Supplemental Evaluation for Bioaccumulation Data from the Dredged Material Evaluation for the Douglas Harbor Marina – Juneau, Alaska June 2009

Supplemental Report

Revised June 2009

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NEWFIELDS

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Background

Approximately 30,000 cubic yards of sediment is proposed for dredging and placement at the dredged material disposal site in Gastineau Channel adjacent to the Douglas Harbor Marina near Juneau, Alaska. Sediments were evaluated using federal guidelines for discharge of dredged material into waters of the U.S. provided in the Inland Testing Manual. Additional state guidance was provided by the Puget Sound Dredged Material Disposal Assessment Procedures (PSDDA Users Manual), the State of Alaska Health Department Bulletin (October 2007) for the protection of Alaskans from consumption of contaminated fish and shellfish, and by resource agencies during the planning and implementation of this assessment program. The sediment from Douglas Harbor has elevated levels of mercury but biological testing revealed no adverse effects in elutriate or sediment exposures using standard testing organisms. Additionally, the mercury present in the sediment, while elevated in concentration relative to the Gastineau Reference area, did not result in tissue body burdens that exceeded the proposed screening level of 0.32 mg/kg wet weight of methyl mercury developed for this program. Recently, a document was issued by USEPA that provides additional information on establishing tissue guidance values for mercury for protection of ecological resources (RSET 2009: *Sediment Evaluation Framework for the Pacific Northwest – May 2009*). The objective of this supplemental report is to expand the evaluation of the test results relative to the new draft guidance document as well as additional mercury guidance documents produced in recent years by the USEPA Science Advisory Board and other USEPA documents.

Presentation of Additional Information

Mercury (Hg) can be a hazardous chemical under certain environmental conditions that either support solubilization and bacterial methylation from marine sediments or the release of solubilized Hg^{+2} (Sadiq 1992). Not all of the conditions that support solubilization processes and methylation are known. Recent studies implicate that an optimum pH and a biotic environment are necessary to foster the growth of the microbes that are associated with the solubilization and methylation of Hg in sediments. The solubilization and release of methyl Hg into seawater is thermodynamically favored as pH increases from 7 to 10 in oxic marine sediments (Figure 1, Sadiq 1992). Studies also demonstrate that increased salinity decreases the presence of free and toxic ions of Hg^{+2} by rapidly complexing with chloride (Cl) in oxic and moderately oxic water. This process decreases the direct toxicity to marine organisms (McLusky et al. 1986). The proposed disposal site location is in marine waters indicating a low likelihood for the release of free Hg^{+2}. This hypothesis was evaluated by conducting biological testing with sediment and sediment elutriates collected from the proposed dredged site; results showed no predictable adverse effects associated with chemicals of potential ecological concern (NewFields 2009). Bioaccumulation of Hg into the tissue of organisms is inversely related to the quantity of total organic carbon (TOC) in sediment (Langston, 1986). The lower composite of sediment was very sandy and relatively dry with a very low TOC (range: 0.047 to 0.062%) compared to both the reference sites (range: 0.54 to 0.92%) and the upper composite sections from Douglas Harbor (range: 0.62 to 1.88%). Mercury concentrations were comparable between the upper composites and the lower composites. However, because of the low TOC content of sediment in the lower composite, accumulation of mercury was higher in tissues of organisms exposed to the lower composites compared to tissue concentrations of mercury from organisms exposed to the upper composites. Reduced TOC levels in the lower sediment composites may not provide sufficient organic material for the biological production of methylation materials for Hg. Because of these interrelated issues, modeling of the uptake of Hg into tissues is problematic and direct measurements are more appropriate.

