CENWS-ODS-ND

MEMORANDUM FOR RECORD February 8, 2018

SUBJECT: DETERMINATION REGARDING THE SUITABILITY OF DREDGED MATERIAL FROM THE SWINOMISH CHANNEL FEDERAL NAVIGATION CHANNEL DREDGING PROJECT, EVALUATED UNDER SECTION 404 OF THE CLEAN WATER ACT, FOR UNCONFINED OPEN-WATER DISPOSAL AT THE PORT GARDNER NONDISPERSIVE SITE OR THE ROSARIO STRAIT DISPERSIVE DISPOSAL SITE.

1. Introduction. This memorandum reflects the consensus determination of the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers (USACE), Washington Departments of Ecology and Natural Resources, and the Environmental Protection Agency) regarding the suitability of 233,923 cubic yards (cy) of dredged material from the Swinomish federal navigation channel for disposal at either the Rosario Strait dispersive and/or Port Gardner nondispersive open-water disposal sites.

2. Background. The Swinomish Channel is a federally maintained shallow-draft navigation channel that connects northern Skagit Bay to Padilla Bay and is utilized by both commercial and recreational boat traffic (Figure 1). The authorized design depth is -12 feet (ft) Mean Lower Low Water (MLLW) throughout the channel. USACE Seattle District is responsible for dredging portions of the authorized project as needed to maintain navigation.

   Sedimentation in the channel is influenced by input from the Skagit River watershed at the south end. Although the north end lacks major adjacent riverine input (such as the Skagit River to the south), regular sedimentation also occurs at the north end with input from Padilla Bay. Other sedimentation throughout the channel may be derived from various sources, including input from various sloughs and streams along the channel, as well as the channel bank.

   Bathymetric surveys conducted in March 2016 and April 2017 indicated significant infilling above authorized depths. USACE contracted with Herrera Environmental and subcontractor NewFields to characterize the waterway to the authorized depth of -12 ft MLLW plus 2 ft of overdepth for all areas of the channel with infilling.

3. Project Summary. Table 1 includes project summary and tracking information.

Table 1. Project Summary and Tracking Information

Project ranking	Low
Characterized volume (CY)	233,923
Authorized (design) depth	-12 ft MLLW
Characterized depth (design depth + 2 ft overdepth)	-14 ft MLLW
Draft SAP received	August 11, 2017
Draft SAP returned for revisions	August 23, 2017

Revised SAP received	August 28, 2017
Revised SAP approved	August 30, 2017
Sampling dates	September 12, 2017
Draft data report received	December 19, 2017
Comments provided on draft report	January 26, 2018
Final data report received	February 6, 2018
DMMO tracking number	SWINC-1-A-F-387
EIM Study ID	SWINC17
Recency Determination (low rank = 7 years)	September 2024

4. Project Ranking and Sampling Requirements. Sediments in the Swinomish Channel are currently ranked "low" by the DMMP agencies for concern for potential contamination (DMMP, 2016). For a low-ranked project with homogeneous sediment, the number of analyses and field samples are calculated using the following guidelines:

   Maximum volume of sediment represented by each field sample = 8,000 CY
   Maximum volume of sediment represented by each analysis = 60,000 CY

   Given the known homogeneous nature of the sediments, no distinction between surface and subsurface material was required, and grab samples were approved by the DMMP agencies as a representative sampling technique.

   Using the April 2017 bathymetric survey data, four (4) Dredged Material Management Units (DMMUs) were defined to characterize 233,923 CY of proposed dredged material (Table 3).

5. Sampling and Analysis. Sampling occurred on September 12, 2017 in accordance with the approved Sampling and Analysis Plan at the locations shown in Figures 2 through 5. All samples were collected using a stainless steel 0.2 m^2 power grab sampler attached to a winch and cable and deployed from the sampling vessel. A total of 32 sediment surface grab locations were collected and composited into four (4) DMMUs (Table 4).

   The DMMU composites were submitted to ALS, located in Kelso, Washington for conventionals and chemical analyses. The Kelso laboratory performed all method analyses except for polybrominated diphenyl ether (PBDE) congeners, which were conducted by the ALS laboratory in Burlington, Ontario.

6. Results. The chemistry results for the four (4) DMMU composites are presented alongside the DMMP marine guidelines in Table 5. Note: Results were not compared to Ecology benthic criteria due to low total organic carbon (TOC), as described below.

   Grain Size and Sediment Conventionals. Percent fines were low overall for the Swinomish Channel, with the lowest values measured in the protected main channel (DMMUs 2 and 3)

with values less than 1.5 percent. Fines in the south and north entrance channels (DMMUs 1 and 4, respectively) were higher, but neither sample exceeded 7.5% fines. TOC, sulfides, and ammonia were consistently low. Organic content did not exceed 0.25% TOC. The maximum sulfides and ammonia concentrations were 23.4 and 5.68 mg/kg, respectively.

Standard DMMP Chemicals of Concern. No chemistry results (detects and non-detects) exceeded the DMMP Screening Level (SL), Bioaccumulation Trigger (BT), or Maximum Level (ML) for the chemicals of concern (COCs). In general, concentrations were low for all chemicals of concern (COC).

Dioxins/furans. Dioxin testing was not required for this sediment characterization due to the absence any "reason-to-believe" factors. Swinomish Channel sediments were most recently tested for dioxins in 2009; the maximum concentration measured at that time was 0.169 pptr TEQ (ND = ½ RL), which is well below the dispersive dioxin criteria of 4 pptr TEQ (USACE, 2009).

TBT. Tributyltin (TBT) analyses were not required for this project based on results from previous monitoring. Bulk sediment TBT was measured during the 2009 characterization; the maximum concentration measured at that time was 3.6 ug/kg, which is well below the DMMP marine BT of 73 ug/kg (DMMP, 2010).

