FINAL
FIRST INSTALLATION-WIDE FIVE-YEAR REVIEW REPORT
JOINT BASE LEWIS-McCHORD
Washington

Prepared for:

U.S. Department of Army
Joint-Base Lewis McChord, Washington

and

US Army Environmental Command
Ft. Sam Houston, Texas

September 2012

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List of Acronyms

ALGT	American Lake Garden Tract
AFB	Air Force Base
Amsl	Above mean sea level
ARAR	Applicable, Relevant and Appropriate Requirements
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	Chloroform
CFR	Code of Federal Regulations
cis-DCE	cis-Dichloroethylene
COC	Contaminant of Concern
CSM	Conceptual Site Model
CT	Carbon Tetrachloride
CWA	Clean Water Act
CX	USACE, Center of Expertise
CY	Calendar Year
DA	Department of the Army
DCE	Dichloroethylene
DCP	1,2-Dichloropropane
DD	Decision Document
DRMO	Defense Reutilization & Marketing Office
Ecology	Washington Department of Ecology
EGDY	East Gate Disposal Yard
EOD	Explosive Ordnance Disposal
ERP	Environmental Restoration Program
ESD	Explanation of Significant Difference
ESL	Environmental Screening Level
ESTCP	Environmental Security Technology Certification Program
FFA	Federal Facility Agreement
FS	Feasibility Study
ft.	Feet
FYR	Five Year Review
GAC	Granulated Activated Carbon
GIS	Geographic Information System
GPM	Gallons per Minute
gw	Groundwater
GWM	Groundwater Monitoring
I-5	Interstate Highway 5
IC	Institutional Controls
ID	Identification
IRP	Installation Restoration Program
IWTP	Industrial Wastewater Treatment Plant
JBLM	Joint Base Lewis-McChord
lb	Pound
LC	Logistics Center

LF	Landfill
LOGRAM	Logistics Center Remedial Action Monitoring
LUCs	Land Use Controls
LUCP	Land Use Control Plan
LTM	Long Term Monitoring
LVA	Lower Vashon Aquifer
MAMC	Madigan Army Medical Center
MCL	Maximum Contaminant Level
MEC	Munitions and Explosives of Concern
Mgal	Million Gallons
mg/kg	milligrams per kilogram
MMRP	Military Munitions Restoration Program
MRS	Munitions Response Site
MTCA	Model Toxics Control Act
MWs	Monitoring Wells
NAPL	Non-aqueous phase liquid
NCP	National Contingency Plan
ND	Non-detect
NEPA	National Environmental Policy Act
NFA	No Further Action
NGVD	National Geodetic Vertical Datum
NPDES	National Pollution Discharge Elimination Standard
NPL	National Priority List
NTCRA	Non-Time-critical Removal Action
OU	Operable Unit
O&M	Operation and Maintenance
P&T	Pump-and-Treat
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated biphenyls
PCE	Perchloroethylene
PDB	Passive Diffusion Bags
PI	Prediction Interval (Statistics)
PLC	Programmable Logic Controller
PNNL	Pacific Northwestern National Laboratory
ppb	Parts Per Billion
PRG	Preliminary Remediation Goal
PQL	Practical Quantitation Limit
p-value	Probability (statistics)
% REM	Percent Removal
QAPP	Quality Assurance Project Plan
RA	Remedial Action
RAO	Remedial Action Objective
RC	Response Complete
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facilities Investigation

RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RL	Reporting Level
ROD	Record of Decision
RSE	Remediation System Evaluation
RSL	Regional Screening Level
SI	Site Investigation
SLA	Sea Level Aquifer
SRCPP	Solvent Refined Coal Pilot Plant
SVE	Soil Vapor Extraction
Swl	Static water level
SVOCs	Semi-volatile Organic Compound
TBC	To Be Considered
TBD	To Be Determined
TCA	Trichloroethane
TCE	Trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Top of casing
TPH-G	Total Petroleum Hydrocarbon – Gasoline
TPH-D	Total Petroleum Hydrocarbon – Diesel
µg/L	Micrograms per Liter
µg/m3	Micrograms per Cubic Meter
USACE	United States Army Corps of Engineers
USACHPPM	United States Army Center for Health Promotion and Preventative Medicine
USEPA	United States Environmental Protection Agency
UU/UE	Unlimited Use Unrestricted Exposure
UVA	Upper Vashon Aquifer
UXO	Unexploded Ordnance
VAMC	Veteran's Administration Medical Center
VC	Vinyl Chloride
VES	Vapor Extraction System
VFD	Variable Frequency Drive
VOC	Volatile Organic Compound
WAC	Washington Administrative Code
WTA	Washrack Treatment Area

Executive Summary

The United States Army Corps of Engineers (USACE) – Sacramento District conducted this first Five-Year Review (FYR) for Joint Base Lewis-McChord (JBLM) to evaluate if remedies selected for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites continue to provide adequate protection of human health and the environment.

Sequentially, this FYR also serves as the fourth FYR for sites at both the former Fort Lewis Army Base (Lewis-Main) and the former McChord Air Force Base (McChord Field). These two installations are located in western central Washington and were combined as a joint base in February 2010 to form JBLM.

There were 16 Lewis-Main and two McChord Field sites assessed under CERCLA. Eight of these 18 Sites require no further action under CERCLA. The last Lewis-Main FYR was done in 2007, while the last McChord FYR was done in 2010. The JBLM CERCLA sites include;

Lewis-Main

- Logistics Center (aka East Gate Disposal Yard (EGDY))
- Landfill 4 (LF 4)
- Solvent Refined Coal Pilot Plant (SRCPP)
- Illicit Polychlorinated Biphenyls (PCB) Dump Site
- Landfill 1 (LF 1)
- Battery Acid Pit
- Defense Reutilization and Marketing (DRMO) Yard
- Industrial Waste Water Treatment Plant (IWTP)
- Pesticide Rinse Area
- Stormwater Outfalls
- Fire Training Pit
- Park Marsh Landfill
- Landfill 6 (LF 6)
- Explosive Ordnance Disposal (EOD) Site 62
- Well LC-6 & Pit Area
- Landfill 5 (LF 5)

McChord Field

- American Lake Garden Tract (ALGT)
- Washrack/Treatment Area

The trigger for the five-year review process was the actual start of remedial action construction at the Logistics Center in 1992. This first JBLM FYR was prepared pursuant to CERCLA §121(c), the National Oil and Hazardous Substances Contingency Plan (NCP), and Executive Order 12580.

A thorough examination of JBLM environmental documentation was made during this FYR. The bulk of the effort required was related to reviewing the former Lewis-Main Logistics Center site, where a large groundwater plume extends from the EGDY source area. Major components of the selected remedy for the Logistics Center are three groundwater pump-and-treat systems, source reduction actions (drum removal and in-situ thermal treatment), long-term groundwater monitoring (LTM), and land use controls (LUCs). The ALGT site also utilizes a pump and treat (P&T) system to remediate a separate groundwater plume in conjunction with LTM and LUCs. Long-term monitoring and LUCs are the primary remedy components for the remaining CERCLA sites.

Protectiveness determination for the short term is deferred. Further data gathering to evaluate the vapor intrusion pathway in industrial facilities above the Logistics Center plume is needed to clarify whether that exposure pathway is complete. Previously completed soil remedies and implementation of LUCs have terminated all other exposure pathways and are protective.

The remedies at JBLM are expected to be protective in the long term contingent on successful implementation of additional source area treatment currently being evaluated at the ALGT site. At the ALGT, the plume boundary is no longer shrinking and contaminant concentrations are no longer decreasing significantly. At the I-5 extraction and treatment system, there is some uncertainty whether the system is capturing the TCE groundwater plume in the Lower Vashon Aquifer. All other JBLM remedial actions are in place and operating as required. LUCs have been implemented and are functioning successfully to limit exposure to contaminants remaining on site. A combined JBLM LUC Plan will be produced when a combined JBLM Master Plan has been completed.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Joint Base Lewis-McChord (JBLM)		
EPA ID: WA9214053465		
Region: 10	**State:** WA	**City/County:** Pierce and Thurston

SITE STATUS	
NPL Status: Final	
Multiple OUs? Operable unit terminology has not been consistently used at JBLM	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: United States Environmental Protection Agency (USEPA) **If "Other Federal Agency" was selected above, enter Agency name:** n/a
Authors names (Federal or State Project Manager): Rick McComb, P.E., Doug Mackenzie, P.E., Maryellen Mackenzie, P.G., Hyland Morrow, R.G.
Author affiliation: US Army Corps of Engineers – Sacramento District
Review period: September 2011 – February 2012
Date of site inspection: 19-21 Dec 2011
Type of review: Statutory
Review number: 1
Triggering action date: 30 Sep 2007
Due date *(five years after triggering action date)*: 30 Sep 2012

Five-Year Review Summary Form (continued)

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:
Operable unit terminology has not been consistently used at JBLM. For the most part, the sites are all addressed separately. The following sites had no protectiveness issues/recommendations: • Industrial Waste Plant • Battery Acid Pit • Pesticide Rinse Area • DRMO Yard • Solvent Refined Coal Pilot Plant • Illicit PCB Dump Site • LF 1 • LF 4 • LF 5 • Washrack Treatment Area

Issues and Recommendations Identified in the Five-Year Review:				
OU(s): Logistics Center (EGDY)	**Issue Category:** Remedy performance			
	Issue: Inadequate data are available to address concern about potential vapor intrusion exposure in industrial facilities above the contaminated groundwater plume.			
	Recommendation: Develop and implement a sampling plan to gather data to characterize the vapor intrusion risk.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
Yes	Yes	Federal facility	EPA	3 Jun 2013

Five-Year Review Summary Form (continued)

OU(s): Logistics Center (I-5 P&T)	**Issue Category:** Remedy performance			
	Issue: Further evaluations are needed to address concerns about the I-5 groundwater extraction and treatment system's capability to capture the TCE groundwater plume within the Lower Vashon Aquifer.			
	Recommendation: Develop and implement a process for evaluating the capture zone of the I-5 system related to the Lower Vashon TCE plume. The evaluation may include utilizing the existing groundwater flow model, a capture zone analysis and continued evaluation of the downgradient groundwater monitoring network, as appropriate.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal facility	EPA	27 Sep 2013

OU(s): American Lake Garden Tract (ALGT)	**Issue Category:** Remedy performance			
	Issue: At the ALGT Site, continued reduction of the contaminant concentrations and the contaminant plume boundary is not being accomplished by the pump-and-treat remedy, potentially reducing the long-term protectiveness of the remedy.			
	Recommendation: Continue to evaluate alternatives to reduce source term and enhance dissolved plume remediation, including verifying that the source area conceptual site model is correct.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal facility	EPA	30 Sep 2014

OU(s): Logistics Center (EGDY), American Lake Garden Tract (ALGT), and LF4	**Issue Category:** Remedy performance			
	Issue: It is not clear that the groundwater monitoring program includes appropriate analytic performance goals for all analytes to ensure long term protectiveness.			
	Recommendation: As part of the JBLM monitoring program, examine cleanup goals and other risk based comparison values for groundwater plumes to assure monitoring is being done for appropriate contaminants of concern and associated monitoring goals.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal facility	EPA	15 Jan 2013

Five-Year Review Summary Form (continued)

Protectiveness Statement(s)		
Operable Unit: Logistics Center EGDY Plume	**Protectiveness Determination*:*** Protectiveness Deferred in short term will be protective in long term	**Addendum Due Date (if applicable):** September 30, 2014
Protectiveness Statement: Determination of protectiveness is deferred, pending additional sampling to address the potential for vapor intrusion at industrial structures above the Logistics Center Plume and an evaluation of the capability of the I-5 groundwater extraction and treatment system to capture the Lower Vashon TCE groundwater plume. The vapor intrusion evaluation is expected to be complete in June 2013, and the evaluation of the Lower Vashon Aquifer plume capture should be complete in September 2013. Upon resolution of those issues, the Logistics Center remedy is expected to be protective of human health and the environment in the long term. An Addendum to determine the protectiveness will be prepared by September 30, 2014. Two of the three groundwater extraction and treatment systems are performing as expected. In-situ thermal treatment has significantly reduced contaminant mass flux from three NAPL source areas. Additional source treatment methods are being evaluated to further reduce source area mass. Due to the large size of the groundwater contamination plume, effects of mass reduction in the source area are not expected to be observed at the toe of the plume in the near term. LUCs are fully implemented and functioning as expected.		

Five-Year Review Summary Form (continued)

Protectiveness Statement(s)		
Operable Unit: American Lake Garden Tract	**Protectiveness Determination***:* Protective in short term Not protective in long term	**Addendum Due Date (if applicable):**

Protectiveness Statement:
The remedy at the ALGT site is protective in the short term for human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled. In the off base area of the ALGT, groundwater meets remediation goals (drinking water criteria).

In order for the remedy to be protective in the long-term, the on-base remediation goal of restoring the aquifer to its beneficial use by meeting RAOs throughout the plume must be met. The Air Force has provided permanent public water supply connections to residents and restricted the shallow aquifer to non-potable uses to control current threats at the site. Additionally, the RAO of restoring the aquifer to its beneficial use must be attainable in a reasonable timeframe. Alternative remedies should be pursued to further reduce plume dimensions and contaminant concentrations.

Protectiveness Statement(s)		
Operable Unit: LF 4, SRCPP, Illicit PCB Dump Site, LF 1, Battery Acid Pit, DRMO Yard, IWTP, and Pesticide Rinse Area	**Protectiveness Determination***:* Protective	**Addendum Due Date (if applicable):**

Protectiveness Statement:
The remedies at LF 4, SRCPP, Illicit PCB Dump Site, LF 1, Battery Acid Pit, DRMO Yard, IWTP, and Pesticide Rinse Area are protective of human health and the environment. LUCs have been implemented at all these sites and have been effective in limiting exposure to site contaminants. Groundwater monitoring at LF 1 and LF 4 has demonstrated no further impact or diminishing impact by site contaminants.

1.0 INTRODUCTION

The purpose of this five-year review is to determine whether the remedies selected for JBLM CERCLA sites are protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports. In addition, FYR reports identify issues found during the review, if any, and recommendations to address them.

This is considered the first FYR for the JBLM installation while sequentially; it is the fourth five-year review for both Lewis-Main and McChord Field. The triggering action for this FYR was the signing of the third FYR for Lewis-Main on 30 September 2007. The third FYR for McChord Field was signed on 6 April 2010. This review was conducted by the Army Corps of Engineers – Sacramento District. The FYR was conducted from September 2011 to February 2012 and covers the period of October 2007 to September 30, 2011.

This review is required by statute. JBLM must implement FYRs consistent with CERCLA Section 121(c), the NCP Part 300.430(f)(4)(ii), and Executive Order 12580 (Superfund Implementation). The NCP states:

"If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after initiation of the selected remedial action." The objective of the review is to determine whether the selected remedy remains protective of human health and the environment. Specifically, the reviews are intended to: (1) confirm that the remedy as specified in the Record of Decision (ROD)/Decision Document (DD) and/or remedial design remains effective in protecting human health and the environment (the remedy is operating as designed, institutional controls remain in place, etc.); and (2) evaluate whether the original cleanup levels remain protective."

The Logistics Center is a site on Lewis-Main that is frequently referenced throughout this FYR and clarification of the site name and frequently used alias, East Gate Disposal Yard (EGDY), is warranted. Initial attempts to define the Logistics Center contaminant source included assessment of many sites in the vicinity of the Logistics Center area. As environmental investigations evolved and source areas became better defined, the ultimate source of the Logistics Center groundwater plume was identified as the EGDY. The EGDY was a landfill (Landfill 2) that received much of the waste from the industrial operations at Lewis-Main. Where appropriate, the site name, "Logistics Center", or "EGDY" will be used.

This JBLM installation-wide FYR provides an initial overview of all 18 sites (Lewis-Main and McChord Field) that have been managed under CERCLA:

Lewis-Main

- Logistics Center (aka East Gate Disposal Yard (EGDY))
- Landfill 4 (LF 4)
- Solvent Refined Coal Pilot Plant (SRCPP)
- Illicit Polychlorinated Biphenyls (PCB) Dump Site

- Landfill 1 (LF 1)
- Battery Acid Pit
- Defense Reutilization and Marketing (DRMO) Yard
- Industrial Wastewater Treatment Plant (IWTP)
- Pesticide Rinse Area
- Stormwater Outfalls
- Fire Training Pit
- Park Marsh Landfill
- Landfill 6 (LF 6)
- Explosive Ordnance Disposal (EOD) Site 62
- Well LC-6 & Pit Area
- Landfill 5 (LF 5)

McChord Field

- American Lake Garden Tract (ALGT)
- Washrack/Treatment Area

Of these 18 sites, the following ten sites were identified as having contamination remaining which does not allow for unlimited use and unrestricted exposure (UU/UE), as well as having remedies in place requiring ongoing action under CERCLA.

- Logistics Center (EGDY)
- ALGT
- LF 4
- SRCPP
- Illicit PCB Dump Site
- LF 1
- Battery Acid Pit
- DRMO Yard
- IWTP
- Pesticide Rinse Area

These ten sites are fully evaluated in this Five-Year Review.

This FYR is also consistent with Section XIX of the FFA, whereby the installation is required to conduct periodic reviews on a 5 year cycle that is consistent with Section 121(c) of CERCLA, 42 U.S.C. § 9621(c) and any pertinent regulations or guidance issued by USEPA or Ecology that is not inconsistent with CERCLA and the NCP.

An FFA update is being considered whereby the B-Range will be added as a new site. The B-Range is an area of Lewis-North that was used for training since the early 1900's. When the B-Range is added to the FFA, regulatory authority will change from RCRA to CERCLA and assessment in future FYRs will be required. Currently, the B-Range area is in the Remedial

Investigation/Feasibility Study (RI/FS) phase and is not being assessed as part of this FYR. This information is being provided for informational purposes.

Two former CERCLA sites have ongoing requirements that are being managed under state programs.

The Washrack Treatment Area is a deleted CERCLA site. Deletion of the site from the NPL occurred in September 1996. Information from the September 2004 FYR for the WTA states the following: "*The assessment of this Five-Year Review found that the remedy is operating as intended by decision documents. Remediation levels for groundwater generally have been attained throughout the site and no CERCLA hazardous substances have been left in place. Weathered, diesel-range total petroleum hydrocarbon (TPH) is the only contaminant that remains in place above Model Toxics Control Act (MTCA) cleanup levels. Future monitoring will be overseen by the Washington State Department of Ecology. As such, it is recommended that this report be considered the final Five-Year Review for the WTA under CERCLA"*. Since this site no longer has CERCLA hazardous substances in place and is overseen under state jurisdiction, it will not be further evaluated in this FYR.

Landfill 5 (LF5) is a deleted CERCLA site, which is currently being managed under State of Washington regulations (Washington Administrative Code 173-351). A No Further Action (NFA) ROD was written in 1992 and the site was deleted from the NPL in 1995. Information from the April 2010 deletion update for LF5 states the following, "*Contaminant concentrations in the ground water declined to levels below state and federal cleanup standards once the cover was in place; therefore, no further action was required under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The Army will continue to monitor ground water to confirm that the remedy remains effective"*. Since this site requires no further action under CERCLA and site monitoring and maintenance is overseen under state jurisdiction, it will not be further evaluated in this FYR.

2.0 SITE CHRONOLOGY

Table 1 provides a chronological summary of significant environmental projects and milestones for JBLM. The identified milestones are illustrative, not comprehensive.

Table 1 - JBLM Chronology

JBLM Projects and Milestones		Date
Former Fort Lewis	**Former McChord AFB**	
-	Disposal activities at the site.	mid-1940s to early 1970s
Soil removal at the SRCPP.	-	1980
-	Department of Defense Installation Restoration Program (IRP) initiated at McChord AFB.	1981
-	IRP Phase I—Records search.	1982
Illicit PCB Dump Site discovered followed by emergency removal action.	IRP Phase II—Site investigation. Discovery/Preliminary Assessment.	1983
	ALGT added to NPL	1984
-	Interim remedial activities—bottled water provided to private residences.	1984-86
Trichloroethylene (TCE) discovered in shallow groundwater beneath the Logistics Center.	-	1985
Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) completed.	Residences located within 5-micrograms per liter (µg/L) contour of the TCE plume connected to the public water system.	1986
Landfill 5 added to NPL	Wash Rack/Treatment Area added to NPL	1987
-	Remedial Investigation/Feasibility Study (RI/FS) negotiations completed.	1988

JBLM Projects and Milestones		Date
Former Fort Lewis	**Former McChord AFB**	
Logistics Center added to NPL	Federal Facilities Agreement (FFA) between Air Force, USEPA, and Washington State Department of Ecology (Ecology) finalized.	1989
FFA signed; Logistics Center ROD signed.	Human Health Risk Assessment finalized.	1990
-	-	
-	Ecological Risk Assessment finalized. RI/FS finalized; Proposed Plan identifying USEPA's preferred remedy presented to public; start of public comment period. ALGT ROD signed.	1991
Construction of two Logistics Center P&T systems in Vashon Aquifer begins.	Remedial Design completed.	1992
LF 4/SRCPP ROD signed and sites added as operable units to Logistics Center.	Began on-site construction of groundwater containment and treatment system. Completed connection of residents in the ALGT to the public water system.	1993
-	Containment system startup. Operations and Maintenance (O&M) Plan approved by USEPA. Completed on-site construction of groundwater containment and treatment system.	1994
Logistics Center Vashon Aquifer P&T systems begin operation.	-	1995
Landfill 5 deleted from NPL	-	1995
-	Wash Rack/Treatment Area deleted from NPL	1996
Low-temperature thermal desorption at SRCPP conducted.	-	1996 – 1997

JBLM Projects and Milestones		Date
Former Fort Lewis	**Former McChord AFB**	
Air sparging/soil vapor extraction at LF 4 conducted.	-	1996 – 1999
First FYR for Logistics Center.	-	1997
Logistics Center Explanation of Significant Difference (ESD) signed.	-	1998
-	Extraction well DX-1 shut down due to low concentrations in aquifer.	1999
DD for Logistics Center source area drum removal action signed.	First FYR completed.	2000
DD for Pesticide Rinse Area signed.	-	2000
Drum removal action at Logistics Center source area conducted.	-	2000 – 2001
DD for Logistics Center source area in-situ thermal treatment signed.	-	2002
Second FYR for Logistics Center, LF 4, & Illicit PCB Dump Site.	-	2002
Logistics Center source area Vashon Aquifer P&T system re-configured (EGDY P&T).	Extraction well DX-2 shut down due to low concentrations in aquifer.	2003 – 2006
In-situ thermal treatment at Logistics Center source area conducted.	-	2003 – 2007
-	Extraction well DX-2 pump replaced and returned to service due to a monitoring well slightly above remediation goal.	2004
Sampling for 1,4-dioxane completed for EGDY.	-	2004
	Second FYR completed. Sampling for 1,4-dioxane completed.	2005
DDs for Battery Acid Pit, DRMO Yard, Illicit PCB Dump Site, LF 1, and LUCs at Logistics Center source area (EGDY soil) signed.	-	2006

JBLM Projects and Milestones		Date
Former Fort Lewis	**Former McChord AFB**	
Optimization of downgradient Vashon Aquifer P&T system (Interstate 5 P&T).	-	2006 - present
No Further Action (NFA) DDs for LF 6 and Park Marsh Landfill signed.	-	2006
ESD for Logistics Center SLA signed.	-	2007
Indoor air sampling conducted at Madigan Housing.	-	2007
Draft DD for IWTP generated.	-	2007
Existing Land Use Controls (LUCs) formally documented in Land Use Control Plan (LUCP).	-	2007
Construction of Logistics Center P&T system in SLA begins.	-	2007
Third FYR completed	-	2007
Environmental Security Technology Certification Program (ESTCP) Cost and Performance Report – In-Situ Bioremediation of Chlorinated Solvents Source Areas with Enhanced Mass Transfer Start up of the Sea Level Aquifer (SLA) P&T began in October	-	2009
-	Third FYR completed.	2010
JBLM: Tech Memo to formalize 1). NFA for Fire Training Pit and Park Marsh Landfill, and 2). remedial alternative selection for the Pesticides Rinse Area, Illicit PCB Dump, and LF 1 (LF1)		2010
JBLM: ESD for Logistics Center that includes the following sites; DRMO Yard, LF 6, IWTP, Battery Acid Pit, and Well LC-6 and Pit Area.		2010
JBLM: Remediation System Evaluation (RSE) completed by USACE Center of Expertise (CX).		2011
-	Existing LUCs formally documented in LUCP.	2011

3.0 BACKGROUND

3.1 PHYSICAL CHARACTERISTICS

The JBLM military installation is located in western central Washington encompassing 90,837 acres within Pierce County (72,311 acres) and Thurston County (18,526 acres). JBLM is comprised of two co-located military bases, Fort Lewis and McChord Air Force Base. These two installations were combined to form JBLM in February 2010 as a result of a 2005 Base Realignment and Closure designation. See Figure 1 for JBLM location. Designations of JBLM include Lewis-Main (Fort Lewis), Lewis-North (North Fort Lewis) and McChord Field (McChord AFB).

JBLM is surrounded by the communities of Lakewood to the north (population 58,000), Olympia, Lacey, and Tumwater (population 86,000) to the south, DuPont to the west (population 7,500), and unincorporated Spanaway/Parkland to the east. JBLM supports an on-base population and in neighboring communities of more than 100,000 people including military personnel, families, civilian and contract employees, and retirees and their families. Interstate Highway 5 (I-5) bisects JBLM in a north-to-south direction with a majority of the JBLM installation to the east of I-5.

3.2 HYDROGEOLOGIC SETTING

The following description is based on the text in the *Numerical Flow and Transport Model for the Fort Lewis Logistics Center – PNNL* (July 2006). This description of the hydrogeologic units also applies to McChord Field with the exception of the "window", which does not exist at McChord Field.

The major hydrogeologic units are as follows:

- The upper unit is termed the Vashon Unconfined Aquifer (Vashon Aquifer). The thickness of the Vashon Aquifer is approximately 100 ft. It is composed of interlayered outwash and glacial till layers that generally overlie an older glacial outwash termed the Pre-Olympia drift. Scattered non-glacial deposits lie between the Vashon and the Pre-Olympia Drift. In the vicinity of the Logistics Center plume, the Vashon is divided into an Upper Vashon (UVA) and Lower Vashon (LVA) aquifers that are separated by discontinuous lower permeability till. Generally, there is communication between the Upper and Lower Vashon Aquifers, their potentiometric surfaces are generally the same. The distinction between the UVA and the LVA is poorly understood in the area of the Logistics Center.
- A generally continuous non-glacial unit having aquitard properties (termed the Qpon Aquitard) underlies the Vashon Aquifer. The thickness of the aquitard varies but it is generally from about 10 to 20 ft thick where the aquitard is present. However, the Qpon Aquitard is locally breached, and one of these breaches is located just near the centerline of the existing TCE plume, between the source area at Landfill 2 (EGDY) and the distal end of the plume. This breach is termed the "Qpon window" or "window" and it

provides a conductive pathway for contaminated groundwater to flow between the Vashon Aquifer and the underlying Sea Level Aquifer (SLA). The hydraulic gradient at this window is downward. Locations of other breaches have been inferred based on borehole logs but are less well defined than this window within the TCE plume.

- Beneath the aquitard is the confined SLA. The SLA is composed of glacial drift with minor silt layers and local areas of till, and it is bounded at the bottom by another non-glacial deposit with aquitard properties. The thickness of the SLA varies between about 50 and 100 ft thick. Groundwater flow patterns are complex. The extent of the "window" in the Qpon aquitard is not known.
- In addition, the 2006 modeling report (Truex, 2006) discusses a "lacustrine sediment feature" that is described as a large geologic feature oriented generally as a north-south trench filled with glaciolacustrine sediment. This lacustrine sediment feature cuts through the Qpon Aquitard and extends more than 50 ft down into the SLA, and serves as a barrier to flow. The "window" in the Qpon aquifer is located just down-gradient of this lacustrine sediment feature (based on flow direction in the Vashon aquifer). The modeling report suggests that the lacustrine feature has a significant impact on hydraulic gradients and flow patterns. The modeling report suggests that the lacustrine sediment feature substantially restricts horizontal flow volumes in the SLA upgradient of the "window", such that impacted groundwater that flows downward to the SLA through the "window" is not substantially diluted. Another feature that adds to the complex flow pattern is American Lake. Groundwater in the Vashon Aquifer flows towards American Lake, but water in the deeper SLA (which has lower hydraulic head than the lake) is diverted to the south around the lake. These features cause the orientation of the plume in the deeper SLA (generally to the southwest) to differ from the orientation of the plume in the Vashon Aquifer (generally to the northwest), as illustrated on Figure 24.
- The 2006 modeling report makes the statement that "The lacustrine sediment feature and associated SLA till and the influence of American Lake are the most important hydrologic features related to the groundwater flow field in the area of the TCE plume. These features combine to create an area of the SLA where the groundwater flow has a relatively low gradient, and the direction of flow turns 90º toward the south compared to the regional flow direction in the SLA." This is shown on Figure 33. "…*where the hydraulic barriers created by the lacustrine sediment feature and associated till and American Lake are shown in relation to the hydraulic head contours. The window between the Vashon Aquifer and SLA is located just down gradient (in the Vashon Aquifer) of the lacustrine sediment feature and is a significant source of groundwater to this area of the SLA…"*

For the Vashon Aquifer, the ROD (EPA, 1990b) states the following with respect to groundwater flow velocity:

"Groundwater beneath the Logistics Center is recharged by groundwater inflow from the southeast, and from infiltration of precipitation through the permeable soils. The water table gradient (slope) is to the north - northwest across the Logistics Center and is approximately10 feet per mile. Groundwater velocities range from 0.03 to 26 feet per day, with a median velocity of 1.5 feet per day. Aquifer transmissivity ranges from 14,000 to 20,000 gallons per day per foot."

The distance from the EGDY to the distal end of the plume is approximately 8,000 feet. Assuming a groundwater flow velocity of 1.5 ft/day as stated in the ROD, a particle of groundwater would flow approximately 550 ft per year and would require approximately 15 years to reach the I-5 system from the source area at the EGDY. This is a simplification since hydraulic properties are not uniform across this entire distance, but this simple calculation provides a reasonable first estimate regarding transport time from the source area.

3.3 HISTORY OF CONTAMINATION, INITIAL RESPONSE, BASIS FOR TAKING ACTION, LAND/RESOURCE USE

3.3.1 LEWIS-MAIN

Fort Lewis was established in 1917 and has been in continuous use since that time. The initial development of the Logistics Center began in 1941 with construction of the Fort Lewis Quartermaster Motor Base. In August 1942, the facility was transferred to ordnance jurisdiction and renamed the Mount Rainier Ordnance Depot, which operated until 1963. In 1963 the facility became the Logistics Center to serve as the primary non-aircraft maintenance facility for the post.

In January 1990, Army, United States Environmental Protection Agency (USEPA) and State of Washington Department of Ecology (Ecology), signed the Fort Lewis Federal Facility Agreement (FFA) (EPA, 1990a). The lead agency for addressing the environmental response at these sites is the Army, which is represented by the Lewis-Main Environmental Restoration Program (ERP). Sixteen Lewis-Main sites were included in the FFA, which establishes the framework for procedures, schedules and standards related to the study and cleanup efforts.

3.3.1.1 Logistics Center (EGDY)

The Logistics Center is the largest and most impacted site at JBLM with the main source area being the former industrial EGDY located at the southeastern edge of the Logistics Center. See Figure 2 for detail on JBLM site locations. The EGDY was a 23-acre landfill used between the 1940s and late 1960s/early 1970s. Trichloroethylene (TCE) was used historically at the Logistics Center in large quantities as a degreasing agent until the mid-1970s when its use was replaced by trichloroethane (TCA). Waste TCE, which was the principal degreaser used for maintenance at the Logistics Center, was disposed along with waste petroleum products.

In 1985, the Army identified traces of TCE in several monitoring wells installed in the unconfined aquifer beneath the Logistics Center. A limited site investigation (SI) (USACE, 1986) was performed in 1986 at which time it was discovered that TCE contaminated groundwater originating from the Logistics Center was a potential threat to the Lakewood Water District well located in nearby Tillicum. During 1986 and 1987, the USEPA performed a groundwater investigation in and around Tillicum and found that groundwater contamination originated from the Logistics Center. The Army agreed to study the groundwater plume off the installation as part of the Logistics Center RI (Envirosphere et al, 1988). In 1988, the RI was modified to include study of the horizontal extent of the off-post groundwater plume.

The results of past investigations have identified a plume of TCE in the Vashon Aquifer and SLA. Both plumes originate from the EGDY. The “source” of the TCE plume in the SLA is contamination originating from the Landfill 2 (EGDY) that passes through a hydrogeologic preferential pathway (commonly called the “window”) between the Vashon Aquifer and SLA. This "window" enables TCE to enter the SLA from the Vashon Aquifer at a location about halfway along the Vashon Aquifer plume.

Current land use for the EGDY is as a restricted industrial cleanup area within Training Area 7 of the Lewis-Main operational range area. Current and anticipated land use designated in the Fort Lewis Master Plan for the areas over the downgradient Vashon Aquifer and SLA TCE plumes is mixed. The majority is industrial/maintenance with a smaller percentages of land designated for family housing (residential), medical (equivalent to commercial), and open space. Current and anticipated land use in the off-post Tillicum community is a mix of residential, commercial, and open space.

3.3.1.2 LF4

The approximately 52-acre LF 4 was reportedly used for disposal of solid waste between 1951 and 1967. Although there are no records, the waste materials probably consisted of domestic and light industrial solid waste (including domestic liquids and biosolids collected by septic tank pump trucks) and construction debris.

Remedial action was required at LF4 for TCE and VC to protect human health and the environment under potential future land use conditions. Action was required because upper aquifer groundwater beneath the site is contaminated with TCE and VC at levels exceeding State and Federal maximum contaminant levels (MCLs) and the excess cancer risk associated with reasonable maximum groundwater exposure for potential future residential populations exceeds both Federal and State allowable risk thresholds.

Potential impacts to nearby surface water bodies were a concern since the highest TCE concentration was detected in a monitoring well located between LF 4 and Sequalitchew Springs. Water quality data for Sequalitchew Springs was obtained for the years 1986 through 1989. Based on the FFA (EPA, 1990a) and the results of the 1988 sampling, a RI/FS was initiated at LF 4 in 1991. The RI/FS (Applied Geotechnology, 1993a/b) concluded there were no complete exposure pathways for the site.

Current and anticipated future land use for LF 4 is restricted training within Training Area 2 of the Lewis-Main operational range area.

3.3.1.3 SRCPP

The approximately 25-acre SRCPP operated from 1974 to 1981 as a production and research facility designed to develop a solvent extraction technology for deriving petroleum hydrocarbon-like products from coal. In 1979, there was a 2,000-gallon spill of solvent refined coal liquid

fuel. Subsequent investigations of both soil and groundwater indicated other sources of soil and groundwater contamination might exist at the SRCPP.

Potential impacts to nearby surface water bodies and groundwater were assessed. Part of the site was paved and the concern was that removal of the pavement could mobilize vadose zone contaminants. Available records are limited, but indicate a large volume of contaminated soil was excavated and removed from the spill area in late 1980. Additional actions that were taken include sludge excavation in the wastewater lagoon in 1982, soil sampling from an overflow channel, and a groundwater monitoring plan that was used as part of the facility decommissioning.

LUCs continue at the site since total petroleum hydrocarbons in the diesel and heavy oil ranges were present at concentrations above the ROD goal in an UVA sample collected from an Area B test pit in 1996. However, there are no complete exposure pathways for the site and there are no potential current drinking water receptors.

The current and anticipated future land use designated for the SRCPP in the Lewis-Main Master Plan is administration, which is equivalent to commercial.

3.3.1.4 Illicit PCB Dump

The approximately 1.4 -acre-site is located in a forested and remote portion of the operational range area in Training Area 11. The dumping of PCBs and trichlorobenzenes by an unknown person was discovered by a timber contractor in 1983.

Initial response was to perform an emergency removal of 1869 tons of PCB contaminated soil in 1983. That action was followed by installation of a low-permeability clay cap and perimeter fence in 1984, a site investigation in 1994, improvements to the cap and fence in 1999, and groundwater monitoring events from 1984 to 2000. Although there are no complete exposure pathways at the capped and fenced site, ongoing action (i.e., cap maintenance and land use controls) continues since PCBs were present in soil in 1983 at concentrations above residential and industrial cleanup levels for the potential direct contact pathway.

The current and anticipated future land use at the site is restricted within the JBLM operational range area.

3.3.1.5 LF1

The approximately 15-acre LF 1 was reportedly used for disposal of solid waste between 1946 and the early 1970s. The site is located in the southern portion of the Cantonment Area, approximately ½ mile southwest of Gray Army Airfield.

In 1984, the initial response to characterizing the landfill was to place monitoring wells around the perimeter to assess potential impacts to groundwater. Additional monitoring wells (MWs) were installed in 1995. Ongoing action (i.e., groundwater monitoring and LUCs) continued at the site since TCE was present in two UVA groundwater MWs located adjacent to the landfill at

concentrations above the MCL. However, there are no complete exposure pathways for the site and the only potential current drinking water receptor is Lewis-Main Well 14. Well 14 is located approximately 1200 feet northeast of the landfill (cross-gradient from the regional direction of groundwater flow) and is screened in the deeper SLA.

LF 1 is located in an area designated for maintenance in the Lewis-Main Master Plan. The main portion of the landfill is currently not being used and has vegetation growing on the cap. Paved parking lots are constructed over former open pit dumping areas. Future land use for the site may include development of recreational ball fields. The current and anticipated future land use designated for LF 1 in the Lewis-Main Master Plan is industrial/maintenance.

3.3.1.6 Battery Acid Pit

The approximately 5-foot by 8-foot by 10-foot deep pit was used from 1971 to 1976 for discarding electrolyte solutions from vehicle batteries. The site is located within the northwest portion of the Logistics Center south of Building 9580 and adjacent to former Building 9589.

The initial response in 1986 was to perform soil sampling. Further action included investigation activities during the 1988 Logistics Center RI (Envirosphere et al, 1988), and site investigations in 1993 and 1995. The concern was for lead to be present in soil that may pose a risk to site workers and potential leaching to groundwater. Although there are no complete exposure pathways at the paved site, ongoing action (i.e., LUCs) continues since lead was present in soil in 1995 at concentrations above residential and industrial cleanup levels for the potential direct contact pathway.

The current and anticipated future land use designated for the site in the Lewis-Main Master Plan is industrial/maintenance.

3.3.1.7 DRMO Yard

The approximately 33-acre DRMO Yard is an active industrial laydown yard for surplus materials to be recycled or reused. The site was evaluated because in May 1981 approximately 10-15 gallons of transformer fluid containing PCBs was spilled. The site is located in the southeast portion of the Logistics Center and immediately northwest of the EGDY.

The initial response was to perform a soil removal of approximately 15 cubic yards in 1982. Subsequent sampling of excavated soil stockpiles indicated the soil could be returned to the excavation. Further activities included PCB confirmation soil sampling in 1986 (USACE, 1986), investigation activities during the 1988 Logistics Center RI, site investigations in 1995 and 2000, and a 2005 risk assessment. Although the site does not pose an unacceptable risk or hazard given current and anticipated future land use, ongoing action (i.e., LUCs) continues since total petroleum hydrocarbons in the heavy oil range, total carcinogenic polycyclic aromatic hydrocarbons, and lead were present in soil in 1995 at concentrations above residential cleanup levels for the potential direct contact pathway.

The site is currently used as an active industrial laydown yard for surplus material to be recycled. The anticipated future land use designated for the site in the Lewis-Main Master Plan is industrial/maintenance.

3.3.1.8 IWTP

The approximately 1-acre IWTP site is located within a fenced portion of the industrial Logistics Center complex. The IWTP began operating in 1954. The facility predominantly receives storm water runoff from nearby maintenance facilities. The IWTP also received floor washings from machine shops, paint spray booths, and rinsate from metal refinishing dip tanks of the Logistics Center. Effluent from the IWTP is discharged to a no-outlet evaporation/percolation lagoon. Sludges and sediments from the lagoon are currently disposed of in the on-post municipal landfill, which is not located at the Logistics Center. From 1954 to the mid-1970s, sediment and sludges from the IWTP's evaporation/percolation lagoon were disposed of in LF 6. In the early 1990's the industrial discharges from the IWTP were rerouted to the sanitary sewer. The storm water settling basins were taken out of service in 2002 when a replacement Outfall #7 was constructed. The evaporation/percolation lagoon currently receives overflows from Outfall #7 only during very high intensity rainfall events. Up through 2010, no flow to the lagoons has been noted. Outfall #7 is regulated under the Clean Water Act (CWA) with a National Pollutant Discharge Elimination System (NPDES) permit.

The initial response at this site was a limited site investigation (SI) in 1986 of surface soil around the former Outfall #7. Sampling for TCE and other volatile organic compounds (VOCs) in groundwater as part of the Logistics Center RI (Envirosphere et al, 1988) in 1988, resulted in the removal of the IWTP as a potential source area for the Logistics Center. A 2002 limited SI for surface soil followed the removal of approximately 80 cubic yards of petroleum impacted soil during Outfall #7 construction activity. A 2007 SI (Bussey, 2007) collected surface and subsurface soil samples to evaluate potential exposure pathways.

The site is currently used for excess stormwater capacity during infrequent stormwater overflows associated with a replacement Outfall #7 installed in 2002. Future land use is expected to remain as industrial/maintenance.

3.3.1.9 Pesticide Rinse Area

The Pesticide Rinse Area is a 34 x 35 ft. concrete pad without secondary containment that was used for at least 24 years as a rinsing area for pesticide applicator equipment and empty chemical containers. The site is located on the south side of Building 2054.

Initial response in 1986 was to sample surface soil around the concrete pad as cracks were noted in the concrete pad which may have extended to the base of the concrete. The perimeter surface sampling approach was deemed inadequate since it provided no information on conditions below the concrete pad, subsurface soils around the pad perimeter were not sampled, and the analyte list was not comprehensive. In 1993 and 1994 additional sampling was done to fill the data gaps noted from earlier sampling. Soil samples from below the slab and groundwater samples were collected.

Although the site does not pose an unacceptable risk or hazard given current and anticipated future land use, ongoing action (i.e., LUCs) continues since chlordane, dieldrin, and heptachlor were present in soil in 1994 at concentrations above residential cleanup levels for the potential direct contact pathway.

The current and anticipated future land use designated for the Pesticide Rinse Area in the Lewis-Main Master Plan is administration, which is equivalent to commercial (residential use is not allowed).

3.3.1.10 Stormwater Outfalls

Five stormwater outfalls receive stormwater from various locations at JBLM, including the Logistics Center. These outfalls are subject to requirements under the CWA and are covered by a NPDES permit.

The initial response in 1986 was to sample the stormwater outfalls that drain into surface water bodies, such as Puget Sound, and determine if contaminants were present. Sediment samples were collected and analyzed, but a quality assurance problem was discovered. In 1993 (Woodward-Clyde, 1993), sediment samples were again collected and result indicated that contamination was present, but at levels below applicable background concentrations therefore, no further CERCLA action is required.

3.3.1.11 Fire Training Pit

The Fire Training Pit area was used for fire response training between 1962 and 1982 by igniting flammable liquids pumped to the pit.

The initial response was to perform an investigation in 1986 and 1987 to characterize contaminants in soil and groundwater from historical usage of flammable liquid waste materials for firefighting training exercises. Various investigations have occurred since 1986 that collected and analyzed soil and groundwater data with results indicating no further CERCLA action is required.

3.3.1.12 Park Marsh Landfill

The Park Marsh was used for disposal of construction debris from the Veteran's Administration Medical Center (VAMC) from about 1948 through 1974.

The initial response was to characterize impacts to sediment quality at the Park Marsh and determine if the nearby Elliot Marsh had also been impacted. SI sampling was conducted for pesticides and metals with results indicating the concentrations were comparable to background levels. A 1994 risk assessment concluded no further CERCLA action is required.

3.3.1.13 LF6

LF 6 is reportedly a small 10-foot by 6-foot wide by 4 to 6-foot deep pit used for drying/disposal of IWTP treatment sludge between years 1954 and 1981. The site is thought to be located near the IWTP and once was considered a potential source area for Logistics Center contaminants. Past investigations have indicated that it is possible this site does not exist.

The initial response described in the 1988 Logistics Center RI (Envirosphere et al, 1988) was to assess the probable location of LF6 using soil gas sampling. A follow-on SI in 1986 and in 2005 gathered more soil data but no evidence of LF6 was discovered. No further CERCLA action is required.

3.3.1.14 Well LC-6 Pit Area

In the 1986 RFA the site was identified as a potential disposal pit, which reportedly contained an underground storage tank. The pit area may have been used for disposal of waste oil and solvent from nearby vehicle storage areas. The site was investigated as part of the 1988 RI (Envirosphere et al, 1988) for the Logistics Center. Soil gas, soil, and groundwater samples were collected from the site but indicated only minor soil gas detections and one soil detection of 0.51 parts per billion (ppb) for TCE. It was included in the 1990 ROD (EPA, 1990b) for further investigation as a potential source of VOC's to the Logistics Center plume.

Well LC-6 was installed in January 1984. It was assumed that groundwater samples from LC-6 would indicate contaminant releases from the Pit Area. However, groundwater concentrations from the well, which range from 10 µg/L TCE to 140 µg/L TCE over the period of record (1988 to 2010), are much higher than would be expected to result from the minimal Pit Area soil concentrations. Consequently, dissolved VOC concentrations in the well LC-6 and Pit Area are not indicative of a separate source area e.g. the former POL pit, but are consistent with the larger Logistics Center plume. TCE concentrations in Well LC-6 are managed as part of the Logistics Center plume, and no further CERCLA action is required at this site.

3.3.1.15 EOD Site 62

EOD Site 62 is a small 100 ft. x 100 ft. area used for training in the handling and triggering of explosive charges. EOD Site 62 was one of the 30 sites evaluated during the 1986 RCRA Facility Assessment (RFA) conducted by the EPA. During the evaluation it was determined that another site, Old EOD, was the actual location where munitions were destroyed instead of EOD Site 62. Old EOD is located in the operational range area (Training Area 4) about one mile south of Exit 118 on Interstate 5. Neither EOD Site 62 nor Old EOD requires evaluation under RCRA or CERCLA as long as they remain in the active operational range area. If required, these sites will be evaluated under the appropriate regulatory program upon operational range closure.

Based on the Final Draft 2010 Technical Memorandum (KEMRON, 2010a), both EOD Site 62 and Old EOD no further CERCLA action is required.

3.3.2 McChord Field

McChord Field started as McChord Army Air Field in 1938 and became McChord Air Force Base when the Air Force became a separate military service in 1947. The base served as a component in the strategic air defense command structure as an airlift base from World War II to the present day.

In August 1982, a Phase I Records Search (CH2MHill, 1982) identified 62 sites at the installation, including fire training areas, spill areas, landfills, and waste pits. Three additional sites were identified in 1984, 1989 and 1991.

In 1989, a FFA (EPA, 1989) was signed by McChord AFB, EPA, and Ecology to address two sites, the ALGT, an area of private property adjacent to McChord AFB, and the former aircraft Washrack/Treatment Area (WTA). Both sites were placed on the NPL.

The installation completed a RI/FS for the ALGT in 1991 (Ebasco et al, 1991a/b). TCE was discovered in the groundwater at concentrations above drinking water standards. A ROD (EPA, 1991) was issued to install a groundwater P&T system. The system was constructed and began operation in 1994.

3.3.2.1 ALGT

Disposal activities at Area D, which is associated with LF 5, occurred from the 1940s to the 1970's. The amount of TCE disposed at Area D is unknown.

Subsequent to the initiation of the IRP program in 1981, soil and groundwater investigations identified the most likely source of contamination was originating from Area D. Concurrent with the McChord IRP investigation, the USEPA discovered TCE in groundwater MWs installed at the ALGT, and in 1984, concluded that the groundwater contamination most likely originated from Area D. The ALGT site was subsequently listed on the NPL in October1984.

A Memorandum of Agreement was signed in September 1985 (McChord AFB, 1985) between the Air Force, EPA, Ecology, Washington Department of Social and Health Service, and the Tacoma-Pierce County Health Department that required the installation of a permanent water supply for residences of the ALGT. An opportunity to hook-up to the Lakewood Water District was offered to residents and beginning in the summer of 1986, approximately 80 residences at the ALGT were connected. The private drinking water wells were generally not abandoned. Seven waste disposal sites within Area D were identified and investigated as potential sources of contamination during the RI. Based upon the Phase 2 RI, the predominant sites contributing to groundwater contamination are three abandoned landfill sites which underlie the current Whispering Fir Golf Course. These sites, former landfills 5, 7 and 39, were identified in the RI by use of soil gas surveys, geophysical studies, source area borings, subsurface soil sampling, surface water and sediment sampling, monitoring, sediment sampling, monitoring well sampling, groundwater sampling and chemical analysis (Ebasco et al, 1991).

ALGT is an off-base residential tract abutting the southwestern boundary of McChord Field that lies between JBLM property and I-5. This tract consists of 1,183 housing units (mostly apartments) with approximately 3,400 residents. A base golf course and driving range now overlie former landfills that were part of the Area D disposal area. A groundwater pump and treat system was constructed and began operation in 1994. It has been in continuous operation since that time.

3.3.2.2 WTA

The WTA was deleted from the NPL in 1996 as a result of findings from detailed investigations. The assessment in the second FYR (McChord AFB, 2004) for the WTA states:

"The assessment of this Five-Year Review found that the remedy is operating as intended by decision documents. Remediation levels for groundwater generally have been attained throughout the site, and no CERCLA hazardous substances have been left in place. Weathered, diesel-range total petroleum, hydrocarbon (TPH) is the only contaminant that remains in place above Model Toxics Control Act (MTCA) cleanup levels. Future monitoring will be overseen by the Washington State Department of Ecology. As such, it is recommended that this report be considered the final Five-Year Review for the WTA under CERCLA."

Based on this statement, no further CERCLA action is required.

4.0 REMEDIAL ACTIONS

4.1 REMEDY SELECTION

4.1.1 LOGISTICS CENTER (EGDY)

The selected remedy for the Logistics Center NPL Site is documented in a ROD dated September 1990 (EPA, 1990b). The remedy primarily addresses groundwater contamination and includes the following elements:

- Install groundwater extraction wells and treatment systems capable of capturing and treating the groundwater contaminant plume in the unconfined aquifer. Install extraction wells near areas of highest concentration of contamination. Discharge treated water upgradient of these extraction wells.
- Monitor the groundwater contaminant plume and the treatment system
- Implement Institutional Controls
- Investigate the lower aquifer(s) to determine presence and extent of contamination. If contamination is found, a groundwater extraction and treatment systems will be installed which is capable of capturing the contaminant plume with subsequent treatment of the extracted groundwater in the on-site treatment facility.
- Perform confirmation soil sampling to ensure all remaining sources of soil contamination are identified and characterized.

The primary remedial action objective is to restore the unconfined aquifer to drinking water status. Cleanup goals were set at the MCL for all VOC contaminants. In the event that deeper aquifers require remediation, the RAO and cleanup goals would also be set at MCL.

An Explanation of Significant Differences (ESD) was completed in 1998 (EPA, 1998) to specify follow-on actions necessary to address the results of the investigations required in the 1990 ROD (EPA, 1990b).

- Soil sampling revealed that the EGDY was the primary source of groundwater contamination. The ESD required enhancements to the remediation strategy to improve source removal considering innovative technologies.
- The ESD required further characterization of TCE in the unconfined aquifer by installing more monitoring wells and add these wells to the groundwater monitoring program.
- Update and enhance the groundwater models to predict the fate and transport of TCE in both the upper and lower aquifers.
- Groundwater investigation revealed the presence of a TCE plume in the SLA and established the requirement to design and construct a remedial action.

Three Decision Documents (DD) s established specific supplemental remediation activities. A July 2000 DD (Ft. Lewis, 2000) specified removal of buried drums. A DD dated August 2002 (Ft. Lewis, 2002) established in-situ thermal treatment for soil and groundwater. In April 2006 (Ft. Lewis, 2006a), a DD required installation of a perimeter fence around the EGDY and implementation of additional institutional controls.

Another ESD was completed February 2007 (EPA, 2007) to document selection of the groundwater extraction/treatment remedy for the SLA.

4.1.2 LF 4

The investigation and remedial action chronology includes installation of five MWs in 1981, a site investigation in 1990, a RI/FS and ROD in 1993 (EPA, 1993), operation of an air sparging/soil vapor extraction system from 1996 to 1999, and groundwater monitoring between 1994 to present. Ongoing action (i.e., groundwater monitoring and LUCs) continues at the site since TCE and vinyl chloride (VC) were present in some Vashon Aquifer groundwater MWs at concentrations above their ROD goals.

Upper aquifer groundwater is the primary medium requiring action. To reduce ongoing groundwater contamination, unsaturated soil in historical disposal and/or degreasing activity areas also required action. RAOs are designed to protect human health and the environment from potential threats associated with site contaminants. RAOs for upper aquifer groundwater included:

- Prevent exposure to contaminated groundwater.
- Restore contaminated groundwater to its beneficial use, which is drinking water.
- Minimize movement of contaminants from soil to groundwater.
- Prevent exposure to landfill contents.

The selected remedy includes treatment of suspected sources of groundwater contamination, treatment of contaminated groundwater, groundwater monitoring, and implementation of institutional controls to protect human health and the environment during remedial action. Major components of the LF4 selected remedy included:

- Installing an active soil vapor extraction system (SVE) in suspected groundwater contamination source areas. Vapors from the system will be treated in compliance with air quality regulations prior to discharge.
- Installing an in situ groundwater sparging system to remove volatile contaminants from groundwater. The sparging system will work in conjunction with the SVE system.
- Monitoring upper aquifer groundwater to determine the effectiveness of the selected remedy. As part of the monitoring program, the localized area of elevated manganese on the western borders of the South and Northwest LF4 will be monitored to determine any changes in manganese concentrations. If the monitoring indicates that manganese

concentrations are not declining, the need for remediation of the localized areas will then be reevaluated. This reevaluation may include supplemental sampling, or additional source characterization.

- Maintaining institutional controls restricting access to and development at the site as long as hazardous substances remain onsite at levels that preclude unrestricted use.

Upper aquifer groundwater cleanup levels have been established to meet regulatory requirements. MTCA Method B was used to determine the cleanup level for VC at 1 µg/l which was the PQL for VC at the time the ROD was signed. The Federal MCL was used to determine the cleanup level for TCE at 5 µg/l.

4.1.3 SRCPP

The selected remedy from the 1993 ROD (EPA, 1993) included soil excavation and on-site treatment, groundwater monitoring, and LUCs. The investigation and remedial action chronology includes a soil removal in 1980, site investigations between 1980 and 1982, a RI/FS in 1993, low-temperature thermal desorption of excavated contaminated soil from 1996 to 1997, and groundwater monitoring/surface water monitoring between 1981 and 1999. Remedial action was required because soils beneath the site were contaminated with carcinogenic PAHs at levels exceeding State regulatory requirements; carcinogenic PAHs in soil have the potential, if site pavements are removed, to adversely impact groundwater. Predictive modeling indicates risks from impacted groundwater could exceed MTCA risk goals.

RAOs were designed to:

- Prevent exposure to contaminated soils,
- Prevent movement of contaminants from soil to groundwater, and
- Prevent exposure to contaminated upper aquifer groundwater beneath the former SRCPP.

Soil cleanup levels were established to meet State ARARs which will result in a cumulative risk not to exceed 1×10^{-5}. MTCA Method B was used to determine the cleanup level for total carcinogenic PAHs at 1.0 mg/kg. The groundwater monitoring program focused on PAHs, manganese, and field parameters. Groundwater cleanup standards were set at 0.1 µg/L for PAHs and 80 µg/L for manganese.

The major components of the selected remedy include:

- Excavation and treating contaminated soils. Soils will be treated using either soil washing to thermal destruction to meet cleanup levels.
- Monitoring upper aquifer groundwater beneath and adjacent to the site to determine the effectiveness of soil treatment.
- Maintaining institutional controls restricting access to and development at the site as long as hazardous substances remain onsite at levels that preclude unrestricted use.

4.1.4 ILLICIT PCB DUMP SITE

A DD dated December 2000 (PNL, 2000) included the Illicit PCB Dump. LUCs were chosen as the selected remedy. A 2006 DD (Fort Lewis, 2006c) was written to serve as a vehicle to provide finality on the selected remedy since the remedy described in the December 2000 DD was contingent upon results of additional groundwater monitoring data. This site is included in a Final Draft Technical Memorandum (KEMRON, 2010a) to formally document the selected remedies for all non-NPL CERCLA sites that were not included in the 1990 Logistics Center ROD. The technical memorandum is currently under EPA review.

The LUCs consist of preventing residential land use, preventing active training access, preventing unplanned excavations in the capped and fenced areas, and providing for maintenance of the cap and fence at the site. USEPA concurred with the selected remedy presented in the 2006 DD in an e-mail correspondence dated January 19, 2005. A LUC Plan containing these elements was prepared by the Army and approved by USEPA in September 2007. The LUC's were implemented in 2008.

4.1.5 LF 1

A DD dated April 2006 (Fort Lewis, 2006b) identified groundwater monitoring and LUCs as the selected remedy. This site is included in the Final Draft Technical Memorandum (KEMRON, 2010a) to formally document the selected remedies for all non-NPL CERCLA sites that were not included in the 1990 Logistics Center ROD (EPA, 1990b). The technical memorandum is currently under EPA review.

The investigation chronology includes installation of four MWs in 1984, site investigations in 1988 and 1994, installation of seven additional MWs in 1995, and groundwater monitoring events conducted between 1997 and current. Since TCE concentrations in groundwater surrounding the landfill are above the MCL, the selected remedy for the site includes the following actions:

- Implement LUCs on land use. A LUC plan would be developed that restricts land uses within the landfill boundary.
- Implement LUCs on groundwater use. The LUC plan would also prevent the installation of new water supply wells within 1,000 feet of the landfill boundary.
- Conduct long-term groundwater monitoring. Conduct annual groundwater monitoring as described in the April 2004 *LF 1 Groundwater Monitoring Plan*, as amended.

EPA concurred with the selected remedy in the 2004 Draft DD and 2004 *Final LF 1 Groundwater Monitoring Plan* (Bussey, 2004) in an e-mail dated April 20, 2004. The above remedy was implemented by the Army in 2008.

4.1.6 BATTERY ACID PIT

This site was included in the 1990 ROD (EPA, 1990b) for the Logistics Center as a potential source of groundwater contamination. It was subsequently found that it was not a source, and it is now considered a non-NPL CERCLA Site. A DD dated December 2000 included several sites including the Battery Acid Pit. Maintenance of the existing pavement cap and institutional controls is the selected remedy. A 2006 DD (Fort Lewis, 2006d) was written to serve as a vehicle to complete public comment requirements and obtain concurrence from USEPA and USACHPPM. The 2006 DD was written because of an omission where USEPA did not comment on the December 2000 selected remedy for the Battery Acid Pit due to the location of the Battery Acid Pit being within the Logistics Center. The DD identified LUCs to prevent residential land use, maintenance of an asphalt cap, and preventing unplanned excavations of contaminated soils along with five-year reviews as the appropriate remedy. USEPA provided concurrence with the selected remedy in the DD of LUCs in an e-mail dated January 19, 2005 however; no formal letter of concurrence was received by the Army.

This site is included in a Final Draft ESD dated October 2010 (KEMRON, 2010b) which was written to formally establish selected remedies for sites identified in the 1990 ROD that were not sources of groundwater contamination and thus are to become non-NPL CERCLA Sites.

4.1.7 DRMO YARD

This site was included in the 1990 ROD (EPA, 1990b) for the Logistics Center as a potential source of groundwater contamination. It was subsequently found that it was not a source, and it is now considered a non-NPL CERCLA Site. A 2006 DD (Fort Lewis, 2006e) selected LUCs to prevent residential land use within the boundaries of the site with five-year reviews as the final remedy for the DRMO Yard. USEPA concurred with the selected remedy in the Draft DD of LUCs to prevent residential land use in an e-mail dated January 27, 2005. However, no formal letter of concurrence was received by the Army.

This site was included in a Final Draft ESD dated October 2010 (EPA, 2010) which was developed to formally establish selected remedies for sites identified in the 1990 ROD that were not sources of groundwater contamination and thus are to become non-NPL CERCLA Sites.

4.1.8 IWTP

This site was included in the 1990 ROD for the Logistics Center as a potential source of groundwater contamination. It was subsequently found that it was not a source, and it is now considered a non-NPL CERCLA Site.

An SI was conducted by the Army for the IWTP in 2007. Soil samples were collected from seven test pits located in the ditch and former lagoon downstream of the IWTP. The screening level risk evaluation, based on MTCA criteria, concluded that there was no unacceptable risk based on the current and foreseeable industrial use of the area. However, LUCs would be needed to ensure the property is not used for residential purposes.

A draft DD was prepared by the Army for the IWTP site in 2007. The DD (Fort Lewis, 2007a) selected LUCs with FYR as the final remedy for the site. However, the draft document was not finalized pending preparation of an ESD for the site. The Army submitted a draft ESD to the Logistics Center ROD for the IWTP (AKA "Stormwater Outfall #7/Settling Basin) in 2010. When the ESD is approved, JBLM will update the LUC Plan for the IWTP with current information.

4.1.9 PESTICIDE RINSE AREA

A DD dated December 2000 (PNL, 2000) included several sites including the Pesticide Rinse Area. LUCs were chosen as the selected remedy. This site is included in a Final Draft Technical Memorandum (KEMRON, 2010b) to formally document the selected remedies for all non-NPL CERCLA Sites that were not included in the 1990 Logistics Center ROD. The Technical Memorandum is currently under EPA review.

A LUC Plan to prevent residential use was prepared by the Army and approved by EPA in 2007. In a letter dated January 7, 2000, USEPA concurred that no further action would be needed after LUCs to prevent residential land use for the Pesticide Rinse Area were in place. The LUCs were implemented in 2008.

4.1.10 ALGT

The selected remedy stated in the ROD (EPA, 1991) included connection of the ALGT residents to a public water system and groundwater extraction and treatment. In addition, groundwater monitoring and institutional controls were also specified as part of the remedy.
The RAO is to "restore the groundwater to its beneficial use, a drinking water source". The cleanup goals are based on ARARs; either MCLs or MTCA Method B values.

4.2 REMEDY IMPLEMENTATION

4.2.1 GROUNDWATER TREATMENT REMEDY

4.2.1.1 Logistics Center (EGDY)

There are three groundwater P&T systems included in the Logistics Center remedial action. Their locations are shown on Figure 3. Remedy implementation began with the design and construction of the two Vashon Aquifer P&T Systems: the source area EGDY P&T System and the downgradient Interstate 5 P&T System. Each Vashon Aquifer P&T System includes extraction wells, a packed tower aeration treatment unit, and infiltration system for discharge of treated water. Both the EGDY and Interstate 5 P&T systems have been modified from the original system designs that began operation in 1995. The current configurations of the EGDY and Interstate 5 (I-5) systems are shown in Figures 4 and 5, respectively. In addition to the P&T systems, in-situ thermal treatment was accomplished at the EGDY in stages beginning in 2003 and ending in 2007.

Re-configuration of the EGDY P&T System occurred in the 2003-2006 timeframe. The design flow rate of the new system is 800 gpm. Beginning in February 2005 there was a period of approximately 1.5 years when the system was off-line while the thermal treatment activity was underway (Tetra Tech GEO, 2011). Partial re-start began in September 2006, and full-scale operation commenced May 2007. The original EGDY infiltration galleries/wells were decommissioned and replaced with two new infiltration galleries and an injection well located southwest of the EGDY. The original galleries were decommissioned because the source area flushing concept of the 1990 ROD was ineffective and the original infiltration location was inhibiting contaminant capture at the extraction wells, and may have actively advanced the plume lobe that reached Madigan Housing Area. They were also abandoned because the in-situ thermal treatment project performed in 2003-2007 would have destroyed the transmission pipeline to the original infiltration location. The original EGDY extraction wells were decommissioned and replaced with Extraction Wells PW-1 through PW-8 to provide significantly improved containment of dissolved-phase contaminants migrating from the EGDY.

The Interstate 5 P&T System is still located as designed. The system consists of a line of extraction wells (LX-1 though LX-15), a treatment unit, and four downgradient infiltration galleries that minimize further flow of dissolved-phase contaminants across the installation boundary towards the community of Tillicum. The design flow rate is 1,600 gpm. Extraction wells LX-1 and LX-15 were shutdown in June 2007 due to low TCE concentrations in these wells and the results of a groundwater flow modeling study showing they had limited pumping influence. In addition, the original line-shaft turbine pumps used in the extraction wells have been replaced with variable-frequency capable submersible pumps to decrease maintenance requirements, improve operational flexibility, and enhance plume capture.

Construction of the SLA P&T System began in September 2007 and was completed in October 2009. Continuous operation began in March 2010, following system commissioning activities. The SLA P&T System includes 11 additional MWs, six extraction wells, a packed tower aeration treatment unit, and transmission of treated effluent to the Madigan Army Medical Center (MAMC) for re-use as hospital cooling water. The design flow rate is 1,600 gpm, and the MAMC is able to use most or all of the flow part of the year. The water is subsequently discharged to a lined pond that serves as a landscaping water feature, followed by an infiltration pond. The configuration of the system is shown on Figure 6.

The in-situ thermal treatment activity was completed in 2007 and was reported in the third Five-Year Review. A Cost and Performance Report was completed in August 2007 (USACE, 2007).

4.2.1.2 ALGT

The Air Force provided connections to the Lakewood Water District Water Supply System for households within the plume extent by 1986 and completed additional connections by June 1993 for the ALGT households that accepted the Air Force's offer of free connections. The Air Force began construction of the remediation system on April 14, 1993, and the extraction wells and treatment system started operation on February 15, 1994.

The pump-and-treat system consists of three groundwater extraction wells, two granular activated carbon vessels for treatment, and two infiltration trenches for disposal of treated water. The design flow rate is 140 gpm. The system layout is shown on Figure 7.

The pump-and-treat system has been operating since 1994 resulting in containment of the TCE plume to beneath the Whispering Firs Golf Course. Reduction in concentrations within the groundwater plume has allowed two of the three extraction wells (DX-1 and DX-2) to be placed on a standby "non-pumping status," although DX-2 was later returned to service due to persistent concentrations of TCE above 5 µg/L in a nearby monitoring well. There have been no further substantial changes to the system.

4.2.2 GROUNDWATER MONITORING REMEDY

4.2.2.1 Logistics Center (EGDY)

Monitoring wells have been installed iteratively over time in all three aquifers. Over 340 wells are part of the monitoring program. An additional 40 have been abandoned or destroyed since monitoring began in the 1980's. Based upon the *2010 Remedial Action Monitoring Program Compliance Monitoring Plan* (JBLM, 2010), approximately 50 groundwater monitoring wells screened in the Upper Vashon Aquifer are sampled per year. In addition, 13 extraction wells for the I-5 groundwater treatment system and 8 extraction wells for the EGDY system, also located in the UVA, are sampled. Fifteen wells screened in the LVA are sampled yearly; and approximately 48 monitoring wells and six extraction wells are sampled yearly in the SLA.

Sampling frequencies vary per well per year. Some wells are sampled quarterly while other wells are sampled semi-annually or annually. In general, the rationale for sampling frequency is to sample new wells more frequently to establish a baseline for determining trends. Once a baseline is established, sampling frequency continues on a semi-annual or annual basis. In general, those wells located at the distal portions of the plumes or in source areas are sampled semi-annually while wells located within the interior of the plumes are sampled annually.

Water level measurements are generally taken twice per year in 87 Vashon Aquifer monitoring wells and 76 SLA monitoring wells. The first measurements are generally taken in March during the wetter season and then again in August or September during the drier season.

Groundwater sampling is accomplished at most of the monitoring wells using Passive Diffusion Bags (PDBs). Two UVA monitoring wells are still sampled with dedicated bladder pumps due to the difficulty in removing the bladder pumps in these wells. Three small diameter monitoring wells are sampled using a peristaltic pump as their casings are too small to accommodate a PDB (3/4-inch diameter). All wells are sampled for the five contaminants of concern: TCE, DCE, PCE, TCA and VC. Groundwater samples are analyzed by USEPA Method 8260B.

Groundwater samples are collected from extraction and production wells using in-line sampling ports. These samples are collected only from wells that are operating and while the pump is operating. Well 13, a production well on standby, was started up and sampled for the same constituents during the 2009 CY sampling.

As of the 2010 LOGRAM Compliance Monitoring Plan, surface water at Murray Creek is sampled at three locations within the Logistics Center.

The JBLM Public Works contractor accomplishes all the groundwater monitoring and reporting. In addition, the in-house crew performs statistical evaluations of the groundwater monitoring data on selected wells. Statistically significant trends are identified and monitored over time. Appendix B discusses the statistical evaluation process. A rationale for which wells would receive statistical evaluations is described in the *2010 Monitoring Report* (JBLM, 2011a). Monitoring wells with a minimum of eight data points are statistically evaluated, except wells with more than 50% non-detects do not have trend analyses performed. The monitoring and reporting are well done and appear to be responsive to the site changes and trends to some degree.

4.2.2.2 ALGT

The primary document for review of the groundwater monitoring system at the ALGT was the CY 2010 Annual Report of remedial action operations and monitoring (TetraTech, 2011).

The RI for the ALGT characterized the nature and extent of groundwater contamination (Ebasco et al, 1991). The 1991 ROD set remediation goals for groundwater for four contaminants of concern: TCE, cis-1,2-DCE, 1,1-DCE and VC.

The list of wells to be monitored has expanded slightly over the 18 years of system operation. The current groundwater monitoring network consists of 14 “shallow-screen” and 10 “intermediate-screen” groundwater monitoring wells. In 2010, static water levels were measured in 3 extraction wells, 2 piezometers, 3 observation wells, and up to 19 monitoring wells. Groundwater samples were collected from 12 monitoring wells for analysis by USEPA Method 8260B for VOCs.

In CY 2010, water levels were taken quarterly in all wells with the exception of the extraction wells and one intermediate-screen, monitoring well (DA-9b). In the extraction wells and DA-9b, water levels were taken weekly.

Groundwater samples were taken annually, semi-annually, and quarterly in 2010 for ALGT. The rationale for groundwater monitoring was established in *The Final Remedial Action Work Plan* (USACE, 1994c) and is repeated in the *Final CY 2010 Annual Report, Remedial-Operation (RA-O) ALGT (LF-5) Groundwater Treatment Plan Quality Project Plan (QAPP)* (TetraTech, 2010a/b). The criteria established protocols for long term monitoring of the extents of the plume and criteria for operation of the extraction wells. Currently, groundwater sampling is being accomplished by low-flow sampling through a Grundfos Redi-Flow submersible pump. Protocols for sampling were found in *Standard Operating Procedure 1* in the *January 2009 Operations and Maintenance Field Sampling Plan*.

4.2.2.3 LF 4

There are currently 23 monitoring wells in the LF 4 monitoring program in the Upper Vashon Aquifer, the LVA and the Sea Level Aquifer. Both the Upper and LVA have been impacted by the site COCs. The current potential receptor to groundwater contamination at LF 4 is Sequalitchew Springs located approximately 1,200 feet southeast of LF 4.

The rationale for groundwater monitoring at LF 4 is presented in a groundwater monitoring plan prepared initially in 2004 and updated in 2007 (Bussey, 2007). In accordance with the plan, groundwater in 17 monitoring wells is sampled for TCE, DCE, VC and a subset on the western edge of the landfill is also analyzed for dissolved manganese.

Groundwater sampling is being performed using passive diffusion bags (PDBs) for those wells where only VOCs are being analyzed. For those wells that also require sampling for dissolved manganese, standard low-flow purging procedures using a bladder pump are used to purge water prior to sampling. Groundwater is purged at approximately one liter per minute. Standard stability parameters are recorded until the water parameters of pH, specific conductivity, temperature and turbidity stabilize. Groundwater samples are obtained through the pump at an unspecified flow rate. Samples for dissolved manganese are field filtered.

Groundwater samples for VOCs are analyzed by USEPA Method 8260B and samples for dissolved manganese are analyzed by USEPA Method 6020.

The 2011 groundwater sampling event was performed in August 2011. A sample was also collected from a spigot on the Sequalitchew Spring wellhead.

JBLM Public Works contractor accomplishes all the groundwater monitoring and reporting at LF 4. In addition, the in-house crew performs statistical evaluations of the groundwater monitoring data on selected wells. Statistically significant trends are identified and monitored over time. Appendix B discusses the statistical evaluation process. A rationale for which wells would receive statistical evaluations was not found.

The monitoring and reporting are well done and appear to be responsive to site changes and trends.

4.2.2.4 SRCPP

Groundwater monitoring was performed for two years after completion of the soil cleanup at SCRPP. Sampling was conducted in five downgradient monitoring wells. No site related contamination was detected at the point of compliance. Based upon a September 28, 1999 Memorandum by the EPA Superfund Project Manager, groundwater monitoring activities were curtailed and only LUC remain as a remedy. This Memorandum was the acceptance by Regional Office EPA of the Remedial Action Report for the SCRPP. The Memorandum states that "Cleanup levels have been achieved in groundwater at the point of compliance and in soils within the boundary of the SCRPP".

Acceptance of the Remedial Action Report by the Unit Manager demonstrates the formal completion of this activity." The declaration of acceptance was signed by Robert E. Kievet, Superfund Project Manager, and Amber Wong, Unit Manager, Environmental Cleanup Office on 30 September 1999.

4.2.2.5 LF 1

Fourteen monitoring wells have been installed at LF 1. Currently seven monitoring wells are monitored annually. All of the wells are screened in the Upper Vashon Aquifer. According to the *2009 Annual Groundwater Monitoring Report* (JBLM, 2011b), localized groundwater flow, as identified on Figure 30, is to the northeast. Regionally, the groundwater flow direction in the Upper Vashon is to the northwest. Groundwater samples are analyzed for VOCs by USEPA Method 8260. Groundwater samples are collected using PDBs. The last event for which data was available occurred May 2011.

Analytical data is reported for the following constituents: TCE, DCE, TCA, 1,2-dichloropropane (1,2-DCP), PCE, carbon tetrachloride, and chloroform. There is no plume at LF 1. Of the monitoring wells sampled in 2011, only groundwater in well 84-CD-LF1-4 exceeded the MCL of 5 µg/L for TCE. TCE is the only contaminant of concern identified in the DD. TCE concentrations were found in wells at the southern end of the landfill in groundwater in four wells: 84-CD-LF1-4, 95-LF1-11, 84-CD-LF-3, 95-LF1-10, at concentrations of 7.8, 1.8, 3.3 and 1.9 µg/L, respectively. This data is consistent with previous annual sampling events with the exception of 84-CD-LF-3 which exceeded the MTCA Method A level generally from installation through 2010 at concentrations of 9.5 to 19.0 µg/L.

The 2011 groundwater sampling event was performed in May 2011.

The JBLM Public Works contractor accomplishes all the groundwater monitoring and reporting at LF 1. No statistical trend analyses are being prepared for LF 1 by the in-house staff. This FYR did an evaluation of the TCE concentrations over time of monitoring well data from well 84-CD-LF1-4 and 84-CD-LF1-3. See Appendix B for the results. A downward trend was noted in well 84-CD-LF1-4 and no trend was noted in 84-CD-LF1-3.

The monitoring and reporting are well done and appear to be responsive to site changes and trends.

4.2.3 LUCs

LUCs are implemented through the Land Use Control Plan (LUCP) for each site where LUCs are the selected remedy or part of the selected remedy. See Table 15 for a listing of the LUCs that are applicable to each site. A combined JBLM LUC Plan will be produced when a combined JBLM Master Plan has been completed.

The LUC processes presented in the LUCP are a collection of LUC overlays on top of existing planning tools, procedures, permits, and regulations that ensure the LUC objectives are continually satisfied as installation development takes place.

To implement the LUCs into the JBLM planning process, the JBLM ERP develops LUC objectives that are used to design GIS overlays that can be integrated into the Real Property Master Plan. The overlays are shared with the appropriate JBLM staff (Real Property Manager, Public Works Manager, NEPA Program Manager, Cultural Resources Program Manager, Water Systems Manager, etc.) that is in charge of making land use decisions, policies, and regulations.

4.3 REMEDIATION SYSTEM OPERATION

Remedial systems operations described in this review include groundwater P&T systems and LUCs. Typical flow rates and contaminant concentrations for all extraction systems are shown in Table 16. Detailed information regarding system flow rates and extraction well flow rates during 2007-2010 is provided in Appendix A.

4.3.1 LOGISTICS CENTER (EGDY) AND I-5 P&T SYSTEMS

The EGDY System and the Interstate 5 System have been operated by a JBLM Public Works contractor since December 2004. The contractor employs staff at the installation full-time to accomplish program management, operation, maintenance, monitoring, and reporting for remedial actions at JBLM. Routine operation and maintenance is performed in accordance with a *Final Management Plan* (USACE, 1994a) and the O&M Plan (Fort Lewis, 2007b). O&M activities are reported annually. The O&M Plan requires weekly site visits for routine tasks. The system operator visits the treatment systems daily however, to closely monitor extraction well flow rates and make flow adjustments to avoid low water levels triggering on/off cycling of the extraction wells.

The EGDY and the I-5 systems have operated nearly continuously since the last five year review. Full system outages have been relatively short, having to do with planned maintenance and repairs or short term outages resulting from power fluctuations. Pumps in several extraction wells were replaced at various times through the past five years, resulting in extended downtime at some individual wells. Appendix A provides tabulated flow data for all extraction wells during 2007-2010. Figures 8 through 12 provide the same information graphically.

As part of a planned optimization program, several measures have been taken in the past five years to enhance performance of the I-5 system:

- Flow surge arrestors and flex piping installed at wellheads to control water hammer
- Variable frequency drives (VFDs) installed at system discharge pumps
- Transient voltage surge suppressor installed on system power supply
- Graphical user interface added to control system computer
- New magnetic flow meter installed on air stripper influent

In general, the O&M staff at JBLM regularly investigates opportunities to optimize all of the systems as a normal part of their work.

Several operation and maintenance issues beyond those normally expected were encountered over the past five years:

- Surges or fluctuations in the power supply may be the root cause of several extraction well or system shutdowns. The O&M staff has been evaluating surge protection for the extraction wells, though during the site visit it was noted that the power supply has been more stable recently.
- Extraction well maintenance has been a greater effort than expected. As an example, the system operator noted that in the past year there have been three extraction well pump replacements at the EGDY system. That re-configured system started continuous operation in May 2007, indicating that those wells failed in significantly less than five years. Well pump replacements have also been frequent at the Interstate 5 system. JBLM is now budgeting for two extraction well pump replacements per year.
- A heat wave in summer 2009 resulted in overheating and failure of the PLC at the EGDY system and also affected VFDs. The VFDs became unstable with temperature fluctuation. Controllers are being replaced and vents are being installed in VFD cabinets.

Bio-fouling has been present at isolated locations to a small extent, though not to the extent to lead to system failure. The system operator anticipates cleaning the air stripper packing at the EGDY system in 2012. At the I-5 system, extraction well LX-13 requires periodic cleaning to restore flow as a result of bio-fouling. There have been no difficulties with the groundwater recharge systems related to bio-fouling.

Extraction wells LX-1 and LX-15 have been off- line since June 2007 resulting from a groundwater flow modeling study showing they had limited pumping influence. LX-15 was re-started in 2012 due to an observed increasing trend in contaminant concentrations at nearby monitoring well LC-124.

JBLM is considering re-use of the effluent from the Interstate 5 system in the cooling system for a nearby motor pool.

Total annual cost for operation, maintenance, and monitoring for EGDY, Interstate 5, and SLA systems was developed from budget and cost information provided by JBLM, and is provided in Table 2 below.

Table 2 - Summary of Annual Costs

Cost Category	Estimated Annual Cost
Project Management	$40,000
Operator	$136,000
Sampling/Data Management/Reporting	$91,000
Laboratory Analysis	$50,000
Equipment	$57,000
Power	$45,000

Total	**$419,000**

It should be noted that the sampling and analysis costs include the groundwater monitoring program, which includes approximately 350 monitoring wells per year. Also, the costs associated with the SLA system include only influent/effluent sampling and major equipment replacement costs and well rehabilitation. The Madigan Army Medical Center pays for routine O&M including power.

4.3.2 SLA P&T SYSTEM

The SLA system has been continuously operated since March 2010. Thus, less than two years of operation have occurred at the time of this review. No operational issues have been reported to date. Routine O&M is performed by the MAMC operations staff. JBLM inspects the system monthly and collects influent and effluent samples. The first annual documentation of activities at the SLA system will be in the 2011 annual report.

4.3.3 ALGT P&T SYSTEM

The ALGT pump-and-treat system has run consistently since startup in February 1994. Operations follow the *Final Operation and Maintenance Plan* (USACE 1994a) and *Final Remedial Action Work Plan* (USACE 1994b), with updated procedures provided in yearly Quality Project Plans for the Groundwater Treatment Plant Monitoring and Optimization Program (latest version, Tetra Tech EC, Inc. 2009b).

Operation and maintenance through the last five years has been performed through a contract with Tetra Tech EC and David T. Johnson Engineers. In January 2012 that contract ended, and O&M responsibility has been assumed by the JBLM staff. Other than this change in operating responsibility, little has changed with the ALGT system since the previous Five-year Review for the site (March 2010). Nine carbon change-outs have been required thus far in the 17 years of operation.

One O&M issue of importance observed in review of 2008 O&M (Tetra Tech, 2009a) report is that extraction well DX-3 must be cleaned periodically to remove biofouling. Cleaning has restored flow to the design rate, but the well's specific capacity continues to decline overall (Figure 22). Continued decline suggests fouling may be occurring beyond the influence of the periodic cleaning. Specific capacity decline may eventually lead to the pumping head within the well lowering all the way to the pump intake. This well may need to be replaced in the future in order to maintain plume capture.

Current operations, maintenance, and monitoring costs total roughly $250,000 per year, and the occasional change-out of GAC every two years or so costs approximately $20,000 each time.

4.3.4 LUCS

Operation of LUCs requires JBLM staff to perform routine monitoring and reporting. The routine monitoring consists of interviews with staff responsible for maintaining LUC overlays

and visual field inspection of areas where LUCs apply. The Fort Lewis CERCLA LUC Monitoring Checklist is used to annually document the monitoring and is provided to USEPA for review. See Appendix G for example checklist. This process assures that the LUCS are still protective of human health and the environment.

In addition to the annual LUC checklist reporting, the FYR process is also used to assess the performance of LUC implementation and determine if any changes to LUC mechanism are necessary.

5.0 PROGRESS SINCE LAST FIVE YEAR REVIEW

An assessment of progress since the last FYRs for both Fort Lewis (2007) and McChord (2010) is provided in this section.

5.1 LEWIS-MAIN

For Lewis-Main, the protectiveness statement from the 2007 FYR stated: *"The Logistics Center remedy is expected to be protective of human health and the environment upon completion, and in the interim, exposure pathways that could result in unacceptable risks are being controlled. The remedies at LF 4, SRCPP, Battery Acid Pit, DRMO Yard, Illicit PCB Dump Site, LF 1, and Pesticide Rinse Area are protective of human health and the environment."*

The status of follow-up to the recommendations from the Third Five-Year Review for Fort Lewis follows:

Recommendation: *"Recommend confirmation of protectiveness of Logistics Center remedy for lower Vashon Aquifer following installation and sampling of two MWs currently being installed in Tillicum (proposed as LC-225 and LC-226). Potential follow-up actions could include additional groundwater monitoring, installation of additional MWs, groundwater modeling, and/or remedy modifications in a decision document, as necessary."*

Action: LC-225 and LC-226 were installed in September 2007. These wells were sampled quarterly since their installation through March 2010. These wells are now sampled semi-annually in the spring (March) and in the late summer/early fall (August or September). The most recent sampling as of this review was in August 2011. At that time, TCE concentrations were 10 µg/L (LC-225) and 2.6 µg/L (LC-226). Based upon the monitoring data, LC-226 TCE concentrations have predominately remained under the 5 µg/L while LC-225 TCE concentrations average about 10 µg/L. A statistical evaluation using Minitab® software (i.e. linear regression, Mann-Kendall, and Senslope) was run on both of these wells. LC-226 TCE concentrations show a statistically significant upward trend while LC-225 concentrations show no apparent trend. These wells were put in to confirm the protectiveness of the remedy for the Logistic Center in the LVA. Consideration should be given to further evaluating the trends in these wells to determine if groundwater contamination is migrating towards production well BC-1 above the action level. Currently LC-225 doesn't provide conclusive information to determine if groundwater contamination is moving downgradient. However in the case of LC-226, the groundwater data may be suggesting otherwise. After evaluating these trends, consideration should be given to another sentry well upgradient of BC-1 and downgradient of LC-225. It is also recommended that groundwater modeling and a capture zone analysis of the I-5 system be performed. Any further actions would depend upon the outcome of these evaluations.

Recommendation: *"Recommend discussion of cis-DCE and VC groundwater monitoring results for MWs located downgradient of Area 3 in future annual groundwater monitoring reports, until no longer warranted."*

Action: The 2007 through 2009 reports and 2010 data were reviewed for cis-1, 2-DCE and VC downgradient of the Pad 3 area at EGDY. The installation is evaluating and monitoring these constituents. While the extraction wells, PW-2, -3, -5, and -8 identified VC at concentrations ranging from 0.69 to 2.2 µg/L with one estimated value of 113J µg/L in 2007, only two downgradient monitoring wells, MT-1 and LC-137b, identified VC in 2007. VC has not been detected in monitoring wells in this area since 2007. Cis-1,2-DCE has been identified in a number of wells but no concentrations have exceeded the MCL of 70 µg/L. Currently, it doesn't appear that VC and cis-1,2-DCE generation is occurring at levels that would pose a risk to human health and the environment. However, if more source treatment is anticipated, continued consideration should be given to monitoring and evaluating the trends of both VC and cis-1,2-DCE in this area.

Recommendation: *"LF 4 monitoring should be optimized by stopping monitoring for manganese at all MWs except LF4-2, LF4-PNL1, and LF4-MW12A and changing the sampling methodology for the rest of the MWs from pumps to passive diffusion bag samplers."*

Action: These recommendations were adopted into an updated groundwater monitoring plan for LF 4 in 2007. Manganese sampling ceased in all wells in 2007 except LF4-2, LF4-PNL1 and LF4-MW-12, as recommended. The last sampling event where manganese was sampled in many of the wells was June 21, 2007. All wells identified in the plan are being sampled for VOCs with passive diffusion bags except the three wells where manganese monitoring continues. Standard low-flow purging procedures were used to purge water prior to sampling monitoring wells LF4-2, LF4-PNL1, and LF4-MW12A. Groundwater from these wells is being sampled for VOCs and manganese.

5.2 MCCHORD FIELD

For McChord Field, the protectiveness statement from the 2010 FYR states, *"The remedial action at the ALGT has been completed, the remedy is protective in the short term of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled. In the off-base area of the ALGT, groundwater meets remediation goals (drinking water criteria). The Air Force has provided public water supply connections to residents and restricted the shallow aquifer to non-potable uses to control current threats at the site. On-base in Area D, in order for the remedy to be protective in the long-term, the remediation goal of restoring the aquifer to its beneficial use must be met and ICs/LUCs must be fully implemented in an enforceable agreement."*

The status of follow-up to the recommendations from the Third Five-Year Review for the ALGT site follows:

Recommendation: *"Identify and evaluate alternatives to reduce source term and enhance dissolved plume remediation, including verifying that the source area conceptual site model is correct."*

Action: A pilot test was conducted in calendar year (CY) 10 to determine bioremediation's viability to further reduce TCE concentrations in the plume. The results of that initial test were inconclusive. A larger scale test will be implemented in 2012.

Results of the first stage pilot study did not impact the current CSM. The review team did not encounter any documentation regarding verification of the source area CSM.

Recommendation: *"Issue ROD modification for any remedy updates or document ICs/LUCs in an enforceable agreement upon change from McChord AFB to Joint Base Lewis-McChord"*

Action: The JBLM (McChord Field) LUC Plan for the ALGT was finalized in August 2011. JBLM was formed on 1 Oct 2012. The August 2011 LUC plan was written as a McChord Field specific document because the master plans for Lewis-Main and McChord Field were not scheduled to be combined until 2012. The Aug 2011 LUC Plan serves as an enforceable agreement that documents the LUCs for the ALGT. On 7 July 2011, USEPA submitted comments to JBLM and stated that an ESD to the existing ALGT ROD is not required to document ALGT LUCs. A combined JBLM LUC Plan will be produced when a combined JBLM Master Plan has been completed.

5.3 OTHER PROGRESS

In addition to addressing the recommendations of the previous FYRs as described above, the following items reflect further progress that has been made in the last five years by the JBLM environmental site restoration program:

- SLA system constructed and brought on line. Discussion is provided in Section 4.
- I-5 system optimization. Discussion is provided in Section 4.
- TCE concentrations in groundwater have continued to decline at the Logistics Center plume source area since completion of thermal treatment. Discussion is provided in Section 4.
- Following effective in-situ thermal treatment in 2003-2007 at the Logistics Center plume source area, other innovative technologies were explored to address areas where lesser, but still significant, contamination remains. In 2008 the Environmental Security Technology Certification Program (ESTCP) funded a demonstration project to further evaluate the treatment effectiveness of in-situ bioremediation to further treat DNAPL at the site. ESTCP also funded another study to evaluate the effects of combining low-energy electrical resistance heating with in-situ bioremediation or with iron based reduction using zero valent iron. In addition, the second study included the use of shear thinning fluids to aid in distribution and retention of the additives in the aquifer matrix. Results of the studies have led to a plan for further testing of in-situ bioremediation (CDM-PNNL, Nov 2009). This plan has not yet been implemented

- In 2010, a Final Draft ESD (KEMRON, 2010b) was prepared to document the selected remedy for the following potential source areas as listed in the 1990 Logistics Center ROD:
    - DRMO Yard
    - North Uses Area - includes LF 6, Industrial Wastewater Treatment Plant (IWTP, referred to as Stormwater Outfall # 7/ Settling Basin in the ESD), and Battery Acid Pit
    - Well LC-6 and Pit Area

- In 2010, a Tech Memo was prepared (final draft in review) which formally documented remedial action selection for group of non-NPL CERCLA sites listed below that were included in the 1990 Fort Lewis FFA. These sites have not been included in any RODs.
    - Fire Training Pit
    - Park Marsh Landfill
    - Pesticides Rinse Area
    - Illicit PCB Dump
    - Landfill
    - EOD Site 62

The selected remedies in the ESD and the Technical Memorandum have all been implemented through prior DDs, and primarily consist of LUCs, groundwater monitoring, or no further action (NFA).

6.0 FIVE-YEAR REVIEW PROCESS

6.1 ADMINISTRATIVE COMPONENTS

This first FYR for JBLM was prepared by the USACE – Sacramento District;

- Rick McComb, P.E., Environmental Engineer
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- Maryellen Mackenzie, P.G., Geologist
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- Cory Koger, Ph. D., Toxicologist

Support and review of the document was provided by;

- Bill Myers, LHG, JBLM
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- Heidi Novotny, USACE Environmental and Munitions Center of Expertise
- Vanessa Musgrave, Army Environmental Command
- Jonathan Harrington, Army Environmental Command

This first FYR was conducted between October 2011 and February 2012, with final regulatory signatures expected by 30 September 2012.

The FYR consisted of the following activities;

- Creation of Table 1 - Master Site Information
- A review of relevant documents and data (see Appendix D)
- Site inspection
- Interviews with installation and regulatory staff
- Development of recommendations (if any) based on technical analysis of remedial actions since last FYR

6.2 COMMUNITY NOTIFICATION AND INVOLVEMENT

A public notice announcing that the JBLM FYR will be made available for public review and comment and will be published in daily newspapers circulating in the Tacoma area, such as the *Tacoma News Tribune.* JBLM does not have a Restoration Advisory Board. A copy of the public notice identifying the initiation of the FYR can be found in Appendix F.

6.3 DOCUMENT AND DATA REVIEW

Reports and information generated from September 2007 to September 2011 were reviewed as part of this first JBLM FYR. A list of documents reviewed is at Appendix D. Since data collection is an ongoing activity at JBLM a data cutoff of 30 September 2011 was set.

An initial review of all DD's, which includes RODs, ESDs, Army DDs, and Technical Memorandums, was performed to determine what remedies were selected for each site, relevant dates, and any additional data pertinent to the FYR process. During this initial review, a master site status table was created as shown on Table 1. This table was of significant value to focus review of the activities that have occurred this review period. It was found that the review could be best accomplished by performing the evaluation on a remedial action approach as opposed to site-by-site approach. Data was used to summarize site conditions, contaminant concentrations and trends, and current status of remedial actions.

6.3.1 P&T SYSTEMS DATA ANALYSIS

Detailed review of treatment system flow rates, TCE concentration trends, and system efficiencies was performed to identify any potential trends of significance. Total annual flow for each system is shown in Table 3 below. Total annual mass of TCE removed and removal efficiency for each system are shown in Table 4 below. Charts showing TCE concentration in each extraction well versus time are at Figures 13 through 19. Logistics Center treatment system influent TCE concentration trends are presented in Figure 21. Tabulated TCE concentration data for all extraction wells and treatment systems at the Logistics Center are presented in Tables 17 through 19.

