Supplementary Materials:

Table S1. Aerial overflight surveys for the *MV Marathassa* oil spill.

Date	Time	Observations
8 April	11:00	No pollution observed
9 April	12:20	2800L oil on water in the English Bay; No shoreline impact
	18:06	667.7 L of oil on water in the English Bay
	19:00	Shoreline contamination reported at the beach of the English Bay
10 April	09:12	40 L of oil on water in the English Bay
	14:10	5.9 L of oil on water; non-recoverable oil
12 April	10:36	A light sheen (about 0.3 L) of oil off the stern of the *M/V Marathassa*

Table S2. Western Canada Marine Response Corporation's (WCMRC) response to the spill

# of vessels	1	2	3	
Strategies	Began collecting fuel oil and skimming at 21:25, on 8 April 2015	Began collecting fuel oil and skimming at 22:15, on 8 April 2015	Began collecting fuel oil and skimming at 23:30, on 8 April 2015	Began booming around *MV Marathassa* at 04:36-05:25, on 9 April 2015

Table S3. The chemical composition of IFO 380 in the OSCAR model.

Substance Name	Fraction in IFO380 (%)
C5-saturates (n-/iso-/cyclo)	0.0000
C6-saturates (n-/iso-/cyclo)	0.0000
Benzene	0.0000
C7-saturates (n-/iso-/cyclo)	0.0000
C1-Benzene (Toluene) et. B	0.0000
C8-saturates (n-/iso-/cyclo)	0.0000

C2-Benzene (xylenes; using O-xylene)	0.0000
C9-saturates (n-/iso-/cyclo)	0.0000
C3-Benzene	0.0913
C10-saturates (n-/iso-/cyclo)	0.2382
C4 and C4 Benzenes	0.0082
C11-C12 (total sat + aro)	0.4458
Naphthalenes 1 (C0-C1-alkylated)	0.0240
C13-C14 (total sat + aro)	0.4815
Naphthalenes 2 (C2-C3-alkylated)	0.0286
C15-C16 (total sat + aro)	0.3977
PAH 1 (Medium soluble polyaromatic hydrocarbons (3 rings-non-alkylated; < 4 rings))	0.0172
C17-C18 (total sat + aro)	0.4928
C19-C20 (total sat + aro)	0.3784
C21-C25 (total sat + aro)	0.8621
PAH 2 (Low soluble polyaromatic hydrocarbons (3 rings-alkylated; 4-5+ rings))	0.0079
C25 (total)	96.5153

Table S4. Assumptions for mechanical response strategies (recovery actions).

# of vessels	1	2	3	4
Cruise Speed (knot)	15	15	15	15
Recover efficiency (%)	80	80	80	80
Skimmer / Boom	160 m^3/hr	160 m^3/hr	160 m^3/hr	180 m
Thickness limit for recoverable oil (mm)	0.1	0.1	0.1	-
Strategy	From 2100 h, April 8th to the end	From 2200 h, April 8th to the end	From 2300 h, April 8th to the end	0400 h – 0500 h, April 9th

Table S5. Factors setting in each simulation

Scenario #	Spilled volume (L)	Wind	Duration (hours)	Response
1	2800	×	2	×
2	2800	√	2	×
3	2800	×	22	×
4	2800	√	22	×
5	2800	×	2	√
6	2800	√	2	√
7	2800	×	22	√
8	2800	√	22	√

Each scenario has 5 potential start-releasing time with 12:00, 13:00, 14:00, 15:00, and 16:00.

Table S6. The influence of studied factors on the mass balance of *MV Marathassa* spilled oil.

Start-releasing time	Scenario #	Mass Balance (%)						
		Surface	Atmosphere	Water Column	Sediments	Ashore	Biodegraded	Recovered
12:00	1	15.1	1	0	0	83.6	0.3	0
	2	0	0.8	0	0	98.2	1	0
	3	92.4	1.2	0	0	6.3	0.1	0
	4	54.4	1.3	0.3	0	43.7	0.3	0
	5	11.2	2	0.2	0	78.3	0.3	8
	6	0	1.6	0.1	0.1	89.5	0.8	7.9
	7	88.4	1.5	0.1	0	5.9	0.1	4.1

