CDM

Closure Plan
Norwegian Salmon Industries Site
Gig Harbor, Washington

November 5, 2004

Prepared For:

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CDM Project No. 5000.36262.Task 6

A Report Prepared for:

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CLOSURE PLAN
NORWEGIAN SALMON INDUSTRIES SITE
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Purpose and Scope

The purpose of this plan is to identify a process for demonstrating that cleanup action conducted at the Norwegian Salmon Industries site (NSI) located near Gig Harbor, Washington (**Figure 1**) will provide long-term protection to the environment. To achieve that stated purpose, Camp Dresser & McKee Inc. (CDM) reviewed Model Toxics Control Act (MTCA) regulations and regulatory guidance documents, records of the investigation and remediation of the NSI site, and evaluated existing groundwater data. The statistical data evaluation included in this document is used to (1) demonstrate that groundwater cleanup standards for the site have been attained, and (2) that current and supplemental groundwater monitoring results can be used to predict long-term effectiveness of the cleanup action.

Background Information

Site History

The NSI site is an approximately 2-acre undeveloped waterfront property located adjacent to the Colvos Passage, about 4 miles north of the City of Gig Harbor, Washington. Site features are shown on **Figure 2**. For about 20 years during the 1960s and 1970s, Manson Construction Company (Manson) used the property as a storage yard for heavy construction equipment. In addition, debris generated during demolition activities at other locations had been barged to the site, burned, and then used to fill the site, ultimately raising the site elevation by about 10 feet. Later, Asarco slag was used as a surfacing material. Most of the slag was removed in 1988.

Remedial Investigation (RI) activities conducted between 1999 through 2000 identified arsenic, cadmium, chromium, lead, petroleum hydrocarbons, and carcinogenic polycyclic aromatic hydrocarbons (cPAH) as contaminants of concern (COC) in soil and groundwater. These COC were selected based on Washington's Model Toxic Control Act (MTCA) cleanup regulations. Arsenic and polycyclic aromatic hydrocarbons (PAH) were identified as COC in intertidal sediments, based on Washington's Marine Sediment Quality Standards for Puget Sound.

Cleanup actions were conducted from July through September 2002 and from July through September 2003. The 2002 cleanup actions consisted of excavating contaminated fill and soil in the upland area. The 2003 cleanup actions consisted of excavating contaminated intertidal sediments, limited upland soil excavation at the south end of the site, and subsequent site capping. During cleanup, 14,060 tons of contaminated fill, sediment, and slag were removed from the site, as well as a substantial amount of wood and construction debris (e.g., concrete and metal). In the northern one-third of the site, slag at or near the land surface and contaminated soil containing only arsenic was removed to an average depth of 3 feet. Cleanup actions in the southern two-thirds of the site included removal of all visible slag and about 4,400 cubic yards of the arsenic, lead, and PAH contaminated soil and fill. A 2-foot-thick soil cap was then placed over the remaining contaminated soil and fill to minimize

potential offsite transport of soil via erosion and to eliminate the direct exposure pathway to humans.

Current Site Conditions

Currently, the site remains undeveloped and has limited road access and use. A locked gate limits access by those who attempt to enter via the driveway. Grass and clover are currently growing on the site and scotch broom is beginning to emerge. Migratory geese feed at the site and have kept the grass short. Current site photographs are included in **Attachment A.** Four groundwater monitoring wells (MW1, MW2, MW3A, and MW5A) currently exist along the eastern side of the site, next to the Colvos Passage (**Figure 2**).

Residual Soil Contamination

To simplify further locational references to areas within the site, the northern one-third of the site will be referred to as the northern area and the southern-two thirds of the site as the southern area. The two areas are discussed separately due to differences in types of contaminants and the way in which cleanup actions were conducted.

Excavation in the northern area removed all arsenic contaminated soil. Excavation depths ranged from 2 to 6 feet, as required, to remove all visible slag and associated arsenic contaminated soils. No other COCs were identified in this area. Focused excavation occurred in the southern area to remove fill soils contaminated with arsenic, lead, PAHs, and petroleum hydrocarbons. The composition of the fill in southern area was different than the northern area in that it contained a 2- to 3-foot layer of fill soil followed by 5 to 15 feet layer of fill that primarily consisted of burned, partially burned, and unburned wood debris with some metal debris and concrete. The wood debris fill was not found in the northern area. In addition, all contaminated intertidal sediments and any visible slag was (e.g., slag present in the crevice located at the juncture of the timber retaining wall and upland soil) was removed. Excavation areas are shown on **Figure 2**.

