without first contacting a Caltrans relocation advisor.

II RELOCATION ASSISTANCE ADVISORY SERVICES

In accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended, Caltrans will provide relocation advisory assistance to any person, business, farm, or nonprofit organization displaced as a result of the acquisition of real property for public use. Caltrans will assist displacees in obtaining comparable replacement housing by providing current and continuing information on the availability and prices of both houses for sale and rental units that are "decent, safe, and sanitary". Nonresidential displacees will receive information on comparable properties for lease or purchase. (For business, farm, and nonprofit organization relocation services, see Section IV.)

Residential replacement dwellings will be in equal or better neighborhoods at rents or prices within the financial ability of the individuals and families displaced and reasonably accessible to their places of employment. Before any displacement occurs, comparable replacement dwellings will be offered to displacees that are open to all persons regardless of race, color, religion, sex, national origin, and consistent with the requirements of Title VIII of the Civil Rights Act of 1968. This assistance will also include the supplying of information concerning Federal- and State-assisted housing programs and any other known services being offered by public and private agencies in the area.

Persons who are eligible for relocation payments and who are legally occupying the property required for the project will not be asked to move without first being given at least 90 days' written notice. Occupants eligible for relocation payment(s) will not be

required to move unless at least one comparable "decent, safe, and sanitary" replacement residence, available on the market, is offered to them by Caltrans.

III RESIDENTIAL RELOCATION PAYMENTS PROGRAM

The Relocation Payment Program will help eligible residential occupants by paying certain costs and expenses. These costs are limited to those necessary for or incidental to the purchase or rental of the replacement dwelling and actual reasonable moving expenses to a new location within 50 miles of the displacement property. Any actual moving costs in excess of the 50 miles are the responsibility of the displacee. The Residential Relocation Program can be summarized as follows:

Moving Costs

Any displaced person who lawfully occupied the acquired property, regardless of the length of occupancy in the property acquired, will be eligible for reimbursement of moving costs. Displacees will receive either the actual reasonable costs involved in moving themselves and personal property up to a maximum of 50 miles, or a fixed payment based on a fixed moving-cost schedule.

Purchase Supplement

In addition to moving and related expense payments, fully eligible homeowners may be entitled to payments for increased costs of replacement housing.

Homeowners, who have owned and occupied their property for 180 days or more prior to the date of the first written offer to purchase the property, may qualify to receive a price differential payment and may qualify to receive reimbursement for certain non-recurring costs incidental to the purchase of the replacement property. An interest differential payment is also available if the interest rate for the loan on the replacement dwelling is higher than the loan rate on the displacement dwelling, subject to certain limitations on reimbursement based upon the replacement property interest rate. The maximum combination of these three supplemental payments that the owner-occupant can receive is $22,500. If the total entitlement (without the moving payments) is in excess of $22,500, the Last Resort Housing Program will be used. (See the explanation of the Last Resort Housing Program below.)

Rental Supplement

Tenants who have occupied the property to be acquired by Caltrans for 90 days or more and owner-occupants of 90-179 days prior to the date of the first written offer to purchase may qualify to receive a rental differential payment. This payment is made when Caltrans determines that the cost to rent a comparable "decent, safe, and sanitary" replacement dwelling will be more than the present rent of the displacement dwelling. As an alternative, the tenant may qualify for a down payment benefit designed to assist in the purchase of a replacement property and the payment of certain costs incidental to the purchase, subject to certain limitations noted below under the Down Payment section. The maximum amount payable to any tenant of 90 days or more and any owner-occupant of 90-179 days, in addition to moving expenses, is $5,250. If the total entitlement for rental supplement exceeds $5,250, the Last Resort Housing Program will be used.

In addition to the occupancy requirements in order to receive any relocation benefits, the displaced person must buy or rent and occupy a "decent, safe, and sanitary" replacement dwelling within one year from the date the department takes legal possession of the property, or from the date the displacee vacates the displacement property, whichever is later.

Down Payment

The down payment option has been designed to aid owner-occupants of 90-179 days and tenants with no less than 90 days of continuous occupancy prior to Caltrans first written offer. The down payment and incidental expenses cannot exceed the maximum payment of $5,250. The one-year eligibility period in which to purchase and occupy a "decent, safe, and sanitary" replacement dwelling will apply.

Last Resort Housing

Federal regulations (49 CFR 24) contain the policy and procedure for implementing the Last Resort Housing Program on Federal-aid projects. Last Resort Housing benefits are, except for the amounts of payments and the methods in making them, the same as those benefits for standard residential relocation as explained above. Last Resort Housing has been designed primarily to cover situations where a displacee cannot be relocated because of lack of available comparable replacement housing, or when the anticipated replacement housing payments exceed the $5,250 and $22,500 limits of the standard relocation procedure, because either the displacee lacks the financial ability or other valid circumstances. In certain exceptional situations, Last Resort Housing may also be used for tenants of less than 90 days.

After the first written offer to acquire the property has been made, Caltrans will, within a reasonable length of time, personally contact the displacees to gather important information, including the following:

- Preferences in area of relocation;
- Number of people to be displaced and the distribution of adults and children according to age and sex;
- Location of school and employment;
- Specific arrangements needed to accommodate any family member(s) special needs; and
- Financial ability to relocate into comparable replacement dwelling that will adequately house all members of the family.

IV THE NONRESIDENTIAL RELOCATION ASSISTANCE PROGRAM

The Nonresidential Relocation Assistance Program provides assistance to businesses, farms, and nonprofit organizations in locating suitable replacement property and reimbursement for certain costs involved in relocation. The Relocation Advisory Assistance Program will provide current lists of properties offered for sale or rent suitable for the specific relocation needs of a particular business. The types of payments available to eligible businesses, farms, and nonprofit organizations are moving and searching expenses and, possibly, re-establishment expenses or a fixed in lieu payment instead of any moving, searching, and re-establishment expenses. The payment types can be summarized as follows:

Moving Expenses

Moving expenses may include the following actual reasonable costs:

- The moving of inventory, machinery, equipment, and similar business-related property dismantling, disconnecting, crating, packing, loading, insuring, transporting, unloading, unpacking, and reconnecting of personal property;
- Loss of tangible personal property provides payment for actual, direct loss of personal property that the owner is permitted not to move; and
- Expenses related to searching for a new business site, up to $1,000 for reasonable expenses actually incurred.

Re-establishment Expenses

Re-establishment expenses related to the operation of the business at the new location, up to $10,000 for reasonable expenses actually incurred.

Fixed In Lieu Payment

A fixed payment in lieu of moving and searching payments and re-establishment payment may be available to businesses which meet certain eligibility requirements. This payment is an amount equal to the average annual net earnings for the last two taxable years prior to the relocation and may not be less than $1,000 nor more than $20,000.

V ADDITIONAL INFORMATION

Relocation Payments Not Income

Reimbursement for moving costs and replacement housing payments are not considered income for the purpose of the Internal Revenue Code of 1954, or resources for the purpose of determining the extent of eligibility of a displacee for assistance under the Social Security Act, local "Section 8" Housing programs, or other Federal assistance programs.

Right to Appeal

Any person, business, farm, or nonprofit organization which has been refused a relocation payment by the Caltrans relocation advisor or believes that the payment(s) offered by the agency are inadequate, may appeal for a special hearing of their complaint. No legal assistance is required. Information about the appeal procedure is available from the relocation advisor.

APPENDIX J
BIBLIOGRAPHY

APPENDIX J
BIBLIOGRAPHY

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APPENDIX K
SEISMIC DESIGN

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SEISMIC DESIGN

Earthquakes are commonly reported in terms of their magnitude. The larger the magnitude, the bigger the earthquake, and the greater the potential for damage. When engineers design structures to resist earthquakes, they use "rock motions" — the vibrations that travel through the bedrock caused by the slipping of an earthquake fault. Seismologists develop the rock motions based on the structure's location in relation to the location of earthquake faults and historical and geotechnical project site data. Engineers use these rock motions to calculate the maximum seismic forces that the structure will experience and then design the structure to resist the forces.

Rock motions propagate up through the soil layers to the ground surface, where they become "ground motions" — rock motions cause ground motions. Ground motions are not the same as rock motions. Ground motions caused by the same rock motions will vary due to the soil conditions. The rock motions can be uniform along a project site, but for a long bridge like the Bay Bridge, the ground motions change along the length of the bridge as the soil changes.

For example, during the Loma Prieta earthquake, the ground motions varied at different locations, and this was reflected in the differing amounts of damage. Rock motions were amplified by the soft Bay Muds, and the resulting ground motions caused substantial damage in particular areas (such as the I-880/Cypress Freeway and San Francisco's Marina District). Where the soil is more stable material, the rock motions were not amplified as much, the ground motions were not as great, and there was little damage. Seismologists and geotechnical engineers use the rock motions and then translate them (by computer) into ground motions. However, rock motions are the basis of engineering calculations.

Design Rock Motions

Bridge design in earthquake-prone areas needs to take into account the anticipated rock motions at the bridge site. The challenge for designers is that the rock motion frequencies of future earthquakes cannot be predicted. The design rock motion is the model of anticipated rock motion that is developed for design purposes. It assumes that rock motions are strong over a broad range of frequencies, although this would never happen in a real earthquake. By assuming that rock motions are strong over a broad range of frequencies, this model takes into account the actual earthquakes that would generate strong motions for one or more of these frequencies.

Design Rock Motions for San Francisco-Oakland Bay Bridge East Span Replacement Structures

Replacement structures for the San Francisco-Oakland Bay Bridge East Span will be designed for rare seismic events. The Hayward and San Andreas faults are the dominant sources for rock motions for this bridge site, though other sources in the area have been considered in development of the bridge design.

There are two methods of estimating the greatest rock motion that a particular structure will experience. In the past, Caltrans considered the motions from the Maximum Credible Event (MCE). The MCE is the largest reasonable earthquake at a fault without regard or consideration of how often the earthquake might occur (the return period). It also does not provide a consistent or rational assessment of the probability that a structure will experience the design earthquake. For the East Span Project, Caltrans estimated the greatest rock motions from the Safety Evaluation Event (SEE). This is defined as an earthquake that generates the largest motions expected to occur at the bridge site once every 1,500 years (a 1500-year return period). The bridge's expected life span is 150 years, so there is approximately a 10% chance that this earthquake would happen during its life span. Caltrans was aided in the development of the ground motions by the Ad Hoc Committee on Seismic Ground Motions. This ad hoc committee is comprised of four members:

- The Chairperson is Professor Bruce Bolt, Professor Emeritus of Seismology at the University of California at Berkeley;

- Dr. Norman Abrahamson, a world-renowned geoscientist with expertise in assessing seismic ground motions;

- Dr. Richard Borcherdt, a seismologist from the U.S. Geological Survey with a specialization in recording earthquake ground motions; and

- Dr. Joseph Penzien, Professor Emeritus from the University of California at Berkeley, who is recognized as a world leader in structural dynamics and probability and statistics.

The Seismic Safety Peer Review Panel and the Metropolitan Transportation Commission's Engineering and Design Advisory Panel both accepted and agreed that the bridge should be designed for these SEE ground motions.

The Ad Hoc Committee on Seismic Ground Motions evaluated the recently issued report by the Army Corps of Engineers (ACOE) on retrofit versus replacement of the East Span. In particular, the committee focused on one of the ACOE's conclusions: "the performance of the replacement bridge during a Maximum Credible Earthquake cannot be determined. The bridge has not been evaluated or designed for a MCE event, which is larger than the SEE event." The Committee pointed out that this conclusion is based on an error in plotting a graph included in the ACOE's report. In fact, the MCE motions fall well below the SEE motions in all relevant data ranges, particularly during the initial shaking. In addition, the Ad Hoc Committee's evaluation of the ACOE's report explained that responses of structures (estimated for earthquakes of various magnitudes and for various source-to-site distances) depend crucially on the measurement of ground motions in actual large earthquakes. As additional recordings become available from such earthquakes, these new ground motion recordings are incorporated into the existing international database. Professor Bolt has stated that the SEE standard takes into account a wider range of possible ground motions, some of which are much higher in impact than MCE's predicted motions. The Ad Hoc Committee concluded that Caltrans studied both standards (MCE and SEE) and designed the bridge to the higher SEE standard.

APPENDIX L

TITLE VI POLICY STATEMENT

DEPARTMENT OF TRANSPORTATION
OFFICE OF THE DIRECTOR
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P. O. BOX 942873
SACRAMENTO, CA 94273-0001
PHONE (916) 654-5267
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July 26, 2000

TITLE VI
POLICY STATEMENT

The California State Department of Transportation under Title VI of the Civil Rights Act of 1964 and related statutes, ensures that no person in the State of California shall, on the grounds of race, color, sex and national origin be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity it administers.

Jeff Morales

JEFF MORALES
Director

APPENDIX M

DREDGED MATERIAL MANAGEMENT PLAN (DMMP)

Errata Sheet for the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project Dredged Material Management Plan, June 1999

The Dredge Material Management Plan (DMMP) was published by Caltrans in June 1999. This errata sheet lists corrections to the DMMP and updated dredged material quantity calculations.

1. On page 3-1 in section 3.1 paragraph 3 second bullet the text states "Excavate within the shallow areas of the east shoreline of the Bay, i.e., less than 4.3 meters (14 feet) below mean low low water (MLLW)." The corrected text should read "Excavate within the shallow areas of the east shoreline of the Bay, i.e., less than 4.3 meters (14 feet) below mean sea level (MSL) in the NGVD datum."

2. Figure 3-1, Dredged Construction Channel Cross-Section, includes incorrect elevation data. The elevation call-outs, -3.7 meters (-12 feet) MLLW and -4.3 meters (-14 feet) MLLW should read -3.7 meters (-12 feet) MSL and -4.3 meters (-14 feet) MSL. The width of the bottom of the channel is corrected from 192 meters (630 feet) to 115 meters (380 feet). The south edge of the channel should align with the south drip line of the eastbound bridge. The distance between the north drip line of the westbound bridge to the north edge of channel is 50 meters (164 feet), not 116 meters (380 feet). The other dimensions should be deleted.

3. Figure 3-5, Dredged Dismantling Channel Cross-Section, includes incorrect information. The elevation call-outs, -3.7 meters (-12 feet) MLLW and -4.3 meters (-14 feet) MLLW should read -3.7 meters (-12 feet) MSL and -4.3 meters (-14 feet) MSL. The dimension of 82 meters (270 feet) should be 80 meters (262 feet). The dimension of 6 meters (20 feet) should be 10 meters (31 feet). The dimension of 21 meters (70 feet) should be 20 meters (66 feet).

4. Figure 6-1, In-Bay Disposal Permit Procedures, has been revised to indicate that the San Francisco Bay Conservation and Development Commission (BCDC) may issue a permit only after the State Lands Commission and the Regional Water Quality Control Board have made their determination. This edit was requested by BCDC as part of its comment letter on the DMMP.

5. On page 6-11 and Table 6-3, the cost information for cubic meters is incorrect. On page 6-11, paragraph one, the second sentence reads "In general, dredging costs are assumed to be $11.50 per cubic meter ($15.00 per cubic yard) for all the reuse/disposal options except for sidecasting which is estimated at $13.00 per cubic meter ($17.00 per cubic yard) and includes the dredging and "disposal" in one unit cost." The corrected sentence should read "In general, dredging costs are assumed to be $19.62 per cubic meter ($15.00 per cubic yard) for all the reuse/disposal options except for sidecasting which is estimated at $22.24 per cubic meter ($17.00 per cubic yard) and includes the dredging and "disposal" in one unit cost." A corrected Table 6-3 is attached.

6. The activities that require dredging and therefore quantities of dredged materials have changed since publication of the DMMP. Some of the factors that have contributed to the difference in dredge quantities include:

- Refinement of the bathymetry of the bottom of the Bay;
- Redesign of some of the components of the bridge footings; and
- A clearer understanding of in-Bay construction methodology.

7. For the northern alternatives, the barge access channel that would be used by the contractor for construction of the Oakland Touchdown portion has been narrowed to 45 meters (150 feet) beyond the north drip line of the westbound bridge from 50 meters (165 feet). The bottom elevation of that section of the dredged channel was raised from -4.3 meters (-14 feet) MSL to -3.7 meters (-12 feet) MSL. This redesign minimizes impacts of dredging on special aquatic sites.

8. The assumptions that led to upper and lower limits of dredged quantities have changed. Construction scenarios envisioned when the DMMP was prepared in 1999 assumed:

(1) a barge access channel would be dredged along the northern edge of the Oakland Touchdown area or

(2) trestles along the northern edge of the Oakland Touchdown from which structures would be built.

Subsequent to a DMMP, it has been determined that barge access along the northern edge of the Oakland Touchdown area would be required to install the large diameter piles for the westbound structure. Construction scenarios now assume use of an access channel with trestles and falsework placed within the channel after dredging.

The following table compares the dredged material quantities in the DMMP and the current estimate of dredged material quantities. Please see Section 4.14.10 – Construction Excavation and Dredging in Volume I of the Final EIS for a description of dredging required to construct East Span Project build alternatives.

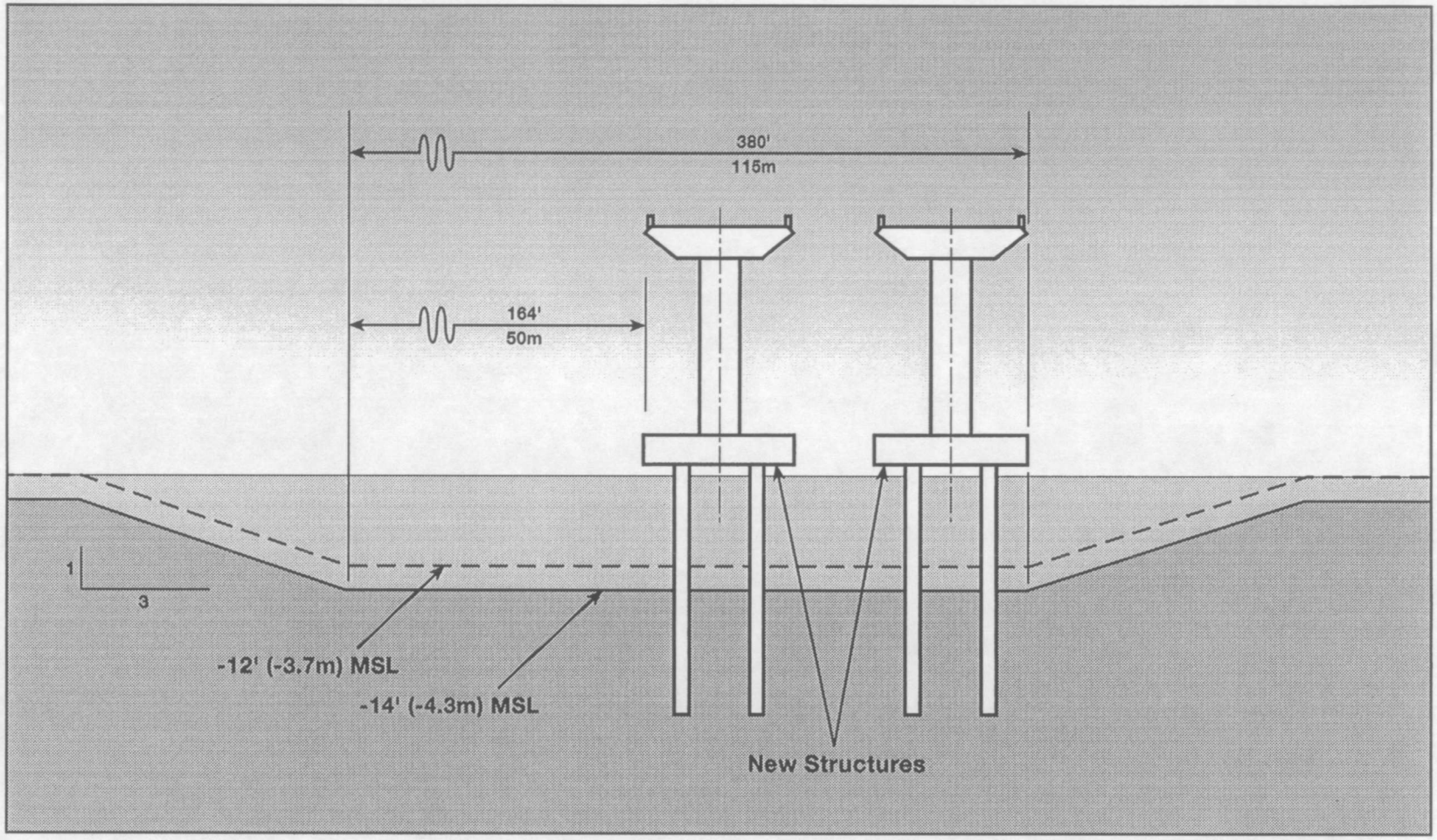
Comparison of Dredged Material Quantities Presented in the DMMP and the Final EIS

	Dredged Material Quantities cubic meters (cubic yards)		
	Replacement Alternative N-6 (Preferred)	**Replacement Alternative N-2**	**Replacement Alternative S-4**
DMMP – upper limit	448,000 (585,000)	448,000 (585,000)	335,000 (438,000)
DMMP – lower limit	262,000 (343,000)	262,000 (343,000)	269,000 (352,000)
Final EIS	413,000 (540,000)	413,000 (540,000)	417,000 (545,000)

Table 6-3
Summary of Reuse/Disposal Estimated Costs

REUSE/DISPOSAL OPTION	COST/m^3 (cost/cy)		
	Dredging	Transport and Disposal	Total
SF-11 (Alcatraz)	$19.62 ($15)	$9.16 ($7)	$28.78 ($22)
SF-DODS (Ocean)	$19.62 ($15)	$15.70 ($12)	$35.31 ($27)
Montezuma Wetlands	$19.62 ($15)	$60.16 ($46)	$79.78 ($61)
Hamilton Wetlands	$19.62 ($15)	$30.08 ($23)	$49.70 ($38)
Upland Landfilles (Class II – average)	$19.62 ($15)	$102.02 ($78)	$121.64 ($93)
Sidecasting	$22.24 ($17)	Included in dredging cost	$22.24 ($17)

Source: Parsons Brinckerhoff and URS Greiner Woodward Clyde, 1999.



View: Looking East, North Side of Replacement Alternative N-6

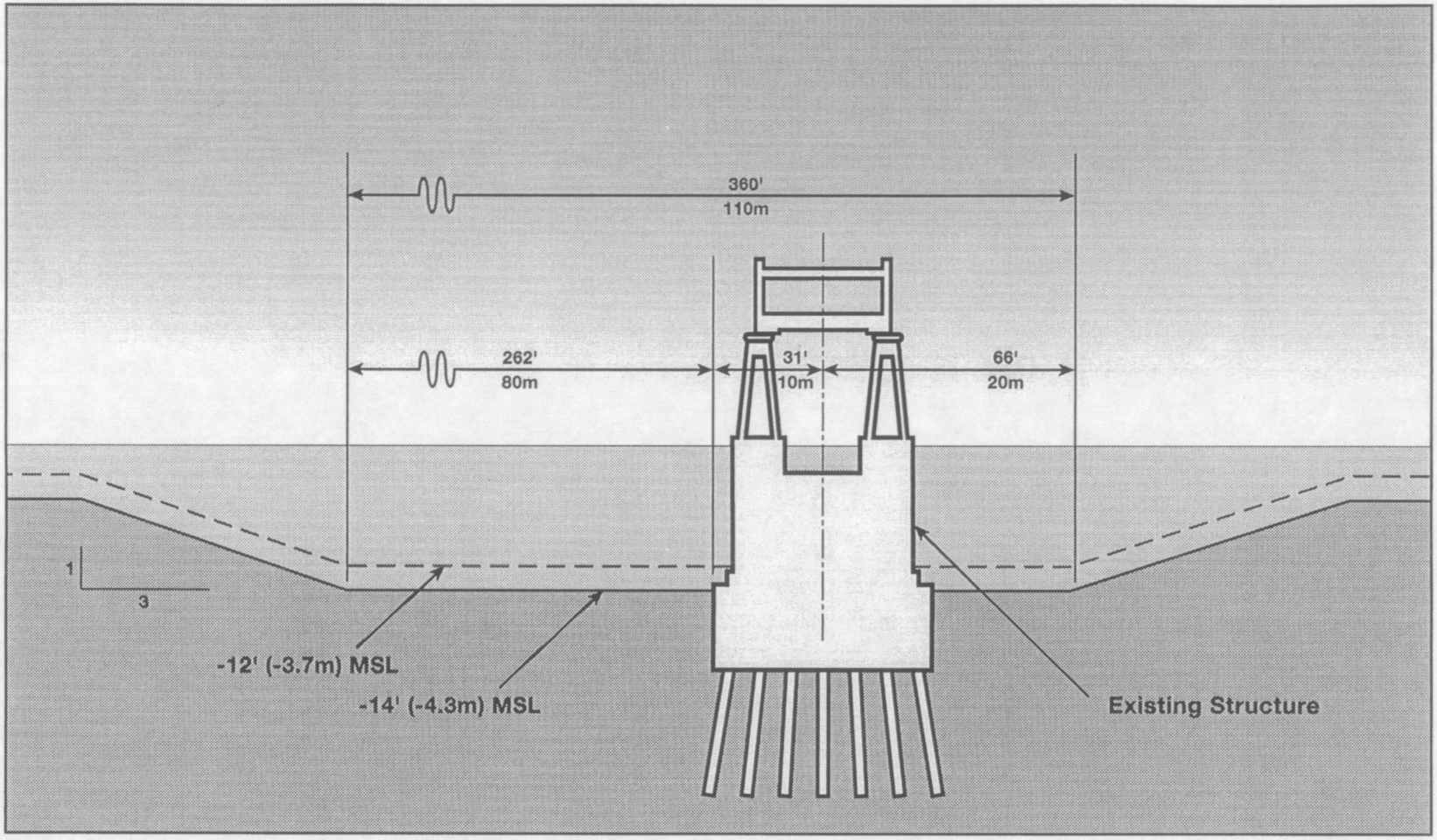
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

NOT TO SCALE

Dredged Construction Channel Cross-Section

Figure 3-1

PDQ&D 11/29/00



View: Looking West, South Side of Existing SFOBB

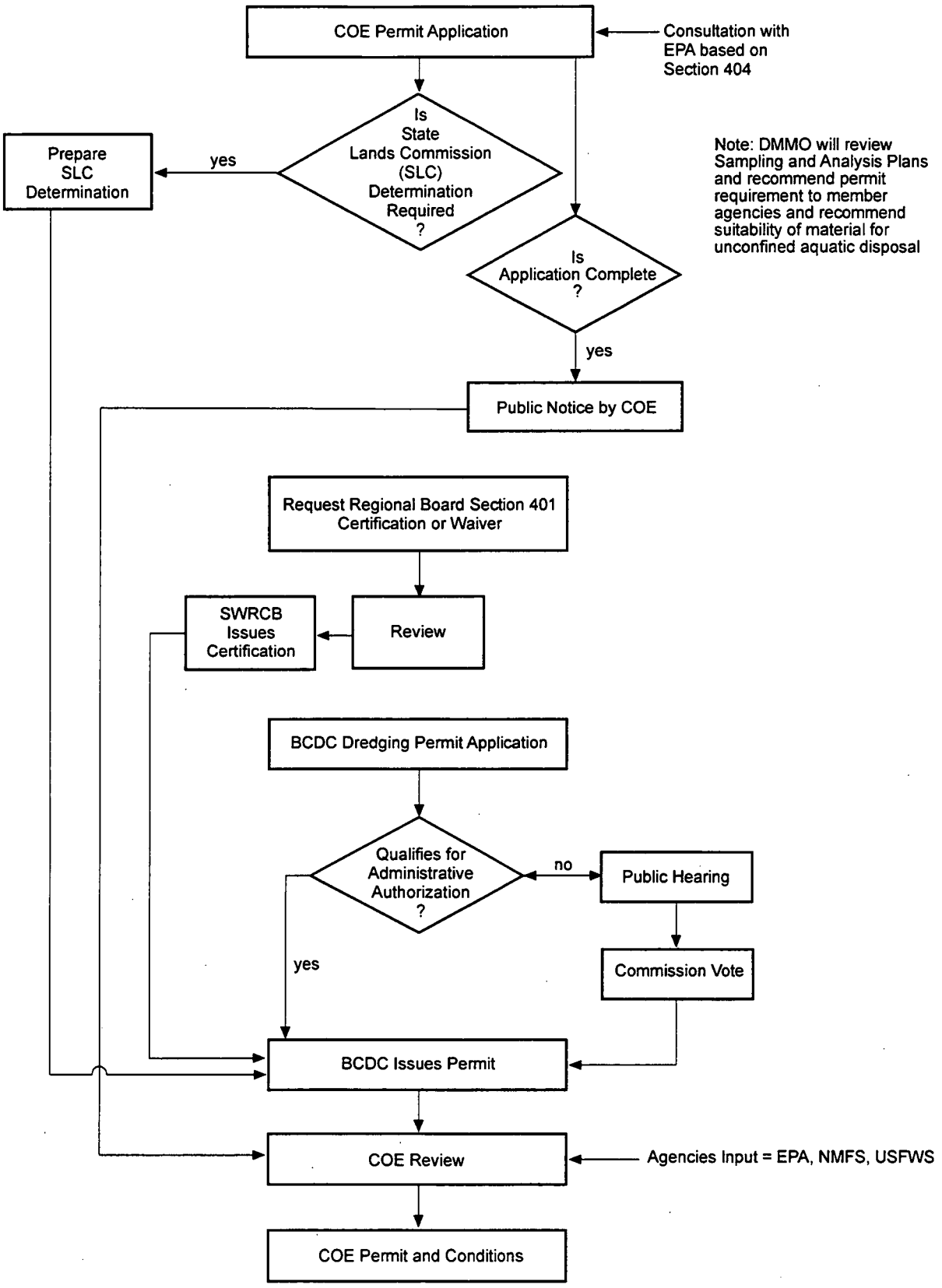
SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

NOT TO SCALE

Dredged Dismantling Channel Cross-Section

Figure 3-5

PDQ&D 11/29/00



Project No.	SFOBB East Span Seismic Safety Project	IN-BAY DISPOSAL PERMIT PROCEDURES	Figure 6-1

San Francisco – Oakland Bay Bridge
East Span Seismic Safety Project

EA 012000
Caltrans Contract 04A0148
Task Order 165.15.05

04-SF-80 KP 12.2/KP 14.3
04-ALA-80 KP 0.0/KP 2.1

Dredged Material Management Plan

21 June 1999

Prepared by

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Caltrans District 4

The San Francisco-Oakland Bay Bridge (SFOBB) East Span Seismic Safety Project is evaluating the retrofit or replacement of the existing SFOBB East Span. Alternatives evaluated are the No-Build; Retrofit Existing Structure; and Replacement Alternatives N-2, N-6, and S-4. Impacts associated with each of these alternatives are addressed in the project's Draft Environmental Impact Statement/Statutory Exemption (DEIS) published September 17, 1998.

This Dredged Material Management Plan (DMMP) provides detailed documentation of dredging activities and reuse/disposal of dredge materials that would be generated by construction activities associated with the build alternatives. The DMMP is being circulated to DEIS distribution list. There will be a 30-day comment period. All comments on this DMMP are due by July 21, 1999 and should be addressed to Mara Melandry, Caltrans District 4, 111 Grand Avenue (P.O. Box 23660), Oakland, California 94623-0660 or by sending e-mail to sfobb.dist04@dot.ca.gov. Comments on the DMMP will be addressed in the Final Environmental Impact Statement/Statutory Exemption.

The DMMP will be presented to the Dredged Material Management Office (DMMO) at a publicly noticed meeting.

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Acronyms

BCDC	San Francisco Bay Conservation and Development Commission
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
COE	U.S. Army Corps of Engineers
Conservancy	California Coastal Conservancy
CZMA	Coastal Zone Management Act
DEIS	Draft Environmental Impact Statement
DMMO	Dredged Material Management Office
DMMP	Dredged Material Management Plan
DWR	Department of Water Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FCWA	Federal Clean Water Act
FHWA	Federal Highway Administration
HAAF	Hamilton Army Air Field
LEDPA	Least Environmentally Damaging Practicable Alternative
LTMS	Long-Term Management Strategy
mcy	million cubic yards
MPRSA	Marine Protection, Research, and Sanctuaries Act
MWP	Montezuma Wetland Project
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NUAD	Not Suitable for Unconfined Aquatic Disposal
ppt	parts per thousand
RMP	Regional Monitoring Program
ROD	Record of Decision
RWQCB	San Francisco Bay Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SF-DODS	San Francisco Deep Ocean Disposal Site

SFOBB	San Francisco-Oakland Bay Bridge
SLC	State Lands Commission
SMMP	Site Management and Monitoring Plan
SUAD	Suitable for Unconfined Aquatic Disposal
SWPPP	Storm Water Pollution Prevention Plan
TSS	Total suspended solids
UWR	Upland/Wetland Reuse
WRDA	Water Resources Development Act
YBI	Yerba Buena Island

1.1 PURPOSE AND NEED FOR THE PROJECT

The San Francisco-Oakland Bay Bridge (SFOBB) is an important part of the Bay Area as it provides regional access between the San Francisco Peninsula and the East Bay. Approximately 350,000 people in 274,000 vehicles currently use the bridge each day. As a component of Interstate 80, it is also a critical link in the interstate network. Figure 1-1 shows the project location.

The purpose of the SFOBB East Span Seismic Safety Project (East Span Project) is to provide a seismically upgraded vehicular crossing for current and future users between Yerba Buena Island (YBI) and Oakland. This project is one of several that the California Department of Transportation (Caltrans) is undertaking to address the overall need to provide a lifeline bridge connection between the cities of San Francisco and Oakland. The other projects include replacing the west approach in San Francisco, retrofitting the West Span, West YBI Viaduct, and YBI tunnel, and the interim retrofit on the East Span.

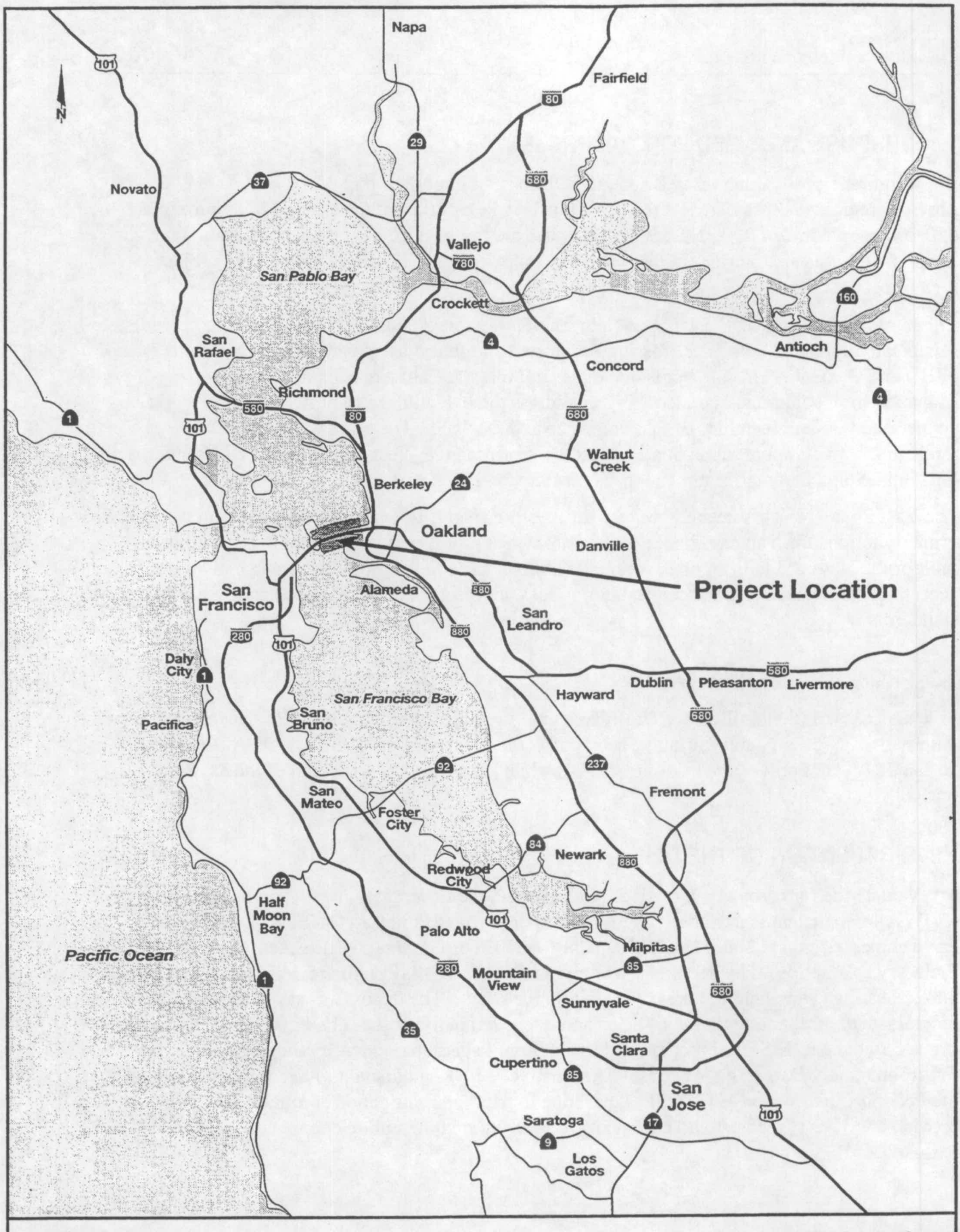
The East Span Project is needed because the existing span is not expected to withstand the ground motions from an earthquake with a 1,500-year return period on either the San Andreas fault or the Hayward fault; it does not meet "lifeline" criteria for providing emergency relief access following such an earthquake; and, it does not meet current operations and safety design standards.

1.2 PROJECT ALTERNATIVES

Five alternatives (the No-Build, Retrofit Existing Structure Alternative, and Replacement Alternatives N-2, N-6, and S-4) have been considered for the East Span Project. Alternatives N-2 and N-6 are north of the existing SFOBB while Alternative S-4 is south of the existing bridge.

1.3 CIRCULATION OF THE DEIS

To evaluate the five project alternatives, Caltrans and the Federal Highway Administration (FHWA) prepared and circulated a National Environmental Policy Act (NEPA) Draft Environmental Impact Statement (DEIS)/California Environmental Quality Act (CEQA) Statutory Exemption. The document was circulated for a 59-day public review period and four public hearings were held to take comments on the DEIS. The document was circulated to federal, state, local and regional agencies and interested individuals. The Final Environmental Impact Statement (EIS) will recommend the preferred alternative, identify the Least Environmentally Damaging Practicable Alternative (LEDPA) pursuant to Section 404(b)(1) of the Federal Clean Water Act (FCWA), describe impacts and mitigation commitments, and provide a written response to all comments received during the public comment period as well as to this DMMP.



SFOBB EAST SPAN SEISMIC SAFETY PROJECT

Scale

Kilometers 0 5 10 15 20 Kilometers

Project Location

Figure 1-1

PDQ&D 3/30/99

1.4 DREDGED MATERIAL MANAGEMENT PLAN PURPOSE AND APPROACH

This Dredged Material Management Plan (DMMP) is a technical report providing documentation of information on the reuse/disposal of dredged materials from to the East Span Project. Impacts and reuse/disposal options addressed in this report would be similar for all the build alternatives, although total dredge quantities would be less for the Retrofit Existing Structure Alternative. The N-6 Replacement Alternative is used in this DMMP to characterize the potential impacts of dredging and disposal. A construction scenario that would result in the maximum foreseeable dredge material quantities was assumed (dredging for new bridge construction and existing East Span dismantling). Differences among the alternatives in construction techniques or material quantities are noted in the text. Figure 1-2 shows the build alternatives.

The DMMP addresses the dredging process for constructing a replacement East Span and dismantling the existing East Span. It describes the estimated amount of materials to be dredged and their composition; potential methods for dredging that may be used; and gives a summary of the potential impacts of dredging that may occur. The DMMP also identifies potential sites for the reuse/disposal of the dredged material and evaluates the impacts of dredged material disposal at these locations. Project dredging activities are addressed in the context of the Long-Term Management Strategy (LTMS). The LTMS is a multi-agency guide for dredged material management decisions in the San Francisco Bay Area.

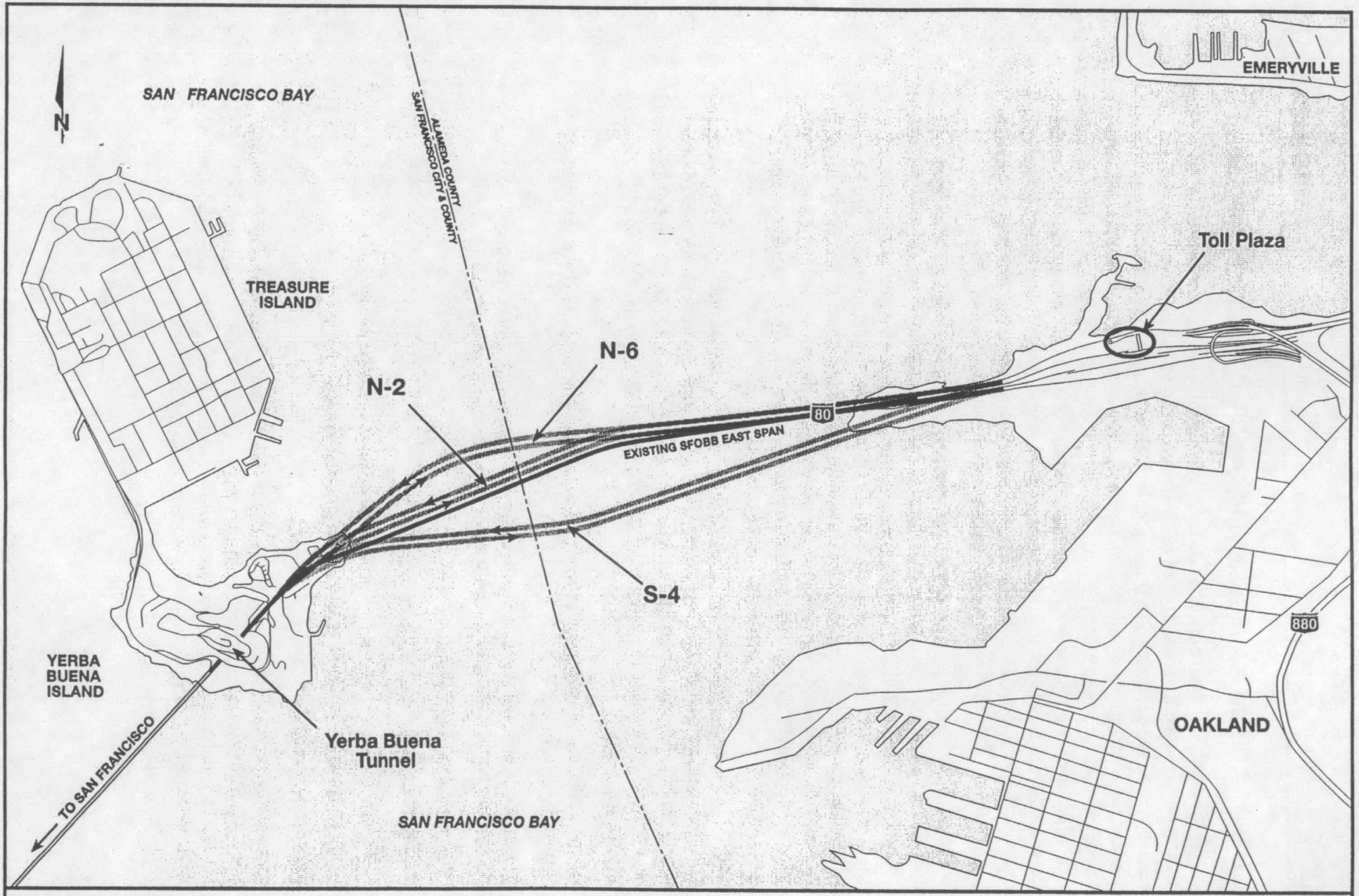
This DMMP will be circulated to the DEIS distribution list. There will be a 30-day comment period. All comments on this DMMP are due by July 21 and should be addressed to Mara Melandry, Caltrans District 4, 111 Grand Avenue (P.O. Box 23660), Oakland, California 94623-0660 or by sending e-mail to sfobb.dist04@dot.ca.gov. Comments on the DMMP will be addressed in the FEIS.

The DMMP will also be presented to the Dredged Material Management Office (DMMO) a publicly noticed meeting.

The multi-agency DMMO seeks to foster a comprehensive and consolidated approach to handling dredged material management issues. Agency members include:

- U.S. Army Corps of Engineers (COE)
- U.S. Environmental Protection Agency (EPA)
- San Francisco Bay Conservation and Development Commission (BCDC)
- San Francisco Bay Regional Water Quality Control Board (RWQCB)
- California State Lands Commission (SLC)

The California Department of Fish and Game provides advice and expertise to the DMMO. Although the DMMO issues a recommendation regarding preferred dredged material management options, individual agencies must still issue specific regulatory approvals. Permits and certifications issued by these agencies are applicable to the East Span Project.



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:27,500

0 250 500 1000 m

Project Alternatives

Figure 1-2

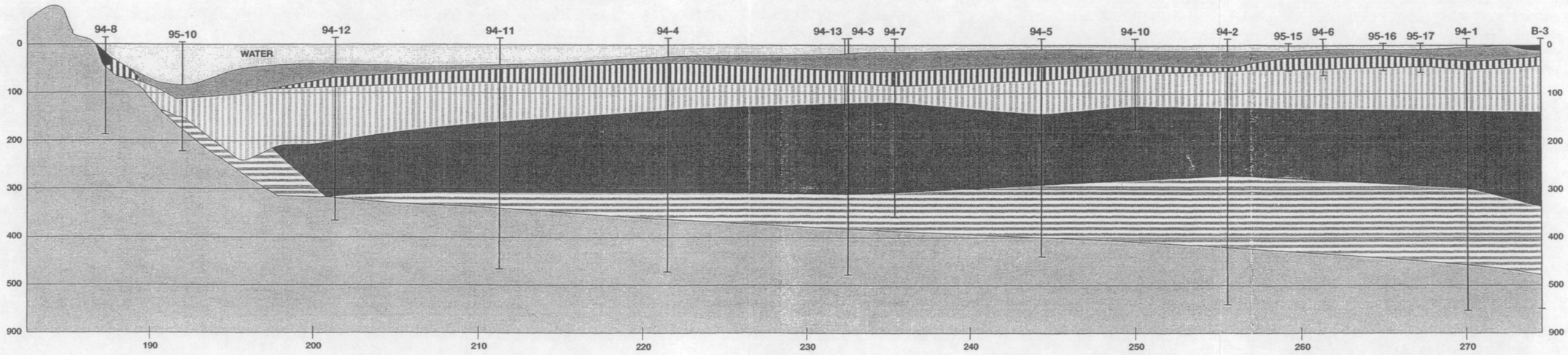
PF F-231 4/15/99

2.1 DESCRIPTION OF TYPES OF MATERIALS

The major geologic formations which underlie the Bay waters in the project area include Young Bay Mud, Merritt Sands, Yerba Buena Mud (Old Bay Mud), the upper and lower Alameda Formations, and Franciscan Bedrock (Figure 2-1). Caltrans has conducted geotechnical investigations of the area. Based on the drilling logs from these studies, the thickness of Young Bay Mud ranges from approximately 1.8 to 15 meters (6 to 50 feet) along the proposed north alignment (N-6). These Young Bay Muds consist primarily of clay, with some silt, sand, and shell fragments. Merritt Sands underlie the Young Bay Mud along much of the alignment.

Sediments encountered during dredging of the construction access and dismantling access channels are expected to consist entirely of Young Bay Muds (see Figure 2-1). Sediment removal during pier construction is expected to encounter all sediment types. Some bedrock will also be removed during pier construction.

Only finer grained materials (Bay Muds and sand) would be suitable for aquatic disposal or upland reuse. Rock, coarse gravel, or materials such as concrete, steel and other construction debris would not be suitable for aquatic disposal/upland wetland reuse and will be taken to the appropriate locations for disposal or recycling. The discussions in the following sections of this DMMP refer only to those types of sediments that are suitable for aquatic disposal, upland disposal, or upland reuse. Steel and concrete debris generated by the dismantling of the existing East Span would be recycled or disposed of upland and would not be placed within areas under the jurisdiction of the COE.



PROFILE
STATIONING INTERVAL = 1000 FEET
VERTICAL EXAGGERATION = 3
ELEVATIONS REFER TO THE MEAN
LOWER LOW WATER DATUM OF 1933 ((MLLW))

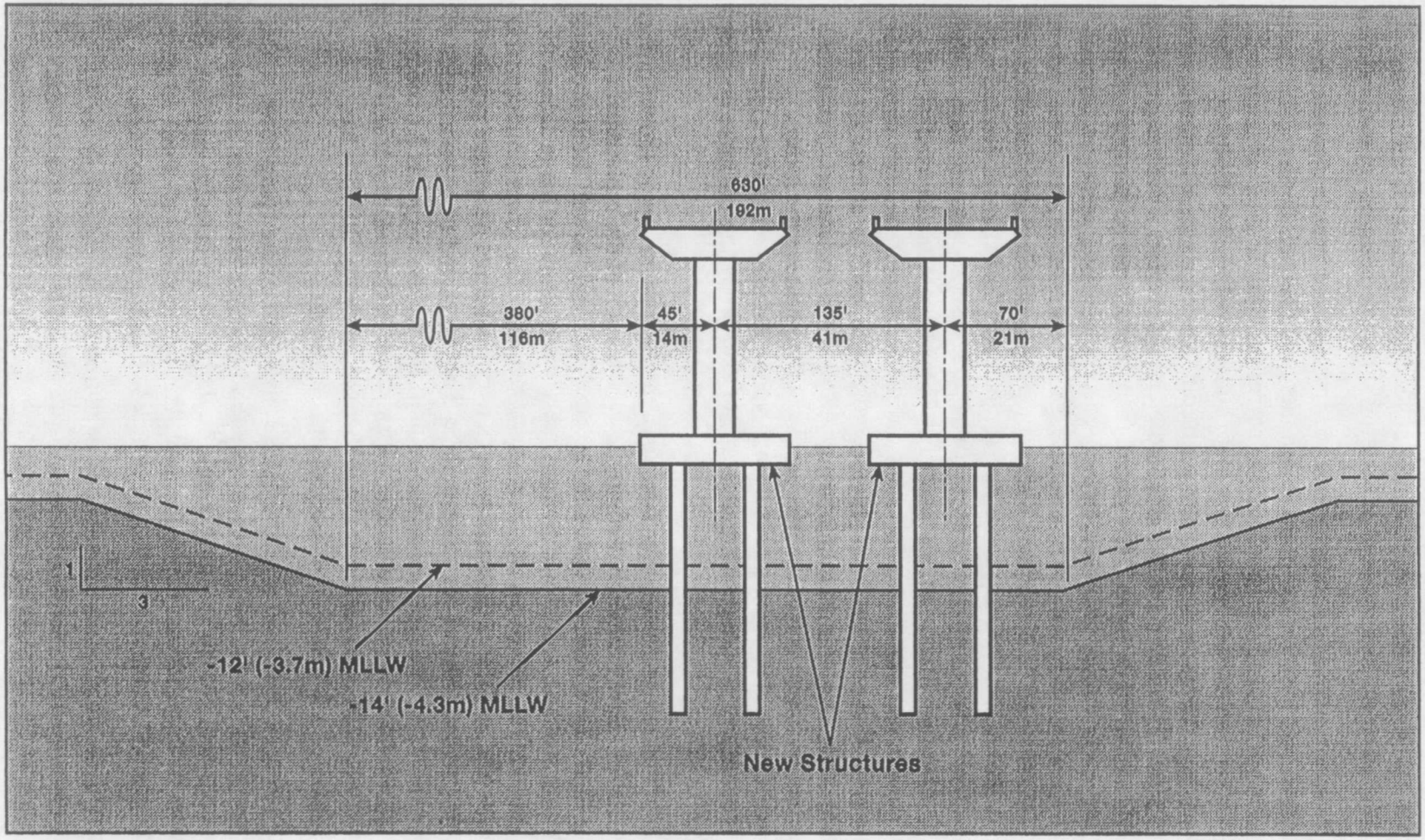
LEGEND
- FILL
- YOUNG BAY MUD
- MERRITT/POSEY/SAN ANTONIO FORMATION
- YERBA BUENA MUD (OLD BAY MUD)
- UPPER ALAMEDA FORMATION
- LOWER ALAMEDA FORMATION
- FRANCISCAN BEDROCK

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Geologic Profile of the Project Area

Figure 2-1

PBQ&D F-GP 2/16/99



View: Looking East, North Side of Replacement Alternative N-6

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

NOT TO SCALE

Dredged Construction Channel
Cross-Section

Figure 3-1

?DQ&D 4/19/99

equipment and methods can create undesirable disturbance and resuspension of sediments through the mechanical excavation and removal of the material at the dredging or excavation site.

The nearby Port of Oakland is currently dredging their harbor areas and access channels to a 12.8-meter (42-foot) depth, and the Port has plans to deepen these channels further to 15 meters (50 feet). Their dredging operations have involved cutterhead dredges for areas of cemented Merritt Sands and Bay Mud, and derrick barges that support clamshell bucket dredging. The cutterhead is a hydraulic type dredge, equipped with a rotating cutter apparatus surrounding the intake end of a suction pipe. These dredges can efficiently dig and remove a wide range of types of alluvial material and compacted deposits. The excavated materials can be pumped off-site from the actual dredging operation, up to several miles away to a handling, reuse, or disposal facility. Clamshell dredging involves the use of a bucket dredge operated from a crane, where the materials are dug and removed by dropping a bucket in an open position into the sediment. The sides or jaws of the bucket are closed to shear the material, and the bucket is hoisted up, swung over and released into a hopper barge or scow. If contaminated sediments, such as those present at the Port of Oakland are identified, an "environmental" bucket can be used which effectively seals upon closure and minimizes the release of the excavated materials during the excavation action. For areas that have not been previously dredged, such as at the East Span alignment, both of these dredge techniques might be employed by the contractors. Potentially two dredging passes might be made, where the first pass is used to remove the loose, unconsolidated materials on top. The second pass might involve the use of a sealed clamshell bucket with teeth or, if necessary, a cutterhead dredge capable of excavating the more compacted, deeper materials.

A typical cross section of the dredge channel for installation of the new bridge is shown in Figure 3-1. Figures 3-2 through 3-4 show estimated dredging limits for each of the replacement alternatives. Dredging limits have been estimated for both "upper" and "lower" limit dredging scenarios. The upper limit scenario would use dredged channels to allow for barge access for construction of all portions of the bridge located over shallow water. The lower limit scenario would use trestles, falsework, or fill as a platform from which to construct nearshore portions of the bridge. The proposed access channel for construction would be placed on the north side of the proposed bridge alternatives. The anticipated maximum draft for the barges is 3.6 meters (12 feet), but to ensure adequate clearance over potential irregularities in channel depth and to allow for some potential resettlement of materials in the channel after dredging, the EPA has recommended overdredging to a 4.3 meter (14-foot) maximum depth.

Because a derrick barge using a clamshell or sealed bucket is capable of dredging down to the 4.3-meter (14 foot) depth necessary for barge access, and this technique minimizes the amount of dredged material, it is a method that the dredging contractor might be expected to employ. Use of this method at the Port of Oakland yielded dredge materials that consisted of about 80 percent solids, and could be adequately dewatered for transport by truck within about one week.

Another option to dredging in nearshore areas might be to install trestles, falsework, or fill platforms and conduct a portion of the work from these platforms rather than from a barge. Installation of a temporary trestle, if feasible, would reduce the extent of dredging necessary at the Oakland shoreline, and might reduce some of the identified impacts to shoreline and nearshore resources such as eelgrass beds and tidal areas. This option would slightly reduce the total dredged volumes (see Figures 3-2 through 3-4 for limits of dredging and/or trestles).

This section describes the range of anticipated activities involving removal of Bay Mud and soil that construction contractors may undertake within the San Francisco Bay waters to install a new bridge and remove the existing structure. Estimated quantity and quality of the dredged material are also presented in this section.

The following construction techniques, methods, and equipment identified are based on information from other projects and industry practices. Actual construction methods and equipment used on the project would ultimately be chosen by the successful construction bidders.

3.1 PURPOSE OF DREDGING AND EXCAVATION

The purpose of the proposed dredging and excavation activities is to support both construction of the new bridge structure and dismantling of the existing bridge. Specifically, the proposed actions would:

- Excavate within the shallow areas of the east shoreline of the Bay, i.e., less than 4.3 meters (14 feet) below mean low low water (MLLW), to allow in-water access for barges and equipment that are necessary for construction of the new bridge and removal of the existing structure;
- Excavate and remove materials necessary for installation of piers, footings, and foundations for the new bridge; and
- Excavate or remove existing East Span piers, footings, and foundations during dismantling.

3.2 ACCESS DREDGING FOR CONSTRUCTION

Because the bridge involves construction in shallow water areas of the San Francisco Bay, it will be necessary to dredge a channel to allow access for the heavy equipment and materials required for construction. This is true for all bridge alternatives. The contractors will use barges to support cranes and pile driving equipment, transport construction materials, and provide above-water platforms from which to work. Since portions of the Bay within the project limits are shallow, especially near the Oakland shoreline, dredging will be required to provide adequate draft for these barges to access and work at the construction site. After construction is completed the access channel would be allowed to refill through natural sedimentation processes.

3.2.1 Construction Activities Requiring Barge Access

The draft, or depth of displacement, of the barges used will vary, but is expected to range from as shallow as 1.8 meters (6 feet) up to 3.7 meters (12 feet). A maximum depth of 4.3 meters (14 feet) has been assumed to account for overdredging that sometimes results from some types of mechanical dredging. Barge draft will ultimately depend upon the construction technique and equipment used by each of the contractors performing different tasks during construction. For example, one of the earliest stages of construction involves the driving of piles that will ultimately provide the foundation and support of the "skyway" portion of the new bridge. The majority of the skyway will be supported on 2.5-meter (8-foot) diameter piles, except nearest to the Oakland shoreline where the pile size is reduced to 1.5 meters (5 feet) in diameter. These piles will be installed by driving a steel casing to below Bay Mud and into Merritt Sand. Piles

are approximately 90 meters (300 feet) in length. The stability of the piles, and ultimately the bridge structure itself, is dependent upon the ability to properly drive and penetrate these piles into the Merritt Sands beneath the Bay. Consequently, the barges that are necessary to support a pile driver that can accomplish this task must have sufficient lifting capacity and stability to hoist the piles into place and drive them at an efficient rate. The alternative of using a greater number of smaller diameter piles, and potentially a smaller pile driver, to achieve the same foundation support for the bridge creates a greater pile cap mass, which is potentially less stable under earthquake conditions. Thus, to provide optimum performance of the bridge under the dynamic load of seismic shaking requires that relatively deep draft barges be used to support the requisite pile driving activity.

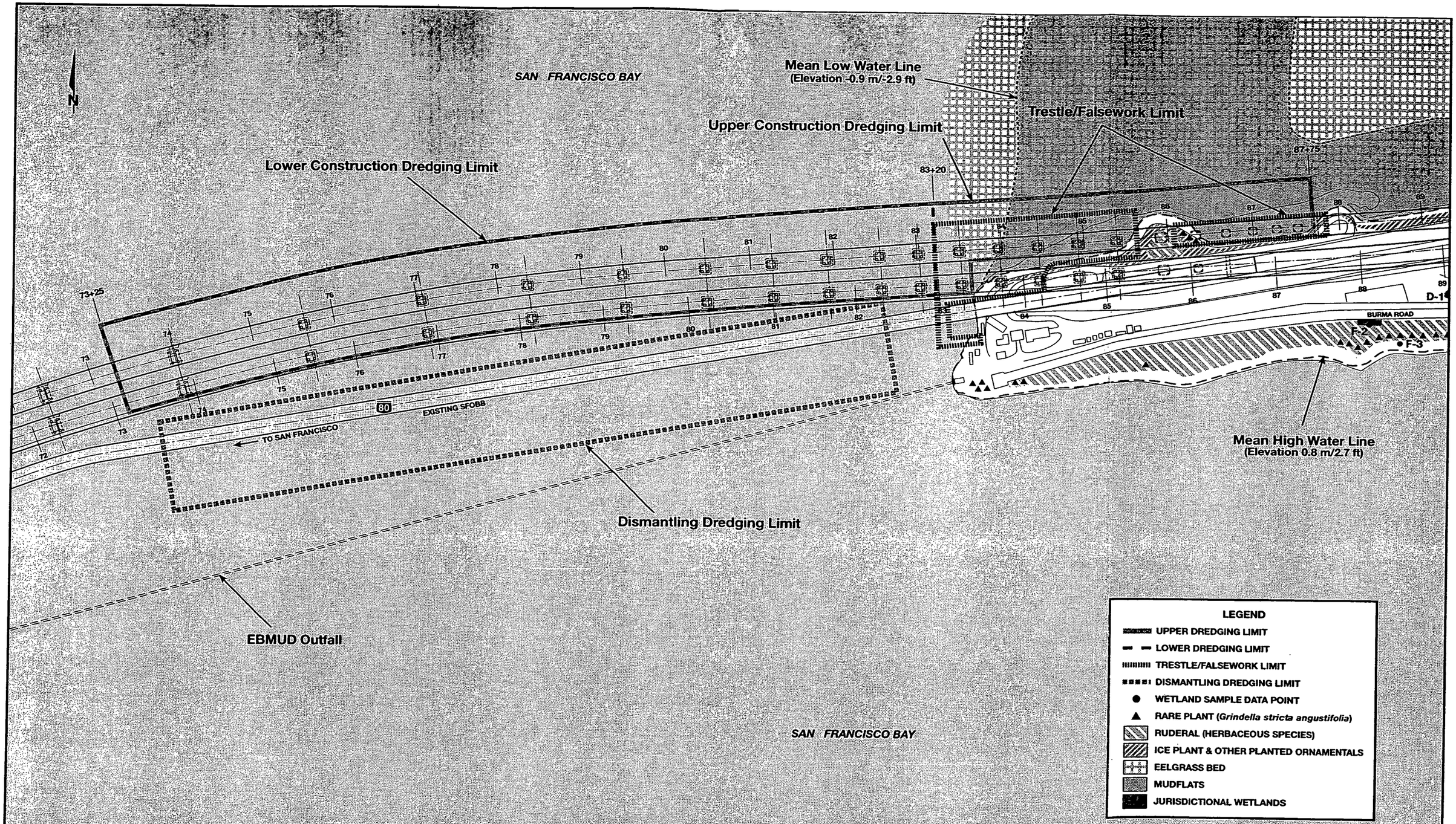
Once driven, the water within the top portion of the pile casing may be pumped and discharged into the Bay in accordance with SWPPP requirements. Techniques such as reverse circulation drilling, jetting, and air lifting may be used by the contractors to remove the "plug" of material within each of the driven piles. These methods generally involve creating a slurry of material within the hollow pile, and lifting or pumping the slurry from the pile into the drilling vessel or a barge. Alternatively, contractors working on other bridge projects have removed large diameter pile plugs by mechanical means through clamshell excavation of the pile core.

As the bridge is constructed, partially or entirely prefabricated sections of the bridge may be barged to their designated locations and then raised into place for installation. Barges would be used for these operations as work platforms to raise large segments of the bridge, and to transport materials and equipment to and from the work sites.

3.2.2 Dredging Techniques and Options

Dredging techniques vary considerably in the types of equipment and methods employed (LTMS 1998, U.S. Army Corps of Engineers 1983). However, dredging techniques can be generally categorized as either hydraulic or mechanical. *Hydraulic* methods involve the removal of loosely compacted materials through suction techniques. Loosely compacted materials that can be removed by hydraulic methods would typically be fine grained sediments that have not yet naturally settled, or have been loosened and entrained in the water column by mechanical or hydraulic means. Hydraulic dredging may involve the use of equipment and methods referred to as cutterheads, dustpans, hoppers, hydraulic pipelines, plain suction, and sidecasters. Hydraulic dredging techniques can have the general advantage of minimizing disturbance and resuspension of sediments at the dredging site. However, this technique can also involve entrainment of high volumes of water many times the quantity of the sediments removed. The generated water and sediment must ultimately be discharged, either at the dredging site or at an approved dewatering or disposal location.

