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May 16, 2003

Dale F. Frank, Jr.
Brown Dog Investments
7825 SE 76th Street
Mercer Island, WA 98040

REFERENCE: Draft RI/FS Report for the Maralco Site Kent, Washington
EMR Project #6070.001-1

Dear Mr. Frank:

Environmental Management Resources, Inc. (EMR) is pleased to present the enclosed draft of the Remedial Investigation/Feasibility Study (RI/FS) for the former Maralco Site in Kent, Washington. This report covers work completed by EMR at the Site as well as summarizing previous investigations and actions that have occurred at the Site.

EMR is pleased to be of assistance to you in the presentation of this report to Ecology. Please review the enclosed report and call me so that we may review and discuss the report prior to scheduling with WDOE. As discussed with you earlier, Don Clabaugh is no longer with our company; however, EMR would like to continue his involvement with this project. Prior to arranging the WDOE meeting, I would like to discuss with you how we may move forward with Don as part of the team.

Please call me as soon as you have a chance to review the document or have any questions. I look forward to continuing work with you.

Very Truly Yours,

Christina Merten, PE
Senior Engineer

Enclosure

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REMEDIAL INVESTIGAITON/FEASIBILITY STUDY FOR THE FORMER MARALCO SITE

Prepared for:

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May, 2003

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EXECUTIVE SUMMARY

This Remedial Investigation (RI)/Feasibility Study (FS) has been prepared by Environmental Management Resources, Inc. (EMR) on behalf of Brown Dog Investments to address environmental concerns at the former Maralco Aluminum Processing plant in Kent, Washington.

The Site is located in the Kent Valley along South 202nd Street. The Site encompasses approximately thirteen acres in an industrial-zoned portion of the city. The elevation is approximately 25 feet above mean sea level (amsl). Maralco operated an aluminum recycling/refinery facility at the Site from 1980 to 1986. Approximately 20,000 cubic yards of dross remain.

The aluminum dross piles are known to contain concentrations of aluminum, copper, barium, and mercury that are of potential concern for human health and ecological receptors. An RI has been completed at the Site, and the data is used to prepare a FS that evaluates remedial alternatives.

The overall objectives of the RI/FS are as follows:

1) Present the results of soil and groundwater investigations conducted at the Site;
2) Determine the nature and extent of contamination at the Site;
3) Evaluate contaminant fate and transport processes and finalize a conceptual Site model;
4) Develop Model Toxic Control Act (MTCA) cleanup levels for soil and groundwater;
5) Complete a baseline risk assessment;
6) Evaluate remedial alternatives in an FS; and,
7) Recommend a preferred remedial alternative.

To accomplish these objectives, the following tasks were completed:

- 20 shallow soil borings;
- 5 deep soil borings;
- Installation of 5 monitoring wells;
- 8 sediment samples were collected;

- 13 surface water samples were collected; and
- 22 dross samples collected.

Samples were analyzed for fluoride, nitrates, chloride, ammonia and other anions, and RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver, plus copper). Selected samples were analyzed for leaching potential. Sample results were compared with Model Toxics Control Act (MTCA) cleanup up goals. Fate and transport evaluations were completed to identify potential fate of the identified contaminants, and to focus the evaluation of transport pathways on persistent contaminants. A baseline risk assessment was completed to determine whether the presence and concentration of contaminants posed a significant risk to human health or the environment. An FS was completed so that remedial alternatives were evaluated to determine the ability to achieve closure goals, the length of time required for closure, and cost-effectiveness in accordance with the Model Toxics Control Act (Washington Administrative Code 173-340). The alternatives that were considered in the FS were: institutional controls with long-term ground-water monitoring; excavation with off-site disposal; and, on-site containment beneath a multi-media liner and cap system.

The on-site containment alternative is recommended for the Site. This approach satisfies the remedial action objectives, is cost effective relative to the benefits of the remedial action, and provides environmental protection from contaminants of concern. It is easily implementable and is cost-effective relative to the other two remedial alternatives evaluated for the Site.

One potential land use for the Site has been suggested by Brown Dog Investments, they are planning on developing the site as a lumber storage yard. The recommended remedial alternative would fit within these re-use plans.

1.0 INTRODUCTION

Environmental Management Resources, Inc. (EMR) has prepared this report for Brown Dog Investments to summarize the Remedial Investigation/Feasibility Study (RI/FS) conducted at the former Maralco Aluminum Company, Inc. (Maralco) Site in Kent, Washington. The RI/FS follows applicable regulations and guidance of the Washington Department of Ecology (WDOE). A description of activities performed during this RI is included in Section 5.0 of this report. Field activities for the RI were performed in January and February 2003.

The objectives of this RI/FS report are to:

8) Present the results of soil and groundwater investigations conducted at the Site;
9) Determine the nature and extent of contamination at the Site;
10) Evaluate contaminant fate and transport processes and finalize a conceptual Site model;
11) Develop Model Toxic Control Act (MTCA) cleanup levels for soil and groundwater;
12) Complete a baseline risk assessment;
13) Evaluate remedial alternatives in an FS; and,
14) Recommend a preferred remedial alternative.

This introduction includes the following subsections:

- Report Organization; and,
- Site Background Information.

1.1 REPORT ORGANIZATION

This RI/FS Report provides a summary of the activities for the RI and presents the FS evaluation. The report is organized into 11 sections and appendices. The contents of the sections are as follows:

- Section 1.0 provides general introductory information for the Maralco Site;
- Section 2.0 summarizes environmental setting data for the vicinity of the Site;

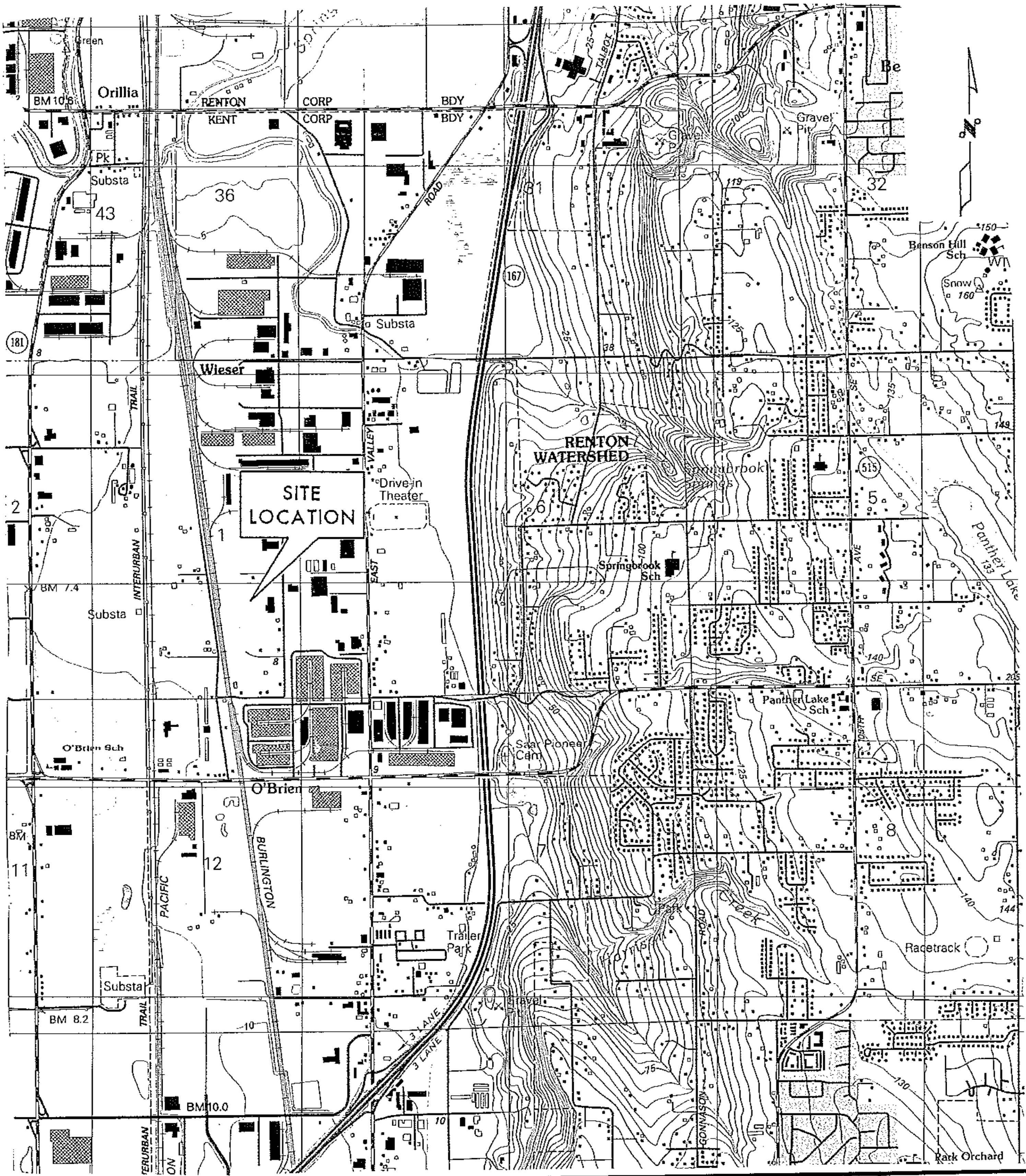
- Section 3.0 describes the current field investigation program;
- Section 4.0 presents the investigation findings;
- Section 5.0 discusses contaminant fate and transport;
- Section 6.0 discusses risk assessment;
- Section 7.0 presents the general remedial action objectives (RAOs) and MTCA cleanup levels to be considered.
- Section 8.0 presents the potential remediation technologies applicable and compares remedial alternatives developed for the Maralco Site against MTCA threshold requirements for remedy selection.
- Section 9.0 describes the evaluation of each remedial alternative by the MTCA remedy selection (WAC 173-340-360) criteria considered during the detailed analysis phase of the FS.
- Section 10.0 presents the conclusions of the RI/FS and recommends a preferred remedial alternative.
- Section 11.0 lists references.

1.2 SITE BACKGROUND INFORMATION

The Maralco Site is located in the City of Kent at 7730 South 202nd Street (see Figure 1-1 for Site location). The Site is bounded by South 202nd Street on the north, 80th Avenue South on the east and Burlington Northern Santa Fe Railway tracks on the west (Figure 1-2). The Site encompasses approximately thirteen acres in an industrial-zoned portion of the city. The elevation is approximately 25 feet above mean sea level (amsl). The location is in the NE 1/4 of the SE 1/4 of Section 1, Township 22 North, Range 4 East. Former investigation reports were reviewed as part of this RI/FS effort.

1.2.1 Historical Site Improvements

A farmhouse and associated buildings were constructed on the Site between 1960 and 1968 (MK-Environmental Services, February 1991). The farmhouse is currently vacant and surrounded by dense blackberry growths.



EMR INCORPORATED

Maralco Site
7730 South 202 Street
Kent, WA 98032

Site Plan

Design By: DLW
Drawn By: SKA
Checked By: CMM
Project #: 6070.001-1

Revision No: 1
Date: 2/28/03
Scale: As Shown
File Name: Fig1box.vcd

FIGURE
1-1

Figure 1-2

in separate pdf file

Maralco operated an aluminum recycling/refinery facility at the Site from 1980 to 1986. The recycling/refinery operations took place in an approximately 45,000 square foot warehouse building. The warehouse building is constructed of precast concrete. A structural review of the building was conducted on January 23, 2003 by Rupert Engineering (Maralco Building Structural Investigation, February 12, 2003). A large asphalt paved parking area is located north of the warehouse building. A 35,000 gallon diesel underground storage tank (UST) was removed from the northwest corner of the parking lot in 1995. The tank area is currently being addressed under WDOE's VCP program for groundwater contamination.

1.2.2 Historical Waste Management Operations

The recycling process used at the Maralco Site produced aluminum alloy from recycled aluminum cans, Kawecki-Berylco, Inc. (KBI) dross, and scrap metal. The wastes created from this process include black dross and particulate matter that was collected in baghouses located in the southwest corner of the warehouse. The KBI dross was imported to the site for an additional source of metallic aluminum (Ecology & Environment, Inc., 1987). During its early operation beginning in 1980, the waste materials were shipped off-site to a landfill. After 1981, the materials were stored east of the warehouse in two locations (MK-Environmental, February 1991). Maralco filed for bankruptcy in 1983 and ceased their operations in November 1986. In February 1986, Ecology received a complaint from the Metro Industrial Wastewater Section concerning leachate from the dross piles that was potentially entering the drainage systems surrounding the Site. WDOE began investigations at the Site in March 1986; however, an enforcement action was never carried out at the site due to the bankruptcy agreements on the property.

1.3 PREVIOUS INVESTIGATIONS AND DOCUMENTATION

Several investigations and interim actions have been completed at the Site as described below.

1.3.1 Previous Investigations

A Site Assessment Report was produced by Ecology & Environment, Inc. (E&E) on WDOE's behalf in October 1987. As part of the initial site assessment investigation E&E collected samples from the dross piles east of the warehouse, samples of the baghouse dust and KBI dross interior of the building, sediment and surface water samples from the drainage ditches trisecting the property, and soil samples from the east side of the property as well as adjacent properties to the south and north. The Site Assessment Report concluded that there were four types of refining waste at the Site that consisted of black dross, washed aluminum oxides, KBI dross, and baghouse dusts. E&E estimated 50,000 tons of black dross, 500 pounds of baghouse dust, 10 tons of KBI dross, and 5,000 tons of washed aluminum oxide. The sampling conducted showed that the black dross had impacted the drainage ditches that trisect the property, and that the KBI dross and baghouse dusts were considered an extremely hazardous waste based on a ninety-six hour fish toxicity test. However, according to the report, the waste, soil, and sediment samples did not exceed toxicity hazardous waste criteria (E&E, October 1987).

A Phase I Remedial Investigation Report was then generated by MK-Environmental Services (MKE) on behalf of WDOE in February 1991. The remedial investigation involved characterizing the black dross piles surrounding the warehouse, installation of four monitoring wells, investigation of a former dross storage area in the eastern portion of the property, and investigation of a holding pond located in the northwest corner of the property. All of the samples collected during this investigation were surficial with the exception of soil and groundwater samples collected from the monitoring well locations. Shallow groundwater results showed elevated concentrations of sodium, potassium, and various metals in MW-3 and MW-4. The groundwater samples from MW-1, on the southeast portion of the site, also had elevated levels of arsenic, aluminum, lead, and zinc. The soil samples from MW-3 and MW-4 showed elevated levels of sodium, potassium, and chloride. The investigation also showed that the material from the piles was entering the drainage ditches on the property and the surface water was then transporting the material off-site (MKE, February 1991).

MKE conducted a feasibility study and pilot plant investigation at the Site from January 1990 to March 1991. These activities were summarized in MKE's report Phase I Feasibility Study Report dated March 1991. In May 1990 MKE transported approximately 74 tons of washed oxide material from the interior of the warehouse building to the La Farge Cement Plant in Kamloops, British Columbia. The material was shipped to the cement plant for investigation of marketability of the material in the cement manufacturing industry.

As part of the feasibility study an aerial topographic survey was conducted. Based on the survey, MKE revised volumetric estimates for the waste materials exterior of the warehouse building as follows:

▪ Volume of black dross:	19,325 cubic yards
▪ Volume of washed oxides	1,074 cubic yards
▪ Tons of black dross (dry basis)	20,871 tons
▪ Tons of washed oxide (dry basis)	1,160 tons

The investigation involved a preliminary assessment of the black dross piles on-site. Thirteen dross samples were analyzed for indicator metals, Toxicity Characteristic Leaching Potential (TCLP) metals, and hexavalent chromium.

Prior to TCLP and chromium analysis the thirteen samples were composited into five samples. All of the TCLP metals concentrations were below detectable levels, except for one sample that had a result of 0.2 mg/kg lead. Dangerous waste classification requires a lead TCLP result above 5 mg/kg; therefore, the dross is not classified a dangerous waste.

The purpose of the pilot plant was to investigate the feasibility of washing the black dross material to remove sodium and potassium and then recycling the washed aluminum oxide. The pilot plant was operated at the Site from July 18, 1990 to December 18, 1990. During the five-month pilot program, the plant processed 2,179 tons of black dross. This processed material was left on-site, while the wash water was discharged to the Seattle Metro sewer system (MKE, March 1991).

1.3.2 Past Interim Actions

In June 1991 MKE submitted a Work Plan for Ongoing RI/FS Activities to WDOE. The report suggested six separate tasks to be completed during the remaining RI/FS investigation. Task 4 of the work plan addressed interim remedial actions to be conducted at the Site. These items were as follows (MKE, June, 1991):

- Cover waste pile with visqueen or plastic sheeting;
- Grade the Site to eliminate standing water and direct drainage to storm sewer;
- Replace fence,
- Wash lot, clean storm drains, excavate old stormwater holding pond; and
- Assess permitting requirements in terms of the classification of the Site as a wetland.

These interim remedial actions were completed in October 1991. All of the tasks are described in a letter report from MKE to WDOE dated December 3, 1991. In September 1991 a fence was placed surrounding the Site with the exclusion of the farmhouse along the northern border of the property. Signs were posted on the fence at site entrances and property corners identifying the sight as containing dangerous waste. The stormwater collection pond located northwest of the warehouse building was excavated in October 1991. The excavation involved removing approximately the top two feet of sediment and soil from the bottom of the pond that measured approximately 80 feet by 20 feet. The extent of excavation was determined based on visual observations of gray dross-like material. All excavated material was drummed and stored on-site in the northwest corner of the parking lot and were removed at a later date. Also in October 1991 the roof drains of the warehouse building were re-routed to prevent drainage running onto the dross piles. Finally, the dross piles surrounding the warehouse building were graded to remove stormwater ponding problems and then the piles were covered with a 5 mil, 3-ply plastic material guaranteed to have a 2-year life.

Operation and maintenance of these interim remedial actions were not maintained at the Site due to a lack of funding at WDOE.

2.0 ENVIRONMENTAL SETTING

The environmental setting at the Maralco Site is presented here to establish a reference for discussion of the RI.

2.1 TOPOGRAPHY

The Maralco Site is in the lower Kent Valley. The valley extends north to Renton and south to Auburn. The Site is relatively flat at an elevation of about 25 feet amsl. Several mounds of aluminum dross exist on-site.

2.2 METEOROLOGY

In the Kent area, temperatures vary from 34°F to 52°F in the winter to 50°F to 78°F in the summer. The average annual precipitation is 39 inches, including 4 inches of snow. The greatest precipitation occurs between the months of November and March, during the winter season. The average monthly precipitation ranges from 0.85 inches in July to 6.00 inches in December. The heaviest 1-day rainfall of 6.00 inches was recorded in December 1949.

2.3 GEOLOGY

The Site is located in the lower Green River Valley. The valley runs north from Auburn to Renton. The valley is located within the Puget Sound Lowland. The physiography of this area has been dominated by the advance and retreat of continental glaciers during the Vashon Glaciation period.

Advance of the glaciers into western Washington carved out the Kent Valley while depositing outwash chiefly composed of sand and gravel, and dense compacted glacial till in the upland areas. Retreat of the glaciers left the valley as a deep marine embayment. The Green, White and Cedar Rivers deposited a thick accumulation of fluvial sediments, which were eroded from the glacial drift uplands, into the valley. The remaining sediments consist of coarse sand and gravel near the mouth of the rivers at Auburn and Renton, and become finer toward the Kent area. (Luzier, 1969)

2.4 SURFACE WATER HYDROLOGY

Drainage ditches trisect the property. Christopher Ditch runs southwest through the property from 80th Avenue South and then at approximately the center of the property the ditch turns northwest and runs to South 202nd Street. An unnamed ditch flows northward along the southeastern edge of the dross piles to Christopher Ditch. Christopher Ditch then discharges into Mill Creek approximately ¾ of a mile northwest of the Site. Mill Creek is a tributary of the Green River.

2.5 HYDROGEOLOGY

The following subsections describe the regional and local hydrogeology in the vicinity of the Maralco Site.

2.5.1 Regional Hydrogeology

The Maralco Site is located within the Duwamish (Green) River Basin. Regional groundwater in the area of the Maralco Site is dominated by the Green River. Five distinct hydrogeological units comprise the aquifer system and are (from youngest to oldest), the White River Alluvium, the Vashon glacial deposits, the Salmon Springs deposit, the Older Undifferentiated Glacial and Interglacial deposits, and the Bedrock of the Puget Group (Hart-Crowser & Associates, 1984).

2.5.2 Local Hydrogeology

Soils at the Site are saturated at approximately five feet below ground surface. Potentiometric mapping from the January groundwater sampling event indicate groundwater in this shallow aquifer flows to the north-northwest. Groundwater on the Site is likely to be influenced by the ditches that cross the Site as well as ponding that occurs west of the property between the rail spur and the mainline tracks.

2.6 LAND USE

The Site has been used as farm land and for aluminum recycling. The Site is bounded on the north by South 202nd Street and Christopher Ditch. Across South 202nd Street is Puget Sound Pipe and Supply, a piping supply warehouse and GE Osmonics, a pump manufacturer. Puget Sound Pipe utilizes the Site for access to the rail spur for loading and shipment of piping materials. The property is bounded to the east by 80th Avenue South and an abandoned warehouse building. To the south is the Colonial Cedar property, a former cedar mill operation that is currently abandoned. The Site and surrounding area east of the railroad tracks are zoned M2 – Industrial. The property west of the railroad tracks is zoned M3 – Heavy Industrial.

Currently the warehouse and parking lot area are being used by URESCO Construction for lumber storage. The proposed future plans for the site involve increasing the paved area at the Site for additional lumber storage area.

2.6.1 Groundwater Supply

Research was conducted to identify the existence and location of water wells around the Site. EMR contacted the City of Kent Water Department for information of water sources and general water use guidelines within the City of Kent. According to Mr. Brad Lake, Water Superintendent, the City of Kent obtains its water exclusively from water supply wells located throughout the city limits. The City does not allow connection to the municipal water supply while a property is using a private well. The City also highly discourages any installation or new connection to private wells.

