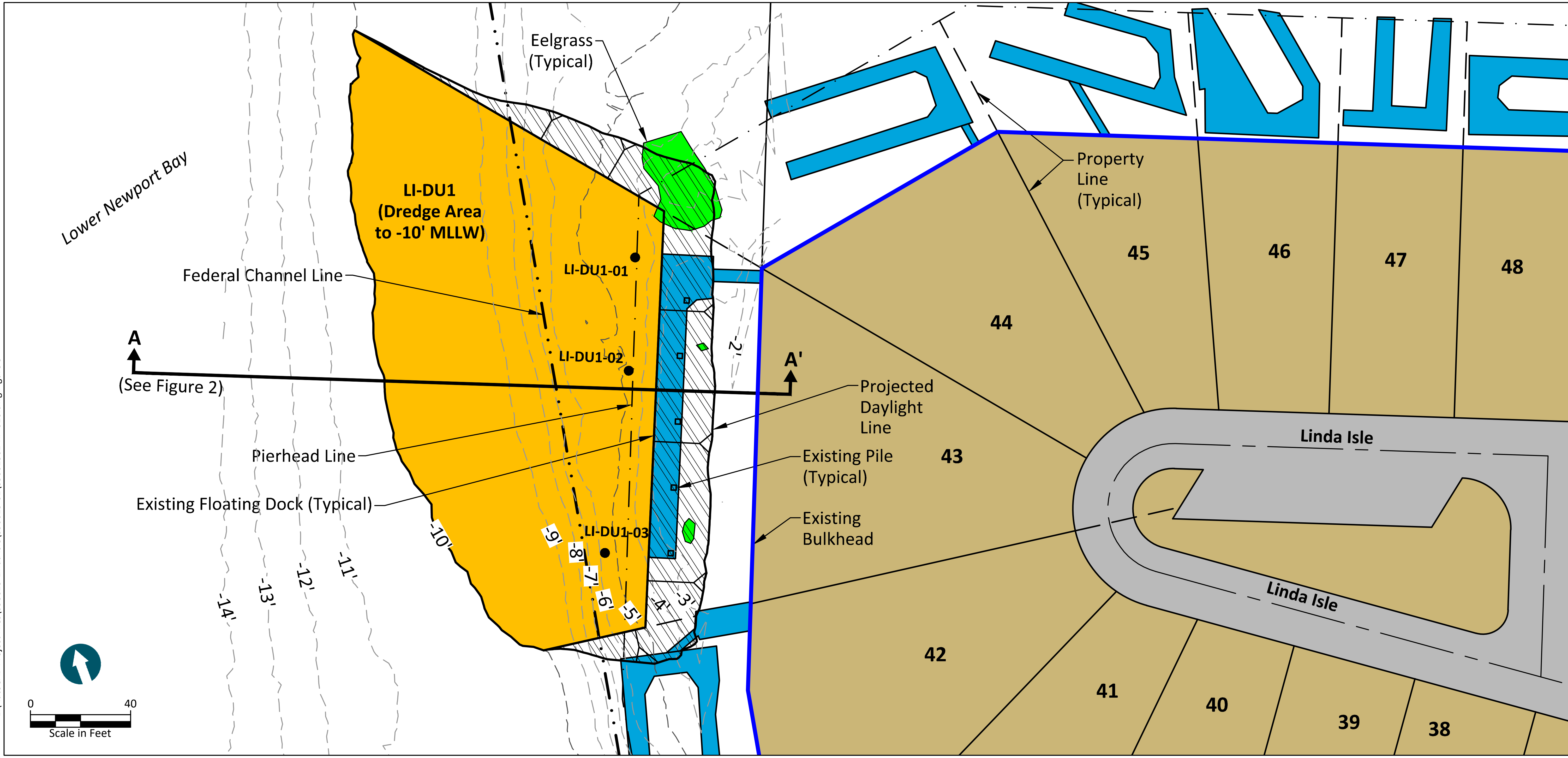
43 Linda Isle (Anchor QEA 2012)



L:\AutoCAD Project Files\090615-01\09061501-RP-010.dwg Figure 3

Jan 18, 2012 9:12am mpratschner

SOURCE: Drawing prepared from City of Newport Beach base maps and Gahagan & Bryant Associates, Inc.'s October 2010 bathymetry survey.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: mean lower low water (MLLW).

LEGEND:

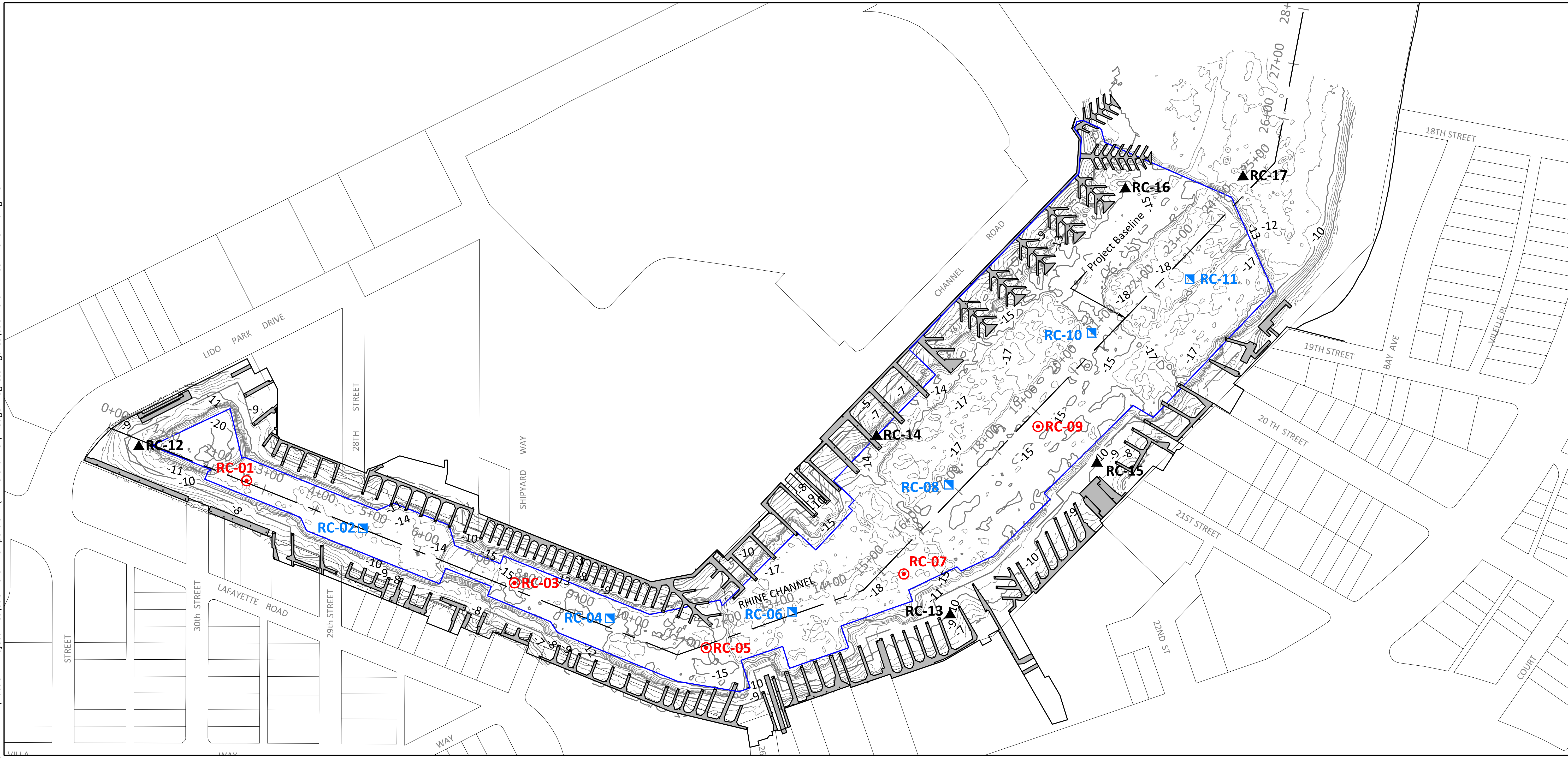
- Eelgrass
- LI-DU1 (Dredge Area to -10' MLLW)
- Projected Side Slope
- Property Line
- Projected Property Line
- Existing Bulkhead
- Existing Floating Dock/Gangway
- Federal Channel Line
- Pierhead Line
- ●LI-DU1-# Sampling Station

Volume Table	
Estimated Volume to -10' MLLW	2,300 CY
1' Paid Overdepth	800 CY
1' Unpaid Overdepth	800 CY
Total Volume	**3,900 CY**

ANCHOR QEA

Figure 3
Dredge Area and Actual Sampling Locations
43 Linda Isle Maintenance Dredging

Rhine Channel Post-Dredge Confirmatory Sampling (Anchor QEA 2013a)



L:\AutoCAD Project Files\090243-01 Newport CAD\Rhine Channel\Dredge Progress Figures\090243-01-RP-097 ACTUAL.dwg FIG 2

Nov 15, 2013 9:03am mpratschner

SOURCE: Drawing prepared from City of Newport Beach and ESRI basemaps, and all Dutra Surveys performed as of November 1, 2011.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83, feet.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

NOTES:
Contours shown are from post-dredge bathymetric survey conducted by Gahagan & Bryant Associates, Inc., on November 2, 2011.

LEGEND:

RC-# Actual Sampling Locations for Sediment Coring

▲RC-# Actual Sampling Locations for Surface Sediment

RC-# Actual Sampling Locations for Sediment Coring and Surface Sediment

-10 Post-Dredge Bathymetry

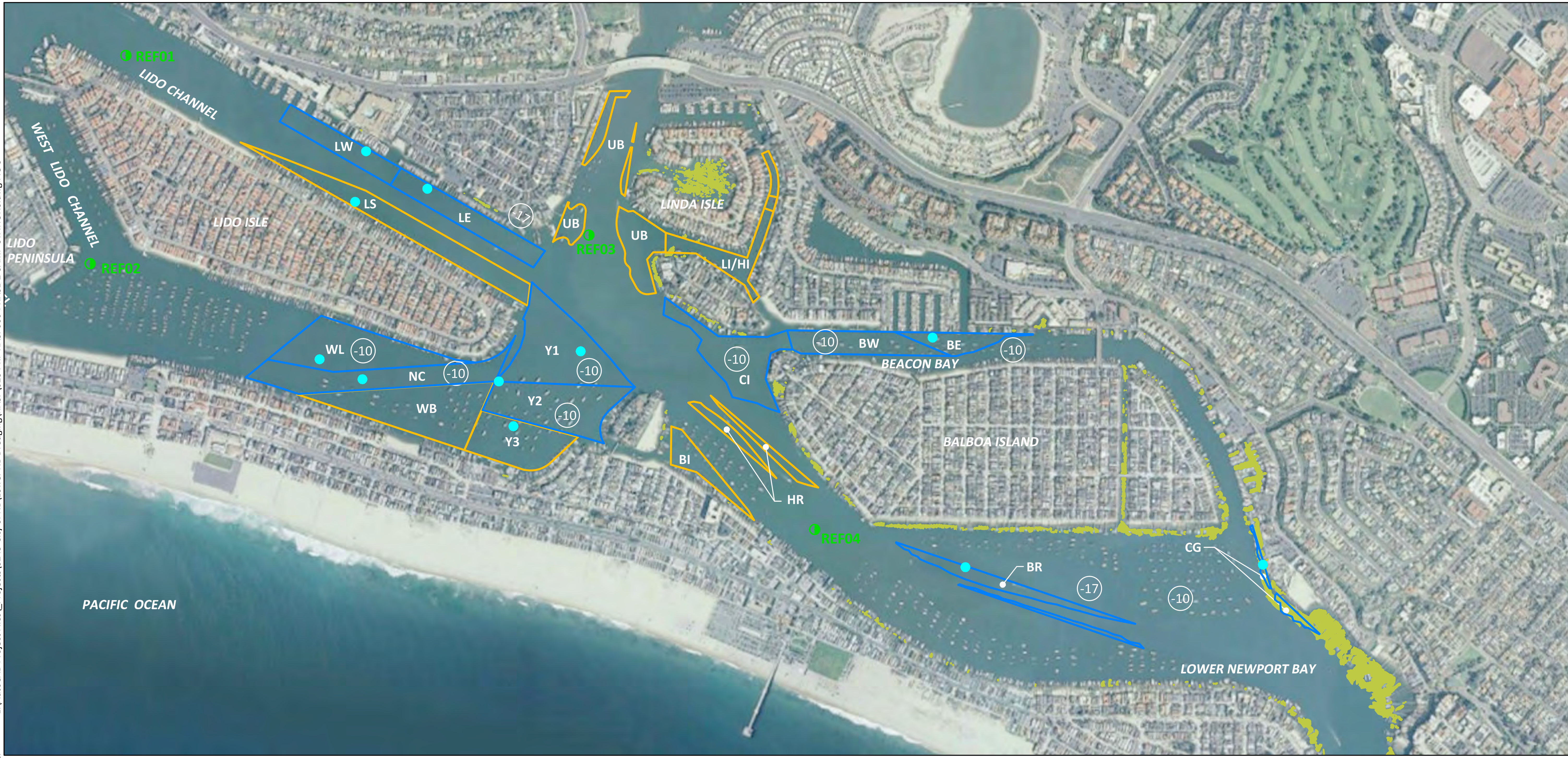
Dredge Boundary

0 180
Scale in Feet

ANCHOR QEA

Figure 2
Post-Dredge Bathymetric Data and Actual Sampling Locations
Rhine Channel Contaminated Sediment Cleanup

Lower Newport Federal Channels
Post-Dredge Sampling
(Anchor QEA 2013b)



SOURCE: Drawing prepared from Bing maps. Dredge units from U.S. Army Corps of Engineers.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

- Phase I Dredge Unit
- Phase II Dredge Unit
- -10 Dredge Depth
- REF# Reference Site
- Sampling Locations

0 1000
Scale in Feet

L:\AutoCAD Project Files_Projects\0243-City of NB\Lower NB Dredging\HASP\0234-RP HASP006-PHASE-2-SAMP-STATIONS.dwg FIG 3

Jul 19, 2013 11:52am mpratschner

ANCHOR QEA

Figure 3
Post-Dredge Sediment Sampling Locations
Lower Newport Bay Federal Dredging

Regional General Permit 54 – Preliminary Testing for Sample Compositing (Anchor QEA 2013c, 2013d)

L:\AutoCAD Project Files\090243-01 Newport CAD\Lower Newport Bay\RGP 54\090243-01-RP-0011 RGP 54 AREAS-ACTUAL OVERALL.dwg Fig 3

Oct 14, 2013 1:35pm mpratschner

SOURCE: Aerial from Bing maps. Lotlines from City of Newport Beach.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

⊙#-# Actual Sampling Locations

Area 1a
Area 1b
Area 2
Area 3
Area 4a
Area 4b
Area 5

0 1500
Scale in Feet

ANCHOR QEA

Figure 3
Actual Sampling Locations
RGP 54 Sediment Characterization

L:\AutoCAD Project Files\090243-01 Newport CAD\Lower Newport Bay\RGP 54\090243-01-RP-0011 RGP 54 AREAS-ACTUAL.dwg FIG 4

SOURCE: Aerial from Bing maps. Lotlines from City of Newport Beach.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

#-# Actual Sampling Locations
Area 1a
Area 1b

0 1,300
Scale in Feet

Oct 14, 2013 12:50pm mpratschner

ANCHOR QEA

Figure 4
Area 1 Boundary and Actual Sampling Locations
RGP 54 Sediment Characterization

L:\AutoCAD Project Files\090243-01 Newport CAD\Lower Newport Bay\RGP 54\090243-01-RP-0011 RGP 54 AREAS-ACTUAL.dwg FIG 5

Oct 14, 2013 3:13pm mpratschner

SOURCE: Aerial from Bing maps. Lotlines from City of Newport Beach.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

⊙#-# Actual Sampling Locations

Area 3

0 700
Scale in Feet

ANCHOR QEA

Figure 5
Area 2 Boundary and Actual Sampling Locations
RGP 54 Sediment Characterization

L:\AutoCAD Project Files\090243-01 Newport CAD\Lower Newport Bay\RGP 54\090243-01-RP-0011 RGP 54 AREAS-ACTUAL.dwg FIG 6

Oct 14, 2013 1:04pm mpratschner

SOURCE: Aerial from Bing maps. Lotlines from City of Newport Beach.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

⊙#-# Actual Sampling Locations

Area 3

0 800
Scale in Feet

ANCHOR QEA

Figure 6
Area 3 Boundary and Actual Sampling Locations
RGP 54 Sediment Characterization

L:\AutoCAD Project Files\090243-01 Newport CAD\Lower Newport Bay\RGP 54\090243-01-RP-0011 RGP 54 AREAS-ACTUAL.dwg FIG 7

SOURCE: Aerial from Bing maps. Lotlines from City of Newport Beach.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

⊙#-# Actual Sampling Locations

Area 4a

Area 4b

0 1,600
Scale in Feet

Oct 14, 2013 3:15pm mpratschner

ANCHOR QEA

Figure 7
Area 4 Boundary and Actual Sampling Locations
RGP 54 Sediment Characterization

SOURCE: Aerial from Bing maps. Lotlines from City of Newport Beach.
HORIZONTAL DATUM: California State Plane, Zone VI, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

⊙#-# Actual Sampling Locations

Area 5

0 500
Scale in Feet

ANCHOR QEA

Figure 8
Area 5 Boundary and Actual Sampling Locations
RGP 54 Sediment Characterization

Balboa Marina West (Newfields 2014)

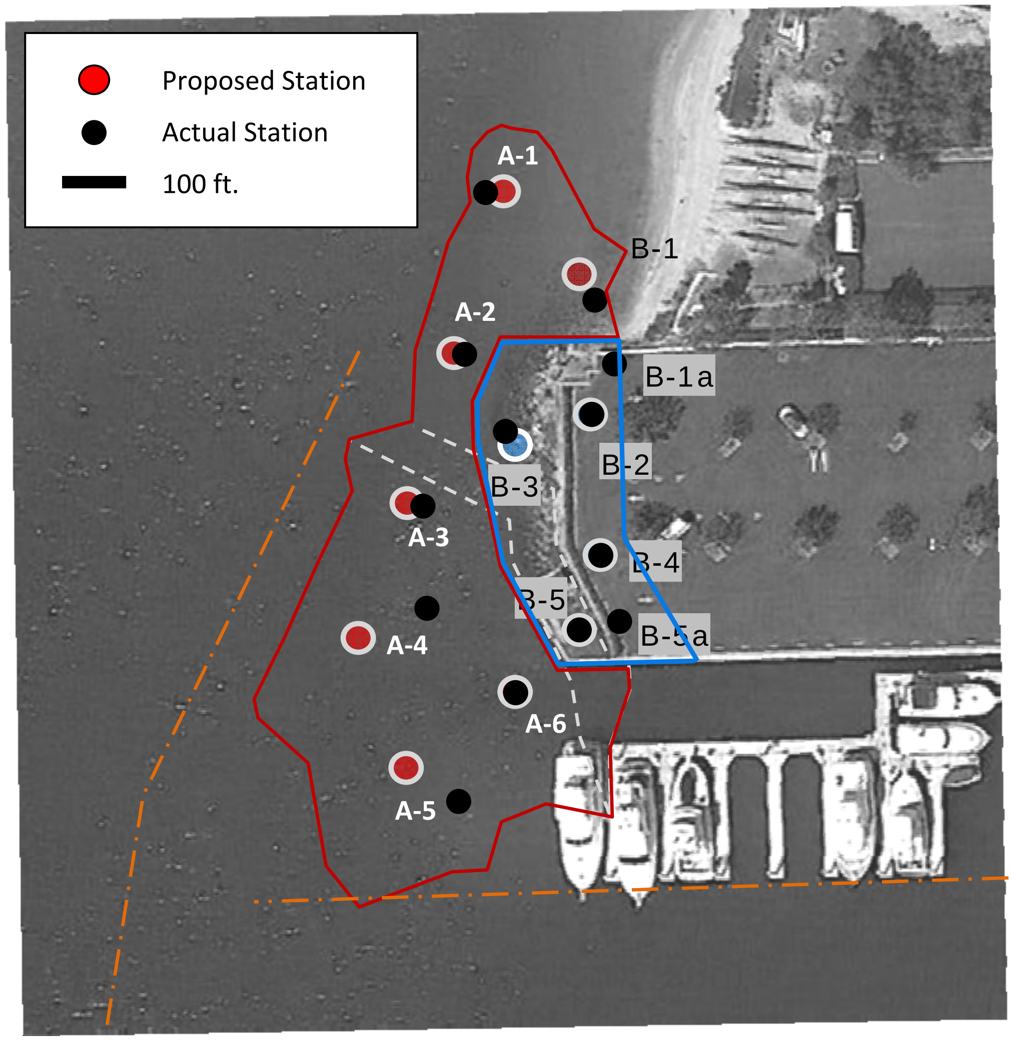
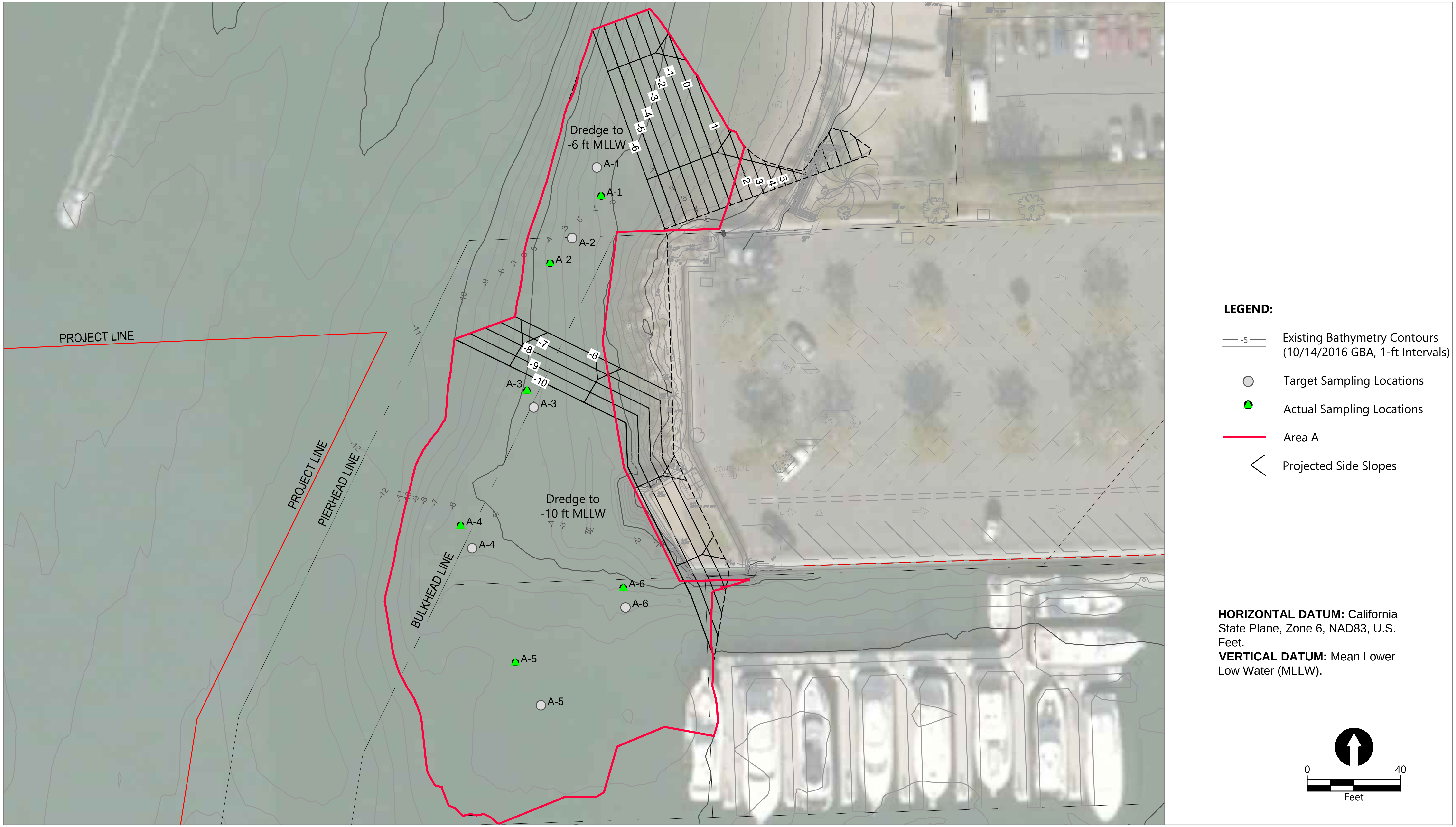


Figure 6. Station Locations for the Balboa Marina West project. The Area A boundary has been modified from the proposed sampling design to reflect the inclusion of Station B-1 in the Area A composite. See Section 3.2 for explanation.

