DEPARTMENT OF THE ARMY
INSTALLATION MANAGEMENT COMMAND
HEADQUARTERS, U.S. ARMY GARRISON, FORT WAINWRIGHT

FORMER COMMUNICATIONS SITE GROUNDWATER SUMMARY

FORT WAINWRIGHT, ALASKA

FINAL
SEPTEMBER 2012

U.S. Army Corps of Engineers, Alaska District
Environmental Remediation Services
Contract No. W911KB-06-D-0006
Task Order No. 07

Prepared by
Jacobs Engineering Group Inc.
4300 B Street, Suite 600
Anchorage, Alaska 99503

FORMER COMMUNICATIONS SITE GROUNDWATER SUMMARY

FORT WAINWRIGHT, ALASKA

FINAL
SEPTEMBER 2012

U.S. Army Corps of Engineers, Alaska District
Environmental Remediation Services
Contract No. W911KB-06-D-0006
Task Order No. 07

Prepared by
Jacobs Engineering Group Inc.
4300 B Street, Suite 600
Anchorage, Alaska 99503

TABLE OF CONTENTS

SECTION **PAGE**

ACRONYMS AND ABBREVIATIONS iii
1.0 INTRODUCTION 1
1.1 HYDROGEOLOGY AND GROUNDWATER USE 1
2.0 GROUNDWATER CONTAMINANTS OF CONCERN 2
3.0 STATISTICAL APPROACH FOR THE ANALYSIS OF TRENDS IN GROUNDWATER 4
4.0 GROUNDWATER PLUMES AND TRENDS 5
4.1 TCE PLUME 6
4.2 TCP PLUME 10
4.3 MAIN DIESEL-RANGE ORGANICS PLUME 13
4.4 MW62 AND MW77 DRO PLUMES 15
5.0 CONCLUSIONS AND RECOMMENDATIONS 18
6.0 REFERENCES 19

TABLES

Table 1 Contaminants of Concern at the Former Communications Site 3
Table 2 MAROS Trend Evaluation Results –TCE Plume MW56 and MW61 8
Table 3 MAROS Trend Evaluation Results – TCP Plume MW47 and MW79 11
Table 4 MAROS Trend Evaluation Results – Main DRO Plume 14
Table 5 MAROS Trend Evaluation Results – MW62 and MW77 DRO Plumes 17

TABLE OF CONTENTS (Continued)

SECTION **PAGE**

FIGURES

Figure 1 Generalized Biodegradation of TCE to Ethene via Reductive Dechlorination...7

Figure 2 TCE Over Time in MW56 9

Figure 3 Geometric Regression of TCE in MW61.....9

Figure 4 Geometric Regression of TCP in MW47.....12

Figure 5 Geometric Regression of TCP in MW79.....12

Figure 6 DRO Over Time in the Main DRO Plume.....15

Figure 7 DRO Over Time in the MW62 and MW77 DRO Plumes 17

APPENDICES

Appendix A Figures – Plume Maps and Results

Appendix B Chemicals of Interest, MAROS Summaries, and Geometric Regression Statistics

ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
COC	contaminant of concern
COI	chemical of interest
DRO	diesel-range organics
EPA	U.S. Environmental Protection Agency
FCS	Former Communications Site
Jacobs	Jacobs Engineering Group Inc.
MAROS	Monitoring and Remedial Optimization Software
mg/L	milligram per liter
mV	millivolts
MW	monitoring well
POL	petroleum, oil, and lubricants
R^2	coefficient of determination
TCE	trichloroethene
$t^{1/2}$	half-life
TCP	1,2,3-trichloropropane
USACE	U.S. Army Corps of Engineers, Alaska District

(intentionally blank)

1.0 INTRODUCTION

The purpose of this Report is to support the use of monitored natural attenuation as a viable remediation alternative at the FCS. This Groundwater Summary Report for the Former Communications Site (FCS) at Fort Wainwright, Alaska reviews the development of the current list of groundwater contaminants of concern (COC), identifies a shortened list for ongoing monitoring, and discusses historical trends and mechanisms of natural attenuation in the five remaining groundwater plumes. For each in-plume well, if the Mann-Kendall trend test indicated that attenuation could be occurring, geometric regression analysis was applied to the time-series data set to estimate a probable cleanup date.

The U.S. Environmental Protection Agency (EPA 1999) defines natural attenuation as including:

> *…a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants.*

Contaminants may be subject to the following:

- Biodegradation wherever geochemical conditions are favorable
- Dispersion as they are advected by flowing groundwater
- Dilution as recharge mixes at the water table
- Volatilization as contaminants with favorable properties move from groundwater to soil gas in the vadose zone

1.1 HYDROGEOLOGY AND GROUNDWATER USE

The main aquifer in the Fort Wainwright area is the Tanana Basin alluvial aquifer, a buried river valley. This aquifer ranges from a few feet thick at the base of Birch Hill to at least 300 feet thick under the main cantonment area of the Post. Groundwater movement between the Tanana and Chena Rivers generally follows a northwest regional direction, similar to the flow direction of the rivers. Typically, groundwater levels rise during spring breakup and late summer runoff and drop during fall and winter, when rainfall decreases and precipitation

becomes snow. The Tanana Basin alluvial aquifer beneath Fort Wainwright consists of deposits of the Chena Formation that vary in texture from sandy silt to coarse sandy gravel. The Chena Formation has a relatively high horizontal hydraulic conductivity in this area, estimated to be as high as 600 feet per day, and the vertical hydraulic conductivity has been estimated to be approximately 30 feet per day (USGS 1996). Groundwater in the Tanana-Chena floodplain is considered generally unconfined in permafrost-free areas. Figure A-1 depicts the approximate groundwater contour in relation to the site.

Groundwater is the only source of potable water used at Fort Wainwright and in the Fairbanks area. Approximately 95 percent of the potable water on Fort Wainwright is supplied through a distribution system fed by two large-capacity wells in Building 3559. These wells are installed to a depth of approximately 100 feet bgs with a screen interval of 60 to 80 feet below ground surface (bgs). These wells provide an average of approximately 59.2 million gallons of water per month to the Fort Wainwright water treatment plant for processing and distribution (based on average water production for the period January 2005 through August 2010).

2.0 GROUNDWATER CONTAMINANTS OF CONCERN

At the FCS, 90 monitoring wells and 2 sentry wells have been installed since 2006; the ongoing groundwater evaluation program currently samples 42 of the monitoring wells and both sentry wells semiannually. Samples from these wells have provided the basis for identifying contaminants and the extent of their presence within the site. A third sentry well was installed and sampled in June 2012. These results will be discussed under a separate cover.

The *FWA 102 Former Communications Site Remedial Investigation Report* (U.S. Army Corps of Engineers [USACE] 2010) used data collected from 2007 to 2009 to identify chemicals of interest (COI) in groundwater. Analytical results were compared to screening levels of one-tenth of the Alaska Department of Environmental Conservation (ADEC) groundwater cleanup levels found in Title 18 Alaska Administrative Code (AAC) Section 75 Table C. Any analyte with one or more screening level exceedances was retained as a COI. Table B-1 in

Attachment B lists the 18 COIs that are the subject of ongoing groundwater monitoring at the FCS. COIs such as bis(2-ethylhexyl)phthalate, 2,6-dinitrotoluene, pentachlorophenol, and some pesticides are occasionally detected above cleanup levels in FCS groundwater samples, the sporadic detections have been associated primarily with wells containing high diesel-range organics (DRO) and are attributed to analytical interferences or laboratory contamination rather than in situ contamination.

Using ADEC groundwater cleanup levels and background metals levels as the selection criteria, the *Former Communications Site Feasibility Study* (USACE 2011a) evaluated the list of COIs and identified COCs that exceeded ADEC cleanup levels. Subsequently, semiannual groundwater monitoring from 2010 and 2011 encountered exceedances of only three of these contaminants, which reduces the number of COCs under consideration at the end of 2011 to three (trichloroethene [TCE], 1,2,3-trichloropropane [TCP], and DRO). Table 1 lists the retained COCs as well as those originally identified in the Feasibility Study (USACE 2011a).

Table 1
Contaminants of Concern at the Former Communications Site

Contaminant	Abbreviation	Cleanup Level[1] (mg/L)	Retained at the end of 2011?*
Trichloroethene	TCE	0.005	Yes
1,2,3-Trichloropropane	TCP	0.00012	Yes
Diesel-Range Organics	DRO	1.5	Yes
Residual-Range Organics	RRO	1.1	No
1,1,2,2-Tetrachloroethane	PCA	0.0043	No
Arsenic	No abbreviation	0.010	No
Iron	No abbreviation	16.9[2]	No
Cobalt	No abbreviation	0.011[2]	No

Notes
Contaminants of concern were determined in the *Feasibility Study* (USACE 2011a).
* COCs were retained if they showed any exceedance in 2010 or 2011
[1] ADEC cleanup levels from 18 AAC 75 Table C Groundwater Cleanup Levels (ADEC 2012).
[2] Preliminary cleanup goals from the Feasibility Study (USACE 2011a).

3.0 STATISTICAL APPROACH FOR THE ANALYSIS OF TRENDS IN GROUNDWATER

The following sections quantitatively analyze attenuation of the retained COCs using non-parametric Mann-Kendall trend tests and geometric (lognormal) regression plots for in-plume wells. The Mann-Kendall test is part of the Air Force Center for Engineering and the Environment Monitoring and Remedial Optimization Software (MAROS) package (GSI 2009). The test does not require any assumptions about the statistical distribution of the data or regularity of the sampling intervals. Therefore, it is a general-purpose tool to identify whether a trend is present and whether the slope of the trend is positive, zero, or negative.

Using time-ordered concentration data, MAROS calculates the Mann-Kendall statistic, the coefficient of variation, and the trend confidence, and uses the results to select an appropriate trend description. The Mann-Kendall statistic is proportional to the strength of the trend, with negative values representing decreasing trends, values close to zero representing stable trends, and positive values representing increasing trends. The coefficient of variation reflects the variability of the data, with values greater than or equal to one indicating excessive scatter; the trend confidence is the probability that there is an increasing or decreasing trend; and the trend description is a statement of whether concentrations are increasing, stable, or declining, or that no trend could be identified.

Unlike the non-parametric Mann-Kendall test, geometric regression analysis is based on two assumptions about the data: (1) concentrations decline at a rate proportional to the amount of contaminant present, and (2) variations due to factors other than attenuation are approximately lognormally distributed. In general, these assumptions appear to be a good fit for the TCE and the 1,2,3-TCP FCS data sets. They permit geometric regression to be carried out using the methodology of linear regression applied to the logarithms of the concentrations, much as the geometric mean (the *n*th root of the product of *n* values) can be calculated from the arithmetic mean of the logarithms of the values.

Functionally, the geometric regression plot is the best-fit first-order decay curve. The rate of decrease is described by a half-life, and the effects of scatter in the data are incorporated by

calculating a 95-percent confidence performance envelope (based on 1.96 standard deviations of the scatter about the regression line). The date on which the upper bound of the performance envelope intersects the cleanup level is the predicted cleanup date. Before this date, the scatter inherent in the data means that a sample has a significant probability (greater than 5 percent) of exceeding the cleanup level. The 95-percent performance envelope is depicted on each geometric regression showing the +95-percent line (far right), the -95-percent line (far left), and the geometric regression line (middle). For the FCS and this report, cleanup dates were estimated using the conservative +95-percent line. The purpose of this +95-percent line was to make a reasonable allowance for the scatter inherent in the determinations, resulting in a more accurate prediction of cleanup. The cleanup date predicted by the +95-percent line indicates when 19 out of 20 samples are likely to meet the cleanup level. If the middle line (geometric regression line) were used to predict cleanup dates, there would be a 50-percent chance that samples would exceed the ADEC cleanup levels.

4.0 GROUNDWATER PLUMES AND TRENDS

Figures A-2 through A-4 show the TCE, TCP, and DRO plumes in groundwater from 2007 to 2009, in 2010, and in 2011, respectively. The shrinking plume boundaries reflect declining concentrations of COCs in in-plume wells due to natural attenuation. Of the seven plumes identified in 2007 to 2009, the TCE plume and two of the three TCP plumes had attenuated to below ADEC cleanup levels by 2011. Plumes remaining at the end of 2011 include the TCP plume, the main DRO plume, MW62 DRO plume, and the MW77 DRO plume. The main DRO plume is defined by four wells, while the remaining plumes are each defined by single wells. The TCE plume continues to be monitored because results from its defining well have been below the TCE cleanup level for only one year.

The groundwater flow direction depicted on the figures is based on regional flow patterns and local plume trajectories. Development of local water table contours would require a new survey of top-of-casing elevations of all monitoring wells, eliminating the multiple vertical datums present in the existing survey data. Because the regional water table gradient is very low (approximately 0.002), small elevation errors have large effects on the pattern of water table contours, such that detailed water table mapping in an area the size of the FCS is of

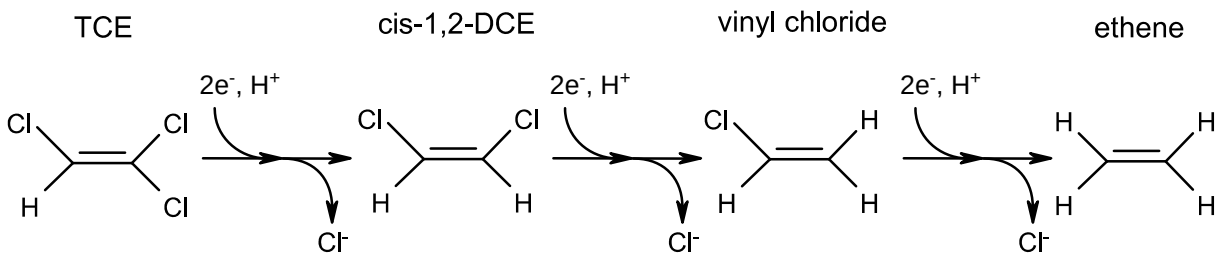
dubious value. The plumes themselves are the best indicators of average groundwater flow directions over the long term. In particular, the main DRO plume geometry (Figure A-4) is tightly constrained by clean wells MW65 and MW67 on either side, indicating that the flow direction here is between 15 and 25 degrees west of north. Nearby, the alignment of the MW62 and MW77 plumes suggests a more northerly flow direction. None of the conclusions discussed below depend strongly on the precise direction of groundwater flow, and the estimated average direction of 15 degrees west of north is adequate for discussions of natural attenuation.

4.1 TCE PLUME

The TCE plume is likely to have originated with previous salvage and waste operations at the FCS. As part of those operations, a section of the historical river channel (Hoppe's Slough) south of Buildings 48 and 49 was filled with metallic debris and covered with soil (USACE 2011b). TCE above the ADEC cleanup level of 0.005 milligrams per liter (mg/L) in two monitoring wells downgradient (to the north-northwest) of Building 49 defines the core of the plume, and low-level TCE concentrations found in nine monitoring wells farther downgradient define the leading edge (Figure A-2). Figures A-5a and A-5b show the monitoring results to date. In September 2007 during the remedial investigation (RI), test pits were used to identify and remove the suspected source area of this plume (see Figure A-6 for source area removals) (USACE 2011b).

Ongoing groundwater monitoring, which began in 2007, shows that TCE concentrations in the core of the plume have declined steadily over time. During 2007 to 2009, maximum TCE concentrations in wells MW56 and MW61 were 0.012 and 0.014 mg/L, respectively. By 2011, the maximum TCE concentrations in these wells were only 0.0029 mg/L and 0.0037 mg/L; both concentrations had decreased to significantly below the cleanup level. Throughout this period, low-level TCE concentrations in the leading edge of the plume have remained relatively constant, ranging from nondetect in many wells to a maximum of 0.0016 mg/L in MW62.

Under strongly reducing conditions (oxidation-reduction potentials typically -100 millivolts [mV] or lower), specific strains of bacteria are capable of degrading TCE via reductive dechlorination that breaks the carbon-chlorine bond with specialized enzymes (EPA 1998). As TCE loses chlorine atoms, it is converted predominantly to cis-1,2-dichloroethene (cis-DCE), then to vinyl chloride, and finally to ethene (Figure 1), although other pathways may play a minor role. The chlorine atoms appear in groundwater as chloride ions, increasing the electrical conductivity of groundwater, and an electron donor such as hydrogen or methane is needed to maintain charge balance.



(Wrenn 2004)

Figure 1 Generalized Biodegradation of TCE to Ethene via Reductive Dechlorination

Low levels of the biodegradation products cis-DCE and vinyl chloride are present throughout the TCE plume (Figures A-5a and A-5b); the levels are highest in the plume core, suggesting that reductive dechlorination has occurred there. Oxidation-reduction potentials provide corroborating evidence, revealing somewhat reducing conditions in the plume core (as low as -117 mV) compared to strongly oxidizing conditions in leading edge wells (up to 231 mV). Although the presence of the biodegradation products indicates that strongly reducing conditions must exist locally, general conditions in the plume are not sufficiently reducing to support widespread reductive dechlorination. A local accumulation of natural organic (similar to that observed in soils during construction and the RI) matter may have absorbed enough TCE to serve as a secondary source, which explains why the plume has persisted near MW56 and MW61 rather than being advected rapidly downgradient following removal of most of the source in 2007. In the leading edge, TCE and its biodegradation products are stable under the oxidizing conditions prevailing there. Their concentrations reflect the effects of dilution and dispersion along the flow path after TCE-bearing water passed through the core zone.