Table 3 - Groundwater Extraction Systems Total Annual Flow (Mgal)

Joint Base Lewis-McChord Groundwater Extraction Systems				
	EGDY	**I-5**	**SLA**	**ALGT**
2006		640		73
2007	325	705		68
2008	363	661		70
2009	320	721		72
2010	372	659	884	64
2011	318	497	836	

Table 4 - Groundwater Extraction Systems Total Annual Mass of TCE Removed and Removal Efficiency

Joint Base Lewis-McChord Groundwater Extraction Systems								
	EGDY		I-5		SLA		ALGT	
	mass (lb)	Efficiency (lb/Mgal)	mass (lb)	Efficiency (lb/Mgal)	mass (lb)	Efficiency (lb/Mgal)	Mass (lb)	Efficiency (lb/Mgal)
2006			216	0.34			16.94	0.23
2007	329	1.01	225	0.32			15.18	0.22
2008	246	0.68	203	0.31			15.84	0.23
2009	129	0.40	224	0.31			13.86	0.19
2010	145	0.39	144	0.22	119	0.13	12.56	0.20
2011	106	0.33	162	0.33	115	0.14		

6.3.1.1 Logistics center (EGDY) P&T System

The EGDY system as currently configured commenced full scale operation in May 2007. Annual volume pumped has been fairly consistent, though wells PW-1 and PW-7 had extended periods of downtime. The mass removal efficiency, expressed as pounds of TCE removed per million gallons extracted, has significantly decreased in the five years of operation. This suggests that the in-situ thermal treatment at the EGDY successfully removed a significant amount of TCE that otherwise would have migrated toward the extraction wells. Data from individual extraction wells, shown on Figures 8 and 9, identify some subtle decreases of TCE concentration with time. In addition, the treatment system influent TCE concentration shows more consistent values at lower levels beginning in July 2009 as shown in Figure 21.

The wells with the highest concentrations, PW-1 and PW-3, had the lowest flow rates (along with PW-8) by a considerable amount. This can be observed in Table 17. Operation staff indicated that the aquifer simply does not produce as well from those locations.

With the exception of two consecutive monthly sampling events in 2007, the air stripper has successfully shown removal of TCE from groundwater to below the discharge criterion of 5 µg/L, as shown on Table 17.

6.3.1.2 I-5 P&T System

Flow rates and TCE concentrations tend to be highest toward the center of the line of extraction wells, as shown in Table 18. Mass removal efficiency has remained stable for six years, with the exception of 2010. During that year several of the extraction wells with higher removal rates failed, with their downtime resulting in a more diluted influent stream. The pumps were ultimately replaced. Qualitative review of TCE concentration trends in individual extraction wells, as shown in Figures 15, 16, and 17, indicates most of the wells have no discernible downward trend. Wells LX-6, LX-11, and LX-12 may have downward trends. At this time there is little evidence to show that effects of source area remediation have propagated downgradient as far as the I-5 system. This is expected due to the distance from the EGDY.

The air stripper at the I-5 system has continuously removed TCE from the groundwater to levels well below the discharge criterion, as shown on Table 18.

6.3.1.3 SLA P&T System

With only two years of operation data available, it is too early to identify any long-term temporal trends. Some concentration drop-off after the initial few months, typical of most pump-and-treat systems, is evident in Figure 18. Similar to the I-5 system, the line of wells shows higher concentrations and flow rates toward the center. Treatment discharge concentrations of TCE exceeded the discharge criterion twice during the first year of operation, as shown in Table 19. In October 2010, a problem with the water distribution at the top of the stripper was corrected, and effluent TCE concentrations have been below 1 µg/L since that time.

6.3.1.4 ALGT P&T System

The previous FYR (JBLM, 2010b) March 2010) identified as an issue the fact that insufficient progress was being made toward achieving the cleanup goal. The most recent data have provided little evidence to the contrary. Figures 19 and 20 do not show obvious downward trends for TCE or 1,2-DCE. The TCE removal efficiency, as shown in Table 4, shows some variability that might suggest a downward trend, but that minor variability could also be a matter of variable flows and concentrations from the two extraction wells.

The 2010 annual O&M report (Tetra Tech, 2011) discussed the continuing decline in the specific capacity of extraction well DX-3, as shown on Figure 22 and Table 20. This well has a history of biofouling, and it is cleaned periodically. The cleaning restores the flow to the design rate, but the specific capacity continues to decline. Well DX-3 accomplishes the majority of the contaminant removal and will likely need to be replaced in the future to maintain the capture zone of the system. The carbon treatment continues to be effective in meeting the discharge criteria, with change-outs occurring approximately once every two years.

6.3.2 GROUNDWATER MONITORING DATA ANALYSIS

6.3.2.1 Logistic Center (EGDY)

Groundwater sampling results, groundwater potentiometric maps and statistical evaluations of the groundwater data were reviewed as part of this 5-year review for JBLM. Data evaluation includes data between the dates of 2002 and Sep 2011.

6.3.2.1.1 Plume Characterization

The 2009 Upper Vashon TCE groundwater plume is depicted on Figure 24 and was taken from the 2009 groundwater monitoring report (JBLM, 2011a) for the Logistics Center. TCE is the predominant groundwater contaminant and the 5 µg/L TCE contour line is generally used to depict the plume within site documents. The Upper Vashon 5 µg/L TCE plumes begins at the EGDY site and extends northwest across the Logistics Center beyond the I-5 system towards

American Lake. TCE concentrations upgradient of the EGDY P&T system and extraction well field are just above the detection limit - to the mid-teens. TCE concentrations in the extraction wells range from 16 µg/L at the southwestern end to 230 µg/L at the northeastern end of the well field (PW-8 and PW-1, Mar 2011, respectively). TCE concentrations immediately downgradient of the pump and treat system range from 100 to 268 µg/L (MT-1 and LC-137b, Mar 2011, respectively). Mid-plume downgradient of the EGDY P&T, TCE concentrations ranged from 61 to 200 µg/L (LC-06 and LC-49, Mar 2011, respectively). In the I-5 system extraction well field, the TCE concentrations range from 5.1 µg/L at LX-02 (Aug 2011) at the north end to 7.2 µg/L at LX-14 at south end (Aug 2011). In the middle of the I-5 extraction well field the highest concentration can be found in LX-8 at 67 µg/L (Aug 2011). Downgradient of the I-5 system, TCE concentrations ranged from 46 µg/L at LC-14A (Mar 2011) to 1.4 µg/L at LC-61B (Mar 2011). In the distal portion of the plume, Tillicum wellsT-04 through T-06, T-08, T-11B and T-13B, TCE concentrations ranged from 1.3 to 9.1 µg/L (Aug, 2011).

In general, the TCE plume in the Upper Vashon is fairly well characterized. There are a few areas where there is no closure of the 5 µg/L concentration line. In general the west side of the plume is missing wells down to the 5 µg/L concentration line near LC-224 (18 µg/L 2009 and 16 µg/L 2011) and 85-PA-381 (34.5 µg/L 2009 and 18 µg/L 2011). The east side of the plume at the EGDY P&T is 32 µg/L at LC-135 (2011). The closest well in the monitoring program is 500 feet northeast at LC-24 (ND in 2011). Further downgradient, the northeast side of the plume is characterized fairly well until nearer the I-5 system where L-16 is the last well near the northeast boundary with concentration of 10.4 µg/L (2009) and 7.8 µg/ L (2011). In these areas, trend data could support whether these wells are increasing or decreasing in concentration and if another well is warranted to further define the 5µg/L plume boundary.

In the last FYR (Bussey, 2007b), the bulge in the area of LC-222 and LC-224 was explained as an artifact of the location and operation of the former location of the infiltration system at EGDY and the source area contamination. The infiltration system has now been moved and the TCE concentrations in these wells have been reduced. 2010 trend data supports downward trends in both of these wells (see Appendix B).

Fewer wells define the Lower Vashon 5 µg/L TCE plume. From Figure 25, the footprint for the Lower Vashon appears similar to the Upper Vashon TCE plume. With the limited well data it is difficult to verify if that is truly the case. Currently, there is little information about the distinction between the two aquifers and whether there is communication between the UVA and the LVA. The highest TCE concentration is mid plume at LC-41B at 69 µg/L (2011). Just upgradient of the I-5 system, TCE concentrations are ND at LC-216 (2011). Within the I-5 extraction well field, TCE is monitored at LC-116b at 42 µg/L (2011). Downgradient of the I-5 system the concentrations are highest in LC-225 at 10.0 µg/L (2011). Few wells were sampled on the east flank of the plume so the TCE extents appear to be projections from the Upper Vashon network of wells. Within and immediately downgradient of the EGDY system, the TCE concentrations are ND as represented in LVA monitoring wells LC-137c (2011).

In 2007, LC-225 and LC-226 were installed in the Tillicum area in the Lower Vashon to better define the distal portion of the plume and to serve as an early warning for concentrations of TCE approaching production well BC-1. Currently, TCE concentrations in BC-1 are ND. These two wells added good information to the understanding of the Lower Vashon aquifer; however, the

results of the limited trend data make it important that perhaps more information is needed in this critical area.

The SLA plume begins where the window through the Qpon aquitard allows downward transport of contaminants from the Vashon Aquifers into the SLA (Figure 27). The lacustrine sediment feature restricts and impedes the flow of the SLA aquifer downgradient of the EGDY and upgradient of the window in the Qpon aquitard. Groundwater flows to the northwest from EGDY to the window. From the window to American Lake, the gradient steepens and the flow direction gradually rotates about 90 degrees from that of the Vashon Aquifers (Figure 26). The eventual flow direction is towards the west/ southwest at the southernmost portion of American Lake and the distal portion of the SLA TCE plume. The SLA plume mimics this flow pattern. The distal portion of the plume is defined by a number of wells downgradient of the SLA P&T system where TCE concentrations hover around the MCL for TCE. The concentration of TCE at the window is represented by well LC-69D at 97 µg/L (2011). Upgradient of the SLA P&T, the TCE concentration ranges from 5.89 (LC-73d, 2009) to 95 (LC-103d, 2011) µg/L. Downgradient of the system, TCE concentrations ranged from 5.4 µg/L (LC-102D-2, 2011), at the distal end of the plume, to 25 µg/L (LC-98D-2, 2011) at the center of the plume. Within the SLA extraction wells, TCE concentrations are highest at LC-99D at 74 µg/L (2011).

Characterization of the SLA plume is fairly complete except in the Tillicum Area. SLA water level data may indicate that contaminated groundwater within this aquifer doesn't reach this area; however, with the current monitoring well network, the TCE contours should not be closed in this direction. It was explained that SLA monitoring well LC-80D was monitored for many years and remained ND; therefore, monitoring of it ceased but this information was not included in the monitoring reports reviewed. It would be helpful to include a discussion of the prior sampling efforts, assumptions made in plume depiction, the regional flow direction and the gradient in SLA in this area in future monitoring reports. TCE concentrations in well LC-126, located in the northern edge of the SLA plume, currently appear to be decreasing but that cannot be stated with any degree of statistical certainty (75 µg/L in well in 2011).

6.3.2.1.2. Statistical Evaluation

The site team does a good job of performing statistical evaluations on quite a bit of the groundwater data. Appendix B includes 2010 statistical evaluations performed by the site team plus an evaluation of the two newly installed Tillicum wells LC-225 and LC-226 screened in the Lower Vashon. Concentrations show no trend in LC-225 but may be increasing in LC-226. Another monitoring well should be considered between LC-225 and BC-1 to serve as an early warning for BC-1 and the site team continue to perform trend analysis on the Tillicum wells.

6.3.2.1.3 Plume Capture

At EGDY, plume capture near PW-1 may not be attained but it is difficult to tell with the current monitoring well network. PW-1 is located at the eastern edge of the system; PW-1 has the highest contaminant concentration of all the extraction wells. In 2011, JBLM began monitoring LC-135. The TCE concentration in LC-135 in September 2011 was 32 µg/L. The closest monitored well in this area of the plume beyond LC-135, is LC-24, which is approximately 850

feet northeast of LC-135. With the existing set of monitoring wells, it is difficult to say that the P&T is capturing the TCE plume east of LC-135.

From the documents reviewed, little mention regarding plume capture at EGDY was found. Water level data is relatively sparse near the extraction wells. VOC chemical data was used to assess plume capture. Within the extraction well field, TCE concentrations are significantly decreasing in monitoring wells LC-160, LC-64A and MT-4. TCE concentrations also tend to be decreasing in LC-108, MT-1, MT-2, and MT-3 but the trends are not considered statistically significant. TCE concentrations are increasing in downgradient monitoring well LC-137B but the trend is not considered statistically significant. In general, the P&T is effective at removing contaminants from the groundwater and effectively decreasing concentrations within the target aquifer.

However, an evaluation of the capture zone near PW-1 is warranted to verify the system is operating as designed. A suggested reference for the capture zone evaluation is EPA/600/R-08/003, January 2008, "A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems." (EPA, 2008)

At the I-5 P&T system, the monitoring well network is robust and wells are placed and monitored in areas where plume capture can more readily be assessed. The 2009 LOGRAM Monitoring Report states that the effects of the pumping system continue to be localized near the I-5 extraction and infiltration system. This appears to be correct and capture of the plume seems to be achieved. The installation carefully monitors the well field response to turning on and off extraction wells. When TCE concentrations around extraction well LX-15 began to increase, the installation's response was to resume pumping in LX-15. In general, TCE concentrations downgradient of the I-5 extraction system appear to be declining or stable in the UVA as signified by monitoring wells LC-14A, LC-61b, and Tillicum wells T-11b, T-06, T-04, T-05, T-13b, and T-08. TCE concentrations downgradient of the I-5 P&T in the Lower Vashon aquifer are not as well understood. Trends seem to indicate both statistically upward and downward trends and everything in between. It was recommended in the last FYR that modeling be performed to better understand the hydrogeology of this area. It is a further recommendation of this FYR that the modeling work be performed as well as a capture zone analysis of the extraction wells in the I-5 system.

The monitoring system around the SLA P&T seems to be adequate to determine capture. However, there were no statements in the 2009 LOGRAM Monitoring Report (JBLM, 2011a) regarding capture at the SLA P&T. Most likely this is because it is too soon to determine. From the limited VOC data, it does appear that TCE concentrations within the monitoring well network between the extraction wells and downgradient of the P&T are trending downward. Downgradient of the SLA P&T at the distal end of the TCE plume the 2009 LOGRAM indicates a statistically increasing trend in LC-84D-2 and LC-101D-1 however; the wells have low concentrations of TCE in addition to being potentially too soon to determine trends. It may also not be prudent to perform trend analyses on wells nearing the method reporting limit (RL).

6.3.2.2 LF 4

6.3.2.2.1 Plume Characterization

TCE and VC are the COCs for this site. TCE in the groundwater at Landfill 4 occurs predominantly in localized areas in the UVA. TCE concentrations above the ROD 5 µg/L goal occur fairly consistently in monitoring wells MW-UG1 and MW-DG1 and somewhat sporadically in MW LF4-1. In the 2011 Annual Groundwater Monitoring Report (JBLM, 2011c), TCE concentrations exceeded the ROD cleanup level of 5 µg/L in samples collected from source area wells MW-DG1 and MW-UG1 at 13 µg/L and 8.5 µg/L, respectively and in downgradient well LF4-1 at 6.5 µg/l. In general, TCE concentrations tend to be decreasing over time. The site is shown on Figure 29 (JBLM, 2011c).

VC in the groundwater continues to occur above the ROD goal of 1 µg/L in only one well, LF4-2. Since the last FYR, concentrations ranged from 1.46 to 1.49 µg/L in well LF4-MW15B (2008 to2009). However, in 2009 through 2011, the VC concentrations in LF4-MW15B have been below the MCL at 0.5 to 0.98 µg/L. VC concentrations appear to be generally decreasing over time.

Groundwater continues to be sampled for dissolved manganese from selected wells. A cleanup goal was not established for dissolved manganese in the ROD and manganese has not been identified as a contaminant of concern at this site. In the ROD (EPA, 1993) section D2b (Nature and Extent of Groundwater Contamination) the occurrence of manganese is discussed. *"...the elevated concentrations of manganese in groundwater are caused by a dissolution of manganese from geologic material in the presence of a localized area of anaerobic groundwater. As the manganese contaminated groundwater moves downgradient, the manganese appears to precipitate, as suggested by rapidly declining concentrations in immediately downgradient wells."* Manganese has not been identified as a compound emanating from a CERCLA related release but rather a natural occurring compound that is affected by the decaying organic material within the landfill. In a further discussion of the remedial action objectives in the ROD, it is stated: *"Manganese is not included because it is expected that the localized area of elevated concentration will rapidly decline due to implementation of the final remedy, as described in the Selected Remedy section."* The intent of monitoring manganese was to verify that the manganese concentrations in groundwater were not spreading and will ultimately decline. Limited strategically located monitoring wells and trend analyses will meet that objective. However, it is a recommendation of this FYR that the two monitoring wells that were previously taken out of the groundwater monitoring program be reinstated to continue to characterize the manganese in the areas on the west and southwest sides of the LF4, LF4-MW6 and LF4–MW16A.

6.3.2.2.2 Flow Direction

The groundwater flow direction at LF 4 area is shown on Figure 29. According to this map, groundwater flows west and then gradually turns and flows northwest. The groundwater gradient appears to be relatively flat across the site. Shallower wells, i.e., LF4-MW-5, LF4-MW-

6, and LF4-MW-7, where the screened intervals are from 10 to20 feet bgs are most likely influenced by Sequalitchew Lake and not the groundwater gradient in the UVA.

Sequalitchew Springs is within the LF 4 area; groundwater monitoring began as a measure to ensure that the Springs are protected from receiving contaminated groundwater. The current groundwater monitoring data reflect non-detects for TCE in the area surrounding Sequalitchew Springs.

6.3.2.2.3 Statistical Evaluation
Statistical analysis has been performed on select groundwater monitoring wells at LF 4 as shown in Appendix B. In general, concentrations are declining for the COCs.

6.3.2.3 LF 1

6.2.2.3.1 Plume Characterization

The monitoring well network adequately defines the groundwater contamination. TCE concentrations detected in groundwater have been steady or decreasing over time. During the 2011 sampling round, only TCE concentration in monitoring well 84-CD-LF1-4 exceeded the MCL of 5 µg/L with a TCE concentration of 7.8 µg/L. Since the last FYR, monitoring well 84-CD-LF1-3 also had exceedances above the 5 µg/L value at concentrations of 9.1, 11.3, and 19.0 in 2008, 2009, and 2010, respectively. Since the last FYR, monitoring well 84-CD-LF1-4 also exceeded the MCL at concentrations of 6.1, 5.4 and 7.8 µg/L in 2008, 2009 and 2011, respectively. However, these are the only wells that have exceeded the cleanup standard since the last FYR and apparently since monitoring began in 1988. Both monitoring well 84-CD-LF1-3 and 84-CD-LF1-4 appears to be relatively stable with respect to TCE concentrations, as described in Appendix B. TCE concentrations in groundwater do not pose an unacceptable risk to human health or the environment since there are no complete exposure pathways. A potential cost savings measure would be to continue to take water level measurements in all wells but discontinue sampling those wells that have never had a detection of TCE above the established groundwater cleanup levels. The site is shown on Figure 28 (JBLM, 2011b).

6.3.2.3.2 Flow Direction
The groundwater flow direction in the Vashon Aquifer at this site appears to be to the south based upon Figure 28 in the *Draft Annual Monitoring Report – 2011 Landfill 1* (JBLM, 2011b).

6.3.2.3.3 Statistical Evaluation
A statistical evaluation of monitoring wells 84-CD-LF1-3 and 84-CD-LF1-4 was performed to determine if the TCE concentrations in these wells could be considered declining or stable as described in Appendix B. If a 90 percent confidence interval is used, the Mann-Kendall confirms a declining trend in well 84-CD-LF1-4. No trend was identified in TCE concentrations in well 84-CD-LF1-3.

6.3.2.4 ALGT

6.3.2.4.1 Plume Characterization

Since system startup, the footprint of the TCE plume is substantially reduced in size and is located entirely within the McChord Field portion of JBLM and lies solely with the installation's Whispering Fir Golf Course. The monitoring wells with the highest remaining TCE concentrations (September 2010) are "intermediate-screen" monitoring wells: DA-7b, DA-21b, DA-29, DA-31, and DA-32 and (TetraTech, 2011). These TCE concentrations are 47, 31, 11, 25, and 10 µg/L, respectively. The cis-1,2-DCE groundwater plume is similar in nature to the TCE plume but most recent concentrations have been under the 70 µg/L MCL with the exception of DA-7b and DA-32 (April 2010) where the cis-1,2-DCE concentrations were 99 and 150 µg/L, respectively. Subsequent sampling of these wells in September 2010 revealed 49and 5.3 µg/L in wells DA-7b and DA-32, respectively. The identified wells are screened from 37 to over 95 feet bgs. Screened intervals range from 5 to 30 feet in length. Extraction wells DX-3 and DX-2 target the TCE and cis-1,2-DCE concentrations in these wells. DX-2 is screened from 40 to 70 feet bgs and DX-3 is screened from 70 to96 feet bgs. The "shallow screen" monitoring wells (DA-28, DA-30a, DB-6, and DR-05 that have been consistently sampled over the years are now all below 5 µg/L or non-detect for TCE and below 8.2 µg/L to ND for cis-1,2-DCE. See Figures 30 and 31. VC is detected in the monitoring program in sporadic but low concentrations. In 2010, VC was detected in DA-31 at a maximum concentration of 0.63 µg/L. 1,1-DCE is also only sporadically detected and was detected in 2010 in DA-31 at 0.31 µg/L.

6.3.2.4.2 Statistical Evaluation

TCE trend data included a linear regression analysis, Mann-Kendall Trend Test for Normal Approximation and a Senslope evaluation using the software Minitab® on data from wells DA-7b, DA-9b, DA-21b, DA-29 and DA-6. All wells confirm a downward trend, as shown in data included in Appendix B.

6.3.2.4.3 Plume Capture

The capture zone was estimated for each extraction well in the CY 2010 Annual Report (TetraTech, 2011). The estimated capture zones as depicted in the 2010 report are shown on Figure 32. If the capture zone is as large as estimated, there should be some measurable response in wells DA-9b, DA-21b and DA-29. It would be worthwhile to confirm this estimate of capture. If the capture zones are as depicted, the plume is being captured by the extraction system. The efficiency of well DX-3 is discussed elsewhere in this FYR. During the last RAO Report, the water level in DX-3 was reported as approximately 40 feet deeper in rounds 1 to4 than in round 5. This period of high water levels coincided with this well was shut down for pump and pump motor repairs during the month of December 2010. Only extraction from DX-2 was being performed during this period.

6.3.3 LUCs Analysis

LUCs are the selected remedy at 10 sites as shown in Table 15. LUCS are the only remedial action at 4 of the 10 sites. All LUCs are in place and functioning as intended.

Each CERCLA site where LUCs are required is included in the LUCP. Decision documents are the source of LUC design for a site or a group of sites. Annual site inspections to confirm that the LUCs are still in place and operating as designed are conducted based on the requirements of the decision documents. There are two versions (2007 and 2011) of the LUCP, which can be found listed in Appendix D.

The history of the LUC inspection process since the last FYR at both Lewis-Main and McChord Field shows very little change in site conditions over time that would impact current LUCs.

6.4 SITE INSPECTION

A site inspection was conducted by the USACE FYR team from the Sacramento District on 19 to 21 Dec 2011. The USACE team was accompanied by the JBLM installation staff. This formal FYR site inspection was conducted after the USACE team had a chance to review historic information and became familiar with DDs, remedial systems O&M, the groundwater monitoring program, and LUCs. Additional information pertaining to groundwater remediation, operation of the pump and treat systems, and LUCs was gathered in addition to visiting each site. Appendix E contains a detailed report of the site inspection.

Prior to the formal site visit, the USACE team took advantage of an opportunity to meet with JBLM staff and USEPA in late October 2011 when an informational meeting was held at JBLM. The purpose of this informational meeting was for JBLM environmental staff and USEPA Region 10 to discuss the status of sites in the JBLM program. As this meeting coincided with the beginning of the FYR, the USACE also attended and used the visit as an opportunity to collect FYR relevant information.

Sites that were visited during the formal site visit and the information meeting visit include;

- Logistics Center
- ALGT
- LF 4
- Illicit PCB Dump Site
- LF 1
- Battery Acid Pit
- DRMO Yard
- IWTP
- Pesticide Rinse Area
- Fire Training Pit
- Park Marsh Landfill
- LF 6
- LF 5

6.5 INTERVIEWS

Information from JBLM environmental staff and USEPA Region 10 staff was gathered during the informational meeting at JBLM on 27 October, 2011. In this meeting, JBLM environmental staff provided a detailed environmental restoration program update for USEPA. Since this

meeting provided an excellent opportunity to understand past, current and future JBLM site information, members of the USACE FYR team also attended.

The information collected during the presentation/site visit serves as the interview of potential stakeholders for the purposes of this FYR. Issues and requests that USEPA presented are summarized below.

- EPA tracking of FYRs
  - Date of protectiveness statement concurrence letter is the milestone that EPA tracks

- Completeness of FYR report
  - The FYR should have data and analyses to support plume trend conclusions. Several specific examples were provided

- Deleted sites in FYR
  - Applies to LF 5 and WTA. FYRs are required for sites where waste is left in place above levels that allow for unlimited use and unrestricted exposure (UU/UE)

- Two toxicity changes since last FYR
  - TCE with new oral slope factor
    - MTCA B value may change
    - USEPA should retain 5 ppb as groundwater cleanup level
    - Inhalation unit risk factor is half of previous value
  - Concern expressed about manganese level used at LF4 to optimize number o wells sampled

- Adequacy of protectiveness for buildings sitting atop VOC plumes
  - Applicable to buildings atop the Logistics Center site (Vashon Aquifer).
  - Should be noted as an issue in FYR that JBLM addresses in future before USEPA provides concurrence with short-term protectiveness.

- Orphan sites
  - EPA concurrence letter stated that orphan sites needed an ESD to consolidate and memorialize the various decision documents, including the institutional controls.
  - JBLM technical memo was written to address this and is in EPA review

7.0 TECHNICAL ASSESSMENT

The technical assessment follows USEPA guidance (USEPA 2001) and answers the following three questions:

- Question A: Are the remedies functioning as intended by the DD(s)?
- Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?
- Question C: Has any other information come to light that could call into question the protectiveness of the remedies?

EPA has expressed concerns regarding comparison values used in the groundwater monitoring program to evaluate the significance of data and to set analytical reporting limits. Several analytes included in the monitoring program do not have specific cleanup goals set, and the cleanup goal for TCE may be changed in the future. At present, it is not clear that the sampling program includes all analytes with analytical performance goals set at levels conservative enough to ensure future protectiveness.

7.1 QUESTION A

Are the remedies functioning as intended by the DD(s)?

7.1.1 LOGISTICS CENTER

No. Remedies for the EGDY and SLA are functioning as intended; however, there is uncertainty as to whether the I-5 system is functioning as intended.

The 1990 ROD for the Logistics Center states:

"The goal of this remedial action is to restore groundwater to its beneficial use, which is, at this site, a drinking water source. The groundwater will be restored to levels consistent with State and Federal ARARs which will result in a cumulative excess cancer risk not to exceed (10^{-4}). Remediation levels will be attained throughout the contaminated plume."

In describing the major components of the remedy, the ROD further indicated that extraction wells must be capable of capturing the contaminated plume in the unconfined aquifer, on-site treatment must remove contaminants from the collected groundwater, and groundwater monitoring must ensure that the remediation goal is met. Institutional controls were also required in the ROD.

7.1.1.1. EGDY

The review of documents, ARARs, risk assumptions, and the results of the site inspection indicates that the remedy at EGDY is functioning as intended by the ROD, as modified by the ESDs and Army Decision Documents. The groundwater extraction and treatment system and the

supplemental removal actions and interim actions have been effective and have greatly reduced groundwater contamination and minimized the migration of contaminants to groundwater. The effective implementation of land use controls prevents direct contact with the contaminated soils and sediments and exposure to contaminated groundwater.

Operation and maintenance of the groundwater remediation at EGDY is considered consistent with original estimates and there are no indications of any difficulties with the remedy implementation. Treatment system downtime has been limited, and the air strippers are removing contamination to meet the treatment standards. System components have been able to achieve their design flow

Plume containment – the EGDY newly configured system now has 5 years of monitoring data. This data indicates that the "bulge" identified in the southwest appears to be declining as the TCE concentrations in the wells in this area have fallen since the relocation of the infiltration gallery. Groundwater monitoring data also suggests that the monitoring well network is limited in its ability to assess TCE concentrations east of PW-1 where the highest TCE contaminant extraction occurs. In the area of PW-1, groundwater monitoring and statistical analysis and perhaps an additional monitoring well in this area can help make the determination whether an additional extraction well is needed. To optimize the system, a capture zone analysis for the EGDY system is recommended to ensure that the groundwater extraction and treatment system, as currently configured is completely capturing the TCE plume.

Groundwater monitoring of the system is occurring at a reasonable frequency. The monitoring team performs trend analyses on a number of wells within the EGDY system. TCE concentrations have been declining at several monitoring wells within the extraction well field. Trend data in LC-137c, downgradient of the EGDY system, shows a statistically significant upward trend. Continued efforts to evaluate this well are recommended.

Groundwater data has shown that the source treatment by in-situ thermal heating has had a positive effect on groundwater concentrations in the source area. There is uncertainty regarding the long term effect on the plume as a whole due to the sheer size of the plume, and the length of time it will take for any source treatment effects to be seen at the distal end. The Army is pro-actively pursuing additional source treatment technologies to reduce contaminant mass in source areas not treated by the thermal heating.

The institutional controls that are in place include prohibitions on the use of groundwater until cleanup levels are achieved. No activities were observed that would violate the institutional controls at EGDY. The locked gate and fence surrounding the EGDY were intact and effective at limiting access to the site by anyone other than authorized JBLM staff or its contractors.

7.1.1.2 I-5 System.

The review of documents, ARARs, risk assumptions make it difficult to determine if the I-5 system is functioning as intended by the DDs. The groundwater extraction and treatment system is functioning as designed; however, there is concern that the treatment system is not extracting groundwater from the full extent of the LVA. When the system was installed the depth of the

LVA was not well known. This question arose in the last FYR which recommended the installation of two new wells sentinel wells. These wells were installed in the Lower Vashon Aquifer north of the I-5 system in the town of Tillicum. However, well data and their trends prove inconclusive and further evaluation is required.

Operation and maintenance of the groundwater remediation at the I-5 system is considered consistent with original estimates. Treatment system downtime has been limited, and the air strippers are removing contamination to meet the treatment standards. System components have been able to achieve their design flow rates.

Groundwater monitoring of the system is occurring at a reasonable frequency. The network of monitoring wells for the I-5 system is appropriate for monitoring the plume in the UVA. Groundwater trends are being evaluated in key areas. In the UVA a general downward trend near the system was noted except for T-13B and T-04 which have a upward trend; however, not statistically significant upward trends. Regarding the LVA, trend data is more limited. Recommend incorporating both LC-225 and LC-226 into the statistical analysis.

Groundwater modeling had indicated groundwater extraction at LX-1 and LX-15 was not necessary, however, based upon trend data, LX-15 was recently restarted. This may also speak to a need to revisit the site groundwater model and the need to perform a capture zone analysis for this system. Therefore, it is recommended that a capture zone analysis be performed on the I-5 system extraction wells as well as updating the existing groundwater model to get more clarity on the system's ability to capture the entire Vashon Aquifer TCE plume. Continued monitoring of the groundwater plume in this area with continued emphasis on the contaminant trends in the offsite Tillicum area is recommended. Lastly, if trend data continue to support an increasing trend near LC-225, another sentinel well is recommended between LC-225 and BC-1.

7.1.1.3 SLA System

The review of documents, ARARs, risk assumptions, and the results of the site inspection indicates that the remedy at SLA system is functioning as intended by the ESD.

The 2007 ESD for the SLA system states:

"The remedial goals used to evaluate remedial alternatives in the [SLA] FS were to: 1) prevent TCE concentrations in the SLA at the installation boundary from exceeding 5 µg/L and 2) prevent the aerial extent of the existing 5 µg/L plume from significantly expanding."

The SLA groundwater extraction and treatment system is functioning as designed with no observations of mechanical difficulties observed during this review that would call into question the effectiveness of the remedy. At this time, it is too soon to determine the effects of the system on the aquifer.

Groundwater monitoring of the system is occurring at a reasonable frequency. The number of monitoring wells and their locations are appropriate for evaluating the groundwater plume in the SLA. Trend data in the SLA shows statistically significant upward trends in MAMC03-3 and LC-101D-1; however the TCE concentrations are currently below the MCL. Much of the area

south of Sequalitchew Lake and downgradient of the SLAP system indicate a potential upward trend; however, the trends are not satistically significant and the TCE concentration are either at or below the MCL.

In general, all the Logistics Center groundwater extraction and treatment systems are operating as intended. Treatment system downtime has been limited, and the air strippers are removing contamination to meet the treatment standards. System components have been able to achieve their design flow rates.

7.1.2 ALGT

Yes. The remedy is functioning as intended by the DD.

The 1991 ROD for the McChord Field ALGT includes essentially the same requirements as those for the Logistics Center systems. The Third FYR for the ALGT was completed in March 2010 before the site became part of JBLM. In that review it was concluded that the remedy was functioning as intended by the ROD. The following is an excerpt from the Question A response in the previous FYR.

"Yes. The remedy is intended to eliminate or reduce the risks posed by the site to levels that are protective of human health and the environment. Containment of the plume is being achieved, although it appears that operation of the pump-and-treat system is not needed to contain off-base migration of contaminants exceeding the MCLs. Operation of the pump-and-treat system has resulted in a reduced areal extent of the TCE plume exceeding 5 µg/L; however, no additional reductions in aerial extent have been observed since the late 1990s. In addition, contaminant concentrations within the current plume boundary may have reached asymptotic conditions since the second Five-Year Review".

In this JBLM FYR, information from the two years since the last review was evaluated. The recent information is generally consistent with the interpretation of plume condition presented in the previous review. In addition, operation of the P&T system has been routine, with no significant system upsets.

Groundwater monitoring is being performed at various intervals for different monitoring wells. Some wells are sampled quarterly, some semiannually and others annually. Given the long history of monitoring at this site, there may be some opportunity to optimize sampling frequencies further.

The *2010 Operations and Monitoring Report* (Tetra Tech, 2011) identified a trend of declining specific capacity in extraction well DX-3, which operates in the most highly contaminated area of the plume. The well has a history of bio-fouling; periodic cleaning is performed to restore flow to near design rate. However, the decline of specific capacity continues. This well will likely need to be replaced in the future in order to maintain system effectiveness.

From April 2010 through March 2011 a pilot test was performed to evaluate enhanced biodegradation as an alternative to further reduce contaminant concentrations in the plume. Conclusions indicated the following:

1) Biodegradation does not likely occur naturally to an appreciable extent,
2) Within the limited data set, augmentation appeared to stimulate some biodegradation activity, though the limited duration of the sampling program did not allow that to be conclusive. Continued sampling of the test wells was recommended before designing additional tests.

7.1.3 LF 4 AND SRCPP

Yes. The remedies for LF 4 and SRCPP are functioning as intended.

The 1993 ROD for LF 4 states:

"The goal of this remedial action is to restore groundwater to its beneficial use, which is, at this site, a potential drinking water aquifer. Based on information obtained during the RI and on a careful analysis of all remedial alternatives, the Army, EPA, and Ecology believe that the selected remedy should be able to achieve this goal."

The only remaining components of the site remedy requiring continued action are maintenance of LUCs along with groundwater monitoring. Groundwater sampling is accomplished in accordance with the updated *2007 Groundwater Monitoring Plan (*Bussey, 2007c). In summary, samples will be collected from a few select MWs during years in which the FYR is not occurring and samples will be collected from all fourteen (14) existing monitoring wells during years in which the five-year review is occurring. The select MWs to be sampled during the non-FYR years will be those MWs with VOC exceedances of the MCLs and those with concentrations slightly below the MCL. The MWs to be sampled during non-FYRs years will be re-evaluated and adjusted as necessary following each comprehensive groundwater monitoring event conducted during a five-year review. All groundwater samples collected will be analyzed for VOCs only. Annual groundwater monitoring will continue until all VOC concentrations are below MCLs for as VOC concentrations are stable or declining. Conducting groundwater monitoring until 2017 represents achieving the thirty (30) years of post-closure monitoring as required under RCRA for landfill closure since monitoring first began in 1988.

Since the last FYR (Bussey, 2007b), the concentrations of TCE in groundwater generally continue to decline. Vinyl chloride occurs in only one well slightly above the ROD goal of 1µg/L (LF4-2) at 1.1 µg/L. Groundwater is sampled in three wells for dissolved manganese; these wells are located along the western side of the site. Manganese data showed an upward trend in LF4-2 and downward in LF4-MW12A and LF4-PNL1.

The 1993 ROD for the SCRPP states:

"The goal of this remedial action is to restore groundwater to its beneficial use, which is, at this site, a potential drinking water aquifer. Based on information obtained during the RI and on a

careful analysis of all remedial alternatives, the Army, EPA, and Ecology believe that the selected remedy would be able to achieve this goal."

The only remaining component of the site remedy requiring continued action is maintenance of LUCs. LUCs are in place as intended by the ROD in order to complement other in-place remedial components and to prevent potentially unacceptable exposures. JBLM ERP has specified the details of how the LUCs are implemented (e.g., LUC objectives, mechanisms, monitoring, enforcement, reporting, enforcement) in the 2007 LUC Plan (Bussey, 2007d). JBLM ERP oversees on a daily basis the effective and consistent functioning of the LUC mechanisms described in the LUC Plan (e.g., LUC data layer in Geographic Information System, LUC overlay for Real Property Master Plan, LUC overlay for environmental review procedures, LUC overlay for Digging Permit approval). There is no direct project cost associated with maintenance of LUCs, which is consistent with the 1993 FS. No additional opportunities for LUC optimization were identified at this time.

Groundwater levels are monitored in two wells for the regional understanding of groundwater flow direction.

7.1.4 TECHNICAL MEMORANDUM (2010)

Yes. Technical Memorandum sites are functioning as intended by their DDs.

Sites in the *Technical Memorandum* (KEMRON, 2010a) with active remedial systems that include cap maintenance as part of an overall LUC program are the Illicit PCB Dump and LF 1.

The Illicit PCB Dump utilizes a low-permeability clay cap with a layer of topsoil covering the site. The integrity of the cap is protected by the use of LUCs that control land use. The perimeter of the site is surrounded with a well maintained cyclone fence. The site is in a very remote location of JBLM and it appears there is no trespassing. Light vegetation composed of mainly grasses and short plants cover the site. The area outside the fence is mature forest.
LF 1 utilizes a landfill cap with the integrity of the cap protected by the use of LUCs that control land use. The site is mainly covered by roads and a large paved area. A section of unpaved area creates an "island" covered with trees and shrubs in the central section of the site.

The LF 1 remedy includes groundwater sampling in accordance with the 2004 Groundwater Monitoring Plan that was updated in May 2005. In summary, samples are collected from a few select MWs during years in which the FYR is not occurring and samples will be collected from all fourteen (14) existing monitoring wells during years in which the FYR is occurring. The select MWs to be sampled during the non-FYR years will be those MWs with VOC exceedances of the MCLs and those with concentrations slightly below the MCL. The MWs to be sampled during non-FYR years will be re-evaluated and adjusted as necessary following each comprehensive groundwater monitoring event conducted during a FYR. All groundwater samples collected will be analyzed for VOCs only. Annual groundwater monitoring will continue until all VOC concentrations are below MCLs for three consecutive years or until the year 2017 as long as VOC concentrations are stable or declining. Conducting groundwater

monitoring until 2017 represents achieving the thirty (30) years of post-closure monitoring as required under RCRA for landfill closure since monitoring first began in 1988.

In general, LF 1 TCE concentrations have been stable or declining over time. TCE was detected above the MTCA Method A cleanup level of 5 µg/L in one monitoring well 84-CD-LF1-4 at 7.8 µg/L in the 2011 groundwater monitoring event. TCE was detected below the cleanup level in the remaining three monitoring wells sampled in 2011. Concentrations in these wells ranged from 1.8 to 3.3 µg/L.

7.1.5 LUCs

Yes. The LUC sites are functioning in accordance with their DDs.

LUCs have been implemented at JBLM sites as either the entire remedy or as a potion of the overall remedy as shown on Table 5 below. LUCs are in place and functioning to assure the other site remedies as specified in the ROD, DD or Technical Memorandum, are not impacted by installation development. JBLM ERP has specified the details of how LUCs are implemented (e.g., LUC objectives, mechanisms, monitoring, enforcement, reporting, enforcement) in the 2007 Fort Lewis LUC Plan and in the 2010 McChord field LUC Plan.. A formal inspection process is performed annually to meet ROD, DD, and Technical Memorandum requirements. A combined JBLM LUC Plan will be produced when a combined JBLM Master Plan has been completed.

JBLM does not have LUCs for any plumes off the installation. However, within the Logistics Center LUCs there are requirements for annual coordination with the Lakewood Water District. For ALGT, the plume no longer resides off the installation.

Table 5 - LUCs and Site Remedy Association

Sites where LUCs are part of overall remedy	Sites where LUCs are entire remedy
Logistics Center	Battery Acid Pit
ALGT	DRMO Yard
LF 4	IWTP
LF 1	Pesticide Rinse Area
Illicit PCB Dump Site	SRCPP

Based on a review of all available information and site visits to confirm LUC implementation, all LUCs are functioning as intended. No installation development of any type is encroaching onto these sites and threatening the selected remedy. There are no additional opportunities for LUC optimization identified from this FYR.

7.2 QUESTION B

Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives Used at the Time of Remedy Selection Still Valid?

7.2.1 LOGISTICS CENTER

No. Further evaluation of the vapor intrusion pathway is necessary.

Changes in Standards and To Be Considered: A review of the 1990 ROD, the 1990 Baseline Human Health Risk Assessment, and the 2002 Risk Assessment Amendment show that there is no longer a complete soil exposure pathway for COCs, and that groundwater is the only medium of concern for the Logistics Center. The cleanup values established for groundwater COCs are based on the EPA MCLs for cis-1,2-dichloroethylene (DCE), PCE and TCE. The ROD required monitoring for 1,1,1-TCA and VC, but did not specify remedial goals. Table 6 below compares the 1990 ROD MCLs to the current MCLs, showing that no significant changes to these standards have occurred. The MCLs are ARARs for this site, and the selected remedy complies with the ARARs listed in Appendix C. There have been no changes to MCLs that impact the protectiveness of the groundwater remedy.

Table 6 - Logistics Center Comparison of 1990 ROD MCLs to Current MCLs

Chemical of Concern	Groundwater Action Level (µg/L)	2012 Federal MCL[1] (µg/L)	2012 Washington MCL (µg/L)
cis-1,2-Dichloroethylene	70	70	-
Tetrachloroethylene	5	5	5
Trichloroethylene	5	5	3

MCL = Maximum contaminant Level
[1] Obtained from http://www.epa.gov/safewater/contaminants/index.html#listmcl as of February 2012

Changes in Exposure Pathways: No known or complete exposure pathways currently exist from domestic use of groundwater. However, exposure of off-site residents and onsite workers is considered to be a potential exposure pathway. It is unlikely, however, that this shallow aquifer would be used as a domestic water supply, and use of groundwater is regulated via issuance of well drilling permits. A review of the human health risk assessment and subsequent source area investigations indicates that there have been no changes in ingestion exposure pathways evaluated. The Logistics Center remains industrial with no changes to land immediately adjacent.

Inhalation of indoor air impacted by volatile compounds in groundwater was not evaluated in the risk assessment and is a potentially complete exposure pathway. To assess potential risks associated with vapor intrusion, an indoor air study was conducted in September 2007 (KTA, 2007) at the Madigan Housing Area. The results indicated that neither TCE nor DCE represent an unacceptable risk to indoor receptors, although the vapor intrusion pathway into indoor air

was apparently complete. Risks associated at the time were considered acceptable. However, TCE toxicity criteria were recently updated by USEPA in September of 2011 (http://www.epa.gov/iris/subst/0199.htm). Three detected concentrations of TCE) in indoor air exceed the current residential RSL as shown in Table 7 below. However, families only live in the housing area from four to six years, while 30 years is used in the screening level calculations to derive the RSL, indicating the apparent exceedance above the RSL may not pose an unacceptable risk. Further, multiple samples were taken from eight vacant housing units, and of 82 indoor air samples, only three exceeded the current residential RSL of 0.43 µg/m^3. Madigan Housing data from the indoor air evaluation are presented in Appendix H.

The most recent reported maximum detected concentrations (2012) of groundwater COCs for monitoring wells closest to the Madigan Housing Area (LC-218, LC-222, LC-223, LC-224) were compared to 2007 concentrations in Table 8 below. Groundwater concentrations of COCs have decreased since the 2007 sampling event, indicating that vapor intrusion likely does not represent an unacceptable risk to residential receptors at the Madigan Housing Area.

Table 7 - Comparison of Maximum Indoor Air Concentration of TCE to Residential Indoor Air RSL – Madigan Housing Area

Sampling Location	Maximum Detected Indoor Air TCE Concentration[1] (µg/m^3)	Residential Indoor Air RSL[2] (µg/m^3)
9819 Coolridge Ave.	**0.66J**	0.43
9824 Coolridge Ave.	**0.99J**	0.43
9838 Coolridge Ave.	**1.3J**	0.43

MCL = Maximum Contaminant Level
RSL = Regional Screening Level
TCE = Trichloroethylene
[1] 2007 Indoor Air Sampling Event (KTA, 2007)
[2] http://www.epa.gov/region9/superfund/prg/index.html as of February 2012
Bolded values indicate an exceedance of the Screening Level

Table 8 - Comparison of 2007 TCE Groundwater Concentrations to 2007 Concentrations – Madigan Housing Area

Well	2007 TCE Groundwater Concentration[1] (µg/L)	2012 TCE Groundwater Concentration[2] (µg/L)
LC-218	37	17
LC-222	39	14
LC-223	10	7.4
LC-224	28	10

MCL = Maximum Contaminant Level

ND = Not Detected
[1] KTA, 2007
[2] 2012
Preliminary Groundwater Sampling Data, JBLM Environmental Office

Bolded values indicate an exceedance of the Screening Level

Vapor intrusion into indoor air at the Logistics Center proper was evaluated by comparing the maximum detected groundwater concentrations of COCs to industrial groundwater to indoor air screening levels, as shown in Table 9 below.

The industrial indoor air RSL (http://www.epa.gov/region9/superfund/prg/index.html as of December 2011) was used to derive a groundwater screening value for TCE. The industrial soil gas screening value for TCE, assuming an attenuation factor of 0.05 (Soil Gas Screening Level = Indoor Air Screening Level (3.0 µg/m3 /attenuation factor) for an existing building, is 60 µg/m3. This value was then divided by both the Henry's Law constant of 0.00892 and a conversion factor of 1000 to derive a groundwater screening value of 6.72 µg/L. Table 9 shows that groundwater concentrations of TCE pose a potential risk to industrial receptors above the plume. No other COCs pose a potential risk via vapor intrusion into indoor air at the Logistics Center.

Table 9 - Comparison of Industrial Groundwater Concentrations to Industrial Air Screening Levels – Logistics Center

Chemical of Concern	Maximum Detected Groundwater Concentration[1] (µg/L)	Industrial Groundwater to Indoor Air Screening Level (µg/L)
cis-1,2-Dichloroethylene	21.3	17000[2]
Tetrachloroethylene	0.32	420[2]
Trichloroethane	1.72	360000[2]
Tricholoroethylene	**268**	**6.72**[3]
Vinyl Chloride	0.23	13

MCL = Maximum Contaminant Level
[1] 2009 Groundwater Sampling Event, Upper Vashon Aquifer, Versar 2011
[2] http://www.swrcb.ca.gov/rwqcb2/water_issues/available_documents/ESL_May_2008.pdf as of February 2012
[3] http://www.epa.gov/region9/superfund/prg/index.html as of February 2012
Bolded values indicate an exceedance of the Screening Level

Changes in Toxicity, Other Contaminant Characteristics, and Risk Assessment Methodologies: A review of the human health risk assessment and ecological risk assessment shows that the methodologies applied are still protective and appropriate. Although there have been changes to the values for toxicity parameters and contaminant properties, the applicable MCLs have not been modified, and therefore the protectiveness of the remedies for groundwater ingestion has not changed. TCE and PCE toxicity criteria were recently updated by USEPA in September of 2011 (http://www.epa.gov/iris/subst/0199.htm). The updated toxicity values were used in the above indoor air evaluation for TCE and PCE. The change in TCE inhalation toxicity factors indicates that a potential risk via vapor intrusion from groundwater exists at the Logistics Center.

7.2.2 LF 4

Yes. The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives at the time the remedy was selected are still valid.

Changes in Standards and To Be Considered: The only remaining components of the site remedy at LF 4 are maintenance of LUCs along with groundwater monitoring. The LUC and groundwater monitoring portion of the remedy selected in the 1993 ROD was based on conservative exposure assumptions and toxicity data that are still valid. There have been no changes in the physical condition assumptions that affect the protectiveness of the remedy. There have been no significant changes to the USEPA MCLs, as shown in Table 10 below, promulgated under the Safe Drinking Water Act. Thus, no necessary changes to these assumptions or remedy goals were identified in this review.

Table 10 - Groundwater Action Levels – LF 4

Chemical of Concern	Groundwater Action Level (µg/L)[1]	2012 Federal and State MCLs[2] (µg/L)
Tricholoroethylene	5	5
Vinyl Chloride	1	2

MCL = Maximum contaminant Level
RSL = Regional Screening Level
[1] 1993 ROD
[2] MCLs obtained from http://www.epa.gov/safewater/contaminants/index.html#listmcl as of February 2012

Changes in Exposure Pathways: A review of the human health risk assessment and subsequent source area investigations indicates that there have been no changes in exposure pathways evaluated.

Changes in Toxicity, Other Contaminant Characteristics, and Risk Assessment Methodologies: A review of the human health risk assessment and ecological risk assessment shows that the methodologies applied are still protective and appropriate. TCE and PCE toxicity criteria were recently updated by USEPA in September of 2011 (http://www.epa.gov/iris/subst/0199.htm). The change in TCE toxicity criteria indicates an unacceptable risk would still be present. Although there have been changes to the values for toxicity parameters and contaminant properties, the applicable MCLs have not been modified, and therefore the protectiveness of the remedies for groundwater contamination has not changed.

7.2.3 SRCPP

Yes. The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives at the time the remedy was selected are still valid.

Changes in Standards and To Be Considered: The only remaining component of the site remedy at SRCPP is the maintenance of LUCs. The LUC portion of the remedy selected in the 1993 ROD was based on conservative exposure assumptions and toxicity data that are still valid.

There have been no changes in the physical condition assumptions that affect the protectiveness of the remedy. Thus, no necessary changes to these assumptions or remedy goals were identified in this review.

Changes in Exposure Pathways: A review of the human health risk assessment and subsequent source area investigations indicates that there have been no changes in exposure pathways evaluated.

Changes in Toxicity, Other Contaminant Characteristics, and Risk Assessment Methodologies: A review of the human health risk assessment and ecological risk assessment shows that the methodologies applied are still protective and appropriate. Although there have been changes to the values for toxicity parameters and contaminant properties, the applicable MCLs and soil action levels have not been modified, and therefore the protectiveness of the remedies for groundwater and soil contamination has not changed.

7.2.4 ILLICIT PCB DUMP SITE

Yes. The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives at the time the remedy was selected are still valid.

Changes in Standards and To Be Considered: The LUC remedy selected in the 2006 DD was based on conservative exposure assumptions and toxicity data that are still valid. No COCs or cleanup standards were identified in either the 2000 or 2006 DD for the Illicit PCB Dump Site. No cleanup ARARs were identified in either DD.

Changes in Exposure Pathways: A review of the risk screening evaluation (2006 DD) and subsequent source area investigations indicates that there have been no changes in exposure pathways evaluated. There are currently no complete exposure pathways given the previous soil removal action, site cap and perimeter fence.

Changes in Toxicity, Other Contaminant Characteristics, and Risk Assessment Methodologies: A review of the risk screening evaluation (2006 DD) shows that the methodologies applied are still protective and appropriate. The screening value used for PCBs (1 mg/kg) is still protective, and therefore the protectiveness of the remedies for groundwater and soil contamination has not changed.

7.2.5 LF 1

Yes. The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives at the time the remedy was selected are still valid.

Changes in Standards and To Be Considered: The LUC and groundwater monitoring remedy selected in the 2006 DD was based on conservative exposure assumptions and toxicity data that are still valid. There have been no changes to the TCE MCLs promulgated under the Safe Drinking Water Act, which are being used for conservative compliance evaluation purposes.

Changes in Exposure Pathways: A review of the human risk screening evaluation (2006 DD) and subsequent source area investigations indicates that there have been no changes in exposure pathways evaluated. Vapor intrusion into indoor air was not considered during the risk screening process. However, LUCs prohibit construction of buildings on or near LF 1.

Changes in Toxicity, Other Contaminant Characteristics, and Risk Assessment Methodologies: A review of the risk screening evaluation (2006 DD) shows that the methodologies applied are still protective and appropriate. The screening value used for TCE (5 µg/L) is still protective, and therefore the protectiveness of the remedies for groundwater and soil contamination has not changed.

7.2.6 BATTERY ACID PIT

Yes. The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives at the time the remedy was selected are still valid.

Changes in Standards and To Be Considered: The LUC remedy selected in the 2006 December DD was based on conservative exposure assumptions and toxicity data that are still valid. No COCs or cleanup standards were identified in either the 2000 or 2006 DDs for the Battery Acid Pit. No cleanup ARARs were identified in either DD.

Changes in Exposure Pathways: A review of the human health risk assessment and subsequent source area investigations indicates that there have been no changes in exposure pathways evaluated.

Changes in Toxicity, Other Contaminant Characteristics, and Risk Assessment Methodologies: A review of the health impact assessment (2000 DD) shows that the methodologies applied are still protective and appropriate. The screening value used for lead (400 mg/kg) is still protective, and therefore the protectiveness of the remedies for groundwater and soil contamination has not changed.

7.2.7 DRMO YARD

Yes. The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives at the time the remedy was selected are still valid.

Changes in Standards and To Be Considered: The LUC remedy selected in the 2006 DD was based on conservative exposure assumptions and toxicity data that are still valid. No COCs or cleanup standards were identified in either the 2000 or 2006 DDs for the DRMO Yard. No cleanup ARARs were identified in either DD.

Changes in Exposure Pathways: A review of the risk screening evaluation (2006 DD) and subsequent source area investigations indicates that there have been no changes in exposure pathways evaluated.

Changes in Toxicity, Other Contaminant Characteristics, and Risk Assessment

Methodologies: A review of the risk-screening evaluation (2006 DD) shows that the methodologies applied are still protective and appropriate. The screening value used for PCBs (1 mg/kg) is still protective, and therefore the protectiveness of the remedies for groundwater and soil contamination has not changed.

7.2.8 PESTICIDE RINSE AREA

Yes. The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives at the time the remedy was selected are still valid.

Changes in Standards and To Be Considered: The LUC remedy selected in the 2006 DD was based on conservative exposure assumptions and toxicity data that are still valid. No COCs or cleanup standards were identified in either the 2000 or 2006 DD for the Pesticide Rinse Area. No cleanup ARARs were identified in either DD.

Changes in Exposure Pathways: A review of the human risk screening evaluation (2000 DD) and subsequent source area investigations indicates that there have been no changes in exposure pathways evaluated.

Changes in Toxicity, Other Contaminant Characteristics, and Risk Assessment:
Methodologies: A review of the risk screening evaluation (2000 DD) shows that the methodologies applied are still protective and appropriate. The screening value used for pesticides are still protective, and therefore the protectiveness of the remedies for groundwater and soil contamination has not changed.

7.2.9 ALGT

Yes. The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives at the time the remedy was selected are still valid.

Changes in Standards and To Be Considered: A review of the 1991 ROD shows that there is no longer a complete soil exposure pathway for COCs, and that groundwater is the only medium of concern for the ALGT. The cleanup values established for groundwater COCs are based on the USEPA MCLs for cis-1,2-dichloroethylene (cis-1,2-DCE), and TCE. The ROD required monitoring for 1,1-dichloroethylene (1,1-DCE) and VC, but did not specify remedial goals. Table 11 below compares the 1991 ROD MCLs to the current MCLs. . The MCL values are ARARs for this site, and the selected remedy complies with the ARARs listed in Appendix C. There have been no changes to MCLs that impact the protectiveness of the remedy.

Table 11 - Groundwater Action Levels – ALGT

Chemical of Concern	Groundwater Action Level (µg/L)	2012 Federal and State MCLs[1] (µg/L)
1,1-Dichloroethylene	0.07	7
cis-1,2-Dichloroethylene	70	70

Chemical of Concern	Groundwater Action Level (µg/L)	2012 Federal and State MCLs[1] (µg/L)
Trichloroethylene	5	5
Vinyl Chloride	0.04	2

MCL = Maximum contaminant Level
[1] Obtained from http://www.epa.gov/safewater/contaminants/index.html#listmcl as of February 2012

Changes in Exposure Pathways: No known or complete exposure pathways currently exist from domestic use of groundwater. Residents currently obtain water from a public water supply. However, exposure of off-site residents and onsite workers is considered to be a potential exposure pathway. A review of the human health risk assessment and subsequent source area investigations indicates that there have been no changes in exposure pathways evaluated.

Inhalation of indoor air impacted by volatile compounds in groundwater was not evaluated in the risk assessment and is a potentially complete exposure pathway. To assess potential risks associated with vapor intrusion from a groundwater source, the most recent maximum detected concentration of groundwater COCs at the ALGT were compared to relevant screening criteria in Table 11.

The residential indoor air RSL (http://www.epa.gov/region9/superfund/prg/index.html as of December 2011) was used to derive a groundwater screening value. The residential soil gas screening value for TCE, assuming an attenuation factor of 0.05 (Soil Gas Screening Level = Indoor Air Screening Level (0.43 µg/m3 /attenuation factor) for an existing building, is 8.6 µg/m3. This value was then divided by both the Henry's Law constant of 0.00892 and a conversion factor of 1000 to derive a groundwater screening value of 1 µg/L. Table 12 shows that groundwater concentrations of TCE pose a potential risk to residents living above the plume. No other COCs pose a potential risk via vapor intrusion into indoor air at the ALGT.

Table 12 - Comparison of Residential Groundwater Concentrations to Residential Groundwater to Indoor Air Screening Levels – AGLT

Chemical of Concern	Maximum Detected Groundwater Concentration[1] (µg/L)	Residential Groundwater to Indoor Air Screening Level (µg/L)
1,1-Dichloroethylene	0.31	6300[2]
cis-1,2-Dichloroethylene	150	6200[2]
Tricholoroethylene	**77**	**1[3]**
Vinyl Chloride	0.63	3.8[2]

MCL = Maximum Contaminant Level
[1] 2010 Groundwater Sampling Event, Tetra Tech 2011
[2] http://www.swrcb.ca.gov/rwqcb2/water_issues/available_documents/ESL_May_2008.pdf as of December 2011
[3] http://www.epa.gov/region9/superfund/prg/index.html as of February 2012
Bolded values indicate an exceedance of the Screening Level

Changes in Toxicity, Other Contaminant Characteristics, and Risk Assessment

Methodologies: A review of the human health risk assessment and ecological risk assessment shows that the methodologies applied are still protective and appropriate. TCE and PCE toxicity criteria were recently updated by USEPA in September of 2011 (http://www.epa.gov/iris/subst/0199.htm). The change in TCE toxicity criteria indicates an unacceptable risk would still be present. Although there have been changes to the values for toxicity parameters and contaminant properties, the applicable MCLs have not been modified significantly, and therefore the protectiveness of the remedies for groundwater contamination has not changed. However, the change in TCE inhalation toxicity factors indicates that a potential risk via vapor intrusion from groundwater exists at the ALGT.

7.3 QUESTION C

Has any other information come to light that could call into question the protectiveness of the remedies?

No. No new information has come to light beyond what is described in this FYR that could call into question the protectiveness of the remedy such as new or previously unidentified ecological risks or natural disaster impacts.

7.4 Technical Assessment Summary.

Through data review, site inspections, and personal communications, it has been found that remedial action operations, maintenance, and monitoring are functioning as intended in the RODS, ESDs and Army Decision Documents. Land use controls have been effectively implemented. There have been no changes in the physical condition at any of the JBLM sites that would affect the protectiveness of the remedies. In two instances, achievement of long term remedial action objectives is in question. Plume capture in the LVA at the I-5 system is uncertain and requires further evaluation. Groundwater extraction and treatment at the ALGT site is no longer reducing concentrations or the size of the plume.
The vapor intrusion pathway was evaluated in 2007 at the Madigan Housing Area over the edge of the Logistics Center plume with results indicating acceptable exposure. However, the vapor intrusive pathway has not yet been evaluated in industrial buildings over the center of the plume. Toxicity criteria for TCE were updated by EPA in September 2011. This change has not yet led to a change in the MCL, which is the groundwater cleanup standard for the JBLM sites. The RSL for TCE in indoor air has been reduced though. Comparison of the 2007data to the new RSL shows that the vapor intrusion pathway is still protective at the Madigan Housing Area. In addition, TCE concentrations in groundwater near the Madigan Housing Area are decreasing.

8.0 ISSUES

Table 13 summarizes outstanding issues identified in this FYR to be addressed at JBLM CERCLA sites.

Table 13 - Issues

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
Inadequate data are available to address concern about potential vapor intrusion exposure in industrial facilities above the contaminated groundwater plume.	Y	Y
Further evaluations are needed to address concerns about the I-5 groundwater extraction and treatment system's capability to capture the TCE groundwater plume within the Lower Vashon Aquifer.	N	Y
At the ALGT Site continued reduction of the contaminant concentrations and the contaminant plume boundary is not being accomplished by the pump-and-treat remedy, potentially reducing the long-term protectiveness of the remedy.	N	Y
It is not clear that the groundwater monitoring program includes appropriate analytic performance goals for all analytes to ensure long term protectiveness.	N	Y

In addition to the issues identified above, issues related to LUCs were identified in the March 2010 FYR for the McChord Field ALGT that have not yet been fully closed.

- An ESD to establish final requirements for several sites that had been included in the Logistics Center ROD has been submitted in draft and is awaiting final approval. The requirements, including LUCs, have been effectively implemented as elaborated in this FYR, thus protectiveness is not in question.
- A LUC plan combining the individual plans for Lewis-Main (2007) and McChord Field (2010) has been mostly developed at the time of this FYR. Finalization of the plan is dependent on completion of the JBLM installation master plan.

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Table 14 summarizes recommendations and follow-up actions associated with this review.

Table 14 - Recommendations and Follow-up Actions

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
Sampling data for Indoor Air exposure	Develop and implement a sampling plan to gather data to characterize the vapor intrusion risk.	JBLM	USEPA	3 Jun 2013	Y	Y
I-5 Capture of Lower Vashon TCE plume	Develop and implement an evaluation strategy for assessing the capture zone of the I-5 P&T extraction wells. In addition, determine if the LVA TCE plume is being captured by the I-5 P&T system.	JBLM	USEPA	27 Sep 2013	N	Y
ALGT groundwater plume remediation	Continue to evaluate alternatives to reduce source term and enhance dissolved plume remediation, including verifying that the source area conceptual site model is correct.	JBLM	USEPA	30 Sep 2014	N	Y

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
Logistics Center (EGDY), American Lake Garden Tract (ALGT), and LF4	As part of the JBLM monitoring program, examine cleanup goals and other risk based comparison values for groundwater plumes to assure monitoring is being done for appropriate contaminants of concern and associated monitoring goals.	JBLM	USEPA	15 Jan 2013	N	Y

10.0 PROTECTIVENESS STATEMENT

Determination of protectiveness is deferred, pending additional sampling to address the potential for vapor intrusion at industrial structures above the Logistics Center Plume and an evaluation of the capability of the I-5 groundwater extraction and treatment system to capture the Lower Vashon TCE groundwater plume. The vapor intrusion evaluation is expected to be complete in June 2013, and the evaluation of the Lower Vashon Aquifer plume capture should be complete in September 2013. Upon resolution of those issues, the Logistics Center remedy is expected to be protective of human health and the environment in the long term. An addendum to determine the protectiveness will be prepared by September 30, 2014. Two of the three groundwater extraction and treatment systems are performing as expected. In-situ thermal treatment has significantly reduced contaminant mass flux from three NAPL source areas. Additional source treatment methods are being evaluated to further reduce source area mass. Due to the large size of the groundwater contamination plume, effects of mass reduction in the source area are not expected to be observed at the toe of the plume in the near term. LUCs are fully implemented and functioning as expected.

The remedy at the ALGT site is protective in the short term for human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled. In the off -base area of the ALGT, groundwater meets remediation goals (drinking water criteria). On base, in order for the remedy to be protective in the long-term, the remediation goal of restoring the aquifer to its beneficial use by meeting RAOs throughout the plume must be met. The Department of Defense has provided permanent public water supply connections to residents and restricted the shallow aquifer to non-potable uses to control current threats at the site. In order for the remedy to be protective in the long term, the RAO of restoring the aquifer to its beneficial use must be attainable in a reasonable timeframe. Alternative remedies should be pursued to further reduce plume dimensions and contaminant concentrations.

The remedies at SRCPP and LF 4 are protective of human health and the environment. LUCs have been implemented at all these sites and have been effective in limiting exposure to site contaminants. Groundwater monitoring at LF 4 has demonstrated no further impact or diminishing impact by site contaminants.

11.0 NEXT REVIEW

The next five year review is expected to be completed by September 2017, which is five years from the anticipated finalization of this report.

Approved by:

H. Charles Hodges Jr.
Colonel, US Army
Commanding

26 Sept 12
Date

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Tables

Table 15 - Master Site Information

Site Name		Regulatory Framework	Decision Document(s)	Selected Remedy(s)	USEPA Concurrence	COC(s) / Media	LUC Document / Description	FYR History
Logistics Center/	Logistics Center, Well LC-6 & Pit Area (FTLE-33)	FFA, NPL CERCLA	ROD (Sep1990), ESD (Sep1998), DD (Jul 2000), DD (Aug 2002), DD (Apr 2006), ESD (Feb2007), ESD (Oct2010)	P&T (EGDY, I-5, SLA), bioremediation; LTM, drum removal, in-situ thermal treatment, LUCs	Yes (ROD & ESD), 11May04 email, 26&27Sep07 letters)	VOCs/soil, gw	ROD (1990), DD (Apr 2006), LUCP (Sep2007)/ No residential land use; dig permit, fences; signs, prevent training area access, prevent installation of drinking water well, update Wellhead Protection Program	FYR3 (26Sep07)
	LF 2 (FTLE-22)	FFA, NPL CERCLA	ROD (Sep1990), Administratively closed	N/A due to admin closure	N/A due to admin closure	N/A due to admin closure	N/A due to admin closure.	FYR1 (26Sep97), FYR2 (19Sep02)
Area D/ALGT (LF-05)		FFA, NPL CERCLA	ROD (Sep1991)	LTM, P&T, chemical oxidation, bioremediation, LUCs	Yes (Sep 1991 ROD)	VOCs/gw	No residential land use; dig permit, prevent installation of drinking water well	FYR1 (Feb 00), FYR2 (Mar 05), FYR3 (Mar 10)
LF 5 (FTLE-58)		FFA, NPL CERCLA	NFA ROD (Jul1992); Delisted (May1995)	Deleted	Yes (May1992 NFA ROD)	VOCs, pesticides, metals, PCBs/gw, swl, sediment, soil gas	None	none

Site Name (Number)	Regulatory Framework	Decision Document(s)	Selected Remedy(s)	USEPA Concurrence	COC(s) / Media	LUC Document / Description	FYR History
Washrack Treatment Area (DP-60)	FFA, NPL CERCLA	ROD (Sep1992); Consent Decree (1992); Delisted (Sep 1996),	Deleted	Yes (Sep 1992 ROD & Sep 1996 Deleleted)	VOCs, SVOCs, metals, petroleum/soil, gw, swl, sediment	None	FYR1 (Sep 99), FYR2 (Sep04)
LF 4 (FTLE 57)	FFA, Non-NPL CERCLA	ROD (Sep1993)	LTM, air sparging, SVE, LUCs	Yes (24Sep1993 ROD signature), (27Sep2007 letter)	VOC/ soil, gw	ROD (1993), LUCP (Sep2007)/ No residential land use; dig permit, prevent installation of drinking water well	FYR3 (26Sep07)
Solvent Refined Coal Pilot Plant (FTLE-32)	FFA, Non-NPL CERCLA	ROD (Sep1993)	Soil excavation and treatment; LTM; LUCs	Yes (9sep1993 ROD signature)	Petroleum, PAHs/soil, gw	ROD (1993), LUCP (Sep2007)/ Prevent installation of drinking water well	FYR3 (26Sep07)
Illicit PCB Dump Site (FTLE-46)	FFA, Non-NPL CERCLA	DD (Sep2000), DD (Dec2006), Tech Memo (Oct2010)	Low permeability cap, LUCs	Yes (19Jan05 email)	PCBs/soil	DD (Apr 2006), LUCP (Sep2007)/ No residential land use; dig permit; fences; signs, prevent training area access, maintain clay cap	FYR3 (26Sep07)

Site Name (Number)	Regulatory Framework	Decision Document(s)	Selected Remedy(s)	USEPA Concurrence	COC(s) / Media	LUC Document / Description	FYR History
LF 1 (FTLE 54)	FFA, Non-NPL CERCLA	DD (Apr2006), Tech Memo (Oct2010)	Long-term monitoring, LUCs	Yes (20Apr04 email)	VOCs/ soil, gw	DD (Apr 2006), LUCP (Sep2007)/ No residential land use; dig permit, prevent installation of drinking water well	FYR3 (26Sep07)
Battery Acid Pit (FTLE-16)	FFA Non-NPL CERCLA	ROD (Sep1990), DD (Dec2000), DD (Apr2006), ESD (Oct2010)	LUCs	Yes (19Jan05 email)	Metals/ soil	DD (Apr 2006), LUCP (Sep2007)/ No residential land use; dig permit, maintain asphalt cap	FYR3 (Sep2007)
DRMO Yard (FTLE-31)	FFA, Non-NPL CERCLA	ROD (Sep1990), DD (Apr 2006), ESD (Oct2010)	LUCs	Yes (19Jan05 email)	Metals, petroleum, PCBs/soil	DD (Apr 2006), LUCP (Sep2007)/ No residential land use	FYR3 (26Sep07)
IWTP (FTLE-5)	FFA, Non-NPL CERCLA	ROD (Sep1990), DD (Dec2007), ESD (Oct2010)	LUCs	Awaiting concurrence based on finalization of LUCP	Metals, petroleum/ soil, sediment	Draft Final LUCP (Dec2007)/ No residential land use	none
Pesticide Rinse Area (FTLE-28)	FFA, Non-NPL CERCLA	DD (Dec2000), Tech Memo (Oct2010)	LUCs	Yes (7Jan00 letter)	VOCs, pesticides/ soil	DD (Apr 2006), LUCP (Sep2007)/ No residential land use	FYR3 (26Sep07)

Site Name (Number)	Regulatory Framework	Decision Document(s)	Selected Remedy(s)	USEPA Concurrence	COC(s) / Media	LUC Document / Description	FYR History
Stormwater Outfalls (FTLE-10)	FFA, Non-NPL CERCLA	DD (Dec2000)	NFA	Yes (7Jan00 letter)	PAHs, metals, petroleum/ soil, swl	none	none
Fire Training Pit (FTLE-17)	FFA, Non-NPL CERCLA	DD (Dec2000), Tech Memo (Oct2010)	NFA	Yes (7Jan00 letter)	VOCs, SVCOs, petroleum, pesticides, PCBs/ soil, gw	none	none
Park Marsh Landfill (FTLE-18)	FFA, Non-NPL CERCLA	DD (Dec2006), Tech Memo (Oct2010)	NFA	Yes (13Jan05 email)	VOCs, metals, pesticides/sediment, gw, swl	none	none
LF 6 (FTLE-59)	FFA, Non-NPL CERCLA	ROD (Sep1990), DD (Feb2007), ESD (Oct2010)	NFA	Yes (9Aug06 letter)	VOCs, SVOCs, metal, petroleum/soil	none	none
EOD Site 62 (FTLE 69)	FFA, Non-NPL CERCLA	MFR (Jun2005), Tech memo (Oct2010)	NFA	N/A site in operational range area.	N/A	N/A	N/A

gw – groundwater

Table 16 - Summary of JBLM LUCs

Site Name	Document Requiring LUC	Applicable Area of Site	LUC Objective
Logistics Center	April 2006 DD	EGDY	• Prevent residential land use • Prevent unplanned excavation of contaminated soil • Prevent training access • Maintain boundary fence and signs
	September 1990 ROD	1000 feet buffer around site boundary and within Lewis-Main boundary	• Prevent new drinking water wells without USEPA approved monitoring plan
		Off-post portion of Vashon Aquifer TCE plume above 5 µg/L	• Remind Lakewood Water District that Logistics Center should remain listed as possible source of contamination in its Wellhead Protection Program
		Upper Vashon Aquifer TCE 100 µg/L isoconcentration contour	• Prevent residential land use
Area D/ ALGT	September 1991 ROD	Area D/ALGT Groundwater Plume	Prevent new drinking water wells until USEPA concurs that groundwater has been restored
		Landfills 5, 6, 7, and 39	• Prevent residential land use (i.e. residential dwelling construction) on landfills • Prevent new drinking water wells within 1000 feet of landfill boundary unless granted State variance (WAC 173-160)
LF 4	September 1993 ROD	Landfill boundary	• Prevent residential land use • Prevent unplanned excavation of contaminated soil • Prevent digging, bivouacking, or off-road vehicle maneuvering during training

Site Name	Document Requiring LUC	Applicable Area of Site	LUC Objective
		1000 feet buffer around site boundary	• Prevent new drinking water wells without USEPA approved monitoring plan
SRCPP	September 1993 ROD	Site boundary	• Prevent new drinking water wells without USEPA approved monitoring plan
Illicit PCB Dump	April 2006 DD	Site boundary	• Prevent residential land use • Prevent unplanned excavation of contaminated soil • Prevent training access • Maintain boundary fence and signs • Maintain clay cap
LF 1	April 2006 DD	Landfill boundary	• Prevent residential land use • Prevent unplanned excavation of contaminated soil
		1000 feet buffer around landfill boundary	• Prevent new drinking water wells without USEPA approved monitoring plan
Battery Acid Pit	April 2006 DD	Site boundary	• Prevent residential land use • Prevent unplanned excavation of contaminated soil • Maintain asphalt cap
DRMO Yard	April 2006 DD	Site boundary	• Prevent residential land use
IWTP	April 2007 DD	Site Boundary	• Prevent residential land use
Pesticide Rinse Area	December 2000 DD	Site boundary	• Prevent residential land use

Table 17 - Groundwater Extraction Well Flow and TCE Concentration - All Systems

Groundwater Extraction Well Flow and TCE Concentration

East Gate Disposal Yard System															
	PW-1	PW-2	PW-3	PW-4	PW-5	PW-6	PW-7	PW-8							
Flow (gpm)[1]	19	61	21	158	168	160	101	26							
TCE[2]	361	142	199	74	49	38	30	23							
Interstate 5 System															
	LX-1	LX-2	LX-3	LX-4	LX-5	LX-6	LX-7	LX-8	LX-9	LX-10	LX-11	LX-12	LX-13	LX-14	LX-15
Flow (gpm)[1]	0	80	120	155	115	123	153	123	127	151	151	153	23	142	0
TCE[2]		5.4	11	30	47	71	69	64	50	50	35	27	7.5	6.9	
Sea Level Aquifer System															
	SLAP-1	SLAP-2	SLAP-3	SLAP-4	SLAP-5	SLAP-6									
Flow (gpm)[1]	195	127	270	427	464	199									
TCE[2]	7.9	15	27	34	14	8.4									
American Lake Garden Tract System															
	DX-1	DX-2	DX-3												
Flow (gpm)[3]	0	35	68												
TCE[3]	2.2	2.7	16.3												

1 – Flow calculated from quarterly averages 2008-2010. Only quarters with >50% uptime included.

2 – TCE concentration (ug/L) is the average of all measurements 2007-2011.

3 – 2010 data only.

Table 18 - EGDY System TCE Concentration Data

Joint Base Lewis McChord - East Gate Disposal Yard Extraction and Treatment System
TCE Concentration Data

Date	Effluent	Influent	% Rem	PW-1	PW-2	PW-3	PW-4	PW-5	PW-6	PW-7	PW-8
6/26/2006				612	651	518	311	151	71.5	26.2	42.3
9/14/2006				450	358	433	293	99.9	79		25.9
12/20/2006				626	52.6	122	58.1	60	52.4	38.4	21.8
1/12/2007	2.6	98.6	97%								
1/31/2007	3.6	67.3	95%								
3/1/2007	0.5	57.1	99%	295	71.7	124	167	72.1	192	51.5	39.1
3/30/2007	0.5	73.3	99%								
4/30/2007	0.5	41.7	99%								
5/31/2007	6.79	86.4	92%						50.9	38.4	18.4
6/29/2007	5.03	101	95%	156	146	334	123	65.8			
8/31/2007	3.82	83.9	95%								
9/19/2007	3.49	79.1	96%		197	246	83	42.7	39.1	29.9	23.8
10/31/2007	3.04	77	96%								
11/30/2007	3.6	59.2	94%								
12/28/2007	2.33	92.7	97%	515	196	284	138	58.9	44.1	44.8	25.2
1/31/2008	2.2	54.6	96%								
2/29/2008	2.1	42	95%		210	304		111	26.5	33.4	25.7
4/4/2008	2.4	59.8	96%								
5/1/2008	2.71	47.2	94%								
6/30/2008	1.44	50.9	97%	319	111	230	84.6	49	36.6	32	31.2
7/25/2008	3.22	37.6	91%								
9/2/2008	1.45	31.4	95%	575	120	220	102	35.8	36.7	28.4	27.4
9/26/2008	1.39	93.1	99%								
10/31/2008	0.81	92	99%								
12/8/2008	1.28	98.4	99%	681	273	263	81.6	20.2	35.3	21.1	21.2
1/2/2009	1.03	52.7	98%								
2/2/2009	1.23	62.3	98%		115	183	59.3	38.2	21.2		18.6
5/15/2009	1.31	102	99%		117	190	42.9	49.8			24.3
7/31/2009	1.69	50.7	97%								

Joint Base Lewis McChord - East Gate Disposal Yard Extraction and Treatment System
TCE Concentration Data

Date	Effluent	Influent	% Rem	PW-1	PW-2	PW-3	PW-4	PW-5	PW-6	PW-7	PW-8
9/3/2009	1.26	47.8	97%		133	135	47.6	37.9	24.8		25.2
11/6/2009	0.77	52	99%								
12/14/2009	0.63	42	99%		240	160	42	31	12		12
3/5/2010	0.86	43	98%	400	160	150	42	51	17	7.4	16
4/19/2010	1.4	51	97%								
5/21/2010	1.8	39	95%								
6/22/2010	1.9	40	95%								
7/21/2010	1.3	39	97%								
8/20/2010	1.2	39	97%								
9/20/2010	1.2	33	96%	290	62	130	34	38	18	23	16
10/29/2010	1.2	45	97%								
11/29/2010	1.1	43	97%								
1/20/2011	2.1	57	96%								
2/28/2011	1.5	43	97%								
3/22/2011	2.2	46	95%	230	40	140	28	40	14	23	16
4/25/2011	2.3	45	95%								
5/26/2011	2	34	94%								
6/24/2011	1.7	35	95%								
7/27/2011	1.6	33	95%								
8/30/2011	1.6	44	96%								
9/16/2011	1.4	40	97%	150	76	92	34	49	7.9	27	21
10/27/2011	1.1	43	97%								
11/21/2011	0.86	39	98%								
avg-07-11				361	142	199	74	49	38	30	23

Table 19 - I5 System TCE Concentration Data

Joint Base Lewis McChord - Interstate 5 Extraction and Treatment System
TCE Concentration Data

Date	Effluent	Influent		LX-01	LX-02	LX-03	LX-04	LX-05	LX-06	LX-07	LX-08	LX-09	LX-10	LX-11	LX-12	LX-13	LX-14	LX-15
11/1/1995					29	49	90	150	130	100		85	64	36	3.1	5.2	1.6	190
2/14/1996					19	45	100		130				70	42	3.1	7.5		220
5/14/1996					29		108	163	175	126	111		102	78	47	4.7	10	4.2
8/17/1996					21	40	91	140	130	110	89	97	89	61		4.6	7.1	3.1
8/31/1998	1	49	98%		16	35		95	120	100	75	74	56	35	20	5.9	5.6	3.1
10/15/1998	0.7	53	99%															
11/18/1998	0.6	45	99%															
12/15/1998	0.7	44	98%		14	35		96	120	110	83	79	67	28	17	5.1	5	2.5
2/10/1999	0.7	46	98%															
3/17/1999	1	49	98%		14	32	92		120	45	86	83	78	50	33	5.4	6	3.5
4/27/1999	0.8	61	99%															
5/12/1999	0.9	50	98%															
6/16/1999	1.5	48	97%		12	25	57	99	94	83	74	69	63	45	27	6.8	7.5	4.4
7/14/1999	0.9	54	98%															
8/26/1999	1	51	98%															
9/15/1999	1.2	46	97%		11	24	59	100	92	83	72	69	61	40	23	5.3	7.3	4
11/17/1999	0.9	37	98%															
12/15/1999	1.2	48	98%		15	24	60	100	93	88	77	68	63	36	22	5.8	6.8	3.4
1/18/2000	0.9	47	98%															
2/16/2000	0.9	44	98%															
3/15/2000	1	44	98%		13	22	51	90	88	84	76	68	110	43	30	6.5	8.2	4.3
4/12/2000	0.9	45	98%															
5/17/2000	0.8	72	99%															
6/13/2000	0.9	44	98%		13	20	50	100	100	96	89	80	77	51	36	5.6	7.6	4.5
7/18/2000	1.1	49	98%															
8/14/2000	0.8	46	98%															
9/20/2000	0.5	38	99%		9.8	20	56	85	89	83		67	64	35	23		5.8	2.9
10/24/2000	0.6	39	98%															
11/21/2000	0.6	36	98%															
12/13/2000	0.5	40	99%		12	27	72	110	110	100		78	71	32	20		5.4	3.1
1/17/2001	0.8	40	98%															
2/15/2001	0.8	44	98%															
3/14/2001	0.7	39	98%		14	23	58	96	82	79	73	61	43	26	20		5.9	3
4/17/2001	1.1	40	97%															
5/15/2001	0.8	39	98%															
6/14/2001	0.6	36	98%		13	27	54	79	79	72	82	55	39	21	16		4.7	2.4
7/18/2001	0.8	37	98%															
8/17/2001	0.5	40	99%															
9/12/2001	0.6	43	99%		11	21	52	72	78	76	68	54	46	20	13	5.3	4.2	2.3
10/18/2001	0.4	36	99%															
11/14/2001	0.5	41	99%															
12/10/2001	0.4	38	99%															
1/16/2002	0.4	37	99%															
2/18/2002	0.5	35	99%															
3/14/2002	0.6	46	99%		11	23	54	69		73	71	61	59	29	23		5.8	3.4

Joint Base Lewis McChord - Interstate 5 Extraction and Treatment System
TCE Concentration Data

Date	Effluent	Influent		LX-01	LX-02	LX-03	LX-04	LX-05	LX-06	LX-07	LX-08	LX-09	LX-10	LX-11	LX-12	LX-13	LX-14	LX-15
4/12/2002	0.5	34	99%															
5/14/2002	0.7	40	98%															
6/11/2002	0.9	41	98%															
7/18/2002	0.7	38	98%															
8/14/2002	0.7	41	98%															
9/12/2002	0.7	46	98%															
10/16/2002	0.5	43	99%															
11/15/2002	0.6	34	98%															
12/12/2002	0.6	40	99%															
1/16/2003	0.4	39	99%															
2/11/2003	0.5	39	99%															
3/17/2003	0.7	36	98%		10	19	43	66	92	79	78	60	63	38	28	6.9	6	3.2
4/15/2003	0.7	45	98%															
5/14/2003	0.5	40	99%															
6/16/2003	0.6	38	98%															
7/15/2003	0.5	36	99%															
8/14/2003	0.4	43	99%															
9/12/2003	0.4	39	99%															
10/15/2003	0.4	34	99%															
11/17/2003	0.4	39	99%															
12/16/2003	0.3	36	99%															
1/15/2004	0.4	36	99%															
2/13/2004	0.5	40	99%															
3/18/2004	0.2	69	100%		10	21	53		86	79	79		68	39	33	8.5	7.7	4.8
4/13/2004	0.4	34	99%															
4/18/2004	0.2	69	100%															
6/17/2004	0.5	40	99%															
7/28/2004	0.6	42	99%															
8/19/2004	0.6	41	99%															
9/17/2004	0.5	38	99%															
10/15/2004	0.5	36	99%															
11/15/2004	0.3	39	99%															
1/26/2005	0.5	44.4	99%															
2/16/2005	0.6	45.3	99%		8.5	20	59.7	82.3	90.8	85.9	92.2	64.1	53.4		20.5	7.8		3.3
4/1/2005	0.7	44.4	98%															
4/27/2005	0.7	56.7	99%															
6/9/2005	0.5	31.7	98%															
6/22/2005	0.5	39.3	99%		9.2	19.7	51.8	75.1	88.5	73.9	78.4	59.2	54.2		21.8	7.2		3.1
7/14/2005	0.5	46.8	99%															
9/1/2005	0.5	41.5	99%		9.4	22.4	54.1	73.5	92.1	66.4	68.4	59.3	42.4		19	6.9		2.7
9/28/2005	0.5	39	99%															
10/27/2005	0.5	44.2	99%															
12/1/2005	0.5	44.9	99%		4.1	19.3	61.5	59.5	104	85.4	91.5	86	69.1		17	8.2		3.3
2/16/2006	0.7	39.6	98%															
3/29/2006	0.8	35.6	98%		8	16.6	40.9		96.5	80.7	75	58.5	30.6		27.8	10.9		3.6

Joint Base Lewis McChord - Interstate 5 Extraction and Treatment System
TCE Concentration Data

Date	Effluent	Influent		LX-01	LX-02	LX-03	LX-04	LX-05	LX-06	LX-07	LX-08	LX-09	LX-10	LX-11	LX-12	LX-13	LX-14	LX-15
4/28/2006	0.5	44.2	99%															
5/25/2006	0.5	35.4	99%				55.6		98.6	80.9	84.4	59.3	73.1		28.9	7.9		
7/27/2006	0.5	39.5	99%		8.7	20.1												3.4
8/31/2006	0.6	37.1	98%		7.9	16.5	60.5		85	71.3	77.9	53	66.2		28.4	7.9		
9/29/2006	0.5	53.2	99%															3.5
11/30/2006	0.5	40	99%															
12/28/2006	0.5	36.6	99%		7.7		37.1		68.9	47.1		41.5	51.6	37.3	25.2	5.8	5.4	2.8
1/31/2007	0.5	34.2	99%															
3/1/2007	0.5	43	99%		5.2		71.8	0.5		59.1		75.5	121	40.2	32.4	7	9.9	3.8
3/29/2007	0.5	43	99%															
4/29/2007	0.5	45.3	99%															
5/31/2007	0.5	34.7	99%		5.6		33.6	58.4	87.5	66.3		52.9	56.9	46.7	35.6	7.19	9.07	3.69
8/31/2007	0.5	0.52	4%		4.15	7.9	20.7	49.9	65.4	65.4	46.7	39	45.7	35.4	27.9	9.11	6.64	5.86
10/31/2007	0.5	42	99%															
11/30/2007	0.5	42.2	99%		5.96	12.6		64.7	69.6	75	73.6	54.3	43.1	41.6	29.8	7.83	7.49	
2/8/2008	0.64	37.9	98%		5.98			58										
2/28/2008	0.5	44.8	99%			13			102	124		54.1	43.7	39.9	30.1	7.48	7.92	5.22
3/28/2008	0.5	66.7	99%															
5/1/2008	0.5	50.5	99%															
6/30/2008	0.51	43.2	99%															
7/25/2008	0.5	40.4	99%															
9/3/2008	0.5	28.3	98%		5.3	11.5	24.6	41.8	71	40.6	69.8	51.8	38.4	28.9	20.2	7.11	5.47	5.43
9/26/2008	0.5	36.3	99%															
10/31/2008	0.5	29.6	98%															
12/8/2008	0.52	30.4	98%															
1/2/2009	0.5	28.7	98%															
1/30/2009	0.5	18.2	97%		7.07		30.8	56.4	78.3	84.4	77.9	53.4		36.1	23.6	8.58	5.88	
5/15/2009	0.56	42	99%															
7/31/2009	0.54	34.6	98%															
9/3/2009	0.52	33.6	98%		5.97	12.2	27.2		59.1	62	62.6	45.3	36.2	33.3	24.2		5.9	
11/6/2009	0.056	32	100%															
12/14/2009	0.23	30	99%															
3/5/2010	0.37	32	99%		5.2	12	23	48		59	62	44	35	27	23	8	5.7	
4/20/2010	0.63	42	99%															
5/21/2010	0.5	36	99%															
6/22/2010	0.5	35	99%															
7/21/2010	0.5	31	98%															
8/20/2010	0.5	28	98%															
9/21/2010	0.5	32	98%		4.5	10	17	42			51	37	36	26		6.1	5.4	
10/29/2010	0.5	37	99%															
11/29/2010	0.5	36	99%															
1/20/2011	0.5	40	99%															
2/28/2011	0.5	45	99%															
3/23/2011	0.5	42	99%		4.8		27	47	56	60		49	39	33	28	6.9	7.2	
4/25/2011	0.5	38	99%															

Joint Base Lewis McChord - Interstate 5 Extraction and Treatment System
TCE Concentration Data

Date	Effluent	Influent		LX-01	LX-02	LX-03	LX-04	LX-05	LX-06	LX-07	LX-08	LX-09	LX-10	LX-11	LX-12	LX-13	LX-14	LX-15
5/26/2011	0.5	39	99%															
6/24/2011	0.5	45	99%															
7/27/2011	0.5	37	99%															
8/24/2011	0.5	43	99%		5.1		23	55	54	66	67	49	52	30	25	6.7	6.6	
9/16/2011	0.5	34	99%															
10/27/2011	0.5	40	99%															
11/21/2011	0.5	32	98%															
avg-07-11					5.4	11.3	29.9	47.4	71.4	69.3	63.8	50.4	49.7	34.8	27.3	7.5	6.9	4.8

Table 20 - SLA System TCE Concentration Data

Joint Base Lewis McChord - Sea Level Aquifer Extraction and Treatment System									
TCE Concentration Data									
	SLAP Effluent	SLAP Influent	% Rem	SLAP-1	SLAP-2	SLAP-3	SLAP-4	SLAP-5	SLAP-6
2/12/2008				12.3	30.7				15.3
9/5/2008				0.5	37.8	18.1	51.5	29.2	14.4
12/10/2008				0.5	41.8	24.8	59	30.4	15.2
2/24/2009				0.5	41.8	20.5	55.2	23.9	14
10/13/2009				2.4	28	26	41	19	9.2
11/18/2009	5.8	22	74%			25	39	17	11
12/11/2009	3.9	21	81%	10	24	24	43	15	9.4
1/21/2010	4.1	20	80%	9.5	17	22	33	14	7.8
3/10/2010	4.2	20	79%	9.5	18	25	33	15	7.7
4/21/2010	4.9	24	80%	11	18	26	41	17	9.3
5/11/2010	5.1	24	79%	11	19	27	39	18	9.9
6/10/2010	3.8	18	79%	8.3	14	20	29	13	7.4
7/19/2010	3.2	19	83%						
8/20/2010	3	17	82%						
9/20/2010	2.9	19	85%	6.7	12	22	28	13	6.9
10/22/2010	0.74	19	96%						
11/24/2010	0.78	18	96%						
12/13/2010	0.68	17	96%	6.9	9.9	27	28	12	7.4
1/19/2011	0.69	19	96%						
2/25/2011	0.69	19	96%						
3/28/2011	0.62	17	96%	7.6	10	32	28	12	8
4/26/2011	0.55	18	97%						
5/25/2011	0.59	17	97%	7.3	10	34	29	13	7.6
6/28/2011	0.72	19	96%						
7/27/2011	0.67	17	96%						
8/24/2011	0.63	17	96%	6.8	9.2	34	32	12	9.2
9/26/2011	0.65	17	96%						
10/27/2011	0.62	17	96%						
11/21/2011	0.52	16	97%	5.7	8	27	26	11	6.7
avg oct09-11				6.9	23.0	24.2	39.1	17.8	10.2