Various agencies were contacted concerning wells in the area of the Site including the WDOE, the City of Kent, Department of Water Resources, the US Geological Survey, and Region 10 of the US Environmental Protection Agency. Numerous wells were identified in the surrounding area within a half-mile radius of the Site. These well data and locations are detailed in the EMR letter report dated March 6, 2003.

The WDOE well database identified two wells that appear to have been residential drinking water or agricultural water supply wells. One well was located near the southwest corner of South 196th Street and 84th Avenue South approximately 0.25 mile northeast of the Maralco property. This well was drilled in 1921. The other was located at 20444 84th Street South, approximately 0.25 mile east of the site. This well was drilled in 1934. Both of these properties are now zoned industrial and are being have large industrial complexes situated on them. No residential properties remain in these areas. Based on the current property use and the City's policy for connecting to private water wells, EMR believes that the wells are not used in these locations.

Several industrial properties near the Site have on-site monitoring or "resource protection" wells. The closest of these is the Colonial Cedar (also known as JG Pendergast) site located at 7800 South 206th Street, just south of the Site. Another is Ketchum Lumber, now occupied by Dayton-Richmond at 7748 South 200th Street approximately 0.15-mile north and down gradient of the Maralco property.

The only remaining residence observed within the surrounding area was located at 8042 South 200th Street approximately 0.25 mile north-northeast of the Site. This address was not included on the WDOE database of water wells within the search area. No other residential or agricultural properties were observed within the half-mile of the Site.

3.0 EMR FIELD PROGRAM

This section describes the field program activities conducted by EMR during the RI at the Maralco Site. The results of the field program are presented and discussed in Section 4.0. Table ~~3-1~~ 4-1 contains a summary of the field activities. Figure 3-1 shows sampling locations. Previous RI field program activities are detailed in Section 4.0.

3.1 SUMMARY OF FIELD ACTIVITIES

EMR commenced field activities in January 2003. The field program as conducted is summarized in this section. The field program consisted of the following:

- Drill and install one groundwater monitoring well MW-5. Collect soil samples during drilling for purposes of logging soils and chemical analyses at selected depth intervals.
- Drill four (4) soil borings DP1 through DP4 through the main aluminum dross pile. Collect soil samples from soil for geotechnical and chemical analyses at selected depth intervals.
- Drill one soil borings DP5 in the area of the former dross storage area in the eastern portion of the property. Collect soil samples from soil for geotechnical and chemical analyses at selected depth intervals.
- Locate existing monitoring wells MW-1 through MW-4. Measure depth to groundwater on all groundwater monitoring wells from surveyed top of casing elevations to construct potentiometric surface map of shallow aquifer.
- Develop and purge groundwater monitoring wells.
- Collect groundwater samples for chemical analyses.

A summary of soil samples collected for laboratory analysis is shown in Table ~~3-2~~ 4-3. A summary of groundwater samples collected for laboratory analysis is shown in Table ~~3-3~~ 4-2. Boring logs and monitoring well construction information are attached as Appendix A.

Figure 3-1

in separate pdf file

3.1.1 Soil Boring Exploration

Five (5) soil borings were advanced with a limited access truck-mounted drill rig by Environmental Services Network, Inc. on February 4, 2003. Locations are shown on Figure 3-1. EMR, represented by David L. Welch, logged the aluminum dross and underlying soils during drilling activities.

The objectives of the soil borings were to:

- Log the aluminum dross based on color and texture;
- Determine the depth of the aluminum dross (i.e., elevation of natural soil or other fill material beneath the dross);
- Evaluate shallow groundwater levels under the aluminum dross piles; and
- Obtain samples of the underlying soil for chemical analysis.

Samples were field screened for inorganic contaminants utilizing a X-RAY fluorescence instrument (XRF). These results are summarized in Section 5.0. Based on these results and the groundwater monitoring results, soils were selected and sent to the laboratory for analysis of aluminum, cadmium, and arsenic.

3.1.2 Groundwater Monitoring Wells

One groundwater monitoring well, MW-5, was installed by hollow stem auger. New and existing well locations are shown on Figure 3-1. The well boring was logged by Mr. Welch of EMR. The boring was completed with a 10-foot length of two-inch diameter ten-slot (0.01 inch) PVC screen. Silica sand pack (number 2/12 Lonestar) was emplaced from the bottom of the screened interval to three feet above the top of the screen. The boring for the wells was logged by collecting wire-line split spoon sample at selected intervals. The well borings were advanced to 16 feet, and then the casing cleaned out and a water level measurement taken.

Immediately after completion, the monitoring well was developed by using a disposable bailer. Temperature, conductivity, specific conductivity and pH were monitored and recorded while a minimum of five well volumes were purged from the well. In addition, observations of turbidity were made. Well development continued until the water was clear and free of sand. Soil cuttings and development water were drummed, labeled and stored in the southeast corner of the parking lot. At the time of this report, the top of casing had not been surveyed; therefore, water elevation could not be determined.

Within 48 hours of development groundwater samples were collected. Prior to collecting the samples, the water level was recorded from top of casing and approximately five well volumes were purged using a disposable bailer. Groundwater levels were also recorded from MW-2, MW-3 and MW-4. MW-1 could not be located due to dense blackberry growth in the area of the well. The existing monitoring wells were then purged of a minimum of five well volumes and samples were collected using dedicated disposable bailers for each well.

A duplicate sample was collected from MW-2 for verification of lab analysis and background conditions. Samples were submitted for laboratory analyses listed in Table 4-3. The groundwater samples were collected into laboratory-prepared sample containers. Samples were labeled and stored on ice.

4.0 REMEDIAL INVESTIGATION FINDINGS

This section describes and discusses the overall geology and hydrogeology of the Maralco Site, presents and discusses the results of soil and groundwater sampling, and discusses the cumulative results of all site characterization findings.

4.1 GEOLOGIC AND HYDROGEOLOGIC INVESTIGATION RESULTS

The following geology and hydrogeology discussion for the Maralco Site is based on boring logs, water levels, soil, and water analytical data. The results of the data, obtained during the RI, are presented below.

4.1.1 Stratigraphy

Based on DP-2, DP-3, and DP-4 the main dross pile is underlain by a brown gravelly sand fill. The fill extends approximately 2 feet below the dross pile. This fill may have been laid as a grade preparation or liner material for the dross. Below the fill material is a uniformly graded dark brown fine silty sand. Boring DP-4 indicates that dross extends approximately 5 feet below the original property grade (the grade prior to placement of dross). All other borings indicate that dross is above the native surface level only.

Boring MW-5 is north of the main dross pile at the Site. This boring indicated uniformly graded brown silty sand from zero to eight feet below ground surface. From eight feet to fifteen feet below ground surface is a dark brown uniformly graded fine sand.

4.1.2 Hydrogeologic Setting

4.1.2.1 Potentiometric Surface of the Groundwater

Groundwater level information indicates the water table is approximately 5 feet below ground surface (bgs) at an approximate elevation of 20 feet above the National Geodetic Vertical Datum (NGVD). Groundwater flow directions from activities conducted in 1990 and 2003 indicate flow in a northerly to northwesterly direction in the vicinity of the Site. Groundwater levels were also collected during the Site surveying activities in April 2003.

Groundwater levels from the January and April 2003 investigation are shown in Table 4-1. A potentiometric surface map based on water levels measured in January and April 2003 are presented as Figure 4-1 and 4-2, respectively. The groundwater flow direction appears to be influenced by the drainage ditches located on the Site. Groundwater gradient is generally in the north-northwesterly direction.

4.1.2.2 Changes in Groundwater Elevations

In the Kent Valley typical changes in shallow groundwater elevations occur on a seasonal basis and generally are fluctuations of up to 5 feet from the highest levels in spring to the lowest levels in late summer and fall. Generally, the shallow groundwater responds rapidly and in proportion with changes in the seasonal rainfall amounts. The drainage ditches that trisect the property are likely to influence the shallow groundwater at the Site.

A comparison of water level information from the 1990 sampling events shows water elevations varied between 17.99 feet msl to 22.89 feet msl, for a maximum variation of 4.9 feet. According to MKE, there was heavy rainfall at the site between the two 1990 sampling events. The 2003 event occurred during the wet season and generally the elevations fell between the two 1990 events.

4.2 GROUNDWATER SAMPLING RESULTS

In 1990, MKE installed four groundwater monitoring wells at the Site to define the nature and extent of groundwater impact at the Site from the dross piles. The MKE wells are MW-1 (reportedly located in the southeast corner of the property), MW-2 (located in the northeast corner of the property), MW-3 (located near the southwest corner of the property between the rail spur and mainline tracks), and MW-4 (located near the northwest corner of the property, just north of the former stormwater holding pond). MKE conducted groundwater sampling of MW-1 through MW-4 in 1990.

EMR installed an additional well (MW-5) in January 2003 between Christopher Ditch and the main aluminum dross pile, just east of the parking lot. EMR purged and sampled monitoring wells MW-2 through MW-5 on January 24, 2003. EMR attempted to located MW-1; however, due to heavy overgrowth of blackberries in the area, the well could not be located.

A summary of analytical results by constituent is provided below. Results are shown in Table 4-2. Laboratory reports are enclosed in Appendix B.

TABLE 4-1

Summary of Remedial Investigation Activities
Maralco Site, Kent, WA

Explorations/Samples	Number
Number of Shallow Soil Borings	20
Number of Sediment/ Surface Water Collection Locations	6
Number of Deep Soil Borings	5
Number of Groundwater Monitoring Wells (Previous)	4
Number of Groundwater Monitoring Wells (New)	1
Number of Aluminum Dross Samples (Chemical Testing)	22
Number of Sediment Samples (Chemical Testing)	8
Number of Surface Water Samples (Chemical Testing)	13
Number of Soil Samples (Chemical Testing)	19
Number of Groundwater Samples	8

Figures 4-1 through 4-6
See Separate pdf file

TABLE 4-2

Results of Groundwater Analyses
Maralco Site, Kent, Washington

		Concentrations in micrograms per liter									Concentrations in milligrams per liter			
Location Identifier	Date Sampled	Aluminum	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver	Ammonia-Nitrogen	Chloride	Nitrate-Nitrogen	Flouride
2003 Analytical Methods		EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	APHA/EPA	EPA 300.0	EPA 300.0	EPA 300.0
2003 Practical Quantitation Limit		110	3.3	56	4.4	11	1.1	0.5	5.6	11	0.100			
MW-1	10/2/1990	17800	7.96	109	ND	16	5.32	.12	ND	ND	0.175	NA	NA	NA
MW-2	10/1/1990	2350	5.30	33.3	ND	ND	2.0	ND	ND	ND	0.124	NA	NA	NA
	1/24/2003	600	ND	ND	ND	ND	1.2	ND	ND	ND	1.26	9.64	ND	ND
MW-2D	1/24/2003	860	ND	ND	ND	ND	1.4	ND	ND	ND	0.433	8.89	ND	ND
MW-3	10/1/1990	3850	5.38	3530	ND	ND	1.0	.11	ND	ND	14.638	NA	NA	NA
	1/24/2003	820	40	2500	ND	14	2.7	ND	43	ND	33.7	9100	ND	ND
MW-4	10/1/1990	27500	17.1	605	ND	25	9.51	0.077	ND	ND	6.683	NA	NA	NA
	1/24/2003	3600	19	77	ND	22	9.0	ND	ND	ND	1.71	92.0	ND	6.89
MW-5	1/24/2003	28000	11	170	ND	38	8.0	ND	ND	ND	1.52	442	1.50	2.10
2001 MTCA Method A Limits			5		5	50	15	2						
Drinking Water Standard MCL		200	50	2000	5	100	15	2	50	100		250	10	4

ND = Not detected above detection level

4.2.1 Major-Ion Chemistry

Alkalinity: Groundwater samples collected in 1990 were analyzed for alkalinity. The 1990 results indicated that alkalinity at the Site ranged from non-detectable in MW-3 to 215.4 mg/l in MW-4. The average concentration was 96.63 mg/l.

Calcium: Groundwater samples collected in 1990 were analyzed for calcium. The 1990 results indicated that calcium in the groundwater at the Site ranged from 16.8 mg/l in MW-1 to 700 mg/l in MW-3. The average concentration was 201.8 mg/l.

Chloride: Groundwater samples collected in 1990 were not analyzed for Chloride. The 2003 results indicated that chloride concentrations at the Site range from 8.89 mg/l in MW-2 to 9,100 from MW-3. The average concentration was 2,410.7 mg/l with a median result of 442 mg/l. An isoconcentration contour map of chloride concentration in groundwater is shown in Figure 4-3. Elevated concentrations extend to the north in the direction of groundwater flow. The plume is centered under the main dross pile, which is apparently the predominant source of chloride on the Site.

Potassium: Groundwater samples collected in 1990 were analyzed for potassium. These samples contained concentrations of potassium from 1.58 mg/l to 583 mg/l.

Sodium: Groundwater samples collected in 1990 were analyzed for sodium. These samples contained concentrations of sodium from 7.77 mg/l to 2005 mg/l. The average concentration was 672.2 mg/l.

4.2.2 Inorganic Compounds

Metals: During the 1990 sample event samples from MW-1 through MW-4 were analyzed for total target analyte metals. During the 2003 sample event samples from MW-2 through MW-5 were analyzed RCRA 8 metals plus aluminum. Results, shown in Table 4-2, show levels of aluminum, arsenic, barium, chromium, and lead that are above typical groundwater concentrations for these constituents.

Arsenic: For the 2003 sampling event Arsenic levels in MW-3 through MW-5 were above MTCA Method A cleanup limits of 5 µg/l. Isoconcentration contour maps of arsenic concentration in groundwater in 1990 and 2003 are shown in Figure 4-4 and 4-5, respectively. There appear to be two plumes at the Site. One in the area of the former stormwater holding pond and one centered under the main dross pile. For the dross pile plume, elevated concentrations extend to the north in the direction of groundwater flow and are generally similar to the chloride plume. A small plume of arsenic also appears to be centered around MW-4, which is in the area of the former stormwater detention pond for the facility. Concentrations above the MTCA Method A cleanup levels extend beyond the Site boundary to the north and south.

Nitrate-Nitrogen: Groundwater samples collected in 1990 were not analyzed for nitrate-nitrogen. Samples collected in 2003 showed a nitrate concentration in MW-5 of 1.50 mg/l and non-detectable levels in MW-2 through MW-4.

Ammonia: Groundwater samples collected from wells MW-1 through MW-4 in 1990 indicate groundwater concentrations at the Site ranged from 0.124 mg/l in MW-2 to 14.6 mg/l in MW-3. The samples collected in 2003 showed groundwater concentrations at the Site ranging from 1.26 mg/l in MW-2 to 33.7 mg/l in MW-3. The average concentration of ammonia for all wells for the two sampling rounds was 7.48 mg/l.

Fluoride: Groundwater samples collected from MW-4 and MW-5 in 2003 show fluoride concentrations of 6.89 mg/l and 2.10 mg/l respectively. The secondary drinking water standard for Fluoride is 5 mg/l. Fluoride was not detected in the samples collected from MW-2 or MW-3. The groundwater samples collected in 1990 were not analyzed for fluoride.

4.3 DROSS INVESTIGATION RESULTS

The aluminum dross has been tested by numerous parties for various reasons. Additional testing has also been conducted to determine if the dross material was suitable for recycling. EMR did not sample any of the dross material as part of this phase of remedial investigation. A summary of results from the previous MKE investigations is provided in this Section.

4.3.1 MKE Investigation

The investigation of aluminum dross conducted by MKE is detailed in their Phase I Remedial Investigation Report (MKE, 1991) and their Work Plan for Ongoing RI/FS Activities report (MKE, 1991).. MKE conducted dross testing beginning in May of 1990 with the collection of samples from shallow hand borings. A comprehensive topographic survey resulted in volume estimates for each pile of dross. An aerial topographic survey was conducted of the Site as part of these investigations. The results of this topographic survey are shown in Figure 4-6. Results for the MKE investigations may be found in the reports referenced above.

The MKE samples were collected in various stages, with the bulk of the samples being collected during Stage 2 of the RI. During this sampling round, 23 samples were collected from five transects across the main dross pile. Samples were collected at 0.5-foot intervals and the material was visually described. Ammonia vapors were encountered in some of these boreholes during sample collection. Following collection of the 23 discrete samples, composite samples were created based on each of the transects. The five composite samples were then analyzed for TCLP and hexavalent chromium analyses. Discrete samples were analyzed for metals, cyanide, ammonia, total kjeldahl nitrogen (TKN), and chloride.

The discrete samples showed elevated levels of metals. Aluminum concentrations ranged from 130,000 mg/kg to 211,000 mg/kg. All TCLP metal concentrations were below detectable levels with the exception of one sample (TC-1) from the southwest end of the main dross pile. The TC-1 sample had a TCLP result of 0.2 mg/l lead. The TCLP results indicate that the dross does not qualify as a dangerous waste, which requires a TCLP result above 5 mg/l.

Discrete samples were also collected from the washed oxides during marketability studies conducted by MKE. These studies were conducted in 1991 and involved analyzing the dross for potential use in the cement industry. Based on a review of available files, the dross was not suitable for re-use in the cement industry.

4.4 SOIL INVESTIGATION RESULTS

The soil at the Site has been sampled as part of the MKE RI/FS investigation and the EMR RI/FS. A summary of results from these investigations is provided in the following Section.

4.4.1 MKE Investigation

MKE collected soil samples during well installation and as part of the two-stage RI conducted in 1990. Results from the RI can be found in the Phase I Remedial Investigation Report (MKE, February 1991). As part of the stage 1 portion of the RI activities, MKE collected six shallow soil samples in the region of the former eastern waste pile. These samples were analyzed for total metals, volatile organic compounds, semivolatile organics, cyanide, ammonia, TKN, and cation exchange capacity. None of the soils had results above MTCA Method A cleanup levels.

MKE also collected soil samples during the second stage of their RI investigation activities. Fourteen samples were collected from various locations throughout the site with a stainless steel hand auger. All of the soil samples collected during this stage of the investigation were analyzed for indicator metals and geochemical parameters. The samples collected from the area of the dross piles, from the Site drainage areas, and from the yard of the former farmhouse on the property had elevated metals. Chloride results also were high in these areas. The shallow soil samples collected in the areas surrounding the dross piles showed aluminum ranging from 17,700 mg/kg to 188,000 mg/kg. None of the soils had results above MTCA Method A cleanup levels.

Four wells were installed during the MKE RI/FS investigation. Soil samples were collected during well installation and submitted for analysis of indicator metals, geochemical parameters, volatile organic compounds, and polynuclear aromatic hydrocarbons. The soils from MW-3 and MW-4 show elevated levels of chloride. None of the monitoring well soils had results above MTCA Method A cleanup levels.

4.4.2 EMR Investigation

Soil samples were collected from approximately three feet below the aluminum dross at the DP-2, DP-3, and DP-4 boring locations. A soil sample was collected approximately one foot below the aluminum dross at the DP-1 boring location. A sample also was collected from 2.5 feet below ground surface at DP-5. Boring locations are shown on Figure 3-1. Soil samples were then screened using an XRF analyzer. The XRF results are shown in Table 4-3. Soil samples were analyzed for cadmium, aluminum, and arsenic. These metals were chosen for analysis based on the results of the groundwater analyses discussed in Section 4.2 and the previous soil investigation results discussed in Section4.4.1. Results are shown in Table 4-4.

TABLE 4-3

Results of XRF Analysis of Soils
Maralco Site, Kent, Washington

Sample I.D.	Date Sampled	Date Tested	COC Group	Pb (ppm)	As	Cr	Hg
MW5 - 5	1/22/2003	1/30/2003	1	18	NA	NA	NA
MW5 - 10	1/22/2003	1/30/2003	1	BDL	NA	NA	NA
MW5 - 15	1/22/2003	1/30/2003	1	13.9	NA	NA	NA
DP 2-1'	2/4/2003	2/11/2003	1	BDL	BDL	BDL	BDL
DP 2-3'	2/4/2003	2/11/2003	1	BDL	BDL	BDL	BDL
DP 3-1'	2/4/2003	2/11/2003	1	BDL	BDL	BDL	BDL
DP 3-3'	2/4/2003	2/11/2003	1	BDL	BDL	BDL	BDL
DP 4-3'	2/4/2003	2/11/2003	1	BDL	BDL	BDL	BDL
DP 5-1'	2/4/2003	2/11/2003	1	BDL	BDL	BDL	BDL
DP 5-2.5'	2/4/2003	2/11/2003	1	BDL	BDL	BDL	BDL

Note:
BDL = Below Detection Limit
NA = Not Analyzed

TABLE 4-4

Results of Heavy Metals Soils Analysis
Maralco Site, Kent, Washington

		Concentrations in milligrams per kilogram		
Location Identifier	Date Sampled	Cadmium	Aluminum	Arsenic
		EPA 7130	EPA 7020	EPA 7061
DP-1-1'	2/4/2003	ND	3000	ND
DP-2-3'	2/4/2003	ND	1400	ND
DP-3-3'	2/4/2003	ND	2000	ND
DP-4-3'	2/4/2003	ND	2300	ND
DP-5-2.5'	2/4/2003	ND	1400	ND
DP-5-2.5' Dup	2/4/2003	ND	1400	ND
		1	50	5

ND = Not detected above detection level

Cadmium and arsenic were not detected in any of the soil samples. Aluminum was detected in all of the samples and ranged from 1,400 mg/kg to 3,000 mg/kg.

Based on the investigation results, soils do not contain contaminants above the MTCA Method A cleanup levels.

4.5 SEDIMENT INVESTIGATION RESULTS

The drainage ditch sediments were tested by MKE in 1990. EMR did not sample any of the sediment material as part of this phase of the RI. The dross piles were covered with a tarp in 1991; therefore, the 1990 samples are assumed to represent the worst-case concentrations. A summary of results from the previous investigation is provided in this Section.