The MAROS analysis for the core of the TCE plume (Table 2) concludes that TCE has no trend in MW56 and is decreasing in MW61. Supporting statistics indicate substantial scatter for MW56 (coefficient of variation greater than 1.0, trend confidence less than 80 percent) whereas MW61 has behaved consistently, resulting in high confidence (99 percent) that TCE concentrations are decreasing there.

A time-series plot of TCE in MW56 (Figure 2) reveals that the cleanup level has been exceeded only once (fall 2008: 0.012 mg/L) since monitoring began in 2007. The subsequent sampling event (summer 2009: 0.00477 mg/L) was also elevated compared to the remaining data. These two outliers appear to reflect an isolated event that raised concentrations at MW56. Without these outliers, TCE concentrations have been well below the cleanup level of 0.005 mg/L, ranging from 0.00055 to 0.0029 mg/L and averaging 0.0012 mg/L. With no exceedances for the past three years of summer and fall monitoring, MW56 is considered clean.

The time-series results from MW61 are reasonably described by a first-order decay regression curve with a half-life of 2.0 years (Figure 3). The 95-percent performance envelope predicts that cleanup levels will be achieved in 2012 at this location.

Table 2
MAROS Trend Evaluation Results –TCE Plume
MW56 and MW61

Well ID	Number of Data Points	Mann-Kendall Statistic	Coefficient of Variation	Trend Confidence	Trend
MW56	9	-8	1.31	76%	No Trend
MW61	9	-26	0.45	99%	Decreasing

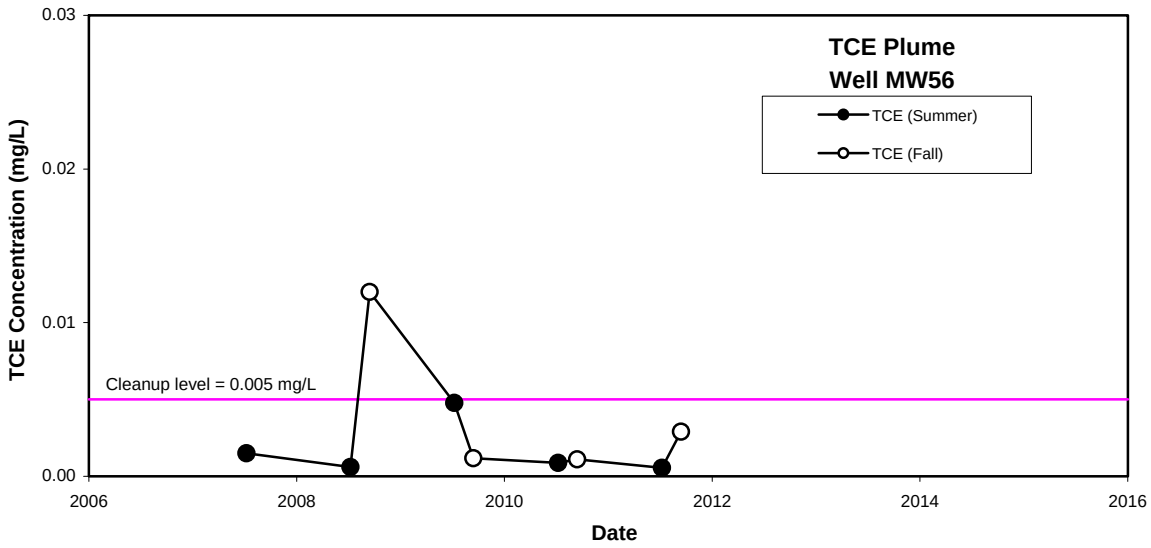


Figure 2 TCE Over Time in MW56

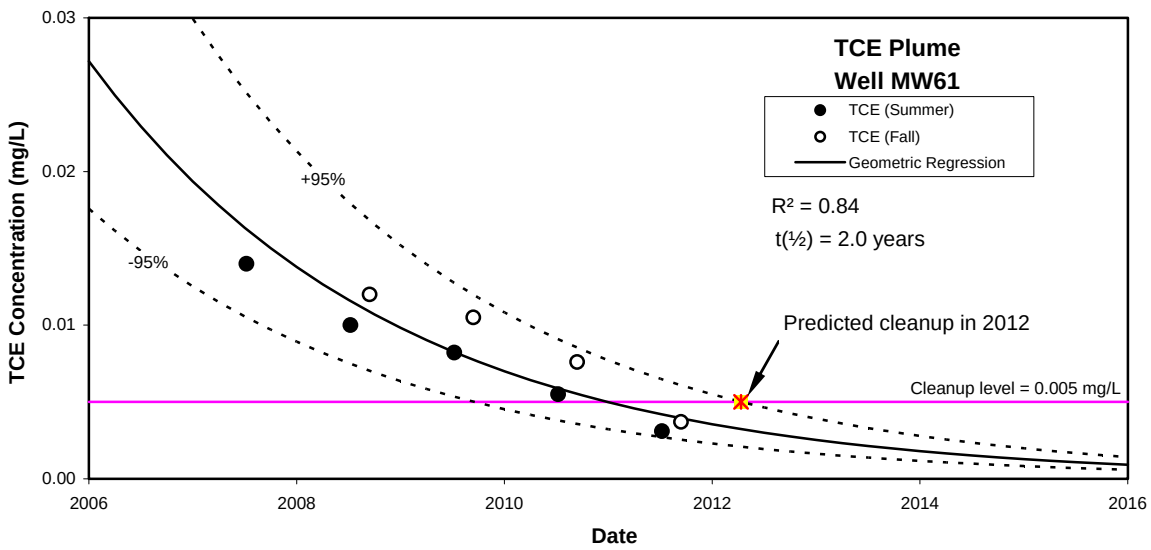


Figure 3 Geometric Regression of TCE in MW61

Further remedial action for the TCE plume does not appear to be warranted because the likely source may have been removed and all monitoring wells within the plume have been below ADEC Table C groundwater cleanup levels for at least the last two rounds of monitoring. Ongoing monitoring will continue to assess contaminant trends until the U.S. Army, EPA, and ADEC agree that groundwater cleanup has been achieved.

4.2 TCP PLUME

The TCP plume likely originated under the same circumstances as the other plumes: historical salvage and waste operations at the FCS from 1942 to 1962. In 2008, TCP was found above its ADEC cleanup level of 0.12 micrograms per liter (µg/L) in three widely separated areas, as shown in Figure A-2. Two of these areas (MW13 and MW32) have been nondetect for TCP in seven subsequent rounds of sampling (Figure A-7). The remaining area, as defined by 2008 cleanup level exceedances in MW08, MW47, and MW79, constitutes the TCP plume. TCP concentrations in these wells have declined over time, with only MW79 exceeding the ADEC cleanup level in 2011 (Figure A-4) while MW08 and MW47 contained only low levels of TCP (Figure A-7). October 2011 TCP concentrations in MW79, MW08, and MW47 were 0.38, 0.057, and 0.087 µg/L, respectively. Groundwater monitoring of this plume is ongoing.

Excavation near Buildings 22, 24, and 26 in 2008 as part of the RI (USACE 2011b) removed a potential source of the TCP plume (Figure A-6). The Building 26 excavation, closest to the southern edge of the plume, yielded one empty crushed drum, airplane parts, and 465 cubic yards of burned soil and metal debris. Additional efforts in 2009 for the RI focused on locating other potential TCP source areas south and east of MW08 via a soil gas survey, but no additional potential source areas were found. The declining TCP trends in groundwater likely reflect natural attenuation in the wake of source removal. Given the oxidizing character of groundwater in these areas, biodegradation is not expected. Instead, the main attenuation processes are most likely dispersion along the flow path, dilution by recharge, and perhaps volatilization into the overlying vadose zone.

The Fort Wainwright water supply well is located approximately 500 feet north-northeast of the core of the TCP plume as defined by MW79. Five monitoring wells (MW39, MW78, MW87, MW91, and MW92, located within the capture zone between the TCP plume and the Fort Wainwright supply well) have been monitored since 2010 to determine whether TCP at detectable levels is migrating toward the water supply well. All results to date in these wells have been nondetect (Figure A-7). Although the practical quantitation limits associated with these analyses commonly exceeded the cleanup level of 0.12 µg/L, method detection limits

were generally much lower than the cleanup level, and TCP would likely have been detected at least occasionally (as in MW08) if it were present in the sentry wells.

The MAROS evaluation and geometric regression analysis have been completed for two of the wells (MW47 and MW79) in the TCP plume (Table 3). The third well, MW08, has not exceeded the cleanup level since October 2008, and is therefore no longer considered contaminated. The MAROS evaluation concluded that TCP concentrations in MW47 and MW79 are stable, albeit with moderate to low confidence. The geometric regression plots shown in Figures 4 and 5 suggest that the time-series data for both wells reflect decreasing trends, and that cleanup levels could be achieved in 2016 for MW47 and 2019 for MW79. The data are highly scattered, however, as reflected by correlation coefficients as low as 0.32. Much of the scatter is due to the limitations of current analytical capabilities at such low concentrations. Because the practical quantitation limit commonly exceeds the TCP cleanup level of 0.12 µg/L, many of the detections are between the practical quantitation limit and the method detection limit and should be considered estimates rather than precise determinations. Correspondingly, the MAROS and geometric regression evaluations are of lower confidence as well.

Table 3
MAROS Trend Evaluation Results – TCP Plume
MW47 and MW79

Well ID	Number of Data Points	Mann-Kendall Statistic	Coefficient of Variation	Trend Confidence	Trend
MW47	8	-9	0.39	83%	Stable
MW79	7	-4	0.59	67%	Stable

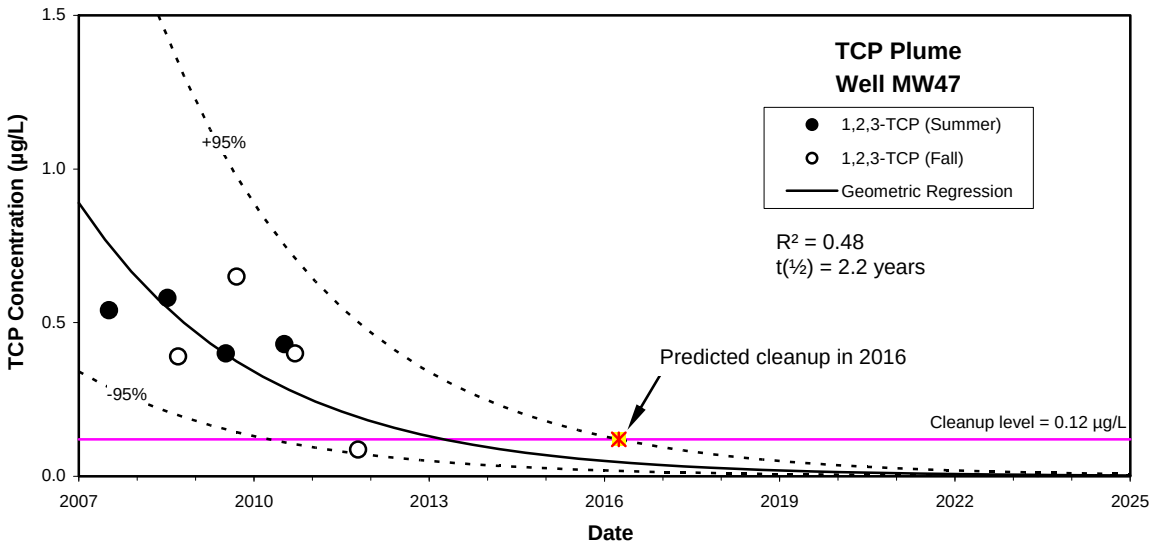


Figure 4 Geometric Regression of TCP in MW47

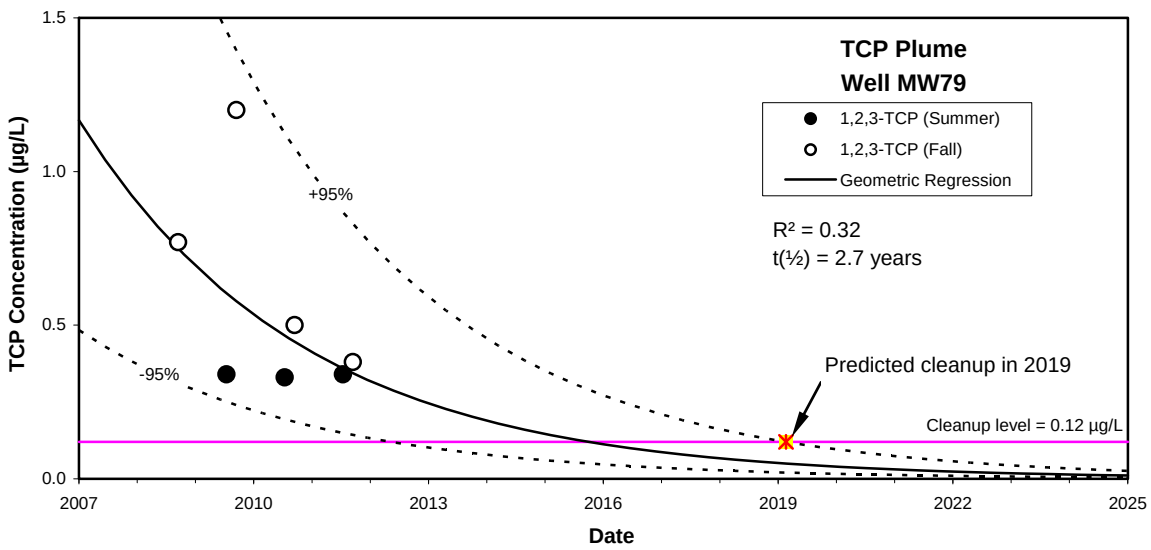


Figure 5 Geometric Regression of TCP in MW79

Further remedial action for the TCP plume does not appear to be warranted because the source area was likely removed during construction and investigation efforts, the two monitoring wells with current or recent exceedances of the cleanup level exhibit stable or decreasing trends, and TCP has never been detected in the early warning monitoring wells between the plume and the Fort Wainwright water supply well. Ongoing monitoring is expected to demonstrate that TCP in groundwater is decreasing and could reach the cleanup

level in 5 to 10 years. Monitoring should continue to assess contaminant trends until the U.S. Army, EPA, and ADEC agree that groundwater cleanup has been achieved.

4.3 MAIN DIESEL-RANGE ORGANICS PLUME

The main DRO plume appears to have originated south of Building 8 and comprises a middle distillate consistent with diesel fuel. Although there is no recorded release of diesel fuel or record of a storage tank in this area of the FCS, sheen and strong fuel odors have been reported in monitoring well MW12 and a large amount of DRO-contaminated soil has been discovered near Building 8. Figure A-4 depicts the plume in 2011, and Figure A-8 contains historical DRO results for in-plume and downgradient wells.

Soil excavation during drainage swale construction south of Building 8 removed most of the suspected source area of this plume in September of 2011 (Figure A-6). Prior to backfilling the excavation, a 20-mil high-density polyethylene liner was placed under the drainage swale to minimize water infiltration through the contaminated soil that remained at the groundwater interface directly below the swale. The excavation of vadose zone and shallow smear zone soil generated 1,430 cubic yards of petroleum, oil, and lubricants (POL)-contaminated soil from a 4,131-square-foot excavation area (USACE 2012).

Regular groundwater monitoring of this plume began in 2007 and is ongoing. Results show that the main DRO plume extends north to northwest along the groundwater flow path from the former source area south of Building 8. Exceedances of the DRO cleanup level of 1.5 mg/L are limited to the area between MW12 and MW58, with low-level DRO detections extending to MW83. Maximum DRO concentrations in the core of the plume in 2011 ranged from 2.2 mg/L (MW58) to 22 mg/L (MW33), while concentrations in the leading edge of the plume ranged from 0.057 mg/L (MW36) to 0.40 mg/L (MW37).

The groundwater at the core of the main DRO plume showed minimal levels of dissolved oxygen in 2011, with concentrations ranging from 0.87 to 1.58 mg/L (MW12, MW33, MW06A, and MW58). Dissolved oxygen levels at the leading edge of the plume (MW35, MW36, MW37, MW82, and MW83) were higher than the plume core during the fall

sampling event, with concentrations ranging from 2.78 to 6.24 mg/L. The reduced levels of DRO and significant dissolved oxygen found at the leading edge relative to the core of the plume are strong indications that aerobic biodegradation is occurring along the flow path as groundwater becomes re-oxygenated.

Table 4 provides the MAROS evaluation of DRO trends in the four in-plume wells. Three were found to be stable whereas no trend could be identified in the fourth. The Mann-Kendall statistic was relatively close to zero (no strong trend present), the coefficient of variation was less than 1.0 (scatter was not excessive), and the trend confidence was only moderate for each well. Geometric regression analysis was not conducted because the data did not exhibit a declining trend.

