FOCUSED FEASIBILITY STUDY – GROUNDWATER

ANIAK MIDDLE SCHOOL ANIAK, ALASKA

NTP 18400211028

FINAL June 2012

Prepared for:



555 Cordova Street Anchorage, AK 99501



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ACRONYMS AND ABBREVIATIONS

ADEC	Alaska Department of Environmental Conservation
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CHP	Catalyzed hydrogen peroxide
CSM	Conceptual site model
cm/sec	centimeters per second
су	Cubic yards
DCE	Dichloroethene
DO	Dissolved oxygen
EPA	Environmental Protection Agency
ERD	Enhanced reductive dechlorination
FS	Feasibility study
ft/ft	Feet per foot
g/kg	Gram per kilogram
gpm	gallons per minute
HRC™	Hydrogen Release Compound
IDC	inhalation/direct contact pathway (cleanup levels)
ISCO	In situ chemical oxidation
µg/L	Micrograms per liter
µg/m ³	Micrograms per cubic meter
mg/kg	Milligrams per kilogram
m/s	meters per second
MNA	Monitored natural attenuation
MTG	Migration to groundwater (cleanup levels)
N	nitrogen
NCP	National Contingency Plan
OASIS	OASIS Environmental, Inc.
ORP	oxidation-reduction potential
PCBs	polychlorinated biphenyls
PCE	Tetrachloroethene
ppbv	parts per billion by volume
RAO	Remedial action objective
RCRA	Resource Conservation and Recovery Act
SSD	Sub-slab depressurization
SI	site investigation
SVE	Soil vapor extraction
тос	total organic carbon
TCE	Trichloroethene
USCS	United States Classification System

VI..... vapor intrusion

VMP Vapor monitoring point

VOC Volatile organic compound

WACS White Alice Communications System

1. PURPOSE AND EXECUTIVE SUMMARY

The purpose of this focused feasibility study (FS) is to evaluate remedial alternatives for addressing contaminated groundwater at the former Aniak White Alice Communications System (WACS) site located in Aniak, Alaska. The Aniak WACS site is currently used by the Kuspuk school district. The former WACS building is currently known as the Aniak Middle School (and alternatively as the Joe Parent School) and is used as a secondary school, temporary lodging, and administration and staff offices.

Soil, soil gas, and groundwater at the Aniak WACS site are contaminated by the chlorinated solvent, trichloroethene (TCE) and its degradation product, cis-1,2-dichloroethene (cDCE). This contamination has resulted in VOC concentrations exceeding the Alaska Department of Environmental Conservation (ADEC) vapor intrusion target levels for residential groundwater and subslab soil gas and drinking water risk-based thresholds. This contamination contributes to exceedances of ADEC Target Levels for indoor air. In addition, shallow soil at the site is also contaminated by polychlorinated biphenyls (PCBs) above ADEC soil cleanup levels.

This Focused FS is a followup analysis to a detailed site characterization report (Shannon & Wilson, 2010a). The Shannon & Wilson report identified the nature and extent of soil gas, soil, and groundwater contamination at the Aniak WACS site and presented remedial alternatives for addressing vapor intrusion and vadose zone soil contamination. Only one remedial alternative for groundwater contamination, air sparging, was presented. The purpose of this Focused FS is to prepare a comprehensive analysis of groundwater remedial alternatives, including remediation of a silt layer that is present across most of the site and is saturated during times of moderate to high groundwater elevations.

Vapor intrusion mitigation has been implemented at the Aniak Middle School, and remedial activities are planned to address vadose zone soil contamination. Vapor intrusion is being mitigated by air purification filters inside the school and a sub-slab depressurization system (SSD). Excavation is planned to address soil contaminated by PCBs above the Alaska cleanup level of 1 milligram per kilogram (mg/Kg). Some of the planned PCB excavation area also has commingled TCE contamination that will be removed along with the PCB contamination. Soil vapor extraction (SVE) is planned to address the vadose-zone TCE contamination remaining after the PCB excavation. The groundwater alternatives evaluated in this Focused FS consider these planned and ongoing soil and soil gas remedies.

A pre-draft Focused FS was prepared in April 2011 (OASIS, 2011a; also included as Appendix D to this report). It presented a summary of the nature and extent of the groundwater contamination, a conceptual site model (CSM) of exposure pathways to the contamination, established preliminary remedial action objectives, identified technologies to be considered in this Focused FS, and made recommendations for addressing data gaps. Based on recommendations in the pre-draft FS, groundwater monitoring events were performed in May and October 2011, pressure transducers with dataloggers were

placed into eight monitoring wells, and the silt layer was analyzed to the maximum degree possible with existing site characterization information.

This Focused FS presents results of the 2011 monitoring events, an updated discussion of the nature and extent of groundwater contamination, an interpretation of the silt layer, five remedial alternatives for addressing groundwater contamination (including the silt layer), and an comparative analysis of the alternatives. Responses to comments received on the draft Focused FS are provided in Appendix E. The five alternatives include one alternative analyzed by Shannon & Wilson (Shannon & Wilson, 2010a), i.e., air sparging, and four additional alternatives. The alternatives are listed below with their estimated remedial timeframes.

- Alternative GW-1: No Action (infinite remedial timeframe)
- Alternative GW-2: Monitored Natural Attenuation (MNA)/Long-Term Monitoring (LTM) (35-year remedial timeframe)
- Alternative GW-3: In Situ Chemical Oxidation (ISCO) (10-year remedial timeframe)
- Alternative GW-4: Enhanced Reductive Dechlorination (ERD) (20-year remedial timeframe)
- Alternative GW-5: Air Sparging (20-year remedial timeframe)

The five alternatives were evaluated against the nine criteria described in Section 121(b) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP) §300.430(f)(5)(i). Results of the comparative analysis are summarized below in Table 1-1. The two "threshold criteria" must be met in order for an alternative to be considered for selection; therefore, "yes" and "no" were used as the scores for these criteria. A numerical scoring scheme was used for evaluating the five balancing criteria. Each alternative was assigned a numerical score between 0 (worst) and 5 (best) for each criterion to reflect the expected performance of the alternative. The scores have no independent value; they are only meaningful when compared among the different alternatives.

Reme	dial Alternative	Threshok	d Criteria	Effect	tiveness S	cores		(Cost					
Identifier Description		Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness and Permanence	Reduction in Toxicity, Mobility, and Volume through Treatment	Short-term Effectiveness	Implementability	Cost Score	Estimated Present Worth Range (-50% to + 100%) (in thousands of dollars)	Effectiveness Total	Total Score	Effectiveness to Cost Quotients		
	Groundwater Alternatives													
									\$0					
GW-1	No Action	No	No	0.0	0.0	0.0	5.0	5.0	\$0	0.0	10.0	NA		
									\$1,217			0.60		
GW-2	LTM/MNA	Yes	Yes	2.0	2.0	3.3	4.0	2.2	\$4,870	7.3	13.5	0.15		
	ISCO (Chamiaal								\$2,152			0.49		
GW-3	Oxidation)	Yes	Yes	4.0	4.0	2.5	3.0	0.0	\$8,608	10.5	13.5	0.12		
	ERD (Substrate								\$1,715			0.57		
GW-4	Addition)	Yes	Yes	3.5	3.0	3.3	3.0	1.0	\$6,858	9.8	13.8	0.14		
									\$1,813			0.39		
GW-5	Air Sparging	Yes	Yes	2.5	2.0	2.5	2.0	0.8	\$7,252	7.0	9.8	0.10		

TABLE 1-1: COMPARISON OF REMEDIAL ALTERNATIVES

Explanation of Scores:

0 Worst (Criterion not satisfied)

1 Poor 2 Below Average 3 Average 4 Above Average

5 Best (Criterion completely satisfied)

Preferred Alternative

Selection of a preferred alternative depends on the relative importance of the variables. GW-2 (MNA) and GW-4 (ERD) are the most cost-effective alternatives; ERD has a higher effectiveness than MNA, but the increased effectiveness is countered by its higher cost. If achieving cleanup in the shortest time is the most important factor, then Alternative GW-3 (ISCO) is preferred, although it is also the most expensive alternative. Air sparging has the lowest total score and effectiveness to cost quotient and is least likely to be considered the preferred alternative.

Overall, it appears that additional plume characterization and implementation of the soil remedies would be beneficial before selecting a groundwater remedy. Additional plume characterization activities should include installing soil borings and monitoring wells east of the Aniak Middle School building, west of the building in the vicinity of SGP-17 and SGP-18, and in several other locations as needed to complete characterization of both plumes and the silt layer. MNA parameter monitoring should be performed at low water level. Microbial community testing for dehalococcoides organisms should be performed. Use of Bio-Trap® in-situ microcosms may be a cost-effective technique to assess the MNA potential, native microbiological community, and expected performance of substrate amendment. During the PCB soil excavation in the vicinity of the former septic tank and truck fill, soil samples should also be analyzed for TCE. If high TCE concentrations are detected in the silt at the base of the PCB excavation, overexcavation of TCE-contaminated soil or direct treatment using a reductant (or possibly an oxidant) during the PCB soil excavation may be a very beneficial and cost-effective remediation strategy. Alternatively, depending on the location, magnitude, and extent of the TCE

contamination and silt characteristics, installation of an engineered solution, such as placement of a gravel layer at the base of the excavation with distribution piping and a standpipe at the surface that could be used to deliver reagents periodically, may be warranted. Sampling details and a decision protocol should be incorporated into the excavation work plan.

Based on existing data and weighing the effectiveness and cost considerations, Alternative 2 (MNA) or Alternative 4 (ERD) may be considered preferred. MNA would be expected to perform satisfactorily at this site if the following conditions are met. The conditions are based on a decision flowchart for MNA and enhanced attenuation presented in (ITRC, 2007).

- 1. Additional site characterization confirms that there is no distinct source/primary plume in the saturated zone. There is no evidence of free-phase or residual-phase TCE, and maximum groundwater concentrations remain three-to-four orders of magnitude below the solubility limit. The groundwater plume configuration is generally as outlined in this FS.
- 2. Additional groundwater monitoring supports the conclusion that the plume is stable.
 - a. The groundwater plume is stable or shrinking, and there is no risk to the nearby drinking water wells. An alternative point of compliance can be established downgradient of the source area.
 - b. The PCB soil excavation and SVE adequately address vapor intrusion risk (i.e., most of the contaminant mass is in the vadose zone). Although volatilization from the silt layer/saturated interval below the silt layer may provide a continuing source for soil gas contamination, the level of continued volatilization is currently unknown and may be minor, especially if the upper portion of the silt layer is directly treated during the PCB soil excavation.
 - c. Future VOC and geochemical parameter sampling indicates that there are zones or areas of highly-reducing groundwater in which reductive dechlorination of TCE is occurring at sustainable rates to adequately remediate the contamination over time.
 - d. This alternative is deemed acceptable to ADEC and all of the interested parties.
- 3. If the above criteria are not completely satisfied, then it may be advantageous to implement ERD in a phased approach.

2. SITE BACKGROUND

Aniak is located approximately 300 miles west of Anchorage and is bordered on the north by the Kuskokwim River and on the south by the Aniak Slough. The Middle School site is approximately 600 feet southeast of the northwest end of the runway and approximately 900 feet south of the Kuskokwim River, as shown on Figure 1. The property and immediate vicinity is generally flat, although the surrounding area has a general slope to the east towards the Aniak Slough. The site is situated on a gravel pad overlying the native alluvial deposits. A site plan showing the location of the former Aniak Middle School on an aerial photograph is provided as Figure 2.

2.1. Investigation Summary

Extensive site investigation and remediation work has been performed at the site, beginning with a 1997 Site Inspection (SI) conducted by the Environmental Protection Agency (EPA). Widespread PCB contamination was documented both inside and outside the Middle School building, and the site has been assigned Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Site Number AK8570028615. A brief summary of the investigation and remediation work performed at the site is provided below; a detailed discussion of the pre-2010 work can be found in Shannon & Wilson (2010a).

- In 1997-1998, PCBs were removed from the inside of the building, and exterior contaminated areas were capped.
- Additional soil sampling was performed in 1999.
- In 2001, limited PCB cleanup activites were performed from a portion of the area that had been capped and from other areas identified by the 1999 sampling. Approximately 872 tons of PCB-impacted material was removed from the site.
- Feasibility studies were performed in 2004 and 2005.
- Site characterization activities in the vicinity of the WACS former septic system were performed in 2006 (Shannon & Wilson, 2007). Activities included soil and groundwater sampling; TCE contamination was discovered, along with additional areas of PCB contamination.
- In 2008, soil and groundwater sampling were performed to delineate the TCE contamination (Shannon & Wilson, 2009). Two distinct source areas and associated groundwater plumes were identified (Figures 2 and 3). The primary source appears to be the Former Septic System and floor drains formerly located within the Middle School Metal Shop. A second source area appears to be the Maintenance Building floor drain or leakage/spillage from a former drum storage area on the south side of the Maintenance Building. Although a third apparent source area was identified off-site in the vicinity of the Runway Apron/Disposal Pit area, it is considered unlikely that this contamination is related to the TCE-

impacted soil and groundwater encountered at the Middle School and is not discussed in this FS.

- Also in 2008, approximately 2,300 cubic yards (cy) of PCB-contaminated soil, construction debris, and tank content wastes were removed from the site. It was concluded that additional PCB contamination likely extends beneath the building foundations. It was not possible to remove all of the PCB contamination with available funding.
- The 2008 Former Septic System excavation reached a maximum depth of approximately 26 feet below ground surface (bgs) in the vicinity of the former seepage pit. The base of the deepest excavation measured approximately 20 feet (east-west) by 25 feet (north-south). The septic tank excavation reached a maximum depth of approximately 18 feet bgs. The excavation depth of the east and west septic line reached a maximum of approximately 11 feet bgs. Groundwater was not encountered during the excavation. The west septic line and seepage pit excavations were not backfilled to their original elevation. The ground surface over these areas is approximately 8 feet lower than the pre-excavation ground surface.
- In 2009, a vapor intrusion (VI) assessment performed at the site determined that TCE exceeded the risk-based screening levels (0.21 parts per billion by volume (ppbv) for commercial indoor air and 0.041 ppbv for residential indoor air¹) for all three indoor air sample locations at the school.
- Also in 2009, Site Characterization activities were performed to further delineate the PCB and TCE contamination, and a Site Cleanup Plan was prepared (Shannon & Wilson, 2010b). Site characterization activities included a soil gas survey, PCB soil borings, installation and sampling of groundwater monitoring wells, feasibility testing for remedial alternatives, and soil and groundwater sampling. Results are shown on Figure 3. The site investigation report also evaluated remedial alternatives for addressing remaining site contamination. The remedial alternative discussion focused on soil remedies, although air sparging was evaluated for groundwater.
- In 2010, a hydrogeologic evaluation was completed to increase the understanding of groundwater behavior at the site, specifically the potential for groundwater contamination to impact the nearby drinking water wells for the Middle School and High School (Figure 2) (Shannon & Wilson, 2010a).
- Also in 2010, air purification filters and a subslab depressurization system (SSD) were installed to mitigate vapor intrusion risk in the Middle School building (OASIS, 2010).

¹ Screening levels from ADEC 2009 *Draft Vapor Intrusion Guidance for Contaminated Sites* (ADEC, 2009). This guidance is undergoing review and update due to revisions in EPA Regional Screening Levels and TCE toxicity values that were recently finalized in IRIS.

- In May 2011, dataloggers were installed into seven monitoring wells, and groundwater samples were collected from all available monitoring wells (i.e., MW-5 through MW-12), as well as two soil gas points (SGP-2 and SGP-9) that were available for groundwater monitoring due to the high water level. The datalogger study is documented in Appendix A to this FS, and the groundwater sampling event is summarized in Appendix B.
- In October 2011, the dataloggers were downloaded and replaced into the monitoring wells. Groundwater samples were collected from all available monitoring wells (i.e., MW-6 through MW-12). MW-5 and the soil gas points were dry due to the low water level.

2.2. Groundwater Contamination Summary

Groundwater impact by TCE above the Alaska Department of Environmental Conservation (ADEC) Table C cleanup level has been documented in two locations: south of the Maintenance Building and beneath the Former Septic System (Figure 3). The Maintenance Building² plume (referred to as the MW-4 plume in this FS) is estimated to cover approximately 2,500 square feet. The Former Septic System³ plume (referred to as the MW-5/7 plume in this FS) was estimated at 12,500 square feet in the April 2011 Pre-Draft FS (OASIS, 2011a); however, based on a groundwater TCE detection in SGP-9 (May 2011) and soil gas detections (2009), the groundwater plume is now interpreted to extend under the Aniak Middle School with an estimated area of 22,000 square feet. Note that groundwater monitoring wells have not been installed at the location of the highest TCE concentration measured in soil gas at SGP-17, within the footprint of the Maintenance or Middle School Buildings, east of the Middle School Building, or between the two plumes, so there is a fair degree of uncertainty in the plume sizes. As shown on Figures 2 and 3, the MW-5/7 groundwater plume has been extended to encompass the locations of Soil Gas Points SGP-8 and SGP-17 and the former floor drains located within the Middle School Metal Shop.

Groundwater contamination plume details are provided in Section 2.5 of this FS.

2.3. Geologic Setting

2.3.1. Regional Surface Geology

Aniak is situated on the floodplain of the Kuskokwim River. The Aniak River flows northward into the Kuskokwim River just east of the village of Aniak, while the Aniak Slough flows southward from the general area where the Aniak River meets the Kuskokwim River. The Kuskokwim River cuts through the Kuskokwim Mountains

² The text in Shannon & Wilson (2010) reports the extent of contamination at 15,000 square feet; however, the area shown in their figures and their air sparging calculation (Table L-2) is approximately 2,500 square feet.

³ The text in Shannon & Wilson (2010) reports the extent of contamination at 25,000 square feet; however, the area shown in their figures and their air sparging calculation (Table L-2) is approximately 12,500 square feet.

approximately 60 miles upstream of Aniak; downstream of the Kuskokwim Mountains, the river flows through a broad floodplain with no significant topography. The central Kuskokwim River floods annually or biennially, usually as a result of ice breakup, which typically occurs in May.

The surficial geology in the vicinity of Aniak consists of Kuskokwim flood plain deposits of unconsolidated silt, sand, and gravel. The river deposits include: sediment deposits of bed-load sand, gravel, and silt from river-channel activity, fine-grained (silt and fine sand) sediments deposited on river banks during flood periods, and sediments deposited during heavy floods (Krause, 1984). Silt thicknesses in Aniak have been reported to range from 1 to 6 meters (Krause, 1984).

The site is located approximately ¹/₂-mile south of the Kuskokwim River and 3/4-mile west of the Aniak Slough.

2.3.2. Local Surface Geology

The school is built on a gravel pad overlying alluvial sediments of the Kuskokwim River floodplain. The pad material consists of soil classified as sandy gravel in accordance with the United Soil Classification System (USCS). The thickness of the pad near the school varies significantly from 12 to 27 feet bgs based on soil borings advanced to install soil gas points around the school by Shannon & Wilson during August 2009 (Shannon & Wilson, 2010a). The native soil type underneath the pad is comprised of a horizon classified as predominantly silt from approximately 10 to 25 feet thick. The silt horizon overlies native material classified as gravelly sand. The silt horizon appears to have been partially removed beneath the Aniak Middle School, presumably prior to building construction. Also, the silt horizon was partially removed during PCB excavation activities at the former septic system (Figure 4A). Specifically it was removed to a depth of approximately 18 feet bgs at the former septic tank location and completely removed (to a depth of 26 feet bgs) around the former seepage pit.

Figure 5 displays elevations of the silt layer base along with plan view locations of crosssections A-A' and B-B'. The cross-sections, presented in Figures 6 and 7, illustrate the subsurface geology and contamination across the site.

Shannon & Wilson (2010a) conducted grain size classification tests on five soil samples from the site to characterize the subsurface materials. Samples, descriptions, and results are summarized below in Table 2-1.

Sample	Boring	Depth	Description	Classification
VES2-9	VES2	25.5-27.5	Gravel fill above silt	Sandy gravel
SB25-0	B25/MW-12	0-2	Native silt	Slightly sandy silt
B20-32	B20/MW-7	32-33	Native sand in water-bearing zone	Gravelly sand
B21-32	B21/MW-8	32-33		
SB14-32	SB14	32-33		

TABLE 2-1: GRAIN SIZE CLASSIFICATION RESULTS

2.4. Hydrogeology

2.4.1. Groundwater Elevation and Horizontal Groundwater Flow

The groundwater elevations at the Aniak WACS site have been investigated by two datalogger studies. Shannon & Wilson recorded groundwater elevations using pressure transducers/dataloggers in five site monitoring wells (MW-8 through MW-12 -- see Figure 2) between September 2009 and May 2010 (Shannon & Wilson, 2010a). OASIS began recording groundwater elevations using pressure transducers/dataloggers in seven monitoring wells (MW-5 and MW-7 through MW-12) in May 2011 and continuing through the date of this report. The dataloggers were downloaded in October 2011. Groundwater elevation plots and groundwater contour maps created from the datalogger data are presented in Appendix A and discussed below.

Chart A1-1 displays all groundwater elevations from the period between May and October 2011, along with the elevation data for the Kuskokwim River at Crooked Creek (USGS Gaging Station 15304000)⁴. The Kuskokwim River at Crooked Creek gaging station, located approximately 50 miles upriver of Aniak, is the nearest USGS gaging station to Aniak. In Aniak, the Kuskokwim River is located approximately ¹/₄-mile from the site. Chart A1-1 shows a strong correlation between the groundwater and Kuskokwim River elevation patterns.

Charts A1-2 and A1-3 display the groundwater elevations in more detail over the spring and summer months, respectively. Groundwater elevations are labeled on these charts for four days: May 14 (spring very high water level); June 12 (early summer high water); August 20 (mid-summer high water); and October 16 (fall low water). The following conclusions were reached from these charts:

- When the groundwater level was at its highest (i.e., early- to mid-May and mid-August 2011), MW-11 had the highest groundwater elevation, while MW-12 experienced the lowest groundwater elevation. This situation occurred only for short periods of time during the highest water levels and is interpreted to represent a "losing stream" situation, i.e., groundwater flowing away from the Kuskokwim River towards the site.
- During the rest of the period between May and October 2011, MW-12 had the highest groundwater elevation, and MW-11 experienced the lowest groundwater elevation. This situation represents groundwater flow from the site toward the Kuskokwim River.
- There is little difference between the groundwater elevations of all site monitoring wells, indicating a relatively low horizontal groundwater gradient.

Figures 7 through 10 are water table elevation contour maps prepared for the four selected dates shown on Charts A1-2 and A1-3 (May 14, June 12, August 20, and

⁴ The gaging station was destroyed by flooding in May 2011 so the record is incomplete until the gaging station was replaced in late June 2011.

October 16) to illustrate the different groundwater flow scenarios. Groundwater flow directions and gradients for these dates are summarized below.

- May 14, 2011 (very high groundwater elevation [72.5 feet amsl in MW-7]): Groundwater flow direction to the south-southwest at a gradient of approximately 0.002 feet/foot
- June 12, 2011 (high groundwater elevation [62.4 feet amsl in MW-7]): Groundwater flow direction to the north-northeast at a gradient of approximately 0.001 feet/foot
- August 20, 2011 (high groundwater elevation [63.5 ft amsl in MW-7]: Groundwater flow direction to the south-southwest at a gradient of approximately 0.0004 feet/foot
- October 16, 2011 (low groundwater elevation [59.7 ft amsl in MW-7]: Groundwater flow direction to the north-northeast at a gradient of approximately 0.0005 feet/foot

The water table elevation graph (Graph 1) and groundwater contour maps (Figures H-1 through H-5) prepared by Shannon & Wilson (2010a) are also included in Appendix A. Groundwater flow directions and gradients measured by Shannon & Wilson (2010a) are summarized below.

- October 3, 2009 (low groundwater elevation [58.1 feet amsl in MW-8]): Groundwater flow direction to the north at a gradient of approximately 0.0004 feet/foot (Shannon & Wilson Figure H-1).
- High groundwater elevation (Fall 2009 and Winter 2009 [60.0 and 60.2 feet amsl in MW-8]): Groundwater flow direction to the south at gradients of 0.0005 and 0.0002 feet/foot (Shannon & Wilson Figures H-2 and H-3).
- January through April 2010 (sustained low groundwater elevation [58.2 feet amsl in MW-8 in February 2010; Shannon & Wilson Figure H-4]): Groundwater flow generally to the west at a gradient of 0.0003 feet/foot.
- May 2010 (maximum groundwater elevation [63.4 feet amsl in MW-8]): Groundwater flow to the south at a gradient of approximately 0.002 feet/foot (Shannon & Wilson Figure H-5).

Overall, the datalogger evaluations concluded that the groundwater elevation is closely tied to the Kuskokwim River. There are significant seasonal fluctuations in the groundwater table elevation and groundwater flow direction, although the groundwater gradient was consistently fairly flat (low). Based on the available data (September 2009 through May 2010 and May 2011 through October 2011), three groundwater flow regimes have been identified:

- Very high water level (i.e., 2 weeks in May 2011)
- High water level (i.e., May through September)
- Low water level (i.e., October through April).

These groundwater flow regimes are summarized below in Table 2-2.

Scen- ario	Description	Approx. GW Elev. (ft amsl)	Timeframe	Primary GW Flow Dir./ Grad	Secondary GW Flow Dir./ Grad.	Basis
Very High	Spring, short duration	72 max	May 2011 (2 weeks +/-)	S-SW 0.002	NA	OASIS dataloggers
High	Consistent drop in water level from end of very high regime (i.e., late May) through mid- June. Fluctuations (<1 to 2.5 ft) due to Kuskukwim River stage changes. Smaller fluctuations possibly due to precipitation events.	61-64	May-Sept. (4.5 months +/-)	N-NE 0.001	S-SW 0.0004 (< 1 month duration)	OASIS dataloggers
Low	Low groundwater corresponding to low river stage. Fluctuations (58-60 ft amsl) in Sept through Dec due to precipitation event (10/10) and temperature variations (above-freezing temps in early 12/10). Late January through April sustained water elevations between 58- 58 5 ft amsl	58-61	OctApril (7 months +/-)	W 0.0003 (Jan-Apr 2010: S&W)	N-NE 0.0005 (10/16/11) 0.0002 to 0.0005 (Fall/Winter 2009 S&W)	OASIS dataloggers (9-10/11); Shannon & Wilson dataloggers

TABLE 2-2: ANIAK GROUNDWATER FLOW REGIMES

2.4.2. Vertical Groundwater Flow

The vertical groundwater flow gradient between monitoring wells MW-7 and MW-8 is being investigated by the OASIS datalogger study. These two monitoring wells are located within approximately 5-feet of each other. Both wells are sxcreened across the sand-gravel interval below the silt; MW-7 is screened from 23-38 feet bgs, while MW-8 is screened from 47-52 ft bgs.

A review of Charts A1-1 through A1-3 illustrates that there is no visible difference between the groundwater elevations in MW-7 and MW-8 over most of the time period between May and October 2011. The groundwater elevations posted on Charts A1-2 and A1-3 indicate a maximum elevation difference of 0.02 feet between MW-7 and MW-8. This elevation difference is within the range of possible measurement error, especially considering that the well elevations have not been surveyed since 2009, and therefore not considered definitive. Chart A1-4 presents a detailed view of the groundwater elevations in only MW-7 and MW-8 over the period between June 16 and August 10, 2011. Chart A1-4 illustrates that there is no measurable difference between the groundwater elevations in MW-7 and MW-8 over this time period. Based on the datalogger data from May 2011 through October 2011, there is no definitive vertical gradient between the screened intervals of MW-7 and MW-8.

2.4.3. Hydraulic Conductivity and Seepage Velocity

Based on the grain size classification tests shown in Table 2-1, physical aquifer parameters were obtained from literature and are summarized below in Table 2-3.

		Hyd C	Cond (K) [ci	m/s] ^{a,b}	Total Porosity (n) ^a	Eff. Porosity (n) ^a	Dry Bulk Density (lbs/ft ³) ^b
Description	Soil Type ^c	High	Low	Geo. Mean	Average	Average	Average
Fill (vadose)	Sandy Gravel (GW)	1	0.03	0.17	0.32	0.28	130
Silt (saturated &	Slightly Sandy Silt						
vadose)	(ML)	1.0E-03	1.0E-07	1.0E-05	0.48	0.16	108
Native Sand Below		1	0.003	0.055	0.20	0.28	110
Native Sand Below Silt (saturated)	Gravelly Sand (SP)	1	0.003	0.055	0.39	0.28	

TABI E 2-3:	GROUNDWATER	FI OW PARAMETER	SUMMARY
	ONCOMPAREN		OOMINIAN

a Natural Attenuation of Fuels and Chlorinated solvents in the Subsurface, Wiedemeier, 1999.

b Freeze & Cherry 1979

c Civil Engineering Reference Manual, Sixth Edition, Lindeburg, 1992.

d S&W 2010 Grain Size Classification Tests

Seepage velocities were calculated for the gravelly sand layer based on the average hydraulic conductivity, porosity, and the range of measured hydraulic gradients. Theoretical annual travel distances were calculated from the seepage velocities reflecting the seasonally-variable groundwater flow directions (northerly, southerly, and westerly directions) and are presented below in Table 2-4. Note that Table 2-4 presents only travel distances based on average hydraulic conductivity and porosity values for sand and does not consider travel through the silt or any heterogeneitites.

The travel speed of dissolved-phase contamination is slower than the travel speed of the water, due to sorption processes slowing the contaminant front. This phenomenon is generally referred to as "retardation" and may be quantified by a retardation coefficient that expresses how much slower a contaminant moves compared to the water. The retardation coefficient for TCE at the Aniak site was calculated by the following equation.

$$R = 1 + \frac{Kd * \rho b}{\varphi}$$

Where: R is the retardation coefficient = 1.25, based on parameter values below;

ρb is the bulk density (2.65*[1- φ]=1.9 g/cm³);

 K_d is the sorption coefficient = K_{oc} [organic carbon coefficient of contaminant]*foc [fraction of organic carbon in the soil]) (100 L/kg*0.00045=0.045; and ϕ is the porosity (0.3).

A retardation factor of 1.25 indicates that TCE travel will be retarded by a factor of 1.25 compared to the groundwater velocity. This is a low retardation factor, reflecting TCE's high mobility and low affinity for sorption onto soil. The calculated TCE travel distance is presented in Table 2-4, along with the groundwater travel distance.

								Ground water	TCE Retarda-		TCE Distance
				K (avg)	Vd	Vs (avg)	Vs (avg)	Distance	tion	TCE Vs	traveled
Flow Regime	Duration	Grad	Dir	cm/sec	(cm/sec)	(cm/sec)	(m/d)	traveled (m)	factor	(m/day)	(m)
Spring High Water	14 days	0.002	S-SW	0.055	1.E-04	4.E-04	3.E-01	5	1.25	0.272	4
Summer Normal	115 days	0.0009	N-NE	0.055	5.E-05	2.E-04	2.E-01	18	1.25	0.122	14
Summer Reversal	21 days	0.0004	S-SW	0.055	2.E-05	8.E-05	7.E-02	1	1.25	0.054	1
Sep-Dec	107 days	0.0005	N-NE	0.055	3.E-05	1.E-04	8.E-02	9	1.25	0.068	7
Jan-Apr	108 days	0.0003	W	0.055	2.E-05	6.E-05	5.E-02	5	1.25	0.041	4
Total	365 days							Water	Total di	stance	TCE
						Tota	I to S-SW:	6			5
						Tota	l to N-NE:	27			21
Definitio	<u>ns:</u>					Т	otal to W:	5			4
К-	Hydraulic con	ductivity									
Vd-	Darcy velocity	'				Net m/y	r to N-NE	20			16
Vs-	Seepage velo	city				Net m/	yr to W	5			4
m-	meter	d-	day								
cm-	centimeter	yr-	year			Net ft/yr to N-NE		67			54
ft-	feet					Net ft/	yr to W	18			14

TABLE 2-4: TRAVEL DISTANCE CALCULATIONS (GRAVELLY SAND)

2.4.4. Pump Test

As part of the hydrogeologic evaluation, Shannon & Wilson performed pumping tests of the Middle School and High School drinking water wells to determine whether pumping affects water levels in nearby monitoring wells and, by extension, whether it can affect migration of the groundwater TCE plumes (Shannon & Wilson, 2010a and 2010b).

Shannon & Wilson installed monitoring Wells MW-11 and MW-12 for use in the pumping tests and as sentry wells for the Middle School and the High School drinking water wells. respectively. MW-11 is located about 55 feet from the Middle School drinking water well, and MW-12 was positioned about 75 feet north of the High School drinking water well (Figure 2). The Middle School drinking water well is about 60 feet deep, whereas the High School drinking water well is about 45 feet deep. During the pumping test, groundwater contact was measured at about 32 feet in MW-11 and 29 feet in MW-12.

Three pumping tests were performed:

- Middle School pumping test in which the drinking water well was pumped at a total net flow rate of about 20 gallons per minute (gpm) for 3.5 hours.
- High School pumping test in which the drinking water well was pumped at a total net flow rate of about 11 gpm for 6 hours.
- Combined pumping test in which both drinking water wells were pumped at a total net flow rate of about 31 gpm for 4 hours.

In all three tests, groundwater level measurements were collected using pressure transducers/dataloggers in five monitoring wells (MW-8, MW-9, MW-10, MW-11, and MW-12), and atmospheric pressure measurements were also collected to correct for barometric pressure variations. All three pumping tests showed very little change in water level during or after pumping. Shannon & Wilson concluded that pumping from the drinking water wells had no measureable influence on water levels in the five nearby monitoring wells.

2.4.5. Silt

As discussed previously, there is a silt layer underlying the sandy gravel pad at the Aniak WACS site. Away from the pad, the silt extends to the ground surface; underneath the pad, the depth to silt varies from approximately 12 to 27 feet bgs⁵. The thickness of the silt layer is variable; in addition to natural variabilities, the silt horizon appears to have partially removed beneath the Aniak Middle School (presumably prior to building construction) and modified further during PCB excavation activities at the former septic system. Specifically, the silt layer was removed to a depth of approximately 18 feet bgs at the former septic tank location and completely removed (to a depth of 26 feet bgs) around the former seepage pit. Figures 4A and 4B show the approximate location of the excavations.

Three figures were prepared to assist in interpreting the silt layer. Figure 5 presents base of silt elevations and the locations of two cross-sections, A-A' and B-B' (Figures 6 and 7, respectively). Each of these figures is discussed below.

<u>Plan View Silt Map:</u> The base of silt elevation was selected as the best way to depict the characteristics of the silt layer in plan view relative to groundwater remediation. The base of the silt elevation better represented the variability of the silt with respect to the water table than a top of silt elevation map or a silt thickness (isopach map). The soil boring logs showed the top of the silt to be relatively constant at an elevation of approximately 80 feet across most of the site, except where it has been modified. The silt appears to have been removed to an elevation of approximately 65 feet under the Aniak Middle School Building and approximately 75 feet under the Maintenance Building and Former Truck Fill stand. In addition as discussed above, the silt was removed to varying elevations (approximately 65 to 75 feet) during the septic system PCB excavation activities. A draft silt isopach map was prepared but did not prove useful for evaluating the relationship between the silt and the variable groundwater elevations.

As shown on Figure 5, the base of silt elevation ranged from a minimum of 59 feet amsl to a maximum between 70 and 75 feet amsl⁶. In comparison, the groundwater table elevation has ranged between approximately 59 and 72 feet amsl. Therefore, during

⁵ based on soil borings advanced to install soil gas points around the school by Shannon & Wilson during August 2009 (Shannon & Wilson, 2010)

⁶ Note, however, that only a fraction of the soil borings advanced at the site penetrated completely through the silt layer. In particular, the base of the silt layer was not reached in MW-5 and was not logged in B-13, so the minimum silt elevation is not actually known.

times of low groundwater elevation (i.e., October through April, see Table 2-2), most or all of the silt is above the water table. During times of extreme high groundwater elevation (i.e., approximately two weeks in May, see Table 2-2) the base of the silt is well below the water table, saturating a significant portion of the silt layer (see also Figure 6). During the summer months (May through September, see Table 2-2), the base of the silt will be up to approximately 5 feet below the water table.

<u>Cross-Section A-A'</u>: Cross-Section A-A' extends in a southwest to northeast direction located to the west of and roughly parallel to the middle school. Cross-Section A-A' intersects B-B' at MW-5. The thickness of the silt layer across Cross-Section A-A' varies from 1 foot (B-8) to at least 16 feet thick in B-13. Note that B-13 was not logged below the bottom of the silt, so the bottom depth is unknown. Three water levels are shown on the cross-section: very high water level (May 2011; approximately 72 feet amsl), high water level (June 2008; approximately 64 feet amsl), and low water level (August 2009 and October 2010; approximately 60 feet amsl).

The groundwater table was located within or above the silt layer at the May 2011 very high water level, resulting in saturated conditions for much of the silt. However, at the June 2008 high water level, only the lower portions of the silt layer are saturated in certain portions of the site, specifically in the vicinity of MW-5, B-11, and B-13. At the August 2009/October 2010 low water level, most of the silt layer was above the water table in the vadose zone⁷.

The area of highest groundwater contamination concentrations extends between temporary well B-12 and MW-5. MW-5 is believed to be screened primarily within the silt (although neither the top nor the bottom of the silt was logged in this location), suggesting that the groundwater contamination may be mainly within the silt. However, temporary well B-12, located approximately 25 feet to the south of MW-5, was screened across 1-foot of silt (64 to 65 feet amsl) and 4-feet of sand (60 to 64 feet amsl), suggesting groundwater contamination may be mainly within the sand at this location. Deeper field-screening in temporary well B-12 indicated TCE contamination in the gravelly layer below the silt. Although at lower concentrations, contamination was also detected by field-screening between 46 and 51 feet amsl. These results suggest that contamination is present in both the silt and underlying sand and gravel horizons in this area. Furthermore, there is at least a 6-foot variation in the elevation of the top of the silt in this area.

<u>Cross-Section B-B</u>[']: Cross-Section B-B' extends in a northwest to southeast direction across most of the Aniak WACS site. It runs parallel to the former septic system and under the middle school. The thickness of the silt layer across Cross-Section B-B' varies from zero (in the former septic system excavation area) to a maximum of 17 feet thick in MW-8. East of SB-14, there are no penetrations completely through the silt layer, so its thickness is unknown. In particular, the top and base of the silt layer are completely unknown between SGP-17, on the west side of Aniak Middle School, and SGP-13,

⁷ Note, however, that there is no data regarding the bottom of the silt layer in MW-5 and B-13.

located on the east side of the school building. Based on boring logs from other boreholes located near the school building, it is inferred that the silt was removed to an elevation of approximately 66 feet amsl under the school building, as shown in Figure 7. Three water levels are shown on the cross-section: very high water level (May 2011; approximately 72 feet amsl), high water level (June 2008; approximately 64 feet amsl), and low water level (August 2009 and October 2010; approximately 60 feet amsl).

Relative to the groundwater table, most of the silt layer was saturated at the May 2011 very high water level. However, at the lower water levels (June 2008, August 2009, and October 2011), most of the silt layer was above the water table in the vadose zone. The deepest silt was encountered in MW-8 (approximately 59 feet amsl) and MW-5 (silt to bottom of well at approximately 59 feet amsl).

The monitoring well with the highest levels of contamination is MW-5, which is interpreted to be screened across 10-feet of silt between an elevation of approximately 59 and 69 feet amsl (although the boring was not logged above 65 feet amsl so the top of silt elevation is inferred from nearby borings). At this location, the silt is saturated during all moderate-to-high water levels and may also be saturated during lowest water levels. The contamination appears to be located largely within the silt layer.

2.5. Detailed Summary of Site Groundwater Conditions

The groundwater TCE plumes are shown in Figure 3. Maintenance Building (MW-4) plume data are summarized in Table 2-5, and Septic System (MW-5/7) plume data are summarized in Table 2-6. The plumes are discussed in detail in the following subsections.

			2008 Color- Tec		Depth to	Silt	Sand/ Gravel	Screened	
	Elevation	Screened	Screening	2008 TCE	GW (ft	Interval	Interval	in	
	(TOC)	Interval	(ppb)	(ug/L)	bgs)	(ft bgs)	(ft bgs)	(Saturated)	Comment
MW-4									
(B-17)	90.68	22-32		19.3	27.05*	?-<25	25-31	SAND	Not logged 0-25'
									No GW sample;
B4						14-27+	0-14		Bottom of boring at 27'
TWB6S	91.03	26.5-31.5 (T)	15 to 30	24.5	27.5*			SAND	
TWB6M	91.03	33-38 (T)	1.25 to 5		26.5*	17-27	27-40	SAND	
TWB6D	91.03	40-45 (T)	0 to 5		26.5*			SAND	
TWB7	91.16	26.5-31.5 (T)	12.5-15	10.1	26.3*	18-20	20-40	SAND	
									Defines south plume boundary;
TWB8	90.82	25.5-30.5 (T)	0 to 5	3.21	26.2*	19.3-19.8	19.8-30	SAND	located between MW-4 and B11
									Defines north plume boundary;
TWB9	91.41	26-31 (T)	0 to 5	ND (<1)	26.5*	13.5-30	0-13.5	SILT	located north of Maintenance Bldg
									Defines north plume boundary;
TWB9	91.41	26-31 (T)	0 to 5	ND (<1)	26.5*	13.5-30	0-13.5	SILT	located north of Maintenance Bldg
TWB10	90.77	25.9-30.9 (T)	0 to 5	ND (<1)	25.8*	14-30	0-14	SILT	Between Maint. Bldg and School

TABLE 2-5: MAINTENANCE BUILDING (MW-4) PLUME DATA SUMMARY

Notes:

TOC = top of casing

TW = temporary well

ft bgs = feet below ground surface

ppb = parts per billion

GW = groundwater

ug/L = micrograms per liter

-- = not available (T)=temporary well TCE=trichloroethene

TCE groundwater results

ND = not detected

Results above 5 ug/L Table C cleanup level shown in bold

* DTW measured 5/21-5/23/08 (Table 2-2 of Shannon & Wilson, 2009 report)

Groundwater Sample TCE Results (ug/L)															
			2008 Color-							Depth to			Sand/		
		Screened	Tec							GW*	Silt	Bottom of	Gravel		
	Elevation	Interval (ft	Screening	10/21/	5/19/	6/4/	8/22/	5/11/	10/19/	(Range in ft	Interval	Silt Elev	Interval (ft	Screened In	
	(TOC)	bgs)	(ppb)	2006	2008	2008	2009	2011	2011	bgs)	(ft bgs)	(ft)	bgs)	(Saturated)	Comment
														Silt: 19-25';	High gw - contam in silt;
MW-1 (B1)	86.76	19-29		ND (<1)	3.63	8.24				21.7-24	17-24.5	62	24.5-30	SAND: 25-29'	Low gw-contam in sand
MW-2 (B2)	89.76	22-32		5.44	11.4	8.48				24.7-27	14.5-24.5	65	24.5-32	SAND	Bottom of boring at 32
										10 ((5/11))					Not logged 0-25; assume silt begins betw. 17
MM/-5 (B18)	90.24	22-22				157		77		18.0 (5/11);	25-21	~50	unk	SUIT	and 23 it bgs (B11 and B12). Base of sit
IVIV-5 (B10)	90.24	22-32				157	47.5			10 (5 /11)	23-31	<39	UIIK	SILI	
/							47.5 (cDCE		42 (cDCE	18 (5/11); 30.3 (8/09				(Silt: 23-26');	Based on MW-8 datalogger, GW depth range
MW-7 (B20)	90.04	23-38					2.73)	ND (<0.2)	3.1)	and 10/11)	13-26	64	26-38	SAND	27-32 ft bgs. Saturated interval is below silt.
MW-8 (B21)	90.03	47-52					ND (<1)	ND (<0.2)	ND (<0.2)	see MW-7	14-31	59	31-52	SAND	
													15-19.5 (Silt above	Sand: 17-19.5';	
MW-3 (B5)	80.75	12-22		ND (<1)		ND (<1)				1/-18	19.5-23	58	& below)	SIIT: 19.5-23	Silt to bottom of boring at 23
1 VV D-19	00.30	24-29	0-5			 ND(<1)	 ND (<1)	 ND (<0.2)	 ND(-0.2)	16 7 29 6	12 22	60	22-29	SAND	Temp wen and perm wen www-6 at B-19
IVIVV-0 (B19)	88.30	10-20						ND (<0.2)	ND(<0.2)	10./-28.0	13-22	00	22-29	SAND	
MW-9 (B22)	83.24	13-28					ND (<1)	ND (<0.2)	(cDCE 0.26)	23.5 (8/09 and 10/11)	3-10.5	73	10.5-29	SAND	Bottom of boring at 29
										19.2 (5/11); 31.4 (8/09					
MW-10 (B23)	91.18	25-40					ND (<1)	ND (<0.2)	ND (<0.2)	and 10/11)	16-21	70	21-40	SAND	Bottom of boring at 40
B3										17***	12-19.5	unk	9.5-12		Silt to bottom of boring at 19.5
TWB11S	90.87	26-31 (T)	27.5-52.5		32.4					26.7**				SILT	
TWB11M	90.87	33-38 (TO	0-5							26.7**	23.5-30	60.87	0-23.5	unk	
TWB11D	90.87	40-45 (T)	0-5							26.7**				unk	Bottom of boring at 30
T\WB125	91.02	26-21 (T)	115-265		187 (D) (cDCE					26.2**	16 7-27	64	27-45	Silt: 26-27'; Sand: 27-30'; Gravel 30-45'	
TWB125	91.03	20-31 (1)	60-124		5.72)					20.2	10.7 27	04	27 45	Gravel	
TWB12D	91.03	40-45 (T)	15-30							26.2**				Gravel	Saturated interval is below silt
100120	51.05	40 45 (1)	15 50		1.58 (cDCE					20.2					saturated intervaris below site.
TWB13S	89.31	26-31 (T)	7.5-15		18.8)					25.8**	14-30	<59	unk	SILT	
TWB13M	89.31	33-38 (T)	5-10							29.8**]			unk	
TWB13D	89.31	40-45 (T)	0-5							26.1**				unk	Apparently not logged below 30' bgs
B14	81.23	16-21 (T)			3.79					16.7**	0-17	64	17-22	SAND	
B15	80.4	16.6-21.6 (T)			0.43J					17.3**	0-15	65	15-22	SAND	
B16	79.79	17-22 (T)			ND (<1)					17.1**	0-15	65	15-22	SAND	
SGP-9	91.8	25.6-26.6						0.29		19	25-27	<27	unk	SILT	Soil gas point sampled at high water

Notes:

TOC = top of casing ppb = parts per billion ft bgs = feet below ground surface

GW = groundwater

(T)=temporary well

Results above 5 ug/L Table C cleanup level shown in bold

TCE groundwater results

TCE=trichloroethene cDCE=cis-1,2-dichloroethene unk=unknown -- = not available

ND = not detected

ug/L = micrograms per liter *At time of sampling

** DTW measured 5/23-5/24/08 (Table 2-2 of Shannon & Wilson, 2009 report)

*** GW depth per boring log at time of drilling

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2.5.1. Maintenance Building (MW-4) Plume

Shannon & Wilson (2010) estimated the surface area of the MW-4 plume to be approximately 2,500 square feet⁸. However, this area should be considered a fairly rough estimate, as the plume delineation is based on one groundwater sample each from MW-4 and temporary wells B-6 and B-7. During the two 2011 monitoring events, OASIS was unable to collect a sample from MW-4, because it was covered by a connex. The plume is bounded to the north by a non-detect in B-9, although TCE and cDCE detections in soil gas at SGP-5, also located on the north side of the maintenance building, indicate contamination in the silt at that location. The plume is bounded to the south by a detection of 3.21 micrograms per liter (μ g/L) in B-8 (below the ADEC Table C Cleanup level of 5 μ g/L). The plume has not been delineated to the east or the west, except by MW-3 (located 90 feet west of the interpreted plume boundary). The presence of underground utilities and fuel tanks limited the ability to install monitoring wells to the east and west of this plume.

The MW-4 plume is characterized by TCE concentrations between 10.1 μ g/L and 24.5 μ g/L (one single sample event for three temporary wells and one permanent well in 2008). The monitoring wells were generally screened across the sand interval below the silt, except for temporary well B-9, which was screened within the silt.

The MW-4 plume is illustrated in Cross Section A-A' (Figure 6). As shown in Figure 6 and discussed in the previous section, the thickness and composition of the saturated interval varies vertically with water table elevation and laterally with variations in the silt layer. To assist in evaluating remedial alternatives for this FS, the following simplified interpretation was made for the saturated interval in the MW-4 groundwater plume: 10foot saturated interval in sand (54 to 64 feet amsl). The simplified interpretation refers to the use of an annualized saturated thickness instead of performing multiple calculations based on the expected saturated interval thickness during each water level scenario (see Table 2-2). The top of the saturated interval corresponds to the summer high water level shown in Table 2-2, which is expected to approximate or overestimate the saturated interval for most of the year, with the exception of the very short-duration breakup period in the spring (approximately 2 weeks). The remedial alternatives evaluated under this assumption would therefore be expected to treat the entire impacted saturated zone during approximately 50 weeks of the year and additionally treat the lower vadose zone during winter low water levels. The saturated thickness interpretations are discussed further with respect to the remedial alternatives in Sections 4.2.3 and 4.2.4.

⁸ The text in Shannon & Wilson (2010) reports the extent of contamination at 15,000 square feet; however, the area shown in their figures and their air sparging calculation (Table L-4) is approximately 2,500 square feet.

2.5.2. Former Septic System (MW-5/7) Plume

The Former Septic System⁹ plume was estimated at 12,500 square feet in the April 2011 Pre-Draft FS (OASIS, 2011a); however, based on a groundwater TCE detection in SGP-9 (May 2011) and soil gas detections (2009), the groundwater plume is interpreted to extend under the Aniak Middle School with an estimated area of 22,000 square feet (Figure 3). The plume boundaries have been well-delineated to the south by temporary wells B-13 through B-16 and monitoring wells MW-6 and MW-9. The plume is not welldelineated to the north (temporary well B-8 only), northeast (MW-3 is approximately 80 feet to the north-northeast), east, or west. It is not delineated at all under or to the east of the Aniak Middle School building (except the single groundwater sample from SGP-9). An elevated TCE concentration was detected in the soil gas sample from SGP-8, located on the east side of the middle school building. There are no groundwater monitoring wells in the vicinity of SGP-8, so it is unknown whether the groundwater plume extends to that area. It should also be noted that the soil gas concentrations detected in SGP-17 and SGP-18 were more than an order of magnitude higher than the soil gas concentrations detected anywhere else in the soil gas survey. There are no groundwater monitoring wells at these locations; the closest groundwater samples were collected from temporary wells B-12 and B-13.

The MW-5/7 plume can be divided into three areas: western lobe, central portion, and eastern lobe. Groundwater in the western lobe is characterized by TCE concentrations between 5 μ g/L and 47.5 μ g/L. The monitoring wells were generally screened across the sand interval below the silt. Based on MW-8, which was screened in the sand from 47 to 52 feet bgs and exhibited no contaminant detections, the contamination appears to decrease with depth below the silt. Groundwater in the central portion of the plume is characterized by TCE concentrations between 32.4 μ g/L and 187 μ g/L. These temporary and permanent monitoring wells were generally screened across the silt. Groundwater in the eastern lobe has not been characterized, because there are no monitoring wells under the Aniak Middle School building or to the east of it. For purposes of this FS, it is assumed that this portion of the plume has TCE concentrations less than approximately 10 μ g/L.

The MW-7 plume is illustrated in Cross Sections A-A' and B-B' (Figure 6 and 7). As shown in these figures and discussed in the previous section, the thickness and composition of the saturated interval varies vertically with water table elevation and laterally with variations in the silt layer. To assist in evaluating remedial alternatives for this FS, the following simplified interpretation was made for the saturated interval in the MW-7 groundwater plume: 5-foot saturated interval in silt (59 to 64 feet amsl) and 10-foot saturated interval in sand (49 to 59 feet amsl). The simplified interpretation refers to the use of an annualized saturated thickness instead of performing multiple calculations based on the expected saturated interval thickness during each water level scenario

⁹ The text in Shannon & Wilson (2010) reports the extent of contamination at 25,000 square feet; however, the area shown in their figures and their air sparging calculation (Table L-4) is approximately 12,500 square feet.

(see Table 2-2). The top of the saturated interval corresponds to the summer high water level shown in Table 2-2, which is expected to approximate or overestimate the saturated interval for most of the year, with the exception of the very short-duration breakup period in the spring (approximately 2 weeks). The remedial alternatives evaluated under this assumption would therefore be expected to treat the entire impacted saturated zone during approximately 50 weeks of the year and additionally treat the lower vadose zone during winter low water levels. The saturated thickness interpretations are discussed further with respect to the remedial alternatives in Sections 4.2.3 and 4.2.4.

2.6. Conceptual Site Model

Shannon & Wilson prepared a pictoral conceptual site model and a graphical human health conceptual site model (CSM) using the ADEC CSM template (ADEC 2005), in their 2010 report. Because this focused FS is limited to groundwater remediation and remediation of the silt layer, only groundwater and subsurface soil pathways are discussed in this report. The following groundwater and subsurface soil exposure pathways are potentially complete:

Ingestion of groundwater: All groundwater in Alaska is considered a potential drinking water source unless determined otherwise using the criteria presented in 18 AAC 75.350. No groundwater determination has been completed for this site under 18 AAC 75.350. There are two drinking water wells near the site (high school drinking water well and middle school drinking water well). Contamination has not been detected in either drinking water well, and sentry monitoring wells installed between the groundwater contamination and the drinking water wells have also not detected any contamination.

Ingestion of groundwater is a potentially complete pathway for the following receptors:

- Current and Future residents, commercial or industrial workers, site visitors/recreational users, and construction workers.
- Inhalation of volatile compounds in tap water (showering): TCE is a volatile compound. If a contaminated water supply were used for tap water, the inhalation of volatile compounds would be a complete exposure pathway for the following receptors:
 - Current and Future residents, commercial or industrial workers, site visitors/recreational users, and construction workers.
- Inhalation of volatile compounds in indoor air: Indoor air inhalation is considered a potentially complete pathway for TCE in groundwater and for TCE in the vadose zone. As discussed previously, air purifying filters and an SSD are in place to mitigate the vapor intrusion pathway for TCE in the Middle School building. The contribution of volatilizing TCE from groundwater to the vapor intrusion pathway is unknown, but ADEC CSM guidance (ADEC, 2005) states that the vapor intrusion

pathway should be considered complete if nonpetroleum contamination in soil or groundwater is found within 100 vertical or horizontal feet of a building.

Several of the pathways shown to be potentially complete in the CSM for the entire site are not considered complete when considering only the groundwater TCE plumes, as explained below.

- Outdoor air inhalation is not considered a potentially complete pathway for TCE in groundwater due to the groundwater depth. ADEC (2005) states that the outdoor inhalation pathway must be considered for contamination detected between ground surface and 15 feet bgs.
- Dermal adsorption is not considered a potentially complete pathway for TCE and DCE (ADEC, 2005).
- Surface water exposure is not considered a potentially complete pathway. The hydrogeological evaluation showed a very low groundwater gradient at the site with variable flow direction. There is no evidence that the groundwater contamination has migrated off-site towards Aniak Slough or the Kuskokwim River, nor do the data suggest that future off-site migration is a concern.

3. REMEDIAL ACTION OBJECTIVES

The overall objectives of environmental site restoration are to ensure that conditions at the site are protective of human health and the environment and to comply with relevant state and federal regulations. The primary goal of remedial action at the Aniak WACS site is to reduce current human health exposure risk below the ADEC threshold cancer risk level of 1:100,000 and threshold non-cancer hazard index of 1.

This Focused FS addresses only groundwater contamination. As such, remedial action objectives (RAOs) are presented only for addressing contamination dissolved in groundwater and in the silt layer that is acting as a source for dissolved-phase groundwater contamination. Full protectiveness of human health at the Aniak WACS site also requires remedial action to address vadose zone soil contamination as evaluated previously (Shannon & Wilson, 2010a) and mitigation of the vapor intrusion pathway, which is being addressed through SSD and air purifying filters. The relative contribution of groundwater versus vadose zone contamination to the vapor intrusion pathway has not been determined.

The specific RAOs proposed to reduce human health exposure risk due to groundwater contamination are listed below.

- 1. Reduce concentrations of TCE in groundwater to meet the ADEC Table C cleanup levels protective of drinking water (ADEC, 2008) (Table 3-1).
- 2. Reduce concentrations of TCE in groundwater within 100 feet of the Aniak Middle School building to meet the ADEC Residential Target Levels for Groundwater protective of vapor intrusion (ADEC, 2009) (Table 3-1).
- 3. If the remedial action results in generation of TCE degradation products (i.e., cDCE and vinyl chloride), ensure that they do not exceed ADEC Table C cleanup levels (ADEC, 2008) or Residential Target Levels for vapor intrusion (Table 3-1) when remedial action is complete.

Contaminant	Maximum Concentration (µg/L)	Location of Maximum Concentration (Sample Month)	ADEC Residendial Target Levels for Groundwater (µg/L)*	ADEC Table C Cleanup Level (µg/L)**
2011 Sampling				
TCE	77	MW-5 (May)	0.55	5
cDCE	3.1	MW-7 (October)	220	70
Vinyl chloride	ND		0.71	2
2009 Sampling				
TCE	47.5	MW-7 (August)	0.55	5
cDCE	2.81	MW-7 (August)-dup	220	70
Vinyl chloride	ND		0.71	2
2008 Sampling				
TCE	187	TWB-12S (June)-dup	0.55	5
cDCE	18.8	TWB-13S (June)	220	70
Vinyl chloride	ND		0.71	2

TABLE 3-1: MAXIMUM GROUNDWATER CONCENTRATIONS AND ADEC CLEANUP LEVELS

Notes:

µg/L = Micrograms per liter

ND = Not detected

TCE = trichloroethene

cDCE = cis-1,2-dichloroethene

Vinyl chloride not detected above laboratory reporting limits in groundwater samples.

*Residential target levels are provided in *Draft Vapor Intrusion Guidance for Contaminated Sites* (ADEC, 2009). This guidance is undergoing review and update due to revisions in EPA Regional Screening Levels and TCE toxicity values that were recently finalized in IRIS.

**Cleanup levels are provided in Table C of the Alaska Contaminated Site Regulations (18 AAC 75.345).

4. DESCRIPTION OF ALTERNATIVES

The pre-draft FS (OASIS, 2011a; also included as Appendix D to this Focused FS) identified remedial technologies that are potentially appropriate for treating dissolved TCE contamination at the Former Aniak WACS site. The following technologies were considered in the pre-draft: monitored natural attenuation (MNA), enhanced bioremediation, air sparging, chemical oxidation, in-well air stripping, and ex situ (i.e., pump and treat) remediation with several different treatment technologies (oxidation and air stripping). In addition, institutional controls (ICs) were discussed as either a standalone remedy or a remedy component. The no action alternative is always included as a baseline for comparison with all of the active alternatives. Containment technologies, along with passive/reactive treatment walls, were not considered appropriate for the Aniak WACS site, because of the groundwater plume's proximity to the Aniak Middle School building. Plume containment could not accomplish the RAO of reducing groundwater TCE concentrations to vapor intrusion target levels at the school. Furthermore, available data suggests minimal groundwater plume migration is occurring so containment may not be necessary for protection of downgradient receptors.

In accordance with comments received to the pre-draft FS, this FS includes remediation of the silt layer in the evaluation of alternatives.

4.1. Remedial Alternatives

Five remedial alternatives were developed and evaluated to address contamination of the groundwater and silt layer at the Former Aniak WACS site. The alternatives are listed below and discussed in the following sections. The cost estimates for each alternative are provided in Appendix C.

- GW-1. No Action;
- GW-2. MNA/Long-Term Monitoring (LTM);
- GW-3. In-Situ Chemical Oxidation (ISCO);
- GW-4. Enhanced Reductive Dechlorination (ERD); and
- GW-5 Air Sparging (evaluated in [Shannon & Wilson, 2010a]).

Although not evaluated as a standalone remedy, treatment of contaminated silt in conjunction with the planned excavation of PCB-contaminated soil in the vicinity of MW-5 is recommended. The excavation in the vicinity of MW-5 will offer unique access to the contaminated silt. Either an oxidant or reductant (depending on the technology selected for groundwater remediation) could be placed into the excavation before backfilling it. Depending on the location, volume, depth, thickness, and magnitude of the silt contamination, it may also be advantageous to overexcavate TCE-contaminated silt, perform some mechanical mixing of the oxidant or reductant to increase its distribution in the silt, or alternatively to install an engineered solution, such placement of a gravel layer at the base of the excavation with distribution piping and a standpipe at the surface that could be used to deliver reagents periodically. Costs were not evaluated for this potential remedy component, because the costs are highly dependent on more complete characterization of the TCE contamination in the silt, in particular relative to the horizontal and vertical location of the PCB-contaminated soil. The detailed silt characterization has not yet been performed.

The pre-draft FS (OASIS, 2011a) presented detailed discussions about all of the remedial technologies evaluated and is included as Appendix D. The following sections discuss the application of each alternative's technology to the Aniak WACS site but do not repeat the general technology descriptions provided in the pre-draft FS.

4.2. General Assumptions for all Alternatives (except No Action)

4.2.1. Vapor Intrusion Mitigation

Although the scope of this Focused FS is limited to remedial alternatives for groundwater (and the silt layer), in order to provide a consistent basis for comparing alternatives, the operation, monitoring and maintenance (OM&M) costs of mitigating the vapor intrusion pathway (via SSD) were included in the analysis. The primary current human health risk at this site is indoor air inhalation due to vapor intrusion into the Aniak Middle School Building and possibly also due to an indoor air source(s). Therefore, continued operation of the SSD system is assumed for protection of human health until groundwater RAOs are met¹⁰. SSD system operation costs include OM&M activities on a quarterly basis for five years and semi-annually thereafter, annual electricity costs, and blower replacement every five years for the duration of the remedy. Ultimate decommissioning costs of the SSD system were not included in this groundwater FS, because the decommissioning costs are considered fixed costs independent of the groundwater remedy timeframe.

4.2.2. Vadose Zone Remediation

All of the groundwater alternatives assume that vadose zone soil remediation will be performed at the site. The vadose zone soil remediation is outside the scope of this Focused FS, and no soil remediation costs are included in any of the groundwater alternatives. Soil contaminated by PCBs above 1 mg/Kg (which is understood to include some soil also contaminated by TCE) will be excavated and shipped off-site for treatment and disposal. Vadose zone soil contaminated by TCE above soil RAOs will be remediated *in situ* by SVE.

¹⁰ The relative contribution to the vapor intrusion pathway of dissolved-phase TCE from the saturated zone versus TCE from soil gas in the vadose zone has not been established. If vadose zone soil remediation decreases soil gas and indoor air TCE concentrations below ADEC target levels, then it is possible that SSD could be discontinued before groundwater RAOs are met. However, this possibility is not considered in the Focused FS cost analysis.

4.2.3. Saturated Zone Assumptions

The approximate areas for active groundwater remediation are shown on Figure 4B, and the planned soil remediation areas are shown on Figure 4A. Area, thickness, and concentration assumptions are listed below for both plumes:

<u>MW-4 Plume</u>:

- Approximate 2,500-square foot area south of the Maintenance Building in the vicinity of MW-4;
- Saturated zone contamination thickness of 10 feet in sand (54 to 64 feet elevation). The silt is generally above the water table, except during spring high water events.
- Groundwater contamination concentration of 19 ug/L; soil contamination concentration of 200 ug/Kg.

<u>MW-5/7 Plume</u>:

- Approximate 9,000-square foot area in the vicinity of MW-5 and MW-7.
- Saturated contamination thickness of 5 feet in silt (59 to 64 feet elevation) and 10 feet in sand (49 to 59 feet elevation).
- Groundwater contamination concentration of 175 ug/L; soil contamination concentration of 600 ug/Kg.

For the MW-5/7 Plume, the area of active remediation is limited to the central plume area. Although the MW-5/7 Plume extends to the east and the west of the 9,000-square foot area shown on Figure 4B, the groundwater concentrations in the east and west lobes are assumed to be near although slightly above the 5 μ g/L Table C cleanup level. Most of the contamination is believed to be present in the central portion of the plume.

In both plumes, approximately the top five feet of the groundwater treatment zone is expected to be saturated only seasonally (i.e., approximately from May through September; see Table 2-2). In addition, for a short period of time during spring breakup (i.e., approximately two weeks), the saturated interval is expected to extend up to another eight feet above the top of the groundwater treatment zone. The seasonal saturation is expected to potentially result in TCE rebound in the groundwater (see discussion in Section **Error! Reference source not found.**). The silt layer, whether saturated or not, is expected to have a relatively high moisture content and provide a fairly competent barrier to air flow, so significant aeration of the seasonally-saturated zone is not expected.

4.2.4. Silt Remediation

The groundwater alternatives evaluated in this Focused FS include remediation of the portion of the silt layer that is saturated during a significant fraction of the year (approximately May through September), which is interpreted to be the interval between

approximately 59 and 64 feet amsl in the MW-5/7 plume¹¹. Based on the limited groundwater datalogger data available, the interval above approximately 64 feet amsl is understood to only be saturated for a short time during spring breakup (Table 2-2 and Figures 5 through 7).

Although the seasonally-saturated silt layer is included in the groundwater remedial alternatives, remediation of the silt is expected to be difficult. Its hydraulic conductivity is estimated to be approximately three orders of magnitude lower than the hydraulic conductivity of the underlying sand layer. Its seasonal saturation is expected to result in a relatively high moisture content and a correspondingly low permeability to air. The remedial alternatives were designed to address the silt characteristics as discussed in Section **Error! Reference source not found.** Specifics of each groundwater alternative regarding silt remediation are discussed in Sections 4.4 through 4.7.

The portion of the silt layer that is located primarily in the vadose zone (i.e., the interval above 64 feet amsl) will not be addressed by the groundwater remedial alternatives, because it is considered to be part of the vadose zone and was therefore included in Shannon & Wilson's remedial alternative analysis for soil (Shannon & Wilson, 2010a).

4.2.5. Design Assumptions for the Injection Alternatives

Allowances were made in the two injection alternatives, Alternative GW-3 (ISCO) and Alternative GW-4 (ERD), to address the challenges posed by the seasonal TCE recharge and the low-permeability silt layer discussed in the previous sections. Both of the injection alternatives were designed to include four annual injection events. Each subsequent injection event will address seasonal TCE recharge that occurred since the previous injection event. The four separate injection events will allow better oxidant or reductant distribution in the low-permeability silt than a single injection event. The injection locations can be shifted for each subsequent injection event to account for the small radius of influence anticipated for each injection. Monitoring results from the first event will be used to optimize subsequent events to address the seasonal TCE recharge and low-permeability silt layer.

4.2.6. Groundwater Monitoring

Groundwater monitoring is an important component of all of the alternatives. The following groundwater monitoring scope was used for each alternative for costestimating purposes, although the actual monitoring scope may deviate somewhat from the details provided below.

- Installation of 12 new monitoring wells;
- Quarterly groundwater monitoring of 15 wells for one year;
- Semi-annual groundwater monitoring of 15 wells for three years;

¹¹ As shown on Figure 6, this interval is actually comprised of a combination of silt and sand but is assumed to have silt characteristics in the FS analysis.
- Annual groundwater monitoring of 15 wells for 15 years (or until remedy completion); and
- Groundwater monitoring of 15 wells every 5 years until remedy completion.
- Confirmation sampling to verify that RAOs have been reached will be provided by the annual groundwater monitoring.

4.2.7. Institutional Controls

All of the groundwater alternatives will have an IC component to protect human health until RAOs are met. In general, ICs include engineering controls, such as fences, and document controls, such as deed restrictions, to restrict site activities that could pose a potential threat to human health. The ICs anticipated for the Aniak WACS site include restricting the installation of drinking water wells in the vicinity of the groundwater plume.

The formality and duration of ICs will vary by alternative, depending on its remedial timeframe. The costs for establishing ICs are not specifically included in the cost analysis but would be included in the contingencies.

4.2.8. Cost Estimating

Costs for each alternative were prepared consistent with the *FS Cost Estimating Guidance* (EPA, 2000). The detailed cost estimates include capital costs, OM&M costs, contingencies, and present value analysis to allow direct comparison of alternatives with different remedial timeframes. Present value costs were calculated using a 7 percent discount rate, as recommended for non-federal-government-funded projects in the EPA guidance. Although detailed cost estimates were prepared for each alternative, the cost estimate accuracy is considered to be more similar to a screening-level analysis than a detailed analysis, due to the significant data gaps remaining with respect to the nature and extent of contamination at the site and the delineation of the silt layer. Therefore, the costs are presented in a range of -50% to +100%, which is the high end of the uncertainty range shown in Exhibit 2-3 of the FS guidance.

4.2.9. Data Gaps

As discussed in the pre-draft FS, there are still some significant data gaps to be addressed before implementing groundwater remediation at this site. The top of the silt layer has been reasonably well-characterized; however, its depth is unknown across much of the site (Figure 5). Geotechnical data are very limited. The nature and extent of contamination in site soil and groundwater has been incompletely characterized. A very small number of soil samples have been analyzed for TCE, and there is no delineation of soil contamination across the silt or underlying sand/gravel units. The relative mass of contamination held in the gravel fill of the vadose zone relative to the mass of contamination in the silt layer is unknown. The extent of groundwater contamination under and to the east of the Aniak WACS Middle School building is unknown. There have been no soil or groundwater samples collected in the vicinity of SGP-17 and SGP-18, the locations with the highest soil gas detections.

Additional plume characterization activities should include installing soil borings and monitoring wells east of the Aniak Middle School building, west of the building in the vicinity of SGP-17 and SGP-18, and in several other locations as needed to complete characterization of both plumes and the silt layer. MNA parameter monitoring should be performed at low water level. Microbial community testing for dehalococcoides organisms should be performed. Use of Bio-Trap® in-situ microcosms may be a cost-effective technique to assess the MNA potential, native microbiological community, and expected performance of substrate amendment. Additional characterization and a pilot test (or tests) of the most promising alternative(s) should be performed before implementing a full-scale cleanup and are recommended before final remedy selection.

4.3. Alternative GW-1: No Action

The No Action Alternative is used as a baseline reflecting current conditions without remediation. This alternative is used for comparison with each of the other alternatives.

4.4. Alternative GW-2: MNA/LTM

Alternative GW-2 uses natural processes occurring in groundwater to reduce contaminant concentrations over time (MNA) and LTM to track progress of the MNA and evaluate the remedy's effectiveness. As with the other alternatives, ICs will be used to protect human health until RAOs are reached.

Dilution, adsorption, volatilization, precipitation, complexation, and biological degradation of the contaminants occur in the groundwater. Of these processes, reductive dechlorination (using biological and/or abiotic degradation processes) is usually the most significant degradation process for chlorinated solvents such as TCE. MNA would allow these processes to continue to occur as they have in the past, without disturbances potentially caused by implementation of active remedial technologies.

Specific considerations and assumptions for implementing Alternative GW-2 at the Aniak WACS site are presented below in Sections 4.4.1 and 4.4.2.

4.4.1. MNA Considerations at Aniak WACS

Two rounds of geochemical parameter samples have been collected from the Aniak groundwater monitoring wells. Samples from MW-1 through MW-6 were analyzed for geochemical parameters in June 2008 (Shannon & Wilson, 2009), and samples from MW-5 through MW-12 were analyzed for geochemical parameters in May 2011. Results are presented in Table 4-1, along with field parameter results from October 2011 and discussed below. It is worth noting that both rounds of geochemical parameter sampling were performed at relatively high groundwater levels.

 The DO and oxidation-reduction potential (ORP) measurements are variable, with indications of somewhat reducing groundwater conditions (DO less than 1 mg/L and negative ORP values) and oxidizing conditions (DO greater than 1 mg/L and positive ORP values) at different times in most of the monitoring wells. The correlation between DO and ORP readings is not great. For example, in September 2009, the DO concentration in MW-9 was 0.3 mg/L with a negative ORP of -129 mV, indicating anaerobic groundwater conditions. However, in October 2011, the DO concentration in MW-9 was 0.5 mg/L but with a positive ORP of 164 mV.