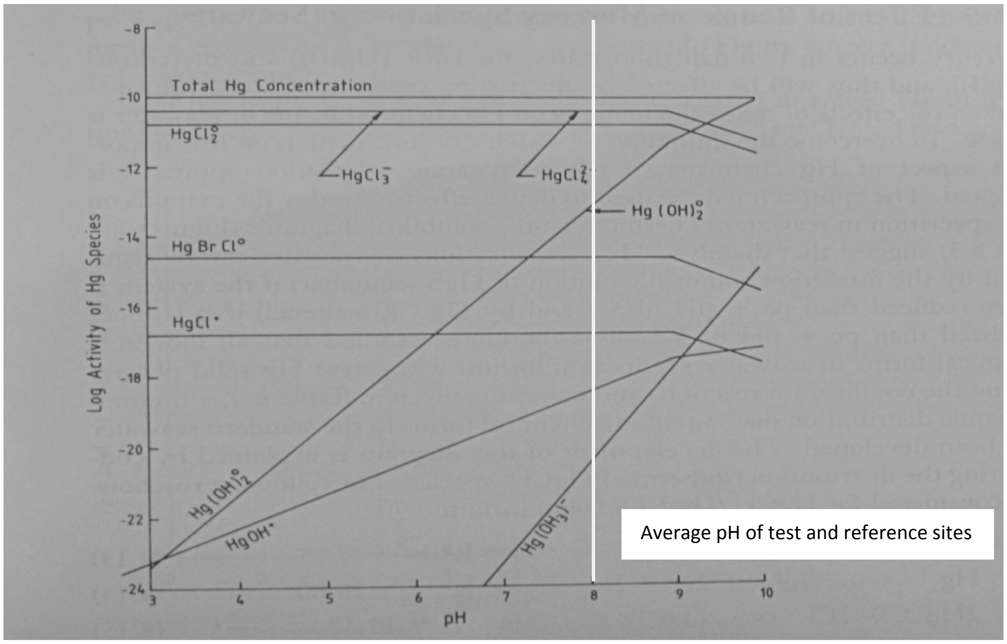

Figure 1. The thermodynamic distribution of Hg chemical forms in seawater (from Sadiq 1992).

Experimental Protocols Provided to Address Hg Toxicity and Bioaccumulation

Our Tier III/IV assessment of the buried sands from Douglas Harbor was designed to closely mimic conditions that would occur during disposal after the sediment had acclimated to conditions at the disposal site (NewFields, 2007). The laboratory acclimation process was designed to permit the development of an aerobic biogenic sediment surface and the removal of the more transient effects of ammonia and sulfides that may be produced from buried non-biogenic sediment (Word et al. 2005). Coincident with the removal or reduction of these more transient factors would be the increased production of an oxic sediment and pH conditions conducive to increasing the bioaccumulation potential of Hg. Prior to testing, a static renewal process acclimated the sediment to site conditions. The static renewal process with unfiltered seawater permitted the very low organic carbon containing sediment (<0.062% TOC) to develop a small but essentially immeasurable TOC addition via the production of algae and bacteria on the surface of the sediment. Upon test initiation standard protocols were followed. The biologically enhanced sediment TOC could be used by the test organisms in lieu of supplemental food which is not a standard procedure when conducting a bioaccumulation test since food may interfere with uptake of potential contaminants of concern. The biologically enhanced sediment may provide a developing community of bacteria with sufficient organic detritus to produce particulate and dissolved organic materials to enhance Hg solubilization and bioavailability. These experimental modifications were designed to closely mimic conditions that would occur at the disposal site, potentially favoring the dissolution of Hg and production of bacteria to increase methylation. This Tier IV study measured pore water and sediment concentrations of methyl and total Hg to obtain site specific uptake data for methyl Hg from pore water to tissues of the bioaccumulation test organisms as recommended by Federal and State Guidance (SAB 1997 and OHHEA2006; RSET, 2009)). These site-specific uptake rates for Douglas Harbor will be compared to uptake rates reported in current literature (SAB, 1997; OHHEA, 2006).

The documents reviewed for this supplement report are summarized below along with relevant information obtained from each review and an assessment regarding applicability to this program.

1. NewFields 2009. *Dredged Material Evaluation for the Douglas harbor Marina, Juneau, Alaska*. This document provides the testing information that was produced for the Tier III/IV evaluation of dredged material from Douglas Harbor Marina based on guidance provided in the Inland Testing Manual, State of Alaska Public Health Department Advisory, discussions and agreement with resource agency personnel during the development and implementation of the SAP. Evaluations of these test results are ongoing with the remaining discussions focused on bioaccumulation of Hg by *Macoma nasuta* after 28 days of exposure to sediment from the lower composite within Douglas Harbor. The concentration of bioaccumulated total Hg from exposure to this composite was 0.21 mg total Hg/kg tissue or 0.092 mg methyl Hg/kg of tissue (wet weight), estimated as 44% of total Hg.
2. Rudis 1996. *Metal Concentrations in Sediments and Selected Biota from Gastineau Channel, Juneau, Alaska.* This document provided historical information on the concentrations of metals in sediment and selected tissues at multiple locations within Gastineau Channel and compares these to other locations in Alaska. Total sediment Hg concentrations in Gastineau Channel ranged from 0.098 to 0.355 mg/kg dw which is comparable to the total Hg concentrations observed in the reference sediments collected for this study (0.178 to 0.303 mg Hg/kg dw). These data were used to help determine the locations for the reference sites sampled for this study.
3. USEPA/USACE 1991. *Inland Testing Manual*. This document is the federal guidance for performing dredged material evaluations prior to discharge into the inland waters of the United States. It provides a tiered approach to evaluating the potential adverse ecological and human health risks associated with the discharge of dredged sediment. The tiered approach includes chemical screening and comparison to guidelines, toxicity evaluations of elutriates of the dredged material and the sediment on multiple species representing different phyla and feeding/dwelling characteristics, and evaluations of the uptake of chemical contaminants from the sediments into two species that are surrogates for potential effects at the disposal site. A Tier IV assessment addresses site specific issues. A Sampling and Analysis Plan was developed in conjunction with appropriate regulatory oversight, and testing was performed to address all Tier III/IV requirements.
4. Beckvar N, T Dillon and L Read. 2005. *Approaches for Linking Whole-Body Fish Tissue Residues of Mercury or DDT to Biological Effects Thresholds.* This document investigated several approaches to establishing a protective level for juvenile and adult fish using lethal and sublethal endpoints. The threshold-effect level provided the best guidance for establishing a protective tissue burden. The concentration established by this method was 0.2 mg/kg wet weight. These concentrations are recorded as total Hg but in most of the studies (five of eight) the concentrations included in the review were based on methyl Hg concentrations and the test species were Trophic Level 3 or higher, for which the general assumption from EPA is that total mercury is equal to methyl mercury. Based on this assumption, the Hg concentration protective of sublethal effects on juvenile and adult fish

