



Lingering Oiled Beaches, Exxon Valdez Oil Spill

Abstract

The *Exxon Valdez* oil spill (EVOS) occurred on March 24, 1989 in Prince William Sound (PWS). An estimated 11 million gallons of oil were spilled in PWS, yet only an estimated 10% of the total oil spill was recovered during immediate cleanup efforts. Since then, hundreds of scientific investigations have studied the long-term fate, transport, and effects of the EVOS on the ecological communities of PWS. More than 30 years of research has provided a great deal of information on the persistence of oil and the responses of different species to both acute (short-term) and chronic (long-term) effects of exposure to oil, as well as the role the ecosystem plays in the recovery of affected species. Despite the action of natural processes and cleanup efforts, a portion of the initial EVOS oil persists in the aquatic environment as sequestered subsurface oil and surface oil patches. This sequestered oil is termed lingering oil and is not considered bioavailable unless disturbed.

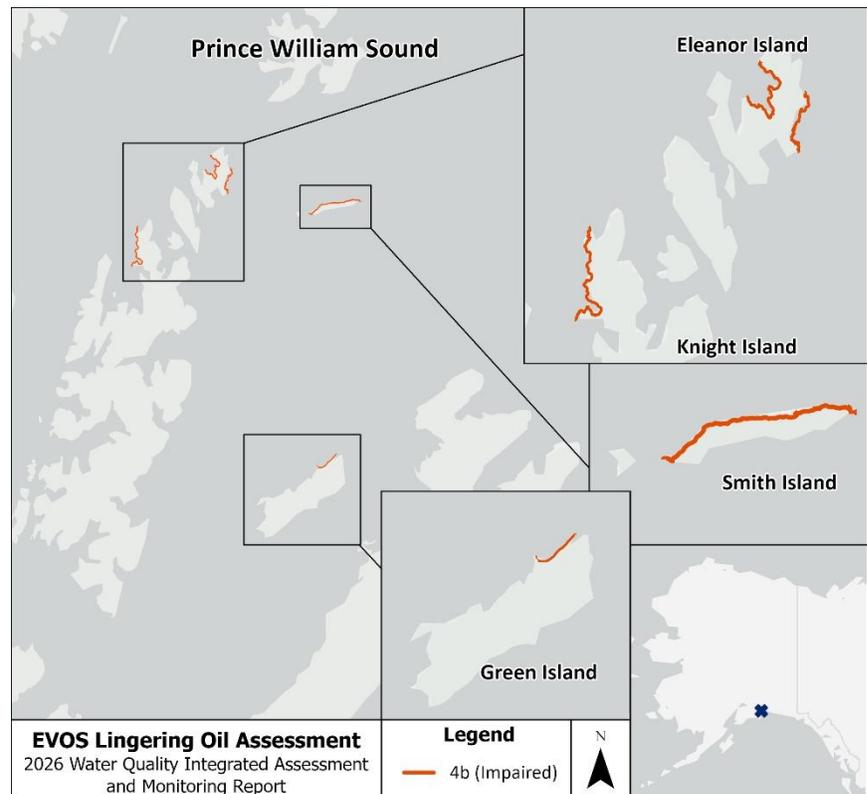


Figure 1. 2026 EVOS lingering oil assessment map

Several nearshore beach areas remain on the Alaska Department of Environmental Conservation (DEC) impaired waters list. DEC recently developed a tiered, science-based process to assess whether lingering oil impairs a beach assessment unit's¹ (AU) designated use(s). Based on this more robust approach, DEC recommends delisting 11 previously listed AUs², leaving five AUs as impaired, and adding no new impaired AUs.³ EVOS

¹ An assessment unit is the segment of a waterbody from which data is analyzed to determine if water quality standards are being met.

² In the 2026 Integrated Report, DEC adjusted the assessment unit segment lengths to be based on shoreline HUC-14 scale watersheds. Throughout this document DEC uses the new assessment units when describing attainments or impairments. Appendix A provides a crosswalk of the previous and revised assessment units.

³ This 4b demonstration is based on the 1989 *Exxon Valdez* oil spill and subsequent research including the new process for determining areas likely impacted by lingering oil developed by DEC in 2025.

scientific literature from the past decade indicates minimal change in the amount and distribution of lingering oil in PWS. The change in impaired areas reflects DEC’s more robust decision approach and modified AUs that more accurately reflect geomorphic conditions. Because there are various recovery plans in place, DEC recommends placing EVOS beaches with lingering oil in Category 4b, Impaired with a Recovery Plan for Petroleum hydrocarbons, Oils and Grease.