- Both the 2008 and 2011 laboratory results show low levels of total organic carbon (TOC) in the groundwater, with a maximum TOC concentration of 3.9 mg/L in MW-3, and most concentrations below 1 mg/L. These TOC concentrations are generally not considered adequate for complete TCE reduction.
- The 2008 laboratory results indicated elevated nitrate and sulfate concentrations, with very low concentrations of dissolved iron and manganese and no methane. These results suggest aerobic groundwater conditions (i.e., there is no indication of significant nitrate, manganese, iron, or sulfate reduction). Also, the elevated nitrate and sulfate concentrations suggest significant competing electron acceptors that will need to be reduced before significant complete TCE reduction would be expected.
- The 2011 laboratory results indicated lower but still elevated nitrate-nitrite and sulfate concentrations. Different monitoring locations are interpreted to be the primary reason for the difference between the 2011 and 2008 nitrate-nitrite and sulfate results. The monitoring wells sampled in 2008 were closer to the former sewer line. Dissolved iron was not detected in any of the 2011 samples, and dissolved manganese results were less than 1 mg/L, suggesting that the groundwater is not significantly iron- or manganese-reducing. Methane was also not detected in 2011. Overall, the 2011 results indicate aerobic or possibly nitrate-reducing groundwater conditions. Significant complete reduction of TCE is not expected in these geochemical conditions.

The presence of TCE degradation products in site groundwater samples is another line of evidence for MNA (reductive dechlorination). Historical groundwater monitoring results (Table 2-5 and Table 2-6) indicate that low concentrations of cDCE have been detected in samples from three site monitoring wells: MW-1, MW-7, and MW-9. In addition, high concentrations of cDCE were detected in the soil gas sample from SGP-18, and the cDCE concentration in temporary monitoring well B-13 (18.8 μ g/L) exceeded its TCE concentration (1.57 μ g/L). The cDCE detections indicate that reductive dechlorination is occurring in some sections of the plume, most significantly in the silt near SGP-18. Elevated total petroleum hydrocarbons (TPH) detected in SGP-18 suggest that petroleum contamination may be providing a carbon source for reductive dechlorination in this area. The difference in MW-7 VOC results between the May 2011 high water level event and the October 2011 low water event (i.e., ND in May 2011; 44 μ g/L TCE and 3 μ g/L cDCE in October 2011) also shows that water level affects contaminant concentrations and may also be expected to affect MNA.

Table 4-1: Geochemical Parameter Results 2008 - 2011 Aniak WACS, Alaska

Monitoring Well	Sample ID	Sample Date	Screened Interval (ft bgs)	рH	Conduc-	DO (mg/L)	ORP (mV)	Ethane/ Ethene (mg/l)	Methane (mg/L)	Alkalinity(Nitrate- Nitrite (mg/L)	Total Organic Carbon (mg/l)	Chloride	Sulfate	Iron, dissolved(mg/l)	Manganese, dissolved (mg/L)	Iron, total	Manganese, total (mg/L)
	comple is	5/19/2008	19-29	6.0	0.19	1.4	78											
MW-1									ND									
		6/3/2008		6.1	0.59	5.3	173		(0.0072)	78.8	35.1	1.74	2.09	60.5	<0.02	5.03	0.11	
MW-2		5/19/2008	22-32	5.93	0.16	1.7	142											
		6/3/2008		5.85	0.28	2.5	163		(0.0072)	111	4.12	1.92	1.06	11	<0.02	0.00223	0.111	
MW-3		6/3/2008	12-22	6.32	0.7	3.9	137		ND (0.0072)	331	3.29	3.89	2.16	45.9	0.216	0.0107	5.75	
MW-4		6/3/2008	22-32	6.1	0.32	1.5	201		ND (0.0072)	146	2.67	0.0953	3.45	10.1	0.229	0.0713	0.0234	
	8/22/09: Dry; 5/11/11 an	d 10/19/11: Cover	ed by Conex															
									ND									
		6/3/2008	22-32	6.1	0.34	3.2	122		(0.0072)	151	2.77	1.98	1.83	14	0.0212	0.0322	0.0645	
MW-5	11-AWA-010-GW	5/11/2011		7.6	0.29	4.6	66	ND (<0.010)	ND (<0.007)	123	2	0.72	4.5	11.9	ND (<0.100)	ND (<0.005)	ND (<0.100)	ND (<0.005)
		= / /						ND	ND		4.00				ND		ND	
	11-AWA-011-GW	5/11/2011						(<0.010)	(<0.007)	121	1.83	0.68	4.4	12.2	(<0.100)	ND (<0.005)	(<0.100)	ND (<0.005)
	8/22/09. DIY, 10/19/11. I	5/y							ND									
		6/3/2008	18-28	6	0.43	1.4	182		(0.0072)	204	2.2	1.3	1.08	18.2	0.248	0.425	1.41	
MW-6		8/27/2009		6.1	0.28	7.3	203											
								ND	ND						ND		ND	
	11-AWA-004-GW	5/10/2011		6.3	0.28	0.9	78	(<0.010)	(<0.007)	123	1.72	0.67	3	11	(<0.100)	ND (<0.005)	(<0.100)	ND (<0.005)
	11-AWA-016-GW	8/30/2009	23-38	73	0.26	10.2	-65											
		0/30/2005	25-50	7.5	0.24	0.0	-05	ND	ND						ND		ND	
MW-7	11-AWA-003-GW	5/10/2011		6.4	0.34	0.8	147	(<0.010)	(<0.007)	154	1.29	0.66	2.7	13.7	(<0.100)	ND (<0.005)	(<0.100)	ND (<0.005)
	11-AWA-015-GW	10/19/2011		5.5	0.4	2.0	143											
		8/30/2009	47-52	7.4	0.28	0.3	-85											
MW-8	11 000 000 000	F/10/2011		C A	0.27	1.1	120	ND	ND	127	0.52	0.40	2.4	12.2	ND	0.252	ND	0.200
	11-AWA-002-GW	10/18/2011		5.5	0.27	0.6	129	(<0.010)	(<0.011)		0.55	0.40	2.4		(<0.100)	0.252	(<0.100)	0.269
	117/014 014	9/1/2009	13-28	7.3	0.24	0.3	-129											
															ND			
MW-9								ND	ND						(<0.100)		ND	
	11-AWA-001-GW	5/10/2011		6.4	0.31	7.4	141	(<0.010)	(<0.007)	137	0.7	0.59	2.6	16.1	UJ	0.278 J	(<0.100)	0.253
	11-AWA-013-GW	9/1/2000	25-40	5.5	0.35	0.5	-242											
MW-10	<u> </u>	5/1/2009	23-40	0.5	0.25	0.4	-242	ND	ND						ND		ND	
	11-AWA-006-GW	5/10/2011		6.3	0.27	0.8	169	(<0.008)	(<0.006)	123	1.21	0.63	2.1	10.9	(<0.100)	0.51	(<0.100)	0.245
	11-AWA-020-GW	10/19/2011		5.8	0.46	1.1	222											
MW-11		9/1/2009	25-40	10.5	0.2	2.2	-267											
	44 4144 000 014	E /44 /2044			0.20	1.2	20.2	ND (10.010)	ND	120	0.00	0.70			ND		ND	
	11-AWA-008-GW	5/11/2011		6.4 5.5	0.29	1.3	20.3	(<0.010)	(<0.007)	129	0.88	0.79	2.3	11.4	(<0.100)	ND (<0.005)	(<0.100)	ND (<0.005)
	11-AVVA-010-GW	9/1/2009	22-37	9.6	0.31	0.8	-265											
NAVA 12		-, _,						ND	ND						ND		ND	
MW-12	11-AWA-005-GW	5/10/2011		6.2	0.25	1.0	116	(<0.010)	(<0.007)	119	1.65	0.71	2.1	9.1	(<0.100)	ND (<0.005)	(<0.100)	ND (<0.005)
	11-AWA-017-GW	10/19/2011		5.7	0.42	4.0	232											
SGP-2	11-AWA-009-GW	5/11/2011	28.5-29.5	8.4	0.24	3.2	31	ND (<0.010)	ND (<0.007)	92	1.05	3.23	23.1	5.4	5.14	0.312	129	3.44
SGP-9	11-AWA-007-GW	5/11/2011	25.6-26.6	5.9	0.22	7.1	201	ND (<0.010)	ND (<0.007)	94	0.57	2.21	15.2	4.6	6.57	0.781	128	5.23

Notes:

AWA = Aniak White Alice GW = groundwater ft = feet

in = inches

bgs=below ground surface

ND = not detected na = not applicable DO=dissolved oxygen ORP=oxidation-reduction potential 2008 data 2009 data Bold, red: DO<1 Overall, data suggest that TCE is being reduced to cDCE in some portions of the site (i.e., the southern portion of the former truck fill area). There is no evidence of further reduction of cDCE to vinyl chloride or ethene to-date. Geochemical parameter data indicate generally aerobic groundwater conditions at high water level, while geochemical conditions at low water level have not been evaluated. Site data do not suggest that MNA (by reductive dechlorination) will be an effective remedy in the short-term, and it is unknown whether MNA can adequately treat groundwater contamination at the Aniak WACS site in the long-term.

4.4.2. Assumptions for Alternative GW-2 at Aniak WACS

For costing purposes, it was assumed that the MNA/LTM groundwater monitoring schedule presented in Section 4.2.5 would be followed. The remediation timeframe was selected to be 35 years, because it is significantly longer than the longest remediation timeframe estimated for an active remedy (20 years), and because the present worth of costs beyond 35 years becomes insignificant (< \$10,000 for SSD OM&M and groundwater monitoring). However, the 35-year timeframe is also somewhat arbitrary, because there has not yet been sufficient monitoring to establish a downward trend in groundwater contamination levels. If future monitoring shows that there are significant areas where reductive dechlorination is occurring at the site and soil remediation addresses most of the risk due to vapor intrusion, the remedial timeframe would be expected to be less than 35 years.

The primary risk associated with this alternative is the uncertainty about whether groundwater geochemistry is sufficiently reducing across enough of the groundwater plume to effectively dechlorinate the TCE and DCE to meet RAOs. If reducing geochemical conditions are established in the aquifer, reaeration due to the fluctuating groundwater level is possible but not expected to be significant. The silt layer present across much of the MW-5/7 plume is expected to have a high moisture content that is expected to minimize air flow from the vadose zone. Reoxygenation of the aquifer from the Kuskokwim River is similarly not expected to be significant, due to the approximate $\frac{1}{2}$ -mile distance to the river.

4.5. Alternative GW-3: In Situ Chemical Oxidation (ISCO)

In Alternative GW-3, a chemical oxidant would be injected into site groundwater to oxidize the contamination. Several different forms of oxidants have been used for ISCO, including permanganate (MnO_4^{-}), Fenton's hydrogen peroxide (H_2O_2) and ferrous iron (Fe⁺²) or catalyzed hydrogen peroxide (CHP), ozone (O_3), and persulfate ($S_2O_8^{2^-}$). In addition, there are proprietary oxidants, such as RegenOx® by Regenesis Bioremediation Products. All of these oxidants are considered effective for oxidizing TCE and its degradation products, DCE and vinyl chloride (ITRC, 2005).

4.5.1. ISCO Considerations at Aniak WACS

Shannon & Wilson (2010) performed an analysis of chemical oxidation for soil at the Aniak WACS site. Groundwater treatment using chemical oxidation was not considered

based on the potential risk to the drinking water wells. However, ISCO for groundwater is considered in this Focused FS, because existing data suggests that the actual risk to the drinking water wells may not be significant, based on pumping test results and pressure transducer/datalogger data suggesting limited migration of groundwater contamination (discussed in Section 2.4).

Shannon & Wilson assumed treatment of the TCE-impacted soil using a potassium permanganate (KMnO₄) solution. Potassium permanganate has a relatively longer halflife than other oxidants, which will allow better distribution in the low-permeability silt. Natural oxidant demand tests performed on three saturated soil samples (SB-14, B-20/MW-7, and B-21/MW-8 from 31-33 feet bgs) showed the oxidant demand of subsurface organic and inorganic components in the soil and groundwater ranged from 3 to 14.6 grams of oxidant (KMnO₄) per kilogram of soil plus groundwater.

Shannon & Wilson assumed that the potassium permanganate liquid mixture would be gravity-fed into the subsurface at points spaced through the zone of contamination. They assumed it would take approximately 1 year for liquid to permeate 5 feet of silt. The initial application would include sufficient liquid to saturate the area so that the chemical could react with available TCE and then still have enough remaining to slowly saturate the silt over an estimated 1 year infiltration period. Bench scale and field pilot tests would be performed to evaluate the radius of influence for the application wells, to determine oxidant dosing requirements, and to refine assumptions regarding the number of applications required.

Extending Shannon & Wilson's soil treatment analysis to groundwater treatment by ISCO, the most significant considerations are the silt layer overlying the saturated layer and the groundwater flow characteristics (low gradient and variable flow direction). To treat the groundwater, the oxidant would be applied through injection points drilled most of the way through the silt layer. In areas where contamination is present in sandy soils below the silt layer (i.e., near temporary well B-13), some injection points may be drilled deeper into the sand layer to distribute oxidant below the silt. This distribution system would allow some oxidation of contaminants in the silt layer, although the distribution of oxidant within the silt layer would be expected to be poor. Similarly, it would be difficult or impossible to achieve a consistent oxidant "front" in or below the silt layer. Instead, the oxidant would migrate into and through the saturated zone in channels/preferential pathways, resulting in incomplete oxidant distribution. Injection of the permanganate oxidant mixture will also be inhibited by precipitation of dissolved metals, and permanganate particles will result in temporary permeability loss in the already low permeability silt. However, the presence of some permanganate particles may be beneficial in that they can provide a source that will dissolve once in the aguifer, thereby extending the half-life of the oxidant in the aquifer. The distribution issues will likely result in the need to inject the oxidant several times to complete remediation.

An additional consideration of ISCO at this site is the potential risk of introducing heavy metals such as arsenic and chromium, found as impurities in the KMnO₄, into the groundwater or mobilizing metals from the soil or aquifer matrix due to changes in pH.

Literature research (i.e., Huling and Pivetz, 2006) indicates that arsenic and chromium introduction could result in MCL exceedences, although natural attenuation has generally achieved adequate reductions in acceptable distances. Remediation-grade KMnO₄ has been developed that contains only minute concentrations of heavy metals. In addition, changes in pH that could occur in conjunction with ISCO and also ERD can also mobilize metals from the soil or aquifer matrix. Bench-scale testing is recommended to evaluate the risk of heavy metal introduction or mobilization, especially at this site with nearby drinking water wells.

4.5.2. Assumptions for Alternative GW-3 at Aniak WACS

Prior to completing the remedial design at the Aniak WACS site, bench-scale testing and a pilot test would be performed for ISCO. The primary goals of the bench-scale testing would be to evaluate the risk of heavy metal mobilization (such as arsenic and chromium) from the KMnO₄ into groundwater, to more directly assess natural oxidant demand, and to evaluate different oxidants. The primary goals of the pilot test would be to assess realistic injection rates and oxidant distribution in the silt in the most highly-contaminated portion of the site (currently thought to be between the former truck fill area and SGP-17).

Potassium permanganate was the oxidant assumed for Alternative GW-3. Permanganate was selected based on its relatively greater persistence in the environment (greater than 3 months [Huling and Pivetz, 2006]) and therefore greater ability to diffuse through the low-permeability silt before degrading. In addition, it is consistent with Shannon & Wilson's remedial alternative analysis for soil. If ISCO is selected as the groundwater remedy, the actual oxidant selection will be based on bench-scale and pilot-scale testing results. Any cost differences are expected to be within the -50% to +100% cost range of this FS.

In Alternative GW-3, the oxidant was assumed to be injected as an aqueous solution into a total of 54 injection points (42 injection points in the MW-5/7 plume and 12 injection points in the MW-4 plume, based on a 15-foot radius of influence) (Figure 4B). The aqueous solution was assumed to have a concentration of approximately 3% oxidant. The injection rate was assumed to be up to approximately 20 liters per minute to help distribute the oxidant within the silt. The chemical oxidation injections would occur over a 4-year period, with 25% of the total calculated oxidant demand injected each year. The purpose of the 4-year injection period is to optimize injection locations by allowing an assessment of the oxidant distribution between injections and thereby revising the injection geometry for subsequent injection events. In particular, oxidant distribution in the low-permeability silt is expected to be problematic, and the four separate injection events are planned to aid the oxidant distribution.

To calculate the amount of oxidant required, average soil TCE concentrations of 200 μ g/Kg (for sand in both plumes) and 600 μ g/Kg (for silt) and average groundwater TCE concentrations of 19 μ g/L (MW-4 plume) and 175 μ g/L (MW-5/7 plume) were assumed. The average value from Shannon & Wilson's oxidant demand analysis (7.4 g KMnO₄/kg

soil plus groundwater) was used to calculate the natural oxidant demand (approximately 73,000 kg oxidant for 8E+06 kg soil and 1.9E+06 kg groundwater). The total amount of oxidant required for the contamination was calculated at approximately 8 kg.

For costing purposes, it was assumed that the MNA/LTM groundwater monitoring schedule presented in Section 4.2.5 would be followed. The remedial timeframe for Alternative GW-3 was estimated at ten years.

4.6. Alternative GW-4: Enhanced Reductive Dechlorination (ERD)

In Alternative GW-4, a substrate would be injected into site groundwater to enhance the biological degradation processes already occurring to a limited degree at the site. The purpose of the substrate addition is to promote environmental conditions necessary for biodegradation of the chlorinated solvents (i.e., reducing conditions). The substrate provides a carbon source for naturally occurring microorganisms to consume oxygen and other electron acceptors such as nitrate and sulfate and a source of hydrogen necessary for the anaerobic biodegradation process.

There are a variety of substrates available for promoting reductive dechlorination at contaminated sites (e.g., sodium lactate, vegetable oil, and Hydrogen Release Compound [HRC[™]], among others). HRC[™] is a viscous (honey-like), proprietary substance manufactured by Regenesis Corporation that, when hydrated, slowly releases lactic acid over a period of months. HRC[™] is composed of glycerol tripolylactate, which is a nontoxic, food-grade substance. Because of its time-release feature, HRC[™] requires less frequent injections than sodium lactate.

4.6.1. Enhanced Bioremediation Considerations at Aniak WACS

A significant consideration for enhanced bioremediation at the Aniak WACS site is the substrate distribution in the lower permeability silt layer. There are no specific concerns about substrate distribution in the saturated gravelly sand.

Another consideration for enhanced bioremediation at this site is concern over the ability to drive the groundwater plume to anaerobic conditions and maintain these conditions over time. The 2008 and 2011 MNA parameter sample results indicate that the site groundwater is generally aerobic (at high water levels), and there are significant competing electron acceptors that will need to be reduced before much TCE reduction will occur. Geochemical conditions at low water level have not been assessed. Groundwater sampling for dehalococcoides ethenogenes (DHC), which are the only known organisms capable of the complete dechlorination of PCE and TCE to ethene, has not been performed at the site.

A third consideration for enhanced bioremediation at the site is the low groundwater temperatures. The dataloggers recorded a temperature range between approximately 2°C and 4°C over the period between May and October 2011. Although enhanced bioremediation of chlorinated solvents has been shown to be effective at cold water sites in Alaska, the Aniak groundwater temperatures are approximately 2°C to 5°C colder. As

discussed in Section 4.2.9, use of Bio-Trap® in-situ microcosms would help evaluate the potential effectiveness of enhanced bioremediation at this site.

Changes in pH that could occur in conjunction with ERD (and also ISCO) can also mobilize metals from the soil or aquifer matrix.

Although the planned SVE system could adversely affect enhanced bioremediation by inducing the flow of oxygenated air into the subsurface, the effects would be expected to be minimized by the low-permeability silt layer.

4.6.2. Assumptions for Alternative GW-4 at Aniak WACS

Prior to completing the remedial design at the Aniak WACS site, bench-scale testing and a pilot test would be performed for ERD. The primary goals of the bench-scale testing would be to evaluate the performance of different electron donors (substrates) and bioaugmentation on reductive dechlorination using site soils and groundwater. The primary goals of the pilot test would be to assess realistic injection rates and substrate distribution in the silt in the most highly-contaminated portion of the site (currently thought to be between the former truck fill area and SGP-17). The effects of cold site groundwater temperatures on the reductive dechlorination process will also be evaluated.

For costing purposes, it was assumed that HRC[™] would be the substrate injected at the Aniak site. However, other substances would likely work as well, or better. For example, Regenesis has also developed a substance called HRC Primer[™], which is less viscous and more readily bioavailable than HRC[™]. Regenesis recommends use of HRC Primer[™] to initiate the remedial process at some sites. Because it is less viscous than HRC[™], HRC Primer[™] is expected to have better distribution in tighter, less-permeable soil layers than HRC[™]. However, HRC Primer[™] will require more frequent reinjection than HRC[™]. There are also nonproprietary substances such as sodium lactate or emulsified vegetable oil or combinations of substances that could be used. If Alternative GW-4 is selected for groundwater remediation at this site, microcosm and/or pilot testing would be used to select the actual substrate to inject.

An online calculator provided by Regenesis (www.regonlinesoft.com) was used to estimate the volume of HRC[™] required for this alternative. To calculate the amount of substrate required, an average soil TCE concentration of 200 µg/Kg was assumed for sand in both plumes, a groundwater TCE concentration of 19 µg/L was assumed for the MW-4 plume, a TCE concentration of 600 µg/Kg was assumed for the silt in the MW-5/7 plume, and a groundwater TCE concentration of 175 µg/L was assumed for the MW-5/7 plume. The average geochemical parameter values from the May 2011 monitoring event were used to calculate the competing electron acceptor concentrations: 2.4 mg/L oxygen, 1.0 mg/L nitrate, 5 mg/L manganese, 128.5 mg/L iron, and 10.9 mg/L sulfate.

The remedial design for enhanced bioremediation was consistent with the design of ISCO; i.e., a 15-foot radius of influence resulting in a total of 42 injection wells in the MW-5/7 plume and 12 injections in the MW-4 plume (Figure 4B). Based on these assumptions, the Regenesis calculator determined a total requirement of 3,800 pounds

of HRC[™]. A closer injection spacing is expected to be necessary to increase substrate distribution within the silt, and some reoxidation of the groundwater may occur with Kuskokwim River fluctuations; therefore, the remedial design includes an initial injection of 3,800 pounds of HRC[™] followed by three additional annual injections of 2,850 pounds of HRC[™] each (i.e., 75% of the initial injection mass), for a total of 12,350 pounds of HRC[™].

This alternative also includes bioaugmentation (i.e., injection of appropriate microbial community [DHC organisms]) for complete reductive dechlorination of TCE to ethene. The presence or absence of DHC organisms is unknown at this site, but bioaugmentation was included in the cost estimate. Bioaugmentation is relatively inexpensive relative to the entire project cost, and it may assist and will not hurt reductive dechlorination at the site. For costing purposes, three bioaugmentation events each of 100 liters of KB-1® dechlorinator were assumed. The KB-1® would be injected into one of the substrate injection rows; i.e., 3 injections in the MW-4 plume and 7 injections in the MW-5 plume. KB-1® injection should not occur until the aquifer has been driven anaerobic; therefore the bioaugmentation was considered to occur in years 1 through 3. KB-1[®] is a naturally occurring, non-pathogenic microbial culture that contains DHC, the only group of microorganisms documented to promote the complete dechlorination of chlorinated ethenes to non-toxic ethene. KB-1® is used to establish complete dechlorination at sites that do not contain DHC (or the right DHC) and to accelerate dechlorination rates to achieve treatment goals. As with the other assumptions in this FS, selection of the actual microbial consortium for injection would occur after additional characterization and in conjunction with a pilot test.

For costing purposes, it was assumed that the MNA/LTM groundwater monitoring schedule presented in Section 4.2.5 would be followed. The remedial timeframe for Alternative GW-4 was estimated at twenty years.

4.7. Alternative GW-5: Air Sparging

Alternative GW-5 involves air sparging in conjunction with SVE, as evaluated by Shannon & Wilson (2010a). Air sparging is an in-situ technology in which air is injected into a contaminated aquifer using air sparge wells to induce volatilization of contaminants. As air moves through the saturated soil within the zone of influence of the air sparge wells, volatile organic contaminants are stripped from the water. Using an SVE system in conjunction with air sparge will enhance the process by increasing flow through the groundwater, controlling gas/vapor movement through the subsurface, and capturing volatiles before they escape at the surface.

4.7.1. Air Sparging Considerations at Aniak WACS

Shannon & Wilson performed an air sparge pilot test that showed that air could be injected into the water-bearing zone beneath the silt with a radius of influence of about 20 feet. However, they also identified that air sparge may not be an effective remedial alternative as the contaminated groundwater is located in a semiconfined aquifer

system. The silt layer overlying the saturated sandy gravel to gravelly sand soil may act as an aquitard, creating semi-confined conditions. Air injected into the semi-confined aquifer could become trapped by the overlying, semi-confining layer and may not be able to escape to the unsaturated zone for capture using SVE wells. However, the competence of the silt layer has not been determined, so the degree to which it may act as an aquitard is not known.

Air sparge is not expected to be an effective remedy for contamination in the silt layer. Due to the fluctuating water table, the silt layer is expected to have a relatively high water saturation. The high water saturation is expected to inhibit air flow through the silt layer.

4.7.2. Assumptions for Alternative GW-5 at Aniak WACS

To ensure that the assumptions used in the air sparge alternative were consistent with the assumptions in Alternatives GW-2 through GW-4, OASIS revised the cost estimate prepared by Shannon & Wilson (2010). In particular, revisions were made to the monitoring schedule and system installation costs. The assumptions for Alternative GW-5 are discussed below.

Consistent with Alternatives GW-3 and GW-4, GW-5 assumes that an air sparge pilot test would be performed prior to remedial system design. Although an air sparge pilot test has been performed at the Aniak WACS site, a second pilot test would be necessary to specifically assess the radius of influence in the silt layer in the most highly-contaminated portion of the site (i.e., between the former truck fill area and SGP-17).

The physical assumptions of Alternative GW-5 are consistent with Shannon & Wilson's physical assumptions, i.e., 15 sparge wells to a total depth of 45 feet bgs (Figure 4B). Costs for the SVE component are already included in the SVE soil remediation and are therefore not repeated in groundwater alternative GW-5. After the first year of operation, the sparge system power requirement was assumed to drop to 50% of the initial power requirement due to system cycling. Blower replacement was assumed every 5 years, with complete sparge system well replacement after ten years.

For costing purposes, it was assumed that the MNA/LTM groundwater monitoring schedule presented in Section 4.2.5 would be followed. The remedial timeframe for Alternative GW-5 was estimated at twenty years.

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5. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

5.1. Evaluation Criteria

The five groundwater remedial alternatives identified in the previous section of this Focused FS were evaluated against the nine criteria described in Section 121(b) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP) §300.430(f)(5)(i). The CERCLA criteria are classified as threshold criteria, balancing criteria, and modifying criteria.

Threshold criteria are standards that an alternative must meet to be eligible for selection as a remedial action. There is little flexibility in meeting the threshold criteria—the alternative must meet them or it is unacceptable. The following are classified as threshold criteria:

- Overall protection of human health and the environment
- Compliance with regulations

Balancing criteria weigh the tradeoffs between alternatives. These criteria represent the standards upon which the detailed evaluation and comparative analysis of alternatives are based. In general, a high rating on one criterion can offset a low rating on another balancing criterion. Five of the nine criteria are considered balancing criteria:

- **Long-term effectiveness and permanence**: This criterion refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, after the remedy has been completed.
- **Reduction of toxicity, mobility, and volume through treatment**: This criterion evaluates the anticipated performance of the treatment technologies that may be included as part of a remedy.
- Short-term effectiveness: This criterion addresses the effectiveness of the remedy during its implementation. It includes the period of time needed to implement the remedy along with any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.
- **Implementability**: This criterion addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.
- **Cost:** This criterion addresses the cost-effectiveness of a remedy based upon design, construction, start-up, monitoring, and maintenance costs.

Modifying criteria evaluate public acceptance and can therefore not be considered in the FS. The final two criteria are considered modifying criteria:

- Community acceptance
- State/regulatory agency acceptance

5.2. Comparative Analysis of Alternatives

A comparative analysis was performed to identify the advantages and disadvantages of each alternative relative to the other alternatives. The relative performance of each alternative was evaluated with respect to each of the NCP criteria. The scoring procedure is discussed in this section.

Threshold criteria are either met or not met; therefore, "yes" and "no" were used as the scores for threshold criteria.

A numerical scoring scheme was used for evaluating the balancing criteria. Each alternative was assigned a numerical score between 0 and 5 for each criterion to reflect the expected performance of the alternative. The scores have no independent value; they are only meaningful when compared among the different alternatives. The numerical scores are presented and defined below:

- 0: Worst (Criterion not satisfied)
- 1: Poor
- 2: Below Average
- 3: Average (Criterion partially satisfied)
- 4: Above Average
- 5: Best (Criterion completely satisfied)

All of the criteria except cost were evaluated on a qualitative basis. Cost was evaluated quantitatively by calculating the expected range of costs (within a range of -50% to +100%) and then normalizing the costs to the 0 to 5 scale, with the least expensive alternative receiving a score of 5, and the most expensive alternative receiving a score of 0. The quantitative cost evaluation was performed based on the EPA document entitled *A Guide to Developing and Documenting Cost Estimates During the Feasibility Studies* (EPA, 2000).

5.3. Comparison of Groundwater Alternatives

The numerical scores of the five groundwater alternatives for the nine NCP criteria are presented in Table 5-1 and discussed in this section. All of the groundwater alternatives assume implementation of the planned vadose zone remedies and continued operation of the SSD system for the duration of the groundwater remedy, i.e., until groundwater RAOs have been met. As discussed in Section 4.2.1, OM&M costs for continued operation of the SSD system for the duration of each groundwater remedy are included in the cost evaluation. Impacts to vadose zone soil and vapor intrusion risk by the groundwater remedies is not considered in the following analysis, except to the extent that the groundwater remedy may directly impact the vadose zone or vapor intrusion.

Table 5-1: Comparative Analysis of Alternatives

Reme	dial Alternative	Threshold Criteria	Effec	tiveness S	cores	oility	Cost					
Identifier	Description	Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness and Permanence	Reduction in Toxicity, Mobility, and Volume through Treatment	Short-term Effectiveness	Implementab	Cost Score	Estimated Present Worth Range (-50% to + 100%) (in thousands of dollars)	Effectiveness Total	Total Score	Effectiveness to Cost Quotients
Groundwater Alternatives												
									\$0			
GW-1	No Action	No	No	0.0	0.0	0.0	5.0	5.0	\$0	0.0	10.0	NA
									\$1,217			0.60
GW-2	LTM/MNA	Yes	Yes	2.0	2.0	3.3	4.0	2.2	\$4,870	7.3	13.5	0.15
									\$2,152			0.49
GW-3	ISCO (Chemical Oxidation)	Yes	Yes	4.0	4.0	2.5	3.0	0.0	\$8,608	10.5	13.5	0.12
	ERD (Substrate								\$1,715			0.57
GW-4	Addition)	Yes	Yes	3.5	3.0	3.3	3.0	1.0	\$6,858	9.8	13.8	0.14
									\$1,813			0.39
GW-5	Air Sparging	Yes	Yes	2.5	2.0	2.5	2.0	0.8	\$7,252	7.0	9.8	0.10

Explanation of

Scores:

0 Worst (Criterion not satisfied)

- 1 Poor
- 2 Below Average

3 Average

4 Above Average

5 Best (Criterion completely satisfied)

5.3.1. Threshold Criteria

5.3.1.1. Protection of Human Health and the Environment

Alternative GW-1 (No Action) is not expected to protect human health or the environment and received a score of "**no**" for this criterion.

The other four alternatives (GW-2 through GW-5) are expected to provide protection of human health and the environment. For all alternatives GW-2 through GW-5, continued operation of the SSD system will mitigate vapor intrusion risk, and ICs will be used as necessary to protect human health until groundwater RAOs are met. Although there are drinking water wells near the site, pumping tests and datalogger studies suggest minimal groundwater migration is occuring. There is no evidence that groundwater contamination will migrate to the drinking water wells under current conditions, and none of the alternatives GW-2 through GW-5 would be used to monitor any plume migration and thereby ensure protectiveness. Alternatives GW-2 through GW-5 received a score of "**yes**" for this criterion.

5.3.1.2. Compliance with Regulations

Alternative GW-1 (No Action) is not expected to meet ADEC Table C cleanup levels and received a score of "**no**" for this criterion.

Evaluating compliance with regulations for the other four alternatives required an assumption that an alternative point of compliance could be established downgradient of the source area. It is possible that none of the alternatives will be able to meet ADEC Table C cleanup levels throughout the site, depending on the amount of contamination held in the silt layer and the permeability of the silt layer, both of which have not yet been assessed.

All four alternatives GW-2 through GW-5 are expected to eventually meet ADEC Table C cleanup levels if a point of compliance were established downgradient of the source area and therefore received scores of "**yes**" for this criterion. Alternatives GW-3 (ISCO) and GW-4 (ERD) are considered to meet cleanup levels to the maximum extent practicable for the site and therefore are considered to be compliant with regulations. There is greater uncertainty to meet compliance with Alternatives GW-2 (MNA) and GW-5 (SVE); this uncertainty is reflected in lower balancing criteria scores discussed below.

5.3.2. Balancing Criteria

5.3.2.1. Long-Term Effectiveness

Alternative GW-1 (No Action) does not provide any groundwater treatment and is not expected to protect human health or the environment in the long-term and received a score of "0" for long-term effectiveness.

Alternatives GW-3 (ISCO) and GW-4 (ERD) are expected to treat most of the groundwater contaminated by TCE to below the ADEC Table C cleanup levels to the

maximum extent practicable. For these alternatives, distribution of the oxidant (GW-3) and substrate (GW-4) in the low-permeability silt layer is considered the most difficult part of the remedy. To the degree that the oxidant and/or substrate can be distributed within the silt layer, both ISCO and ERD are considered effective remedies. For comparison purposes, the silt layer is expected to similarly affect alternatives GW-3 and GW-4. Alternative GW-3 is ranked the highest ("4") for long-term effectiveness, because there are no expected impediments to effective groundwater treatment using ISCO other than distribution concerns. The ERD alternative (GW-4) is ranked "3.5," because ERD requires activity from microbial communities whose activity has not been confirmed at this site and whose effectiveness may be adversely affected by the cold groundwater temperatures but are ultimately expected to be capable of mediating complete reductive dechlorination of the TCE. Both ISCO and ERD are considered permanent remedies that are effective in the long-term and not reversible.

The air sparge alternative (GW-5) received a score of "2.5" for long-term effectiveness. The effectiveness of air sparging is expected to be limited by the silt layer. In areas of the site where the silt layer is not present or not highly-competent, air sparging would be expected to be effective. However, even in highly-permeable soils, the sparged air tends to travel in preferential pathways, creating a challenge to complete groundwater treatment. Air sparging is not expected to be effective for addressing contamination within the silt layer, because the relatively high expected water saturation levels will create a barrier to air flow. Air sparging is considered a permanent remedy that is effective in the long-term and not reversible.

The MNA alternative (GW-2) received a score of "2" for long-term effectiveness. MNA is considered a permanent and effective remedy; however, the effectiveness of reductive dechlorination (the primary biological component of MNA for TCE) is dependent upon anaerobic groundwater conditions and the presence of a carbon source. The analytical evidence suggests that organic carbon content in the aquifer may be a limiting factor for effective and complete degradation of TCE to its non-toxic endpoint, ethene. Also, the analytical evidence suggests that aerobic groundwater conditions are present across most of the site, at least at high water levels. The uncertainty of this alternative is reflected in the long remedial timeframe (35 years) as well as the long-term effectiveness score of "2."

5.3.2.2. Reduction in Toxicity, Mobility, and Volume through Treatment

Alternative GW-1 (No Action) does not provide any treatment, so it received a score of "0" for reduction in toxicity, mobility, and volume through treatment.

The remaining alternatives are expected to treat most of the groundwater contaminated by TCE to below the ADEC Table C cleanup levels as described below.

• The ISCO alternative (GW-3) is ranked highest ("4") for reduction in toxicity, mobility, and volume through treatment, because it results in the immediate destruction of the contaminant where contacted.

- The ERD alternative (GW-4) is received a score of "3" for reduction in toxicity, mobility, and volume through treatment. It relies on activity from a microbial community whose activity has not been confirmed at this site and whose effectiveness may be adversely affected by the cold groundwater temperatures but are ultimately expected to be capable of mediating complete reductive dechlorination of the TCE. In addition, ERD creates toxic intermediate daughter products (i.e., vinyl chloride) whose presence is expected to be of limited duration but must be managed properly. ERD provides the carbon source that is necessary for the reductive dechlorination and therefore has a higher likelihood of effectively treating groundwater than MNA alone.
- The air sparge alternative (GW-5) received a score of "2," because air sparging does not actually treat the TCE contamination but instead volatilizes it to air. In addition, there is uncertainty about whether the TCE volatilized below the silt layer can be effectively captured and removed from the site through SVE rather than simply readsorbing to the silt. Air sparging is not expected to be effective within the silt layer due to its high water saturation and resulting low permeability to air.
- The MNA alternative (GW-2) received a score of "2" for this criterion. MNA reduces toxicity, mobility, and volume of contamination; however, its effectiveness is dependent upon anaerobic groundwater conditions and the presence of a carbon source. The analytical evidence suggests that elevated oxygen and low organic carbon content in the aquifer may be limiting factors for effective and complete degradation of TCE to its non-toxic endpoint, ethene.

5.3.2.3. Short-Term Effectiveness

Alternative GW-1 (No Action) does not provide any treatment. Although the community, workers, and environment do not incur any added risks due to this remedy, there is an infinite time frame until remedy completion. Alternative GW-1 received a score of "0" for short-term effectiveness.

As discussed previously, the short-term effectiveness criterion contains two main components: protection of the community, workers, and environment during remedy implementation, and time until remedy completion. The ranking of alternatives for these two components is nearly opposite each other, resulting in similar overall short-term effectiveness scores. These components are discussed separately below with respect to Alternatives GW-2 through GW-5.

Regarding the first component (protection during remedy implementation), Alternative GW-2 (MNA/LTM) is the most protective, because it involves very little risk due to remedy construction. The only exposure to groundwater contamination would be from groundwater monitoring; this exposure can be readily mitigated by appropriate worker health and safety procedures. Added risks from implementation of Alternative GW-4 (ERD) result from handling of the substrate, although the substrate handling risks are considered minor, because it is not reactive. Alternative GW-5 (Air Sparging) volatilizes

TCE and daughter products that were previously dissolved in water, resulting in added vapor inhalation risks. This risk can be mitigated by capturing the volatilized chemicals through the SVE system; however, the silt layer increases the uncertainty of complete capture. Added risks to the community from Alternative GW-3 (ISCO) result from handling of the oxidant. The reactivity of the oxidant will pose increased risk to workers relative to the other alternatives, although the risk can be mitigated with appropriate health and safety procedures.

Regarding the second component (remedy time frame), Alternative GW-3 (ISCO) is superior to the other alternatives, because it offers the shortest time to remedy completion (ten years). Alternatives GW-4 (ERD) and GW-5 (air sparging) have equal times to remedy completion (20 years). The time frame for air sparging is expected to be lengthy, because treatment of contamination located in the silt and sand layers away from the preferential pathways for air flow is diffusion-limited. The lengthy time frame assumed for the ERD alternative is based on the need to establish and maintain reducing geochemical conditions and an active microbial community of reductive dechlorinators. Also, the cold groundwater temperatures are expected to lengthen treatment time relative to treatment in warmer temperatures. The time frame until remedy completion using MNA (GW-2) is uncertain and likely to take many years; a remediation timeframe of 35 years was assumed.

Based on the two components of short-term effectiveness, the overall short-term effectiveness scores for Alternatives GW-2 and GW-4 are "3.3," whereas the overall short-term effectiveness for the other alternatives is "2.5."

5.3.2.4. Implementability

There are no technical or administrative barriers to implementation of Alternative GW-1 (No Action). Alternative GW-1 received the maximum score of "5" for this criterion.

Alternative GW-2 (MNA) received an implementability score of "4." There are no significant barriers to implementing MNA at this site, but groundwater sampling and analysis is required. Alternatives GW-3 and GW-4 both received scores of "3" for this criterion, because they involve similar implementation tasks such as drilling, plumbing, monitoring, and logistics. Alternative GW-5 received an implementability score of "2," because of expected implementability difficulties associated with the silt layer. If the silt layer is higly competent and continuous across the site, then air sparging would be considered to be poorly implementable and earn a score of "1;" however, the competency and extent of the silt layer is unknown. Alternatives GW-3, GW-4, and GW-5 all involve obtaining property owner consent and drilling multiple injection or extraction wells at this site.

5.3.2.5. Cost

The relative cost scores of the three groundwater alternatives are presented in Table 5-1, and detailed cost spreadsheets are presented in Appendix C. There are no costs associated with Alternative GW-1; therefore, it received the maximum normalized score of "5" for the cost criterion. Alternative GW-3 (ISCO) was the most expensive alternative (\$2,200,000 to \$8,600,000); therefore, it received the minimum normalized score of "0" for this criterion. Excluding the No Action Alternative, Alternative GW-2 (MNA/LTM) was the least expensive (\$1,200,000 to \$4,900,000) and received a cost score of "2.2." Alternatives GW-4 (ERD) (\$1,700,000 to \$6,900,000) and GW-5 (Air Sparge) (\$1,800,000 to \$7,300,000) received cost scores of "1.0" and "0.8," respectively.

5.4. Preferred Alternative

In addition to the individual criteria scores discussed above, there are three comparison tools presented in Table 5-1 that may be used to help select the preferred alternative: the total effectiveness score, the total score, and the effectiveness to cost ratio. The total effectiveness score reflects the expected overall effectiveness of the alternative; the alternative with the highest score is expected to be the most effective, without regard for implementability and cost. The total score includes cost and implementability considerations along with effectiveness. Therefore, an alternative that is very expensive and/or difficult to implement will have a lower total score compared to an alternative that is less expensive and/or easier to implement. The effectiveness to cost ratio is a measure of the cost-effectiveness of the remedy; a high effectiveness to cost ratio implies a cost-effective remedy.

Results for the Aniak WACS groundwater alternatives are summarized below.

- Alternative GW-3 (ISCO) received the highest effectiveness score, "10.5." The second-highest effectiveness score was ERD with "9.8," followed by MNA at 7.3 and Air Sparging at 7.0.
- Alternative GW-4 (ERD) received the highest total score, "13.8." The secondhighest total scores were Alternatives GW-2 (MNA) and GW-3 (ISCO) with "13.5." Air Sparging has the lowest total score of 9.8, which interestingly was even lower than Alternative GW-1 (No Action).
- For each alternative, effectiveness to cost quotients were calculated for both the low-end and high-end of the cost range. The low-end quotients are used in the comparison discussion in this paragraph. Alternative GW-2 (MNA) and Alternative GW-4 (ERD) received the highest effectiveness to cost ratios, "0.60" and "0.57," respectively. ISCO has an effectiveness to cost ratio of "0.49," and Air Sparging has the lowest effectiveness to cost ratio of "0.39."

Selection of a preferred alternative depends on the relative importance of the variables. GW-2 (MNA) and GW-4 (ERD) are the most cost-effective alternatives; ERD has a higher effectiveness than MNA, but the increased effectiveness is offset by its higher cost. If achieving cleanup in the shortest time is the most important factor, then Alternative GW-3 (ISCO) is preferred, although it is also the most expensive alternative. ISCO is expensive primarily because most of the oxidant will be used to treat the natural oxidant demand in the soil and groundwater (i.e., 72,840 kg KMnO₄ versus 8 kg KMnO₄

to treat the contamination). Air sparging has the lowest total score and effectiveness to cost quotient and is least likely to be considered the preferred alternative.

To evaluate the relative merits of MNA versus ERD (the two most cost-effective alternatives) at this site, a decision flowchart from the Interstate Technology Regulatory Council (ITRC) (ITRC, 2007) was used. The decision flowchart presents three criteria for consideration. These three criteria are listed below, with an interpretation of how the Aniak WACS site meets them.

1. Source and/or Primary Plume Treatment;

The current understanding of the groundwater contamination at the Aniak WACS site suggests a plume of low-to-moderate concentrations that has not migrated significantly. Based on the plume geometry, there has been no distinct source and/or primary plume area identified in the saturated zone. The highest TCE concentration detected is 0.19 mg/L (almost four orders of magnitude below the solubility limit of 1,100 mg/L). It is possible that the mass of TCE released at the site is relatively small and mostly in the vadose zone; however, the site has not been adequately characterized to definitively state this.

- 2. Evaluate Plume Stability;
 - a. Are the risks acceptable?
 - b. Is the plume stable or shrinking?
 - c. Are conditions sustainable?
 - d. Is the remediation timeframe acceptable?
 - e. Are the cost-benefits acceptable?

The groundwater monitoring performed to-date is insufficient to definitively answer the five questions on plume stability. However, a preliminary analysis based on existing monitoring data suggests that the plume is stable or shrinking (i.e., no evidence of plume expansion). The risks due to drinking water appear to be acceptable, because there is no evidence of plume migration toward the existing drinking water wells. Risks due to vapor intrusion into the Aniak Middle School Building are not acceptable without vapor mitigation (i.e., SSD system), although the relative contribution of groundwater versus vadose zone contamination to the vapor intrusion pathway has not been determined. The sustainability of biodegradation over the expected life of the plume is something that cannot yet be determined. Current data suggest that there is an insufficient carbon source for significant reductive dechlorination plume-wide; however, the apparent plume stability suggests that attenuation mechanisms are acting to limit plume size. The acceptability of the remediation timeframe and cost-benefit analysis must be determined by the responsible parties and regulators.

3. Evaluate Enhancement Options.

Enhancement options (i.e., ERD) may be considered if the plume stability criteria are not met or as a contingency if future monitoring suggests that MNA is not progressing adequately.

Overall, it appears that additional plume characterization and implementation of the soil remedies would be beneficial before selecting a groundwater remedy. Additional plume characterization activities should include installing soil borings and monitoring wells east of the Aniak Middle School building, west of the building in the vicinity of SGP-17 and SGP-18, and in several other locations as needed to complete characterization of both plumes and the silt layer. MNA parameter monitoring should be performed at low water level. Microbial community testing for dehalococcoides organisms should be performed. Use of Bio-Trap® in-situ microcosms may be a cost-effective technique to assess the MNA potential, native microbiological community, and expected performance of substrate amendment. During the PCB soil excavation in the vicinity of the former septic tank and truck fill, soil samples should also be analyzed for TCE. If high TCE concentrations are detected in the silt at the base of the PCB excavation, direct treatment using a reductant (or possibly an oxidant) during the PCB soil excavation may be a very beneficial and cost-effective remediation strategy. Alternatively, depending on the location, magnitude, and extent of the TCE contamination and silt characteristics, installation of an engineered solution, such as placement of a gravel layer at the base of the excavation with distribution piping and a standpipe at the surface that could be used to deliver reagents periodically, may be warranted. Sampling details and a decision protocol should be incorporated into the excavation work plan.

Based on existing data, Alternative 2 (MNA) with Alternative 4 (ERD) as a contingency may be considered preferred. MNA would be expected to perform satisfactorily at this site if the following conditions (based on future characterization and planned soil remediation efforts to address the three ITRC criteria) are met.

- 1. Additional site characterization confirms that there is no distinct source/primary plume in the saturated zone. There is no evidence of free-phase or residual-phase TCE, and maximum groundwater concentrations remain three-to-four orders of magnitude below the solubility limit. The groundwater plume configuration is generally as outlined in this FS.
- 2. Additional groundwater monitoring supports the conclusion that the plume is stable.
 - a. The groundwater plume is stable or shrinking, and there is no risk to the nearby drinking water wells. An alternative point of compliance can be established downgradient of the source area.
 - b. The PCB soil excavation and SVE adequately address vapor intrusion risk (i.e., most of the contaminant mass is found in the vadose zone). Although volatilization from the silt layer/saturated interval below the silt layer may provide a continuing source for soil gas contamination, the level of continued volatilization is currently unknown and may be minor,

especially if the upper portion of the silt layer is directly treated during the PCB soil excavation.

- c. Future VOC and geochemical parameter sampling indicates that there are zones or areas of highly-reducing groundwater in which reductive dechlorination of TCE is occurring at sustainable rates to adequately remediate the contamination over time
- d. This alternative is deemed acceptable to ADEC and all of the interested parties.
- 3. If the above criteria are not completely satisfied, then it may be advantageous to implement ERD in a phased approach.

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FIGURES

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APPENDIX A

Hydrologic (Datalogger) Analysis











LEGEND

B19/MW6

B22/MW9

Approximate location of Monitoring Well MW6 installed by Shannon & Wilson Inc. in May 2008.

Approximate location of vapor extraction system and/or groundwater monitoring wells, installed by Shannon & Wilson, Inc. in August 2009. Note that MW7 and MW8 are a nested pair of groundwater monitoring wells.

Approximate location of Soil Boring B22/Groundwater Monitoring Well MW9,installed by Shannon & Wilson Inc. in August 2009. Well was screened from about 7 feet above to 8 feet below groundwater contact.

Groundwater potentiometric surface contour and elevation based on October 3, 2009 groundwater elevations and September 2009 survey conducted by Del Norte Surveying, Inc. (based on elevations measured at Monitoring Wells MW8, MW9, MW10, MW11, and MW12) ➤ 58.15 —

Ð High School Drinking Water Well











B19/MW6

B21/MW8

B22/MW9







APPENDIX B

Summary of 2011 Groundwater Monitoring Events

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B-1: 2011 Groundwater Monitoring Results

ATTACHMENTS

- 1: Field Notes and Water Sample Data Sheets
- 2: Photograph Log
- 3: Quality Assurance Review (QAR) and ADEC Checklists

ACRONYMS AND ABBREVIATIONS

ADEC	Alaska Department of Environmental Conservation
bgs	Below ground surface
DCE	Dichloroethene
DO	Dissolved oxygen
EPA	Environmental Protection Agency
FS	Feasibility study
µg/L	Micrograms per liter
mg/L	Milligrams per liter
MNA	Monitored natural attenuation
O&M	operation and maintenance
OASIS	OASIS Environmental, Inc.
ORP	oxidation-reduction potential
QAR	quality assurance review
QA/QC	quality assurance/quality control
PCBs	polychlorinated biphenyls
SSD	Sub-slab depressurization
тос	total organic carbon
TCE	Trichloroethene
VOC	Volatile organic compound
WACS	White Alice Communications System

1. 2011 GROUNDWATER MONITORING EVENTS

In accordance with Modification 1 and 2 to NTP 18400211028, OASIS performed groundwater monitoring events at the Aniak White Alice Communications Site (WACS) on May 9-12, 2011 and October 18-20, 2011. In addition, OASIS placed groundwater pressure transducers with dataloggers into selected monitoring wells on May 12, 2011 and downloaded the data in June, September, and October 2011. The 2011 monitoring activities provided additional data to support a focused feasibility study (FS) for evaluating groundwater remedies for the site.

The purpose of the groundwater sample events was to augment existing groundwater monitoring data for the site. Prior to May 2011, there was only one round of analytical data available for most site monitoring wells (MW-1 through MW-3 were sampled in October 2008 for volatile organic compounds [VOCs], polychlorinated biphenyls (PCBs), and metals; MW-1 through MW-6 were sampled in June 2008 for VOCs and geochemical parameters; and MW-6 through MW-12 were sampled in August-September 2009 for VOCs only). Prior sampling has showed the presence of two groundwater plumes with trichloroethene (TCE) present above its ADEC Table C cleanup level of 5 micrograms per liter (μ g/L).

The Datalogger Study is an expansion of a datalogger study performed by Shannon & Wilson in 2010. Shannon & Wilson placed groundwater pressure transducers with dataloggers into site monitoring wells MW-8, 9, 10, 11, and 12 from September 2009 until May 2010. The dataloggers recorded significant groundwater elevation fluctuations (approximately 5 feet) over this time period. However, the period of maximum groundwater fluctuations would be expected to occur during spring breakup of the Kuskokwim River and summer precipitation, which were not completely recorded in the 2009-2010 study. The purposes of the new Datalogger Study are to fill the data gap from the previous datalogger study and to provide ongoing groundwater elevation information.

1.1. Scope

The work scope is summarized below:

- Install Solinst Gold Leveloggers into the following monitoring wells: MW-5, MW-7, MW-8, MW-9, MW-10, MW-11, and MW-12. Program the Leveloggers to record the groundwater level four times per day.
- Collect groundwater samples from all existing groundwater monitoring wells (MW-4 through MW-12).
- Analyze samples for VOCs and, for the May event only, also for the following geochemical parameters: permanent gases (methane, ethane, ethene), total organic carbon (TOC), dissolved and total iron and manganese, alkalinity, chloride, sulfate, and nitrate-nitrite.

1.2. Summary of Field Procedures

The May and October 2011 monitoring events were performed in accordance with the Work Plan and its addendum (OASIS, 2011a and b). The field procedures are summarized below in this section, and a copy of the field notebook and water sample data sheets is included as Attachment 1 to this Appendix. A photograph log is included as Attachment 2 to this Appendix. Note that all of the field documentation consistently switches MW-7 and MW-8; i.e., all of the information recorded for MW-7 actually pertains to MW-8 and vice versa. The monitoring wells are not labeled in the field so the field crew inadvertently referenced MW-7 and MW-8 incorrectly. The error was discovered due to the depth difference of the monitoring wells. MW-7 is approximately 38 feet deep, and MW-8 is approximately 51 feet deep. Although the field documentation incorrectly references MW-7 and MW-8, all text, tables, and figures present the information correctly. To avoid this problem in the future, labeling the site monitoring wells during the next monitoring event is recommended.

1.2.1. Datalogger Installation and Download

OASIS installed the Leveloggers into monitoring wells MW-5, MW-7, MW-8, MW-9, MW-10, MW-11, and MW-12 between 0645 and 0800 on May 12, 2011. In addition, a Barologger (used to measure barometric pressure) was deployed well above the water table in MW-8. In MW-5 and MW-7, the dataloggers were deployed using steel cables. The other dataloggers were deployed using strings that were still attached to the well caps from Shannon & Wilson's datalogger study. The dataloggers are programmed to record water level four times per day; i.e., at 0200, 0800, 1400, and 2000.

The dataloggers were downloaded in conjunction with subslab depressurization system (SSD) operation & maintenance (O&M) activities after the 1400 reading on June 20, 2011, September 20, 2011, and October 19, 2011. On June 20, 2011, all dataloggers were downloaded, and the dataloggers in monitoring wells MW-8, MW-9, and MW-10 were re-deployed on steel cables. On September 20, 2011, only dataloggers MW-7, MW-8, MW-9, and the Barologger were downloaded. On October 19, 2011, all dataloggers were downloaded, and the dataloggers in monitoring wells MW-11 and MW-12 were re-deployed on steel cables.

1.2.2. May Groundwater Monitoring

OASIS mobilized to the site on May 9, 2011. OASIS found all of the monitoring wells to be in good condition and able to be sampled, except MW-4, which was located under a Connex and therefore could not be accessed. The water level was measured and found to be high enough to submerge the screens in some of the deeper soil gas points installed by Shannon & Wilson in 2009. Therefore, groundwater samples were collected from SGP-2 and SGP-9, in addition to monitoring wells MW-5 through MW-12.

The monitoring wells were purged and samples collected using low-flow methodology. A stainless steel submersible Fultz sample pump (i.e., the same sample technique used by Shannon & Wilson in 2009) was used for purging and sampling, until the pump quit

working due to the silt load from SGP-9. Locations MW-5, MW-11, and SGP-2 were purged and sampled using a peristaltic pump. At all locations, a YSI 556 MPS multiparameter instrument was used to measure field parameters, including pH, temperature, conductivity, dissolved oxygen (DO), and oxidation-reduction potential (ORP). When all readings stabilized to within the acceptable range as stated in the work plan, samples were collected for VOC analysis and the following geochemical parameters: alkalinity, total & dissolved manganese, total & dissolved iron, TOC, sulfate, nitrate-nitrite, chloride, and methane.

Investigation-Derived Waste (IDW) included disposable sample equipment (i.e., sample gloves and tubing) and purge water/decontamination water. The disposable sample equipment was shipped to Anchorage and disposed of in a permitted landfill. The purge/decontamination water was collected in 5-gallon buckets and transferred to a 50-gallon drum that was available onsite after each well was sampled. From May 10, 2011 until the morning of May 12, 2011, an air-sparging treatment system constructed from a section of PVC screen operated inside the drum to treat the purgewater to below the 5 µg/L cleanup level for TCE. A drum sample was collected on May 12, 2011. Pending analytical results, the drum was labeled "Satellite Accumulation Area – Potentially TCE contaminated waste," and stored in the locked SSD system enclosure. Upon confirmation that the drum sample was below cleanup levels for all contaminants, the drum contents were discharged to the gravel pad on June 20, 2011.

VOC samples were analyzed by OnSite Environmental of Redmond, Washington. OnSite is an ADEC-approved laboratory for these analyses. MNA parameter samples were analyzed by Keystone Laboratories of Newton, Iowa. Although Keystone is not an ADEC-approved laboratory, they are approved by other states (Iowa and Kansas) and have been used for MNA parameter analysis for other projects in Alaska.

1.2.3. October Groundwater Monitoring

October Field Procedures: OASIS mobilized to the site on October 18, 2011. OASIS found all of the monitoring wells to be in good condition and able to be sampled, except MW-4, which was located under a Connex and therefore could not be accessed. MW-5 was found to be dry and therefore could not be sampled. Groundwater samples were collected from monitoring wells MW-4 and MW-6 through MW-12.

The monitoring wells were purged and samples collected using low-flow methodology. A stainless steel submersible SS Monsoon sample pump was used for purging and sampling, except for MW-6. MW-6 was purged and sampled using a bailer, because its recharge rate was too slow for the submersible pump. At all locations, a YSI 556 MPS multiparameter instrument was used to measure field parameters, including pH, temperature, conductivity, DO, and ORP. When all readings stabilized to within the acceptable range as stated in the work plan, samples were collected for VOC analysis

IDW included disposable sample equipment (i.e., sample gloves and tubing) and purge water/decontamination water. The disposable sample equipment was shipped to Anchorage and disposed of in a permitted landfill. The purge/decontamination water was

collected in 5-gallon buckets and transferred to a 50-gallon drum that was available onsite after each well was sampled. From October 18, 2011 until the morning of October 20, 2011, an air-sparging treatment system constructed from a section of PVC screen operated inside the drum to treat the purgewater to below the 5 μ g/L cleanup level for TCE. A drum sample was collected on October 20, 2011. Pending analytical results, the drum was labeled "Satellite Accumulation Area – Potentially TCE contaminated waste," and stored in the locked SSD system enclosure. As discussed in the Results section of this Appendix, the drum sample was below cleanup levels for all contaminants, so the drum contents will be discharged to the gravel pad during the next SSD system O&M event.

VOC samples were analyzed by OnSite Environmental of Redmond, Washington. OnSite is an ADEC-approved laboratory for these analyses.

1.3. Water Levels

The May 2011 monitoring event occurred during a period of very high water level associated with spring breakup. The October 2011 monitoring event occurred during a period of low water level. A comparison of Photographs 19 and 20 (Attachment 2) illustrates the difference between the level of the Aniak Slough/Kuskokwim River during the May and October 2011 monitoring events.

Table B-1 summarizes the groundwater depths measured during the 2011 and previous groundwater monitoring events.

The datalogger results are discussed in Section 2.4 of the main body of the FS report, and graphs of the datalogger data are presented in Appendix A of the FS report.

1.4. Groundwater Monitoring Results

1.4.1. Data Validation

The laboratory data were reviewed by an OASIS chemist for quality assurance/quality control (QA/QC) purposes to evaluate the integrity of the analytical data generated during the May and October sample events. The Quality Assurance Review (QAR) discussion and ADEC QA/QC checklists are included as Attachment 3 to this Appendix.

The overall quality of the data was acceptable for the objectives established for this project. Two sample results (dissolved iron and dissolved manganese in sample 11-AWA-001-GW) required J- or UJ-flagging as "estimated" due to matrix spike duplicate percent recoveries outside quality control limits. All sample results are considered usable for project objectives. No results were rejected. The overall project completeness is 100%.

1.4.2. VOC Results

VOC Results: The 2011 groundwater VOC results are presented in Table B-2 and shown in Figure B-1. Contaminants of concern in the site groundwater include TCE and its degradation products cis-1,2-dichloroethene (cDCE), trans-1,2-dichloroethene

(tDCE), and vinyl chloride. Detections of TCE and its degradation products above Table C cleanup levels are summarized below:

- 77 µg/L TCE in MW-5 (May)
- 42 µg/L TCE in MW-7 (October)

Detections of TCE and its degradation products below Table C cleanup levels are summarized below:

- 0.29 µg/L TCE in SGP-9 (May)
- 3.1 µg/L cDCE in MW-7 (October)
- 0.3 µg/L cDCE in MW-7 (October)
- 0.26 µg/L cDCE in MW-9 (October)

Several other VOCs were detected at concentrations below their Table C cleanup levels, as summarized below.

- Carbon tetrachloride was detected at a concentration of 0.22 µg/L in SGP-2
- Chloroform was detected at a concentration of 0.24 µg/L in SGP-2
- Carbon disulfide was detected at concentration of 0.39 µg/L in MW-6 (October)
- Dichlorodifluoromethane was detected at concentrations between 0.54 μ g/L and 2.1 μ g/L in MW-5, MW-6, MW-7, MW-9,and MW-11

Groundwater plume analysis is provided in Section 2.5 of the FS report.

1.4.3. Geochemistry Results

The 2011 groundwater geochemical parameter results are presented in Table B-3 and summarized below.

- pH ranged between 5.9 and 8.4 pH units. Excluding the two soil gas points, the pH range was between 6.2 and 7.6 pH units.
- Alkalinity ranged between 92 milligrams per liter (mg/L) (SGP-2) and 154 mg/L (MW-8). Most alkalinities were between approximately 120 mg/L and 140 mg/L, except SGP-2 and SGP-9, which were below 100 mg/L, and MW-8, which was above 140 mg/L.
- Chloride ranged between 2.1 mg/L (MW-12) and 23.1 mg/L (SGP-2). Excluding the two soil gas points, the maximum chloride detection was 4.5 mg/L (MW-5).
- TOC ranged between 0.46 mg/L (MW-7) and 3.23 mg/L (SGP-2). Excluding the two soil gas points, TOC values were all below 1 mg/L.
- DO ranged between 7.4 mg/L (MW-9) and 0.79 mg/L (MW-10). DO was below 1 mg/L in MW-6, MW-7, MW-10, and MW-12, suggesting somewhat depleted oxygen levels compared to the rest of the site.
- ORP ranged between 201 millivolts (mV) (SGP-9) and 31 mV (SGP-2). All of the ORP values were positive, suggesting generally oxidizing conditions.
- Nitrogen (nitrate plus nitrite) ranged between 2 mg/L (MW-5) and 0.53 mg/L (MW-7).

- Dissolved and total manganese were detected in MW-7, MW-9, and MW-10 and in SGP-2 and SGP-9. Dissolved manganese concentrations ranged from 0.781 mg/L (SGP-9) to 0.252 mg/L (MW-7). Total manganese concentrations ranged from 5.23 mg/L (SGP-9) to 0.245 mg/L (MW-10).
- Dissolved and total iron were not detected in any of the monitoring well samples. Dissolved iron was detected at 5.14 mg/L and 6.57 mg/L in SGP-2 and SGP-9, respectively. Total iron was detected at 129 mg/L and 128 mg/L in SGP-2 and SGP-9, respectively.
- Sulfate ranged between 16.1 mg/L (MW-9) and 4.6 mg/L (SGP-9).
- Ethene, ethane, and methane were not detected in any monitoring wells.

The geochemical parameter results are used in the monitored natural attenuation (MNA) analysis presented in Section 4.4.1 of the FS report.

2. REFERENCES

- OASIS, 2011a. Letter Work Plan to Mr. John Halverson, re: Final Work Plan for Additional Characterization and Groundwater Monitoring at Former Aniak WACS Site, Aniak, Alaska. May 2.
- OASIS, 2011b. Letter Work Plan to Mr. John Halverson, re: Addendum to May 2, 2011 Final Work Plan for Additional Characterization and Groundwater Monitoring at Former Aniak WACS Site, Aniak, Alaska. October 6.

