

GROUNDWATER MONITORING PLAN

FORMER TIGER OIL SITE
2312 WEST NOB HILL BOULEVARD
YAKIMA, WASHINGTON



MAUL
FOSTER
ALONGI

Prepared for
CITY OF YAKIMA
August 26, 2015
Project No. 0818.02.01

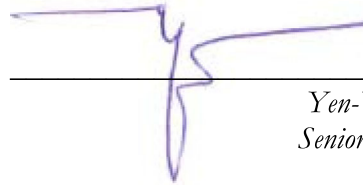
Prepared by
Maul Foster & Alongi, Inc.
1329 N State Street, Suite 301, Bellingham WA 98225

GROUNDWATER MONITORING PLAN

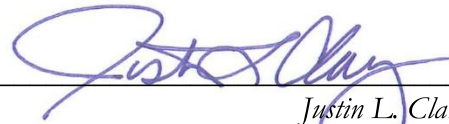
FORMER TIGER OIL SITE
2312 WEST NOB HILL BOULEVARD
YAKIMA, WASHINGTON

*The material and data in this report were prepared
under the supervision and direction of the undersigned.*

MAUL FOSTER & ALONGI, INC.



*Yen-Vy Van, LHG
Senior Hydrogeologist*



*Justin L. Clary, PE
Principal Engineer*

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ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
the City	City of Yakima, Washington
GMP	groundwater monitoring plan
COC	chemical of concern
CUL	cleanup level
Ecology	Washington State Department of Ecology
GWE	groundwater extraction
IHS	indicator hazardous substance
IRA	interim remedial action
LNAPL	light non-aqueous phase liquid
MFA	Maul Foster & Alongi, Inc.
MTCA	Model Toxics Control Act
New Tiger	Tiger Oil Corporation
Plan	remedial action plan and engineering design report
POC	point of compliance
the Property	2312 West Nob Hill Boulevard, Yakima, Washington
the Site	Ecology Facility Site No. 469, Cleanup Site No. 4919
SVE	soil vapor extraction
TPH	total petroleum hydrocarbons
USEPA	United States Environmental Protection Agency
UST	underground storage tank
WAC	Washington Administrative Code

1 INTRODUCTION

On behalf of the City of Yakima (the City), Maul Foster & Alongi, Inc. (MFA) has prepared this groundwater monitoring plan (GMP) to direct groundwater monitoring activities at the former Tiger Oil facility at 2312 West Nob Hill Boulevard, Yakima, Washington, Washington State Department of Ecology (Ecology) Facility Site No. 469, Cleanup Site No. 4919. Throughout this report and consistent with Ecology's definition, the term "Property" is used specific to the real property located at 2312 West Nob Hill Boulevard, and "Site" is used specific to where contamination resulting from former operations at the Tiger Oil facility has come to lie, irrespective of property boundaries. A retail gasoline station was operated on the Property from 1978 until 2001; since that time no commercial activities have occurred on the Property. Several fuel releases at the Property during active facility operations resulted in adverse impacts to soil and groundwater at the Property and adjoining parcels to the east, south, and southeast.

This GMP has been prepared to meet the groundwater monitoring requirements specified in the Ecology-approved Interim Remedial Action Plan and Engineering Report (the Plan) (MFA, 2015a) for cleanup actions at the Site. The GMP was developed in accordance with the monitoring requirements put forth in the Washington State Model Toxics Control Act (MTCA) (Washington Administrative Code [WAC] 173-340-410).

1.1 Purpose of Groundwater Monitoring Plan

Groundwater monitoring will be conducted at the Site following an interim remedial action (IRA) completed in March 2015. Post-IRA actions, as described in the Plan, includes:

- Groundwater monitoring
- Institutional controls to be recorded in an environmental covenant

This GMP:

- Identifies existing wells in the monitoring network
- Identifies sentry wells beyond the leading edge of the dissolved phase contaminant plume to allow for monitoring of potential migration of contamination beyond the currently confirmed extent
- Describes the cleanup levels (CULs) against which cleanup attainment will be measured
- Provides guidelines and criteria for each stage of monitoring, including criteria for assessing compliance with CULs and monitoring frequency
- Provides decision process diagrams identifying contingent actions to be implemented in response to non-compliance with CULs within the network of monitoring and the criteria for triggering them

- Provides criteria for decommissioning monitoring wells
- Defines requirements for terminating the monitoring program

2 BACKGROUND

2.1 Site Description

The physical address for the Property is 2312 West Nob Hill Boulevard in Yakima, Washington (see Figure 1). The Property, a 0.52-acre, rectangular parcel (tax assessor parcel number 18132642051), is bordered by West Nob Hill Boulevard to the north, a Safeway Shopping Center parking lot to the east and southeast, the Xochimilco Mexican Restaurant to the east, the One Love Smoke Shop to the south, and South 24th Avenue to the west (see Figure 2). The Property is currently a vacant lot.

2.2 Site History and Operations

The Property was operated by the Tiger Oil Company as a retail fuel station until it was purchased by Tiger Oil Corporation (New Tiger) in 1987. New Tiger operated the Property as an Exxon-branded fuel station and convenience store from 1987 until 2001. All commercial operations ceased in 2001 and the Property has remained vacant since (TerraGraphics, 2013). The fuel station included four underground storage tanks (USTs) (one 20,000-gallon, two 10,000-gallon, and one 8,000-gallon tank) and associated product lines. The system was used for bulk petroleum storage and distribution.

In April 1981, volatilization of petroleum products in a drainage improvement district storm drain line adjacent to the Property resulted in an explosion and triggered an investigation by the City and Ecology to test the Property's UST system (Ecology, 2014). During the investigation, it was determined that a leak in the product line of the UST system had impacted the surrounding soil and groundwater at the Property and adjoining properties. The leak in the UST line was determined to be the source of the petroleum products found in the nearby drainage improvement district line. Ecology issued a Notice of Violation and Enforcement Order No. DE 82-517 to Tiger Oil Company, requiring recovery of light non-aqueous phase liquid (LNAPL, i.e., free product) from the Site (Ecology, 2014).

It was estimated that approximately 20,000 gallons of petroleum-related product was released from the Property's UST system in the early 1980s (Ecology, 2014). Several recovery wells were installed by early 1983 at the Property and on adjacent parcels to the east and south. By March 1984, approximately 16,000 gallons of LNAPL had been extracted from the recovery wells (Kleinfelder, 1994).

In March 1990, Ecology issued EO No. DE 90-C140 to New Tiger and Federated Insurance, requiring site stabilization and a remedial investigation and feasibility study for the Site (Ecology, 2014). In 1991, a site hazard assessment was conducted, resulting in a hazard ranking of 1 (with 1 as the highest risk and 5 the lowest risk).

In August 1995, operation of soil vapor extraction (SVE) and groundwater extraction (GWE) systems began in order to collect LNAPL, impacted groundwater, and soil vapor on the Site, as well as to mitigate off-site migration of dissolved-phase gasoline-range total petroleum hydrocarbons (TPH) and LNAPL. However, the SVE and GWE systems were limited in scope and did not adequately target areas of LNAPL present on the Site. Ecology concluded that the SVE and GWE systems were not representative of final cleanup actions for the Site (Ecology, 2014).

In October 2004, New Tiger and Federated Insurance entered into a Consent Decree with Ecology requiring implementation of Ecology's 2004 Amended Cleanup Action Plan. In December 2004, the USTs and their associated piping, along with approximately 650 cubic yards of impacted soil around the UST system, were removed from the Site. Two trenches were dug in the vicinity of the USTs to determine the amount of LNAPL, if present, at the top of the water table at the Site. LNAPL was encountered, and an additional SVE system was installed to treat the impacted soil vapor at the Site. Appreciable LNAPL was encountered at monitoring wells MW-7 (at 2.34 feet thick, located east of the Property on the Xochimilco restaurant parking lot) and MW-11 (at 1.46 feet thick, located on the Property southeast of the former USTs) during groundwater monitoring conducted in June 2013 (TerraGraphics, 2013). An approximate delineation of the extent of LNAPL and dissolved-phase gasoline-range TPH in groundwater based on the June 2013 sampling event is presented in Figure 3.

The City purchased the Property in 2014 and entered into an Amended Consent Decree with Ecology to implement an Amended Cleanup Action Plan at the Site (Ecology, 2014).

2.3 Interim Remedial Action

An IRA was completed at the Site during February and March 2015. Figure 4 illustrates the elements of remedial action, which included:

- Demolition of the former convenience store
- Decommissioning of groundwater monitoring wells MW-8, MW-12, MW-15, KMW-20, and KMW-22
- Removal of subsurface piping of the former treatment system within the bounds of the IRA excavation, and demolition of the treatment system at the adjoining property
- Excavation and off-site disposal of contaminated soil
- Application of in situ treatment compounds Regeneration RegenOx® oxidizer and Regeneration Oxygen Release Compound Advanced® activator during backfill of the excavation
- Installation of an infiltration gallery within the excavation footprint to provide the option for additional treatment compound injection should groundwater monitoring determine the treatment application within the excavation area is not effective in fully attaining groundwater CULs
- Backfill of the excavation with clean import fill and overburden from the excavation that was deemed appropriate for reuse by laboratory analysis

- Installation of three groundwater monitoring wells (YMW-1 through YMW-3) within the footprint of the excavation

Further information associated with the IRA is provided in the IRA completion report (MFA, 2015b).

3 SITE CONDITIONS

Geology, hydrogeology, and environmental conditions of the Site are summarized below.

3.1 Geology and Hydrogeology

The Site and vicinity have been mapped as eolian (windblown sediment) deposits. These deposits, approximately 20 feet thick, are underlain by the Thorp gravel, a moderately to highly weathered sand and gravel deposit, which has been logged to a depth of approximately 135 feet below ground surface (bgs) (Kleinfelder, 1992). Kleinfelder reported that the Site is underlain by fill to approximately 9 to 12 feet bgs, and by sandy clay to silty gravel below the fill to about 16 feet bgs where gravel is present.

The matrix of the unconfined shallow aquifer appears to be interbedded sands and silts. The depth to groundwater is variable at the Site, ranging approximately from 9 to 13 feet bgs, and is influenced by seasonal fluctuations in the groundwater table due to local irrigation practices. The annual irrigation schedule is from April through September, which may impact the groundwater table, causing it to rise between 2 and 4 feet during that general period (Kleinfelder, 1992).

The direction of groundwater flow at the Site, based on groundwater monitoring completed by TerraGraphics and G-Logics is generally to the east-southeast (TerraGraphics, 2013; G-Logics, Inc., 2010).

3.2 Residual Contamination

Residual soil contamination remains near and below the building footprints of the Xochimilco Mexican Restaurant and the One Love Smoke Shop. Excavation activities completed during the IRA were limited in these areas to protect building foundation integrity.