Table 4
MAROS Trend Evaluation Results – Main DRO Plume

Well ID	Number of Data Points	Mann-Kendall Statistic	Coefficient of Variation	Trend Confidence	Trend
MW06a	8	-2	0.39	55%	Stable
MW12	8	6	0.33	73%	No Trend
MW33	9	-5	0.52	66%	Stable
MW58	9	-5	0.40	66%	Stable

Figure 6 plots DRO as a function of time for the four in-plume wells, graphically revealing the absence of a declining trend through 2011. Seasonality, with high DRO correlating with an elevated water table in the fall, is strong in MW33, which is also the most contaminated well. Seasonality declines with declining average DRO concentration, and reverses slightly in the downgradient well (MW58) where average DRO is approaching the cleanup level. These trends imply the existence of a contaminated smear zone near MW33 and attenuation along the in-plume flow path such that summer oxygenation of groundwater leads to enhanced biodegradation by the time water reaches the downgradient in-plume well (MW58).

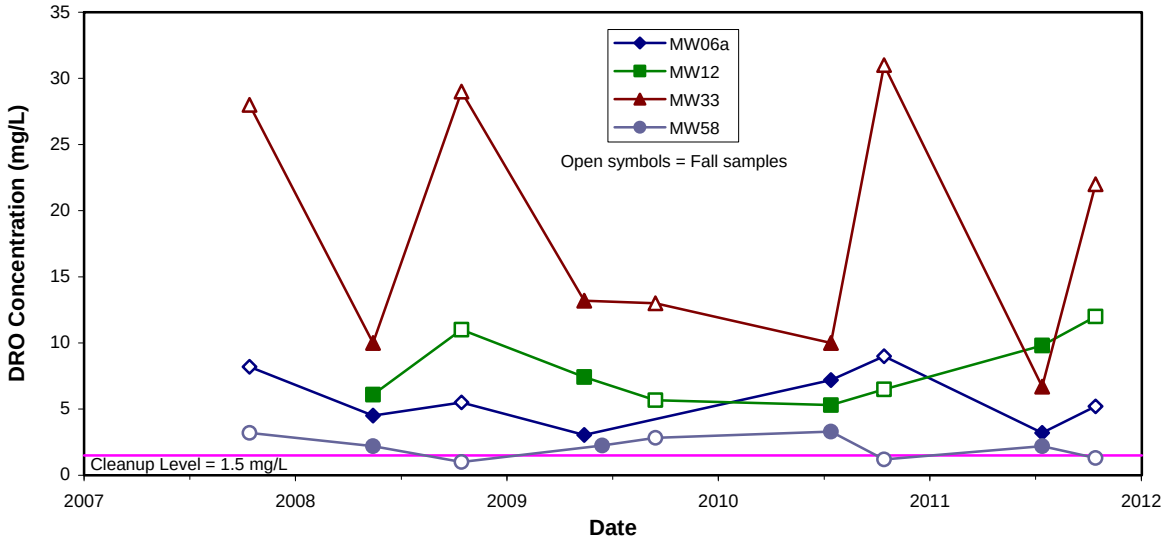


Figure 6 DRO Over Time in the Main DRO Plume

Following source removal in 2011, the main DRO plume is expected to begin decreasing as the remaining residual fuel dissolves in groundwater and degrades as it is advected downgradient. Declining trends may become apparent in 2012 or may be delayed for several years, depending on the quantity of residual fuel.

Ongoing groundwater monitoring is needed to measure the progress of natural attenuation and provide a basis for estimating a cleanup date, but active remediation is not recommended at this time. The plume has been stable, and it is expected to begin shrinking due to removal of most of the source. There is no pathway for human or ecological exposure, and natural attenuation is expected to remediate the remaining DRO over time. Given the high levels of DRO encountered in groundwater in 2011, cleanup is unlikely to be achieved in the near future. Cleanup could be further delayed if the remaining quantity of residual fuel is substantial. Geometric regression analysis may be able to predict the duration of natural attenuation with reasonable certainty after three or four years of additional monitoring.

4.4 MW62 AND MW77 DRO PLUMES

The MW62 and MW77 DRO plumes are located near the main DRO plume but do not appear to be connected to it. Although there is no recorded release of diesel fuel or record of a storage tank in this area of the FCS, DRO exceedances, sheen, and fuel odors have been

reported in monitoring wells MW62 and MW77 since sampling began in 2007 and 2008, respectively. Figure A-8 shows the MW62 and MW77 monitoring results to date. In 2011, the two in-plume wells exceeded the DRO cleanup level (1.5 mg/L) with maximum DRO concentrations of 4.2 mg/L at MW77 and 18 mg/L at MW62.

Results from groundwater monitoring and temporary well point investigative work conducted in 2009 (USACE 2011b) show that these plumes are localized and do not appear to be migrating. DRO concentrations in downgradient wells MW64, MW82, and MW84 have ranged from nondetect to 0.39 mg/L. Dissolved oxygen in both in-plume and downgradient wells was approximately 1 mg/L or less, indicating anaerobic conditions. Biodegradation of DRO is believed to be occurring along downgradient flow paths, consuming all oxygen as it enters the groundwater system. Dispersion also operates to reduce DRO concentrations along the flow paths, as does dilution by infiltrating precipitation reaching the water table.

Figure 7 shows that exceedances at MW62 have been strongly seasonal, occurring only in the fall but not every year, while MW77 has displayed very slight seasonality. The widely variable and seasonal results imply the existence of contaminated smear zones with residual (immobile) levels of free product near MW62. Groundwater makes contact with the smear zone when the water table is elevated, typically following the summer rainy season, resulting in DRO exceedances. This pattern is expected to continue until natural attenuation depletes the residual free product.

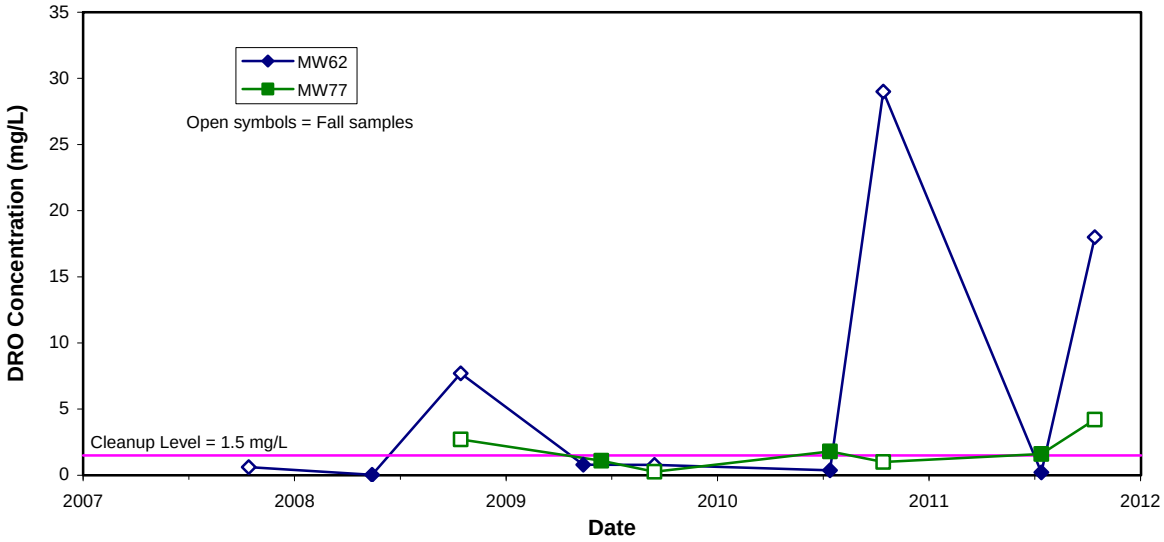


Figure 7 DRO Over Time in the MW62 and MW77 DRO Plumes

The MW62 and MW77 DRO plume trend evaluations were limited to the MAROS analysis because neither plume exhibited the declining trend needed for the geometric regression analysis. MAROS could not identify a trend in either plume (Table 5), a consequence of the widely variable results over time.

Table 5
MAROS Trend Evaluation Results – MW62 and MW77 DRO Plumes

Well ID	Number of Data Points	Mann-Kendall Statistic	Coefficient of Variation	Trend Confidence	Trend
MW62	9	2	1.65	54%	No Trend
MW77	7	3	0.72	61%	No Trend

Groundwater monitoring is ongoing to measure the progress of natural attenuation. The plumes appear to be at quasi-steady state, with no significant change expected from year to year, and they pose no threat of exposure.

5.0 CONCLUSIONS AND RECOMMENDATIONS

At the FCS, TCE last exceeded its cleanup level in 2010, and only TCP and DRO remained above ADEC cleanup levels at the end of 2011, while the remaining five COCs listed in the Feasibility Study (USACE 2011a) have been below their cleanup levels for more than two years.

These ongoing or recent exceedances define five groundwater plumes: the TCE plume, the TCP plume, the main DRO plume, the MW62 DRO plume, and the MW77 DRO plume. Conditions for these plumes are as follows:

- **TCE plume.** Natural attenuation may have already remediated this plume. TCE in groundwater was less than the ADEC cleanup level in all wells in 2011, and the cleanup criterion using geometric regression analysis may be met for the final well (MW61) in 2012.
- **TCP plume.** This plume has been shrinking since monitoring began in 2007, with geometric regression analysis predicting cleanup in 2019. Natural attenuation prevents downgradient migration of TCP at detectable levels, as demonstrated by nondetect results from the early warning wells between the plume and the Fort Wainwright water supply well.
- **Main DRO plume.** The 2011 POL source removal near Building 8 may result in lower groundwater concentrations of DRO in the next several years. .
- **MW62 and MW77 DRO plumes.** These plumes are stable, with natural attenuation (likely biodegradation) along the flow path preventing downgradient advection of DRO. These plumes are likely derived from nearby contaminated smear zones and thus will persist until DRO in those zones is depleted.

Based on the information presented in this groundwater summary report, monitored natural attenuation is a viable remediation alternative at the FCS for all remaining groundwater COCs.

6.0 REFERENCES

ADEC (Alaska Department of Environmental Conservation). 2012 (April). *Oil and Other Hazardous Pollution Control Regulations—Discharge Reporting, Cleanup, and Disposal of Oil and Other Hazardous Substances*. 18 AAC 75.

EPA (U.S. Environmental Protection Agency). 1999 (April). *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*. Office of Solid Waste and Emergency Response, Directive 9200.4-17P.

EPA. 1998 (September). *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water*. EPA/600/R-98/128.

GSI (GSI Environmental). 2009. *Monitoring and Remediation Optimization Systems (MAROS), v. 2.2*. http://www.gsi-net.com/en/software/free-software/maros.html (accessed 2 May 2012).

USACE (U.S. Army Corps of Engineers, Alaska District). 2012 (March). *2011 Former Communications Site After-Action Report*. Draft. Prepared by Jacobs Engineering Group Inc.

USACE. 2012 (May). *2011 Former Communications Site Groundwater Data Report.* Final. Prepared by Jacobs Engineering Group Inc.

USACE. 2011a (May). *Former Communications Site Feasibility Study*. Final. Prepared by CH2M HILL.

USACE. 2011b (January). *2007/2008/2009 Former Communications Site Drum and Debris and PCB Remedial Investigation.* Fort Wainwright, Alaska. Final. Prepared by Jacobs Engineering Group Inc.

USACE. 2010 (December). *FWA 102 Former Communications Site Remedial Investigation Report.* Fort Wainwright, Alaska. Final. Prepared by CH2M HILL.

USGS (U.S. Geological Survey). 1996. *Numerical Simulations of Ground-Water/Surface-Water Interactions at Fort Wainwright, Alaska.* Draft Report.

Wrenn, B. 2004 (June). "Enhanced Reductive Dechlorination through Biological Interactions with Zero-Valent Iron." Presented at the Federal Remediation Technologies Roundtable General Meeting, Arlington, Virginia, 9 June 2004.

(intentionally blank)

APPENDIX A

Figures – Plume Maps and Results

Figure A-1 Groundwater Elevation Contour Map

Figure A-2 2007 to 2009 Former Communications Site In-Plume Boundaries

Figure A-3 2010 Former Communications Site In-Plume Boundaries

Figure A-4 2011 Former Communications Site In-Plume Boundaries

Figure A-5a Former Communications Site (North) Historical Trichloroethene Results for In-Plume and Surrounding Wells

Figure A-5b Former Communications Site (South) Historical Trichloroethene Results for In-Plume and Surrounding Wells

Figure A-6 Source Removal Areas 2007 - 2011

Figure A-7 Former Communications Site Historical 1,2,3-Trichloropropane Results for In-Plume and Surrounding Wells

Figure A-8 Former Communications Site Historical Diesel-Range Organics Results for In-Plume and Surrounding Wells

Contours provided by CH2M HILL are based on water levels in the displayed wells.

All Locations Are Approximate

0 250 500 750 1,000
Feet

WGS 1984 UTM Zone 6N

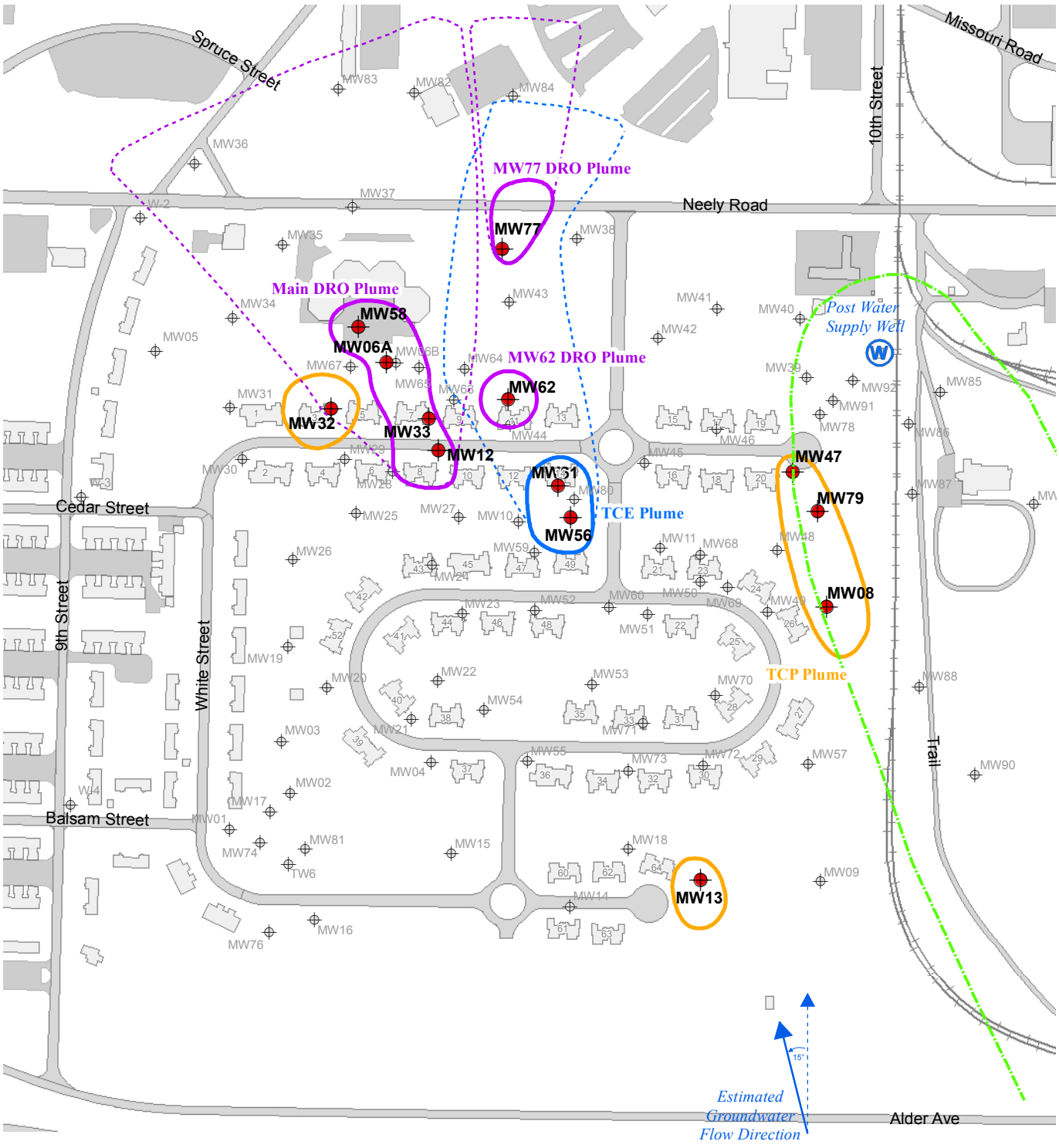
N

GROUNDWATER ELEVATION CONTOUR MAP

FORT WAINWRIGHT, ALASKA

JACOBS	DATE:	PROJECT MANAGER:	FIGURE NO:
	06 AUG 2012	T. HEIKKILA	A-1

P:\Taku_Gardens\MXD\FigA-1_GroundwaterElevationContours.mxd beatycj



Post Water Supply Well Capture Zone*

DRO Above ADEC Criteria (Plume Area)

TCE Above ADEC Criteria (Plume Area)

TCP Above ADEC Criteria (Plume Area)

DRO Below ADEC Criteria (Leading Plume Edge)

TCE Below ADEC Criteria (Leading Plume Edge)

Monitoring Well Sampled 2007-2009 - Exceedance

Post Water Supply Well

Monitoring Well

Building

Railroad

Road or Trail

TCP: 1,2,3-Trichloropropane
*Modeled by CH2M Hill (USACE 2010 Appendix B), for a pumping rate of 1,700 gpm.