TABLES

Table B-1: Groundwater Elevation Summary 2006 through 2011 Monitoring Events Aniak WACS, Alaska

Ference Weil Weil Weil Weil Weil Win.GW Min.GW Min.GW Min.GW (TOC) ¹ bgsyth bgsyth (i) 10/21/06 5/19/16 5/11/11 10/19/11 5/11/11 10/19/11 (i) (i) 86.76 bgsyth (i) 10/21/06 5/19/08 5/23/08 5/21/11 10/19/11 5/11/11 10/19/11 (i) (i) (i) 86.76 19.22 2 2 23.09 s/21/21 2 6.50.6 65.04 (i)						Dep	oth to Groun	idwater (ft k	igs)					
Screened Well Well Well Well Well Well Well Win.GW Min.GW Min.GW Min.GW Min.GW Min.GW Min.GW Min.GW Min.GW (TOC1 ¹ bg) bg) bg) (i) jupul jup											GW			
Elevation Interval (th Depth (th Diameter Junction S/10/11-bit (10/19/11) Elevation Elevation </td <td></td> <td>Screened</td> <td>Well</td> <td>Well</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>Elevation</td> <td>ВW</td> <td>Min. GW</td> <td>Max. GW</td>		Screened	Well	Well							Elevation	ВW	Min. GW	Max. GW
	Elevatio	n Interval (ft	Depth (ft	Diameter					5/10/11-		(5/10/11-	Elevation	Elevation	Elevation
86.76 19-29 24.07 21.72 23.09 62.69 65.04 89.76 22-32 24.07 24.72 26.07 62.71 65.04 65.04 80.75 12-22 18 17.01 62.75 63.74 65.04 80.75 12-22 18 62.75 63.74 65.04 90.68 22-32 31.78 2 29.71 71.67 65.95 63.74 71.67 90.24 22-32 31.78 2 29.71 28.75 71.67 71.67 69.75 63.74 90.24 23-38 37.5 4 24.7 28.55 16.66 71.7 59.75 71.67 71.67 90.24 23-38 37.5 4 28.61 71.7 59.75 59.75 71.67 </td <td>(TOC)¹</td> <td>bgs)</td> <td>bgs)*</td> <td>(in)</td> <td>10/21/06</td> <td>5/19/08</td> <td>6/3/2008</td> <td>8/22/09</td> <td>5/11-11</td> <td>10/19/11</td> <td>5/11-11)</td> <td>(10/19/11)</td> <td>(ft)</td> <td>(ft)</td>	(TOC) ¹	bgs)	bgs)*	(in)	10/21/06	5/19/08	6/3/2008	8/22/09	5/11-11	10/19/11	5/11-11)	(10/19/11)	(ft)	(ft)
89.76 22-32 - 27.05 24,72 56.07 - - 6.2,71 65.04 80.75 12-22 - 18 - - - - - 6.07 6.07 65.04 80.75 12-22 - 18 - - - - - 6.07 6.07 63.04 90.68 22-32 31.78 - - - - - - - 6.07 6.03 63.03 63.04 71.67 60.95 59.75 63.03 71.67 90.68 18-28 29.91 2 - 24.7 28.55 16.66 28.61 71.7 59.75 59.75 71.67 90.04 23-38 37.5 4 - - 24.7 28.61 71.7 59.75 59.73 71.67 90.04 23-38 37.5 50.75 17.67 28.71 71.67 <td< td=""><td>86.76</td><td>19-29</td><td></td><td>-</td><td>24.07</td><td>21.72</td><td>23.09</td><td>-</td><td></td><td>-</td><td>-</td><td>-</td><td>62.69</td><td>65.04</td></td<>	86.76	19-29		-	24.07	21.72	23.09	-		-	-	-	62.69	65.04
80.75 12-22 18 17,01 62.75 63.74 63.74 63.75 63.74 63.74 63.74 63.74 63.74 63.75 63.74 71.67 90.24 22-32 31.78 2 22.93 18.57 29.91 71.67 60.95 59.75 59.75 53.63 71.67 90.24 23-38 37.5 4 27.02 28.93 18.91 71.67 59.75 59.75 71.67 71.67 90.03 47-52 50.65 2 30.31 17.99 30.31 72.05 59.75 71.76 71.67 90.03 47-52 50.65 2 2 2 71.67 71.67 71.67 71.67 71.67 71.67 71.67 71.67 71.67 71.67	89.76	22-32		-	27.05	24.72	26.07	-			-	1	62.71	65.04
90.68 22-32 31.78 c - 27.05 >31.78 nm nm nm nm etc. 63.63 90.24 22-32 29.75 2 - - - 27.22 >29.94 18.57 >29.75 71.67 650.55 59.75 71.67 88.36 18.28 29.91 2 - - - 24.7 28.55 16.66 28.61 71.7 59.75 71.7 90.04 23-38 37.5 4 - - 24.7 28.55 16.66 28.61 71.7 59.75 71.7 90.04 23-38 37.5 4 - - 24.7 28.45 11.59 30.31 72.05 59.73 72.05 90.05 23-50.65 2 - - - 23.45 11.59 71.67 71.67 71.65 90.18 13-240 37.24 17.53 11.59 23.51 71.65 59.74 71	80.75	12-22		-	18	:	17.01	-	-	I	-	-	62.75	63.74
90.24 22-32 29.75 29.94 18.57 >29.75 71.67 <60.95 <59.24 71.67 88.36 18-28 29.91 2 - - 24.7 28.55 16.66 28.61 71.7 59.75 59.75 71.7 88.36 18-28 29.91 2 - - 24.7 28.55 16.66 28.61 71.7 59.75 59.75 71.7 90.03 47-52 50.65 2 - - - 30.3 18.01 30.31 72.05 59.73 59.73 72.05 90.03 47-52 50.65 2 - - - 30.3 18.01 30.31 72.05 59.74 59.73 72.05 91.18 13-28 30.95 2 - - - 23.45 11.59 73.16 71.65 91.18 25-40 36.86 2 1 19.23 14.16 71.45 71.65 71.65 <	90.68	22-32	31.78	2	-	1	27.05	>31.78	nm	nm	шu	un	<59.22	63.63
88.36 18-28 29.91 2 - 24.7 28.55 16.66 28.61 71.7 59.75 59.75 71.7 90.04 23-38 37.5 4 - - 30.3 17.99 30.31 72.05 59.73 59.73 72.05 90.03 47-52 50.65 2 - - - 30.3 18.01 30.31 72.05 59.73 59.73 73.05 90.03 47-52 50.65 2 - - - 30.3 18.01 30.31 72.02 59.73 73.05 83.24 13-28 30.95 2 - - - 31.37 19.23 31.41 71.65 71.65 71.65 91.18 25-40 37.25 2 - - - - 31.37 19.23 31.41 71.95 59.74 71.65 92.12 31.31 2 37.41 71.65 59.71	90.24	22-32	29.75	2	-	1	27.22	>29.94	18.57	>29.75	71.67	<60.95	<59.24	71.67
90.04 23-38 37.5 4 30.3 17.99 30.31 72.05 59.73 59.73 72.05 90.03 47-52 50.65 2 30.3 18.01 30.31 72.05 59.73 72.05 72.05 90.03 47-52 50.65 2 30.3 18.01 30.31 72.02 59.73 71.65 72.02 83.24 13-28 30.95 2 23.45 11.59 23.41 71.65 59.74 71.65 91.18 25-40 36.86 2 31.37 19.23 31.41 71.95 59.77 71.95 92.12 25-40 37.35 2 </td <td>88.36</td> <td>18-28</td> <td>29.91</td> <td>2</td> <td>-</td> <td>1</td> <td>24.7</td> <td>28.55</td> <td>16.66</td> <td>28.61</td> <td>71.7</td> <td>59.75</td> <td>59.75</td> <td>71.7</td>	88.36	18-28	29.91	2	-	1	24.7	28.55	16.66	28.61	71.7	59.75	59.75	71.7
90.03 47-52 50.65 2 - - - - 30.3 18.01 30.31 72.02 59.72 59.72 72.02 72.02 83.24 13-28 30.95 2 - - - - 23.45 11.59 23.5 71.65 59.74 71.65 91.18 25-40 36.86 2 - - - 31.37 19.23 31.41 71.95 59.77 71.95 92.12 25-40 37.25 2 - - - 32.37 19.23 31.41 71.95 59.77 71.95 92.12 25-40 37.25 2 - - - 32.37 19.58 32.41 71.47 59.71 71.95 87.63 34.131 2 - - - 28.78 16.16 27.81 71.47 71.47 91.86 28.52.95 28.71* 29.82 59.82 59.82 71.47	90.04	23-38	37.5	4	-	1	-	30.3	17.99	30.31	72.05	59.73	59.73	72.05
83.24 13-28 30.95 2 23.45 11.59 23.5 71.65 59.74 71.65 71.65 91.18 25-40 36.86 2 31.37 19.23 31.41 71.95 59.77 59.77 71.95 92.12 25-40 37.25 2 32.37 19.58 32.41 71.95 59.77 71.95 92.12 25-40 37.25 2 32.37 19.58 32.41 71.95 59.71 71.95 92.12 25-37 34.31 2 32.37 19.58 32.41 71.47 59.71 71.47 87.63 28.51** 2 - 28.78 16.16 27.81 71.47 59.82 59.82 71.47 91.86 28.5-29.5 28.71** 2 - - - 28.78 10.08 mm 72.78	90.03	47-52	50.65	2	-	1	-	30.3	18.01	30.31	72.02	59.72	59.72	72.02
91.18 25-40 36.86 2 31.37 19.23 31.41 71.95 59.77 59.77 71.95 92.12 25-40 37.25 2 32.37 19.58 32.41 71.95 59.77 59.77 71.95 87.63 25-37 37.25 2 28.78 16.16 27.81 71.47 59.71 72.54 87.63 22-37 34.31 2 28.78 16.16 27.81 71.47 59.82 71.47 91.86 28.5-29.5 28.71** 2 28.78 16.16 27.81 71.47 59.82 71.47 91.8 25.6-26.6 25.67** 2 28.78 nm 72.78 nm 72.78	83.24	13-28	30.95	2	ł	1	1	23.45	11.59	23.5	71.65	59.74	59.74	71.65
92.12 25-40 37.25 2 32.37 19.58 32.41 72.54 59.71 59.71 72.54 87.63 22-37 34.31 2 28.78 16.16 27.81 71.47 59.82 59.82 71.47 91.86 28.5-29.5 28.71** 2 28.78 16.16 27.81 71.47 59.82 59.82 71.47 91.86 28.5-29.5 28.71** 2 19.08 nm 72.78 nm 72.78 91.8 25.6-26.6 25.67** 2 7 18.96 nm 72.84 nm 72.84 nm 72.78	91.18	25-40	36.86	2	-	1	-	31.37	19.23	31.41	71.95	59.77	59.77	71.95
87.63 22-37 34.31 2 28.78 16.16 27.81 71.47 59.82 59.82 71.47 91.86 28.5-29.5 28.71** 2 nm 19.08 nm 72.78 nm nm 72.78 91.86 28.5-29.5 28.71** 2 nm 19.08 nm 72.78 nm 72.78 91.8 25.6-26.6 25.67** 2 7 78.96 nm 72.84 nm 72.84	92.12	25-40	37.25	2		ł	-	32.37	19.58	32.41	72.54	59.71	59.71	72.54
91.86 28.5-29.5 28.71** 2 1 1 19.08 nm 72.78 nm 72.78 91.8 25.6-26.6 25.67** 2 1 18.96 nm 72.84 nm 72.84	87.63	22-37	34.31	2		ł	-	28.78	16.16	27.81	71.47	59.82	59.82	71.47
91.8 25.6-26.6 25.67** 2 m 18.96 nm 72.84 nm 72.84 nm 72.84	91.86	28.5-29.5	28.71**	2				nm	19.08	nm	72.78	nm	nm	72.78
	91.8	25.6-26.6	25.67**	2				nm	18.96	nm	72.84	nm	nm	72.84

Notes:

¹: MW-1, MW-2, and MW-3 elev surveyed 10/26/06. MW-4 through MW-12 and SGPs surveyed 9/2/09 (data from Shannon & Wilson Table 6.4-1 and Appendix N). TOC = top of casing GW = groundwater in = inches bgs = below ground surface ft = feet wells are decommissioned -- = well does not exist nm=not measured

											Dichloro-		Carbon	
			Screened	Well	Well					Vinyl	difluoro-	Carbon	tetra-	Chloro-
Monitoring			Interval (ft	Depth (ft	Diameter		TCE	tDCE	CDCE	chloride	methane	disulfide	chloride	form
Well	Sample ID	Sample Date	bgs)	bgs)	(in)	PCE (ug/L)	(ng/L)	(ng/L)	(ug/L)	(ng/L)	(ng/L)	(ng/L)	(ng/L)	(ng/L)
	Table C (Cleanup Level (I	(T/br.			5	5	100	20	2	2300	3700	5	140
N/N/-A	not sampled; covered by Conex		17-27	31 78	ć	1			:				;	:
MW-5	11-AWA-010-GW	5/11/2011	22-32	29.94	2	ND(<0.4)	77	ND(<0.4)	ND(<0.4)	ND(<0.4)	0.55	ND(<0.2)	ND(<0.4)	ND(<0.4)
MW-5 (Dup)	11-AWA-011-GW	5/11/2011	23-38	29.94	2	ND(<0.4)	11	ND(<0.4)	ND(<0.4)	ND(<0.4)	0.56	ND(<0.2)	ND(<0.4)	ND(<0.4)
	well was dry	10/18/2011						-	well dry-	no sample c	collected	-	-	
MW-6	11-AWA-004-GW	5/10/2011	18-28	30.1	2	ND(<0.2)	ND (<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	0.79	ND(<0.2)	ND(<0.2)	ND(<0.2)
	11-AWA-016-GW	10/19/2011				ND(<0.2)	ND (<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	0.54	0.39	ND(<0.2)	ND(<0.2)
MW-7	11-AWA-002-GW	5/10/2011	23-38	38.11	4	ND(<0.2)	ND (<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)
	11-AWA-015-GW	10/19/2011				ND(<0.2)	42	0.3	3.1	ND(<0.2)	2.1	ND(<0.2)	ND(<0.2)	ND(<0.2)
MW-8	11-AWA-003-GW	5/10/2011	47-52	52	2	ND(<0.2)	ND (<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)
	11-AWA-014-GW	10/18/2011				ND(<0.2)	ND (<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)
6-WW	11-AWA-001-GW	5/10/2011	13-28	31.13	2	ND(<0.2)	ND (<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)
	11-AWA-013-GW	10/18/2011				ND(<0.2)	ND (<0.2)	ND(<0.2)	0.26	ND(<0.2)	0.85	ND(<0.2)	ND(<0.2)	ND(<0.2)
MW-10	11-AWA-006-GW	5/10/2011	25-40	38.86	2	ND(<0.2)	ND (<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)
	11-AWEA-020-GW	10/19/2011				ND(<0.2)	ND (<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)
MW-11	11-AWA-008-GW	5/11/2011	25-40	38.25	2	ND(<0.2)	ND (<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)
	11-AWA-018-GW	10/19/2011				ND(<0.2)	ND (<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	0.54	ND(<0.2)	ND(<0.2)	ND(<0.2)
	11-AWA-019-GW	10/19/2011				ND(<0.2)	ND (<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	0.53	ND(<0.2)	ND(<0.2)	ND(<0.2)
MW-12	11-AWA-005-GW	5/10/2011	22-37	34.46	2	ND(<0.2)	ND (<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)
	11-AWA-017-GW	10/19/2011				ND(<0.2)	ND (<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)
SGP-2	11-AWA-009-GW	5/11/2011	28.5-29.5	29.5	2	ND(<0.2)	ND (<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	0.22	0.24
SGP-9	11-AWA-007-GW	5/11/2011	25.6-26.6	26.6	2	ND(<0.2)	0.29	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)	ND(<0.2)
DRUM	11-AWA-012-GW	5/12/2011	na	na	na	ND(<0.2)	ND (<0.2)	0.22	ND(<0.2)	ND(<0.2)	ND (<0.2)	ND (<0.2)	ND (<0.2)	ND (<0.2)
DRUM	11-AWA-021-GW**	10/20/2011	na	na	na	ND(<0.2)	ND (<0.2)	0.33	ND(<0.2)	ND(<0.2)	ND (<0.2)	ND (<0.2)	ND (<0.2)	ND (<0.2)

<u>Notes:</u> ft = feet in = inches bgs = below ground surface ug/L = micrograms per liter AWA = Aniak White Alice

GW = groundwater

ND = not detected na = not applicable PCE = tetrachloroethene TCE = trichloroethene cDCE = cis-1,2-dichloroethene t-DCE = trans-1,2-dichloroethene

* 18 AAC 75.345(b)(1) Table C Groundwater Cleanup Levels Results exceeding Table C Cleanup Levels shown in bold

** Other detections: acetone 9.6 ug/L and 2-Butanone 13 ug/L
Table B-3: 2011 Groundwater Monitoring Results Geochemical Data Aniak WACS, Alaska

		Manganese,	total (mg/L)	:		ND (<0.005)		ND (<0.005)		ND (<0.005)		0.269		ND (<0.005)			0.253		0.245		ND (<0.005)		ND (<0.005)		3.44		5.23
		Iron, total	(mg/L)		QN	(<0.100)	QN	(<0.100)	DN	(<0.100)	DN	(<0.100)	DN	(<0.100)		QN	(<0.100)	DN	(<0.100)	DN	(<0.100)	DN	(<0.100)		129		128
	Manganese,	dissolved	(mg/L)			ND (<0.005)		ND (<0.005)		ND (<0.005)		0.252		ND (<0.005)			0.278J		0.51		ND (<0.005)		ND (<0.005)		0.312		0.781
	Iron,	dissolved(mg/L)		DN	(<0.100)	ND	(<0.100)	Б	ND	(<0.100)	ND	(<0.100)	ND	(<0.100)		5.14		6.57								
		Sulfate	(mg/L)			11.9		12.2		11		13.3		13.7			16.1		10.9		11.4		9.1		5.4		4.6
		Chloride	(mg/L)	-		4.5		4.4		3		2.4		2.7			2.6		2.1		2.3		2.1		23.1		15.2
Total	Organic	Carbon	(mg/L)	-		0.72		0.68		0.67		0.46		0.66			0.59		0.63		0.79		0.71		3.23		2.21
		Nitrogen	(mg/L)			2		1.83		1.72		0.53		1.29			0.7		1.21		0.88		1.65		1.05		0.57
		Alkalinity(mg/L)	-		123		121		123		127		154			137		123		129		119		92		94
		Methane	(mg/L)		ND	(<0.007)	ND	(<0.007)	ND	(<0.007)	ND	(<0.011)	ND	(<0.007)		ND	(<0.007)	ND	(<0.006)	ND	(<0.007)	ND	(<0.007)	ND	(<0.007)	ND	(<0.007)
		Ethene	(mg/L)	-	DN	(<0.010)	ND	(<0.010)	ΠN	(<0.010)	ΠN	(<0.016)	ΠN	(<0.010)		ND	(<0.010)	DN	(<0.008)	ND	(<0.010)	DN	(<0.010)	DN	(<0.010)	ND	(<0.010)
		Ethane	(mg/L)	1	QN	(<0.010)	QN	(<0.010)	DN	(<0.010)	ΔN	(<0.016)	DN	(<0.010)		ND	(<0.010)	ΠN	(<0.008)	ND	(<0.010)	ΠN	(<0.010)	DN	(<0.010)	DN	(<0.010)
			ORP (mV)	1		99				78		147		129			141		169		20.3		116		31		201
			DO (mg/L)	1		4.6				0.87		0.82		1.1			7.4		0.79		1.3		0.95		3.2		7.1
			Ηd	1		7.6				6.3		6.4		6.4			6.4		6.3		6.4		6.2		8.4		5.9
	Well	Diameter	(in)	2		2		2		2		4		2			2		2		2		2		2		2
	Well	Depth (ft	(sgq	31.78		29.94		29.94		30.1		38.11		52			31.13		38.86		38.25		34.46		29.5		26.6
	Screened	Interval (ft	bgs)	22-32		22-32		23-38		18-28		23-38		47-52			13-28		25-40		25-40		22-37		28.5-29.5		25.6-26.6
			Sample Date			5/11/2011		5/11/2011		5/10/2011		5/10/2011		5/10/2011			5/10/2011		5/10/2011		5/11/2011		5/10/2011		5/11/2011		5/11/2011
			Sample ID	not sampled; covered bv Conex		11-AWA-010-GW		11-AWA-011-GW		11-AWA-004-GW		11-AWA-002-GW		11-AWA-003-GW			11-AWA-001-GW		11-AWA-006-GW		11-AWA-008-GW		11-AWA-005-GW		11-AWA-009-GW		11-AWA-007-GW
		Monitoring	Well	MW-4		MW-5		MW-5 (Dup)		MW-6		MW-7		MW-8			6-MM		MW-10		MW-11		MW-12		SGP-2		SGP-9

ft = feet in = inches bgs = below ground surface mg/L = milligrams per liter AWA = Aniak White Alice GW = groundwater

ND = not detected na = not applicable J = estimated value

FIGURES



ATTACHMENT 1

Field Notes and Water Sample Data Sheets

Ground water Study - May II *** ALL-WEATHER **TRANSIT** No. 303 n o k cle was 30 ľ ľ ľ 0 ľ Ľ ſ ľ ſfor outdoor writing people." paper created to shed water and enhance the Available in a variety of standard and custom printed case-bound field books, loose leaf, spiral and stapled For best results, use a pencil or an all-weather pen. "Rite in the Rain" - A unique All-Weather Writing written image. It is widely used throughout the world for recording critical field data in all kinds of weather notebooks, multi-copy sets and copier paper post-consumer recycled material. RECYCLED / RECYCLABLE J. L. DARLING CORPORATION Tacoma, WA 98424-1017 USA www.RiteintheRain.com Item No. 303 ISBN: 978-1-932149-83-8 Made in the USA US PAT NO: 6,863.940 "Outdoor writing products... This cover contains 32281 30311 a product of ¢3 0 ø 16.66

CW sample dataloges "Rite in the Rain" - a unique all-weather writing surface created to shed water and to enhance the written image. Makes it possible to write sharp, legible field data in any kind of weather. Aniak White Alice Sike . @ J. L. DARLING CORPORATION ה ו TACOMA, WA 98424-1017 USA www.RiteintheRain.com Enter Enter to ALL-WEATHER WRITING PAPER 14-201-2a product of O wyuulenhous cle in m 000 100 Address Project Phone Name I 100

1300 Ern NCDonald 04515 conducts tailsate safety meeting conducts OASIS at Aurert Airbort & Fransport to Aurah Middle School 1400 0 Lu Era Carso V 1500 Rena Byan & Will Rhoder NON, 5-9.11 about replacement for MW. Ym 50 E, Sun to 10 cate , 5 wins 40, 9090 d Reterin the Rein record observations on well 1830 0 45 15 offsite will call Jane tomorrow am. to cale 1240 Charlie Thacker pickup Amal WACS 14-201-2 eres Conditions VO-WIDSI/ See table R. B. van Q Ű U DATE Kusput 174250331e CONTENTS Internet.

R. B-201 ANJak WACS 505 Sun W. Chodes 14+201-2 Non, 5-9-11	Calins Movement Observations	Other Movement Description DLot	No. 1. Lect + 4464. 375'String 368.369	Minor: Flush, 36.8'string 370 371	9 savel sabside d Could Consider replacead 372 .	NO intact duck	No, 1,1 fact fluch, 33.53 +11-0376,377	No. in Fact Stickup. 30.55string 378. 379.580	Vellow Stickaph Swamp		NO. Intect Plush Closed to Level 1: 4 382 383 834	Lewoh, Closest to Care 385 386	* 05-built leselme conflicts w toste	labeling for MW.128	NO 1 Mach 1 Clush 2" 10 387, 388, 389, 380	L Aderne M. COREX	No. Intact Cluck recolars wert for 393		No n La Ch Llesh, replacement for 394,395		1431-443-			3 of 3 Rear the land
50 E. Sun Mon, 5: 9-11	Ne II	rost Jacked	2 2 2 2	N o				0 2			2 ~ ~)			° 2		Na Na) ~~~~	0				•
Aniak WACS 14-201-2	DTw TD	J (2018 +1) (2018 +	0.23' 37.25'	1.69' 36.86'		1.05/ 29.91	.56' 34.31'	50' 30.95'			1.311 50.651	:34' 37.5'		•••••	82 29.75'		V/A 15.52		1.72' 28.41'		×.96' 28.71'	: q2: 1,25.67.	X	2 of 3
2. 8-2010 V. Rhodes	me Well	HTCO ANTE	44 WW 11 2	06 MW-10		1 J WW C I	33 JMW-1.2 16	48 NW-9	(AMA-JUB)	~ Mursell	703 NW-7 18	S 8-WW L I			32 MW-5 18.	4 0 MW-4	58 ANNA	590 ?		592 3	11 1549 5902	11 0920 530 9 19	Refe	

MNA Sample, Sample 1D: 11- AWA-005-30 E overrast Tucs, 5-10-1 Sample on NW-10, Sample 10: 830 Move to MW-10, see datasheet 720 Move to MW-12, see datasheer 1910 Collect NOC & MNA primary Reprinted Rowing 2010 C) ASIS ollsike, samples on ite In cool metal shop room. 2000 Check email on Sgp. 9 800 collect MW-12 primary Vac 2 Send email On deploying 11- AWA-006-EW Anak WACS 14-201-2 da La 1058ers N, Rhodes N J 2,00,00 1200 move to MW-75 closest to fuelline, 730 call / email Jane updafel 0715 (Dadact tadsets Safety meting I Ĵ 1031 mobilize to NW-9, See datasheef Ű Ц П Π Ω 1350 collect VOC 2 MNA primary On MW-J Π П Q Ω 1615 cullect Voc 2 MNA primaryon MW-9, Sample 10:11-AWA-001-6W 1415 move to MW-8*, closes to fence, 1455 collect VOC 2 MNA primary on 1125 collect VOC & MNA primary on * note as built labeling conflicts w/ NW-8. Sample 10:11-AWA-003-GW Tues 5.10-11 305,840 1230 break for lunch, Chick email: also Sample Sgp-9 in addition for MW-4 Shut to use sgo2 NW-6, Sample 1D: 11-AWA-004-6W use sgp3 as a replacement 1030 CONFIRM W Jane to not replacement well guestion 525 move to MW-6, see datasheet Sample 1D: 11- AWA-002-GW table labeling for MW-7 28 0830 calibrate JSI Amol WACS 14-201-2 9 E Seo datasheet W. Chodes Revan Ø

Dump Set up w/ 12" poly & Silicone amps Increased to 4 then decreased 07 11 W-11 5 ample 1D: 11-AWA-008.6W Wed, S-N. 11 W/ AC power Stopped again when forward Switch flipped of from Jane Switch to peristally pump S9 P-9 pump. Upon Set up at MWIN Sultz may have been too furbud for fulta VOC & Ormery MNA Samples HOESUN 505 collect primary & ms/msd Relation the Rente working started working again to zero, control bex stopped 549 move to Sgot 2 , see dahashed , ~ ~ 2 2 330 return to MW-11, peristaltic a hoto Dho to ot or a e hoto × 40to p Koto Fultz pump 1 SSUE SUMMARY: Fabing - OK From Jane 590°2 590°2 500 590.9 4nca k WACS 596 ~ 2 14-20-2 S 9 0 1 Shoot Kultz pump <u>т</u> 87 И の オ オ プ () 7 7 n Sec Sec and the second 143 ete sege 43 43 138 W. Rhoder R.Bran 523 25 9 526 52% 523 Q 0 0800 replace le 1 Sample cooler U П IJ U Ш П U U Ц 040 collect VOC & MNA primary Wed, 5-11-11 Sampled as 14 15 a Soil gas point. 200 break for lunch, more trouble A portron of the purge time and high turbidity of the water is 0920 mobilize to Sgp. 9 see datasheet This well had not been previously 0715 W. Rhodes conduct tad safe Scumple on Sgp-9, Sample 1D: 305 , Sun 1115 move to NW-11 see detasheet contrar to do MNAS ON S9 p.9 and move to Shade outside 034 Water quality parameters dup VOC ON MW-5 ms/msd On MW-11) calibrate US1 0830 Check easil Cram Jane, attributed to no prior well 120 troubleshoot fults pump Amak WACS 14-201-2 N-AWA-007-6W 4 6 Mark Cutrance. salety meching development. Stabulize W. Chodes R, BOUAN

305, sun R.Bryan Amak WACS 305 dear		V. ZO45 Sawple Summay.	"side Date Time Well Sample ID VO C MNA Notes	1 2019. 5-10-11 1125 MW-9 11-AWA-001-CW X X	ver 510-11 1350 MW-7 11-AWA-002-CW X X	to 5-10-10 1455 MW-8 11-AWA-003-6W X X	210 m 5-10-11/1615 MW-6 11-AWA-0046W X X	5-10-11 [800 MW-12 11-AWA-0056W X X	X X X X X X X X X X X X X X X X X X X	5-11-11 1040 3pg-9 11-AWA-007-6W X X	Where S-11-11 1505 MW-11 11-AWA-008-6W X X NOCOMP	5-11-11 1730 3922 11-AWA 0096W X N X	Lee 5-11-11 1850 MW5 111-AWA-010-64 X X	Sh MUA 5-11-11/1910 MW-5 11/2MA-011-6W X X 44011-641	WNA 512-11 108451 DRUM 111-AWA-013-6W X Characterizat	sample - 2100 checked evelogsers are all	Correctly 109,5119 - Started SY 8.400	didnot - 6 hr interval casonable room	tem t	MUA 2120 draw SWIR9Hes For Wellssampled	D: 2300 preples.	2330 OASIS ollerte	2 WNA		the second se
R.Bryan Anak WACS 301	W. KADOCO 1659 Hole IN SiliCONE Fubing COUSED	pumping cleday. Begin pumping.	1725 Sand began depositing insid	The Dow through cell during ourse.	Water aughts Darameters not vet	stable decide to sample to	and closena the 251 & Clar		130 Pollock Inc & ANA Dr.	in source in the Distance	11 A 2 4 00 - 4 10 - 11	contain water and Sand.	1808 moverto MW-5, see datawheet	810 descover we have enough 1	bottles to do a duplicate MNA	as well as cluplicate voc sam	en MW-S	1849 Water guality parameters dia	stabilize	1850 Cellert Drimary VOC & MU.	Sample & MW-S Sample 1D.	11- AWA 010-6W	1910 Collect duplicate VOC 21	sample on MW-5, Sample It	











Thur 6, 5-12-11 COMPLETE COC.) PACK COOKENS. drum where swarsing was occuring 40F, Sun Cate in the have Sparsing continued over nightar 2 mishts, until 0840 on 5-12-11. 4 nishts, until 0840 on 5-12-11 0905 QA/QC Samples & 35,75 - 8700 leasth to measurement live 34.8018700 27.92 13706 29.65' BTOC 32.64' BTOC 32.02 8700 33.60, 8700 35.7518700 1.28, 8700 XXX 1/2 Anak WACS <1/3 1135 04515 offsite 2000 14-201-2 Supplies. 0ASIS 10 10/00 OASIS/ocalian Soilgas point Soil oas wind DTW-16.31. SQW10calion 52W location 1054 89r SQW location SQW (oct.on SOW LECTION Barologger R. BUAN 00 0 0 U 11 5-gal bucket & transferred to 55-gal U U I U purge & decon water was containerized 2655 MW-5 18.06 18.05' 29.75' 1062390 MW-7 17.67' 17.66' 50.65' 1062873 0755 390.9 18.95' N/A 28.71' N/A 0755 390.9 18.95' N/596' 25.67' N/A 0710 MW-7 17.67' 17.66' 5065' 1062728' TIME Well DTWW/ DTWW TD Hahalogser MW-9 11.14' 11.14' 30.95' 1062388 MW-8 17.68' 17.68' 37.5' 1062265 MW-10 18.97' 18.97' 36.86' 106287 MW-11 19.54 19.54 19.64 37.25 1062866 Sample (VOC ould) from sparging Oby 5 Qustre te gage wells & deploy Sampling each well (S-10-11 - 5-11-11) 0845 collect waste characterization MW-12 15,81' 15,81' 34.31' 1061507 Tuns, 5-2-11 40 FJ SUN purge water / decon water drum, 0630 conduct tailsafe safety Sample 10: 11-4WA-012-QW Purge/decon water summary: Atter ANDER WALS 4-2013 200 datalogs s weeting W. Rhedes K. 5300 LALC 0110 0739 0725) 701 0230

Book # 2 ANIAR - WHITE ALICE GUANANIGG TIONS SITE taurs areavanter strag Kite in the Kain. ALL-WEATHER **FIELD** Nº 353N PRUJECT # H-201 ×, Ŗ R R R R R

RAZU/CLOUDS	255°	NITHC	ATE LUNCH.	which Levensalions	CA NOTES	90 N/A	W/A CEPTINE SORE SORE	73 PERNYED W/STEEL CABLE 34 80	S N/A	88 CARLE @ 29.65 872C	126-0ERLOYED ON STEEL 57 CABLE @ 31.64' 1375C	STZLL ON STATING	Trzue on Stazowa	These PARLED ON TOP	N/A	28 BAROLOKUEN (3-1)	TTU ATCR & 14:00	LTNG.		IEUS FUR RE-DEPROYZNG	ARE ON SZUJSTRING.	E REPLACED IN VELL		NA, LEVELOCIEN DWNLD	TEEL WHENE POSSEBLE		
6/21/2 E.ALLONHID	Haithe ANIANE	II'SO APPENED IN A	IT:15 UNPARE GEAR	13:00 PREPED TO PO	TIME NELL DTW LOGL	15:35 MW-528.65 10623	18:35 MW-6 86.77 N/A	14:05 MW-7 28.46 10628	14:35 MW-8 28:45 106 226	15:55 MN-9 21.61 10623	16:40 MN-10 29.53 106280	18:00 MM-11 30 60 106286	17:30 MW 1225.86 106/50	56-2	18:20 66-9 DRY N/A	MN-7 10627	13:15 FOUND WELLS - UAI	READING BEFORE AN	12:25	17:30 RAN ONT OF SWITH	LENBLOUGHERS WHICH	MW-11 \$ MW-12 WER	V/STRZNU.	18:40 DOMPLETED GAGE	# RE-DEPUNTNG W/S)
	I.	Q			Q.	Q					,		Ŵ	U				R			R.	F			A	A	

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2 Chapit an EMCOMPLO	tetter Juston	NOTE: STRANK WAS PRETTY STREPENT, SOMEWAAT	DIFFICULT TO TELL WHERE THEY WERE MEASUR	U. I ACHSURCED STEEL LENGTH PASED an	MEASUREMENT RECORDED BY R. BRYAN ON 5101. J	WESDO OF STORED WERE TO STOP OF OASMY	WEWIVEL CLIP.	HO FRUM MAY EVENT DED DAME WAY OF	lesucts. WORKING ON 14-184.	21:45 EMAIL COOP & JANE. END OF DAY.										

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1405 MW-9, dept to water=21, BEA 1415 MW-9, DTW=20, 71FE 1415 MW-6, DTW=20, 70 FE 1600 NW-6, DTW=20, 70 FE 1600 NW-6, DTW=26, 99FE 1000 NW-6, DTW=26, 99FE 1000 NW-6, DTW=26, 99FE 1000 NW-6, DTW=26, 99FE 1000 NW-6, DTW=26, 70 FE 1000 NW-6, 70 TW=26, 70 FE 1000 NW-70, 70 FE 1000 NW-9/22/3 HATTING BYS ANNE ON SITE + UNCOVER [1225 ANIAK sound N. Alil-1-1-1-5 U MUMMAL T I DIFFICULT TO TELL WHERE PIEY WERE MONSURA NOTE: STREML WAS PRETTY STREPENY, SOMEWART NESPO 2020 10 549 20 549 20 05 05 04 04 11/21/2 MEASURENENT REQUEDED BY R.BRYAN ON TU. I MEASURED STEEL LENGTH BASED IN 9:45 SET up SYPHON TO DZOPOSE OF PURUE 21:45 EMAIL OWOY & JANE. END OF DAY. 4.0 FRUM MAY EVENT PER ANANTICAL RESULTS. WORKING ON 14-184. EMCOMPLO MACRE W/SWINEL LLIP. 2 haple m 17-17-

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۳ ۵ 10/13/11 Sample 10: 11-AWA-018-GW T.M. 1745 14 Time: 1755 Sample 10: 11-AWA-017-GW Time: 1650 1400 Remove, download, re-deploy duta loggers 1030 Loud up gear on 4-wheeler. Pump stopped working while taking Submersible pump was not able Sample 10: 11- 40.4-015-GL) porouneters. Changed pumphead Sample 10: 11-44 4-016-GM for this well so used bailer. to have low enough flow Sample 10: 11- AWA-019-GW A150 Collect M5/M50 10 40 Set up on MW-8 10/calut and it worked fine 11. Da (104 E. R. Buñen 1140 Set up on Mul-6 set up on MW-11 1550 Set woon MW-12 Lsee ner padel Aniak HIME: 1115 moren Calibrate 451 time: 1330 Wercust dup + 30° = 1720 0 Street and Street pulling solution Rain/Snoo +35°F Sample 10: 11-AWA-014-GW Sumple 10: 11-AWQ-013-6W Pack up gear and return to unpuck gear at School set up on MW-07 N. Ballou Fet up on MW-09 Arial Calibrate 4S1 time: 1835 School. 10/18/11 いとら 1800 14 30 1400 1640 5181

Hel Runder Frank 7. Birling Frank Anish 7. Birling Frank Olucions -Mill-B. -Mill-B. -Mill-B. - looking trunads Munintentrance - Room Mul-B - looking trunads Munintentrance - Room Mul-B - looking trundertion From Mar-S - looking trundertion From wood shop - underna Foundation From - wood shop - underna Foundation From - Mul-II - Bucklede of SSO trailer From MW-II - From anderdae of Sobrailer - from and for Mul-II - Rund on the Sobrailer - Bubbler System of puge water - Mul-IO - Bubbler System of puge water - Mul-IO - Bubbler System of puge water - Mul-IO - Mul-IO - Mul-IO - Mul-IN - Mul-IN	10/19/11 ANIAK E.A.COMPLEN	TIME WELL DIW DIW LOGGER NOTES	1409 MW-S N/A N/A 1062390 DRY	14 20 MW-7 30.31 30.31 1062873	14 27 MW-8 30.31 30.31 1062265	► 14 51 MW-9 23.50 23.50 1062308	15 05 MW-10 31, 41 31, 41 106 28 67 STRIAUL 33. 38	UN 15 19 MW-11 27.81 N/A 10628 66 CABLE 33.60	15 35 MW-12 106 15 0 + CABLE 32.02	NOTE: AS DESORIBED ON 6/20/11 THE STRIME	WERE VERY STRETCHY \$ IT WAS DIFFICALT	TO DETERMENTE WIERE TO MEASURE FRAM.	AN ATTEMPT WAY MADE BY PULLTUK, NUT TO	THE MAX, BUT FIRMUN & THEN MEASUREDUL	TO THE INTENIAR CAP RINK. THE CABLE WAS	THEN ULT TO ARTEN THE LEVETH ACTIVERED	DECORDED ON S/12/11. THE DIPPERENCE SHOWS	ENROR INTRODUCED. IT IS NOT CLEAR WHY	THE MEGSURED STREAMS LEWGTH IN MW-11	whe shouted trith neganices an S/12/11.		MMIOT	- Andrew -	nk.	
	P. Runder + 30'S	que photos remained by	* pooking towards MW-9 From	· looking towards Main Entrance	From MK-B	· looking towards former	anterna foundation from New-5	leading at word shap close	·looking at high school from	· antenna Frandation Fronn		· Buckside of sso trailer From	M.W.V.	From backside of Soptrailor	looking towards runway	"From antenna Found. to MW-11	"Anterna found to high school	01-MM.	· Burnt out pump (2 photod)	· Bubbler system of puge water	· Main entrance SPVC	· Mlx6-4 not accessible	* Temp Ferry From Mud-5	have MEN-9 toward know	

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N. Barlion R. Barlen	Anial + 305	on MW-10	10: 11-444-020-6W	i dear and return		W-5 was dry	nple was fallew.	reference to							· · · · · · · · · · · · · · · · · · ·					•			· · · · · · · · · · · · · · · · · · ·	
N. Barrion R. Berrion	Anial + 205	up on MW-10	16 10: 11-4WA-020-6W	up day and return	h Sh Sh	MW-5 was dry	sample was factor.	purge water to							and the second sec							· · ·		
N. Ballow Beriev	Aniut + 305	+ up on MW-10	mple 10: 11-4434-020-64	the 1030	school	770: MW-5 was day	no sample was taken.	le purge water to	belex	316													· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·
N. Ballow Berich	Anine + 305	set up on NW-10	Sample 10: 11-444-020-64	Pack up dear and return	to school	NOTE: MW-5 was dry	so no sample was taken.	Take purge weater to	bubbler	०स् अह					· · ·	ANACA				•				· · · · ·
N. 184 liou B. Berten	111 Priver + 305	20 Set up on MW-10	Sample 10: 11-4434-020-64) Pack up dear and return	to school	NOTE: MW-5 was dry	so no sample was taken.	Take purge weather to	bubbler	0년 3년						A								
R. Barien Durchsch	10/14/11 Anial + 305	1800 set up on MW-10	Sample 10: 11-4WA-020-6W	B40 Pack we gear and return	to school	NOTE: MW-5 Was dry	so no sample was fallew.	100 Take purge weater to	bubbler	115 off Sile					and the second sec	ANNY								
R. Berrich Durchsch	10/10/11 Anial 205	1800 Set up on MW-10	Sample 10: 11-4474-020-64	1840 Pack we day and return	to school	NOTE: MW- 5 was dry	so no sample was fallew.	1900 Tarke purge weater to	bubbler	1915 off Sile														
R. Ballow R. Barier	colection Anime + 305	1800 Set up on MW-10	Sample 10: 11-4414-020-64	1840 Pack up day and return	to school	NOTE: MW-5 was dry	so no sample was fallen.	1900 Take purge water to	bubbler	1915 off Sile														



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	Lov	v-Flow	Groun	dwater Sam	npling	g with N	/linimal	Drawc	lown V	Vorksh	eet	TAINING BELLING AND ARD
Proiect # :	14-201	. Phase 2						Well ID: Date		<u>MW-</u> 5-10	9	
Project Name	Aniak	WACS ES						art Timo		104	10	
Site:	Aniak	WACS					- Si	nd Time:	······	1 58 1		
Field Team:	ľ	2. Brol	2n / V	V. Rhodes	»			na mno.				
Sample ID:	11-1	AWA-	001-1	GW	Time:	1125	primary	🔿 dup	split	ms/msd		
Sample ID:					Time:		primary	dup	split	ms/msd		
Sample ID:	<u>,</u>				Time:		primary	dup	split	ms/msd		
Purg	ing and	Sampling	g Methoo	d (e.g. peristalt	tic, bla To	dder, sub tal Volum	mersible) e Purged	:	ful	1+2		
Weather Condi	tions:			30F, sui	h							
Depth to Top of	Product	t (ft BTOC).	-			Denth to	Water (•	115	3'
Depth to Oil/Wa	ter Inter	face* (ft B). TOC):				Total De	enth (ft B	TOCI	•	200	801
* Note: Same as	depth to	water	/	······································			. star De				<u> </u>	1.1
Criteria for S	Stable	Parame	ters	·····				<u></u>				
Parameter			Working	g Range	I	Stability (Criteria	Notes				
Temperature		.::	>0.00 °C	>		± 3%		1				
pН		·	0-14			± 0.1		1				
Conductivity			0-999 m	S/m		± 3%						
ORP			± 1999 r	nV	1	± 10 mv						
Dissolved Oxyg	en		0-19.99	mg/L		± 10%						
Turbidity			0-800 N	TU								
A					l.							
Sensory Obs	servati	ions										
Sensory Obs Color:	servati	i ons Clear, A	mber, Ta	an, Brown, Gre	ey, Mill	ky White,	Other:	-L	· · · · · ·		***	
Sensory Ob: Color: Odor:	servati	i ons Clear, A None, Lo	mber, Ta ow, Medi	an, Brown, Gre um, High, Very	ey, Mill y Stron	ky White, g, H2S, I	Other: ⁻ uel Like,	Chemica	al ?, Unkr	nown	******	
Sensory Ob: Color: Odor: Turbidity:	servati	i ons Clear, A None, Lo None, Lo	mber, Ta ow, Medin ow, Medin	an, Brown, Gre um, High, Very um, High, Very	ey, Mill y Stron y Turbio	ky White, g, H2S, I d, Heavy	Other: Fuel Like, Silts	Chemica	al ?, Unkr	nown		
Sensory Ob: Color: Odor: Turbidity: Instrument C	servati Dbserv	i ons Clear, A None, Lo None, Lo /ations	mber, Ta ow, Medin ow, Medin	an, Brown, Gre um, High, Very um, High, Very	ey, Mill y Stron y Turbio	<y white,<br="">g, H2S, I d, Heavy ش ه هر إ</y>	Other: -uel Like, Silts	Chemica	al ?, Unkr 160	nown ml/	pu. Î M	
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Sensory Ob: Color: Odor: Turbidity: Instrument C Round	Dbserv Time	ions Clear, A None, Lo None, Lo vations Temp °C	mber, Ta ow, Mediu ow, Mediu pH	an, Brown, Gre um, High, Very um, High, Very Conduct'ity	ey, Mill y Stron y Turbio C Tu	ky White, g, H2S, I d, Heavy شهر العامي heavy heavy f f feavy f f f f f f f f f f f f f f f f f f f	Other: -uel Like, Silts /e r a f DO (mg/L)	Chemica ORP (mV)	al ?, Unkr	nown mb/	الله المعالم ال Materia (ft BTOC)	Drav
Sensory Ob: Color: Odor: Turbidity: Instrument C Round	Dbserv Time	Clear, A None, Lo None, Lo rations Temp °C	mber, Ta ow, Mediu ow, Mediu pH	an, Brown, Gre um, High, Very <u>wm, High, Very</u> Conduct'ity (^{MJ} (2))	ey, Mill y Stron y Turbio c Tu (1 N	ky White, g, H2S, I d, Heavy S & M P rbidity ITUs)	Other: -uel Like, Silts / e r a f DO (mg/L)	Chemica e 2 ORP (mV) [95.0	al ?, Unkr 160 Color Clear	nown ML/ Odor None	พ. /ํค Water Level (ft BTOC)]]. 5 8 ′	Drav dow
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Sensory Ob: Color: Odor: Turbidity: Instrument C Round 1 2 3 4 5 6 6 7 7 8 9 10 11 12 12 Notes: Drawdown s iter/minute) and cor	Servati Dbserv Time [] 05 [] 08 [] 108 [] 111 [] 120 [] 200 [] 12	ions Clear, A None, Lo Vations Temp °C 4.39 5.2,6 5.01 4,43 4,26 4,43 4,26 4,43 4,26 4,43 4,26 5.2,6 5.01 4,66 4,43 4,26 5.2,6 5.01 4,66 4,43 4,26 4,26 5.01 4,66 4,43 4,26 5.01 4,66 4,70 5.2,6 5.01 5.01 5.02 5.01 5.01 5.01 5.01 5.01 5.01 5.01 5.01	mber, Ta ow, Mediu pH 6.4 6 6.37 6.37 6.37 6.37 6.37 6.37 6.37	an, Brown, Gre um, High, Very Pars Conduct'ity (**/(20) 0.309 0.309 0.309 0.309 0.309 0.309 0.309 0.309 0.309 0.309 0.309 0.309 0.309 0.309 0.309	ey, Mill y Strony y Turbio C Tu (M N drawdow t site's hy	ky White, g, H2S, I d, Heavy 5 a m p rbidity NTUs) On e.	Other: -uel Like, Silts / / / / / / / / / / / / / / / / / / /	Chemica 0RP (mV) 195.0 176.1 169.2 159.0 148.3 141.1 measured difficult to a	al ?, Unkr	own Mone Odor None at a low rat s specificatio	Water Level (ft BTOC) 11.58' 11.58' 11.58' 11.58' 11.58' 11.58' 11.58' 11.58' 11.56'	Drav dow -0.0 0.0 0.0 0.0 0.0 0.0
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Sensory Ob: Color: Turbidity: Instrument C Round 1 2 3 4 5 6 <i>Fine</i> 1 7 <i>Pess</i> 4 5 6 <i>Fine</i> 1 7 <i>Pess</i> 4 9 10 11 12 Notes: Drawdown s iter/minute) and cor Analyses <i>V Q G</i> All <i>L / Sul F/Ch</i>	Servati Dbserv Time [1 0 \$	ions Clear, A None, Lo Vations Temp °C 4.39 5.2.6 5.2.6 5.01 4.43 4.26 4.43 4.26 4.43 4.26 5.26 5.01 4.66 4.43 4.26 5.26 5.01 4.66 4.43 4.26 5.26 5.01 4.66 4.43 4.26 5.26 5.01 4.66 4.43 4.26 5.26 5.01 4.66 4.20 5.26 5.01 4.66 5.01 5.02 5.02 5.01 5.02 5.01 5.02 5.02 5.02 5.02 5.02 5.02 5.02 5.02	mber, Ta ow, Mediu pH 6.4 6 6.37 6.37 6.37 6.37 6.37 6.37 6.37	an, Brown, Gre um, High, Very Pars Conduct'ity (**/(**)) Q.309 Q.300 Q.309 Q.300 Q.3	ey, Mill y Strony y Turbio C Tu (M N drawdow t site's hy	(y White, g, H2S, I d, Heavy s a m p rbidity NTUs) On e. i i i i i i i i i i i i i i i i i i i	Other: -uel Like, Silts / / / a / DO (mg/L) 17.7 9.1 9.1 9.1 9.1 9.2 7.5 7.4 	Chemica @ 2 ORP (mV) 195.0 176.1 169.2 159.0 148.3 141.1 measured I difficult to a	al ?, Unkr	own	Water Level (ft BTOC) 11.58' 11.58' 11.58' 11.58' 11.56' 11.56' 11.56' 11.56'	Drav dow -2.0 0.0 0.0 0.0 0.0
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Ethan 9/5th ene /McHane 2 Signed/reviewer:

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Date:

	LOV	v-Flow	Ground	Iwater Sam	pling	g with M	linimal I	Drawd	own W	/orksh	et	
			,	<u>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</u>	- <u>-</u>	<u>~</u>		Well ID:		MW	7t closest	-to Gall
Project # :	14-201	, Phase 2						Date:		5-10	- 11	
Project Name:	Aniak \	NACS FS				****	– Sta	rt Time:		1320	3	
Site:	Aniak \	NACS					– Er	d Time:		141	5	
Field Team:	(2.800	an/w	. Qhodos			-			ijiji		
Sample ID:		11- AW	A - 00	2-6W	Time:	13.50	_ primary	dup	split	ms/msd		
Sample ID:				-	Time:		_ primary	dup	split	ms/msd		
Sample ID:					Time:		_ primary	dup	split	ms/msd		
Purgi	ng and	Sampling	g Method	(e.g. peristalti	ic, bla	dder, subr	nersible):		f.	lt2		
-	-		-		Тс	tal Volum	e Purged:		<u>1-2-</u>			
Weather Conditi	ions:			30F,	, pa	the	loudy					
Depth to Top of	Product	(ft BTOC):	, ,			Depth to	Water (f	t BTOC)		17.91	1
Depth to Oil/Wat	ter Inter	face* (ft B	TOC):				Total De	oth (ft BT	TOC):		50.65	ø
Note: Same as d	epth to v	vater	,					,	,			
Criteria for S	table	Parame	ters			<u></u>	1444-4476(MONDAW-24476464646464	Incat we are a second and a second			*******	5.0
Parameter			Working	Range		Stability C	riteria	Notes				
emperature			>0.00 °C			± 3%						*****
эH			0-14			± 0.1						
Conductivity			0-999 m	S/m		± 3%						
			<u>± 1999 n</u>	1V		± 10 mv						***
Dissolved Oxyge	en		10-19.99	mg/L		± 10%				****		
			10-800 N	10								
Sensory Ups	ervati	ons						*****			1	
Color:		Clear, A	mber, la	n, Brown, Gre	ey, Mil	ky White,	Other:	<u>.</u>				
Jaor: Fushidituu		None, Lo	w, Mediu	im, High, Very	Stror	ig, H2S, F	Uel Like, (Chemica	I?, Unkr	own		
natrument C	hoom	none, Lo	w, meun	ini, nigri, very		u, neavy	Sills	200	and and	1.		
	l noseiv	ations	1	purge-	<u>50</u>	moler	$\frac{arc}{1}$, , , , , , , , , , , , , , , , , , ,	-/ MAIM	Mator	1
		Tomo		Conductity	т.	urbiditu	0	000			water	Draw
Pound	Time	remp ∘c		(m S/m)	1	MTHe)	(mall)		Color	Odor	(4 PTOC)	down
1	/320	504	166	0 256		14103)		1625	COIDI C.LEAA		17991	0.90/
	1032		148	0.260	(9th g	1	2.67	155 4	1	None	1800	0 01
2	1333		1 60 0 0 00	1971-1	N	one	1.51	147 7			18 00	
2	1333	4.77	6.42	had a dant of the								1 8 8 8 31.8
2 3 4	1333 1336 1339	4.77 4.75	6.42	0.269			1.44	142.5		1	18.00	0.00
2 3 4 5	1333 1336 1339 1342	4.77 4.75 4.57	6.42	0.269			1.44	142.5			18.00	0.00'
2 3 4 5 6	1333 1336 1339 1342 1345	4.77 4.75 4.57 4.57 4.57	6.42 6.43 6.43 6.44	0.269 0.270 0.270			1.44 1.30 1.19	142.5 136.7 131.5			18.00 17.99 18.00	0.00'
2 3 4 5 6 7	1333 1336 1339 1342 1345 1345	4.97 4.77 4.75 4.57 4.76 4.70	6.42 6.43 6.43 6.44 6.44 6.44	0.269 0.270 0.270 0.270 0.271			1.44 1.30 1.19 1.11	142.5 136.7 131.5 128.7			18.00 17.99 18.00	0.00' -0.01' -0.01'
2 3 4 5 6 7 Final 8 sample	1333 1336 1339 1342 1342 1345 1348 1348	4.87 4.77 4.75 4.57 4.57 4.76 4.70	6.42 6.43 6.43 6.44 6.44 6.44	0.269 0.270 0.270 0.270 0.271			1.44 1.30 1.19 1.11	142.5 136.7 131.5 128.7			18.00 17.99 18.00 17.97	-0.03'
2 3 4 5 6 7 Final 8 3 8 3 6 9	1333 1336 1339 1342 1345 1345 1348 1348	4.87 4.77 4.75 4.57 4.57 4.76 4.70	6.42 6.43 6.43 6.44 6.44	$\begin{array}{c} 0.269 \\ 0.270 \\ 0.270 \\ 0.271 \\ 0.271 \end{array}$		 	1.44 1.30 1.19 1.11	142.5 136.7 131.3 128.7			18.00 17.99 18.00 17.97	0.00' -0.01' 0.01' -0.03'
2 3 4 5 6 7 Final 8 9 10	1333 1336 1339 1342 1345 1345 1348 1348	4.87 4.77 4.75 4.57 4.76 4.70	6.42 6.43 6.43 6.44 6.44	$\begin{array}{c} 0.269 \\ 0.270 \\ 0.270 \\ 0.271 \\ 0.271 \end{array}$			1.44 1.30 1.19 1.11	142.5 136.7 131.5 128.7			18.00	0.00' -0.01' 0.01' -0.03'
2 3 4 5 6 7 FINGI 8 POST 9 10 11	1333 1336 1337 1342 1345 1345 1348 1348	4.87 4.77 4.75 4.57 4.76 4.70	6.42 6.43 6.43 6.44 6.44	0.269 0.270 0.270 0.270 0.271			1.44 1.30 1.19 1.11	142.5 136.7 131.5 128.7			18.00	-0.03'
2 3 4 5 6 7 7 7 7 7 7 8 9 9 10 11 12	1333 1336 1339 1342 1345 1345 1348 1413	4.87 4.77 4.75 4.57 4.76 4.70	6.42 6.43 6.43 7.44 6.44	$\begin{array}{c} 0.269 \\ 0.270 \\ 0.270 \\ 0.271 \\ 0.271 \end{array}$			1.44 1.30 1.19 1.11	142.5 136.7 131.5 128.7			18.00	-0.03 -0.03
2 3 4 5 6 7 7 7 7 7 7 9 10 11 12	1333 1336 1339 1342 1345 1345 1348 1413	<u>4.87</u> <u>4.77</u> <u>4.75</u> <u>4.57</u> <u>4.76</u> <u>4.70</u>	6.42 6.43 6.43 6.44 6.44	$ \begin{array}{c} 0.269 \\ 0.270 \\ 0.270 \\ 0.271 \\ 0.271 \end{array} $			1.44 1.30 1.19 1.11	142.5 136.7 131.5 128.7			18.00	- 0.03 - 0.01
2 3 4 5 6 7 <i>Final 8 Post</i> 9 10 11 11 12 Votes: Drawdown sl	1333 1336 1339 1342 1345 1348 1413	4.77 4.75 4.57 4.76 4.70	6.42 6.43 6.43 6.44 6.44 6.44	0.269 0.270 0.270 0.271	drawdo	wn shall be ac	1.44 1.30 1.19 1.11	142.5 136.7 131.5 128.7	by pumping	at a low ra	18.00 17.99 18.00 17.97 17.97	y 0.1 to 0.5
2 3 4 5 6 7 Finel 8 9 10 11 12 Notes: Drawdown sliter/minute) and con	/333 /336 /339 /342 /345 /345 /348 /4/3 /4/3 hould be I tinually m	4.77 4.75 4.57 4.76 4.70 ess than 0.3 easuring wa	6.42 6.43 6.43 6.44 6.44 6.44 6.44	0.269 0.270 0.270 0.271	drawdov t site's h	wn shall be ac	1.44 1.30 1.19 1.11	142. 5 136. 7 131. 5 128. 7	by pumping	at a low rai	18.00 17.99 18.00 17.97 17.97 te (approximatel	y 0.1 to 0.5
2 3 4 5 6 7 <i>Final 8 Post</i> 9 10 11 12 Notes: Drawdown sl iter/minute) and con	/333 /336 /337 /342 /345 /348 /4/3 /4/3 /4/3 /4/3 /4/3 /4/3 /4/3	4.77 4.75 4.57 4.76 4.70 6.70 6.70 6.70 6.70 6.70 6.70 6.70 6	6.42 6.43 6.43 6.44 6.44 6.44 6.44	0.269 0.270 0.270 0.271	drawdo t site's h	wn shall be ac	1.44 1.30 1.19 1.11	142. 5 136. 7 131. 5 128. 7	by pumping	at a low ra	18.00 17.99 18.00 17.97 17.97 te (approximatel	y 0.1 to 0.5
2 3 4 5 6 7 Finel 8 9 10 11 12 Notes: Drawdown sl iter/minute) and con	/333 /336 /337 /342 /345 /345 /345 /348 /4/3 /4/3 /4/3 /4/3 /4/3 /4/3 /4/3	4.77 4.75 4.57 4.76 4.70 4.70 4.70 4.70 4.70 4.70 4.70 4.70	6.42 6.43 6.43 6.44 6.44 6.44 6.44 6.44 6.44	0.269 0.270 0.270 0.271 0.271	drawdo t site's h	wn shali be ac	1.44 1.30 1.19 1.11	142. 5 136. 7 131. 5 128. 7	by pumping	at a low ra	18.00 17.99 18.00 17.97 17.97	y 0.1 to 0.5
2 3 4 5 6 7 Finel 8 9 10 11 12 Notes: Drawdown sl iter/minute) and con	/333 /336 /337 /342 /345 /345 /345 /345 /345 /345 /345 /345	4.77 4.75 4.57 4.57 4.76 4.70 4.70 4.70 4.70 4.70 4.70 4.70 4.70	6.42 6.43 6.43 6.44 6.44 6.44 6.44 6.44 6.44	0.269 0.270 0.270 0.271 0.271	drawdo t site's h	wn shali be ac	I. 19 I. 19 I. 19 I. 11 chieved and r may make it o	142. 5 136. 7 131. 5 128. 7	by pumping achieve this	at a low ra	18.00 17.99 18.00 17.97 te (approximatel	y 0.1 to 0.5
2 3 4 5 6 7 Finel 8 Post 9 10 11 12 Notes: Drawdown sl iter/minute) and con Analyses V 0 C Alk/Sulf/(bld	1333 1336 1339 1342 1345 1345 1345 1345 1345 1413 1413 1413	4.77 4.75 4.57 4.57 4.76 4.70 4.70 4.70 4.70 4.70 4.70 4.70 4.70	6.42 6.43 6.43 6.44 6.44 6.44 6.44 6.44 6.44	0.269 0.270 0.270 0.271 0.271	drawdo t site's h	wn shall be ac	I. 44 I. 30 I. 19 I. 11 chieved and r may make it o	142. 5 136. 7 131. 3 128. 7	by pumping	at a low ra	18.00 17.99 18.00 17.97 te (approximatel	y 0.1 to 0.5
2 3 4 5 6 7 Final 8 9 10 11 12 Notes: Drawdown sl iter/minute) and con Analyses V 0 C Alk/Sulf/(blo T 0 C	/333 /336 /339 /339 /342 /345 /345 /345 /345 /345 /345 /345 /345	4.77 4.75 4.57 4.57 4.70 4.70 4.70 4.70 4.70 4.70 4.70 4.7	6.42 6.43 6.43 6.44 6.44 6.44 6.44 6.44 6.44	0.269 0.270 0.270 0.271 0.271	drawdo t site's h	wn shali be ac	I. 444 I. 3 Q I. 19 I. 11 Chieved and r may make it o	142. 5 136. 7 131. 5 128. 7	by pumping	at a low ra	18.00 17.99 18.00 17.97 te (approximatel	y 0.1 to 0.5
2 3 4 5 6 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	/333 /336 /339 /342 /345 /345 /348 /4/3 /4/3 /4/3 /4/3 /4/3 /4/3 /4/3	4.77 4.75 4.77 4.75 4.70 4.70 4.70 4.70 4.70 4.70 8 57 4.70 4.70 4.70 4.70 4.70 4.70 4.70 4.7	6.42 6.43 6.44 6.44 6.44 6.44 6.44 6.44 6.44	0.269 0.270 0.270 0.271 0.271 0.271	drawdov : site's h	wn shali be ac	1.30 1.19 1.11 1.11	142. 5 136. 7 131. 3 128. 7	by pumping	at a low ra	18.00 17.99 18.00 17.97 te (approximatelon.	y 0.1 to 0.5
2 3 4 5 6 7 Final 8 Post 9 10 11 12 Votes: Drawdown sliter/minute) and con 11 12 Votes: Drawdown sliter/minute) and con Analyses V 0 C Alk/Sulf/(Glo Nitrole /-itre Fe/Ma F) Fo/Ma	/333 /336 1339 1342 1345 1345 1348 1413 1413 1413 1413 1413 1413 1413	4.77 4.75 4.77 4.75 4.57 4.70 4.70 4.70 4.70 4.70 4.70 4.70 8 6 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	6.42 6.43 6.44 6.44 6.44 6.44 6.44 6.44 6.44	0.269 0.270 0.270 0.270 0.271	drawdov site's h	wn shali be ac	1.30 1.30 1.19 1.11	142. 5 136. 7 131. 3 128. 7	by pumping	at a low ra	18.00 17.99 18.00 17.97 te (approximatelon.	y 0.1 to 0.5
2 3 4 5 6 7 <i>Final 8 Post</i> 9 10 11 12 Notes: Drawdown sl iter/minute) and con Analyses VO (Alk/Sulf/(hla <u>TO C</u> Nitrak 1. ite <u>Fe/Ma</u> Signed:	/333 /336 /339 /342 /345 /345 /345 /348 /4/3 /4/3 /4/3 /4/3 /4/3 /4/3 /4/3	4.77 4.75 4.77 4.75 4.70 4.70 4.70 4.70 4.70 4.70 80 4.70 4.70 4.70 4.70 4.70 4.70 4.70 4.7	6.42 6.43 6.44 6.44 6.44 6.44 6.44 6.44 6.44	0.269 0.270 0.270 0.270 0.271 0.271	drawdou site's h	wn shali be ac	1.30 1.30 1.19 1.11	142. 5 136. 7 131. 3 128. 7	by pumping	at a low ra specification	18.00 17.99 18.00 17.97 te (approximatelon.	y 0.1 to 0.5
2 3 4 5 6 7 Final 8 Post 9 10 11 12 Notes: Drawdown sliter/minute) and con 11 12 Notes: Drawdown sliter/minute) and con Analyses VOC AIK/Sulf/(hld TOC Nytrak 1. ite Fe/Ma Signed: Ethabel from a	1333 1336 1339 1342 1345 1345 1413 1413 1413 1413 1413	4.77 4.75 4.77 4.75 4.70 4.70 4.70 4.70 4.70 4.70 8 easuring wa Bottles lected 3 7 4 1 1	Comme	0.269 0.270 0.270 0.271 0.271	drawdo site's h	wn shali be ac	1.30 1.30 1.19 1.11	142. 5 136. 7 131. 3 128. 7 128. 7	by pumping	at a low ra	18.00 17.99 18.00 17.97 18.00	y 0.1 to 0.5

,

	Lov	v-Flow (Ground	lwater Sam	plin	g with N	linimal	Drawd	own W	orksł	neet	
				**************************************				Well ID:	MW	V - 8*	closest t	ofence
Project # :	14-201	, Phase 2						Date:	ferres .	10-1	1	
Project Name	Aniak \	NACS FS					– Sta	art Time [.]	i Ll		5	
Site:	Aniak \	WACS					- Ei	nd Time:	15	35		
Field Team:		L. Brva	4~ W.	Rhodes			-		·····			*****
Sample ID:	11-	AWA-	003	-GW	Time	1455	F primary	dup	split	ms/ms	d	
Sample ID:					Time	-	primary	dup	split	ms/ms	d	
Sample ID:					Time	-	_ primary	dup	split	ms/ms	d	
Purgi	ing and	Sampling	g Method	(e.g. peristalti	ic, bla T	adder, subi otal Volum	mersible): e Purged:		f	ulta	ע	
Weather Conditi	ions:			35F	. <u>.</u> , <u>s</u>	un.						
Depth to Top of	Product	(ft BTOC)):		and a		Depth to	Water (f	t BTOC):		18.	01'
Depth to Oil/Wat	ter Inter	face* (ft B	TOC):			-	Total De	pth (ft B	TOC):		37.	5 1
* Note: Same as d	lepth to v	water		<i></i>		_			-			
Criteria for S	table	Paramet	ters									
Parameter			Working	Range		Stability C	Criteria	Notes				
Temperature			>0.00 °C	,		± 3%						
pН			0-14			± 0.1						
Conductivity			0-999 m	S/m		± 3%		ļ				
ORP			<u>± 1999 n</u>	nV		± 10 mv		ļ				
Dissolved Oxyge	ən		0-19.99	mg/L		± 10%		ļ				
Furbidity	- meeti	000	10-800 N	10				L				
Sensory Obs	servau	Clear A	mahay Ta	Distance Care		Har Ada tea	Otherm					
Color: Odor:		None Lo	mber, ra w Modi	in, Brown, Gre im High Voru	iy, ivi (Stro	IIKY VVNILE,	Other:	Chomion	12 Hoko	0.00		
Turbidity		None Lo	w Mediu	im, High, Very im High Very	/ Sub / Turh	ng, rizo, r id Heavy	Silts	Chemica	i ?, Unkn	OWN		
Instrument C	bserv	ations	,	Ca 40	ala	1 au was		2 2	00 ml	Llmai.		
				<u> </u>	<u> </u>	- pu-je	<u> </u>			1 1000	Water	[
		Temp		Conduct'ity	т	urbidity	DO	ORP			Level	Draw-
Round	Time	°C	рН	(#5/cm)		(NTUs)	(mg/L)	(mV)	Color	Odor	(ft BTOC)	down
1	1435	5.02	6.45	n.345	1	Vone	3.58	184.0	Clear	None	2 18.01	0.00'
2	1438	4.21	6.48	0.341			1.18	171.2			18.00'	- 0.01
3	1441	4.08	6.44	0.340			1.02	161.5			18.00'	0.00'
4	1444	3.43	6.43	0.338			0.92	152.5		}	18.00	0.00'
5	1447	3.95	6.43	0.337			0.88	149.5		ļ/	18.00'	0.00
0 7 / 051	1420	5.80	6.46	9.338		J	0.82	176.8	8		18.90	Q.00″
<u>Emailiandi</u>					******							0.00.
9	<u> </u>											
10					*****							
11												
12	1						1					
Notes: Drawdown s	hould be l	less than 0.3	feet while s	ampling. Minimal d	drawdo	wn shall be a	chieved and	measured b	by pumping	at a low i	rate (approximatel	y 0.1 to 0.5
liter/minute) and con	tinually m	easuring wa	ter levels in	the well. Note that	site's	hydrogeology	may make it	difficult to a	achieve this	specifica	tion.	
	# of	Bottles										
Analyses	Col	lected	Comme	nts:								
VOC		3										
Alk/Sull/Chi	oride		t i									
TOC	6	<u>†</u>										
Nitrare/ire												
C Pre / MIN	.L	1	I									
Signed:			R	mlan		-		Date:	5-	10-1		
Ethanc 546n Signed/reviewer	e-Meth	pre 2						Date:				

	*****	man -						unauzonianaiziaitiini Ma			*****	
	Low	/-Flow	Ground	lwater Sam	pling	g with N	linimal I	Drawd	own W	orkshe	et	
								Well ID:	/	NW-	. 6	
Project # :	14-201	, Phase 2						Date:		5-10	-	
Project Name:	Aniak \	NACS FS					Sta	art Time:		152	5	
Site: Field Team [.]	Aniak	ACS A Bru	ration LA	1. Phodes	•	1615	- 10 E	ia rime:		1200	<u>/</u>	
Sample ID:		- AW	A- 00	4-GW	Time:	445	primary	> dup	split	ms/msd		
Sample ID:					Time:		_ primary	dup	split	ms/msd		
Sample ID:					lime:		_ primary	aup	split	ms/msa		
Purg	ing and	Sampling	g Method	(e.g. peristalt	ic, bla	dder, sub	mersible):		<u> </u>	1+2		
				. 4	To	tal Volum	e Purged:					
Weather Condi	tions:			40	ېر 	part	y cloui	dy, n	und			0
Depth to Top of	Product	(ft BTOC):	~			Depth to	Water (f	t BTOC):		29	4.73
Depth to Oil/Wa	ter Inter	face* (ft B	TOC):				Total De	pth (ft B1	OC):		29.0	71
* Note: Same as	depth to v	vater	6 a w-									
Criteria for S	stable	rarame	Working	Ranco		Stability /	ritoria	Notes				
Temperature			>0.00 °C	i i lange		± 3%	JINCHA	INUICS				
pH		·	0-14			± 0.1						· · · · ·
Conductivity			0-999 m	S/m		± 3%		ļ				
ORP Dissolved Oxyo	on		± 1999 n	nV ma/l		± 10 mv + 10%		 				
Turbidity	CII	<u></u>	0-800 N	ru		<u> </u>		<u> </u>				
Sensorv Ob	servati	ons						1 .,				
Turbidity: Instrument (Observ	None, Lo ations	ow, Mediu	um, High, Ven	/ Turbi	d, Heavy	Silts		mL/	M 1 M		
			1								Water	
Downd	Time	Temp	-14	Conduct'ity	Tu	urbidity			Color	Odor	Level	Draw-
1	1554	616	6.20	0 2.87		None	<u>(mg/c)</u> 5.85	(117)	Color	Nade.	16731	0.00 ·
2	1557	4.70	6.15	0.290		- aw	2.02	134.2	1	ł	16.75'	Q. 92'
3 /600	LSET	4.21	6.23	0.279			1.12	118.5			16.74'	-0.01'
<u> </u>	1603	4.25	6.25	0.276	٨	1	1.01				16.74'	0.00'
6	1600	4.76	6.32	0.275	I\	<u>i v ne</u> 1	0.88	809	*		16.73	-0.01
7	1612	4.33	6.32	0.277		ļ	0.87	78.1	1		16.73'	00.0
Final 8 Para	1700										16.66'	
9								 				
10								<u> </u>				
	1		+					 				
12								J				·····
12	should be l	ess than 0.3	feet while s	ampling. Minimal	drawdov	wn shall be a	chieved and r	neasured I	y pumping	at a low ra	te (approximatel	y 0.1 to 0.5
12 Notes: Drawdown		easuring wa	iter levels in	the well. Note that	t site's h	ydrogeology	may make it	difficult to a	chieve this	specificatio	oń.	
12 Notes: Drawdown liter/minute) and co	ntinually m	Bottles		m fa 1				ĸ				
12 Notes: Drawdown liter/minute) and co	# of	lonted		1113.								
12 Notes: Drawdown liter/minute) and co Analyses	# of Col	lected	Comme									
Notes: Drawdown liter/minute) and co Analyses	ntinually m # of Col	lected 3										
12 Notes: Drawdown · liter/minute) and co Analyses V 0 C A K / Sulf/ C	ntinually m # of Col	lected 3	Comme									
12 Notes: Drawdown liter/minute) and co Analyses V 0 C Al K / Sulf/ C N , Trate 7 - ite	ntinually m # of Col	lected 3										
12 Notes: Drawdown liter/minute) and co Analyses V 0 C Al K / Sulf/ C N . tratef - ite F e / Mn	minually m # of Col	lected 3										