	8	17.3	0.7	0.2	0	23.4	0.2	55.1
13:00	1	16.9	1	0	0	81.9	0.3	0
	2	4.8	1	0.2	0	93.3	0.7	0
	3	98.9	0.9	0	0	0	0.1	0
	4	49.8	1.3	0.3	0	48.4	0.3	0
	5	13	2	0	0	76.7	0.3	8
	6	0.9	1.9	0.6	0.1	87.9	0.6	7.9
	7	89.7	1.5	0.1	0	4.5	0.1	4.1
	8	28.9	1	0.3	0	30	0.2	39.7
14:00	1	52.5	1	0	0	46.3	0.2	0
	2	7.4	1.3	0.6	0	90.2	0.4	0
	3	95.9	1.2	0	0	2.8	0.1	0
	4	24.9	1.4	0.4	0	72.9	0.4	0
	5	9.6	0.7	0.7	0	9.2	0.1	79.7
	6	1.1	0.8	1.2	0	17.4	0.1	79.3
	7	28.2	0.7	0	0	1	0	70.1
	8	13.4	0.7	0.2	0	23.7	0.1	61.8
15:00	1	91.3	1	0	0	7.5	0.2	0
	2	25.9	1.5	0.8	0	71.6	0.2	0
	3	97.5	1.2	0	0	1.2	0.1	0
	4	43.1	1.4	0.5	0	54.6	0.4	0
	5	60.3	1	0.2	0	1.8	0.1	36.6
	6	16.3	1.3	0.9	0	40.3	0.2	40.9
	7	93	1.5	0.1	0	1.8	0.1	3.5
	8	10.1	0.7	0.2	0	23.3	0.1	65.5
16:00	1	98.7	1.1	0	0	0.1	0.1	0
	2	45.7	1.6	1.4	0	51	0.2	0

3	97.3	1.2	0	0	1.5	0.1	0
4	99.2	0.7	0	0	0	0	0
5	89.4	2.1	0.2	0	0.2	0.1	8
6	31.2	2	1.5	0.1	56.9	0.2	8
7	93.6	1.5	0.1	0	1.4	0.1	3.3
8	8.8	0.7	0.3	0	22.1	0.1	68.1

Detail factors in each scenario was showed in Table S5.