Table 21 - ALGT Well DX-3 Specific Capacity

Table C-1. Well DX-3 Specific Capacity

Date	Pumping Rate	Drawdown	Pumping Rate/Drawdown	Specific Capacity
03/20/1995	88.4	6.46	13.68421	100%
06/20/1995	74.5	5.6	13.30357	97%
09/19/1995	73.6	6	12.26667	90%
12/12/1995	77.0	6.47	11.90108	87%
06/19/1996	75.1	7.02	10.69801	78%
09/13/1996	68.1	7.05	9.659574	71%
12/16/1996	58.3	6.16	9.464286	69%
03/21/1997	54.6	6.43	8.491446	62%
06/10/1997	46.7	5.12	9.121094	67%
09/17/1997	47.4	5.70	8.315789	61%
12/16/1997	51.3	5.84	8.784247	64%
03/18/1998	72.5	8.77	8.266819	60%
06/17/1998	67.0	8.64	7.75463	57%
09/22/1998	60.0	8.32	7.211538	53%
12/16/1998	70.0	10.05	6.965174	51%
03/19/1999	69.2	9.56	7.238494	53%
09/08/1999	58.0	9.55	6.073298	44%
12/14/1999	62.7	11.18	5.608229	41%
03/16/2000	65	12.44	5.22508	38%
04/14/2000	63.6	12.30	5.170732	38%
05/02/2000	76.8	9.66	7.950311	58%
06/19/2000	75.6	10.44	7.241379	53%
09/15/2000	72.3	10.55	6.853081	50%
12/21/2000	75.1	12.39	6.06134	44%
03/22/2001	76.2	13.88	5.489914	40%
06/08/2001	77.4	15.91	4.864865	36%
09/20/2001	72.8	14.38	5.062587	37%
12/18/2001	75.6	16.42	4.604141	34%
03/19/2002	75.3	17.12	4.398364	32%
06/18/2002	74.8	18.17	4.116676	30%
09/17/2002	74.6	21.58	3.456905	25%
12/17/2002	77.3	20.72	3.730695	27%
03/18/2003	80.0	23.84	3.355705	25%
06/18/2003	80.1	25.57	3.132577	23%
09/16/2003	81.2	27.34	2.970007	22%
12/16/2003	100.8	33.56	3.003576	22%
03/16/2004	100.5	33.39	3.009883	22%
06/15/2004	97.0	36.80	2.63587	19%
09/15/2004	73.8	30.09	2.452642	18%
03/15/2005	93.9	40.3	2.330025	17%
06/14/2005	90.5	40.1	2.256858	16%
09/13/2005	71.9	34.4	2.090116	15%
10/11/2005	74.1	37.34	1.984467	15%
11/17/2005	95.6	22.3	4.286996	31%

Table C-1. Well DX-3 Specific Capacity (Concluded)

Date	Pumping Rate	Drawdown	Pumping Rate/Drawdown	Specific Capacity
12/13/2005	98.6	23.1	4.268398	31%
03/14/2006	99.1	23.97	4.134335	30%
06/06/2006	95.3	26.82	3.553318	26%
09/19/2006	83.9	29.88	2.807898	21%
12/12/2006	92.8	37.62	2.466773	18%
03/13/2007	87.8	38.2	2.298429	17%
06/12/2007	79.1	36.4	2.173077	16%
09/18/2007	72.6	38.3	1.895561	14%
12/19/2007	65.8	39.5	1.665823	12%
03/13/2007	87.8	38.2	2.298429	17%
06/12/2007	79.1	36.4	2.173077	16%
09/18/2007	72.6	38.3	1.895561	14%
12/19/2007	65.8	39.5	1.665823	12%
03/18/2008	65.0	38.8	1.673532	12%
06/17/2008	61.9	44.0	1.406179	10%
09/10/2008	58.5	39.4	1.485149	11%
09/17/2008	80.0	27.5	2.909091	21%
12/16/2008	79.2	28.6	2.769231	20%

Figures

Figure 1 - JBLM Location and Vicinity Map

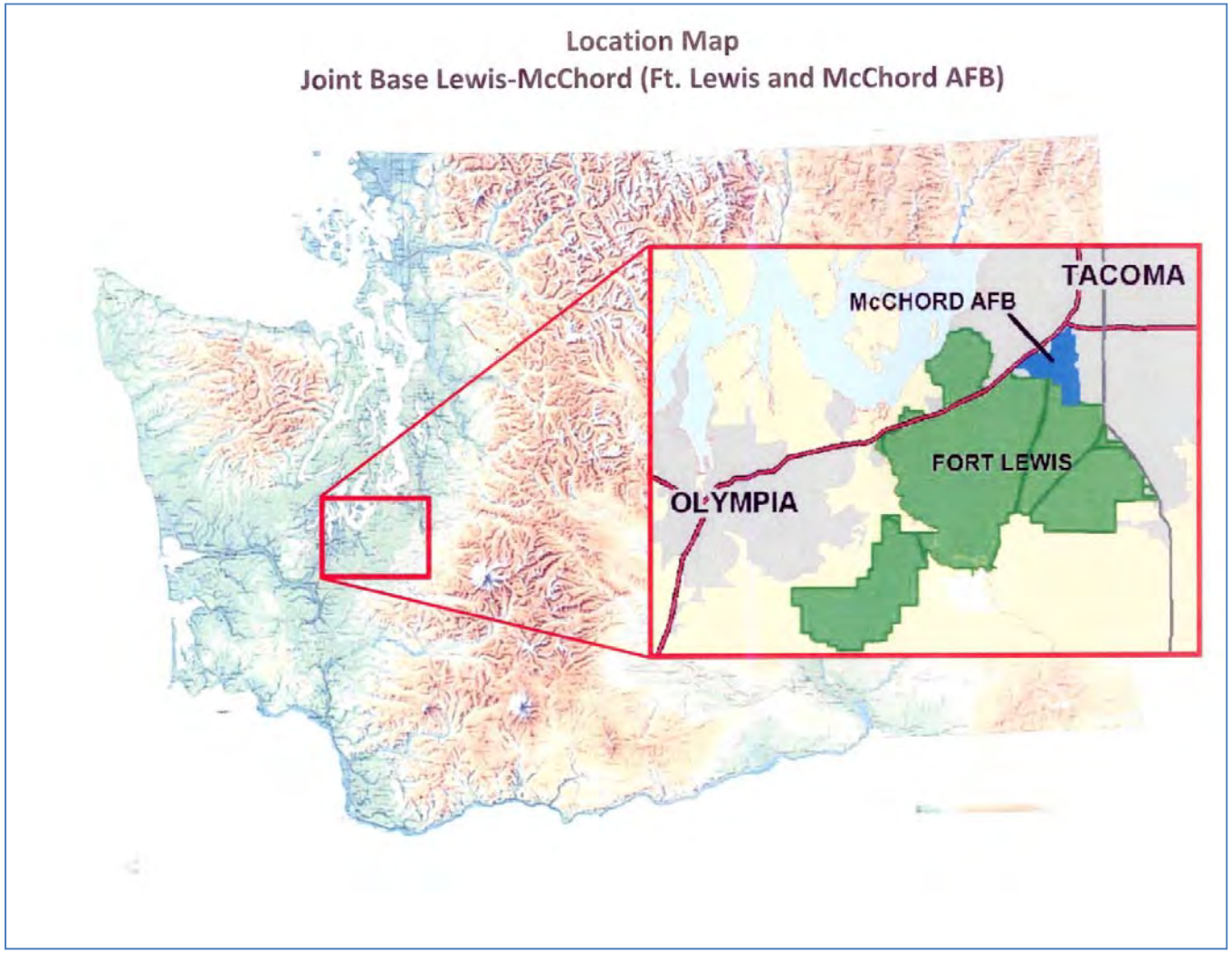

Figure 2 - JBLM Site Map

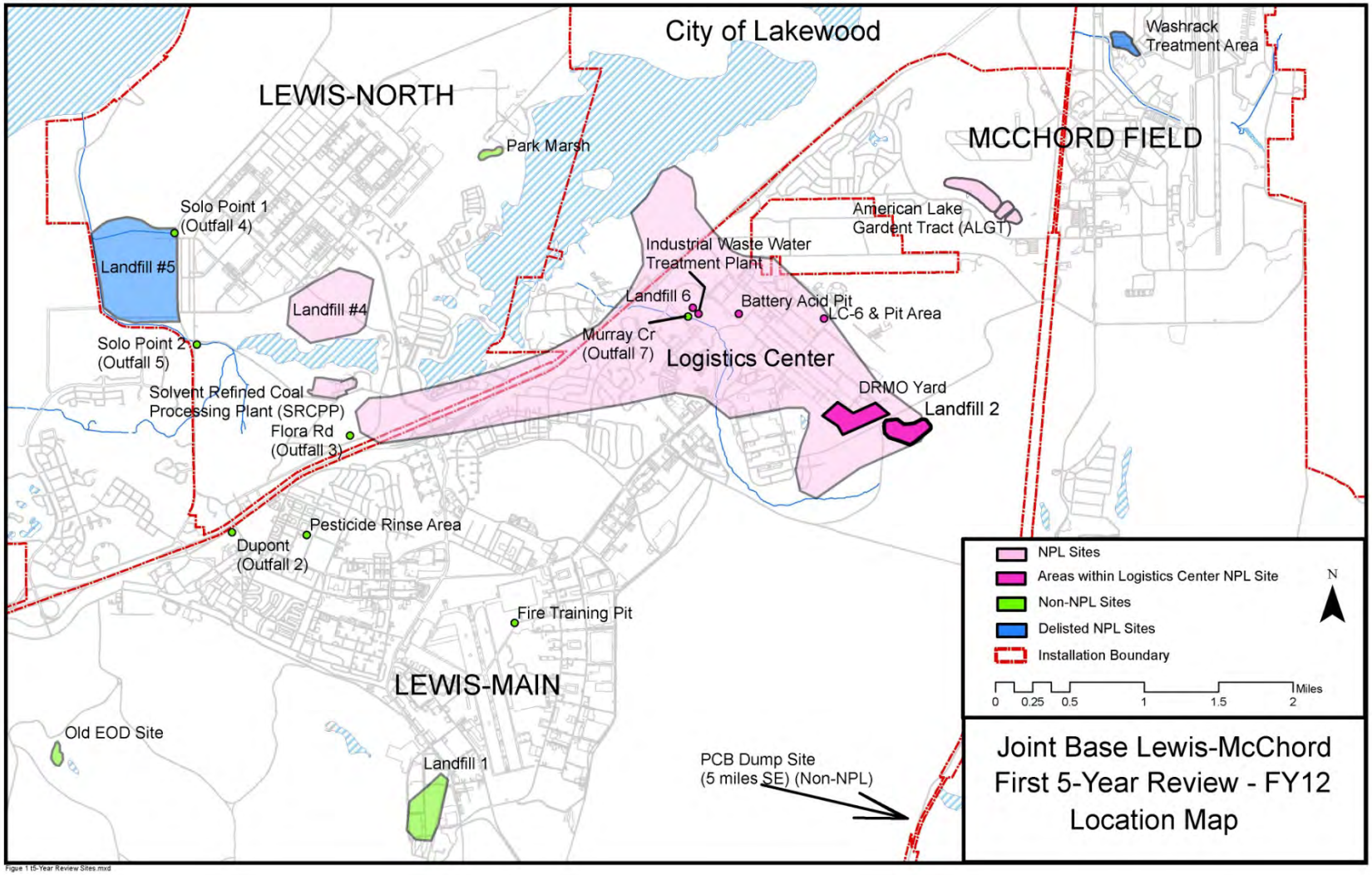

Figure 3 - Groundwater Treatment Systems Locations

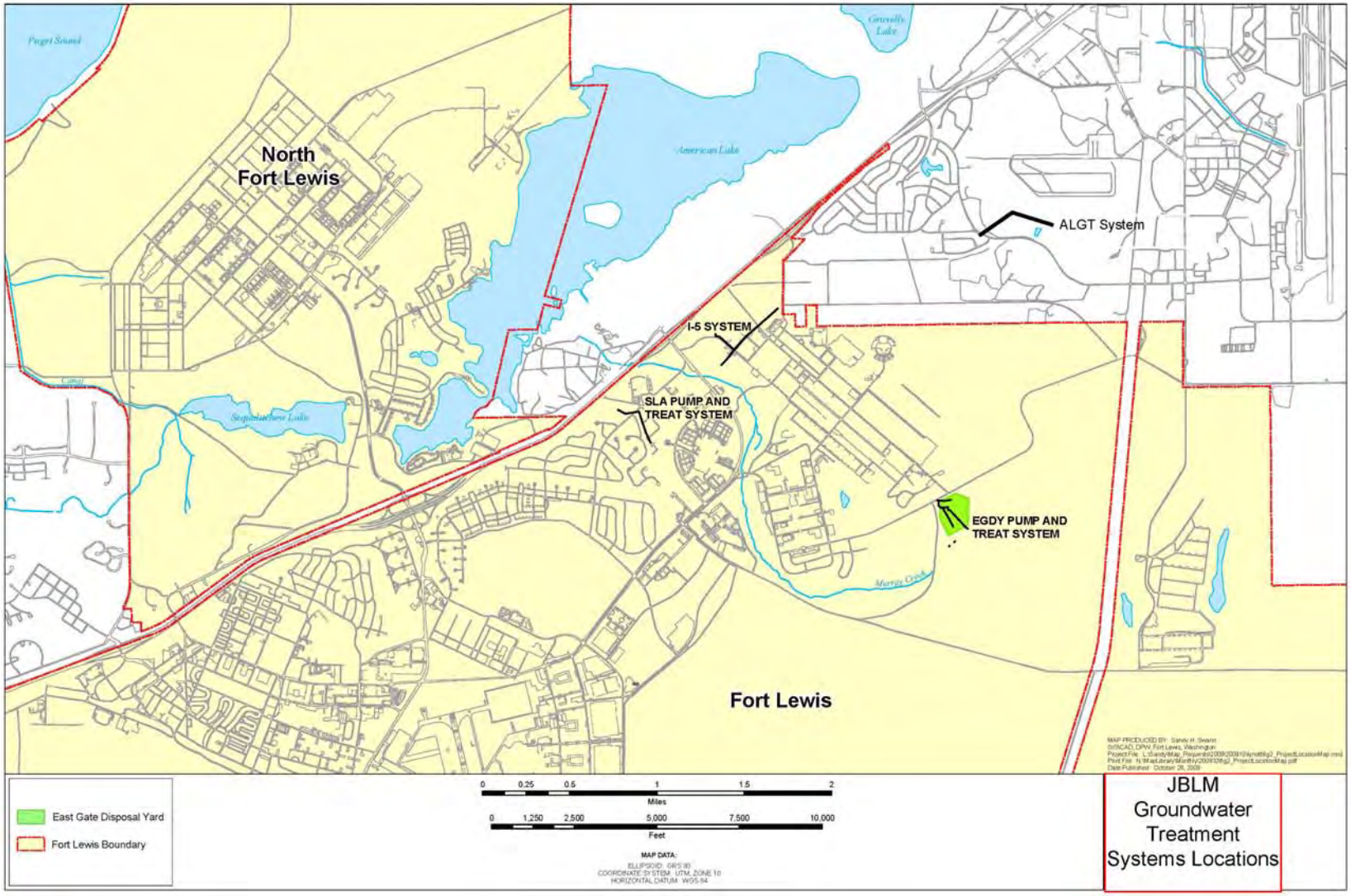

Figure 4 - Current Layout of EGDY Extraction Wells

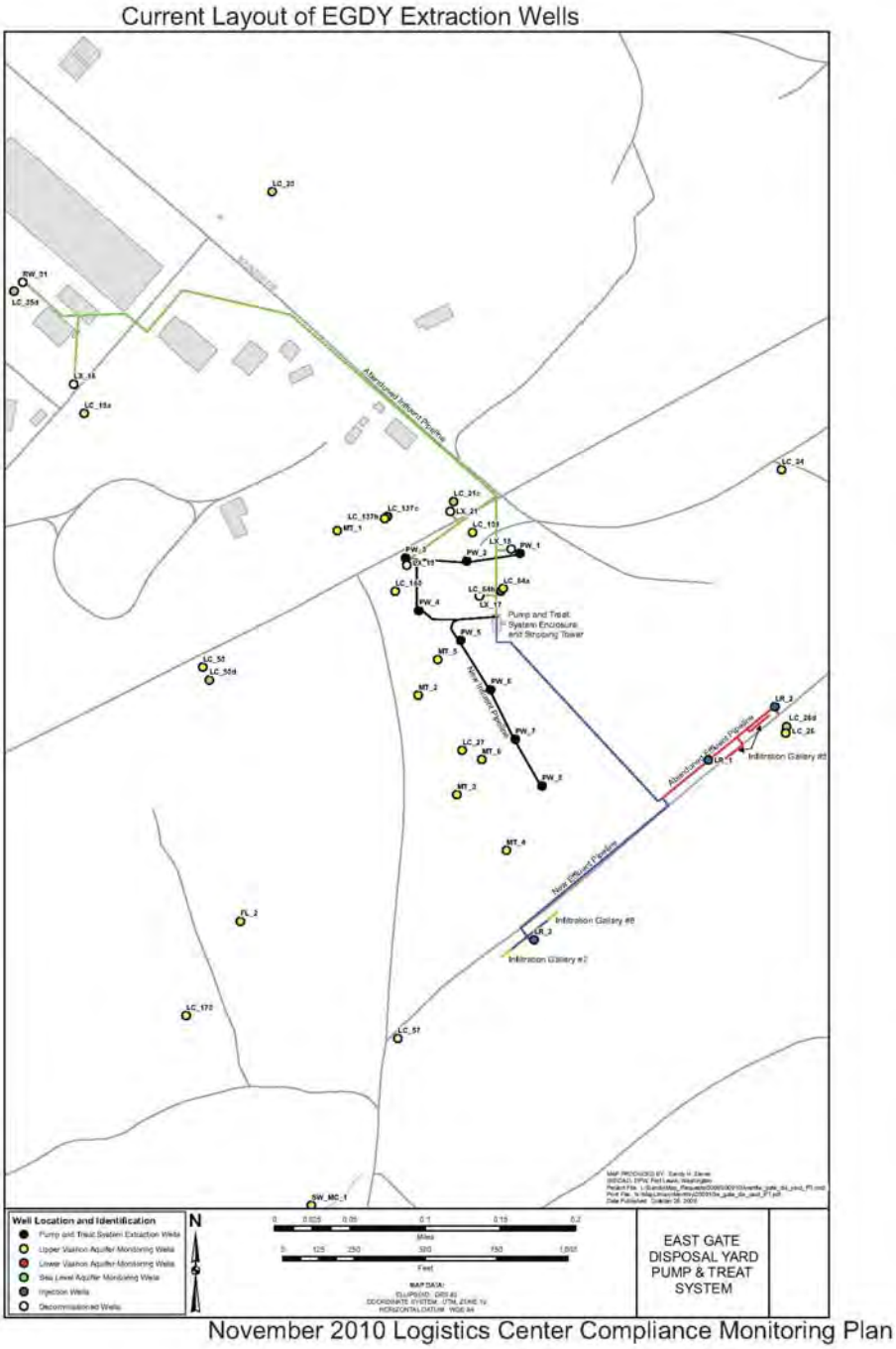

Figure 5 - Current Layout of I-5 Extraction Wells

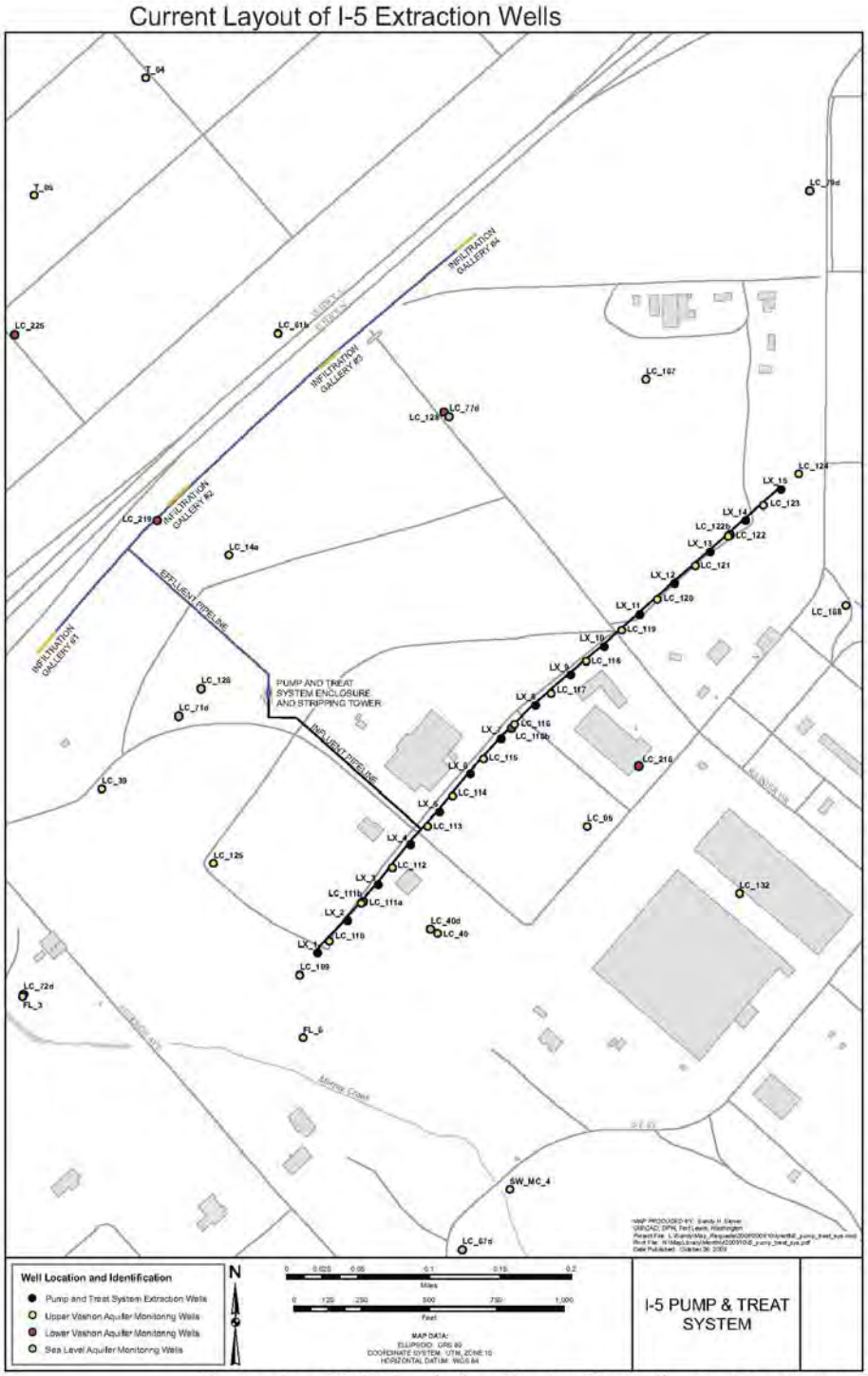

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Figure 6 - Current Layout of SLA Extraction Wells

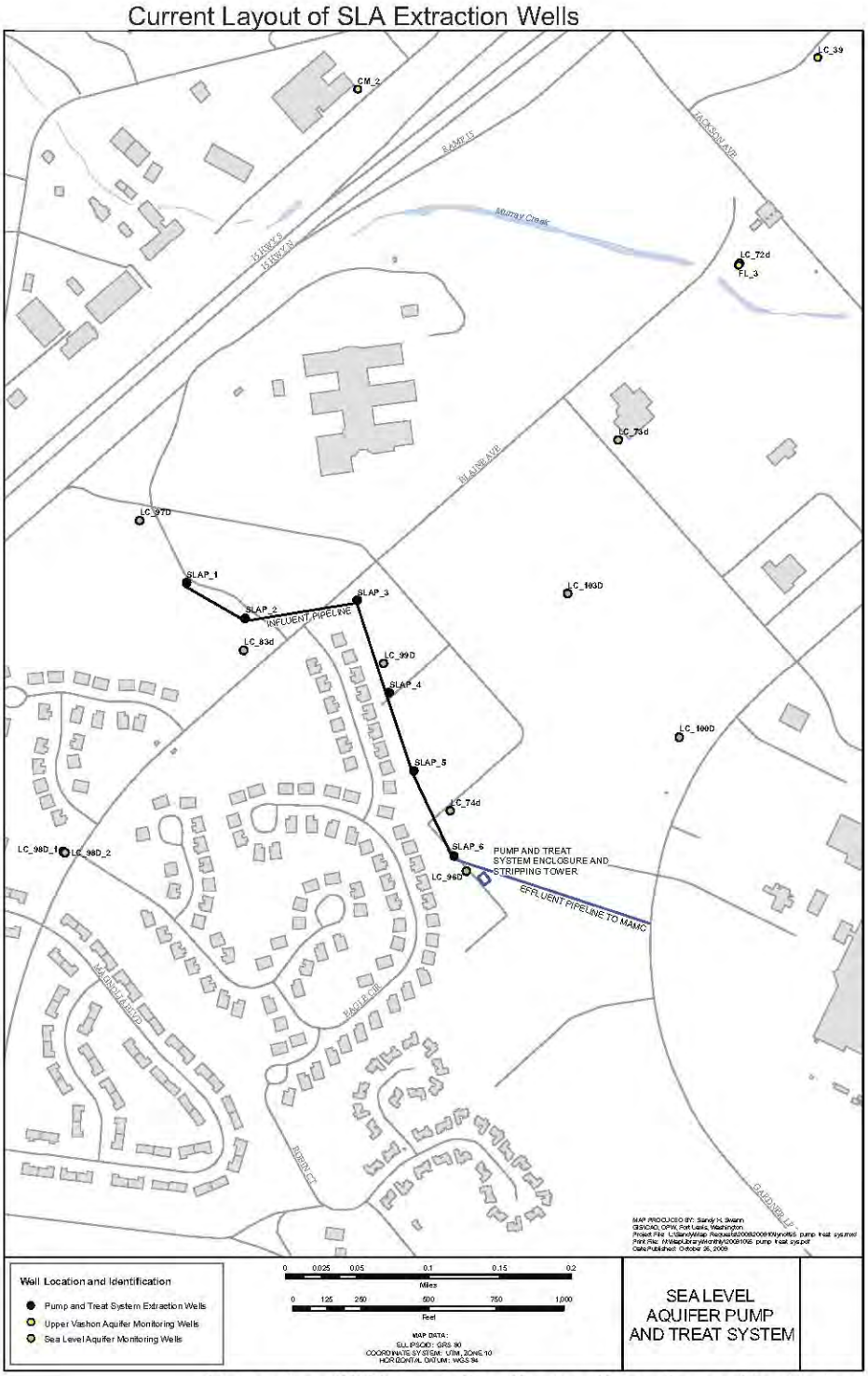

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Figure 7 - Current Layout of ALGT Extraction Wells