is 0.2 mg/kg. Because the data represent a high trophic level and the high percentage of total Hg represented by methyl Hg in tissue of these fish, the protective level determined by Beckvar et al. is assumed to be based on methyl Hg.

5. RSET 2009. Draft Final Review - *Sediment Evaluation Framework for the Pacific Northwest* Feb 2009. (Note: this document was released as Final in May 2009; data used herein did not change between the February and May releases). This document, produced by a multi-agency task force, addresses the analytical methods and interpretive guidelines proposed for application to sediment testing for the Pacific Northwest. It includes fresh and marine waters and addresses toxicology testing, bioaccumulation testing, and interpretation among other assessment tools. The guidance provided for bioaccumulation testing is contained in Chapter 8 and Appendices C and D. This proposed approach to bioaccumulation is recognized as different and is a significant departure from earlier work conducted in the Northwest. The following statement in the document provides some context for the present status of this effort: *"…represents a significant change, it will not be ready for implementation until further analysis of its application, reliability, and impacts have been completed by the RSET…"*. Highlights of issues relative to Hg bioaccumulation into tissues of test organisms are:
    a. The document provides several guidance values that can be used to determine potential risk from Hg. While not specifically stated, the bioavailable Hg concentrations which provide the basis for interpretation framework are based on methyl Hg and not total Hg. This is in line with guidance issued by other regulatory agencies (USEPA, SAB, and OHHEA).
    b. The Toxicity Threshold Level (TTL) developed for protection of aquatic life is 0.11 mg/kg wet weight. The TTL is derived from Beckvar et al. (2005) and is protective for mortality, growth, reproductive and behavioral endpoints represented by the data summarized in this document. Most of the test species were fish dosed with methyl Hg resulting in methyl Hg in tissue body burden.
    c. The literature discussed by Beckvar et al. provides the highest no observable effect dose (NOED) as 0.23 mg/kg and the lowest observable effects dose (LOED) as 0.25 mg/kg with an extrapolation to 0.2 mg/kg wet weight as being protective of the effects with this assessment. Therefore, the cited value of 0.11 mg Hg/kg tissue for the protection of aquatic life in the RSET document is inconsistent with this information, and does not appear to base the guidance value on methyl Hg. While the specification of total or methyl Hg is not a major concern for fish species, it is a significant factor when evaluating lower trophic levels.
    d. Regarding Hg concentration in the tissues of wildlife consuming aquatic resources, distinctions are made between deep water and nearshore environments and endangered or threatened species and other wildlife species (referred to as "population"). The concentrations protective for these environments (deep or shallow) and types of organisms (ESA or population) range from 0.02 to 0.12 mg Hg/kg tissue wet weight. For application to Gastineau Channel we selected the population value for deep water as the appropriate assessment endpoint (0.12 mg Hg/kg tissue) for the following reasons.
        i. The aquatic-dependent wildlife values for the shallow and endangered or threatened species are predominantly represented by shorebirds and are not appropriate for the deeper water disposal site within Gastineau Channel (>120 ft). The two species that are appropriate for deep water

that are likely to dive to deep waters of the Gastineau Channel disposal site include the Harbor seal and the Orca whale and with reported TTL values of 2.67 and 0.42 mg Hg/kg wet weight, respectively.

ii. Because these values are higher than the guidance for the aquatic life (0.11 mg Hg/kg wet weight) they will not influence or control decisions for protection of ecological receptors.

e. The human health guidance value provided in the document is the EPA reference dose value of 0.0001 mg methyl Hg/kg body mass-day. Assuming a person is either 63 kg (Asian or Pacific Islander), 70 kg (general population), or 79-82 kg (tribal populations), the consumption of methyl Hg that would still be protective on a daily basis would range from ~0.006 to 0.0082 mg methyl Hg/day. Based on the concentration of total Hg in the test organisms from the lower composite exposure and a conversion factor of 44% to methyl Hg (0.2 mg total Hg/kg * 0.44 = 0.092 mg methyl Hg/kg tissue wet weight), a consumption of between 68 and 100 g of shellfish per day would need to be consumed to exceed this guidance value, assuming all shellfish consumed were at this equivalent concentration.