	Low	/-Flow	Ground	lwater San	npling	g with M	inimal	Drawd	own W	orksh	eet	Provide and and the second
						2	· · · · · · · · · · · · · · · · · · ·	Well ID:		Mw-	-12	
Project # :	14-201	, Phase 2					_	Date:		5-10) -)]	
Project Name:	Aniak V	WACS FS					Sta	rt Time:		172	. 0	
Site:	Aniak V	WACS					_ Er	nd Time:	(P)	3)17-2	:0	
Field Team:	/	2.60	<u>an</u>	W. Rhod	Time	1000	- brimany) dun	enlit	me/med		
Sample ID:		IN JAV	<u> </u>	00 - G-W	Time:	1000	primary	dup	split	ms/msd		
Sample ID:					Time:		primary	dup	split	ms/msd		
Purg	ing and	Sampling	g Method	(e.g. peristali	tic, bla	dder, subn	nersible):			fult	2	
	•		-		То	tal Volume	e Purged:			¢		
Weather Condi	tions:			3	0 F	, ove	, reas	t, w	ind			
Depth to Top of	Product		۱.				Denth to	Water (f			16	16'
Depth to Oil/Wa	iter Inter	face* (ft B	,. TOC):				Total De	pth (ft BT	OC):		<u> </u>	31'
* Note: Same as	depth to v	vater		/								
Criteria for S	Stable	Paramet	ters	-	т	0		[N]				
Parameter Temperature			>0 00 °C	I Kange		stability C	riteria	Notes				
pH			0-14			± 0.1						
Conductivity			0-999 m	S/m		± 3%		ļ				
URP Dissolved Oxya	en		± 1999 n	nV mg/l		<u>± 10 mv</u> + 10%						·
Turbidity	<u> </u>		0-800 N	TU								
					the second se							
Sensory Obs Color: Odor: Furbidity: nstrument (servati Observ	ons Clear, A None, Lc None, Lc ations	mber, Ta ow, Medit ow, Medit ργι	in, Brown, Gru um, High, Ver um, High, Ver	ey, Mil y Stron y Turbi M 0 le	ky White, ig, H2S, F d, Heavy rate	Other: uel Like, Silts	Chemica りり ゕレ	I ?, Unkn ๗๚ ไห	own		
Sensory Obs Color: Odor: Turbidity: Instrument (servati Dbserv	ons Clear, A None, Lo None, Lo ations Temp	mber, Ta ow, Mediu ow, Mediu pv () (in, Brown, Gru um, High, Ver um, High, Ver Conduct'ity	ey, Mil y Stron y Turbi m p le Tu	ky White, ig, H2S, F d, Heavy rake urbidity	Other: uel Like, Silts	Chemica	l ?, Unkn	own	Water Level	Draw-
Sensory Obs Color: Odor: Turbidity: Instrument (Round	Dbserv Time	ons Clear, A None, Lc None, Lc ations Temp °C	mber, Ta ow, Mediu ow, Mediu PH	in, Brown, Gru um, High, Ver um, High, Ver <u>Conduct'ity</u> (^{m 5} / ₄ m)	ey, Mil y Stron y Turbi M p le Tu (1	ky White, ig, H2S, F d, Heavy rate ntbidity NTUs)	Other: uel Like, Silts DO (mg/L)	Chemica	I ?, Unkn ๗ ไห Color	own Odor	Water Level (ft BTOC)	Draw- down
Sensory Obs Color: Odor: Turbidity: Instrument (Round 1 2	Servati Dbserv Time	Ons Clear, A None, Lo vations Temp °C 2.05 2,28	mber, Ta bw, Mediu bw, Mediu P D D D D D D D D D D D D D D D D D D	in, Brown, Gru um, High, Ver um, High, Ver (<u>M5(m)</u> <u>0.251</u> 0.251	ey, Mil y Stron y Turbi m p le Tu (1 Very	ky White, ig, H2S, F d, Heavy rate rate ntbidity NTUs) Turkid,	Other: uel Like, Silts DO (mg/L) 2.99	Chemica 00 #44 ORP (mV) 134.0 129.9	I?, Unkn м Ĩи <u>Color</u> <u>Brown</u> (Блеу	own Odor None	Water Level (ft BTOC)	Draw- down
Sensory Obs Color: Odor: Turbidity: Instrument (Round 1 2 3	Dbserv Time 1741 1744 1748	ons Clear, A None, Lc vations Temp °C 2.05 2.28 2.02	mber, Ta ow, Mediu ow, Mediu 0 1 pH 6,28 6,28 6,22 6,21	in, Brown, Grum, High, Ver um, High, Ver <u>rgl. / Ga</u> <u>Conduct'ity</u> (^{m5} / ₂ m) <u>0.257</u> 0.251 <u>0.253</u>	ey, Mil y Stron y Turbi M p le Tu (I Very	ky White, Ig, H2S, F d, Heavy Make NTUs) Turkid, Lyk	Other: uel Like, Silts DO (mg/L) 2.99 1.50 1.16	Chemica 00 mV ORP (mV) 134.0 129.9 128.3	I ?, Unkn м Ĩи Color Brown (Lrey	own Odor Nane	Water Level (ft BTOC)	Draw- down
Sensory Obs Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 - 7821	Servati Dbserv Time 1741 1744 1748 1751	ons Clear, A None, Lo ations Temp °C 2.05 2.78 2.92 2.53 2.745	mber, Ta ow, Mediu 0, Mediu 0, 1 pH 6, 28 6, 28 6, 21 6, 18	in, Brown, Gru um, High, Ver <u>ingl. / Ga</u> Conduct'ity (^{m5} / ₂ m) 0.257 0.251 0.253 0.253	ey, Mil y Stron y Turbi m p le Tu (()	ky White, Ig, H2S, F d, Heavy Pake Indity NTUS) Turlid by I	Other: uel Like, Silts DO (mg/L) 2.97 1.50 1.16 1.01	Chemica 00 #4 0RP (mV) 134.0 129.9 129.3 125.8	I?, Unkn MIN Color Brown (Lrey	own Odor None	Water Level (ft BTOC)	Draw- down 0.00 ⁷ 0.00 ⁷
Sensory Obs Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 : 754 6	Dbserv Time 1741 1744 1744 1751 1751 1757	ons Clear, A None, Lc rations Temp °C 2.05 2.28 2.02 2.53 2.75 2.96	mber, Ta bw, Mediu bw, Mediu pH 6,28 6,22 6,21 6,18 6,27 6,19	in, Brown, Grum, High, Ver Jm, High, Ver Conduct'ity (^{M5} / ₂ m) 0.257 0.253 0.253 0.254 0.254	ey, Mil y Stron y Turbi m p le Tu (1 Very	ky White, Ig, H2S, F d, Heavy Nate rbidity NTUS) Tuckid Lgh Car I	Other: uel Like, Silts DO (mg/L) 2.99 1.16 1.01 0.99 0.95	Chemica 00 #4 ORP (mV) 134.0 129.9 128.3 125.8 18.9 115.5	I?, Unkn м Ĩи Color Brown (Lrey] Lear	own Odor None	Water Level (ft BTOC) /6./6' /6./6'	Draw- down 0.00' 0.00'
Sensory Obs Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 : 754 6 7	Dbserv Time 1741 1744 1748 1751 1751 1757	ons Clear, A None, Lo ations Temp °C 2.05 2.25 2.95 2.75 2.96	mber, Ta ow, Mediu ow, Mediu pH 6,28 6,28 6,22 6,21 6,18 6,19	in, Brown, Grum, High, Ver um, High, Ver (mg), / G (m ⁵ / ₂ m) 0.257 0.253 0.253 0.254 0.254	ey, Mil y Stron y Turbi m p le Tu (! Very L-	ky White, ig, H2S, F d, Heavy rate ratidity NTUS) Turbid igh ow l ear l	Other: uel Like, Silts DO (mg/L) 2.99 1.50 1.16 1.01 0.99	Chemica 00 # 0RP (mV) 129.9 128.3 125.8 (18.9 115.5	I ?, Unkn M In Color Brown (Lrey] Сеат I	own Odor None	Water Level (ft BTOC) /6./6' /6./6'	Draw- down 0.00 ⁷ 0.00 ⁷
Sensory Obs Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 : 754 6 7 8 9	Dbserv Time 1741 1744 1744 1744 1751 1751 1757	ons Clear, A None, Lo ations Temp °C 2.05 2.05 2.02 2.53 2.75 2.96	mber, Ta bw, Mediu bw, Mediu pH 6,28 6,28 6,21 6,21 6,21 6,21 6,27 6,27	in, Brown, Grum, High, Ver Jm, High, Ver Conduct'ity (^{m5} / ₂ m) 0.257 0.253 0.253 0.254 0.254	ey, Mil y Stron y Turbi m p le Tu ((Very L-	ky White, Ig, H2S, F d, Heavy rate rate rate NTUS) Turkid b b c c ar l c ar l	Other: uel Like, Silts DO (mg/L) 2.99 1.50 1.16 1.01 0.99 0.95	Chemica 00 #4 0RP (mV) 134.0 129.9 128.3 125.8 (18.9 115.5	I?, Unkn M In Color Brown Grey Lear I	own Odor None	Water Level (ft BTOC) /6./6' /6./6'	Draw- down 0.00 ^{-/} 0.00 ^{-/}
Sensory Obs Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 1754 6 7 8 9 10	Dbserv Time 1741 1744 1749 1751 1751 1757	ons Clear, A None, Lc vations Temp °C 2.05 2.28 2.02 2.53 2.75 2.96	mber, Ta w, Mediu w, Mediu pH 6,28 6,28 6,28 6,28 6,21 6,18 6,19	in, Brown, Grum, High, Ver um, High, Ver (m5/(m)) 0.257 0.251 0.253 0.253 0.254 0.254	ey, Mil y Stron y Turbi m p le Tu (! Very L-	ky White, Ig, H2S, F d, Heavy Nate arbidity NTUS) Turkid. L G W I CAR I	Other: uel Like, Silts DO (mg/L) 2.99 1.50 1.16 1.01 0.99	Chemica 00 #4 0RP (mV) 134.0 129.9 128.3 125.8 118.9	I?, Unkn M İw Color Brown (Grey J	Odor None	Water Level (ft BTOC) /6./6' /6./6'	Draw- down 0.00' 0.00'
Sensory Obs Color: Odor: Turbidity: Instrument (1 2 3 4 5 : 754 6 7 8 9 10 11	Servati Dbserv Time 1741 1744 1748 1751 1753 1757	ons Clear, A None, Lo ations Temp °C 2.05 2.02 2.53 2.75 2.96	mber, Ta w, Mediu w, Mediu w, Mediu pH 6, 28 6, 28 6, 21 6, 18 6, 27 6, 19	in, Brown, Grum, High, Ver um, High, Ver <u>Conduct'ity</u> (^{M 5} / ₄ m) 0.257 0.253 0.253 0.254 0.254	ey, Mil y Stron y Turbi m p le Tu ((Very L	ky White, Ing, H2S, F d, Heavy Nate rate rate NTUS) Turkid typh ear 1	Other: uel Like, Silts DO (mg/L) 2.97 1.50 1.16 1.01 0.99	Chemica 00 #4 0RP (mV) 134.0 129.9 125.8 125.8 115.5	I?, Unkn MIN Color Brown (Lrex I	own Odor None	Water Level (ft BTOC) /6./6' /6./6'	Draw- down 0.00 ⁷ 0.00 ⁷
Sensory Obs Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 1754 6 7 8 9 10 11 12	Dbserv Time 1741 1744 1745 1751 1757	ons Clear, A None, Lc rations Temp °C 2.05 2.28 2.02 2.53 2.75 2.96	mber, Ta bw, Mediu bw, Mediu pH 6,28 6.27 6.18 6.19	in, Brown, Grum, High, Ver Jm, High, Ver Conduct'ity (^{m5} / ₂ m) 0.257 0.253 0.253 0.254 0.254	ey, Mil y Stron y Turbi m p le Tu (1 Very L	ky White, Ig, H2S, F d, Heavy Nate Indity NTUS) Turbid, L G M L C A L C A L C A L C A L C A L C A L C A L C A L C A L C A L C A L C A L C A L C A L A C A L A C A L A C A L A C A L A C A L A C A L A C A L A C A L A C A L A C A L A C A L A C C A C A C A C A C A C A C A C A C C A C C C C C C C C C C C C	Other: uel Like, Silts DO (mg/L) 2.99 1.50 1.16 1.01 0.99 0.95	Chemica 00 #4 0RP (mV) 134.0 129.9 125.8 (18.9 115.5	I ?, Unkn м Îм Color Brown (Lrex] Lear]	Odor None	Water Level (ft BTOC) /6./6' /6./6'	Draw- down 0.00 ^{-/} 0.00 ^{-/}
Sensory Obs Color: Odor: Turbidity: Instrument O Round 1 2 3 4 5 : 754 6 7 8 9 10 11 12	Servati Dbserv Time 1741 1742 1751 1757 1757 1757 1757	ons Clear, A None, Lo vations Temp °C 2.05 2.28 2.02 2.53 2.75 2.96	mber, Ta w, Mediu w, Mediu w, Mediu w pH 6, 28 6, 19 6, 19 6, 28 6, 19 6, 1	In, Brown, Grum, High, Ver Jm, High, Ver Jgl. / Sa Conduct'ity (^{M5} / ₂ m) 0.257 0.251 0.253 0.253 0.254 0.254 0.254	ey, Mil y Stron y Turbi m p le Tu ((Vey L	ky White, ng, H2S, F d, Heavy Make rabidity NTUS) Turbid b urbidity L car 1	Other: uel Like, Silts DO (mg/L) 2.99 1.50 1.16 1.01 0.95 	Chemica 00 mV (mV) 134.0 129.9 125.8 115.5	I ?, Unkn M IN Color Brown (Lrey] Clear]	own	Water Level (ft BTOC) /6./6' /6./6'	Draw- down 0.00 ⁻ 0.00 ⁻
Sensory Obs Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 : 754 6 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and co	Servati Dbserv Time 1741 1741 1741 1741 1751 1757	Ons Clear, A None, Lo ations Temp °C 2.05 2.75 2.75 2.75 2.75 2.75 2.75 2.75 2.75 2.75 2.75 2.75 2.75 2.96	mber, Ta bw, Mediu bw, Mediu pH 6, 28 6, 28 6, 27 6, 19 6, 19 6, 19 6, 19 6, 19 6, 19	in, Brown, Grum, High, Ver Jm, High, Ver Conduct'ity (**5//m) 0.257 0.253 0.253 0.254 0.25546 0.25566 0.25566 0.25566 0.255666 0.25566666666666666666666666666666666666	ey, Mil y Stron y Turbi m p le Tu (() Very L-	ky White, Ig, H2S, F d, Heavy Pate Indity NTUS) Turkid Lak ear I ear I wn shall be ac	Other: uel Like, Silts DO (mg/L) 2.97 1.50 1.16 1.01 0.99 0.95 Chieved and may make it	Chemica 0 (0 # 4 0 (mV) 134.0 129.9 128.3 125.8 (18.9 115.5	I ?, Unkn <u>Color</u> <u>Brown</u> <u>Crex</u> <u>Crex</u> <u>J</u> <u>Crex</u> <u>J</u> <u>Crex</u> <u>J</u> <u>Crex</u> <u>Crex</u>	own Odor Nane	Water Level (ft BTOC) /6./6' /6./6' /6./6' /6./6'	Draw- down 0.00 0.00 0.00
Sensory Obs Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 : 754 6 7 8 9 10 11 12 Notes: Drawdown s iter/minute) and co	Servati Dbserv Time 1741 1741 1741 1741 1751 1753 1757	ons Clear, A None, Lc vations Temp °C 2.05 2.28 2.02 2.53 2.75 2.96 2.96 Ess than 0.3 easuring wa Bottles	mber, Ta w, Mediu w, Mediu w, Mediu w, Mediu pH 6, 28 6, 28 6, 22 6, 18 6, 19 6, 19 6 feet while s ter levels in	an, Brown, Grum, High, Ver Jm, High, Ver Conduct'ity (^{m5} / ₂ m) 0.257 0.251 0.253 0.254 0.254 0.254 0.254 0.254 0.254 0.254 0.254	ey, Mil y Stron y Turbi m p le Tu ((Very L-	ky White, Ig, H2S, F d, Heavy Note Indiaty NTUS) Tuckid G M I EQF I Monshall be active Note and the second se	Other: uel Like, Silts DO (mg/L) 2.99 1.16 1.16 1.01 0.99 0.95 DO 0.95	Chemica 00 #U ORP (mV) 134.0 129.9 125.8 125.8 115.5	I ?, Unkn M IM Color Brown (Lrey Lear J Clear J Clear J Clear J	Odor None	Water Level (ft BTOC) /6./6' /6./6' /6./6'	Draw- down Q.QQ [*] Q.QQ [*] Q.QQ [*] Q.QQ [*]
Sensory Obs Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 : 754 6 7 8 9 10 11 12 Notes: Drawdown s iter/minute) and co Analyses	Servati Dbserv Time 1741 1744 1745 1751 1757	ons Clear, A None, Lo vations Temp °C 2.05 2.23 2.75 2.96 2.96 2.96 2.96 2.96 2.96 2.96 2.96	mber, Ta bw, Mediu W, Mediu W PH 6, 28 6, 28 6, 28 6, 28 6, 28 6, 21 6, 19 6, 19 7, 10 7,	in, Brown, Grum, High, Ver um, High, Ver (m5/(m)) 0.257 0.253 0.253 0.254 0.2554 0.2556 0.2556 0.2556 0.25566 0.25566 0.25566 0.25566 0.25666 0.25666 0.25666 0.25666 0.256666 0.25666666666666666666666666666666666666	ey, Mil y Stron y Turbi m p le Tu (() Very L- C I	ky White, ig, H2S, F d, Heavy Pake Indity NTUS) Turkid Lgk Sw I Car I wn shall be ac hydrogeology f	Other: uel Like, Silts DO (mg/L) 2.97 1.50 1.16 1.01 0.99 0.95 	Chemica 0 (0 # 4 0 (mV) 134.0 129.9 129.3 125.8 (18.9 115.5	I ?, Unkn M IM Color Brown (Lray Lear I Sy pumping achieve this	Odor None	Water Level (ft BTOC) /6./6' /6./6' /6./6'	Draw- down
Sensory Obs Color: Odor: Turbidity: Instrument O Round 1 2 3 4 5 1754 6 7 8 9 10 11 12 Notes: Drawdown s iter/minute) and co Analyses V O C AlK/5ulf/C V	Servati	ons Clear, A None, Lc vations Temp °C 2.05 2.28 2.02 2.53 2.75 2.96 ess than 0.3 easuring wa Bottles lected	mber, Ta w, Mediu w, Mediu w, Mediu pH 6, 28 6, 27 6, 18 6, 27 6, 19 6, 19 6 feet while s ter levels in Comme	in, Brown, Grum, High, Ver Jm, High, Ver Conduct'ity (^{M5} / ₂ m) 0.257 0.253 0.253 0.254 0.2	ey, Mil y Stron y Turbi m p le Tu ((Very L-	ky White, Ig, H2S, F d, Heavy Pate Irbidity NTUS) Tuckid L Car I Car Car I Car I Car Car I Car Car Car Car Car Car Car Car	Other: uel Like, Silts DO (mg/L) 2.99 1.50 1.6 1.61 0.99 0.95 Chieved and may make it	Chemica 00 #4 0RP (mV) 134.0 129.9 125.8 125.8 125.5 115.5	I ?, Unkn <u>M IM</u> <u>Color</u> <u>Brown</u> <u>Color</u> <u>Brown</u> <u>Color</u> <u>Brown</u> <u>Color</u> <u>Brown</u> <u>Color</u> <u>Brown</u> <u>Color</u> <u>Brown</u> <u>Color</u> <u>Brown</u> <u>Color</u> <u>Brown</u> <u>Color</u> <u>Brown</u> <u>Color</u> <u>Brown</u> <u>Color</u> <u>Brown</u> <u>Color</u> <u>Brown</u> <u>Color</u> <u>Brown</u> <u>Color</u> <u>Brown</u> <u>Color</u> <u>Brown</u> <u>Color</u> <u>Brown</u> <u>Color</u> <u>Brown</u>	Odor None	Water Level (ft BTOC) /6./6' /6./6' /6./6'	Draw- down
Sensory Obs Color: Odor: Turbidity: Instrument O Round 1 2 3 4 5 \cdot 754 6 7 8 9 10 11 12 Notes: Drawdown s iter/minute) and col Analyses V O C Alk / Sµlf/C h T, O C	Servati Dbserv Time 1741 1742 1751 1751 1757	ons Clear, A None, Lc vations Temp °C 2.05 2.28 2.02 2.53 2.75 2.96 C C C 2.05 2.75 2.96 C C 2.05 2.75 2.96 C C 2.05 2.75 2.96 C C C 2.05 2.75 2.96 C C C 2.05 2.75 2.96 C C C C C C C C C C C C C	mber, Ta w, Mediu w, Mediu w, Mediu w, Mediu pH 6, 2.8 6, 18 6, 2.9 6, 19 6, 2.8 6, 19 6, 19 6, 2.8 6, 2.8 6, 19 6, 19 6, 19 6, 19 6, 2.8 6, 19 6, 1	an, Brown, Grum, High, Ver Jm, High, Ver Conduct'ity (^{M5} / ₂ m) 0.257 0.253 0.253 0.2546 0.2546 0	ey, Mil y Stron y Turbi m p le Tu ((Very L-	ky White, Ig, H2S, F d, Heavy Pate Indity NTUS) Turbid Lgh GAV L EQF J wn shall be ach hydrogeology i	Other: uel Like, Silts DO (mg/L) 2.99 1.16 1.16 1.01 0.99 0.95 DO 0.95	Chemica 00 #U ORP (mV) 134.0 129.9 125.8 125.8 115.5 measured I difficult to a	I ?, Unkn <u>M IW</u> <u>Color</u> <u>Brown</u> (Lrey <u>Lrey</u> <u>J</u> <u>C</u> <u>Brown</u> (Lrey <u>J</u> <u>C</u> <u>Brown</u>	Odor None	Water Level (ft BTOC) /6./6' /6./6'	Draw- down 0.00 ^{-/} 0.00 ^{-/}
Sensory Obs Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 : 754 6 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and col Analyses V () (AlK / SµIF/C V T () C Nitrate (-it 6)	Servati Dbserv Time 1741 1744 1749 1751 1757	ons Clear, A None, Lo vations Temp °C 2.05 2.75 2.75 2.75 2.96 ess than 0.3 easuring wa Bottles lected 3	mber, Ta w, Mediu w, Mediu w, Mediu pH 6, 28 6, 28 6, 21 6, 18 6, 21 6, 19 6, 19 6 6 6 6 6 6 7 6 7 6 7 6 7 7 7 7 7 7 7 7 7 7 7 7 7	an, Brown, Grum, High, Ver um, High, Ver (m5/cm) 0.257 0.253 0.253 0.254 0.2554 0.254 0.2556 0.2556 0.25566 0.25566 0.25566 0.25566 0.25566 0.25566 0.25566 0.25666 0.25666 0.25666 0.25666 0.256666 0.25666666666666666666666666666666666666	ey, Mil y Stron y Turbi m p le Tu (() Very L- C I	ky White, Ig, H2S, F d, Heavy Pake Inbidity NTUS) Turkid Lgk & W I ear I wn shall be ac	Other: uel Like, Silts DO (mg/L) 2.97 1.50 1.16 1.01 0.95 	Chemica 0 (0 # 4 0 (mV) 134.0 129.9 128.3 125.8 115.5 115.5	I ?, Unkn <u>Color</u> <u>Brown</u> <u>Crex</u> <u>Crex</u> <u>Crex</u> <u>Crex</u>	own Odor None	Water Level (ft BTOC) /6./6' /6./6'	Draw- down Q
Sensory Obs Color: Odor: Turbidity: Instrument O Round 1 2 3 4 5 1754 6 7 8 9 10 11 12 Notes: Drawdown s iter/minute) and col Analyses V O C AlK/Sulf/C V T O C Nutrate / -ite FC / MA	Servati Dbserv Time 1741 1741 1741 1741 1741 1741 1741 1741 1741 1741 1741 1741 1741 1744 1751 1757	ons Clear, A None, Lc vations Temp °C 2.05 2.28 2.02 2.53 2.75 2.96	mber, Ta w, Mediu w, Mediu w, Mediu w, Mediu mber, Ta pH 6, 28 6, 28 6, 21 6, 18 6, 27 6, 19 6, 19 6, 19 6, 19 6, 19 6, 19 6, 28 6, 21 6, 19 6, 19 6, 28 6, 29 6, 19 6, 28 6, 29 6, 19 6, 28 6, 29 6, 19 6, 28 6, 29 6, 19 6, 20 6, 20 7, 20 7	an, Brown, Grum, High, Ver Jan, High, Ver Jan, High, Ver Conduct'ity (^{M5} / ₄ m) 0.257 0.253 0.253 0.254 0.2554 0.254	ey, Mil y Stron y Turbi m p le Tu (I Very L-	ky White, Ig, H2S, F d, Heavy Pate Irbidity NTUS) Tuckid L ear I ear I wn shall be ac ydrogeology i	Other: uel Like, Silts DO (mg/L) 2.99 1.50 1.16 1.01 0.99 0.95 Chieved and may make it	Chemica 0 0 # 4 0 RP (mV) 134.0 129.9 125.8 125.8 115.5 115.5 measured b difficult to a	I ?, Unkn M IM Color Brown (Lrex] Clear] by pumping achieve this	Odor None	Water Level (ft BTOC) /6./6' /6./6' /6./6'	Draw- down Q.QQ [*] Q.QQ [*] Q.QQ [*]
Sensory Obs Color: Odor: Turbidity: Instrument O Round 1 2 3 4 5 \cdot 754 6 7 8 9 10 11 12 Notes: Drawdown s iter/minute) and col Analyses VOC AIK/SµIF/C M TOC Nitrate I - it 6 FC / MM Signed:	Servati Dbserv Time 1741 1742 1751 1751 1757	Ons Clear, A None, Lc vations Temp °C 2.05 2.75 2.75 2.75 2.75 2.96 easuring wa Bottles lected 3	mber, Ta bw, Mediu W, Mediu W PH 6,28 6,28 6,22 6,21 6,18 6,21 6,18 6,27 6,19 6,19 Comme	an, Brown, Grum, High, Ver Jm, High, Ver Jan, High, Ver Jan, High, Ver Jan, High, Ver Jan, Conduct'ity (^{M5} / ₂ m) 0.257 0.253 0.253 0.254	ey, Mil y Stron y Turbi m p le Tu ((Very L-	ky White, Ig, H2S, F d, Heavy Note Indity NTUS) Turbid Ligh 6 M 1 Car 1 Mon shall be act hydrogeology 1	Other: uel Like, Silts DO (mg/L) 2.99 1.16 1.16 1.01 0.99 0.95 	Chemica 00 #U ORP (mV) 134.0 129.9 125.8 125.8 115.5 115.5 Date:	I ?, Unkn <u>M IW</u> <u>Color</u> <u>Brown</u> (Lrey <u>Lrey</u> <u>J</u> <u>C</u> py pumping achieve this	Odor None	Water Level (ft BTOC) /6./6' /6./6' /6./6' /6./6'	Draw- down Q.QQ [*] Q.QQ [*] Q.QQ [*] Q.QQ [*]
Sensory Obs Color: Odor: Turbidity: Instrument O Round 1 2 3 4 5 \cdot 754 6 7 8 9 10 11 12 Notes: Drawdown silter/minute) and color Analyses VOC AIK/5ulf/CV ToC Nutrate/-ite FC/MN Signed: EThane Jethe	Servati Dbserv Time 1741 1744 1749 1751 1751 1757	ons Clear, A None, Lo vations Temp °C 2.05 2.28 2.02 2.53 2.75 2.96 ess than 0.3 easuring wa Bottles lected 3 hane 2	mber, Ta w, Mediu w, Mediu w, Mediu w, Mediu pH 6, 28 6, 28 6, 22 6, 18 6, 27 6, 19 6, 19 6, 19 6, 19 6, 19 6, 19 6, 19 6, 19 6, 19 6, 28 6, 28 6, 21 6, 19 6, 19 6, 28 6, 29 6, 29 6, 20 6, 20 7, 2	an, Brown, Grum, High, Ver um, High, Ver (m, High, Ver (m, High, Ver (m, M, M) 0.257 0.253 0.253 0.254 0.	ey, Mil y Stron y Turbi m p le Tu (() Very L- C I	ky White, Ig, H2S, F d, Heavy Pate Irbidity NTUS) Turkid Lgh ear I wh shall be ach hydrogeology i	Other: uel Like, Silts DO (mg/L) 2.97 1.50 1.16 1.01 0.95 	Chemica 00 #U ORP (mV) 134.0 129.9 125.8 125.8 18.9 115.5 Date:	I ?, Unkn Color Brown Gray Clear I Sy pumping achieve this	Odor None	Water Level (ft BTOC) /6./6' /6./6' /6./6' /6./6' /6./6'	Draw- down Q

	Low	-Flow (Ground	lwater Sam	ıplin	g with Mi	nimal	Drawd	<u>own W</u>	orkshe	et	
								Well ID:		M. W -	- 10	
Project # :	14-201, Phase 2						Date:		5-10	- 11		
Project Name:	Anjak WACS FS					Sta	art Time:		18	30		
Site:	Aniak WACS						Er	nd Time:				
Field Team:	R. Bryan / W. Rhodes							\ \		-		
Sample ID:	1- AWA 006-GW Time: 1910						primary	/ dup	split	ms/msd		
Sample ID:	Time:						primary	dup	split	ms/msd		
Sample ID:	·				lime		primary	dup	split	ms/msd		
Purgi	ng and	Sampling	g Method	(e.g. peristalt	ic, bla Te	adder, subm otal Volume	ersible): Purged:		Jacon (ultz		
Weather Conditi	ions:			SOF		Overce	<u>ast, i</u>	wind			18 400	
Depth to Top of	Product	(ft BTOC)):				Depth to	Water (f	t BTOC):		19,23	5
Depth to Oil/Wat	ter Interl	face* (ft B	TOC):			_	Total De	pth (ft B7	TOC):		36.86	1
* Note: Same as d	lepth to v	vater										
Criteria for S	table I	Paramet	ters		_,	1						
Parameter			Working Range			Stability C	riteria	Notes				
l emperature			>0.00 °C			$\pm 3\%$						
Conductivity			0-14	S/m		± 0.1		1				
ORP			+ 1999 m	אר <u>ס</u> אר		+ 10 my						
Dissolved Oxyge	<u>en</u>		0-19 99 mg/l			+ 10%		+				
Turbidity		0-800 NTU					1					
Sensory Obs	servati	ons	· ·									
Color:		Clear, A	mber, Ta	n, Brown, Gre	ey, M	ilky White, (Other:					
Odor:		None, Lo	w, Mediu	ım, High, Ver	y Stro	ng, H2S, Fi	uel Like,	Chemica	il ?, Unkn	iown		
Turbidity:		None, Lo	w, Mediu	ım, High, Ver	y Turb	id, Heavy S	Silts				******	
Instrument C)bserv	ations										
12												
				0	_		50	000			Water	Durau
Pound	Time	Temp	 Li	Conduct'ity	T	urbidity (NTUe)	DO (mg/l.)	ORP	Color	Odor	Water Level (ft BTOC)	Draw-
Round	Time	Temp °C	pH	Conduct'ity	T	urbidity (NTUs)	DO (mg/L)	ORP (mV)	Color	Odor	Water Level (ft BTOC)	Draw- down
Round 1 2	Time 1849	Temp °C 5.20 4.94	рН 6.44 6.30	$\frac{\text{Conduct'ity}}{\binom{\text{A}^{5}/\text{(A})}{2.275}}$	T B	urbidity (NTUs) TW Nove	DO (mg/L) 8.63	ORP (mV) 200.4	Color Clear	Odor None	Water Level (ft BTOC) 19.24	Draw- down
Round 1 2 3	Time 1849 1852 1855	Temp °C 5.20 4.96 4.3	рН 6.44 6.30	Conduct'ity $\binom{A^{5}/(A)}{0.275}$ 0.272 0.270	P	urbidity (NTUs) TW Note	DO (mg/L) 8.63 1.70	ORP (mV) 200.4 193.2 180.7	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 (9.23	Draw- down 0.01
Round 1 2 3 4	Time 1849 1852 1855	Temp °C 5,20 4,96 4,03 3,85	pH 6.44 6.30 6.27 6.27	Conduct'ity $\binom{A^{5}/A}{A}$ 0.275 0.272 0.270 0.270 0.270	т Д	urbidity (NTUs) TW None	DO (mg/L) 8.63 1.70 0.78 0.75	ORP (mV) 200.4 193.2 (%0.7 174.7	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 (9.23 19.23	Draw- down 0.01 0.00
Round 1 2 3 4 5	Time 1849 1852 1855 1858 1901	Temp ℃ 5.20 4.96 4.3 3.85 3.72	рН 6.44 6.30 6.27 6.27 6.29	Conduct'ity $(^{AS}/_{CA})$ 0.275 0.272 0.270 0.270 0.270 0.270	т Ф	urbidity (NTUs) TW None	DO (mg/L) 8.63 1.70 0.78 0.75 0.79	ORP (mV) 200.4 193.2 180.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 19.23 19.23 19.22	Draw- down 0.01 0.00 0.00 -0.01
Round 1 2 3 4 5 Final 6 fost plan	Time 1849 1852 1855 1858 1901 1920	Temp ℃ 5.20 4.96 4.3 3.85 3.72	рН 6.44 6.30 6.27 6.27 6.29	Conduct'ity (^{AS} / _{CA}) 0.275 0.272 0.270 0.270 0.270	T P	urbidity (NTUs) TW Nove	DO (mg/L) 8.63 1.70 0.78 0.75 0.79	ORP (mV) 200.4 193.2 180.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 (9.23 19.23 19.22 19.22	Draw- down 0.01 0.00 0.00 -0.02
Round 1 2 3 4 5 Final 6 gost 7	Time 1849 1852 1855 1858 1901 1920	Temp ℃ 5.20 4.96 4.3 3.85 3.72	рН 6.44 6.30 6.27 6.27 6.29	Conduct'ity (^{A5} / _{(A}) 0.275 0.272 0.270 0.270		urbidity (NTUs) TW NDAC	DO (mg/L) 8.63 1.70 0.78 0.75 0.79	ORP (mV) 200.4 193.2 180.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 (9.23 19.23 19.22 19.22	Draw- down 0.01 0.00 -0.01 -0.02
Round 1 2 3 4 5 Final 6 fost 7 8 0	Time 1849 1852 1855 1858 1901 1920	Temp ℃ 5.20 4.96 4.3 3.85 3.72	рН 6.44 6.30 6.27 6.27 6.29	Conduct'ity (^{A5} / _{(A}) 0.275 0.272 0.270 0.270		urbidity (NTUs) TW Nove	DO (mg/L) 8.63 1.70 0.78 0.75 0.79	ORP (mV) 200.4 193.2 180.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 (9.23 19.23 19.22 19.22	Draw- down 0.01 0.00 -0.02 -0.02
Round 1 2 3 4 5 Final 6 fogt 7 8 9 10	Time 1849 1855 1855 1858 1901 1920	Temp ℃ 5.20 4.96 4.3 3.85 3.72	рН 6.44 6.30 6.27 6.27 6.29	Conduct'ity (^{A5} / _{(A}) 0.275 0.272 0.270 0.270 0.270		urbidity (NTUS) TW None	DO (mg/L) 8.63 (.70 0.78 0.75 0.75	ORP (mV) 200.4 193.2 180.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 (9.23 19.23 19.22 19.20	Draw- down 0.01 -0.02 -0.02
Round 1 2 3 4 5 Final 6 forther 7 8 9 10 11	Time 1849 1855 1855 1958 1901 1920	Temp ℃ 5.20 4.96 4.96 3.85 3.72	рН 6.44 6.30 6.27 6.29	Conduct'ity (^{A5} / _{(A}) 0.275 0.272 0.270 0.270		urbidity (NTUS) TW None	DO (mg/L) 8.63 1.70 0.78 0.75 0.79	ORP (mV) 200.4 193.2 180.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 (9.23 19.23 19.22 19.20	Draw- down 0.01 0.00 -0.01 -0.02
Round 1 2 3 4 5 Final 6 foother 7 8 9 10 11 12	Time 1849 1855 1855 1858 1901 1920	Temp ℃ 5.20 4.96 ↓,(3) 3.85 3.72	рН 6.44 6.30 6.27 6.29	Conduct'ity (^{AS} / _{CA}) 0.275 0.270 0.270 0.270		urbidity (NTUS) TW None	DO (mg/L) 8.63 1.70 0.78 0.75 0.79	ORP (mV) 200.4 193.2 180.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 19.23 19.23 19.22 19.20	Draw- down a. a1 -0.a(0.a0 -0.06 -0.02
Round 1 2 3 4 5 Final 6 fort share 7 8 9 10 11 12	Time 1849 1855 1858 1901 1901	Temp ℃ 5.20 4.96 ↓, (3) 3.85 3.72	рН 6.44 6.30 6.27 6.27 6.29	Conduct'ity (^{A5} / _{(A}) 0.275 0.272 0.270 0.270		urbidity (NTUs) TW Nove	DO (mg/L) 8.63 1.70 0.78 0.75 0.79	ORP (mV) 200.4 193.2 180.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 19.23 19.22 19.22	Draw- down g. @1 -0.0(0.00 -0.0(-0.02
Round 1 2 3 4 5 Final 6 7 8 9 10 11 12 Notes: Drawdown s	Time 1849 1855 1855 1901 1920 	Temp °C 5, 2.0 4.96 4, (3 3.85 3.72	рН 6.30 6.37 6.27 6.29 	Conduct'ity (^{A5} / _{(A}) 0.275 0.270 0.270 0.270	drawdo	urbidity (NTUs) TW None	DO (mg/L) 8.63 1.70 0.78 0.75 0.79	ORP (mV) 200.4 193.2 180.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 19.23 19.22 19.22	Draw- down g. @1 -0.a(0.ao -0.a(-0.a(-0.a) -0.a(-0.a(-0.a) -0.a(
Round 1 2 3 4 5 Find 6 \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	Time (849 1 855 1855 1901 1901 1920 hould be I tinually m	Temp °C 5, 2, 0 4, 96 ↓, (3 3, 85 3, 72 ess than 0,3 easuring wa	рН 6.44 6.30 6.27 6.27 6.29 feet while s ter levels in	Conduct"ity (^{A5} / _{(A}) 0.275 0.272 0.270 0.270 0.270	drawdo	urbidity (NTUs)	DO (mg/L) 8.63 1.70 0.75 0.75 0.79	ORP (mV) 200.4 193.2 180.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 19.23 19.22 19.22 19.20 19.20 te (approximatel	Draw- down 0.01 0.00 -0.01 -0.02 y 0.1 to 0.5
Round 1 2 3 4 5 Find 6 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and cont	Time (849 1855 1855 1901 1920 hould be I tinually m # of	Temp °C 5, 2, 0 4, 96 4, (3) 3, 85 3, 72 ess than 0.3 easuring wa Bottles	pH 6.44 6.30 6.27 6.27 6.29 feet while s ter levels in	Conduct'ity (^{A5} / _{(A}) 0.275 0.270 0.270 0.270 0.270	drawdo	urbidity (NTUs)	DO (mg/L) 8.63 1.70 0.78 0.75 0.79	ORP (mV) 200.4 193.2 180.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 19.23 19.22 19.20 19.20 19.20 19.20	Draw- down 0.01 0.00 -0.01 -0.02 y 0.1 to 0.5
Round 1 2 3 4 5 Final 6 \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	Time 1849 1855 1855 1901 1920 1920 hould be I tinually m # of Col	Temp °C 5, 2, 0 4, 9, 6 4, 7, 7 3, 8, 5 3, 7, 2 ess than 0.3 easuring wa Bottles lected	рН 6.44 6.30 (0.27 6.29 б.29 feet while s ter levels in Comme	Conduct'ity (^{A5} / _{(A}) 0.275 0.270 0.270 0.270 0.270	drawdo	urbidity (NTUS)	DO (mg/L) 8.63 1.70 0.78 0.75 0.75 0.79	ORP (mV) 2.00.4 193.2 180.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 19.23 19.23 19.22 19.20 19.20	Draw- down g. g1 -0.g(-0.g2 -0.g2 y 0.1 to 0.5
Round 1 2 3 4 5 Final 6 forther 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and con Analyses VO C.	Time 1849 1855 1855 1901 1920 1920 1920 1920 1920 1920 1920 1920 1920 1920 1920 1920 1920 1920 1920 1955	Temp °C 5. 2. 0 4. 96 4. 96 4. 96 3. 85 3. 7 2 3. 7 2 ess than 0.3 easuring wa Bottles lected 3	рН 6.44 6.30 6.27 6.29 6.29 feet while s ter levels in Comme	Conduct'ity (^{A5} / _{(A}) 0.275 0.272 0.270 0.270 0.270	drawdo	urbidity (NTUS) W None	DO (mg/L) 8.63 1.70 0.78 0.75 0.79	ORP (mV) 200.4 193.2 (%0.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) I 9.24 I 9.23 I 9.23 I 9.23 I 9.22 I 9.20 Le (approximatel on.	Draw- down g. a1 g. a2 g. a0 g. a0 g. a0 g. a0 g. a0 g. a0 g. a0 g. a0 g. a2 g. a1 g. a1 g. a1 g. a1 g. a1 g. a2 g. a2 g
Round 1 2 3 4 5 Final 6 forther forthe	Time (849 1855 1855 1901 1920 1920 1920 1920 1920 401 1920 1	Temp °C 5, 2.0 4.96 4, (3 3.85 3.72 3.72 ess than 0.3 easuring wa Bottles lected 3	pH 6.30 6.27 6.27 6.29 feet while s ter levels in Comme	Conduct'ity (^{A5} / _{(A}) 0.275 0.270 0.270 0.270	drawdo	urbidity (NTUS) TW NoAC	DO (mg/L) 8.63 1.70 0.78 0.75 0.79	ORP (mV) 200.4 193.2 180.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) I 9.24 I 9.23 I 9.23 I 9.23 I 9.22 I 9.20 Le (approximatel on.	Draw- down g. gl g. gl g. gg g. gg g
Round 1 2 3 4 5 Final 6 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and con Analyses VOC AIK Sult/Ch TOC	Time (849 1855 1855 1901 1901 1920 hould be I trinually m # of Col	Temp °C 5, 2.0 4.96 4, (3 3.85 3.72 ••••••••••••••••••••••••••••••••••••	pH 6.44 6.30 6.27 6.27 6.29 feet while s ter levels in Comme	Conduct"ity (^{A5} / _{(A}) 0.275 0.272 0.270 0.270 0.270	drawdo	urbidity (NTUs)	DO (mg/L) 8.63 1.70 0.78 0.75 0.79	ORP (mV) 200.4 193.2 180.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 (9.23 19.22 19.22 19.20 te (approximatel on.	Draw- down 0.01 0.00 -0.01 -0.02 y 0.1 to 0.5
Round 1 2 3 4 5 Final 6 for and 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and con Analyses VOC AIKS (V/Ch TOC Nitrate 1-it g	Time (849 1855 1855 1901 1901 1920 hould be I tinually m # of Col	Temp °C 5, 2.0 4.96 4, (3) 3.85 3.72 3.72 a.72 a.72 b.72 a.72 a.72 a.72 a.72 a.72 a.72 a.72 a	рН 6.44 6.30 6.27 6.27 6.29 feet while s ter levels in Comme	Conduct"ity (^{A5} / _{(A}) 0.275 0.272 0.270 0.270 0.270	drawdo	urbidity (NTUs)	DO (mg/L) 8.63 1.70 0.75 0.75 0.79	ORP (mV) 200.4 193.2 180.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 19.23 19.22 19.20 19.20 Le (approximatelon.	Draw- down 0.01 0.00 -0.02 -0.02
Round12345 $F_{INA} $ 6789101112Notes: Drawdown sliter/minute) and conAnalysesVOCAIK Suff/ChTOCNitrate 1-it sFc / MaContrate 1-it s	Time (849 1855 1855 1901 1920 hould be I tinually m # of Col	Temp °C 5, 2, 0 4, 96 4, (3 3, 85 3, 72 3, 72 3, 72 3, 72 3, 72 3, 72 3, 72 3, 72 3, 72 4, (3) 3, 85 3, 72 4, (3) 3, 85 4, (3) 3, 85 5, (3) 4, (3) 3, 85 5, (3) 6, (3) 7,	рН 6.44 6.30 (0.2.7 6.2.7 6.2.9 feet while s ter levels in Comme	Conduct'ity (^{A5} / _{(A}) 0.275 0.272 0.270 0.270 0.270	drawdo	urbidity (NTUS)	DO (mg/L) 8.63 (.70 0.78 0.75 0.79	ORP (mV) 200.4 193.2 180.7 174.7 168.9	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 19.23 19.22 19.20 19.20 19.20	Draw- down 0.01 0.00 -0.01 -0.02 y 0.1 to 0.5
Round 1 2 3 4 5 Final 6 fost 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and con Analyses VOC ALKS(I/Ch TOC. Nitrate I-ite Fe/Mm Fe/Mm Signed:	Time 1849 1855 1855 1901 1920 1920 hould be I tinually m # of Col	Temp °C 5, 2, 0 4, 96 4, 73 3, 85 3, 72 3, 72 3, 72 3, 72 3, 72 3, 72 3, 72 3, 72 3, 72 3, 72 4, 73 3, 72 3, 72 4, 73 5, 72 5, 72, 72 5, 7	рН 6.444 6.30 (0.2.7 6.2.9 feet while s ter levels in Comme	Conduct'ity (^{A5} / _{(A}) 0.275 0.270 0.270 0.270 0.270	drawdo	urbidity (NTUS)	DO (mg/L) 8.63 1.70 0.78 0.75 0.79	ORP (mV) 200.4 193.2 180.7 174.7 168.9 	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 19.23 19.22 19.20 19.20 19.20	Draw- down g. gl -0.gl -0.gl -0.gl -0.gl -0.gl -0.gl -0.gl
Round12345 $F_{INA} $ 6789101112Notes: Drawdown sliter/minute) and conAnalysesVOCAlk Sulf/chTOCNitrate 1-iteFe/MnSigned:Ethaw letha	Time (849 1855 1855 1855 1901 1901 1920 hould be I tinually m # of Col 071d; 1 201 20	Temp °C 5, 2.0 4, 96 4, (3 3, 85 3, 72 3, 72 3, 72 3, 72 3, 72 4, 1 5 6 8 6 8 6 8 6 8 6 7 8 7 8 7 8 7 8 7 8 7	рН 6.44 6.30 6.27 6.27 6.29 feet while s ter levels in Comme	Conduct'ity (^{A5} / _{(A}) 0.275 0.272 0.270 0.270 0.270	drawdo	urbidity (NTUS)	DO (mg/L) 8.63 1.70 0.78 0.75 0.79	ORP (mV) 2.00.4 193.2 180.7 174.7 168.9 168.9 168.9 168.9 Date:	Color Clear	Odor None	Water Level (ft BTOC) 19.24 19.23 19.23 19.22 19.20 19.20 19.20 19.20	Draw- down 0.01 0.00 -0.02 -0.02

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	1: 4	₽	a e						at Na an				
			Scound	wator Sam	e oling with M	linimal I	Trawd		orksh	aat			
	LOW		JIOUIIU	water Sam	pinig with iv	mman			a a	561			
	44.004						vven iD,	- 3 GF	_ 11				
Project # :	14-201, Phase 2						Date:						
Project Name:	Aniak WACS FS						Start Time:0 9 20						
Field Team:	Rhodes, Bryan						iu nine.		<u></u>	*un#			
Sample ID:	11- AWA-00 7- GW Time: 1040					_ primary) dup	split	ms/msd				
Sample ID:	Time:						dup	split	ms/msd				
Sample ID:	Time:						dup	split	ms/msa				
Purg	ing and	Sampling	Method	(e.g. peristalti	c, bladder, sub	mersible):	FUI	12					
					Total Volum	e Purged:							
Weather Condit	tions:		3001	F, Overco	6t								
Depth to Top of	Product	(ft BTOC)	: ·	/		Depth to	Water (f	t BTOC):		19.08			
Depth to Oil/Wa	ter Interf	ace* (ft B	FOC):			Total De	oth (ft B1	FOC):		25.67			
* Note: Same as o	depth to v	vater								, 			
Criteria for S	stable i	Paramei	ers	Dango	Stability (ritoria	Notes						
Temperature			>0.00 °C	Kange	± 3%	Jillena	NOLES						
pH			0-14		± 0.1					·			
Conductivity			0-999 mS	6/m	± 3%								
ORP Discoluted Oracle	~ ~		± 1999 m		<u>± 10 mv</u>								
Dissolved Oxyg	en		0-19.991		± 10%								
Sensory Ob	servati	ons					I						
Color:		Clear, A	mber, Ta	n, Brown, Gre	y, Milky White,	Other:		maine én ministra d'Annahili					
Odor:		None, Lo	w, Mediu	ım, High, Very	Strong, H2S, I	-uel Like,	Chemica	ıl ?, Unkn	own				
Turbidity:	~ 1	None, Lo	w, Mediu	im, High, Very	Turbid, Heavy	Silts	00 *	11					
Instrument (Jbserv	ations	rĤ	urge > o	impie ra	T	.00 **		г Г	Water	l .		
Round	Time	Temp °C	рН	Conduct'ity (^{m.5} / ₆))	Turbidity (NTUs)	DO (mg/L)	ORP (mV)	Color	Odor	Level (ft BTOC)	Draw- down		
1	1007	4,96	6.47	0.164	N ONE	15.10	220.6	Clear	NORE	20.09'	1.01'		
2	1011	4.57	6.00	0.163		12.2	221.0			20.30	0.21		
4	1014	7.º 6 2 au	5.81 5 ac	0.172	<u> </u>	10.10	212.7	Gray		20.05'	- 0.03'		
5	1020	3.71	5.90	0.185		9.53	204,7			20.05	0.00'		
6	1030	-2 Gil.	594	0.192	High	8.56	209.6	Brown		20.38'	0.33		
	1427	31 14	<u> </u>		4.2		-			- C J			
/	1027	4.04	5.93	0.216		7, 98	205.1			20.28	-0.10		
8	1027	4.04 3.86 4.05	5.93 5.93 5.93	0.216 0.222		7.88	205.1 204.1 2012			20.28	-0.10 -0.02' 0.06'		
9 Final 10 Carel	1027 1030 1034 1034	4.04 3.86 4.05	5.93 5.93 5.91	0.216 0.222 0.222		7.98 7.58 7.09	203.1 204.1 201.2			20.28	-0.10 -0.02' 0.05'		
7 8 9 Final 10 Carpl 11	1027 1030 1034 1034	4.04 3.86 4.05	5.93 5.93 5.91	0.216 0.222 0.222		7.98	203.1 204.1 201.2			20.26' 20.31' 19.35'	-0.10 -0.02' 0.05'		
7 8 9 Final 10 prove 11 12	1027 1027 1030 1034 1034	4.04 3.86 4.05	5.93 5.93 5.91	0.216 0.222 0.222		7, 98 7, 58 7, 09	205.1 204.1 201.2			20.26	-0.19 -0.02' 0.05'		
7 8 9 Fine [10 Case] 11 12 Notes: Drawdown s	10.27 10.30 10.34 61.059	4.04 3.86 4.05 ess than 0.3	5.93 5.93 5.91 feet while s	0.216 0.222 0.222 ampling. Minimal of	drawdown shall be a	7, 38 7, 58 7, 69 7, 69 chieved and r	205.1 204.1 201.2	by pumping	at a low ra	20,26* 20,31' 19.55*	y 0.1 to 0.5		
7 8 9 Final 10 provident 11 12 Notes: Drawdown s liter/minute) and con	1027 1027 1030 1034 61059 61059 should be Intinually m	4.04 3.86 4.05 ess than 0.3 easuring wa	5.93 5.93 5.91 feet while s ter levels in	O.215 O.222 O.222 ampling. Minimal of the well. Note that	drawdown shall be a site's hydrogeology	7, 88 7, 58 7, 09 7, 09 chieved and r may make it	203.1 204.1 201.2 neasured difficult to	by pumping achieve this	at a low ra	20.28 20.31 19.35 te (approximatel on.	y 0.1 to 0.5		
7 8 9 Final 10 Carrol 11 12 Notes: Drawdown s liter/minute) and con	1027 1027 1030 1034 21059 20059 20050 20050 20050 20000000000	4.04 3.86 4.05 ess than 0.3 easuring wa Bottles	5.93 5.91 5.91 feet while s ter levels in	A.215 O.222 O.222 ampling. Minimal of the well. Note that	drawdown shall be a site's hydrogeology	7, 98 7, 58 7, 09 7, 09 chieved and r may make it	203.1 204.1 201.2 measured difficult to	by pumping achieve this	at a low ra	20.26 20.31 19.55 te (approximatel on.	y 0.1 to 0.5		
7 8 9 Find 10 Case 1 11 12 Notes: Drawdown s liter/minute) and cor	1027 1027 1030 1034 21059 21059 21059 21059 21059 21059 21059 200 200 200 200 200 200 200 200 200 20	4.04 3.86 4.05 ess than 0.3 easuring wa Bottles lected 2	5.93 5.93 5.91 feet while s ter levels in	O.216 O.222 O.222 ampling. Minimal of the well. Note that	drawdown shall be a site's hydrogeology	7, 98 7, 59 7, 09 7, 09 chieved and r may make it	205.1 204.1 201.2 measured difficult to	by pumping achieve this	at a low ra	20.26' 20.31' 19.55' ate (approximatel on.	y 0.1 to 0.5		
7 8 9 Final 10 Prove 11 12 Notes: Drawdown s liter/minute) and con Analyses V o C	1027 1030 1034 1034 21059 1034 21059 1034 21059 1034 21059 1034 21059	ess than 0.3 easuring wa Bottles lected	5.93 5.93 5.91 feet while s ter levels in Commen	ampling. Minimal of the well. Note that	trawdown shall be a site's hydrogeology	7.88 7.58 7.09 chieved and r may make it een βl	203.1 201.2 measured difficult to	by pumping achieve this	at a low ra specificati	$\frac{20.28}{20.31'}$ $\frac{19.35'}{19.35'}$ $\frac{19.35'}{19.35'}$ $\frac{1}{19.35'}$	y 0.1 to 0.5		
7 8 9 Final 10 Care I 11 12 Notes: Drawdown s liter/minute) and con Analyses V 0 (ALL / Sulf (Ch b) T 0 6	1027 1027 1030 1034 21059 21000 21000 2000 2000 2000 2000 2000 2	4.04 3.86 4.05 4.05 easuring wa Bottles lected 3	5.93 5.93 5.91 feet while s ter levels in Commen Th	0.216 0.222 0.222 ampling. Minimal of the well. Note that nts: 15 Well h 5 or 1 9 0 5	drawdown shall be a site's hydrogeology ad not b point.	chieved and may make it	205.1 204.1 201.2 measured difficult to	by pumping achieve this $u \le l_y$ o f = T l	at a low rates specification	$\frac{20.28}{20.31}$ $\frac{19.55}{19.55}$ $\frac{19.55}{100}$ $\frac{19.55}{100}$ $\frac{19.55}{100}$ $\frac{19.55}{100}$	-0.10 -0.02' 0.05' y 0.1 to 0.5		
$ \frac{7}{8} $ 9 Find 10 Prove for the formation of the for	1027 1027 1030 1034 21059 20050 200000000	4.04 3.86 4.05 4.05 ess than 0.3 easuring wa Bottles lected 3 1 4	feet while s ter levels in Commen Th	0.216 0.222 0.222 ampling. Minimal of the well. Note that nts: 15 well h 5 orl gas furbidit	trawdown shall be a site's hydrogeology ad not b point. of the w	1,88 7,58 7,09 7,09 chieved and r may make it een pi A por afcr i	203.1 204.1 201.2 measured difficult to fre VIO fron S affi	by pumping achieve this u s ly of m $r_1 \delta u f e f$	at a low ra specificati Samp he pu	20.28 20.31 19.55 ite (approximatel on. led as rge tim no prio	y0.1 to 0.5		
$\frac{7}{8}$ 9 Find 10 Control 10 C	1027 1027 1030 1034 21059 21000 21000 2000 2000 2000 2000 2000 2	4.04 3.86 4.05 4.05 ess than 0.3 easuring wa Bottles lected 3 1 1	5.93 5.93 5.91 feet while s ter levels in Commen Th 15 a high	ampling. Minimal of the well. Note that $rts:$ rts:	trawdown shall be a site's hydrogeology ad not b point. of the w	chieved and r may make it een pr A por	205.1 201.2 neasured difficult to re VIO fion S aff	by pumping achieve this of M ribute	specificati Samp cleves	20.28 20.31 19.55 19.55 te (approximatel on. 1ed as rge fim no priori	y 0.1 to 0.5		
$\frac{7}{8}$ 9 Fing [10 $\frac{2}{3}$ and [10 $\frac{2}{3}$ and [10 $\frac{2}{3}$ and [10 $\frac{2}{3}$ and [11 $\frac{11}{12}$] Notes: Drawdown s liter/minute) and con Analyses $\frac{V \circ (c}{AAA} + \frac{1}{3}	1027 1030 1034 1034 1034 1034 1034 1034 1034	4.04 3.86 4.05 4.05 ess than 0.3 easuring wa Bottles lected 3 1 1 1 1	5.93 5.93 5.91 feet while s ter levels in Commen Th 15 a high	$\begin{array}{c} 0.216\\ 0.222\\ 0.222\\ \hline \end{array}$ ampling. Minimal of the well. Note that the well. Not	trawdown shall be a site's hydrogeology ad not b point. of the w	chieved and r may make it een pr A por	205.1 201.2 neasured difficult to fe V10 from S aff. Date:	by pumping achieve this usly of th ribute	at a low rates specification SAMP Ae Phie $A = PhieClevel5 - 1$	20.28 20.31 19.55 19.55 te (approximatel on. 1ed as rge fim no prior 10pme = 1 1-11	-0.10 -0.02' D.05' y 0.1 to 0.5 it C and r well		
$\frac{7}{8}$ 9 Find 10 F	1027 1027 1030 1034 21059 21059 21059 21059 21059 21059 200 200 200 200 200 200 200 20	4.04 3.86 4.05 4.05 ess than 0.3 easuring wa Bottles lected 3 1 1 1 1 1	5.93 5.93 5.91 feet while s ter levels in Commen Th 1 S A h 1 g h	ampling. Minimal a ampling. Minimal a the well. Note that nts: 15 well h 5 orl gas turbidits Aurbidits	trawdown shall be a site's hydrogeology ad not b point. point. pot the w	7.88 7.58 7.09 7.09 7.09 6 may make it een pi A por	205.1 201.2 201.2 measured difficult to $re vio$ $4i0n$ $Saff$ Date: Date:	by pumping achieve this $u \le l_y$ of M $r_1 \le u + e$	at a low ra specificati Samp he pu d to clevel 5-1	20.28 20.31' 19.35' 19.35' ate (approximatel on. 1ed as rge tim no prior 10pme = 1 1-11	-0.10 -0.02' 0.05' y 0.1 to 0.5 it e and r well		

Strategy - which is the state of the state of the state
	LOW-FIO	w Gr	ound	water Sam	ipiin	y with M	iiiiimai I	Jiawd		VUTK	SIIE	יסו	
								Well ID:		MW	/ _][1	
Project # :	14-201, Phas	se 2					-	Date:		5-		8	
Project Name:	Aniak WACS	FS					_ Sta	rt Time:		and the second	15	49 	
Site:	Aniak WACS	;			ç		_ Er	nd Time:			543	5	
Field Team:	R.]	Brya	(A ,	W. Rhod	25					and the second se		3	
Sample ID:		<u>4 ŵ</u>	4-0	08-6W	Time:	1505	_ @rimary	> dup	split	(ms/	msd	1	
Sample ID:		•••••••			Time:		_ primary	dup	split	ms/	msd		
Sample ID:					lime:		_ primary	dup	split	ms/	msd	*	
Purg	ing and Sam	pling N	lethod	(e.g. peristalt	ic, bla To	adder, subr otal Volum	nersible): e Purged:		- L	H	5	perista	<u>Ific</u>
Weather Condit	tions:			4.	0 F	<u>, sun</u>)						
Depth to Top of	Product (ft B1	FOC):		0			Depth to	Water (f	t BTOC	:		19.3	58'
Depth to Oil/Wa	iter Interface*	(ft BTO	DC): -			-	Total De	pth (ft B	roc):		-	37.	25'
* Note: Same as o	depth to water		· _				-	· · ·			•		
Criteria for S	Stable Para	meter	rs										
Parameter		W	/orking	Range		Stability C	Criteria	Notes					
Temperature	*******	>(0.00 °C			± 3%							
рН		0-	-14			± 0.1							
Conductivity		0-	-999 mS	3/m		± 3%							
ORP		±	1999 m	١V		± 10 mv							
Dissolved Oxyg	en	0-	-19.99 n	ng/L		± 10%							
Turbidity		0-	-800 NT	-U		L		<u> </u>					
Sensory Ob	servations												
Color:	Clear	, Amb	ber, Tai	n, Brown, Gre	ey, Mi	ilky White,	Other:	<u>.</u>					
Odor:	None	, Low,	, Mediu	m, High, Ver	y Stro	ng, H2S, F	uel Like,	Chemica	ai ?, Unk	nown			
l urbidity:	None	, Low,	, Mediu	im, High, Ver	y Turb	na, Heavy	SIIIS	الد الأمر و	2 A				
Instrument (Joservatio	ns		purge 1 s	s a m	ple ro	ite z	160	m lo /1	% 199		101-1	I
				Conductit	.	، رواح ما اغ						vvater	
Dound	Time of	- up				urviuity (NTHe)			Color	0		(ff RTOC)	down
1	14294	$\frac{1}{\sqrt{7}}$	7 84	<u> </u>		014/	5.56	42.9	Grow	MA		19 65	Lonzi
2	1429 4 1	9+	8.47	0 200			1117	-30.0	1			19.55	0.001
3	1436 4		8.08	0.289	Al	one	1.93	51.7	Clear	1		19.55	0.00
4	1439 4.7	<u>5</u> +	7,19	0.288	1 <u>~~</u>	<u>, x · · · · · · · · · · · · · · · · · · </u>	1.71	-35.9				19.55	0.001
5	1442. 4.	16 T	6.74	0.2.87	1		1.59	-21.2		1		19.55	0.00
6	1446 4.1	14	6.62	0.286	1	1	1.52	12.1				19.55	0.00
7	1449 4.0	24 1	6.56	0.286			1.47	-10.0			4	19.55	0.001
8	1452 3,9	16	6.46	0.287		ł.	1.40	0.4				19.55	0.001
9	1455 4.0	06	6.49	0.285			1.31	12.8	ļ{	_		19.55	0.00
10	1459 4.0	29	6.37	0.284	ļ		1.27	16.8	L (4		19.55	0.00'
11	11502 4.0) _	6.35	0.285	ļ	g	1.27	20.3	ļ	4		19.55	0.00'
	<u>'4</u>				L			<u> </u>	l	1		19.52	- 0. 03'
Final 12 gamp													
Final 12 gang		an 0.3 fee	et while s	ampling. Minimal	drawdo	own shall be a	chieved and	measured	by pumpir	g at a	low rat	te (approximate	ly 0.1 to 0.5
Notes: Drawdown	should be less the		ievels in	the well. Note that	IL SILE'S	nyarogeology	may make it	unicult to	achieve th	is spec	ancauo	μι,	
Notes: Drawdown sliter/minute) and co	should be less that ntinually measurin	ng water											
Notes: Drawdown s	should be less that ntinually measurin # of Bottl	es d	`ommo-	nte ·									4
Notes: Drawdown : liter/minute) and co	should be less that ntinually measurin # of Bottl Collecter	es d C	ommer	nts:		Laure 1	a	1 1	11	_ /	11.	and Bridger and	
Notes: Drawdown : liter/minute) and co	should be less that ntinually measurin # of Bottl Collecter	es d C	ommer 7	nts: S90.9	may	have be	ien too	hurbs	d for	- h	.1+2	pump.	lypon
Notes: Drawdown : liter/minute) and co Analyses V Q C Alk(Sulf) Cklo	should be less the ntinually measurin # of Bottl Collecter 3 x 2ride /	es d C	ommer १ ३९	nts: Sgp·9 tupat	may MV	hove be v-11, f	ien too	, turbi pum	d for p an	- L. , p. j	.//2 ' / n	pump.	. Upon d to 4,
Notes: Drawdown : liter/minute) and co Analyses VOC Alk(sulf)C(all	should be less th: ntinually measuri # of Bottl Collecter 3 x pride 1	d C	commer 7 3e 74 (nts: Sgp·9 tup at en de cr	тау МV easi	hove bo v-11, f ed to	en too ultz 0, th	pum en c	d for p an on tr	- fr n p s o l t	.//2 ///2 / / n / o x	creased stoppe	. lypon d to 4 d
Notes: Drawdown : liter/minute) and co Analyses VOC Auk(sufficule Notrate Lite	should be less th: ntinually measuri # of Bottl Collecter ?rtde 1	d C	commer 7 7 7 7 4 W	nts: Sgp·9 tup at en de cr forking	т <i>ау</i> МV easi	have be v-11 f od to 0 k.e d	en too ultz o, th w/ J	pum en c ane	d for p an on tr , sw	- fr	.//2 // / / / /	creased stoppe	. Upon d to 4 _. d stalle
Notes: Drawdown : liter/minute) and co Analyses VOC AUK(Sufficule Nitrate J. ite Fo J. Ma	should be less th: ntinually measuri # of Botti Collecte 3 x yride 1 4 1	d C	Commer 7 7 7 7 7 0 W	nts: Sgp-9 tupat en decr jørking	т <i>аў</i> М V easi	have be v-11, f od to 0 K.e.d	en too u/tz v/7	pum en c ane	d for p an on tr , sw	- fr	1/2 , n o x h J	pump. creased stoppe	. Upon d to 4 d staltic
Notes: Drawdown : liter/minute) and co Analyses VOC Auk(sufficult TOC Nitrate/-ite Fo/Ma Signod:	should be less th: ntinually measuri # of Botti Collecte 3 x 7 de 1 4 1	d C	Commer 7 7 7 7 7 0 0 0	nts: Sgp-9 tup at en de cr iorking	may MV ease	have be v-11, f ed to 0 Ken	$\frac{en}{wl+2}$	pum en c ane	d for p an on tr , sw	- L. , P. 2 , t. c 5 -	-1+2 , n o x h J	pump creased stoppe	. Woon d to 4 _, d staltic
Notes: Drawdown : liter/minute) and co Analyses VOC Auk(ISulf)Chlo TOC Nitrate)-ite Fo/An Signed:	should be less th: ntinually measuri # of Bottl Collecte 3 x pride 1 1	d C	Commer 7 7 7 7 0 0 0	nts: Sgp.9 tup at en de cr forking Runnle	таў М V easi . (have be v-11, f ed to 0 K.e A	en too ultz 0, th w/ 7	pum en c ane Date:	d for p an on tr , sw	- L. , p. s , t c 5 -	1/+2 / n > 0 × h + 11 -	pump creased stoppe to peri	. Uypon d to 4, d staltic