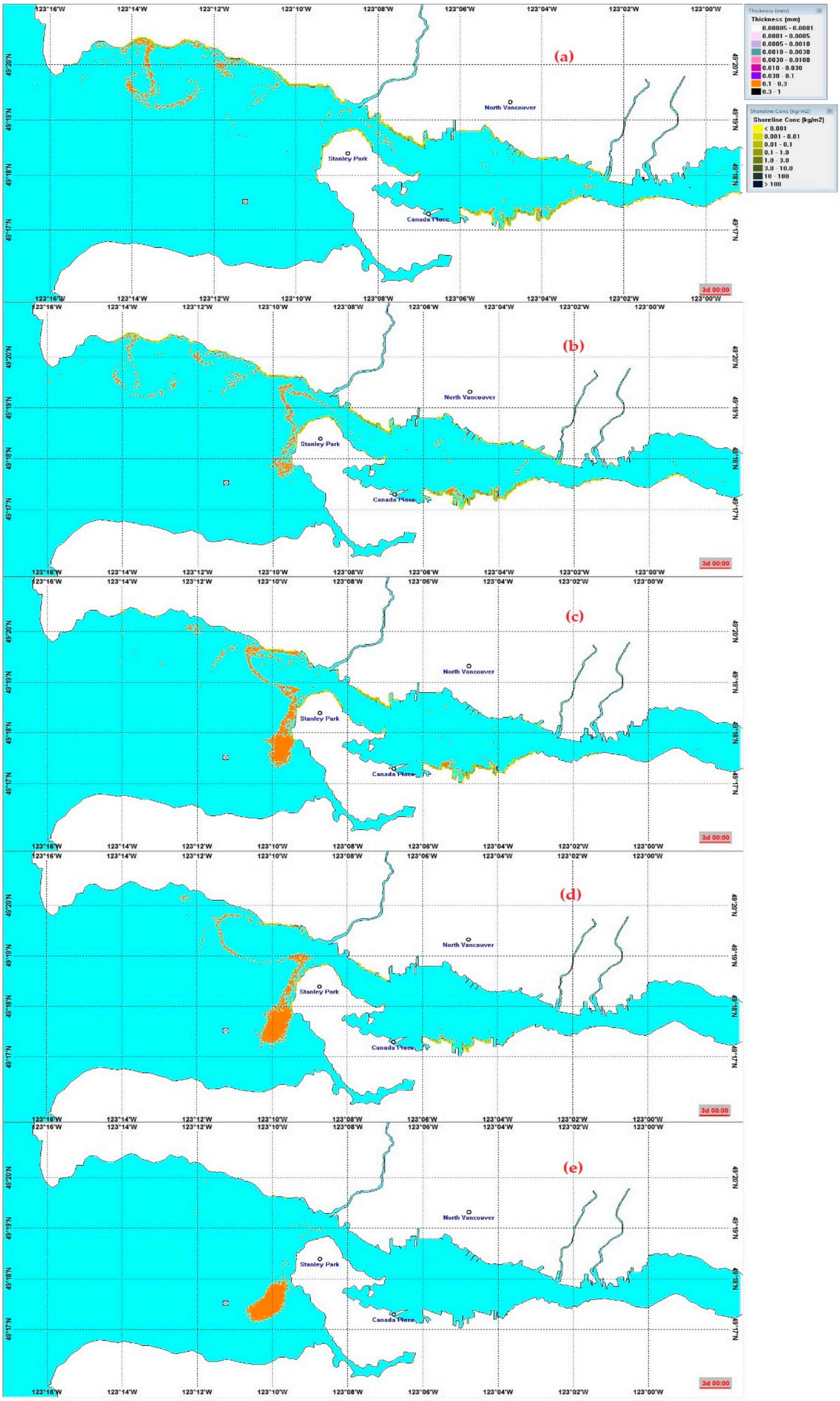

Figure S1. Example of oil trajectories for oil spill with different oil start-releasing time. Figures from top to bottom are oil start release oil at (a) 12:00, (b) 13:00, (c) 14:00, (d) 15:00, and (e) 16:00.