Balboa Marina West (Anchor QEA 2017)



Publish Date: 2017/11/27 3:41 PM | User: mpratschner
Filepath: K:\Projects\0483-Irvine Co\Balboa marina West\0483-RP-006 DREDGE AND SAMPLE.dwg FIG 4

ANCHOR QEA

Figure 4
Dredge Area and Sampling Locations
Balboa Marina West Dredging and Public/Transient Dock Development
City of Newport Beach and Irvine Company

Regional General Permit 54
(Anchor QEA 2018a)

SOURCE: Aerial from Bing maps. Lotlines from City of Newport Beach.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

#-# Actual Sampling Locations (-10 ft + 2 ft Overdepth)

#-# Actual Sampling Locations (-7 ft + 1 ft Overdepth)

Area 1
Area 2
Area 3
Area 4
Area 5

0 1,500
Feet

Publish Date: 2018/06/08 12:25 PM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\RGP 54\0243-RP-014 RGP 54 ACTUAL.dwg Figure 3

ANCHOR QEA

Figure 3
Project Areas and Actual Sampling Locations
RGP 54 Sediment Characterization

SOURCE: Aerial from Bing maps. Lotlines from City of Newport Beach.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

#-# Actual Sampling Locations (-10 ft + 2 ft Overdepth)

#-# Actual Sampling Locations (-7 ft + 1 ft Overdepth)

Area 1

0 1000
Feet

Publish Date: 2018/06/08 12:37 PM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\RGP 54\0243-RP-015 RGP 54 ACTUAL_AREA1.dwg FIG 4

ANCHOR QEA

Figure 4
Project Areas and Actual Sampling Locations - Area 1
RGP 54 Sediment Characterization

SOURCE: Aerial from Bing maps. Lotlines from City of Newport Beach.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

⦿#-# Actual Sampling Locations (-10 ft + 2 ft Overdepth)

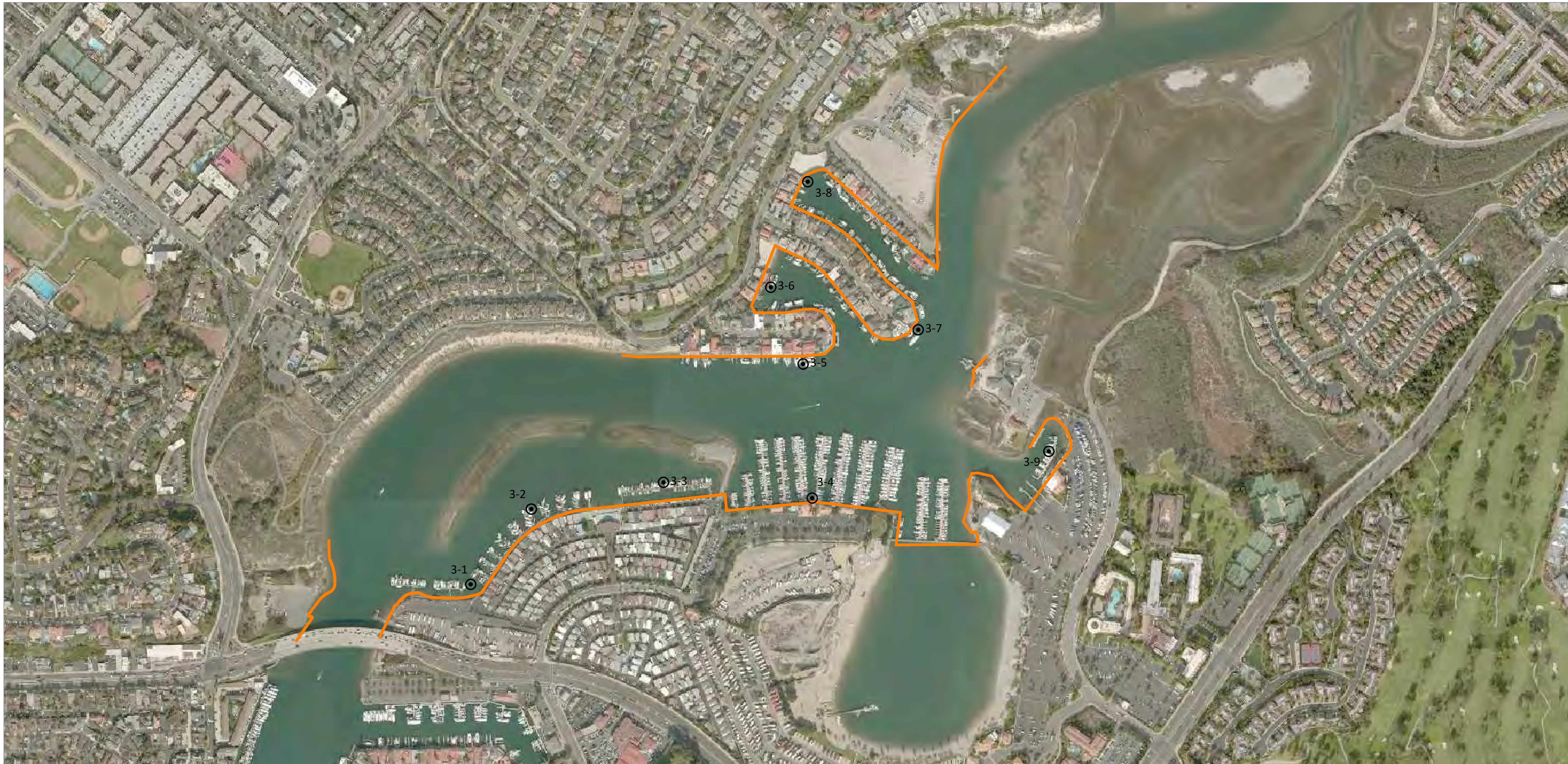
Area 2

0 500
Feet

Publish Date: 2018/06/08 12:42 PM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\RGP 54\0243-RP-016 RGP 54 ACTUAL_AREA2.dwg FIG 5

ANCHOR QEA

Figure 5
Project Areas and Actual Sampling Locations - Area 2
RGP 54 Sediment Characterization



SOURCE: Aerial from Bing maps. Lotlines from City of Newport Beach.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

⊙#-# Actual Sampling Locations (-10 ft + 2 ft Overdepth)

Area 3

0 600
Feet

Publish Date: 2018/06/08 12:47 PM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\RGP 54\0243-RP-017 RGP 54 ACTUAL_AREA3.dwg FIG 6

ANCHOR QEA

Figure 6
Project Areas and Actual Sampling Locations - Area 3
RGP 54 Sediment Characterization

SOURCE: Aerial from Bing maps. Lotlines from City of Newport Beach.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

#-# Actual Sampling Locations (-10 ft + 2 ft Overdepth)

#-# Actual Sampling Locations (-7 ft + 1 ft Overdepth)

Area 4

0 1000
Feet

Publish Date: 2018/06/08 1:17 PM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\RGP 54\0243-RP-018 RGP 54 ACTUAL_AREA4.dwg FIG 7

ANCHOR QEA

Figure 7
Project Areas and Actual Sampling Locations - Area 4

SOURCE: Aerial from Bing maps. Lotlines from City of Newport Beach.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

⦿#-# Actual Sampling Locations (-10 ft + 2 ft Overdepth)

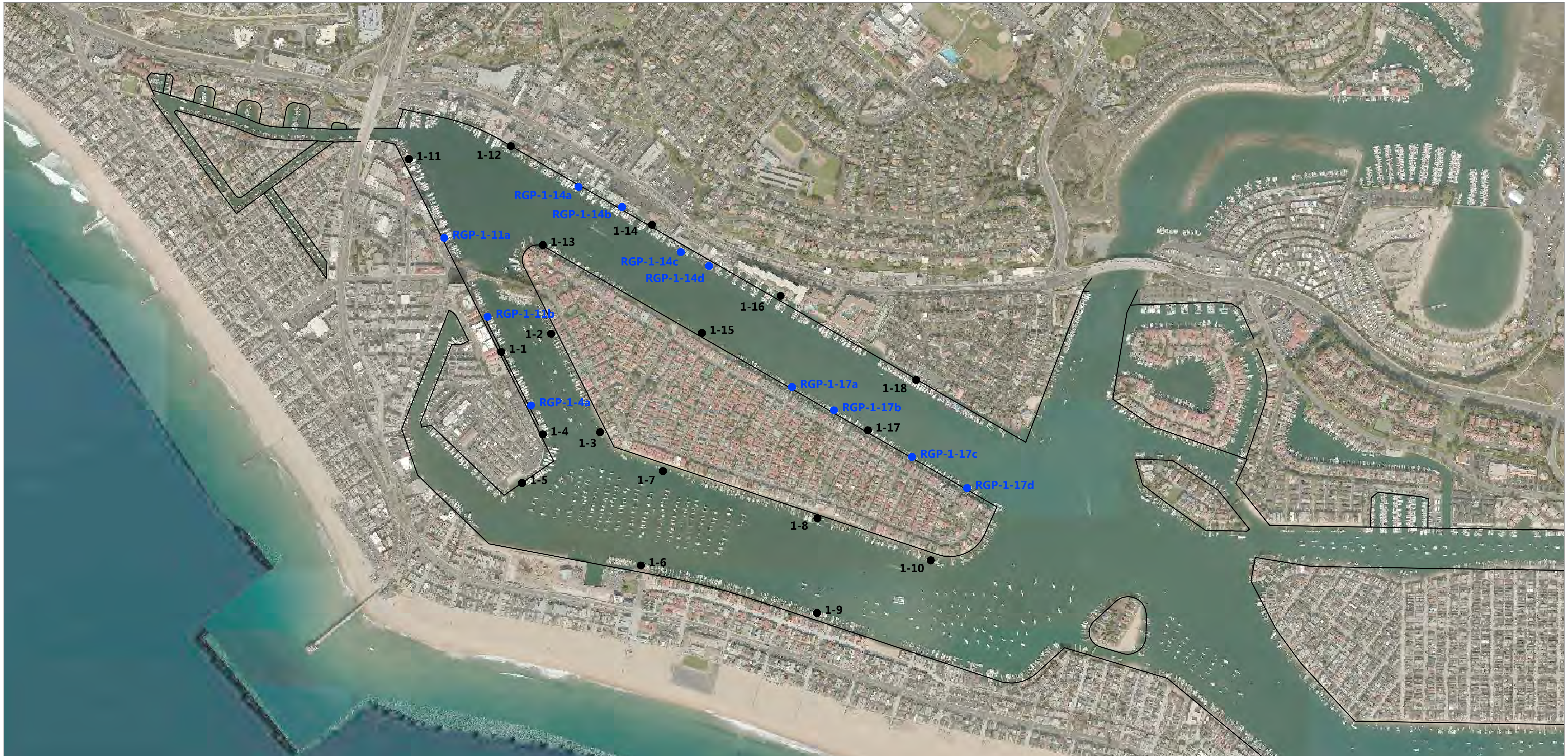
Area 5

0 500
Feet

Publish Date: 2018/06/08 1:22 PM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\RGP 54\0243-RP-019 RGP 54 ACTUAL_AREA5.dwg FIG 8

ANCHOR QEA

Figure 8
Project Areas and Actual Sampling Locations - Area 5
RGP 54 Sediment Characterization



SOURCE: Aerial from Bing maps. Lotlines from City of Newport Beach.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

●# Additional Sampling Locations from April 2018 (-10 ft MLLW + 2 ft Overdepth)

●# Initial Sampling Locations from September and October 2017

0 1000
Feet

Publish Date: 2018/06/08 1:29 PM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\RGP 54\0243-RP-020 MERCURY AREA 1.dwg FIG 9

ANCHOR QEA

Figure 9
Additional Sampling Locations - Area 1
RGP 54 Sediment Characterization

SOURCE: Aerial from Bing maps. Lotlines from City of Newport Beach.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

- ● # Additional Sampling Locations from April 2018 (-10 ft MLLW + 2 ft Overdepth)
- ● # Initial Sampling Locations from September and October 2017

0 500
Feet

Publish Date: 2018/06/08 1:41 PM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\RGP 54\0243-RP-021 MERCURY AREA 5.dwg FIG 10

ANCHOR QEA

Figure 10
Additional Sampling Locations - Area 5
RGP 54 Sediment Characterization

Lower Newport Federal Channels Dredging (Anchor QEA 2018b)

SOURCE: Drawing prepared from Bing maps. Bathymetric contours from U.S. Army Corps of Engineers survey dated June 2017. Dredge units from U.S. Army Corps of Engineers.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

- Dredge Unit Boundary
- (-20) Design Depth
- Dredge Footprint
- —-10— Existing Bathymetry

Publish Date: 2017/12/04 11:56 AM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\Dredging Options\0243-RP-011 PROPOSED SAMPLING.dwg FIG 4

ANCHOR QEA

Figure 4
Overview of Dredge Units and Bathymetry
Lower Newport Bay Federal Channels Dredging

SOURCE: Drawing prepared from Bing maps. Bathymetric contours from U.S. Army Corps of Engineers survey dated June 2017. Dredge units from U.S. Army Corps of Engineers.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

- Dredge Unit Boundary
- (-20) Design Depth
- Dredge Footprint
- ⊙-# Actual Sampling Location
- -10 Existing Bathymetric Contour
- -16.5 Existing Bathymetric Sounding

Publish Date: 2018/02/09 7:40 AM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\Dredging Options\0243-RP-015A ACTUAL SAMPLING.dwg FIG 6

ANCHOR QEA

Figure 5
Dredge Unit, Bathymetry, and Actual Sampling Locations - Turning Basin
Lower Newport Bay Federal Channels Dredging

SOURCE: Drawing prepared from Bing maps. Bathymetric contours from U.S. Army Corps of Engineers survey dated June 2017. Dredge units from U.S. Army Corps of Engineers.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

- Dredge Unit Boundary
- (-20) Design Depth
- Dredge Footprint
- ⊙-# Actual Sampling Location
- —-10— Existing Bathymetric Contour
- -16.5 Existing Bathymetric Sounding

0 300 Feet

Publish Date: 2018/02/09 9:06 AM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\Dredging Options\0243-RP-015B ACTUAL SAMPLING.dwg FIG 7

ANCHOR QEA

Figure 6
Dredge Unit, Bathymetry, and Actual Sampling Locations - Main Channel North 1
Lower Newport Bay Federal Channels Dredging

SOURCE: Drawing prepared from Bing maps. Bathymetric contours from U.S. Army Corps of Engineers survey dated June 2017. Dredge units from U.S. Army Corps of Engineers.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

- Dredge Unit Boundary
- (-20) Design Depth
- Dredge Footprint
- ⊙-# Actual Sampling Location
- —-10— Existing Bathymetric Contour
- -16.5 Existing Bathymetric Sounding

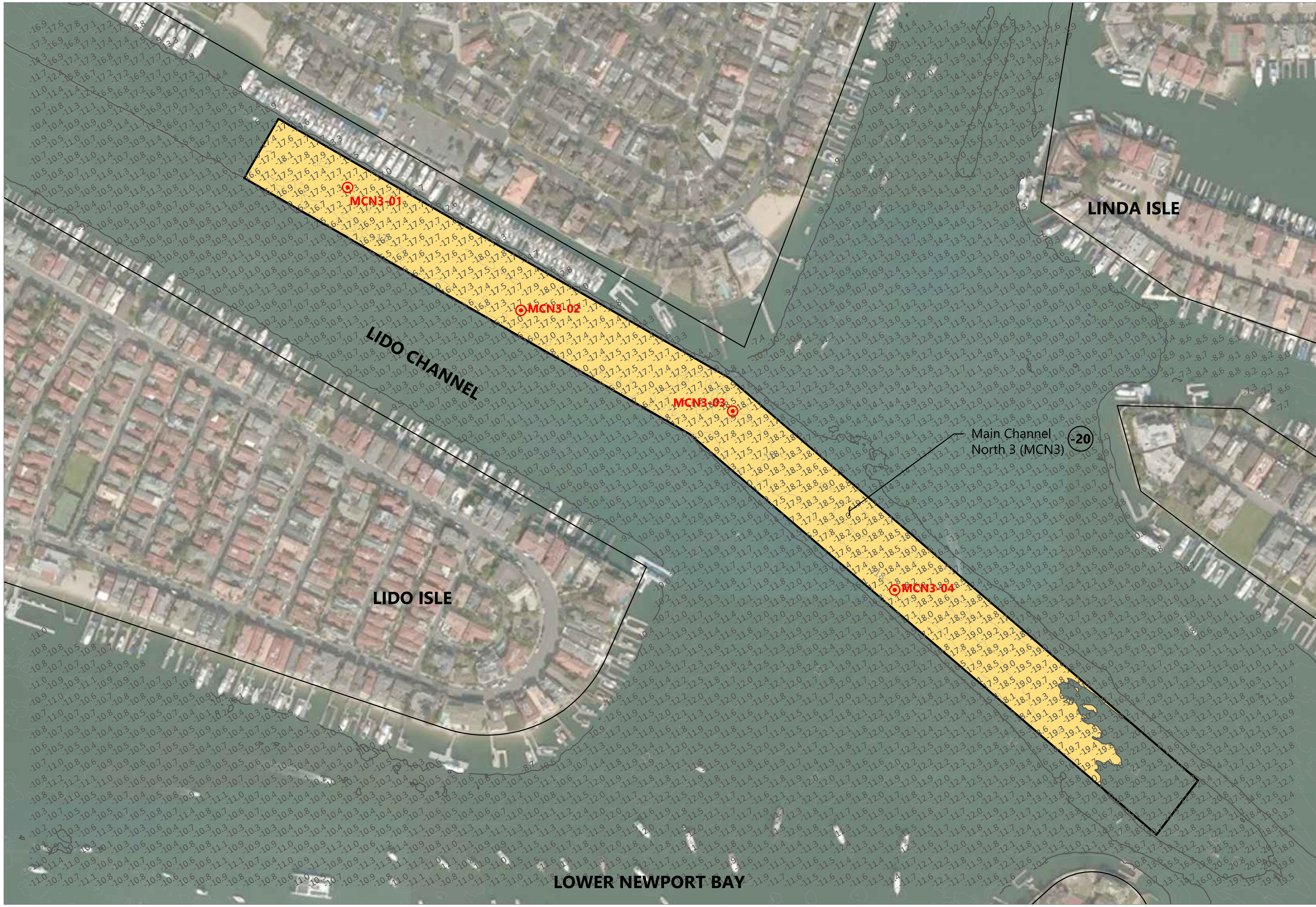
0 300
Feet

Publish Date: 2018/02/09 9:11 AM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\Dredging Options\0243-RP-015C ACTUAL SAMPLING.dwg FIG 8

ANCHOR QEA

Figure 7
Dredge Unit, Bathymetry and Actual Sampling Locations - Main Channel North 2

Lower Newport Bay Federal Channels Dredging



SOURCE: Drawing prepared from Bing maps. Bathymetric contours from U.S. Army Corps of Engineers survey dated June 2017. Dredge units from U.S. Army Corps of Engineers.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

- Dredge Unit Boundary
- (-20) Design Depth
- Dredge Footprint
- ⊙-# Actual Sampling Location
- —-10— Existing Bathymetric Contour
- -16.5 Existing Bathymetric Sounding

Publish Date: 2018/02/09 10:36 AM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\Dredging Options\0243-RP-015D ACTUAL SAMPLING.dwg FIG 9

ANCHOR QEA

Figure 8
Dredge Unit, Bathymetry, and Actual Sampling Locations - Main Channel North 3

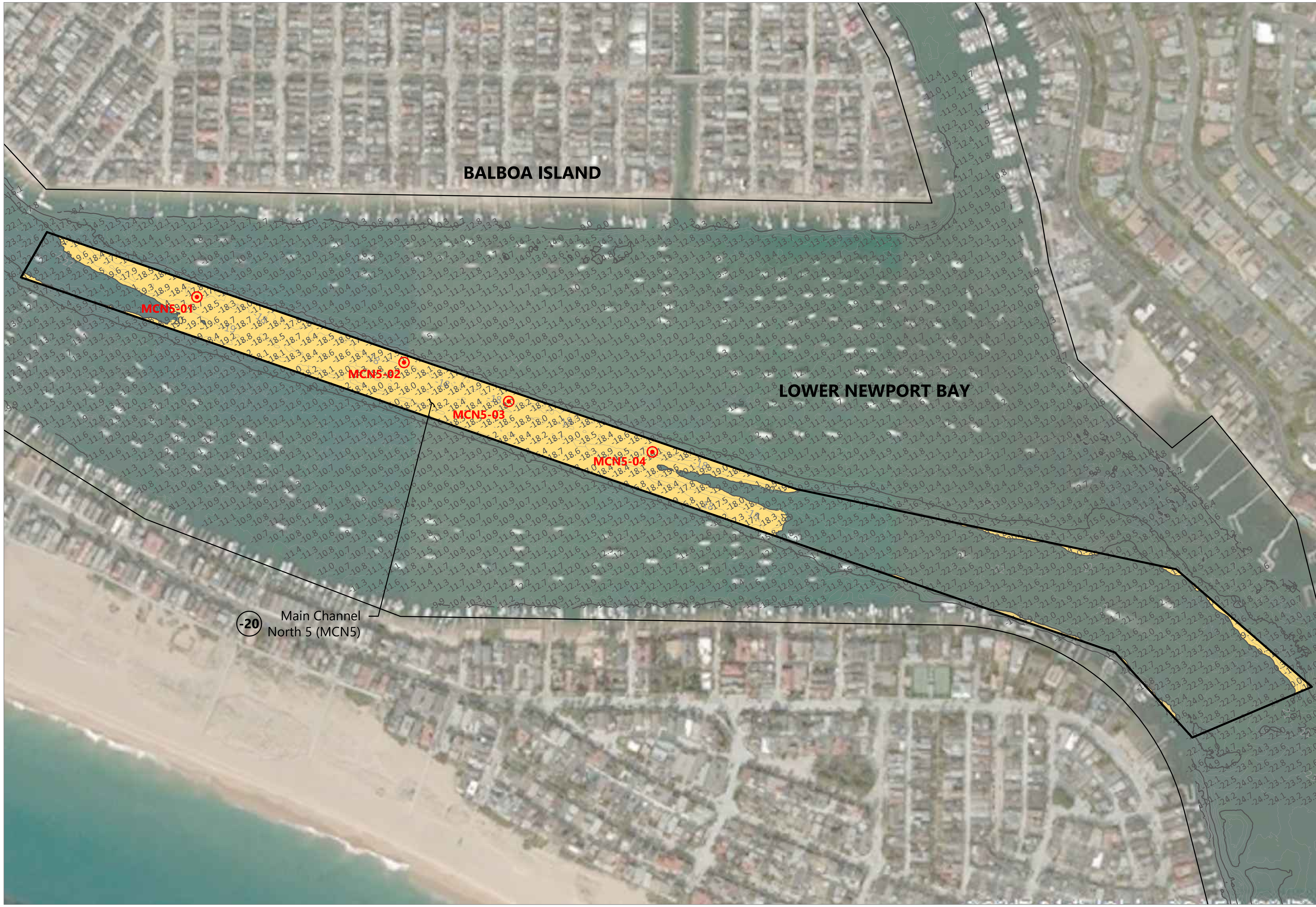
SOURCE: Drawing prepared from Bing maps. Bathymetric contours from U.S. Army Corps of Engineers survey dated June 2017. Dredge units from U.S. Army Corps of Engineers.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

- Dredge Unit Boundary
- (-20) Design Depth
- Dredge Footprint
- ⊙-# Actual Sampling Location
- —-10— Existing Bathymetric Contour
- -16.5 Existing Bathymetric Sounding

0 300
Feet

Figure 9
Dredge Unit, Bathymetry, and Actual Sampling Locations - Main Channel North 4



SOURCE: Drawing prepared from Bing maps. Bathymetric contours from U.S. Army Corps of Engineers survey dated June 2017. Dredge units from U.S. Army Corps of Engineers.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

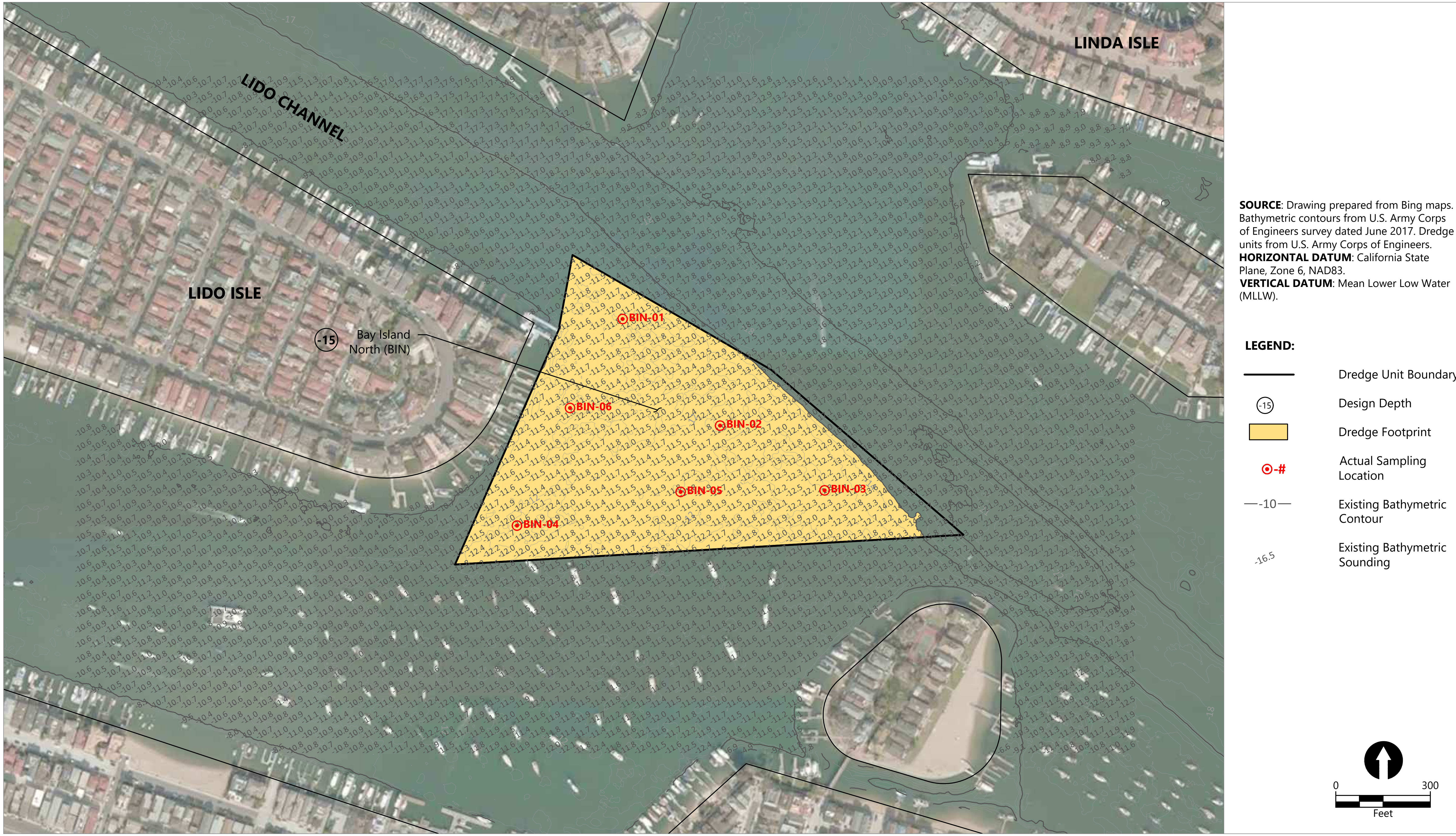
- Dredge Unit Boundary
- (-20) Design Depth
- Dredge Footprint
- ⊙-# Actual Sampling Location
- —-10— Existing Bathymetric Contour
- -16.5 Existing Bathymetric Sounding

