
Safe and Effective Threshold Determination Report for the Tesoro Port Angeles Marine Terminal

March 17 2026

Submitted to WDOE by:

Terminal Manager
Tesoro Petroleum Companies
1720 Ediz Hook Rd
Port Angeles, WA 98362
360 452 1433 (office)

Updated by:

Environmental Resources Management (ERM)
1201 3rd Avenue, Floor 22
Seattle, WA 98101

Originally Prepared by:



Gordon A Robilliard, Ph.D.
ENTRIX, Inc.
2701 First Avenue, Suite 500
Seattle, WA 98121

Table of Contents

SUMMARY	iii
SECTION 1 Introduction.....	1
1.1 PURPOSE	1
1.2 OBJECTIVES.....	1
1.3 LOCATION OF MARINE TERMINAL	1
1.4 BACKGROUND	1
SECTION 2 Site-Specific Safety and Environmental Conditions	5
2.1 PERSONNEL SAFETY	5
2.2 PRIMARY ENVIRONMENTAL CONDITIONS.....	5
2.2.1 Sea State	5
2.2.2 Water Currents.....	8
2.2.3 Weather Conditions.....	8
SECTION 3 Safe and Effective Threshold Values	11
3.1 PRIORITY OF SAFE AND EFFECTIVE THRESHOLD VALUES.....	11
3.2 DATA COLLECTION.....	11
3.3 PERSONNEL SAFETY	11
3.3.1 High Winds.....	11
3.3.2 Precipitation.....	12
3.3.3 Dockside Booming Operations	12
3.4 PRIMARY ENVIRONMENTAL CONDITIONS.....	13
3.4.1 Sea State	13
3.4.2 Water Currents.....	13
3.4.3 Weather Conditions.....	13
3.5 OTHER CONDITIONS THAT INFLUENCE OIL TRANSFER OPERATIONS	13
3.6 EFFICACY OF OIL BOOM UNDER RANGE OF ENVIRONMENTAL CONDITIONS	14
SECTION 4 References	16

List of Tables

Table 1. Wave Data.....	6
Table 2. Fetch-limited sea state (wave height and period). Highest sea state possible for specified fetch and wind speed.....	7
Table 3. Current Speed and Direction.....	8
Table 4. Monthly precipitation and wind averages (2021-2024).	9
Table 5. Advisory Oil Transfer Operation Actions Related to Wind Speed.....	12

List of Figures

Figure 1. Vicinity Map.....	3
Figure 2. Site Map	4

Change Log

Date	Reviewer	Changes
Apr 24, 2007	Entrix	Initial Publication
Oct 30, 2020	ERM	Updated meteorological and hydrology data and evaluated against conclusions.
August 18, 2025	ERM	Updated meteorological and hydrology data and evaluated against conclusions.
March 10, 2026	ERM	Added data collection methods in Section 3.2 and description of boom deployment and retrieval in Section 3.3.3.

SUMMARY

This report provides Tesoro Petroleum Companies (Tesoro) Person In Charge (PIC) of pre-booming for oil transfer operations at the Port Angeles Marine Terminal (the Terminal) with the threshold values for environmental conditions that allow the safe and effective deployment of oil boom around vessels prior to and during oil transfer operations. The Terminal is located at 1720 West Ediz Hook Road, Port Angeles Harbor, Port Angeles, Washington 98362 (latitude 48°08'24" N; longitude 123°27'48" W)

As of 26 October 2006, Washington State rules were adopted for Facility Oil Handling Standards (Washington Administrative Code [WAC] 173-180-224) and Vessel Oil Transfer Advance Notice and Containment Requirements (WAC 173-184). The most recent updates to these rules were made in June 2023. These rules require that Class 1 facilities, like the Terminal, to establish guidance on criteria and threshold values for the safe and effective deployment of oil boom for pre-booming operations.

In accordance with WAC 173-180-224 (2)(b), the values in this report are based on-site environmental monitoring data recorded at specific times, dates, and locations, if available. These specific data sources are identified in this report.

SAFETY AND ENVIRONMENTAL CONDITIONS AT THE PORT ANGELES MARINE TERMINAL

PERSONNEL SAFETY

Safety of personnel is the first and overriding priority for Tesoro's pre-booming and oil transfer operations at the Terminal. Tesoro's PIC at the Terminal has the ultimate responsibility and authority to determine if it is safe for personnel to deploy oil boom to meet the pre-booming requirement. That is, the PIC may determine that, even though the environmental threshold values described later in this report are not exceeded, there are other factors that render the pre-booming operation unsafe for personnel and, therefore, the PIC may terminate the pre-booming operation. In this situation and any other situation where the PIC determines that pre-booming is not safe and/or effective, the PIC will document the circumstances supporting the decision to not pre-boom.