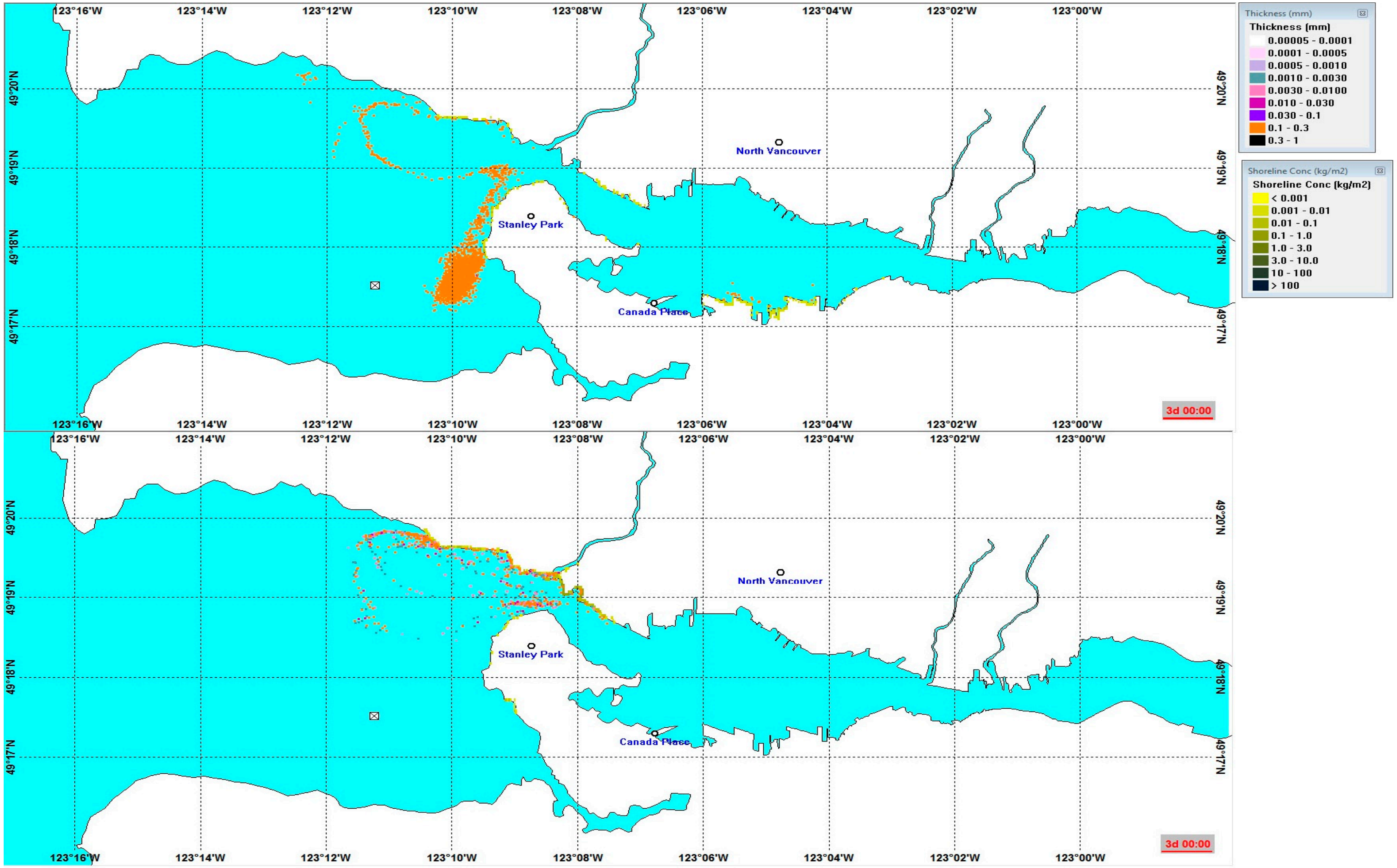

Figure S2. Example of oil trajectories for spilled oil forced without wind (top) or with wind (bottom).