Mechanical dredging typically involves the removal of more compacted materials by equipment such as clamshell, dipper, or ladder dredges. These techniques involve removing sediments by dislodging and excavating the material, and then raising it to the surface and discharging it into a barge or scow. Equipment may involve backhoes, buckets (including different types referred to as clamshell, orange-peel, dragline, bucket ladder, bucket wheel, and dipper dredges). Mechanical dredging has the advantage of minimizing disposal quantities because little additional water is entrained by the equipment. Its disadvantages are that some types of



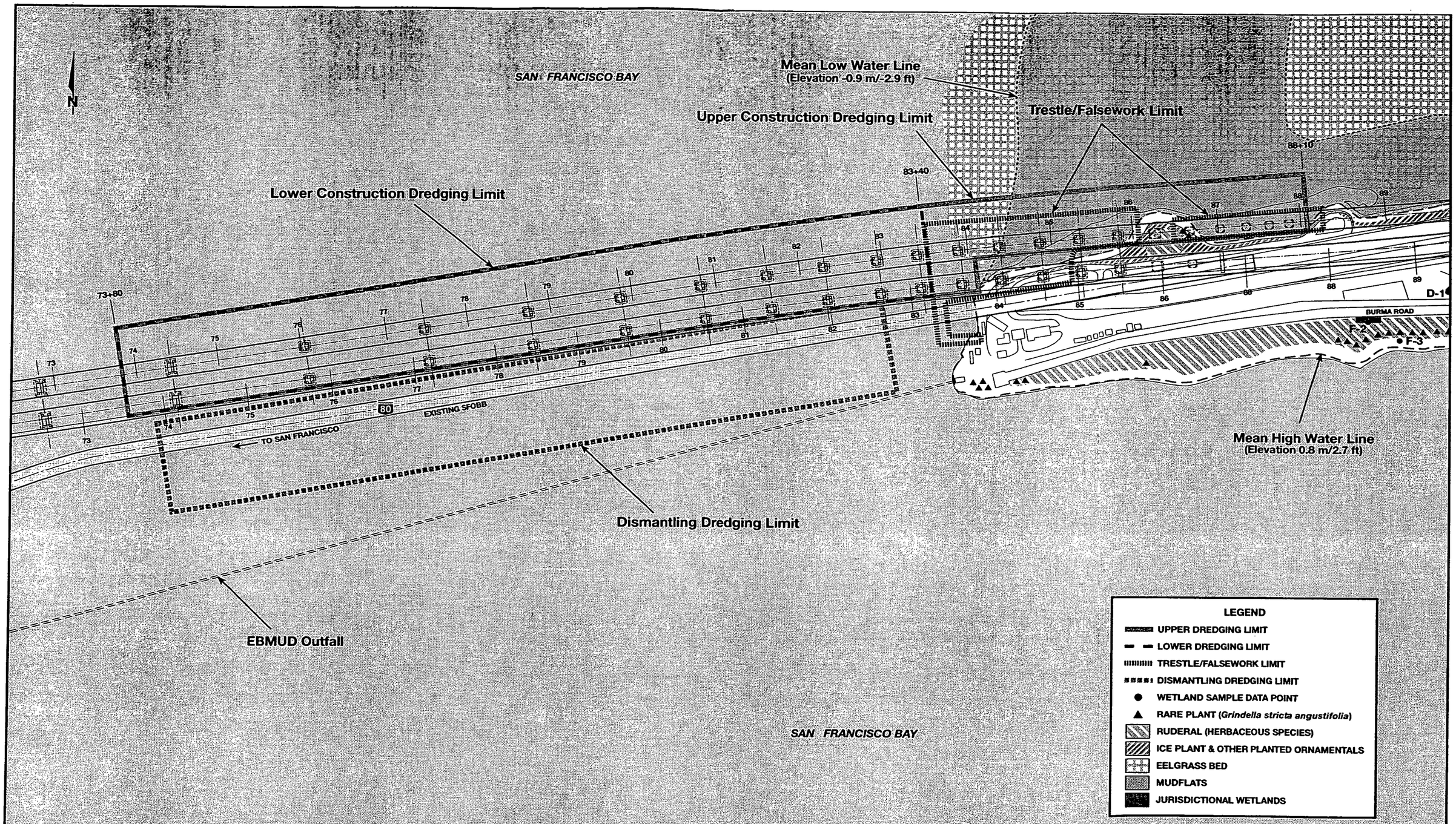
SFOBB EAST SPAN SEISMIC SAFETY PROJECT

GRAPHIC SCALE 1:6,000
0 50 100 150 m

Construction Dredging Limits- Alternative N-2

Figure 3-2

PDQ&D BROAK 6/10/99



SFOBB EAST SPAN SEISMIC SAFETY PROJECT

GRAPHIC SCALE 1:6,000

0 50 100 150 m

Construction Dredging Limits- Alternative N-6

Figure 3-3

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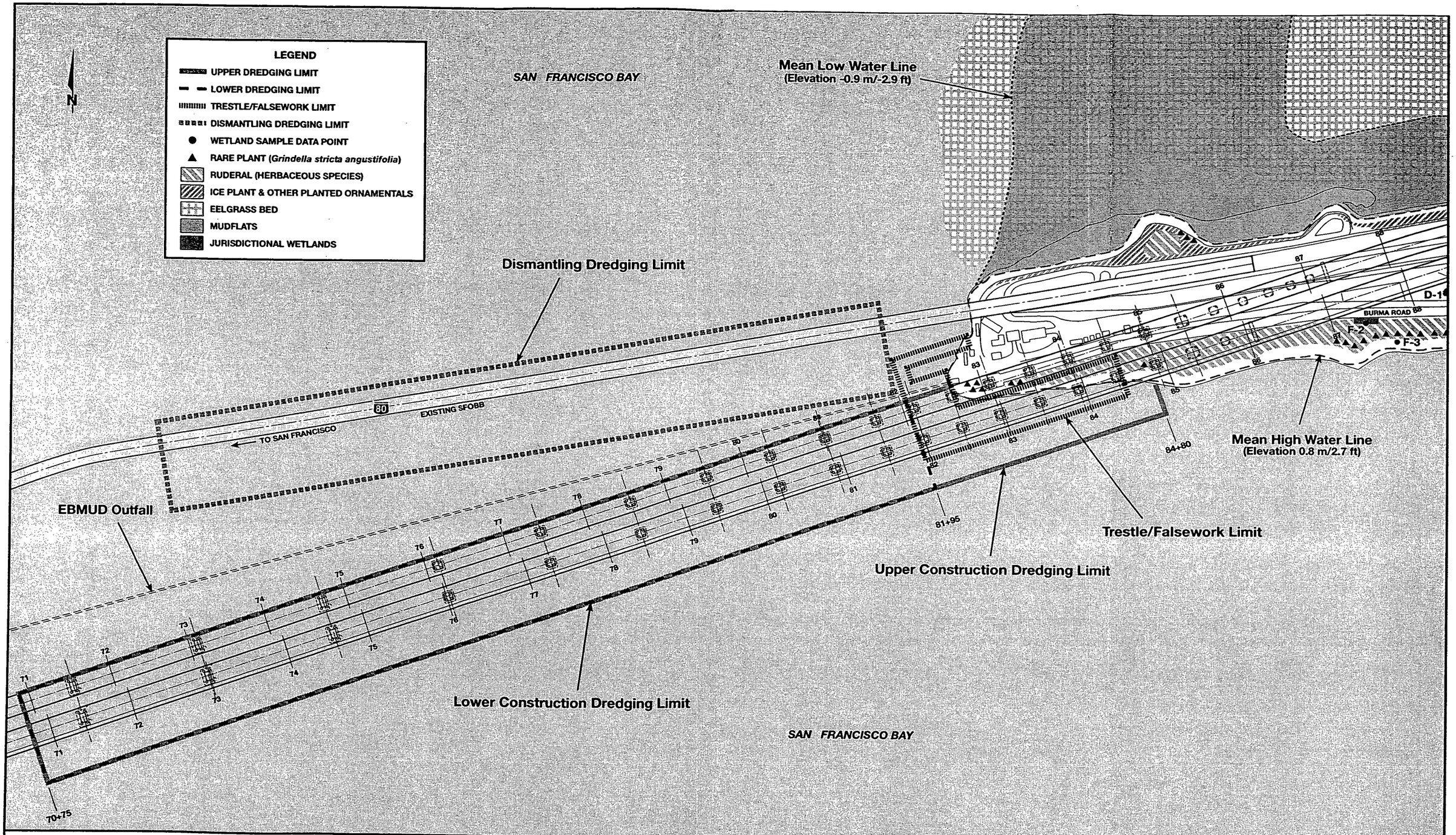

SFOBB EAST SPAN SEISMIC SAFETY PROJECT

GRAPHIC SCALE 1:6,000

0 50 100 150 m

Construction Dredging Limits-Alternative S-4

Figure 3-4

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However, temporary disturbance to these areas would still occur since the trestle would have to be both installed and removed by the contractor. Use of trestles would be dependent upon whether a contractor could install necessary bridge piers from temporary trestles or fill platforms.

3.3 ACCESS DREDGING FOR DISMANTLING

After the new bridge is constructed, the existing bridge will be dismantled. The techniques for dismantling the existing East Span involve separating and removing large, essentially intact pieces of the span. The pieces will be dismantled and lowered onto large barges, then transported to an upland site for further dismantling and appropriate disposal. Similar to construction of the new span, areas near the Oakland Touchdown are too shallow to accommodate the large barges needed to complete the dismantling process; thus an access channel will need to be dredged. Figure 3-5 shows the cross section of the area that will be dredged for barge access. A plan view of the access channel was shown in Figures 3-2, 3-3, and 3-4 (the channel is the same for all alternatives). This channel will be approximately half as wide as the channel for construction access, but the depth will be similar at 4.3 meters (14 feet). Dredging for this access channel will use the same techniques described in Section 3.2.2 for construction barge access. As with the access channel for construction, the dismantling access channel will be allowed to refill through natural sedimentation.

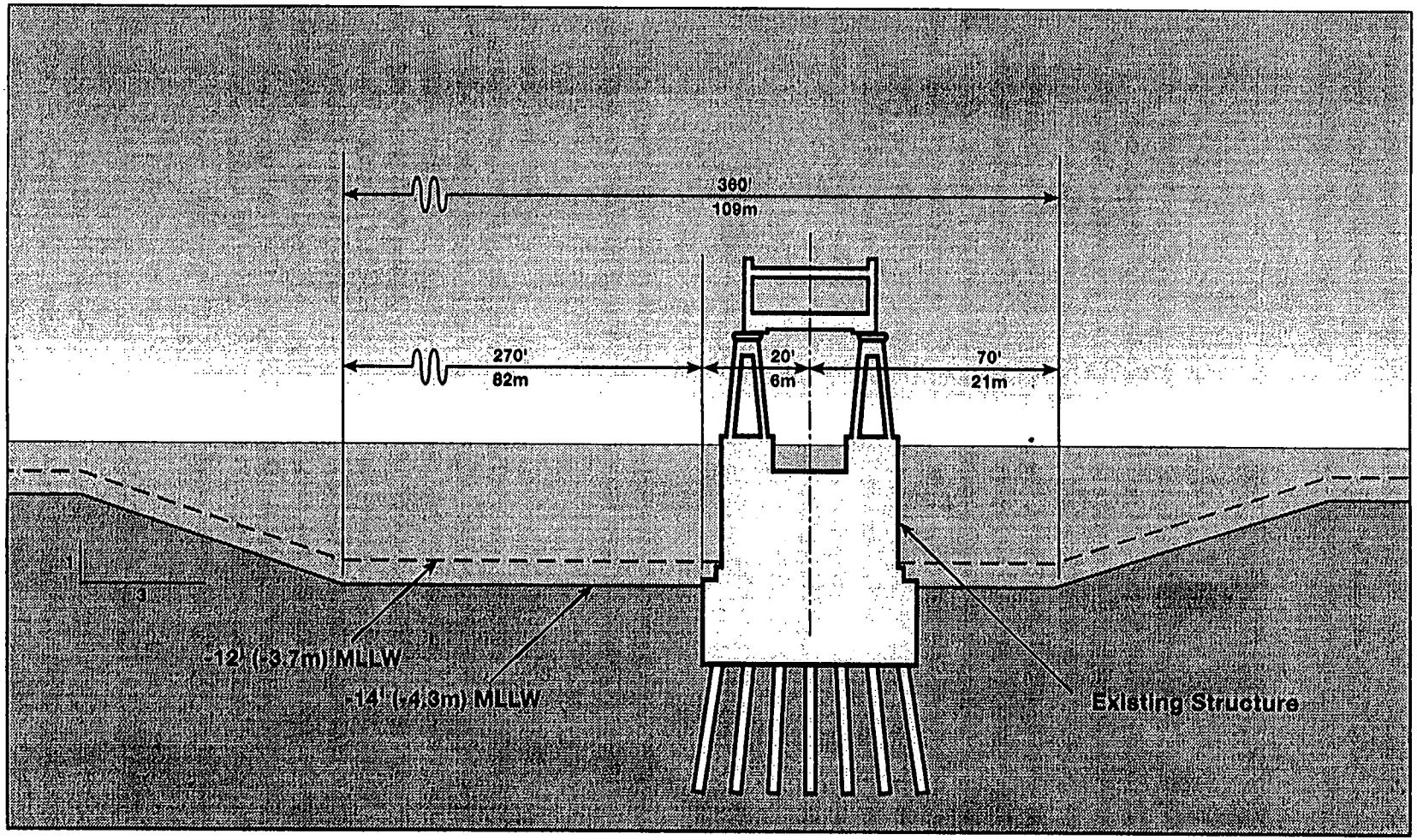
3.4 SEDIMENT EXCAVATION FOR REMOVAL OF EXISTING BRIDGE FOUNDATIONS

Once the existing bridge superstructure is removed, the bridge foundations will be removed. This will require excavation of sediments around the footings. Footing locations are shown in Figure 3-6.

To accomplish this, coffer dams will be placed around the footings. A coffer dam is a temporary enclosure which can be dewatered, allowing construction or installation of structures around the foundation footings. Overlying water may be discharged to the Bay in accordance with SWPPP requirements. The sediment would then be removed in a similar manner to sediment removal for pile construction for the new span. Techniques such as reverse circulation drilling, jetting, and air lifting may be used by the contractors to remove the material around the footings. These methods generally involve creating a slurry of material within the hollow pile, and lifting or pumping the slurry from the pile into the drilling vessel or a barge. Alternatively, the material may be removed by mechanical means through clamshell excavation. The footings would then be removed and existing piles would be cut off below the mudline. Once the coffer dams are removed, natural sedimentation will fill the areas surrounding the cut-off piles.

3.5 QUALITY OF MATERIAL TO BE DREDGED

Testing sediments to be dredged and excavated for the East Span Project is not yet complete. A Sampling and Analysis Plan (SAP) for sediment testing has been prepared (see Caltrans 1999) and approved by the DMMO. Caltrans is currently conducting the testing. Sediments were tested in 1996 for retrofit of the existing bridge and, given the close proximity to the replacement



View: Looking West, South Side of Existing SFOBB

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NOT TO SCALE

Dredged Dismantling Channel Cross-Section

Figure 3-5

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N

ALAMEDA COUNTY
SAN FRANCISCO CITY & COUNTY

N-6

80

E-2 E-3 E-4 E-5 E-6 E-7 E-8 E-9 E-10 E-11 E-12 E-13 E-14 E-15 E-16 E-17 E-18 E-19 E-20 E-21 E-22 E-23

EXISTING SFOBB

EBMUD Outfall

YERBA BUENA ISLAND

SAN FRANCISCO BAY

OAKLAND

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

GRAPHIC SCALE 1:12,000

0 100 200 300 400 500 1000 m

Existing Bridge Footing Locations

Figure 3-6

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alternatives, the results of this testing can provide some insight as to what might be expected when sediment testing for the new span is completed.

Sediment samples were collected in July 1996 from the upper 1.8 meters (six feet) of sediment around each of the East Span piers, as required by the DMMO. Laboratory characterization included physical and chemical analysis and both suspended and solid phase bioassay tests. Results of the physical testing showed that the sediments were primarily sand with lesser and approximately equal percentages of silt and clay. Although chemical analyses detected some contaminants, suspended phase and solid phase bioassay tests indicated that most of the sediments were Suitable for Unconfined Aquatic Disposal (SUAD) and would not cause adverse effects to marine biota. Of the approximately 199,000 m^3 (260,000 cy) that were to be dredged for the SFOBB Retrofit Project, approximately 190,000 m^3 (249,000 cy) were suitable for aquatic disposal. The remaining 9,000 m^3 (11,000 cy) were Not Suitable for Unconfined Aquatic Disposal (NUAD) and would have been disposed of at an appropriate upland site. The volume of material found to be NUAD was primarily due to physical characteristics (much of the material was upland soil) and not due to chemical contamination.

Based on this testing, and the percentages of suitable versus unsuitable material identified, estimates of suitable vs. unsuitable material were made for purposes of this DMMP. Actual amounts of suitable and unsuitable materials may be different, based on testing of the sediments along the specific alignment of the new span. Suitability refers to the chemical, biological, and physical properties of the sediment.

According to the LTMS Sediment Classification Framework (LTMS 1998), SUAD material is chemically and biologically suitable for any reuse option and can be placed in a wide variety of locations, including in-Bay, ocean, construction, landfills, and can be used to create wetlands. NUAD materials may not be biologically and/or chemically suitable for use in all environments. There are three classes of NUAD material. Category 1 material can be used in wetland creation as "non-cover" material if SUAD materials are used to cap the NUAD material. NUAD Category 2 material requires additional analyses and may or may not be suitable as wetland non-cover material. NUAD Category 3 material generally must be taken to appropriate landfills. For this document, it is assumed that any NUAD material would be taken to a landfill.

3.6 SUMMARY OF DREDGED MATERIAL VOLUMES

Tables 3-1 and 3-2 present a summary of dredged material volumes, according to activity, for the three Replacement Alternatives. The estimated dredged quantities for the N-2 and N-6 Alternatives are the same. The S-4 Alternative would result in slightly higher volumes than N-2/N-6 under the "lower limit" scenario, while the "upper limit" scenario would dredge approximately 100,000 m^3 less material than N-2/N-6. Less volume would be dredged for the S-4 Alternative upper limit scenario because water depths in the nearshore areas are somewhat greater to the south of the bridge; thus less material would need to be dredged to achieve the 4.3 meter (14 foot) working depth for the construction barges.

Table 3-1

Estimated Dredged Quantities for the N-2 and N-6 Alternatives

Cubic Meters (Cubic Yards)[1]

Dredging Area	Dredged Material to Construct New Piers and Footings		Dredged Material from Construction Access to Construct New Bridge		Dredged Material from Construction Access to Dismantle Existing Bridge	Dredged Material from Removal of Existing Bridge Piers to Mudline	Total
	SUAD[2]	NUAD[3]	SUAD	NUAD	(SUAD)	(SUAD)	
With Trestle/ Falsework (lower limit)	32,000 (42,000)	6,000 (7,000)	104,000 (135,000)	0	116,000 (152,000)	5,000 (6,000)	Total lower limit volume: 262,000 (343,000)
Without Trestle/ Falsework (upper limit)	32,000 (42,000)	3,000 (3,000)	173,000 (226,000)	109,000 (142,000)	116,000 (152,000)	16,000 (21,000)	Total upper limit volume: 448,000 (585,000)

Source: Parsons Brinckerhoff, January 26, 1999.

1. Figures rounded to nearest thousand.
2. SUAD = Suitable for Unconfined Aquatic Disposal.
3. NUAD = Not suitable for Unconfined Aquatic Disposal. (Estimated based on existing sediment data collected in 1996 for the retrofit project.)

Table 3-2

Estimated Dredged Quantities for the S-4 Alternative

Cubic Meters (Cubic Yards)[1]

DREDGE QUANTITIES							
Dredging Area	**Dredged Material to Construct New Piers and Footings**		**Dredge Material from Construction Access to Construct New Bridge**		**Dredge Material from Construction Access to Dismantle Existing Bridge**	**Dredge Material from Removal of Existing Bridge Piers to Mudline**	**Total**
	SUAD	NUAD	SUAD	NUAD			
With Trestle/Falsework							Total Lower Limit Volume
(Lower Limit)	32,000 (42,000)	6,000 (7,000)	111,000 (145,000)		116,000 (154,000)	5,000 (6,000)	269,000 (352,000)
Without Trestle/Falsework							Total Upper Limit Volume
(Upper Limit)	32,000 (42,000)	3,000 (3,000)	169,000 (221,000)	0	116,000 (154,000)	16,000 (21,000)	335,000 (438,000)

Source: Parsons Brinckerhoff, March 12, 1999

1 Figures rounded to nearest thousand.

2. SUAD = Suitable for Unconfined Aquatic Disposal

3. NUAD = Not Suitable for Unconfined Aquatic Disposal (Estimated based on existing sediment data collected in 1996 for the retrofit project).

The dredging footprints for new piers, footings and the access channel are shown on Figures 3-2, 3-3 and 3-4. It is assumed that the channel would extend from the point where the depth of the Bay drops below 4.2 meters (14 feet) to where the bridge is almost entirely on land at the Oakland shoreline. Use of a trestle, falsework, or fill extending west from the Oakland Touchdown area would provide an above water area from which to construct this segment of the bridge, and would minimize the amount of dredging needed as shown on Figures 3-2, 3-3, and 3-4.

Access dredging volumes for removal of the existing piers and bridge structure are also listed in Tables 3-1 and 3-2, and Appendix A and footprints are shown on Figures 3-2, 3-3, and 3-4.

Dredging of these volumes will not occur at one specific time in the project. Rather, dredging and dredge material reuse/disposal will occur throughout the project schedule. Most of the volumes, however, will be generated during two periods: 1) dredging of the construction access channel, near the beginning of the project and 2) dredging of the access channel to dismantle the existing bridge toward the end of the project. Figures 3-7 and 3-8 show anticipated monthly volumes over the course of new bridge construction and dismantling of the existing bridge.

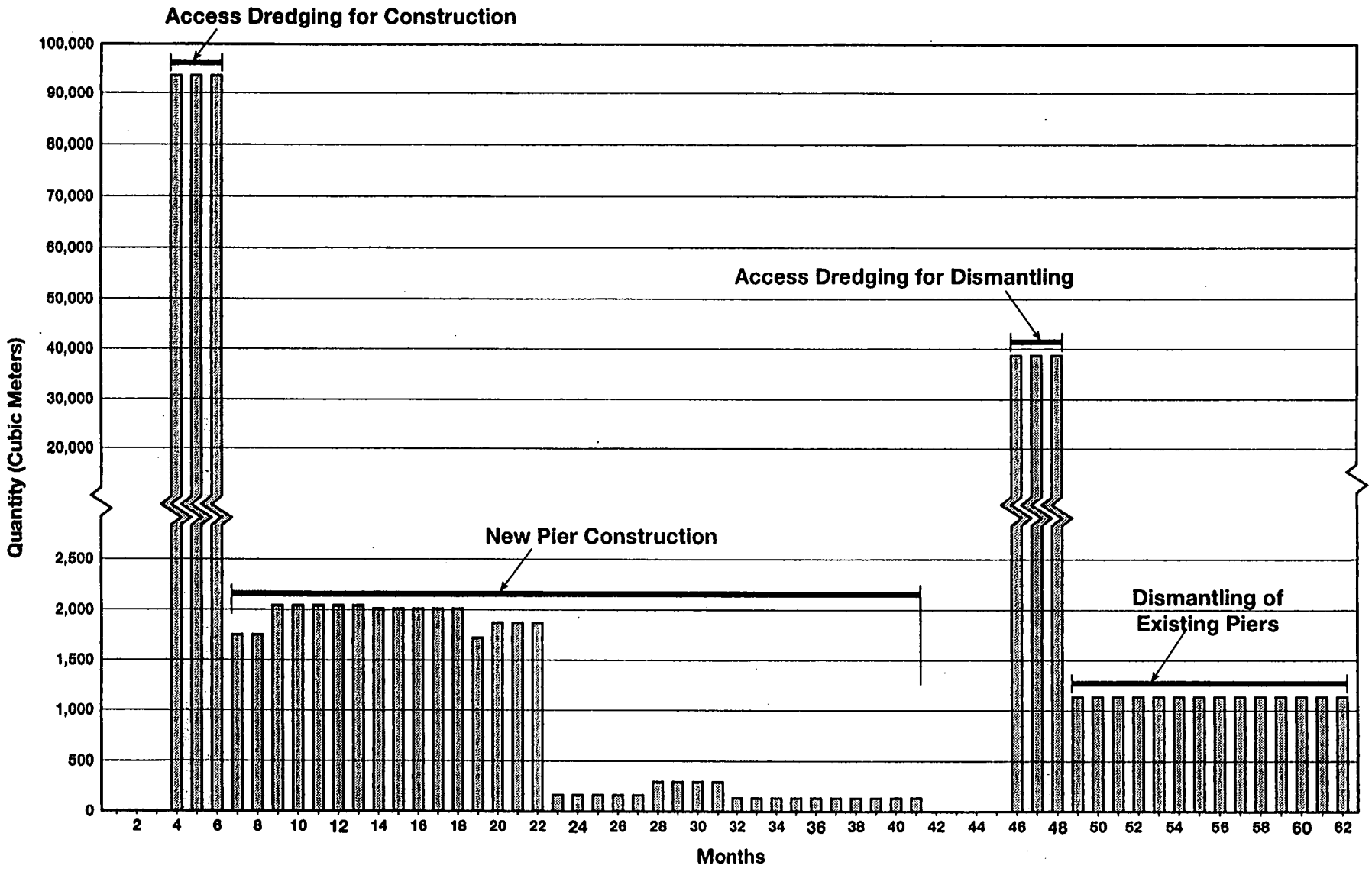
For the N-2 and N-6 Alternatives (Figure 3-7) total of approximately 281,000 m^3 (366,000 cy) will be dredged during months 4 through 6 for construction barge access (upper limit dredging scenario). Volumes will drop between months 7 to 22 to about 2,000 m^3 (2,600 cy) per month once sediment removal for westbound pier construction begins. This volume would amount to approximately one barge trip per month to an approved reuse/disposal site. Volumes would drop even further to approximately 150 to 300 m^3 (200 to 400 cy) per month during construction of eastbound piers. No sediment removal is anticipated between months 42 and 45.

Dredge volumes for the S-4 Alternative are similar to N-2 and N-6 for most of the project, except that quantities for the construction access dredging are lower near the beginning of the project (Figure 3-8).

As dismantling of the existing bridge begins, approximately 116,000 m^3 (152,000 cy) will be dredged for creation of the barge access channel (months 46 to 48). Volumes then drop to approximately 1,200 m^3 (1,600 cy) per month, representing sediment dredged to remove existing bridge footings and cutting the existing piles off at or below the mudline.

3.7 DREDGING IMPACTS AND MITIGATION

This section discusses potential impacts associated with dredging operations (biological and water quality issues) during construction of the East Span. Numerous studies have been conducted concerning the general aquatic impacts of dredging operations in San Francisco Bay. Both the recent LTMS EIS (LTMS 1998) and the Port of Oakland 50-foot Dredging Project EIS (Port of Oakland 1998) have information on the potential impacts of dredging. Information utilized in this section was obtained primarily from those documents. The dredging impacts described in this section are generally similar for all Replacement Alternatives. Alternative-specific impacts are discussed when differences occur.



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Estimated Dredge Quantities per Month (Upper Limit Scenario) for Alternatives N-2 and N-6

Figure 3-7

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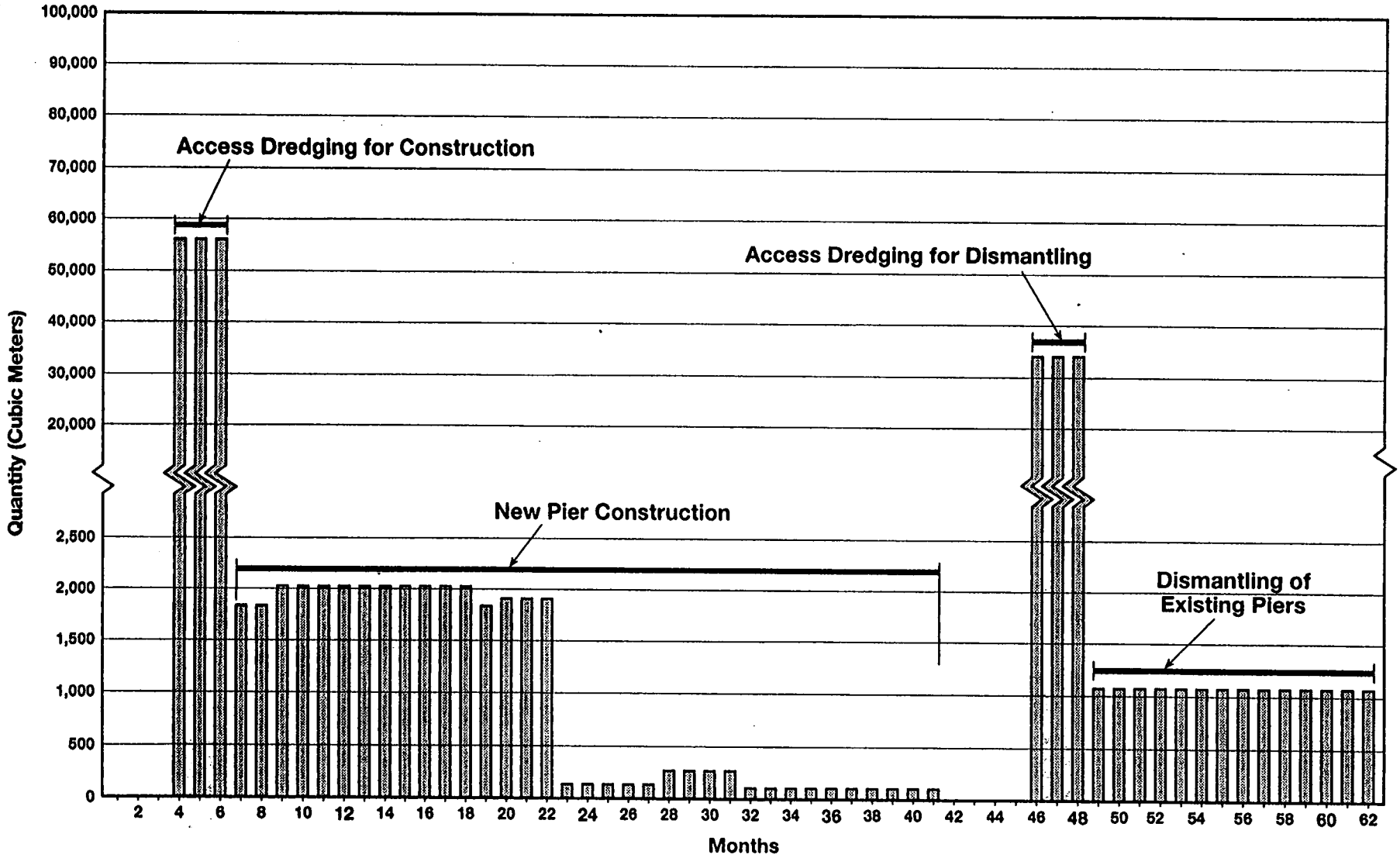

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Estimated Dredge Quantities per Month
(Upper Limit Scenario) for Alternative S-4

Figure 3-8

PB -DQ 6/15/99

It should be noted that this DMMP, and thus the discussion in this section, focuses primarily on impacts related to dredging and reuse/disposal of dredged materials. Other impacts, such as those that could occur as a result of the construction and use of trestles, falsework, and fill during construction are fully discussed in the body of the FEIS. Dredging impacts presented here will also be summarized in Section 4.14.9--Construction Excavation and Dredging in the FEIS.

Biological Resources

General Impacts. Potential impacts to biological resources resulting from dredging operations are related to increases in water column turbidity, physical disturbance, alteration or loss of habitat, and potential releases of contaminants associated with the sediments.

The Port of Oakland evaluated turbidity plumes associated with clamshell dredging operations for its 50-foot deepening project. The results indicated that increases in turbidity are expected to be localized with the most concentrated portion of the plume located near the bottom and with decreasing concentrations nearer the surface. The lateral extent of a turbidity plume during dredging for the SFOBB project will depend on the tide, currents, and wind conditions during the dredging activities.

Increased turbidity levels can result in reduced light penetration in the water column. Studies conducted for the Port of Oakland (Port of Oakland 1998) showed that light transmissivity in a 13-meter (42-foot) water column decreases approximately 5 percent (from 40 to 35 percent transmissivity) in near-surface waters while transmissivity near the bottom may decrease to only 5 percent.

Turbidity plumes are expected to dissipate quickly after dredging activities are completed. Sand will settle very rapidly, in a matter of minutes. Silts are expected to settle at approximately 1.2 meters (4 feet) per day and would be expected to settle in 1 to 3 days given the anticipated depths for the East Span Project. Very fine clay particles could remain suspended in the water column . for longer periods of time.

Physical disturbances, including the use of dredging barges, tender vessels, etc. could disturb fish, birds, and mammals, due to the noise and movement generated by the activities. It is anticipated that the disturbance will cause animals to avoid the area during dredging activities.

Habitat would be altered in the area due to physical removal of sediments, primarily from the access channels. This would affect portions of existing eelgrass beds, mudflats, and subtidal areas in the vicinity. In subtidal areas, habitat would be deepened, as necessary, to 4.3 meters (14 feet). In nearshore intertidal mudflat areas, a channel would be created, changing the habitat type from intertidal to shallow subtidal habitat, and probably resulting in the removal of eelgrass. This would occur under the "upper limit" dredging option, if no trestles, falsework, or fill are used nearshore.

Sediments along the proposed alignment are being tested to determine chemical constituents and toxicity. Most sediments tested for the SFOBB Retrofit Project, which may be indicative of the sediment conditions for the replacement alternatives, were relatively clean and considered Suitable for Unconfined Aquatic Disposal (SUAD) (see Section 3.7).

Plankton. As discussed above, increased turbidity can result in decreased light penetration. This can in turn reduce phytoplankton productivity. This is not expected to be a common occurrence during East Span Project dredging. Most plankton productivity occurs in near surface waters, and studies for the Port of Oakland have shown that the most concentrated portion of the turbidity plume would be near the bottom. The plume is expected to settle rapidly following activities in a given area. Phytoplankton also mature very rapidly, and blooms of new plankton communities could occur every few days (Port of Oakland 1998).

Though results of the sediment testing are not yet available, toxic metals and organic compounds could be released into the water column. If this occurs, exposure to the plankton community is expected to be limited, since most chemicals would be attached to sediment particles and the turbidity plume is expected to be most concentrated near the bottom. Much of the sediment tested for the retrofit of the existing East Span did not exhibit toxicity.

Benthos. Impacts to benthic (bottom dwelling) organisms include the removal of existing benthic organisms in areas to be dredged, increased turbidity, potential burial of organisms in areas adjacent to the dredged area, and potential release of toxic chemicals associated with the sediments.

Material to be removed for construction and dismantling access channels is expected to be Young Bay Mud (see Section 2) since these channels are relatively shallow (3.6 to 4.3 meters or 12 to 14 feet deep). These areas are expected to recolonize rapidly. If dredging for access channels exposes the Merritt Sand layer, recolonization would likely not begin until silty sediments settle over the exposed sands. Disturbance of the benthic community is not considered to be significant given the extent of existing shallow soft-bottom habitat in the area, relative to the area to be deepened for access channels. Since the access channels are temporary features, they will not continue to be dredged and disturbed after bridge construction is complete.

Fish. Increased turbidity levels may adversely affect dissolved oxygen levels in the water and oxygen uptake by fish in the immediate vicinity of the plume due to clogged or lacerated gills. Studies cited by the Port of Oakland indicated that juvenile Chinook salmon *(Oncorhynchus tshawytscha)* showed damage to the gill tissues after exposure to suspended solids concentrations of 1,547 mg/L for 96 hours. Because fish tend to avoid areas of high turbidity and return to them when concentrations of solids are lower, impacts are expected to be minimal.

Increased turbidity and sedimentation could adversely affect Pacific herring (*Clupea harengus*), a commercially important species which spawns in the Bay. The herring attach their eggs to eelgrass which exists in the area. If dredging occurs during spawning season (December through February) eggs attached to the eelgrass could be impacted. The use of silt curtains while dredging will reduce the impacts on eelgrass adjacent to the dredging area.

Underwater noise generated by dredging activities may also drive fish from the immediate vicinity. It is expected that fish would return when activity ceases.

Birds. A number of bird species inhabit the area and were described fully in the EIS and the Natural Environment Study. Increased turbidity and disturbances from dredging equipment during dredging activities could reduce foraging success of these birds in the immediate area. An increase in turbidity can reduce foraging success by reducing visibility of prey (e.g., fish) in the area of the plume. Since birds are highly mobile and forage over large areas, a temporary

decrease in visibility on a localized area is not expected to have great impacts considering the total foraging area for the birds. It is also expected that fish will also avoid the immediate vicinity of the plume and it is likely that the birds would follow the prey to nearby areas.

Special Status Species. Special status species described in the EIS include the American peregrine falcon (*Falco peregrinus anatum*), double-crested cormorant (*Phalacrocorax auritus*), Chinook salmon (winter, fall and spring-run), steelhead (*Oncorhynchus mykiss*), green sturgeon (*Acipenser medirostris*), longfin smelt (*Spirinchus thaleichthys*), Pacific herring, harbor seal (*Phoca vitulina*), and California sea lion (*Zalophus californicus*).

Impacts to peregrine falcon and double-crested cormorant are primarily related to the construction and dismantling of the bridge itself. Dredging activities are not expected to seriously impact these species.

Chinook salmon, steelhead, green sturgeon, and longfin smelt may occur in the area. Localized increases in turbidity might reduce foraging success and other impacts described above for all fish. These species are expected to avoid the turbidity plume, and migration to and from spawning areas in the Bay/Delta region would not be affected. As described above, Pacific herring could be affected by increased turbidity due to sedimentation of eelgrass beds which the herring use for spawning.

Marine mammals such as the harbor seal and California sea lion may occasionally forage in the area; however, they range widely and would be expected to avoid the turbidity plume and activities during dredging operations.

Special Aquatic Sites. Special aquatic sites in the project area that would be affected by dredging include eelgrass beds and mudflats. Impacts to special aquatic sites as a result of dredging would only occur under the "upper limit" dredging scenario for Alternatives N-2 and N-6. Dredging would not occur in special aquatic sites under the "lower limit" dredging scenarios, however impacts to special aquatic sites could still occur due to construction of trestles, falsework, and/or fill.

Eelgrass (*Zostera marina*) beds are known to occur in shallow waters, less than 2 meters deep (6.56 feet), within the project study area. Eelgrass beds were observed on the north side of the Oakland Touchdown extending to depths ranging from about 1 to 1.5 meters (3.5 to 5.0 feet) (See Figures 3-2 through 3-4). Eelgrass beds in this area are patchy, occurring within 3 to 5 meters (10 to 15 feet) of each other. Individual patches of eelgrass vary from 1.5 to 4 meters (5 to 12 feet) in diameter. The eelgrass bed near the shore of the Oakland Touchdown appears to be young which suggests that the bed may be increasing in size and density. Eelgrass beds are highly productive habitats for numerous species of fish including Pacific herring which use eelgrass as spawning habitat.

Dredging for the construction of the access channel ("upper limit" dredging scenario) for Replacement Alternatives N-2 and N-6 may result in the loss of 0.57 hectare (1.4 acres) of eelgrass beds near the Oakland Touchdown (Figures 3-2 and 3-3). Under the "lower limit" dredging scenario, no eelgrass beds would be lost due to dredging, however, use of trestles, falsework, or fill in the nearshore area would result in the loss of 0.32 hectares (0.8 acres) of eelgrass beds. As noted above, eelgrass in this area is not dense so these numbers do not necessarily indicate the amount of eelgrass lost due to dredging or trestle construction.

The Southern Replacement Alternative (S-4) would result in the loss of 0.18 hectare (0.46 acre) of eelgrass near Yerba Buena Island. Eelgrass disturbance on the S-4 Alternative would result from construction of trestles, but not dredging per se. No eelgrass would be affected by the S-4 Alternative on the Oakland Touchdown due to dredging or trestle construction (Figure 3-4).

Eelgrass in the immediate vicinity of dredging operations that is not physically removed may be adversely affected by turbidity and sedimentation. Physical controls such as silt curtains may be used to control sedimentation in adjacent areas. Mitigation measures for losses of eelgrass are proposed and described in the following section entitled "Mitigation Cited in the EIS".

Mudflats that may be impacted by dredging occur along the north side of the Oakland Touchdown (see Figures 3-2 through 3-4). Mudflats also occur along the southeast side of Yerba Buena Island although these would not be affected by dredging. Mudflats provide valuable feeding, bathing, and roosting habitat for a variety of shorebirds.

Replacement Alternatives N-2 and N-6 would result in the removal of 2.3 hectares (5.7 acres) of mudflat near the Oakland Touchdown due to dredging for the construction access channel (Figures 3-2, 3-3). It should be noted that eelgrass also occurs in the intertidal mudfalt area, thus the total area of these habitat types is "double-counted" in the estimates in this section. Under the "lower limit" dredging scenario, trestles, falsework, or fill would cover 0.55 hectares (1.4 acres) of mudflat. This mudflat would be restored after construction is complete and the temporary fill or trestles are removed.

Replacement Alternative S-4 would not affect mudflats due to dredging. Approximately 0.07 hectare (0.18 acre) of mudflat habitat would be affected near Yerba Buena Island due to placement of construction trestles.

Mitigation Cited in the EIS

Several mitigation measures have been proposed to reduce or avoid impacts to biological resources related to dredging operations. These include:

Chinook salmon, steelhead, green sturgeon, longfin smelt. Mitigation would include: the use of physical barriers such as silt curtains, if practicable, to contain the turbidity plume as much as possible; selection of dredging equipment to reduce suspended materials; and, if construction sequencing permits, dredging in shallow water would be restricted to a window between June 1 and November 30.

Pacific herring. Construction activities occurring during the seasonal spawning period will be monitored by a qualified biologist (approved by CDPG) to watch for the presence of herring. If spawning is observed in the project area, in-water activities such as dredging, will be suspended within 200 meters (656 feet) of observed spawning. Dredging would not resume in that area for a period of up to 14 days (as determined by the qualified biologist), allowing herring eggs to hatch and the larvae to disperse. This avoidance measure has been suggested by CDFG (personal communication, Becky Ota, CDFG) and is commonly used for projects that may affect Pacific herring.

Eelgrass Beds. Conceptual plans for eelgrass mitigation include engineering a site for optimal eelgrass success and transplanting eelgrass to the prepared site. Creation of eelgrass beds is considered experimental and depends on several variables including: balance of sedimentation and scour, compression and settling of the sediment fill and underlying material, contamination, and the transplanting protocol. A pilot program is currently being conducted by Merkel and Associates for the Port of Oakland. The results of this program should provide insight into preparing a mitigation site for the SFOBB project. Mitigation is proposed at a 3:1 ratio and will include mitigation for dredging impacts discussed in this DMMP as well as other project impacts not related to dredging.

Use of physical barriers such as silt curtains will reduce the impacts of sedimentation on adjacent eelgrass beds during dredging of the access channel. Sediment removal for the construction of bridge piers in shallow water will take place within cofferdams, minimizing turbidity in the water column.

Intertidal Mudflats. Potential mitigation sites that would provide opportunity to restore intertidal mudflats are being reviewed. As for eelgrass beds, a mitigation ratio of 3:1 is proposed for mudflat restoration.

Mitigation for the entire project will be discussed in the FEIS (Sections 4.9.2 and 4.14.8). A separate, detailed Mitigation and Monitoring Plan will also be prepared for the project. This will include mitigation for dredging impacts, as well as other project impacts such as permanent loss of habitat due to bridge pier, and other structures, both in the water and on land.

Water Quality

Water quality parameters that could be affected by dredging activities include, but are not limited to suspended solids concentrations, dissolved oxygen, salinity, pH, and concentrations of metals and organic compounds. Most of the impacts described here would result from dredging of the access channels. Sediment removal for bridge piers would occur within coffer dams and is not expected to affect water quality.

Suspended Solids. As described above under biological effects, elevated total suspended solids (TSS) concentrations can reduce light transmittance in the water column, dissolved oxygen levels, and potentially release toxic metals and organic compounds that may be associated with the sediments being dredged. The concentration of suspended material varies with the type of dredging equipment used and the materials being dredged. In general, clamshell buckets create the highest level of suspended material and turbidity while cutterhead dredging creates the least. Studies by the Port of Oakland have shown that the concentrated portion of the plume would be near the bottom and that most of the plume would dissipate quickly. Sediment concentrations, measured by the COE and reported by the Port of Oakland, were generally less than 200 mg/L and averaged 30 to 90 mg/L in the upper water column 50 meters (164 feet) downstream from clamshell dredging operations. Higher concentrations extended about 450 meters (1,476 feet) near the bottom. Background considerations measured near Yerba Buena Island by the Regional Monitoring Program (RMP) were less than 10 mg/L.

The Port of Oakland estimated through modeling efforts that TSS concentrations would not exceed 1,500 mg/L at a distance of 8 meters (26.3 feet) from the dredging activity. As noted

above, juvenile Chinook salmon have been shown to be adversely affected by concentrations slightly higher than 1,500 mg/L after 96 hours of exposure. It is likely that the fish could withstand higher concentrations for shorter periods of time without adverse effects.

Dissolved Oxygen. Dissolved oxygen concentrations are expected to decline in the immediate vicinity of dredging operations because the resuspension of oxygen poor (anoxic) sediments would create an oxygen demand in the water column. COE studies have shown that depressions in dissolved oxygen concentrations were greatest in the lower 2 meters (6.5 feet) of the water column and background levels were regained within approximately 10 minutes. Decreases in dissolved oxygen concentrations are expected to be localized and of short duration.

Salinity, pH, and Nutrients. COE studies have shown that dredging operations rarely have an effect on salinity and pH. Slight changes in these parameters were noted only 25 percent of the time during monitoring studies.

Nutrient enrichment in the water column can occur when nutrients (phosphorus, nitrogen, silica) in the sediments are released to the water column through the dredging operations. This can cause a slight increase in turbidity in some cases by enhancing primary productivity. Nutrient enrichment and associated effects would be minimal due to the expected rapid dilution and tidal exchange in the project area.

Metals and Organic Compounds. Dredging of sediments can resuspend metals and organic compounds associated with the sediment particles. Though results of the sediment tests for the proposed Replacement Alternatives are not yet available, sediments collected and tested near the existing bridge were largely clean and suitable for unconfined aquatic disposal (see Section 3.7). Any material found to be contaminated and not suitable for aquatic disposal will require careful removal.

Several studies of metals released during dredging operations have been conducted in various parts of the U.S. and were reported in the Port of Oakland 50-Foot Dredging Project EIS. Though the sites reported had metal enriched sediments, San Francisco Bay water quality objectives were generally not exceeded. Modeling conducted for the Port of Oakland indicated that metals and organic compounds would not generally exceed water quality objectives for the protection of aquatic life.

Mitigation

Mitigation measures for biological resources, such as the use of silt curtains, are primarily designed to protect water quality which in turn would protect aquatic life.

The range of reuse and disposal options considered for dredged material include:

- In-Bay, ocean disposal, and Upland/Wetland Reuse (UWR)
- Upland landfill disposal or reuse as fill material for construction projects
- Sidecasting adjacent to the dredging site

The range of options considered for in-Bay, ocean disposal, and UWR is presented in Section 4.1. The range of options considered for upland reuse/disposal is presented in Section 4.2. The sidecasting option is presented in Section 4.3.

4.1 IN-BAY, OCEAN DISPOSAL, AND UPLAND/WETLAND REUSE

A wide range of reuse/disposal sites within the nine county region was considered. This initial range of sites includes sites listed as part of the Dredging and Disposal Road Map (BCDC and LTMS 1998). The Road Map is a compilation of existing and planned sites identified by the BCDC and the COE that can potentially accomodate current and potential dredged Bay materials. In addition to the Road Map, other persons knowledgeable of potential disposal sites were consulted to identify potential locations, and the Regional Dredged Rehandling Facility Feasibility Study (Port of Oakland 1999), recently prepared for the Port of Oakland was reviewed. Treasure Island was also considered as a potential reuse/disposal site due to its proximity to the East Span project area.

Due to the large number of initial alternatives, screening criteria were applied to focus further analysis only upon those that are "practicable options." The selection of practicable alternatives is the first step in the sequential analytical process that is at the core of Section 404(b)(1) permit decisions. The term practicable is defined in Section 404(b)(1) guidelines to mean "available and capable of being done after taking into account considerations of cost, existing technology, and logistics of overall project purposes."

Table 4-1 summarizes the status of each of the sites considered. The sites range from operating upland landfills that accept project dredge materials for daily cover over refuse to former tidal marsh sites that have been diked. Sites were determined to be potential reuse/disposal sites for the East Span Project if the following conditions were met:

- In-Bay or deep ocean sites must be designated and available to accept SUAD material in quantities equal to those to be generated by the East Span Project;
- Planned dredge material reuse sites developed by other public agencies or private entities (e.g., Hamilton or Montezuma Wetlands Restoration sites) would need to be permitted and in place by 2000;
- Sites for restoration of tidal marsh habitat (e.g., Alameda Naval Air Station, Black Point) using dredge material from the East Span Project must have undergone environmental review and regulatory agency permitting and approval (by the permittee or others) by the time construction begins in 2000;
- Upland landfill sites (e.g., Altamont Landfill) would need to be online and available to accept the quantities generated on a month-by-month basis;

Table 4-1

Potential Reuse/Disposal and Rehandling Sites

Reuse/disposal Site	Excluded	Comments
In-Bay		
Alcatraz (SF-11)[1]		Site presents seasonal volume constraints; new bridge material may not be accepted under the maintenance definition. *Identified for further evaluation for SUAD material.*
Carquinez Strait (SF-9)		Site has volume limits and seasonal restrictions on disposal capacity, but could accept SUAD material.
San Pablo Bay (SF-10)		Site has volume limits and seasonal restrictions on disposal capacity, but could accept SUAD material.
Suisun Bay (SF-16)	X	Site is used exclusively for Suisun Bay Channel material disposal.
Bay Farm Island		Site does not currently exist and has low feasibility of being built.
Middle Harbor Enhancement Areas	X	Site will be constructed as part of 50' project for placement of Port of Oakland material; site priority is for Port of Oakland materials. No need for sediments from other projects.
Ocean		
S.F. Bar Channel	X	Site is used exclusively for Bar Channel material placement.
S.F. DODS[1]		Site is designated (Marine Protection, Research, and Sanctuaries Act Section 102 permit); sufficient volume for SUAD material under EPA rulemaking limit. *Identified for further evaluation.*
Reuse/Non Tidal		
Airport Borrow Pits, Solano		Site does not currently exist as a UWR site; would accept NUAD (material not suitable for unconfined aquatic disposal) for rehandling.
Alameda Naval Air Station, Alameda		Site has feasibility study for golf course underway; it has been proposed for the Port's 50' project use and has a priority for that project. Environmental documentation and project planning underway but not complete.

[1] These sites represent typical UWR sites. Other sites on this table that are not evaluated in detail may have somewhat different environmental concerns.

Table 4-1

Potential Reuse/Disposal and Rehandling Sites

Reuse/disposal Site	Excluded	Comments
Blackpoint, Marin County		Site does not currently exist as a UWR but has potential to be restored. Property is owned by State Lands Commission. Would require environmental review, permitting, and wetland design. Environmental issues at this site include historic structures, endangered species, and seasonal wetlands.
Bel Marin Keys, Marin		Site does not yet exist for reuse/disposal; it may be incorporated into Hamilton restoration project. Would require environmental review, permitting, and wetland design.
Cargill Salt Evaporator Ponds, Solano and Napa		Site does not currently exist for reuse/disposal; opposition from owner makes construction unlikely.
Cargill Salt Crystallizer Ponds, Solano and Napa		Site does not currently exist as a UWR site; would require land acquisition, environmental review, permitting, and wetland design.
Cullinan Ranch, Napa and Solano	X	Site does not exist for reuse/disposal; restoration concepts call for tidal marsh restoration using natural processes. Dredged materials are not being sought.
Galbraith Golf Course, Alameda	X	Site capacity has been utilized by Port of Oakland 42' project. No additional capacity.
Hamilton Airfield, Marin[1]		CEQA/NEPA process started March 1998. Final EIR/EIS due in Spring 1999. *Identified for further evaluation as a representative site.*
Landfills *Examples*: Redwood Altamont Vasco Road		Upland confined disposal can accept clean cover material (SUAD) as well as NUAD materials.
Leonard Ranch, Sonoma		Site does not exist as a UWR site; may face opposition from owner. Would require land acquisition, environmental review, permitting and design. Would require a 1-2 mile pipeline for offloading.

[1] These sites represent typical UWR sites. Other sites on this table that are not evaluated in detail may have somewhat different environmental concerns.

Table 4-1

Potential Reuse/Disposal and Rehandling Sites

Reuse/disposal Site	Excluded	Comments
Mare Island, Solano		Reuse plan includes confined disposal and capping.
Marin County Flood Control District		Site does not yet exist as UWR site. Would require environmental review, permitting, and wetland design.
Moffet Field, Mountain View	X	Site does not currently exist. Property owner has no plans for wetland creation. Wetland development may conflict with current and planned land use. Would require a 3-4 mile pipeline for offloading.
Montezuma, Solano[1]		Site's Final EIR/EIS was issued in July 1998. Site is planning to accept both SUAD and NUAD (non-wetland cover) material. *Identified for further evaluation as a representative site for UWR.*
Napa River, Napa	X	Site is used exclusively for federal channel material disposal.
North Point Property, Sonoma		Site does not currently exist as a UWR site but has potential to be restored. Would require environmental review, permitting and wetland design. Would require a pipeline for offloading.
Petaluma Drying Ponds, Sonoma	X	Site is used exclusively for federal channel material disposal.
Pierce Island, Solano	X	Site is used exclusively for federal channel material disposal.
Port of Oakland Berth 10, Alameda		Site's rehandling facility may be available; RWQCB permits are needed. Not a reuse/disposal site.
Port of Richmond Shipyard No.3, Contra Costa		Site's rehandling facility may be available; RWQCB permits are needed. Not a reuse/disposal site.
Port of S.F. Pier 94, San Francisco	X	Site does not currently exist; local community opposition is expected. Possible future use as a regional rehandling facility, but not a UWR site.
Port Sonoma Drying Ponds, Sonoma	X	Site is used for marina materials only.

[1] These sites represent typical UWR sites. Other sites on this table that are not evaluated in detail may have somewhat different environmental concerns.

Table 4-1

Potential Reuse/Disposal and Rehandling Sites

Reuse/disposal Site	Excluded	Comments
Port Sonoma- Hwy 37, Sonoma	X	Site is used for Port Sonoma materials only.
Praxis-Pacheco, Contra Costa		Site does not exist as a reuse/disposal site; it has been proposed for commercial development. Site development could affect existing wetlands and endangered species. Would require environmental review, permitting, and wetland design.
San Leandro, Alameda	X	Site is used exclusively for federal channel materials.
Sherman Island Scour Pond, Sacramento		Site does not exist; salinity impacts are a concern. Would require permitting, environmental review, and rehandling of material to reduce salinity.
Skaggs Island, Sonoma	X	Site's reuse plan does not contemplate disposal.
Sonoma Baylands, Sonoma	X	Site's capacity has been reached with Port of Oakland 42' project.
Treasure Island, San Francisco		Site's landfill at site 11 is undergoing remediation. No current plans that would use dredged materials.
White Slough Project, Route 29/37 Interchange, Solano County		Material could be used as fill for roadway construction. Use at this site would depend on geotechnical suitability of the dredged material, coordination of construction schedules of the East Span Project and White Slough Project, and costs.
Winter Island, Contra Costa	X	Site is used exclusively for federal channel material disposal. Salinity of the Bay sediment is an issues in freshwater areas due to potential degradation of water quality.

Source: BCDC and LTMS 1998; Tetra Tech EMI, January 1999; Port of Oakland 1999; URSGWC 1999, direct contact with facility management.

[1] These sites represent typical UWR sites. Other sites on this table that are not evaluated in detail may have somewhat different environmental concerns.

- Upland construction projects (e.g., Caltrans roadway projects or private development sites) would need to be identified and have material drying and/or storage sites.

In regard to upland construction projects, Caltrans has identified one highway project that may be able to use the dredged material as fill. This project involves improvements to the Highway 29/37 interchange in Solano County at White Slough near the Napa River. The project will need approximately 765,000 m^3 (1 million cy) of fill material for the roadbed and embankments. Use of the material at this site will be contingent upon several factors. The project is expected to start approximately one year after the start of the East Span dredging activities, thus material would need to be stockpiled in the interim. Costs of drying, trucking, and storage of the material will also need to be considered. Most importantly though, the material must be suitable as structural roadway fill. Merritt Sand can sometimes be used for roadbeds; however, this material is not suitable for construction of embankments. The material must also be compactable to within 90 percent of its original volume to be suitable for use in construction projects. The specific geotechnical characteristics of the sediments to be dredged are not known at this time and the potential use of this material for this project cannot be determined until geotechnical testing of the material has been conducted.

There are no other Caltrans projects in Western Contra Costa County or Northwestern Alameda County that need fill materials. However, at least three other projects will be generating large amounts of upland fill that may be more suitable for use on the Highway 29/37 interchange project.

Sites Evaluated in the DMMP

Based on the initial screening criteria, 16 sites cannot be considered practicable options and are excluded from further evaluation. Some of the excluded sites do not accept material other than from specific projects (e.g., Federal dredging projects): other sites are only available for temporary use as a rehandling location, but not for permanent reuse/disposal. At some excluded sites the use of sediments would be contrary to current land use plans.

In addition to landfills, 23 of the identified sites can potentially accept East Span Project dredge material and are retained for future consideration. Four sites among them have been selected as representative for the purpose of the DMMP. The four sites are currently available or are expected to be available for disposal of East Span Project dredge material to meet the project schedule and best meet the screening criteria presented above. The remaining 19 sites are not currently available and may not be available within the timeframe of the project since permitting, environmental studies, or infrastructure requirements are lacking, or their use faces public or owner opposition. Those sites may necessitate longer time to develop than allowed by the project schedule to become viable options. However, they are not excluded from future consideration.

The sites further assessed in the DMMP are:

- Alcatraz (SF-11)
- San Francisco Deep Ocean Disposal Site (SF-DODS)
- Hamilton Wetlands Restoration

- Montezuma Wetlands Restoration

Two upland/wetland reuse sites were carried forward for detailed analysis. The two sites selected to represent this reuse approach, Hamilton and Montezuma, were selected because environmental documents have been prepared for the projects. Information from the environmental documents has been used to characterize the potential effects of reuse of East Span Project dredge materials for tidal wetlands recreation. The types of benefits and impacts that would result from use of these sites is representative of the other potential upland/wetland reuse sites listed in Table 4-1.

Figure 4-1 shows the location of in-Bay, ocean, and UWR disposal sites selected for further analysis among the range of sites presented in Section 4.1. Figure 4-1 also shows the location of landfill sites presented in Section 4.2. The following subsections summarize the affected environment at each of the sites. Section 5.0 presents the impacts, cost, and technical feasibility associated with the sites, consistent with 404 (b)(1) criteria.

4.1.1 Alcatraz (SF-11)

The Alcatraz disposal site (SF-11) is located approximately 0.5 kilometer (0.3 mile) south of Alcatraz Island in central San Francisco Bay (Central Bay) and approximately 8 kilometers (5 miles) from the East Span Project site. The site is a circular area, approximately 610 meters (2,000 feet) in diameter. The site was formally designated as a sediment disposal site in 1972, although dredged material has been deposited there since 1894. Because of frequent disposal at this site a mound developed in the 1980s which posed a potential threat to navigation in the area. The site is actively managed by the COE to maintain it at navigable depths. It currently has an annual limit of 3,058,104 m^3, or 4 million cubic yards (mcy), with a monthly restriction of 305,810 m^3 (400,000 cy) from October to April, and 299,357 m^3 (300,000 cy) from May to September (LTMS 1998). Its availability is discussed in Section 5.1.

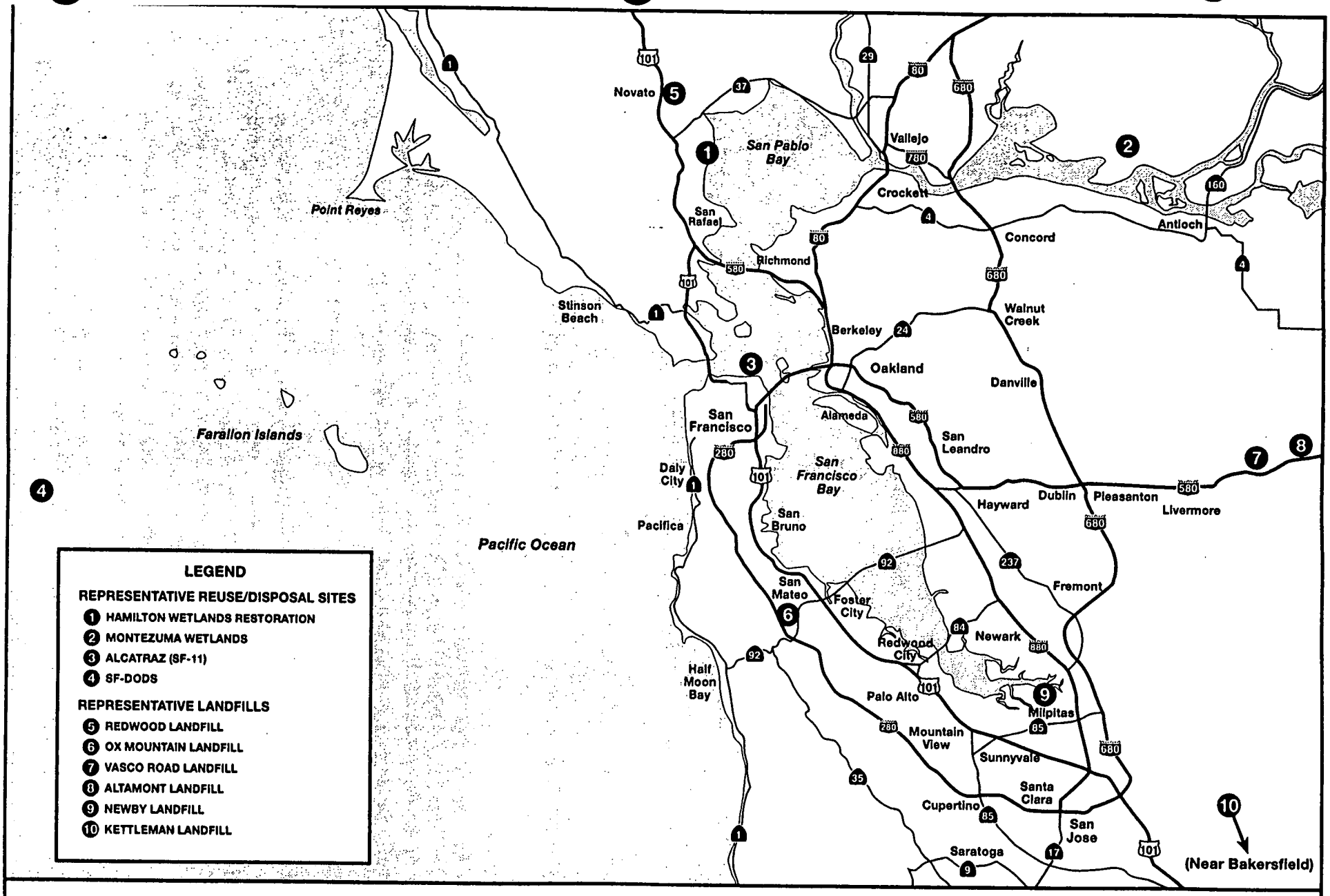
Biological Resources

Phytoplankton and zooplankton populations in the Central Bay are largely dominated by influxes from ocean and South Bay waters. Ghost shrimp and oceanic species of krill can be found in this portion of the Bay.

Benthic (bottom dwelling) organisms that live in the deeper parts of the Central Bay are typical of those found in sandy sediments along the outer coast (COE et al. 1998). Common species include the polychaetes *Armandia brevis, Mediomastus* sp., *Siphones missionensis,* and *Glycinde picta,* the amphipod *Foxiphalus obtusidens* and the crab *Cancer magister.* All of these are native species. There are also a number of benthic species that have been introduced to the Bay such as *Potamocarbula amurensis.*

Fish commonly found in the Central Bay include the northern anchovy (*Engraulis mordax*), Pacific halibut (*Hippoglossus stenolepis*), striped bass (*Roccus saxatilis*), American shad (*Alosa sapidissima*), Chinook salmon, white croaker (*Genyonemus lineatus*), Staghorn sculpin (*Leptocottus armatus*), and shiner surfperch (*Cymatogaster aggregata*). Within the Estuary, the English sole (*Parophrys vetulus*) is found most abundantly in the Central Bay. Except for striped bass, all of the species commonly found in the Central Bay are native. Shiner surfperch,

jacksmelt jacksmelt *(Atherinopsis californiensis)*, topsmelt (*Atherinops affinis)*, diamond turbot



SFOBB
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PROJECT

Reuse/Disposal Sites

Figure 4-1

PDQ&D 6/14/99

(*Hypsopsetta guttulata*), and the speckled sanddab (*Citharichthys stigmaeus*) are common in shallow waters around the Central Bay.

Typical birds of the open water of the Central Bay are the western grebe (*Aechmophorus occidentalis*), California brown pelican (*Pelecanus occidentalis*), lesser scaup (*Aythya affinis*), canvasback (*Aythya valisineria*), surf scoter (*Melanitta perspicillata*), and osprey (*Pandion haliaetus*). The common loon (*Gavia immer*), and Caspian tern (*Sterna caspia*) also use the open water habitat of the Central Bay.

The species of special concern identified by the resource agencies within the Central Bay that could be present in the vicinity of SF-11 during migration are the endangered winter-run Chinook salmon, coho salmon (*Oncorhynchus kisutch*), Pacific herring (commercially fished), and recreational marine fishes (LTMS 1998). Pinnipeds (protected under the Marine Mammal Protection Act) such as harbor seals (*Phoca vitulina*) and the California sea lion (*Zalophus californicus*) may also be present in the area, as they are widely distributed in the Bay.

Water Resources

The Alcatraz site is typically dominated by marine waters, and salinity levels are generally representative of such. Salinity measured at nearby Regional Monitoring Program (RMP) monitoring stations ranged from 24 to 33 parts per thousand (ppt). There is often a slight salinity gradient from shallow to deep waters at the site. Dissolved oxygen levels near the Alcatraz site are generally range from 7.1 to 9.6 mg/L. TSS in Central Bay generally ranges from 10 to 60 mg/L.

Representative water column data from a monitoring location near the Alcatraz site are presented in Table 4-2. Chemicals of concern in the water column at the site can be affected by the disposal of dredged material, although measurable differences in parameters are only observed for a short period of time (less than 1.5 hours) after the release of dredged material (LTMS 1998).

Sediments at the Alcatraz site are characterized by predominately fine to coarse sand, with pockets of finer silt and areas of bedrock and boulders just south and southwest of Alcatraz Island. In the area immediately surrounding the Alcatraz site, the sediment is comprised of 18 to 98 percent sand with up to 17 percent gravel and 0 to 6 percent silt and clay.

4.1.2 Deep Ocean Disposal (SF-DODS)

The SF-DODS is located on the continental shelf, approximately 91 kilometers (50 nautical miles) west of the Golden Gate, at a depth of approximately 230 meters (760 feet) (Figure 4-1). This site is approximately 102 kilometers (55 nautical miles) from the proposed dredging location. This site was designated in 1994 under Section 102 of the Marine Protection, Research, and Sanctuaries Act (MPRSA). It can accept up to 3,669,725 m^3 (4.8 mcy) per year, and has the capacity to accept all SUAD material from the proposed dredging activities for the East Span Project assuming physical criteria such as sediment grain size are met.

The Marine Protection, Research, and Sanctuaries Act requires project sponsors to consider feasible, practicable, and environmentally superior alternatives to the use of this site if they are available.

Table 4-2
Water Quality Parameters near the Alcatraz Disposal Site

Parameter	Dissolved Concentrations		Water Quality Objective
pH	7.8 - 8.0		between 6.5 and 8.5
ammonia	1.84 - 2.10	µM	no numerical objective
Ag	0.68 - 1.95	µg/L	2-3 µg/L maximum
As	1.57 - 2.08	µg/L	4-day average 9.3 µg/L 1-hour average 69 µg/L
Cd	33.63 - 63.85	µg/L	4-day average 9.3 µg/L 1-hour average 43 µg/L
Cr	0.09 - 0.13	µg/L	4-day average 50.0 µg/L, 1-hour avearge 1100.00 µg/L
Cu	0.87 - 1.91	µg/L	1-hour average 4.9 µg/L
Hg	0.79 - 1.64	ng/L	4-day average 0.025 µg/L 1-hour average 2.1 µg/L
Ni	0.84 - 1.99	µg/L	24-hour average 7.1 µg/L 140.0 µg/L maximum
Pb	9.50 - 13.17	ng/L	4-day average 5.6 µg/L, 1-hour average 140.0 µg/L
Zn	0.49 - 1.22	µg/L	24-hour average 58.0 µg/L 170.0 mg/L maximum
PAHs	2,926*	pg/L	24-hour average 15.0 µg/L
PCBs	2,886*	pg/L	no numerical objective
Pesticides	1,722*	pg/L	no numerical objective

µg/M = micromoles (10^{-6})
µg/L = micrograms/Liter (10^{-6})
ng/L = nanograms/Liter (10^{-9})
pg/L = picograms/Liter (10^{-12})

Notes:
Sampling Station at the mouth of Richardson Bay.
* Samples taken at the Golden Gate.
Source: (LTMS 1998).

