avis budget group

CONFIDENTIAL COMMUNICATION
NOT SUBJECT TO DISCLOSURE

November 30, 2018

Nevada Division of Environmental Protection
Bureau of Corrective Actions
2030 E. Flamingo Road, Suite 230
Las Vegas, NV 89119
Attn: Ben Moan
Submitted Via E-mail: *bmoan@ndep.nv.gov*

Re: Request for Draft Documents and Work-In-Progress
Fate and Transport Report
Offsite Commingled MTBE Plume
Avis Rent A Car Facility
NDEP Facility ID: 8-000217

Dear Mr. Moan:

In a letter to Avis Budget Car Rental, LLC, (ABCR) dated November 16, 2018, the Nevada Division of Environmental Protection (NDEP) requested that ABCR electronically produce to it all draft documents and models related to ABCR's response to the NDEP's request for a Fate and Transport Report in association with Petroleum Fund ID 200800005. In response to the NDEP, and on behalf of ABCR, Broadbent & Associates, Inc. (Broadbent) compiled the requested electronic files of the draft documents. Broadbent's transmittal letter and electronic files of the draft documents are attached. As you are aware, the information, conclusions and recommendations in the enclosed files are draft, and therefore subject to modification and updating prior to finalization. Because they are working drafts and have not been QAQC'ed, the conclusions contained therein may be incorrect or misleading, and therefore, ABCR requests that they not be disclosed to third parties or relied upon by any party to draw conclusions or be used as the basis for any actions.

Please do not hesitate to contact me if you have any questions.

Very truly yours,

Rose Pelino, PE
Avis Budget Car Rental, LLC
Director of Environmental Affairs

Attachment:
Broadbent transmittal of drafts, with enclosures

Cc:
Jason Hoffman, CEM, Broadbent & Associates, jhoffman@broadbentinc.com
Linda Bullen, Bullen Law, linda@bullenlaw.com
Robert Schultz, Geo Blue Consulting, Inc., rschultz@geoblueconsulting.com
Todd Croft, NDEP, tcroft@ndep.nv.gov
Jeff Collins, NDEP, jcollins@ndep.nv.gov
Frederick Perdomo, State of Nevada, fperdomo@ag.nv.gov

BROADBENT
8 West Pacific Avenue Henderson, NV 89015
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broadbentinc.com

Creating Solutions. Building Trust.

November 29, 2018 Project No. 95-01-150

Ms. Rose Pelino
Avis Budget Group, Inc.
6 Sylvan Way
Parsippany, NJ 07054

Re: Fate and Transport Report and EPA BIOSCREEN Model, Avis Rent A Car System, Inc., 5164 Rent-A-Car Road, Las Vegas, Nevada 89119, Facility I.D. #8-000217.

Dear Ms. Pelino,

As requested in the Nevada Division of Environmental Protection's (NDEP's) correspondence dated November 16, 2018 and as clarified by Mr. Ben Moen, case officer for the NDEP, in a telephone call of November 26, 2018 and e-mail and subsequent responses memorializing that call on November 26 and November 27, 2018, attached are the following as regards a draft fate and transport report and completed draft EPA BIOSCREEN Model for the Avis / Payless project:

- A completed draft BIOSCREEN model in Excel format which will include future model projections and input parameters,
- Draft PDFs of the model's graphical projections in lieu of screenshots, and
- A draft discussion of the results in Microsoft Word with a references section that lists other documents used to complete the draft model. Please note that, as this is a draft, there will be incomplete sections of the text that will be highlighted in yellow and there may be comments in the margins explaining work to be done to reach completion of the text.

Should you have questions or require additional information, please do not hesitate to contact us (702) 563-0600.

Sincerely,
BROADBENT & ASSOCIATES, INC.

Kirk Stowers, CEM #1549 (exp. 10/11/20)
Principal Geologist

Attachments: Draft Fate and Transport Report
Draft BIOSCREEN Model in Excel format
Draft PDFs of the Model's Graphical Representations

JURAT: I, Kirk Stowers, hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and to the best of my knowledge comply with all applicable federal, state, and local statutes, regulations, and ordinances.

Fate and Transport Report
Former McCarran International Airport Car Rental Facilities
Las Vegas, Nevada

Prepared for:

Nevada Division of Environmental Protection
Bureau of Corrective Actions
2030 East Flamingo Road, Suite 230
Las Vegas, Nevada 89119

Prepared by:

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MONTH DATE, YEAR

Project No. 95-01-150

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MONTH DATE, YEAR

Project No. 95-01-150

Nevada Division of Environmental Protection
Bureau of Corrective Actions
2030 East Flamingo Road, Suite 230
Las Vegas, Nevada 89119

Attn: Mr. Ben Moan

Re: Fate and Transport Report, Former McCarran International Airport Car Rental Facilities, Las Vegas, Nevada

Dear Mr. Moan:

Presented herein is the Fate and Transport Report for the groundwater plume located in the offsite area downgradient from the former McCarran International Airport Car Rental facilities in Las Vegas, Nevada. This report presents the results of EPA BIOSCREEN software utilized to estimate potential future offsite MTBE plume length and persistence downgradient of the facilities.

Please do not hesitate to contact us if you should have any questions or require additional information.

Sincerely,
BROADBENT & ASSOCIATES, INC.

Jason Hoffman, CEM #1904 (exp. 1/26/19)
Associate Geologist

enclosures:

ec:
Mr. Ben Moan, NDEP, bmoan@ndep.nv.gov
Mr. Todd Croft, NDEP, tcroft@ndep.nv.gov
Mr. Jeff Collins, NDEP, jcollins@ndep.nv.gov
Ms. Rose Pelino, Avis Budget Group, rose.pelino@avisbusget.com
Mr. Bob Schultz, Geo Blue Consulting, Inc., rschultz@geoblueconsulting.com
Ms. Linda Bullen, Bullen Law, LLC, linda@bullenlaw.com
Mr. Chuck Giesler, chuckg@mccarran.com
Mr. Kurt Goebel, Converse Consultants, kgoebel@converseconsultants.com
Mr. Rob Gegenheimer, Converse Consultants, rgegenheimer@ConverseConsultants.com

Fate and Transport Report
Former McCarran International Airport Car Rental Facilities
Las Vegas, Nevada

REVIEW AND APPROVAL:

JURAT: I, Jason Hoffman, hereby certify that I am responsible for the services in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and to the best of my knowledge comply with all applicable federal, state and local statutes, regulation and ordinances.

