

Comparison of Loading Estimates to Puget Sound for Oil and Petroleum Products by Ecology and the National Research Council

An Addendum to the Phase 1 and Phase 2 Toxics Loading Reports

A reviewer (Loehr, 2008) recently found an apparent discrepancy between the estimates of the total loadings of petroleum hydrocarbons from surface runoff to Puget Sound prepared by the Department of Ecology (Ecology) and a similar estimate for all of North America prepared by the National Research Council (NRC). Ecology's estimates were presented in its Phase 1 toxics loading report (Hart Crowser, Inc., *et al.*, 2007) and in one of its Phase 2 toxics loading reports (EnviroVision Corporation, *et al.*, 2008). The NRC's estimate was presented in *Oil in the Sea III* (National Research Council, 2003). The discrepancy was "that the Puget Sound calculation equals about 45% of the total of all North American Marine waters from the NRC study," but of course the discharge from Puget Sound can be only a small part of the discharge from all of North America.

Ecology has reviewed the NRC's estimation procedure and compared it with Ecology's estimation procedure. We have found consistency among the calculated loading values prepared by Ecology and the NRC. However, a discrepancy in nomenclature was the cause for the confusion at issue.

At the beginning of the Phase 1 toxics loading project, Ecology's project team identified "oil or petroleum product" as one of the toxic chemicals of concern, and described this parameter as "crude oil, specific refined product (*e.g.*, diesel, gasoline, heavy fuel oil), or analytical result as TPH-D or TRPH." Later, the project team identified three references from which they retrieved "oil or petroleum product" concentration data for use in calculating loadings. These were:

- California Environmental Protection Agency (California EPA). "Characterization of Used Oil in Stormwater Runoff in California," Office of Environmental Health Hazard Assessment, September 2006.
- Maestra, A. and R. Pitt. "The National Stormwater Quality Database, Version 1.1 – A Compilation and Analysis of NPDES Stormwater Monitoring Information," U.S. Environmental Protection Agency, Office of Water, Washington, D.C., 2005.
- Silverman, G.S., M.K. Stenstrom, and S. Fam. "Land Use Considerations in Reducing Oil and Grease in Urban Stormwater Runoff," *Journal of Environmental Systems*, 18(1), pages 31 – 46. 1988-1989. Amityville, NY.

The California EPA report distinguished "oil and grease" from "oil and petroleum products" as follows:

- "Oil and petroleum products" included lubricating and industrial oils refined from petroleum and containing polyaromatic hydrocarbons.

- “Oil and grease” included oil and petroleum products plus animal fats, vegetable oils, soaps, and other biological oils.

However, the California EPA then reported its monitoring data simply as “oil and grease” without distinguishing whether the reported concentrations represented solely petroleum-derived material or material that also included the less toxic biological pollutants. For California EPA’s purpose of identifying concentration ranges, assuming that the two types of oil were the same was a reasonable simplification.

Both Silverman *et al.* and Maestra and Pitt reported concentration data for “oil and grease.”

One of the reasons that the literature has been ambiguous in how it has reported petroleum hydrocarbons and oil and grease was the continually evolving methodologies for analyzing environmental samples for this group of pollutants. Early and inexpensive methods (similar to SM 5520B, APHA 1998) consisted of extracting oily matter (biological lipids and mineral hydrocarbons) into one of several organic solvents, followed by evaporating the solvent and weighing the residue (called “oil and grease”). Later analytical methods (similar to SM 5520C and 5520E) employed infrared detection rather than a gravimetric technique so that the more volatile hydrocarbons would be included and the non-petroleum materials would be excluded. Optional “cleanup” modifications of these methods included removal of ionized materials from the organic extract by passing it through an exchange column and of water by passing the extract through a drying agent (SM 5520A). Laboratories reported results often without specifying whether cleanup was performed. Standard reference oils have also varied from one laboratory to another, typically either being prepared with available laboratory reagents or consisting of a sample of the local product of concern, itself. Thus, the inherently empirical nature of “oil and grease” and “petroleum hydrocarbons” has imparted considerable uncertainty in what substances the analyses were actually measuring.

