Matthew M. Carroll, PE
&
TENEN ENVIRONMENTAL
121 West 27th Street, 702
New York, NY 10001
(646) 606-2332

April 24, 2019

Sondra Martinkat, Environmental Engineer 2
Division of Environmental Remediation
NYS Department of Environmental Conservation
47-40 21st Street, Long Island City, NY 11101

Re: In-Situ Chemical Oxidation Design Document
JS Cleaners – Rochdale Village
165-50 Baisley Boulevard, Jamaica, Queens, NY
BCP Site #C241165
Block 12495, Lot 2 (portion)

Dear Sondra:

In accordance with the approved March 2019 Remedial Action Work Plan (RAWP) prepared by Matthew M. Carroll, PE and Tenen Environmental, LLC (Tenen), the proposed remedy includes the completion of a pilot test to evaluate the potential full-scale use of in-situ chemical oxidation (ISCO) technology. Implementation of ISCO involves introducing oxidants into the subsurface via injection in order to break down contaminants into less toxic compounds. A pilot test was completed in order to determine the type and dosing of the oxidant to treat chlorinated volatile organic compounds (cVOCs), namely tetrachloroethene (PCE).

Background
As documented in Tenen's Remedial Investigation Report (RIR), PCE was detected in the groundwater above the Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations – Class GA (Class GA Standard) of 5 micrograms per liter (ug/L). PCE was detected at a maximum concentration of 860 ug/L in the shallow on-site well, JS-GW-1, located adjacent to the former dry cleaning equipment. This location corresponds with the location of the highest PCE concentrations in soil. PCE concentrations in groundwater are shown in Figure 1.

ISCO Pilot Test
The pilot test was completed in August 2018 and included one round of sampling at the Site. A soil boring was advanced in an area adjacent to JS-GW-1, installed as part of Tenen's Remedial Investigation (RI), and located adjacent to the former location of dry cleaning equipment. The soil boring was advanced utilizing a hand-held 420M Geoprobe® unit. The boring was advanced to the groundwater interface, located at approximately 12.5 feet below grade (ft-bg). One soil sample was collected from acetate liners through macrocores.

One soil sample, JS-01-SOD (10-12), was collected on August 7, 2018, from the interval of ten to twelve ft-bg. The sample consisted of three jars, which were homogenized prior to testing. The soil sample was analyzed for soil oxidant demand (SOD) by PRIMA Environmental, Inc. of El Dorado Hills, California. In addition to measuring SOD, the soil sample was analyzed to estimate the amount of potassium permanganate needed to treat one cubic meter of saturated soil based on the measured SOD and PCE data provided by Tenen.

Potassium permanganate, $KMnO_4$, as provided by Remox®, was used during the analysis. The results of the $KMnO_4$ SOD test are included in Attachment 1 of this letter report. The analysis determined that 2.2 kilograms of $KMnO_4$ would be needed to treat one cubic meter of saturated soil. This value was based on the measured SOD and the concentration of PCE in soil and groundwater. The SOD value used was 1.3 grams $KMnO_4$ per kilogram soil; this value was the average for tests in which $KMnO_4$ was present at 48 hours. Groundwater PCE data was provided by Tenen; the highest concentration (as of the date of the SOD analysis), 620 ug/l at JS-GW-1, was used. Later VOC analysis, completed in August 2018 as supplement to Emerging Contaminant sampling, detected PCE at a concentration of 860 ug/l at this location. The final dosage may be updated if determined that changes should be made given the increased PCE concentration.

ISCO Design

The proposed injection area will be approximately 30 feet (ft) by 30 ft. The proposed injection area was selected to target the area of highest cVOC concentrations as determined during the RI. The boundary of the injection area is limited along the eastern border of the Site due to a boiler room and the former PCE equipment room. Target injection depths will be 14 to 21.5 ft-bg to account for back pressure. Given the results of the SOD test, a solution of 100 gallons of 40% $NaMnO_4$ will be mixed with water to create approximately 500 gallons of 10% solution. The 10% solution will be injected in up to thirteen locations within the 30 by 30 ft area, shown in Figure 2.

A hand-held 420M Geoprobe® unit will be used for injection at the various locations. Work activities will include concrete coring and borehole abandonment/concrete patching of each injection area. Potential impacts from various exposure routes will be mitigated through the implementation of a Health and Safety Plan (HASP) and Community Air Monitoring Plan (CAMP) as detailed in Appendix A and C of the approved RAWP.