PBDEs. Analyses of polybrominated diphenyl ethers (PBDEs) as congeners were conducted on 3 of the 4 composite samples to fulfill the Essential Fish Habitat conservation recommendations that accompanied the National Marine Fisheries Service's biological opinion on the effects of dredged material disposal on listed rockfish species (DMMO, 2016).The three DMMU composites analyzed for PBDEs were selected to provide spatial coverage across the Swinomish Channel. Results from these analyses are included in Table 6. Most individual congeners were non-detect in all three samples. PBDE-99 and PBDE-209 had the highest detected concentrations in all three samples, ranging from 4.84 to 55.1 ng/kg for PBDE-99 and from 5 to 25.6 ng/kg for PBDE-209. No sediment guidelines (DMMP, state, or federal) exist for PBDE congeners.

Comparison to SMS Benthic Criteria. Ecology does not recommend carbon-normalization when TOC is below 0.5 percent. The maximum measured TOC for the DMMU composite samples was 0.24% (DMMU 4); therefore, comparisons using OC-normalized chemistry results are not indicated.

Data Validation. All chemistry data were validated to a minimum of EPA Stage 2b; in addition, PBDE data underwent 10% Stage 4 data validation. Only minor issues were encountered during the data validation, and all data were considered usable by the data validator for the study purpose.

7. Biological Testing. Biological testing was not required; concentrations of all detected and non-detected chemicals of concern were below the DMMP screening level criteria.

8. Sediment Exposed by Dredging. Sediment exposed by dredging must either meet the State

of Washington Sediment Quality Standards (SQS) (Ecology, 2013) or the State's anti-degradation standard (DMMP, 2008). All DMMU composite sample chemical data are below the SL criteria. Therefore, this project is in compliance with the State of Washington anti-degradation standard.

9. Debris Management. The DMMP agencies implemented a debris management requirement following the 2015 SMARM in order to prevent the disposal of debris (wood or otherwise) greater than 12 inches in any dimension at open-water disposal sites in Puget Sound (DMMP, 2015). The Swinomish Channel is in a non-urban area and receives significant sediment input from nearby riverine sources. Furthermore, the USACE conducts regular maintenance dredging of the channel typically every 2-3 years. Past dredging has historically encountered homogeneous sandy sediment; large woody debris or anthropogenic debris is rarely, if ever, encountered. The DMMP agencies concur that the dredge area is of low concern for debris and a 12" x 12" screening grid is not required for this project. However, if any debris larger than 12 inches in any dimension is encountered, it must be segregated and disposed of in an upland landfill or other appropriate location. At no time may any debris greater than 12 inches in any dimension be disposed at an open-water disposal site.

10. Suitability Determination. This memorandum documents the evaluation of the suitability of sediment from the Swinomish Channel authorized federal navigation project for unconfined open-water disposal. The data gathered were determined to be sufficient and acceptable for regulatory decision-making under the DMMP program.

In summary, based on the results of the testing, the DMMP agencies have concluded that all 233,923 CY of dredged material are suitable for open-water disposal at the Port Gardner non-dispersive site or the Rosario Strait dispersive site.

9. References.

DMMO, 2016. *Statutory Response to EFH Conservation Recommendations for the Continued Use of Multi-User Dredged Material Disposal Sites in Puget Sound and Grays Harbor (Fourth Field HUCs 17110020 Dungeness-Elwha, 17110002 Strait of Georgia, 1711019 Puget Sound, and 17100105 Grays Harbor) Washington. NMFS Consultation Number: WCR-2015-2975.* Prepared by the Seattle District Dredged Material Management Office, January 2016.

DMMP, 2008. *Quality of Post-Dredge Sediment Surfaces (Updated).* A Clarification Paper Prepared by David Fox (USACE), Erika Hoffman (EPA) and Tom Gries (Ecology) for the Dredged Material Management Program, June 2008.

DMMP, 2009. *Memorandum for Record: Determination on the Suitability for Proposed dredged Material Tested for the Federal Swinomish Channel Navigation Dredging Project (NWS-OD-TS-32) Evaluated under Section 404 of the Clean Water Act for either Open-Water Disposal at the Rosario Strait Dispersive disposal Site, or an Appropriate Beneficial Use Site*. Prepared by the Seattle District Dredged Material Management Office for the Dredged Material Management Program, December 11, 2009.

DMMP, 2016. *Dredged Material Evaluation and Disposal Procedures (User Manual)*.

Prepared by the Seattle District Dredged Material Management Office for the Dredged Material Management Program, August 2016.

Ecology, 2013. *Sediment Management Standards – Chapter 173-204 WAC*. Washington State Department of Ecology, Revised February 2013.

Herrera, 2017. *Swinomish River Federal Navigation Channel Dredged Material Characterization, Bellingham, Washington – Sampling and Analysis Plan*. Prepared by Herrera and NewFields for the U.S. Army Corps of Engineers, Seattle District, September 5, 2017.

Herrera, 2018. *Swinomish River Federal Navigation Channel Dredged Material Characterization, Bellingham, Washington – Data Report*. Prepared by Herrera and NewFields for the U.S. Army Corps of Engineers, Seattle District, February 5, 2018.

10. Agency Signatures.

Concur:

signed copy on file in DMMO - Seattle District office

_____ _____
Date Heather Whitney Fourie. - Seattle District Corps of Engineers

_____ _____
Date Justine Barton - Environmental Protection Agency

_____ _____
Date Laura Inouye, Ph.D. - Washington Department of Ecology

_____ _____
Date Celia Barton - Washington Department of Natural Resources

Copies furnished:

DMMP signatories
John Hicks, CENWS-ODS-NS
Elizabeth Chien, CENWS-ODS-NS
John Pell, CENWS-ODS-NS

Table 2. Project Features, Characterization Depths, and Characterization Volumes from March/April 2017 Condition Survey

Feature	Stations	Authorized Depth (ft MLLW)	Design Depth + 2ft Allowable Overdepth Volume (cy)
South entrance channel	10+00 to 55+00	-12	55,327
Main channel	99+00 to 464+00*	-12	80,474
North entrance channel	475+00 to 675+00*	-12	98,121
		Total:	233,923

