2010 Groundwater Monitoring Report

Lockheed Martin Tallevast Site

Prepared for:

Lockheed Martin Corporation

Prepared by:

ARCADIS

February 9, 2011

Engineers Certification

This 2010 Groundwater Monitoring Report for the Lockheed Martin Tallevast Site (also known as the Former American Beryllium Company Site) located at 1600 Tallevast Road in Manatee County, Florida has been prepared in accordance with good scientific and engineering practices by individuals under my direct supervision and me. No other warranty is implied or intended.

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Acronyms, Abbreviations, and Units of Measurement

ABC	American Beryllium Company
AF	Arcadia Formation
AF Gravels	Upper AF Gravels Unit in the Intermediate Aquifer System
BBL	Blasland, Bouck & Lee, Inc.
°C	Celsius
cis-1,2-DCE	cis-1,2- dichloroethene
COC	contaminants of concern
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
DO	dissolved oxygen
F.A.C.	Florida Administrative Code
Facility	Lockheed Martin Tallevast Facility
Floridan	Upper Floridan Aquifer
FDEP	Florida Department of Environmental Protection
ft	feet
ft bgs	feet below ground surface
ft/ft	feet per foot
ft msl	feet mean sea level
GCTL	Groundwater Cleanup Target Level
GeoTrans	GeoTrans, Inc.
GWMR	2010 Groundwater Monitoring Report
IAS	Intermediate Aquifer System
ICP	Inductively Coupled Plasma
ID	Isotope Dilution

IRA	Interim Remedial Action
IRAP	*Interim Remedial Action Plan*
ISCO	*in situ* chemical oxidation
Lockheed Martin	Lockheed Martin Corporation
Lower AF Sands	Lower AF Sands unit within the Intermediate Aquifer System
LSAS	Lower Shallow Aquifer System
LTWLM	Long-Term Water Level Monitoring
MCAWW	Methods for Chemical Analysis of Water and Wastes
MCL	Maximum Contaminant Level
µg/L	micrograms per liter
mL/min	milliliters per minute
MS/MSD	matrix spike/matrix spike duplicate
NADC	Natural Attenuation Default Criteria
ORP	oxidation reduction potential
PCE	tetrachloroethene
PRF	Peace River Formation
QA/QC	quality assurance/quality control
RAP	*Remedial Action Plan*
RFPP	reverse flow peristaltic pump
S&P Sands	Salt & Pepper Sands in the Intermediate Aquifer System
SARA	*Site Assessment Report Addendum*
SAS	Surficial Aquifer System
SIM	selective ion monitoring
Site	The “Site” consists of both the Tallevast Facility and the surrounding area’s groundwater impacted by contaminants of concern (COCs)
SM	Standard Methods for the Examination of Water and Wastewater
SOP	Standard Operating Procedure
TCE	trichloroethene
TDS	total dissolved solids

TPOC	temporary point of compliance
UIC	underground injection control
USAS	Upper Surficial Aquifer System
USD	undifferentiated surficial deposit
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

Section 1

1. Introduction

This *2010 Groundwater Monitoring Report* (GWMR) contains a description of groundwater monitoring activities, analytical results, and interpretations of the nature and extent of specific compounds at the Lockheed Martin Corporation (Lockheed Martin) Tallevast Site [previously described as the former American Beryllium Company (ABC) Facility] located at 1600 Tallevast Road in Tallevast, Manatee County, Florida. The Site consists of both the Tallevast Facility (referred to as the "Facility" or "on-facility" portion of the Site) and the affected groundwater in the surrounding area (referred to as the "off-facility" portion of the Site).

Figure 1-1 is a site location map showing the entire study area (Site). Figure 1-2 is a map of the vicinity surrounding the Tallevast Facility. The assessment and cleanup tasks are being conducted pursuant to the requirements detailed in Consent Order No. 04 1328 executed by and between Lockheed Martin and the Florida Department of Environmental Protection (FDEP), effective July 28, 2004. The assessment activities described in this annual GWMR comply with applicable sections of Chapter 62-780, Florida Administrative Code (F.A.C.).

Lockheed Martin acquired ownership of the Facility through its 1996 acquisition of Loral Corporation, the parent company of ABC. Lockheed Martin ceased operations in 1997 and, in 2000, sold the former ABC Facility to BECSD, LLC. Lockheed Martin leased the property from BECSD in July 2007 and in June 2009, purchased it from BECSD, LLC.

Lockheed Martin submitted a *Remedial Action Plan* (RAP) to FDEP on May 4, 2007 in accordance with applicable sections of Chapter 62-780, F.A.C., Contaminated Site Cleanup Criteria. The FDEP commented on the RAP in a letter dated July 27, 2007. On September

11, 2007, Lockheed Martin requested a time extension to respond to the FDEP RAP comments. Lockheed Martin proposed supplemental field activities in a meeting with FDEP on September 27, 2007. In a letter dated October 2, 2007, FDEP granted the extension request and Lockheed Martin subsequently completed the supplemental field activities.

A revised RAP incorporating the results of the supplemental field activities was submitted to FDEP on August 29, 2008. The FDEP commented on the revised RAP in a letter dated March 16, 2009. Lockheed Martin responded by submitting a RAP *Addendum* on July 14, 2009 (ARCADIS, 2009b). A RAP approval order was issued by FDEP in a November 4, 2010 letter.

Annual groundwater monitoring events were conducted in December 2006 and January/February 2008 to collect data for use in making remedial action decisions during development of the 2007 and 2008 RAPs. An annual groundwater monitoring event was conducted in March/April 2009 to support preparation of the July 2009 RAP Addendum. Annual groundwater monitoring will continue until the approved remedial action is implemented at the Site and the appropriate monitoring associated with the approved remedial action begins. The 2010 sampling event was conducted to satisfy the annual monitoring requirement for calendar year 2010.

1.1 Objectives

Objectives of the 2010 groundwater monitoring event included the following:

- Periodically obtain data to monitor the characteristics and extent of the groundwater plume.
- Obtain analytical data to generate an Interim Redial Action Plan (IRAP) quarterly groundwater monitoring report [in accordance with the April 25, 2006 FDEP approved IRAP (BBL 2006)].

- Obtain analytical data to comply with In Situ Chemical Oxidation (ISCO) Pilot Test Underground Injection Control (UIC) monitoring requirements (in accordance with the UIC monitoring program outlined in the April 25, 2008 Interim Data Report – In Situ Pilot-Study (ARCADIS, 2008b), the In Situ Pilot Study Work Plan (ARCADIS, 2008a), and the May 14, 2008 internal FDEP memo from Simone Core, P.E. to Bill Kutash).

- Obtain analytical data to verify or adjust the temporary point of compliance (TPOC) on an annual basis. [Note that the TPOC is the boundary of all COC GCTL lines in each affected aquifer projected to the ground surface. The outermost edge of these lines is composited and is used to establish the proposed TPOC line.]

Only the field sampling and analytical data collected to monitor the characteristics and extent of the plume (referred to as the annual event) are discussed in detail below. Information collected to satisfy other program requirements may be found in the quarterly IRAP report (ARCADIS, 2010) and a pending UIC monitoring report. Some minor portions of data collected under these other programs are presented in the GWMR when they augment analysis and understanding of the annual event data. Validated laboratory analytical reports and data assessment reports for the annual and Interim Remedial Action (IRA) programs and analytical reports for the UIC program are included as Appendix A.

This 2010 GWMR includes potentiometric contour maps constructed using groundwater elevations measured in August and September 2010, contaminant of concern (COC) concentration contour maps constructed using analytical results for samples collected in September 2010, and concentration vs. time plots for selected wells. This report also includes water level and groundwater sampling logs, chain-of-custody forms, and historical data tables in appendices. Based on analysis of results obtained from this and prior sampling events, this report also contains recommendations for future annual groundwater sampling events and analyses.

1.2 Summary of Activities Included in 2010 GWMR

The groundwater monitoring program described in this report consists of the following primary activities:

- 2010 comprehensive water level monitoring event. This task is referred to as the August and September 2010 comprehensive water level event. Both the raw data and interpreted potentiometric surface maps are presented herein.

- 2010 comprehensive groundwater sampling event. The 2010 comprehensive groundwater sampling event was conducted in September 2010. The comprehensive event is comprised of annual, UIC, and IRA sampling components. The 2010 sampling event analytical data, associated maps, summaries, and interpretations are presented herein.

Figure 1-3 is a map showing the location of groundwater extraction and monitoring wells and open private wells within the Site. There are 180 monitoring wells and private wells listed in the July 2009 RAP Addendum that were scheduled to be sampled during the 2010 comprehensive groundwater sampling event (see Table 1-1 of this report and Table 13-1 of the RAP Addendum). The only modifications to this list of wells that occurred during the 2010 sampling event included the following:

- Addition of monitoring well MW-255 (replacement well for private well 2411 Tallevast Road) and private well 2411 Tallevast Road Well #2 (replacement well for MW-218)

- Deletion of private well 2105 Tallevast Road, private well 2411 Tallevast Road, and monitoring well MW-218 due to abandonment of these wells

- Inclusion of the analytical results for the 10 quarterly IRA extraction wells sampled concurrently with the other wells in the annual event

In addition to the 180 wells proposed to be sampled for the annual event, the 45 wells that are sampled for the quarterly IRA program are listed in Table 2-2. The 31 wells that are sampled for the quarterly UIC program are also listed in Table 2-2. All of these wells (except for two monitoring wells and five pilot test wells sampled for the UIC program and 10 extraction wells sampled for the IRA program) are a subset of the wells sampled for in the annual program.

A summary of the well types that were sampled in 2010 for each of the sampling programs is provided below.

Well Type	Annual Program	UIC Program	IRA Program	Unique Wells Sampled in 2010 Comprehensive Groundwater Event
Monitoring Wells	165	16 *	35	167
Extraction Wells	10	10	10	10
Private Wells	7	0	0	7
Piezometers	7	0	0	7
Pilot Test Wells	0	5 *	0	5
Subtotal	189	31	45	196

* MW-3, MW-4, CO-A1D, CO-B1D, CO-B4D, CO-C1D, and CO-D1D were sampled as part of the UIC program, but are not part of the annual monitoring event.

In summary, the wells sampled for each type of event follow:

- 196 total wells sampled in the 2010 comprehensive groundwater event
- 189 wells sampled as part of the annual event

- 31 wells sampled as part of the UIC event (24 wells also part of the annual event and 7 wells unique to the UIC event)
- 45 wells sampled as part of IRA event (all part of the annual event as well)

1.3 Overview of Site Hydrogeology

The regional hydrogeologic setting is described in this section. There are three main lithostratigraphic units, which are further subdivided for monitoring purposes into hydrogeologic units and water-bearing zones. The lithology, physical characteristics, and hydrostratigraphic characteristics of each of the units is summarized on Figure 1-4. From the surface downward, the geologic units underlying southern Manatee County consist of the following:

- Undifferentiated surficial deposits (USD) (Pleistocene to Recent).
- The Hawthorn Group, consisting of the Peace River Formation (PRF) and the Arcadia Formation (AF) (Miocene to Oligocene). The AF consists of an upper undifferentiated section and the lower Tampa Member.
- A thick sequence of marine carbonates (limestone and dolomite) exists below the Tampa Member of the AF and includes the Suwannee Limestone (Oligocene), Ocala Limestone (Eocene), and the Avon Park Formation (Eocene), (not shown on Figure 1-4).