The application of chemical injection is considered a Class V Well under the Environmental Protection Agency (EPA) Underground Injection Control (UIC) Program. Class V Wells are “used to inject non-hazardous fluids underground”. EPA must be notified of the construction, operation and decommissioning of a Class V injection well. The notification will be made using the inventory form referenced in 40 CFR 144.26.

Conclusions
ISCO is a viable alternative for remediation of cVOCs in groundwater. The solution has been designed to limit the potential for rebound of chemical concentrations following one injection of the chemical oxidant.

Post-remedial groundwater monitoring will be completed in accordance with a Site Management Plan (SMP) for long term management of residual contamination. It is anticipated that groundwater samples will be collected quarterly for two years (i.e., eight quarters). Three existing permanent groundwater wells, (JS-GW-1, JS-GW-3S and JS-GW-7) will be sampled for VOCs only.

Please contact us if you require any additional information.

Sincerely,
Tenen Environmental, LLC

Matthew Carroll, P.E.
Principal / Environmental Engineer

Attachment 1: Soil Oxidant Demand Report of Findings, Prima Environmental Inc.

Figure 1: PCE in Groundwater
Figure 2: Proposed Injection Area

Attachment 1: Soil Oxidant Demand Report of Findings, Prima Environmental Inc.

August 20, 2018

Mohamed Ahmed, PhD., C.P.G., P.G.
Tenen Environmental, LLC
121 W 27th Street Suite 702
New York, NY 10001

RE: Report of Findings, $KMnO_4$ Soil Oxidant Demand
Tenen Project ID: JS Cleaners

Dear Dr. Ahmed:

This letter report describes the results of the soil oxidant demand (SOD) measurement conducted by PRIMA Environmental, Inc on soil from the JS Cleaners site. The oxidant used was potassium permanganate, $KMnO_4$. In addition to measurement of SOD, PRIMA estimated the amount of $KMnO_4$ needed to treat 1 cubic meter (m^3) of saturated soil based on the measured SOD and tetrachloroethene data provided by Tenen Environmental.

Sample Receipt and Preparation

One soil sample [JS-01-SOD (10-12)] was received on August 10, 2018. The sample consisted of three jars, which were homogenized prior to testing.

Materials

Potassium Permanganate, $KMnO_4$. Remox® brand $KMnO_4$ was used in this study. It may be obtained from Carus Corporation (http://www.caruscorporation.com). Dilute solutions were prepared as needed by dissolving the appropriate amount of solid in deionized (DI) water.

Procedures

$KMnO_4$ SOD. Six reactors, each containing 20 g soil and 20 mL of $KMnO_4$ solution were prepared. Each reactor contained a different initial concentration of $KMnO_4$: 250, 510, 1,000, 2,500, 5,100, and 10,100 mg/L $NaMnO_4$. Controls containing $KMnO_4$

solution, but no soil were also prepared. The reactors were placed on a shaker table. At 48 hours, the reactors were destructively sampled and the residual $KMnO_4$ was measured colorimetrically by PRIMA. The SOD is the mass of oxidant consumed, divided by the amount of soil used in the test.

Results

$KMnO_4$ SOD. The results of the $KMnO_4$ SOD test are shown in **Table 1.** All of the $KMnO_4$ added to the two lowest dosed tests was consumed within the time frame of the study. However, $KMnO_4$ remained in the higher-dosed tests. In these tests, the 48 hr $KMnO_4$ SOD values ranged from 790 to 1,800 mg $KMnO_4$/kg soil depending upon the initial concentration of $KMnO_4$. Higher SOD values with increasing initial concentration of $KMnO_4$ is a common phenomenon.

Table 1. 48-Hour $KMnO_4$ SOD Results.

Soil ID	Initial $KMnO_4$	$KMnO_4$ Remaining	$KMnO_4$ Consumed**
	mg/L	mg/L	mg/kg soil
Control (No soil)	250	250	not applicable
	510	510	
	1,000	1,000	
	2,500	2,400	
	5,100	5,100	
	10,100	10,300	
Composited Soil	250	< 1	250
	510	< 1	510
	1,000	210	790
	2,500	1,300	1,200
	5,100	3,600	1,500
	10,100	8,300	1,800

$KMnO_4$ Requirement. *Disclaimer: PRIMA Environmental, Inc. provides laboratory services, not remediation design services. The $KMnO_4$ requirement presented here is for guidance purposes only and should be reviewed by Tenen Environmental prior to use.*

The amount of $KMnO_4$ needed to treat 1 m^3 of saturated soil is 2.2 kg. This value is based on the measured SOD and the concentration of PCE in soil and groundwater. The calculations are presented in Table 2. The SOD value used was 1.3 g $KMnO_4$/kg soil – the average value for tests in which $KMnO_4$ was present at 48 hours. Groundwater PCE data was provided by Tenen Environmental; the highest concentration – 620 μg/L – was used.