4.5.1 MKE Investigation

MKE collected sediment samples as part of the two-stage RI conducted in 1990. Samples for sediments were only collected in the first stage of the RI effort. Results from the sediment investigation are listed in the 1991 MKE report. MKE collected five sediment samples from the on-site drainage ditches, one sample from a former stormwater detention pond northwest of the warehouse building, and one sediment sample from Christopher Ditch immediately north of the Site. These samples were analyzed for total metals, cyanide, ammonia, TKN, semivolatile organics, priority pollutants, and cation exchange capacity.

Sediment sample SW-4 contained 53.4 mg/kg arsenic, which is above the MTCA Method A cleanup level of 20 mg/kg. This result is more than an order of magnitude above the other results for arsenic in the Site sediments. Therefore, the SW-4 result is considered to be an outlier. The next highest arsenic result was 6.8 mg/kg at SW-8, which is well below the MTCA Method A cleanup level for soil.

Samples SW-4, SW-7, and SW-8 had results of cadmium above the MTCA Method A cleanup level of 2 mg/kg. Sample SW-8 had a concentration of 261 mg/kg of lead; which is above the Method A cleanup level of 250 mg/kg. All other sediment samples were below the MTCA Method A level for metals.

5.0 CONTAMINANT FATE AND TRANSPORT

This section summarizes the environmental fate and transport for those compounds identified in Maralco Site soils or groundwater. Potential routes of migration at the Maralco Site include:

- infiltration of rainwater or surface water through dross and contaminated sediments;
- surface water transport;
- sediment transport;
- groundwater transport; and,
- air transport.

Tarps were placed over the dross piles as part of the 1991 Interim Remedial Action at the Site. With these tarps in place, air transport is assumed to be minimal at the Site and therefore will not be considered further in this analysis.

Current potential receptors include on-site workers or visitors and ecological receptors. Future use of the Site is assumed to remain industrial based on the planned use and property zoning. Future or hypothetical potential receptors include on-site workers or visitors.

The geochemical and physical relationships that control the distribution of contaminants in soil and groundwater are evaluated by considering the following:

- Properties of the contaminants of concern;
- Properties of the soil and aquifer materials;
- Physical processes of infiltration and groundwater flow; and,
- Oxidation-reduction (redox) controls on chemical contaminant persistence.

The characteristics of the contaminants of concern are discussed in Section 5.1. Physical processes that influence the fate and transport of contaminants of concern along the important pathways at the Maralco Site are described in Section 5.2. Routes of migration are discussed in Section 5.3.

5.1 PROPERTIES OF CONTAMINANTS OF CONCERN

Metals, saline compounds and nitrogen compounds have been detected in sediment or groundwater at the Site. Properties of these chemicals are discussed below.

5.1.1 Metals

Aluminum. Aluminum is the most abundant metal to be found in the earth's crust. The soils of the Puget Sound area are reported to have a natural background concentration of 37,200 mg/kg (WDOE, 1994).

Aluminum solubility in water is dependent upong pH. As pH increases or decreases from near neutrality, solubility increases. Aluminum is also highly persistent in water. The metal has moderate acute toxicity to aquatic life and high acute toxicity to birds. Toxicity to aquatic life does increase after chronic exposure and is documented to cause shortened lifespan and reproductive problems (AQUIRE Database, ERL-Duluth, U.S.EPA).

Arsenic. Arsenic is an inorganic chemical subject to complex oxidation/reduction, precipitation, dissolution and sorption reactions. A common concentration range from 1 to 50 milligrams per kilogram (mg/kg) has been reported for arsenic in soils (Lindsay, 1979). The soils of the Puget Sound area are reported to have a natural background concentration of 7 mg/kg (WDOE, 1994).

Arsenic oxides in soil are moderately soluble and readily transported in natural waters in dissolved form (Hem, 1970). Upon dissolution, anionic complexes of arsenate (AsO_4^{-3}) are formed. In oxidizing environments, arsenic is present in natural waters in its pentavalent form as anion complexes $H_2AsO_4^-$ and $HAsO_4^{-2}$. For pH ranges below 7.2, $H_2AsO_4^-$ is the predominant species, whereas $HAsO_4^{-2}$ predominates for more alkaline waters (i.e. pH > 7.2) (Hem, 1970). In reducing aqueous environments, $HAsO_2$ may be present.

The solubility of arsenic in subsurface waters is controlled primarily by the precipitation of arsenate solids, sorption onto immobile solids, and by coprecipitation with other metals (Hem, 1970). The latter process could be significant at inhibiting arsenic mobility in natural waters at the Maralco Site, as pentavalent arsenic forms insoluble salts with heavy metals including cadmium, copper, lead, and zinc (USEPA, 1985). For example, arsenic solubility in the presence of major cations such as calcium and magnesium is on the order of 30 mg/l, whereas a copper concentration of only 0.065 mg/l limits the equilibrium solubility of arsenic by several orders of magnitude to less than 0.5 mg/l. Arsenate sorption by iron hydroxides or other inorganic or organic surfaces also limits arsenic solubility (Hem, 1970).

In general, arsenic is bound in soil minerals and compounds by insoluble complexes and sorption onto clays, hydroxides and organic matter. Arsenate, which is predominant in aerobic soils, is bound as slightly soluble salts of iron and aluminum and more soluble salts of calcium, sodium and magnesium. The availability of arsenic for leaching depends on the amount of arsenic, the amount of precipitation, and the type of soil. Arsenic can be mobile under other conditions such as anaerobic conditions, and high or low pH.

Barium. Barium is abundant in natural soil and groundwater. The chief sources of barium are the minerals barite (barium sulfate) and witherite (barium carbonate). Barium metal is produced in limited quantities by aluminum reduction of barium oxide in a retort and is little used by industry. Barium occurs naturally in most water at concentrations ranging from 2 to 340 μg/l.

Cadmium. Cadmium is a relatively mobile heavy metal that is transported in the aqueous environment in solution as a hydrated cation or as an inorganic or organic compound. A typical cadmium concentration range reported for soils is 0.01 to 0.7 mg/kg (Lindsay,1979); Dragun (1988) reports an extreme range from 0.01 to 45 mg/kg. The soils of the Puget Sound area are reported to have a natural background concentration of 1 mg/kg (WDOE, 1994).

The limits on cadmium solubility depend on the presence of inorganic or organic ligands present. In most cases, organic substances (i.e. humic substances) can account for the majority of cadmium complexes. The second most important complexing ligand is probably carbonate followed by hydroxide. Cadmium sulphate minerals are generally highly soluble and are unlikely to form in soils. However, under reducing conditions, in the presence of sulfide, insoluble sulfide precipitates could form (USEPA, 1979). Sorption of cadmium by clays and organic matter, coprecipitation with hydrous iron, aluminum and manganese oxides, and isomorphous substitution in carbonate minerals are all mechanisms for the removal of cadmium from natural waters.

Chromium. Chromium exists in two possible oxidation states in soil: the trivalent chromium present in reducing environments is relatively immobile; the hexavalent ion is present in oxidizing environments and is mobile. Trivalent chromium is relatively more prevalent and less toxic than hexavalent chromium.

A typical chromium concentration in western United States soils is 3 to 2,000 mg/kg (Shacklette and Boerngen, 1984); the mean concentration is 41 mg/kg. The soils of the Puget Sound area are reported to have a natural background concentration of 48 mg/kg total chromium(WDOE, 1994).

Under normal soil and redox conditions hexavalent chromium is reduced to trivalent chromium by soil organic matter. Trivalent chromium is readily adsorbed by soils. Sorption by clays and organic matter, and nonspecific adsorption by iron and aluminum oxides, effectively removes chromium from most natural waters (Lindsay, 1979).

Copper. Copper is a common metallic element that is primarily associated with various sulfide minerals. Typical copper concentrations in soils range from 2 to 100 mg/kg (Lindsay, 1979); extreme copper concentration ranges for soils are from 0.1 to 14,000 mg/kg (Dragun, 1988). The soils of the Puget Sound area are reported to have a natural background concentration of 36 mg/kg (WDOE, 1994). Copper is generally present in oxidizing soils and waters as a divalent cation (Cu^{+2}) (U.S. EPA,1985). Under reducing conditions, the monovalent cation (Cu^{+1}) is present. Copper is strongly bound to inorganic and

Lead. Lead is a relatively immobile element. Typical lead concentrations in soils range from 2 to 200 mg/kg (Lindsay, 1979); extreme lead concentration ranges for soils are from 0.1 to 3,000 mg/kg (Dragun, 1988). The soils of the Puget Sound area are reported to have a natural background concentration of 24 mg/kg lead (WDOE, 1994).

Natural lead minerals (i.e. carbonates, sulfates, and sulfides) have low solubilities in water and are generally not very mobile in natural waters because of the tendency to be adsorbed or to precipitate from solution (USEPA, 1979). In an aqueous environment, Pb_2^+ is expected to be the primary species at a pH less than about 7. At a pH from 7 to 9, $PbCO_3$ is the primary species. Under oxidizing conditions, lead carbonates and sulfates (i.e. cerrusite [$PbCO_3$] and anglesite [$PbSO_4$]) will to a large extent limit lead solubility. In the presence of reduced sulfur, galena (PbS) will greatly limit the solubility of lead due to its extremely low solubility.

Hem (1970) suggests that in most natural waters at equilibrium, lead solubility (as Pb_2^+) is limited to about 0.02 mg/l. As with the other metals, lead solubility is pH dependent and rapidly increases with an increase or decrease in pH. Also, as with cadmium, lead readily forms complexes with organic ligands, which can increase lead solubility (USEPA, 1985).

Selenium. Selenium is usually found as a sulfide ore of the heavy metals. Natural weathering of rocks and soils provide the major source of selenium to soil and groundwater. Selenium solubility varies from greater than forty percent by weight for the sodium selenates to between 16,000 and 33,000 µg/l for the silver selenates.

5.1.2 Other Inorganic Compounds

Chloride. Chloride is abundant in soil and groundwater. Sources of chloride ion probably include release of evaporite minerals from fluid inclusions in carbonates, and concentration by evaporation of recharging water in the unsaturated zone (Feth, 1981). In dilute natural waters, chloride does not participate in oxidation-reduction reactions and does not complex with other ions or form low solubility salts. Chloride transport is mainly from physical processes.

Fluoride Concentrations of fluoride in natural waters are typically low; usually less than 1 mg/l. Sources of fluoride include igneous and sedimentary rock minerals. The free fluoride ion is predominant in neutral pH. Strong fluoride complexes with aluminum, beryllium and ferric iron are possible (Hem, 1970).

Nitrate and Ammonia Nitrogen occurs in water in cationic form as ammonia, and in anionic form as nitrate or nitrite. Nitrogen concentrations attributable to natural sources are typically less than 1 mg/l as nitrate and less than 0.05 mg/l as ammonia (Hallberg, 1989). Ammonia is strongly adsorbed onto clay and mineral surfaces. Nitrate and nitrite, however, are stable under natural conditions and are transported by physical processes in groundwater and surface water. Sources of nitrogen are fertilizers and septic tanks (Hem, 1970).

5.2 PHYSICAL PROCESSES

The contaminants of concern are subjected to several physical processes including advection, dispersion, and molecular diffusion. Advection is the migration of a substance due to the bulk movement of water. Advection tends to move chemicals in the direction of flow. Hydrodynamic dispersion, which consists of both mechanical dispersion and molecular diffusion, dilutes concentrations primarily in the direction of flow. Mechanical dispersion of groundwater plumes is caused primarily by the movement of groundwater around the soil particles that are in the flow path. These particles divert the forward motion of groundwater and tend to disperse substances. Molecular diffusion, caused by intermolecular collisions, also causes chemicals to dilute in groundwater. As contaminants of concern migrate, therefore, these physical processes, in combination with the chemical and biological processes, retard and dilute contaminants of concern concentrations in water along the infiltration and groundwater pathways.

Infiltrating rainwater comes into contact with dross at the Site through breaks in the cover system. Surface water also come into contact with contaminated sediments at the Site. For pathways activated by contact of water with contaminated soil (e.g., overland runoff and infiltration), the migration rate is controlled by the availability of water, the time of contact between the water and contaminants, the rate of evaporation, the permeability and wetting characteristics of soil and the Vadose Zone, and the solubility of the contaminants of concern. The relative partitioning of contaminants of concern between the dissolved and particulate phases is controlled by a complex combination of precipitation, dissolution and sorption reactions.

Sorption is an important process affecting metals migration for infiltrating rainwater, surface water, and groundwater. Sorption can be thought of as an equilibrium-partitioning process between the soil and water. For relatively greater sorbed or residual concentrations in soil, correspondingly greater concentrations in water are related by the K_{oc} factor.

The soil-water partition coefficient (K_d) is the ratio of contaminant concentration in soil to concentration in water at equilibrium. Partitioning between soil and water strongly influences the fate and transport of contaminants, and K_d is a key parameter for predicting mobility in such systems. K_ds may be derived experimentally or estimated from K_{oc} by the following relationship, where K_{oc} is either measured or calculated.

$$K_d = f_{OC} \times K_{oc}$$

K_ds for metals are dependent on several parameters (e.g., pH and redox potential [Eh]) and for a given metal may vary over several orders of magnitude depending on site-specific conditions.

Metals exist within various forms including: primary and secondary minerals, chemical compounds, adsorbed ions, colloid-bound ions, ion complexes, and freely dissolved ions. Properties of the soil that affect the fate of the substances of concern include pH, redox potential, particle size, mineralogy, cation exchange capacity, concentration of various cations and anions, organic carbon concentration, alkalinity, and moisture content.

One of the controlling factors that determine the partitioning of metals is pH. Metals can be fixed by chemical reaction within the structure or on the surface of a mineral or compound. Adsorption is the removal of an ion or compound from water by accumulation on the surface of a solid. Most ions exist in liquid in more than one molecular or ionic form, and the fate and migration rate varies depending on the form for each of the metals of concern.

The pH of a soil is the negative logarithm of the hydrogen (H^+) ion concentration in the soil moisture. The hydrogen ion is in dynamic equilibrium with the predominantly negatively charged surfaces of the soil particles. Hydrogen ions are strongly attracted to the surface negative charges, and they have the ability to replace other ions. Cationic metals, such as copper, lead, and zinc compete with the hydrogen ion for adsorption sites on solids. At low pH values the hydrogen ion preferentially gains the Site. As pH increases, reflecting the decrease in hydrogen ion in solution, additional adsorption sites are available for cationic metals and a corresponding decrease in metals concentrations in solution occurs. In general, the opposite is the case for anionic metals such as arsenic, which are commonly present as anions of weak acids. Their solubility generally decreases with decreasing pH.

5.3 CONTAMINANT MIGRATION

The migration pathways discussed in the previous sections have either been documented or are suspected to be contributing to the transport of contaminants of concern. The primary release mechanism includes infiltration and runoff of rainwater. The principle routes of migration include the following:

- Transport of contaminant compounds in solution or via sediment transport from surface soils via surface water runoff;
- Vertical transport of contaminant compounds from the Vadose Zone to groundwater via leaching; and,
- Horizontal and vertical transport of contaminant compounds in groundwater via groundwater flow.

The primary potential migration pathways for contaminant movement at the Maralco Site are leaching of dross contaminants to groundwater and transport of contaminants downgradient of the source area by groundwater and surface water flow. Other pathways are important to consider further in assessing risk to human health and are discussed further in Section 7.0.

5.3.1 Metals Solubility in Pore Water

Based on the processes discussed in Section 5.2, the partitioning of metals from waste to the aqueous phase is related to solubility of the pH-dependent compounds and the pH. The amount of pore water is controlled by the amount of precipitation after evapotranspiration, and the concentration of metals in pore water is limited by the metals concentration in the solid phase and the chemical processes discussed in Section 5.1.1.

5.3.2 Other Inorganic Compounds Solubility in Pore Water

Ammonia and chloride have been detected in groundwater. Generally the levels decreased between 1990 and 2003. The exception is MW-3, which increased from 14.638 mg/kg ammonia in 1990 to 33.7 mg/kg in 2003. The analysis of groundwater in 1990 did not include chloride. The concentration of these compounds in groundwater should decrease over time. The same is probably true for other anions.

5.3.3 Groundwater Transport

Groundwater flow through the shallow aquifer is assumed to be relatively fast. Over the course of a few hundred feet concentrations are diluted. The 1990 sampling round showed elevated levels of metals and geochemical properties in MW-3 and MW-4. The sediment in the stormwater detention pond located upgradient of MW-4 was removed as part of the interim remedial action in 1991.

This interim remedial action did not involve confirmational sampling. Based on the 2003 sampling results, some contamination may be continuing to affect MW-4.

5.3.4 Surface Water Runoff

There are three drainage ditches that trisect the property. The dross piles have a steep slope and two of the drainage ditches border the main dross pile. The drainage ditches are likely to influence the shallow groundwater at the Site. In 1990 the sediments in the drainage ditches contained elevated levels of metals and geochemical parameters. The dross piles were covered as part of the 1991 interim remedial action response. The cover has not been maintained and as a result, portions of the dross pile are exposed to surface water runoff; however, the cover has prevented a large portion of the material runoff into the ditches. The sediment samples from 1990 are assumed to be the worst-case conditions.

6.0 RISK ASSESSMENT

The elements of the risk assessment, including data evaluation, exposure assessment and risk calculation, are summarized below.

6.1 HUMAN HEALTH RISK ASSESSMENT

Consistent with the MTCA, the human health risk assessment prepared for the Maralco Site followed the risk assessment process defined by WAC 173-340-708. This process entails the following steps:

- Selection of Indicator Hazardous Substances – Since there are a limited number of hazardous substances, all of the detected hazardous substances will be considered for defining site cleanup requirements.
- Reasonable Maximum Exposure – Cleanup levels are based on estimates of current and future resource uses and reasonable maximum exposures. In the exposure assessment, populations that may be potentially exposed to site contaminants are identified, and potential exposure pathways are defined. Once complete exposure pathways are identified, exposure scenarios are developed, exposure point concentrations are calculated, and chemical intakes are estimated for each contaminant, consistent with the defined conditions of exposure. A complete exposure pathway requires a contaminant source, an exposure point (such as on-site sediments), and an exposure route (such as inhalation, dermal contact, or ingestion).
- Cleanup Levels for Individual Substances – Cleanup levels for individual hazardous substances established under Method B are compared with reasonable maximum exposure concentrations. Cleanup levels are adjusted downward to take into account exposure to multiple hazardous substances. Cancer risks are assumed to be additive. Exposure to hazardous substances from more than one exposure pathway is assumed to be additive. Cleanup levels are established using the established reference doses from current WDOE (CLARC Tables) databases.

The human health risk assessment prepared for the Site utilized current risk assessment guidance developed by the WDOE. The basic approaches used to develop each step of the human health risk assessment and the results of each step are outlined in the following subsections.

6.1.1 Selection of Indicator Hazardous Substances

In the first step of the human health risk assessment for the Maralco Site, available analytical data was reviewed and contaminants of concern were selected for evaluation. Identification of these contaminants was performed separately for soil and groundwater as discussed below.

Groundwater. All contaminants detected in both current and historic groundwater samples were selected for evaluation in the risk assessment.

Soil/Sediments. All inorganic constituents positively detected at concentrations above potentially applicable cleanup levels in soils and sediments were selected for evaluation in the human health risk assessment. For this evaluation of metals and other inorganic contaminants, it should be emphasized that some of these contaminants occur naturally in soils at concentrations that are generally similar to those reported for site soils. However, to ensure that potential risks would not be underestimated, all inorganic contaminants were conservatively carried through the analysis.

Table 6-1 lists potentially applicable Federal and State concentration-based screening or cleanup up goals for all metal and inorganic parameters analyzed for this project. Ranges of detected contaminants, and frequency of detection, are shown in Tables 6-2, 6-3, and 6-4.

Based on the limited number of contaminants of concern, selection of indicator parameters is not necessary at the Maralco Site. All detected parameters will be carried through the risk assessment.

6.1.2 Reasonable Maximum Exposure Assessment

In the next step of the human health risk assessment for the Maralco Site, an exposure assessment was developed. As discussed below, the exposure assessment consisted of three principal components:

- Identification of potentially exposed populations;
- Exposure pathway analysis; and,
- Calculation of chemical intakes.

The following sections describe the potentially exposed populations and the exposure pathways that were identified, followed by a discussion of the exposure scenarios developed for the Site. The final sections describe the estimation of chemical intakes for the defined exposures.