The main geologic units listed above have been further subdivided into the local hydrogeologic units and water-bearing zones listed below. More detailed descriptions are presented on Figure 1-4. Characteristics of these systems are briefly described below.

- Surficial Aquifer System (SAS) – The unconfined surficial aquifer overlying the Hawthorn Group.

  - Upper Surficial Aquifer System (USAS) – The unconfined surficial aquifer, consisting of unconsolidated Pleistocene to recent siliciclastic sand units with up to 20 percent fines.

- Intermediate Aquifer System (IAS) and Confining Units – The confined aquifers overlying the Upper Floridan Aquifer (Floridan). This aquifer system is made up of strata from the Hawthorn Group, which is comprised of the PRF and the AF.

  - Lower Shallow Aquifer System (LSAS) – The uppermost portion of the PRF, the top of which is indurated limestone/calcareous rock, known locally as the Hard Streak. The LSAS consists of a series of interbedded limestone, clay, and carbonate mudstone units. The LSAS is generally encountered around 30 feet below ground surface (ft bgs).

  - Venice Clay – The lower portion of the PRF, consisting of siliciclastic to calcareous clays with a distinctive greenish-grey to olive color.

  - Clay/Sand Zone 1 – The uppermost sub-unit of the AF, consisting of a series of low-permeability carbonate mudstones.

  - Upper AF Gravels (AF Gravels) – A fractured to vuggy carbonate unit approximately 100 ft bgs in the AF. This unit is significantly more permeable than the overlying and underlying AF units, and is usually identified in drilling logs as “wet.” Hereafter, the term AF Gravels is only used to refer to the Upper AF Gravels.

  - Clay/Sand Zone 2 – A sub-unit of the AF consisting primarily of low-permeability carbonate mudstones.

  - Salt & Pepper (S&P) Sands – A sub-unit of the AF characterized by increased sand content and dark phosphatic sand grains, which give it a black and white speckled (salt and pepper) appearance. The S&P Sands are more permeable than the overlying and underlying units, but less permeable than the AF Gravels. It is generally found approximately 145 ft bgs.Clay/Sand Zone 3 & 4 and Lower AF Gravels - A sub-unit of the AF consisting of a series of low-permeability calcareous mudstones and underlying a somewhat higher permeability carbonate (Lower AF Gravels).

- Lower AF Sands – A sub-unit of the AF containing an increased percentage of sand sized particles and located approximately 280 ft bgs.
- Clay/Sand Zone 5 – A sub-unit of the AF consisting of a series of calcareous mudstones.

In addition to the SAS and IAS, the underlying Floridan (Oligocene) is monitored at seven locations across the Site. The Floridan consists of the Tampa Member of the AF, the Suwannee and Ocala Limestones, and the upper part of the Avon Park Formation (Tetra Tech 2005). The Floridan is comprised of a series of limestone to dolomite units, which are used for local water supply and irrigation wells.

1.4 Description of Contaminants of Concern

Groundwater COCs at the Facility have been defined as 1,4-dioxane; trichloroethene (TCE); tetrachloroethene (PCE); cis-1,2-dichloroethene (cis-1,2-DCE); 1,1-dichloroethene (1,1-DCE); and 1,1-dichloroethane (1,1-DCA). Additional compounds with concentrations greater than the Florida Groundwater Cleanup Target Levels (GCTLs) were identified during the March/April 2009 sampling event. Concentrations of methylene chloride, dibromochloromethane, bromodichloromethane, and vinyl chloride detected in groundwater samples in March/April 2009 exceeded the GCTLs thus these compounds were added as Site COCs in the 2009 RAP *Addendum*. Methylene chloride, dibromochloromethane, and bromodichloromethane were not detected at concentrations greater than GCTLs in the September 2010 event and are not considered further in this report.

The applicable criteria for each COC, the GCTLs, and Natural Attenuation Default Criteria (NADC), are listed below. Concentrations of compounds other than the COCs listed below that were detected during the monitoring event were also compared to the GCTLs and their results shown in report tables (Table 2-3).

Contaminants of Concern	**Groundwater Cleanup Target Levels (µg/L)[1]**		**Natural Attenuation Default Criteria (µg/L)**
	G-II Aquifer	**Basis**	
1,4-Dioxane	3.2	Minimum Criteria	320
PCE	3	Primary MCL[2]	300
TCE	3	Primary MCL	300
Cis-1,2-DCE	70	Primary MCL	700
1,1-DCE	7	Primary MCL	70
1,1-DCA	70	Minimum Criteria	700
Vinyl Chloride	1	Primary MCL	100

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[1] µg/L— micrograms per liter

[2] MCL— Maximum Contaminant Level

2. 2010 Comprehensive Groundwater Sampling

ARCADIS personnel began the 2010 comprehensive groundwater monitoring and sampling event on August 30, 2010. The IRA and UIC ISCO quarterly sampling events were conducted concurrently with the annual event. Field personnel vented accessible wells on the first day of the event (August 30), allowed the water levels to stabilize for up to 24 hours, and then gauged the water level on the following day. Surface water levels were also measured at accessible staff gauges and stilling wells. Most monitoring well water levels were measured on August 31; however, 48 of the monitoring wells located in low areas northeast and southeast of the Facility could not be gauged on August 31 because they were inaccessible due to localized flooding caused by heavy rainfall. Consequently, three smaller gauging events occurred on September 7, 8, and 13 after the water receded. Since 1 to 2 weeks had elapsed since the August 31 water level measuring event, additional water levels were measured on September 8 and 13 in previously gauged wells surrounding the flooded areas for comparison with the August data.

Water levels were eventually measured in 279 wells during the gauging events. Only four targeted monitoring wells (MW-82, MW-88, MW-147, and MW-250) did not have water levels measured in this time frame for reasons described below.

MW-147 and MW-250 initially could not be located because these wells were buried under fill material. MW-250 was ultimately located and sampled as part of the annual monitoring program, but the water level obtained at that time was not used for the annual water level data set because it was collected after September 13. MW-147 could not be located, is not part of the annual monitoring program, and will not be targeted for water level measurements in the future.

The well pads at MW-82 and MW-88 were underwater on August 31 during the initial gauging event. The water level was measured in MW-82 on September 10, 2010 during the annual monitoring program and was added to the annual water level data set because it was measured before September 13. The water level in MW-88 was not collected as this well is not included in the annual monitoring program and therefore was not revisited before September 13.

Additionally, water levels were not gauged at four staff gauges and five stilling wells because they were submerged. The water level measured in Stilling Well 2 on September 3, 2010, when the transducer was downloaded for the Long-Term Water Level Monitoring (LTWLM) program, has been added to the annual water level data set because it was measured before September 13. Table 2-1 provides the well completion information and the August/ September 2010 groundwater and surface water level measurements. Water level measurement logs are included in Appendix B.

Groundwater sampling for the annual, UIC, and quarterly IRA programs began on September 1, 2010, and was completed on September 27, 2010. Most of the sampling was completed by September 17 except for wells located on the airport property and irrigation well MW-203 located east of the Facility and just north of Tallevast Road. The airport wells were sampled on September 22 after property access was obtained. Sampling of well MW-203 was delayed because of localized flooding in the area and because the down-hole pump did not operate during initial sampling. The well was sampled on September 27 after the electricity was restored to operate the pump. Figure 1-3 shows the locations of extraction wells, monitoring wells, private wells, piezometers, staff gauges, and stilling wells associated with the Tallevast Site. Table 2-2 lists the wells sampled during the September 2010 event. The following sections describe sampling methods, laboratory analytical methods, and data validation procedures.

2.1 Sampling Methodology

Groundwater sampling was conducted in accordance with FDEP Standard Operating Procedure (SOP) FS 2200 Groundwater Sampling, revision date March 31, 2008. Three FDEP SOP sampling scenarios were used during the annual sampling event, two for well screens completely submerged (Options 1a and 1b) and one for well screens partially submerged (Option 2b). Most Site wells have completely submerged well screens that are 10-feet or less in length and were sampled using the minimal purge volume method (Option 1a). However, several Site monitoring wells have 20-foot submerged well screens. These wells were sampled using the conventional purge method (Option 1b). A variable speed submersible pump was used for purging and sampling these wells because of the depth to water (which can be more than 20 ft bgs) and quantity of water purged. A few site wells have partially submerged screens which required the use of Option 2b.

In accordance with the SOP, purging was conducted as follows for the three FDEP SOP sampling scenarios:

Well Screen Completely Submerged (FDEP SOP Option 1a: Minimal Purge Volume): Dedicated tubing was connected to a peristaltic pump and the bottom of the tubing was set at mid-screen. At least one equipment volume was purged before the first set of stabilization parameters was recorded. Subsequent stabilization parameters were recorded no fewer than two to three minutes apart. The SOP requires that at least three equipment volumes are purged.

Well Screen Completely Submerged (FDEP SOP Option 1b: Conventional Purge): These wells were purged and sampled using a submersible pump. The pump was placed at the top of the water column. At least one well volume was removed before the first set of stabilization parameters was recorded. Thereafter, one quarter of a well volume was purged between stabilization parameter readings.

Well Screen Partially Submerged Wells (FDEP SOP Option 2b): This procedure is the same as that for Option 1a with two exceptions: the bottom of the tubing is set in the middle of the saturated portion of the screen and one well volume must be removed before the first set of stabilization parameters is recorded.

Wells that are sampled with peristaltic pumps are equipped with dedicated tubing which was inspected and replaced if necessary.

At each monitoring well, a copy of FDEP Form FD 9000-24 Groundwater Sampling Log was completed. These forms include entries for field measurements as wells as observations and other notes from the samplers. Completed groundwater sampling logs are included in Appendix B. Equipment used for field measurements was calibrated in the morning before beginning sampling and a calibration check was conducted in the afternoon after sampling was completed for the day. Equipment primarily used in the field included a LaMotte 2020e for turbidity and a YSI 556 multimeter for all other parameters. While most teams used this standard set of equipment, other types of field meters were used including a HACH 2100P, YSI 55, Oakton Acorn pH6 meter, Oakton Acorn CON6, and LaMotte 2020.

The following procedures were conducted at each monitoring well during purging and sampling. A containment system was set up around the flow-through cell prior to purging. After the well water level was gauged, the pump tubing was connected to the flow-through cell (the cell that comes with the instrument or any other container that allows water to flow past the meter probes). After purging was initiated, the pump speed was adjusted to allow the water level in the well to stabilize. A specified number of equipment volumes or well volumes were purged depending on the FDEP sampling scenario (discussed above) used to sample the well. Calculations for equipment volume and well volume were recorded on the groundwater sampling log. At pre-determined intervals during purging, field measurements were collected per FDEP SOP FS 2212 (Well Purging Techniques) for the following parameters: pH, specific conductance, dissolved oxygen (DO), temperature, and turbidity. Oxidation reduction potential (ORP) readings were also collected, but were not used in determining well water stability. Purging continued until stabilization criteria were met (at least three sets of readings within FDEP SOP-approved ranges).

After stabilization criteria were met, a groundwater sample was collected. For wells sampled with peristaltic pumps, first, metals and inorganic sample bottles were filled through the pump head. Then, volatile organic compound (VOC) and 1,4-dioxane vials were filled using the reverse flow peristaltic pump method (RFPP or straw method). The RFPP steps include: turn the pump off; disconnect the tubing from the flow-through cell and remove the tubing from the well; and reverse the pump flow direction to allow the water to flow from the bottom of the tubing into the VOC and 1,4-dioxane vials. After samples were collected, the dedicated tubing for the peristaltic pump was returned to the well and the well was properly secured.