Residual groundwater contamination remains after completion of the IRA; though the bulk of petroleum contaminated soil was removed, saturated impacted groundwater remained present below the excavation depth and laterally beyond the excavation boundaries.

3.2.1 Indicator Hazardous Substances

Historical subsurface investigations, remedial investigations, and groundwater monitoring events conducted between 1981 and 2013 identified the following chemicals of concern (COCs) in soil and

groundwater at the Site: gasoline-range TPH and petroleum-fuel-associated volatile organic compounds. These COCs are also confirmed as indicator hazardous substances (IHSs) which are defined as chemicals exceeding a CUL at one or more locations.

Soil and groundwater IHSs confirmed at the Site include:

- Gasoline-range TPH
- Benzene
- Ethylbenzene
- Toluene
- Xylenes

3.2.2 Distribution of Indicator Hazardous Substances in Groundwater

Groundwater monitoring data from 1992 to 2013 were evaluated for each IHS to assess groundwater CUL exceedances at the Site. The MTCA Method A CULs for groundwater was established as the applicable CULs for the Site (Table 1). Table 2 presents the analytical results and Figure 3 shows the extent of LNAPL and dissolved phase plumes that were delineated in the most recent pre-IRA comprehensive groundwater monitoring event conducted in 2013 (TerraGraphics, 2013).

LNAPL was frequently recorded at MW-7, MW-8 (removed during implementation of the IRA and replaced by YMW-2), MW-11, MW-15, and/or KMW-20 (removed during implementation of the IRA and replaced by YMW-3) during groundwater monitoring events conducted from 2004 through 2010 (G-Logics, 2010). CUL exceedances for gasoline-range TPH and benzene were exhibited in wells located within the dissolved phase plume shown in Figure 3 during the 2013 sampling event. KMW-14 and KMW-15, located downgradient and east-southeast of the dissolved phase plume, exhibited detectable concentrations of gasoline-range TPH during that groundwater monitoring period; however, all IHS detections were reported below associated CULs during the 2013 event (see Figure 3).

The most recent groundwater monitoring event, conducted by MFA in May 2015 (MFA, 2015c), indicated IHSs had increased at certain wells (Table 3) relative to the 2013 monitoring event (Table 2). While not fully understood at this time, it is possible some of these concentration increases are due to IHSs being mobilized through completion of the IRA. A goal of this monitoring program, as discussed further in Section 4, is to collect a consistent data set to gain a better understanding of the contaminant plume. Despite the increase in concentrations between the 2013 and 2015 monitoring events, it does not appear that the LNAPL or dissolved phase plume boundaries have changed significantly. Currently, IHS concentrations in groundwater do not exceed CULs outside the dissolved phase plume boundary depicted in Figure 3.

4 MONITORING PROGRAM

This section defines the groundwater monitoring program, including identification of the monitoring network, stages of monitoring, the sampling and analysis program, and a decision matrix for continuation or cessation of monitoring in each well or the need for implementation of additional remedial action(s).

4.1 Monitoring Objectives

The primary objectives of groundwater monitoring are:

- Assess the effectiveness the 2015 IRA
- Evaluate ongoing groundwater quality conditions
- Evaluate compliance with MTCA Method A CULs
- Evaluate the IHS concentration trends of the dissolved phase plume (i.e., whether concentrations are declining, stable, or increasing) and whether the lateral extent has stabilized or has continues to migrate
- Gather data to evaluate additional supplemental remedial actions, as necessary

4.2 Point of Compliance

The point of compliance (POC) at the Site includes all monitoring wells designated within the monitoring network (see Table 2). To demonstrate that CULs are being met at the POC, sentry wells will be monitored to demonstrate ongoing compliance with CULs. Sentry wells are designated for monitoring beyond the leading edge of the dissolved phase plume. Detection of elevated concentrations of COCs in a sentry monitoring well may indicate that the dissolved phase plume is migrating beyond the known extent of the plume and warrant consideration of additional actions.

4.3 Groundwater Monitoring Network

To meet the groundwater monitoring requirements stipulated in WAC 173-340-410, quarterly groundwater monitoring activities will be conducted at the following types of wells: 1) a monitoring well located upgradient of the known dissolved phase plume; 2) monitoring wells within the confirmed dissolved phase plume; and 3) sentry monitoring wells located beyond the leading edge of the dissolved phase plume (see Figure 5). Groundwater monitoring will be conducted at the following site-specific wells:

- **Upgradient/background well:** MW-10

- **Dissolved phase plume monitoring wells:** YMW-1, YMW-2, YMW-3, MW-7, MW-9, MW-11, MW-13, KMW-6, KMW-7, KMW-16, and MWG-3
- **Sentry wells:** KMW-14 and KMW-15

Tables 2 and 3 present a summary of the most recently observed conditions of each of the network wells. Construction logs for the recently constructed monitoring wells YMW-1 through YMW-3 are included in Appendix A.

4.4 Sampling and Analysis

Groundwater monitoring will include measuring the presence and thickness of LNAPL, water levels, and water quality parameters (e.g., dissolved oxygen, pH, temperature, specific conductance, and oxygen reduction potential), and collection and analysis of groundwater samples, which will be conducted in accordance with the methods and protocol outlined in the Sampling and Analysis Plan (see Appendix B).

Groundwater samples will be analyzed for IHSs using the following analytical methods, or other comparable analytical methods deemed to be suitable alternatives and as approved for use by Ecology:

- Gasoline-range organics by Northwest Method NWTPH-Gx.
- Petroleum-associated volatile organic compounds, specifically benzene, toluene, ethylbenzene, and xylenes by United States Environmental Protection Agency (USEPA) Method 8260 or 8021.

The following activities will be conducted during each groundwater monitoring event:

- Groundwater sample collection and analysis from each applicable monitoring well for evaluating compliance with CULs
- Water level measurements in each applicable monitoring well (see Table 2 and Figure 5) for evaluating hydraulic gradient trends
- Analysis of IHS concentration trends relative to associated CULs, and geochemical parameter monitoring to assess the efficacy of in situ bioremediation and assessment of the trend of biodegradation of IHSs

4.5 Quarterly Reporting

Quarterly groundwater monitoring reports will be prepared in accordance with Ecology reporting requirements [WAC 173-340-840(5)] and submitted within 60 days of receipt of final laboratory analytical results. Quarterly reports will provide a description of sampling methodologies and activities (inclusive of sampling frequency, laboratory containers/preservations, and field equipment), analytical data and analytical laboratory data reports and associated chains of custody, field measurements of groundwater quality parameters and groundwater levels, a discussion of

analytical data trends, a comparison of analytical results to MTCA cleanup levels, and data validation reports. Deviations from this GMP, if applicable, will be described and explained. All final, validated data will also be uploaded to Ecology's Environmental Information Management database within 30 days of receipt of validated data.

The reports will also include a description of the monitoring well network inclusive of a table presenting the specifications of each well and a map showing the network of wells.

The data validation reports will provide a review of all raw data to verify that the laboratory has supplied the required quality assurance and quality control deliverables. The data will be validated against USEPA, Washington State, and laboratory-specific criteria for completeness and usability.

5 PROGRAM NOTIFICATION REQUIREMENTS

Ecology will be notified 30 days prior to installation or replacement of groundwater monitoring wells and within 30 days of receipt of laboratory analyses indicating an IHS CUL exceedance or measurement of LNAPL in a sentry or background well.

6 SCHEDULE

Groundwater monitoring activities, as outlined in this GMP, will commence six months following completion of IRA (anticipated initiation of groundwater monitoring in November 2015) and continue for a minimum of eight consecutive quarters. The GMP will be re-evaluated after completion of four quarterly events.

LIMITATIONS

The services undertaken in completing this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report.

REFERENCES

- Ecology. 2014. Amended cleanup action plan, Tiger Oil facility, 2312 West Nob Hill Boulevard, Yakima, Washington. Washington State Department of Ecology. June.
- Kleinfelder. 1992. RI/FS work plan, Tiger Oil facility, West Nob Hill Boulevard and South 24th Avenue, Yakima, Washington. Kleinfelder, Inc., Bellevue, Washington. January 29.
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- MFA. 2015a. Final remedial action plan and engineering design report: former Tiger Oil Site. Prepared for the City of Yakima. Maul Foster & Alongi, Inc., Bellingham, Washington. January 23.
- MFA. 2015b. Interim remedial action completion report – Former Tiger Oil Site, 2312 West Nob Hill Boulevard, Yakima, Washington. June 17.
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TABLES



**Table 1
Groundwater Cleanup Levels
Former Tiger Oil Site
Yakima, Washington**

Indicator Hazardous Substance:	Gasoline Range TPH	Petroleum Fuel Associated VOCs			
		Benzene	Toluene	Ethylbenzene	Xylenes
Cleanup Level (ug/L):	800	5	1,000	700	1,000
PQL (ug/L):	100	1	1	1	3
<p>NOTES: Cleanup levels are based on MTCA Method A CULs for groundwater. MTCA = Model Toxics Control Act PQL = practical quantification limit ug/L = micrograms per liter. TPH = total petroleum hydrocarbons VOCs = volatile organic compounds</p>					

Table 2
Groundwater Monitoring Well Network - Groundwater Analytical Results 2013
Former Tiger Oil Site
Yakima, Washington

Well ID	IHSs Above CULs ^a	Gasoline TPH Concentration (ug/L) ^a	Benzene Concentration (ug/L) ^a	Location Description	Notes
KMW-6	Benzene	<50	5.8	Downgradient of historical source area. On Safeway parking lot property.	Analytical results from TerraGraphics, April 2013.
KMW-7	Benzene	230	6.0	Located within historical source area.	Analytical results from TerraGraphics, April 2013.
KMW-14		130	2.5	Sentry well. Adjacent east-southeast of dissolved phase plume.	Analytical results from TerraGraphics, April 2013.
KMW-15		15	<0.1	Sentry well. Adjacent east-southeast of dissolved phase plume.	Analytical results from TerraGraphics, April 2013.
KMW-16	Benzene	250	5.5	Downgradient of historical source area. Leading edge of dissolved phase plume. On Safeway parking lot property.	Analytical results from TerraGraphics, April 2013.
MW-7	Gasoline TPH & benzene	LNAPL	LNAPL	Located adjacent and downgradient of historical source area.	LNAPL (2.34 feet thick) recorded by TerraGraphics in April 2013.
MW-9	Gasoline TPH & benzene	6,000	25	Downgradient of historical source area.	Analytical results from TerraGraphics, April 2013.
MW-10		No LNAPL	No LNAPL	Upgradient monitoring well.	No analytical results from G-Logics, March 2010. Report showed no LNAPL measured.
MW-11	Gasoline TPH & benzene	LNAPL	LNAPL	Located within historical source area.	LNAPL (1.46 feet thick) recorded by TerraGraphics in April 2013.
MW-13	Gasoline TPH	1,800	1.9	Downgradient of historical source area.	Analytical results from TerraGraphics, April 2013.
MWG-3	Benzene	470	600	Downgradient of historical source area. On Safeway parking lot property.	Analytical results from TerraGraphics, April 2013.
YMW-1	Gasoline TPH & benzene	34,000	4,900	Located adjacent and downgradient of historical source area.	YMW-1 replaced previous well KMW-22 which was decommissioned during Interim Remedial Action. Analytical results from TerraGraphics, April 2013.
YMW-2	Gasoline TPH & benzene	LNAPL	LNAPL	Located adjacent and downgradient of historical source area.	YMW-2 replaced previous well MW-8 which was decommissioned during Interim Remedial Action. LNAPL noted by TerraGraphics in April 2013.
YMW-3	Gasoline TPH & benzene	LNAPL	LNAPL	Located adjacent and downgradient of historical source area.	YMW-3 replaced previous well KMW-20 which was decommissioned during Interim Remedial Action. LNAPL (0.01 feet thick) recorded by TerraGraphics in April 2013.