6. OHHEA 2006. *Evaluation of Bioaccumulation Factors and Translators for Methyl mercury*. This document is a critical review of USEPA 2000 – *National Bioaccumulation Factors for Methyl mercury*. This critical review was designed to either accept USEPA factors or to develop site-specific bioaccumulation factors using California data. The evaluation examined freshwater (lentic and lotic) as well as estuarine environments. The percentage of total dissolved Hg that is methyl Hg for water was determined from a few studies for this OHHEA effort. We did not use these factors except to compare to our data because we had site specific methyl and total Hg concentrations in pore water. Trophic level 2 organisms were determined by USEPA (2000) to have methyl Hg at 44% of the total Hg in the tissues (comparable to clams and worms in our study) while organisms at trophic levels 3 and 4 were assumed to be at 100% methyl Hg. The arithmetic mean BAF for transfer of methyl Hg from water into the tissues of Trophic Level 2 estuarine species ranges from 2.2 to 2.45 x 10^5 for San Francisco Bay organisms. Our site specific values for the lower core composite and *Macoma nasuta* was 0.944 X 10^5; BAFs for the upper composites ranged from 0.16 to 1.0 x 10^5. *Nepthys caecoides* BAFs ranged from 0.08 to 0.4 x10^5 for composites (upper and lower) with no difference for the lower composite BAF. These values are similar and are all less than the site specific values developed for the OHHEA project, indicating that the site specific conditions at Douglas Harbor are less conducive to bioaccumulation of methyl Hg than was observed for the OHHEA effort.

7. USACE/USEPA 2008. *Environmental Residue-Effects Database (ERED)*, Updated November 2008. This database provides a compilation of the literature that relates the tissue body burdens for various chemicals and the biological effects associated with those levels. Currently there are in excess of 14,000 data pairs for various chemical tissue residue concentrations and effects representing effects ranging from no observed effect dose (NOED), lowest observed effect dose (LOED), effective dose for any percentage (ED_X) for multiple endpoints (including lethality, reproduction, growth , and biochemical changes in organisms). The peer-reviewed literature compilation for mercury and methyl mercury contained in this database was summarized for all NOED and LOED values. There were 242 NOED and 91 LOED data points. Figure 2 summarizes this data and depicts the 95% protective levels for all LOED responses and compares this value to the NOED value for this same protective level. The 95% protective level for all LOED effects values is ~0.2 mg/kg wet weight which is the same value suggested by Beckvar et al. 2005.

8. SAB, 1997. *An SAB Report: Review of the EPA Draft Mercury Study Report to Congress.* This critical review document was generally very complimentary of the report to Congress but it did make a number of suggestions. Suggestions that were relevant to the Douglas Harbor program include the measurement of methyl Hg in environmental samples so that site specific issues would not interfere with assessment of uptake. This type of information would aid in the understanding the methylation process which would be key to improving these types of assessment. Consideration of the effect of higher consumption by sensitive populations was also recommended to strengthen the document. Our analytical chemical methods included measuring total Hg and methyl Hg for sediment and pore water analyses; tissues were measured for total Hg and used the EPA estimate of 44% of total Hg to represent methyl Hg for Trophic Level 2 species. We adjusted testing protocols so that aerobic sediments and biogenic structure of the sediment was developed before implementing the bioaccumulation tests. Additionally, we consulted with the state agencies prior to initiating the tests to develop site specific consumption numbers for Alaskan populations.
9. USEPA, 1997. *Mercury Study Report to Congress*. The report that was reviewed and commented on by the SAB discussed in item 6.
10. Verbrugge, 2007. *Fish Consumption Advice for Alaskans: A Risk Management Strategy to Optimize the Public's Health- State of Alaska Epidemiology.* Consumption of fish and shellfish by Alaskans was reviewed by state agencies and concluded that the EPA/FDA federal fish advisory limiting consumption of fish to 340 g/day for sensitive populations is inappropriately restrictive because it does not adequately factor in the relatively low levels of Hg in most Alaska fish and the important benefits of fish consumption. Further, they derived a protective value for fish consumption of 0.0004 mg/kg body weight/day for the most sensitive populations based on a 3-fold uncertainty factor applied to the no observed adverse effects levels provided by ATSDR. This is four times higher than the guidance provided by EPA. We calculated a consumption rate per day based on the concentrations of mercury in the clams from the lower composite that yielded a consumption rate of 272 to 400g daily which is equivalent to the protective consumption level specified in the EPA/FDA advisory when applied to concentrations of methyl Hg in the clams exposed to the lower composited sediment.