In the southern area, pre- and post-cleanup action soil data indicate that arsenic contamination occurs sporadically in the upper 3 feet of the original fill. One sample collected from the south wall of the northern area excavation (juncture with the southern area) at a depth of 1 foot below ground surface (ft bgs) contained 22 mg/kg arsenic. A second sample collected from RI test pit TP14 at 2.5 ft bgs contained 100 mg/kg arsenic. PAH concentrations exceed the Method A cleanup level in much of the fill/soil that contains wood debris. At some locations this same fill/soil also contains lead at concentrations that exceed the Method A cleanup level. Lead was detected in sidewall samples (350, 1,100, 1,200, and 3,400 mg/kg) collected from the excavation at MW3. Cadmium and chromium were typically not detected, or were detected at concentrations well below their respective cleanup levels.

Currently, all residual soil contamination is covered by the 2 foot soil cap.

Site Hydrology

Based on local topography and hydrologic features (i.e., the Colvos Passage), groundwater flows eastward across the site into the Colvos Passage. The site's monitoring wells are tidally influenced with the magnitude of this influence decreasing from south to north. Prior to the replacement of MW5A, groundwater at low tide appeared to be directed southward from MW3 towards the south end of the site. Since installation of well MW5A, groundwater flow from the southern portion of the site appears to be directed north towards MW3A and then eastward to the Colvos Passage. The reason for the change in the flow direction has not been ascertained but the deep excavations in the southern area, which were backfilled with imported soil that contained minimal fines, may be some of the cause.

It should be noted that the excavation at MW3 was one of the smallest (25 foot by 25 foot area) and is completely surrounded on three sides by historic fill soils. MW3A was installed at the northern edge of the MW3 excavation where some of the highest lead concentrations were observed. MW3 is also located approximately 30 feet east (downgradient) of TP14 where arsenic was detected at 100 mg/kg in a 2.5 ft soil sample. Of all the well locations, MW3A is the one most likely to show adverse impact to groundwater by residual soil contaminants.

Attainment of Groundwater Cleanup Levels

Regulatory Guidance

MTCA (Washington Administrative Code [WAC] section 173-340-410) defines the three types of compliance monitoring to be conducted during and after cleanup actions:

- *Protection monitoring*: This type of monitoring confirms that human health and the environment are adequately protected during a cleanup action.
- *Performance monitoring*: This type of monitoring confirms that a cleanup action has attained cleanup standards.
- *Confirmational monitoring*: This type of monitoring confirms the long-term effectiveness of a cleanup action once cleanup standards have been attained.

Washington State Department of Ecology's (Ecology) document *Guidance on Sampling and Data Analysis Methods* (1995) provides direction, in lieu of Ecology site-specific requirements, on evaluating attainment of cleanup levels following groundwater remediation or source control efforts. This document also references the U.S.

Environmental Protection Agency (EPA) guidance document *Methods for Evaluating the Attainment of Cleanup Standards Vol. 2: Groundwater* (1992). EPA's guidance document discusses three cleanup action decision points:

1. When to begin collecting attainment data
2. Whether cleanup standards have been attained
3. When to end treatment

Groundwater Water Quality

Pre-cleanup action groundwater monitoring began in June 1999 and continued until March 2000. Samples were collected for four consecutive quarters. Performance groundwater monitoring at wells MW1 and MW2, which are located in the northern portion of the site, was conducted between September 2002 and July 2003. Performance groundwater monitoring at MW3A, which is located near the center of the site, was conducted between November 2002 and October 2003. No post-cleanup groundwater monitoring was conducted at MW4, since this well was removed during soil excavation. Performance monitoring for MW5/MW5A, located in the southern portion of the site, began in November 2002 and the latest quarterly sampling round for this well location was in October 2004.

