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RECEIVED

8:54 am, Sep 12, 2011
Alameda County
Environmental Health

September 9, 2011

Mr. Jerry Wickham
Hazardous Materials Specialist
Alameda County Environmental Health
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502-6577

**Subject: Work Plan for ISCO Pilot Test
1619 1st Street, Livermore, California
Tesoro No. 67076 (Former Beacon 3604); ACEH Case No. RO0434**

Dear Mr. Wickham:

Enclosed please find a copy of the work plan for an ISCO pilot test for the subject site located at 1619 1st Street in Livermore, California. This report is submitted by Arctos Environmental on behalf of Tesoro Environmental Resources Company.

Based on my inquiry of the person or persons directly responsible for gathering the information contained in this report, I believe the information was prepared by qualified personnel who properly gathered and evaluated the information, and that the information submitted is, to the best of my knowledge and belief, true, correct, and complete. Please feel free to call me at 253/896-8700 or Matthew Nelson of Arctos Environmental at 562/988-2755 with questions.

Sincerely,

A handwritten signature in blue ink that reads "Jeffrey M. Baker".

Jeffrey M. Baker, P.E.
Supervisor, Environmental
Compliance & Remediation
Tesoro Companies, Inc.

Attachments

CC: Arctos – Matthew Nelson



Arctos Environmental
1332 Peralta Avenue 510 525-2180 PHONE
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9 September 2011
Project No. 01LV

Jerry Wickham
Hazardous Materials Specialist
Alameda County Environmental Health
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502-6577

**Subject: Work Plan for ISCO Pilot Test
1619 1st Street, Livermore, California
Tesoro No. 67076 (Former Beacon 3604); ACEH Case No. RO0000434**

Dear Mr. Wickham:

Arctos Environmental (Arctos), on behalf of Tesoro Environmental Resources Company (Tesoro), is submitting this work plan for a proposed pilot test to monitor and evaluate the effects of in situ chemical oxidation (ISCO) at the subject site (Figure 1).

Executive Summary

In January 2011, Arctos performed a membrane interface probe (MIP) investigation to assess the lateral and vertical extent of free product detected in injection well IP-8 in October 2010. The highest impacts were generally encountered between 55 and 70 feet below grade, located near injection well IP-9 at the southwest corner of the underground storage tanks (USTs). Based on the investigation results, Arctos is proposing a pilot test injection of RegenOx™, an ISCO technology developed by Regenesi Bioremediation Products, Inc. (Regenesi), of San Clemente, California, in injection well IP-9.

Arctos will conduct up to three injection events with associated groundwater extraction events following each injection. This will maximize mass removal and take advantage of the desorption effects of RegenOx™ solutions. Results of the injection and extraction events will be monitored in the surrounding wells throughout the pilot test.

Site Background

The site description and background are included in Arctos's Interim Remedial Action Plan (IRAP) dated 21 March 2008 (Arctos, 2008).

Objective and Scope of Work

The objective of the planned activities is to evaluate the effectiveness of the RegenOx™ ISCO technology in remediating petroleum hydrocarbons in the source area identified during the MIPs investigation. To meet this objective, Arctos will perform the following scope of work:

- Obtain Alameda County Environmental Health approval of this work plan
- Obtain a sanitary sewer discharge permit from the City of Livermore
- Shut down oxygen injection in the pilot test area (wells IP-1 and IP-8 through IP-10)
- Collect baseline groundwater samples
- Inject RegenOx™ solutions into injection well IP-9
- Collect post-injection groundwater samples from six wells approximately 2 weeks after injection
- Extract groundwater from well IP-9, treat using liquid-phase granular activated carbon (GAC), and discharge to the sanitary sewer
- Repeat injection and extraction for up to 3 events based on groundwater monitoring results
- Conduct final performance monitoring
- Evaluate the pilot test results and prepare a summary report.

Pilot Test Design

RegenOx™ is an ISCO technology developed by Regenesis that includes a two-phase injection process involving a solid oxidant complex (sodium percarbonate) and an activator complex. The published benefits of RegenOx™ include subsurface longevity

ranging from weeks to months and a relatively low increase in groundwater temperature due to the oxidation reaction (Regenesis, 2007).

