ADEQ Arizona Department of Environmental Quality **TECHNICAL SUPPORT DOCUMENT**

PROPOSED UNDERGROUND STORAGE TANK (UST) RELEASE CASE CLOSURE EVALUATION SUMMARY

LUST Case File #1686.02
Facility ID #0-005684
Navajo County

City of Winslow - Fleet Yard
317 East 4th Street
Winslow, AZ 86047

***Background*:**

The City of Winslow Public Works Yard is located at 317 East 4th Street in Winslow. The site was formerly the City of Winslow's Fleet Yard. The site is currently used as a storage yard for City of Winslow's equipment and is developed with a maintenance building on the southwest edge, a shed at the southeast corner, and paved parking and drive areas. The use of the site is anticipated to remain unchanged for the foreseeable future. The site is surrounded by residential or commercially developed properties.

Two 1,000-gallon USTs for a former fuel facility, one for gasoline and one for diesel fuel were installed at the site in January 1966. These USTs were permanently removed and closed in April 1991. Sampling results from the two UST closures in 1991 indicated petroleum hydrocarbons had impacted soil, and the releases were assigned LUST #1686.01 and LUST# 1686.02 by the 1,000-gallon diesel tank and the 1,000-gallon gasoline tank, respectively. Impacted soils were excavated and transported offsite for remediation.

A 4,000-gallon diesel tank was installed in January 1992 and removed in September 1995. A confirmed diesel fuel release (LUST #1686.03) was added to the existing releases in 1995. Closure of LUST files 1686.01 and 1686.03 was approved in April 2007, but LUST # 1686.02 remains open.

The most widespread and persistent UST-related contaminants of concern (CoC) at the site has been 1,2-Dichloroethane (1,2-DCA), formerly used as a lead scavenger in leaded gasoline. Less prevalent has been the UST related CoC, Methyl Tertiary Butyl Ether (MTBE), formerly used as a gasoline additive in unleaded gasoline.

In February 2002, ADEQ determined that the soil impacts at the site were adequately characterized, but requested further characterization of groundwater impacts.

The consultant submitted a *Site Characterization Addendum and Closure Report* to ADEQ on April 19, 2019. ADEQ disapproved this request in June 2019, due to incomplete groundwater characterization.

Removal or Control of the Source of Contamination

As mentioned previously, two 1,000-gallon USTs used for storing gasoline and diesel fuel were installed in January 1966. The USTs were removed in 1991 because they failed nonvolumetric precision tank testing in February 1991. During removal of the USTs, numerous points of failure were observed on the tanks and piping, with visible soil staining observed above and below the tanks, particularly at the western base of the excavation.

A 4,000-gallon compartmented gasoline and diesel fuel UST was subsequently installed in late 1991 and early 1992. It was removed in September 1995. Detailed inspection showed no failure of the tank, but a diesel fuel release was confirmed based on soil sampling and attributed to the original UST, which had been in roughly the same location. Two remedial excavations were conducted in 1991 and 2000 at the suspected source area to remove residual hydrocarbon contamination acting as a source of contamination to groundwater.

In March and May 2000, the environmental consultant (Verde) conducted soil excavations in the former fuel release areas. During the excavations, soil samples were collected and field screened for volatile organic compounds (VOCs). The field data showed impacts to be limited from roughly 14 to 16 feet (ft) below ground surface (bgs). During the excavations in 2000, monitor wells MW-4, MW-5 and MW-6 were destroyed and approximately 170 cubic yards of soil were removed.

The excavations eliminated a significant volume of petroleum contaminated material (bedrock and soil) that had served as a source of groundwater contamination. The remedial excavations conducted in 1991 and 2000 are believed to have removed most contaminated materials at shallow depths that represented the source of most groundwater and soil vapor CoC impacts at the site. However, persistent sources of 1,2-DCA at the site may exist in a smear zone, below the base of the 1991 remedial excavation, and where the 18-ft deep trench excavations were not performed with the excavation carried out in 2000.

Characterization of the Groundwater Plume

The site is located in the Colorado Plateau physiographic province, near the southern end of the Painted Desert in the Little Colorado River Valley, approximately three miles west of the Little Colorado River and 1.2 miles east of the Toltec Divide. The Colorado Plateau is characterized by a broad uplifted section of continental crust, including layered sedimentary and volcanic rocks, dissected by deep canyons covering section of Utah, Colorado, Arizona and New Mexico. The surface is covered by relatively flat-lying beds of Mesozoic and Paleozoic sedimentary rocks. At Winslow, the Triassic age Moenkopi Formation composed mostly of interbedded shales, gypsum and limestone, crops out at the surface.

The Little Colorado River flows west towards the City of Winslow, then turns north near the eastern edge of the city. Flow in the Little Colorado River is perennial in this reach based on data from a stream gage located just east of the city. The Little Colorado River flows west toward the City of Winslow, then turns north near the eastern edge of the city.

There are two primary water-bearing aquifers at the site: the Coconino or C aquifer and the overlying local perched aquifer in the Moenkopi Formation. The C aquifer is widely used for public water supply. At some locations near the site, the Moenkopi Formation functions as a confining layer and the C aquifer is fully saturated. The perched aquifer in the Moenkopi Formation is not usable as a water supply due to low production capacity and generally poor water quality related to high concentrations of total dissolved solids. Groundwater contamination from the site is restricted to the perched aquifer.

Materials encountered during site characterization activities were noted to consist primarily of red-brown interbedded silts and clays with some sands, interpreted to be weathered and/or pulverized siltstone, mudstone and sandstone of the Moenkopi Formation. In 1998, a sewage odor was noted in the formation at 28 to 30 ft bgs in the MW-4 soil boring (located southeast of MW-7 in the excavated area), suggesting anaerobic conditions. Plant root organic material was noted in the MW-9 soil boring from 21 to 24 ft bgs in 2005.

A lithologic log for a public supply well (#55-914106) at the City of Winslow wellfield, located roughly 8 miles southwest of the site, indicates the Moenkopi Formation is present from the surface to 75 ft-bgs. The Kaibab Formation extends from 75 ft bgs to 180 ft-bgs, and the Coconino Sandstone is encountered from 180 ft to 991 ft (the total depth of the supply well).

Water level elevations measured during the January 2005 monitoring event, indicated the groundwater gradient had shifted from its historical northwest direction to the northeast. This groundwater flow pattern is generally consistent with previous observations, to the north-northwest across the source property, and to the north-northeast in an area east of the source property.

Groundwater monitoring has been conducted as early as 1998, and has progressed through 2021 as the monitoring well network expanded. Initial site characterization was conducted in May 1991 that included installation of monitoring wells MW-1, MW-2 and MW-3 to delineate onsite petroleum hydrocarbon impacts to soil and groundwater.

In September 1998, the new consultant abandoned MW-1, MW-2 and MW-3, and installed monitoring wells MW-4 through MW-7. Groundwater samples recovered from these wells had concentrations of 1,2-DCA (MW-5) and benzene (MW-4) above Arizona Aquifer Water Quality Standards (AWQS). During the remedial excavations conducted in 2000, MW-4, MW-5 and MW-6 were destroyed. Monitoring well MW-5A was installed as a replacement well for MW-5 in August 2002. Monitoring wells MW-8, MW-9 and MW-10 were completed in November and December 2004, to help characterize the extent of groundwater impacts. MW-8 was installed on the west side of the property, while MW-9 was installed off-site to the north/northwest. MW-10 was installed by the former UST pit, based on impacts observed during the remedial soil excavation activities.

The installation of off-site well MW-11, located northeast of the source area, occurred because of the shift in groundwater flow direction in January 2005. The groundwater elevation data from this monitoring event indicated that the gradient had shifted back to the northwest.

Off-site monitoring well MW-12 was installed northeast of MW-11 in 2007. Based on the results generated from the environmental investigations, ADEQ approved closure of LUST #1686.01 and #1686.03.

Monitoring well MW-13 was installed in July 2017, to the northwest of monitoring well MW-9, to delineate contamination off-site to the north/ northwest and to improve estimates of groundwater flow direction. Monitoring wells MW-14 and MW-15 were installed between March 23 and 24, 2020, while monitoring well MW-16 was installed on January 4, 2021. The three wells were constructed to a depth of 30 ft.

The groundwater contamination above AWQS in the shallow perched aquifer from the UST release currently consists predominantly of 1,2-DCA. Chlorinated ethenes, Tetrachloroethene (PCE) and Trichloroethylene (TCE) are also present in the groundwater at the site but are not believed to be related to the UST release. The 1,2-DCA groundwater solute plume has extended off-site approximately 250 ft downgradient to the northeast of the source area. However, concentrations of 1,2-DCA exceeding the AWQS are not known to have extended more than approximately 150 ft from the source area.

Chlorinated ethenes in the groundwater in the vicinity of MW-8 and MW-15 may originate from a former vehicle lube pit potentially used at the site, or from an off-site source. A lube pit is not specifically described in historical site documentation, but if one had existed, it could potentially have been the source of chlorinated ethene contamination at the site. Although the actual source of the chlorinated ethene contamination in groundwater at the site is unknown, it is not believed to be related to the UST release because of its location/distribution and concentrations. The relatively similar concentrations of PCE and TCE observed in MW-15 (installed in 2020) and in MW-8, suggest a similar distance downgradient or adjacent to a source.

The City of Winslow Public Works Yard submitted an application, which was accepted by the Voluntary Remediation Program (VRP) on March 11, 2022. A kickoff meeting is in the process of being scheduled to address the PCE and TCE concentrations at the City of Winslow Public Works Yard.

As mentioned previously, the CoC from the UST release at the site is 1,2-DCA. During the most recent groundwater event carried out in April 2021, concentrations of 1,2-DCA in monitoring wells MW-5A, MW-9, and MW-14 exceeded the AWQS of 5 micrograms per liter (µg/L). Concentrations of MTBE have been historically detected in MW-7, MW-8 and MW-10, but at concentrations below the Tier 1 Standard of 94 µg/L.

Groundwater Plume Stability

A plume of residual elevated 1,2-DCA has been identified in a zone approximately centered under MW-5A and MW-9 and at MW-14 to the east of the property. No other petroleum hydrocarbon or associated constituents, other than MTBE (at concentrations below the Tier 1 Standard of 94 µg/L) have been reported in groundwater since 1999. The lateral extent of the 1,2-DCA plume decreased between 2016 and 2021.

It must be noted that the LUST Freedom Fuels site (0-001830, LUST # 5813.01) lies on the east side of Colorado Street, while the City of Winslow site lies on the west side of Colorado Street. Groundwater flow in the area is towards the north, northwest, making the City of Winslow site downgradient of the Freedom Fuels site. Monitoring well MW-5, located on the Freedom Fuels property reported concentrations of 1,2-DCA below the AWQS (<0.0819 µg/L) during the sampling event conducted on June 23, 2021. The highest concentrations of 1,2-DCA reported from the Freedom Fuels site is from MW-3, in the former tank pit, at 9.45 µg/L. The concentration of 1,2-DCA encountered during the most recent sampling event at the City of Winslow's well MW-14 on April 27, 2021 is 18 µg/L.

Time series concentrations of 1,2-DCA detected in monitoring wells were evaluated using the non-parametric Mann-Kendall test for trend. The Mann-Kendall trend testing showed statistically significant (>95% confidence level) decreasing trends for 1,2-DCA concentrations at MW-5A, MW-7, MW-9, MW-11 and MW-14.

Currently, concentrations of 1,2-DCA in exceedance of the AWQS exist in the three monitoring wells MW-5A, MW-9 and MW-14 (6.4, 10 and 18 µg/L respectively). Sampling results from the downgradient and cross gradient wells surrounding the three impacted wells have shown concentrations below standards for several years, documenting that the 1,2-DCA contamination is not likely to be moving or spreading to surrounding wells.

Natural Attenuation

The transport mechanism for the CoCs consist of advection and dispersion in groundwater. CoCs dissolved in groundwater will normally be transported in the direction of groundwater flow with spreading of the solute plume under the influence of horizontal and vertical variation in permeability within the formation. Some retardation of contaminant migration rates will also occur due to the sorption of contaminants onto the aquifer matrix. Volatile petroleum hydrocarbons and related contaminants in bedrock and groundwater near the source area potentially could volatilize from groundwater into the vadose zone and be transported by vapor-phase diffusion to the surface or into overlying structures.

Natural attenuation of petroleum hydrocarbons and other organic contaminants is driven by naturally occurring biodegradation. When the rate of biodegradation in groundwater downgradient from the source equals or exceeds the rate of contaminant dissolution and transport away from the source, the solute plume will stabilize or recede. The natural biodegradation of hydrocarbons by indigenous microbes is universal and occurs to varying extents in all subsurface environments. 1,2-DCA can be biodegraded under oxic and anoxic conditions.

The current (April 2021) extent of the 1,2-DCA solute plume in groundwater is lower compared to previous events. This demonstrates that the solute plume in groundwater is shrinking in extent and that natural attenuation is effective at preventing contaminant migration and in reducing contaminant concentrations in groundwater at the site. Naturally occurring biodegradation of 1,2-DCA in groundwater appears to be occurring at a rate greater than the rate of these constituents being released to the groundwater and transported downgradient.

The observed decreasing trends in 1,2-DCA concentration time series suggest that 1,2-DCA is being naturally attenuated in site groundwater. Some of the observed concentration reduction appears to be related to groundwater elevation changes at MW-5A and MW-9. The notable lack of any increasing concentration trends, particularly in downgradient monitoring wells, indicates the general stability of the 1,2-DCA solute plume in groundwater at the site.