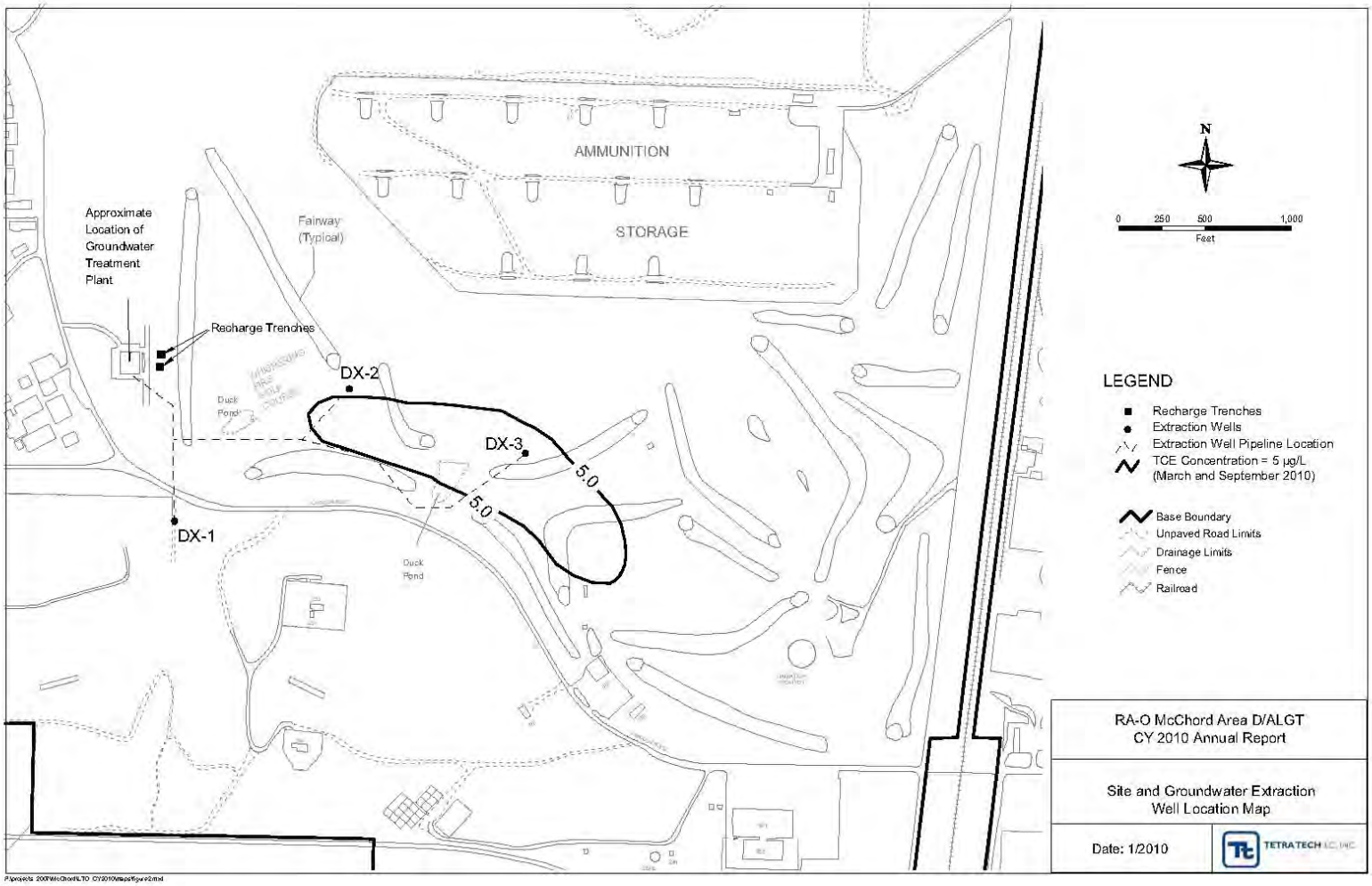


Figure 8 - Extraction Well Flow - EGDY System P1 thru P4

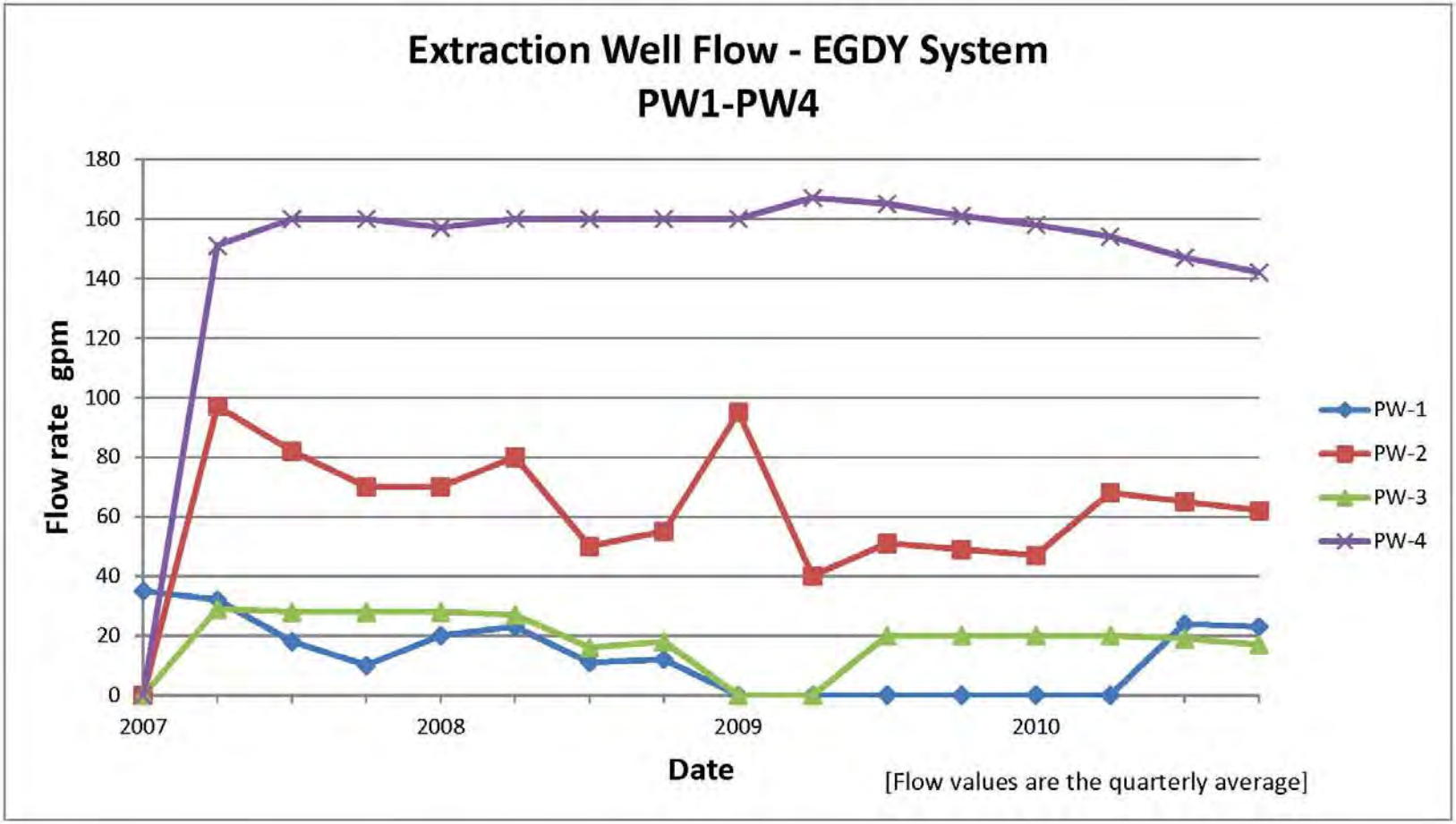


Figure 9 - Extraction Well Flow EGDY System P5 thru P8

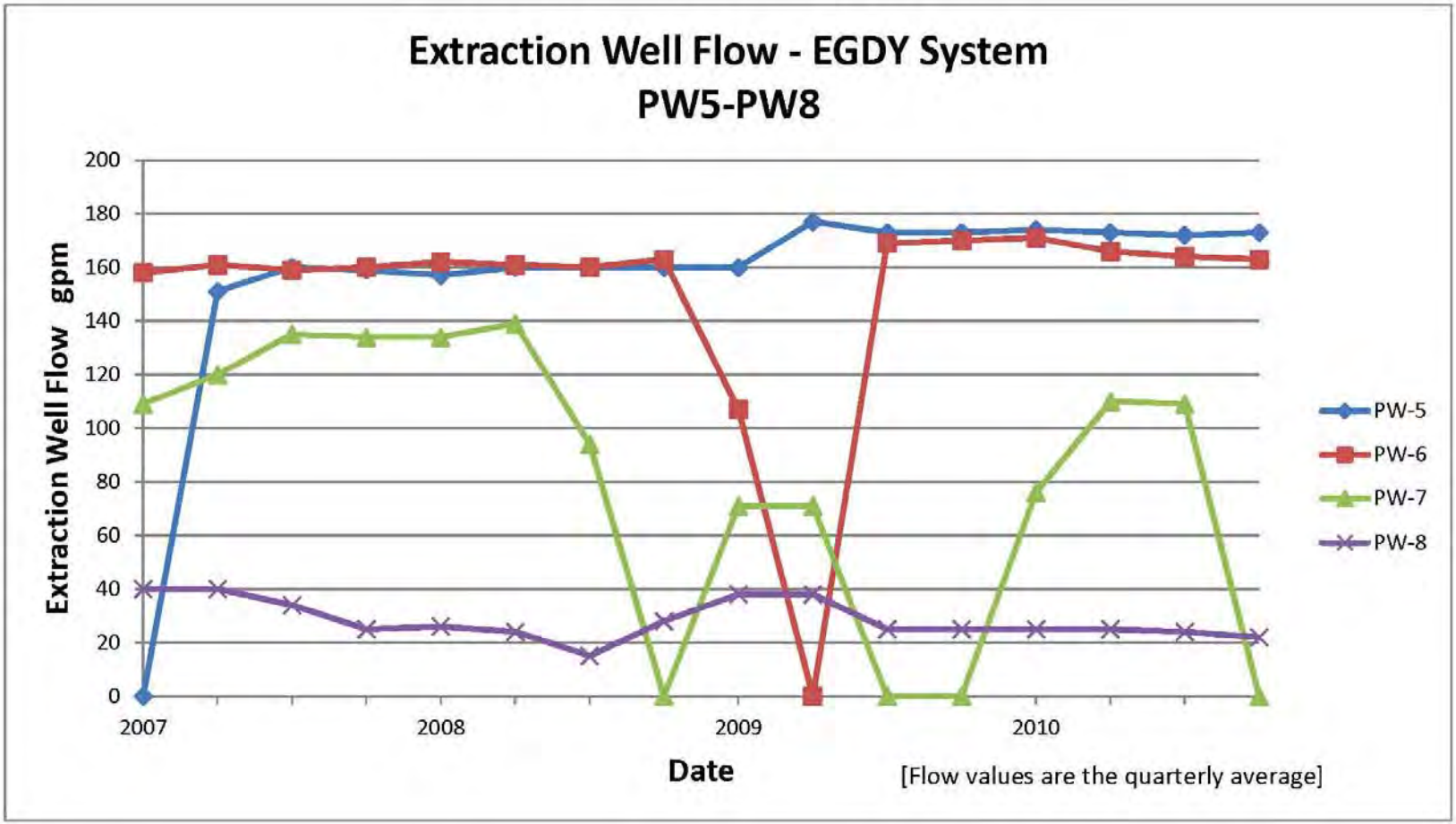


Figure 10 - Extraction Well Flow I5 System LX2 thru LX6

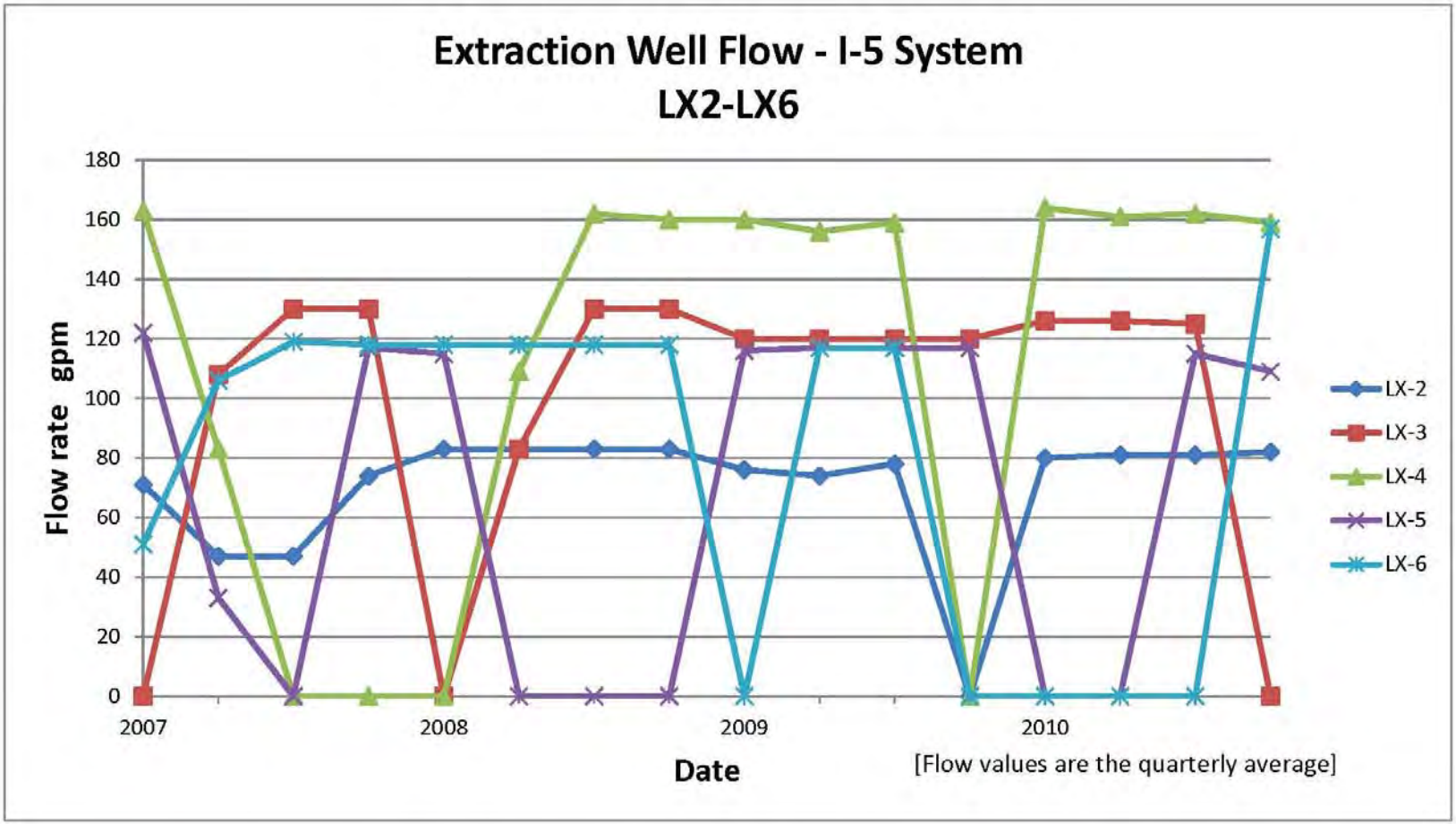


Figure 11 - Extraction Well Flow I5 System LX7 thru LX10

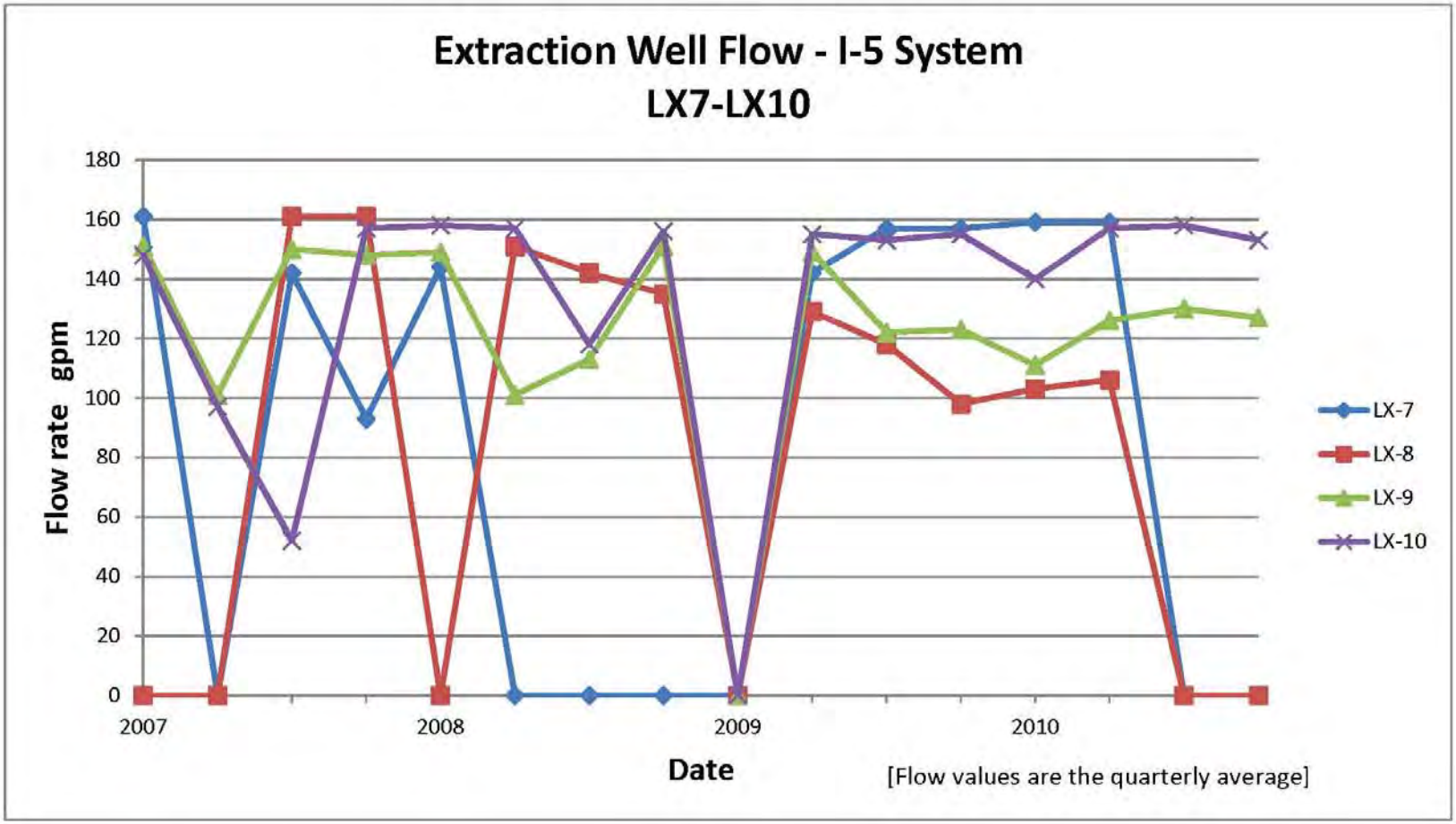


Figure 12 - Extraction Well Flow I5 System LX11 thru LX14

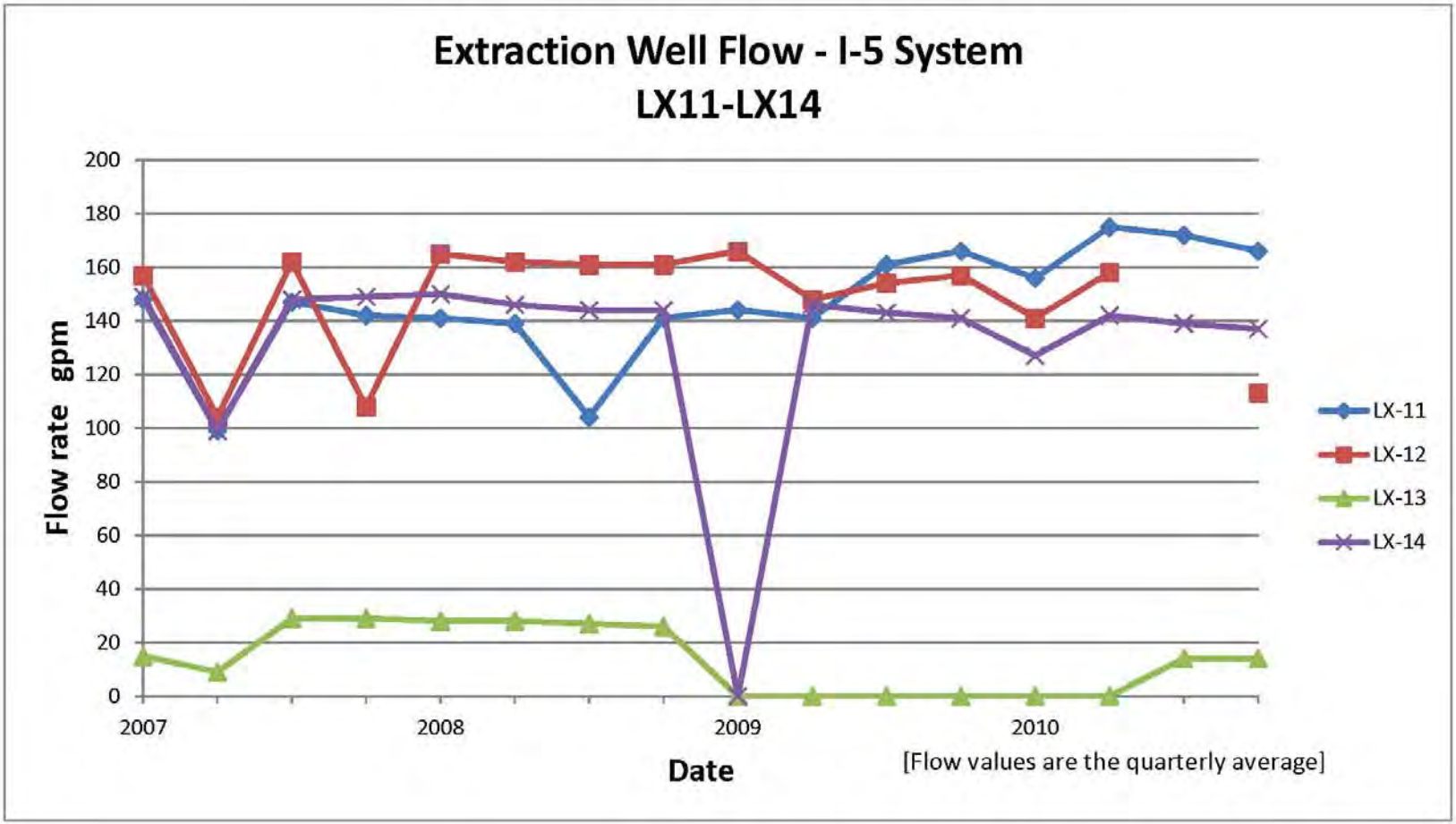


Figure 13 - EGDY System Extraction Well TCE Concentration PW1 thru PW4

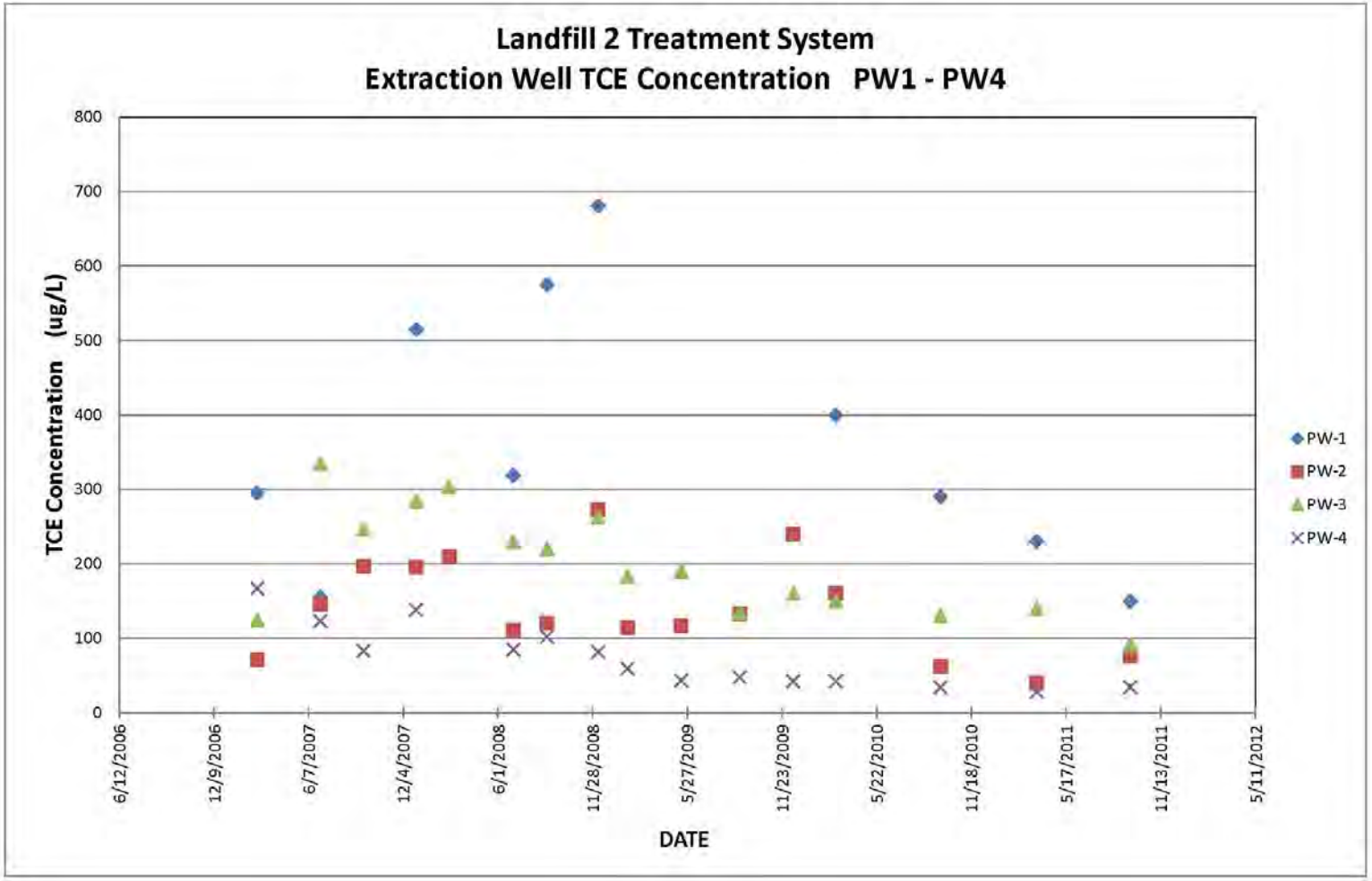


Figure 14 - EGDY System Extraction Well TCE Concentration PW5 thru PW8

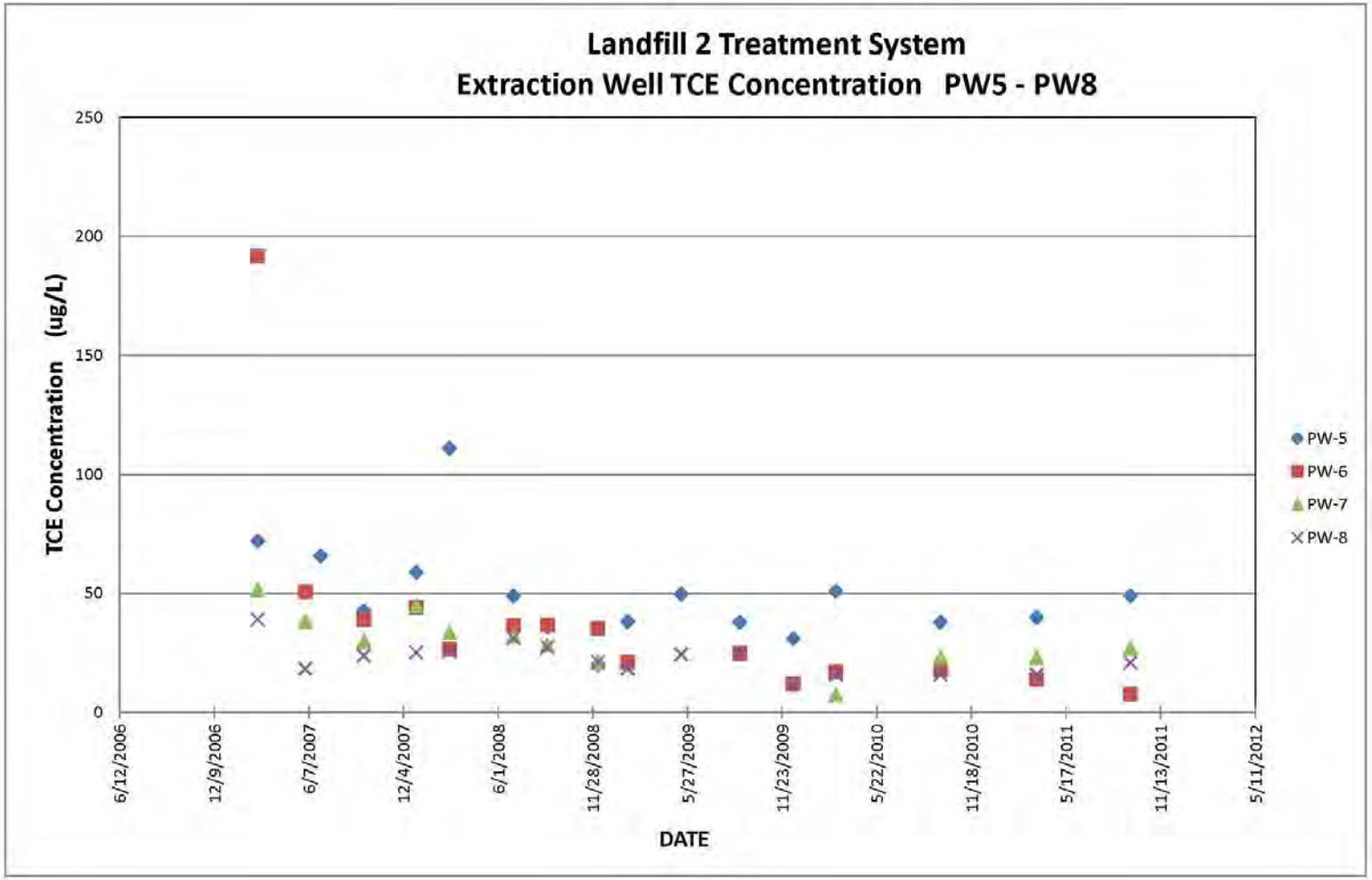


Figure 15 - I5 System Extraction Well TCE Concentration LX2 thru LX5

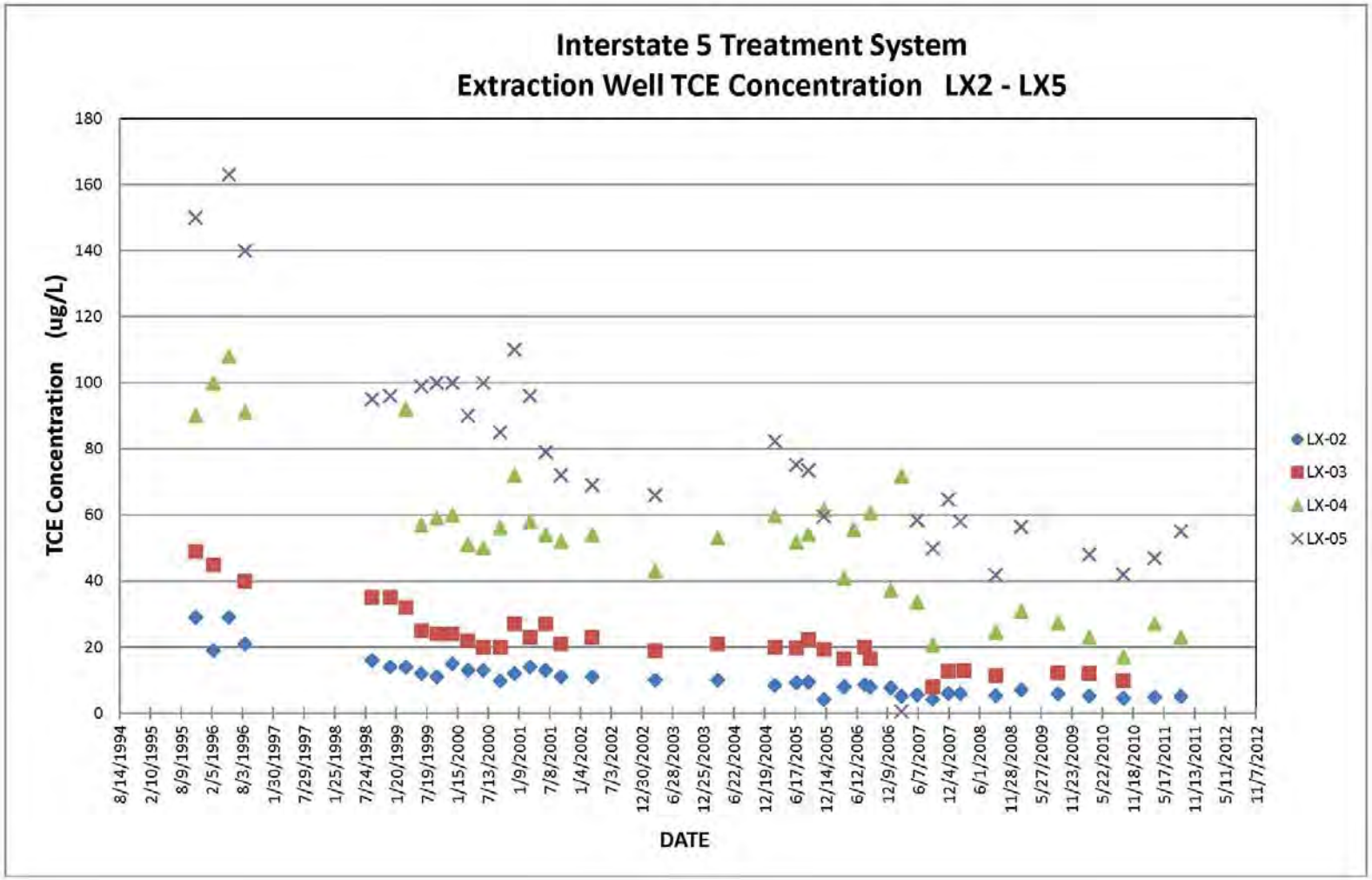


Figure 16 - I5 System Extraction Well TCE Concentration LX6 thru LX10

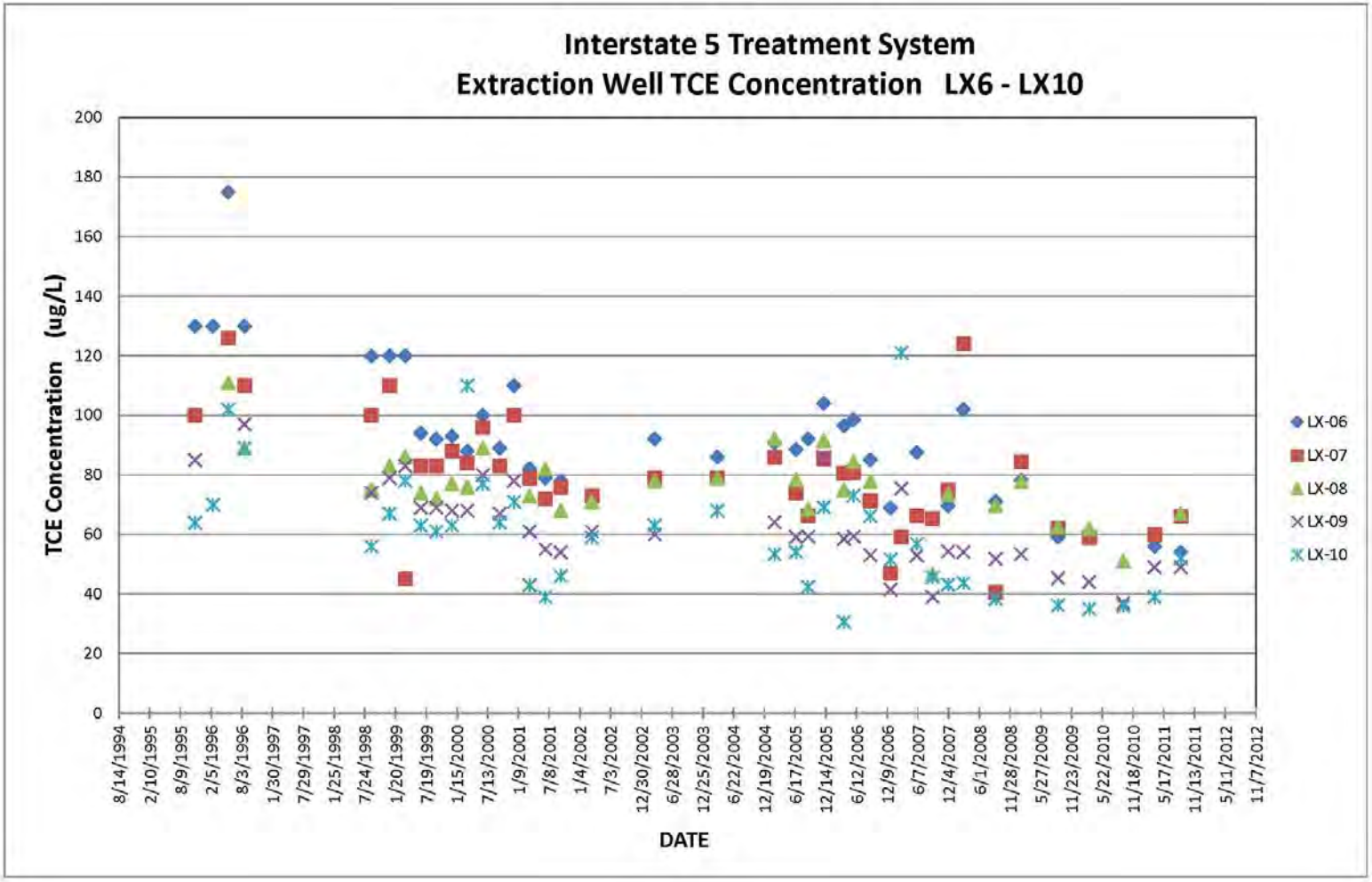


Figure 17 - I5 System Extraction Well TCE Concentration LX11 thru LX14

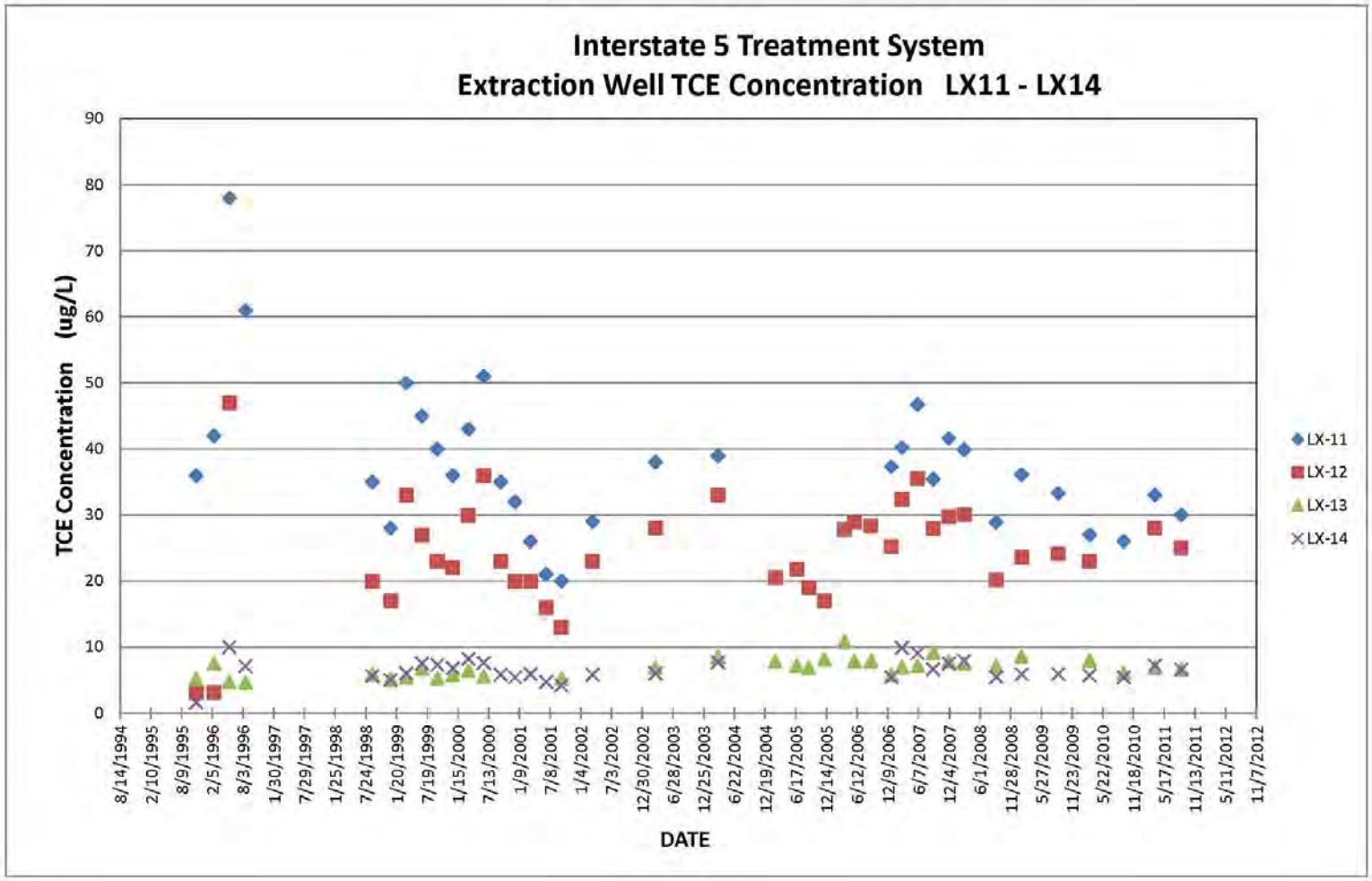


Figure 18 - SLA System Extraction Well TCE Concentration

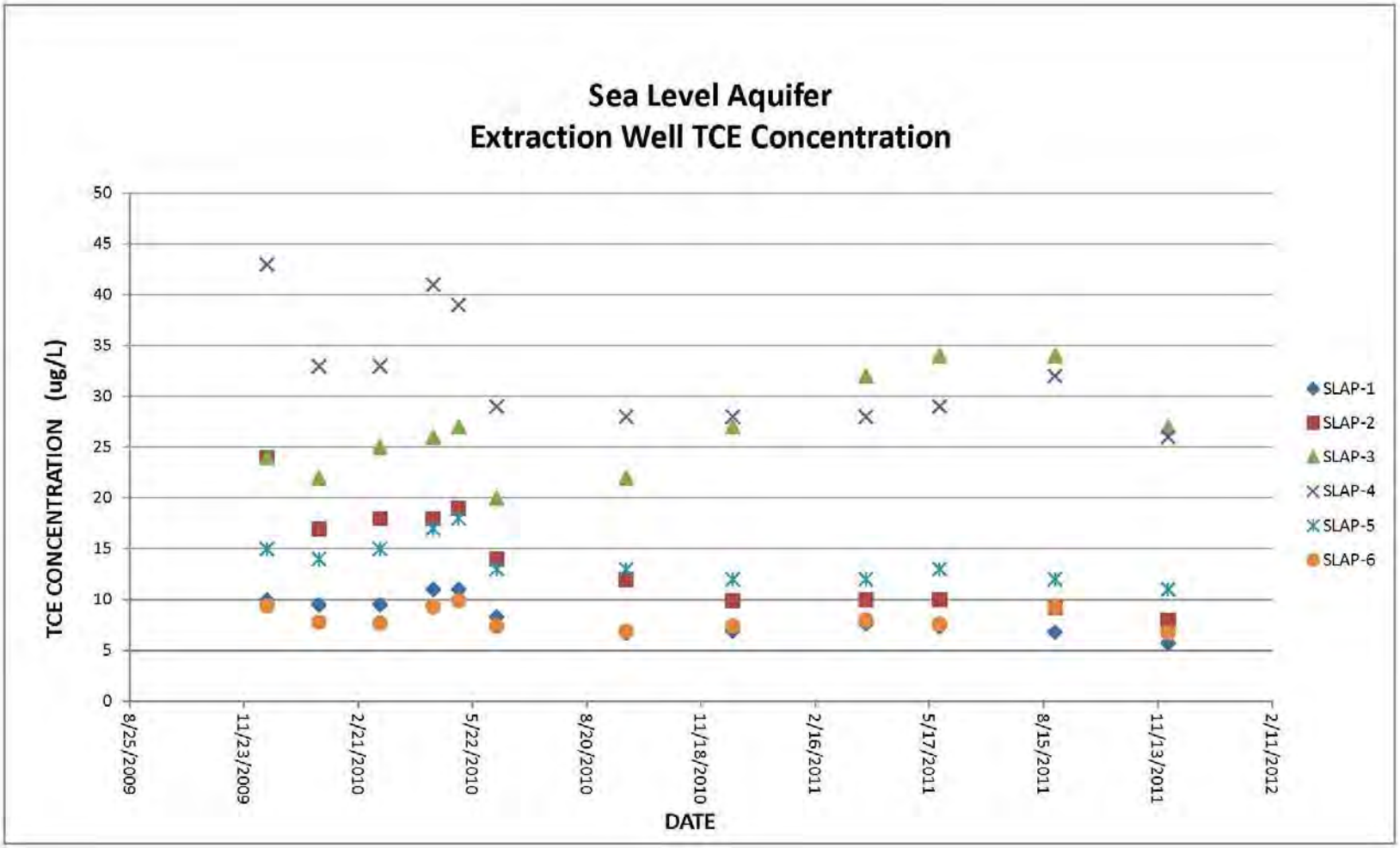


Figure 19 - ALGT System Extraction Well TCE Concentration

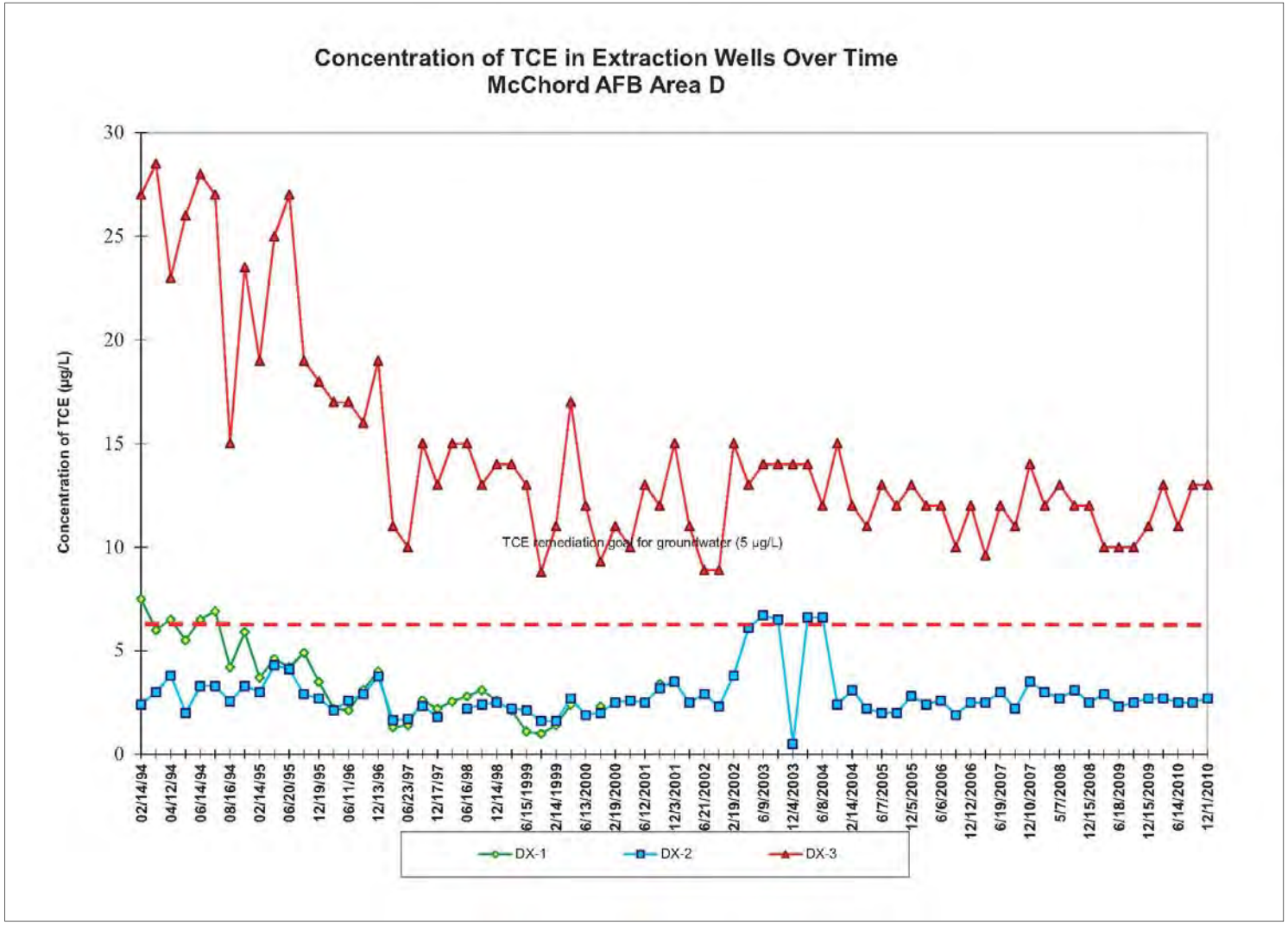


Figure 20 - ALGT System Extraction Well cis 1,2 -DCE Concentration

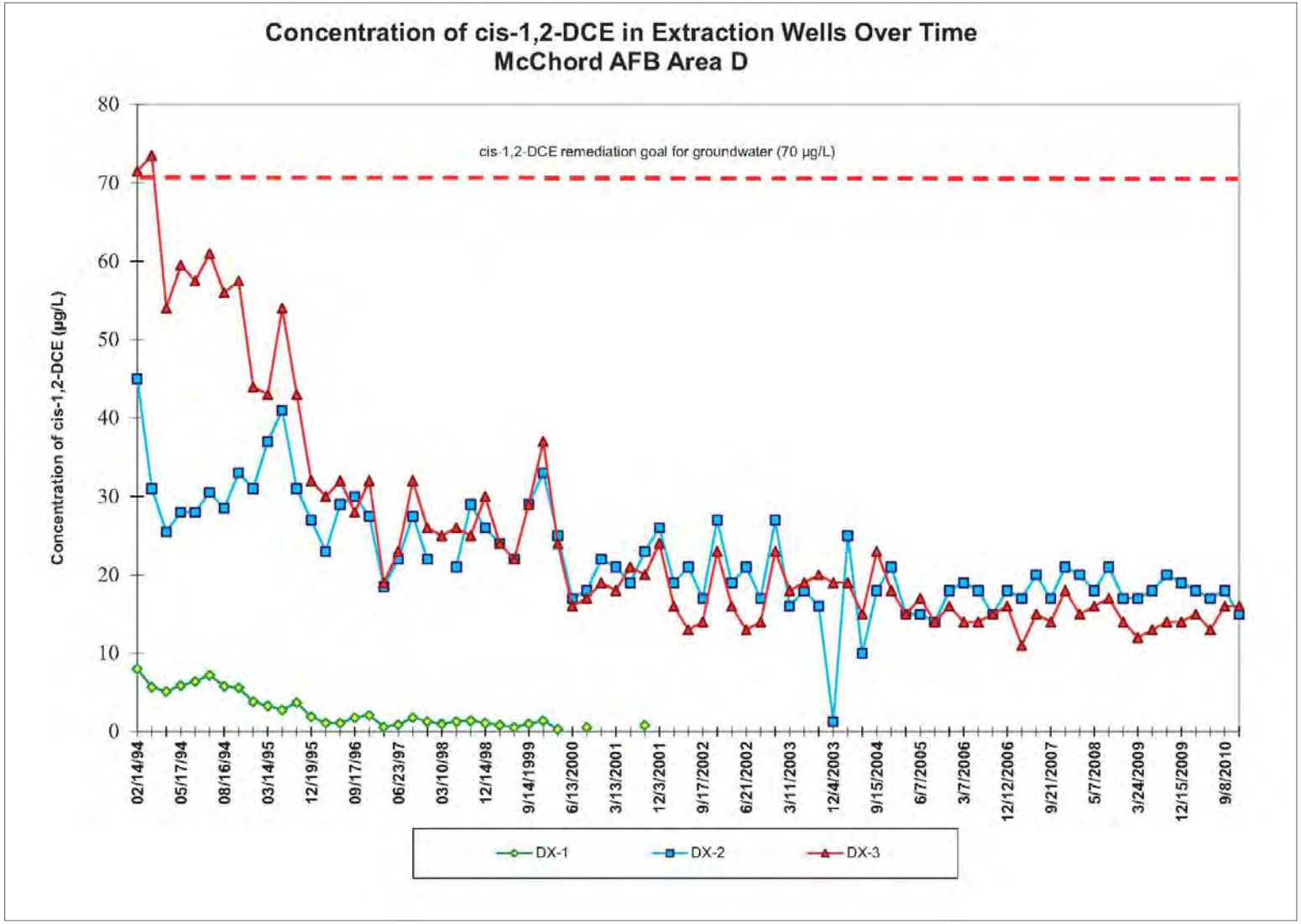


Figure 21 - EGDY, I5, and SLA Influent TCE Concentrations

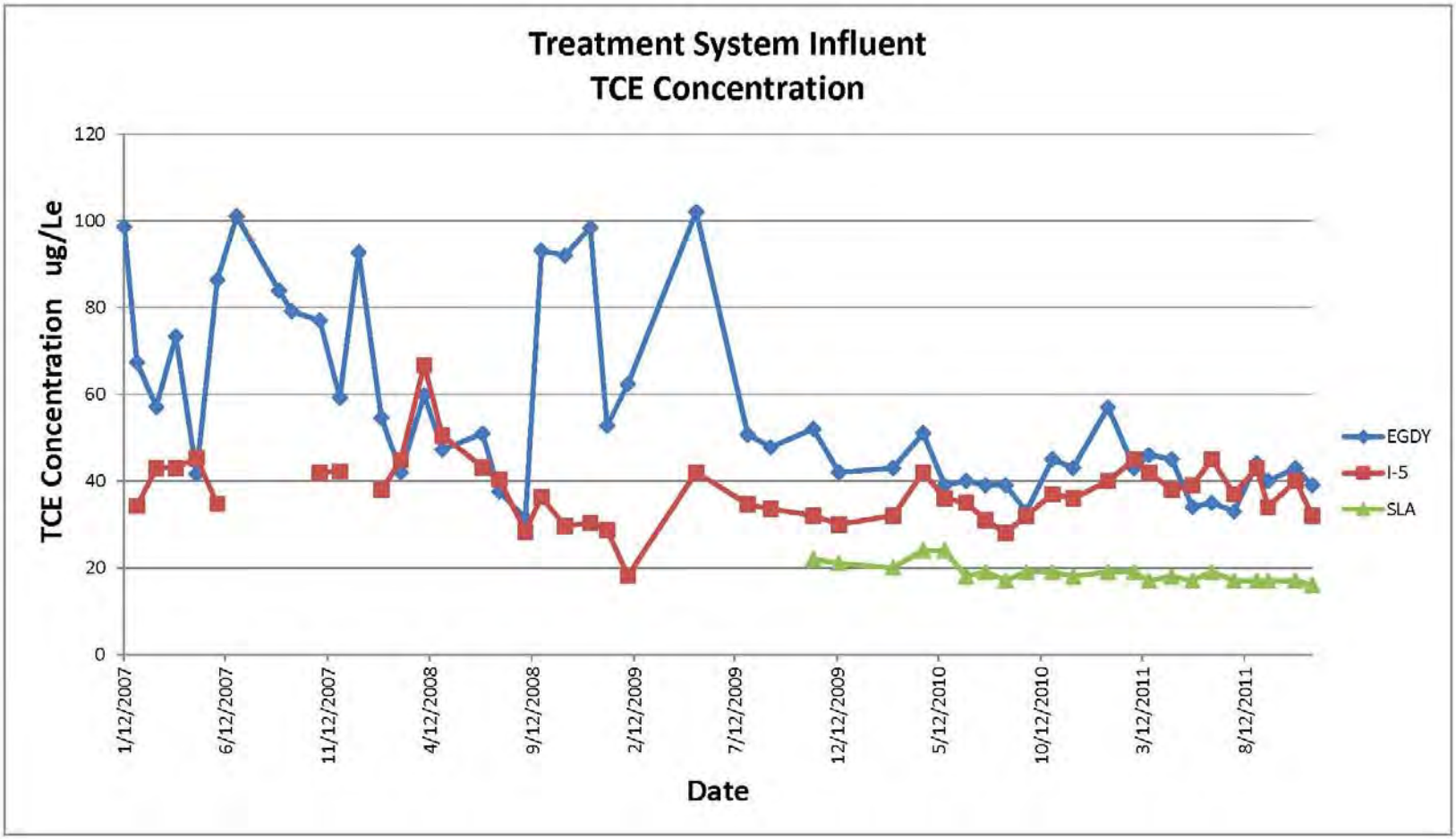


Figure 22 - ALGT Well DX3 Specific Capacity

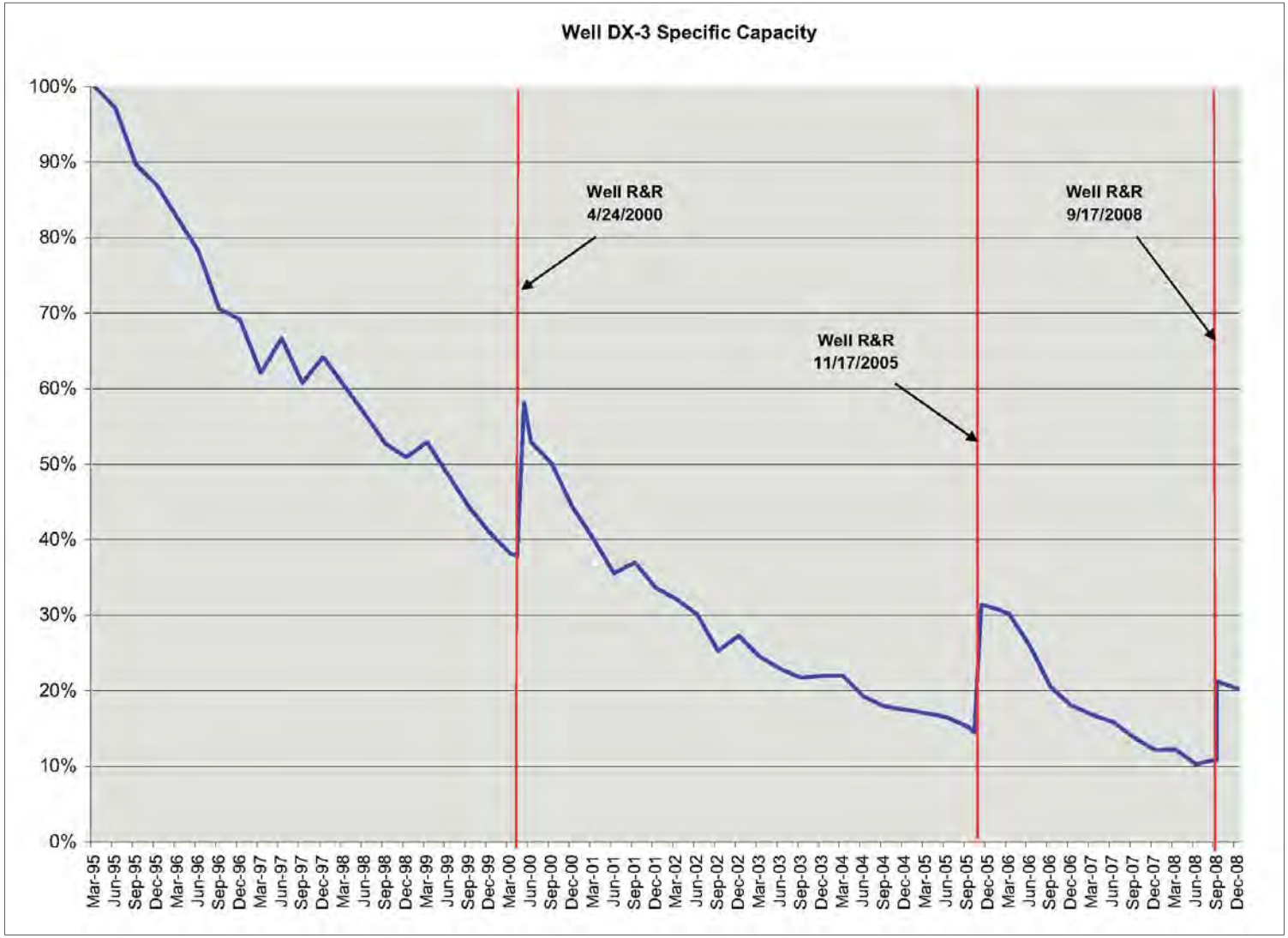


Figure 23-Wet/Dry Season Upper Vashon Aquifer Water Table Contours 2009

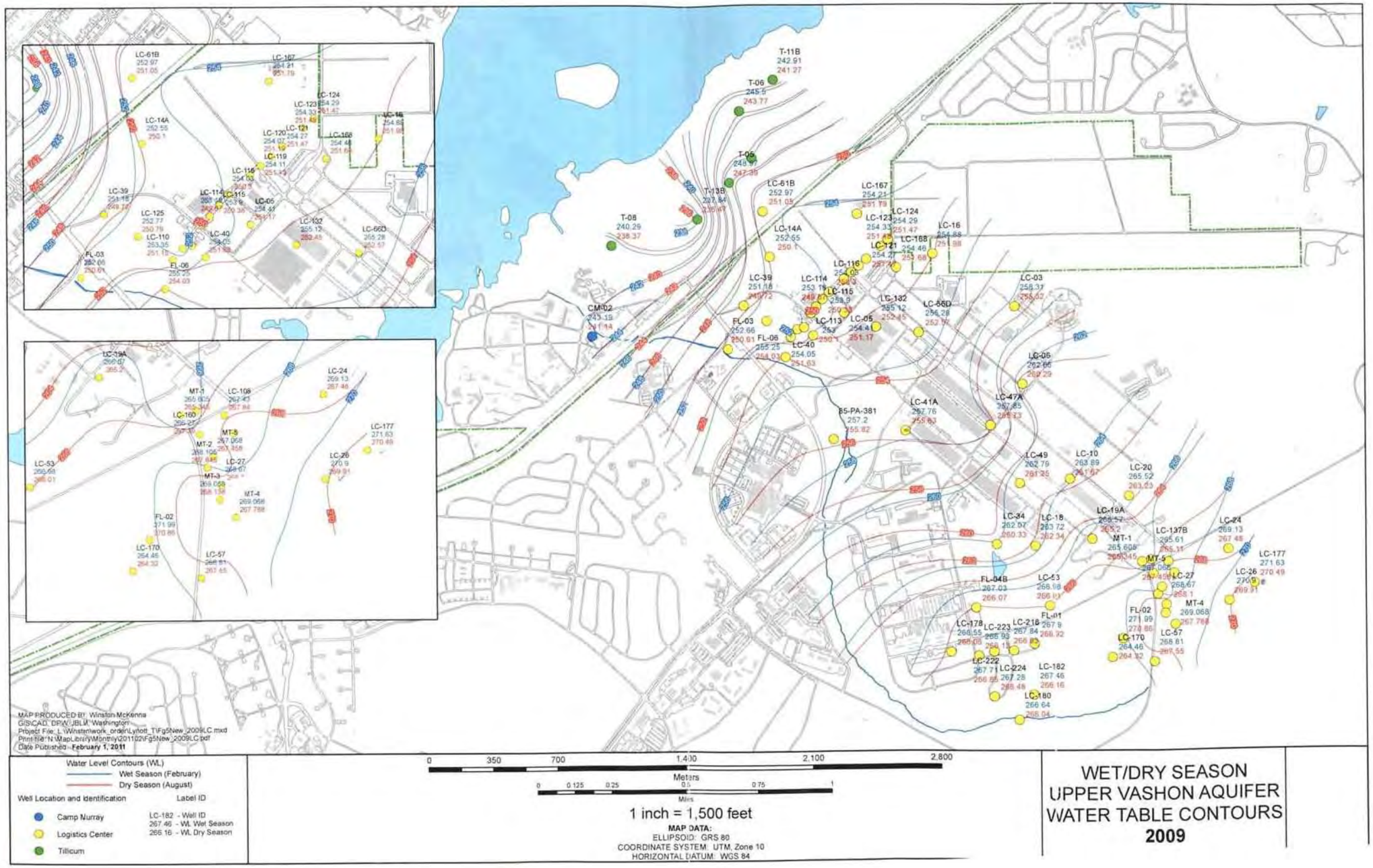


Figure 24 - Upper Vashon Aquifer TCE Plume Map 2009

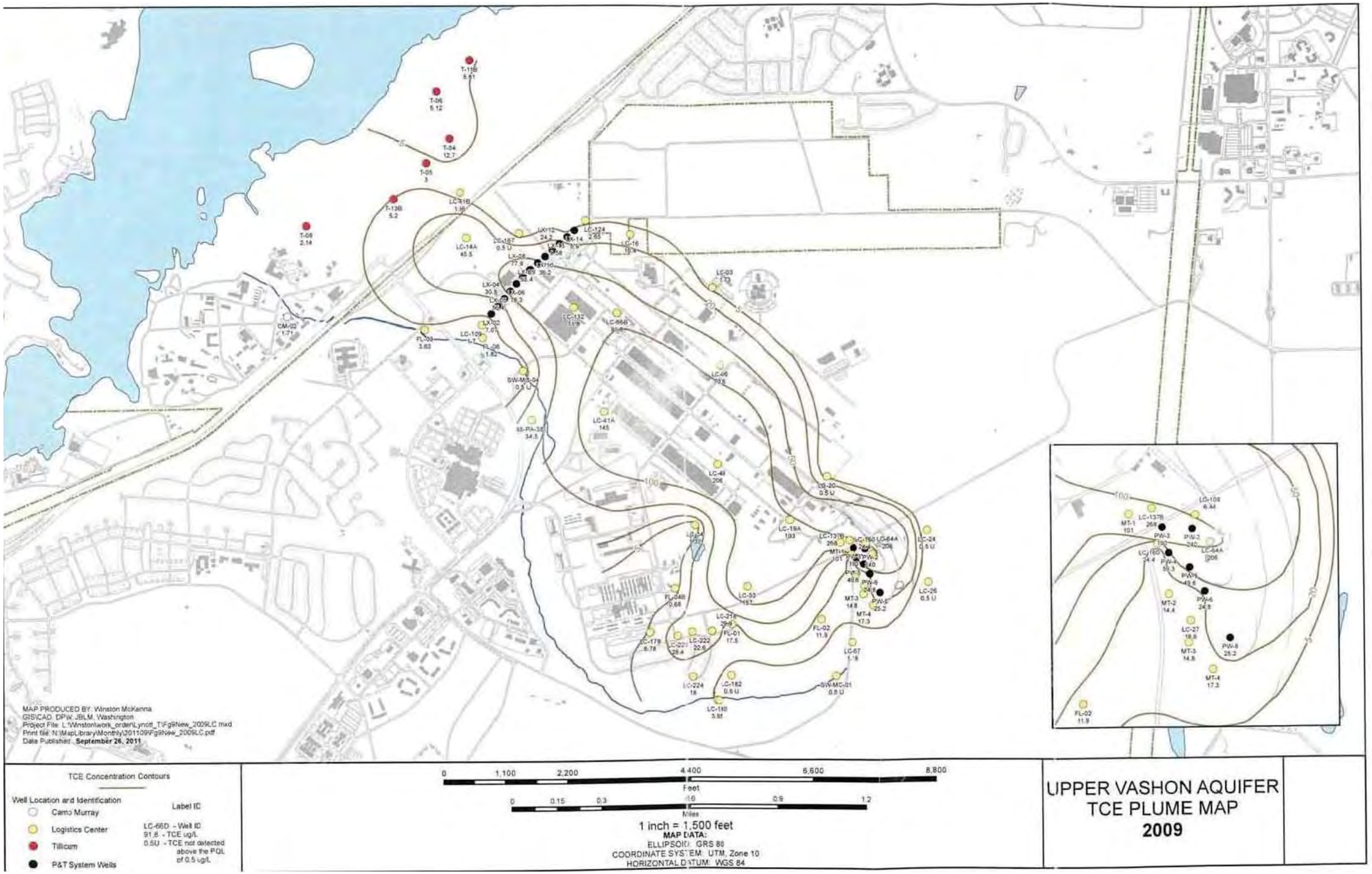


Figure 25 - Lower Vashon Aquifer TCE Plume Map 2009

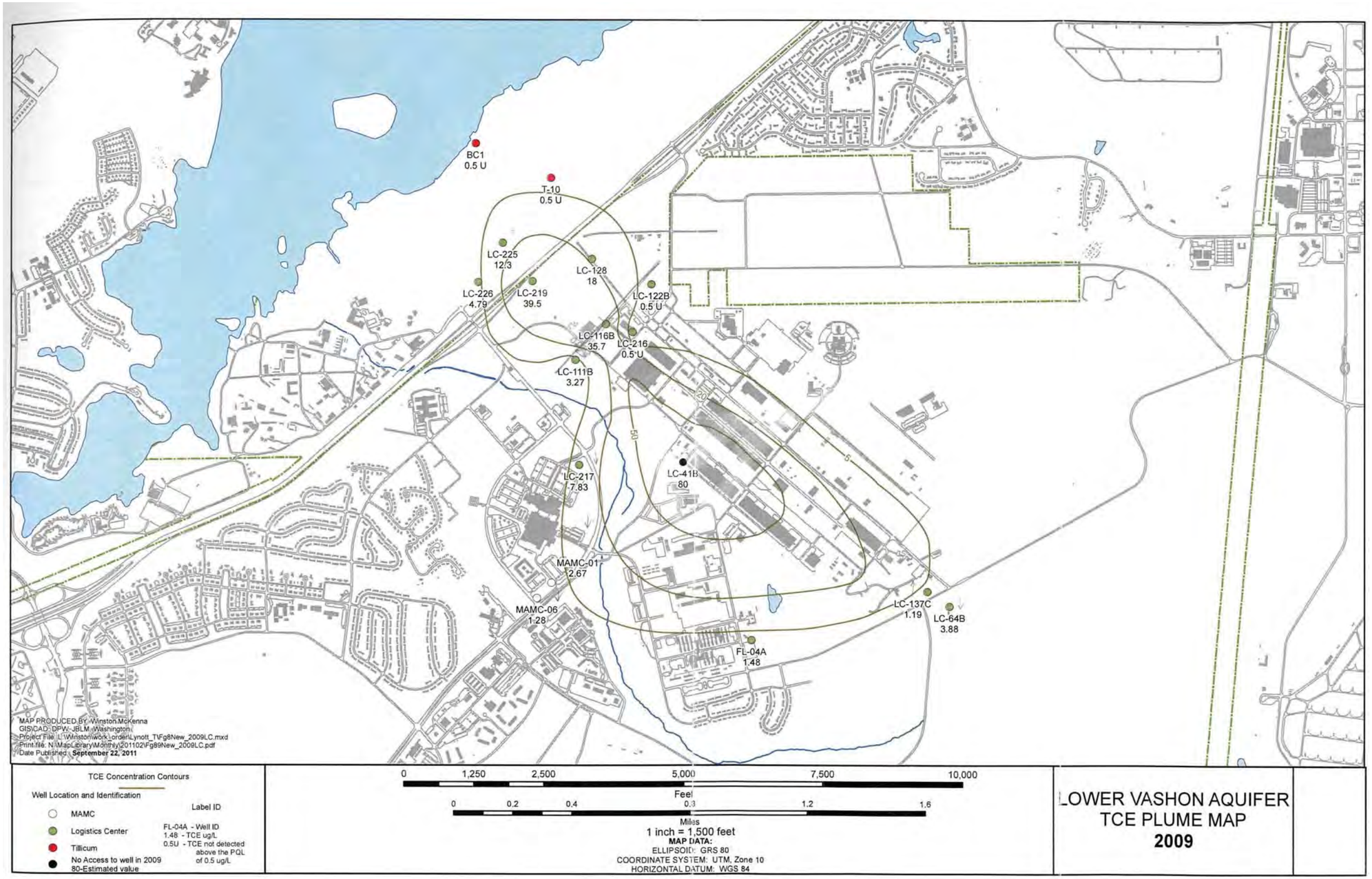


Figure 26 - Wet/Dry Season SLA Water Table Contours 2009

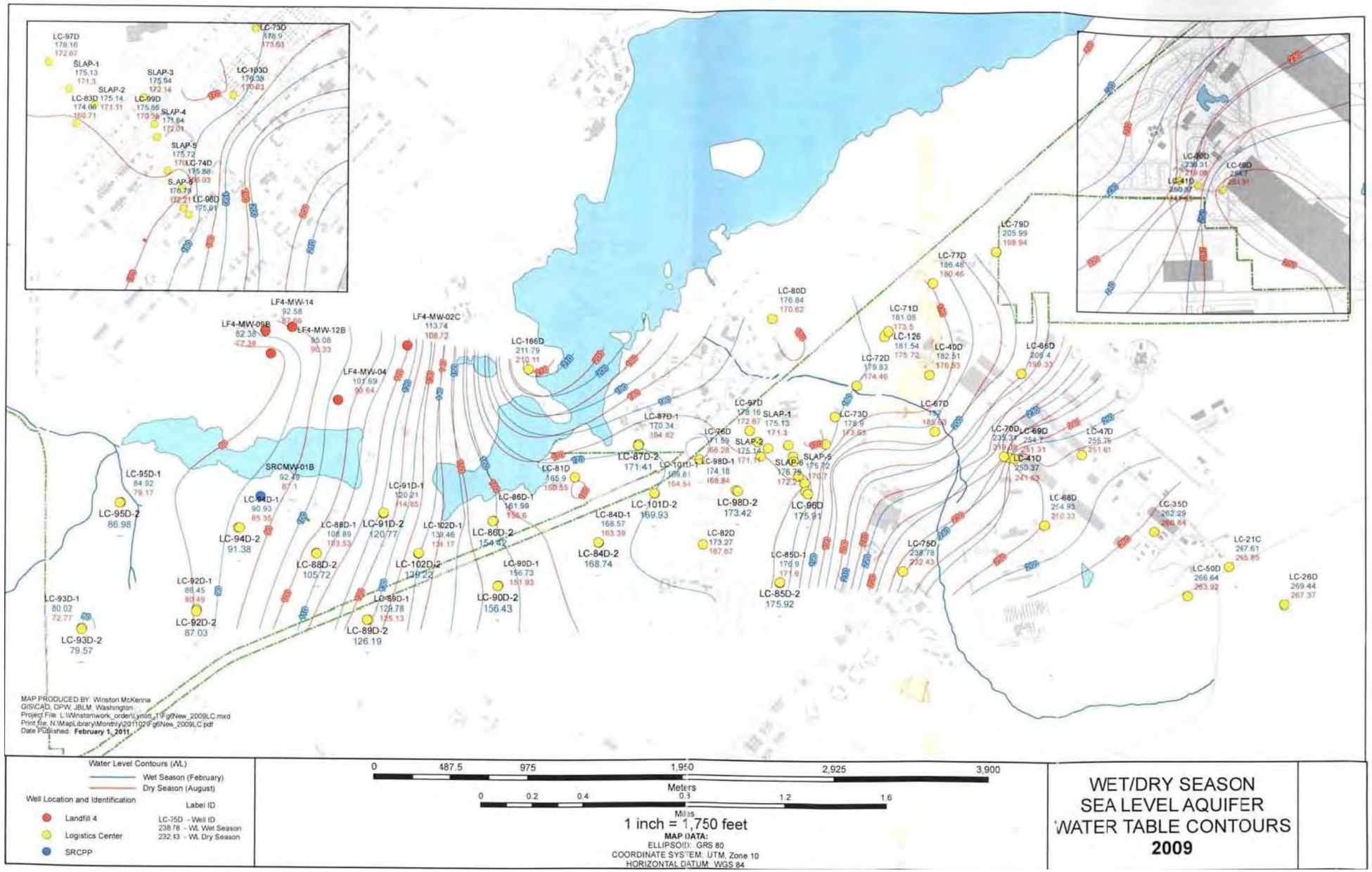


Figure 27 - Sea Level Aquifer TCE Plume Map 2009

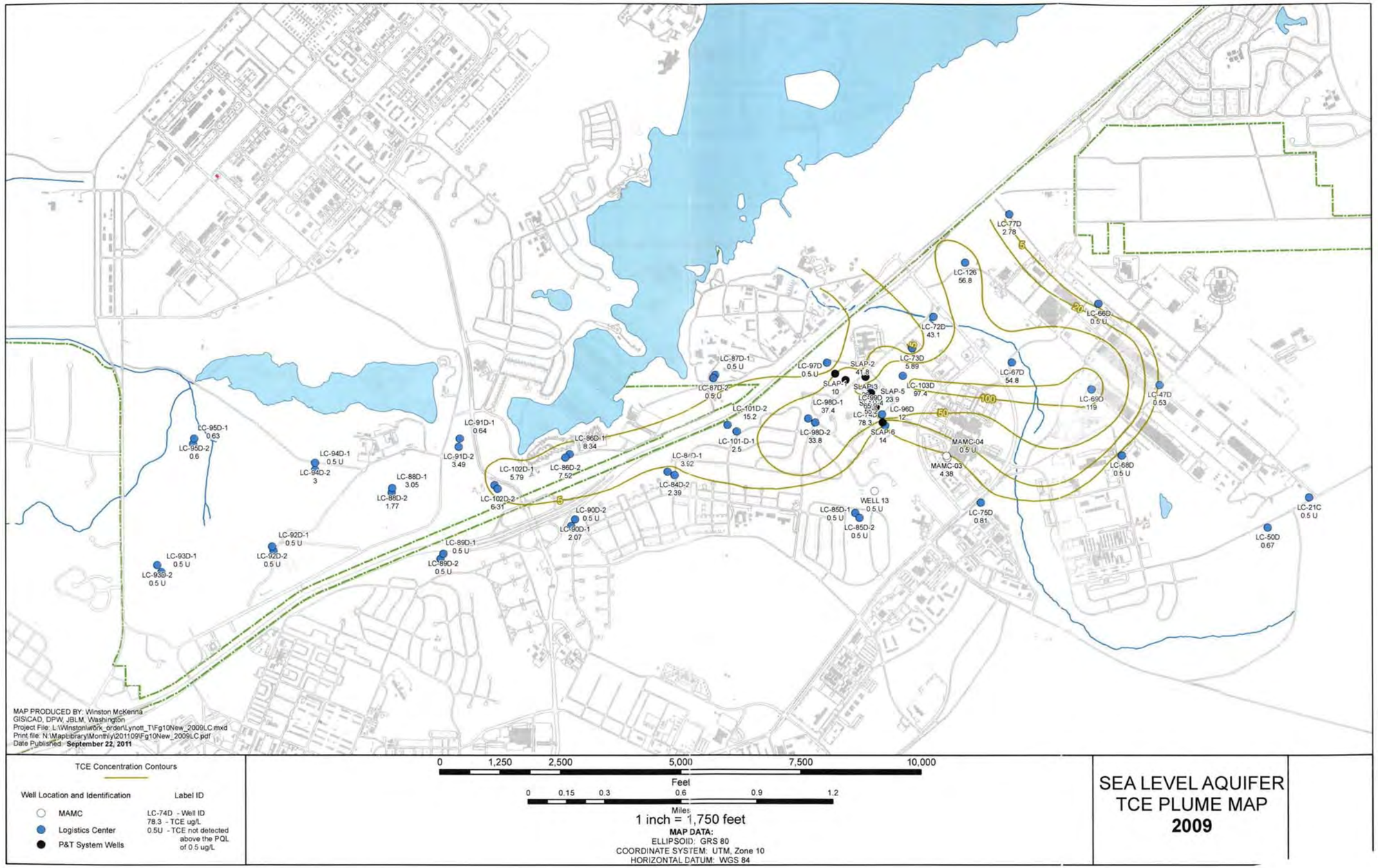


Figure 28 - LF 1 Location

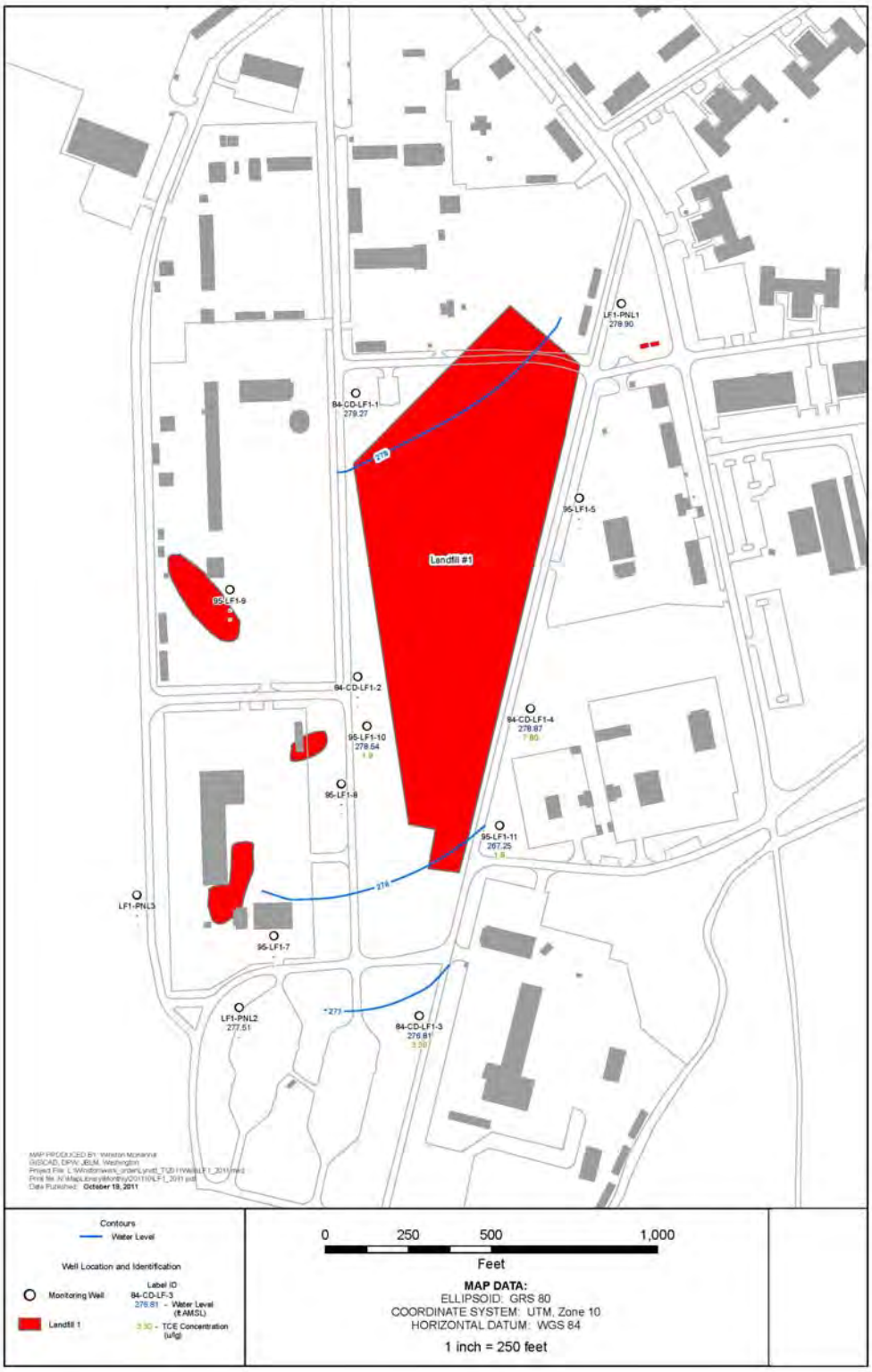


Figure 29 - LF 4 Water Table and TCE Concentration

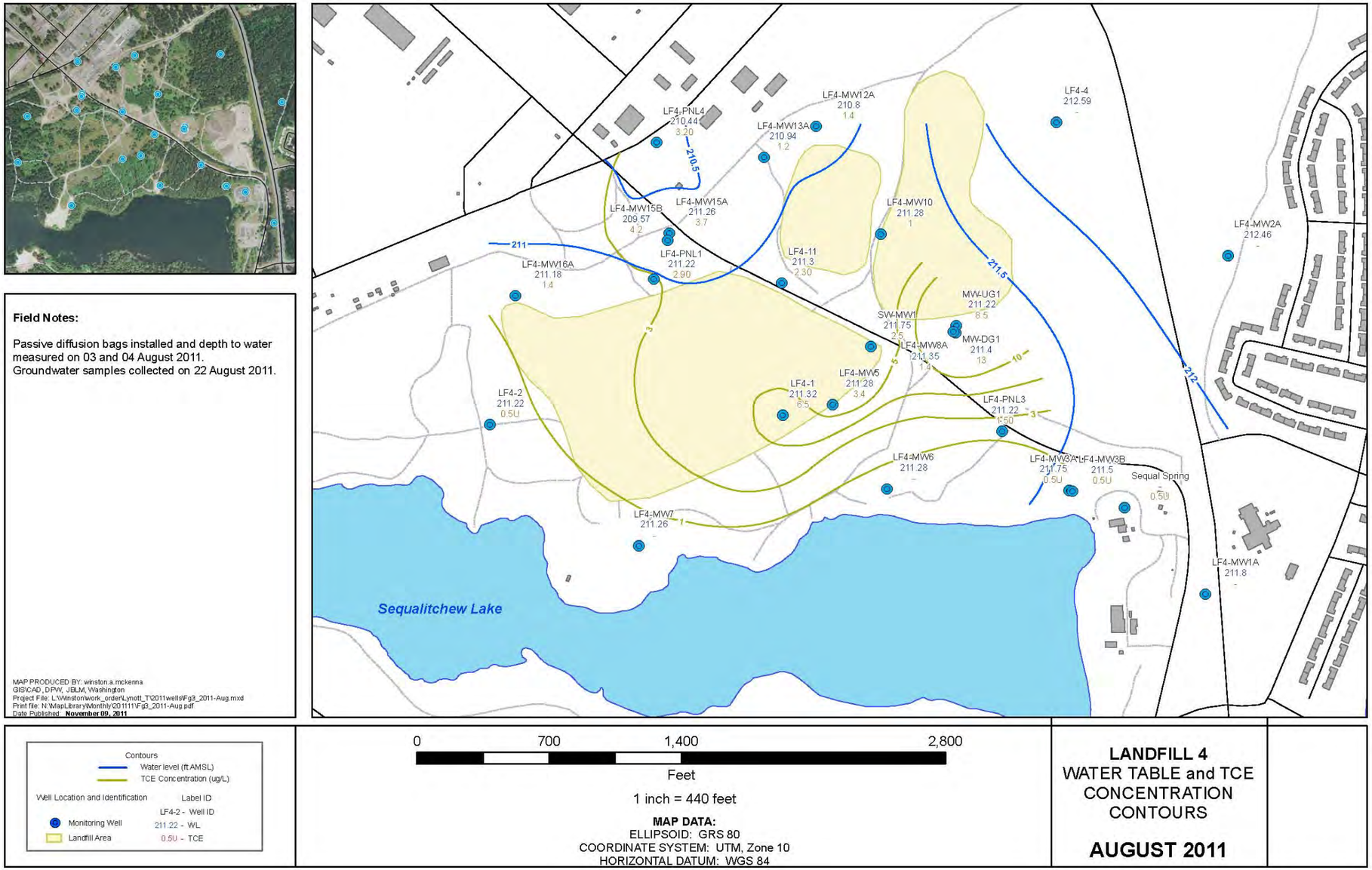


Figure 30 - ALGT TCE Groundwater Plume Evolution

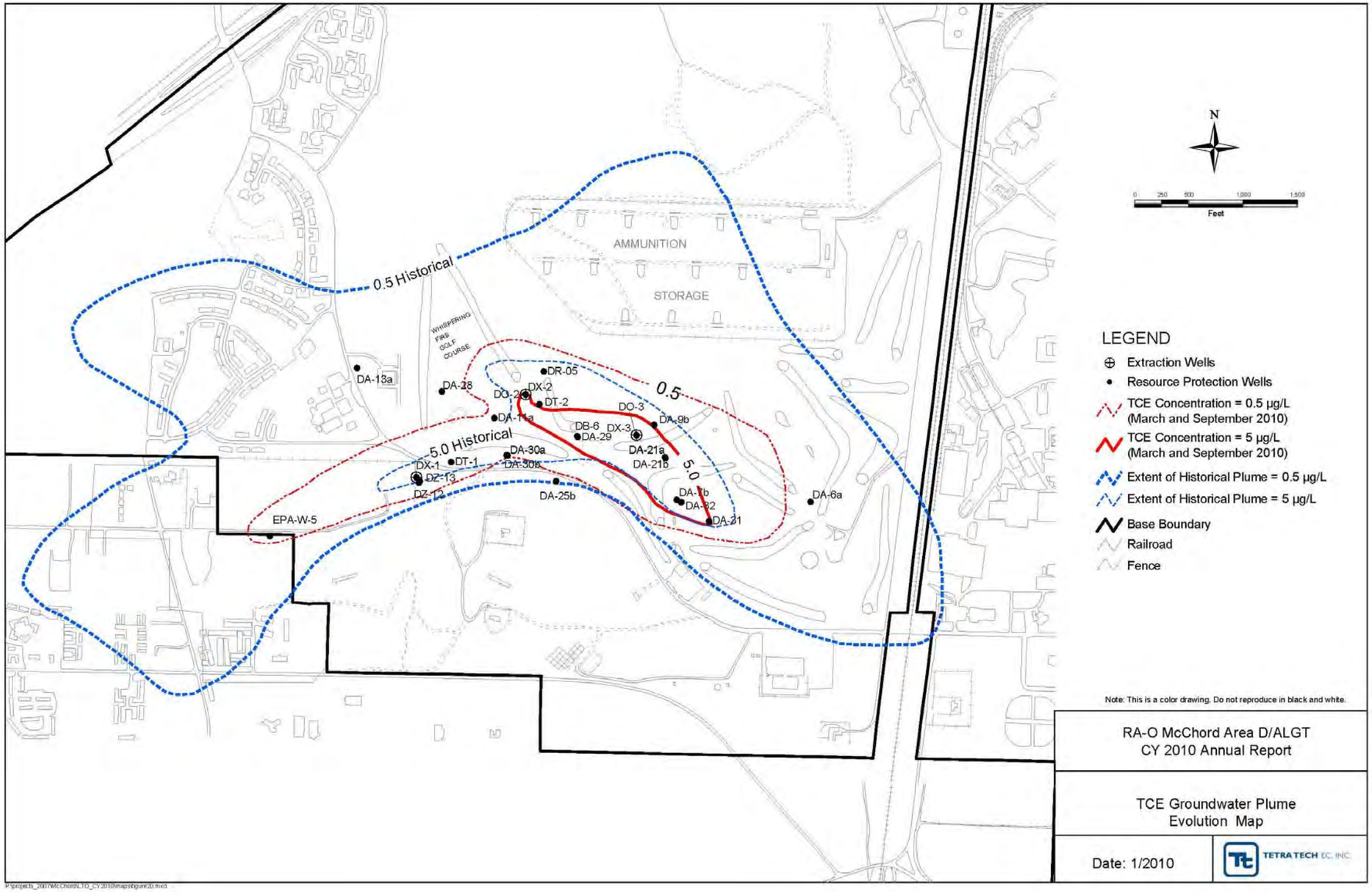


Figure 31 - ALGT cis-1,2-DCE Groundwater Plume Evolution

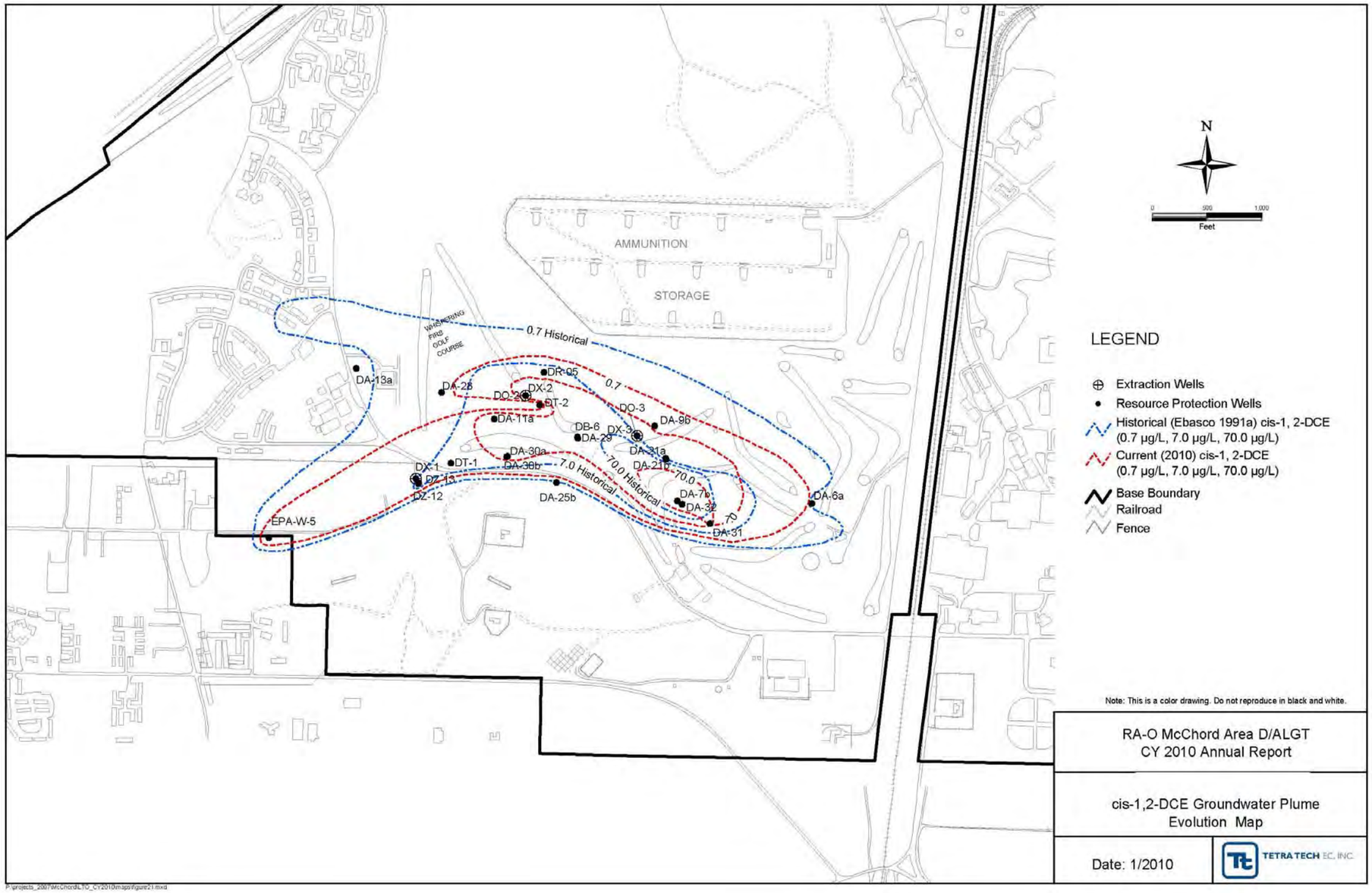


Figure 32 - RAO McChord Area D/ALGT CY 2012 Annual Report

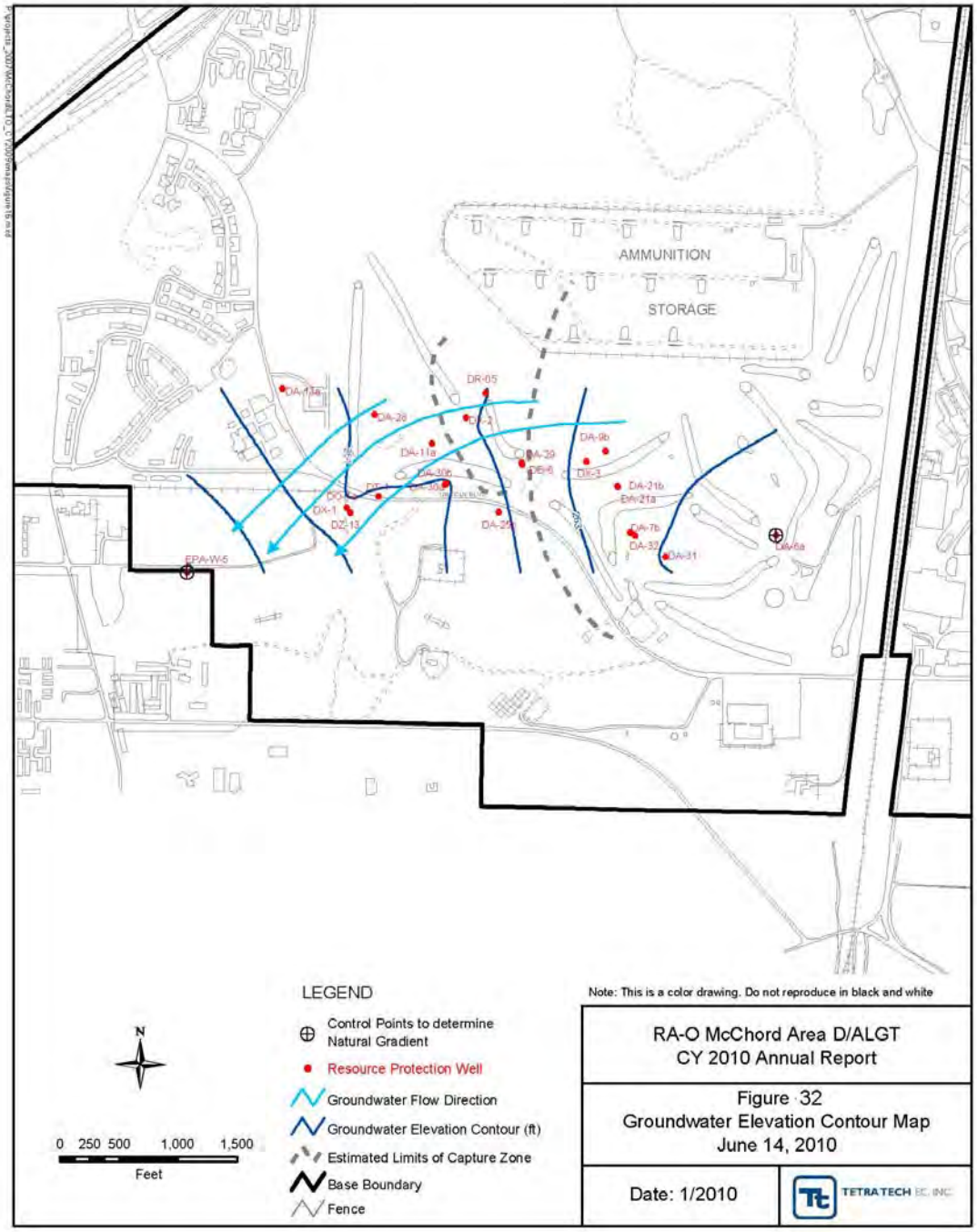
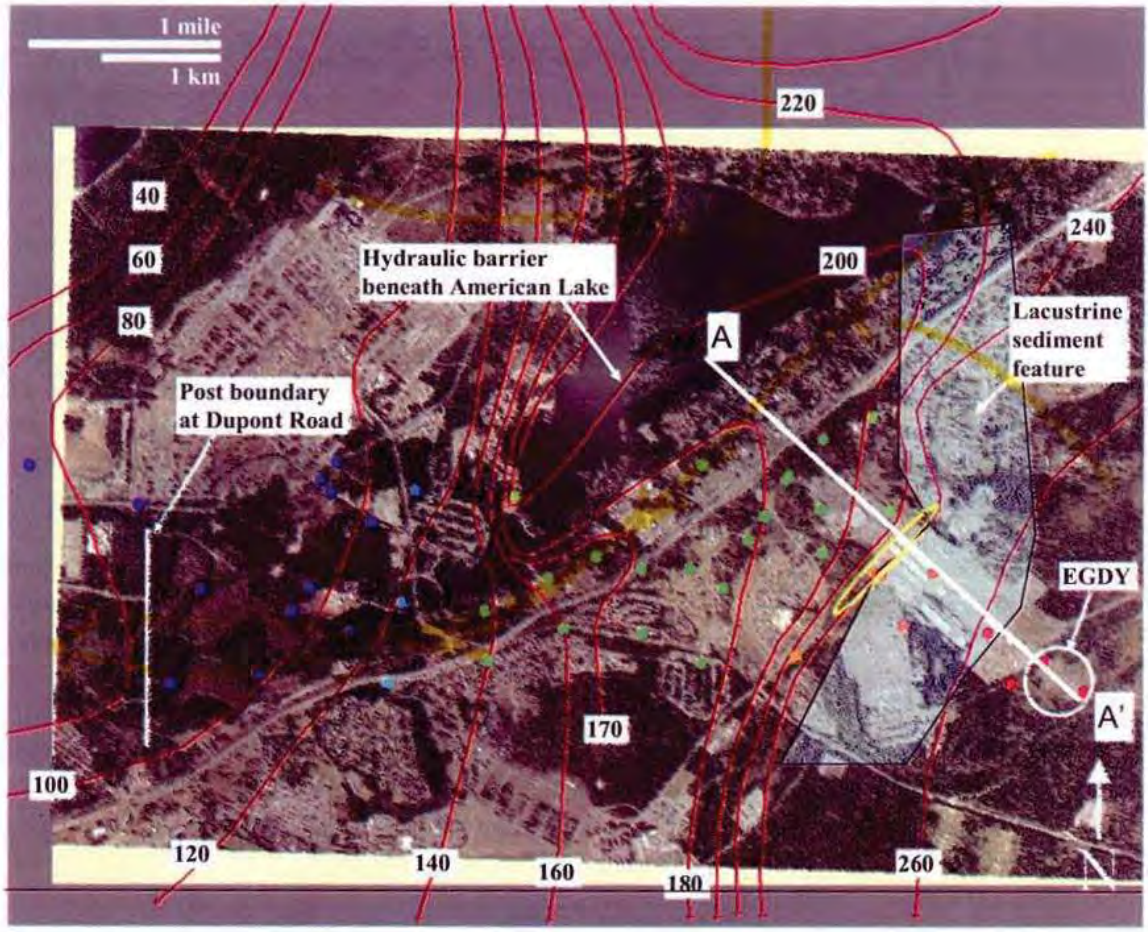


Figure 33 - Qpon Aquitard Window to SLA



Generalized view of hydrologic features in the Sea Level Aquifer between the EGDY and American lake. The shaded area shows the approximate extent of the Lacustrine feature within the SLA. Labeled hydraulic head contours (feet elevation relative to the NGVD29 datum) are from USGS (Dinicola 2005). Dots indicate the location of monitoring wells in the SLA. Red and orange dots show low gradient upgradient of the window where groundwater from the Vashon Aquifer enters the SLA. Transition to green dots shows high gradient near the window. Green dots show the low gradient area upgradient of American Lake where the flow direction changes toward the west. Transition to blue dots shows the high gradient at the end of American Lake where groundwater from the Vashon Aquifer again enters the SLA. Blue dots show the area of low gradient between American Lake and the post boundary.

Appendices

Appendices are contained in the enclosed CD

Appendix A - Groundwater Treatment Systems Extraction Flow Rates
Appendix B - Groundwater Data and Trend Analysis
Appendix C - ARARs and TBC Analysis for JBLM
Appendix D - Documents Reviewed
Appendix E - Site Visit Report
Appendix F - Public Notice
Appendix G - LUC Monitoring Checklist
Appendix H - Vapor Intrusion Study - Madigan Family Housing Area

Appendix A - Groundwater Treatment Systems Extraction Flow Rates

Extraction Well Flow Rates – East Gate System

DATE	WATER FLOW RATES (gpm)								
	PW-1	PW-2	PW-3	PW-4	PW-5	PW-6	PW-7	PW-8	Total
1/31/2007	36	100	30	140	150	155	110	40	759
3/1/2007	35	0[a]	0[a]	0[a]	0[a]	159	109	40	343
3/30/2007	34	0[a]	0[a]	0[a]	0[a]	159	109	40	342
1st Qtr. Avg.	**35**	---	---	---	---	**158**	**109**	**40**	**342**
4/27/2007	34	0[a]	0[a]	0[a]	0[a]	155	110	40	339
5/31/2007	34	99	30	141	151	163	120	40	778
6/28/2007	27	94	28	161	160[b]	164	130	40	804
2nd Qtr. Avg.	**32**	**97**	**29**	**151**	**151**	**161**	**120**	**40**	**780**
7/30/2007	21	89	28	161	161	163	135	35	793
8/27/2007	17	80	28	160	160	157	135	35	772
9/28/2007	16	77	28	160	160	157	134	31	763
3rd Qtr. Avg.	**18**	**82**	**28**	**160**	**160**	**159**	**135**	**34**	**776**
10/31/2007	13	70	28	160	160	158	135	25	749
11/30/2007	0	70	28	159	159	161	133	24	734
12/28/2007	17	70	28	160	159	160	135	25	754
4th Qtr. Avg.	**10**	**70**	**28**	**160**	**159**	**160**	**134**	**25**	**746**
Annual Avg.	**24**	**62**	**21**	**118**	**118**	**159**	**125**	**35**	**661**

[a]Pumps PW-02, PW-03, PW-04, and PW-05 shutdown for performance assesment at Thermal Area #3.

[b]Pump was shut off during weekly inspection to pump out acid wash tank. Pump would not restart initially, but returned to 160 gpm when the pump began running again.

Notes:

Average flow rates are calculated using data taken when pump was running, and are only calculated for periods where the pump was running for the majority of a reporting period.

avg - average
gpm - gallons per minute
"---" - average not calculated

Extraction Well Flow Rates – East Gate System

DATE	WATER FLOW RATES (gpm) from PLC data logger									Total Volumes
	PW-1	PW-2	PW-3	PW-4	PW-5	PW-6	PW-7	PW-8	Total Rates	
12/31/2007	19	69	28	160	160	160	135	25	756	
1/1/2008	20	70	28	160	160	160	135	25	758	
2/1/2008	20	70	28	160	160	160	135	25	758	
3/1/2008	21	70	28	160	160	160	135	24	758	
3/31/2008	--	--	--	--	--	--	--	--	--	
1st Qtr. Avg.	**20**	**70**	**28**	**160**	**160**	**160**	**135**	**25**	**758**	99,328,320
4/1/2008	21	70	28	160	160	160	135	26	760	
5/1/2008	25	80	28	160	160	160	140	23	776	
6/1/2008	21	80	26	160	160	160	140	23	770	
6/30/2008	--	--	--	--	--	--	--	--	--	
2nd Qtr. Avg.	**22**	**77**	**27**	**160**	**160**	**160**	**138**	**24**	**769**	100,726,080
7/7/2008	24	75	24	160	160	160	140	23	766	
8/1/2008	14	74.4	22	160	60	167	138	0	635	
9/7/2008	9	76	24	160	160	160	0	1	590	
9/30/2008	--	--	--	--	--	--	--	--	--	
3rd Qtr. Avg.	**16**	**75**	**23**	**160**	**127**	**162**	**93**	**8**	**664**	87,940,224
10/1/2008	1	75	32	160	160	160	0	1	589	
11/2/2008	1	0	25	161	160	160	0	0	507	
12/1/2008	3	49	26	161	160	160	0	0	559	
12/31/2008	0	74	23	159	160	160	0	45	621	
4th Qtr. Avg.	**1**	**50**	**27**	**160**	**160**	**160**	**0**	**12**	**569**	74,561,760
Annual Avg.	**15**	**50**	**19**	**120**	**112**	**161**	**92**	**17**	**585**	**362,556,384**

Notes:
Unless otherwise indicated, flow readings were retrieved from the PLC data log at the control building.

Extraction Well Flow Rates – Landfill 2 System

	WATER FLOW RATES (gpm) from PLC data logger								
DATE	PW-1	PW-2	PW-3	PW-4	PW-5	PW-6	PW-7	PW-8	Total Rates
1/1/2009	0	75	0	160	160	159	0	44	599
1/2/2009	0	99	0	160	160	160	71	38	688
2/2/2009	0	99	31	160	160	160	71	38	720
3/2/2009	0	86	28	161	160	0	71	38	545
3/31/2009	0	115	0	167	176	171	71	38	738
1st Qtr. Avg.	**0**	**95**	**20**	**160**	**160**	**107**	**71**	**38**	**651**
4/1/2009	0	0	0	168	176	172	71	38	625
5/15/2009	0	5	88	167	177	0	71	38	545
6/26/2009	0	116	0	166	177	0	71	38	568
6/30/2009	0	55	0	165	177	0	71	38	--
2nd Qtr. Avg.	**0**	**40**	**29**	**167**	**177**	**57**	**71**	**38**	**580**
7/1/2009									
7/24/2009	0	52	20	165	174	170	0	26	608
8/31/2009	0	50	20	164	173	169	0	25	601
9/2/2009	0	50	20	164	173	169	0	25	601
9/30/2009	0	49	20	164	173	170	0	25	601
3rd Qtr. Avg.	**0**	**51**	**20**	**165**	**173**	**169**	**0**	**25**	**603**
10/2/2009	0	49	20	164	173	170	0	25	601
10/15/2009	0	48	20	163	173	170	0	25	599
11/12/2009	0	49	20	162	173	170	0	25	600
12/26/2009	0	50	20	159	174	171	0	25	598
12/31/2009	0	50	20	159	174	171	0	25	598
1/1/2010	0	50	20	159	174	171	0	25	598
4th Qtr. Avg.	**0**	**49**	**20**	**161**	**173**	**170**	**0**	**25**	**599**
Annual Avg.	**0**	**59**	**22**	**163**	**171**	**126**	**35**	**32**	**608**
Annual Volumes		**30,777,558**	**11,716,452**	**85,832,442**	**89,843,765**	**66,299,466**	**18,476,118**	**16,708,470**	**319,654,271**

Notes:
Unless otherwise indicated, flow readings were read from the the data logged at the PLC in the control building.
Average flow calculated using data taken during pump operation, and only calculated for periods of pump operation for the majority of a reporting period.
PW-1 and PW-7 were off for much of year due to mechanical and control failure.
avg - average
gpm - gallons per minute
"---" - average not calculated

Extraction Well Flow Rates – LF-2 System

DATE	WATER FLOW RATES (gpm)									VOLUMES
	PW-1	PW-2	PW-3	PW-4	PW-5	PW-6	PW-7	PW-8	Total	
12/31/2009	0								0	
1/7/2010	0	51	20	158	175	171	0	25	600	
1/15/2010	0	55	20	159	176	171	0	25	606	
1/22/2010	0	54	20	158	176	171	0	25	604	
2/5/2010	0	53	20	158	175	172	0	25	603	
2/12/2010	0	53	20	158	175	172	0	25	602	
2/26/2010	0	54	20	158	175	172	0	25	605	
3/5/2010	0	55	20	158	175	172	0	25	604	
3/19/2010	0	61	20	158	175	171	10	25	619	
3/26/2010	0	20	20	157	171	171	9	25	574	
3/31/2010	*0*	*20*	*20*	*157*	*171*	*171*	*9*	*25*	*574*	
1st Qtr. Avg. Rate (gpm)	**0**	**47**	**20**	**158**	**174**	**171**	**3**	**25**	**545**	78,432,624
4/1/2010	*0*	*70*	*20*	*157*	*175*	*172*	*9*	*25*	*627*	
4/2/2010	0	70	20	157	175	172	9	25	627	
4/15/2010	0	71	20	157	175	172	0	25	618	
4/30/2010	0	69	20	157	174	167	66	25	678	
5/7/2010	15	67	20	156	173	167	66	25	690	
5/14/2010	15	67	20	156	173	167	67	25	689	
5/21/2010	35	64	20	154	173	163	110	25	744	
5/28/2010	32	64	20	153	172	163	111	25	741	
6/4/2010	34	66	20	154	173	164	111	25	746	
6/11/2010	37	65	20	153	173	164	110	25	746	
6/18/2010	36	66	20	153	173	164	111	25	748	
6/25/2010	37	71	20	152	173	163	111	25	751	
6/30/2010	*37*	*71*	*20*	*152*	*173*	*163*	*111*	*25*	*751*	
2nd Qtr. Avg. Rate (gpm)	**21**	**68**	**20**	**154**	**173**	**166**	**76**	**25**	**704**	97,736,184
7/1/2010	33	71	20	152	173	163	111	25	748	
7/8/2010	30	71	20	150	172	163	111	25	743	
7/16/2010	31	72	20		173	173	111	25	603	
7/23/2010	28	71	20	150	173	163	111	25	740	
7/30/2010	28	70	20	149	172	163	110	25	738	
8/6/2010	25	70	20	149	172	163	110	25	734	
8/13/2010	24	70	20	148	172	163	109	25	731	
8/20/2010	23	69	25	147	172	163	109	25	734	
8/23/2010	22	69	20	147	173	164	109	25	729	
8/27/2010	22	69	20	148	173	163	109	25	729	
9/2/2010	20	55	17	147	172	164	109	22	705	
9/10/2010	19	54	17	146	172	164	109	22	702	
9/17/2010	18	54	17	145	172	164	109	22	701	
9/20/2010	20	55	17	145	172	163	109	25	705	
9/24/2010	17	54	17	144	171	164	109	25	701	
9/30/2010	*17*	*54*	*17*	*144*	*171*	*164*	*109*	*25*	*701*	
3rd Qtr. Avg. Rate (gpm)	**24**	**65**	**19**	**147**	**172**	**164**	**110**	**24**	**715**	92,966,515
10/1/2010	17	54	17	143	172	164	109	25	701	
10/8/2010	16	53	17	143	172	163	109	22	694	
10/15/2010	16	53	17	143	172	164	108	22	695	
10/22/2010	15	53	17	142	172	164	109	22	694	
10/29/2010	16	55	17	144	172	164	109	22	698	
11/5/2010	18	61	17	143	172	164	109	22	705	
11/15/2010	19	60	17	142	172	164	109	22	705	
11/19/2010	21	63	17	142	173	163	109	22	711	
11/24/2010	22	66	17	1442	173	163	110	22	2015	
11/26/2010	22	65	17	141	173	163	110	22	714	
12/3/2010	21	66	17	140	173	163	110	22	711	
12/10/2010	22	66	17	140	173	163	110	21	713	
12/17/2010	44	78	17	140	174	164	111	22	750	
12/21/2010	42	66	20	140	174	164	111	22	738	
12/31/2010	39	66	20	140	174	164	111	22	736	
4th Qtr. Avg. Rate (gpm)	**23**	**62**	**17**	**228**	**173**	**163**	**109**	**22**	**799**	94,240,973
Annual Avg. Rate (GPM)	**17**	**60**	**19**	**172**	**173**	**166**	**75**	**24**	**691**	**363,376,296**
Annual Volumes (gal)	**9,007,248**	**31,768,826**	**10,045,731**	**90,473,050**	**91,008,516**	**87,357,110**	**39,382,447**	**12,680,207**	**--**	**371,723,136**

Notes:
Unless otherwise indicated, flow readings were read directly from the local display at each magmeter or from instantaneous readings at the PLC display in the control building.
Average flow rates are calculated using data taken when pump was running, and are only calculated for periods of pump operation for the majority of a reporting period.
avg - average
gpm - gallons per minute
"--" - average not calculated
PW-1 and PW-7 were off due to mechanical and control system failures. PW-7 was replaced on 1 March 2010. PW-1 was replaced on 2 March 2010.

Extraction Well Flow Rates – I-5 System

DATE	WATER FLOW RATES (gpm)															
	LX-1	LX-2	LX-3	LX-4	LX-5	LX-6	LX-7	LX-8	LX-9	LX-10	LX-11	LX-12	LX-13	LX-14	LX-15	Total
1/31/2007	152	69	0	159	120	51	160	0	151	148	147	156	15	148	100	1576
3/1/2007	150	69	0	163	120	50	160	0	150	148	147	157	15	148	89	1566
3/29/2007	0	75	0	168	125	52	162	0	153	149	149	159	15	150	85	1442
1st Qtr. Avg.	**101**	**71**	**0**	**163**	**122**	**51**	**161**	**0**	**151**	**148**	**148**	**157**	**15**	**149**	**91**	**1528**
4/27/2007	0	72	0	163	124	50	160	0	152	147	148	157	13	149	81	1416
5/31/2007	0	70	0	162	124	49	158	0	152	145	148	156	13	148	76	1401
6/28/07[a]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2nd Qtr. Avg.	**0**	**47**	**0**	**108**	**83**	**33**	**106**	**0**	**101**	**97**	**99**	**104**	**9**	**99**	**52**	**939**
7/30/2007	0[b]	72	130[c]	0[d]	122	119	143	162	151	0[e]	149	166	29	149	0[b]	1262
8/27/2007	0[b]	69	130[c]	0[d]	121	118	140	159	147	156	146	161	29	147	0[b]	1393
9/28/2007	0[b]	0	130[c]	0[d]	121	119	143	162	152	0	145	159	29	149	0[b]	1179
3rd Qtr. Avg.	**0**	**47**	**130**	**0**	**0**	**119**	**142**	**161**	**150**	**52**	**147**	**162**	**29**	**148**	**0**	**1287**
10/31/2007	0[b]	70	0[f]	0[d]	120	119	0[f]	164	152	160	148	0[f]	29	153	0[b]	1115
11/30/2007	0[b]	67	130[c]	0[d]	116	117	138	159	145	154	138	160	28	147	0[b]	1369
12/28/2007	0[b]	84	130[c]	0[d]	116	118	140	161	148	156	140	163	29	148	0[b]	1403
4th Qtr. Avg.	**0**	**74**	**130**	**0**	**117**	**118**	**93**	**161**	**148**	**157**	**142**	**108**	**29**	**149**	**0**	**1426**
Annual Avg.	**---**	**60**	**65**	**68**	**80**	**80**	**125**	**54**	**138**	**114**	**134**	**133**	**20**	**136**	**36**	**1243**

[a]Pumps off for I-5 extraction well pump upgrade.

[b]Pumps at LX-1 and LX-15 shut off following modeling analysis which indicated that these two perimeter pumps could be turned off with no adverse affect to overall system performance.

[c]Pump is running but flowmeter needs a new battery. Flow rate is estimated.

[d]Pump off due to leak at top seal of the dischage line.

[e]Pump off for indeterminate cause or length of time. No pertaining logbook entries.

[f]LX-3, LX-7, and LX-12 off for pump repair.

Notes:

Average flow rates are calculated using data taken when pump was running.

No averages calculated for pumps which are down for the majority of a reporting period.

avg - average gpm = gallons per minute

Extraction Well Flow Rates – I-5 System

DATE	WATER FLOW RATES (gpm)																
	LX-1[a]	LX-2	LX-3	LX-4	LX-5	LX-6	LX-7	LX-8	LX-9	LX-10	LX-11	LX-12	LX-13	LX-14	LX-15[a]	Total	# Days
12/31/2007	--	–	–	--	–	–	--	–	–	--	–	–	--	–	–	–	
2/8/2008	0	83	--	0	115	118	144	0	152	158	141	165	28	150	--	**1,254**	
2/28/2008	0	83	--	0	116	118	144	0	149	159	141	166	28	150	--	**1,254**	
3/28/2008	0	82	--	0	114	118	143	0	147	158	140	164	27	149	--	**1,242**	
3/31/2008	--	–	–	--	–	–	--	–	–	--	–	–	--	–	–	–	
1st Qtr. Avg.	**0**	**83**	**0**	**0**	**115**	**118**	**144**	**0**	**149**	**158**	**141**	**165**	**28**	**150**	**0**	**1,250**	91
4/1/2008	--	–	–	--	–	–	--	–	–	--	–	–	--	–	–	–	
5/1/2008	0	83	130[b]	0	113	118	143	164	0	158	140	163	29	147	0	**1,258**	
6/4/2008	0	83	83	163	0	118	0	146	152	156	139	161	28	146	0	**1,375**	
6/30/2008	0	83	130[b]	163	0	118	0	144	151	157	138	161	28	144	0	**1,287**	
2nd Qtr. Avg.	**0**	**83**	**83**	**109**	**38**	**118**	**48**	**151**	**101**	**157**	**139**	**162**	**28**	**146**	**0**	**1,307**	91
7/1/2008	--	–	–	--	–	–	--	–	–	--	–	–	--	–	–	–	
7/11/2008	0	83	130[b]	161	0	117	0	142	149	155	139	160	27	143	0	**1,276**	
8/1/2008	0	83	130[b]	163	0	118	0	143	154	0	140	162	27	145	0	**1,135**	
8/29/2008	0	83	130[b]	163	0	0[e]	0[d]	140	150	155	137	159	26	143	0	**1,156**	
9/26/2008	0	83	130[b]	162	0	118	0[d]	141	0	160	0	164	27	145	0	**1,000**	
9/30/2008	--	–	–	--	–	–	--	–	–	--	–	–	--	–	–	–	
3rd Qtr. Avg.	**0**	**83**	**130**	**162**	**0**	**118**	**0**	**142**	**113**	**118**	**104**	**161**	**27**	**144**	**0**	**1,142**	91
10/1/2008	--	–	–	--	–	–	--	–	–	--	–	–	--	–	–	–	
10/31/2008	0	82	130[b]	159	0	0[e]	0[d]	135	149	154	138	158	26	139	0	**1,140**	
11/21/2007	0	84	130[b]	159	0	118[c]	0[d]	135	151	155	141	161	27	159	0	**1,172**	
12/8/2008	0	83	130[b]	160	0	118[c]	0[f]	134	152	156	140	160	26	139	0	**1,150**	
1/2/2009	0	0[f]	0[f]	160	0[f]	0[f]	0[f]	135	0[f]	158	143	164	26	140	0	**926**	
1/1/2009	--	–	–	--	–	–	--	–	–	--	–	–	--	–	–	–	
4th Qtr. Avg.	**0**	**83**	**43**	**160**	**0**	**59**	**0**	**135**	**151**	**156**	**141**	**161**	**26**	**144**	**0**	**1,097**	92
Annual Avg.	**0**	**77**	**65**	**108**	**38**	**103**	**48**	**98**	**116**	**147**	**131**	**162**	**27**	**146**	**0**	**1,265**	**365**

Annual Flow (gallons/yr) **665,035,335**

Notes:

Average flow rates are calculated using data taken when pump was running.

No averages calculated for pumps which are down for the majority of a reporting period.

avg - average gpm = gallons per minute

gpm - gallons per minute

[a]Pumps at LX-1 and LX-15 were shut off in 2007 following modeling analysis indicated that these two perimeter pumps could be turned off with no adverse effect on plume interception.

[b]Pump was operating but flowmeter was not functioning. Flow rate is estimated based on pump discharge pressure and operating history.

[c]Pump off due to leak at top seal of the discharge line and/or broken ell at well head.

[d]Pump off for indeterminate cause or length of time. No pertaining logbook entries.

[f]LX-2,LX-3, LX-7, and LX-12 off for pump repair and mechanical upgrades project.

Extraction Well Flow Rates – I-5 System

DATE	WATER FLOW RATES (gpm)															
	LX-1[a]	LX-2[a]	LX-3[b]	LX-4	LX-5[b]	LX-6[c]	LX-7[c]	LX-8	LX-9[a]	LX-10[a]	LX-11	LX-12	LX-13[f]	LX-14	LX-15[a]	Total
1/2/2009	0	0[f]	120	160	115	0[f]	0[f]	135	0[f]	158	143	164	26	140	0	1,161
1/9/2009	0	0	120	162	115	119	0	136	0	160	143	165	27	141	0	1,288
1/16/2009	0	0	120	163	115	120	0	136	0	161	144	166	26	141	0	1,292
1/23/2009	0	85	120	164	115	0	0	0	0	0	147	171	27	144	0	973
1/30/2009	0	85	120	164	115	0	0	0	0	0	147	171	27	144	0	973
2/6/2009	0	85	120	162	115	0	152	0	0	0	146	170	27	143	0	1,120
2/13/2009	0	84	120	160	115	0	149	0	0	0	144	168	27	142	0	1,109
2/20/2009	0	84	120	159	115	118	145	135	154	0	142	165	26	139	0	1,502
2/27/2009	0	105	120	157	115	118	143	143	152	0	141	163	34	139	0	1,530
3/6/2009	0	105	120	159	117	118	146	147	157	163	151	165	0	0	0	1,548
3/16/2009	0	105	120	158	117	118	144	144	153	159	143	166	0	0	0	1,527
3/27/2009	0	103	120	155	117	117	142	141	150	156	140	160	34	140	0	1,675
1st Qtr. Avg.	**0**	**76**	**120**	**160**	**116**	**75**	**93**	**93**	**70**	**80**	**144**	**166**	**23**	**118**	**0**	**1308**
4/3/2009	0	70	120	155	117	117	141	140	149	155	140	156	28	141	0	1,629
4/17/2009	0	68	120	156	117	118	142	140	149	150	141	68	0	156	0	1,525
5/8/2009	0	67	120	157	117	118	143	138	150	156	141	158	0	145	0	1,610
5/29/2009	0	77	120	156	117	117	143	131	149	155	141	157	0	144	0	1,607
6/5/2009	0	77	120	156	117	117	142	125	149	155	141	157	0	143	0	1,599
6/11/2009	0	78	120	156	117	117	142	119	149	154	140	157	0	143	0	1,592
6/26/2009	0	78	120	157	117	117	142	109	149	155	141	157	0	142	0	1,584
2nd Qtr. Avg.	**0**	**74**	**120**	**156**	**117**	**117**	**142**	**129**	**149**	**155**	**141**	**148**	**3**	**146**	**0**	**1597**
7/31/2009	0	82	120	160	117	118	161	119	125	155	162	155	0	145	0	1,619
8/14/2009	0	81	120	159	117	117	157	121	122	153	166	155	0	143	0	1,611
8/21/2009	0	81	120	158	117	117	156	121	122	153	165	155	0	143	0	1,608
9/3/2009	0	81	120	158	117	117	156	119	121	152	161	154	0	143	0	1,599
9/30/2009	0	69	120	159	117	117	155	111	122	153	155	154	0	142	0	1,574
3rd Qtr. Avg.	**0**	**78**	**120**	**159**	**117**	**117**	**157**	**118**	**122**	**153**	**161**	**154**	**0**	**143**	**0**	**1,598**
10/9/2009	0	0	120	0	117	117	155	106	121	152	152	154	0	141	0	1,335
10/23/2009	0	0	120	0	117	117	156	98	122	154	148	156	0	141	0	1,329
11/6/2009	0	0	120	0	117	117	156	92	122	154	149	155	0	141	0	1,323
11/27/2009	0	76	120	0	117	117	157	97	123	155	176	157	0	141	0	1,436
12/11/2009	0	76	120	0	117	0	159	99	125	157	178	159	0	142	0	1,332
12/29/2009	0	79	120	162	117	0	158	101	123	157	177	158	0	141	0	1,493
4th Qtr. Avg.	**0**	**45**	**120**	**16**	**117**	**82**	**157**	**98**	**123**	**155**	**166**	**157**	**0**	**141**	**0**	**1,375**
Annual Avg.	**0**	**68**	**120**	**123**	**117**	**98**	**137**	**109**	**116**	**136**	**153**	**156**	**7**	**137**	**0**	**1,470**

Notes:

Average flow rates are calculated using data taken when pump was running.

No averages calculated for pumps which are down for the majority of a reporting period.

avg - average

gpm - gallons per minute

[a] Pumps at LX-1 and LX-15 were shut off in 2007 following modeling analysis indicated that these two perimeter pumps could be turned off with no adverse effect on plume interception.

[b] Pump was operating but flowmeter was not functioning. Flow rate is estimated based on pump discharge pressure and operating history.

[c] Pump off due to leak at top seal of the discharge line and/or broken ell at well head.

[d] LX-2,LX-3, LX-7, and LX-12 off for pump repair, control system failure and mechanical upgrades project.

[e] LX-13 pump failed in April 2009 and off for remainder of year.

Extraction Well Flow Rates – I-5 System

DATE	WATER FLOW RATES (gpm)															
	LX-1[a]	LX-2	LX-3[b,g]	LX-4	LX-5[b]	LX-6[c]	LX-7[c]	LX-8	LX-9[e]	LX-10[e]	LX-11	LX-12	LX-13[f]	LX-14	LX-15[a]	Total
12/29/2009	0	79	*126*	162	117	0	158	101	123	157	177	158	0	141	0	**1,493**
12/31/2009	0	79	*126*	162	117	0	158	101	123	157	177	158	0	141	0	**1,493**
1/1/2010	0	80	*126*	164	*0*	0	160	121	126	159	175	159	0	144	0	**1,414**
1/22/2010	0	80	*126*	164	*0*	0	160	121	126	159	175	159	0	144	0	**1,414**
1/30/2010	*0*	80	*126*	164	*0*	0	160	121	126	159	175	159	0	144	*0*	***1,414***
2/26/2010	0	0	*0*	0	0	0	0	0	0	0	0	0	0	0	0	***0***
2/27/2010	*0*	*81*	*126*	*164*	*0*	*0*	*159*	*121*	*126*	*157*	*175*	*158*	*0*	*144*	*0*	***1,411***
3/4/2010	*0*	*81*	*126*	*164*	*0*	*0*	*159*	*121*	*126*	*157*	*175*	*158*	*0*	*144*	*0*	***1,425***
3/31/2010	*0*	*81*	*126*	*164*	*0*	*0*	*159*	*121*	*126*	*157*	*175*	*158*	*0*	*144*	*0*	***1411***
1st Qtr. Avg.	**0**	**71**	**112**	**145**	**26**	**0**	**141**	**103**	**111**	**140**	**156**	**141**	**0**	**127**	**0**	**1275**
4/1/2010	*0*	*81*	*126*	*163*	*0*	*0*	*159*	*121*	*126*	*157*	*175*	*158*	*0*	*144*	*0*	***1420***
4/9/2010	0	81	*126*	163	0	0	159	127	127	158	178	160	0	147	0	**1,426**
4/20/2010	0	81	*126*	162	*0*	0	159	124	126	158	175	158	0	146	0	**1,415**
5/14/2010	0	81	*126*	162	*0*	0	161	116	127	158	175	158	0	145	0	**1,409**
6/23/2010	0	81	*127*	160	115	0	158	93	126	156	174	156	30	138	0	**1,514**
6/30/2010	*0*	*81*	*127*	*160*	*115*	*0*	*0*	*69*	*126*	*156*	*174*	*156*	*14*	*136*	*0*	***1314***
2nd Qtr. Avg.	**0**	**81**	**126**	**161**	**46**	**0**	**127**	**106**	**126**	**157**	**175**	**158**	**9**	**142**	**0**	**1180**
7/1/2010	*0*	*80*	*127*	*162*	*115*	*0*	*0*	*69*	*126*	*156*	*174*	*158*	*14*	*136*	*0*	***1420***
7/23/2010	0	80	126	162	115	0	0	69	130	158	175	158	14	136	0	**1,323**
8/20/2010	0	82	134	164	0	0	0	71	131	161	179	0	14	139	0	**1,075**
9/21/2010	0	80	120	161	115	0	0	70	131	160	169	0	14	143	0	**1,163**
9/30/2010	*0*	*80*	*120*	*161*	*115*	*0*	*0*	*0*	*128*	*154*	*166*	*0*	*14*	*139*	*0*	***1420***
3rd Qtr. Avg.	**0**	**81**	**125**	**162**	**86**	**0**	**0**	**53**	**130**	**158**	**172**	**40**	**14**	**139**	**0**	**830**
10/1/2010	*0*	*80*	*120*	*158*	*110*	*0*	*0*	*0*	*128*	*154*	*166*	*0*	*13*	*139*	*0*	***1,420***
10/29/2010	0	80	113	158	110	157	0	0	128	154	166	116	13	140	0	**1,335**
11/26/2010	0	84	114	158	109	158	134	0	126	152	165	145	16	138	0	**1,499**
12/21/2010	0	84	0	161	109	160	136	0	126	153	166	153	15	137	0	**1,400**
12/31/2010	0	84	0	160	108	159	135	0	126	153	166	153	15	135	0	**1,394**
4th Qtr. Avg.	**0**	**82**	**69**	**159**	**109**	**127**	**81**	**0**	**127**	**153**	**166**	**113**	**14**	**138**	**0**	**783**
Annual Avg.	**0**	**79**	**108**	**157**	**67**	**32**	**87**	**65**	**124**	**152**	**167**	**113**	**9**	**137**	**0**	**1,017**

Notes:

Unless otherwise indicated, average flow rates are calculated using real time data collected at local flow meter.

avg - average

No averages calculated for pumps which are down for the majority of a reporting period.

gpm - gallons per minute

aPumps at LX-1 and LX-15 were shut off in 2007 following modeling analysis indicating that these two perimeter pumps could be turned off with no adverse effect on plume interception.

[b]Pump was operating but flowmeter was not functioning. Flow rate is estimated based on pump discharge pressure and operating history.

[c]LX-3 flow meter did not function until replaced in June 2010. Pump motor malfunctioned in early December 2010.

[d]LX-2,LX-3, LX-7, and LX-12 off for pump repair, control system failure and mechanical upgrades project.

[e]LX-13 pump failed in April 2009 and replaced on 3 March 2010.

LX-5 flow meter not indicating. Repaired by replacing relay at Control Building Panel on 20 June 2010.

Seal and shaft failure on air stripper blower. System down for blower repair and sump cleanout from 30 January until repaired on 26 February 2010.

LX-6 was off due to motor heater failure from 9/26/10 to 10/27/10.

LX-7 was off due to motor failure from 6/28/10 to 10/28/10.

LX-6, LX-7, LX-12 pumps replaced and started on 10/28/10.

LX-8 motor failure in late September 2010.

Average flow rates are calculated using data taken when pump was running.

Extraction Well Flow Rates – Sea Level Aquifer Pump and Treat System

DATE	WATER FLOW RATES (gpm)							Comments
	SLAP-1	SLAP-2	SLAP-3	SLAP-4	SLAP-5	SLAP-6	Total	
11-Jan-10	0	0	0	0	0	0	0	System Off
21-Jan-10	151	149	300	423	449	200	1671	
18-Feb-10	0	0	0	0	0	0	0	System Off
21-Feb-10	0	0	0	0	0	0	0	System Off
21-Mar-10	0	0	0	0	0	0	0	System Off
2-Apr-10	0	0	0	0	0	0	0	System Off
21-Apr-10	201	124	274	423	548	199	1769	
11-May-10	201	124	250	424	499	200	1699	
11-Jun-10	-	-	-	-	-	-	-	No data
11-Jul-10	-	-	-	-	-	-	-	No data
22-Aug-10	201	124	231	425	422	199	1600	
24-Sep-10	201	124	262	424	448	199	1659	
22-Oct-10	201	124	232	423	449	199	1629	
24-Nov-10	201	124	424	449	449	199	1846	
13-Dec-10	201	124	184	424	449	199	1581	
Average Rate (gpm)	**120**	**78**	**166**	**263**	**286**	**123**	**1035**	

Notes:

Unless otherwise indicated, flow readings were read directly from the local display at each magmeter.
Average flow rates are calculated using data taken when pump was running and are not
average flows for the entire period.
avg - average
gpm - gallons per minute
"---" - average not calculated
PW-1 and PW-7 were off due to mechanical and control system failures. PW-7 was replaced on 1 March 2010. PW-1 was replaced on 2 March 2010.

Appendix B - Groundwater Data and Trend Analysis

Statistical Analysis of Groundwater Trends

Groundwater trends were evaluated in selected monitoring wells at both McChord ALGT Area D wells, Log Center, Landfill 1 and Landfill 4 at Fort Lewis. As the installation is already performing a significant amount of statistical evaluation, it wasn't necessary to evaluate many wells outside of those currently being monitored for trends. JBLM staff use primarily linear regression analysis of the TCE data in a substantial number of wells at the Logistic Center and also at LF 4. The groundwater monitoring contractor for ALGT also performs an evaluation of the trends. This review includes the installation's scatter plots with linear regression lines, confidence intervals and prediction intervals drawn. Also included are selected wells where the installation is currently not performing that analysis within the Logistics Center, ALGT and LF 1 wells. JBLM staff compare the *p* value against the α values to determine the statistical significance of the trend. This is a reasonable approach. A brief discussion of their approach to evaluating trends is provided in their 2009 GW Monitoring Report (Versar, 2011).

Data evaluation includes data between the dates of 2002 and Sep 2011.

For the reader, in order to determine whether or not the observed relationship between the changes in contaminant concentrations over time is statistically significant, several statistical parameters need to be discussed:

Slope (b_1): Slope is the slant of the regression line. The regression line is a best fit line that statistically represents the change in contaminant concentrations that occurs over time.

Coefficient p-values (*p*): The coefficient value for P (p-value) indicates whether or not the associations between the changes in contaminant concentration over time are significantly significant. If the p-value is smaller than the α-level selected, the association is statistically significant. A commonly used α-level is 0.05 (95% confidence level) so if the p-value is less than 0.05 then the equation is statistically significant.

Prediction intervals (PI): The prediction intervals illustrate the range of likely values for new observations (values for contaminant concentrations). They represent a series of prediction intervals that span the range of observed values (known contaminant concentrations from sampling and analysis).

Confidence intervals (CI): Confidence intervals area used to indicate the reliability of an estimate. How likely the interval is to contain the parameter is determined by the confidence level or confidence coefficient.

A confidence interval is always qualified by a particular confidence level, usually expressed as a percentage; for example a "95% confidence interval" was used to evaluate most of the JBLM groundwater data. The end points of the confidence interval are referred to as confidence limits. For a given estimation procedure, the higher the confidence level, usually the wider the confidence interval will be. A 95% confidence interval does not mean that there is a 95% probability that the interval contains the true mean. The interval computed from a given sample either contains the true mean or it does not. Instead, the level of confidence is associated with the method of calculating the interval. The confidence coefficient t is simply the proportion of samples of a given size that may be expected to contain the true mean. That is, for a 95% confidence interval, if many samples are collected and the confidence interval computed, in the long run about 95 percent of these intervals would contain the true mean.

Mann-Kendall Test: The Mann-Kendall is a signed rank test and assumes no particular distribution for the data, that is, it doesn't have to be normally distributed. It is based on the difference between the numbers of pair-wise differences (number of positive signs minus the number of negative). If the difference is a large positive value, then there is evidence of an increasing trend in the data and if it is a large negative value, then there is evidence of a decreasing trend. The baseline condition for this test (null hypothesis, Ho) is that there is no temporal (time) trend in the data values. The alternative hypothesis is that of either an upward trend or a downward trend. The null hypothesis (there is no trend) is rejected when the computed Z value is greater than Z_α where α is the level of statistical significance.

The Mann-Kendall test is used for detecting trends in data collected over time. An adjustment is made for tied observations in this non-parametric test. You must have at least 10 observations for the normal approximation to be appropriate. Normal approximation is often used to test the difference between scores of data where the central point under the null hypothesis would be expected to be zero. Scores exactly equal to the central point are excluded and the absolute values of the deviations from the central point of the remaining scores are ranked such that the smallest deviation has a rank of 1. Tied scores are assigned a mean rank. The sums for the ranks of scores with positive and negative deviations from the central point are then calculated separately. A value *S* is defined as the smaller of these two rank sums. *S* is then compared to a table of all possible distributions of ranks to calculate *p*, the statistical probability of attaining *S* from a population of scores that is symmetrically distributed around the central point. *S* is measured in the units of the response variable and represents the standard distance data values from the regression line. Normally, the better the equation predicts the response, the lower the value for *S*.

As the number of scores used, *n*, increases, the distribution of all possible ranks *S* tends towards the normal distribution. So although for $n \leq 20$, exact probabilities would usually be calculated, for $n>20$, the normal approximation is used. The recommended cutoff varies; some use 20 although some put it lower (10) or higher (25). Minitab® calculates the Mann-Kendall trend test by normal approximation for data where $n>10$.

Z-value: The z-value measures how far an observation lies from its mean in units of standard deviation. Converting an observation to a z-value is called standardization. To standardize an observation in a population, subtract the population mean from the observation of interest and divide the result by the population standard deviation. The product of these operations is the z-value associated with the observation of interest. As discussed above, there is no trend when the computed z value is greater than the z_α where α is the level of statistical significance (for definition statistical significance see coefficient *p*-values above.)

Sen's Slope Sen's slope is an alternative for estimating a slope. This approach involves computing slopes for all the pairs of time points and then using the median of these slopes as an estimate of the overall slope. If there is no underlying trend, there will be an approximately equal number of positive and negative slopes, and thus the median will be near zero. Sen's slope provides an estimate of the slope (unit change, i.e., concentration of TCE per time period) or the magnitude of the trend.

The following is a table summarizing the statistical evaluation that was performed on wells as part of this FYR. The evaluation was performed using Minitab® software. Within the software, linear regression, Mann-Kendall and Sen's Slope were used to evaluate the TCE trends in these wells. Four wells at the distal end of the Upper Vashon aquifer near American Lake were evaluated; two wells installed in 2007 downgradient of the I-5 P&T system in the Lower Vashon aquifer, LC-225 and LC-226 were evaluated; five wells within the ALGT monitoring network were evaluated and two wells at Landfill 1 were also evaluated for TCE trends. The following is a table of their trend information. Statistically significant trends were found in T-08 (downward), LC-226 (upward), all the wells evaluated at ALGT (downward) and one well at LF 1 showed a downward trend at a 90 percent confidence interval using the Mann-Kendall Approximation.

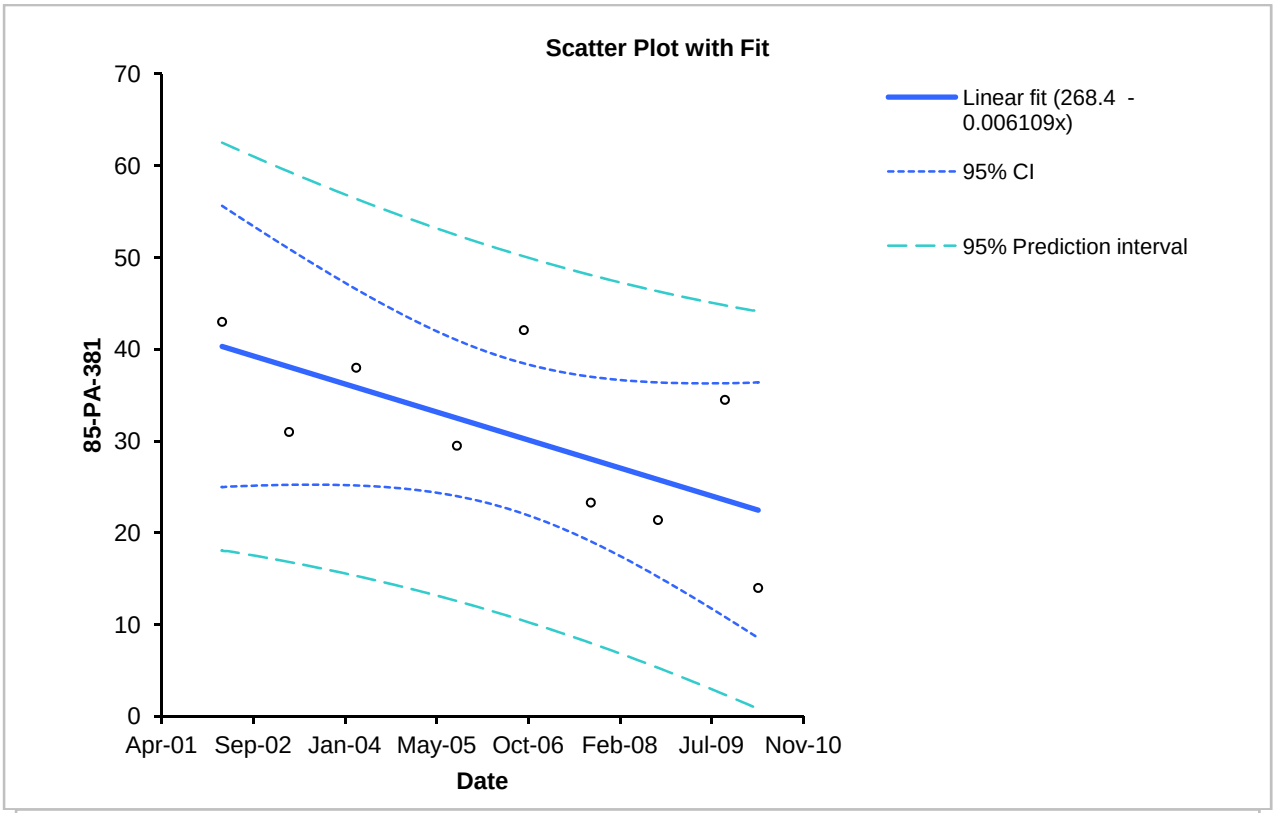
In the end, it is useful to look at these wells with statistically significant trends for a guide as to where actions might be needed. For ALGT, it is of some comfort to know that all wells are showing a downward trend but not much of a surprise. The for the wells at the distal end of the Upper Vashon plume near American Lake, it is reassuring that many of those wells show a stable or downward trend and one shows a statistically significant downward trend. The Lower Vashon Aquifer, LC-226 shows a statistically significant upward

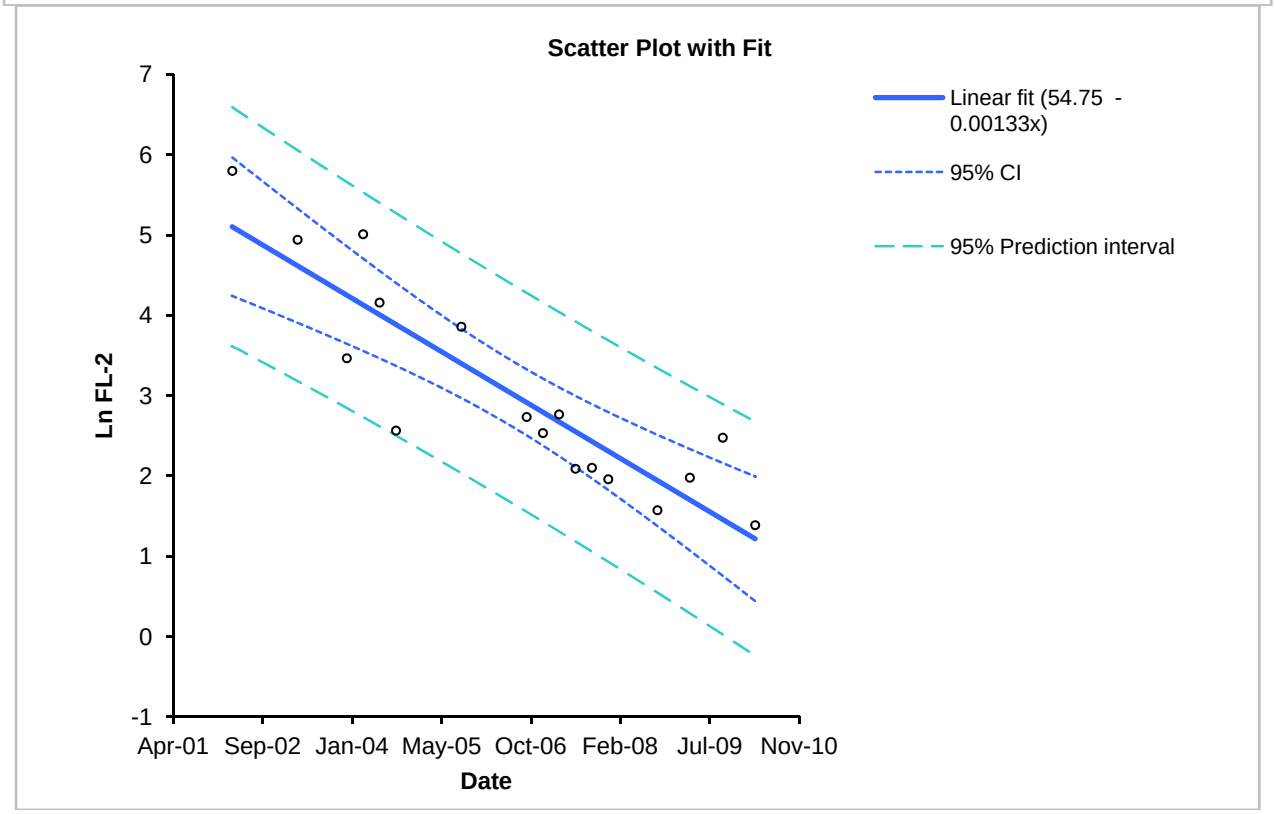
trend. As this well is likely a sentry well in the Lower Vashon and provides early warning for potential contamination reaching production well BC-1, this identifies a well and an area of concern.

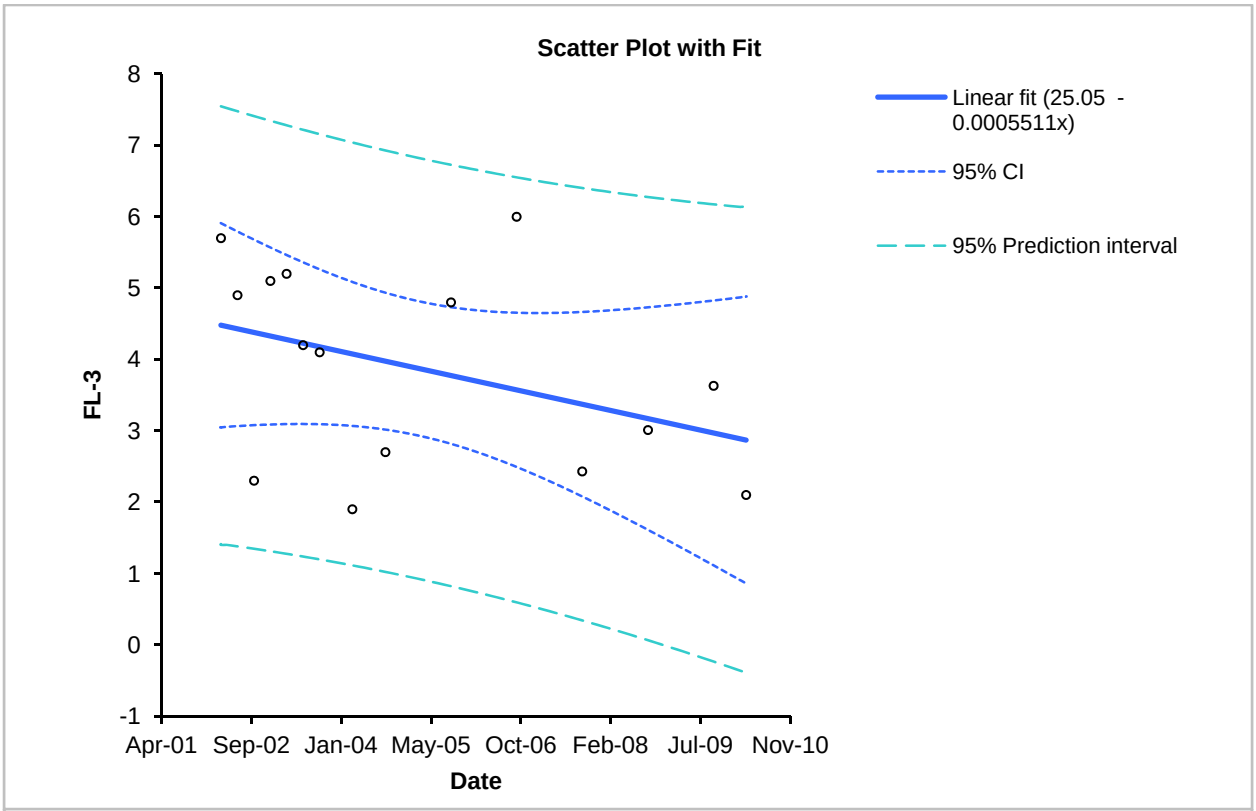
That the installation is also performing similar analyses in key area is outstanding. Unfortunately a strategy for performing the statistical analyses and a response plan was not found in this review. This could be easily incorporated into any of their groundwater monitoring plan. In addition, it seems that in areas like LF 1 where there remains little groundwater contamination and little risk the statistical analyses are not being performed. This may be an area where it would be a simple task to incorporate and yield benefits in reducing or eliminating groundwater monitoring over time.