For wells sampled using a variable speed submersible pump, the metals, inorganic, VOC, and 1,4-dioxane samples were collected using the submersible pump. The pump was then removed from the well and decontaminated according to FDEP SOP FC 1000 before use in the next well.

In addition to monitoring wells, extraction wells and private wells were sampled during this event. The ten extraction wells associated with the IRA treatment system were sampled via dedicated sample ports located inside the IRA treatment system building. Prior to sample collection, at least 0.25 gallon was purged from each sample port.

Six private wells with spigots were tested. Samples were collected from the private wells following FDEP SOP FS 2215 (Purging Wells with Plumbing). The spigot and pump were turned on and a volume of water sufficient to clear the line was purged. Flow rate was then reduced to less than 500 milliliters per minute (mL/min) and samples were collected. One private irrigation well (2411 Tallevast Rd Well #2) did not have a pump when it was sampled. Therefore, tubing was placed down the well into the open borehole portion and a peristaltic pump was used to purge 2 gallons (more than two equipment volumes) before collecting a sample.

ARCADIS field staff collected the following quality assurance/quality control (QA/QC) samples: two equipment blanks, 10 field blanks, 11 sets of matrix spike/matrix spike duplicate (MS/MSD) samples, and 13 blind duplicate samples. Trip blanks were placed in most coolers containing VOCs to evaluate potential impacts to samples during transport.

Samples were placed into insulated coolers and maintained at temperatures below 4 degrees Celsius (°C). The coolers were sealed and the contained samples were delivered to TestAmerica Laboratories in Tampa, Florida for laboratory analysis. The coolers and samples were delivered to the laboratory under appropriate chain-of-custody procedures. Chain-of-custody forms are included in Appendix A.

All groundwater purged during monitoring well sampling was stored in containers within secondary containment. Purged water was later transferred and treated through the on-facility IRA treatment system. All disposable equipment including personal protective equipment was placed into labeled 55-gallon drums for appropriate off-site disposal.

2.2 Laboratory Analytical Methods

Unless otherwise stated, the annual groundwater monitoring event samples were analyzed for VOCs by United States Environmental Protection Agency (USEPA) Method 8260B and for 1,4-dioxane by USEPA Method 8260C Selective Ion-Monitoring by Isotope Dilution (SIM ID).

In addition to the annual groundwater monitoring event, wells were also sampled in September 2010 as part of the UIC or IRA quarterly monitoring event. Most wells included in the UIC and IRA programs were also scheduled to be sampled for the annual sampling event. Seven of the 31 monitoring wells for the UIC program were only sampled under the UIC program and not for the annual event. The 10 extraction wells sampled for the IRA quarterly monitoring event included the annual event analytical parameters, but had additional parameters analyzed that were unique to the IRA quarterly monitoring. The additional analyses included for those wells sampled under the IRA and/or UIC sampling programs are:

- IRA— The 10 extraction wells included in the IRA quarterly monitoring were analyzed for metals by USEPA Inductively Coupled Plasma (ICP) Method 6010B (aluminum, arsenic, beryllium, cadmium, chromium, copper, iron, lead, nickel and zinc).

- ISCO UIC— Wells included in the ISCO UIC monitoring were analyzed for metals by USEPA ICP Method 6010B (aluminum, arsenic, beryllium, cadmium, chromium, copper, iron, manganese, lead, nickel, sodium and zinc); sulfate by Methods for Chemical Analysis of Water and Wastes (MCAWW) Method 300.0; and total dissolved solids (TDS) by Standard Methods for the Examination of Water and Wastewater (SM) Method 2540C.

All samples were analyzed at TestAmerica laboratories in Tampa, Florida. Analytical results from the IRA samples were presented in the November 2010 *Interim Remedial Action Monitoring Report* (ARCADIS, 2010). Analytical results associated with the ISCO UIC monitoring program will be presented in a future UIC monitoring report. Table 2-2 provides a listing of the wells included in the IRA and ISCO UIC sampling programs.

The laboratory reports for the annual monitoring event samples are included in the data review summaries in Appendix A. Analytical data from the annual event are summarized in Table 2-3. Analytical results associated with the annual monitoring event are discussed in Section 3 below.

2.3 Data Validation/QC Summary

Data validation was performed by ARCADIS on the September 2010 annual groundwater monitoring data for VOCs, 1,4-dioxane, and IRA metals. Data were qualified based on the data quality review. Results of the validation indicated that all the COC analytical data associated with the September 2010 sampling event are usable for the intended purpose. Data review and verification were performed in accordance with Organic USEPA National Functional Guidelines (USEPA, 1999 and 2005) and Inorganic USEPA National Functional

Guidelines (USEPA, 2002). USEPA Region II SOP HW-24, Revision 2 (USEPA 2006) Validating Volatile Organic Compounds by SW-846 Method 8260B was also used to supplement data review. Details of the data review and verification are presented in the validation report and data review summaries provided in Appendix A.

Section 3

3. Groundwater Monitoring Results

The following sections discuss the results of the groundwater and surface water elevation monitoring and annual groundwater sampling. The manual water level measurements that were collected in conjunction with the annual sampling event are discussed in Sections 3.1.1 through 3.1.7. Analytical results from the annual groundwater monitoring event are discussed in Section 3.2. Graphical trends of historic data over time at representative wells are described in Section 3.3.

3.1 Surface Water and Groundwater Elevation Measurements

The August/September 2010 Comprehensive Water Level Event was conducted primarily on August 31, 2010; however, certain monitoring wells were measured on subsequent dates (September 7, 8, and 13, 2010). Flooding in low areas due to the high rainfall in August at well locations northeast and southeast of the Facility delayed water level measurements until the September dates. The manual groundwater elevations collected in August/September 2010 are shown in Table 2-1. Historical groundwater elevation data are summarized in Appendix C.

This GWMR includes potentiometric surface maps and associated analyses for the USAS, upper portion of the LSAS, lower portion of the LSAS, AF Gravels, S&P Sands, Lower AF Sands, and Floridan aquifer zones. An effort was made to incorporate groundwater elevation data on the contoured maps from every well measured. However, in some cases, not every data point could be contoured. Cases in which data were plotted on the map but not used in contouring are noted on the maps by an asterisk (*). Horizontal and vertical gradients were calculated for each unit. Vertical gradients between the overlying unit and underlying unit were estimated by dividing the difference of the groundwater elevations between the two units by the distance between the midpoint of the screens for the wells in each of the units.

Less than 20 percent of wells could not be measured during the August 31 gauging due to flooding in low-lying areas northeast and southeast of the Facility. Therefore; these and other nearby wells (that were measured initially on August 31) were gauged between September 7 and 13, 2010. The water levels gauged in nearby wells were used to compare the August 31 readings to the September readings. The comparison indicated that the water levels measured in the nearby wells on August 31 and September 7 were similar to the water levels measured in these same wells on September 8 and 13. Due to the similarity in water levels over this timeframe, the water level measurement closest to August 31 was used in contouring. The multiple water levels are posted on the potentiometric contour maps. Water levels were not measured in AF Gravels well MW-250 and LSAS well MW-147 because these wells could not be located when water levels were attempted to be measured on these private properties.

A LTWLM program was initiated in 2008 to obtain water level information on a continuous basis from a subset of monitoring wells. A total of 36 pressure transducers collect water level information from across the site as part of this program. The LTWLM program is currently in the baseline data collection stage. A report describing the findings of the LTWLM program will be submitted annually after the start up of the RAP system for the site per the RAP Addendum schedule.

The following sections describe the potentiometric surface maps that were prepared using the water level measurements. Salient features of each map are presented, and explanations provided as appropriate.

3.1.1 Upper Surficial Aquifer System Potentiometric Surface

Figure 3-1 shows the USAS potentiometric surface in August and September 2010. Surface water elevations in ponds and stilling wells were contoured with the USAS groundwater elevations where appropriate, because the surface water bodies are believed to act as recharge and discharge points to the USAS. Groundwater elevations ranged from 12.24 to 29.88 feet (above) mean sea level (ft msl) in August and September 2010. The USAS potentiometric surface during the measurement events shows a groundwater depression beneath the Facility. The USAS potentiometric surface also shows a groundwater high on the adjacent golf course to the southwest of the Facility. The horizontal component of groundwater flow is towards the Facility within the groundwater depression. Outside the depression, groundwater flows radially away from the Facility with a gradient ranging from approximately 0.002 to 0.02 feet per foot (ft/ft). The average vertical downward gradient from the USAS to the lower LSAS at the Facility and across the monitored area is approximately 0.5 ft/ft.

Some features of the USAS potentiometric surface include the following:

- A groundwater high near the southwestern portion of the Facility and the northeastern portion of the golf course that is likely due to increased recharge at the golf course.

- A groundwater low beneath the eastern portion of the Facility that is due to the IRA system pumping. Water levels in on-facility USAS wells are greatly influenced by the IRA System when it is operating, as is reported in IRA Quarterly Monitoring Reports (ARCADIS 2009a, ARCADIS 2010).

- Potentiometric lows near the Tallevast Road ditch. Stilling well and monitoring well groundwater elevation data indicate that the Tallevast Road ditch acts as a discharge zone for the USAS and is exerting a significant influence on the USAS groundwater elevations in this area.

- Some surface water features may be lined to allow artificial maintenance of water levels; therefore, water levels on staff gauges in these features may not represent the water table. Other surface water features appear to be unlined (e.g., TL-1) and maintained, which affects local groundwater flow patterns.

- Groundwater elevations generally increased by 0.50 to 6.25 ft in the USAS monitoring wells between March/April 2009 and August/September 2010. A groundwater elevation decrease was measured in only one well (MW-121). The increase in groundwater elevations in 96 percent of the wells was greater than 2 ft.

- The lowest hydraulic head in a monitoring well was measured at MW-208, in the southeast portion of the contoured area, near the Pearce Canal.

3.1.2 Upper Portion of the Lower Shallow Aquifer System Potentiometric Surface

Figure 3-2 shows the potentiometric surface of the upper portion of the LSAS in August 2010. Monitoring of water levels and hydraulic responses during pumping tests or IRA pumping changes has demonstrated that the upper portion of the LSAS at the Facility responds differently than the lower portion. Therefore, water level contours are displayed for the upper portion separately. Hydraulic heads in the upper portion of the LSAS ranged from 21.81 to 25.39 ft msl in the August and September 2010 monitoring event. Limited data points are available in the uppermost LSAS. The wells in this zone are screened just below the Hard Streak, which forms the interface between the USAS and LSAS, and the vertical downward gradient from the USAS to the uppermost portion of the LSAS is approximately 0.12 ft/ft, as measured from MW-38 to PZ-LSAS-2. Groundwater elevations in the piezometers on-facility decreased by 0.49 to 0.80 ft due to the operation of the IRA system in 2010 (the system was shut down during the 2009 event). Groundwater elevations increased by 0.17 to 2.57 ft in the upper portion of the LSAS monitoring wells between March/April 2009 and August/ September 2010.

3.1.3 Lower Portion of the Lower Shallow Aquifer System Potentiometric Surface

Figure 3-3 shows the potentiometric surface of the lower portion of the LSAS in August and September 2010. Hydraulic heads in the lower portion of the LSAS ranged from 6.26 to 24.50 ft msl during the monitoring events. The highest head was at well MW-87 (on the golf course). The lowest contoured hydraulic head was at well MW-246, located in the northwest corner of the contoured area.