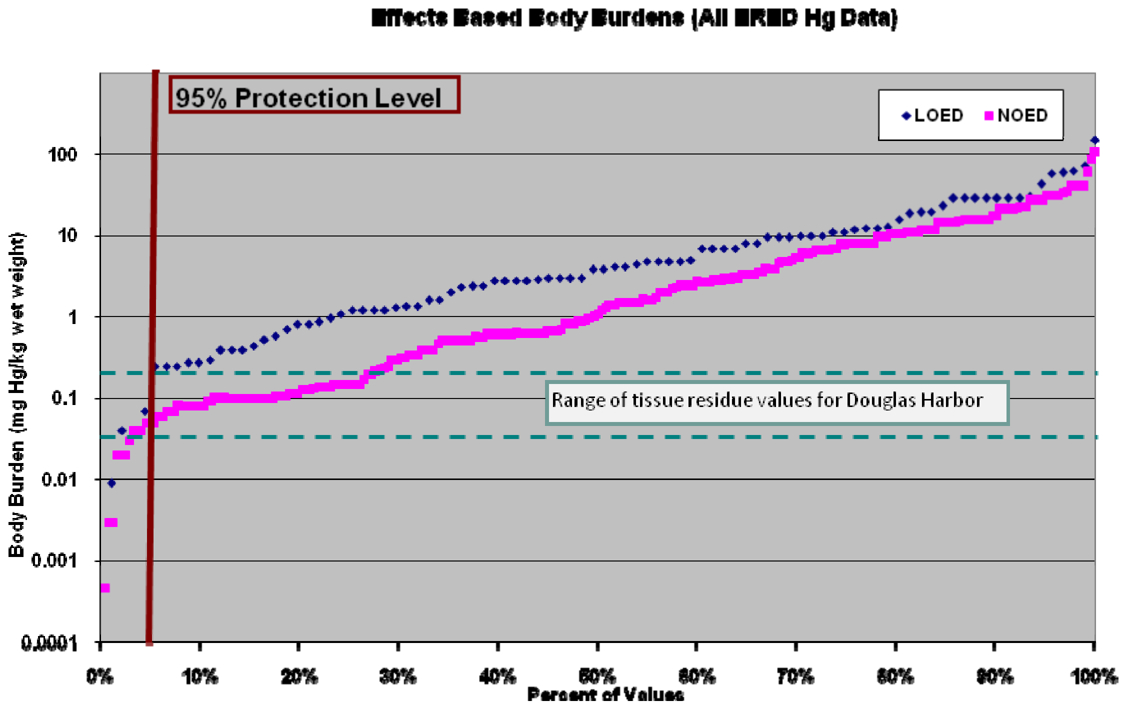

Figure 2. Compilation of Data from ERED on the concentrations of Hg that produce not observable adverse effects and also those data showing the lowest effects based values for all end points in the database [LOED values= 91 datapoints; NOED values= 242 datapoints; USEPA/USACE 2008].

11. ADEC 2009 (Memo from William Ashton, 1/12/09) – Douglas Harbor Soil Testing – ADEC comment. Based on consensus discussion, the agencies decided that a concentration of 0.32 mg methyl Hg/kg tissue is an acceptable concentration for the consumption of 16 meals per month for Alaskans. This value is consistent with Verbrugge 2007 (State of Alaska Epidemiology Bulletin, October 2007) that was established for protection of human health by consumption of fish/shellfish having concentrations ranging from 0.15 to 0.32 mg/kg. The total Hg concentration in shellfish of 0.21 mg/kg reported for bioaccumulation testing of Douglas Harbor lower composite sediment would meet this guideline. Additionally, since the methyl Hg concentration is the target measurement of interest for the guidance values and since the clams are trophic level 2 consumers then the actual methyl Hg would be 44% of this value or a concentration of 0.092 mg/kg which is less than the unrestricted consumption value (<0.15 mg/kg) provided by Verbrugge, 2007.

Table 1 summarizes relevant information extracted from these sources that can be used to further evaluate the potential for ecological and human health risk of tissue contamination from Douglas Harbor sediment. The pertinent documents are cited within the table.

