CENWS-OD-TS-DMMO

MEMORANDUM FOR: RECORD October 3, 2009

SUBJECT: SUPPLEMENTAL DETERMINATION REGARDING THE SUITABILITY, WITH RESPECT TO DIOXIN, OF FEDERAL OPERATION AND MAINTENANCE DREDGED MATERIAL FROM THE SNOHOMISH RIVER, EVERETT, SNOHOMISH COUNTY, WASHINGTON (*Public Notice CENWS-OD-TS-NS-30*) EVALUATED UNDER SECTION 404 OF THE CLEAN WATER ACT FOR BENEFICIAL USE OR UNCONFINED OPEN-WATER DISPOSAL AT THE PORT GARDNER NONDISPERSIVE SITE.

1. Introduction. This memorandum reflects the consensus determination of the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, Washington Departments of Ecology and Natural Resources, and the Environmental Protection Agency) regarding the suitability, with respect to dioxin, of up to 801,849 cubic yards (cy) of dredged material from the Snohomish River federal navigation project for beneficial use or disposal at the Port Gardner nondispersive open-water site.

2. Background. The Everett Harbor and Snohomish River Project and maintenance dredging by the Department of the Army was adopted June 25, 1910 and modified by subsequent acts. The project consists of deep and shallow-draft navigation channels and two settling basins to serve navigation in Everett Harbor and the Snohomish River (see Figure 1). Table 1 includes details regarding the dimensions of the navigation channels and settling basins. The Corps proposes to dredge portions of the authorized project between stations 46+00 and 375+00.

   The project was last sampled in 2003 (downstream) and 2004 (upstream). Details can be found in the suitability determinations for the two characterization events (DMMP 2004a; DMMP 2004b). Figure 2 illustrates the areas covered by those determinations. There were no DMMP screening level exceedances in either characterization and all material was found suitable for open-water disposal. While the minor shoals illustrated in Figure 2 were not explicitly included, the material in these shoals is predominantly sand and is not expected to differ chemically from what was found upstream or downstream.

   Although the frequency periods for the downstream and upstream portions of the project do not expire until September 2010 and March 2011 respectively, dioxin analysis was not conducted in either characterization event. Because of increased concern over dioxin in recent years, the DMMP agencies required that dioxin testing be conducted prior to the next dredging cycle. This supplemental suitability determination presents the results of that dioxin testing, including testing of the minor shoals between the settling basins.

3. Project Summary. Table 2 includes project summary and tracking information.

Table 2. Project Summary

Project ranking	Low-moderate
Total dredging volume	801,849 cubic yards
Proposed dredging depth	-10 to -32 feet MLLW
Draft dioxin analysis plan received	July 9, 2009
Draft dioxin analysis plan returned for revisions	July 13, 2009
Revised dioxin analysis plan received	July 14, 2009
Revised dioxin analysis plan approved	July 14, 2009
Data report received	October 2, 2009
DAIS Tracking number	EVEDX-1-A-H-278
USACE Public Notice Number	CENWS-OD-TS-NS-30

4. Testing Requirements. For the supplemental dioxin characterization, the DMMP agencies agreed to the following sampling and testing requirements:

Stations 46+00 to 55+00 (shallow-draft channel upstream of upstream settling basin)

The design depth of the shallow-draft channel is -8 feet (MLLW). Two feet of overdepth will be included when dredged. The total volume to -10 feet is 24,186 CY. One dredged material management unit (DMMU) was required, represented by two composited surface samples. Because the sediment in this area is typically the coarsest grained of the entire project, only sediment conventionals and grain size analysis were required.

Stations 68+00 to 88+00 (upstream settling basin)

The design depth is -40 feet, but dredging is proposed only to -30 feet plus 2 feet of overdepth. The total volume to -32 feet is 342,237 CY. Four DMMUs were required, each represented by two composited surface samples.

Stations 88+00 to 333+50 (shallow-draft channel between settling basins)

The design depth of the shallow-draft channel is -8 feet. Two feet of overdepth will be included when dredged. Six shoals exist within this reach. The total volume to -10 feet is 55,685 CY. One DMMU was required, represented by six composited surface samples (one sample from each shoal).

Stations 333+50 to 345+50 (downstream settling basin)

The design depth is -20 feet. Two feet of overdepth will be included when dredged. The total volume to -22 feet is 282,456 CY. Seven DMMUs were required, each represented by two composited surface samples.

Stations 345+50 to 375+00 (deep-draft channel)

The design depth of the deep-draft channel is -15 feet (MLLW). Two feet of overdepth will be included when dredged. The total volume to -17 feet is 97,285 CY. Three DMMUs were required, each represented by two composited surface samples.

The sampling plan addressed these requirements with the DMMU delineations shown in Figure 3. The volume for each DMMU can be found in Table 3, along with the analytical requirements.

5. Sampling. Sampling took place July 15 and 16, 2009. A van Veen grab sampler was deployed using the Corps of Engineer's M/V Puget. Figures 4 through 10 show the sampling locations for the various sections of the project. Table 4 includes the geographic coordinates and mudline elevation for each sample.

6. Chemical Analysis. The grain size and sediment conventional data can be found in Table 5. The dioxin results are in Table 6.

   The grain-size results indicate that the dredged material becomes finer grained as one moves downstream within the project. As anticipated, DMMU 1 consisted of sand and gravel. Material in the upper settling basin was greater than 90% sand, as were the shoals between the turning basins. The lower settling basin was approximately 70% sand with the remaining volume made up of roughly equal parts of silt and clay. The deep-draft channel had the highest fines content of all the DMMUs.

   Total organic carbon (TOC) ranged from 0.14% to 1.84%. The spatial trend for TOC was similar to that for grain size, with very low concentrations in the upper settling basin and higher concentrations downstream.

   Ammonia and sulfide concentrations were moderate, again following the same pattern with low concentrations upstream and higher concentrations downstream.

   Dioxin concentrations were low throughout the project. The toxicity equivalents (TEQs, with undetects = ½ detection limit) ranged from 0.16 to 1.06 parts per trillion (pptr).

7. Chemical Analysis QA/QC. Quality control guidelines specified by PSEP and DMMP were met, with minor exceptions. The data were considered sufficient and acceptable for regulatory decision-making under the DMMP program. EcoChem conducted an independent stage-4 validation of the sediment conventional and dioxin data. Tables 5 and 6 include both the original laboratory qualifiers (LQ) and the validation qualifiers (VQ) assigned by EcoChem.

8. Open-Water Disposal Analysis. In 2007, the DMMP agencies formulated interim dioxin disposal guidelines for each of the nondispersive disposal sites in Puget Sound. The interim guidelines include a maximum concentration for each site. Any DMMU with a concentration above this maximum value is considered unsuitable for open-water disposal. The interim guidelines also include a mean concentration for each site. The volume-weighted average concentration of all DMMUs proposed for disposal from a project must be less than the site mean. For the Port Gardner site, the maximum concentration is 5.2 pptr TEQ and the mean concentration is 4.1 pptr TEQ. The TEQs for the Snohomish River project are all below the maximum concentration. The volume-weighted average for the project is 0.36 pptr, well below the mean for the Port Gardner site.

9. Beneficial-Use Analysis. The suitability determinations for the downstream and upstream portions of the project (DMMP 2004a; DMMP 2004b) concluded that all material was suitable for beneficial use, including as capping material. The dioxin results support this conclusion. There is no numeric sediment quality standard (SQS) for dioxin, so the DMMP agencies have used a 2.44 pptr Samish Bay reference guideline for decision-making in recent projects. The TEQs for all DMMUs were well below this guideline. Therefore, the DMMP agencies determined that all material proposed for dredging is suitable for beneficial use in a marine environment. To assess the suitability for upland beneficial use, the dioxin results were compared to the Model Toxics Control Act (MTCA) guidelines (Ecology, 2007). For dioxin, the Method B guideline for unrestricted land use is 11 pptr. The TEQs for the Snohomish River DMMUs were well below this guideline. Therefore, all the material is suitable for beneficial use in an upland environment.