	LOW	-riow (Jrouna	water Sam	ıbımő	j with Mi	nimai L	Jrawd	own vv	UINSII	eet]
							1	Well ID:		Sop-	· 2.	
Project # :	14-201,	, Phase 2						Date:	ŝ	5'. ii -		
Proiect Name:	Aniak V	VACS FS					Sta	rt Time:		154	9	
Site:	Aniak V	VACS					En	d Time:		180	 0	
Field Team:	ſ	2. Bry	on 2	W. Rhode	ę <i>S</i>							
Sample ID:	1	I-AW.	4. 00	1-6.W	Time:	1730	primary	⁾ dup	split	ms/msd		
Sample ID:			~	-	Time:		primary	dup	split	ms/msd		
Sample ID:					lime:		primary	dup	split	ms/msd	Λ	
Purg	ing and	Sampling	J Method	(e.g. peristalf	tic, bla To	dder, subr tal Volume	ersible): Purged:		Per	·1sta	lfre	
Weather Condi	tions:			40)F,	SUN						
Depth to Top of	Product	(ft BTOC)	i.		*Asci ^a		Depth to	Water (f	(BTOC):		18.	.96'
Depth to Oil/Wa	ter Interf	ace* (ft B	TOC):				Total Dep	oth (ft BT	OC): (28	. 71'
* Note: Same as	depth to w	vater							-			
Criteria for S	Stable I	Paramet	ers									
Parameter			Working	Range		Stability C	riteria	Notes				
Temperature			>0.00 °C			± 3%						
H			0-14			± 0.1						
Conductivity			0-999 m	5/m		± 3%			,			
			± 1999 n	1V		± 10 mV						
Dissolved Oxyg	en		0-19.991			I 1070						
Sancon Oh	eorvati	one	0-000 14	0							. <u>.</u>	
Color:	SCIVALI	Clear A	mher To	n Brown Gr		ky White	Other:					
Odor:		None Lo	w Medi	in High Ver	cy, will v Stron	α H2S Fi	ullika (Chamiaa		own		
					V 1317171			JUEITICA	i e unkn			12
Turbidity:		None, Lo	w. Mediu	ım, High, Ver	v Turbi	d. Heavy S	Silts	Jiemica	i ?, Unkn	OWN		
Turbidity: Instrument (Observ	None, Lo ations	w, Mediu	ım, High, Ver Du v ⊄	y Turbi	d, Heavys Sanol	Silts craft		160	mbr	min	
Turbidity: Instrument (Observ	None, Lo ations	w, Mediu	um, High, Ver <u>Purg</u>	y Turbi	d, Heavys Sanpl	Silts c raf		160	m L /	m in Water	
Instrument (Observ	None, Lo ations Temp	w, Mediu	Im, High, Ver Purg Conduct'ity	y Turbi	d, Heavy S Sanpl Irbidity	Bilts c rat		160	m L /	<i>m in</i> Water Level	Draw-
Turbidity: Instrument (Round	Observ Time	None, Lo ations Temp °C	w, Mediu v pH	Im, High, Ver <u>PUF</u> Conduct'ity (^{M5/} cm)	y Turbi	d, Heavy S Sanpl Irbidity NTUs)	DO (mg/L)	ORP (mV)	I 2, Ohkh I 6 Q Color	m L / Odor	Min Water Level (ft BTOC)	Draw- down
Turbidity: Instrument (Round	Observ Time	None, Lo ations Temp °C 4,014	pH	Im, High, Ver <u>PUV</u> Conduct'ity (^{M5/} cm) Q.3Q2	y Turbi e / Tu Me	d, Heavy S Sanpl Irbidity NTUS)	DO (mg/L)	ORP (mV) (32, /	Color	m L / Odor N0#e	Min Water Level (ft BTOC) 20.11	Draw- down
Turbidity: Instrument (Round 1 2	Dbserv Time 1659 (704	None, Lo ations Temp °C 4.014 4.31	pH 1.66 7.20	Im, High, Ver <u>PUV9</u> <u>Conduct'ity</u> (^{M5/} cm) <u>0.302</u> <u>0.221</u>	y Turbi e / Tu (I Me	d, Heavy S Sanpl Irbidity NTUS)	DO (mg/L)	ORP (mV) (32. / 73. 8	Color brown	m L/ Odor NØME	Min Water Level (ft BTOC) 20.11 20.10	Draw- down 1.15' -0.01'
Round 1 2 3	Dbserv Time 1659 1764 1767	None, Lo ations Temp °C 4.94 4.31 4.24	pH 6.66 7.20 7.34	Im, High, Ver <u>PUV</u> <u>Conduct'ity</u> (^{M5/cM)} <u>0.302</u> <u>0.291</u> <u>0.291</u>	y Turbi e / Tu (I Me	d, Heavy S Sanpl Irbidity NTUS)	DO (mg/L) 10.38 5.00 4.48	ORP (mV) (32.1 73.8 45.1	Color	Odor NØde	Min Water Level (ft BTOC) 20.11 20.10 19.85	Draw- down 1.15' -0.01' -0.25'
Round 1 2 3 4 5	Dbserv Time 1659 1704 1707	None, Lo ations Temp °C 4.04 4.37 4.24 4.24	pH 5.66 7.20 7.34 7.49	Im, High, Ver PUVG Conduct'ity (^{M5} /cm) 0.302 0.291 0.291 0.291 0.291	Turbi	d, Heavy S Sanpl Irbidity NTUS) dium	DO (mg/L) 10.38 5.00 4.48	ORP (mV) (32. / 73. 8 45. / 31.0	Color	Odor	Min Water Level (ft BTOC) 20.11 20.10 19.85 19.97	Draw- down 1.15' -0.25' 0.12'
Round 1 2 3 4 5 6	Dbserv Time 1659 1707 1707 1710 1713	None, Lo ations Temp °C 4,014 4,37 4,24 4,17 4,18 4,22	pH (Im, High, Ver PUV9 Conduct'ity (^{M3} /cm) 0.302 0.291 0.291 0.291 0.291 0.291 0.297	y Turbi e / Tu (I Me	d, Heavy S Sanpl Irbidity NTUS) dium High	DO (mg/L) 10.38 5.00 4.48 4.48 4.48 4.48 3.92	ORP (mV) (32.1 73.8 45.1 71.0 4.5 4.5		own	Min Water Level (ft BTOC) 20.11 20.10 19.85 19.97	Draw- down 1.15' -0.25' 0.12' 0.01'
Round 1 2 3 4 5 6 7	Dbserv Time 1659 1764 1767 1710 1713 1716	None, Lo ations Temp °C 4.04 4.37 4.24 4.17 4.18 4.33 4.33 4.24	pH 6.66 7.20 7.34 7.49 7.92 7.92 7.92 7.92 7.92 7.92 7.92	Im, High, Ver PUV 9 Conduct'ity (^{M3} /cm) 0.302 0.291 0.291 0.291 0.291 0.281 0.284	y Turbi y E J Tu ((Me	d, Heavy S Sanpl Irbidity NTUS) dium High Turbid	Silts L ra. 1 DO (mg/L) 10.38 5.00 4.48 4.20 3.92 3.44 3.44 3.54	ORP (mV) (32.1 73.8 45.1 71.0 45.1 71.0 4.5 13.5		Odor NØde	M in Water Level (ft BTOC) 20.11 20.10 19.85 19.99 19.99	Draw- down 1.15' -0.25' 0.12' 0.01' 0.01'
Round 1 2 3 4 5 6 7 8	Dbserv Time 1659 1704 1707 1710 1713 1716 1719 1719	None, Lo ations Temp °C 4.94 4.37 4.24 4.17 4.18 4.33 4.37 4.37	pH 6.66 7.20 7.34 7.49 7.92 7.99 7.99	Im, High, Ver PUV 9 Conduct'ity (^{M3} /cm) 0.302 0.291 0.291 0.291 0.284 0.284 0.284	y Turbi y E / Tu ((I Me	d, Heavy S Sampl Irbidity NTUS) dium High Jurbid	Silts 2 ra. 1 DO (mg/L) 10.38 5.00 4.48 4.20 3.92 3.44 3.54 3.11	ORP (mV) (32.1 73.8 45.1 73.8 45.1 73.6 73.6		Odor NØđe	Min Water Level (ft BTOC) 20.11 20.10 19.85 19.97 19.98 19.99 20.07 20.30	Draw- down 1.15' -0.25' 0.12' 0.01' 0.01' 0.08' 0.23'
Round 1 2 3 4 5 6 7 8 9	Dbserv Time 1659 1704 1707 1710 1710 1713 1716 1719 1722 1725	None, Lo ations Temp °C 4.04 4.37 4.24 4.17 4.13 4.33 4.33 4.37 4.26 4.34	pH 6.66 7.20 7.34 7.49 7.92 7.99 7.99 7.04 8.08	$\begin{array}{c} \text{m, High, Ver} \\ \hline p \ u \ v \ g \\ \hline conduct'ity \\ (^{M'/cm)} \\ \hline 0.302 \\ \hline 0.291 \\ \hline 0.291 \\ \hline 0.291 \\ \hline 0.291 \\ \hline 0.284 \\ \hline 0.284 \\ \hline 0.276 \\ \hline 0.235 \end{array}$	y Turbi y e / Tu (I Me	d, Heavy S Sanpl Irbidity NTUS) dium High 7 Turbid	DO (mg/L) 10.38 5.00 4.48 4.20 3.92 3.44 3.54 3.11 3.24	ORP (mV) (32.1 73.8 45.1 31.0 4.5 13.5 33.6 79.6 30.5		Odor NØ86	M.in Water Level (ft BTOC) 20.11 20.10 19.85 19.97 19.98 19.99 20.07 20.07	Draw- down 1.15' -0.25' 0.12' 0.01' 0.01' 0.08' 0.23'
Round 1 2 3 4 5 6 7 8 9 Funct 10 Formula	Dbserv Time 1659 1704 1707 1710 1710 1713 1716 1719 1722 1725 1725	None, Lo ations Temp °C ↓ 04 ↓ 37 ↓ 24 ↓ 17 ↓ 12 ↓ 13 ↓ 33 ↓ 37 ↓ 26 ↓ 34	pH 6.66 7.20 7.34 7.49 7.92 7.99 7.99 7.04 8.08 8.37	$\begin{array}{c} \text{m, High, Ver} \\ \hline p \ u \ v \ g \\ \hline conduct'ity \\ (^{M'}/cm) \\ \hline 0.302 \\ \hline 0.291 \\ \hline 0.294 \\ \hline 0.284 \\ \hline 0.284 \\ \hline 0.284 \\ \hline 0.235 \end{array}$	y Turbi ye / Tu ((Me	d, Heavy S Sanpl Irbidity NTUS) dium high y Turbid	DO (mg/L) 10.38 5.00 4.48 4.20 3.92 3.44 3.54 3.11 3.24	ORP (mV) (32.1 73.8 45.1 31.0 4.5 13.5 33.6 79.6 30.5		Odor N9%e	Min Water Level (ft BTOC) 20.10 19.85 19.97 19.98 19.99 20.07 20.30	Draw- down 1.15' -0.25' 0.12' 0.01' 0.01' 0.03' 0.23' 0.23'
Round 1 2 3 4 5 6 7 8 9 Final 10 [05] 11	Dbserv Time 1659 1704 1707 1710 1710 1713 1716 1719 1722 1725	None, Lo ations Temp °C ↓ 04 ↓ 37 ↓ 24 ↓ 17 ↓ 24 ↓ 17 ↓ 18 ↓ 33 ↓ 37 ↓ 26 ↓ 34	pH 6.66 7.20 7.34 7.49 7.92 7.99 7.99 8.04 8.08 8.31	$\begin{array}{c} \text{Im, High, Ver} \\ \hline p \ u \ v \ g \\ \hline conduct'ity \\ (M^{5/cM}) \\ \hline 0.302 \\ \hline 0.291 \\ \hline 0.284 \\ \hline 0.284 \\ \hline 0.284 \\ \hline 0.235 \end{array}$	y Turbi y Turbi y e ∕ Tu ((Me	d, Heavy S Sanpl Irbidity NTUS) dium High J	DO (mg/L) 10.38 5.00 4.48 4.20 3.92 3.44 3.54 3.54 3.11 3.24	ORP (mV) 132.1 73.8 45.1 31.0 4.5 13.5 33.6 79.6 30.5		Odor NØME	Min Water Level (ft BTOC) 20.10 19.85 19.97 19.99 20.07 20.07 20.30	Draw- down 1.15' -0.25' 0.12' 0.01' 0.01' 0.08' 0.23' 0.23'
Round 1 2 3 4 5 6 7 8 9 Finel 10 (200) 11 12	Dbserv Time 1659 1704 1707 1710 1710 1710 1713 1716 1719 1722 1725	None, Lo ations Temp °C 4,014 4,21 4,24 4,17 4,18 4,37 4,37 4,37 4,26 4,34	pH (.66 7.20 7.34 7.49 7.92 7.99 7.04 8.03 8.31	Im, High, Ver PUV9 Conduct'ity (^{M3} /cm) 0.302 0.291 0.291 0.291 0.291 0.297 0.286 0.284 0.284 0.276 0.235	Very	d, Heavy S Sanpl Irbidity NTUS) dium High J	DO (mg/L) 10.38 5.00 4.48 4.20 3.92 3.44 3.54 3.11 3.24	ORP (mV) (32. / 73. 8 45. / 31.0 4.5 13. 5 33.6 79.6 30.5		M L /	Min Water Level (ft BTOC) 20.11 20.10 19.85 19.97 19.99 20.07 20.07 20.30	Draw- down 1.15' -0.25' 0.12' 0.01' 0.01' 0.01' 0.08' 0.23' -0.59F
Round 1 1 2 3 4 5 6 7 8 9 10 Final 10 53 11 12	Dbserv Time 1659 1704 1707 1710 1710 1713 1716 1719 1722 1725 101750	None, Lo ations Temp °C 404 4.37 4.24 4.17 4.18 4.33 4.37 4.26 4.34	pH (.66 7.20 7.34 7.49 7.92 7.92 7.99 7.99 7.99 8.04 8.31	Im, High, Ver PUV9 Conduct'ity (^{M3} /cm) 0.302 0.291 0.291 0.291 0.284 0.284 0.284 0.284 0.276 0.235	Very	d, Heavy S Sampl Irbidity NTUS) dium High Turbid	DO (mg/L) 10.38 5.00 4.48 4.20 3.92 3.44 3.54 3.11 3.24	ORP (mV) (32.1 73.8 45.1 1.0 4.5 13.5 33.6 79.6 30.5		Odor NORC	M in Water Level (ft BTOC) 20.11 20.10 19.85 19.97 19.99 20.07 20.07 20.30	Draw- down 1.15' -0.25' 0.12' 0.01' 0.01' 0.03' 0.23' -0.59F
Round 1 1 2 3 4 5 6 7 8 9 11 12 11 12 11 12 Notes: Drawdown	Dbserv Time 1659 1704 1707 1710 1713 1716 1713 1716 1713 1725 1725 1725 1725	None, Lo ations Temp °C 404 4.37 4.24 4.17 4.24 4.17 4.18 4.33 4.37 4.37 4.37 4.37 4.37	w, Media w, Media pH (.66 7.20 7.34 7.20 7.34 7.49 7.97 7.04 8.03 8.31 feet while s	Im, High, Ver PUVG Conduct'ity (^{M3} /cm) 0.302 0.291 0.291 0.291 0.281 0.284 0.284 0.284 0.284 0.276 0.235	y Turbi y Turbi v Tu (I Me	d, Heavy S Sampl Irbidity NTUS) di um High / Turbid	Silts C ra. 1 DO (mg/L) 10.38 5.00 4.48 4.20 3.92 3.44 3.54 3.54 3.11 3.24 hieved and r	ORP (mV) (32. / 73.8 45. / 73.8 45. / 73.6 79.6 30.5	Color	Odor Node	M in Water Level (ft BTOC) 20.11 20.10 19.85 19.97 20.07 20.07 20.30 19.71	Draw- down 1.15' -0.25' 0.12' 0.01' 0.01' 0.03' 0.23' 0.59'
Round 1 2 3 4 5 6 7 8 9 Final 10 5 6 7 8 9 Final 10 5 11 12 Notes: Drawdown liter/minute) and co	Dbserv Time 1659 1704 1707 1710 1713 1716 1713 1716 1725 1725 1725 1725 1725 1725	None, Lo ations Temp °C 494 4.37 4.24 4.17 4.18 4.33 4.37 4.26 4.37 4.26 4.34 4.37	w, Media w, Media pH (.66 7.20 7.34 7.49 7.92 7.99 7.99 7.04 8.08 8.31 feet while ster levels in	Im, High, Ver PUVG Conduct'ity (^{MJ} /cm) 0.302 0.291 0.291 0.291 0.284 0.284 0.276 0.235 0.235 0.235	Turbi c / Tu ((Me	d, Heavy S Sampl Irbidity NTUS) di um High / Turbid	DO (mg/L) 10.38 5.00 4.48 4.20 3.92 3.44 3.54 3.11 3.24 hieved and r hay make it	ORP (mV) (32. / 73.8 45. / 13.5 33.6 79.6 30.5	Color	Odor None	M in Water Level (ft BTOC) 20.11 20.10 19.93 19.99 20.07 20.07 20.30 [9.71] ate (approximate ion.	Draw- down 1.15' -0.25' 0.12' 0.01' 0.03' 0.23' -0.59'
Round 1 2 3 4 5 6 7 8 9 Final 10 5 6 7 8 9 Final 10 5 6 7 8 9 Final 10 5 11 12 Notes: Drawdown iter/minute) and co	Dbserv Time 1659 1704 1707 1710 1713 1716 1713 1716 1713 1716 1719 1725 1725 1750 should be Intinually m # of	None, Lo ations Temp °C 494 4.37 4.24 4.17 4.13 4.33 4.37 4.26 4.37 4.26 4.34 4.37 4.26 4.34 8 4.37 4.26 4.34 4.37 4.26 4.34 4.37 4.26 4.34 5 5 8 6 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	w, Media w, Media pH 6.66 7.20 7.34 7.49 7.92 7.99 7.99 7.99 8.08 8.31 feet while s ter levels in	Im, High, Ver PUV9 Conduct'ity (^M /cm) 0.302 0.291 0.291 0.291 0.284 0.284 0.276 0.235 0.235 campling. Minimal the well. Note the	Turbi y Turbi y Turbi y C Tu (I Me Ver	d, Heavy S Sampl Irbidity NTUS) di um High / Turbid	Silts C ra. 1 DO (mg/L) 10.38 5.00 4.48 4.20 3.92 3.44 3.54 3.11 3.24 	ORP (mV) (32, / 73.8 45. 1 31.0 4.5 13, 5 33.6 79.6 30.5	Color	Odor NORC A at a low ra specificat	M in Water Level (ft BTOC) 20.11 20.10 19.93 19.99 20.07 20.30 19.71	Draw- down 1.15' -0.25' 0.12' 0.01' 0.03' 0.23' 0.23' -0.59F
Round 1 2 3 4 5 6 7 8 9 Final 10 5 6 7 8 9 Final 10 5 7 8 9 Final 10 5 6 7 8 9 Final 10 5 7 8 8 9 Final 10 5 7 8 8 9 Final 10 5 7 8 8 9 Final 10 5 7 8 8 9 Final 10 5 7 8 8 9 Final 10 5 7 8 8 8 8 9 Final 10 5 7 8 8 8 8 8 8 8 8 8 8 8 8 8	Dbserv Time 1659 1704 1707 1710 1713 1716 17122 1725 1725 1750 should be intinually m # of Col	None, Lo ations Temp °C 494 4.37 4.24 4.17 4.24 4.17 4.13 4.33 4.37 4.26 4.33 4.37 4.26 4.34 4.37 4.26 4.34 8 4.37 4.26 4.34 4.37 4.26 4.34 4.37 4.26 4.34 4.37 4.26 4.34 4.37 4.26 4.34 4.37 4.26 4.34 4.37 4.26 4.34 4.37 4.34 4.37 4.37 4.37 4.37 4.37	w, Media w, Media pH 6.66 7.20 7.34 7.49 7.92 7.99 7.99 7.99 7.04 8.37 8.37 feet while s ter levels in Comme	Im, High, Ver PUVG Conduct'ity (^M /cm) 0.302 0.291 0.291 0.291 0.291 0.284 0.276 0.235 0.235 campling. Minimal the well. Note that	y Turbi y Turbi y C Tu (I Me Ver A drawdov at site's h	d, Heavy S Sampl Irbidity NTUS) di UM High / Turbid	Silts C ra. 1 DO (mg/L) 10.38 5.00 4.48 4.20 3.92 3.44 3.54 3.11 3.24 hieved and r may make it	ORP (mV) (32, 1 73.8 45.1 31.0 4.5 13, 5 33.6 79.6 30.5	Color	odor <u>NØR</u> at a low ra specificat	M /M Water Level (ft BTOC) 20.11 20.10 19.93 19.99 20.07 20.07 20.30 [9.71] ate (approximate ion.	Draw- down 1.15' -0.25' 0.12' 0.01' 0.03' 0.23' -0.59F
Round 1 2 3 4 5 6 7 8 9 Finel 10 5 6 7 8 9 Finel 10 5 6 7 8 9 Finel 10 5 11 12 Notes: Drawdown liter/minute) and co Analyses VOC	Dbserv Time 1659 1704 1707 1710 1713 1716 1712 1723 1725 1725 1750 should be l ntinually m # of Col	None, Lo ations Temp °C 494 4.37 4.24 4.17 4.13 4.33 4.37 4.26 4.37 4.26 4.33 4.37 4.26 4.37 4.26 4.34 5 4.37 4.26 4.34 5 4.34 5 4.34 4.37 4.26 4.34 5 5 8 5 8 5 8 5 8 5 8 5 8 5 8 5 8 5 8	w, Mediu w, Mediu pH 6.66 7.20 7.34 7.92 7.99 7.99 7.99 7.04 8.37 6 eet while s ter levels in Сотте	$\begin{array}{c} \text{m, High, Ver} \\ \hline p \ u \ r g \\ \hline conduct'ity \\ (M'/cM) \\ \hline 0.302 \\ \hline 0.291 \\ \hline 0.286 \\ \hline 0.284 \\ \hline 0.284 \\ \hline 0.284 \\ \hline 0.285 \\ \hline 0.235 \\ \hline \end{array}$	Turbi y Turbi y Condense y	d, Heavy S Sampl Irbidity NTUS) di um High / Turbid	Silts 2 ra. 1 DO (mg/L) 10.38 5.00 4.48 4.20 3.92 3.44 3.54 3.54 3.24 hieved and r may make it	ORP (mV) (32. 1 73.8 45. 1 21.0 4.5 13,5 33.6 79.6 30.5	Color	odor <u>NØde</u> at a low ra specificat	$ \begin{array}{c c} M & im \\ \hline Water \\ Level \\ (ft BTOC) \\ \hline 20.10 \\ \hline 19.85 \\ \hline 19.97 \\ \hline 19.98 \\ \hline 19.99 \\ \hline 20.07 \\ \hline 20.07 \\ \hline 20.07 \\ \hline 20.07 \\ \hline 20.30 \\ \hline \hline \\ 19.71 \\ \hline \\ ate (approximate ion. \\ \hline \\ e \ av(15) \\ \hline \end{array} $	Draw- down 1.15' -0.01' -0.25' 0.12' 0.01' 0.01' 0.23' -0.59' -0.59'
Round 1 2 3 4 5 6 7 8 9 Frol 10 Comp 11 12 Notes: Drawdown liter/minute) and co Analyses V.O.C. Alik SulC/Ch	Dbserv Time 1659 1704 1707 1710 1713 1716 1713 1716 1717 1718 1719 1723 1725 1725 1725 1725 1725 1725 1725 1725 1725 1725 1720 1700 1700	None, Lo ations Temp °C 4.04 4.37 4.24 4.17 4.24 4.17 4.18 4.33 4.37 4.26 4.37 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.26 4.37 4.37 4.26 4.37 4.37 4.37 4.37 4.37 4.37 4.37 4.37	w, Mediu w, Mediu pH 6.66 7.20 7.34 7.79 7.92 7.99 7.04 9.03 8.37 6 eet while s ter levels in Сотте HC	$\begin{array}{c} \text{m, High, Ver} \\ \hline p \ u \ v \ g \\ \hline conduct'ity \\ (M^{3}/cM) \\ \hline 0.302 \\ \hline 0.291 \\ \hline 0.291 \\ \hline 0.291 \\ \hline 0.291 \\ \hline 0.286 \\ \hline 0.284 \\ \hline 0.284 \\ \hline 0.284 \\ \hline 0.284 \\ \hline 0.285 \\ \hline 0.235 \\ \hline \end{array}$	y Turbi ye / Tu (I Me Ven Ven drawdov at site's h	d, Heavy S Sampl Irbidity NTUS) di um High 7 Jurbid	DO (mg/L) 10.38 5.00 4.48 4.20 3.92 3.44 3.92 3.54 3.24 1.3.24	ORP (mV) (32. / 73. 8 45. / 31.0 4.5 13. 5 33.6 79.6 30.5	Color brown	Odor <u>NØRE</u> A at a low ra at a low ra specification	$ \begin{array}{c c} m & im \\ \hline Water \\ Level \\ (ft BTOC) \\ \hline 20.10 \\ \hline 19.85 \\ \hline 19.97 \\ \hline 19.98 \\ \hline 19.99 \\ \hline 20.07 \\ \hline 19.71 \\ \hline \\ ate (approximate ion. \\ \hline \\ elay(15) \\ \hline \\ 1 \end{array} $	Draw- down 1.15' -0.25' 0.12' 0.01' 0.03' 0.23' 0.23' 0.59F
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Round 1 2 3 4 5 6 7 8 9 Final 10 [and colored and color	Time 1659 1704 1707 1710 1710 1713 1716 1717 1718 1719 1723 1725 1725 1725 1725 1725 1726 1727 1728 1729 1720 1721 1722 1725 1725 1726 1727 1728 1729 1720 1721 1722 1725 1725 1750 1710 1720 1721 1722 1725 1720 1721 1722 1723 1750 1700 1710 1710 1720	None, Lo ations Temp °C 4.04 4.37 4.24 4.17 4.24 4.17 4.18 4.33 4.37 4.26 4.37 4.26 4.33 4.37 4.26 4.34 4.37 4.26 4.34 5 80ttles lected 3 1 1	w, Media w, Media pH 6.66 7.20 7.34 7.49 7.92 7.99 7.04 7.92 7.99 7.04 8.37 8.37 8.37	m, High, Ver PUVg Conduct'ity (M^3/cM) Q.3Q2 Q.291 Q.291 Q.291 Q.291 Q.291 Q.291 Q.291 Q.291 Q.291 Q.291 Q.291 Q.293 Q.235	I drawdow conce	d. Heavy S Sanpl Irbidity NTUS) di um High VTurbid I I I I I I I I I I I I I	ber Like, v Silts 2 ra. f DO (mg/L) 10.38 5.00 4.48 420 3.92 3.44 3.92 3.44 3.54 3.54 3.24 13.24 13.24 13.24 13.24 13.24 13.24 13.24 13.24 13.24	$\begin{array}{c} & \underline{\mathbb{C}} \\ & & \underline{\mathbb{C}} \\ & & & \\ &$	Color brown br	odor <u>NØdor</u> <u>NØde</u> <u>NØde</u> <u>NØde</u> <u>NØde</u> <u>NØde</u> <u>NØde</u> <u>NØde</u> <u>NØde</u> <u>NØde</u> <u>NØde</u> <u>NØde</u> <u>NØde</u> <u>NØde</u> <u>NØde</u> <u>NØde</u> <u>N</u> <u>N</u> <u>N</u> <u>N</u> <u>N</u> <u>N</u> <u>N</u> <u>N</u>	M. in Water Level (ft BTOC) 20.11 20.10 19.85 19.97 19.98 19.99 20.07 20.07 20.07 20.30 19.71 20.07 20.30 19.71 19.71 20.07 20.30 19.71	Draw- down 1.15' -0.25' 0.12' 0.01' 0.01' 0.03' 0.23' 0.59' 1.
Round 1 2 3 4 5 6 7 8 9 Final 10 [0] 11 12 Notes: Drawdown liter/minute) and co Analyses VOC Alk / Sull/ICh TOC N:tratej-it Fe/Min	Time 1659 1704 1707 1710 1713 1716 1717 1718 1719 1722 1725 1725 1725 1725 1725 1726 1727 1728 1729 1720 1720 1721 1722 1725 1750 1719 1720 1721 1722 1725 1719 1720 1721 1725 1750 5 6	None, Lo ations Temp °C 4.04 4.27 4.24 4.17 4.24 4.17 4.18 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.34 5 8 0 8 0 8 0 8 0 8 0 8 0 1 1 1 1	w, Media w, Media pH 6.66 7.20 7.34 7.49 7.92 7.99 7.04 7.92 7.99 7.04 8.03 8.31 9.04 9.04 8.31 9.04 8.31 9.04 9.04 8.31 9.04 8.31 9.04 8.31 9.04 8.31 9.04 8.31 9.04 8.31 9.04 8.31 9.04 8.31 9.04 8.31 9.04 8.31 8.31 8.31 8.31 8.31 8.31 8.31 8.31	sampling. Minimal the well. Note the $p_{U} r_{g}$ Conduct'ity (M^{3}/cm) 0.302 0.291 0.291 0.291 0.291 0.291 0.284 0.284 0.235 0.235	y Turbi y Turbi e Tu (() Me Very Very very conc essites h	d. Heavy S Sanpl Irbidity NTUS) dium High 7 Urbid I I I I I I I I I I I I I I I I I I I	Silts Can A Silts Can A Can A Ca	$\begin{array}{c} & \underline{\mathbb{C}} \\ & & \underline{\mathbb{C}} \\ & & & \\ &$	Color brown br	at a low rasspecificat	Min Water Level (ft BTOC) 20.10 19.85 19.97 19.99 20.07 20.07 20.30 [9.71] ate (approximate ion.	Draw- down 1.15' -0.25' 0.12' 0.01' 0.01' 0.01' 0.03' 0.23' 0.59' 19.0.59' 19.0.1 to 0.5
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Round 1 2 3 4 5 6 7 8 9 Final 10 form 11 12 Notes: Drawdown liter/minute) and co Analyses VOC Alk (Sulf /Ch TOC Nitrate 1-it Fe/Mn © Fe/Mn Signed: Eth.Me/Eth	Dbserv Time 1659 1704 1707 1710 1713 1716 1713 1716 1719 1722 1725 1725 1725 1725 1725 1725 1725 1725 1725 1725 1725 1725 1725 1726 1727 1727 1727 1727 1727 1727 1727 1728 17888 1788 1788 1788 1788 1788 1788 1788 1788 1788 178	None, Lo ations Temp °C 494 4.37 4.24 4.17 4.24 4.17 4.18 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.33 4.37 4.26 4.34 4.33 4.37 4.26 4.34 4.33 4.37 4.26 4.34 4.33 4.37 4.26 4.34 4.34 4.34 4.34 4.33 4.37 4.26 4.34 4.34 4.34 4.34 4.34 4.34 4.34 4.3	w, Media w, Media pH 6.66 7.20 7.34 7.92 7.99	$\begin{array}{c} \text{m, High, Ver} \\ \text{High, Ver} \\ \hline \begin{array}{c} \rho \ u \ v \ g \end{array} \\ \hline \begin{array}{c} \text{Conduct'ity} \\ (M^3/cm) \\ \hline \begin{array}{c} 0.302 \\ \hline 0.291 \\ \hline 0.291 \\ \hline 0.291 \\ \hline 0.291 \\ \hline 0.286 \\ \hline 0.284 \\ \hline$	y Turbi y Turbi e Tu (() Me Ven Ven Ven ven ven ven	d, Heavy S Sampl Irbidity NTUS) di um High / Turbid High / Turbid High / Turbid di us di us global beac ydrogeology r	ber Like, v Silts c ra. f DO (mg/L) 10.38 5.00 4.48 4.20 3.92 3.44 3.54 3.54 3.54 3.54 3.24 hieved and r hay make it c.a.w de Cla	$\begin{array}{c} & @\\ & @\\ & @\\ & @\\ & @\\ & @\\ & & & & \\ & & & \\ & & & &$	Color brown brown brown brown brown color brown color brown color brown color brown color brown color brown color brown color brown color brown color brown color brown color brown color brown color brown color brown color color brown color color brown color color brown color color brown color colo	odor <u>MORE</u> <u>A</u> A A A A A A A A A A A A A	Min Water Level (ft BTOC) 20.10 19.85 19.99 20.07 20.07 20.30 19.71 ate (approximate ion. lelay(15 during p	Draw- down 1.15' -0.25' 0.12' 0.01' 0.01' 0.03' 0.23' 0.23' 10.59' 19 0.1 to 0.5

<	Low	-Flow (Ground	water San	nplin	g with N	linimal	Drawd	own W	/orkshe	et	
								Well ID:	Λ	1 W-5		
Proiect # :	14-201	. Phase 2						Date:		5-11-1	1	
Project Name	Aniak V	VACS ES					– Sta	art Time [.]	1	808		
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Sample ID:	h	<u> </u>	·····	}**_``````````````````````````````	Time:		primary	dup	split	ms/msd	North Contraction	
Purg	ing and	Sampling) Method	(e.g. peristal	- tic, bla To	idder, subi otal Volum	mersible): e Purged		pe	nstal	ltic	
Weather Condi	tions:											
Depth to Top of	Product	(ft BTOC)	e.	,			Depth to) Water (f	t BTOC):		18.	57'
Depth to Oil/Wa	ter Interf	face* (ft B	TOC):			•	Total De	oth (ft BT	TOC):		29.	751
* Note: Same as	depth to v	vater	, .		*******	•						·
Criteria for S	Stable I	Paramet	ers	· · · · · · · · · · · · · · · · · · ·			***************************************					
Parameter			Working	Range		Stability (Criteria	Notes				
Temperature			>0.00 °C			± 3%						
pН			0-14			± 0.1						
Conductivity			0-999 m	S/m		± 3%						
ORP			± 1999 n	יV		± 10 mv						
Dissolved Oxyg	en		0-19.99 ı	ng/L		± 10%		<u> </u>				
Turbidity			0-800 N	TU		l						
Sensory Ob	servati	ons										
Color:		Clear, A	mber, Ta	n, Brown, Gr	ey, Mi	lky White,	Other:					
Odor:		None, Lo	w, Mediu	ım, High, Ver	y Stroi	ng, H2S, F	Fuel Like,	Chemica	ıl ?, Unkr	Iown		
Turbidity:		None, Lo	w, Mediu	ım, High, Ver	y Turb	id, Heavy	Silts					
Instrument (Observ	ations		PUP	sel	sample	Vale =	. 200	mlm	in		
					-						Water	
		Temp		Conduct'ity		urbidity	DO	ORP			Level	Draw-
Round	Time	<u>0°</u>	pH	(***/ CMA)	RE)	NTUs)	(mg/L)	(mV)	Color	Odor	(ft BTOC)	down
1	11810	7.11	6.45	0.211	-64	ett NOV	10 7.95	153.4	aear	<u>1 None</u>	18.21	-0.36
2	1826	5.50	612	0.295	<u> </u>		6.48	149.6		┝─┤──	18.21	0.00'
3	1825	6.21	6.14	0.274	↓		5.50	137.0		<u>↓ </u>	18.21	0.00'
4	1828	6.24	6.26	0.293	 		5,15	128.0		<u> </u>	18.21	0.20'
5	1831	4.65	6.47	0.277	<u> </u>		5.07	123.6		↓	18.21	Q.00'
6	1834	4.73	6.58	0.0472	 		4.67	114.6	<u> </u>	<u> </u>	18.21	0.00
/	1837	4.78	6,79	0.241			4.62	102.9			10.21	0.00
8	1840	4.88	6.84	0.271			17.65	46.0	<u> </u>		10.6	0.00'
<u>у</u> 10	1843	2.16	1.01	0.201	<u> </u>	<u> </u>	4.46	76.1		 	10.01	u.00°
· IU 11	1840	5.3]	1.31	0.283	+		<u> </u>	7.0		┼─┦───	10.21	0.00
G - 12 808	1047	5.1 do	-7.51	0.200	╂	1	19.61	- 66.0	·`	· · ·	1820	-0 -1°
FINA 12 Som P	4 1967	L	L	L	1				l	I	10.00	<u> </u>
	-6		f		امىلما	um abellin -	ا بيم المريط	manager			to (annovinat-	v 0 1 to 0 5
liter/minute) and co	snouid be i ntinually m	ess man 0.3 easuring wa	ter levels in	the well. Note the	i urawdo at site's	wn snall be a hvdrogeology	may make if	difficult to a	by pumping achieve this	s specification	ie (approximate) on.	y 0. i to 0.0
	# of	Bottles	<u> </u>			,						
Analyses		lected	Comme	nts:								
U Ar	+	3.49 5	6	1. / . 1	es da	O An And	la Asa	INL	Jul - r	1.0.0	Lod.	alcal
ALLIS BIRLI	nricla	1 2 7 2	10 7.	we r	ave.	enows	Mr NVV	VM 00	rries	tu c	io ~ cik	NICar
TAG	AL 10/10	4 2 7 =	8	on A	ANA	-soulsa	٥					
NIL Lide	+	1 8 6 2	0 7.	Ň.	. 10		d	etal.	:1:00			
LIVITY AND FOLD		1 2 2 5	9	K d ra	いして	er> Ori	N N 01	3100	yuer.	•		
EMARDO/EM ALC	1/ ARA MAN	1 ~ 6 · · · · · · · · · · · · · · · · · ·	. s U			\ \						
Signed:	,,			Rei	an (June.		Date:		5-14	- [[_
E Fe/Ma	C. C.	×5 2 2			~~~	9 Oldo		D /				
Signed/reviewe	r:	-						Date:				-

(Ø)

	Low	-Flow (Ground	Iwater Sam	pling with N	linimal	Drawd	own W	orkshe	eet	
						e.	Well ID:	MW	- 9		
Project # :	14-201	, Phase 2					Date:	10/18	11		
Project Name:	Aniak V	NACS FS				— Sta	art Time:	1640)		
Site:	Aniak V	NACS				— Ei	nd Time:	1730	2		
Field Team:	At F	Bullon B	Burle	h							
Sample ID:	11	- AWA -	013-9	M	Time: 1725	primary) dup	split	ms/msd		
Sample ID:					Time:	primary	dup	split	ms/msd		
Sample ID:					Time:	primary	dup	split	ms/msd		
Pura	ing and	Sampling	a Method	(e.g. peristalti	ic. bladder. sub	mersible):	Sub	mentil	nle		
					Total Volum	ne Purged:	2,5	and	211		
Weather Condit	ione:	C .	10	2015				2			
Weather Condit	10113.	241612	01.4000		/					0.0	- 1
Depth to Top of	Product	(ft BTOC)):	NIA		Depth to	Water (f	t BTOC):	8	20.	51
Depth to Oil/Wa	ter Inter	face* (ft B	TOC):	MA		l otal De	ptn (π B	100):	15	29.9	18
[^] Note: Same as c		water Doromot	tore								
Parameter	lable	Falame	Working	Range	Stability	Criteria	Notes				
Temperature			>0.00 °C	Trange	+ 3%	ontena	Notes				
nH			0-14		+ 0.1	0					
Conductivity			0-999 m	S/m	± 3%						
ORP			± 1999 n	nV	± 10 mv						
Dissolved Oxyg	en		0-19.99	mg/L	± 10%						
Turbidity			0-800 N	ΤŪ							
Sensory Obs	servati	ons									
Color:		Clear, A	mber, Ta	an, Brown, Gre	ey, Milky White,	Other:					
Odor:		None, Lo	w, Mediu	um, High, Very	Strong, H2S,	Fuel Like,	Chemica	al ?, Unkn	iown		
Turbidity:		None, Lo	ow, Mediu	um, High, Very	/ Turbid, Heavy	/ Silts					
Instrument C	Observ	vations									
		the second s									-
				64						Water	
		Temp	4	e Conduct'ity	Turbidity	DO	ORP	0.1	Odan	Water Level	Draw-
Round	Time	Temp °C	ø pH	رش5/دیک) (ش5/دیک	Turbidity (NTUs)	DO (mg/L)	ORP (mV)	Color	Odor	Water Level (ft BTOC)	Draw- down
Round	Time	Temp °C	pH	Conduct'ity (^{M.5} / _{Lw3})	Turbidity (NTUs)	DO (mg/L)	0RP (mV)	Color	Odor Mone	Water Level (ft BTOC)	Draw- down
Round 1 2 3	Time	Temp °C 5.13 4.52	* pH 5.57 5.51	Conduct'ity (^{MS} /L _M) - 351 - 352	Turbidity (NTUs) Med	DO (mg/L) . 57 . 52	ORP (mV) 1635	Color Chey Cipor	Odor Alone	Water Level (ft BTOC) 23.52 23.52	Draw- down
Round 1 2 3 4	Time 1650 1658	Temp ℃ 5.13 4.52 4.38	pH 5.57 5.51 5.49	Conduct'ity (^{M5} / _{Lw3}) * 351 * 357 * 354	Turbidity (NTUs) Med issu	DO (mg/L) - 47(657 - 532 - 548	ORP (mV) ୮ ୮ (ଜନ୍ୟ ୮ ୮ ଜନ୍ୟ ୮ ୮ ଜନ୍ୟ	Color Cney Cipor	Odor Alone	Water Level (ft BTOC) 23.52 23.52 23.52 2.3.52	Draw- down
Round 1 2 3 4 5	Time 1650 1655 1658	Temp °C 5.13 4.52 4.38	pH 5.57 5.51 5.49	Conduct'ity (^{m5} /いる) ・351 ・352 ・354	Turbidity (NTUs) Med Low	DO (mg/L) . 57 . 52 . 48	ORP (mV) 1635 1636	Color (min Cipor	Odor Alone i Final	Water Level (ft BTOC) 23.52 23.52 23.52	Draw- down
Round 1 2 3 4 5 6	Time 1650 1659	Temp ℃ 5.13 4.52 4.38	* pH 5.57 5.31 5.49	Conduct'ity (^{m5/L}) ・3ら1 ・3らて ・3らて	Turbidity (NTUs) Med Long	DO (mg/L) . 57 . 52. . 48	ORP (mV) (ଜV) (ଜନ୍ୟ (ଜନ୍ୟ (ଜନ୍ୟ	Color (men Clpur	Odor Alone i Final	Water Level (ft BTOC) 23.52 23.52 23.52	Draw- down
Round 1 2 3 4 5 6 7	Тіте 1650 1655 1658	Temp °C 5.13 4.52 4.38	* pH 5.57 5.51 5.49	Conduct'ity (^{M5} /いる) ・3ら1 ・3ウユ ・3ちЧ	Turbidity (NTUs) Med Lon	DO (mg/L) . 52 . 48	ORP (mV) 1 (<i>ତ୍ୟୁ</i> 1 (ତ୍ୟୁ 1 (ତ୍ୟୁ))	Color (men Cipor	Odor Alone I Final	Water Level (ft BTOC) 23.52 23.52 23.52	Draw- down
Round 1 2 3 4 5 6 7 8	Time 1655 1658	Temp ℃ (3:13) 4:52 (4:38)	* pH 5.57 5.51 5.49	Conduct'ity (^{M5/L}) ・3ら1 ・3ウユ ・3らЧ	Turbidity (NTUs) Med isn	DO (mg/L) 532 648	ORP (mV) 1635 1636	Color Coress Colpor	Odor Alone I Final	Water Level (ft BTOC) 23.52 23.52 23.52	Draw- down
Round 1 2 3 4 5 6 7 8 9	Time	Temp °C 5.13 4.52 4.38	* 5.57 5.51 5.49	* Conduct'ity (^{M5/L}) * 351 * 354	Turbidity (NTUs) Med issue	DO (mg/L) . 572 . 572 . 418	ORP (mV) (634 (635 (635)	Color Cnem Cipor	Odor Alone I Final	Water Level (ft BTOC) 23.52 23.52 23.51	Draw- down
Round 1 2 3 4 5 6 7 8 9 10	Time 1650 1655 1658	Temp ℃ ℃ 4.52 4.38	* 5.57 5.51 5.49	Conduct'ity (^{m5/L}) - 351 - 352 - 354	Turbidity (NTUs) Med Long	DO (mg/L) . 57 . 52 . 48	ORP (mV) 1635 1638	Color (min Clpur	Odor Alone i Final	Water Level (ft BTOC) 23.52 23.52 23.57	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11	Тіте 1655 1659	Temp ℃ 5.13 4.52 4.38	* pH 5.57 5.51 5.49	Conduct'ity (^{m5/L}) ・3ら1 ・3ウユ ・3らЧ	Turbidity (NTUs) Med Long	DO (mg/L) . 57 . 52. . 48	ORP (mV) ((୦ <u>୫୦</u>) (୦ ୫୦) (୦ ୫୦) (୦ ୫୦) (୦ ୫୦) (୦ ୫୦) (୦) (୦ ୫୦) (୦) (୦) (୦) (୦) (୦) (୦) (୦) (୦	Color (men Cipar	Odor Alone i Final	Water Level (ft BTOC) 23.52 23.52 23.51	Draw- down ~+0/ 0- C
Round 1 2 3 4 5 6 7 8 9 10 11 12	Тіте 1655 1659	Temp °C 5.13 4.52 4.38	* pH 5.57 5.51 5.49	Conduct'ity (^{M5} /いる) ・3ら1 ・3らて ・354	Turbidity (NTUs) Med is not	DO (mg/L) - 52 - 52 - 78	ORP (mV) (ଜ <u>୬</u> ୍ (୧୫.୫.୨) ଜ୫.୫ (୧୫.୫.୫ (୧୫.୫.୫)	Color (mem Cipor	Odor Alone i Final	Water Level (ft BTOC) 23.52 23.52 23.52	Draw- down ~
Round 1 2 3 4 5 6 7 8 9 10 11 12	Тіте 1655 1658	Temp °C (3,13, 4,52 (4,38)	* 9H 5.57 5.51 5.49	* Conduct'ity (^{M5/L}) * 3ら! * 3らЧ	Turbidity (NTUs) Med isn	DO (mg/L) . 572. . 418	ORP (mV) 1 (ଜ <u>୫</u> ୟ 1 (ଜ <u>୫</u> ୟ	Color Coress Colpor I	Odor Alone I Final	Water Level (ft BTOC) 23.52 23.52 23.52	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown s	Time	Temp °C (3, 13, 4, 52, 4, 38	Ф р 5 .57 5 .49 5 .49 6 6 6 6 6 6 7 7 7 7 7 7 7 7	* Conduct'ity (^{(MS/LN3}) * 3ら! * 3らく * 3らく	Turbidity (NTUs) Med issue i drawdown shall be a	DO (mg/L) 532 548	0RP (mV) 1635 1636	Color Coress Colpor P	Odor Alone I Final	Water Level (ft BTOC) 23.52 23.52 23.57	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and control	Time	Temp °C G. 13 G. 14 G. 1	پ ه ج. ج. ج. ج ا ج. ب ۹ ه ه ه ه ه ه ه ه ه ه ه ه ه ه ه ه ه ه	sampling. Minimal	Turbidity (NTUs) M.l.d issue drawdown shall be a t site's hydrogeology	DO (mg/L)	ORP (mV)	Color (mm Clear 1	Odor Alone i Final	Water Level (ft BTOC) 23.52 23.52 23.57	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and control	Time	Temp °C G. 13 G. 14 G. 14 G. 14 G. 14 G. 14 G. 15 G. 1	پ ه ج. ج] ج. ج. ج] ج. ج. ج. ج. ج. ج. ج. ج. ج. ج. ج. ج. ج. ج. ج. ج. ج. ج. ج	Sampling. Minimal the well. Note that	Turbidity (NTUs) Med Com C	DO (mg/L)	©RP (mV) ↓ (₃ , <u>4</u> ↓ (<u>3</u> , <u>5</u> ↓ (<u>3</u> , <u>6</u>)	Color	Odor Alone i Final	Water Level (ft BTOC) 23.52 23.52 23.57 te (approximatel on.	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and corr Analyses	Time	Temp °C G. 13 G. 13 G. 57 G. 5	* pH 5.57 5.51 5.49 5.49 5.61 5.49 5.49 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 7 7 7 7 7 7	Sampling. Minimal the well. Note that	Turbidity (NTUs) Med issue (drawdown shall be a t site's hydrogeology	DO (mg/L)	ORP (mV) (ଜ୦୬୦୦ ଜ୦୬୦୦ ଜ୦୬୦୦ ଜ୦୬୦୦ ଜ୦୬୦୦ ଜ୦୬୦୦ ଜ୦୬୦୦ ଜ୦୬୦୦ ଜ୦୬୦୦ ଜ୦୬୦୦ ଜ୦୬୦୦ ଜ୦୬୦୦ ଜ୦୬୦ ଜ୦୬୦ ଜ୦୬୦ ଜ୦୬୦ ଜ୦୬୦ ଜ୦୬୦ ଜ୦୦ ଜ୦	Color	Odor Alone i Final	Water Level (ft BTOC) 23.52 23.52 23.57	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and constant Analyses VO ∽	Time	Temp °C G. 13 G. 14 G. 15 G. 1	* pH 5.57 5.51 5.49 5.49 5.49 5.49 5.49 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 7 7 7 7 7 7	sampling. Minimal the well. Note tha	Turbidity (NTUs) Med issue i drawdown shall be a t site's hydrogeology	DO (mg/L)	ORP (mV)	Color	Odor Alone I Final	Water Level (ft BTOC) 23.52 23.52 23.52 23.52 23.52 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and constant Analyses VO ∽	Time	Temp °C 4.52 4.38 less than 0.3 neasuring wa Bottles llected	* 5.57 5.57<	sampling. Minimal the well. Note tha	Turbidity (NTUs) Med issue i	DO (mg/L)	ORP (mV)	Color Chrew Cilpor	Odor Alone I Final	Water Level (ft BTOC) 23.52 23.52 23.57	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and cord Analyses VO ∽	Time	Temp °C (3, 13, 4, 57, 4, 38, (4, 38,)))))))))))))))))))))))))))))))))))	Ф рН 5.57 5.51 5.49 5.49 5.49 6 6 6 6 6 6 6 6 6 6 6 6 7 6 7 6 7 6 7 7 7 7 7 7 7 7 7 7 7 7 7	sampling. Minimal the well. Note tha	Turbidity (NTUs) Med issue i	DO (mg/L)	ORP (mV)	Color	Odor Alone I Final	Water Level (ft BTOC) 23.52 23.52 23.57	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and con Analyses V 0 ←	Time	Temp °C G. 13 G. 14 G. 14 G. 15 G. 14 G. 15 G. 1	を PH 5、57 5、57 5、44 5、44 5 Feet while ster levels in Comme	sampling. Minimal the well. Note tha	Turbidity (NTUs) M.l.d issue i	DO (mg/L)	ORP (mV)	Color	Odor Alone I Final	Water Level (ft BTOC) 23.52 23.52 23.57 te (approximatel on.	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and condition Analyses V 0 ←	Time	Temp °C G. 13 G. 13 G. 57 G. 13 G. 14 G. 1	* 5.57 5.57<	sampling. Minimal the well. Note tha	Turbidity (NTUs) Med isw i	DO (mg/L)	ORP (mV)	Color	Odor Alone i Final at a low ra	Water Level (ft BTOC) 23.52 23.52 23.57	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and content Analyses VO ∽	Time	Temp °C G.13 H.52 H.38 Hess than 0.3 heasuring wa Bottles llected	* pH 5.57 5.49 5.49 5.49 5.49 Comme	sampling. Minimal the well. Note tha	Turbidity (NTUs) Med issue i	DO (mg/L)	ORP (mV)	Color	Odor Alone I Final	Water Level (ft BTOC) 23.52 23.52 23.52 23.52 1 23.52 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and cord Analyses V 0 ⊂ Signed:	Time	Temp °C G.13 H.52 H.38 Iess than 0.3 Bottles Ilected	* pH 5.57 5.51 5.49	sampling. Minimal the well. Note tha	Turbidity (NTUs) Med issue (drawdown shall be a t site's hydrogeology	DO (mg/L)	ORP (mV)	Color	Odor Alone i Final	Water Level (ft BTOC) 23.52 23.52 23.52 23.52 1 23.52 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown s liter/minute) and cord Analyses VO ∽ Signed: Signed/reviewe	Time	Temp °C 4.52 4.38 less than 0.3 neasuring wa Bottles llected	* pH 5.57 5.51 5.49	Sampling. Minimal the well. Note tha	Turbidity (NTUs) Med issue (DO (mg/L)	ORP (mV)	Color	Odor Alone i Final at a low ra specification	Water Level (ft BTOC) 23.52 23.52 23.57 23.57 te (approximatel on.	Draw- down

P

	Low	-Flow (Ground	water Sam	pling with M	linimal	Drawd	own W	orkshe	et	
							Well ID:	M	W-8		
Project # ·	14-201	Phase 2					Date:	10/19	141		
	Anick						art Time:	1040			
Project Name:	Aniak V	MACS F5				_ 30	nd Time.	1130			
Field Team	Aniak		Que at ala				id fillio.	1.00			
Sample ID:	M. Da	LI- D.	A-ALE	- 614)	Time: 1115	primary	dup	split	ms/msd		
Sample ID:		LI- MA	R ULS	GIV	Time:	primary	dup	split	ms/msd		
Sample ID:					Time:	primary	dup	split	ms/msd		
Purg	ing and	Sampling	y Method	(e.g. peristalti	c, bladder, sub Total Volun	mersible): ne Purged:	Subn	·5 gal	le		
Weather Condit	ions:	+ 30.5 .	overu	ast							
Depth to Top of	Product	(ff BTOC)		NIA		Denth to	Water (f	HBTOC)		20 31	
Depth to Oil/Wa	ter Inter	face* (ft B		ALA		Total De	oth (ft B1	(DC):		32.97	0
* Note: Same as o	depth to v	vater		P46 6 ***		rotai Do	p (
Criteria for S	stable	Paramet	ers								
Parameter			Working	Range	Stability	Criteria	Notes				
Temperature			>0.00 °C		± 3%						
pН			0-14		± 0.1						
Conductivity			0-999 m	S/m	± 3%						
ORP			± 1999 m	۱V	± 10 mv						
Dissolved Oxyg	en		0-19.99 ı	mg/L	± 10%						
Turbidity			0-800 NT	ΓU							(a
Sensory Obs	servati	ons									
Color:		Clear, A	mber, Ta	n, Brown, Gre	ey, Milky White,	Other:					
Odor:		None, Lo	w, Mediu	ım, High, Very	Strong, H2S,	Fuel Like,	Chemica	I ?, Unkn	iown		
Turbidity:		None, Lo	w, Mediu	ım, High, Very	Turbid, Heavy	/ Silts					
Instrument C	Observ	ations	(0	FIOW =	300 mu	min					
		Temp		Conduct'ity	Turbidity	DO	ORP		Orlan	Water Level	Draw-
Round	lime	2.17				(mg/L)	(mv)	Color	Udor		aown
2	1100	2.30	5.41	.403	Morie	2.20	130.6	Licar	None	312.32	0.0
3		2 44	5.47	. 406		2.01	130 0			10.02	1
4	114	2.60	5.41	.406		1.98	142.6			-	
5	P10-1								Trial	30.32	
6									1 Ma		
7											
8											
9											
10											
11											
12											
Notes: Drawdown s	should be l ntinually m	ess than 0.3 easuring wa	feet while s ter levels in	ampling. Minimal the well. Note that	drawdown shall be a t site's hydrogeology	achieved and may make it	measured I difficult to a	by pumping achieve this	at a low rat specificatio	e (approximatel on.	y 0.1 to 0.5
liter/minute) and cor	# of		-						6		
liter/minute) and con	# of Col	lected	Comme	nts:							
Analyses	# of Col	lected	Comme	nts:					1.9	8	
Iter/minute) and con Analyses Voc	# of Col	lected 7	Comme	nts:					1.9	8 4.8	
Iiter/minute) and con	# of Col	lected	Comme	nts:					1.9	8 18 79	
Iiter/minute) and con	# of Col	lected 7	Comme	nts:	2				1.9 10.1	8 78 79	
Iiter/minute) and con	# of Col	lected	Comme	nts:	ž				1.9 2.1	8 79 79	
Iiter/minute) and con	# of Col	lected 7 MMI	Comme	nts:	2		Date:	10, (a.].	1.9 10.1	8 78 79	

	Low	-Flow (Ground	water Sam	oling with M	linimal l	Drawd	own W	orkshe	eet	
							Well ID:	MU	N-06)	
Proiect # :	14-201	Phase 2					Date:	10	-19-11		
Project Name:	Aniak V	VACS FS				– Sta	art Time:	114	0		
Site:	Aniak V	VACS				– Er	nd Time:	133	0		
Field Team:	N.E	Ballar/	R. Bu	rich.							
Sample ID:	Hita	F IL-A	WA-0	16-Gul 7	Time: <u>(3(5</u>	primary) dup	split	ms/msd		
Sample ID:				1	Time:	primary	dup	split	ms/msd		
Sample ID:					ime:	_ primary	dup	split	ms/msd		
Purgi	ng and	Sampling	g Method	(e.g. peristaltio	c, bladder, sub Total Volum	mersible): e Purged:	Sale	Bai	er# 90 mL		
Weather Condit	ions:		Su	nny v	35.6						
Depth to Top of	Product	(ft BTOC)	:	NIA		Depth to	Water (f	t BTOC):		28.61	
Depth to Oil/Wa	ter Interf	ace* (ft B	TOC):	NIA		Total De	pth (ft B1	TOC):		29.91	
* Note: Same as c	lepth to v	vater				14	#F 1945				
Criteria for S	table l	Paramet	ers								
Parameter			Working	Range	Stability	Criteria	Notes				
Temperature			>0.00 °C		± 3%						
рН			0-14		± 0.1						
Conductivity			0-999 mS	S/m	± 3%	τ.	ļ				
ORP			± 1999 m	<u>וע</u>	± 10 mv						
Dissolved Oxyge	en		0-19.99 r	ng/L	± 10%						
			U-000 N I	10							
Sensory Obs	servati	Ons	mhor To	n Provin Crow		Othor					
Color:		Nono Lo	mber, Ta w. Modi	in, Brown, Grey	Strong H2S	Uner. Eugl Liko	Chemica	12 Unkn	own		
Turbidity:		None Lo	w, Medi	ım, High, Very ım High Very	Turbid Heavy	Silts	Chemica	u :, UIKI	100011		
Instrument (heary	ations	w, wear	ani, riign, very		Onto			1		
mstrument c		ations					1		1	Water	
		Temp		Conduct'ity	Turbidity	DO	ORP			Level	Draw-
Round	Time	°C	pН	()	(NTUs)	(mg/L)	(mV)	Color	Odor	(ft BTOC)	down
1	1255	3.85	5.28	- 275	HIGH	9.89	187.8	Brown	Nore	28.91	-13
2	1300	3.65	3.24	.275	Medium	8.09	211.4			28.00	t · 3
3	1313	2.98	4.96	.255	1	10.18	232	•		28.91	3
4									Fine	28.61	*- >
5											
6						-					
/											
0											
10											
11											
12											
12 Notes: Drawdown s liter/minute) and cor	hould be I	ess than 0.3 easuring wa	feet while s ter levels in	sampling. Minimal c the well. Note that	lrawdown shall be a site's hydrogeology	chieved and may make it	measured difficult to a	by pumping achieve this	at a low ra specification	te (approximatel on.	ly 0.1 to 0.5
12 Notes: Drawdown s liter/minute) and cor	should be l ntinually m # of	ess than 0.3 easuring wa Bottles	e feet while s ter levels in	ampling. Minimal c the well. Note that	lrawdown shall be a site's hydrogeology	chieved and may make it	measured difficult to a	by pumping achieve this	at a low ra s specification	te (approximatel on.	y 0.1 to 0.5
12 Notes: Drawdown s liter/minute) and cor Analyses	hould be l ntinually m # of Col	ess than 0.3 easuring wa Bottles lected	feet while s ter levels in Comme	ampling. Minimal c the well. Note that	Irawdown shall be a site's hydrogeology	chieved and may make it	measured difficult to a	by pumping achieve this	at a low ra s specification	te (approximatel on.	ly 0.1 to 0.5
12 Notes: Drawdown s liter/minute) and cor Analyses	hould be l htinually m # of Col	ess than 0.3 easuring wa Bottles lected 3	feet while s ter levels in Comme	ampling. Minimal of the well. Note that	Irawdown shall be a site's hydrogeology 24 c	chieved and may make it	measured difficult to a	by pumping achieve this	at a low ra specificati	te (approximatel	ly 0.1 to 0.5
12 Notes: Drawdown s liter/minute) and cor Analyses	hould be intinually m # of Col	ess than 0.3 easuring wa Bottles lected 3	feet while s ter levels in Comme	ampling. Minimal of the well. Note that	irawdown shall be a site's hydrogeology 24 c *tlad to	chieved and may make it	measured difficult to a	by pumping achieve this	at a low ra specification	te (approximatel on. dur.ກຸ ແຂງ	ly 0.1 to 0.5
12 Notes: Drawdown s liter/minute) and cor Analyses	should be l ntinually m # of Col	ess than 0.3 easuring wa Bottles lected 3	ter levels in Comme	sampling. Minimal c the well. Note that nts:	Irawdown shall be a site's hydrogeology 24 cl *tlad to Small a	chieved and may make it ia. cas use bail	measured difficult to a	by pumping achieve this	at a low ra s specification	te (approximatel on. ducu ງ ແຂງ	ly 0.1 to 0.5
12 Notes: Drawdown s liter/minute) and cor Analyses	should be l htinually m # of Col	ess than 0.3 easuring wa Bottles lected 3	ter levels in Comme	ampling. Minimal of the well. Note that nts:	Irawdown shall be a site's hydrogeology 24 cl *Had to Small a	ia. cas use bail	ing ler bec		at a low ra	te (approximatel	ly 0.1 to 0.5
12 Notes: Drawdown s liter/minute) and cor Analyses	hould be l htinually m # of Col	ess than 0.3 easuring wa Bottles lected 3	Comme	sampling. Minimal c the well. Note that nts:	irawdown shall be a site's hydrogeology 24 cl *tlad to Small o Remove	chieved and may make it i.a. cas use bail i.a. rech d 3 we	measured difficult to a ing ler bec any ing cul cas	by pumping achieve this	at a low ra s specification	te (approximatel on. duren y was	ly 0.1 to 0.5
12 Notes: Drawdown s liter/minute) and cor Analyses	hould be I htinually m # of Col	ess than 0.3 easuring wa Bottles lected 3	feet while s ter levels in Comme Comme Vol	ampling. Minimal of the well. Note that nts:	Irawdown shall be a site's hydrogeology 24 c *tlad to Small a Remove	chieved and may make it ia. cas use bail ind rech d 3 we	measured difficult to a ling ler bec wy wy but cas Date:	ause u	at a low ra specification	te (approximatel on. durn wel	y 0.1 to 0.5

	Low	-riow v	Jionna	water Gam							
							Well ID:	MM-	12		
Project # ·	14-201	Phase 2					Date:	10-19	1-11		
						St	art Time:	+SER	15507		
Project Name.	Aniak W	ACS FS				— E	nd Time:	+10-1	500		
Sile. Field Team	Allak V	AUS (P.B.	ci ch			ind rinner,				
Sample ID:	NAL DA	11-0	41A- 11	3-641	Time: 1650	primary	dup	split	ms/msd		
Sample ID:	THIN	16 14	UM UI		Time:	primary	dup	split	ms/msd		
Sample ID:					Time:	primary	dup	split	ms/msd		
Purg	jing and S	Sampling	g Method	(e.g. peristalt	ic, bladder, su Total Volu	ibmersible) me Purged	<u>Sub</u> 3 gc	mersil	ble	1815 B	
Weather Condi	tions:	Ou	recas	+ + 30'5							
Depth to Top of	Product	(ff BTOC).			Depth to	o Water (f	t BTOC):		27.80'	
Depth to Oil/Wa	ater Interf	ace* (ft B	TOC):			Total De	epth (ft B1	OC):	-	34.34	
* Note: Same as	denth to w	ater	,00).				- F X	,	-		
Criteria for S	Stable P	Parame	ters				-				
Parameter			Working	Range	Stabilit	y Criteria	Notes				
Temperature			>0.00 °C		± 3%						
pH			0-14		± 0.1	1					
Conductivity			0-999 m	S/m	± 3%						
ORP			± 1999 n	nV	± 10 mv	1					
Dissolved Oxyc	ien		0-19.99	ma/L	± 10%						
Turbidity	,		0-800 N	τŬ							
Sensory Ob	servatio	ons									
concery en						01					
Color:		Clear A	mber Ta	an Brown Gre	ev. Milkv White	e. Other:					
Color: Odor:		Clear, A None Lu	mber, Ta w Medii	an, Brown, Gre um, High, Ver	ey, Milky White v Strona, H2S	e, Other: . Fuel Like.	Chemica	l ?. Unkr	nown		
Color: Odor: Turbidity:		Clear, A None, Lo None, Lo	mber, Ta ow, Mediu ow, Mediu	an, Brown, Gro um, High, Ver um, Hiah, Ver	ey, Milky White y Strong, H2S v Turbid, Hea	e, Otner: , Fuel Like, vv Silts	Chemica	ıl ?, Unkr	iown		
Color: Odor: Turbidity:	Observ	Clear, A None, Lo None, Lo ations	mber, Ta ow, Mediu ow, Mediu	um, Brown, Gre um, High, Ver um, High, Ver	y Strong, H2S y Turbid, H2S	e, Otner: , Fuel Like, vy Silts	Chemica	Il ?, Unkn	nown	o motor	charac
Color: Odor: Turbidity: Instrument (Observa	Clear, A None, Lo None, Lo ations	amber, Ta bw, Mediu bw, Mediu F ໄດ້ປີ ໄ	an, Brown, Gra um, High, Ver um, High, Ver rate 340	y Strong, H2S y Turbid, Hea	e, Otner: , Fuel Like, vy Silts	Chemica	a (jer	iown Pan	<i>Motor</i> Water	Change
Color: Odor: Turbidity: Instrument (Observ;	Clear, A None, Lo None, Lo ations	ເmber, Ta bw, Mediu <u>bw, Mediu</u> <mark>Fໄ⊳ຟ</mark>	in, Brown, Gra um, High, Ver um, High, Ver rate 340 Conduct [*] ity	y Strong, H2S y Turbid, Hea	e, Otner: , Fuel Like, vy Silts	Chemica	ıl ?, Unkn a f-}e≁	iown P <i>um</i>	0 motor Water Level	<u>Charge</u> Draw-
Color: Odor: Turbidity: Instrument (Observa	Clear, A None, Lo <u>None, Lo</u> ations Temp °C	nder, Ta ow, Mediu <u>ow, Mediu</u> <mark>Flow</mark> nH	an, Brown, Gra um, High, Ver um, High, Ver rate 340 Conduct'ity	y Strong, H2S y Turbid, H2S <u>m</u> / mn Turbidity (NTUs)	e, Other: , Fuel Like, <u>yy Silts</u> <u>250 m</u> DO (mg/L)	Chemica	a f jer Color	own	Water Level (ft BTOC)	Chauge Draw- down
Color: Odor: Turbidity: Instrument (Round	Observa Time	Clear, A None, Lo None, Lo ations Temp °C	mber, Ta ow, Mediu <u>Flow</u> PH	an, Brown, Gra um, High, Ver <u>rate</u> 340 Conduct'ity ()	y Strong, H2S y Turbid, Hea <u>ml / min /</u> Turbidity (NTUs)	e, Otner: , Fuel Like, yy Silts 250 m DO (mg/L)	Chemica ORP (mV)	ll ?, Unkr a f-fer Color	Odor	Water Level (ft BTOC)	Chauge Draw- down
Color: Odor: Turbidity: Instrument (Round 1 2	Observa Time	Clear, A None, Lo Ations Temp °C 2.44	mber, Ta ow, Mediu Flow PH S.S.7-	an, Brown, Gra Jum, High, Ver Jum, High, Ver Conduct'ity () 0.653 0.503	y Strong, H2S y Turbid, Hea <u>ml / min /</u> Turbidity (NTUs) High	e, Otner: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.36	Chemica ORP (mV) 256-7	l ?, Unkn a f jer Color G Ry	own Pam Odor More Ann	0 Motor Water Level (ft BTOC) 27-81 27-81	Chauge Draw- down
Color: Odor: Turbidity: Instrument (Round 1 2 3	Observa Time [\$\$7- [400	Clear, A None, La ations Temp °C 2.44 2.52	mber, Ta w, Mediu w, Mediu Flow pH 5.57 5.57 5.58	In, Brown, Gra Jm, High, Ver Jm, High, Ver Conduct'ity () 0.653 0.503	y Strong, H2S y Turbid, Hea <u>ml / min /</u> Turbidity (NTUs) High <u>Maliam</u>	e, Otner: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.34 2.34	Chemica ORP (mV) 256-7 254-9 249 1	Color	own Pan Odor None None	0 Motor Water Level (ft BTOC) 27-81 27-81 27-81	Chauge Draw- down O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4	Observa Time 1557- 1400 1431-	Clear, A None, Lo ations Temp °C 2.44 2.52 2.96	mber, Ta w, Mediu w, Mediu Flow pH 5.57 5.58 5.58	an, Brown, Gra Jm, High, Ver Jm, High, Ver Conduct'ity () 0.653 0.503 0.482 0.434	y Strong, H2S y Turbid, Hea <u>ml / min /</u> Turbidity (NTUs) <u>High</u> <u>C lear/N</u>	e, Other: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.34 one 2.34 5.83	Chemica ORP (mV) 256-7 254-9 249.1 260.4	Color Grey Clear	Odor Mone None	0 motor Water Level (ft BTOC) 27.81 27.81 27.81 27.81 27.81	Chauge Draw- down O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5	Observa Time (\$\$7- (400 (400 (403)	Clear, A None, Lo None , Lo ations Temp °C 2.44 2.52 2.95 3.10	mber, Ta w, Mediu w, Mediu Flow pH 5.57 5.57 5.58 5.58 5.68 5.68	an, Brown, Gra Jm, High, Ver Jm, High, Ver Take 340 Conduct'ity () 0.653 0.503 0.434 0.434	y Strong, H2S y Turbid, Hea <u>ml / min /</u> Turbidity (NTUs) High Clear/N High	e, Other: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.34 5.83 5.83	Chemica ORP (mV) 254-9 249.1 249.4 235.5	Color Grey Clear	Odor Mone None None	0 motor Water Level (ft BTOC) 27.81 27.81 27.81 27.81 27.81	Chauge Draw- down O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6	Observa Time (\$\$7- (400 (403 (403) (640 (1640	Clear, A None, Lo None , Lo ations Temp °C 2.44 2.52 2.95 3-1) 2.10	mber, Ta w, Mediu w, Mediu Flow pH S.S7- S.S7- S.S8 S-68 S-68 S-68	an, Brown, Gra Jm, High, Ver Jm, High, Ver Tate 340 Conduct'ity () 0.653 0.503 0.482 0.434 0.434 0.434	ey, Milky White y Strong, H2S y Turbid, Hea ml /min / Turbidity (NTUs) High Actium Clear/N High Medium	e, Other: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.36 012 5.83 5.83 5.83 4.51	Chemica ORP (mV) 256-7 254-9 249.1 240-4 235.5 733-3	Color Grey Clear Grey Grey Grey	оwn <i>рим</i> <i>Оdor</i> <i>поле</i> <i>поле</i> <i>поле</i> <i>поле</i> <i>поле</i> <i>поле</i> <i>поле</i>	0 motor Water Level (ft BTOC) 27.81 27.81 27.81 27.81 27.81 27.81 27.81	Chauge Draw- down O O O O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6 7	Observa Time (\$\$7- (400 (400) (400) (440) (440) (640)	Clear, A None, Lo None, Lo ations Temp °C 2.44 2.52 2.45 3-11 2.10 3 23	mber, Ta w, Mediu w, Mediu Flow PH S.S7- S.S7- S.S7- S.S8 S.68 S.68 S.68 S.68 S.68	an, Brown, Gra Jm, High, Ver Jm, High, Ver Tate 340 Conduct'ity () 0.553 0.503 0.482 0.434 0.434 0.434 0.434	ey, Milky White y Strong, H2S y Turbid, Hea ml/min/ Turbidity (NTUs) High Medium Clear/N High Medium Medium	e, Otner: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.36 012 5.83 5	Chemica ORP (mV) 256.7 254.9 249.1 249.1 249.1 249.1 249.1 249.1 249.1 249.1 249.1 249.1 249.1 249.1 249.1 249.2 2	Color Grey Grey Grey Grey Grey Grey	оwn <i>р</i> чж Оdor <i>Моле</i> <i>поле</i> <i>поле</i> <i>поле</i> <i>поле</i> <i>поле</i>	0 motor Water Level (ft BTOC) 27.81 27.81 27.81 27.81 27.81 27.81 27.81 27.81 27.81	Chauge Draw- down O O O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6 7 8	Observa Time 1537- 1400 1403 1634 1640 1643 1649	Clear, A None, Lo ations Temp °C 2.44 2.52 2.95 3-11 2.10 3.23	mber, Ta w, Mediu w, Mediu Flow PH S.S7- S.S7- S.S7- S.S8 S.68 S.68 S.68 S.68 S.68	an, Brown, Gra Jm, High, Ver Jm, High, Ver Tate 340 Conduct'ity () 0.653 0.503 0.434 0.434 0.434 0.434 0.434	ey, Milky White y Strong, H2S y Turbid, Hea ml /min / Turbidity (NTUs) High Acdium Clear/N High Midium Low	e, Otner: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.34 012 2.34 5.83 5.94 5.83 5.94	Chemica ORP (mV) 256.7 254.9 249.1 240.4 235.5 233.7 231.7	Color Grey Cicar Grey Grey Grey Grey Grey Grey	Odor Mone None None None None None	0 Motor Water Level (ft BTOC) 27.81 27.81 27.81 27.81 27.81 27.81 27.81 27.81 27.81	Chauge Draw- down O O O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6 7 8 9	Observa Time 1537- 1400 1403 1634 1640 1643 1640	Clear, A None, Lo ations Temp °C <u>2.44</u> <u>2.52</u> <u>2.95</u> <u>3-11</u> <u>2.10</u> <u>3.23</u>	mber, Ta w, Mediu w, M	an, Brown, Gra Jm, High, Ver Jm, High, Ver Tate 340 Conduct'ity () 0.653 0.503 0.482 0.434 0.434 0.434 0.434	ey, Milky White y Strong, H2S y Turbid, Hea ml /min / Turbidity (NTUs) High Clear/N High Medium Low	e, Otner: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.34 5.83 5.83 5.83 5.83 5.83 5.93 5.94	Chemica ORP (mV) 256.7 254.9 249.1 249.1 249.4 235.5 233.7 231.7	Color Grey Cicar Grey Grey Grey Grey Grey Grey	Down	0 Motor Water Level (ft BTOC) 27.81 27.81 27.81 27.81 27.81 27.81 27.81 27.81 27.81 27.81 27.81	Chauge Draw- down O O O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6 7 8 9 10	Observa Time (\$37- (400) (400) (403) (440) (440) (440) (440) (440) (440)	Clear, A None, Lo ations Temp °C 2.44 2.52 2.95 3-11 3.10 3.23	mber, Ta w, Mediu w, Mediu w, Mediu pH 5.57- 5.57- 5.58 5.68 5.68 5.68 5.68 5.68 5.68	an, Brown, Gra Jm, High, Ver Jm, High, Ver Conduct'ity () 0.653 0.482 0.434 0.434 0.434 0.434 0.434	ey, Milky White y Strong, H2S y Turbid, Hea ml / min / Turbidity (NTUs) High Clear/N High Medium Medium	e, Otner: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.34 5.83 5.85 5.83 5.85	Chemica ORP (mV) 256.7 254.9 249.1 249.1 249.4 235.5 233.7 231.7	Color Grey Clear Grey Grey Grey Grey Grey	Down	0 Motor Water Level (ft BTOC) 27-81 27-81 27-81 27-81 27-81 27-81 27-81 27-81 27-81 27-81	Chauge Draw- down O O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6 7 8 9 10 10	Observa Time (\$\$7- (400 (403) (400) (403) (440) (440) (440) (440) (440) (440)	Clear, A None, La ations Temp °C 2.44 2.52 2.95 3-11 3.10 3.23	mber, Ta w, Mediu w, Mediu Flow PH 5.57- 5.58 5.58 5.58 5.58 5.58 5.58 5.58 5.58 5.58 5.58 5.58 5.58 5.58	an, Brown, Gra Jm, High, Ver Jm, High, Ver Conduct'ity () 0.653 0.434 0.434 0.434 0.434 0.434	ey, Milky White y Strong, H2S y Turbid, Hea ml / min / Turbidity (NTUs) High Medium Low	e, Otner: , Fuel Like, yy Silts 250 m/ DO (mg/L) 2.47 2.34 0me 2.24 5.83 5.83 5.83 5.83 5.93 5.94	Chemica ORP (mV) 256.7 254.9 249.1 2	Color Grey Clear Grey Grey Grey Grey Grey Grey	Odor Mone Mone Mone Mone Mone Mone Mone	0 Motor Water Level (ft BTOC) 27-81 27-81 27-81 27-81 27-81 27-81 27-81 27-81 27-81 27-81	Chauge Draw- down O O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6 7 8 9 10 10 11 11	Observa Time [\$\$7- [400 [403] [634 [440]640 [640 [640]	Clear, A None, La ations Temp °C 2.44 2.52 2.15 3-11 2.10 3.23	mber, Ta w, Mediu w, Mediu Flow pH 5.57- 5.58 5.58 5.58 5.58 5.58 5.58 5.58 5.58 5.58 5.58	an, Brown, Gra Jm, High, Ver Jm, High, Ver Conduct'ity () 0.653 0.503 0.434 0.434 0.434 0.434 0.434	ey, Milky White y Strong, H2S y Turbid, Hea ml /min / Turbidity (NTUs) High Clear/N High Medium Low	e, Otner: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.34 0m 2.24 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.94	Chemica ORP (mV) 256.7 254.9 249.1 2	Color Grey Grey Grey Grey Grey Grey Grey	Odor More Nore Nore Nore Nore	0 Motor Water Level (ft BTOC) 27.81 27.81 27.81 27.81 27.81 27.81 27.81 27.81 27.81 27.81	Chauge Draw- down O O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6 7 8 9 10 10 11 12 Notes: Drawdown liter/minute) and co	Observa Time /\$\$7- /\$636 /\$636 /\$636 /\$640 1636 /\$640 1640 \$\$1636 1640 \$\$1636	Clear, A None, Lo ations Temp °C 2.44 2.52 2.45 3-11 2.10 3.23 ess than 0. easuring w.	mber, Ta bw, Mediu bw, Mediu Flow PH S.S7- S.S7- S.S7- S.S7- S.S8 S-68 S-68 S-68 S-68 S-68 S-68 S-68 S-	an, Brown, Gra Jm, High, Ver Jm, High, Ver Take 340 Conduct'ity () 0.553 0.482 0.434 0.444	drawdown shall bat site's hydrogeold	e, Other: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.3(c 012 5.83 5.92 5.83 5.92 5.83 5.92 5.92 5.93 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92	Chemica ORP (mV) 256.7 254.9 249.1 249	Color Grey Grey Clear Grey Grey Clear Grey Grey Grey Grey Grey Grey Grey Gre	Odor Odor None None None None None Specification	0 Mode/ Water Level (ft BTOC) 27.81 27.81 28	Change Draw- down O O O O O O O O O O O O O O O O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6 7 8 9 10 10 11 12 Notes: Drawdown liter/minute) and cc	Observa Time (\$\$7- (400 (400 (400 (440 (440 (440 (440 (440 (440 (440 (440 (440 (440 (440 (440 (440 (440 (440) (44)	Clear, A None, Lo ations Temp °C 2.44 2.52 2.95 3-11 3.10 3.23 ess than 0. easuring with Bottles lected	mber, Ta bw, Mediu bw, Mediu Flow Flow Flow S.S7- S.S7	an, Brown, Gra Jm, High, Ver Jm, High, Ver Conduct'ity () 0.653 0.503 0.434 0.444 0.	ey, Milky White y Strong, H2S y Turbid, Hea ml /min / Turbidity (NTUs) High Action C lear/N High Medium Low drawdown shall b at site's hydrogeolo	e, Otner: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.34 5.83 5.94 5.83 5.83 5.94 5.83 5.94 5.83 5.94	Chemica ORP (mV) 256.7 254.9 249.1 249	Color Grey Clear Grey Clear Grey Clear Grey Clear	own Pan Odor None None None None None None None None None None None None	0 Model Water Level (ft BTOC) 27.81 27.81 27.81 27	Change Draw- down O O O O O O O O O O O O O O O O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses	Observa Time (\$37- (400 (400 1634 /440 1642 /440 1642 /440 1642 /440 1642 /440 1643 /440 1643 /440 1643 /640 1657- (400 1636 /640 1657- 1	Clear, A None, Lo ations Temp °C 2.44 2.52 2.15 3.11 2.10 3.23 ess than 0. easuring wo Bottles lected	mber, Ta bw, Mediu bw, Mediu Flow Flow Flow S.S7- S.S7	an, Brown, Gra Jm, High, Ver Jm, High, Ver Conduct'ity () 0.653 0.503 0.434 0.444 0.	drawdown shall bat site's hydrogood	e, Other: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.34 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.94 5.83 5.94	Chemica ORP (mV) 256.7 254.9 249.1 249	Color Grey Clear Grey Clear Grey Grey Grey Grey Grey Grey Grey Gre	own Pam Odor None No	0 10 10 Water Level (ft BTOC) 1 1 1 1 1 1 1 2 1 1 2 1 2 3 1 2 3 1 2 3 1 2 2 1 2 2 3 1 2 2 1 2 2 1 2 2 1 2 2 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 3 3 1 3 3 1 3 3 1 3 3 1 3 3 </td <td>Charge Draw- down O O O O O O O O O O O O O O O O O O O</td>	Charge Draw- down O O O O O O O O O O O O O O O O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses	Observa Time (\$37- (400 1403 1634 /440 1643 /440 1643 /440 1643 /440 1643 /440 1643 /440 1643 /440 1643 /440 1643 /640 1657- 1636 /640 1657- 16	Clear, A None, Lo ations Temp °C 2.44 2.52 2.15 3.11 2.10 3.23 ess than 0. easuring we Bottles lected	Imber, Ta bw, Mediu	an, Brown, Gra Jm, High, Ver Jm, High, Ver Take 340 Conduct'ity () 0.653 0.503 0.482 0.434 0.444	by, Milky White y Strong, H2S y Turbid, Hea ml /min / Turbidity (NTUs) High Action Clear/N High Michian Low drawdown shall b at site's hydrogeold	e, Other: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.34 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.94 5.83 5.94	Chemica ORP (mV) 256.7 254.9 249.1 249	Color Grey Clear Grey Clear Grey Grey Grey Grey Grey Grey Grey Gre	own Pam Odor None No	0 10 10 Water Level (ft BTOC) 1 1 1 1 1 1 1 2 1 1 2 1 2 3 1 2 3 1 2 3 1 2 2 1 2 2 3 1 2 2 1 2 2 1 2 2 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 3 3 1 3 3 1 3 3 1 3 3 1 3 3 </td <td>Charge Draw- down O O O O O O O O O O O O O O O O O O O</td>	Charge Draw- down O O O O O O O O O O O O O O O O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6 7 8 9 10 10 11 12 Notes: Drawdown liter/minute) and co Analyses	Observa Time (\$57- (400 1634 /440 /6	Clear, A None, La ations Temp °C 2.44 2.52 2.15 3.11 2.10 3.23 ess than 0. easuring we Bottles lected	Imber, Ta bw, Mediu	an, Brown, Gra Jm, High, Ver Jm, High, Ver Take 340 Conduct'ity () 0.653 0.503 0.482 0.434 0.444	ey, Milky White y Strong, H2S y Turbid, Hea ml /mn / Turbidity (NTUs) High Action Clear/N High Miching drawdown shall b at site's hydrogeold	e achieved and ogy may make	Chemica ORP (mV) 256.7 254.9 249.1 249	Color Grey Clear Grey Clear Grey Grey Grey Grey Grey Grey Grey Gre	own Pan Odor None No	0 10 10 Water Level (ft BTOC) 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 3 3 1 3 3 1 3 3 1 3 3 1 3 3 </td <td>Change Draw- down O O O O O O O O O O O O O O O O O O O</td>	Change Draw- down O O O O O O O O O O O O O O O O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6 7 8 9 10 11 11 12 Notes: Drawdown liter/minute) and co Analyses	Observa Time (\$57- (400 1636 1636 1636 1636 1640 1643 1640 1643 1640 1643 1640 1643 1640 1643 16400 1640 1640 1640 1640 1640 1640 1640 1640 1	Clear, A None, Lo ations Temp °C 2.44 2.52 2.15 3.11 2.10 3.23 ess than 0. easuring w. Bottles lected	mber, Ta bw, Mediu bw, Mediu Flow PH S.S7- S.S7- S.S8 S.68 S.68 S.68 S.68 S.68 S.68 S.68	an, Brown, Gra Jm, High, Ver Jm, High, Ver Take 340 Conduct'ity () 0.653 0.434 0.444	ey, Milky White y Strong, H2S y Turbid, Hea ml / min / Turbidity (NTUs) High Medium Clear/W High Medium Low drawdown shall b at site's hydrogeold	e, Other: , Fuel Like, yy Silts 250 m/ DO (mg/L) 2.47 2.34 5.83 5.92 5.83 5.92 5.83 5.92 5.92 5.92 5.93 5.92 5.93 5.92 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.92 5.93 5.93 5.92 5.93	Chemica ORP (mV) 256.7 254.9 249.1 249	Color Grey Clear Grey Clear Grey Grey Grey Grey Grey Grey Grey Gre	own Pam Odor Nove No	0 10 10 Water Level (ft BTOC) 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 1 2 2 1 1 2 2 1 1 2 2 1 1 2 2 1 1 2 2 1 1 2 2 1 1 2 2 1 1 2 2 1 1 2 2 1 1 2 2 1 1 2 2 1 1 2 2 1 1 2 2 1 1 2 3 1 1 3 3	Change Draw- down O O O O O O O O O O O O O O O O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6 7 8 9 10 10 11 11 12 Notes: Drawdown liter/minute) and cc Analyses	Observa Time (\$57- (400 1634 /640 /640 /640 /640 Ju 43 /640 Ju 43 /640 Ju 43 /640 Ju 43 /640 Ju 63 Coll 3	Clear, A None, Lo ations Temp °C 2.44 2.52 2.15 3.11 2.10 3.23 ess than 0. easuring w Bottles lected	mber, Ta bw, Mediu bw, Mediu Flow PH S.S7- S.S7- S.S8 S-68 S-68 S-68 S-68 S-68 S-68 S-68 S-	an, Brown, Gra Jm, High, Ver Jm, High, Ver Take 340 Conduct'ity () 0.653 0.434 0.444	ey, Milky White y Strong, H2S y Turbid, Hea ml / min / Turbidity (NTUs) High Action Clear/W High Medium Low drawdown shall b at site's hydrogeold	e, Other: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.36 012 2.47 2.36 012 2.47 2.36 012 3.98 3.98 012 012 012 012 012 012 012 012	Chemica ORP (mV) 256.7 254.9 249.1 249	Color Grey Clear Grey Clear Grey Clear Grey Clear Grey Clear Grey Clear	own Pam Odor Nove No	0 100 -	Change Draw- down O O O O O O O O O O O O O O O O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and cc Analyses	Observa Time 1557- 1600 1603 1636 1636 1640 1643 1640 1643 1640 1643 1640 1643 1640 1643 1640 1640 1640 1640 1640 1640 1657- 1636 1600 1640 1	Clear, A None, Lo ations Temp °C 2.44 2.52 2.15 3.11 2.10 3.23 ess than 0. easuring w Bottles lected	mber, Ta bw, Mediu bw, Mediu Flow PH 5.57 5.57 5.58 5.58 5.58 5.58 5.58 5.58	an, Brown, Gra Jm, High, Ver Jm, High, Ver rate 340 Conduct'ity () 0.653 0.434 0.444 0.4	ey, Milky White y Strong, H2S y Turbid, Hea ml /min / Turbidity (NTUs) High Action Clear/N High Medium Low drawdown shall b at site's hydrogeolo	e, Other: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.3(c 0xe 2.3(c 5.83 5.92 5.83 5.92 5.83 5.92 5.83 5.92 5.92 5.93 5.92 5.92 5.92 5.92 5.92 5.93 5.92 5.93 5.92 5.92 5.93 5.92 5.92 5.92 5.92 5.92 5.92 5.93 5.92	Chemica ORP (mV) 256.7 254.9 249.1 249	Color Grey Grey Clear Grey Grey Clear Grey Clear Grey Grey Clear Grey Grey Clear	own Pam Odor None No	0 100 -	Change Draw- down O O O O O O O O O O O O O O O O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses	Observa Time (\$57- (400 1634 /640 /6	Clear, A None, Lo ations Temp °C 2.44 2.52 2.95 3-11 2.10 3.23 ess than 0. easuring was Bottles lected	mber, Ta bw, Mediu bw, Mediu Flow PH S.S7- S.S7- S.S7- S.S7- S.S8 S-68 S-68 S-68 S-68 S-68 S-68 S-68 S-	an, Brown, Gra Jm, High, Ver Jm, High, Ver Take 340 Conduct'ity () 0.553 0.482 0.434 0.444	ey, Milky White y Strong, H2S y Turbid, Hea ml /min / Turbidity (NTUs) High Acdium Clear/N High Medium Low drawdown shall b at site's hydrogeold	e, Other: , Fuel Like, yy Silts 250 m/ DO (mg/L) 2.47 2.3(c one 2.3(c 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.92 4.51 3.9(c 000 000 000 000 000 000 000 0	Chemica ORP (mV) 256.7 54.9 249.1 249.	Color Grey Grey Grey Grey Grey Grey Grey Gre	own Pan Odor None None None None None Specification	0 100 -	Challer Draw- down O O O O O O O O O O O O O O O O O O O
Color: Odor: Turbidity: Instrument (Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses	Observa Time (\$37- (400 1403 1634 /640 1640 1640 1640 1640 1640 1640 1640 1640 1640 1640 1640 1640 1640 1640 1640 1640 1657 1636 1636 1636 1636 1636 1636 16577 1657 1657 1657 16577 1657 1657 1657 1657	Clear, A None, Lo ations Temp °C 2.44 2.52 2.15 3.10 3.23 ess than 0. easuring we Bottles lected	mber, Ta bw, Mediu bw, Mediu Flow Flow Flow S.S7- S.S7	an, Brown, Gra Jm, High, Ver Jm, High, Ver Tate 340 Conduct'ity () 0.553 0.482 0.434 0.444	ey, Milky White y Strong, H2S y Turbid, Hea ml /min / Turbidity (NTUs) High Acdium Clear/N High Medium Low drawdown shall b at site's hydrogeold	e, Other: , Fuel Like, yy Silts 250 m DO (mg/L) 2.47 2.34 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.83 5.94 5.83 5.94 5.83 5.94 5.83 5.94 5.83 5.94	Chemica ORP (mV) 256.7 254.9 249.1 249.1 249.1 249.1 249.1 249.4 235.5 233.7 231.7 231.7	Color Grey Grey Clear Grey Clear Grey Clear Grey Clear Grey Grey Clear Grey Grey Grey Grey Grey Grey Grey Gre	own Pam Odor None No	0 Model Water Level (ft BTOC) 27-81 27-81 27-81 27-81 27-81 27-81 27-81 27-81 27-81 27-81 27-81 27-81 27-81 27-81 27-81 27-81 27-81 4 22-81 0 0 te (approximate on. 0	Charge Draw- down O O O O O O O O O O O O O O O O O O O