All Locations Are Approximate

0 250 500 750 1,000
Feet

WGS 1984 UTM Zone 6N

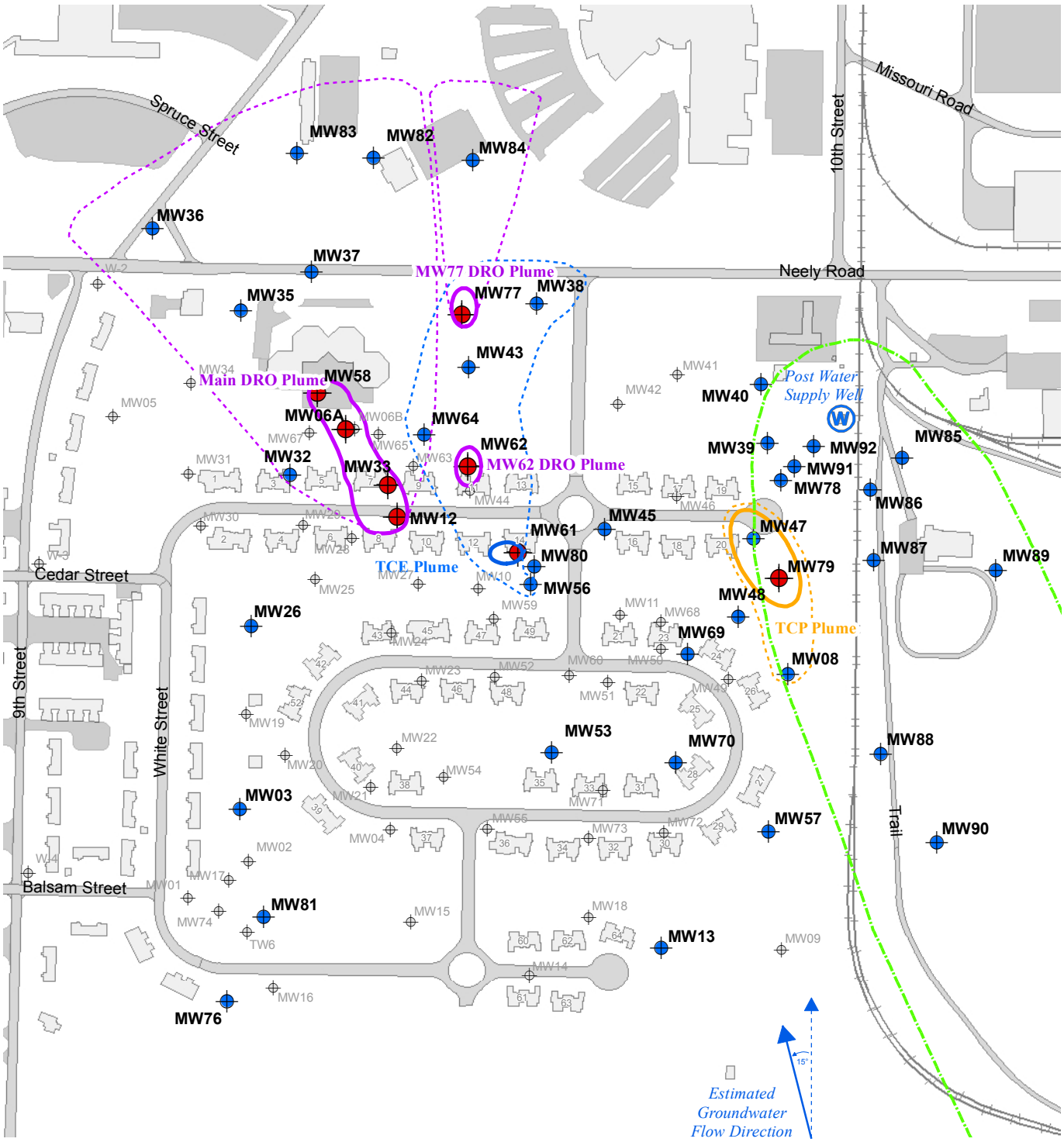
N

2007 to 2009 FORMER COMMUNICATIONS SITE IN-PLUME BOUNDARIES

FORT WAINWRIGHT, FAIRBANKS, ALASKA

JACOBS	DATE: 07 AUG 2012	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-2

P:\Taku_Gardens\MXD\Taku_GWMP_Plumes_07to09.mxd beatycj



Post Water Supply Well Capture Zone*
DRO Above ADEC Criteria (Plume Area)
TCE Above ADEC Criteria (Plume Area)
TCP Above ADEC Criteria (Plume Area)
DRO Below ADEC Criteria (Leading Plume Edge)
TCE Below ADEC Criteria (Leading Plume Edge)
TCP Below ADEC Criteria (Leading Edge of Plume)

Monitoring Well Sampled in 2010 - Exceedance
Monitoring Well Sampled in 2010 - No Exceedance
Monitoring Well
Post Water Supply Well
Building
Railroad
Road or Trail

TCP: 1,2,3-Trichloropropane
*Modeled by CH2M Hill (USACE 2010 Appendix B), for a pumping rate of 1,700 gpm.

All Locations Are Approximate

0 250 500 750 1,000
Feet

WGS 1984 UTM Zone 6N

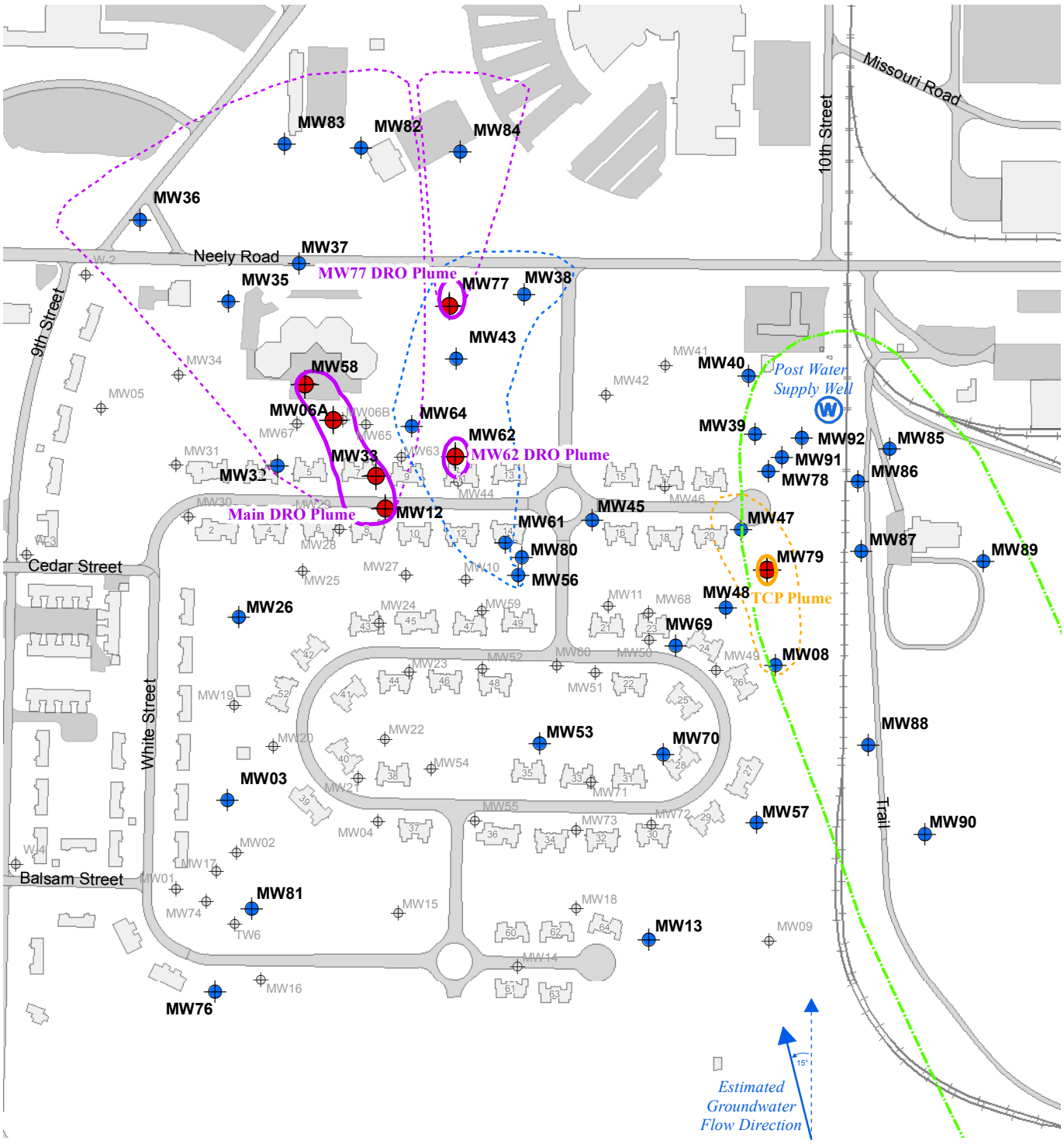
N

2010 FORMER COMMUNICATIONS SITE IN-PLUME BOUNDARIES

FORT WAINWRIGHT, FAIRBANKS, ALASKA

JACOBS	DATE: 07 AUG 2012	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-3

P:\Taku_Gardens\MXD\Taku_GWMP_Plumes_2010.mxd beatycj



Post Water Supply Well Capture Zone*

DRO Above ADEC Criteria (Plume Area)

TCP Above ADEC Criteria (Plume Area)

DRO Below ADEC Criteria (Leading Plume Edge)

TCE Below ADEC Criteria (Leading Plume Edge)

TCP Below ADEC Criteria (Leading Edge of Plume)

Monitoring Well Sampled in 2011 - Exceedance

Monitoring Well Sampled in 2011 - No Exceedance

Monitoring Well

Post Water Supply Well

Building

Railroad

Road or Trail

TCP: 1,2,3-Trichloropropane
*Modeled by CH2M Hill (USACE 2010 Appendix B), for a pumping rate of 1,700 gpm.

All Locations Are Approximate

0 250 500 750 1,000
Feet

WGS 1984 UTM Zone 6N

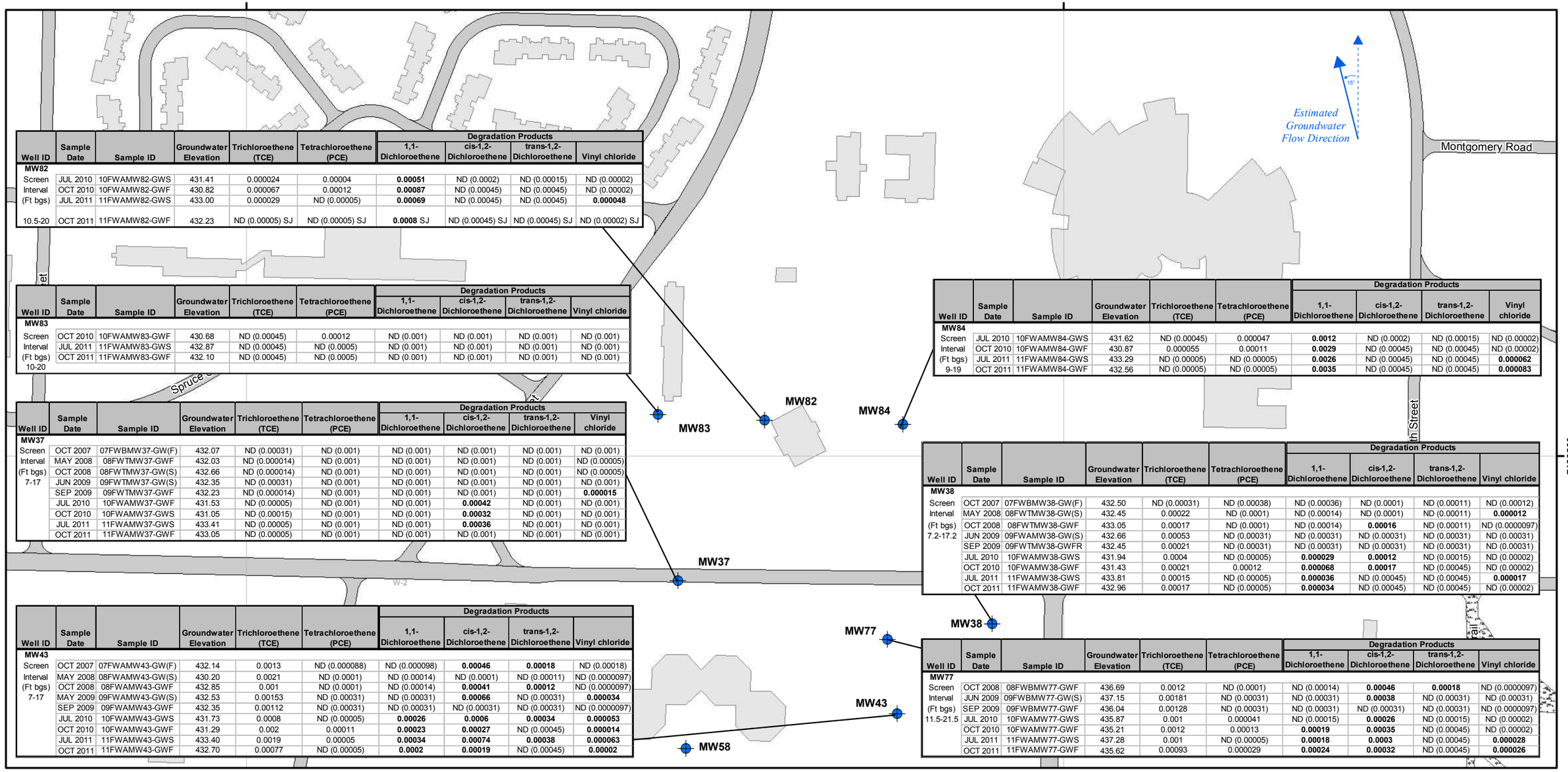
N

2011 FORMER COMMUNICATIONS SITE IN-PLUME BOUNDARIES

FORT WAINWRIGHT, FAIRBANKS, ALASKA

JACOBS	DATE:	PROJECT MANAGER:	FIGURE NO:
	07 AUG 2012	T. HEIKKILA	A-4

P:\Taku_Gardens\MXD\Taku_GWMP_Plumes.mxd beatycj



Well ID	Sample Date	Sample ID	Groundwater Elevation	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products 1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW82									
Screen	JUL 2010	10FWAMW82-GWS	431.41	0.000024	0.00004	**0.00051**	ND (0.0002)	ND (0.00015)	ND (0.00002)
Interval	OCT 2010	10FWAMW82-GWF	430.82	0.000067	0.00012	**0.00087**	ND (0.00045)	ND (0.00045)	ND (0.00002)
(Ft bgs)	JUL 2011	11FWAMW82-GWS	433.00	0.000029	ND (0.00005)	**0.00069**	ND (0.00045)	ND (0.00045)	**0.000048**
10.5-20	OCT 2011	11FWAMW82-GWF	432.23	ND (0.00005) SJ	ND (0.00005) SJ	**0.0008** SJ	ND (0.00045) SJ	ND (0.00045) SJ	ND (0.00002) SJ

Well ID	Sample Date	Sample ID	Groundwater Elevation	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products 1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW83									
Screen	OCT 2010	10FWAMW83-GWF	430.68	ND (0.00045)	0.00012	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
Interval	JUL 2011	11FWAMW83-GWS	432.87	ND (0.00045)	ND (0.0005)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
(Ft bgs)	OCT 2011	11FWAMW83-GWF	432.10	ND (0.00045)	ND (0.0005)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
10-20									

Well ID	Sample Date	Sample ID	Groundwater Elevation	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products 1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW84									
Screen	JUL 2010	10FWAMW84-GWS	431.62	ND (0.00045)	0.000047	**0.0012**	ND (0.0002)	ND (0.00015)	ND (0.00002)
Interval	OCT 2010	10FWAMW84-GWF	430.87	0.000055	0.00011	**0.0029**	ND (0.00045)	ND (0.00045)	ND (0.00002)
(Ft bgs)	JUL 2011	11FWAMW84-GWS	433.29	ND (0.00005)	ND (0.00005)	**0.0026**	ND (0.00045)	ND (0.00045)	**0.000062**
9-19	OCT 2011	11FWAMW84-GWF	432.56	ND (0.00005)	ND (0.00005)	**0.0035**	ND (0.00045)	ND (0.00045)	**0.000083**

Well ID	Sample Date	Sample ID	Groundwater Elevation	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products 1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW37									
Screen	OCT 2007	07FWBMW37-GW(F)	432.07	ND (0.00031)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
Interval	MAY 2008	08FWTMW37-GWF	432.03	ND (0.000014)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.00005)
(Ft bgs)	OCT 2008	08FWTMW37-GW(S)	432.66	ND (0.000014)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.00005)
7-17	JUN 2009	09FWTMW37-GW(S)	432.35	ND (0.00031)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
	SEP 2009	09FWTMW37-GWF	432.23	ND (0.000014)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	**0.000015**
	JUL 2010	10FWAMW37-GWF	431.53	ND (0.00005)	ND (0.001)	ND (0.001)	**0.00042**	ND (0.001)	ND (0.001)
	OCT 2010	10FWAMW37-GWS	431.05	ND (0.00015)	ND (0.001)	ND (0.001)	**0.00032**	ND (0.001)	ND (0.001)
	JUL 2011	11FWAMW37-GWS	433.41	ND (0.00005)	ND (0.001)	ND (0.001)	**0.00036**	ND (0.001)	ND (0.001)
	OCT 2011	11FWAMW37-GWF	433.05	ND (0.00005)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)