The horizontal component of groundwater flow in the center of the area is towards the Facility due to the operation of the IRA system. A groundwater depression exists over most of the Facility and extends to the north and east. Outside the depression, the horizontal gradient ranges from approximately 0.001 to 0.007 ft/ft, depending on direction. The vertical gradient is downward throughout most of the mapped area. However, the vertical gradients are upward from the AF Gravels to the lower portion of the LSAS over the eastern portion of the Facility and extending approximately 300 feet to the north of the Facility. In addition, upward gradients from the AF Gravels to the lower portion of the LSAS are present in the far northeast and far northwest. The average vertical gradient is approximately 0.05 ft/ft downward to the AF Gravels. The vertical gradient ranges from -0.05 ft/ft (upward) to 0.2 ft/ft (downward).

Some notable features of the lower portion of the LSAS potentiometric surface are:

- A groundwater high beneath the golf course. The groundwater high under the golf course is likely due to increased recharge from the golf course. This is also an indication of hydraulic connection between the USAS and the LSAS in this area.
- The groundwater low present in the southwest corner of the map area in March/April 2009 is absent in August/September 2010. This groundwater low was due to groundwater extraction from a private well, located at 7921 15th Street E in the area,

used to maintain water levels in a decorative pond (TL-1). A flow control device has been installed which has resulted in a reduction in water usage at this property.

- In the vicinity of the Facility, groundwater elevations at 14 wells generally decreased by -7.37 to -0.33 ft in the lower portion of the LSAS monitoring wells between March/April 2009 and August/September 2010 due to operation of the IRA system. In areas farther from the Facility, the water levels in 31 wells increased by 0.71 to 10.34 ft.

3.1.4 AF Gravels Potentiometric Surface

Figure 3-4 shows the potentiometric surface of the AF Gravels in August and September 2010. The hydraulic heads in the AF Gravels ranged from 9.64 to 15.90 ft msl in August and September. The lowest head was at well MW-247, in the northwest corner of the contoured area. The highest head occurred at the Facility at MW-130. The horizontal component of groundwater flow is to the northwest and southeast, away from the Facility. The horizontal gradient ranges from approximately 0.002 to 0.007 ft/ft with the strongest gradients toward the southeast and south. The vertical gradient is downward from the AF Gravels to the S&P Sands throughout most of the mapped area. However, the vertical gradients are upward from the S&P Sands to the AF Gravels south of the Facility (including part of the golf course area) and in the far northeast portion of the contoured area. The vertical gradient ranges from approximately -0.05 ft/ft (upward) to 0.06 ft/ft (downward). The main features of the potentiometric surface of the AF Gravels are as follows:

- A groundwater high beneath the western portion of the Facility which extends to the north, west, and south of the Facility. The horizontal flow is to the northwest and southeast, away from this high. The Facility and immediate vicinity are located in a regional recharge area between discharge boundaries (ARCADIS BBL 2007, GeoTrans 2008).

- The apparent depression present in the southwest contoured area in March/April 2009 was not evident in August/September 2010. The depression was due to groundwater extraction from a private well, located at 7921 15th Street E in the area, used to maintain water levels in a decorative pond (TL-1). A flow control device has been installed which has resulted in a reduction in water usage at this property.

- An apparent depression was present in the south contoured area during this monitoring event. The depression is attributed to groundwater extraction from a private well, located at 8005 15th St E. in the area, used for landscaping associated with the property. This private well, which was not being used during the March/April 2009 monitoring event, began operating in September 2009 after repairs were made to the well.

- An apparent groundwater low was present in the AF Gravels south of the Facility.

- Groundwater elevations generally increased by 3.06 to 9.29 ft in the AF Gravels monitoring wells between March/April 2009 and August/September 2010. The greatest increase in water levels (15.69 ft) was observed southwest of the Facility, where the apparent depression was located in March/April 2009. Water levels decreased in MW-169 (located south of the golf course).

3.1.5 S&P Sands Groundwater Potentiometric Surface

Figure 3-5 shows the S&P Sands potentiometric surface in August and September 2010. The hydraulic heads in the S&P Sands ranged from 8.66 to 16.25 ft msl in the August and September 2010 event. The lowest heads were in the northwest and south/southeast portions of the contoured area, and the highest heads were on the golf course and in the northeastern portion of the Site. The horizontal component of groundwater flow is toward the northwest and southeast away from the Facility. The horizontal gradient ranges from approximately 0.002 to 0.007 ft/ft. The vertical gradient ranges from -0.04 to 0.02 ft/ft (flow is downward to the southwest away from the Facility). Upward gradients were observed throughout most of the contoured area; however, downward gradients from the S&P Sands to the Lower AF Sands exist southwest of the Facility and in the far northeast portion of the contoured area. The average vertical gradient across the contoured area is slightly upward from the Lower AF Sands to the S&P Sands, at approximately 0.01 ft/ft.

The main features of the S&P Sands potentiometric surface are as follows:

- The groundwater low southwest of the Facility present in March and April 2009 was absent in August and September 2010. This groundwater low was due to groundwater extraction occurring from a private well, located at 7921 15th Street E, in the area that is used to maintain water levels in a decorative pond (TL-1). A flow control device has been installed which has resulted in a reduction in water usage at this property.
- A groundwater high is evident south of the Facility. Previous reports and the potentiometric surface map indicate that the Facility and immediate vicinity are located in or west of a regional recharge area between discharge boundaries (ARCADIS BBL 2007, GeoTrans 2008).
- Groundwater elevations increased by 0.89 to 16.45 ft in the S&P Sands monitoring wells between March/April 2009 and August/September 2010. The groundwater elevation decreased in MW-240 located to the southwest, near the Convention Center. The greatest increases in water levels (10.26 to 16.45 ft) were observed southwest of the Site, where the apparent groundwater low was located (near MW-56) in March/April 2009, and in the area northeast of the Facility (near MW-139).

3.1.6 Lower Arcadia Formation Sands Groundwater Potentiometric Surface

Figure 3-6 shows the Lower AF Sands potentiometric surface in August and September 2010. Groundwater elevations in the Lower AF Sands ranged from 10.57 to 17.04 ft msl in August and September 2010. A local groundwater high is located east of the Facility. The horizontal component of groundwater flow near the Facility is toward the northwest and southwest with a gradient of between 0.001 and 0.002 ft/ft. The vertical gradient averaged 0.04 ft/ft upwards from the Floridan Aquifer System during this monitoring event.

Groundwater elevations generally increased by 1.29 to 5.10 ft in the Lower AF Sands monitoring wells between March/April 2009 and August/September 2010. The increase in groundwater elevations in 96 percent of the wells was found to be more than 2.00 ft.

3.1.7 Floridan Aquifer System Groundwater Potentiometric Surface

Figure 3-7 shows the upper Floridan Aquifer potentiometric surface in August and September 2010. Monitoring data from this event indicate that groundwater flows primarily to the west-northwest. The horizontal gradient was 0.0001 ft/ft to the west-northwest in August 2010. Groundwater elevations increased by 8.79 to 10.22 ft in the Floridan monitoring wells between March/April 2009 and August/September 2010. The main feature of the Floridan potentiometric surface is the overall lower horizontal gradient as compared to shallower units.

3.2 Horizontal and Vertical Distribution of COCs

The following sections contain a description of the horizontal and vertical distribution of COCs in the study area. Recent concentrations (results from the August/September 2010 sampling event) are compared with previous sampling results (as provided in the Historical Summary of Analytical Results tables in Appendix C) to provide a historical perspective of the extent of concentrations that have exceeded GCTLs. The sections below specifically compare historical results in wells around the perimeter of each COC plume within each aquifer zone. In some cases, historical results of a few COCs in wells on the Facility are discussed below to provide a historical perspective of the area of highest concentrations in this area.

Notable points to consider with respect to trends in COC concentrations and distribution include the following:

- The method of 1,4-dioxane analysis was modified from USEPA 8270C to USEPA 8260C SIM ID, which was first used in October 2006 (between the preparation of the Site Assessment Report Addendum [SARA] 3 and the RAP). Findings from studies conducted by FDEP and others in 2006 indicate that Method 8260C SIM ID provides better accuracy over a wider range of 1,4-dioxane concentrations than previously approved methods. As a result, 1,4-dioxane concentrations analyzed since October 2006 provide a more reliable comparison than earlier results.

- The first monitoring wells were installed and sampled in 2001, and numerous wells have been installed and sampled over the years. Eleven monitoring wells were installed in late 2007 and early 2008, and one monitoring well was installed in 2010. As a result, some wells have more historical results for comparison than others. Generally, the higher the well identification number, the more recent the well was installed and the fewer times it has been sampled. The 11 monitoring wells installed in 2007/2008 have been sampled only 3 times, and the monitoring well installed in 2010 has been sampled only once, so limited historical comparison can be made in these cases.

- All COC contour figures were plotted using the contouring intervals of the GCTL; 10 times the GCTL; the NADC (which is 10 times, or 100 times the GCTL, depending on the compound), and 10 times the NADC.

- The natural neighbor algorithm method of contouring was used to generate the COC plume maps for the August/September 2010 sampling event. All data were converted to base 10 logarithmic form before interpolating concentrations using natural neighbor. The interpolated data were converted back to base 10 numbers before generating the COC concentration contours. Non-detects were assigned a value of one-half the reporting limit for the purpose of contouring. For duplicate samples, the higher reported result (or in the case of non-detects, half the lower reporting limit) was used for contouring.

- Extraction well data have historically not been used while preparing the contours for the COC maps; however, since the extraction wells were sampled during the August/September 2010 event, the data are posted on the COC maps for completeness. Extraction well data were specifically not used for contouring because they are constructed with 15 to 20-foot screens and were not installed as monitoring wells; however, these data were considered in the contouring, if appropriate. Cases in which data were plotted on the map but not used in contouring are noted on the maps by an asterisk (*).

- As is typical in groundwater plumes and as detailed below, concentrations of COCs in groundwater samples from specific wells have decreased in some instances and increased in others. This is to be expected due to some groundwater movement between sampling events and also due to minor differences in analytical variation. The overall distribution of COCs within monitoring wells in August/September 2010 was similar to the distribution during the March/April 2009 monitoring event (ARCADIS, 2009b) and within expected variation. There were a very few instances of somewhat larger differences between groundwater COC depictions between the last two sampling events, such as contours in the AF Gravels which were more similar to the January/February 2008 monitoring event (ARCADIS, 2008c and 2008d), but these too are within the overall range of expected results.

- Analytical data from the August/September 2010 sampling event are summarized in Table 2-3 and historical analytical data are presented in Appendix C. As a convention, when presenting August/September 2010 analytical results compared to historical results below, concentrations in wells are presented in the following order: south, west, north, and east of the Facility.

3.2.1 COC Distribution in the USAS

The COC distribution in the USAS is shown in Figures 3-8A through 3-8F. Observed historical variations in distribution and concentrations of COCs are indicated below.