Table 1. Summary of Body Burden Data Literature

Parameter	Value	Assumption	Citation
Mean *Macoma nasuta* Tissue concentration for Lower Comp	0.21 mg total Hg/kg ~0.092 mg methyl Hg/kg wet weight	44% of the total concentration is methyl Hg based on Trophic Level 2 adjustment	NewFields 2009; USEPA 1997; and OHHEA 2006.
FDA Action Limit	1.0 ppm wet weight	Acceptable methyl mercury daily intake of 0.5 ppb body weight/day, a half pound (226 g) of fish consumed/week , and a 70 kg adult = tolerance level of 1 ppm (0.5*7days*70 kg/226 g of seafood)	USEPA /USACE 1998
EPA reference dose	0.0001 mg Hg/kg body weight/day	methyl Hg guidance value through HHRA modeling and application of safety factors	USEPA/FDA Joint Advisory 2004
U.S. Agency for Toxic Substances and Disease Registry (ATSDR) No Observed Adverse Effect Level (NOAEL)	0.0013 mg Hg /kg body weight/day	Based upon the analysis of the Seychelles Island data	Verbrugge 2007
U.S. Agency for Toxic Substances and Disease Registry (ATSDR) Oral Minimum Risk Level	0.3 mg Hg/kg tissue	Based on mean maternal hair level of 15.3 ppm and an uncertainty factor of 4.5 used to human pharmacokinetic and pharmacodynamic variability (3.0) and a modifying factor of 1.5 for lack of domain specific tests.	Verbrugge 2007
Alaska-specific chronic oral Acceptable Daily Intake for methyl mercury for women who are or can become pregnant, nursing mothers, and young children	0.0004 mg methyl Hg/kg body weight/day	Based on ATSDR data but removing the 1.5 uncertainty factor for domain specific findings and using only the 3-fold uncertainty factor applied to the NOAEL= 0.0013 ppm body weight per day / 3-fold uncertainty factor	Verbrugge 2007
Alaska- specific Project Action limit for Douglas Harbor bioaccumulation test tissue concentrations	0.32 mg methyl Hg/kg tissue	Protective level for women who are or can become pregnant, nursing mothers, and children age 12 and under. Based on eating 16 meals per month and assuming a 6-ounce (=170 g) portion and all mercury – methyl mercury. All other groups are unlimited consumption	Verbrugge 2007
Alaska-specific advisory for unlimited consumption for specific fish listed in Table 8 p.31 of report	0.15 mg methyl Hg/kg tissue wet weight	Unlimited consumption all people.	Verbrugge 2007
Historical sediment data for Gastineau Channel and areas around Douglas Harbor	Mean metal concentration of 0.222 pm (0.098 ppm to 0.376) in sediment samples in Gastineau channel.	Sediment collected by grab samples and analyzed for a variety of metals	Rudis 1996
Published ecological effects from mercury exposure	<0.2 mg/kg – LOED	Protection of 95% of all data points including sublethal and biochemical end-points. 91 data points for LOED and 241 data points for NOED. Total Hg in tissues.	USACE/USEPA 2008
Target Tissue Levels for Aquatic Life - Species Sensitivity Distribution (SSD)	0.11 mg Hg/kg tissue - wet weight	Target Threshold Levels for Aquatic Life data taken from Chapter 8 table 8-2. Responses are mortality, growth, reproduction, and behavior taken from Beckvar et al. 2005. (does not specify methyl mercury but uses data that is based on Methyl Hg dosing)	RSET 2009

Table 1. Summary of Body Burden Data Literature *(Continued)*

Parameter	Value	Assumption	Citation
Target Tissue Levels for Aquatic-dependent Wildlife	TTL = 0.06 ppm wet weight ESA (endangered species act) TTL= 0.12 ppm wet weight Population Deep water sites TTL = 0.02 ppm wet weight nearshore ESA TTL = 0.03 ppm wet weight nearshore Population	Target Threshold Levels for Aquatic-dependent wildlife Life data taken from Chapter 8 table 8-3. Aquatic dependant wildlife is predominantly shorebirds. Harbor seal and Orca whales have TTL that are much higher (2.67 and 0.42 mg kg wet weight, respectively) Appendix D of this report Section D.2 and Table D-3 and D-4 Several values are given based on ESA (endangered species or population and the parameters of the disposal site Deep water sites non-dispersive sites like Puget Sound and ocean disposal	RSET 2009
Target Tissue Levels (TTL) for Human Health	TTL1= general population = 0.13 mg methyl Hg/kg - wet weight TTL2= recreational anglers, Asian and Pacific Islander groups, mid-range tribal consumption= 0.040 mg methyl Hg/kg - wet weight TTL3= high-end tribal consumption = 0.012 mg methyl Hg/kg tissue wet weight	Target Threshold Levels Human Health data taken from Chapter 8 table 8-4 Appendix D.3	RSET 2009
Whole-body mercury t-TEL	0.2 ppm wet weight t-TEL Simple ranking Highest NER = 0.23 Lowest LER = 0.25 ppm	Data used for this number represents methyl mercury and not total mercury. According to EPA the conversion from methyl to total mercury at Trophic level 2 is 44%.	Beckvar et al. 2005
Ambient water quality criterion for methyl mercury in fish	0.3 mg methyl Hg/kg tissue wet weight	State water quality board (SWRCB) funded office of Environmental Health and /Hazard Assessment evaluate the national bioaccumulation factors	OHHEA 2006.
Calculation of BAF	BAF, L/kg = mercury in biota mg/kg/dissolved methyl mercury in water, mg/L	National BAF are functional default when more representative regional or local BAFs are not available (EPA, 2003)	OHHEA 2006.
Assumptions of methyl and total mercury	Trophic Level 2 = EPA assumed that 44% of total mercury is methyl mercury Trophic Level 3 and 4 EPA assumed 100% of total mercury is methyl mercury	Report describes numerous approaches to calculating translators for estimating the methyl mercury from total mercury data.	OHHEA, 2006.
BAF (L/kg)	TL2 = 2.2 TO 2.45 x10^5 based on direct measurement of dissolved methyl mercury	Tables 28 and 31 of the report	OHHEA, 2006.
Mean mercury level across all fish and sites	0.26 mg total Hg/kg tissue wet weight	See Table 2-2 of report (source of data was Bahnick et al. 1994)	USEPA 1996
BSAF for total mercury in aquatic biota	Ranged from 0.4 to 50 within a given system	Indicates that site specific BSAF and portioning needs to be performed.	USEPA 1996