Well ID	Sample Date	Sample ID	Groundwater Elevation	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products 1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW38									
Screen	OCT 2007	07FWBMW38-GW(F)	432.50	ND (0.00031)	ND (0.00038)	ND (0.00036)	ND (0.0001)	ND (0.00011)	ND (0.00012)
Interval	MAY 2008	08FWTMW38-GW(S)	432.45	0.00022	ND (0.0001)	ND (0.00014)	ND (0.0001)	ND (0.00011)	**0.000012**
(Ft bgs)	OCT 2008	08FWTMW38-GWF	433.05	0.00017	ND (0.0001)	ND (0.00014)	**0.00016**	ND (0.00011)	ND (0.0000097)
7.2-17.2	JUN 2009	09FWAMW38-GW(S)	432.66	0.00053	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)
	SEP 2009	09FWTMW38-GWFR	432.45	0.00021	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)
	JUL 2010	10FWAMW38-GWS	431.94	0.0004	ND (0.00005)	**0.000029**	**0.00012**	ND (0.00015)	ND (0.00002)
	OCT 2010	10FWAMW38-GWF	431.43	0.00021	0.00012	**0.000068**	**0.00017**	ND (0.00045)	ND (0.00002)
	JUL 2011	11FWAMW38-GWS	433.81	0.00015	ND (0.00005)	**0.000036**	ND (0.00045)	ND (0.00045)	**0.000017**
	OCT 2011	11FWAMW38-GWF	432.96	0.00017	ND (0.00005)	**0.000034**	ND (0.00045)	ND (0.00045)	ND (0.00002)

Well ID	Sample Date	Sample ID	Groundwater Elevation	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products 1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW43									
Screen	OCT 2007	07FWAMW43-GW(F)	432.14	0.0013	ND (0.000088)	ND (0.000098)	**0.00046**	**0.00018**	ND (0.00018)
Interval	MAY 2008	08FWAMW43-GW(S)	430.20	0.0021	ND (0.0001)	ND (0.00014)	ND (0.0001)	ND (0.00011)	ND (0.0000097)
(Ft bgs)	OCT 2008	08FWAMW43-GWF	432.85	0.001	ND (0.0001)	ND (0.00014)	**0.00041**	**0.00012**	ND (0.0000097)
7-17	MAY 2009	09FWAMW43-GW(S)	432.53	0.00153	ND (0.00031)	ND (0.00031)	**0.00066**	ND (0.00031)	**0.000034**
	SEP 2009	09FWAMW43-GWF	432.35	0.00112	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.0000097)
	JUL 2010	10FWAMW43-GWS	431.73	0.0008	ND (0.00005)	**0.00026**	**0.0006**	**0.00034**	**0.000053**
	OCT 2010	10FWAMW43-GWF	431.29	0.002	0.00011	**0.00023**	**0.00027**	ND (0.00045)	**0.000014**
	JUL 2011	11FWAMW43-GWS	433.40	0.0019	0.00005	**0.00034**	**0.00074**	**0.00038**	**0.000063**
	OCT 2011	11FWAMW43-GWF	432.70	0.00077	ND (0.00005)	**0.0002**	**0.00019**	ND (0.00045)	**0.00002**

Well ID	Sample Date	Sample ID	Groundwater Elevation	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products 1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW77									
Screen	OCT 2008	08FWBMW77-GWF	436.69	0.0012	ND (0.0001)	ND (0.00014)	**0.00046**	**0.00018**	ND (0.0000097)
Interval	JUN 2009	09FWBMW77-GW(S)	437.15	0.00181	ND (0.00031)	ND (0.00031)	**0.00038**	ND (0.00031)	ND (0.00031)
(Ft bgs)	SEP 2009	09FWBMW77-GWF	436.04	0.00128	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.0000097)
11.5-21.5	JUL 2010	10FWAMW77-GWS	435.87	0.001	0.000041	ND (0.00015)	**0.00026**	ND (0.00015)	ND (0.00002)
	OCT 2010	10FWAMW77-GWF	435.21	0.0012	0.00013	**0.00019**	**0.00035**	ND (0.00045)	ND (0.00002)
	JUL 2011	11FWAMW77-GWS	437.28	0.001	ND (0.00005)	**0.00018**	**0.0003**	ND (0.00045)	**0.000028**
	OCT 2011	11FWAMW77-GWF	435.62	0.00093	0.000029	**0.00024**	**0.00032**	ND (0.00045)	**0.000026**

Onsite Well

2011 Sample - No Exceedance

Base Water Supply Well

Notes:

Units: mg/L
ND: not detected
Ft bgs: feet below ground surface
Trichloroethene (TCE) ADEC Action Level = 0.005 mg/L
cis-1,2-Dichloroethene ADEC Action Level = 0.07 mg/L
1,1-Dichloroethene ADEC Action Level = 0.007 mg/L
trans-1,2-Dichloroethene ADEC Action Level = 0.1 mg/L
Vinyl chloride ADEC Action Level = 0.002 mg/L
Tetrachloroethene (PCE) ADEC Action Level = 0.005 mg/L

The F or S at the end of the sample ID indicates the Spring or Fall sampling event.
(F) or (S) is appended to the sample ID where the original sample ID did not include an F or an S.
Results are presented without qualifiers.
RED exceeded the ADEC Table C cleanup criteria.
BOLD detections of degradation products.

All Locations Are Approximate

0 150 300 450 600
Feet

WGS 1984 UTM Zone 6N

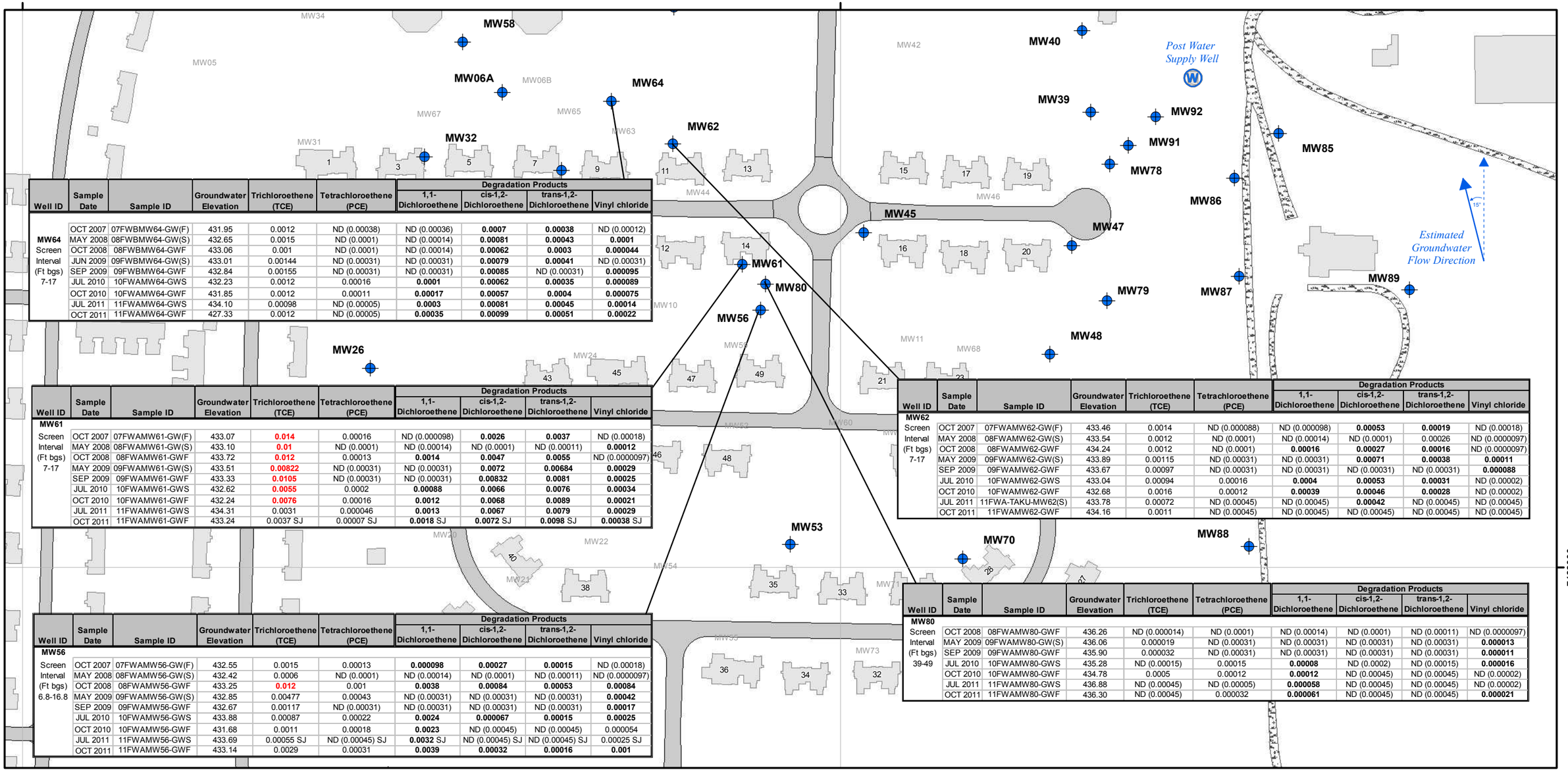
N

FORMER COMMUNICATIONS SITE (NORTH)
HISTORICAL TRICHLOROETHENE RESULTS
FOR IN-PLUME AND SURROUNDING WELLS
FORT WAINWRIGHT, FAIRBANKS, ALASKA

JACOBS

DATE:	PROJECT MANAGER:	FIGURE NO:
02 AUG 2012	T. HEIKKILA	A-5a

P:\Taku_Gardens\MXD\Taku_GWMP_TCE_Con_N.mxd beatycj



Well ID	Sample Date	Sample ID	Groundwater Elevation	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products 1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW64 Screen Interval (Ft bgs) 7-17	OCT 2007	07FWBMW64-GW(F)	431.95	0.0012	ND (0.00038)	ND (0.00036)	**0.0007**	**0.00038**	ND (0.00012)
	MAY 2008	08FWBMW64-GW(S)	432.65	0.0015	ND (0.0001)	ND (0.00014)	**0.00081**	**0.00043**	**0.0001**
	OCT 2008	08FWBMW64-GWF	433.06	0.001	ND (0.0001)	ND (0.00014)	**0.00062**	**0.0003**	**0.000044**
	JUN 2009	09FWBMW64-GW(S)	433.01	0.00144	ND (0.00031)	ND (0.00031)	**0.00079**	**0.00041**	ND (0.00031)
	SEP 2009	09FWBMW64-GWF	432.84	0.00155	ND (0.00031)	ND (0.00031)	**0.00085**	ND (0.00031)	**0.000095**
	JUL 2010	10FWAMW64-GWS	432.23	0.0012	0.00016	**0.0001**	**0.00062**	**0.00035**	**0.000089**
	OCT 2010	10FWAMW64-GWF	431.85	0.0012	0.00011	**0.00017**	**0.00057**	**0.0004**	**0.000075**
	JUL 2011	11FWAMW64-GWS	434.10	0.00098	ND (0.00005)	**0.0003**	**0.00081**	**0.00045**	**0.00014**
	OCT 2011	11FWAMW64-GWF	427.33	0.0012	ND (0.00005)	**0.00035**	**0.00099**	**0.00051**	**0.00022**

Well ID	Sample Date	Sample ID	Groundwater Elevation	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products 1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW61 Screen Interval (Ft bgs) 7-17	OCT 2007	07FWAMW61-GW(F)	433.07	**0.014**	0.00016	ND (0.000098)	**0.0026**	**0.0037**	ND (0.00018)
	MAY 2008	08FWAMW61-GW(S)	433.10	**0.01**	ND (0.0001)	ND (0.00014)	ND (0.0001)	ND (0.00011)	**0.00012**
	OCT 2008	08FWAMW61-GWF	433.72	**0.012**	0.00013	**0.0014**	**0.0047**	**0.0055**	ND (0.0000097)
	MAY 2009	09FWAMW61-GW(S)	433.51	**0.00822**	ND (0.00031)	ND (0.00031)	**0.0072**	**0.00684**	**0.00029**
	SEP 2009	09FWAMW61-GWF	433.33	**0.0105**	ND (0.00031)	ND (0.00031)	**0.00832**	**0.0081**	**0.00025**
	JUL 2010	10FWAMW61-GWS	432.62	**0.0055**	0.0002	**0.00088**	**0.0066**	**0.0076**	**0.00034**
	OCT 2010	10FWAMW61-GWF	432.24	**0.0076**	0.00016	**0.0012**	**0.0068**	**0.0089**	**0.00021**
	JUL 2011	11FWAMW61-GWS	434.31	0.0031	0.000046	**0.0013**	**0.0067**	**0.0079**	**0.00029**
	OCT 2011	11FWAMW61-GWF	433.24	0.0037 SJ	0.00007 SJ	**0.0018** SJ	**0.0072** SJ	**0.0098** SJ	**0.00038** SJ

Well ID	Sample Date	Sample ID	Groundwater Elevation	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products 1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW56 Screen Interval (Ft bgs) 6.8-16.8	OCT 2007	07FWAMW56-GW(F)	432.55	0.0015	0.00013	**0.000098**	**0.00027**	**0.00015**	ND (0.00018)
	MAY 2008	08FWAMW56-GW(S)	432.42	0.0006	ND (0.0001)	ND (0.00014)	ND (0.0001)	ND (0.00011)	ND (0.0000097)
	OCT 2008	08FWAMW56-GWF	433.25	**0.012**	0.001	**0.0038**	**0.00084**	**0.00053**	**0.00084**
	MAY 2009	09FWAMW56-GW(S)	432.85	0.00477	0.00043	ND (0.00031)	ND (0.00031)	ND (0.00031)	**0.00042**
	SEP 2009	09FWAMW56-GWF	432.67	0.00117	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)	**0.00017**
	JUL 2010	10FWAMW56-GWS	433.88	0.00087	0.00022	**0.0024**	**0.000067**	**0.00015**	**0.00025**
	OCT 2010	10FWAMW56-GWF	431.68	0.0011	0.00018	**0.0023**	ND (0.00045)	ND (0.00045)	0.000054
	JUL 2011	11FWAMW56-GWS	433.69	0.00055 SJ	ND (0.00045) SJ	**0.0032** SJ	ND (0.00045) SJ	ND (0.00045) SJ	0.00025 SJ
	OCT 2011	11FWAMW56-GWF	433.14	0.0029	0.00031	**0.0039**	**0.00032**	**0.00016**	**0.001**

Well ID	Sample Date	Sample ID	Groundwater Elevation	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products 1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW62 Screen Interval (Ft bgs) 7-17	OCT 2007	07FWAMW62-GW(F)	433.46	0.0014	ND (0.000088)	ND (0.000098)	**0.00053**	**0.00019**	ND (0.00018)
	MAY 2008	08FWAMW62-GW(S)	433.54	0.0012	ND (0.0001)	ND (0.00014)	ND (0.0001)	0.00026	ND (0.0000097)
	OCT 2008	08FWAMW62-GWF	434.24	0.0012	ND (0.0001)	**0.00016**	**0.00027**	**0.00016**	ND (0.0000097)
	MAY 2009	09FWAMW62-GW(S)	433.89	0.00115	ND (0.00031)	ND (0.00031)	**0.00071**	**0.00038**	**0.00011**
	SEP 2009	09FWAMW62-GWF	433.67	0.00097	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)	**0.000088**
	JUL 2010	10FWAMW62-GWS	433.04	0.00094	0.00016	**0.0004**	**0.00053**	**0.00031**	ND (0.00002)
	OCT 2010	10FWAMW62-GWF	432.68	0.0016	0.00012	**0.00039**	**0.00046**	**0.00028**	ND (0.00002)
	JUL 2011	11FWA-TAKU-MW62(S)	433.78	0.00072	ND (0.00045)	ND (0.00045)	**0.00042**	ND (0.00045)	ND (0.00045)
	OCT 2011	11FWAMW62-GWF	434.16	0.0011	ND (0.00045)	ND (0.00045)	ND (0.00045)	ND (0.00045)	ND (0.00045)

Well ID	Sample Date	Sample ID	Groundwater Elevation	Trichloroethene (TCE)	Tetrachloroethene (PCE)	Degradation Products 1,1-Dichloroethene	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl chloride
MW80 Screen Interval (Ft bgs) 39-49	OCT 2008	08FWAMW80-GWF	436.26	ND (0.000014)	ND (0.0001)	ND (0.00014)	ND (0.0001)	ND (0.00011)	ND (0.0000097)
	MAY 2009	09FWAMW80-GW(S)	436.06	0.000019	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)	**0.000013**
	SEP 2009	09FWAMW80-GWF	435.90	0.000032	ND (0.00031)	ND (0.00031)	ND (0.00031)	ND (0.00031)	**0.000011**
	JUL 2010	10FWAMW80-GWS	435.28	ND (0.00015)	0.00015	**0.00008**	ND (0.0002)	ND (0.00015)	**0.000016**
	OCT 2010	10FWAMW80-GWF	434.78	0.0005	0.00012	**0.00012**	ND (0.00045)	ND (0.00045)	ND (0.00002)
	JUL 2011	11FWAMW80-GWS	436.88	ND (0.00045)	ND (0.00005)	**0.000058**	ND (0.00045)	ND (0.00045)	ND (0.00002)
	OCT 2011	11FWAMW80-GWF	436.30	ND (0.00045)	0.000032	**0.000061**	ND (0.00045)	ND (0.00045)	**0.000021**

Onsite Well

2011 Sample - No Exceedance

Base Water Supply Well

Notes:

Units: mg/L
ND: not detected
Ft bgs: feet below ground surface
Trichloroethene (TCE) ADEC Action Level = 0.005 mg/L
cis-1,2-Dichloroethene ADEC Action Level = 0.07 mg/L
1,1-Dichloroethene ADEC Action Level = 0.007 mg/L
trans-1,2-Dichloroethene ADEC Action Level = 0.1 mg/L
Vinyl chloride ADEC Action Level = 0.002 mg/L
Tetrachloroethene (PCE) ADEC Action Level = 0.005 mg/L

The F or S at the end of the sample ID indicates the Spring or Fall sampling event.
(F) or (S) is appended to the sample ID where the original sample ID did not include an F or an S.
Results are presented without qualifiers.
RED exceeded the ADEC Table C cleanup criteria.
BOLD detections of degradation products.