	Low	-Flow (Ground	water Samp	oling with M	inimal I	Drawdo	own W	orkshe	et	
							Well ID:	MW	1-11		
Project # ·	14-201	Phase 2					Date:	10-19	- U		
Project Name:	Anick M					- Sta	- art Time [.]	1720			
Site	Aniak V	VACS				- Er	nd Time:	1800			
Field Team:	LI-Bal	Mar R	. Buri	Cha	0	_					
Sample ID:	LI- HW	A - 018-	Ghi	Т	ime: 1745	primary	dup	split	ms/msd		
Sample ID:	L- AV	NA-019	- GN	Т	ime: 1755	primary	dup	split	ms/msd		
Sample ID:				ΤΤ	ime:	_ primary	dup	split	ms/msd		
Purg	ing and	Sampling	g Method	(e.g. peristaltio	c, bladder, subr	nersible):	Sub.				
					Total Volum	e Purged:	1.5	gal			
Weather Condi	tions:	Overc	ast	100° 30's					5		
Depth to Top of	Product	(ft BTOC)):	NA		Depth to	Water (f	t BTOC):		32.41	
Depth to Oil/Wa	ater Interf	ace* (ft B	TOC):	NA		Total De	pth (ft BI	OC):	6	37.32	
* Note: Same as	depth to w	vater									
Criteria for S	Stable I	Paramet	ters	Denne	Stability (ritorio	Notos				
Parameter				Range		riteria	Notes				
			20.00 0		+ 0 1						
μπ Conductivity			0-999 m	S/m	+ 3%						
			+ 1999 n	ο//// ηV	+ 10 mv						
Dissolved Oxyc	ien		0-19.99	ma/L	± 10%						
Turbidity			0-800 N	г <u>и</u>							
Sensory Ob	servati	ons									
Color: Odor:		Clear, A None, Lo	mber, Ta w, Mediu	in, Brown, Grey um, High, Very	y, Milky White, Strong, H2S, F	Other: uel Like,	Chemica	I ?, Unkn	iown		
Turbidity:	<u></u>	None, Lo	w, weak	um, High, Very	Turbiu, neavy	Sills					
Instrument	Observ	ations	5	100= 250	mill		1			Wator	
Round	Time	Temp °C	μ	Conduct'ity	Turbidity (NTUs)	DO (mg/L)	ORP (mV)	Color	Odor	Level (ft BTOC)	Draw- down
1	17211	2.00	5.50	.318	Medium	2.48	2374	Grey	None	32.45	- 04
• · · · ·	1706	2-194		3.0			0.0.1				.01
2	6137	3.10	5.48	• 315	ι,	1.94	254.2	9.		3247	02
2	1137	3.10	5.48	· 315		1.94	239.2	1.		32.47 32.50	02
2 3 4	137 137 1740	3.10	5.48 5.51 5.54	· 315 · 311 · 313		1.94 1.96 1.82	234.2 223.5 ZB-4	1	4	32.47 32.50 32.46	02 03 +.04
2 3 4 5	137	3.10 3.55 3.45	5.48 5.51 5.54	• 315 • 3 [1 • 3 [3		1.94 1.96 1.82	239.2 223.5 2. B .4	1	Final	32.47 32.50 32.46 32.41	02 03 +.04
2 3 4 5 6	137 1740 1143	2.64 3.10 3.55 3.45	5.48 5.91 5.54	· 315 · 311 · 313		[.94 [.96 1.82	234.2. 223.5 2. B .4		Final	32.47 32.50 32.46 32.41	02 03 +.04
2 3 4 5 6 7	1740 1740 1743	2.64 3.10 3.55 3.45	5.48 5.51 5.54	· 315 · 311 · 313		1.94 1.96 1.82	234.2. 223.5 2. B .4		Final	32.47 32.50 32.46 JZ.41	02 03 +.04
1 2 3 4 5 6 7 8	174 137 1740 1143	2.89 3.10 3.55 3.45	5.48 5.91 5.54	· 315 · 311 · 313		1.94 1.96 1.82	234.2. 223.5 2. B .4		Figal	3247 32.50 32.46 32.41	02 03 +.04
	1740 1740 1740	3.10 3.55 3.45	5.48 5.51 5.54	· 315 · 3 (1 · 313		1.94 1.96 1.82	234,2. 223.5 2. B .4		Figal	3247 32.50 32.46 32.41	02 03 +.04
	1740 1740 1740	3.10 3.55 3.45	5.48 5.51 5.54	· 315 · 3 (1 · 313		1.94 1.96 1.82	234,2. 223.5 Z.B.4		Final	3247 32.50 32.46 Jz.41	02 03 +.04
$ \begin{array}{r} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \\ 8 \\ 9 \\ 10 \\ 11 \\ 12 \\ \end{array} $	1740 1740 1740	3.10 3.55 3.45	5.48 5.51 5.54	· 515 · 3 (1 · 513		1.94 1.96 1.82	234,2. 283.5 2.B.U		Final	3247 32.50 32.46 JZ.41	02 03 +.04
1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown	1131 1140 1140 1140 1140 140	2.84 3.10 3.55 3.45	5.48 5.91 5.54	• 315 • 3 (1 • 3 (3	drawdown shall be a	1.94 1.96 1.82	234,2. 283.5 2.8.4	by pumping	Final Final at a low ra	3247 32.50 32.46 32.41 52.41	- 02 - 03 + 04
1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and compared on the second o	should be ontinually m	2-84 3.10 3.55 3.45 	5.48 5.51 5.54	• 315 • 3 (1 • 313 • • • • • • • • • • • • • • • • • • •	drawdown shall be a site's hydrogeology	L.94 L.96 L.82	234.2. 283.5 2.8.4	by pumping achieve this	Figal Figal g at a low ra	3247 32.50 32.46 32.47 52.57 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.57 57 57 57 57 57 57 57 57 57 57 57 57 5	- 02 - 03 + 04
1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and compared to the second s	should be ontinually m	3.10 3.55 3.45 	5.48 5.54 5.54	sampling. Minimal c	drawdown shall be a site's hydrogeology	L.94 L.96 L.82	measured difficult to a	by pumping	Figal Figal at a low ra	32.47 32.50 32.46 32.46 32.47 52.57 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.47 52.57 57 57 57 57 57 57 57 57 57 57 57 57 5	- 02 - 03 + 04
1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses	should be lontinually m	2-54 3.10 3.55 3.45 	5.48 5.54 5.54	• 315 • 3 (1 • 3 (3 • 1 • 1 • 1 • 1 • 1 • 1 • 1 • 1 • 1 • 1	drawdown shall be a site's hydrogeology	L.94 L.96 L.92	234.2. 283.5 2.6.4	by pumping	at a low ra	3247 32.50 32.46 32.47 32.47 32.47 32.47 32.47 32.47 32.47 32.47 32.47 32.47 32.47 32.47 32.47 32.47 32.47 32.47 32.50 32.47 32.46 32.57 32.46 32.56 32.56 32.56 32.56 32.56 32.56 32.56 32.56 32.56 3	- 02 - 03 + 04
Image: 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and compared to the second to	should be ontinually m # of Col	2-59 3.10 3.55 3.45 3.45 	5.48 5.54 5.54	SL5 SL5 SC3 Scanner Sampling. Minimal of the well. Note that nts:	drawdown shall be a site's hydrogeology	L.94 L.96 L.92	measured	by pumping	at a low ra	3247 32.50 32.46 32.41 32.41 32.41	- 02 - 03 + 04
Image: 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses V Q C_	should be bontinually m # of Col	2-59 3.10 3.55 3.45 	5.48 5.54 5.54	• 315 • 3 (1 • 3 (3 • 5 (3 • 6 (1) • 6 (1) • 6 (1) • 7	drawdown shall be a site's hydrogeology	L.94 L.96 L.92	measured	by pumping achieve this	g at a low ra	32.47 32.50 32.46 32.41 32.41 52.41 52.41	y 0.1 to 0.5
Image: 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses V Q C_	should be lontinually m # of Col	less than 0.3 Bottles	5.48 5.51 5.54 5.54	SL5 Sl,1 Sl,2 Sampling. Minimal of the well. Note that	drawdown shall be a site's hydrogeology	L.94 L.96 L.92	measured	by pumping achieve this	g at a low ra	32.47 32.50 32.46 32.46 32.47 52.47	y 0.1 to 0.5
1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses V Q ←	should be ontinually m	less than 0.3 Bottles	5.48 5.54 5.54 5.54	sampling. Minimal control the well. Note that	drawdown shall be a site's hydrogeology	L.94 L.96 L.92	measured a difficult to a	by pumping achieve this	at a low ra	32.47 32.50 32.46 32.46 32.47	y 0.1 to 0.5
1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses V Q C_	should be bontinually m # of Col	2-84 3.10 3.55 3.45 	5.48 5.54 5.54	sampling. Minimal c	drawdown shall be a site's hydrogeology	L.94 L.96 L.92	measured	by pumping achieve this	g at a low ra	32.47 32.50 32.46 32.46 32.47 52.47	y 0.1 to 0.5
1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses V Q ← Signed:	should be bontinually m # of Col	2-54 3.10 3.55 3.45 	5.48 5.54 5.54 B feet while ter levels in Comme	SI5 S	drawdown shall be a site's hydrogeology	L.94 L.96 L.92	measured difficult to	by pumping achieve this 2.16	g at a low ra	3247 32.50 32.46 32.46 32.47	y 0.1 to 0.5

	Levi	Elaw	Cround	water Com	nling with	Minimal	Tawd	own W	orkehe	et	
	LOW	-FIOW (JIOUNG	water Sam				<u>///.</u>	- 10		
							weil ID:	1440	0-11		
Project # :	14-201	, Phase 2					Date:	10-1	8		
Project Name:	Aniak V	VACS FS				Sta	rt Time:	1800			
Site:	Aniak V	VACS	16 0			Er	id Time:	18-11			
Field Leam:	·	saller	12.	mor	Time: 1820	primary	dup	split	ms/msd		
Sample ID:		HWA-C	LU-G		Time:	primary	dup	split	ms/msd		
Sample ID:					Time:	primary	dup	split	ms/msd		
		• •		/	- bladdan ar		Su	1			
Purg	ing and	Sampling	g Method	(e.g. peristalti	c, bladder, si Total Volu	upmersible):	T	eme re	DIE		
						ine i uigeu.					
Weather Condit	ions:	0	veras	f high	205						
Denth to Top of	Product	(ff BTOC)):	ALIA		Depth to	Water (f	t BTOC):		31.41	
Depth to Oil/Wa	ter Inter	face* (ft B	TOC):	NA		Total De	oth (ft B	TOC):		36.20	
* Note: Same as	depth to v	vater									
Criteria for S	Stable	Paramet	ters								
Parameter			Working	Range	Stabilit	y Criteria	Notes				
Temperature			>0.00 °C		± 3%						
pН			0-14		± 0.1						
Conductivity			0-999 m	S/m	± 3%						
ORP			± 1999 m	1V	± 10 m	/					
Dissolved Oxyg	en		0-19.991		± 10%						
Sancary Ob	convoti	000	0-000 14	10							
Color:	Servau	Clear A	mber Ta	n Brown Gre	Wilky Whit	e Other:					
Odor:		None Lo	w Medi	ım High Verv	Strong H2S	Fuel Like.	Chemica	al ?. Unkn	iown		
Turbidity:		None, Le	W, Madi		etterig, 112e	, 1 401 2110,		,			
		NONE. LC	ow. ivieaiu	ım, High, Very	/Turbid, Hea	avy Silts					
Instrument (Observ	ations	w, weak	um, Hign, Very ໃຈຟີ - 237	Turbid, Hea	vy Silts					
Instrument () Dbserv	ations		um, Hign, Very Cow = 257	Turbid, Hea mc(min	vy Silts	•			Water	
Instrument	Dbserv	Temp		Conduct'ity	rurbid, Hea کر مرزمین Turbidity	DO	ORP			Water Level	Draw-
Instrument (Round	Dbserv Time	Temp °C	pH	Conduct'ity	rurbid, Hea <i>سد (سنت</i> Turbidity (NTUs)	DO (mg/L)	ORP (mV)	Color	Odor	Water Level (ft BTOC)	Draw- down
Round	Dbserv Time	Temp °C	pH	Im, Hign, Very 	Turbid, Hea Turbidity (NTUs) Med.	DO (mg/L)	ORP (mV)	Color	Odor	Water Level (ft BTOC)	Draw- down
Round	Time	Temp °C 3.28	pH 5.72 5.72	um, Hign, Very 	Turbid, Hea Turbidity (NTUs) Med.	DO (mg/L) 3.34 2.52	• ORP (mV) 2299 227.7	Color	Odor	Water Level (ft BTOC) 31. 44	Draw- down
Round 1 2 3	Time	Temp °C 3.28 3.10 3.12	pH 5.12 5.12	Im, Hign, Very Conduct'ity () .450 .450 .460	Turbid, Hea Turbidity (NTUs) Med.	DO (mg/L) 3.34 2.52 <i>l.44</i>	• ORP (mV) 2.299 2.27.7 2.22.8	Color	Odor	Water Level (ft BTOC) 3 2. 44 31. 44	Draw- down
Round 1 2 3 4	Time	Temp °C 3.28 3.10 3.12 3.64	pH 5.12 5.14 5.81	Im, Hign, Very Conduct'ity () .450 .460 .460 .460	Turbid, Hea Turbidity (NTUs) Med.	DO (mg/L) 3.34 2.52 1.4(1.09	• ORP (mV) 2299 227-7 222-8 2219	Color	Odor	Water Level (ft BTOC) 32-44 31-44	Draw- down
Round 1 2 3 4 5 6	Dbserv Time 183 (81) 184 182	Temp °C 3.28 3.78 3.72 3.64	pH 5.12 5.24 5.91	Im, Hign, Very Conduct'ity () .450 .450 .460 .460	Turbid, Hea Turbidity (NTUs) Med.	DO (mg/L) 3.34 2.52 l-4l L.01	• ORP (mV) 2.299 2.21.7 2.22.8 2.2.19	Color	Odor Final	Water Level (ft BTOC) 31. 44 31. 44 31. 44	Draw- down
Round 1 2 3 4 5 6 7	Time	Temp °C 3.28 3.10 3.12 3.64	pH 5.12 5.24 5.94	Im, Hign, Very Conduct'ity () .450 .450 .460 .460	Turbid, Hea Turbidity (NTUs) Med.	DO (mg/L) 3.34 2.52 <i>l-4ll</i> J.01	• ORP (mV) 2.299 2.27.7 2.27.8 2.21.9	Color	Odor Final	Water Level (ft BTOC) 31. 44 31. 44	Draw- down
Round 1 2 3 4 5 6 7 8	Time	Temp °C 3.28 3.10 3.12 3.64	pH 5.72 5.72 5.73 5.81	Im, Hign, Very Conduct'ity () .450 .450 .460 .460	Turbid, Hea Turbidity (NTUs) Med.	DO (mg/L) 3.34 2.52 <i>l.4(</i> 1.09	• ORP (mV) 2.249 2.27.7 2.22.8 2.2.19	Color	Odor Final	Water Level (ft BTOC) 3 2. 44 31. 44 1	Draw- down - 03 - 0 -
Round 1 2 3 4 5 6 7 8 9	Dbserv Time 186 (81, 184 182	Temp °C 3.28 3.78 3.78 3.72 3.64	pH 5.12 5.12 5.23 5.9(Im, Hign, Very Conduct'ity () .450 .450 .460 .460	Turbid, Hea Turbidity (NTUs) Med.	DO (mg/L) 3.34 2.52 <i>l.4</i> (1.09	• ORP (mV) 2299 227-7 222-8 2219	Color	Odor Final	Water Level (ft BTOC) 3 2. 44 31. 44	Draw- down
Round 1 2 3 4 5 6 7 8 9 10	Dbserv	Temp °C 3.28 3.18 3.72 3.64	pH 5.12 5.12 5.9(Im, Hign, Very	Turbid, Hea Turbidity (NTUs) Med.	DO (mg/L) 3.34 2.52 1-41 1.01	• ORP (mV) 2.299 2.27.7 2.22.8 2.2.19	Color	Odor Final	Water Level (ft BTOC) 31. 44 31. 44	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11	Time	Temp °C 3.28 3.10 3.12 3.64	pH 5.72 5.72 5.73 5.8(Im, Hign, Very Conduct'ity () .450 .450 .460 .460	Turbid, Hea	DO (mg/L) 3.34 2.52 l-4l L01	• ORP (mV) 2.299 2.21.7 2.22.8 2.2.19	Color	Odor	Water Level (ft BTOC) 31. 44 31. 44	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12	Time	Temp °C 3.28 3.10 3.12 3.64	pH 5.72 5.72 5.81	Im, Hign, Very Conduct'ity () .450 .450 .460 .460	Turbid, Hea	DO (mg/L) 3.34 2.52 <i>l-4ii</i>	• ORP (mV) 2299 227-7 221-8 2219	Color	Odor Final	Water Level (ft BTOC) 31. 44 1 	Draw- down - 23 - 2 - 1
Round 1 2 3 4 5 6 7 8 9 10 11 12	Dbserv Time 186 (81, 182-	None, Ltc ations Temp °C 3.28 3.18 3.18 3.12 3.64	pH 5.12 5.12 5.9(Im, Hign, Very	Turbid, Hea	DO (mg/L) 3.34 2.52 1.4(1)	• ORP (mV) 2299 227-7 222-8 2219	Color	Odor Final	Water Level (ft BTOC) 32.44	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown	Time 183 (81) 182	Temp C 3.28 3.78 3.78 3.78 3.78 3.78	pH 5.12 5.12 5.13 5.9(Am, Hign, Very	drawdown shall b	DO (mg/L) 3.34 2.52 <i>l.4(</i> L.01	• ORP (mV) 2299 227-7 222-8 22-19	Color	Odor Final Binal	Water Level (ft BTOC) 3 1. 44 31. 44 31.44	Draw- down
Round Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and compared to the second compared totthe second compared totthe second compared tothe second compar	Time	Temp °C 3.28 3.10 3.12 3.12 3.64	pH 5.12 </td <td>Am, Hign, Very Conduct'ity () .450 .46</td> <td>drawdown shall bt</td> <td>DO (mg/L) 3.34 2.52 1.4(1.01</td> <td>P (mV) 2.299 2.27.7 2.72.8 2.2.19 2.2.19 </td> <td>Color</td> <td>Odor File g at a low ra</td> <td>Water Level (ft BTOC) 31. 44 31. 44 1 31. 44 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td> <td>Draw- down - @3 - 0 - (</td>	Am, Hign, Very Conduct'ity () .450 .46	drawdown shall bt	DO (mg/L) 3.34 2.52 1.4(1.01	P (mV) 2.299 2.27.7 2.72.8 2.2.19 2.2.19 	Color	Odor File g at a low ra	Water Level (ft BTOC) 31. 44 31. 44 1 31. 44 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Draw- down - @3 - 0 - (
Round 1 1 2 3 4 5 6 7 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co	Should be mtinually m	Temp °C 3.28 3.10 3.12 3.10 3.12 3.64	pH 5.12 5.12 5.12 5.12 5.12 5.12 5.12 5.12	Am, Hign, Very	drawdown shall b t site's hydrogeol	DO (mg/L) 3.34 2.52 1.4(L.01	P ORP (mV) 2299 227.7 222.8 22.19 22.19 22.19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Color	Odor Final g at a low ra	Water Level (ft BTOC) 31. 44 1 31.44	Draw- down - 23 - 20 - (
Round Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses	Should be ntinually m # of Col	Temp °C 3.28 3.18 3.18 3.12 3.18 3.12 3.64	B feet while ster levels in	am, High, Very Conduct'ity () .450 .450 .460 .460 .460 .460 .460 .460 .460 .46	drawdown shall b t site's hydrogeol	DO (mg/L) 3.34 2.52 <i>l.4(</i> 1.09	ORP (mV) 2299 227-7 222-8 22-19 22-19 22-19 measured difficult to	Color	Odor Final g at a low ra	Water Level (ft BTOC) 31. 44]]]]]]]]]]]]]]]]]]	Draw- down
Instrument (Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses √𝔅()	Should be ntinually m	Temp °C 3.28 3.10 3.12 3.12 3.12 3.12 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.10 3.12 3.10 3.10 3.10 3.10 3.10 3.10 3.10 3.10	pH 5.12 5.12 5.12 5.12 5.12 5.12 5.12 5.12	Im, High, Very	drawdown shall b	DO (mg/L) 3.34 2.52 1.4(L.01	ORP (mV) 2299 227-7 222-8 22-19 22-19 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Color	Odor Final Binal gata low ra s specification	Water Level (ft BTOC) 3 2 - 44 31. 44 	Draw- down
Instrument (Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses √/♀ ∠	Time	Temp °C 3.28 3.78 3.78 3.72 3.64 Seasuring ware Bottles llected	pH 5.12 5.12 5.12 5.12 5.12 5.12 5.12 5.12	am, Hign, Very Conduct'ity () .450 .450 .460 .460 .460 .460 .460 .460 .460 .46	drawdown shall b	DO (mg/L) 3.34 2.52 1.4(1.01	oRP (mV) 2299 227-7 222-8 22-19 22-19 measured difficult to	Color	Odor File g at a low ra s specification	Water Level (ft BTOC) 31.44 31.44 31.44 te (approximatel on.	Draw- down
Instrument (Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses √ŶC	Should be	Temp °C 3.28 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.12 3.10 3.10 3.10 3.10 3.10 3.10 3.10 3.10	B feet while s ater levels in Comme	Im, High, Very Conduct'ity () .450 .460 .460 .460 .460 .460 .460 .460 .46	drawdown shall b	DO (mg/L) 3.34 2.52 1.4(1.01 	• ORP (mV) 2.29.9 2.27.7 2.22.8 2.2.19 2.2.19 	Color	Odor Final Bata low ra	Water Level (ft BTOC) 31. 44 31. 44 1 31. 44 1 te (approximatel on.	Draw- down - 23 - 2 - (
Instrument (Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses	Should be ntinually m # of Col	Temp °C 3.28 3.10 3.12 3.10 3.12 3.64	B feet while s	am, Hign, Very	drawdown shall b	DO (mg/L) 3.34 2.52 1.4(L.01	ORP (mV) 2.299 2.27.7 2.22.8 2.2.19 2.2.19 	Color	Odor Final Final g at a low ra s specification	Water Level (ft BTOC) 31. 44 31. 44 1 31. 44 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Draw- down - 23 - 2 - 1
Instrument (Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses √𝒫C_	Should be ntinually m # of Col	Interior Provide a constraint of the second	bw, Medit	am, High, Very	drawdown shall b t site's hydrogeol	DO (mg/L) 3.34 2.52 1.4(L.09	ORP (mV) 2299 227-7 222-8 22-19 22-19 22-19 	Color	Odor Final Final g at a low ra s specification	Water Level (ft BTOC) 31.44	Draw- down - 23 - 27 - 1
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses VX2 Signed:	Time 183 (814 182 182 182 182 182 193 193 193 193 193 193 193 193 193 193	Itess than 0.3 Bottles	B feet while s ter levels in Comme	am, High, Very	drawdown shall t	DO (mg/L) 3.34 2.52 1.4(L.01	ORP (mV) 2299 227-7 222-8 22-19 22-19 22-19 0 0 0 0 0 0 0 0 0 0 0 0 0	Color	Odor Final Binal g at a low ra s specification	Water Level (ft BTOC) 3 1. 44 31. 44 31.44 1 31.44 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Draw- down
Instrument (Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses √𝒫C_ Signed:	Time	Atonie, Luc rations Temp °C 3.2.8 3.7.8 3.7.8 3.7.2 3.7.8 3.7.2 3.7.8 3.7.2 3.7.8 3.7.2 3.7.8 3.7.2 3.7.8 3.7.2 3.7.8 3.7.2 3.7.8 5.7.8 5.7.9 5.7.8 5.7.8 5.7.8 5.7.9 5.	pH 5.12 5.12 5.12 5.12 5.12 5.12 5.12 5.12	am, High, Very	drawdown shall b	DO (mg/L) 3.34 2.52 1.4(1.01 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	ORP (mV) 2299 227-7 222-8 22-19 22-19 0 0 0 0 0 0 0 0 0 0 0	Color	Odor File g at a low ra s specification	Water Level (ft BTOC) 31.44 31.44 1 31.44 1 te (approximatel on.	Draw- down - 23 - 2 - 1

4	1	2	
	•	_	

	Low	-Flow	Ground	water Samp	ling with N	linimal I	Drawd	own W	orkshe	eet	
				•			Well ID:	-	- 101-	7	
Draigat # :	14 201	Dhase 2					Date:	im	val H		
	14-201	, FIIdSE 2				-	rt Timo:	1000	n		
Project Name:	Aniak V	VACS FS				- 518 Fr	nt Time.	180	9		
Site:	Aniak v	VAUS	0 1			-	iu nine.	107	J		
Sample ID:	11-10	Man 12	BURGEL	~T	ime: 1835	orimary	dup	split	ms/msd		
Sample ID:	11-11	VA-OR	-l- com		ime:	primary	dup	split	ms/msd		
Sample ID:				T	ime:	_ primary	dup	split	ms/msd		
oumpio ib:						_	~	13	- 1 - 1		
Purg	ing and	Sampling	g Method	(e.g. peristaltic	, bladder, sub	mersible):	<u> </u>	upme	rsi lol	L	
					lotal Volum	e Purgea:	Lgo	l.			
Weather Condi	tions:	\bigcirc ,	en cost	+ 303	light show	\sim					
			\	ι, ί Δ.		Denth to	Mator /f			30.3	41
Depth to Top of	Product	(π BIOC		MUA		Total Do	nth (ft B			51.2	
* Noto: Somo os	denth to y	lace (ILD	100).	NJR		Total De	pui (it D	100).			•
Note. Same as		Doromo	tore								
Deremeter	Slaple	ralame	Working	Pango	Stability	ritoria	Notes				
Tomporaturo				Kange	+ 3%	Sillena	Notes				
nH			0-14		+ 0 1						
Conductivity			0-999 m	S/m	+ 3%						
ORP			± 1999 n	nV	± 10 mv						
Dissolved Oxyc	ien		0-19.99	mg/L	± 10%						
Turbidity			0-800 N	ТŬ							
Sensory Ob	servati	ons									
Color:		Clear, A	mber, Ta	n, Brown, Grey	, Milky White,	Other:					
Odor:		None, Lo	ow, Mediu	um, High, Very	Strong, H2S,	Fuel Like,	Chemica	al ?, Unkr	nown		
Turbidity:		None, Lo	ow, Mediu	um, High, Very	Turbid, Heavy	Silts					
Instrument	A I		3 7 3	an i i							
monument	Observ	ations	1 H 4	5-L/M							
instrument	Observ	ations	1.	5-L/M		ė	7			Water	_
mstrument	Observ	Temp	1 1 1 1 1 1 1	Conduct'ity	Turbidity	bO () ()	⁷ ORP		Other	Water Level	Draw-
Round	Time	Temp °C	pH	Conduct'ity (Ms/LA2)	Turbidity (NTUs)	ہ DO (mg/L)	oRP (mV)	Color	Odor	Water Level (ft BTOC)	Draw- down
Round	Time	Temp °C	рН 5.35	Conduct'ity (<i>msluit</i>) - 141	Turbidity (NTUs)	・ DO (mg/L)	ORP (mV)	Color	Odor None	Water Level (ft BTOC)	Draw- down
Round	Time	Temp °C 2.59 4.00	рН 5.35 5.53	Conduct'ity (Ms[L3]) - 141 - 229	Turbidity (NTUs)	DO (mg/L)	* ORP (mV) 158:こ 147:0	Color Clear	Odor None	Water Level (ft BTOC) 50.35 30.36	Draw- down
Round 1 2 3	Dbserv Time / 248 16 24	rations Temp °C 2.59 4.90 3.59	pH 5.35 5.53 5.53 5.52	Conduct'ity (ms/L2) - 141 - 229 - 230	Turbidity (NTUs) Clear No Le	DO (mg/L)	ORP (mV) 158:2- 147:0 148:5	Color Cleve	Odor	Water Level (ft BTOC) ろひ. うら るひ. うら	Draw- down
Round 1 2 3 4	Time 1824 1827	Temp °C 3.69 4.00 3.73	pH 5.35 3.53 5.52 5.50	Conduct'ity (<i>ms/ck</i>) - 141 - 229 - 230 - 230 - 243	Turbidity (NTUs) Clear No 2-e	DO (mg/L) .17 .60 .5 ? .00	ORP (mV) 158:22 147:0 148:5 149:0	Color Clear	Odor None	Water Level (ft BTOC) 30.35 30.36 t	Draw- down
Round 1 2 3 4 5 6	Time 1621 1827	Temp °C ふらう <u>ひつて</u> ふ、うう	pH 5.35 5.53 5.53 5.50	Conduct'ity (ms/w?) - 141 - 229 - 230 - 230 - 243	Turbidity (NTUs) Clear N'A Le	DO (mg/L) .17 .666 .59 .60	* ORP (mV) 158: こ- 147: 0 148: 5 149: 0	Color Cley Cley	Odor	Water Level (ft BTOC) 30.35 30.36 t t	Draw- down
Round 1 2 3 4 5 6 7	Time 1212 1824 1827	Temp °C ふらで ふらで ふらで ふうひ	pH 5.35 5.53 5.52 5.50	Conduct'ity (mslu2) - 141 - 229 - 230 - 230 - 243	Turbidity (NTUs) Clear N'S Le	DO (mg/L) .17 .66 .59 .00	プ ORP (mV) 158. で 1-17: 0 1-48-5 1-49: 0	Color Cler Cler	Odor	Water Level (ft BTOC) 30.36 1 Final	Draw- down
Round 1 2 3 4 5 6 7 8	Time 1824 1827	Temp °C 3.51 <u>いい</u> 3.73	pH 5.35 5.53 5.52 5.50	Conduct'ity (ms/c3) - 141 - 229 - 230 - 230 - 243	Turbidity (NTUS) Clear N'3 Le	DO (mg/L) .17 .60 .59 .00	ORP (mV) 158: こ- 1-17: ジ 1-48-5 149: 0	Color Clar Clar	Odor None	Water Level (ft BTOC) 30.36 t Filmar	Draw- down
Round 1 2 3 4 5 6 7 8 9	Time 1824 1827	/ations Temp °C 3.561 ビー 0.0 3.13 3.73	• µ • pH • 5,35 • 5,35 • 5,52 • 5,50 • • • • • •	Conduct'ity (ms/L2) - [4] - 230 - 230 - 230	Turbidity (NTUS) Clear N'3 Le	DO (mg/L) 	7 ORP (mV) 158:2- 149:5 149:0	Color Cler	Odor None	Water Level (ft BTOC) 30.35 30.36 t fibal	Draw- down
Round 1 2 3 4 5 6 7 8 9 10	Time 7.248 16-24 18-24 18-27	Temp °C 3.59 ひ うい 3.73	5.35 5.35 5.53 5.52 5.50	S-L/M Conduct'ity (ms/L2) - 141 - 230 - 200 -	Turbidity (NTUs) Clear Min Le	DO (mg/L) -17 -66 -57 -60	7 (mV) 158:2- 147:0 148:5 149.0	Color Cler Cler	Odor	Water Level (ft BTOC) 30.35 30.36 t t fibal	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11	Time 1218 1324 1324 1327	/ations Temp °C ふらず <u>ししょうで</u> ろいがす ろこうう	PH 5.35 5.53 5.53 5.50	S-L/M Conduct'ity (ms/Lm ²) - 141 - 729 - 230 - 230 - 243	Turbidity (NTUS) Clear N'A Le	DO (mg/L) .17 .66 .59 .60	* ORP (mV) 158: こと 147: 0 148: 5 149: 0	Color Cler Cler	Odor	Water Level (ft BTOC) 30.36 t f f h f h a1	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12	Time 1212 1324 1327	/ations Temp °C ふらず <u>しし</u> うして うして うして うして うして うして うして うして	pH 5,35 5,35 5,53 5,50	Conduct'ity (ms/u ²) - 141 - 229 - 230 - 230 - 243	Turbidity (NTUs) Clear N'A Le	DO (mg/L) - 17 - 666 - 59 - 60 	* ORP (mV) 158. で 148.5 149.0		Odor	Water Level (ft BTOC) 30.36 t f h h h	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12	Dbserv Time / 618 16 2.4 18 2.4 18 2.7	/ations Temp °C 3.59 	pH 5.35 5.53 5.52 5.50	Conduct'ity (ms/u3) - 141 - 229 - 230 - 230 - 24 - 230 - 200 - 20	Turbidity (NTUs) Clear N'3 Le	DO (mg/L) .17 .60 	ず ORP (mV) 158、こ 148-5 149-0 		Odor None	Water Level (ft BTOC) 30.36 t Filmar	Draw- down ∪[∪[220.35
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown	Time / 818 16 2.4 18 2.4 18 2.7	/ations Temp °C 3.54 ビー・ひて 3.73 	pH 5.35 5.53 5.52 5.30	S-レ(M Conduct'ity (Ms/レス) - レビー - レビー - ンろい - レビろ - レビス - ション - レビス - ション - レビス - ション - レビス - ション - レビス - レビー - ション - ション - - - - - - - - - - - -	Turbidity (NTUs) Clear N'S Le	DO (mg/L) . 1 . 60 . 5 . 00	ず ORP (mV) 15度、ひ 14日、5 14日、0 14日 0 14日、0 14日 14日、0 14日 14日 14日 14日 14日 14日 14日 14日 14日 14日	Color Cler	Odor	Water Level (ft BTOC) 30.35 30.36 fibar	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and compared to the second se	Time / 248 16 24 18 24 18 24 18 27 18 27 should be pontinually m	rations Temp °C کیجم کیجم کیجم کیجم کیجم کیجم کیجم کیجم	9H 5-35 5-53 5-53 5-53 5-50	Conduct'ity (ms/L2) - LUI - Z29 - Z30 - Z30 - Z30 - Z30 - DU3 - DU	Turbidity (NTUs) Clear Min Le Min Le	DO (mg/L)	ORP (mV) 158.2 149.5 149.0	Color Cler	Odor	Water Level (ft BTOC) 30.35 30.36 fibar	Draw- down ○/ ○/ ○/ ○/ ○/ ○/ ○/ ○/ ○/ ○/ ○/ ○/ ○/ ○/ ○/ ○/ ○/ ○/
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and color	Time	remp °C 3.59 3.73 3.73 .73 .73 .73 .73 .73 .73 .73	9H 5,35 3,53 4,52 5,30 5,30	Conduct'ity (ms/L2) - LUI - ZZ-9 - Z30 - LU3 - LU1 - LU3 - LU3 - LU1 - LU3 - L	Turbidity (NTUS) (NTUS) MARCA I	DO (mg/L)	* ORP (mV) 158. ひ 148.5 149.0	Color	Odor	Water Level (ft BTOC) 30-36 1 Filas	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses	Should be ontinually n	rations Temp °C 3.51 4.00 3.11 3.73 3.73 3.73 1.00 3.10 3.73 1.00 3.10 1.00 1.00 1.00 1.00 1.00 1.0	3 feet while s	Conduct'ity (ms/L2) - LUI - ZZ-9 - Z3U - LU3 - LU4 - LU3 - LU4 - LU3 - LU4 - L	Turbidity (NTUs) (Non-e Non-e I I rawdown shall be a site's hydrogeology	bO (mg/L)	* ORP (mV) 158. で 1-(?:) 148-5 149.0 -	Color	Odor	Water Level (ft BTOC) 30.36 t final final	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses	Should be ontinually n	rations Temp °C 3.54 3.73 3.73 3.73 9.73 9.73 9.73 9.73 9.73	pH 5.35 5.53	S-L(M Conduct'ity (MS(L3)) - L41 - 229 - 230 - 240 - 240	Turbidity (NTUs)	DO (mg/L)	ず ORP (mV) 158. ひ 148.5 149.0	Color	Odor	Water Level (ft BTOC) 30.36 T Final	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses	Should be ontinually m	rations Temp °C 3.51 4.00 3.13 3.73 3.73 best than 0.1 measuring was Bottles Ilected	3 feet while sater levels in	Conduct'ity (MS/L2) - LUI - ZZ-9 - ZBU - Z	Turbidity (NTUS)	DO (mg/L)	ORP (mV) 158. こ 1-17: ジ 1-48-5 1-49.0	Color	Odor	Water Level (ft BTOC) 30.35 30.36 Fibar	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co	Should be ontinually m	rations Temp °C 3.59 3.73 3.73 3.73 bess than 0.7 beasuring was Bottles Ilected	3 feet while :	Conduct'ity (MS/L2) - LUI - ZZ-9 - Z3U - Z3U - Z3U - Z3U - Z3U - LU3 	Turbidity (NTUS)	DO (mg/L)	ず ORP (mV) 15度、 ひ 14日、5 14日、5 14日、0 14日、5	Color	Odor	Water Level (ft BTOC) 30-35 30-36 Fibac	Draw- down
Round Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses V ()	Should be	rations Temp °C 3.54 3.73 3.73 3.73 1.73 1.73 1.73 1.73 1.73	3 feet while sater levels in	Conduct'ity (ms/L2) - LUI - Z29 - Z30 - Z30 - Z30 - Z30 - LU3 	Turbidity (NTUS) Clear Min Le J	DO (mg/L)	プ ORP (mV) 158.2 149.5 149.0	Color Cler Cler by pumping achieve this	Odor	Water Level (ft BTOC) 30.35 30.36 fibar	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co	Should be	rations Temp °C 3.59 3.73 3.73 3.73 .73 .73 .73 .73 .73 .73	3 feet while state levels in Comme	Conduct'ity (ms/L2) - LUI - ZZ-9 - Z30 - LU3 - LU3 - LU3 - LU3 - LU3 - LU3 - LU3 - LU3 - Sampling. Minimal dr	Turbidity (NTUS) Clear Min Le I	DO (mg/L)	* ORP (mV) 158. で 1-(?:) 148-5 149.0-	Color	Odor	Water Level (ft BTOC) 30-36 1 Filing /	Draw- down ○[○[○[○] 20.33
Round Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses V() Signod:	Should be ontinually n	rations Temp °C 3.51 4.00 3.73 3.73 3.73 1.373 1.47 Bettles Ilected	pH 5,35 3.53 4.53 5.53 6.53	Conduct'ity (ms/L2) - LUI - ZZ-9 - Z3U - LU3 - LU3 - LU3 - LU3 - Sampling. Minimal dr the well. Note that s	Turbidity (NTUS) Clear Min Le I	DO (mg/L)	7 ORP (mV) 158.2- 1-(?.) 148.5 149.0- С	Color	Odor	Water Level (ft BTOC) 30.36 t Final	Draw- down
Round 1 2 3 4 5 6 7 8 9 10 11 12 Notes: Drawdown liter/minute) and co Analyses V() C Signed:	Should be ontinually m	rations Temp °C 3.51 4.00 3.73 3.73 3.73 bess than 0.1 heasuring was Bottles Ilected 3 4 4 4 4 5 4 4 4 4 5 4 4 4 4 4 5 4 4 4 4 5 4 4 4 5 4 4 4 5 7 5 7	pH 5.35 5.35 5.30 5.30 5.30 3 feet while a ter levels in Comme Comme	S-L(M Conduct'ity (MS/L2) - LUI - ZZ-9 - Z3U - Z3U - LU3 - LU3 - LU3 - Sampling. Minimal dr the well. Note that so nts:	Turbidity (NTUS)	DO (mg/L)	7 ORP (mV) 158.2- 1-1.2 148.5 149.0	Color	Odor	Water Level (ft BTOC) 30.35 70.36 Fibar	Draw- down

ATTACHMENT 2

Photograph Log

Appendix B, Attachment 2:

Photo Log for 2011 Groundwater Monitoring Events

Photographs 1 through 15: General Site Photographs (October 2011) Photographs 16 through 18: Detailed Monitoring Well Photographs (May 2011) Photographs 19 and 20: Aniak Slough/Kuskokwim River (May 2011 and October 2011)



PHOTOGRAPH 1: LOOKING TOWARDS WOOD SHOP ENTRANCE FROM HIGH SCHOOL



PHOTOGRAPH 2: STANDING ADJACENT TO WOODSHOP LOOKING TOWARDS MW-11



PHOTOGRAPH 3: TAKEN FROM MW-11 LOOKING TOWARDS E. ANTENNA FOUNDATION



PHOTOGRAPH 4: TAKEN FROM MW-11 LOOKING N. TOWARDS RUNWAY



PHOTOGRAPH 5: TAKEN FROM MW-11 LOOKING WEST



PHOTOGRAPH 6: TAKEN FROM BEHIND SYSTEM TRAILERLOOKING SOUTHWEST



PHOTOGRAPH 7: MAIN ENTRANANCE



PHOTOGRAPH 8: TAKEN FROM MAIN ENTRANCE, MW-4 UNDER CONNEX

Alaska Department of Environmental Conservation



PHOTOGRAPH 9: TAKEN FROM MW-5 LOOKING TOWARDS BUILDING



PHOTOGRAPH 10: TAKEN FROM MW-5 LOOKING TOWARDS S ANTENNA FOUNDATION



PHOTOGRAPH 11: NEAR MAIN ENTRANCE LOOKING TOWARDS HIGH SCHOOL



PHOTOGRAPH 12: TAKEN NEAR HIGH SCHOOL LOOKING TOWARDS MW-5



PHOTOGRAPH 13: LOOKING TOWARDS MW-9 FROM MW-8



PHOTOGRAPH 14: TAKEN NEAR FENCE TO MW-9 LOOKING N. TOWARDS RUNWAY



PHOTOGRAPH 15: TAKEN AT MW-6 LOOKING TOWARDS HIGH SHOOL



PHOTOGRAPH 16: MW-7 (CLOSEST TO FENCE) AND MW-8



PHOTOGRAPH 17: SGP-9



PHOTOGRAPH 18: LEVELOGGER SETUP



PHOTOGRAPH 19: ANIAK SLOUGH/KUSKOKWIM RIVER AT ANIAK, LOOKING ROUGHLY NE (PHOTO TAKEN FROM RETAINING WALL; WATER LEVEL ³/₄ UP THE WALL)



PHOTOGRAPH 20: SAME GENERAL VIEW AS PHOTOGRAPH 19, (TAKEN 10/20/11)

ATTACHMENT 3

QAR and ADEC Checklists

Appendix B, Attachment 3:

Quality Assurance/Quality Control (QA/QC) Text and ADEC Checklists

Laboratory QA/QC data associated with the analysis of project samples has been reviewed to evaluate the integrity of the analytical data generated during the May and October 2011 groundwater sampling events at the Joe Parent Voc-Technical Educational building in Aniak, AK to support the Focused Feasibility Study (FS) for groundwater remediation at the Former Aniak White Alice Site, Aniak, Alaska. Sampling was performed in accordance with a May 2011 work plan and its October 2011 addendum (OASIS, 2011a and b).

Water samples were shipped to OnSite Environmental Inc in Redmond, WA and Keystone Laboratories Inc in Newton, IA for analysis. May 2011 results were reported in work orders (WO): 1105-150 (OnSite) and 11E0946 (Keystone). October 2011 results were reported in OnSite WO 1110-167. Samples were collected, reported, and shipped in general accordance with the ADEC-approved work plan and addendum (OASIS, 2011a and b).

All data were reviewed in accordance with United States Environmental Protection Agency (USEPA) National Functional Guidelines for Organic Methods (EPA 2008), USEPA National Functional Guidelines for Inorganic Methods (EPA 2010) and ADEC regulatory guidance documents (ADEC 2005; 2008; 2009a; 2009b; 2010a; 2010b). This data review focused on the following QC parameters and their effect on the quality of data and usability: sample handling and chain-of-custody documentation; holding time compliance; field QC (trip blanks, field duplicates); laboratory QC (method blanks, surrogates, matrix spikes (MS) and MS duplicates (MSD); method reporting limits; and completeness).

All samples were extracted, digested and analyzed within the holding time criteria for the applicable analytical methods and in accordance with work plan (OASIS, 2010) specifications. All trip blank results were not detected (ND) at concentrations above the analytical reporting limit (RL) or practical quantitation limit (PQL).

During the May 2011 sampling event, 11 primary samples and 1 duplicate were collected and submitted – primary 10-AWA-010-GW with duplicate 10-AWA-011-GW. During the October 2011 sampling event, 8 primary samples and 1 duplicate were collected and submitted – primary 10-AWA-018-GW with duplicate 10-AWA-019-GW. All RPDs between primary and duplicate samples were within the ADEC recommended <30% between field duplicates.

The LCS percent recoveries (%R) and relative percent differences (RPDs) were within limits. MS/MSD %R and RPDs were within limits, with one exception. In WO 11E0946, the MSD %R and RPD was outside the quality control limits for dissolved iron and dissolved manganese. The associated sample is 11-AWA-001-GW. Associated positive and ND results were flagged J and UJ, and considered estimated. Method Reporting Limits (MRLs) and PQLs met or were below established criteria specified for all analyses in the project work plan. The reporting limits were also below the ADEC established cleanup levels and target levels.

The overall quality of the data was acceptable for the objectives established for this project. All sample results are considered usable for project objectives. No results were rejected. The overall project completeness is 100%.

REFERENCES

ADEC. 2005. Draft Guidance on Developing Conceptual Site Models, March 24.

- ADEC. 2008. 18 AAC 75, Oil and Other Hazardous Substances Pollution Control, October 9.
- ADEC. 2009a. Technical Memorandum: Environmental Laboratory Data and Quality Assurance Requirements. March.
- ADEC. 2009b. Draft Vapor Intrusion Guidance for Contaminated Sites. July.
- ADEC. 2010a. Laboratory Data Review Checklist. Version 2.7. January.
- ADEC. 2010b. Laboratory Data Review Checklist for Air Samples. Version 1.0. January.
- EPA. 2008. Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA 540/R-94/012).
- EPA. 2010. Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. January (EPA 540-R-10-011).
- OASIS, 2011a. Letter Work Plan to Mr. John Halverson, re: Final Work Plan for Additional Characterization and Groundwater Monitoring at Former Aniak WACS Site, Aniak, Alaska. May 2.
- OASIS, 2011b. Letter Work Plan to Mr. John Halverson, re: Addendum to May 2, 2011 Final Work Plan for Additional Characterization and Groundwater Monitoring at Former Aniak WACS Site, Aniak, Alaska. October 6.

Laboratory Data Review Checklist

C	1 - 4 - 1 1	Maliana Dilan				
Comp	leted by:]		
Title:		Environmental	Scientist		Date:	May 27, 2011
CS Re	port Name:	FORMER AN	IAK WHITE AL	ICE SITE, ANIAK, AK	Report Date:	Jun 17, 2011
Consu	lltant Firm:	OASIS Enviro	nmental, Inc			
Labora	atory Name:	OnSite Enviror	nmental	Laboratory Report Nu	mber: 1105-15	0
ADEC	File Number:			ADEC RecKey Numb	per:	
1. <u>L</u> a	<u>aboratory</u>					
	a. Did an A	ADEC CS appro	oved laboratory r	eceive and <u>perform</u> all of	the submitted	sample analyses?
	• Yes	\bigcirc No	🔿 NA (Plea	ase explain.)	Comments:	
	b. If the sat laborato	mples were tran ry, was the labo	sferred to anothe ratory performin	r "network" laboratory or g the analyses ADEC CS	r sub-contracted approved?	d to an alternate
	• Yes	\bigcirc No	○NA (Pleas	e explain)	Comments:	
	Samples were n	ot subcontracte	d or transferred to	o another network labora	tory.	
2. Ch	ain of Custody	(COC)				
	a. COC infor	mation complet	ed, signed, and d	ated (including released/	received by)?	
Г	• Yes	⊖ No	○NA (Pleas	se explain)	Comments:	
	b. Correct an	alyses requeste	d?			
F	• Yes	⊖ No	○NA (Plea	ase explain)	Comments:	
3. <u>La</u>	boratory Sampl	e Receipt Docu	mentation			
	a. Sample/co	oler temperatur	e documented an	d within range at receipt	at receipt $(4^\circ \pm 2^\circ C)$?	
	• Yes	○ No	○NA (Ple	ease explain)	Comments:	
	Case narrative s	tates samples w	vere received with	hin range. It is not docum	nented on the C	OC.

• Yes	⊖ No	○NA (Please explain)	Comments:
c. Sample cor	ndition documer	nted - broken, leaking (Methanol),	zero headspace (VOC vials)?
• Yes	⊖ No	○NA (Please explain)	Comments:
Samples were re	ported in good o	condition.	
d. If there we preservation,	re any discrepar sample tempera	ncies, were they documented? - Fo ature outside of acceptance range, i	r example, incorrect sample contain insufficient or missing samples, etc.
⊖ Yes	○ No	•NA (Please explain)	Comments:
There are no disc	repancies.		
	1.11.	26	
e Data qualit	v or usability at	Tected / I Please exhlain i	
e. Data qualit	y or usability af	rected? (Please explain)	Comments
e. Data qualit	y or usability at	affect with respect to the laborator	Comments:
e. Data qualit	y or usability af usability is not	affect with respect to the laborator	Comments: ry receipt documentation.
e. Data qualit Data quality and use Narrative	y or usability af	affect with respect to the laborator	Comments: ry receipt documentation.
e. Data qualit Data quality and use Narrative a. Present and	y or usability af usability is not understandable	affect with respect to the laborator	Comments: ry receipt documentation.
e. Data quality Data quality and use Narrative a. Present and • Yes	usability af usability is not understandable	affect with respect to the laborator	Comments: ry receipt documentation. Comments:
e. Data quality Data quality and use Narrative a. Present and Yes	usability is not understandable	affect with respect to the laborator	Comments: ry receipt documentation. Comments:
e. Data quality Data quality and use Narrative a. Present and Yes b. Discrepance	y or usability af usability is not understandable No	affect with respect to the laborator ?? ONA (Please explain) C failures identified by the lab?	Comments: ry receipt documentation. Comments:
e. Data quality Data quality and <u>use Narrative</u> a. Present and • Yes b. Discrepanc • Yes	usability is not usability is not understandable No ies, errors or Q0	affect with respect to the laborator ? ONA (Please explain) C failures identified by the lab? ONA (Please explain)	Comments: ry receipt documentation. Comments: Comments:
e. Data quality Data quality and <u>use Narrative</u> a. Present and	usability is not understandable No ies, errors or Qo No crepancies.	affect with respect to the laborator ?? ONA (Please explain) C failures identified by the lab? ONA (Please explain)	Comments: ry receipt documentation. Comments: Comments:
e. Data quality Data quality and <u>use Narrative</u> a. Present and	usability is not usability is not understandable No ies, errors or Qo No crepancies.	affect with respect to the laborator affect with respect to the laborator ?? ONA (Please explain) C failures identified by the lab? ONA (Please explain)	Comments: Comments: Comments:
e. Data quality Data quality and <u>use Narrative</u> a. Present and	usability is not usability is not understandable No vies, errors or Qo No crepancies.	affect with respect to the laborator affect with respect to the laborator ?? ONA (Please explain) C failures identified by the lab? ONA (Please explain)	Comments: ry receipt documentation. Comments: Comments:
e. Data quality Data quality and ase Narrative a. Present and • Yes b. Discrepanc • Yes There are no disc c. Were all co • Yes	understandable understandable No No No Crepancies. Orrective actions No	affect with respect to the laborator affect with respect to the laborator ?? ONA (Please explain) C failures identified by the lab? ONA (Please explain) documented? ONA (Please explain)	Comments: Comments: Comments: Comments:

Data quality and usability is not affected.

5. Samples Results

• Yes	⊖ No	○NA (Please explain)	Comments:
b. All applical	ble holding tim	es met?	
• Yes	⊖ No	○NA (Please explain)	Comments:
c. All soils rer	ported on a dry	weight basis?	
⊖ Yes	⊖ No	• NA (Please explain)	Comments:
There are no soil	samples in this	s sample delivery group.	
d. Are the repo project?	orted PQLs les	s than the Cleanup Level or the min	imum required detection level for the
• Yes	\bigcirc No	○NA (Please explain)	Comments:
e. Data quality	y or usability at	ffected? (Please explain)	Comments:
Data quality and	usability is not	affected with respect to the reporte	d sample results.
<u>C Samples</u> a. Method Blar i. One me	ık ethod blank rep	orted per matrix, analysis and 20 sa	mples?
• Ye	es 🔿 No	○NA (Please explain)	Comments:
ii. All met • Ye	hod blank resu es () No	lts less than PQL? ○NA (Please explain)	Comments:
	DOL	1 00 1 10	Communitar
111. If abov	re PQL, what sa	amples are attected?	Comments:
NA. All results a	re ND.		

6.

\bigcirc Yes \bigcirc No \bigcirc NA (Please explain) Comments:	
---	--

NA. All results are ND.

v. Data quality or usability affected? (Please explain)	Comments:
Data quality and usability is not affected with respect to the repo	rted method blank results.

b. Laboratory Control Sample/Duplicate (LCS/LCSD)

i. Organics - One LCS/LCSD reported per matrix, analysis and 20 samples? (LCS/LCSD required per AK methods, LCS required per SW846)

⊖ Yes	No	○ NA (Please explain)	Comments:
-------	----	-----------------------	-----------

There is no LCS/LCSD. There is an MS/MSD.

ii. Metals/Inorganics - One LCS and one sample duplicate reported per matrix, analysis and 20 samples?

 \bigcirc Yes \bigcirc No \bigcirc NA (Please explain)

There are no metals or inorganic analyses.

iii. Accuracy - All percent recoveries (%R) reported and within method or laboratory limits? And project specified DQOs, if applicable. (AK Petroleum methods: AK101 60%-120%, AK102 75%-125%, AK103 60%-120%; all other analyses see the laboratory QC pages)

● Yes ○ No ○ NA (Please explain) Comments:

iv. Precision - All relative percent differences (RPD) reported and less than method or laboratory limits? And project specified DQOs, if applicable. RPD reported from LCS/LCSD, MS/DMSD, and or sample/sample duplicate. (AK Petroleum methods 20%; all other analyses see the laboratory QC pages)

• Yes	\bigcirc No	○NA (Please explain)	Comments:	

v. If %R or RPD is outside of acceptable limits, what samples are affected?

Comments:

Comments:

NA. All results are within acceptable limits.

10

	\bigcirc No	• NA (Please explain)	Comments:
NA. All results	are within acc	eptable limits.	
vii. Data c	uality or usab	ility affected? (Please explain)	Comments:
Data quality an	d usability is r	ot affected with respect to the report	ted LCS/LCSD results.
c. Surrogates	- Organics On	lv	
i. Are surr	ogate recoveri	es reported for organic analyses - fie	ld, QC and laboratory samples?
• Yes	○ No	CNA (Please explain)	Comments:
ii. Accura project sp the labora	cy - All percer ecified DQOs, tory report pag	nt recoveries (%R) reported and with if applicable. (AK Petroleum metho ges)	in method or laboratory limits? And ods 50-150 %R; all other analyses see
• Yes	⊖ No	ONA (Please explain)	Comments:
clearly de	fined?	\bigcirc NA (Please explain)	Comments:
iv. Data q	uality or usabi	lity affected? (Use the comment box	to explain.). Comments:
iv. Data q Data quality and	uality or usabi usability is no	lity affected? (Use the comment box ot affected with respect to the reporte	to explain.). Comments: ed surrogate results.
iv. Data q Data quality and d. Trip Blank <u>Soil</u> i. One trip (If not, en	uality or usabi l usability is no - Volatile ana blank reporte ter explanation	lity affected? (Use the comment box ot affected with respect to the reporte lyses only (GRO, BTEX, Volatile Cl d per matrix, analysis and for each co 1 below.)	to explain.). Comments: ed surrogate results. hlorinated Solvents, etc.): <u>Water and</u> ooler containing volatile samples?
iv. Data q Data quality and d. Trip Blank <u>Soil</u> i. One trip (If not, en © Yes	uality or usabi l usability is no - Volatile ana blank reporte ter explanation O No	lity affected? (Use the comment box ot affected with respect to the reporte lyses only (GRO, BTEX, Volatile Cl d per matrix, analysis and for each co n below.) O NA (Please explain.)	to explain.). Comments: ed surrogate results. hlorinated Solvents, etc.): <u>Water and</u> ooler containing volatile samples? Comments:
iv. Data q Data quality and d. Trip Blank <u>Soil</u> i. One trip (If not, en • Yes ii. Is the c (If not,	uality or usabi l usability is no - Volatile ana blank reporte ter explanation O No ooler used to t a comment ex	lity affected? (Use the comment box ot affected with respect to the reporter lyses only (GRO, BTEX, Volatile Cl d per matrix, analysis and for each co n below.) O NA (Please explain.) ransport the trip blank and VOA sam plaining why must be entered below)	to explain.). Comments: ed surrogate results. hlorinated Solvents, etc.): <u>Water and</u> ooler containing volatile samples? Comments:

		x	
• Yes	⊖ No	○ NA (Please explain.)	Comments:
Il results are NI).		
iv. If abov	e PQL, what	samples are affected?	
			Comments:
NA. All results a	re ND.		
v. Data qu	ality or usabil	ity affected? (Please explain.)	
1	5		Comments:
Data quality and	usability are	not affected with respect to the report	rted trip blank results.
e Field Dunlic	ate		
i. One field	l duplicate sul	omitted per matrix, analysis and 10 I	project samples?
	-		
• Yes	○ No	ONA (Please explain)	Comments:
There was one f	eld duplicate	primary 11-AWA-010-GW with	duplicate 11-AWA-011-GW.
ii. Submit	ted blind to la	b?	
• Yes	○ No	○ NA (Please explain.)	Comments:
iii. Precisi (Recon	on - All relati 1mended: 30%	ve percent differences (RPD) less th 6 water, 50% soil)	an specified DQOs?
iii. Precisi (Recon	on - All relati 1mended: 30%	ve percent differences (RPD) less th 6 water, 50% soil) RPD (%) = Absolute Value of: <u>(R1- J</u>	an specified DQOs? $\frac{R_2}{x} \times 100$
iii. Precisi (Recon	on - All relati nmended: 30% F	we percent differences (RPD) less th 6 water, 50% soil) RPD (%) = Absolute Value of: (R_{1-1}) $((R_{1+1})$	an specified DQOs? <u>R₂)</u> x 100)/2)
iii. Precisi (Recon Where R	on - All relation nmended: 30% $I_1 = Sample Control $	we percent differences (RPD) less th 6 water, 50% soil) RPD (%) = Absolute Value of: $(\underline{R_{1-1}})$ (($R_{1+}R_2$) oncentration	an specified DQOs? $\frac{R_2}{x \ 100}$
iii. Precisi (Recon Where R R	on - All relation nmended: 30% $I_1 = Sample CoI_2 = Field Dupl$	we percent differences (RPD) less th 6 water, 50% soil) RPD (%) = Absolute Value of: $(R_1 - 1)$ (($R_1 + R_2$) oncentration icate Concentration	an specified DQOs? <u>R₂)</u> x 100)/2)
iii. Precisi (Recon Where R R (• Yes	on - All relati nmended: 30% I $_1$ = Sample Co $_2$ = Field Dupl \bigcirc No	we percent differences (RPD) less th 6 water, 50% soil) RPD (%) = Absolute Value of: (R_{1-}] ((R_{1+} R_2) oncentration icate Concentration \bigcirc NA (Please explain)	an specified DQOs? <u>R_2)</u> x 100)/2) Comments:
iii. Precisi (Recon Where R R • Yes iv. Data q	on - All relati nmended: 30% I $_1 = Sample Co_2 = Field Dupl\bigcirc NoJulity or usabi$	we percent differences (RPD) less th 6 water, 50% soil) RPD (%) = Absolute Value of: (R_{1-}) (($R_{1+} R_2$) oncentration icate Concentration \bigcirc NA (Please explain) lity affected? (Use the comment box	an specified DQOs? <u>R_2)</u> x 100)/2) Comments: x to explain why or why not.)
f. Decontamin	ation or Equip	ment Blank (if applicable)	
--------------------	------------------	--------------------------------------	----------------------------------
⊖ Yes	○ No	• NA (Please explain)	Comments:
NA. All sampling	g equipment w	as disposable.	
i. All resul	ts less than PQ	L?	
⊖ Yes	⊖ No	• NA (Please explain)	Comments:
NA. All sampling	g equipment wa	as disposable. No decontamination or	equipment blanks were collected.
ii. If above	PQL, what sa	mples are affected?	Comments:
NA. No decontan	nination or equ	ipment blanks were collected.	
iii. Data qu	uality or usabil	ity affected? (Please explain.)	Comments:
NA. No decontan	nination or equ	ipment blanks were collected.	
Other Data Flags/Q	ualifiers (ACC	DE, AFCEE, Lab Specific, etc.)	
○ Yes		• NA (Please explain)	Comments:
There are no othe	er data flags or	qualifiers.	

Reset Form

7.

Laboratory Data Review Checklist

Comp	leted by:	Melissa Pike				
Title:		Environmental	Scientist		Date:	Dec 6, 2011
CS Re	eport Name:	FORMER AN	AK WHITE AL	ICE SITE, ANIAK, AK	Report Date:	December 2011
Consu	ıltant Firm:	OASIS Environ	nmental, Inc			
Labor	atory Name:	OnSite Enviror	nmental	Laboratory Report Nu	mber: 1110-16	7
ADEC	File Number:			ADEC RecKey Numb	per:	
1. L	aboratory					
	a. Did an <i>j</i>	ADEC CS appro	oved laboratory r	eceive and perform all of	f the submitted	sample analyses?
	• Yes	⊖ No	○ NA (Plea	use explain.)	Comments:	F)
	b. If the sat laborato	mples were tran ry, was the labo	sferred to anothe ratory performin	r "network" laboratory of g the analyses ADEC CS	r sub-contracted approved?	d to an alternate
	• Yes	⊖ No	○NA (Pleas	e explain)	Comments:	
	Samples were n	ot subcontracted	d or transferred to	o another network labora	tory.	
2. <u>Cł</u>	nain of Custody	<u>(COC)</u>				
	a. COC infor	mation complet	ed, signed, and d	ated (including released/	received by)?	
Г	• Yes	⊖ No	○NA (Pleas	se explain)	Comments:	
l	b. Correct an	alyses requested	d?			
	• Yes	⊖ No	○NA (Plea	ase explain)	Comments:	
3. <u>La</u>	boratory Sampl	e Receipt Docu	mentation			
	a. Sample/co	oler temperature	e documented an	d within range at receipt	$(4^\circ \pm 2^\circ \mathrm{C})?$	
	• Yes	\bigcirc No	⊖NA (Ple	ase explain)	Comments:	
	Case narrative s	tates samples w	ere received with	hin range. It is not docum	nented on the C	OC.

• Yes	⊖ No	○NA (Please explain)	Comments:
c. Sample cor	dition documer	nted - broken, leaking (Methanol),	zero headspace (VOC vials)?
• Yes	⊖ No	○NA (Please explain)	Comments:
Samples were re	ported in good o	condition.	
d. If there were preservation,	re any discrepar sample tempera	ncies, were they documented? - Fo ature outside of acceptance range, i	r example, incorrect sample contain insufficient or missing samples, etc.
○ Yes	\bigcirc No	•NA (Please explain)	Comments:
here are no discu	repancies.		
	1.11.4	Factad? (Place applain)	
e Data qualit	v or licability at		
e. Data qualit	y or usability af	rected? (riease explain)	Comments
e. Data qualit	y or usability at	affect with respect to the laborator	Comments:
e. Data qualit	usability is not	affect with respect to the laborator	Comments: ry receipt documentation.
e. Data quality Data quality and use Narrative	usability is not	affect with respect to the laborator	Comments: ry receipt documentation.
e. Data quality Data quality and use Narrative a. Present and	usability is not understandable	affect with respect to the laborator	Comments: ry receipt documentation.
e. Data quality Data quality and use Narrative a. Present and ves	usability is not understandable	affect with respect to the laborator	Comments: ry receipt documentation. Comments:
e. Data quality Data quality and use Narrative a. Present and • Yes	usability is not understandable	affect with respect to the laborator	Comments: ry receipt documentation. Comments:
e. Data quality Data quality and use Narrative a. Present and Yes b. Discrepanc	understandable O No	affect with respect to the laborator ?? ONA (Please explain) C failures identified by the lab?	Comments: ry receipt documentation. Comments:
e. Data quality Data quality and <u>use Narrative</u> a. Present and • Yes b. Discrepanc • Yes	understandable No ies, errors or Q0 No	affect with respect to the laborator ?? ONA (Please explain) C failures identified by the lab? ONA (Please explain)	Comments: ry receipt documentation. Comments:
e. Data quality Data quality and <u>use Narrative</u> a. Present and	understandable No ies, errors or Qo No repancies.	affect with respect to the laborator ?? ONA (Please explain) C failures identified by the lab? ONA (Please explain)	Comments: ry receipt documentation. Comments: Comments:
e. Data quality Data quality and <u>use Narrative</u> a. Present and	understandable No ies, errors or Qo No repancies.	affect with respect to the laborator ?? ONA (Please explain) C failures identified by the lab? ONA (Please explain)	Comments: ry receipt documentation. Comments: Comments:
e. Data quality Data quality and <u>use Narrative</u> a. Present and	understandable No ies, errors or QC No rrective actions No	affect with respect to the laborator affect with respect to the laborator NA (Please explain) C failures identified by the lab? NA (Please explain) documented? NA (Please explain)	Comments: ry receipt documentation. Comments: Comments:
e. Data quality Data quality and ase Narrative a. Present and • Yes b. Discrepanc • Yes There are no disc c. Were all co • Yes	understandable No ies, errors or QC No rrective actions No	affect with respect to the laborator ?? ONA (Please explain) C failures identified by the lab? ONA (Please explain) documented? ONA (Please explain)	Comments: ry receipt documentation. Comments: Comments:

Data quality and usability is not affected.

5. Samples Results

• Yes	⊖ No	○NA (Please explain)	Comments:
b. All applicat	ble holding tim	es met?	
• Yes	\bigcirc No	○NA (Please explain)	Comments:
c. All soils rer	ported on a dry	weight basis?	
⊖ Yes	⊖ No	• NA (Please explain)	Comments:
There are no soil	samples in this	s sample delivery group.	
d. Are the repo project?	orted PQLs les	s than the Cleanup Level or the min	imum required detection level for the
• Yes	\bigcirc No	○NA (Please explain)	Comments:
	1 •1•.	20 / 10 /D1 1 1	
e. Data quality	y or usability at	ffected? (Please explain)	Comments:
Data quality and	usability is not	affected with respect to the reporte	d sample results.
<u>C Samples</u> a. Method Blar	ık		
i. One me	ethod blank rep	orted per matrix, analysis and 20 sa	umples?
• Ye	s 🔿 No	○NA (Please explain)	Comments:
ii. All met	hod blank resu	lts less than PQL?	
• Ye	es 🔿 No	○NA (Please explain)	Comments:
iii. If abov	ve PQL, what sa	amples are affected?	Comments:
NA. All results a	re ND.		

6.