Assessment of Bioaccumulation Data From Douglas Harbor Sediments

Benthic marine organisms representing genera and species which were encountered at the Gastineau Channel reference area (*Macoma nasuta* and *Nepthys caecoides*) were exposed to sediment from Douglas Harbor, Juneau, Alaska and Gastineau Channel reference areas for 28 days as recommended by the ITM. The average accumulated concentrations of total Hg ranged from 0.008 to 0.21 mg/kg wet weight. These total Hg concentrations are equivalent to methyl Hg concentrations of 0.003 to 0.092 mg/kg wet weight based on USEPA extrapolations for Trophic Level 2 methyl Hg contributions to total Hg values (methyl mercury is 44% of total mercury at Trophic Level 2). The highest concentration of methyl mercury in the tissues of *Macoma* was found in the lower composite, represented by the deeper sandy sediments in the harbor. The mean methyl mercury concentration of 0.092 mg/kg wet weight is below the ecological effects based values established from the peer reviewed literature contained in ERED and below the levels established by Beckvar et al. (0.2 mg/kg methyl Hg). Our analysis of the data shows that 0.092 mg methyl Hg/kg wet weight is below levels that would be protective of all assessment endpoints (includes sublethal and biomarker endpoints). The methyl mercury levels in the tissue of *M. nasuta* for the lower composite are within guidelines provided by Verbrugge (2007) for unrestricted consumption of fish/shellfish (<0.15 mg/kg wet weight methyl mercury). A discussion was presented in Verbrugge about whether methyl or total Hg for these assessments should be used. The US guidance cited in the document is based on methyl Hg consumption and the development of methyl Hg guidelines. The tissues that were analyzed to develop the Alaskan guidelines are for Trophic level 3 and 4 which contain essentially 100% methyl Hg. As a result, this guidance value (<0.15 mg/kg) is apparently based on methyl Hg consumption. The interagency consensus value released in January of 2009 (<0.32 mg Hg/kg tissue) is also assumed to be based on methyl Hg. The concentrations in the *M. nasuta* from the lower composite, although statistically significantly greater than reference, are less than those provided for the protection of aquatic life and the deep water aquatic dependent wildlife values by RSET 2009 (0.11 mg/kg or 0.12 mg/kg – assumed to be methyl Hg based on cross reference to the Beckvar paper from which the guidance was derived).

The sediment in Douglas Harbor does have elevated concentrations of total Hg ranging from 1.1 to 3.2 mg/kg dry weight in the composite samples. The measured concentration of methyl Hg in the sediment ranges from 0.8 to 2.6 μg/kg. The methyl Hg in the pore water of the core samples ranged from 0.2 to 1 ng/L in the Douglas Harbor sediment overlapping the range of 0.4 to 1.9 ng/L observed in the reference sediment samples. The site specific BAF values were calculated based on methyl mercury concentrations in pore water and Trophic Level 2 tissue as shown in Table 2. The site-specific values are all less than the BAF values that have been suggested for generic application (OHHEA, 2007; SAB, 1997). The site-specific sediment bioaccumulation values are less than the proposed BAF for estimating the concentration of methyl Hg in tissues of Trophic Level 2 species (USEPA), suggesting that the bioavailability of methyl Hg from Douglas Harbor sediment is less than sediment from other regions. This may explain why levels detected in sediment do not appear to be bioavailable or occur at concentrations that exceed critical body burden or human health risk consumption levels, even with experimental programs that are designed to increase this potential for bioaccumulation. Based on the entire set of test results reported in Newfields 2009 and this supplemental evaluation, Hg present in the Douglas Harbor sediment is not available for uptake to Trophic Level 2 organisms in excess of guidance levels established at the initiation of this dredged material evaluation (0.32 mg methyl Hg/kg) or those put forth by EPA and state agencies (OEHHA or RSET (Region 9).