Table 3. Dredged Material Volumes by DMMU

Feature	DMMU	Design Depth + 2 ft Allowable Overdepth Volume (cy)
South entrance channel to main channel	1	58,631
Main channel	2	59,250
Main channel to north entrance channel	3	59,482
North entrance channel	4	56,560
	Total:	233,923

Table 4. Sampling Locations, DMMU Composites, water depths, and mudline elevations

DMMU	Location ID	Mudline Elevation (ft. MLLW)	Decimal Degree (NAD83)		State Plane North (NAD83)	
			Latitude (N)	Longitude (W)	Easting	Northing
1	D01-1	-10.1	48.361704	-122.554281	1222080.17	501392.65
1	D01-2	-11.3	48.362048	-122.552699	1222467.63	501509.46
1	D01-3	-11.2	48.362806	-122.549211	1223321.45	501766.85
1	D01-4	-11.0	48.363323	-122.546830	1223904.37	501942.58
1	D01-5	-9.0	48.363836	-122.544466	1224483.07	502117.03
1	D01-6	-9.9	48.364526	-122.541376	1225239.46	502352.12
1	D01-7	-9.6	48.365005	-122.538712	1225890.93	502512.35
1	D01-8	-10.9	48.369664	-122.518000	1230961.77	504100.55
2	D02-1	-8.3	48.371858	-122.509855	1232958.52	504857.72
2	D02-2	-8.7	48.377721	-122.507977	1233461.30	506985.97
2	D02-3	-9.1	48.385099	-122.505514	1234118.25	509663.74
2	D02-4	-10.7	48.400006	-122.496948	1236316.90	515055.47
2	D02-5	-10.7	48.405919	-122.496770	1236406.79	517211.31
2	D02-6	-10.2	48.414690	-122.497969	1236184.80	520416.64
2	D02-7	-11.4	48.426436	-122.500659	1235624.38	524714.55
2	D02-8	-10.2	48.429352	-122.499218	1235997.30	525770.80
3	D03-1	-11.8	48.434689	-122.499932	1235866.05	527720.80
3	D03-2	-10.2	48.437813	-122.501602	1235485.58	528869.15
3	D03-3	-11.6	48.442468	-122.505909	1234477.25	530589.64
3	D03-4	-9.1	48.454128	-122.514439	1232500.16	534887.56
3	D03-5	-10.6	48.456892	-122.514547	1232496.00	535895.89
3	D03-6	-10.1	48.460635	-122.516388	1232079.33	537270.89
3	D03-7	-10.9	48.462505	-122.518026	1231696.69	537961.86
3	D03-8	-11.5	48.465338	-122.520170	1231199.47	539006.31
4	D04-1	-10.0	48.469437	-122.523668	1230383.76	540519.85
4	D04-2	-11.5	48.472421	-122.526003	1229841.40	541620.89
4	D04-3	-10.7	48.475074	-122.528153	1229341.39	542600.06
4	D04-4	-11.2	48.477204	-122.529795	1228960.15	543385.47
4	D04-5	-11.1	48.479256	-122.531241	1228626.12	544141.72
4	D04-6	-11.8	48.483898	-122.534895	1227777.51	545854.22
4	D04-7	-10.7	48.506080	-122.552925	1223586.53	554041.72
4	D04-8	-11.6	48.507852	-122.554330	1223260.58	554695.54

Table 5. Swinomish Waterway Federal Navigation Channel Chemistry and Conventionals Results

				SW17-D01-C			SW17-D02-C			SW17-D03-C			SW17-D04-C		
	SL	ML	BT	9/12/17	LQ	VQ	9/12/17	LQ	VQ	9/12/217	LQ	VQ	9/12/17	LQ	VQ
Conventionals															
Total Solids (%)	--	--	--	77.4			81.1			77.1			74.5		
Total Organic Carbon (%)	--	--	--	0.159			0.062			0.166			0.243		
Sulfides (mg/kg)	--	--	--	23.4			0.62	U		0.65	U		2.3		
Ammonia (mg/kg)	--	--	--	0.22	J		0.6	U		0.21	J		5.68		J
Total Volatile Solids (%)	--	--	--	1.1			1.1			1.2			1.4		
Grain Size (%)															
Gravel (>2,000 µm)	--	--	--	0.11			2.06			1.45			0.14		
Very Coarse Sand	--	--	--	2.93			4.09			4.36			0.66		
Coarse Sand	--	--	--	41.55			34.81			19.22			3.46		
Medium Sand	--	--	--	44.07			52.9			51.94			26.04		
Fine Sand	--	--	--	3.08			3.77			20.46			51.74		
Very Fine Sand	--	--	--	1.61			0.05			0.96			10.81		
Sand (62.5 to 2,000 µm)	--	--	--	93.24			95.62			96.94			92.71		
Silt (3.9 to 62.5 µm)	--	--	--	4.7			0.08			0.17			4.68		
Clay (0 to 3.9 µm)	--	--	--	1.71			0.81			1.09			2.78		
Percent Fines[a]	--	--	--	6.41			0.89			1.26			7.46		
Metals (mg/kg)															
Antimony	150	200	--	3.7	U		3.7	U		4	U		4	U	
Arsenic	57	700	507.1	3.4	J		2.8	J		2.6	J		4.3		
Cadmium	5.1	14	--	0.19	U		0.18	U		0.2	U		0.2	U	
Chromium	260	--	--	16.8			18.4			13.8			17.4		
Copper	390	1300	--	8.68			6.56			5.93			6.97		
Lead	450	1200	975	2.3			2.4			2			2.1		
Mercury	0.41	2.3	1.5	0.015	J		0.005	J		0.006	J		0.013	J	
Selenium	--	--	3	0.034	J		0.093	U		0.097	U		0.04	J	
Silver	6.1	8.4	--	0.75	U		0.73	U		0.8	U		0.81	U	
Zinc	410	3800	--	24.3			24.3			25.6			25.3		
PAHs (ug/kg)															
Naphthalene	2100	2400	--	6.4	U		6.2	U		6.5	U		6.7	U	
Acenaphthylene	560	1300	--	6.4	U		6.2	U		6.5	U		6.7	U	
Acenaphthene	500	2000	--	6.4	U		6.2	U		6.5	U		6.7	U	
Fluorene	540	3600	--	6.4	U		6.2	U		6.5	U		6.7	U	
Phenanthrene	1500	21000	--	6.4	U		6.2	U		6.5	U		6.7	U	
Anthracene	960	13000	--	6.4	U		6.2	U		6.5	U		6.7	U	
2-Methylnaphthalene	670	1900	--	6.4	U		6.2	U		6.5	U		6.7	U	
Total LPAHs[b]	5200	29000	--	6.4	U		6.2	U		6.5	U		6.7	U	
Fluoranthene	1700	30000	4600	6.4	U		6.2	U		6.5	U		6.7	U	
Pyrene	2600	16000	11980	6.4	U		6.2	U		6.5	U		6.7	U	
Benzo(a)anthracene	1300	5100	--	6.4	U		6.2	U		6.5	U		6.7	U	
Chrysene	1400	21000	--	6.4	U		6.2	U		6.5	U		6.7	U	
Benzo(b)fluoranthene	--	--	--	6.4	U		6.2	U		6.5	U		6.7	U	
Benzo(k)fluoranthene	--	--	--	6.4	U		6.2	U		6.5	U		6.7	U	
Benzofluoranthenes	3200	9900	--	6.4	U		6.2	U		6.5	U		6.7	U	
Benzo(a)pyrene	1600	3600	--	6.4	U		6.2	U		6.5	U		6.7	U	
Indeno(1,2,3-cd)pyrene	600	4400	--	6.4	U		6.2	U		6.5	U		6.7	U	
Dibenzo(a,h)anthracene	230	1900	--	6.4	U		6.2	U		6.5	U		6.7	U	
Benzo(g,h,i)perylene	670	3200	--	6.4	U		6.2	U		6.5	U		6.7	U	
Total HPAHs[c]	12000	69000	--	6.4	U		6.2	U		6.5	U		6.7	U	

