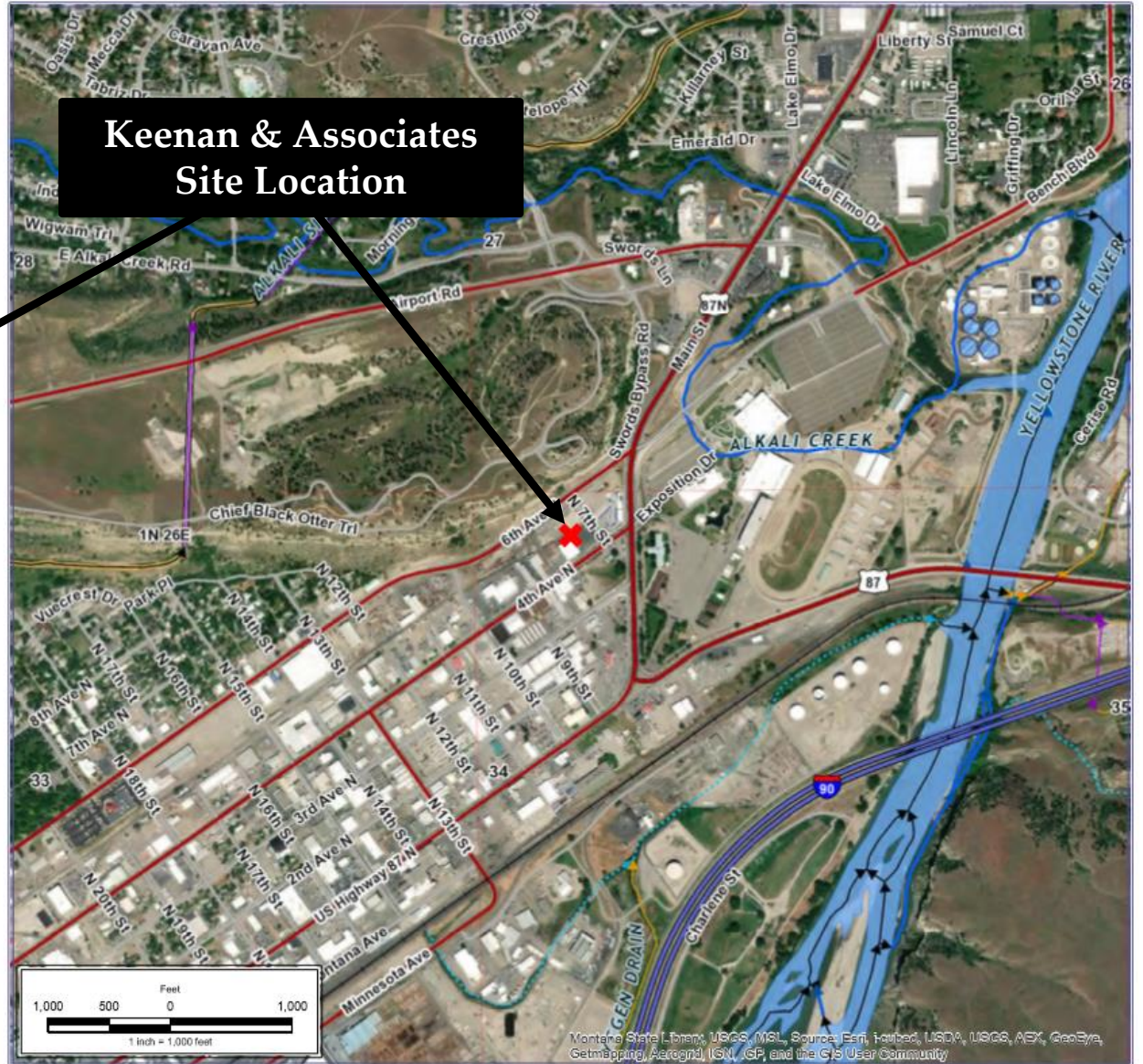
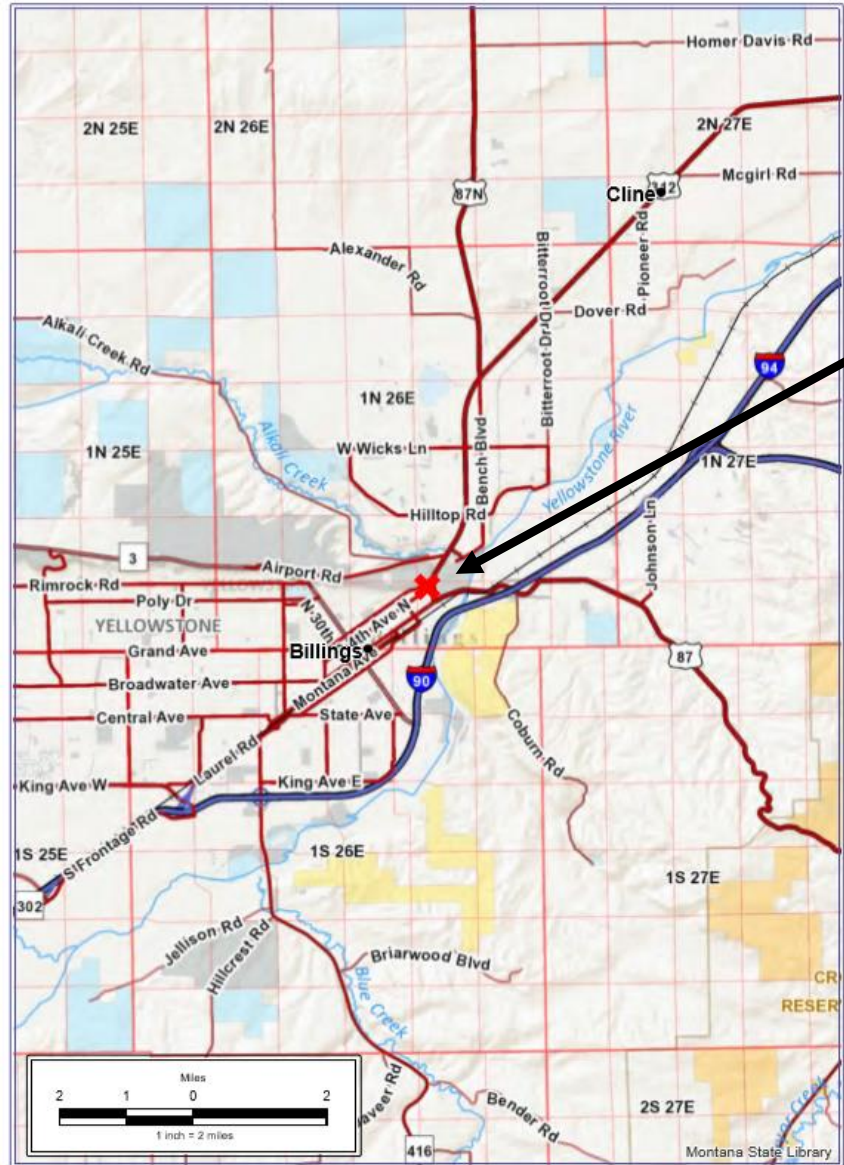


# **Petroleum Release Investigation Using Laser-Induced Fluorescence (LIF) Ultra-Violet Optical Screening Tool (UVOST) Technology**