- *1,4-Dioxane*— The distribution and concentration of 1,4-dioxane decreased in the southern portion of the contoured area. Concentrations in MW-25 decreased from 4.3 µg/L in March/April 2009 to non-detect in September 2010 resulting in a smaller depiction of the plume in this area. Concentrations in wells MW-73 and MW-74, which are used to contour the nature and extent of COCs above the GCTL to the south and southwest, have decreased over the last five sampling events (October 2006, December 2006, January 2008, March/April 2009, and August/September 2010). The most recent concentrations detected in wells MW-73 and MW-74 are 5 µg/L and 81 µg/L, respectively. Concentrations in well MW-75, located to the south of the Facility, increased from 16 µg/L in March 2010 to 60 µg/L in September 2010, but remain within the range of historical concentrations (16 µg/L to 260 µg/L). In addition, concentrations detected in well MW-100 (25 ug/L), to the southwest, fluctuate, but the results show no upward or downward trend. The concentrations detected at MW-100 in October 2006, December 2006, January 2008, March 2009, and September 2010 were 32 µg/L, 12 µg/L, 28 µg/L, 17 µg/L, and 25 µg/L, respectively. Concentration over time data plots for MW-74 and MW-100 are included in Appendix D.

  Recent concentrations detected in well MW-69 and MW-108, used to contour the plume extent northwest of the Facility, and recent concentrations in well MW-109, used to contour the plume extent north of the Facility, are similar to concentrations detected in the December 2006, January 2008, and March/April 2009 sampling events. The recent concentration detected in MW-110, also located to the north of the Facility, increased to 61 µg/L which is also in the expected range, as concentrations detected in this well in December 2006, January 2008, and March 2009 were 80 µg/L, 62 µg/L, and 46 µg/L, respectively. Concentration-over-time data plots for MW-69 and MW-108 are included in Appendix D.

The extent of 1,4-dioxane above the GCTL to the northeast of the Facility changed between March/April 2009 and August/September 2010. In March/April 2009, concentrations were detected above the GCTL for the first time at wells MW-65 (14 µg/L) and MW-62 (10 µg/L). The recent concentration detected in MW-62 remained above the GCTL (8.6 ug/L); however, 1,4-dioxane was not detected in well MW-65 during the August/September 2010 event. Concentrations in MW-17D and MW-71 dropped to below GCTL during the August/September 2010 event which resulted in separation of the depiction of the GCTL boundary in the area northeast of the Facility from one plume into two smaller plumes. Concentrations detected in well MW-63 exceeded the GCTL in January 2008 (6.7 µg/L) and have been below the GCTL during all other sampling events. Concentrations detected in MW-16D have remained stable. There were no detections of 1,4-dioxane during any sampling event at MW-26, which is east of MW-63. Concentration over time data plots for MW-62 and MW-65 are included in Appendix D.

Data from MW-95 were used to contour the extent of the plume to the east of the Facility. Concentrations detected in MW-95 have fluctuated from 3 µg/L to 35 µg/L to 5.8 µg/L to 11 µg/L in December 2006, January 2008, March 2009, and September 2010, respectively. A concentration of 11 µg/L was detected in MW-95 when it was first sampled in January 2005. There have not been any detections of 1,4 dioxane during any sampling event at MW-107, which is east and downgradient of well MW-95. Concentrations in well MW-27 increased between January 2008 (69 µg/L) and March 2009 (1,100 µg/L) and remained stable in September 2010 (950 µg/L); however, these concentrations are similar to the range detected before January 2008 (760 and 790 µg/L in 2006). Concentration over time data plots for MW-95 and MW-27 are included in Appendix D.

- *TCE*— The extent of TCE above the GCTL to the south has remained relatively stable. Concentrations of TCE have been detected above the GCTL at well MW-25 in early sampling events, whereas concentrations in the January 2008, April 2009, and September 2010 sampling events have been below the GCTL. Concentrations in MW-74 have remained above the GCTL in all sampling events except in January 2008, when TCE was not detected. The September 2010 TCE concentration detected in MW-35 (6.6 µg/L) is lower than the March 2009 concentration (25 µg/L).

  Concentrations of TCE above the GCTL do not extend west or northwest off the Facility. North of the Facility, the recent concentration in well MW-67 (24 µg/L) is the same concentration detected in March 2010. These concentrations are slightly higher than concentrations detected in past sampling events (7 to 15 µg/L). The overall extent of the plume in the northern direction is similar to the 2009 depiction.

  To the east, the recent concentration at well MW-64 (26 µg/L) is slightly higher than the concentration detected in the previous sampling event (14 µg/L) and is slightly higher than historic concentrations (5.5 to 18 µg/L). In addition, to the east, the recent concentrations at well MW-27 (86 µg/L) are higher than concentrations detected in March 2009 (39 µg/L) but within the range of concentrations detected in past sampling events (23 to 120 µg/L) between June 2005 and January 2008. Concentration over time data plots for MW-27 and MW-64 are included in Appendix D.

  TCE concentrations in most wells on the Facility were stable; however, some wells exhibited a significant decrease. Most notably, the recent concentration at MW-42 (920 µg/L) is significantly lower than the highest concentration detected at this well (4,600 µg/L), which was sampled in January 2006, before the IRA groundwater system began operations. One on-facility well, MW-40, has exhibited fluctuating TCE concentrations. The recent concentration in MW-40 decreased to 140 µg/L. Concentrations have been as high as 1,100 µg/L in March 2008, whereas the lowest concentration detected at this well was 137 µg/L in June 2005. Concentration over time data plots for MW-40 and MW-42 are included in Appendix D. On the Facility, the area where TCE concentrations exceed the GCTL is larger than the area where 1,4-dioxane exceeds the GCTL. However, off the Facility the area where TCE concentrations exceed the GCTL is smaller than the area where 1,4-dioxane exceeds the GCTL.

- *PCE*— To the south, the extent of PCE decreased between March 2009 and September 2010. The concentration detected at MW-73 in March 2009 decreased from 7.5 µg/L to below the GCTL (1.7 µg/L) in September 2010. Concentrations of PCE detected at well MW-35 have fluctuated between 12 and 44 µg/L; the most recent concentration detected (11 µg/L) decreased to slightly below the historical range. PCE concentrations above the GCTL do not extend north off the Facility. To the east, the recent concentration at MW-27 (280 µg/L) is slightly higher than the March 2009 detection (130 µg/L), but significantly lower than the concentrations detected in sampling events conducted before 2008. Overall, the mapped extent of the PCE plume in this area is similar or slightly less than the 2009 depiction.

  Similar to TCE, PCE concentrations on-facility have fluctuated, possibly as a result of the influence of the IRA groundwater recovery system. The recently installed MW-254 at the Facility showed a significantly lower concentration of PCE (1,100 µg/L) than was previously detected in January 2008 (11,000 µg/L) and March 2009 (8,800 µg/L), which was a higher concentration than had been previously detected at the Facility. This well was located near the center of an area within the USAS that in late 2007 and early 2008 exhibited the highest electron capture detector response from membrane interface probes. Similar to TCE, the area of PCE concentrations above the GCTL off-facility is also smaller than the area of 1,4-dioxane above the GCTL, and PCE concentrations appear to have decreased. Concentration over time data plots for MW-27 and MW-35 are included in Appendix D.

- *Cis-1,2-DCE*— In the 2010 sampling event, there were no concentrations of cis-1,2-DCE that exceeded the GCTL. The concentration detected in MW-42 (on-facility well) in February 2008 (83 µg/L) decreased to below the GCTL in May 2008 and has remained below the GCTL. The concentration over time data plot for MW-42 is included in Appendix D.

- *1,1-DCE*— An overall decrease in the concentration and distribution of 1,1-DCE is reflected in the recent sampling event. To the south of the Facility, the 1,1-DCE concentration at MW-25 decreased to below the GCTL in March 2009 (4 µg/L) and remained below the GCTL in September 2010 (1.2 µg/L). Additionally, the concentration of 1,1-DCE detected at well MW-35 decreased to below the GCTL in September 2010 (2.5 µg/L) versus March 2009 (10 µg/L). Concentrations in MW-35 fluctuate and have previously been below the GCTL. Concentrations at MW-75 had been below the GCTL for the previous two sampling events [January 2008 (5.1 µg/L) and March 2009 (3.4 µg/L)]. Recent concentrations at MW-75 (24 µg/L) increased to above the GCTL but are within the range of concentrations measured during previous sampling events (3.4 to 45 µg/L).

  To the southwest, the concentrations at MW-73 in January 2008 (91 µg/L), March 2009 (45 µg/L), and September 2010 (8.2 µg/L) exhibit a decreasing trend. The concentrations at MW-74 in September 2010 (39 µg/L), March 2009 (49 µg/L), and January 2008 (37 µg/L) remained lower than the concentrations measured during historical sampling events, which ranged from 85 to 150 µg/L. The concentration over time data plot for MW-74 is included in Appendix D.

  To the north of the Facility, the recent concentration at MW-110 (22 µg/L) is similar to concentrations measured during previous sampling events (6.4 µg/L to 22 µg/L). The concentrations at well MW-67 in January 2008 (41 µg/L), March 2009 (36 µg/L), and September 2010 (12 µg/L) exhibit a decreasing trend and are significantly lower than those measured during historical sampling events (88 to 140 µg/L).

To the east, the recent 1,1-DCE concentration at MW-29 (5.1 µg/L) decreased to below the GCTL. The concentration at MW-104 (45 µg/L) is similar to concentrations measured during previous sampling events. The concentration at MW-27 increased from 230 µg/L in March 2009 to 350 µg/L in September 2010 which is within the range of concentrations measured during previous sampling events (120 to 600 µg/L). Concentration over time data plots for MW-27 and MW-104 are included in Appendix D.

- *1,1-DCA*—One off-facility well (MW-27) had a concentration detected above the GCTL. To the southeast, the 1,1-DCA concentrations in MW-27 have remained above the GCTL (ranging from 140 to 290 µg/L), except in January 2008 (69 µg/L); the September 2010 concentration (160 µg/L) is within the range previously detected. Recent concentrations decreased to below the GCTL in extraction wells EW-105 (5.6 µg/L) and EW-101 (22 µg/L), which is similar to historic detections in these wells.

  To the southwest, the concentrations decreased slightly in MW-74 between the January 2008 (82 µg/L) and March 2009 (72 µg/L) sampling events and decreased to below the GCTL in the September 2010 (68 µg/L) sampling event. Concentrations remained significantly lower than the range of concentrations measured during previous sampling events (130 to 300 µg/L).

3.2.2 COC Distribution in the LSAS

The COC distribution in the LSAS is shown on Figures 3-9A through 3-9F. Observed historical changes in concentrations and distribution of the COCs are indicated below.

- *1,4-Dioxane*—The detected concentration of 1,4-dioxane in MW-85 (260 µg/L), used to contour the plume extent to the south, has decreased compared to concentrations from the previous sampling events (October 2006, December 2006, January 2008, and March 2009). The 2010 concentration detected at well MW-82 (280 µg/L) is lower than previous sampling events (560 µg/L to 700 µg/L). Although concentrations in samples collected from this well before October 2006 are lower, note (as presented above) that the analytical methodologies used before October 2006 were different than the current method. The September 2010 detected concentration in MW-101 (14 µg/L) increased to above the GCTL. Concentrations in this well exceeded the GCTL one time previously, in October 2006 (19 µg/L). Recent concentrations in MW-168, MW-106, and MW-220, which are south of MW-82, MW-85, and MW-101, are below GCTLs as was the case in past sampling events. The concentrations detected in MW-98 in September 2010 (530 µg/L) and March 2009 (500 µg/L) remained significantly lower than the three previous sampling events (1,200 µg/L, 900 µg/L, and 710 µg/L). Concentration versus time data plots for MW-82, MW-85, MW-101, and MW-98 are included in Appendix D.