Table 1. Current assessment unit status and applicable water quality standard (WQS)

Parameter	Lingering oil
Category Change	See Table 2
Water Quality Standard	Petroleum hydrocarbons, oils and grease, for marine water uses ⁴
Designated Uses Affected	All

Table 2. EVOS assessment units (AU) with Integrated Report category information⁵.

Assessment Unit Name	Assessment Unit ID	Number Previous AUs in New AU	PWS Island	Data Type Used for Decision	Current Category	2026 IR Proposed Category
Smith Island North	AK_B_3020207_000	3	Smith Island	Test pit	4b	4b
Herring Bay	AK_B_3020603_004	3	Knight Island	Test pit	4b	4b
Point Eleanor	AK_B_3020302_002	3	Eleanor Island	Modeled data	4b	4b
Northwest Bay	AK_B_3020301_000	5	Eleanor Island	Test pit	4b	4b
Gibbon Anchorage-Frontal Prince William Sound	AK_B_3040303_002	2	Green Island	Test pit	4b	4b
Smith Island South	AK_B_3020207_001	1	Smith Island	Modeled data	4b	2
South Arm Bay of Isles	AK_B_3020403_000	2	Knight Island	Modeled data	4b	2
Herring Bay	AK_B_3020603_006	1	Knight Island	Modeled data	4b	2
Herring Bay	AK_B_3020603_005	1	Knight Island	Modeled data	4b	2
Herring Bay	AK_B_3020603_003	1	Knight Island	Modeled data	4b	2
Sleepy Bay-Frontal Montague Strait	AK_B_3030605_000	4	Latouche Island	Modeled data	4b	2

⁴ Alaska Department of Environmental Conservation. 2025. *18 AAC 70.010 Water Quality Standards*. Amended as of January 8, 2025.

⁵ See Appendix A for a complete crosswalk of the 2014/16 Integrated Report impaired AUs to the revised 2026 assessment units.

Point Eleanor North	AK_B_3020302_000	2	Eleanor Island	Modeled data	4b	2
Lower Passage-Frontal Prince William Sound	AK_B_3020305_008	3	Knight Island	Modeled data	4b	2
Lower Passage-Frontal Prince William Sound	AK_B_3020305_007	2	Disk Island	Modeled data	4b	2
Lower Passage-Frontal Prince William Sound	AK_B_3020305_003	2	Ingot Island	Modeled data	4b	2
Evans Point-Frontal Knight Island Passage	AK_B_3030505_000	1	Evans Island	Modeled data	4b	2

Identification of Impaired Segment and Statement of Problem Causing the Impairment

On March 24, 1989 the T/V *Exxon Valdez* ran aground and discharged approximately 11 million gallons of crude oil into PWS. Immediate cleanup activities included the use of mechanical recovery, dispersants, and in-situ burning in an attempt to mitigate the effect of spilled product. Activities specific to the initial remediation of oiled shoreline between 1989 and 1992 consisted of sediment removal, tilling, and bioremediation.

The persistence of lingering oil is associated with finer grain sand and gravel sediments and is in areas of heavy initial oiling that are sheltered from natural disturbance patterns (wave energy, groundwater flow). Studies have documented that lingering oil occurs in discontinuous patches in the subsurface. Field surveys and mathematical modeling in a 2018 study⁶ suggests that about 0.6% of oil from the EVOS remains sequestered below 10 to 20 centimeters of clean sediment in intertidal areas and shorelines.

Lingering oil is defined as: *“an oil residue deposited in shoreline sediment from an anthropogenic [from human activity] release that is generally not bioavailable [sequestered, under clean gravel] unless disturbed.”*

Lingering oil acts differently than other oils in three specific ways.

1. It has been in the environment a long time and is not part of an active spill.
2. It is typically buried several inches under the sediment.
3. Unless it’s disturbed, it generally doesn’t interact with humans, fish, birds, or other animals.

As of 2014, the EVOS Trustee Council (EVOSTC) has declared many species fully recovered, including glaucous-winged gulls, bald eagles, river and sea otters, and harlequin ducks, while other species including Pacific herring, pigeon guillemots, marbled murrelets, and orca whales have not. The mechanisms leading to both the injury and recovery timelines of populations vary greatly between the different species.