10. Suitability Determination. This memorandum documents the evaluation, with respect to dioxin, of the suitability of sediment proposed for dredging from the Snohomish River federal navigation project for beneficial use or disposal at the Port Gardner nondispersive open-water site. Based on the results of the previously described testing, the DMMP agencies conclude that all 801,849 cubic yards are suitable for beneficial use or open-water disposal.

    This suitability determination does ***not*** constitute final agency approval of the project. A final decision will be made after full consideration of agency input, and after an alternatives analysis is done under section 404(b)(1) of the Clean Water Act.

11. References.

DMMP, 2004a. *Memorandum for Record: Determination on the Suitability of Proposed Federal Operations and Maintenance Material from the Lower Snohomish River Settling Basin and Adjacent Navigation Channels Evaluated Under Section 404 of the Clean Water Act for Open-Water Disposal at the Port Gardner Nondispersive Disposal Site or Beneficial Use.* Prepared by the U.S. Army Corps of Engineers for the DMMP Agencies, January 28, 2004.

DMMP, 2004b. *Memorandum for Record: Determination on the Suitability of Proposed Federal Operations and Maintenance Material from the Upper Snohomish River Settling Basin and Upstream Navigation Channel Evaluated Under Section 404 of the Clean Water Act for Open-Water Disposal at the Port Gardner Nondispersive Disposal Site or Beneficial Use.* Prepared by the U.S. Army Corps of Engineers for the DMMP Agencies, October 1, 2004.

Ecology, 2007. *Model Toxics Control Act - Chapter 173-340 WAC*. Washington State Department of Ecology, October 2007.

SAIC, 2009a. *Dioxin Testing of the Snohomish River Federal Navigation Channel and Settling Basins, Everett, Washington – Sampling and Analysis Plan.* Prepared by Science Applications International Corporation, Bothell, Washington for the U.S. Army Corps of Engineers. July 14, 2009.

SAIC, 2009b. *Dioxin Testing of the Snohomish River Federal Navigation Channel and Settling Basins, Everett, Washington – Data Report.* Prepared by Science Applications International Corporation, Bothell, Washington for the U.S. Army Corps of Engineers. October 2, 2009.

12. Agency Signatures.

Concur:

10/3/09 David F. Fox
Date David Fox, P.E. - Seattle District Corps of Engineers

10/3/09
Date Erika Hoffman - Environmental Protection Agency

10/03/09 Laura Inouye
Date Laura Inouye, Ph.D. - Washington Department of Ecology

10/07/09
Date Lionel Klikoff - Washington Department of Natural Resources

Copies furnished:

DMMP signatories
Hiram Arden, Seattle District Navigation Section
Steve Martin, Seattle District Environmental Resources Section

Table 1 - Snohomish River Project Features

Feature	Stationing	Depth[1] (ft)	Width (ft)	Side slope
Shallow-draft channel	42+00 to 68+00	8	150 (wider at turns)	2H:1V
Upstream Settling Basin	68+00 to 88+00[2]	40	30 at -40 ft 150 at -32 ft	3H:1V (left bank) 3H:1V (right bank: -32 to -40 ft) 6H:1V (right bank: mudline to -32 ft)
Shallow-draft channel	88+00 to 333+50	8	150 (wider at turns)	2H:1V
Downstream Settling Basin	333+50 to 345+50	20	700	2H:1V
Deep-draft channel	345+50 to 358+00	15	425	2H:1V
Deep-draft channel	358+00 to 363+50	15	Varies (150 to 425)	2H:1V
Deep-draft channel	363+50 to 421+34.62	15	150	2H:1V

[1]Authorized depth relative to MLLW; does not include 2 feet of overdepth

[2]The authorized length of the upstream settling basin is 1,760 ft. The stationing shown in the table includes a 130-foot transition at either end of the settling basin.

Table 3 – DMMU volumes and analytical requirements

DMMU	Volume (cy)	Analytical Requirements
1	24,186	Grain size, conventionals
2	85,560	Dioxin, grain size, conventionals
3	85,559	Dioxin, grain size, conventionals
4	85,559	Dioxin, grain size, conventionals
5	85,559	Dioxin, grain size, conventionals
6	55,685	Dioxin, grain size, conventionals
7	40,351	Dioxin, grain size, conventionals
8	40,351	Dioxin, grain size, conventionals
9	40,351	Dioxin, grain size, conventionals
10	40,351	Dioxin, grain size, conventionals
11	40,351	Dioxin, grain size, conventionals
12	40,351	Dioxin, grain size, conventionals
13	40,350	Dioxin, grain size, conventionals
14	37,009	Dioxin, grain size, conventionals
15	32,209	Dioxin, grain size, conventionals
16	28,067	Dioxin, grain size, conventionals
	801,849	

Table 4 - Sampling Locations - July 2009

Station ID	DMMU	Latitude[1]	Longitude[1]	Mudline Elevation (ft MLLW)	**Sample Type**
1	1	47.984121	-122.168712	-6.3	van Veen
2	1	47.983470	-122.168794	-6.8	van Veen
3	2	47.988195	-122.172665	-7.1	van Veen
4	2	47.988627	-122.173399	-6.8	van Veen
5	3	47.989059	-122.173887	-5.9	van Veen
6	3	47.989643	-122.175120	-9.3	van Veen
7	4	47.990248	-122.176422	-9.1	van Veen
8	4	47.989876	-122.175701	-12.8	van Veen
9	5	47.991263	-122.177982	-7.9	van Veen
10	5	47.990942	-122.177164	-8.9	van Veen
11	6	48.003864	-122.177407	-8.1	van Veen
12	6	48.010640	-122.179472	-7.8	van Veen
13	6	48.014159	-122.182199	-7.6	van Veen
14	6	48.019368	-122.196456	-8.6	van Veen
15	6	48.015479	-122.221245	-7.8	van Veen
16	6	48.007654	-122.224769	-6.4	van Veen
17	7	48.002880	-122.224423	-9.8	van Veen
18	7	48.002889	-122.225570	-14.6	van Veen
19	8	48.002397	-122.224408	-10.0	van Veen
20	8	48.002431	-122.225519	-14.1	van Veen
21	9	48.001935	-122.224444	-10.2	van Veen
22	9	48.002046	-122.225629	-13.3	van Veen
23	10	48.001402	-122.224472	-9.7	van Veen
24	10	48.001520	-122.225526	-13.8	van Veen
25	11	48.000970	-122.224511	-9.9	van Veen
26	11	48.001048	-122.225668	-14.7	van Veen
27	12	48.000521	-122.224490	-10.7	van Veen
28	12	48.000568	-122.225681	-14.2	van Veen
29	13	48.000156	-122.224557	-11.1	van Veen
30	13	48.000148	-122.225701	-13.6	van Veen
31	14	47.999569	-122.224989	-11.3	van Veen
32	14	47.998675	-122.225026	-11.6	van Veen
33	15	47.997839	-122.225321	-12.6	van Veen
34	15	47.996702	-122.225439	-12.6	van Veen
35	16	47.996017	-122.225684	-13.2	van Veen
36	16	47.994122	-122.226017	-13.2	van Veen

[1]datum = North American Datum 1983

Sample ID:	DMMU 1			DMMU 2			DMMU 3			DMMU 4			DMMU 5			DMMU 6			DMMU 7			DMMU 8		
Collection Date:	07/16/2009			07/16/2009			07/16/2009			07/16/2009			07/15/2009			07/15/2009			07/15/2009			07/15/2009		
	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ
Conventionals																								
Total Solids (% WW)	86.1			81.1			87.9			77.4			85.9			79.3			67			65.2		
Total Volatile Solids (% DW)	0.83			0.87			0.81			0.92			0.85			1.15			3.13			3.24		
Total Organic Carbon (% DW)	0.14			0.14			0.18			0.17			0.15			0.41			1.78			1.35		
Ammonia (mg N/kg DW)	0.12	U	U	0.24	U	U	0.22	U	U	0.13	U	U	0.23	U	U	0.21			9.49			7.83		
Sulfide (mg/kg DW)	1.34	U	U	1.35	U	U	1.35	U	U	1.32	U	U	1.32	U	U	1.39	U	U	414			156		
Grain Size (%)																								
Gravel	36			2.1			3.9			0.9			1.1			0.9			0.1			0.2		
Sand	61.8			94.1			92.1			94.6			95.3			92.2			72.5			67.1		
Silt	1.3			3			2.8			3.1			2.3			4.4			14			20.6		
Clay	0.8			0.8			1.2			1.3			1.3			2.5			13.5			12.1		
Fines	2.1			3.8			4			4.4			3.6			6.9			27.5			32.7		