Biological Resources

Detailed surveys of the plankton community at the ocean disposal site have not been performed, although information about plankton communities expected within the study area were inferred from various studies performed along the central California coast and Gulf of the Farallones and reported by the Port of Oakland (1998).

Phytoplankton expected to be present within the ocean disposal area include various diatoms, coccolithophores, dinoflagellates, and silicoflagellates. Species that have been observed during upwelling events include the diatoms *Chaetoceros* sp. and *Rhizosolenia* sp. Dinoflagellates such as *Ceratium* sp. and *Peridinium* sp. are predominant during non-upwelling periods. Abundances and productivity are expected to be lower in the vicinity of the ocean disposal area, which is located in deep waters along the continental slope and rise, than in shallower nearshore waters.

Zooplankton serve as an important food source for various organisms including other zooplankton, squid, fish, seabirds, and marine mammals. Commonly occurring species include various copepods (e.g., *Calanus* sp., *Neocalanus* sp., *Eucalanus* sp., and *Acartia* sp.), arrow worms chaetognaths (such as *Sagitta* sp.), and salps (Thaliaceans such as *Thalia democratica* and *Doliolum denticulatum*). Pelagic mollusks likely to be present include the gastropods *Limacina helicina, Clio pyramidata,* and *Corolla spectabilis*.

Surveys of benthic (bottom dwelling) organisms were conducted in 1990 and 1991 in the vicinity of the SF-DODS for the EPA's LTMS program Ocean Studies Plan for dredging and disposal and are summarized in the Port of Oakland's 50-Foot Project EIS. The study area incorporated the SF-DODS. A total of 385 faunal species were collected, consisting of 48 percent polychaetes, 32 percent crustaceans, 8 percent mollusks, and 12 percent miscellaneous taxa. The taxa tended to be typical of deep-sea infaunal communities. Densities range from 4,970 to 9,870 individuals/m^2 in 1990, and from 750 to 7,540 individuals/m^2 in the 1991 survey. Species diversities were also higher in 1990 than in 1991. This study area tended to have lower infaunal densities than shallower areas surveyed. This is consistent with trends of decreasing density with depth in continental slope environments.

Fish trawl surveys were conducted by the U.S. Navy in 1991 and 1992. Fish densities were low in 1991 (e.g., 207 individuals/ha), and the dominant demersal (bottom dwelling) species were rattails, eelopouts, and morids such as finescale codling (*Antimora microlepis*). Pinniped species observed within the study area included the California sea lion, northern elephant seal (*Mirounga angustirostris*), Steller's sea lion (*Eumetopias jubatus*), and northern fur seal (*Callorhinus ursinus*). The California seal lion and northern fur seal are primarily within the study area during migration and while foraging. The other pinnipeds observed (harbor seal, elephant seal, and Steller's sea lion) breed in the central California coast region.

Several surveys of bird populations have been conducted by various groups off the California coast and in the general vicinity of SF-DODS between 1985 and 1991. The survey results were summarized in Port of Oakland (1998). The species reported include both migratory species and those that are present year round. Because the study site is located near the Farallon Islands, many species that use the islands as a breeding site may be found foraging near or within the study site year-round. Species which breed on the Farallon Islands and may commonly be seen within the vicinity of the study site year round include Cassin's auklet (*Ptychoramphus*

aleuticus), rhinocerous auklet (*Cerorhinca monocerata*), and ashy storm petrel (*Oceanodroma homochri*). The common murre (*Uria aalge*), which also breeds in the Farallon Islands, exhibited moderate to high densities within the study area during the spring but generally moved to shallower waters closer to shore in the summer. Commonly observed migratory species in the study area include sooty shearwaters (*Puffinus griseus*), red-necked phalarope (*Phalaropus lobatus*), and Sabine's gull (*Xema sabini*).

Special Status Species. Special status species known to occur at the San Francisco Deep Ocean Disposal Site and vicinity are listed in Table 4-3. None of these species are known to breed at this site, though several species are known to use the Farallon Islands, approximately 22 nautical miles away, for nesting and breeding activities.

Water Quality

Several studies conducted in the vicinity of SF-DODS have been summarized in the Port of Oakland 50-Foot Dredging Project EIS (Port of Oakland 1998). Results of the surveys indicate that there is a high variability in the temperature profile related to seasonal changes in association with upwelling, changes in the California current system, wind conditions, and various other current patterns within the area. Temperature profiles in July 1991 indicated a well-mixed surface layer, below which temperatures decreased rapidly (thermocline), followed by gradual changes with depth. Temperatures in the upper 100 m (328 feet) of the water column ranged from 11° C to 14° C. Temperatures dropped to 4° C at about 1,000 m (3,280 feet) and approximately 2° C at 2,000 m (6,562 feet). The profiles were typical for California coastal areas in the summer.

Dissolved oxygen profiles indicated an oxygen minimum zone (due to sinking and decomposition or grazing of organic material) at about 800 m (2,625 feet) with oxygen concentrations of 0.5 mg/L. Surface waters had oxygen levels of 8 mg/L, with a gradual decline in concentrations with depth through the mixed layer. Below the minimum zone, dissolved oxygen levels increased to greater than 3 mg/L at about 2,000 m (6,561 feet).

Measurements of pH in the Gulf of the Farallones ranged from 7.8 to 8.3 and are expected to vary with changes in carbon dioxide and oxygen levels resulting from changes in planktonic primary production (i.e., higher pH values occur where oxygen levels are high and carbon dioxide levels are low as a result of high productivity).

Salinity profiles within the study area were obtained in July 1991 from a Navy study near SF-DODS. Values ranged from 32.9 ppt in surface waters (25 meters or 82 feet) to 34.7 ppt at a depth of 390 meters (1,280 feet). As with temperature, salinity values varied seasonally, particularly in the surface layer, which had lower values in the winter and spring during periods of high river outflow.

TSS measured in the Gulf of the Farallones for regions over the continental shelf tended to be higher than slope and shelf break areas, ranging from 0.3 to 2.9 mg/L in the top 25 meters (82 feet) of the water column. Concentrations near the shelf-break ranged from 0.08 to 2.51 mg/L.

Light transmissivity measurements were made in the fall of 1991 as an indication of suspended solids and turbidity. Light transmissivity measurements made throughout the water column on the western boundary of SF-DODS were 88 to 90 percent. Similar values were found along the

Table 4-3

Special Status Species that have Potential to Occur within the Proposed San Francisco Deep Ocean Disposal Site and Vicinity

Common Name *Scientific Name*	Status	Likely Habitat Use
Winter-run Chinook salmon *Oncorhynchus tshawytscha*	FE / CE	M / F
Central California steelhead *Oncorhynchus mykiss*	FT / CSMS	M / F
Double-crested cormorant *Phalacrocorax auritus*	SSC	F / R
California brown pelican *Pelecanus occidentalis californicus*	FE / CE	F / R
American peregrine falcon *Falco peregrinus anatum*	FE / CE	F
California sea lion *Zalophus californicus californianus*	MMPA	F
Steller's sea lion *Eumetopias jubatus*	FT / MMPA	F
Humpback whale *Megaptera novaeangliae*	FE / MMPA	F / M
Blue whale *Balaenoptera musculus*	FE / MMPA	F / M
Fin whale *Balaenoptera physalus*	FE / MMPA	F / M
Sperm whale *Physeter macrocephalus*	FE / MMPA	F / M

Notes:

Status:
- CE = Listed as Endangered under the California Endangered Species Act
- CSMS = California Special Management Species
- FE = Listed as Endangered under the Federal Endangered Species Act
- FT = Listed as Threatened under the Federal Endangered Species Act
- MMPA = Protected under the Marine Mammal Protection Act
- SSC = California State Species of Special Concern

Likely Habitat Use:
- F = Foraging
- M = Migration
- R = Roosts or perches within project area

Source: Port of Oakland (1998)

shelf break, but much lower values were found over the continental shelf (transmittance levels of 10 to 80 percent) as a result of the higher concentrations of suspended solids. Light transmittance / turbidity is expected to vary seasonally in relation to seasonal changes in river outflow in San Francisco Bay, during periods of upwelling and high productivity, particularly over the continental shelf.

Limited trace metal data available in the vicinity of SF-DODS includes studies reported by Bruland (1980) and summarized by the Port of Oakland (Port of Oakland 1998). These studies were performed along the continental slope off central California. Trace metals measured include cadmium, copper, nickel, and zinc. Concentrations of these metals tended to be generally lower in surface water than deeper waters due to uptake from biological processes. Cadmium showed maximum concentration near the oxygen minimum zone, while copper, zinc and nickel increased with depth, likely due to solubilization from particulates. Other factors which influence surface concentrations of these metals include upwelling, resuspension of bottom sediments by currents, atmospheric deposition, and transport from river outflow from San Francisco Bay.

Organic compounds are likely to enter the site through various processes such as transport by San Francisco Bay outflow, atmospheric deposition, and oil spills or discharges (EPA 1993). Studies of organic chemicals were previously performed along the continental shelf and within the vicinity of the Gulf of the Farallones. Trace amounts of petroleum hydrocarbons, PCBs, diphenyldichlorethylene, chlordane, hexachlorocyclohexane, dieldrin, and toxaphene were measured with values less than 0.05 µg/L.

4.1.3 Hamilton Wetlands Restoration

The former Hamilton Army Airfield (HAAF) is located near the City of Novato in Marin County, approximately 29 km (18 miles) from the East Span Project. The site is bounded by San Pablo Bay to the east and U.S. 101 and Hamilton Base facilities to the west. Bel Marin Keys, a housing development, is located to the north. The site was historically within the tidal zone of San Pablo Bay. In the 1930s, portions of the area were diked and used as a military base and airfield until the 1970s when the base was closed. The site is currently being prepared for transfer and reuse under the Base Realignment and Closure Act of 1988. A wetlands restoration project has been proposed to restore a mix of seasonal and tidal wetlands on up to 360 hectares (900 acres) of land which were previously used as the airstrip for the base and an adjacent antenna field to the north (State Lands Commission parcel). The site is not yet ready to accept dredged material.

The State of California is the project sponsor for the Hamilton Wetlands Restoration Project and is considering use of dredged material from a variety of sources. The Hamilton restoration project is managed by the California Coastal Conservancy (Conservancy) and the San Francisco BCDC, with the close coordination of the City of Novato, which is managing the contracts for preparation of the conceptual restoration plan, and the Hamilton Restoration Group, comprised of representatives of government, business, and environmental communities.

A conceptual restoration plan for the Hamilton site has been prepared under the auspices of the Hamilton Restoration Group. The Hamilton site includes low elevation areas that were once marshland and are now protected from inundation by a series of levees and pumps. The re-establishment of tidal wetlands would require higher elevations (approximately 1.5 meters or 5

feet mean lower low water (MLLW) for inter-tidal marsh plain) than currently exist to allow growth of wetland vegetation. These higher elevations could probably be achieved by simply breaching the existing outboard levee and allowing tidal activity to deposit sediments. However, placement of clean dredged material at the site in order to raise elevations closer to the eventual marsh plain is the preferred alternative to hasten the colonization of the wetland plants and animals (Conservancy and LTMS 1998).

The placement of dredged material at the Hamilton restoration site would be achieved by pumping a slurry of dredged material across the site from barges moored in San Pablo Bay. To allow the natural formation of marsh channels and to prevent over-filling of the site, dredged material would be placed below the target elevation of the tidal marsh plain.

Dredged material would also be used to restore seasonal wetland and upland transitional habitat at the Hamilton site. This would be accomplished by placing dredged material in certain areas to raise elevations above the tidal marsh plain. Dredged material may also be used to construct perimeter levees and internal berms at the site. This would be accomplished by placing dredged material, allowing it to dewater and consolidate, and then re-positioning it with construction equipment. The Conservancy estimates that under the preferred alternative, up to 6,422,018 m^3 (8.4 mcy) of dredged material (SUAD) could be used to restore tidal wetlands at the Hamilton Airfield and the former antenna field.

Technical studies analyzing the various restoration alternatives and issues necessary to assess their feasibility are currently underway. A NEPA/CEQA analysis and a final restoration design plan for the Hamilton project are scheduled for completion prior to commencement of East Span Project dredging.

Funding for construction of the project is included in the Water Resources Development Act (WRDA) that is currently before the U.S. Congress. If WRDA is passed this year, the Coastal Conservancy believes that the project could begin accepting dredged material by about midyear 2000. If the vote on WRDA is postponed, the Hamilton project might not begin until the year 2001, and would be unavailable to accept sediments during at least the first portion of the East Span Project.

Biological Resources

This description is based on information provided in the Hamilton Wetland Restoration Plan EIR/EIS (Conservancy and LTMS 1998).

The Hamilton airfield consists of several habitat types including grasslands, coastal salt marsh, brackish marsh, seasonal wetlands, and a wetland created as mitigation. Wetlands historically covered much of the airfield. Construction of levees along San Pablo Bay and the subsequent draining of historic marshland resulted in the conversion of hundreds of acres of coastal wetland into farmland. Much of the site naturally converted to grassland following establishment of the airfield.

The grassland community that dominates the project site is characterized by weedy, non-native species that are regionally abundant on agricultural lands and disturbed sites. This ruderal habitat has lower value to wildlife due to an over-abundance of weeds that provide little cover or food resources, including yellow star-thistle (*Centaurea solstitialis*), ripgut grass (*Bromus diandrus*),

ox-tongue (*Picris echioides*), and black mustard (*Brassica nigra*). Regionally common wildlife species typical of upland grassland habitats have been observed on the site.

Reptiles observed in annual grasslands during field surveys included the gopher snake (*Pituophis melanoleucus*) and western fence lizard (*Sceloporus occidentalis*). Turkey vulture (*Cathartes aura*), red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), California quail (*Callipepla californica*), ring-necked pheasant (*Phasianus colchicus*), savannah sparrow (*Passerculus sandwichensis*), and western meadowlark (*Sturnella neglecta*) were among the birds observed in the grasslands. Mammals included black-tailed jackrabbit (*Lepus californicus*), black-tailed deer (*Odocoileus hemionus*), coyote (*Canis latrans*) and raccoon (*Procyon lotor*).

Many of the salt marsh plain communities were once part of San Pablo Bay and have been altered by the construction of the levees. A 26-hectare (65-acre) strip of tidal salt marsh occurs outboard of the levee at the east end of the airfield. A small area of nontidal salt marsh, approximately 0.2 hectare (0.5 acre), occurs between the northwest end of the runway and Ammo Hill. The isolated pickleweed marsh drains westward into a saltgrass marsh and eventually into a small basin dominated by cattails.

Birds observed in the salt marsh during field surveys included the double-crested cormorant, great blue heron (*Ardea herodias*), great egret (*Casmerodius albus*), American coot (*Fulica americana*), killdeer (*Charadrius vociferus*), the California Species of Special Concern northern harrier (*Circus cyaneus*), and the federal Candidate San Pablo song sparrow (*Melospiza melodia samuelis*). Raccoons are also expected to occur in this habitat.

The Hamilton airfield site has its groundwater actively pumped and drained. Flooding is prevented by drainage ditches and pumping operations, but shallow ponding may occur briefly following storms allowing for areas of seasonal wetland. Seasonal wetlands at the Hamilton airfield include the majority of the low areas throughout the airfield. Though most of these areas are dominated by upland weeds, many of the areas are capable of supporting predominantly hydrophytic vegetation.

A drainage ditch surrounds most of the airfield between the perimeter road and the north, east, and southeast levees. The ditch varies in size, but averages approximately 1.5 meter (5 feet) deep and 8 meters (25 feet) wide. The ditch is lined with concrete for most of its length. It has been periodically cleared of sediment and vegetation. Dominant vegetation between ditch clearing episodes includes alkali bulrush (*Scirpus maritimus*), cattails (*Typha* sp.) and waterplaintain (*Alisma plantago-aquatica*).

The grassy banks and patches of cattail marsh provide cover and food for many birds and mammals. Barn swallow (*Hirundo rustica*), savannah sparrow, red-winged blackbird (*Agelaius phoeniceus*), lesser goldfinch (*Carduelis psaltria*), house finch (*Carpodacus mexicanus*), and black-tailed deer were observed in the ditch habitats during field surveys. Northern harriers have also been observed foraging along portions of the ditches.

In addition to wetlands that have naturally formed in topographic depressions, approximately 5 hectares (12.5 acres) of wetland were created at the northwestern end of the runway to mitigate for the loss of 1.7 hectares (4.1 acres) of wetland at Hamilton during a previous Army remediation effort.

Special status plants observed in the area inc lude the Soft birds-beak (*Cordylanthus mollis* var. *mollis*), North coast birds-beak, Petaluma popcornflower (*Plagiobothrys mollis* var. *vestitus*), and Marin knotweed (*Polygonum marinense*).

Special status wildlife species that may occur in the area include the California clapper rail (*Rallus longirostris*), California black rail (*Laterallus jamaicensis*), California brown pelican, double crested cormorant, saltmarsh common yellowthroat (*Geothlypis trichas sinuosa*), San Pablo song sparrow (*Melospiza melodia samuelis*), northern harrier, burrowing owl (*Athene cunicularia*), short eared owl (*Asio flammeus*), American peregrine falcon, and the salt marsh harvest mouse (*Reithrodontomys raviventris*) (Conservancy and LTMS 1998).

Water Quality

Hydrology and drainage. HAAF and adjacent properties to the north, west and south are low-lying, subsided diked historic baylands. Average annual precipitation in the region is from 61 to 76 centimeters (24 to 30 inches). Soils in the area typically exhibit rapid runoff rates with low groundwater infiltration rates and low erosion potential. Much of the airfield property is developed and therefore exhibits high runoff rates typically associated with urban development. The airfield area consists of depressed grassy areas and raised concrete and asphalt areas associated with taxiways and perimeter roads. Because the airfield runway area has extensive impervious surfaces of concrete and asphalt, it also may exhibit locally increased runoff rates.

Surface runoff within Hamilton is conveyed by a system of storm drains that feed into perimeter drainage ditches along the northern and southern perimeter levees. These channels drain to a series of pumps located in the northeastern corner of the Hamilton airfield adjacent to the eastern levee, and storm water runoff is discharged into San Pablo Bay by these pumps.

Off-site surface water inputs from adjacent areas include the Pacheco Creek and Arroyo San Jose watersheds to the west, Bel Marin Keys to the northwest, and the St. Vincent's and New Hamilton Partnership properties to the south. Stormwater flows from Pacheco Creek and Arroyo San Jose feed into Pacheco Pond. Pacheco Pond (also known as Ignacio Reservoir) is a freshwater wetland and flood detention basin located northwest of Hamilton airfield. It provides temporary storage of flood flows on Arroyo San Jose and Pacheco Creek and drains through tide gates to Novato Creek at low tide. A portion of the properties drain to the south as well as a portion of the Bel Marin Keys property to the north also drain into the Hamilton drainage and pump system. The Hamilton Airfield lies within the 100-year floodplain.

Salinity at the Hamilton site is a mix of surface runoff during rainstorms and shallow groundwater seepage. The salinity varies from fresh to brackish, depending on rainfall and evaporation. Salinity in San Pablo Bay is typically 32 parts per thousand, with lower levels during periods of high runoff.

Urban runoff from the airfield area and adjacent parcels to the west is collected by a series of storm sewers and drainage channels around the perimeter of the airfield and drains to pump stations that discharge into San Pablo Bay. Limited water quality measurements in the vicinity of the Novato/Ignacio and the Hamilton Field treatment plant outfalls found that annual median values for most physical and chemical water parameters were in compliance with standards set

by the RWQCB in the Basin Plan. However, the annual maximum values of pH, total coliform, turbidity, color, and ammonia exceeded the Basin Plan criteria at times.

4.1.4 Montezuma Restoration Project

Montezuma Wetlands is the site of a privately-sponsored wetlands restoration proposal, referred to as the Montezuma Wetlands Project (MWP). The MWP would use dredged material to restore approximately 730 hectares (1,800 acres) of historic tidal wetlands, providing habitat for a variety of sensitive species that inhabit brackish tidal marshes and shallow-water habitats. The MWP is currently being considered by federal, state, and local agencies. A Final EIR/EIS on the MWP was released for public review in July 1998 (COE and Solano County 1998). This site could be used for sediment disposal from the Oakland project only after receiving all necessary permits.

The Montezuma Wetlands site is located in the Suisun Marsh in Solano County, near Collinsville (see Figure 4-1). The distance from SFOBB to this site is approximately 80 kilometers (50 miles). The MWP applicant proposes to restore tidal wetlands by placing approximately 15.3 mcm (20 mcy) of dredged material over approximately 737 hectares (1,822 acres) of the 969 hectares (2,394 acre) site. The MWP is proposed to be constructed in four phases or cells in order to minimize temporary losses of wetlands during construction and to facilitate engineered placement of dredged material. The MWP would be divided into four phase areas, separated by engineered levees. Each completed phase would be hydrologically independent, and each would have a single connection to Montezuma Slough or the Sacramento River. Phases would range in size from about 97 to 243 hectares (240 to 600 acres). The project will also have a 36.4-hectare (90-acre) rehandling facility for drying of clean sediments that may be used for levee stabilization and landfill daily cover.

The MWP could accept a total of 15.3 million m^3 (20 mcy) of sediment. Up to 20 percent of the dredged material received could be classified as non-cover material and the remaining 80 percent would need to be classified as wetland cover material or better. "Cover" and "non-cover" material is defined by the RWQCB based on sediment test results. Cover material passes leaching and bioassay tests and combines pollutants at concentrations below specified RWQCB criteria. It may be used for wetland creation and restoration. Non-cover material passes leaching tests, and has pollutants in concentrations above cover sediment criteria, but does not exceed non-cover sediment RWQCB criteria.

The dredged sediment would be pumped through transport pipelines to the cells and deposited in layers known as "lifts." Non-cover material would be covered by a minimum 0.9-meter (3-foot) thick layer of cover material. The sediment in the slurry would settle over time. Sand and larger-grained material would settle first, and the finer-grained material would settle last. Water would be decanted off the cells into holding ponds and channels before a subsequent lift of sediment would be placed. The placement and draining operation in each cell would continue until a target elevation is reached. Several cells would be operated simultaneously to allow for disposal of a large quantity of sediments at the same time and for flexibility in receiving and placing cover and non-cover sediments.

The MWP is currently undergoing environmental review and permitting. Permits have not yet been approved and there is public opposition to this project. Although the Solano County Board

of Supervisors has recently approved the Project, a lawsuit has been filed by environmental groups which may delay the opening of the site. It is therefore unknown whether this site will be operational when the East Span Project dredging commences.

Biological Resources

About 300 species, subspecies, and varieties of plants occur in the MWP area. These plants occur in two broad groupings, separated mainly by their elevation with respect to high tide. An upland community, which is less saline and drier, is primarily located on the hills at the eastern edge of the site and on levees and other fill areas within the site. These areas are dominated by introduced and native species of annual and perennial grasses, and native herbaceous species. A lowland community occupies most of the other portions of the site, principally diked and drained areas below high tide. The lowland community includes areas of permanent and seasonal standing waters, with halophytic and hydrophytic plant species. Predominant halophytic species include pickleweed, saltgrass, and alkali heath.

Birds that occur at this site include waterfowl, shorebirds, raptors, and passerines. Of the 89 species identified at the site in recent surveys, 10 were breeding on site, and 45 were migratory species. The most common shorebirds were the long-billed dowitcher (*Limnodromus scolopaceus*), western sandpiper (*Calidris mauri*), and dunlin (*Calidris alpina*). During wet years, migratory waterfowl such as the northern pintail (*Anas acuta*), northern shoveler (*Anas clypeata*), gadwall (*Anas strepera),* and mallard (*Anas platyrhynchos*) have been observed. Although no threatened or endangered bird species were observed on the Montezuma site, special status bird species were observed at or near the site (including American white pelican (*Pelecanus erythrorhynchos*), California gull (*Larus californicus*), and burrowing owl). The grassland areas harbor common landbirds such as horned lark (*Eremophila alpestris*), western meadowlark (*Sturnella neglecta*), and savannah sparrow (*Passerculus sandwichensis*). Seasonality of flooding in these areas provide distinctly different habitat types in the wet versus the dry season. During the wetter periods, these areas support a large array of raptors, migratory waterfowl, shorebirds, and passerine species.

Mammals observed at the site include the California meadow vole (*Microtus californicus*), California ground squirrel (*Spermophilus beechyi*), coyote, raccoon, striped skunk (*Mephitis mephitis*), black-tailed jackrabbit, and Audubon's cottontail (*Sylvilagus audubonii*). River otters (*Lutra canadensis*) have also been seen adjacent to the site in Montezuma Slough. Several small mammals also exist on site, including the federally listed endangered salt marsh harvest mouse.

Because the Montezuma site was diked and drained, it generally lacks permanent water. Consequently, it has little fishery value. However, the Montezuma Slough adjacent to the site is an important rearing and nursery area for salmon and striped bass. Twenty species of fish were collected in the Montezuma Slough during trawl surveys conducted by the California Department of Fish and Game from 1962 to 1974. The delta smelt (*Hypomesus transpacificus*), a federally listed threatened species, and the Sacramento splittail (*Pogonichthys macrolepidotus*), a federally proposed threatened species, may be found in the sloughs of the Delta, such as Montezuma Slough.

Special Status Species. The delta smelt (threatened) is found in Montezuma Slough as is the proposed threatened Sacramento splittail. The Montezuma Slough may also provide rearing habitat for the winter-run Chinook salmon (state and federally listed as endangered).

The salt marsh harvest mouse (state and federally listed as endangered) is present in areas of Montezuma Wetlands project site where pickleweed is dominant or co-dominant species; about 48 hectares (119 acres) of the site are considered good-quality habitat, and about 164 hectares (405 acres) are considered lesser-quality mouse habitat.

Several sensitive species of birds can be found in the area, including northern harrier, golden eagle (*Aquila chrysaetos*), ferruginous hawk (*Buteo regalis*), loggerheaded shrike (*Lanius ludovicianus*) , salt marsh common yellowthroat, Suisun song sparrow (*Melospiza melodia maxillaris*), and burrowing owl. The burrowing owl is the only species that nests on the site.

The federally listed (threatened) vernal pool fairy shrimp (*Branchinecta lynchi*) also occurs on the wetland restoration site in specific areas.

No federally listed or proposed plant species were found at the site. Masons lilaeopsis (*Lilaeopsis masonii*), a federal species of special concern, was the only legally protected special status species on the project site. Other species were found in the vicinity of the project, but all were outside areas where dredged material would be placed (COE and Solano County 1998).

Water Quality

Hydrology and Drainage. Two small watersheds adjacent to the site with a combined area of about 1,254 hectares (3,100 acres) drain intermittently into the site from the Montezuma Hills to the east. These watersheds support agricultural activities including sheep and cattle grazing and feed production. During major winter storms considerable runoff reaches the site, providing moderate quantities of nutrients and TSS. Surface water in the interior of the site results from rainfall runoff and groundwater discharge. Some of this water collects in seasonal ponds during the winter and spring. The site is drained through a series of shallow channels which flow to two float-activated pump stations.

Potential sources of flooding include daily tidal fluctuations, storm runoff from upland drainage areas, and flooding from the Sacramento-San Joaquin rivers and Delta system. The site is protected from daily tidal flooding by a manmade levee system. This levee forms the eastern bank of Montezuma Slough and the northern bank of the Sacramento River.

Water Quality. The two major surface water bodies in the vicinity of the site are the Sacramento River along the southern site boundary and the Montezuma Slough along the western site boundary. Quality and salinity in these waters vary considerably with tides, season, annual rainfall, and delta outflow. Surface water salinity levels in the immediate vicinity of the site have been affected by the recent installation of the Montezuma Salinity Control Structure. This structure was designed to capture less saline Sacramento River water at ebb tide and tidally pump it to the more saline western Suisun Marsh, to meet state water quality control standards.

On-site shallow groundwater is brackish and unsuitable as a potential drinking water source or for agricultural purposes, and its potential beneficial uses are limited although the deeper aquifer has beneficial uses in domestic, industrial, and agricultural water supply.

Surface water and shallow groundwater quality were obtained by Levine-Fricke at the Montezuma Wetlands site and by the Department of Water Resources (DWR) at five monitoring stations in the project vicinity. Total and dissolved concentrations of inorganic elements that were detected (arsenic, cadmium, chromium, copper, lead, mercury, and zinc) were all below their respective maximum contaminant levels (standards set by the State Department of Health Services), except for one sample for total lead collected from a DWR monitoring station located off site in Suisun Bay near Martinez. Concentrations of total and dissolved arsenic, cadmium, chromium, and mercury levels were below San Francisco Bay Basin Plan objectives. Both total and dissolved concentrations of copper, lead, and zinc exceeded Basin Plan objectives at DWR monitoring stations in the project vicinity. Laboratory detection limits for copper, lead, and zinc were greater than the Basin Plan objectives so it is not known whether samples collected from the Montezuma site exceeded the objectives for these elements.

4.2 UPLAND LANDFILL REUSE AND DISPOSAL

Evaluation of the upland disposal option included identification of several landfills within the general vicinity of the project. The selected landfills were considered based on their capacity to handle the quantity of material potentially generated by the East Span Project. The dredged quantities generated by the project activities are presented in Table 3-1.

The various landfills identified below are grouped by class according to their site-specific characteristics and their ability to minimize the potential for waste to come into contact with the state's water resources. Specific permit restrictions for each landfill may apply depending upon the results of a waste characterization analysis which must be performed within one year prior to disposal.

In general, Class III landfills accept only non-hazardous materials. Class II landfills can accept non-hazardous materials in addition to designated wastes. Class I landfills are subject to the most stringent permitting and operating regulations as they can accept hazardous materials. Based on prior sampling and analysis at the project site, most of the East Span dredged material will not be classified as hazardous and will therefore not require disposal at a California Class I facility.

If the dredged material is determined to be suitable for disposal at a Class III facility, as is expected, then the greatest number of options is available. Figure 4-1 shows the locations of some of the potential landfill sites in relation to the project site.

The following are Class III sites which can accept non-hazardous material only:

- Vasco Road
  - Located in Livermore on Vasco Road off of I-580 in eastern Alameda County. This facility is approximately 60 kilometers (40 miles) by truck from the project site.
- Redwood Landfill
  - Located in Novato on Redwood Hwy, off Highway 101 in northern Marin County. This facility is approximately 60 kilometers (40 miles) by truck from the project site.

- Newby Island
  - Located in Milpitas on Dixon Landing Road off I-880 in northern Santa Clara County. This facility is approximately 60 kilometers (40 miles) by truck from the project site. This facility may be the best landfill choice as it is located on the San Francisco Bay and is specially permitted to receive dredged material.
- Ox Mountain
  - Located near Half Moon Bay on Highway 92 San Mateo County. This facility is approximately 55 kilometers (35 miles) by truck from the project site.

The following is a Class II site which can accept non-hazardous material and designated waste:

- Altamont Landfill
  - Located near Altamont Pass off of I-580 in eastern Alameda County. This landfill is approximately 70 kilometers (45 miles) by truck from the project site.

The following is a Class I site which can accept all waste including RCRA and CERCLA regulated hazardous waste:

- Kettleman Hills
  - Located near Kettleman City off of I-5 in Kings County. This landfill is approximately 320 kilometers (200 miles) by truck from the project site.

It is anticipated that portions of this project-generated material could be utilized as clean fill, daily cover or even as a clay cap under certain conditions including degree of uniformity and hydraulic conductivity.

If any of the material is taken to a landfill, the material must be dried to a moisture content of less than 50 percent by weight prior to disposal. The material cannot contain any free liquids if it is to be transported by truck. The Port of Oakland maintains a temporary rehandling and drying facility (Berth 10) that might be available for use on the East Span Project. Its use and indemnity requirements would need to be negotiated with the Port. In addition, land on the Oakland Touchdown might be apportioned for construction of a rehandling facility during the construction phase of the East Span Project. Environmentally sensitive areas would be avoided. Any rehandling facility within Caltrans right-of-way would need a Storm Water Pollution Prevention Plan (SWPPP) outlining precautions and management practices that would be used to minimize impacts to water quality by eliminating sediment laden discharges to the Bay.

4.3 SIDECASTING

Sidecasting is the process of dredging sediments and placing them to the side of the dredged area, rather than barging the material to a remote reuse/disposal site. This alternative might be useful if sediments are required to be replaced in the dredged areas after construction/dismantling activities are complete.

Sidecasting would only be used during dredging for construction and dismantling access channels which would be dredged in shallower waters near the Oakland Touchdown, subject to all federal and state permits. Sediments removed for pier construction would be taken to an

approved reuse/disposal site. The following section describes the general environmental setting for the area along the eastern portion of the project construction zone.

Biological Resources

Intertidal mudflats occur nearshore and generally to the north of the Oakland Touchdown. Substrate composition in these areas generally ranges from silt and clay to fine sand and includes organic debris and shell fragments. Mudflat vegetation is usually dominated by algae, and the flats support diverse communities of benthic invertebrates including clams, worms, mussels, and crabs. Because mudflats experience periods of exposure, wave action, and varying salinities, the benthic communities are dominated by colonizer species that develop quickly, rapidly reach maturity, and have high reproductive rates (Nichols and Pamatmat 1988). The mudflats provide important foraging areas for shorebirds.

Open water (subtidal) habitat is classified as the area of the Bay below the low tide line (also known as subtidal habitat). Sediment in these areas ranges from silts and clays to coarser sands and gravel in deeper channels near the center of the Bay. Phytoplankton are the dominant plants of the open water areas. Open waters provide habitat for many species of benthic organisms, fish, and birds, as well as marine mammals that occur in the Bay.

Plankton. The plankton community is comprised of photosynthetic phytoplankton, zooplankton (small, free floating or feebly swimming animals), and ichthyoplankton (eggs and larval forms of marine fishes). Phytoplankton abundance varies seasonally in San Francisco Bay, with a relatively low biomass in winter, a large spring to early summer bloom, and a smaller fall bloom. Common species include *Skeletonema costatum*, *Thalassiosira* spp. and *Coscinodiscus*. Phytoplankton are important to the growth and productivity of other organisms including zooplankton and benthic organisms. Common zooplankton species found in the Bay include the copepods *Acartia californiensis* and other *Acartia* species, *Oithona davisae*, *Paracalanus quasimodo,* harpacticoid copepods, tintinnids, and larval forms of gastropods, bivalves, barnacles, and polychaetes. (Ambler et al. 1985; Kimmerer 1998).

Ichthyoplankton populations consist of eggs and larvae of commonly occurring fish species including pacific herring, northern anchovy, Gobiidae (goby), white seabass (*Cynoscion nobilis*), staghorn sculpin, and diamond turbot. Both the number of species and overall abundance are usually highest in winter for most species.

Benthos. The benthic (bottom dwelling) fauna in the Bay are typical of soft-bottomed bays and estuaries and is dominated by mollusks, polychaete worms, and small crustaceans. Mollusks are generally the principal contributors to biomass throughout much of the Bay (Nichols and Pamatmat 1988). Common benthic macroinvertebrates that might be found in sediments near the Bay Bridge include the bivalves *Macoma balthica, Mya arenaria,* and *Saxidomus nuttalli* in intertidal areas and *Gemma gemma, Musculatia senhousia, Mya arenaria*, and *Tapes japonica* in subtidal areas. In general, the most abundant species found in Central and South Bay include amphipods such as *Ampelisca* sp. and *Corophium* sp. (Thompson and Peterson 1998). The Dungeness crab (*Cancer magister*) may also occur in the area. The crab normally inhabits deeper waters (7.6 to 27.4 meters or 25 to 90 feet) but migrates to shallow inlets during the summer months.

Many of the more common benthic species are not native to the Bay and have been transported here in ballast water of ships, or on the shells of oysters brought from the east coast for commercial farming in the late 19th century (Carlton 1979). Among the common introduced species in the Bay are *Mya arenaria, Gemma gemma, Musculatia senhousia*, and some species of *Corophium*. The Asian clam (*Potamocorbula amurensis*) was introduced in the mid-1980s and has been increasing in abundance throughout the Bay in recent years. It is now one of the dominant benthic organisms in many areas (Monroe and Kelly 1992, Thompson and Peterson 1998).

Eelgrass beds have been surveyed and mapped within the project area. Eelgrass is an important habitat for many organisms and may influence benthic community structure by creating a refuge and nursery for small organisms, stabilizing sediments, producing organic matter, and exporting detritus (Phillips 1988). Eelgrass can provide a substrate for spawning of Pacific herring.

Macroinvertebrates and Fish. The open water communities of the Bay are comprised of large, free swimming invertebrates and fish, including many commercially and recreationally important species. Free swimming invertebrates in San Francisco Bay consists mainly of shrimp, euphausids, and other crustaceans. Common shrimp species include *Crangon franciscorum, C. nigricauda, Palaemon macrodactylus*, and *C. nigromaculata* (Hatfield 1985). Bay shrimp are important forage for some species of fish, including sturgeon and striped bass (Smith and Kato 1979).

Examples of fish species common to Central Bay include northern anchovy, topsmelt, jacksmelt, striped bass, white croaker, Pacific herring, and English sole.

Marine Mammals. Open water areas and intertidal mud flats provide foraging habitat for marine mammals including the California sea lion and the harbor seal. These species are protected by the Federal Marine Mammals Protection Act.

Special Status Species. Several listed species of fish may occur in the area as well as two species of special concern. In addition, the marine mammals described above are protected. These species are shown in Table 4-4.

Water Quality

Surface water quality in the vicinity of the East Span is expected to be generally similar to that found at nearby RMP sites. The RMP has monitored water quality at several stations in Central San Francisco Bay in the vicinity of the project area. Table 4-5 presents the range of values from four stations: Alameda, located south of the bridge; Point Isabel, located north of the bridge in the Central Bay; Yerba Buena Island, located near the existing East Span and Horseshoe Bay, located north of the bridge toward the Golden Gate Channel.

Table 4-4
Special Status Species in the Vicinity of SFOBB East Span

Species/Resource	Federal[a]	State[b]
Harbor seal *(Phoca vitulina)*	MMPA	NA
California sea lion *(Zalophus Californianus)*	MMPA	NA
Central California-coast steelhead *(Oncorhynchus mykiss)*	T	SC
Central California-valley steelhead *(Oncorhynchus mykiss)*	PE	SC
Winter-run chinook salmon *(Oncorhynchus tshawytscha)*	E	E
Spring-run chinook salmon *(Oncorhynchus tshawytscha)*	PE	SC
Fall-run chinook salmon *(Oncorhynchus tshawytscha)*	PT	SC
Longfin smelt *(Sprinchus thaleichtys)*	SC	SC
Green sturgeon *(Acipenser medirostris)*	SC	SC

Source: Caltrans 1998.

[a] Federal

E: Listed as endangered under the Federal Endangered Species Act
T: Listed as threatened under the Federal Endangered Species Act
PE: Proposed as endangered under the Federal Endangered Species Act
PT: Proposed as threatened under the Federal Endangered Species Act
SC: Federal species of concern; USFWS lacks sufficient information to support a listing proposal
MMPA Marine Mammal Protection Act

[b] State

E: Listed as endangered under the California Endangered Species Act
SC: California species of special concern
NA: No state status

Table 4-5

Central San Francisco Bay Surface Water Concentrations

Pollutant	Range of Concentrations	Water Quality Objective
Salinity	5-32 ppt	Controllable water quality factors shall not increase salinity of waters so as to adversely affect beneficial uses.
Total Suspended Solids	2-25 µg/L	Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.
Dissolved Organic Carbon	960-3,840 µg/L	No objective
Nutrients: ammonia	10.92-159.46 µg/L	Annual mean 0.025 mg/L, maximum 0.16 mg/L
nitrite	185.64-487.34 µg/L	No objective
nitrate	9.24-58.8 µg/L	No objective
phosphate	59.83-207.7 µg/L	No objective
Trace Elements: arsenic	1.3-2.1 µg/L	4-day average 9.3 µg/L, 1-hour average 69.0 µg/L
cadmium	0.030-0.10 µg/L	4-day average 9.3 µg/L, 1-hour average 43.0 µg/L
chromium	0.1-3 µg/L	4-day average 50.0 µg/L, 1-hour average 1100.0 µg/L
copper	0.3-3.3 µg/L	1-hour average 4.9 µg/L
lead	0.03-0.9 µg/L	4-day average 5.6 µg/L, 1-hour average 140.0 µg/L
nickel	0.5-7 µg/L	24-hour average 7.1 µg/L, instantaneous 140.0 µg/L
zinc	0.09-8 µg/L	24-hour average 58.0 µg/L, instantaneous 170.0 µg/L

Source: Caltrans District 4, April 1998 (Data from SFEI 1995).

Note: µg/L = microgram per liter

This section discusses the options carried forward from Section 4 in terms of implementability, environmental effects (biology and water quality), and potential costs. This information will be used in the decision-making process (Section 6) to select a recommended reuse/disposal option.

5.1 ALCATRAZ (SF-11)

Implementability

The Alcatraz disposal site (SF-11) is the closest disposal site to the East Span Project area, 6.5 to 10 kilometers (4 to 6 miles) away. This option would likely use smaller transport barges (e.g. 2,293 m^3 [3,000 cy] capacity) for ocean disposal (see below) and trips to the disposal site would likely be more frequent.

The site can accept a total of 305,810 m^3 (400,000 cy) per month between October and April and 299,357 m^3 (300,000 cy) per month between May and September. This site has the physical capacity to accept most of the material generated on the East Span Project, depending upon the exact timing of dredging. Since other dredgers use this site and the volume limitations above represent total volumes for all dredgers, the actual volume that could be discharged here would depend on other existing disposal allotments scheduled for the site. The BCDC Road Map lists expected volumes to be discharged by various dredgers.

Although this site is available and is used regularly by Bay Area dredgers, it is generally reserved for disposal of "maintenance" dredging projects only. Maintenance dredging is performed to keep existing channels and marinas at permitted depths. Sediments dredged during maintenance dredging activities are usually recently deposited and relatively unconsolidated materials. "New work" projects are those that involve dredging areas which have not been previously dredged or deepening to depths not previously achieved. Sediments dredged from these projects can be older deposits which can be much more consolidated than recently deposited material. The DMMO has suggested that the East Span Project may not qualify as "maintenance" dredging and thus may not qualify for disposal at SF-11. However, the BCDC Road Map for dredged material disposal in the Bay accounts for disposal of approximately 189,602 m^3 (248,000 cy) of sediment from the SFOBB Retrofit Project, which is the Retrofit Existing Bridge Alternative in the DEIS.

Effects

Biological Resources

Plankton. Dredged material disposal can result in an increase in water column turbidity. The potential effects of increased water column turbidity during disposal operations can include: decreased phytoplankton productivity due to reduction of light penetration; and decreased survival, growth rates, and body weights of zooplankton resulting from clogged and damaged feeding appendages. The extent of these effects depends on the proportion of fine-grained sediments in the dredged material. Turbidity increase during disposal is localized, and most of the disposed material settles to the bottom within minutes to a few hours. Because most of this material settles rapidly, reductions in light attenuation and associated reduction in primary productivity is expected to be short term from a single disposal event. This site is used by many dischargers and the severity of impacts would depend on the frequency of use. At low disposal

volumes and frequencies the cumulative effects of disposal are expected to be negligible (LTMS 1998).

Toxic effects caused by contaminants associated with suspended sediments are not expected to occur because only material that has been determined to be suitable for unconfined aquatic disposal may be disposed of at this site. Sediments are required to be tested prior to disposal.

Benthos. Disposal at SF-11 can also result in the burial of benthic organisms. The potential impacts would depend on the amount of disposed material, frequency of disposal, rate of accumulation, and the types of organisms present. Severity of impacts to benthic organisms would depend on the frequency of disposal events and the volumes disposed of. This site is actively managed (by limitations on the amount and type of materials disposed here) to avoid mounding of materials. Some burial of and degradation of benthic habitat is expected, particularly during high frequency disposal operations. Benthic habitats are expected to recover as disposal volumes at this site are reduced.

Fish. Impacts of dredged material disposal on fish from increased suspended solids include impaired oxygen exchange due to clogging or laceration of gills, reduced food availability due to burial of benthic organisms, reduced visibility for foraging activities, and burial of slower-moving bottom fish (Port of Oakland 1998). Fish that are highly mobile are expected to avoid the disposal plume. Localized effects have been documented around Alcatraz where some fish species have been observed to avoid the area for 2 to 3 hours following a disposal event (LTMS 1998). Many of the species of bottom dwelling fish should also be able to avoid burial during the disposal, although they may be displaced from the area until the disposal area is recolonized by prey species. The displaced fish should be able to feed in adjacent areas. Toxic effects and bioaccumulation in fish are also not expected at this site because only suitable materials can be disposed of here.

Special Status Species. Special status species that potentially occur near the site include Chinook salmon and Pacific herring. Impacts to these species are minimized with monthly volume limits on disposal during critical migration periods when these species might be present.

Water Quality

Water quality parameters potentially impacted by dredged material disposal at Alcatraz include suspended solids, dissolved oxygen, and concentrations of contaminants.

Total Suspended Solids (TSS). Suspended particulates in the water column following disposal can result in the potential for adverse effects on biota, particularly fish. Effects can include clogging of the gills and laceration of the gills, impeding uptake of oxygen. Increased turbidity from each disposal event is not considered significant by the COE, however the cumulative effect of several disposal events over a short time frame may result in substantial elevations of near-bottom turbidity levels (LTMS 1998).

Dissolved Oxygen. Dissolved oxygen levels at the site are generally high. Dissolved oxygen concentrations in the water column, and particularly near the Bay bottom, may potentially decrease during disposal if chemical oxygen demand is increased by the presence of inorganic compounds associated with the dredged material. The effects would generally be short-term and localized (LTMS 1998).

Metals and Other Contaminants. Because only dredged material found suitable for unconfined, aquatic disposal would be deposited at SF-11, adverse impacts on site water by contaminants are not anticipated. Analysis of sediments specific to the proposed alignment of the East Span Project have not been conducted, but a sampling and analysis plan is being prepared and results will be available before dredging occurs. Sampling and analyses of sediments near the existing East Span indicated that most of the material was suitable for disposal at SF-11.

Costs

Disposal costs for SF-11 were estimated at $5.35 per m^3 ($7 per cy). This assumes the use of 2,294 m^3 (3,000 cy) dump scows, single propeller tugs to move the barges to the location, and all labor and mobilization fees averaged over the time frame of the project. This cost does not include dredging and excavation operations. The assumptions used to calculate the disposal costs are included in Appendix B of this report. All costs are shown in first quarter 1999 dollars and include a 25% contingency factor.

5.2 DEEP OCEAN DISPOSAL (SF-DODS)

Implementablity

As described in Section 4, SF-DODS is approximately 55 nautical miles from the proposed dredging location. The site can accept up to 3,669,725 m^3 (4.8 mcy) per year, and could accept all material from the proposed dredging activities for the East Span Project. This site has been used in the past for several dredging projects. One of the requirements of the use of SF-DODS will be to conduct post-disposal monitoring. If other dredging projects are using this site during the same time frame as the East Span Project, costs for monitoring (estimated at approximately $770,000 per year) could be shared between Caltrans and the other parties. Material would be transported to this site in 5,352 m^3 (7,000 cy) barges.

Effects

Biological Resources

Plankton. Dredged material disposal results in an increase in suspended particulates and a corresponding increase in turbidity within the water column. During disposal, potential effects of increased water column turbidity can result in decreased phytoplankton primary productivity due to reduction of light penetration; entrapment and sinking of plankton due to ingestion by or adhesion of particles to the plankton; and decreased survival, growth rates, and body weight concentrations of zooplankton resulting from clogged and damaged feeding appendages (Port of Oakland 1998). The extent of these effects depends on the proportion of fine-grained sediments in the dredged material, which tend to remain suspended within the water column for longer periods than coarser material. EPA has shown that turbidity increase during disposal is localized, and most of the disposed material settles to the bottom within a few hours. Because most of this material settles rapidly, reductions in light penetration and associated reduction in primary productivity would be minor and short term. Effects are expected to last only until the plume dissipates.

Toxic effects caused by contaminants associated with suspended sediments are not expected to occur, because only material that has been determined to be suitable for unconfined aquatic disposal would be disposed of at this site. Sediments are required to be tested prior to disposal.

Potential impacts on the plankton community, such as decreased productivity, growth, survival, and other effects as a result of increased turbidity, are expected to be minimal and only temporary since the dredge plume dissipates relatively quickly within hours.

Benthos. Disposal of dredged material at this site would result in impacts to benthic organisms due to burial. The potential impacts would be dependent on the amount of disposed material, frequency of disposal, rate of accumulation, and the types of organisms present. Burrowing organisms would likely be less impacted or could withstand slightly deeper burial than surface and suspension feeding organisms, which do not possess a strong ability to burrow upward through newly deposited sediments. The Port of Oakland EIS (Port of Oakland 1998) contained information suggesting that average critical burial depths ranged from 5 centimeters (2 inches) for surface feeders to 30 centimeters (12 inches) for active burrowers. Ten centimeters (4 inches) was treated as the critical thickness in the Port of Oakland studies since many of the surface and suspension feeders are also organisms that would rapidly recolonize after a disturbance.

EPA has modeled the dispersion characteristics at SF-DODS for disposal of 4,587,155 m^3 (6 mcy) of sand, silt, and clay over a period of one year. Their results indicated that the footprint of the disposed material was less than 10 centimeters (4 inches) thick over most of the disposal site. The results of modeling disposal of 1,223,241 m^3 (1.6 mcy) at one time indicated that a mound approximately 27 centimeters (11 inches) thick would form at the center of the site. Monitoring results for disposal of 588,685 m^3 (770,000 cy) from Navy projects showed that over a four month period, actual accumulations were approximately 1 to 3 centimeters (.39 to 1.2 inches) over most of the site and 5 to 16 centimeters (1.9 to 6.3 inches) near the center. Biological activity continued at nearly all locations and benthic organisms were recolonizing at a faster rate than anticipated.

The East Span Project would result in disposal of considerably less than what has been both modeled and monitored at the site as described above. The East Span Project would place up to 447,630 m^3 (585,400 cy) (upper limit; refer to Table 3-1) of sediment, which is approximately 10 percent of the 4,587,155 m^3 (6 mcy) analyzed above. The total amount of sediment from the East Span Project would also be placed over an approximate four year period, rather than a one-year period, as was previously studied. Total accumulation of sediments could be expected to be proportionately less.

Impacts to benthic organisms are expected to be limited to areas that are covered by more than 10 centimeters (4 inches) of material which will likely be limited to a central mound that may be formed at the release site. These effects are expected to be temporary as recolonization occurs. The Port of Oakland indicated that they expected disposal of 5,275,229 m^3 (6.9 mcy) over four years to result in only localized, short term effects to the benthos for most of the site. Toxic effects are not expected as the material could not be placed at this site if was not deemed suitable for aquatic disposal after a series of chemical and toxicity tests to be conducted as part of the East Span Project Sampling and Analysis Program.

Fish. As described for the Alcatraz site, potential impacts of dredged material disposal on fish from increased suspended solids include impaired oxygen exchange due to clogging or laceration

of gills, reduced food availability due to burial of benthic organisms, reduced visibility for foraging activities, and burial of slower-moving bottom fish (Port of Oakland 1998). However, fish, which are highly mobile, are expected to avoid the disposal plume so that effects of turbidity are expected to be negligible. Many of the species of bottom dwelling fish should also be able to avoid burial during the disposal, although they may be displaced from the area until the disposal area is recolonized by prey species. The effects of this temporary displacement are expected to be minimal because the displaced fish would be able to feed in adjacent areas. Although some of the more sedentary species present may have more difficulty avoiding burial, fish densities and biomass are low at the site, and potential impacts are expected to be localized and minimal.

Toxic effects and bioaccumulation in fish are also not expected at this site because only suitable materials can be disposed of here.

Mammals and Birds. Impacts to marine mammals and birds in the vicinity of the disposal site are expected to be localized and temporary. Impacts include reduced visibility for foraging activities, reduction in available prey and alteration of passage routes to avoid the turbidity, and ship traffic. Although reductions in water clarity due to increased turbidity during disposal may limit the foraging efficiency of both birds and mammals, reductions in clarity are generally concentrated at the release site, and are of short duration (several hours). Availability of prey items, such as fish, krill, and other zooplankton, may be temporarily reduced in the disposal area because these organisms likely would escape or avoid the disposal plume. Foraging success within the immediate disposal area may be limited temporarily, although birds and mammals are capable of foraging in unaffected areas within the region and should not be significantly affected by any reduction in prey. Feeding activities and passage routes might be altered during disposal operations due to increased ship traffic.

Special-Status Species. As discussed in Section 4, special-status species that have the potential to occur at the SF-DODS and vicinity include winter-run Chinook salmon, central California steelhead trout, California brown pelican, American peregrine falcon, California sea lion, Steller's sea lion, humpback whale (*Megaptera novaeangliae)*, blue whale (*Balaenoptera musculus)*, fin whale (*Balaenoptera physalus)*, and sperm whale (*Physeter macrocephalus)*. Proposed disposal activities could impair visibility for foraging and rescue food availability within the disposal area, which could alter normal feeding or passage activities, however, as discussed above, impaired visibility and reduced food availability would be temporary and localized at the release site.

The listed species range widely and forage throughout the region, so reduction of food supplies in the disposal area would be insignificant. Many of the pinniped species typically forage and range over the continental shelf waters, so few would be affected by disposal activities. Additionally, whales and pinnipeds are highly mobile and are capable of avoiding the dredge plume. Therefore, potential impacts to special-status species are expected to be minimal.

Measures to reduce impacts on the biological community in general at the SF-DODS include accurate positioning to ensure that dredged material is confined within the disposal site boundaries so that adjacent communities are not affected. Measures would also include monitoring the disposal operations and potential effects on the existing pelagic and benthic communities according to the monitoring program specifically designed for SF-DODS and for individual projects using this site. The monitoring program outlined in the EIS for the EPA

Section 102 deep water ocean disposal site (EPA 1993) and the Site Management and Monitoring Plan (SMMP) Implementation Manual for the ocean disposal site (EPA 1998) specify monitoring for both long- and short-term (project-specific) impacts of dredged material disposal.

Water Quality

Local and regional hydrodynamics influence the dispersion and fate of dredged material discharged at SF-DODS. The dispersion of sediment particles can affect water quality conditions. The discussions that follow are based on disposal plume modeling performed by the EPA and the U.S. Navy and summarized by the Port of Oakland (1998).

Disposal of dredged material at the SF-DODS would result in temporary and localized disturbance of water column stratification. Ocean currents, however, would not be affected. Local hydrodynamics can, however, have an effect on the material being disposed by eroding and spreading materials. Near-bottom currents at the site are generally less than 1 cm/sec, although tidal currents may be significantly (up to five times) higher, though these higher velocities have little potential to erode material on the bottom. Periodic turbidity flows (down-slope movement of sediments) may be more significant in eroding and transporting sediments in the vicinity of the SF-DODS though this is not considered an impact.

Water quality parameters potentially affected by dredged material disposal at SF-DODS include salinity, temperature, pH, nutrients, dissolved oxygen, suspended solids, and concentrations of contaminants.

Salinity, Temperature, and pH. Changes in salinity temperature, and pH of ambient waters would occur as the disposed material descends to the bottom. Entrainment of site waters in the disposal plume would cause minimal, localized, and short-term impacts of these parameters at the SF-DODS site.

Nutrients. The addition of nutrients (especially nitrogen and phosphorus) to the area during disposal operations may cause enhanced production of plytoplankton. Increased turbidity resulting from disposal, however, would reduce light transmittance and, as a result, tend to depress primary production. This net effect is expected to be small, transient, and localized within the discharge plume.

Dissolved Oxygen. Dissolved oxygen concentrations in the water column may potentially decrease during disposal if chemical oxygen demand is increased by inorganic compounds that may be associated with the dredged material.

The effects may be most pronounced in the "oxygen minimum zone" (at about 800 meters [2,625 feet]) where ambient oxygen levels are less than 1.09 mg/L. The potential reduction in dissolved oxygen is expected to be restricted to the dredged material plume. Because of the small ratio of disposed volume to volume of receiving waters, it is unlikely that the oxygen content and deep ocean waters would be affected. Therefore, reduction in dissolved oxygen concentrations in the water column would be a temporary impact.

TSS. Similar to the effects from dredging sediments, suspended particulates in the water column following disposal can result in the potential for adverse effects on biota, particularly fish. Excessive particulates in the water can clog the gills of fish and impede uptake of oxygen. The

modeling of dredged material disposal at the ocean site conducted by the Corps of Engineers and described in Port of Oakland (1998) indicated that the exposed elevation of suspended particulate concentration after a 4-hour initial mixing period would be approximately 40 mg/L. Actual measured concentrations were lower, ranging from 19.9 mg/L to 24.2 mg/L. The sediment plumes at SF-DODS ceased to be detectable approximately two nautical miles from the release point, and TSS measured at the boundary of the site four hours after release could not be distinguished from background. These field measurements indicated that the material that remained in the water column was dispersed rapidly. The effects of suspended sediments on fish and shellfish summarized in the literature indicated that biological effects were not noted for concentrations below 1,500 mg/L. No significant effects on the hatching success of herring were noted at concentrations as high as 5,000 mg/L. Based on this information, impacts within the water column caused by suspended sediment alone would not likely be substantial.

Metals and Other Contaminants. Biological uptake of chemical constituents could occur at the ocean site. However, because only dredged material found suitable for unconfined, open-water disposal would be deposited at SF-DODS, significant adverse impacts on site water by contaminants are not anticipated. Analysis of sediments specific to the proposed alignment of the East Span Project have not been conducted, but a sampling and analysis plan is being prepared and test results will be available before dredging occurs. Sampling and analyses of sediments near the existing bridge indicated that most of the material was suitable for aquatic disposal.

The SMMP Implementation Manual for SF-DODS (EPA 1998) provides a basis for making site use management decisions using data collected in a tiered monitoring program. The plan was devised to avoid or mitigate adverse environmental impacts at and adjacent to this site. The SMMP also lists several provisions for site use that have been incorporated into the disposal site use permit (in the MPRSA Section 103 process) that aim to (1) restrict the inadvertent disposal of material in transit to SF-DODS, (2) define a target for material release, and (3) provide guidelines for compliance monitoring of these restrictions (Port of Oakland 1998).

Following dredged material placement, a tiered monitoring program would be required to address the effects of dredged material on the marine environment.

Costs

Disposal costs for SF-DODS were estimated at $9.18 per m^3 ($12.00 per cy). This does not include the cost of dredging/excavation of the material. Disposal costs were estimated assuming the use of 5,352 m^3 (7,000 cy) barges, twin propeller tugs to move the barges, and an approximately 20 hour round trip tow time. Monitoring the site for one year (approximately $770,000 per year) has also been incorporated into this estimate. This assumes that if this site is used for a longer period of time, monitoring costs can be shared with other users. Assumptions used for determining disposal costs can be found in Appendix B.

5.3 UPLAND WETLAND RESTORATION SITES

5.3.1 Hamilton Wetlands Restoration

Implementablity

The Hamilton Wetlands Restoration project is managed by the California Coastal Conservancy and BCDC. The City of Novato is managing the contracts for preparation of a conceptual restoration plan. The site is not currently permitted for placement of dredged material. Technical studies have been conducted, and NEPA/CEQA environmental documentation is currently being prepared for the project. A Draft Environmental Impact Statement/ Environmental Impact Report (EIS/EIR) was circulated in August 1998 and the Final EIS/EIR was released in February 1999. Under the preferred alternative, up to 6,422,018 m^3 (8.4 mcy) of dredged material could be used to restore the wetland. Materials must be "clean" and classified as cover material suitable for wetland creation.

Funding for construction of the project is included in the Water Resources Development Act (WRDA) that is currently before the U.S. Congress. If WRDA is passed this year, the Coastal Conservancy believes that the project could begin accepting dredged material by about midyear 2000. If the vote on WRDA is postponed, the Hamilton project might not begin until the year 2001, and would be unavailable to accept sediments during at least the first portion of the East Span Project.

This site is approximately 29 kilometers (18 miles) from the East Span Project site. To place material at this site, barges (2,293 to 3,823 m^3 [3,000 to 5,000 cy]) would dock offshore in San Pablo Bay at a barge mounted pumping station. Sediments would be pumped as a slurry (sediment/water mix) through an approximately 8 kilometer (5-mile) pipeline to the site. The pumping facilities are planned as part of the project to be used primarily for reuse of sediments from federal navigation dredging projects. If the federal projects begin before the East Span Project, the pumping facilities would already be in place and Caltrans would need to pay only the costs of the crew used to operate the equipment and other operational costs such as electricity (pers. comm. Steve Goldbeck, BCDC). If Caltrans wishes to place sediment prior to deployment of the equipment for the federal projects, then the costs for deployment of the equipment, as well as operational costs, would be borne by Caltrans. In addition, the pumping equipment will not likely be continuously deployed at the site. Caltrans would need to schedule sediment deliveries during times when the equipment is on-site in order to avoid deployment costs.

Current estimates of dredge quantities for the East Span Project indicate that a maximum of approximately 93,000 m^3 (122,000 cy) per month would be placed during months 4 to 6 of the project. This quantity could be easily handled at the Hamilton site with proper scheduling of barge arrivals.

Effects

Biological

The biological impacts of the five alternatives for the Hamilton Wetlands Restoration project have been assessed in a Draft EIS/EIR dated August 1998. The results of this analysis are

summarized below for the preferred alternative. This alternative would restore the airfield as well as State Lands Commission property to the north, using dredged materials in the restoration. Impacts from placement of dredged material at the Hamilton site would not be attributable specifically to the reuse of the East Span Project material because the site would be used for other projects regardless of whether Caltrans placed material here. Mitigation measures for the site are the responsibility of the project sponsors.

The majority of biological effects of the Hamilton Wetlands Restoration are related to temporary construction impacts to habitats and special status species. During construction activities, certain habitat types may be disturbed, including coastal salt marsh and brackish marsh. With required mitigation, these habitats will generally be reestablished in greater amounts or impacts would be minimized through avoidance. Impacts to special status species are generally related to habitat disturbances. These impacts will be minimized by monitoring marsh development and implementing measures to increase the rate of marsh development, if necessary. At the stage of site preparation, direct impacts to special status species will be minimized by avoiding levee construction or alteration during critical seasons and surveying for the presence of special status species before construction is initiated. Impacts and mitigation associated with the Hamilton project, regardless of the source of the dredged material, would be the responsibility of the Hamilton project sponsor.

Water Quality

Hydrology and water quality impacts from the Hamilton Wetlands Restoration are expected to be minor. Lands adjoining the HAAF parcel are drained by a series of pipes and channels. The New Hamilton Partnership owns lands adjacent to HAAF and has recently constructed a stormwater pumping station near the southwest corner of the parcel. Restoration of tidal wetlands would encroach on the drainage outlet channel for the New Hamilton Partnership property. The Hamilton Wetlands Restoration project design will allow for drainage.

Surface and groundwater quality impacts are all expected to be less than significant. Sediments accepted for reuse at this site will only be clean "cover" material and will need to meet RWQCB screening criteria.

Costs

A number of variables will govern the costs for reuse at the Hamilton Wetland Restoration Project. For example, the number of pump stations available, pumping capacity, the need to mobilize pumping equipment, and schedule with other users of the site may alter costs. Costs for this site were estimated assuming that mobilization of a pumping station at the beginning of the East Span Project will be necessary. If federal navigation dredging projects have already begun, the pump station(s) may already be in place and costs might be somewhat less. The estimate also assumes the use of 2,293 m^3 (3,000 cubic yard) barges and a pumping capacity of about 2,293 m^3 (3,000 cubic yards) per day. All labor for transport, offloading, and other equipment mobilization fees were included. It is assumed however, that once material is offloaded at Hamilton, no costs to Caltrans will be incurred to move material around the site itself.

Based on these assumptions, costs were estimated at $17.59 per cubic meter ($23.00 per cubic yard) averaged over the life of the project. This cost does not include dredging. Assumptions used for determining disposal costs can be found in Appendix B.

5.3.2 Montezuma Wetlands Project

Implementability

The Montezuma Wetlands Project (MWP) is located in the Suisun Marsh near Collinsville. This approximately 970 hectare (2,400 acre) site is a privately sponsored project. Impacts related to placement of dredged material at the Montezuma site would therefore not be specifically attributable to the reuse of the East Span Project material because the site would be used for other dredging projects, regardless of whether Caltrans placed materials here. The project sponsor proposes to restore tidal wetlands by placing approximately 15,290,519 m^3 (20 mcy) of dredged material over approximately 728 hectares (1,800 acres) of the site.

Use of this site would require transporting material approximately 50 miles by barge. The site will be able to accept both cover and non-cover materials. In other words, some material accepted at this facility may not be suitable for aquatic disposal or wetland creation. This material would be placed first and covered with cleaner material. All of the infrastructure, including pumping stations, pipelines for sediment placement etc., would be developed by the project sponsor. The project will also include a rehandling/drying facility. Material would be transported by barge (2,293 to 3,823 m^3 [3,000 to 5,000 cy]) to the site and the project sponsor would handle the material from that point on. Costs for receiving the sediment would be offset by a tipping fee to be charged by the project sponsor.

A Final EIS/EIR has been prepared, although permits have not yet been approved for this site. There has been significant public opposition to this project, due to concerns regarding handling of "non-cover" material. Mitigation was incorporated and the Solano County Board of Supervisors has recently approved the project. Permitting will now begin and the project sponsors expect to begin accepting sediments by late 1999 (Doug Lipton, Levine Fricke pers. com.). It should be noted however that a lawsuit has recently been filed by environmental groups opposed to the project. The effect on the timing of the opening of the Montezuma site is unknown.

Effects

Biological

Potential impacts to biological resources during implementation of the project are fully described in the MWP Final EIR/EIS and are summarized here. If the Montezuma Project goes forward, these impacts would occur regardless of whether Caltrans places sediments at the site since the project would be accepting dredged material from other sources as well. Impacts and mitigation associated with the Montezuma project, regardless of the source of dredged material, would be the responsibility of the Montezuma sponsor.