Groundwater parameters like temperature, conductivity, pH, oxidation-reduction potential (ORP) and dissolved oxygen were collected during sampling events between July 2019 and April 2021. Measured ORP values ranged from +356 mV to about -119 mV during the 2019 to 2021 time period, indicating groundwater conditions range from oxidizing to weakly reducing across the site. Dissolved oxygen measurements across the site indicated hypoxic to anoxic conditions for most sampling events. In general, site geochemical data indicated that favorable conditions for CoC degradation existed heterogeneously in the perched aquifer, consistent with anisotropy within the formation. Data from MW-7 and MW-11 were the most suggestive of degradation processes, consistent with these wells' positions on the upgradient and downgradient edges of the plume, respectively.

TABLE 6
Groundwater Purge Parameters
City of Winslow Public Works Yard
317 E 4th Street, Winslow, Arizona
ADEQ Facility ID 0-005684, LUST # 1686.02

Well ID	Date	Temperature (°C)	Conductivity (µS/cm)	pH	ORP (mV)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
	1/30/2014	18.3	36,128	6.74	62.3	0.61	NM
	7/22/2015	20.3	13,923	6.99	68.6	0.08	NM
	1/13/2016	18.7	14,225	6.99	31.8	0.09	NM
	7/19/2017	21.0	15,027	6.88	68.2	3.27	5.02
	1/16/2018	19.2	15,755	6.81	35.4	1.14	5.11
MW-5A	7/10/2019	19.5	15,259	6.93	57.4	4.98	NM
	4/9/2020	17.7	16,422	6.92	50.5	0.14	NM
	7/8/2020	22.2	16,088	6.86	31.5	–	NM
	1/28/2021	17.7	16,389	6.75	16.5	1.4	NM
	4/28/2021	21.5	16,636	7.18	253.9	1.15	NM
	1/29/2014	18.0	19,877	6.78	-77.2	0.77	NM
	7/23/2015	19.4	10,274	6.79	231.6	0.1	NM
	1/13/2016	18.0	8,806	6.98	-190.5	1.37	NM
	7/25/2017	20.6	7,324	6.97	-165.5	0.25	NM
	1/18/2018	18.2	12,643	6.81	-137.3	1.32	0.57
MW-7	7/9/2019	19.6	11,284	7.01	-118.5	4.61	NM
	4/9/2020	17.8	13,486	7.05	-21.1	0.22	NM
	7/9/2020	20.6	13,339	6.91	-82.1	–	NM
	1/28/2021	17.6	13,523	6.76	-46.2	4.03	NM
	4/28/2021	21.6	13,750	7.03	261.3	2.5	NM
	1/29/2014	18.1	31,630	6.71	108.9	0.78	NM
	7/23/2015	19.8	14,190	6.87	124.7	0.06	NM
	1/14/2016	17.8	13,258	6.92	20.2	0.52	NM
	7/20/2017	19.5	13,679	7.20	157.8	3.58	9.26
	1/17/2018	18.2	15,368	6.78	124	1.32	3.97
MW-8	7/10/2019	19.7	14,498	7.03	48.9	1.33	NM
	4/7/2020	17.8	15,513	5.98	356.4	0.81	NM
	7/9/2020	20.1	16,792	6.84	225.1	–	NM
	1/28/2021	17.5	15,769	6.70	76.2	0.45	NM
	4/30/2021	25.2	16,613	7.24	250.6	0.37	NM
	1/30/2014	19.9	31,041	6.75	133.5	0.59	NM
	7/22/2015	20.4	11,923	6.83	175.8	0.43	NM
	1/13/2016	18.5	12,169	6.92	87	1.53	NM
	7/20/2017	20.4	12,804	6.80	103.3	4.24	2.47
	1/17/2018	19.2	14,549	6.82	78.5	1.03	2.65
MW-9	7/10/2019	19.4	12,933	7.01	32.5	0.13	NM
	4/8/2020	18.1	13,525	6.70	123.2	0.30	NM
	7/9/2020	20.9	13,444	6.81	93.9	–	NM
	1/28/2021	18.3	13,579	6.71	71.6	0.22	NM
	4/30/2021	28.2	12,712	7.30	247.3	0.61	NM
	1/29/2014	18.9	32,091	6.65	120.9	0.74	NM
	7/23/2015	20.0	14,143	6.85	-167.6	0.17	NM
	1/15/2016	18.1	17,636	6.93	83.9	0.08	NM
	7/20/2017	19.9	13,409	6.84	70.2	2.4	9.43
	1/16/2018	18.4	14,026	6.78	76.4	1.12	6.86
MW-10	7/10/2019	19.9	13,690	6.94	35.3	1.91	NM
	4/9/2020	17.2	14,890	6.53	124.7	0.15	NM
	7/9/2020	21.4	14,770	6.77	35.5	–	NM
	1/28/2021	17.7	15,350	6.62	42.2	0.36	NM
	4/28/2021	17.9	15,721	7.18	255.2	0.87	NM

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Well ID	Date	Temperature (°C)	Conductivity (µS/cm)	pH	ORP (mV)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
MW-11	1/29/2014	18.7	20,307	6.91	18.7	0.69	NM
	7/24/2015	19.4	9,473	6.84	54.4	0.25	NM
	1/14/2016	19.3	9,030	7.10	8.8	0.09	NM
	7/20/2017	20.8	9,196	6.96	100.7	3.32	0.81
	1/17/2018	19.3	10,273	6.95	61.8	0.87	0.43
	7/11/2019	20.7	9,264	7.17	7.9	1.29	NM
	4/8/2020	19.3	10,001	6.87	54.7	1.05	NM
	7/8/2020	22.3	9,872	6.97	95.3	–	NM
	1/27/2021	18.6	9,883	6.88	83.6	0.33	NM
	4/27/2021	19.4	10,225	7.07	255.9	1.74	NM
MW-12	1/29/2014	17.9	39,948	6.81	-28.9	0.72	NM
	7/24/2015	19.1	17,844	6.97	-54.2	0.65	NM
	1/14/2016	18.3	16,984	7.05	-35.1	0.27	NM
	7/20/2017	19.6	17,616	6.81	114.6	3.8	2.8
	1/18/2018	19.0	19,960	6.84	11.3	1.28	4.3
	7/11/2019	19.4	18,015	7.01	46.0	1.36	NM
	4/8/2020	18.9	19,120	8.26	34.5	1.49	NM
	7/8/2020	21.9	18,936	6.29	101.9	–	NM
	1/29/2021	17.9	19,023	6.69	48.3	0.45	NM
	4/27/2021	19.4	19,850	7.19	249.0	1.56	NM
MW-13	7/25/2017	21.7	11,904	7.14	-15.8	0.43	NM
	1/16/2018	19.0	12,108	7.60	-219.7	1.05	29.1
	7/11/2019	20.7	11,830	7.26	0.9	0.60	NM
	4/8/2020	19.0	12,695	7.11	-31.8	1.32	NM
	7/8/2020	22.2	12,535	7.13	-6.6	–	NM
	1/27/2021	18.7	12,647	7.01	-77.4	1.22	NM
	4/27/2021	19.4	12,764	7.23	247.4	0.98	NM
MW-14	4/8/2020	19.3	14,443	7.27	72.0	0.95	NM
	7/8/2020	22.3	14,856	6.61	-28.1	–	NM
	1/28/2021	18.9	15,325	6.74	-65.3	1.23	NM
	4/27/2021	17.8	15,560	7.03	258.7	1.42	NM
MW-15	4/7/2020	18.4	12,060	8.06	307.9	0.18	NM
	7/8/2020	20.8	13,101	7.10	93.1	–	NM
	1/29/2021	17.7	10,910	7.04	58.3	7.23	NM
	4/28/2021	17.1	9,411	7.35	240.7	0.91	NM
MW-16	1/29/2021	18.9	8,582	7.11	-6.8	1.90	NM
	4/27/2021	18.6	11,778	7.33	241.3	1.24	NM

Notes:
ORP = oxidation-reduction potential
°C = degrees Celsius
µS/cm = microSiemens per centimeter
mV = millivolts (relative to silver-chloride electrode)
mg/L = milligrams per liter
NTU = nephelometric turbidity unit
NM = not measured

BIOSCREEN is another analytical model-based software tool that simulates solute transport assuming relatively homogenous conditions in a porous media aquifer. Biodegradation is represented using either the instantaneous reaction model or as a first-order decay process. The instantaneous reaction model uses the change in redox constituents (dissolved oxygen, nitrate, ferrous iron, sulfate and methane) along the length of the plume to calculate a degradation rate from the depletion of electron acceptors and generation of reduced species within the plume.

For January 2021 monitoring data, the modeled area length for the northwest transect was set to 120 ft, the approximate distance from the suspected source area (MW-5A) to MW-13. For the April 2021 monitoring data, the modeled area length was set to 68 ft. The results of the BIOSCREEN modeling indicate that for the January 2021 data in the northwest transect, the 1,2-DCA solute plume would not be expected to migrate more than 12 ft from the source. There is no change to modeling output with or without biodegradation. Using the April 2021 data for modeling in the northwest transect with or without biodegradation, the 1,2-DCA solute plume would not be expected to migrate more than 7 ft downgradient. For the northeast transect using either January or April 2021 data, the 1,2-DCA solute plume would be expected to migrate less than 21 ft from the source within 30 years, there is no change in modeling output with or without biodegradation. Based on the BIOSCREEN data, the distance the contamination is expected to migrate in 30 years is approximately 21 ft, which would still keep the contamination onsite. It must be noted that BIOSCREEN data for 1,2-DCA is historically not considered very supportive, but is presented to show that 1,2-DCA does not move far from the source area in groundwater.

<u>Other Exposure Pathways</u>

The site is surrounded by residential or commercially developed properties. The nearest downgradient residential properties are located about 50 ft to the northwest and about 80 ft to the northeast of the site across East 3rd Street. A childcare facility called Mary's Little Lambs is located roughly 0.25 mile south-southwest of the site, cross to upgradient from the site based on observed gradients. Winslow Early Head Start, Washington Elementary School and Winslow High School are located 0.3 miles north-northeast, 0.3 miles northwest and 0.4 miles northeast from the site. There is no soil contamination onsite, which would eliminate the receptors being impacted.

Potential exposure pathways for site CoCs are dermal contact with petroleum-impacted soils for construction workers, 2) vapor inhalation in indoor and outdoor air, and 3) direct ingestion of petroleum hydrocarbon contaminated groundwater associated with the release.

These pathways were evaluated previously as part of the Tier 3 risk evaluation, using groundwater concentrations. Inhalation risk to indoor air was re-evaluated for this closure report. Although, soil vapor data was collected at the site in order to evaluate inhalation risk, the samples had to be diluted in the laboratory due to high chlorinated VOC concentrations which caused the reporting limits for 1,2-DCA to exceed 10% of the residential regional screening level. Therefore, groundwater concentrations were used in lieu of soil vapor concentrations for modeling the inhalation risk.

The potentially complete exposure pathways at the site include transport of vapor-phase contaminants to outdoor and indoor air with subsequent inhalation exposure. Potential vapor intrusion into buildings with subsequent inhalation exposure to indoor air is of potential concern.

Inhalation risks were evaluated using the USEPA online screening version of the Johnson and Ettinger (J&E) 1991 vapor intrusion model in the forward calculation of indoor air concentration mode. The model was configured for slab-on-grade construction and the default values for building properties were used. The soils at the site are predominantly clayey silts with some sand. The groundwater temperature measured at the site was 19.5°C.

The only petroleum-related CoC with a concentration in groundwater that exceeds an AWQS is 1,2-DCA. Non-petroleum hydrocarbon related CoCs with concentrations at exceed an AWQS were PCE and TCE in MW-8.

The J&E modeling results using the on-site and off-site groundwater concentration in MW-9 and MW-14, presented a cancer risk of 7.57×10^{-7} and 1.37×10^{-6} respectively. The Cumulative cancer risk was 2.13×10^{-6}. The hazard index for MW-9 and MW-14 were 0.010 and 0.018 respectively.

The data from both these wells represent an acceptable cancer risk.

Fuel hydrocarbon-related contamination is present in shallow groundwater that occurs at a depth of around 15 to 17 ft-bgs. Because of the location of the contamination, the current site use and conditions and the lack of water supply wells, there is no potential for direct exposure to contaminated groundwater.

<u>Threatened or Impacted Drinking Water Wells</u>

ADEQ performed a search on the Arizona Department of Water Resources database and discovered 120 registered water wells within a 0.5-mile radius of the site. Of these, 109 were registered monitoring wells. The depth of these wells ranged from 0 ft to 44 ft. There was one exempt monitoring well owned by Conoco Phillips Company (55-205879) and one non-exempt well owned by La Posada Hotel (55-219815). The Conoco Phillips well was a cross-gradient monitoring well that was abandoned in October 2009. The well owned by La Posada is an upgradient commercial water production well that is approximately 200 ft in depth. There are eight wells listed as ‘other’. Three of these wells are currently abandoned, while five of the remaining wells listed as ‘other’ are used as test wells, monitoring wells and geotechnical wells.

Water supply wells in the area are not screened in the perched aquifer in the Moenkopi Formation due to high total dissolved solids, that make the shallow groundwater too poor to be used as a potable water source.