______________________________ **MONTH DATE, YEAR**

Jason Hoffman, CEM #1904 (exp. 1/26/19) **Date**
Associate Geologist

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ADD UPON COMPLETION

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

Broadbent & Associates, Inc. (Broadbent), at the request of the Nevada Division of Environmental Protection (NDEP), prepared this Fate and Transport Report for the offsite methyl tertiary-butyl ether (MTBE) groundwater plume downgradient from the former car rental facilities of McCarran International Airport (the Facilities). In the October 5, 2016 Sensitive Receptor Survey prepared for the Facilities, the nearest downgradient water wells were identified as four domestic wells located approximately 7,700 to 8,600 feet downgradient from the source areas, approximately 4,000 feet from the distal end of the MTBE plume (Broadbent, 2016). Accordingly, the primary goal of the investigation leading to the production of this Fate and Transport Report was to demonstrate that the remaining MTBE concentrations in groundwater should not migrate to these four domestic wells, with a secondary goal that the MTBE concentrations should not migrate further than the current investigation area (i.e., past Maryland Parkway). The locations of the Facilities and specific areas downgradient of the Facilities, as referenced in this report, are depicted on Figure 1.

This Fate and Transport Report includes an interpretation of the United States Environmental Protection Agency's (EPA) BIOSCREEN Version 1.4 groundwater modeling software as applied to the commingled MTBE groundwater plume located downgradient of the aforementioned Facilities (the Offsite Plume). BIOSCREEN is a screening tool that can then be utilized to predict natural attenuation (time) and plume migration (distance). The BIOSCREEN software, programmed in Microsoft Excel and based on the Domenico analytical solute transport model, produces a model that has the ability to simulate advection, dispersion, adsorption, and aerobic decay reactions that have been shown to be the dominant biodegradation processes at many petroleum hydrocarbon release sites. As the model is typically calibrated based on existing plume data, the long-term predictions of the model assume that biodegradation will continue at the current rates and that potentially limiting factors (e.g., availability of nutrients, aerobic dissolved oxygen (DO) concentrations (> 1.0 mg/L), etc.) do not appreciably change in the future. These assumptions may or may not be appropriate for a given site.

1.1 Background Information

A draft BIOSCREEN model was prepared for the Facilities in 2009 and was subsequently presented at the "All Facilities" meeting on January 14, 2010. The results of the draft BIOSCREEN model were favorable for protection of identified downgradient sensitive receptors; however, as the model was built using limited data and additional source area remedial activities were planned, the group agreed that a final BIOSCREEN model would be prepared at a later date (herein).

1.2 Evaluation of Biodegradation

From May 2012 through December 2017, Converse Consultants collected groundwater bioparameter data on behalf of the Facilities on a quarterly basis from up to 80 groundwater monitoring wells. The bioparameter data (i.e., "supplemental groundwater data") was collected to further assess groundwater conditions beneath the former Facilities and in the Offsite Plume. As presented in the October 1, 2018 report prepared to evaluate biodegradation in the Offsite Plume (Broadbent, 2018), Broadbent, on behalf of the Facilities, evaluated the bioparameter data and concluded the following:

- Ambient groundwater conditions in the vicinity of the Facilities is aerobic groundwater with negative oxidation reduction potential (ORP) likely due to the lack of degradation substrates.

- Ambient groundwater is affected as it moves through the upgradient source areas that have been impacted by petroleum hydrocarbons: dissolved hydrocarbon concentrations (e.g., MTBE) increase and the accompanying increase in bacterial activity reduces DO concentrations to anaerobic conditions.
- In areas where DO has been supplemented by remedial activities, apparent bacterial activity increases as indicated by ORP increases, and this is followed by marked decreases in MTBE concentrations. Elevated DO does not extend a significant distance downgradient from remedial areas; however, elevated ORP has been observed to persist and migrate downgradient into the offsite area.
- Nitrate and sulfate are historically lower than suggested ambient conditions of the shallow aquifer of the Las Vegas Valley. Nitrate depletion in petroleum-impacted groundwater indicates that anaerobic biodegradation likely occurred. Sulfate is found in the highest concentrations in the Offsite Plume, suggesting that anaerobic biodegradation is not likely limited by lack of a terminal electron acceptor in the Offsite Plume. However, given the steady concentrations of MTBE observed in the Offsite Plume, significant aerobic biodegradation is not likely occurring.
- Microbial populations in the Offsite Plume appear adequate for natural biodegradation and these bacteria appear to be actively degrading MTBE in the Offsite Plume. However, these populations are limited by low DO in the Offsite Plume

Source area remediation at the Facilities is projected to be discontinued by the end of 2019; accordingly, it is possible or likely that groundwater conditions in the Offsite Plume area will become less conducive to biodegradation in the future. These types of future changes are unable to be accounted for in a BIOSCREEN model and, inherently, introduce uncertainty in the findings included in this Fate and Transport Report.

2.0 METHODS

The following sections describe the methods utilized to conduct this fate and transport analysis.

2.1 Area Classifications

Groundwater monitoring has been ongoing at the Facilities and areas downgradient of the Facilities for more than 20 years. For classification purposes, this Fate and Transport Report describes groundwater in three separate areas:

- Source Areas, which comprise the historical UST basins of Avis, National, and Payless, and the areas immediately downgradient of those source areas;
- The Downgradient Area, which includes the commingled portions of the Offsite Plume located in residential areas downgradient of the Source Areas; and
- The Distal End Area, which is comprised of a transect of groundwater monitoring wells located in Maryland Parkway.

The locations of these areas and associated groundwater monitoring wells are depicted on Figure 1.

Commented [A1]: This may need to be revised, due to NDEP's recent comments that each individual RP will be required to prepare a source area BIOSCREEN.

2.2 Groundwater Plume Status

Commented [A2]: This section could be reorganized a bit and moved to the Background Section

Remedial efforts within the Source Areas have been successful at targeting and reducing source petroleum hydrocarbon concentrations found in soil and resulting dissolved concentrations of petroleum hydrocarbons found in groundwater. Historically, MTBE concentrations have been observed as high as 192,250 µg/L and benzene as high as 21,500 µg/L in the Source Areas. Due to this remediation, the contiguous groundwater plume, which at one time extended almost 5,000 feet, has been "split", creating detached areas. With exception to a small area of benzene concentrations remaining at the National Source Area (MW-2, average 2017 benzene concentration of 110 µg/L), the remaining petroleum hydrocarbons of concern are MTBE and tertiary butyl alcohol (TBA), which is a biodegradation product of MTBE.