Some of the potential biological impacts associated with the Montezuma site relate to the proposal to accept material classified as "non-cover." "Non-cover" material is material that is

not considered hazardous by California Code of Regulations Title 23 standards, but does contain low concentrations of contaminants which make it unsuitable for aquatic disposal. Impacts at the MWP range from potential exposure of wildlife to non-cover sediments before the material has been covered with cleaner material, to the potential for plant uptake of contaminants and subsequent reintroduction of the contaminants into the food chain. These risks are considered low, but potentially significant if they occur. It is believed that these impacts can be minimized through proper placement of non-cover materials and careful monitoring of potential bioaccumulation. If adverse effects are indicated during operation of the project, areas would be remediated by techniques such as additional capping, isolation of the area, or bioremediation techniques.

Other potential impacts relate to loss of existing habitat at the site and/or changes in habitat functions and values which may affect the support of listed species occurring at the site. For example, the project would eliminate or alter habitat supporting the salt marsh harvest mouse and burrowing owl. Mitigation would be implemented to create or enhance similar habitat both on-site and at off-site locations, at ratios negotiated with the wildlife resource agencies.

Successful restoration of tidal shallow water, wetland habitats, and habitats supporting sensitive species could provide significant ecological benefits.

Water Quality

Potential impacts to water quality and hydrology during implementation of the project are fully described in the MWP Final EIR/EIS. Impacts and mitigation associated with construction and operation of the Montezuma project, regardless of the source of dredged material would be the responsibility of the project sponsor.

Water quality impacts include the potential for erosion of placed sediments in any non-cover material and a subsequent release of contaminants into the water. To mitigate for this, areas containing non-cover materials would be isolated using levees created of cohesive clays and slopes designed to minimize erosion potential.

The project proposes to use water from the Sacramento River to create sediment slurries for off-loading and placement of the material. Excess water would be discharged to the river and if contaminated, could exceed water quality standards. Water would be stored in a pond prior to discharge to the river. Water in the water pond would be monitored and measures including increased settling time and treatment would be implemented prior to releasing the water back to the river. The project operators would be responsible for water quality monitoring and for meeting water quality objectives.

All of the impacts associated with the Montezuma project would be attributed to that project and would not be a result of reuse/disposal of materials from the East Span Project at this site.

Costs

Costs for reuse of dredged material at the MWP were estimated at \$35.17 per m^3 (\$46.00 per cy). This cost includes a \$12.23 per m^3 (\$16.00 per cy) tipping fee that the MWP will charge users. This assumes the use of 3,000 yard barges. Five barges would be needed to meet the cycle times to and from this site. The cost does not include mobilization or labor for offloading the sediment

at the site. It is assumed that these costs are incorporated into the $12.23 per m^3 ($16.00 per cy) tipping fee. Assumptions used for determining disposal costs can be found in Appendix B.

5.4 LANDFILL DISPOSAL

Implementability

Several factors should be considered with respect to implementation of the landfill disposal option. Since the material will be dredged from the bottom of the San Francisco Bay it will be saturated upon removal. In this condition it is too wet to be hauled by truck and too wet to be acceptable as fill or cover at any landfill.

Therefore some provision is required to dry and stockpile the material prior to transport. This will require multiple handling of the material. It must first be loaded onto a barge then off-loaded to a receiving area where it must be "worked" with heavy equipment in order to obtain a suitably low moisture content for transport and disposal. As described in Section 4, the Port of Oakland Berth 10 facility or a portion of the Oakland Touchdown could potentially be used as temporary rehandling sites.

At this point the material can be loaded onto tarped end-dump trucks with approximately 9.2 m^3 (12 cy) of capacity given the nature of the material. This would require a substantial number of truck trips to transport all of the material. Near the beginning of the project, approximately 3,100 m^3 (4,000 cy) per day will be dredged. If this material were dried and trucked to a landfill site at the same rate, this would amount to approximately 340 truck trips per day.

Effects

The landfill disposal option would use existing permitted facilities constructed and operated specifically for this purpose. Through their respective permitting processes, each of these facilities has already met applicable federal, state and local requirements to assess and mitigate against adverse effects to the environment and the public health and safety. Therefore, this option would not introduce new effects which would merit consideration. This option could be exercised under existing operating permits excepting any routine transportation permits which may be required.

Impact to Longevity

Use of landfill for disposal of dredged materials raises concern about the impact of such disposal on the longevity of the landfill and the indirect impact upon a county's future landfill capacity. Those concerns can be shown as negligible on the basis of the most conservative assumptions of a single landfill and accommodation of all dredged material (as clean cover or disposal fill). According to discussions with Redwood Landfill personnel, the total amount of material is not expected to shorten the life of Bay Area landfill capacity even if all material were to be transported to landfills (Joseph Lynch, Redwood Landfill, personal communication, on 2/24/99). Using the throughput of 2,970 m^3/day (2,300 cy/day), representative of the Redwood landfill facility, it would take 0.56 years, or between 6 and 7 months, to dispose of the entire volume. Given a 50-year lifetime for the Redwood facility, the hypothetical case of the exclusive disposal

of all material at a single landfill would reduce that landfill capacity by approximately one percent. Therefore, disposal of all material or of a fraction of it would not have a substantial impact on the overall landfill capacity of the Bay Area counties.

Costs

Based on discussion with several Bay Area landfill operators, the costs for upland disposal will vary depending on the location chosen due to transportation, handling and other costs. Assuming use of a Class II landfill which can accept non-hazardous and designated wastes, costs were estimated at $59.63 per cubic meter ($78.00 per cubic yard).

Material taken to these facilities must be dried before it can be handled. This requires double handling of the material; after dredging, the material must be taken to a facility where it is spread and mixed in order to dry it to the point where it can be placed on trucks for hauling to the facility. The cost estimate assumes that a 4 hectare (10 acre) rehandling facility, such as the Port of Oakland's Berth 10 rehandling facility or a location on the Oakland touchdown, would be available. No costs have been included for a rehandling facility.

On rare occasions and depending upon the immediate needs of a given landfill, a landfill operation may pay a small price (e.g., generally less than $3.80 per cubic meter [$5 per cubic yard]) for clean cover material. In most cases, the best a landfill will offer for clean cover material is to dispose of the material without a charge from the landfill. Waste Management, a company that owns and operates several landfills in the Bay Area, may be closing one of its facilities soon, in which case it may need relatively large quantities of clean material to cap the landfill. Depending on the timing of the landfill closure (uncertain at this time) and the East Span Project dredging, this may be an option for the use of clean dredged materials.

Costs for drying, handling, and trucking the material would still be incurred. The amount that might be paid for the material would likely be more than offset by the costs of handling required for this option. Assumptions used for determining upland disposal costs can be found in Appendix B.

5.5 SIDECASTING

Implementability

As discussed in Section 3, sidecasting would involve placing the dredged material near the dredged channel. Sidecasting, if approved, would only be used during dredging for construction and dismantling access channels. Sediments removed for pier construction would still be taken to an approved reuse/disposal site. Sidecasting might be useful if sediments must be replaced in the dredged access channels after construction/dismantling operations are complete.

There are two approaches to sidecasting. The first method would pump sediments as a slurry through a pipe to the desired location next to the channel. The second method would place clamshelled material onto a barge. The barge would then move to the side of the dredged channel and the material would be placed back into the water using a clamshell bucket. Slurry pumping would be the most cost effective method, but would also create the largest sediment

plume and greatest impacts to water quality and biological resources. The second method is significantly more expensive due to double handling of the material.

Effects

Impacts of sidecasting would be generally similar to those already described for disposal at Alcatraz (SF-11) and offshore (SF-DODS). The primary impacts would be increased turbidity with associated water quality effects such as temporarily decreased dissolved oxygen levels, and burial of benthic organisms. Increased turbidity in the area from sidecasting would be in addition to turbidity created during the sediment removal operations. Fish and mammals in the area are expected to avoid the turbidity plume. The extent of the turbidity plume and length of time it is expected to persist would depend upon local conditions of wind and current at the time the material is placed and the method used for sidecasting. As discussed above, pumping slurried material back in to the Bay is expected to create a much larger turbidity plume than placement of clamshelled material.

This method may create cumulative impacts in that the impacts from dredging and disposal would occur in the same vicinity. If material needs to be placed back into the dredged channels to refill them, impacts similar to those described for dredge material disposal would occur during the refilling operations.

Turbidity caused by sidecasting could affect migrating special status fish species including Chinook salmon and steelhead, as well as other important species or species of special concern including green sturgeon, longfin smelt and Pacific herring. Dredging with sidecasting would need to be conducted during times when special status species (e.g., Chinook salmon) would be least affected or dredging activities would be temporarily curtailed during spawning. Silt curtains may also be used during dredging and sidecasting operations to contain the sediment plume as much as possible.

There are extensive eelgrass beds in the vicinity of the Oakland Touchdown (See Figures 3-2 through 3-4). Eelgrass is somewhat rare in San Francisco Bay and is important to the ecosystems because Pacific herring attach eggs to the plants during spawning. The eelgrass could be impacted by sidecasting due to the potentially high turbidity levels causing sedimentation on the plants and reduced light penetration which can reduce photosynthetic activity and diminish plant growth and reproduction.

Costs

The cost of sidecasting was estimated at $13.00 per cubic meter ($17.00 per cubic yard) since sidecasting involves dredging and placement of the material in essentially the same location; this cost includes the cost of dredging. This cost assumes that material can be dredged and pumped to the drop off location as a single step. However, this method can create a great deal of turbidity in the area. Clamshell dredging would create less turbidity. If a clamshell is used for dredging and sidecasting, costs would rise to $27.53 per cubic meter ($36.00 per cubic yard). Because of the width of the channel, and the reach of typical clamshell dredges, some of the material might need to be dredged more than once. Material would be dredged and placed as far to the side as possible. However, because of the reach of the dredge, this may not be outside the ultimate

width of the channel. Thus, this same material would need to be dredged again and placed farther to the side; this would increase the handling and increase the costs. Assumptions used for determining sidecasting dredging and placement costs can be found in Appendix B.

This section discusses the applicability of the Long-Term Management Strategy (LTMS) to the East Span Project in terms of goals and policies, and the LTMS preferred alternative. It also introduces the decision-making criteria to be used to arrive at feasible dredge-and-reuse/disposal approachs in Section 7.0.

6.1 APPLICABILITY OF THE LTMS TO THE EAST SPAN PROJECT

Discussion of the LTMS goals and policies

Dredged material disposal in San Francisco Bay has been a controversial subject for some time. In 1990, a consensus-based approach, the "Long-Term Management Strategy," was initiated by a group of federal, state, and local agencies to address and resolve the issue of dredging and dredged material disposal in the Bay Area. The signatories to the LTMS are the COE, RWQCB, SLC, EPA, and BCDC. The LTMS program signatories established a pilot DMMO in 1995. The DMMO program is reviewed every six months, and is charged with fostering a comprehensive and consolidated approach to the processing of dredging reuse/disposal permit applications.

An LTMS Policy Environmental Impact Statement/Programmatic Environmental Impact Report (1998) has developed policy recommendations and strategies for the placement of dredged material in the Bay region. The LTMS aims at three objectives:

1. To distribute the dredged material among the three environments (UWR, ocean, and in-Bay) in a manner that minimizes environmental impacts and maximizes environmental benefits in an economically sound manner.
2. To identify guidelines for use during project planning to avoid or reduce potential harm while conducting necessary dredging and disposal activities.
3. To develop policies to improve regulatory certainty across all disposal options.

Each of those objectives translates, respectively, into the following LTMS proposed actions:

- Dredged material placement distributions
- Comprehensive analysis of environmental impacts and risks (including cumulative impacts), and mitigation of potential adverse environmental effects
- A management system that successfully improves regulatory certainty

Despite its comprehensive scope, the LTMS only addresses the needs of routine maintenance dredging projects (that is, dredging to maintain needed operational depth at marinas, harbors, ports and channels). The LTMS does not address the specific needs of "new projects," i.e., those that involve new construction or alteration of existing depths. While it has been the implicit policy of LTMS to effectively discourage "new project" dredged material for in-Bay disposal, the LTMS does not consider directly the overall environmental benefit/impact and practicability of alternative placement of new project sediments at either ocean or upland/wetland sites. One of the shortcomings of the LTMS is a lack of forecast of the relative contributions of routine (maintenance) and new work projects over the long-term and transition period. Since new work accounted for 66.5 percent of the actual 1997 dredge volume and 41.5 percent of the 1998

projected dredge volume, this is a substantial problem that affects the goal of regulatory certainty. At the same time, ocean disposal accommodated 92.1 percent of the 1997 dredge volume from new work projects, and has been planned to accommodate 96 percent of the projected new work 1998 dredge volume (1998 Roadmap).

The LTMS Preferred Alternative

The LTMS preferred policy alternative combines the highest level of upland/wetland reuse and the lowest level of in-Bay disposal of all alternatives considered in the EIS/EIR. Under the preferred alternative, the proposed long-term average targets are 20 percent disposal in the Bay, 40 percent disposal in the ocean, and 40 percent placement at upland/wetland reuse sites. In order to achieve the 20/40/40 disposal distribution, the LTMS has proposed to decrease the in-Bay disposal limit to a final volume of about 764,600 m^3 (1 mcy) per year. The LTMS has conceived a transition period for the implementation of its goals whereby the in-Bay disposal limits will be reduced every third year by 290,520 m^3 (380,000 cy) from an initial overall in-Bay volume of 2,140,673 m^3 (2.8 mcy). While the total disposal limit is reduced over time, a contingency volume of 229,358 m^3 (300,000 cy) and a set-aside volume of 191,131 m^3 (250,000 cy) for "small dredgers" will remain unaffected. The transition period would begin after the signing of the LTMS Record of Decision (ROD) and acceptance of a management plan, and would extend for 12 years. It should be noted that the Biological Opinion for the LTMS may affect disposal restrictions. If so, this may also affect reuse/disposal options for this project.

The LTMS preferred alternative relies on ocean disposal (SF-DODS) as a "relief valve" between the slow mandatory reduction at in-Bay sites and an increase in placement at UWR sites. The LTMS recommends that the current interim SF-DODS disposal limit of 3,669,725 m^3 (4.8 mcy) be set as permanent. Given the annual dredge volume of 4,587,156 m^3 (6 mcy) that is the planning basis of LTMS, ocean disposal could conceivably accommodate up to 80 percent of the total annual dredge volume until such time that speculative UWR sites become available. That recommended strategy is not expected to have adverse environmental impacts at the SF-DODS site. However, it detracts from the overall goal of encouraging upland/wetland reuse options. The initial overall annual in-Bay disposal limit proposed by LTMS at the start of the transition period is 2,140,673 m^3 (2.8 mcy). This initial volume represents 46.7 percent of the total LTMS planning basis volume of 4,587,156 m^3 (6 mcy).

Because of the rapid increase in new projects (whose dredged material are allocated to sites other than the Bay), the goals set by the LTMS for the transition period would be met even before implementation of the management plan. In fact, only after 9 years during the LTMS transition would the in-Bay disposal limits be reduced to the same volume levels already experienced in the last two years. Table 6-1 presents the percentage distribution of dredged volumes among in-Bay, ocean, and upland sites for recent years and as projected in the LTMS transition.

The 1998 projected in-Bay volume has been reduced considerably by the rescheduling of some Caltrans retrofit dredging activities. In 1998 Caltrans had disposed of only about 22,936 m^3 (30,000 cy) as opposed to the 468,257 m^3 (612,480 cy) planned for 1998 (BCDC 1998). Deducting from the 1998 projected disposal the volumes from those Caltrans projects that have not been implemented as planned, the actual percentage of in-Bay disposal from the 1998 total was as low as 33 percent.

Table 6-1
Disposal Distribution Percentages

	1997 Projected	1997 Actual	1998 Projected	1st-3rd year of transition
In-Bay	45.8	34.6	42.3	46.7
Ocean	47.5	61.0	40.0	?
Upland	6.7	4.4	17.7	?

Raw data source: 1998 Roadmap and LTMS Policy EIS (LTMS 1998)

Application of LTMS to East Span Project

The LTMS does not account specifically for the cases of replacement alternatives for retrofit projects that necessitate a dredging and disposal component. The LTMS recognizes the following dredger categories:

- *Small dredgers*: defined as projects within channels, harbors, and marinas not exceeding a depth of 3.7 meters (12 feet) or a volume of 38,336 m^3 (50,000 cy) per year on average.
- *Major dredgers*: projects with depth of 4 meters (13 feet) or more. For the purposes of implementation of the LTMS preferred alternative, major dredgers are further classified as *COE maintenance* projects and *medium dredgers* (non-COE).

Future in-Bay disposal will be allocated among small, medium, and COE projects according to the approaches adopted during the LTMS Management Plan. No project proponent, including small dredgers, will be allowed to dispose in the Bay if UWR or ocean disposal options are practicable for them. With that caveat in mind, the LTMS transition period strategies put forth in the EIS/EIR indicate that medium dredgers would be considered for in-Bay allocation on a first-come, first-served basis. Medium and COE projects would be allocated a disposal volume at the in-Bay sites within the total disposal limit established after accounting for a "small-dredger set-aside" and a "contingency volume." Depending on the strategy adopted, medium dredgers may engage in "banking" and "trading" of their allotments, that is, using the disposal allocation at a later year or exchanging it with another dredger.

The dredge volumes for the originally proposed SFOBB retrofit were accounted for as part of the 1998 Roadmap, the SAPs were approved for it by the DMMO, and in-Bay disposal suitability was determined. Since 1998 is past, Caltrans may be able, as a medium dredger, to "bank" on its unused allotment.

Another area of uncertainty to be defined in the LTMS Management Plan is whether "contingency volume" disposal may be used for dredged material from either the replacement bridge construction or existing bridge dismantling. The annual contingency volume of 229,357 m^3 (300,000 cy) for the in-Bay sites is meant to accommodate emergency or unforeseen situations.

DMMO

The LTMS program signatories have established a pilot DMMO. The DMMO is working towards improving coordination and implementation of the laws, regulations and policies of the member agencies as part of a cooperative permitting framework. The purpose of the DMMO is to increase the efficiency and reduce the redundancy of the dredging permitting process. The DMMO has devised a consolidated dredging and dredge material reuse/disposal permit application form. The DMMO consolidated application may not be used for any new work projects involving over 76,453 m^3 (100,000 cy) in a five-year period or for disposal projects seeking authorization for a period longer than five years. Such projects require a standard BCDC application.

While the individual member agencies continue to meet their statutory requirements, the DMMO makes joint staff reviews and recommendations regarding:

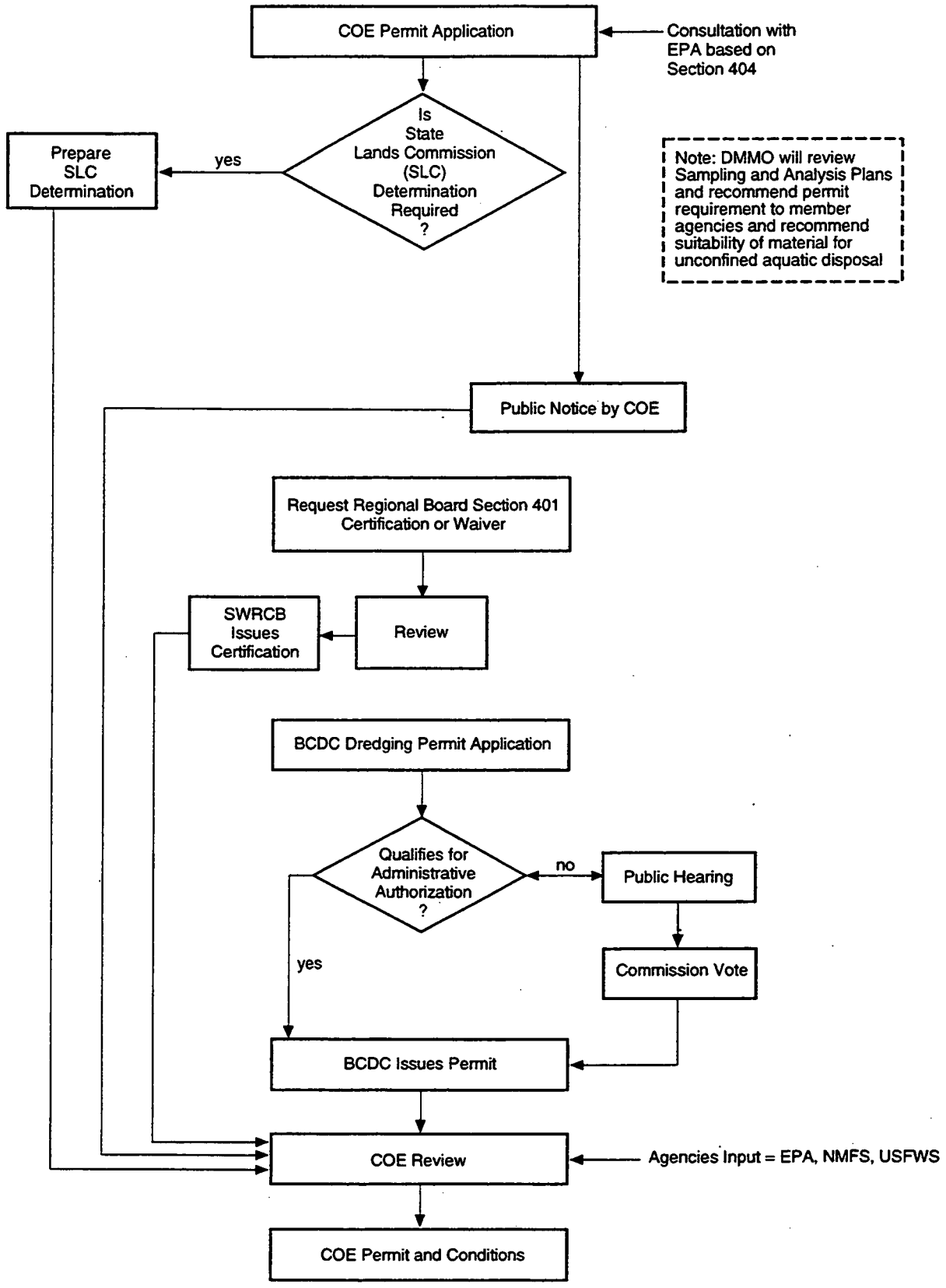
- Approval of sampling and testing plans;
- Testing results
- Completeness of consolidated permit application
- Material suitability for disposal at existing in-bay disposal sites, ocean disposal site, and upland disposal sites.

DMMO staff members may sign a DMMO recommendation for a given site only if their own agencies have regulatory authority over that site. Following DMMO recommendations regarding dredging material suitability, disposal permit decision-making procedures for in-Bay and ocean sites involve different regulatory agency requirements. Those procedures are presented in a schematic and simplified manner in Figures 6-1 and 6-2, respectively. It is likely that separate authorization will be required for the use of aquatic disposal sites on this project and that individual applications to the regulatory agencies will be required. Permitted upland wetland reuse/disposal and upland landfill disposal sites have their individual regulatory requirements. Those are the responsibility of the site operators and are not directly relevant to the DMMP. If the dredging project involves disposal at a wetland site that is not already authorized, individual applications to the regulatory agencies will be required.

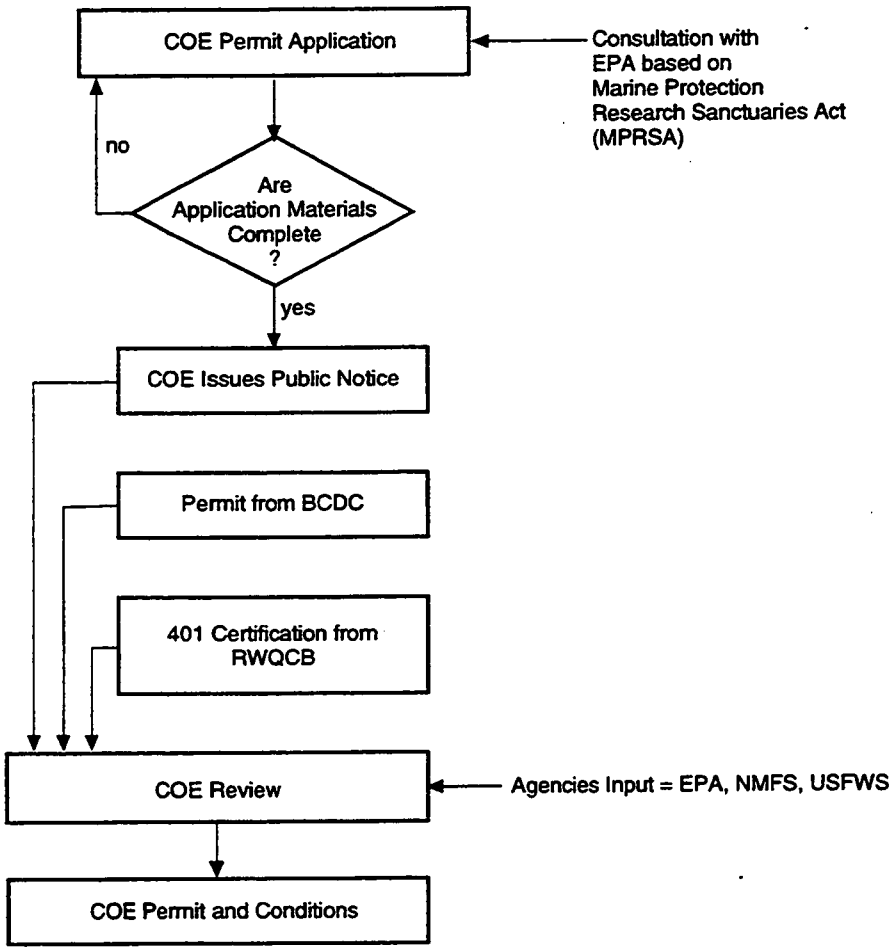
6.2 DECISION-MAKING CRITERIA

In addition to the factors of implementability, effects, and cost, Caltrans has considered the following factors in developing the proposal for reuse/disposal of dredged material:

- Impact of reuse/disposal options on meeting the project schedule
- Reliability of sites
- Consistency with LTMS goals
- Consistency with individual permitting requirements of DMMO member agencies
- Results of the sediment testing program



Project No. 971080NF	SFOBB East Span Seismic Safety Project	IN-BAY DISPOSAL PERMIT PROCEDURES	Figure 6-1



Project No. 971080NF	SFOBB East Span Seismic Safety Project	OCEAN DISPOSAL PERMIT PROCEDURES	Figure 6-2

51-971080NF-00-PMMP1/033099/ursgwc/graphics/mci

These factors are discussed below.

Impact of reuse/disposal options on meeting the project schedule

The reuse/disposal options differ in their respective ability to accommodate the project schedule, considering that dredged material will be generated in different quantities at different times through the project timeline. The bulk of the material will be dredged at months 4-6 and 46-48 (see Figures 3-7 and 3-8), when the approach access dredging and demolition access dredging, respectively, will take place. During the previous, intervening, and later months, the dredging activities will generate low and steady quantities of material. The impacts of each disposal option in meeting the schedule is as follows:

- In-Bay disposal option: the Alcatraz site has 30-day limits of 305,810 m^3 (400,000 cy) for October-April, and of 229,357 m^3 (300,000 cy) for May-September. From February to May, disposal priority is reserved for federal channel maintenance. In addition to having to meet any permitting requirements, the COE will consider these restrictions in granting first-come first served access to the site. While the volume restrictions do not appear problematic for most months of the project, they may preclude disposal of the larger quantities of material (months 4-6 and 46-48), depending on the other site users. In this regard, volumes may be accommodated more easily if the 30-day periods of the project and 30-day periods of the Alcatraz schedule are staggered.
- Ocean disposal option: the SF-DODS does not appear to present obstacles in terms of volume and times of disposal.
- UWR option: neither of the representative sites (Hamilton nor Montezuma) will present obstacles in terms of overall volume and times of disposal, provided they are permitted and operational. However, daily disposal amounts may be constrained by the site's off-loading capacity and their use by other dredgers.
- Side-casting option: this option does not present any conflict with the project timeline and dredged volumes.
- Upland disposal options: these options do not present any conflict with the project timeline and dredged volumes. This option will require a dewatering and rehandling facility that may have associated logistical constraints.

Reliability of Sites

This factor refers to the reliability of the sites (or combination of sites) being functional and permitted in time to accept dredged material from the project. In this regard, the UWR option sites are less reliable than the other options. Any of the options will need to receive disposal permits and approvals in time for the dredging activities to proceed according to the East Span project schedule. Acceptability of the sites by the agencies is therefore a consideration of the reliability of the options.

Consistency with LTMS

The LTMS goals apply to average annual disposal volumes as a whole. Therefore, an individual project cannot be judged in isolation from other projects considered in a given year, or within a specified planning period. The applicability of the LTMS to the project is discussed in Section 6.1. While the LTMS framework will be further articulated in a Management Plan, the dredging and disposal component options of the East Span Project correspond to the LTMS program goals in the following manner:

- In-Bay disposal option: may be considered inconsistent with the goals of the LTMS even though retrofit volumes have been deemed suitable for in-Bay disposal.
- Ocean disposal option: considered as preferable to in-Bay disposal, and not detrimental to the environment when within interim disposal limit; would be consistent with LTMS goals.
- UWR option: this is the preferred LTMS destination whenever available and practicable.
- Sidecasting option: the LTMS does not address sidecasting specifically. However, a non-designated, unapproved site, would likely not be considered consistent with LTMS objectives.
- Upland disposal option: this option is likely to be reserved for any portion of dredged material determined to be contaminated, or for the reuse of clean material, such as for capping, or use as fill in other highway projects, and as such is considered to be consistent with LTMS objectives.

Consistency with individual permitting requirements

The regulatory framework that would govern the proposed dredging and reuse/disposal options involves:

- National Marine Fisheries Service (Fish and Wildlife Coordination Act; Endangered Species Act; Marine Mammals Protection Act)
- U.S. Army Corps of Engineers (Clean Water Act Section 404; Marine Protection, Research and Sanctuaries Act Sections 102 and 103; Rivers and Harbors Act)
- U.S. Environmental Protection Agency (Clean Water Act Section 404; Marine Protection, Research and Sanctuaries Act Sections 102 and 103)
- U.S. Fish and Wildlife Service (Fish and Wildlife Coordination Act, Endangered Species Act)
- California Department of Fish and Game (California Fish and Game Code; several other State and federal statutes)
- San Francisco Bay Conservation and Development Commission (McAteer-Petris Act; Suisun Marsh Preservation Act; Coastal Zone Management Act)
- State Water Resources Control Board and Regional Water Quality Control Boards (Clean Water Act Section 401; Porter-Cologne Water Quality Control Act)
- State Lands Commission (Public Resources Code; several State and federal statutes)

While the proposed dredge activity is common to all options, the disposal and/or reuse options are subject to different types of review, and as detailed below, each option must show compliance with different statutory and regulatory requirements.

Federal Water Pollution Control Act of Clean Water Act (FCWA)

The COE will apply 401 certification requirements to its permits under Section 404 of FCWA. Compliance with FCWA Section 404(b)(1) guidelines will be required from all options considered, except for ocean and upland disposal. Section 401 of FCWA requires that an applicant for a federal license or permit provide a certification that any discharges from the proposed activity will comply with FCWA, including water quality requirements.

Marine Protection, Research and Sanctuaries Act (MPRSA)

Requirements under Sections 102 and 103 would apply only to the ocean disposal options. Site SF-DODS is designated by EPA under Section 102. The COE will require compliance with procedures and criteria established in Title 40 of the CFR, Subchapter H, Parts 220 through 229.

Porter-Cologne Act

Requirements under the Porter-Cologne Act will apply only to waste discharges to land for upland and wetland reuse alternatives.

Rivers and Harbors Act of 1899

The COE is required by Section 10 of the Rivers and Harbors Act to authorize certain structures or work in or affecting navigable waters of the United States. This will apply to in-Bay disposal as well as to the dredging activity itself. The Coast Guard takes jurisdiction for the construction and demolition of bridges under the General Bridges Act and the Rivers and Harbors Act to grant a Section 9 permit.

Coastal Zone Management Act (CZMA)

The CZMA requires the COE to coordinate permit review with State level coastal zone review agencies. In the case of the East Span Project, BCDC will need to make a consistency determination on the project as a whole, including in-Bay disposal. Wetland reuse sites will need to be certified in order to accept material from SFOBB or any other source.

California Public Resources Code

The California Public Resources Code requires that anyone proposing to dredge submerged lands under the jurisdiction of the State Lands Commission obtain a dredging lease from the State Lands Commission. The State Lands Commission has given jurisdiction of lands that would be dredged for the East Span Project to the Ports of Oakland and San Francisco.

The specific requirements of the different options are summarized in Table 6-2.

Results of the Sediment Analysis Program

Following the results of the sediment testing program, DMMO will determine suitability of the dredged material for aquatic disposal. This factor will be used by Caltrans to propose reuse/disposal options, and to determine the appropriate destination for the different volumes of material, and indicate the most effective combination of sites to accommodate the material.

Table 6.2

Applicability of Regulatory Requirements to Dredge, Disposal, and Reuse Options

Option/ Requirement	Section 404	Section 401	MPRSA	CZMA	Porter Cologne Act	Public Resources Code
Dredge	404(b)(1) Guideline compliance required of applicant	Certification required of applicant	N/A	BCDC consistency required of applicant	N/A	State Lands Commission lease/Determination required of applicant
In-Bay Disposal	404(b)(1) Guideline compliance required of applicant	Certification	N/A	BCDC consistency required of applicant	N/A	N/A
Ocean Disposal	N/A	N/A	Section 103 compliance required of applicant	N/A	N/A	N/A
Sidecasting	404(b)(1) Guideline compliance required of applicant	Certification required of applicant	N/A	BCDC consistency required of applicant	N/A	N/A
UWR	Guideline compliance/ permit required of site operator	Certification required of site operator	N/A	Site certification required of operator	Discharge permit required of applicant if dewatering	N/A
Upland Landfills	Guideline compliance/ Permit required of fill operator	Certification required of fill operator	N/A	N/A	Discharge permit required of applicant if dewatering	N/A

Source: URSGWC, 1999.

Cost Summary

Dredging, transportation, and reuse/disposal costs for each potential reuse/disposal site, are summarized in Table 6-3. In general, dredging costs are assumed to be $11.50 per cubic meter ($15.00 per cubic yard) for all the reuse/disposal options except for sidecasting which is estimated at $13.00 per cubic meter ($17.00 per cubic yard) and includes the dredging and "disposal" in one unit cost. These costs are in addition to transportation and disposal costs described earlier in Section 5.

All of the unit costs shown are in first quarter 1999 dollars and include a 25 percent contingency. (See Appendix B for additional cost estimating assumptions.) Permitting fees and testing of the sediments prior to dredging are not included in the unit costs. Costs for dredging of the material are the same for all reuse/disposal options, except for sidecasting which includes dredging and disposal in one unit cost. It should be noted that "dredging" includes typical linear dredging used for creation of the construction and dismantling access channels as well as excavation from pier casings and behind cofferdams for pier construction and dismantling. The latter process can be time consuming and much less cost-efficient than typical linear dredging to deepen a channel.

Table 6-3
Summary of Reuse/Disposal Estimated Costs

REUSE/DISPOSAL OPTION	COST/m^3 (cost/cy)		
	Dredging	Transport and Disposal	Total
SF-11 (Alcatraz)	$11.47 ($15)	$5.35 ($7)	$16.82 ($22)
SF-DODS (Ocean)	$11.47 ($15)	$9.18 ($12)	$20.65 ($27)
Montezuma Wetlands	$11.47 ($15)	$35.17 ($46)	$46.64 ($61)
Hamilton Wetlands	$11.47 ($15)	$17.59 ($23)	$29.06 ($38)
Upland Landfills (Class II - average)	$11.47 ($15)	$59.63 ($78)	$71.11 ($93)
Sidecasting	$13 ($17)	included in dredging cost	$13 ($17)

Source: Parsons Brinckerhoff and URS Greiner Woodward Clyde, 1999.

This final section incorporates the previous information into the recommendation of a reuse/disposal option and its determination as the dredging option.

7.1 COMPARATIVE EVALUATION

Based on the information given in sections 4 through 6, the representative reuse/disposal sites were compared in terms of the decision-making criteria described in Section 6. Table 7-1 summarizes the cross evaluation of sites. Table 7-2 summarizes the cost of disposal of all dredged materials at each representative site, according to suitability of materials. Costs are given for upper and lower limit dredging scenarios. Only upland landfills can accommodate all dredged materials, SUAD and NUAD. The site options for SUAD material are: Alcatraz, Hamilton, SF-DODS, Montezuma, side-casting, or at an upland landfill. NUAD materials may be disposed of at an appropriate upland landfill. Montezuma is also proposing to accept certain NUAD material, though this is currently a subject of controversy for the Montezuma project.

As Table 7-2 shows, Montezuma is the most expensive UWR site option, exceeding the cost of the other UWR site, Hamilton, by over 100 percent. As detailed in Section 4.1, other reuse/disposal sites besides those selected as representative for the DMMP may be considered in the future, particularly other UWR sites that may become available at a later date but in time for use on the East Span Project. New UWR options would be considered during the project implementation, provided their costs are not more than ten percent greater than Hamilton reuse costs and that they meet the criteria used in evaluating Hamilton.

Side-casting presents a probable range of cost from the least expensive site up to costs comparable to disposal at Hamilton, if double handling of material is required. Side-casting may have potential negative impacts. Furthermore, being a non-designated site it is unlikely that side-casting would be granted regulatory approval, unless there is adequate mitigation proposed for lost habitat values.

Montezuma and side-casting will not be evaluated further. Based on the comparative evaluation of representative sites, it appears that no single reuse/disposal option is adequate or preferred for all the dredged material generated throughout the East Span Project. Only the landfill option could accommodate all the dredge material (both NUAD and SUAD). Combinations of sites, including landfill and one to three other reuse/disposal sites, are presented in Section 7-2.

It should be noted that while combined reuse/disposal options generally present the best balance between environmental concerns and costs, project timing and logistics must also be considered. In the event that no in-bay disposal, ocean disposal, or upland wetland reuse sites are available or approved for use in time to accept dredged materials from the project (according to the proposed East Span Project schedule), Caltrans would opt to place all dredged material from the project at landfill sites. Further, if during the life of the project options other than the representative sites analyzed in this document become available, meet the screening criteria, and are cost-effective for the contractor and Caltrans, the contractor may choose to reuse/dispose of materials at such sites.

Table 7-1

Comparative Evaluation of Reuse/Disposal Sites According to Decision-Making Criteria

REUSE/DISPOSAL SITE	CRITERIA						
	Availability / Reliability	**Capacity to Meet Project Schedule**	**Consistency with LTMS[1]**	**Permitting Requirements[2]**	**Acceptable Sediments**	**Impacts**	**Total Cost per m^3 (per cy)**
In-Bay (Alcatraz SF-11)	OK	Uncertain due to first come-first served policy and seasonal restrictions	Uncertain due to DMMO policy on "new work"	Secured by applicant (CWA 404, 401; CZMA)	SUAD	Not significant[4]	$5.3 ($7)
Ocean (SF-DODS)	OK	OK	Consistent with LTMS "relief valve"	Secured by applicant (MPRSA 103)	SUAD	Not significant	$9.2 ($12)
Hamilton[6]	Uncertain; depends on permitting and funding	Uncertain due to logistics of daily volumes	Consistent with LTMS goal for UWR expansion	Secured by site operator	Wetland cover	Beneficial	$17.6 ($23)
Montezuma[6]	Uncertain; depends on permitting and funding	Uncertain due to logistics of daily volumes	Consistent with LTMS goal for UWR expansion	Secured by site operator	Cover/non-cover	Beneficial	$35.2 ($46)
Sidecasting	Depends on likelihood of permit	OK	Inconsistent; disposal to non-designated site	Secured by applicant (404, 401, CZMA, SLC)	SUAD	Adverse	$1.52 ($2)[5]
Upland Landfills	OK	OK	Consistent for NUAD materials and for clean material used as capping	Secured by site operator	SUAD and NUAD	Not significant; beneficial for clean cover	$59.6 ($78)

1) LTMS goals refer to overall disposal from all dredgers, not individual projects.
2) Assumes permitting for disposal only. Permitting for all dredging operation alternatives will be similar.
3) Cost of transport, handling and disposal.
4) Disposal will be within volume and frequency restrictions for the permitted sites and pose no significant impacts.
5) Could be as high as $36/cy if double handling of material is required.
6) Hamilton and Montezuma are representative UWR sites and define a potentially acceptable range of availability effects and costs considerations for potential UWR sites.
Source: URSGWC, April 1999

Table 7-2
Upper and Lower Limit Dredging Disposal Costs for Individual Site Options[1]

Disposal/Reuse Site	Alcatraz	Hamilton	SF-DODS	Montezuma	Sidecasting	Landfill
Costs for Upper Limit Dredging Disposal (x1000)	$3,081	$10,123	$5,281	$20,426	$880	$45,665
Costs for Lower Limit Dredging Disposal (x1000)	$2,042	$8,060	$4,205	$16,119	$701	$27,903

1) Disposal volumes according to SUAD and NUAD distribution to aquatic/wetland site and landfill, respectively.

Source: Parsons Brinkerhoff, April 1999.

7.2 PROPOSED COMBINED REUSE/DISPOSAL SITE OPTIONS

The project will generate varying quantities of dredged material of different quality throughout the project construction timeline (see discussion in Section 3 and Figures 3-7 and 3-8). The majority of the material will come from dredging of the construction and dismantling access channels. Smaller amounts (approximately 1,500 m^3 [2,000 cy] per month) will be generated during construction of new piers and dismantling existing piers. The dredged material disposal sites will need to accommodate dredged material in a manner that satisfies three factors:

- Adequate volume capacity
- Suitability of the site for the proposed material
- Logistics of dredging, transport, and disposal of the materials

Based on the above, seven combined site options, A through G, have been developed to accommodate the materials from construction access, construction piers, dismantling access and dismantling piers. The options are presented in Tables 7-3 and 7-4 for the upper and lower limit dredging, respectively. All NUAD material is allocated to upland landfill. Option A is the preferred option. The others are in no particular order of preference. The seven combined-site options present different allocations of SUAD material to Hamilton (or similar UWR site), Alcatraz, and or SF-DODS, as follows:

- Option A: construction and dismantling access dredging material is allocated to Hamilton, and a small amount of dredged material per month from construction and dismantling piers is allocated to Alcatraz.
- Option B: construction and dismantling access dredging material is allocated to SF-DODS, and a small amount of dredged material per month from construction of new piers and dismantling of existing piers is allocated to Alcatraz.
- Option C: SUAD material is allocated entirely to SF-DODS.
- Option D: construction and dismantling access dredging material is allocated to Hamilton, and a small amount of dredged material per month from construction and dismantling piers is allocated to SF-DODS.
- Option E: SUAD material is allocated entirely to Hamilton.
- Option F: construction access dredging material is allocated to SF-DODS, dismantling access dredging material is allocated to Hamilton, and a small amount of dredged material per month from construction and dismantling piers is allocated to Alcatraz.
- Option G: construction access dredging material is allocated to SF-DODS, and all other SUAD material from dismantling access and the piers is allocated to Hamilton.

Under the upper limit dredging, all options would include about 25 percent of the total volume for upland landfill disposal. Under the lower limit dredging, all options include disposal of two percent of the total volume at an upland landfill. Tables 7-5 and 7-6 indicate the percentage of SUAD material allocated to each disposal/reuse site under each option for upper limit and lower limit dredging, respectively. The costs associated with each combined option are also given on

Tables 7-5 and 7-6. For both upper and lower limit dredging, Option E (placing all SUAD material at Hamilton) is the most expensive option, and Option B (placing SUAD material at SF-DODS and Alcatraz) is the least expensive option.

7.2.1 Air Quality Emissions Comparison of Combined Reuse/Disposal Options

Air quality emissions were calculated for the seven combined reuse/disposal options discussed in Section 7.2. In addition, another option that would send all dredged material to the Altamont Landfill was considered and is called Option H is this section. A technical memorandum discussing the analysis in further detail, including methodology and results, is presented in Appendix C. The analysis used dredge quantities for Alternative N-6 for analysis purposes.

It should be noted that the FHWA has concluded that the East Span Project is subject to the Transportation Conformity rule and thus does not require a Clean Air Act General Conformity assessment. Project conformity under the Transportation Conformity rule is addressed in Section 4.4.3 of the DEIS. The U.S. Army Corps of Engineers may address general conformity in its subsequent NEPA document for the Project's Section 404 permit.

The emission inventory consists of activities related to dredging, transport of dredged materials to the disposal sites, and unloading/loading of the material. Emissions were calculated for total organic gases (TOG), reactive organic gases (ROG), carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), and particulate matter (both total PM and PM_{10}).

Since the volume of dredging would vary greatly over the total construction period, emissions on a daily basis were not calculated for an average construction day. Instead, emissions were calculated for a maximum daily scenario. First, it was determined, based on dredge quantities, that a maximum day would occur during the preparation of an access channel for construction of the new bridge. During this phase of construction, depending on which combined reuse/disposal option is chosen, dredged material may be taken to the Hamilton Wetlands Restoration site and the Altamont Landfill (Options A, D, and E), to the ocean disposal site and the Altamont Landfill (Options B, C, F, and G), or just to the Altamont Landfill (Option H).

Based on the level of activity required for each of these options, it was determined that a maximum daily scenario would likely occur during a situation where dredged material would be taken to both the ocean disposal site and the Altamont Landfill on particular day. It was estimated that during this maximum daily scenario, there would be between 0.2 and 0.4 metric tons (0.2 and 0.4 tons) of TOG, ROG, SO_2, and particulate matter, 0.8 metric tons (0.9 tons) of CO, and 3.4 metric tons (3.8 tons) of NO_x.

Table 7-7 summarizes the total amount of air pollutant emissions that would be generated over the whole construction period for each option, using the upper dredging limit. Table 7-8 presents the same information, but for the lower dredging limit. Construction with the lower dredging limit would result in approximately 30 to 42 percent lower emissions than construction with the upper dredging limit, depending upon the reuse/disposal option.

The option that would generate the greatest amount of emissions would be Option C because under this scenario all dredged material suitable for unconfined aquatic disposal would be transported to the ocean disposal site. The tug boats used to take dredged material to the ocean disposal site would generate the greatest amount of emissions of any of the equipment potentially

used during transport of material. As a result, options with less ocean disposal would lower emissions.

Options A, E, and H generate the lowest levels of emissions among the eight scenarios evaluated. The option generating the least emissions overall would be Option H (all material transported to

Table 7-3

Upper Limit Dredging Proposed Combined Reuse/Disposal Options[1]

	Dredged Material Quality[2]	Dredged Material Quantity m^3 (cy)	Option A	Option B	Option C	Option D	Option E	Option F	Option G
Construction Access	SUAD	172,782 (225,977)	Hamilton	SF-DODS	SF-DODS	Hamilton	Hamilton	SF-DODS	SF-DODS
	NUAD	108,576 (142,004)	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill
Construction Piers	SUAD	31,919 (41,747)	Alcatraz	Alcatraz	SF-DODS	SF-DODS	Hamilton	Alcatraz	Hamilton
	NUAD	2,544 (3,328)	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill
Dismantling Access	SUAD	115,955 (151,654)	Hamilton	SF-DODS	SF-DODS	Hamilton	Hamilton	Hamilton	Hamilton
Dismantling Piers	SUAD	15,792 (20,654)	Alcatraz	Alcatraz	SF-DODS	SF-DODS	Hamilton	Alcatraz	Hamilton

1) Site allocation reflects logistics and assumed material suitability. Amounts may change based on actual sediment testing results.
2) Assumptions to be verified by sampling and analysis.
Source: URSGWC, 1999.

Table 7-4

Lower Limit Dredging Proposed Combined Reuse/Dispoal Site Options[1]

	Dredged Material Quality[2]	Dredged Material Quantity m^3 (cy)	Option A	Option B	Option C	Option D	Option E	Option F	Option G
Construction Access	SUAD	103,520 (135,391)	Hamilton	SF-DODS	SF-DODS	Hamilton	Hamilton	SF-DODS	SF-DODS
Construction Piers	SUAD	32,595 (42,631)	Alcatraz	Alcatraz	SF-DODS	SF-DODS	Hamilton	Alcatraz	Hamilton
	NUAD	5,588 (7,308)	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill
Dismantling Access	SUAD	115,955 (151,654)	Hamilton	SF-DODS	SF-DODS	Hamilton	Hamilton	Hamilton	Hamilton
Dismantling Piers	SUAD	4,592 (6,006)	Alcatraz	Alcatraz	SF-DODS	SF-DODS	Hamilton	Alcatraz	Hamilton

1) Site allocation reflects logistics and assumed material suitability. Amounts may change based on actual sediment testing results.
2) Assumptions to be verified by sampling and analysis.
Source: URSGWC, 1999.

Table 7-5

Upper Limit Dredging Proposed Combined Reuse/Disposal Options - Percentage of SUAD Volume Placed at Each Site and Total Cost[1]

Option	SF-DODS	Hamilton	Alcatraz	Cost (x $1000)
A	--	86	14	$20,458
B	86	--	14	$16,304
C	100	--	--	$16,617
D	14	86	--	$20,771
E	--	100	--	$21,459
F	52	34	14	$17,971
G	52	48	--	$18,970

1) Includes landfill disposal costs for NUAD portion. .

Source: URSGWC, 1999.

Table 7-6

Lower Limit Dredging Proposed Combined Reuse/Disposal Site Options Percentage of the SUAD Volume Placed at Each Site and Total Cost[1]

Option	SF-DODS	Hamilton	Alcatraz	Cost (x $1000)
A	--	85.5	14.5	$7,512
B	85	--	14.5	$4,355
C	100	--	--	$4,600
D	14.5	85.5	--	$7,862
E	--	100	--	$8,396
F	40.5	45	14.5	$6,023
G	40.5	59.5	--	$6,801

1) Includes landfill disposal costs for NUAD portion.

Source: URSGWC, 1999.

Table 7-7

Total Air Quality Emissions by Option for the Upper Dredging Limit
(in metric tons [tons])

Option	Total Emissions (metric tons[tons])						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
A	19 (21)	18 (20)	66 (73)	249 (273)	16 (18)	13 (14)	11 (12)
B	22 (24)	21 (23)	67 (74)	264 (291)	17 (19)	15 (17)	14 (15)
C	23 (25)	22 (24)	68 (75)	272 (299)	18 (20)	16 (17)	14 (16)
D	20 (22)	19 (21)	68 (75)	258 (284)	17 (18)	14 (15)	12 (13)
E	19 (21)	18 (20)	68 (74)	254 (279)	16 (18)	13 (14)	11 (13)
F	21 (23)	20 (22)	67 (73)	258 (284)	17 (18)	14 (16)	13 (14)
G	21 (23)	20 (22)	67 (74)	259 (285)	17 (19)	14 (16)	13 (14)
H (all landfill disposal)	19 (21)	18 (20)	89 (98)	235 (258)	13 (14)	13 (14)	12 (13)

Source: Parsons Brinckerhoff, 1999.

Table 7-8

Total Air Quality Emissions by Option for the Lower Dredging Limit (in metric tons[tons])

Option	Total Emissions (metric tons [tons])						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
A	12 (13)	12 (13)	41 (45)	158 (174)	10 (11)	8 (9)	7 (8)
B	15 (16)	14 (16)	41 (45)	170 (187)	11 (12)	10 (11)	9 (10)
C	15 (17)	15 (16)	42 (46)	176 (194)	12 (13)	11 (12)	10 (11)
D	13 (14)	12 (14)	42 (46)	165 (182)	11 (12)	9 (10)	8 (9)
E	12 (14)	12 (13)	42 (46)	162 (179)	11 (12)	9 (9)	8 (8)
F	13 (15)	13 (14)	41 (45)	164 (180)	11 (12)	9 (10)	8 (9)
G	13 (15)	13 (14)	41 (45)	164 (180)	11 (12)	9 (10)	8 (9)
H (all landfill disposal)	11 (12)	11 12)	52 (57)	137 (151)	8 (8)	8 (8)	7 (7)

Source: Parsons Brinckerhoff, 1999.

the Altamont Landfill). Options A and E would generate lower emissions of certain pollutants (CO, organcis, and PM10) compared to Option H. Option H, which would require double-handling of material and trucking to a landfill, would generate the least amounts of NOx and SO2, and would have levels of organics and particulates similar to the other options. The lower levels of emissions generated by Option H would occur because the trucks and material handling equipment used with this option generate lower levels of pollutants than the tug boats used with the other options. However, motor vehicles, including heavy-duty diesel trucks, generate more CO as a result of incomplete fuel combustion.

7.3 PREFERRED OPTION AND CONTINGENCIES

The preferred reuse/disposal option can be derived from among the seven options identified above by selecting the optimal solution to the following objectives: maximization of UWR as a commitment to the LTMS goals, while minimizing costs, and facilitating project logistics. On the basis of the information available to date, the preferred disposal option is A. Option A involves reuse/disposal of construction and dismantling access dredging materials at Hamilton (or a comparable UWR site), corresponding to 86 percent of the SUAD material or 65 percent of the total for the upper limit dredging, and to 85.5 of the SUAD material or 80.3 percent of the total dredged material for the lower limit dredging. Option A also involves disposal of construction and pier dismantling dredging material at Alcatraz, corresponding to 14 percent of the SUAD material or to 11 of the total dredged volume for the upper limit dredging, and 14.5 percent of the SUAD material or 17.7 percent of the total dredged material for the lower limit dredging. By disposing of the piers' dredging at the Alcatraz site, Option A reduces the distance of barge trips carrying low volumes, easing project logistics and achieving a reduction in costs.

Should the approval of the Hamilton site (or comparable UWR site) be delayed past the initiation of the dredging activities, the following options may be noted as contingencies: Option F and Option G can allow for disposal of material dredged during the early part of the project at SF-DODS. Materials dredged at a later date can be reused/disposed of at Hamilton (or similar site) as soon as the site is operational.

In addition, other upland/wetland reuse sites that are not currently available may become operational during the schedule of dredging activities. New sites may substitute for Hamilton to maintain the commitment to UWR expressed in this DMMP, provided that the transportation and disposal costs at the potential new site do not exceed those of Hamilton by more than ten percent. As mentioned previously, if no sites (in-Bay, ocean, or UWR) are available or approved for use in time, Caltrans may opt to place all materials at landfill sites in order to maintain the East Span Project schedule.

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Appendix A
Dredged Materials Calculations

SFOBB Project
Dredging Quantities

Based on N6 Alternative

by BLN 1/15/99
checked by GVL

Estimated Dredge Quantities (cubic meters)							
	Dredged Material to Construct New Piers and Footings		Dredge Material from Construction Access to Construct New Bridge		Dredge Material from Removal of Existing Bridge Piers to Mudline	Dredge Material from Construction Access to Dismantle Existing Bridge	Total (cubic meters)
	SUAD	NUAD	SUAD	NUAD		SUAD	
Lower Limit	32,257	5,587	103,520	0	4,592	115,955	**261,911**
Upper Limit	31,919	2,545	172,782	108,576	15,792	115,955	**447,568**

Assumptions:

Lower Limit-Pier Dredging

Dredging in the Coffer Dam only occurs if bottom of pile cap is below bay mud.
Depth of dredging for the Piles is the depth of structural concrete minus depth of water.
Width of coffer dam is 2 m beyond width of pile cap.
Piers E22 through E29 assumed to contain contaminated material.
Mud depth at E1 is 3 m above rock layer.

Lower Limit-Access Dredging

Dredging width is 115 m.
Dredging depth required is -4.3 m below MSL.
1:3 side slopes used.
Limits of Dredging is sta 73+80 to 83+40.
A trestle would be used from 83+40 to Oakland shore.

Lower Limit - Demolition of Existing Piers

Width of coffer dam is 2 m beyond width of pile cap.
A depth of 1 m will be dredged around existing footings.

Lower Limit - Demolition Access Dredging

Dredging width is 110 m.
Dredging depth required is -4.3 m below MSL.
1:3 side slopes used.
Limits of Dredging is sta 73+80 to 82+60.

Upper Limit - Pier Dredging

Dredging in the Coffer Dam only occurs if bottom of pile cap is below bay mud.
Depth of dredging for the Piles is the depth of structural concrete minus depth of water.
Width of coffer dam is 6 m beyond width of pile cap.
Piers E22 through E29 assumed to contain contaminated material.
Mud depth at E1 is 3 m above rock layer.

Upper Limit-Access Dredging

Dredging width is 115 m.
Dredging depth required is -4.3 m below MSL.
1:3 side slopes used.
Limits of Dredging is sta 73+80 to 88+12.
In the condition of the upper-limit dredging, no new pier coffer dam dredging required.

Upper Limit - Demolition of Existing Piers

Width of coffer dam is 6 m beyond width of pile cap.
A depth of 1 m will be dredged around existing footings.

Upper Limit - Demolition Access Dredging

Dredging width is 110 m.
Dredging depth required is -4.3 m below MSL.
1:3 side slopes used.
Limits of Dredging is sta 73+80 to 82+60.

Pier Dredge Volumes - without Coffer Dams
(used with upper limit dredging.)

Pier	Pile Cap				Coffer dam				Piles							Total Dredge Volume			
	wdth	lngth	depth total	depth water	wdth	lngth	depth water	depth dredge	vol	dia	#	length water	length conc	length **dredge**	length total	volume	EB	WB	**both**	Comments
E1										2.5	20	15	50	3	78	**295**			**295**	
E2										2.5	16	12.8	50	37.2	78	**2,922**			**2,922**	
E3	13.8	20	6	4						2.5	6	12.4	50	37.6	78	**1,107**	1,107	1,107	**2,215**	
E4	13.8	20	6	4						2.5	6	12	50	38	78	**1,119**	1,119	1,119	**2,238**	
E5	13.8	20	6	4						2.5	6	9.4	50	40.6	78	**1,196**	1,196	1,196	**2,392**	
E6	13.8	20	6	4						2.5	6	7.5	50	42.5	78	**1,252**	1,252	1,252	**2,503**	
E7	13.8	20	6	4						2.5	6	5.9	50	44.1	78	**1,299**	1,299	1,299	**2,598**	
E8	13.8	20	6	4						2.5	6	4.8	50	45.2	78	**1,331**	1,331	1,331	**2,663**	
E9	13.8	20	6	4						2.5	6	4.3	50	45.7	78	**1,346**	1,346	1,346	**2,692**	
E10	13.8	20	6	4						2.5	6	3.9	50	46.1	78	**1,358**	1,358	1,358	**2,716**	
E11	13.8	13.8	4	2						1.5	9	3.7	50	46.3	97	**736**	736	736	**1,473**	
E12	13.8	13.8	4	2						1.5	9	3.7	50	46.3	97	**736**	736	736	**1,473**	
E13	13.8	13.8	4	2						1.5	9	3.3	50	46.7	97	**743**	743	743	**1,485**	

E14	13.8	13.8	4	2		1.5	9	3	50	47	97	**748**	748	748	**1,495**		
E15	9	9	3.5	1.5		1	9	3	30	27	98	**191**	191	191	**382**		
E16	9	9	3.5	1.5		1	9	3	30	27	98	**191**	191	191	**382**		
E17	9	9	3.5	1.5		1	9	2.9	30	27.1	98	**192**	192	192	**383**		
E18	9	9	3.5	1.5		1	9	2.1	30	27.9	98	**197**	197	197	**394**		
E19	9	9	3.5	1.5		1	9	1.7	30	28.3	98	**200**	200	200	**400**		
E20	9	9	3.5	1.5		1	9	1.2	30	28.8	98	**204**	204	204	**407**		
E21	9	9	3.5	1.5		1	9	0.8	30	29.2	98	**206**	206	206	**413**		
														Total	**31,919**		

Contaminated Pier Dredge Volumes -without coffer dams

Pier	Pile Cap					Coffer dam					Piles						Total Dredge Volume			
	wdth	lngth	depth total	water		wdth	lngth	depth water	dredge	vol	dia	#	water	length conc	**dredge**	total	volume	EB	WB	**both**	Comments
E22	9	9	3.5	1.5							1	9	0	30	30	98	**212**	212	212	**424**	contaminated
E23	9	9	3.5	1.5							1	9	0	30	30	98	**212**	212	212	**424**	contaminated
E24	9	9	3.5	1.5																	on land
E25	9	9	3.5	1.5																	on land
E26	9	9	3.5	1.5							1	9	0	30	30	98	**212**	212	212	**424**	contaminated

E27	9	9	3.5	1.5		1	9	0	30	30	98	**212**	212	212	**424**	contaminated
E28	9	9	3.5	1.5		1	9	0	30	30	98	**212**	212	212	**424**	contaminated
E29	9	9	3.5	1.5		1	9	0	30	30	98	**212**	212	212	**424**	contaminated
														Total	**2,545**	

Demolition Access Dredging

Station	depth required	water depth	dredge depth	width	length	area	volume
73+80	4.3	4	0.3	110		33.3	
					20		778
74+00	4.3	3.9	0.4	110		44.5	
					100		3,888
75+00	4.3	4	0.3	110		33.3	
					100		3,327
76+00	4.3	4	0.3	110		33.3	
					100		3,327
77+00	4.3	4	0.3	110		33.3	
					100		4,451
78+00	4.3	3.8	0.5	110		55.8	
					100		9,019
79+00	4.3	3.2	1.1	110		124.6	
					100		13,635
80+00	4.3	3	1.3	110		148.1	
					100		20,230
81+00	4.3	2.1	2.2	110		256.5	
					100		31,962
82+00	4.3	1.1	3.2	110		382.7	
					61		25,339
82+61	4.3	0.6	3.7	110		448.1	
						Total	**115,955**

Demolition - Existing Piers - Lower Limit

Pier	Pile Cap			Coffer dam					
	width	length	area	width	length	dredge depth	area	area diff	vol
E2	13	37	481	17	41	1	697	216	**216**
E3	24	41	984	28	45	1	1260	276	**276**
E4	19	28	532	23	32	1	736	204	**204**
E5	19	28	532	23	32	1	736	204	**204**
E6	21	39	819	25	43	1	1075	256	**256**
E7	21	39	819	25	43	1	1075	256	**256**
E8	21	39	819	25	43	1	1075	256	**256**
E9	31	31	961	35	35	1	1225	264	**264**
E10	13	34	442	17	38	1	646	204	**204**
E11	13	34	442	17	38	1	646	204	**204**
E12	13	34	442	17	38	1	646	204	**204**
E13	13	33	429	17	37	1	629	200	**200**
E14	13	33	429	17	37	1	629	200	**200**
E15	13	33	429	17	37	1	629	200	**200**
E16	13	33	429	17	37	1	629	200	**200**
E17	15	33	495	19	37	1	703	208	**208**
E18	15	33	495	19	37	1	703	208	**208**
E19	15	33	495	19	37	1	703	208	**208**
E20	15	33	495	19	37	1	703	208	**208**
E21	15	33	495	19	37	1	703	208	**208**
E22	15	33	495	19	37	1	703	208	**208**

Total **4,592**

Demolition - Existing Piers - Upper Limit

Pier	Pile Cap			Coffer dam					
	width	length	area	width	length	dredge depth	area	area diff	vol
E2	13	37	481	25	49	1	1225	744	**744**
E3	24	41	984	36	53	1	1908	924	**924**
E4	19	28	532	31	40	1	1240	708	**708**
E5	19	28	532	31	40	1	1240	708	**708**
E6	21	39	819	33	51	1	1683	864	**864**
E7	21	39	819	33	51	1	1683	864	**864**
E8	21	39	819	33	51	1	1683	864	**864**
E9	31	31	961	43	43	1	1849	888	**888**
E10	13	34	442	25	46	1	1150	708	**708**
E11	13	34	442	25	46	1	1150	708	**708**
E12	13	34	442	25	46	1	1150	708	**708**
E13	13	33	429	25	45	1	1125	696	**696**
E14	13	33	429	25	45	1	1125	696	**696**
E15	13	33	429	25	45	1	1125	696	**696**
E16	13	33	429	25	45	1	1125	696	**696**
E17	15	33	495	27	45	1	1215	720	**720**
E18	15	33	495	27	45	1	1215	720	**720**
E19	15	33	495	27	45	1	1215	720	**720**
E20	15	33	495	27	45	1	1215	720	**720**
E21	15	33	495	27	45	1	1215	720	**720**

E22	15	33	495		27	45	1	1215	720	**720**
									Total	**15,792**

Access Dredging - Lower Level

Station	depth required	water depth	dredge depth	width	length	area	volume
73+80	4.3	4.0	0.3	115		34.8	
					120		5,581
75+00	4.3	3.8	0.5	115		58.3	
					100		5,825
76+00	4.3	3.8	0.5	115		58.3	
					100		6,417
77+00	4.3	3.7	0.6	115		70.1	
					100		8,200
78+00	4.3	3.5	0.8	115		93.9	
					100		11,203
79+00	4.3	3.2	1.1	115		130.1	
					100		14,235
80+00	4.3	3.0	1.3	115		154.6	
					100		15,457
81+00	4.3	3.0	1.3	115		154.6	
					100		15,457
82+00	4.3	3.0	1.3	115		154.6	
					100		17,313
83+00	4.3	2.7	1.6	115		191.7	
					40		3,834
83+40	4.3	2.2	2.1	115			
						Total	**103,520**

Access Dredging - Upper Level - Clean

Station	depth required	water depth	dredge depth	width	length	area	volume
73+80	4.3	4.4	-0.1	115			
					20		348
74+00	4.3	4.0	0.3	115		34.8	
					100		4,651
75+00	4.3	3.8	0.5	115		58.3	

					100		5,825
76+00	4.3	3.8	0.5	115		58.3	
					100		6,417
77+00	4.3	3.7	0.6	115		70.1	
					100		8,200
78+00	4.3	3.5	0.8	115		93.9	
					100		11,203
79+00	4.3	3.2	1.1	115		130.1	
					100		14,235
80+00	4.3	3.0	1.3	115		154.6	
					100		15,457
81+00	4.3	3.0	1.3	115		154.6	
					100		15,457
82+00	4.3	3.0	1.3	115		154.6	
					100		17,313
83+00	4.3	2.7	1.6	115		191.7	
					40		8,928
83+40	4.3	2.2	2.1	115		254.7	
					80		30,509
84+20	4.3	0.3	4.0	115		508.0	
					80		34,240
85+00	4.3	0.3	4.0	75		348.0	
					Total		**172,782**

Access Dredging - Upper Level - Contaminated

85+00	4.3	0.3	4.0	75		348.0	
					312		108,576
88+12	4.3	0.3	4.0	75		348.0	
					Total		**108,576**

Pier Dredge Volumes - Lower Limit

Pier	Pile Cap				Coffer dam				Piles						Total Dredge Volume			Comments
	wdth	lngth	depth total	depth water	wdth	lngth	depth water	vol dredge	dia	#	length water	length conc	length **dredge**	length total	volume	EB	WB	**both**
E1									2.5	20	15	50	3	78	**295**			**295**	
E2									2.5	16	12.8	50	37.2	78	**2,922**			**2,922**	
E3	13.8	20	6	4					2.5	6	12.4	50	37.6	78	**1,107**	1,107	1,107	**2,215**	
E4	13.8	20	6	4					2.5	6	12	50	38	78	**1,119**	1,119	1,119	**2,238**	
E5	13.8	20	6	4					2.5	6	9.4	50	40.6	78	**1,196**	1,196	1,196	**2,392**	
E6	13.8	20	6	4					2.5	6	7.5	50	42.5	78	**1,252**	1,252	1,252	**2,503**	
E7	13.8	20	6	4					2.5	6	5.9	50	44.1	78	**1,299**	1,299	1,299	**2,598**	
E8	13.8	20	6	4					2.5	6	4.8	50	45.2	78	**1,331**	1,331	1,331	**2,663**	
E9	13.8	20	6	4					2.5	6	4.3	50	45.7	78	**1,346**	1,346	1,346	**2,692**	
E10	13.8	20	6	4					2.5	6	3.9	50	46.1	78	**1,358**	1,358	1,358	**2,716**	
E11	13.8	14	4	2					1.5	9	3.7	50	46.3	97	**736**	736	736	**1,473**	
E12	13.8	14	4	2					1.5	9	3.7	50	46.3	97	**736**	736	736	**1,473**	
E13	13.8	14	4	2					1.5	9	3.3	50	46.7	97	**743**	743	743	**1,485**	
E14	13.8	14	4	2					1.5	9	3	50	47	97	**748**	748	748	**1,495**	

Pier	Pile Cap				Coffer dam					Piles							Total Dredge Volume			Comments
	wdth	lngth	depth		wdth	lngth	depth		vol	dia	#	length				volume	EB	WB	both	
E15	9	9	3.5	1.5						1	9	3	30	27	98	**191**	191	191	**382**	
E16	9	9	3.5	1.5						1	9	3	30	27	98	**191**	191	191	**382**	
E17	9	9	3.5	1.5						1	9	2.9	30	27.1	98	**192**	192	192	**383**	
E18	9	9	3.5	1.5						1	9	2.1	30	27.9	98	**197**	197	197	**394**	
E19	9	9	3.5	1.5						1	9	1.7	30	28.3	98	**200**	200	200	**400**	
E20	9	9	3.5	1.5	13	13	1.2	0.3	**51**	1	9	1.2	30	28.8	98	**204**	254	254	**509**	
E21	9	9	3.5	1.5	13	13	0.8	0.7	**118**	1	9	0.8	30	29.2	98	**206**	325	325	**649**	
																		Total	**32,257**	

Contaminated Pier Dredge Volumes - Lower Limit

Pier	Pile Cap				Coffer dam					Piles							Total Dredge Volume			Comments
	wdth	lngth	depth		wdth	lngth	depth		vol	dia	#	length				volume	EB	WB	both	
			total	water			water	dredge				water	conc	**dredge**	total					
E22	9	9	3.5	1.5	13	13	0	1.5	**254**	1	9	0	30	30	98	**212**	466	466	**931**	contaminated
E23	9	9	3.5	1.5	13	13	0	1.5	**254**	1	9	0	30	30	98	**212**	466	466	**931**	contaminated
E24	9	9	3.5	1.5																on land
E25	9	9	3.5	1.5																on land
E26	9	9	3.5	1.5	13	13	0	1.5	**254**	1	9	0	30	30	98	**212**	466	466	**931**	contaminated
E27	9	9	3.5	1.5	13	13	0	1.5	**254**	1	9	0	30	30	98	**212**	466	466	**931**	contaminated

Pier	Pile Cap				Coffer dam					Piles							Total Dredge Volume			Comments
	wdth	lngth	depth		wdth	lngth	depth	vol	dia	#		length			volume	EB	WB	both	
E28	9	9	3.5	1.5	13	13	0	1.5	**254**	1	9	0	30	30	98	**212**	466	466	**931**	contaminated
E29	9	9	3.5	1.5	13	13	0	1.5	**254**	1	9	0	30	30	98	**212**	466	466	**931**	contaminated
																		Total	**5,587**	

Appendix B
Cost Assumptions

SFOBB DREDGE REUSE/DISPOSAL COST ASSUMPTIONS

This section of the report describes the cost assumptions used to derive the dredging, transportation, and reuse/disposal costs associated with the excavation of material for building the SFOBB East Span Seismic Safety Project and for dismantling the existing East Span structure.