Northwest of the Facility, the recent concentration of 1,4-dioxane detected in MW-68 is 4.0 µg/L, which is at the lower end of the concentrations detected in the previous annual sampling events (March 2009, January 2008, and December 2006) which were 7.1 µg/L, 16 µg/L, and 4.3 µg/L, respectively. Recent concentrations in MW-152, MW-178, and MW-243, west and northwest of MW-68, are below the GCTL, as was the case in past sampling events. North of the Facility, 1,4-dioxane concentrations in MW-86 are stable through the sampling record. The recent concentration in well MW-86 (19 µg/L) is similar to the highest concentration (18 µg/L) detected in previous sampling events. East of the Facility, the recent 1,4-dioxane concentration detected in well MW-91 is 110 µg/L, which is within the range of concentrations detected in previous sampling events (85 µg/L to 140 µg/L). Again, although concentrations in samples collected from this well before October 2006 were somewhat lower, the analytical methodologies were different. Concentration over time data plots for MW-68 and MW-91 are included in Appendix D.

Northeast of the Facility, the recent concentration detected in MW-79 (26 µg/L) remained stable compared to March 2009 (27 µg/L). Concentrations in this well have fluctuated but an overall decreasing trend in concentrations is apparent from the highest level of 76 µg/L, detected in October 2006.

On the Facility, historical concentrations of 1,4-dioxane detected in MW-33, MW-37, and MW-43 (which have been sampled quarterly since October 2006 as part of the IRA groundwater extraction system operation) remain above the GCTL but show overall downward trends. The concentrations of 1,4-dioxane detected in MW-41 fluctuate. Concentration over time data plots for MW-33, MW-37, MW-41, and MW-43 are included in Appendix D.

- *TCE*— The plume extent for TCE decreased between March 2009 and September 2010. Concentrations of TCE detected in MW-85 (which is used to contour the plume extent to the south) decreased between March 2009 and September 2010 to below the GCTL. Concentrations in this well have ranged between 2.1 and 9.4 µg/L. To the southwest, concentrations detected in MW-98 have fluctuated between 7.7 and 73 µg/L. The latest concentration of 56 µg/L indicates that the plume is relatively stable at this location. Northwest of the Facility, the concentration detected in MW-68 decreased to below the GCTL in May 2009 and remained below the GCTL at 0.62 µg/L during the September 2010 sampling event. This well historically has tended to fluctuate above and below the GCTL. North of the Facility, the extent of TCE distribution is defined by MW-86, which continues to not have detectable TCE concentrations in groundwater samples. Concentrations in samples collected from MW-91 have ranged from 3.5 to 25 µg/L, with the most recent result of 24 µg/L. The area of TCE above GCTLs in the LSAS is similar in shape to that of 1,4-dioxane in the LSAS, but slightly smaller in area.

  On the Facility, historical concentrations detected in MW-33, MW-37, MW-41, and MW-43 reflect fluctuating concentrations, Concentrations in MW-39 have increased from 190 µg/L (February 2008) to 1,400 µg/L (March 2009) and declined to 140 ug/L in September 2010. Concentration over time data plots for MW-33, MW-37, MW-41, MW-43, MW-68, MW-85, MW-91, and MW-98 are included in Appendix D.

- *PCE*.— To the south and southwest, recent concentrations at MW-87 and MW-98 are similar to concentrations in March 2009 and are within the range of concentrations detected in these wells during previous sampling events. The recent concentration detected at MW-87, which had the highest concentration of PCE in wells to the south or southwest, was 61 µg/L; the range of concentrations detected in previous sampling events was 61 to 150 µg/L. The recent concentrations in MW-78 decreased from 25 µg/L to 17 µg/L. These two most recent concentrations are slightly above the historical range (non-detect to 9.3 µg/L). The area of PCE above GCTLs is much smaller than the area of 1,4-dioxane and TCE above GCTLs. PCE concentrations exceeding GCTLs exist primarily in groundwater at the Facility and to the south and southwest under the golf course. The concentration over time data plots for MW-78 and MW-98 are included in Appendix D.

  Samples from on-facility wells MW-33, MW-39, and MW-37 had recent detected concentrations that decreased to 44 µg/L, 2.8 µg/L, and 3.2 µg/L, respectively. In March 2010, the concentrations detected in these wells (450 µg/L, 220 µg/L, and 160 µg/L, respectively) were notably higher than concentrations detected during previous sampling events. The concentration over time data plots for MW-33 and MW-37 are included in Appendix D.

- *Cis-1,2-DCE*— Concentrations exceeding GCTLs occur primarily below the eastern half of the Facility and off-facility at nearby wells MW-78 and MW-79, to the south and northeast of the Facility, respectively. The recent decrease in concentrations in on-facility wells MW-33, PZ-LSAS-2, PZ-LSAS-3, and PZ-LSAS-7 to below the GCTL reduced the area above GCTLs beneath the eastern half of the Facility and to the north and south. Concentrations in PZ-LSAS-2, PZ-LSAS-4, PZ-LSAS-5, and PZ-LSAS-7 located on the Facility have decreased over the last two sampling events.

Although concentrations in MW-78 and MW-79 have fluctuated some, the results do not show an upward or downward trend. For example, concentrations detected in MW-79 range from 67 µg/L to 420 µg/L, with the most recent concentration at 99 µg/L. As with PCE, the area of cis-1,2-DCE above GCTLs is much smaller than the area of 1,4-dioxane and TCE above GCTLs. Concentration over time data plots for MW-33, MW-78 and MW-79 are included in Appendix D.

- *1,1-DCE*— The area of the 1,1-DCE plume above the GCTL is slightly smaller than the 1,4-dioxane plume above the GCTL in the LSAS. The 1,1-DCE plume does not extend as far to the northwest as the 1,4-dioxane plume. Concentrations in MW-82 and MW-85 are used to depict the extent to the south. Although concentrations have fluctuated in both of these wells, the recent concentrations at MW-82 (59 µg/L) and MW-85 (33 µg/L) were slightly lower than the March 2009 results.

  To the west, the recent concentration at MW-98 (280 µg/L) is relatively stable and is similar to concentrations from prior sampling events, excluding the December 2006 event (86 µg/L). North of the Facility, the recent concentration detected at MW-81 (20 µg/L) is lower than the March 2009 (73 µg/L) concentration. Concentrations historically have fluctuated in samples from MW-81 and at times concentrations have been below the GCTL. The concentrations in MW-86, which is farther north and downgradient of MW-81, are stable and have always been below the GCTLs. Northeast of the Facility, the September 2010 concentration detected in MW-91 (4.7 µg/L) decreased to below the GCTL. The concentrations detected in samples from this well have been below the GCTL in all previous sampling events except for March 2009 (7.9 µg/L). The recent concentration detected in MW-79 (2.6 µg/L), which has historically fluctuated, was below the GCTL. To the east, concentrations appear to be stable in MW-77 as the recent concentration (12 µg/L) is very similar to concentrations detected in most of the previous sampling events (8.7 µg/L to 34 µg/L). Concentration over time data plots for MW-82, MW-85, MW-98, MW-81, MW-91, and MW-79 are included in Appendix D.

- *1,1-DCA*— The extent of the 1,1-DCA plume is principally limited to the area south and southwest of the Facility. Wells where concentrations have been detected above GCTLs have remained stable over all sampling events, with one exception. To the west, concentrations detected at MW-98 have ranged between 149 to 200 µg/L, except in December 2006 when the concentration detected was 35 µg/L. The concentrations detected in on-facility well MW-33 have historically fluctuated. The most recent concentration (20 µg/L) was below the GCTL as have samples since May of 2008. Concentration over time data plots for MW-98 and MW-33 are included in Appendix D.

3.2.3 COC Distribution in the AF Gravels

The COC distribution in the AF Gravels is shown on Figures 3-10A through 3-10F. Observed changes in concentrations and distribution of COCs are indicated below.

- *1,4-Dioxane*— Concentrations of the COC 1,4-dioxane in the AF Gravels are generally low to very low, and include fluctuations above and below the GCTL within wells. Concentrations of 1,4-dioxane detected in MW-55, which is used to contour the plume extent to the south, fluctuate between non-detect and 15 µg/L, and the current concentration (10 ug/L) is within the historical range. Historic concentrations detected in MW-55 from the latest five sampling events, from oldest to most recent, were 15 µg/L, 3 µg/L, 15 µg/L, non-detect (5.2 µg/L was detected in the duplicate sample), and 10 µg/L. To the west, the September 2010 concentration detected at MW-130 was 25 µg/L, which is substantially lower than the concentrations detected in January 2008 (92 µg/L), December 2006 (70 µg/L), and October 2006 (110 µg/L). The concentration in MW-129 (2 µg/L) decreased from 4.6 µg/L in March 2009 to below the GCTL in September 2010.

  North of the Facility, recent concentrations detected at MW-135, MW-232, and MW-239 are similar to previous concentrations obtained from these wells, indicating stable concentrations. Northeast of the Facility, concentrations increased to above the GCTL in MW-131 (23 µg/L) and MW-133 (20 µg/L). Concentrations in these wells have previously been above the GCTL in June 2006 and October 2006, respectively. The presence of 1,4-dioxane in these wells above the GCTL has increased the extent of the impacted area to the east as compared with the 2009 plume depiction.

Southeast of the Facility, the concentration detected at MW-248 decreased from 12 µg/L (1,4-dioxane was detected in the duplicate sample) in January 2008, to non-detect in March 2009 and remained non-detect in September 2010. The absence of 1,4-dioxane in MW-248 has decreased the extent of the impacted area in the south and southeast when compared to the 2008 depiction. However, the depiction of the 1,4-dioxane GCTL boundary in the southeast appears to have increased from 2009 to 2010 based on the concentrations detected in MW-133. Concentration over time data plots for MW-130, MW-131, MW-133, MW-135, MW-239, and MW-248 are included in Appendix D.

A detached area of the plume is indicated farther to the east, based on concentrations detected in MW-158, MW-250, and MW-255 as well as historical data in private supply wells located at 2105 and 2411 Tallevast Road. Private supply wells located at 2105 and 2411 Tallevast Road were not sampled in September 2010 because these wells were abandoned. Monitoring well MW-255 was installed in February 2010 to replace the private well located at 2411 Tallevast Road. The highest concentration previously detected in this area was 120 µg/L at well MW-158 (which occurred both in October 2006 and December 2008). The concentration detected at MW-158 in September 2010 decreased to 39 µg/L. The concentrations detected at MW-250 fluctuate and have been non-detect (duplicate result was 4.4 µg/L), 15 µg/L, 4.1 µg/L, and 6.1 µg/L in February 2007, January 2008, March 2009, and September 2010 respectively. The recent concentration detected in newly installed MW-255 (replacement for 2411 Tallevast Road) was 20 µg/L which was similar to the concentration detected in private well 2411 Tallevast Road in January 2008 (22 µg/L). Recent results from all of the AF Gravels wells surrounding this area were non-detect or below GCTL, confirming the extent of the detached area. The concentration over time data plots for 2411 Tallevast Road/MW-255 and MW-158 are included in Appendix D.