Arctos will combine each RegenOx™ component with water to form separate 5 percent concentration solutions. The activator complex will be injected first at approximately 4 gallons per minute (gpm) into injection well IP-9 (Figures 2 and 3). Approximately five casing volumes of clean water will then be injected to flush the well casing and surrounding well pack. The oxidant complex will be injected next at a rate of approximately 4 gpm followed by another clean water injection to flush the casing and well pack. The following table summarizes the pilot test design parameters for IP-9 based on existing soil and groundwater data in the area.

Design Parameters	Units	Value
Assumed radius of influence	feet (ft)	10
Assumed saturated thickness affected by injection well	ft	10
Assumed porosity	percent	30
Volume of water within treatment zone	gallons	7,050
Mass of total petroleum hydrocarbons as gasoline (TPHg) in groundwater	pounds (lbs)	5.4
Mass of TPHg in soil	lbs	753
Total TPHg mass within treatment zone	lbs	758
RegenOx™ mass required (assumes 20 lbs RegenOx™ to 1 lb TPHg)*	lbs	15,170
Proposed mass of RegenOx™ (oxidant complex) per injection	lbs	900
Proposed total mass of RegenOx™ for pilot test (assumes three injections)	lbs	2,700

Note – The estimated oxidant requirement does not include natural soil oxidant demand.

RegenOx™ is similar to other ISCO technologies in that only the soluble portion of the petroleum hydrocarbons will be remediated by the oxidation reaction. However, due to its surfactant properties, RegenOx™ will also desorb additional hydrocarbon mass from the soil matrix, resulting in dissolved-phase hydrocarbon rebound following an injection event. Within the soil and groundwater column of the estimated treatment zone, approximately 99 percent of the hydrocarbon mass is sorbed onto soil, so a relatively high spike in groundwater hydrocarbon concentrations is expected. Arctos will capture this mass by extracting groundwater from well IP-9 approximately 2 weeks after oxidant injection, treating it with GAC vessels, and discharging the treated water into the sanitary

sewer under a permit from the City of Livermore. Arctos will conduct up to three injection and groundwater extraction events based on the monitoring results.

Monitoring and Analytical Program

The effects of RegenOx™ will be monitored at the following wells to (1) measure the change in petroleum hydrocarbon concentrations, (2) measure the general groundwater quality and compare to background values, and (3) track the changes in groundwater quality with time and observe for the reduction/rebound in petroleum hydrocarbon concentrations:

- Background (Upgradient) Well: Injection well IP-10 (24 ft southeast)
- Injection Well: Injection well IP-9
- Cross Gradient Wells: Injection well IP-8 (15 ft north-northwest)
Injection well IP-1 (34 ft north-northwest)
- Downgradient Wells: Monitoring well MW-11 (6 ft northwest)
Monitoring well DW-8 (26 ft northwest)

Groundwater monitoring will be conducted at the injection well and 5 monitoring locations before and during the pilot test. Before the application of RegenOx™, a monitoring event will be conducted to determine the baseline groundwater conditions. Groundwater samples will be collected following the procedures in the approved IRAP and analyzed for the following parameters:

- Field parameters including pH, temperature, conductivity, dissolved oxygen (DO), and oxidation reduction potential (ORP)
- TPHg, benzene, toluene, ethylbenzene, and xylenes (BTEX), and oxygenates including methyl tert-butyl ether (MTBE), di-isopropyl ether (DIPE), ethyl tert-butyl ether (ETBE), tert-amyl methyl ether (TAME), and tert-butyl alcohol (TBA) by Environmental Protection Agency (EPA) Method 8260B
- Water quality parameters including ferrous iron, total iron, methane, total dissolved solids (TDS), nitrate, sulfate, sodium, carbon dioxide, manganese, total chromium, hexavalent chromium, arsenic, and alkalinity.

Arctos will monitor DO and ORP weekly following the initial injection and until 2 weeks after the final injection. DO and ORP will then be monitored as part of monthly oxygen

system monitoring. Performance monitoring will occur 2 weeks after each injection, before the groundwater extraction events, and quarterly thereafter. The following table summarizes the parameters and sampling frequency during monitoring to assess the effectiveness of the pilot test.

Monitoring Wells	Sampling Frequency	Parameter
MW-11, DW-8, IP-1, IP-8, IP-9, and IP-10	Baseline and weekly until 2 weeks after last groundwater extraction event and monthly thereafter	Temperature, conductivity, pH, DO, and ORP
	Baseline, 2 weeks after each injection, and quarterly thereafter	Temperature, conductivity, pH, DO, and ORP
		Dissolved petroleum hydrocarbons including TPHg, BTEX, MTBE, and TBA
		Water quality parameters

A summary report will be submitted to Alameda County Environmental Health (ACEH) after completing the ISCO pilot test. The summary report will include the following:

- Evaluation of the monitoring results
- Estimate of mass removed for both oxidant injected and groundwater extracted
- Recommendations for a continued monitoring schedule and analytical list.