Table 2. Approximate KMnO4 Requirement per Cubic Meter of Soil.

Assumptions	Units	Value	Basis
Volume Soil to Treat,	m3	1	Assumption
bulk density	g/cm3 (=kg/L)	1.5	Assumption
porosity	--	0.3	Assumption
SOD	g KMnO4/kg	1.3	lab value
KMnO4 Demand due to COCs in Soil	g KMnO4/kg soil	0.0	theoretical value based on conversion of COC
KMnO4 Demand due to COCs in Water	g KMnO4/L water	0.8	to CO2 and COCs concentrations in matrix
Implications			
Volume soil to treat	L	1000	= m3 soil x 1000L/m3
Volume GW to treat	L	300	= volume soil x porosity
Mass of soil to treat	**kg**	**1500**	**= volume soil (L) x bulk density**
KMnO4 Requirement Due to COCs			
in soill	g	0	= KMnO4 demand in soil x mass soil
in GW	g	240	= KMnO4 demand of water x volume water
KMnO4 Requirement due to SOD	g	1950	= SOD of soil x mass soil
Total KMnO4 Requirement	g	2190	= KMnO4 Requirement due to COCs + KMnO4 Requirement due to SOD
	kg	2.19	= KMnO4 Requirement (g) / 1000 g/kg