As of 2014/16 Integrated Report, 36 impaired beach AUs remained in Category 4b. Since then, additional scientific studies and lingering oil modeling efforts led DEC to develop a standardized and systematic process for

⁶ Aderhold, D.G.R., Lindeberg M.R., Holderied K., Pegau W.S. 2018. “Spatial and Temporal Ecological Variability in the Northern Gulf of Alaska: What Have We Learned Since the *Exxon Valdez* Oil Spill?” *Deep Sea Research Part II: Topical Studies in Oceanography*. 147:3–8. doi:10.1016/j.dsr2.2017.11.015.

determining areas impaired by lingering oil (see Appendix C). This Category 4b demonstration updates the list of impaired beach areas and realigns the segments using Alaska’s new assessment units (Table 2 and Appendix B).

The new assessment units were drawn by segmenting the shoreline using HUC-14 scale watersheds as boundaries. Where oiling was present based on past evidence (current impaired waters, predictive model data, test pit data, or initial oil trajectory), assessment units were further delineated using a headland-to-headland approach and taking into consideration shore types⁷ and aspect. Using the new assessment units, there are five impaired AUs covering 25,600 meters, or 15.91 miles⁸.

Description of Pollution Controls and How They Will Achieve Water Quality Standards

In the decades since the *Exxon Valdez* ran aground in PWS, there have been hundreds of studies conducted in PWS, making it one of the most studied oil spills in the United States. In November 1994, EVOSTC adopted an official Restoration Plan. This plan identified injured resources and services as a result of the spill. Since its adoption, EVOSTC has updated the list of injured resources and services six times, the most recent being 2014. Since 2015, EVOSTC has focused on understanding where lingering oil occurs, if the oil is bioavailable, and the role that changes to the ecosystem have on the ability of species injured by EVOS to recover. Studies also include long-term monitoring of marine conditions and injured resources, harbor protection and marine restoration, and habitat acquisition and protection.

In 2023 DEC completed a literature review of lingering oil studies conducted since 2015⁹. Key findings include:

- Surveys conducted in PWS during the summer of 2015 indicate there is little evidence of change in subsurface oil area or mass over the last 14 years, and no change in the distribution of oiling intensities¹⁰.
- The estimated area and mass of subsurface oil, weathering, oiling intensities, and oil locations have not changed since the surveys conducted in 2001.
- Subsurface oils have higher concentrations of phenanthrenes and chrysenes, which indicates that the subsurface oil has the potential to be toxic, but the lack of weathering suggests that the oil is sequestered in the subsurface.
- Mathematical modeling suggests that lingering subsurface oil is typically sequestered below 10-20 centimeters (cm) of clean sediment.
- This sequestered oil is not bioavailable unless disturbed and is predicted to persist in the environment for at least another decade, likely more.

⁷ Shore types were downloaded from the NOAA Response and Restoration website at https://response.restoration.noaa.gov/esi_download#Alaska, and classifications were rated as 1-5 based on their oil capturing capabilities (sand and gravel = high oil capture, rocky outcrops = low oil capture).

⁸ The 2014/16 Integrated Report included 36 impaired areas covering 10,071 meters or 6.26 miles.

⁹ Alaska Department of Environmental Conservation. 2023. “Final Long-term Effects and Location of Lingering Oil from the Exxon Valdez Oil Spill in Prince William Sound, Literature Review”.

¹⁰ The change in impaired areas in the 2026 Integrated Report reflects DEC’s more robust decision approach and modified AUs that more accurately reflect geomorphic conditions in PWS.

Water Quality Target

Table 3. Summary of designated uses and narrative Water Quality Standards

Designated Use	Reference	Summarized Narrative Criteria
(A) Water supply - drinking water, culinary, food processing - agriculture - aquaculture - seafood processing - industrial	Petroleum Hydrocarbons, Oils and Grease 18 AAC 70.020(5) & (20)	Surface waters, adjoining shorelines, and waterbody floor must be virtually free from floating oil, film, sheen, or discoloration.
(B) Water recreation - contact recreation - secondary recreation	Toxic and Other Deleterious Organic and Inorganic Substances 18 AAC 70.020(11) & (23)	There can be no concentrations of petroleum hydrocarbons, animal fats, or vegetable oils in shoreline or bottom sediments that cause deleterious effects to aquatic life. ¹¹
(C) Growth and propagation of fish, shellfish, other aquatic life, and wildlife	Residues 18 AAC 70.020(8) & (20)	May not exceed concentrations that individually or in combination impart undesirable odor or taste to organisms as determined by bioassay or organoleptic tests.
(D) Harvesting for consumption of raw mollusks or other raw aquatic life	Color 18 AAC 70.020(1) & (13)	
	Sediment 18 AAC 70.020(9) & (21)	

See 18 AAC 70 for complete narrative criteria.