Schedule

Arctos is requesting approval to conduct the RegenOx™ injection pilot test starting in September 2011. The pilot test will be completed by the end of the year.

Jerry Wickham
Alameda County Environmental Health
9 September 2011
Page 6



If you have any questions or comments, please call Mike Purchase at 510/525-2180 or Matthew Nelson at 562/988-2755.

Very truly yours,

ARCTOS ENVIRONMENTAL

A handwritten signature in black ink, appearing to read "Matt Nelson".

Matthew Nelson, P.E.
Project Engineer



A handwritten signature in black ink, appearing to read "Michael P. Purchase".

Michael P. Purchase, P.E.
Senior Project Manager

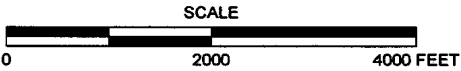
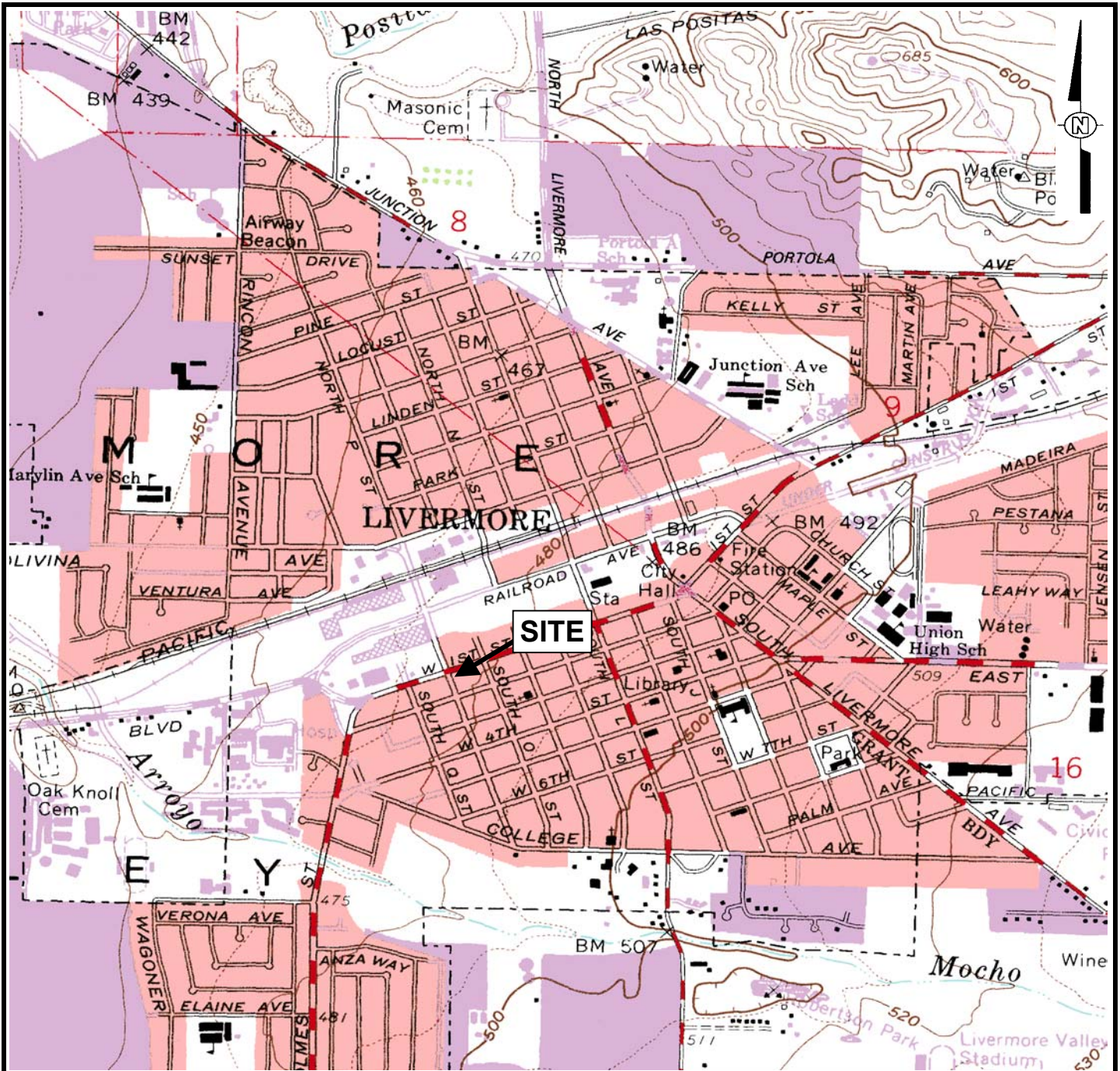
Copy: Jeffrey M. Baker, P.E. – Tesoro Companies, Inc.
Colleen Winey – Zone 7 Water Agency