SUMMARY

Listed below are the quantities, unit costs, and total costs for each reuse/disposal option. All unit costs are expressed in cubic yards (CY).

	QTY	UOM	Unit Cost	Total Cost
Clean Material				
Sidecast Dredge	276,777	CY	$17.00	$4,705,209
Dredge Material	440,121	CY	15.00	6,601,815
Transport & Reuse/Disposal of Material				
SF-DODS (Ocean)	440,121	CY	12.00	5,281,452
SF-11 (Alcatraz)	440,121	CY	7.00	3,080,847
Montezuma Wetlands	440,121	CY	49.00	21,565,929
Hamilton Wetlands	440,121	CY	23.00	10,122,783
Not Suitable for Unconfined Aquatic Disposal				
Class II Upland Landfill Facility	145,362	CY	78.00	11,338,236

DEFINITIONS

- Barge tow (double screw) - two propeller tug boat
- Scow - vessel used for collected dredged material
- Slick line - transport pipe used for spreading suspended dredge material
- Loose quantity - dredged material that swells once dewatered, typically by 20%

GENERAL ASSUMPTIONS

1. Quantity dredged is assumed to be 440,121 cubic yards of clean sediment, and 145,362 cubic yards of contaminated material. Estimates assume "Upper Limit" design quantities.

2. Costs for dredging of materials are the same for all reuse/disposal costs, except for sidecasting which includes dredging and reuse/disposal in one unit cost.
3. Any additional analytical work (e.g., testing) would be paid for by Caltrans.
4. All estimates are in first quarter 1999 dollars.
5. For reuse/disposal options, assume a 30% subcontractor/general contractor markup.
6. All unit costs include a 25% contingency.
7. Montezuma Wetlands and Hamilton are included to illustrate a range of potential upland wetland restoration (UWR) site costs.

DREDGING ASSUMPTIONS

8. "Dredging" is defined to include typical linear dredging used for creation of construction and dismantling access channels, and excavation from pier casings and behind cofferdams for pier construction and dismantling.
9. Assumes scows are filled to 85% of capacity.
10. Dredging assumes use of the following equipment and activities. The amount of equipment varies among the different reuse/disposal options:
    - Dredge barge for dredging equipment
    - Tug for towing scows
    - Anchor scow to relocate dredge barge
    - Scow for accumulating dredged material
    - Mobilization of equipment
    - All equipment includes labor in accordance with local labor agreements
11. Sidecast dredging:
    - Unit price for sidecast dredge includes slick line pumped method of broadcasting sediment to develop access channel width.
    - Unit price for sidecast dredge material without slick line pump method is $36 per cubic yard. This unit price accounts for doubling handling of dredge material.
12. Unit prices do not include dewatering or treatment of water in cofferdamed excavations.
13. For SF-DODS only, assumes EPA inspection charges shared by other agencies for one year of the two year monitoring/inspection period.
14. Assumes Caltrans to pay permit fees (e.g., lease permit for Port of Oakland facility, etc.).
15. Testing of sediments prior to dredging not included in unit costs.

TRANSPORTATION ASSUMPTIONS

16. Scow rental costs
    - 3,000 cubic yard scow, $600 per day
    - 7,000 cubic yard scow, $700 per day
17. Upland costing assumes that Caltrans would provide a berthing facility (e.g., Caltrans painting warehouse at the Oakland touchdown) suitable for accommodating a dredge scow/dredge barge and up to 10 acres of property for aerating material within one-quarter mile of the facility.
18. Assumes use of 14-wheel trucks; mileage cost is $0.50/mile.

REUSE/DISPOSAL ASSUMPTIONS

19. For upland disposal, estimates assume material would be disposed of at a Class II regulated landfill.

20. Dumping fee for Montezuma Wetlands at $16.00 per cubic yard; fee of $15.00 per cubic yard waived for Hamilton facility.
21. Estimates for Hamilton and Montezuma Wetlands assume dredged material would be off-loaded by slick line pumping.

SOURCES

22. Dutra Construction -- for barge availability and other dredging information
23. Weststar Marine -- for tug/barge costs
24. Local Bay Area Class II landfill operators

REUSE/DISPOSAL OPTION 1 - SF-DODS (OCEAN)

Quantity: 440,121 cubic yards
Loose: 528,145 cubic yards

Item	Quantity	UOM	Unit Cost	Disposal	Transport
2 Scow/Barge Tow (double screw)	1,906	HRS	$1,100	—	$2,096,600
4 Scow (7,000 cubic yard capacity)	193	DAYS	2,800	—	540,400
6 Mobilization of equipment	1	LS	513,369	—	30,722
Subtotal Cost:				0	2,667,722
Subcontractor/General Contractor Markup			30%	0	800,317
Owners Testing					
EPA Inspection Charges	1	YR	770,000	770,000	—
Subtotal Cost:				770,000	3,468,039
Contingency			25%	192,500	867,010
Total Cost:				962,500	4,335,049
Total Cost per Cubic Yard:				$2.19	$9.85

REUSE/DISPOSAL OPTION 2 - SF-11 (ALCATRAZ)

Quantity: 440,121 cubic yards
Loose: 528,145 cubic yards

Item	Quantity	UOM	Unit Cost	Disposal	Transport
1 Barge Tow (single screw)	1,483	HRS	$1,100	—	$1,631,300
2 Scow (3,000 cubic yard capacity)	193	DAYS	1,200	—	231,600
4 Mobilization of equipment	1	LS	88,590	—	88,590
Subtotal Cost:				0	1,951,490
Subcontractor/General Contractor Markup			30%	0	585,447
Subtotal Cost:				0	2,536,937
Contingency			25%	0	634,234
Total Cost:				0	3,171,171
Total Cost per Cubic Yard:				$0	$7.20

REUSE/DISPOSAL OPTION 3 - MONTEZUMA WETLANDS

Quantity: 440,121 cubic yards
Loose: 528,145 cubic yards

Item	Quantity	UOM	Unit Cost	Disposal	Transport	
Dredge Non-Contaminated Sediment Material						
2 Barge Tow (double screw)	3,521	HRS	$1,100	—	$3,873,100	
6 Scow (3,000 cubic yard capacity)	193	DAYS	3,600	—	694,800	
9 Mobilization of equipment	1	LS	319,791	—	319,791	
Offload Dredge Material in Slick Line						
Pump Equipment	1	LS	100,000	100,000	—	
Pump Mobilization	1	LS	100,000	100,000	—	
Pump Labor	2,321	HRS	195	452,518	—	
Dump Fee	528,145	CY	16	8,450,321	—	
Subtotal Cost:				9,102,839	4,887,691	
Subcontractor/General Contractor Markup (Disposal)			30%	2,730,852	—	
Subcontractor/General Contractor Markup (Transport) *				10%	—	488,
Subtotal Cost:				11,833,691	5,376,461	
Contingency			25%	2,958,423	1,344,115	
Total Cost:				14,792,114	6,720,576	
Total Cost per Cubic Yard:				$33.61	$15.27	

* Accounts for reduced General Contractor coordination in the handling and transportation of the dredged material.

REUSE/DISPOSAL OPTION 4 - HAMILTON WETLANDS

Quantity: 440,121 cubic yards
Loose: 528,145 cubic yards

Item	Quantity	UOM	Unit Cost	Disposal	Transport	
Dredge Non-Contaminated Sediment Material						
1 Barge Tow (double screw)	2,201	HRS	$550	—	$1,210,550	
4 Scow (3,000 cubic yard capacity)	193	DAYS	2,400	—	463,200	
6 Mobilization of equipment	1	LS	28,494	—	28,494	
Offload Dredge Material in Slick Line						
Pump Equipment	1	LS	50,000	50,000	—	
Pump Mobilization	1	LS	100,000	100,000	—	
Pump Labor	2,400	HRS	195	468,000	—	
Spread Dumped Material	528,145	CY	8	4,225,160	—	
Subtotal Cost:				4,843,160	1,702,244	
Subcontractor/General Contractor Markup (Disposal)			30%	1,452,948	—	
Subcontractor/General Contractor Markup (Transport) *				10%	—	170,
Subtotal Cost:				6,296,108	1,872,468	
Contingency			25%	1,574,027	468,117	
Total Cost:				7,870,135	2,340,585	
Total Cost per Cubic Yard:				$17.88	$5.32	

* Accounts for reduced General Contractor coordination in the handling and transportation of the dredged material.

REUSE/DISPOSAL OPTION 5 - UPLAND DISPOSAL

Quantity: 145,362 cubic yards
Loose: 174,434 cubic yards

Item	Quantity	UOM	Unit Cost	Disposal	Transport
1 Barge Tow (double screw)	403	HRS	$387	—	$155,961
4 Scow (3,000 cubic yard capacity)	101	DAYS	800	—	80,800
6 Mobilization of equipment	1	LS	209,131	—	209,131
Scow/Barge Transport to Berth for Material Offload to Containment					
Barge Tow	8	HRS	1,000	—	8,000
Scow (7,000 cubic yards)	—	DAYS	150	—	Included above
Scow Labor	—	HRS	55	—	Included above
Berthing Facilities					
Berthing Fees	—	LS	20,000	—	By Caltrans
Build Containment Berm					
Build Berm	1,056	CY	2.5	2,640	—
Port of Oakland Facility Lease	1	LS	53,200	53,200	—
Unload Dredge Material to Containment Facility					
Aeration Equipment	2	MONTHS	9,500	19,000	—
Aeration Equipment Idle	3	MONTHS	2,500	7,500	—
Aeration Labor	2,304	HRS	50	115,200	—
Derrick Barge	4,652	DAYS	550	2,558,600	—
Scow (7,000 cubic yard capacity)	291	DAYS	150	43,650	—
Scow Labor	1,163	DAYS	55	63,965	—
Laborers for Cleanup	6,977	HRS	75	523,275	—
Trucking	2,492	HRS	75	186,900	—
Load and Transport Dredge Material to Class II Landfill					
235 Excavator & Operator	872	HRS	228	—	198,816
Trucking	31,149	HRS	75	—	2,336,175
Laborers for Cleanup	1,744	HRS	75	—	130,800
Dump fee	174,434	CY	0	0	—
Decommission Containment Facility					
Demo Berm	1,056	CY	5	5,280	—
Clean up of Port of Oakland Facility	1	LS	5,233	5,233	—
Subtotal Cost:				3,584,443	3,431,173
Subcontractor/General Contractor Markup			30%	1,075,333	1,029,352
Subtotal Cost:				4,659,776	4,460,525
Contingency:			25%	1,164,944	1,115,131
Total Cost:				5,824,720	5,575,666
Total Cost per Cubic Yard:				$40.07	$38.36

SIDECAST DREDGE Quantity: 276,777 cubic yards

Item	Quantity	UOM	Unit Cost	Disposal	Transport
Offload Dredge Material in Slick Line					
Pump Equipment	1	LS	$150,000	$150,000	—
Pump Labor	3,690	HRS	130	479,700	—
Dump Fee	—	CY	16	—	—
Subtotal Cost:				629,700	—
Subcontractor/General Contractor Markup			30%	188,910	0
Subtotal:				818,610	0
Contingency			25%	204,653	0
Total Cost:				1,023,263	0
Total Cost per Cubic Yard:				$3.70	—

Appendix C
Air Quality Analysis For Dredging Related Activities

San Francisco-Oakland Bay Bridge East Span Seismic Safety Project

Air Quality Analysis For Dredging-Related Activities

This memorandum summarizes the methods and results of an air quality emissions analysis comparing representative dredged material reuse/disposal options for the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project. Dredged material will be generated as a result of construction of a new East Span and dismantling of the existing East Span. Dredged quantities for the bridge replacement alternatives (N-2, N-6, and S-4) are similar. Volumes for N-6 have been used in this analysis as a representative scenario.

Due to the nature of the dredging-related activities, the primary sources of air pollutant emissions would be from the exhaust of diesel-powered dredging and support equipment, marine vessels and on-road vehicles used for transport, and equipment used during unloading/loading of material. It is assumed that there would be no fugitive dust emissions as the dredged material would always be relatively moist. The emission inventory for these sources consists of emissions of total organic gases (TOG), reactive organic gases (ROG), carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), and particulate matter (both total PM and PM_{10}).

Methodology

Construction activities have been divided into three general categories for evaluation and discussion: dredging, transport, and unloading/loading. Tables 1-8 summarize the types of equipment to be used and their level of usage for each of the activity categories. These tables are presented by reuse/disposal option (see the transport discussion below for option details).

Dredging

Dredging would occur over a 62-month period and would occur in four phases: construction access to construct the new bridge, construction of new piers and footings, construction access to dismantle the existing bridge, and removal of the existing bridge to the mudline (see Section 3 of the Dredged Material Management Plan). Estimated dredge quantities by construction phase are presented in Table 9 for an upper limit (construction without use of trestles and falsework) and a lower limit (construction with the use of trestles and falsework). The highest volume of dredging would occur during construction of the access channel for the new bridge, near the beginning of the project (months 4-6). The second highest volume of dredging would occur during construction of the existing bridge dismantling access channel, towards the end of the project (months 46-48). Dredging from the other two construction phases would be significantly lower.

Dredging would occur by mechanical means (e.g., by a clamshell dredge). Support equipment that would also be utilized during dredging include tug, support, and survey boats and equipment on the deck of the barges.

Transport

While a wide range of reuse/disposal sites have been considered during the preparation of the Dredged Material Management Plan, the sites that were assessed in to this air quality analysis are:

- In-Bay Disposal (Alcatraz [SF-11]), approximately 8 kilometers (5 miles) from the SFOBB site.
- Ocean Disposal (San Francisco Deep Ocean Disposal Site [SF-DODS]), approximately 102 kilometers (55 nautical miles) from the SFOBB site.
- Wetlands Reuse (Hamilton Wetlands Restoration), approximately 29 kilometers (18 miles) from the SFOBB site.
- Landfill Disposal (Altamont Landfill), approximately 70 kilometers (45 miles) from the SFOBB site.

A variety of disposal combinations, using the various disposal locations, have been developed. These options and their distribution of dredged material quantities by disposal location are presented in Tables 10 and 11 for the upper and lower dredging limits, respectively.

Emissions in this category include emissions generated by marine vessels and on-road trucks traveling to the disposal sites and while idling during unloading of the dredged material.

Unloading/Loading

For the unloading of materials at in-Bay and ocean disposal sites, the only source of air pollutant emissions would be the idling of the tugboats as the material is released into the water. Since idling is the only source of unloading emissions for these disposal options, the emissions have been included in the transport category. With the upland wetlands reuse option, sediments would be pumped as a slurry (sediment/water mix) through a eight kilometer (five mile) pipeline to the site from barges docked offshore in San Pablo Bay. Emissions would be generated by support equipment used to operate and oversee the pumping facilities. With upland disposal, dredged material would be handled twice. It would first be loaded onto a barge then off-loaded to a receiving area where it must be "worked" with heavy equipment in order to obtain a moisture content of less than 50 percent for transport and disposal. After being dried, the material would be loaded onto trucks and transported to the landfill site.

Emission Factors

Emission factors used in the analysis include those from the U.S. Environmental Protection Agency's AP-42 Compilation of Air Pollutant Emission Factors (for most equipment), the California Air Resources Board's Report to the California Legislature on Air Pollutant Emissions from Marine Vessels (for the tug boats), and the California Air Resources Board's mobile source emissions factor model (EMFAC7G) (for on-road vehicles). Emission factors are presented in Table 12.

The emissions factors are applied to usage units such as fuel usage, hours of operation, and vehicle miles traveled (which are presented in Tables 1-8) in order to calculate emissions. Emission factors for all equipment and marine vessels are presented in pounds per 1,000 gallons of fuel used. The emission factors for trucks are in grams per mile and grams per hour, depending on if the truck is moving or at idle.

Results

Daily Emissions

Construction activities and related emissions typically vary day by day depending on the level of activity. This is especially true in the case of dredging-related activities for the East Span Project, for which activities would be conducted over a 62-month period and in various phases.

Since the volume of dredging would vary greatly over the total construction period, emissions on a daily basis were not calculated for an average construction day. Instead, emissions were calculated for a maximum daily scenario. First, it was determined, based on dredge quantities, that a maximum day would occur during the preparation of an access channel for construction of the new bridge. During this phase of construction, depending on which combined reuse/disposal option is chosen, dredged material may be taken to the Hamilton Wetlands Restoration site and the Altamont Landfill (Options A, D, and E), to the ocean disposal site and the Altamont Landfill (Options B, C, F, and G), or just to the Altamont Landfill (Option H). Based on the level of activity required for each of these options, it was determined that a maximum daily scenario would likely occur during a situation where dredged material would be taken to both the ocean disposal site and the Altamont Landfill on particular day.

Table 13 includes the emissions that would be generated during the maximum daily scenario. It should be noted that the maximum daily scenario would likely only occur during construction months 4-6 and only with Options B, C, F, and G. Emissions during other phases of construction would be lower, especially during new pier construction and dismantling of existing piers.

The pollutants emitted in the largest amount would be primarily NO_x and secondarily CO. The emissions source generating the most air pollutants would be the tug boats used to transport the dredged material to the ocean disposal site. These tug boats have large engines and require more fuel than the tug boats used for the other disposal options. The dump trucks that would be used to transport the dredged material to Altamont Landfill would produce less emissions than the other means of transport used during the project (the single and double screw tug boats).

Total Emissions

The amount of emissions would vary depending upon the reuse/disposal options chosen. These variations would occur despite the fact that the same amount of material would be dredged because different equipment would be used for transport and unloading/loading

depending on where the material would be going and the distances to these disposal sites would be different.

Tables 14-21 summarize the emissions for both the upper and lower dredging limits. Construction with the lower dredging limit would result in approximately 30 to 38 percent lower emissions than construction with the upper dredging limit, depending upon the reuse/disposal option (Options A-G). The lower dredging limit would result in almost 42 percent lower emissions for Option H compared to the upper dredging limit.

The option that would generate the greatest amount of emissions would be Option C because under this scenario all dredged material suitable for unconfined aquatic disposal would be transported to the ocean disposal site. As discussed under the daily emissions discussion, the tug boats used to take dredged material to the ocean disposal site would generate the greatest amount of emissions of any of the equipment potentially used during transport of material. As a result, options with fewer or no ocean disposal trips would have lower emissions.

Options A, E, and H generate the lowest levels of emissions among the eight scenarios evaluated. The option generating the least emissions overall would be Option H (all material transported to the Altamont Landfill). Options A and E would generate lower emissions of certain pollutants (CO, organics, and PM_{10}) compared to Option H. Option H, which would require double-handling of material and trucking to a landfill, would generate the least amounts of NO_x and SO_2 and would have levels of organics and particulates similar to the other options. The lower levels of emissions generated by Option H occur because the trucks and material handling equipment used with this option generate lower levels of pollutants than the tug boats used with the other options. However, motor vehicles, including heavy-duty diesel trucks, generate more CO as a result of incomplete fuel combustion. CO emissions generated with Option H would be on average 25 percent higher than the other disposal options, assuming an upper dredging limit, and 20 percent higher for the lower dredging limit. Organics emissions would be similar the other options.

References

California Air Resources Board 1984, *Report to the California Legislature on Air Pollutant Emissions from Marine Vessels, Volume I.*

California Air Resources Board 1996, *Methodology for Estimating Emissions from On-road Motor Vehicles, Volume II: EMFAC7G.*

San Joaquin Valley Unified Air Pollution Control District 1998, *URBEMIS7G Computer Program User's Guide, Emissions Estimation for Land Use Development Projects.*

United States Environmental Protection Agency 1993, *AP-42 Compilation of Air Pollutant Emission Factors: Volume II: Mobile Sources.*

United States Environmental Protection Agency 1996, *AP-42 Compilation of Air Pollutant Emission Factors: Volume I: Stationary, Point and Area Sources, Supplement B.*

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 1 - Emission Source Information for Option A

Prepared By: P. McNamee
Date Prepared: 4/14/99
Checked By: I. Edmonds-Hess

Table 1
Emission Source Information for Option A

Activity / Equipment Type / Disposal Alternative	Pieces of Equipment	Horse Power (Hp)	Load Factor	Hp-Hours	Fuel Use (Gal/Hr.)	Hours Per Max. Day	Hours Per Ave. Day	Number of Work Days	Daily Maximum Fuel Usage (gals)	Total Project Fuel Usage (Upper Limit) (gals)	Total Project Fuel Usage (Lower Limit) (gals)	
Dredging												
Clamshell Dredge	2	1,800	0.80	2,880	190.2	20	10	294.0	3,804	559,188	327,125	
Anchor Tug	2	400	0.80	640	22.4	20	10	294.0	448	65,856	38,526	
Barge Equipment	3	100	0.80	240	15.9	20	10	294.0	318	46,746	27,346	
Support Boat	1	250	0.80	200	8.5	20	10	294.0	170	24,990	14,619	
Survey Boat	1	250	0.80	200	8.5	10	10	294.0	85	24,990	14,619	
Alcatraz Disposal Site												
Transport & Unloading												
Tug Boat (Single Screw)	2	1,800	0.80	2,880	210.0	8	8	20.4	1,680	34,188	26,393	
Barge Equipment	2	100	0.50	100	10.6	4	4	20.4	42	863	666	
Ocean Disposal Site												
Transport & Unloading												
Tug Boat (Double Screw)					0.0							
Barge Equipment												
Hamilton Wetland Restoration Site												
Transport												
Tug Boat (Double Screw)	1	3,000	0.80	2,400	200.0	20	10	143.0	4,000	286,000	217,360	
Barge Equipment	2	250	0.50	250	10.6	4	4	143.0	42	6,063	4,608	
Unloading												
Hydraulic Unloader	1	1,500	0.80	1,200	63.0	8	4	143.0	504	36,036	27,387	
Booster Pump	1	1,500	0.80	1,200	126.0	8	4	143.0	1,008	72,072	54,775	
Work Tug	1	400	0.50	200	11.2	8	4	143.0	90	6,406	4,869	
Generator	1	75	0.50	38	1.9	8	4	143.0	15	1,087	826	
Support Boat	1	250	0.50	125	8.5	4	2	143.0	34	2,431	1,848	
Altamont Landfill												
Transport												
Tug Boat (Single Screw)	1	1,800	0.80	1,440	105.0	8	6	25.0	840	15,750	7,922	
Barge Equipment	2	250	0.50	250	10.6	8	6	25.0	85	1,590	800	
Dump Trucks Traveling to Drying Area[1]	84	0.25						145.0	21	3,045	1,532	<- VMT
Dump Trucks Idling at Drying Area[2]	84					0.17	0.17	145.0	14	2,030	1,021	
Dump Trucks Traveling to Landfill[1]	242	90						50.0	21,780	1,089,000	547,767	<- VMT
Dump Trucks Idling at Landfill[2]	242					0.17	0.17	50.0	40	2,017	1,014	
Unloading/Loading												
Clamshell Dredge	1	1,800	0.80	1,440	95.1	10	8	36.3	951	27,617	13,891	
Barge Equipment	3	100	0.80	240	15.9	10	8	36.3	159	4,617	2,323	
D-6 Dozer	1	300	0.50	150	16.0	10	8	66.3	160	8,486	4,269	
Loader	1	300	0.50	150	16.0	10	8	66.3	160	8,486	4,269	
Support Boat	1	250	0.80	200	8.5	10	8	36.3	85	2,468	1,242	

Notes:

[1] In this case, the value in the pieces of equipment column is actually the number of truck trips, the value in the horsepower column is the round trip travel distance, and the values in the fuel usage columns are vehicle miles traveled.

[2] In this case, the value in the pieces of equipment column is actually the number of truck trips, the value in the hours per day column is the amount of idling per trip, and the values in the fuel usage columns are total amount of idling hours.

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 2 - Emission Source Information for Option B

Prepared By: P. McNamee
Date Prepared: 4/14/99
Checked By: I. Edmonds-Hess

Table 2
Emission Source Information for Option B

Activity / Equipment Type / Disposal Alternative	Pieces of Equipment	Horse Power (Hp)	Load Factor	Hp-Hours	Fuel Use (Gal/Hr.)	Hours Per Max. Day	Hours Per Ave. Day	Number of Work Days	Daily Maximum Fuel Usage (gals)	Total Project Fuel Usage (Upper Limit) (gals)	Total Project Fuel Usage (Lower Limit) (gals)
Dredging											
Clamshell Dredge	2	1,800	0.80	2,880	190.2	20	10	294.0	3,804	559,188	327,125
Anchor Tug	2	400	0.80	640	22.4	20	10	294.0	448	65,856	38,526
Barge Equipment	3	100	0.80	240	15.9	20	10	294.0	318	46,746	27,346
Support Boat	1	250	0.80	200	8.5	20	10	294.0	170	24,990	14,619
Survey Boat	1	250	0.80	200	8.5	10	10	294.0	85	24,990	14,619
Alcatraz Disposal Site											
Transport & Unloading											
Tug Boat (Single Screw)	2	1,800	0.80	2,880	210.0	8	8	20.4	1,680	34,188	26,393
Barge Equipment	2	100	0.50	100	10.6	4	4	20.4	42	863	666
Ocean Disposal Site											
Transport & Unloading											
Tug Boat (Double Screw)	2	3,000	0.80	4,800	400.0	24	24	52.0	9,600	499,200	379,392
Barge Equipment	2	250	0.50	250	10.6	4	4	52.0	42	2,205	1,676
Hamilton Wetland Restoration Site											
Transport											
Tug Boat (Double Screw)											
Barge Equipment											
Unloading											
Hydraulic Unloader											
Booster Pump											
Work Tug											
Generator											
Support Boat											
Altamont Landfill											
Transport											
Tug Boat (Single Screw)	1	1,800	0.80	1,440	105.0	8	6	25.0	840	15,750	7,922
Barge Equipment	2	250	0.50	250	10.6	8	6	25.0	85	1,590	800
Dump Trucks Traveling to Drying Area[1]	84	0.25						145.0	21	3,045	1,532
Dump Trucks Idling at Drying Area[2]	84					0.17	0.17	145.0	14	2,030	1,021
Dump Trucks Traveling to Landfill[1]	242	90						50.0	21,780	1,089,000	547,767
Dump Trucks Idling at Landfill[2]	242					0.17	0.17	50.0	40	2,017	1,014
Unloading/Loading											
Clamshell Dredge	1	1,800	0.80	1,440	95.1	10	8	36.3	951	27,617	13,891
Barge Equipment	3	100	0.80	240	15.9	10	8	36.3	159	4,617	2,323
D-6 Dozer	1	300	0.50	150	16.0	10	8	66.3	160	8,486	4,269
Loader	1	300	0.50	150	16.0	10	8	66.3	160	8,486	4,269
Support Boat	1	250	0.80	200	8.5	10	8	36.3	85	2,468	1,242

Notes:

[1] In this case, the value in the pieces of equipment column is actually the number of truck trips, the value in the horsepower column is the round trip travel distance, and the values in the fuel usage columns are vehicle miles traveled.

[2] In this case, the value in the pieces of equipment column is actually the number of truck trips, the value in the hours per day column is the amount of idling per trip, and the values in the fuel usage columns are total amount of idling hours.

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 3 - Emission Source Information for Option C

Prepared By: P. McNamee
Date Prepared: 4/14/99
Checked By: I. Edmonds-Hess

Table 3
Emission Source Information for Option C

Activity / Equipment Type / Disposal Alternative	Pieces of Equipment	Horse Power (Hp)	Load Factor	Hp-Hours	Fuel Use (Gal/Hr.)	Hours Per Max. Day	Hours Per Ave. Day	Number of Work Days	Daily Maximum Fuel Usage (gals)	Total Project Fuel Usage (Upper Limit) (gals)	Total Project Fuel Usage (Lower Limit) (gals)
Dredging											
Clamshell Dredge	2	1,800	0.80	2,880	190.2	20	10	294.0	3,804	559,188	327,125
Anchor Tug	2	400	0.80	640	22.4	20	10	294.0	448	65,856	38,526
Barge Equipment	3	100	0.80	240	15.9	20	10	294.0	318	46,746	27,346
Support Boat	1	250	0.80	200	8.5	20	10	294.0	170	24,990	14,619
Survey Boat	1	250	0.80	200	8.5	10	10	294.0	85	24,990	14,619
Alcatraz Disposal Site											
Transport & Unloading											
Tug Boat (Single Screw)					0.0						
Barge Equipment											
Ocean Disposal Site											
Transport & Unloading											
Tug Boat (Double Screw)	2	3,000	0.80	4,800	400.0	24	24	60.0	9,600	576,000	438,912
Barge Equipment	2	250	0.50	250	10.6	4	4	60.0	42	2,544	1,939
Hamilton Wetland Restoration Site											
Transport											
Tug Boat (Double Screw)					0.0						
Barge Equipment											
Unloading											
Hydraulic Unloader											
Booster Pump											
Work Tug											
Generator											
Support Boat											
Altamont Landfill											
Transport											
Tug Boat (Single Screw)	1	1,800	0.80	1,440	105.0	8	6	25.0	840	15,750	7,922
Barge Equipment	2	250	0.50	250	10.6	8	6	25.0	85	1,590	800
Dump Trucks Traveling to Drying Area[1]	84	0.25						145.0	21	3,045	1,532
Dump Trucks Idling at Drying Area[2]	84					0.17	0.17	145.0	14	2,030	1,021
Dump Trucks Traveling to Landfill[1]	242	90						50.0	21,780	1,089,000	547,767
Dump Trucks Idling at Landfill[2]	242					0.17	0.17	50.0	40	2,017	1,014
Unloading/Loading											
Clamshell Dredge	1	1,800	0.80	1,440	95.1	10	8	36.3	951	27,617	13,891
Barge Equipment	3	100	0.80	240	15.9	10	8	36.3	159	4,617	2,323
D-6 Dozer	1	300	0.50	150	16.0	10	8	66.3	160	8,486	4,269
Loader	1	300	0.50	150	16.0	10	8	66.3	160	8,486	4,269
Support Boat	1	250	0.80	200	8.5	10	8	36.3	85	2,468	1,242

Notes:

[1] In this case, the value in the pieces of equipment column is actually the number of truck trips, the value in the horsepower column is the round trip travel distance, and the values in the fuel usage columns are vehicle miles traveled.

[2] In this case, the value in the pieces of equipment column is actually the number of truck trips, the value in the hours per day column is the amount of idling per trip, and the values in the fuel usage columns are total amount of idling hours.

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 4 - Emission Source Information for Option D

Prepared By: P. McNamee
Date Prepared: 4/14/99
Checked By: I. Edmonds-Hess

Table 4
Emission Source Information for Option D

Activity / Equipment Type / Disposal Alternative	Pieces of Equipment	Horse Power (Hp)	Load Factor	Hp-Hours	Fuel Use (Gal/Hr.)	Hours Per Max. Day	Hours Per Ave. Day	Number of Work Days	Daily Maximum Fuel Usage (gals)	Total Project Fuel Usage (Upper Limit) (gals)	Total Project Fuel Usage (Lower Limit) (gals)
Dredging											
Clamshell Dredge	2	1,800	0.80	2,880	190.2	20	10	294.0	3,804	559,188	327,125
Anchor Tug	2	400	0.80	640	22.4	20	10	294.0	448	65,856	38,526
Barge Equipment	3	100	0.80	240	15.9	20	10	294.0	318	46,746	27,346
Support Boat	1	250	0.80	200	8.5	20	10	294.0	170	24,990	14,619
Survey Boat	1	250	0.80	200	8.5	10	10	294.0	85	24,990	14,619
Alcatraz Disposal Site											
Transport & Unloading											
Tug Boat (Single Screw)					0.0						
Barge Equipment											
Ocean Disposal Site											
Transport & Unloading											
Tug Boat (Double Screw)	2	3,000	0.80	4,800	400.0	24	24	8.8	9,600	84,480	65,219
Barge Equipment	2	250	0.50	250	10.6	4	4	8.8	42	373	288
Hamilton Wetland Restoration Site											
Transport											
Tug Boat (Double Screw)	1	3,000	0.80	2,400	200.0	20	10	143.0	4,000	286,000	217,360
Barge Equipment	2	250	0.50	250	10.6	4	4	143.0	42	6,063	4,608
Unloading											
Hydraulic Unloader	1	1,500	0.80	1,200	63.0	8	4	143.0	504	36,036	27,387
Booster Pump	1	1,500	0.80	1,200	126.0	8	4	143.0	1,008	72,072	54,775
Work Tug	1	400	0.50	200	11.2	8	4	143.0	90	6,406	4,869
Generator	1	75	0.50	38	1.9	8	4	143.0	15	1,087	826
Support Boat	1	250	0.50	125	8.5	4	2	143.0	34	2,431	1,848
Altamont Landfill											
Transport											
Tug Boat (Single Screw)	1	1,800	0.80	1,440	105.0	8	6	25.0	840	15,750	7,922
Barge Equipment	2	250	0.50	250	10.6	8	6	25.0	85	1,590	800
Dump Trucks Traveling to Drying Area[1]	84	0.25						145.0	21	3,045	1,532
Dump Trucks Idling at Drying Area[2]	84					0.17	0.17	145.0	14	2,030	1,021
Dump Trucks Traveling to Landfill[1]	242	90						50.0	21,780	1,089,000	547,767
Dump Trucks Idling at Landfill[2]	242					0.17	0.17	50.0	40	2,017	1,014
Unloading/Loading											
Clamshell Dredge	1	1,800	0.80	1,440	95.1	10	8	36.3	951	27,617	13,891
Barge Equipment	3	100	0.80	240	15.9	10	8	36.3	159	4,617	2,323
D-6 Dozer	1	300	0.50	150	16.0	10	8	66.3	160	8,486	4,269
Loader	1	300	0.50	150	16.0	10	8	66.3	160	8,486	4,269
Support Boat	1	250	0.80	200	8.5	10	8	36.3	85	2,468	1,242

Notes:

[1] In this case, the value in the pieces of equipment column is actually the number of truck trips, the value in the horsepower column is the round trip travel distance, and the values in the fuel usage columns are vehicle miles traveled.

[2] In this case, the value in the pieces of equipment column is actually the number of truck trips, the value in the hours per day column is the amount of idling per trip, and the values in the fuel usage columns are total amount of idling hours.

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 5 - Emission Source Information for Option E

Prepared By: P. McNamee
Date Prepared: 4/14/99
Checked By: I. Edmonds-Hess

Table 5
Emission Source Information for Option E

Activity / Equipment Type / Disposal Alternative	Pieces of Equipment	Horse Power (Hp)	Load Factor	Hp-Hours	Fuel Use (Gal/Hr.)	Hours Per Max. Day	Hours Per Ave. Day	Number of Work Days	Daily Maximum Fuel Usage (gals)	Total Project Fuel Usage (Upper Limit) (gals)	Total Project Fuel Usage (Lower Limit) (gals)
Dredging											
Clamshell Dredge	2	1,800	0.80	2,880	190.2	20	10	294.0	3,804	559,188	327,125
Anchor Tug	2	400	0.80	640	22.4	20	10	294.0	448	65,856	38,526
Barge Equipment	3	100	0.80	240	15.9	20	10	294.0	318	46,746	27,346
Support Boat	1	250	0.80	200	8.5	20	10	294.0	170	24,990	14,619
Survey Boat	1	250	0.80	200	8.5	10	10	294.0	85	24,990	14,619
Alcatraz Disposal Site											
Transport & Unloading											
Tug Boat (Single Screw)					0.0						
Barge Equipment											
Ocean Disposal Site											
Transport & Unloading											
Tug Boat (Double Screw)					0.0						
Barge Equipment											
Hamilton Wetland Restoration Site											
Transport											
Tug Boat (Double Screw)	1	3,000	0.80	2,400	200.0	20	10	165.0	4,000	330,000	251,460
Barge Equipment	2	250	0.50	250	10.6	4	4	165.0	42	6,996	5,331
Unloading											
Hydraulic Unloader	1	1,500	0.80	1,200	63.0	8	4	165.0	504	41,580	31,684
Booster Pump	1	1,500	0.80	1,200	126.0	8	4	165.0	1,008	83,160	63,368
Work Tug	1	400	0.50	200	11.2	8	4	165.0	90	7,392	5,633
Generator	1	75	0.50	38	1.9	8	4	165.0	15	1,254	956
Support Boat	1	250	0.50	125	8.5	4	2	165.0	34	2,805	2,137
Altamont Landfill											
Transport											
Tug Boat (Single Screw)	1	1,800	0.80	1,440	105.0	8	6	25.0	840	15,750	7,922
Barge Equipment	2	250	0.50	250	10.6	8	6	25.0	85	1,590	800
Dump Trucks Traveling to Drying Area[1]	84	0.25						145.0	21	3,045	1,532
Dump Trucks Idling at Drying Area[2]	84					0.17	0.17	145.0	14	2,030	1,021
Dump Trucks Traveling to Landfill[1]	242	90						50.0	21,780	1,089,000	547,767
Dump Trucks Idling at Landfill[2]	242					0.17	0.17	50.0	40	2,017	1,014
Unloading/Loading											
Clamshell Dredge	1	1,800	0.80	1,440	95.1	10	8	36.3	951	27,617	13,891
Barge Equipment	3	100	0.80	240	15.9	10	8	36.3	159	4,617	2,323
D-6 Dozer	1	300	0.50	150	16.0	10	8	66.3	160	8,486	4,269
Loader	1	300	0.50	150	16.0	10	8	66.3	160	8,486	4,269
Support Boat	1	250	0.80	200	8.5	10	8	36.3	85	2,468	1,242

Notes:

[1] In this case, the value in the pieces of equipment column is actually the number of truck trips, the value in the horsepower column is the round trip travel distance, and the values in the fuel usage columns are vehicle miles traveled.

[2] In this case, the value in the pieces of equipment column is actually the number of truck trips, the value in the hours per day column is the amount of idling per trip, and the values in the fuel usage columns are total amount of idling hours.

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 6 - Emission Source Information for Option F

Prepared By: P. McNamee
Date Prepared: 4/14/99
Checked By: I. Edmonds-Hess

Table 6
Emission Source Information for Option F

Activity / Equipment Type / Disposal Alternative	Pieces of Equipment	Horse Power (Hp)	Load Factor	Hp-Hours	Fuel Use (Gal/Hr.)	Hours Per Max. Day	Hours Per Ave. Day	Number of Work Days	Daily Maximum Fuel Usage (gals)	Total Project Fuel Usage (Upper Limit) (gals)	Total Project Fuel Usage (Lower Limit) (gals)
Dredging											
Clamshell Dredge	2	1,800	0.80	2,880	190.2	20	10	294.0	3,804	559,188	327,125
Anchor Tug	2	400	0.80	640	22.4	20	10	294.0	448	65,856	38,526
Barge Equipment	3	100	0.80	240	15.9	20	10	294.0	318	46,746	27,346
Support Boat	1	250	0.80	200	8.5	20	10	294.0	170	24,990	14,619
Survey Boat	1	250	0.80	200	8.5	10	10	294.0	85	24,990	14,619
Alcatraz Disposal Site											
Transport & Unloading											
Tug Boat (Single Screw)	2	1,800	0.80	2,880	210.0	8	8	20.4	1,680	34,188	26,393
Barge Equipment	2	100	0.50	100	10.6	4	4	20.4	42	863	666
Ocean Disposal Site											
Transport & Unloading											
Tug Boat (Double Screw)	2	3,000	0.80	4,800	400.0	24	24	31.2	9,600	299,520	179,412
Barge Equipment	2	250	0.50	250	10.6	4	4	31.2	42	1,323	739
Hamilton Wetland Restoration Site											
Transport											
Tug Boat (Double Screw)	1	3,000	0.80	2,400	200.0	20	10	57.2	4,000	114,400	114,400
Barge Equipment	2	250	0.50	250	10.6	4	4	57.2	42	2,425	2,425
Unloading											
Hydraulic Unloader	1	1,500	0.80	1,200	63.0	8	4	57.2	504	14,414	14,414
Booster Pump	1	1,500	0.80	1,200	126.0	8	4	57.2	1,008	28,829	28,829
Work Tug	1	400	0.50	200	11.2	8	4	57.2	90	2,563	2,563
Generator	1	75	0.50	38	1.9	8	4	57.2	15	435	435
Support Boat	1	250	0.50	125	8.5	4	2	57.2	34	972	972
Altamont Landfill											
Transport											
Tug Boat (Single Screw)	1	1,800	0.80	1,440	105.0	8	6	25.0	840	15,750	7,922
Barge Equipment	2	250	0.50	250	10.6	8	6	25.0	85	1,590	800
Dump Trucks Traveling to Drying Area[1]	84	0.25						145.0	21	3,045	1,532
Dump Trucks Idling at Drying Area[2]	84					0.17	0.17	145.0	14	2,030	1,021
Dump Trucks Traveling to Landfill[1]	242	90						50.0	21,780	1,089,000	547,767
Dump Trucks Idling at Landfill[2]	242					0.17	0.17	50.0	40	2,017	1,014
Unloading/Loading											
Clamshell Dredge	1	1,800	0.80	1,440	95.1	10	8	36.3	951	27,617	13,891
Barge Equipment	3	100	0.80	240	15.9	10	8	36.3	159	4,617	2,323
D-6 Dozer	1	300	0.50	150	16.0	10	8	66.3	160	8,486	4,269
Loader	1	300	0.50	150	16.0	10	8	66.3	160	8,486	4,269
Support Boat	1	250	0.80	200	8.5	10	8	36.3	85	2,468	1,242

Notes:

[1] In this case, the value in the pieces of equipment column is actually the number of truck trips, the value in the horsepower column is the round trip travel distance, and the values in the fuel usage columns are vehicle miles traveled.

[2] In this case, the value in the pieces of equipment column is actually the number of truck trips, the value in the hours per day column is the amount of idling per trip, and the values in the fuel usage columns are total amount of idling hours.

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 7 - Emission Source Information for Option G

Prepared By: P. McNamee
Date Prepared: 4/14/99
Checked By: I. Edmonds-Hess

Table 7
Emission Source Information for Option G

Activity / Equipment Type / Disposal Alternative	Pieces of Equipment	Horse Power (Hp)	Load Factor	Hp-Hours	Fuel Use (Gal/Hr.)	Hours Per Max. Day	Hours Per Ave. Day	Number of Work Days	Daily Maximum Fuel Usage (gals)	Total Project Fuel Usage (Upper Limit) (gals)	Total Project Fuel Usage (Lower Limit) (gals)
Dredging											
Clamshell Dredge	2	1,800	0.80	2,880	190.2	20	10	294.0	3,804	559,188	327,125
Anchor Tug	2	400	0.80	640	22.4	20	10	294.0	448	65,856	38,526
Barge Equipment	3	100	0.80	240	15.9	20	10	294.0	318	46,746	27,346
Support Boat	1	250	0.80	200	8.5	20	10	294.0	170	24,990	14,619
Survey Boat	1	250	0.80	200	8.5	10	10	294.0	85	24,990	14,619
Alcatraz Disposal Site											
Transport & Unloading											
Tug Boat (Single Screw)	2	1,800	0.80	2,880	210.0	8	8	13.0	1,680	21,840	22,080
Barge Equipment	2	100	0.50	100	10.6	4	4	13.0	42	551	557
Ocean Disposal Site											
Transport & Unloading											
Tug Boat (Double Screw)	2	3,000	0.80	4,800	400.0	24	24	31.2	9,600	299,520	179,412
Barge Equipment	2	250	0.50	250	10.6	4	4	31.2	42	1,323	739
Hamilton Wetland Restoration Site											
Transport											
Tug Boat (Double Screw)	1	3,000	0.80	2,400	200.0	20	10	63.8	4,000	127,600	116,754
Barge Equipment	2	250	0.50	250	10.6	4	4	63.8	42	2,705	2,475
Unloading											
Hydraulic Unloader	1	1,500	0.80	1,200	63.0	8	4	63.8	504	16,078	14,711
Booster Pump	1	1,500	0.80	1,200	126.0	8	4	63.8	1,008	32,155	29,422
Work Tug	1	400	0.50	200	11.2	8	4	63.8	90	2,858	2,615
Generator	1	75	0.50	38	1.9	8	4	63.8	15	485	444
Support Boat	1	250	0.50	125	8.5	4	2	63.8	34	1,085	992
Altamont Landfill											
Transport											
Tug Boat (Single Screw)	1	1,800	0.80	1,440	105.0	8	6	25.0	840	15,750	7,922
Barge Equipment	2	250	0.50	250	10.6	8	6	25.0	85	1,590	800
Dump Trucks Traveling to Drying Area[1]	84	0.25						145.0	21	3,045	1,532
Dump Trucks Idling at Drying Area[2]	84					0.17	0.17	145.0	14	2,030	1,021
Dump Trucks Traveling to Landfill[1]	242	90						50.0	21,780	1,089,000	547,767
Dump Trucks Idling at Landfill[2]	242					0.17	0.17	50.0	40	2,017	1,014
Unloading/Loading											
Clamshell Dredge	1	1,800	0.80	1,440	95.1	10	8	36.3	951	27,617	13,891
Barge Equipment	3	100	0.80	240	15.9	10	8	36.3	159	4,617	2,323
D-6 Dozer	1	300	0.50	150	16.0	10	8	66.3	160	8,486	4,269
Loader	1	300	0.50	150	16.0	10	8	66.3	160	8,486	4,269
Support Boat	1	250	0.80	200	8.5	10	8	36.3	85	2,468	1,242

Notes:

[1] In this case, the value in the pieces of equipment column is actually the number of truck trips, the value in the horsepower column is the round trip travel distance, and the values in the fuel usage columns are vehicle miles traveled.

[2] In this case, the value in the pieces of equipment column is actually the number of truck trips, the value in the hours per day column is the amount of idling per trip, and the values in the fuel usage columns are total amount of idling hours.

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 8 - Emission Source Information for Option H

Prepared By: P. McNamee
Date Prepared: 4/14/99
Checked By: I. Edmonds-Hess

Table 8
Emission Source Information for Option H

Activity / Equipment Type / Disposal Alternative	Pieces of Equipment	Horse Power (Hp)	Load Factor	Hp-Hours	Fuel Use (Gal/Hr.)	Hours Per Max. Day	Hours Per Ave. Day	Number of Work Days	Daily Maximum Fuel Usage (gals)	Total Project Fuel Usage (Upper Limit) (gals)	Total Project Fuel Usage (Lower Limit) (gals)
Dredging											
Clamshell Dredge	2	1,800	0.80	2,880	190.2	20	10	294.0	3,804	559,188	327,125
Anchor Tug	2	400	0.80	640	22.4	20	10	294.0	448	65,856	38,526
Barge Equipment	3	100	0.80	240	15.9	20	10	294.0	318	46,746	27,346
Support Boat	1	250	0.80	200	8.5	20	10	294.0	170	24,990	14,619
Survey Boat	1	250	0.80	200	8.5	10	10	294.0	85	24,990	14,619
Alcatraz Disposal Site											
Transport & Unloading											
Tug Boat (Single Screw)					0.0						
Barge Equipment											
Ocean Disposal Site											
Transport & Unloading											
Tug Boat (Double Screw)					0.0						
Barge Equipment											
Hamilton Wetland Restoration Site											
Transport											
Tug Boat (Double Screw)					0.0						
Barge Equipment											
Unloading											
Hydraulic Unloader											
Booster Pump											
Work Tug											
Generator											
Support Boat											
Altamont Landfill											
Transport											
Tug Boat (Single Screw)	1	1,800	0.80	1,440	105.0	8	6	100.0	840	63,000	36,855
Barge Equipment	2	250	0.50	250	10.6	8	6	100.0	85	6,360	3,721
Dump Trucks Traveling to Drying Area[1]	336	0.25						145.0	84	12,180	7,125
Dump Trucks Idling at Drying Area[2]	336					0.17	0.17	145.0	56	8,120	4,750
Dump Trucks Traveling to Landfill[1]	340	90						144.0	30,600	4,406,400	2,577,744
Dump Trucks Idling at Landfill[2]	340					0.17	0.17	144.0	57	8,160	4,774
Unloading/Loading											
Clamshell Dredge	1	1,800	0.80	1,440	95.1	10	8	145.0	951	110,316	64,535
Barge Equipment	3	100	0.80	240	15.9	10	8	145.0	159	18,444	10,790
D-6 Dozer	1	300	0.50	150	16.0	10	8	265.0	160	33,920	19,843
Loader	1	300	0.50	150	16.0	10	8	265.0	160	33,920	19,843
Support Boat	1	250	0.80	200	8.5	10	8	145.0	85	9,860	5,768

Notes:

[1] In this case, the value in the pieces of equipment column is actually the number of truck trips, the value in the horsepower column is the round trip travel distance, and the values in the fuel usage columns are vehicle miles traveled.

[2] In this case, the value in the pieces of equipment column is actually the number of truck trips, the value in the hours per day column is the amount of idling per trip, and the values in the fuel usage columns are total amount of idling hours.

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 9 - Estimated Dredge Quantities By Construction Phase

Prepared By: I. Edmonds-Hess
Date Prepared: 4/13/99
Checked By: L. Spurgeon

Table 9
Estimated Dredge Quantities

	Dredged Material to Construct New Bridge Access		Dredged Material to Construct New Piers and Footings		Dredged Material to Construct Dismantling Access		Dredged Material to Remove Existing Piers		Total	
	(m^3)	(yds^3)	(m^3)	(yds^3)	(m^3)	(yds^3)	(m^3)	(yds^3)	(m^3)	(yds^3)
Without Trestle/Falsework (Upper Limit)	282,000	368,000	35,000	45,000	116,000	152,000	16,000	21,000	448,000	585,000
With Trestle/Falsework (Lower Limit)	104,000	135,000	38,000	49,000	116,000	152,000	5,000	6,000	262,000	343,000

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 10 - Distribution of Dredged Material - Upper Limit

Prepared By: I. Edmonds-Hess
Date Prepared: 4/13/99
Checked By: L. Spurgeon

Table 10
Distribution of Dredged Material Among Reuse/Disposal Options
For Upper Limit Dredging

	Alcatraz (SF-11)		San Francisco Deep Ocean Disposal Site (SF-DODS)		Hamilton Wetlands Restoration		Altamont Landfill	
Option	Dredged Material Quantity (m^3)	Dredged Material Quantity (yds^3)	Dredged Material Quantity (m^3)	Dredged Material Quantity (yds^3)	Dredged Material Quantity (m^3)	Dredged Material Quantity (yds^3)	Dredged Material Quantity (m^3)	Dredged Material Quantity (yds^3)
A	47,711	62,401	0	0	288,737	377,631	111,120	145,332
B	47,711	62,401	288,737	377,631	0	0	111,120	145,332
C	0	0	336,448	440,032	0	0	111,120	145,332
D	0	0	47,711	62,401	288,737	377,631	111,120	145,332
E	0	0	0	0	336,448	440,032	111,120	145,332
F	47,711	62,401	172,782	225,977	115,955	151,654	111,120	145,332
G	31,919	41,747	172,782	225,977	131,747	172,308	111,120	145,332
H	0	0	0	0	0	0	447,568	585,364

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 11 - Distribution of Dredged Material - Lower Limit

Prepared By: I. Edmonds-Hess
Date Prepared: 4/13/99
Checked By: L. Spurgeon

Table 11
Distribution of Dredged Material Among Reuse/Disposal Options
For Lower Limit Dredging

	Alcatraz (SF-11)		San Francisco Deep Ocean Disposal Site (SF-DODS)		Hamilton Wetlands Restoration		Altamont Landfill	
Option	Dredged Material Quantity (m^3)	Dredged Material Quantity (yds^3)	Dredged Material Quantity (m^3)	Dredged Material Quantity (yds^3)	Dredged Material Quantity (m^3)	Dredged Material Quantity (yds^3)	Dredged Material Quantity (m^3)	Dredged Material Quantity (yds^3)
A	36,849	48,198	0	0	219,475	287,045	5,588	7,308
B	36,849	48,198	219,475	287,045	0	0	5,588	7,308
C	0	0	256,324	335,243	0	0	5,588	7,308
D	0	0	36,849	48,198	219,475	287,045	5,588	7,308
E	0	0	0	0	256,324	335,243	5,588	7,308
F	36,849	48,198	103,520	135,391	115,955	151,654	5,588	7,308
G	32,257	42,192	103,520	135,391	120,547	157,660	5,588	7,308
H	0	0	0	0	0	0	261,912	342,551

Project:	San Francisco-Oakland Bay Bridge East Span Seismic Safety Project	Prepared By:	L. Spurgeon
Subject:	Table 12 - Emission Factors for Equipment Used	Date Prepared:	4/12/99
		Checked By:	I. Edmonds-Hess

Table 12
Emission Factors for Equipment Used
(in pounds pollutant per 1,000 gallons Diesel consumed)

Equipment	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	Source
Barge Equipment	58.93	56.57	130.18	604.3	39.74	42.48	40.78	c
Boat, Support	45.7	43.87	70.2	407.5	28.5	33	31.68	b
Boat, Survey	180	172.8	140	340	27	-	-	d
Boat, Tug	45.7	43.87	70.2	407.5	28.5	33	31.68	b
Dozer, D-6	33.82	32.47	78.5	284.92	31.1	25.3	24.29	e
Dredge, Clamshell	12.33	11.84	116.48	424.79	27.68	10.46	6.8	a
Generator	40.48	38.86	153.51	258.6	31.2	27.3	26.21	e
Hydraulic Unloader	12.33	11.84	110.99	424.79	27.68	10.46	6.8	a
Loader	50.33	48.32	98.66	321.23	31.2	29.3	28.13	e
Pump, Booster	12.33	11.84	116.48	424.79	27.68	10.46	6.8	a
Truck, End-dump (g/mile at 30 mph)	1.45	1.39	8.32	9.28	0.00	1.07	1.03	f
Truck, End-dump (g/hr at idle)	19.53	18.70	169.30	82.80	0.00	3.35	3.35	f

Source:

a AP-42, Table 3.4-1, Volume I Supplement B (Environmental Protection Agency 1996)

b Report on Air Pollutant Emissions from Marine Vessels (California Air Resources Board, 1984)
SO_2 and PM emission factors from Scott Environmental Technology (1981)

c AP-42, Table 3.3-1, Volume I Supplement B (Environmental Protection Agency 1996)

d AP-42, Table II-3.5, Volume II (Environmental Protection Agency 1993)

e AP-42, Table II-7.1, Volume II (Environmental Protection Agency 1993)

f EMFAC7G emission factor model for year 2000. Heavy-duty diesel truck at 30 mph and idle (5 mph)
PM emission factors include exhaust, tire and brake wear, and entrained dust (from URBEMIS7G)
SO_2 assumed to be zero.

Project:	San Francisco-Oakland Bay Bridge East Span Seismic Safety Project	Prepared By:	I. Edmonds-Hess
Subject:	Table 13 - Maximum Daily Emissions (Occurs during Dredging for Construction Access for the New Bridge)	Date Prepared: Checked By:	4/14/99 L. Spurgeon

Table 13
Maximum Daily Emissions

Activity/Equipment	Maximum Daily Emissions[1] (in pounds/day)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Dredging							
Clamshell Dredge	47	45	443	1,616	105	40	26
Anchor Tug	20	20	31	183	13	15	14
Barge Equipment	19	18	41	192	13	14	13
Support Boat	8	7	12	69	5	6	5
Survey Boat[2]	15	15	12	29	2	3	3
Dredging Total	109	105	540	2,089	138	76	61
Transport							
Transport to Altamont							
Tug Boat (Single Screw)	38	37	59	342	24	28	27
Barge Equipment	5	5	11	51	3	4	3
Dump Trucks Traveling to Drying Area[3]	0	0	0	0	0	0	0
Dump Trucks Idling at Drying Area[4]	1	1	5	3	0	0	0
Dump Trucks Traveling to Landfill[3]	69	67	399	445	0	51	49
Dump Trucks Idling at Landfill[4]	2	2	15	7	0	0	0
Transport to & Unloading at Ocean Disposal Site							
Tug Boat (Double Screw)	439	421	674	3,912	274	317	304
Barge Equipment	2	2	6	26	2	2	2
Transport Total	556	534	1,169	4,786	303	402	385
Unloading							
Unloading/Loading for Altamont							
Clamshell Dredge	12	11	111	404	26	10	6
Barge Equipment	9	9	21	96	6	7	6
D-6 Dozer	5	5	13	46	5	4	4
Loader	8	8	16	51	5	5	5
Support Boat	4	4	6	35	2	3	3
Unloading Total	38	37	166	632	45	28	24
Total	704	676	1,874	7,507	485	506	471

Notes:

[1] Emissions (lbs/day) = Daily Fuel Usage (in gals)/1000 x Emission Factor (in lbs/1000 gals of fuel)

[2] Particulate matter emission factors were not available, so emission factors for support boats was used.

[3] Emissions (lbs/day) = Vehicle Miles Traveled x Emission Factor (in grams/mile) x 0.0022 lbs/gram

[4] Emissions (lbs/day) = Hours of Idling x Emission Factor (in grams/hour) x 0.0022 lbs/gram

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 14 - Total Dredging-Related Emissions for Option A

Prepared By: I. Edmonds-Hess
Date Prepared: 4/14/99
Checked By: L. Spurgeon

Table 14
Total Dredging-Related Emissions for Option A

Activity/Equipment	Total Emissions[1] for the Upper Dredge Limit (in tons)							Total Emissions[1] for the Lower Dredge Limit (in tons)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Dredging														
Clamshell Dredge	3.45	3.31	32.57	118.77	7.74	2.92	1.90	2.02	1.94	19.05	69.48	4.53	1.71	1.11
Anchor Tug	1.50	1.44	2.31	13.42	0.94	1.09	1.04	0.88	0.85	1.35	7.85	0.55	0.64	0.61
Barge Equipment	1.38	1.32	3.04	14.12	0.93	0.99	0.95	0.81	0.77	1.78	8.26	0.54	0.58	0.56
Support Boat	0.57	0.55	0.88	5.09	0.36	0.41	0.40	0.33	0.32	0.51	2.98	0.21	0.24	0.23
Survey Boat[2]	2.25	2.16	1.75	4.25	0.34	0.41	0.40	1.32	1.26	1.02	2.49	0.20	0.24	0.23
Alcatraz Disposal Site														
Transport & Unloading														
Tug Boat (Single Screw)	0.78	0.75	1.20	6.97	0.49	0.56	0.54	0.60	0.58	0.93	5.38	0.38	0.44	0.42
Barge Equipment	0.03	0.02	0.06	0.26	0.02	0.02	0.02	0.02	0.02	0.04	0.20	0.01	0.01	0.01
Ocean Disposal Site														
Transport & Unloading														
Tug Boat (Double Screw)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barge Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hamilton Wetland Restoration Site														
Transport														
Tug Boat (Double Screw)	6.54	6.27	10.04	58.27	4.08	4.72	4.53	4.97	4.77	7.63	44.29	3.10	3.59	3.44
Barge Equipment	0.18	0.17	0.39	1.83	0.12	0.13	0.12	0.14	0.13	0.30	1.39	0.09	0.10	0.09
Unloading														
Hydraulic Unloader	0.22	0.21	2.00	7.65	0.50	0.19	0.12	0.17	0.16	1.52	5.82	0.38	0.14	0.09
Booster Pump	0.44	0.43	4.20	15.31	1.00	0.38	0.25	0.34	0.32	3.19	11.63	0.76	0.29	0.19
Work Tug	0.15	0.14	0.22	1.31	0.09	0.11	0.10	0.11	0.11	0.17	0.99	0.07	0.08	0.08
Generator	0.02	0.02	0.08	0.14	0.02	0.01	0.01	0.02	0.02	0.06	0.11	0.01	0.01	0.01
Support Boat	0.06	0.05	0.09	0.50	0.03	0.04	0.04	0.04	0.04	0.06	0.38	0.03	0.03	0.03

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 14 - Total Dredging-Related Emissions for Option A

Prepared By: I. Edmonds-Hess
Date Prepared: 4/14/99
Checked By: L. Spurgeon

Table 14
Total Dredging-Related Emissions for Option A

Activity/Equipment	Total Emissions[1] for the Upper Dredge Limit (in tons)							Total Emissions[1] for the Lower Dredge Limit (in tons)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Altamont Landfill														
Transport														
Tug Boat (Single Screw)	0.36	0.35	0.55	3.21	0.22	0.26	0.25	0.18	0.17	0.28	1.61	0.11	0.13	0.13
Barge Equipment	0.05	0.04	0.10	0.48	0.03	0.03	0.03	0.02	0.02	0.05	0.24	0.02	0.02	0.02
Dump Trucks Traveling to Drying Area[3]	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00
Dump Trucks Idling at Drying Area[4]	0.04	0.04	0.38	0.18	0.00	0.01	0.01	0.02	0.02	0.19	0.09	0.00	0.00	0.00
Dump Trucks Traveling to Landfill[3]	1.74	1.67	9.97	11.12	0.00	1.28	1.23	0.87	0.84	5.01	5.59	0.00	0.64	0.62
Dump Trucks Idling at Landfill[4]	0.04	0.04	0.38	0.18	0.00	0.01	0.01	0.02	0.02	0.19	0.09	0.00	0.00	0.00
Unloading/Loading														
Clamshell Dredge	0.17	0.16	1.61	5.87	0.38	0.14	0.09	0.09	0.08	0.81	2.95	0.19	0.07	0.05
Barge Equipment	0.14	0.13	0.30	1.40	0.09	0.10	0.09	0.07	0.07	0.15	0.70	0.05	0.05	0.05
D-6 Dozer	0.14	0.14	0.33	1.21	0.13	0.11	0.10	0.07	0.07	0.17	0.61	0.07	0.05	0.05
Loader	0.21	0.21	0.42	1.36	0.13	0.12	0.12	0.11	0.10	0.21	0.69	0.07	0.06	0.06
Support Boat	0.06	0.05	0.09	0.50	0.04	0.04	0.04	0.03	0.03	0.04	0.25	0.02	0.02	0.02
Total	21	20	73	273	18	14	12	13	13	45	174	11	9	8

Notes:

[1] Emissions (tons) = Total Fuel Usage (in gals)/1000 x Emission Factor (lbs/1000 gals of fuel) x 0.0005 tons/lb

[2] Particulate matter emission factors were not available, so emission factors for support boats was used.