	SL	ML	BT	SW17-D01-C			SW17-D02-C			SW17-D03-C			SW17-D04-C		
				9/12/17	LQ	VQ	9/12/17	LQ	VQ	9/12/217	LQ	VQ	9/12/17	LQ	VQ
Phenols															
2,4-Dimethylphenol[g]	29	210	--	6.3	U		6.3	U		6.3	U		6.3	U	
2-Methylphenol	63	77	--	6.4	U		6.2	U		6.5	U		6.7	U	
4-Methylphenol	670	3600	--	6.4	U		6.2	U		6.5	U		6.7	U	
Pentachlorophenol	400	690	504	64	U		62	U		65	U		67	U	
Phenol	420	1200	--	20	U		19	U		20	U		3.4	J	
Phthalates (ug/kg)															
Butyl benzyl phthalate	63	970	--	6.4	U		6.2	U		6.5	U		6.7	U	
Dibutyl phthalate	1400	5100	--	13	U		13	U		13	U		14	U	
Di-n-Octyl phthalate	6200	6200	--	5.1	J		5.5	J		5.8	J		5.7	J	
Diethyl phthalate	200	1200	--	6.4	U		6.2	U		6.5	U		6.7	U	
Dimethyl phthalate	71	1400	--	6.4	U		6.2	U		6.5	U		6.7	U	
Bis(2-Ethylhexyl) Phthalate	1300	8300	--	64	U		62	U		65	U		67	U	
Other SVOCs (ug/kg)															
Dibenzofuran	540	1700	--	6.4	U		6.2	U		6.5	U		6.7	U	
Benzoic Acid	650	760	--	260	U	UJ	250	U	UJ	260	U	UJ	270	U	UJ
Benzyl Alcohol	57	870	--	13	U		13	U		13	U		14	U	
1,2-Dichlorobenzene	35	110	--	6.4	U		6.2	U		6.5	U		6.7	U	
1,4-Dichlorobenzene	110	120	--	6.4	U		6.2	U		6.5	U		6.7	U	
Hexachlorobenzene	22	230	168	6.4	U		6.2	U		6.5	U		6.7	U	
Hexachlorobutadiene	11	270	--	6.4	U		6.2	U		6.5	U		6.7	U	
N-Nitrosodiphenylamine	28	130	--	6.4	U		6.2	U		6.5	U		6.7	U	
1,2,4-Trichlorobenzene	31	64	--	6.4	U		6.2	U		6.5	U		6.7	U	
PCB Aroclors (ug/kg)															
Aroclor 1016	--	--	--	12	U		12	U		12	U		12	U	
Aroclor 1221	--	--	--	23	U		24	U		23	U		23	U	
Aroclor 1232	--	--	--	12	U		12	U		12	U		12	U	
Aroclor 1242	--	--	--	12	U		12	U		12	U		12	U	
Aroclor 1248	--	--	--	12	U		12	U		12	U		12	U	
Aroclor 1254	--	--	--	12	U		12	U		12	U		12	U	
Aroclor 1260	--	--	--	12	U		12	U		12	U		12	U	
Total PCBs[d]	130	3100	--	23	U		24	U		23	U		23	U	
Pesticides (ug/kg)															
Heptachlor	1.5	270	--	1.2	U		1.2	U		1.2	U		1.2	U	
Aldrin	9.5	--	--	1.2	U		1.2	U		1.2	U		1.2	U	
Dieldrin	1.9	1700	--	1.2	U		1.2	U		1.2	U		1.2	U	
4,4'-DDE	9	--	--	1.2	U		1.2	U		1.2	U		1.2	U	
4,4'-DDD	16	--	--	1.2	U		1.2	U		1.2	U		1.2	U	
4,4'-DDT	12	--	--	1.2	U		1.2	U		1.2	U		1.2	U	
Total DDTs[e]	--	69	50	1.2	U		1.2	U		1.2	U		1.2	U	
Oxychlordane	--	--	--	1.1	U		1.1	U		1	U		1.2	U	
cis-Nonachlor	--	--	--	1.1	U		1.1	U		1	U		1.2	U	
trans-Nonachlor	--	--	--	1.1	U		1.1	U		1	U		1.2	U	
gamma-Chlordane	--	--	--	1.2	U		1.2	Ui	U	1.2	U		1.2	U	
cis-Chlordane	--	--	--	1.2	U		1.2	U		1.2	U		1.2	U	
Total chlordane[f]	2.8	--	37	1.2	U		1.2	U		1.2	U		1.2	U	