TBA concentrations are elevated in the vicinity of the Source Areas where active MTBE remediation has occurred. EPA does not recommend the use of the BIOSCREEN model to predict TBA fate and transport, and instead favors long-term monitoring of TBA concentrations to evaluate fate and transport. Historically, TBA concentrations associated with the Facilities are rapidly reduced to below laboratory detection limits once they migrate out of the Source Areas into the more aerobic conditions. TBA has rarely been observed in the Downgradient Areas and has never been observed at the Distal End Area. Consequently, TBA will not be included any further in this fate and transport model.

Dissolved MTBE concentrations remain in the Source Areas and the Downgradient Area above the MTBE Oxygenated Fuel Corrective Action Policy level of 200 µg/L that has been established for the Facilities. Active remediation was completed in the Avis Source Area in December 2014 and was discontinued in the Payless Source Area in December 2017. Additional active remediation is still planned for the National Source Area to reduce MTBE concentrations and the previously mentioned dissolved benzene concentrations in the vicinity of monitoring well MW-2. Additional active remediation is being evaluated by NDEP for the Payless Source Area to address remaining MTBE concentrations.

For the Downgradient Area, historical data collected by the Facilities and presented to NDEP in electronic format by CE2 Corporation (concentration trend graphs, plume maps, etc.) and other analyses presented at NDEP "All Facilities" meetings suggest that concentrations in the Offsite Plume have been decreasing over time. In addition, the Offsite Plume has been slowly decreasing in size. A Mann Kendall analyses worksheet prepared by Broadbent for seven wells located within the Offsite Plume is attached in Appendix A. As depicted on the worksheet, the majority of wells are decreasing or probably decreasing, with exception to well OMW-79-52, located at the leading edge of the Offsite Plume, which is increasing.

The Offsite Plume has been contracting away from the Distal End Area since the Maryland Transect of monitoring wells were installed in 2011. MTBE concentrations above the MTBE Oxygenated Fuel Corrective Action Policy level of 200 µg/L that has been established for the Facilities have not been observed in the Distal End Area since 2013.

As of the Fourth Quarter, 2017, the highest dissolved concentrations of MTBE in each area are found in groundwater at the following wells/locations:

Area	Well ID	Location	Average MTBE Concentration in 2017 (µg/L)
Source Areas	AVMW-50-65	Avis Source Area: Former Avis Property (75 feet downgradient from former Avis UST basin)	148.5
	MW-16-60	National Source Area: Former National Property (200 feet downgradient from former National UST basin)	2,150
	PMW-17-52	Payless Source Area: Former Avis Property (450 feet downgradient from former Payless UST basin)	1,040
Downgradient Area	OMW-73-57	Downgradient residential area (2,400 to 3,300 feet downgradient from Avis/National/Payless source areas)	1,450
	OMW-43-60	Downgradient residential area (2,750 to 3,650 feet downgradient from Avis/National/Payless source areas)	1,500
Distal End Area	OMW-68-50	Furthest downgradient well (3,800 to 4,700 feet downgradient from Avis/National/Payless source areas)	13.5

As active remediation is still planned for the National Source Area (the area with the highest observed MTBE concentrations in 2017), this Fate and Transport Report will focus on the Offsite Plume in the Downgradient Area.

Commented [A3]: As with above, we may need to remove this justification for only generating one BIOSCREEN for everyone.

2.3 BIOSCREEN Model

For the BIOSCREEN model, hydrogeologic, dispersion, adsorption, and biodegradation parameters were established. Hydrogeologic parameters included hydraulic conductivity, hydraulic gradient, and soil porosity; dispersion parameters included longitudinal, transverse, and vertical dispersivity; the adsorption parameter was the retardation factor; and the biodegradation parameter was the first order decay rate. Typically, BIOSCREEN models are calibrated utilizing actual data collected during the history of the project. Due to the remediation of the Source Areas and the detached Offsite Plume which does not have a true remaining "source" component, model calibration relied on conservative estimations for MTBE which is potentially trapped in the interstitial spaces of the finer soils in the Downgradient Area. This is discussed in further detail in *Source Data* section below.

The following is a breakdown of the parameters input into the BIOSCREEN software. A listing of the parameters can also be found in Appendix B.

2.3.1 Hydrogeology

Seepage Velocity = 375 feet/year

Previous estimates of seepage velocity conducted by others have estimated plume seepage velocity at 375 feet per year within the coarser lithologic layers (AMEC, 2014). The calculation for seepage velocity was made by multiplying the hydraulic conductivity of the MTBE-saturated zone at 45 to 70 feet below ground surface [3.0 x 10-3] [estimated from the known lithology of the highest transmissivity soils within this zone (silty sands with intermittent gravels)] by the actual hydraulic gradient [0.009 feet/foot] (2017 average from field data) and dividing by the estimated effective porosity [0.20] (standard value utilized for silts and sands). The proper unit conversions were made by the BIOSCREEN software.

Commented [A4]: Need to justify using 375 instead of the model calculation. Can reference the info from the CSM.

2.3.2 Dispersion

Longitudinal Dispersivity = 24.5 feet
Transverse Dispersivity = 2.4 feet
Vertical Dispersivity = 0.0 feet

Dispersivity is the process through which a groundwater plume will spread out in a longitudinal direction (along the axis of the groundwater flow), in a transverse direction (perpendicular to groundwater flow), and in a vertical direction (downwards) due to mechanical mixing in the aquifer and the process of chemical diffusion. The estimates of longitudinal, transverse, and vertical dispersivity were made by the BIOSCREEN software via input of the estimated plume length in the Downgradient Area [1,000 feet]. Software interpolation is a commonly accepted method of estimating dispersivity; however, this approach results in increased uncertainty.

2.3.3 Adsorption

Retardation factor = 1.1

The retardation factor is the unitless rate used to account for differences between advective groundwater flow and contaminant migration rates. Retardation is a general term for the many physical process by which dissolved contaminants located within groundwater can be hindered from migrating with groundwater, including sorption to solids located within the aquifer (generally organic carbon) and diffusion into areas of immobile waters. The calculation for the unitless retardation factor was made by the BIOSCREEN software using the assumed soil bulk density [1.7 kg/L] (the typical estimation), an assumed organic carbon partition coefficient [11 L/kg] (typical value for MTBE), and an assumed fraction organic carbon [0.001]. The assumed retardation factor has a high degree of uncertainty and is generally used to account for hindered solute migration resulting from processes that are not well-quantified at a given site.

2.3.4 Biodegradation

First-order decay coefficient = 1.4

The first-order decay coefficient is used to quantify the loss rate o dissolved constituents in groundwater. The first-order decay coefficient is calculated by the BIOSCREEN software using an assumed MTBE half-life (0.693 divided by the half-life). Modelers frequently utilize the first-order decay coefficient as a calibration parameter and adjust the coefficient until the output model matches field data.