[3] Emissions (tons) = Vehicle Miles Traveled x Emission Factor (in grams/mile) x 0.0022 lbs/gram x 0.0005 tons/lb

[4] Emissions (tons) = Hours of Idling x Emission Factor (in grams/hour) x 0.0022 lbs/gram x 0.0005 tons/lb

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 15 - Total Dredging-Related Emissions for Option B

Prepared By: I. Edmonds-Hess
Date Prepared: 4/14/99
Checked By: L. Spurgeon

Table 15
Total Dredging-Related Emissions for Option B

Activity/Equipment	Total Emissions[1] for the Upper Dredge Limit (in tons)							Total Emissions[1] for the Lower Dredge Limit (in tons)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Dredging														
Clamshell Dredge	3.45	3.31	32.57	118.77	7.74	2.92	1.90	2.02	1.94	19.05	69.48	4.53	1.71	1.11
Anchor Tug	1.50	1.44	2.31	13.42	0.94	1.09	1.04	0.88	0.85	1.35	7.85	0.55	0.64	0.61
Barge Equipment	1.38	1.32	3.04	14.12	0.93	0.99	0.95	0.81	0.77	1.78	8.26	0.54	0.58	0.56
Support Boat	0.57	0.55	0.88	5.09	0.36	0.41	0.40	0.33	0.32	0.51	2.98	0.21	0.24	0.23
Survey Boat[2]	2.25	2.16	1.75	4.25	0.34	0.41	0.40	1.32	1.26	1.02	2.49	0.20	0.24	0.23
Alcatraz Disposal Site														
Transport & Unloading														
Tug Boat (Single Screw)	0.78	0.75	1.20	6.97	0.49	0.56	0.54	0.60	0.58	0.93	5.38	0.38	0.44	0.42
Barge Equipment	0.03	0.02	0.06	0.26	0.02	0.02	0.02	0.02	0.02	0.04	0.20	0.01	0.01	0.01
Ocean Disposal Site														
Transport & Unloading														
Tug Boat (Double Screw)	11.41	10.95	17.52	101.71	7.11	8.24	7.91	8.67	8.32	13.32	77.30	5.41	6.26	6.01
Barge Equipment	0.06	0.06	0.14	0.67	0.04	0.05	0.04	0.05	0.05	0.11	0.51	0.03	0.04	0.03
Hamilton Wetland Restoration Site														
Transport														
Tug Boat (Double Screw)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barge Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unloading														
Hydraulic Unloader	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Booster Pump	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Work Tug	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Generator	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Support Boat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 15 - Total Dredging-Related Emissions for Option B

Prepared By: I. Edmonds-Hess
Date Prepared: 4/14/99
Checked By: L. Spurgeon

Table 15
Total Dredging-Related Emissions for Option B

Activity/Equipment	Total Emissions[1] for the Upper Dredge Limit (in tons)							Total Emissions[1] for the Lower Dredge Limit (in tons)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Altamont Landfill														
Transport														
Tug Boat (Single Screw)	0.36	0.35	0.55	3.21	0.22	0.26	0.25	0.18	0.17	0.28	1.61	0.11	0.13	0.13
Barge Equipment	0.05	0.04	0.10	0.48	0.03	0.03	0.03	0.02	0.02	0.05	0.24	0.02	0.02	0.02
Dump Trucks Traveling to Drying Area[3]	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00
Dump Trucks Idling at Drying Area[4]	0.04	0.04	0.38	0.18	0.00	0.01	0.01	0.02	0.02	0.19	0.09	0.00	0.00	0.00
Dump Trucks Traveling to Landfill[3]	1.74	1.67	9.97	11.12	0.00	1.28	1.23	0.87	0.84	5.01	5.59	0.00	0.64	0.62
Dump Trucks Idling at Landfill[4]	0.04	0.04	0.38	0.18	0.00	0.01	0.01	0.02	0.02	0.19	0.09	0.00	0.00	0.00
Unloading/Loading														
Clamshell Dredge	0.17	0.16	1.61	5.87	0.38	0.14	0.09	0.09	0.08	0.81	2.95	0.19	0.07	0.05
Barge Equipment	0.14	0.13	0.30	1.40	0.09	0.10	0.09	0.07	0.07	0.15	0.70	0.05	0.05	0.05
D-6 Dozer	0.14	0.14	0.33	1.21	0.13	0.11	0.10	0.07	0.07	0.17	0.61	0.07	0.05	0.05
Loader	0.21	0.21	0.42	1.36	0.13	0.12	0.12	0.11	0.10	0.21	0.69	0.07	0.06	0.06
Support Boat	0.06	0.05	0.09	0.50	0.04	0.04	0.04	0.03	0.03	0.04	0.25	0.02	0.02	0.02
Total	24	23	74	291	19	17	15	16	16	45	187	12	11	10

Notes:

[1] Emissions (tons) = Total Fuel Usage (in gals)/1000 x Emission Factor (lbs/1000 gals of fuel) x 0.0005 tons/lb

[2] Particulate matter emission factors were not available, so emission factors for support boats was used.

[3] Emissions (tons) = Vehicle Miles Traveled x Emission Factor (in grams/mile) x 0.0022 lbs/gram x 0.0005 tons/lb

[4] Emissions (tons) = Hours of Idling x Emission Factor (in grams/hour) x 0.0022 lbs/gram x 0.0005 tons/lb

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 16 - Total Dredging-Related Emissions for Option C

Prepared By: I. Edmonds-Hess
Date Prepared: 4/14/99
Checked By: L. Spurgeon

Table 16
Total Dredging-Related Emissions for Option C

Activity/Equipment	Total Emissions[1] for the Upper Dredge Limit (in tons)							Total Emissions[1] for the Lower Dredge Limit (in tons)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Dredging														
Clamshell Dredge	3.45	3.31	32.57	118.77	7.74	2.92	1.90	2.02	1.94	19.05	69.48	4.53	1.71	1.11
Anchor Tug	1.50	1.44	2.31	13.42	0.94	1.09	1.04	0.88	0.85	1.35	7.85	0.55	0.64	0.61
Barge Equipment	1.38	1.32	3.04	14.12	0.93	0.99	0.95	0.81	0.77	1.78	8.26	0.54	0.58	0.56
Support Boat	0.57	0.55	0.88	5.09	0.36	0.41	0.40	0.33	0.32	0.51	2.98	0.21	0.24	0.23
Survey Boat[2]	2.25	2.16	1.75	4.25	0.34	0.41	0.40	1.32	1.26	1.02	2.49	0.20	0.24	0.23
Alcatraz Disposal Site														
Transport & Unloading														
Tug Boat (Single Screw)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barge Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ocean Disposal Site														
Transport & Unloading														
Tug Boat (Double Screw)	13.16	12.63	20.22	117.36	8.21	9.50	9.12	10.03	9.63	15.41	89.43	6.25	7.24	6.95
Barge Equipment	0.07	0.07	0.17	0.77	0.05	0.05	0.05	0.06	0.05	0.13	0.59	0.04	0.04	0.04
Hamilton Wetland Restoration Site														
Transport														
Tug Boat (Double Screw)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barge Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unloading														
Hydraulic Unloader	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Booster Pump	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Work Tug	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Generator	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Support Boat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 16 - Total Dredging-Related Emissions for Option C

Prepared By: I. Edmonds-Hess
Date Prepared: 4/14/99
Checked By: L. Spurgeon

Table 16
Total Dredging-Related Emissions for Option C

Activity/Equipment	Total Emissions[1] for the Upper Dredge Limit (in tons)							Total Emissions[1] for the Lower Dredge Limit (in tons)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Altamont Landfill														
Transport														
Tug Boat (Single Screw)	0.36	0.35	0.55	3.21	0.22	0.26	0.25	0.18	0.17	0.28	1.61	0.11	0.13	0.13
Barge Equipment	0.05	0.04	0.10	0.48	0.03	0.03	0.03	0.02	0.02	0.05	0.24	0.02	0.02	0.02
Dump Trucks Traveling to Drying Area[3]	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00
Dump Trucks Idling at Drying Area[4]	0.04	0.04	0.38	0.18	0.00	0.01	0.01	0.02	0.02	0.19	0.09	0.00	0.00	0.00
Dump Trucks Traveling to Landfill[3]	1.74	1.67	9.97	11.12	0.00	1.28	1.23	0.87	0.84	5.01	5.59	0.00	0.64	0.62
Dump Trucks Idling at Landfill[4]	0.04	0.04	0.38	0.18	0.00	0.01	0.01	0.02	0.02	0.19	0.09	0.00	0.00	0.00
Unloading/Loading														
Clamshell Dredge	0.17	0.16	1.61	5.87	0.38	0.14	0.09	0.09	0.08	0.81	2.95	0.19	0.07	0.05
Barge Equipment	0.14	0.13	0.30	1.40	0.09	0.10	0.09	0.07	0.07	0.15	0.70	0.05	0.05	0.05
D-6 Dozer	0.14	0.14	0.33	1.21	0.13	0.11	0.10	0.07	0.07	0.17	0.61	0.07	0.05	0.05
Loader	0.21	0.21	0.42	1.36	0.13	0.12	0.12	0.11	0.10	0.21	0.69	0.07	0.06	0.06
Support Boat[2]	0.06	0.05	0.09	0.50	0.04	0.04	0.04	0.03	0.03	0.04	0.25	0.02	0.02	0.02
Total	25	24	75	299	20	17	16	17	16	46	194	13	12	11

Notes:

[1] Emissions (tons) = Total Fuel Usage (in gals)/1000 x Emission Factor (lbs/1000 gals of fuel) x 0.0005 tons/lb

[2] Particulate matter emission factors were not available, so emission factors for support boats was used.

[3] Emissions (tons) = Vehicle Miles Traveled x Emission Factor (in grams/mile) x 0.0022 lbs/gram x 0.0005 tons/lb

[4] Emissions (tons) = Hours of Idling x Emission Factor (in grams/hour) x 0.0022 lbs/gram x 0.0005 tons/lb

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 17 - Total Dredging-Related Emissions for Option D

Prepared By: I. Edmonds-Hess
Date Prepared: 4/15/99
Checked By: L. Spurgeon

Table 17
Total Dredging-Related Emissions for Option D

Activity/Equipment	Total Emissions[1] for the Upper Dredge Limit (in tons)							Total Emissions[1] for the Lower Dredge Limit (in tons)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Dredging														
Clamshell Dredge	3.45	3.31	32.57	118.77	7.74	2.92	1.90	2.02	1.94	19.05	69.48	4.53	1.71	1.11
Anchor Tug	1.50	1.44	2.31	13.42	0.94	1.09	1.04	0.88	0.85	1.35	7.85	0.55	0.64	0.61
Barge Equipment	1.38	1.32	3.04	14.12	0.93	0.99	0.95	0.81	0.77	1.78	8.26	0.54	0.58	0.56
Support Boat	0.57	0.55	0.88	5.09	0.36	0.41	0.40	0.33	0.32	0.51	2.98	0.21	0.24	0.23
Survey Boat[2]	2.25	2.16	1.75	4.25	0.34	0.41	0.40	1.32	1.26	1.02	2.49	0.20	0.24	0.23
Alcatraz Disposal Site														
Transport & Unloading														
Tug Boat (Single Screw)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barge Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ocean Disposal Site														
Transport & Unloading														
Tug Boat (Double Screw)	1.93	1.85	2.97	17.21	1.20	1.39	1.34	1.49	1.43	2.29	13.29	0.93	1.08	1.03
Barge Equipment	0.01	0.01	0.02	0.11	0.01	0.01	0.01	0.01	0.01	0.02	0.09	0.01	0.01	0.01
Hamilton Wetland Restoration Site														
Transport														
Tug Boat (Double Screw)	6.54	6.27	10.04	58.27	4.08	4.72	4.53	4.97	4.77	7.63	44.29	3.10	3.59	3.44
Barge Equipment	0.18	0.17	0.39	1.83	0.12	0.13	0.12	0.14	0.13	0.30	1.39	0.09	0.10	0.09
Unloading														
Hydraulic Unloader	0.22	0.21	2.00	7.65	0.50	0.19	0.12	0.17	0.16	1.52	5.82	0.38	0.14	0.09
Booster Pump	0.44	0.43	4.20	15.31	1.00	0.38	0.25	0.34	0.32	3.19	11.63	0.76	0.29	0.19
Work Tug	0.15	0.14	0.22	1.31	0.09	0.11	0.10	0.11	0.11	0.17	0.99	0.07	0.08	0.08
Generator	0.02	0.02	0.08	0.14	0.02	0.01	0.01	0.02	0.02	0.06	0.11	0.01	0.01	0.01
Support Boat	0.06	0.05	0.09	0.50	0.03	0.04	0.04	0.04	0.04	0.06	0.38	0.03	0.03	0.03

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 17 - Total Dredging-Related Emissions for Option D

Prepared By: I. Edmonds-Hess
Date Prepared: 4/15/99
Checked By: L. Spurgeon

Table 17
Total Dredging-Related Emissions for Option D

Activity/Equipment	Total Emissions[1] for the Upper Dredge Limit (in tons)							Total Emissions[1] for the Lower Dredge Limit (in tons)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Altamont Landfill														
Transport														
Tug Boat (Single Screw)	0.36	0.35	0.55	3.21	0.22	0.26	0.25	0.18	0.17	0.28	1.61	0.11	0.13	0.13
Barge Equipment	0.05	0.04	0.10	0.48	0.03	0.03	0.03	0.02	0.02	0.05	0.24	0.02	0.02	0.02
Dump Trucks Traveling to Drying Area[3]	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00
Dump Trucks Idling at Drying Area[4]	0.04	0.04	0.38	0.18	0.00	0.01	0.01	0.02	0.02	0.19	0.09	0.00	0.00	0.00
Dump Trucks Traveling to Landfill[3]	1.74	1.67	9.97	11.12	0.00	1.28	1.23	0.87	0.84	5.01	5.59	0.00	0.64	0.62
Dump Trucks Idling at Landfill[4]	0.04	0.04	0.38	0.18	0.00	0.01	0.01	0.02	0.02	0.19	0.09	0.00	0.00	0.00
Unloading/Loading														
Clamshell Dredge	0.17	0.16	1.61	5.87	0.38	0.14	0.09	0.09	0.08	0.81	2.95	0.19	0.07	0.05
Barge Equipment	0.14	0.13	0.30	1.40	0.09	0.10	0.09	0.07	0.07	0.15	0.70	0.05	0.05	0.05
D-6 Dozer	0.14	0.14	0.33	1.21	0.13	0.11	0.10	0.07	0.07	0.17	0.61	0.07	0.05	0.05
Loader	0.21	0.21	0.42	1.36	0.13	0.12	0.12	0.11	0.10	0.21	0.69	0.07	0.06	0.06
Support Boat	0.06	0.05	0.09	0.50	0.04	0.04	0.04	0.03	0.03	0.04	0.25	0.02	0.02	0.02
Total	22	21	75	284	18	15	13	14	14	46	182	12	10	9

Notes:

[1] Emissions (tons) = Total Fuel Usage (in gals)/1000 x Emission Factor (lbs/1000 gals of fuel) x 0.0005 tons/lb

[2] Particulate matter emission factors were not available, so emission factors for support boats was used.

[3] Emissions (tons) = Vehicle Miles Traveled x Emission Factor (in grams/mile) x 0.0022 lbs/gram x 0.0005 tons/lb

[4] Emissions (tons) = Hours of Idling x Emission Factor (in grams/hour) x 0.0022 lbs/gram x 0.0005 tons/lb

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 18 - Total Dredging-Related Emissions for Option E

Prepared By: I. Edmonds-Hess
Date Prepared: 4/15/99
Checked By: L. Spurgeon

Table 18
Total Dredging-Related Emissions for Option E

Activity/Equipment	Total Emissions[1] for the Upper Dredge Limit (in tons)							Total Emissions[1] for the Lower Dredge Limit (in tons)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Dredging														
Clamshell Dredge	3.45	3.31	32.57	118.77	7.74	2.92	1.90	2.02	1.94	19.05	69.48	4.53	1.71	1.11
Anchor Tug	1.50	1.44	2.31	13.42	0.94	1.09	1.04	0.88	0.85	1.35	7.85	0.55	0.64	0.61
Barge Equipment	1.38	1.32	3.04	14.12	0.93	0.99	0.95	0.81	0.77	1.78	8.26	0.54	0.58	0.56
Support Boat	0.57	0.55	0.88	5.09	0.36	0.41	0.40	0.33	0.32	0.51	2.98	0.21	0.24	0.23
Survey Boat[2]	2.25	2.16	1.75	4.25	0.34	0.41	0.40	1.32	1.26	1.02	2.49	0.20	0.24	0.23
Alcatraz Disposal Site														
Transport & Unloading														
Tug Boat (Single Screw)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barge Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ocean Disposal Site														
Transport & Unloading														
Tug Boat (Double Screw)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barge Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hamilton Wetland Restoration Site														
Transport														
Tug Boat (Double Screw)	7.54	7.24	11.58	67.24	4.70	5.45	5.23	5.75	5.52	8.83	51.23	3.58	4.15	3.98
Barge Equipment	0.21	0.20	0.46	2.11	0.14	0.15	0.14	0.16	0.15	0.35	1.61	0.11	0.11	0.11
Unloading														
Hydraulic Unloader	0.26	0.25	2.31	8.83	0.58	0.22	0.14	0.20	0.19	1.76	6.73	0.44	0.17	0.11
Booster Pump	0.51	0.49	4.84	17.66	1.15	0.43	0.28	0.39	0.38	3.69	13.46	0.88	0.33	0.22
Work Tug	0.17	0.16	0.26	1.51	0.11	0.12	0.12	0.13	0.12	0.20	1.15	0.08	0.09	0.09
Generator	0.03	0.02	0.10	0.16	0.02	0.02	0.02	0.02	0.02	0.07	0.12	0.01	0.01	0.01
Support Boat	0.06	0.06	0.10	0.57	0.04	0.05	0.04	0.05	0.05	0.08	0.44	0.03	0.04	0.03

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project	Prepared By: I. Edmonds-Hess
Subject: Table 18 - Total Dredging-Related Emissions for Option E	Date Prepared: 4/15/99
	Checked By: L. Spurgeon

Table 18
Total Dredging-Related Emissions for Option E

Activity/Equipment	Total Emissions[1] for the Upper Dredge Limit (in tons)							Total Emissions[1] for the Lower Dredge Limit (in tons)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Altamont Landfill														
Transport														
Tug Boat (Single Screw)	0.36	0.35	0.55	3.21	0.22	0.26	0.25	0.18	0.17	0.28	1.61	0.11	0.13	0.13
Barge Equipment	0.05	0.04	0.10	0.48	0.03	0.03	0.03	0.02	0.02	0.05	0.24	0.02	0.02	0.02
Dump Trucks Traveling to Drying Area[3]	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00
Dump Trucks Idling at Drying Area[4]	0.04	0.04	0.38	0.18	0.00	0.01	0.01	0.02	0.02	0.19	0.09	0.00	0.00	0.00
Dump Trucks Traveling to Landfill[3]	1.74	1.67	9.97	11.12	0.00	1.28	1.23	0.87	0.84	5.01	5.59	0.00	0.64	0.62
Dump Trucks Idling at Landfill[4]	0.04	0.04	0.38	0.18	0.00	0.01	0.01	0.02	0.02	0.19	0.09	0.00	0.00	0.00
Unloading/Loading														
Clamshell Dredge	0.17	0.16	1.61	5.87	0.38	0.14	0.09	0.09	0.08	0.81	2.95	0.19	0.07	0.05
Barge Equipment	0.14	0.13	0.30	1.40	0.09	0.10	0.09	0.07	0.07	0.15	0.70	0.05	0.05	0.05
D-6 Dozer	0.14	0.14	0.33	1.21	0.13	0.11	0.10	0.07	0.07	0.17	0.61	0.07	0.05	0.05
Loader	0.21	0.21	0.42	1.36	0.13	0.12	0.12	0.11	0.10	0.21	0.69	0.07	0.06	0.06
Support Boat	0.06	0.05	0.09	0.50	0.04	0.04	0.04	0.03	0.03	0.04	0.25	0.02	0.02	0.02
Total	21	20	74	279	18	14	13	14	13	46	179	12	9	8

Notes:

[1] Emissions (tons) = Total Fuel Usage (in gals)/1000 x Emission Factor (lbs/1000 gals of fuel) x 0.0005 tons/lb

[2] Particulate matter emission factors were not available, so emission factors for support boats was used.

[3] Emissions (tons) = Vehicle Miles Traveled x Emission Factor (in grams/mile) x 0.0022 lbs/gram x 0.0005 tons/lb

[4] Emissions (tons) = Hours of Idling x Emission Factor (in grams/hour) x 0.0022 lbs/gram x 0.0005 tons/lb

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 19 - Total Dredging-Related Emissions for Option F

Prepared By: I. Edmonds-Hess
Date Prepared: 4/15/99
Checked By: L. Spurgeon

Table 19
Total Dredging-Related Emissions for Option F

Activity/Equipment	Total Emissions[1] for the Upper Dredge Limit (in tons)							Total Emissions[1] for the Lower Dredge Limit (in tons)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Dredging														
Clamshell Dredge	3.45	3.31	32.57	118.77	7.74	2.92	1.90	2.02	1.94	19.05	69.48	4.53	1.71	1.11
Anchor Tug	1.50	1.44	2.31	13.42	0.94	1.09	1.04	0.88	0.85	1.35	7.85	0.55	0.64	0.61
Barge Equipment	1.38	1.32	3.04	14.12	0.93	0.99	0.95	0.81	0.77	1.78	8.26	0.54	0.58	0.56
Support Boat	0.57	0.55	0.88	5.09	0.36	0.41	0.40	0.33	0.32	0.51	2.98	0.21	0.24	0.23
Survey Boat[2]	2.25	2.16	1.75	4.25	0.34	0.41	0.40	1.32	1.26	1.02	2.49	0.20	0.24	0.23
Alcatraz Disposal Site														
Transport & Unloading														
Tug Boat (Single Screw)	0.78	0.75	1.20	6.97	0.49	0.56	0.54	0.60	0.58	0.93	5.38	0.38	0.44	0.42
Barge Equipment	0.03	0.02	0.06	0.26	0.02	0.02	0.02	0.02	0.02	0.04	0.20	0.01	0.01	0.01
Ocean Disposal Site														
Transport & Unloading														
Tug Boat (Double Screw)	6.84	6.57	10.51	61.03	4.27	4.94	4.74	4.10	3.94	6.30	36.56	2.56	2.96	2.84
Barge Equipment	0.04	0.04	0.09	0.40	0.03	0.03	0.03	0.02	0.02	0.05	0.22	0.01	0.02	0.02
Hamilton Wetland Restoration Site														
Transport														
Tug Boat (Double Screw)	2.61	2.51	4.02	23.31	1.63	1.89	1.81	2.61	2.51	4.02	23.31	1.63	1.89	1.81
Barge Equipment	0.07	0.07	0.16	0.73	0.05	0.05	0.05	0.07	0.07	0.16	0.73	0.05	0.05	0.05
Unloading														
Hydraulic Unloader	0.09	0.09	0.80	3.06	0.20	0.08	0.05	0.09	0.09	0.80	3.06	0.20	0.08	0.05
Booster Pump	0.18	0.17	1.68	6.12	0.40	0.15	0.10	0.18	0.17	1.68	6.12	0.40	0.15	0.10
Work Tug	0.06	0.06	0.09	0.52	0.04	0.04	0.04	0.06	0.06	0.09	0.52	0.04	0.04	0.04
Generator	0.01	0.01	0.03	0.06	0.01	0.01	0.01	0.01	0.01	0.03	0.06	0.01	0.01	0.01
Support Boat	0.02	0.02	0.03	0.20	0.01	0.02	0.02	0.02	0.02	0.03	0.20	0.01	0.02	0.02

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 19 - Total Dredging-Related Emissions for Option F

Prepared By: I. Edmonds-Hess
Date Prepared: 4/15/99
Checked By: L. Spurgeon

Table 19
Total Dredging-Related Emissions for Option F

Activity/Equipment	Total Emissions[1] for the Upper Dredge Limit (in tons)							Total Emissions[1] for the Lower Dredge Limit (in tons)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Altamont Landfill														
Transport														
Tug Boat (Single Screw)	0.36	0.35	0.55	3.21	0.22	0.26	0.25	0.18	0.17	0.28	1.61	0.11	0.13	0.13
Barge Equipment	0.05	0.04	0.10	0.48	0.03	0.03	0.03	0.02	0.02	0.05	0.24	0.02	0.02	0.02
Dump Trucks Traveling to Drying Area[3]	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00
Dump Trucks Idling at Drying Area[4]	0.04	0.04	0.38	0.18	0.00	0.01	0.01	0.02	0.02	0.19	0.09	0.00	0.00	0.00
Dump Trucks Traveling to Landfill[3]	1.74	1.67	9.97	11.12	0.00	1.28	1.23	0.87	0.84	5.01	5.59	0.00	0.64	0.62
Dump Trucks Idling at Landfill[4]	0.04	0.04	0.38	0.18	0.00	0.01	0.01	0.02	0.02	0.19	0.09	0.00	0.00	0.00
Unloading/Loading														
Clamshell Dredge	0.17	0.16	1.61	5.87	0.38	0.14	0.09	0.09	0.08	0.81	2.95	0.19	0.07	0.05
Barge Equipment	0.14	0.13	0.30	1.40	0.09	0.10	0.09	0.07	0.07	0.15	0.70	0.05	0.05	0.05
D-6 Dozer	0.14	0.14	0.33	1.21	0.13	0.11	0.10	0.07	0.07	0.17	0.61	0.07	0.05	0.05
Loader	0.21	0.21	0.42	1.36	0.13	0.12	0.12	0.11	0.10	0.21	0.69	0.07	0.06	0.06
Support Boat	0.06	0.05	0.09	0.50	0.04	0.04	0.04	0.03	0.03	0.04	0.25	0.02	0.02	0.02
Total	23	22	73	284	18	16	14	15	14	45	180	12	10	9

Notes:

[1] Emissions (tons) = Total Fuel Usage (in gals)/1000 x Emission Factor (lbs/1000 gals of fuel) x 0.0005 tons/lb

[2] Particulate matter emission factors were not available, so emission factors for support boats was used.

[3] Emissions (tons) = Vehicle Miles Traveled x Emission Factor (in grams/mile) x 0.0022 lbs/gram x 0.0005 tons/lb

[4] Emissions (tons) = Hours of Idling x Emission Factor (in grams/hour) x 0.0022 lbs/gram x 0.0005 tons/lb

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 20 - Total Dredging-Related Emissions for Option G

Prepared By: I. Edmonds-Hess
Date Prepared: 4/15/99
Checked By: L. Spurgeon

Table 20
Total Dredging-Related Emissions for Option G

Activity/Equipment	Total Emissions[1] for the Upper Dredge Limit (in tons)							Total Emissions[1] for the Lower Dredge Limit (in tons)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Dredging														
Clamshell Dredge	3.45	3.31	32.57	118.77	7.74	2.92	1.90	2.02	1.94	19.05	69.48	4.53	1.71	1.11
Anchor Tug	1.50	1.44	2.31	13.42	0.94	1.09	1.04	0.88	0.85	1.35	7.85	0.55	0.64	0.61
Barge Equipment	1.38	1.32	3.04	14.12	0.93	0.99	0.95	0.81	0.77	1.78	8.26	0.54	0.58	0.56
Support Boat	0.57	0.55	0.88	5.09	0.36	0.41	0.40	0.33	0.32	0.51	2.98	0.21	0.24	0.23
Survey Boat[2]	2.25	2.16	1.75	4.25	0.34	0.41	0.40	1.32	1.26	1.02	2.49	0.20	0.24	0.23
Alcatraz Disposal Site														
Transport & Unloading														
Tug Boat (Single Screw)	0.50	0.48	0.77	4.45	0.31	0.36	0.35	0.50	0.48	0.78	4.50	0.31	0.36	0.35
Barge Equipment	0.02	0.02	0.04	0.17	0.01	0.01	0.01	0.02	0.02	0.04	0.17	0.01	0.01	0.01
Ocean Disposal Site														
Transport & Unloading														
Tug Boat (Double Screw)	6.84	6.57	10.51	61.03	4.27	4.94	4.74	4.10	3.94	6.30	36.56	2.56	2.96	2.84
Barge Equipment	0.04	0.04	0.09	0.40	0.03	0.03	0.03	0.02	0.02	0.05	0.22	0.01	0.02	0.02
Hamilton Wetland Restoration Site														
Transport														
Tug Boat (Double Screw)	2.92	2.80	4.48	26.00	1.82	2.11	2.02	2.67	2.56	4.10	23.79	1.66	1.93	1.85
Barge Equipment	0.08	0.08	0.18	0.82	0.05	0.06	0.06	0.07	0.07	0.16	0.75	0.05	0.05	0.05
Unloading														
Hydraulic Unloader	0.10	0.10	0.89	3.41	0.22	0.08	0.05	0.09	0.09	0.82	3.12	0.20	0.08	0.05
Booster Pump	0.20	0.19	1.87	6.83	0.45	0.17	0.11	0.18	0.17	1.71	6.25	0.41	0.15	0.10
Work Tug	0.07	0.06	0.10	0.58	0.04	0.05	0.05	0.06	0.06	0.09	0.53	0.04	0.04	0.04
Generator	0.01	0.01	0.04	0.06	0.01	0.01	0.01	0.01	0.01	0.03	0.06	0.01	0.01	0.01
Support Boat	0.02	0.02	0.04	0.22	0.02	0.02	0.02	0.02	0.02	0.03	0.20	0.01	0.02	0.02

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 20 - Total Dredging-Related Emissions for Option G

Prepared By: I. Edmonds-Hess
Date Prepared: 4/15/99
Checked By: L. Spurgeon

Table 20
Total Dredging-Related Emissions for Option G

Activity/Equipment	Total Emissions[1] for the Upper Dredge Limit (in tons)							Total Emissions[1] for the Lower Dredge Limit (in tons)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Altamont Landfill														
Transport														
Tug Boat (Single Screw)	0.36	0.35	0.55	3.21	0.22	0.26	0.25	0.18	0.17	0.28	1.61	0.11	0.13	0.13
Barge Equipment	0.05	0.04	0.10	0.48	0.03	0.03	0.03	0.02	0.02	0.05	0.24	0.02	0.02	0.02
Dump Trucks Traveling to Drying Area[3]	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00
Dump Trucks Idling at Drying Area[4]	0.04	0.04	0.38	0.18	0.00	0.01	0.01	0.02	0.02	0.19	0.09	0.00	0.00	0.00
Dump Trucks Traveling to Landfill[3]	1.74	1.67	9.97	11.12	0.00	1.28	1.23	0.87	0.84	5.01	5.59	0.00	0.64	0.62
Dump Trucks Idling at Landfill[4]	0.04	0.04	0.38	0.18	0.00	0.01	0.01	0.02	0.02	0.19	0.09	0.00	0.00	0.00
Unloading/Loading														
Clamshell Dredge	0.17	0.16	1.61	5.87	0.38	0.14	0.09	0.09	0.08	0.81	2.95	0.19	0.07	0.05
Barge Equipment	0.14	0.13	0.30	1.40	0.09	0.10	0.09	0.07	0.07	0.15	0.70	0.05	0.05	0.05
D-6 Dozer	0.14	0.14	0.33	1.21	0.13	0.11	0.10	0.07	0.07	0.17	0.61	0.07	0.05	0.05
Loader	0.21	0.21	0.42	1.36	0.13	0.12	0.12	0.11	0.10	0.21	0.69	0.07	0.06	0.06
Support Boat	0.06	0.05	0.09	0.50	0.04	0.04	0.04	0.03	0.03	0.04	0.25	0.02	0.02	0.02
Total	23	22	74	285	19	16	14	15	14	45	180	12	10	9

Notes:

[1] Emissions (tons) = Total Fuel Usage (in gals)/1000 x Emission Factor (lbs/1000 gals of fuel) x 0.0005 tons/lb

[2] Particulate matter emission factors were not available, so emission factors for support boats was used.

[3] Emissions (tons) = Vehicle Miles Traveled x Emission Factor (in grams/mile) x 0.0022 lbs/gram x 0.0005 tons/lb

[4] Emissions (tons) = Hours of Idling x Emission Factor (in grams/hour) x 0.0022 lbs/gram x 0.0005 tons/lb

Source: Parsons Brinckerhoff, 1999.

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 21 - Total Dredging-Related Emissions for Option H

Prepared By: I. Edmonds-Hess
Date Prepared: 4/15/99
Checked By: L. Spurgeon

Table 21
Total Dredging-Related Emissions for Option H

Activity/Equipment	Total Emissions[1] for the Upper Dredge Limit (in tons)							Total Emissions[1] for the Lower Dredge Limit (in tons)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Dredging														
Clamshell Dredge	3.45	3.31	32.57	118.77	7.74	2.92	1.90	2.02	1.94	19.05	69.48	4.53	1.71	1.11
Anchor Tug	1.50	1.44	2.31	13.42	0.94	1.09	1.04	0.88	0.85	1.35	7.85	0.55	0.64	0.61
Barge Equipment	1.38	1.32	3.04	14.12	0.93	0.99	0.95	0.81	0.77	1.78	8.26	0.54	0.58	0.56
Support Boat	0.57	0.55	0.88	5.09	0.36	0.41	0.40	0.33	0.32	0.51	2.98	0.21	0.24	0.23
Survey Boat[2]	2.25	2.16	1.75	4.25	0.34	0.41	0.40	1.32	1.26	1.02	2.49	0.20	0.24	0.23
Alcatraz Disposal Site														
Transport & Unloading														
Tug Boat (Single Screw)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barge Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ocean Disposal Site														
Transport & Unloading														
Tug Boat (Double Screw)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barge Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hamilton Wetland Restoration Site														
Transport														
Tug Boat (Double Screw)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barge Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unloading														
Hydraulic Unloader	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Booster Pump	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Work Tug	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Generator	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Support Boat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Project: San Francisco-Oakland Bay Bridge East Span Seismic Safety Project
Subject: Table 21 - Total Dredging-Related Emissions for Option H

Prepared By: I. Edmonds-Hess
Date Prepared: 4/15/99
Checked By: L. Spurgeon

Table 21
Total Dredging-Related Emissions for Option H

Activity/Equipment	Total Emissions[1] for the Upper Dredge Limit (in tons)							Total Emissions[1] for the Lower Dredge Limit (in tons)						
	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}	TOG	ROG	CO	NO_x	SO_2	PM	PM_{10}
Altamont Landfill														
Transport														
Tug Boat (Single Screw)	1.44	1.38	2.21	12.84	0.90	1.04	1.00	0.84	0.81	1.29	7.51	0.53	0.61	0.58
Barge Equipment	0.19	0.18	0.41	1.92	0.13	0.14	0.13	0.11	0.11	0.24	1.12	0.07	0.08	0.08
Dump Trucks Traveling to Drying Area[3]	0.02	0.02	0.11	0.12	0.00	0.01	0.01	0.01	0.01	0.07	0.07	0.00	0.01	0.01
Dump Trucks Idling at Drying Area[4]	0.17	0.17	1.51	0.74	0.00	0.03	0.03	0.10	0.10	0.88	0.43	0.00	0.02	0.02
Dump Trucks Traveling to Landfill[3]	7.03	6.74	40.33	44.98	0.00	5.19	4.97	4.11	3.94	23.59	26.31	0.00	3.03	2.91
Dump Trucks Idling at Landfill[4]	0.18	0.17	1.52	0.74	0.00	0.03	0.03	0.10	0.10	0.89	0.43	0.00	0.02	0.02
Unloading/Loading														
Clamshell Dredge	0.68	0.65	6.42	23.43	1.53	0.58	0.38	0.40	0.38	3.76	13.71	0.89	0.34	0.22
Barge Equipment	0.54	0.52	1.20	5.57	0.37	0.39	0.38	0.32	0.31	0.70	3.26	0.21	0.23	0.22
D-6 Dozer	0.57	0.55	1.33	4.83	0.53	0.43	0.41	0.34	0.32	0.78	2.83	0.31	0.25	0.24
Loader	0.85	0.82	1.67	5.45	0.53	0.50	0.48	0.50	0.48	0.98	3.19	0.31	0.29	0.28
Support Boat	0.23	0.22	0.35	2.01	0.14	0.16	0.16	0.13	0.13	0.20	1.18	0.08	0.10	0.09
Total	21	20	98	258	14	14	13	12	12	57	151	8	8	7

Notes:

[1] Emissions (tons) = Total Fuel Usage (in gals)/1000 x Emission Factor (lbs/1000 gals of fuel) x 0.0005 tons/lb

[2] Particulate matter emission factors were not available, so emission factors for support boats was used.

[3] Emissions (tons) = Vehicle Miles Traveled x Emission Factor (in grams/mile) x 0.0022 lbs/gram x 0.0005 tons/lb

[4] Emissions (tons) = Hours of Idling x Emission Factor (in grams/hour) x 0.0022 lbs/gram x 0.0005 tons/lb

Source: Parsons Brinckerhoff, 1999.

APPENDIX N

CONCEPTUAL MITIGATION PLAN FOR SPECIAL AQUATIC SITES

San Francisco – Oakland Bay Bridge
East Span Seismic Safety Project

EA 012000
Caltrans Contract 04A0148
Task Order 180.10

04-SF-80 KP 12.2/KP 14.3
04-ALA-80 KP 0.0/KP 2.1

Conceptual Mitigation Plan for Special Aquatic Sites

November 2000
Revision 6

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PROJECT PURPOSE

Caltrans proposes to replace the East Span of the San Francisco-Oakland Bay Bridge (SFOBB) between Yerba Buena Island (YBI) in the City and County of San Francisco and Oakland in Alameda County. The Federal Highway Administration (FHWA) is the federal lead agency pursuant to the National Environmental Policy Act (NEPA). The purpose of the project is to provide a seismically upgraded vehicular crossing for current and future users. The N-6 Replacement Alternative, the northernmost of the replacement alternatives, is Caltrans' Preferred Alternative. This plan only addresses the mitigation for special aquatic sites for Replacement Alternative N-6. Caltrans has developed this plan through a review of project impacts, mitigation options and consultation with regulatory agencies.

PROJECT IMPACTS

Potential impacts of the N-6 Replacement Alternative are summarized in Table 1-1. The assessment of construction impacts is based on a worst case scenario utilizing a likely construction methodology. The special aquatic sites affected by Replacement Alternative N-6 are located at the Oakland Touchdown and at Clipper Cove on the north side of YBI. The N-6 Replacement Alternative will permanently impact 1.36 hectares (3.36 acres) of sand flats and 0.22 hectares (0.55 acres) of eelgrass (*Zostera marina*). At the Oakland Touchdown, permanent impacts will be caused by dredging for the barge access channel, the placement of engineered fill for the westbound roadway and the Caltrans maintenance road, and shading from the east and westbound bridge structures. At Clipper Cove, permanent impacts will be caused by the construction of barge dock 'A'. In addition, the N-6 Replacement Alternative will temporarily impact 0.69 hectares (1.70 acres) of sand flats and 0.01 hectares (0.02 acres) of eelgrass. At the Oakland Touchdown, temporary impacts will be caused by the placement of a "geotube", a large high density polyethylene tube filled with excavated material used for dewatering purposes, and increased turbidity generated by dredging, pile-driving, prop wash and mud boils. No temporary impacts to eelgrass or sand flats are expected at YBI.

Caltrans will avoid potential impacts to two isolated non-tidal wetlands at the Oakland Touchdown and tidal wetlands at Clipper Cove by designating them as environmentally sensitive areas (ESAs) during construction. Caltrans will also avoid potential impacts to eelgrass at the Oakland Touchdown and YBI that are located outside the direct impact zone by designating them as ESAs during construction.

Caltrans proposes a plan to avoid and minimize impacts to wetlands, sand flats and eelgrass in the project area, and compensate for unavoidable temporary and permanent impacts. The mitigation concept for unavoidable impacts has two objectives. The first objective is to mitigate and/or restore impacted areas within the project limits to the maximum extent practicable. The second objective is to mitigate off-site to compensate for unavoidable impacts that cannot be mitigated in the project area.

AVOIDANCE MEASURES

Caltrans will implement measures on-site to avoid potential impacts. These measures include:

- Installing fencing around non-tidal wetlands and marking them as ESAs to avoid impacts during construction; and
- Marking the eelgrass beds and tidal wetlands outside the direct impact zone as ESAs to avoid additional impacts during construction.

MINIMIZATION MEASURES

Caltrans will also implement measures on-site to minimize potential impacts. These measures include:

- Installing turbidity curtains to contain and reduce turbidity impacts to eelgrass;
- Narrowing part of the barge access channel from the original dimensions identified in the Dredged Materials Management Plan (DMMP) to a smaller channel that reduces permanent and temporary impacts to eelgrass beds;
- Using a geotube as a dewatering berm rather than engineered fill; and
- Using removable trestles for construction access.

ON-SITE MITIGATION

Caltrans will implement measures on-site to restore special aquatic sites affected during construction. Restoration measures include:

- Harvesting approximately 0.22 hectares (0.54 acres) of eelgrass from the footprint of the barge access channel, planting test plots in adjacent eelgrass beds and monitoring to evaluate performance;
- Restoring up to approximately 0.70 hectares (1.73 acres) of the barge access channel with stockpiled dredge material and excavated sand to facilitate eelgrass colonization and possibly replanting with eelgrass;
- Restoring approximately 0.69 hectares (1.70 acres) of sand flats that are temporarily affected by the placement of a geotube or mud boils from engineered fill;
- Constructing rock slope protection to allow sand to accrete over the rock in areas subject to tidal action. Slope gradients will be 1:3 (V:H) at the toe of the slope and transitioning to a 1:2 gradient at mid-slope; and
- Capping rock slope protection areas with soil above the limits of tidal action to provide a medium to support growth of native upland plants.

OFF-SITE MITIGATION

Tidal Marsh and Mudflat Creation and Enhancement

Permanent impacts to sand flats and eelgrass beds will be further mitigated by creation of a tidal marsh ecosystem. This out-of-kind mitigation will provide enhanced functions and values relative to the affected special aquatic sites. The tidal marsh ecosystem will include creation of

new mudflats, tidal channels, and tidal marsh and enhancement of existing wetlands and uplands. The synergistic effect of these complementary habitats will provide greater foraging, roosting, and breeding opportunities for many of the species that utilize the affected special aquatic sites.

Caltrans is considering two sites for creation of an aquatic ecosystem, although it will only select one site. The Breuner property, described below, is the preferred mitigation site.

- **Breuner Property:** Bay Area Wetlands, L.L.C. currently owns this property. Caltrans proposes to create approximately 4.73 hectares (11.70 acres) of tidal marsh ecosystem at this site. The estimated cost is approximately two million dollars including acquisition of the mitigation rights, fill removal, grading, planting and monitoring. The Breuner property is the only suitable site with a landowner that intends to use its property for habitat creation, restoration and enhancement.
- **Liquid Gold Property:** Southern Pacific Transportation Company (SPTCo) currently owns this property. Caltrans could create approximately 4.73 hectares (11.70 acres) of a tidal marsh ecosystem at this site. Estimated costs include three to five million dollars for acquisition and approximately one million dollars for fill removal, grading, planting and monitoring.

1.1 PROJECT PURPOSE

The purpose of the SFOBB East Span Project is to provide a seismically upgraded vehicular crossing for current and future users between Yerba Buena Island and Oakland. A maximum credible earthquake (MCE) on either the San Andreas or Hayward faults is expected to inflict far greater damage to the East Span than it experienced as a result of the 1989 Loma Prieta earthquake. On the existing SFOBB East Span, a MCE could cause a multi-span collapse, potentially resulting in numerous casualties and requiring months to reopen the bridge or years to build a replacement. The replacement bridge will be designed not only to withstand an MCE but also to provide necessary post-disaster service and assist in emergency response efforts. The replacement bridge will also be upgraded to meet current operational and safety standards to the maximum extent feasible.

1.2 PROPOSED PROJECT

Caltrans worked closely with the Metropolitan Transportation Commission (MTC) Bay Bridge Task Force and the Engineering and Design Advisory Panel (EDAP) to develop the proposed project. Consistent with MTC's recommendations, Caltrans' Preferred Replacement alternative is the N-6 alignment just north of the existing bridge. The replacement bridge will consist of a concrete skyway that begins at the Oakland Touchdown area west of the SFOBB Toll Plaza (Figure 1-1). The skyway will connect to a steel, self-anchored suspension span just east of YBI. The self-anchored suspension bridge will span the navigation channel near YBI and connect to a concrete transition structure on YBI. The transition structure will then connect to the existing double deck configuration at the YBI tunnel.

Replacement Alternative N-6 will be approximately 3.6-kilometers-long (2.2-miles-long). A single tower will be located between the east and westbound structures and will support the self-anchored suspension span (Figure 1-2). The new East Span will include side-by-side bridge decks, separated by approximately 15.24 meters (50 feet). Each structure will have five 3.6-meter-wide (12-foot-wide) lanes and two 3-meter-wide (10-foot-wide) shoulders. As a public amenity, there will be a 4.73-meter-wide (15.5-foot-wide) bicycle and pedestrian path on the south side of the eastbound lane elevated 0.30-meter (one foot) above the roadway. The existing bridge will be dismantled after construction of the replacement bridge. The replacement bridge will not increase vehicle capacity within the transbay corridor, but will be operationally superior to the existing span due to the addition of shoulders.

1.3 DESCRIPTIONS OF THE AFFECTED SPECIAL AQUATIC SITES

The affected sand flats are located along the northern side of the Oakland Touchdown area beginning just west of Radio Point Beach and continuing to the west end of the Touchdown (Figure 1-3). The habitat value of the sand flats in the project area is diminished by the abrupt transitions with adjacent uplands and the lack of adjacent wetland habitats. The existing shoreline adjacent to these sand flats is protected with rock riprap and the transition to uplands is abrupt. These characteristics reduce the potential for species to utilize the sand flats in the project area for resting, breeding and foraging. A detailed description of the functions and values of sand flats is presented in Section Two.

The affected eelgrass beds are located at the outer margins of the sand flats along the north side of the Oakland Touchdown area and at Clipper Cove, north of Yerba Buena Island (Figures 1-3 and 1-4). These beds consist of widely scattered patches of eelgrass. This pattern is typical of eelgrass beds in San Francisco Bay and is a result of environmental stresses that may vary unpredictably over time and lead to intermittent emergence or loss of eelgrass patches from an area. These eelgrass patches are part of a larger complex that is one of the most extensive stands of eelgrass in the Bay (Merkel 2000).

The largest patches of eelgrass in the project area occur on the high points of sandy shoals north of the Oakland Touchdown. Other relatively large coalesced beds occur within Clipper Cove on a narrow band of silty sands adjacent to the deeper navigational basin. A detailed description of the functions and values of eelgrass beds is presented in Section Two.

1.4 IMPACT SUMMARY

Replacement Alternative N-6 will affect sand flats and eelgrass beds. These habitats are jurisdictional waters of the U.S. regulated under Sections 404 and 401 of the federal Clean Water Act. Wetlands, sand flats and eelgrass beds are also designated as special aquatic sites.

Table 1-1 summarizes the temporary and permanent impacts to sand flats and eelgrass beds. Approximately 1.36 hectares (3.36 acres) of sand flats and approximately 0.22 hectares (0.55 acres) of eelgrass beds will be permanently impacted. Approximately 0.69 hectares (1.70 acres) of sand flats and approximately 0.01 hectares (0.02 acres) of eelgrass beds will be temporarily impacted. The N-6 Replacement Alternative will not affect tidal or non-tidal wetlands.

Permanent impacts to eelgrass and sand flats at the Oakland Touchdown area will include:

- Dredging for the barge access channel (Figure 1-5);
- Engineered fill for the westbound roadway;
- Engineered fill for the maintenance road; and
- Shading from the bridge deck.

Permanent impacts to eelgrass at Yerba Buena Island will include:

- Construction of barge dock 'A' near Clipper Cove (Figure 1-6).

Because the water at the easternmost portion of the project area at the Oakland Touchdown is too shallow for construction barges, an access channel must be dredged. Dredging will affect stands of eelgrass (*Zostera marina*) (Figure 1-7). Barges are necessary to construct the piles, pile caps and bridge deck. Construction from land in this area is not feasible due to geologic conditions.

Engineered fill will be placed along the northwest side of the Oakland Touchdown area for the westbound roadway and the Caltrans maintenance road. This fill will permanently affect sand flats. In addition, permanent shading from the east and westbound bridge structures will permanently affect sand flats.

A temporary dock may be constructed at Clipper Cove to transport construction equipment, supplies and workers to and from the YBI project area. Although the dock is temporary, it will permanently affect a limited area of eelgrass along the margin of the Island when it is constructed.

Temporary impacts to eelgrass and sand flats at the Oakland Touchdown will include:

- Placement of a geotube for dewatering (Figure 1-8); and
- Increased turbidity due to prop wash from barges and tugboats, dredging, pile driving, and mud boils.

There will be no temporary impacts at Yerba Buena Island.

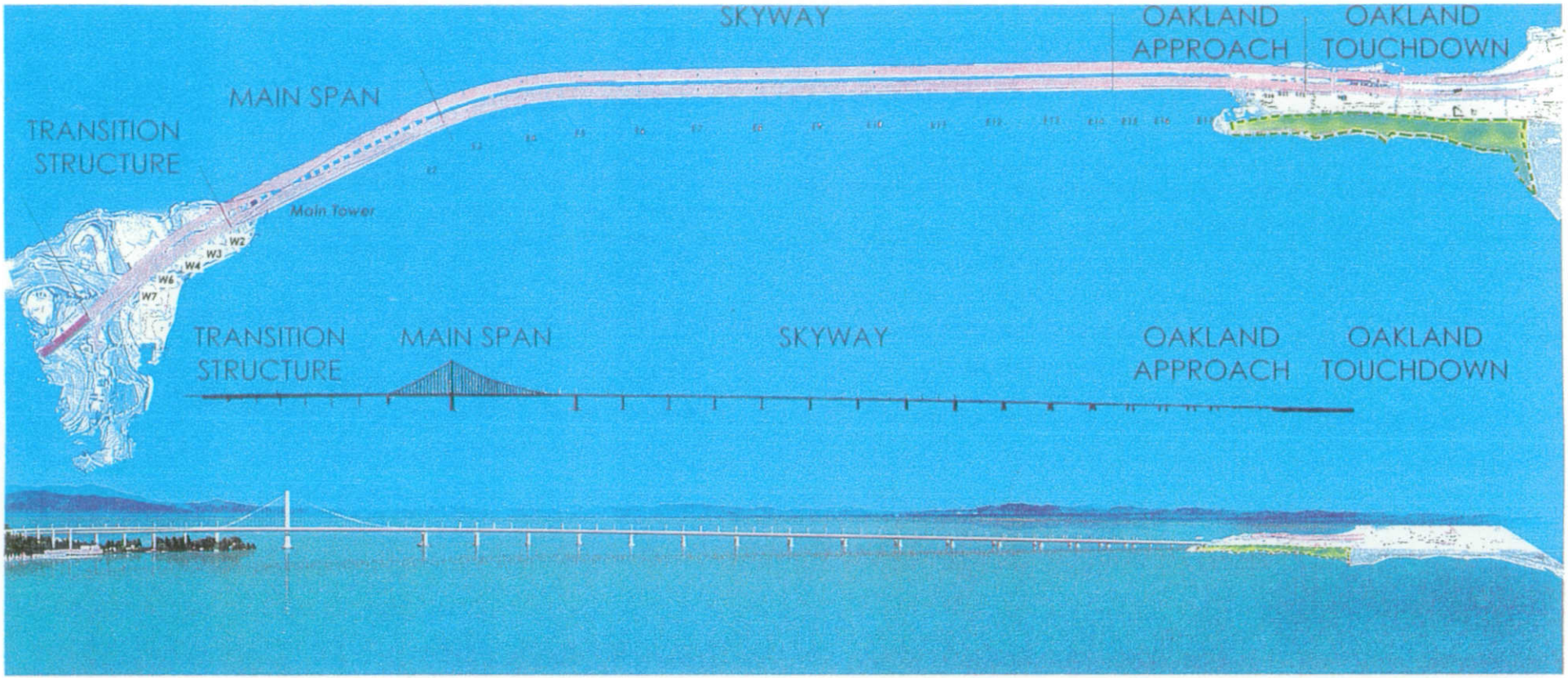
Temporary fill will consist of access trestles and a large, high-density polyethylene tube filled with excavated material, known as a geotube. The geotube will be placed north of the Oakland Touchdown area along the outside border of the work area to facilitate dewatering, installation of wick drains and placement of fill and surcharge for construction of the bridge approach. The geotube will be placed on sand flats, which may increase turbidity if fill material becomes suspended or if mud boils occur. The geotube is self-contained, with the ability to conform to the microtopography of the site. The geotube will help to minimize the displacement of sand flats and the high-density material will not erode, thereby minimizing turbidity.

Pile-supported trestles for temporary construction access will be constructed at the west end of the Oakland Touchdown. Because the access trestles will be constructed within the footprint of the dredged area, they will not result in any permanent impacts. However, pile driving to install the trestles may temporarily increase turbidity. Turbidity may also temporarily increase during dredging activities and later due to prop wash from barges and tugboats moving in and out of the barge access channel. Temporary impacts from turbidity are not expected at YBI.

Table 1-1

SUMMARY OF SPECIAL AQUATIC SITE IMPACTS

Type of Impact	Sand Flats hectares (acres)	Eelgrass hectares (acres)	Total hectares (acres)
Temporary	0.69 (1.70)	0.01 (0.02)	0.70 (1.72)
Permanent	1.36 (3.36)	0.22 (0.55)	1.58 (3.91)
Total	**2.05 (5.06)**	**0.23 (0.57)**	**2.28 (5.63)**



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

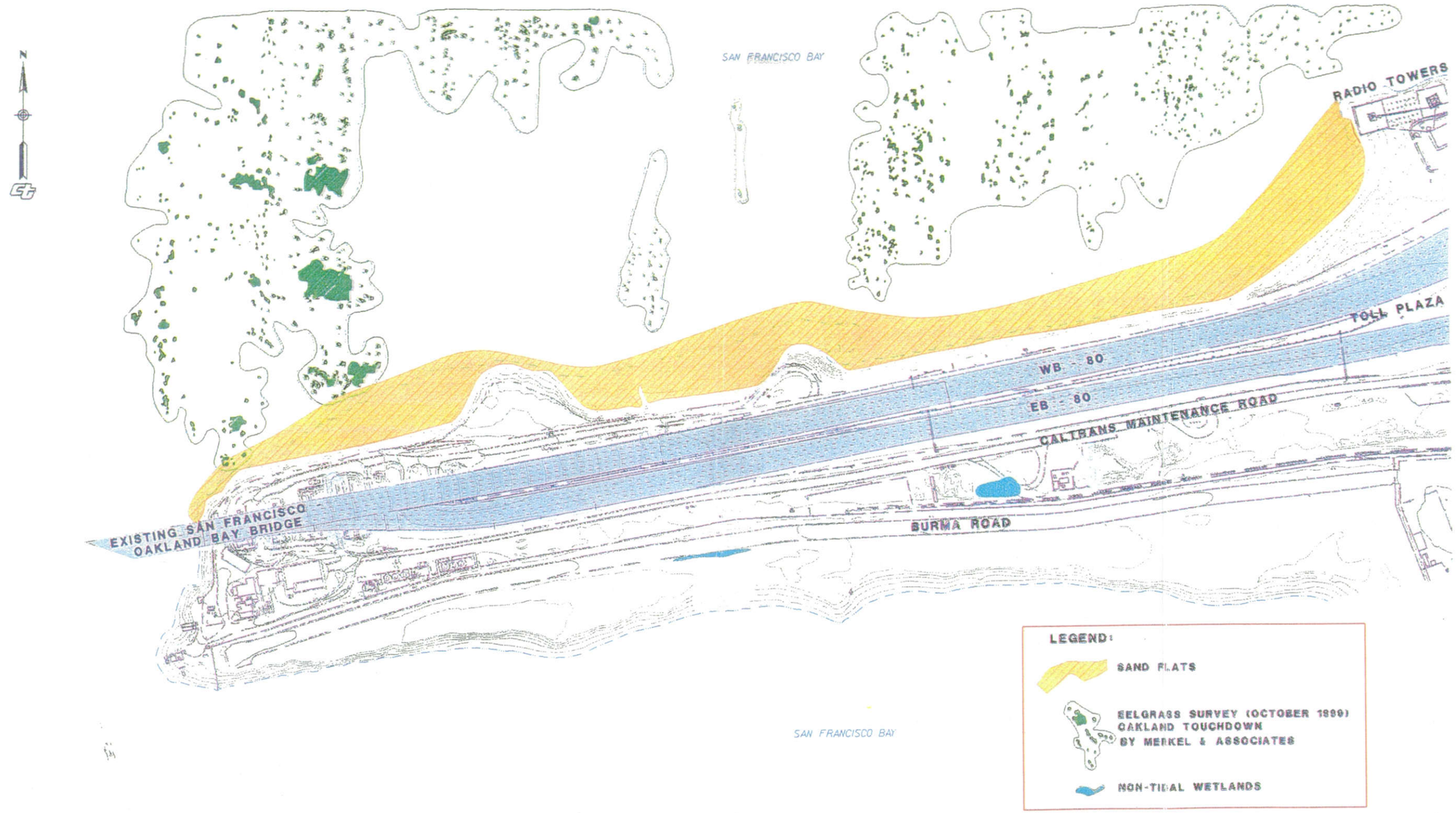
Project Layout

Figure 1-1

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Visual Simulation of the
Proposed Project

Figure 1-2



SFOBB
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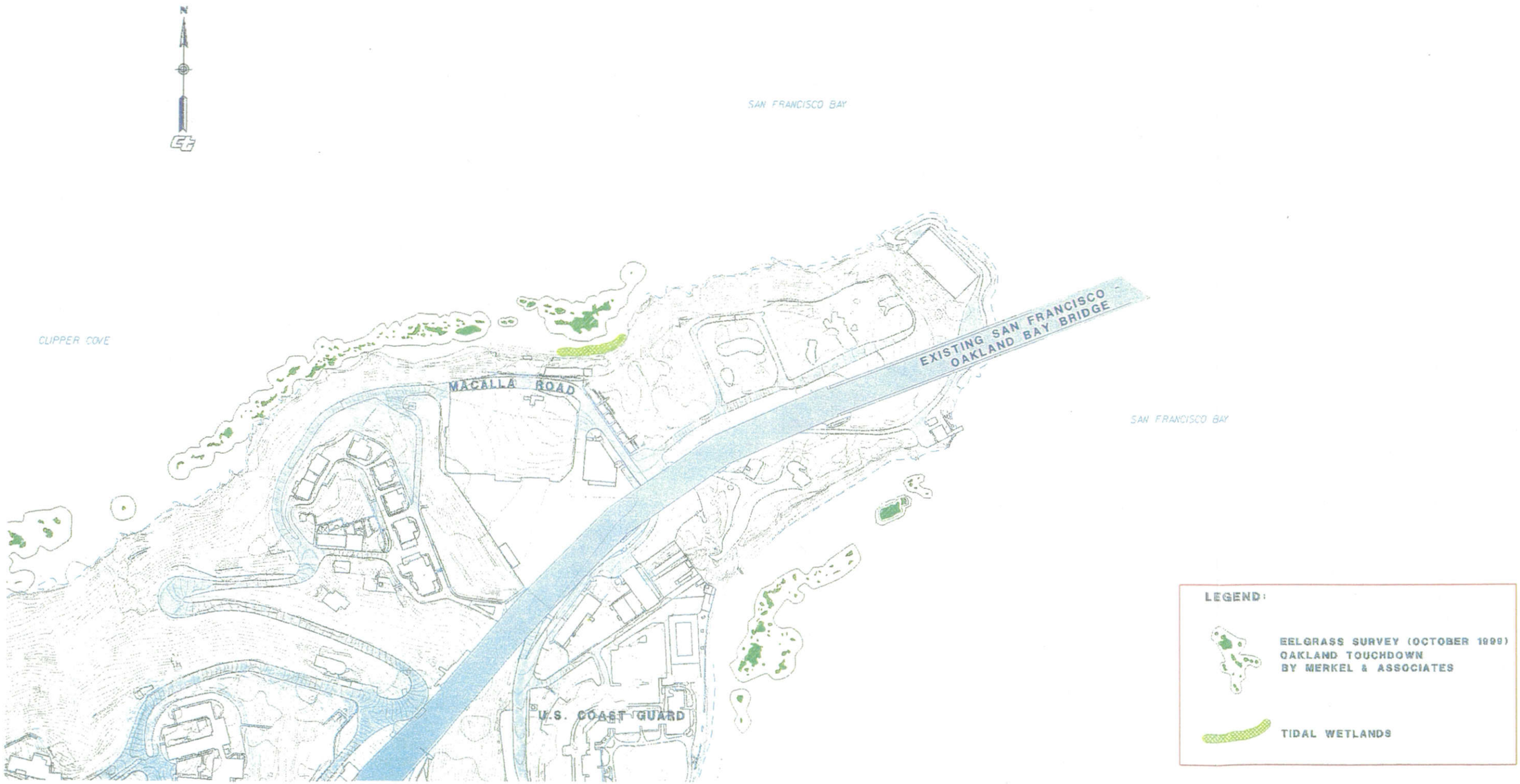
PROJECT

Special Aquatic Sites at the
Oakland Touchdown Area

Not to Scale

Figure 1-3



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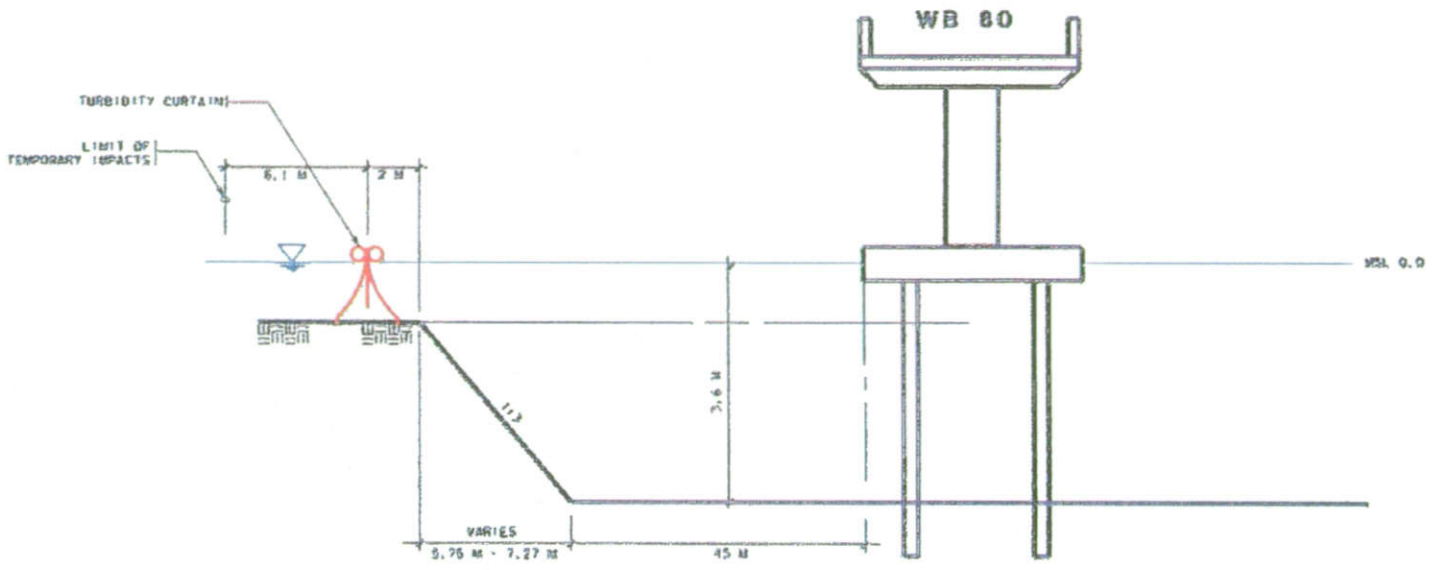
PROJECT

Special Aquatic Sites at Yerba Buena Island

Not to Scale

Figure 1-4



ADJUSTED PROPOSAL FULL WIDTH BOTTOM

VIEW: LOOKING EAST, NORTH SIDE OF REPLACEMENT ALTERNATIVE N-6

TYPICAL SECTION A-A - NO SCALE

SFOBB
EAST SPAN
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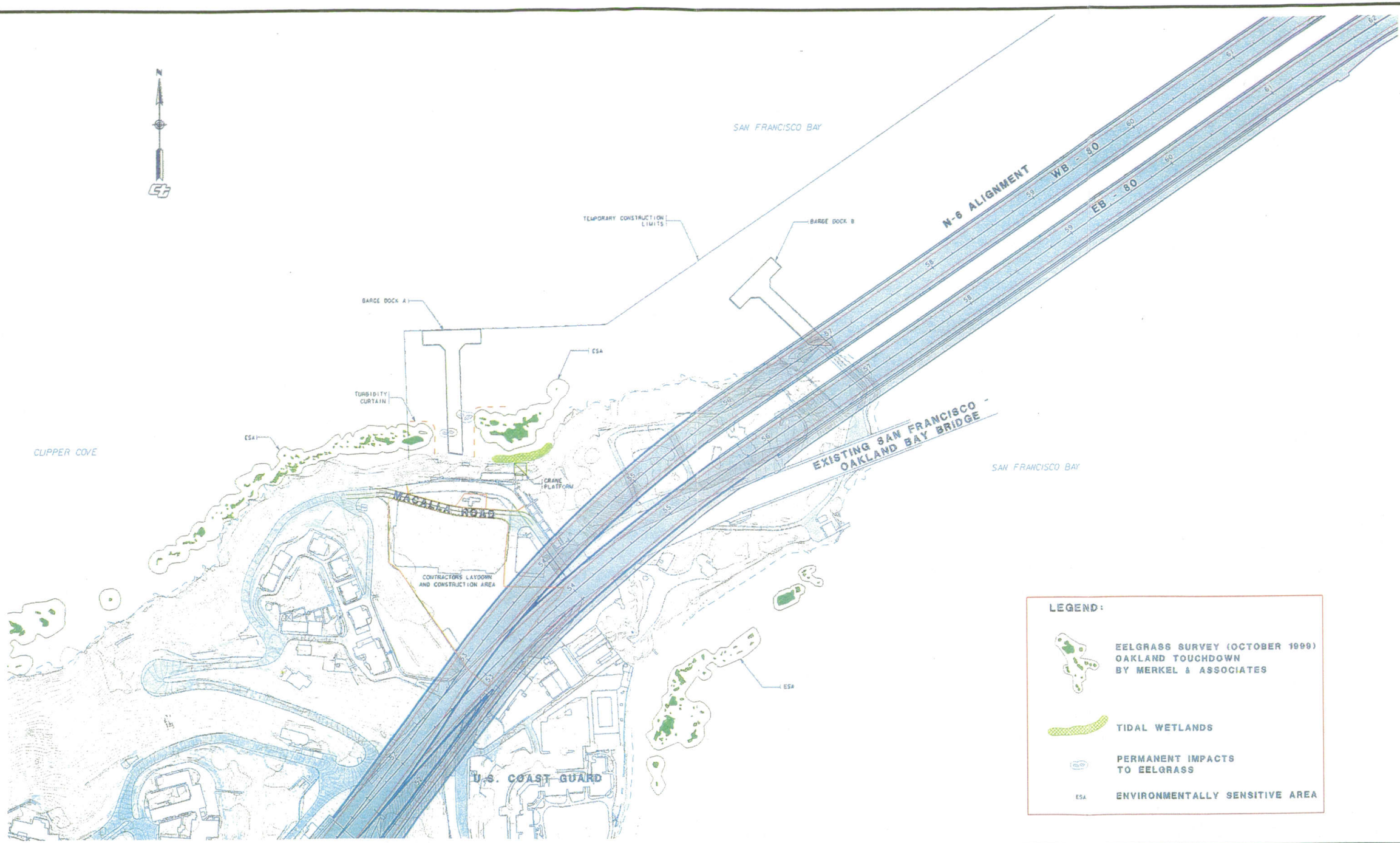
PROJECT