Sample ID:	DMMU 9			DMMU 10			DMMU 11			DMMU 12			DMMU 13			DMMU 14			DMMU 15			DMMU 16		
Collection Date:	07/15/2009			07/15/2009			07/15/2009			07/15/2009			07/15/2009			07/15/2009			07/15/2009			07/15/2009		
	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ
Conventionals																								
Total Solids (% WW)	67.7			65.7			68.7			66.5			69.5			65.2			47.7			51.7		
Total Volatile Solids (% DW)	2.74			3.23			2.65			2.9			2.41			3.48			7.58			7.57		
Total Organic Carbon (% DW)	1.12			1.84			1.25			1.01			0.95			1.34			1.12			0.94		
Ammonia (mg N/kg DW)	10.7			11.1			11.7			11.3			5.74			7.97			27.8			19.5		
Sulfide (mg/kg DW)	234			547			272			493			461			91.1			111			120		
Grain Size (%)																								
Gravel	0.2			0.1	U	U	0.1	U	U	0.1	U	U	0.1	U	U	0.1	U	U	0.1			0.2		
Sand	69.6			71.9			74.1			68.9			73.8			67.7			32			48.5		
Silt	14.9			15.7			12.9			17.7			13.3			18.3			44.8			29.9		
Clay	15.3			12.5			13			13.4			13			13.9			23.1			21.2		
Fines	30.2			28.2			25.9			31.1			26.3			32.2			67.9			51.1		

U = undetected

Sample ID: / Collection Date:	TEF	DMMU 2 07/16/2009			DMMU 3 07/16/2009			DMMU 3 - Dup 07/16/2009			DMMU 4 07/16/2009			DMMU 5 07/15/2009			DMMU 6 07/15/2009		
		conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ
Dioxin/Furan Congeners (pg/g)																			
2,3,7,8-TCDD	1	0.0489	U	U	0.0506	U	U	0.053	K J	U	0.0479	U	U	0.0484	U	U	0.059	K J	U
1,2,3,7,8-PeCDD	1	0.127	U	U	0.132	U	U	0.128	U	U	0.125	U	U	0.126	U	U	0.126	U	U
1,2,3,4,7,8-HxCDD	0.1	0.186	U	U	0.192	U	U	0.187	U	U	0.182	U	U	0.184	U	U	0.184	U	U
1,2,3,6,7,8-HxCDD	0.1	0.186	U	U	0.192	U	U	0.187	U	U	0.182	U	U	0.184	U	U	0.184	U	U
1,2,3,7,8,9-HxCDD	0.1	0.186	U	U	0.268	J	J	0.187	U	U	0.182	U	U	0.184	U	U	0.184	U	U
1,2,3,4,6,7,8-HpCDD	0.01	0.318	J	J	1.01	J	J	0.307	J	J	0.666	J	J	0.307	J	J	1.84	J	J
OCDD	0.0003	2.31	J	J	3.29	J	J	2.15	J	J	5.66	J	J	2.13	J	J	16		
2,3,7,8-TCDF	0.1	0.0489	U	U	0.0506	U	U	0.0492	U	U	0.0479	U	U	0.0484	U	U	0.069	J	J
1,2,3,7,8-PeCDF	0.03	0.0938	U	U	0.0972	U	U	0.0944	U	U		U	U	0.0929	U	U	0.093	U	U
2,3,4,7,8-PeCDF	0.3	0.0938	U	U	0.0972	U	U	0.0944	U	U	0.092	U	U	0.0929	U	U	0.093	U	U
1,2,3,4,7,8-HxCDF	0.1	0.117	U	U	0.121	U	U	0.118	U	U	0.115	U	U	0.116	U	U	0.116	U	U
1,2,3,6,7,8-HxCDF	0.1	0.117	U	U	0.121	U	U	0.118	U	U		U	U	0.116	U	U	0.116	U	U
2,3,4,6,7,8-HxCDF	0.1	0.117	U	U	0.121	U	U	0.118	U	U	0.115	U	U	0.116	U	U	0.116	U	U
1,2,3,7,8,9-HxCDF	0.1	0.117	U	U	0.121	U	U	0.118	U	U	0.115	U	U	0.116	U	U	0.116	U	U
1,2,3,4,6,7,8-HpCDF	0.01	0.0968	U	U	0.1	U	U	0.0973	U	U	0.0948	U	U	0.0958	U	U	0.334	J	J
1,2,3,4,7,8,9-HpCDF	0.01	0.0968	U	U	0.1	U	U	0.0973	U	U	0.0948	U	U	0.0958	U	U	0.0959	U	U
OCDF	0.0003	0.274	U	U	0.283	U	U	0.275	U	U	0.268	U	U	0.271	U	U	0.906	J	J
WHO-2005 TEQ (ND=0)		0.004			0.038			0.004			0.008			0.004			0.034		
WHO-2005 TEQ (ND=½)		0.162			0.192			0.163			0.164			0.160			0.193		

J = estimated concentration

K = did not meet quantification criteria

U = undetected

LQ = laboratory qualifier

VQ = validation qualifier

TEF = toxicity equivalence factor

TEQ = toxicity equivalents

ng/kg = nanogram/kilogram (parts per trillion)

DMMU

QA sample

Sample ID: / Collection Date:	TEF	DMMU 7 07/15/2009			DMMU 7 - Dup 07/15/2009			DMMU 8 07/15/2009			DMMU 9 07/15/2009			DMMU 10 07/15/2009			DMMU 11 07/15/2009		
		conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ
Dioxin/Furan Congeners (pg/g)																			
2,3,7,8-TCDD	1	0.079	K J	U	0.095	K J	U	0.089	K J	U	0.073	K J	U	0.072	K J	U	0.084	K J	U
1,2,3,7,8-PeCDD	1	0.135	J	J	0.127	J	J	0.16	J	J	0.123	U	U	0.125	U	U	0.132	U	U
1,2,3,4,7,8-HxCDD	0.1	0.197	K J	U	0.184	U	U	0.27	J	J	0.179	U	U	0.194	J	J	0.193	U	U
1,2,3,6,7,8-HxCDD	0.1	0.543	K J	U	0.592	J	J	0.831	J	J	0.494	J	J	0.52	J	J	0.456	J	J
1,2,3,7,8,9-HxCDD	0.1	0.805	J	J	0.826	J	J	1.03	J	J	0.782	J	J	0.631	J	J	0.587	J	J
1,2,3,4,6,7,8-HpCDD	0.01	8.81			10.8			13.5			9.13			8			7.22		
OCDD	0.0003	92.3			111			142			105			84.6			75.2		
2,3,7,8-TCDF	0.1	0.139	J	J	0.147	J	J	0.18	K J	U	0.14	J	J	0.128	J	J	0.102	J	J
1,2,3,7,8-PeCDF	0.03	0.0919	U	U	0.0932	U	U	0.0951	U	U	0.0907	U	U	0.092	U	U	0.0975	U	U
2,3,4,7,8-PeCDF	0.3	0.129	J	J	0.0932	U	U	0.124	J	J	0.092	J	J	0.108	K J	U	0.0975	U	U
1,2,3,4,7,8-HxCDF	0.1	0.115	U	U	0.132	K J	U	0.153	J	J	0.113	U	U	0.115	U	U	0.122	U	U
1,2,3,6,7,8-HxCDF	0.1	0.115	U	U	0.117	U	U	0.119	K J	U	0.113	U	U	0.115	U	U	0.122	U	U
2,3,4,6,7,8-HxCDF	0.1	0.115	U	U	0.117	U	U	0.119	U	U	0.113	U	U	0.115	U	U	0.122	U	U
1,2,3,7,8,9-HxCDF	0.1	0.115	U	U	0.117	U	U	0.129	J	J	0.113	U	U	0.115	U	U	0.122	U	U
1,2,3,4,6,7,8-HpCDF	0.01	1.28	J	J	2.39	J	J	1.85	J	J	1.29	J	J	1.48	J	J	1.03	J	J
1,2,3,4,7,8,9-HpCDF	0.01	0.103	J	J	0.144	J	J	0.133	K J	U	0.101	K J	U	0.0949	U	U	0.101	U	U
OCDF	0.0003	3.26	J	J	8.31	J	J	5.17	J	J	3.66	J	J	5.73	J	J	2.74	J	J
WHO-2005 TEQ (ND=0)		0.399			0.453			0.636			0.306			0.269			0.220		
WHO-2005 TEQ (ND=½)		0.500			0.549			0.704			0.437			0.409			0.379		