Notes:

TPH = total petroleum hydrocarbons

CUL = cleanup level.

IHS = indicator hazardous substance.

MTCA = Model Toxics Control Act

ug/L = micrograms per liter.

LNAPL = light non-aqueous phase liquid

Bold indicates concentration exceeds the gasoline range organics TPH CUL of 800 ug/L, and/or benzene CUL of 5 ug/L (MTCA Method A CUL), or have free product. Monitoring well with exceedance is shown in bold.

^aData from TerraGraphic's Final Groundwater Sampling Report (dated June 12, 2013) for all listed wells except MW-10. Data from G-Logics' Quarterly Monitoring (dated March 1, 2010) for well MW-10.

Table 3
Groundwater Analytical Results - May 2015
Former Tiger Oil Site
Yakima, Washington

Location: Sample Name: Collection Date:	KMW-5 KMW-5 5/27/2015	KMW-6 KMW-6 5/28/2015	KMW-7 KMW-7 5/29/2015	KMW-8 KMW-8 5/29/2015	KMW-10 KMW-10 5/29/2015	KMW-14 KMW-14 5/28/2015	KMW-16 KMW-16 5/28/2015	KMW-18 KMW-18 5/27/2015
VOCs (ug/L)^a								
Benzene	1 U	47	8.4	1 U	830	1.9	60	1 U
Ethylbenzene	1 U	1.6	14	1 U	1200	1 U	9.6	1 U
m,p-Xylene	1 U	1 U	47	1	4400	1 U	4.6	1 U
o-Xylene	1 U	1 U	41	1 U	2000	1 U	1 U	1 U
Toluene	1 U	1 U	2	1 U	4000	1 U	1 U	1 U
TPH (ug/L)^a								
Gasoline	100 U	100 U	620	100 U	81000	100 U	280	100 U

Table 3
Groundwater Analytical Results - May 2015
Former Tiger Oil Site
Yakima, Washington

Location: Sample Name: Collection Date:	KMW-24 KMW-24 5/29/2015	KMW-24 DUP-24 5/29/2015	MW-9 MW-9 5/28/2015	MW-13 MW-13 5/28/2015	MWG-1 MWG-1 5/28/2015	MWG-3 MWG-3 5/28/2015	S-1 S-1 5/28/2015	S-2 S-2 5/27/2015
VOCs (ug/L)^a								
Benzene	1 U	1.7	1200	32	1 U	3300	1 U	1300
Ethylbenzene	1 U	1 U	740	1500	1 U	2700	7.2	200
m,p-Xylene	1 U	1 U	1800	8700	1 U	6200	2	51
o-Xylene	1 U	1 U	980	3800	1 U	1800	1.2	10 U
Toluene	1 U	1 U	1900	510	1 U	710	1 U	10 U
TPH (ug/L)^a								
Gasoline	100 U	100 U	28000	92000	100 U	64000	200	1600

NOTES:

Detected results are indicated by bold font.

TPH = total petroleum hydrocarbon.

U = the result is non-detect.

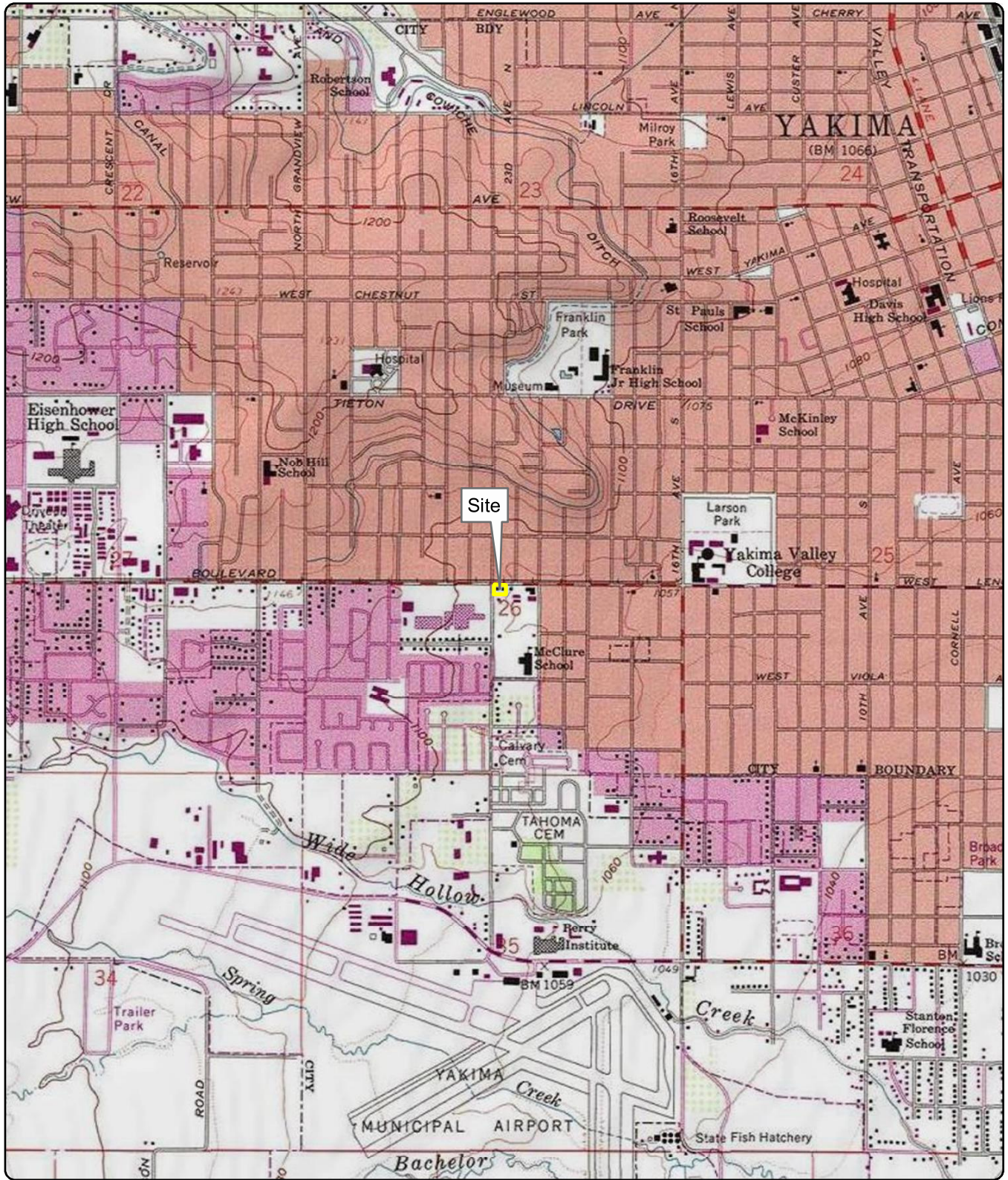
ug/L - micrograms per liter.

VOC = volatile organic compound.

^aData from MFA's May 2015 groundwater sampling event of selected monitoring wells after completion of Interim Remedial Action.

FIGURES





Site Address: 2312 West Nob Hill Boulevard, Yakima, Washington 98902
 Source: Taxlots obtained from City of Yakima GIS,
 US Geological Survey (1990) 7.5-minute
 topographic quadrangle: Yakima West
 Section 26, Township 13 North, Range 18 East