Dredging Impacts at the Oakland Touchdown Area

Not to Scale

Figure 1-5



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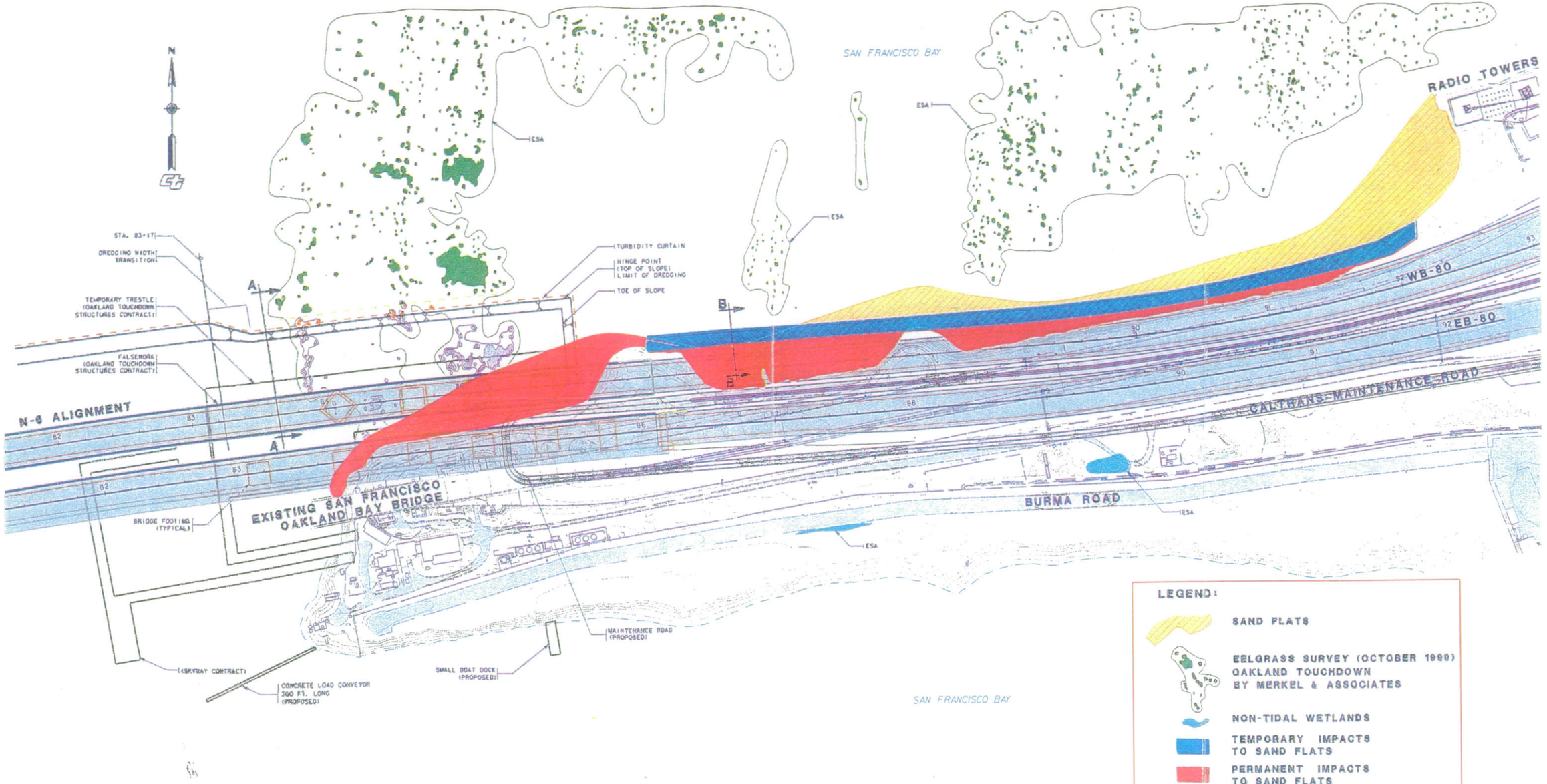
PROJECT

Impacts to Eelgrass at Yerba Buena Island

Not to Scale

Figure 1-6



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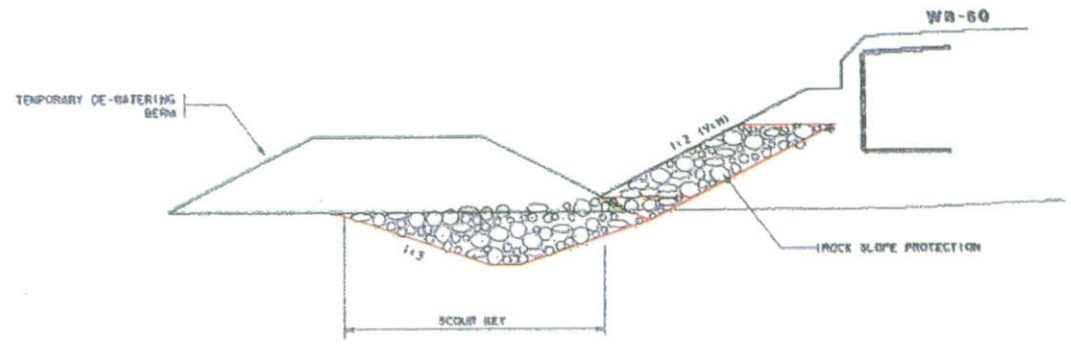
PROJECT

Impacts to Sand Flats and Eelgrass at the Oakland Touchdown Area

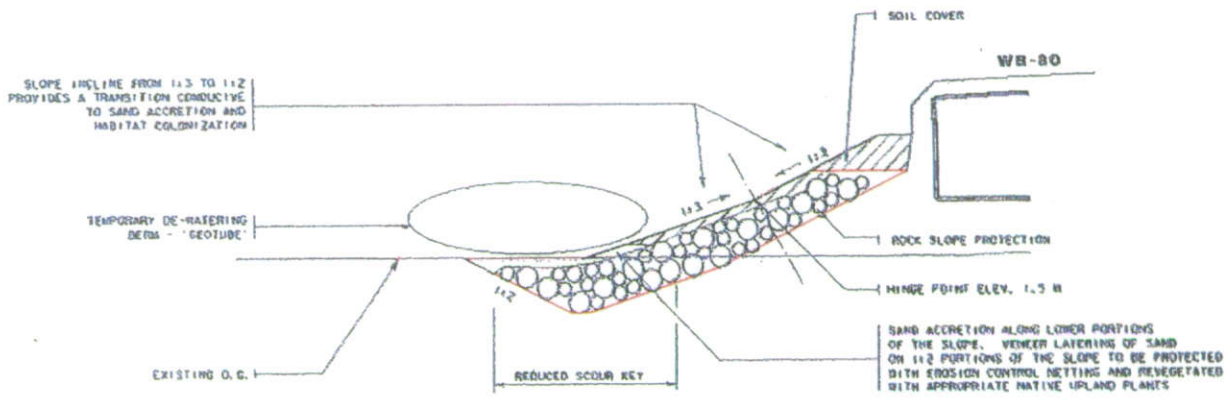
Not to Scale

Figure 1-7



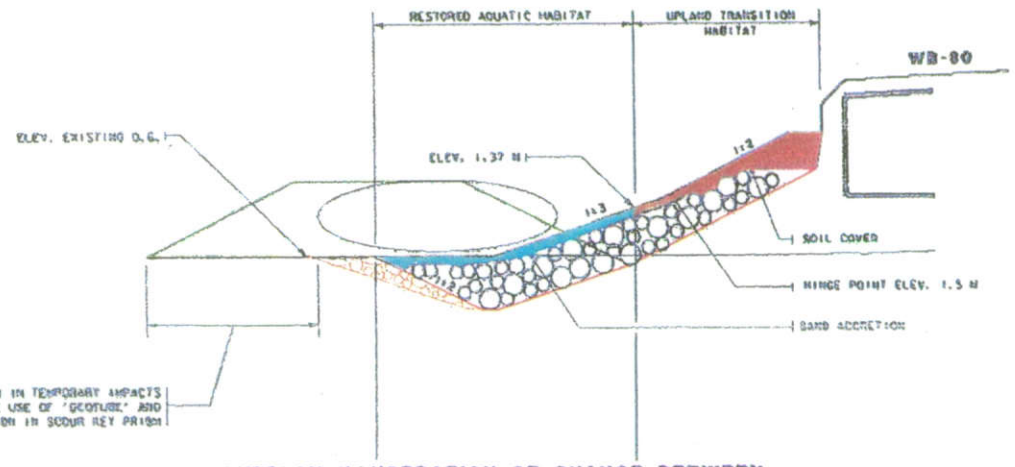
INITIAL CONCEPTUAL SLOPE TREATMENT

TYPICAL SECTION B-B - NO SCALE



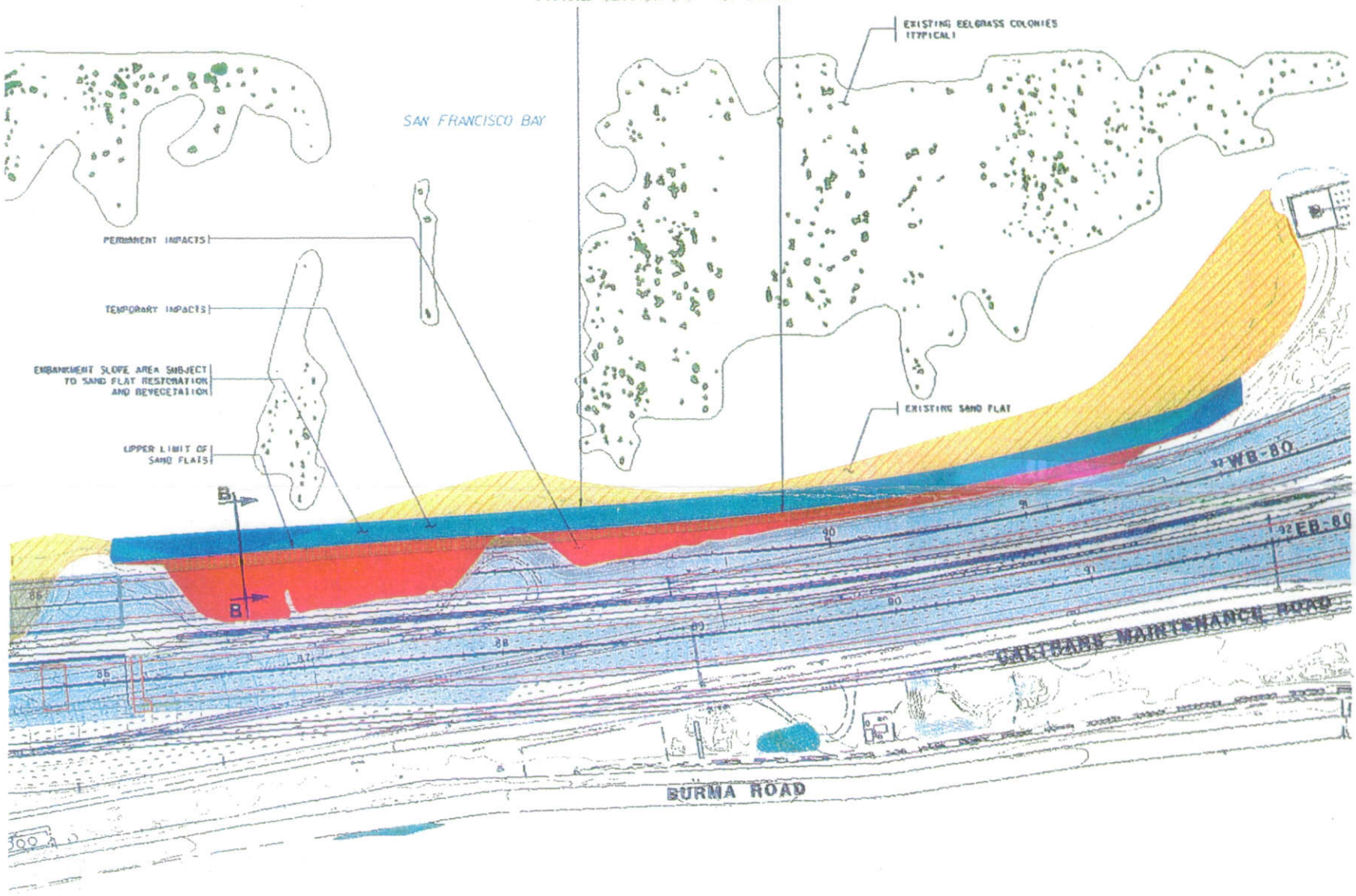
PROPOSED SLOPE TREATMENT

TYPICAL SECTION B-B - NO SCALE



OVERLAY ILLUSTRATION OF CHANGE BETWEEN INITIAL AND FINAL SLOPE TREATMENTS

TYPICAL SECTION B-B - NO SCALE



SFOBB
EAST SPAN
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PROJECT

Impacts to Sand Flats at the Oakland Touchdown Area

Not to Scale

Figure 1-8

The mitigation goal is to replace the habitat values of the affected sand flats and eelgrass beds. Caltrans proposes to achieve this goal by:

- Implementing measures to avoid and minimize impacts on-site;
- Restoring on-site special aquatic sites temporarily affected during construction; and
- Creating off-site new mudflats, tidal marsh, and tidal channels and enhancing existing wetlands and uplands.

The following sections describe the functions and values of the affected habitat and describe the habitat to be created, restored and enhanced.

2.1 FUNCTIONS AND VALUES OF AFFECTED HABITAT

2.1.1 Eelgrass

Eelgrass (*Zostera marina*) is a native marine vascular plant indigenous to the soft-bottom bays and estuaries of the Northern Hemisphere. The species is found from middle Baja California and the Sea of Cortez to northern Alaska along the west coast of North America and is common in healthy shallow bays and estuaries. The depth at which this species grows is a function of light penetration. At greater depths light is reduced to a level below which photosynthesis is unable to meet the metabolic demands of the plant to sustain net growth (the photocompensation depth).

Eelgrass beds perform multiple functions within an estuarine ecosystem. For example, they provide a nursery area for many species of fish including California halibut (*Paralichthys californicus*) and English sole (*Parophrys vetulus*). They are nursery areas for the commercially important Pacific herring (*Clupea harengus*). Detritus from eelgrass is not only used by animals immediately adjacent to the beds but also is transported further into the estuary, making it an important part of the detrital-based food web. As substrate for the epiphytic algae, invertebrates, and crustaceans on which these species feed, eelgrass beds also contribute to the ecosystem at multiple trophic levels. Eelgrass beds are also foraging areas for wintering waterfowl such as American wigeon (*Anas americana*) that feed on the roe and invertebrates.

In addition to being refugia for young fish, eelgrass beds stabilize shorelines by dampening the wave energy that transports sediment to and from the shore, preventing erosion. They also improve water quality by collecting and filtering organic matter and sediments. This filtering also acts as a nutrient pump, transferring waterborne nutrients to the sediments and invertebrates.

Eelgrass is easily affected by changes in water quality and turbidity. They are extremely dynamic, expanding and contracting by as much as several hectares per season depending on the quality of the site. Consequently, eelgrass beds serve as an indicator community for the overall health of an estuary.

The San Francisco estuarine complex is the second largest estuary in the nation and the largest estuary on the Pacific Coast. A 1987 National Marine Fisheries Service (NMFS) survey of the Bay documented 128 hectares (316 acres) of eelgrass, covering less than 0.1% of the total Bay bottom. Much of the existing eelgrass exhibits conditions of environmental stress (Wyllie-Echeverria and Rutten, 1989; Wyllie-Echeverria, 1990).

Merkel and Associates conducted surveys for Caltrans of eelgrass at the project site in October 1999. These surveys covered approximately 82 hectares (203 acres) of the project area north and south of the Oakland Touchdown area and along the eastern shoreline of YBI and Clipper Cove. Merkel and Associates found eelgrass in areas north and south of Yerba Buena Island and the area north of the Oakland Touchdown called the Emeryville Flats. The most extensive eelgrass beds were on the Emeryville Flats.

In total, the surveyed area supported approximately 16.4 hectares (40.6 acres) of eelgrass at the time of the survey, with the majority of the eelgrass beds having a vegetative coverage[1] of between 5% and 20% of the bay bottom area surveyed. This vegetative coverage varied significantly between Yerba Buena Island and the Oakland touchdown. Within the Yerba Buena Island eelgrass beds, a mean vegetative cover of 31.9% characterized the eelgrass beds. At the Oakland Touchdown area, the overall mean vegetative cover was approximately 10.6%, approximately one third the coverage, as compared to eelgrass at Yerba Buena Island. Eelgrass cover at both of these sites is similar to coverage of eelgrass beds in San Pablo Bay and eastern San Francisco Bay. However, the eelgrass beds at Yerba Buena Island had slightly greater coverage than that reported at other East Bay sites (SAIC and Merkel & Associates, 1997a and 1997b; Merkel & Associates, 1997, 1999a, 1999b).

The vegetative cover values at the Oakland Touchdown area and Yerba Buena Island compare favorably to those measured elsewhere in San Francisco Bay. Eelgrass vegetative coverage ranged from less than 5% to over 20% in a survey of Richmond Harbor and Point Richmond conducted in October 1996 (SAIC and Merkel & Associates, Inc., 1997a). In October 1998, Richmond Harbor and Point Richmond continued to support eelgrass at comparable but somewhat reduced coverages ranging from less than 5% to between 16% and 20% in subsequent surveys (Merkel and Associates, 1999a). By far, the greatest portion of these eelgrass beds fell at or below 5% vegetative cover during both 1996 and 1998. At Point Richmond in San Pablo Bay, eelgrass cover ranged between 0% and 25% with the mean cover being around 5% within Point Orient, Point Molate, and the San Pablo Shoal areas. The shallower and more sheltered portions of Point Molate supported eelgrass beds with a cover of 10% to 20% (SAIC and Merkel & Associates, 1997b). In August 1997, an eelgrass survey was completed at the Richmond-San Rafael Bridge. These eelgrass beds were found to range between 8% and 17% vegetative coverage at the east end of the bridge (Merkel & Associates, Inc., 1997b). In October 1999, the eelgrass coverage on Middle Harbor Shoal was determined to be 12% for this small bed (Merkel & Associates, 1999b).

Within the SFOBB East Span project area, the largest patches of eelgrass occurred on the high points of sandy shoals located on the Emeryville Flats. Other relatively large coalesced beds occurred within Clipper Cove on a narrow band of silt sands adjacent to the deeper navigational basin. Eelgrass is found on a range of sediment types, from fine sands to silt, and eelgrass survival and growth have not been linked to a particular sediment type (Merkel & Associates, 1998). At Yerba Buena Island, 178 eelgrass patches were recorded, while 2,493 individual eelgrass patches were recorded at the Oakland Touchdown portion of the survey area. This difference in eelgrass coverage is likely due to presence of a large amount of shallow water habitat at the Emeryville Flats, rather than specific sediment conditions.

[1] Vegetative coverage" is the percentage of turions (eelgrass shoots) in a given area of 1/16 square meters.

The patchy, leopard-spot distribution of eelgrass observed around the SFOBB East Span is fairly typical of San Francisco Bay. This pattern is a result of environmental stresses that may vary unpredictably over time and lead to intermittent emergence or loss of eelgrass patches from an area. Typically, these dynamic eelgrass environments are strongly influenced by recruitment of new plants and mortality of older plants. Sexual reproduction may account for a portion of the plant growth within the bed. Thus, beds may be fairly diverse genetically. For such areas, the size, shape and density of eelgrass beds can be highly variable and indicative of the time between less favorable environmental conditions. The leopard-spot distribution pattern observed in the survey area is not unique to San Francisco Bay, but can be observed within marginal environments in other Bay locations as well. This pattern is typically observed at the deeper margins of eelgrass beds where light limitations preclude eelgrass growth over portions of the year or intermittently between years.

Low density of eelgrass in the project area may be the result of environmental stresses such as high turbidity. Although low density and a patchy distribution is typical of other stands in the Bay, the habitat value of the occurrences in the project area is important because of the limited distribution of eelgrass in the Bay.

2.1.2 Sand Flats

The intertidal flats north of the Oakland Touchdown have a larger grain size (> 0.6 mm) than is typical of mudflats (<0.1 mm), and are more accurately described as sand flats (Merkel 2000). The larger grain size of sand flats is due to higher wave energy. Both sand flats and mudflats are protected under the Clean Water Act, 1972 (as amended), section 404(b)(1), "Guidelines for Specification of Disposal Sites for Dredged or Fill Material", subpart E, "Potential Impacts on Special Aquatic Sites." The intertidal flats in the project area are described as sand flats to reflect their grain size.

Sand flats and mudflats are sparsely vegetated intertidal areas that occur from approximately mean lower low water (MLLW) to mean tide level (MTL). They provide protection to banks and upland shoreline from wave energy and sediment. Sand flats around San Francisco Bay provide habitat for many species of invertebrates, including diatoms, polychaetes, oligochaetes, amphipods, isopods and crustaceans. Sand flats generally have lower densities of benthic invertebrates compared to mudflats because they occur in sites with higher waver energy and more active sediment transport.

During low tide, sand flats and mudflats provide crucial foraging and roosting areas for almost one million shorebirds that utilize the Bay during the spring migration. Shorebirds present in the project area include western sandpiper (*Calidris mauri*), least sandpiper (*Calidris minutilla*), dunlin (*Calidris alpina*), long- and short-billed dowitcher (*Limnodromus griseus,* and *L. scolopaceus,* respectively), and American avocet (*Recurvirostra americana*). The longer-billed shorebirds such as long-billed curlews and whimbrels may not utilize the sand flats in the project area as frequently as nearby mudflats. This may be due to lower densities of benthic invertebrates, higher wave energy and the absence of tidal marsh along the upper margins of the sand flats (Merkel 2000). The habitat value of the sand flats in the project area is diminished by the abrupt transitions with adjacent uplands and the lack of adjacent wetland habitats. The existing shoreline adjacent to these sand flats is protected with rock riprap and the uplands are

landscaped with non-native vegetation. These characteristics reduce the potential for species to utilize the sand flats in the project area for resting, breeding and foraging.

During high tide, mudflats and sand flats provide foraging habitat for fish, including longfin smelt (*Spirinchus thaleichthys)*, staghorn sculpin (*Leptocottus armatus*), starry flounder (*Platichthys stellatus)* and leopard shark *(Triakis semifasciata)*. One of the few mammals that are occasionally present on mudflats and sand flats is the Pacific harbor seal (*Phoca vitulina*).

2.2 TYPES OF HABITAT TO BE CREATED, RESTORED, AND ENHANCED

The mitigation plan includes on-site restoration of sand flats and eelgrass beds; off-site creation of mudflats, tidal channels, and tidal marsh and enhancement of existing wetlands and uplands. This section briefly describes the habitats that will be created, restored and enhanced. Section Four presents a detailed discussion of the proposed mitigation. Figure 2-1 shows the locations of the proposed sites.

Caltrans will implement on-site restoration of sand flats and eelgrass beds at the Oakland Touchdown. Existing sand flats are bordered by rock riprap at the upper margins and open water at the lower margins. These sand flats and eelgrass beds are contiguous with mudflats that extend eastward into the Emeryville Crescent. Substrates of the sand flats and eelgrass beds are relatively coarse sands.

Off-site creation of mudflats, tidal channels, and tidal marsh, and enhancement of existing wetlands and uplands will be implemented at either the Breuner property or the Liquid Gold site. These sites are characterized by upland fill, abrupt transition zones between uplands and wetlands, and non-native ruderal vegetation. Existing fill will be removed to create topography that will support tidal marsh, mudflats, tidal channels and uplands as shown on Figure 2-2.

2.3 FUNCTIONS AND VALUES OF HABITAT TO BE CREATED/ENHANCED

The habitat to be created or enhanced at the Breuner property or the Liquid Gold site will have the potential for greater diversity and utilization by animal and plant species as compared to the affected habitats at the Oakland Touchdown area and Yerba Buena Island. Mudflats, tidal channels and tidal marsh are utilized by many of the same species for resting, foraging and breeding (Table 2-1). The habitat values are greatest when mudflats, tidal channels, tidal marsh and uplands occur in one location where they can function holistically as a complete ecosystem. Habitat creation proposed at the Breuner property or the Liquid Gold site will provide this kind of synergistic value which is not present in the project area.

The following sections describe the functions and values of the mudflats, tidal channels and tidal marsh that Caltrans will create.

2.3.1 Mudflats and Tidal Channels

A general description of the functions and values of mudflats and sand flats is provided in Section 1.4.2. Caltrans will create tidal mudflats and tidal channels at either the Breuner property or the Liquid Gold site. As shown on Table 2-1, these habitats are utilized by many species that also utilize tidal marsh habitats. The proposed mitigation will provide a complex of adjoining

intertidal habitats that will be used by many of the same species that are present on the sand flats at the Oakland Touchdown area.

A natural gradient from open water to uplands that includes mudflats and tidal channels will provide enhanced functions and values relative to the fragmented and isolated sand flats in the project area. In particular, this suite of habitats or ecosystem will benefit special status species such as the California clapper rail that utilize the ecotones (transition zones) between habitats.

The mudflats created at either the Breuner property or the Liquid Gold site will be located along the outer margins of the marsh and within tidal channels. Creating new tidal marsh and tidal channels and enhancing existing wetlands will expand the suitable habitat for the California clapper rail at the Breuner property or the Liquid Gold site.

2.3.2 Tidal Marsh

Tidal marshes are one of the most productive ecosystems in the world (Mitsch and Gosselink, 1993). Tidal marshes play a role in the tidal ecosystem as both sinks and sources of nutrients. In the San Francisco Bay, for example, net primary production of native cordgrass (*Spartina foliosa*) is between 274-1400 grams per square meter per year (Josselyn, 1983). Tidal salt marshes are prolific producers of detritus, or decomposed organic matter, which plays an important role in the food chain for both the salt marsh and the estuary itself. In a study conducted in a Georgia tidal marsh, twenty-three percent of the net productivity of the tidal marsh was exported to the estuary (Teal, 1962). Tidal marshes are also used by many species of fish for shelter and foraging and as nursery areas. Striped bass (*Morone saxatilis*), chinook salmon (*Oncorhynchus tshawytscha)*, Delta smelt (*Hypomesus transpacificus)*, longfin smelt (*Spirinchus thaleichthys*) and green sturgeon (*Acipenser medirostris*) are special status species fish which utilize various tidal salt marshes in the San Francisco Bay region.

Existing tidal marshes at the Liquid Gold site and the Breuner property are dominated by species of cordgrass (*Spartina* spp.) in the lower intertidal zone and pickleweed *(Salicornia virginica*) in the middle intertidal zone. Just above the mean water line, but still within the intertidal zone, pickleweed is frequently present with saltgrass (*Distichlis spicata*), alkali heath (*Frankenia salina*), marsh jaumea (*Jaumea carnosa*) and California sea lavender (*Limonium californicum*). Tidal marsh habitat is utilized by many of the same species that utilize tidal flat habitat and the two habitats provide similar and complementary habitat functions. Table 2-1 provides a list of species and their utilization of these habitats.

Other special status species which utilize tidal salt marshes for shelter and foraging include the salt-marsh harvest mouse (*Reithrodontomys raviventris)*, California clapper rail *(Rallus longirostris obsoletus)*, salt marsh common yellowthroat *(Geothlypis trichas sinuosa)*, Alameda song sparrow (*Melospiza melodia pusillula)*, short-eared owl (*Asio flammeus)* and salt marsh wandering shrew (*Sorex vagrans halicoetes*). California clapper rail and salt marsh harvest mouse are assumed to be present on the Breuner property based on suitable habitat and observations at the adjacent Giant Marsh site. These species are not confirmed from the vicinity of the Liquid Gold site but they may be present based on the presence of suitable habitat.

Suitable habitat is present at the Breuner property and the Liquid Gold site for special status plant species such as soft bird's beak (*Cordylanthus mollis* spp. *mollis*) and johnny-nip

(*Castilleja ambigua* ssp. *ambigua*). Salt marsh gumplant (*Grindelia stricta* var. *angustifolia*), another special status species, occurs at both the Breuner property and the Liquid Gold site.

2.3.3 Uplands

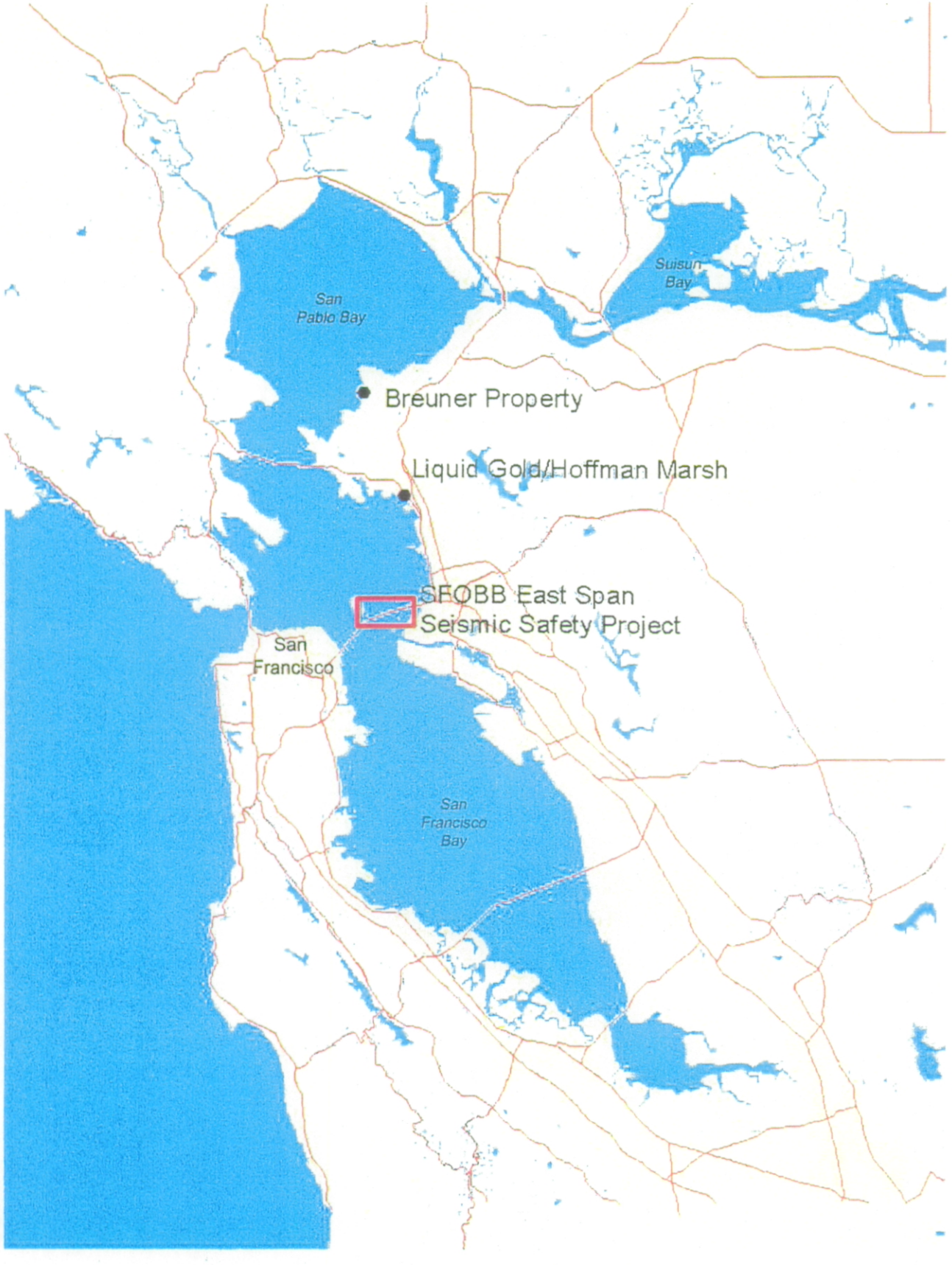
Enhanced uplands at the Breuner property or the Liquid Gold site would provide refugia and foraging habitat for tidal marsh species such as the salt marsh harvest mouse. Many portions of the Bay, including the affected special aquatic sites in the project area, are bordered by uplands that are developed or dominated by ruderal and invasive non-native species. Caltrans will enhance uplands at the selected mitigation site by removing non-native plant species and replanting native upland species including grasses and shrubs such as coyote bush (*Baccharis pilularis*). The enhanced uplands will improve the habitat value of the adjacent wetlands by creating a broad gradient of intertidal and upland habitats that offer greater capacity for species utilization compared to isolated wetlands, sand flats, or mudflats.

Table 2-1

HABITAT UTILIZATION BY SPECIES

Species	Tidal Flat	Low Tidal Marsh	Mid Tidal Marsh	High Tidal Marsh	Muted Tidal Marsh	Eelgrass
MAMMALS						
Harbor seal	RB	RF				
WATERFOWL						
Mallard	F	F		RFB	RF	
Canvasback	F				RF	
Ruddy duck	F	RFB	RFB	RFB	RF	
Shorebirds						
Marbled godwit	RF	RF	RF	RF	RF	
Black turnstone	RF	R	R	R	R	
Red knot	R	RF	RF	RF	RF	
Western sandpiper	RF	RF	RF	RF	RF	
Long-billed dowitcher	RF	RF	RF	RF	RF	
OTHER BAYLAND BIRDS						
Eared grebe	F	RF		RF		
American white pelican	R				F	
Brown pelican	R	RF			R	
Double-crested cormorant	R	RF			F	
Snowy egret	F	RF	RF	RFB	RFB	
Black-crowned night heron	F	RF	RF	RF	RF	
Northern harrier	F	F	F	RFB	RF	
Peregrine falcon	RF	RF	F	RFB	F	
California clapper rail	F	RFB	RFB	RFB	RF	
California gull	RF	F			RF	
Western gull	RF	RFB		RFB	RFB	
California least tern	RF	F	F	F	RF	
Forster's tern	RF	F	F	F	RFB	
Caspian tern	RF	F			RFB	
Belted kingfisher	F	RF			RF	
Barn swallow	F	RF	RF	RFB	RFB	
FISH AND INVERTEBRATES						
White sturgeon	F	RF				F
Striped bass	F	F	F	F		
Arrow goby	RFB	RF				
Topsmelt	FB	F	F	F		
Pacific staghorn sculpin	FB	F	F	F		FR
White croaker	F		F			
Bay ray	RF	RF				
Starry flounder	RF	F				
Longjaw mudsucker	RFB	RFB	FB	FB		
Dungeness crab	RF	RF				
Mud crab	FB	FB	RF	RF		FB
California bay shrimp	RFB	RF				FR
California horn snail	RFB	RFB	RFB	RFB		
Amphipods	RFB	RFB	RFB	RFB		RFB

Note: R=Resting/Roosting, F=Foraging, B=Breeding;
Source: Goals Project 1999.



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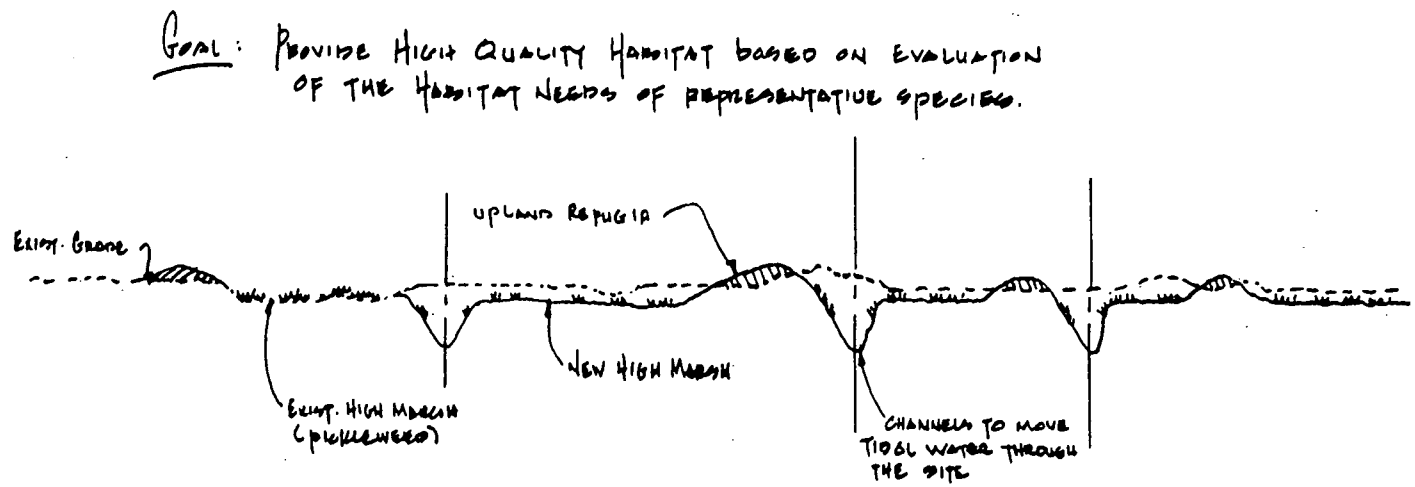
Locations of the Proposed Off-Site
Mitigation Areas

Figure 2-1



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Typical Cross Section of the Proposed Off-Site Mitigation Concept

Not to Scale

Figure 2-2

3.1 SITE SELECTION RATIONALE

Caltrans evaluated fourteen potential mitigation sites to identify locations suitable for creation or enhancement of eelgrass beds, sand flats, mudflats and tidal marsh (Figure 3-1). Caltrans consulted with the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, California Department of Fish and Game (CDFG), U.S. Fish and Wildlife Service (USFWS), the San Francisco Bay Conservation and Development Commission (BCDC) and the East Bay Regional Park District (EBRPD) regarding the suitability of these sites.

The following selection criteria were used to screen off-site locations for mitigation:

- Consistency with regional management and planning proposals for possible mitigation sites (Goals Project 1999);
- Sufficient area for habitat creation and enhancement;
- Compatibility with habitat values of adjacent wetlands and mudflats;
- Landowner cooperation; and
- Feasibility and cost of implementing mitigation.

Potential sites for tidal marsh creation were identified from a variety of sources that included local agencies, city planners, biologists familiar with the project vicinity, and the regional priority sites identified by the Baylands Ecosystem Goals Project. The Goals Project priorities were based on regional biological data on key species and habitats assembled by a consortium of public agencies, non-profit groups and private industry. Sites were selected that conformed with several ecological design principles including (Goals Project, 1999):

- Centering tidal marsh restoration, where possible, around existing populations of threatened and endangered species;
- Restoring tidal marshes along the salinity gradients of the estuary and its tributaries;
- Emphasizing tidal marsh restoration along the Bay edge and where streams enter the baylands;
- Providing natural features, such as pannes[2] and large tidal channels, within tidal marshes;
- Reestablishing natural transitions from tidal flat through tidal marsh to upland and between diked wetlands and adjacent uplands; and
- Providing undeveloped buffers on adjacent lands to protect habitats from disturbance.

Indicators of wetland ecosystem health, including nutrient cycling, flood control and water quality are expected to improve if the regional recommendations of the Baylands Ecosystem Habitat Goals are implemented. Table 3-1 is a matrix of the sites that Caltrans evaluated during the site selection process. The Baylands Ecosystem Goals Project has identified several sites throughout the San Francisco Bay that could be restored to their historical habitat (Goals Project 1999, Appendix E). Restoration of these sites will improve the health and diversity of the San

[2] Pannes are natural ponds that form in the marsh plain and fill only during very high tides.

Francisco Bay ecosystem and could also provide necessary habitat for some of the endangered species in this region. Each site is numbered with a short description of the restoration potential of the site as described in Appendix E of the Baylands Ecosystem Habitat Goals. The site numbers from the Baylands Ecosystem Goals Project list are included in Table 3-1.

Caltrans investigated potential mitigation sites in the vicinity of the project area. Most were not considered feasible for the reasons discussed below. The Breuner property and the Liquid Gold site were the only options with sufficient area within central San Francisco Bay that meet the mitigation needs of the project. Moreover, the Breuner property is the only site with a landowner that currently intends to use its site for habitat creation and enhancement. Therefore, the Breuner property is Caltrans preferred mitigation site.

Sites immediately adjacent to the project area and the Emeryville Crescent were rejected because the land is unavailable or lacks adequate size for the required mitigation. These sites include:

- **Radio Point**: the Radio Point site is located immediately north of the Bay Bridge Toll Plaza, less than 160 meters (525 feet) from the project area. The Port of Oakland currently owns the land and may use it for its own mitigation needs.
- **West Grand Avenue**: the West Grand Avenue site is located north of the new West Grand Avenue overpass at Interstate 80, just east of the Bay Bridge Toll Plaza. This site is partially owned by the Port of Oakland and the State of California. The portion of this site that is owned by the State of California is managed by EBRPD as part of the Eastshore State Park. Caltrans previously used part of the site for mitigation.
- **Oakland Touchdown**: the Oakland Touchdown site is located where the existing Bay Bridge touches land in Oakland. This property is located on Caltrans right-of-way within the project area. It will revert to the Port of Oakland if Caltrans declares it excess to transportation needs. EBRPD has expressed interest in this land becoming part of the proposed Gateway Park.

Several potential sites north of the project area within Eastshore State Park are managed by the EBRPD. EBRPD will develop a long-range development plan for the Park to identify potential recreational uses and improvements, including habitat creation and enhancement. However, the planning process, which will include extensive public participation, will not be completed until 2001 at the earliest. Until the planning process is completed, EBRPD cannot make commitments for habitat creation or enhancement on these lands. EBRPD's timeline is not in accord with the plans for the East Span Project; therefore these sites were eliminated from consideration as potential mitigation sites. These sites included:

- **Brickyard Cove**: the Brickyard Cove site is located south of University Avenue, and west of the frontage road on the west side of Interstate 80 in the City of Berkeley. The EBRPD manages Brickyard cove as part of the Eastshore State Park complex, but the State of California owns the property.
- **Berkeley Meadows/Virginia Street**: the Virginia Street site is located north of University Avenue and west of the frontage road on the west side of Interstate 80 in the City of Berkeley. The EBRPD manages the Virginia Street site as part of the Eastshore State Park complex, but the State of California owns the property.

Potential mitigation sites at and near the City of Albany's former landfill were identified. However, these sites are too small to meet Caltrans' mitigation needs. Moreover, the City of Albany has received funds from the State of California to restore Albany Bulb and Albany Beach. This precludes the use of these sites by Caltrans for mitigation purposes.

- **Buchanan Marsh**: the Buchanan Marsh site is located in the City of Albany south of Buchanan Street and west of Interstate 80. Magna Entertainment, owner of the adjacent Golden Gate Fields Race Track, owns this property.
- **Albany Bulb and Beach**: the Albany Bulb and Beach are located northwest of Golden Gate Fields racetrack, west of Interstate 80, near the terminus of Buchanan Street. The City of Albany owns these parcels and plans to restore them.

3.2 RATIONALE FOR OUT-OF-KIND MITIGATION FOR SAND FLATS

Sand flats permanently impacted during construction will be mitigated by the off-site creation of a tidal marsh ecosystem including tidal channels and mudflats. Caltrans evaluated options for in-kind replacement of permanently impacted sand flats at or near the project site. Although it is desirable to mitigate sand flat impacts with in-kind replacement, Caltrans has concluded that this option is not feasible on the scale required for the proposed project. This conclusion was based on the difficulty in finding sufficient and suitable land at or near the project site for creation of this type of habitat. However, Caltrans does propose on-site restoration of sand flats.

Creation of sand flat habitat is constrained by several factors. First, sand flats are a transitional intertidal habitat. Water permanently borders the lower edge of the sand flat while the upper end of the sand flat transitions to tidal marsh or directly to uplands. There are two options for creation of new sand flats: 1) extend the sand flat at the lower edge; or 2) extend the sand flat at the upper edge. Extending the sand flat at the lower edge is feasible, but not desirable, because it requires filling open water to create appropriate intertidal elevations. Extending the sand flat at the upper margin is desirable only if the sand flat is bordered directly by uplands. Otherwise it is necessary to excavate wetlands or other jurisdictional habitat.

If the sand flat is bordered directly by uplands, the sand flat can be extended on the landward side by excavating the uplands. The uplands need to be excavated to a sufficient depth to prevent colonization by tidal marsh species. But the upper end of the existing sand flat is generally just slightly lower than the lower limit of tidal marsh species. This leaves very little freeboard with which to construct the new sand flats. It is likely that the created sand flats would quickly fill with sediment and become colonized by tidal marsh species. One possible solution, creating long strips of narrow sand flats, is not feasible because there are no sites in the project vicinity with sufficient shoreline available.

3.3 RATIONALE FOR OUT-OF-KIND MITIGATION FOR EELGRASS

Creation of eelgrass habitat is still experimental in the Bay, and the success rate for such projects varies depending on what method is used (Merkel & Associates, 1998). The Richmond Harbor Training Jetty Eelgrass Transplant Program, which was completed in 1985, was among the first transplant programs in the Bay Area. Eelgrass was transplanted to an unmanipulated site. The survival of the plants was mixed, depending on the location and age of the donor material. The eelgrass in the control and transplant areas did not expand their range in the spring and summer

of the transplant year. Based on the experience of this project, Merkel concluded that in the Bay sites specifically manipulated for eelgrass transplantation may be more successful (Fredette et al, 1988; Merkel & Associates, 1998). The habitat in the San Francisco Bay is sufficiently different that available data from southern California is not readily transferable to this area.

Despite these challenges, Caltrans proposes on-site eelgrass mitigation. The proposed approach will maximize the potential for planting success by incorporating site manipulation, monitoring and data collection. These measures are described in Section Four. However, due to the experimental nature of eelgrass mitigation, Caltrans will also implement off-site mitigation in the form of a tidal marsh ecosystem (out-of-kind mitigation). Tidal marsh creation and enhancement have historically been more successful than eelgrass transplantation and are identified by the Goals Project as a priority for the eastern portion of the central Bay.

Table 3-1

SUMMARY OF HABITAT MITIGATION SITES EVALUATED BY CALTRANS

Goals Project Site No.	Site	County	Total Estimated Area (Acres)	Owners	Site Conditions	Mitigation Potential/Area (Acres)				Opportunities/Constraints
						Upland Enhancement	Mudflat/ Channel Creation	Tidal Marsh Creation	Eelgrass Planting	
57	Breuner Property	Contra Costa	90-100	Bay Area Wetlands, L.L.C.	Upland fill, tidal marsh, seasonal wetlands	0.9	1.8	8.5		Remove upland fill to create tidal marsh, tidal channels, and transition zone habitats. Approximately 48 acres of the land were available, but 12 acres are now under contract.
86	Liquid Gold/ Hoffman Marsh	Contra Costa	47	Southern Pacific and EBRPD	Undeveloped fill, tidal marsh, seasonal wetland	12.8	1.0	15.2		Remove upland fill to create tidal marsh. Restore native upland vegetation. Approximately 18 upland acres of the site was a former superfund site, but has since been remediated.
N/A	Oakland Touchdown	Alameda	1.5-2	Caltrans	Upland fill, landscaped uplands	0.3	0.1	0.5	X (adjacent areas)	This property will revert to the Port of Oakland if Caltrans declares it excess to transportation needs. Upland fill would be removed to create tidal marsh, channels, and transitional habitats.
80	Radio Point	Alameda	6.9	Port of Oakland	Developed and landscaped upland fill, sandy beach, sand dunes	0.8 (uplands) 0.5 (dunes)	0.6	1.3	X (adjacent areas)	The Port of Oakland may use this site for its own mitigation needs. Mitigation opportunities include enhancement of the existing marsh by removing the buildings and parking lot presently on site, restoration of the tidal marsh and sandy beaches as well as *Spartina alterniflora* eradication. The feasibility of eelgrass transplantation needs to be assessed.
80	West Grand Avenue Overpass	Alameda	0.5	Caltrans/ East Bay Regional Park District (EBRPD)	Upland fill, rock-reinforced shoreline	0.9		1.0		This parcel borders tidal marsh. Upland fill can be removed for restoration and non-native upland vegetation removed and planted with native upland species.
81	Brickyard Cove	Alameda	Unknown	State of California; managed by EBRPD	Upland habitat on artificial fill, small tidal marsh, rubble rip-rap shoreline	6.0	1.0	2.2		Non-native species from upland and wetland habitats can be removed. Remove upland fill to create transition zone habitats, tidal mash, and mudflats. The EBRPD must finalize its planning process before mitigation plan can be finalized.
82	Berkeley Meadows/ Virginia Street	Alameda	20-30	State of California; managed by EBRPD	Upland habitat on artificial fill, seasonal wetlands, rubble rip-rap shoreline	6.0	3.6	8.6		Remove rock slope protection and upland fill to create a transition zone between tidal and upland habitats. Restore lower reach of Schoolhouse Creek at confluence with Bay. The EBRPD must finalize their planning process before mitigation plan can be finalized.

Table 3-1

SUMMARY OF HABITAT MITIGATION SITES EVALUATED BY CALTRANS

Goals Project Site No.	Site	County	Total Estimated Area (Acres)	Owners	Site Conditions	Mitigation Potential/ Area (Acres)				Opportunities/Constraints
						Upland Enhancement	Mudflat/ Channel Creation	Tidal Marsh Creation	Eelgrass Planting	
83	Buchanan Marsh	Alameda	4.15	Magna Entertainment	Tidal marsh with adjacent upland fill	1.85		2.3		Replace culverts and remove fill and debris. Restore upland-wetland transition zone and remove non-native species. There is potential to expand the marsh into the Golden Gate Field corporation yard.
84	Albany Beach	Alameda	3.36	City of Albany	Beach dunes	1.46 (dune) 1.1 (upland)		0.8 (brackish marsh)		Existing dune and brackish marsh habitats. Dominated by non-native species with narrow transition zone. Remove non-native species and replace with natives. Owned by City of Albany.
84	Albany Bulb	Alameda	31	City of Albany	Isolated lagoon surrounded by breakwater		6.1 (outer) 1.4 (inner)		X	Remove section of breakwater to restore tidal flow and create tidal marsh and mudflat. The City of Albany will receive $637,000 in state funds to breach the levees and restore some tidal marsh and aquatic habitat.
51	Hamilton Air Force Base	Marin	900	State Lands Commission	Diked marsh			26 (3% of total)		Approximately 93,000 m^3 (122,000 cy) of dredged material from the project area may be provided for tidal marsh restoration. The Hamilton AFB site will require approximately 4.2 million cubic yards of dredged material. This project would provide 3 percent of that total.
N/A	Robert's Landing	Alameda	50	State Lands Commission, City of San Leandro	Tidal marsh, mudflat	2.1 (uplands) 1.8 (dunes)				Stable dune system could be enhanced and re-established with native vegetation. *Spartina alterniflora* is present and could be removed, enhancing the existing mudflat.
N/A	Treasure Island	San Francisco	40	U.S. Navy	Developed fill			9		Thirty-one out of 40 acres are planned for a wastewater treatment marsh. The San Francisco Board of Supervisors has approved wetlands in the overall plan. EIR/EIS for the Island is currently being written.
N/A	Martinez Regional Shoreline Park	Contra Costa	unknown	EBRPD	Tidal marsh			X		Caltrans, EBRPD, and the City of Martinez will enhance the quality of the marsh, provide flood hazard reduction and provide Delta smelt habitat in the shallow water tidal area as mitigation for the Carquinez Bridge Project. Units 6,7 and 8 can still be restored to tidal marsh.

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Locations of Potential Mitigation Sites Evaluated by Caltrans

Figure 3-1

4.1 SUMMARY OF PROPOSED MITIGATION

The proposed mitigation emphasizes avoidance and minimization of impacts in the project area. Potential impacts to wetlands, sand flats and eelgrass will be avoided by designating special aquatic sites as ESAs on the plans and specifications and physically delineating them on-site in the construction zone. Additional impacts to eelgrass and sand flats will be minimized by on-site restoration following completion of construction. Eelgrass test plots will be created on-site and monitored to determine the best methods for eelgrass transplantation in the portion of the barge access channel that currently supports eelgrass. Portions of this channel may be restored to the original depths using coarser grained sediment on the top, and replanted with eelgrass. In addition, the sand flats affected during construction of the new bridge approach will be restored to their original profile and substrate.

In addition to the on-site avoidance and minimization measures, Caltrans will implement off-site mitigation. This involves creation of a fully functional tidal marsh ecosystem including new mudflats, tidal channels and tidal marsh, and enhanced wetlands and uplands. Caltrans will provide approximately 4.73 hectares (11.70 acres) of off-site mitigation to compensate for permanent and temporary impacts to eelgrass and sand flats. This will result in a mitigation ratio of approximately three to one. Caltrans will provide an additional 0.38 hectares (0.94 acres) of tidal marsh habitat to address Bay fill impacts associated with the San Francisco Bay Conservation and Development Commission's (BCDC) regulatory requirements. This is reflected in the totals shown on Figure 4-2.

The three to one ratio is a valid replacement ratio given that the replacement mitigation will be of a higher value than what is currently found at the Oakland Touchdown area. The existing habitats are not bordered by complementary habitats that provide important transitional zones and structural diversity for wildlife. The off-site habitat creation and restoration proposed by Caltrans will create a natural gradient between open water, mudflats, tidal marsh and upland habitats typical of high value shoreline habitat.

4.2 AVOIDANCE AND MINIMIZATION

4.2.1 Sand Flats

To minimize impacts to sand flats at the Oakland Touchdown area, Caltrans will place geotextile fabric and plywood onto the sand flats before placing a geotube for temporary dewatering, installation of wick drains and placement of engineered fill for the westbound roadway A "geotube" is a large, high density polyethylene tube filled with excavated material used as a temporary tidal barrier during construction.

4.2.2 Eelgrass

Construction in the vicinity of eelgrass beds will be tightly controlled to minimize temporary impacts caused by increased turbidity. Controls will include turbidity curtains, limitations on barge and tug maneuvering and post-construction monitoring to evaluate effects of turbidity on eelgrass. Construction controls and ESAs will be added to project plans, specifications, and estimates to further minimize construction period impacts. Caltrans will mark the ESA in the

field during construction with buoys or similar devices to keep construction activities outside the beds. This ESA will apply to those beds located outside the direct construction zone.

4.2.3 Wetlands

Construction controls and ESAs will be shown on project plans, specifications, and estimates to avoid construction period impacts. Caltrans will place exclusion fencing around all non-tidal wetlands in the project during construction to keep construction activities outside of the wetlands. Caltrans will also delineate tidal wetlands in the field with buoys or similar devices to prevent construction period impacts.

4.3 EELGRASS MITIGATION

No sites in the Bay have been manipulated for eelgrass transplantation and accordingly there is no available data from the Bay about the factors in success or failure of eelgrass transplantation. Therefore, Caltrans proposes eelgrass mitigation to include:

- Harvesting eelgrass from the barge access channel prior to construction and planting it in test plots adjacent to the project area north of the Oakland Touchdown. Caltrans will design these plots to identify a successful methodology for transplanting eelgrass in the restored barge access channel. In addition, the test plots will generate additional data for eelgrass transplantation in the Bay since this information is limited.
- Restoring a portion of the barge access channel that was vegetated with eelgrass to facilitate colonization of eelgrass or possibly transplanting the access channel with eelgrass from an adjacent area. Eelgrass is prolific and grows easily where suitable habitat exists. The probability that eelgrass will recolonize an area where it once grew is high if the conditions are suitable (Merkel 2000). Replanting the site before natural colonization occurs may expedite the process.

Caltrans will harvest eelgrass from within the barge access channel prior to dredging it and transplant it in adjacent areas outside the construction zone. These eelgrass test plots will be established north of the Oakland Touchdown area to determine appropriate planting strategies to restore the barge access channel. Only one transplantation of eelgrass has occurred in the Bay, at the Richmond Harbor Training Jetty in 1985. The site was not manipulated and the results were unsuccessful. Unmanipulated sites have a 38.2% success rate (Merkel & Associates, Inc., 1998). The eelgrass coverage at the unmanipulated sites may depend more upon whether the dynamic beds are contracting or expanding at the time of the transplants than upon transplanting itself (Merkel 2000; Merkel & Associates, Inc., 1998). "Such transplants performed while a native bed is contracted in its distribution may be successful, but in fact, the transplant does little for the overall status of the resource since a natural expansion phase in the native bed would render the same results (Merkel & Associates, 1998)."

Because of the dynamic nature of eelgrass beds, test plots will provide additional data on methodologies to create and enhance existing eelgrass beds in the Bay. The plots will contain at least one control plot adjacent to but not affected by the project, in addition to plots that have been manipulated to increase eelgrass success. Manipulations in the test plots may include experimenting with the type of planting unit employed (i.e. bare root or sediment plug), planting depth, substrate grain size, and the microtopography of the surface sediment, among others.

Caltrans will monitor for temporary impacts of turbidity due to dredging, pile driving, prop wash and mud boils. If additional eelgrass beds have been affected during construction, Caltrans will consult with the permitting agencies to determine if additional mitigation is warranted. Caltrans will restore up to approximately 0.70 hectares (1.73 acres) of the barge access channel to its original bathymetry where eelgrass currently exists. The restoration will occur following construction. Dredge material from the project site suitable for in-Bay disposal will be stockpiled and used to fill and restore the barge access channel to suitable depths for eelgrass colonization. A cap of sand, obtained from the affected sand flats, will be placed on top of the dredged material to provide an appropriate substrate for eelgrass. The restored channel outside the area shadowed by the westbound bridge structure may be replanted with eelgrass. Replanting depends upon the availability of an adequate donor site and the demonstrated success of the transplanted eelgrass described above.

Caltrans has not yet determined the costs for eelgrass test plots and restoration of portions of the barge access channel. In addition to on-site mitigation measures, Caltrans will provide out-of-kind mitigation to offset the remainder of the eelgrass impacts by creating a new tidal marsh ecosystem as described in Section 4.4.1.

4.4 SAND FLAT MITIGATION

Sand flats are difficult to create in areas where they have not been historically present. This is because sand flats are a complex balance of sediment deposition and erosion that is influenced by the physical, chemical and biological properties of the sediment as well as by wave energy and currents. For sand flats to sustain this balance, it is vital that the wave energy is strong and frequent enough to prevent the establishment of tidal marsh vegetation such as cordgrass. Otherwise, sedimentation will occur and vegetation will convert a newly created sand flat into a tidal marsh.

Due to the low potential for success in artificially establishing this balance, Caltrans will provide out-of-kind mitigation for sand flat impacts, by creating new mudflats, tidal channels and tidal marsh. As part of the tidal marsh ecosystem, approximately 1.54 hectares (3.80 acres) of mudflat habitat will be created along the margins of tidal channels and at the outer margins of restored tidal marsh. Tidal channels are utilized as foraging and roosting areas during low tide by many of the same shorebird and seabird species typical of sand flats and mudflats. Additionally, tidal channels are used by California clapper rails during low tide for transit, roosting and foraging. Mudflat creation will require grading upland to the intertidal zone and depositing fine sediment on the surface. Two alternate sites are proposed for mudflat, tidal channel and tidal marsh creation, and enhancement of existing upland habitats and wetlands.

4.4.1 Creation of Tidal Marsh Ecosystem

The Breuner property is Caltrans preferred location for creation of a tidal marsh ecosystem. This preference is based on the availability of the land for mitigation and the site selection criteria outlined in Section Three. The Breuner property and the Liquid Gold site are described below. If the Breuner property were unavailable, tidal marsh, tidal channel and mudflat creation and enhancement would be implemented at the Liquid Gold site.

Breuner Property

The Breuner property is located approximately 18 kilometers (11 miles) north of the project area in Richmond, California, west of Interstate 80 and north of the Richmond Parkway (Figure 4-1). The Baylands Ecosystem Habitat Goals Project (1999) recommended the creation of tidal marsh at this property as a conservation goal in the Contra Costa West segment of the plan.

The property is controlled by Bay Area Wetlands, L.L.C. (BAW), a privately owned company founded in 1999 to acquire, develop and manage properties for their ecological and development potential. Bay Area Wetlands operates the property as a third party mitigation bank. It is not a formal mitigation bank and BAW does not have mitigation credits available for purchase. Instead, habitat restoration is implemented on an as-needed basis. Mitigation needs are assessed annually and implemented each fall.

The Breuner property has approximately 19.4 hectares (48 acres) of upland on bay fill, intermixed with seasonal and tidal wetlands. Caltrans will create 4.73 hectares (11.70 acres of tidal marsh. The property is contiguous with Giant Marsh, a tidal marsh located in EBRPD's Point Pinole Regional Park (Figure 4-2). Because the new tidal marsh will be contiguous with Giant Marsh, it will provide a greater benefit for tidal marsh species than if the same area of habitat was created in isolation. Giant Marsh will be used as a template for the development of the Breuner marsh and will provide a seed source. Examples of the marsh topography, channel dimensions, species composition and cover can be directly applied to the restoration plan on the Breuner property.

Presently, the upland portions of the Breuner property are dominated by ruderal herbaceous vegetation growing on fill. Typical species are non-native and include yellow fennel (*Foeniculum vulgare*), yellow star thistle (*Centaurea solstitialis*), prickly lettuce (*Lactuca seriola*) and wild oats (*Avena barbata*). Seasonal wetlands and some muted[3] tidal wetlands are present on the property.

Vegetation within the muted tidal marsh includes pickleweed (*Salicornia virginica*), alkali heath (*Frankenia salina*), jaumea (*Jaumea carnosa*), California sea-lavender (*Limonium californicum*), saltgrass (*Distichlis spicata*) and California cordgrass (*Spartina foliosa*).

Mitigation options at the site include:

- Removing upland fill to create a tidal marsh ecosystem including mudflats, tidal channels, tidal marsh, and wetland-upland transitional habitats, and enhance existing upland habitats and wetlands (Figure 2-2). Approximately 4.73 hectares (11.70 acres) of tidal marsh could be created at this site. This total includes 0.73 hectare (1.8 acres) of mudflats, 0.81 hectare (2.0 acres) of tidal channels, 3.21 hectares (7.94 acres) of tidal marsh and 0.36 hectares (0.90 acres) of enhanced uplands; and
- Enhancing hydrology and vegetation composition of existing seasonal wetlands and muted tidal marsh.

[3] Muted tidal marshes receive less than full tidal flow because of a physical impediment. At the Breuner property full tidal flow is excluded from portions of the site adjacent to the railroad embankment by intervening fill.

The estimated cost of mitigation at the Breuner property is approximately two million dollars for 4.73 hectares (11.70 acres). This estimate includes acquisition of the mitigation rights, fill removal, grading, planting and monitoring.

Liquid Gold

The Liquid Gold site consists of approximately 7.3 hectares (18 acres) of a 12.0 hectare (29 acre) property owned by Southern Pacific Transportation Company (SPTCo) in south Richmond, Contra Costa County (Figure 4-3). The Liquid Gold site is located approximately 10 kilometers (6 miles) north of the project area. Hoffman Marsh borders the site to the east and southeast; tidal channels connect to San Francisco Bay border the site to the west and southwest. As with the Breuner property, the healthy tidal marsh adjacent to the Liquid Gold site can act as a template for the new marsh and serve as a seed source.

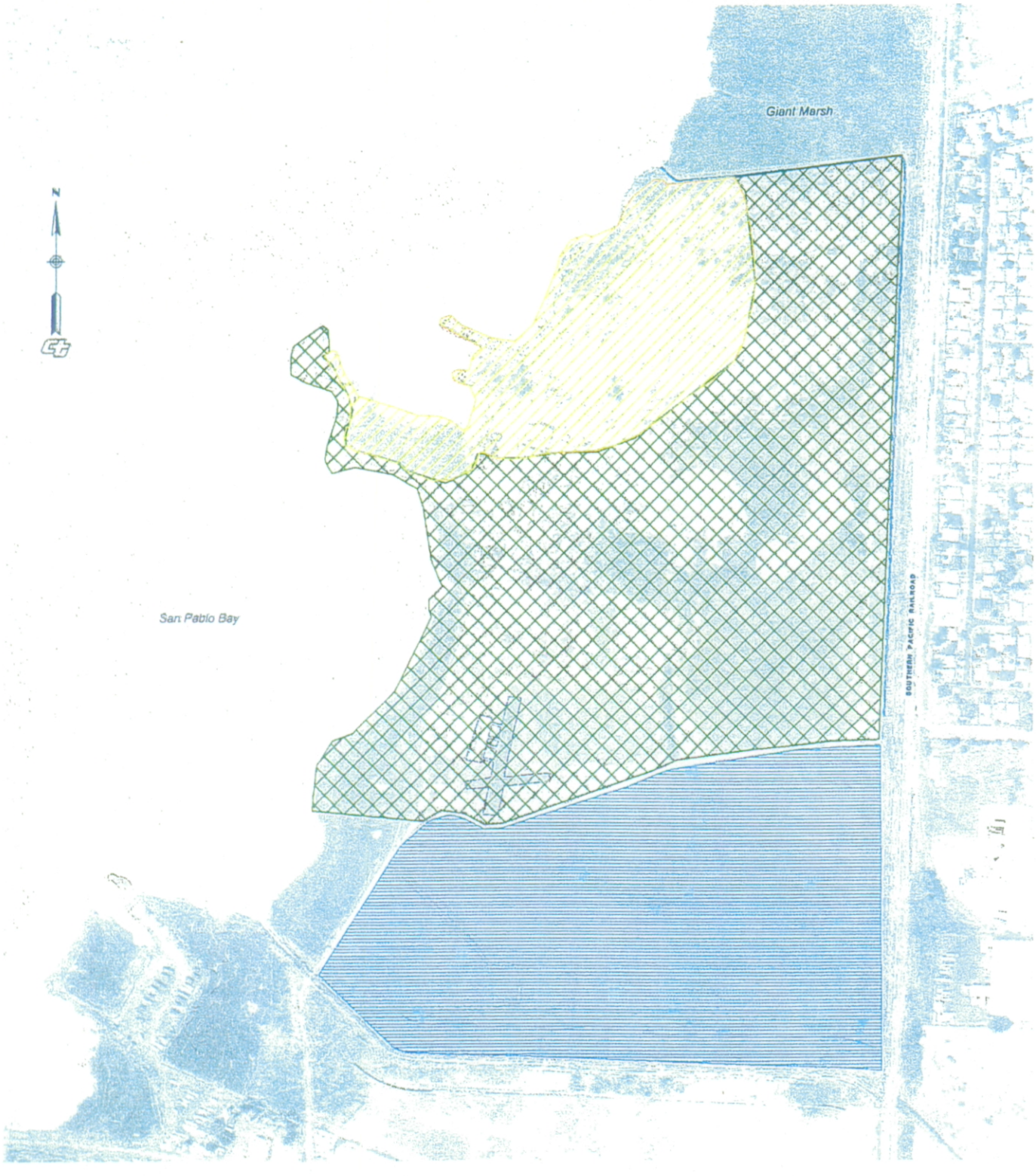
Originally, a major portion of the property was marshlands that were filled in the 1940s and 1950s. SPTCo leased approximately 1.2 hectares (3 acres) of the site to an asphalt manufacturing plant and later to a waste oil storage and transfer facility that operated under the name of Liquid Gold Oil Corporation. From 1965 to 1980, Liquid Gold Oil Corporation operated a used oil and solvent collection, storage and transfer facility on the site. In 1983, Liquid Gold Oil ceased operations. Over the next several years, 27 storage tanks were removed, buildings were demolished and contaminated soil was removed for off-site disposal.