Personnel safety during pre-booming may be compromised by one or more of the following conditions:

- High winds, especially >30 knots sustained (35 miles per hour [mph])
- Waves, especially high, choppy (i.e., short period) waves (>2.5 feet)

- Icy conditions on surfaces of wharf or vessel
- Heavy rain, fog, snow, or other conditions that reduce visibility to unsafe levels
- Other conditions as determined and documented by Tesoro's PIC or marine contractor responsible for deploying the boom

PRIMARY ENVIRONMENTAL CONDITIONS

Sea State (Wave Height and Period). The Terminal is protected from almost all wind and wave regimes except from the easterly direction. There is no available historical recorded data on waves for inner Port Angeles Harbor including the Tesoro wharf. The Terminal Manager reports 20- to 25-knot (~23- to 29-mph) winds about 10 to 12 times per year. Using methods described in the Shoreline Protection Manual, wave height and period were estimated for easterly winds. The analysis indicates that, at the 20- to 25-knot sustained winds reported by the Terminal Manager, wave heights could reach about 3.0 feet with a wave period of about 4 seconds. At 35-knot (~40mph) wind speed, wave heights could be over 4 feet with a period of about 4.5 seconds. It would take about 2.5 to 3 hours of sustained easterly winds to generate these wave heights and periods. Wind data show monthly averages in the 3.9 to 10.1 knots (4.5 to 11.5 mph) range and from the southwest direction. Therefore, the calculated wave action based on high sustained winds from the east is unlikely. Because winds from any other direction, which is the typical situation, have a short fetch, waves generated are unlikely to be large enough to affect personnel safety or boom effectiveness.

Water Currents. There are no historically available, continuously recorded, water current data for inner Port Angeles Harbor including the Tesoro wharf area. National Oceanic and Atmosphere Administration (NOAA) describes currents as "light and variable." Observations by the Tesoro wharf personnel and Terminal Manger concur with that description and indicate that currents do not reach 1 knot.

Weather (Wind and Precipitation). NOAA's National Ocean Service maintains a weather station inside the Port Angeles Harbor approximately 1.25 miles southwest of the Tesoro wharf. Based on this data, as stated above, wind averages from about 3.9 to 10.1 knots (4.5 to 11.5 mph). Precipitation data are recorded at the United States Coast Guard Station at the end of Ediz Hook Spit. Monthly average precipitation, primarily rain, is heaviest in mid-fall through spring months, and generally less in late spring through early fall. Wet months are generally in the range of 2 to 4 inches of precipitation per month. Rainfall is seldom heavy enough to, by itself, pose a safety hazard to the personnel involved in pre-booming.

OTHER CONDITIONS

According to the Terminal Manager, other conditions that might, or might not, affect pre-booming are:

- Low visibility due to heavy rainfall, fog, or snowfall
- Freezing conditions from some combination of high winds, cold weather, and rain/sleet/snowfall may cause ice build-up on the wharf and/or vessel used for deploying boom
- Other commercial vessel traffic in the immediate vicinity of the wharf typically will not restrict pre-booming
- Recreational activities are very limited in the vicinity of the Terminal wharf and should not affect pre-booming

EFFICACY OF OIL BOOM UNDER ENVIRONMENTAL CONDITIONS

Ideal performance conditions for 18-inch fence boom used by Tesoro are:

- Surface current speeds <1.0 knot
- Wave heights <1.5 to 2.0 feet
- Wind speeds <20 knots (~23 mph)

Generally accepted rules among the response industry are that (Mark Ploen, Quali-tech, personal communication):

- Water current speeds >0.8 to 1.0 knot begin to result in product loss
- Water current speed >1.5 knots will result in significant or complete product loss; i.e., boom efficacy approaches zero
- Waves heights > 1.5 to 2.0 feet high will result in splash-over of product, reducing boom effectiveness by 10 to 20 percent
- Waves 2.0 to 2.5 feet in height will dramatically decrease the effectiveness of the boom
- Waves >2.5 feet will render the boom essentially useless for retaining oil, even if the water current speeds are essentially zero

SAFE AND EFFECTIVE THRESHOLD VALUES

PERSONNEL SAFETY THRESHOLD VALUES.

Because safety of personnel is the first and overriding priority for Tesoro's pre-booming and oil transfer operations at the Terminal, Tesoro's PIC may determine that, even though the environmental threshold values described in the following are not exceeded, there are other factors that render the pre-booming operation unsafe for personnel and, therefore the PIC may terminate the pre-booming operation.

ENVIRONMENTAL CONDITIONS THRESHOLD VALUES

The following are threshold values for environmental conditions above which Tesoro PIC will consider it is not safe and/or effective to pre-boom:

- Water current speed > 1.0 knot will be the effective threshold value
- Wave heights >2.0 to 2.5 feet will be the safe and effective threshold value
- Sustained wind speed greater than 30 knots (~35 mph) or wind gusts greater than 35 knots (~40 mph) will be the safe and effective threshold value
- Low visibility resulting from fog, heavy precipitation, or snow at the wharf and/or boom deployment vessel that, in the opinion of the Tesoro PIC, jeopardize the safety of personnel involved in pre-booming
- Freezing and icy conditions that, in the opinion of the Tesoro PIC, jeopardize the safety of personnel involved in pre-booming

SECTION 1 Introduction

1.1 PURPOSE

The purpose of this report is to provide Tesoro's PIC of oil transfer operations at the Terminal with the threshold values for environmental conditions that allow the safe and effective deployment of oil boom around vessels prior to and during oil transfer operations (also referred to as pre-booming).

1.2 OBJECTIVES

The objectives of the analysis and report are:

- Identify personnel safety conditions and oil boom oil-retention efficacy under a range of environmental conditions;
- Provide guidance on the criteria and threshold values for environmental conditions affecting personnel safety and oil-retention efficacy; and
- Comply with the Safe and Effective Threshold Determination Report requirements of the Washington State Facility Oil Transfer Regulations (Washington Administrative Code [WAC] 173-180-224)

1.3 LOCATION OF MARINE TERMINAL

The Tesoro's Port Angeles, Washington, Terminal is located in the southwestern corner of 1720 West Ediz Hook Road, Port Angeles Harbor, Port Angeles, Washington 98362 (latitude 48.08.24° N; longitude 123.27.48° W).