**FORMER KEENAN & ASSOCIATES  
BILLINGS, MONTANA**





**LEGEND**

**X** SITE LOCATION



**Site Location Maps**

Keenan & Associates  
711 4th Avenue North  
Billings, MT 59101

DRAWN BY: MM  
DATE: 08/26/19  
SCALE: 1:12,000



**FIGURE 1**

PROJECT NUMBER: 19-12543-70

IMAGE SOURCE: ESRI BASEMAPS





**Keenan &  
Associates**



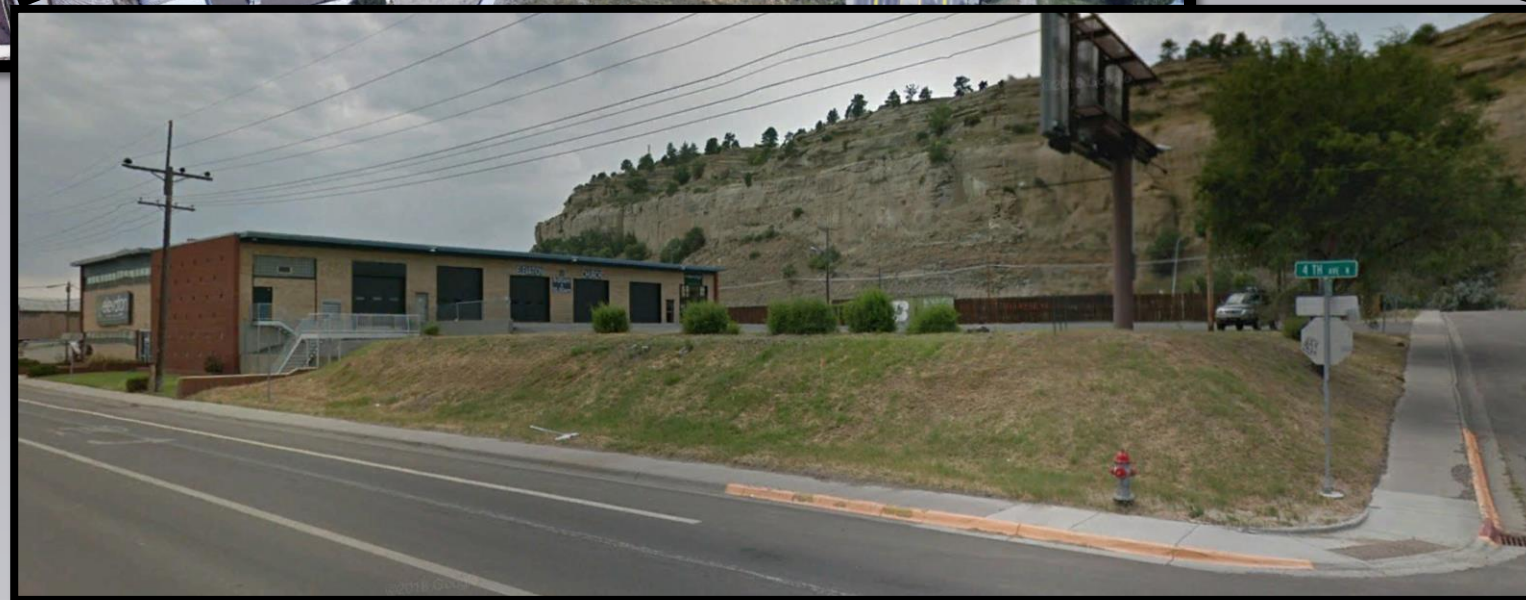




Pacific Hide & Fur

Keenan & Associates

Consolidated Freightways  
Petroleum Release 1094





# Keenan Release Investigation 2015 and 2017

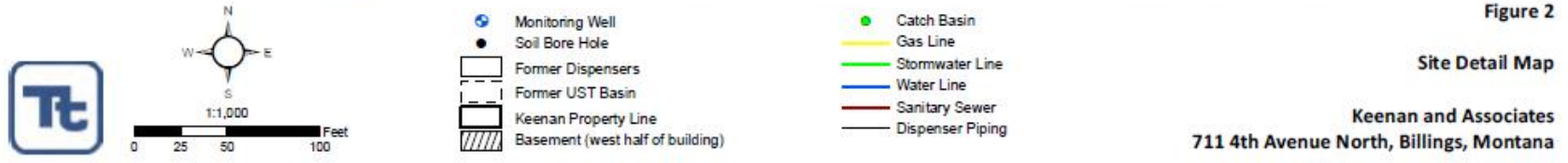
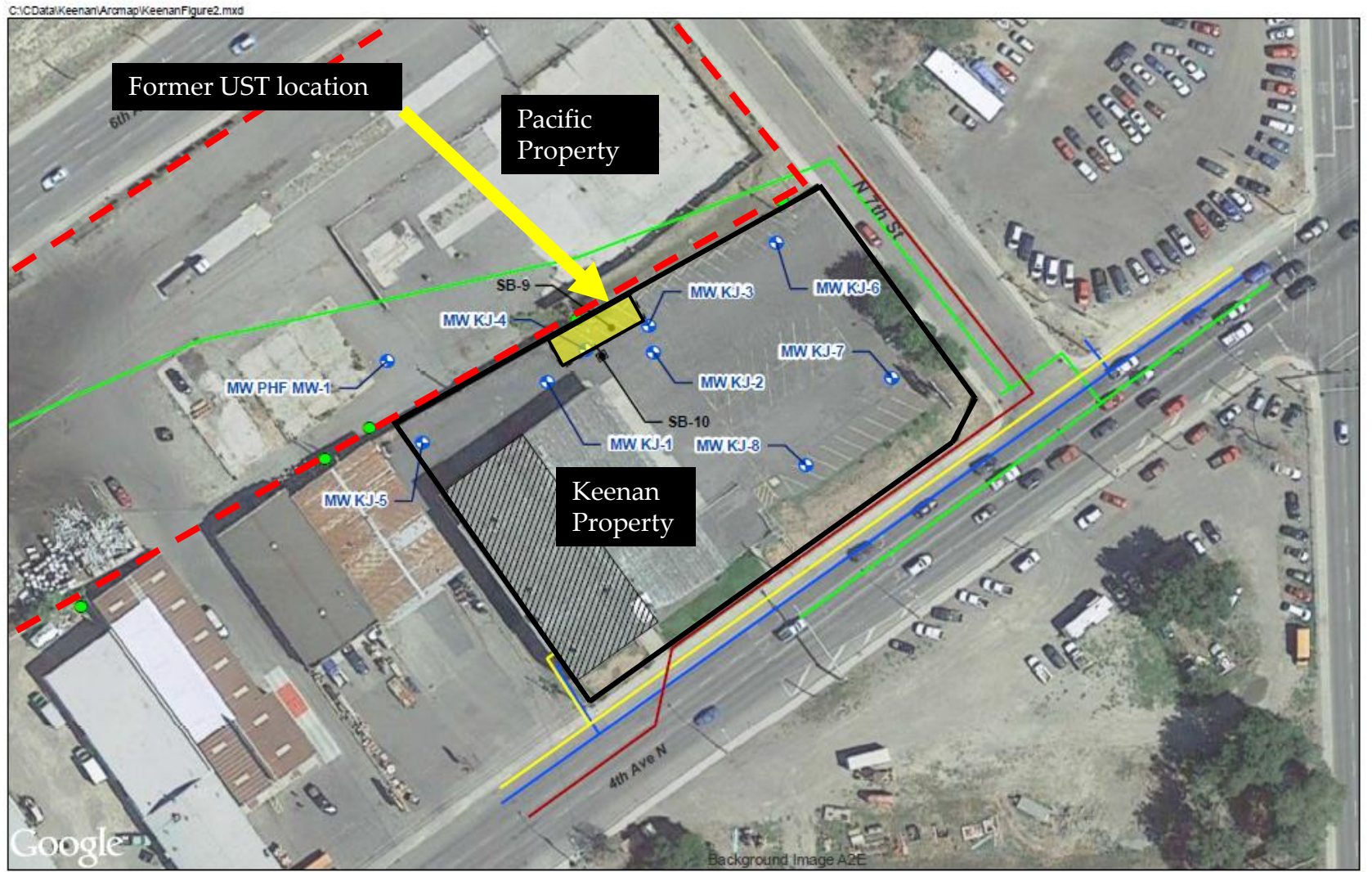