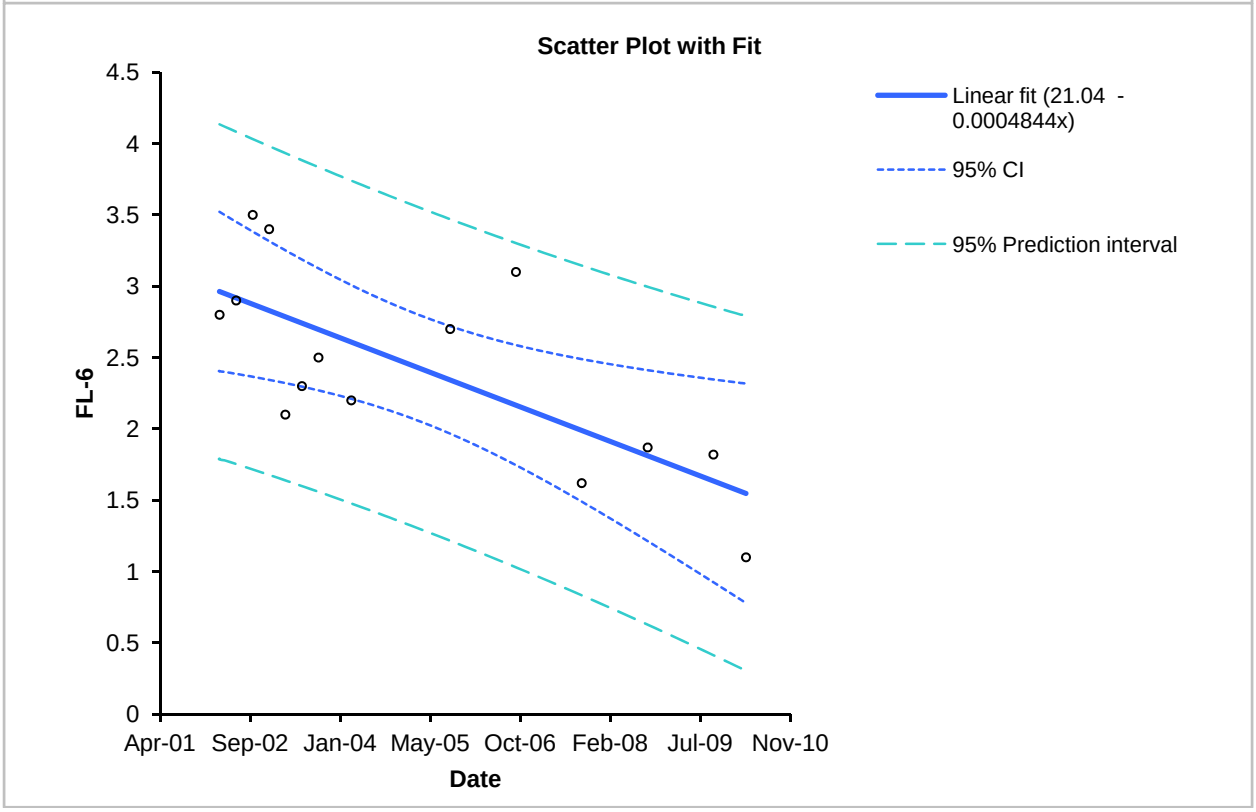
Well No	Predicted Trend	Calculated Z	Sen's Slope concentration per event (ug/L)	Statistically Significant Trend at 95 % CI
LC-03	Stable	0.647844	0.01	No
T-04	Downward	-1.21561	-0.243214	No
T-08	Downward	-2.27462	-0.0629762	Yes
LC-49	Downward	-0.160997	-4.8	No
LV- LC-225	Downward	-0.48898	-0.1	No
LV-LC-226	Upward	1.89	0.245	Yes
ALGT D-7b	Downward	-3.86098	-1.41987	Yes
ALGT D-9b	Downward	-3.54005	-4.9	Yes
ALGT D-21b	Downward	-2.24576	0.71426	Yes
ALGT D-29	Downward	-1.82321	NA	Yes
ALGT D-6	Downward	-1.78885	NA	Yes
84-CD-LF1-4	Downward	-1.62246	-0.122527	No at 95% CI but Yes at 90% CI
84-CD-LF1-3	Not enough evidence to support a trend	0.225570	0.104167	No at 95, 90 and 80% CI

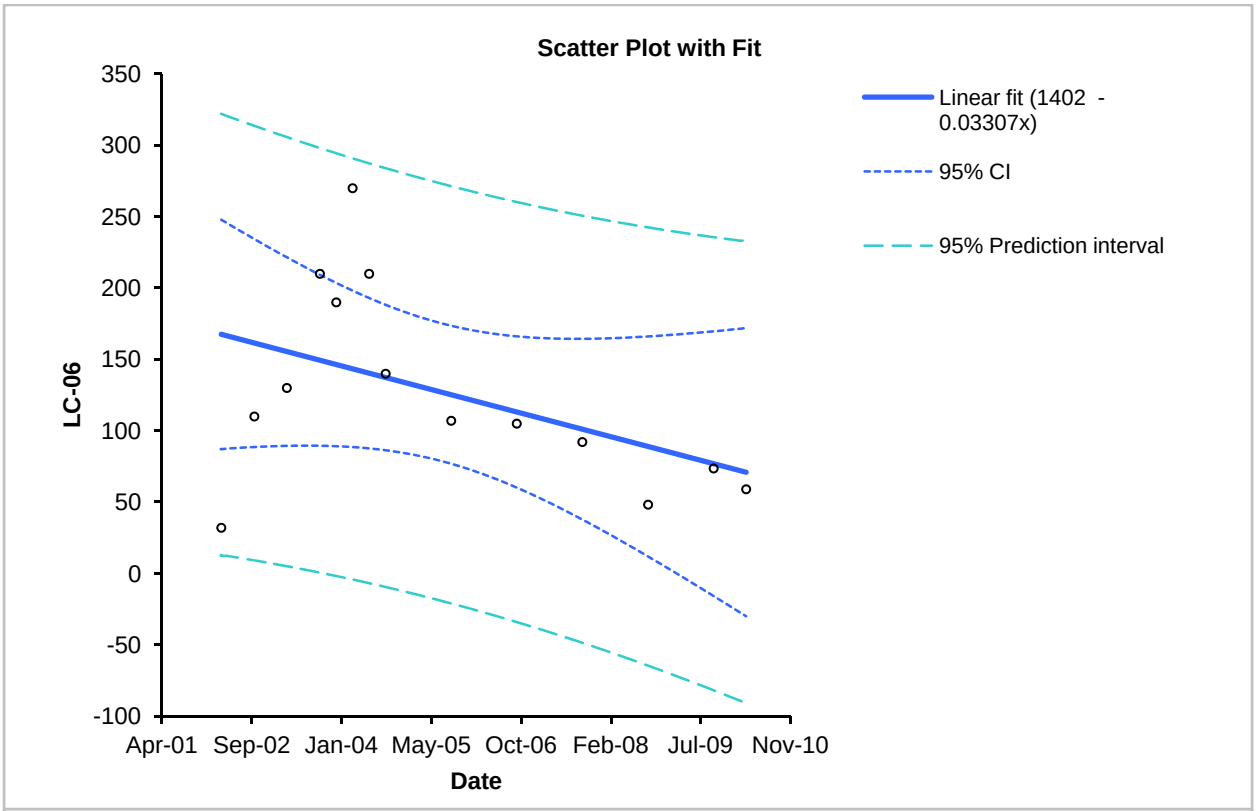
Linear Regression Plots and Map for Upper Vashon Aquifer (Logistics Center)

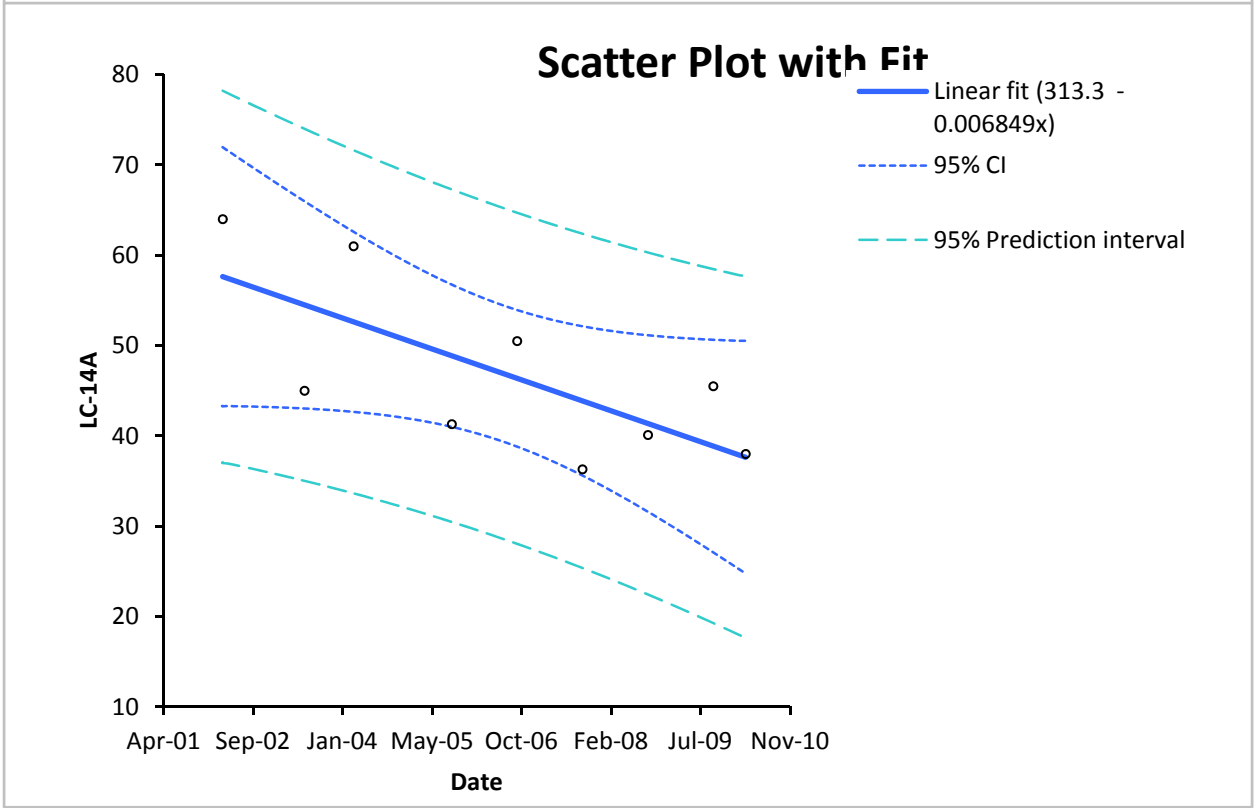

Scatter Plot with Fit
85-PA-381
70
60
50
40
30
20
10
0
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (268.4 - 0.006109x)
95% CI
95% Prediction interval

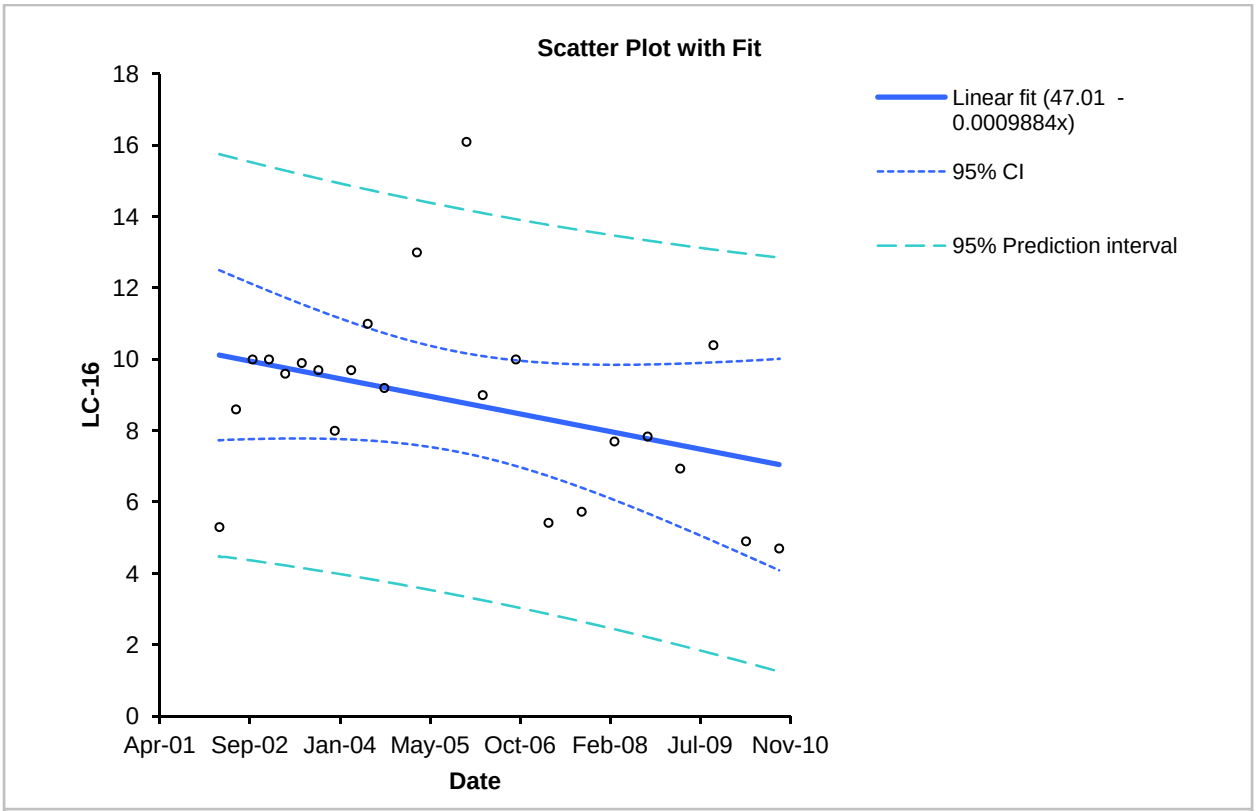

Scatter Plot with Fit
Ln FL-2
7
6
5
4
3
2
1
0
-1
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (54.75 - 0.00133x)
95% CI
95% Prediction interval

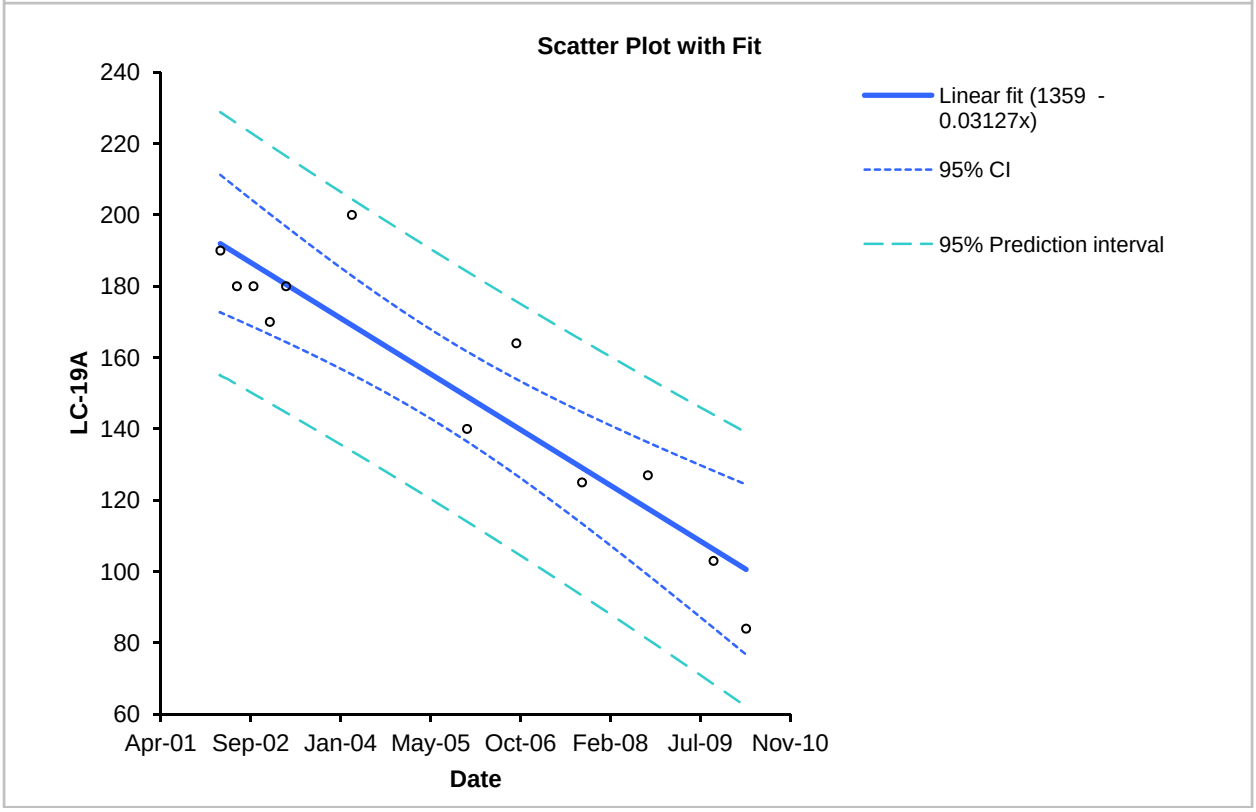

Scatter Plot with Fit
FL-3
8
7
6
5
4
3
2
1
0
-1
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (25.05 - 0.0005511x)
95% CI
95% Prediction interval

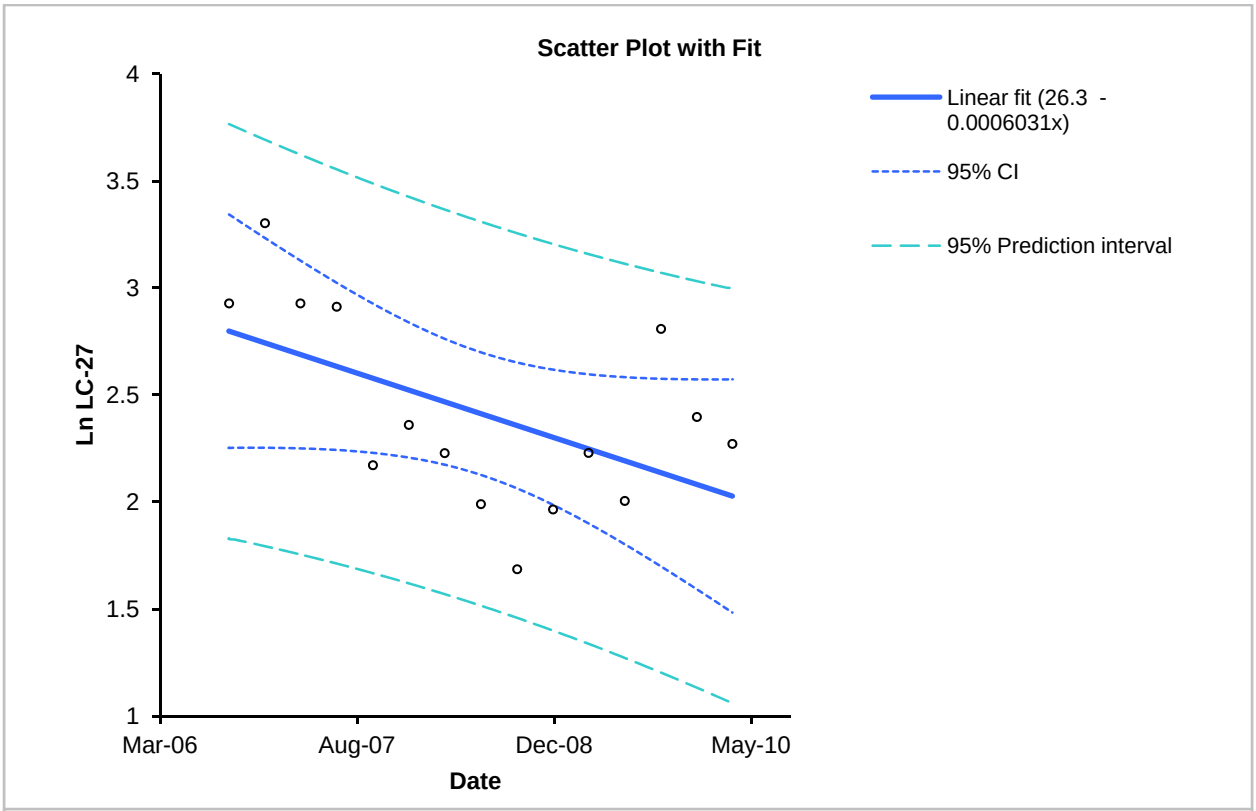

Scatter Plot with Fit
FL-6
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (21.04 - 0.0004844x)
95% CI
95% Prediction interval

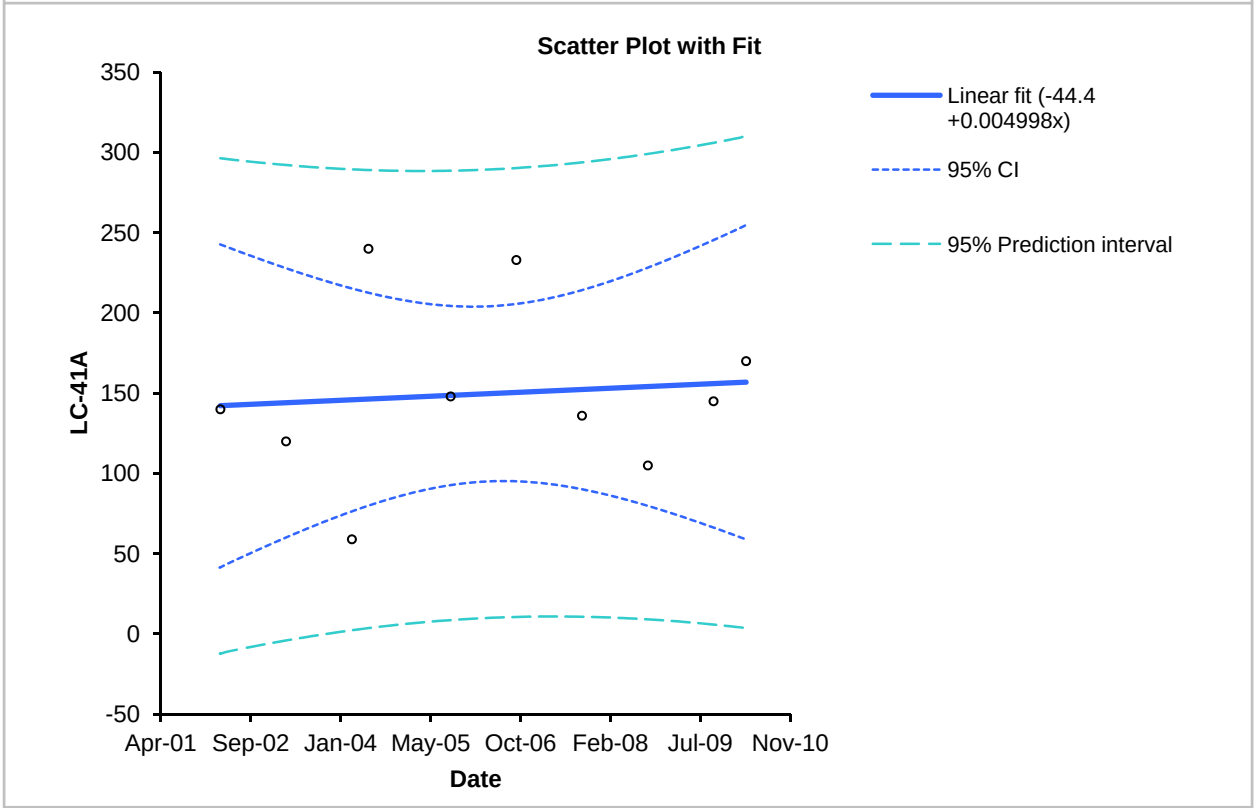

Scatter Plot with Fit
350
300
250
200
150
100
50
0
-50
-100
LC-06
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (1402 - 0.03307x)
95% CI
95% Prediction interval

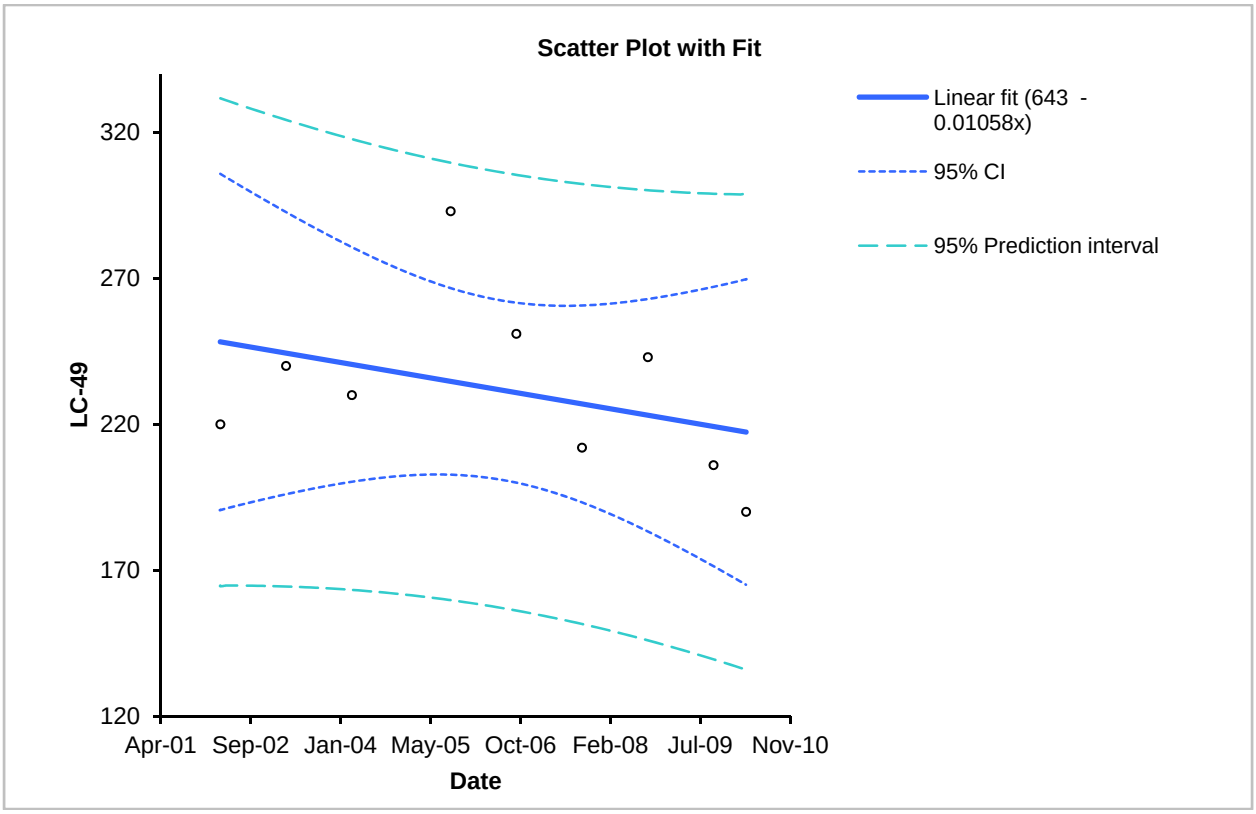

Scatter Plot with Fit
80
70
60
50
40
30
20
10
LC-14A
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (313.3 - 0.006849x)
95% CI
95% Prediction interval

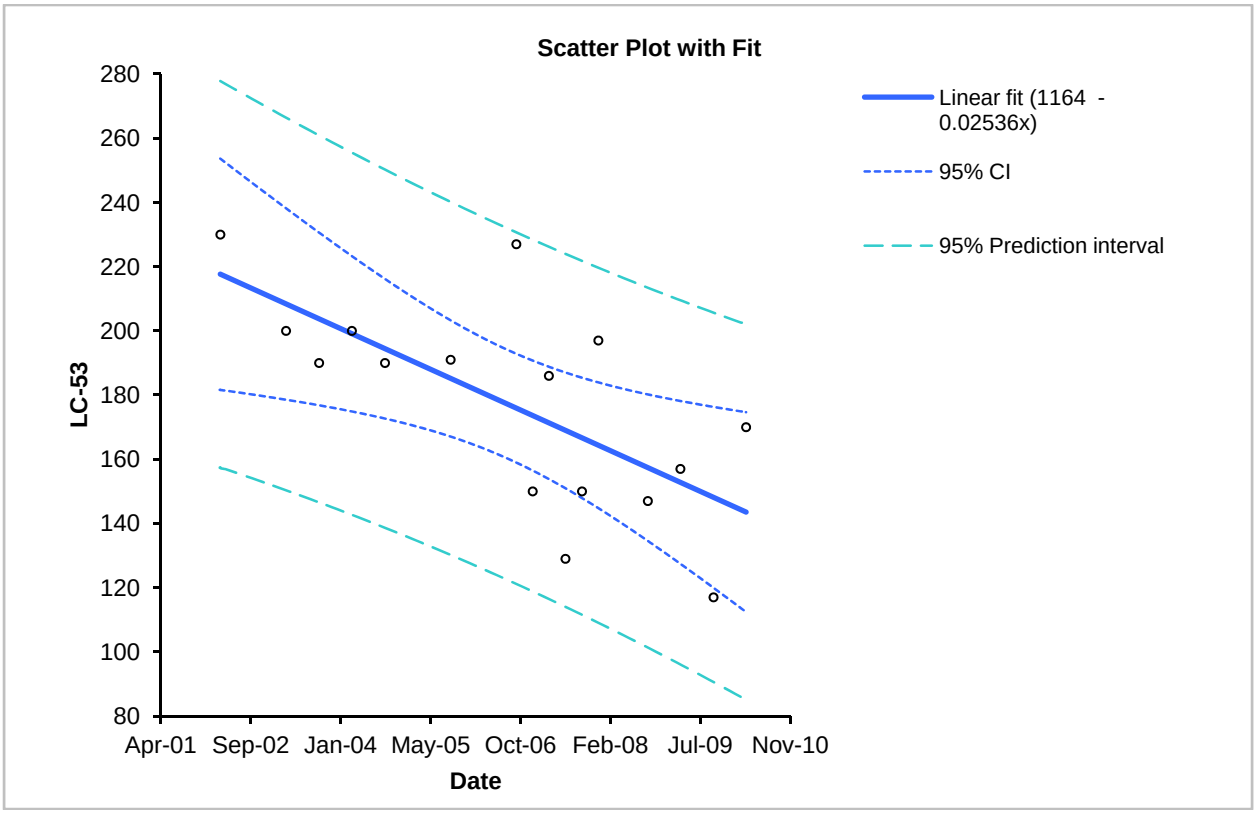

Scatter Plot with Fit
LC-16
Date
Linear fit (47.01 - 0.0009884x)
95% CI
95% Prediction interval
0
2
4
6
8
10
12
14
16
18
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10

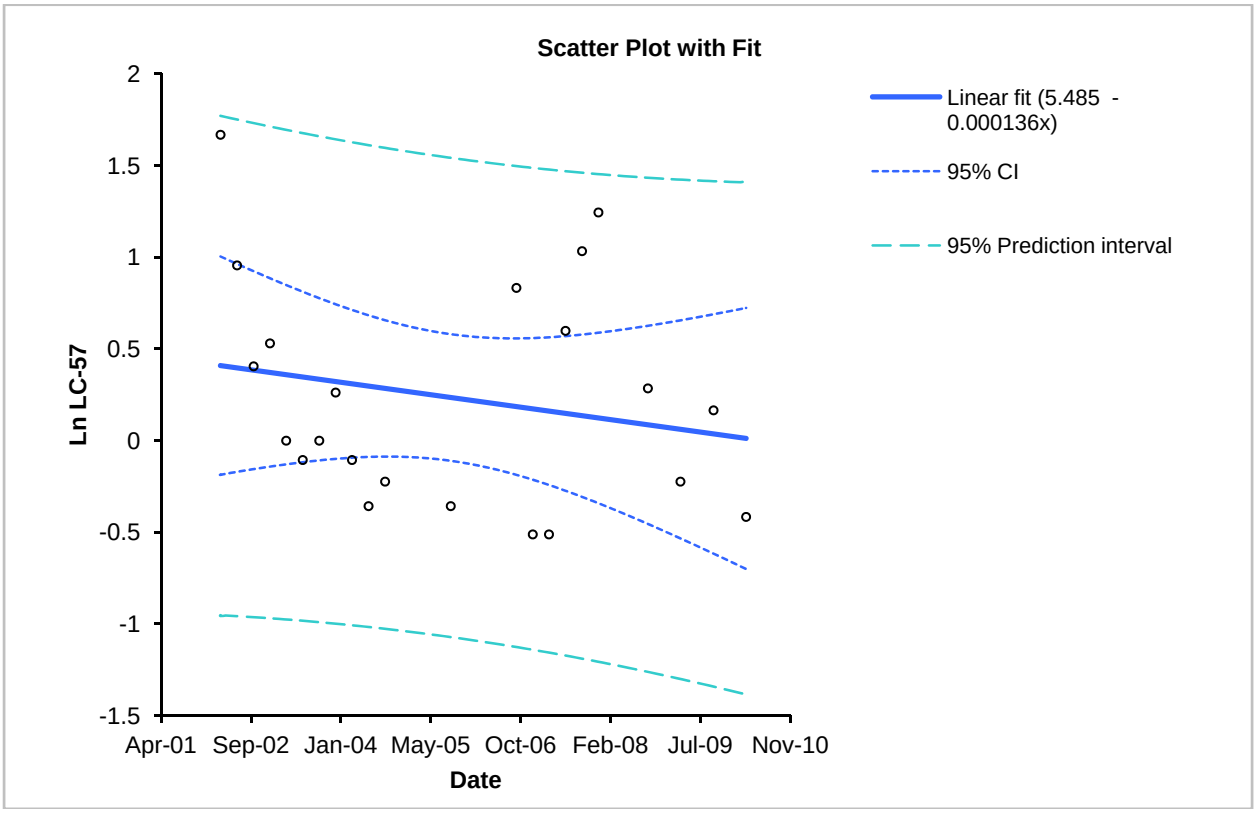

Scatter Plot with Fit
LC-19A
Date
Linear fit (1359 - 0.03127x)
95% CI
95% Prediction interval
60
80
100
120
140
160
180
200
220
240
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10

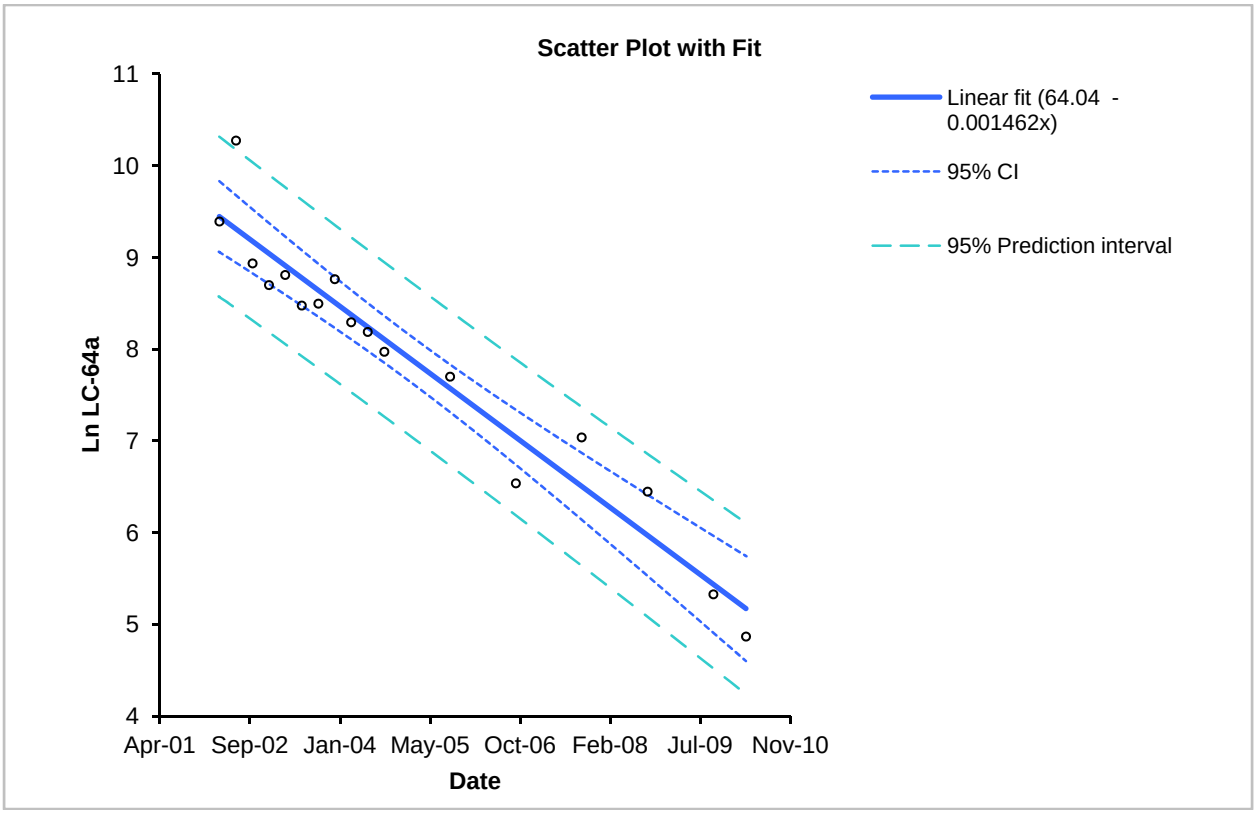

Scatter Plot with Fit
Ln LC-27
4
3.5
3
2.5
2
1.5
1
Mar-06
Aug-07
Dec-08
May-10
Date
Linear fit (26.3 - 0.0006031x)
95% CI
95% Prediction interval

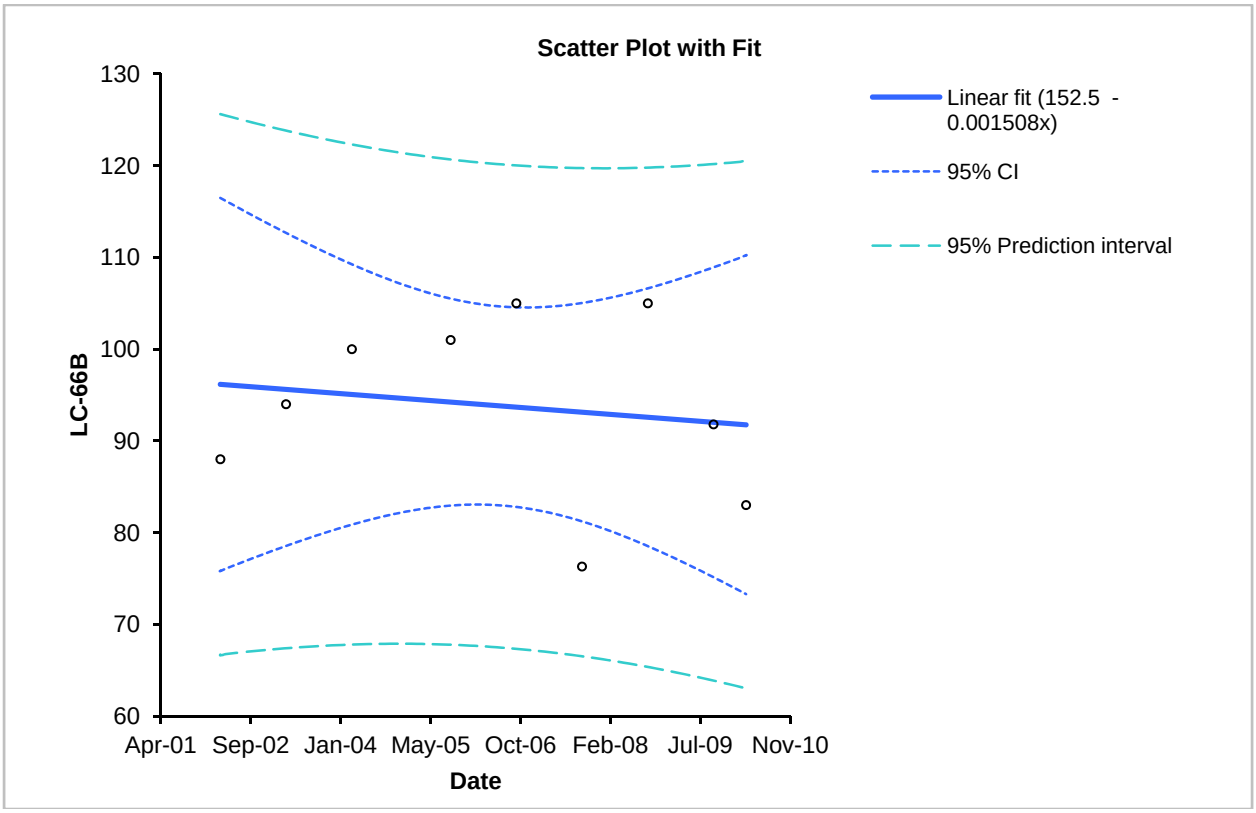

Scatter Plot with Fit
LC-41A
350
300
250
200
150
100
50
0
-50
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (-44.4 +0.004998x)
95% CI
95% Prediction interval

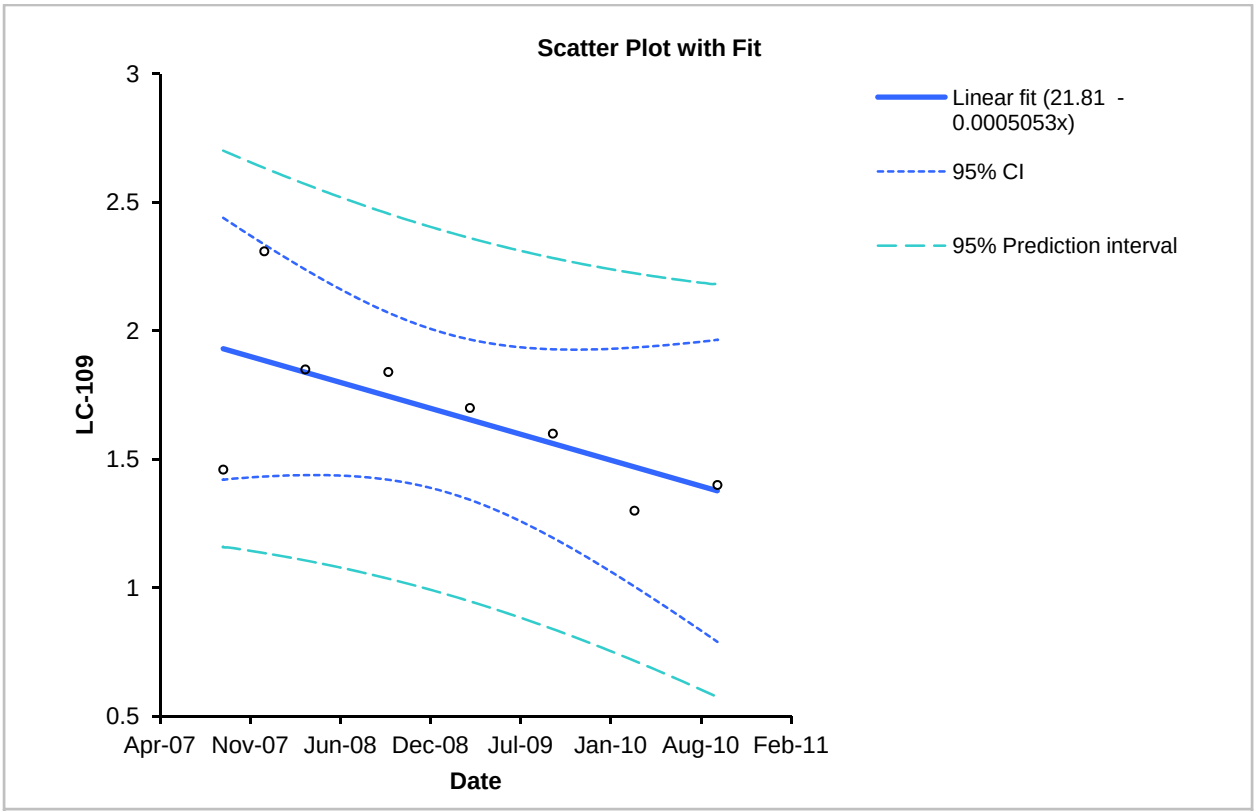

Scatter Plot with Fit
Linear fit (643 - 0.01058x)
95% CI
95% Prediction interval
LC-49
320
270
220
170
120
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date

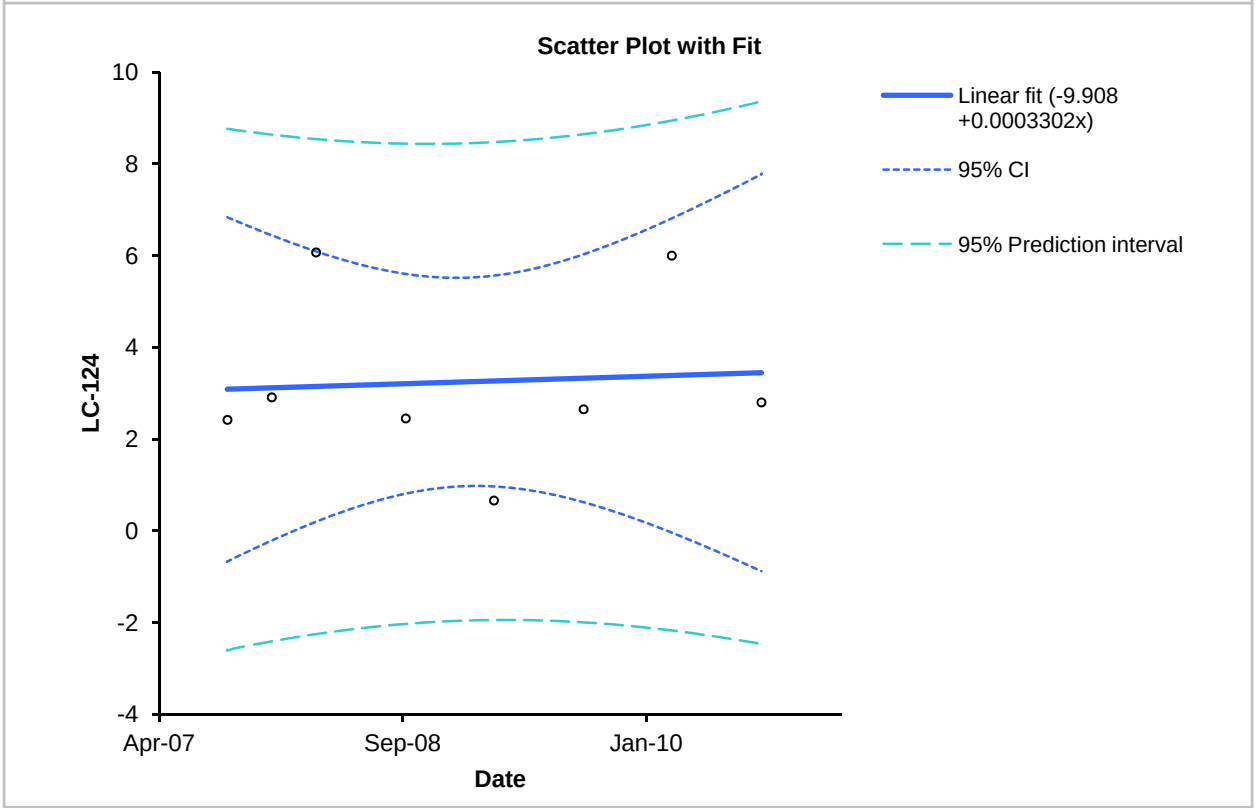

Scatter Plot with Fit
280
260
240
220
200
180
160
140
120
100
80
LC-53
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (1164 - 0.02536x)
95% CI
95% Prediction interval

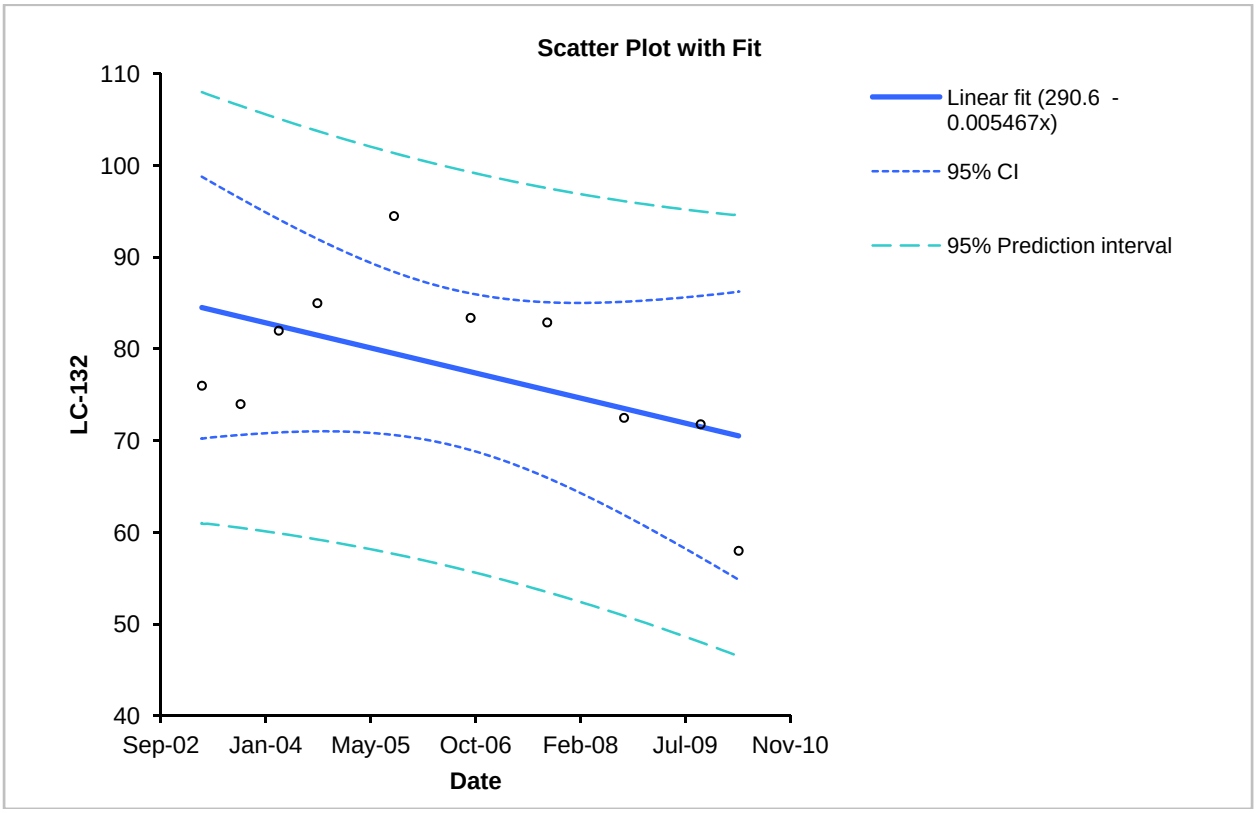

Scatter Plot with Fit
2
1.5
1
0.5
0
-0.5
-1
-1.5
Ln LC-57
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (5.485 - 0.000136x)
95% CI
95% Prediction interval

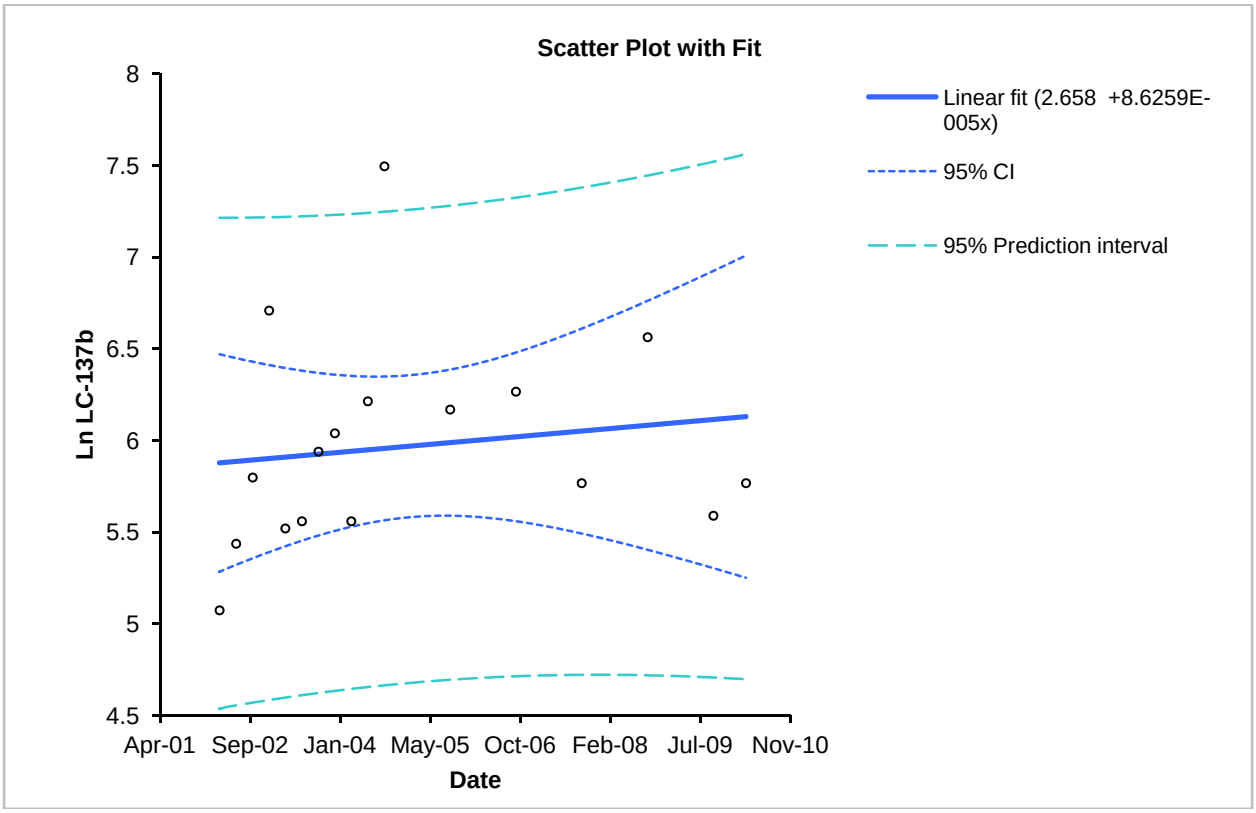

Scatter Plot with Fit
Ln LC-64a
11
10
9
8
7
6
5
4
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (64.04 - 0.001462x)
95% CI
95% Prediction interval

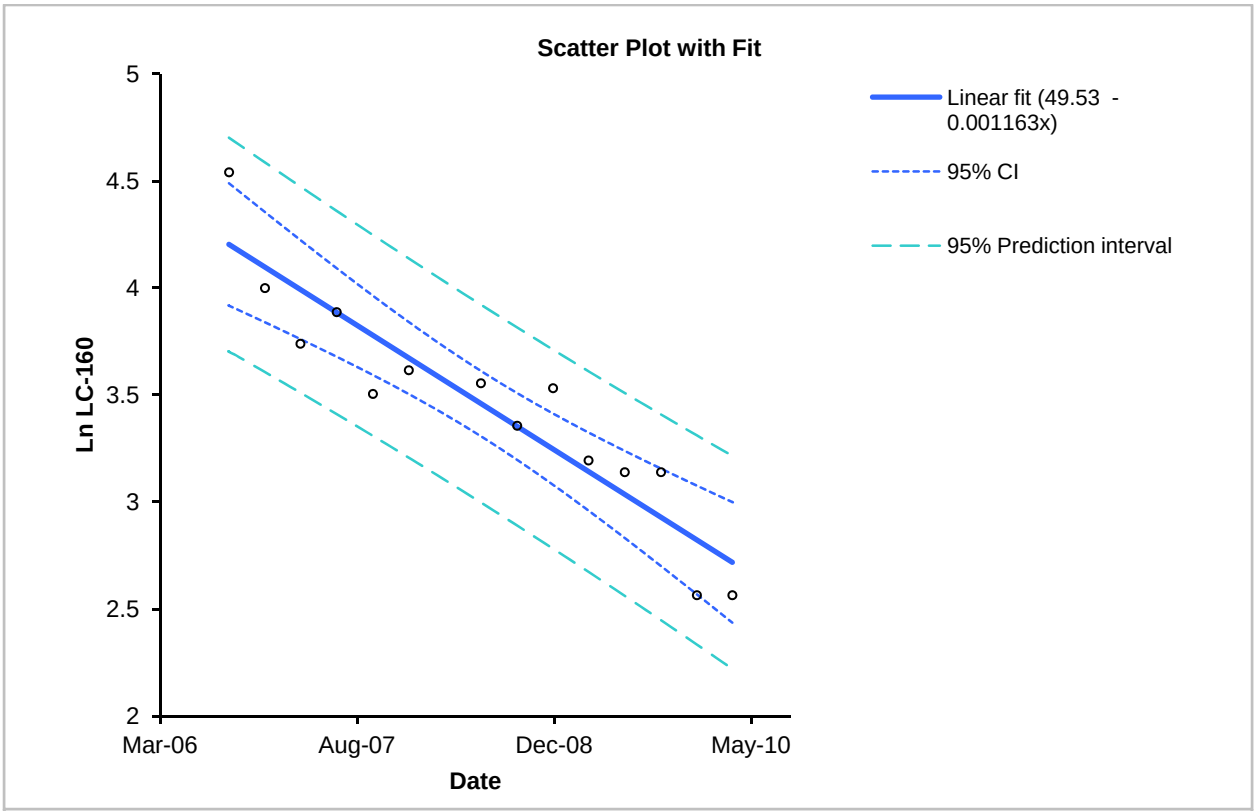

Scatter Plot with Fit
LC-66B
130
120
110
100
90
80
70
60
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (152.5 - 0.001508x)
95% CI
95% Prediction interval

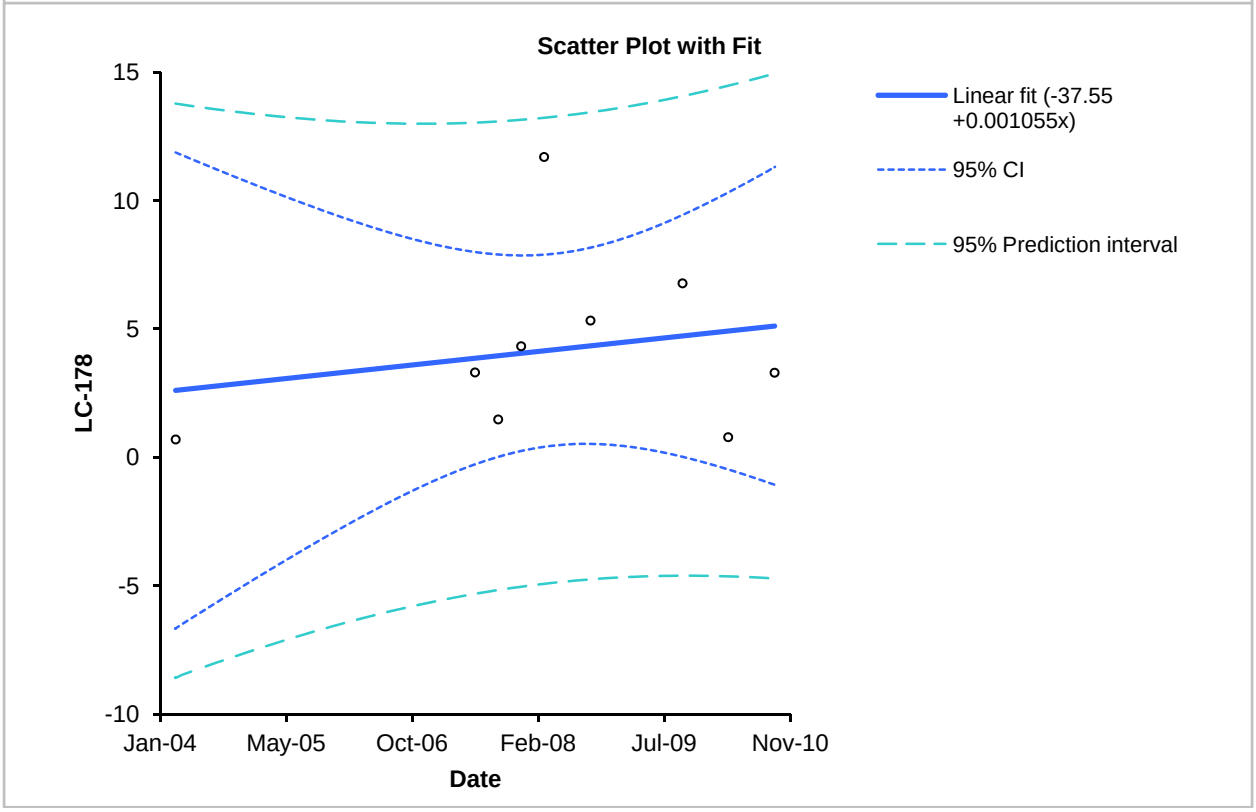

Scatter Plot with Fit
LC-109
3
2.5
2
1.5
1
0.5
Apr-07
Nov-07
Jun-08
Dec-08
Jul-09
Jan-10
Aug-10
Feb-11
Date
Linear fit (21.81 - 0.0005053x)
95% CI
95% Prediction interval

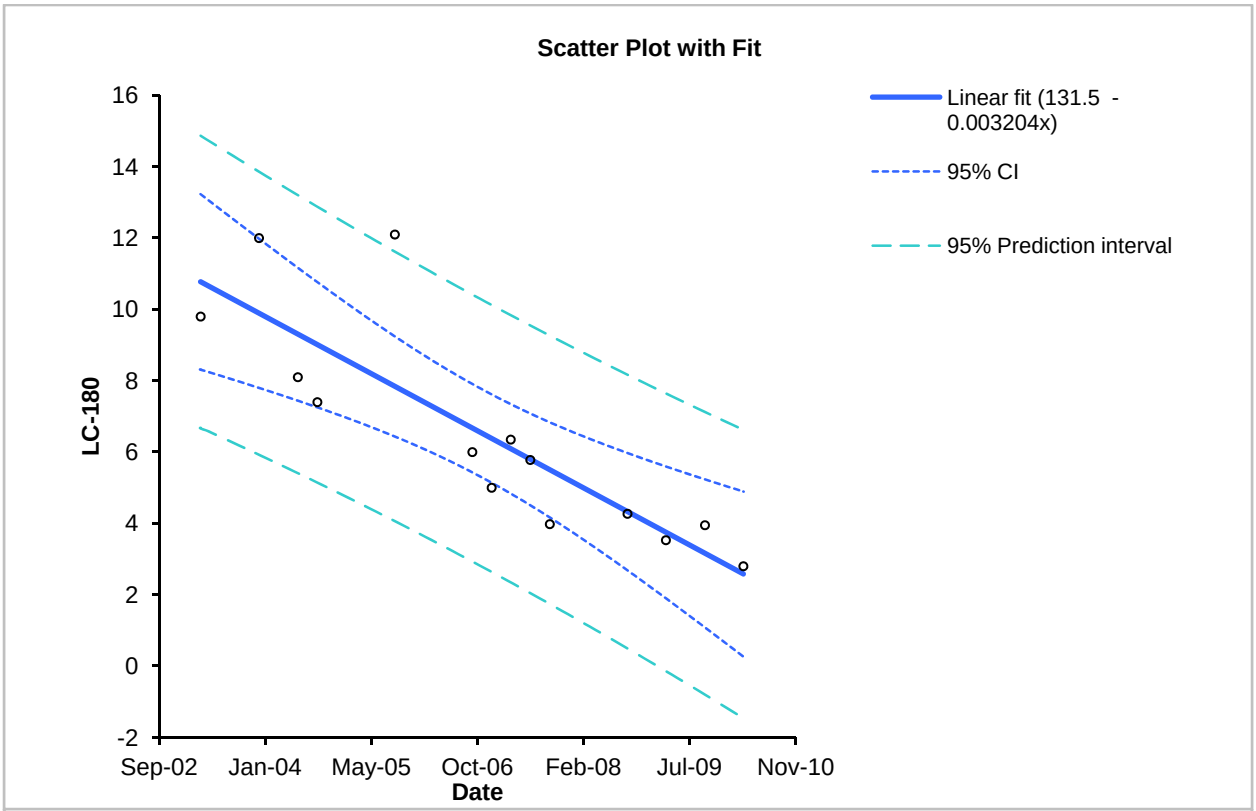

Scatter Plot with Fit
LC-124
10
8
6
4
2
0
-2
-4
Apr-07
Sep-08
Jan-10
Date
Linear fit (-9.908 +0.0003302x)
95% CI
95% Prediction interval

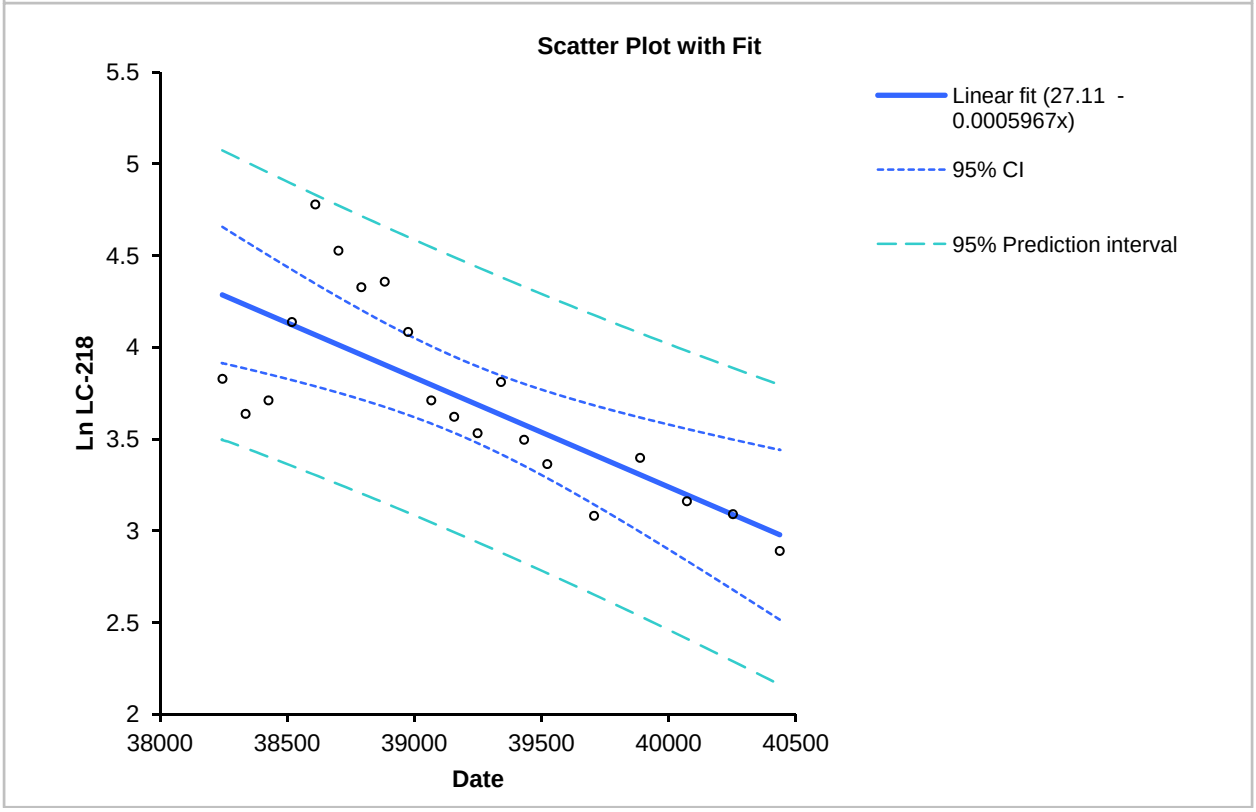

Scatter Plot with Fit
LC-132
110
100
90
80
70
60
50
40
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (290.6 - 0.005467x)
95% CI
95% Prediction interval

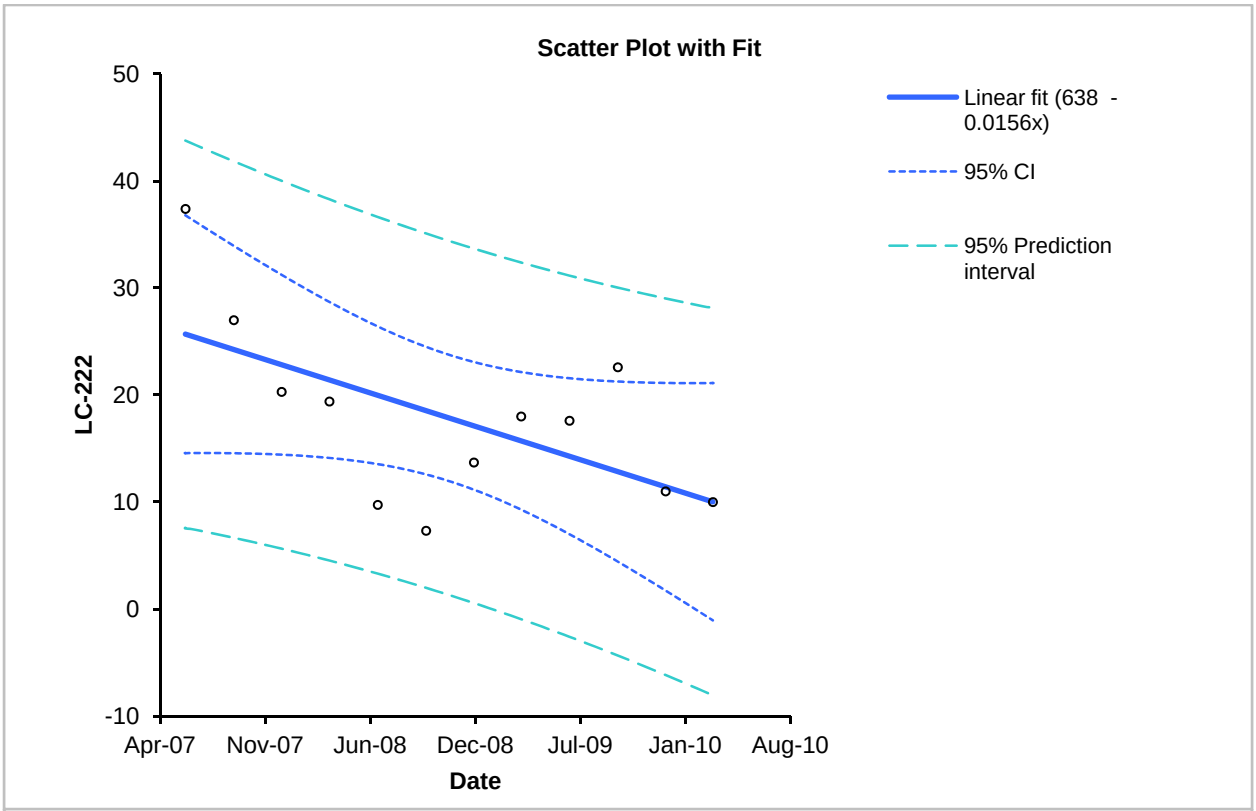

Scatter Plot with Fit
Ln LC-137b
8
7.5
7
6.5
6
5.5
5
4.5
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (2.658 +8.6259E-005x)
95% CI
95% Prediction interval

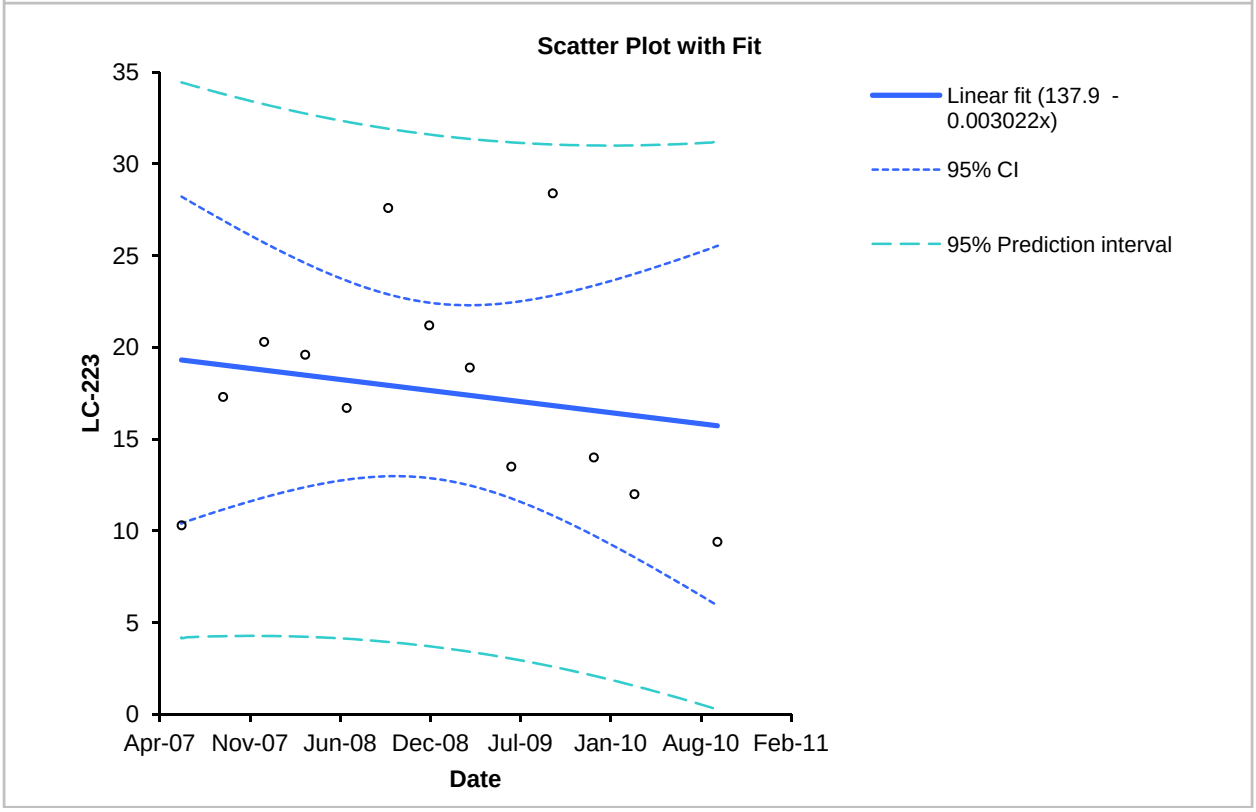

Scatter Plot with Fit
Ln LC-160
5
4.5
4
3.5
3
2.5
2
Mar-06
Aug-07
Dec-08
May-10
Date
Linear fit (49.53 - 0.001163x)
95% CI
95% Prediction interval

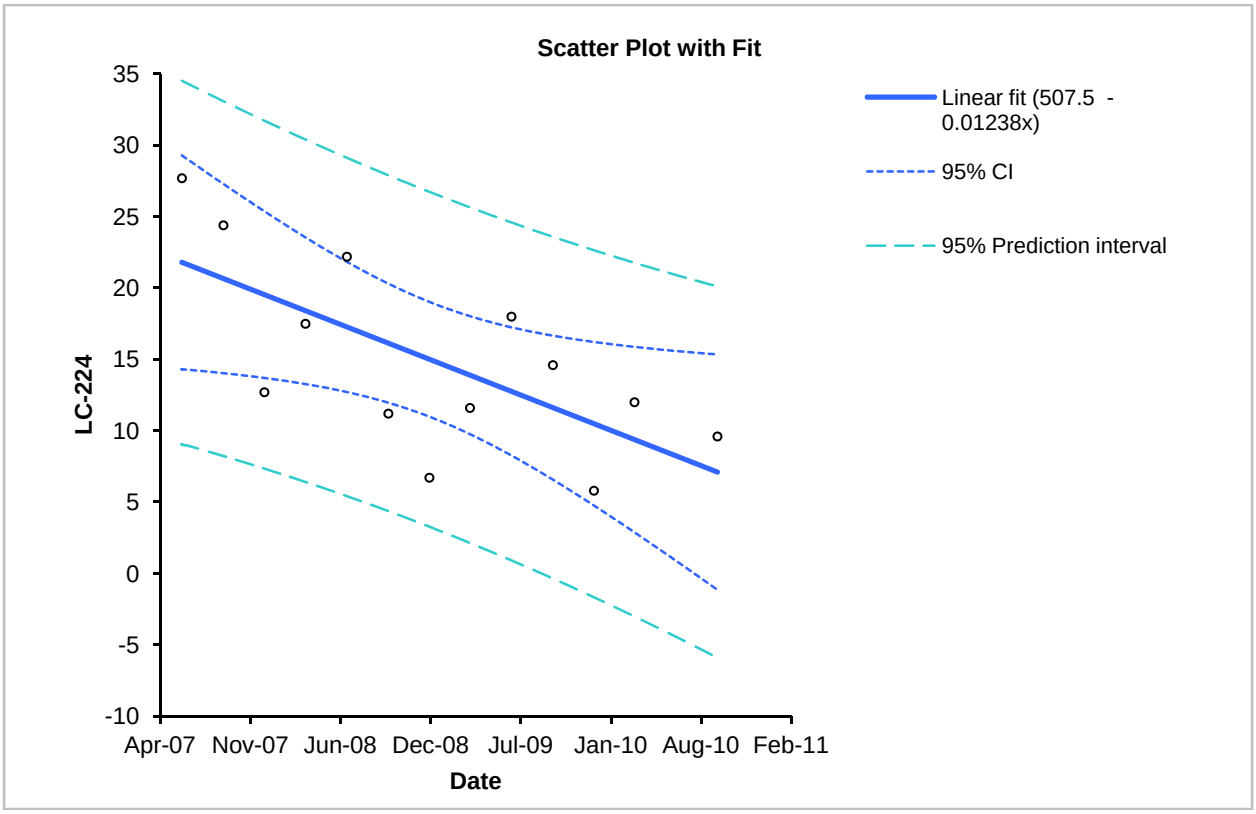

Scatter Plot with Fit
LC-178
15
10
5
0
-5
-10
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (-37.55 +0.001055x)
95% CI
95% Prediction interval


Scatter Plot with Fit
LC-180
16
14
12
10
8
6
4
2
0
-2
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (131.5 - 0.003204x)
95% CI
95% Prediction interval

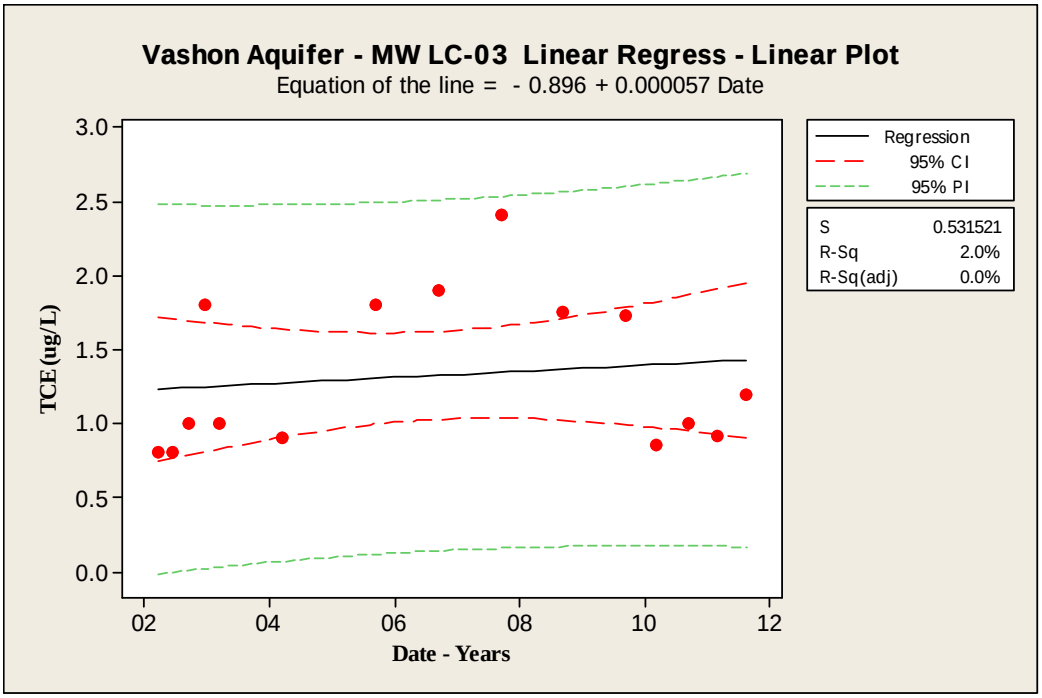

Scatter Plot with Fit
Ln LC-218
5.5
5
4.5
4
3.5
3
2.5
2
38000
38500
39000
39500
40000
40500
Date
Linear fit (27.11 - 0.0005967x)
95% CI
95% Prediction interval


Scatter Plot with Fit
LC-222
50
40
30
20
10
0
-10
Apr-07
Nov-07
Jun-08
Dec-08
Jul-09
Jan-10
Aug-10
Date
Linear fit (638 - 0.0156x)
95% CI
95% Prediction interval


Scatter Plot with Fit
LC-223
35
30
25
20
15
10
5
0
Apr-07
Nov-07
Jun-08
Dec-08
Jul-09
Jan-10
Aug-10
Feb-11
Date
Linear fit (137.9 - 0.003022x)
95% CI
95% Prediction interval


Scatter Plot with Fit
35
30
25
20
15
10
5
0
-5
-10
LC-224
Apr-07
Nov-07
Jun-08
Dec-08
Jul-09
Jan-10
Aug-10
Feb-11
Date
Linear fit (507.5 - 0.01238x)
95% CI
95% Prediction interval

Upper Vashon Plume Boundary Well – LC-03



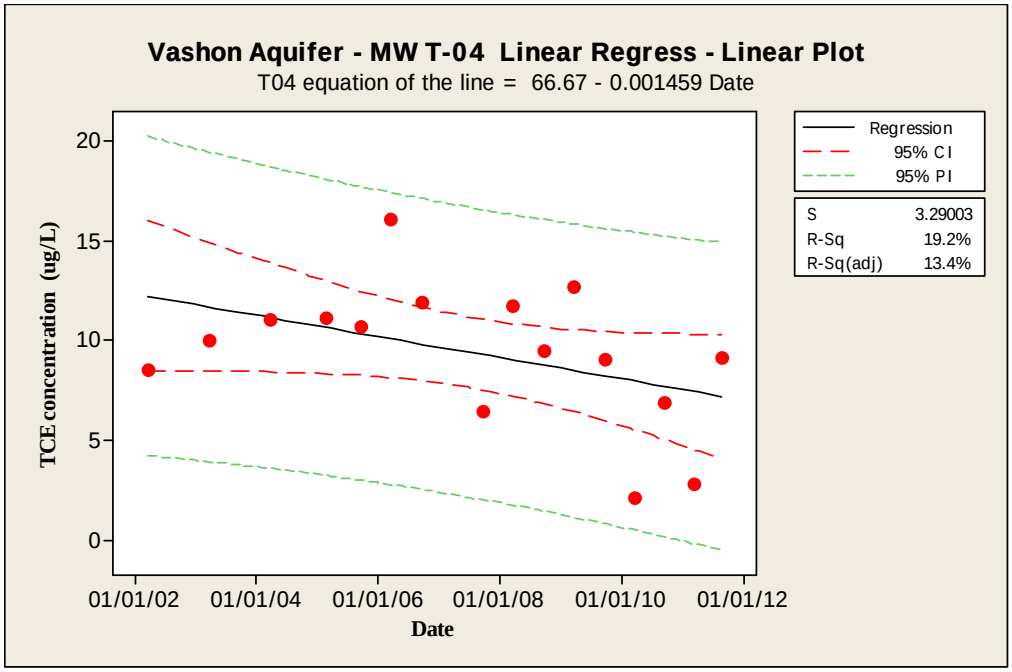
The calculated z = 0.647844

For Ha: Upperward trend, the p-value = 0.258543
At alpha = 0.05, there <u>is not</u> enough evidence to determine that there is an upward trend.

For Ha: Downward trend, the p-value = 0.741457
At alpha = 0.05, there <u>is not</u> enough evidence to determine that there is a downward trend.

Sen's Slope for TCE for LC-03 = 0.01

Upper Vashon Plume Boundary Well – T-04



Mann-Kendall Trend Test by Normal Approximation
Ho: No trend in UV-T04

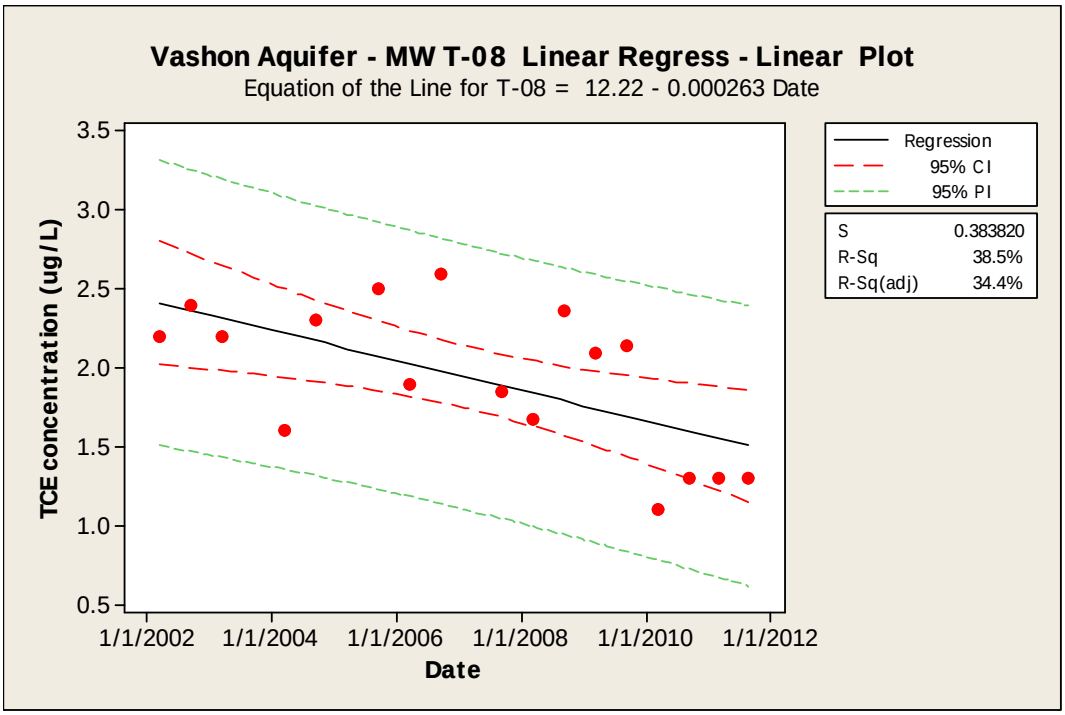
The calculated z = -1.21561

For Ha: Upperward trend, the p-value = 0.887933
At alpha = 0.05, there <u>is not</u> enough evidence to determine that there is an upward trend.

For Ha: Downward trend, the p-value = 0.112067
At alpha = 0.05, there <u>is not</u> enough evidence to determine that there is a downward trend.

Sen's Slope for UV-T04 = -0.243214

Upper Vashon Plume Boundary Well – T-08



Mann-Kendall Trend Test by Normal Approximation

Ho: No trend in UV T-08;

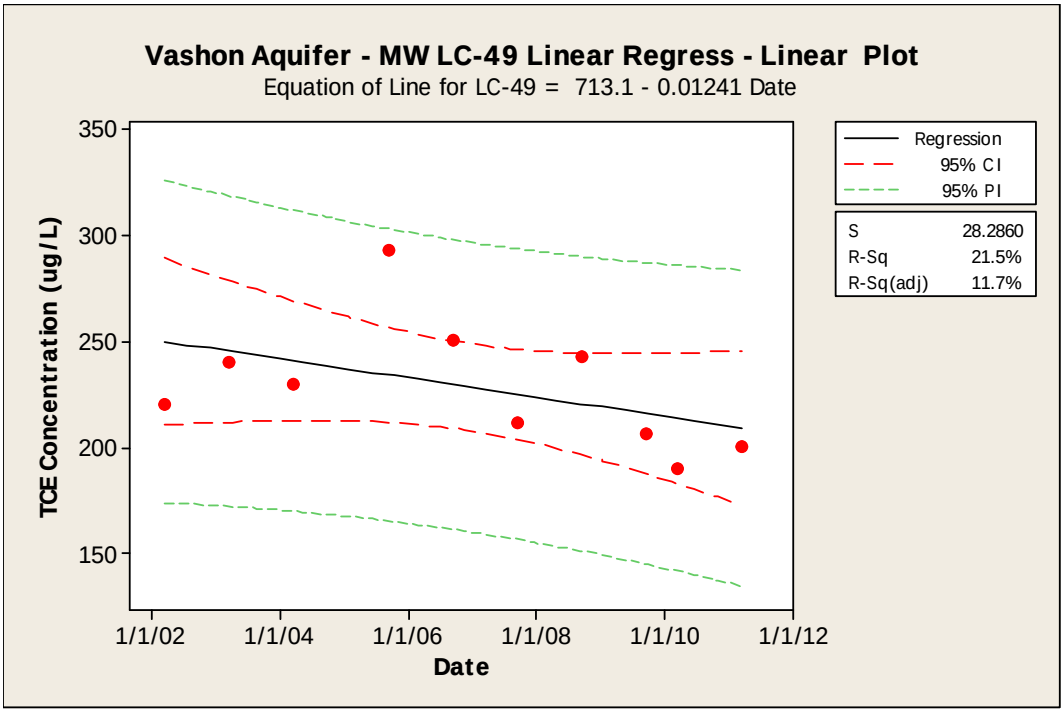
The calculated z = -2.27462

For Ha: Upperward trend, the p-value = 0.988536
At alpha = 0.05, there <u>is not</u> enough evidence to determine that there is an upward trend.

For Ha: Downward trend, the p-value = 0.0114644
At alpha = 0.05, there <u>is enough</u> evidence to determine that there is a downward trend.

Sen's Slope for UV T-08 = -0.0629762

Upper Vashon Plume Boundary Well – LC-49



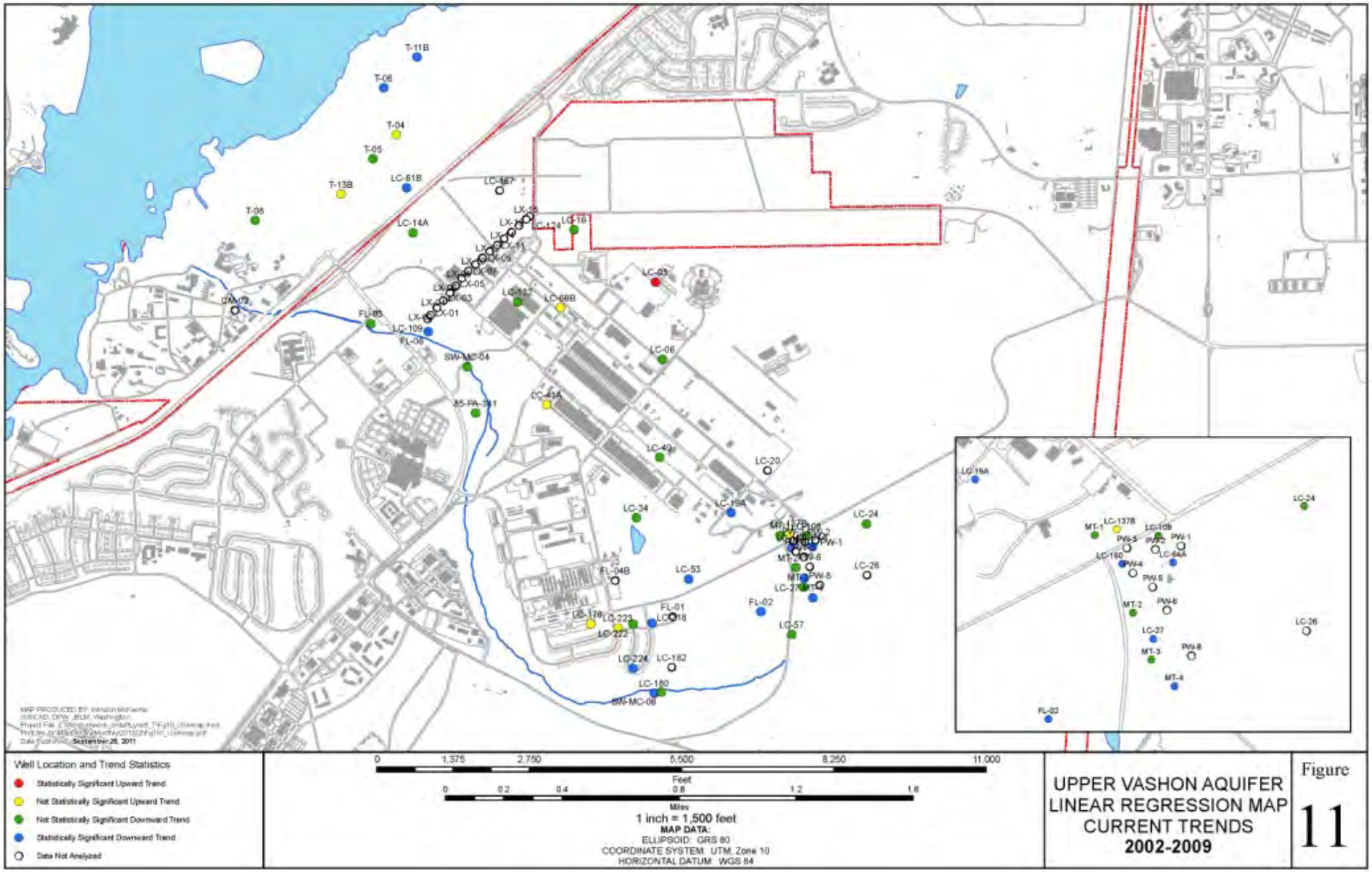
Mann-Kendall Trend Test by Normal Approximation
Ho: No trend in UV LC-49

The calculated z = -1.60997

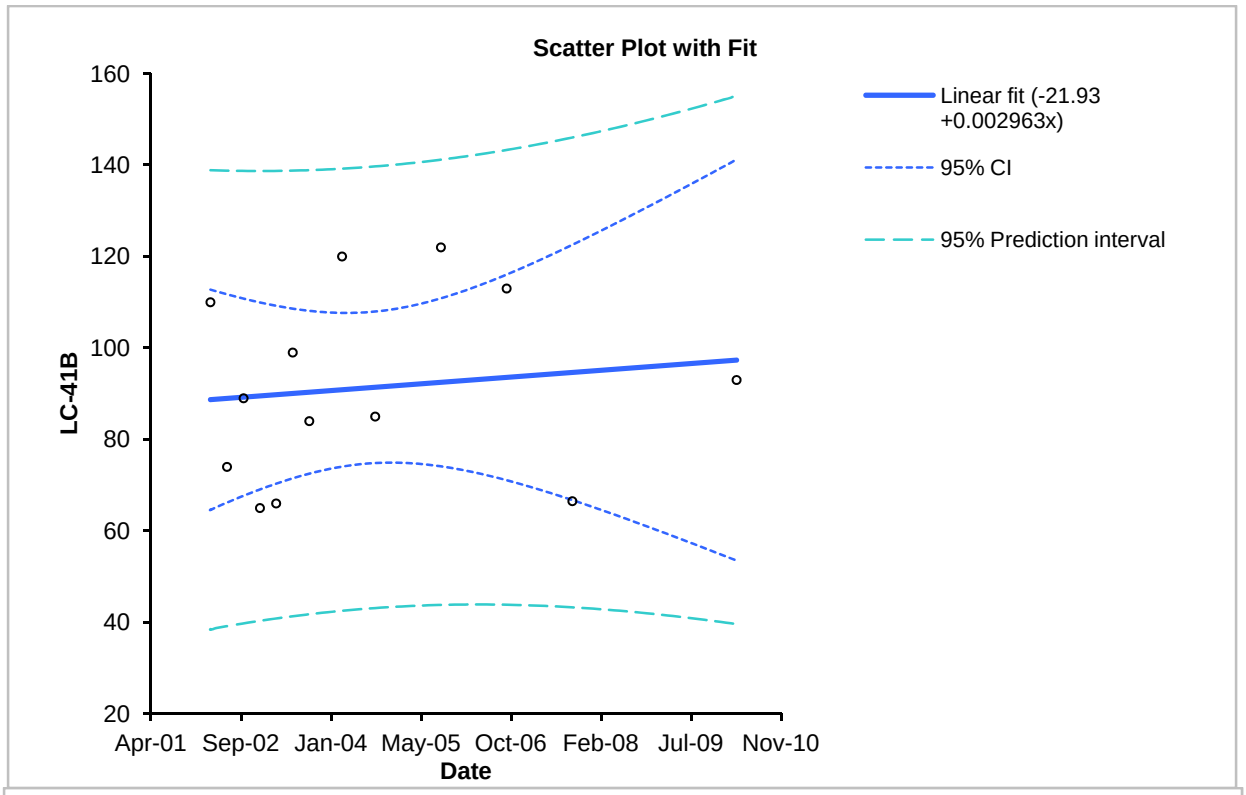
For Ha: Upperward trend, the p-value = 0.946298
At alpha = 0.05, there <u>is not</u> enough evidence to determine that there is an upward trend.

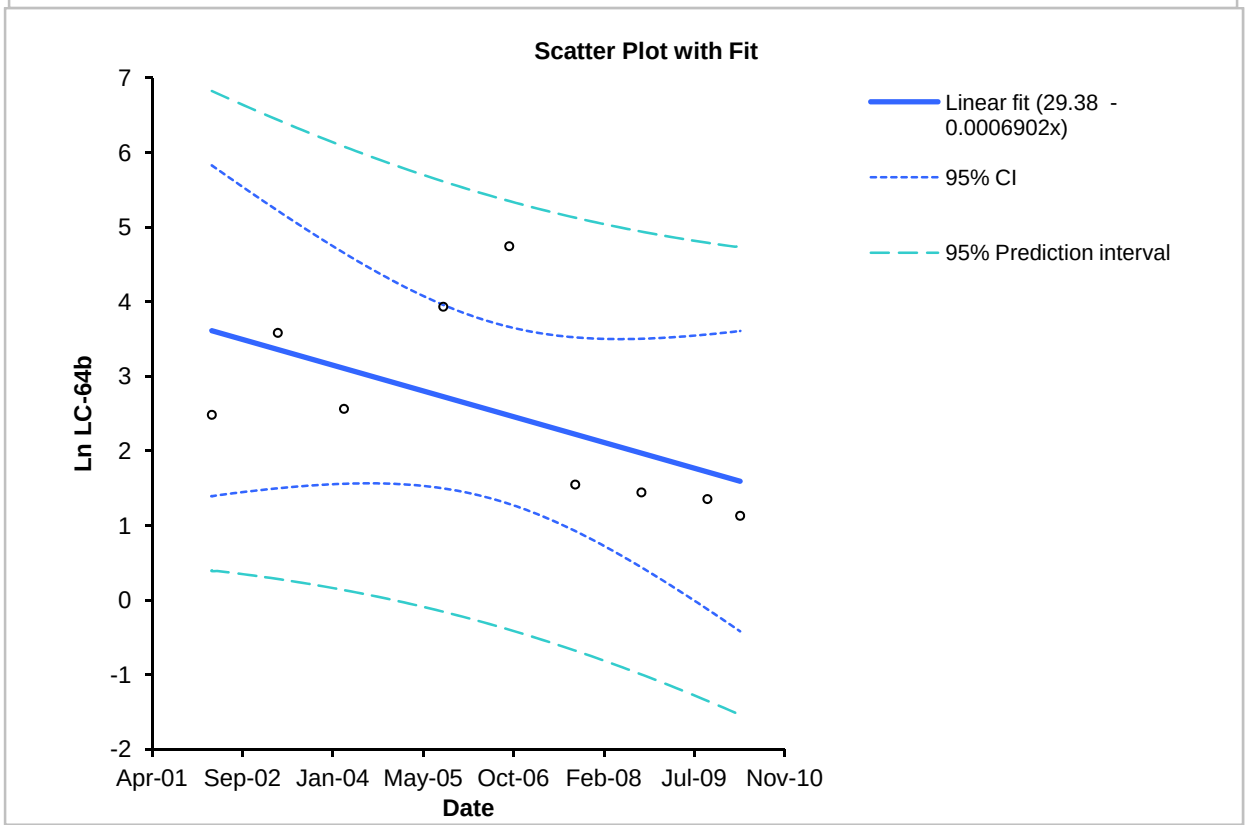
For Ha: Downward trend, the p-value = 0.0537023
At alpha = 0.05, there <u>is not</u> enough evidence to determine that there is a downward trend.