TABLE 6-1

Potentially Applicable Screening-Level or Cleanup Goals
Maralco Site, Kent, Washington

	GROUND WATER Concentration in µg/l						SOILS Concentration in mg/kg				
	Primary MCL	Secondary MCL	MTCA - Method A	MTCA - Method B Cancer	MTCA - Method B Non-Cancer	Minimum	MTCA - Method A Industrial	MTCA - Method B Cancer	MTCA - Method B Non-Cancer	100 x Ground Water Non-Cancer	Minimum
Aluminum	--	50	--	--	--	50	--	--	--	--	--
Ammonia	--	--	--	--	272,000	272,000	--	--	--	27,200	27,200
Arsenic	50	--	5	0.0583	4.8	0.0583	20	0.667	24	0.48	0.4800
Barium	2,000	--	--	--	1,120	1,120	--	--	5,600	112	112
Cadmium	5	--	5	--	8	5	2	--	80	8.0	8.0
Chloride	--	250,000	--	--	--	250,000	--	--	--	--	--
Total Chromium	100	--	50	--	--	50	--	--	--	--	--
Copper	--	--	--	--	592	592	--	--	2,960	59.2	59
Fluoride	4,000	2,000	--	--	--	2,000	--	--	--	--	--
Lead	--	--	15	--	--	15	1,000	--	--	--	1,000
Mercury (inorganic)	2	--	2	--	4.8	2	2	--	24	0.48	0.48
Nitrate-Nitrogen	10,000	--	--	--	1,600	1,600	--	--	8,000	160	160
Selenium	50	--	--	--	80	50	--	--	400	8	8
Silver	--	100	--	--	80	80	--	--	400	8	8
Sulfate	--	250,000	--	--	--	250,000	--	--	--	--	--
Sodium	--	--	--	--	--	--	--	--	--	--	--

µg/l = micrograms per liter
mg/kg = milligrams per kilogram
-- = Not available
MCL = Federal Maximum Contaminant Level (40 CFR 141)
MTCA Method A/B = Model Toxics Control Act 2001

TABLE 6-2

Screening of Selected Compounds Positively Detected in Dross Samples
Maralco Site, Kent, Washington

	Number of Analyses	Number of Detections	Percent Detections	Maximum Concentration*	Average Concentration*	Median Concentration*	Standard Deviation	Coeff. Variation	Minimum Potential ARAR*	Number of Exceedences	Percent > Min ARAR
Aluminum	11	11	100%	211000	167900	166000	25410	977.5	–	–	–
Ammonia	14	14	100%	686	144.6	105.0	162.6	1.124	27200	0	0%
Arsenic	6	6	100%	8.61	4.024	3.810	2.832	0.704	20	0	0%
Barium	11	11	100%	152	98.23	91.50	26.50	0.270	112	3	27%
Cadmium	6	6	100%	7.8	4.950	5.130	2.280	0.4605	8	0	0%
Total Chromium	11	11	100%	1860	458.4	196.0	558.9	1.219	–	–	–
Copper	11	11	100%	5400	2408	2100	1449	0.6017	59	11	100%
Lead	11	11	100%	214	119.2	115.0	42.02	0.1964	1000	0	0%
Mercury	6	6	100%	0.351	0.1570	0.116	0.1174	0.7469	0.2	2	33%

TABLE 6-3

Screening of Selected Compounds Positively Detected in Sediment Samples
Maralco Site, Kent, Washington

	Number of Analyses	Number of Detections	Percent Detections	Maximum Conentration*	Average Concentration*	Median Concentration*	Standard Deviation	Coeff. Variation	Minimum Potential ARAR*	Number of Excedences	Percent > Min ARAR
Aluminum	8	8	100%	132000	59770	58650	43230	1.383	--	--	--
Arsenic	8	8	100%	53.40	10.53	4.400	17.39	0.605	20	1	13%
Barium	8	8	100%	188.0	113.0	94.95	50.90	2.220	112	5	63%
Cadmium	8	8	100%	7.40	3.66	2.900	2.825	1.296	8	0	0%
Total Chromium	8	8	100%	150.0	77.00	73.00	46.74	1.648	--	--	--
Copper	8	8	100%	1330	641.4	706.5	457.9	1.406	59	8	100%
Lead	8	8	100%	261.0	117.0	75.00	96.46	1.213	1000	0%	0%
Mercury	8	8	100%	0.7300	0.2500	0.1700	0.2444	1.033	0.48	4	50%
Selenium	8	8	100%	3.300	1.530	1.000	1.06	1.441	8	0	0%
Silver	8	8	100%	1.800	0.9800	1.050	0.5676	1.718	8	0	0%
Sodium	8	8	100%	44300	15880	8450	15420	1.030	--	--	--

TABLE 6-4

Screening of Selected Compounds Positively Detected in Groundwater Samples
Maralco Site, Kent, Washington

	Number of Analyses	Number of Detections	Percent Detections	Maximum Conentration*	Average Concentration*	Median Concentration*	Standard Deviation	Coeff. Variation	Minimum Potential ARAR*	Number of Exceedences	Percent > Min ARAR
Aluminum	9.00	9.00	100%	28,000.00	9,486.67	3,600.00	11,630.75	1.23	50	9	100%
Ammonia	9.00	9.00	100%	33,700.00	6,693.33	1,520.00	11,171.89	1.67	272,000	0	0%
Arsenic	9.00	7.00	77%	40.00	12.12	7.96	12.14	1.00	0.0583	9	100%
Barium	9.00	7.00	77%	3,530.00	786.70	109.00	1,301.74	1.65	1,120	2	22%
Cadmium	9.00	0.00	0%	NA	NA	NA	NA	NA	5	0	0%
Chloride	9.00	5.00	55%	9,100,000.00	1,930,506.00	92,000.00	4,011,849.10	2.07	250,000	2	22%
Total Chromium	9.00	5.00	55%	38.00	14.56	14.00	12.10	0.83	50	0	0%
Fluoride	5.00	2.00	40%	6,890.00	1,918.00	200.00	2,898.64	1.50	2,000	2	40%
Lead	9.00	9.00	100%	9.51	4.46	2.70	3.54	0.79	15	0	0%
Mercury	9.00	3.00	33%	0.25	0.18	0.25	0.09	0.53	2	0	0%
Nitrate-Nitrogen	5.00	1.00	20%	1,500.00	380.00	100.00	626.10	1.64	1,600	0	0%
Selenium	9.00	1.00	11%	43.00	6.47	2.80	13.73	2.12	50	0	0%
Silver	9.00	0.00	0%	5.50	3.50	5.50	2.37	0.68	80	0	0%

*All concentrations are in micrograms/liter (ug/L)

6.1.2.1 Identification of Potentially Exposed Populations and Potential Exposure Pathways

The Maralco Site is in an area of industrial and heavy industrial land use. The immediate area consists of paved areas and buildings with some vegetative cover. The Site contains approximately 5 acres of undeveloped land. The Site is fenced and access is restricted. The Site is bordered on the west by BNSF rail and a wood processing facility, to the north by a pipe supply company and a pump manufacturer, to the east by warehouse property, and to the south by a vacant wood warehouse facility. Thus, under current conditions, potential receptors include:

- On-site workers;
- Trespassers; and,
- Various off-site populations (e.g., workers, passers-by).

The Site is highly industrialized and is expected to remain under industrial use in the foreseeable future. Thus, under future conditions, potential receptors include:

- Construction workers;
- Trespassers; and,
- Various off-site populations (e.g., workers, residents, passers-by).

As shown on Table 6-5, the following exposure pathways were determined to represent potentially complete pathways and were selected for evaluation in this human health risk assessment.

Potential exposure pathways associated with sediments include:

- Direct contact with sediments (i.e., incidental ingestion and dermal contact).

Potential exposure pathways associated with dross and surface soil material include:

- Infiltration of surface water through the dross and/or sediments.

Potential exposure pathways associated with surface water include:

- Direct contact with surface water (i.e., incidental ingestion and dermal contact).

TABLE 6-5

Summary of Potential Exposure Scenarios
Maralco Site, Kent, Washington

Exposure Medium	Release Mechanism	Exposure Point	Potentially Exposed Population	Exposure Route
Soil/Sediments	Direct Contact	On-site	Construction workers	Incidental ingestion
			Trespassers	Incidental ingestion
Surface water	Direct Contact	On-site	Construction workers	Incidental ingestion
			Trespassers	Incidental ingestion
Groundwater	Leaching	On-site	Construction workers	Incidental ingestion

Notes:
Currently there is no on-site use of groundwater.

Potential exposure pathways associated with groundwater include:

- Direct contact with groundwater during excavation activities (i.e., incidental ingestion and dermal contact).

With regard to populations potentially exposed to groundwater, it should be noted that the Site and the surrounding area is served by municipal water; there are no known supplemental groundwater supply wells on site. Any potential future development of the site would have restricted access to groundwater based on the City of Kent's policy for connection to the City water supply.

6.1.2.2 Potential Exposure Scenarios

Potential exposure scenarios were developed based on an analysis of current and future use conditions and the exposure pathways identified at the Site. Table 6-5 summarizes the exposure pathways selected for analysis in this risk assessment.

- Direct contact with contaminated sediments and/or dross resulting in incidental ingestion or dermal contact is currently limited by a site-boundary fence. Exposure to the dross material is further limited by the placement of a plastic tarp over the material. However, the tarp has been torn or blown away in areas on the dross pile; therefore, exposure to contaminated surface soils for on-site workers, construction workers and trespassers, is possible. The eastern portion of the Site is unpaved. The western portion contains a parking lot and the warehouse building. Access to sediments is possible during the dry season, but is limited by the site fence and blackberry growths. This is the reasonable maximum exposure scenario for sediments and dross.

- Residential use of the Site currently is prohibited by zoning. The extent of on-site and off-site groundwater exposure is restricted due to industrial zoning and the City of Kent regulations on using groundwater for domestic use. Therefore, there are no current exposure pathways. Due to the shallow nature of the groundwater in the area, construction workers may come into contact with groundwater during on-site excavation activities. This is the reasonable maximum exposure scenario for groundwater.

6.1.2.3 Calculation of Intakes

The last step of the exposure assessment involves the selection of appropriate exposure parameters and the calculation of chemical intakes. Exposure parameters and chemical intakes are as specified in MTCA guidance (WDOE, 2001).

6.1.3 Cleanup Levels for Individual Hazardous Substances

MTCA Method B levels for individual chemicals in soil, groundwater, and surface water are developed from formula values based on human health. The Method B input parameters are listed on Tables 6-6, 6-7 and 6-8.

6.1.4 Multiple Hazardous Substances Risk Characterization

In the last step of this risk assessment, exposure and toxicity information were integrated to derive quantitative estimates of potential risks, following the standard procedures defined in the WDOE's MTCA regulation (WAC 173-340; WDOE, 2001). Intake and risk calculations for each medium and scenario are presented in Tables 6-6, 6-7, and 6-8. The Table 6-7 shows sediment values with the outlier excluded.

In reviewing the results of this risk characterization, it should be emphasized that the potential risks estimated in this analysis are based on a series of conservative assumptions regarding exposure and toxicity. As discussed at the conclusion of this section, these assumptions have been used to ensure that potential risks are not underestimated; however, any actual risks associated with the Site are expected to be much less than those estimated in this analysis.

The following subsections discuss the specific results of the risk characterization at the Site. Following the discussion of the risk assessment results, a brief discussion of the uncertainties is presented.

- The cumulative Hazard Quotient associated with exposure routes from dross for the on-site worker, construction worker, and trespasser is 2.33. Potential cancer risk is 0.0000129 for ingestion and 0.000179 for inhalation.

- For sediments, the calculations shown in Table 7-6 were conducted without the consideration of the outlier. If the outlier is taken into consideration, the cumulative Hazard Quotient associated with exposure routes from contaminated sediment for the construction worker, trespasser, and hypothetical on-site resident was 2.84. Potential cancer risk is 0.0000801 for ingestion and 0.000850 for inhalation. With the outlier thrown out, the Hazard Quotient is 0.902 and the potential cancer risk is 0.0000105 for ingestions and 0.000149 for inhalation.

- The cumulative Hazard Quotient associated with exposure routes from groundwater for the hypothetical on-site resident is 13.0. Potential cancer risk is 0.000686.

TABLE 6-6

Calculation of Potential Risks/Dross/Hypothetical Industrial Scenario
Maralco Site, Kent, Washington

Constituent	Maximum Concentration mg/kg	Oral CPFo kg-day/mg	Inhalation CPFi kg-day/mg	RFDo mg/kg-day	Risk AT years	ABW kg	ED years	UCF mg/kg	SIR mg/day	AB1	EF	Hazard Quotient	Potential Oral Risk	Potential Respiratory Risk
Arsenic	8.61	1.5	15.05	3.00E-04	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	3.59E-01	1.29E-05	1.30E-04
Barium	152	NA	NA	7.00E-02	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	2.71E-02	0.00E+00	0.00E+00
Cadmium	7.8	NA	6.3	1.00E-03	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	9.75E-02	0.00E+00	4.91E-05
Chloride	131988	NA	NA	NA	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Chromium	1860	NA	NA	NA	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	5400	NA	NA	3.70E-02	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	1.82E+00	0.00E+00	0.00E+00
Fluoride	14	NA	NA	NA	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead	214	NA	NA	NA	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury	0.351	NA	NA	3.00E-04	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	1.46E-02	0.00E+00	0.00E+00
Nitrate-Nitrogen	83.8	NA	NA	1.00E-01	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	1.05E-02	0.00E+00	0.00E+00
Sulfate	74.8	NA	NA	NA	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00
											TOTALS	**2.33E+00**	**1.29E-05**	**1.79E-04**

Potential Risk = (Maximum Concentration x CPF x SIR x AB1 X ED x EF) / (ABW x AT x UCF)
Hazard Quotient = (Maximum Concentration x SIR x AB1 x EF) / (RFD x ABW x UCF)
CPFo = Oral Carcinogenic Potency Factor
CPFi = Inhalation Carcinogenic Potency Factor

RFDo = Oral Reference Dose (Method B Formula Value for Non-Carcinogen)
SIR = Soil Ingestion Rate
AB1 = Gastrointestinal Absorption Rate
EF = Exposure Frequency
ABW = Average Body Weight
UCF = Unit Conversion Factor
ED = Exposure Duration
AT = Averaging time

TABLE 6-7

Calculation of Potential Risks/Sediment/Hypothetical Residential Scenario
Maralco Site, Kent, Washington

Constituent	Maximum Concentration mg/kg	Oral CPFo kg-day/mg	Inhalation CPFi kg-day/mg	RFDo mg/kg-day	Risk AT years	ABW kg	ED years	UCF mg/kg	SIR mg/day	AB1	EF	Hazard Quotient	Potential Oral Risk	Potential Respiratory Risk
Arsenic	6.8	1.50E+00	15.05	3.00E-04	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	2.83E-01	1.02E-05	1.02E-04
Barium	188	NA	NA	7.00E-02	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	3.36E-02	0.00E+00	0.00E+00
Cadmium	7.4	NA	6.3	1.00E-03	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	9.25E-02	0.00E+00	4.66E-05
Total Chromium	150	NA	NA	NA	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	1330	NA	NA	3.70E-02	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	4.49E-01	0.00E+00	0.00E+00
Lead	261	NA	NA	NA	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury	0.73	NA	NA	3.00E-04	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	3.04E-02	0.00E+00	0.00E+00
Selenium	3.3	NA	NA	5.00E-03	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	8.25E-03	0.00E+00	0.00E+00
Silver	1.8	NA	NA	5.00E-03	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	4.50E-03	0.00E+00	0.00E+00
Sodium	44300	NA	NA	NA	7.50E+01	1.6E+01	6.0E+00	1.0E+06	2.0E+02	1.0E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00
											TOTALS	**9.02E-01**	**1.02E-05**	**1.49E-04**

Potential Risk = (Maximum Concentration x CPF x SIR x AB1 X ED x EF) / (ABW x AT x UCF)
Hazard Quotient = (Maximum Concentration x SIR x AB1 x EF) / (RFD x ABW x UCF)
CPFo = Oral Carcinogenic Potency Factor
RFDo = Oral Reference Dose (Method B Formula Value for Non-Carcinogen)
SIR = Soil Ingestion Rate
AB1 = Gastrointesitnal Absorption Rate
EF = Exposure Frequency
ABW = Average Body Weight
UCF = Unit Conversion Factor
ED = Exposure Duration
AT = Averaging Time

TABLE 6-8

Calculation of Potential Risks/Groundwater/Hypothetical Industrial Scenario
Maralco Site, Kent, Washington

Constituent	Maximum Concentration µg/l	Oral CPFo kg-day/mg	RFDo mg/kg-day	Risk AT years	Hazard ABW kg	Risk ABW kg	UCF µg/mg	Risk ED years	INH	Hazard DWIR l/day	Risk DWIR l/day	Hazard Quotient	Potential Risk
Aluminum	28000	NA	NA	7.50E+01	1.6E+01	7.0E+01	1.0E+03	3.0E+01	1.0E+00	1.0E+00	2.0E+00	0.00E+00	0.00E+00
Ammonia	33700	NA	NA	7.50E+01	1.6E+01	7.0E+01	1.0E+03	3.0E+01	1.0E+00	1.0E+00	2.0E+00	0.00E+00	0.00E+00
Arsenic	40	1.50E+00	3.00E-04	7.50E+01	1.6E+01	7.0E+01	1.0E+03	3.0E+01	1.0E+00	1.0E+00	2.0E+00	8.33E+00	6.86E-04
Barium	3530	NA	7.00E-02	7.50E+01	1.6E+01	7.0E+01	1.0E+03	3.0E+01	1.0E+00	1.0E+00	2.0E+00	3.15E+00	0.00E+00
Chloride	9100000	NA	NA	7.50E+01	1.6E+01	7.0E+01	1.0E+03	3.0E+01	1.0E+00	1.0E+00	2.0E+00	0.00E+00	0.00E+00
Total Chromium	38	NA	NA	7.50E+01	1.6E+01	7.0E+01	1.0E+03	3.0E+01	1.0E+00	1.0E+00	2.0E+00	0.00E+00	0.00E+00
Fluoride	6890	NA	NA	7.50E+01	1.6E+01	7.0E+01	1.0E+03	3.0E+01	1.0E+00	1.0E+00	2.0E+00	0.00E+00	0.00E+00
Lead	9.51	NA	NA	7.50E+01	1.6E+01	7.0E+01	1.0E+03	3.0E+01	1.0E+00	1.0E+00	2.0E+00	0.00E+00	0.00E+00
Mercury	0.25	NA	3.00E-04	7.50E+01	1.6E+01	7.0E+01	1.0E+03	3.0E+01	1.0E+00	1.0E+00	2.0E+00	0.00E+00	0.00E+00
Nitrate-Nitrogen	1500	NA	1.00E-01	7.50E+01	1.6E+01	7.0E+01	1.0E+03	3.0E+01	1.0E+00	1.0E+00	2.0E+00	9.38E-01	0.00E+00
Selenium	43	NA	5.00E-03	7.50E+01	1.6E+01	7.0E+01	1.0E+03	3.0E+01	1.0E+00	1.0E+00	2.0E+00	5.38E-01	0.00E+00
Silver	5.5	NA	5.00E-03	7.50E+01	1.6E+01	7.0E+01	1.0E+03	3.0E+01	1.0E+00	1.0E+00	2.0E+00	0.00E+00	0.00E+00
											TOTAL	1.30E+01	6.86E-04

Hazard Quotient = (Maximum Concentration x DWIR x INH) / (RFD x ABW x UCF)

Potential Risk = (Maximum Concentration x CPF x DWIR x ED x INH x DWF)/(ABW x AT x UCF)

CPFo = Oral Carcinogenic Potency Factor
RFDo = Oral Reference Dose (Method B Formula Value for Non-Carcinogen)
ABW = Average Body Weight
UCF = Unit Conversion Factor
DUR = Duration of Exposure
INH = Inhalation Correction Fraction
DWIR = Drinking Water Ingestion Rate
ED - Exposure Duration
AT - Averaging Time

6.1.5 Multiple Pathways of Exposure

Multiple pathways exist for the hypothetical on-site resident. Adding the cumulative Hazard Quotient for sediment (without the outlier), dross, and groundwater results is a total of 16.232. Total potential respiratory risk is 0.000328, and total potential oral risk is 0.0007094.

6.1.6 Uncertainty Analysis

This section includes a discussion of the uncertainties associated with each step of the human health risk assessment, as well as an evaluation of the significance of those uncertainties. This discussion includes identification of some of the uncertainties associated with the risk assessment process itself, as well as with the specific assumptions used in developing this human health risk assessment. Information regarding uncertainty is an integral part of any risk assessment because it provides important insight into the significance of the results, thus supporting risk management decisions.

Data Evaluation. Data used in this human health risk assessment were based on site investigation efforts, which generally focused on areas of known impact, in order that the presence and extent of any detected contaminants could be determined. The SW-4 data point for arsenic was an order of magnitude greater than for any of the other sediment arsenic results. All other arsenic results for sediment are below the published regional 90th Percentile Value for background arsenic in soil, which is 7 mg/kg. This data point; therefore is considered an outlier and was not considered in the final risk analysis.

Exposure Assessment. The exposure assessment utilized a number of exposure assumptions that are also anticipated to result in an overestimation of any potential risks. These assumptions include:

- The use of maximum contaminant concentrations; and,
- The use of conservative, default factors to characterize exposure by future on-site receptors.

Risk Characterization. Methods used for the characterization of potential risk were developed by WDOE to streamline and simplify the risk assessment process, while ensuring that potential risks are not underestimated. Furthermore, the risk estimates presented in this human health risk assessment incorporated the various uncertainties associated with each step of the risk assessment process, as described above. Thus, the potential risks calculated in this assessment are anticipated to overestimate potential risks associated with the defined exposure scenarios. Actual risks are expected to be less than estimated in this report.

6.2 ECOLOGICAL EVALUATION

The Maralco Site qualifies for an exclusion from the terrestrial ecological evaluation process. The planned use for the site involves placing all dross contamination under physical barriers that will prevent plants or wildlife from being exposed to the contamination.

7.0 REMEDIAL ACTION OBJECTIVES

This section identifies Remedial Action Objectives (RAOs) developed for medium-specific and/or area-specific protection of human health and the environment at the Site. Chemical-, action-, and location-specific Applicable or Relevant and Appropriate Requirements (ARARs) and To-Be-Considered (TBC) criteria for the Site are also addressed. MTCA cleanup levels are included in the discussion of ARARs.

7.1 IDENTIFICATION OF OBJECTIVES

RAOs developed for protecting human health typically address both chemical concentrations and potential exposure routes. Protection can be achieved by either reducing concentrations or reducing or eliminating potential exposure pathways. The Risk Assessment identified the following exposure routes that require RAOs for protecting human health at the Site:

- Direct contact with dross and contaminated sediments resulting in incidental ingestion.
- Ingestion of surface waters.
- Incidental ingestion of groundwater by on-site construction workers.

The recommended RAOs for human health are to prevent human exposure to contaminants of concern, to minimize exposure to contaminants of concern in airborne particulates, and to minimize exposure to contaminants of concern via groundwater migration. Specifically, RAO-1 is to reduce the Hazard Quotient for the Site to less than one, and to reduce the potential cancer risk for the Site to less than one in one million.