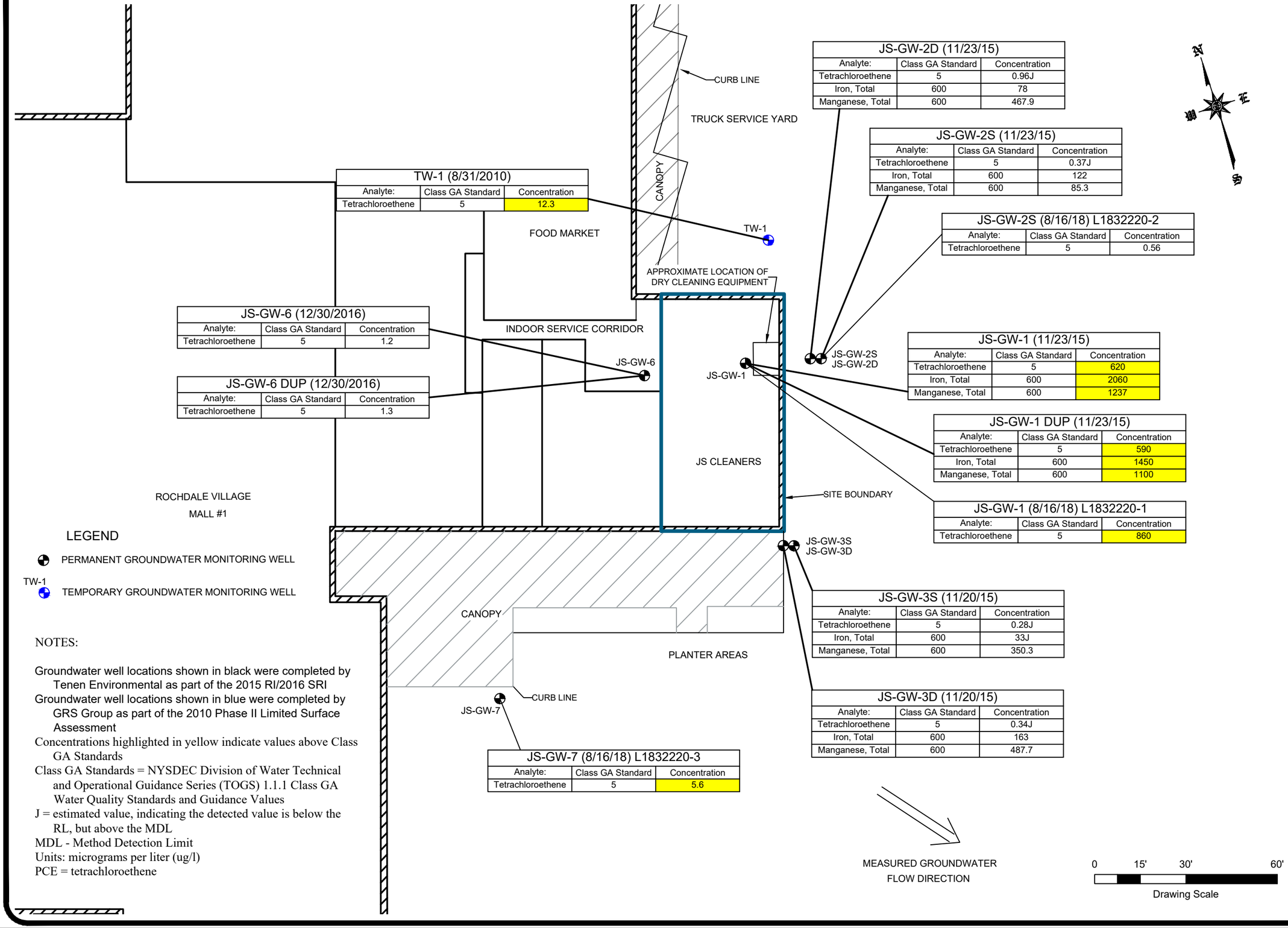
Input this data

If you have any questions regarding these results, please give me a call at 916-939-7300. Thank you for the opportunity to be of service.

Sincerely,
PRIMA Environmental

Cindy G. Schreier, Ph.D.
President

Figures



TW-1 (8/31/2010)		
Analyte:	Class GA Standard	Concentration
Tetrachloroethene	5	12.3

JS-GW-6 (12/30/2016)		
Analyte:	Class GA Standard	Concentration
Tetrachloroethene	5	1.2

JS-GW-6 DUP (12/30/2016)		
Analyte:	Class GA Standard	Concentration
Tetrachloroethene	5	1.3

JS-GW-2D (11/23/15)		
Analyte:	Class GA Standard	Concentration
Tetrachloroethene	5	0.96J
Iron, Total	600	78
Manganese, Total	600	467.9

JS-GW-2S (11/23/15)		
Analyte:	Class GA Standard	Concentration
Tetrachloroethene	5	0.37J
Iron, Total	600	122
Manganese, Total	600	85.3

JS-GW-2S (8/16/18) L1832220-2		
Analyte:	Class GA Standard	Concentration
Tetrachloroethene	5	0.56

JS-GW-1 (11/23/15)		
Analyte:	Class GA Standard	Concentration
Tetrachloroethene	5	620
Iron, Total	600	2060
Manganese, Total	600	1237

JS-GW-1 DUP (11/23/15)		
Analyte:	Class GA Standard	Concentration
Tetrachloroethene	5	590
Iron, Total	600	1450
Manganese, Total	600	1100

JS-GW-1 (8/16/18) L1832220-1		
Analyte:	Class GA Standard	Concentration
Tetrachloroethene	5	860

JS-GW-3S (11/20/15)		
Analyte:	Class GA Standard	Concentration
Tetrachloroethene	5	0.28J
Iron, Total	600	33J
Manganese, Total	600	350.3

JS-GW-3D (11/20/15)		
Analyte:	Class GA Standard	Concentration
Tetrachloroethene	5	0.34J
Iron, Total	600	163
Manganese, Total	600	487.7

JS-GW-7 (8/16/18) L1832220-3		
Analyte:	Class GA Standard	Concentration
Tetrachloroethene	5	5.6

LEGEND

PERMANENT GROUNDWATER MONITORING WELL

TW-1 TEMPORARY GROUNDWATER MONITORING WELL

NOTES:

Groundwater well locations shown in black were completed by Tenen Environmental as part of the 2015 RI/2016 SRI

Groundwater well locations shown in blue were completed by GRS Group as part of the 2010 Phase II Limited Surface Assessment

Concentrations highlighted in yellow indicate values above Class GA Standards

Class GA Standards = NYSDEC Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1 Class GA Water Quality Standards and Guidance Values

J = estimated value, indicating the detected value is below the RL, but above the MDL

MDL - Method Detection Limit

Units: micrograms per liter (ug/l)