Attachments: Figure 1 – Site Location Map
Figure 2 – Site Plan
Figure 3 – Geologic Cross Section A-A'

References

Arctos Environmental, 2008. *Interim Remedial Action Plan for Groundwater, 1619 1st Street, Livermore, California, Tesoro Station No. 67076, Former Beacon Station No. 3604, ACEH Case No. RO0434*, 21 March.

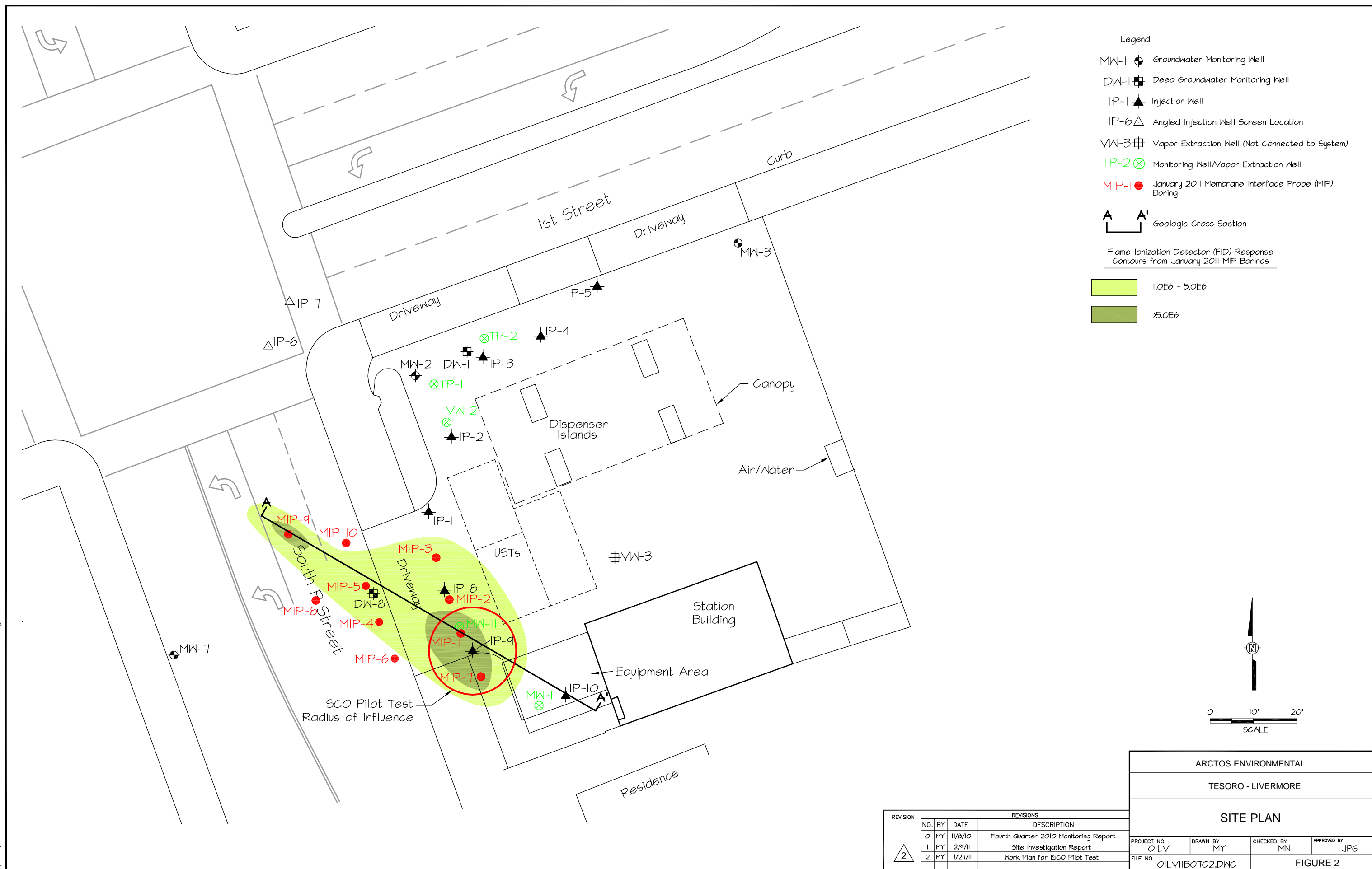
Regenesi Bioremediation Products, 2007. *Principles of Chemical Oxidation Technology for the Remediation of Groundwater and Soil: RegenOx™ Design and Application Manual*, 7 April.