0 400
Feet

Publish Date: 2018/02/09 12:53 PM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\Dredging Options\0243-RP-015J ACTUAL SAMPLING.dwg FIG 15

ANCHOR QEA

Figure 10
Dredge Unit, Bathymetry, and Actual Sampling Locations - Main Channel North 5
Lower Newport Bay Federal Channels Dredging



Publish Date: 2018/02/09 11:09 AM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\Dredging Options\0243-RP-015E ACTUAL SAMPLING.dwg FIG 10

ANCHOR QEA

Figure 11
Dredge Unit, Bathymetry, and Actual Sampling Locations - Bay Island North

SOURCE: Drawing prepared from Bing maps. Bathymetric contours from U.S. Army Corps of Engineers survey dated June 2017. Dredge units from U.S. Army Corps of Engineers.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

- Dredge Unit Boundary
- (-15) Design Depth
- Dredge Footprint
- ⊙-# Actual Sampling Location
- —-10— Existing Bathymetric Contour
- -16.5 Existing Bathymetric Sounding

Publish Date: 2018/02/09 3:35 PM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\Dredging Options\0243-RP-015G ACTUAL SAMPLING.dwg FIG 12

ANCHOR QEA

Figure 12
Dredge Unit, Bathymetry, and Actual Sampling Locations - Bay Island Middle East

SOURCE: Drawing prepared from Bing maps. Bathymetric contours from U.S. Army Corps of Engineers survey dated June 2017. Dredge units from U.S. Army Corps of Engineers.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

- Dredge Unit Boundary
- (-15) Design Depth
- Dredge Footprint
- ⊙-# Actual Sampling Location
- —-10— Existing Bathymetric Contour
- -16.5 Existing Bathymetric Sounding

0 300
Feet

Publish Date: 2018/02/09 3:57 PM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\Dredging Options\0243-RP-015F ACTUAL SAMPLING.dwg FIG 11

ANCHOR QEA

Figure 13
Dredge Unit, Bathymetry, and Actual Sampling Locations - Bay Island Middle West
Lower Newport Bay Federal Channels Dredging

SOURCE: Drawing prepared from Bing maps. Bathymetric contours from U.S. Army Corps of Engineers survey dated June 2017. Dredge units from U.S. Army Corps of Engineers.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

- Dredge Unit Boundary
- (-15) Design Depth
- Dredge Footprint
- ⊙-# Actual Sampling Location
- —-10— Existing Bathymetric Contour
- -16.5 Existing Bathymetric Sounding

0 300
Feet

Publish Date: 2018/02/09 12:29 PM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\Dredging Options\0243-RP-015H ACTUAL SAMPLING.dwg FIG 13

ANCHOR QEA

Figure 14
Dredge Unit, Bathymetry, and Actual Sampling Locations - Bay Island South

SOURCE: Drawing prepared from Bing maps. Bathymetric contours from U.S. Army Corps of Engineers survey dated June 2017. Dredge units from U.S. Army Corps of Engineers.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

- Dredge Unit Boundary
- (-20) Design Depth
- Dredge Footprint
- ⊙-# Actual Sampling Location
- —-10— Existing Bathymetric Contour
- -16.5 Existing Bathymetric Sounding

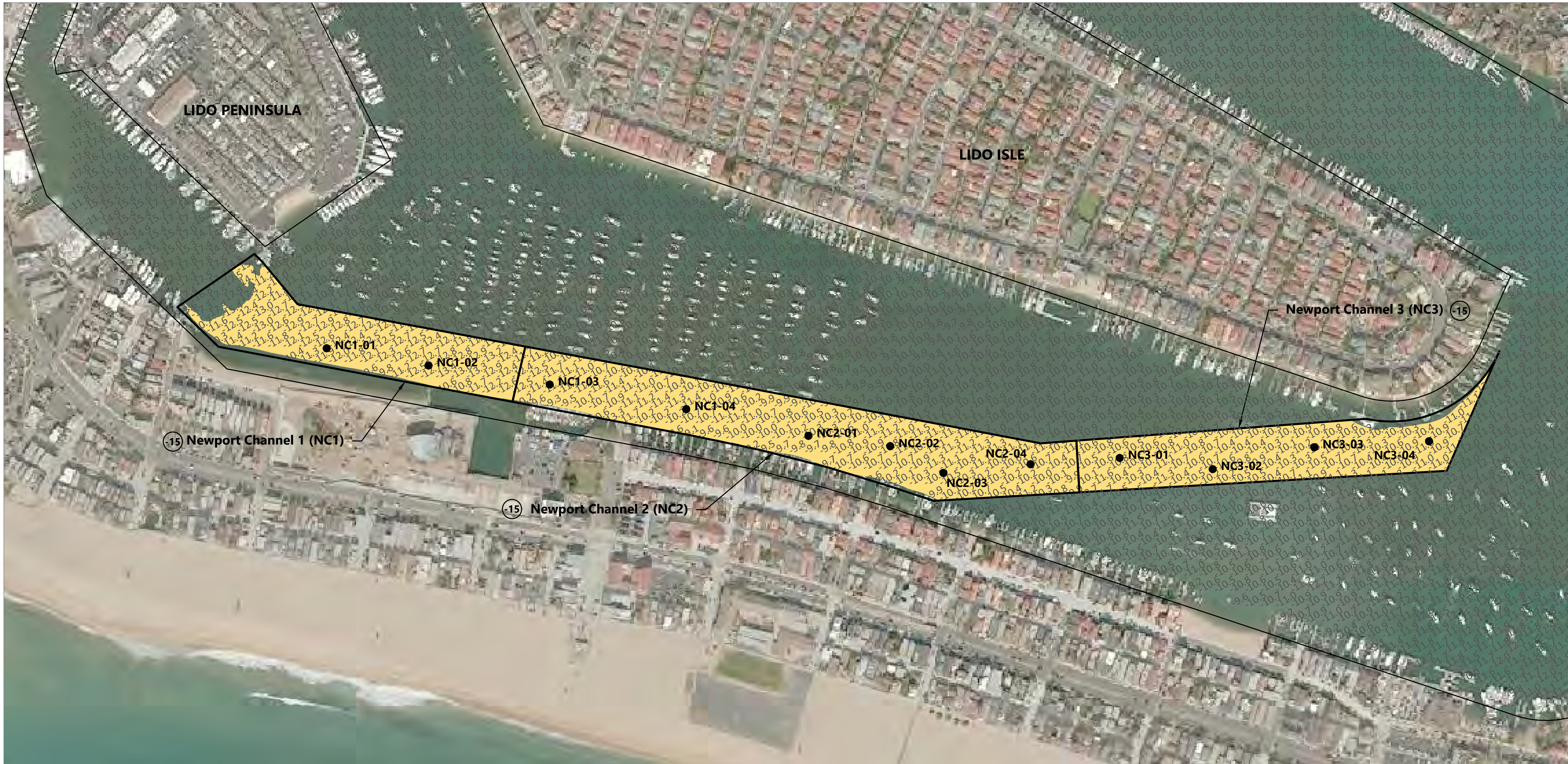
0 500
Feet

Publish Date: 2018/02/09 1:09 PM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\Dredging Options\0243-RP-015K ACTUAL SAMPLING.dwg FIG 16

ANCHOR QEA

Figure 15
Dredge Unit, Bathymetry, and Actual Sampling Locations - Entrance Channel

Newport Channel
(Nautilus 2019; Anchor QEA 2019)



SOURCE: Drawing prepared from Bing maps. Bathymetric contours from U.S. Army Corps of Engineers survey dated June 2017. Dredge units from U.S. Army Corps of Engineers.
HORIZONTAL DATUM: California State Plane, Zone 6, NAD83.
VERTICAL DATUM: Mean Lower Low Water (MLLW).

LEGEND:

- Dredge Unit Boundary
- (-15) Design Depth
- Dredge Footprint
- -12.8 Existing Bathymetry
- ●NC-# Actual Sampling Location

0 400
Feet

Publish Date: 2019/04/12 12:37 PM | User: mpratschner
Filepath: K:\Projects\0243-City of Newport Beach\Dredging Options\0243-RP-018 NEWPORT CHANNEL.dwg FIG 1

ANCHOR QEA

Figure 1
Dredge Units, Bathymetry, and Actual Sampling Locations - Newport Channel
Lower Newport Bay Federal Channels Dredging

Attachment B
Mercury Concentrations in Sediment from Individual Stations (Newfields 2009b)

Table 3-3. Mercury Concentrations in Sediment from Individual Stations

Area	Station	Mercury (mg/kg)
BR	1	0.22
	2	0.35
	3	0.17
	4	0.27
	5	0.26
	6	0.17
	6A	0.27
	7	0.16
	8	0.17
	8A	0.15
HIR	9	0.43
	10	0.32
	11	0.13
	12	0.48
	12A	0.29
	13	0.49
	13A	0.58
	14	0.35
	15	0.13
	15A	0.34
LIN	16	1.63
	16A	0.89
	17	1.61
	18	1.09
	19	1.61
	20	0.53
	21	0.28
	22	0.5
LIS	23	0.26
	23A	0.55
	23B	1.38
	23C	0.84
	23D	--
	24	0.37
	25	0.97
	25A	0.26
WLB	26	1.19
	27	0.41
	28	0.31
	29	0.23
	30	0.66
	30 A	0.41
	31	0.38
	32	0.35

Area	Station	Mercury (mg/kg)
BICI	33	0.14
	34	0.17
	35	0.45
	36	0.32
	37	0.29
	38	0.88
	39	0.57
	40	0.57
	41	0.80
BC	42	0.16
	43	0.58
	44	0.60
	44A	3.01
	45	2.60
	46	0.53
	46A	0.42
	47	0.11
UNC	48	0.71
	49	0.13
	50	ND
	51	ND
	52	ND
	53	ND
	53A	0.42
YAN	54	0.48
	55	0.35
	56	0.23
	57	0.15
	58	0.49

Table 3-3 Continued.

Area	Station	Mercury (mg/kg dry)
YAM-U	59	0.28
	60	0.13
	61	0.12
	62	0.15
	63	0.10
	64	0.15
	65	0.13
	66	0.11
YAS-U	67	0.13
	68	0.12
	69	0.14
	70	ND
	71	0.13
	72	ND
	73	0.13

Area	Station	Mercury (mg/kg dry)
YAM-L	59	2.22
	60	0.35
	61	2.25
	62	1.17
	63	0.23
	64	1.28
	65	0.19
	66	0.11
YAS-L	67	0.30
	68	0.58
	69	0.20
	70	ND
	71	0.28
	72	0.12
	73	0.56

ND: No data, archive sample unavailable for analysis.

Figure 3-1. Mercury concentrations (mg/kg) for Individual Stations, Lower Newport Bay 2009.

Figure 3-2. Mercury concentrations (mg/kg) for Individual Stations, Lower Newport Bay 2009.

Figure 3-3. Mercury concentrations (mg/kg) for Individual Stations, Lower Newport Bay 2009.

Figure 3-4. Mercury concentrations (mg/kg) for Individual Stations, Lower Newport Bay 2009; U: upper portion of core; L: lower portion of core.

Appendix I
Mass Loading Calculations

9700 Research Drive
Irvine, California 92618
949.347.2780

Memorandum

April 18, 2019

To: Chris Miller, City of Newport Beach

From: Andrew Martin, Adam Gale, Chris Osuch, and Steve Cappellino, Anchor QEA, LLC

Re: Lower Newport Bay Federal Channels Maintenance Dredging – Mass Loading Calculations

As requested by the U.S. Environmental Protection Agency, Anchor QEA calculated mass loadings of mercury and total polychlorinated biphenyls (PCBs) to support the Lower Newport Bay Federal Channels maintenance dredged material evaluation. Table 1 shows results from these calculations for each dredge unit (DU), as well as a summary of the mass loadings of mercury and total PCBs for the following scenarios:

- The entire project (all DUs)
- All DUs except Turning Basin and Newport Channel 1
- Only Turning Basin and Newport Channel 1 DUs

The calculations show that approximately 50% of the mercury loadings and nearly 40% of the total PCB loadings are attributable to the Turning Basin and Newport Channel 1 DUs.

Please note that this memorandum has been developed for the purpose of presenting an estimate of mass loading for both total PCBs and mercury based strictly on the results of two sediment sampling events conducted in January of 2018 and 2019. The mass estimates were derived through a series of calculations using anticipated dredge volumes (including overdredge estimates of 2 feet), average analytical results for total solids and contaminant concentrations, and reasonable assumptions of the density of solids and porewater in sediment based on similar samples from Newport Harbor. While the mass has been estimated based on these parameters, they should still be considered approximate values that can vary based on a number of variables, including sample location (i.e., site variability), field and laboratory homogenization variability, and laboratory methods. Considering this potential variability in the input parameters, the calculated mass loadings for total PCBs and mercury presented in this memorandum should be used only for making relative comparisons between DUs and for estimating overall magnitude of loading potential, and not for any other purpose.

Approach to Mass Loading Calculation

The following approach was used to calculate mass loading of mercury and total PCBs from dredged material proposed as part of the Lower Newport Bay Federal Channels project.

Known Values

- Total dredged material volume (V_t, in cubic yards [cy]) generated using AutoCAD for known design depths + overdredge depths for specific proposed dredge footprints

- For the purpose of these calculations, units of cubic meters (m^3) are more useful. The conversion factor from cy to m^3 is determined as:

Equation 1

$$1\ \text{cy}\ \times \frac{(36\ \text{inches})^3}{\text{cy}} \times \frac{(2.54\ \text{cm})^3}{(\text{inches})^3} \times \frac{\text{m}^3}{100\ \text{cm}^3}\ = 0.76455\ \text{m}^3$$

- Mercury (Hg) concentrations (in milligrams per kilogram [mg/kg]) dry weight were provided by Eurofins Calscience, Inc. (ECI)
- Total PCB concentrations (in micrograms per kilogram [µg/kg]) dry weight were provided by ECI
- Total solids content of dredged material (S in percent of mass [%]) were provided by ECI

Estimated/Assumed Values

- Density of solids in dredged material (ρ_s in grams per cubic centimeter [g/cm^3]) as derived from specific gravity (SG) values
  - SG of solids (unitless value) was estimated from several Newport Bay and other regional sediment or dredged material characterization projects:
    - Newport Bay Regional General Permit 54 (2011)
      - Range 2.67 to 2.69
    - Balboa Marina West (2014)
      - Range 2.66 to 2.69
    - Port of Long Beach Pier T/S (2014)
      - Range 2.67 to 2.74
  - A value of 2.68 was selected based on the above measured values, with emphasis given to Newport Bay-specific values over other regional values measured
  - SG is the ratio of the density of a substance to a standard, typically assumed to be pure water, which has a density of 1.00 g/cm^3
  - The density of solids in dredged material (ρ_s), therefore, is calculated as:

Equation 2

$$2.68\ \times 1.00 \frac{\text{g}}{\text{cm}^3} = 2.68 \frac{\text{g}}{\text{cm}^3}$$

  - For the purpose of these calculations, units of kilograms per cubic meter (kg/m^3) are more useful. The conversion factor from g/cm^3 to kg/m^3 is determined as:

Equation 3

$$1.00\,\frac{\mathrm{g}}{\mathrm{cm}^3} \times 0.001\,\frac{\mathrm{kg}}{\mathrm{g}} \times 1{,}000{,}000\,\frac{\mathrm{cm}^3}{\mathrm{m}^3} = 1{,}000\,\frac{\mathrm{kg}}{\mathrm{m}^3}$$

– As such, a more useful value of density of solids in dredged material (ρ_s) is:

Equation 4

$$2.68\,\frac{\mathrm{g}}{\mathrm{cm}^3} \times 1{,}000 = 2{,}680\,\frac{\mathrm{kg}}{\mathrm{m}^3}$$

- Density of porewater in sediment (ρ_w) in kg/m^3 is assumed to be equivalent to the density of saltwater for average temperature and salinity conditions of 18°C and 32 parts per thousand, respectively, which is approximately 1,023 kg/m^3 (Pond and Pickard 1983)

Key Assumption

Because analytical chemistry concentrations are provided in mg/kg dry weight, the mass loading calculation assumes 100% of the contaminant is bound to the solid (particulate) portion of the sample. As such, total dredged material volumes were adjusted based on total solids measurements.

Approach

Using the CAD-generated volumes for each DU, the analytical-laboratory-measured values for total solids, and the assumed values for density of solids and porewater in dredged material, the volume of solids in dredged material (V_s; m^3) was calculated. The V_s was derived by algebraically manipulating the following fundamental equations:

Equation 5

$$\rho_t = \frac{M_t}{V_t}$$

where:

ρ_t	=	Density total
M_t	=	Mass total
V_t	=	Volume total

Equation 6

$$\rho_w = \frac{M_w}{V_w}$$

where:

ρ_w	=	Density water
M_w	=	Mass water
V_w	=	Volume water

Equation 7

$$\rho_s = \frac{M_s}{V_s}$$

where:

ρ_s	=	Density solids
M_s	=	Mass solids
V_s	=	Volume solids

Equation 8

$$M_t = M_s + M_w$$

where:

M_t	=	Mass total
M_s	=	Mass solids
M_w	=	Mass water

Equation 9

$$V_t = V_s + V_w$$

where:

V_t	=	Volume total
V_s	=	Volume solids
V_w	=	Volume water

First, the mass of solids (M_s) needs to be defined relative to the total solids content (S) and mass of water (M_w):

Equation 10

$$M_s = S \times M_t$$

The following may then be derived:

Equation 11

$$M_w = (1 - S) \times M_t$$

Rearranging Equations 10 and 11 and solving for M_t results in:

Equation 12

$$M_t = \frac{M_s}{S} = \frac{M_w}{(1 - S)}$$

Mass of solids can then be defined as:

Equation 13

$$M_s = \frac{M_w \times S}{(1 - S)}$$

Rearranging Equation 7 and solving for M_s results in:

Equation 14

$$M_s = \rho_s \times V_s$$

The M_s from Equations 13 and 14 can then be made equal:

Equation 15

$$\rho_s \times V_s = \frac{M_w \times S}{(1 - S)}$$

Solving for V_s results in:

Equation 16

$$V_s = \frac{M_w \times S}{((1 - S) \times \rho_s)}$$

Rearranging Equation 6 and solving for M_w results in:

Equation 17

$$M_w = \rho_w \times V_w$$

Substituting M_w into Equation 16 results in:

Equation 18

$$V_s = \frac{(\rho_w \times V_w \times S)}{((1 - S) \times \rho_s)}$$

Rearranging Equation 9 and solving for V_w results in:

Equation 19

$$V_w = V_t - V_s$$

Substituting V_w into Equation 18 results in:

Equation 20

$$V_s = \frac{(\rho_w \times (V_t - V_s) \times S)}{((1 - S) \times \rho_s)}$$

Using the distributive property of multiplication over subtraction, Equation 20 is then equal to:

Equation 21

$$V_s = \frac{(\rho_w \times V_t \times S) - (\rho_w \times V_s \times S)}{((1 - S) \times \rho_s)}$$

Similarly, Equation 21 is then equal to:

Equation 22

$$V_s = \frac{(\rho_w \times V_t \times S)}{((1 - S) \times \rho_s)} - \frac{(\rho_w \times V_s \times S)}{((1 - S) \times \rho_s)}$$

Rearranging Equation 22 results in:

Equation 23

$$\mathrm{V_s} + \frac{(\rho_\mathrm{w} \times \mathrm{V_s} \times \mathrm{S})}{((1 - \mathrm{S}) \times \rho_\mathrm{s})} = \frac{(\rho_\mathrm{w} \times \mathrm{V_t} \times \mathrm{S})}{((1 - \mathrm{S}) \times \rho_\mathrm{s})}$$

The V_s term may be multiplied by a value equivalent to 1, using the denominator of both fractions in Equation 23 as both the numerator and denominator:

Equation 24

$$\frac{(\mathrm{V_s} \times ((1 - \mathrm{S}) \times \rho_\mathrm{s}))}{((1 - \mathrm{S}) \times \rho_\mathrm{s})} + \frac{(\rho_\mathrm{w} \times \mathrm{V_s} \times \mathrm{S})}{((1 - \mathrm{S}) \times \rho_\mathrm{s})} = \frac{(\rho_\mathrm{w} \times \mathrm{V_t} \times \mathrm{S})}{((1 - \mathrm{S}) \times \rho_\mathrm{s})}$$

Multiplying all the terms by $((1 - \mathrm{S}) \times \rho_\mathrm{s})$, the equation becomes:

Equation 25

$$(\mathrm{V_s} \times ((1 - \mathrm{S}) \times \rho_\mathrm{s})) + (\rho_\mathrm{w} \times \mathrm{V_s} \times \mathrm{S}) = (\rho_\mathrm{w} \times \mathrm{V_t} \times \mathrm{S})$$

This is equivalent to:

Equation 26

$$\mathrm{V_s} \times (\big((1 - \mathrm{S}) \times \rho_\mathrm{s}\big) + (\rho_\mathrm{w} \times \mathrm{S})) = (\rho_\mathrm{w} \times \mathrm{V_t} \times \mathrm{S})$$

It may be rearranged to solve for V_s:

Equation 27

$$V_s = \frac{(\rho_w \times V_t \times S)}{(((1 - S) \times \rho_s) + (\rho_w \times S))}$$

Now that V_s has been solved, rearranging Equation 7, the M_s in dredged material can be defined by:

Equation 28

$$M_s = \rho_s \times \frac{(\rho_w \times V_t \times S)}{(((1 - S) \times \rho_s) + (\rho_w \times S))}$$

Multiplying the M_s in the dredged material by the dry weight concentration of a contaminant in the dredged material results in the mass of the contaminant in the dredged material (in this example, the contaminant is mercury):

Equation 29

$$M_s \times [Hg] = M_{Hg}\ (mg) \text{ in dredged material}$$

This value may be converted to kg by dividing by 1,000,000:

Equation 30

$$M_{Hg} \times \frac{1\ kg}{1{,}000{,}000\ mg} = M_{Hg}\ kg$$

Example Calculation

The following is an example calculation for determining mercury loads using values from the Main Channel North 1 DU.

- Dredge volume = V_t = 63,180 cy = 48,304 m^3
- Mercury concentration = [Hg] = 1.18 mg/kg
- Total solids = S = 45.5%
- Density of solids = ρ_s = 2,680 kg/m^3
- Density of [pore]water = ρ_w = 1,023 kg/m^3

$$M_s = 2{,}680 \text{ kg/m}^3 \times \frac{\left(1{,}023 \frac{\text{kg}}{\text{m}^3} \times 48{,}304 \text{ m}^3 \times 0.455\right)}{\left(\left((1 - 0.455) \times 2{,}680 \text{ kg/m}^3\right) + (1{,}023 \text{ kg/m}^3 \times 0.455)\right)}$$

$$M_s = 2{,}680 \text{ kg/m}^3 \times \frac{22{,}483{,}821.36 \text{ kg}}{1926.065 \text{ kg/m}^3}$$

$$M_s = 31{,}284{,}843.06 \text{ kg}$$

$$M_{Hg} = 31{,}284{,}843.06 \text{ kg} \times 1.18 \frac{\text{mg}}{\text{kg}} \times \frac{1 \text{ kg}}{1{,}000{,}000 \text{ mg}}$$

$$M_{Hg} = 36.9 \text{ kg}$$

Reference

Pond, S., and G.L. Pickard, 1983. *Introductory Dynamical Oceanography, 2nd Edition*. New York: Butterworth-Heinemann.