Table 2. Site-Specific BAF Calculations for Douglas Harbor, Juneau AK

Station Composite	Sediment (dry weight)		Pore Water		*Macoma* (wet weight)		*Nepthys* (wet weight)	
	Total Hg µg/g	Methyl Hg ng/g	Total Hg ng/L	Methyl Hg ng/L	Total/CH_3Hg mg/kg	BAF X 10^5	Total/CH_3 Hg mg/kg	BAF X 10^5
Station 1	1.11	2.47	13.1	0.35	0.03/0.012	0.34	0.008/0.003	0.008
Station 2	2.50	0.80	25.3	0.23	0.05/0.023	1.0	0.012/0.005	0.22
Station 4A	3.22	1.34	14.8	0.38	0.04/0.017	0.45	0.010/0.004	0.11
Station 4B	2.33	1.08	17.4	0.23	0.04/0.018	0.8	0.009/0.004	0.17
Lower Composite[a]	2.24	2.62	29.2	0.979	0.21/0.092	0.94	0.027/0.012	0.12
Reference Composite[a]	0.23	0.28	8.1	0.4	0.016/0.007	0.16	0.008/0.004	0.10
Trophic Level 2 BAF[b]	NA				2.2-2.45 x 10^5			

a- Values are an average of the lower composite samples and an average of the reference composite and reference stations.

b- OHHEA 2006

Literature Cited

ADEC 2009 (Personal communication, William Ashton, 1/12/09) – Douglas Harbor Soil Testing – ADEC memo

Beckvar N, TM Dillon, LB Read. 2005. Approaches for Linking Whole-Body Fish Tissue Residues of Mercury or DDT to Biological Effects Thresholds. Environ Toxicol & Chem. 24(8):2094-2105.

Langston WJ. 1986. Metals in Sediments and Benthic Organisms in the Mersey Estuary. Estu. Coast Shelf Sci. 23:239-261.

McLusky DS, V Bryant, and R Cambell. 1986. The Effects of Temperature and Salinity on the Toxicity of Heavy Metals to Marine and Estuarine Invertebrates. Oceanogr. Mar. Biol. Ann. Rev. 254:481-520.

NewFields. 2009. Dredged Material Evaluation for the Douglas Harbor Marina, Juneau, Alaska. NewFields, Port Gamble WA. 80 p.

OHHEA. 2006. Evaluation of Bioaccumulation Factors and Translators for Methylmercury. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency.

RSET. 2009. Draft Final Review - Sediment Evaluation Framework for the Pacific Northwest Feb 2009/ May 2009. USACE, USEPA, WDOE, WDNR, ODEQ, IDEQ, NMFS, USFWS.

Rudis, D. 1996. Metal Concentrations in Sediments and Selected Biota from Gastineau Channel, Juneau, Alaska. US Fish & Wildlife Service, Southeast Alaska Ecological Services, Juneau AK.

Sadiq M. 1992. Toxic Metal Chemistry in Marine Environments. Marcel Dekker, Inc. New York, New York. 390 p.

USEPA. 1996. Mercury Study Report to Congress. US Environmental Protection Agency. Washington, DC. EPA-452/R-96-001a-h.

USEPA-SAB 1997. An SAB Report: Review of the EPA Draft Mercury Study Report to Congress. Science Advisory Board, USEPA, Washington DC. EPA-SAB-EC-98-001.

USEPA /USACE. 1998. Evaluation of Dredged Material Proposed for Discharge in Waters of the US- Testing Manual. USEPA, Office of Water; USACE. EPA-823-B-98-004.

USACE/USEPA. 2008. Environmental Residue-Effects Database (ERED). Website: http://el.erdc.usace.army.mil/ered/.

Verbrugge LA. 2007. Fish Consumption Advice for Alaskans: A Risk Management Strategy to Optimize the Public's Health. State of Alaska, Division of Public Health. Anchorage, AK. 39 p.

Word JQ, WW Gardiner, DW Moore. 2005. Influence of Confounding Factors on SQGs and Their Application to Estuarine and Marine Sediment Evaluations. In: *Use of Sediment Quality Guidelines and Related Tools for the Assessment of Contaminated Sediments.* RJ Wenning, GE Batley, CG Ingersoll, DW Moore, eds. SETAC Press, Raleigh, North Carolina. pp 633-686.