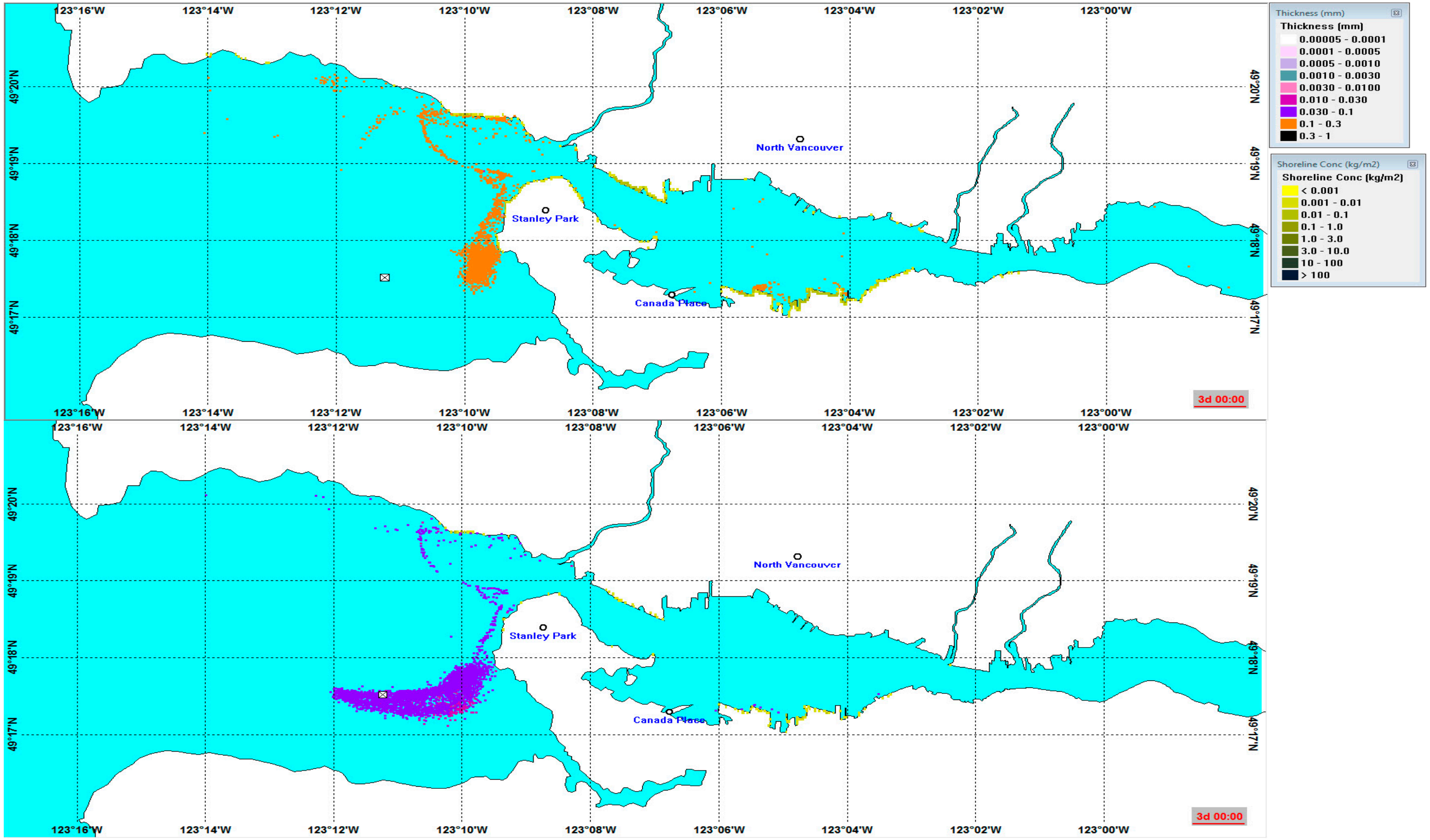

Figure S3. Example of oil trajectories for oil discharge instantly (top) or continuously (bottom).