\bigcirc Yes \bigcirc No \bigcirc NA (Please explain) Comments:		
---	--	--

NA. All results are ND.

v. Data quality or usability affected? (Please explain)	Comments:
Data quality and usability is not affected with respect to the repo	rted method blank results.

b. Laboratory Control Sample/Duplicate (LCS/LCSD)

i. Organics - One LCS/LCSD reported per matrix, analysis and 20 samples? (LCS/LCSD required per AK methods, LCS required per SW846)

⊖ Yes	No	○ NA (Please explain)	Comments:
-------	----	-----------------------	-----------

There is no LCS/LCSD. There is an MS/MSD.

ii. Metals/Inorganics - One LCS and one sample duplicate reported per matrix, analysis and 20 samples?

 \bigcirc Yes \bigcirc No \bigcirc NA (Please explain)

There are no metals or inorganic analyses.

iii. Accuracy - All percent recoveries (%R) reported and within method or laboratory limits? And project specified DQOs, if applicable. (AK Petroleum methods: AK101 60%-120%, AK102 75%-125%, AK103 60%-120%; all other analyses see the laboratory QC pages)

● Yes ○ No ○ NA (Please explain) Comments:

iv. Precision - All relative percent differences (RPD) reported and less than method or laboratory limits? And project specified DQOs, if applicable. RPD reported from LCS/LCSD, MS/DMSD, and or sample/sample duplicate. (AK Petroleum methods 20%; all other analyses see the laboratory QC pages)

• Yes	○ No	○NA (Please explain)	Comments:	

v. If %R or RPD is outside of acceptable limits, what samples are affected?

Comments:

Comments:

NA. All results are within acceptable limits.

10

	⊖ No	• NA (Please explain)	Comments:
NA. All results	are within acc	eptable limits.	
vii. Data c	quality or usab	vility affected? (Please explain)	Comments:
Data quality an	d usability is r	not affected with respect to the report	ted LCS/LCSD results.
c. Surrogates	- Organics On	ılv	
i. Are surr	ogate recoveri	es reported for organic analyses - fiel	ld, QC and laboratory samples?
• Yes	○ No	CNA (Please explain)	Comments:
ii. Accura project sp the labora	cy - All percer ecified DQOs, tory report pa	nt recoveries (%R) reported and with , if applicable. (AK Petroleum metho ges)	in method or laboratory limits? And ods 50-150 %R; all other analyses see
• Yes	⊖ No	ONA (Please explain)	Comments:
clearly de	fined?	\bigcirc NA (Please explain)	Comments:
iv. Data q	uality or usabi	lity affected? (Use the comment box	to explain.). Comments:
iv. Data q Data quality and	uality or usabi l usability is n	lity affected? (Use the comment box ot affected with respect to the reporte	to explain.). Comments: ed surrogate results.
iv. Data q Data quality and d. Trip Blank <u>Soil</u> i. One trip (If not, en	uality or usabi l usability is no - Volatile ana o blank reporte ter explanation	lity affected? (Use the comment box ot affected with respect to the reporte lyses only (GRO, BTEX, Volatile Ch d per matrix, analysis and for each co n below.)	to explain.). Comments: ed surrogate results. hlorinated Solvents, etc.): <u>Water and</u> ooler containing volatile samples?
iv. Data q Data quality and d. Trip Blank <u>Soil</u> i. One trip (If not, en © Yes	uality or usabi l usability is no - Volatile ana o blank reporte ter explanation	lity affected? (Use the comment box ot affected with respect to the reporte lyses only (GRO, BTEX, Volatile Ch d per matrix, analysis and for each co n below.) O NA (Please explain.)	to explain.). Comments: ed surrogate results. hlorinated Solvents, etc.): <u>Water and</u> ooler containing volatile samples? Comments:
iv. Data q Data quality and d. Trip Blank <u>Soil</u> i. One trip (If not, en • Yes ii. Is the c (If not,	uality or usabi l usability is no - Volatile ana o blank reporte ter explanation O No ooler used to t a comment ex	ility affected? (Use the comment box ot affected with respect to the reporte lyses only (GRO, BTEX, Volatile Ch ed per matrix, analysis and for each co n below.) O NA (Please explain.) ransport the trip blank and VOA sam plaining why must be entered below)	to explain.). Comments: ed surrogate results. hlorinated Solvents, etc.): <u>Water and</u> ooler containing volatile samples? Comments:

		x =-:	
• Yes	\bigcirc No	○ NA (Please explain.)	Comments:
ll results are NE).		
iv. If abov	e PQL, what	samples are affected?	
			Comments:
NA. All results a	re ND.		
v. Data qu	ality or usabil	ity affected? (Please explain.)	
1	5		Comments:
Data quality and	usability are	not affected with respect to the repo	rted trip blank results.
e. Field Duplic	ate		
i. One field	l duplicate sul	omitted per matrix, analysis and 10 J	project samples?
		(NA (Blassa avalain)	Comments
There was one f	iald dumlicate	mimory 11 AWA 018 CW with	durlicate 11 AWA 010 CW
There was one in	eid duplicate	primary 11-AWA-018-GW with	duplicate 11-AWA-019-GW.
ii. Submit	ted blind to la	b?	
• Yes	\bigcirc No	○ NA (Please explain.)	Comments:
iii. Precisi (Recon	on - All relativimended: 30%	ve percent differences (RPD) less th 6 water, 50% soil)	an specified DQOs?
iii. Precisi (Recon	on - All relati mended: 30%	ve percent differences (RPD) less th 6 water, 50% soil)	an specified DQOs?
iii. Precisi (Recon	on - All relati 1mended: 30% F	ve percent differences (RPD) less th 6 water, 50% soil) $RPD(\%) = Absolute Value of: (R_1- R_2)$	an specified DQOs? $(\underline{R}_2) = x \ 100$ (x)/2)
iii. Precisi (Recon Where R	on - All relati nmended: 30% F 1 = Sample Co	ve percent differences (RPD) less th 6 water, 50% soil) $PD(\%) = Absolute Value of: (R_1 - 1) ((R_1 + R_2))$	an specified DQOs? (\underline{R}_2) x 100 $(\underline{2})/2)$
iii. Precisi (Recon Where R R ₂	on - All relation nmended: 30% $I_1 = Sample Control Sample Contr$	ve percent differences (RPD) less th % water, 50% soil) RPD (%) = Absolute Value of: (R ₁ - ((R ₁ + R ₂)) oncentration icate Concentration	an specified DQOs? $\frac{R_2}{x \ 100}$
iii. Precisi (Recon Where R R ₂ • Yes	on - All relation nmended: 30% $I_1 = Sample CoI_2 = Field Dupl\bigcirc No$	ve percent differences (RPD) less th 6 water, 50% soil) RPD (%) = Absolute Value of: $(R_1 - 1)$ (($R_1 + R_2$) oncentration icate Concentration \bigcirc NA (Please explain)	an specified DQOs? (\underline{R}_2) x 100 (2)/2) Comments:
iii. Precisi (Recon Where R R ₂ • Yes iv. Data qu	on - All relation nmended: 30% I $_1 = Sample Co_2 = Field DuplO Nouality or usabi$	ve percent differences (RPD) less th 6 water, 50% soil) RPD (%) = Absolute Value of: $(R_1 - T_1)$ (($R_1 + R_2$) ncentration icate Concentration \bigcirc NA (Please explain) lity affected? (Use the comment box	an specified DQOs? R2) x 100 2)/2) Comments: x to explain why or why not.)

f. Decontamin	ation or Equip	ment Blank (if applicable)				
⊖ Yes	○ No	• NA (Please explain)	Comments:			
NA. All sampling equipment was disposable.						
i. All resul	ts less than PQ	L?				
⊖ Yes	⊖ No	• NA (Please explain)	Comments:			
NA. All sampling	g equipment wa	as disposable. No decontamination or	equipment blanks were collected.			
ii. If above	PQL, what sa	mples are affected?	Comments:			
NA. No decontan	nination or equ	ipment blanks were collected.				
iii. Data qu	uality or usabil	ity affected? (Please explain.)	Comments:			
NA. No decontan	nination or equ	ipment blanks were collected.				
Other Data Flags/Q	ualifiers (ACC	DE, AFCEE, Lab Specific, etc.)				
○ Yes		• NA (Please explain)	Comments:			
There are no othe	er data flags or	qualifiers.				

Reset Form

7.

APPENDIX C

FS Cost Estimate Spreadsheets

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Aniak WACS Site Feasibility Study Alternative Cost Summary										
					Potentia	l Ra	ange			
Remedial Alterna	Remedial Alternatives at Aniak WACS Site Cost (-50%) (+100%				(+100%)	Normalized Score				
Alternative GW-1	No Action	\$	-	\$	-	\$	-	0.00	1.00	5.0
Alternative GW-2	LTM/MNA	\$	2,434,927	\$	1,217,463	\$	4,869,853	0.57	0.43	2.2
Alternative GW-3	Chemical Oxidation	\$	4,304,138	\$	2,152,069	\$	8,608,276	1.00	0.00	0.0
Alternative GW-4	ERD	\$	3,429,247	\$	1,714,624	\$	6,858,495	0.80	0.20	1.0
Alternative GW-5	Air Sparging	\$	3,626,153	\$	1,813,077	\$	7,252,306	0.84	0.16	0.8

Alternative GW-2 LTM/MNA (35 years)							
Function	Units	Quantity	Cost Per Unit	Total Cost	Total Cost (- 50%)	Total Cost (+ 100%)	
Capital Costs (Year 0 for PW analysis) Establish ICs and LTM Network and conduct initial year of LTM and SSD							
Well Installation	event	1	\$60,000	\$60,000			
Well Installation Oversight	hr	120	\$85	\$10,200			
Surveying	estimate	1	\$15,000	\$15,000			
Soli Sampling Well Installation Oversight Transportation and per diem	event	1	\$4,000	\$4,000			
GW Monitoring Equipment, Materials, Shipping	event	4	\$2,500	\$10,000			
GW Monitoring Labor Transportation and per diem	event	4	\$2,600	\$10,400			
GW Monitoring Labor	hr	336	\$85	\$28,560			
Laboratory Analysis (VOC)	well	40	\$200	\$8,000			
VI Mitigation: SSD 0&M (1/4ly) and Power	estimate	1	\$100,000	\$100,000			
Capital Costs Total				\$264,160			
ONEM Costo (Verre 1.2)							
OM&M Costs (Years 1-3) Monitoring Labor (semiannual)	hr	168	\$85	\$14 280			
GW Monitoring Equipment, Materials, Shipping	event	2	\$2,500	\$5,000			
GW Monitoring Labor Transportation and per diem	event	2	\$2,600	\$5,200			
Laboratory Analysis (VOC)	well	40	\$200	\$8,000	\$136,897	\$384,410	
Laboratory Analysis (MINA param)	well	40	\$350	\$14,000	\$127,941 \$119,571		
Annual Costs Total (Years 1-3)	courriate		\$100,000	\$146,480	φ113,371		
Present Worth of OM&M Costs (Years 1-3)				\$384,410			
OM&M Costs (Years 4-14)	br	84	¢95	\$7.140			
GW Monitoring Equipment, Materials, Shipping	event	1	\$2.500	\$2.500			
GW Monitoring Labor Transportation and per diem	event	1	\$2,600	\$2,600			
Laboratory Analysis (VOC)	well	20	\$200	\$4,000			
Laboratory Analysis (MNA param)	well	20	\$350	\$7,000			
VI Mitigation: SSD 0&M (1/2ly) and Power Annual Costs Total (Years 4-14)	estimate	1	\$60,000	\$60,000			
SSD System replace parts/repair (Years 4, 9, 14)	estimate	1	\$10,000	\$10,000			
Present Worth of SSD System Maintenance (Years 4,9,14)	cotimate		φ10,000	\$16,946			
Present Worth of OM&M Costs Total (Years 4-14)				\$526,471			
VI Mitigation: SSD O&M (1/2h) and Power (Vears 15-34)	estimate	1	\$60,000	\$60,000			
Present Worth of 1/2ly SSD 0&M (Years 15-34)	courriate		\$00,000	\$246,512			
SSD System replace parts/repair (Years 19, 24, 29)	estimate	1	\$10,000	\$10,000			
Monitoring labor, equipment, analysis (Years 19, 24, 29, 34)	estimate	1	\$23,240	\$23,240			
Present Worth of Every 5 Year Costs (Years 19-34)				\$22,746			
				\$209,230			
Well Decommissioning (Year 34)							
Well decommissioning	estimate	1	\$50,000	\$50,000			
Well decommissioning oversight	hours	78	\$85	\$6,630			
Decommissioning Costs Total (Year 34)	eveni	1	\$3,200	\$3,200 \$59.830			
Present Worth of Decommissioning Cost Total (Year 34)				\$5,996			
Total Present Worth of OM&M (Years 1-34)				\$1,186,135			
Cost (Capital + OM&M) Subtotal				\$1,450,295	\$725,148	\$2,900,591	
Bid Contigency	%	1	15%	\$217 544			
Did contigency	70		1370	Ψ217,577			
Scope Contigency	%	1	20%	\$290,059			
Capital + OM&M Cost Plus Contingency Subtotal				\$1,957,899	\$978,949	\$3,915,797	
Project Management	0/	4	60/	¢117 /7/			
	70		0%	φιι <i>ι</i> ,4/4			
Remedial Design	%	1	12%	\$42,794		·	
Construction Management	%	1	8%	\$28,529			
Technical Support (Annual OM&M)	%	1	18%	\$288.231			
	70			φ 2 00,201			
Professional/Technical Cost Subtotal				\$477,028	\$238,514	\$954,056	
	<u> </u>						
Total Present Worth Cost				\$2,434,927	\$1,217,463	\$4,869,853	

Alternative GW-3 Chemical Oxidation (10 years)						
Function	Units	Quantity	Cost Per Unit	Total Cost	Total Cost (- 50%)	Total Cost (+ 100%)
Capital Costs (Year 0 for PW analysis)						
Chemical Oxidation Application	overt	1	\$70,000	¢70.000		
Prior Test	ka	18 212	\$70,000	\$200,335		
Permanganate Shipping	ka	18,212	\$1	\$18,212		
Water for Chemical Oxidation	liters	610,000	\$0.05	\$30,500		
Permanganate Injection Drilling Subcontractor	est	1	\$115,000	\$115,000		
Subsurface Injection Equipment	estimate	1	\$30,000	\$30,000		
Permanganate Injection Oversight	hr	540	\$75	\$40,500		
Permanganate Injection Oversight Transportation and per diem	event	1	\$10,500	\$10,500		
Install 12 new monitoring wells	lump	1	\$58,200	\$58,200		
GW Post Injection Monitoring Labor	hr	336	\$85	\$28,560		
GW Monitoring Equipment, Materials, Shipping	event	4	\$2,500	\$10,000		
GW Monitoring Labor Transportation and per diem	event	4	\$2,600	\$10,400		
GW Laboratory Analysis - Groundwater Monitoring	well	80	\$550	\$44,000		
VI Mitigation: SSD O&M (1/4ly) and Power	estimate	1	\$100,000	\$100,000		
Capital Costs Total				\$781,208		
Annual Chemical Oxidation (Years 1 - 3)						
Permanganate	kg	18,212	\$11	\$200,335		
Permanganate Shipping	kg	18,212	\$1	\$18,212		
Water for Chemical Oxidation	liters	610,000	\$0.05	\$30,500		
Permanganate Injection Equipment & Subcontractor	est	1	\$115,000	\$115,000		
Permanganate Injection Oversight	hr	540	\$75	\$40,500		
Permanganate Injection Oversight Transportation and per diem	event	1	\$10,500	\$10,500		
GW Semi-Annual Monitoring Labor	hr	168	\$85	\$14,280		
GW Monitoring Equipment, Materials, Snipping	event	2	\$2,500	\$5,000		
GW Laboratory Analysis - Groundwater Monitoring	well	2 40	\$2,600	\$5,200		
VI Mitigation: SSD Q&M (1/4lv) and Power	estimate	40	\$100.000	\$100.000		
Total for Annual Source Area Chemical Oxidation	ootiinato		\$100,000	\$561.528		
Present Worth of Annual Chemical Oxidation Injection (Years 1-3)				\$1,473,626		
Annual OM&M Costs (Years 4 -9)						
GW Long-Term Monitoring Labor	hr	84	\$85	\$7,140		
GW Monitoring Equipment, Materials, Shipping	event	1	\$2,500	\$2,500		
GW Monitoring Labor Transportation and per diem	event	1	\$2,600	\$2,600		
GW Laboratory Analysis - Groundwater Monitoring	well	20	\$550	\$11,000		
VI Mitigation: SSD O&M (1/2ly) and Power	estimate	1	\$60,000	\$60,000		
Annual Costs Total (Years 4-9)				\$83,240		
SSD System replace parts/repair (Year 4)	estimate	1	\$10,000	\$10,000		
Present Worth of SSD System Maintenance (Year 4)				\$7,629		
I otal Present worth of OM&M (Years 4-9)				\$331,509		
Well Decommissioning (Year 9)						
Well decommissioning, oversight, transportation & per diem	estimate	1	\$69,830	\$69,830		
Present Worth of Decommissioning Cost Total (Year 9)				\$37,983		
				A4 040 447		
I otal Present worth of OM&M (Years 1-9)				\$1,843,117		
Cost (Capital + OM&M) Subtotal				\$2,624,325	\$1,312,162	\$5,248,650
Bid Contigency	%	1	15%	\$393,649		
Scope Contigency	%	1	20%	\$524,865		
						-
Capital + OM&M Cost Plus Contingency Subtotal				\$3,542,839	\$1,771,419	\$7,085,677
Project Management	%	1	5%	\$177,142		
Remedial Design	%	1	12%	\$126,556		
Construction Management	%	1	8%	\$84.370		
	-					
Technical Support (Annual OM&M)	%	1	15%	\$373,231		
Professional/Technical Cost Subtotal				\$7 <mark>61,299</mark>	\$380,650	\$1,522,599
Total Present Worth Cost				\$4,304,138	\$2,152,069	\$8,608,276

Alternative GW-4 ERD (20 years)							
					Total Cost	Total Cost	
Function	Units	Quantity	Cost Per Unit	Total Cost	(- 50%)	(+ 100%)	
Capital Costs (Year 0 for PW analysis) Enhanced Reductive Dechlorination - Substrate Application							
Pilot Test	event	1	\$70,000	\$70,000			
ERD Substrate	lbs	3,800	\$10	\$38,000			
ERD Substrate Shipping	lbs	3,800	\$1 \$115.000	\$3,800			
ERD Substrate Injection Drining Subcontractor	hr	540	\$75	\$40,500			
ERD Substrate Injection Oversight Transportation and per diem	event	1	\$10,500	\$10,500			
Install 12 new monitoring wells	lump	1	\$58,200	\$58,200			
Surveying	estimate	1	\$15,000	\$15,000			
GW Post Injection Monitoring Labor GW Monitoring Equipment Materials Shipping	nr event	336	\$85 \$2,500	\$28,560			
GW Monitoring Labor Transportation and per diem	event	4	\$2,600	\$10,400			
GW Laboratory Analysis - Groundwater Monitoring	well	80	\$550	\$44,000			
VI Mitigation: SSD O&M (1/4ly) and Power	estimate	1	\$100,000	\$100,000			
Capital Costs Total				\$543,960			
Annual ERD Costs (Years 1-3)							
ERD Substrate	lbs	2,850	\$10	\$28,500			
ERD Substrate Shipping	lbs	2,850	\$1	\$2,850			
ERD Substrate Injection Equipment & Subcontractor	est	1	\$100,000	\$100,000			
ERD Substrate Injection Oversight Transportation and per diem	nr event	432	\$/5 \$8,700				
Bioaugmentation	event	1	\$25,000	\$25,000			
GW Semi-Annual Monitoring Labor	hr	168	\$85	\$14,280			
GW Monitoring Equipment, Materials, Shipping	event	2	\$2,500	\$5,000			
GW Monitoring Labor Transportation and per diem	event	2	\$2,600	\$5,200			
VI Mitigation: SSD O&M (1/4lv) and Power	Well	40	\$550 \$100.000	\$22,000			
Total for Annual ERD Costs	countate	1	φ100,000	\$343,930			
Present Worth of Annual ERD Costs (Years 1-3)				\$902,581			
Annual OM&M Costs (Years 4-14)	br	94	¢05	¢7 140			
MNA Monitoring Equipment Materials Shipping	event	04	\$2,500	\$2,500			
MNA Monitoring Labor Transportation and per diem	event	1	\$2,600	\$2,600			
MNA Laboratory Analysis - Groundwater Monitoring	well	20	\$550	\$11,000			
VI Mitigation: SSD O&M (1/2ly) and Power	estimate	1	\$60,000	\$60,000			
Total for Annual OM&M Costs				\$83,240			
SSD System replace parts/repair (Years 4, 9, 14)	estimate	1	\$10,000	\$10,000			
Present Worth of SSD System Maintenance (Years 4 -14)				\$16,946			
				<i>4020,411</i>			
OM&M Costs (Years 15-19)							
VI Mitigation: SSD O&M (1/2ly) and Power (Years 15-19)	estimate	1	\$60,000	\$60,000			
Present Worth of 1/2ly SSD O&M (Years 15-19)	octimoto	1	¢22.240	\$95,408			
Present Worth of Every 5 Year Costs (Year 19)	estimate	1	\$23,240	\$6.426			
Present Worth of OM&M Costs Total (Years 15-19)				\$101,834			
Well Decommissioning (Year 19)		4	¢00.000	¢00.000			
Present Worth of Decommissioning Cost Total (Year 19)	estimate	1	\$69,830	\$69,830			
				\$10,000			
Total Present Worth of OM&M (Years 1-19)				\$1,550,194			
				<u> </u>	A1 0 17 077	A 1 100 000	
Cost (Capital + OM&M) Subtotal				\$2,094,154	\$1,047,077	\$4,188,309	
Bid Contigency	%	1	15%	\$314,123			
Scope Contigency	%	1	20%	\$418,831			
Capital + OM&M Cost Plus Contingency Subtotal				\$2,827,108	\$1,413,554	\$5,654,217	
Project Management	0/_	1	5%	¢1/1 355			
	/0		570	ψ141,000			
Remedial Design	%	1	12%	\$88,122			
Construction Management	%	1	8%	\$58,748			
Technical Support (Annual OM&M)	%	1	15%	\$313,914			
Professional/Technical Cost Subjects				\$602.420	\$201.000	\$1 204 079	
rioressional/recinical Cost Subtotal				\$602,139	\$301,069	\$1,204,278	
Lotal Present Worth Cost				\$3.429.247	\$1.714.624	\$6.858.495	

HRC Grid Design

Version 1

Technical Support (949) 366-8000

Basic Site Characteristics

Width of plume (intersecting flow)		50	ft
Length of plume		50	ft
Depth to contaminated zone		25	ft
Thickness of contaminated saturated zone		10	ft
Nominal aquifer soil (gravel, sand, silty sand, silt, clay)		sand	
Porosity		0.39	
Hydraulic conductivity, Kh		100	ft/day
Hydraulic gradient		0.0007	ft/ft
Seepage velocity	0.179 ft/day =	65.5	ft/yr
Treatment Zone Pore Volume (cu. ft.)		9,750	ft ³

Dissolved Phase Groundwater VOC Concentrations: Cgw in mg/L

PCE	
TCE	
DCE	
VC	
Carbon tetrachloride	
Chloroform	
TCA	
DCA	

Sorbed Phase VOC Mass:

Soil	bull	< der	sity
_	-	-	

Fraction of	f organic carbon	: foc
(Values ar	e estimated usir	na Sa

(Values are estimated using Soil Conc=foc*Koc*Cgw)
(Adjust Koc as nec. to provide realistic estimates)
PCE
TCE
DCE
VC
Carbon tetrachloride
Chloroform
TCA
DCA

Competing Electron Acceptor (CEA) Concentrations:

Oxygen	
Nitrate	

Manganese reduction potential

Iron reduction (potential amount of Fe2+ that can be formed) Sulfate reduction

	1.9	kg/L
	0.002	
Koc	Soil Conc.	
(L/kg)	(mg/kg)	
450	0.00	
107	0.00	
80	0.00	
2.5	0.00	
110	0.00	
34	0.00	
183	0.00	
40	0.00	

 (mg/L)
2.40
1.00
5.00
128.50
10.90

Site Name: Aniak GW [MW-4]

Location: FS Scoping

Consultant: Oasis

Microbial Demand Factor Additional Demand Factor

Injection Point Spacing

0.00 0.02

0.01 0.00 0.00 0.00 0.00 0.00

Nominal injection spacing (ft)

rows (w/desired spacing)

points in row(w/desired spacing) Actual spacing between columns (ft)

Actual spacing between rows (ft)

Advective travel time bet. rows (days)

3	Recommend 3-4x
3	Recommend 2-3x

Rec.	Min.	Max.
10.0	5	15
5	10	3
10.0	5.0	16.7
5	10	3
10.0	5.0	16.7
56	28	93
25	100	9

HRC Injection Amount

Number of points in grid

Minimum req. HRC per foot (lbs/ft) Feasibility of above HRC per foot:

2.5	2.0	6.9
(ok)	(ok)	(ok)

Proposed HRC Grid Specifications		
Proposed number of HRC delivery points	(adjust as nec. for site)	25
Proposed HRC applic. rate lbs/foot (adjust	t as nec. for site)	2.5
Corresponding amount of HRC per point (lbs)	25
Buckets per injection point		0.8
Total Buckets		21
Total Amt of HRC (lbs)		625
Unit cost of HRC		\$ 9.00
Total Material Cost		\$ 5,625
Shipping and/or Tax Estimate		
HRC (\$0.1 to \$0.4/lb, call for exact rate)	cost per lb: 1	\$ 625
Sales tax (call for exact rate)	rate: 0%	\$ -
Total Regenesis Material Cost		\$ 6,250

HRC Installation Cost Estimate (responsibility of customer to contract	t work	K)
Footage for each inj. point = uncontaminated + HRC inj. interval (feet)		35
Total vertical feet for project (feet)		875
Estimated production rate (feet per hour: 50 for push, 25 for drilling)		25
Estimated hole completion rate (holes per hour)		0.7
Time per day spent pushing/drilling (hrs)		8
Required number of days		5
Mob/demob cost for injection subcontrator	\$	15,000
Daily rate for inj. Sub. (\$1-2K for geoprobe or \$3-4K for drill rig)	\$	5,000
Total injection subcontrator cost for application	\$	40,000
Total Project Cost(not including consultant oversight, GWM, etc.)	\$	46,250

HRC Grid Design

Version 1

Technical Support (949) 366-8000

Basic Site Characteristics

Width of plume (intersecting flow)	90	ft
Length of plume	100	ft
Depth to contaminated zone	25	ft
Thickness of contaminated saturated zone	15	ft
Nominal aquifer soil (gravel, sand, silty sand, silt, clay)	silty sand	I
Porosity	0.44	I
Hydraulic conductivity, Kh	40	ft/c
Hydraulic gradient	0.0007	ft/f
Seepage velocity 0.064 ft/day =	23.2	ft/y
Treatment Zone Pore Volume (cu. ft.)	59,400	ft ³

Dissolved Phase Groundwater VOC Concentrations: Cgw in mg/L

PCE	
TCE	
DCE	
VC	
Carbon tetrachloride	
Chloroform	
TCA	
DCA	

Sorbed Phase VOC Mass:

Soil bulk density 10

Fraction of	f organic carbon: fo	C
(Values ar	o optimated using	90

(Values are estimated using Soil Conc=foc*Koc*Cgw)
(Adjust Koc as nec. to provide realistic estimates)
PCE
TCE
DCE
VC
Carbon tetrachloride
Chloroform
TCA
DCA

Competing Electron Acceptor (CEA) Concentrations:

Oxygen	
Nitrate	

Manganese reduction potential

Iron reduction (potential amount of Fe2+ that can be formed) Sulfate reduction

	1.9	kg/L
	0.002	
Koc	Soil Conc.	
(L/kg)	(mg/kg)	
450	0.00	
107	0.04	
80	0.00	
2.5	0.00	
110	0.00	
34	0.00	
183	0.00	
40	0.00	

 (mg/L)
2.40
1.00
5.00
128.50
10.90

Site Name: Aniak GW [MW-5]

Location: FS Scoping

Consultant: Oasis

Microbial Demand Factor Additional Demand Factor

Injection Point Spacing

Nominal injection spacing (ft) # points in row(w/desired spacing) Actual spacing between columns (ft)

rows (w/desired spacing)

Actual spacing between rows (ft)

ft/day ft/ft

ft/yr

0.00

0.18

0.01 0.00 0.00 0.00 0.00 0.00

3	Recommend 3-4x
3	Recommend 2-3x

Rec.	Min.	Max.
15.0	5	15
6	18	6
15.0	5.0	15.0
7	20	7
14.3	5.0	14.3
224	79	224
42	360	42

HRC Injection Amount

Number of points in grid

Minimum req. HRC per foot (lbs/ft) Feasibility of above HRC per foot:

Advective travel time bet. rows (days)

6.1	2.0	6.1
(ok)	(ok)	(ok)

Proposed HRC Grid Specifications		
Proposed number of HRC delivery points	42	
Proposed HRC applic. rate lbs/foot (adjust	4.9	
Corresponding amount of HRC per point (74	
Buckets per injection point	2.4	
Total Buckets		103
Total Amt of HRC (lbs)		3,087
Unit cost of HRC		\$ 9.00
Total Material Cost		\$ 27,783
Shipping and/or Tax Estimate		
HRC (\$0.1 to \$0.4/lb, call for exact rate)	cost per lb: 1	\$ 3,087
Sales tax (call for exact rate)	rate: 0%	\$ -
Total Regenesis Material Cost		\$ 30,870

HRC Installation Cost Estimate (responsibility of customer to contract work)					
Footage for each inj. point = uncontaminated + HRC inj. interval (feet)					
Total vertical feet for project (feet)		1,680			
Estimated production rate (feet per hour: 50 for push, 25 for drilling)		25			
Estimated hole completion rate (holes per hour)		0.6			
Time per day spent pushing/drilling (hrs)		8			
Required number of days		9			
Mob/demob cost for injection subcontrator	\$	15,000			
Daily rate for inj. Sub. (\$1-2K for geoprobe or \$3-4K for drill rig)	\$	5,000			
Total injection subcontrator cost for application	\$	60,000			
Total Project Cost(not including consultant oversight, GWM, etc.)	\$	90,870			

Aniak Site Characteristics

Dissolved Phase Plume ^c

Area Average HVO Concentration		23,550 175	sq ft μg/L	MW-4 and MW- Average concer	-7 Plumes ntration in Sept	ic Central																	
Soil Type Sandy Gravel Slightly Sandy Silt Coarse Sand (GW)	Average	Hy High 1 0.00100 1.00000 0.66700	vd Cond (K) [cn Low 0.03 0.0000001 0.003 0.01100	n/s] ^a Geo. Mean 0.17 0.000010 0.055 0.07600	High 2835 3 2835 1, 891	yd Cond (K) [ft/da Low 85 0.0003 8.5039 31	ay] ^a Geo. Mean 491 0.03 155 215	T High 0.38 0.61 0.46 0.48	otal Porosity (n Low 0.25 0.34 0.31 0.30	Average 0.32 0.48 0.39 0.39 0.39	High 0.35 0.30 0.35 0.33	Eff. Porosity (n) Low 0.2 0.01 0.2 0.14	a Average 0.28 0.16 0.28 0.24	High 135 120 120 125	Dry Bulk Density (lbs Low 125 95 100 107	5/ft ³) ^b Average 130 108 110 116							
Groundwater ^d Spring High Water Summer Normal Summer Reversal Sep-Dec Jan-Apr		Gradient 0.002 0.0009 0.0004 0.0005 0.0003	K 0.05 0.05 0.05 0.05 0.05	Eff. Porosity 0.28 0.28 0.28 0.28 0.28 0.28	4.0E-04 1.8E-04 8.0E-05 1.0E-04 6.0E-05	cm/sec cm/sec cm/sec cm/sec cm/sec	Seepage 412 185 82 103 62	Velocity ft/yr ft/yr ft/yr ft/yr ft/yr	1.13 0.51 0.23 0.28 0.17	ft/day ft/day ft/day ft/day ft/day	Direction S-SW N-NE S-SW N-NE W												
Chemical Oxidation Calculations (Ozone/Water Recirculation) [NOT EVALUATED AS AN ALTERNATIVE] Septic - Central (silt) [60-65 msl] Septic - Central (sand) [50-60 msl]		Area ^c 9,000 9,000	Thickness 5 10	Soil Volume (ft ³) 45,000 90,000	Soil Mass (lbs) 4,838,000 9,900,000	Soil Mass (kg) 2,199,091 4,500,000 6,699,091	С _{нуо} Soil (µg/kg) 200 200	Mass _{Hvo} Soil (kg) 0.44 0.90 1.34	С _{нvo} GW (µg/L) 175 175	Mass_{Hvo} GW (kg) 0.11 0.17	/ Mass _{Hvo} Tota (kg) 0.55 1.07	al Void Volume (ft ³) 21,375 34,650	Void Volume (L) 605,340 981,288	Oxygen: Contaminant Mass Ratio 3:1 3 3	Measured Oxidant Demand (g/kg- MnO₄) 5.60 5.60	Contaminant Oxidant Demand (kg) 1.63726 3.21518	Total Oxygen Demand in Soil (kg) 12317 25203 37520	Mass per volume of injection (Aq. Sol. at 5 °C) mg/L 30 30	Volume of O ₃ Laden Water to meet Oxygen Demand (L) 410,551,545 840,107,173 1,250,658,718		Recirculation Rate (lpm) 200	Pears of Recirculation	
Chemical Oxidation Calculations (Permanganate Injection) Septic - Central (silt) [59-64 msl] Septic - Central (sand) [49-59 msl] MW-4 plume (sand) [54-64]		Area ^c 9,000 9,000 2,500	Thickness 5 10 10	Soil Volume (ft ³) 45,000 90,000 25,000	Soil Mass (lbs) 4,838,000 9,900,000 2,750,000	Soil Mass (kg) 2,199,091 4,500,000 1,250,000 7,949,091	С _{нvo} Soil (µg/kg) ^d 600 200 200	Mass _{HVO} Soil (kg) 1.32 0.90 0.25 2.47	С _{нvo} GW (µg/L)° 175 175 19	Mass _{Hvo} GW (kg) 0.11 0.17 0.01	/ Mass _{Hvo} Tota (kg) 1.43 1.07 0.26	al Void Volume (ft ³) 21,375 34,650 9,625	Void Volume (L) 605,340 981,288 272,580	kg KMnO4/kg Contaminant ⁶ 3.00 3.00 3.00	% oxygen in Potassium Permanganate ^g 40% 40% 40%	Measured Natural Oxidant Demand (g KMnO4/kg soil+gw) ^h 7.43 7.43 7.43	Contaminant Oxidant Demand (kg KMnO4) 4.28 3.22 0.77 8.26	Total KMnO4 Demand in Soil and Groundwater (kg)i 20829 40712 11309 72849	Potassium Permanganate (kg) 20829 40712 11309 72849	Volume of Water for 3% Solution (L) ^j 693,592 1,355,705 376,581 2,425,878	Injection Flov Rate (L per minute per well) 20 20	 Number of Wells 42 12 54 	Injection Time (Hours) 41 26
Enhanced Reductive Dechlorination (Substrate Addition) Septic - Central (silt) [59-64 msl] Septic - Central (sand) [49-59 msl] MW-4 plume (sand) [54-64]		Area ^c 9,000 9,000 2,500	Thickness 5 10 10	Soil Volume (ft ³) 45,000 90,000 25,000	Soil Mass (lbs) 4,838,000 9,900,000 2,750,000	Soil Mass (kg) 2,199,091 4,500,000 1,250,000 7,949,091	Void Volume (ft ³) 21,375 34,650 9,625 65,650	Void Volume (L) 605,340 981,288 272,580 1,859,208	Mass of Water in Void Volume (kg) 602386 976500 271250 1850136									Assume inject 25% of	total volume each∶	year for 4 years	Total # of Injection Minutes at 20 Lpm 121293.9 606469.4	Total # of Injection Minutes per well (54 wells) 2246.2 4 Liters 9 Total appual L (w	Total # of Injection hours per well (54 wells) 37.4
Enhanced Reductive Dechlorination - Substrate Addition HRC (scoping worksheet) [Septic - Central] HRC (scoping worksheet) [MW-4 Plume]		Substrate (lbs) 3,087 625	% Carbon in Substrate* 40% 40% * Primary com	Substrate (mg) 1,400,000,000 300,000,000 ponent of HRC ha	Increase in TOC (mg/L) 354 417 as chemical for	nula - CH3CHOH	COOH (90 g/mol	of which 36 g/n	nol is carbon - or	r 40%)									Assume inject 4 w	ells/10-hour day llons (3.79L/gal)	1123.3 1123.3 18.3 160018.3 2963.3 2963.3	 If inject in one 10- If inject in one 10- Liters per minute Less than 20 L/m be feasible to do Total annual injection vo Gallons per hour 	-hr day; L/hour/well per well inute so should a well in a day ction volume lume per well (annual) (10-hr day)
S	Sources:	а	Natural Attenu	ation of Fuels and	d Chlorinated s	olvents in the Sub	surface . Wieder	meier, 1999.														· 5r	

b

с

Civil Engineering Reference Manual, Sixth Edition, Lindeburg, 1992. S&W March 2009 as modified in FS Figures Maximum soil concentration 600 ug/Kg in B-12 (silt); most other soil detections ~ 200 ug/Kg d

е	175 ug/L=approx. avg. two highest groundwater detections (187 ug/L and 157 ug/L) for MW-5/7 plume; 19 ug/L=MW-4 detection for MW-4 plume				
f	from EPA Engineering Issue In Situ Chemical Oxidation (EPA/600/R-06/072) (Huling & Pivetz)	Molecular Weight		Molar Ratio	Mass Ratio
	The stoichiometric requirement for PCE, TCE, DCE, and VC are 1.33, 2.0, 2.67, and 3.33 mol KMnO4/mol contaminant, respectively.	158 g/mol	Permanganate		
	Converting molar ratio to mass ratio: (2 mol KMnO4/mol TCE)*(mol TCE/131.4 g TCE)*(158 g KMnO4/mol KMnO4)=2.4 g KMnO4/g TCE	131.4 g/mol	TCE	2	2.40
	For DCE: (2.67 mol KMnO4/mol DCE)*(mol DCE/97 g DCE)*(158 g KMnO4/mol KMnO4)=4.35 g KMnO4/g DCE	97 g/mol	DCE	2.67	4.35
	Contamination is mostly TCE but there is some DCE; use a factor of 3 g KMnO4/g contaminant for calculations				

 g
 Not used in this analysis: KMnO4: (39+55+16*4)=158 g/mol (atomic weight); 48/158=40.5% oxygen

 h
 Average of Calculated Natural Oxidant Demand (g/kg) KMnO4 from Shannon & Wilson, 2010 (3, 14.6, and 4.7 g/kg KMnO4)

 i
 Total oxidant demand=(Natural oxidant demand)*(Mass of soil + groundwater) + (Contaminant oxidant demand)

 j
 Solubility of KMnO4 = 60 g/L (6%); 3% is typical injection concentration (EPA/600/R-06/072)

 Volume of H2O for 3% solution=(kg KMnO4)*(1000 g/Kg)*(L H20/30g KMnO4); density of H2O is 1 kg/L

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APPENDIX D

Pre-Draft FS

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FEASIBILITY STUDY

ANIAK MIDDLE SCHOOL ANIAK, ALASKA

Pre-DRAFT April 2011

Prepared for:



555 Cordova Street Anchorage, AK 99501

Prepared by:



825 W. 8th Ave. Anchorage, AK 99501 - Page Intentionally Left Blank -

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APPENDICES

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ACRONYMS AND ABBREVIATIONS

ADEC	Alaska Department of Environmental Conservation
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability
	Act
CHP	Catalyzed hydrogen peroxide
CSM	Conceptual site model
cm/sec	centimeters per second
су	Cubic yards
DCE	Dichloroethene
DO	Dissolved oxygen
EPA	Environmental Protection Agency
ERD	Enhanced reductive dechlorination
FS	Feasibility study
ft/ft	Feet per foot
g/kg	Gram per kilogram
gpm	gallons per minute
HRC™	Hydrogen Release Compound
IDC	inhalation/direct contact pathway (cleanup levels)
ISCO	In situ chemical oxidation
µg/L	Micrograms per liter
µg/m ³	Micrograms per cubic meter
mg/kg	Milligrams per kilogram
m/s	meters per second
MNA	Monitored natural attenuation
MTG	Migration to groundwater (cleanup levels)
N	nitrogen
NCP	National Contingency Plan
OASIS	OASIS Environmental, Inc.
ORP	oxidation-reduction potential
PCBs	polychlorinated biphenyls
PCE	Tetrachloroethene
ppbv	parts per billion by volume
RAO	Remedial action objective
RCRA	Resource Conservation and Recovery Act
SSD	Sub-slab depressurization
SI	site investigation
SVE	Soil vapor extraction
тос	total organic carbon
TCE	Trichloroethene
USCS	United States Classification System

VI..... vapor intrusion

VMP Vapor monitoring point

VOC Volatile organic compound

WACS White Alice Communications System

1. PURPOSE AND EXECUTIVE SUMMARY

The purpose of this focused feasibility study (FS) is to evaluate remedial alternatives for addressing contaminated groundwater at the former Aniak White Alice Communications System (WACS) site located in Aniak, Alaska (Figure 1). The Aniak WACS site is currently used by the Kuspuk school district. The former WACS building is currently known as the Joe Parent school (and alternatively as the Aniak Middle School) and is used as a secondary school, temporary lodging, and administration and staff offices (Figure 2).

Soil, soil gas, and groundwater at the Aniak WACS site are contaminated by the chlorinated solvent, trichloroethene (TCE) and its degradation product, cis-1,2-dichloroethene (DCE) (Figure 3). This contamination has resulted in levels exceeding both indoor air quality and drinking water risk based thresholds. In addition, shallow soil at the site is also contaminated by polychlorinated biphenyls (PCBs).

The goal of this FS is to identify remedial alternatives for the two groundwater plumes. Remedies for soil and soil gas contamination have already been proposed. Vapor intrusion into the Joe Parent School is being mitigated by air purification filters inside the school and a sub-slab depressurization system (SSD). Soil excavation is planned to address soil contaminated by PCBs above the Alaska cleanup level of 1 milligram per kilogram (mg/Kg) (Figure 4). Some of the planned PCB excavation area also has commingled TCE contamination that will be removed along with the PCB-contamination. Soil vapor extraction (SVE) is planned to address the remaining vadose-zone TCE contamination (Figure 4). The groundwater alternatives evaluated in the focused FS will consider these planned and ongoing soil and soil gas remedies.

This pre-draft focused FS presents a summary of the nature and extent of the groundwater contamination, a conceptual site model (CSM) of exposure pathways to the contamination, identifies site features that should be considered when evaluating groundwater remedial alternatives, establishes preliminary remedial action objectives, and identifies technologies that may be considered in the detailed focused FS. The Treatment Technologies Screening Matrix (Table 3-2 in www.frtr.org) was used as the first step in identifying technologies for the pre-draft FS.

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2. SITE BACKGROUND

Aniak is located approximately 300 miles west of Anchorage and is bordered on the north by the Kuskokwim River and on the south by the Aniak Slough. The Middle School site is approximately 600 feet southeast of the northwest end of the runway and approximately 900 feet south of the Kuskokwim River, as shown on Figure 1. The property and immediate vicinity is generally flat, although the surrounding area has a general slope to the east towards the Aniak Slough. The site is situated on a gravel pad overlaying the native alluvial deposits. A site plan showing the location of the former Aniak Middle School on an aerial photograph is provided as Figure 2.

2.1. Contamination Summary

Extensive site investigation and remediation work has been performed at the site, beginning with 1997 Site Inspection (SI) conducted by the Environmental Protection Agency (EPA). Widespread PCB contamination was documented both inside and outside the Middle School building, and the site has been assigned Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Site Number AK8570028615. A brief summary of the investigation and remediation work performed at the site is provided below; a detailed discussion can be found in Shannon & Wilson (2010a).

- In 1997-1998, PCBs were removed from the inside of the building, and exterior contaminated areas were capped.
- Additional soil sampling was performed in 1999.
- In 2001, limited PCB cleanup activites were performed from a portion of the area that had been capped and from other areas identified by the 1999 sampling. Approximately 872 tons of PCB-impacted material was removed from the site.
- Feasibility studies were performed in 2004 and 2005.
- Site characterization activities in the vicinity of the WACS former septic system were performed in 2006 (Shannon & Wilson, 2007). Activities included soil and groundwater sampling; TCE contamination was discovered, along with additional areas of PCB contamination.
- In 2008, soil and groundwater sampling were performed to delineate TCE contamination at the site (Shannon & Wilson, 2009). Two distinct source areas and associated groundwater plumes were identified (Figure 3). The primary source appears to be the Former Septic System and floor drains formerly located within the Middle School Metal Shop. A second source area appears to be the Maintenance Building floor drain or leakage/spillage from a former drum storage area on the south side of the Maintenance Building. Although a third apparent source area was identified off-site in the vicinity of the Runway Apron/Disposal Pit area, it is considered unlikely that this contamination is related to the TCE-

impacted soil and groundwater encountered at the Middle School and is not discussed in this FS.

- Also in 2008, approximately 2,300 cubic yards (cy) of PCB-contaminated soil, construction debris, and tank content wastes were removed from the site. It was concluded that additional PCB contamination likely extends beneath the building foundations. It was not possible to remove all of the PCB contamination with available funding.
- The 2008 Former Septic System excavation (Figure 4) reached a maximum depth of approximately 26 feet below ground surface (bgs) in the vicinity of the former seepage pit. The base of the deepest excavation measured approximately 20 feet (east-west) by 25 feet (north-south). The septic tank excavation reached a maximum depth of approximately 18 feet bgs. The excavation depth of the east and west septic line reached a maximum of approximately 11 feet bgs. Groundwater was not encountered during the excavation. The west septic line and seepage pit excavations were not backfilled to their original elevation. The ground surface over these areas is approximately 8 feet lower than the pre-excavation ground surface.
- In 2009, a vapor intrusion (VI) assessment performed at the site determined that TCE exceeded the risk-based screening level (0.21 parts per billion by volume (ppbv) for commercial indoor air and 0.041 ppbv for residential indoor air) for all three indoor air sample locations at the school.
- Also in 2009, Site Characterization activities were performed to further delineate the PCB and TCE contamination, and a Site Cleanup Plan was prepared (Shannon & Wilson, 2010a). Site characterization activities included a soil gas survey, PCB soil borings, installing and sampling groundwater monitoring wells, conducting feasibility testing for remedial alternatives, and collecting soil and groundwater samples. The site investigation report also evaluated remedial alternatives for addressing remaining site contamination. The remedial alternative discussion focused on soil remedies; only three groundwater alternatives were considered for the TCE contamination: no action, enhanced bioremediation, and air sparging.
- Also in 2010, a hydrogeologic evaluation was completed to increase the understanding of groundwater behavior at the site, specifically the potential for groundwater contamination to impact the nearby drinking water wells for the Middle School and High School (Figure 2) (Shannon & Wilson, 2010b).
- In 2010, air purification filters and an SSD were installed to mitigate vapor intrusion risk in the Middle School building.

2.2. Groundwater Contamination Summary

Groundwater impact by TCE above Alaska Department of Environmental Conservation (ADEC) cleanup levels has been documented in two locations: an estimated 2,500

square foot plume south of the Maintenance Building¹ and an estimated 12,500 square foot plume beneath the Former Septic System² from the Former Seepage Pit location to the western portion of the Middle School. Note that groundwater monitoring wells have not been installed at the location of the highest TCE concentration measured in soil gas at SGP17, or within the footprint of the Maintenance or Middle School Buildings, or between the two plumes. As shown on Figure 3, the groundwater plume at the Former Septic System has been extended to encompass the locations of Soil Gas Point SGP17 and the former floor drains located within the Middle School Metal Shop.

More details about the groundwater contamination are provided in Section 2.5 of this FS.

2.3. Geologic Setting

2.3.1. Regional Surface Geology

The site is situated on the floodplain of the Kuskokwim River. The Aniak River flows northward into the Kuskokwim River just east of the village of Aniak, while the Aniak Slough flows southward from the general area where the Aniak River meets the Kuskokwim River. The Kuskokwim River cuts through the Kuskokwim Mountains approximately 60 miles upstream of Aniak; downstream of the Kuskokwim Mountains, the river flows through a broad floodplain with no significant topography. The central Kuskokwim River floods annually or biennially, usually as a result of ice breakup, which typically occurs in May.

The surficial geology in the vicinity of Aniak consists of Kuskokwim flood plain deposits of unconsolidated silt, sand, and gravel. The river deposits include: sediment deposits of bed-load sand, gravel, and silt from river-channel activity, fine-grained (silt and fine sand) sediments deposited on river banks during flood periods, and sediments deposited during heavy floods (Krause, 1984). Silt thicknesses in Aniak have been reported to range from 1 to 6 meters (Krause, 1984).

2.3.2. Site-Specific Geology

The school is built on a gravel pad overlying alluvial sediments of the Kuskokwim River floodplain. The pad material consists of soil classified as sandy gravel in accordance with the United Soil Classification System (USCS). The thickness of the pad near the school varies significantly from 12 to 27 feet bgs based on soil borings advanced to install soil gas points around the school by Shannon & Wilson during August 2009 (Shannon & Wilson, 2010). The native soil type underneath the pad is comprised of a horizon classified as predominantly silt from 10 to 25 feet thick. The silt horizon overlies native material classified as gravelly sand. The silt horizon appears to have been

¹ The text in Shannon & Wilson (2010) reports the extent of contamination at 15,000 square feet; however, the area shown in their figures and their air sparging calculation (Table L-4) is approximately 2,500 square feet.

² The text in Shannon & Wilson (2010) reports the extent of contamination at 25,000 square feet; however, the area shown in their figures and their air sparging calculation (Table L-4) is approximately 12,500 square feet.

partially removed beneath the Aniak Middle School, presumably prior to building construction. Also, the silt horizon was partially removed during PCB excavation activities at former septic system (Figure 4) specifically it was removed to a depth of approximately 18 feet bgs at the former septic tank location and completely removed (to a depth of 26 feet bgs) around the former seepage pit.

Shannon & Wilson (2010a) prepared cross-sections E-E' and F-F' to display the subsurface geology across the site. The locations of these cross-sections are shown on Figure 3, and the cross-sections are provided in Appendix A.

Shannon & Wilson (2010a) conducted grain size classification tests on five soil samples from the site to characterize the subsurface materials. Samples, descriptions, and results are summarized below in Table 2-1.

Sample	Boring	Depth	Description	Classification
VES2-9	VES2	25.5-27.5	Gravel fill above silt	sandy gravel
SB25-0	B25/MW-12	0-2	Native silt	Slightly sandy silt
B20-32	B20/MW-7	32-33	Native sand in water-bearing zone	Gravelly sand
B21-32	B21/MW-8	32-33		
SB14-32	SB14	32-33		

TABLE 2-1: GRAIN SIZE CLASSIFICATION RESULTS

2.4. Hydrogeology

2.4.1. Groundwater Elevation

Shannon & Wilson placed dataloggers in five site monitoring wells (MW-8 thorugh MW-12-see Figure 2) between September 2009 and May 2010 to measure groundwater table fluctuations (Shannon & Wilson, 2010b). Overall, the datalogger evaluation concluded that there are significant seasonal fluctuations in the groundwater table and groundwater flow direction, although the groundwater gradient was consistently fairly flat (low). There were four separate events that caused observable increases in the groundwater elevation:

- A precipitation event in October raised the groundwater elevation an average of 1.9 feet;
- A period of above-freezing temperatures in early December resulted in a second groundwater elevation peak; and
- The low groundwater level was measured on February 23, 2010, and groundwater levels began slowly rising on April 20, concurrent with the first notable increasing air temperatures for the season.
- Between April 20 and May 12 and 13, groundwater elevations increased approximately 5 feet to the maximum groundwater elevation measured during the study.

Over this time period, the depth to groundwater is summarized below for each location:

- MW-8: 27 ft bgs to 32 ft bgs;
- MW-9: 20 ft bgs to 25 feet bgs;
- MW-10: 28 ft bgs to 33 ft bgs;
- MW-11: 29 ft bgs to 34 ft bgs; and
- MW-12: 25 ft bgs to 30 ft bgs.

2.4.2. Horizontal Groundwater Flow

Water table elevation graphs and groundwater contour maps prepared by Shannon & Wilson are included in Appendix B to this report. Groundwater flow directions and gradients measured by Shannon & Wilson (2010b) are summarized below.

- October 3, 2009 (low groundwater elevation): Groundwater flow direction to the north at a gradient of approximately 0.0004 feet/foot.
- High groundwater elevation (Fall 2009 and Winter 2009): Groundwater flow direction to the south at gradients of 0.0005 and 0.0002 feet/foot.
- January through April 2010 (sustained low groundwater elevation): Groundwater flow generally to the west at a gradient of 0.0003 feet/foot.
- May 2010 (maximum groundwater elevation): Groundwater flow to the south at a gradient of approximately 0.002 feet/foot.

Hydraulic conductivities and seepage velocities were calculated for the silt and native sand layers at the Aniak WACS site, as shown in Table 2-2 and described below.

Based on the grain size classification tests (Table 2-1), a hydraulic conductivity of approximately 4E-02 centimeters per second (cm/sec) was calculated for the gravelly sand layer (using the Hazen Method). Literature hydraulic conductivity values for the sand range from approximately 1 to 1E-03 cm/sec and for the slightly sandy silt range from approximately 1E-03 to 1E-07 cm/sec (Freeze & Cherry, 1979).

Seepage velocities were calculated for the silt and gravelly sand layers based on the minimum and maximum hydraulic gradients (0.0002 ft/ft to 0.002 ft/ft), the minimum and maximum hydraulic conductivities and estimated porosities.

- Gravelly sand: 0.2 meters per year (m/yr) to 2000 m/yr
- Slightly sandy silt: 3E-05 m/yr to 3 m/yr

However, the variable groundwater flow directions (northerly, southerly, and westerly directions measured) suggest that the groundwater is not expected to migrate significantly in any one direction.

Soil Description	Soil Classification (1)	Porosity (2)	Hydraulic Conductivity (cm/sec) (3)	Hydraulic Conductivity (cm/sec) (4)	Hydraulic Conductivity (cm/sec) (5)	Hydraulic Gradient Range (ft/ft) (6)	Darcy velocity (min, max) cm/sec (7)	Seepage velocity (min, max) cm/sec (8)	Seepage velocity (min, max) m/yr	Seepage velocity (average) m/yr (9)
Gravel Fill Above	Sandy gravel									
Silt	(GW)	0.28	n/c	n/c	n/c					
	Slightly sandy			1E-07 to	1E-06 to	0.0002 to	2E-06 to	1E-10 to	3E-05 to	
Native Silt	silt (ML)	0.2		1E-03	1E-04	0.002	2E-11	1E-05	3	0.008
Native Sand	Gravelly sand			5E-03 to	1E-03 to	0.0002 to	2E-07 to	7E-07 to	0.2 to	
(Water-Bearing)	(SP)	0.3	0.04	1	1E-01	0.002	2E-03	8E-03	2000	21

Notes

F

(1) Grain size analysis (Shannon & Wilson, 2010a); reported in Table 1

(2) Literature values reported in (Shannon & Wilson, 2010)

(3) Hazen method: $K=c(d_{10})^2$; $d_{10}=0.02$ cm and C ~ 100; Hazen method only applicable for d_{10} from 0.1 to 3 mm

(4) Table 2.2 in (Freeze & Cherry, 1979) range for silt, loess (native silt) and clean sand (gravelly sand)

(5) Table 4.5 in (Fetter, 1988) range for silt and sandy silts (native silt) and well-sorted sands (gravelly sand)

(6) Shannon & Wilson (2010a): min gradient 0.0002 ft/ft to W-SW in Dec. 2009 (medium water level)

- and 0.0003 ft/ft to W (winter low water) and max gradient 0.002 ft/ft to the S May 2010 (high water) (7) $V_d=Q/A=Hyd$. Cond. * Gradient
- (7) $V_d = Q_f A H_f d$. Cond.

(8) V_s=V_d/porosity

(9) Based on available data: Grad (avg) = 0.0005 ft/ft; Hyd. Cond. (avg) for sand=0.04 cm/sec and for silt=1E-05 cm/sec n/c Not calculated; gravel fill is unsaturated or method is inappropriate for soil type

2.4.3. Vertical Groundwater Flow

Vertical groundwater gradient has not been evaluated at this site.

2.4.4. Pump Test

As part of the hydrogeologic evaluation, Shannon & Wilson performed pumping tests of the Middle School and High School drinking water wells to determine whether pumping affects water levels in nearby monitoring wells and, by extension, whether it can affect migration of the groundwater TCE plumes (Shannon & Wilson, 2010a and 2010b).

Shannon & Wilson installed monitoring Wells MW-11 and MW-12 for use in the pumping tests and as sentry wells for the Middle School and the High School drinking water wells. MW-11 is located about 55 feet from the Middle School drinking water well, and MW-12 was positioned about 75 feet north of the High School drinking water well (Figure 2). The Middle School drinking water well is about 60 feet deep, whereas the High School drinking water contact was at about 32 feet in MW-11 and 29 feet in MW-12.

Three pumping tests were performed:

- Middle School pumping test in which the drinking water well was pumped at a total net flow rate of about 20 gallons per minute (gpm) for 3.5 hours.
- High School pumping test in which the drinking water well was pumped at a total net flow rate of about 11 gpm for 6 hours.
- Combined pumping test in which both drinking water wells were pumped at a total net flow rate of about 31 gpm for 4 hours.

In all three tests, groundwater level measurements were collected using pressure transducer/dataloggers in five monitoring wells (MW-8, MW-9, MW-10, MW-11, and MW-12), and atmospheric pressure measurements were also collected to correct for

barometric pressure variations. All three pumping tests showed very little change in water level during or after pumping. Shannon & Wilson concluded that pumping from the drinking water wells had no measureable influence on water levels in the five nearby monitoring wells.

2.5. Detailed Summary of Site Groundwater Conditions

The groundwater TCE plumes are shown in Figure 3. MW-4 plume data are summarized in Table 2-3, and Septic System plume data are summarized in Table 2-4.

	Elevation	Screened	2008 TCE	Depth to GW (ft	Silt Interval (ft bgs)	Gravel Interval (ft bgs)	Screened in (Saturated)	Comment
MW-4 (B-17)	90.68	22-32	19.3	27->32	?-<25	25-31	SAND	Not logged 0-25'
								No GW sample;
B4					14-27+	0-14		Bottom of boring at 27'
B6	91.03	26.5-31.5 (T)	24.5	27.5	17-27	27-40	SAND	
B7	91.16	26.5-31.5 (T)	10.1	26.3	18-20	20-40	SAND	
								Defines south plume boundary;
B8	90.82	25.5-30.5 (T)	3.21	26.2	19.3-19.8	19.8-30	SAND	located between MW-4 and B11
		26.24		26.5	40 5 00	0.40 5	CU T	Defines north plume boundary;
89	91.41	26-31	ND (<1)	26.5	13.5-30	0-13.5	SILI	liocated north of Maintenance Bidg

TABLE 2-3: MAINTENANCE BUILDING (MW-4) PLUME DATA SUMMARY

Notes:

TOC = top of casing ug/L = micrograms per liter

TCE=trichloroethene GW = groundwater bgs = below ground surface (T)=temporary well

2.5.1. Maintenance Building (MW-4) Plume

Shannon & Wilson (2010) estimated the surface area of the MW-4 plume to be approximately 2,500 square feet³. However, this area should be considered a fairly rough estimate, as the plume delineation is based on one groundwater sample each from MW-4 and temporary wells B-6 and B-7. The plume is bounded to the north and south by a non-detect in B9 and a dectection of 3.21 micrograms per liter (μ g/L) in B-8.

³ The text in Shannon & Wilson (2010) reports the extent of contamination at 15,000 square feet; however, the area shown in their figures and their air sparging calculation (Table L-4) is approximately 2,500 square feet.

			Ground	dwater Sampl	e TCE Result	s (ug/L)						
							Depth to			Sand/		
		Screened					GW	Silt	Bottom	Gravel		
	Elevation	Interval (ft					(Range in	Interval	of Silt	Interval (ft	Screened In	
	(TOC)	bgs)	10/21/2006	5/19/2008	6/4/2008	8/22/2009	ft bgs)	(ft bgs)	Elev (ft)	bgs)	(Saturated)	Comment
											Silt: 19-25;	High gw - contam in silt;
MW-1 (B1)	86.76	19-29	<1	3.63	8.24		21.7-24	17-24.5	62	24.5-30	SAND: 25-29	Low gw-contam in sand
MW-2 (B2)	89.76	22-32	5.44	11.4	8.48		24.7-27	14.5-24.5	65	24.5-32	SAND	Bottom of boring at 32
												Not logged 0-25; assume silt begins
												betw. 17 and 23 ft bgs (B11 and B12).
MW-5 (B18)	90.24	22-32			157		27.2->31	25-31	<59		SILT	Base of silt unknown.
												Based on MW-8 datalogger, GW depth
											(Silt: 23-26);	range 27-32 ft bgs. Saturated interval is
MW-7 (B20)	90.04	23-38				47.5	30.3	13-26	64	26-38	SAND	below silt.
MW-8 (B21)	90.03	47-52				ND (<1)	27-32*	14-31	59	31-52	SAND	
										15-19 5		
										(Silt above	Sand: 17-19 5.	
MW-3 (B5)	80.75	12-22	<1		ND (<1)		17-18	19.5-23	58	& below)	Silt: 19.5-23	Silt to bottom of boring at 23
MW-6 (B19)	88.36	18-28				ND (<1)	24.7-28.6	13-22	66	22-29	SAND	
MW-9 (B22)	83.24	13-28				ND (<1)	20-25*	3-10.5	73	10.5-29	SAND	Bottom of boring at 29
MW-10 (B23)	91.18	25-40					28-33*	16-21	70	21-40	SAND	Bottom of boring at 40
В3							17**	12-19.5		9.5-12		Silt to bottom of boring at 19.5
B11	90.87	26-31 (T)		32.4			27**	23.5-30	61	0-23.5	SILT	Bottom of boring at 30
											Silt: 26-27;	
B12	91.03	26-31 (T)		187 (dup)			27**	16.7-27	64	27-45	Sand: 27-31	Saturated interval is below silt.
B13	89.31	26-31 (T)		1.58			26**	14-30	<59		SILT	Bottom of boring at 30
B14	81.23	16-21 (T)		3.79			17**	0-17	64	17-22	SAND	
B15	80.4	16.6-21.6 (T)		0.43J			17**	0-15	65	15-22	SAND	
B16	79.79	17-22 (T)		ND (<1)			17**	0-15	65	15-22	SAND	

TABLE 2-4: SEPTIC SYSTEM (MW-7) PLUME DATA SUMMARY

Notes:

TOC = top of casing ug/L = micrograms per liter *Datalogger 9/09-5/10 bgs = below ground surface (T)=temporary well GW = groundwater ** GW depth per boring log at time of drilling
The plume has not been delineated to the east or the west, except by MW-3 (located 90 feet west of the interpreted plume boundary). The presence of underground utilities limited the ability to install monitoring wells to the east of this plume.

Within the plume, the subsurface is generally characterized by:

- Gravel from ground surface to approximately 15 feet bgs;
- Silt from approximately 15 feet bgs to 27 feet bgs*; and
- Sand from approximately 30 feet bgs to 40 feet bgs.

*However, the silt layer was substantially thinner in boring B7 (18-20 feet bgs) and B8 (19.3-19.8 feet bgs).

Based on limited data (two events), the depth to groundwater varied from approximately 27 feet bgs to greater than 32 feet bgs.

The plume is characterized by TCE concentrations between 10.1 μ g/L and 24.5 μ g/L (one single sample event for 3 temporary wells and 1 permanent well in 2008). The monitoring wells were generally screened across the sand interval below the silt, except for temporary well B9, which was screened within the silt.

There is the potential for groundwater to perch in the coarse-grained sediments on top of the silt particularly beneath the Aniak Middle School where the top of the silt is at a lower elevation relative to the surrounding area. Perched groundwater was only observed in one of the soil borings at this site (MW-2), suggesting that groundwater ponding would most likely only be temporary. The potential for perched groundwater has not been characterized.

2.5.2. Former Septic System (MW-7) Plume

Shannon & Wilson (2010) estimated the surface area of the Former Septic System plume to be approximately 12,500 square feet⁴. The plume boundaries have been well-delineated to the south by temporary wells B-13 through B-16 and monitoring wells MW-6 and MW-9. The plume is not well-delineated to the north (temporary well B8 only), northeast (MW-3 is approximately 80 feet to the north-northeast), east, or west.

Within the plume, the subsurface is generally characterized by variable layers of silt, sand, and gravel. In the western lobe of the plume (between MW-1 and AIW), the subsurface is generally characterized as follows:

- Silt (MW-1) or Sandy/gravelly fill from ground surface to approximately 15 feet bgs;
- Silt from approximately 15 feet bgs to 25 feet bgs*; and
- Sand from approximately 25 feet bgs to 30 feet bgs.

*Note, however, that the soil in the vicinity of the former seepage pit was excavated to a maximum depth of 26 feet bgs in 2008, thereby removing most or all of the silt in that

⁴ The text in Shannon & Wilson (2010) reports the extent of contamination at 25,000 square feet; however, the area shown in their figures and their air sparging calculation (Table L-4) is approximately 12,500 square feet.

area. The soil in the vicinity of the former septic tank was excavated to a maximum depth of 18 feet bgs in 2008, thereby removing some of the silt in that area. Note further that the excavation was not completely backfilled to the former ground surface over the west septic line and former seepage pit area, resulting in a ground surface approximately 8 feet lower than the pre-excavation surface. This elevation change is not reflected in the depths cited above.

Groundwater in the western lobe of the Septic System plume is characterized by TCE concentrations between 5 μ g/L and 47.5 μ g/L. The monitoring wells were generally screened across the sand interval below the silt. Based on MW-8, which was screened in the sand from 47 to 52 feet bgs and exhibited no contaminant detections, the contamination appears to decrease with depth below the silt.

The subsurface in the central portion of the Septic system plume (between AIMP, MW-5, B-12, and B-13) is generally characterized by:

- Gravel fill from ground surface to approximately 17-23 feet bgs;
- Silt from approximately 17-23 feet bgs to 27-30 feet bgs; and
- Sand from approximately 27 feet bgs to 45 feet bgs*.

*Based on the B-12 boring log; most of the boring logs did not extend below approximately 30 feet bgs.

Groundwater in the central portion of the plume is characterized by TCE concentrations between 32.4 μ g/L and 187 μ g/L. These temporary and permanent monitoring wells were generally screened across the silt.

The northwest, northeast, and southeast portions of the plume have not been fully delineated. An elevated TCE concentration was detected in the soil gas sample from SGP-8, located on the east side of the middle school building. There are no groundwater monitoring wells in the vicinity of SGP-8, so it is unknown whether the groundwater plume extends to that area. It should also be noted that the soil gas concentrations detected in SGP-17 and SGP-18 were more than an order of magnitude higher than the soil gas concentrations detected anywhere else in the soil gas survey.. There are no groundwater monitoring wells at these locations; the closest ones groundwater samples were collected from temporary wells B-12 and B-13.

Based on the MW-8 datalogger data, the depth to groundwater varied from approximately 27 feet bgs to 32 feet bgs. Manual measurements from MW-1 and MW-2 (May and June 2008) suggest a higher groundwater table (24 to 27 feet bgs).

As discussed in the previous section, there is the potential for groundwater to perch in the coarse-grained sediments on top of the silt. Perched groundwater was only observed in one of the soil borings at this site (MW-2), suggesting that groundwater ponding would most likely only be temporary. The potential for perched groundwater has not been characterized.

2.5.3. General Conclusions/Considerations for Groundwater Remedial Alternatives Analysis

- Groundwater remediation alternatives should consider the planned soil remediation activities for the site. The timeframe for these activities has not been established yet. The planned soil remediation activities are summarized below. They would not be expected to have much of an effect on contamination in the silt layer.
 - Figure 4 shows the locations of the planned excavation of soil contaminated by PCBs commingled with TCE. Planned excavation depths are variable, primarily dependent upon the depths of PCB contamination.
 - Figure 4 also shows the locations of the planned SVE system for vadose zone treatment. The SVE system has not yet been designed; however, the preliminary design described in Shannon & Wilson (2010) calls for SVE wells with a 5-foot well screen installed at approximately 2/3 the depth to silt (roughly 18 feet to 23 feet bgs).
- Available data suggests a very slow groundwater seepage velocity at the site, with significant seasonal variability in the flow direction. Monitoring data and a pumping test performed by Shannon & Wilson (2010) do not indicate that the groundwater contamination plume is migrating. However, the groundwater elevation dataset is incomplete; there are no datalogger data available from May and September, which is when the highest water table and maximum water table fluctuations would be expected. Collection of additional datalogger data is strongly recommended before deciding on a groundwater remedy at this site.
- Available data indicates dramatic seasonal fluctuations in the groundwater table elevation (from approximately 24 to 32 feet bgs). As discussed in the previous bullet, the groundwater elevation dataset is incomplete, and collection of additional datalogger data is strongly recommended before deciding on a groundwater remedy at this site.
- The silt layer appears to hold much, if not most, of the TCE contamination; as such, remediation of the silt layer is necessary to affect overall site cleanup goals. The highest TCE concentrations were detected in monitoring wells screened across the silt (MW-5) or across both the silt and the underlying sand (B-12). The planned soil remediation activities (excavation and SVE) are unlikely to adequately address vadose zone contamination in the silt layer. To be effective, site remediation will need to address both sorbed and dissolved-phase contamination in the silt layer. Remediation in the silt layer will be complicated by the approximately 8-foot zone of groundwater fluctuation. Contamination allowed to remain in the vadose zone silt will continue to provide a source of both soil vapor and dissolved-phase groundwater contamination.
- The potential for perched groundwater contamination on top of the silt layer has not been evaluated.

2.6. Conceptual Site Model

Shannon & Wilson prepared a pictoral conceptual site model and a graphical human health conceptual site model (CSM) using the ADEC CSM template (ADEC 2005), in their 2010 report. Because this focused FS is limited to groundwater remediation, only groundwater pathways are discussed in this report. The following groundwater exposure pathways are potentially complete:

- Ingestion of groundwater: All groundwater in Alaska is considered a potential drinking water source unless determined otherwise using the criteria presented in 18 AAC 75.350. No groundwater determination has been completed for this site under 18 AAC 75.350. There are two drinking water wells near the site (high school drinking water well and middle school drinking water well).
 - Current and Future residents, commercial or industrial workers, site visitors/recreational users, and construction workers.
- Inhalation of volatile compounds in tap water (showering): TCE is a volatile compound.
 - Current and Future residents, commercial or industrial workers, site visitors/recreational users, and construction workers.
 - Indoor air inhalation is considered a potentially complete pathway for TCE in groundwater, as well as for TCE in the vadose zone. As discussed previously, air purifying filters and a sub-slab depressurization system (SSD) are in place to mitigate the vapor intrusion pathway for TCE in the Middle School building. The contribution of volatilizing TCE from groundwater to the vapor intrusion pathway is unknown, but ADEC CSM guidance (ADEC, 2005) states that the vapor intrusion pathway should be considered complete if nonpetroleum contamination in soil or groundwater is found within 100 vertical or horizontal feet of a building.

Several of the pathways shown to be potentially complete in the CSM for the entire site are not considered complete when considering only the groundwater TCE plumes.

- Outdoor air inhalation is not considered a potentially complete pathway for TCE in groundwater due to the groundwater depth. ADEC (2005) states that the outdoor inhalation pathway must be considered for contamination detected between ground surface and 15 feet bgs.
- Dermal adsorption is not considered a potentially complete pathway for TCE and DCE (ADEC, 2005).
- Surface water exposure is not considered a potentially complete pathway. The hydrogeological evaluation showed a very low groundwater gradient at the site with variable flow direction. There is no evidence that the groundwater contamination has migrated off-site towards Aniak Slough or the Kuskokwim River, nor do the data suggest that future off-site migration is a concern. However, a longer-duration (i.e., including all seasons) datalogger study would be very useful before completely ruling this out.

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3. REMEDIAL ACTION OBJECTIVES

The overall objectives of environmental site restoration are to ensure that conditions at each site are protective of human health and the environment and to comply with relevant state and federal regulations. The primary goals of remedial action at the Aniak WACS site are the following:

• Reduce current human health exposure risk below the ADEC threshold cancer risk level of 1:100,000 and threshold non-cancer hazard index of 1.

The specific remedial action objective (RAO) proposed to reduce human health exposure risk is listed below.