The Terminal is a Class 1- Rate A bulk loading facility that receives and discharges refined oil products from and to ships and barges via a docking facility. Products transferred across this dock include Diesel and Marine Fuel Oil.

1.4 BACKGROUND

As of 26 October 2006, Washington State rules were adopted for Facility Oil Handling Standards (WAC 173-180) and Vessel Oil Transfer Advance Notice and Containment Requirements (WAC 173-184). The most recent updates to these rules were made in June 2023. These rules require that Class 1 facilities such as the Terminal develop guidance on criteria and threshold values for the safe and effective deployment of oil boom around vessels during oil transfer operations. Washington State Department of Ecology (Ecology) provided publication 06-08-031 for guidance on the pre-booming requirements for vessels and facilities delivering oil (Ecology, 2023).

This report provides the personnel safety and environmental criteria and threshold values for determination of when it is safe and effective to pre-boom at the Terminal. The analyses are based on data available from a variety of sources including National Oceanic and Atmosphere Administration (NOAA) Ocean Services; NOAA National Weather Service (NWS), including the NOAA station 1.25 miles away; peer-reviewed and technical publications; boom manufacturers' technical specifications for their products; experience of the oil spill response contractors retained by Tesoro for the Terminal; marine contractors retained by Tesoro to handle normal docking and oil transfer operations at the Terminal; and on-site observations and experience of the Terminal

SECTION 1
SAFE AND EFFECTIVE THRESHOLD DETERMINATION REPORT FOR THE TESORO
PORT ANGELES MARINE TERMINAL

operators and wharf personnel. This data is consistent with the real-time weather station data located at the Terminal.

WAC 173-180-221 requires pre-booming of (a) any bulk oil transfer operation greater than 500 gallons per minute from a vessel to a non-recreational vessel or facility, or (b) oil transfer from a Class 1 facility to a vessel, "... when it is safe and effective to do so" The rule provides guidance on the determination of when it is, and is not, safe and effective to pre-boom the oil transfer vessel and facility.

SECTION 1
SAFE AND EFFECTIVE THRESHOLD DETERMINATION REPORT FOR THE TESORO
PORT ANGELES MARINE TERMINAL

Figure 1. Vicinity Map



SECTION 1
SAFE AND EFFECTIVE THRESHOLD DETERMINATION REPORT FOR THE TESORO
PORT ANGELES MARINE TERMINAL



Figure 2. Site Map

SECTION 2 Site-Specific Safety and Environmental Conditions

2.1 PERSONNEL SAFETY

The Terminal relies on highly trained PICs to safely transfer petroleum and chemical products. The PICs are required to be properly trained and certified in accordance with United States Coast Guard (USCG) regulations in 33 Code of Federal Regulations 154 Subpart A and 33 Code Federal Regulations 156. The PIC may determine that, even though the threshold values described later in this report are not exceeded, there are other factors that render the pre-booming operation unsafe for personnel, and therefore the PIC may terminate the pre-booming operation. In this situation and any other situation where the PIC determines that pre-booming is not safe and/or effective, the PIC will document the circumstances supporting the decision to not pre-boom and to proceed with Alternative Measures as required in WAC 173-180-221 and WAC 173-180-222.

The safety of personnel is the highest priority when determining whether to pre-boom an oil transfer. The PIC has the ultimate responsibility and authority to determine if it is safe for personnel to deploy boom based on environmental threshold values and other factors. Conditions that may compromise personnel safety include, but are not limited to:

- High winds that affect the docking of the vessel or maintaining its position at the wharf during transfer operations, such as sustained wind speeds greater than 20 knots (23 miles per hour [mph]); even if these winds do not result in large waves.
- Waves, especially high, choppy (i.e., short period) waves that affect the stability and maneuverability of the vessels deploying the boom.
- Icy conditions that make the wharf and/or boom deployment vessel slippery.
- Air temperatures of less than 32 degrees Fahrenheit (°F) increase the risk of cold-related illnesses such as hypothermia or frostbite if an employee were to fall overboard.
- Water temperature of less than 40 °F which increase the risk of cold-related illnesses such as hypothermia or frostbite if an employee were to fall overboard.
- Heavy rain, fog, or other conditions that reduce visibility to unsafe levels for the boom deployment crew.
- Presence of floating or partially submerged debris in or near the deployment area.
- Other conditions as determined and documented by the PIC, or Tesoro's marine contractor responsible for deploying the boom.

If the PIC determines that pre-booming is not safe or effective, the PIC will contact either the Terminals Operations Coordinator on site or their vessel dispatch who will document the circumstances supporting the decision to not pre-boom in Ecology's online transfer notification system <https://secureaccess.wa.gov/>. The PIC will ensure that the alternative measures required in WAC 173-180-221 and 173-180-222 are in place.