Table

Table 1

Lower Newport Bay Federal Channels 2019 Maintenance Dredging – Summary of Mercury and Total PCB Mass Loadings

Dredge Unit	Dredge Unit Code	Design Depth (feet MLLW)	Estimated Volume to Design Depth (cy)	1-Foot Payable Overdepth Allowance Volume (cy)	1-Foot Non-Pay Overdepth Allowance Volume (cy)	Total Volume (cy)	Total Volume (m^3) [1 cy = 0.76455 m^3]	Total Solids (%)	Volume of Solids in Dredged Material (m^3)	Mass of Solids in Dredged Material (kg)	Concentration of Mercury (mg/kg)	Mass of Mercury in Dredged Material (solids portion) (kg)	% of Total Mass of Mercury in Dredged Material (all areas combined)	Concentration of Total PCBs (µg/kg)	Mass of Total PCBs in Dredged Material (solids portion) (kg)	% of Total Mass of Total PCBs in Dredged Material (all areas combined)
Turning Basin	TB	-20	23,066	34,370	34,370	91,806	70,190	45.1	16,756	44,905,657	3.64	163.5	31.7	195.0	8.8	33
Main Channel North 1	MCN1	-20	36,584	13,298	13,298	63,180	48,304	45.5	11,674	31,285,017	1.18	36.9	7.2	41.7	1.3	5
Main Channel North 2	MCN2	-20	37,504	11,587	11,587	60,678	46,391	48.8	12,376	33,166,870	1.04	34.5	6.7	53.4	1.8	7
Main Channel North 3	MCN3	-20	44,505	19,374	19,374	83,252	63,650	52.3	18,780	50,329,395	0.797	40.1	7.8	44.1	2.2	8
Main Channel North 4	MCN4	-20	28,294	13,344	13,344	54,982	42,036	54.8	13,299	35,642,037	0.181	6.5	1.3	29.0	1.0	4
Main Channel North 5	MCN5	-20	50,106	19,798	19,798	89,701	68,581	54.7	21,637	57,988,264	0.205	11.9	2.3	30.6	1.8	7
Bay Island North	BIN	-15	77,358	27,546	27,546	132,450	101,265	51.9	29,541	79,169,872	0.431	34.1	6.6	30.4	2.4	9
Bay Island Middle East	BIME	-15	41,219	12,178	12,178	65,576	50,136	49.2	13,532	36,266,281	0.142	5.1	1.0	23.0	0.8	3
Bay Island Middle West	BIMW	-15	41,121	12,396	12,396	65,912	50,393	48.9	13,483	36,133,629	0.153	5.5	1.1	24.1	0.9	3
Bay Island South	BIS	-15	51,136	15,798	15,798	82,731	63,252	47.5	16,237	43,515,718	0.233	10.1	2.0	22.7	1.0	4
Entrance Channel	EC	-20	51,663	9,595	9,595	70,852	54,170	82.4	34,734	93,087,517	0.0125	1.2	0.2	0.2	0.0	0
Newport Channel 1	NC1	-15	28,216	9,339	9,339	46,894	35,853	***55.4***	*11,532*	30,905,234	***3.07***	*94.9*	*18.4*	***46.7***	*1.4*	*5*
Newport Channel 2	NC2	-15	85,798	19,761	19,761	125,319	95,813	65.3	40,054	107,343,402	0.529	56.8	11.0	22.8	2.4	9
Newport Channel 3	NC3	-15	54,155	12,268	12,268	78,690	60,162	73.1	30,632	82,093,806	0.173	14.2	2.8	8.0	0.7	2

Total (All Areas Combined)			650,725	230,649	230,649	1,112,023	850,197			**Average Mercury Concentration (mg/kg)**	0.84	**515**	**Average Total PCBs Concentration (µg/kg)**	40.83	**27**	
Total (Excluding Turning Basin and Newport Channel 1)			599,443	186,940	186,940	973,323	744,154				0.42	**257**		27.50	**16**	
Total (Turning Basin and Newport Channel 1 Only)			51,282	43,709	43,709	138,700	106,043				3.36	**258**		120.85	**10**	

Notes:

Bold italics Values are averages calculated from the individual cores that make up the DU. Composite sample was not analyzed based on individual core chemistry.

Italics Values are based on averages taken from individual cores used for total solids, mercury, and total PCB concentrations.

µg/kg: microgram per kilogram
cy: cubic yard
DU: dredge unit
kg: kilogram
m^3: cubic meter
mg/kg: milligram per kilogram
MLLW: mean lower low water
PCB: polychlorinated biphenyl

Appendix C
Utility Location Report (RES 2012)

R. E. Staite Engineering, Inc.

Lower Newport Bay Maintenance Dredging
Orange County, California
W912PL-12-C-0014
Section 35 20 23 Dredging
Paragraph 3.3- Utility Location Report

Per the requirements of Specification section 35 20 23 part 3.3, the following is a Utility Location Report identifying the coordinates and elevations of all utilities within the dredge footprint.

Information Sources:

Utility locations were obtained from respective utility companies and municipalities. The information provided is reported to be the best available and most up to date. The following names are the contact points for the utilities and municipalities consulted in order to obtain the information in this report.

Submarine Electrical Power Cables
Southern California Edison
Contact: Owen Yano – SCE Planner
Huntington Beach Service Center
7333 Bolsa Ave
Westminster, CA 92683
Cell: 310-387-3691
Office: 714-895-0246

Submarine Communications Cables
AT&T
Contact: Craig Akin
1265 Van Buren Room 180
Anaheim, CA 92807
Ca1818@att.com
Phone- 714-237-6156

Wet Utilities
Harbor Resources
City of Newport Beach
829 Harbor Island Drive
Newport Beach, CA 92663
Contacts: Shannon Levin- Harbor Resources Supervisor- 949-644-3041
Chris Miller- Harbor Resources Manager- 949-644-3043

*Additionally a DigAlert request was made for all utilities within the dredge footprint.

Sources Used:

W912PL-11-B-0006 Contract Drawings and Specification Appendix B

Electrical:

-Appendix B: Location of Submarine Cable in Newport Bay- From Owen Yano
-Appendix B: Proposed 12 kV armored submarine cable plan drawing – 1967

Communications:

-As-built drawings for submarine cables in Newport Bay provided by AT&T- Sheet #s 0049-0060

Water and Sewer:

-Appendix B: DUDEK Newport Beach Bay Crossings Evaluation
-Site visit with City of Newport Beach representative to physically locate water lines

Information on the existing utilities reported herein is considered the best available from the above mentioned agencies. Agencies have provided this information with the disclaimer that the accuracy of the information is not guaranteed. Coordinates, depths, and other information as required in this submittal are unavailable for many of the utilities included in this report. Further, many of the as-builts provided are 40-plus years old with landmarks noted such as residences and stationary vessels which likely no longer exist.

The attached table, in conjunction with the attached color coded utility location map represents the available information regarding the presence and location of utilities in the dredge project vicinity.

Attachments:

Utility Location Map
Utility Description Table

Lower Newport Bay Utilities Crossing Analysis

* Yellow Highlighted Utilities Not Shown on Plans

Electrical 'e' (RED LINES)

Number	Description	Size	Nearest Streets at Crossing	Heading	Burial Depth	Shown on Plans?	Crosses Dredge Footprint?
1	SCE Cable- 1210' long	Unknown	14th + Via Jucar	Unknown	Unknown	NO	NO
2	SCE 12 kV Cable	12 kV	7th + South end of Linda Isle	N 25°21'02" E	7' below Harbor Floor - 20 MLLW to -30 MLLW	YES	YES- Yacht Anchorage
3	SCE Cable- 500' Long	Unknown	Balboa Ave + Bahia Corinthian N end	Unknown	Unknown	NO	NO
4	SCE Cable- 1410' long	Unknown	Channel Rd @ M Street Pier + Bayside Pl	Unknown	Unknown	NO	NO

Communications 'c' (ORANGE LINES)

Number	Description	Size	Nearest Streets at Crossing	Heading	Burial Depth	Shown on Plans?	Crosses Dredge Footprint?
1	3-4 ATT Cables	16 GA-22GA	Between 8th and 9th + East end of Lido Isle	S29°W	-16' MLLW to Lido Isle	YES	YES- WEST LIDO B
2	ATT Cable	24 GA	Between 8th and 9th + East end of Lido Isle + Along Bayshore Dr Bulkhead Line	S29°W	-16' MLLW to Lido Isle, -20 MLLW to -30 MLLW in Lido Channel	YES	YES- WEST LIDO B, Yacht Anchorage, Lido Isle Reach
3	ATT Cable	16"	Alvarado Pl + Cape Cove	S54°10'W	-15' MLLW	YES	YES- Collins Is. Reach
4	ATT Cable	24 GA	S. Bay Front/Alley + Cape Cove	N12°W	-15' MLLW To -25' MLLW	NO	YES- Collins Is. Reach
5	2 ATT Cables	24 GA	Palm St + Agate Ave	N42°E	-15' MLLW to -25' MLLW	NO	NO- Harbor Is. Reach
6	3 ATT Cables	26 GA	Palm St + Opal Ave	N49°E	-15' MLLW to -25' MLLW	NO	NO- Harbor Is. Reach
7	4 ATT Cables	24 GA- 26 GA	Channel Rd & M St Pier + Bayside Pl	N86°47'E	Unknown	NO	NO- In Main Channel
8	ATT Cable	22 GA	Dahlia Ave + Channel @ Ocean	N70°E	Unknown	NO	NO- In Main Channel

Water 'w' (BLUE LINES)

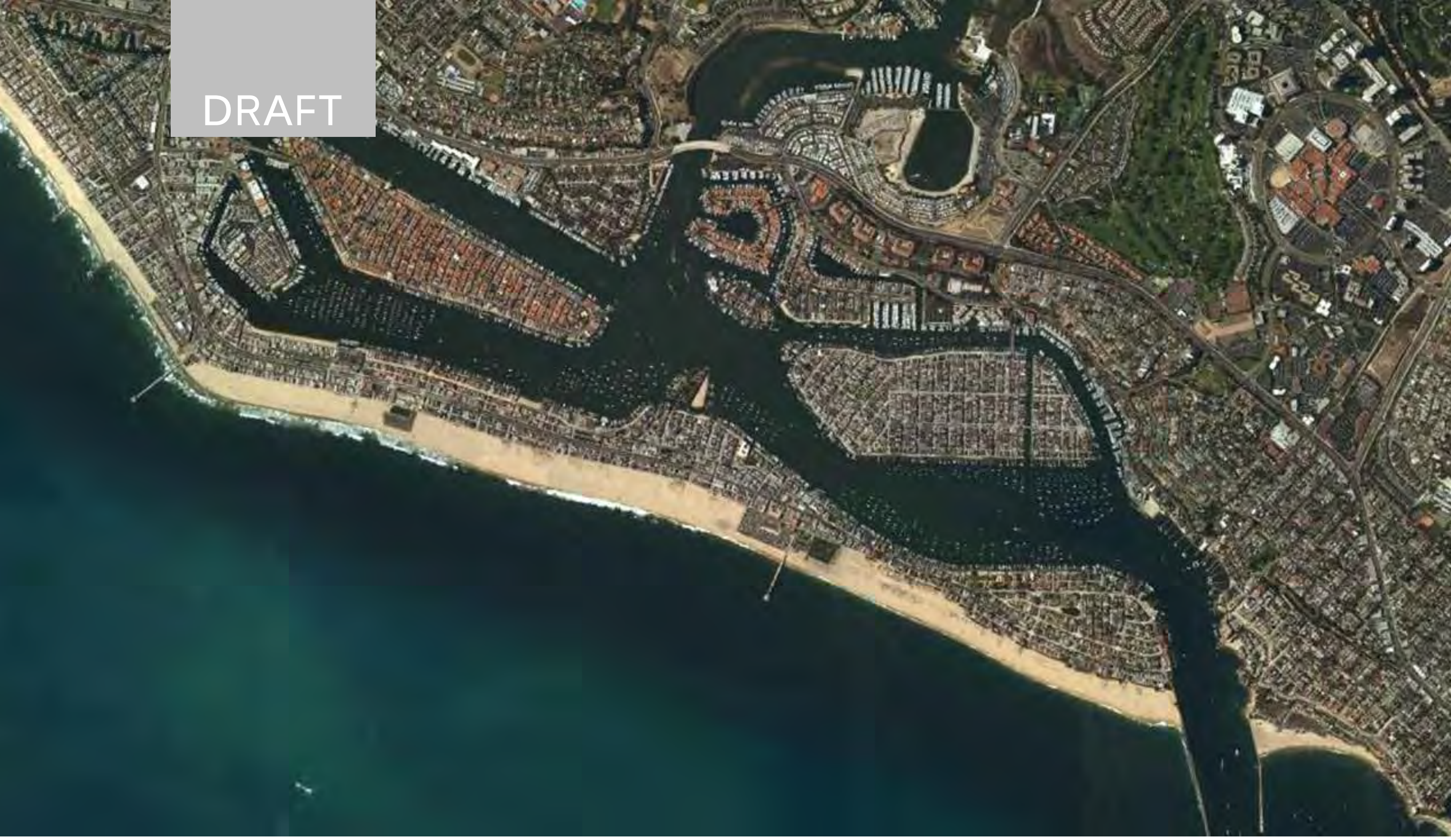
Number	Description	Size	Nearest Streets at Crossing	Heading	Burial Depth	Shown on Plans?	Crosses Dredge Footprint?
1	Cast Iron Waterline	8"	Via San Remo + Alley W of Crestview	Crestview (N33°36.866, W117°54.786) San Remo (N33°36.438 W117°54.499)	Unknown	YES	YES- Lido Is. Reach North
2	Ductile Iron Pipe (abandoned)	8"	Harbor Is. + Linda Is.	Unknown	Unknown	NO	NO
3	Cast Iron Waterline	12"	Washington + Opal	Wash. (N33°36.116, W 117°53.584) Opal (N33°26.181, W 117°53.524)	Unknown	YES	NO
4	Ductile Iron Pipe	24"	Harbor Is. Dr + Bayside	Unknown	Unknown	NO	NO
5	HDPE Pipe	10"	Bay Front Alley N + Crystal Ave.	Unknown	Unknown	NO	NO
6	Cast Iron Waterline	14"	Channel Rd N of M St Pier + 2107 Bayside Dr	Unknown	Unknown	YES	NO

Sewer 's' (GREEN LINES)

Number	Description	Size	Nearest Streets at Crossing	Heading	Burial Depth	Shown on Plans?	Crosses Dredge Footprint?
1	2 Cast Iron Sewer pipes	8"	S Bayfront Dr + 1907 Bayside Dr	Unknown	Unknown	NO	NO

UTILITY LOCATION
SITE PLAN
2000 0 2000
FEET
SCALE: 1"=800'
LEGEND:
DREDGING AREA (LA-3 PLACEMENT)
DREDGING AREA (POLB PLACEMENT)
-10
PROJECT DEPTH
1w- WATER PIPE
1s- SEWER PIPE
1c- COMMUNICATION CABLE
1e- ELECTRICAL CABLE
*SEE UTILITY TABLE FOR DESCRIPTIONS
PACIFIC OCEAN
NEWPORT PIER
BALBOA PIER
LIDO PENINSULA
LIDO ISLE
WEST LIDO CHANNEL
TURNING BASIN
LIDO ISLE REACH NORTH
WEST LIDO "A"
WEST LIDO "B"
NEWPORT CHANNEL
DOVER DR.
LOWER CASTAWAYS STAGING AREA
PACIFIC COAST HWY.
BAY SHORES
UPPER CHANNEL
Linda Isle
HARBOR ISLAND
COLLINS IS. REACH
BALBOA ISLAND CHANNEL
BAY ISLAND
HARBOR ISLE REACH
BALBOA ISLAND
BALBOA REACH
CORONA DEL MAR BEND
COAST GUARD
ENTRANCE CHANNEL
WEST JETTY
EAST JETTY
1w
2w
3w
4w
5w
6w
1s
1c
2c
3c
4c
5c
6c
7c
8c
1e
2e
3e
4e

Appendix D
Chemical Isolation Cap Analysis



November 24, 2020
Draft Basis of Design Report
Lower Newport Bay Confined Aquatic Disposal

Appendix D: Chemical Isolation Cap Analysis

Prepared for the City of Newport Beach

DRAFT

November 24, 2020
Draft Basis of Design Report
Lower Newport Bay Confined Aquatic Disposal

Appendix D: Chemical Isolation Cap Analysis

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ABBREVIATIONS

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
BODR	Basis of Design
CAD	confined aquatic disposal
City	City of Newport Beach
cm	centimeter
cm^2/s	square centimeters per second
COPC	contaminant of potential concern
CTR	California Toxics Rule
DDx	comprises DDT, DDE, DDD, including isomers thereof
ERM	effects range median
Federal Channels	Lower Newport Bay Federal Channels
f_{OC}	fraction organic carbon
g/cm^3	grams per cubic centimeter
interim cover	interim cover containment layer
K_d	equilibrium partition coefficient
K_{OC}	organic carbon partition coefficient
K_{OW}	octanol-water partition coefficient
L/kg	liters per kilogram
mg/kg	milligrams per kilogram
mL	milliliter
mL/min	milliliters per minute
MLLW	mean lower low water
ng/L	nanograms per liter
PCB	polychlorinated biphenyl
RGP 54	Regional General Permit 54
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

1 Introduction

The City of Newport Beach (City) is in the process of designing a confined aquatic disposal (CAD) facility to support the disposal of dredge material classified as unsuitable for open ocean disposal (referred to hereafter as unsuitable material) that will be generated as part of the upcoming maintenance dredging projects to be conducted in the Lower Newport Bay Federal Channels (Federal Channels) and elsewhere.

The overall intent of the dredging program presented in the Draft Basis of Design Report (BODR) is to dredge the Federal Channels to its current federally authorized design depths. Although a majority of the sediments within the Federal Channels are suitable for open ocean disposal, sediments in Main Channel 1 and 2, the Turning Basin, and Newport Channel 1 (see Figure 1-2 of the Draft BODR) were classified as unsuitable and will therefore require containment in the CAD facility. Contaminants of potential concern (COPCs) in these sediments include total polychlorinated biphenyls (PCBs), total DDx (comprising DDT, DDE, and DDD), and mercury. Additional maintenance dredging is expected to occur outside of the Federal Channels and either permitted or not permitted under the City's Regional General Permit 54 (RGP 54) program. The long-term plan is for those additional materials to also be placed in the CAD facility during a second phase of filling. The CAD facility will be located in the Bay Island Area dredge unit southeast of Lido Isle in Newport Beach, California (see Figure 1-2 of the Draft BODR).

This appendix to the Draft BODR describes numerical modeling evaluations performed to assess the ability of the CAD facility's cap system to chemically isolate dredge material placed into the CAD facility using a two-phase construction approach. Specifically, this modeling is used for the following:

- To evaluate potential transport of dissolved phase contaminants from the dredge materials into the cap and overlying water column
- To design the cap to limit and attenuate such transport so that potentially unacceptable concentrations do not result within the surface of the cap in the future

The primary goal of the modeling documented in this appendix was to simulate the dissolved phase transport of COPCs within the sediment caps overlying the dredge material to assess whether COPC concentrations within the biologically active zone at the cap's surface remain below target levels for at least 100 years following construction of the CAD facility. The analyses included in this report were performed in accordance with the U.S. Environmental Protection Agency's (USEPA's; Palermo et al. 1998) and the Interstate Technology and Regulatory Council's (ITRC) Remedy Selection for Contaminated Sediments guidance (ITRC 2014).

1.1 Confined Aquatic Disposal Design and Sequencing

Dredge material is expected to be placed within the CAD facility in two phases. It is expected that there will be a 2-year gap between the end of the first phase of construction and the beginning of the second phase of construction. The modeling evaluation was performed for each phase of the CAD design. The model domain was based on the CAD design presented in the Draft BODR, and chemical and physical data were drawn from sediment samples collected within the applicable dredge units. Sediment sample results are presented in the *Sampling and Analysis Report Regional General Permit 54 Sediment Characterization* (Anchor QEA 2013) and the *Lower Newport Bay Federal Channels Dredging: Sampling and Analysis Program Report* (Anchor QEA 2019).

The first phase of the CAD facility construction would involve excavation of the CAD facility footprint and backfill with unsuitable dredge materials from the Federal Channels (Newport Channel 1, Turning Basin, select areas within Main Channel North 1, and select areas within Main Channel North 2; see Figure 1-2 of the Draft BODR), as defined in the Draft BODR. Unsuitable material placed in the CAD facility during the first phase would then be covered with an interim cover containment layer (interim cover) using cleaner material excavated from the Newport Channel 3 dredge unit. The second phase of CAD construction would then involve the placement of additional materials on top of the interim cover. These additional unsuitable materials would be excavated from outside of the Federal Channels and either permitted or not permitted under the City's RGP 54 program. A final cap layer will then be placed on top of the dredge material from the second phase; this final cap layer is anticipated to be constructed from clean material excavated from either the Entrance Channel, Newport Channel 3, or Newport Chanel 2 dredge units. Dredge and placement plans for the first phase of CAD construction are presented in the Draft BODR; additional construction activities for the second phase are still under development.

The evaluations presented in this appendix were performed to design the specifications (thickness and sorptive capacity) of the interim cover and final cap layer needed to limit and attenuate chemical transport such that COPC concentrations at the cap surface are within target levels (Section 1.2).

1.2 Target Levels

Target levels used for the interim cover and final cap layer design analysis were based on the effects range median (ERM) values developed by Long et al. (1995). COPCs were identified for modeling based on review of data from dredge area sediment samples and comparison of chemical concentrations to ERM values; chemicals for which sampling data exceeded ERMs were identified as COPCs (as discussed previously, the COPCs consist of total PCBs, total DDx, and mercury). In addition to the ERM values, sediment porewater concentrations calculated in this evaluation were compared to California Toxics Rule (CTR) saltwater chronic criteria for the protection of aquatic life (for total

PCBs and total DDx) and human health criteria (for mercury); these CTR criteria were used in conjunction with the ERM values as target concentrations.

Sediment and porewater target concentrations used in the cap design modeling are listed in Table D-1.

Table D-1
Sediment and Porewater Target Concentrations

COPC	ERM[1] Used for Sediment Target

2 Dissolved Phase Chemical Isolation Analysis

This section describes chemical transport modeling performed to evaluate the long-term performance of the interim cover and final cap layer being designed to chemically isolate unsuitable material placed within the CAD facility. The model described in this appendix simulates the transport of PCBs, total DDx, and mercury within the interim cover and final cap layer for the purpose of designing the cap properties (thickness and sorptive capacity) to maintain COPC concentrations in the biologically active zone below target levels (Table D-1) over the lifetime of the evaluation (100 years). The numerical modeling described in this section was performed in accordance with guidance on cap design set forth by the USEPA, U.S. Army Corps of Engineers (USACE) guidance (Palermo et al. 1998), and ITRC guidance (ITRC 2014).

2.1 Approach

The assessment described in Sections 2.1.1 through 2.1.4 consists of applying a one-dimensional chemical fate and transport model to simulate dissolved phase COPC transport within the interim cover and final cap layer. The assessment is used to support the design of the interim cover and final cap layer to maintain concentrations in its biologically active zone to be less than target levels (Section 1.2).

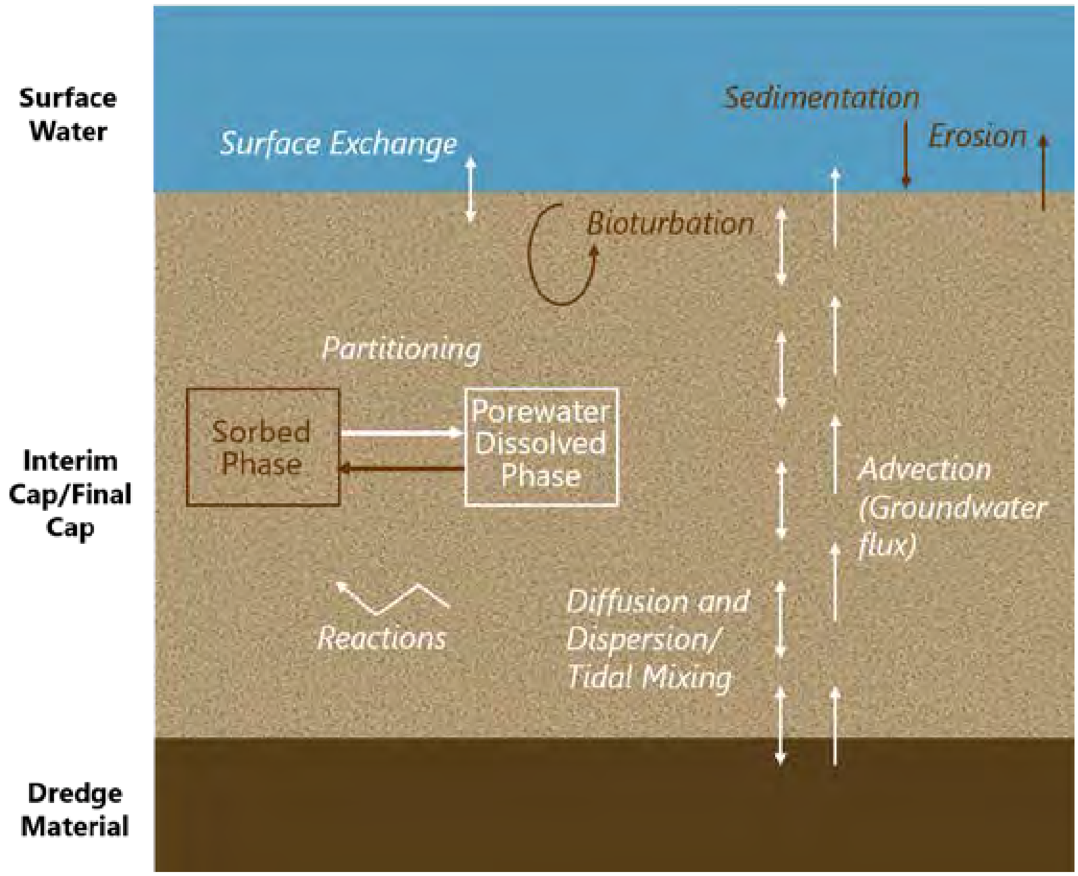
2.1.1 Model Framework

CapSim (Reible 2017, Version 3.5), a one-dimensional model of chemical transport in sediment and cap systems, was used for this evaluation. This model simulates the time-variable fate and transport of chemicals (dissolved and sorbed phases, including partitioning between these phases) under the processes of advection, diffusion and dispersion, biodegradation, bioturbation and bioirrigation, and exchange with the overlying surface water (Go et al. 2009; Lampert and Reible 2009). This model has been used to support the evaluation and design of sediment caps at numerous sites around the United States and internationally, including the development of the Outer Harbor Sediment Placement and Ecosystem Restoration CAD facility in Long Beach, California (Anchor QEA 2016). Details on the model structure and underlying theory and equations are provided in USEPA and USACE capping guidance (Palermo et al. 1998, Appendix B; Go et al. 2009; Lampert and Reible 2009; and Shen et al. 2018).