Notes: LQ: laboratory qualifier VQ: validation qualifier SL: screening level ML: maximum level BT: bioaccumulation trigger
U the analyte was analyzed for, but not detected
i the LOQ is elevated due to chromatographic interference
J the result is estimated
--not targeted for analysis
a. sum of silt and clay fractions
b. sum of detected values of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene
c. sum of detected values of fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, and benzo(ghi)perylene

d. sum of detected PCB Aroclors
e. sum of 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT
f. sum of gamma-chlordane, cis-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane
g. non-detect results reported at the method detection limit

Table 6. Polybrominated Diphenyl Ether Results (Herrera/NewFields, 2018)

	SW17-D01-C	LQ	VQ	SW17-D02-C	LQ	VQ	SW17-D03-C	LQ	VQ
PBDEs (ng/kg)									
PBDE-008/011	0.11	MJR	U	0.075	MJR	U	0.066	U	
PBDE-015	0.235	J		0.4	J		0.264	J	
PBDE-017/025	0.46	JR	U	0.283	J		0.48	MJR	U
PBDE-028/033	0.329	MJ		0.275	J		0.41	JR	U
PBDE-032	0.073	U		0.068	U		0.098	U	
PBDE-035	0.064	U		0.06	U		0.087	U	
PBDE-037	0.062	U		0.058	U		0.084	U	
PBDE-047	6.14	M		2.69	B		40.5		
PBDE-049	0.85	MJ		0.31	JR	U	1.15	J	
PBDE-051	0.14	MJR	U	0.085	U		0.095	U	
PBDE-066	0.26	JR	U	0.15	U		0.82	JR	U
PBDE-071	0.15	U		0.14	U		0.15	U	
PBDE-075	0.13	U		0.12	U		0.13	U	
PBDE-077	0.11	U		0.1	U		0.11	U	
PBDE-079	0.1	U		0.096	U		0.11	U	
PBDE-085	0.35	MJ		0.18	U		2.6	J	
PBDE-099	4.84			1.43	JB	U	55.1		
PBDE-100	1.15	J		0.476	J		9.44		
PBDE-105	0.18	U		0.23	U		0.33	U	
PBDE-118	0.18	U		0.22	U		0.33	U	
PBDE-119/120	0.17	U		0.21	U		0.31	U	
PBDE-126	0.11	U		0.15	U		0.22	U	
PBDE-128	0.79	U		0.8	U		0.64	U	
PBDE-138/166	0.6	U		0.61	U		0.69	JR	U
PBDE-140	0.38	U		0.39	U		0.31	U	
PBDE-153	0.46	U		0.51	U		4.79	J	
PBDE-154	0.43	J		0.35	U		3.36	J	
PBDE-155	0.27	U		0.33	U		0.28	U	
PBDE-156	0.89	U		0.91	U		0.73	U	
PBDE-181	0.35	U		0.46	U		0.41	U	
PBDE-183	0.21	U		0.28	U		0.25	U	
PBDE-184	0.18	U		0.23	U		0.2	U	
PBDE-190	0.49	U		0.64	U		0.56	U	
PBDE-191	0.4	U		0.52	U		0.46	U	
PBDE-196	0.32	U		0.39	U		0.32	U	
PBDE-197	0.26	U		0.32	U		0.26	U	
PBDE-203	0.34	U		0.42	U		0.35	U	
PBDE-206	0.5	MJ		0.83	MJ		0.23	U	
PBDE-207	0.87	MJ		0.82	J		0.66	MJ	
PBDE-208	0.81	MJR	U	0.26	U		0.24	U	
PBDE-209	9.2	JR	U	25.6			5	JR	U

Notes:
LQ: laboratory qualifier VQ: validation qualifier DW: dry weight BDE: brominated diphenyl ether
M a peak has been manually integrated
R the ion abundance ratio(s) did not meet the acceptance criteria. Value is an estimated maximum.
J the analyte was detected below the calibrated range but above the EDL
U the analyte was not detected above the EDL

Figure 1. Swinomish Channel Study Area (NewFields, 2017)