Figure 2

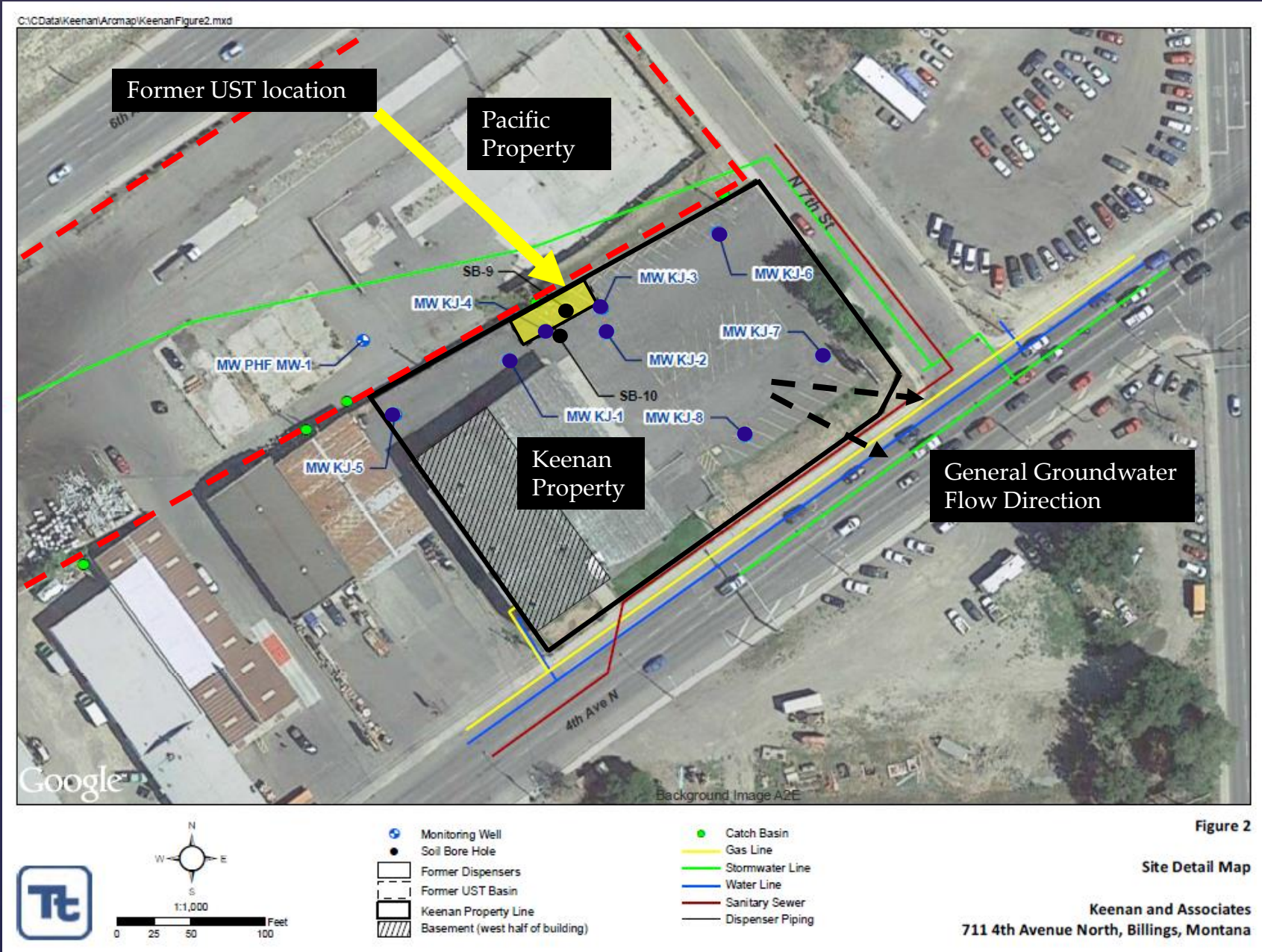
Site Detail Map

Keenan and Associates  
711 4th Avenue North, Billings, Montana



# Keenan Release Investigation 2015 and 2017

10 Soil Borings  
8 Monitoring Wells

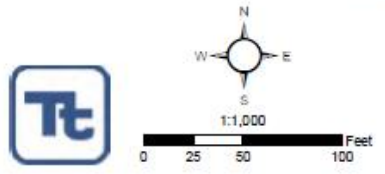
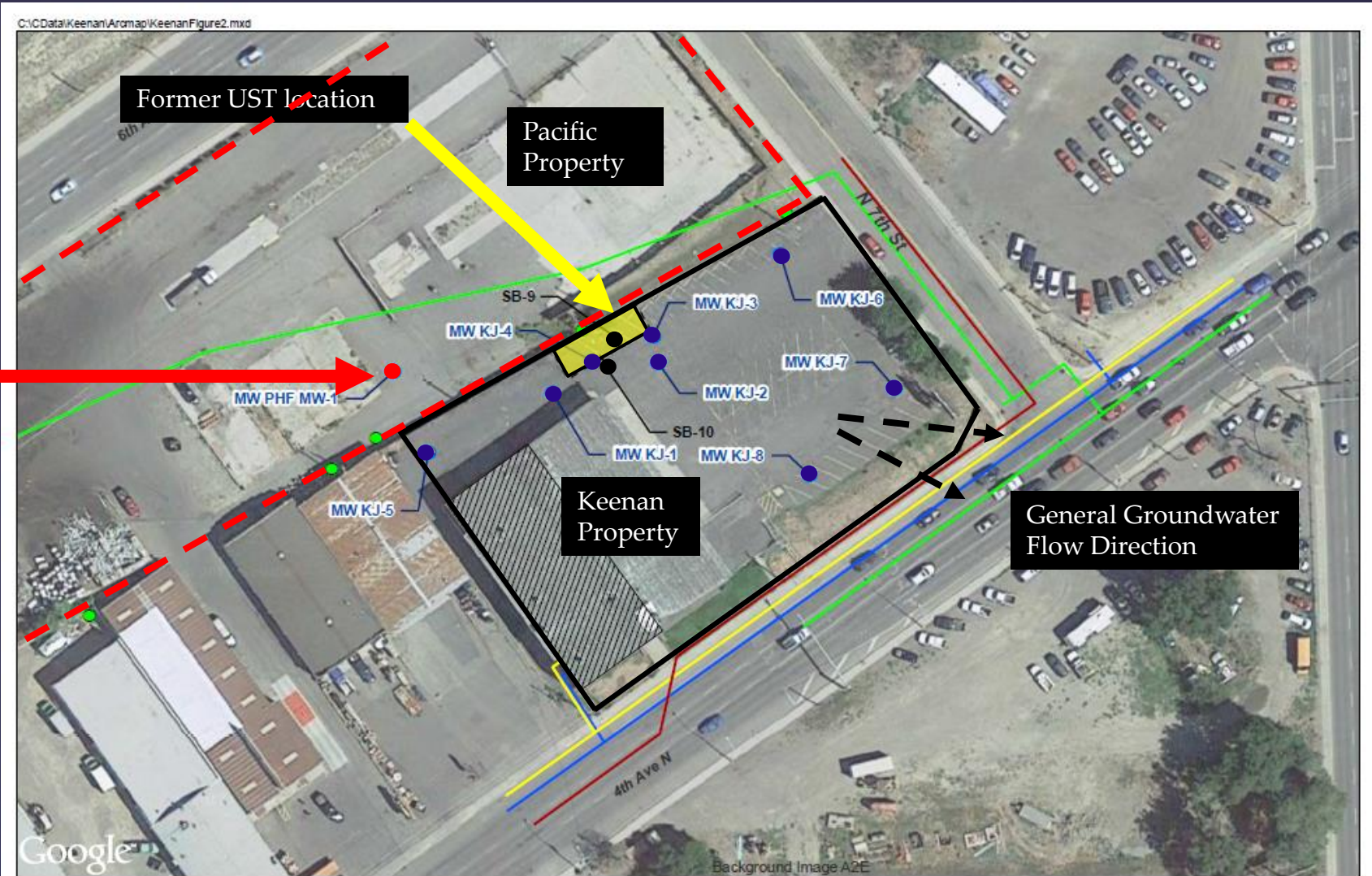