Appendix C describes the decision process and types of data DEC used to identify lingering oil impaired nearshore assessment units. It specifies the preferred data type, quantity, quality and age; and provides criteria used to determine whether the AU is impaired or meeting WQS.

In summary, four data types are preferred, listed in order of preference (Table 4). Generally, at least 10 high-quality data points are needed per AU being assessed. For example, Tier 1 will first be explored and if test pit data does not exist or does not meet the minimum data requirements, Tier 2 would be explored. Exceptions to the minimum data requirements are allowed under the Overwhelming Evidence tier (Tier 5).

This approach prioritizes direct measurements (Tiers 1 and 2) while still allowing consideration of important indirect measurements (Tiers 3 and 4). If multiple types of screening level data fall short of one or more of the data requirements described in Appendix C, they can be assessed together using the Tier 5 overwhelming evidence approach.

¹¹ Although 18 AAC 70 contains numeric water quality standards for hydrocarbons, fats, or oils, when assessing lingering oil impairment, chemical concentrations alone might not provide sufficient data for the impairment decisions due to lingering oil's sequestered state within the shoreline sediments.

Table 4. Tiered data types for evaluating lingering oil.

Tier	Data Type
1	Test Pit Data dug to see how much oil has penetrated deeper sediment. Depth and amount of oiling are used to compare to water quality standards.
2	Sediment Chemistry Data analyzed for polycyclic aromatic hydrocarbon concentrations. Results are compared to safe thresholds for humans and aquatic organisms.
3	Biological Data evaluates impacts to wildlife by looking at tissue chemistry data, whether sediment is toxic to organisms, whether populations of organisms are low, or if an organism’s diet uptakes pollutants. At least one of two lines of evidence must show a negative difference compared to an unimpacted reference.
4	Modeled Data that predicts locations and probability of oil. The probability of oiling is used to compare to water quality standards.
5	Overwhelming Evidence allows for multiple lines of evidence when only partial or inconclusive data is available for other tiers but as a whole, they may indicate if it meets water quality standards.

Controls That Will Achieve WQS

Oil is removed through either physical factors or microbial degradation, and the lack of change in vertical distribution suggests beach armoring and other geomorphic features are sequestering oil by reducing the effects of wave action. Microbial degradation, on the other hand, is limited by the low dissolved oxygen levels found within subsurface layers of oiled beaches in PWS. Low exposure to waves, beach armoring, and protective geomorphic features all play a large role in the sequestration of the oil, which contributes to its persistence but also its lack of bioavailability unless disturbed.

Several EVOS studies have identified potential site locations and different remediation techniques that might be possible. However, EVOS-related oil removal or remediation activities have not occurred for several years and are not likely to occur in the near future due to cost and potential for causing additional environmental harm.

After EVOS, safety measures have been instituted to reduce the risk of future spills such as use of double hulled tanker ships, two escort vessels accompany each tanker while passing through PWS, and improved spill prevention and response measures.

Even with improved safety and operational measures, the most likely recovery process for lingering oiled beaches is through monitored natural attenuation over time. Despite the potential for chronic toxicity from remaining oil, results from passive samplers measuring polycyclic aromatic hydrocarbons in a 2018 study¹² indicate low exposure to oil at the sediment surface, and the oil within the sediment is isolated from the environment. DEC is committed to evaluating new data as it becomes available and recommending further recovery activities if warranted.

Description of Requirements under which Pollution Controls Will Be Implemented

EVOSTC was formed to oversee restoration of the injured ecosystem using the civil settlement funds. EVOSTC consists of three state and three federal trustees and is advised by members of the public and scientific

¹² Lindeberg M.R., Carls M., Maselko J. 2018 “Lingering Oil: Extending the Tracking of Oil Levels and Weathering (PAH Composition) in Prince William Sound through Time. Exxon Valdez Oil Spill Trustee Council Project 16120114-S.

community. The DEC commissioner is a member of EVOSTC. As a member of EVOSTC DEC is committed to overseeing the restoration of injured resources through engagement with the public and scientific community.

Public Advisory Committee (PAC)

EVOSTC PAC is a Federal Advisory Committee Act (FACA) committee formed pursuant to FACA and advises the Trustee Council on decisions relating to allocation of funds and the restoration and monitoring activities related to the oil spill. The composition of the PAC is intended to reflect balanced representation from the public at large as well as members from selected principal interests. Starting in 2024, PAC members serve a four-year period effective the date of appointment by the Secretary of the Interior.