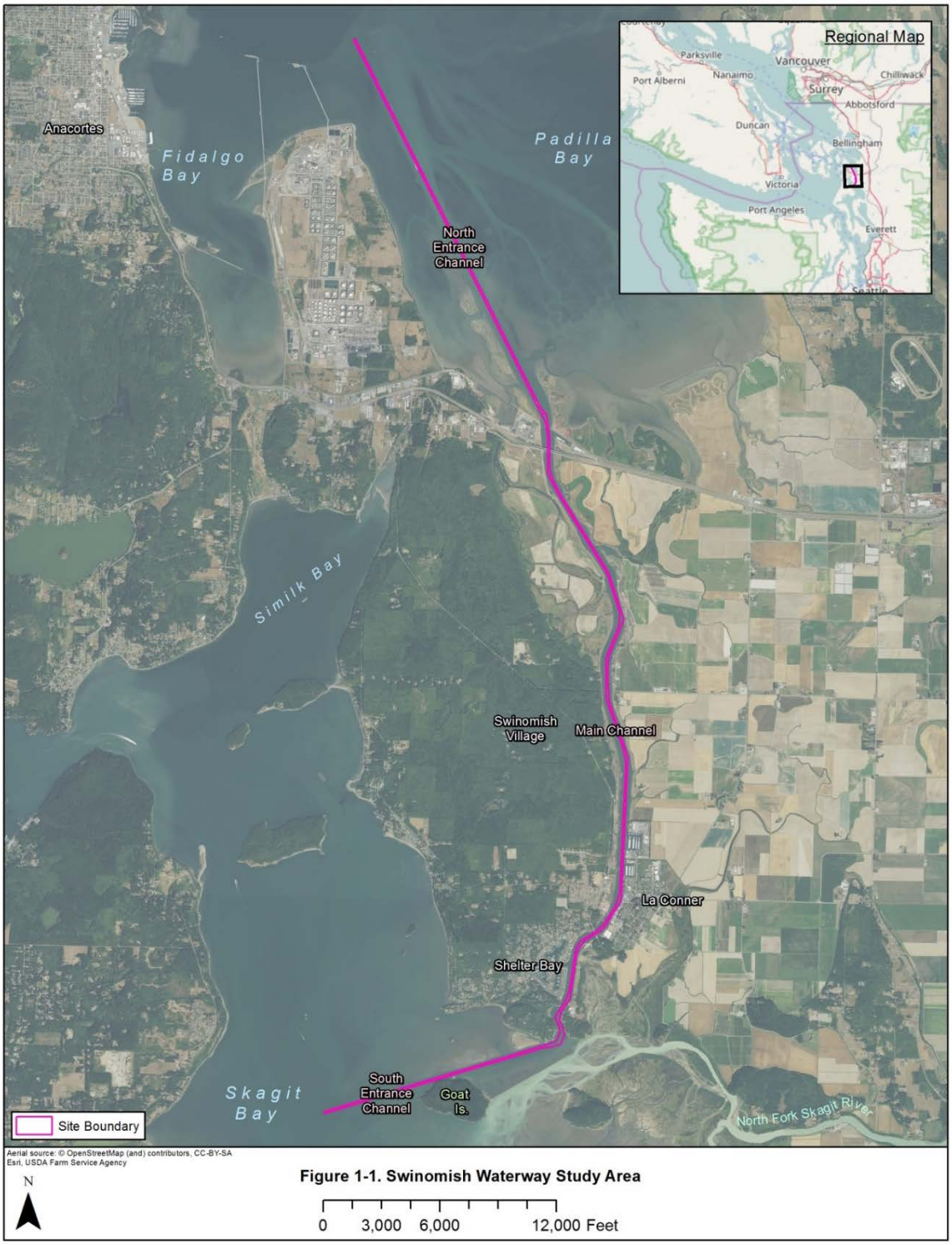

Figure 1-1. Swinomish Waterway Study Area

Figure 2. Swinomish Waterway South Entrance Sampling Locations (NewFields, 2018)