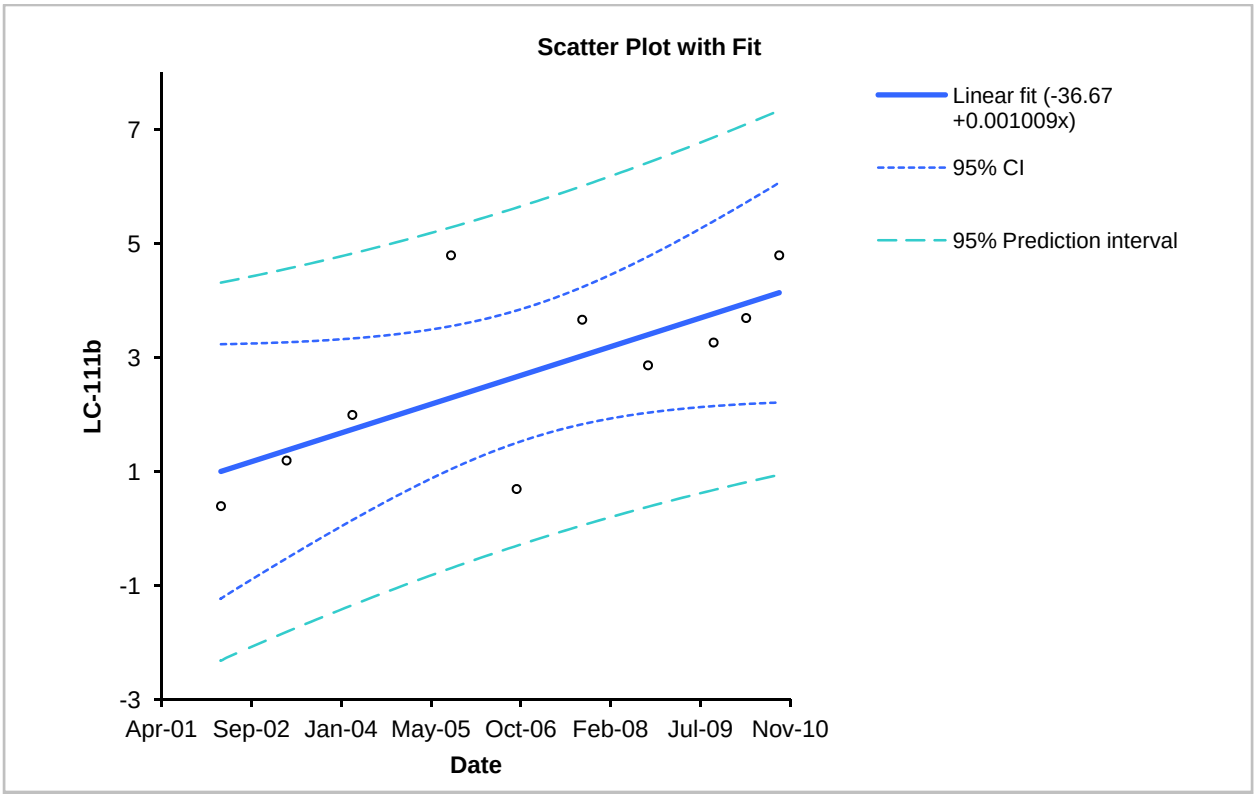
Sen's Slope for UV LC-49 = -4.8

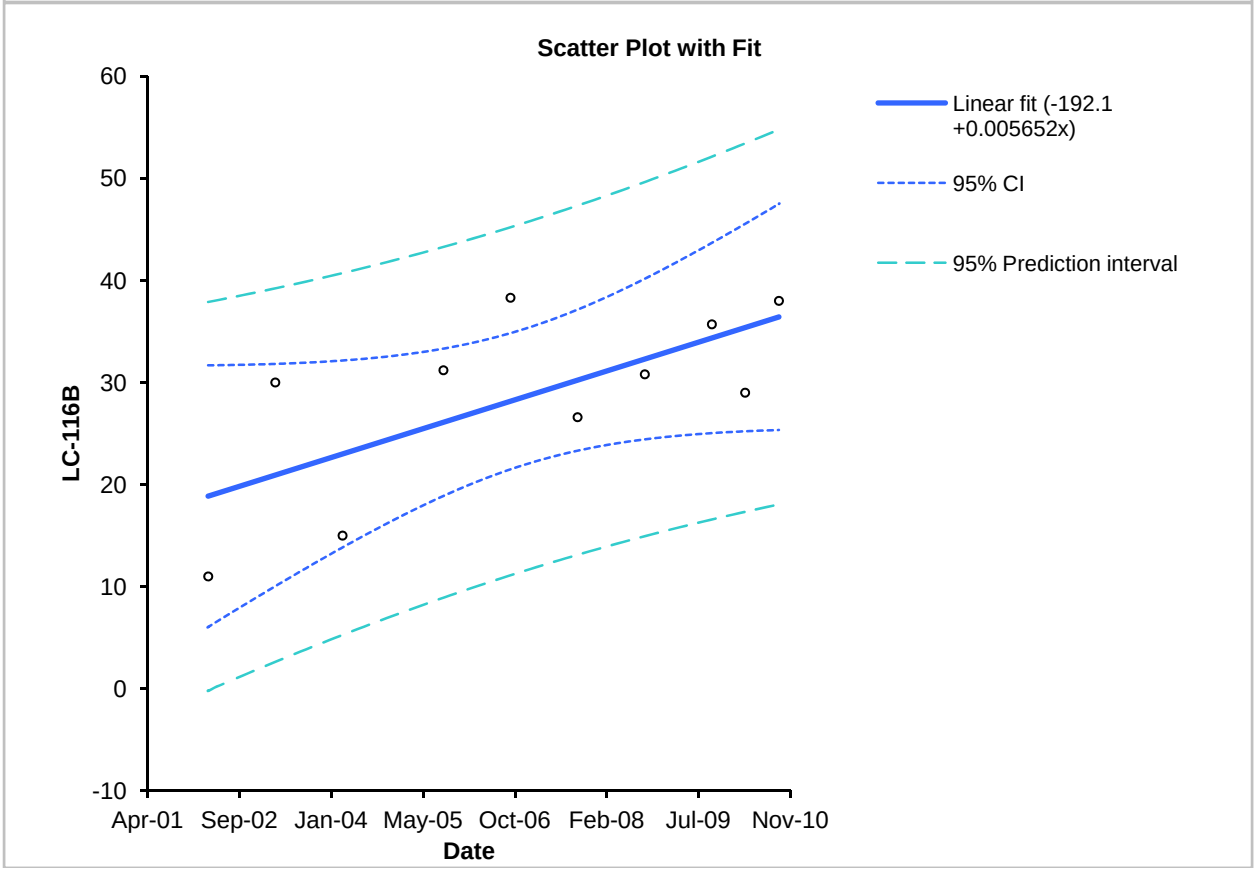

Well Location and Trend Statistics
Statistically Significant Upward Trend
Not Statistically Significant Upward Trend
Not Statistically Significant Downward Trend
Statistically Significant Downward Trend
Data Not Analyzed
0 1,375 2,750 5,500 8,250 11,000
Feet
0 0.2 0.4 0.8 1.2 1.6
Miles
1 inch = 1,500 feet
MAP DATA:
ELLIPSOID: GRS 80
COORDINATE SYSTEM: UTM, Zone 10
HORIZONTAL DATUM: WGS 84
UPPER VASHON AQUIFER
LINEAR REGRESSION MAP
CURRENT TRENDS
2002-2009
Figure
11

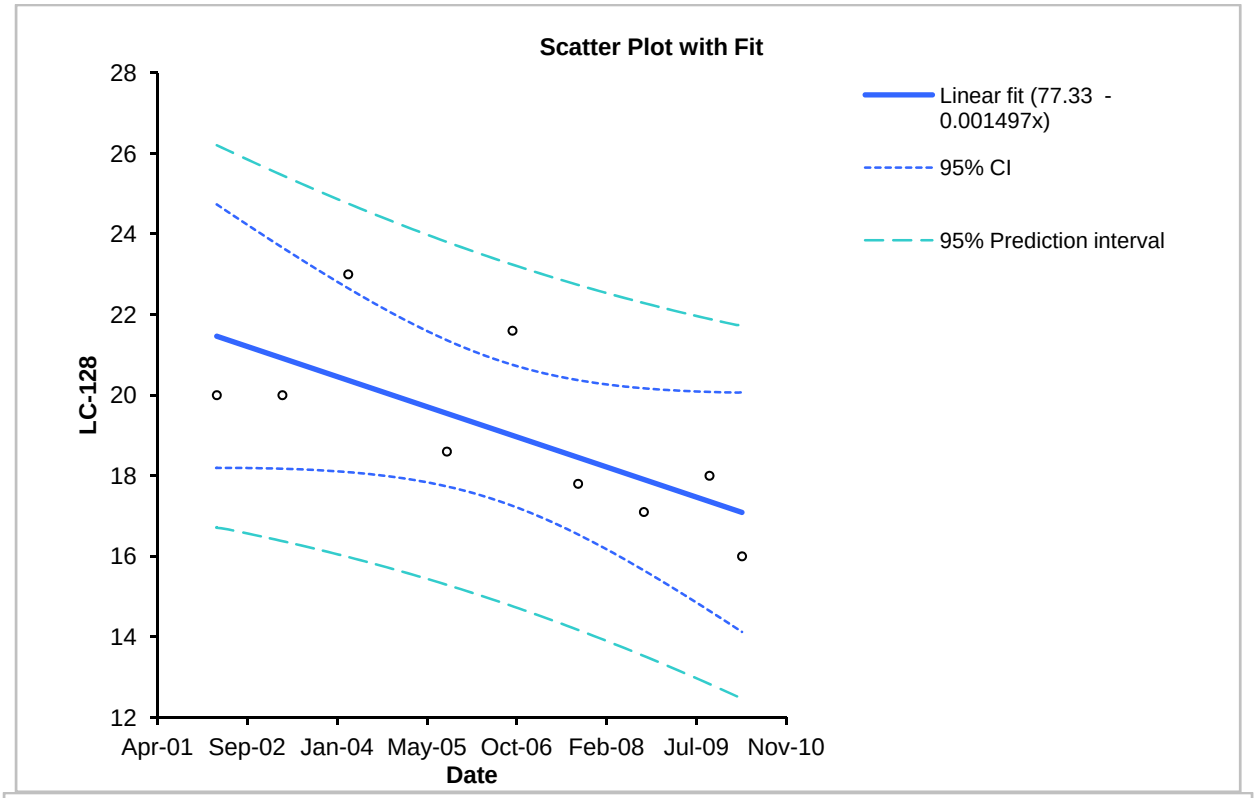
Linear Regression Plots and Map for Lower Vashon Aquifer (Logistics Center)

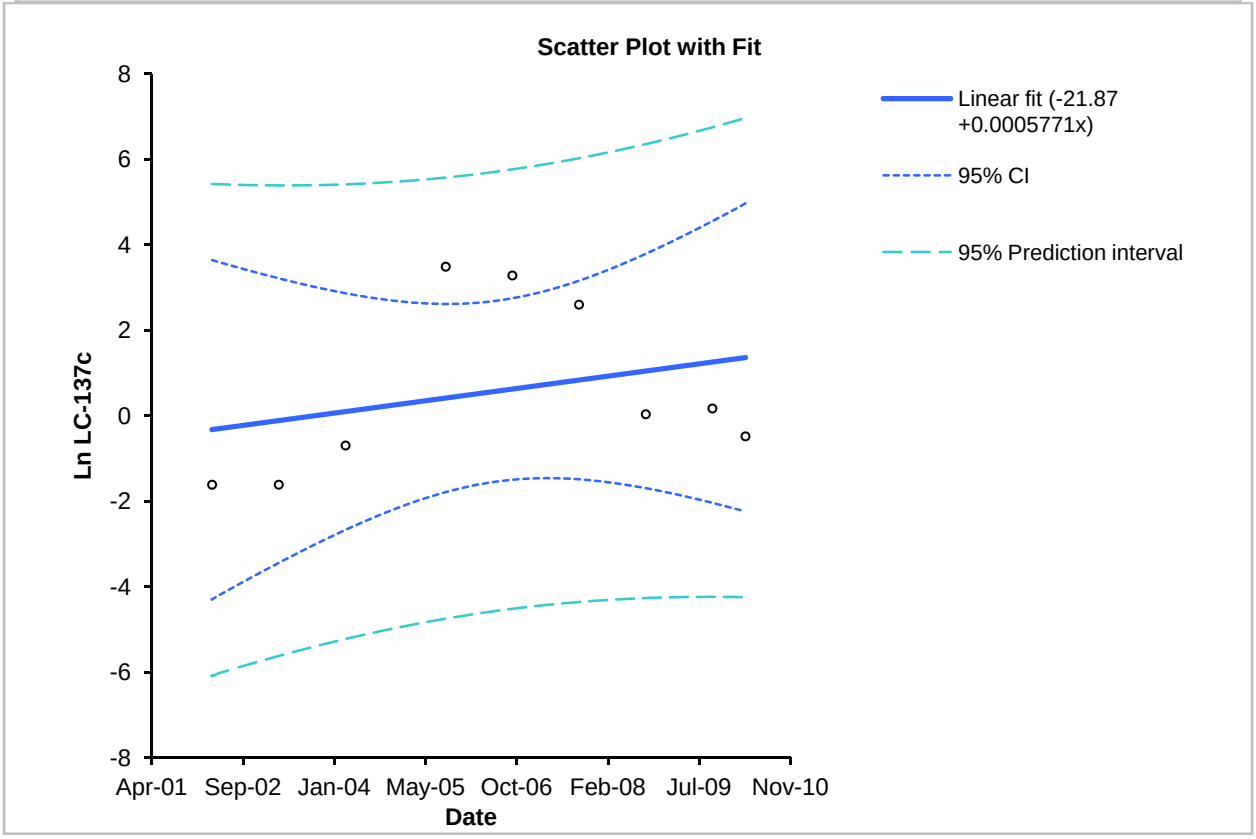

Scatter Plot with Fit
160
140
120
100
80
60
40
20
LC-41B
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (-21.93 +0.002963x)
95% CI
95% Prediction interval

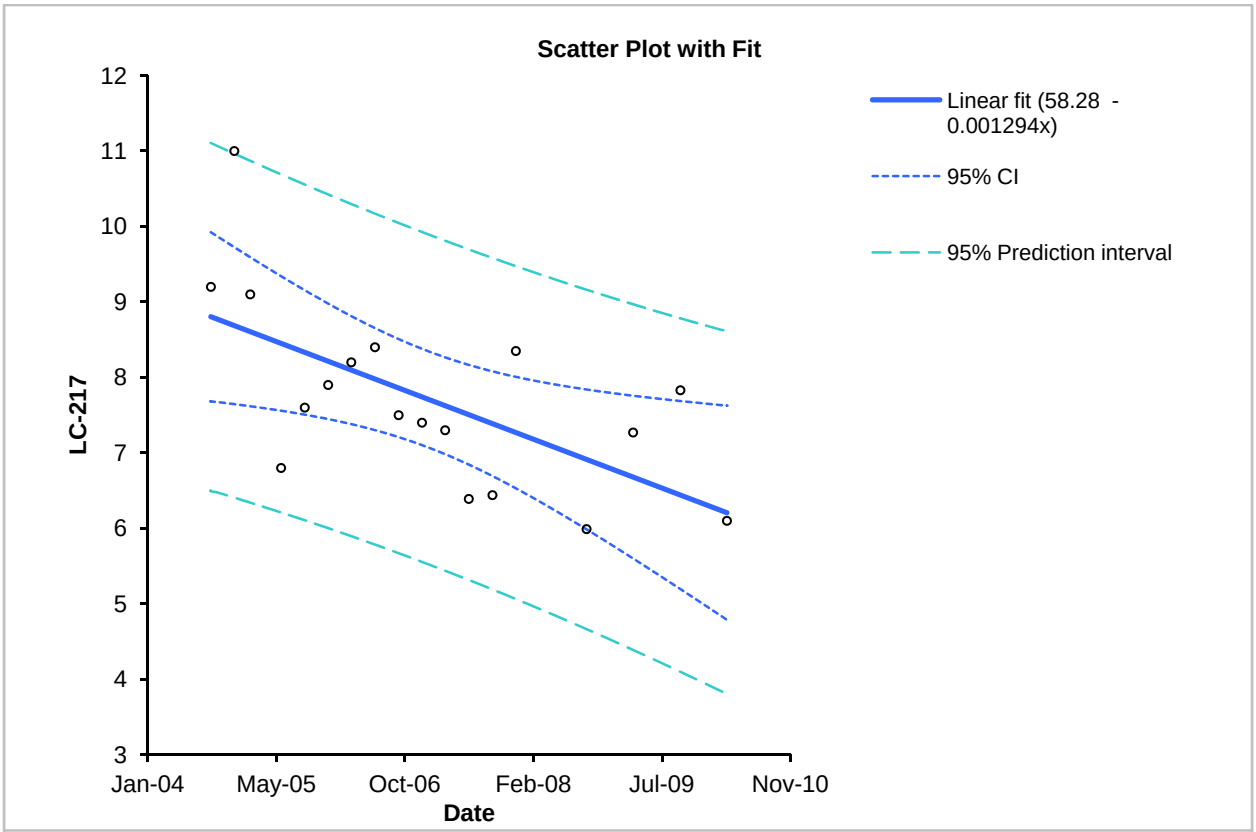

Scatter Plot with Fit
7
6
5
4
3
2
1
0
-1
-2
Ln LC-64b
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (29.38 - 0.0006902x)
95% CI
95% Prediction interval

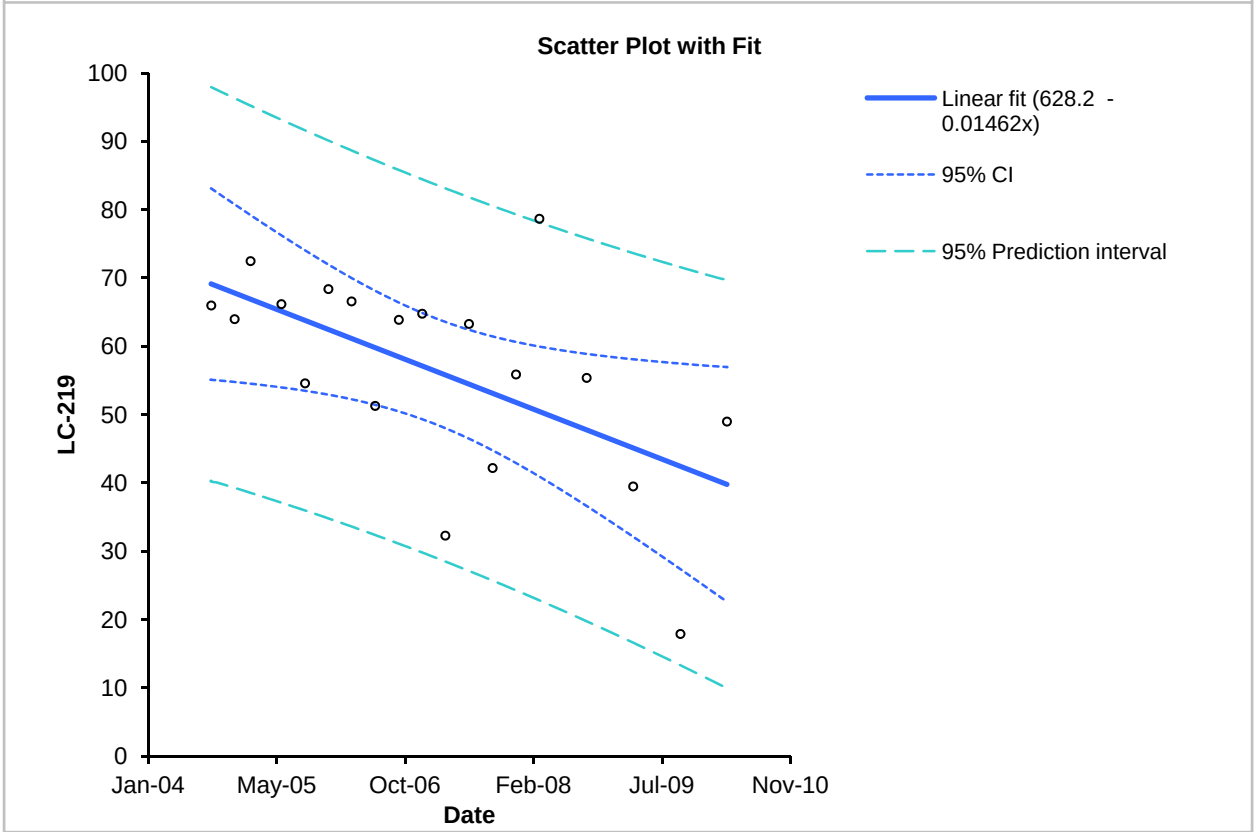

Scatter Plot with Fit
LC-111b
7
5
3
1
-1
-3
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (-36.67 +0.001009x)
95% CI
95% Prediction interval

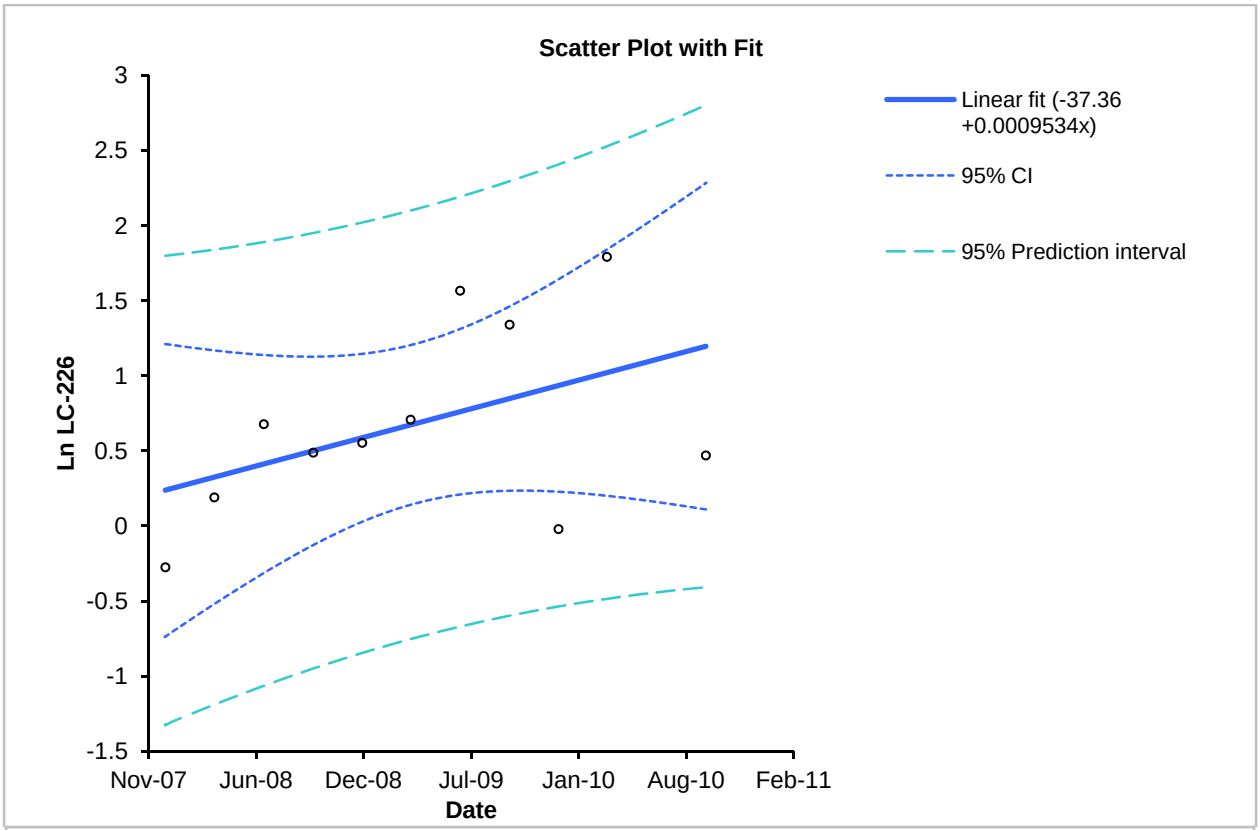

Scatter Plot with Fit
LC-116B
60
50
40
30
20
10
0
-10
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (-192.1 +0.005652x)
95% CI
95% Prediction interval

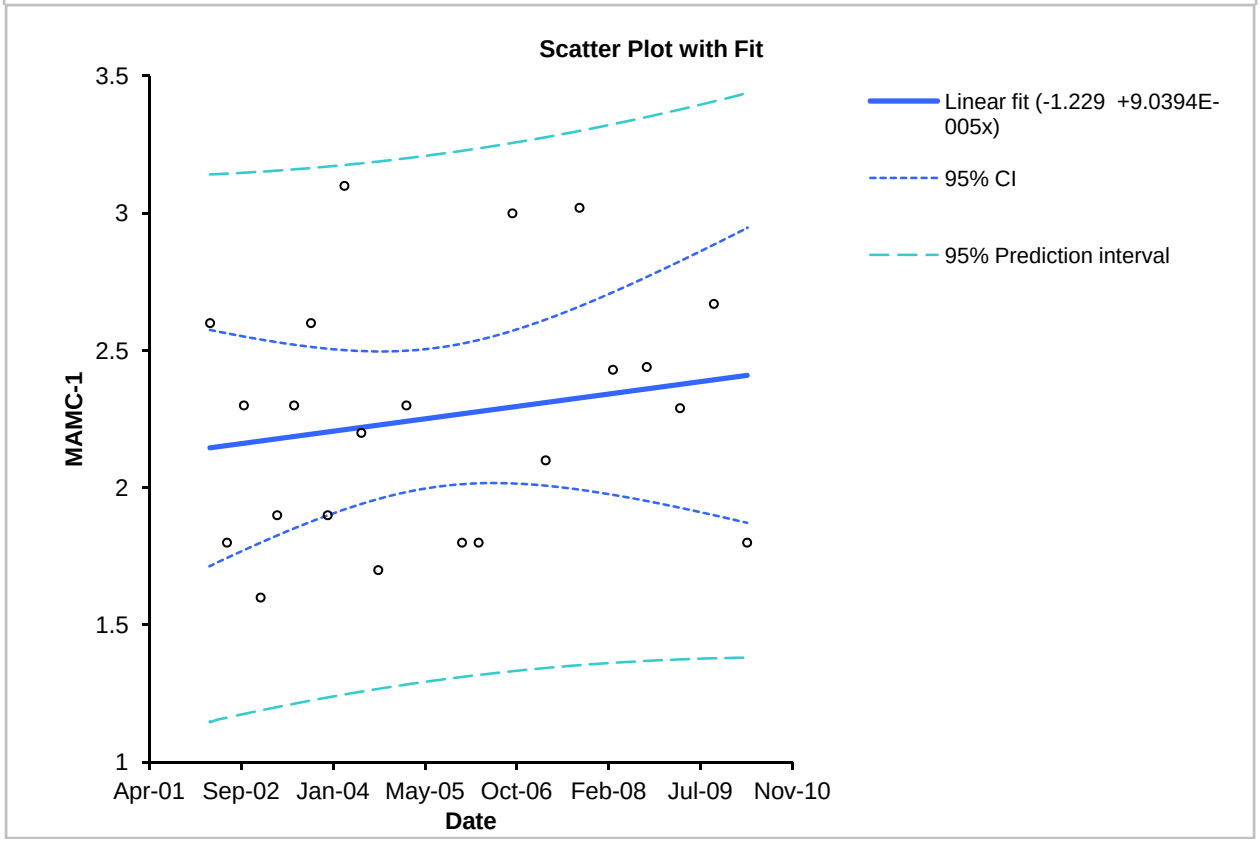

Scatter Plot with Fit
LC-128
28
26
24
22
20
18
16
14
12
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (77.33 - 0.001497x)
95% CI
95% Prediction interval

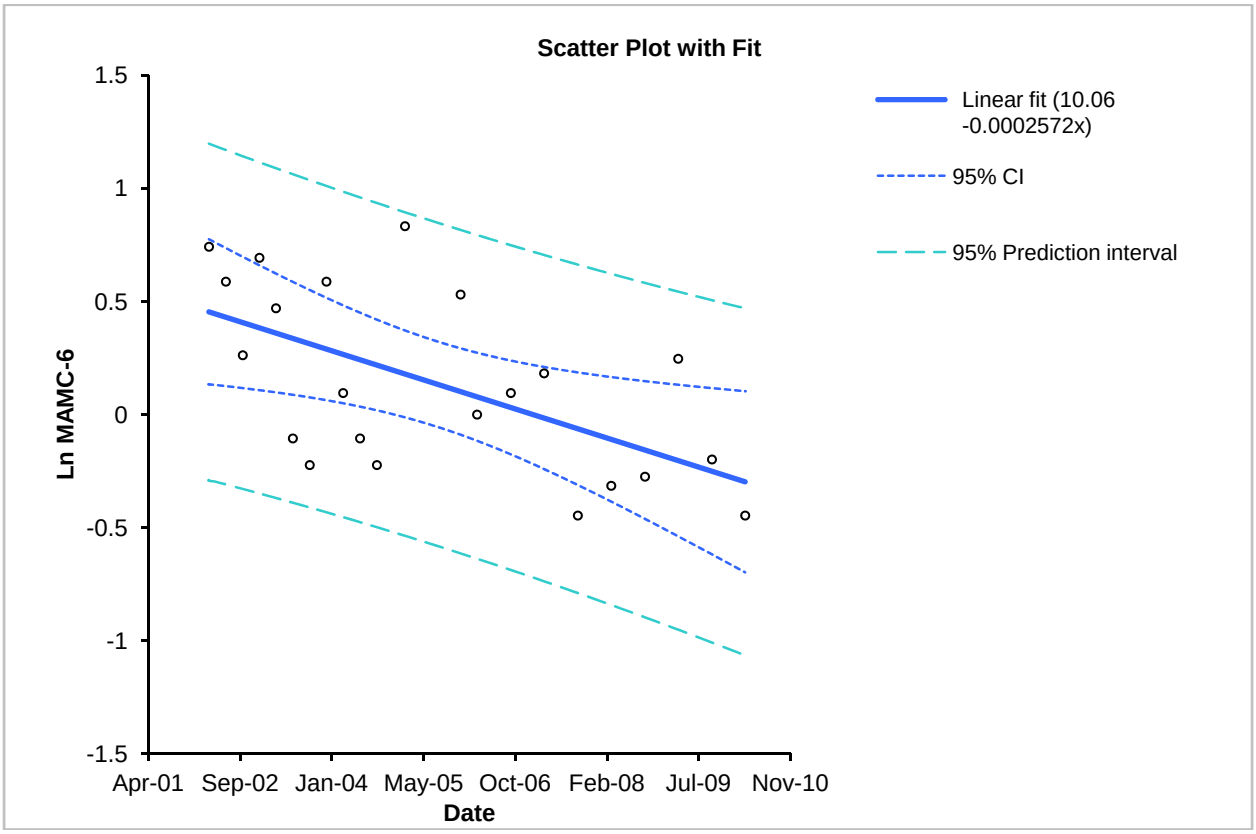

Scatter Plot with Fit
Ln LC-137c
8
6
4
2
0
-2
-4
-6
-8
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (-21.87 +0.0005771x)
95% CI
95% Prediction interval

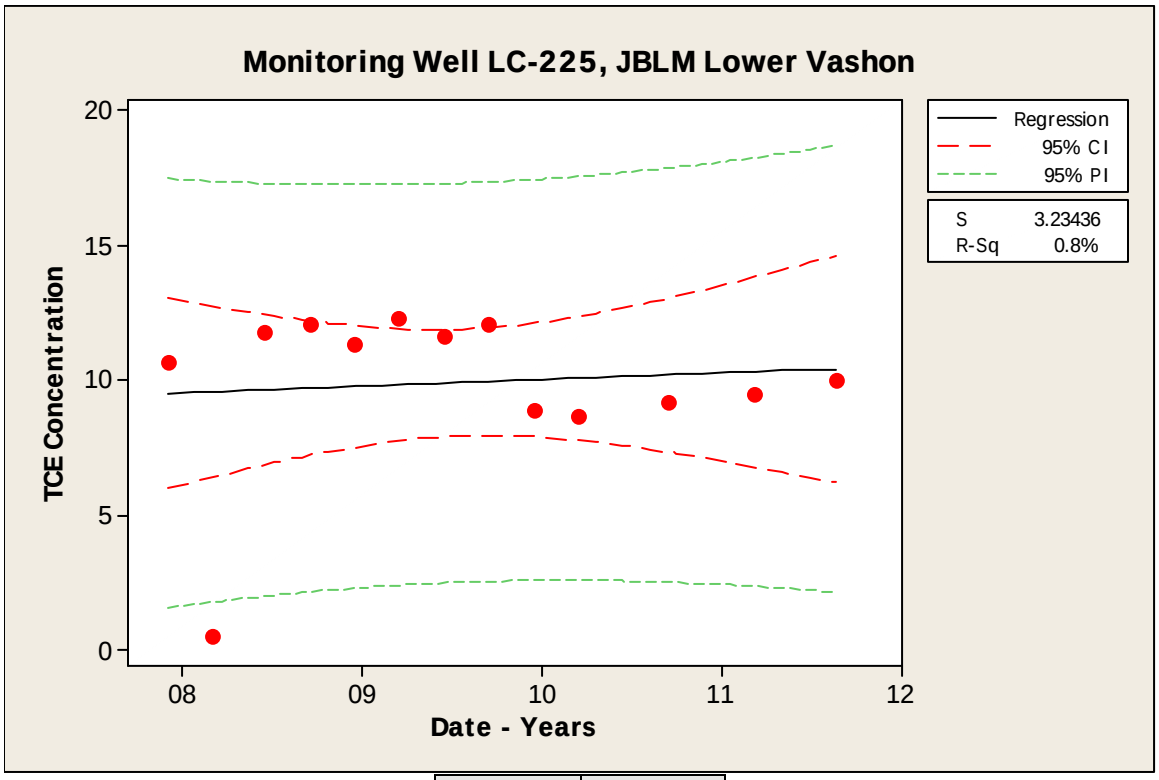

Scatter Plot with Fit
LC-217
Date
12
11
10
9
8
7
6
5
4
3
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Linear fit (58.28 - 0.001294x)
95% CI
95% Prediction interval


Scatter Plot with Fit
LC-219
Date
100
90
80
70
60
50
40
30
20
10
0
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Linear fit (628.2 - 0.01462x)
95% CI
95% Prediction interval


Scatter Plot with Fit
Ln LC-226
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
Nov-07
Jun-08
Dec-08
Jul-09
Jan-10
Aug-10
Feb-11
Date
Linear fit (-37.36 +0.0009534x)
95% CI
95% Prediction interval


Scatter Plot with Fit
MAMC-1
3.5
3
2.5
2
1.5
1
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (-1.229 +9.0394E-005x)
95% CI
95% Prediction interval


Scatter Plot with Fit
1.5
1
0.5
0
-0.5
-1
-1.5
Ln MAMC-6
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (10.06 -0.0002572x)
95% CI
95% Prediction interval

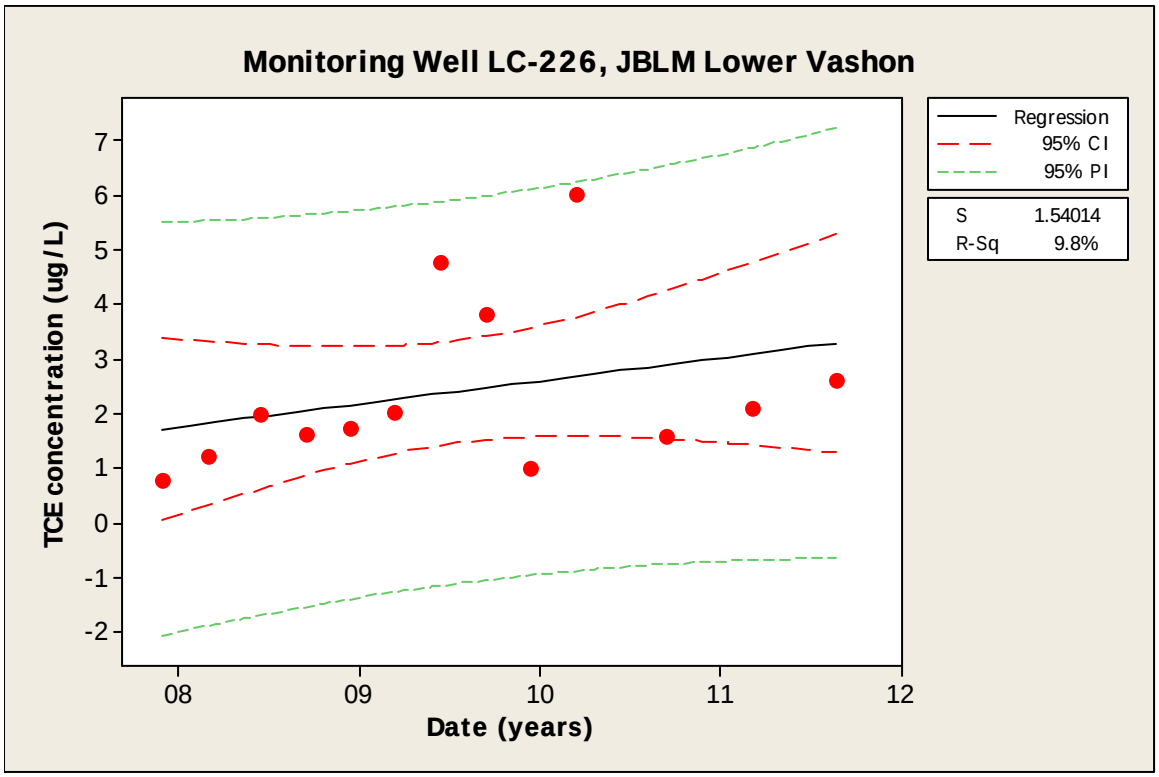


Date	TCE µg/L
Dec-07	10.7
Mar-08	0.5
Jun-08	11.8
Sep-08	12.1
Dec-08	11.3
Mar-09	12.3
Jun-09	11.6
Sep-09	12.1
Dec-09	8.9
Mar-10	8.7
Sep-10	9.2
Mar-11	9.5
Aug-11	10

Using the Mann-Kendall Trend Test by Normal Approximation at 95% confidence interval
For Ha: Upperward trend, the p-value = 0.687573
At alpha = 0.05, there is <u>not enough</u> evidence to determine that there is an upward trend.

For Ha: Downward trend, the p-value = 0.312427
At alpha = 0.05, there is <u>not enough</u> evidence to determine that there is a downward trend.

For Senslope: Sen's Slope for Concentration = -0.129545 (ug/L)

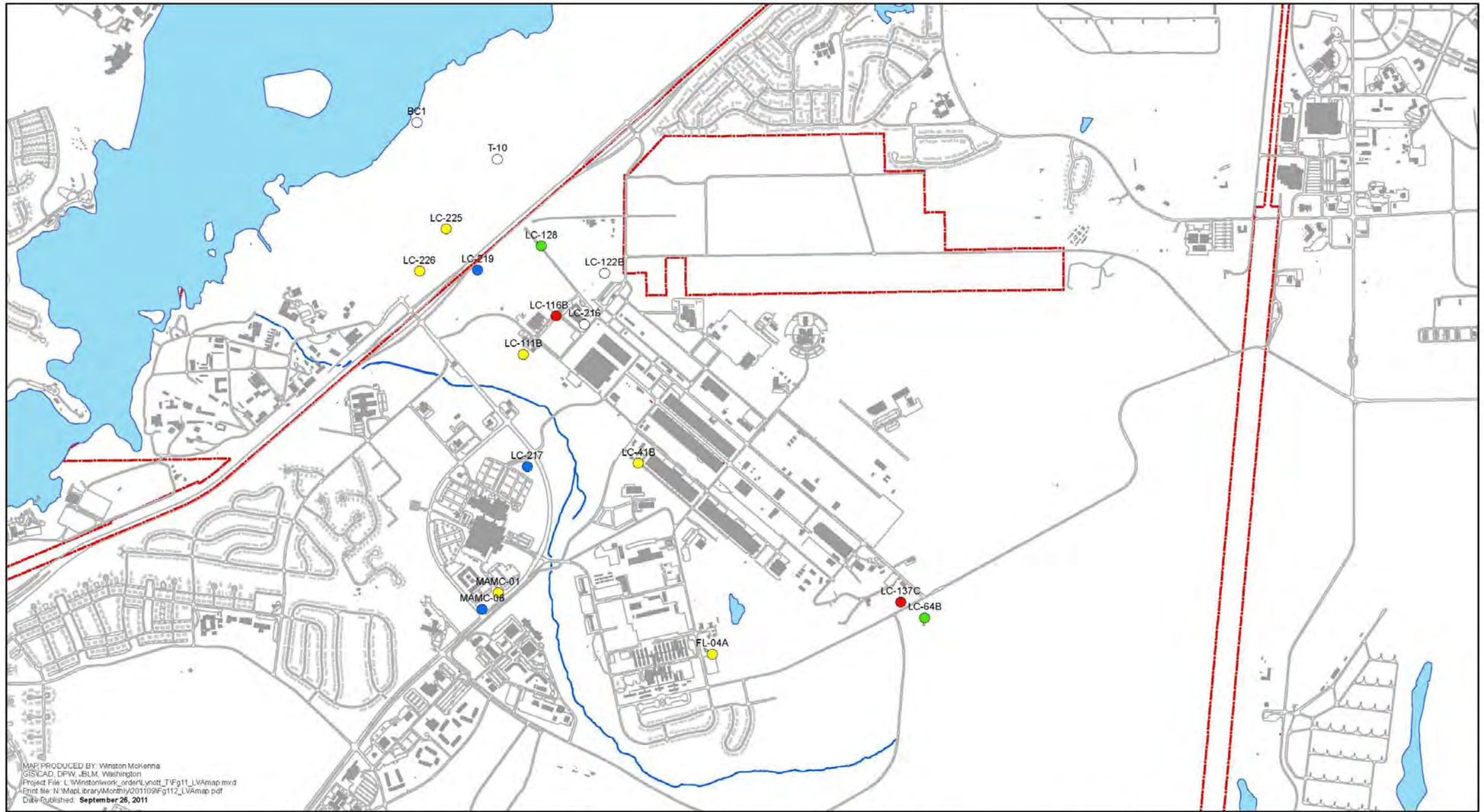


Date	TCE µg/L
Dec-07	0.76
Mar-08	1.21
Jun-08	1.97
Sep-08	1.63
Dec-08	1.74
Mar-09	2.03
Jun-09	4.79
Sep-09	3.82
Dec-09	0.98
Mar-10	6
Sep-10	1.6
Mar-11	2.1
Aug-11	2.6

Using the Mann-Kendall Trend Test by Normal Approximation at 95% confidence interval
For Ha: Upperward trend, the p-value = 0.0292938
At alpha = 0.05, there is enough evidence to determine that there is an upward trend.

For Ha: Downward trend, the p-value = 0.970706
At alpha = 0.05, there is not enough evidence to determine that there is a downward trend.

Using Senslope: Sen's Slope for LC-226 = 0.139848 (ug/L)



Well Location and Trend Statistics

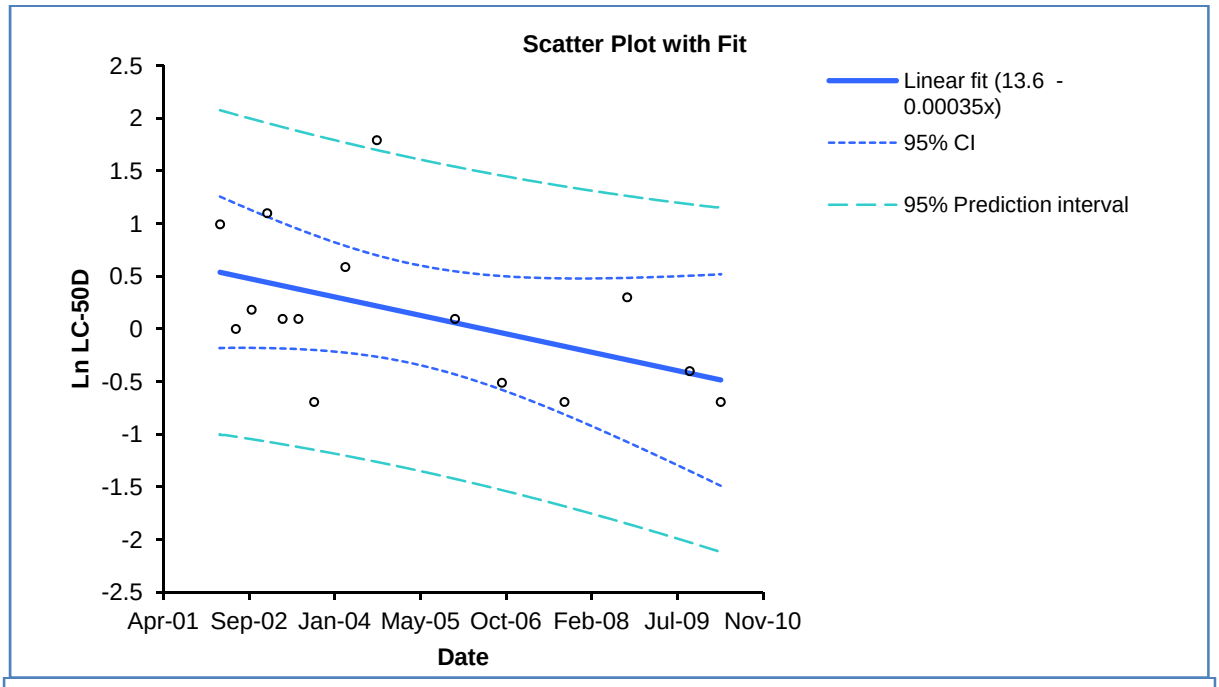
- Statistically Significant Upward Trend
- Not Statistically Significant Upward Trend
- Not Statistically Significant Downward Trend
- Statistically Significant Downward Trend
- Data Not Analyzed

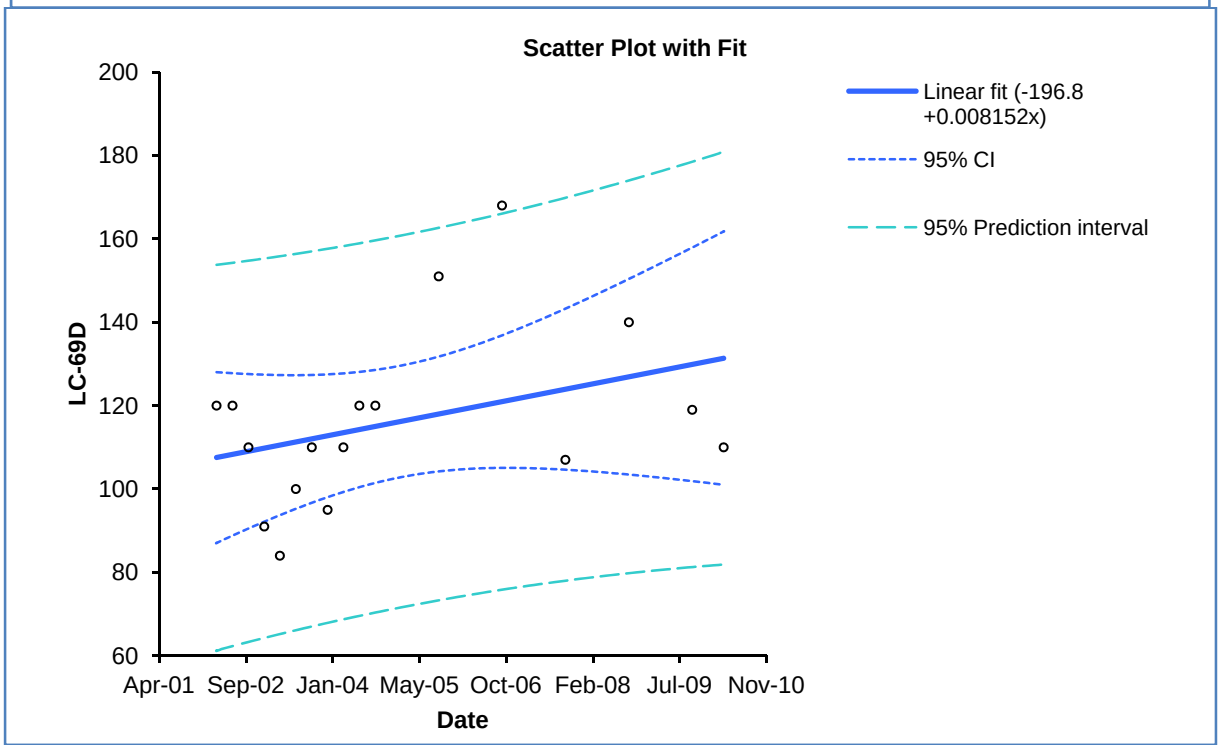
0 1,375 2,750 5,500 8,250 11,000
Feet
0 0.2 0.4 0.8 1.2 1.6
Miles
1 inch = 1,500 feet
MAP DATA:
ELLIPSOID: GRS 80
COORDINATE SYSTEM: UTM, Zone 10
HORIZONTAL DATUM: WGS 84

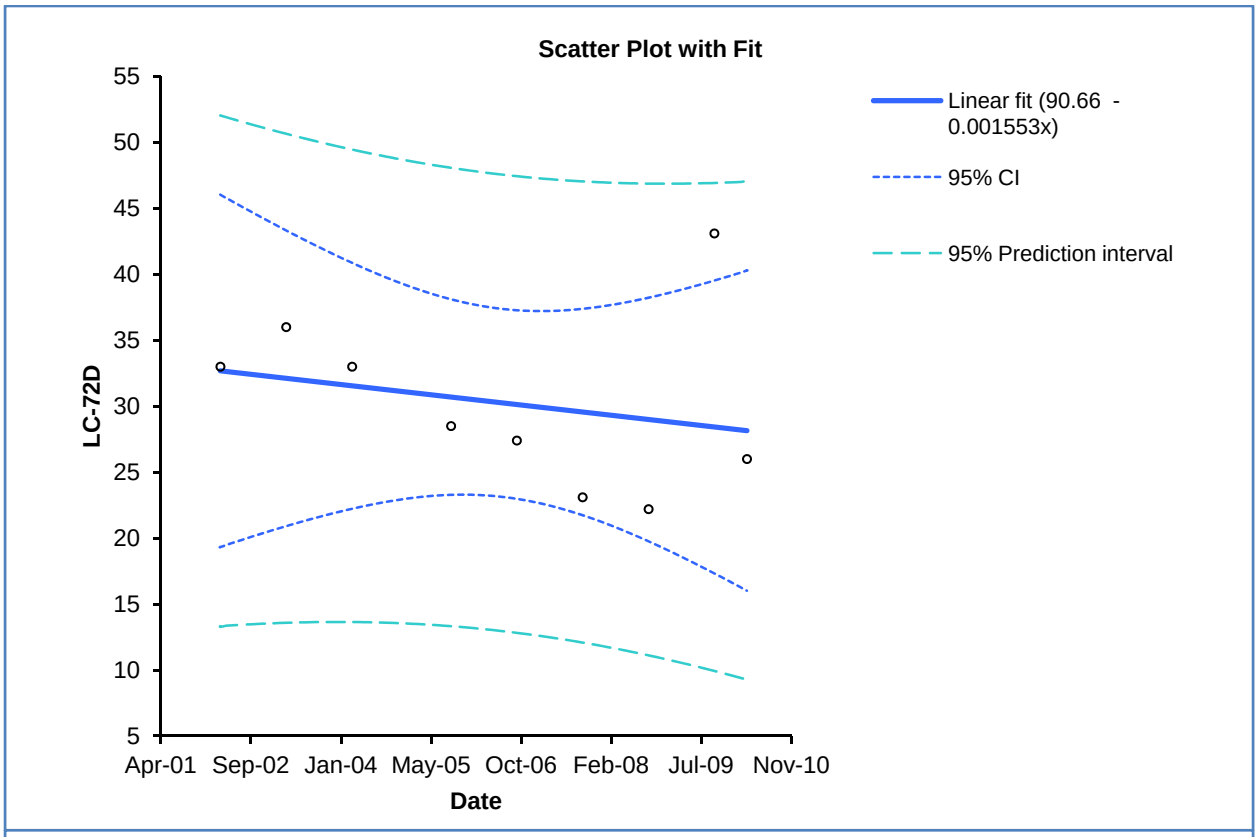
LOWER VASHON AQUIFER
LINEAR REGRESSION MAP
CURRENT TRENDS
2002-2009

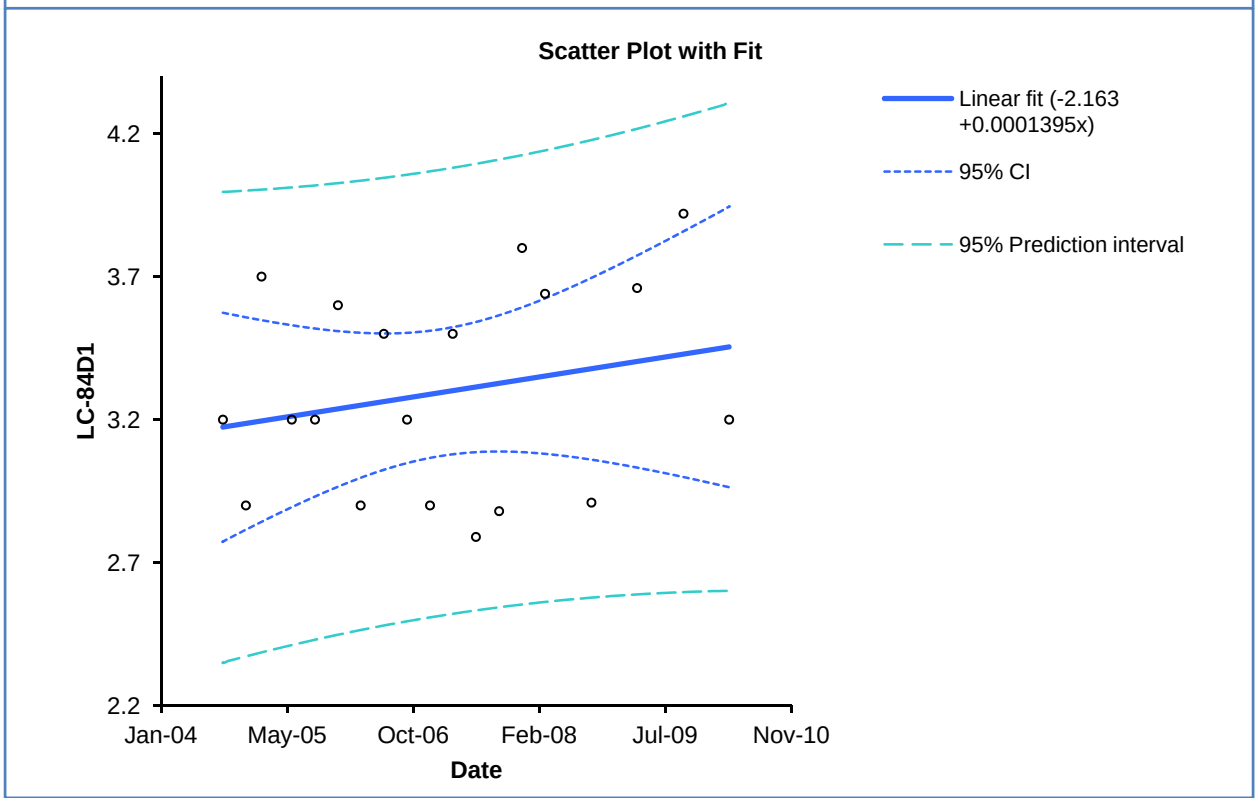
Figure
12

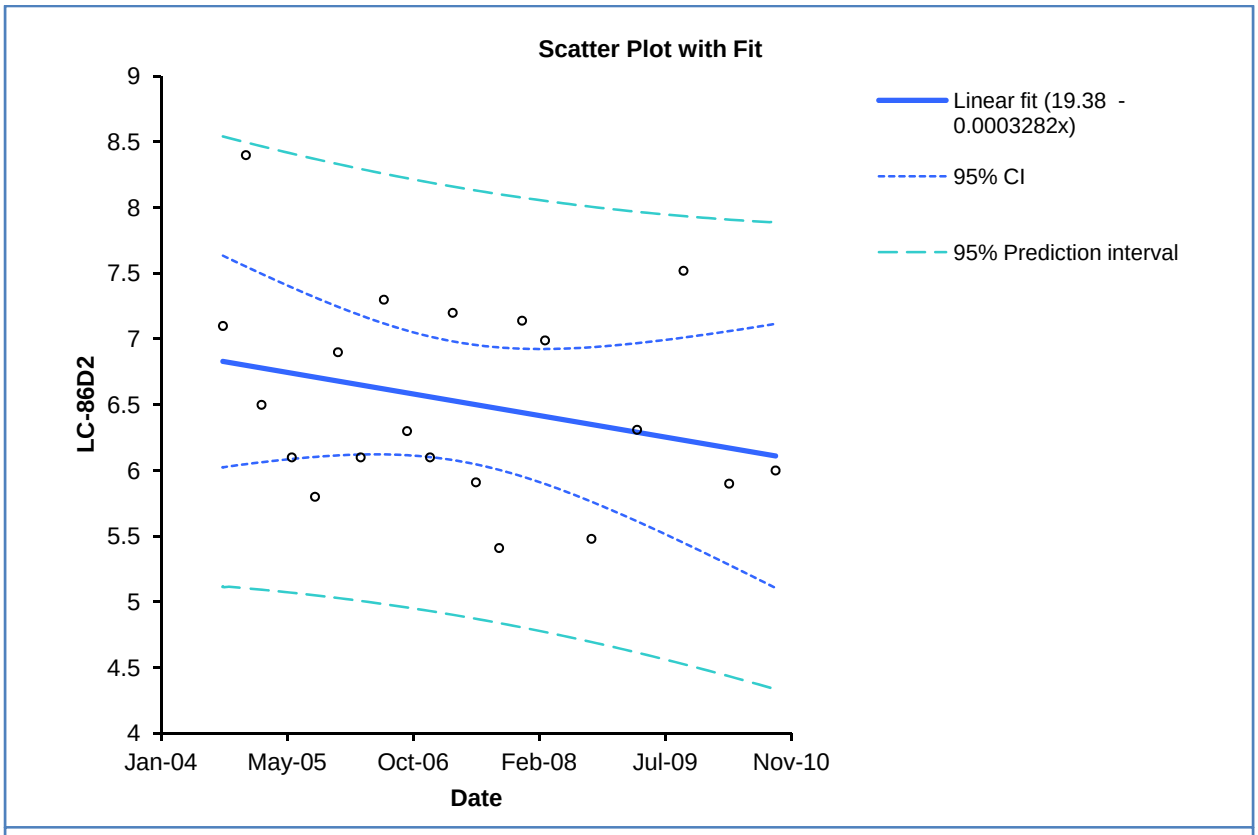
Linear Regression Plots and Map for Sea Level Aquifer (Logistics Center)

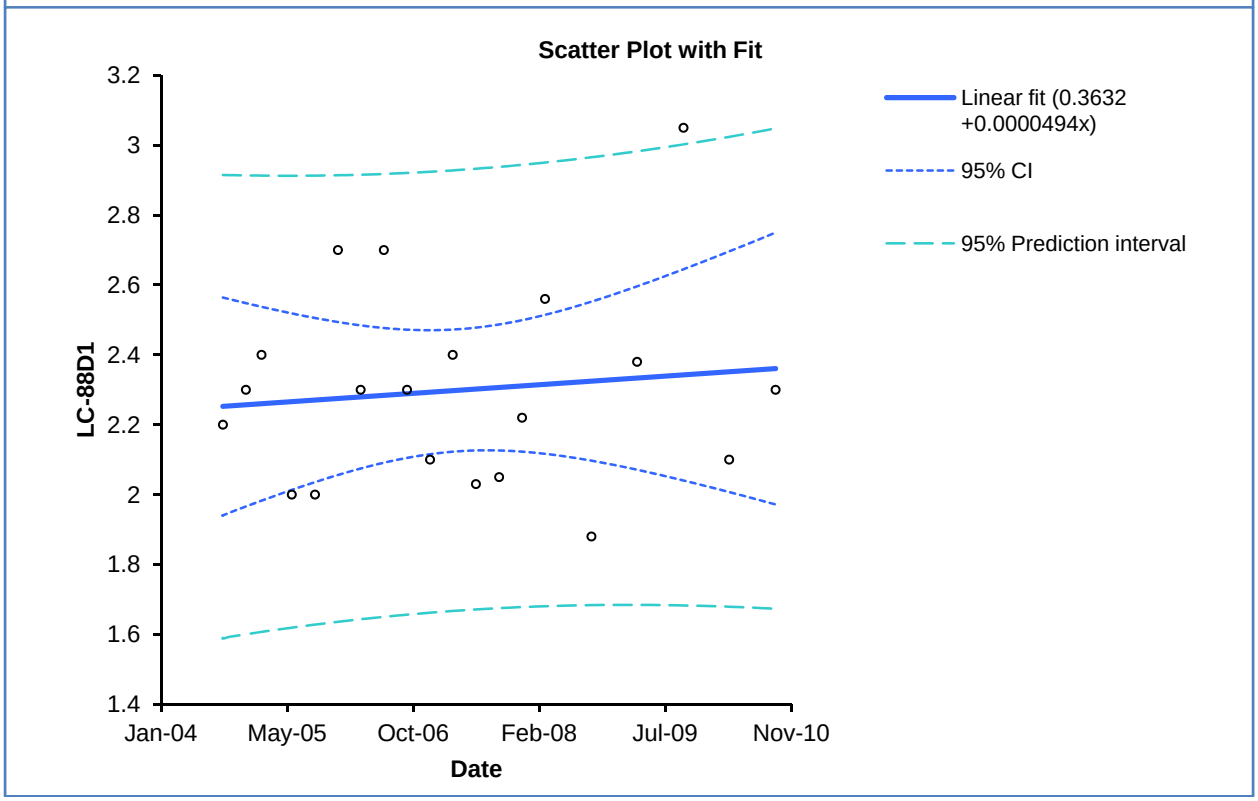

Scatter Plot with Fit
Ln LC-50D
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (13.6 - 0.00035x)
95% CI
95% Prediction interval

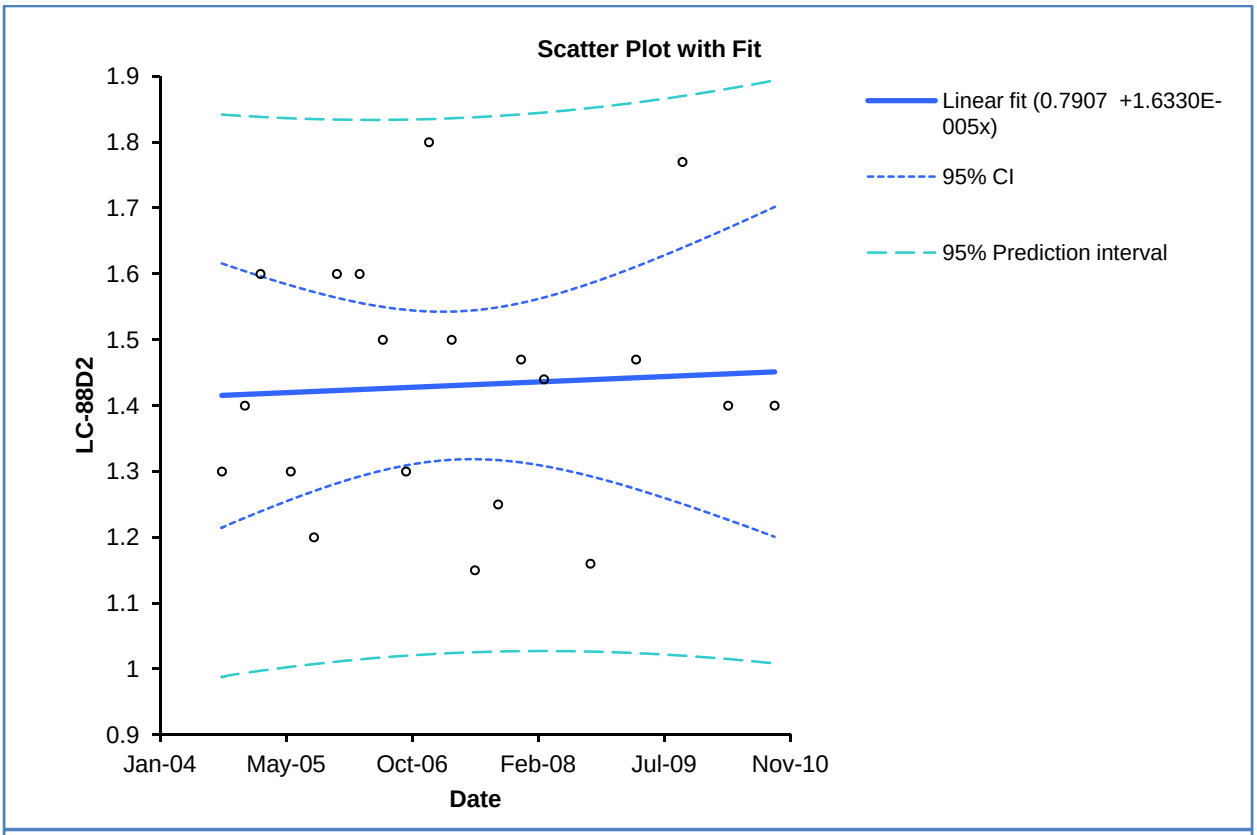

Scatter Plot with Fit
LC-69D
200
180
160
140
120
100
80
60
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (-196.8 +0.008152x)
95% CI
95% Prediction interval

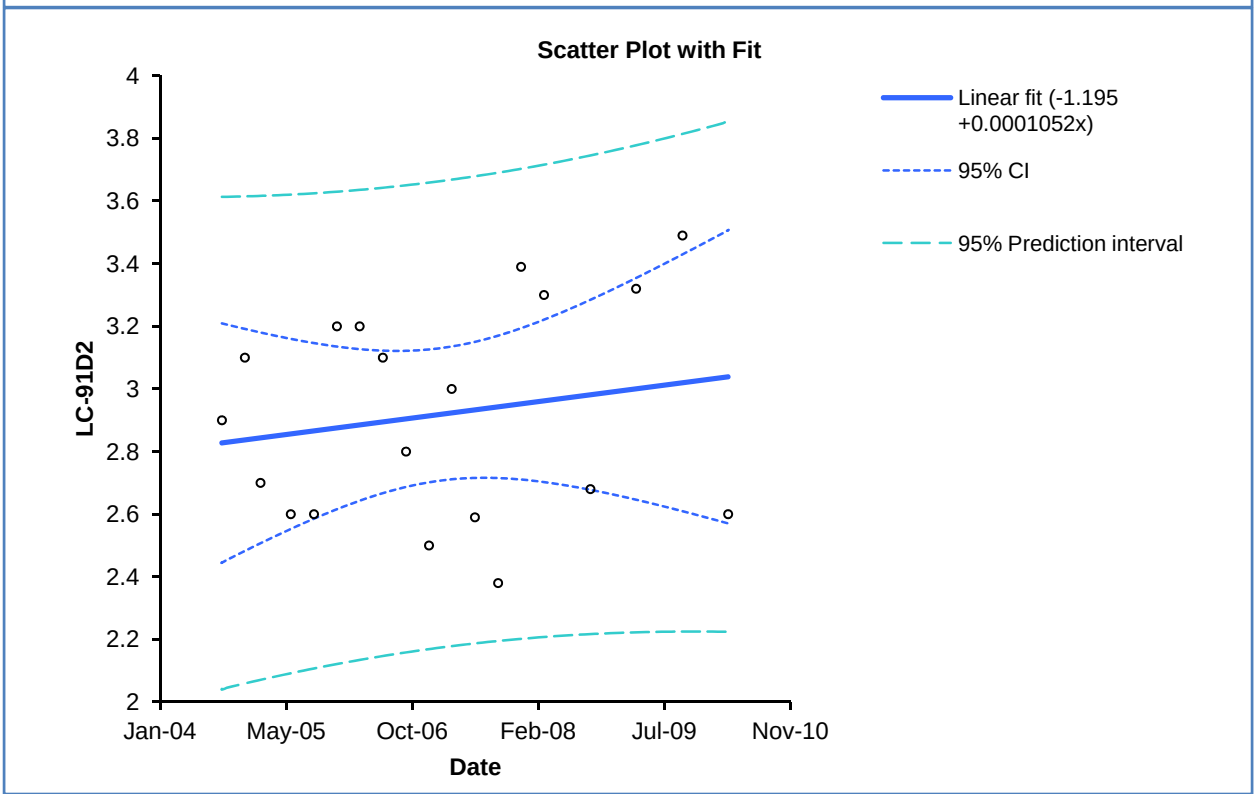

Scatter Plot with Fit
LC-72D
55
50
45
40
35
30
25
20
15
10
5
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (90.66 - 0.001553x)
95% CI
95% Prediction interval

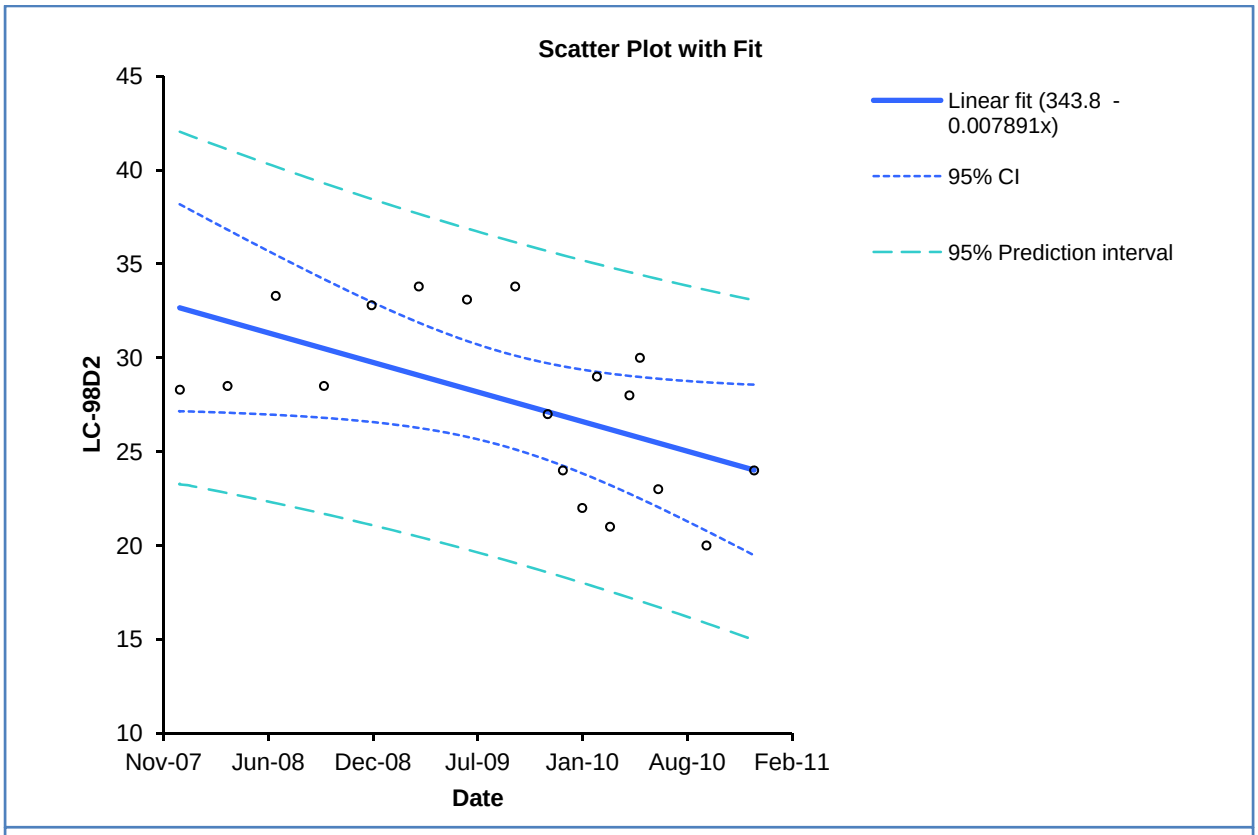

Scatter Plot with Fit
LC-84D1
4.2
3.7
3.2
2.7
2.2
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (-2.163 +0.0001395x)
95% CI
95% Prediction interval

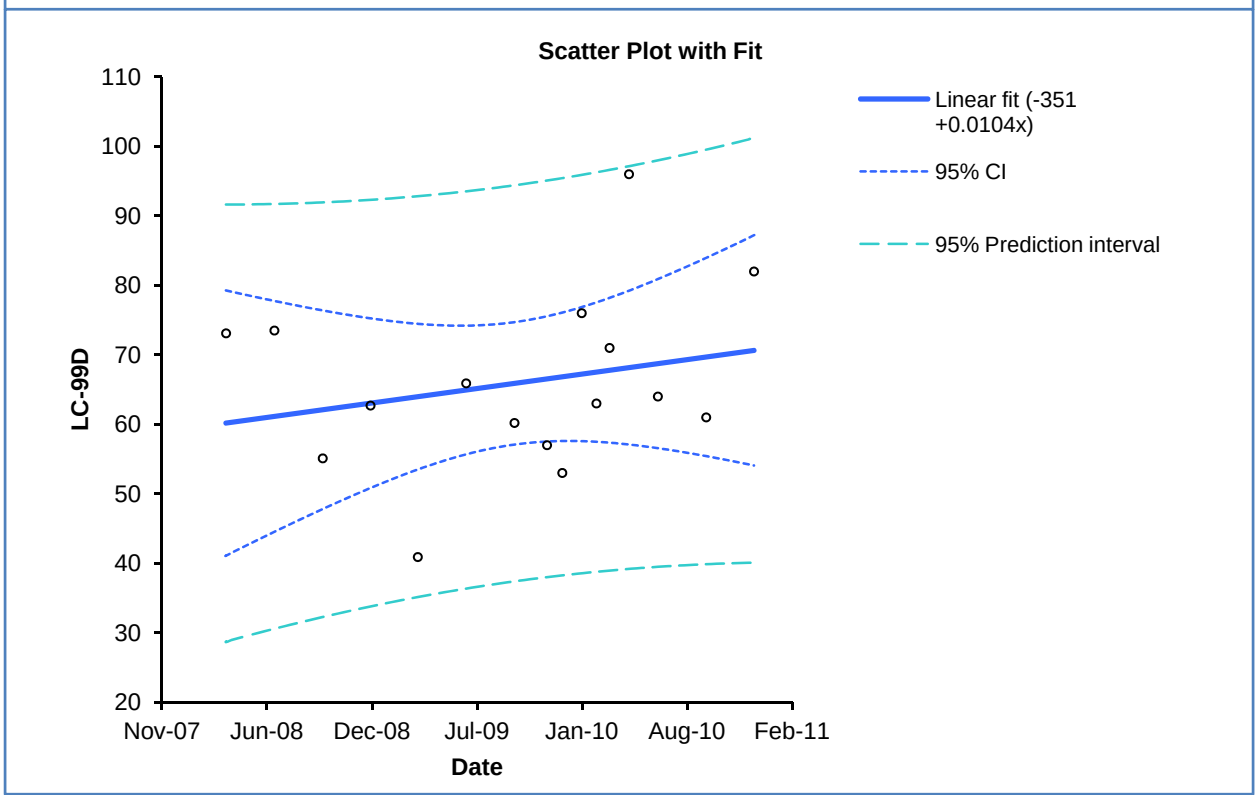

Scatter Plot with Fit
LC-86D2
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (19.38 - 0.0003282x)
95% CI
95% Prediction interval

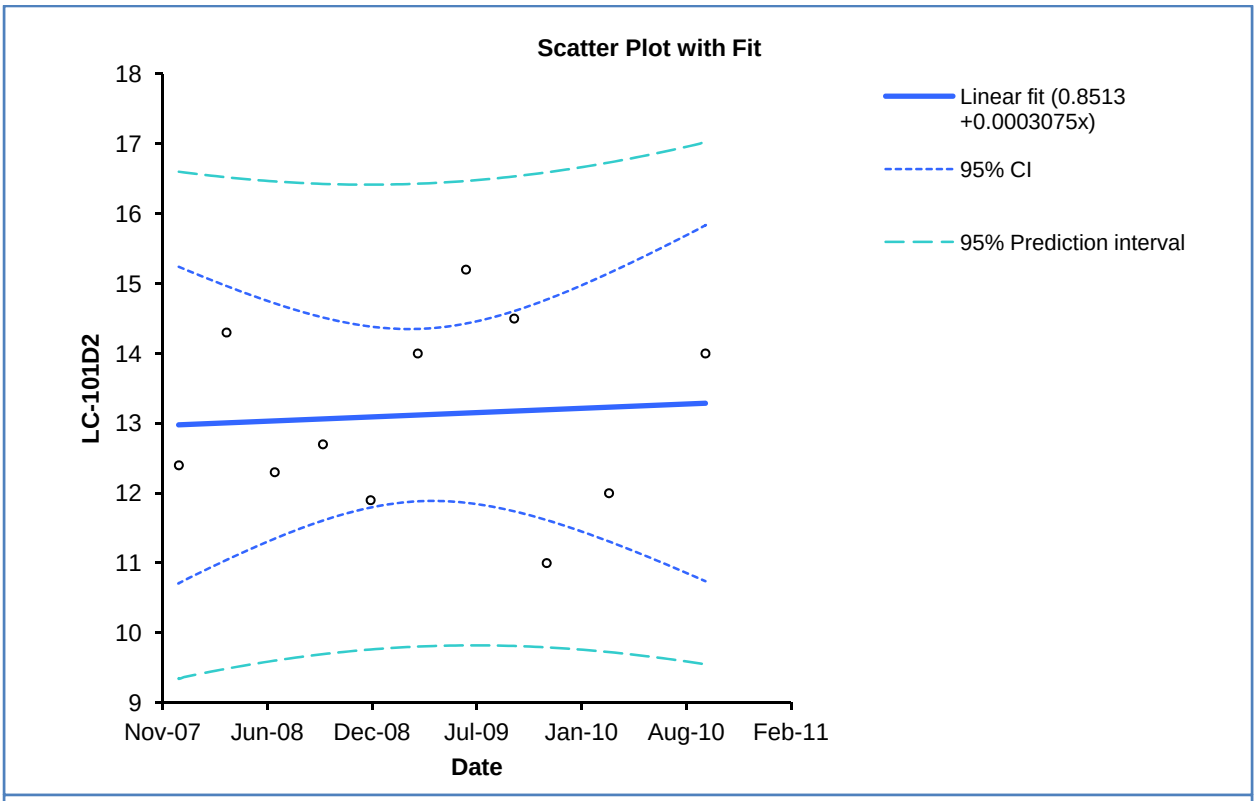

Scatter Plot with Fit
LC-88D1
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (0.3632 +0.0000494x)
95% CI
95% Prediction interval

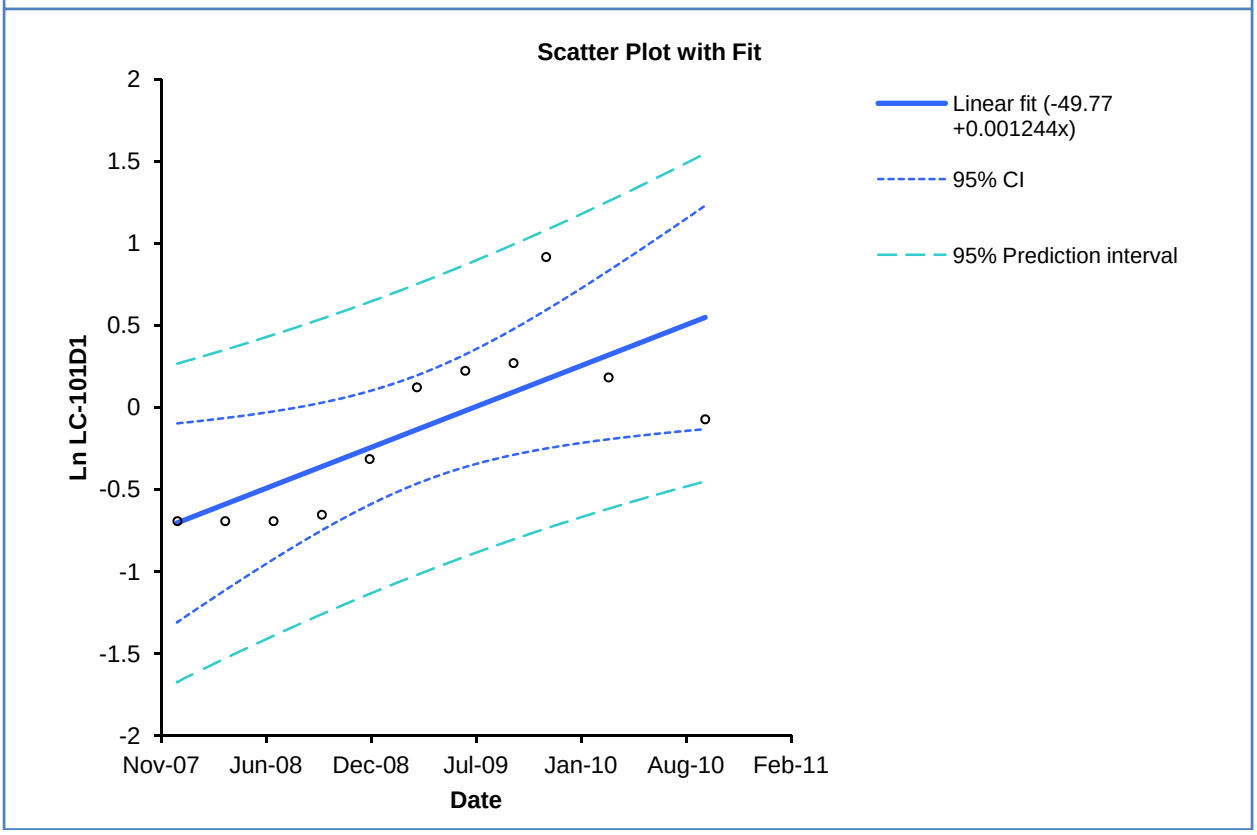

Scatter Plot with Fit
LC-88D2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (0.7907 +1.6330E-005x)
95% CI
95% Prediction interval

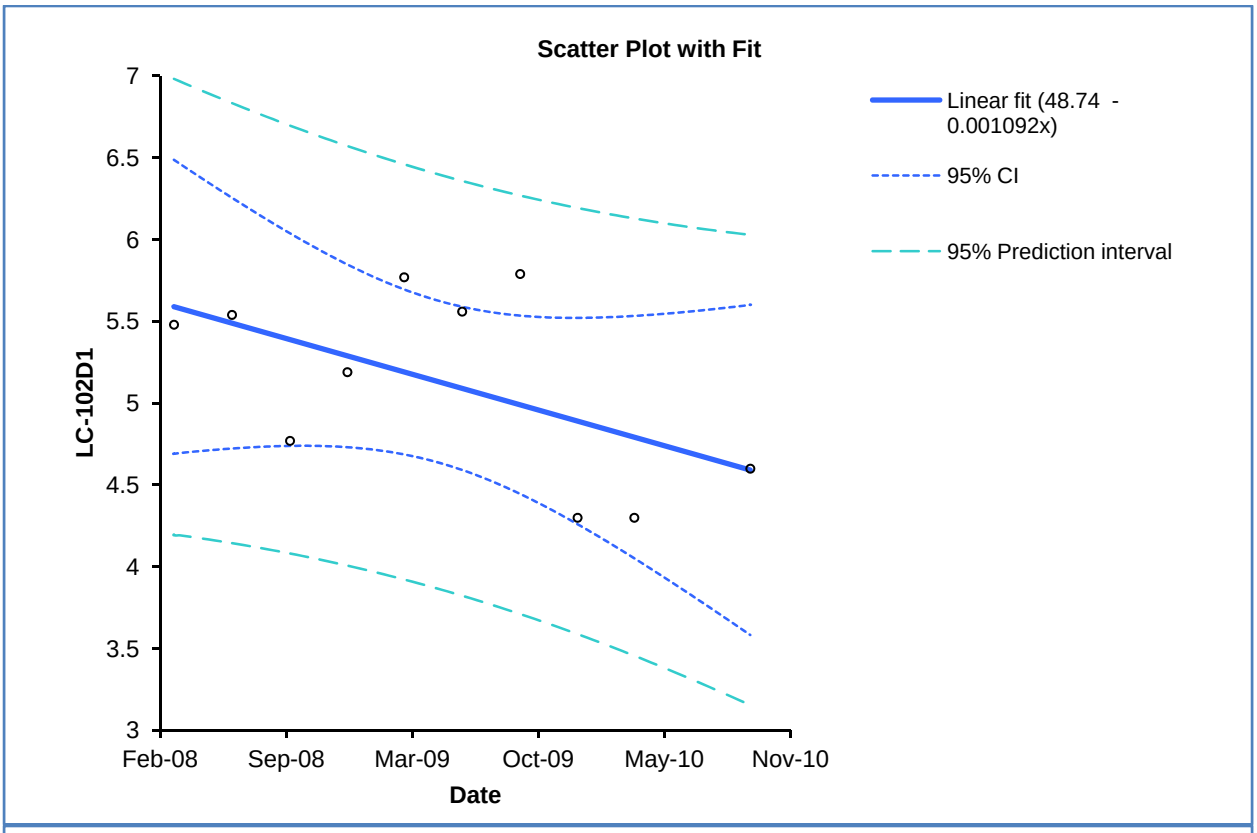

Scatter Plot with Fit
LC-91D2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (-1.195 +0.0001052x)
95% CI
95% Prediction interval

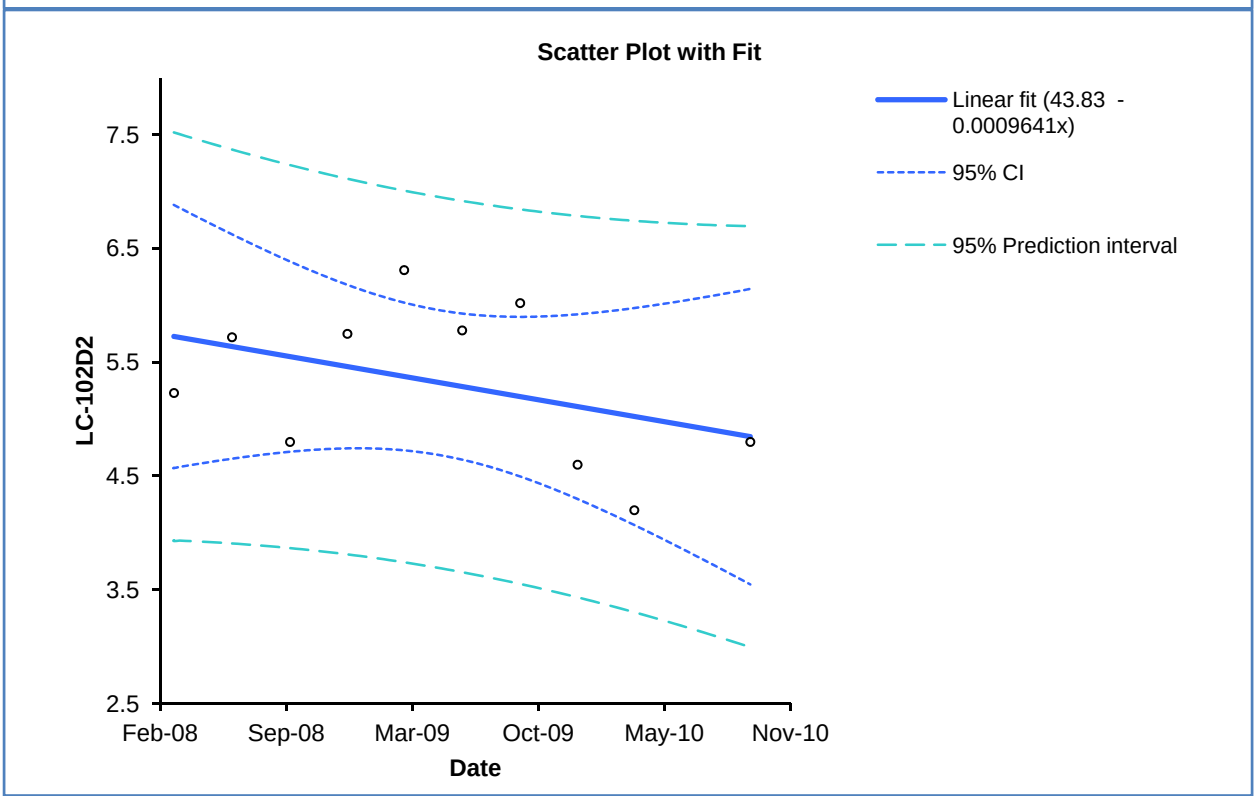

Scatter Plot with Fit
LC-98D2
45
40
35
30
25
20
15
10
Nov-07
Jun-08
Dec-08
Jul-09
Jan-10
Aug-10
Feb-11
Date
Linear fit (343.8 - 0.007891x)
95% CI
95% Prediction interval

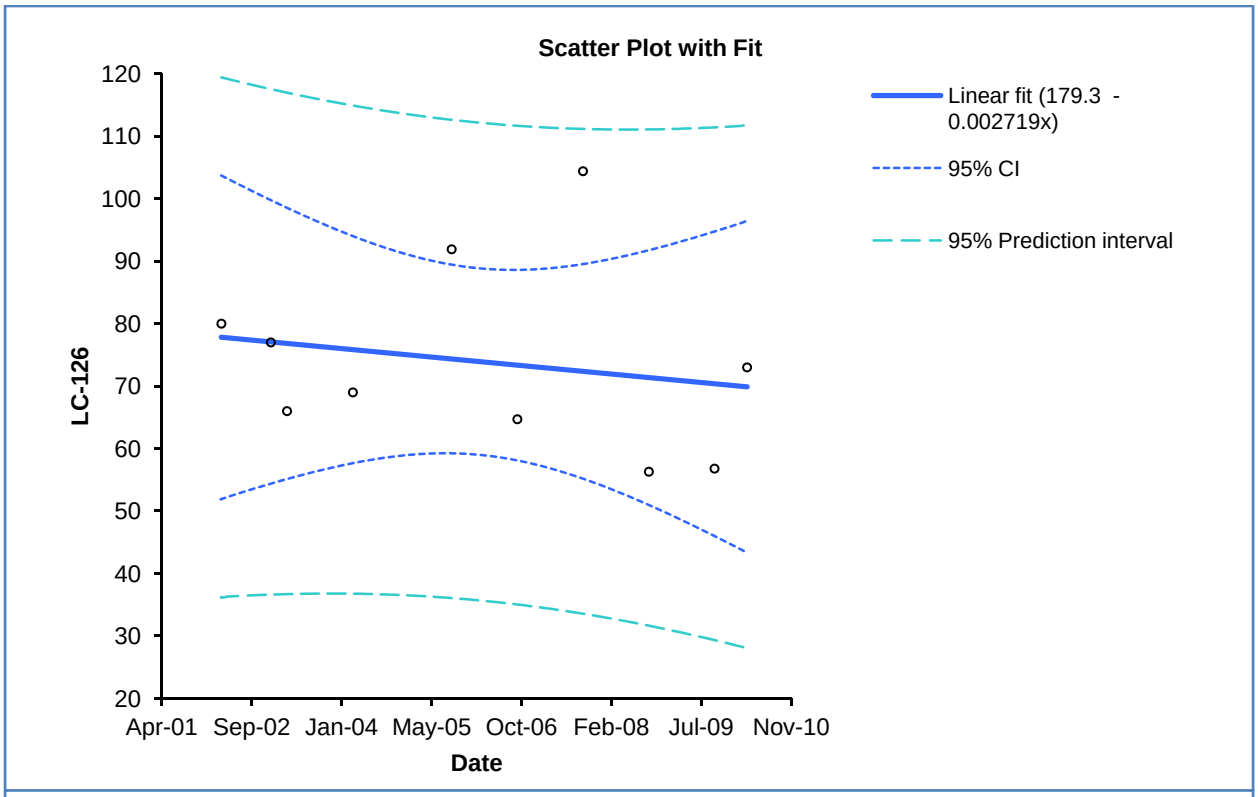

Scatter Plot with Fit
LC-99D
110
100
90
80
70
60
50
40
30
20
Nov-07
Jun-08
Dec-08
Jul-09
Jan-10
Aug-10
Feb-11
Date
Linear fit (-351 +0.0104x)
95% CI
95% Prediction interval