# Keenan Release Investigation 2015 and 2017

Pacific Hide & Fur Well  
PHF MW-1  
Installed 1993

10 Soil Borings  
8 Monitoring Wells



- Monitoring Well
- Soil Bore Hole
- Former Dispensers
- Former UST Basin
- Keenan Property Line
- Basement (west half of building)
- Catch Basin
- Gas Line
- Stormwater Line
- Water Line
- Sanitary Sewer
- Dispenser Piping

Figure 2

Site Detail Map

Keenan and Associates  
711 4th Avenue North, Billings, Montana

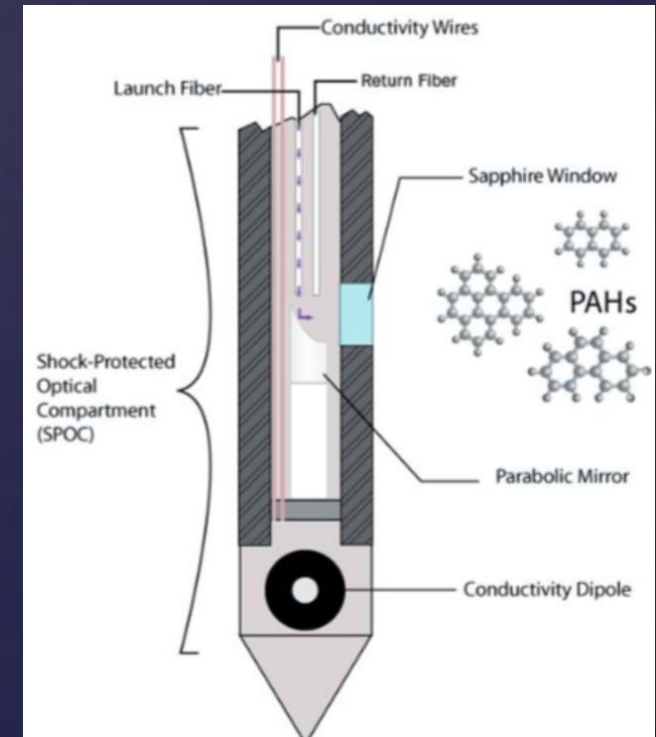
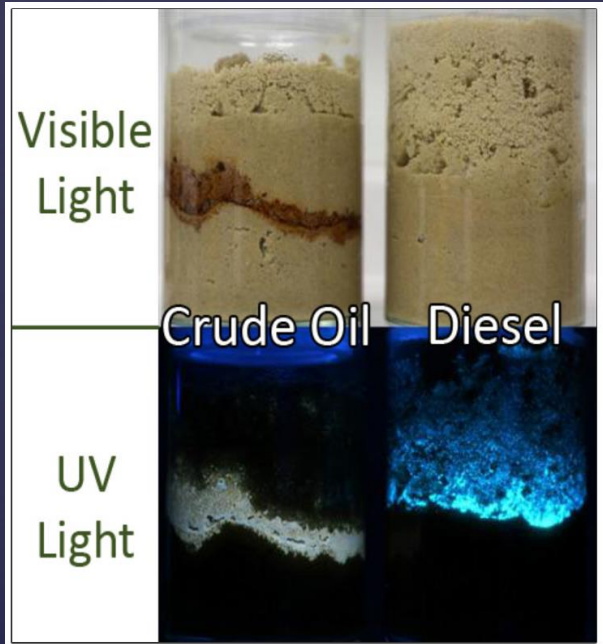
# DEQ July/August 2019 - Petroleum Release Investigation

## Laser-Induced Fluorescence (LIF) Ultra-Violet Optical Screening Tool (UVOST)

### What is LIF?

Polycyclic Aromatic Hydrocarbons (PAHs) fluoresce when hit with a laser emitting ultra-violet light.

The ultra-violet optical screening tool (UVOST) is housed in the end of a direct-push probe.





# LIF Equipment Set Up





49 LIF Borings

LIF-40

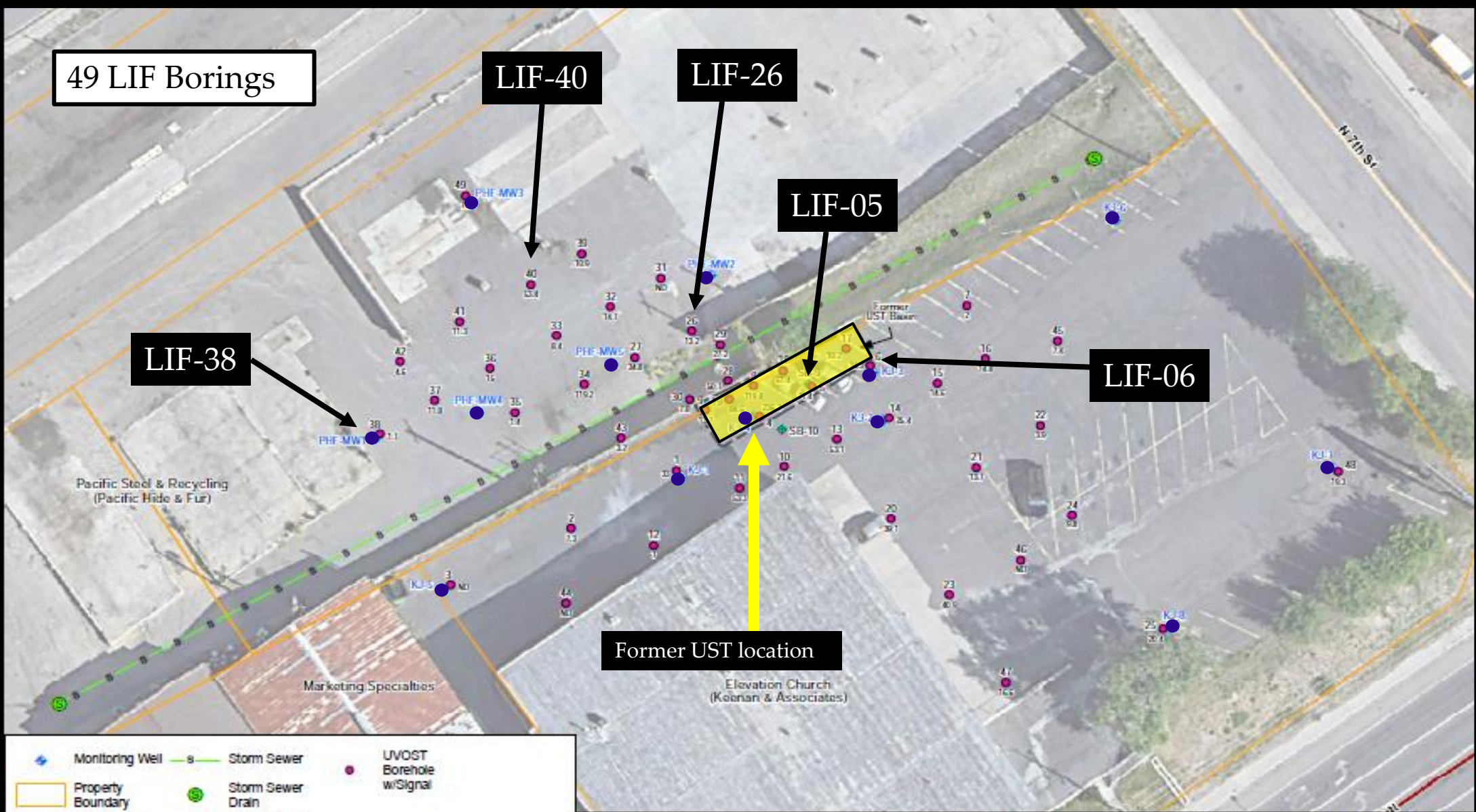
LIF-26

LIF-05

LIF-06

LIF-38

Former UST location



	Monitoring Well		Storm Sewer		UVOST Borehole w/Signal
	Property Boundary		Storm Sewer Drain		
	Former UST Basin		Soil Borehole (2017)		