The remaining contamination at the site is in the shallow aquifer, while the City of Winslow relies on groundwater from the C aquifer for municipal use and operates a wellfield located about six miles southwest of the site. Groundwater in the C aquifer flows to the north, making the site downgradient of the wellfield. The contamination from the shallow aquifer cannot migrate to the underlying C-aquifer, due to the fine-grained lithologies and the Moenkopi formation acting as an aquitard, limiting the hydraulic connection between the shallow contaminated groundwater and the underlying productive aquifer.

Drinking water is supplied to the area by the Winslow Water Department. According to the Consumer Confidence Report for the City of Winslow from 2020, the source of the drinking water includes seven groundwater wells located seven miles south of the City of Winslow. These wells are sampled annually. The most recent sampling event was carried out in 2020, but VOC analysis was not required. Per the 2018 sampling event, there were no VOCs detected in the system.

Any new or replacement well located at or near this site, would need to meet the criteria of ADWR's R-12-15-1302 (B)(3).

Requirements of A.R.S. §49-1005(D) and (E):

The results of the groundwater data from the site assure protection of public health, welfare and the environment, to the extent practicable, and allow for the maximum beneficial use of the site, while being reasonable, necessary and cost effective.

Other information that is pertinent to the LUST case closure approval:

The facility and LUST files were reviewed for information regarding prior cleanup activities, prior site uses and operational history of the UST system.

Groundwater data tables:

AWQS	Arizona Water Quality Standards
Ft	Feet
ug/L	micrograms/ liter
DTW	Depth to Water

Well	DATE	DTW (ft)	1,2-Dicholoethane (1,2-DCA)
			AWQS: 5 µg/L
MW-5A (source) Screen (10-30)' 31 ft deep	8/12/2002	14.98	**75**
	9/17/2002	14.47	**73**
	1/10/2005	12.08	**31**
	5/25/2006	15.69	**32**
	10/24/2007	16.27	**37**
	1/30/2014	16.43	**42**
	7/22/2015	15.90	**53**
	1/13/2016	15.56	**47**
	7/19/2017	16.63	**19**
	1/16/2018	17.07	**28**
	7/10/2019	16.81	**17**
	7/9/2020	16.38	**19**
	1/28/2021	17.18	**17**
	4/28/2021	17.66	**6.4**

Well	DATE	DTW (ft)	Benzene
			AWQS: 5 µg/L
MW-7 (upgradient) Screen (10-30)' 30 ft deep	10/19/1998	14.30	2.3
	1/11/1999	13.99	<1.0
	9/27/1999	13.54	<1.0
	12/16/1999	12.40	**8.4**
	1/10/2005	11.90	<0.50
	5/25/2006	15.27	<0.50
	10/24/2007	15.88	<0.50
	1/29/2014	16.19	<2.0
	7/23/2015	15.39	<0.50
	1/13/2016	15.06	<0.50
	7/25/2017	16.18	<2.0
	1/18/2018	16.67	<2.0
	7/9/2019	16.46	<0.50
	4/9/2020	15.46	<0.50
	7/9/2020	16.02	<0.50
	1/28/2021	16.92	<0.50
	4/28/2021	17.12	<0.50

	DATE	DTW (ft)	1,2-Dicholoethane (1,2-DCA)	Trichloro-ethylene (TCE)	Tetrachloro-ethene (PCE)
			AWQS: 5 µg/L		
MW-8 (downgradient) Screen (8-28)' 28 ft deep	1/10/2005	11.65	<1.0	**85**	**8,700**
	5/25/2006	16.36	<1.0	**59**	**5,200**
	10/24/2007	16.88	<1.0	**52**	**3,100**
	1/29/2014	17.01	**9.0**	**15**	**200**
	7/23/2015	16.95	**8.5**	**11**	**150**
	1/14/2016	16.02	**7.1**	**13**	**180**
	7/20/2017	17.55	3.2	4	**40**
	1/17/2018	17.71	**5.7**	**10**	**100**
	7/10/2019	17.59	**5.4**	**9.0**	**73**
	4/7/2020	16.28	**5.4**	**7.2**	**47**
	7/8/2020	17.25	**6.4**	**9.5**	**58**
	1/28/2021	17.48	4.0	**8.4**	**39**
	4/30/2021	17.83	3.7	**9.7**	**37**

	DATE	DTW (ft)	1,2-Dicholoethane (1,2-DCA)
			AWQS: 5 µg/L
MW-9 (downgradient) Screen (8-27)' 28 ft deep	1/10/2005	13.61	**45**
	5/25/2006	15.89	**81**
	10/24/2007	16.41	**46**
	1/30/2014	16.40	**33**
	7/22/2015	16.46	**30**
	1/13/2016	16.20	**23**
	7/20/2017	16.90	**12**
	1/17/2018	17.16	**18**
	7/10/2019	16.86	**17**
	4/8/2020	15.97	**13**
	7/9/2020	16.58	**15**
	1/28/2021	17.05	**11**
	4/30/2021	17.38	**10**

	DATE	DTW (ft)	1,2-Dicholoethane (1,2-DCA) AWQS: 5 µg/L
MW-10 (cross gradient) Screen (8-27)' 27 ft deep	1/10/2005	12.21	1.7
	5/25/2006	15.70	2.4
	10/24/2007	16.26	1.7
	1/29/2014	17.20	**5.2**
	7/23/2015	15.98	**7.5**
	1/15/2016	15.30	**6.1**
	7/20/2017	16.58	2.6
	1/16/2018	17.02	3.0
	7/10/2019	16.73	2.8
	4/9/2020	15.76	3.3
	7/9/2020	16.40	3.6
	1/28/2021	17.13	3.2
	4/28/2021	17.65	1.6

	DATE	DTW (ft)	1,2-Dicholoethane (1,2-DCA) AWQS: 5 µg/L
MW-11 (downgradient) Screen (10-30)' 30 ft deep	5/25/2006	13.90	**22**
	10/24/2007	14.19	**9.9**
	1/29/2014	13.87	**5.7**
	7/24/2015	14.34	**9.2**
	1/14/2016	13.93	**5.8**
	7/20/2017	14.96	<2.0
	1/17/2018	15.53	3.0
	7/11/2019	15.17	1.5
	4/8/2020	13.95	<0.50
	7/8/2020	14.55	1.0
	1/27/2021	15.46	0.93
	4/27/2021	16.35	0.99

	DATE	DTW (ft)	1,2-Dicholoethane (1,2-DCA) AWQS: 5 µg/L
MW-14 (cross gradient) Screen (10-30)' 30 ft deep	4/8/2020	14.11	**31**
	7/8/2020	14.82	**30**
	1/28/2021	15.70	**22**
	4/27/2021	16.30	**18**

MW-16 (cross gradient well beyond MW-14) Screen (10-30)' 30 ft deep	DATE	DTW (ft)	1,2-Dicholoethane (1,2-DCA) AWQS: 5 µg/L
	1/28/2021	15.55	1.6
	4/27/2021	15.98	1.7

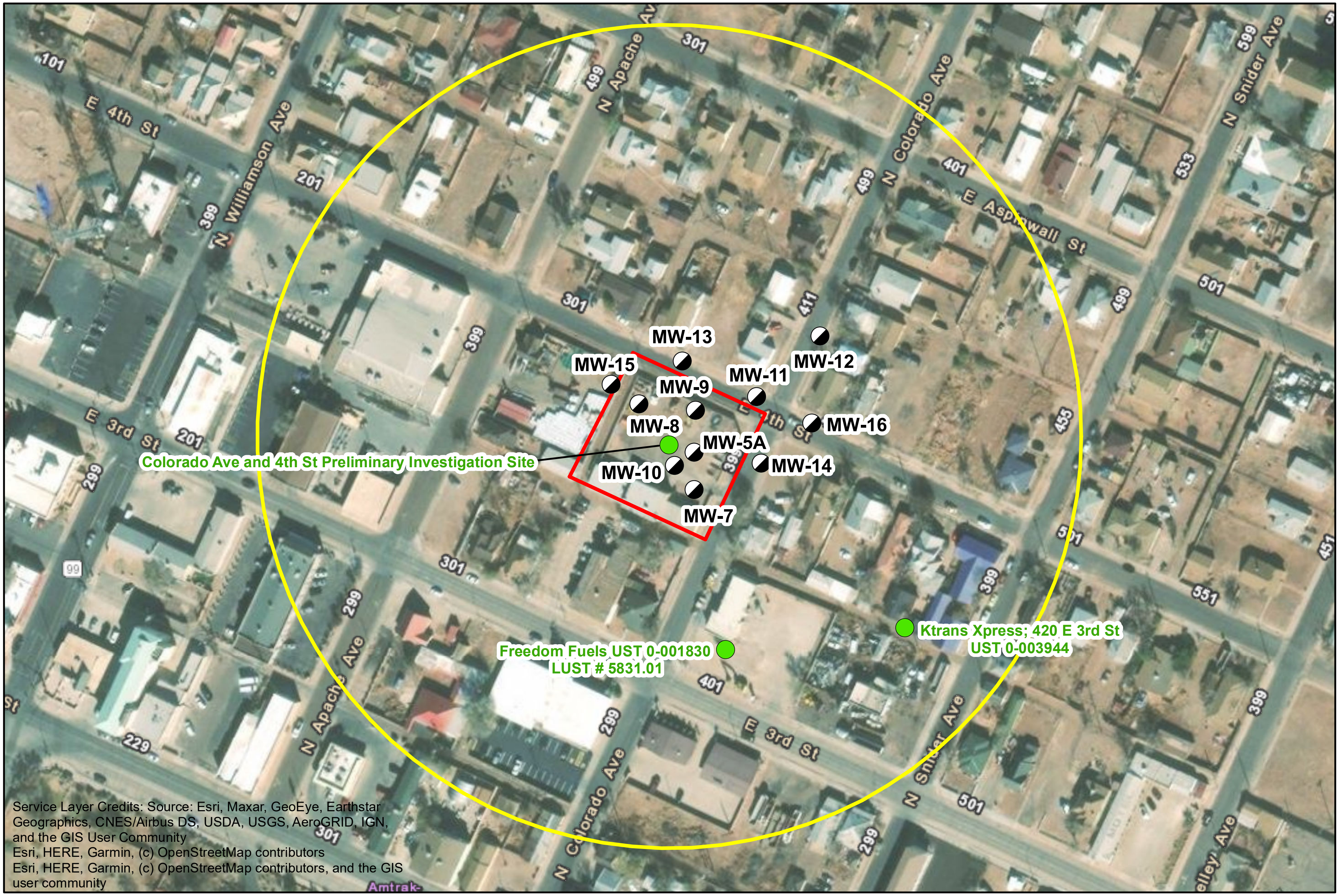
NAD1983 HARN State Plane Arizona Central FIPS 0202 Feet Intl

770 0 1,540 Feet

N

HYDRO GEO CHEM, INC.

SITE LOCATION MAP CITY OF WINSLOW PUBLIC WORKS YARD WINSLOW, ARIZONA			
Approved MJB	Date 04/23/14	File 201202116G_SITLOC	Figure 1



Symbol	Meaning
Red box	Site
Yellow circle	500-ft radius
Green dot	UST/WQARF site
Half-filled circle	Monitoring well

80 40 0 80 Feet

N

HYDRO GEO CHEM, INC.

SITE VICINITY MAP
CITY OF WINSLOW PUBLIC WORKS YARD
FACILITY 0-005684, 317 E. 4TH ST., WINSLOW, ARIZONA

Approved	Date	Author	Date	File Name	Figure
AJB	01/26/22	MRW	01/26/22	2012021076G	2

MW-7 Monitoring well with ID

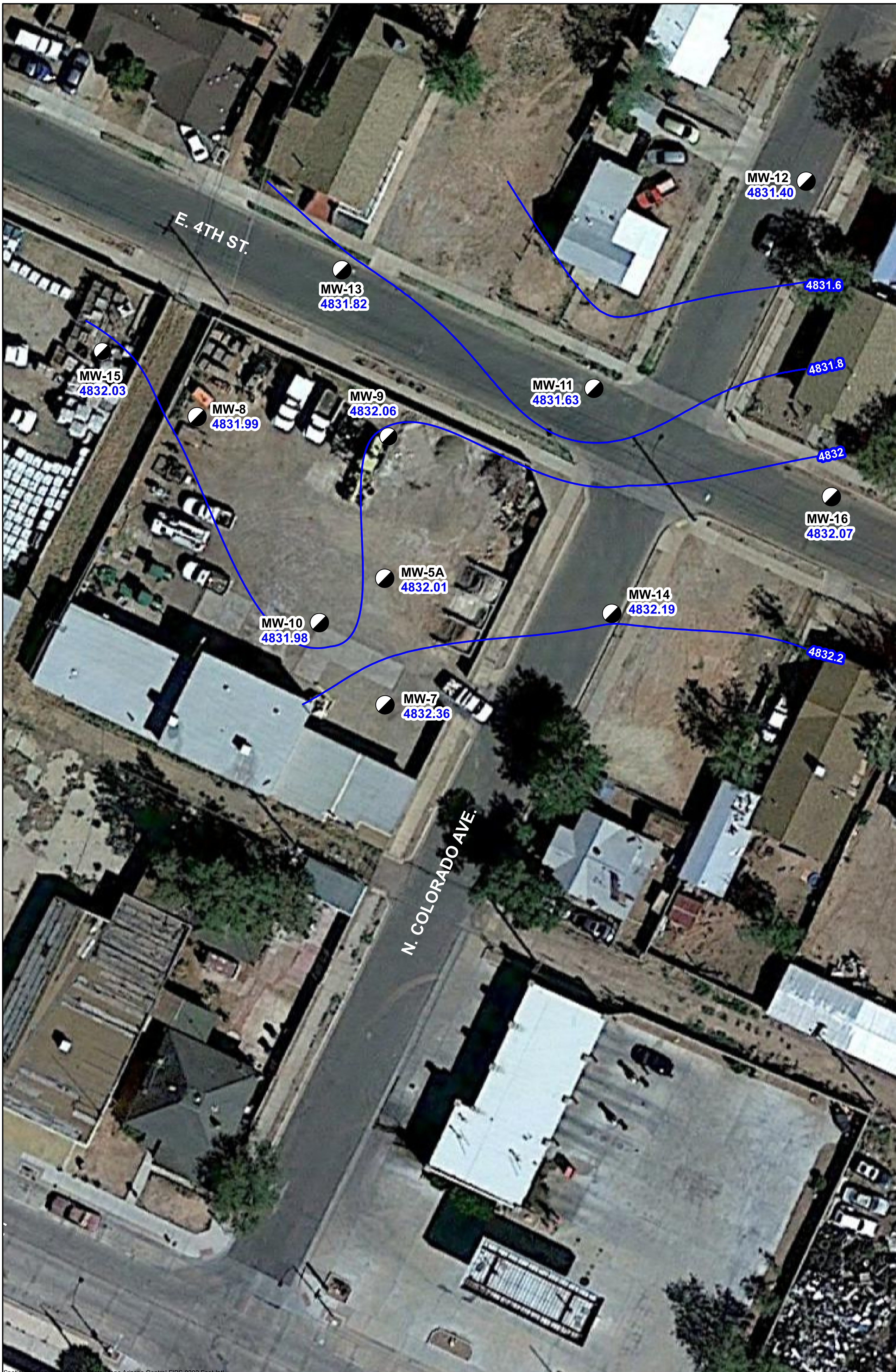
0 25 50
SCALE IN FEET

N

HYDRO GEO CHEM, INC.