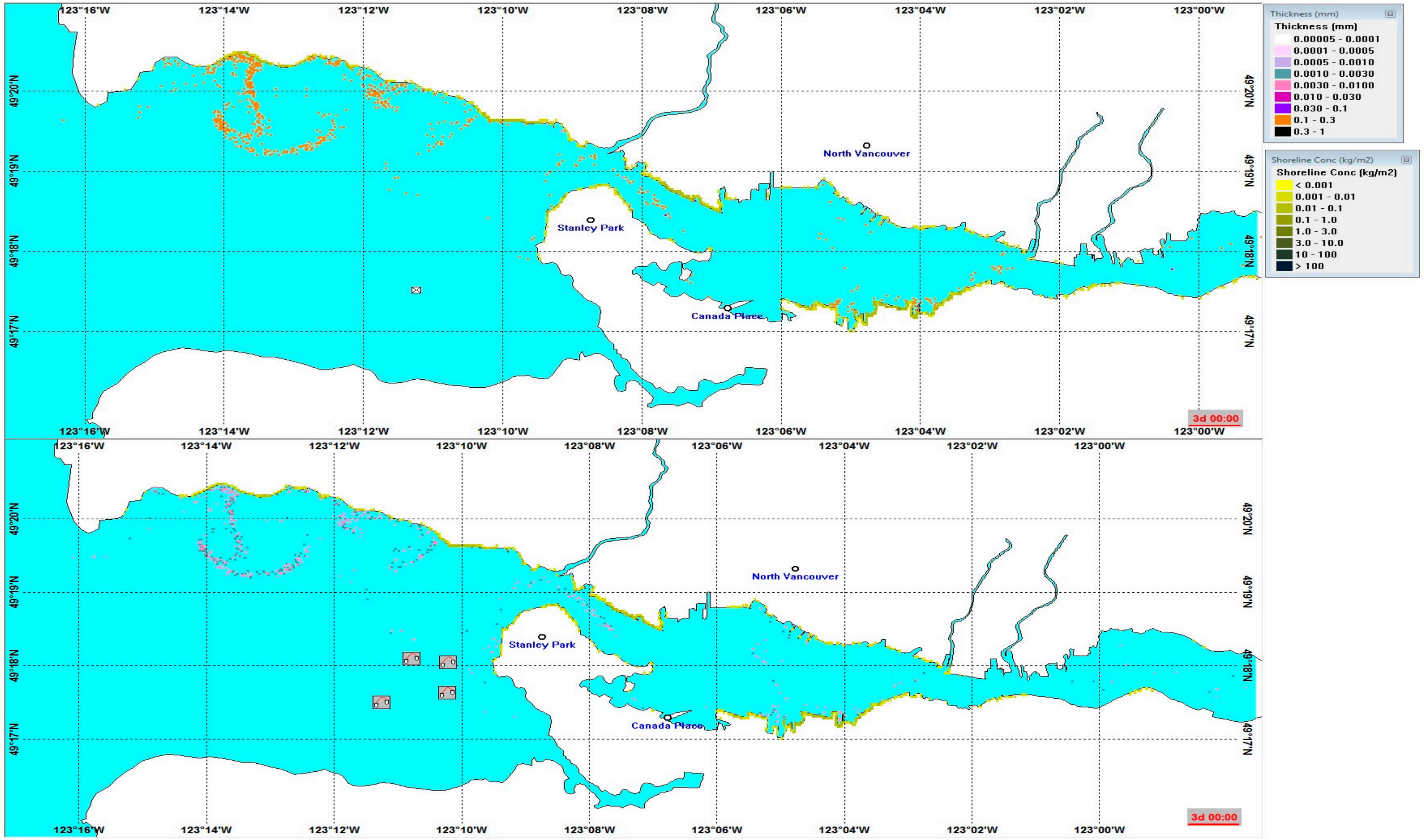

Figure S4. Example of oil trajectories for oil spill without (top) or taken (bottom) recovery actions.

Table S7. Water surface contaminant comparison. The simulated results were compared with observation data.

Time to start spill	Scenarios #	Labels of surface contaminant										Matches (%)
		1	2	3	4	5	6	7	8	9	10	
12:00	1	×	×	√	×	√	√	√	×	×	×	40
	2	√	×	×	×	×	×	×	×	×	×	10
	3	×	×	×	×	√	×	√	√	√	×	40
	4	×	×	√	√	√	√	√	×	√	×	60
	5	×	×	√	×	√	√	√	×	×	×	40
	6	√	×	×	×	×	×	×	×	×	×	10
	7	×	×	√	√	×	√	√	√	√	×	60
	8	×	×	√	√	√	√	√	×	√	×	60
13:00	1	×	×	√	×	×	×	√	×	×	×	20
	2	√	×	×	×	×	×	×	×	√	×	20
	3	×	×	×	×	×	×	×	√	√	×	20
	4	√	×	√	×	√	√	√	×	√	×	60
	5	×	×	√	√	×	√	√	×	×	×	40
	6	×	×	×	×	×	×	×	√	√	×	20
	7	×	×	×	×	×	×	×	√	×	×	10
	8	√	×	√	×	√	√	√	×	√	×	60
14:00	1	×	×	×	×	×	×	×	×	×	×	0
	2	√	×	×	×	×	×	×	√	√	×	30
	3	×	×	×	×	×	×	×	√	√	×	20
	4	√	×	√	√	√	×	√	√	√	×	70
	5	×	×	×	×	×	×	×	×	×	×	0
	6	√	×	×	×	×	×	×	√	√	×	30

	7	×	×	×	×	×	×	×	√	√	×	20
	8	√	×	√	√	×	√	√	√	√	×	70
15:00	1	×	×	×	×	×	×	×	×	×	×	0
	2	×	×	×	×	×	×	×	√	√	×	20
	3	×	×	×	×	×	×	×	×	√	×	10
	4	×	√	√	√	√	×	√	√	√	×	70
	5	×	×	×	×	×	×	×	×	×	×	0
	6	√	×	×	×	×	×	×	√	√	×	30
	7	×	×	×	×	×	×	×	√	√	×	20
	8	×	√	√	√	√	×	√	√	√	×	70
16:00	1	×	×	×	×	×	×	×	×	×	×	0
	2	×	×	×	×	×	×	×	×	√	×	10
	3	×	×	×	×	×	×	×	×	√	×	10
	4	×	×	√	√	×	√	√	√	√	×	60
	5	×	×	×	×	×	×	×	×	×	×	0
	6	×	×	×	×	×	×	×	×	√	×	10
	7	×	×	×	×	×	×	×	×	√	×	10
	8	×	×	√	√	×	√	√	√	√	×	60

Detail factors in each scenario was showed in Table S5. "×" represents the simulated results does not match with the observed data; "√" indicates the simulated results matches the observed data.