1. Reduce concentrations of TCE and DCE in groundwater to meet the ADEC Table C cleanup levels (ADEC 2008) (Table 3-1).

TABLE 3-1: 2008-2009 MAXIMUM GROUNDWATER CONCENTRATIONS AND ADEC CLEANUP LEVELS

Contaminant	Maximum Concentration (μg/L)	Location of Maximum Concentration (Sample Depth in ft)	ADEC Table C Cleanup Level (µg/L)*			
2009 Sampling						
TCE	47.5	MW-7 (34)	5			
cis-1,2-DCE	2.81	MW-7 (34)-dup	70			
Vinyl chloride	*		2			
2008 Sampling						
TCE	187	TWB-12S (26-31)-dup	5			
Cis-DCE	18.8	TWB-13S (26-31)	70			
Vinyl chloride	*		2			

Notes:

µg/L = Micrograms per liter

Vinyl chloride not detected above laboratory reporting limits in groundwater samples.

*Cleanup levels are provided in Table C of the Alaska Contaminated Site Regulations (18 AAC 75.345).

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4. REMEDIAL TECHNOLOGIES

The EPA's 13th Annual Superfund Remedy Report (EPA, 2010) was reviewed to investigate recent trends in groundwater remedial actions. Although the report is limited to remedial actions at Superfund sites, it is reflective of current trends in technology. The report presented the following conclusions:

- The selection of in situ treatment, monitored natural attenuation (MNA), and institutional controls (ICs) has increase over time, whereas the selection of pump and treat has decreased.
- Bioremediation and chemical treatment are the most frequently selected in situ groundwater treatment technologies.

The Federal Remediation Technologies Roundtable Table 3-2: Treatment Technologies Screening Matrix (http://www.frtr.gov/matrix2/section3/table3_2.pdf) was used to identify remedial technologies that are potentially appropriate for consideration at the Aniak WACS site. Table 4-1 presents all of the treatment technologies shown in the FRTR matrix for groundwater, along with a brief description of the technology, FRTR's rating of the technology for cleanup of halogenated VOCs, and a brief discussion of site-specific considerations for use of the technology at the Aniak WACS site. The technologies presented in Table 4-1 are color-coded to reflect whether they are discussed in this predraft FS (green), not considered applicable and therefore not discussed in this pre-draft FS (red), or not a standalone remedy (yellow).

As shown in Table 4-1, containment technologies, along with passive/reactive treatment walls, were not considered appropriate for consideration at the Aniak WACS site. The groundwater plume is located right beside and possibly underneath the Aniak Middle School building, so plume containment would not accomplish the RAO of reducing risk to people inside the school. Furthermore, available data suggests minimal groundwater plume migration is occurring so containment is likely not necessary for protection of downgradient receptors.

Based on Table 4-1, the following technologies warrant consideration for use at the Aniak WACS site: monitored natural attenuation (MNA), enhanced bioremediation, air sparging, chemical oxidation, in-well air stripping, and ex situ (i.e., pump and treat) with several different treatment technologies (oxidation and air stripping). Although not shown in Table 4-1, institutional controls (ICs) may be considered as either a standalone remedy or a remedy component. The no action alternative is always included as a baseline for comparison with all of the active alternatives. Detailed discussions of these technologies are presented in the following sections of this report.

Table 4-1: Treatment Technologies Screening for Halogenated VOCs in Groundwater (from www.frtr.gov, Table 3-2)

Technology	Effectiveness Rating	Brief Description	Aniak WACS Site-Specific Considerations			
In-Situ Biological Treatment						
Enhanced Bioremediation	Effectiveness highly dependent on site- specific conditions	Enhance natural biodegradation processes by increasing the concentration of electron acceptors and/or nutrients.	Evaluated by Shannon & Wilson (2010) Low groundwater flow gradients will aid residence time; substrate distribution may be problematic.			
Monitored Natural Attenuation	Average	Use natural biodegradation processes to degrade contaminants. Chlorinated ethenes degrade under anaerobic conditions.	Evaluated by Shannon & Wilson (2010)			
Phytoremediation	Average	Use plants to remove, transfer, stabilize, or destroy contamination.	Groundwater too deep for in-situ phytoremediation (> 25 ft bgs). Not applicable.			
		In Situ Physical/Chemical Treatment				
Air Sparging	Average	Air is injected into saturated matrices to remove contaminants through volatilization.	Evaluated by Shannon & Wilson (2010). Silt layer will likely impede volatilization.			
Bioslurping	Average	Bioslurping combines the two remedial approaches of bioventing and vacuum-enhanced free-product recovery.	No evidence of free-phase solvent at the site. Not applicable			
Chemical Oxidation	Average	Oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide	Evaluated by Shannon & Wilson (2010) for soil; potentially applicable for groundwater also. Oxidant distribution may be problematic.			
Directional wells (enhancement)	Average	Drilling techniques are used to position wells horizontally, or at an angle, to reach contaminants not accessible by direct vertical drilling	Not a standalone technology. Possibly appropriate as a remedy component in near buildings.			
Dual Phase Extraction	Above Average	A high vacuum system is applied to simultaneously remove contaminated groundwater, separate-phase product, and vapor from the subsurface.	No evidence of free-phase solvent at the site. Not applicable			
Thermal Treatment	Above Average	Steam is forced into an aquifer through injection wells to vaporize volatile and semivolatile contaminants. Vaporized components rise to the unsaturated zone where they are removed by vacuum extraction and then treated	Silt layer will likely impede vaporized/volatilized contaminants.			
Hydrofracturing Enhancements	Average	Injection of pressurized water through wells cracks in low permeability sediments. Cracks are filled with porous media that serve as substrates for bioremediation or to improve pumping efficiency	Not a standalone technology. Possibly appropriate as a remedy component in silt layer.			
In-Well Air Stripping	Average	Air is injected into a double screened well, lifting the water in the well and forcing it out the upper screen. Simultaneously, additional water is drawn in the lower screen. Once in the well, some of the VOCs in the contaminated ground water are transferred from the dissolved phase to the vapor phase by air bubbles. The contaminated air rises in the well to the water surface where vapors are drawn off and treated by a soil vapor extraction system.	Silt layer will likely impede use of in-well air stripper. Circulating wells may have an application.			

Technology	Effectiveness Rating	Brief Description	Aniak WACS Site-Specific Considerations		
Passive/Reactive Treatment Walls	Above Average	These barriers allow the passage of water while causing the degradation or removal of contaminants.	Variable groundwater flow direction would make this technology difficult t implement. Furthermore, the source as of the plume underlies the Aniak Mido School and is therefore the primary target treatment area.		
		Ex Situ Biological Treatment			
Bioreactors	Above Average	Contaminants in extracted groundwater are put into contact with microorganisms in attached or suspended growth biological reactors.	Not appropriate for this site.		
Constructed Wetlands	Average	The constructed wetlands-based treatment technology uses natural geochemical and biological processes inherent in an artificial wetland ecosystem to accumulate and remove contaminants from influent waters.	Not appropriate for this site.		
		Ex Situ Physical/Chemical Treatment			
Adsorption/ Absorption	Average	In liquid adsorption, solutes concentrate at the surface of a sorbent, thereby reducing their concentration in the bulk liquid phase.	Not appropriate for this application.		
Advanced Oxidation Processes	Above Average	Advanced Oxidation Processes including ultraviolet (UV) radiation, ozone, and/or hydrogen peroxide are used to destroy organic contaminants as water flows into a treatment tank. If ozone is used as the oxidizer, an ozone destruction unit is used to treat collected off gases from the treatment tank and downstream units where ozone gas may collect, or escape.	Possibly appropriate.		
Air Stripping	Above Average	Volatile organics are partitioned from extracted groundwater by increasing the surface area of the contaminated water exposed to air. Aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration	Possibly appropriate.		
Granulated Activated Carbon/Liquid Phase Cation Adsorption	Above Average	Groundwater is pumped through a series of canisters or columns containing activated carbon to which dissolved organic contaminants adsorb. Periodic replacement or regeneration of saturated carbon is required.	Inferior to air stripping or oxidation as an ex-situ technology, due to the need for periodic replacement of carbon.		
Pump and Treat	Average	Groundwater pumping is a component of many pump-and- treat processes, which are some of the most commonly used ground water remediation technologies at contaminated sites.	Would be a component of any ex situ technology.		
Ion Exchange	Below Average	Ion exchange removes ions from the aqueous phase by exchange with counter ions on the exchange medium.	Not applicable.		
Precipitation/ Coagulation/ Floccuation	Below Average	This process transforms dissolved contaminants into an insoluble solid, facilitating the contaminant's subsequent removal from the liquid phase by sedimentation or filtration. The process usually uses pH adjustment, addition of a chemical precipitant, and flocculation.	Not applicable.		
Separation	Above Average	Separation techniques concentrate contaminated waste water through physical and chemical means (i.e., distillation or filtration).	Not applicable.		
Sprinkler Irrigation	Above Average	The process involves the pressurized distribution of VOC- laden water through a standard sprinkler irrigation system.	Not applicable.		

Technology	Effectiveness Rating	Brief Description	Aniak WACS Site-Specific Considerations		
	Containment				
Physical Barriers	Above Average	These subsurface barriers consist of vertically excavated trenches filled with slurry. The slurry, usually a mixture of bentonite and water, hydraulically shores the trench to prevent collapse and retards ground water flow.	Available hydrogeology data suggests that groundwater is not migrating off-site. Probably not appropriate.		
Deep Well Injection	Average	Deep well injection is a liquid waste disposal technology. This alternative uses injection wells to place treated or untreated liquid waste into geologic formations that have no potential to allow migration of contaminants into potential potable water aquifers.	Not applicable.		
Air Emissions/Off-Gas Treatment*					
A number of technologies have been widely applied for removal of VOCs from off-gas streams. These technologies are not specifically considered in this FS, which is primarily concerned with groundwater remediation technologies. Shannon & Wilson (2010) concluded that off-gas treatment would most likely not be necessary.					

Color Key

Technology evaluated in pre-draft FS

Technology not evaluated in pre-draft FS

Not a standalone remedy

4.1. No Action

The No Action Alternative is used as a baseline reflecting current conditions without remediation. This alternative is used for comparison with each of the other alternatives.

4.2. MNA

MNA uses periodic sampling to monitor the reduction of contaminant concentrations by natural processes occurring in groundwater. Dilution, adsorption, volatilization, precipitation, complexation, and biological degradation of the contaminants occur in the groundwater. Of these processes, biological degradation is usually the most significant. MNA would allow these processes to continue to occur as they have in the past, without disturbances potentially caused by implementation of active remedial technologies.

4.2.1. Biological Degradation of TCE

The most important process for the natural biodegradation of the most highly chlorinated solvents (PCE and TCE) is reductive dechlorination. During this process, the chlorinated hydrocarbon is used as an electron acceptor, and a chlorine atom is removed and replaced with a hydrogen atom. In general, reductive dechlorination occurs by sequential dechlorination from PCE to TCE to DCE to vinyl chloride to ethene. Reductive dechlorination occurs in anaerobic groundwater conditions; the most rapid rates occur under highly reducing (sulfate-reducing and methanogenic) conditions (Wiedemeier, et. al. 1998), although reductive dechlorination has also been documented to occur under nitrate- and iron-reducing conditions. Because chlorinated hydrocarbons are used as electron acceptors during reductive dechlorination, there must be an appropriate source of carbon for microbial growth in order for this process to occur. Potential carbon

sources include natural organic matter, fuel hydrocarbons, or other anthropogenic organic compounds.

The geochemical evolution of groundwater is shown in the diagram below. Dissolved oxygen (DO) is the most thermodynamically favored electron acceptor used by microbes for the biodegradation of organic carbon. During aerobic respiration, DO concentrations decrease. After depletion of DO, anaerobic microbes will use nitrate as an electron acceptor, followed by iron (and manganese, not shown on the diagram), sulfate, and finally carbon dioxide (methanogenesis). Each sequential reaction drives the oxidation-reduction potential of the groundwater downward into the range within which reductive dechlorination can occur. PCE and TCE degradation can occur in less reducing (i.e., iron-reducing) groundwater than DCE and vinyl chloride degradation (i.e., sulfate-reducing and methanogenic).

Although reductive dechlorination is the most prominent method for biological degradation of PCE and TCE, the daughter products DCE and vinyl chloride can be oxidized either anaerobically or aerobically. In fact, the aerobic oxidation rate of vinyl chloride is actually much faster than the anaerobic reductive dechlorination rate.



Therefore, at some sites the optimal remedial technique is reductive dechlorination of PCE and TCE and possibly DCE, followed by downgradient oxidation of vinyl chloride, and possibly also DCE. Due to the dramatically different geochemical conditions required for reductive dechlorination and aerobic oxidation, combining these two degradation mechanisms can be difficult.

4.2.2. MNA Considerations for Aniak WACS

Natural attenuation potential was evaluated during the 2008 TCE Characterization efforts (Shannon & Wilson, 2009). Natural attenuation parameters were measured in samples from monitoring wells MW1 through MW6; results are presented in Table 4-2.

The data in Table 4-2 do not suggest that any significant reductive dechlorination is occurring at the site. The elevated DO and oxidation-reduction potential (ORP) concentrations suggest oxygenated groundwater. The elevated nitrate and sulfate concentrations suggest that no significant nitrate or sulfate reduction has occurred at the site, and, furthermore, that there are significant competing electron acceptors that will need to be reduced before TCE reduction will occur. Methane was not detected in any of the samples. The low total organic carbon (TOC) concentrations indicate the need for an outside carbon source for the reductive dechlorination process.

The presence of TCE degradation products in site groundwater samples is another line of evidence for MNA. A review of groundwater monitoring results shows that only low concentrations of cis-DCE have been detected in samples from two site monitoring wells: MW-1 and MW-7. However, high concentrations of cis-DCE were detected in the soil gas sample from SGP-18, and the cis-DCE concentration in B-13 (18.8 μ g/L) exceeded its TCE concentration (1.57 μ g/L), suggesting that MNA is occurring in this section of the plume. Elevated total petroleum hydrocarbons (TPH) detected in SGP-18 suggest that petroleum contamination may be providing a carbon source for reductive dechlorination in this area.

	Units	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6
Alkalinity	mg/L	78.8	111	331	146	151	204
Chloride	mg/L	2.09	1.06	2.16	3.45	1.83	1.08
Iron	mg/L	0.11	0.111	5.75	0.0234	0.0645	1.41
Dissolved Iron	mg/L	<0.02	<0.02	0.216	0.229	0.0212	0.248
Dissolved Manganese	mg/L	5.03	0.00223	0.0107	0.0713	0.0322	0.425
Nitrate-N	mg/L	35.1	4.12	3.29	2.67	2.77	2.2
Nitrite-N	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	mg/L	60.5	11	45.9	10.1	14	18.2
Methane	mg/L	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072	<0.0072
Total Organic Carbon	mg/L	1.74	1.92	3.89	0.0953	1.98	1.3
рН	pH units	6.11	5.85	6.32	6.1	6.06	6.04
Dissolved Oxygen	mg/L	5.25	2.48	3.89	1.51	3.17	1.35
ORP	mV	173.2	162.7	137.3	200.6	122	182.1

TABLE 4 2: ANIAK WACS GROUNDWATER MNA PARAMET	R DATA (2008)
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mg/L milligrams per liter ORP oxidation-reduction potential N nitrogen

Overall, site data do not suggest MNA is a viable alternative for treating groundwater contamination at the Aniak WACS site. However, another round of MNA parameter sampling is suggested to evaluate whether the groundwater geochemistry has changed since 2008. The current monitoring well network is more extensive than the 2008 monitoring well network.

4.3. Enhanced Bioremediation

4.3.1. Enhanced Bioremediation Description

Enhanced bioremediation would involve injection of a substrate into site groundwater to enhance (or initiate) the reductive dechlorination process at the site. The purpose of the substrate addition is to promote environmental conditions necessary for biodegradation of the chlorinated solvents (i.e., reducing conditions). The substrate provides a carbon source for naturally occurring microorganisms to consume oxygen and other electron acceptors such as nitrate and sulfate and a source of hydrogen necessary for the anaerobic biodegradation process.

There are a variety of substrates available for promoting reductive dechlorination at contaminated sites (e.g., sodium lactate, vegetable oil, and Hydrogen Release Compound [HRC[™]], among others).

4.3.2. Enhanced Bioremediation Considerations for Aniak WACS

Although Shannon & Wilson's 2010 report evaluated enhanced bioremediation for soil at the Aniak WACS site, they did not consider enhanced bioremediation for groundwater, due to concerns about impacting the drinking water wells. The final chlorinated end

product of reductive dechlorination (vinyl chloride) is considered a human carcinogen so incomplete reductive dechlorination could potentially pose a risk to the drinking water wells. However, the hydrogeologic evaluation performed by Shannon & Wilson suggests that migration of the contaminated groundwater is limited and there is no evidence that it has migrated to the drinking water wells.

In order to more fully evaluate the potential risks of enhanced bioremediation at the site, a more complete hydrogeologic evaluation is needed. The hydrogeologic evaluation performed by Shannon & Wilson (2010a, 2010b) and discussed in Section 2.4 of this FS did not suggest significant migration of the groundwater plume or plume impacts by pumping of the drinking water wells. The more complete hydrogeologic evaluation should include pressure transducer/datalogger recordings of groundwater levels in site monitoring wells for the summer months (i.e., period of maximum expected groundwater level fluctuation and flow direction variability), at a minimum, and preferably for a whole year. A second pumping test at a different groundwater elevation may also be warranted.

A significant consideration for enhanced bioremediation is the substrate distribution. There are no specific concerns about substrate distribution in the saturated gravelly sand; however, effective substrate distribution in the lower permeability silt layer would be expected to be difficult. If the enhanced bioremediation only targeted the gravelly sand layer, then contamination sorbed onto the silt would continue to desorb into groundwater and provide a continuing source of dissolved-phase contamination.

Another specific consideration for enhanced bioremediation is concern over the ability to drive the groundwater plume to anaerobic conditions and maintain these conditions over time. The 2008 MNA parameter sample results indicate that the site groundwater is generally aerobic and there are significant competing electron acceptors that will need to be reduced before TCE reduction will occur. In addition, the significant recharge events shown by Shannon & Wilson's datalogger study likely result in significant influxes of aerobic water to the subsurface that would have to be driven anaerobic. Groundwater sampling for dehalococcoides ethenogenes (DHC), which are the only known organisms capable of the complete dechlorination of PCE and TCE to ethene, has not been performed at the site. However, DHC sampling is not currently recommended for this site, because low TCE daughter product concentrations suggest that the native DHC population would be low. In summary, it appears likely that the natural aerobic conditions at the site and periodic influxes of aerobic recharge water will exert a significant substrate demand, in addition to the substrate necessary to initiate and sustain the degradation of TCE. Because limited reductive dechlorination appears to be occurring at the site naturally, its effectiveness at this site is unknown.

Although the planned SVE system could also adversely affect enhanced bioremediation by inducing the flow of oxygenated air, the effects would be expected to be minor due to the silt layer.

4.4. Air Sparging

4.4.1. Air Sparging Technology Description

Air sparging is an in-situ technology in which air is injected into a contaminated aquifer to induce volatilization of contaminants. Air is forced into the saturated soil using air sparge wells. As air moves through the saturated soil within the zone of influence of the air sparge wells, volatile organic contaminants are stripped from the water. An SVE system is usually used in conjunction with air sparge to enhance the process by increasing flow through the groundwater, controlling gas/vapor movement through the subsurface, and capturing volatiles before they escape at the surface or expand the zone of contamination.

Air sparging is a proven and effective technology for addressing volatile contaminants in groundwater. Air sparging depends upon efficient mass transfer processes from the dissolved contaminanation into the air. The major limitation of the mass transfer process is the soil matrix itself. Injected air will flow in channels rather than in a uniform front across the soil. Small changes in soil texture (heterogeneities) can cause significant channeling of the air flow.

4.4.2. Air Sparging Considerations for Aniak WACS

Shannon & Wilson performed two air sparging pilot tests for the Aniak WACS site in September and November 2009. The second test was performed due to problems with the first test. For the pilot test, they installed an air injection well (designated AIW) and an air injection monitoring point (designated AIMP) in the vicinity of the Former Septic Tank and vapor extraction pilot test well VES1 (Figure 3). The AIW consists of 2-inch pipe with a 2.5-foot section of well screen set at about 15 feet below the water table (42.1 to 44.6 feet bgs) in granular soil. The AIMP consists of 2-inch pipe with a 2.5-foot section of well screen set at about 5 feet below the water table (33.1 to 35.6 feet bgs) in granular soil. Positive pressure was applied to the AIW to induce sparging. In the September test, a vacuum was also applied to VES-1, although no vacuum was applied in the November test. The radius of influence (ROI) of the air injected at the AIW was evaluated by measuring changes in water depth, dissolved oxygen levels, and pressure at nearby monitoring points. A change in water depth was not notable in AIMP, MW8, or VES1 during the air sparge test. The water level in AIW was depressed during the blower test from about 31.17 feet below the monitoring point before applying pressure to about 32.60 feet below the monitoring point and rising rapidly after applying pressure at AIW. Pressure increases were recorded in monitoring points AIMP (0 to 0.13 psi), VES1 (0 to 0.18 psi), MW5 (0 to 0.12 psi) and SGP1 (0 to 0.11 psi) located 15, 13, 21, and 12 feet from AIW, respectively. Likewise, increases in DO content were measured in monitoring points AIMP (0.68 ppm to 0.75 ppm), VES1 (0.78 ppm to 1.02 ppm), and MW8 (0.73 ppm to 0.77 ppm).

Results of the pilot testing conducted at the site indicate that air can be injected into the water bearing zone beneath the silt with a radius of influence of about 20 feet. One

possible advantage of air sparging over other in situ technologies is that the radius of influence could allow some remediation under the Middle School building. However, air sparging may not be an effective remedial alternative as the silt layer overlying the saturated sandy gravel/gravelly sand may act as an aquitard, creating semi-confined conditions. Air injected into the semi-confined aquifer could become trapped by the overlying, semi-confining layer and may not be able to escape to the unsaturated zone for capture using SVE wells.

4.5. Chemical Oxidation

Chemical oxidation is potentially both an in-situ and ex-situ groundwater cleanup technology. In situ oxidation is described in the following subsection, whereas ex situ oxidation is discussed in Section 4.7.3.

4.5.1. Chemical Oxidation Technology Description

In situ chemical oxidation (ISCO) is a rapidly growing remedial technology that involves the introduction of a chemical oxidant into the subsurface to transform groundwater or soil contamination into innocuous substances such as carbon dioxide and water. The ISCO technology is briefly summarized in this pre-draft FS; much more detail on the technology and its application is available in the following publications by the EPA and the Interstate Technology and Regulatory Council (ITRC): *Technical and Regulatory Guidance for In Situ Chemical Oxidation of Contaminated Soil and Groundwater* (ITRC, 2005) and EPA Engineering Issue: In-Situ Chemical Oxidation (Huling and Pivetz, 2006). In addition, the Department of Defense's Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP) are developing a Technology Practices Manual for ISCO that is due out later in 2011 (ER-200623).

In general, the oxidant is reduced by accepting electrons released from the transformation (oxidation) of target and non-target reactive species. Oxidation can result in the rapid and complete chemical destruction of many toxic organic chemicals, although some oxidants do not result in complete contaminant destruction. ISCO is applicable to treatment of chlorinated solvents, as well as a variety of other contaminants including petroleum hydrocarbons, PCBs, organochloride pesticides, and munitions.

Several different forms of oxidants have been used for ISCO, including permanganate (MnO₄⁻), Fenton's hydrogen peroxide (H₂O₂) and ferrous iron (Fe⁺²)) or catalyzed hydrogen peroxide (CHP), ozone (O₃), and persulfate (S₂O₈²⁻). In addition, there are proprietary compounds, such as RegenOx® by Regenesis Bioremediation Products. All of these oxidants are considered effective for oxidizing TCE and its degradation products DCE and vinyl chloride (ITRC, 2005). For other contaminants detected at the site (carbon tetrachloride detected in soil gas and PCBs detected in soil), permanganate, ozone, and persulfate are not considered effective. Peroxone (ozone/hydrogen peroxide) and Fenton's (H₂O₂/Fe) show some positive results for oxidation of carbon tetrachloride and PCBs.

The type of oxidant selected for an ISCO application depends on both the target contaminant and subsurface conditions. Stronger oxidants have less persistence in the subsurface than weaker oxidants and are therefore more suitable for high permeability layers and hot spots. On the other hand, weaker oxidants with more persistence are better suited for diffusion-controlled distribution in low permeability layers. For example, permanganate persists for long periods of time (greater than 3 months [Huling and Pivetz, 2006]), and diffusion into low-permeability materials and greater transport distances through porous media are possible. Ozone and H_2O_2 has been reported to persist in soil and aquifer material for minutes to hours, and the diffusive and advective transport distances will be relatively limited (Huling and Pivetz, 2006). Permanganate and non-activated persulfate are more suitable for low permeability layers and diffuse contamination, while CHP and activated persulfate are more suitable in high permeability layers and hotspots. Although low soil permeability is a barrier to all forms of remediation, ozone can be used to take advantage of the much higher gas-phase permeability (ITRC, 2005).

Two advantages of ISCO over other conventional treatment technologies are that large volumes of waste material are not usually generated, and the treatment time is frequently much shorter.

As with most in situ technologies, a primary consideration for effective in situ oxidation is the ability to effectively distribute the oxidant throughout the area of contamination. Other key considerations for effective ISCO include proper oxidant selection and dosage. Proper oxidant selection is based on the type of contaminant and subsurface conditions (i.e., heterogeneities). Correct oxidant dosage must consider the contaminant mass (both dissolved and sorbed), along with the inherent natural oxygen demand of the soil. Therefore, the ability to overcome site-specific heterogeneitites and geochemistry are key requirements for effective ISCO implementation.

4.5.2. Chemical Oxidation Considerations for Aniak WACS

Shannon & Wilson (2010) performed an analysis of chemical oxidation for soil at the Aniak WACS site. Groundwater treatment using chemical oxidation was not considered based on the risk to the on-site drinking water well. As discussed in Section 4.3.2, existing data suggests that the actual risk to the on-site drinking water well may not be significant, although further evaluation is needed.

Shannon & Wilson assumed treatment of the TCE-impacted soil using a potassium permanganate solution, although other equally viable oxidants are available. They performed oxidant demand tests which showed the oxidant demand of subsurface organic and inorganic components in the soil and groundwater was relatively low, ranging from about 0.3 to 1.5 percent by weight of soil.

Shannon & Wilson assumed that the potassium permanganate liquid mixture would be gravity-fed into the subsurface at points spaced through the zone of contamination. They assumed it would take approximately 1 year for liquid to permeate 5 feet of silt. The initial application will include sufficient liquid to saturate the area so that the chemical

can react with available TCE and then still have enough remaining to slowly saturate the silt over an estimated 1 year infiltration period. Bench scale and field pilot tests would be performed to evaluate the radius of influence for the application wells, to determine oxidant dosing requirements, and to refine assumptions regarding the number of applications required.

Extending Shannon & Wilson's analysis to groundwater treatment by ISCO, the most significant considerations for in situ chemical oxidation at Aniak WACS are the silt layer overlying the saturated layer and the low and variable groundwater flow direction. To treat the groundwater, the oxidant would be applied through injection points drilled most of the way through the silt layer. This distribution system would allow some oxidation of contaminants in the base of the silt layer, although the distribution of oxidant within the silt layer would be expected to be poor. Similarly, it would be difficult or impossible to achieve a consistent oxidant "front" below the silt layer. Instead, the oxidant would migrate into and through the saturated zone in channels/preferential pathways, resulting in incomplete oxidant distribution. Injection of the permanganate oxidant mixture will also be inhibited by precipitation of dissolved metals, and permanganate particles will result in temporary permeability loss in the already low permeability silt. The issues will likely result in the necessity to inject the oxidant several times to complete remediation.

There are several potentially competing considerations for oxidant selection at Aniak WACS. Based on its greater persistence in the environment and therefore greater ability to diffuse through the low-permeability silt before degrading, permanganate would be expected to be the best oxidant for consideration of groundwater remediation in the dissolved-phase plume within the silt. However, shipping of permanganate to Aniak will be expensive, versus an on-site ozone generation system would likely be more cost-effective over the long term. A combination of in situ and ex situ ozone treatment may be worth considering; ozone is discussed further as an ex situ technology.

4.6. In-Well Air Stripping

In-well air stripping technology involves the injection of air into a vertical well that has been screened at two depths. The lower screen is set in the groundwater saturated zone, and the upper screen is in the unsaturated zone. Pressurized air is injected into the well below the water table, aerating the water. The aerated water rises in the well and flows out of the system at the upper screen. Contaminated groundwater is drawn into the system at the lower screen. The VOCs vaporize within the well at the top of the water table, as the air bubbles out of the water. The vapors are drawn off by an SVE system. The partially treated groundwater is never brought to the surface; it is forced into the unsaturated zone, and the process is repeated as water follows a hydraulic circulation pattern or cell that allows continuous cycling of groundwater. As groundwater circulates through the treatment system in situ, contaminant concentrations are gradually reduced. In-well air stripping is a pilot-scale technology.

Modifications to the basic in-well stripping process may involve additives injected into the stripping well to enhance biodegradation (e.g., nutrients, electron acceptors, etc.).

Alternatively, the area around the well affected by the circulation cell (radius of influence) can be modified through the addition of oxidants to affect chemical oxidation.

The duration of in-well air stripping is short- to long-term, depending contaminant concentrations, Henry's law constants of the contaminants, the radius of influence, and site hydrogeology. In general, in-well air strippers are more effective at sites containing high concentrations of dissolved contaminants with high Henry's law constants. In well air stripping may not be efficient in sites with strong natural flow patterns.

4.6.1. In-Well Air Stripping Considerations for Aniak WACS

The most significant consideration for application of in-well air stripping for Aniak WACS is the presence of the silt layer. The silt layer will limit the ability to draw off vapors by an SVE system and circulate groundwater at the water table.

4.6.2. Circulating Wells

Circulating wells provide a technique for subsurface remediation by creating a threedimensional circulation pattern of the groundwater. Groundwater is drawn into a well through one screened section and is pumped through the well to a second screened section where it is reintroduced to the aquifer. The flow direction through the well can be specified as either upward or downward to accommodate site-specific conditions. Because groundwater is not pumped above ground, pumping costs and permitting issues are reduced and eliminated, respectively. Also, the problems associated with storage and discharge are removed. In addition to ground water treatment, circulating well systems can provide simultaneous vadose zone treatment in the form of bioventing or soil vapor extraction.

Circulating well systems can provide treatment inside the well, in the aquifer, or a combination of both. For effective in-well treatment, the contaminants must be adequately soluble and mobile so they can be transported by the circulating ground water. Because circulating well systems provide a wide range of treatment options, they provide some degree of flexibility to a remediation effort.

Circulating well systems are most effective at treating sites with volatile contaminants with relatively high aqueous solubility and strong biodegradation potential, e.g., halogenated and non-halogenated VOCs. Circulating wells operate more efficiently with horizontal conductivities greater that 10-3 cm/sec and a ratio of horizontal to vertical conductivities between 3 and 10. A ratio of less than 3 indicates short circulation times and a small radius of influence. If the ratio is greater that 10, the circulation time may be unacceptably long.

Effective circulating well installations require a well-defined contaminant plume to prevent the spreading or smearing of the contamination. They should not be applied to sites containing NAPLs to prevent the possibility of smearing the contaminants. Circulating wells are limited to sites with horizontal hydraulic conductivities greater than 10-5 cm/sec and should not be utilized at sites that have lenses of low-conductivity deposits.

4.6.3. Circulating Well Considerations for Aniak WACS

Circulating wells may be an effective groundwater remedy component at Aniak WACS. The use of circulating wells may assist in distributing oxidant (for ISCO) or substrate (for enhanced bioremediation) in the gravelly sand layer under the silt. However, circulating wells cannot be effectively used for remediation of contamination within the silt layer.

4.7. Ex-Situ Treatment

4.7.1. Groundwater Pumping

Possible objectives of groundwater pumping include removal of dissolved contaminants from the subsurface, or containment of contaminated groundwater to prevent migration. Groundwater containment is not desired at the Aniak WACS site; therefore, the groundwater pumping discussion is limited to consideration of removal of dissolved contaminants.

The criteria for well design, pumping system, and treatment are dependent on the physical site characteristics and contaminant type. Actual treatment may include the design of a train of processes to remove specific contaminants. Possible treatment processes are discussed in subsequent subsections of this FS.

Another component of any groundwater extraction system is a groundwater monitoring program to verify its effectiveness. One documented drawback of most pump and treat systems is the long time necessary to achieve site cleanup. Groundwater pumping does not effectively treat residual saturation of the contaminant in the soil pores or sorbed to the soil matrix. Pumping is not applicable to contaminants with high residual saturation, high sorption capabilities, and homogeneous aquifers with hydraulic conductivity less than 10-5 cm/sec.

Biofouling of the extraction wells and associated treatment stream is a common problem which can severely affect system performance. The potential for this problem should be evaluated prior to the installation.

4.7.2. Air Stripping:

Volatile organics are partitioned from groundwater by increasing the surface area of the contaminated water exposed to air. Aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration.

4.7.3. Oxidation

Similarly to ISCO, oxidation can be used in ex situ applications. Oxidation of target contaminants is caused by direct reaction with an oxidizing agent. Unlike in situ applications, where a slow reaction time is desirable, fast reaction times are desired for ex situ applications. Combinations of oxidizers are also beneficial for some treatment systems. If complete mineralization is achieved, the final products of oxidation are carbon dioxide, water, and salts. The main advantage of oxidation is that it is a

destruction process, as opposed to air stripping or carbon adsorption, for which contaminants are extracted and concentrated in a separate phase.

Possible oxidizing agents include Fenton's ($H_2O_2 + Fe$), ultraviolet (UV) light, ozone (O_3), ozone plus UV, and ozone plus peroxide ($O_3 + H_2O_2$), which react to create a hydroxyl radical, similar to the Fenton's. However, oxidation by UV light is highly dependent on water clarity and will not be effective in turbid water without pretreatment. Permanganate and persulfate reactions are too slow for effective ex situ applications.

A combination of ozone and peroxide or ozone and UV may be applicable for ex situ oxidation at Aniak WACS. Ozone is a gas and a strong oxidant that upon reaction does not leave a residual other than O_2 . Environmental contaminants can be oxidized either by direct reaction with O_3 , or indirectly via O_3 decomposition and formation of the hydroxyl radical (·OH), a stronger oxidant. Direct oxidation of PCE and TCE is impractical due to slow reaction time, although direct oxidation of DCE and vinyl chloride is very rapid. However, TCE and PCE are readily oxidized by the hydroxyl radical. The addition of H_2O_2 or UV to O_3 in water generates OH, thereby increasing the oxidative capabilities of the treatment system and increasing oxidation rates for PCE and TCE.

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5. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

Promising groundwater technologies will be developed into three to five detailed alternatives and evaluated against the nine criteria described in Section 121(b) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP) §300.430(f)(5)(i).

The costing of remedial alternatives will be conducted in accordance with the USEPA Remedy Cost Estimating Procedures Manual: A Guide to Developing and Documenting Remedial Alternative Cost Estimates During the Feasibility Study (USEPA 2000).

5.1. Evaluation Criteria

The CERCLA criteria are classified as threshold criteria, balancing criteria, and modifying criteria.

Threshold criteria are standards that an alternative must meet to be eligible for selection as a remedial action. There is little flexibility in meeting the threshold criteria—the alternative must meet them or it is unacceptable. The following are classified as threshold criteria:

- Overall protection of human health and the environment
- Compliance with regulations

Balancing criteria weigh the tradeoffs between alternatives. These criteria represent the standards upon which the detailed evaluation and comparative analysis of alternatives are based. In general, a high rating on one criterion can offset a low rating on another balancing criterion. Five of the nine criteria are considered balancing criteria:

- Long-term effectiveness and permanence: This criterion refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, after the remedy has been completed.
- Reduction of toxicity, mobility, and volume through treatment: This criterion evaluates the anticipated performance of the treatment technologies that may be included as part of a remedy.
- Short-term effectiveness: This criterion addresses the effectiveness of the remedy during its implementation. It includes the period of time needed to implement the remedy along with any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.
- **Implementability**: This criterion addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.
- **Cost**: This criterion addresses the cost-effectiveness of a remedy based upon design, construction, start-up, monitoring, and maintenance costs.

Modifying criteria evaluate public acceptance and can therefore not be considered in the FS. The final two criteria are considered modifying criteria:

- Community acceptance
- State/regulatory agency acceptance

5.2. Comparative Analysis of Alternatives

A comparative analysis will be performed to identify the advantages and disadvantages of each alternative relative to the other alternatives. The relative performance of each alternative will be evaluated with respect to each of the NCP criteria. The scoring procedure is discussed in this section.

Threshold criteria are either met or not met; therefore, "yes" and "no" will be used as the scores for threshold criteria.

A numerical scoring scheme will be used for evaluating the balancing criteria for the various alternatives. Each alternative will be assigned a numerical score between 0 and 5 for each criterion to reflect the expected performance of the alternative. The scores have no independent value; they are only meaningful when compared among the different alternatives. The numerical scores are presented and defined below:

- 0: Worst (Criterion not satisfied)
- 1: Poor
- 2: Below Average
- 3: Average (Criterion partially satisfied)
- 4: Above Average
- 5: Best (Criterion completely satisfied)

All of the criteria except cost will be evaluated on a qualitative basis. Cost will be evaluated quantitatively by calculating the expected range of costs (within a range of - 50% to +100%) and then normalizing the costs to the 0 to 5 scale, with the least expensive alternative receiving a score of 5, and the most expensive alternative receiving a score of 5, and the most expensive alternative receiving a score of 0. The quantitative cost evaluation will be performed based on the EPA document entitled *A Guide to Developing and Documenting Cost Estimates During the Feasibility Studies* (EPA, 2000).

5.3. Site-Specific Considerations Affecting Remedy Selection

5.3.1. Data Gaps

As discussed in Section 2.5.3, further evaluation is warranted at this site to address the following data gaps.

 Incomplete record of seasonal groundwater elevations. Dataloggers recorded groundwater elevations between September 2009 and May 2010 (Shannon & Wilson, 2010b); however, there is no record of groundwater elevations over the summer months when fluctuations would be expected to be the greatest.

- Scarcity of groundwater sample results. The plume delineation is primarily based on one round of groundwater monitoring results, collected during different times of the year (and associated groundwater elevations). The temporary well data were collected in May/June 2008 at a relatively high groundwater level, whereas the samples from monitoring wells MW-7 through MW-12 were collected in August 2009 at a relatively low groundwater level. There is also only one round of MNA parameter results available. Another round of groundwater samples would help verify the plume characterization.
- No characterization of groundwater under the Aniak Middle School or to the east of the school. Soil gas results from SGP-8 indicate elevated TCE soil gas results. There has been no soil or groundwater characterization in this area.
- Incomplete characterization of the Septic Tank Plume. The southern plume boundary is well delineated; however, the plume boundaries have not been welldefined to the northwest (in the vicinity of the ASTs), northeast (under Aniak Middle School building), or to the southeast. Soil gas readings from SGP-17 and SGP-18 suggest that the maximum contaminant concentrations are in this area. There are no monitoring wells to characterize groundwater in this area.
- Incomplete characterization of the Maintenance Building TCE plume has not been completely characterized. The east, west, and northern boundaries of the plume are not defined..
- Incomplete characterization of the silt layer. Additional characterization of the top and base of the silt layer, especially in the area of highest contamination levels, would be very helpful in determining the amount of contamination at the site.

Incomplete characterization of groundwater flow patterns could result in a misunderstanding of groundwater flow at the site. An understanding of groundwater flow is critical for designing an effective groundwater remedy.

Incomplete characterization of the groundwater plumes could result in a significantly larger (or smaller) area of groundwater contamination, which could have a significant impact on remedy costs and evaluation.

5.3.2. Silt Layer

The presence of low-permeability silt overlying slightly gravelly sand and the seasonal groundwater elevation fluctuation of at least 5 feet significantly complicates groundwater remediation at the site. The scope of this focused FS is limited to evaluating groundwater remedies, and the planned soil remedial activities (excavation and SVE) will only address contamination in the fill above the silt layer. However, the available data suggests that the highest contaminant concentrations were detected in the silt. The contamination sorbed to silt (in the vadose zone and in the groundwater fluctuation interval) will act as a continuing source of both dissolved-phase contamination and soil gas. In order to effectively address contamination at the site, contamination in the silt must also be remediated.

5.4. Recommended Technologies for Consideration in the Detailed FS

OASIS recommends a detailed evaluation of the following groundwater remedial technologies in the detailed FS:

- No Action
- MNA and ICs: The feasibility of this potential remedy is contingent on additional monitoring results showing the occurrence of significant MNA at the site and a decision by ADEC and the stakeholders that this remedy is appropriate. Available (although incomplete) groundwater data suggests minimal migration of the groundwater plume, so it is possible that groundwater plume migration to existing drinking water wells or further offsite is not a complete pathway. However, the vapor intrusion pathway into the Middle School building from groundwater is a potentially complete pathway that needs to be considered.
- Chemical oxidation: Chemical oxidation appears to be a more promising technology than enhanced bioremediation at this site, primarily due to the site's (apparent) aerobic groundwater geochemistry. A key challenge for chemical oxidation at this site is delivery of the oxidant. Several delivery methods may be considered, including direct application of a solid oxidant (such as permanganate) on the base of the planned PCB/TCE soil excavation (Figure 4), direct injection of oxidant into the silt and underlying sand, or use of circulating wells for oxidant distribution.

Air sparging may also warrant further evaluation but also faces considerable challenges due to the presence of the silt layer. The feasibility of sparging in the silt layer has not been evaluated, and sparging beneath the silt layer could cause entrapment of air bubbles under the silt. Further delineation of the silt and contamination in the southwest portion of the septic tank plume (near SGP-17) would be helpful in evaluating the potential applicability of air sparging at this site. Excavation data suggests that the silt layer may be mostly or entirely removed in the seepage pit area; however, a thick silt layer was detected in all of the borings/monitoring wells near MW-5 and B-12 (where the highest groundwater contamination was detected).

Enhanced bioremediation may also warrant further evaluation, although the naturally aerobic groundwater conditions will need to be driven anaerobic, and there are concerns about groundwater reoxygenation during river- and snowmelt-driven recharge events. One possible application of enhanced bioremediation may be injection in recirculating wells.

OASIS recommends considering expanding the scope of this FS to include remediation of contamination in the silt in the vadose zone and zone of groundwater fluctuation.

Pilot testing will be critical to choosing an effective remedy at this site, especially considering remediation of contamination in the silt layer.

6. REFERENCES

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FIGURES

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APPENDIX A

Cross-Sections E-E' and F-F'

(Shannon & Wilson, 2010a)

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APPENDIX B

Potentiometric Surface Maps

October 2006 August 2009 October 2009 (High) October 2009 (Low) December 2009 (High) February 2010 (Low) May 2010 (High) and Groundwater Elevation Graph (September 2009 through May 2010) (Shannon & Wilson, 2007, 2010a, and 2010b) - Page Intentionally Left Blank -







LEGEND

B19/MW6

B22/MW9

Approximate location of Monitoring Well MW6 installed by Shannon & Wilson Inc. in May 2008.

Approximate location of vapor extraction system and/or groundwater monitoring wells, installed by Shannon & Wilson, Inc. in August 2009. Note that MW7 and MW8 are a nested pair of groundwater monitoring wells.

Approximate location of Soil Boring B22/Groundwater Monitoring Well MW9,installed by Shannon & Wilson Inc. in August 2009. Well was screened from about 7 feet above to 8 feet below groundwater contact.

Groundwater potentiometric surface contour and elevation based on October 3, 2009 groundwater elevations and September 2009 survey conducted by Del Norte Surveying, Inc. (based on elevations measured at Monitoring Wells MW8, MW9, MW10, MW11, and MW12) ➤ 58.15 —

Ð High School Drinking Water Well











B19/MW6

B21/MW8

B22/MW9





APPENDIX E

Comment Response Summary

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REVI COM	IEW MENTS		PROJECT: Aniak WACS PRP/HTRW DOCUMENT: Draft Focused Feasibility Study - Groundwater– February 2012 Location: Aniak, AK					
U.S. ARMY CORPS OF ENGINEERSDATE: 13 April 2012 REVIEWER: Aaron Shewman PHONE: 753-5558		Acti	on taken on comment by:					
Item Drawing COMMENTS No. Sheet No., Spec. Para.			CONTRACTOR RESPONSE	COMMENTOR REPLY (A-AGREE) (D-DISAGREE)				

1.	Page 2, Section 1, Tables 1-1 and 5-1	Please add a note with a definition of how a score of 0 relates to a score of 1, etc. up to a score of 5.	The scoring explanation in Section 5-2 was copied into Section 1, above Table 1-1. This explanation is provided below. The two "threshold criteria" are either met or not met; therefore, "yes" and "no" were used as the scores for these criteria. A numerical scoring scheme was used for evaluating the five balancing criteria. Each alternative was assigned a numerical score between 0 (worst) and 5 (best) for each criterion to reflect the expected performance of the alternative. The scores have no independent value; they are only meaningful when compared among the different alternatives. Also, footnotes were provided on Tables 1-1 and 5-1 explaining the relative meaning of scores 0 to 5.	
2.	Figure 3	B20/VES1/MW7 (shallow) is shown as shaded, which indicates it has been decommissioned/destroyed. Please clarify.	The monitoring wells in this area are mislabeled and will be labeled correctly for the final report. The shaded well is MW-2; the one labeled B21/MW8 should actually be B20/VES1/MW7 (shallow), and the well to the right of that should be B21/MW8.	
3.	Page 20 Section 2.5.2	First paragraph, last sentence – Delete "ones".	ОК	
4.	Page 27 Section 4.2.4	Second paragraph, last sentence – Change "expect" to "expected".	ОК	

REVI	EW		PROJECT: Aniak WACS PRP/HTRW					
COMMENTS DOCUMENT: Draft Focused Feasibility Study - Groundwater – February 2012 Location: Aniak, AK					Aniak, AK			
U.S. ARMY CORPS OF ENGINEERS		S OF	DATE: 13 April 2012 REVIEWER: Aaron Shewman PHONE: 753-5558	Action taken on comment by:				
Item Drawing COMMENTS No. Sheet No., Spec. Para.			CONTRACTOR RESPONSE	COMMENTOR REPLY (A-AGREE) (D-DISAGREE)				

5.		End of Comments	
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			Comment Response
		DRAFT Comment/Recommendation	
Comment #,	Section		
1. 1	1.	Second paragraph: Oasis writes, "This contamination has resulted in levels exceeding both indoor air quality and drinking water risk-based thresholds." The fact that sub-slab depressurization has decreased sub-slab vapor concentrations but not had an appreciable impact on indoor air strongly suggests that an indoor source is, at a minimum, contributing to indoor air quality exceedances. Suggest revising: "This contamination has resulted in VOC levels exceeding drinking water risk-based thresholds, and is potentially contributing to levels exceeding indoor air quality."	The data do suggest a possible indoor air source; however, the subslab samples also indicate that vapor intrusion is occurring (without the SSD system). We suggest the following wording This contamination has resulted in VOC levels exceeding the ADEC vapor intrusion target levels for residential groundwater and subslab soil gas and drinking water risk-based thresholds. This contamination contributes to exceedances of ADEC Target Levels for indoor air.
2. 12	2.4.3	A note should be added to this section to make it clear that TCE will not migrate at the same rate as groundwater, i.e., that TCE will be subject to some retardation factor. Some estimate of the rate of TCE migration should be added to Section 2.5 or 2.6.	The following text will be added: The travel speed of dissolved-phase contamination is slower than the travel speed of the water, due to sorption processes slowing the contaminant front. This phenomenon is generally referred to as "retardation" and may be quantified by a retardation coefficient that expresses how much slower a contaminant moves than does the water itself. The retardation coefficient for TCE at the Aniak site was calculated by the following

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			equation.
			$R = 1 + \frac{Kd * \rho b}{\varphi}$
			Where: R is the retardation coefficient = 1.25, based on parameter values below;
			ρb is the bulk density (2.65*[1- φ]=1.9 g/cm3);
			K_d is the sorption coefficient = K_{oc} [organic carbon coefficient of contaminant]*foc [fraction of organic carbon in the soil]) (100 L/kg*0.00045=0.045; and
			φ is the porosity (0.3).
			A retardation factor of 1.25 indicates that TCE travel will be retarded by a factor of 1.25 compared to the groundwater velocity. This is a low retardation factor, reflecting TCE's high mobility and low affinity for sorption onto soil. The TCE travel distance is presented in Table 2- 4, along with the groundwater travel distance.
3. 13	2.4.4	This section re-states conclusions made by Shannon and Wilson in their 2010 <i>Final Site</i>	The purpose of Section 2.4.4 is specifically to present the information from Shannon &

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Characterization Report and Hudrogeologic	Wilson's nump test OASIS has not
<i>Evaluation.</i> Oasis' interpretation of the geometry of the TCE plume, as depicted on	performed any additional pump tests.
geometry of the TCE plume, as depicted on Figure 3, raises the question of whether operation of the Middle School well is affecting plume migration. This could impact the effectiveness of the long-term MNA remedy. Refer also to Page 2-Section1; Page 20-Section 2.5.2; Page 30-Section 4.4.1; Page 32-Section 4.4.2.	Regarding the plume geometry shown in Figure 3, the plume lobe east of the school building is based on the soil gas detection in SGP-8 (corroborated by the fact that there was a groundwater detection associated with the soil gas detection in SGP-9). There have been no groundwater samples collected in this area, so the potential plume has not been confirmed but is suspected based on the soil gas detection. There may be an additional source area in this location that has not been delineated. Also, because there has been no sampling under the building, the groundwater plume was extended from the known plume on the west side of the building to incorporate SGP-8. The plume geometry is discussed in Section 2.5.2. Additional characterization is required to further refine the plume shape and to determine whether it suggests possible
	DRAFT Comment/Recommendation Characterization Report and Hydrogeologic Evaluation. Oasis' interpretation of the geometry of the TCE plume, as depicted on Figure 3, raises the question of whether operation of the Middle School well is affecting plume migration. This could impact the effectiveness of the long-term MNA remedy. Refer also to Page 2-Section1; Page 20-Section 2.5.2; Page 30-Section 4.4.1; Page 32-Section 4.4.2.

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			suggested by the reviewer.
4 10	251 and	Both sections state that a simplified	No changes to the text are recommended in this section that specifically is reporting the results of Shannon & Wilson's pump test.
4. 17	2.5.2	interpretation is made with respect to the saturated interval to assist in evaluating remedial alternatives. Would changes in the assumptions, e.g., assuming a thicker saturated interval, change the evaluation of remedial alternatives?	sections refers to the use of an annualized saturated thickness instead of performing multiple calculations based on the expected saturated interval thickness during each water level scenario (see Table 2-2). The assumed saturated thicknesses cited in the report (54-64' in sand at MW-4 and 59-64' in silt and 54-59' in sand) are based on the maximum "summer" water level of ~64', which is expected to overestimate the saturated interval for most of the year, with the exception of the very short-duration breakup period in the spring. The following explanatory text will be added to both Sections 2.5.1 and 2.5.2, right after the simplified interpretation is presented.

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			performing multiple calculations based on the expected saturated interval thickness during each water level scenario (see Table 2-2). The top of the saturated interval corresponds to the summer high water level shown in Error! Reference source not found. , which is expected to approximate or overestimate the saturated interval for most of the year, with the exception of the very short-duration breakup period in the spring (approximately 2 weeks). The remedial alternatives evaluated under this assumption would therefore be expected to treat the entire impacted saturated zone during approximately 50 weeks of the year and additionally treat the lower vadose zone during winter low water levels. The saturated thickness interpretations are discussed further with respect to the remedial alternatives in Sections 4.2.3 and 4.2.4.
5. 23	3.	Numbered bullet 1 should specify the area over which the cleanup level is to be met, presumably the entire plume extent.	The area over which the cleanup level is to be met has not been determined. If an alternative point of compliance is established at this site (see discussion in Section 5.3.1.2), then the cleanup level would need to be met at the alternative point of compliance. Otherwise, the cleanup level will need to be met throughout the entire plume extent, as

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			suggested in the comment. Suggest no changes to the RAO, because the area has not yet been determined.
6. 25	4.1	It would be helpful to combine the relevant portions of the pre-draft FS with this document.	Concur; the pre-draft will be added as an appendix.
7. 25	4.1	Last paragraph. Does Oasis think an engineered remedy implemented in conjunction with excavation of PCB contaminated soil in the vicinity of MW-5 deserve consideration? For example, placement of a gravel layer at the base of the excavation with distribution piping and a standpipe at the surface could be used to deliver reagents periodically. Refer also to Page 3, Item 2b.	Concur this is a good suggestion. The following text (in red) was added to Section 4.1. Depending on the location, volume, depth, thickness, and magnitude of the silt contamination, it may also be advantageous to <u>overexcavate TCE-contaminated silt</u> , perform some mechanical mixing of the oxidant or reductant to increase its distribution in the silt, or alternatively to install an engineered solution, such placement of a gravel layer at the base of the excavation with distribution piping and a standpipe at the surface that could be used to deliver reagents periodically. Costs were not evaluated for this potential remedy component, because the costs are highly dependent on more complete characterization of the TCE contamination in the silt, in particular relative to

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			the horizontal and vertical location of PCB-
			contaminated soil. The detailed silt
			characterization has not yet been performed.
			Also, the recommended additional
			characterization paragraph in the executive
			summary and recommended alternative
			sections was revised as follows:
			Overall, it appears that additional plume
			characterization and implementation of the soil
			remedies would be beneficial before selecting a
			groundwater remedy. Additional plume
			characterization activities should include
			installing monitoring wells east of the Aniak
			Middle School building, west of the building in
			the vicinity of SGP-17 and SGP-18, and in
			several other locations as needed to complete
			characterization of both plumes and the silt layer.
			MNA parameter monitoring should be performed
			at low water level. Microbial community testing
			tor dehalococcoides organisms should be
			performed. Use of Bio-Trap® in-situ microcosms
			may be a cost-effective technique to assess the
			MNA potential, native microbiological
			community, and expected performance of

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			substrate amendment. During the PCB soil excavation in the vicinity of the former septic tank and truck fill, soil samples should also be analyzed for TCE. If high TCE concentrations are detected in the silt at the base of the PCB excavation, overexcavation of TCE-contaminated soil or direct treatment using a reductant (or possibly an oxidant) during the PCB soil excavation may be a very beneficial and cost- effective remediation strategy. Alternatively, depending on the location, magnitude, and extent of the TCE contamination and silt characteristics, installation of an engineered solution, such as placement of a gravel layer at the base of the excavation with distribution piping and a standpipe at the surface that could be used to deliver reagents periodically, may be warranted. Sampling details and a decision protocol should be incorporated into the excavation work plan
8. 26	4.2.1	Oasis states: "The primary current human health risk associated at this site is indoor air inhalation due to vapor intrusion into the Aniak Middle School Building." For the reasons discussed in comments to Section 1 (Comment #1), recommend revising to: "The primary current human health risk associated	Suggest the following revised wording to account for possible indoor air sources in addition to vapor intrusion: The primary current human health risk at this site is indoor air inhalation, due to vapor intrusion into the Aniak Middle School Building and

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		at this site is indoor air inhalation, possibly due in part to vapor intrusion into the Aniak Middle School Building and possibly due to an	possibly also due to an indoor air source(s).
		indoor air source(s)."	
9. 27	4.2.3	Last paragraph. Does Oasis think the seasonal saturation of the silt might result in rebound of TCE in groundwater if ISCO or ERD were employed as a remedy?	Rebound is anticipated, which is one of the reasons that four separate injection events are included in both the ISCO and ERD alternatives. The following changes were made to the text to better explain this. The following text (in red) was added in Section 4.2.3. In both plumes, approximately the top five feet of the groundwater treatment zone is expected to be saturated only seasonally (i.e., approximately from May through September; see Table 2-2). In addition, for a short period of time during spring breakup (i.e., approximately two weeks), the saturated interval is expected to extend up to another eight feet above the top of the groundwater treatment zone. The seasonal saturation is expected to potentially result in TCE rebound in the groundwater (see discussion in Section 4.2.5). The silt layer (discussed further below) whether saturated or not is expected to

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			have a relatively high moisture content and provide a fairly competent barrier to air flow, so significant aeration of the seasonally-saturated zone is not expected.
			The second-to-last paragraph in Section 4.2.4 was rewritten as follows:
			Although the seasonally-saturated silt layer is included in the groundwater remedial alternatives, remediation of the silt is expected to be difficult. Its hydraulic conductivity is estimated to be approximately three orders of magnitude lower than the hydraulic conductivity of the underlying sand layer. Its seasonal saturation is expected to result in a relatively high moisture content and a correspondingly low permeability to air. The remedial alternatives were designed to address the silt characteristics as discussed in Section Error! Reference source not found. Specifics of each groundwater alternative regarding silt remediation are discussed in Sections 4.4 through 4.7.
			New Section 4.2.5 was inserted:

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			4.2.5 Design Assumptions for the Injection Alternatives Allowances were made in the two injection alternatives, Alternative GW-3 (ISCO) and Alternative GW-4 (ERD), to address the seasonal TCE recharge and the low-permeability silt layer discussed in the previous sections. Both of the injection alternatives were designed to include four annual injection events. Each subsequent injection event will address seasonal TCE recharge that occurred since the previous injection event. The four separate injection events will allow better oxidant or reductant distribution in the low-permeability silt than a single injection event. The injection locations can be shifted for each subsequent injection event to account for the small radius of influence anticipated for each injection. Monitoring results from the first event will be used to optimize subsequent events to address the seasonal TCE recharge and low- permeability silt layer
10. 28	4.2.5	Without seeing a groundwater monitoring plan, the installation of 12 new wells for this site seems excessive given the low TCE concentrations, small size of the site, and	There are some significant data gaps remaining with respect to groundwater plume delineation at the site. The 12 new monitoring wells are based on the need to

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		infinited extent of highauon observed to date.	and 2.5.2.
			The actual number of new monitoring wells
			Ω ASIS contends that 12 is a reasonable
			approximation and the actual number is
			expected to fall within the $-50\%/+100\%$ cost
			range for this FS.
11. 28	4.2.5	Quarterly monitoring is likely impractical at Aniak.	Quarterly monitoring would be expensive at Aniak but may be needed to provide adequate detail about initial remedial system performance. Quarterly monitoring in the first year would also provide the data necessary to begin robust trend analysis using Mann-Kendall.
			In recognition of the difficulty and expense associated with quarterly monitoring at Aniak, the cost estimates assumed only one year of quarterly monitoring. Changing the monitoring frequency for one year would not be expected to affect overall remedy costs beyond the -50%/+100% range.

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12. 28	4.2.6	Should the type of institutional controls considered be expanded and/or other options considered in conjunction with MNA? e,g, shutdown of the Middle School well with substitution of alternative water supply from a new well or connection to the High School supply well?	If additional data collection suggests the plume may be migrating toward the Middle School well then well shutdown may indeed be worth considering. IC costs were not specifically included in the FS but would be included in the contingencies. The contingencies would be expected to cover an additional IC such as the one suggested by the reviewer.
13. 30	4.4.1	First bullet point, change DO and ORP concentrations to DO and ORP measurements or readings	OK
14. 30	4.4.1	Second bullet point, last sentence. Omit "significant".	ОК
15. 32	4.4.1	1st full paragraph. Should be 'ethene' rather than 'ethane'.	Yes
16. 33	4.5.1	Fourth Paragraph: Did Oasis consider that ISCO using potassium permanganate may mobilize constituents such as arsenic and chromium from the aquifer materials or whether such mobilization could pose a threat to the drinking water wells?	Literature research OASIS performed on this subject indicated that ISCO using potassium permanganate may increase groundwater concentrations of arsenic and chromium due to the presence of these metals in the KMnO4 (i.e., Huling and Pivetz, 2006). Apparently technical grade KMnO4 may contain elevated concentrations of As and Cr,

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			although remediation grade KMnO4 has
			been developed with lower As and Cr
			concentrations. Bench-scale testing and/or
			use of remediation grade KMnO4 is
			recommended to address this potential issue.
			In addition, changes in pH that could occur
			in conjunction with ISCO and also ERD can
			also mobilize metals from the soil or aquifer
			matrix. The following text was added at the
			end of Section 4.5.1.
			An additional consideration of ISCO at this site is
			the potential risk of introducing heavy metals
			such as arsenic and chromium, found as
			impurities in the KMnO ₄ , into the groundwater.
			Literature research (i.e., Huling and Pivetz, 2006)
			indicates that arsenic and chromium introduction
			could result in MCL exceedences, although
			adaquata reductions in accortable distances
			Remediation-grade KMnO4 has been developed
			that contains minute concentrations of heavy
			metals In addition changes in pH that could
			occur in conjunction with ISCO and also FRD
			can also mobilize metals from the soil or aquifer
			matrix. Bench-scale testing is recommended to

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			evaluate the risk of heavy metal introduction <u>or</u> <u>mobilization</u> , especially at this site with nearby drinking water wells.
			In addition, bench testing was specifically added as a requirement in the beginning of Section 4.5.2. New text in red below.
			Prior to completing the remedial design, bench- scale testing and a pilot test would be performed for ISCO at the Aniak WACS site. The primary goals of the bench-scale testing would be to evaluate the risk of heavy metal mobilization (such as arsenic and chromium) from the KMnO ₄ into groundwater and to more directly assess
			natural oxidant demand. The primary goals of the pilot test would be to assess realistic injection rates and oxidant distribution in the silt in the most highly-contaminated portion of the site (currently thought to be between the former truck fill area and SGP-17).
			<u>A similar paragraph was inserted into the</u> beginning of Section 4.6.2, as shown below. <u>Prior to completing the remedial design</u> , bench-scale testing and a pilot test would be

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			performed for ERD at the Aniak WACS site.
			The primary goals of the bench-scale testing
			would be to evaluate the performance of
			different electron donors (substrates) and
			bioaugmentation on reductive
			dechlorination using site soils and
			groundwater. The primary goals of the pilot
			test would be to assess realistic injection
			rates and substrate distribution in the silt in
			the most highly-contaminated portion of the
			site (currently thought to be between the
			former truck fill area and SGP-17). The
			effects of cold site groundwater temperatures
			on the reductive dechlorination process will
			also be evaluated.
17. 33	4.5.1	Second paragraph discussion of ISCO with	The "clogging" potential is discussed in the
		permanganate should discuss the potential of	fourth paragraph of this section, as excerpted
		aquifer clogging due to generation of	below.
		manganese oxides.	
			Injection of the permanganate oxidant mixture
			will also be inhibited by precipitation of dissolved
			metals, and permanganate particles will result in
			temporary permeability loss in the already low
			permeability silt. However, the presence of some
			permanganate particles may be beneficial in that

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Tage	beenon		they can provide a source that will dissolve once
			in the aquifer, thereby extending the half-life of
			the oxidant in the aquifer. The distribution issues
			will likely result in the necessity to inject the
			oxidant several times to complete remediation.
18. 33	4.5.1	Given the relatively high natural potassium	Concur that other oxidants besides
		permanganate oxidant demand indicated by	potassium permanganate may be considered
		Shannon and Wilson's testing, a combination	for use at the site. For example, the Regenesis
		of unactivated persultate and bicarbonate	product Regenox does not oxidize plant
		pormanganate, while cortainly longer lasting	matter and some other carbon, so the overall
		in many cases has higher ovidant demand than	consumption of oxidant on NOM is not as
		unactivated persulfate	great as with permanganate. However, it is
			likely that the reduction in oxidant
			requirements would be offset by the increase
			in oxidant price. All of this would be
			expected to fall within the -50%/+100% cost
			range. If ISCO were selected as the remedy
			for the site, the actual oxidant selection
			would be based on a pilot study.
19. 34	4.5.2	Third paragraph, third sentence. Add a space	OK
		between "of" and "approximately."	
20. 34	4.5.2	The basis for evaluation assumes a 15 ft radius	As discussed in response to Comment #9,
		of influence and injection at rates up to 20 liters	OASIS agrees that injection into the silt is
		per minute. Considering the assumed	likely to be difficult and a 15-ft radius of
		properties of the silt, both of these assumptions	influence is optimistic The four planned

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		are highly optimistic. The injected fluids will likely follow preferential pathways, including induced soft sediment fractures, limiting the contact with much of the silt mass.	injection events will allow optimization of subsequent injection locations to decrease injection spacing as warranted by site conditions based on performance monitoring results.
21. 35	4.6.1	Consider the applicability of high-viscosity substrates in a low temperature aquifer.	The cost analysis was based on HRC injection, in part because Regenesis provides a good calculation tool. However, as discussed in Section 4.6.2, OASIS recognizes that HRC may not be the substrate selected for this project and concurs that a high- viscosity substrate is probably not ideal. There are several low viscosity substrates on the market. The actual substrate selection will be based on a pilot test. Substrate selection should not affect the cost estimate beyond the -50%/+100% cost range for this FS.
22.	4.6	Literature research indicates that low aquifer temperatures (5-6 °C) may adversely affect microbial activity such that EAB may be stalled at cis-1,2-DCE or vinyl chloride. Accumulation of either or both daughter products is a significant concern.	OASIS has experience with a low aquifer temperature site in which ERD has been used successfully; however, the groundwater temperatures in Aniak do appear lower than at the other site. OASIS expects that the cold temperatures will slow microbial activity
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			it. The low aquifer temperatures are one of
			the reasons for the recommendation for a
			Bio-Trap study in the short-term and a pilot
			study before selecting the final remedy for
			this site. The following text was added to
			Section 4.6.1 to specifically address concerns
			with temperature.
			A third consideration for enhanced
			low groundwater temperatures. The dataloggers
			recorded a temperature range between
			approximately 2°C and 4°C over the period
			between May and October 2011, although manual
			temperature readings were as high as 7°C. As
			discussed in Section Error! Reference source
			would help evaluate the potential effectiveness of
			enhanced bioremediation in the cold groundwater
			temperatures found at this site.
			OASIS' experience at the other site is related
			below for the reviewer's information.

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			in dead at all at a a 12 DCE (and 2 Fragme
			(different time from as appendiated with
			different course areas and different initial
			and the source areas and uniferent initial
			geochemical conditions), nowever, after that,
			ethene generation. There was a relatively
			short lag period between vinyl chloride
			generation and ethene generation
			generation and energe generation.
			At this other site, OASIS and the client
			concluded that the cold aguifer temperatures
			were not the primary reason for the stall,
			although they certainly contribute to the long
			treatment time. Rather, the proper
			geochemical conditions had not yet been
			established, and/or the proper
			microbiological community was not
			adequately established.
23. 36	4.6.2	Recommend assuming that bioaugmentation	Concur; bioaugmentation was added to the
		will be necessary, both in the approach	approach discussion and cost estimate.
		discussion and in cost estimate.	Revised text shown below.
			This alternative also includes bioaugmentation
			(i.e., injection of appropriate microbial

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			community [DHC organisms]) for complete reductive dechlorination of TCE to ethene. The presence or absence of DHC organisms is unknown at this site, but bioaugmentation was included in the cost estimate. Bioaugmentation is relatively inexpensive relative to the entire project cost, and it may assist and will not hurt reductive dechlorination at the site. For costing purposes, three bioaugmentation events each of 100 liters of KB-1® dechlorinator was assumed. The KB-1® would be injected into one of the substrate injection rows; i.e., 3 injections in the MW-4 plume and 7 injections in the MW-5 plume. KB-1® injection should not occur until the aquifer has been driven anaerobic; therefore the bioaugmentation was considered to occur in years 1 through 3. KB-1® is a naturally occurring, non-pathogenic microbial culture that contains DHC, the only group of microorganisms documented to promote the complete dechlorination at sites that do not contain DHC (or the right DHC) and to accelerate dechlorination rates to achieve treatment goals. As with the other assumptions in this FS,
			dechlorination at sites that do not contain DHC (or the right DHC) and to accelerate dechlorination rates to achieve treatment goals. As with the other assumptions in this FS, selection of the actual microbial consortium for

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-			injection would occur after additional characterization and in conjunction with a pilot test.
24. 39	5.	Consideration should be given to scenarios under which the school is replaced and/or demolished when the local airport runway is expanded. Should this long-term expectation be considered in scoring the remedies?	Although the airport's 20-year plan does include moving the runway closer to the site and removing the school building, there has been no funding commitment on this project to-date. Our understanding is the School District plans to continue using the building in the foreseeable future. Therefore, we do not feel like this potential future scenario can be incorporated into the FS at his point.
25. 41	Table 5.1	GW-2 – MNA is less prone to a 100% upside estimate exceedance than other remedies. MNA costs are not nearly as likely to risk a 100% overrun. If adjusted for such relative risk, MNA's total score and cost effectiveness quotient increases relative to any other alternative remedy.	The cost range is selected based on the EPA guidance document and is appropriate for the level of characterization at the site, as described in Section 4.2.8. The greater the data gaps, the greater the range. The range is not intended to be remedy specific.
26. 41	Table 5.1	GW-3 – Long-Term Effectiveness and Permanence. The relative degree of TCE contamination in the Silt, seasonal saturation of the Silt, combined with the relatively short anticipated half-life of dissolved potassium permanganate (relative to groundwater	As discussed in Section 4.2.3, the four injection events are intended to address TCE rebound and the difficulty of oxidant distribution in the silt.

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Section	fluctuations at the site) indicate that this	Scores are intended to be relative between
	remedial technology could be subject to	different alternatives, and OASIS contends
	rebound of TCE concentrations in	that ISCO is expected to have more of a "4"
	groundwater. Recommend reducing score	rather than "3" level LTE & permanence,
	from '4' to '3'.	relative to ERD and sparging.
Table 5.1	GW-3 – Implementability. The discussion of	OASIS contends that ISCO can be
	ISCO presented in the FS raises serious doubts	successfully implemented at the site;
	whether this technology can be successfully	however, the radius of influence is expected
	implemented in the silt and doesn't support a (2)	to be small and may require multiple
	score of 3. Recommend reducing score to 2.	injections as scoped in the FS.
		As discussed with comment #26, the scores
		are relative between different alternatives.
		OASIS contends that ISCO and ERD are
		equally implementable, because the silt is
		expected to have a relatively equal influence
TT 11 F 4		on both of these injection-type alternatives.
Table 5.1	GW-4 – Reduction in Toxicity. EAB may not be	Short-term accumulation of daughter
	aquifer temperature due to potential cis-1 2-	products, cis-1,2-DCE (primarily) and
	DCE or VC stall. Recommend reducing this	possibly also vinyl chloride would be
	score to '2'.	anucipated with EKD. However, snort-term
		filtering sustants. In the long term, this
		remody is expected to result in complete
		reductive dechlorination of all the TCF
	Section Table 5.1 Table 5.1	SectionSectionfluctuations at the site) indicate that this remedial technology could be subject to rebound of TCE concentrations in groundwater. Recommend reducing score from '4' to '3'.Table 5.1GW-3 - Implementability. The discussion of ISCO presented in the FS raises serious doubts whether this technology can be successfully

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			daughter products.
			OASIS contends that ERD is expected to
			have more of a "3" rather than "2" level
			reduction in toxicity.
29. 41	Table 5.1	GW-5 – Implementability. The discussion of air sparging presented in the FS raises serious doubts whether this technology can be successfully implemented in the silt and doesn't support a score of '3'. Recommend reducing score to '1'.	Concur that air sparging is less implementable than ISCO and ERD and suggest reducing score to "2." OASIS contends that air sparging is expected to be implementable in areas where the silt layer is incompetent or absent but may not be implementable where it is competent. The competence of the silt is not known adequately to support a score of "1."
30. 45	5.3.2.3	Ten years versus 20 years versus 35 years tempers the significance of relative "speed."	The scores for short-term effectiveness express this tempering by providing little differentiation between alternatives.
31. 47	5.4	At the top of this page, TCE solubility is noted as 1.3 mg/L. This should be 1,100 mg/L	OK
32. appendix	HRC costing sheets	The hydraulic conductivity used in the HRC costing does not use hydraulic conductivity values consistent with estimates in the text. This is especially apparent in the case of the silt, since a hydraulic conductivity for the silt	For the sand, the text shows a geo mean K value of 155 ft/day versus 100 ft/day in the HRC costing sheet. This difference is insignificant.

			Comment Response
Comment #, Page	Section	DRAFT Comment/Recommendation	
		zone costing used a value of 40 ft/day, while the text presents an estimated value of 0.03 ft/day	The value of 40 ft/day was used for the "silty sand" scenario, not silt. For the "silty sand," the assumption is 5' of silt and 10' of sand. In the text, the sand K is 155 ft/day and silt is 0.03 ft/day. In this scenario, most of the groundwater flow will occur in the more highly-permeable sand layer. A value of 40 was chosen to acknowledge some decrease in "average" hydraulic conductivity due to the silt layer while recognizing that the effective K value will be skewed toward the sand value, because most of the flow will occur in the sand.