Legend

 Property Taxlot

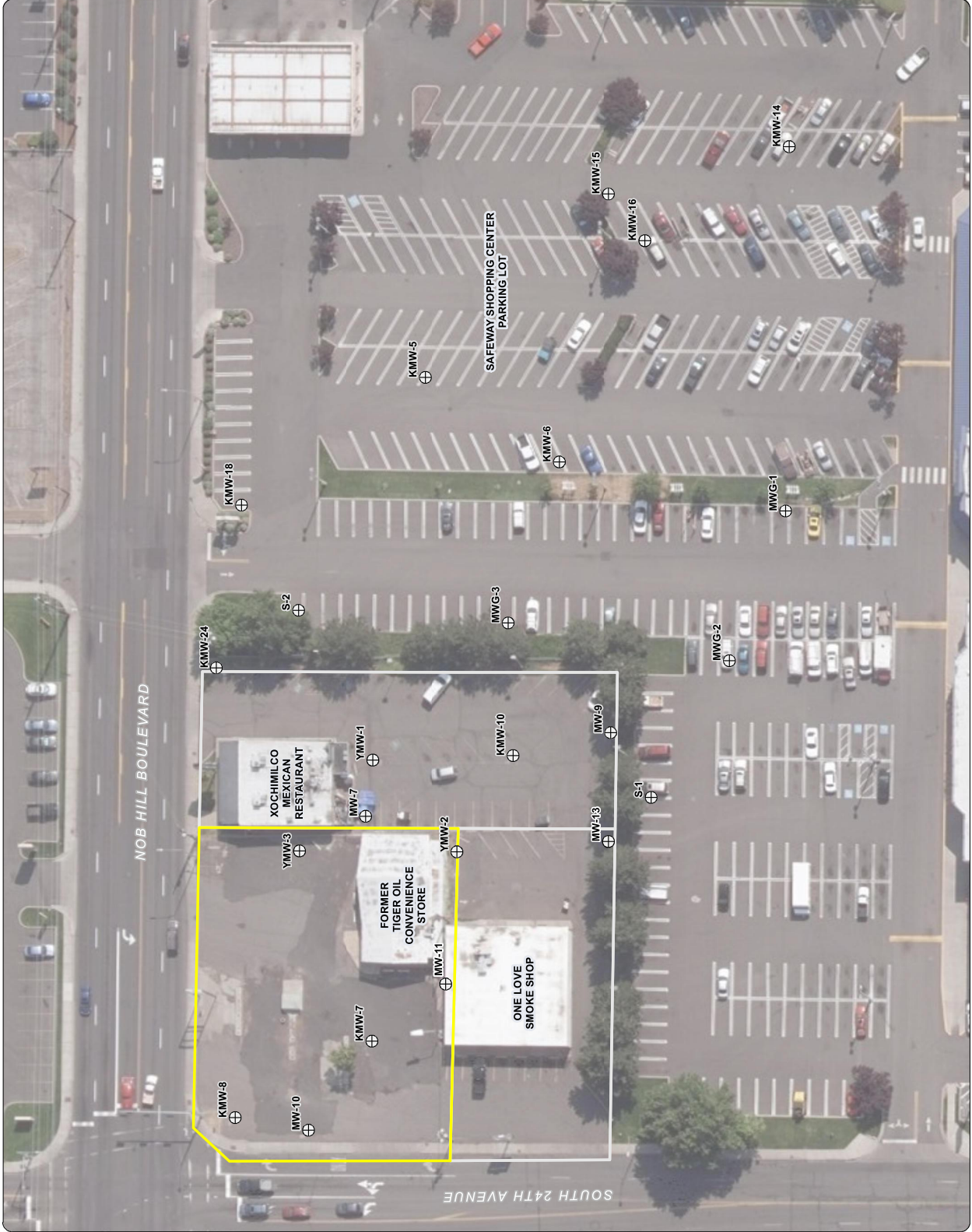
**Figure 1
Site Location**

Former Tiger Oil Site
 2312 West Nob Hill Boulevard
 Yakima, Washington

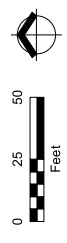


Figure 2
Site Features

Former Tiger Oil Site
2312 West Nob Hill Boulevard
Yakima, Washington



- Legend**
- ⊕ Monitoring Well
 - ▭ Former Tiger Oil Property Boundary
 - ▭ Adjacent Taxlot Boundaries



Source: Aerial photograph obtained from Esri ArcGIS Online; Infiltration Gallery delineated by Maul Foster & Alongi, Inc.; stormwater line and taxlot boundaries obtained from City of Yakima; all other features obtained from PLSA.

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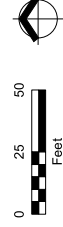
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Figure 3 LNAPL and Dissolved Phase Plumes 2013

Former Tiger Oil Site
2312 West Nob Hill Boulevard
Yakima, Washington

- Legend**
-  Monitoring Well
 -  Approximate LNAPL Plume, 2013
 -  Approximate Dissolved Phase Plume, 2013
 -  Property Taxlot Boundary
 -  Adjacent Taxlot Boundaries

Notes:
1. All features are approximate.
2. LNAPL = light nonaqueous-phase liquid.



Source:
Aerial Image, Esri ArcGIS Online;
Monitoring wells, PLUSA;
Plumes, TerraGraphics, 2013;
Taxlot boundaries, City of Yakima.



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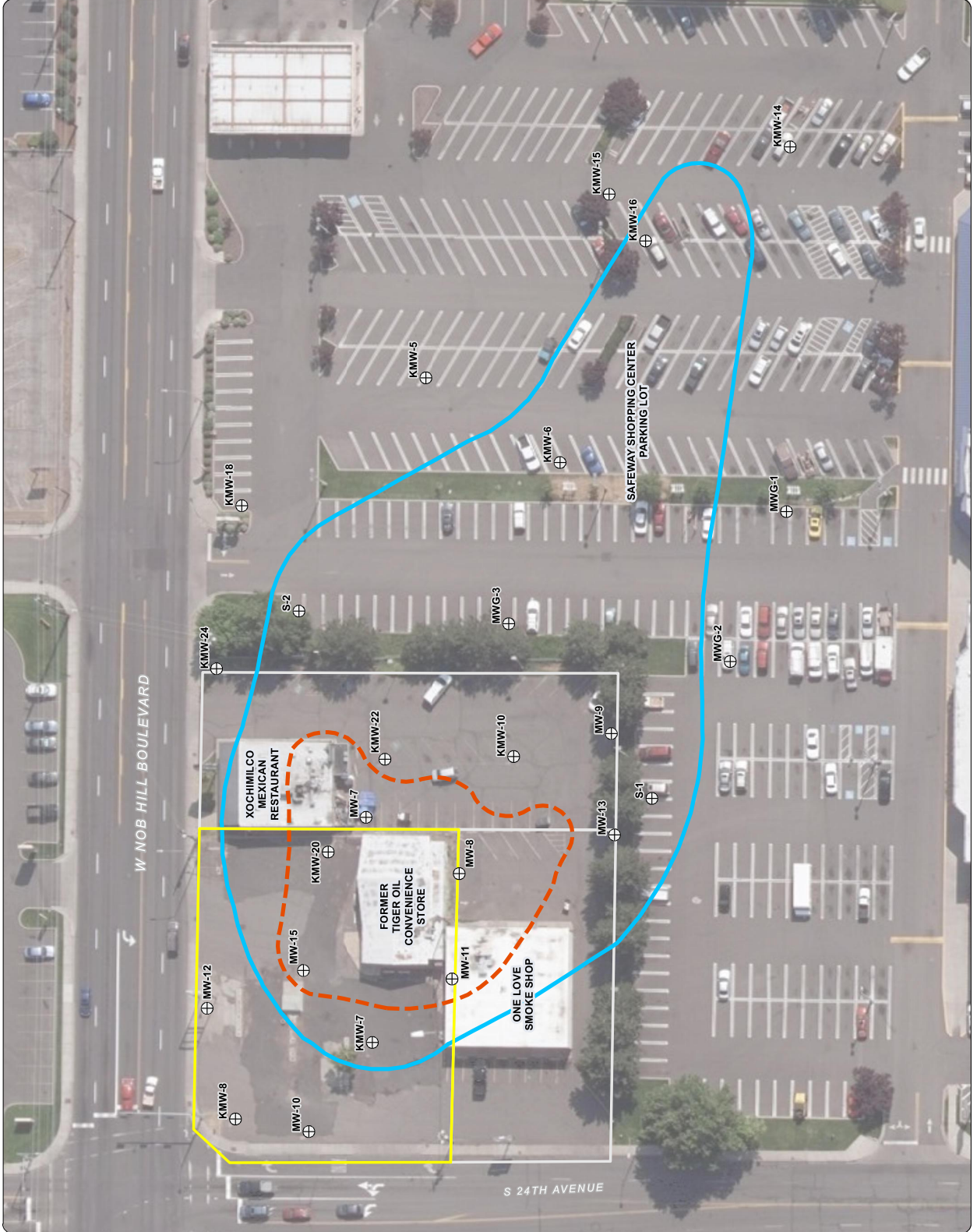
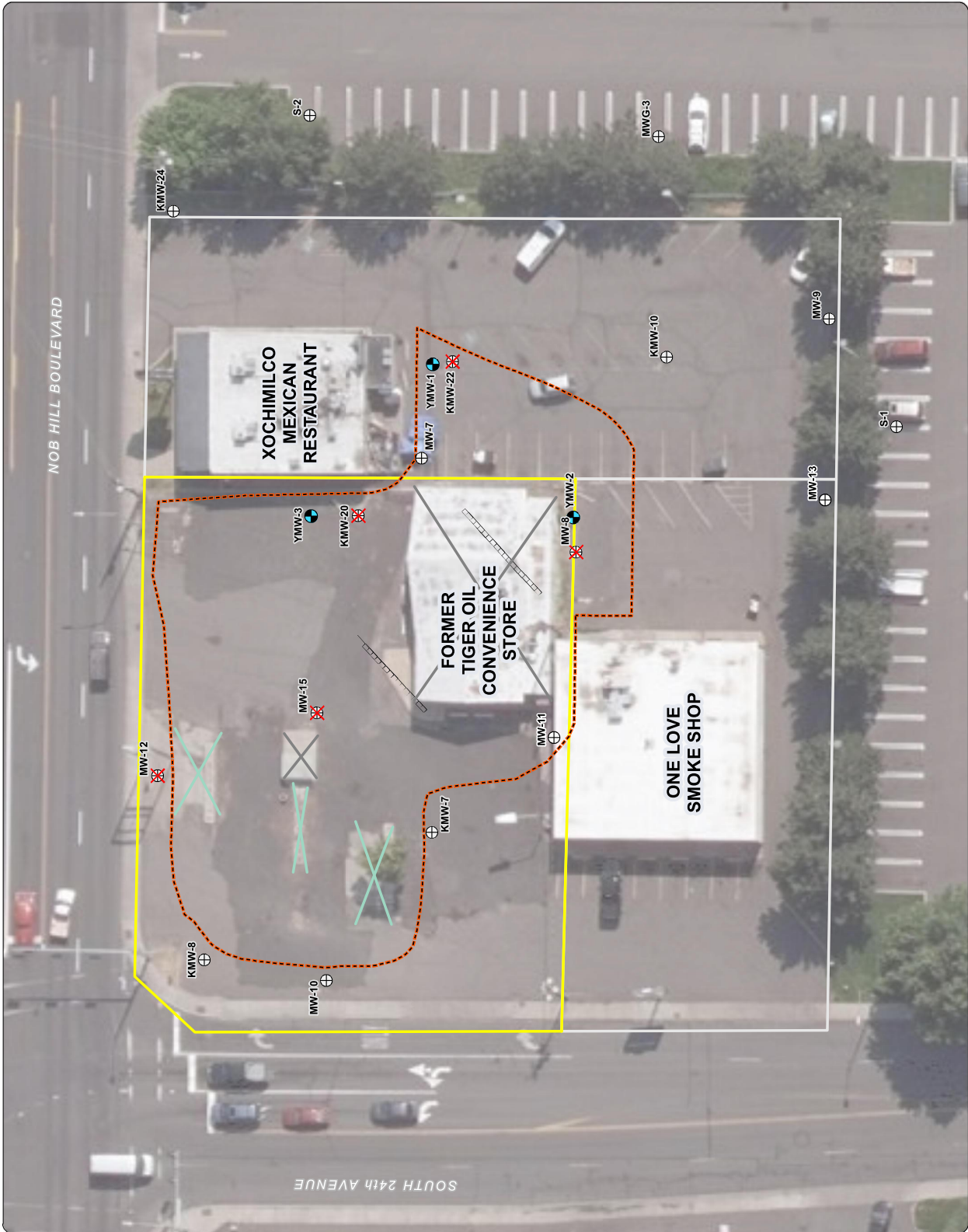


Figure 4

Remedial Action Elements Completed

Former Tiger Oil Site
2312 West Nob Hill Boulevard
Yakima, Washington



Legend

- Monitoring Well
- Decommissioned Monitoring Well
- Monitoring Well Installed on May 26, 2015
- Infiltration Gallery for Supplemental Bioremediation
- Excavation Area
- Former Tiger Oil Property Taxlot Boundary
- Building Demolished
- Cement Pad Demolished



Source: Aerial photograph obtained from Esri ArcGIS Online; Infiltration Gallery delineated by Maul Foster & Alongi, Inc.; stormwater line and taxlot boundaries obtained from City of Yakima; all other features obtained from PLSA.