2.1.2 Simulation Approach

The model was configured to represent the presence of the chemical isolation layer over dredged material placed in the CAD facility for both the interim cover and final cap layer. A schematic of the general cap profile and the fate and transport processes represented in the model are shown in Figure D-1.

Figure D-1
Example Model Domain and Processes



Note:
Sedimentation, erosion, and reactions are not simulated in this evaluation.

2.1.3 Model Layers

The layer configuration represented in the model differed between the two phases of CAD facility construction. The model domain consisted of two layers for the evaluation of the first phase (interim cover), and the model domain consisted of four layers for the evaluation of the second phase (final cap layer). The conceptual design of the second phase is shown in Figure 4-1 of the Draft BODR. The model layers for these two cap simulations are provided in the following list from highest elevation to lowest elevation (i.e., top to bottom):

- First phase (interim cover), listed from top to bottom:
  1. Interim cover (1 foot thick, -31 to -30 feet MLLW): The proposed material would be a silty sand excavated from the Newport Channel 3 dredge unit.
  2. Unsuitable material dredged from within the Federal Channels (15 feet thick, -46 to -31 feet MLLW): The proposed material would be a sandy silt excavated from the

Newport Channel 1, Turning Basin, Main Channel North 1, and Main Channel North 2 dredge units. Volume-weighted average based on sediment data from these areas was calculated for the physical properties and COPC concentrations of this layer based on the volume of unsuitable material in each dredge unit.

- Second phase (final cap layer), listed from top to bottom:
  1. Final clean sediment cap (3 feet thick, -25 to -22 feet MLLW): Cap was simulated separately with material from three potential sources: a) fine to coarse sand excavated from the Entrance Channel dredge unit; b) silty sand excavated from the Newport Channel 2 dredge unit; or c) silty sand excavated from the Newport Channel 3 dredge unit. Based on the propeller wash analysis described in Appendix E of the Draft BODR, up to 3 inches of scour is predicted to potentially occur. Because this potential scour depth is small relative to the total 3-foot cap layer thickness, it was not explicitly considered in this evaluation. The final cap thickness relative to potential future scour will be evaluated as part of future design stages to determine if updated cap modeling is warranted.
  2. Unsuitable material dredged from outside the Federal Channels (15 feet thick, -30 to -25 feet MLLW): The proposed material would be a silty sand excavated from outside of the Federal Channels. Because specific dredge units have not been identified, COPC concentrations were conservatively assumed to be the maximum of all sediment samples collected from outside the Federal Channels.
  3. Interim cover (1 foot thick, -31 to -30 feet MLLW): The proposed material would be a silty sand excavated from the Newport Channel 3 dredge unit.
  4. Unsuitable material dredged from within the Federal Channels (15 feet thick, -46 to -31 feet MLLW): The proposed material would be a sandy silt excavated from the Newport Channel 1, Turning Basin, Main Channel North 1, and Main Channel North 2 dredge units.

2.1.4 Temporal Simulation Approach

Model simulations of both the interim cover and final cap layer were conducted over a 100-year period to evaluate long-term performance. For simplicity, these simulations were conducted independently for the interim cover and final cap layer configurations. It is recognized that there is potential for COPC flux to generate concentrations within the interim cover for the approximate 2 years between its construction and completion of the final cap layer; however, evaluation of the interim cover model results (Section 3) revealed that the predicted concentrations in the interim cover after 2 years were lower than initial concentrations in the interim cover material and lower than those in the phase 2 dredge material, such that the approximation associated with simulating the two periods independently does not affect the model results.

2.2 Model Inputs

The model uses several input parameters that describe chemical-specific properties, physical properties of the unsuitable dredge material and clean sediment cap and cover material, and chemical mass transfer rates. These input parameters were developed based on site-specific data, information from literature, and experience with cap design at other comparable sites. A listing of model input parameters, the values used for this modeling assessment, and the source(s) from which they were derived are provided in Table D-2. A detailed discussion of key model inputs (i.e., those to which the model is most sensitive) is provided in Sections 2.2.1 through 2.2.3.

Table D-2
Input Parameter Values for the Chemical Isolation Cap Model

Model Input Parameter	Value	Data Source
Chemical-Specific Properties		
PCB homolog porewater concentration	See Table D-4	Sediment PCB samples were analyzed for the Southern California Coastal Water Research Project list of 41 congeners used for the Bight '08 Regional Monitoring Program, which is the same list used in Southern California Total Maximum Daily Loads and recommended by USEPA for dredge material evaluations in southern California. Based on this analytical method, individual PCB congeners were summed into homolog groups, which included the tri through nona PCB groups, and modeled separately. Total PCB sums were calculated based on results from model predictions of the individual homologs to facilitate comparisons to the target levels in Table D-1. See Section 2.2.3.
DDx isomer porewater concentrations	See Table D-4	Each individual isomer was modeled separately. Total DDx sums were calculated based on results from model predictions of individual isomers to facilitate comparisons to the target levels in Table D-1. See Section 2.2.3.
Mercury porewater concentration	See Table D-4	See Section 2.2.3.
Organic carbon partition coefficient, log K_{OC} (log L/kg)	See Table D-3	Log K_{OC} values used for PCBs and DDx were calculated based on a relationship with K_{OW} (see Section 2.2.2). K_{OW} values used for PCBs and DDx are from De Bruijn et al. (1989).
Partition coefficient, log K_d for mercury (log L/kg)	See Table D-3	The mean K_d is from Allison and Allison (2005) and is consistent with values reported in USEPA (1997). See Section 2.2.2.
Molecular diffusivity for mercury (cm^2/s)	See Table D-3	The value for mercury was calculated based on average molar volume using the correlation identified by Hayduk and Laudie (1974). The model calculates an effective diffusion coefficient using this chemical-specific input value for the molecular diffusivity and an empirical equation based on the cap material porosity using the approach developed by Boudreau (1997). See Section 2.2.2.
Molecular diffusivity for PCB homologs and DDx isomers (cm^2/s)	See Table D-3	Values were calculated by chemical based on average molecular weight using the correlation identified in Schwarzenbach et al. (1993). The model calculates an effective diffusion coefficient using this chemical-specific input value for the molecular diffusivity and an empirical equation based on the cap material porosity using the approach developed by Boudreau (1997). See Section 2.2.2.
Chemical biodegradation rate (per year)	0	Biodegradation was not simulated in the model.

Model Input Parameter	Value	Data Source
Final Cap Layer Properties		
Thickness (cm)	91	The thickness simulated in the model consisted of 3 feet of material from either the Entrance Channel, Newport Channel 3, or Newport Channel 2 dredge units.
Dry bulk density (g/cm^3)	Entrance Channel: 1.66 Newport Channel 3: 1.27 Newport Channel 2: 1.09	Values were calculated based on typical sediment specific gravity of 2.6 g/cm^3 and site-specific porosity of 0.61 for the Entrance Channel, 0.51 for Newport Channel 3, and 0.58 for Newport Channel 2.
Total porosity	Entrance Channel: 0.36 Newport Channel 3: 0.51 Newport Channel 2: 0.58	Site-specific values were calculated from the percent solids of representative sediment samples from the Entrance Channel, Newport Channel 3, and Newport Channel 2 dredge areas.
Fraction of organic carbon (%)	Entrance Channel: 0.089 Newport Channel 3: 0.44 Newport Channel 2: 1.6	Values were based on representative sediment samples collected from the Entrance Channel, Newport Channel 3, and Newport Channel 2 dredge areas.
Unsuitable Material Dredged from Outside the Federal Channels Layer Properties (Phase 2 Dredging)		
Thickness (cm)	152	The thickness simulated in the model consisted of 5 feet of Phase 2 dredge material from outside the Federal Channels.
Total porosity	0.61	A site-specific value was calculated from the percent solids of representative sediment samples from Phase 2 dredge area.
Dry bulk density (g/cm^3)	1.01	The value was calculated based on typical sediment specific gravity of 2.6 g/cm^3 and site-specific porosity of 0.61.
Fraction of organic carbon (%)	0.42	The value is based on representative sediment samples from Phase 2 dredge areas.
Interim Cover Properties		
Thickness (cm)	30	The thickness simulated in the model consisted of 1 foot of material from the Newport Channel 3 dredge unit.
Total porosity	0.51	A site-specific value was calculated from the percent solids of representative sediment samples from the Newport Channel 3 dredge unit.
Dry bulk density (g/cm^3)	1.27	The value was calculated based on typical sediment specific gravity of 2.6 g/cm^3 and site-specific porosity of 0.49.
Fraction organic carbon (%)	0.44	The value is based on representative sediment samples from the Newport Channel 3 dredge unit.

Model Input Parameter	Value	Data Source
Unsuitable Material Dredged from Inside the Federal Channels Layer Properties (Phase 1 Dredging)		
Thickness (cm)	457	The thickness simulated in the model consisted of 15 feet of dredge material from within the Federal Channels.
Total porosity	0.71	The value was calculated from the percent solids of representative sediment samples from Phase 1 dredge area. Representative samples were averaged based on the volume of material being placed in this layer.
Dry bulk density (g/cm^3)	0.75	The value was calculated based on a typical sediment specific gravity of 2.6 g/cm^3 and site-specific porosity of 0.71.
Fraction organic carbon (%)	0.91	This value was based on representative sediment samples within Phase 1 dredge area. Representative samples were averaged based on the volume of material being placed in this layer.
Mass Transport Properties		
Boundary layer mass transfer coefficient (cm/hour)	0.75	Selected value is a typical value used for cap design (e.g., Reible 2012) and consistent with a range of values measured in other systems (e.g., Thibodeaux et al. 2001).
Groundwater seepage rate (cm/year)	9.1	A conservative groundwater seepage rate was selected based on studies conducted in the area (Todd Engineers 2006). See Section 2.2.1.
Net sedimentation rate (cm/year)	0	Conservatively assumed no net sedimentation in the project area.
Dispersion length (cm)	Final Cap: 73 Interim Cover: 49	Dispersion was set to 10% of model domain length. See Section 2.2.1.
Bioturbation layer thickness (cm)	15	The selected value is consistent with literature values for marine systems (e.g., Clarke et al. 2001; USEPA 2005, 2015).
Porewater biodiffusion coefficient (cm^2/year)	1,000	Parameter represents bioturbation rate applied to the dissolved phase; the selected value is a typical value used for cap design in a marine environment (e.g., Reible 2012).
Particle biodiffusion coefficient (cm^2/year)	10	The parameter represents the bioturbation rate applied to the particulate phase; the selected value is a typical value used for cap design in a marine environment (e.g., Reible 2012).
Consolidation thickness (cm)	152	The value is based on preliminary geotechnical modeling using site-specific data (see Section 6.3.2 of the Draft BODR).
90% consolidation time (year)	0.33	The value is based on preliminary geotechnical modeling using site-specific data (see Section 6.3.2 of the Draft BODR).

2.2.1 Groundwater Darcy Flux and Dispersion

Groundwater seepage rates (i.e., Darcy flux) within the Lower Newport Bay area have been documented to be very low to negligible, as a majority of groundwater from upland flows through steep slopes and banks as seepage above the water table (Weston Solutions 2007). As a result of the low-permeability geological deposits of the Newport Coast area (consolidated sandstone, shales, and volcanic rocks), groundwater flow rates are expected to be very low, but a site-specific study has not been performed. For this design, a conservative estimate of the Darcy flux through the CAD facility was assumed to be 9.1 centimeters (cm) per year (Todd Engineers 2006).

Dispersivity values for flow in porous media over relatively short distances are typically in the range of 1% of the domain length, whereas those for large-scale groundwater plumes are on the order of 10% (Gelhar et al. 1985; Neuman 1990). In addition to net advective flow associated with seepage, groundwater transport within the sediments and within a cap can be influenced by tidal fluctuations. Lower Newport Bay's location along the California coast means that it experiences tidal influence; the typical tidal range in this area is 5.4 feet (NOAA 2003). Tidal action can reduce the groundwater flow rate (or reverse the rate) as the tide rises, and conversely can increase the groundwater flow rate as the tide falls, due to increased or decreased hydrostatic pressure, respectively. Therefore, in the cap model, the hydrodynamic dispersivity was set to a value of 10% of the cap thickness because this modeling is reflecting additional mixing associated with tidal exchange. Representing tidal mixing with a dispersion coefficient is a common approach in groundwater modeling (e.g., La Licata et al. 2011). Because of this approximation (i.e., simulating short-term velocity fluctuations due to tides as a dispersion process in the long term), a sensitivity analysis was conducted to understand how changes in the dispersivity affect the model results.

2.2.2 Partitioning Coefficients and Diffusivity

Partitioning of chemicals between the dissolved and sorbed (i.e., dredge or cap/cover material) phases is described in the model by the chemical-specific equilibrium partition coefficient (K_d). This approach assumes that sorption follows linear isotherms and is instantaneous (not rate-limited) and reversible. For non-polar organic compounds, such as PCBs and DDx, the partition coefficient is calculated in the model based on the customary $K_d = f_{OC} \times K_{OC}$ approach (e.g., Karickhoff 1984), where K_{OC} is the compound's organic carbon partition coefficient and f_{OC} is the organic carbon fraction of the solid phase (i.e., CAD material).

For PCBs, average log K_{OC} values were developed by arithmetically averaging log K_{OW} results from individual congeners within each homolog group based on literature.[1] Average log K_{OC} values were

[1] Log K_{OW} values for PCBs as cited by Hawker and Connell (1988) are widely used, though they were measured by a generator column. Log K_{OW} values measured by the "slow-stirring" method are considered more accurate. Therefore, the Hawker and Connell PCB log K_{OW} values were adjusted based on a correlation with log K_{OW} values measured by De Bruijn et al. (1989) using the "slow-stirring" method (De Bruijn's log K_{OW} values were not used directly because that study only measured 20 PCB congeners).

then calculated from the K_{OW} results by the widely used Di Toro (1985) empirical relationship ($\log K_{OC} = [\log K_{OW} \times 0.983] + 0.00028$). For DDx, literature-based K_{OW} values were obtained from De Bruijn et al. (1989) for each simulated isomer (i.e., DDD, DDE, and DDT), and it was assumed that isomers (e.g., 2,4'-DDD and 4,4'-DDD) had the same K_{OW} values. Log K_{OC} values were then calculated from the Di Toro (1985) empirical relationship described previously for PCBs. A literature-based K_d value for mercury was used in the model based on the value reported in Allison and Allison (2005). Values of K_{OC} and K_d for each of the COPCs are listed in Table D-3.

Water diffusivities for DDx and PCBs were specified using a literature-based correlation with molecular weight (Schwarzenbach et al. 1993) and are listed in Table D-3. Water diffusivity for mercury was specified using a literature-based correlation with molar volume (Hayduk and Laudie 1974) and is also listed in Table D-3.

Table D-3
Chemical-Specific Properties

Chemical Name[1,2]	Molecular Diffusivity (cm^2/s)	log K_{OC} (log L/kg)	log K_d (log L/kg)
Trichlorobiphenyl	5.2E-06	5.8	--
Tetrachlorobiphenyl	4.9E-06	6.3	--
Pentachlorobiphenyl	4.7E-06	6.7	--
Hexachlorobiphenyl	4.5E-06	7.1	--
Heptachlorobiphenyl	4.3E-06	7.4	--
Octachlorobiphenyl	4.2E-06	7.8	--
Nonachlorobiphenyl	4.0E-06	8.1	--
2,4'-DDT	4.2E-06	6.8	--
4,4'-DDT	4.2E-06	6.8	--
2,4'-DDE	4.5E-06	6.8	--
4,4'-DDE	4.5E-06	6.8	--
2,4'-DDD	4.5E-06	6.1	--
4,4'-DDD	4.5E-06	6.1	--
Mercury	2.8E-05	--	4.9

Notes:
1. PCBs were modeled by homolog group and summed to total PCBs for comparison with the criteria.
2. DDx compounds were modeled separately and summed to total DDx for comparison with the criteria.
--: not applicable

2.2.3 Sediment Porewater Concentrations

The porewater concentration input defines the source term in the cap model and represents the effective concentrations present in each layer of the CAD facility at the beginning of the simulation. Porewater concentrations for the dredge material and interim cover layer and final cap layer were calculated based on the measured COPC concentrations of sediment samples collected in the areas where those materials will be obtained and the layer-specific f_{OC} values presented in Table D-2 and the COPC-specific K_{OC} values presented in Table D-3. Measured concentrations of COPCs in sediment core samples collected from the Main Channel 1, Main Channel 2, Turning Basin, and Newport Channel 1 dredge units in January 2018 were composited per area; the results from these tests were used to represent sediment concentrations of the Phase 1 dredge material layer (Anchor QEA 2019). A volume-weighted average sediment concentration was calculated using the volume contributed from each dredge unit.

Because the specific source(s) of the Phase 2 dredge material outside of the Federal Channels has not yet been identified, the maximum sediment concentration for each of the COPCs measured in composite samples collected from these areas in 2013 and 2017 was used as a conservative assumption. Core samples from the Newport Channel 3 dredge unit were used to represent the interim cover. Core samples from Newport Channel 3 and Newport Channel 2 were collected in January 2019 and used in this model. Core samples from the Entrance Channel were collected in January 2018; results from a composite of these samples were used in this model.

The equilibrium porewater concentration of total DDx in the Newport Channel 3 dredge material exceeds the total DDx porewater target level (Table D-1). However, because the sorbed-phase concentrations in this material are below target levels (and was classified as suitable for open ocean disposal, as described in the Draft BODR), this material was retained for consideration as the interim cover material and potential final cap material. As a result, DDx concentrations predicted by the cap modeling for Newport Channel 3 dredge material described herein were compared to the sediment-based target level rather than to the porewater-based value for the interim cover simulations.

The starting PCB, DDx, and mercury porewater concentrations used in the model evaluations are listed in Table D-4.

Table D-4
Sediment Porewater Concentrations

Chemical Name	COPC Porewater Concentration (ng/L)					
	Final Cap Layer			Phase 2 Dredge Material Layer	Interim Cover Layer	Phase 1 Dredge Material Layer
	Entrance Channel	Newport Channel 3	Newport Channel 2			
Trichlorobiphenyl	0	0	1.89×10^{-4}	1.24×10^{-3}	0	1.87×10^{-3}
Tetrachlorobiphenyl	0	3.93×10^{-5}	1.66×10^{-4}	2.60×10^{-3}	3.93×10^{-5}	1.84×10^{-2}
Pentachlorobiphenyl	0	2.65×10^{-5}	7.95×10^{-5}	1.36×10^{-3}	2.65×10^{-5}	7.45×10^{-3}
Hexachlorobiphenyl	0	3.97×10^{-5}	3.07×10^{-5}	6.42×10^{-4}	3.97×10^{-5}	3.33×10^{-3}
Heptachlorobiphenyl	0	3.91×10^{-5}	8.22×10^{-6}	1.69×10^{-4}	3.91×10^{-5}	8.28×10^{-4}
Octachlorobiphenyl	0	0	4.25×10^{-7}	1.22×10^{-5}	0	3.00×10^{-6}
Nonachlorobiphenyl	0	0	0	4.00×10^{-7}	0	1.80×10^{-6}
Total PCB[1]	0	3.93×10^{-5}	4.74×10^{-4}	4.78×10^{-3}	3.93×10^{-5}	1.88×10^{-2}
2,4′-DDT	0	0	0	5.74×10^{-5}	0	7.25×10^{-4}
4,4′-DDT	0	0	0	3.50×10^{-4}	0	3.89×10^{-3}
2,4′-DDE	0	1.98×10^{-5}	0	3.17×10^{-4}	1.98×10^{-5}	4.88×10^{-3}
4,4′-DDE	1.44×10^{-5}	4.16×10^{-4}	1.27×10^{-4}	2.75×10^{-3}	4.16×10^{-4}	7.48×10^{-2}
2,4′-DDD	0	0	0	7.32×10^{-4}	0	1.58×10^{-2}
4,4′-DDD	0	8.48×10^{-4}	3.38×10^{-4}	4.01×10^{-3}	8.48×10^{-4}	9.29×10^{-2}
Total DDx[2]	1.44×10^{-5}	1.28×10^{-3}	4.65×10^{-4}	1.30×10^{-2}	1.28×10^{-3}	2.25×10^{-1}
Mercury	1.57×10^{-5}	2.11×10^{-3}	6.66×10^{-3}	2.71×10^{-1}	2.11×10^{-3}	3.31×10^{-2}

Notes:
Zero values are non-detects reported as U = 0.

1. Total PCB is included for reference; each individual homolog is modeled, and results are summed to calculate total PCB for comparison to target levels.
2. Total DDx is included for reference; each individual isomer is modeled, and results are summed to calculate total DDx for comparison to target levels.

3 Model Results

Chemical isolation modeling was conducted to simulate the transport of mercury, DDx isomers, and PCB homologs for both the interim cover and final cap layer configurations (Section 2). Model simulations were conducted to assess the performance of the cover and final cap over a 100-year period. Performance was evaluated by comparing vertically averaged, model-predicted dry weight and porewater COPC concentrations from the top 15 cm of the interim cover or final cap to target levels. Model-predicted COPC concentrations for the interim cover and final cap layer are predicted to remain below the target levels provided in Section 1.2 (both sorbed-phase ERMs and CTR porewater criteria) for more than 100 years, as discussed in Sections 3.1 through 3.3.

3.1 Phase 1 Interim Cover Model Results

Figures D-2 through D-4 show the model results for the first phase of CAD construction, which evaluated the performance of a 1 foot layer of clean dredge material (i.e., interim cover) overlying 15 feet of unsuitable Phase 1 dredge material removed from within the Federal Channels. Although the interim cover is only expected to be exposed for 2 years before it will be covered with additional material, final post-construction concentrations for all COPCs are predicted to remain below target levels for more than 100 years. Concentrations within the interim cover start at the specified initial concentration (Section 2.2.3 and Table D-4) and are predicted to decrease as the chemical mass depletes from this layer into the surface water at a rate faster than mass from the Phase 1 dredge material enters the interim cover from below. Concentrations of all COPCs are predicted to decrease throughout the 100-year model simulation, indicating little to no influence on the surface of the interim cover from the dredge material layer beneath. Model results in the top 15 cm of the interim cover after 2 years are as follows:

- Total PCB sorbed-phase concentrations are predicted to be 3.3 , which is less than the ERM of 180 μg/kg. Porewater concentrations are predicted to be 0.11 nanograms per liter (ng/L), which is less than the CTR criteria of 30 ng/L (Figure D-2).
- Total DDx sorbed-phase concentrations are predicted to be 17 , which is less than the ERM of 46.1 μg/kg. Porewater concentrations are predicted to be 1.2 ng/L (Figure D-3). As described in Section 2.2.3, porewater concentrations are not compared with CTR criteria for DDx in the interim cover.
- Mercury sorbed-phase concentrations are predicted to be 170 , which is less than the ERM of 710 μg/kg. Porewater concentrations are predicted to be less than 2.1 ng/L, which is below the CTR criteria of 50 ng/L (Figure D-4).