All Locations Are Approximate

0 150 300 450 600
Feet

WGS 1984 UTM Zone 6N

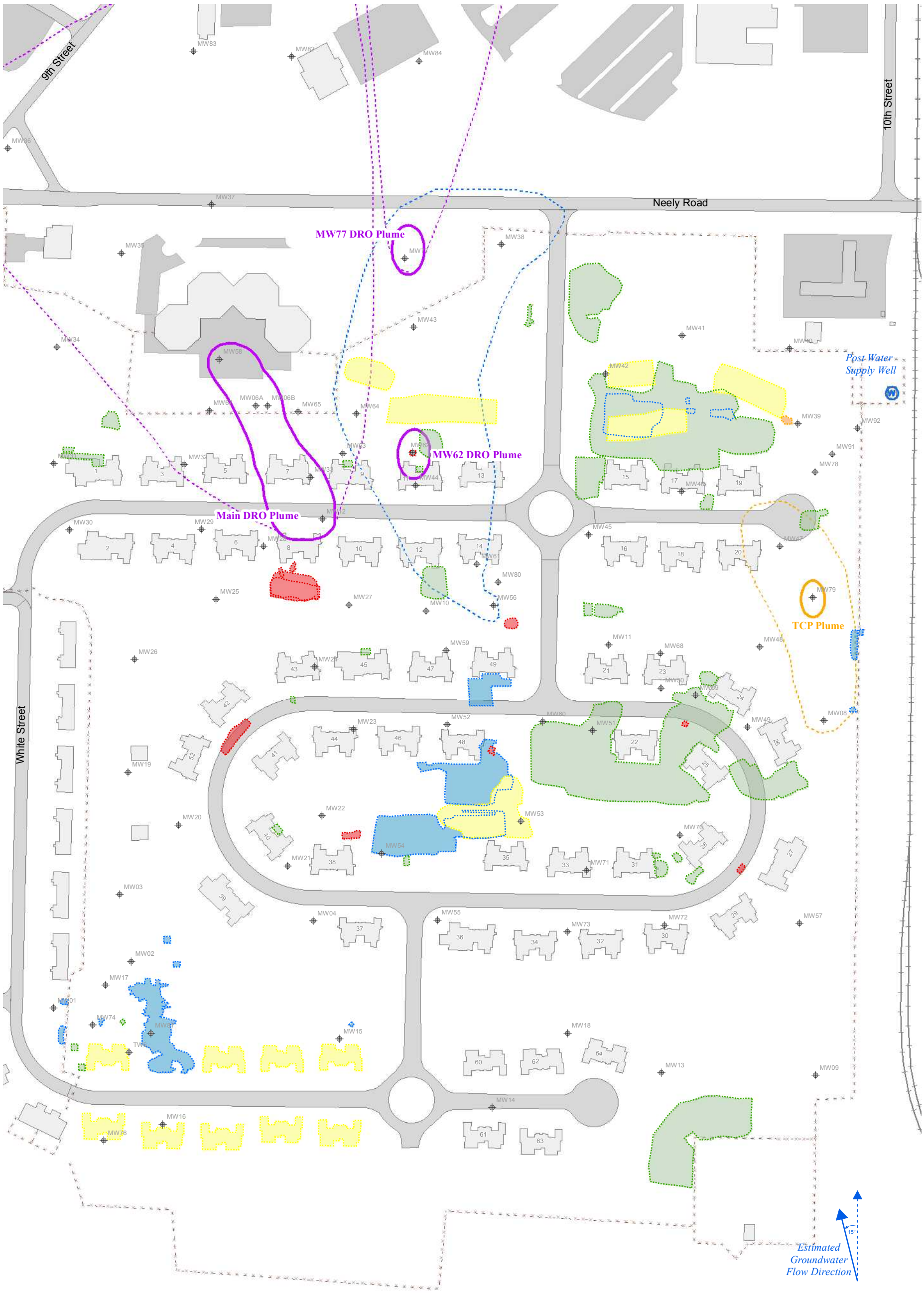
N

FORMER COMMUNICATIONS SITE (SOUTH)
HISTORICAL TRICHLOROETHENE RESULTS
FOR IN-PLUME AND SURROUNDING WELLS
FORT WAINWRIGHT, FAIRBANKS, ALASKA

JACOBS

DATE:	PROJECT MANAGER:	FIGURE NO:
02 AUG 2012	T. HEIKKILA	A-5b

P:\Taku_Gardens\MXD\Taku_GWMP_TCE_Con_S.mxd beatycj



2011 Removal Area
2010 Removal Area
2009 Removal Area
2008 Removal Area
2007 Removal Area

DRO Above ADEC Criteria (Plume Area)
TCP Above ADEC Criteria (Plume Area)
DRO Below ADEC Criteria (Leading Plume Edge)
TCE Below ADEC Criteria (Leading Plume Edge)
TCP Below ADEC Criteria (Leading Edge of Plume)

Building
Road or Trail
Railroad
Monitoring Well
Post Water Supply Well

* TCP: 1,2,3-Trichloropropane

All Locations Are Approximate

0 125 250 375 500
Feet

WGS 1984 UTM Zone 6N

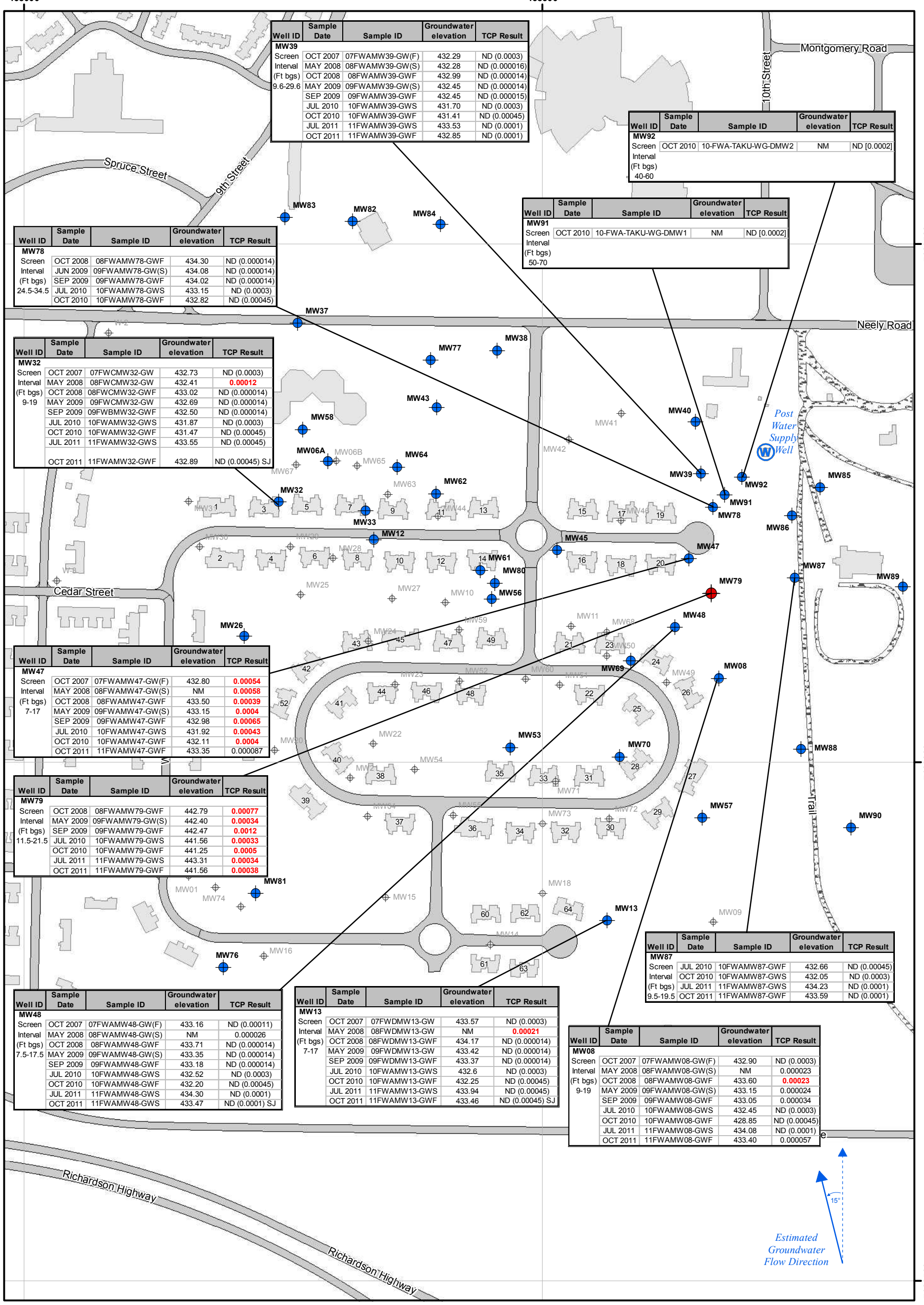
N

SOURCE REMOVAL AREAS
2007 - 2011

FORT WAINWRIGHT, FAIRBANKS, ALASKA

JACOBS	DATE: 06 AUG 2012	PROJECT MANAGER: T. HEIKKILA	FIGURE NO: A-6

P:\Taku_Gardens\MXD\SourceRemovalAreas2007to2011.mxd beatycj



Well ID	Sample Date	Sample ID	Groundwater elevation	TCP Result
MW39				
Screen	OCT 2007	07FWAMW39-GW(F)	432.29	ND (0.0003)
Interval	MAY 2008	08FWAMW39-GW(S)	432.28	ND (0.000016)
(Ft bgs)	OCT 2008	08FWAMW39-GWF	432.99	ND (0.000014)
9.6-29.6	MAY 2009	09FWAMW39-GW(S)	432.45	ND (0.000014)
	SEP 2009	09FWAMW39-GWF	432.45	ND (0.000015)
	JUL 2010	10FWAMW39-GWS	431.70	ND (0.0003)
	OCT 2010	10FWAMW39-GWF	431.41	ND (0.00045)
	JUL 2011	11FWAMW39-GWS	433.53	ND (0.0001)
	OCT 2011	11FWAMW39-GWF	432.85	ND (0.0001)

Well ID	Sample Date	Sample ID	Groundwater elevation	TCP Result
MW92				
Screen Interval (Ft bgs) 40-60	OCT 2010	10-FWA-TAKU-WG-DMW2	NM	ND [0.0002]

Well ID	Sample Date	Sample ID	Groundwater elevation	TCP Result
MW91				
Screen Interval (Ft bgs) 50-70	OCT 2010	10-FWA-TAKU-WG-DMW1	NM	ND [0.0002]

Well ID	Sample Date	Sample ID	Groundwater elevation	TCP Result
MW78				
Screen	OCT 2008	08FWAMW78-GWF	434.30	ND (0.000014)
Interval	JUN 2009	09FWAMW78-GW(S)	434.08	ND (0.000014)
(Ft bgs)	SEP 2009	09FWAMW78-GWF	434.02	ND (0.000014)
24.5-34.5	JUL 2010	10FWAMW78-GWS	433.15	ND (0.0003)
	OCT 2010	10FWAMW78-GWF	432.82	ND (0.00045)

Well ID	Sample Date	Sample ID	Groundwater elevation	TCP Result
MW32				
Screen	OCT 2007	07FWCMW32-GW	432.73	ND (0.0003)
Interval	MAY 2008	08FWCMW32-GW	432.41	0.00012
(Ft bgs)	OCT 2008	08FWCMW32-GWF	433.02	ND (0.000014)
9-19	MAY 2009	09FWCMW32-GW	432.69	ND (0.000014)
	SEP 2009	09FWBMW32-GWF	432.50	ND (0.000014)
	JUL 2010	10FWAMW32-GWS	431.87	ND (0.0003)
	OCT 2010	10FWAMW32-GWF	431.47	ND (0.00045)
	JUL 2011	11FWAMW32-GWS	433.55	ND (0.00045)
	OCT 2011	11FWAMW32-GWF	432.89	ND (0.00045) SJ

Well ID	Sample Date	Sample ID	Groundwater elevation	TCP Result
MW47				
Screen	OCT 2007	07FWAMW47-GW(F)	432.80	0.00054
Interval	MAY 2008	08FWAMW47-GW(S)	NM	0.00058
(Ft bgs)	OCT 2008	08FWAMW47-GWF	433.50	0.00039
7-17	MAY 2009	09FWAMW47-GW(S)	433.15	0.0004
	SEP 2009	09FWAMW47-GWF	432.98	0.00065
	JUL 2010	10FWAMW47-GWS	431.92	0.00043
	OCT 2010	10FWAMW47-GWF	432.11	0.0004
	OCT 2011	11FWAMW47-GWF	433.35	0.000087

Well ID	Sample Date	Sample ID	Groundwater elevation	TCP Result
MW79				
Screen	OCT 2008	08FWAMW79-GWF	442.79	0.00077
Interval	MAY 2009	09FWAMW79-GW(S)	442.40	0.00034
(Ft bgs)	SEP 2009	09FWAMW79-GWF	442.47	0.0012
11.5-21.5	JUL 2010	10FWAMW79-GWS	441.56	0.00033
	OCT 2010	10FWAMW79-GWF	441.25	0.0005
	JUL 2011	11FWAMW79-GWS	443.31	0.00034
	OCT 2011	11FWAMW79-GWF	441.56	0.00038

Well ID	Sample Date	Sample ID	Groundwater elevation	TCP Result
MW87				
Screen	JUL 2010	10FWAMW87-GWF	432.66	ND (0.00045)
Interval	OCT 2010	10FWAMW87-GWS	432.05	ND (0.0003)
(Ft bgs)	JUL 2011	11FWAMW87-GWS	434.23	ND (0.0001)
9.5-19.5	OCT 2011	11FWAMW87-GWF	433.59	ND (0.0001)

Well ID	Sample Date	Sample ID	Groundwater elevation	TCP Result
MW48				
Screen	OCT 2007	07FWAMW48-GW(F)	433.16	ND (0.00011)
Interval	MAY 2008	08FWAMW48-GW(S)	NM	0.000026
(Ft bgs)	OCT 2008	08FWAMW48-GWF	433.71	ND (0.000014)
7.5-17.5	MAY 2009	09FWAMW48-GW(S)	433.35	ND (0.000014)
	SEP 2009	09FWAMW48-GWF	433.18	ND (0.000014)
	JUL 2010	10FWAMW48-GWS	432.52	ND (0.0003)
	OCT 2010	10FWAMW48-GWF	432.20	ND (0.00045)
	JUL 2011	11FWAMW48-GWS	434.30	ND (0.0001)
	OCT 2011	11FWAMW48-GWS	433.47	ND (0.0001) SJ

Well ID	Sample Date	Sample ID	Groundwater elevation	TCP Result
MW13				
Screen	OCT 2007	07FWDMW13-GW	433.57	ND (0.0003)
Interval	MAY 2008	08FWDMW13-GW	NM	0.00021
(Ft bgs)	OCT 2008	08FWDMW13-GWF	434.17	ND (0.000014)
7-17	MAY 2009	09FWDMW13-GW	433.42	ND (0.000014)
	SEP 2009	09FWDMW13-GWF	433.37	ND (0.000014)
	JUL 2010	10FWAMW13-GWS	432.6	ND (0.0003)
	OCT 2010	10FWAMW13-GWF	432.25	ND (0.00045)
	JUL 2011	11FWAMW13-GWS	433.94	ND (0.00045)
	OCT 2011	11FWAMW13-GWF	433.46	ND (0.00045) SJ

Well ID	Sample Date	Sample ID	Groundwater elevation	TCP Result
MW08				
Screen	OCT 2007	07FWAMW08-GW(F)	432.90	ND (0.0003)
Interval	MAY 2008	08FWAMW08-GW(S)	NM	0.000023
(Ft bgs)	OCT 2008	08FWAMW08-GWF	433.60	0.00023
9-19	MAY 2009	09FWAMW08-GW(S)	433.15	0.000024
	SEP 2009	09FWAMW08-GWF	433.05	0.000034
	JUL 2010	10FWAMW08-GWS	432.45	ND (0.0003)
	OCT 2010	10FWAMW08-GWF	428.85	ND (0.00045)
	JUL 2011	11FWAMW08-GWS	434.08	ND (0.0001)
	OCT 2011	11FWAMW08-GWF	433.40	0.000057

2011 Sample - Exceedance

2011 Sample - No Exceedance

Onsite Well

Post Water Supply Well

Notes:
ADEC Action Level: 0.00012
Units: mg/L
Method: SW8260, SW8260SIM

The F or S at the end of the sample ID indicates Spring or Fall sampling.