J = estimated concentration

K = did not meet quantification criteria

U = undetected

LQ = laboratory qualifier

VQ = validation qualifier

TEF = toxicity equivalence factor

TEQ = toxicity equivalents

ng/kg = nanogram/kilogram (parts per trillion)

DMMU

QA sample

Sample ID:		DMMU 12			DMMU 13			DMMU 14			DMMU 15			DMMU 16		
Collection Date:		07/15/2009			07/15/2009			07/15/2009			07/15/2009			07/15/2009		
	TEF	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ	conc	LQ	VQ
Dioxin/Furan Congeners (pg/g)																
2,3,7,8-TCDD	1	0.095	K J	U	0.056	K J	U	0.076	K J	U	0.118	K J	U	0.11	K J	U
1,2,3,7,8-PeCDD	1	0.185	J	J	0.146	J	J	0.129	U	U	0.2	J	J	0.22	J	J
1,2,3,4,7,8-HxCDD	0.1	0.219	J	J	0.186	U	U	0.2	K J	U	0.358	J	J	0.333	J	J
1,2,3,6,7,8-HxCDD	0.1	0.682	J	J	0.502	J	J	0.548	J	J	1	J	J	1.3	J	J
1,2,3,7,8,9-HxCDD	0.1	0.914	J	J	0.759	J	J	0.777	J	J	1.38	J	J	1.24	J	J
1,2,3,4,6,7,8-HpCDD	0.01	10.6			8.63			8.95			16.2			21.7		
OCDD	0.0003	126			103			98.9			164			223		
2,3,7,8-TCDF	0.1	0.122	J	J	0.116	J	J	0.12	J	J	0.258	J	J	0.364	J	J
1,2,3,7,8-PeCDF	0.03	0.096	U	U	0.094	U	U	0.095	U	U	0.099	J	J	0.113	K J	U
2,3,4,7,8-PeCDF	0.3	0.117	J	J	0.094	U	U	0.109	K J	U	0.179	J	J	0.196	J	J
1,2,3,4,7,8-HxCDF	0.1	0.12	U	U	0.118	U	U	0.119	U	U	0.214	J	J	0.306	J	J
1,2,3,6,7,8-HxCDF	0.1	0.12	U	U	0.118	U	U	0.119	U	U	0.169	K J	U	0.215	J	J
2,3,4,6,7,8-HxCDF	0.1	0.12	U	U	0.118	U	U	0.119	U	U	0.119	K J	U	0.19	J	J
1,2,3,7,8,9-HxCDF	0.1	0.12	U	U	0.118	U	U	0.119	U	U	0.117	U	U	0.118	U	U
1,2,3,4,6,7,8-HpCDF	0.01	1.44	J	J	1.19	J	J	1.21	J	J	2.34	J	J	3.23	J	J
1,2,3,4,7,8,9-HpCDF	0.01	0.121	K J	U	0.097	U	U	0.098	U	U	0.176	J	J	0.2	K J	U
OCDF	0.0003	3.88	J	J	3.37	J	J	3.12	J	J	6.41	J	J	7.98	J	J
WHO-2005 TEQ (ND=0)		0.573			0.414			0.277			0.816			0.992		
WHO-2005 TEQ (ND=½)		0.647			0.487			0.496			0.895			1.056		

J = estimated concentration

K = did not meet quantification criteria

U = undetected

LQ = laboratory qualifier

VQ = validation qualifier

TEF = toxicity equivalence factor

TEQ = toxicity equivalents

ng/kg = nanogram/kilogram (parts per trillion)

DMMU

QA sample

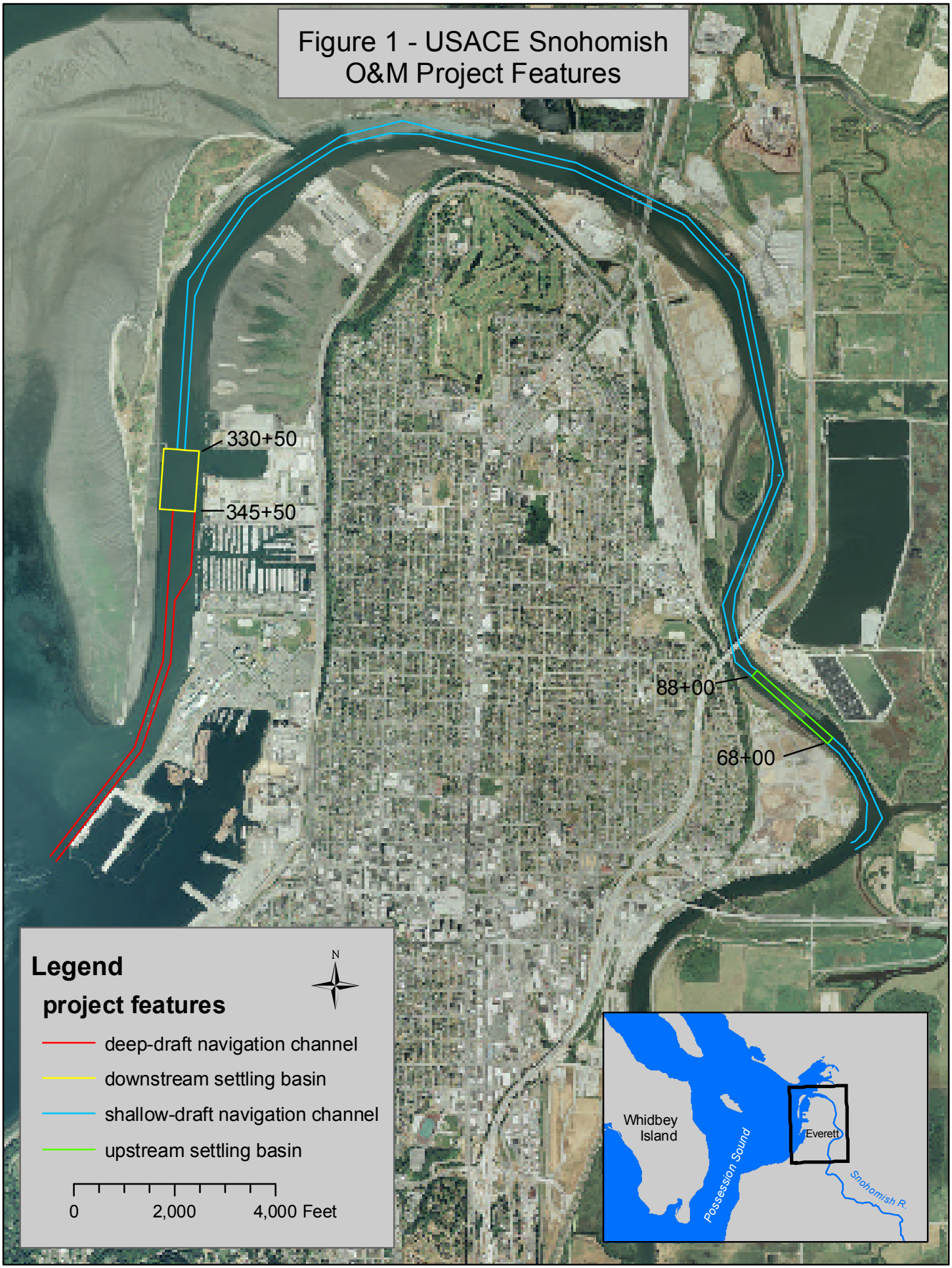
Figure 1 - USACE Snohomish O&M Project Features
330+50
345+50
88+00
68+00
Legend
project features
deep-draft navigation channel
downstream settling basin
shallow-draft navigation channel
upstream settling basin
N
0
2,000
4,000 Feet
Whidbey Island
Possession Sound
Everett
Snohomish R.