An MTBE half-life of 2.0 years is typically an assumed initial value.

Commented [A5]: Expand on justification for ending up at 1.4

2.3.5 General

Modeled Area Length = 3,000 feet
Modeled Area Width = 400 feet
Simulation Time = 23 years

The modeled area length and width were generated from historical field measurements and the known distance to the nearest sensitive receptors (domestic wells), resulting in model dimensions of 3,000 feet by 400 feet. These numbers do not affect the output values of the BIOSCREEN software and are only used for the purposes of creating a range of data display within the graphic model created by the BIOSCREEN software. The simulation time variable controls the amount of time across which the BIOSCREEN data is extrapolated.

Commented [A6]: Full distance not needed based on model outputs. Update

2.3.6 Source Data

Source thickness in saturated zone = 15 feet
Source zone width (in feet) and MTBE concentrations (mg/L) = 300 feet / 1.5 mg/L
Soluble Mass = 165 Kg

Source thickness refers to the physical thickness of the impacted soil zone that is contributing to groundwater impacts. Typical values for source thickness in the saturated zone for light non-aqueous phase liquids (LNAPLs) range from 5 to 20 feet. The source thickness was derived based on historical data collected from the Downgradient Area [15 feet], as the depth below ground surface of the Offsite Plume ranges from approximately 45 to 70 feet with observed thicknesses ranging from approximately 10 to 15 feet.

Soluble Mass is used by the model to simulate a continuing, yet depleting, source of petroleum hydrocarbons from soils. As the Offsite Plume is a detached dissolved MTBE plume from the original source areas, traditional estimates (such as soil analytical data from boreholes in the source areas) are not applicable for this model. MTBE does not readily sorb to soil particles and primarily exists as a "source area" in the interstitial pore space in the finer soils (silts and clays) in this area. As groundwater is thought to move more rapidly through the coarser soils (sands and gravels) in this area (Geo Blue, 2018), MTBE held in these interstitial pore spaces will back-diffuse out into the coarser soils over time. In order to provide a cursory estimate of soluble mass for the model...

Commented [A7]: Needs justification.

2.3.7 Modeling Process

The BIOSCREEN model was subsequently utilized to evaluate the fate and transport of the Offsite Plume in the Downgradient Area. Multiple simulations were run until MTBE was projected to be reduced in dissolved concentrations in groundwater to below the MTBE Oxygenated Fuel Corrective Action Policy level of 200 µg/L that has been established for the Facilities, which also determined the maximum projected distance of plume migration. This process was repeated for both chosen seepage velocities, as discussed in Section 2.3.1.

3.0 RESULTS AND INTERPRETATIONS

The following sections detail Broadbent's evaluation of the BIOSCREEN results and a comparison of the BIOSCREEN results to recent field data from the Offsite Plume.

3.1 EPA BIOSCREEN Results

Analysis of the plots found in Appendix C suggest that, without further active remediation, the maximum anticipated distance that dissolved concentrations of MTBE in excess of the Oxygenated Fuel Corrective Action Policy of 200 µg/L would travel is less than the distance to the nearest domestic wells identified in the Sensitive Receptor Survey and... The model predicts that dissolved MTBE concentrations below 200 µg/L would be realized in 23 years and travel approximately XXX feet. As discussed in Section 1.0, these results are based on historical observations and assumes that biodegradation will continue at the current rates and that potentially limiting factors do not appreciably change in the future.

Commented [A8]: And within the current monitoring network? Measure and confirm.

Commented [A9]: Confirm exact distance within model.

3.2 EPA BIOSCREEN Results Compared to Field Trends

MTBE concentrations within the Offsite Plume have demonstrated an average yearly reduction of 8.25%. Using the highest average 2017 MTBE concentration of 1,500 µg/L, and assuming a continued average 8.25% reduction in year over year MTBE concentrations, MTBE concentrations will be reduced to below 200 µg/L in approximately 23 years. This estimate comes with as many assumptions as the BIOSCREEN model (e.g., continued favorable conditions for biodegradation).

Date	OWM-72-59 Average MTBE Concentration (µg/L)	OMW-73-57 Average MTBE Concentration (µg/L)	OMW-74-61 Average MTBE Concentration (µg/L)	OMW-75-61 Average MTBE Concentration (µg/L)	OMW-43-60 Average MTBE Concentration (µg/L)
2014	2,200	2,200	2,100	1,400	1,800
2015	2,150	2,100	1,130	1,250	1,750
2016	1,550	1,105	1,600	1,015	1,550
2017	1,300	1,450	1,105	1,045	1,500
Four-Year Reduction	41%	34%	47%	25%	17%
Average Yearly Reduction	10%	9%	12%	6%	4%
	Average Four-Year Reduction: **33%**				
	Average Yearly Reduction: **8.25%**				

4.0 SUMMARY

Commented [A10]: Expand or update, upon finalization of document.

This Fate and Transport Report predicts that the dissolved MTBE concentrations in the Offsite Plume will naturally attenuate to below 200 µg/L within the next 23 years, prior to reaching the identified sensitive receptors. The results are based on historical observations and assumes that biodegradation will continue at the current rates and that potentially limiting factors do not appreciably change in the future.

5.0 LIMITATIONS

The findings presented in this report and electronic submissions from CE2 Corporation are based upon observations of field personnel, points investigated, results of laboratory tests performed by Veritas Laboratories, and our understanding of Nevada Administrative Code. Our services were performed in accordance with the generally accepted standard of practice at the time the electronic data was submitted and that this report was written. No other warranty, expressed or implied was made. It is possible that variations in soil or groundwater conditions could exist beyond points explored in this investigation. Also, changes in site conditions could occur in the future due to variations in rainfall, temperature, regional water usage, or other factors.

6.0 REFERENCES

AMEC, 2014, Preliminary Conceptual Site Model, All Facilities Meeting Slide Presentation. (February 4, 2014).

Broadbent & Associates, Inc., 2016, Sensitive Receptor Survey, Vicinity of Former Avis (8-000217), National (8-000416) and Payless (8-000006) Car Rental Facilities, McCarran International Airport, Las Vegas, Nevada. (October 5, 2016).

Broadbent & Associates, Inc., 2018, Evaluation of Biodegradation in the Offsite Commingled Plume, Former McCarran International Airport Car Rental Facilities, Las Vegas, Nevada. (October 1, 2018).

Geo Blue Consulting, 2018, Hydrogeologic Conceptual Site Model Report (Draft), Former Payless/Allstate, Avis, and National Facilities, McCarran International Airport, Las Vegas, Nevada. (August 28, 2018).