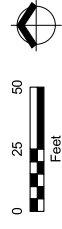
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Figure 5 Groundwater Monitoring Well Network

Former Tiger Oil Site
2312 West Nob Hill Boulevard
Yakima, Washington

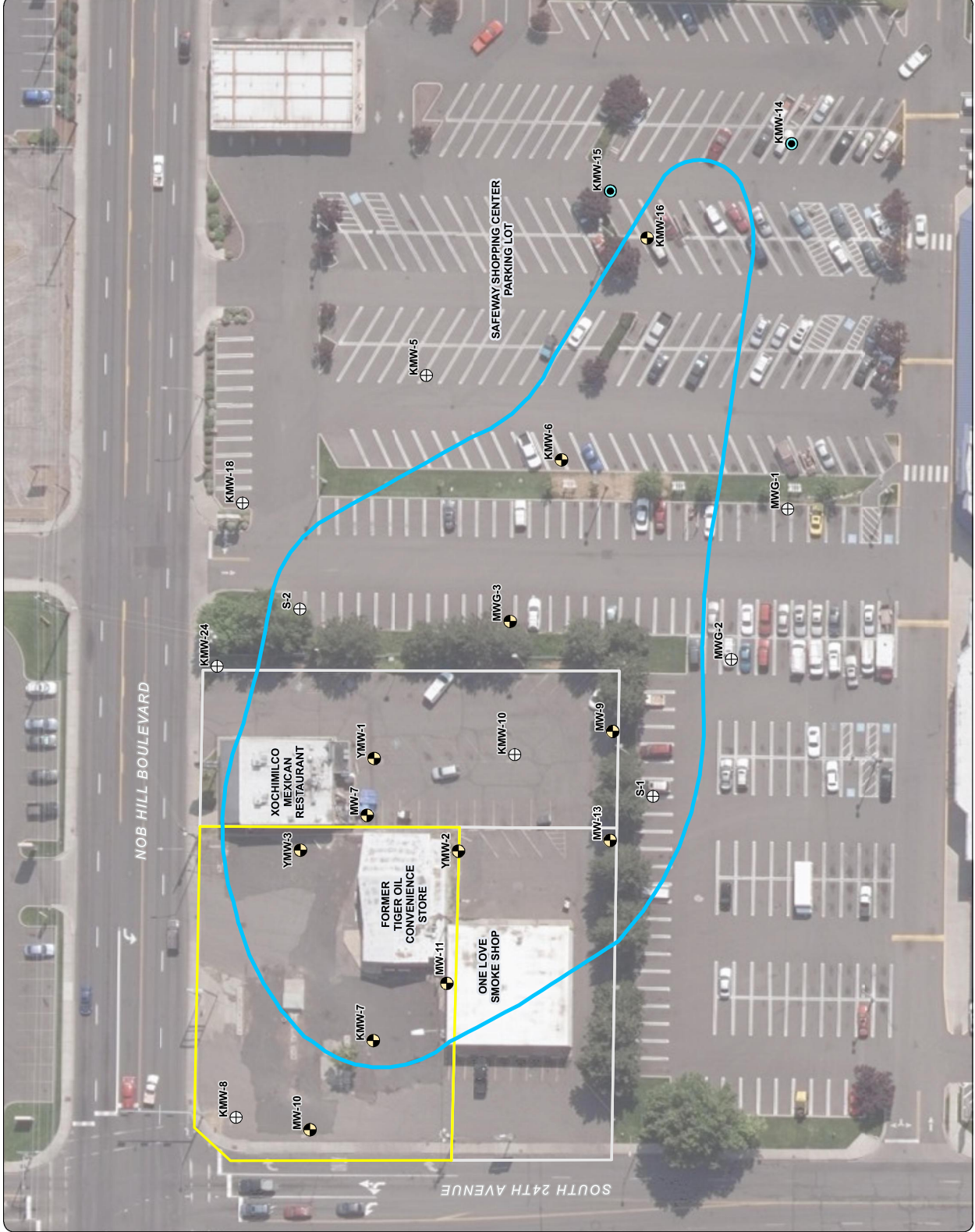
- Legend**
- GW Monitoring Network Well
 - Monitoring Well
 - Sentry Monitoring Well
 - Approximate Dissolved Phase Plume, 2013
 - Former Tiger Oil Property Boundary
 - Adjacent Taxlot Boundaries



Source: Aerial photograph obtained from Esri ArcGIS Online; Infiltration Gallery delineated by Maul Foster & Alongi, Inc.; stormwater line and taxlot boundaries obtained from City of Yakima; all other features obtained from PLSA.

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APPENDIX A

GROUNDWATER MONITORING WELL NETWORK CONSTRUCTION LOGS



Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number
0818.02.01

Well Number
YMW-1

Sheet
1 of 1


Project Name **Tiger Oil - West Nob Hill Blvd.**
 Project Location **2312 West Nob Hill Blvd., Yakima, Washington**
 Start/End Date **5/26/15 to 5/26/15**
 Driller/Equipment **Holt Drilling/Hollow Stem Auger**
 Geologist/Engineer **C. Wise**
 Sample Method **None**

TOC Elevation (feet) **1089.05**
 Surface Elevation (feet) **1089.4**
 Northing **456449.8**
 Easting **1630364.6**
 Hole Depth **20.0-feet**
 Outer Hole Diam **4-inch**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Sample Data			Blows/6"	Lithologic Column	Soil Description
				Collection Method	Number	Name (Type)			
0.0 to 0.3									0.0 to 0.3 feet: ASPHALT; black; dry. (FILL)
0.3 to 1.0									0.3 to 1.0 feet: GRAVEL (GW); gray; 10% fines; 30% sand, coarse, angular; 60% gravel, fine, angular; dry. (FILL)
1.0 to 13.0									1.0 to 13.0 feet: GRAVELLY SAND WITH SILT (SW-SM); reddish brown; 15% fines; 60% sand, fine to coarse, angular; 25% gravel, fine, angular; dry to moist. (FILL)
13.0 to 20.0									13.0 to 20.0 feet: SILTY SAND (SM); blue gray; 40% fines; 60% sand, very fine to fine, subangular to angular; soft; very strong hydrocarbon-like odor; moist.

Total Depth = 20.0 feet below ground surface.
 Well Completion Details =
 2.0 inch well casing.
 2.0 inch well cap.
 0.01 inch slotted screen.
 Well Permit No. BIQ055.

NOTES: No samples collected.

 Water level following well construction and development.

GBLWC WA:\GINT\GINT\PROJECTS\0818.02.01\YMW-1 TO YMW-3.GPJ 8/19/15

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number
0818.02.01

Well Number
YMW-2

Sheet
1 of 1


Project Name **Tiger Oil - West Nob Hill Blvd.**
 Project Location **2312 West Nob Hill Blvd., Yakima, Washington**
 Start/End Date **5/26/15 to 5/26/15**
 Driller/Equipment **Holt Drilling/Hollow Stem Auger**
 Geologist/Engineer **C. Wise**
 Sample Method **None**

TOC Elevation (feet) **1090.86**
 Surface Elevation (feet) **1091.2**
 Northing **456406.2**
 Easting **1630317.0**
 Hole Depth **20.0-feet**
 Outer Hole Diam **4-inch**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Sample Data			Blows/6"	Lithologic Column	Soil Description
				Collection Method	Number	Name (Type)			
0.0 to 0.3									0.0 to 0.3 feet: ASPHALT; black; dry. (FILL)
0.3 to 1.0									0.3 to 1.0 feet: GRAVEL (GW); gray; 10% fines; 30% sand, coarse, angular; 60% gravel, fine, angular; dry. (FILL)
1.0 to 13.5									1.0 to 13.5 feet: GRAVELLY SAND WITH SILT (SW-SM); reddish brown; 15% fines; 60% sand, fine to coarse, angular; 25% gravel, fine, angular; dry to moist. (FILL)
14.0 to 20.0									14.0 to 20.0 feet: SILTY SAND (SM); blue gray; 40% fines; 60% sand, very fine to fine, subangular to angular; soft; very strong hydrocarbon-like odor; moist.

Total Depth = 20.0 feet below ground surface.
 Well Completion Details =
 2.0 inch well casing.
 2.0 inch well cap.
 0.01 inch slotted screen.
 Well Permit No. BIQ056.

NOTES: No samples collected.

 Water level following well construction and development.

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number
0818.02.01

Well Number
YMW-3

Sheet
1 of 1


Project Name **Tiger Oil - West Nob Hill Blvd.**
 Project Location **2312 West Nob Hill Blvd., Yakima, Washington**
 Start/End Date **5/26/15 to 5/26/15**
 Driller/Equipment **Holt Drilling/Hollow Stem Auger**
 Geologist/Engineer **C. Wise**
 Sample Method **None**

TOC Elevation (feet) **1089.53**
 Surface Elevation (feet) **1090.2**
 Northing **456487.7**
 Easting **1630317.4**
 Hole Depth **20.0-feet**
 Outer Hole Diam **4-inch**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Sample Data			Blows/6"	Lithologic Column	Soil Description
				Collection Method	Number	Name (Type)			
1									0.0 to 0.5 feet: GRAVEL (GP); reddish gray; 100% gravel, angular, coarse; dry. (FILL)
2									0.5 to 14.0 feet: GRAVELLY SAND WITH SILT (SW-SM); reddish brown; 15% fines; 55% sand, fine to coarse, subangular to angular; 30% gravel, fine, subangular to angular; dry to moist. (FILL)
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									14.0 to 20.0 feet: SILTY SAND (SM); blue gray; 40% fines; 60% sand, very fine to fine, subangular to angular; soft; very strong hydrocarbon-like odor; moist.
16									
17									
18									
19									
20									

Total Depth = 20.0 feet below ground surface.
 Well Completion Details =
 2.0 inch well casing.
 2.0 inch well cap.
 0.01 inch slotted screen.
 Well Permit No. BIQ057.

NOTES: No samples collected.

 Water level following well construction and development.