The final clean-up actions for the entire site included capping the remaining contamination and excavating portions of the adjacent wetlands. Clean-up activities were completed in 1995. SPTCo continues to monitor the cap and the groundwater. The site was deleted from the National Priorities List (NPL) list in September 1996. The NPL constitutes Appendix B of 40 CFR part 300 which is the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), which EPA promulgated pursuant to Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA) (EPA, Federal Register #47825).

The upland fill is dominated by coyote bush (*Baccharis pilularis*), gumplant (*Grindelia camporum*), and ruderal upland species including yellow fennel (*Foeniculum vulgare*) and wild oats (*Avena barbata)*. Steep slopes around the margins of the fill create an abrupt transition zone with the adjacent tidal marsh habitat that is dominated by pickleweed (*Salicornia virginica*).

Mitigation options at this site include removing upland fill to create a tidal marsh ecosystem including mudflats, tidal channels, tidal marsh, and wetland-upland transitional habitats, and enhance existing upland habitats and wetlands (Figure 2-2). Approximately 4.73 hectares (11.70 acres) of tidal marsh could be created at this site. This total includes 0.73 hectare (1.8 acres) of mudflats, 0.81 hectare (2.0 acres) of tidal channels, and 3.21 hectares (7.94 acres) of tidal marsh and 0.36 hectares (0.90 acres) of enhanced uplands; and

Estimated costs to implement this mitigation at the Liquid Gold site are three to five million dollars for acquisition and approximately one million dollars for fill removal, grading, planting and monitoring.



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Breuner Property Land Use Plan

Not to Scale

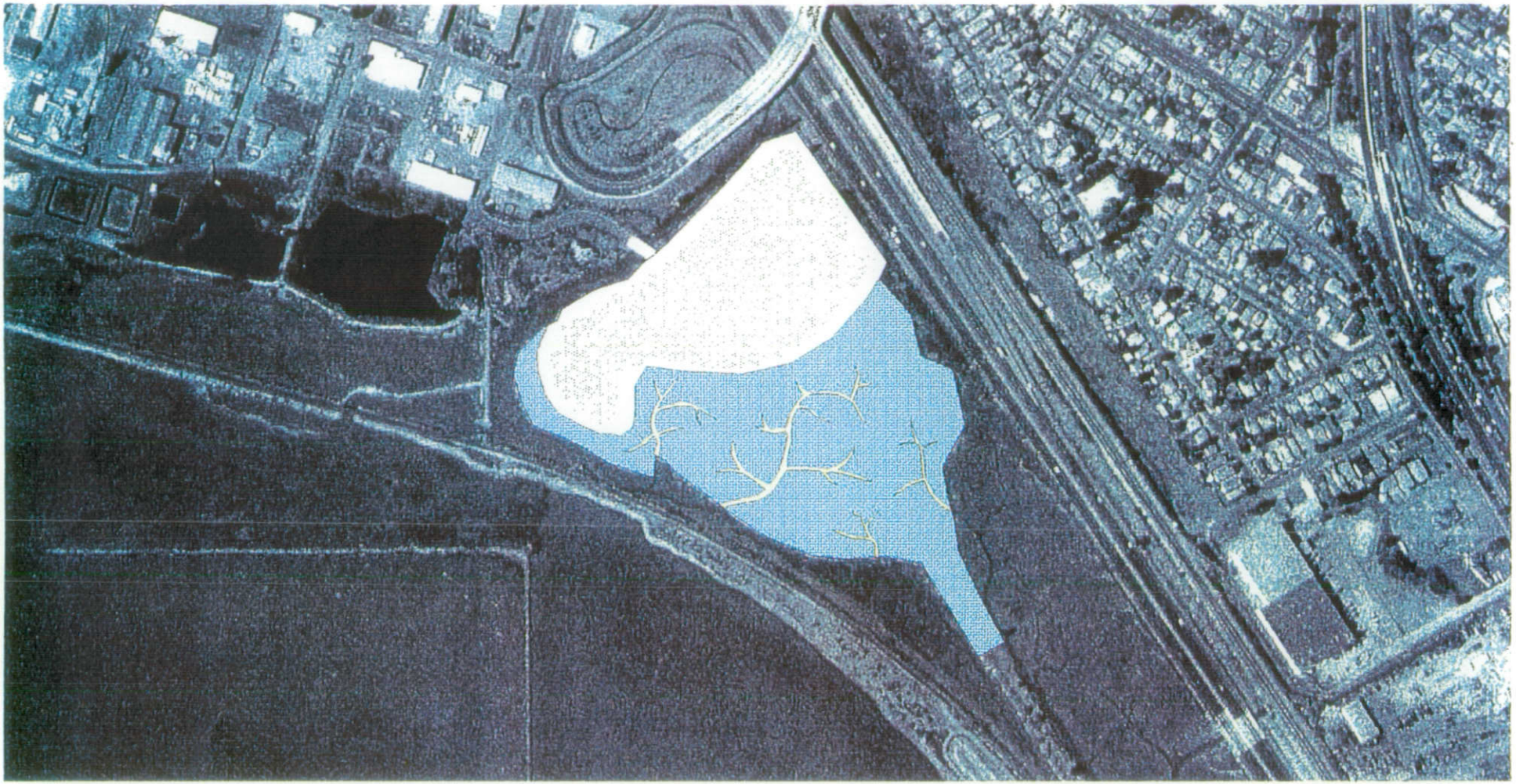
Figure 4-1

SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Conceptual Plan for the Proposed Mitigation at the Breuner Property

Not to Scale

Figure 4-2



SFOBB
EAST SPAN
SEISMIC SAFETY
PROJECT

Conceptual Plan for the Proposed Mitigation
at the Liquid Gold Site

Not to Scale

Figure 4-3

5.1 EELGRASS MITIGATION

Caltrans will implement eelgrass mitigation before or concurrently with project construction. On-site eelgrass mitigation consists of two major components. First, Caltrans will harvest eelgrass from the location of the barge access channel. This eelgrass will then be transplanted in adjacent eelgrass beds outside the direct impact zone. These plots will be monitored to determine success and evaluate planting methodology.

Second, sediment dredged from the barge access channel and sand excavated from the sand flats will be stockpiled to restore a portion of the channel after construction. Immediately after construction is completed, Caltrans will restore to its original bathymetry up to approximately 0.70 hectares (1.73 acres) of the barge access channel where eelgrass beds existed prior to dredging to facilitate colonization by eelgrass. Depending upon the success of the test plots, eelgrass will be transplanted to the site of the original beds using either sediment plugs or the bareroot method. Transplanting will begin in the fall. Merkel and Associates (1998) and Fredette et al (1988) have recommended planting in the fall in the San Francisco Bay due to the higher growth rates in the Bay at this time of year.

Transplanting eelgrass in San Francisco Bay has had mixed results. Zimmerman et al (1995) successfully transplanted eelgrass in the Bay, but other attempts have failed due to poor site location, plant selection, or planting methods. Merkel and Associates (1998) have comprehensively reviewed the eelgrass restoration projects along the West Coast, recommending techniques that have proved successful in the past. The factors that Hanson (1999) recommends for successful transplantation can be met for this project. These recommendations include:

- Conducting a survey to assess the physical conditions of the site, including pilot plantings, before beginning a project;
- Evaluating light availability to ensure that it is adequate for successful eelgrass survival;
- Using stocks for transplanting that are from a site ecologically similar to the transplant site;
- Limiting planting to areas with small tidal ranges to provide greater light availability;
- Utilizing areas where the parameters for deeper vertical distribution are available. This makes the bed less vulnerable to adverse conditions due to availability of energy from deeper shoots; and
- Planting in fall.

5.2 SAND FLAT MITIGATION

To minimize impacts to sand flats at the Oakland Touchdown area, Caltrans will place geotextile fabric and plywood onto the sand flats before installing a geotube After construction, the geotube will be removed and approximately 0.69 hectares (1.70 acres) of the site will be restored to its original bathymetry. The new rock slope protection along this section of the shoreline would be keyed below the existing grade to allow natural deposition of sediment to establish pre-existing conditions in portions of the sand flats temporarily affected by the placement of the geotube. The embankment where the rock slope protection will be placed will have a gradient of 1:3 (V:H) at the toe of the slope and transitioning to a 1:2 gradient at mid-slope to minimize scouring impacts.

The rock slope protection areas will then be capped with soil above the limits of tidal action to provide a medium to support growth of native upland plants and high marsh plants.

The remaining impacts to sand flats will be mitigated by out-of-kind replacement with creation of tidal marsh ecosystem. Implementation of this mitigation is described below.

5.2.1 Tidal Marsh Creation and Enhancement

To minimize temporary impacts, creation of a tidal marsh ecosystem at the Breuner Property or the Liquid Gold site will occur before or concurrently with construction.

At either the Breuner property or the Liquid Gold site, Caltrans will remove upland fill and will grade the tidal marsh areas to elevations between mean lower low water (MLLW) for mudflats and channels and mean higher high water (MHHW) for the upland transition zone. This will allow for daily or intermittent tidal inundation. New primary and/or secondary channels may be created or smaller channels will be allowed to develop naturally. Native wetland and upland vegetation will be planted at the site at elevations appropriate to the species.

The Breuner property and the Liquid Gold site present ideal opportunities for wetland restoration because they are located adjacent to high quality tidal marsh areas. The adjacent marsh areas, Giant and Hoffman marshes, respectively, will result in greater habitat values for the restored marsh habitats. Larger blocks of habitat are less affected by short-term disturbances, support greater diversities of species and are utilized by larger numbers of species. No water control structures will be required because both sites have excellent connections to the Bay and can be graded to the appropriate elevations to meet the desired mix of habitats.

Caltrans will implement mitigation monitoring to evaluate success, identify problems and implement corrective measures as needed. The following monitoring methodology will be developed in greater detail with the development of the detailed mitigation plans.

6.1 ON-SITE AVOIDANCE AND MINIMIZATION MEASURES

Caltrans will implement monitoring for all on-site avoidance and minimization measures. Construction monitoring will evaluate the following parameters:

- Placement of a geotextile fabric and plywood beneath the geotube and removal of the geotube after construction;
- Detailed bathymetry of the barge access channel before dredging to establish elevations for restoration of eelgrass beds after construction;
- Enforcement of wetland and eelgrass avoidance including maintenance of ESA markers and fencing; and
- Removal of all temporary construction access structures (e.g. trestles).

6.2 TIDAL MARSH AND MUDFLAT CREATION AND ENHANCEMENT

The monitoring plan for the Breuner Property or Liquid Gold site, depending on which site is selected as project mitigation, will include:

- Vegetation monitoring to determine cover, species composition and survival of individual plantings;
- Hydrological monitoring to determine extent of inundation, channel depth, channel cross-sectional area, sedimentation rates and other identified parameters as needed;
- Photodocumentation of the mitigation site at designated locations;
- Monitoring for special status species (e.g. salt marsh harvest mouse); and
- Ornithological monitoring to document bird density and diversity in the area, including special status species such as the California clapper rail and black rail.

Newly created and restored wetland areas will be monitored for five years.

6.3 EELGRASS MITIGATION

Pre- and post-construction data will be collected for the eelgrass site for comparison after the mitigation has been completed. The monitoring program will include measurement of the density of the eelgrass beds. Modified hydrolab(s) that measure light irradiance (photosynthetically active radiation, or PAR), turbidity, depth, salinity and temperature will be placed above the eelgrass beds (Langis et al. 1999). These will measure the relationship between light availability (PAR) and the estimated hours of irradiance-saturated photosynthesis (H_{sat}) necessary for maintenance and growth. The average H_{sat} values will be calculated from the PAR measurements and compared to the H_{sat} values necessary to sustain the health of the eelgrass.

6.4 MAINTENANCE DURING MONITORING PERIOD

Caltrans will be responsible for routine maintenance during the monitoring period. Sand flat maintenance will include clearing the area of any debris that may be deposited on the restored area. Tidal marsh maintenance activities will include replacing failed plantings, removing non-native species, watering as needed, installing browse protection for vegetation or other measures to facilitate success of the restored wetlands.

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APPENDIX O
MEMORANDUM OF AGREEMENT

Memorandum of Agreement

Among
the Federal Highway Administration,
the United States Coast Guard,
the California State Historic Preservation Officer
and the Advisory Council on Historic Preservation
For the San Francisco Oakland Bay Bridge East Span Seismic Safety Project
in San Francisco and Alameda Counties, California

WHEREAS, the Federal Highway Administration (FHWA) proposes to approve design changes to the Interstate system and possibly to fund a seismic safety project for the east span of the San Francisco-Oakland Bay Bridge (Undertaking) proposed by the California Department of Transportation (Caltrans); and

WHEREAS, the four build alternatives being considered for this Undertaking include retrofit of the existing structure, constructing a replacement bridge to the south of the existing bridge, and constructing a replacement bridge to the north of the existing bridge on one of two possible alignments; and

WHEREAS, FHWA will be the lead federal agency for this Undertaking ; and

WHEREAS, the United States Coast Guard (Coast Guard) has independent review responsibilities for its bridge permit for navigational features; and

WHEREAS, portions of this Undertaking will occur on lands currently under the federal jurisdictions of the Department of the Navy (Navy) and the Coast Guard, and

WHEREAS, the Undertaking will include transfer of land, or interest in land, necessary for the Undertaking, under United States Department of Transportation (USDOT) authority pursuant to Title 23 of United States Code (U.S.C.) Section 107(d) and acquisition of such land has been delegated by the Secretary of Transportation to FHWA, which would then transfer the land to Caltrans; and

WHEREAS, such land transfer will not include title to any historic properties with the exceptions of the archaeological site CA-SFr-04/H and the air space over the Navy Building 262; and

WHEREAS, this Undertaking may adversely affect historic properties listed or eligible for listing on the National Register of Historic Places, including the San Francisco-Oakland Bay Bridge, the Navy Building 262, the Naval Officers' Quarters Historic District, the Key Pier Substation, and archaeological site CA-SFr-04/H, and may have effects on archaeological properties that have not yet been identified; and

WHEREAS, Naval Station Treasure Island Base Closure and Reuse is a separate Undertaking from the subject Undertaking; and

WHEREAS, FHWA has consulted with the California State Historic Preservation Officer (SHPO) and the Advisory Council on Historic Preservation (Council) pursuant to 36 CFR Part 800, regulations implementing Section 106 of the National Historic Preservation Act (16 U.S.C. 470f); and

WHEREAS, FHWA and Caltrans have consulted with local governments; the Department of the Navy; City of Oakland and City and County of San Francisco; the Foundation for San Francisco's Architectural Heritage; the San Francisco Planning & Urban Research Association; the Mayor's Treasure Island Project Office; the National Park Service (Western Regional Office); the National Trust for Historic Preservation; the California Preservation Foundation; the Oakland Landmarks Preservation Advisory Board; the San Francisco Landmarks Preservation Advisory Board; the Oakland Cultural Heritage Survey; the Port of Oakland; the Oakland Heritage Alliance and the Oakland Department of Public Works about the Undertaking and its effects on historic properties, and have taken all comments received from these parties into account; and

WHEREAS, FHWA and Caltrans have consulted with the following non-federally recognized Ohlone Native Americans identified by the California Native American Heritage Commission as Native American groups and individuals with a potential interest in the project area about the effects of the Undertaking on archaeological properties, and have taken all comments received from these parties into account: Chairperson Rosemary Cambra of the Muwekma Indian Tribe, Chairperson Tony Cerda of the Costanoan Rumsen Carmel Tribe, Mr. Andrew Galvan of The Ohlone Indian Tribe, Ms. Jakki Kehl, Mr. Kenneth Marquis, Ms. Jenny Mousseaux (Mcleod), Mr. Patrick Orozco, Ms. Katherine Erolinda Perez, Mr. Alex Ramirez, Chairperson Rudy Rosales of the Ohlone/Costanoan-Esselen Nation, Chairperson Ann Marie Sayer of the Indian Canyon Mutsun Band of Costanoan, Ms. Linda G. Yamane and Chairperson Irene Zwierlein of the Amah Tribal Band; and

WHEREAS, all non-federally recognized Ohlone Native Americans listed above will be invited to concur in the Agreement and to participate in the development and implementation of the Research Design and Treatment Plan (Treatment Plan); and

WHEREAS, Caltrans, the Department of the Navy, the City of Oakland and the City and County of San Francisco have been or will be invited to concur in the Agreement,

NOW, THEREFORE, FHWA, the Coast Guard, the SHPO, and the Council agree that the Undertaking will be implemented in accordance with the following stipulations in order to take into account the effect of the Undertaking on historic properties.

STIPULATIONS

FHWA will ensure that the following stipulations are carried out as applicable:

I. Applicability of Stipulations

A. Retrofit existing bridge

If the alternative chosen is to retrofit the existing bridge, the following stipulations will be carried out: II, III.E, III.G, IV.A, IV.B, V.A, V.B, V.C, V.D, and VII through XII.

B. Replacement bridge to south of existing bridge

If the alternative chosen is a replacement bridge to the south of the existing bridge, all of the stipulations in this Agreement will be carried out except for IV.C and V.D.

C. Replacement bridge to north of existing bridge

If the alternative chosen is a replacement bridge to the north of the existing bridge, all of the stipulations in this Agreement will be carried out except for V.D.

II. Professional Standards

All activities regarding history, historic preservation, historical archaeology and prehistoric archaeology that are carried out pursuant to this Agreement will be carried out by or under the direct supervision of persons meeting at a minimum the Secretary of the Interior's professional qualifications standards (48 FR 44738–9) in these disciplines.

III. Mitigation of effects on the San Francisco–Oakland Bay Bridge (Bay Bridge)

A. Salvage

Caltrans will offer selected components of the bridge to the East Bay Regional Park District or other owner of the proposed Oakland touchdown park (south of the new bridge, between the toll plaza and the shoreline in Oakland), for display or other use in the park. Caltrans will also provide the Oakland Museum of California, the Western Railway Museum in Rio Vista, Solano County, and any other interested parties an opportunity to select components of the bridge for curation, display, or other appropriate use. Caltrans will remove the items selected in a manner that minimizes damage and will deliver them with legal title to the recipient.

B. Permanent interpretive exhibits

1. Caltrans will consult with the East Bay Regional Park District or other owner of the proposed Oakland touchdown park about their interest in having interpretive exhibits incorporated into the design of the park which describe the Bay Bridge as originally constructed. If consultation results in agreement between Caltrans and the park owner concerning the nature and extent of the exhibits before January 1, 2008, Caltrans will produce and install the exhibits. The interpretive exhibits may include, but are not necessarily limited to: plaques or markers, salvaged components of the bridge, a mural or other depiction of the bridge, and the large clock that formerly stood atop the toll plaza canopy.

2. If consultation does not result in agreement between Caltrans and the park owner, Caltrans will seek an alternative East Bay location for the interpretive exhibits. Appropriate alternative locations may include Marina Park in Emeryville or the Berkeley Pier.

3. Caltrans will also consult with the City and County of San Francisco about their interest in having similar interpretive exhibits on Yerba Buena Island, and will produce and install the exhibits only if consultation results in agreement between Caltrans and the City and County of San Francisco before January 1, 2008.

C. Museum exhibit

1. Caltrans will consult with the Oakland Museum of California, the Academy of Sciences in San Francisco and/or other Bay Area museums about their interest in preparing and presenting an exhibit relating to the history and engineering of the major bridges of the San Francisco Bay, and will discuss with an interested museum the scope, content, and cost of such an exhibit.

2. If this consultation results in agreement between Caltrans and a museum to prepare and present such an exhibit, Caltrans will identify and conserve documentary materials in its possession related to the Bay Bridge and other major bridges of the San Francisco Bay that are considered most appropriate for such an exhibit, possibly including photographs, drawings, videotape, models, oral histories, and salvaged components from the bridges. In addition, Caltrans will assist the museum by contributing to the cost of preparing and presenting the exhibit, as well as the cost of an exhibit catalog or related museum publication in conjunction with the exhibit, in a manner and to the extent agreed upon by Caltrans and the museum.

D. Permanent curation and display of exhibit materials

At the conclusion of the museum exhibit described in Stipulation III.C., Caltrans will select historic items and interpretive materials from the exhibit to be offered to local governments, historical societies, and other interested parties in the Bay Area for permanent curation and public display. Caltrans will notify potential public and non-profit venues, which Caltrans has determined meet acceptable curation standards, of the availability of materials and will deliver the materials at its own expense to the selected venues. In the event there are multiple requests for the same items, Caltrans shall consider the proposals submitted by the requesters for the materials and shall decide which party shall receive the item, based on the ability of the requester properly to curate and exhibit the item.

E. Oral history

Caltrans will produce oral history documentation related to the construction and operation of the Bay Bridge, which will include audiotape and transcripts and may also include videotape. Caltrans will select appropriate subjects for interviews, who may include engineers and construction workers who participated in the construction of the bridge, bridge maintenance workers, bridge railway train operators, and others whose lives were affected by the bridge. Copies of the documentation will be provided to the Bancroft Library of the University of California at Berkeley, the Oakland History Room of the Oakland Public Library, the History Center at the San Francisco Public Library, the California Historical Society, and the Oakland Museum of California.

F. Documentary videos

1. Caltrans will provide copies of one or more of the existing documentary videos about the construction of the Bay Bridge to the public libraries of Oakland, San Francisco, Emeryville and Berkeley, as well as the California Historical Society.

2. In addition, Caltrans will produce curriculum materials to accompany the videos and will provide the curriculum materials and videos to the public school systems of Oakland, San Francisco, Emeryville and Berkeley, and to other school districts upon request.

3. Within 180 days after FHWA determines that the Undertaking has been completed, FHWA, in consultation with the SHPO, will re-evaluate the Bay Bridge, a property listed on the National Register of Historic Places, and determine whether the National Register nomination should be amended or whether the bridge no longer qualifies for listing and should be removed from the National Register. As appropriate, FHWA will prepare and submit to the SHPO either an amended nomination or petition for removal, to be processed according to the procedures set forth in 36 CFR Part 60 (60.14 and 60.15).

IV. Mitigation of effects on Navy Building 262 on Yerba Buena Island

A. Protective measures

Caltrans, in consultation with the property owner, will develop and implement measures to protect Building 262 from damage by any aspect of the Undertaking. Such measures will include, but not necessarily be limited to, vibration monitoring during pile driving in the vicinity of this building. The protective measures will be included in the contract specifications and in Caltrans' Resident Engineer's "pending" file.

B. Repair of inadvertent damage

Caltrans will ensure that any damage to Building 262 resulting from the Undertaking will be repaired in accordance with the Secretary of the Interior's *Standards for Rehabilitation.* Caltrans will photographically document the condition of the building prior to the start of the Undertaking to establish the baseline condition for assessing damage. A copy of this photographic documentation will be provided to the Navy and the City and County of San Francisco. Prior to implementation, Caltrans shall provide the plans for any repairs to the SHPO for review and comment to ensure conformance with the Secretary of the Interior's Standards for Rehabilitation.

C. Historic Structure Report

Caltrans will prepare or fund the preparation of an historic structure report for Building 262, to promote the reuse of this building. The historic structure report will, at a minimum, describe the significance and historic uses of the building; identify and assess the condition of original materials; describe later alterations; assess the structural condition of the building, including seismic safety considerations; and make recommendations for future seismic retrofit, other structural improvements, and appropriate preservation treatments. The scope of the historic structure report will be developed in consultation with the property owner. Copies of the report will be provided to the Navy and the City and County of San Francisco for review and to the SHPO for its records.

V. Mitigation of effects on the Naval Officers' Quarters Historic District, Quarters 8, Quarters 10, and Building 267 on Yerba Buena Island

A. Protective measures

Caltrans, in consultation with the Navy and the Coast Guard, will develop and implement measures to protect the Naval Officers' Quarters Historic District, Quarters 8, Quarters 10, and Building 267 from damage by any aspect of the Undertaking. The protective measures will be included in the contract specifications and in Caltrans' Resident Engineer's "pending" file.

B. Repair of inadvertent damage to buildings

Caltrans will ensure that any damage to the buildings of the Naval Officers' Quarters Historic District, Quarters 8, Quarters 10, or Building 267 resulting from the Undertaking will be repaired in accordance with the Secretary of the Interior's Standards for Rehabilitation. Caltrans will photographically document the condition of these buildings prior to the start of the Undertaking to establish the baseline condition for assessing damage. A copy of this photographic documentation will be provided to the Navy, the Coast Guard, and the City and County of San Francisco. Prior to implementation, Caltrans shall provide the plans for any repairs to SHPO for review and comment to ensure conformance with the Secretary of the Interior's Standards for Rehabilitation.

C. Restoration of the grounds

1. Caltrans will ensure that the grounds within the National Register boundaries of the Naval Officers' Quarters Historic District, Quarters 8, and Quarters 10 are restored after completion of the bridge project and removal of all temporary structures, to their condition prior to the start of the Undertaking. Caltrans will photographically document the grounds of these properties prior to the start of the Undertaking to establish the baseline condition for restoration. A copy of this photographic documentation will be provided to the Navy, the Coast Guard, and the City and County of San Francisco. Restoration of the grounds will include, but will not necessarily be limited to: new sod in grass areas, replacement of shrubbery and trees; regrading and revegetation of disturbed slopes; repair or replacement of damaged paving, sidewalks and curbs.

2. The Undertaking includes revegetation of disturbed slopes, including the areas south of the Naval Officers' Quarters Historic District and southeast of Quarters 10, which currently screen the existing bridge from these historic properties. Caltrans will establish construction limits in this area to preserve as much of the existing vegetation around Quarters 1 as possible, and will develop and implement a revegetation plan for affected areas, including the planting of mature trees, monitoring, and replanting as necessary to ensure success of the plan, in order to return the slope behind Quarters 1

to a natural appearance and to establish visual screening of the bridge comparable to the existing condition.

D. Screen planting in front of YB-3

In consultation with the property owner, Caltrans will develop and implement a planting plan to screen the concrete-encased pier YB-3 from Quarters 1, a property within the Naval Officers' Quarters Historic District and individually listed on the National Register of Historic Places, by planting along the top of the slope at the east end of the Naval Officers' Quarters Historic District.

VI. Minimizing Visual and Physical Impacts on Historic Properties on Yerba Buena Island

A. Design Features

FHWA shall ensure that the final design for any replacement structure minimizes visual and physical impacts to the Officers' Quarters Historic District and other historic properties with regard to the following features: color of concrete surface; texture of concrete surface; size, type and spacing of bridge deck light standards; bridge accent lighting, if it is considered; bridge suspension cables uplighting; landscaping restoration around the historic district; signage in the vicinity of the Historic District; number, mass, spacing of bridge piers; and height of the deck.

B. Review of Design Features

FHWA will afford the Council and SHPO the opportunity to review the design for the specific features cited in section A. of this stipulation, and will provide the Council and SHPO with documentation relevant to that review. The Council and SHPO shall have thirty (30) days after receipt to review and comment on this documentation. If the Council or SHPO so requests, FHWA, Caltrans, and any project design consultants, will meet with the Council and SHPO during the time frame stipulated, to address any Council or SHPO comments. Absent objection from the Council or SHPO within the stipulated time frame, FHWA may assume Council and SHPO concurrence with the proposed design and authorize Caltrans to proceed with final design. Final design documents will not be subject to further review under this Agreement. If the Council or SHPO objects within the stipulated time frame, FHWA will proceed in accordance with Stipulation X., below, to resolve the objection, except that objections pertaining to the number, mass, and spacing of bridge piers, or to the height of the bridge deck, will be exempt from Stipulation X. Objections exempt from Stipulation X. will be taken into account by FHWA before it authorizes Caltrans to proceed with final design.

C. Construction period

Caltrans shall take all practical measures to minimize the construction period of the project, particularly the period of use of temporary structures in the vicinity of the Officers' Quarters Historic District.

VII. Mitigation of effects on archaeological properties and development and implementation of a Treatment Plan for Archaeological Resources

FHWA will ensure that all required archaeological work is carried out by Caltrans or Caltrans' consultants.

A. Treatment plan development

Caltrans will prepare a comprehensive Treatment Plan for archeological resources. The Treatment Plan will include a data recovery plan for the prehistoric component of CA-SFr-4/H, guidelines for evaluation and data recovery of any American Period deposits within CA-SFr-4/H, as well as for treatment of unanticipated discoveries of any other archaeological deposits within the area of the Undertaking. The Treatment Plan will be consistent with the Secretary of the Interior's Standards and Guidelines for Archaeological Documentation (48 FR 44734–37) and take into account the Council's publication, Treatment of Archaeological Properties: A Handbook (ACHP 1980), and SHPO guidelines.

B. Treatment Plan specifics

The Treatment Plan will specify, at a minimum:

a. the properties or portion of properties where evaluation and/or data recovery are to be carried out;
b. the properties, if any, that will be affected by the Undertaking but for which no data recovery will be carried out;
c. the manner in which any unanticipated discoveries will be treated;
d. the research questions to be addressed through data recovery, with an explanation of their relevance and importance;
e. the methods to be used for data recovery, with an explanation of their relevance to the research questions;
f. the methods to be used in analysis, data management, and dissemination of data, including a schedule;
g. the proposed disposition of recovered materials and records;
h. the manner in which any human remains and sacred objects of Native American origin on federal or non-federal lands will be treated;

i. coordination with interested Native Americans during development and implementation of the Treatment Plan;

j. the proposed methods for disseminating results of the work;

k. a plan to comply with NAGPRA, if appropriate.

l. archival research required to establish context for evaluation of any American Period deposits found and to predict types of other archaeological properties that may be buried within the area of the Undertaking.

C. Treatment Plan review

Caltrans will coordinate with tribes and other interested Native Americans during the development of the Treatment Plan to solicit their views on the contents of the Treatment Plan, the public interpretive material, treatment of burials, the scope of the data recovery, and other topics of interest to Native Americans. Caltrans, in consultation with interested Native Americans, will develop a process for determining appropriate tribal affiliation should there be a discovery of human remains.

Caltrans will submit the Treatment Plan to all parties to this Agreement and interested Native Americans for a thirty (30) calendar day review following receipt of the Plan. If any party fails to submit their comments within thirty (30) days, Caltrans may assume that party's concurrence with the Treatment Plan. Caltrans will take any review comments into account, revise the Treatment Plan accordingly, and will notify any party whose comments were not incorporated into the Treatment Plan. Any disputes arising under the terms of this stipulation and not able to be solved by consensus will be resolved in accordance with Stipulation X.

D. Notification

Caltrans will promptly notify the SHPO, the Navy and the Coast Guard, as appropriate, if any properties are found that meet the conditions for eligibility set forth in the Treatment Plan. Absent objection pursuant to Stipulation X, Caltrans may combine the evaluation and data recovery phases of treatment of American Period or previously unidentified archaeological deposits and proceed in accordance with the Treatment Plan for any properties that meet the conditions for eligibility set forth in the Treatment Plan, and terminate any further consideration of properties which do not meet such conditions.

E. Report standards and dissemination

Caltrans will ensure that all reports resulting from implementation of the Treatment Plan meet contemporary professional standards and the Secretary of the Interior's Standards and Guidelines for Archaeological Documentation (48 FR 44734–37). Copies of all final reports will be provided to the SHPO, the Northwest Information Center at Sonoma State University, the Navy, Coast Guard and other interested parties as appropriate, such as

Native Americans, the Native American Heritage Commission, historical societies, and professional and amateur archaeological societies.

F. Public interpretive materials

Caltrans will develop public interpretive materials, covering potential historical and archaeological resources within the project area, and will disseminate these materials to both the public at large and educational institutions. Interpretive materials may include, but are not necessarily limited to: a mobile exhibit on the archaeology and history of Yerba Buena Island, curriculum materials, a web site, and other public presentations.

G. Confidentiality

The signatories to this Agreement acknowledge that historic properties covered by this Agreement are subject to the provisions of § 304 of the National Historic Preservation Act of 1966 and § 6254.10 of the California Government Code (Public Records Act), relating to the disclosure of archeological site information and, having so acknowledged, will ensure that all actions and documentation prescribed by this Agreement are consistent with § 304 of the National Historic Preservation Act of 1966 and § 6254.10 of the California Government Code.

VIII. Annual report

Caltrans will prepare an annual report describing the status of its efforts to comply with the mitigation measures set forth in Stipulations III through VII of this Agreement. The annual report will be prepared following the end of each fiscal year (July 1 to June 30) and will be distributed by Caltrans to all of the signatories to this Agreement by July 30 of each year, until FHWA determines that the *applicable* mitigation measures set forth in Stipulations III through VII inclusive, of this Agreement have been completed.

IX. Amendments, termination and new agreement

A. Amendments

If any signatory to this Agreement determines that an amendment to its terms should be made, the signatory will immediately consult with the other signatories to this Agreement pursuant to 36 CFR 800.6 (c)(7). This agreement may be amended only upon written concurrence of all signatory parties.

B. Termination

If the signatory parties to this Agreement do not reach consensus on amendment(s) as provided for in this stipulation, FHWA, the Council or the SHPO may terminate it. The party terminating the Agreement will in writing provide all other signatories with an explanation of the reasons for termination. If the Agreement is not amended or terminated, the Agreement will remain in effect as originally executed, and FHWA will notify the other signatories that the attempt to reach consensus on amendment(s) was unsuccessful.

C. Action following termination

If this Agreement is terminated by FHWA, the Council or the SHPO for any reason, and FHWA determines that the Undertaking will proceed, FHWA will execute a new Memorandum of Agreement with the signatories under 36 CFR 800.6, or request the comments of the Council pursuant to 36 CFR 800.7(a).

X. Dispute resolution

A. Disputes regarding actions

1. Should any signatory to this Agreement object to the manner in which the terms of this Agreement are implemented, or to any documentation prepared in accordance with and subject to the terms of this Agreement, FHWA will consult further with the objecting party to resolve the objection. If FHWA determines within fourteen (14) days of receipt that such objection cannot be resolved, FHWA will forward all documentation relevant to the dispute to the Council, including FHWA's proposed response to the objection. Within thirty (30) days after receipt of all pertinent documentation, the Council will:

   a. advise FHWA that it concurs in FHWA's proposed response, whereupon FHWA will respond to the objection accordingly; or

   b. provide FHWA with recommendations which FHWA will take into account in reaching a final decision regarding the dispute.

2. Any Council comment provided in response to FHWA's request will be taken into account by FHWA with reference only to the subject of the dispute. The signatories' responsibilities to carry out all actions under this Agreement that are not the subject of the dispute will remain unchanged. FHWA may authorize Caltrans to implement that portion of the Agreement which is subject to dispute after receiving and taking into account, any Council comments issued in accordance with this stipulation. FHWA's decision regarding resolution of the dispute will be final.

3. If the Council fails to comment within the time period specified in this stipulation, FHWA may authorize Caltrans to implement that portion of the Agreement which is subject to dispute in accordance with FHWA's proposed response to the objection as submitted to the Council, and after taking into account any SHPO or Council comments. FHWA's decision regarding resolution of the dispute will be final.

XI. Public objections

If any member of the public objects to the manner in which the provisions of this Agreement are implemented, FHWA shall immediately notify the other parties in writing of the objection and take the objection into account. FHWA shall consult with the objecting party and, if the objecting party so requests, with any or all of the other signatories, for no more than thirty (30) calendar days. Within fourteen (14) calendar days following closure of the consultation period, FHWA will render a decision regarding the objection and notify all parties of this decision in writing. In reaching its decision, FHWA will take comments from all parties into account. . No provision of this stipulation will preclude FHWA and Caltrans from continuing to implement any provision of the Agreement that is subject to public objection.

XII. Duration

A. Reconsideration

If FHWA determines that construction of the Undertaking has not been initiated within ten years following execution of this Agreement, the signatories shall consult to reconsider its terms. Reconsideration may include continuation of the Agreement as originally executed, amendment, or termination in accordance with Stipulation IX.

B. Terms fulfilled

This Agreement will be in effect through FHWA's implementation of the Undertaking, and will terminate and have no further force or effect when FHWA, in consultation with the other signatories, determines that the terms of this Agreement have been fulfilled in a satisfactory manner. FHWA will provide the other signatories with written notice of its determination and of termination of this Agreement.

Execution and implementation of this Agreement evidence that FHWA and the Coast Guard have afforded the Council a reasonable opportunity to comment on the Undertaking and the effect of the Undertaking on historic properties, and have themselves taken into account the effect of the Undertaking on historic properties.

Federal Highway Administration

By: David A. Nicol Date: 25 May 00

Title: Assistant Division Administrator

United States Coast Guard

By: R Jankowsky CAPT, USCG Date: 25 May 00

Title: Chief, Civil Engineering Division

California State Office of Historic Preservation

By: Daniel Abeyta Date: 25 May 00

Title: Acting SHPO

Advisory Council on Historic Preservation

By: John M. Fowler Date: 5/26/00

Title: EXECUTIVE DIRECTOR

Concurring Parties:

Concur:
United States Navy

By: _____ Date: _____

Title: _____

Concur:
California Department of Transportation

By: Jerry V. Davis Date: 5/25/00

Title: Acting Director

Concur:
City of Oakland

By: _____ Date: _____

Title: _____

Concur:
City and County of San Francisco

By: _____ Date: _____

Title: _____

Concur:
Chairperson Rosemary Cambra, Muwekma Indian Tribe

By: _____ Date: _____

Concur:
Chairperson Tony Cerda, Costanoan Rumsen Carmel Tribe

By: _____ Date: _____

Concur:
Mr. Andrew Galvan, The Ohlone Indian Tribe

By: Andrew A Galvan Date: 14 VII 2000
Feast Day of Blessed Kateri Tekawitha

Concur:
Ms. Jakki Kehl

By: _____ Date: _____

Concur:
Mr. Kenneth Marquis

By: _____ Date: _____

Concur:
Ms. Jenny Mousseaux (Mcleod)

By: _____ Date: _____

Concur:
Mr. Patrick Orozco

By: _____ Date: _____

Concur:
Ms. Katherine Erolinda Perez

By: _____ Date: _____

Concur:
Chairperson Tony Cerda, Costanoan Rumsen Carmel Tribe

By: _____ Date: 6/27/00

Concur:
Mr. Andrew Galvan, The Ohlone Indian Tribe

By: _____ Date: _____

Concur:
Ms. Jakki Kehl

By: _____ Date: _____

Concur:
Mr. Kenneth Marquis

By: _____ Date: _____

Concur:
Ms. Jenny Mousseaux (Mcleod)

By: _____ Date: _____

Concur:
Mr. Patrick Orozco

By: _____ Date: _____

Concur:
Ms. Katherine Erolinda Perez

By: _____ Date: _____

Concur:
Mr. Alex Ramirez

By: _____ Date: _____

Concur:
Chairperson Rudy Rosales, Ohlone/Costanoan-Esselen Nation

By: _____ Date: _____

Concur:
Chairperson Ann Marie Sayer, Indian Canyon Mutsun Band of Costanoan

By: Ann Marie Sayer Date: July 20, 00

Concur:
Ms. Linda G. Yamane

By: _____ Date: _____

Concur:
Chairperson Irene Zwierlein, Amah Tribal Band

By: _____ Date: _____

I would like to see more input from the native American people & history & contributions of the original people. This is as though we are invisible

APPENDIX P
NOISE ABATEMENT ANALYSIS

APPENDIX P

Noise Abatement Analysis

Noise abatement measures (e.g., construction of a noise barrier) were considered for reducing noise impacts when the predicted peak-noise-hour levels were expected to approach or exceed FHWA Noise Abatement Criteria (NAC) for appropriate land use categories (see Table 3.5-1). For this project, noise abatement measures were considered and evaluated for effectiveness based upon the FHWA NAC.

The noise abatement analysis evaluated the acoustical effectiveness of noise barriers. Noise barriers must reduce future predicted noise levels at impacted receptors by at least five dBA to be considered feasible. The feasibility criterion is not necessarily a noise abatement design goal. Greater noise reductions are encouraged if they can be reasonably achieved. Feasibility may be restricted by topography, access requirements for ramps, other noise sources in the area and safety considerations. Reasonableness of noise barriers must be evaluated as well, including such additional factors as cost per benefited receptor, absolute noise levels, change in noise levels, viewshed preservation, appearance, views of impacted residents, input from other agencies, and other social, economic, environmental, legal and technological factors. Noise insulation of residential dwellings is typically only considered when severe traffic noise impacts are predicted and normal abatement measures are not physically feasible or economically reasonable. Because substantial noise impacts are not predicted for any of the project alternatives, noise insulation of structures was not considered. When affected receptors experience traffic noise levels or increases considerably greater than at other similar receptors, extraordinary abatement measures may be justified. Examples of such situations include private residential units with noise levels greater than 75 dBA L_{eq} after project implementation or a predicted noise level increase of 30 dBA or more as a result of the project. The SFOBB East Span Project would not cause any such increases.

The effectiveness of a range of soundwall heights from 1.8 to 4.9 meters (6 to 16 feet) was tested using the criteria of reducing noise levels a minimum of five dBA at the receptor. In addition, for a soundwall to be considered effective, it must interrupt the line-of-sight between the receptor (assumed to be 1.5 meters [5 feet] tall) and an exhaust stack of a heavy-duty truck. The truck-stack height is considered to be 3.5 meters (11.5 feet) above the roadway surface. If soundwalls are installed, they should be constructed along the outer edges of the bridge decks for maximum noise abatement effectiveness.

Replacement Alternative N-2.

Yerba Buena Island. The noise levels at Locations 2, 3, 4, 9, and 11 would equal or exceed the 67 dBA L_{eq} standard, therefore, noise abatement measures have been considered. Practical noise measures that effectively reduce these modeled noise levels consist of barriers, due to the limitations of other abatement measures for bridge structures such as berms and buffer zones. Installation of the barriers summarized below would result in soundwalls extending along both sides of the existing bridge structure wherever I-80 is above land on YBI. The soundwall locations which would be required to

reduce noise levels by 5 dB or more and break truck-stack line-of-sight between receptors and truck exhaust stacks are summarized below and presented in Table P-1. (See Figure 4-16 in Appendix A for potential soundwall locations for Alternative N-2.) Soundwalls would be ineffective for Locations 9 and 11 as Replacement Alternative N-2 would place the bridge above these locations.

On the northern side of the bridge, two 4.27-meter (14-foot) high walls 245 meters (800 feet) long at each of the bridge decks exiting YBI would reduce noise levels 5 dBA or more and break truck-stack line-of-sight. Together, the walls would provide effective noise reduction for approximately 90 residential units at Location 2. Both the U.S. Navy and the City and County of San Francisco have expressed their desire to rent out these residential units on YBI. From Station 52+40 to Station 53+40 SW-2A and SW-2B would be 3.05 meters (10 feet) high, with a 3.66-meter (12-foot) transition area from Station 52+00 to Station 52+40. The soundwalls would need to be approximately 140 meters (459 feet) in length to provide effective noise reduction to the one residence at Location 3. On the south side of the bridge, walls 3.66 meters (12 feet) in height on both bridge decks exiting the tunnel would reduce noise levels 5 dB or more and break truck-stack line-of-sight. These walls would extend for 245 meters (800 feet) to the east of the tunnel portal. These walls would provide noise reduction for the one residence at Location 4.

Oakland Touchdown Area. One of the ten modeled receptors for Replacement Alternative N-2 (Receptor 17-M1) in the Oakland Touchdown area has a peak-noise-hour level which exceeds the FHWA NAC for Activity Category C of 72 dBA L_{eq}. However, there are no exterior areas of frequent human use for which lower noise levels would be of benefit.

Replacement Alternative N-6

Yerba Buena Island. The noise levels at Locations 2, 3, 4, 9, and 11 would equal or exceed the 67 dBA L_{eq} criteria.

On the northern side of the bridge, two 4.27-meter (14-foot) high walls 245 meters (800 feet) long at each of the bridge decks exiting YBI would reduce noise levels 5 dB or more and break truck-stack line-of-sight. Together, the walls would provide effective noise reduction for approximately 90 residential units at Location 2. These walls would transition to 3.66 meters (12 feet) in height for 140 meters (460 feet) in length and would provide noise reduction for the one residence at Location 3. On the south side of the bridge, walls 3.66 meters (12 feet) in height on both bridge decks exiting the tunnel would reduce noise levels 5 dB or more and break truck-stack line-of-sight. These walls would extend for 245 meters (800 feet) to the east of the tunnel portal. These walls would provide noise reduction for the one residence at Location 4. (See Table P-2 in this section and Figure 4-17 in Appendix A for potential soundwall locations for Replacement Alternative N-6.)

Soundwalls would be ineffective for Locations 9 and 11 as Replacement Alternative N-6 would place the bridge above these locations.

TABLE P-1: SUMMARY OF PEAK-NOISE-HOUR NOISE LEVELS: EXISTING AND FUTURE N-2

Location #	Noise Receptor	Modeled Existing Noise Level L_{eq} (dBA)	Future-N-2 Alignment Noise Level L_{eq} (dBA)	Soundwall Number and Begin/End Stations	Soundwall Placement	Soundwall Height (meters)**	Noise Level (dBA) with Different Wall Heights						Wall Ht. Required to Break L-O-S (m)**
							1.83m**	2.44m**	3.05m**	3.66m**	4.27m**	4.88m**	
1	1A	72	62	N/A	N/A	None							
	1C	70	63	N/A	N/A	None							
	1-LT	71	61	N/A	N/A	None							
	1-M1	74	64	N/A	N/A	None							
	1-M2	70	62	N/A	N/A	None							
	1-M3	69	62	N/A	N/A	None							
	1-M4	70	62	N/A	N/A	None							
	1-M5	75	64	N/A	N/A	None							
2	2A	74	73	SW 1A,1B (2)	E/B	4.27	72	70	69	67	66	65	4.2
	2-M1	71	70	SW 1A,1B (2)	E/B	4.27	69	67	66	65	63	62	4.0
3	3A	75	71	SW 2A,2B (1)	E/B	3.05	68	66	65	63	62	61	3.0
4	4A	72	70	SW 3A, 3B (2)	E/B	3.66	68	67	65	64	62	61	3.3
5	5A	66	65	N/A	N/A	None							
	5C	64	63	N/A	N/A	None							
	5D	64	60	N/A	N/A	None							
	5-M1	67	65	N/A	N/A	None							
6	6A	72	62	N/A	N/A	None							
	6C	71	61	N/A	N/A	None							
	6-M1	72	62	N/A	N/A	None							
	6-M2	72	61	N/A	N/A	None							
7	7A	69	60	N/A	N/A	None							
	7-M1	71	61	N/A	N/A	None							
9	9A	76	67*	N/A	N/A	None							
	9-M1	76	67*	N/A	N/A	None							
10	10A	77	N/A*	N/A	N/A	None							
	10-M1	77	N/A*	N/A	N/A	None							

E/B = EDGE OF BRIDGE DECK
LOS = LINE OF SITE
N/A = NOT APPLICABLE: NOISE LEVELS EITHER BELOW NOISE ABATEMENT CRITERIA OR MODELING DATA INDICATES THAT A SOUNDWALL WOULD BE INEFFECTIVE
SOUNDWALL STATIONING:
(1) = 52+00 TO 53+40
(2) = 49+55 TO 52+00
*** - THIS ALTERNATIVE WOULD PLACE THE BRIDGE ABOVE OR ON TOP OF THIS LOCATION; SOUNDWALL INEFFECTIVE.**
**** - TO CONVERT TO ENGLISH UNITS, DIVIDE BY 0.3048.**

TABLE P-1: SUMMARY OF PEAK-NOISE-HOUR NOISE LEVELS: EXISTING AND FUTURE N-2 (Continued)

Location #	Noise Receptor	Modeled Existing Noise Level L_{eq} (dBA)	Future-N-2 Alignment Noise Level L_{eq} (dBA)	Soundwall Number and Begin/End Stations	Soundwall Placement	Soundwall Height (meters)**	Noise Level (dBA) with Different Wall Heights						Wall Ht. Required to Break L-O-S (m)**
							1.83m**	2.44m**	3.05m**	3.66m**	4.27m**	4.88m**	
11	11A	75	64	N/A	N/A	None							
	11C	77	68*	N/A	N/A	None							
	11-M1	77	68*	N/A	N/A	None							
	11-M2	77	69*	N/A	N/A	None							
	11-M3	77	69*	N/A	N/A	None							
12	12A	72	N/A*	N/A	N/A	None							
	12-M1	71	N/A*	N/A	N/A	None							
	12-M2	74	N/A*	N/A	N/A	None							
	12-LT	73	N/A*	N/A	N/A	None							
13	13A	73	67	N/A	N/A	None							
	13C	74	70	N/A	N/A	None							
	13-M1	73	67	N/A	N/A	None							
	13-M2	71	68	N/A	N/A	None							
	13-M3	71	68	N/A	N/A	None							
17	17A	66	69	N/A	N/A	None							
	17-M1	70	73	N/A	N/A	None							
18	18A	69	71	N/A	N/A	None							
	18-M1	66	68	N/A	N/A	None							
	18-M2	65	67	N/A	N/A	None							
20	20A	72	62	N/A	N/A	None							
	20-M1	72	62	N/A	N/A	None							
21	21A	74	60	N/A	N/A	None							
	21-M1	73	N/A	N/A	N/A	None							
	21-M2	73	60	N/A	N/A	None							
	21-M3	73	59	N/A	N/A	None							
	STUDIO	67	59	N/A	N/A	None							

E/B = EDGE OF BRIDGE DECK
LOS = LINE OF SITE
N/A = NOT APPLICABLE: NOISE LEVELS EITHER BELOW NOISE ABATEMENT CRITERIA OR MODELING DATA INDICATES THAT A SOUNDWALL WOULD BE INEFFECTIVE
SOUNDWALL STATIONING:
(1) = 52+00 TO 53+40
(2) = 49+55 TO 52+00
*** - THIS ALTERNATIVE WOULD PLACE THE BRIDGE ABOVE OR ON TOP OF THIS LOCATION; SOUNDWALL INEFFECTIVE.**
**** - TO CONVERT TO ENGLISH UNITS, DIVIDE BY 0.3048.**

TABLE P-2: SUMMARY OF PEAK-NOISE-HOUR NOISE LEVELS: EXISTING AND FUTURE N-6

Location #	Receptor Number	Noise Receptor	Modeled Existing Noise Level L_{eq} (dBA)	Future - N-6 Alignment Noise Level L_{eq} (dBA)	Soundwall Number and Begin/End Stations	Soundwall Placement	Soundwall Height (meters)**	Noise Level (dBA) with Different Wall Heights						Wall Ht. Required to Break L-O-S (m)**
								1.83m**	2.44m**	3.05m**	3.66m**	4.27m**	4.88m**	
1	1	1A	72	63	N/A	N/A	None							
	2	1C	70	63	N/A	N/A	None							
	3	1-LT	71	62	N/A	N/A	None							
	4	1-M1	74	64	N/A	N/A	None							
	5	1-M2	70	63	N/A	N/A	None							
	6	1-M3	69	63	N/A	N/A	None							
	7	1-M4	70	63	N/A	N/A	None							
	8	1-M5	75	65	N/A	N/A	None							
2	9	2A	74	73	SW 1A,1B [2]	E/B	4.27	72	71	69	68	67	65	4.2
	10	2-M1	71	70	SW 1A,1B [2]	E/B	4.27	69	68	66	65	64	63	4.0
3	11	3A	75	71	SW 2A,2B [1]	E/B	3.66	68	67	65	64	63	62	0.0
4	12	4A	72	71	SW 3A, 3B [2]	E/B	3.66	68	67	66	64	63	61	0.0
5	13	5A	66	65	N/A	N/A	None							
	14	5C	64	63	N/A	N/A	None							
	15	5D	64	60	N/A	N/A	None							
	16	5-M1	67	65	N/A	N/A	None							
6	17	6A	72	62	N/A	N/A	None							
	18	6C	71	61	N/A	N/A	None							
	19	6-M1	72	62	N/A	N/A	None							
	20	6-M2	72	62	N/A	N/A	None							
7	21	7A	69	60	N/A	N/A	None							
	22	7-M1	71	61	N/A	N/A	None							
9	23	9A	76	67*	N/A	N/A	None							
	24	9-M1	76	67*	N/A	N/A	None							

E/B = EDGE OF BRIDGE DECK
LOS = LINE OF SIGHT
N/A = NOT APPLICABLE: NOISE LEVELS EITHER BELOW NOISE ABATEMENT CRITERIA OR MODELING DATA INDICATES THAT A SOUNDWALL WOULD BE INEFFECTIVE.
SOUNDWALL STATIONING:

(1) = 52+00 TO 53+40

(2) = 49+55 TO 52+00

*** - THIS ALTERNATIVE WOULD PLACE THE BRIDGE ABOVE OR ON TOP OF THIS LOCATION; SOUNDWALL INEFFECTIVE.**
**** - TO CONVERT TO ENGLISH UNITS, DIVIDE BY 0.3048.**

TABLE P-2: SUMMARY OF PEAK-NOISE-HOUR NOISE LEVELS: EXISTING AND FUTURE N-6 (Continued)

Location #	Receptor Number	Noise Receptor	Modeled Existing Noise Level L_{eq} (dBA)	Future - N-6 Alignment Noise Level L_{eq} (dBA)	Soundwall Number and Begin/End Stations	Soundwall Placement	Soundwall Height (meters)**	Noise Level (dBA) with Different Wall Heights						Wall Ht. Required to Break L-O-S (m)**
								1.83m**	2.44m**	3.05m**	3.66m**	4.27m**	4.88m**	
10	25	10A	77	65	N/A	N/A	None							
	26	10-M1	77	N/A*	N/A	N/A	None							
11	27	11A	75	64	N/A	N/A	None							
	28	11C	77	68*	N/A	N/A	None							
	29	11-M1	77	68*	N/A	N/A	None							
	30	11-M2	77	69*	N/A	N/A	None							
	31	11-M3	77	69*	N/A	N/A	None							
12	1	12A	72	85*	N/A	N/A	None							
	2	12-M1	71	84*	N/A	N/A	None							
	3	12-M2	74	86*	N/A	N/A	None							
	4	12-LT	73	83*	N/A	N/A	None							
13	5	13A	73	67	N/A	N/A	None							
	6	13C	74	70	N/A	N/A	None							
	7	13-M1	73	67	N/A	N/A	None							
	8	13-M2	71	68	N/A	N/A	None							
	9	13-M3	71	68	N/A	N/A	None							
17	10	17A	66	69	N/A	N/A	None							
	11	17-M1	70	72	N/A	N/A	None							
18	12	18A	69	70	N/A	N/A	None							
	13	18-M1	66	68	N/A	N/A	None							
	14	18-M2	65	67	N/A	N/A	None							
20	32	20A	72	62	N/A	N/A	None							
	33	20-M1	72	62	N/A	N/A	None							
21	34	21A	74	60	N/A	N/A	None							
	35	21-M1	73	60	N/A	N/A	None							
	36	21-M2	73	60	N/A	N/A	None							
	37	21-M3	73	59	N/A	N/A	None							
	38	STUDIO	67	59	N/A	N/A	None							

E/B = EDGE OF BRIDGE DECK

LOS = LINE OF SIGHT

N/A = NOT APPLICABLE: NOISE LEVELS EITHER BELOW NOISE ABATEMENT CRITERIA OR MODELING DATA INDICATES THAT A SOUNDWALL WOULD BE INEFFECTIVE.

SOUNDWALL STATIONING:

(1) = 52+00 TO 53+40

(2) = 49+55 TO 52+00

*** . THIS ALTERNATIVE WOULD PLACE THE BRIDGE ABOVE OR ON TOP OF THIS LOCATION; SOUNDWALL INEFFECTIVE.**

**** . TO CONVERT TO ENGLISH UNITS, DIVIDE BY 0.3048.**

Oakland Touchdown Area. One of the ten modeled receptors for Replacement Alternative N-6 (Receptor 17-M1) in the Oakland Touchdown area has peak-noise-hour levels which exceed the FHWA NAC for Activity Category C (commercial uses) of 72 dBA L_{eq}. However, there are no exterior areas of frequent human use for which lower noise levels would be of benefit.

Replacement Alternative S-4

Yerba Buena Island. The noise levels at Locations 2, 3, 4, 9, and 11 would equal or exceed the 67 dBA L_{eq} criteria.

Soundwalls which would reduce noise levels 5 dB or more and break truck-stack line-of-sight at YBI are the same for Replacement Alternative S-4 as for Replacement Alternative N-2. (See Table P-3 in this section and Figure 4-18 in Appendix A for recommended soundwall locations for Replacement Alternative S-4.)

Oakland Touchdown Area. Four of the ten modeled receptors in the Oakland Touchdown area (Receptors 12-M2, 13-M3, 17-M1, and 18-A) have peak-noise-hour levels which approach or exceed the FHWA NAC for Activity Category C of 72 dBA L_{eq} under this alternative. However, there are no exterior areas of frequent human use for which lower noise levels would be of benefit.

Options for Noise Abatement Materials and Treatment. Options for abating noise by using different barrier materials, tunnel portal treatments, and roadway pavement materials were reviewed for the East Span Project. These options and their and their potential potential effectiveness are summarized below. Selection of barrier materials would be subject to evaluation of a number of factors in addition to their effectiveness in providing noise abatement. Additional factors include maintenance requirements, expected period of serviceability, and life-cycle costs.

Standard Soundwall. Examples of standard materials are masonry block and precast concrete. Generally the heaviest barrier per unit dimension, it requires a slightly more massive supporting structure; the reverberant soundfield may increase noise level between closely spaced parallel soundwalls; it has potential for reflecting traffic noise into adjacent areas that are located nearby, above, and opposite from the soundwall; it is not visually transparent.

Acoustically Absorptive Soundwall. Multiple reflections between parallel barriers can potentially reduce the acoustical performance of each individual barrier. When designing reflective parallel noise barriers, it is recommended that a minimum 10:1 ratio is maintained between two barriers in order to avoid the possibility of perceivable barrier performance degradations. If that is not possible, acoustically absorptive barriers may have to be considered. The recommended aspect ratio (10:1 or greater) could be achieved for this project and, therefore, no further noise abatement in the form of acoustically absorptive barriers would be required.

TABLE P-3: SUMMARY OF PEAK-NOISE-HOUR NOISE LEVELS: EXISTING AND FUTURE S-4

Location #	Noise Receptor	Modeled Existing Noise Level L_{eq} (dBA)	Future - S-4 Alignment Noise Level L_{eq} (dBA)	Soundwall Number and Begin/End Stations	Soundwall Placement	Soundwall Height (meters)**	Noise Level (dBA) with Different Wall Heights						Wall Ht. Required to Break L-O-S (m)**
							1.83m**	2.44m**	3.05m**	3.66m**	4.27m**	4.88m**	
1	1A	72	63	N/A	N/A	None							
	1C	70	63	N/A	N/A	None							
	1-LT	71	62	N/A	N/A	None							
	1-M1	74	64	N/A	N/A	None							
	1-M2	70	62	N/A	N/A	None							
	1-M3	69	62	N/A	N/A	None							
	1-M4	70	62	N/A	N/A	None							
	1-M5	75	64	N/A	N/A	None							
2	2A	74	73	SW 1A,1B (2)	E/B	4.27	71	70	69	68	67	66	4.2
	2-M1	71	70	SW 1A,1B (2)	E/B	4.27	69	67	66	65	64	63	4.0
3	3A	75	71	SW 2A,2B (1)	E/B	3.66	68	67	65	64	63	61	3.2
4	4A	72	70	SW 3A, 3B (2)	E/B	3.66	68	67	66	65	63	62	3.5
5	5A	66	65	N/A	N/A	None							
	5C	64	64	N/A	N/A	None							
	5D	64	61	N/A	N/A	None							
	5-M1	67	66	N/A	N/A	None							
6	6A	72	62	N/A	N/A	None							
	6C	71	62	N/A	N/A	None							
	6-M1	72	62	N/A	N/A	None							
	6-M2	72	62	N/A	N/A	None							
7	7A	69	61	N/A	N/A	None							
	7-M1	71	62	N/A	N/A	None							
9	9A	76	67	N/A	N/A	None							
	9-M1	76	67	N/A	N/A	None							
10	10A	77	65	N/A	N/A	None							
	10-M1	77	66	N/A	N/A	None							

E/B = EDGE OF BRIDGE DECK
LOS = LINE OF SIGHT
N/A = NOT APPLICABLE: NOISE LEVELS EITHER BELOW NOISE ABATEMENT CRITERIA OR MODELING DATA INDICATES THAT A SOUNDWALL WOULD BE INEFFECTIVE
SOUNDWALL STATIONING:
(1) = 52+00 TO 53+40
(2) = 49+55 TO 52+00
*** - THIS ALTERNATIVE WOULD PLACE THE BRIDGE ABOVE OR ON TOP OF THIS LOCATION; SOUNDWALL INEFFECTIVE.**
**** - TO CONVERT TO ENGLISH UNITS, DIVIDE BY 0.3048.**

TABLE P-3: SUMMARY OF PEAK-NOISE-HOUR NOISE LEVELS: EXISTING AND FUTURE S-4 (Continued)

Location #	Noise Receptor	Modeled Existing Noise Level L_{eq} (dBA)	Future - S-4 Alignment Noise Level L_{eq} (dBA)	Soundwall Number and Begin/End Stations	Soundwall Placement	Soundwall Height (meters)**	Noise Level (dBA) with Different Wall Heights						Wall Ht. Required to Break L-O-S (m)**
							1.83m**	2.44m**	3.05m**	3.66m**	4.27m**	4.88m	
11	11A	75	64	N/A	N/A	None							
	11C	77	N/A*	N/A	N/A	None							
	11-M1	77	N/A*	N/A	N/A	None							
	11-M2	77	69	N/A	N/A	None							
	11-M3	77	N/A*	N/A	N/A	None							
12	12A	72	68	N/A	N/A	None							
	12-M1	71	67	N/A	N/A	None							
	12-M2	74	71	N/A	N/A	None							
	12-LT	73	70	N/A	N/A	None							
13	13A	73	68	N/A	N/A	None							
	13C	74	N/A*	N/A	N/A	None							
	13-M1	73	N/A*	N/A	N/A	None							
	13-M2	71	N/A*	N/A	N/A	None							
	13-M3	71	72	N/A	N/A	None							
17	17A	66	69	N/A	N/A	None							
	17-M1	70	73	N/A	N/A	None							
18	18A	69	72	N/A	N/A	None							
	18-M1	66	69	N/A	N/A	None							
	18-M2	65	67	N/A	N/A	None							
20	20A	72	63	N/A	N/A	None							
	20-M1	72	63	N/A	N/A	None							
21	21A	74	62	N/A	N/A	None							
	21-M1	73	62	N/A	N/A	None							
	21-M2	73	62	N/A	N/A	None							
	21-M3	73	61	N/A	N/A	None							
	STUDIO	67	58	N/A	N/A	None							

E/B = EDGE OF BRIDGE DECK
LOS = LINE OF SIGHT
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SOUNDWALL STATIONING:
(1) = 52+00 TO 53+40
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**** - TO CONVERT TO ENGLISH UNITS, DIVIDE BY 0.3048.**

Viewshed Soundwall. These soundwalls are visually transparent noise barriers; alternative material is glass; acoustical performance equivalent to standard reflective soundwalls; substantially lighter weight per unit area than standard masonry soundwall material; reverberant soundfield may increase noise level between parallel soundwalls; has potential for reflecting traffic noise into adjacent areas that are located nearby, above, and opposite from the soundwall; panel sections designed to be readily disassembled and replaced without affecting adjacent sections or losing acoustical performance; newer generation of materials are non-yellowing/glazing to maintain visual transparency; the vertical (and optionally) horizontal framing and supporting structures are fabricated of solid material that is not transparent.

Combination Viewshed/Acoustically Absorptive Soundwall. The metal sandwich type of transportation noise panel system has provision for intermixing transparent view panels with the visually opaque, acoustically absorptive panels. The see-through panels may be inserted below, between, and/or above the solid panels. Depending on the specific combination and placement of panel types, the acoustic characteristics of the combination soundwall will be more or less similar to reflective or absorptive soundwalls; substantially lighter weight per unit area than standard masonry soundwall material; panel sections designed to be readily disassembled and replaced without affecting adjacent sections, or changing acoustical performance and visual characteristics.

Reduced Noise Pavement Surfaces. Non-standard pavement surfaces have been alleged to reduce traffic noise. The most common pavement types referred to for this effect are "open graded" asphalt concrete and "rubberized" asphalt. Although the non-acoustic properties of these pavement types are documented and standard specifications for their use are available, their benefits in noise reduction are only recently being published, with scientific research by Caltrans in process. Recently released data[1] concluded that dense asphalt is approximately 3 dBA quieter than PCC with new open graded asphalt providing an additional 1.5 dBA lower noise level. However, the data suggests that open graded noise levels will be similar to dense graded material after some years of wear. Rubberized binder asphalt may reduce pavement noise levels by approximately three decibels; however sufficient study data is not currently available to support firm conclusions. Another study[2] found that noise levels from open graded asphalt were approximately five decibels lower than for grooved PCC. These pavement types should be considered for use on the SFOBB project, but their noise abatement abilities must be considered along with other factors (such as life-cycle cost) important to pavement type selection.

Tunnel Portal Acoustic Treatment. Noise levels in the immediate vicinity of traffic tunnel portals are noted to be higher than at some distance from the portals. Placement of acoustically absorptive materials inside the portals has resulted in reduction of higher

[1] Wayson, Roger, NCHRP Synthesis, Transportation Research Board Proceedings, St. Petersburg, Florida, July 1998.

[2] Bajkec, Christopher, Vehicle Noise Emissions and Pure-Tone Characteristics of Different Pavements: A Case Study.

noise levels experienced outside the portal.[3] According to the literature, however, the benefits of tunnel portal treatment diminish substantially at distances of approximately 100 meters (328 feet). Because the nearest noise-sensitive receptors are approximately 100 meters away from the tunnel portal, the benefits of acoustic treatment of the tunnel portal for this project would likely be marginal.

[3] Noise Control Engineering Journal, Institute of Noise Control Engineering of the USA, *Sound Propagation at Tunnel Openings*, September-October 1992.

Box 1, Folder 2

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