MONITORING WELL LOCATIONS
CITY OF WINSLOW PUBLIC WORKS YARD
WINSLOW, ARIZONA

Approved	Date	Author	Date	File Name	Figure
AJB	01/26/22	MRW	01/26/22	2012021088G	3



4832.9 —— Water level contours (ft amsl)

MW-7 4832.83 ◐ Monitor well ID and water level (ft amsl)

0 25 50

SCALE IN FEET

N

HYDRO GEO CHEM, INC.

APRIL 2021 GROUNDWATER ELEVATIONS
CITY OF WINSLOW PUBLIC WORKS YARD,
WINSLOW, ARIZONA

Approved	Date	Author	Date	File Name	Figure
AJB	01/27/22	MRW	01/27/22	2012021093G	8

MW-7

PCE	<0.50
TCE	<0.50
1,2-DCA	31
MTBE	<0.50

Monitoring well with ID and analytical results (µg/L).
Duplicate samples separated by "/".

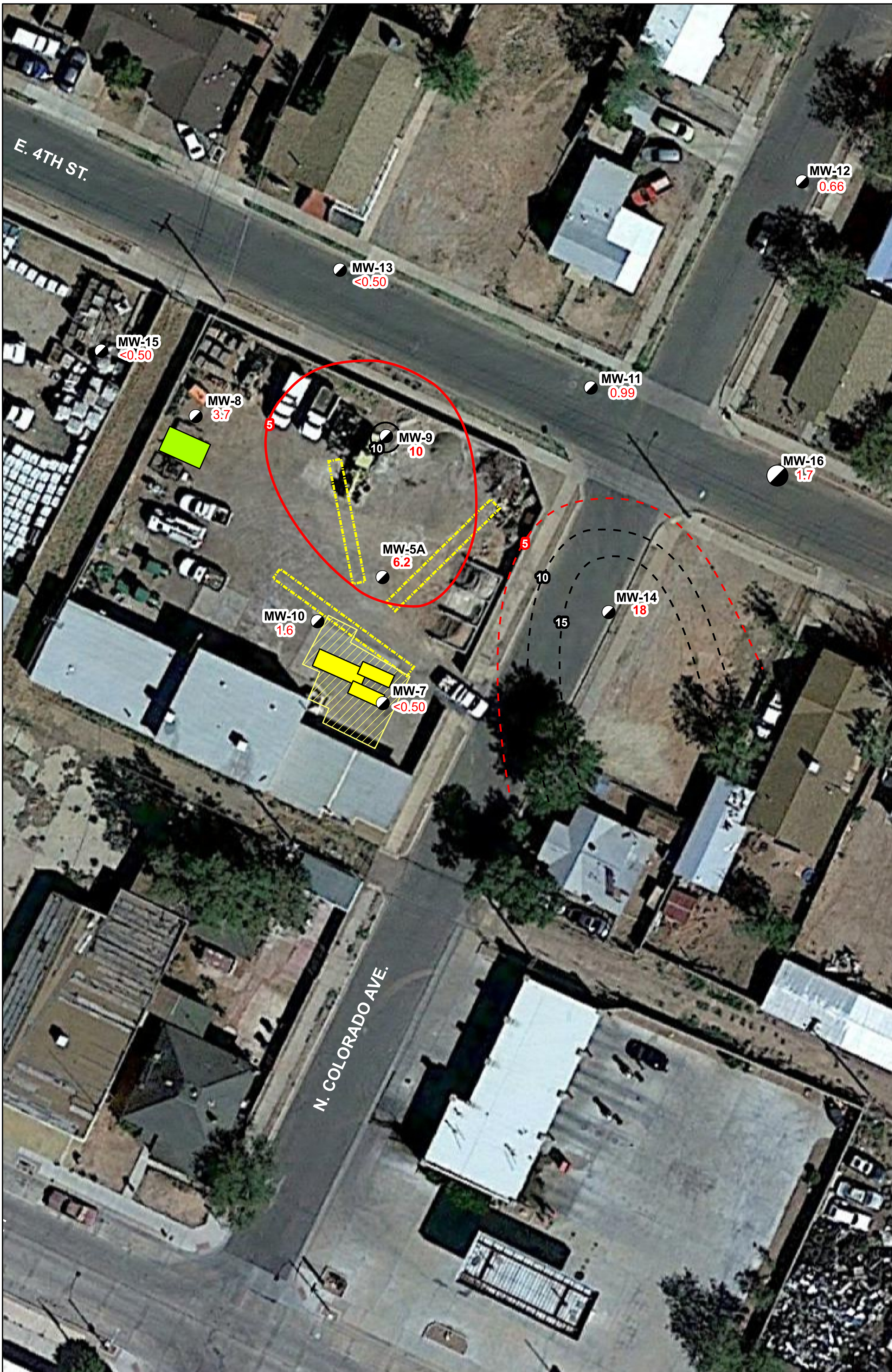
BOLD values exceed detection limit.
RED values exceed applicable Aquifer Water Quality Standard (AWQS) or Interim Remediation Goal.

0 15 30
SCALE IN FEET
N

HYDRO GEO CHEM, INC.

APRIL 2021 GROUNDWATER VOC RESULTS
PCE, TCE, 1,2-DCA, AND MTBE
CITY OF WINSLOW PUBLIC WORKS YARD
WINSLOW, ARIZONA

Approved	Date	Author	Date	File Name	Figure
AJB	01/27/22	MRW	01/27/22	2012021094G	13



MW-7 3.6 Monitoring well with ID and DCA concentrations (µg/L)

Groundwater DCA concentration contours (µg/L) (red contour represents the AWQS = 5 µg/L)

Approximate area of excavations

Approximate trench excavation locations

Former UST

Former lube pit

0 15 30

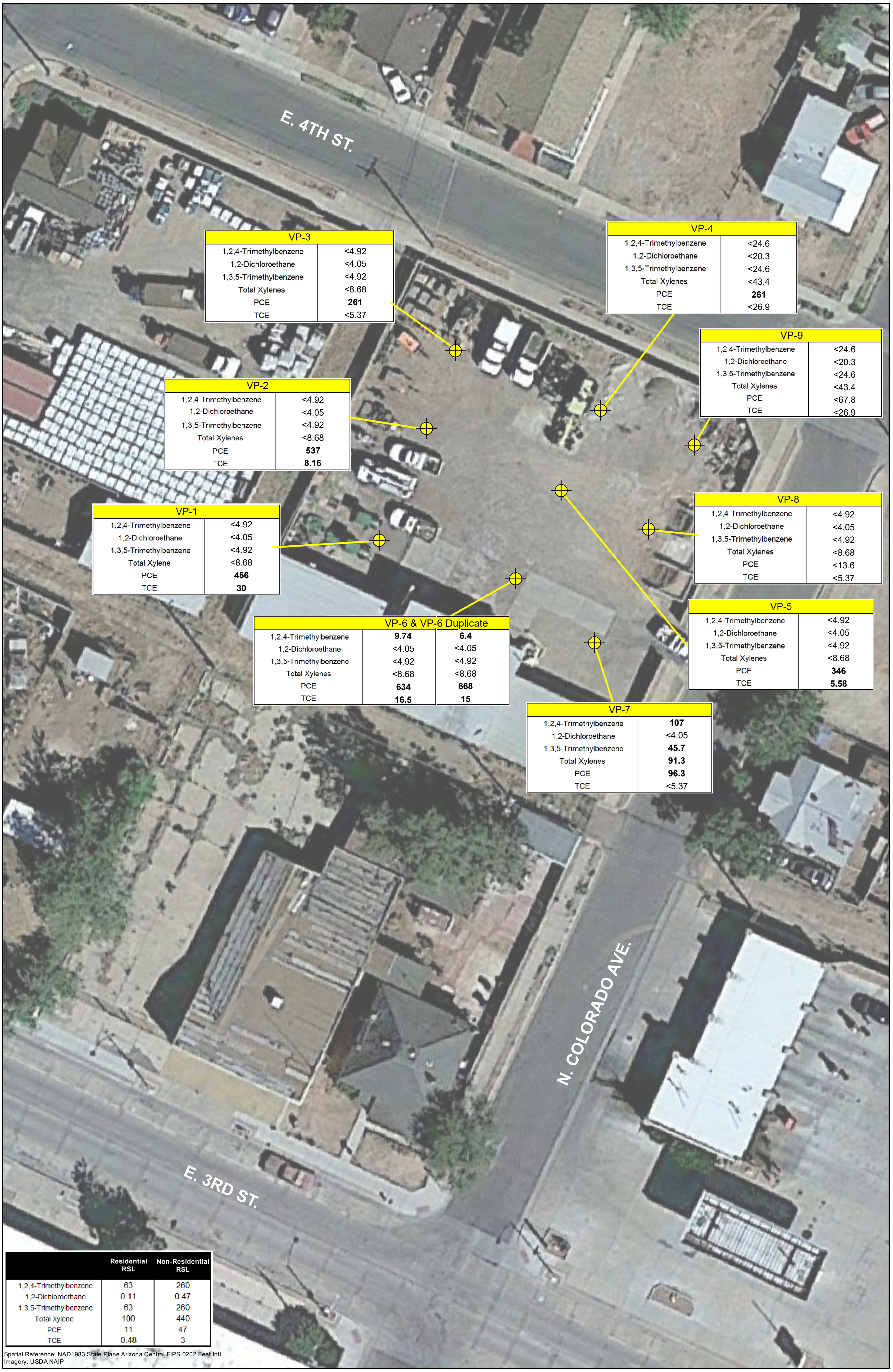
SCALE IN FEET

N

HYDRO GEO CHEM, INC.

APRIL 2021 1,2-DCA PLUME BOUNDARY
CITY OF WINSLOW PUBLIC WORKS YARD
WINSLOW, ARIZONA

Approved	Date	Author	Date	File Name	Figure
AJB	01/27/22	MRW	01/27/22	2012021095G	14



VP-3	
1,2,4-Trimethylbenzene	<4.92
1,2-Dichloroethane	<4.05
1,3,5-Trimethylbenzene	<4.92
Total Xylenes	<8.68
PCE	**261**
TCE	<5.37

VP-4	
1,2,4-Trimethylbenzene	<24.6
1,2-Dichloroethane	<20.3
1,3,5-Trimethylbenzene	<24.6
Total Xylenes	<43.4
PCE	**261**
TCE	<26.9

VP-9	
1,2,4-Trimethylbenzene	<24.6
1,2-Dichloroethane	<20.3
1,3,5-Trimethylbenzene	<24.6
Total Xylenes	<43.4
PCE	<67.8
TCE	<26.9

VP-2	
1,2,4-Trimethylbenzene	<4.92
1,2-Dichloroethane	<4.05
1,3,5-Trimethylbenzene	<4.92
Total Xylenes	<8.68
PCE	**537**
TCE	**8.16**

VP-1	
1,2,4-Trimethylbenzene	<4.92
1,2-Dichloroethane	<4.05
1,3,5-Trimethylbenzene	<4.92
Total Xylene	<8.68
PCE	**456**
TCE	**30**

VP-8	
1,2,4-Trimethylbenzene	<4.92
1,2-Dichloroethane	<4.05
1,3,5-Trimethylbenzene	<4.92
Total Xylenes	<8.68
PCE	<13.6
TCE	<5.37

VP-6 & VP-6 Duplicate		
1,2,4-Trimethylbenzene	**9.74**	**6.4**
1,2-Dichloroethane	<4.05	<4.05
1,3,5-Trimethylbenzene	<4.92	<4.92
Total Xylenes	<8.68	<8.68
PCE	**634**	**668**
TCE	**16.5**	**15**

VP-5	
1,2,4-Trimethylbenzene	<4.92
1,2-Dichloroethane	<4.05
1,3,5-Trimethylbenzene	<4.92
Total Xylenes	<8.68
PCE	**346**
TCE	**5.58**

VP-7	
1,2,4-Trimethylbenzene	**107**
1,2-Dichloroethane	<4.05
1,3,5-Trimethylbenzene	**45.7**
Total Xylenes	**91.3**
PCE	**96.3**
TCE	<5.37

	Residential RSL	Non-Residential RSL
1,2,4-Trimethylbenzene	63	260
1,2-Dichloroethane	0.11	0.47
1,3,5-Trimethylbenzene	63	260
Total Xylene	100	440
PCE	11	47
TCE	0.48	3

Spatial Reference: NAD1983 State Plane Arizona Central FIPS 0202 Feet Intl
Imagery: USDA NAIP

VP-1	
1,2,4-Trimethylbenzene	<49.2
1,2-Dichloroethane	<40.5
1,3,5-Trimethylbenzene	<49.2
Total Xylene	<86.8
PCE	**4,560**
TCE	**300**

soil vapor sampling location with VOC concenrations in μg/m^3

30 15 0
Feet

N

NOTE: **BOLD** values exceed laboratory reporting limit. All table values in μg/m^3.