2.2 PRIMARY ENVIRONMENTAL CONDITIONS

2.2.1 Sea State

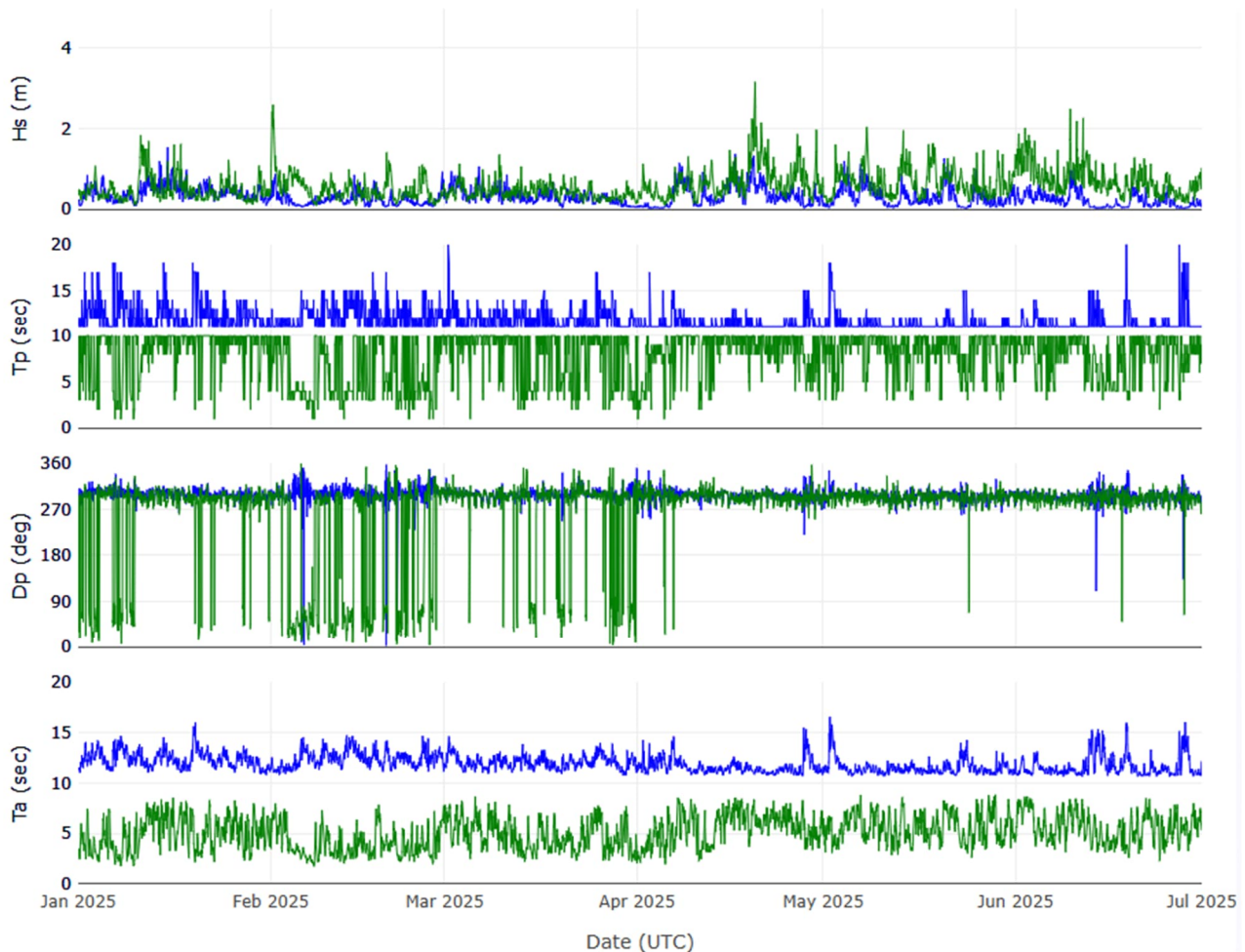
Under almost all wind and wave regimes, inner Port Angeles Harbor, where the Terminal is located, is sheltered from significant wave action. Except from easterly wind directions, the fetch (i.e., straight-line distance in a specified direction over water from the Terminal to land or large structure) is short and waves are not an environmental factor for oil transfer operations. However, the Terminal Manager reports that about 10 to 12 times per year, easterly winds in the range of 20

SECTION 2
 SAFE AND EFFECTIVE THRESHOLD DETERMINATION REPORT FOR THE TESORO
 PORT ANGELES MARINE TERMINAL

to 25 knots (~23 to 29 mph)¹ have occurred resulting in waves and wind chop that affect, but usually do not stop, the oil transfer operations. Although tidal water level changes occur regularly, tidal currents and overall tidal influence within the sheltered Port Angeles Harbor are minimal and unlikely to significantly affect oil transfer operations

In Port Angeles Harbor, wave height and period (i.e., time between wave crests passing a fixed point) do not appear to have been continuously recorded or are not publicly available if they were. SAIC (1999) and Ebbesmeyer et al. (1979) also describe Port Angeles Harbor as being a low wave energy regime, especially in the shallow, southwesterly portions; but they do not provide long-term, continuous records. In March 2020, the Coastal Data Information Program (CDIP) deployed buoy 248 at latitude 48°10'21" N; longitude 123°36'25" W, which is approximately 7 miles northeast of the Terminal. Data are shown in Table 1 below. Although this buoy is in close proximity to the Terminal, it is outside of the Port Angeles Harbor, so it is subject to more significant wave action.

Table 1. Wave Data



¹Wind speed is typically reported in mph by the weather service databases accessed for this report and the Tesoro Marine Terminal weather station wind speed readout is in statute mph. Marine operations typically report wind speed and water current speed in nautical miles per hour (knots). WAC 173-180-224(1)(d)(ii)(D) requires that Safe and Effective Threshold Determination Reports include wind speed in knots. For this report, wind speed is presented in knots with speed in mph provided in parentheses where appropriate. Also, for comparison, a statute mile is 5,280 feet and a nautical mile is 6,076 feet long.