FIGURES

Figure 1 **Site Map with Fourth Quarter 2017 MTBE Results**

APPENDICIES

Appendix A: Mann-Kendall Worksheet

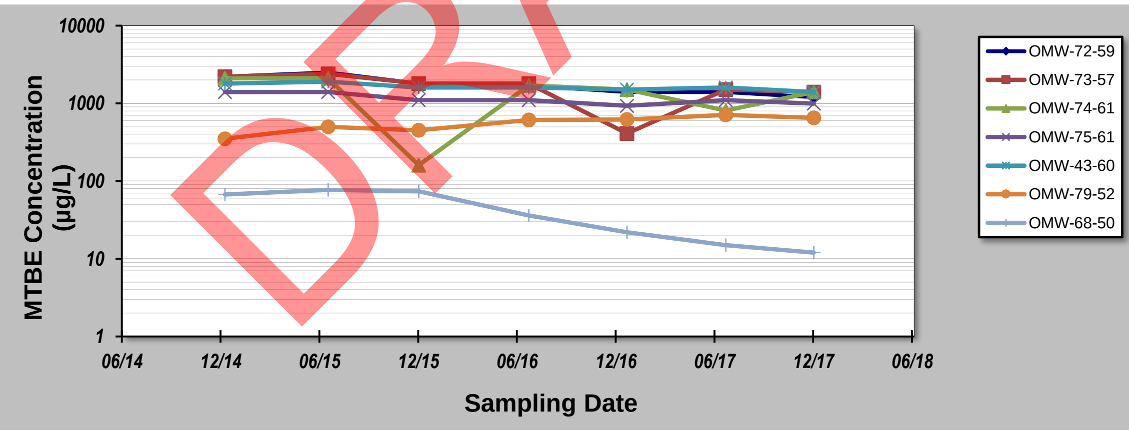
Appendix B: BIOSCREEN Parameters

Appendix C: BIOSCREEN Plots

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: 1-Mar-18
Facility Name: McCarran Car Rental Facilities
Conducted By: Broadbent & Associates, Inc.
Job ID: 95-01-150
Constituent: MTBE
Concentration Units: µg/L

Sampling Point ID:		OMW-72-59	OMW-73-57	OMW-74-61	OMW-75-61	OMW-43-60	OMW-79-52	OMW-68-50
Sampling Event	Sampling Date	MTBE CONCENTRATION (µg/L)						
1	12/17/14	2200	2200	2100	1400	1800	350	67
2	6/25/15	2500	2400	2100	1400	1900	500	77
3	12/9/15	1800	1800	160	1100	1600	450	74
4	6/29/16	1700	1800	1700	1100	1600	610	36
5	12/27/16	1400	410	1500	930	1500	620	22
6	6/27/17	1400	1500	810	1100	1600	710	15
7	12/6/17	1200	1400	1400	990	1400	650	12
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
Coefficient of Variation:		0.27	0.40	0.50	0.16	0.10	0.23	0.66
Mann-Kendall Statistic (S):		-18	-14	-10	-13	-14	17	-17
Confidence Factor:		99.7%	97.5%	90.7%	96.5%	97.5%	99.5%	99.5%
Concentration Trend:		Decreasing	Decreasing	Prob. Decreasing	Decreasing	Decreasing	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.

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

McCarran Facilities
MTBE
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*	375.0	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	3.0E-03	*(cm/sec)*
Hydraulic Gradient	*i*	0.009	*(ft/ft)*
Porosity	*n*	0.2	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	24.5	*(ft)*
Transverse Dispersivity*	*alpha y*	2.4	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		or	
Estimated Plume Length	*Lp*	1000	*(ft)*

3. ADSORPTION

Retardation Factor*	*R*	1.1	*(-)*
or		or	
Soil Bulk Density	*rho*	1.7	*(kg/l)*
Partition Coefficient	*Koc*	11	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E-3	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	1.4E+0	*(per yr)*
or		or	
Solute Half-Life	*t-half*	0.50	*(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*	3000	*(ft)*
Modeled Area Width*	400	*(ft)*
Simulation Time*	23.0	*(yr)*

L
W

6. SOURCE DATA

Source Thickness in Sat.Zone* 15 *(ft)*

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

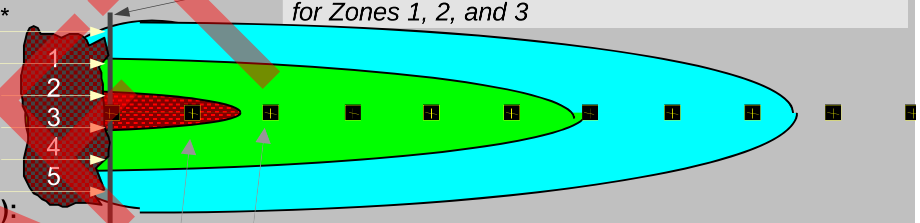
Source Zones:

Zone	Width* (ft)	Conc. (mg/L)*
1	0	0
2	0	0
3	300	1.5
4	0	0
5	0	0

Source Halflife (see Help):

Inst. React.	1st Order	
8	8	*(yr)*

Soluble Mass 165 *(Kg)*
In Source NAPL, Soil



View of Plume Looking Down

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

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	1.5		.65		.012						
Dist. from Source (ft)	*0*	*300*	*600*	*900*	*1200*	*1500*	*1800*	*2100*	*2400*	*2700*	*3000*