RED exceeded the ADEC action level.
TCP: 1,2,3-Trichloropropane
Results are presented without qualifiers.
ND = not detected

All Locations Are Approximate

0 250 500 750 1,000
Feet

WGS 1984 UTM Zone 6N

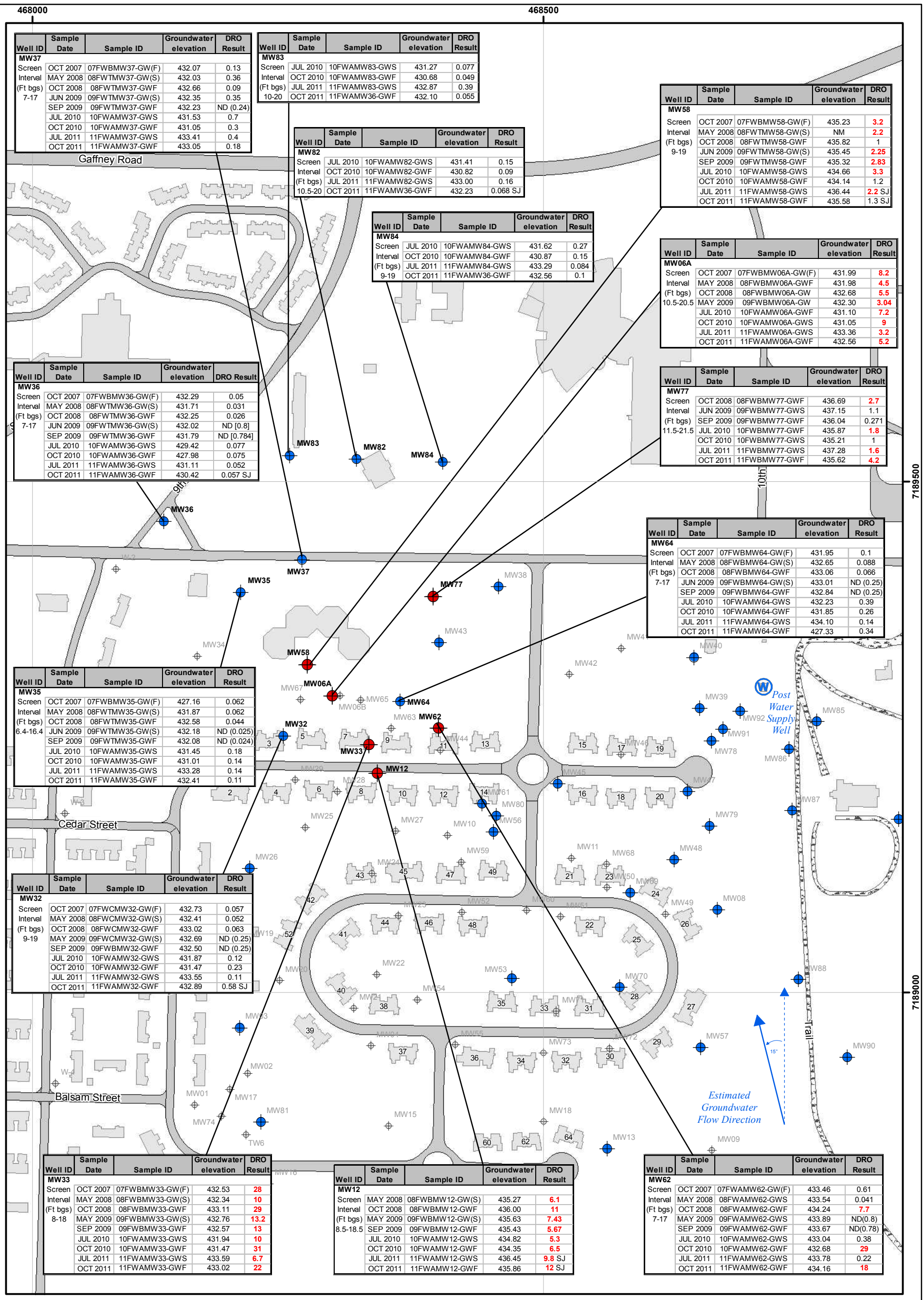
N

FORMER COMMUNICATIONS SITE
HISTORICAL 1,2,3-TRICHLOROPROPANE
RESULTS FOR IN-PLUME AND SURROUNDING WELLS
FORT WAINWRIGHT, FAIRBANKS, ALASKA

JACOBS

DATE:	PROJECT MANAGER:	FIGURE NO:
02 AUG 2012	T. HEIKKILA	A-7

P:\Taku_Gardens\MXD\Taku_GWMP_TCP.mxd beatycj



Well ID	Sample Date	Sample ID	Groundwater elevation	DRO Result
MW37				
Screen	OCT 2007	07FWBMW37-GW(F)	432.07	0.13
Interval	MAY 2008	08FWTMW37-GW(S)	432.03	0.36
(Ft bgs)	OCT 2008	08FWTMW37-GWF	432.66	0.09
7-17	JUN 2009	09FWTMW37-GW(S)	432.35	0.35
	SEP 2009	09FWTMW37-GWF	432.23	ND (0.24)
	JUL 2010	10FWAMW37-GWS	431.53	0.7
	OCT 2010	10FWAMW37-GWF	431.05	0.3
	JUL 2011	11FWAMW37-GWS	433.41	0.4
	OCT 2011	11FWAMW37-GWF	433.05	0.18

Well ID	Sample Date	Sample ID	Groundwater elevation	DRO Result
MW83				
Screen	JUL 2010	10FWAMW83-GWS	431.27	0.077
Interval	OCT 2010	10FWAMW83-GWF	430.68	0.049
(Ft bgs)	JUL 2011	11FWAMW83-GWS	432.87	0.39
10-20	OCT 2011	11FWAMW36-GWF	432.10	0.055

Well ID	Sample Date	Sample ID	Groundwater elevation	DRO Result
MW82				
Screen	JUL 2010	10FWAMW82-GWS	431.41	0.15
Interval	OCT 2010	10FWAMW82-GWF	430.82	0.09
(Ft bgs)	JUL 2011	11FWAMW82-GWS	433.00	0.16
10.5-20	OCT 2011	11FWAMW36-GWF	432.23	0.068 SJ

Well ID	Sample Date	Sample ID	Groundwater elevation	DRO Result
MW58				
Screen	OCT 2007	07FWBMW58-GW(F)	435.23	3.2
Interval	MAY 2008	08FWTMW58-GW(S)	NM	2.2
(Ft bgs)	OCT 2008	08FWTMW58-GWF	435.82	1
9-19	JUN 2009	09FWTMW58-GW(S)	435.45	2.25
	SEP 2009	09FWTMW58-GWF	435.32	2.83
	JUL 2010	10FWAMW58-GWS	434.66	3.3
	OCT 2010	10FWAMW58-GWF	434.14	1.2
	JUL 2011	11FWAMW58-GWS	436.44	2.2 SJ
	OCT 2011	11FWAMW58-GWF	435.58	1.3 SJ

Well ID	Sample Date	Sample ID	Groundwater elevation	DRO Result
MW84				
Screen	JUL 2010	10FWAMW84-GWS	431.62	0.27
Interval	OCT 2010	10FWAMW84-GWF	430.87	0.15
(Ft bgs)	JUL 2011	11FWAMW84-GWS	433.29	0.084
9-19	OCT 2011	11FWAMW36-GWF	432.56	0.1

Well ID	Sample Date	Sample ID	Groundwater elevation	DRO Result
MW06A				
Screen	OCT 2007	07FWBMW06A-GW(F)	431.99	8.2
Interval	MAY 2008	08FWBMW06A-GWF	431.98	4.5
(Ft bgs)	OCT 2008	08FWBMW06A-GW	432.68	5.5
10.5-20.5	MAY 2009	09FWBMW06A-GW	432.30	3.04
	JUL 2010	10FWAMW06A-GWF	431.10	7.2
	OCT 2010	10FWAMW06A-GWS	431.05	9
	JUL 2011	11FWAMW06A-GWS	433.36	3.2
	OCT 2011	11FWAMW06A-GWF	432.56	5.2

Well ID	Sample Date	Sample ID	Groundwater elevation	DRO Result
MW36				
Screen	OCT 2007	07FWBMW36-GW(F)	432.29	0.05
Interval	MAY 2008	08FWTMW36-GW(S)	431.71	0.031
(Ft bgs)	OCT 2008	08FWTMW36-GWF	432.25	0.026
7-17	JUN 2009	09FWTMW36-GW(S)	432.02	ND [0.8]
	SEP 2009	09FWTMW36-GWF	431.79	ND [0.784]
	JUL 2010	10FWAMW36-GWS	429.42	0.077
	OCT 2010	10FWAMW36-GWF	427.98	0.075
	JUL 2011	11FWAMW36-GWS	431.11	0.052
	OCT 2011	11FWAMW36-GWF	430.42	0.057 SJ

Well ID	Sample Date	Sample ID	Groundwater elevation	DRO Result
MW77				
Screen	OCT 2008	08FWBMW77-GWF	436.69	2.7
Interval	JUN 2009	09FWBMW77-GWS	437.15	1.1
(Ft bgs)	SEP 2009	09FWBMW77-GWF	436.04	0.271
11.5-21.5	JUL 2010	10FWBMW77-GWF	435.87	1.8
	OCT 2010	10FWBMW77-GWS	435.21	1
	JUL 2011	11FWBMW77-GWS	437.28	1.6
	OCT 2011	11FWBMW77-GWF	435.62	4.2

Well ID	Sample Date	Sample ID	Groundwater elevation	DRO Result
MW64				
Screen	OCT 2007	07FWBMW64-GW(F)	431.95	0.1
Interval	MAY 2008	08FWBMW64-GW(S)	432.65	0.088
(Ft bgs)	OCT 2008	08FWBMW64-GWF	433.06	0.066
7-17	JUN 2009	09FWBMW64-GW(S)	433.01	ND (0.25)
	SEP 2009	09FWBMW64-GWF	432.84	ND (0.25)
	JUL 2010	10FWAMW64-GWS	432.23	0.39
	OCT 2010	10FWAMW64-GWF	431.85	0.26
	JUL 2011	11FWAMW64-GWS	434.10	0.14
	OCT 2011	11FWAMW64-GWF	427.33	0.34

Well ID	Sample Date	Sample ID	Groundwater elevation	DRO Result
MW35				
Screen	OCT 2007	07FWBMW35-GW(F)	427.16	0.062
Interval	MAY 2008	08FWTMW35-GW(S)	431.87	0.062
(Ft bgs)	OCT 2008	08FWTMW35-GWF	432.58	0.044
6.4-16.4	JUN 2009	09FWTMW35-GW(S)	432.18	ND (0.025)
	SEP 2009	09FWTMW35-GWF	432.08	ND (0.024)
	JUL 2010	10FWAMW35-GWS	431.45	0.18
	OCT 2010	10FWAMW35-GWF	431.01	0.14
	JUL 2011	11FWAMW35-GWS	433.28	0.14
	OCT 2011	11FWAMW35-GWF	432.41	0.11

Well ID	Sample Date	Sample ID	Groundwater elevation	DRO Result
MW32				
Screen	OCT 2007	07FWCMW32-GW(F)	432.73	0.057
Interval	MAY 2008	08FWCMW32-GW(S)	432.41	0.052
(Ft bgs)	OCT 2008	08FWCMW32-GWF	433.02	0.063
9-19	MAY 2009	09FWCMW32-GW(S)	432.69	ND (0.25)
	SEP 2009	09FWBMW32-GWF	432.50	ND (0.25)
	JUL 2010	10FWAMW32-GWS	431.87	0.12
	OCT 2010	10FWAMW32-GWF	431.47	0.23
	JUL 2011	11FWAMW32-GWS	433.55	0.11
	OCT 2011	11FWAMW32-GWF	432.89	0.58 SJ

Well ID	Sample Date	Sample ID	Groundwater elevation	DRO Result
MW33				
Screen	OCT 2007	07FWBMW33-GW(F)	432.53	28
Interval	MAY 2008	08FWBMW33-GW(S)	432.34	10
(Ft bgs)	OCT 2008	08FWBMW33-GWF	433.11	29
8-18	MAY 2009	09FWBMW33-GW(S)	432.76	13.2
	SEP 2009	09FWBMW33-GWF	432.57	13
	JUL 2010	10FWAMW33-GWS	431.94	10
	OCT 2010	10FWAMW33-GWF	431.47	31
	JUL 2011	11FWAMW33-GWS	433.59	6.7
	OCT 2011	11FWAMW33-GWF	433.02	22

Well ID	Sample Date	Sample ID	Groundwater elevation	DRO Result
MW12				
Screen	MAY 2008	08FWBMW12-GW(S)	435.27	6.1
Interval	OCT 2008	08FWBMW12-GWF	436.00	11
(Ft bgs)	MAY 2009	09FWBMW12-GW(S)	435.63	7.43
8.5-18.5	SEP 2009	09FWBMW12-GWF	435.43	5.67
	JUL 2010	10FWAMW12-GWS	434.82	5.3
	OCT 2010	10FWAMW12-GWF	434.35	6.5
	JUL 2011	11FWAMW12-GWS	436.45	9.8 SJ
	OCT 2011	11FWAMW12-GWF	435.86	12 SJ

Well ID	Sample Date	Sample ID	Groundwater elevation	DRO Result
MW62				
Screen	OCT 2007	07FWAMW62-GW(F)	433.46	0.61
Interval	MAY 2008	08FWAMW62-GWS	433.54	0.041
(Ft bgs)	OCT 2008	08FWAMW62-GWF	434.24	7.7
7-17	MAY 2009	09FWAMW62-GWS	433.89	ND(0.8)
	SEP 2009	09FWAMW62-GWF	433.67	ND(0.78)
	JUL 2010	10FWAMW62-GWS	433.04	0.38
	OCT 2010	10FWAMW62-GWF	432.68	29
	JUL 2011	11FWAMW62-GWS	433.78	0.22
	OCT 2011	11FWAMW62-GWF	434.16	18

2011 Sample - Exceedance

2011 Sample - No Exceedance

Onsite Well

Post Water Supply Well

Notes:
ADEC Action Level: 1.5
Units: mg/L
Method: AK102

The F or S at the end of the sample ID indicates Spring or Fall sampling.

RED exceeded the ADEC action level.
DRO: Diesel Range Organics (C10-C25)
Results presented without qualifiers.
ND = not detected

All Locations Are Approximate

0 250 500 750 1,000
Feet

WGS 1984 UTM Zone 6N

N

FORMER COMMUNICATIONS SITE
HISTORICAL DIESEL RANGE ORGANICS
RESULTS FOR IN-PLUME AND SURROUNDING WELLS
FORT WAINWRIGHT, FAIRBANKS, ALASKA

JACOBS

DATE:	PROJECT MANAGER:	FIGURE NO:
02 AUG 2012	T. HEIKKILA	A-8

P:\Taku_Gardens\MXD\Taku_GWMP_DRO.mxd beatycj

APPENDIX B

Chemicals of Interest, MAROS Summaries, and Geometric Regression Statistics

Table B-1 Chemicals of Interest at the Former Communications Site
MAROS Input Data, Former Communications Site
MAROS Statistical Trend Analysis Summary
MAROS Mann-Kendall Statistics Summary
Statistical Geometric Regression to Extrapolate Cleanup Date, MW61
Statistical Geometric Regression to Extrapolate Cleanup Date, MW47
Statistical Geometric Regression to Extrapolate Cleanup Date, MW79

Table B-1
Chemicals of Interest at the Former Communications Site

Chemical	Abbreviation
Benzene	No abbreviation
Benzo(a)pyrene	No abbreviation
bis-(2-Ethylhexyl)phthalate	No abbreviation
cis-1,2-Dichloroethene	No abbreviation
Dibenzo(a,h)anthracene	No abbreviation
1,1-Dichloroethene	No abbreviation
Dieldrin	No abbreviation
gamma-BHC	No abbreviation
Heptachlor	No abbreviation
Hexahydro-1,3,5-trinitro-1,3,5-triazine	RDX
Tetrachloroethene	PCE
Trichloroethene	TCE
1,1,2,2-Tetrachloroethane	PCA
1,1,2-Trichloroethane	1,1,2-TCA
1,2,3-Trichloropropane	TCP
Vinyl chloride	VC
Diesel-range organics	DRO
Residual-range organics	RRO

Note:
Chemicals of interest were determined in *FWA 102 Former Communications Site Remedial Investigation at Fort Wainwright, Alaska* (Final, prepared by CH2M HILL for the USACE).