SECTION 2
SAFE AND EFFECTIVE THRESHOLD DETERMINATION REPORT FOR THE TESORO
PORT ANGELES MARINE TERMINAL

Hs – significant wave height
Tp – peak period
Dp – peak direction
Ta – average period

Green – total energy in all bands less than the 10 seconds cut-off period also known as the sea
Blue – total energy in all bands greater than the 10 seconds cut-off period also known as the swell

These 6 months of data show that for about 70 percent of the time, waves come primarily from the west (~290°) and the mean wave height is ~2 feet.

The wave height and period regime can be estimated if continuous and long-term wind speed and direction as well as fetch are known (Shore Protection Manual 1984).

An approach, which was employed here, is to select one or more fetches and a range of representative wind speeds over the fetch(es) to calculate the wave height and period for each pairing. Wave height and period were computed according to Shore Protection Manual (1984) for greatest exposure (i.e., longest "fetch"), which, at azimuth (i.e., True North = 000) 086 degrees, is 13 statute miles and is limited by Dungeness Spit. Wave properties were computed for this situation using steady wind speeds of 10 to 40 knots (~12 to 46 mph) in 5-knot increments and over a few hours duration to estimate wave height that could reach X feet and wave period of about Y seconds.

The results of the calculation are provided in Table 2. The analysis indicates that, at the 20- to 25-knot sustained winds reported as occurring infrequently by the Terminal Manager, wave heights could reach about 3.0 feet with a wave period of about 4 seconds. At 35-knot wind speeds, wave heights could be over 4.0 feet with a period of about 4.5 seconds. It would take about 2.5 to 3 hours of sustained easterly winds to generate these wave heights and periods. Winds from any other direction have a short fetch and waves generated are unlikely to be large enough to affect personnel safety or effectiveness of the boom. As described in Section 2.2.3 later in this report, wind data recorded by the USCG Station at the offshore end of Ediz Hook (Table 4) show that wind averages from about 3.9 to 10.1 knots (4.5 to 11.5 mph) from the southwest. Based on the calculations in Table 2, for a wind speed of 10 knots, wave height would be approximately 1.6 feet, which is consistent with the average wave height of ~2 feet obtained from the CDIP buoy.

Table 2. Fetch-limited sea state (wave height and period). Highest sea state possible for specified fetch and wind speed

WIND SPEED			WAVE PROPERTIES		
Wind Speed	Wind Speed	Wind Stress Factor ¹	Significant Wave Height ²	Significant Wave Period ³	Time for Fully Developed Sea ⁴
Uobs	Uobs	Ua	Hs	Ts	tf
(kts)	(m/sec)	(m/sec)	(ft)	(sec)	(hr)
10	5.14	6.66	1.6	3.2	3.6
15	7.72	9.13	2.2	3.6	3.3
20	10.29	11.42	2.8	3.9	3.0
25	12.86	13.59	3.3	4.1	2.8
30	15.43	15.66	3.8	4.3	2.7
35	18.00	17.65	4.3	4.5	2.6
40	20.58	19.59	4.8	4.6	2.5

¹ Wind stress factor (Ua): Accounts for nonlinear relationship between wind speed and stress on water surface

SECTION 2
SAFE AND EFFECTIVE THRESHOLD DETERMINATION REPORT FOR THE TESORO
PORT ANGELES MARINE TERMINAL

² Significant wave height (Hs): Mean of highest one-third of all waves

³ Significant wave period (Ts): Mean wave period of highest one-third of all waves

⁴ Time for Fully Developed Sea (tf): Time required for waves to reach highest state for specified fetch and wind speed
ft = feet; hr = hour; kts = knots; m/sec = meters per second; sec = seconds; Uobs = observed east-west wind component

2.2.2 Water Currents

Continuous and long-term recorded current data for the surface currents in inner Port Angeles Harbor were not identified despite extensive internet and literature searches, and contacts with USCG, NOAA NWS, Port of Port Angeles, other consulting firms, and cleanup contractors. Currents are not recorded by the Terminal. Based on these efforts, it appears unlikely that long-term, continuous observational data of current velocities for inner Port Angeles Harbor exist. However, CDIP's buoy located outside of Port Angeles Harbor does record current speed and direction. A table of average current speed and direction by month from CDIP is presented in Table 3.

Table 3. Current Speed and Direction

Month (2025)	Average Current Speed (knots)	Average Current Direction (degrees)
January	0.98	195.21
February	0.88	175.55
March	0.93	161.49
April	0.98	184.35
May	0.99	194.76
June	1.09	197.25

While the results associated with previous studies were mixed in regard to current patterns, all seem to indicate that the current velocities within Port Angeles Harbor are typically very low (Ebbesmeyer, et. al. 1979; Evans-Hamilton 1987; Klinger and Ebbesmeyer 2001, Washington Dept. of Health 2002; and Floyd Snider 2002), which is consistent with the near-term data obtained from CDIP. Contemporary NOAA tide and current prediction models report only that the currents within the harbor are "Light and Variable." While describing conditions within the harbor during an oil spill incident, the USCG also reported that the movement of the surface waters within Port Angeles Harbor is dominated by wind activity (USCG 1985) and the currents are light and unpredictable.

The Terminal Manager and MSRC (Marine Spill Response Corporation) response contractor personnel in the area confirm the lack of recorded current velocity measurements (personal communications). They also note that, based on their experience, the current velocity in the vicinity of the Tesoro wharf does not exceed 1 knot and is typically less. They report that the current generally flows westward on the flood tide and eastward during ebb tide.

2.2.3 Weather Conditions

Tesoro has a limited weather station that measures wind speed in mph in real time but does not record the data.