RAOs for protecting the environment typically seek to minimize impacts on resources by addressing the media of concern and the target cleanup levels. The risk assessment identified no exposure routes for ecological receptors that require RAOs.

RAOs for protecting the probable and beneficial use of the land also are considered. This land has been, and will continue to be, zoned industrial and used for that purpose. RAO-2, therefore, seeks to restore the land to a condition that would allow its use by industry (RAO2).

While a current exposure to contaminated groundwater migration is not occurring at this time, the groundwater in the area of the Site is extremely shallow.

Exposure to groundwater is possible during basic excavation activities. RAO3, therefore, is for groundwater protection.

7.2 ARARs

Appendix C provides a preliminary summary of key ARARs that may be relevant to RI and cleanup activities at the Maralco Site. This information provides a framework for determining remediation goals based on the fate and transport evaluations and risk assessment.

7.2.1 Dross and Sediment Project Remediation Goals

Soil ARARs are listed in Table 6-2 and 6-3. These ARARs apply to the aluminum dross and contaminated sediments. They are exceeded by arsenic, barium, copper, and mercury in dross and sediments. All of these parameters; contribute significantly to the risk to human health at the Site. PRGs for these compounds are listed in Table 7-1. The dross and sediments were analyzed for total chromium, which at the time of sampling had an ARAR. Currently the ARARs for chromium in soils are set for chromium VI and chromium III separately.

The PRGs are based on the minimum ARAR, which is generally the Method B formula values. Arsenic, which is the only parameter contributing to the potential carcinogenic risk formula, has a MTCA Method A – Industrial cleanup level of 20 mg/kg. This number will be utilized in place of the 100x groundwater non-cancer. The cumulative Hazard Quotient using either the PRGs or the maximum detected concentration at the site, whichever is less, is less than 1.

Dross sample analytical data compare to these PRGs as follows:

- The PRG for copper, at 59 mg/kg, is exceeded by all samples analyzed. Eleven (11) samples were analyzed for copper.
- The PRG for barium, at 112 mg/kg, is exceeded by three sample concentrations; a total of 11 samples were analyzed.
- The PRG for mercury, at 0.2 mg/kg, is exceeded by two sample concentrations; a total of six samples were analyzed.

Sediment sample analytical data compare to PRGs as follows:

- The PRG for copper is exceeded in all of the samples. Eight samples were analyzed for all constituents.
- Five sediment sample concentrations exceed the PRG for barium out of a total of eight samples analyzed.

- Four sediment sample concentrations exceed the PRG for mercury out of a total of eight samples analyzed.

- One sediment sample exceeded the PRG for arsenic. The SW-4 data point for arsenic was an order of magnitude greater than for any of the other sediment arsenic results. EMR could not verify the lab results because they were originally analyzed as part of the 1990 remedial investigation. All other arsenic results for sediment are below the published regional 90th Percentile Value for background arsenic in soil, which is 7 mg/kg. This data point; therefore is considered an outlier and was not considered in the final risk analysis.

7.2.2 Groundwater Project Remediation Goals

Groundwater ARARs are listed in Table 7-4. They are exceeded in on-site wells by aluminum, arsenic, barium, chloride, and fluoride. Fluoride is considered a health risk to children for brain development. PRGs for these compounds are listed in Table 7-1. The PRGs are generally based on Method B formula values corresponding to the lesser concentration for a Hazard Quotient of 1 or a potential carcinogenic risk of one in one million. PRGs are adjusted to maintain a cumulative Hazard Quotient of 1.

Groundwater PRGs are exceeded for aluminum and arsenic in all of the nine samples that have been collected during the two RIs. The PRGs for aluminum and arsenic are 50 µg/l and 0.0583 µg/l, respectively.

Groundwater PRGs are exceeded for barium, chloride, and flouride in two out of the nine samples that have been collected during the two RIs. The PRG for barium is 1,120 ug/l; during the October 1990 and January 2003 sampling events the PRG was exceeded in the MW-3 samples, which had concentrations of 3,530 and 2,500 ug/l, respectively. The PRG for chloride is 250 mg/l; during the January 2003 sampling event the PRG is exceeded in samples MW-3 and MW-5, which had concentrations of 9,100 and 442 mg/l, respectively. The PRG for fluoride is 0.2 mg/l; during the January 2003 sampling event the PRG is exceeded in samples MW-4 and MW-5, which had concentrations of 6.89 and 2.1 mg/l, respectively.

7.3 OTHER FACTORS TO BE CONSIDERED AT THE SITE

7.3.1 Land Use

The Maralco Site was developed within an industrial corridor and surrounding properties consist of industrial properties, which is unlikely to be used for any land use besides industrial in the future. The Site is zoned industrial, and land use will be presumed to remain industrial in the future.

TABLE 7-1

Project Remediation Goals
Maralco Site, Kent, Washington

	GROUND WATER Concentration in µg/l						
	Primary MCL	Secondary MCL	MTCA - Method A	MTCA - Method B Cancer	MTCA - Method B Non-Cancer	Required to Achieve HQ < 1	PRG
Aluminum	--	50	--	--	--	50	50
Ammonia	--	--	--	--	272000	272,000	272,000
Arsenic	50	--	5	0.0583	4.8	4.8	0.0583
Barium	2,000	--	--	--	1,120	1,120	1,120
Chloride	--	250,000	--	--	--	250,000	250,000
Total Chromium	100	--	50	--	--	50	50
Copper	--	--	--	--	592	592	592
Fluoride	4,000	2,000	--	--	--	2,000	2,000
Mercury	2	--	2	--	4.8	2	2
Nitrate-Nitrogen	10,000	--	--	--	1,600	1,600	1,600
Selenium	50	--	--	--	80	80	50

	SOILS Concentration in mg/kg					
	MTCA - Method A Industrial	MTCA - Method B Cancer	MTCA - Method B Non-Cancer	100 x Ground Water Non-Cancer	Required to Achieve HQ < 1	PRG
Aluminum	--	--	--	5	5	5
Arsenic	20	0.667	24	0.48	0.6670	20
Barium	--	--	5,600	112.0	112	112
Cadmium	2	--	80	0.5	0.5	0.5
Copper	--	--	2,960	59.2	59	59
Lead	1,000	--	--	--	1,000	1,000
Mercury	2	--	24	0.48	0.48	0.48
Nitrate-Nitrogen	--	--	8,000	160	160	160
Selenium	--	--	400	5	5.0	5.0
Silver	--	--	400	8	8	8

µg/l = micrograms per liter
mg/kg = milligrams per kilogram
-- = Not available
MCL = Federal Maximum Contaminant Level (40 CFR 141)
MTCA Method A/B = Model Toxics Control Act

7.3.2 Obnoxious Odors

When recently disturbed aluminum dross is wetted, the resulting chemical reaction results in the release of ammonia. During the interim remedial action conducted in 1991, ammonia odors were noted during grading activities on the dross piles.

During any remedial actions, odor control must be practiced. Of particular concern is the fact that normal dust suppression by water application is not appropriate for the aluminum dross.

8.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

In this section, remediation technologies and process options are combined to form potential remedial alternatives. These alternatives are designed to address the affected soil and dross at the Maralco Site and the significant pathways of potential contaminant migration. The objective of this step is to develop remedial alternatives that protect human health and the environment and encompass a variety of response options, including:

- Control of potential exposure pathways;
- Prevention of further contact of contaminants with percolating water infiltrating to groundwater; and,
- Reduction of risk to an acceptable level and prevention of potential off-site migration.

In accordance with MTCA regulations, potential remedial alternatives are first developed, and then further considered if they:

1. Effectively protect human health and the environment (effectiveness criterion);
2. Comply with state and federal cleanup standards (effectiveness criterion);
3. Comply with ARARs (effectiveness criterion);
4. Provide for compliance monitoring (effectiveness criterion);
5. Provide permanent solutions to the maximum extent practicable (implementability criterion);
6. Provide for a reasonable restoration time frame (implementability criterion);
7. Consider public concerns raised during public comment on the draft cleanup action plan (implementability criterion);

Screening of potential alternatives using the above criteria results in a smaller, more manageable set of the most appropriate alternatives, which are then further evaluated during the detailed analysis phase of the FS (Section 9.0).

8.1 DEVELOPMENT OF ALTERNATIVES

Several potential alternatives for remediation are outlined below. This section describes the site parameters used to develop conceptual designs and evaluate each remedial alternative. These site parameters include the following:

- Site Surface Area: The Site is currently enclosed by a chain-link fence. This area includes the dross piles, the warehouse building and approximately 5.5 acres of undeveloped land. Total site surface area available for use is approximately 261,500 square feet, which conservatively covers the known extent of undeveloped land.
- Volume of Dross: The volume of dross at the Site was surveyed in detail during the 1990 RI conducted by MKE. Total volume in piles is 20,400 cubic yards.
- Depth to the Water Table: The water table is approximately five feet bgs.
- Soil Characteristics: Soil in the vicinity of the site consists predominately of a silty sand.

8.2 SCREENING CRITERIA

This section describes the potential remedial alternatives outlined below and evaluates each alternative with respect to criteria of effectiveness, and implementability.

The factors considered for each of these screening criteria include:

- Effectiveness
    1. Protection of human health and the environment
    2. Compliance with state and federal cleanup standards
    3. Compliance with the ARARs
    4. Provide for compliance monitoring

- Implementability
  1. Provide for a reasonable restoration time frame;
  2. Consider public concerns raised during public comment on the draft cleanup action plan;
  3. Are problematic with respect to technical or administrative feasibility.

8.3 SCREENING OF ALTERNATIVES

The three remedial alternatives developed for evaluation of their ability to meet site RAOs are described in this section. These include:

• Remedial Alternative 1:	Limited Action/Institutional Controls;
• Remedial Alternative 2:	Removal and Off-Site Disposal; and,
• Remedial Alternative 3:	On-Site Containment.

Initial subsections present the conceptual designs for each remedial alternative. The evaluation of the three remedial alternatives based on applicable screening criteria is discussed in the following subsections. A comparative analysis of remedial alternatives and the recommended remedial alternative for addressing site RAOs are presented in Section 9.

8.4 ALTERNATIVE 1 - LIMITED ACTION/INSTITUTIONAL CONTROLS

The remedial action components that constitute Alternative 1 are described below.

Remedial Action Component 1a – Groundwater Monitoring: The groundwater monitoring program would consist of semi-annual sampling events conducted at downgradient monitoring wells MW-3, MW-4 and MW-5 and cross-gradient well MW-2. Samples would be collected from dedicated in-well pump systems. Samples collected from these monitoring wells would be subject to laboratory analysis for contaminants of concern. The groundwater monitoring program would be conducted during summer and winter.

Groundwater quality data collected as part of Remedial Action Component 1a would be used to evaluate potential off-site migration of contaminants of concern in groundwater. Under the no action alternative, however, no remedial actions would be taken to address potential migration of contaminants of concern in groundwater.

Remedial Action Component 1b - Maintenance of the Existing Fence: An approximately 8-foot high chain-link fence with razor wire currently surrounds a majority of the Site. The former farmhouse is not enclosed within the fence. Locked, sliding gate is located along the northern property boundary near the northeast corner of the Site. An entrance gate is located at the northeastern edge of the parking lot associated with the warehouse. The gate is locked during non-business hours. This fence would remain in-place if Alternative 1 was implemented. Additional fence would be required on the south and east sides of the parking lot. The current fence requires maintenance at this time and would also be subject to maintenance events concurrent with groundwater monitoring at the Site in the future. Warning signs would be posted at the fence gate and at each of the four sides of the Site. These signs would also be maintained.

Remedial Action Component 1c – Replacement of Existing Tarp: A plastic tarp was placed over the dross piles in 1991 as part of the Interim Remedial Action. The tarp has become damaged in places and has also blown away in other areas. This tarp would be replaced. The netting and sandbags that currently hold down the existing tarp would be re-used.

Remedial Action Component 1d – Deed Restriction: Because implementation of Alternative 1 would leave contaminants above PRGs, a restriction to the land deed is required with mandated restrictions and notifications to WDOE.

Remedial Action Component 1e - Five-Year Reviews: Because implementation of Alternative 1 would leave contaminants above PRGs, a periodic review by WDOE will be necessary. The purpose of the review is to evaluate whether the chosen remedial action remains protective of public health and the environment. Because Alternative 1 ensures protectiveness through exposure protection (e.g., deed restrictions, fence, and tarp) the review will focus on whether the controls remain in place.

For Alternative 1, five-year review activities will include the following:

- Evaluation of annual groundwater monitoring data; and
- Preparation of a five-year report summarizing site conditions and implementation of the selected remedial action, identifying the scope and nature of the five-year review, describing activities performed during the five-year review period, and presenting results and recommendations pursuant to the five-year review.

8.5 ALTERNATIVE 2 - REMOVAL AND OFF-SITE DISPOSAL

Alternative 2, removal and off-site disposal would involve removal of the existing dross and surface soils. The material would then be removed from the Site and transported to a disposal facility.

The remedial action components, which constitute Alternative 2, are described below.

Remedial Action Component 2a - Site Preparation: Site preparation would consist of removing portions of the existing fence in preparation for excavation activities. Initially, an exclusion zone would be established. The exclusion zone would encompass the area of the dross and necessary maneuvering space for construction equipment such as the excavator. The exclusion zone would also include an area for loading the dross and soil. Site preparation would also include the installation of temporary roads to enable access on the eastern side of the warehouse building and provide access to the rail spur on the west side of the Site. Dust and odor suppression would be supplied by trucks standing by with non-water based dust suppressor. The nitrogen reaction with water that forms ammonia would be minimized or eliminated by using non-water based dust suppression.

Remedial Action Component 2b - Removal of Dross and contaminated sediment: Excavators would be used to excavate dross and contaminated sediment onto dump trucks. Dump trucks would then carry the load to the rail spur. Characterization samples would be collected and analyzed for approval at the disposal facility.

Remedial Action Component 2c – Transport and Disposal: Dross and contaminated sediment would be loaded onto rail cars and transported to a landfill for disposal.

Remedial Action Component 2d - Site Restoration: Any excavation areas would be filled and graded to original grade.

Remedial Action Component 2e - Groundwater Monitoring: The groundwater monitoring program described for Alternative 1 would be implemented at the Site as part of Alternative 2 for a period of 5 years to confirm restoration of groundwater beneath the Site.

8.6 ALTERNATIVE 3 – ON-SITE CONTAINMENT

Alternative 3 involves excavation of contaminated sediments, blocking of drainage onto the Site from the southern adjacent property, grading of the undeveloped areas of the Site, placement of a geocomposite and bottom liner over the graded areas, grading the dross and excavated sediments to a mounded surface over the bottom liner, and then installing a concrete cap at the Site to address RAOs. The cap would be installed over the entire surface of the graded dross. It is designed to prevent human and ecological receptor exposure to the dross beyond the protection offered by the fence, and to allow limited reuse of the Site for industrial purposes. The concrete pad would be used for material storage at the Site.

8.6.1 Description of Multi-media Liner and Cap System

The following is a discussion of the material layers of the bottom liner and concrete cap for Alternative 3. The material layers of the liner and cap system are schematically represented in Figure 8-1. It will be noted that this is a generalized conceptual design for multi-media installation, and not an absolute specification.

Geocomposite: A geocomposite fabric will be placed over the top of the graded Site surface. The geocomposite will consist of a single layer of non-woven geotextile bonded to a layer of geonetting. The geocomposite layer will function as a drainage layer for groundwater that may come in contact with the liner, thus increasing multi-media cap life by providing protection against erosion and settling under the dross. The geotextile layer will prevent clogging of the geonetting layer. Drainage systems will be installed to direct geocomposite drainage to the on-site ditches.

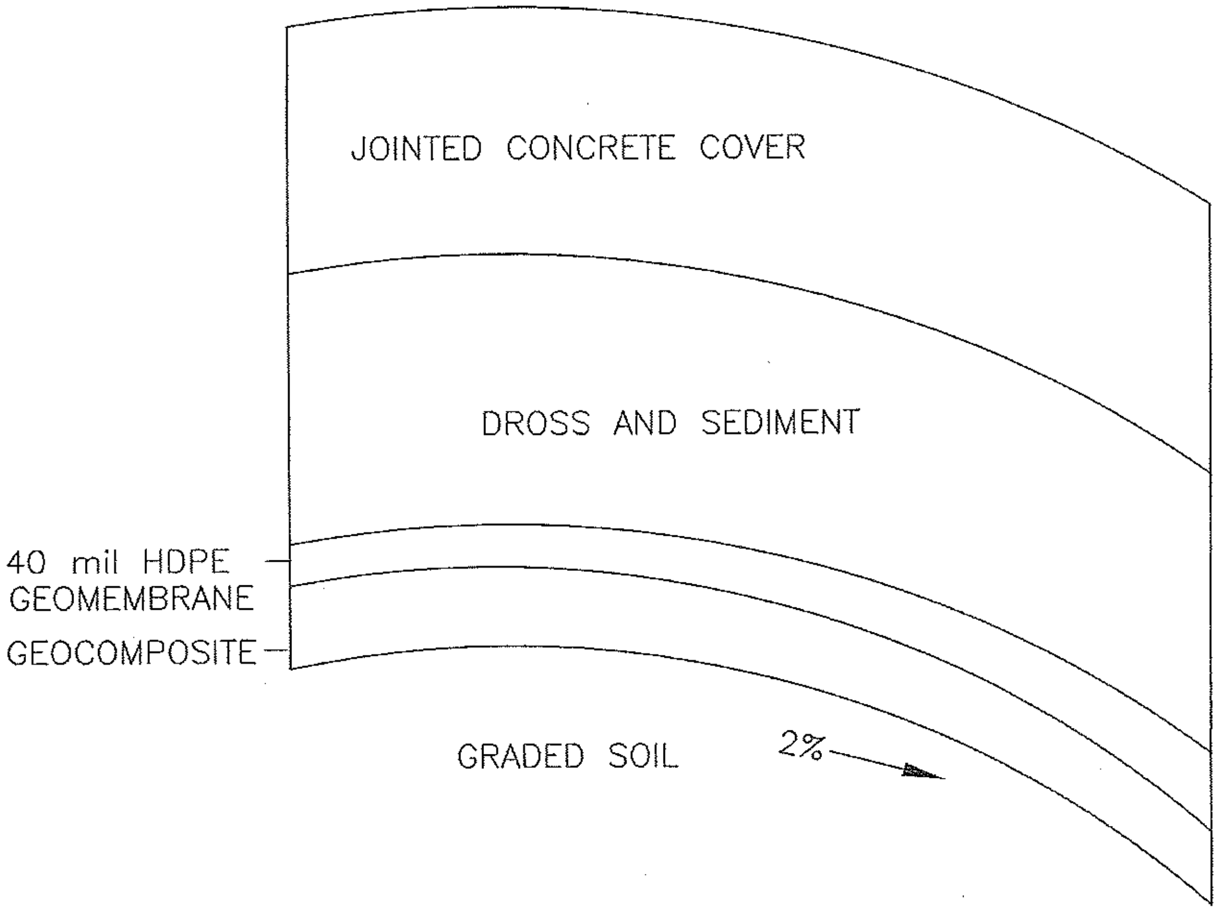
HDPE Liner: A high tensile strength, high density polyethylene (HDPE) liner would be placed directly over the geocomposite and installed drainage structures. The geogrid/liner would serve as a low permeability barrier to infiltrating groundwater. The HDPE geogrid/liner also would act to distribute loading over the Site surface, and therefore limit long-term multi-media cap deflection caused by localized subsidences at the Site surface. Furthermore, the HDPE geogrid/liner would reduce short-term subsidence at the Site surface during dross placement and surface cap construction.

Concrete Cover: A concrete cover would be placed over the graded dross and sediments. The purpose of the concrete cover is to provide a surface barrier to prevent exposure to the buried aluminum dross. The concrete cover would also prevent stormwater infiltration.

8.6.2 Remedial Action Components for Alternative 3

The remedial action components that constitute Alternative 3 are described in the following subsections.

Remedial Action Component 3a - Site Preparation: Portions of the existing fence would be dismantled. The drainage that is entering the Site from the Former Colonial Cedar Company property would be blocked from coming on-site. The drainage ditches would then be dredged for contaminated sediments. The Site would then be graded to establish a surface water runoff pattern for the installed cap. The runoff pattern would optimize surface water drainage from the concrete cover, as well as drainage of water from the geocomposite layer.



SCHEMATIC NOT TO SCALE

EMR INCORPORATED	*Maralco Site* *Kent, Washington* *Multi–Media Liner and Cap Schematic*	Drawn by: CNM Checked By: CNM Project No.: 6070.001–1 File Name: FIG 8–1.DWG Revision No.: 0 Date: 5/16/03 Scale: as shown	FIGURE 8–1

Remedial Action Component 3b – Placement of Bottom Liner: Following site grading, the geocomposite and liner system would be installed. As part of the geocomposite drainage system, discharge lines will be installed to discharge any collected groundwater into the drainage ditches on-site. The layers of the liner system would then be installed sequentially.

Remedial Action Component 3c – Dross Grading: After the placement of the bottom liner, the dross and dredged sediments would be graded over the entire lined area. During grading, a truck with non-water based dust suppression would be on stand-by to apply to the ground surface for dust and odor suppression, if necessary. The nitrogen reaction with water that forms ammonia would be minimized or eliminated by using anon-water based agent.

Remedial Action Component 3d - Cap Installation: Following placement of the dross and sediments, the concrete cover would be installed. The concrete pad would be installed over the entire area of graded dross material and would be designed to meet the potential future Site use plans.

Remedial Action Component 3e - Deed Restrictions: A deed restriction would be instituted at the Site to prohibit any future site construction that could breach the multi-media liner and cap system and expose the dross.