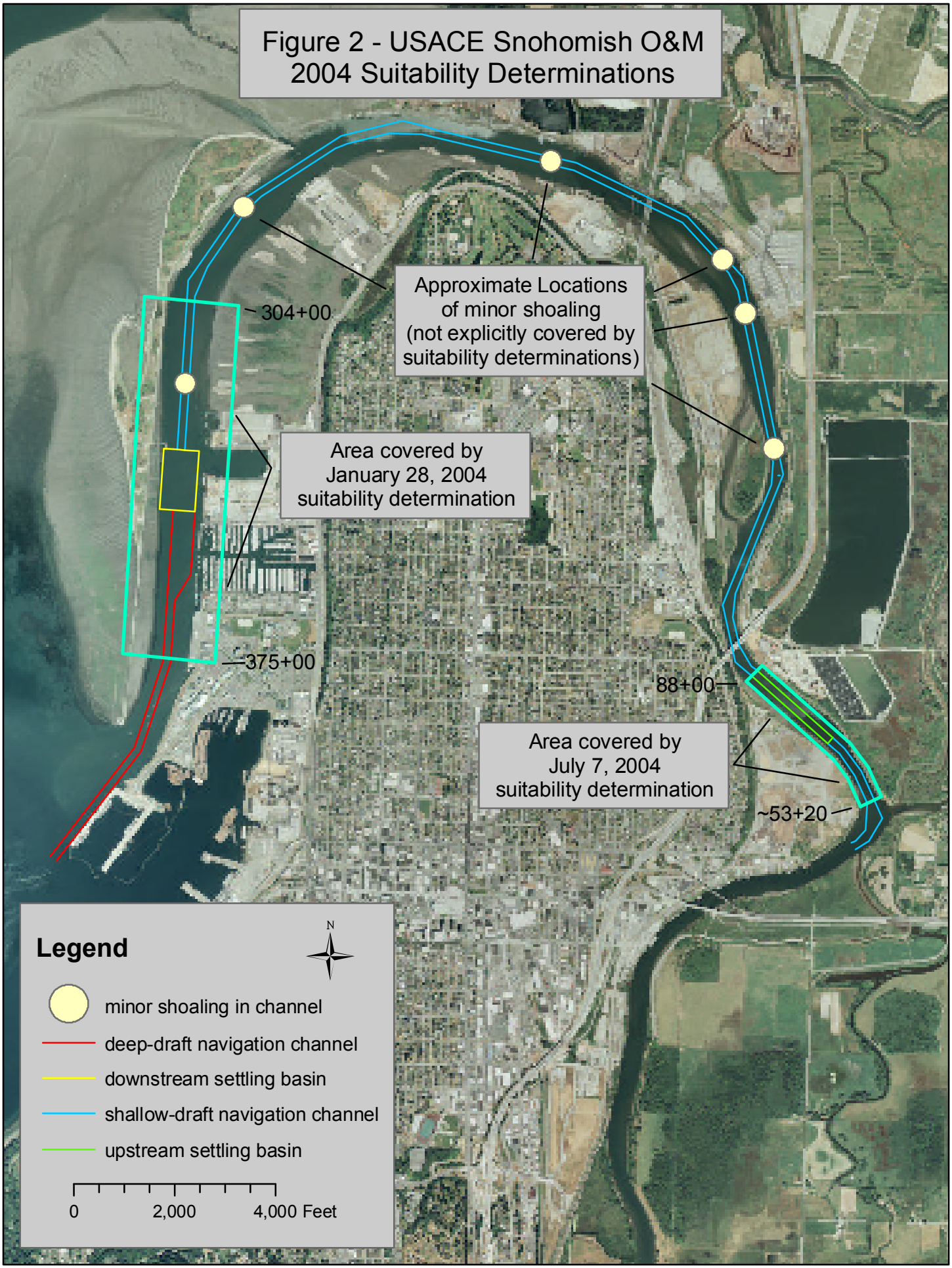
Figure 2 - USACE Snohomish O&M
2004 Suitability Determinations
Approximate Locations
of minor shoaling
(not explicitly covered by
suitability determinations)
304+00
Area covered by
January 28, 2004
suitability determination
375+00
88+00
Area covered by
July 7, 2004
suitability determination
~53+20
Legend
N
minor shoaling in channel
deep-draft navigation channel
downstream settling basin
shallow-draft navigation channel
upstream settling basin
0
2,000
4,000 Feet

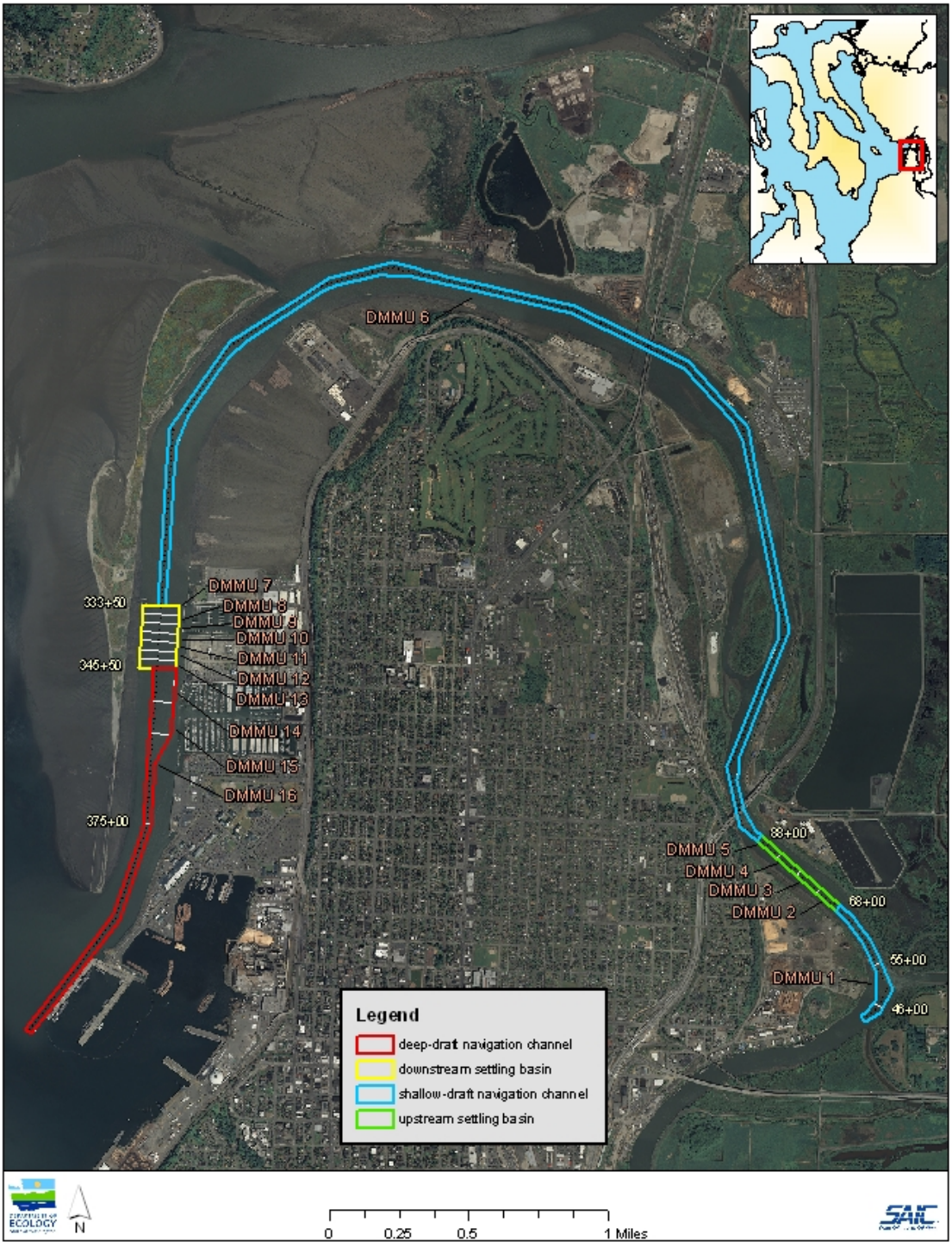

Figure 3. Dredged Material Management Units (from SAIC, 2009b)