Figure D-2
Temporal Profile of Vertically Averaged Total PCB Concentrations in the Bioturbation Zone – First Phase

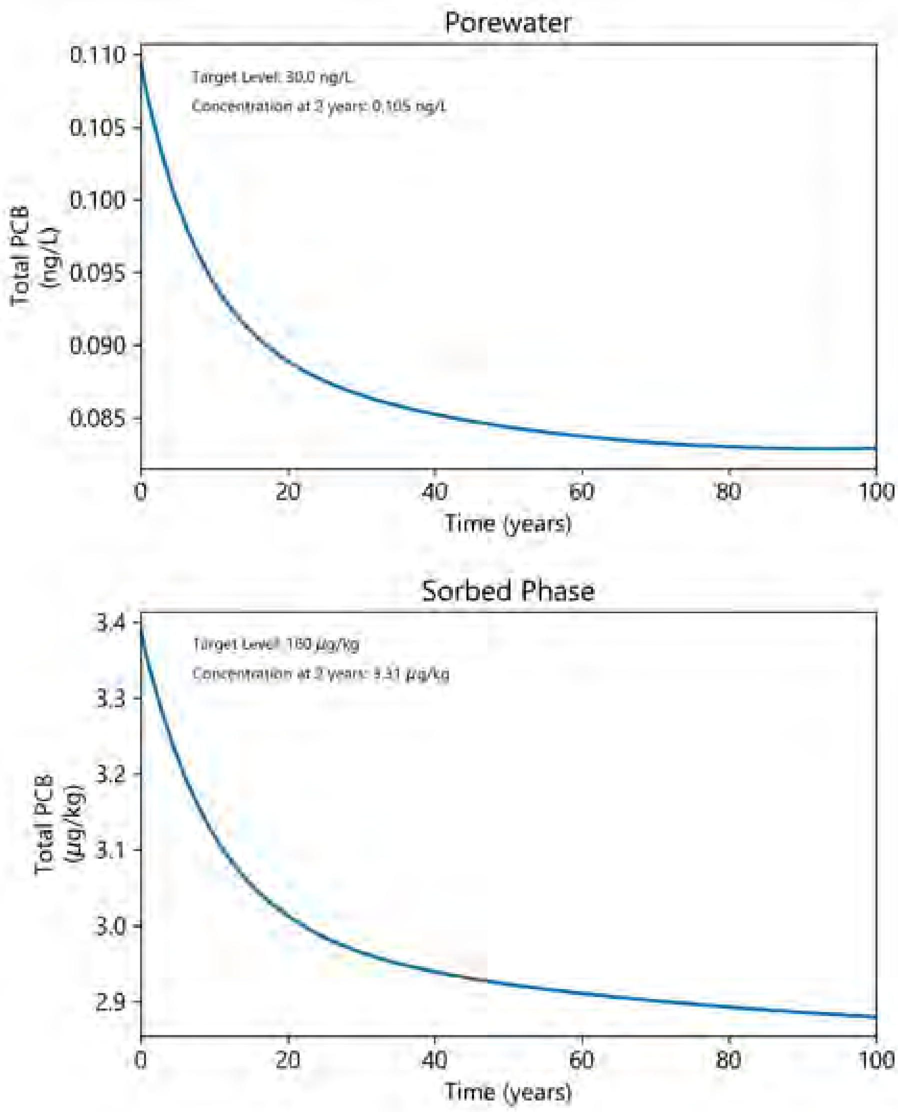


Figure D-3
Temporal Profile of Vertically Averaged Total DDx Concentrations in the Bioturbation Zone – First Phase

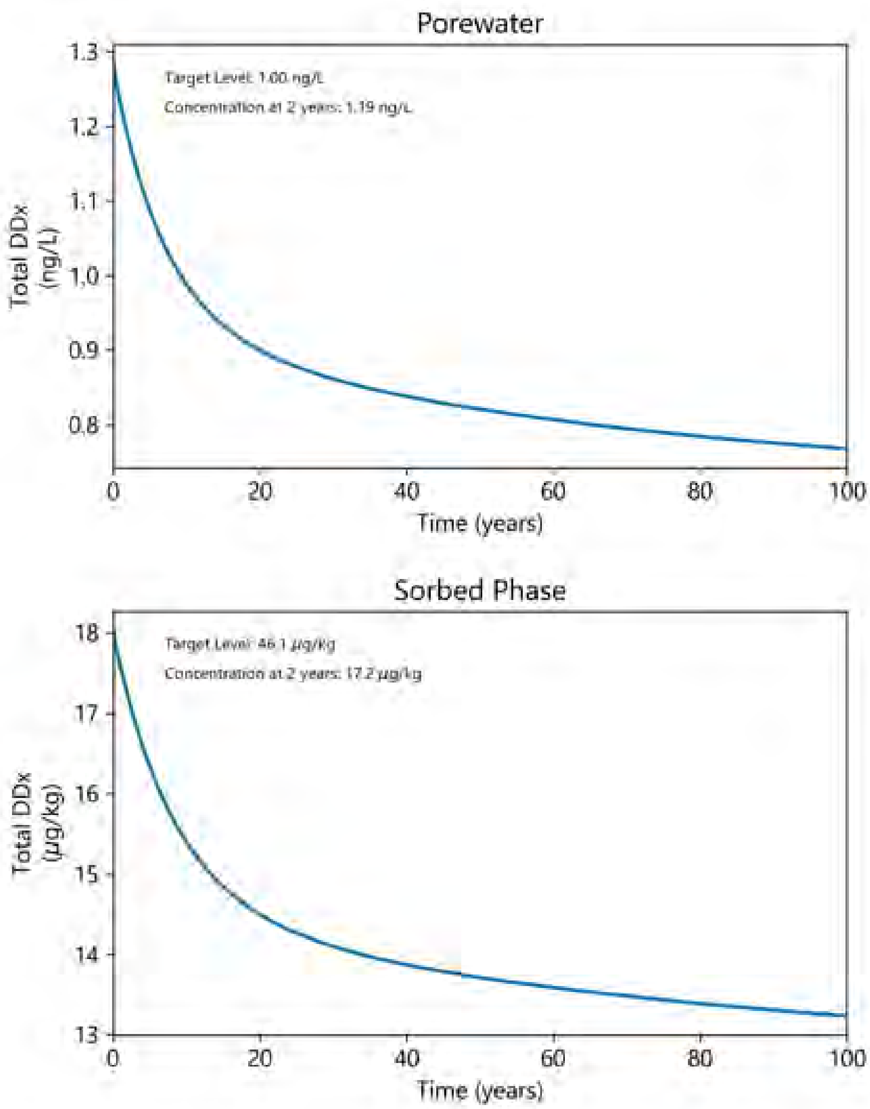
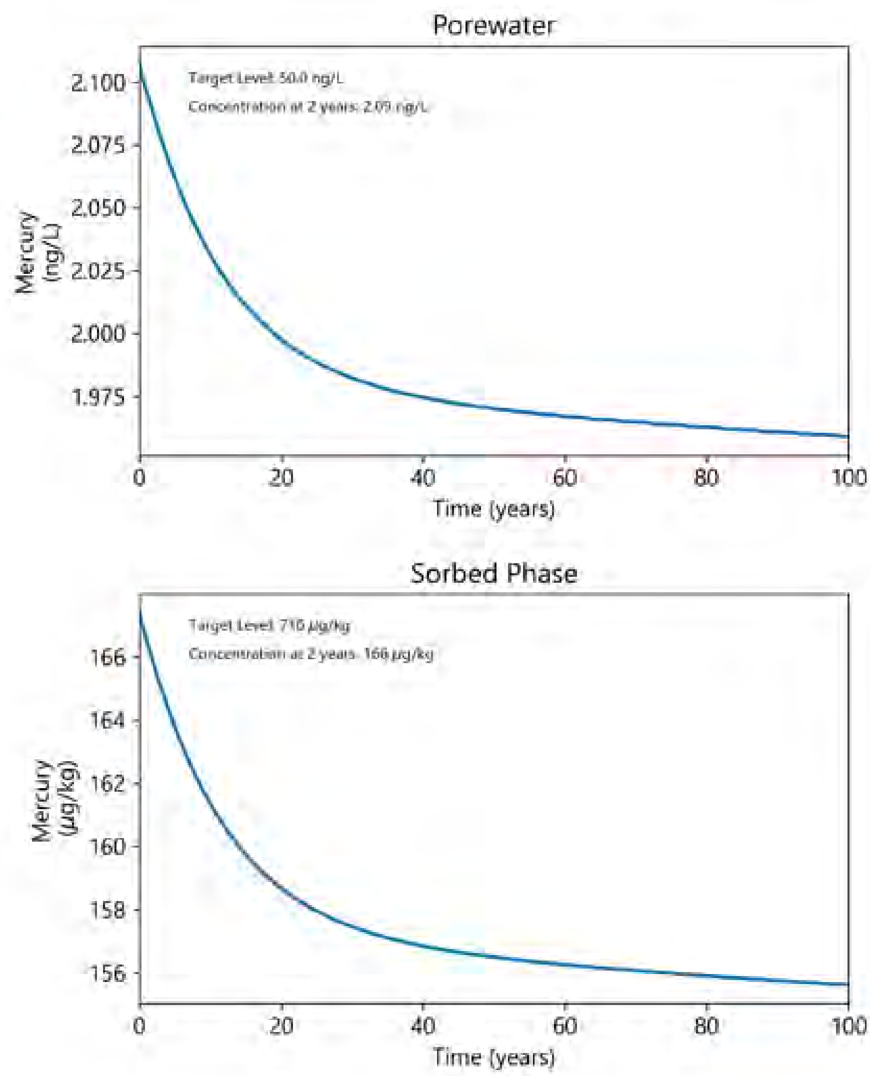


Figure D-4
Temporal Profile of Vertically Averaged Mercury Concentrations in the Bioturbation Zone – First Phase



3.2 Phase 2 Final Cap Model Results

Figures D-5 through D-12 show the model results for the second phase of CAD facility construction. Because the source of the final cap material has not been identified, model simulations were conducted separately for three different material types for the final cap: Entrance Channel dredge material (Figures D-5 through D-7), Newport Channel 3 dredge material (Figures D-8 through D-10), and Newport Channel 2 dredge material (Figures D-11 through D-13). As described in Section 2.1.1, Phase 2 construction will include the placement of a 3 foot layer of clean dredge material (i.e., final cap) on top of 5 feet of unsuitable Phase 2 dredge material from outside of the Federal Channels, which in turn will be placed on top of the interim cover (i.e., following the first phase of construction).

Vertically averaged concentrations in the top 15 cm of the Phase 2 final cap are predicted to remain below sorbed-phase and porewater target levels for all three cap materials (i.e., Entrance Channel, Newport Channel 3, and Newport Channel 2) for at least 100 years. With the exception of total PCBs in the Entrance Channel material, concentrations within the final cap layer start at the specified initial concentration (Section 2.2.3 and Table D-4) and are predicted to decrease for all chemical and cap material combinations, as the chemical mass depletes from this layer into the surface water at a rate faster than mass from the Phase 2 dredge material enters the final cap layer from below. Total PCB concentrations in the Entrance Channel material begin at zero, and influence from the Phase 2 dredge material is not predicted to occur in the surface of the final cap layer until approximately year 80. After year 80, concentrations of total PCBs increase through year 100 although predicted concentrations remain much lower than target levels. Model results in the top 15 cm of the final cap layer after 100 years are summarized for the three potential final cap materials as follows:

- Entrance Channel
    - Total PCB sorbed-phase concentrations are predicted to be less than 10^{-8} , which is less than the ERM of 180 µg/kg. Porewater concentrations are predicted to be less than 10^{-8} ng/L, which is below the CTR criteria of 30 ng/L (Figure D-5).
    - Total DDx sorbed-phase concentrations are predicted to be 0.52 than the ERM of 46.1 µg/kg. Porewater concentrations are predicted to be 0.08 ng/L, which is below the CTR criteria of 1.0 ng/L (Figure D-6).
    - Mercury sorbed-phase and porewater concentrations are predicted to be 11.9 which is less than the ERM of 710 µg/kg. Porewater concentrations are predicted to be less than 0.15 ng/L, which is below the CTR criteria of 50 ng/L (Figure D-7).
- Newport Channel 3
    - Total PCB sorbed-phase concentrations are predicted to be 2.9 the ERM of 180 µg/kg. Porewater concentrations are predicted to be less than 0.083 ng/L, which is below the CTR criteria of 30 ng/L (Figure D-8).
    - Total DDx sorbed-phase concentrations are predicted to be 13.4 than the ERM of 46.1 µg/kg. Porewater concentrations are predicted to be 0.78 ng/L (Figure D-9). As described in Section 2.2.3, porewater concentrations are not compared with CTR criteria.
    - Mercury sorbed-phase and porewater concentrations are predicted to be 157 which is less than the ERM of 710 µg/kg. Porewater concentrations are predicted to be 1.97 ng/L, which is below the CTR criteria of 50 ng/L (Figure D-10).

- Newport Channel 2
  - Total PCB sorbed-phase concentrations are predicted to be 20.3
than the ERM of 180 µg/kg. Porewater concentrations are predicted to be 0.36 ng/L, which is below the CTR criteria of 30 ng/L (Figure D-11).
  - Total DDx sorbed-phase concentrations are predicted to be 18.4
than the ERM of 46.1 µg/kg. Porewater concentrations are predicted to be 0.37 ng/L, which is below the CTR criteria of 1.0 ng/L (Figure D-12).
  - Mercury sorbed-phase and porewater concentrations are predicted to be 488
which is less than the ERM of 710 µg/kg. Porewater concentrations are predicted to be 6.0 ng/L, which is below the CTR criteria of 50 ng/L (Figure D-13).

Figure D-5
Temporal Profile of Vertically Averaged Total PCB Concentrations in the Bioturbation Zone – Phase 2 Entrance Channel

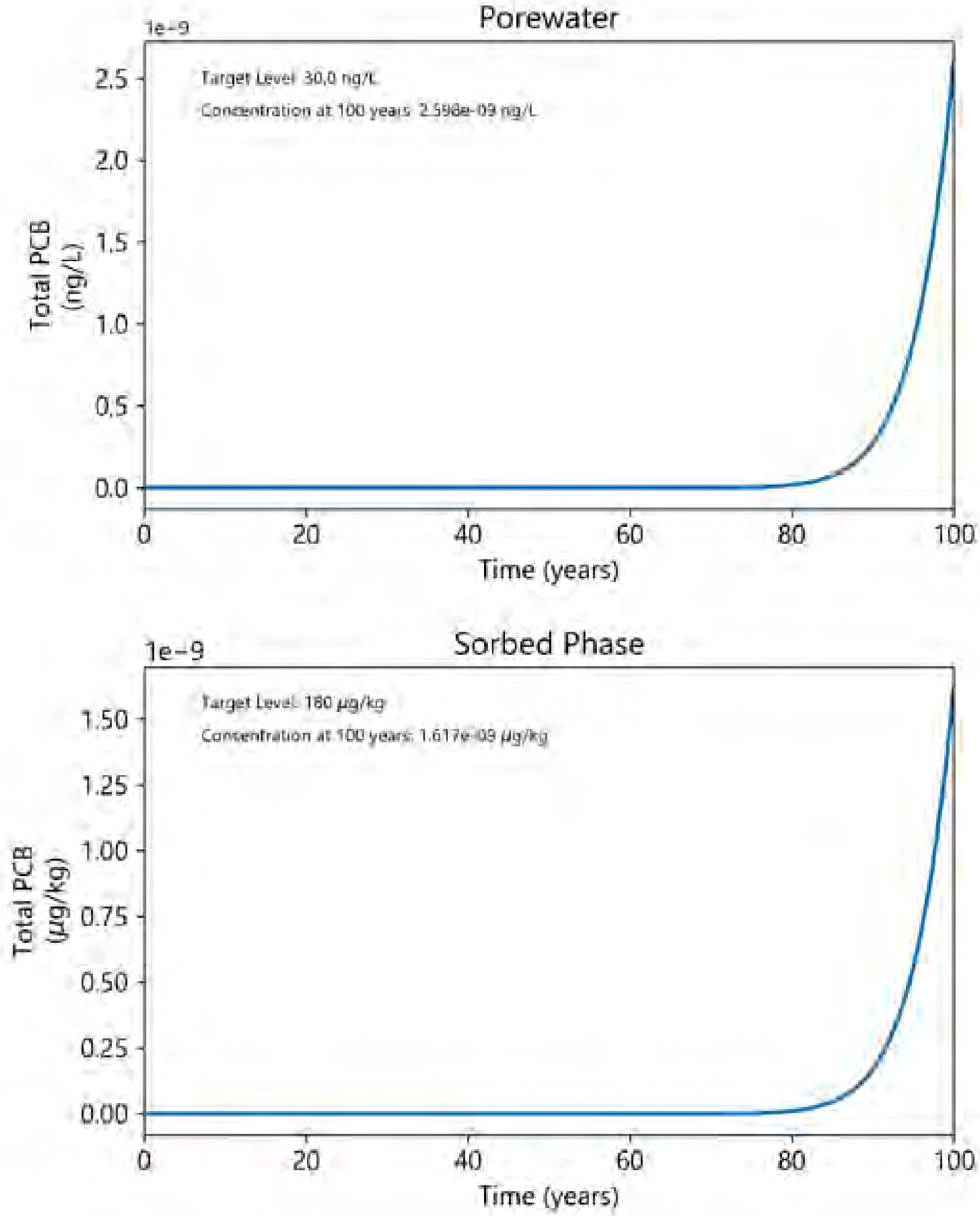


Figure D-6
Temporal Profile of Vertically Averaged Total DDx Concentrations in the Bioturbation Zone – Phase 2 Entrance Channel

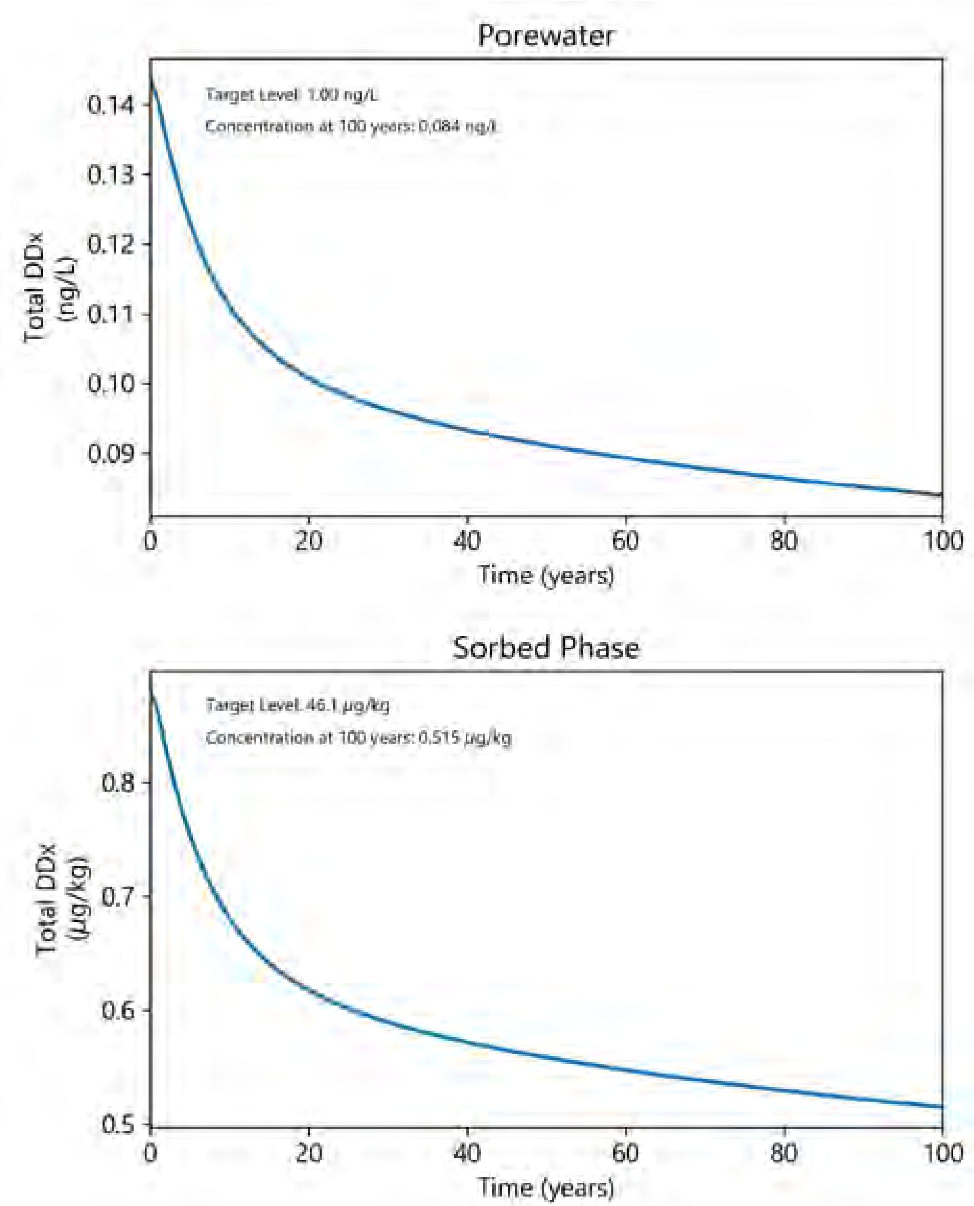


Figure D-7
Temporal Profile of Vertically Averaged Mercury Concentrations in the Bioturbation Zone – Phase 2 Entrance Channel

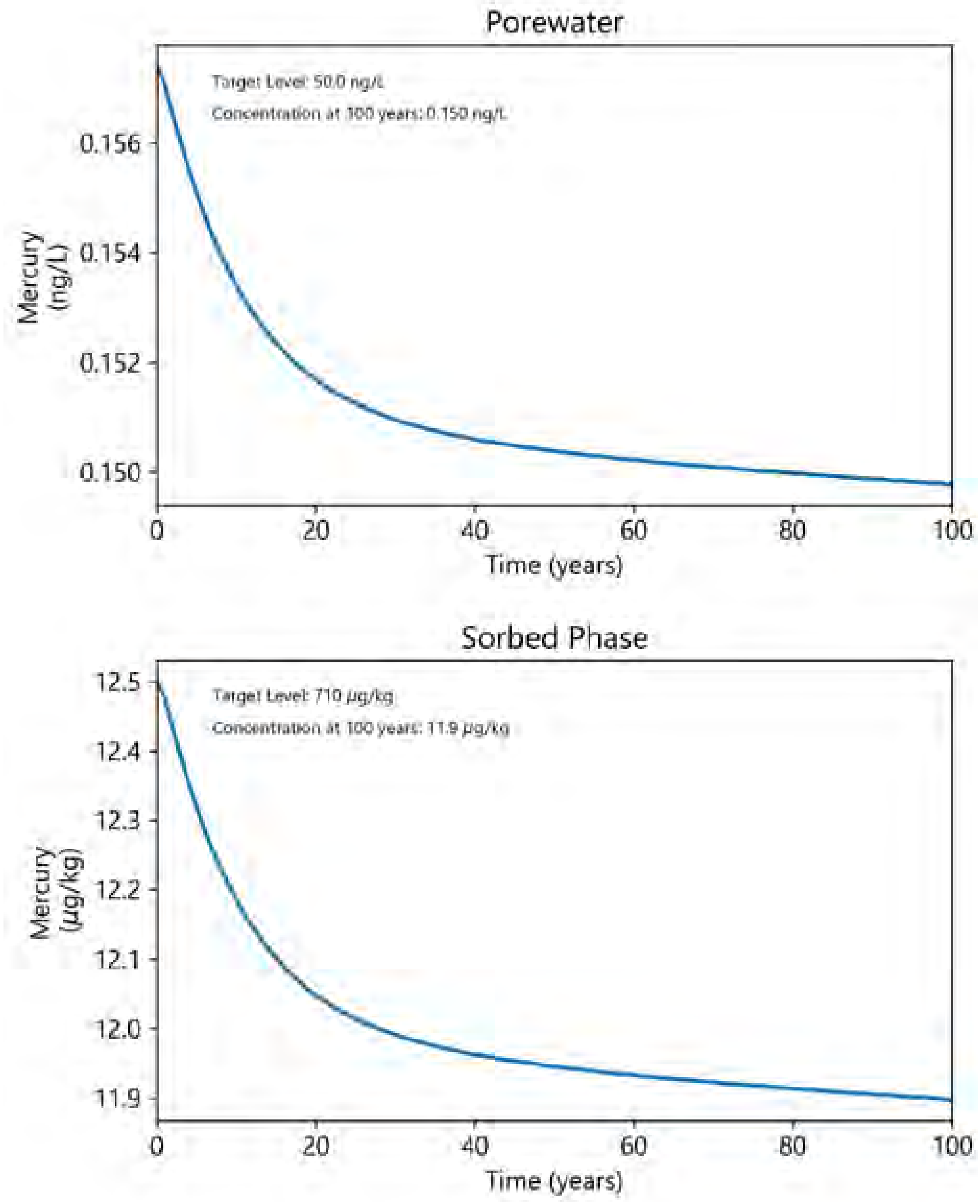


Figure D-8
Temporal Profile of Vertically Averaged Total PCB Concentrations in the Bioturbation Zone – Phase 2 Newport Channel 3

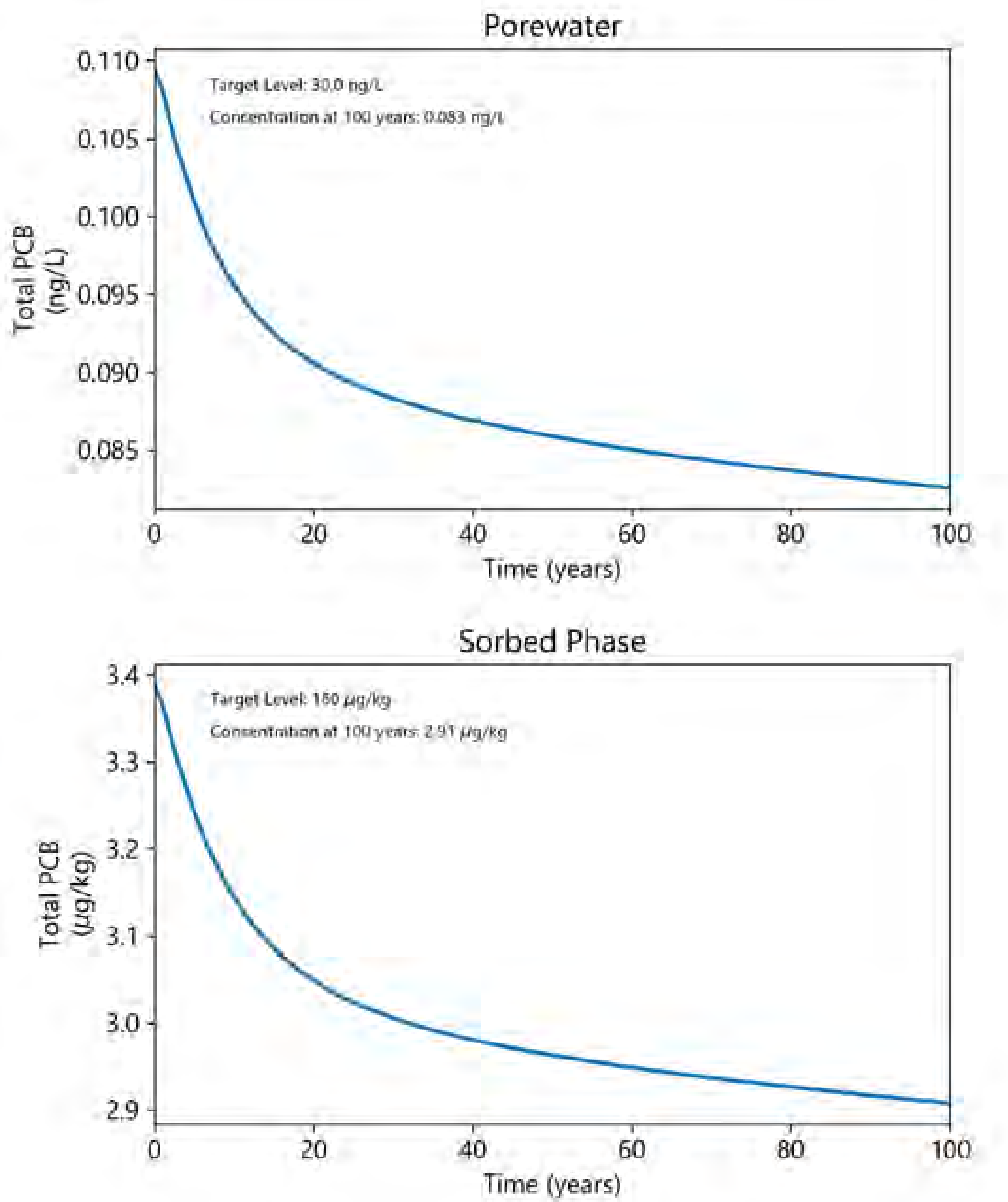


Figure D-9
Temporal Profile of Vertically Averaged Total DDx Concentrations in the Bioturbation Zone – Phase 2 Newport Channel 3