Remedial Action Component 3f - Reinstallation of Existing Site Fence: Portions of the existing site fence would be removed prior to beginning remedial activities for Alternative 3. Following installation of the multi-media cap, this fence would be reinstalled around the site perimeter.

Remedial Action Component 3g - Groundwater Monitoring: The groundwater monitoring program described under Alternative 1 would be implemented following completion of this remedial action. The focus of the monitoring program, which would be performed every five years, is as described for Alternative 1. Reports describing the results of monitoring would be prepared upon completion of each event, and would be incorporated with five-year review reports described below.

Remedial Action Component 3h - Surface Cap Maintenance: Long-term cap monitoring would be performed concurrently with groundwater monitoring events. As necessary, cap maintenance would be conducted. It is anticipated that cap maintenance would consist of the periodic repair of cracking due to possible Site ground surface subsidence.

The surface cap maintenance component would include conducting periodic surveys to monitor possible future subsidence. These surveys would be conducted every five years, and the results would be incorporated into the five-year review reports addressed below.

Remedial Action Component 3i - Five-Year Reviews: Implementation of Alternative 3 ensures protection of public health and the environment through exposure protection and institutional controls. As described for Alternative 1, a five-year review by WDOE, focusing on whether the multi-media cap remains effective and the controls remain in place, will be required. Five-year review activities for Alternative 3 are identical to those described for Alternative 1.

9.0 DETAILED ANALYSIS OF ALTERNATIVES

In this section, the three alternatives for addressing RAOs for the Site are evaluated.

9.1 REMEDIAL ALTERNATIVES EVALUATION CRITERIA

The criteria used to evaluate remedial alternatives for the Site are:

- The effectiveness of the alternative in meeting RAOs; and,
- The implementability of the alternative.

These evaluation criteria, which are described in detail below, are derived from MTCA (WAC 173-340-360) regulation for selection of cleanup actions. In addition, capital cost and the operation and maintenance cost associated with implementing the alternative are considered consistent with WAC 173-340-360 (3)(e).

9.1.1 Effectiveness

The effectiveness of a remedial alternative is a measure of the ability of the alternative to satisfy the RAOs established for a remedial action. The effectiveness of each alternative was assessed by evaluating:

- The degree to which the alternative protects persons from exposures to the contaminants of concern during construction of the alternative (short-term effectiveness) and following completion of the alternative (long-term effectiveness); and
- The degree to which the alternative protects the existing and potential beneficial uses of the Site during construction of the alternative (short-term effectiveness) and following completion of the alternative (long-term effectiveness).

9.1.2 Implementability

The implementability of an alternative is assessed by evaluating the technical feasibility and the administrative feasibility of constructing the alternative. Technical feasibility has been evaluated against the following factors:

- The degree to which an alternative can be constructed and reliably operated and maintained following construction; and

- The ability of the alternative to meet technology-specific regulations pertaining to the alternative until a remedial action is complete.

Administrative feasibility has been evaluated against the following factors:

- The likelihood of obtaining necessary permits and approvals from regulatory agencies and offices;
- The availability of required treatment, storage, and disposal services and the capacity of available services;
- The availability of equipment required to construct the alternative; and
- The time required to complete remediation.

9.1.3 Cost

The costs for implementing each alternative have been estimated to perform cost comparisons. Costs include both capital and operation and maintenance costs. The total estimated costs developed herein include the present worth cost for 30 years of operation and maintenance (O&M) following construction of the alternative. Indirect capital costs such as engineering design, legal and financial costs, construction management, and contingencies are also included. A 3% inflation rate was used to develop present worth costs. Cost estimates for each alternative are included in Table 10-1.

The costs developed for each alternative include the following qualifications and assumptions:

- Sufficient qualified labor would be available to support construction needs and schedule requirements;
- Access to work areas would be available;
- Taxes, environmental permitting costs, and deed restrictions were excluded (but are expected to influence costs by less than ten percent);
- O&M costs were calculated for a maximum 30-year period;
- Published unit cost data were used where appropriate;
- Quantities applied to unit costs were approximate and would be accurately established at the time of implementation;
- Vendor quotes were used where available and appropriate.

TABLE 9-1

Approximate Cost of Remedial Alternatives
Maralco Site, Kent, Washington

ITEM	Capital	Annual O&M	Life of O&M	Total	Present Worth
Limited Action/Institutional Controls					
1a - Ground Water Monitoring (1)	$ 24,000	$ 16,000	30	$ 504,000	$ 269,960
1b - Maintenance of the Existing Fence	$ 34,440	$ 1,000	30	$ 64,440	$ 49,813
1c - Maintenance of the Existing Tarp	$ 9,065	$ 500	30	$ 24,065	$ 16,751
1d – Deed Restriction	$ 5,000	$ -	-	$ 5,000	$ 5,000
1e - Five-Year Reviews	$ -	$ 2,000	6	$ 12,000	$ 30,745
Subtotal Alternative 1	$ 72,505	$ 19,500		$ 609,505	$ 372,269
Removal and Off-Site Disposal					
2a - Site Preparation (2)	$ 10,336	$ -	-	$ 10,336	$ 10,336
2b - Removal of Dross and Soil (3)	$ 103,305	$ -	-	$ 103,305	$ 103,305
2c – Transport and Disposal (4)	$ 832,320	$ -	-	$ 832,320	$ 832,320
2d - Site Restoration	$ 93,061	$ -	-	$ 93,061	$ 93,061
2e - Ground Water Monitoring (1)	$ 24,000	$ 16,000	5	$ 104,000	$ 93,272
Subtotal Alternative 2	$ 1,063,022	$ 16,000		$ 1,143,022	$ 1,132,294
Multimedia Cap					
3a - Site Preparation (5)	$ 15,723.09	$ -	-	$ 15,723	$ 15,723
3b - Placement of Bottom Liner (6)	$ 183,424	$ -	-	$ 183,424	$ 183,424
3c - Grading of Dross (7)	$ 148,505	$ -	-	$ 148,505	$ 148,505
3d - Concrete Cap Installation (8)*	$ 111,844	$ -	-	$ 111,844	$ 12,111
3e - Deed Restrictions	$ 5,000	$ -	-	$ 5,000	$ 5,000
3f - Reinstallation of Existing Site Fence	$ 24,108	$ -	-	$ 24,108	$ 24,108
3g - Ground Water Monitoring (1)	$ 24,000	$ 16,000	5	$ 104,000	$ 93,264
3h - Surface Cap Maintenance*	$ -	$ 1,000	5	$ 5,000	$ -
3i - Five-Year Reviews	$ -	$ 2,000	1	$ 2,000	$ 8,658
Subtotal Alternative 3	$ 512,605	$ 19,000		$ 599,605	$ 490,794

Life of ground-water monitoring for Alternative 1 is 30 years and for Alternatives 2 and 3 is five years.
Interest for present worth calculations is 5 percent.
Capital cost for ground-water monitoring is installation of dedicated pumps.
Notes on construction estimates:
(1) Capital cost is for installation of four dedicated sample pumps. O&M costs is based on sampling four wells each quarter.
(2) Mobilization ($6,000) plus create 600 ft access road ($6.27/ft) plus remove 700 lf of fencing.
(3) Assumes excavation rate of $5/cy for soil and $4/cy for sediment
(4) Assumes transportation plus tipping fee of $32/cy
(5) Mobilization ($6,000), create 600 ft access road ($6.27/ft), remove 700 lf of fencing, and clear/grub/grade undeveloped area.
(6) Assumes 160,000 sf of liner area and drainage system with oversight of $5,000
(7) Assumes fill/borrow rate of $0.92/cy for soil and excavation rate of $4 for sediments.
(8) Assumes 160,000 sf of jointed concrete, final grading of dross for placement, and oversight costs of $5,000.
*Concrete installation and maintenance would be a realized cost for site development and therefore will not be considered in the final costing.

9.2 REMEDIAL ALTERNATIVES EVALUATION

In the following sections, each alternative is evaluated according to the effectiveness, implementability, and cost criteria.

9.2.1 Alternative 1 – Limited Action/Institutional Controls

Implementability of Alternative 1. The existing fence and plastic tarp at the Site would be repaired and maintained, and long-term groundwater monitoring would be conducted. Groundwater monitoring and maintenance of the existing fence and tarp could easily be implemented, although the long-term integrity and long-term maintenance requirements of the existing cap cannot be quantified with certainty.

Cost of Alternative 1. The estimated present worth cost to implement Alternative 1 is $372,269. This includes fence and tarp maintenance and groundwater monitoring for a period of 30 years following implementation of remedial actions for Alternative 1.

9.2.2 Alternative 2 - Removal and Off-Site Disposal

The evaluation of Alternative 2 for addressing RAOs is presented in the following subsections.

Effectiveness of Alternative 2 in Meeting RAOs: Alternative 2 would provide long-term effectiveness and reduction in toxicity, mobility, or volume since the contaminants of concern would be completely removed from the Site. Alternative 2 would provide short-term and long-term effectiveness for meeting RAO-1 and RAO-2, as well as RAO-3.

Implementability of Alternative 2. Alternative 2 is technically feasible. Routine excavation and transport methods would be used.

Cost of Alternative 2: The estimated present worth cost to implement Alternative 2 is $1,132,294. This includes groundwater monitoring according to the groundwater monitoring program described under Alternative 2 on a semiannual basis for five years following implementation of remedial actions for Alternative 2.

9.2.3 Alternative 3 – On-Site Containment

The evaluation of Alternative 3 for addressing RAOs is presented in the following subsections.

Effectiveness of Alternative 3 in Meeting RAOs: Installing the multi-media cap for Alternative 3 would be effective in prohibiting human exposure to contaminants of concern whether by direct contact or by airborne particulates.

Therefore, Alternative 3 would be effective in reducing the mobility of contaminants of concern. The cap contains flexible material components so that even if large-scale subsidence did occur in the long-term at the Site, the cap would flex with the subsidence such that a barrier to contaminants of concern would be maintained. The presence of three feet of soil cover would prohibit exposure due to vandalism or weathering, and deed restrictions in combination with warning tape would provide notification in the event of future site construction actions in the area. Alternative 3 is viewed as effective in satisfying RAO-1.

Alternative 3 also addresses RAO-2 and RAO-3. The Site could be redeveloped for industrial uses. The geogrid/liner would eliminate the amount of leachate that infiltrates to groundwater.

Implementability of Alternative 3. Alternative 3 presents no implementation difficulties. The multi-media cap design shown in Figure 9-1 can be constructed with standard construction equipment and methods. An air monitoring program would be in-place during site grading, therefore regulatory agency permission to perform site grading can be obtained.

Cost of Alternative 3. The estimated present worth cost to implement Alternative 3 is $490,794. This includes fence and cap maintenance and groundwater monitoring for a period of 30 years following implementation of remedial actions for Alternative 3.

9.3 COMPARATIVE ANALYSIS

The following discussion summarizes the degree to which the various remedial alternatives meet the evaluation criteria of effectiveness in meeting RAOs, implementability and cost, and presents a recommendation for the preferred alternative.

This analysis is based on the understanding that current conditions partially satisfy short- and long-term effectiveness criteria for meeting RAO1 established for the Site.

Alternative 1 would be effective in the long-term in meeting RAO1. However, this alternative would not adequately satisfy short-term effectiveness criteria for RAOs.

The two other alternatives, Alternative 2 and Alternative 3, are both viewed as satisfying RAO-1 and RAO-2. However, Alternate 2 is cost prohibitive. Additionally, removal of the dross and contaminated soil is not viewed as necessary to satisfy RAO-2, based on the results of historic groundwater monitoring, soil characteristics, site hydrogeologic conditions, and the chemical properties of contaminants of concern in the subsurface environment. Since it is not practicable to reuse, destroy or detoxify the aluminum dross, Alternative 3, which relies on on-site containment can be considered under WAC 173-340-360 (8).

Remedial Alternative 2, off-site disposal, is over two times the cost as Alternative 3, on-site containment. The degree of protection from both alternatives is equivalent.

- Metals are currently mobile and would be permanently contained under both alternatives.
- Other contaminants of concern would be contained under both alternatives.

9.4 RECOMMENDED ALTERNATIVE

Alternative 3 is therefore the recommended remedial alternative for the Site. This approach satisfies RAOs, is cost effective relative to the benefits of the remedial action, and provides environmental protection from contaminants of concern. This alternative will satisfy all RAOs for the Site by protecting persons from direct exposure to the contaminants of concern, and by protecting the existing and potential and probable beneficial uses of land. It is easily implementable and is cost-effective relative to the other two remedial alternatives evaluated for the Site.

One potential land use for the Site has been suggested by Brown Dog Investments. The Site could be used as a lumber storage yard. That land use is consistent with the recommended alternative.

10.0 CONCLUSIONS

10.1 REMEDIAL INVESTIGATION

EMR's RI analytical results confirm previous investigations results showing that elevated concentrations of aluminum, arsenic, barium, chloride, and fluoride are present in groundwater. In addition, results show that site soils do not contain elevated levels of metals or other contaminants.

During boring operation the main dross pile was found to be underlain by a brown gravelly sand fill. This fill extends approximately two (2) feet below the dross pile and may have been laid as a grade preparation or liner material for the pile. Below the fill material is uniformly graded dark brown fine silty sand. The uppermost aquifer is approximately five (5) feet below the ground surface. The regional groundwater flow direction in the vicinity of the Morse Site is north-northwest.

Drainage ditches trisect the Site. These ditches may affect groundwater at the Site. Recharge of the shallow groundwater is from precipitation and the drainage ditches. Leachate formed by rainwater infiltrating through the aluminum dross at the Site contains elevated concentrations of aluminum, arsenic, and chloride. These compounds flow through the unsaturated zone to groundwater. The concentrations in groundwater have generally diminished since 1990. Metals are present above naturally occurring concentrations in groundwater.

10.2 Fate and Transport Evaluations

Inorganic contaminants from the aluminum dross are transported along the following routes of migration:

- infiltration of rainwater or surface water through dross and contaminated sediments;
- surface water transport;
- sediment transport;
- groundwater transport; and,
- air transport.

The primary potential migration pathways for contaminant movement at the Maralco Site are leaching of dross contaminants to groundwater, transport of contaminants downgradient of the source area by groundwater flow, and surface water impact from stormwater runoff.

10.3 Risk Assessment

The risk assessment evaluated the following current potential receptors:

- On-site workers;
- Trespassers; and,
- Various off-site populations (e.g., workers, passers-by).

Under future conditions, the following potential receptors were evaluated:

- On-site workers;
- Construction workers;
- Trespassers; and,
- Various off-site populations (e.g., workers, residents, passers-by).

Consistent with the fate and transport evaluation, the following exposure pathways were evaluated for the human health risk assessment. Potential exposure pathways associated with soil include:

- Direct contact with dross, sediments, and surface water (i.e., incidental ingestion and dermal contact); and,

Potential exposure pathways associated with groundwater include:

- Incidental contact and ingestion during on-site construction.

The SW-4 sediment sample result for arsenic was an order of magnitude greater than for any of the other sediment arsenic results. All other arsenic results for sediment are below the published regional 90th Percentile Value for background arsenic in soil, which is 7 mg/kg. This data point; therefore is considered an outlier and was not considered in the final risk analysis.

The cumulative Hazard Quotient associated with exposure routes from dross for the construction worker and trespasser was 2.33. Potential cancer risk was $1.29\text{x}10^{-5}$ for ingestion and $1.79\text{x}10^{-4}$ for inhalation. The cumulative Hazard Quotient associated with exposure routes from contaminated sediment for the construction worker and trespasser was 0.902. Potential cancer risk was $1.05\text{x}10^{-5}$ for ingestion and $1.49\text{x}10^{-4}$ for inhalation. The cumulative Hazard Quotient associated with exposure routes from groundwater for the on-site construction worder was 13. Potential cancer risk was 6.86×10^{-4}.

10.4 Project Remediation Goals

The project ARARs are exceeded by arsenic, barium, copper, and mercury in dross and sediments. Groundwater ARARs are exceeded in on-site wells by aluminum, arsenic, barium, chloride, and fluoride. PRGs for contaminants that contribute significantly to the risk to human health are listed in Table 7-1. Dross sample concentrations exceed PRGs for barium, mercury, and copper. Sediment sample concentrations exceed PRGs for barium, copper, and mercury. A single outlier result for sediment was not considered during the risk assessment. This outlier was the only result above PRGs and was an order of magnitude above the other results. Groundwater PRGs are exceeded for aluminum, arsenic, barium, chloride and fluoride.

10.5 Feasability Study

The three remedial alternatives developed for evaluation include:

- Remedial Alternative 1: Limited Action/Institutional Controls;
- Remedial Alternative 2: Removal and Off-Site Disposal; and,
- Remedial Alternative 3: On-Site Containment.

Each alternative is evaluated according to the effectiveness, implementability, and cost criteria.

Under the Limited Action/Institutional Controls alternative, the existing fence and tarp at the Site would be maintained, and long-term groundwater monitoring would be conducted. Groundwater monitoring and maintenance of the existing fence and tarp could easily be implemented, although the long-term integrity and long-term maintenance requirements of the existing cap cannot be quantified with certainty. The estimated present worth cost to implement Alternative 1 is $372,269. This includes fence and tarp maintenance and groundwater monitoring for a period of 30 years following implementation of remedial actions for Alternative 1.

The effectiveness of the Removal and Off-Site Disposal alternative for the aluminum dross and contaminated sediments is obvious, and it is technically feasible. Routine excavation and transport methods would be used. The estimated present worth cost to implement Alternative 2 is $1,132,294. This includes removal of contaminated materials and groundwater monitoring for a period of five years following implementation of remedial actions for Alternative 2.

Installation of a multi-media liner and cap system would be effective in prohibiting human and environmental receptor exposure to contaminants of concern whether by direct contact or by airborne particulates. In addition, the amount of water infiltrating through the cap and dross material to groundwater would be negligible. Therefore, the alternative is viewed as effective in satisfying remedial action objectives. Construction presents no implementation difficulties, and can be constructed with standard construction equipment and methods. The estimated present worth cost to implement Alternative 3 is $490,794. This includes fence and cap maintenance and groundwater monitoring for a period of 5 years following implementation of remedial actions for Alternative 3.

10.6 Preferred Remedial Alternative

Alternative 3 is the recommended remedial alternative for the Site. This approach satisfies RAOs, is cost effective relative to the benefits of the remedial action, and provides environmental protection from contaminants of concern. This alternative will satisfy all RAOs for the Site by protecting persons from direct exposure to the contaminants of concern, and by protecting the existing and potential and probable beneficial uses of land. It is easily implementable and is cost-effective relative to the other two remedial alternatives evaluated for the Site.

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APPENDIX A

BORING LOGS FOR MONITORING WELL INSTALLATIONS AND SOIL SAMPLES

VISUAL CLASSIFICATION OF SOILS

EMR INCORPORATED
ENVIRONMENTAL MANAGEMENT RESOURCES

EMR Project Name: Maralco Investigation
EMR Project Number: 6060.001-1
Note:

Drilling Information

Drilling Contractor:	ESN Northwest
Drilling Method:	Direct Push
Drillers Name:	Don Hornden
Borehole Diameter:	2"
Sampler Type:	Direct Push 4 ft. Sleeve

Event Information

Logged by:	D.L. Welch	Boring #:	DP-1
Boring Depth:	8 ft	MW #:	
GW Encountered	5 ft	Surface Elevation:	
Static GW Level:		Start time/date:	2/4/03 8:45 a.m.
Location:	South End of Dross Pile	End time/date:	2/4/03 9:00 a.m.

Depth (ft)	Sample Interval	Sample Recovery	Evacuation Rate	Groundwater	PID/FID Readings	GC Reading	Graphic Log	USCS Classification	Soil Classification/ Description
0	0-4							DROSS	Starting elevation at 1 ft. Gray aluminum dross, dry, no ammonia odors
1								SM	Dark brown silty fine sand, damp.
2		DP-1-1'							
3									
4	4-8			▽					Groundwater at 5 ft.
5		DP-1-5'						SP	Dark brown silty fine sand, wet, no odors, no sheen
6									
7									End of Boring at 8 ft.
8	8-12								
9									
10									
11									

VISUAL CLASSIFICATION OF SOILS

EMR INCORPORATED
ENVIRONMENTAL MANAGEMENT RESOURCES

EMR Project Name:
Maralco Investigation
EMR Project Number:
6060.001-1
Note:

Drilling Information
Drilling Contractor: ESN Northwest
Drilling Method: Direct Push
Drillers Name: Don Hornden
Borehole Diameter: 2"
Sampler Type: Direct Push 4 ft. Sleeve

Event Information

Logged by: D. L. Welch
Boring Depth: 20 ft.
GW Encountered 15 ft.
Static GW Level:
Location: East Central Lobe of Dross Pile
Boring #: DP-2
MW #:
Surface Elevation:
Start time/date: 2/4/03 9:40 a.m.
End time/date: 2/4/03 10:10 a.m.