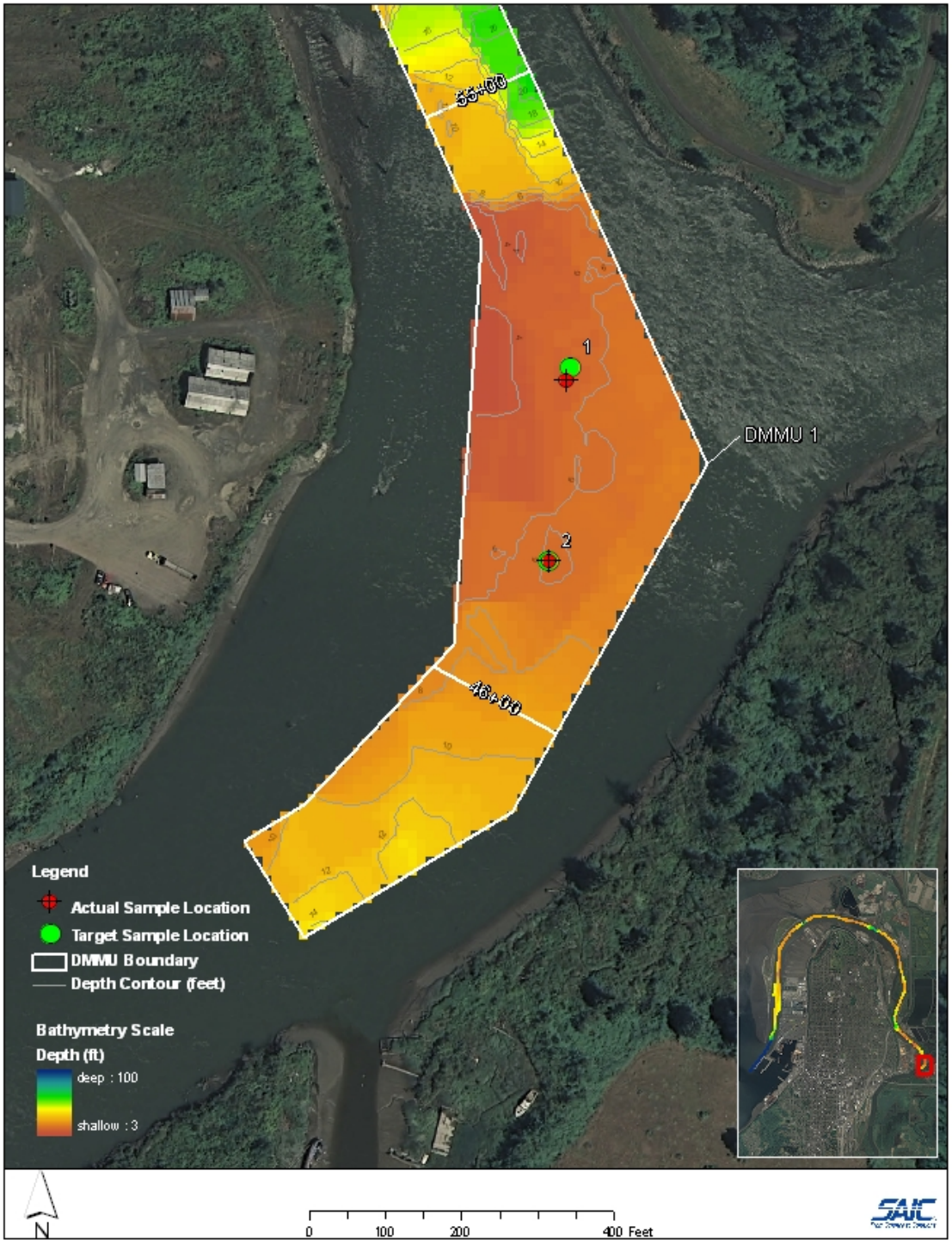

Figure 4. Sampling locations within DMMU 1 (from SAIC, 2009b)

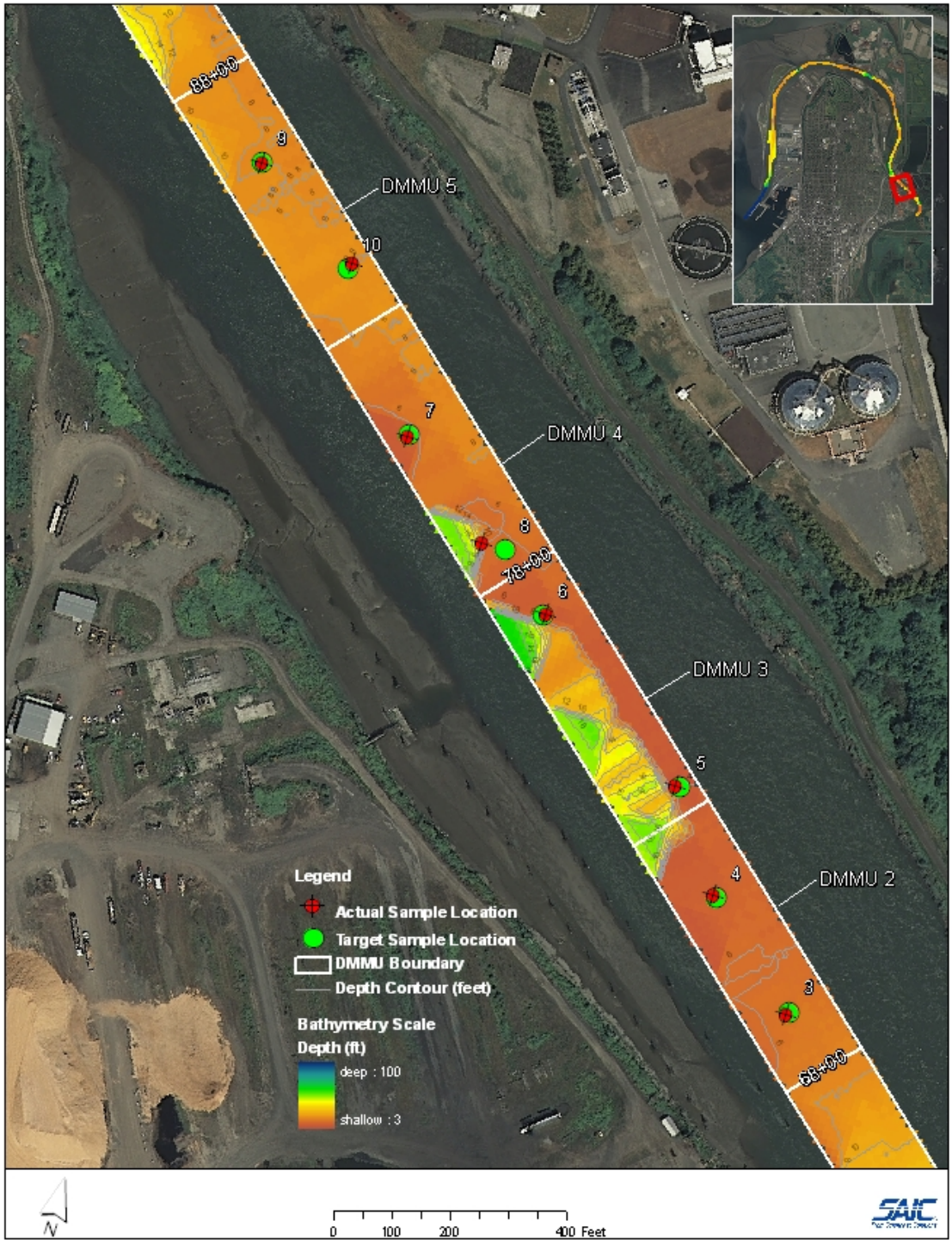

Figure 5. Sampling locations within DMMUs 2, 3, 4, and 5 (from SAIC, 2009b)