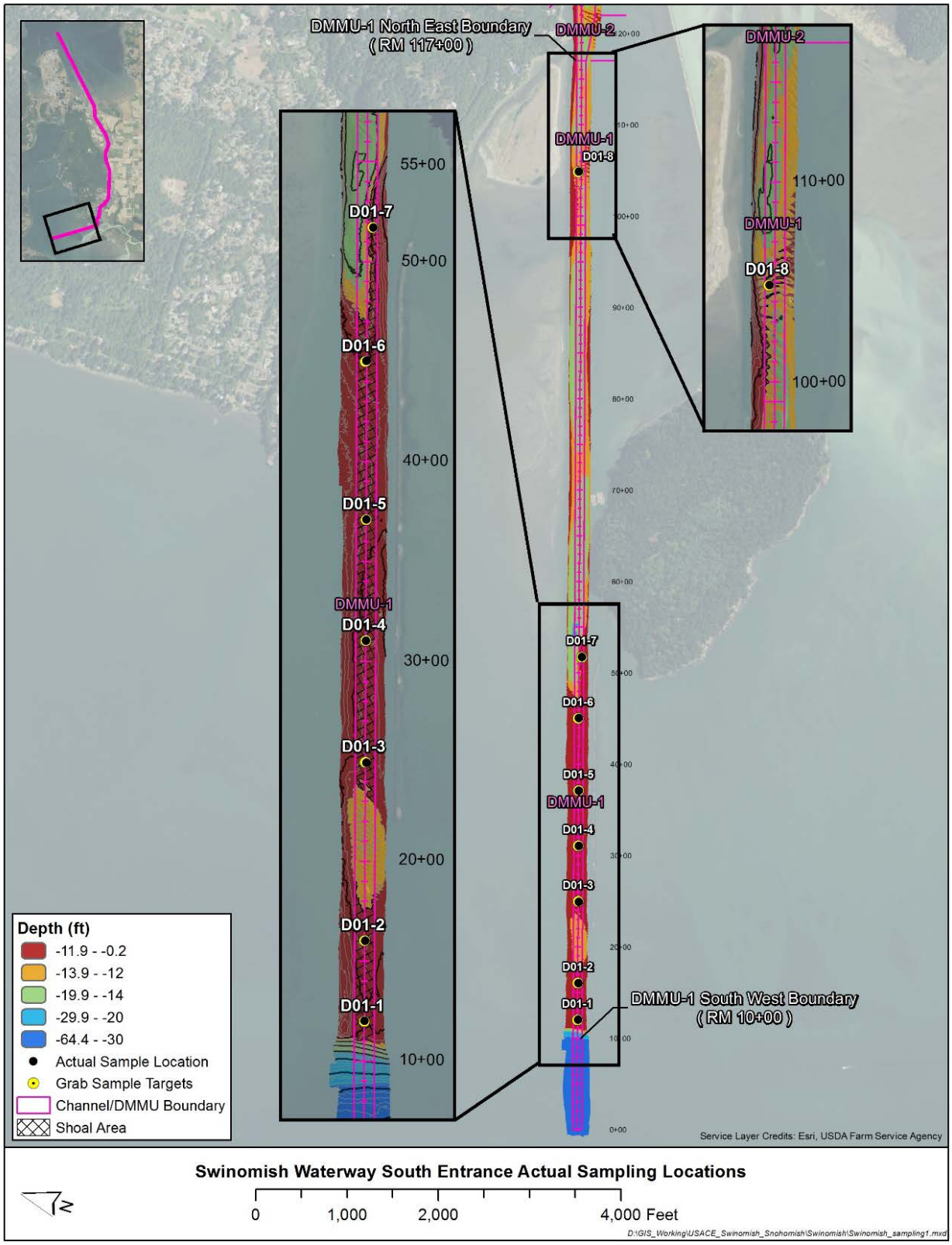

Figure 3. Swinomish Waterway Main Channel Sampling Locations

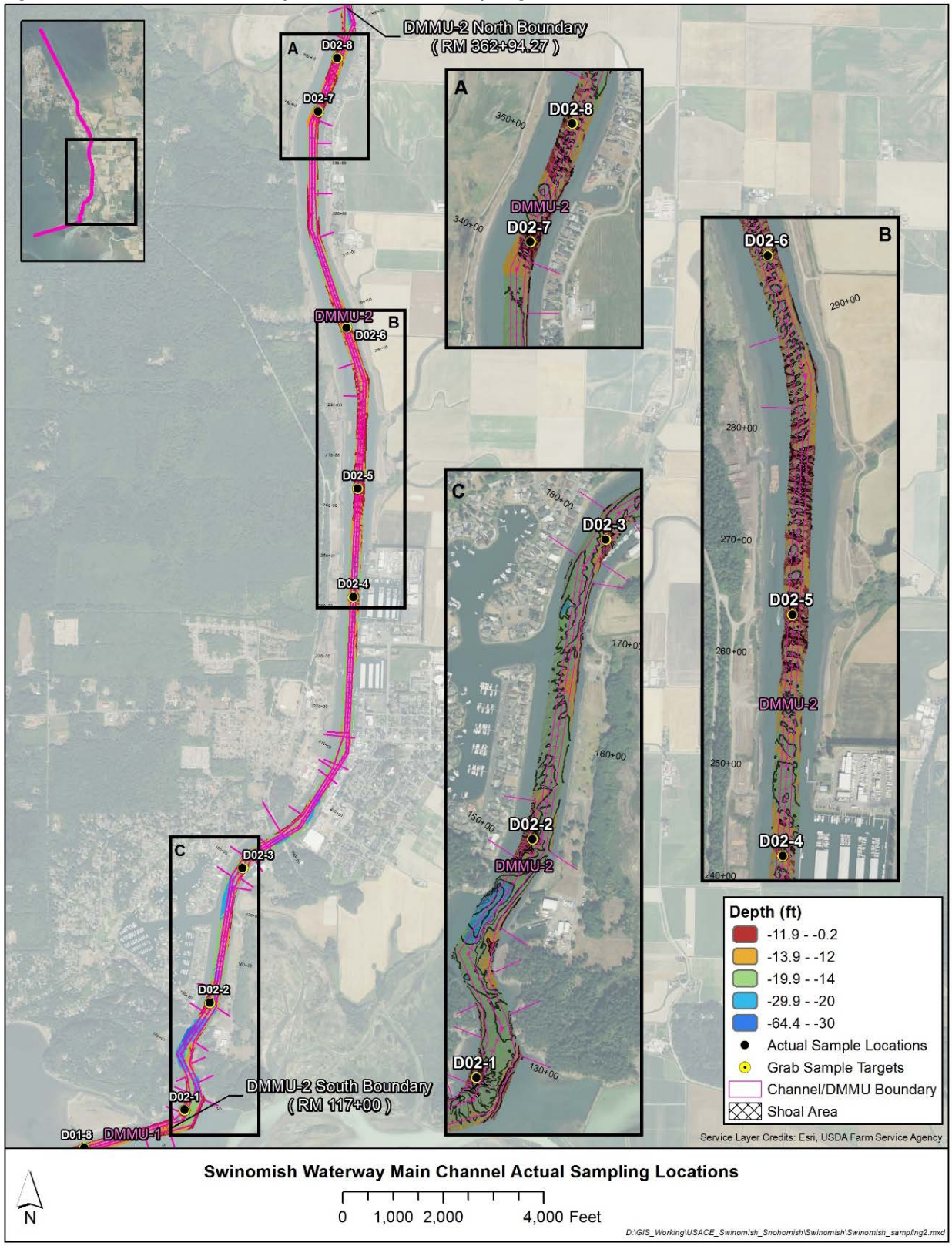

Figure 4. Swinomish Waterway Main Channel to North Entrance Sampling Locations (Herrera/NewFields 2018)