MAROS INPUT DATA Former Communications SIte

WellName	Xcoord	Ycoord	Constituent	SampleDate	Result	Units	DetLim	Flags
MW61	1084.43631	1431.89	TRICHLORO	7/10/2007	0.014	mg/l		
MW61	1084.43631	1431.89	TRICHLORO	7/10/2008	0.01	mg/l		
MW61	1084.43631	1431.89	TRICHLORO	9/15/2008	0.012	mg/l		
MW61	1084.43631	1431.89	TRICHLORO	7/10/2009	0.00822	mg/l		
MW61	1084.43631	1431.89	TRICHLORO	9/15/2009	0.0105	mg/l		
MW61	1084.43631	1431.89	TRICHLORO	7/10/2010	0.0055	mg/l		
MW61	1084.43631	1431.89	TRICHLORO	9/15/2010	0.0076	mg/l		
MW61	1084.43631	1431.89	TRICHLORO	7/10/2011	0.0031	mg/l		
MW61	1084.43631	1431.89	TRICHLORO	9/15/2011	0.0037	mg/l		
MW56	1125.28067	1342.76743	TRICHLORO	7/10/2007	0.0015	mg/l		
MW56	1125.28067	1342.76743	TRICHLORO	7/10/2008	0.0006	mg/l		TR
MW56	1125.28067	1342.76743	TRICHLORO	9/15/2008	0.012	mg/l		
MW56	1125.28067	1342.76743	TRICHLORO	7/10/2009	0.00477	mg/l		
MW56	1125.28067	1342.76743	TRICHLORO	9/15/2009	0.00117	mg/l		
MW56	1125.28067	1342.76743	TRICHLORO	7/10/2010	0.00087	mg/l		TR
MW56	1125.28067	1342.76743	TRICHLORO	9/15/2010	0.0011	mg/l		
MW56	1125.28067	1342.76743	TRICHLORO	7/10/2011	0.00055	mg/l		
MW56	1125.28067	1342.76743	TRICHLORO	9/15/2011	0.0029	mg/l		
MW47	1742.40437	1500.77384	1,2,3-TRICHL	7/10/2007	0.00054	mg/l		
MW47	1742.40437	1500.77384	1,2,3-TRICHL	7/10/2008	0.00058	mg/l		
MW47	1742.40437	1500.77384	1,2,3-TRICHL	9/15/2008	0.00039	mg/l		
MW47	1742.40437	1500.77384	1,2,3-TRICHL	7/10/2009	0.0004	mg/l		
MW47	1742.40437	1500.77384	1,2,3-TRICHL	9/15/2009	0.00065	mg/l		
MW47	1742.40437	1500.77384	1,2,3-TRICHL	7/10/2010	0.00043	mg/l		
MW47	1742.40437	1500.77384	1,2,3-TRICHL	9/15/2010	0.0004	mg/l		TR
MW47	1742.40437	1500.77384	1,2,3-TRICHL	9/15/2011	0.000087	mg/l		
MW79	1818.71173	1393.67042	1,2,3-TRICHL	9/15/2008	0.00077	mg/l		
MW79	1818.71173	1393.67042	1,2,3-TRICHL	7/15/2009	0.00034	mg/l		
MW79	1818.71173	1393.67042	1,2,3-TRICHL	9/15/2009	0.0012	mg/l		
MW79	1818.71173	1393.67042	1,2,3-TRICHL	7/15/2010	0.00033	mg/l		TR
MW79	1818.71173	1393.67042	1,2,3-TRICHL	9/15/2010	0.0005	mg/l		TR
MW79	1818.71173	1393.67042	1,2,3-TRICHL	7/15/2011	0.00034	mg/l		
MW79	1818.71173	1393.67042	1,2,3-TRICHL	9/15/2011	0.00038	mg/l		
MW08	1855.87788	1126.36735	1,2,3-TRICHL	7/10/2007		mg/l	0.0003	ND
MW08	1855.87788	1126.36735	1,2,3-TRICHL	7/10/2008	0.000023	mg/l		
MW08	1855.87788	1126.36735	1,2,3-TRICHL	9/15/2008	0.00023	mg/l		
MW08	1855.87788	1126.36735	1,2,3-TRICHL	7/10/2009	0.000024	mg/l		TR
MW08	1855.87788	1126.36735	1,2,3-TRICHL	9/15/2009	0.000034	mg/l		TR
MW08	1855.87788	1126.36735	1,2,3-TRICHL	7/10/2010		mg/l	0.0003	ND
MW08	1855.87788	1126.36735	1,2,3-TRICHL	9/15/2010		mg/l	0.00045	ND
MW08	1855.87788	1126.36735	1,2,3-TRICHL	7/10/2011		mg/l	0.0001	ND
MW08	1855.87788	1126.36735	1,2,3-TRICHL	9/15/2011	0.000057	mg/l		TR
MW06a	587.00013	1753.64219	EXTRACTAB	7/10/2007	8.2	mg/l		
MW06a	587.00013	1753.64219	EXTRACTAB	7/10/2008	4.5	mg/l		
MW06a	587.00013	1753.64219	EXTRACTAB	9/15/2008	5.5	mg/l		
MW06a	587.00013	1753.64219	EXTRACTAB	9/15/2009	3.04	mg/l		
MW06a	587.00013	1753.64219	EXTRACTAB	7/10/2010	7.2	mg/l		
MW06a	587.00013	1753.64219	EXTRACTAB	9/15/2010	9	mg/l		
MW06a	587.00013	1753.64219	EXTRACTAB	7/10/2011	3.2	mg/l		
MW06a	587.00013	1753.64219	EXTRACTAB	9/15/2011	5.2	mg/l		
MW58	502.48586	1850.51662	EXTRACTAB	7/10/2007	3.2	mg/l		
MW58	502.48586	1850.51662	EXTRACTAB	7/10/2008	2.2	mg/l		
MW58	502.48586	1850.51662	EXTRACTAB	9/15/2008	1	mg/l		

MW58	502.48586	1850.51662	EXTRACTAB	7/10/2009	2.25	mg/l		
MW58	502.48586	1850.51662	EXTRACTAB	9/15/2009	2.83	mg/l		
MW58	502.48586	1850.51662	EXTRACTAB	7/10/2010	3.3	mg/l		
MW58	502.48586	1850.51662	EXTRACTAB	9/15/2010	1.2	mg/l		
MW58	502.48586	1850.51662	EXTRACTAB	7/10/2011	2.2	mg/l		
MW58	502.48586	1850.51662	EXTRACTAB	9/15/2011	1.3	mg/l		
MW33	712.88555	1603.3935	EXTRACTAB	7/10/2007	28	mg/l		
MW33	712.88555	1603.3935	EXTRACTAB	7/10/2008	10	mg/l		
MW33	712.88555	1603.3935	EXTRACTAB	9/15/2008	29	mg/l		
MW33	712.88555	1603.3935	EXTRACTAB	7/10/2009	13.2	mg/l		
MW33	712.88555	1603.3935	EXTRACTAB	9/15/2009	13	mg/l		
MW33	712.88555	1603.3935	EXTRACTAB	7/10/2010	10	mg/l		
MW33	712.88555	1603.3935	EXTRACTAB	9/15/2010	31	mg/l		
MW33	712.88555	1603.3935	EXTRACTAB	7/10/2011	6.7	mg/l		
MW33	712.88555	1603.3935	EXTRACTAB	9/15/2011	22	mg/l		
MW12	743.5801	1513.67891	EXTRACTAB	7/10/2008	6.1	mg/l		
MW12	743.5801	1513.67891	EXTRACTAB	9/15/2008	11	mg/l		
MW12	743.5801	1513.67891	EXTRACTAB	7/10/2009	7.43	mg/l		
MW12	743.5801	1513.67891	EXTRACTAB	9/15/2009	5.67	mg/l		
MW12	743.5801	1513.67891	EXTRACTAB	7/10/2010	5.3	mg/l		
MW12	743.5801	1513.67891	EXTRACTAB	9/15/2010	6.5	mg/l		
MW12	743.5801	1513.67891	EXTRACTAB	7/10/2011	9.8	mg/l		
MW12	743.5801	1513.67891	EXTRACTAB	9/15/2011	12	mg/l		
MW62	933.22696	1667.08324	EXTRACTAB	7/10/2007	0.61	mg/l		TR
MW62	933.22696	1667.08324	EXTRACTAB	7/10/2008	0.041	mg/l		TR
MW62	933.22696	1667.08324	EXTRACTAB	9/15/2008	7.7	mg/l		
MW62	933.22696	1667.08324	EXTRACTAB	7/10/2009		mg/l	0.8	ND
MW62	933.22696	1667.08324	EXTRACTAB	9/15/2009		mg/l	0.78	ND
MW62	933.22696	1667.08324	EXTRACTAB	7/10/2010	0.38	mg/l		
MW62	933.22696	1667.08324	EXTRACTAB	9/15/2010	29	mg/l		
MW62	933.22696	1667.08324	EXTRACTAB	7/10/2011	0.22	mg/l		TR
MW62	933.22696	1667.08324	EXTRACTAB	9/15/2011	18	mg/l		
MW77	896.04492	2089.07581	EXTRACTAB	9/15/2008	2.7	mg/l		
MW77	896.04492	2089.07581	EXTRACTAB	7/10/2009	1.1	mg/l		
MW77	896.04492	2089.07581	EXTRACTAB	9/15/2009	0.271	mg/l		TR
MW77	896.04492	2089.07581	EXTRACTAB	7/10/2010	1.8	mg/l		
MW77	896.04492	2089.07581	EXTRACTAB	9/15/2010	1	mg/l		
MW77	896.04492	2089.07581	EXTRACTAB	7/10/2011	1.6	mg/l		
MW77	896.04492	2089.07581	EXTRACTAB	9/15/2011	4.2	mg/l		

MAROS Statistical Trend Analysis Summary

Project: Former Communications Site

Location: Fairbanks

User Name: Jacobs

State: Alaska

Time Period: 7/10/2007 **to** 9/15/2011

Consolidation Period: No Time Consolidation

Consolidation Type: Median

Duplicate Consolidation: Maximum

ND Values: 1/2 Detection Limit

J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Average Conc. (mg/L)	Median Conc. (mg/L)	All Samples "ND" ?	Mann-Kendall Trend	Linear Regression Trend
1,2,3-TRICHLOROPROPANE								
MW08	S	9	5	1.0E-04	5.7E-05	No	NT	S
MW47	T	8	8	4.3E-04	4.2E-04	No	S	D
MW79	S	7	7	5.5E-04	3.8E-04	No	S	PD
EXTRACTABLE PETROLEUM HYDROCARBON								
MW06a	T	8	8	5.7E+00	5.3E+00	No	S	S
MW12	S	8	8	8.0E+00	7.0E+00	No	NT	NT
MW33	T	9	9	1.8E+01	1.3E+01	No	S	S
MW58	T	9	9	2.2E+00	2.2E+00	No	S	S
MW62	S	9	7	6.3E+00	4.0E-01	No	NT	NT
MW77	S	7	7	1.8E+00	1.6E+00	No	NT	NT
TRICHLOROETHYLENE (TCE)								
MW56	S	9	9	2.8E-03	1.2E-03	No	NT	NT
MW61	S	9	9	8.3E-03	8.2E-03	No	D	D

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); No Detectable Concentration (NDC)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Mann-Kendall Statistics Summary

Project: Former Communications Site

User Name: Jacobs

Location: Fairbanks

State: Alaska

Time Period: 7/10/2007 **to** 9/15/2011
Consolidation Period: No Time Consolidation
Consolidation Type: Median
Duplicate Consolidation: Maximum
ND Values: 1/2 Detection Limit
J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Coefficient of Variation	Mann-Kendall Statistic	Confidence in Trend	All Samples "ND" ?	Concentration Trend
1,2,3-TRICHLOROPROPANE								
MW79	S	7	7	0.59	-4	66.7%	No	S
MW08	S	9	5	0.81	5	65.7%	No	NT
MW47	T	8	8	0.39	-9	83.2%	No	S
EXTRACTABLE PETROLEUM HYDROCARBONS C1								
MW77	S	7	7	0.72	3	61.4%	No	NT
MW62	S	9	7	1.65	2	54.0%	No	NT
MW12	S	8	8	0.33	6	72.6%	No	NT
MW58	T	9	9	0.40	-5	65.7%	No	S
MW33	T	9	9	0.52	-5	65.7%	No	S
MW06a	T	8	8	0.39	-2	54.8%	No	S
TRICHLOROETHYLENE (TCE)								
MW61	S	9	9	0.45	-26	99.7%	No	D
MW56	S	9	9	1.31	-8	76.2%	No	NT

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events); Source/Tail (S/T)

The Number of Samples and Number of Detects shown above are post-consolidation values.

Statistical Geometric Regression to Extrapolate Cleanup Date

Developed by D. Ward, Jacobs Engineering, March 2007

All concentrations in mg/L

FCS			
MW61			Log
Year	Date	TCE (Summer)	TCE (Summer)
2007-1	7/10/07	0.014	-1.85
2008-1	7/10/08	0.01	-2.00
2008-2	9/15/08	0.012	-1.92
2009-1	7/10/09	0.00822	-2.09
2009-2	9/15/09	0.0105	-1.98
2010-1	7/10/10	0.0055	-2.26
2010-2	9/15/10	0.0076	-2.12
2011-1	7/10/11	0.0031	-2.51
2011-2	9/15/11	0.0037	-2.43

Dates in red are estimated.

LinEst of Log COCs		
-4.03E-04	14.05	m (1/day), b
6.61E-05	2.65	se(m), se(b)
0.84	0.10	r^2, se(y intercept)
37.28	7	F,degrees of freedom
0.35	0.07	regression sum of squares, residual sum of squares
	0.10	Standard Deviation
	1.96	normal z for two-tailed 95% confidence interval
	0.19	± for 95% CI

Cleanup Level		
	Date	TCE
	1/2/06	0.005
	1/3/16	0.005

Goal Seek to find year of cleanup

	Log			Linear		
				-95%	Trend	+95%
Date	-95%	Trend	+95%	0.002091	0.0032334	0.005
4/12/12	-2.68	-2.49	-2.30			

Statistical Geometric Regression to Extrapolate Cleanup Date

Developed by D. Ward, Jacobs Engineering, March 2007

All concentrations in µg/L

FCS			
MW47			Log
Year	Date	1,2,3-TCP (Summer)	1,2,3-TCP (Summer)
2007-1	7/10/07	0.54	-0.27
2008-1	7/10/08	0.58	-0.24
2008-2	9/15/08	0.39	-0.41
2009-1	7/10/09	0.4	-0.40
2009-2	9/15/09	0.65	-0.19
2010-1	7/10/10	0.43	-0.37
2010-2	9/15/10	0.4	-0.40
2011-2	10/15/11	0.087	-1.06

Dates in red are estimated.

LinEst of Log COCs		
-3.81E-04	14.84	m (1/day), b
1.60E-04	6.42	se(m), se(b)
0.48	0.21	r^2, se(y intercept)
5.64	6	F,degrees of freedom
0.25	0.27	regression sum of squares, residual sum of squares
	0.21	Standard Deviation
	1.96	normal z for two-tailed 95% confidence interval
	0.42	± for 95% CI

Cleanup Level		
	Date	1,2,3-TCP
	1/2/07	0.12
	1/3/25	0.12

Goal Seek to find year of cleanup

	Log			Linear		
				-95%	Trend	+95%
Date	-95%	Trend	+95%	0.0176472	0.046018	0.12
3/31/16	-1.75	-1.34	-0.92			

Statistical Geometric Regression to Extrapolate Cleanup Date

Developed by D. Ward, Jacobs Engineering, March 2007

All concentrations in µg/L

FCS			
MW79			Log
Year	Date	1,2,3-TCP (Summer)	1,2,3-TCP (Summer)
2008-2	9/15/08	0.77	-0.11
2009-1	7/15/09	0.34	-0.47
2009-2	9/15/09	1.2	0.08
2010-1	7/15/10	0.33	-0.48
2010-2	9/15/10	0.5	-0.30
2011-1	7/15/11	0.34	-0.47
2011-2	9/15/11	0.38	-0.42

Dates in red are estimated.

LinEst of Log COCs		
-3.09E-04	12.15	m (1/day), b
1.99E-04	8.04	se(m), se(b)
0.32	0.20	r^2, se(y intercept)
2.40	5	F,degrees of freedom
0.09	0.19	regression sum of squares, residual sum of squares
	0.20	Standard Deviation
	1.96	normal z for two-tailed 95% confidence interval
	0.38	± for 95% CI

Cleanup Level		
	Date	1,2,3-TCP
	1/2/07	0.12
	1/3/25	0.12

Goal Seek to find year of cleanup

	Log			Linear		
				-95%	Trend	+95%
Date	-95%	Trend	+95%	0.0206108	0.0497322	0.12
2/20/19	-1.69	-1.30	-0.92			