Figure 6. Sampling locations within eastern DMMU 6 (from SAIC, 2009b)

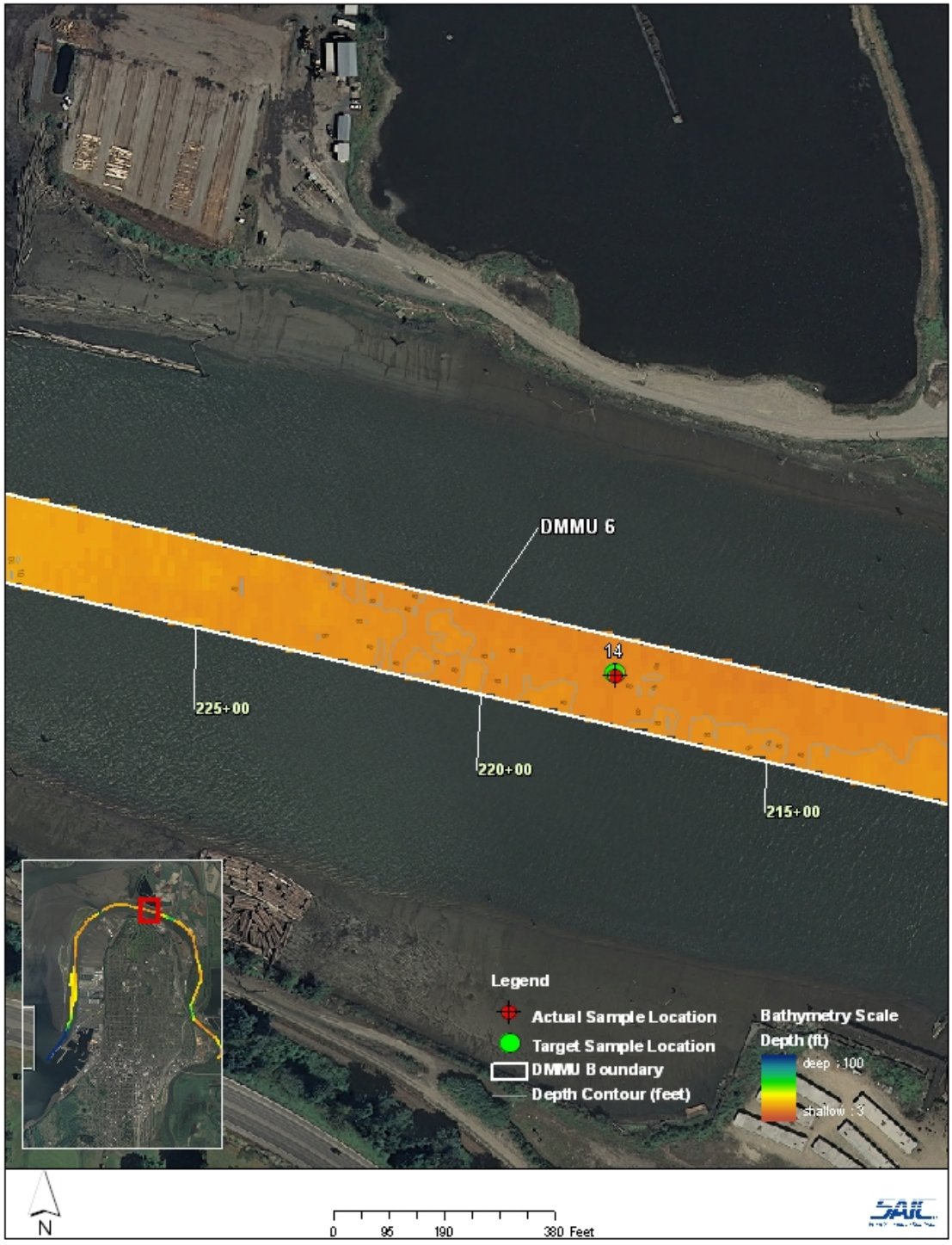

Figure 7. Sampling locations within northern DMMU 6 (from SAIC, 2009b)

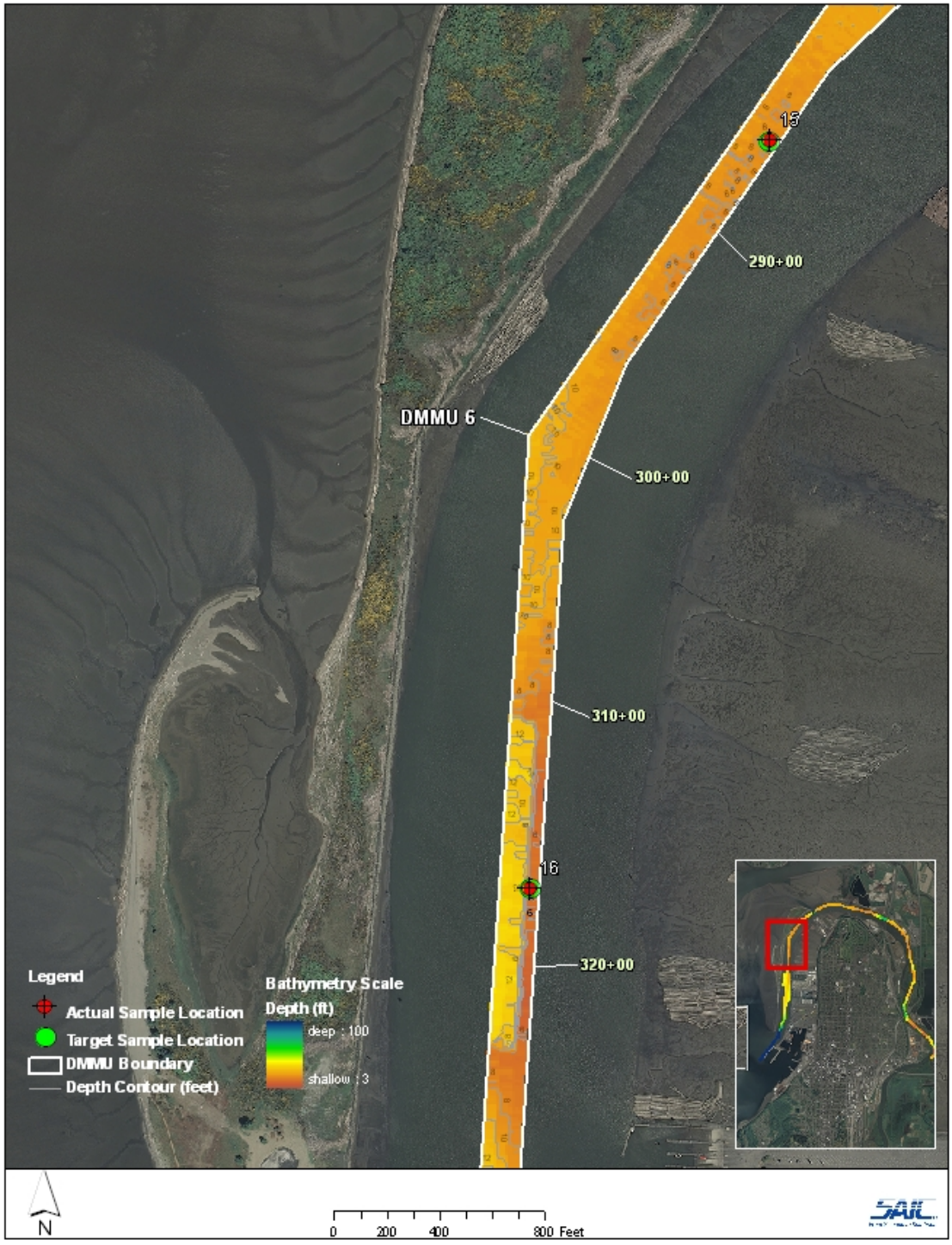

Figure 8. Sampling locations within western DMMU 6 (from SAIC, 2009b)