30 15 0 1:000 = 30' NAD 83

### UVOST Borehole Locations

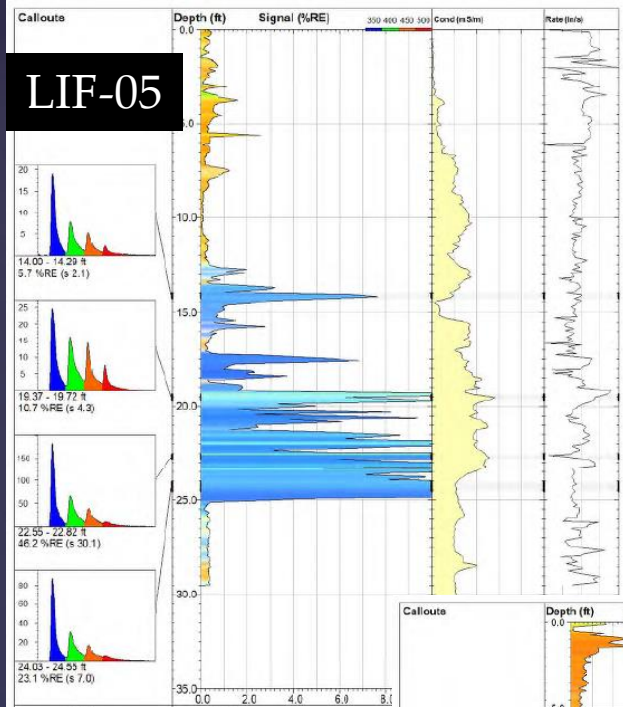
Keenan & Associates  
711 4th Avenue North  
Billings, MT 59101

DRAWN BY: BMM  
DATE: 08/03/19  
SCALE: 1:300

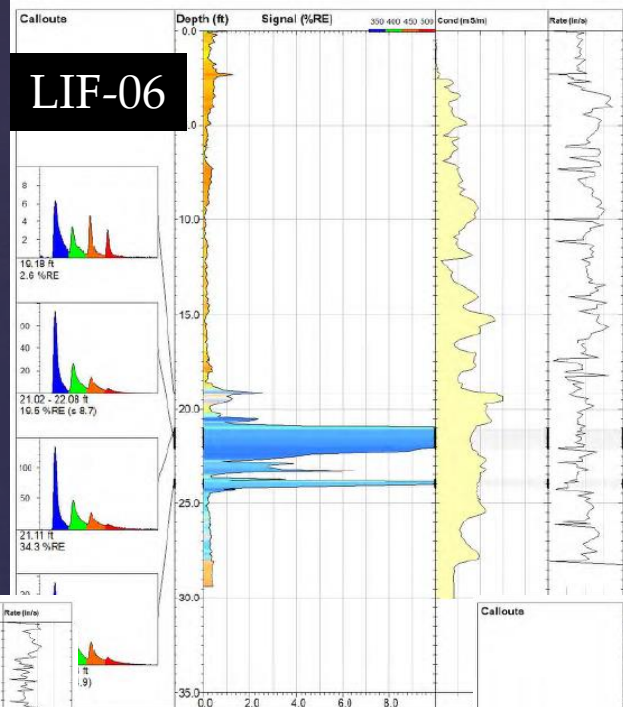


FIGURE 3

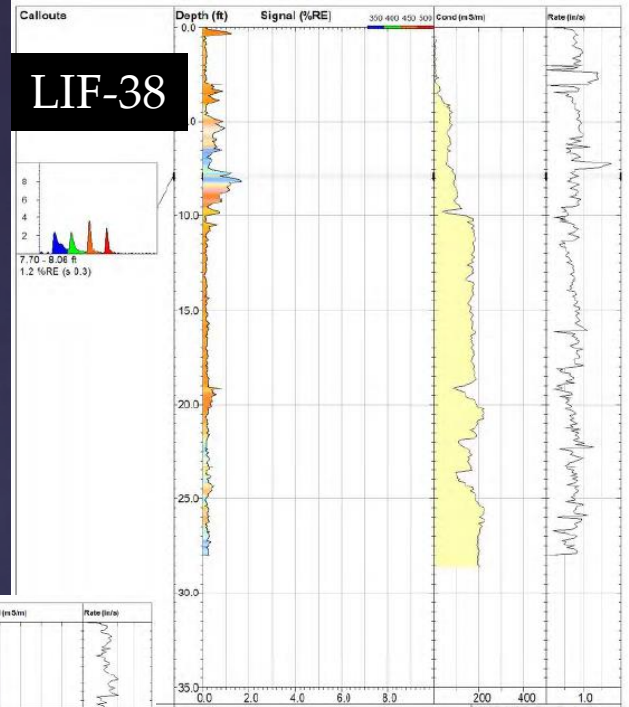




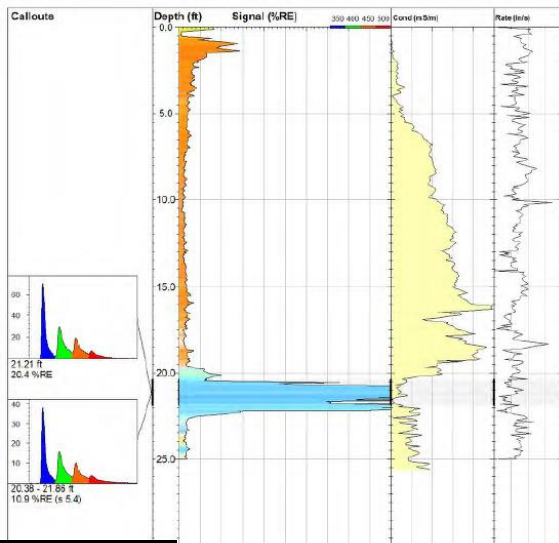
**LIF-05**  
 Site: MTDEQ Keenan & Associates  
 Client / Job: WCEC / 0271.19  
 Operator / Unit: BG/LG / UVOST1612  
 Y Coord (Lat-N) / System: Unavailable / NA  
 X Coord (Long-E) / Fix: Unavailable / NA  
 Elevation: Unavailable



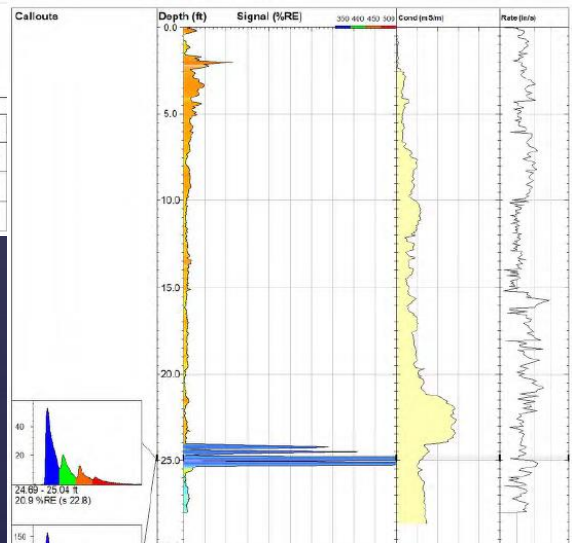
**LIF-06**  
 Site: MTDEQ Keenan & Associates  
 Client / Job: WCEC / 0271.19  
 Operator / Unit: BG/LG / UVOST1612  
 Y Coord (Lat-N) / System: Unavailable / NA  
 X Coord (Long-E) / Fix: Unavailable / NA  
 Elevation: Unavailable