- *TCE*—TCE concentrations above the GCTL in the AF Gravels are limited to wells on-facility and five wells northeast and east of the Facility - MW-131, MW-132, MW-239, MW-135, and MW-133. Northeast of the Facility, the concentration detected at MW-131 (41 µg/L) increased to above the GCTL in September 2010. Concentrations have historically been detected above the GCTL in this well in October 2005 (13.9 µg/L) and January (18 µg/L), June (29 µg/L) and October 2006 (4.6 µg/L). The concentration at MW-132 increased to slightly above the GCTL in January 2008 (3.7 µg/L) and remained above the GCTL in April 2009 (5.9 µg/L) and September 2010 (3.9 µg/L). Results from all previous sampling events at MW-132 have been non-detect. The recent concentration detected at MW-135 (3.9 µg/L) was considerably lower than concentrations detected during previous sampling events conducted between October 2005 and March 2009 (excluding a non-detect result in December 2006), which ranged from 38 to 150 µg/L. This has resulted in a somewhat smaller depiction of the plume to the northeast. To the east, the concentration detected at MW-133 (5.2 µg/L) increased to slightly above the GCTL in September 2010. Results from all the previous sampling events at MW-133 have been non-detect. The extent of the depicted TCE plume to the northeast and east of the Facility has increased because of the increased concentrations detected in MW-131 and MW-133. The concentration over time data plots for MW-131, MW-133, MW-135, and MW-239 are included in Appendix D.

Recent concentrations detected in on-facility wells are similar to concentrations detected during previous sampling events, except for MW-134, EW-UAFG-1, and MW-130. Concentrations detected in MW-134 decreased significantly from 420 µg/L (the duplicate concentration was 640 µg/L) in March 2009 to 7.9 µg/L in September

2010. The concentration detected in September 2010 was similar to historical concentrations detected in MW-134 before 2008, which were 10 µg/L or less. The concentrations detected in EW-UAFG-1 increased significantly between January 2008 (19 µg/L) and March 2009 (2,400 µg/L). The concentration (3,000 µg/L) detected in September 2010 in this well was similar to the concentration detected in March 2009. Concentrations of TCE detected in MW-130, which were historically slightly above the GCTL, decreased to below the GCTL after December 2008. The plume extent to the southeast has decreased due to the decrease in MW-134 concentrations. The concentration over time data plots for MW-130 and MW-134 are included in Appendix D.

- *PCE*— A small area of elevated PCE concentration (up to 54 µg/L) exists on the east side of the Facility, based on measurements at four on-facility wells, EW-UAFG-1. IWI-1, MW-127, and MW-253. The concentration detected in EW-UAFG-1 increased from non-detect in January 2008 to 100 µg/L in March 2009 and decreased to 36 µg/L in September 2010. The concentration detected in MW-127 increased from 3.3 µg/L in January 2008 to 170 µg/L in March 2009 and decreased to 54 µg/L in September 2010. September 2010 concentrations detected in wells IWI-1 and MW-253 (4.8 µg/L and 4.1 µg/L) were slightly above the GCTL. In March 2009, these wells were included in the March/April PCE contour due to elevated reporting limits (25 µg/L reporting limit). The recent concentrations of PCE were similar to concentrations detected in IWI-1 and MW-253 in January 2008 (6.8 µg/L and 5.4 µg/L, respectively). The concentration over time data plots for MW-127 and MW-253 are included in Appendix D.

  Cis-1,2-DCE— The area of cis-1,2-DCE above the GCTL is limited to five on-facility wells (EW-UAFG-1, IWI-1, MW-127, MW-134, and MW-253). The recent concentrations detected at the on-facility wells IWI-1 and MW-253 are similar to concentrations detected during previous sampling events. Concentrations detected in EW-UAFG-1 notably decreased from 3,000 µg/L in January 2008 to 270 µg/L in

March 2009 and 240 µg/L in September 2010. Concentrations in MW-134 increased to above the GCTL in May 2009 and remained above the GCTL in September 2010 (840 µg/L). The concentration in MW-127 increased from 120 µg/L in March 2009 to 350 µg/L in September 2010. The concentration over time data plots for MW-127, MW-134, and MW-253 are included in Appendix D. Cis-1,2-DCE concentrations detected in MW-135, northeast of the Facility, have fluctuated over time and have periodically been above the GCTL. Cis-1,2-DCE was previously detected in MW-135 at a concentration below the GCTL (41 µg/L) in March 2009. In September 2010, the concentration increased to above the GCTL (84 µg/L). The concentration over time data plot for MW-135 is included in Appendix D.

- *1,1-DCE*— The area of 1,1-DCE concentrations above GCTLs is defined by six on-facility wells (EW-UAFG-1, IWI-1, MW-127, MW-134, MW-130, and MW-253). Recent concentrations in wells on the Facility are similar to previous concentrations, except for MW-130 and MW-134. Concentrations increased in well MW-134 between February 2008 (23 µg/L), March 2009 (75 µg/L), and September 2010 (95 µg/L). Concentrations detected in MW-134 before February 2008 were 2.7 µg/L or less. The concentrations of 1,1-DCE detected in MW-130 increased to above the GCTL in September 2010 (7.9 µg/L). Concentrations in this well, which have historically been above the GCTL, were below the GCTL between December 2008 and March 2009. The concentration over time data plots for MW-127, MW-130, MW-134, and MW-253 are included in Appendix D.

- *1,1-DCA*—Concentrations in all Site wells were below the GCTL in the September 2010 event. The concentration in on-facility well MW-127 (76 µg/L), which was the only well with a detected concentration in March 2009, decreased to below the GCTL in September 2010 (51 µg/L). Concentrations in MW-127 have historically been below the GCTL except in March, May, and September 2009. The concentration detected in MW-253 decreased to below the GCTL in March 2009 and remained below the GCTL in September 2010. The concentration over time data plots for MW-127 and MW-253 are included in Appendix D.

3.2.4 COC Distribution in the S&P Sands and Clay/Sand Zone 3 & 4

The COC distribution in the S&P Sands is shown on Figures 3-11A through 3-11F. Observed changes in the concentrations and distribution of COCs are indicated below. Analytical data from well IWI-2 (located in the Clay/Sand Zone 3 & 4 unit immediately underlying the S&P Sands) are also posted on the S&P Sands figures and discussed in this section for convenience.

- *1,4-Dioxane*— Recent concentrations of 1,4-dioxane were detected above GCTLs in two off-facility wells (MW-45 and MW-44). The concentration detected at on-facility well MW-128, which was above the GCTL in March 2009 (4 µg/L), decreased to non-detect in September 2010. The concentrations detected during previous sampling events in this well ranged from non-detect to 7.6 µg/L. The concentration detected at MW-45 located north of the Facility increased to above the GCTL for the first time in March 2009 (5.3 µg/L) and remained slightly above the GCTL in September 2010 (3.6 µg/L). Increasing concentrations were observed in MW-44, located south of the Facility, beginning in September 2008 (62 µg/L). The concentrations detected at MW-44 in March 2009 and September 2010 remained stable (73 µg/L and 70 µg/L, respectively). Before September 2008, the concentrations detected in MW-44 ranged from non-detect to 5.5 µg/L. The concentration in MW-23 decreased between January 2008 (4.9 µg/L) and March 2009 (3 µg/L) to below the GCTL and remained below the GCTL in September 2010 (2.5 µg/L). Concentrations and distributions have remained approximately the same between March 2009 and September 2010. The concentration over time data plots for MW-128, MW-44, and MW-45 are included in Appendix D.

Concentrations in IWI-2 (noted as a Clay Zone 3 & 4 well) increased from 4.1 µg/L in October 2005 to 69 µg/L in the March/April 2009 event. Concentrations (61 µg/L) remained stable in this well in September 2010. The 2010 result is posted on the S&P Sands COC distribution Figure 3-11A, but is not included in contouring.

- *TCE*— Only one on-facility well, MW-128, contained detectable concentrations of TCE above the GCTL in the S&P Sands during the September 2010 sampling event. The recent concentration in MW-128 (3.7 µg/L) was less than concentrations detected during previous sampling events which ranged from 12 to 67 µg/L. The concentration at well MW-252 decreased from 13 µg/L in March 2009 (first time detected above the detection limit) to non-detect in September 2010. Generally, concentrations and distributions have decreased slightly during the September 2010 sampling event.

  Concentrations in IWI-2 (noted as a Clay Zone 3 & 4 well) have increased from 0.99I µg/L (February 2008) to 21 µg/L (March 2009). The concentration of TCE in IWI-2 during September 2010 decreased to 5.2 µg/L. The 2010 result is posted on the S&P Sands COC distribution Figure 3-11B, but is not included in contouring.

- *PCE*— No PCE concentrations above GCTLs were detected in the S&P Sands during the recent sampling event. PCE was detected in well MW-44 at 5.7 µg/L (above the GCTL) during the June 2006 sampling event.

- *Cis-1,2-DCE*— No cis-1,2-DCE concentrations above GCTLs were detected in the S&P Sands.

- *1,1-DCE*— No 1,1-DCE concentrations were detected above GCTLs in the S&P Sands during the September 2010 sampling event. The concentration in MW-128 increased to above the GCTL in March 2008 and remained above the GCTL through March 2009 when the highest concentration (83 µg/L) detected to date was reported. The September 2010 concentration decreased to 1.5 µg/L and is within the range of historical concentrations detected before March 2008 (non-detect to 4 µg/L). The compound 1,1-DCE has also periodically been detected above the GCTL in well MW-44 during five previous sampling events (twice in 2005, once in 2006, and twice in 2008). The highest concentration detected was 24 µg/L in September 2008. The concentration of 1,1-DCE detected in September 2010 (1.4 µg/L) was below the GCTL. The concentration over time data plots for MW-128 and MW-44 are included in Appendix D.

- *1,1-DCA*— No 1,1-DCA concentrations were detected above the GCTL in the S&P Sands during the recent sampling event. This compound has previously been detected above the GCTL in one well, MW-44, located south of the Facility. Concentrations in this well increased to above the GCTL for the first time in December 2008 (73 µg/L) and remained above the GCTL through June 2010 (72 µg/L). In September 2010, the concentration (59 µg/L) in this well decreased to below the GCTL. Historical concentrations before September 2008 ranged from non-detect to 9.5 µg/L.

3.2.5 COC Distribution in the Lower AF Sands and Floridan Aquifer System

No COCs were detected above GCTLs in either the Lower AF Sands or Floridan Aquifer System. The COC distribution in the Lower AF Sands and Floridan Aquifer System is shown on Figures 3-12A through 3-12F and Figures 3-13A through 3-13F, respectively. The concentration over time data plots for MW-19 (Lower AF Sands well) are included in Appendix D.

3.2.6 Additional Volatile Organic Compounds

In addition to the six COCs defined for the Tallevast Site, data from laboratory analyses were reviewed to determine if any other analyses for compounds from groundwater samples exceeded GCTL limits. Review of the September 2010 annual event results indicate that vinyl chloride was detected at concentrations greater than its GCTL (1 µg/L). Vinyl chloride distribution in each of the aquifer systems is illustrated on Figures 3-14A through 3-14D. Concentrations of bromodichloromethane, dibromochloromethane, and methylene chloride which were detected above GCTLs in March/April 2009 did not exceed GCTLs in September 2010.

Analytical results for vinyl chloride are discussed below.

- *Vinyl Chloride*— Vinyl chloride is a known biodegradation byproduct of chlorinated compounds such as TCE and PCE. The low concentrations presented below that occur within the Site are likely due to the biodegradation of Site COCs. Vinyl chloride was detected at concentrations greater than the GCTL of 1 µg/L at two USAS monitoring locations, four LSAS monitoring locations, two AF Gravels monitoring locations, and one Clay Zone 3 & 4 monitoring location during the September 2010 event. Detections of vinyl chloride in the USAS greater than the GCTL occurred in on-facility well MW-42 (1.1 µg/L) and MW-27 (1.3 µg/L) located southeast of the Facility (Figure 3-14A). Detections in the LSAS of vinyl chloride greater than its GCTL occurred on-facility at PZ-LSAS-4 (1.1 µg/L) and EW-108 (1.4 µg/L) and occurred off-facility at MW-87 (1.7 µg/L) and MW-98 (1.1 µg/L) (Figure 3-14B). Both AF Gravels detections of vinyl chloride greater than the GCTL occurred on-facility at MW-127 (13 µg/L) and IWI-1 (280 µg/L) (Figure 3-14C). The one Clay Zone 3 & 4 detection of vinyl chloride at a concentration greater than the GCTL occurred on-facility at well IWI-2 (32 µg/L), as depicted on Figure 3-14D.