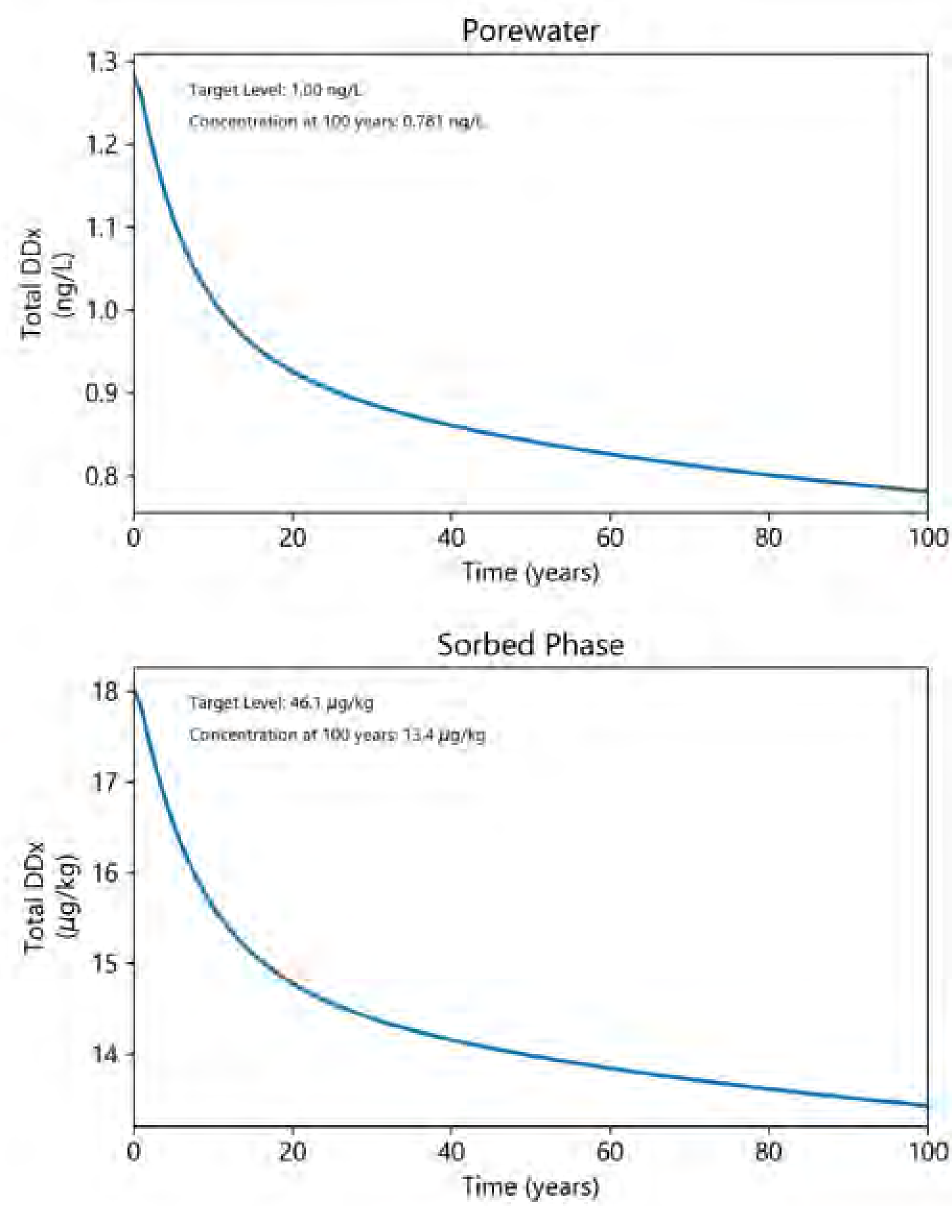


Figure D-10
Temporal Profile of Vertically Averaged Mercury Concentrations in the Bioturbation Zone – Phase 2 Newport Channel 3

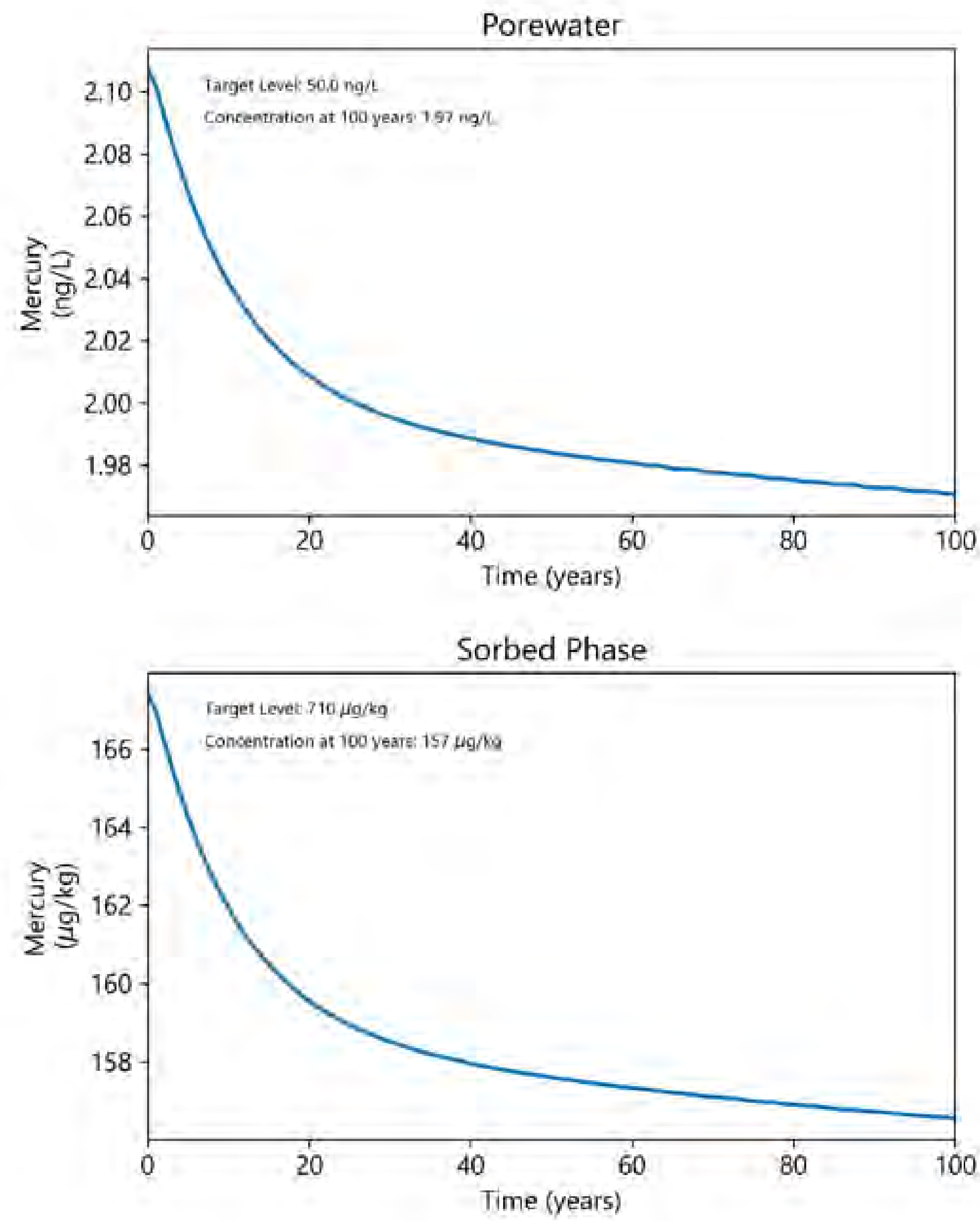


Figure D-11
Temporal Profile of Vertically Averaged Total PCB Concentrations in the Bioturbation Zone – Phase 2 Newport Channel 2

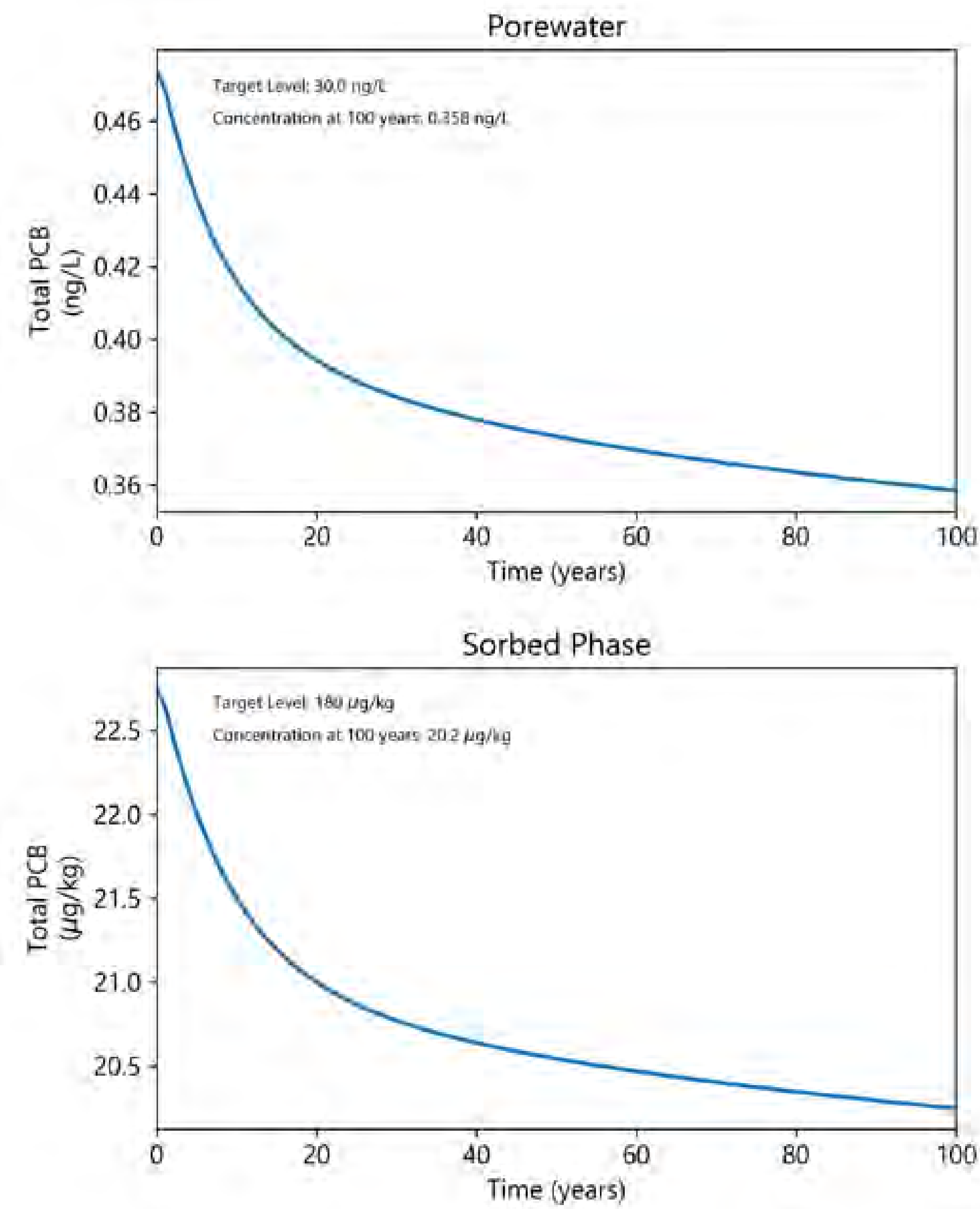


Figure D-12
Temporal Profile of Vertically Averaged Total DDx Concentrations in the Bioturbation Zone – Phase 2 Newport Channel 2

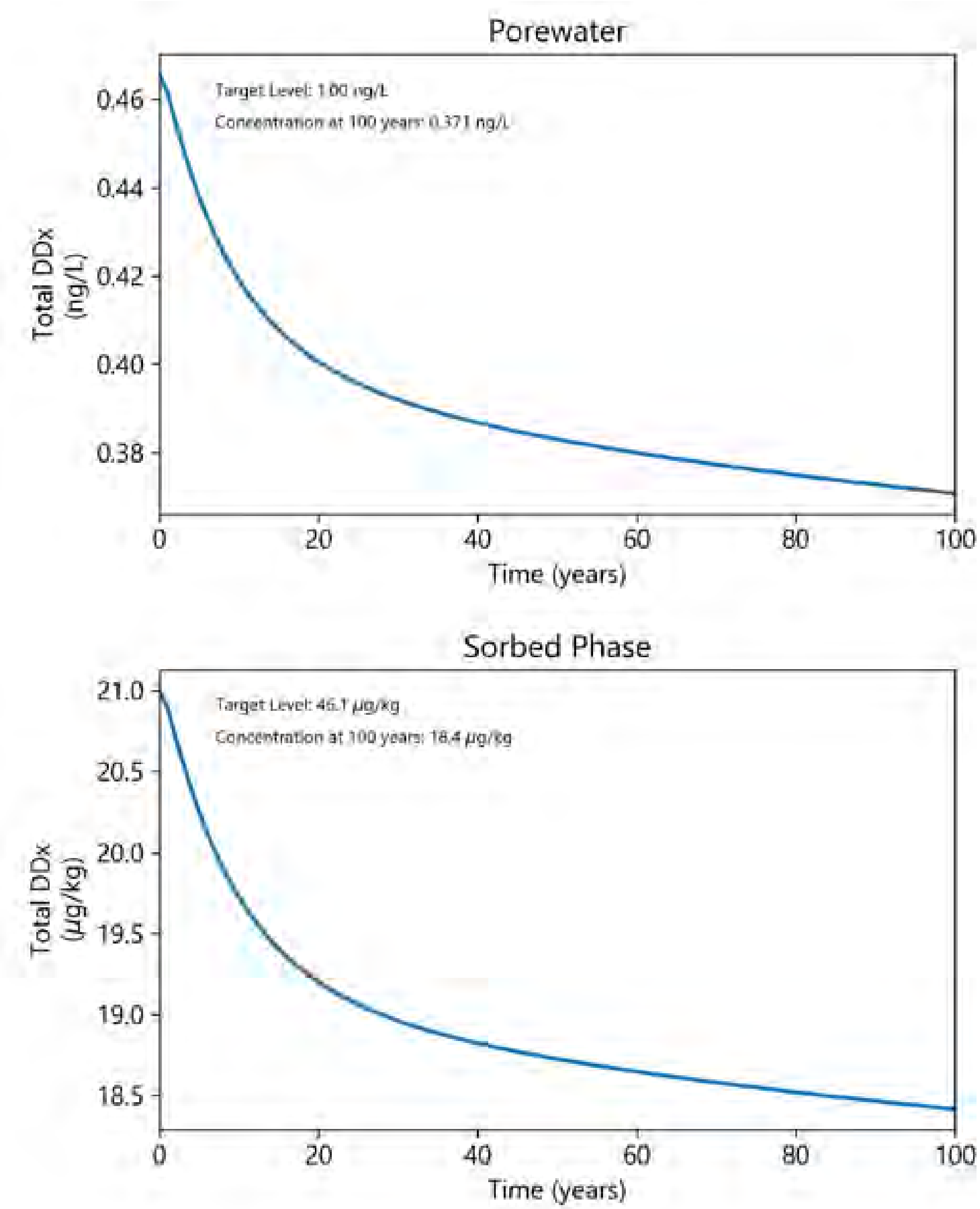
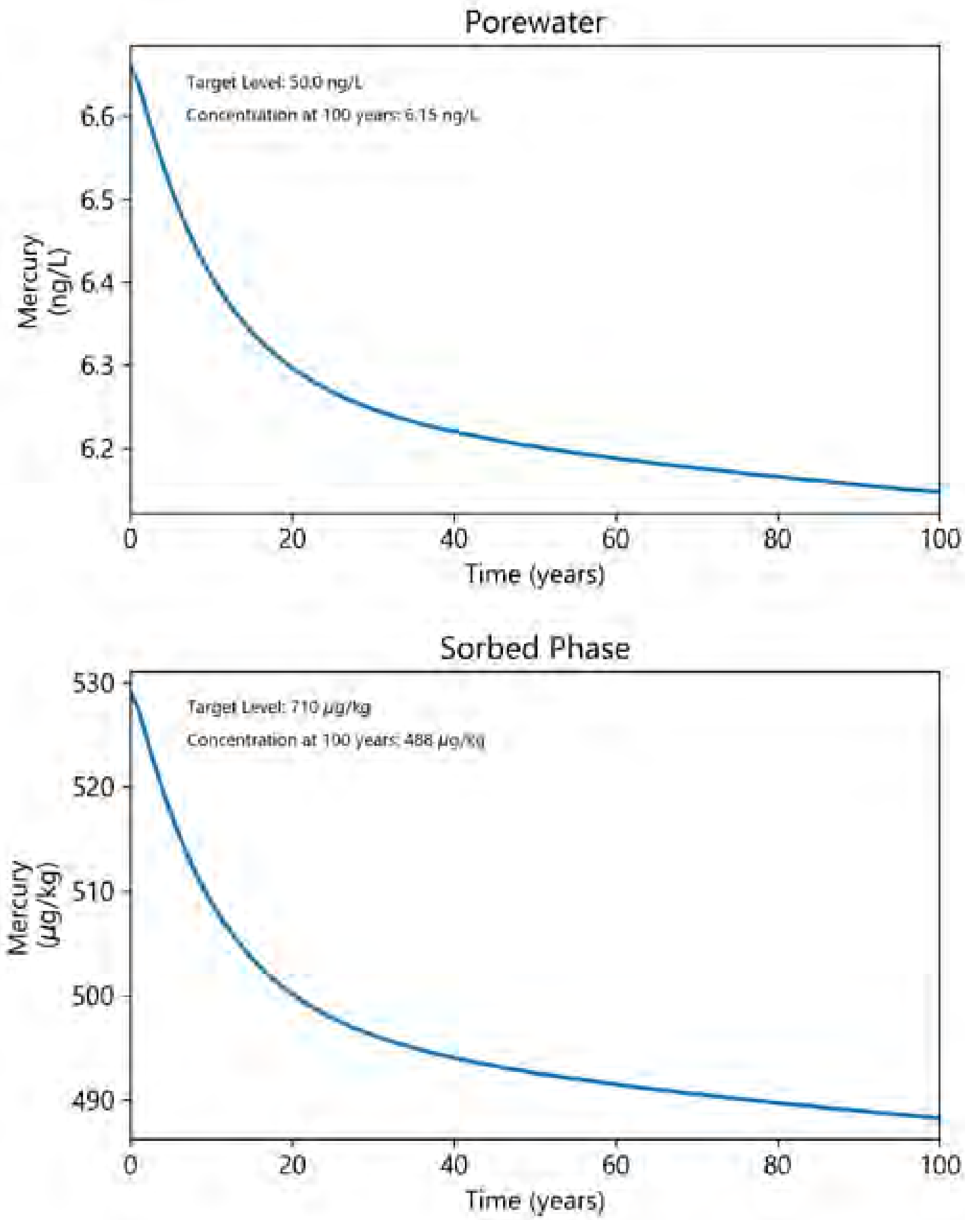


Figure D-13
Temporal Profile of Vertically Averaged Mercury Concentrations in the Bioturbation Zone – Phase 2 Newport Channel 2



3.3 Sensitivity Analysis

As discussed in Section 2.2.1, a sensitivity analysis was conducted to evaluate how uncertainty in the dispersion length affects model results. The sensitivity analysis was run for only the simulation of the Phase 1 interim cover, because that scenario produced higher concentration results for all COPCs than did the simulation of the Phase 2 final cap.

The dispersion length was set to 10% of the model domain length to account for increased dispersion due to tidal mixing. For the sensitivity analysis, alternate values for the dispersion length of 1% and 20% of the domain length were evaluated—this range covers the bounds of realistic values. A dispersion length of 1% of the domain length is typical for flow in porous media over relatively short distances, with no influence from tidal mixing, and a dispersion length of 20% of domain length is at the upper end of the range for a system with tidal mixing (Gelhar et al. 1985; Neuman 1990; La Licata et al. 2011). The resulting porewater concentrations averaged over the interim cover bioturbation zone are presented in Table D-5. The small range of model-predicted porewater and sorbed-phase concentrations for COPCs (Table D-5) indicate that the model is relatively insensitive to changes in the dispersion term. The model predicts that increasing the dispersivity term generally increases model-predicted concentrations, whereas decreasing the dispersity term generally decreases the model-predicted concentrations. Results of the sensitivity analysis indicate that model-predicted concentrations remain below target levels for each scenario evaluated.

Table D-5
Sensitivity Analysis Model Results

Chemical Name	Average Surface Porewater Concentration at 100 Years (			CTR Porewater	Average Surface Sorbed-Phase Concentration at 100 Years (			ERM
	10% of Domain Length	1% of Domain Length	20% of Domain Length		10% of Domain Length	1% of Domain Length	20% of Domain Length	
Total DDx	0.0011	0.00088	0.0019	--	15.6	14.1	20.0	46.1
Total PCBs	0.00012	0.000087	0.00027	0.030	3.20	2.95	4.03	180
Mercury	0.0020	0.0020	0.0020	0.051	160	159	160	710

Note:
--: As described in Section 2.2.3, model-predicted DDx porewater concentrations for Newport Channel 3 dredge material are not compared with the aqueous CTR criteria for interim cover.

4 Summary and Next Steps

Chemical transport modeling was conducted to evaluate the protectiveness of the interim cover and final cap layer for the CAD facility being designed to support the disposal of dredge material classified as unsuitable for open ocean disposal. The material will be generated as part of upcoming maintenance dredging projects to be conducted in the Lower Newport Bay Federal Channels and elsewhere. The analysis incorporated site-specific data, including COPC concentrations in unsuitable dredge material as well as clean sediment for capping, conservative estimates of Darcy groundwater seepage flux based on regional hydraulic data, information from literature, and experience from capping design at other sites. Modeling indicates the interim cover and final cap layer (including sediments from Newport Channel 2, Newport Channel 3, and the Entrance Channel) as currently designed are predicted to meet the target levels for more than 100 years.

These design variables include the following:

- The scour analysis has identified that up to 3 inches of scour from vessels traversing the CAD facility is possible.
- The specific source of the Phase 2 dredge material outside of the Federal Channels has not been identified. Therefore, the maximum sediment concentration for each COPC measured in composite samples collected from potential areas was used as a conservative assumption.
- Any changes to the presumed interim and final cap variables may require updates to the chemical isolation cap model.

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Appendix E
Vessel Scour Analysis

DRAFT

November 24, 2020
Draft Basis of Design Report
Sediment Dredging and Confined Aquatic Disposal, Lower Newport Bay

Appendix E: Vessel Scour Analysis

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1 Introduction

Vessels traveling over the proposed confined aquatic disposal (CAD) facility produce propeller-generated currents (i.e., propeller wash) that may scour the CAD's surface. The CAD facility will be constructed in phases with an initial layer from the Lower Newport Bay and Federal Channels maintenance dredging program, an interim cover containment layer. After placement of the interim cover containment layer, the public and City of Newport (City) will have a predetermined amount of time to continue placing material from outside the Federal Channels that is determined unsuitable for open ocean disposal. Finally, a clean sediment cap (final cap) will be placed over this material. Due to the extensive time gaps, potential scour effects of propeller wash were evaluated for the following three surface layers: interim cover containment layer, material outside the Federal Channels, and final cap.