PCE = tetrachloroethene

SITE

JS Cleaners
Rochdale Village
165-50 Baisley Boulevard
Jamaica, Queens

CONSULTANT

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DRAWN BY: LM

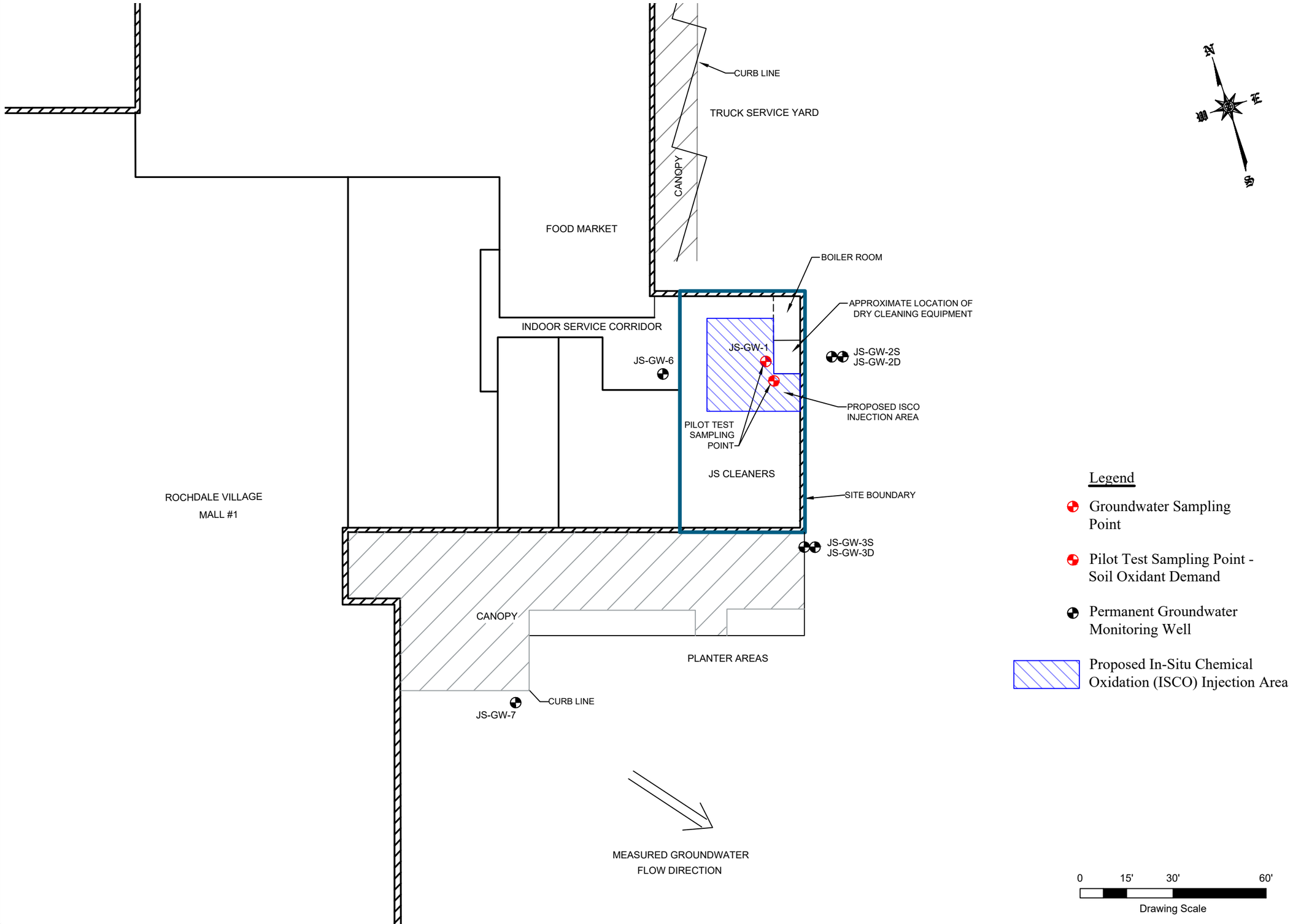
CHECKED BY: KM

DATE: September 2018

SCALE: As Noted

DRAWING TITLE: Summary of Groundwater Concentrations above Class GA Standards

DRAWING NO.: Figure 1



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DRAWN BY	CHECKED BY	DATE	SCALE:
LM	KM	September 2018	As Noted

DRAWING TITLE: ISCO Pilot Test & Injection Area

DRAWING NO.: Figure 2