3.3 Data Plots for Individual Wells

Contaminant concentrations over time at 54 representative wells distributed throughout the aquifer zones are provided in Appendix D. The wells were selected based on the following criteria:

- At least one COC had been detected above GCTLs at that well at some point in time.
- The well is located in an area where a COC GCTL boundary is present or nearby.
- The well is located in an area representative of the higher range of detected COC concentrations.
- The well is not located near another monitoring well with similar water sample analytical results. This criterion was intended to prevent multiple graphs of similar concentration patterns in a very small area.
- The well is not an active extraction well. Extraction well concentrations are often affected by temporal changes in pumping rate or other operational conditions.

Data are plotted for 21 USAS wells, 15 LSAS wells, 11 AF Gravels wells, 5 S&P Sands wells, 1 Clay/Sand Zone 3 & 4 well, and 1 Lower AF Sands well. Concentrations of 1,4-dioxane resulting from analytical methods other than USEPA Method 8260C SIM ID were not plotted; hence, the 1,4-dioxane data extend from October 2006 to present.

The data plots in Appendix D also include an operational history of the IRA treatment system for context in interpreting results.

4. Discussion and Recommendations to Modify the Future Annual Monitoring Plan

4.1 Summary of Potentiometric Surface Data

The September 2010 sampling event was conducted during the rainy season. Significant precipitation occurred immediately prior to the start of the field program. This resulted in significant increases in water elevations in most monitored geologic layers and surface water features compared to the March/April 2009 event, which occurred during a period of significant drought. Additionally, reduced groundwater pumping also resulted in increased water level elevations. The reduced pumping to the southwest of the Facility resulted in increased water level elevations in the LSAS, AF Gravels, and S&P Sands. Further south, there may be a new pumping source that is reducing water level elevations in the AF Gravels and S&P Sands.

4.2 Summary of Contaminants of Concern Data

The September 2010 annual monitoring event included sampling of 189 wells (165 monitoring wells, 10 extraction wells, seven private wells, and seven piezometers) for field and laboratory water quality analysis. A total of 31 wells (16 monitoring wells, 10 extraction wells, and 5 pilot test wells) were sampled and analyzed for the UIC program. A total of 45 wells (35 monitoring wells and 10 extraction wells) were sampled as part of the quarterly IRA program. This groundwater quality data set provided the basis for comparisons with historical results. Groundwater quality trends at specific monitoring wells were analyzed, as discussed in Section 3 above. In addition, the September 2010 annual monitoring event results were assessed in relation to the data from March/April 2009. This was done on both a Site-wide basis, as well as on an aquifer (layer by layer) basis, as described below.

On a unit-specific basis, the following primary points of differences between 2010 and 2009 annual event results were observed:

- *USAS* — Representation of the 1,4-dioxane GCTL boundary (Figure 3-8A) to the north and northeast of the Facility in 2010 included a separation of the plume compared to 2009 based on MW-71, MW-17D, and MW-65 having no detections of 1,4-dioxane in 2010. An increase in concentration at MW-89 to above GCTL resulted in a shift of the 1,4-dioxane GCTL boundary to the north in this area. Representation of the 1,4-dioxane GCTL boundary northwest and southeast of the Facility moved slightly due to increased detections in MW-108 (northwest), MW-94 (southeast), and MW-95 (southeast). Representation of the PCE and 1,1-DCE GCTL boundaries (Figures 3-8C and 3-8E, respectively) southwest of the Facility are smaller in 2010 compared to 2009. This change is primarily based on reduced 1,1-DCE detections in MW-25 and reduced PCE detections in MW-73. Representation of the 1,1-DCE GCTL boundary extended farther south of the Facility due to an increased detection in MW-75 which more closely resembles the depiction in 2008. Representation of the PCE and TCE (Figure 3-8B) GCTL boundaries moved slightly southeast of the Facility due to increased detections in MW-27.

- *LSAS* — Representation of the 1,4-dioxane GCTL boundary (Figure 3-9A) extended slightly farther to the south and to the north of the Facility in 2010 compared to 2009. The change to the south is primarily based on an increase in detected concentration in MW-101. The change to the north is primarily due to an increase in detected concentration in MW-86. Representation of the TCE GCTL boundary (Figure 3-9B) contracted in the west/northwest of the Facility due to reduced concentrations detected in MW-68 and MW-80. The boundary also contracted in the south due to not detecting TCE in MW-85. Representation of the 1,1-DCE GCTL boundary (Figure 3-9E) contracted slightly south and north/northeast of the Facility due to decreased concentrations in MW-85 (south), MW-82 (south), MW-81 (north), and MW-91 (northeast). Representation of the PCE GCTL boundary (Figure 3-9C) contracted slightly south of the Facility due to not detecting PCE in MW-82 and MW-85.

- *AF Gravels*— Representation of the 2010 1,4-dioxane GCTL boundary (Figure 3-10A) extended slightly farther northeast of the Facility. This change is primarily based on an increase in concentrations in MW-131, MW-133, and MW-255. This representation more closely resembles the 2008 depiction around MW-255. Additionally, there is a slight contraction of the 1,4-dioxane GCTL boundary west of the Facility due to lower concentrations in MW-129. Representation of the TCE GCTL boundary (Figure 3-10B) extended farther northeast of the Facility due to increased concentrations in MW-131 and MW-133. The northern representation of the TCE GCTL boundary contracted slightly due to a decrease in concentration in MW-135. Representation of the cis-1,2-DCE GCTL boundary (Figure 3-10D) extended farther to the northeast due to a higher concentration in MW-135, which more closely resembles the 2008 depiction. Additionally, there is an extension to the south of the Facility due to a detection in MW-134.

- *S&P Sands* — Representation of the TCE GCTL boundary (Figure 3-11B) contracted due to decreased concentrations in MW-128 and MW-252. Representation of the 1,4-dioxane GCTL boundary (Figure 3-11A) was similar between 2010 and 2009.

- *Clay Zone 3 & 4* — Well IWI-2 was included on the S&P Sands maps because it is the only well in the Clay Zone 3 & 4 unit with COC detections and is located in the upper portion of this unit, near the S&P Sands layer. Concentrations of

1,4-dioxane stayed approximately the same, concentrations of TCE decreased, and concentrations of vinyl chloride increased in IWI-2 from 2009 to 2010.

- *Lower AF* — To date, no exceedances of GCTLs have occurred in this unit.
- *Floridan* — To date, no exceedances of GCTLs have occurred in this unit.

On a site-wide basis, the overall GCTL boundary of COCs in groundwater during September 2010 has slightly expanded to the northwest (1,4-dioxane in the USAS), east/northeast (1,4-dioxane and TCE in the AF Gravels), north (1,4-dioxane in the LSAS), and south (1,4-dioxane in the LSAS) compared to that observed during the March/April 2009 event, which was used previously during development of the July 2009 RAP Addendum (ARCADIS, 2009b) and TPOC notice. The majority of these changes are associated with 1,4-dioxane concentration differences that oscillate around the GCTL (3.2 µg/L) which is also near the method detection level (1 µg/L) for this compound. The 1,4-dioxane GCTL boundary in the east/northeast is similar to the 2008 representation. The 1,4-dioxane GCTL boundary in the northwest is similar to the 2007 representation. The remedial alternative presented in the July 2009 RAP Addendum continues to be appropriate for addressing the overall GCTL boundary of COCs.

The 2010 overall GCTL boundary is presented on Figure 4-1. Based on the depiction presented on Figure 4-1, additional TPOC notices are proposed to be provided to the parcel owners listed in Table 4-1.

4.3 Recommended Future Groundwater Monitoring

As stated in Section 1, the annual groundwater monitoring event is intended to provide current data representative of groundwater plume conditions upon which remedial decisions can be made. Previous sampling events included all accessible groundwater monitoring wells at the Site. Based on sampling in 2006, 2008, and 2009, the boundaries of the groundwater plume were well established, and adequate information was obtained to design the recommended remedy. The 2009 RAP Addendum included a recommendation to sample a subset of all Site wells (180 wells) for ongoing annual monitoring. A RAP approval order dated November 4, 2010 was issued by FDEP; therefore, Lockheed Martin will continue to use a subset of wells in the ongoing annual monitoring until the remedy approved in the RAP Addendum is installed and its associated monitoring program (i.e., RAP effectiveness monitoring) can replace the annual monitoring program.

As discussed in Section 1.2, due to closure of certain wells since submittal of the RAP Addendum, the list of 180 wells has changed slightly. Table 1-1 shows the wells that are to be monitored during the next annual event. These wells are also shown on Figure 4-2. Changes from the list presented in the 2009 RAP Addendum include:

- Replacement of AF Gravels private well 2411 Tallevast Road with MW-255 (AF Gravels well)
- Replacement of Floridan well MW-218 with private well 2411 Tallevast Road Well #2 (Floridan well)
- Deletion of AF Gravels private well 2105 Tallevast Road due to closure of this well (note the proximity of AF Gravels well MW-158 which will provide data for this area)

Thus a total of 179 monitoring wells is proposed for the 2011 monitoring event (65 USAS, 42 LSAS, 38 AF Gravels, 19 S&P Sands, 8 Lower AF, and 7 Floridan wells).

5. References

ARCADIS BBL. 2007. *Remedial Action Plan, Former American Beryllium Company (ABC) Facility and Site, Tallevast, Florida*. May 4.

ARCADIS. 2008a. *In Situ Pilot-Study Work Plan*. January 22.

ARCADIS. 2008b. *Interim-Data Report— In Situ Pilot Study*. April 25.

ARCADIS. 2008c. *2008 Groundwater Monitoring Report*. July 7.

ARCADIS. 2008d. *Revised Remedial Action Plan, Former American Beryllium Company Site*. August 28.

ARCADIS. 2009a. *Interim Remedial Action Monitoring Report*. August, September, and October 2009, November 24, 2009 Lockheed Martin Tallevast Facility.

ARCADIS. 2009b. *Remedial Action Plan Addendum*. July 2009 Lockheed Martin Tallevast Facility.

ARCADIS. 2010. *Interim Remedial Action Monitoring Report*. August, September, and October 2009, November 24, 2010 Lockheed Martin Tallevast Facility.

BBL. 2006. *Interim Remedial Action Plan (IRAP) (Revised)*. February.

GeoTrans, Inc. 2008. *Groundwater Flow and Transport Model, Former American Beryllium Company Site, Tallevast, Florida— Interim Report— Conceptual Model, Numerical Model, and Preliminary Flow-Calibration*. March 19.

Tetra Tech. 2005. *Site Assessment Report Addendum*. January 31.

USEPA. 1999 and 2005. *Organic USEPA National Functional Guidelines*. October 1999 and January 2005.

USEPA. 2002. *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*. July 2002.

USEPA. 2006. *USEPA Region II SOP HW-24, Revision 2 (October 2006) Validating Volatile Organic Compounds by SW-846 Method 8260B.*