NOAA's National Ocean Service maintains weather station PTAW1 located at latitude 48°7'29" N; longitude 123°26'28" W, which is Terminal 3 in Port Angeles Harbor approximately 1.25 miles southwest from the Tesoro dock. This weather station measures wind speed and direction, which

SECTION 2
SAFE AND EFFECTIVE THRESHOLD DETERMINATION REPORT FOR THE TESORO
PORT ANGELES MARINE TERMINAL

is shown below in Table 4. Historical wind data were downloaded from:
<https://www.ndbc.noaa.gov/histsearch.php?station=ptaw1>.

Based on this data, it appears that wind averages from about 3.9 to 10.1 knots (4.5 to 11.5 mph) from the southwest.

The USCG Station (WMEC 618) is located at the end of Ediz Hook Spit, which forms the northern boundary of Port Angeles Harbor and is approximately 2.27 miles east of the Terminal. The USCG Station records precipitation data, which was downloaded from an online source (the Weather Underground at www.wunderground.com) that automatically archives this information (Table 4).

Monthly average precipitation, primarily rain, is heaviest in mid-fall through spring months, and generally less in late spring through early fall. The monthly total rainfall rarely exceeds 5 inches, but wet months are generally in the range of 2 to 4 inches of precipitation. Rainfall is seldom heavy enough to, by itself, pose a safety hazard to the personnel involved in pre-booming.

Table 4. Monthly precipitation and [wind averages](#) (2021-2024).

Year	Month	Precipitation Average (inches per day)	Precipitation Total (inches per month)	Wind Direction Average (Degrees True)	Wind Speed Average (knots)
2021	1	0.18	5.54	192	4.5
	2	0.07	2.02	203	6.1
	3	0.05	1.42	207	5.4
	4	0.03	0.85	220	5.4
	5	0.01	0.38	257	7.0
	6	0.01	0.35	241	6.6
	7	T	T	302	10.1
	8	0.01	0.31	268	7.4
	9	0.08	2.32	224	4.4
	10	0.12	3.73	204	4.4
	11	0.28	8.41	205	4.6
	12	0.17	5.30	183	5.2
2022	1	0.12	3.57	189	4.5
	2	0.09	2.56	192	4.7
	3	0.03	0.96	202	4.4
	4	0.10	3.07	215	5.2
	5	0.03	0.97	261	7.4
	6	0.03	0.98	281	4.6
	7	0.01	0.20	268	7.5
	8	T	T	254	6.6
	9	0.00	0.01	228	5.4
	10	0.11	3.33	204	4.0
	11	0.12	3.48	191	5.2
	12	0.11	3.30	177	4.9
2023	1	0.04	1.34	196	4.3
	2	0.06	1.81	197	5.8
	3	0.04	1.20	201	5.2
	4	0.04	1.33	220	5.4

SECTION 2
 SAFE AND EFFECTIVE THRESHOLD DETERMINATION REPORT FOR THE TESORO
 PORT ANGELES MARINE TERMINAL

Year	Month	Precipitation Average (inches per day)	Precipitation Total (inches per month)	Wind Direction Average (Degrees True)	Wind Speed Average (knots)
	5	0.02	0.65	258	7.5
	6	0.01	0.26	259	8.2
	7	0.02	0.61	279	8.6
	8	0.01	0.27	250	6.4
	9	0.02	0.45	223	4.7
	10	0.06	1.97	194	4.0
	11	0.08	2.41	195	4.8
	12	0.12	3.81	199	4.3
2024	1	0.11	3.44	204	4.6
	2	0.08	2.45	185	4.3
	3	0.03	1.05	195	4.5
	4	0.02	0.51	222	5.8
	5	0.03	0.92	256	7.7
	6	0.02	0.64	257	7.1
	7	0.00	0.10	269	7.9
	8	UNV	UNV	245	5.7
	9	0.04	1.05	222	4.3
	10	0.11	3.28	195	3.9
	11	0.14	4.16	201	4.8
	12	0.12	3.78	197	4.3

T- Indicates only a trace of precipitation has fallen
 UNV – indicates the meter was down and data is unavailable
 Precipitation data is for the Port Angeles US Coast Guard Station
 Wind data is from Terminal 3 in Port Angeles.

SECTION 3 Safe and Effective Threshold Values

3.1 PRIORITY OF SAFE AND EFFECTIVE THRESHOLD VALUES

Safety of the personnel assigned to the pre-booming of barges or ships prior to oil transfer operations is the first and highest priority for the Tesoro PIC. This priority, whatever the reason, will supersede all environmental threshold values (though it may be influenced by one or more of these environmental conditions).

Once the safety of the personnel is assured to the PIC's satisfaction, the PIC will then evaluate the environmental factors that affect the efficacy of oil-retention by the deployed boom. If these conditions, primarily surface water currents or sea state (e.g., wave height and period), exceed the threshold values provided here as guidance, the PIC will make and document the decision to pre-boom or not.

The PIC will, during transfer operations, re-evaluate the environmental and weather conditions for changes that may affect their original safe and effective determination analysis. If such changes occur, the PIC should immediately employ changes in transfer operations (this may include entirely suspending transfer operations).

3.2 DATA COLLECTION

The Terminal relies on external reporting agencies for severe weather notifications, including StormGeo, the National Oceanic and Atmospheric Administration (NOAA), and the National Weather Service (NWS). The facility is equipped with an on-site weather station that monitors and records ambient temperature, relative humidity, barometric pressure, precipitation, wind direction, sustained wind speed, and wind gusts. Weather stations are installed at the Terminal in both office and dock areas. The stations are Davis Instruments Vantage VUE units (Model No. 6351), integrated with the Vantage VUE Sensor Suite.