Table S8. Shoreline contaminant comparison. The simulated results were compared with observation data.

Time to start spill	Scenarios #	Labels of shoreline contaminant																Matches (%)
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	
12:00	1	√	√	√	√	√	×	√	√	√	√	×	√	×	×	√	×	68.75
	2	×	×	×	×	×	×	√	√	√	×	×	√	√	×	√	×	37.5

	3	√	√	√	√	√	×	√	√	√	√	×	√	×	×	√	×	68.75
	4	×	√	√	√	√	×	√	√	√	√	×	√	×	×	√	×	62.5
	5	√	√	√	√	√	×	√	√	√	√	×	√	×	×	√	×	68.75
	6	×	√	×	×	×	×	√	√	√	×	×	√	√	×	√	×	43.75
	7	√	√	√	√	×	√	√	√	√	×	√	√	×	×	√	×	68.75
	8	×	√	√	√	×	√	√	√	√	√	×	√	×	√	×	×	62.5
13:00	1	√	√	√	√	√	×	√	√	√	√	×	√	×	×	√	×	68.75
	2	×	√	√	√	×	×	√	√	√	×	×	√	√	×	√	×	56.25
	3	√	√	√	√	√	×	√	√	√	√	×	√	×	×	√	×	68.75
	4	×	√	√	√	√	×	√	√	√	√	×	√	×	√	×	×	62.5
	5	√	√	√	√	√	×	√	√	√	√	×	√	×	×	√	×	68.75
	6	×	√	×	√	√	×	√	√	√	×	×	√	√	×	√	×	56.25
	7	×	√	√	√	√	×	√	√	√	√	×	√	×	×	√	×	68.75
	8	×	√	√	√	√	×	√	√	√	√	×	√	×	√	×	×	62.5
14:00	1	√	√	×	√	√	×	√	√	√	√	×	√	×	×	√	×	37.5
	2	×	√	×	√	×	√	√	√	√	×	√	√	√	×	√	×	37.5
	3	×	√	×	√	√	×	√	√	√	√	√	√	×	×	√	×	37.5
	4	×	√	√	√	√	×	√	√	√	√	×	√	×	√	×	×	62.5
	5	√	√	√	√	√	×	√	√	√	√	×	√	×	×	√	×	68.75
	6	×	√	×	√	√	×	√	√	×	×	×	√	√	×	√	×	50
	7	×	√	×	√	√	×	√	√	√	√	×	√	√	×	√	×	62.5
	8	×	√	√	√	√	×	√	√	√	√	×	√	×	√	×	×	62.5
15:00	1	×	√	×	√	√	×	√	√	√	√	×	√	×	×	√	×	43.75
	2	×	√	×	√	√	√	√	√	√	×	√	√	√	×	√	×	31.25
	3	×	√	×	√	√	×	√	√	√	√	×	√	√	×	√	×	37.5

	4	×	√	√	√	√	×	√	√	√	√	×	√	×	√	×	×	62.5
	5	×	√	×	√	√	×	√	√	√	√	×	√	×	×	√	×	56.25
	6	×	√	×	√	√	√	√	√	√	√	×	√	√	×	√	×	68.75
	7	×	√	×	√	√	×	√	√	√	√	×	√	√	×	√	×	62.5
	8	×	√	√	√	√	×	√	√	√	√	×	√	×	√	×	×	62.5
16:00	1	×	×	×	×	√	×	√	√	√	×	√	√	√	×	√	×	50
	2	×	√	×	√	√	√	√	√	√	×	×	√	√	×	√	×	37.5
	3	×	×	×	×	×	×	√	√	√	×	√	√	√	×	√	×	56.25
	4	×	√	√	√	√	×	√	√	√	√	√	√	×	√	×	×	68.75
	5	×	×	×	×	√	×	√	√	√	√	×	√	√	×	√	×	50
	6	×	√	×	√	√	×	√	√	√	×	×	√	√	×	√	×	56.25
	7	×	×	×	×	√	×	√	√	√	×	√	√	√	×	√	×	50
	8	×	√	√	√	√	×	√	√	√	√	×	√	×	√	×	×	62.5

Detail factors in each scenario was showed in Table S5. "×" represents the simulated results does not match with the observed data; "√" indicates the simulated results matches the observed data.