Each well was sampled on a quarterly basis for a minimum of five quarters following cleanup actions. COC concentrations were below their respective MTCA Method A groundwater cleanup levels for a minimum of four consecutive quarters before the conclusion of groundwater monitoring at each well location. The fourth quarter of groundwater monitoring at MW5A occurred on October 25, 2004 and it is expected that arsenic will be reported as undetected, based on historical data.

Metals

Arsenic data exists for all pre- and post- cleanup action groundwater sampling events. Cadmium, chromium, and lead were analyzed during the four quarterly rounds prior to cleanup actions and for four to five rounds (with the exception of MW4) subsequent to the 2002 cleanup actions. Arsenic was detected a total of 19 times. The cleanup level for arsenic was exceeded 9 times -- at least one time in each well. Cadmium was never detected. Chromium was detected nine times. Lead was detected 16 times. In MW1, chromium and lead exceeded their respective cleanup levels during the first and second sampling events of the RI. From March 2000 onward, chromium was not detected and lead was sporadically detected at low concentrations. Because subsequent groundwater data does not confirm the initial RI data, and because these samples were analyzed on the totals basis, it is likely that reported metals concentrations in the initial RI samples from MW1 are primarily due to turbidity and are not reflective of dissolved metals concentrations. It is particularly notable that at MW3, where soil contains high lead concentrations, lead was detected

only three times with the maximum reported concentration of 0.006 milligrams per liter (mg/L). This level is less than one-half of the 0.015 mg/L cleanup level.

Given the lack of cleanup level exceedences for cadmium, chromium, and lead, both before and after cleanup actions, a decision was made with the approval of Ecology to drop these metals from further evaluation as COC in groundwater and continue only with the evaluation of arsenic.

Semivolatile Organic Compounds (SVOC)/PAH

Four quarterly rounds of groundwater samples were analyzed for SVOCs and/or PAH prior to cleanup actions and, with the exception of MW4, four rounds were analyzed subsequent to the 2002 cleanup action. The only wells where SVOCs were consistently detected prior to cleanup actions were MW3 and MW4. SVOC/PAH cleanup levels were never exceeded at MW1, MW2, and MW4. On two occasions prior to cleanup actions, cPAH concentrations at MW3 exceeded the toxicity equivalency factor. During cleanup actions, MW3 was found to have been drilled and installed directly through a buried creosote-treated timber bulkhead, which in effect emulsified the creosote and assisted with its migration into groundwater. The resulting PAH detections are a consequence of well installation. Subsequently, cPAH were not detected at MW3 during three of the four post-cleanup sampling rounds. Analysis of an equipment blank indicated that the presence of low PAH concentrations detected during the remaining post-cleanup sampling round was due to contamination from the sampling equipment.

The only instance where cPAH were found to be present in groundwater at concentrations of concern occurred when samples were collected immediately after MW3 was installed through the treated wood bulkhead, Therefore, the data show that the presence of SVOC/PAH in fill is related to a source composed of treated and burned wood debris. These source materials do not easily leach their chemical compounds and therefore are not likely to adversely impact groundwater. Therefore, a decision was made with the approval of Ecology to drop SVOC/PAH as COC in site groundwater.

Steady-State Groundwater Conditions

EPA's document "Methods for Evaluating the Attainment of Cleanup Standards" states that transient water level and water quality conditions frequently occur subsequent to groundwater treatment or source control activities. Arsenic data from MW1, MW2, MW3A, and MW5/5A show that local groundwater quality has experienced transient conditions as a result of cleanup activities, but has since reached steady state conditions. In every instance but one, arsenic concentrations increased during the sampling quarter immediately following cleanup actions, and declined during subsequent quarters. The one exception was MW2, where this observation was delayed by one additional quarter.

Pre- and post-cleanup arsenic concentrations versus sampling event for MW1, MW2, MW3/3A, MW4, and MW5/5A are shown on **Figures 3** through **7**. These figures also show arithmetic means for pre-cleanup samples as a basis for comparing pre- and post-cleanup water quality conditions.