3.3 PERSONNEL SAFETY

The primary environmental conditions that generally influence personnel safety at the Terminal during oil transfer operations are high winds and sea state. Low visibility or ice formation is rare but may cause possible limitations.

3.3.1 High Winds

High winds may be detrimental to the pre-booming and other oil transfer operations at the wharf. For the safety of wharf personnel and the marine contractor deploying the boom, the Port Angeles wharf PIC will consider a Small Craft Advisory (SCA) issued by the NWS for the area of operation as an initial guide for personnel safety in the PIC's determination to authorize the launch or use of company-owned and operated oil spill response equipment for pre-boom deployment. These SCA conditions may either be present or forecasted. By definition, the NWS SCA conditions reference sustained winds of over 18 knots (~21 mph) and under 33 knots (~38 mph) that may pose a hazard for small vessel operators. The SCA is also prominently

SECTION 3
SAFE AND EFFECTIVE THRESHOLD DETERMINATION REPORT FOR THE TESORO
PORT ANGELES MARINE TERMINAL

displayed at the USCG Station at the seaward end of Ediz Hook, the spit that protects Port Angeles Harbor. Tesoro recognizes that certain conditions or combinations thereof may occur that could allow the PIC to proceed with pre-booming. This may occur only after conditions are documented and agreed to between Tesoro PIC and the marine contractor.

The following wind guidelines will be applied to all vessels at the Terminal wharf. The wind speeds included in the guidelines are sustained wind speeds as opposed to winds gusting up to these speeds. Sustained winds are determined when the speed is constant for more than 5 minutes. Table 5 provides guidance as to the appropriate action to consider when wind speeds are high and sustained.

Table 5. Advisory Oil Transfer Operation Actions Related to Wind Speed

Wind Speed (mph)	Wind Speed (knots)	Actions
0-35	0-30	Monitor vessel tie-up lines and hose connections as normal.
35-40	30-35	Shut down oil transfer operations and drain hoses.
Over 40	Over 35	Disconnect and stow hoses, if safe to do so.
Over 45	Over 39	Request vessel to prepare and sail if the vessel or wharf is in jeopardy of sustaining damage. If safe to do so, sail the vessel.

Sea state (e.g., wave height and period) in Port Angeles Harbor are almost entirely a function of wind speed and direction, with easterly winds resulting in the highest sea state. The vessel used to deploy the boom in the pre-booming operation is to be determined but is likely to be a stable platform in most wave conditions expected at the wharf. In the unusual case when wave heights exceed about 2.0 to 2.5 feet in a "choppy" sea (i.e., short-period wind chop on top of the large, long-period swells), the PIC may consider it unsafe for personnel to deploy the boom, regardless of the potential efficacy of the boom to retain oil.

3.3.2 Precipitation

Low visibility resulting from fog, heavy precipitation, or snow at the wharf and/or boom deployment vessel may jeopardize the safety of personnel involved in transfer operations. Close consultation between the Tesoro PIC and Vessel PIC will be undertaken to determine if conditions are unsafe for personnel to pre-boom the vessel.

Freezing conditions that result in ice build-up on the wharf and/or boom deployment vessel may jeopardize the safety of personnel involved in pre-booming operations. Close consultation between the Tesoro PIC and Vessel PIC will be undertaken to determine if conditions are unsafe for personnel to pre-boom the vessel.

3.3.3 Dockside Booming Operations

The Terminal has retained a booming contractor to conduct dockside booming operations, which is essential to maintaining preparedness and response capabilities during transfer activities. Booming is performed using a specially configured dual outboard motor vessel operated by a two-person crew, (One Coxswain, One Deckhand). This two-person crew enables

SECTION 3
SAFE AND EFFECTIVE THRESHOLD DETERMINATION REPORT FOR THE TESORO
PORT ANGELES MARINE TERMINAL

efficient deployment and control of the boom during each operation.

A fence boom is used for transfer operations, wet stored along the east end of the dock for immediate deployment. Prior to each operation, the booming contractor reviews current weather conditions to confirm it is safe to proceed. Upon completion, the boom is retrieved in accordance with established safety and operational protocols.

3.4 PRIMARY ENVIRONMENTAL CONDITIONS

3.4.1 Sea State

Sea state will rarely be a factor limiting pre-booming during oil transfer operations at the Terminal, based on the long-term experience and observations of the Terminal Manager, wharf operations personnel, and marine contractors supporting Tesoro in oil transfer operations.

However, they do indicate that wave action may be a factor on those occasions when sustained easterly winds exceed about 10 to 15 knots (~11 to 17 mph) and may cause waves from 1.5 to 2.0 feet high. Under these conditions, sea state will begin to exceed the capabilities of the boom to retain oil. At sustained easterly wind speeds greater than about 20 to 25 knots (~23 to 29 mph) wave height may exceed 3.0 feet, which will render the oil boom almost completely ineffective in retaining oil. Therefore, wave heights greater than 2.0 to 2.5 feet will be the effective threshold value for waves at the Terminal.

3.4.2 Water Currents

Based on years of experience at the Terminal, Tesoro does not expect surface current speed to exceed 1.0 knot. Tesoro does not anticipate that current speed will be a deterrent to pre-booming at the Terminal. Therefore, the effective threshold value for current speed will be 1.0 knot at the Terminal.