HYDRO GEO CHEM, INC.

APRIL 2020 SOIL VAPOR VOC RESULTS
CITY OF WINSLOW PUBLIC WORKS YARD
WINSLOW, ARIZONA

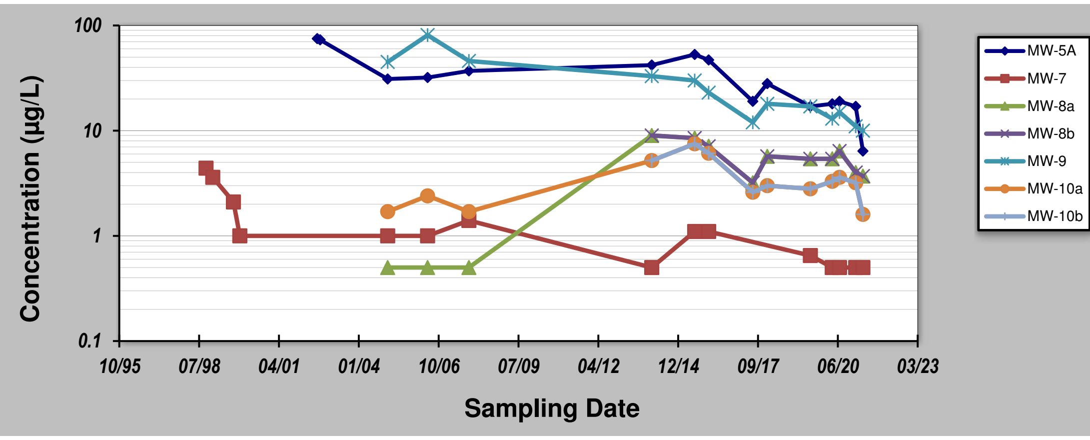
Approved	Date	Author	Date	File Name	Figure
AJB	01/28/22	MRW	01/28/22	2012021047G	15

TABLE H.1A
Mann-Kendall Trend Analysis 1,2-DCA
City of Winslow Public Works Yard
317 N Colorado Ave, Winslow, Arizona
ADEQ Facility ID 0-005684, LUST # 1686.02

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	23-Jan-22	Job ID:	2012021
Facility Name:	City of Winslow Public Works	Constituent:	1,2-DCA
Conducted By:	AJB	Concentration Units:	µg/L

	Sampling Point ID:	MW-5A	MW-7	MW-8a	MW-8b	MW-9	MW-10a	MW-10b
Sampling Event	Sampling Date	1,2-DCA CONCENTRATION (µg/L)						
1	19-Oct-98		4.4					
2	11-Jan-99		3.6					
3	27-Sep-99		2.1					
4	16-Dec-99		1					
5	12-Aug-02	75						
6	17-Sep-02	73						
7	10-Jan-05	31	1	0.5		45	1.7	
8	25-May-06	32	1	0.5		81	2.4	
9	24-Oct-07	37	1.4	0.5		46	1.7	
10	30-Jan-14	42	0.5	9.0	9.0	33	5.2	5.2
11	22-Jul-15	53	1.1	8.5	8.5	30	7.5	7.5
12	13-Jan-16	47	1.1	7.1	7.1	23	6.1	6.1
13	19-Jul-17	19		3.2	3.2	12	2.6	2.6
14	16-Jan-18	28		5.7	5.7	18	3.0	3.0
15	10-Jul-19	17	0.65	5.4	5.4	17	2.8	2.8
16	09-Apr-20	18	0.5	5.4	5.4	13	3.3	3.3
17	09-Jul-20	19	0.5	6.4	6.4	15	3.6	3.6
18	28-Jan-21	17	0.5	4	4	11	3.2	3.2
19	28-Apr-21	6.4	0.5	3.7	3.7	10	1.6	1.6
20								
	Coefficient of Variation:	0.60	0.89	0.63	0.33	0.75	0.52	0.46
	Mann-Kendall Statistic (S):	-67	-67	4	-26	-64	7	-17
	Confidence Factor:	>99.9%	>99.9%	57.1%	98.9%	>99.9%	64.0%	92.2%
	Concentration Trend:	Decreasing	Decreasing	No Trend	Decreasing	Decreasing	No Trend	Prob. Decreasing



Notes:

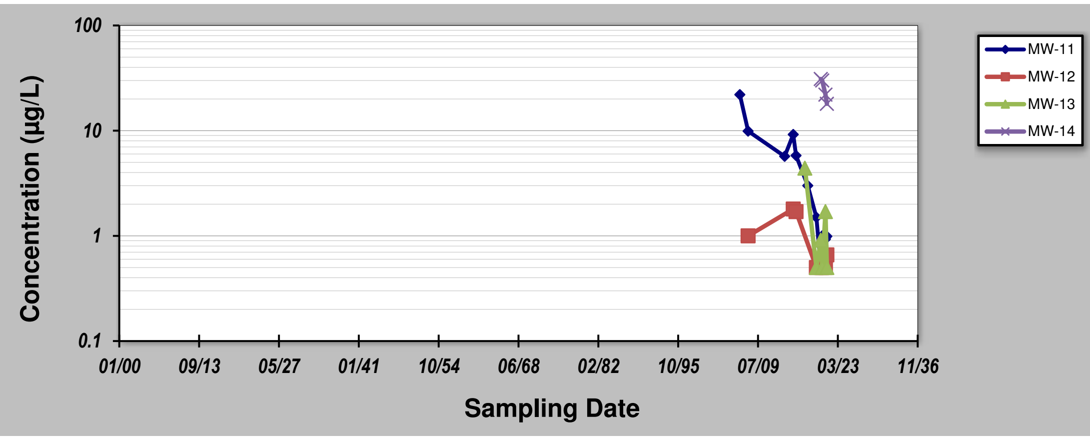
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

TABLE H.1B
Mann-Kendall Trend Analysis 1,2-DCA
City of Winslow Public Works Yard
317 N Colorado Ave, Winslow, Arizona
ADEQ Facility ID 0-005684, LUST # 1686.02

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	23-Jan-22	Job ID:	2012021
Facility Name:	City of Winslow Public Works	Constituent:	1,2-DCA
Conducted By:	AJB	Concentration Units:	µg/L

	Sampling Point ID:	MW-11	MW-12	MW-13	MW-14			
Sampling Event	Sampling Date	1,2-DCA CONCENTRATION (µg/L)						
1	19-Oct-98							
2	11-Jan-99							
3	27-Sep-99							
4	16-Dec-99							
5	12-Aug-02							
6	17-Sep-02							
7	10-Jan-05							
8	25-May-06	22						
9	24-Oct-07	9.9	1					
10	30-Jan-14	5.7						
11	22-Jul-15	9.2	1.8					
12	13-Jan-16	5.8	1.7					
13	19-Jul-17			4.4				
14	16-Jan-18	3.0						
15	10-Jul-19	1.5	0.5	0.5				
16	09-Apr-20	0.5	0.5	0.91	31			
17	09-Jul-20	1	0.5	0.5	30			
18	28-Jan-21	0.93	0.5	1.7	22			
19	28-Apr-21	0.99	0.66	0.5	18			
20								
	Coefficient of Variation:	1.17	0.62	1.08	0.25			
	Mann-Kendall Statistic (S):	-43	-10	-4	-6			
	Confidence Factor:	>99.9%	86.2%	70.3%	95.8%			
	Concentration Trend:	Decreasing	Stable	No Trend	Decreasing			



Notes:

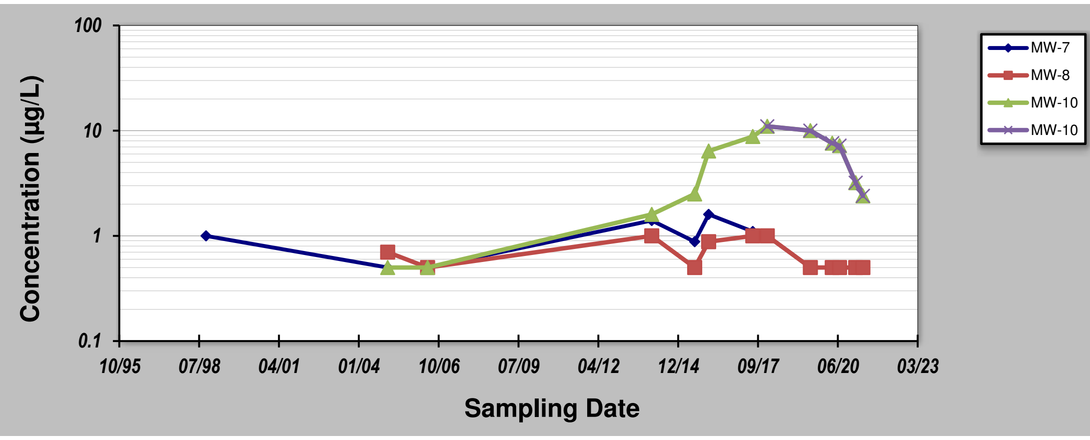
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

TABLE H.2
Mann-Kendall Trend Analysis MTBE
City of Winslow Public Works Yard
317 N Colorado Ave, Winslow, Arizona
ADEQ Facility ID 0-005684, LUST # 1686.02

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	23-Jan-22	Job ID:	2012021
Facility Name:	City of Winslow Public Works	Constituent:	MTBE
Conducted By:	AJB	Concentration Units:	µg/L

Sampling Event	Sampling Date	MW-7	MW-8	MW-10	MW-10			
		MTBE CONCENTRATION (µg/L)						
1	19-Oct-98	1						
2	11-Jan-99							
3	27-Sep-99							
4	16-Dec-99							
5	12-Aug-02							
6	17-Sep-02							
7	10-Jan-05	0.5	0.7	0.5				
8	25-May-06	0.5	0.5	0.5				
9	24-Oct-07							
10	30-Jan-14	1.4	1.0	1.6				
11	22-Jul-15	0.88	0.5	2.5				
12	13-Jan-16	1.6	0.88	6.4				
13	19-Jul-17	1.1	1	8.8				
14	16-Jan-18	1	1	11.0	11.0			
15	10-Jul-19	0.5	0.5	10	10			
16	09-Apr-20	0.5	0.5	7.6	7.6			
17	09-Jul-20	0.5	0.5	7.2	7.2			
18	28-Jan-21	0.5	0.5	3.2	3.2			
19	28-Apr-21	0.5	0.5	2.4	2.4			
20								
Coefficient of Variation:		0.48	0.34	0.73	0.51			
Mann-Kendall Statistic (S):		-22	-16	21	-15			
Confidence Factor:		89.8%	84.5%	91.3%	99.9%			
Concentration Trend:		Stable	Stable	Prob. Increasing	Decreasing			



Notes:

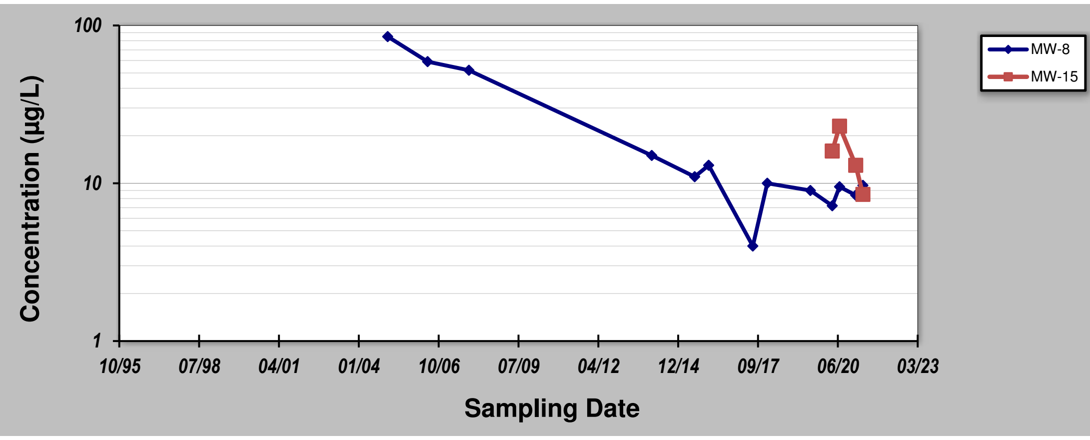
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