APPENDIX B

SAMPLING AND ANALYSIS PLAN



SAMPLING AND ANALYSIS PLAN

GROUNDWATER MONITORING PLAN
FORMER TIGER OIL SITE
2312 WEST NOB HILL BOULEVARD
YAKIMA, WASHINGTON

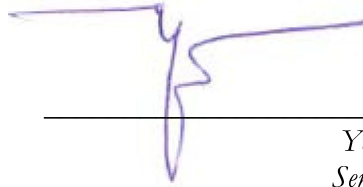
Prepared for
CITY OF YAKIMA
August 26, 2015
Project No. 0818.02.01

Prepared by
Maul Foster & Alongi, Inc.
1329 N State Street, Suite 301, Bellingham WA 98225

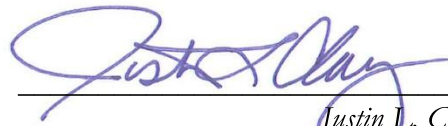
SAMPLING AND ANALYSIS PLAN
GROUNDWATER MONITORING PLAN
FORMER TIGER OIL SITE
2312 WEST NOB HILL BOULEVARD
YAKIMA, WASHINGTON

*The material and data in this plan were prepared
under the supervision and direction of the undersigned.*

MAUL FOSTER & ALONGI, INC.



*Yen-Vy Van, LHG
Senior Hydrogeologist*



*Justin L. Clary, PE
Principal Engineer*

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FOLLOWING PLAN:

TABLE

GROUNDWATER SAMPLE HANDLING SUMMARY

ACRONYMS AND ABBREVIATIONS

the City	City of Yakima, Washington
COC	chain of custody
Ecology	Washington State Department of Ecology
GMP	groundwater monitoring plan
IDW	investigation-derived waste
LCS	laboratory control sample
LDS	laboratory duplicate sample
MFA	Maul Foster & Alongi, Inc.
MS/MSD	matrix spike and matrix spike duplicate
Property	2312 West Nob Hill Boulevard, Yakima, Washington
QA	quality assurance
QC	quality control
SAP	sampling and analysis plan
Site	Ecology Facility Site No. 469, Cleanup Site No. 4919
USEPA	U.S. Environmental Protection Agency
WAC	Washington Administrative Code

1 INTRODUCTION

Maul Foster and Alongi, Inc. (MFA) has prepared this sampling and analysis plan (SAP), including quality assurance project plan elements, consistent with the requirements of Washington Administrative Code (WAC) 173-340-820, on behalf of the City of Yakima (the City) for the former Tiger Oil facility at 2312 West Nob Hill Boulevard, Yakima, Washington, Washington State Department of Ecology (Ecology) Facility Site No. 469, Cleanup Site No. 4919, to guide the collection of groundwater samples during groundwater compliance monitoring events. Throughout this report and consistent with Ecology's definition, the term "Property" is used specific to the real property located at 2312 West Nob Hill Boulevard, and "Site" is used specific to where contamination resulting from former operations at the Tiger Oil facility has come to lie, irrespective of property boundaries.

This SAP has been prepared consistent with the requirements of Ecology's Guidance on Sampling and Data Analysis Methods (Ecology, 1995), Guidance for Preparing Quality Assurance Project Plans for Environmental Studies (Ecology, 2004), and the Model Toxics Control Act (WAC Chapter 173-340).

1.1 Investigation Objectives

The primary objective of this SAP is to establish procedures for the collection of data of sufficient quality to evaluate the nature and extent of impacted groundwater at the Site. The groundwater compliance monitoring plan (CMP) references the relevant procedures and protocols from this SAP and the locations, frequency, and types of field or laboratory analyses that will be conducted. This SAP is meant to ensure that reliable data are obtained in support of consideration of additional remedial actions at the Site, if such actions are necessary for the protection of human health and the environment, and ultimate demonstration of Site compliance with associated cleanup levels (CULs). It provides a consistent set of procedures that will be used throughout implementation of the CMP (MFA, 2015).

If a phase of work or an otherwise unforeseen change in methodology requires modification to this SAP, an addendum will be prepared that describes the specific revision(s) or the alternative procedures. Procedures are provided that will be used to direct the monitoring process so that the following conditions are met:

- Data collected are of high quality, representative, and verifiable.
- Use of resources is cost effective.
- Data can be used by the Property owner and operator and by Ecology supporting compliance monitoring for the selected Site remedy.

This SAP provides guidance on procedures for groundwater sampling, monitoring well installation and decommissioning (as applicable), and management of investigation-derived waste (IDW). It also

includes procedures for collecting, analyzing, evaluating, and reporting useful data. The document includes quality assurance (QA) procedures for field activities, sampling QA and quality control (QC) procedures, and data validation. The goal of the procedures outlined in this SAP is to obtain reliable data about physical, environmental, and chemical conditions at the Site in order to support the goals and objectives of the CMP.

2 ACCESS AND SITE PREPARATION

2.1 Access

MFA personnel will be on the Site during compliance monitoring activities. Access to the Site is allowed at all reasonable times for the purpose of performing work, as stipulated in the Amended Consent Decree. Work activities resulting in loud noises will generally be confined to the hours between 7 a.m. and 7 p.m. MFA will notify the City and Ecology before beginning work at the Site.

2.2 Site Preparation

As applicable, before any subsurface field activities (e.g., monitoring well installation) begin at the Site, public and private utility-locating services will be used to check for underground utilities and pipelines near each proposed well or boring location. MFA will coordinate fieldwork with the City to define the locations of possible on-site utilities, piping, and other subsurface obstructions. Ecology will be notified a minimum of 48 hours before activities begin at the Site.

3 GROUNDWATER ASSESSMENT

Procedures for installation of monitoring wells are provided below in the event that future monitoring well installation activities are deemed necessary.

3.1 Monitoring Well Installation

Monitoring wells will be constructed according to the Washington well construction standards (Chapter 173-160 WAC) and as described below.

- Monitoring wells will be constructed with 2-inch-diameter polyvinyl chloride or stainless steel riser pipe and screened sections consisting of 0.010-inch machine slots. The monitoring wells may be constructed with prepacked well screen with 10 x 20 washed silica sand or by placing materials downhole, following the WAC regulation listed above.
- Additional filter pack may be placed around the prepacked screen (if used). The additional filter pack will consist of graded 10 x 20 washed silica sand and will extend a

maximum of 1 foot below the bottom of the screen and 3 feet above the top of the screen. A weighted line will be used to monitor the level of the filter pack during installation. The filter pack may be surged during installation.

- Bentonite grout or hydrated chips (e.g., 0.75-inch minus) will be used to seal the annulus above the filter pack. Potable water will be used. A weighted line will be used to measure the top of the bentonite chips as they are poured into place.
- At least 48 hours after installation of a well, the well will be developed by surging, bailing, or pumping to remove sediment that may have accumulated during installation and to improve the hydraulic connection with the water-bearing zone.
- Water quality field parameters such as specific conductance, pH, temperature, and turbidity will be measured during well development as deemed appropriate. The wells will be developed until the turbidity measurements are 10 nephelometric turbidity units or less, or until there is no noticeable decrease in turbidity. To the extent practical, water quality field parameters will be considered stable when the specific conductance is within 10 percent of the previous reading, pH is within 0.1 standard unit of the previous reading, and temperature is within 0.1 degree Celsius of the previous reading.

During well installation, a log of the soil will be prepared by a geologist or hydrogeologist licensed by the State of Washington or a person working under the direct supervision of a geologist or hydrogeologist licensed by the State of Washington. Site characterization of the extent of the dissolved phase plume is considered complete based prior groundwater sampling completed at the Site. Therefore, soil samples associated with any future borings are not anticipated to be collected for chemical analysis. Soil logs will include information such as the project name and location, the name of the drilling contractor, the drilling method, the sampling method, sample depths, blow counts (if applicable), a description of soil encountered, and screened intervals. Soils will be described using American Society for Testing and Materials D2488-00, Standard Practice for Description and Identification of Soils (Visual-Manual Procedures). The information will be recorded on an MFA boring log form, as shown in Appendix A, or in the field notes.

3.2 Groundwater Elevations

Depth to LNAPL and water level measurements, to the nearest 0.01 foot, will be recorded using an electronic water level indicator. If LNAPL is present, a measurement of its thickness will be recorded. Groundwater elevations at wells with LNAPL present will be corrected to compensate for the effect of differing densities of the LNAPL and water. If the total well or boring depth is not known, the total depth will also be measured. The depth to water will be measured from the designated measuring point (typically the top of the casing, which is typically a polyvinyl chloride riser pipe) The measuring point will be marked so that readings are measured from the same reference point during each monitoring event, and the measuring point elevation will be surveyed. During monitoring events, the well condition (including the condition of the lock, monument integrity, and legibility of well labels) will be recorded for each location. The water level indicator will be decontaminated between wells in accordance with the procedures outlined in Section 3.5.

3.3 Surveying

The installation locations for proposed wells, as applicable, and other features of interest will be surveyed using a global positioning unit (e.g., Trimble™) capable of submeter accuracy. The location and measuring point elevation for newly installed monitoring wells will be surveyed by a licensed surveyor.

The Trimble global positioning unit will tie in to published survey control, establish onsite control, and survey horizontal positions of monitoring wells. The published accuracy of the Trimble system, which is calibrated annually by a Trimble Certified Service Center, is as follows:

Network RTK Positioning Performance
Horizontal 8 mm + 0.5 ppm RMS
Vertical. 15 mm + 0.5 ppm RMS

If there is not an established Washington State Department of Transportation benchmark onsite, the surveyors will use a differential level loop from the established onsite control through all of the monitoring wells to survey their elevations. Differential level loops are only accepted if the data are within 0.02 feet. The survey would be re-run if the accuracy is not within this range. The referenced survey datum for the Site is NAVD88 datum in the State Plane South Projection.

3.4 Equipment Cleaning and Decontamination

3.4.1 Drilling Equipment

The working area of the drill rig and downhole drilling equipment will be steam-cleaned or pressure-washed after arrival on the Site and after use in each borehole or monitoring well. Decontamination fluids will be transferred to drums approved by the Washington State Department of Transportation, and will be managed according to the procedures outlined in Section 3.6.

3.4.2 Sampling Equipment

Nondisposable sampling equipment and reusable materials that contact the soil or water will be decontaminated on site and before and after each sample and sampling location. Decontamination will consist of the following:

- Tap-water rinse (may consist of an equivalent high-pressure or hot-water rinse); visible soil to be removed by scrubbing
- Nonphosphate detergent wash, consisting of a dilute mixture of Liqui-Nox® (or equivalent) and tap water
- Distilled-water rinse
- Methanol solution rinse (1:1 solution of methanol with distilled water)
- Distilled-water rinse

Decontamination fluids will be transferred to drums for management.

3.5 Management of Investigation-Derived Waste

IDW may include items such as soil cuttings, purged groundwater, decontamination fluids, sampling debris, and personal protective equipment. The IDW will be segregated into solids, liquids, and sampling debris (e.g., personal protective equipment, tubing, bailers). IDW will be stored in a designated area on the Site in Washington State Department of Transportation-approved drums.