This document summarizes the vessel scour analysis, evaluating the CAD surface's physical stability and thickness from exposure to propeller wash. Design elements for the proposed CAD facility are described in Section 2. The propeller-generated currents in Section 3 and propeller-induced scouring in Section 4 were evaluated in Section 5 for the following CAD facility surface elevations, sediment material, tide conditions, and vessel characteristics:

- CAD facility surface elevations (from bottom to top)
  - Final cap surface (-22 feet mean lower low water [MLLW])
  - Surface elevation after the public and City placement period for material outside of the Federal Channels (-25 feet MLLW)
  - Interim cover containment layer surface (-30 feet MLLW)
- Sediment materials
  - Physical properties of clean material within the Federal Channels (assumed to be used to construct the interim cover containment layer) (Anchor QEA 2019)
  - Physical properties of samples collected during 2013 and 2017 for the Regional General Permit (RGP) 54 program (Anchor QEA 2013 and 2018); assumed to be the layer from material outside the Federal Channel that will result from public and City dredging projects
  - Physical properties of the final cap material (assumed to be from the Entrance Channel or Newport Channel 3) (Anchor QEA 2019)
- Tide conditions and water depths
  - Mean higher high water (MHHW)
  - MLLW
  - Lowest observed water (LOW)
- Vessel characteristics
  - 25% maximum power
  - 50% maximum power

2 Design Elements for the Proposed CAD Facility

The proposed CAD facility will be constructed in a layered approach extending from a bottom elevation of -46 feet MLLW (including 1-foot overdredge) to the top final design elevation of -22 feet MLLW. The CAD facility will be initially constructed from dredge material from the Lower Newport Bay and Federal Channels maintenance dredging program. Material unsuitable for open ocean disposal will be placed at the bottom of the CAD facility to an elevation of -31 feet MLLW. This material will then be covered with an interim cover containment layer of clean material with a thickness of 1 foot and surface elevation of -30 feet MLLW. Over a predetermined time frame, material suitable and unsuitable for open ocean disposal from the public and City dredging projects, including material permittable and not permittable under the City's RGP 54 program, will be periodically placed in the CAD facility. This layer will be 5 feet thick to an elevation of -25 feet MLLW. A 3-foot final cap of clean material would complete the CAD facility to a surface elevation of -22 feet MLLW.

The propeller wash scour analysis evaluated potential scour conditions of the CAD surface at three elevations as follows: interim cover containment layer, material outside the Federal Channels, and final cap (Table E-1). Details of the sediment material, tide conditions, and vessel characteristics used to evaluate each layer are provided in Sections 2.1 to 2.3.

Table E-1
CAD Facility Elements

Element	Elevation (feet MLLW)	Sediment Material	Thickness (feet)
Final Cap	-22	Entrance Channel, Newport Channel 3, or RGP 54 clean material	3
Material Outside the Federal Channels	-25	Material within Lower Newport Bay but outside the Federal Channels permittable and not permittable under the City's RGP 54 program	5
Interim Cover Containment Layer	-30	Lower Newport Bay and Federal Channels maintenance dredging clean material	1

2.1 Sediment Material

Sediment grain size compositions were defined for the interim cover containment layer, material outside the Federal Channels, and final cap, as illustrated in Figure E-1. These grain size distributions were determined based on sediment data of the respective source material. Since the source material will have a range in sediment composition, the average sediment compositions were used (Table E-2).

Sediments dredged from Newport Channel 3 (NC3), as part of the Lower Newport Bay and Federal Channels maintenance dredging program, will likely be used for the interim cover containment layer. The sediment composition was determined from four sediment samples taken in NC3 (Anchor QEA 2019). The average sediment composition was used to define the interim cover containment layer sediment properties.

Sediments for material outside the Federal Channels were characterized with data from two previous RGP 54 sediment suitability determinations. These comprehensive bay-wide sediment investigations included grain size analyses of composite samples throughout the RGP 54 area in 2013 (Anchor QEA 2013) and 2017 (Anchor QEA 2018). Composite samples from each sediment investigation were collected for the following five areas: 1) Lido Isle; 2) Linda Isle/Harbor Island; 3) Upper Newport Bay, 4) Balboa Island; and 5) Newport Island Channels. In general, grain sizes in Lower Newport Bay (Areas 1, 4, and 5) are similar with mostly sands. Grain sizes from Area 2 to Area 3 transition to mostly fines (silt and clay). Sediment properties for this layer were defined based on the average sediment composition of data from the 2013 and 2017 RGP 54 sediment investigations.

The final cap material will depend on the availability of sediment material when the final cap is constructed. Potential sources of clean material include the Lower Newport Bay and Federal Channels maintenance dredging or RGP 54 programs. For this vessel scour analysis, the final cap sediment composition was based on sediment from the Entrance Channel (EC-COMP), which is mostly sands, and NC3 (Anchor QEA 2019).

Table E-2
CAD Material Sediment Compositions and Properties

Sediment Class	Diameter (millimeters)	Newport Channel 3	Material Outside Federal Channels	Entrance Channel
Gravel	>2.0	0.56	0.00	0.00
Very Coarse Sand	1.0 to 2.0	6.41	0.96	0.27
Coarse Sand	0.5 to 1.0	19.57	12.43	3.94
Medium Sand	0.25 to 0.5	33.06	22.37	28.92
Fine Sand	0.125 to 0.25	15.55	16.62	56.93
Very Fine Sand	0.0625 to 0.125	2.39	7.25	8.06
Silt	0.00391 to 0.0625	15.68	28.32	1.32
Clay	<0.00391	6.79	11.95	0.55
D_{85}		0.752 mm	0.476 mm	0.386 mm
D_{50}		0.306 mm	0.138 mm	0.204 mm
D_{15}		0.017 mm	0.005 mm	0.133 mm

Notes:
Units in percent unless otherwise indicated
Newport Channel 3 for interim cover containment layer (Anchor QEA 2019)

Material outside the Federal Channels (Anchor QEA 2013, 2018)
Entrance Channel and Newport Channel 3 for final cap (Anchor QEA 2019)

2.2 Tide Conditions and Water Depths

Water levels at the proposed CAD facility are influenced primarily by astronomical tides. Other factors that affect water levels include temperature variations (e.g., during El Niño Southern Oscillation), barometric pressure changes, wind setup (i.e., storm surge), and wave setup. These factors are secondary in magnitude and episodic in nature, hence their effects on the water levels are not considered in the analysis presented herein. The long-term representation of water levels at the project location is calculated based on astronomical tides alone.

The National Oceanic and Atmospheric Administration monitors water levels around the United States and establishes tidal datums used to reference water levels. Tidal datums for Newport Harbor are summarized in Table E-3 based on the latest tidal epoch from 1983 to 2001.

Table E-3
Tides at the Harbor

Tidal Datum	Water Level (feet MLLW)
Highest observed water (January 28, 1983)	7.67
Mean higher high water (MHHW)	5.41
Mean high water (MHW)	4.68
Mean tide level (MTL)	2.80
Mean sea level (MSL)	2.78
Mean low water (MLW)	0.92
Mean lower low water (MLLW)	0.00
Lowest observed water (January 28, 1988)	-2.35

Note:
Source: NOAA 2003

Water depths were calculated as the difference between the tide water level and CAD surface elevation. This analysis used three water levels for determining the propeller wash velocities. The three water levels selected were two representative tide conditions (i.e., MHHW and MLLW) and one extreme condition (i.e., lowest observed water).

2.3 Vessel Characteristics

Propeller-generated currents were evaluated for the types of vessels traveling over the proposed CAD facility. City personnel provided vessel information and operation characteristics of vessels expected to transverse the proposed CAD facility, including sailboats, tugboats, charter boats (e.g., Hornblower), and powerboats. Properties of representative vessels operating in Newport Harbor are listed in Table E-4. To adhere to speed limits within the harbor (no wake zone and maximum speed limit of 5 miles per hour), maximum power would not be used under operating conditions. Thus, propeller wash currents were determined assuming 25% and 50% of the vessel maximum power.

Table E-4
Newport Harbor Vessel Characteristics

Vessel Type	Vessel Draft (feet)	Number of Propellers	Propeller Diameter (feet)	Maximum Power (horsepower)
50-foot Sailboat	6	1	1.67	100
70-foot Sailboat	12	1	1.67	100
Tugboat	7	2	4.50	2,200
Charter boat	8	2	3.33	2,500
90-foot Powerboat	9	2	2.67	1,800
135-foot Powerboat	10	2	3.33	2,500

3 Propeller-Generated Currents

The propeller wash exposure on the proposed CAD facility surface depends on the vessel characteristics and water depths. Propeller-generated currents were estimated with a propeller wash model (Anchor 2002) for a range of hydrodynamic conditions and vessel types. The model uses equations developed by Blaauw and van de Kaa (1978), Blaauw et al. (1984), and Verhey (1983). It predicts the velocity field behind a propeller jet based on the momentum theory and assumes the propeller thrust equals the change of the fluid momentum caused by the propeller. It also predicts the laws of free jet turbulence for submerged jets by assuming that flow is steady, uniform, and frictionless. In the zone of established flow, the velocity of the propeller jet at a distance, x, from the propeller and a radial distance, r, from the propeller axis was calculated based on engine operating power, propeller diameter, number of propellers, vessel draft, and water depth (Equation 1). For a non-ducted propeller, the velocity of the propeller jet can be written as shown in Equation 1.

Equation 1

$$V_{x,r} = 9.72 * \left(\frac{P_d}{{D_p}^2}\right)^{1/3} * \left(1.964 * \frac{D_p}{x}\right)^{1.1} * exp\left(-15.43 * \frac{r^2}{x^2}\right)$$

where:

Vx,r	=	water velocity at a given longitudinal distance, x, and radial distance, r, (feet/second)
x	=	distance behind propeller (feet)
r	=	radial distance from propeller axis (feet)
Pd	=	applied engine or propeller power (horsepower)
Dp	=	propeller diameter (feet)

Propeller wash velocities were determined for various combinations of CAD surface elevations, water levels, and vessel operations. Analyses were conducted for the following three surface elevations: interim containment cover layer at -30 feet MLLW; material outside the Federal Channels at -25 feet MLLW; and final cap at -22 feet MLLW. The CAD surface elevations were combined for the following three water levels: MHHW, MLLW, and lowest observed water (LOW). Vessel operations were based on 25% and 50% of maximum power.

3.1 Interim Cover Containment Layer

Propeller wash velocities at the interim cover containment layer surface (-30 feet MLLW) for 25% vessel power are shown in Figure E-2. In the figure, bottom velocities at the three water levels are shown in individual panels for the six vessels. For the 135-foot powerboat, the maximum propeller wash velocities range from 0.9 to 1.3 feet per second, occurring at 140 and 100 feet behind the vessel, respectively. The maximum bottom velocities correspond to the highest vessel power and shallowest water depth (Table E-5).

Table E-5
Maximum Propeller Wash Velocities at Interim Cover Containment Layer Surface for 25% Vessel Power

Vessel Type	Maximum Bottom Velocity (feet per second)		
	MHHW	MLLW	LOW
50-foot Sailboat	0.16	0.20	0.22
70-foot Sailboat	0.21	0.27	0.31
Tugboat	0.86	1.07	1.19

Vessel Type	Maximum Bottom Velocity (feet per second)		
	MHHW	MLLW	LOW
Charter boat	0.84	1.05	1.18
90-foot Powerboat	0.72	0.91	1.03
135-foot Powerboat	0.91	1.16	1.32

Note:
Interim cover containment layer surface elevation at -30 feet MLLW

Figure E-3 illustrates the propeller wash bottom velocities at the interim cover containment layer surface (-30 feet MLLW) for 50% vessel power. For the 135-foot powerboat, the range in maximum propeller wash velocities increased to 1.1 and 1.7 feet per second. The maximum propeller wash velocities for 50% vessel power occurring at the interim cover containment layer surface are provided in Table E-6.

Table E-6
Maximum Propeller Wash Velocities at Interim Cover Containment Layer Surface for 50% Vessel Power

Vessel Type	Maximum Bottom Velocity (feet per second)		
	MHHW	MLLW	LOW
50-foot Sailboat	0.20	0.25	0.28
70-foot Sailboat	0.26	0.34	0.40
Tugboat	1.09	1.35	1.50
Charter boat	1.06	1.32	1.49
90-foot Powerboat	0.91	1.15	1.30
135-foot Powerboat	1.14	1.46	1.66

Note:
Interim cover containment layer surface elevation at -30 feet MLLW

3.2 Material Outside the Federal Channels

Material outside the Federal Channels unsuitable for open ocean disposal from public and City projects determined unsuitable for open ocean disposal could be placed in the proposed CAD facility over a predetermined time frame, increasing the surface elevation over time. For the propeller wash analysis, the top surface elevation of this layer at -25 feet MLLW was used because this produces in the highest bottom velocities expected to occur for the layer. Propeller wash velocities at the layer's surface (-25 feet MLLW) are shown in Figure E-4 for 25% vessel power and Figure E-5 for 50% vessel power. Compared to the interim cover containment layer surface, the propeller-generated velocities are higher on this layer's surface due to the higher surface elevation (i.e., shallower water depths). The 135-foot powerboat (50% power) would generate the greatest bottom velocities from 1.4 to 2.3 feet per second, corresponding to distances of 120 and 80 feet behind the vessel, respectively. Tables E-7 and E-8 summarize the maximum propeller wash velocities at this layer surface for 25% and 50% vessel power, respectively. Bottom velocities would be lower for elevations lower than this layer surface.

Table E-7
Maximum Propeller Wash Velocities at Material Outside the Federal Channels Surface for 25% Vessel Power

Vessel Type	Maximum Bottom Velocity (feet per second)		
	MHHW	**MLLW**	**LOW**
50-foot Sailboat	0.20	0.26	0.29
70-foot Sailboat	0.27	0.38	0.47
Tugboat	1.05	1.36	1.56
Charter boat	1.03	1.37	1.58
90-foot Powerboat	0.89	1.21	1.42
135-foot Powerboat	1.14	1.55	1.82

Note:
Material outside the Federal Channels surface elevation at -25 feet MLLW

Table E-8
Maximum Propeller Wash Velocities at Material Outside the Federal Channels Surface for 50% Vessel Power

Vessel Type	Maximum Bottom Velocity (feet per second)		
	MHHW	**MLLW**	**LOW**
50-foot Sailboat	0.25	0.32	0.37
70-foot Sailboat	0.33	0.48	0.59
Tugboat	1.32	1.72	1.96
Charter boat	1.30	1.72	1.99
90-foot Powerboat	1.13	1.52	1.78
135-foot Powerboat	1.43	1.95	2.30

Note:
Material outside the Federal Channels surface elevation at -25 feet MLLW

3.3 Final Cap

Propeller wash velocities at the final cap surface (-22 feet MLLW) are shown in Figures E-6 and E-7 for 25% and 50% vessel power, respectively. Overall, the highest propeller-generated velocities occur at the final cap surface due to the shallower water depths. The 135-foot powerboat (50% power) would generate bottom velocities from 1.7 feet per second at 100 feet behind the vessel to 3.0 feet per second at 80 feet behind the vessel. Tables E-9 and E-10 summarize the maximum propeller wash velocities at the CAD final cap elevation for 25% and 50% vessel power, respectively.

Table E-9
Maximum Propeller Wash Velocities at Final Cap Surface for 25% Vessel Power

Vessel Type	Maximum Bottom Velocity (feet/second)		
	MHHW	MLLW	LOW
50-foot Sailboat	0.23	0.31	0.36
70-foot Sailboat	0.32	0.50	0.65
Tugboat	1.20	1.63	1.91
Charter boat	1.20	1.65	1.98
90-foot Powerboat	1.04	1.48	1.80
135-foot Powerboat	1.33	1.92	2.37

Note:
Final cap surface elevation at -22 feet MLLW

Table E-10
Maximum Propeller Wash Velocities at Final Cap Surface for 50% Vessel Power

Vessel Type	Maximum Bottom Velocity (feet/second)		
	MHHW	MLLW	LOW
50-foot Sailboat	0.29	0.39	0.46
70-foot Sailboat	0.40	0.63	0.81
Tugboat	1.52	2.05	2.41
Charter boat	1.51	2.08	2.50
90-foot Powerboat	1.31	1.87	2.27
135-foot Powerboat	1.68	2.42	2.99

Note:
Final cap surface elevation at -22 feet MLLW

4 Propeller Wash Induced Scouring

The propeller wash velocities may induce scouring of the CAD surface, depending on the sediment composition. Dücker and Miller (1996) developed an empirical method to estimate the fully formed scour depth as a function of jet load intensity (Equation 2). In this method, the scour depth is related to the grain size of the material and propeller jet load, which is a function of the maximum propeller wash velocity and sediment properties. For the vessel maneuvering coefficient, a value of 0.3 was found to be appropriate for this method (Schokking 2002).

Equation 2

$$\frac{d_{hole}}{D_{85}} = C_m * 0.1\left(\frac{B}{B_{crit}}\right)^{13} \quad \text{for} \quad 1.0 < \left(\frac{B}{B_{crit}}\right) < 1.4$$

$$\frac{d_{hole}}{D_{85}} = C_m * 4.6\left(\frac{B}{B_{crit}}\right)^{2.25} \quad \text{for} \quad 1.4 < \left(\frac{B}{B_{crit}}\right)$$

where:

d_{hole}	=	bed scour depth (meter)
D_{85}	=	particle diameter for which 85% of the soil particles are finer by weight (meter)
C_m	=	vessel maneuvering coefficient, 0.3 for maneuvering condition and 1.0 for stationary condition (dimensionless)
B	=	propeller jet load intensity, $\frac{U_{max,bot}}{\sqrt{D_{85}*g*\frac{\rho s-\rho}{\rho}}}$ (dimensionless)
B_{crit}	=	stability coefficient of bed material, 1.25 (dimensionless)

Propeller-induced scour depths were estimated for vessel types and operating conditions expected to scour the CAD surface. Analyses were conducted using the maximum propeller wash velocities (Section 3.1) and corresponding sediment compositions (Section 2.1).

For each CAD surface evaluated, scour depths were determined for vessel types with propeller wash velocities high enough to cause scour. Figure E-8 shows the Hjulstrom curve, which is commonly used to determine the critical current speed that would cause incipient particle motion of material of a given grain size. In each panel of Figure E-8, the propeller wash velocities by vessel type are compared to the mean particle size. For the final cap, the Hjulstrom curve (black line) indicates the threshold for scour is 0.6 foot per second for a median grain size of 0.204 millimeters (mm; red dashed line). Propeller wash velocities (solid colored lines) are shown for 50% vessel power at LOW. Propeller wash velocities from the 50-foot sailboat are lower than the threshold for scour, while other vessel propeller wash velocities are higher and may cause scouring of the final cap surface. For the layer of material outside the Federal Channels and interim cover containment layer, scour depths were evaluated for vessels larger than a tugboat.

4.1 Interim Cover Containment Layer

Scour depths of the interim cover containment layer were determined for the tugboat, charter boat, 90-foot powerboat, and 135-foot powerboat. These vessels could produce velocities high enough to erode the interim cover containment layer at -30 feet MLLW. Table E-11 summarizes the estimated interim cover containment layer scour depths for vessel operation at 25% and 50% power and three water levels. Scour depths less than 0.1 foot were considered negligible. All scour depths for the interim cover containment layer were negligible.

Table E-11
Scour Depths at Interim Cover Containment Layer Surface

Vessel Type	Scour Depth (feet) at 25% Power			Scour Depth (feet) at 50% Power		
	MHHW	MLLW	LOW	MHHW	MLLW	LOW
Tugboat	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Charter Boat	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
90-foot Powerboat	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
135-foot Powerboat	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Note:
Scour depths based on propeller wash velocities at -30 feet MLLW and sediment with D_{85} of 0.752 mm

4.2 Material Outside the Federal Channels

Scour depths of the layer for material outside the Federal Channel were determined for the tugboat, charter boat, 90-foot powerboat, and 135-foot powerboat, which could produce velocities high enough to erode the surface at -25 feet MLLW. Estimated scour depths of this layer surface for vessel operation at 25% and 50% power and three water levels are provided in Table E-12. At 25% power, scour depths were negligible. A scour depth of 0.1 foot was estimated for the 135-foot powerboat at 50% power and MLLW. At LOW, scour depths of 0.1 foot were estimated for the tugboat, charter boat, and 135-foot powerboat.

Table E-12
Scour Depths at Material Outside the Federal Channels Surface

Vessel Type	Scour Depth (feet) at 25% Power			Scour Depth (feet) at 50% Power		
	MHHW	MLLW	LOW	MHHW	MLLW	LOW
Tugboat	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Charter Boat	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
90-foot Powerboat	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
135-foot Powerboat	<0.1	<0.1	<0.1	<0.1	0.1	0.1

Note:
Scour depths propeller wash velocities at -25 feet MLLW and sediment with based on D_{85} of 0.476 mm

4.3 Final Cap

Scour depths at the final cap surface with material from the Entrance Channel, as shown in Table E-13, were determined for vessel types that could produce velocities high enough to erode the surface at -22 feet MLLW. Vessel types include the 70-foot sailboat, tugboat, charter boat, 90-foot powerboat, and 135-foot powerboat. Scour depths for the 70-foot sailboat were negligible. Scour depths ranged from 0.1 to 0.2 foot for the tugboat (50% power at MLLW and LOW) and charter boat (25% power at LOW and 50% power at MLLW and LOW). For the 90-foot powerboat, a scour depth of 0.1 foot was estimated at 50% power at LOW. The 135-foot powerboat scour depths range from 0.1 to 0.3 foot, which occurs for vessel operations at 25% and 50% and water levels at MLLW and LOW.

Table E-13
Scour Depths at Final Cap Surface with Material from Entrance Channel

Vessel Type	Scour Depth (feet) at 25% Power			Scour Depth (feet) at 50% Power		
	MHHW	MLLW	LOW	MHHW	MLLW	LOW
70-foot Sailboat	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tugboat	<0.1	<0.1	<0.1	<0.1	0.1	0.2
Charter Boat	<0.1	<0.1	0.1	<0.1	0.1	0.2
90-foot Powerboat	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
135-foot Powerboat	<0.1	0.1	0.2	<0.1	0.2	0.3

Note:
Scour depths based on propeller wash velocities at -22 feet MLLW and sediment with D_{85} of 0.386 mm

Table E-14 summarizes scour depths at the final cap surface with material from NC3 and elevation at -22 feet MLLW. Scour depths for the NC3 material were the same as the Entrance Channel material for all the vessel types except the 135-foot powerboat, which was slightly lower. The 135-foot powerboat scour depths range from 0.1 to 0.2 foot, which occurs for vessel operations at 25% and 50% and water levels at MLLW and LOW.

Table E-14
Scour Depths at Final Cap Surface with Material from Newport Channel 3

Vessel Type	Scour Depth (feet) at 25% Power			Scour Depth (feet) at 50% Power		
	MHHW	MLLW	LOW	MHHW	MLLW	LOW
70-foot Sailboat	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tugboat	<0.1	<0.1	<0.1	<0.1	0.1	0.2
Charter Boat	<0.1	<0.1	0.1	<0.1	0.1	0.2
90-foot Powerboat	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
135-foot Powerboat	<0.1	0.1	0.1	<0.1	0.2	0.2

Note:
Scour depths based on propeller wash velocities at -22 feet MLLW and sediment with D_{85} of 0.752 mm

5 Evaluation

Vessels traveling over the proposed CAD facility produce propeller wash velocities that may scour the CAD surface depending on vessel characteristics and water depths. Vessels with larger operating power and propeller size in combination with shallower water depths would result in the greatest propeller wash velocities at the CAD surface (as discussed in Section 3). Exposure to propeller wash velocities may impact the CAD surface's physical stability by scouring of the sediment material. (These propeller-induced scour depths are discussed in Section 4.) Based on the range of vessel types analyzed, the 135-foot powerboat would result in the greatest scour depths. Estimated scour depths of the CAD surface at three elevations for the 135-foot powerboat are summarized in Table E-15. For the final cap, scour depths are based on the material from the Entrance Channel.

Table E-15
Scour Depths for 135-Foot Powerboat

Element	Scour Depth (feet) at 25% Power			Scour Depth (feet) at 50% Power		
	MHHW	MLLW	LOW	MHHW	MLLW	LOW
Interim Cover Containment Layer	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Material Outside the Federal Channels	<0.1	<0.1	<0.1	<0.1	0.1	0.1
Final Cap	<0.1	0.1	0.2	<0.1	0.2	0.3

5.1 Propeller Wash

The interim cover containment layer of clean material will be used to cover material unsuitable for open ocean disposal from the Lower Newport Bay and Federal Channels maintenance dredging. The interim cover containment layer will be constructed with a 1-foot thickness and surface elevation of -30 feet MLLW. Impacts from vessels traveling over the interim cover containment layer are expected to be negligible. Water depths are deep enough that propeller wash velocities result in negligible scour depths, thus maintaining the physical stability of the interim cover containment layer.

Over a predetermined time frame, material outside the Federal Channels from public and City dredging projects that have material suitable or unsuitable for open ocean disposal will be periodically placed on top of the interim cover containment layer. This layer will be 5 feet thick to an elevation of -25 feet MLLW. At the surface, propeller-induced scour depths will be negligible for vessel operations at 25% power. At 50% power, the scour depth is estimated to be 0.1 foot during low tide conditions when water levels are less than MLLW. Over the duration of the material placements, impacts from vessel traffic over the proposed CAD facility are expected to be minimal. Initially, placements for the layer will have negligible impacts from propeller wash due to the deeper water depths and would likely remain negligible for most of the time. Propeller-induced scour depths of about 0.1 foot could start occurring when this layer is near completion. Upon completion, the CAD surface will be stable given the relatively small scour depths. Impacts to the layer from vessel traffic may be minimized by limiting the time between completion of this layer and placement of the final cap.

A 3-foot final cap of clean material would complete the proposed CAD facility to a surface elevation of -22 feet MLLW. Maximum scour depths of the final cap are estimated to range from 0.1 to 0.3 foot, which occur at water levels less than MLLW. Vessels that may impact the final cap include tugboat, charter boat, 90-foot powerboat, and 135-foot powerboat. However, since these scour depths are substantially less than the final cap thickness of 3 feet, the final CAD surface is expected to be physical stable from exposure to propeller wash.

6 References

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