REFERENCE
 7.5 MINUTE USGS TOPOGRAPHIC MAP OF
 LIVERMORE, CALIFORNIA QUADRANGLE
 DATE: 1961, PHOTOREVISED 1980
 SCALE = 1:24,000

ARCTOS ENVIRONMENTAL			
TESORO - LIVERMORE			
SITE LOCATION MAP			
PROJECT NO. 01LV	DRAWN BY MP	CHECKED BY MP	APPROVED BY JG
FILE NO. Site Map.xls		FIGURE 1	

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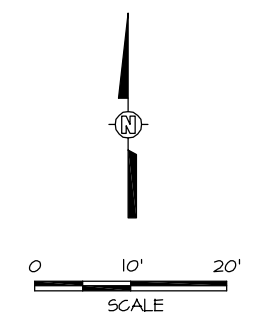


Legend

- MW-1 Groundwater Monitoring Well
- DW-1 Deep Groundwater Monitoring Well
- IP-1 Injection Well
- IP-6 Angled Injection Well Screen Location
- VW-3 Vapor Extraction Well (Not Connected to System)
- TP-2 Monitoring Well/Vapor Extraction Well
- MIP-1 January 2011 Membrane Interface Probe (MIP) Boring
- A A' Geologic Cross Section

Flame Ionization Detector (FID) Response Contours from January 2011 MIP Borings

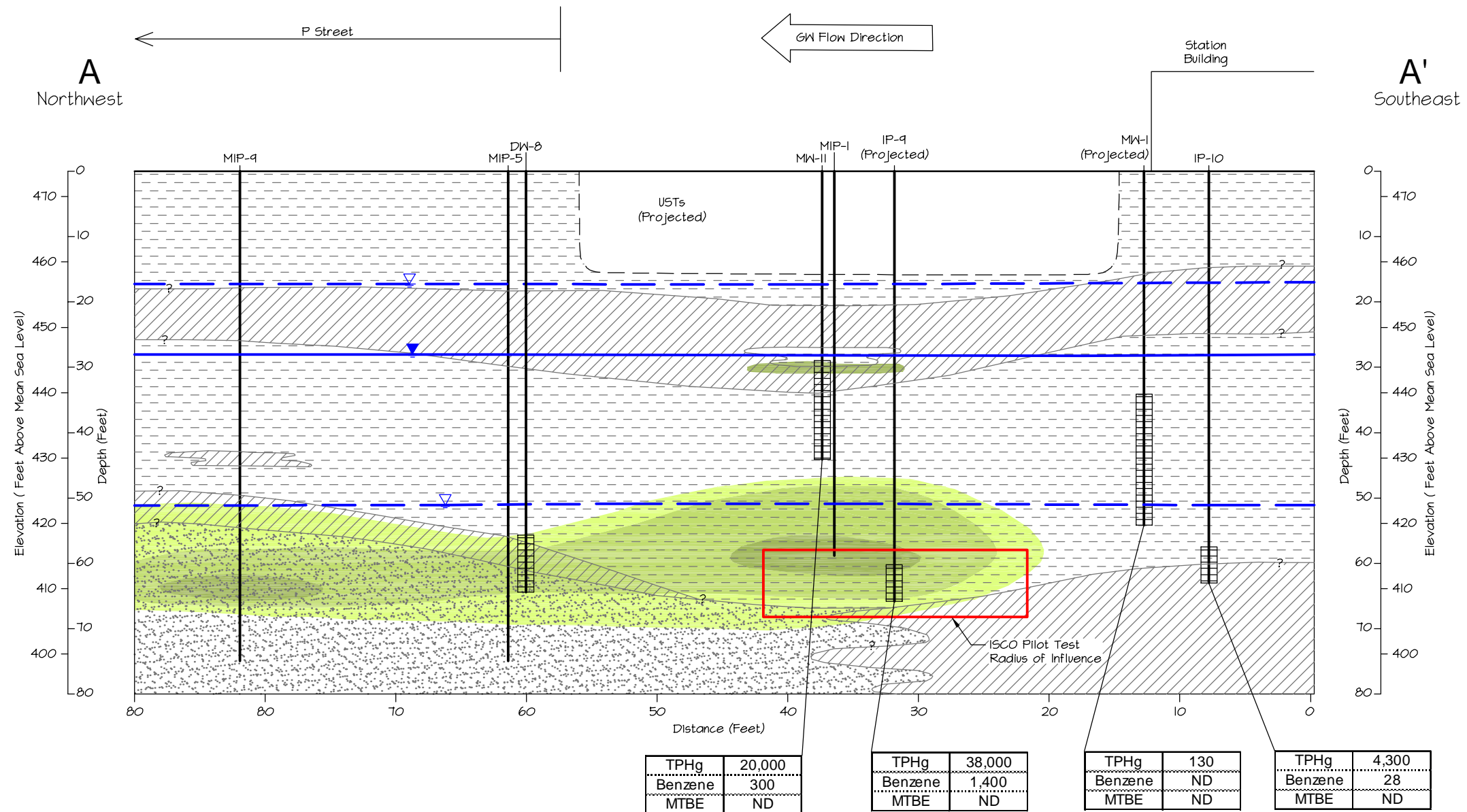
- $1.0E6 - 5.0E6$
- $>5.0E6$



REVISION	REVISIONS			
	NO.	BY	DATE	DESCRIPTION
2	0	MY	11/8/10	Fourth quarter 2010 Monitoring Report
	1	MY	2/9/11	Site Investigation Report
	2	MY	7/27/11	Work Plan for ISCO Pilot Test

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TESORO - LIVERMORE			
SITE PLAN			
PROJECT NO. OILV	DRAWN BY MY	CHECKED BY MN	APPROVED BY JPG
FILE NO. O1LV11B0702.DWG		FIGURE 2	