As shown on **Figures 3** and **4** post-cleanup arsenic concentration means at MW1 and MW2 are lower than pre-cleanup means. Transient conditions at MW1 were observed during the November 2002 sampling round when the arsenic concentration was just above the practical quantitation limit (PQL). Arsenic was not detected during prior and subsequent quarters. Unlike other well locations where the transient condition was observed during the fall sampling quarter(s) immediately after cleanup action, a delay was observed at MW 2. The transient effect for arsenic was observed during the February 2003 sampling round, but was not observed during the prior (November 2002) and subsequent quarters.

Figure 5 shows arsenic data for MW3 and MW3A. At this location, all but one of the pre-cleanup samples (June 1999), as well as all post-cleanup samples, had arsenic concentrations lower than the pre-cleanup mean. For the June 1999 event, arsenic was reported as not detected and one-half the PQL (0.25 mg/L) was used to calculate the mean. The remaining pre-cleanup samples were all reported as less than the arsenic cleanup level of 0.005 mg/L. It is notable that arsenic has only been detected in this well immediately following cleanup actions (i.e., November 2002 and October 2003).

Figure 6 shows pre-cleanup arsenic data for MW4. This well was removed during soil excavation. **Figure 7** shows the data for MW5 and MW5A. Transient conditions were particularly evident at MW5/5A where arsenic concentrations before cleanup action ranged between 0.003 mg/L and 0.008 mg/L. However, during November 2002 and October 2003, arsenic concentrations spiked to 0.032 mg/L and 0.036 mg/L, respectively. After the initial spike, arsenic concentrations dropped by an order of magnitude and continued to decline. Pre-cleanup groundwater samples collected after June 1999 and those collected between the summers of 2002 and 2003 appear to have similar arsenic concentrations. Arsenic was not detected in samples collected during the three quarterly rounds after October 2003.

Section 6.1.1 of Ecology's document *Guidance on Sampling and Data Analysis Methods* states that data used to demonstrate the attainment of cleanup standards should be from a steady-state time period or should start when concentrations decline below the cleanup standard. The data shown on **Figures 3** through **6** were used to estimate the dates listed below:

- MW1—September 2002
- MW2—September 2002
- MW3A—November 2002
- MW5 and MW5A—February to July 2002 and January 2004.

Demonstration of Attainment

Regulatory Guidance

The cleanup level for arsenic in groundwater is 0.005 mg/L (5 μg/L). Arsenic concentrations in pre- and post-cleanup samples were grouped according to the steady state on-set dates listed above. Data were then statistically analyzed using Ecology's document *Statistical Guidance for Ecology Site Managers*. Statistical results and raw data were compared Ecology's three cleanup attainment decision criteria as follows:

1. Ninety-five-percent upper confidence limit (median) should be lower than the cleanup level.
2. No sample result can exceed twice the cleanup level.
3. Less than 10 percent of the sample results can exceed the cleanup level.

Data Analysis Process

Chapter 5 of the *Statistical Guidance for Ecology Site Managers* was used to evaluate arsenic data for each well (MW1, MW2, MW3/3A, and MW5/5A). Data for MW4 was used only to establish pre-cleanup mean and median concentrations.

Table 1 lists arsenic data for all sampling events from June 1999 through July 2004. Arsenic results reported as not-detected were replaced with one-half the PQL for that sampling event. For example, arsenic non-detections (<0.05 mg/L) reported for June 1999 samples were replaced with 0.025 mg/L. Note that in all succeeding groundwater sampling rounds the PQL was lower than the cleanup level of 0.005 mg/L.

Table 2 lists the pre- and post-cleanup data for each well (with the exception of MW4). These data were used to calculate the arithmetic mean, median, standard deviation (sample mean), and 95-percent upper confidence limit (UCL) for each monitoring well.

- Means were calculated as the sum of all data divided by the number of samples.
- Medians were calculated by ranking the data and then selecting the (n/2) value for odd numbered data sets and the result of [(n/2) + (n+2)]/2 for even numbered data sets.
- Standard deviations were calculated for the sample data set.