TABLE H.3
Mann-Kendall Trend Analysis TCE
City of Winslow Public Works Yard
317 N Colorado Ave, Winslow, Arizona
ADEQ Facility ID 0-005684, LUST # 1686.02

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	23-Jan-22	Job ID:	2012021
Facility Name:	City of Winslow Public Works	Constituent:	TCE
Conducted By:	AJB	Concentration Units:	μg/L

Sampling Event	Sampling Date	MW-8	MW-15					
		TCE CONCENTRATION (μg/L)						
1	19-Oct-98							
2	11-Jan-99							
3	27-Sep-99							
4	16-Dec-99							
5	12-Aug-02							
6	17-Sep-02							
7	10-Jan-05	85						
8	25-May-06	59						
9	24-Oct-07	52						
10	30-Jan-14	15						
11	22-Jul-15	11						
12	13-Jan-16	13						
13	19-Jul-17	4.0						
14	16-Jan-18	10						
15	10-Jul-19	9						
16	09-Apr-20	7.2	16					
17	09-Jul-20	9.5	23					
18	28-Jan-21	8.4	13					
19	28-Apr-21	9.7	8.5					
20								
Coefficient of Variation:		1.13	0.40					
Mann-Kendall Statistic (S):		-50	-4					
Confidence Factor:		99.9%	83.3%					
Concentration Trend:		Decreasing	Stable					



Notes:

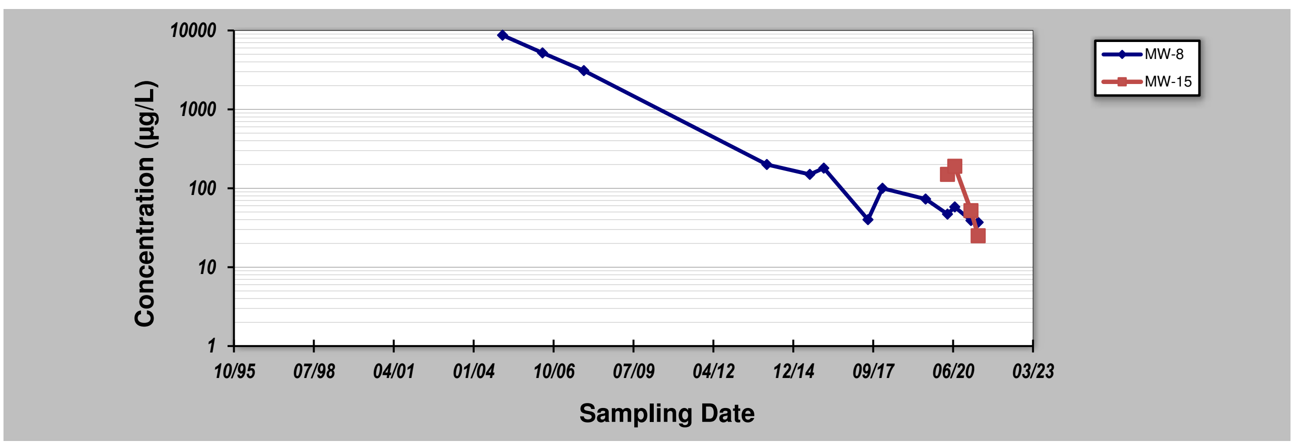
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

TABLE H.4
Mann-Kendall Trend Analysis PCE
City of Winslow Public Works Yard
317 N Colorado Ave, Winslow, Arizona
ADEQ Facility ID 0-005684, LUST # 1686.02

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: 23-Jan-22
Facility Name: City of Winslow Public Works
Conducted By: AJB
Job ID: 2012021
Constituent: PCE
Concentration Units: µg/L

Sampling Event	Sampling Date	PCE CONCENTRATION (µg/L)						
Sampling Point ID:		MW-8	MW-15					
1	19-Oct-98							
2	11-Jan-99							
3	27-Sep-99							
4	16-Dec-99							
5	12-Aug-02							
6	17-Sep-02							
7	10-Jan-05	8700						
8	25-May-06	5200						
9	24-Oct-07	3100						
10	30-Jan-14	200						
11	22-Jul-15	150						
12	13-Jan-16	180						
13	19-Jul-17	40						
14	16-Jan-18	100						
15	10-Jul-19	73						
16	09-Apr-20	47	150					
17	09-Jul-20	58	190					
18	28-Jan-21	39	52					
19	28-Apr-21	37	25					
20								
Coefficient of Variation:		1.96	0.75					
Mann-Kendall Statistic (S):		-66	-4					
Confidence Factor:		>99.9%	83.3%					
Concentration Trend:		Decreasing	Stable					



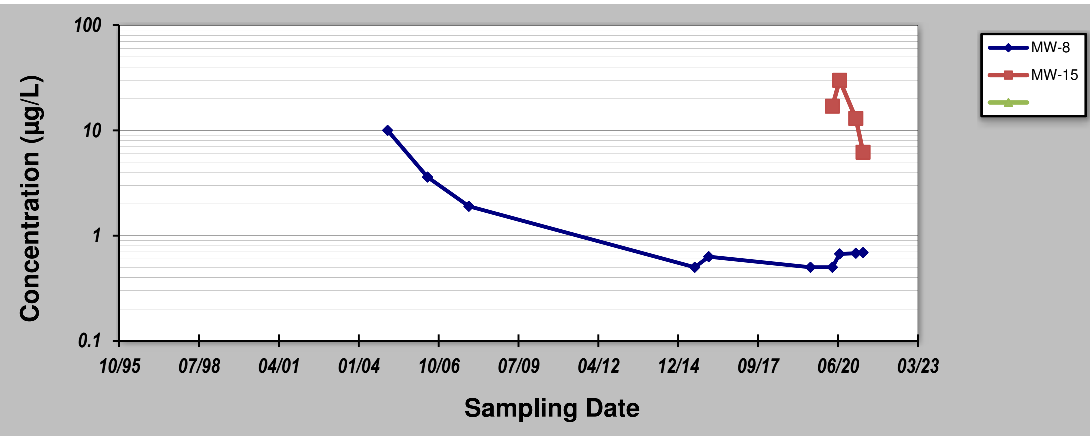
Notes:
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

TABLE H.5
Mann-Kendall Trend Analysis cis-1,2-DCE
City of Winslow Public Works Yard
317 N Colorado Ave, Winslow, Arizona
ADEQ Facility ID 0-005684, LUST # 1686.02

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	23-Jan-22	Job ID:	2012021
Facility Name:	City of Winslow Public Works	Constituent:	*cis* 1,2-DCE
Conducted By:	AJB	Concentration Units:	µg/L

Sampling Point ID:		MW-8	MW-15					MW-15
Sampling Event	**Sampling Date**	**CIS 1,2-DCE CONCENTRATION (µg/L)**						
1	19-Oct-98							
2	11-Jan-99							
3	27-Sep-99							
4	16-Dec-99							
5	12-Aug-02							
6	17-Sep-02							
7	10-Jan-05	10						
8	25-May-06	3.6						
9	24-Oct-07	1.9						
10	30-Jan-14							
11	22-Jul-15	0.5						
12	13-Jan-16	0.63						
13	19-Jul-17							
14	16-Jan-18							
15	10-Jul-19	0.5						
16	09-Apr-20	0.5	17					
17	09-Jul-20	0.67	30					
18	28-Jan-21	0.68	13					
19	28-Apr-21	0.69	6.2					
20								
Coefficient of Variation:		1.52	0.61					
Mann-Kendall Statistic (S):		-10	-4					
Confidence Factor:		78.4%	83.3%					
Concentration Trend:		No Trend	Stable					



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

First-Order Rate Estimate Using One-Dimensional, Steady-State Solution (Bear, 1979)

GEOSCIENCE RESOURCES INC

Northwest Flow Path
EXPONENTIAL FIT FOR SUM OF VOC CONCENTRATIONS VS. DISTANCE

Enter data for concentrations and distance along a flow path

ID	Distance	Conc.
MW-5A	0	0.0063
MW-9	50	0.01
MW-13	113	0.0005

Transport Parameters

0.0370	hydraulic conductivity (m/day)
0.0038	hydraulic gradient (m/m)
0.15	effective porosity (cm³/cm³)
0.0009	average linear velocity (m/day)
38	Koc (L/kg)
1.00E-03	foc (g/g)
0.038	Kd (L/kg)
2.4	dry bulk density (g/cm³)
0.15	total porosity (cm³/cm³)
1.61	retardation factor (R)
0.001	solute transport velocity (m/day)
3	longitudinal dispersivity (m)

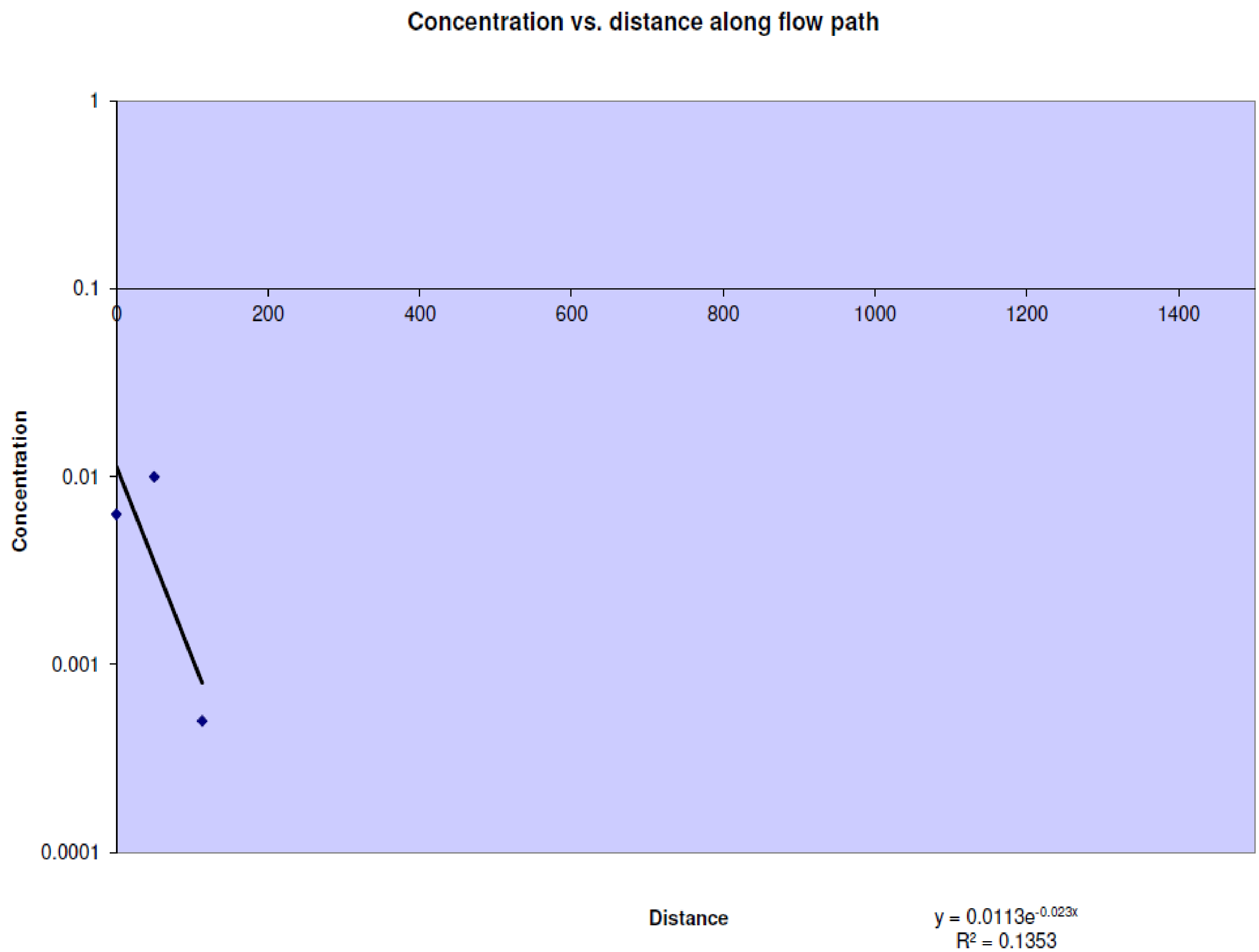
INSTRUCTIONS
This spreadsheet is set up to use any consistent set of units for length and time.
The value for the first-order rate constant will be in whatever time unit you choose to use.

Slope (m) = -0.0234919

λ = 1.47E-05

$$\lambda = \left(\frac{v_c}{4\alpha_x}\right)\left[(1-2\alpha_x m)^2 - 1\right]$$

HYDRO GEO CHEM, INC.	FIRST-ORDER RATE ESTIMATE USING 1-D STEADY STATE SOLUTION (BEAR, 1979) NORTHWEST TRANSECT				
Approved AJB	Date 4/9/19	Author GEM	Date 4/9/19	File Name FN.xlsx	Figure I.1a



HYDRO GEO CHEM, INC.

SEMI-LOG PLOT OF CONCENTRATION VS. DISTANCE USED IN BEAR (1979) CALCULATION NORTHWEST TRANSECT

Approved	Date	Author	Date	File Name	Figure
AJB	4/9/19	GEM	4/9/19	FN.xlsx	I.1b

First-Order Rate Estimate Using One-Dimensional, Steady-State Solution (Bear, 1979)

GEOSCIENCE RESOURCES INC

Enter description here
EXPONENTIAL FIT FOR SUM OF VOC CONCENTRATIONS VS. DISTANCE

Enter value

Calculated or enter value

INSTRUCTIONS
This spreadsheet is set up to use any consistent set of units for length and time.
The value for the first-order rate constant will be in whatever time unit you choose to use.