8/3/2011 10:12AM 01LV11B0801.dwg



TPHg	20,000	TPHg	38,000	TPHg	130	TPHg	4,300
Benzene	300	Benzene	1,400	Benzene	ND	Benzene	28
MTBE	ND	MTBE	ND	MTBE	ND	MTBE	ND

Legend

Soil Classification

- Silts and Clays
- Sands and Silty Sands
- Cemented Sands or Silts
- Well or Boring Identification

Screened Interval

Groundwater Elevation at MW-1 on 25 April 2011

Historic High Groundwater Elevation at MW-1 (21 March 1996) and Historic Low Groundwater Elevation at MW-1 (4 August 2009)

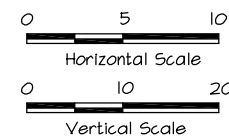
Groundwater Results From April 2011

TPHg	20,000	Total Petroleum Hydrocarbons as Gasoline ($\mu\text{g/l}$)
Benzene	300	Benzene ($\mu\text{g/l}$)
MTBE	ND	Methyl Tert-Butyl Ether ($\mu\text{g/l}$)

ND Not Detected at Reporting Limit

Flame Ionization Detector (FID) Response Contours From January 2011 Membrane Interface Probe (MIP) Borings

- $1.0\text{E}6 - 3.0\text{E}6$
- $3.0\text{E}6 - 5.0\text{E}6$
- $>5.0\text{E}6$



REVISION	REVISIONS			
	NO.	BY	DATE	DESCRIPTION
0	MY	2/10/11	Site Investigation Report	
1	MY	1/27/11	Work Plan for ISCO Pilot Test	

ARCTOS ENVIRONMENTAL			
TESORO - LIVERMORE			
GEOLOGIC CROSS SECTION A-A'			
PROJECT NO. OILV	DRAWN BY MY	CHECKED BY MN	APPROVED BY JPG
FILE NO. OILV11B0801.DWG		FIGURE 3	