Depth (ft)	Sample Interval	Sample Recovery	Evacuation Rate	Groundwater	PID/FID Readings	GC Reading	Graphic Log	USCS Classification	Soil Classification/ Description
0	0-4							DROSS	Gray to dark gray aluminum dross, no ammonia odors, dry
1									
2									
3									
4	4-8								
5									
6									
7									
8	8-12								
9									
10								SW	
11		DP-2-1							

Boring Number:	DP-2	Project :	Maralco Investigation	Project #:	6060.001-1

Depth (ft)	Sample Interval	Sample Recovery	Evacuation Rate	Ground water	PID/FID Readings	GC Reading	Graphic Log	USCS Classificatio	Soil Classification/ Description
12	12-16'							SP	Dark brown find sand grading into gray-brown silty fine sand, wet to saturated; streaks of oxidation
13		DP-2-3'							
14				▽					Groundwater at 15 ft.
15		DP-2-5'							
16	16-20'								
17									
18									
19									End of boring at 20 ft.
20	20-24'								
21									
22									
23									
24	24-28'								
25									
26									
27									
28									

VISUAL CLASSIFICATION OF SOILS

EMR INCORPORATED
ENVIRONMENTAL MANAGEMENT RESOURCES

EMR Project Name: Maralco Investigation
EMR Project Number: 6060.001-1
Note:

Drilling Information

Drilling Contractor:	ESN Northwest
Drilling Method:	Direct Push
Drillers Name:	Don Hornden
Borehole Diameter:	2"
Sampler Type:	Direct Push 4 ft. Sleeve

Event Information

Logged by:	D. L. Welch	Boring #:	DP-3	
Boring Depth:	16 ft.	MW #:		
GW Encountered	13 ft.	Surface Elevation:		
Static GW Level:		Start time/date:	2/4/03	10:30
Location:	Center of Pile (Dross)	End time/date:	2/4/03	10:50

Depth (ft)	Sample Interval	Sample Recovery	Evacuation Rate	Groundwater	PID/FID Readings	GC Reading	Graphic Log	USCS Classification	Soil Classification/ Description
0	0-4							DROSS	Gray to dark gray aluminum dross, dry, no ammonia odors
1									
2									
3									
4	4-8			∇					
5									
6									
7									
8	8-12							SW	Brown gravelly sand fill
9		DP-3-1'							
10									
11		DP-3-3'							

Boring Number: DP-3 Project : Maralco Investigation Project #: 6060.001-1

Depth (ft)	Sample Interval	Sample Recovery	Evacuation Rate	Ground water	PID/FID Readings	GC Reading	Graphic Log	USCS Classificatio	Soil Classification/ Description
12	12-16'			▽				SP	Dark brown fine sand grading to gray fine sand. Wet to saturated , no odors, no sheen. Streaks of iron oxidation Groundwater at 13 ft.
13		DP-3-5'							
14									
15									End of boring at 16 ft.
16	16-20'								
17									
18									
19									
20	20-24'								
21									
22									
23									
24	24-28'								
25									
26									
27									
28									

VISUAL CLASSIFICATION OF SOILS

EMR
INCORPORATED
ENVIRONMENTAL MANAGEMENT RESOURCES

EMR Project Name:
Maralco Investigation
EMR Project Number:
6060.001-1
Note:

Drilling Information

Drilling Contractor:	ESN Northwest
Drilling Method:	Direct Push
Drillers Name:	Don Homden
Borehole Diameter:	2"
Sampler Type:	Direct Push 4 ft. Sleeve

Event Information

Logged by:	D. L. Welch	Boring #:	DP-4
Boring Depth:		MW #:	
GW Encountered	7 ft	Surface Elevation:	Elevated 5 ft.
Static GW Level:		Start time/date:	
Location:	North end of pile (Dross)	End time/date:	

Depth (ft)	Sample Interval	Sample Recovery	Evacuation Rate	Groundwater	PID/FID Readings	GC Reading	Graphic Log	USCS Classification	Soil Classification/ Description
0	0-4							DROSS	Dark gray dross
1									
2									
3									
4	4-8								
5									
6				▽					Fill brown gravelly sand Groundwater at 7 ft.
7									Dark brown fine sand
8	8-12								
9									
10									
11		DP-4-3'		▽				SW SP	Brown gravelly sand fill Groundwater at 11.5 ft.

Boring Number: DP-4 Project : Maralco Investigation Project #: 6060.001-1

Depth (ft)	Sample Interval	Sample Recovery	Evacuation Rate	Ground water	PID/FID Readings	GC Reading	Graphic Log	USCS Classificatio	Soil Classification/ Description
12	12-16'	DP-4-3'						**SP**	Dark brown fine sand grading to gray brown; streaks of iron oxidation, no sheen or odors; wet to saturated
13									
14									
15									End of boring at 16 ft.
16	16-20'								
17									
18									
19									
20	20-24'								
21									
22									
23									
24	24-28'								
25									
26									
27									
28									

VISUAL CLASSIFICATION OF SOILS

EMR
INCORPORATED
ENVIRONMENTAL MANAGEMENT RESOURCES

EMR Project Name:
Maralco Investigation
EMR Project Number:
6060.001-1
Note:

Drilling Information

Drilling Contractor: ESN Northwest
Drilling Method: Direct Push
Drillers Name: Don Hornden
Borehole Diameter: 2"
Sampler Type: Direct Push 4 ft. Sleeve

Event Information

Logged by: D.L. Welch
Boring Depth: 4 ft
GW Encountered 4.0 ft.
Static GW Level: 3.5 ft.
Location: North corner of site

Boring #: DP-5
MW #:
Surface Elevation:
Start time/date: 2/4/03 12:20
End time/date: 2/4/03 12:35

Depth (ft)	Sample Interval	Sample Recovery	Evacuation Rate	Groundwater	PID/FID Readings	GC Reading	Graphic Log	USCS Classification	Soil Classification/ Description
0	0-4	DP5-1'						OL	No visible aluminum dross. Top soil.
1								SM	Brown silty sand.
2		DP5-2.5'						SP	Dark brown fine sand
3		DP-5-4'		▽					End of boring at 4 ft. Groundwater at 4 ft.
4	4-8								
5									
6									
7									
8	8-12								
9									
10									
11									

VISUAL CLASSIFICATION OF SOILS

EMR
INCORPORATED
ENVIRONMENTAL MANAGEMENT RESOURCES

EMR Project Name:
Maralco Investigation
EMR Project Number:
6060.001-1
Note:

Drilling Information

Drilling Contractor:	Cascade Drilling
Drilling Method:	Hollow-stem Auger
Drillers Name:	
Borehole Diameter:	6"
Sampler Type:	Split Spoon

Event Information

Logged by:	D.L. Welch	Boring #:	MW-5	
Boring Depth:	16.5 ft (sampled); 15 ft (driled)	MW #:	MW-5	
GW Encountered	7.5 ft	Surface Elevation:		
Static GW Level:	7.5 ft	Start time/date:	1/22/03	9:00a.m.
Location:	Off paved lot north of dross pile	End time/date:	1/22/03	9:30 a.m.

Depth (ft)	Sample Interval	Sample Recovery	Evacuation Rate	Groundwater	PID/FID Readings	GC Reading	Graphic Log	USCS Classification	Soil Classification/ Description
0	0-4							SM	Brown, silty sand, trace coarse gravel, moist
1									
2									
3									Brown, dense silty sand, damp
4	4-8								
5			13 15 17		0				
6									
7				∇					Groundwater encountered at 7.5 ft
8	8-12							SP	Dark brown, loose, fine sand; trace medium sand, wet
9									
10			2 2 2		0				
11									

Boring Number: MW-5 Project : Maralco Investigation Project #: 6060.001-1

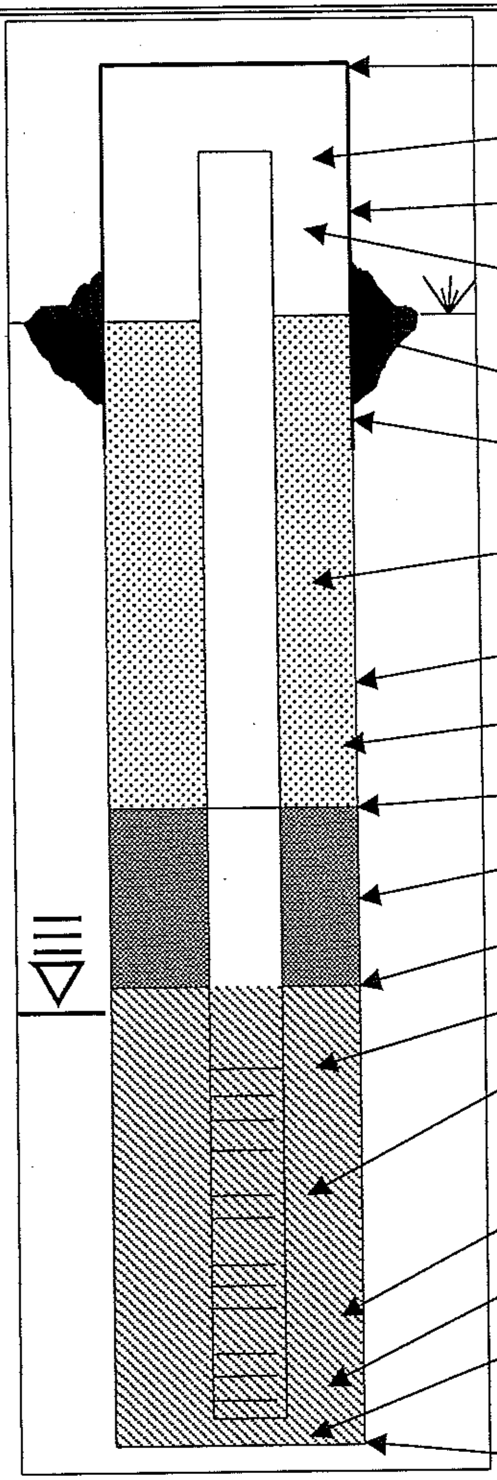
Depth (ft)	Sample Interval	Sample Recovery	Evacuation Rate	Ground water	PID/FID Readings	GC Reading	Graphic Log	USCS Classificatio	Soil Classification/ Description
12	12-16'							SP	Dark brown medium dense fine sand, saturated
13									
14									
15			4 6 6		0				Bottom of boring at 15 ft.; sampled depth at 16.5 ft.
16	16-20'								*Installed 2-inch monitoring well
17									
18									
19									
20	20-24'								
21									
22									
23									
24	24-28'								
25									
26									
27									
28									

WELL CONSTRUCTION LOG

EMR
INCORPORATED
ENVIRONMENTAL MANAGEMENT RESOURCES

Date 1/22/03
Project Maralco
Project No. 6070.001-1
Location N. of Dross Pile
Boring I.D. MW-5
Elevation
Geologist David Welch

Driller Cascade Drilling
Drilling License
Drilling Method Hollow-stem Auger
Developement Method Purge Pump
Static Water Level 7.5 ft.



Elevation of top of Casing: Survey
Elevation of top of Riser Pipe: Survey
Stick - up top of Protective Casing: None
Stick - up Riser Pipe: None
Type of Surface Seal: Concrete
I.D. of Surface Casing: 8-inch
Type of Surface Casing: Monument (Flush)
I.D. of Riser Pipe: 2 inch
Type of Riser Pipe: PVC
Borehole Diameter 9-inch
Type of Backfill: Concrete
Depth of Top of Seal: 2 ft.
Type of Seal: Bentonite Chip
Depth to top of Sand Pack: 4 ft.
Depth to top of Screen: 5 ft.
I.D. of Screen 2-inch
Type of Screen: PVC
Slot size & Length 0.010 inch; 10 feet
Type of Sand Pack: 2-12 Sand
Depth to bottom of Screen: 15 ft.
Depth to bottom of sand pack: 16.5 ft
Type of Backfill below Observation Well: Silty sand
Depth of Hole 16.5 ft. (sampled)

APPENDIX B

ANALYTICAL RESULTS FOR EMR SOIL AND GROUNDWATER SAMPLES

ESN NORTHWEST CHEMISTRY LABORATORY

MARALCO INVESTIGATION PROJECT
Kent, Washington
EMR, Inc.
Client Project #6070.001-1

Heavy Metals in Soil by EPA-7000 Series

Sample Number	Date Analyzed	Cadmium (Cd) EPA 7130 (mg/kg)	Aluminum (Al) EPA 7020 (mg/kg)	Arsenic (As) EPA 7061 (mg/kg)
Method Blank	2/17/03	nd	nd	nd
DP-1-1'	2/17/03	nd	3000	nd
DP-2-3'	2/17/03	nd	1400	nd
DP-3-3'	2/17/03	nd	2000	nd
DP-4-3'	2/17/03	nd	2300	nd
DP-5-2.5'	2/17/03	nd	1400	nd
DP-5-2.5'	2/17/03	nd	1400	nd
Method Detection Limits		1	50	5

"nd" Indicates not detected at listed detection limits.

ANALYSES PERFORMED BY: Dean Phillips

ESN NORTHWEST CHEMISTRY LABORATORY

MARALCO INVESTIGATION PROJECT
Kent, Washington
EMR, Inc.
Client Project #6070.001-1

QA/QC Data - Total Metals EPA-7000 Series Analyses

Sample Number: DP-5-2.5'

	Matrix Spike			Matrix Spike Duplicate			RPD
	Spiked Conc. (mg/kg)	Measured Conc. (mg/kg)	Spike Recovery (%)	Spiked Conc. (mg/kg)	Measured Conc. (mg/kg)	Spike Recovery (%)	(%)
Cadmium	12.5	12.7	102	12.5	11.9	95	6.50
Aluminum	125	128	102	125	112	90	13.33
Arsenic	125	119	95	125	122	98	2.49

Laboratory Control Sample

	Spiked Conc. (mg/kg)	Measured Conc. (mg/kg)	Spike Recovery (%)
Cadmium	12.5	13.2	106
Aluminum	125	144	115
Arsenic	125	130	104

ACCEPTABLE RECOVERY LIMITS FOR MATRIX SPIKES: 65%-135%
ACCEPTABLE RPD IS 35%

ANALYSES PERFORMED BY: Dean Phillips

ESN NORTHWEST | Environmental Services Network

CHAIN-OF-CUSTODY RECORD

CLIENT: EMR, Inc.
ADDRESS: 2509 152nd AVE NE Suite E Redmond WA 98052
PHONE: 425-861-4561 FAX: 425 869-7820
CLIENT PROJECT #: 6070.001-1 PROJECT MANAGER: Christina Merten

DATE: 2-4-03 PAGE 1 OF 1
PROJECT NAME: Marcco Investigation
LOCATION: 7730 South 202nd ST, Kent WA
COLLECTOR: David L Welch DATE OF COLLECTION 2-4-03

ANALYSES

Sample Number	Depth	Time	Sample Type	Container Type	VOA 8021B	VOA 8021B BTEX Only	VOA 8260	SEMI VOL 8270	TPH - HCID	TPH 8015 (gasoline)	TPH 8015 (diesel)	TPH 8015 (d & o)	PAH 8100	PAH 8270	PCBs 8082	Pesticides 8081	EPH	VPH	Methamphetamine	Pb	Hex Chrome	Al, As, Cd			NOTES	Total Number of Containers	Laboratory Note Number
1. DP-1-1'		0910	Soil	4 oz																		X			HOLD	2	
2. DP-1-5'		0915	Soil	4 oz																					//	2	
3. DP-2-1'		0955	Soil	4 oz																					//	2	
4. DP-2-3'		1005	Soil	4 oz																		X			//	2	
5. DP-2-5'		1015	Soil	4 oz																					//	2	
6. DP-3-1'		10:45	Soil	4 oz																					//	2	
7. DP-3-3'		10:50	Soil	4 oz																		X			//	2	
8. DP-3-5'		10:55	Soil	4 oz																					//	2	
9. DP-4-1'		1125	Soil	4 oz																					//	2	
10. DP-4-3'		1135	Soil	4 oz																		X			//	2	
11. DP-4-5'		1140	Soil	4 oz																					//	2	
12. DP-5-1'		1225	Soil	4 oz																					//	2	
13. DP 5-~~[illegible]~~ 2.5'		1230	Soil	4 oz																		X			//	2	
14. DP-5-~~[illegible]~~ 4'		1235	Soil	4 oz																					//		
15.																											
16.																											
17.																											
18.																											

RELINQUISHED BY (Signature)	DATE/TIME	RECEIVED BY (Signature)	DATE/TIME
D. Welch	2-4-03 1250		2-4-03/1250

RELINQUISHED BY (Signature)	DATE/TIME	RECEIVED BY (Signature)	DATE/TIME

SAMPLE DISPOSAL INSTRUCTIONS

☐ ESN DISPOSAL @ $2.00 each ☐ Return ☐ Pickup:

SAMPLE RECEIPT	
TOTAL NUMBER OF CONTAINERS	
CHAIN OF CUSTODY SEALS Y/N/NA	
SEALS INTACT? Y/N/NA	
RECEIVED GOOD COND./COLD	
NOTES:	

LABORATORY NOTES:
ADDED metals 2/14/03 per CM / mrF

Turn Around Time: 24' 48 HR 5 DAY

OnSite Environmental Inc.
Analytical Testing and Mobile Laboratory Services

February 27, 2003

Christina Merten
Environmental Management Resources, Inc.
2509 152nd Avenue NE, Suite E
Redmond, WA 98052-5548

Re: Analytical Data for Project 6070.001-1
Laboratory Reference No. 0301-137

Dear Christina:

Enclosed are the analytical results and associated quality control data for samples submitted on January 24, 2003.

The standard policy of OnSite Environmental Inc. is to store your samples for 30 days from the date of receipt. If you require longer storage, please contact the laboratory.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning the data, or need additional information, please feel free to call me.

Sincerely,

David Baumeister
Project Manager

Enclosures

Date of Report: February 27, 2003
Samples Submitted: January 24, 2003
Lab Traveler: 01-137
Project: 6070.001-1

Case Narrative

Samples were collected on January 24, 2003. Samples were maintained at the laboratory at 4°C and followed SW846 analysis and extraction methods.

Total Metals EPA 200.8/7470A Analysis

Any QA/QC issues associated with this extraction and analysis will be indicated with a footnote reference and discussed in detail on the Data Qualifier page.

Date of Report: February 27, 2003
Samples Submitted: January 24, 2003
Lab Traveler: 01-137
Project: 6070.001-1

TOTAL METALS
EPA 200.8/7470A

Date Extracted:	1-31&2-3-03
Date Analyzed:	1-31&2-3&4-03
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	01-137-01
Client ID:	MW-4-1-24-03

Analyte	Method	Result	PQL
Aluminum	200.8	**3600**	110
Arsenic	200.8	**19**	3.3
Barium	200.8	**77**	56
Cadmium	200.8	**ND**	4.4
Chromium	200.8	**22**	11
Lead	200.8	**9.0**	1.1
Mercury	7470A	**ND**	.50
Selenium	200.8	**ND**	5.6
Silver	200.8	**ND**	11

Date of Report: February 27, 2003
Samples Submitted: January 24, 2003
Lab Traveler: 01-137
Project: 6070.001-1

TOTAL METALS
EPA 200.8/7470A

Date Extracted:	1-31&2-3-03
Date Analyzed:	1-31&2-3&4-03
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	01-137-02
Client ID:	MW-5-1-24-03

Analyte	Method	Result	PQL
Aluminum	200.8	**28000**	110
Arsenic	200.8	**11**	3.3
Barium	200.8	**170**	56
Cadmium	200.8	**ND**	4.4
Chromium	200.8	**38**	11
Lead	200.8	**8.0**	1.1
Mercury	7470A	**ND**	.50
Selenium	200.8	**ND**	5.6
Silver	200.8	**ND**	11

Date of Report: February 27, 2003
Samples Submitted: January 24, 2003
Lab Traveler: 01-137
Project: 6070.001-1

TOTAL METALS
EPA 200.8/7470A

Date Extracted: 1-31&2-3-03
Date Analyzed: 1-31&2-3&4-03

Matrix: Water
Units: ug/L (ppb)

Lab ID: 01-137-03
Client ID: MW-3-1-24-03

Analyte	Method	Result	PQL
Aluminum	200.8	**820**	440
Arsenic	200.8	**40**	3.3
Barium	200.8	**2500**	56
Cadmium	200.8	**ND**	4.4
Chromium	200.8	**14**	11
Lead	200.8	**2.7**	1.1
Mercury	7470A	**ND**	.50
Selenium	200.8	**43**	5.6
Silver	200.8	**ND**	11

Date of Report: February 27, 2003
Samples Submitted: January 24, 2003
Lab Traveler: 01-137
Project: 6070.001-1

TOTAL METALS
EPA 200.8/7470A

Date Extracted:	1-31&2-3-03
Date Analyzed:	1-31&2-3&4-03
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	01-137-04
Client ID:	MW-2-1-24-03

Analyte	Method	Result	PQL
Aluminum	200.8	**600**	110
Arsenic	200.8	**ND**	3.3
Barium	200.8	**ND**	56
Cadmium	200.8	**ND**	4.4
Chromium	200.8	**ND**	11
Lead	200.8	**1.2**	1.1
Mercury	7470A	**ND**	.50
Selenium	200.8	**ND**	5.6
Silver	200.8	**ND**	11

Date of Report: February 27, 2003
Samples Submitted: January 24, 2003
Lab Traveler: 01-137
Project: 6070.001-1

TOTAL METALS
EPA 200.8/7470A

Date Extracted:	1-31&2-3-03
Date Analyzed:	1-31&2-3&4-03
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	01-137-05
Client ID:	MW-2D-1-24-03

Analyte	Method	Result	PQL
Aluminum	200.8	**860**	110
Arsenic	200.8	**ND**	3.3
Barium	200.8	**ND**	56
Cadmium	200.8	**ND**	4.4
Chromium	200.8	**ND**	11
Lead	200.8	**1.4**	1.1
Mercury	7470A	**ND**	.50
Selenium	200.8	**ND**	5.6
Silver	200.8	**ND**	11

Date of Report: February 27, 2003
Samples Submitted: January 24, 2003
Lab Traveler: 01-137
Project: 6070.001-1

TOTAL METALS
EPA 200.8/7470A
METHOD BLANK QUALITY CONTROL

Date Extracted:	1-31&2-3-03
Date Analyzed:	1-31&2-3&4-03
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	MB0131W1&MB0203W1

Analyte	Method	Result	PQL
Aluminum	200.8	**ND**	110
Arsenic	200.8	**ND**	3.3
Barium	200.8	**ND**	56
Cadmium	200.8	**ND**	4.4
Chromium	200.8	**ND**	11
Lead	200.8	**ND**	1.1
Mercury	7470A	**ND**	.50
Selenium	200.8	**ND**	5.6
Silver	200.8	**ND**	11

Date of Report: February 27, 2003
Samples Submitted: January 24, 2003
Lab Traveler: 01-137
Project: 6070.001-1

TOTAL METALS
EPA 200.8/7470A
DUPLICATE QUALITY CONTROL

Date Extracted:	1-31&2-3-03
Date Analyzed:	1-31&2-3&4-03
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	01-164-08

Analyte	Sample Result	Duplicate Result	RPD	PQL	Flags
Aluminum	**589**	**633**	7.3	110	
Arsenic	**ND**	**ND**	NA	3.3	
Barium	**ND**	**ND**	NA	56	
Cadmium	**ND**	**ND**	NA	4.4	
Chromium	**ND**	**ND**	NA	11	
Lead	**1.57**	**1.65**	4.8	1.1	
Mercury	**ND**	**ND**	NA	0.50	
Selenium	**ND**	**ND**	NA	5.6	
Silver	**ND**	**ND**	NA	11	

Date of Report: February 27, 2003
Samples Submitted: January 24, 2003
Lab Traveler: 01-137
Project: 6070.001-1

TOTAL METALS
EPA 200.8/7470A
MS/MSD QUALITY CONTROL

Date Extracted:	1-31&2-3-03
Date Analyzed:	1-31&2-3&4-03
Matrix:	Water
Units:	ug/L (ppb)
Lab ID:	01-164-08

Analyte	Spike Level	MS	Percent Recovery	MSD	Percent Recovery	RPD	Flags
Aluminum	1200	**1890**	108	**1870**	107	0.78	
Arsenic	110	**108**	98	**113**	102	3.9	
Barium	110	**120**	109	**124**	112	2.9	
Cadmium	110	**111**	101	**115**	105	3.8	
Chromium	110	**118**	108	**123**	112	4.0	
Lead	110	**121**	109	**121**	109	0	
Mercury	5.0	**5.05**	101	**5.36**	107	6.0	
Selenium	110	**102**	92	**107**	97	4.8	
Silver	110	**107**	97	**124**	113	15	

OnSite Environmental Inc.