Enter data for concentrations and distance along a flow path

ID	Distance	Conc.
MW-5A	0	0.0063
MW-11	103	0.00099
MW-12	210	0.00066

Transport Parameters

0.0370	hydraulic conductivity (m/day)
0.0059	hydraulic gradient (m/m)
0.15	effective porosity (cm^3/cm^3)
0.0015	average linear velocity (m/day)
38	Koc (L/kg)
1.00E-03	foc (g/g)
0.038	Kd (L/kg)
2.4	dry bulk density (g/cm^3)
0.15	total porosity (cm^3/cm^3)
1.61	retardation factor (R)
0.001	solute transport velocity (m/day)
3	longitudinal dispersivity (m)

Slope (m) = -0.01069818

λ = 9.99E-06

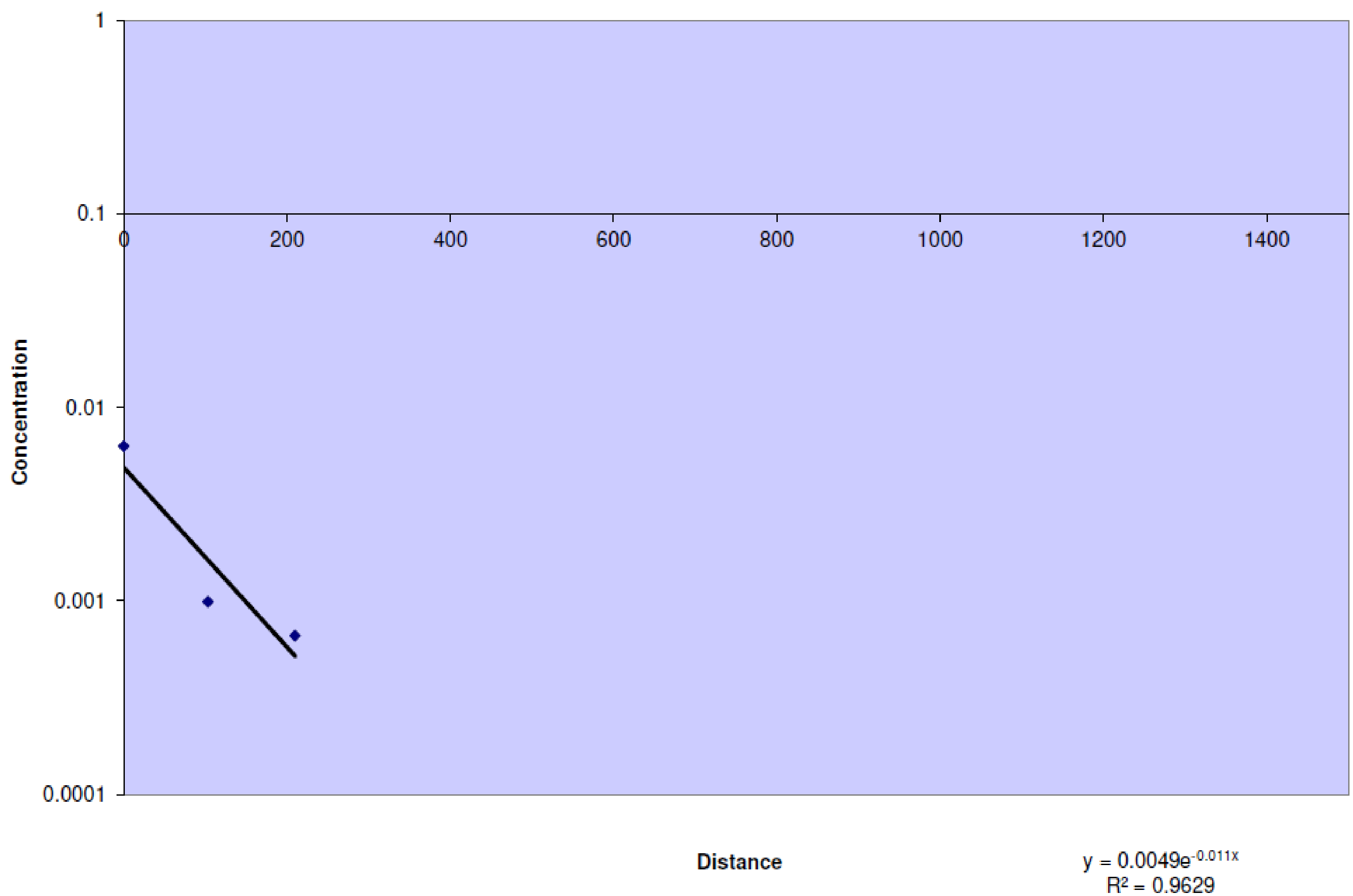
$$\lambda = \left(\frac{v_c}{4\alpha_x}\right)\left[(1-2\alpha_x m)^2 - 1\right]$$

HYDRO GEO CHEM, INC.

FIRST-ORDER RATE ESTIMATE USING 1-D STEADY STATE SOLUTION (BEAR, 1979) NORTHEAST TRANSECT

Approved	Date	Author	Date	File Name	Figure
AJB	4/9/19	GEM	4/9/19	FN.xlsx	I.2a

Concentration vs. distance along flow path



HYDRO GEO CHEM, INC.	SEMI-LOG PLOT OF CONCENTRATION VS. DISTANCE USED IN BEAR (1979) CALCULATION NORTHEAST TRANSECT				
Approved AJB	Date 4/9/19	Author GEM	Date 4/9/19	File Name FN.xlsx	Figure I.2b

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

COW PW Yard — *Run Name*

Data Input Instructions:

115	1. Enter value directly....or
or	2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
0.02	
Variable*	Data used directly in model.
20	Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	0.3	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.3E-05	(cm/sec)
Hydraulic Gradient	i	0.0038	(ft/ft)
Porosity	n	0.15	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	12.0	(ft)
Transverse Dispersivity*	alpha y	1.2	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	105	(ft)

3. ADSORPTION

Retardation Factor*	R	1.6	(-)
or		or	
Soil Bulk Density	rho	2.4	(kg/l)
Partition Coefficient	Koc	38	(L/kg)
FractionOrganicCarbon	foc	1.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	5.4E-3	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	120	(ft)
Modeled Area Width*	80	(ft)
Simulation Time*	30	(yr)

L W

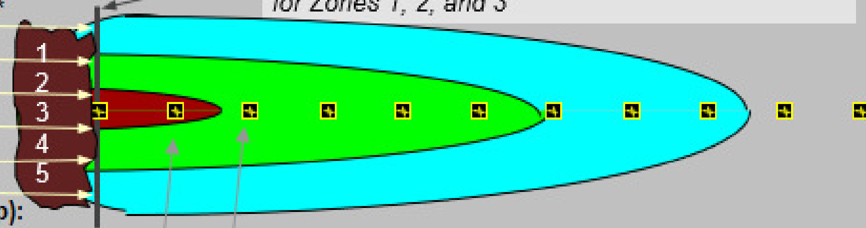
0.34

Source Thickness in Sat.Zone* 2 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
30	0.0165
0	0
0	0

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Source Halflife (see Help):

>1000	>1000	(yr)
Inst. React.	1st Order	

Soluble Mass 0 (Kg)

In Source NAPL, Soil

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	.017				.011						.002
Dist. from Source (ft)	0	12	24	36	48	60	72	84	96	108	120

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **RUN ARRAY**

View Output — **View Output**

Help — Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

HYDRO GEO CHEM, INC.

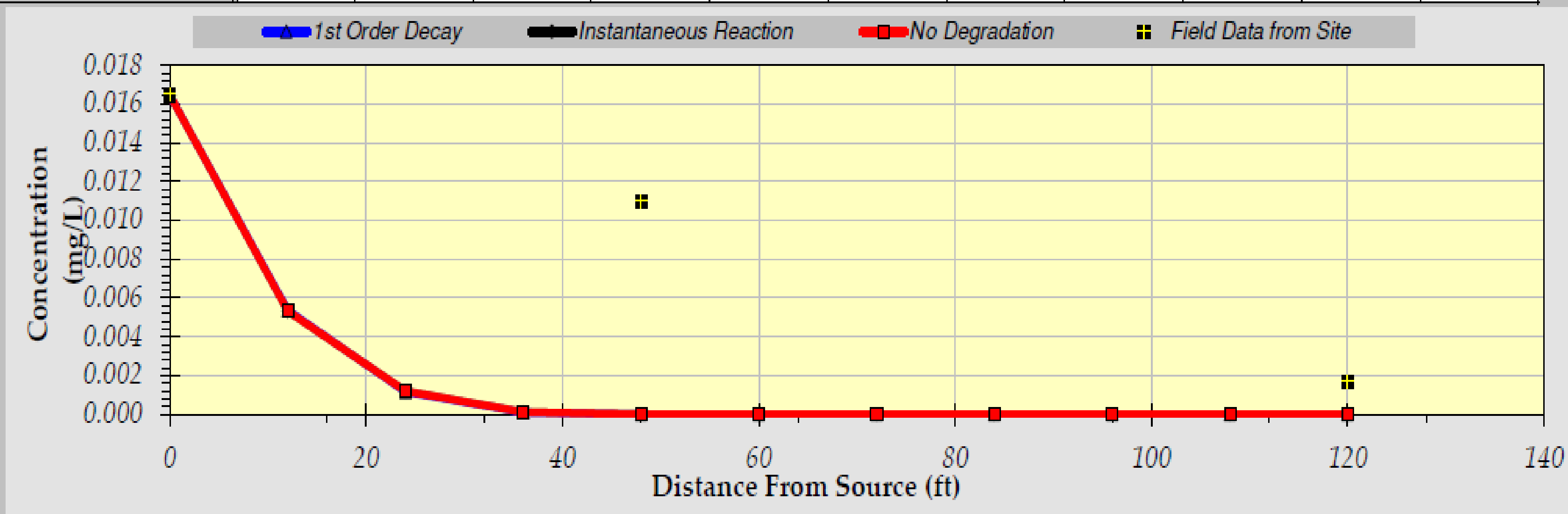
OBSERVED VS. MODELED PLUME PROFILE AT 30 YEARS BIOSCREEN INPUT NORTHWEST TRANSECT

Approved	Date	Author	Date	File Name	Figure
AJB	4/9/19	GEM	4/9/19	FN.xlsx	I.3a

H:\2012021.00 City of Winslow\Reporting\2022 SCR Addendum\App I - BIOSCREEN\App FI 1A-5B.xlsx: F I.3a

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft)										
	0	12	24	36	48	60	72	84	96	108	120
No Degradation	0.016	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.016	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.016	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	0.017				0.011						0.002



Calculate Animation

Time: 30 Years

Return to

Recalculate This

HYDRO GEO CHEM, INC.

OBSERVED VS. MODELED PLUME PROFILE AT 30 YEARS BIOSCREEN OUTPUT NORTHWEST TRANSECT

Approved	Date	Author	Date	File Name	Figure
AJB	4/9/19	GEM	4/9/19	FN.xlsx	I.3b

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence *Version 1.4*

COW PW Yard

Run Name

Data Input Instructions:

115	1. Enter value directly....or
or 0.02	2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
Variable*	Data used directly in model.
20	Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	0.3	*(ft/yr)*
or		*or*	
Hydraulic Conductivity	*K*	1.3E-05	*(cm/sec)*
Hydraulic Gradient	*i*	0.0038	*(ft/ft)*
Porosity	*n*	0.15	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	6.8	*(ft)*
Transverse Dispersivity*	*alpha y*	0.7	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		*or*	
Estimated Plume Length	*Lp*	105	*(ft)*

3. ADSORPTION

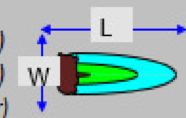
Retardation Factor*	*R*	1.6	*(-)*
or		*or*	
Soil Bulk Density	*rho*	2.4	*(kg/l)*
Partition Coefficient	*Koc*	38	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E-3	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	5.4E-3	*(per yr)*
or		*or*	
Solute Half-Life	*t-half*	0.15	*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	68	*(ft)*
Modeled Area Width*	80	*(ft)*
Simulation Time*	30	*(yr)*



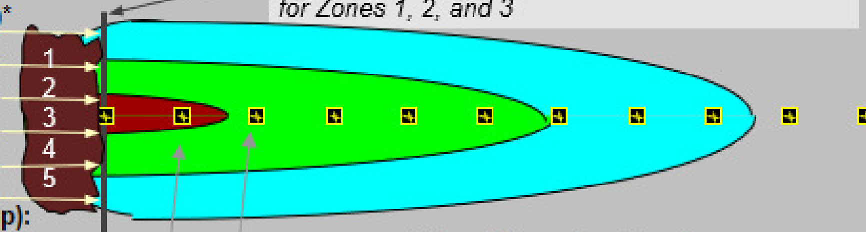
6. SOURCE DATA

Source Thickness in Sat.Zone* 2 *(ft)*

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

Source Zones:

Zone	Width* (ft)	Conc. (mg/L)*
1		
2		
3	30	0.01
4	0	0
5	0	0



View of Plume Looking Down

Source Halflife (see Help):

>1000	>1000	*(yr)*
Inst. React.	1st Order	

Soluble Mass 0 *(Kg)*

In Source NAPL, Soil

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	.01										.001
Dist. from Source (ft)	0	7	14	20	27	34	41	48	54	61	68

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY** | **Help** | Recalculate This Sheet