Drums will be labeled with their contents, the approximate volume of material, the date of collection, and the origin of the material. The drums will be sealed, secured, and transferred to a designated area on the Site, pending characterization. Analytical data from groundwater sampling activities previously described may be used to characterize the soil cuttings, drilling fluids, purge water, and decontamination fluids generated during drilling and monitoring well sampling. A plan for IDW management specific to future field tasks will be developed prior to conducting the associated fieldwork.

4 GROUNDWATER SAMPLING

Groundwater samples will be collected from monitoring wells following the procedures outlined below.

4.1 Monitoring Well Groundwater Sampling

If a peristaltic pump is used, standard low-flow sampling techniques will be used to collect groundwater samples from monitoring wells, per Ecology Standard Operating Procedure and Sampling Monitoring Wells (Ecology, 2015). If possible, groundwater samples should be collected from the middle of the screened interval or, if the water level is below the top of the screen, from the middle of the water column. New, disposable teflon-lined polyethylene tubing will be used at each monitoring location.

Before collection of groundwater samples, the water level will be measured and the well will be purged. If a peristaltic pump is used, the well should be purged at a low flow rate (e.g., 0.1 to 0.5 liter per minute). A minimum of three well volumes will be purged before sample collection or until selected water quality field parameters (e.g., temperature, specific conductance, oxidation reduction potential, pH, turbidity) have stabilized. If the well goes dry during purging, a sample can be collected once the well recharges enough water; field observations regarding the length of time for a well to recharge will be recorded. During purging, the flow rates, water levels, and water quality parameters will be recorded on an appropriate field form or in the field notes. Groundwater will be transferred directly into laboratory-supplied containers specific to the analysis required.

4.2 Nomenclature

Groundwater samples will be labeled with a prefix to describe the sampling location identification number, a “W” to indicate a water sample matrix, and the midpoint of the screened or open area sample depth in feet. For example, a groundwater sample collected from monitoring well YMW-1 and with its screen from 5 feet to 20 feet below ground surface will have the sample nomenclature of YMW1-W-12.5.

Duplicate groundwater samples will replace the location number with “DUP,” and the sample will have the same sample time as the primary sample. To avoid confusion, collection of more than one a duplicate sample from the same depth at the same date and time should be avoided. A duplicate sample of the abovementioned sample would appear as YMW1-DUP-W-12.5.

Relevant sample information will be documented on the exploratory boring log (see Appendix A) or a field sampling data sheet (see Appendix B); documentation may include items such as the screened interval or open space, equipment used, water quality field parameters, and the amount of water purged before sampling. The screened interval or open borehole will be recorded on the boring log.

5 ANALYTICAL METHODS

5.1 Chemicals of Interest

All compliance monitoring network wells defined in the CMP will be analyzed for the following chemicals, which have been identified as indicator hazardous substances for Site groundwater:

- Gasoline-range total petroleum hydrocarbons
- Benzene
- Ethylbenzene
- Toluene
- Xylenes

All samples will be analyzed on a standard analytical laboratory turnaround time. Analytical methods and sample handling procedures for these indicator hazardous substances are included in the attached table.

5.2 Laboratory Test Methods and Reporting Limits

5.2.1 Groundwater

In accordance with the QA/QC requirements set forth in this SAP, a Washington State-accredited laboratory will perform the following analyses. Laboratory methods are summarized below and in the attached table

- Gasoline-range total petroleum hydrocarbons by Northwest Method NWTPH-Gx
- Petroleum associated VOC specifically benzene, toluene, ethylbenzene, and xylenes by United States Environmental Protection Agency (USEPA) Method 8260 or 8021

5.3 QA/QC Samples Generated in Field

To ensure that field samples and quantitative field measurements are representative of the media collected and conditions being measured, sample collection and measurement methods will follow procedures documented in Section 4.1. QC samples collected in the field include field equipment rinsate blanks, trip blanks, and field duplicates. Field QC samples will be identified on the field data sampling sheets. Field and trip blank results may indicate possible contamination introduced by field or laboratory procedures; field duplicates indicate precision in both field and laboratory procedures.

5.4 Laboratory Operations

In the laboratory, QC samples may include matrix spike and matrix spike duplicate (MS/MSD) samples, laboratory control samples (LCSs), surrogate spike samples, and method blanks, as well as other QC samples and procedures as required by the individual methods.

5.5 Sample Containers, Preservation, and Handling

5.5.1 Preservation

Water samples will be collected in laboratory-supplied containers with preservative, as applicable, as summarized in the table.

All samples will be stored in iced coolers at approximately 4 degrees Celsius. Sample containers will be supplied by the laboratory.

5.5.2 Sample Packaging and Shipping

All samples will be stored in shipping containers with ice or a refrigerator designated for samples and transported to the analytical laboratory. All samples will be submitted to the analytical laboratory within the timeframes necessary to allow for analysis within the applicable holding time (table).

5.6 Sample Custody

Sample custody will be tracked from point of origin through analysis and disposal, using a chain-of-custody (COC) form, which will be filled out with the appropriate sample and analytical information after samples are collected.

The following items will be recorded on the COC form:

- Project name
- Project number
- MFA project manager
- Sampler name(s)
- Sample number, date and time collected, media, number of bottles submitted
- Requested analyses for each sample
- Type of data package required
- Turnaround requirements
- Signature, printed name, and organization name of persons having custody of samples, and date and time of transfer
- Additional instructions or considerations that would affect analysis (nonaqueous layers, archiving, etc.)

Persons in possession of the samples will be required to sign and date the COC form whenever samples are transferred between individuals or organizations. The COC will be included in the shipping containers. The laboratory will implement its in-house custody procedures, which begin when sample custody is transferred to laboratory personnel.

If samples are shipped via air or ground transportation (by a third party), the following custody procedures will be followed. The COC will be signed and custody will be relinquished to the carrier. The signed COC(s) will be packed in shipping containers with the samples, and a custody seal will be placed on the container. The shipping documentation will be used by the carrier to document custody of the package while it is in transit to the laboratory.

At the analytical laboratory, a designated sample custodian will accept custody of the samples and will verify that the COC form matches the samples received. The shipping container or set of containers is given a laboratory identification number, and each sample is assigned a unique sequential identification number.

5.7 Instrumentation

5.7.1 Field Instrumentation

Field instruments will be used during the investigations. The following field equipment may require calibration before use and periodically during sampling activities:

- pH meter
- Conductivity meter
- Dissolved-oxygen meter
- Oxygen/reduction potential meter
- Turbidity meter
- Thermometer
- Photoionization detector
- Electronic water-level probe

Field-instrument calibration and preventive maintenance will follow the manufacturers' guidelines, and any deviations from the established guidelines will be documented.

5.7.1.1 Field Calibration

Generally, field instruments should be calibrated daily before work begins. Field personnel may decide to calibrate more than once a day if inconsistent or unusual readings occur, or if conditions warrant more frequent calibration. Calibration activities should be recorded in logbooks or field notebooks. To ensure that field instruments are properly calibrated and remain operable, the following procedures will be used, at a minimum:

- Operation, maintenance, and calibration will be performed in accordance with the instrument manufacturers' specifications.
- Standards used to calibrate field instruments will meet the minimum requirements for source and purity recommended in the equipment operation manual. Standards will be checked for expiration dates that may be printed on the bottle. Standards that have expired should not be used.
- Acceptable criteria for calibration will be based on the limits set in the operations manual.
- Users of the equipment will be trained in the proper calibration and operation of the instrument.
- Operation and maintenance manuals for each field instrument will be available to persons using the equipment.
- Field instruments will be inspected before they are taken to the Site.

- Field instruments will be calibrated at the start of each workday. Meters will be recalibrated, as necessary, during the work period.
- Calibration procedures (including items such as time, standards used, and calibration results) will be recorded in a field notebook. The information should be available if problems are encountered.

5.7.1.2 Preventive Maintenance

Preventive maintenance of field instruments and equipment will follow the operations manuals. A schedule of preventive-maintenance activities should be followed to minimize downtime and ensure the accuracy of measurement systems. Maintenance will be documented in the field notebook.

5.7.2 Laboratory Instrumentation

Specific laboratory instrument calibration procedures, frequency of calibration, and preparation of calibration standards will be according to the method requirements as developed by the USEPA, following procedures presented in SW-846 (USEPA, 1986).

5.7.2.1 Laboratory Calibration and Preventive Maintenance

The laboratory calibration ranges specified in SW-846 (USEPA, 1986) will be followed.

Preventive maintenance of laboratory equipment will be the responsibility of the laboratory personnel and analysts. This maintenance includes routine care and cleaning of instruments and inspection and monitoring of carrier gases, solvents, and glassware used in analyses. The preventive-maintenance approach for specific equipment should follow the manufacturers' specifications, good laboratory practices, and industry standard techniques.

Precision and accuracy data will be examined for trends and excursions beyond control limits to determine evidence of instrument malfunction. Maintenance should be performed when an instrument begins to change, as indicated by the degradation of peak resolution, shift in calibration curves, decrease in sensitivity, or failure to meet any of the QC criteria.

5.8 Laboratory QA/QC Samples

The laboratory QC samples will be used to assess the accuracy and precision of the laboratory analysis. Each category of laboratory QA/QC will be performed by the laboratory as required by method-specific guidelines. The acceptance criteria presented in the guidelines will be adhered to, and samples that do not meet the criteria will be reanalyzed or qualified, as appropriate.

5.8.1 Calibration Verification

Instruments will initially be calibrated at the start of the project or sample run, as required, and when any ongoing calibration does not meet control criteria. The number of points used in the initial calibration is defined in the analytical method. Calibration will be continued as specified in the

analytical method to track instrument performance. If a continuing calibration does not meet control limits, analysis of project samples will be suspended until the source of the control failure is either eliminated or reduced to within control specifications.

5.8.2 Matrix Spike/Matrix Spike Duplicate

MS samples are analyzed to assess the matrix effects on the accuracy of analytical measurements. MS/MSD samples will be prepared by spiking investigative samples with known amounts of analytes before extraction and preparation and analysis. The recoveries for the MS/MSD samples will be used to assess the accuracy and precision in the analytical method by measuring how well the analytical method recovers the target compounds in the investigative matrices. For each matrix type, at least one set of MS/MSD samples will be analyzed for each batch of samples (consisting of 20 or fewer samples) received.

5.8.3 Method Blanks

Method blanks are prepared using analyte-free (reagent) water and are processed with the same methodology (e.g., extraction, digestion) as the associated investigative samples. Method blanks are used to document contamination resulting in the laboratory from the analytical process. A method blank shall be prepared and analyzed in every analytical batch. The method blank results are used to verify that reagents and preparation do not impart unacceptable bias to the investigative sample results. The presence of analytes in the method blank sample will be evaluated against method-specific thresholds. If analytes are present in the method blank above the method-specific threshold, corrective action will be taken to eliminate the source of contamination before proceeding with analysis. Investigative samples of an analytical batch associated with method blank results outside acceptance limits will be appropriately qualified by the data validation contractor.