Data Qualifiers and Abbreviations

A - Due to a high sample concentration, the amount spiked is insufficient for meaningful MS/MSD recovery data.

B - The analyte indicated was also found in the blank sample.

C - The duplicate RPD is outside control limits due to high result variability when analyte concentrations are within five times the quantitation limit.

D - Data from 1:____ dilution.

E - The value reported exceeds the quantitation range, and is an estimate.

F - Surrogate recovery data is not available due to the high concentration of coeluting target compounds.

G - Insufficient sample quantity for duplicate analysis.

H - The analyte indicated is a common laboratory solvent and may have been introduced during sample preparation, and be impacting the sample result.

I - Compound recovery is outside of the control limits.

J - The value reported was below the practical quantitation limit. The value is an estimate.

K - Sample duplicate RPD is outside control limits due to sample inhomogeniety. The sample was re-extracted and re-analyzed with similar results.

L - The RPD is outside of the control limits.

M - Hydrocarbons in the gasoline range (toluene-napthalene) are present in the sample.

O - Hydrocarbons outside the defined gasoline range are present in the sample.

P - The RPD of the detected concentrations between the two columns is greater than 40.

Q - Surrogate recovery is outside of the control limits.

S - Surrogate recovery data is not available due to the necessary dilution of the sample.

T - The sample chromatogram is not similar to a typical ____________.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

V - Matrix Spike/Matrix Spike Duplicate recoveries are outside control limits due to matrix effects.

W - Matrix Spike/Matrix Spike Duplicate RPD are outside control limits due to matrix effects.

X - Sample extract treated with a silica gel cleanup procedure.

Y - Sample extract treated with an acid cleanup procedure.

Z -

ND - Not Detected at PQL
MRL - Method Reporting Limit
PQL - Practical Quantitation Limit
RPD - Relative Percent Difference

nca™
www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
425.420.9200 fax 425.420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
509.924.9200 fax 509.924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906.9200 fax 503.906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
541.383.9310 fax 541.382.7588
Anchorage 3209 Denali Street, Anchorage, AK 99503
907.334.9200 fax 907.334.9210

26 February 2003

David Baumeister
OnSite Environmental Inc.
14648 NE 95th Street
Redmond, WA/USA 98052
RE: Not Provided.

Enclosed are the results of analyses for samples received by the laboratory on 01/25/03 08:55. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Sandra Yakamavich

Sandra Yakamavich
Project Manager

OnSite Environmental Inc.
14648 NE 95th Street
Redmond WA/USA, 98052

Project: Not Provided.
Project Number: 6070.001-1
Project Manager: David Baumeister

Reported:
02/10/03 15:35

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
MW-4-1-24-03	B3A0516-01	Water	01/24/03 12:00	01/25/03 08:55
MW-5-1-24-03	B3A0516-02	Water	01/24/03 12:00	01/25/03 08:55
MW-3-1-24-03	B3A0516-03	Water	01/24/03 12:00	01/25/03 08:55
MW-2-1-24-03	B3A0516-04	Water	01/24/03 12:00	01/25/03 08:55
MW-2D-1-24-03	B3A0516-05	Water	01/24/03 12:00	01/25/03 08:55

Sandra Yakamavich

Sandra Yakamavich, Project Manager

OnSite Environmental Inc.
14648 NE 95th Street
Redmond WA/USA, 98052

Project: Not Provided.
Project Number: 6070.001-1
Project Manager: David Baumeister

Reported:
02/10/03 15:35

Conventional Chemistry Parameters by APHA/EPA Methods

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
MW-4-1-24-03 (B3A0516-01) Water	**Sampled: 01/24/03 12:00**		**Received: 01/25/03 08:55**						
Ammonia-Nitrogen	**1.71**	0.100	mg/l as N	1	3A27014	01/27/03	01/27/03	EPA 350.3	
MW-5-1-24-03 (B3A0516-02) Water	**Sampled: 01/24/03 12:00**		**Received: 01/25/03 08:55**						
Ammonia-Nitrogen	**1.52**	0.100	mg/l as N	1	3A27014	01/27/03	01/27/03	EPA 350.3	
MW-3-1-24-03 (B3A0516-03) Water	**Sampled: 01/24/03 12:00**		**Received: 01/25/03 08:55**						
Ammonia-Nitrogen	33.7	0.100	mg/l as N	1	3A27014	01/27/03	01/27/03	EPA 350.3	
MW-2-1-24-03 (B3A0516-04) Water	**Sampled: 01/24/03 12:00**		**Received: 01/25/03 08:55**						
Ammonia-Nitrogen	**1.26**	0.100	mg/l as N	1	3A27014	01/27/03	01/27/03	EPA 350.3	
MW-2D-1-24-03 (B3A0516-05) Water	**Sampled: 01/24/03 12:00**		**Received: 01/25/03 08:55**						
Ammonia-Nitrogen	**0.433**	0.100	mg/l as N	1	3A27014	01/27/03	01/27/03	EPA 350.3	

Sandra Yakamavich

Sandra Yakamavich, Project Manager

OnSite Environmental Inc.
14648 NE 95th Street
Redmond WA/USA, 98052

Project: Not Provided.
Project Number: 6070.001-1
Project Manager: David Baumeister

Reported:
02/10/03 15:35

Anions by EPA Method 300.0
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
MW-4-1-24-03 (B3A0516-01) Water	**Sampled: 01/24/03 12:00**		**Received: 01/25/03 08:55**						
Chloride	**92.0**	8.00	mg/l	20	3A30037	01/29/03	01/29/03	EPA 300.0	
Fluoride	**6.89**	0.400	"	2	3B07009	02/06/03	02/06/03	"	
Nitrate-Nitrogen	ND	0.200	mg/l as N	1	3A26010	01/25/03	01/25/03	"	
MW-5-1-24-03 (B3A0516-02) Water	**Sampled: 01/24/03 12:00**		**Received: 01/25/03 08:55**						
Chloride	**442**	40.0	mg/l	100	3A31001	01/30/03	01/30/03	EPA 300.0	
Fluoride	**2.10**	0.200	"	1	3B07009	02/06/03	02/06/03	"	
Nitrate-Nitrogen	**1.50**	0.200	mg/l as N	"	3A26010	01/25/03	01/25/03	"	
MW-3-1-24-03 (B3A0516-03) Water	**Sampled: 01/24/03 12:00**		**Received: 01/25/03 08:55**						
Chloride	**9100**	800	mg/l	2000	3A31001	01/30/03	01/30/03	EPA 300.0	
Fluoride	ND	1.00	"	5	3B07009	02/06/03	02/06/03	"	
Nitrate-Nitrogen	ND	0.800	mg/l as N	4	3A26010	01/25/03	01/25/03	"	A-01
[illegible]-2-1-24-03 (B3A0516-04) Water	**Sampled: 01/24/03 12:00**		**Received: 01/25/03 08:55**						
Chloride	**9.64**	2.00	mg/l	5	3A30037	01/29/03	01/29/03	EPA 300.0	
Fluoride	ND	0.200	"	1	3B07009	02/06/03	02/06/03	"	
Nitrate-Nitrogen	ND	0.200	mg/l as N	"	3A26010	01/25/03	01/25/03	"	
MW-2D-1-24-03 (B3A0516-05) Water	**Sampled: 01/24/03 12:00**		**Received: 01/25/03 08:55**						
Chloride	**8.89**	0.800	mg/l	2	3A30037	01/29/03	01/29/03	EPA 300.0	
Fluoride	ND	0.200	"	1	3B07009	02/06/03	02/06/03	"	
Nitrate-Nitrogen	ND	0.200	mg/l as N	"	3A26010	01/25/03	01/25/03	"	

Sandra Yakamavich

Sandra Yakamavich, Project Manager

OnSite Environmental Inc.
14648 NE 95th Street
Redmond WA/USA, 98052

Project: Not Provided.
Project Number: 6070.001-1
Project Manager: David Baumeister

Reported:
02/10/03 15:35

Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 3A27014: Prepared 01/27/03 Using General Preparation										
Blank (3A27014-BLK1)										
Ammonia-Nitrogen	ND	0.100	mg/l as N							
LCS (3A27014-BS1)										
Ammonia-Nitrogen	5.05	0.100	mg/l as N	5.00		101	90-110			
LCS Dup (3A27014-BSD1)										
Ammonia-Nitrogen	5.23	0.100	mg/l as N	5.00		105	90-110	3.50	20	
Duplicate (3A27014-DUP1)					**Source: B3A0273-01**					
Ammonia-Nitrogen	0.181	0.100	mg/l as N		0.197			8.47	25	
Matrix Spike (3A27014-MS1)					**Source: B3A0273-01**					
nia-Nitrogen	5.35	0.100	mg/l as N	5.00	0.197	103	75-140			

Sandra Yakamavich

Sandra Yakamavich, Project Manager

OnSite Environmental Inc.
14648 NE 95th Street
Redmond WA/USA, 98052

Project: Not Provided.
Project Number: 6070.001-1
Project Manager: David Baumeister

Reported:
02/10/03 15:35

Anions by EPA Method 300.0 - Quality Control
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 3A26010: Prepared 01/25/03 Using General Preparation										
Blank (3A26010-BLK1)										
Nitrate-Nitrogen	ND	0.200	mg/l as N							
LCS (3A26010-BS1)										
Nitrate-Nitrogen	0.986	0.200	mg/l as N	1.00		98.6	90-110			
LCS Dup (3A26010-BSD1)										
Nitrate-Nitrogen	1.01	0.200	mg/l as N	1.00		101	90-110	2.40	20	
Duplicate (3A26010-DUP1)					**Source: B3A0516-02**					
Nitrate-Nitrogen	1.51	0.200	mg/l as N		1.50			0.664	25	
Duplicate (3A26010-DUP2)					**Source: B3A0519-01**					
e-Nitrogen	3.60	0.200	mg/l as N		3.66			1.65	25	
Matrix Spike (3A26010-MS1)					**Source: B3A0516-02**					
Nitrate-Nitrogen	2.41	0.200	mg/l as N	1.00	1.50	91.0	60-130			
Matrix Spike (3A26010-MS2)					**Source: B3A0519-01**					
Nitrate-Nitrogen	4.40	0.200	mg/l as N	1.00	3.66	74.0	60-130			
Batch 3A30037: Prepared 01/29/03 Using General Preparation										
Blank (3A30037-BLK1)										
Chloride	ND	0.400	mg/l							
LCS (3A30037-BS1)										
Chloride	1.98	0.400	mg/l	2.00		99.0	90-110			

th Creek Analytical - Bothell

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Sandra Yakamavich

Sandra Yakamavich, Project Manager

OnSite Environmental Inc.
14648 NE 95th Street
Redmond WA/USA, 98052

Project: Not Provided.
Project Number: 6070.001-1
Project Manager: David Baumeister

Reported:
02/10/03 15:35

Anions by EPA Method 300.0 - Quality Control
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 3A30037: Prepared 01/29/03 Using General Preparation										
LCS Dup (3A30037-BSD1)										
Chloride	1.94	0.400	mg/l	2.00		97.0	90-110	2.04	20	
Duplicate (3A30037-DUP2)					**Source: B3A0516-05**					
Chloride	9.17	0.800	mg/l		8.89			3.10	25	
Matrix Spike (3A30037-MS2)					**Source: B3A0516-05**					
Chloride	10.0	2.00	mg/l	2.00	8.89	55.5	54-124			
Batch 3A31001: Prepared 01/30/03 Using General Preparation										
Blank (3A31001-BLK1)										
Chloride	ND	0.400	mg/l							
(3A31001-BS1)										
Chloride	1.95	0.400	mg/l	2.00		97.5	90-110			
LCS Dup (3A31001-BSD1)										
Chloride	1.90	0.400	mg/l	2.00		95.0	90-110	2.60	20	
Duplicate (3A31001-DUP1)					**Source: B3A0609-01**					
Chloride	3.78	0.400	mg/l		3.74			1.06	25	
Duplicate (3A31001-DUP2)					**Source: B3A0588-05**					
Chloride	3.04	0.400	mg/l		2.96			2.67	25	
Matrix Spike (3A31001-MS2)					**Source: B3A0588-05**					
Chloride	5.06	0.800	mg/l	2.00	2.96	105	54-124			

Sandra Yakamavich

Sandra Yakamavich, Project Manager

OnSite Environmental Inc.
14648 NE 95th Street
Redmond WA/USA, 98052

Project: Not Provided.
Project Number: 6070.001-1
Project Manager: David Baumeister

Reported:
02/10/03 15:35

Anions by EPA Method 300.0 - Quality Control
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 3A31001: Prepared 01/30/03 Using General Preparation										
Matrix Spike (3A31001-MS3)					**Source: B3A0609-01**					
Chloride	5.73	0.800	mg/l	2.00	3.74	99.5	54-124			
Batch 3B07009: Prepared 02/06/03 Using General Preparation										
Blank (3B07009-BLK1)										
Fluoride	ND	0.200	mg/l							
LCS (3B07009-BS1)										
Fluoride	0.784	0.200	mg/l	0.800		98.0	90-110			
LCS Dup (3B07009-BSD1)										
Fluoride	0.765	0.200	mg/l	0.800		95.6	90-110	2.45	20	
icate (3B07009-DUP3)					**Source: B3A0516-01**					
Fluoride	6.78	0.400	mg/l		6.89			1.61	25	
Matrix Spike (3B07009-MS3)					**Source: B3A0516-01**					
Fluoride	7.64	0.400	mg/l	0.800	6.89	93.8	75-125			

Sandra Yakamavich

Sandra Yakamavich, Project Manager

OnSite Environmental Inc.
14648 NE 95th Street
Redmond WA/USA, 98052

Project: Not Provided.
Project Number: 6070.001-1
Project Manager: David Baumeister

Reported:
02/10/03 15:35

Notes and Definitions

A-01	This sample was diluted due to matrix interference.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

h Creek Analytical - Bothell

Sandra Yakamavich

Sandra Yakamavich, Project Manager

OnSite Environmental Inc.
14648 NE 95th Street • Redmond, WA 98052
Phone: (425) 883-3881 • Fax: (425) 885-4603

Chain of Custody

Page 1 of ____

Laboratory Number: 01-137

Company: EMR, Inc.
Project Number: 6070.001-1
Project Name: MARALCO INVESTIGATION
Project Manager: CHRISTINA MERTEN
Sampled by: DAVID L. WELCH

Turnaround Request (in working days)
(Check One)
☐ Same Day ☐ 1 Day
☐ 2 Day ☐ 3 Day
☐ Standard (7 working days)
☐ ________ (other)

Requested Analysis

Lab ID	Sample Identification	Date Sampled	Time Sampled	Matrix	# of Cont.	NWTPH-HCID	NWTPH-Gx/BTEX	NWTPH-Dx	Volatiles by 8260B	Halogenated Volatiles by 8260B	Semivolatiles by 8270C	PAHs by 8270C	PCB's by 8082	Pesticides by 8081	Herbicides by 8151A	Total RCRA Metals (8) +Al	TCLP Metals	HEM by 1664	VPH	EPH	Nitrate	Flouride	Ammonia	Chloride	% Moisture
1	MW-4-1-24-03	1-24-03	12:45	W	3											X					X	X	X	X	
2	MW-5-1-24-03	1-24-03	13:30													X					X	X	X	X	
3	MW-3-1-24-03	1-24-03	13:00													X					X	X	X	X	
4	MW-2-1-24-03	1-24-03	15:20													X					X	X	X	X	
5	MW-2D-1-24-03	1-24-03	12:20													X					X	X	X	X	

	Signature	Company	Date	Time
Relinquished by		EMR, Inc.	1/24/03	@ 17:30
Received by	Stacey Dunn	OnSite Environmental	1/24/03	5:30p
Relinquished by				
Received by				
Relinquished by				
Received by				
Reviewed by/		Reviewed by/Date		

Comments/Special Instructions:

Chromatograms with final report ☐

DISTRIBUTION LEGEND: White - OnSite Copy Yellow - Report Copy Pink - Client Copy

APPENDIX C

PERTINENT FEDERAL AND STATE LAWS AND REGULATIONS

Pertinent Federal Laws and Regulations

Safe Drinking Water Act of 1974, 42 USC 300, et seq. National Primary Drinking Water Standards, 40 CFR 141	Establishes maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) that are drinking water criteria designed to protect human health from the potential adverse effects of contaminants in drinking water.	Ground water at the Hillyard Site is not a current drinking water source, but it is considered a potential future source of drinking water. In addition, ground-water is hydraulically connected to ground-water that is used for drinking water. MCLs and MCLGs should be considered in establishing cleanup levels that are protective of ground-water, points of compliance, and institutional controls.
National Secondary Drinking Water Standards, 40 CFR 143	Establishes secondary drinking water standards for use in establishing cleanup levels.	Federal secondary standards are not enforceable standards and are not typically applicable or relevant and appropriate requirements; however, the State of Washington Model Toxics Control Act requires that these standards be considered in establishing cleanup levels protective of ground-water.
Clean Water Act of 1977, 33 USC 1251, as amended Water Quality Standards, 40 CFR 131	Establishes the requirements and procedures for states to develop and adopt water quality standards based on federal water quality criteria that are at least as stringent as the federal standards. Provides EPA authority to review and approve state standards. Washington State has received EPA approval and has adopted more stringent standards under WAC 173-201A.	Not applicable (the requirement to develop standards applies to the states, not individual facilities) but relevant in establishing the basis for state regulation.
Resource Conservation and Recovery Act, 42 USC 6901, et seq. Criteria for Classification of Solid Waste Disposal Facilities and Practices, 40 CFR 257	Criteria specified under this standard are used to determine which solid waste disposal facilities and practices pose a reasonable possibility of adverse risk to human health and the environment.	Most of the provisions of this chapter have been delegated to the state. (See State Hazardous Waste Management Act.).
Clean Air Act of 1977, as amended 42 USC 7401, et seq. National Ambient Air Quality Standards, 40 CFR 50	Requirements of these regulations are applicable to airborne releases of criteria pollutants specified	Applicable to airborne releases of

Pertinent State Laws and Regulations (continued)

Ambient Air Quality Standards for Particulate Matter, WAC 173-470	These requirements set maximum acceptable levels for particulate matter in the ambient air and the 24-hour ambient air concentration standard for particles less than 10 µm in diameter (PM_{10}). The section defines standards for particle fallout in industrial, commercial, and residential areas. Alternate levels are set for areas where natural dust levels are high.	These requirements are applicable to assessment and response actions (e.g., drilling) that might emit particulate matter to the air.
Water Well Construction, Ch. 18.104 RCW Minimum Standards for Construction and Maintenance of Water Wells, WAC 173-160	These requirements establish minimum standards for design, construction, capping, and sealing of all wells. The requirements set additional requirements, including disinfection of equipment, decommissioning of wells, and quality of drilling water.	These requirements are applicable because assessment or response actions include construction of wells for ground-water monitoring of ground-water.
Rules and Regulations Governing the Licensing of Well Contractors and Operators, WAC 173-162	This regulation establishes training standards for well contractors and operators.	This regulation is relevant and appropriate because assessment or response actions could involve ground-water well installation or construction of geotechnical borings.
State Environmental Policy Act, Chapter 43.21C RCW SEPA Rules, WAC 197-11	These requirements establish compliance with the State Environmental Policy Act.	These requirements are applicable.
Water Quality Standards for Ground Waters of the State of Washington; WAC 173-200	Establishes ground-water quality standards to provide for protection of the environment and human health, as well as an antidegradation policy to protect existing and future beneficial uses of ground-water.	WAC 173-200 standards do not apply to cleanup actions undertaken pursuant to the Model Toxics Control Act (MTCA). Instead, MTCA establishes ground-water cleanup standards at such sites.

CFR = Code of Federal Regulations
Ecology = Washington Department of Ecology
MCL = maximum contaminant level
MCLG = maximum contaminant level goal
MTCA = Model Toxics Control Act
RCRA = Resource Conservation and Recovery Act

RCW = Revised Code of Washington
SEPA = State Environmental Policy Act
SDWA = Safe Drinking Water Act
WAC = Washington Administrative Code.