- Ninety-five percent UCL of the median were calculated using a one-sided confidence limit table, alpha = 0.05, and the following equation:

  UCL = median + (t1-0.05,n-1)[standard deviation/sqrt(n)]

  where:

  n = number of samples
  sqrt = square root

Pre-Cleanup Data

Table 2 contains a list of pre-cleanup median and means for each well. A summary of these data is provided below:

Median	
MW1	0.013 mg/L
MW2	0.011 mg/L
MW3	0.001 mg/L
MW4	0.016 mg/L
MW5	0.007 mg/L

Mean	
MW1	0.013 mg/L
MW2	0.013 mg/L
MW3	0.007 mg/L
MW4	0.016 mg/L
MW5	0.010 mg/L

Ninety-five percent UCLs were not calculated for pre-cleanup samples.

Post-Cleanup Data

Table 2 contains a list of post-cleanup median and means for each well. **Table 3** lists the statistical parameters used to calculate the 95-percent UCL of the median. A summary of these data is provided below:

Median	
MW1	0.002 mg/L
MW2	0.002 mg/L
MW3A	0.002 mg/L
MW5/5A	0.003 mg/L

Mean	
MW1	0.002 mg/L
MW2	0.002 mg/L
MW3A	0.003 mg/L
MW5/5A	0.004 mg/L

95% Upper Confidence Limit of the Median	
MW1	0.003 mg/L
MW2	0.003 mg/L
MW3A	0.004 mg/L
MW5/5A	0.005 mg/L

The statistical analysis results for MW1, MW2, and MW3A data indicate that cleanup standards have been attained at these locations. Statistical analysis results for MW5A data indicate that additional groundwater sampling should be completed at this location.

Supplemental Groundwater Sampling and Statistical Analysis

To ensure that arsenic-bearing soil left in place near Test Pit 14 is not contributing to current and future exceedences of the arsenic cleanup level in groundwater, supplemental groundwater samples will be collected from MW3A. Supplemental groundwater samples will also be collected at MW5A. The first of three scheduled sampling events occurred on October 25, 2004. Samples from MW3A and MW5A will also be collected in January and April 2005. Exact dates will depend on tidal cycle since samples will continue to be collected at low tide when the hydraulic gradient in the upland area is directed towards the east (seaward). All samples will be analyzed for arsenic.

Predicted Confirmation Monitoring

Ecology's document *Guidance on Sampling and Data Analysis Methods* provides the option that performance monitoring data may also be used along with conformational monitoring data to determine whether future contaminant concentrations will remain below cleanup levels. These data can then be used to predict long-term conditions. The next three sampling events for MW3A and MW5A are predicted to report non-detectable concentrations of arsenic. For comparison purposes, the additional statistical analysis results presented below used one-half the predicted non-detect level (0.0017 mg/L) of arsenic for the next three sampling events. **Table 2** contains the results of this calculation and the statistical results are summarized below:

Mean	
MW3A	0.002 mg/L
MW5/5A	0.003 mg/L

Median	
MW3A	0.002 mg/L
MW5/5A	0.002 mg/L

95% Upper Confidence Limit of the Median	
MW3A	0.003 mg/L
MW5/5A	0.003 mg/L

If actual sampling results do show arsenic to be non-detectable, then cleanup standards will have been attained at each well location. Actual results from each new sampling round will be used to update the post-cleanup statistical data analysis.

Long-Term Effectiveness

Long-term effectiveness of the upland soil cleanup action on attainment and maintenance of arsenic's cleanup standard will be demonstrated using performance and confirmation groundwater monitoring results and Ecology approved statistical data analysis methods. Current performance monitoring results show that groundwater has entered a steady-state condition. Water level and field parameter measurement data from the October 2004, January 2005, and April 2005 sampling events will be used to confirm the continuance of steady-state conditions. If reported arsenic concentrations for the three additional sampling events are below the cleanup standard (0.005 mg/L) or are reported as not-detected, statistical analysis results reported within this closure plan will not be substantially altered. New sampling event results will be used to predict that cleanup level for arsenic should not be exceeded in the future and to confirm that upland area cleanup actions will be effective for long-term protection of groundwater. This conclusion will also be supported by restrictions on disturbing the clean fill cap and on subsurface excavation, as well as annual cap inspections. If future site development becomes necessary, all contaminated materials disturbed by that development will be excavated and removed from the site at that time.

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