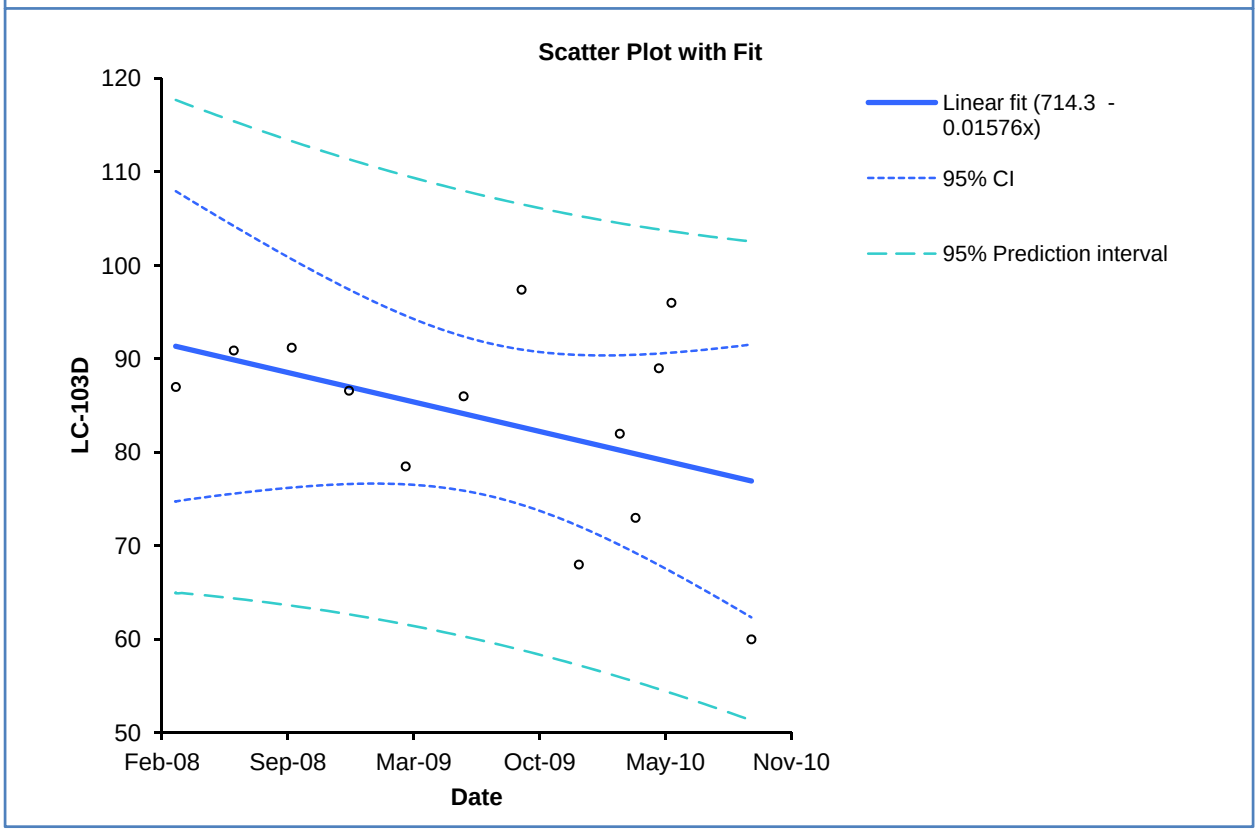

Scatter Plot with Fit
LC-101D2
18
17
16
15
14
13
12
11
10
9
Nov-07
Jun-08
Dec-08
Jul-09
Jan-10
Aug-10
Feb-11
Date
Linear fit (0.8513 +0.0003075x)
95% CI
95% Prediction interval

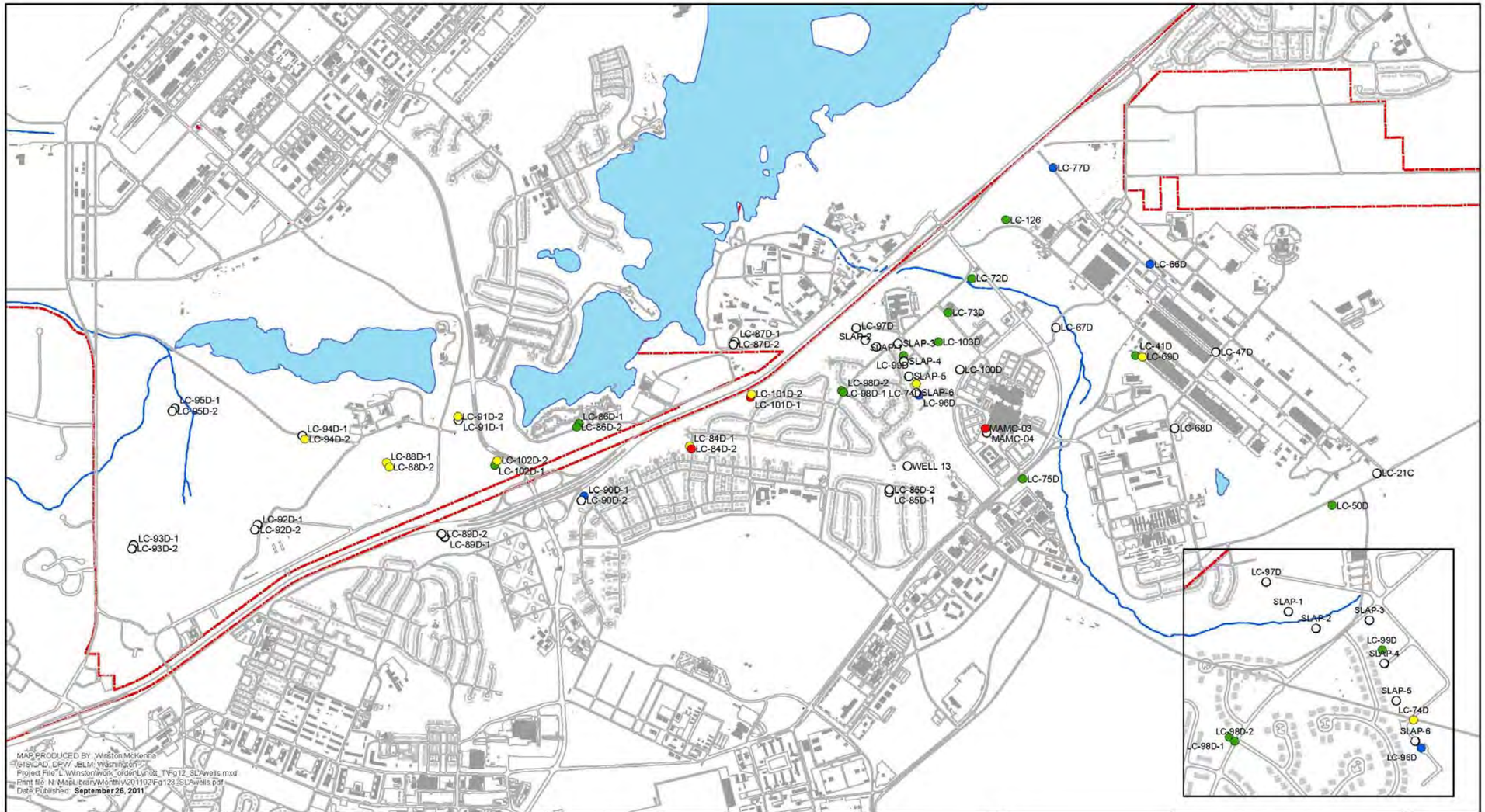

Scatter Plot with Fit
Ln LC-101D1
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
Nov-07
Jun-08
Dec-08
Jul-09
Jan-10
Aug-10
Feb-11
Date
Linear fit (-49.77 +0.001244x)
95% CI
95% Prediction interval


Scatter Plot with Fit
LC-102D1
7
6.5
6
5.5
5
4.5
4
3.5
3
Feb-08
Sep-08
Mar-09
Oct-09
May-10
Nov-10
Date
Linear fit (48.74 - 0.001092x)
95% CI
95% Prediction interval


Scatter Plot with Fit
LC-102D2
7.5
6.5
5.5
4.5
3.5
2.5
Feb-08
Sep-08
Mar-09
Oct-09
May-10
Nov-10
Date
Linear fit (43.83 - 0.0009641x)
95% CI
95% Prediction interval


Scatter Plot with Fit
LC-126
120
110
100
90
80
70
60
50
40
30
20
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Nov-10
Date
Linear fit (179.3 - 0.002719x)
95% CI
95% Prediction interval


Scatter Plot with Fit
LC-103D
120
110
100
90
80
70
60
50
Feb-08
Sep-08
Mar-09
Oct-09
May-10
Nov-10
Date
Linear fit (714.3 - 0.01576x)
95% CI
95% Prediction interval


LC-77D
LC-126
LC-66D
LC-72D
LC-73D
LC-67D
LC-97D
SLAP-2
SLAP-1
SLAP-3
LC-103D
LC-99D
SLAP-4
LC-100D
SLAP-5
LC-98D-2
LC-98D-1
LC-74D
SLAP-6
LC-96D
LC-41D
LC-69D
LC-47D
LC-68D
LC-21C
LC-50D
LC-87D-1
LC-87D-2
LC-101D-2
LC-101D-1
MAMC-03
MAMC-04
LC-75D
WELL 13
LC-85D-2
LC-85D-1
LC-84D-1
LC-84D-2
LC-86D-1
LC-86D-2
LC-91D-2
LC-91D-1
LC-102D-2
LC-102D-1
LC-90D-1
LC-90D-2
LC-89D-2
LC-89D-1
LC-88D-1
LC-88D-2
LC-94D-1
LC-94D-2
LC-95D-1
LC-95D-2
LC-92D-1
LC-92D-2
LC-93D-1
LC-93D-2
MAP PRODUCED BY: Winston McKenna
GIS/CAD, CPW, JBLM, Washington, U.S.
Project File: L:\Winston\work_orders\Lynott_TV\g12_SLAwells.mxd
Print file: N:\MapLibrary\Monthly\201102\Fig123_SLAwells.pdf
Date Published: September 26, 2011
Well Location and Trend Statistics
Statistically Significant Upward Trend
Not Statistically Significant Upward Trend
Not Statistically Significant Downward Trend
Statistically Significant Downward Trend
Data Not Analyzed
0 1,250 2,500 5,000 7,500 10,000
Feet
0 0.2 0.4 0.8 1.2 1.6
Miles
1 inch = 1,750 feet
MAP DATA:
ELLIPSOID: GRS 80
COORDINATE SYSTEM: UTM, Zone 10
HORIZONTAL DATUM: WGS 84
SEA LEVEL
AQUIFER LINEAR
REGRESSION MAP
CURRENT TRENDS
2002-2009
Figure
13

Logistics Center Tabular Groundwater Data

Logistics Center VOC Data - 2011

Location ID	Sample Collection Date	TCE (µg/L)		cis-DCE (µg/L)		PCE (µg/L)		TCA (µg/L)		VC (µg/L)	
Upper Vashon Aquifer											
85-PA-381	3/7/2011	16		0.5	U	0.5	U	0.5	U	0.5	U
CM-02	3/8/2011	**1.8**		0.5	U	0.5	U	0.5	U	0.5	U
Duplicate	3/8/2011	**1.7**		0.5	U	0.5	U	0.5	U	0.5	U
FL-01	3/9/2011	11		0.5	U	0.5	U^	0.5	U	0.5	U^
	9/26/2011	11		0.5	U	0.5	U^	0.5	U	0.5	U
Duplicate	9/26/2011	11		0.5	U	0.5	U^	0.5	U	0.5	U
FL-02	3/9/2011	**3**		0.5	U	0.5	U	0.5	U	0.5	U
Duplicate	3/9/2011	**3**		0.5	U	0.5	U	0.5	U	0.5	U
FL-03	3/7/2011	**2.9**		0.5	U	0.5	U	0.5	U	0.5	U
FL-04b	3/8/2011	**0.72**		0.5	U	0.5	U	0.5	U	0.5	U
FL-06	3/7/2011	**1.1**		0.5	U	0.5	U	0.5	U	0.5	U
LC-01	3/10/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	5/25/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	9/26/2011	0.5	U^	0.5	U	0.5	U^	0.5	U	0.5	U
	11/21/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-03	3/10/2011	**0.92**		0.5	U	0.5	U	0.5	U	0.5	U
	8/25/2011	**1.2**		0.5	U	0.5	U	0.5	U	0.5	U
LC-06	3/10/2011	61		**1.5**		0.5	U	0.5	U	0.5	U
Duplicate	3/10/2011	68		**1.6**		0.5	U	0.5	U	0.5	U
LC-14a	3/7/2011	46		**0.7**		0.5	U	0.5	U	0.5	U
LC-16	3/10/2011	**4.6**		0.5	U	0.5	U	0.5	U	0.5	U
	8/25/2011	7.8		0.5	U	0.5	U	0.5	U	0.5	U
LC-19a	3/9/2011	90		**1.4**		0.5	U	0.5	U	0.5	U
Duplicate	3/9/2011	87		**1.3**		0.5	U	0.5	U	0.5	U
LC-20	3/9/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-24	3/9/2011	**0.81**		0.5	U	0.5	U^	0.5	U	0.5	U^
LC-26	3/9/2011	0.5	U	0.5	U	0.5	U^	0.5	U	0.5	U^
LC-27	3/9/2011	14		**1.6**		0.5	U^	0.5	U	0.5	U^
LC-34	3/8/2011	**1.1**		**2.3**		0.5	U	0.5	U	0.5	U
LC-41a	3/8/2011	120		**1.2**		0.5	U	0.5	U	0.5	U
LC-49	3/8/2011	200		**9.5**		0.5	U	0.5	U	0.5	U
LC-53	3/9/2011	170		**5.4**		0.5	U^	0.5	U	0.5	U^
LC-57	3/9/2011	**1**		0.5	U	0.5	U^	0.5	U	0.5	U^
LC-61b	3/10/2011	**1.4**		0.5	U	0.5	U	0.5	U	0.5	U
LC-64a	3/9/2011	**1.1**		110		0.5	U	0.5	U	0.5	U
LC-66b	3/7/2011	66		**0.73**		0.5	U	0.5	U	0.5	U
LC-108	3/9/2011	**2.8**		0.5	U	0.5	U	0.5	U	0.5	U
	5/26/2011	**2.8**		0.5	U	0.5	U	0.5	U	0.5	U
Duplicate	5/26/2011	**2.8**		0.5	U	0.5	U	0.5	U	0.5	U
	8/25/2011	5.6		0.5	U	0.5	U	0.5	U	0.5	U
Duplicate	8/25/2011	6.2		0.5	U	0.5	U	0.5	U	0.5	U
	11/21/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U

Location ID	Sample Collection Date	TCE (µg/L)		cis-DCE (µg/L)		PCE (µg/L)		TCA (µg/L)		VC (µg/L)	
LC-109	3/7/2011	**1.1**		0.5	U	0.5	U	0.5	U	0.5	U
	8/25/2011	**1.4**		0.5	U	0.5	U	0.5	U	0.5	U
LC-124	3/7/2011	5.3		0.5	U	0.5	U	0.5	U	0.5	U
	8/25/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-132	3/7/2011	65		**0.72**		0.5	U	0.5	U	0.5	U
LC-135	9/26/2011	32		0.5	U	0.5	U^	0.5	U	0.5	U
LC-137b	3/9/2011	220		**2**		0.5	U	0.5	U	0.5	U
LC-160	3/9/2011	16		0.5	U	0.5	U	0.5	U	0.5	U
LC-167	3/7/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-178	3/9/2011	**3.7**		0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	5.2		0.5	U	0.5	U	0.5	U	0.5	U
Duplicate	8/24/2011	5.4		0.5	U	0.5	U	0.5	U	0.5	U
LC-180	3/9/2011	**2.9**		0.5	U	0.5	U	0.5	U	0.5	U
LC-182	3/9/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-202	9/26/2011	130		**5**		0.5	U^	0.5	U	0.5	U
LC-218	3/9/2011	31		0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	33		**0.58**		0.5	U	0.5	U	0.5	U
LC-222	3/9/2011	21		0.5	U	0.5	U	0.5	U	0.5	U
LC-223	3/9/2011	7.2		0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	6.4		0.5	U	0.5	U	0.5	U	0.5	U
LC-224	3/9/2011	10		0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	16		0.5	U	0.5	U	0.5	U	0.5	U
LX-02	3/23/2011	**4.8**		0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	5.1		0.5	U	0.5	U	0.5	U	0.5	U
LX-04	3/23/2011	27	*	**0.9**		0.5	U	0.5	U	0.5	U
	8/24/2011	23		**0.72**		0.5	U	0.5	U	0.5	U
LX-05	3/23/2011	47	*	**1.9**		0.5	U	0.5	U	0.5	U
	8/24/2011	55		**1.8**		0.5	U	0.5	U	0.5	U
LX-06	3/23/2011	56	*	**1.4**		0.5	U	0.5	U	0.5	U
	8/24/2011	54		**1.1**		0.5	U	0.5	U	0.5	U
LX-07	3/23/2011	60	*	**1.9**		0.5	U	0.5	U	0.5	U
	8/24/2011	66		**1.4**		0.5	U	0.5	U	0.5	U
LX-08	8/24/2011	67		**1.1**		0.5	U	0.5	U	0.5	U
LX-09	3/23/2011	49	*	**1.7**		0.5	U	0.5	U	0.5	U
	8/24/2011	49		**1.3**		0.5	U	0.5	U	0.5	U
LX-10	3/23/2011	39	*	**0.9**		0.5	U	0.5	U	0.5	U
	8/24/2011	52		**0.91**		0.5	U	0.5	U	0.5	U
Duplicate	8/24/2011	50		**0.74**		0.5	U	0.5	U	0.5	U
LX-11	3/23/2011	33	*	**1.1**		0.5	U	0.5	U	0.5	U
	8/24/2011	30		**0.91**		0.5	U	0.5	U	0.5	U
LX-12	3/23/2011	28	*	**0.61**		0.5	U	0.5	U	0.5	U
	8/24/2011	25		**0.53**		0.5	U	0.5	U	0.5	U
LX-13	3/23/2011	6.9	*	0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	6.7		0.5	U	0.5	U	0.5	U	0.5	U
LX-14	3/23/2011	7.2	*	0.5	U	0.5	U	0.5	U	0.5	U

Location ID	Sample Collection Date	TCE (µg/L)		cis-DCE (µg/L)		PCE (µg/L)		TCA (µg/L)		VC (µg/L)	
	8/24/2011	6.6		0.5	U	0.5	U	0.5	U	0.5	U
MAMC-OF-1	3/28/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
MT-1	3/9/2011	110		**1.7**		0.5	U	0.5	U	0.5	U
	5/25/2011	120		**1.7**		0.5	U	0.5	U	0.5	U
	8/25/2011	100		**1.6**		0.5	U	0.5	U	0.5	U
	11/21/2011	56		**0.76**		0.5	U	0.5	U	0.5	U
MT-2	3/9/2011	7.7		**0.59**		0.5	U	0.5	U	0.5	U
	5/25/2011	6.3		**0.81**		0.5	U	0.5	U	0.5	U
	8/24/2011	**4.8**		**0.55**		0.5	U	0.5	U	0.5	U
	11/21/2011	7.7		**0.57**		0.5	U	0.5	U	0.5	U
MT-3	3/9/2011	7		0.5	U	0.5	U	0.5	U	0.5	U
	5/26/2011	8.1		**2.1**		0.5	U	0.5	U	0.5	U
	8/25/2011	6.8		**0.53**		0.5	U	0.5	U	0.5	U
	11/21/2011	**4.1**		**0.53**		0.5	U	0.5	U	0.5	U
MT-4	3/9/2011	**1.6**		0.5	U	0.5	U	0.5	U	0.5	U
	5/26/2011	8		**0.75**		0.5	U	0.5	U	0.5	U
	8/25/2011	21		**3.8**		0.5	U	0.5	U	0.5	U
	11/21/2011	**1.6**		0.5	U	0.5	U	0.5	U	0.5	U
NAPL1-E07	9/26/2011	**2.4**		**0.55**		0.5	U^	0.5	U	0.5	U
NAPL1-L07	9/26/2011	**2.2**		**1.5**		0.5	U^	0.5	U	0.5	U
NAPL2-F12	9/26/2011	**1.6**		**0.7**		0.5	U^	0.5	U	0.5	U
NAPL2-G15	9/26/2011	18		**0.59**		0.5	U^	0.5	U	0.5	U
NAPL2-L15	9/26/2011	8.3		0.5	U	0.5	U^	0.5	U	0.5	U
PW-1	3/22/2011	230	H	**69**		**0.75**		0.5	U	0.5	U
	9/16/2011	150		**3.9**		0.5	U	0.5	U	0.5	U
PW-2	3/22/2011	40	*	**2.7**		0.5	U	0.5	U	0.5	U
	9/16/2011	76		**1.2**		0.5	U	0.5	U	0.5	U
PW-3	3/22/2011	140	H	**8.4**		0.5	U	0.5	U	0.5	U
	9/16/2011	92		**2.3**		0.5	U	0.5	U	0.5	U
PW-4	3/22/2011	28	*	**1.6**		0.5	U	0.5	U	0.5	U
	9/16/2011	34		**3.2**		0.5	U	0.5	U	0.5	U
PW-5	3/22/2011	40	*	**9.8**		0.5	U	0.5	U	0.5	U
	9/16/2011	49		**11**		0.5	U	**0.95**		0.5	U
PW-6	3/22/2011	14	*	**1.1**		0.5	U	0.5	U	0.5	U
	9/16/2011	7.9		0.5	U	0.5	U	0.5	U	0.5	U
PW-7	3/22/2011	23	*	**1.4**		0.5	U	0.5	U	0.5	U
	9/16/2011	27		**0.64**		0.5	U	0.5	U	0.5	U
PW-8	3/22/2011	16	*	**3.2**		0.5	U	0.5	U	0.5	U
	9/16/2011	21		**1.9**		0.5	U	0.5	U	0.5	U
SW-MC-07	3/9/2011	**0.55**		0.5	U	0.5	U	0.5	U	0.5	U
	5/26/2011	**0.78**		0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	**0.68**		0.5	U	0.5	U	0.5	U	0.5	U
	11/21/2011	**0.61**		0.5	U	0.5	U	0.5	U	0.5	U
SW-MC-08	3/9/2011	**0.6**		0.5	U	0.5	U	0.5	U	0.5	U

Location ID	Sample Collection Date	TCE (µg/L)		cis-DCE (µg/L)		PCE (µg/L)		TCA (µg/L)		VC (µg/L)	
	5/26/2011	**0.81**		0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	**0.71**		0.5	U	0.5	U	0.5	U	0.5	U
	11/21/2011	**0.68**		0.5	U	0.5	U	0.5	U	0.5	U
SW-MC-09	3/9/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	5/26/2011	**0.53**		0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	**0.54**		0.5	U	0.5	U	0.5	U	0.5	U
	11/21/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
T-04	3/11/2011	**2.8**		0.5	U	0.5	U	0.5	U	0.5	U
	8/23/2011	**9.1**		0.5	U	0.5	U	0.5	U	0.5	U
T-05	3/10/2011	**1.6**		0.5	U	0.5	U	0.5	U	0.5	U
	8/23/2011	**1.3**		0.5	U	0.5	U	0.5	U	0.5	U
T-06	3/10/2011	**3.9**		0.5	U	0.5	U	0.5	U	0.5	U
	8/23/2011	**3.8**		0.5	U	0.5	U	0.5	U	0.5	U
T-08	3/8/2011	**1.3**		0.5	U	0.5	U	0.5	U	0.5	U
	8/23/2011	**1.3**		0.5	U	0.5	U	0.5	U	0.5	U
T-11b	Could Not Locate										
T-13B	3/10/2011	**4.2**		**1.2**		0.5	U	0.5	U	0.5	U
	8/23/2011	**3.7**		**1.3**		0.5	U	0.5	U	0.5	U
Lower Vashon Aquifer											
BC1	3/10/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	9/26/2011	0.5	U^	0.5	U	0.5	U^	0.5	U	0.5	U
FL-04a	3/8/2011	**1.1**		0.5	U	0.5	U	0.5	U	0.5	U
LC-041b	3/8/2011	**69**		**0.71**		0.5	U	0.5	U	0.5	U
Duplicate	3/8/2011	**77**		**0.71**		0.5	U	0.5	U	0.5	U
LC-064b	3/9/2011	**2.1**		0.5	U	0.5	U	0.5	U	0.5	U
Duplicate	3/9/2011	**2.3**		0.5	U	0.5	U	0.5	U	0.5	U
LC-111b	3/7/2011	**1.3**		**0.98**		0.5	U	0.5	U	0.5	U
	8/25/2011	**1.4**		**1.5**		0.5	U	0.5	U	0.5	U
LC-116b	3/7/2011	**48**		**1**		0.5	U	0.5	U	0.5	U
	8/25/2011	**42**		**1.4**		0.5	U	0.5	U	0.5	U
LC-122b	3/7/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	8/25/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-128	3/7/2011	**13**		0.5	U	0.5	U	0.5	U	0.5	U
Duplicate	3/7/2011	**16**		0.5	U	0.5	U	0.5	U	0.5	U
LC-137c	3/9/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-216	3/7/2011	0.5	U	**1.2**		0.5	U	**0.75**		0.5	U
LC-217	3/7/2011	**6.1**		0.5	U	0.5	U	0.5	U	0.5	U
Duplicate	3/7/2011	**6.2**		0.5	U	0.5	U	0.5	U	0.5	U
LC-219	3/7/2011	**41**		**3.4**		0.5	U	**2.4**		0.5	U
LC-225	3/10/2011	**9.5**		**0.93**		0.5	U	0.5	U	0.5	U
Duplicate	3/10/2011	**9.4**		**0.93**		0.5	U	0.5	U	0.5	U
	8/23/2011	**10**		**1**		0.5	U	0.5	U	0.5	U
Duplicate	8/23/2011	**10**		**0.99**		0.5	U	0.5	U	0.5	U
LC-226	3/10/2011	**2.1**		**1.6**		0.5	U	**4.1**		0.5	U

Location ID	Sample Collection Date	TCE (µg/L)		cis-DCE (µg/L)		PCE (µg/L)		TCA (µg/L)		VC (µg/L)	
	8/23/2011	**2.6**		**2.2**		0.5	U	**3**		0.5	U
MAMC-01	3/10/2011	**0.88**		0.5	U	0.5	U	0.5	U	0.5	U
MAMC-06	3/10/2011	**0.88**		0.5	U	0.5	U	0.5	U	0.5	U
T-10	3/10/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	9/26/2011	0.5	U^	0.5	U	0.5	U^	0.5	U	0.5	U
Sea Level Aquifer											
LC-021c	3/9/2011	0.5	U	0.5	U	0.5	U^	0.5	U	0.5	U^
LC-047D	3/9/2011	0.5	U	0.5	U	0.5	U^	0.5	U	0.5	U^
LC-050D	3/9/2011	0.5	U	0.5	U	0.5	U^	0.5	U	0.5	U^
LC-066D	3/7/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-067D	3/7/2011	66		**6.4**		0.5	U	0.5	U	0.5	U
LC-068D	3/8/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	5/25/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	8/25/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	11/21/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Duplicate	11/21/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-069D	3/8/2011	97		**0.91**		0.5	U	0.5	U	0.5	U
LC-072D	3/7/2011	20		**0.6**		0.5	U	0.5	U	0.5	U
LC-074D	3/28/2011	6.5		0.5	U	0.5	U	0.5	U	0.5	U
	5/25/2011	6.4		0.5	U	0.5	U	0.5	U	0.5	U
Duplicate	5/25/2011	6.6		0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	6.2		0.5	U	0.5	U	0.5	U	0.5	U
	11/21/2011	5.1		0.5	U	0.5	U	0.5	U	0.5	U
LC-075D	3/7/2011	**0.61**		0.5	U	0.5	U	0.5	U	0.5	U
LC-077D	3/7/2011	**2.6**		0.5	U	0.5	U	0.5	U	0.5	U
LC-084D-1	3/7/2011	**2.7**		0.5	U	0.5	U	0.5	U	0.5	U
Duplicate	3/7/2011	**2.9**		0.5	U	0.5	U	0.5	U	0.5	U
LC-084D-2	3/7/2011	**2.2**		0.5	U	0.5	U	0.5	U	0.5	U
LC-085D-1	3/7/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-085D-2	3/7/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-086D-1	3/8/2011	7.5		0.5		0.5	U	0.5	U	0.5	U
	8/23/2011	7.8		**0.58**		0.5	U	0.5	U	0.5	U
LC-086D-2	3/8/2011	6.3		**0.67**		0.5	U	0.5	U	0.5	U
	8/23/2011	6		**0.75**		0.5	U	0.5	U	0.5	U
LC-087D-1	3/8/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-087D-2	3/8/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-088D-1	3/8/2011	**2.6**		0.5	U	0.5	U	0.5	U	0.5	U
	8/23/2011	**2.6**		0.5	U	0.5	U	0.5	U	0.5	U
LC-088D-2	3/8/2011	**1.6**		0.5	U	0.5	U	0.5	U	0.5	U
	8/23/2011	**1.5**		0.5	U	0.5	U	0.5	U	0.5	U
LC-089D-1	3/7/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-089D-2	3/7/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-090D-1	3/7/2011	**1.6**		0.5	U	0.5	U	0.5	U	0.5	U
LC-090D-2	3/7/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-091D-1	3/8/2011	0.5		0.5	U	0.5	U	0.5	U	0.5	U

Location ID	Sample Collection Date	TCE (µg/L)		cis-DCE (µg/L)		PCE (µg/L)		TCA (µg/L)		VC (µg/L)	
	8/23/2011	**0.55**		0.5	U	0.5	U	0.5	U	0.5	U
LC-091D-2	3/8/2011	**2.8**		0.5	U	0.5	U	0.5	U	0.5	U
	8/23/2011	**2.7**		0.5	U	0.5	U	0.5	U	0.5	U
LC-092D-1	3/8/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-092D-2	3/8/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-093D-1	3/8/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	8/23/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-093D-2	3/8/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	8/23/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-094D-1	3/8/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-094D-2	3/8/2011	**2.6**		0.5	U	0.5	U	0.5	U	0.5	U
LC-095D-1	3/8/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	8/23/2011	**0.53**		0.5	U	0.5	U	0.5	U	0.5	U
LC-095D-2	3/8/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	8/23/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-096D	3/28/2011	7.7		0.5	U	0.5	U	0.5	U	0.5	U
	5/25/2011	8.1		0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	9.1		0.5	U	0.5	U	0.5	U	0.5	U
	11/21/2011	6.9		0.5	U	0.5	U	0.5	U	0.5	U
LC-097D	3/28/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
LC-098D-1	3/28/2011	11		0.5	U	0.5	U	0.5	U	0.5	U
	5/25/2011	12		0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	7		0.5	U	0.5	U	0.5	U	0.5	U
	11/21/2011	7.1		0.5	U	0.5	U	0.5	U	0.5	U
LC-098D-2	3/28/2011	19		**0.87**		0.5	U	0.5	U	0.5	U
	5/25/2011	32		**1.2**		0.5	U	0.5	U	0.5	U
	8/24/2011	19		**0.79**		0.5	U	0.5	U	0.5	U
	11/21/2011	24		**0.87**		0.5	U	0.5	U	0.5	U
Duplicate	11/21/2011	25		**0.95**		0.5	U	0.5	U	0.5	U
LC-099D	3/28/2011	73		**2.1**		0.5	U	0.5	U	0.5	U
	5/25/2011	71		**2**		0.5	U	0.5	U	0.5	U
	8/24/2011	77		**2.1**		0.5	U	0.5	U	0.5	U
	11/21/2011	74		**2.2**		0.5	U	0.5	U	0.5	U
LC-101D-1	3/7/2011	**1.3**		**0.52**		0.5	U	0.5	U	0.5	U
	8/24/2011	**1.4**		**0.51**		0.5	U	0.5	U	0.5	U
LC-101D-2	3/7/2011	14		**0.98**		0.5	U	0.5	U	0.5	U
	8/24/2011	13		**1.1**		0.5	U	0.5	U	0.5	U
LC-102D-1	3/8/2011	**4.8**		0.5	U	0.5	U	0.5	U	0.5	U
Duplicate	3/8/2011	**4.8**		0.5	U	0.5	U	0.5	U	0.5	U
	8/23/2011	5.7		0.5	U	0.5	U	0.5	U	0.5	U
LC-102D-2	3/8/2011	5.2		0.5	U	0.5	U	0.5	U	0.5	U
	8/23/2011	**4.9**		0.5	U	0.5	U	0.5	U	0.5	U
Duplicate	8/23/2011	5.4		0.5	U	0.5	U	0.5	U	0.5	U
LC-103D	3/28/2011	95		**1.6**		0.5	U	0.5	U	0.5	U

Location ID	Sample Collection Date	TCE (µg/L)		cis-DCE (µg/L)		PCE (µg/L)		TCA (µg/L)		VC (µg/L)	
	8/24/2011	80		**1.7**		0.5	U	0.5	U	0.5	U
LC-126	3/7/2011	75		**4.7**		0.5	U	0.5	U	0.5	U
MAMC-03	3/10/2011	**1.7**		0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	**1.4**		0.5	U	0.5	U	0.5	U	0.5	U
MAMC-04	3/10/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
SLAP-1	3/28/2011	7.6		**0.66**		0.5	U	0.5	U	0.5	U
Duplicate	3/28/2011	7.4		**0.61**		0.5	U	0.5	U	0.5	U
	5/25/2011	7.3		0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	6.8		**0.56**		0.5	U	0.5	U	0.5	U
Duplicate	8/24/2011	7		**0.58**		0.5	U	0.5	U	0.5	U
	11/21/2011	5.7		0.5	U	0.5	U	0.5	U	0.5	U
SLAP-2	3/28/2011	10		**0.63**		0.5	U	0.5	U	0.5	U
	5/25/2011	10		0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	9.2		**0.56**		0.5	U	0.5	U	0.5	U
	11/21/2011	8		0.5	U	0.5	U	0.5	U	0.5	U
SLAP-3	3/28/2011	32		**1.1**		0.5	U	0.5	U	0.5	U
	5/25/2011	34		**0.84**		0.5	U	0.5	U	0.5	U
	8/24/2011	34		**1**		0.5	U	0.5	U	0.5	U
	11/21/2011	27		**0.92**		0.5	U	0.5	U	0.5	U
SLAP-4	3/28/2011	28		**0.66**		0.5	U	0.5	U	0.5	U
	5/25/2011	29		**0.54**		0.5	U	0.5	U	0.5	U
	8/24/2011	32		**0.71**		0.5	U	0.5	U	0.5	U
	11/21/2011	26		**0.54**		0.5	U	0.5	U	0.5	U
SLAP-5	3/28/2011	12		0.5	U	0.5	U	0.5	U	0.5	U
	5/25/2011	13		0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	12		0.5	U	0.5	U	0.5	U	0.5	U
	11/21/2011	11		0.5	U	0.5	U	0.5	U	0.5	U
SLAP-6	3/28/2011	8		0.5	U	0.5	U	0.5	U	0.5	U
	5/25/2011	7.6		0.5	U	0.5	U	0.5	U	0.5	U
	8/24/2011	9.2		0.5	U	0.5	U	0.5	U	0.5	U
	11/21/2011	6.7		0.5	U	0.5	U	0.5	U	0.5	U
Well 13	3/10/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	8/25/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
TB-01	3/10/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
QC_TB	3/10/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	3/15/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	3/30/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	5/26/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	8/26/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	9/26/2011	0.5	U^	0.5	U	0.5	U^	0.5	U	0.5	U
	10/27/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
	11/22/2011	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
ROD Remediation Goal		**5.0**		**70.0**		**5.0**		**-**		**-**	

Notes

Location ID	Sample Collection Date	TCE (µg/L)	cis-DCE (µg/L)	PCE (µg/L)	TCA (µg/L)	VC (µg/L)

TCE =	Tricholoroethylene
cis-DCE =	cis 1,2 Dichloroethylene
PCE =	Perchloroethylene
TCA =	1,1,1 Trichloroethane
VC =	Vinyl Chloride
µg/L =	Micrograms per liter
QC_TB =	Trip blank
BOLD =	Analyte detected above practical quantification limit
SHADED =	Analyte detected above ROD Remediation Goal Value
U =	Analyte not detected above practical quantification limit
H =	Sample analyzed after 14 day holding time
^ =	LCS exceeded control limits during instrument calibration QC
* =	Relative percent difference between the LCS and LCSD of sample exceeded control limits
- =	Not Applicable, no data

Log Center Historical Groundwater Data

Date	FL-1	FL-2	FL-3	FL-4A	FL-6	LC-01	LC-03	LC-06	LC-14A	LC-16	LC-19A	LC-20	LC-24	LC-27	LC-34	LC-41A	LC-41B	LC-49	LC-53
Mar-02		330.00	5.70	1.20	2.80		0.80	32.00	64.00	5.30	190.00	0.20	1.30		1.50	140.00	110.00	220.00	230.00
Jun-02			4.90	1.20	2.90		0.80			8.60	180.00	0.20	0.90		1.30		74.00		
Sep-02			2.30	1.30	3.50		1.00	110.00		10.00	180.00	9.60	2.60		1.40		90.00		
Dec-02			5.10	1.30	3.40		1.80			10.00	170.00	0.20	0.50		1.60		65.00		
Mar-03		140.00	5.20	1.20	2.10		1.00	130.00	45.00	9.60	180.00	50.00	1.00		1.40	120.00	66.00	240.00	200.00
Jun-03			4.20	1.20	2.30					9.90		6.10	0.90		1.30		99.00		
Sep-03			4.10	1.20	2.50			210.00		9.70		9.90	0.60		1.20		84.00		190.00
Dec-03		33.00								8.00		0.20							
Mar-04		150.00	1.90	1.30	2.20		0.90	270.00	61.00	9.70	200.00	0.30	0.80		1.50	240.00	120.00	230.00	200.00
Jun-04		64.00								11.00		0.30							
Sep-04		13.00	2.70					140.00		9.20		11.00					85.00		190.00
Dec-04																			
Feb-05										13.00									
Jun-05																			
Sep-05							1.80	107.00	41.30	16.10	140.00	11.00	0.50		1.50	148.00		293.00	191.00
Dec-05		47.40	4.80	10.80	2.70												122.00		
Mar-06										9.00									
Jun-06																			
Sep-06		15.40	6.00	1.70	3.10		1.90	105.00	50.50	10.00	164.00	0.50	1.20	18.70	2.60	233.00	113.00	251.00	227.00
Dec-06		12.60		1.00										27.20					150.00
Mar-07		15.90		2.70						5.42				18.70					186.00
Jun-07	18.50	8.08		0.88										18.41					129.00
Sep-07	20.40	8.18	2.43	1.08	1.62		2.41	92.10	36.30	5.73	125.00	0.50	0.50	8.78	1.39	136.00	66.50	212.00	150.00
Dec-07	17.80	7.09		5.73										10.60					197.00
Mar-08										7.70				9.29					
Jun-08														7.32					
Sep-08	16.80	4.82	3.01	3.36	1.87		1.75	48.20	40.10	7.84	127.00	0.50	0.50	5.40	0.68	105.00		243.00	147.00
Dec-08														7.14					
Mar-09		7.23		1.19						6.94				9.30					157.00
Jun-09														7.43					
Sep-09	17.50	11.90	3.63	1.48	1.82		1.73	73.60	45.50	10.40	103.00	0.50	0.50	16.60	1.32	145.00		206.00	117.00
Dec-09														11.00					
Mar-10	11	4.0	2.1	0.95	1.1	0.056	0.86	59	38	4.9	84	0.094	0.58	9.7	0.91	170	93.00	190	170
Jun-10						0.5													
Sep-10	11					0.5	1			4.7									
Dec-10						0.5													
Mar-11	11	3	2.9	1.1	1.1	0.5	0.92	61	46	4.6	90	0.5	0.81	14	1.1	120	69	200	170
May-11						0.5													
Aug-11	11					0.5	1.2			7.8									
Nov-11						0.5													

Date	LC-57	LC-61B	LC-64A	LC-64B	LC-66B	LC-108	LC-111b	LC-116B	LC-122b	LC-128	LC-132	LC-136A	LC-136B	LC-137B	LC-137C	LC-160	LC-178	LC-180	LC-182
Mar-02	**5.30**	**2.10**	12000.00	12.00	88.00		0.4	11.00	0.2	20.00		150000.00	110.00	160.00	0.20				
Jun-02	**2.60**	**2.00**	29000.00									150000.00		230.00					
Sep-02	1.50	2.50	7600.00									160000.00		330.00					
Dec-02	1.70	2.20	6000.00									180000.00		820.00					
Mar-03	1.00	2.50	6700.00	36.00	94.00		1.2	30.00	0.2	20.00	76.00	160000.00	86.00	260.00	0.20			9.80	
Jun-03	0.90	2.30	4800.00									170000.00		260.00					0.20
Sep-03	1.00	4.80	4900.00								74.00	35000.00		530.00					0.20
Dec-03	1.30		6400.00									50000.00		420.00				12.00	
Mar-04	0.90	2.30	4000.00	13.00	100.00		2	17.00	0.2	23.00	82.00	78000.00	58.00	260.00	0.50		0.70		
Jun-04	0.70		3600.00									55000.00		500.00					
Sep-04	0.80	1.70	2900.00								85.00	46000.00		1800.00					
Dec-04																			
Feb-05																			
Jun-05																			
Sep-05	0.70		2210.00	51.10	101.00		4.8	31.20	0.5	18.60	94.50	1350.00	149.00	478.00	32.80			12.10	
Dec-05		1.80																	
Mar-06		1.80																	
Jun-06																			
Sep-06	2.30	1.60	691.00	115.00	105.00	2.60	0.7	38.30	0.5	21.60	83.40			527.00	26.70	93.80		6.00	
Dec-06						4.90										54.60		5.00	
Mar-07	0.60	1.68				18.40										42.10		6.35	
Jun-07	1.82					4.23										48.80	3.31	5.78	0.50
Sep-07	2.81	1.41	1140.00	4.71	76.30	0.73	3.67	26.60	0.5	17.80	82.90			320.00	13.50	33.30	1.48	3.98	
Dec-07	3.47					7.79										37.20	4.33		0.50
Mar-08		2.01														35.00	7.60		0.50
Jun-08						1.00													
Sep-08	1.33	0.50	631.00	4.24	105.00	0.63	2.87	30.80	0.71	17.10	72.50			709.00	1.04	28.70	5.33	4.27	0.50
Dec-08						0.65													
Mar-09	0.80	0.50				5.01										24.40		3.53	0.50
Jun-09						6.44										23.10			
Sep-09	1.18	1.56	206.00	3.88	91.80	0.68	3.27	35.70	0.5	18.00	71.80			268.00	1.19	23.10	6.78	3.95	0.50
Dec-09						6.40										13.00			
Mar-10	0.66	1.3	130		83	5.1	3.70	29.00	0.06	16.00	58			320	0.62	13	0.79	2.8	0.056
Jun-10						3.5													
Sep-10		1.5				0.5	4.80	38.00	0.50								3.3		
Dec-10						3.4													
Mar-11	1	1.4	1.1	2.1	66	2.8	1.3	48	0.5	13	65			220	0.5	16	3.7	2.9	0.5
May-11						2.8													
Aug-11						5.6	1.4	42	0.5								5.2		
Nov-11						0.5													

Date	LC-217	LC-218	LC-219	LC-222	LC-223	LC-224	LC-225	LC-226	MAMC-1	MAMC-6	MAMC-OF-1	MT-1	MT-2	MT-3	MT-4	PA-381	PA-383	SW-MC-2/4
Mar-02									2.60	2.10						43.00	1.20	1.20
Jun-02									1.80	1.80								1.40
Sep-02									2.30	1.30								1.70
Dec-02									1.60	2.00								0.20
Mar-03									1.90	1.60						31.00	1.10	0.70
Jun-03									2.30	0.90								0.50
Sep-03									2.60	0.80								0.20
Dec-03									1.90	1.80								0.20
Mar-04									3.10	1.10						38.00	1.20	0.50
Jun-04									2.20	0.90								0.50
Sep-04									1.70	0.80								0.30
Dec-04																		
Feb-05	9.10	40.90	72.50						2.30	2.30								
Jun-05	6.80	62.70	66.50															
Sep-05	7.60	119.00	54.60						1.90	1.70						29.50	1.10	0.50
Dec-05	7.90	92.50	62.70															
Mar-06	8.20	78.70	68.40															
Jun-06																		
Sep-06																		
Dec-06																		
Mar-07																		
Jun-07																		
Sep-07																		
Dec-07																		
Mar-08																		
Jun-08																		
Sep-08																		
Dec-08																		
Mar-09																		
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Sep-09																		
Dec-09																		
Mar-10																		
Jun-10																		
Sep-10																		
Dec-10																		
Mar-11																		
May-11																		
Aug-11																		
Nov-11																		

Date	SW-MC-6	SW-MC-7	SW-MC-8	SW-MC-9	T-04	T-05	T-06	T-08	T-10	T-11B	T-13B	5µg/L	100µg/L
Mar-02	1.80				8.50			2.20	0.2	8.50	4.50	5.00	100.00
Jun-02	1.60								0.2			5.00	100.00
Sep-02	1.60							2.40	0.2		4.20	5.00	100.00
Dec-02	1.10								0.2	9.30		5.00	100.00
Mar-03	0.80				10.00		6.30	2.20	0.2	8.00	4.10	5.00	100.00
Jun-03	0.60						5.60		0.2	7.50		5.00	100.00
Sep-03	0.40						5.70		0.2	6.80	3.60	5.00	100.00
Dec-03	0.60											5.00	100.00
Mar-04	0.70				11.00	3.00	6.20	1.60	0.2	7.70	4.20	5.00	100.00
Jun-04	0.70											5.00	100.00
Sep-04	0.50				6.50	1.90	5.60	2.30	0.2	7.20	4.20	5.00	100.00
Dec-04												5.00	100.00
Feb-05					11.10	1.70	5.50		0.5	7.30		5.00	100.00
Jun-05												5.00	100.00
Sep-05	0.60				10.70	1.60	5.20	2.50	0.5	7.20	4.10	5.00	100.00
Dec-05												5.00	100.00
Mar-06					16.10	3.80	4.90	1.90	0.5	7.00	3.70	5.00	100.00
Jun-06												5.00	100.00
Sep-06	0.50				11.90	2.00	5.10	2.60	0.5	3.60	4.90	5.00	100.00
Dec-06												5.00	100.00
Mar-07									0.5			5.00	100.00
Jun-07												5.00	100.00
Sep-07	0.56				6.47	1.78	4.06	1.85	0.5	5.03	3.51	5.00	100.00
Dec-07												5.00	100.00
Mar-08					11.70	2.10	4.17	1.67	0.5	4.70	4.38	5.00	100.00
Jun-08												5.00	100.00
Sep-08	0.50				9.50	1.66	6.34	2.36	0.5	5.23	4.49	5.00	100.00
Dec-08												5.00	100.00
Mar-09					12.70	3.00	5.12	2.09	0.5	5.81	3.89	5.00	100.00
Jun-09												5.00	100.00
Sep-09	0.50				9.01	1.96	4.89	2.14	0.5	5.69	5.20	5.00	100.00
Dec-09												5.00	100.00
Mar-10	0.056	0.55			2.1	11	3.9	1.1	0.05	4.2	3.7	5.00	100.00
Jun-10		0.65	0.63	0.76								5.00	100.00
Sep-10		0.56	0.58	0.61	6.9	1.5	3.7	1.3	0.5		3.5	5.00	100.00
Dec-10		0.53	0.64	0.74								5.00	100.00
Mar-11		0.55	0.6	0.5	2.8	1.6	3.9	1.3	0.5		4.2	5.00	100.00
May-11		0.78	0.81	0.53								5.00	100.00

Date	SW-MC-6	SW-MC-7	SW-MC-8	SW-MC-9	T-04	T-05	T-06	T-08	T-10	T-11B	T-13B	5µg/L	100µg/L
Aug-11		0.68	0.71	0.54	9.1	1.3	3.8	1.3	0.5		3.7	5.00	100.00
Nov-11		0.61	0.68	0.5								5.00	100.00
Mar-02	1.80				8.50			2.20	0.2	8.50	4.50	5.00	100.00
Jun-02	1.60								0.2			5.00	100.00
Sep-02	1.60							2.40	0.2		4.20	5.00	100.00
Dec-02	1.10								0.2	9.30		5.00	100.00
Mar-03	0.80				10.00		6.30	2.20	0.2	8.00	4.10	5.00	100.00
Jun-03	0.60						5.60		0.2	7.50		5.00	100.00
Sep-03	0.40						5.70		0.2	6.80	3.60	5.00	100.00
Dec-03	0.60											5.00	100.00
Mar-04	0.70				11.00	3.00	6.20	1.60	0.2	7.70	4.20	5.00	100.00
Jun-04	0.70											5.00	100.00
Sep-04	0.50				6.50	1.90	5.60	2.30	0.2	7.20	4.20	5.00	100.00
Dec-04												5.00	100.00
Feb-05					11.10	1.70	5.50		0.5	7.30		5.00	100.00
Jun-05												5.00	100.00
Sep-05	0.60				10.70	1.60	5.20	2.50	0.5	7.20	4.10	5.00	100.00
Dec-05												5.00	100.00
Mar-06					16.10	3.80	4.90	1.90	0.5	7.00	3.70	5.00	100.00
Jun-06												5.00	100.00
Sep-06	0.50				11.90	2.00	5.10	2.60	0.5	3.60	4.90	5.00	100.00
Dec-06												5.00	100.00
Mar-07									0.5			5.00	100.00
Jun-07												5.00	100.00
Sep-07	0.56				6.47	1.78	4.06	1.85	0.5	5.03	3.51	5.00	100.00
Dec-07												5.00	100.00
Mar-08					11.70	2.10	4.17	1.67	0.5	4.70	4.38	5.00	100.00
Jun-08												5.00	100.00
Sep-08	0.50				9.50	1.66	6.34	2.36	0.5	5.23	4.49	5.00	100.00
Dec-08												5.00	100.00
Mar-09					12.70	3.00	5.12	2.09	0.5	5.81	3.89	5.00	100.00
Jun-09												5.00	100.00
Sep-09	0.50				9.01	1.96	4.89	2.14	0.5	5.69	5.20	5.00	100.00
Dec-09												5.00	100.00
Mar-10	0.056	0.55			2.1	11	3.9	1.1	0.05	4.2	3.7	5.00	100.00
Jun-10		0.65	0.63	0.76								5.00	100.00
Sep-10		0.56	0.58	0.61	6.9	1.5	3.7	1.3	0.5		3.5	5.00	100.00
Dec-10		0.53	0.64	0.74								5.00	100.00
Mar-11		0.55	0.6	0.5	2.8	1.6	3.9	1.3	0.5		4.2	5.00	100.00

Date	SW-MC-6	SW-MC-7	SW-MC-8	SW-MC-9	T-04	T-05	T-06	T-08	T-10	T-11B	T-13B	5µg/L	100µg/L
May-11		0.78	0.81	0.53								5.00	100.00
Aug-11		0.68	0.71	0.54	9.1	1.3	3.8	1.3	0.5		3.7	5.00	100.00
Nov-11		0.61	0.68	0.5								5.00	100.00

Wells in Long-Term Monitoring Program

Well ID	Samp Freq	Aquifer	Well ID	Samp Freq	Aquifer	Well ID	Samp Freq	Aquifer
85-PA-381	Annual	Up Vashon	LC-224	Semiann	Up Vashon	LC- 74d	Quarterly	Sea Level
CM-2	Annual	Up Vashon	LC-54	Quarterly	Up Vashon	LC- 75d	Annual	Sea Level
FL-1	Semiann	Up Vashon	LX- 3	Semiann	Up Vashon	LC- 76d	WL	Sea Level
FL-2	Annual	Up Vashon	LX- 4	Semiann	Up Vashon	LC- 77d	Annual	Sea Level
FL-3	Annual	Up Vashon	LX- 5	Semiann	Up Vashon	LC- 79d	WL	Sea Level
FL-4b	Annual	Up Vashon	LX- 6	Semiann	Up Vashon	LC- 80d	WL	Sea Level
FL-6	Annual	Up Vashon	LX- 7	Semiann	Up Vashon	LC- 81d	WL	Sea Level
LC- 03	Semiann	Up Vashon	LX- 8	Semiann	Up Vashon	LC- 82d	WL	Sea Level
LC- 05	WL	Up Vashon	LX- 9	Semiann	Up Vashon	LC- 83d	WL	Sea Level
LC- 06	Annual	Up Vashon	LX-10	Semiann	Up Vashon	LC- 84D-1	Semiann	Sea Level
LC- 10	WL	Up Vashon	LX-11	Semiann	Up Vashon	LC- 84D-2	Annual	Sea Level
LC- 14a	Annual	Up Vashon	LX-12	Semiann	Up Vashon	LC- 85D-1	Annual	Sea Level
LC- 16	Semiann	Up Vashon	LX-13	Semiann	Up Vashon	LC- 85D-2	Annual	Sea Level
LC- 18	WL	Up Vashon	LX-14	Semiann	Up Vashon	LC- 86D-1	Semiann	Sea Level
LC- 19a	Annual	Up Vashon	MT-1	Quarterly	Up Vashon	LC- 86D-2	Semiann	Sea Level
LC- 20	Annual	Up Vashon	MT-2	Quarterly	Up Vashon	LC- 87D-1	Annual	Sea Level
LC- 24	Annual	Up Vashon	MT-3	Quarterly	Up Vashon	LC- 87D-2	Annual	Sea Level
LC- 26	Annual	Up Vashon	MT-4	Quarterly	Up Vashon	LC- 88D-1	Semiann	Sea Level
LC- 27	Annual	Up Vashon	MT-5	WL	Up Vashon	LC- 88D-2	Semiann	Sea Level
LC- 34	Annual	Up Vashon	MT-6	WL	Up Vashon	LC- 89D-1	Annual	Sea Level
LC- 39	WL	Up Vashon	PW-1	Semiann	Up Vashon	LC- 89D-2	Annual	Sea Level
LC- 40	WL	Up Vashon	PW-2	Semiann	Up Vashon	LC- 90D-1	Annual	Sea Level
LC- 41a	Annual	Up Vashon	PW-3	Semiann	Up Vashon	LC- 90D-2	Annual	Sea Level
LC- 47a	WL	Up Vashon	PW-4	Semiann	Up Vashon	LC- 91D-1	Annual	Sea Level
LC- 49	Annual	Up Vashon	PW-5	Semiann	Up Vashon	LC- 91D-2	Annual	Sea Level
LC- 50	WL	Up Vashon	PW-6	Semiann	Up Vashon	LC- 92D-1	Annual	Sea Level
LC- 53	Annual	Up Vashon	PW-7	Semiann	Up Vashon	LC- 92D-2	Annual	Sea Level
LC- 57	Annual	Up Vashon	PW-8	Semiann	Up Vashon	LC- 93D-1	Semiann	Sea Level
LC- 61b	Semiann	Up Vashon	SRCMW-02	WL	Up Vashon	LC- 93D-2	Semiann	Sea Level
LC- 64a	Annual	Up Vashon	T-04	Semiann	Up Vashon	LC- 94D-1	Annual	Sea Level
LC- 66b	Annual	Up Vashon	T-05	Semiann	Up Vashon	LC- 94D-2	Annual	Sea Level
LC-01	Quarterly	Up Vashon	T-06	Semiann	Up Vashon	LC- 95D-1	Semiann	Sea Level
LC-108	Quarterly	Up Vashon	T-08	Semiann	Up Vashon	LC- 95D-2	Semiann	Sea Level
LC-109	Semiann	Up Vashon	T-11b	Semiann	Up Vashon	LC- 96D	Quarterly	Sea Level
LC-110	WL	Up Vashon	T-13b	Semiann	Up Vashon	LC- 99D	Quarterly	Sea Level
LC-111a	WL	Up Vashon	BC-1	Semiann	Low Vashon	LC-101D1	Semiann	Sea Level
LC-112	WL	Up Vashon	FL-4a	Annual	Low Vashon	LC-101D2	Semiann	Sea Level
LC-113	WL	Up Vashon	LC- 21c	Annual	Low Vashon	LC-102D1	Semiann	Sea Level
LC-114	WL	Up Vashon	LC-111b	Semiann	Low Vashon	LC-102D2	Semiann	Sea Level
LC-115	WL	Up Vashon	LC-116b	Semiann	Low Vashon	LC-103D	Semiann	Sea Level
LC-116	WL	Up Vashon	LC-122b	Semiann	Low Vashon	LC-126	Annual	Sea Level
LC-117	WL	Up Vashon	LC-128	Annual	Low Vashon	LC-166d	WL	Sea Level
LC-118	WL	Up Vashon	LC-137c	Annual	Low Vashon	LC-35D	WL	Sea Level
LC-119	WL	Up Vashon	LC-216	Annual	Low Vashon	LC-97D	Annual	Sea Level
LC-120	WL	Up Vashon	LC-217	Annual	Low Vashon	LC-98D1	Quarterly	Sea Level
LC-121	WL	Up Vashon	LC-219	Annual	Low Vashon	LC-98D2	Quarterly	Sea Level
LC-122	WL	Up Vashon	LC-225	Semiann	Low Vashon	LF4-MW-02c	WL	Sea Level
LC-123	WL	Up Vashon	LC-226	Semiann	Low Vashon	LF4-MW-04	WL	Sea Level
LC-124	Semiann	Up Vashon	LC-41b	Annual	Low Vashon	LF4-MW-09b	WL	Sea Level
LC-125	Semiann	Up Vashon	LX- 2	Semiann	Low Vashon	LF4-MW-12b	WL	Sea Level
LC-132	Annual	Up Vashon	MAMC-1	Annual	Low Vashon	LF4-MW-14	WL	Sea Level
LC-137b	Annual	Up Vashon	MAMC-6	Annual	Low Vashon	MAMC-3	Semiann	Sea Level
LC-160	Annual	Up Vashon	T-10	Semiann	Low Vashon	MAMC-4	Semiann	Sea Level
LC-167	Annual	Up Vashon	LC- 40d	WL	Sea Level	SLAP-1	Quarterly	Sea Level
LC-168	WL	Up Vashon	LC- 41d	WL	Sea Level	SLAP-2	Quarterly	Sea Level
LC-170	WL	Up Vashon	LC- 47d	Annual	Sea Level	SLAP-3	Quarterly	Sea Level
LC-177	WL	Up Vashon	LC- 50d	Annual	Sea Level	SLAP-4	Quarterly	Sea Level
LC-178	Semiann	Up Vashon	LC- 66d	Annual	Sea Level	SLAP-5	Quarterly	Sea Level
LC-180	Annual	Up Vashon	LC- 67d	Annual	Sea Level	SLAP-6	Quarterly	Sea Level
LC-182	Annual	Up Vashon	LC- 68d	Quarterly	Sea Level	SRCMW-01b	WL	Sea Level
LC-218	Semiann	Up Vashon	LC- 69d	Annual	Sea Level	Well 13	Semiann	Sea Level
LC-222	Annual	Up Vashon	LC- 70d	WL	Sea Level	SW-MC-7	Quarterly	Surf Water
LC-223	Semiann	Up Vashon	LC- 72d	Annual	Sea Level	SW-MC-8	Quarterly	Surf Water
			LC- 73d	WL	Sea Level	SW-MC-9	Quarterly	Surf Water

JBLM Statistical Evaluation

Well ID	P Value	Normally Distributed?	Log P Value	Log Normally Distributed?	Linear Regression P Value	Slope	Trend	Statistically?
Upper Vashon Aquifer Unit								
85-PA-381	0.778	Yes	-	-	0.058	-0.006109	Down	No
FL-2	<0.0001	No	0.083	Yes	<0.0001	-0.00133	Down	Yes
FL-3	0.268	Yes	-	-	0.143	-0.0005511	Down	No
FL-6	0.985	Yes	-	-	0.003	-0.0004844	Down	Yes
LC- 03	0.024	No	0.030	No	-	-	-	-
LC- 06	0.450	Yes	-	-	0.104	-0.03307	Down	No
LC- 14a	0.169	Yes	-	-	0.030	-0.006849	Down	Yes
LC- 16	0.106	Yes	-	-	0.089	-0.0009884	Down	No
LC- 19a	0.276	Yes	-	-	<0.0001	-0.03127	Down	Yes
LC- 24	0.000	No	0.022	No	-	-	-	-
LC- 27	0.023	No	0.334	Yes	0.039	-0.0006031	Down	Yes
LC- 34	0.005	No	0.032	No	-	-	-	-
LC- 41a	0.462	Yes	-	-	0.799	0.004998	Up	No
LC- 49	0.754	Yes	-	-	0.331	-0.01058	Down	No
LC- 53	0.563	Yes	-	-	0.004	-0.02536	Down	Yes
LC- 57	0.000	No	0.126	Yes	0.354	-0.000136	Down	No
LC- 61b	0.002	No	0.006	No	-	-	-	-
LC- 64a	<0.0001	No	0.256	Yes	<0.0001	-0.001462	Down	Yes
LC- 66b	0.534	Yes	-	-	0.686	-0.001508	Down	No
LC-108	0.001	No	0.069	No	-	-	-	-
LC-109	0.559	Yes	-	-	0.098	-0.0005053	Down	No
LC-124	0.065	Yes	-	-	0.868	0.0003302	Up	No
LC-132	0.710	Yes	-	-	0.129	-0.005467	Down	No
LC-137b	<0.0001	No	0.181	Yes	0.588	8.6259E-05	Up	No
LC-160	0.019	No	0.747	Yes	<0.0001	-0.001163	Down	Yes
LC-178	0.185	Yes	-	-	0.583	0.001055	Up	No
LC-180	0.117	Yes	-	-	0.000	-0.003204	Down	Yes
LC-218	0.012	No	0.787	Yes	0.000	-0.0005967	Down	Yes
LC-222	0.321	Yes	-	-	0.038	-0.0156	Down	Yes
LC-223	0.531	Yes	-	-	0.541	-0.003022	Down	No
LC-224	0.553	Yes	-	-	0.011	-0.01238	Down	Yes
MT-1	0.236	Yes	-	-	0.030	-0.06047	Down	Yes
MT-2	0.045	No	0.078	Yes	0.020	-0.0003601	Down	Yes
MT-3	0.110	Yes	-	-	0.057	-0.005752	Down	No
MT-4	0.000	No	0.099	Yes	0.001	-0.00139	Down	Yes
SW-MC-6	0.147	Yes	-	-	0.009	-0.0001686	Down	Yes
T-04	0.778	Yes	-	-	0.375	-0.0008469	Down	No
T-05	<0.0001	No	0.006	No	-	-	-	-
T-06	0.706	Yes	-	-	<0.0001	-0.0006759	Down	Yes
T-08	0.628	Yes	-	-	0.046	-0.0002332	Down	Yes
T-11b	0.514	Yes	-	-	<0.0001	-0.001312	Down	Yes

JBLM Statistical Evaluation

Well ID	P Value	Normally Distributed?	Log P Value	Log Normally Distributed?	Linear Regression P Value	Slope	Trend	Statistically?
T-13b	0.274	Yes	-	-	0.881	1.7830E-05	Up	No
Lower Vashon Aquifer Unit								
FL-4a	<0.0001	No	0.000	No	-	-	-	-
LC-41b	0.287	Yes	-	-	0.682	0.002963	Up	No
LC-64b	0.002	No	0.260	Yes	0.120	-0.0006902	Down	No
LC-111b	0.418	Yes	-	-	0.026	0.001009	Up	Yes
LC-116b	0.103	Yes	-	-	0.029	0.005652	Up	Yes
LC-128	0.867	Yes	-	-	0.035	-0.001497	Down	Yes
LC-137c	0.001	No	0.099	Yes	0.435	0.0005771	Up	No
LC-217	0.264	Yes	-	-	0.006	-0.001294	Down	Yes
LC-219	0.105	Yes	-	-	0.010	-0.01462	Down	Yes
LC-225	0.000	No	<0.0001	No	-	-	-	-
LC-226	0.020	No	0.569	Yes	0.147	0.0009534	Up	No
MAMC-1	0.174	Yes	-	-	0.405	9.0394E-05	Up	No
MAMC-6	0.034	No	0.186	Yes	0.004	-0.0002572	Down	Yes
Sea Level Aquifer Unit								
LC-50D	0.000	No	0.175	Yes	0.070	-0.00035	Down	No
LC-66D	0.012	No	0.012	No	-	-	-	-
LC-67D	<0.0001	No	0.001	No	-	-	-	-
LC-69D	0.125	Yes	-	-	0.151	0.008152	Up	No
LC-72D	0.636	Yes	-	-	0.529	-0.001553	Down	No
LC-74D	0.017	No	0.001	No	-	-	-	-
LC-75D	<0.0001	No	0.000	No	-	-	-	-
LC-77D	0.024	No	0.011	No	-	-	-	-
LC-84D-1	0.082	Yes	-	-	0.343	0.0001395	Up	No
LC-84D-2	0.007	No	<0.0001	No	-	-	-	-
LC-86D-1	0.015	No	0.000	No	-	-	-	-
LC-86D-2	0.266	Yes	-	-	0.236	-0.0003282	Down	No
LC-88D-1	0.156	Yes	-	-	0.639	0.0000494	Up	No
LC-88D-2	0.544	Yes	-	-	0.809	1.6330E-05	Up	No
LC-90D-1	0.036	No	0.000	No	-	-	-	-
LC-91D-2	0.230	Yes	-	-	0.453	0.0001052	Up	No
LC-94D-2	0.009	No	<0.0001	No	-	-	-	-
LC-96D	0.044	No	0.024	No	-	-	-	-
LC-98D-1	0.007	No	0.007	No	-	-	-	-
LC-98D-2	0.156	Yes	-	-	0.017	-0.007891	Down	Yes
LC-99D	0.848	Yes	-	-	0.371	0.0104	Down	No
LC-101D-1	0.011	No	0.132	Yes	0.009	0.001244	Up	Yes
LC-101D-2	0.527	Yes	-	-	0.832	0.0003075	Up	No
LC-102D-1	0.114	Yes	-	-	0.105	-0.001092	Down	No

JBLM Statistical Evaluation

Well ID	P Value	Normally Distributed?	Log P Value	Log Normally Distributed?	Linear Regression P Value	Slope	Trend	Statistically?
LC-102D-2	0.577	Yes	-	-	0.245	-0.0009641	Down	No
LC-103D	0.309	Yes	-	-	0.154	-0.01576	Down	No
LC-126	0.449	Yes	-	-	0.597	-0.002719	Down	No
MAMC-3	0.657	Yes	-	-	0.891	4.1869E-05	Up	No

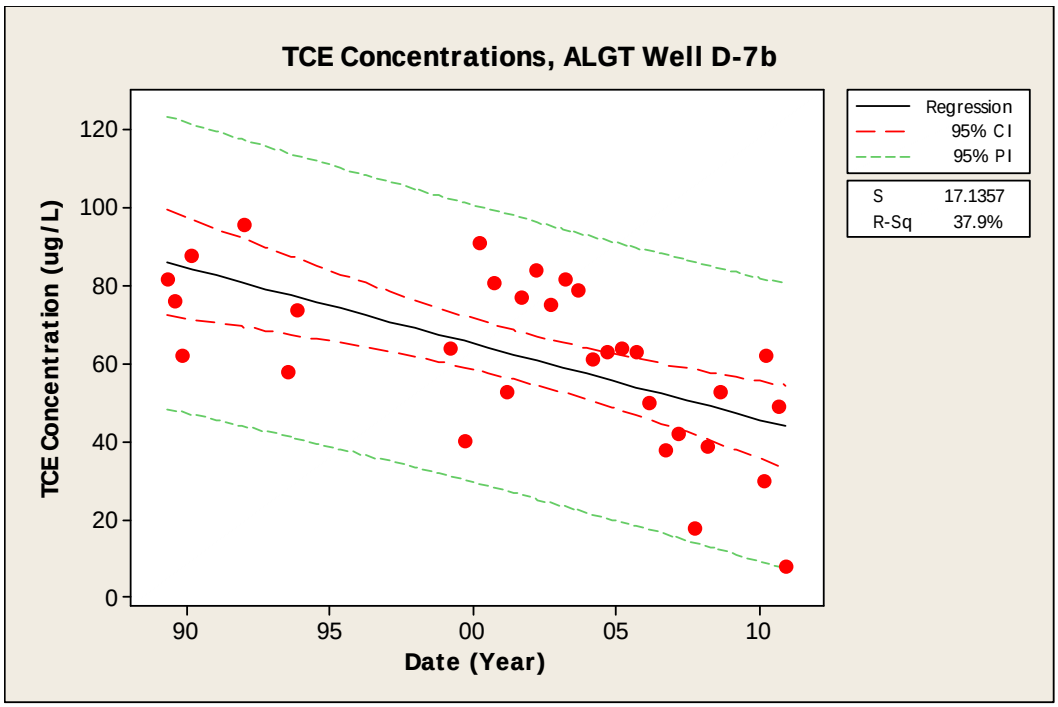
Notes:

- = Not measured, not applicable

JBLM Statistical Evaluation - Tau

Well ID	Tau Statistic	Two Tailed P Value	Trend	Statistically?
Upper Vashon Aquifer Unit				
LC- 03	0.23	0.2945	Up	No
LC- 24	-0.47	0.0244	Down	Yes
LC- 34	-0.27	0.1851	Down	No
LC- 61b	-0.55	0.0005	Down	Yes
LC-108	-0.15	0.4100	Down	No
T-05	-0.06	0.7599	Down	No
Lower Vashon Aquifer Unit				
FL-4A	0.00	1.0000	None	Yes
LC-225	-0.07	0.7548	Down	No
Sea Level Aquifer Unit				
LC-66D	-0.90	0.0009	Down	Yes
LC-67D	-0.11	0.7614	Down	No
LC-74D	-0.54	0.0005	Down	Yes
LC-75D	-0.37	0.0560	Down	No
LC-77D	-0.66	0.0003	Down	Yes
LC-84D-2	0.47	0.0055	Up	Yes
LC-86D-1	-0.17	0.2987	Down	No
LC-90D-1	-0.28	0.0920	Down	No
LC-94D-2	0.26	0.2224	Up	No
LC-96D	-0.64	0.0003	Down	Yes
LC-98D-1	-0.77	<0.0001	Down	Yes

Linear Regression Plots and Tabular Groundwater Data for American Lake Garden Tract



Date Sampled	TCE Concentration µg/L
May-89	82
Aug-89	76
Nov-89	62
Mar-90	88
Jan-92	96
Jul-93	58
Nov-93	74
Mar-99	64
Sep-99	40
Mar-00	91
Sep-00	81
Mar-01	53
Sep-01	77
Mar-02	84
Sep-02	75
Mar-03	82
Sep-03	79
Mar-04	61
Sep-04	63
Mar-05	64

Date Sampled	TCE Concentration µg/L
Sep-05	63
Mar-06	50
Sep-06	38
Mar-07	42
Sep-07	18
Mar-08	39
Sep-08	53
Mar-10	30
Apr-10	62
Sep-10	49
Dec-10	7.8

Mann-Kendall Trend Test by Normal Approximation at 95% Confidence Interval

Ho: No trend in TCE

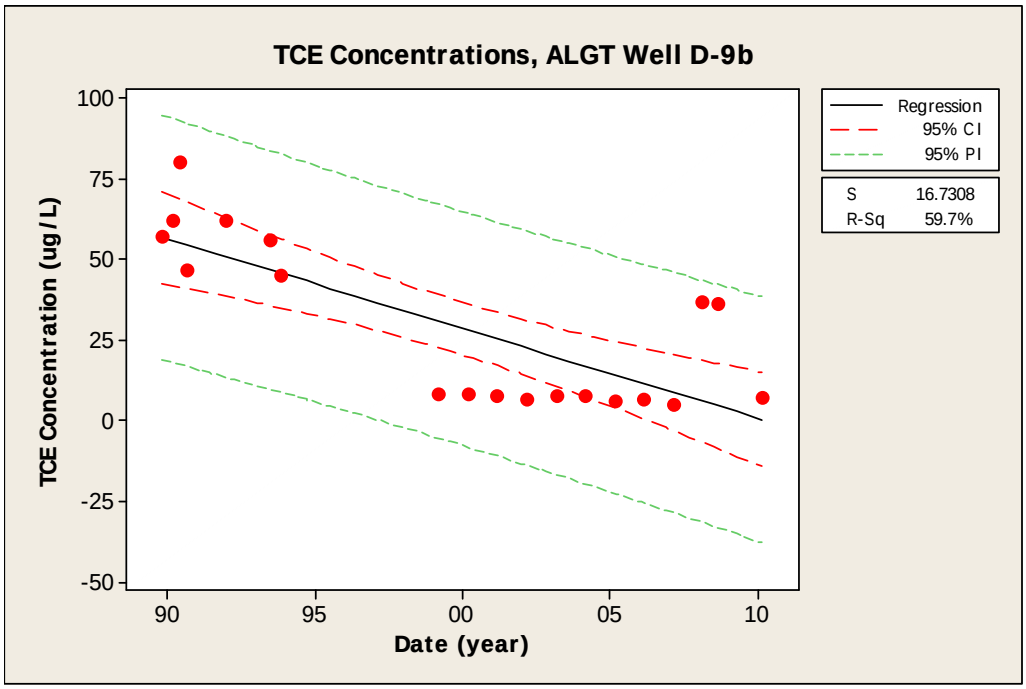
The calculated z = -3.86098

For Ha: Upperward trend, the p-value = 0.999944
At alpha = 0.05, there is not enough evidence to determine that there is an upward trend.

For Ha: Downward trend, the p-value = 0.0000565
At alpha = 0.05, there is enough evidence to determine that there is a downward trend.

Sen's Slope

Sen's Slope for TCE in Da-7b = -1.41987



Date	TCE Concentration (µg/L)
Nov-89	57
Mar-90	62
Jun-90	80
Sep-90	46.5
Jan-92	62
Jul-93	56
Nov-93	45
Mar-99	8
Mar-00	8
Mar-01	7.5
Mar-02	6.8
Mar-03	7.5
Mar-04	7.6
Mar-05	6.1
Mar-06	6.4
Mar-07	4.8
Mar-08	37
Sep-08	36
Mar-10	7.2

Mann-Kendall Trend Test by Normal Approximation

Ho: No trend in TCE

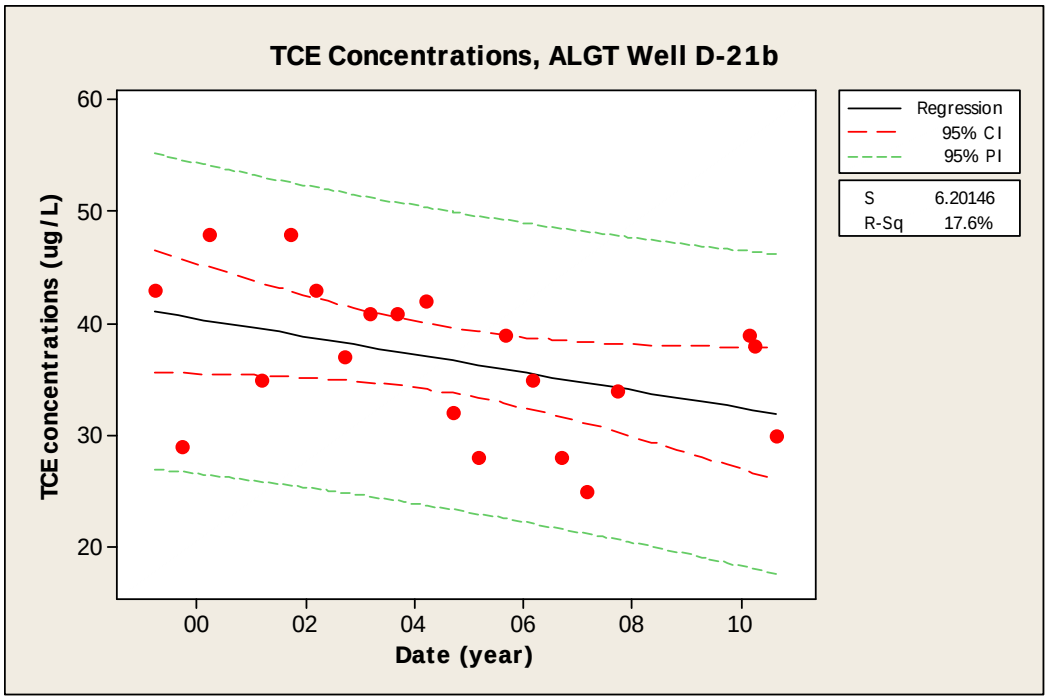
The calculated z = -3.54005

For Ha: Upperward trend, the p-value = 0.999800
At alpha = 0.05, there is not enough evidence to determine that there is an upward trend.

For Ha: Downward trend, the p-value = 0.0002000
At alpha = 0.05, there is enough evidence to determine that there is a downward trend.

Sen's Slope

Sen's Slope for TCE in DA-9b = -4.9



Date	TCE Concentration (µg/L)
Mar-99	43
Sep-99	29
Mar-00	48
Mar-01	35
Sep-01	48
Mar-02	43
Sep-02	37
Mar-03	41
Sep-03	41
Mar-04	42
Sep-04	32
Mar-05	28
Sep-05	39
Mar-06	35
Sep-06	28
Mar-07	25
Sep-07	34
Mar-10	39
Apr-10	38
Sep-10	30

Mann-Kendall Trend Test by Normal Approximation at 95% Confidence Interval

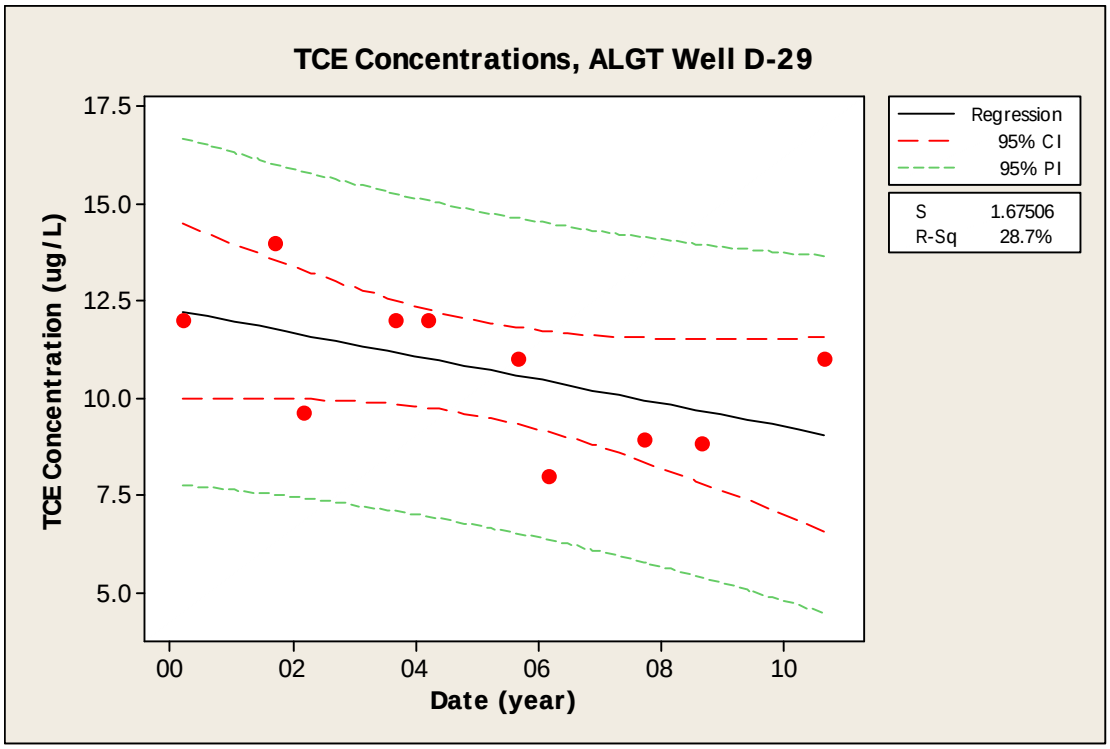
Ho: No trend in TCE

The calculated z = -2.24576

For Ha: Upperward trend, the p-value = 0.987640
At alpha = 0.05, there is not enough evidence to determine that there is an upward trend.

For Ha: Downward trend, the p-value = 0.0123597
At alpha = 0.05, there is enough evidence to determine that there is a downward trend.

Sen's Slope for TCE in DA-21b = 0.714286



Date	TCE Concentration (µg/L)
Mar-00	15
Sep-01	19
Mar-02	11
Sep-03	14
Mar-04	14
Sep-05	10
Mar-06	8.1
Sep-07	7
Sep-08	6.5
Sep-10	7.2

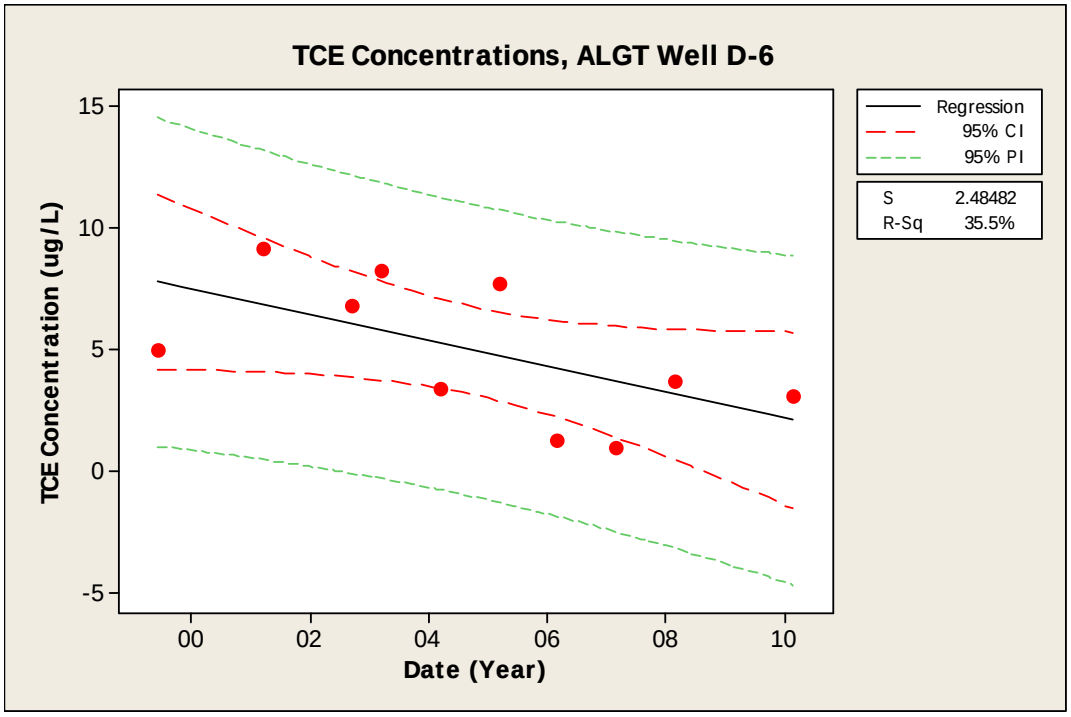
Mann-Kendall Trend Test by Normal Approximation at 95% Confidence Interval

Ho: No trend in TCE

The calculated z = -1.82321

For Ha: Upperward trend, the p-value = 0.965864
At alpha = 0.05, there is not enough evidence to determine that there is an upward trend.

For Ha: Downward trend, the p-value = 0.0341357
At alpha = 0.05, there is enough evidence to determine that there is a downward trend.



Date	TCE concentration (µg/L)
Jun-99	6.6
Mar-01	5.4
Sep-02	2.6
Mar-03	3
Mar-04	1.2
Mar-05	2.3
Mar-06	<0.5
Mar-07	<0.5
Mar-08	1.2
Mar-10	0.79

Mann-Kendall Trend Test by Normal Approximation at 95% Confidence Interval

Ho: No trend in TCE_4

The calculated z = -1.78885

For Ha: Upperward trend, the p-value = 0.963181
At alpha = 0.05, there is not enough evidence to determine that there is an upward trend.