View Output | **View Output** | Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

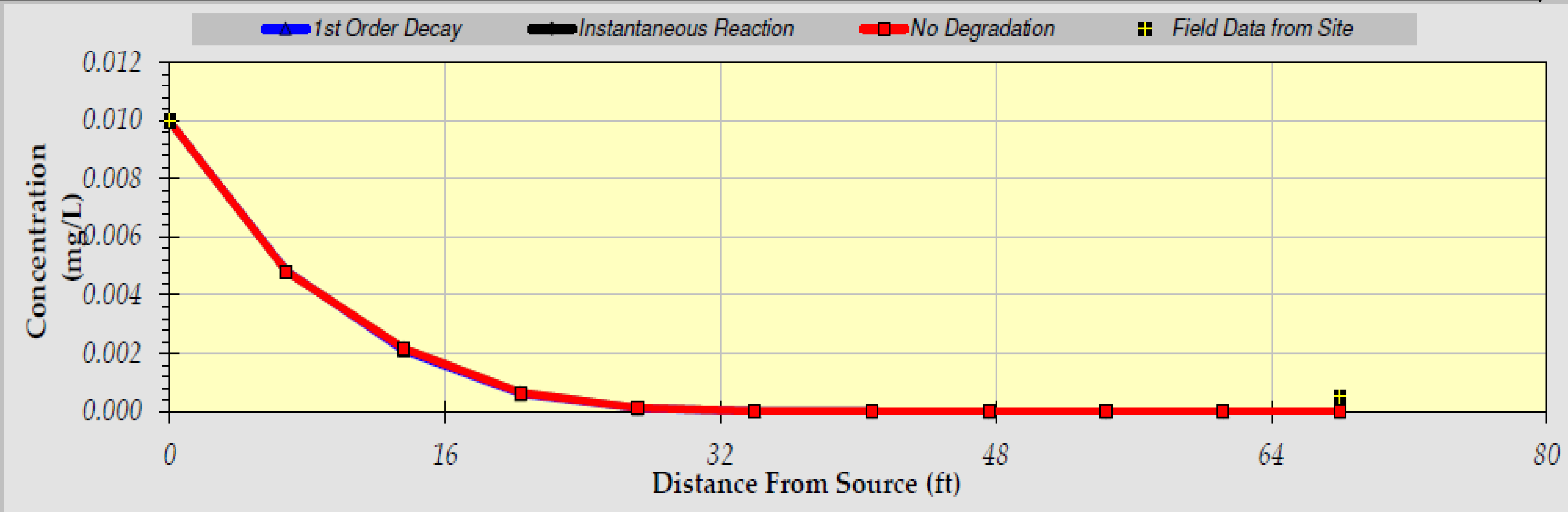
HYDRO GEO CHEM, INC.

MODELED PLUME PROFILE AT 30 YEARS BIOSCREEN INPUT NORTHWEST TRANSECT

Approved	Date	Author	Date	File Name	Figure
AJB	4/9/19	GEM	4/9/19	FN.xlsx	I.4a

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	7	14	20	27	34	41	48	54	61	68
No Degradation	0.010	0.005	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.010	0.005	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.010	0.005	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	0.010										0.001



Calculate Animation

Time:

30 Years

Return to

Recalculate This

HYDRO GEO CHEM, INC.

MODELED PLUME PROFILE AT 30 YEARS BIOSCREEN OUTPUT NORTHWEST TRANSECT

Approved	Date	Author	Date	File Name	Figure
AJB	4/9/19	GEM	4/9/19	FN.xlsx	I.4b

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	0.5	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	1.3E-05	*(cm/sec)*
Hydraulic Gradient	*i*	0.0059	*(ft/ft)*
Porosity	*n*	0.15	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	21.0	*(ft)*
Transverse Dispersivity*	*alpha y*	2.1	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		or	
Estimated Plume Length	*Lp*	210	*(ft)*

3. ADSORPTION

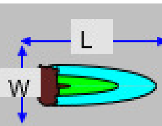
Retardation Factor*	*R*	1.6	*(-)*
or		or	
Soil Bulk Density	*rho*	2.4	*(kg/l)*
Partition Coefficient	*Koc*	38	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E-3	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	3.7E-3	*(per yr)*
or		or	
Solute Half-Life	*t-half*	0.15	*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	210	*(ft)*
Modeled Area Width*	75	*(ft)*
Simulation Time*	30	*(yr)*



0.02 *cells below. (To restore formulas, hit button below).*

Variable* → *Data used directly in model.*

20 → *Value calculated by model. (Don't enter any data).*

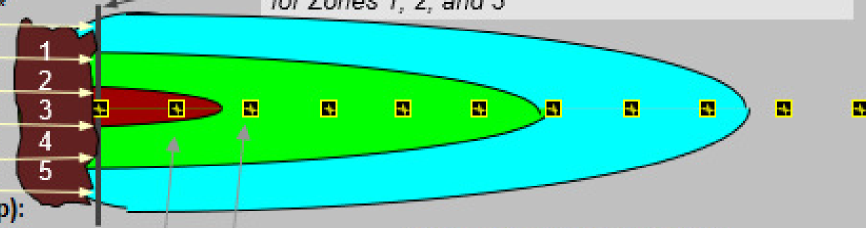
6. SOURCE DATA

Source Thickness in Sat.Zone* 2 *(ft)*

Source Zones:

Width* (ft)	Conc. (mg/L)*
30	0.0165
0	0
0	0

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Source Halflife (see Help):

>1000	>1000	*(yr)*
Inst. React.	1st Order	

Soluble Mass 0 *(Kg)*

In Source NAPL, Soil

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	.017					.001					.001
Dist. from Source (ft)	0	21	42	63	84	105	126	147	168	189	210

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE

View Output

RUN ARRAY

View Output

Help

Recalculate This Sheet

Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

HYDRO GEO CHEM, INC.

OBSERVED VS. MODELED PLUME PROFILE AT 30 YEARS BIOSCREEN INPUT NORTHEAST TRANSECT					
Approved AJB	Date 4/9/19	Author GEM	Date 4/9/19	File Name FN.xlsx	Figure I.5a

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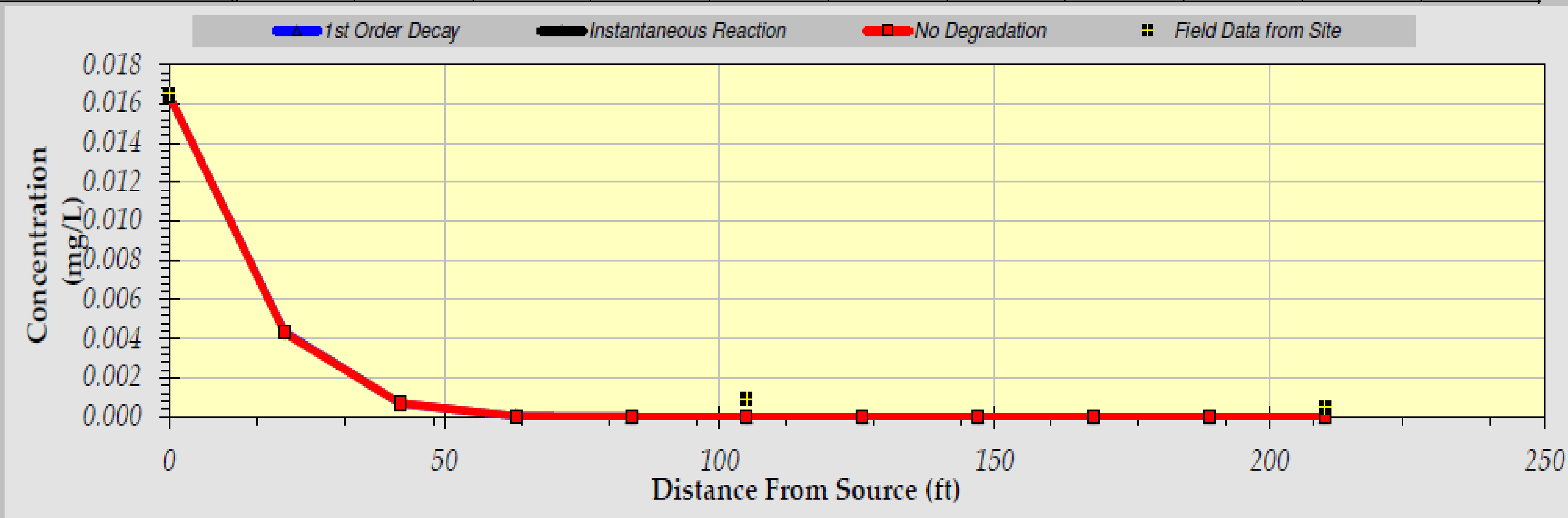
DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft)										
	0	21	42	63	84	105	126	147	168	189	210
No Degradation	0.016	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.016	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.016	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	0.017					0.001					0.001



Calculate Animation

Time:

30 Years

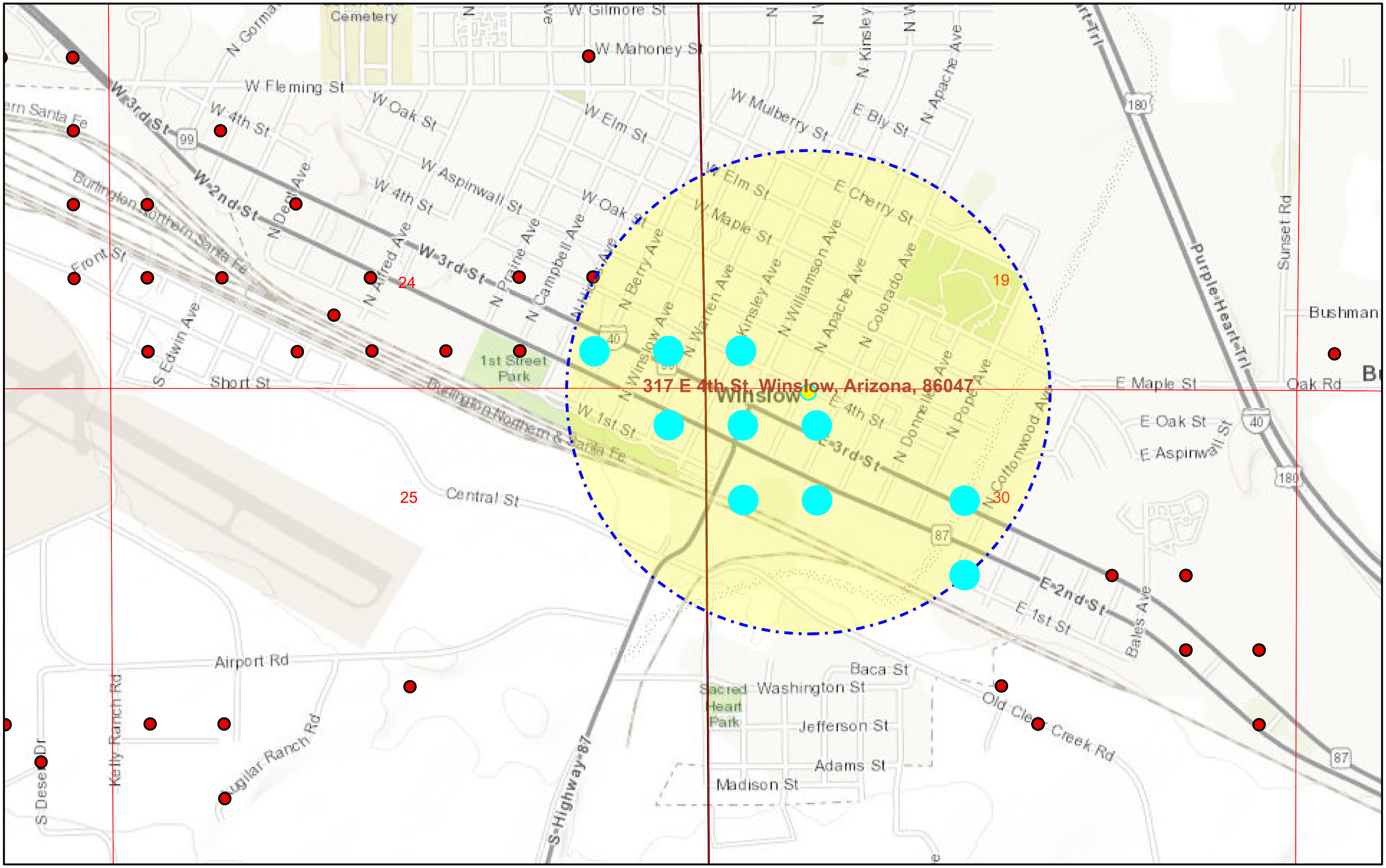
Return to

Recalculate This

HYDRO GEO CHEM, INC.	OBSERVED VS. MODELED PLUME PROFILE AT 30 YEARS BIOSCREEN OUTPUT NORTHEAST TRANSECT					
	Approved AJB	Date 4/9/19	Author GEM	Date 4/9/19	File Name FN.xlsx	Figure I.5b

H:\2012021.00 City of Winslow\Reporting\2022 SCR Addendum\App I - BIOSCREEN\App FI 1A-5B.xlsx: F I.5b

Registry of Wells in AZ (0.5 miles)



February 25, 2022

Well_Registry
Township
Section
County

1:18,056

0 0.13 0.25 0.5 mi

0 0.2 0.4 0.8 km

Bureau of Land Management, Esri, HERE, Garmin, GeoTechnologies, Inc.,

Arizona Department of Water Resources