5.8.4 Laboratory Control Samples

LCSs are prepared by spiking laboratory-certified, reagent-grade water with the analytes of interest or a certified reference material that has been prepared and analyzed. The result for percent recovery of the LCS is a data quality indicator of the accuracy of the analytical method and laboratory performance.

5.8.5 Laboratory Duplicate Samples

Laboratory duplicate samples (LDSs) are prepared by the laboratory by splitting an investigative sample into two separate aliquots and performing separate sample preparation and analysis on each aliquot. The results for relative percent difference of the primary investigative sample and the respective LDSs are used to measure precision in the analytical method and laboratory performance. For nonaqueous matrices, sample heterogeneity may affect the measured precision for the LDSs.

5.9 Field QC

The following samples will be prepared by the sampling personnel in the field and submitted to the laboratory:

- **Equipment Rinse Blanks** — To ensure that decontamination procedures are sufficient, an equipment rinse blank will be collected when nondedicated, nondisposable equipment is used. At least one equipment rinse blank will be collected for every 20 samples collected. If more than 20 samples are collected with the same equipment, or if high concentrations of contaminants are encountered, additional equipment rinse blanks may be collected. Equipment rinse blanks will be collected by passing laboratory deionized/distilled water through or over nondisposable sampling equipment.
- **Trip Blanks** — A trip blank monitors the potential for sample contamination during sample collection and transport. A trip blank consists of reagent-grade water in a new sample container, which is prepared at the same time as the sample containers. The trip blank will accompany the samples throughout collection, shipment, and storage. At least one trip blank should be included with each cooler in which samples for volatile organic compound analyses are stored.
- **Field Duplicates** — Field duplicates are collected to measure sampling and laboratory precision. At least one duplicate sample will be collected for every 20 samples.

5.10 Data Reduction, Validation, and Reporting

The analytical laboratory will submit analytical data packages that include laboratory QA/QC results to permit independent and conclusive determination of data quality. Data quality will be determined by MFA, using the data evaluation procedures described in this section. The results of the MFA evaluation will be used to determine if the project data quality objectives are being met.

5.10.1 Field Data Reduction

Daily internal QC checks will be performed for field activities. Checks will consist of reviewing field notes and field activity memoranda to confirm that the specified measurements, calibrations, and procedures are being followed. The need for corrective action will be assessed on an ongoing basis, in consultation with the project manager.

5.10.2 Laboratory Evaluation

Initial data reduction, evaluation, and reporting at the analytical laboratory will be carried out as described in USEPA SW-846 manuals for analyses (USEPA, 1986), as appropriate. Additional laboratory data qualifiers may be defined and reported to further explain the laboratory's QC concerns about a particular sample result. Additional data qualifiers will be defined in the laboratory's case narrative reports.

5.10.3 Data Deliverables

Laboratory data deliverables are listed below. Electronic deliverables will contain the same data that are presented in the hard-copy report.

- Transmittal cover letter
- Case narrative
- Analytical results
- COC
- Surrogate recoveries
- Method blank results
- MS/MSD results
- Laboratory duplicate results
- Laboratory data qualifiers and associated definitions

5.10.4 MFA Evaluation

5.10.4.1 Data QA/QC Review

MFA will evaluate the laboratory data for precision, completeness, accuracy, and compliance with the analytical method. MFA will review data according to applicable sections of USEPA organics and inorganic procedures (USEPA, 2008, 2010), as well as appropriate laboratory method-specific guidelines (USEPA, 1986).

Data qualifiers, as defined by the USEPA, are used to classify sample data according to their conformance to QC requirements. Common qualifiers are listed below:

- J—Estimate, qualitatively correct but quantitatively suspect.
- R—Reject, data not suitable for any purpose.
- U—Not detected at a specified reporting limit.

Poor surrogate recovery, blank contamination, or calibration problems, among other things, can require qualification of the sample data. When sample data are qualified, the reasons for the qualification should be stated in the data evaluation report.

QC criteria not defined in the guidelines for evaluating analytical data are adopted, where appropriate, from the analytical method.

The following information will be reviewed during data evaluation, as applicable:

- Sampling locations and blind sample numbers
- Sampling dates
- Requested analysis
- COC documentation

- Sample preservation
- Holding times
- Method blanks
- Surrogate recoveries
- MS/MSD results
- Laboratory duplicates (if analyzed)
- Field duplicates
- Field blanks
- LCSs
- Method reporting limits above requested levels
- Additional comments or difficulties reported by the laboratory
- Overall assessment

The results of the data evaluation review will be summarized for each data package. Data qualifiers will be assigned to sample results on the basis of USEPA guidelines, as applicable.

5.10.4.2 Data Management and Reduction

MFA uses the database EQuIS™ to manage laboratory data. The laboratory will provide the analytical results in electronic, EQuIS-compatible format. Following data evaluation, data qualifiers will be entered into the database. Following validation, complete data packages will be uploaded to Ecology's Environmental Information Management database.

Data may be reduced to summarize particular data sets and to aid interpretation of the results. Statistical analyses may also be applied to results. Data reduction QC checks will be performed on hand-entered data, calculations, and data graphically displayed. Data may be further reduced and managed using one or more of the following computer software applications:

- Microsoft Excel® (spreadsheet)
- EQuIS™ (database)
- Microsoft Access® (database)
- AutoCad and/or Arc GIS (graphics)
- USEPA ProUCL (statistical software)

6 REPORTING

After the data are received, MFA will generate a data report in accordance with Ecology reporting requirements [WAC 173-340-840(5)], which will summarize and screen the data against the applicable criteria.

LIMITATIONS

The services undertaken in completing this plan were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This plan is solely for the use and information of our client unless otherwise noted. Any reliance on this plan by a third party is at such party's sole risk.

Opinions and recommendations contained in this plan apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this plan.

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USEPA. 2008. USEPA contract laboratory program, national functional guidelines for organics data review. EPA 540/R-08/01. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. June.

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TABLE



Table
Groundwater Sample Handling Summary
Former Tiger Oil Site
Yakima, Washington

Analyte	Method	Suggested Volume	Container	Number of Containers	Preservative	Storage Temperature	Holding Time from Collection
Gasoline-range organics	NWTPH-Gx	40 milliliter	VOA	3	HCL pH < 2	4 degrees C	14 days
BTEX	USEPA 8021B/8260	40 milliliter	VOA	3	HCL pH < 2	4 degrees C	14 days

NOTES:
--- = no preservative
ASTM = American Society for Testing and Materials.
BTEX = benzene, toluene, ethylbenzene, xylenes.
C = Celsius.
HCL = hydrochloric acid.
NWTPH = Northwest Total Petroleum Hydrocarbons.
USEPA = U.S. Environmental Protection Agency.
VOA = volatile organic analysis vial.
VOC = volatile organic compound.

APPENDIX A

BORING LOG FORM





Boring/Well No.:

Boring Log Form

Site:

Location:

Project #:

Drill Rig		MFA Staff:		Hole Dia:		Total Depth:	
Drilling Co.:				Water Level:		WLE Note:	
Start Date:		End Date:		Water Level:		WLE Note:	

Completion	Sample			Lithology			
	Top:	Time:	Depth:	Soil Type:	Color:		
Length:			Top:	Fines:		Moisture:	
Type:	Sample ID		Bottom:	Sand:		PID:	
% Recov:			Soil Class:	Gravel:		Line Type:	
			Trace:	Impacts:			
			Notes:				
Top:	Time:	Depth:	Soil Type:	Color:			
Length:			Top:	Fines:		Moisture:	
Type:	Sample ID		Bottom:	Sand:		PID:	
% Recov:			Soil Class:	Gravel:		Line Type:	
			Trace:	Impacts:			
			Notes:				
Top:	Time:	Depth:	Soil Type:	Color:			
Length:			Top:	Fines:		Moisture:	
Type:	Sample ID		Bottom:	Sand:		PID:	
% Recov:			Soil Class:	Gravel:		Line Type:	
			Trace:	Impacts:			
			Notes:				
Top:	Time:	Depth:	Soil Type:	Color:			
Length:			Top:	Fines:		Moisture:	
Type:	Sample ID		Bottom:	Sand:		PID:	
% Recov:			Soil Class:	Gravel:		Line Type:	
			Trace:	Impacts:			
			Notes:				
Top:	Time:	Depth:	Soil Type:	Color:			
Length:			Top:	Fines:		Moisture:	
Type:	Sample ID		Bottom:	Sand:		PID:	
% Recov:			Soil Class:	Gravel:		Line Type:	
			Trace:	Impacts:			
			Notes:				

Borehole Notes:

APPENDIX B

FIELD SAMPLING DATA SHEET FORM



Maul Foster & Alongi, Inc.

7223 NE Hazel Dell Avenue, Suite B, Vancouver, WA 98665 (360) 694-2691 Fax. (360) 906-1958

Soil Field Sampling Data Sheet

Client Name		Sample Location					
Project Number		Sampler					
Project Name		Sampling Date					
Sampling Event		Sample Name					
Sub Area		Sample Depth					
FSDS QA:		Easting		Northing		TOC	

Sample Information

Sampling Method	Sample Type	Sample Category	PID/FID	Sampling Time	Container Code	#
(1) Backhoe	Liquid	Composite			2 oz. soil	
					4 oz. soil	
					8 oz. soil	
					Other	
					Total Containers	0

Sample Description:

General Sampling Comments

Sampling Method Code:

(1) Backhoe, (2) Hand Auger, (3) Drill Bit Cutting Head, (4) Geoprobe, (5) Split Spoon, (6) Shelby Tube, (7) Grab, (8) Other (Specify)

Signature _____

Maul Foster & Alongi, Inc.

7223 NE Hazel Dell Avenue, Suite B, Vancouver, WA 98665 (360) 694-2691 Fax. (360) 906-1958

Water Field Sampling Data Sheet

Client Name		Sample Location	
Project #		Sampler	
Project Name		Sampling Date	
Sampling Event		Sample Name	
Sub Area		Sample Depth	
FSDS QA:		Easting	<input style="width: 50px;" type="text"/>
		Northing	<input style="width: 50px;" type="text"/>
		TOC	<input style="width: 50px;" type="text"/>

Hydrology/Level Measurements

Date	Time	DT-Bottom	DT-Product	DT-Water	(Product Thickness) DTP-DTW	(Water Column) DTB-DTW	(Gallons/ft x Water Column) Pore Volume

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	EH	Turbidity
Final Field Parameters									

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

Water Quality Observations:

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
	Groundwater		VOA-Glass		
			Amber Glass		
			White Poly		
			Yellow Poly		
			Green Poly		
			Red Total Poly		
			Red Dissolved Poly		
			Total Bottles	0	

General Sampling Comments

Signature _____