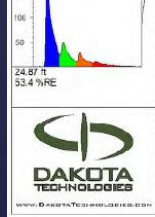
**LIF-38**  
 Site: MTDEQ Keenan & Associates  
 Client / Job: WCEC / 0271.19  
 Operator / Unit: BG/LG / UVOST1612  
 Y Coord (Lat-N) / System: Unavailable / NA  
 X Coord (Long-E) / Fix: Unavailable / NA  
 Elevation: Unavailable  
 Final depth: 28.00 ft  
 Max signal: 1.7%RE @ 8.13 ft  
 Date & Time: 2019-07-31 16:23 CDT



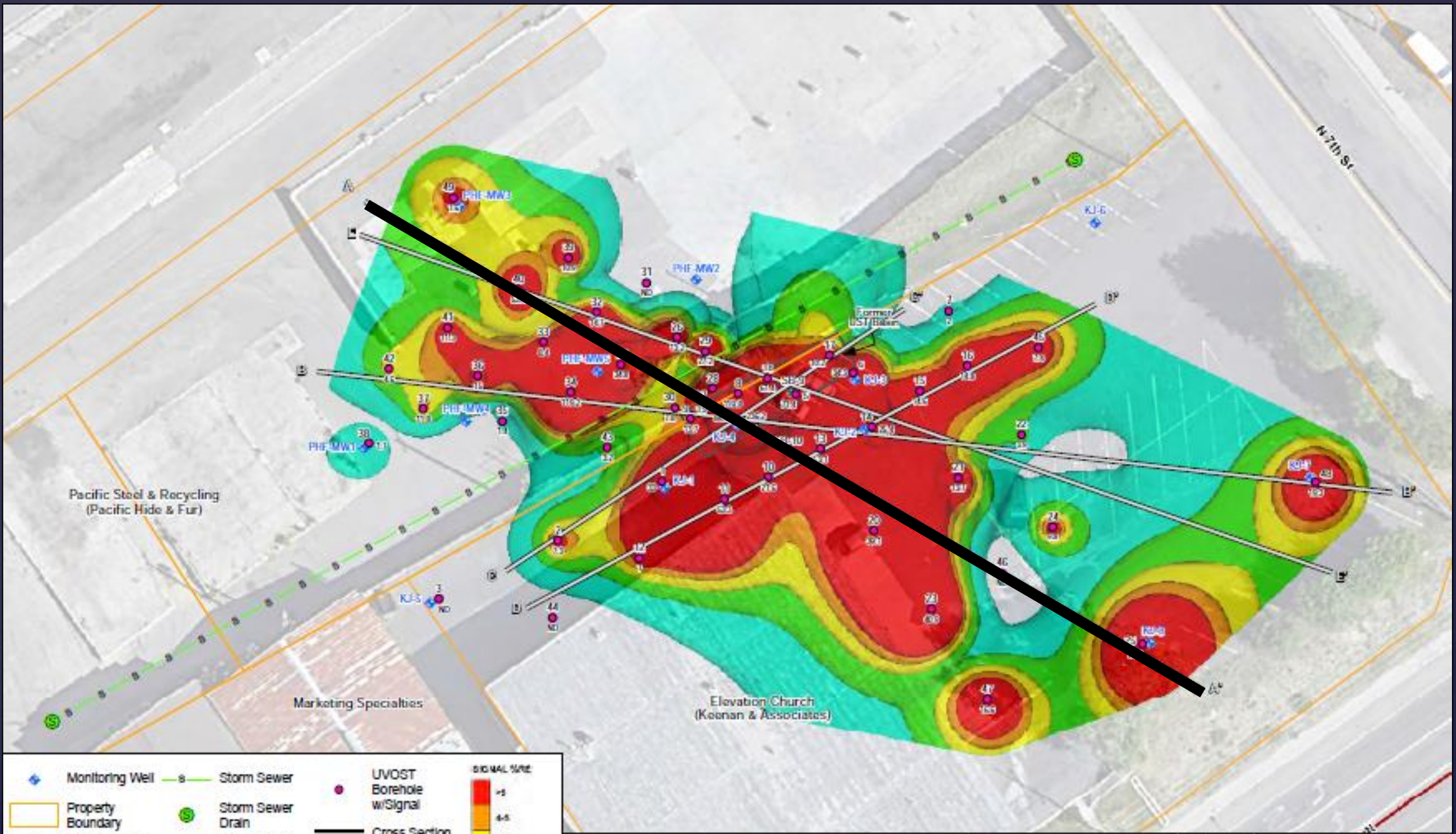
**LIF-26**  
 Site: MTDEQ Keenan & Associates  
 Client / Job: WCEC / 0271.19  
 Operator / Unit: BG/LG / UVOST1612  
 Y Coord (Lat-N) / System: Unavailable / NA  
 X Coord (Long-E) / Fix: Unavailable / NA  
 Elevation: Unavailable  
 Final depth: 25.01 ft  
 Max signal: 20.4%RE @ 21.21 ft  
 Date & Time: 2019-08-01 16:98 CDT



**LIF-40**  
 Site: MTDEQ Keenan & Associates  
 Client / Job: WCEC / 0271.19  
 Operator / Unit: BG/LG / UVOST1612  
 Y Coord (Lat-N) / System: Unavailable / NA  
 X Coord (Long-E) / Fix: Unavailable / NA  
 Elevation: Unavailable  
 Final depth: 28.91 ft  
 Max signal: 53.4%RE @ 24.87 ft  
 Date & Time: 2019-08-01 09:16 CDT







Monitoring Well	Storm Sewer	UVOST Borehole w/Signal	<b>SIGNAL STRENGTH</b>  +5 4-5 3-4 2-3 1-2
Property Boundary	Storm Sewer Drain	Cross Section	
Former UST Basin	Soil Borehole (2017)		

Scale: 1 inch = 30 feet

**3D Top View Overlay with Cross Section Locations**

Keenan & Associates  
 711 4th Avenue North  
 Billings, MT 59101

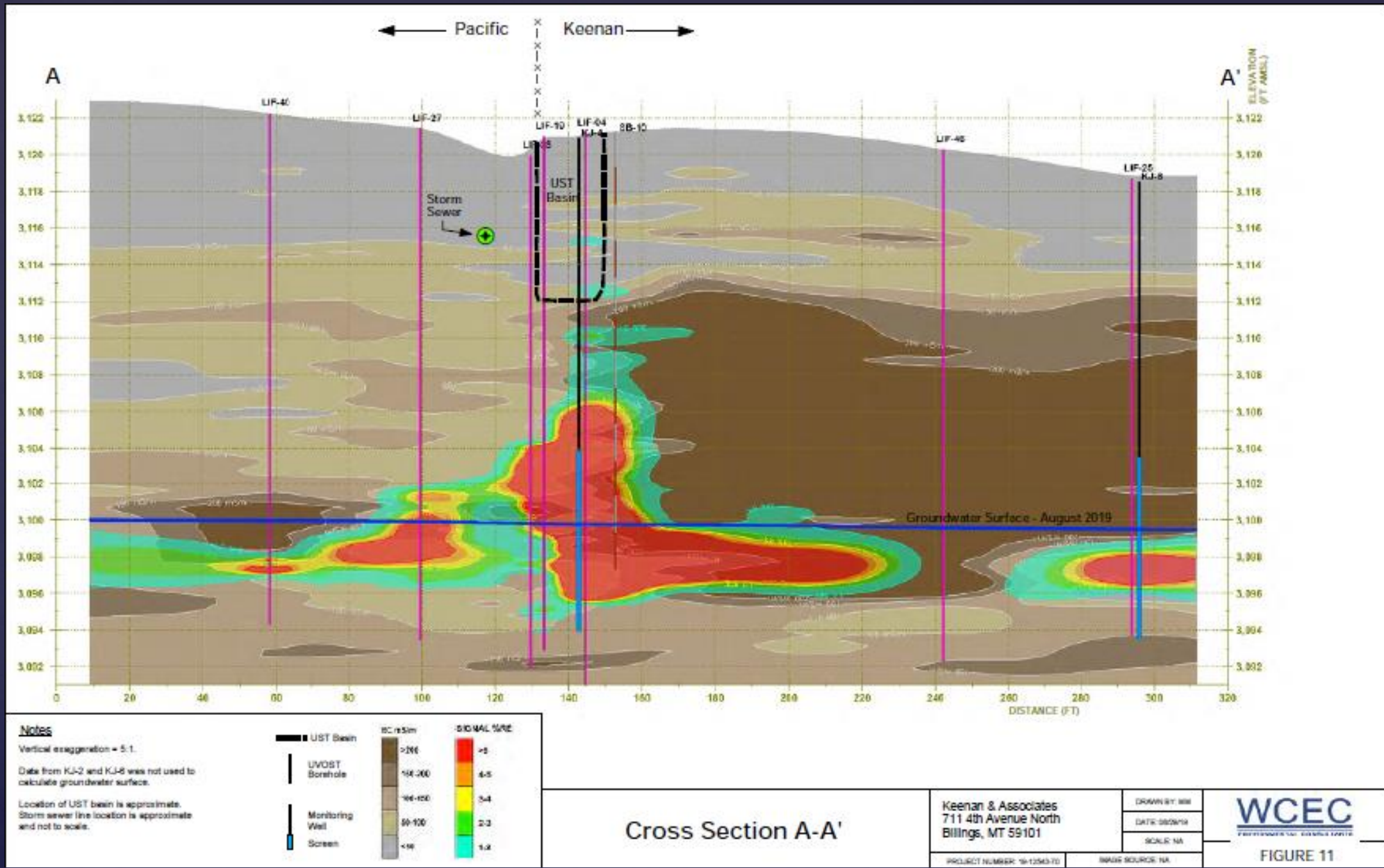
DRAWN BY: MM  
 DATE: 08/05/18  
 SCALE: 1:300