3.4.3 Weather Conditions

As noted in Section 3.2, if SCA conditions, i.e., sustained winds of over 18 knots (~21 mph) and under 33 knots (~38 mph), that may pose a hazard for small vessel operators are posted or measured at the Terminal, the PIC will evaluate potential for impacts to personnel safety and to effectiveness of boom deployment. The PIC may make a real time determination that, because of the wind direction and shelter at the dock, it is safe to pre-boom the vessel and continue with oil transfer operations.

Also, as noted in Section 3.2, wind speed >30 knots (~35 mph) for longer than 5 minutes will exceed the personnel safe operating limit and booming as well as oil transfer operations will be terminated. Therefore, sustained wind speed greater than 30 knots (~35 mph) will be the effective threshold value for wind at the Terminal.

3.5 OTHER CONDITIONS THAT INFLUENCE OIL TRANSFER OPERATIONS

Low visibility due to heavy rainfall, fog, or snowfall may occur at the Terminal wharf. No data to document frequency or duration were found, although the Terminal Manager indicates that low visibility conditions can occur and may impact the safe conditions for pre-booming.

Freezing conditions from some combination of high winds, cold weather, and rain/sleet/snowfall may cause ice build-up on the wharf and/or vessel used for deploying boom (as well as on the

SECTION 3
SAFE AND EFFECTIVE THRESHOLD DETERMINATION REPORT FOR THE TESORO
PORT ANGELES MARINE TERMINAL

vessel being loaded or unloaded). This could result in unsafe operating conditions for the personnel.

The presence of floating or partially submerged debris in or near the deployment area may also pose a hazard to safe boom deployment and retrieval operations.

Other commercial vessel traffic in the immediate vicinity of the wharf during an oil transfer operation will typically not restrict the ability of the Tesoro marine contractor to deploy boom around the vessel.

Recreational activities are very limited in the vicinity of the Terminal wharf and should not present a limitation on oil transfer operations.

3.6 EFFICACY OF OIL BOOM UNDER RANGE OF ENVIRONMENTAL CONDITIONS

The Terminal will deploy up to 1,400 feet of fence boom. This fence boom is 11 inches of freeboard and 7 inches of skirt.

The 18-inch fence boom is a standard type of boom best suited for use in semi-protected environments such as Port Angeles Harbor where light to moderate currents and winds are the normal condition. Ideal performance conditions for 18-inch fence boom are:

- Surface current speeds <1.0 knot
- Wave heights <1.5 to 2.0 feet
- Wind speeds <20 knots (~23 mph)

As currents pushing against the boom increase beyond ideal operating conditions, the boom becomes subject to hydraulic failure, commonly referred to as entrainment, and the oil product may begin to slip under the boom skirt. Entrainment is common to all types of boom regardless of size or design. Entrainment does not indicate a complete failure of the boom but does impact the efficacy of the boom.

It is difficult to establish exact limits of current speed to boom efficacy. A generally accepted rule among the response industry is that current speeds >0.8 to 1.0 knot will begin to result in product loss and current speed >1.5 knots will result in significant or complete product loss (Mark Ploen, Quali-tech, personal communication).

Modifying the boom configuration under different current regimes can have a dramatic impact on efficacy, and in many cases, can improve the capability to control product into a collection point. However, for oil transfer pre-booming where the boom needs to surround a vessel, the opportunity to develop alternative configuration is limited.

There will be performance degradation at currents >1.0 to 1.5 knots. At this current, product loss begins. At currents >1.5 knots, near total loss of product occurs. Waves > 1.5- to 2-feet high will result in splash over of water or product, causing the boom effectiveness to be reduced by 10 to 20 percent. Waves > 2 feet in height will dramatically decrease the effectiveness of the boom through wash over and waves >2.5 feet will render the boom essentially useless for retaining oil, even if the water current speeds are essentially zero.

At winds >30 knots (35 mph), operations must stop for safety. These conditions make it unsafe for personnel.

SECTION 3
SAFE AND EFFECTIVE THRESHOLD DETERMINATION REPORT FOR THE TESORO
PORT ANGELES MARINE TERMINAL

SECTION 4 References

- Ebbesmeyer, C., J. Cox, J. Helseth, L. Hinchey, and D. Thomson. 1979. Dynamics of Port Angeles Harbor and Approaches, Washington. Prepared by Evans-Hamilton Inc. for U.S. Environmental Protection Agency, Washington, D.C., EPA6007-79-252 (NTIS PB80140791).
- Evans-Hamilton, Inc., and D.R. Systems, Inc. 1987. Puget Sound Environmental Atlas. Prepared for the U.S. Environmental Protection Agency, the Puget Sound Water Quality Authority, and the U.S. Army Corp of Engineers.
- Floyd Snider and Evans-Hamilton, Inc. 2002. Port Angeles Delisting Request. Prepared for the Washington Dept. of Ecology, Water Quality Group and the Port Angeles Users Group.
- Klinger, T., and C. Ebbesmeyer. 2001. Using Oceanographic Linkages to Guide Marine Protected Area Network Design. Puget Sound Research.
- Not Listed. 1984. Shore Protection Manual (2 vol.), Coastal Engineering Research Center, Vicksburg, MS 39180
- SAIC. 1999. Port Angeles Harbor Wood Waste Study, Port Angeles, Washington. Final Report prepared for Washington Department of Ecology.
- United States Coast Guard (USCG). 1985. Incident Report: TN ARGO Anchorage.
- Washington State Department of Health. 2002. Health Consultation, Exposure Investigation Work plan: Lower Elwha Klallam Tribe Shellfish Beds near Port Angeles Harbor, Port Angeles, Clallam County, Washington. www.atsdr.cdc.gov/hac/pha/lowerelwha