Science Panel

Members of the Science Panel advise EVOSTC on the effectiveness of specific restoration efforts. The Science Panel also participates in peer review of research proposals.

Projection of Time When WQS Will Be Met

DEC will continue to evaluate PWS lingering oil studies and restoration efforts. The timeframe for full recovery is expected to be decades unless areas with sequestered lingering oil become disturbed.

Schedule for Implementing Pollution Controls

There is no on-going point or nonpoint source loading to the impaired beaches or adjacent water as a result of the *Exxon Valdez* oil spill; hence there is no need for “pollution controls.” Rather, DEC is continuing to evaluate data on the extent of the impairment, the hindrances to recovery, and will establish and implement (most likely through the work of partnering agencies and EVOSTC) any appropriate methods to enhance the recovery timeframe and spill reduction.

Monitoring Plan to Track Effectiveness of Pollution Controls

The 1994 Restoration Plan (Plan) recognized that recovery from the spill would likely take decades. A Restoration Reserve¹³ was created in part to provide for long-term observation of injured resources and services and for appropriate restoration actions into the future. To further this effort, in 1999 EVOSTC also supported development of a long-term research and monitoring program. Long-term monitoring after a spill has two components: monitoring the recovery of resources from the initial injury and monitoring how factors other than oil may inhibit full recovery or adversely impact recovered resources.

Ongoing monitoring of lingering oil continues under the EVOSTC Long-Term Monitoring Program (Gulf Watch Alaska). The program goal is to provide data on the quantity of oil remaining and to assess the weathering state through time. Because of the slow degradation rate, oil sampling is scheduled once every five to ten years.

Commitment to Revise Pollution Controls, as Necessary

DEC and EVOSTC are committed to the long-term health and sustainability of the PWS region. DEC will review submitted data and assessments and will determine whether remediation activities are effective in achieving WQS. If future data collection efforts show that actions taken to-date are insufficient to attain and maintain

¹³ EVOS Restoration Reserve is part of EVOSTC efforts to restore PWS and the Gulf of Alaska to their pre-spill state. EVOSTC has developed a habitat protection program that includes purchasing lands or establishing conservation easements to protect habitat important to injured species.

WQS, DEC will work with EVOSTC and partner agencies to identify additional needed measures and recovery actions.

As long-term monitoring, biologic, and chemical degradation data associated with the remaining lingering oil becomes available, DEC will update the public through future Integrated Reports.

Appendix A. Assessment Unit Crosswalk

New AU identifiers compared to AU numbers used in Alaska’s 2014/16 Integrated Report.

New Assessment Unit ID	2014/16 Integrated Report DEC AU Number	Prince William Sound Island
AK_B_3020305_007	AK-20202-849	Disk Island
	AK-20202-850	
AK_B_3020302_002	AK-20202-810	Eleanor Island
	AK-20202-827	
	AK-20202-828	
AK_B_3020302_000	AK-20202-829	Eleanor Island
	AK-20202-830	
AK_B_3020301_000	AK-20202-831	Eleanor Island
	AK-20202-832	
	AK-20202-833	
	AK-20202-834	
	AK-20202-835	
AK_B_3030505_000	AK-20202-820	Evans Island
AK_B_3040303_002	AK-20202-847	Green Island
	AK-20202-848	
AK_B_3020305_003	AK-20202-851	Ingot Island
	AK-20202-852	
AK_B_3020403_000	AK-20202-845	Knight Island Bay of Isles
	AK-20202-846	
AK_B_3020603_006	AK-20202-836	Knight Island Herring Bay
AK_B_3020603_003	AK-20202-837	Knight Island Herring Bay
AK_B_3020603_005	AK-20202-838	Knight Island Herring Bay
AK_B_3020603_004	AK-20202-839	Knight Island Herring Bay
	AK-20202-840	
	AK-20202-841	
AK_B_3020305_008	AK-20202-842	Knight Island Herring Bay
	AK-20202-843	
	AK-20202-844	
AK_B_3030605_000	AK-20202-803	Latouche Island
	AK-20202-806	
	AK-20202-807	
	AK-20202-823	
AK_B_3020207_001	AK-20202-824	Smith Island
AK_B_3020207_000	AK-20202-822	Smith Island
	AK-20202-825	
	AK-20202-826	

Appendix B. Map of Assessment Units