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **View Output**

RUN ARRAY | **View Output**

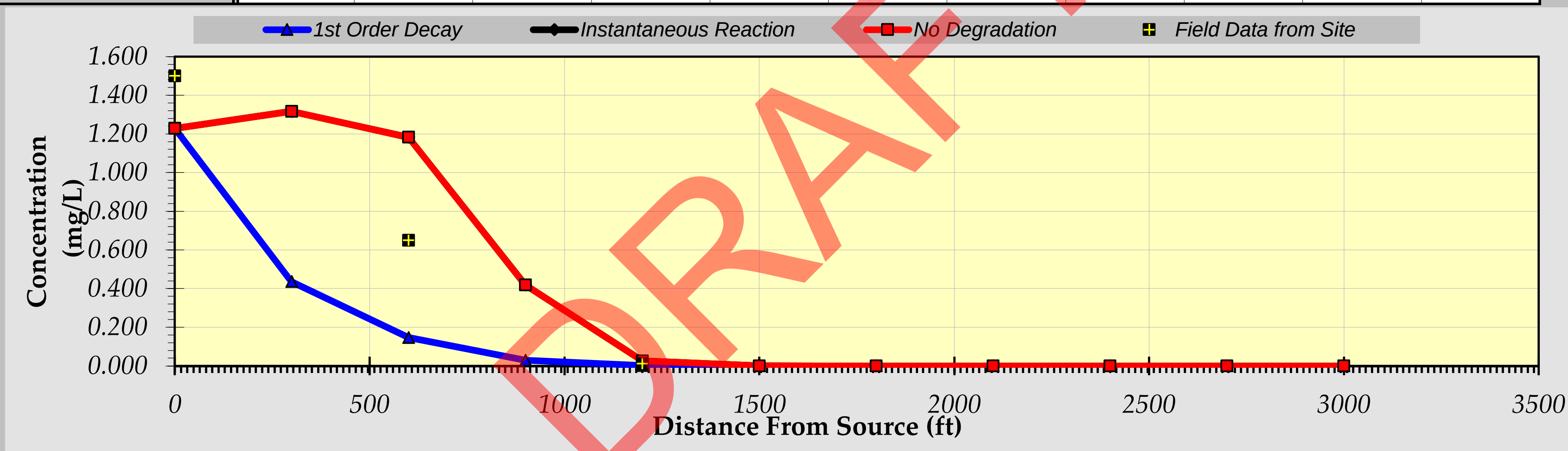
Help | Recalculate

Paste Example Dataset

Restore Formulas for Vs,

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

TYPE OF MODEL	Distance from Source (ft)										
	0	300	600	900	1200	1500	1800	2100	2400	2700	3000
No Degradation	1.228	1.317	1.182	0.418	0.026	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	1.228	0.436	0.147	0.029	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	1.228	1.317	1.182	0.418	0.026	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	1.500		0.650		0.012						



Replay Animation

Next Timestep

Prev Timestep

Time:

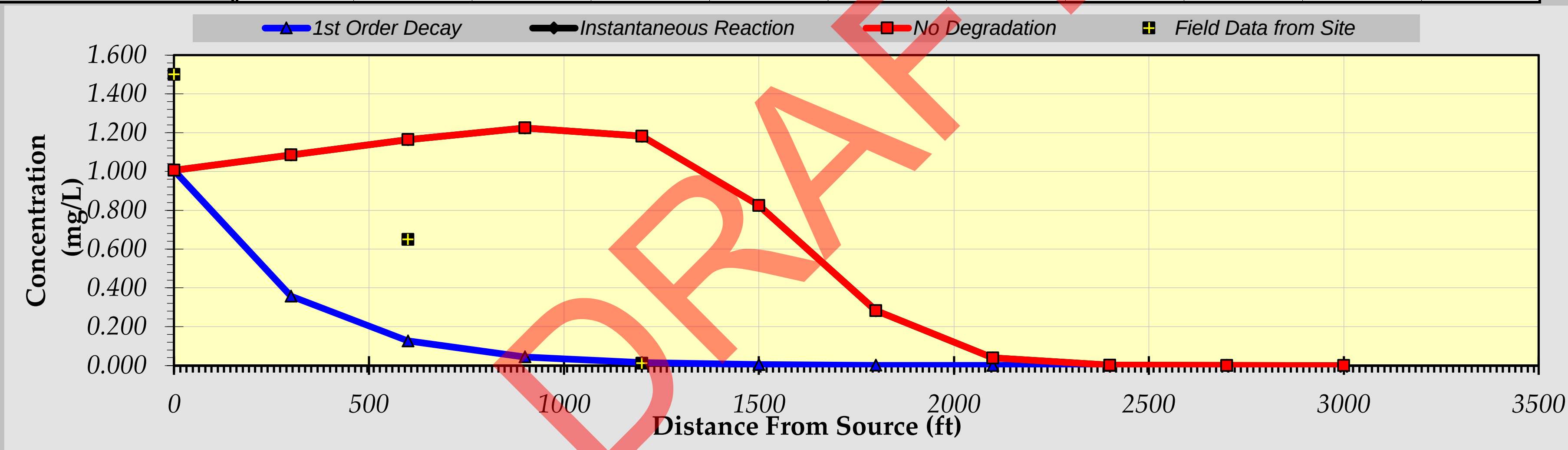
2.3 Years

Return to

Recalculate This

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

TYPE OF MODEL	Distance from Source (ft)										
	0	300	600	900	1200	1500	1800	2100	2400	2700	3000
No Degradation	1.006	1.085	1.164	1.224	1.182	0.825	0.283	0.039	0.002	0.000	0.000
1st Order Decay	1.006	0.357	0.126	0.044	0.015	0.005	0.001	0.000	0.000	0.000	0.000
Inst. Reaction	1.006	1.085	1.164	1.224	1.182	0.825	0.283	0.039	0.002	0.000	0.000
Field Data from Site	1.500		0.650		0.012						



Replay Animation

Next Timestep

Prev Timestep

Time:

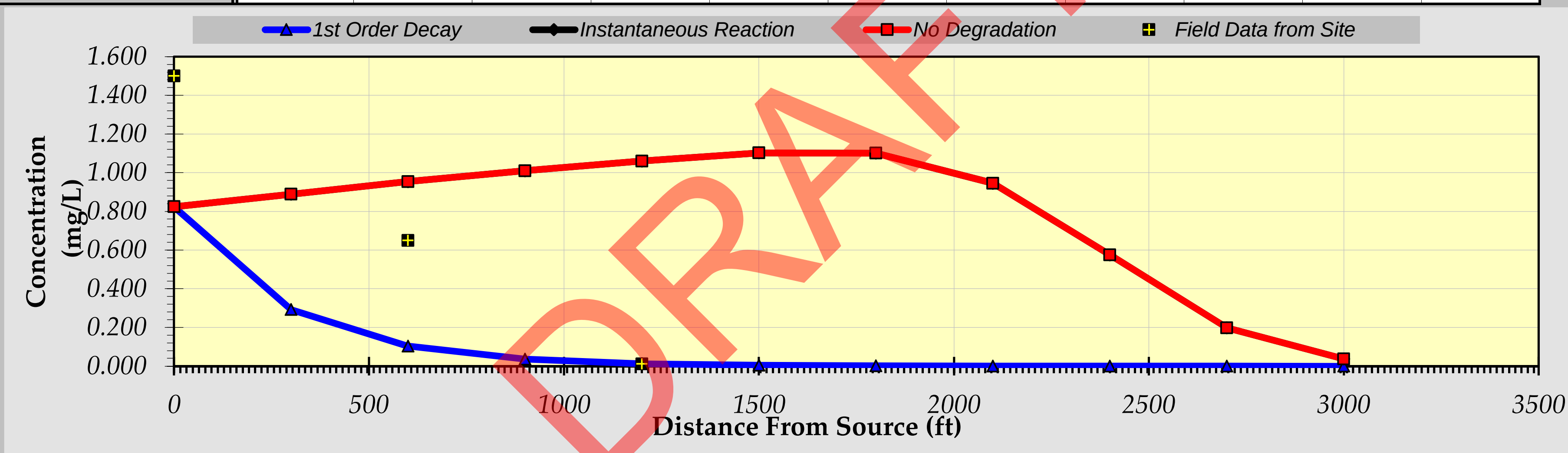
4.6 Years

Return to

Recalculate This

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

TYPE OF MODEL	Distance from Source (ft)										
	0	300	600	900	1200	1500	1800	2100	2400	2700	3000
No Degradation	0.824	0.889	0.954	1.010	1.060	1.102	1.101	0.945	0.576	0.198	0.037
1st Order Decay	0.824	0.292	0.103	0.036	0.012	0.004	0.001	0.000	0.000	0.000	0.000
Inst. Reaction	0.824	0.889	0.954	1.010	1.060	1.102	1.101	0.945	0.576	0.198	0.037
Field Data from Site	1.500		0.650		0.012						



Replay Animation

Next Timestep

Prev Timestep

Time:

6.9 Years

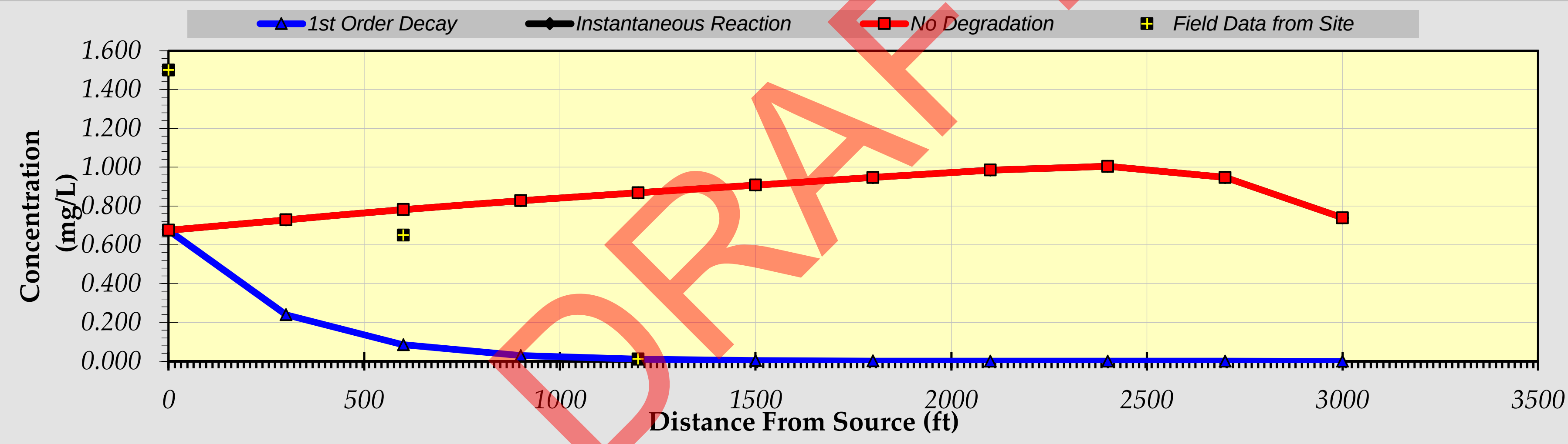
Return to

Recalculate This

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

Distance from Source (ft)

TYPE OF MODEL	0	300	600	900	1200	1500	1800	2100	2400	2700	3000
No Degradation	0.675	0.728	0.781	0.827	0.868	0.907	0.947	0.985	1.004	0.947	0.739
1st Order Decay	0.675	0.240	0.085	0.029	0.010	0.003	0.001	0.000	0.000	0.000	0.000
Inst. Reaction	0.675	0.728	0.781	0.827	0.868	0.907	0.947	0.985	1.004	0.947	0.739
Field Data from Site	1.500		0.650		0.012						



Replay Animation

Next Timestep

Prev Timestep

Time:

9.2 Years

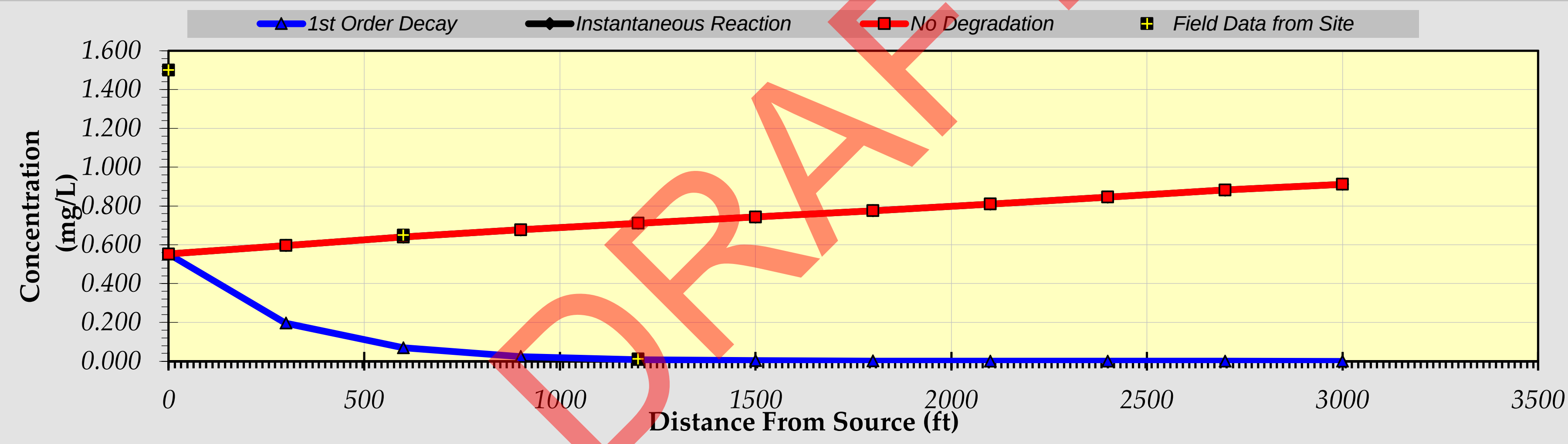
Return to

Recalculate This

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

Distance from Source (ft)