**WCEC**  
 MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY

FIGURE 10







Cross Section A-A'

Keenan & Associates  
 711 4th Avenue North  
 Billings, MT 59101

DRAWN BY: BMM  
 DATE: 08/09/19  
 SCALE: NA

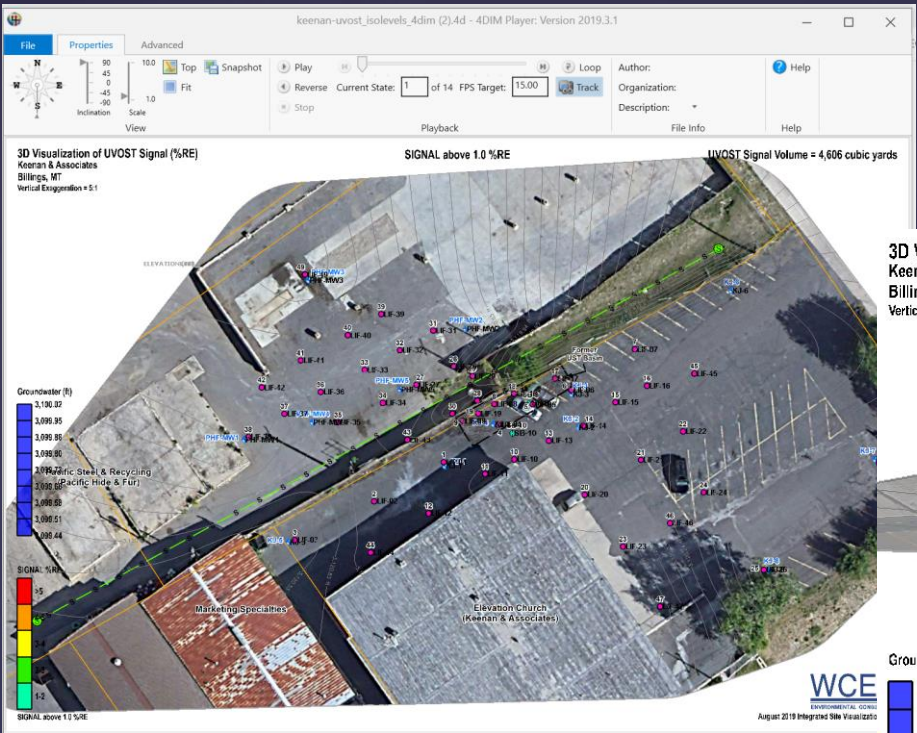


FIGURE 11

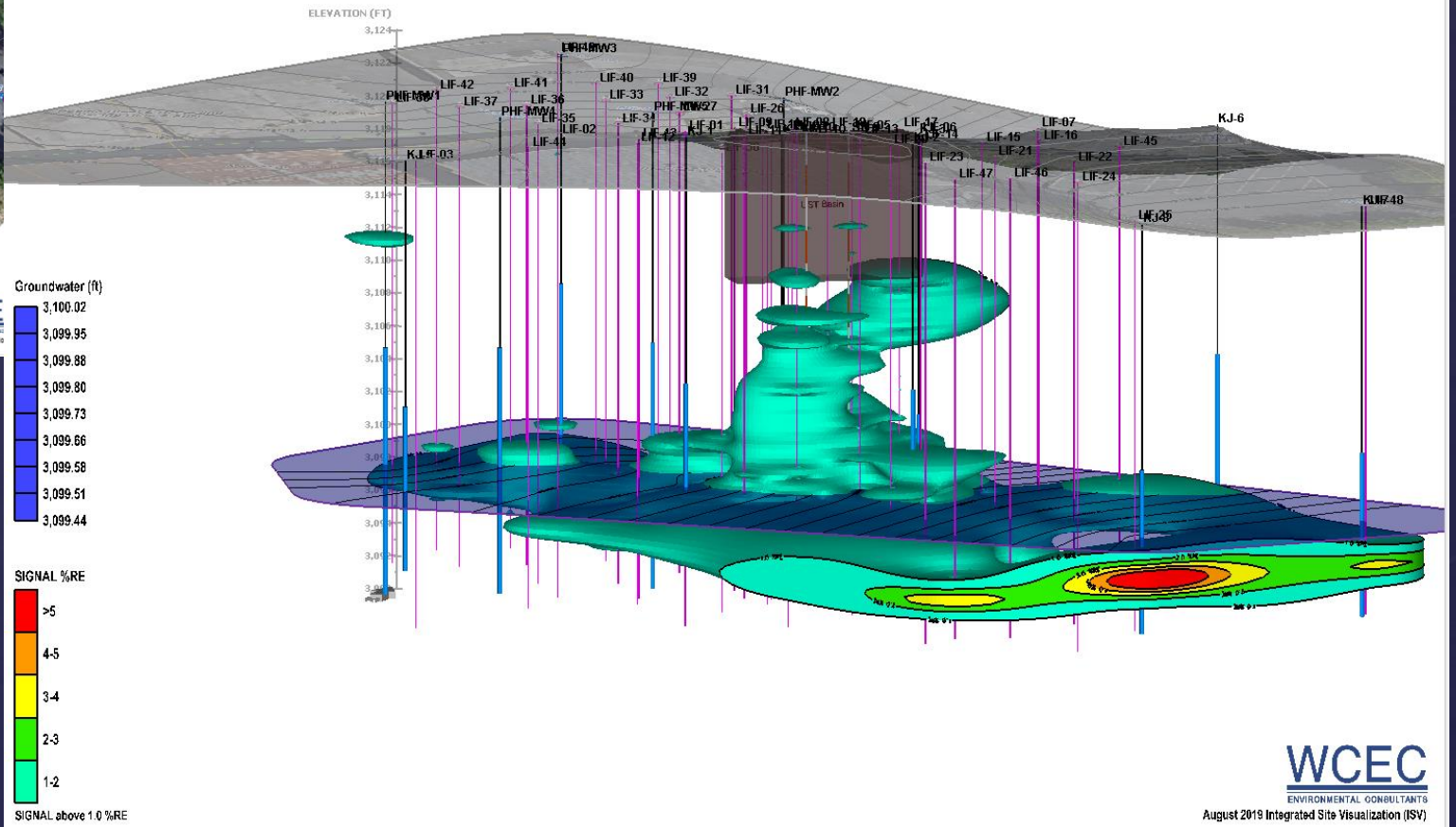
PROJECT NUMBER: 19-12543-10

IMAGE SOURCE: NA





3D Visualization of UVOST Signal (%RE)  
Keenan & Associates  
Billings, MT  
Vertical Exaggeration = 5:1