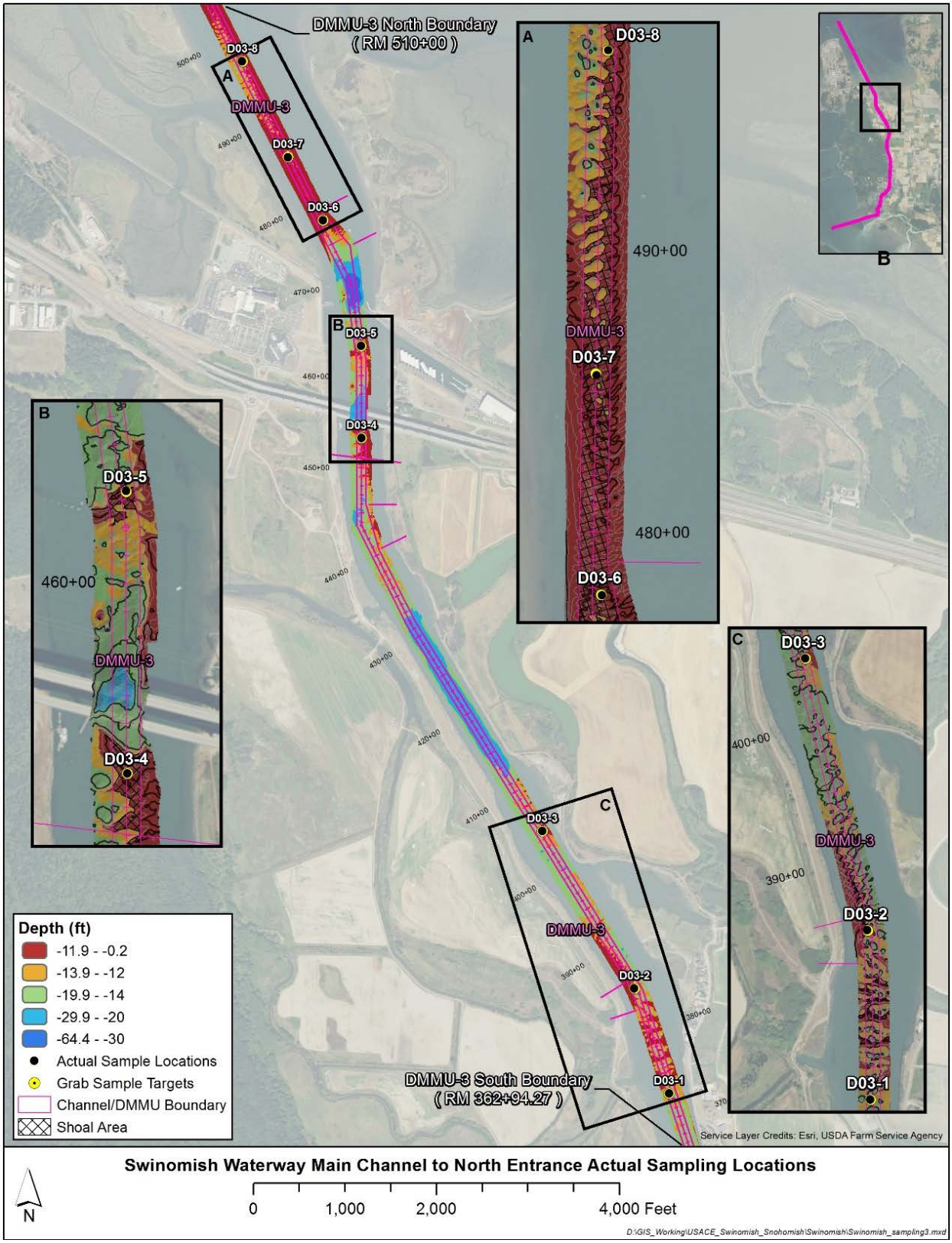
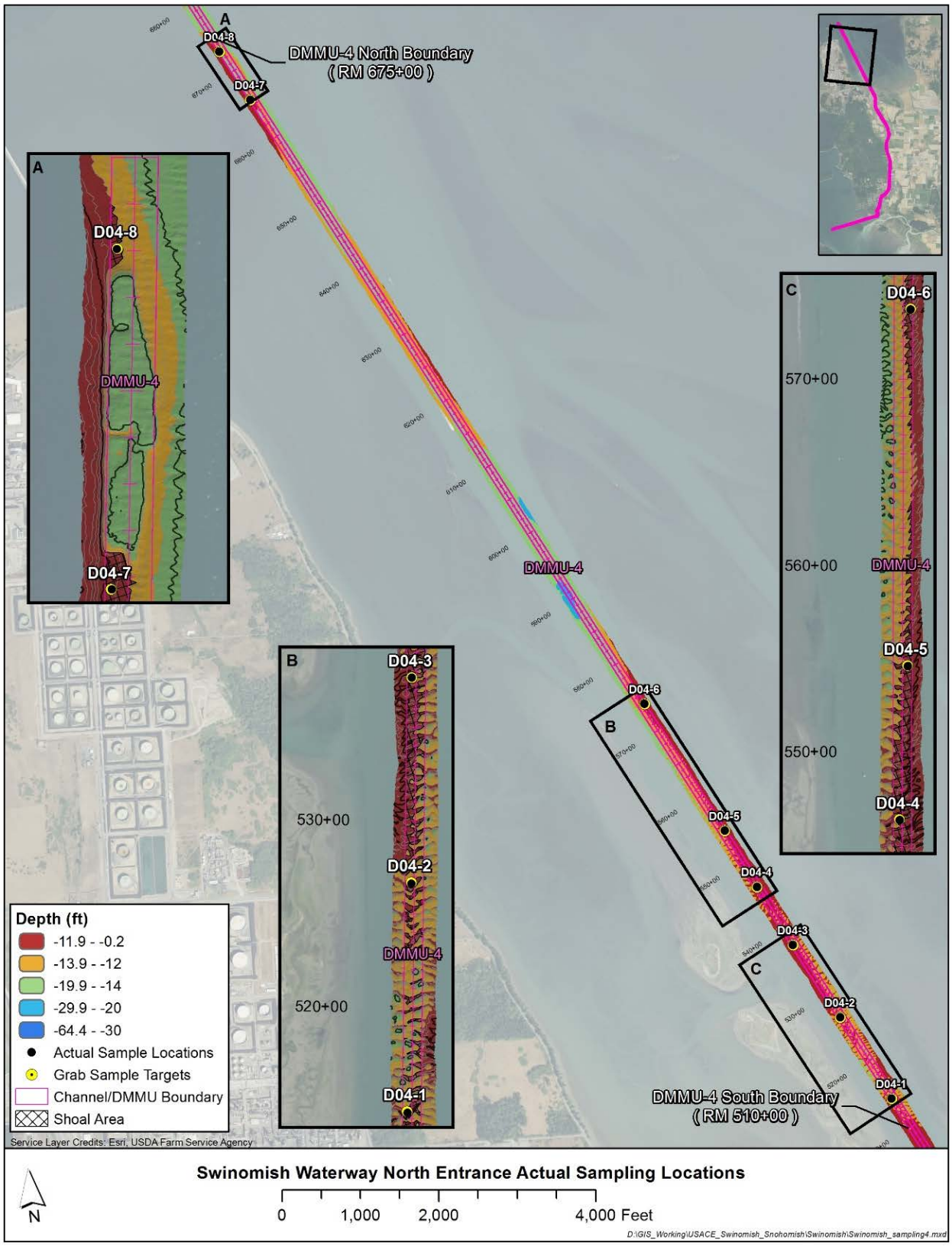
Figure 5. Swinomish Waterway North Entrance Sampling Locations (Herrera/NewFields, 2018)