Although the concentration data employed by the toxics loading project teams were for the most part reported as “oil and grease,” Ecology’s Phase 1 and Phase 2 loading reports identified loadings to Puget Sound as loadings of “oil or petroleum product” and “total petroleum hydrocarbons,” respectively.

Table 1 below sets out the loading amounts calculated by Ecology, the NRC, and the California EPA for oil and grease, petroleum hydrocarbons, and polyaromatic hydrocarbons (PAHs), a toxic fraction of petroleum hydrocarbons. Ecology’s loading estimates for “oil and grease” are reasonably comparable with the NRC’s estimate for loading nationwide and with California EPA’s estimate for its entire state. Also Ecology’s PAH-to-oil and grease ratios are roughly similar to the ratio determined by the NRC (within a factor of about 2).

Ecology expects that the actual loading of petroleum hydrocarbons to Puget Sound will be larger than that suggested in Table 1 by the TPH / O&G ratio for the NRC data (1.5%). Review of the results of paired analyses of petroleum hydrocarbons and oil and grease from several studies indicated a range of 59% to 71%, shown in Table 2 below. The relative difference between the ratios for commercial/industrial and residential land uses (69% versus 58%) is reasonable because commercial/industrial areas are more likely to have sources of petroleum contamination.

The NRC’s particularly small 1.5% ratio may have been due to (a) its derivation from unpaired analyses of petroleum hydrocarbons and oil and grease; and (b) the large 2-order of magnitude uncertainty of its estimate of the fraction of petroleum hydrocarbons in water that consists of PAHs.

Table 1. Loading Estimates

<u>Study</u>	<u>Loading (metric tons / year)</u>			<u>(PAH / O&G)</u>
	<u>O&G</u>	<u>TPH</u>	<u>PAH</u>	
Ecology Puget Sound Phase 1	22,580 (a)	–	9.9	0.00044
Ecology Puget Sound Phase 2	52,300 (b)	–	14.6	0.00028
Ecology Puget Sound Phase 2 (75% POE)	22,900 (b)	–	5.3	0.00023
National Research Council North America	3,443,557	51,653	517	0.00015
California Statewide	20,000	–	–	–

- O&G = Oil and Grease.
- PAH = Polyaromatic Hydrocarbons.
- POE = Probability of Exceedance.
- TPH = Total Petroleum Hydrocarbons.
- (a) = Identified in the report as “oil or petroleum product.”
- (b) = Identified in the report as “total petroleum hydrocarbons.”
- = Not Reported.

Table 2. Percentage of Petroleum Hydrocarbons in Oil and Grease

<u>Study Location (Source)</u>	<u>Number of Paired Results</u>	<u>TPH / O&G</u>
Bellevue, Washington (City of Bellevue)	68	69%
Boston, Massachusetts (NSQD)	12	59%
Eugene, Oregon (NSQD)	17	70%
Portland, Oregon (NSQD)	75	71%
Oregon DOT (NSQD)	9	66%
Land Use > 75% Commercial/Industrial (NSQD)	76	69%
Land Use > 75% Residential (NSQD)	25	58%

- DOT = Department of Transportation.
- NSQD = National Stormwater Quality Database.
- O&G = Oil and Grease.
- TPH = Total Petroleum Hydrocarbons.

Confusion about “oil and grease” versus “petroleum hydrocarbons” will be reduced as Ecology’s Phase 3 toxics loading projects begin. In these projects, Ecology will collect environmental samples of river discharges and surface runoff and will analyze them for petroleum hydrocarbons

using Methods NWTPH-Dx and NWTPH-Gx. These methods specifically measure refined petroleum-derived materials. Future estimates of toxic chemical loadings to Puget Sound will be based on analyses for refined petroleum-derived materials in locally collected samples.

References

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