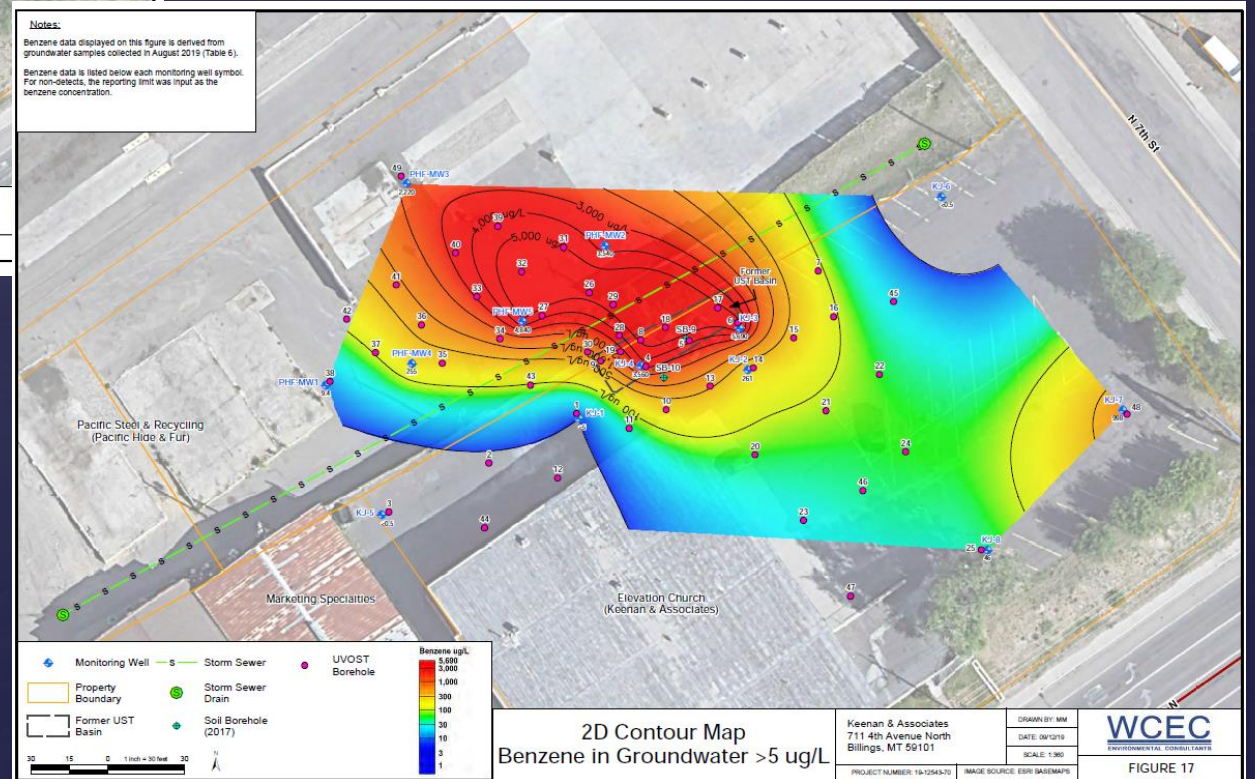
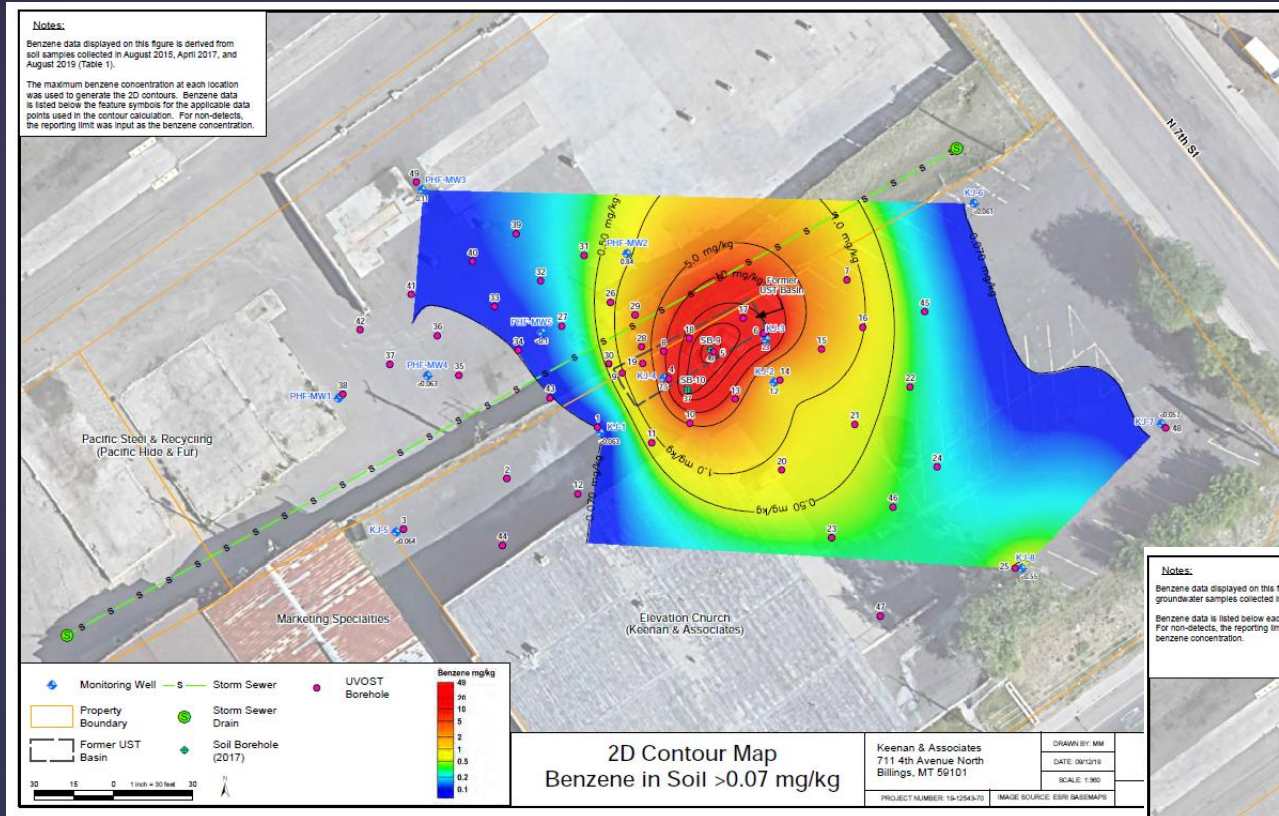
WCEC  
ENVIRONMENTAL CONSULTANTS  
August 2019 Integrated Site Visualization (ISV)



# Benzene Concentrations



Soil Sample Results  
From 14 Borings



Groundwater Sample Results  
From 13 Wells



# Discussion of Results

- LIF UVOST Investigation:
  - A good screening tool for making field decisions.
    - Soil borings and monitoring well locations.
    - Delineating a release area.
  - Assists in identifying petroleum release sources, migration pathways and/or cleanup strategies.
- For the Keenan release - Additional investigation needed:
  - Completely define impacts upgradient and downgradient.
  - Identify other sources.



# Questions?

Further information on LIF:

LUST Line article, Paul Stock , MN, June 2011:

[http://www.neiwpcc.org/lustline/lustline\\_pdf/lustline\\_68.pdf](http://www.neiwpcc.org/lustline/lustline_pdf/lustline_68.pdf)

Clu-In: Article by Dakota Technologies, Randy St. Germain

<https://clu-in.org/characterization/technologies/lif.cfm>