For Ha: Downward trend, the p-value = 0.0368191
At alpha = 0.05, there is enough evidence to determine that there is a downward trend

ALGT Historical Groundwater VOC Data

Well No.	DA-7b	DA-7b	DA-9b	DA-9b	DA-21b	DA-21b	DA-29	DA-29	DA-30b	DA-30b	DA-31	DA-31	DA-32	DA-32	DA-28	DA-28	DA-30a	DA-30a	DB-6	DB-6	DR-05	DR-05	DT-1	DT-1	EPA-W-5	EPA-W-5
	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Date																										
May-89	82																									
Aug-89	76																									
Nov-89	62		57																							
Mar-90	88		62																							
Jun-90			80																							
Sep-90			46.5																							
Jan-92	96		62																							
Jul-93	58		56																							
Nov-93	74		45																							
Mar-99	64	220	8	6	43	72									0.36	<0.2	1.8	10			0.66	0.5			<0.2	2.5
Jun-99																			5	6.6						
Sep-99	40	180			29	88			0.93	6.6					0.24	<0.2										
Mar-00	91	210	8	4.5	48	28	12	15							<0.2	<0.2	2.2	2.2					3.5	1.2	<0.2	3.1
Sep-00	81	190																					2.9	1	0.66	0.71
Mar-01	53	150	7.5	5.3	35	51			0.71	4.2					0.86	<0.5			9.2	5.4			3	1.1	<0.5	1.6
Jun-01																							3.2	1.2		
Sep-01	77	200			48	59	14	19									1.6	15			3.3	1.3	4.2	1.2	1	1.1
Dec-01																							4.2	1.3		
Mar-02	84	210	6.8	3.7	43	56	9.6	11	0.6	3.2					<0.5	<0.5							2.8	0.8	<0.5	2.6
Jun-02																							2.3	<0.5		
Sep-02	75	210			37	50											1.1	8.2	6.8	2.6	2.1	1	2.3	0.7		
Dec-02																							3.9	1.2		
Mar-03	82	220	7.5	4.5	41	54			0.7	3.6					<0.5	<0.5			8.3	3	<0.5	<0.5				
Sep-03	79	190			41	53	12	14									1.4	14								
Mar-04	61	110	7.6	4.3	42	54	12	14									1.6	14	3.4	1.2						
Sep-04	63	140			32	43																				
Mar-05	64	150	6.1	3.2	28	32			0.7	2.9					0.5	<0.5			7.7	2.3	1.4	0.6				
Sep-05	63	140			39	44	11	10									1.3	12								
Mar-06	50	88	6.4	3.5	35	45	8	8.1	0.8	4.2									1.3	<0.5	<0.5	<0.5				
Sep-06	38	58			28	38											0.9	8								
Mar-07	42	55	4.8	2	25	30			0.63	3									1	<0.5	0.61	0.32J				
Jun-07															<0.5	0.36J										
Sep-07	18	9.5			34	42	8.9	7									0.9	6.3								

ALGT Historical Groundwater VOC Data

Well No.	DA-7b	DA-7b	DA-9b	DA-9b	DA-21b	DA-21b	DA-29	DA-29	DA-30b	DA-30b	DA-31	DA-31	DA-32	DA-32	DA-28	DA-28	DA-30a	DA-30a	DB-6	DB-6	DR-05	DR-05	DT-1	DT-1	EPA-W-5	EPA-W-5
	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Mar-08	39	31	37	41					0.75	2.9					0.33J	<0.5			3.7	1.2						
Sep-08	53	81	36	41			8.8	6.5									1.2	8.6			2.9	1.5				
Mar-10	30	16	7.2	3.2	39	38			0.78	3					.27J	<0.5			3.1	0.79						
Apr-10	62	99			38	38					32	5	77	150												
Sep-10	49	47			30	31	11	7.2			25	3.9	10	5.3			1.3	8.2			2.6	1.3				
Dec-10	7.8	22																								

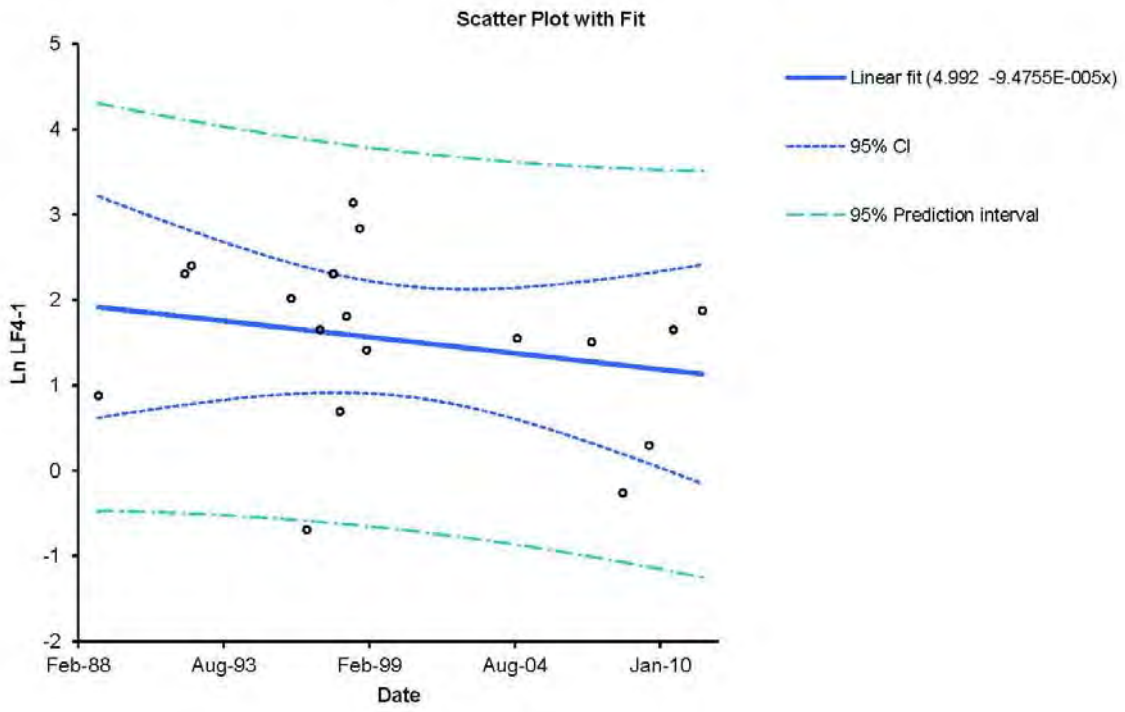
Table B-1. Static Water Levels in Area D/ALGT Wells during CY 2010

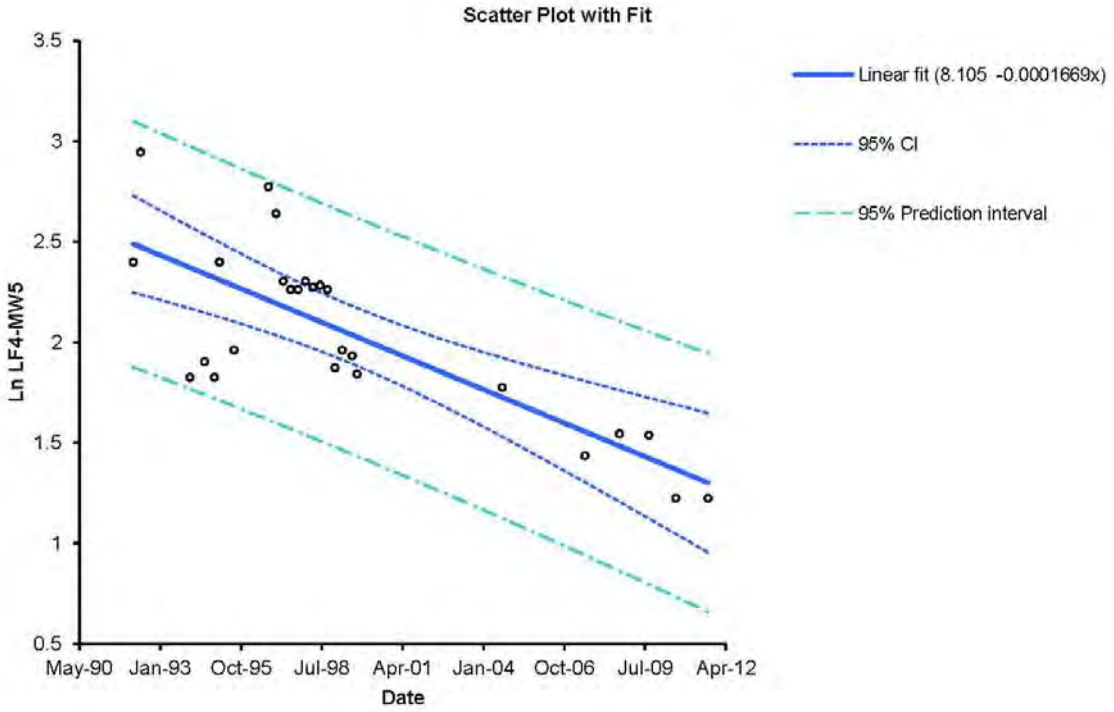
Well ID	Round 1 – 02/10 SWL Elevations (feet NGVD)	Round 2 – 03/10 SWL Elevations (feet NGVD)	Round 3 – 06/10 SWL Elevations (feet NGVD)	Round 4 – 09/10 SWL Elevations (feet NGVD)	Round 5 – 12/10 SWL Elevations (feet NGVD)
DA-6a	265.85	265.47	264.04	261.11	262.52
DA-7b	265.32	265.02	263.47	260.46	261.97
DA-9b	265.12	264.88	263.34	260.32	261.90
DA-11a	263.45	262.97	261.68	258.71	260.16
DA-13a	262.19	261.73	260.65	258.02	259.27
DA-21a	265.86	265.45	264.07	261.11	262.46
DA-21b	265.26	265.10	263.41	260.42	NA
DA-28	262.85	262.30	261.12	258.36	259.66
DA-29	264.45	264.03	262.47	259.49	260.96
DA-30a	264.58	263.21	261.79	258.75	260.23
DA-30b	263.31	261.10	260.02	257.19	258.82
DA-31	277.64	277.64	264.12	261.14	262.51
DA-32	282.20	282.20	263.53	260.86	262.30
DB-6	264.47	263.94	262.44	259.41	260.87
DO-1a	262.67	262.15	261.09	258.53	259.73
DO-2	263.90	263.33	262.05	258.95	260.39
DO-3	264.36	263.89	262.35	259.55	262.18
DO-5a	262.69	262.18	<261.7	<261.7	<261.7
DO-5b	262.72	262.22	261.14	258.45	259.70
DR-05	263.19	263.82	261.97	259.18	260.68
DT-1	262.47	262.01	260.92	258.22	259.38
DT-2	264.75	263.39	262.02	259.05	260.29
DZ-13	261.91	261.43	260.36	257.83	259.07
EPA-W-5	258.88	258.61	257.90	256.00	256.99
DX-2	262.30	261.80	260.50	257.40	258.80
DX-3	224.40	226.30	223.80	224.80	265.30

Notes:
NA = not available – could not access well
NGVD = National Geodetic Vertical Datum
SWL = static water level

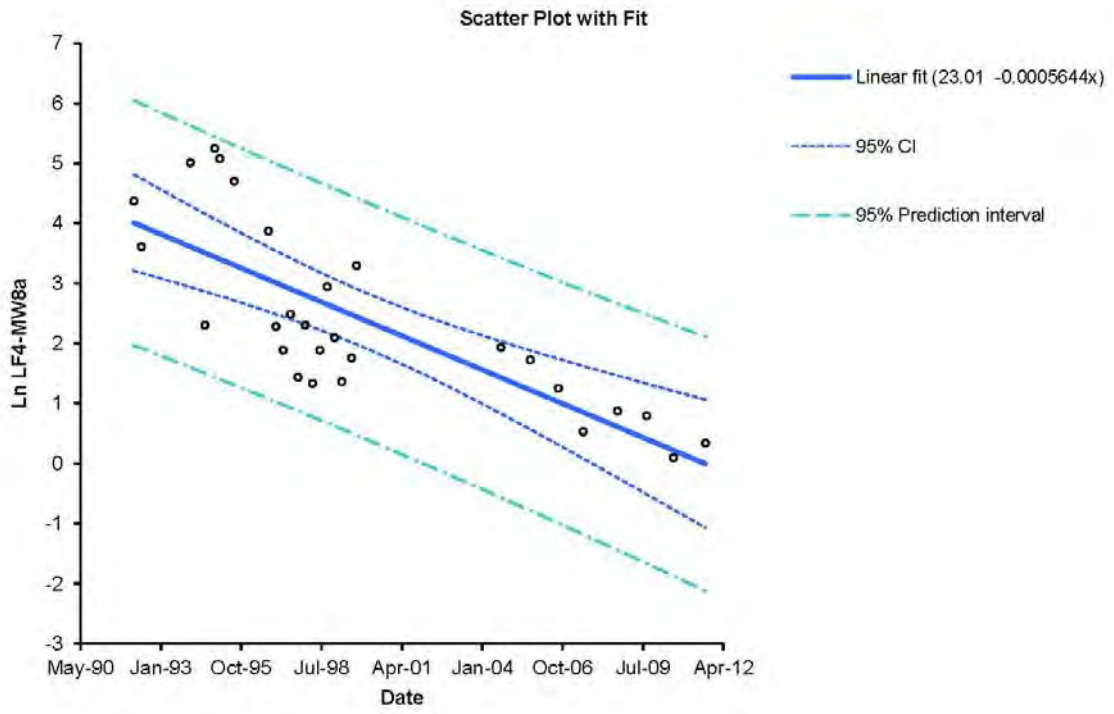
Linear Regression Plots for Landfill 4

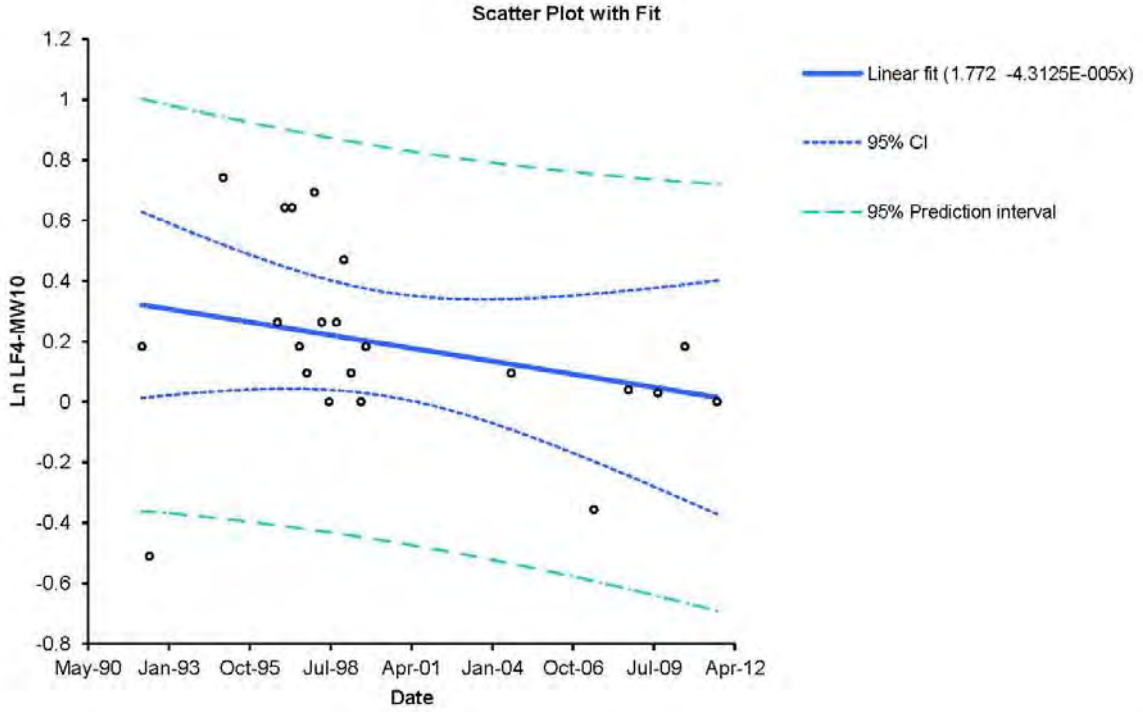
Landfill 4 Statistics
Linear Regression Graphs
Landfill 4, Joint Base Lewis-McChord, Washington 98433



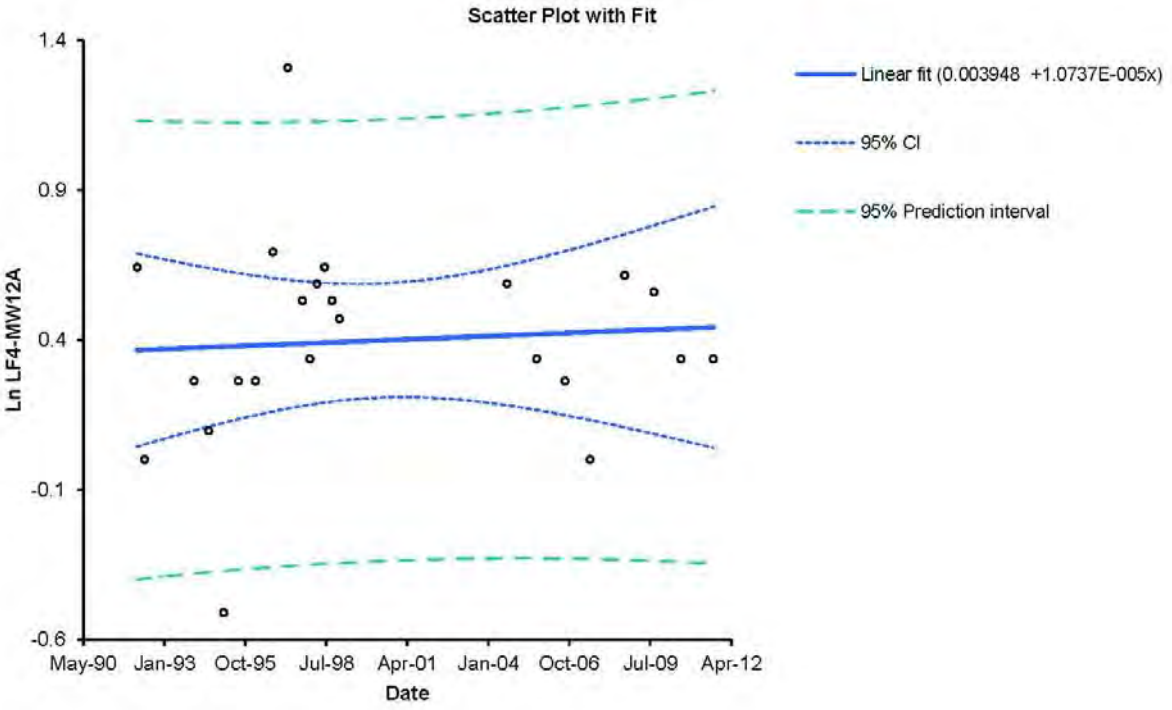


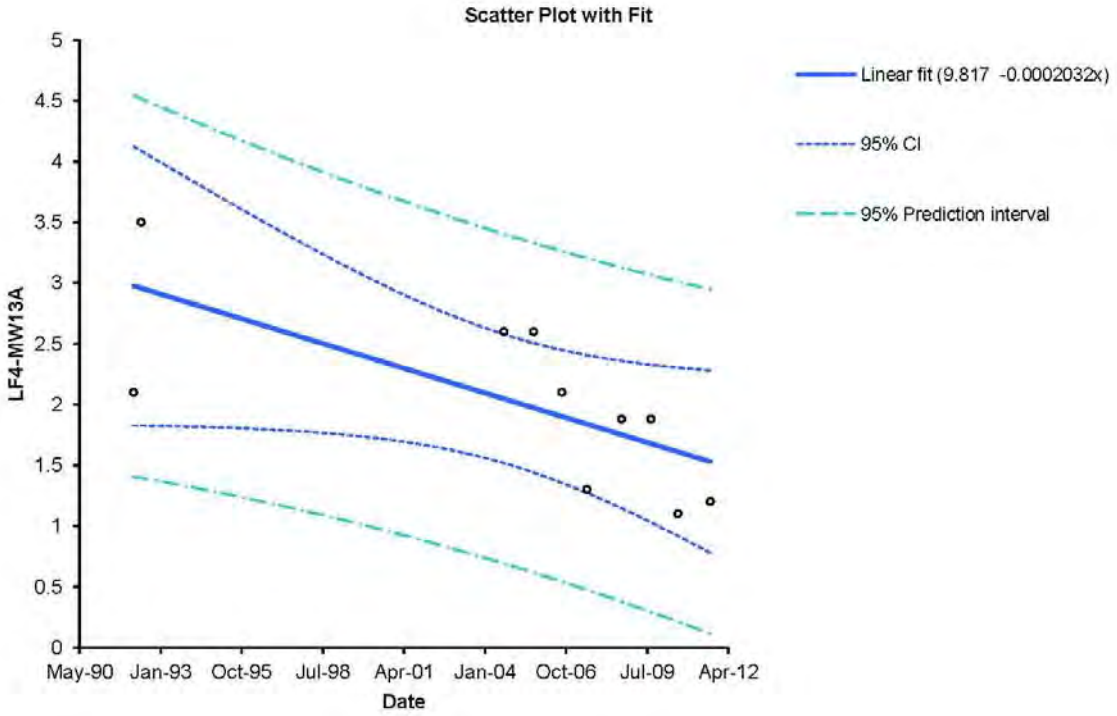
Landfill 4 Statistics
Linear Regression Graphs
Landfill 4, Joint Base Lewis-McChord, Washington 98433



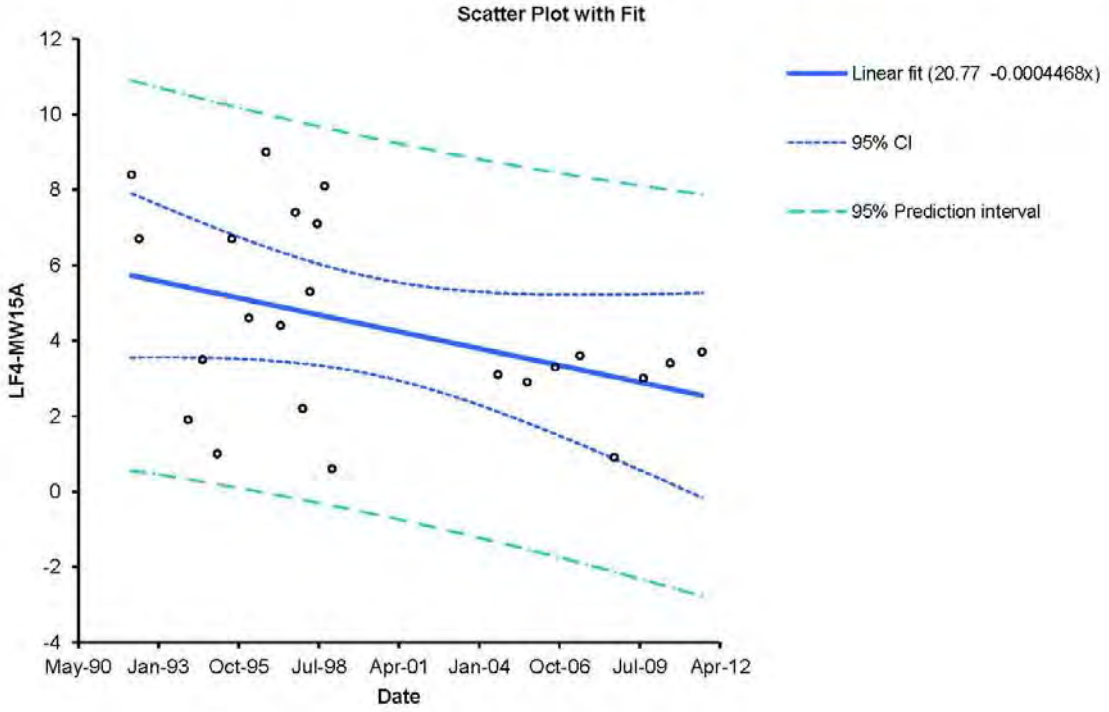


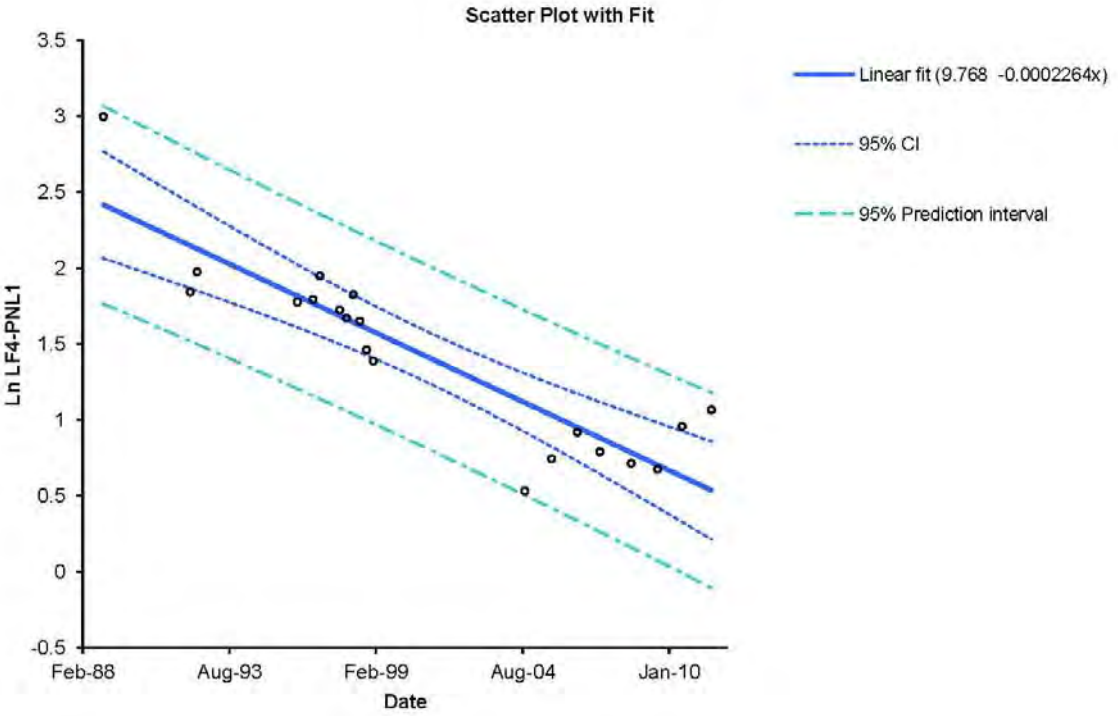
Landfill 4 Statistics
Linear Regression Graphs
Landfill 4, Joint Base Lewis-McChord, Washington 98433



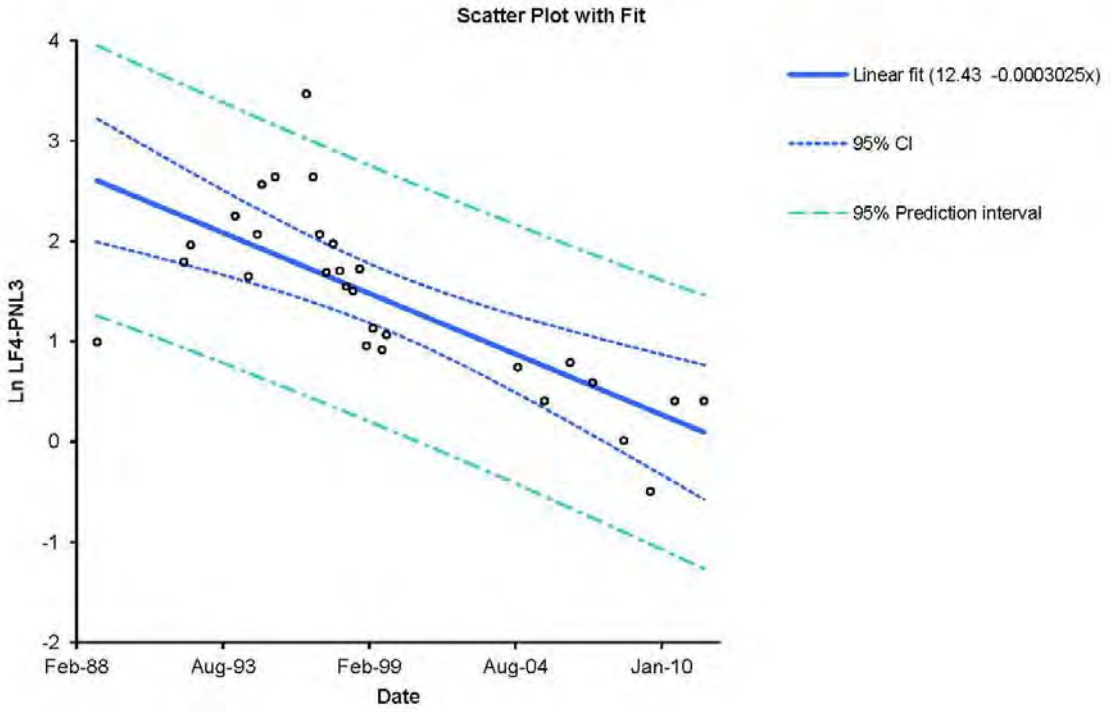


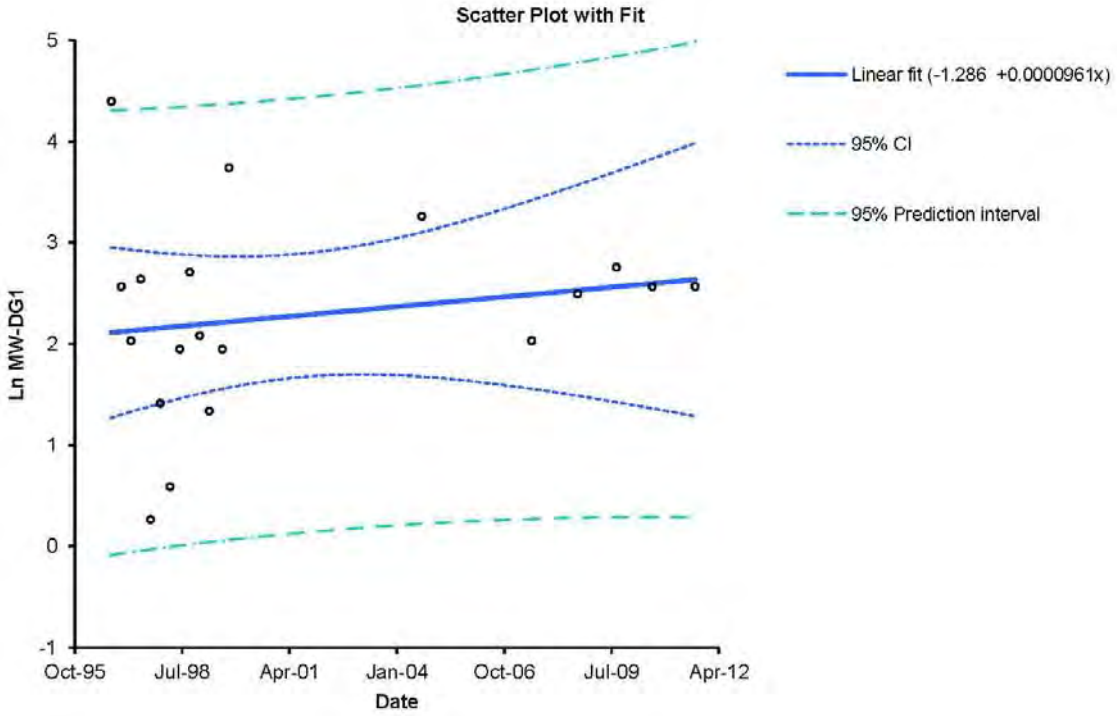
Landfill 4 Statistics
Linear Regression Graphs
Landfill 4, Joint Base Lewis-McChord, Washington 98433



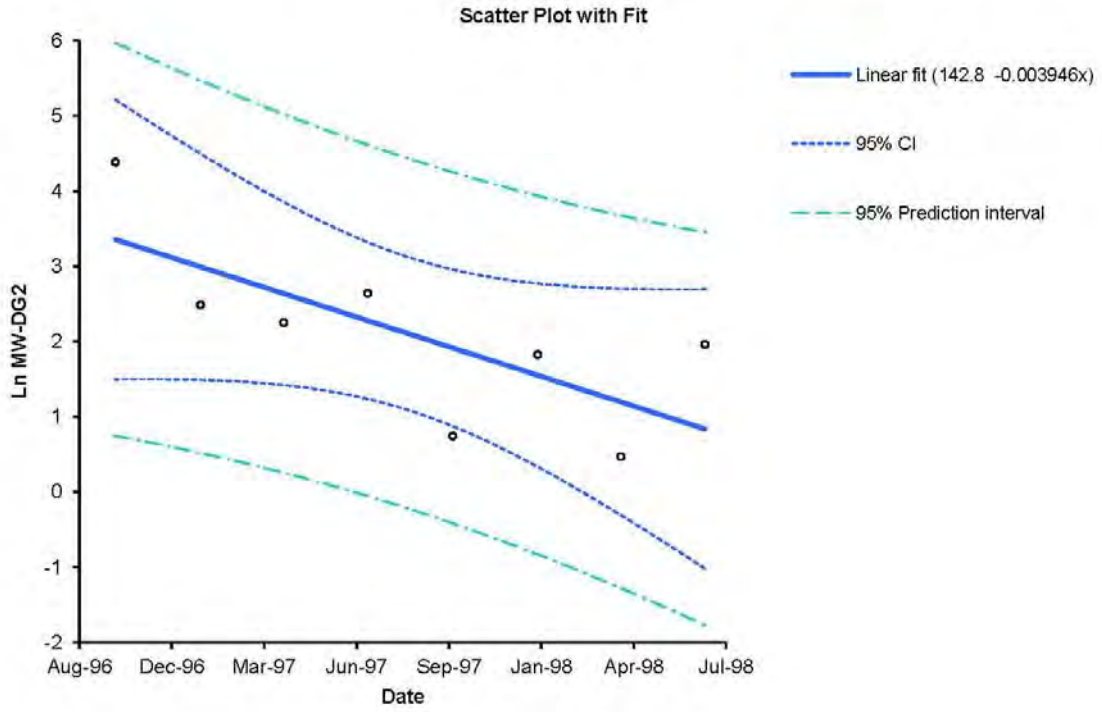


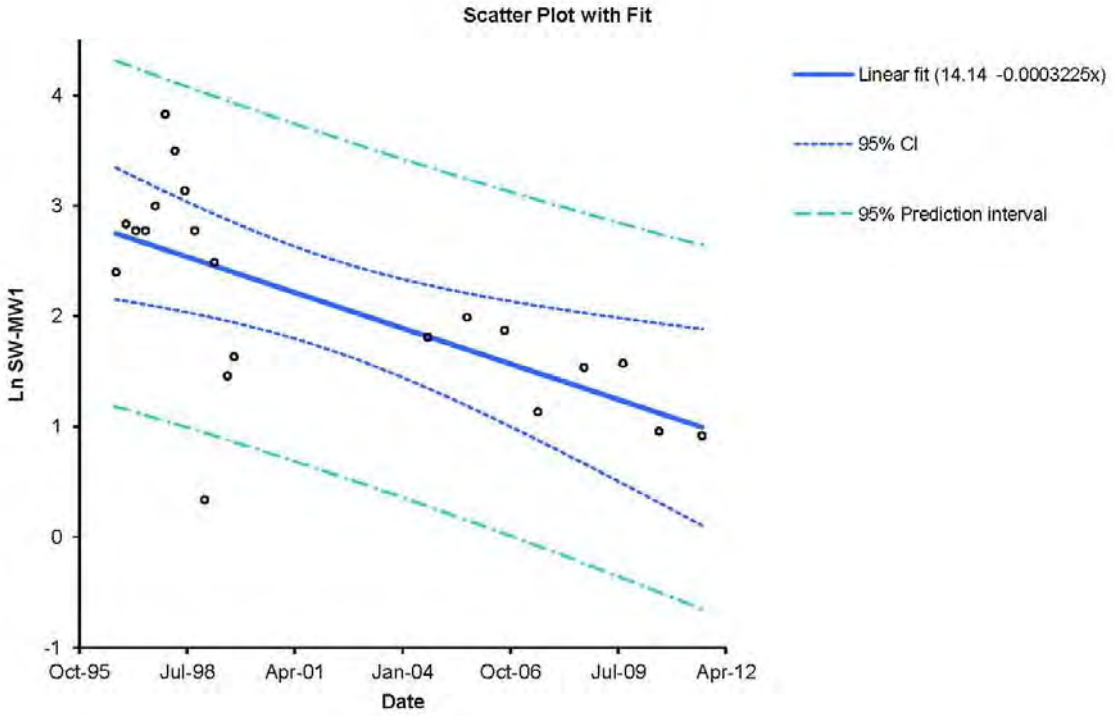
Landfill 4 Statistics
Linear Regression Graphs
Landfill 4, Joint Base Lewis-McChord, Washington 98433



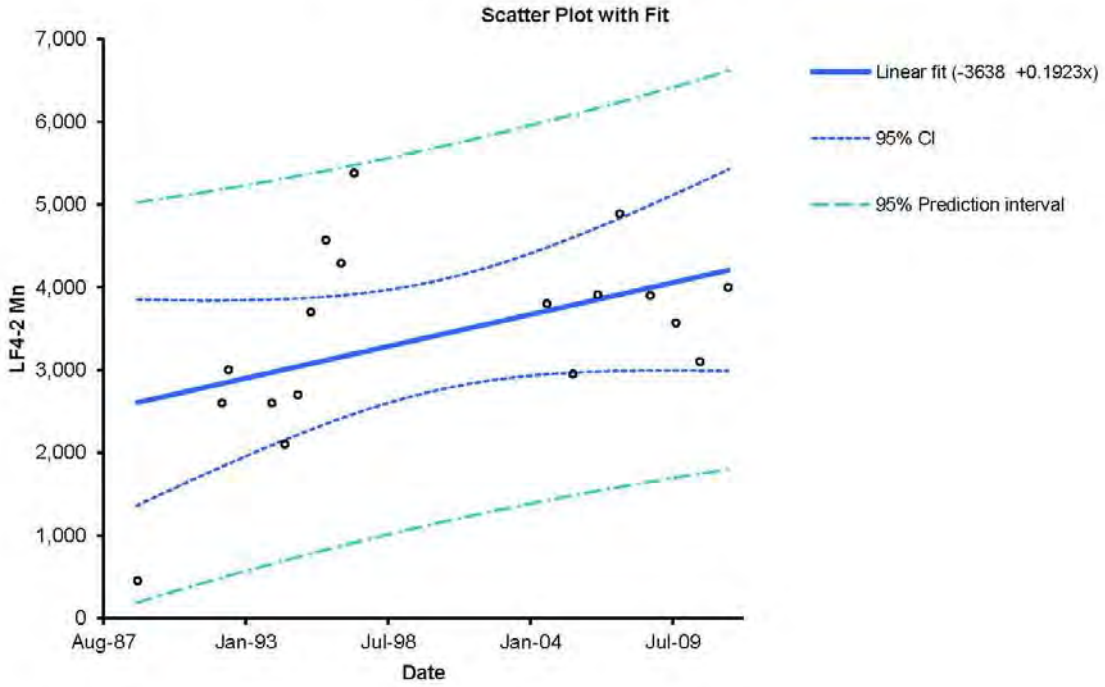


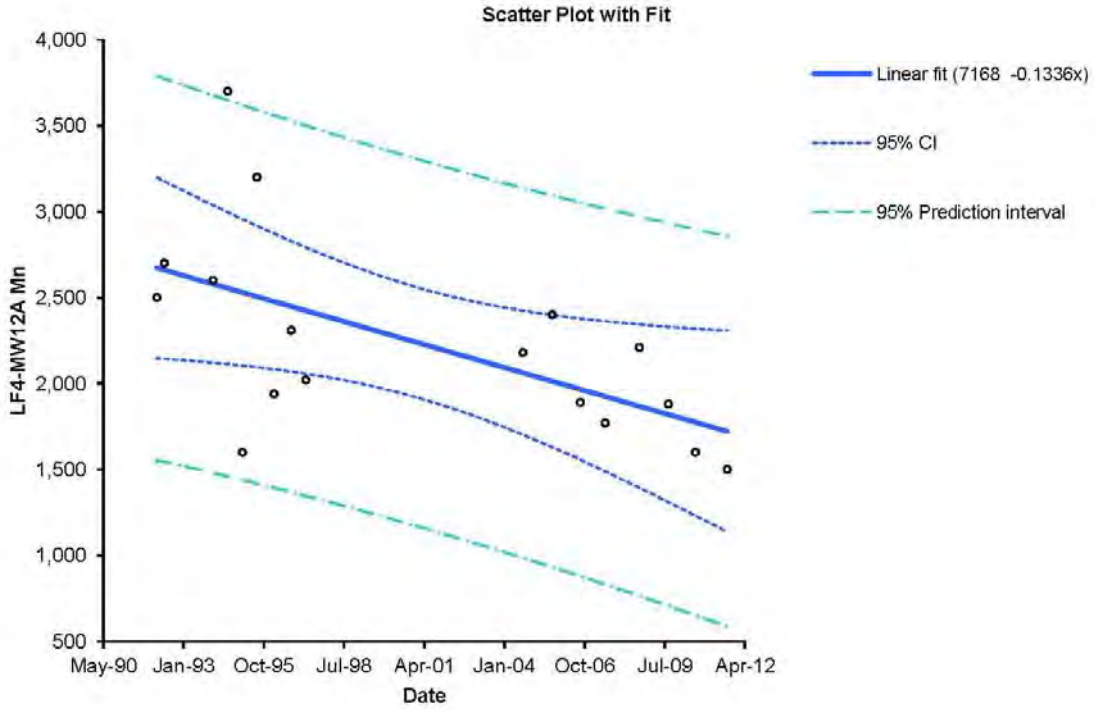
Landfill 4 Statistics
Linear Regression Graphs
Landfill 4, Joint Base Lewis-McChord, Washington 98433



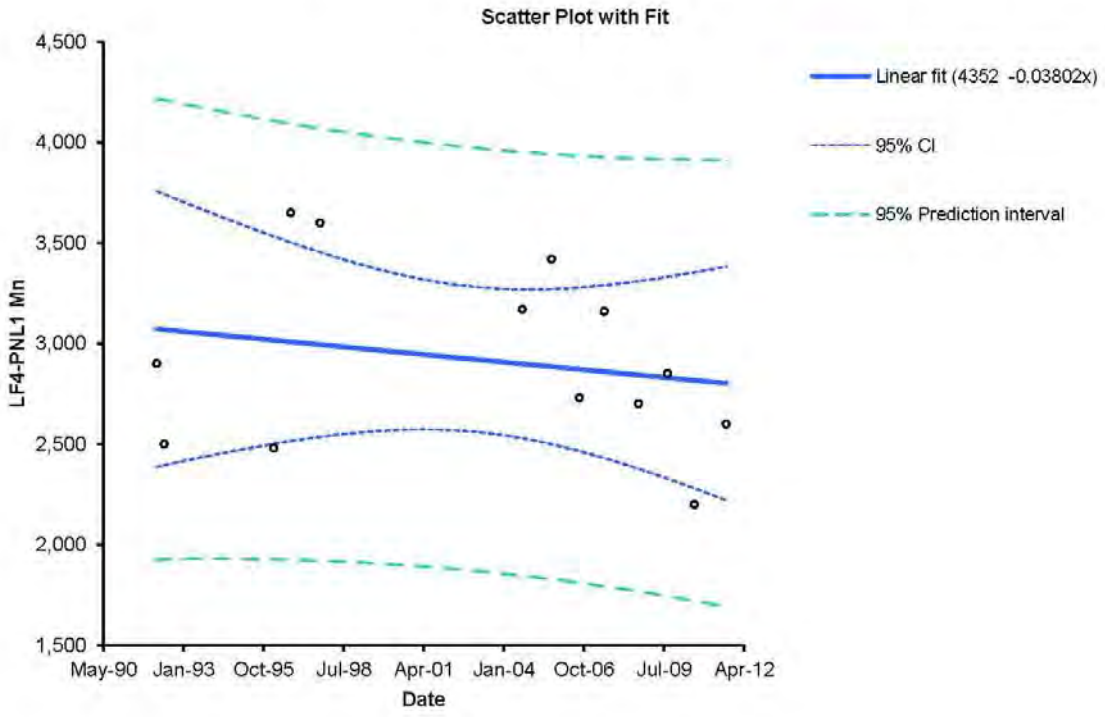


Landfill 4 Statistics
Linear Regression Graphs - Dissolved Manganese
Landfill 4, Joint Base Lewis - McChord, Washington 98433

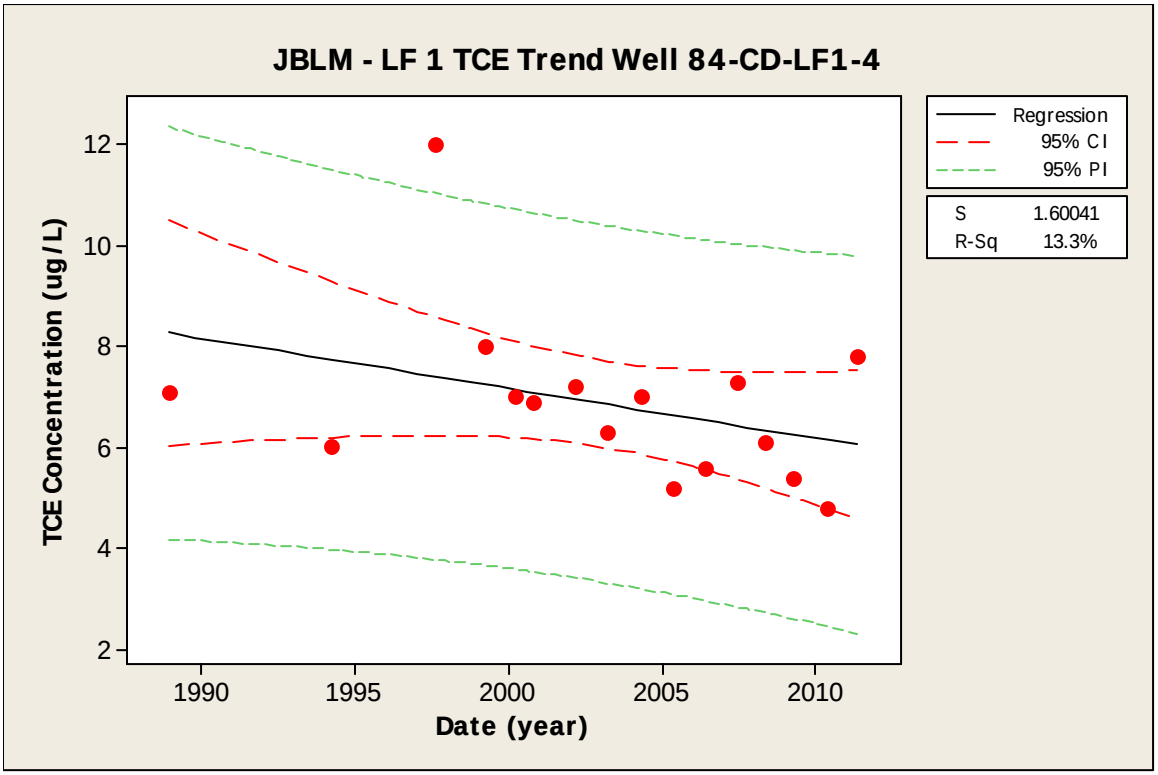




Landfill 4 Statistics
Linear Regression Graphs - Dissolved Manganese
Landfill 4, Joint Base Lewis - McChord, Washington 98433



Linear Regression Plots and Tabular Groundwater Data for Landfill 1



Date	TCE Concentration µg//L
1 Dec 1988	7.1
1 Apr 1994	6.0
1 Aug 1997	12.0
1 Apr 1999	8.0
1 Apr 2000	7.0
1 Nov 2000	6.9
1 Mar 2002	7.2
1 Apr 2003	6.3
28 Apr 2004	7.0
24 May 2005	5.2
13 Jun 2006	5.6
15 Jun 2007	7.3
27 May 2008	6.1
22 Apr 2009	5.4
4 Jun 2010	4.8
26 May 2011	7.8

Mann-Kendall Trend Test by Normal Approximation at 95 Percent Confidence Interval
Ho: No trend in TCE

The calculated z = -1.62246

For Ha: Upperward trend, the p-value = 0.947647

At alpha = 0.05, there is not enough evidence to determine that there is an upward trend.

For Ha: Downward trend, the p-value = 0.0523529
At alpha = 0.05, there is not enough evidence to determine that there is a downward trend.

Sen's Slope

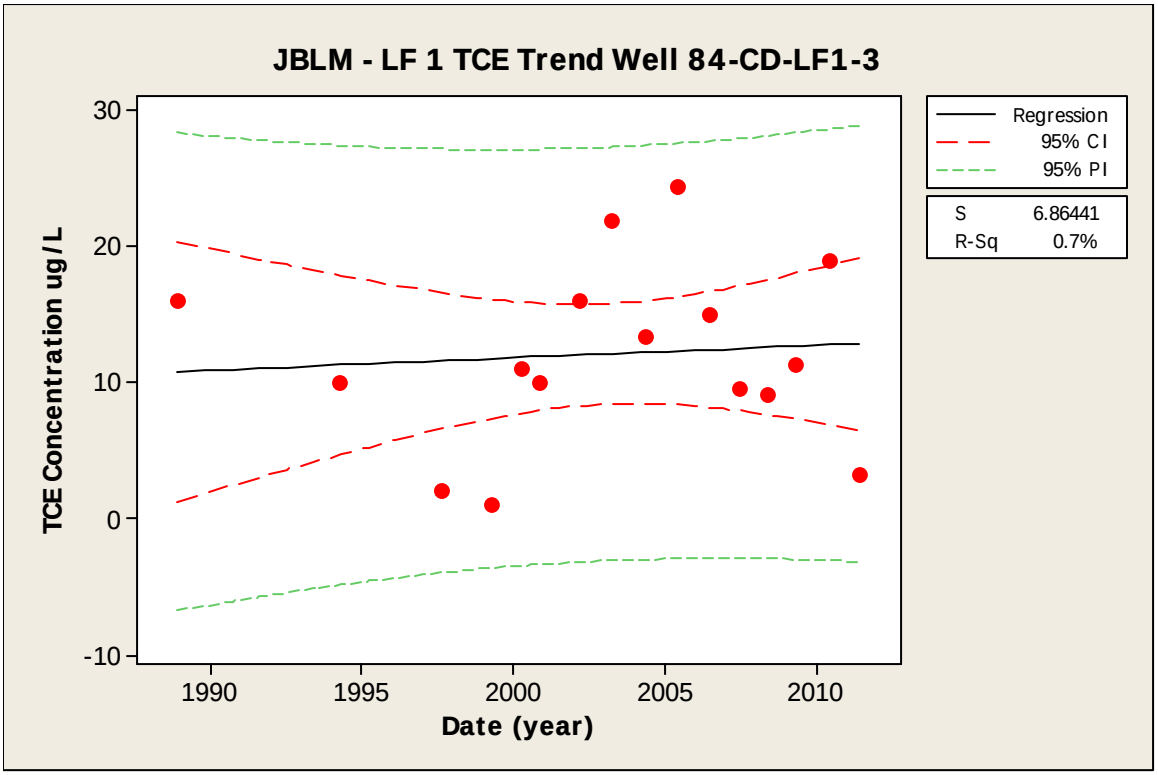
Sen's Slope for TCE = -0.122527

Mann-Kendall Trend Test by Normal Approximation at 90% confidence interval Ho: No trend in TCE

The calculated z = -1.62246

For Ha: Upperward trend, the p-value = 0.947647
At alpha = 0.1, there is not enough evidence to determine that there is an upward trend.

For Ha: Downward trend, the p-value = 0.0523529
At alpha = 0.1, there is enough evidence to determine that there is a downward trend.



Date	TCE Concentration (µg/L)
1 Dec 1988	16.0
1 Apr 1994	10.0
1 Aug 1997	2.0
1 Apr 1999	3.0
1 Apr 2000	11.0
1 Nov 2000	10.0
1 Mar 2002	16.0
1 Apr 2003	21.9
28 Apr 2004	13.4
24 May 2005	24.4
13 Jun 2006	15.0
15 Jun 2007	9.5
27 May 2008	9.1
22 Apr 2009	11.3
4 Jun 2010	19.0
26 May 2011	3.3

Mann-Kendall Trend Test by Normal Approximation at 95% Confidence Interval

Ho: No trend in TCE

The calculated z = 0.225570

For Ha: Upperward trend, the p-value = 0.410768
At alpha = 0.05, there is not enough evidence to determine that there is an upward trend.

For Ha: Downward trend, the p-value = 0.589232
At alpha = 0.05, there is not enough evidence to determine that there is a downward trend.

Mann-Kendall Trend Test by Normal Approximation at 90% Confidence Interval

Ho: No trend in TCE

The calculated z = 0.225570

For Ha: Upperward trend, the p-value = 0.410768
At alpha = 0.1, there is not enough evidence to determine that there is an upward trend.

For Ha: Downward trend, the p-value = 0.589232
At alpha = 0.1, there is not enough evidence to determine that there is a downward trend.

Mann-Kendall Trend Test by Normal Approximation at 80 % Confidence Interval

Ho: No trend in TCE

The calculated z = 0.225570

For Ha: Upperward trend, the p-value = 0.410768
At alpha = 0.2, there is not enough evidence to determine that there is an upward trend.

For Ha: Downward trend, the p-value = 0.589232
At alpha = 0.2, there is not enough evidence to determine that there is a downward trend.

Sen's Slope

Sen's Slope for TCE = 0.104167

LF 1 VOC Data

Well ID TOC Elevation	Sample Date	DTW (ft bgs)	GWELEV (ft AMSL)	TCE (µg/L)	cis-DCE (µg/L)	trans-DCE (µg/L)	1,1,1-TCA (µg/L)	1,2-DCP (µg/L)	PCE (µg/L)	CT (µg/L)	CF (µg/L)
84-CD-LF1-1	1-Sep-88	-	271.65	-	-	-	-	-	-	-	-
303.64	1-Dec-88	-	273.14	0.03U	0.2U	0.5U	-	-	-	0.01U	-
	1-Apr-94	-	273.30	0.5U	0.2U	-	0.2U	0.5U	0.5U	0.2U	0.2U
	1-Aug-97	25.78	277.86	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-99	21.25	282.39	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-00	26.05	277.59	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U
	1-Nov-00	31.81	271.83	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U
	1-Mar-02	27.59	276.05	-	-	-	-	-	-	-	-
	1-Apr-03	29.50	274.14	0.02U	1.0U	1.0U	1.0U	1.0U	0.05U	0.05U	1.0U
	15-Jun-07	26.20	277.44	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	22-Apr-09	30.07	273.57	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	10-May-10	29.16	274.48	-	-	-	-	-	-	-	-
	26-Apr-11	24.37	279.27	-	-	-	-	-	-	-	-
84-CD-LF1-2	1-Sep-88	-	277.51	-	-	-	-	-	-	-	-
303.48	1-Dec-88	-	277.82	**0.3**	0.2U	0.5U	-	-	-	0.01U	-
	1-Apr-94	-	277.70	0.5U	0.2U	-	0.2U	0.5U	0.5U	0.2U	0.2U
	1-Aug-97	26.17	277.31	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-99	21.77	281.71	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U

Well ID TOC Elevation	Sample Date	DTW (ft bgs)	GWELEV (ft AMSL)	TCE (µg/L)	cis-DCE (µg/L)	trans- DCE (µg/L)	1,1,1- TCA (µg/L)	1,2- DCP (µg/L)	PCE (µg/L)	CT (µg/L)	CF (µg/L)
	1-Apr-00	20.98	282.50	**0.081J**	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U
	1-Nov-00	27.66	275.82	**0.044J**	0.4U	0.4U	0.018J	0.4U	0.4U	**0.025J**	0.4U
	1-Mar-02	25.00	278.48	-	-	-	-	-	-	-	-
	1-Apr-03	25.18	278.30	**0.1**	1.0U	1.0U	1.0U	1.0U	0.05U	0.05U	1.0U
	15-Jun-07	26.32	277.16	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
84-CD-LF1-3	1-Sep-88	-	274.02	-	-	-	-	-	-	-	-
297.69	1-Dec-88	-	275.13	**16.0**	**12.0**	0.5U	-	-	-	**0.1**	-
	1-Apr-94	-	273.02	**10.0**	**3.0**	-	0.2U	0.5U	0.5U	0.2U	0.2U
	1-Aug-97	21.84	275.85	**2.0**	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-99	18.38	279.31	**1.0**	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-00	21.96	275.73	**11.0**	**0.5**	0.4U	0.4U	0.4U	**0.06J**	0.4U	**0.33J**
	1-Nov-00	25.01	272.68	**10.0**	**1.6**	**0.056J**	0.4U	0.4U	**0.033J**	0.4U	**0.12J**
	1-Mar-02	23.25	274.44	**16.0**	**0.6**	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
	1-Apr-03	21.95	275.74	**21.9**	1.0U	1.0U	1.0U	1.0U	**0.1**	**0.1**	1.0U
	28-Apr-04	24.81	272.88	**13.4**	**1.3**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	24-May-05	22.97	274.72	**24.4**	**0.6**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	13-Jun-06	23.69	274.00	**15.0**	**0.7**	0.5U	0.5U	0.5U	0.5U	**0.5**	0.5U
	15-Jun-07	23.27	274.42	**9.5**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	27-May-08	24.84	272.85	**9.1**	**0.7**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U

Well ID TOC Elevation	Sample Date	DTW (ft bgs)	GWELEV (ft AMSL)	TCE (µg/L)	cis-DCE (µg/L)	trans-DCE (µg/L)	1,1,1-TCA (µg/L)	1,2-DCP (µg/L)	PCE (µg/L)	CT (µg/L)	CF (µg/L)
	22-Apr-09	24.45	273.24	11.3	**0.7**	0.5U	0.5U	0.5U	0.5U	0.5U	-
84-CD-LF1-3	4-Jun-10	24.31	273.38	19.0	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Cont.	26-May-11	20.88	276.81	**3.3**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
84-CD-LF1-4	1-Sep-88	-	270.80	-	-	-	-	-	-	-	-
312.59	1-Dec-88	-	271.28	7.1	**17.0**	0.5U	-	-	-	**0.0**	-
	1-Apr-94	-	270.86	6.0	**13.0**	-	0.2U	**2.0**	0.5U	0.2U	0.3U
	1-Aug-97	34.96	277.63	12.0	**7.0**	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-99	30.59	282.00	8.0	**6.0**	1.0U	1.0U	**1.0**	1.0U	1.0U	1.0U
	1-Apr-00	35.51	277.08	7.0	**9.9**	**0.15J**	0.4U	**1.4**	0.4U	0.4U	0.27J
	1-Nov-00	41.74	270.85	6.9	**11.0**	**0.21J**	0.4U	**1.5**	0.4U	0.4U	0.22J
	1-Mar-02	37.14	275.45	7.2	**11.0**	**0.2**	0.2U	**1.6**	0.2U	0.2U	0.2U
	1-Apr-03	40.17	272.42	6.3	**11.8**	1.0U	1.0U	**1.6**	0.05U	0.05U	1.0U
	28-Apr-04	40.23	272.36	7.0	**9.9**	0.5U	0.5U	**1.5**	0.5U	0.5U	0.5U
	24-May-05	41.46	271.13	5.2	**8.7**	0.5U	0.5U	**1.3**	0.5U	0.5U	0.5U
	13-Jun-06	36.78	275.81	5.6	**9.8**	0.5U	0.5U	**1.6**	0.5U	0.5U	0.5U
	15-Jun-07	35.46	277.13	7.3	**3.3**	0.5U	0.5U	**0.6**	0.5U	0.5U	0.5U
	27-May-08	39.65	272.94	6.1	**7.0**	0.5U	0.5U	**1.2**	0.5U	0.5U	0.5U
	22-Apr-09	39.30	273.29	5.4	**10.0**	0.5U	0.5U	**1.5**	0.5U	0.5U	0.5U
	4-Jun-10	38.77	273.82	**4.8**	**8.9**	0.5U	0.5U	**1.4**	0.5U	0.5U	0.5U

Well ID TOC Elevation	Sample Date	DTW (ft bgs)	GWELEV (ft AMSL)	TCE (µg/L)	cis-DCE (µg/L)	trans-DCE (µg/L)	1,1,1-TCA (µg/L)	1,2-DCP (µg/L)	PCE (µg/L)	CT (µg/L)	CF (µg/L)
	26-May-11	33.72	278.87	7.8	**4.0**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
95-LF1-5	1-Aug-97	37.38	277.55	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
314.93	1-Apr-99	32.87	282.06	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-00	37.95	276.98	**0.24J**	**0.038J**	0.4U	0.4U	0.4U	**0.057J**	**0.11J**	**0.11J**
	1-Nov-00	dry	-	-	-	-	-	-	-	-	-
	1-Mar-02	39.63	275.30	-	-	-	-	-	-	-	-
	1-Apr-03	43.15	271.78	**0.6**	1.0U	1.0U	1.0U	1.0U	**0.1**	0.05U	1.0U
	15-Jun-07	37.79	277.14	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
95-LF1-7	1-Aug-97	20.91	276.22	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
297.13	1-Apr-99	17.92	279.21	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-00	20.64	276.49	0.18J	**0.038J**	0.4U	0.4U	0.4U	0.4U	0.4U	**0.37J**
	1-Nov-00	20.87	276.26	0.19J	-	0.4U	0.4U	-	**0.023J**	0.4U	**0.13J**
	1-Mar-02	20.61	276.52	-	-	-	-	-	-	-	-
	1-Apr-03	20.10	277.03	**0.1**	1.0U	1.0U	1.0U	1.0U	0.05U	0.05U	1.0U
	15-Jun-07	20.99	276.14	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
95-LF1-8	1-Aug-97	19.87	276.04	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
295.91	1-Apr-99	16.77	279.14	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-00	19.61	276.30	**0.18J**	0.4U	0.4U	0.4U	0.4U	**0.069J**	0.4U	**0.081J**
	1-Nov-00	20.04	275.87	**0.19J**	0.4U	0.4U	0.4U	0.4U	**0.17J**	0.4U	**0.12J**

Well ID TOC Elevation	Sample Date	DTW (ft bgs)	GWELEV (ft AMSL)	TCE (µg/L)	cis-DCE (µg/L)	trans-DCE (µg/L)	1,1,1-TCA (µg/L)	1,2-DCP (µg/L)	PCE (µg/L)	CT (µg/L)	CF (µg/L)
	1-Mar-02	19.55	276.36	-	-	-	-	-	-	-	-
95-LF1-8	1-Apr-03	19.22	276.69	**0.1**	1.0U	1.0U	1.0U	1.0U	0.12U	0.05U	1.0U
Cont.	15-Jun-07	20.15	275.76	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
95-LF1-9	1-Aug-97	13.57	286.23	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
299.80	1-Apr-99	11.06	288.74	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-00	12.12	287.68	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U
	1-Nov-00	13.99	285.81	0.4U	0.11J	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U
	1-Mar-02	11.67	288.13	-	-	-	-	-	-	-	-
	1-Apr-03	12.09	287.71	0.02U	1.0U	1.0U	1.0U	1.0U	0.05U	0.05U	1.0U
	15-Jun-07	13.32	286.48	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
95-LF1-10	1-Aug-97	25.21	277.55	**1.0**	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
302.76	1-Apr-99	21.80	280.96	**1.0**	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-00	25.25	277.51	**0.13J**	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U
	1-Nov-00	26.97	275.79	**2.8**	**0.047J**	0.4U	0.4U	**0.051J**	**0.11J**	**0.024J**	**0.093J**
	1-Mar-02	24.85	277.91	**2.4**	0.2U	0.2U	0.2U	0.2U	**0.3**	0.2U	0.2U
	1-Apr-03	24.92	277.84	**2.6**	1.0U	1.0U	1.0U	1.0U	**0.3**	0.05U	1.0U
	28-Apr-04	26.28	276.48	**3.0**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	24-May-05	25.57	277.19	**2.2**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	13-Jun-06	25.51	277.25	**2.6**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U

Well ID TOC Elevation	Sample Date	DTW (ft bgs)	GWELEV (ft AMSL)	TCE (µg/L)	cis-DCE (µg/L)	trans- DCE (µg/L)	1,1,1- TCA (µg/L)	1,2- DCP (µg/L)	PCE (µg/L)	CT (µg/L)	CF (µg/L)
	15-Jun-07	25.63	277.13	**2.4**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	27-May-08	26.60	276.16	**2.8**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	22-Apr-09	25.68	277.08	**2.5**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Duplicate	22-Apr-09	25.68	277.08	**2.5**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	4-Jun-10	25.71	277.05	**2.0**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	26-May-11	24.22	278.54	**1.9**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
95-LF1-11	1-Aug-97	31.35	276.50	**1.0**	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
307.85	1-Apr-99	26.69	281.16	**3.0**	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-00	31.34	276.51	**1.7**	**0.047J**	0.4U	0.4U	0.4U	0.4U	**0.052J**	**0.09J**
	1-Nov-00	33.23	274.62	**1.9**	**0.076J**	0.4U	0.4U	0.4U	**0.021J**	0.4U	**0.11J**
	1-Mar-02	32.75	275.10	**1.8**	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U	0.2U
	1-Apr-03	32.22	275.63	**2.2**	1.0U	1.0U	1.0U	1.0U	0.05U	**0.2**	1.0U
	28-Apr-04	32.66	275.19	**2.1**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	24-May-05	32.06	275.79	**1.6**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	13-Jun-06	31.87	275.98	**1.6**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	15-Jun-07	31.75	276.10	**1.5**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	27-May-08	32.98	274.87	**2.2**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	4-Jun-10	32.43	275.42	**1.8**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	26-May-11	40.60	267.25	**1.7**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U

Well ID TOC Elevation	Sample Date	DTW (ft bgs)	GWELEV (ft AMSL)	TCE (µg/L)	cis-DCE (µg/L)	trans- DCE (µg/L)	1,1,1- TCA (µg/L)	1,2- DCP (µg/L)	PCE (µg/L)	CT (µg/L)	CF (µg/L)
Duplicate	26-May-11	40.60	267.25	**1.8**	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
LF1-PNL1 308.66	1-Sep-88	-	267.81	0.6U	-	0.6U	0.6U	0.6U	0.6U	0.6U	**1.4**
	1-Dec-88	-	269.04	0.1	0.2U	0.5U	-	-	-	0.01U	-
	1-Apr-94	-	268.41	0.5U	**0.4**	-	**0.3**	0.5U	0.5U	**0.2**	0.5U
	1-Aug-97	31.12	277.54	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-99	26.64	282.02	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-00	31.69	276.97	0.4U	0.4U	0.4U	0.4U	0.4U	**0.098J**	**0.15J**	**0.097J**
	1-Nov-00	39.23	269.43	**0.032J**	**0.027J**	0.4U	**0.031J**	0.4U	**0.026J**	**0.062J**	**0.11J**
	1-Mar-02	33.41	275.25	-	-	-	-	-	-	-	-
	1-Apr-03	36.94	271.72	**2.6**	1.0U	1.0U	1.0U	1.0U	**0.3**	0.05U	1.0U
	15-Jun-07	31.54	277.12	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
	22-Apr-09	37.03	271.63	-	-	-	-	-	-	-	-
	10-May-10	35.10	273.56	-	-	-	-	-	-	-	-
	26-Apr-11	29.76	278.90	-	-	-	-	-	-	-	-
LF1-PNL2 298.37	1-Sep-88	-	275.95	2U	-	2U	2U	2U	2U	2U	2U
	1-Dec-88	-	277.35	0.2	0.2U	0.5U	-	-	-	**0.0**	-
	1-Apr-94	-	277.31	-	-	-	-	-	-	-	-
	1-Aug-97	21.12	277.25	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-99	19.33	279.04	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U

Well ID TOC Elevation	Sample Date	DTW (ft bgs)	GWELEV (ft AMSL)	TCE (µg/L)	cis-DCE (µg/L)	trans- DCE (µg/L)	1,1,1- TCA (µg/L)	1,2- DCP (µg/L)	PCE (µg/L)	CT (µg/L)	CF (µg/L)
	1-Apr-00	20.98	277.39	**0.088J**	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U
	1-Nov-00	22.46	275.91	**0.092J**	0.021J	0.4U	0.4U	0.4U	0.022J	0.4U	0.4U
	1-Mar-02	21.01	277.36	-	-	-	-	-	-	-	-
	1-Apr-03	20.95	277.42	**0.0**	1.0U	1.0U	1.0U	1.0U	0.05U	0.05U	1.0U
	15-Jun-07	21.20	277.17	-	-	-	-	-	-	-	-
	22-Apr-09	21.12	277.25	-	-	-	-	-	-	-	-
	10-May-10	21.29	277.08	-	-	-	-	-	-	-	-
	26-Apr-11	20.86	277.51	-	-	-	-	-	-	-	-
LF1-PNL3 307.74	1-Sep-88	-	278.34	2U	-	2U	2U	2U	2U	2U	2U
	1-Dec-88	-	280.48	0.03U	0.2U	0.5U	-	-	-	0.01U	-
	1-Apr-94	-	281.34	-	-	-	-	-	-	-	-
	1-Aug-97	26.58	281.16	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-99	23.83	283.91	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-00	25.71	282.03	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U
	1-Nov-00	29.21	278.53	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U	0.4U
	1-Mar-02	inaccessable	-	-	-	-	-	-	-	-	-
	1-Apr-03	25.29	282.45	0.02U	1.0U	1.0U	1.0U	1.0U	0.05U	0.05U	1.0U
	15-Jun-07	26.72	281.02	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
LF1-PNL4	1-Sep-88	-	267.82	2U	-	2U	2U	2U	2U	2U	2U

Well ID TOC Elevation	Sample Date	DTW (ft bgs)	GWELEV (ft AMSL)	TCE (µg/L)	cis-DCE (µg/L)	trans- DCE (µg/L)	1,1,1- TCA (µg/L)	1,2- DCP (µg/L)	PCE (µg/L)	CT (µg/L)	CF (µg/L)
305.00	1-Dec-88	-	269.03	**0.1**	0.2U	0.5U	-	-	-	0.01U	-
	1-Apr-94	-	268.41	**0.7**	0.4	-	0.2U	0.5U	0.5U	0.2U	0.2U
	1-Aug-97	27.46	277.54	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-99	23.04	281.96	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U	1.0U
	1-Apr-00	28.00	277.00	**0.29J**	**0.076J**	0.4U	0.4U	0.4U	0.4U	0.4U	0.074J
	1-Nov-00	35.55	269.45	0.4U	0.021J	0.4U	0.4U	0.4U	0.4U	0.4U	0.047J
	1-Mar-02	29.76	275.24	-	-	-	-	-	-	-	-
	1-Apr-03	33.26	271.74	0.044U	1.0U	1.0U	1.0U	1.0U	0.05U	0.05U	1.0U
	15-Jun-07	27.87	277.13	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
MTCA Method A Cleanup Level			**-**	**5**	**-**	**-**	**200**	**-**	**5**	**-**	**-**
MTCA Standard Method B Cleanup Level			**-**	**-**	**70**	**100**	**-**	**5**	**-**	**3**	**7**

Notes:

TOC = Top of casing
DTW (ft bgs) = Depth to water feet below ground surface
GWELEV (ft AMSL) = Groundwater elevation feet above mean sea level
TCE = Tricholoroethylene
cis-DCE = cis 1,2-dichloroetheylene
trans-DCE = trans 1,2-dichloroethylene
1,1,1-TCA = 1,1,1-trichloroethane
1,2-DCP = 1,2-dichloropropane
PCE = Tetrachloroethylene
CT = Carbon tetrachloride
CF = Chloroform
µg/L = Micrograms per liter

Well ID TOC Elevation	Sample Date	DTW (ft bgs)	GWELEV (ft AMSL)	TCE (µg/L)	cis-DCE (µg/L)	trans- DCE (µg/L)	1,1,1- TCA (µg/L)	1,2- DCP (µg/L)	PCE (µg/L)	CT (µg/L)	CF (µg/L)

BOLD = Analyte detected at or above laboratory practical quantification limit
BOLD Analyte detected at or above MTCA Method A cleanup level
J = Value estimated
U = Analyte not detected above laboratory practical quantification limit reported
- = No data, not applicable

Depth to water was measured in wells on 26April2011

Appendix C - ARARs and TBC Analysis for JBLM

Appendix C: Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Analysis for JBLM

Act/Authority	Requirements	Status	Citation for Federal Requirements	Citation for Washington Requirements
Federal Safe Drinking Water Act	National Primary Drinking Water Standards- maximum contaminant levels (MCLs), maximum contaminant level goals (MCLGs) and regulation implementation Establishes health- and technology-based standards for public drinking water systems. Also establishes drinking water quality goals set at levels at which no adverse health effects are anticipated, with an adequate margin of safety.	Relevant and Appropriate	40 CFR 141, 40 CFR 142 40 CFR 143 40 CFR 131	
Environmental Protection Agency Guidance	USEPA Region 9 Preliminary Remediation Goals (Now RSLs) Provides risk-based concentrations for contaminants that are used for screening level evaluations of environmental measurements and can be used as initial cleanup goals.	To Be Considered	http://www.epa.gov/ region09/waste/sfund/prg/	
Resource Conservation and Recovery Act	Identification and listing of hazardous waste Identifies solid wastes that are subject to regulation as hazardous wastes. Also establishes requirements (e.g., USEPA ID numbers and manifests) for generators of hazardous waste.	Applicable	40 CFR 261 40 CFR 262	
Washington Toxics Control Act	Establishes primary and secondary drinking water standards	Applicable		WAC 246-290-310

Appendix D - Documents Reviewed

- October 1989 Federal Facility Agreement for McChord AFB
- January 1990, Federal Facility Agreement for Fort Lewis
- May 1990, Feasibility Study Report for Logistics Center
- May 1990, Baseline Human Health Risk Assessment for Logistics Center
- July 1990, Hazardous Waste Evaluation Report for Fort Lewis
- September 1990, Record of Decision for Logistics Center
- September 1991, Record of Decision American Lake Garden Tract McChord AFB
- July 1992, Record of Decision LF 5
- February 1993, Remedial Investigation Report for LF 4 and SRCPP
- March 1993, Baseline Risk Assessment Report for LF 4 and SRCPP
- May 1993, Feasibility Study Report for LF 4 and SRCPP
- September 1993, Record of Decision for LF 4 and SRCPP
- November 1994, Limited Field Investigation Report: Multi-Site Limited Field Investigation
- March 1997, Chemical Reports 2 and 3 for SRCPP Soil Remediation
- September 1997, Five-Year Review Report for Logistics Center
- September 1998, Explanation of Significant Difference for Logistics Center
- November 1998, Remedial Action Report for Groundwater Treatment Project at Logistics Center
- July 1999, Remedial Action Report for SRCPP, along with 28 September 1999 letter from USEPA
- July 2000, Decision Document for Removal Action for Containerized Source from LF 2 (EGDY)
- December 2000, Decision Document for the Storm Water Outfalls/Industrial Wastewater Treatment Plant, Pesticide Rinse Area, Old Fire Fighting Training Pit, Illicit PCB Dump Site, and the Battery Acid Pit
- August 2002, Decision Document for In-Situ Thermal Treatment LF 2 (EGDY)
- March 2001, LF 4 Air Sparging/Soil Vapor Extraction Remediation Report
- September 2002, Second Five-Year Review Report for Logistics Center
- October 2002, Risk Assessment Addendum for East Gate Disposal Yard and Logistics Center
- April 2004, Groundwater Monitoring Plan for LF 1, as amended in May 2005
- June 2004, Closure Report for Logistics Center EGDY Infiltration System Relocation
- January 2005, Screening-Level Risk Evaluation for DRMO Yard
- April 2005, NAPL Area 1 Completion Report for In Situ Thermal Remediation at East Gate Disposal Yard
- February 2006, Groundwater Monitoring Plan for LF 4
- April 2006, Decision Document for Battery Acid Pit
- April 2006, Decision Document for Direct Contact with LF 2 (EGDY) Soil
- April 2006, Decision Document for DRMO Yard
- April 2006, Decision Document for Illicit PCB Dump Site
- April 2006, Decision Document for LF 1
- April 2006, Decision Document for NFA Park Marsh Landfill

- April 2006, NAPL Area 2 Completion Report for In Situ Thermal Remediation at East Gate Disposal Yard
- June 2006, Groundwater Monitoring Report for June 2006 Event at LF 1 (Draft), along with to be published data for 2007 from ERP files
- August 2006, Army Defense Environmental Restoration Program Installation Action Plan for Fort Lewis
- October 2006, 9th Annual Report for Logistics Center Operation and Maintenance, along with to be published data for period between January 2006 and June 2007 from ERP files
- December 2006, Groundwater Monitoring Report for August 2006 Event at LF 4 (Draft), along with to be published data for 2007 from ERP files
- December 2006, Fort Lewis East Gate Disposal Yard Pump-And-Treat System Upgrade Completion Report
- February 2007, Logistics Center SLA Feasibility Study
- February 2007, Explanation of Significant Difference for Logistics Center
- February 2007, Decision Document for NFA LF6
- March 2007, Logistics Center Remedial Action Monitoring Compliance Plan
- May 2007, 2005 Annual Monitoring Report for Logistics Center Remedial Action Monitoring Program, along with to be published data for period between January 2006 and June 2007 from ERP files
- June 2007, Well Installation Work Plan for the SLA Pump-and-Treat System
- June 2007, NAPL Area 3 Completion Report for In Situ Thermal Remediation at East Gate Disposal Yard
- June 2007, I-5 Capture Analysis (Draft)
- June 2007, Quality Assurance Project Plan for Vapor Intrusion Study at Madigan Family Housing Area
- September 2007, Madigan Family Housing Area Vapor Intrusion Sampling Report
- September 2007, Land Use Control Plan for Fort Lewis CERCLA Sites
- September 2007, Final Five Year review Report, Third Five Year Review Report for Ft. Lewis CERCLA Sites
- December 2007, Draft Decision Document for IWTP
- March 2010, Final Third Five Year Review Report for Area D/ALGT
- October 2010, Final Draft, Explanation of Significant Differences, Logistics Center NPL Site
- October 2010, Final Draft Technical Memorandum for Fire Training Pit, Park Marsh Landfill, Pesticides Rinse Area, Illicit PCB Dump, Landfill1, Explosive Ordnance Demolition Site 62
- August 2011, Land Use Control Plan JBLM-McChord-McChord Field American Lake Garden Tract CERCLA Site

Appendix E - Site Visit Report

CESPK-ED-GG (200-1a) 4 January 2012

MEMORANDUM FOR FILE

SUBJECT: Site Visit, Joint Base Lewis McChord, 5-Year Review, Tacoma, Washington

1. On 20 December 2011, the undersigned and Mr. Doug Mackenzie visited Joint Base Lewis McChord (JBLM) to perform the official site visit for the first 5-year review for JBLM. Fort Lewis and McChord AFB were merged into JBLM in February 2010. Each of the installations has in the past, independently had 5-year reviews for various projects. Previously, the undersigned and Mr. Rick McComb attended a kick-off meeting for the 5-year review with JBLM staff and USEPA. At that time many of the sites were visited with emphasis on the CERCLA sites for JBLM. However, the formal site visit of 20 December is described below.

2. The following individuals from JBLM participated in the site visit.

Mr. Jim Gillie, Versar, Inc., JBLM Environmental Coordinator, 253-966-1774
Mr. Tom Lynott, Versar, Inc., Fort Lewis LTM Manager,
Mr. Robert Thomas, Versar, Inc., Fort Lewis Systems Operator, 253-966-1803

In addition, the previous visit included meeting with the following individuals:

Mr. Bill Myers, JBLM, Environmental Restoration Program Manager, 253 477-3742
Ms. Nancy Harney, USEPA Region 10, Program Manager, 206 553-6635
Ms. Marcia Knadle, USEPA Region 10, Hydrogeologist, 206 553-1641
Mr. Jonathan Harrington, US AEC, Environmental Restoration Manager (ERM) 210 466-1719

3. The site visit included a briefing of the sites, a brief discussion of the JBLM regulatory framework and a field visit to selected sites. JBLM has four types of environmental sites; CERCLA sites, a MMRP Site, RCRA Sites (also known as Agreed Order sites) and Consent Decree Sites. It has been determined that the 5-year review will include only the CERCLA sites. A periodic review will follow on the heels of submitting the draft 5-year CERCLA review. After the periodic review, a review of the non-CERCLA No Further Action (NFA) sites will be performed. Based upon the successful completion of the 5-year CERCLA review and the periodic review, the review of the non-CERCLA NFA sites may be slipped into next FY. That has yet to be determined. The critical review is the 5-year review. It is imperative that the 5-year review be completed in total by the end of FY-12 (30 September 2012). Regarding the MMRP site, the B-Range, USEPA would like to add the B-Range to the 5-year review as a status update. A new Federal Facility Agreement is in development and the B-Range will be included.

4. The site discussions reiterated and enhanced information being summarized on the Site Information Table being compiled for the 5-year review (attached).

5. The discussion of the sites included an update of the various operations at each site where remedial operations are underway. The standard Site Inspection Checklist was used in general to focus the discussions, though it was not formally filled out and included in the review. Messrs. Gillie, Lynott and Thomas participated in the discussions.

5.1 Public participation/public interest. JBLM just completed their open house to the public regarding their environmental program. They are required under the FFA to have a public open house every other year. This year there were four participants; in the more recent past there has not been much interest from the public. The regional groundwater issue was of some concern. Only one person was interested in follow-on information. In the early 1980's there was a lot of interest. Prior to the installations merging, McChord had a public notice process and newsletter. Now they have combined with Fort Lewis on the every other year open house. This change has not been formalized but should be included in the new FFA.

5.2 O&M of various treatment systems. The Area D/ALGT and I-5 treatment systems at Fort Lewis are operated by a contractor for the installation, Versar. The primary operator is Mr. Robert Thomas. The SLA system is operated by Madigan Medical Center (MAMC). The American Lake Garden Tract (AFGT) system at McChord is currently being operated through a contract with Tetra Tech. It was expressed that Mr. Thomas would soon be taking over operation of the Area D/ALGT system once the Tetra Tech contract expired. Groundwater sampling at Fort Lewis is being performed by Versar employee Mr. Thomas Lynott. Similarly, Tetra Tech was performing this task for McChord; however, Mr. Lynott is now also sampling wells at McChord Field.

5.2.1 The Fort Lewis Area D/ALGT and I-5 systems are inspected weekly. Mr. Thomas inspects the SLA system and collects samples from that system monthly. Madigan Medical Center (MAMC) uses effluent from the SLA system for use in their cooling system. Maintenance logs are scanned and put into the annual O&M reports.

5.2.2 Site-Specific Health and Safety Plans are up to date as of last year.

5.2.3 Air discharge permit that requires that the discharge be less than 1,000 pounds per year of volatile organics. The requirement, however, is that the discharge must be under the MCL for groundwater to be reinjected. Discharge compliance records are reported in the annual O&M reports. Fort Lewis averaged 200-300 pounds per last year (it was thought that the ~224 pounds per year for I-5 and ~111 pounds per year at the EGDY. The team didn't recall the SLA (SLA) system's air discharge).

5.2.4 The costs for the O&M were itemized in the Optimization Report prepared by the USACE-CX last spring (Remediation System Evaluation Final Report, Tetra Tech Geo, May 2011).

According the Versar team, the costs have not changed.

5.2.5 Anticipated and Unanticipated O&M costs. An anticipated cost is that about two groundwater pumps per year need to be replaced. But these are included in the annual budget requirements for the sites.

- An unanticipated costs at the East Gate Disposal Yard (EGDY), was identified in the same optimization report identified in paragraph 5.3.1, above. The variable frequency drives (VFDs) are temporarily unstable in excessive heat. This was first noticed in a heat wave in 2009. Since then, efforts have been made to install ventilation in the pump house cabinets containing the VFDs and it appears the issue may be resolved.
- Another unanticipated cost at EGDY is that it may be necessary to clean the packing material. The bio study may have allowed biological material to invade the tower.
- At the I-5 system they intend to repair the discharge pump this winter.
- At the I-5 system, they are also discussing the possibility of allowing the effluent to be used at the cooling systems at the motor pools at Fort Lewis. No additional costs to the system were identified if this is to occur.
- Also at the I-5 system, some biofouling has been detected in extraction well LX13. Contractor URS recommended shutting this well down and have it not be included in the treatment system. They are evaluating the effects of shutting this well down.

5.2.6 Fencing. All treatment systems have fences. In addition, the Illicit PCB Dump Site is fenced, the DRMO has a general security fence and EGDY has access restricting fencing.

5.2.7 Other Access Restrictions. The installations themselves have security fencing and access restrictions in the form of guarded security gates.

5.2.8 Institutional Controls. January 2011 was the last installation-wide site inspection. Inspections are performed annually in January. An inspection checklist is followed at each site, there is a January Report available for Fort Lewis. They just completed the combined LUC inspection for JBLM.

5.2.9 Record keeping. Getting input from MAMC is troublesome. O&M data is housed in a proprietary data base. MAMC pays O&M costs. Fort Lewis pays for major repairs. However, it was noted that it is difficult to get data from MAMC. Data that would be valuable to Fort Lewis is the throughput, extraction rates per well, etc. Without this it is difficult to ensure or verify that the SLA plume is being captured.

6. The sites were then visited. Photographs were taken and are included as follows:

Photo 1 - Area D/ALGT Treatment Plant Building Exterior

Photo 2 - Carbon Inlet and Outlet for one of the Carbon Vessels outside of the Area D/ALGT System

Photo 3 - Inside the plant at the Area D/ALGT GW Treatment System; three vessels. Two in use containing carbon and a third vessel for backup and other uses.

Photo 4 - East Gate Disposal Yard (EGDY) Pump House and Tower

Photo 5 - Control interface for EGDY

Photo 6 - Pad 1 for Termal Treatment at EGDY

Photo 7 - EGDY view of tower, two pump houses in distance at center of the photograph. On the left had side of the picture at distance is the ESTCP biostudy area. A typical monitoring well is in the foreground.

Photo 8 - Fencing for EGDY and signage at the gate. Entire area is fenced similarly.

Photo 9 - Asphalt patch identifying the excavation area at the Battery Acid Pit, located within the Logistics Center

Photo 10 - Pump Houses for the I-5 Extraction System

Photo 11 - Treatment System for the I-5 Pump and Treat System

Photos 12 - Inside I-5 pump house, extraction wellhead and injection wellhead

Photos 13 - Inside I-5 pump house, extraction wellhead and injection wellhead

Figures 14 - Inside the I-5 Treament System Building

Figure 15 - Inside the I-5 Treament System Building

Figure 16 - SLA Treatment System

Figures 17 - Inside SLA Treatment System

Figure 18 - Inside SLA Treatment System

Figures 19 - Effluent from SLA P&T at Madigan Medical Center

Figures 20 - Effluent from SLA P&T at Madigan Medical Center

Photo 21 - Illicit PCB Dump Site

Appendix F - Public Notice

PUBLIC NOTICE
JOINT BASE LEWIS-MCCHORD (JBLM), WA
ANNOUNCES
FIVE-YEAR REVIEW

The U.S. Army Corps of Engineers, in conjunction with the U.S. Army and the Army Environmental Command, is conducting a five-year review of environmental remediation at Joint Base Lewis-McChord (JBLM), Washington. JBLM was created by combining the Army's Fort Lewis and the Air Force's McChord Air Force Base on 1 February 2010. Both Fort Lewis and McChord AFB have conducted three previous five-year reviews. This five-year review will evaluate the effectiveness of the cleanup remedies and determine whether the remedies continue to be protective of human health and the environment.

Interested members of the public are invited to provide input for the Five-Year Review. The Draft Final FYR version will be made available on-post at the Grandstaff Library and at the Lakewood Pierce County Library, 6300 Wildaire Rd SW, Lakewood, WA. In addition, a public notice announcing the completion of the five-year review and the location of the Final Five-Year Review Report will be released in or near September 2012.

If you wish to submit comments or have any questions, you may contact Mr. Rick McComb of the U.S. Army Corps of Engineers (Sacramento, California District) at (916) 557-7752 or Mr. Bill Myers of the JBLM at (253) 477-3742.

Appendix G - LUC Monitoring Checklist

JOINT BASE LEWIS MCCHORD CERCLA LUC MONITORING CHECKLIST

A. FIELD INSPECTION

Date(s): 21DEC 10

Site	Question	Answer
Logistics Center	1. Any family housing within Landfill 2 or within 100 ug/L groundwater contour?	Yes / No
	2. Any obvious recent construction/excavation within Landfill 2?	Yes / No
	3. Any obvious recent training activities within Landfill 2?	Yes / No
	4. Does Landfill 2 boundary fence and/or signs need maintenance?	Yes / No
Landfill 4	5. Any family housing within landfill boundary?	Yes / No
	6. Any obvious recent construction/excavation within landfill boundary?	Yes / No
	7. Any obvious recent digging, bivouacking, or off-road maneuvering in landfill?	Yes / No
Battery Acid Pit	8. Any family housing within site boundary?	Yes / No
	9. Any obvious recent construction/excavation within site boundary?	Yes / No
	10. Does asphalt cap need maintenance?	Yes / No
DRMO Yard	11. Any family housing within site boundary?	Yes / No
Illicit PCB Dump Site	12. Any family housing within site boundary?	Yes / No
	13. Any obvious recent construction/excavation within site boundary?	Yes / No
	14. Any obvious recent training activities within site boundary?	Yes / No
	15. Does boundary fence and/or signs need maintenance?	Yes / No
	16. Does clay cap need maintenance?	Yes / No
IWTP Site	17. Any family housing within site boundary?	Yes / No
Landfill 1	18. Any family housing within landfill boundary?	Yes / No
	19. Any obvious recent construction/excavation within landfill?	Yes / No
Pesticide Rinse Area	20. Any family housing within site boundary?	Yes / No

21. Any comments (required for "Yes" answers from Field Inspection)? **YES or NO** If yes, describe on back.

B. INTERVIEWS

Date(s): 21DEC 10 - 03JAN11

Position	Name	Question	Answer
PW GIS Lab	Winston McKenna	22. Are you still storing LUC data layer in GIS?	Yes / No
		23. Is LUC data layer still available to GIS users?	Yes / No
Master Planner	GARY SIEDMAN	24. Do you still have access to LUC data when you need it?	Yes / No
		25. Are you still using the LUC data for a Master Plan overlay?	Yes / No
NEPA Program Manager	BILL VAN HOSEN	26. Do you still have access to LUC data when you need it?	Yes / No
		27. Are you still using the LUC data as environmental review overlay?	Yes / No
		28. Are training LUCs still included on the Environmental Coordination Map?	Yes / No
		29. Are you still using the LUC data for a digging permit overlay?	Yes / No
Cultural Resources PM	DALE & ADLER	30. Do you still have access to LUC data when you need it?	Yes / No
		31. Are you still using the LUC data for a digging permit overlay?	Yes / No
Range Operations		32. Are you still using Environmental Coordination Map as primary tool for implementing environmental LUCs under FLR 350-30?	Yes / No
Water Systems Manager	LYLE Fobb	33. Do you still have access to LUC data when you need it?	Yes / No
		34. Are WSP LUCs going to (be added / remain) in future WSP updates?	Yes / No
		35. Any existing drinking water wells within LUC boundaries besides Well 13, MAMC 4, Well 12A, Well 12B, and Sequalitchew Springs?	Yes / No
		36. Any plans for new drinking water wells in Cantonment Area Water System?	Yes / No
LWD Water Quality Dept.	ROGER NOTTAGE	*37. Any existing drinking water wells within Tillicum besides Well A-1?*	Yes / No
		38. Any plans for new drinking water wells within Tillicum?	Yes / No

39. Any comments? (see instructions for required comments) **YES or NO** If yes, describe on back.
40. Any changes noted about how LUC mechanisms are executed? **YES or NO** If yes, describe on back.

253 588 4423

C. CERTIFICATION

Based on this monitoring, LUC mechanisms appear to be working and achieving LUC objectives.

03JAN11

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JBLM LUC CHECKLIST 21 DEC 2010

LOG CENTER - PCS CONTINUES TO BE STOCK PILED OUT AT LANDFILL 2 PER THE "PLAN OF OPERATION FOR FORT LEWIS PETROLEUM CONTAMINATED SOIL & SEDIMENT STORAGE & TREATMENT FACILITY AT FORT LEWIS LANDFILL NO 5"

LANDFILL 4 - NO ACTIVITY NOTED WITHIN FENCED AREA OF LF 4 HOWEVER, AREAS W/ NO FENCES ARE ANALIZVE TRAINING AREA FOR SOLDIERS

NEW 03JAN 11

3 WELLS NOBLE HILL, MILLER HILL, ROSS HILL SLATED FOR 2013/2014 COMPLETION. CONSTRUCTION TO BEGIN ON WELLS IN 2011, 2012. WELLS TO BE COMPLETED NEAR EXISTING RESEVOIRS AT EACH LOCATION

PG 2 OF 2

Appendix H - Vapor Intrusion Study - Madigan Family Housing Area

Vapor Intrusion Study
Madigan Family Housing Area
Fort Lewis, WA

September 2007

Prepared for:

U.S. Army Corps of Engineers, Seattle District
4735 E Marginal Way South
Seattle, Washington 98134

USACE HTRW Contract W912DW-06-1007
Delivery Order No. 011

Prepared by:

KTA

TEC inc

US Army Corps of Engineers®

Table 5-1 Analytical Results

House Address	Sample Date	Sample ID	Sample Type	Collection Method	Time	Location	TCE	cis-1,2-DCE
9803	6/27/2007	VI-35	ES	Tedlar Bag	Morning	Living Room	ND[1]	ND[1]
Codidge Ave.		VI-36	FD	Tedlar Bag	Morning	Kitchen	ND	ND
		VI-37	FD	Tedlar Bag	Morning	Kitchen	ND	ND
		VI-38	ES	Tedlar Bag	Morning	Master Bedroom	ND	ND
		VI-45	ES	Tedlar Bag	Afternoon	Living Room	ND	ND
		VI-46	ES	Tedlar Bag	Afternoon	Kitchen	ND	ND
		VI-47	ES	Tedlar Bag	Afternoon	Master Bedroom	ND	ND
		SVI-7	ES	SUMMA Canister	Morning	Living Room	ND[1]	ND[1]
9813	6/26/2007	VI-21	ES	Tedlar Bag	Morning	Living Room	ND	ND
Codidge Ave.		VI-22	ES	Tedlar Bag	Morning	Kitchen	ND	ND
		VI-23	ES	Tedlar Bag	Morning	Master Bedroom	ND	ND
		VI-31	ES	Tedlar Bag	Afternoon	Living Room	ND	ND
		VI-32	FD	Tedlar Bag	Afternoon	Kitchen	ND	ND
		VI-33	FD	Tedlar Bag	Afternoon	Kitchen	ND	ND
		VI-34	ES	Tedlar Bag	Afternoon	Master Bedroom	ND	ND
		SVI-5	FD	SUMMA Canister	Morning	Living Room	ND	ND
		SVI-6	FD	SUMMA Canister	Morning	Living Room	ND	ND
9815	6/26/2007	VI-18	ES	Tedlar Bag	Morning	Living Room	ND	ND
Codidge Ave.		Vi-19	ES	Tedlar Bag	Morning	Kitchen	ND	ND
		VI-20	ES	Tedlar Bag	Morning	Master Bedroom	ND	ND
		VI-28	ES	Tedlar Bag	Afternoon	Living Room	ND	ND
		VI-29	ES	Tedlar Bag	Afternoon	Kitchen	ND	ND
		VI-30	ES	Tedlar Bag	Afternoon	Master Bedroom	ND	ND
		SVI-4	ES	SUMMA Canister	Morning	Living Room	ND	ND
9819	6/26/2007	VI-14	FD	Tedlar Bag	Morning	Living Room	ND	ND
Codidge Ave.		VI-15	FD	Tedlar Bag	Morning	Living Room	ND	ND
		VI-16	ES	Tedlar Bag	Morning	Kitchen	ND	ND
		VI-17	ES	Tedlar Bag	Morning	Master Bedroom	ND	ND
		VI-24	ES	Tedlar Bag	Afternoon	Living Room	ND	ND
		VI-25	ES	Tedlar Bag	Afternoon	Kitchen	ND	ND
		VI-26	FD	Tedlar Bag	Afternoon	Master Bedroom	ND	ND
		VI-27	FD	Tedlar Bag	Afternoon	Master Bedroom	ND	ND
		SVI-3	ES	SUMMA Canister	Morning	Living Room	0.66 J	ND

Table 5-1 Analytical Results

House Address	Sample Date	Sample ID	Sample Type	Collection Method	Time	Location	TCE	cis-1,2-DCE
9824	6/25/2007	VI-1	ES	Tedlar Bag	Morning	Living Room	ND	ND
Codidge Ave.		VI-2	ES	Tedlar Bag	Morning	Kitchen	ND	ND
		VI-3	ES	Tedlar Bag	Morning	Master Bedroom	ND	ND
		VI-8	ES	Tedlar Bag	Afternoon	Living Room	ND	ND
		VI-9	ES	Tedlar Bag	Afternoon	Kitchen	ND	ND
		VI-10	ES	Tedlar Bag	Afternoon	Master Bedroom	ND UJ	ND UJ
		SVI-1	ES	SUMMA Canister	Morning	Living Room	0.99 J	ND
9830	6/25/2007	VI-4	ES	Tedlar Bag	Morning	Living Room	ND	ND
Codidge Ave.		VI-5	ES	Tedlar Bag	Morning	Kitchen	ND	ND
		VI-6	ES	Tedlar Bag	Morning	Master Bedroom	ND	ND
		VI-7	Ambient ES	Tedlar Bag	Afternoon	NE of 9830	ND	ND
		VI-11	ES	Tedlar Bag	Afternoon	Living Room	ND	ND
		VI-12	ES	Tedlar Bag	Afternoon	Kitchen	ND	ND
		VI-13	ES	Tedlar Bag	Afternoon	Master Bedroom	ND	ND
		SVI-2	ES	SUMMA Canister	Morning	Living Room	10 R[2]	ND
	6/28/2007	SVI-12	ES	SUMMA Canister	Morning	Living Room	ND	ND
9838	6/27/2007	VI-39	ES	Tedlar Bag	Morning	Living Room	ND	ND
Codidge Ave.		VI-40	ES	Tedlar Bag	Morning	Kitchen	ND	ND
		VI-41	ES	Tedlar Bag	Morning	Master Bedroom	ND	ND
		VI-48	FD	Tedlar Bag	Afternoon	Living Room	ND	ND
		VI-49	FD	Tedlar Bag	Afternoon	Living Room	ND	ND
		VI-50	ES	Tedlar Bag	Afternoon	Kitchen	ND	ND
		VI-51	ES	Tedlar Bag	Afternoon	Master Bedroom	ND	ND
		SVI-8	ES	SUMMA Canister	Morning	Living Room	1.3 J	ND
9840	6/27/2007	VI-42	ES	Tedlar Bag	Morning	Living Room	ND	ND
Codidge Ave.		VI-43	ES	Tedlar Bag	Morning	Kitchen	ND	ND
		VI-44	ES	Tedlar Bag	Morning	Master Bedroom	ND	ND
		VI-52	ES	Tedlar Bag	Afternoon	Living Room	ND	ND
		VI-53	ES	Tedlar Bag	Afternoon	Kitchen	ND	ND
		VI-54	ES	Tedlar Bag	Afternoon	Master Bedroom	ND	ND
		SVI-9	ES	SUMMA Canister	Morning	Living Room	12 R[2]	ND
	7/5/2007[3]	SVI-13	FD	SUMMA Canister	Afternoon	Living Room	ND	ND
		SVI-14	FD	SUMMA Canister	Afternoon	Living Room	ND	ND
		VI2-1	FD	Tedlar Bag	Afternoon	Living Room	ND	ND
		VI2-2	FD	Tedlar Bag	Afternoon	Living Room	ND	ND

Table 5-1 Analytical Results

House Address	Sample Date	Sample ID	Sample Type	Collection Method	Time	Location	TCE	cis-1,2-DCE
9840		VI2-3	ES	Tedlar Bag	Afternoon	Living Room	ND	ND
Coolidge Ave.		VI2-4	FD	Tedlar Bag	Afternoon	Living Room	ND	ND
cont.		VI2-5	FD	Tedlar Bag	Afternoon	Living Room	ND	ND
		VI2-6	ES	Tedlar Bag	Afternoon	Living Room	ND	ND
		VI2-7	FD	Tedlar Bag	Afternoon	Living Room	ND	ND
		VI2-8	FD	Tedlar Bag	Afternoon	Living Room	ND	ND
	7/6/2007[3]	VI2-9	ES	Tedlar Bag	Morning	Living Room	ND	ND
		VI2-10	ES	Tedlar Bag	Morning	Living Room	ND	ND
		VI2-11	ES	Tedlar Bag	Morning	Living Room	ND	ND
		VI2-12	ES	Tedlar Bag	Morning	Living Room	ND	ND
		VI2-13	ES	Tedlar Bag	Morning	Living Room	ND	ND
		VI2-14	ES	Tedlar Bag	Morning	Living Room	ND	ND
		VI2-15	ES	Tedlar Bag	Morning	Living Room	ND	ND
		VI2-16	ES	Tedlar Bag	Afternoon	Living Room	ND	ND
9843	6/28/2007	VI-55	ES	Tedlar Bag	Morning	Living Room	ND	ND
Adams St.		VI-56	ES	Tedlar Bag	Morning	Kitchen	ND	ND
		VI-57	ES	Tedlar Bag	Morning	Master Bedroom	ND	ND
		VI-65	ES	Tedlar Bag	Afternoon	Living Room	ND	ND
		VI-66	ES	Tedlar Bag	Afternoon	Kitchen	ND	ND
		VI-67	ES	Tedlar Bag	Afternoon	Master Bedroom	ND	ND
		SVI-10	ES	SUMMA Canister	Morning	Living Room	ND	ND
9851	6/28/2007	VI-58	ES	Tedlar Bag	Morning	Living Room	ND	ND
McKinley Ave.		VI-59	ES	Tedlar Bag	Morning	Kitchen	ND	ND
		VI-60	FD	Tedlar Bag	Morning	Master Bedroom	ND	ND
		VI-61	FD	Tedlar Bag	Morning	Master Bedroom	ND	ND
		VI-62	Ambient ES	Tedlar Bag	Morning	Backyard	ND	ND
		VI-68	ES	Tedlar Bag	Afternoon	Living Room	ND	ND
		VI-69	ES	Tedlar Bag	Afternoon	Kitchen	ND	ND
		VI-70	ES	Tedlar Bag	Afternoon	Master Bedroom	ND	ND
		SVI-11	ES	SUMMA Canister	Morning	Living Room	**0.24 J**	ND

1 The RLs for non detects (ND) for TCE and cis-1,2-DCE in Tedlar bag grab samples are 1 ug/m3. The RLs for ND for TCE and cis-1,2-DCE in SUMMA canister samples are 0.2 ug/m3.
2 TCE values in SUMMA canister samples SVI-2 and SVI-9 were rejected due to evidence that the detected TCE concentrations were due to contaminated sampling equipment and subsequent resampling and reanalysis could not confirm and replicate the results. A detailed discussion is provided in Section 5.2.
3 Phase II Field Effort