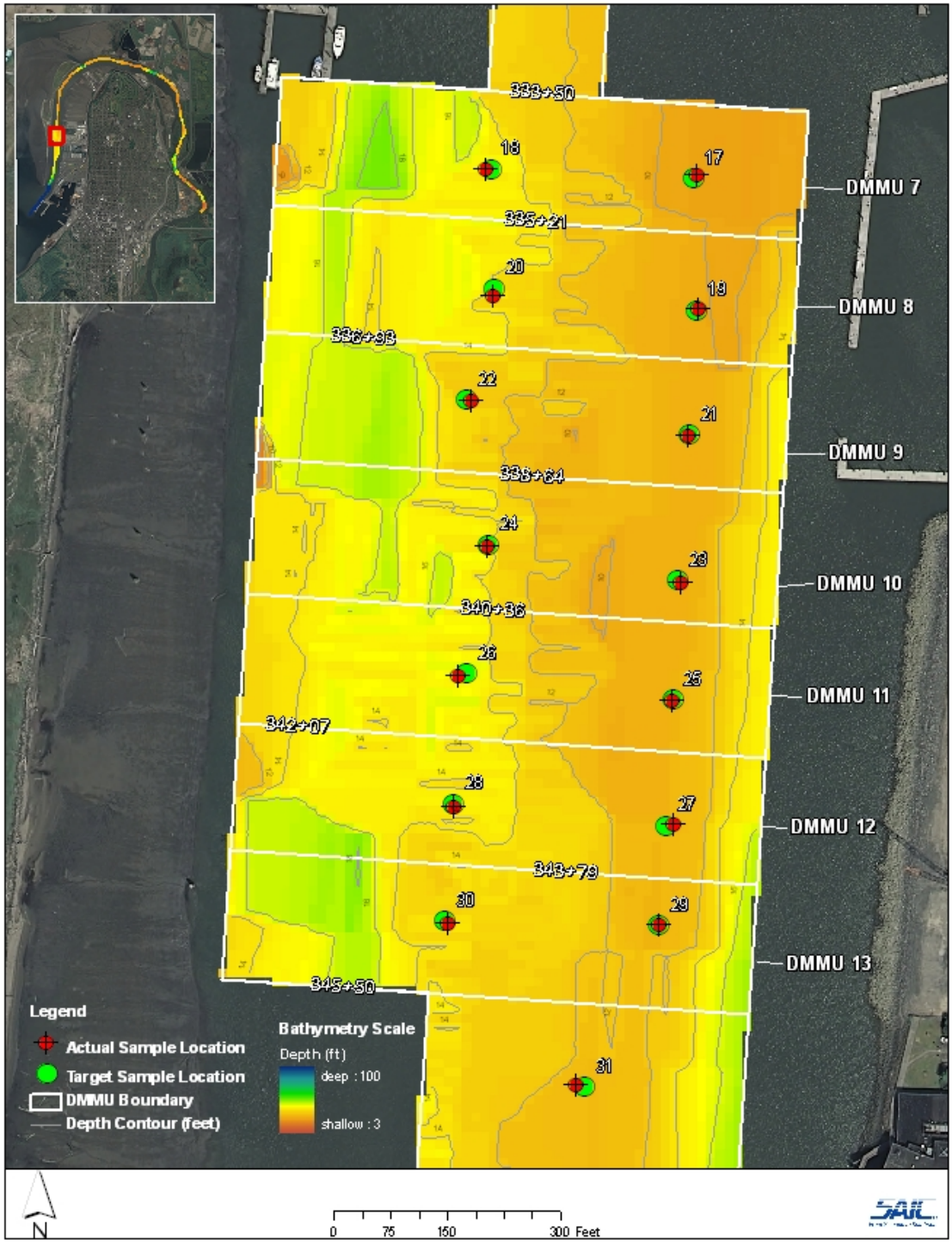

Figure 9. Sampling locations within DMMUs 7, 8, 9, 10, 11, 12, and 13 (from SAIC, 2009b)

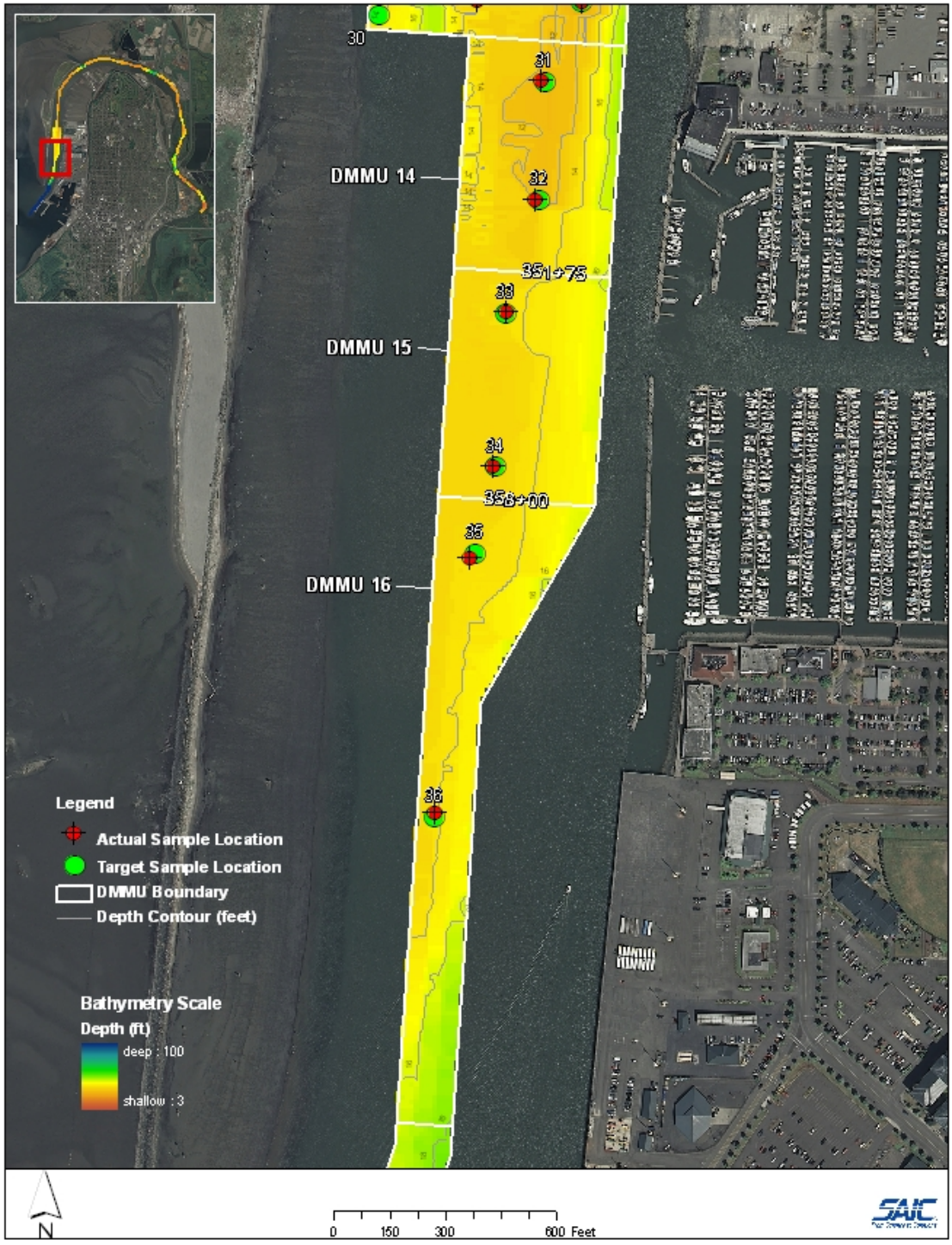

Figure 10. Sampling locations within DMMUs 14, 15, and 16 (from SAIC, 2009b)