TYPE OF MODEL	0	300	600	900	1200	1500	1800	2100	2400	2700	3000
No Degradation	0.553	0.596	0.640	0.678	0.711	0.743	0.776	0.810	0.846	0.882	0.911
1st Order Decay	0.553	0.196	0.069	0.024	0.008	0.003	0.001	0.000	0.000	0.000	0.000
Inst. Reaction	0.553	0.596	0.640	0.678	0.711	0.743	0.776	0.810	0.846	0.882	0.911
Field Data from Site	1.500		0.650		0.012						



Replay Animation

Next Timestep

Prev Timestep

Time:

11.5 Years

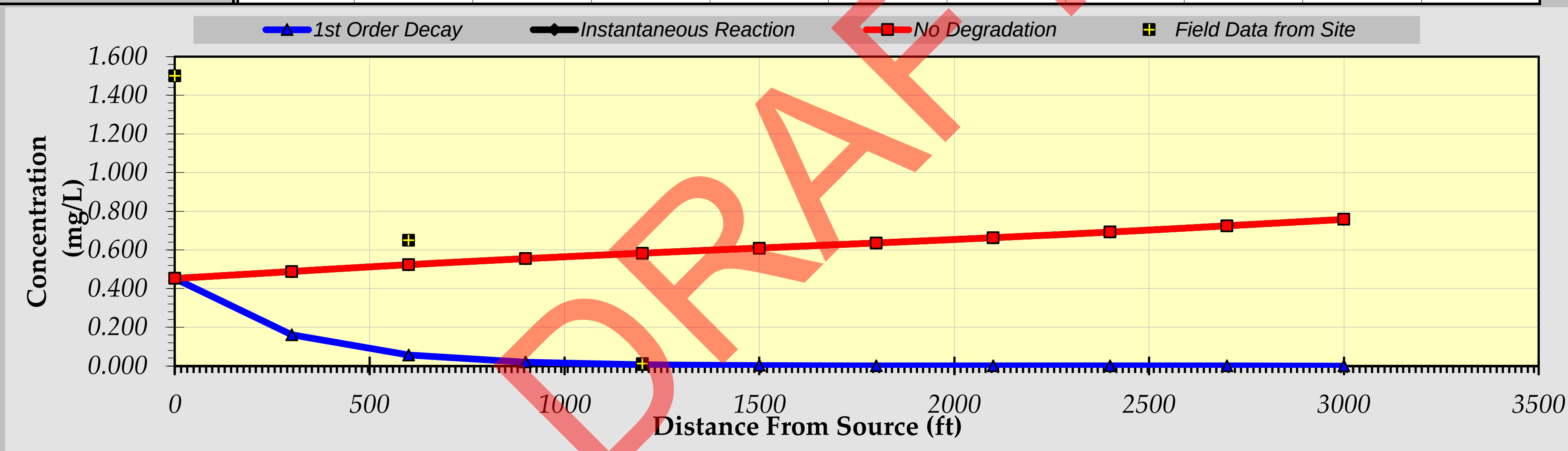
Return to

Recalculate This

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

Distance from Source (ft)

TYPE OF MODEL	0	300	600	900	1200	1500	1800	2100	2400	2700	3000
No Degradation	0.453	0.488	0.524	0.555	0.582	0.609	0.635	0.663	0.693	0.724	0.758
1st Order Decay	0.453	0.161	0.057	0.020	0.007	0.002	0.001	0.000	0.000	0.000	0.000
Inst. Reaction	0.453	0.488	0.524	0.555	0.582	0.609	0.635	0.663	0.693	0.724	0.758
Field Data from Site	1.500		0.650		0.012						



Replay Animation

Next Timestep

Prev Timestep

Time:

13.8 Years

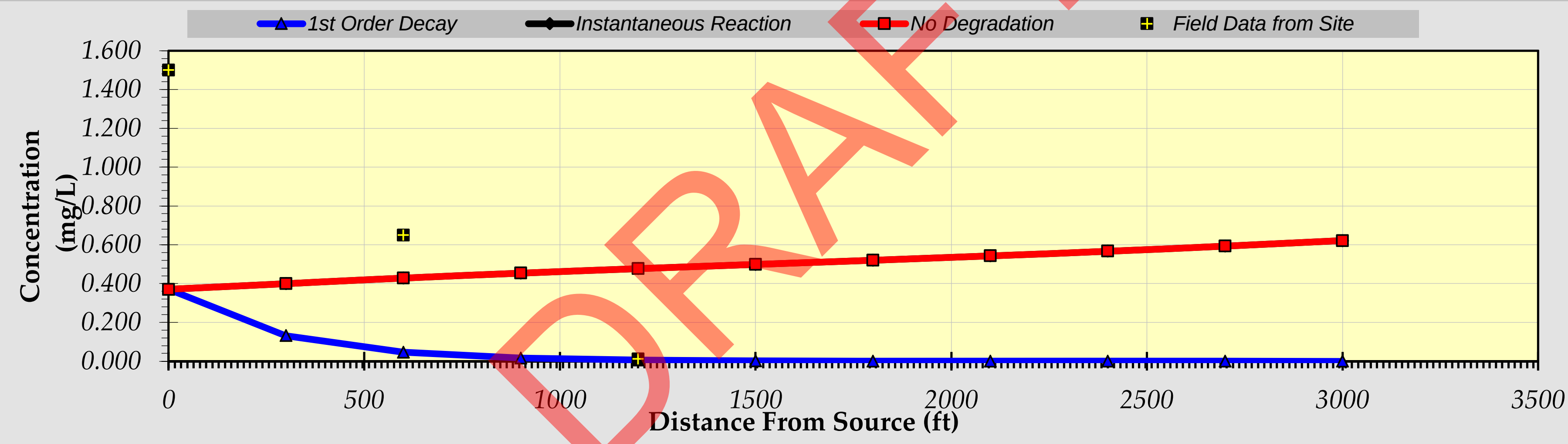
Return to

Recalculate This

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

Distance from Source (ft)

TYPE OF MODEL	0	300	600	900	1200	1500	1800	2100	2400	2700	3000
No Degradation	0.371	0.400	0.429	0.454	0.477	0.498	0.520	0.543	0.567	0.593	0.621
1st Order Decay	0.371	0.132	0.046	0.016	0.006	0.002	0.001	0.000	0.000	0.000	0.000
Inst. Reaction	0.371	0.400	0.429	0.454	0.477	0.498	0.520	0.543	0.567	0.593	0.621
Field Data from Site	1.500		0.650		0.012						



Replay Animation

Next Timestep

Prev Timestep

Time:

16.1 Years

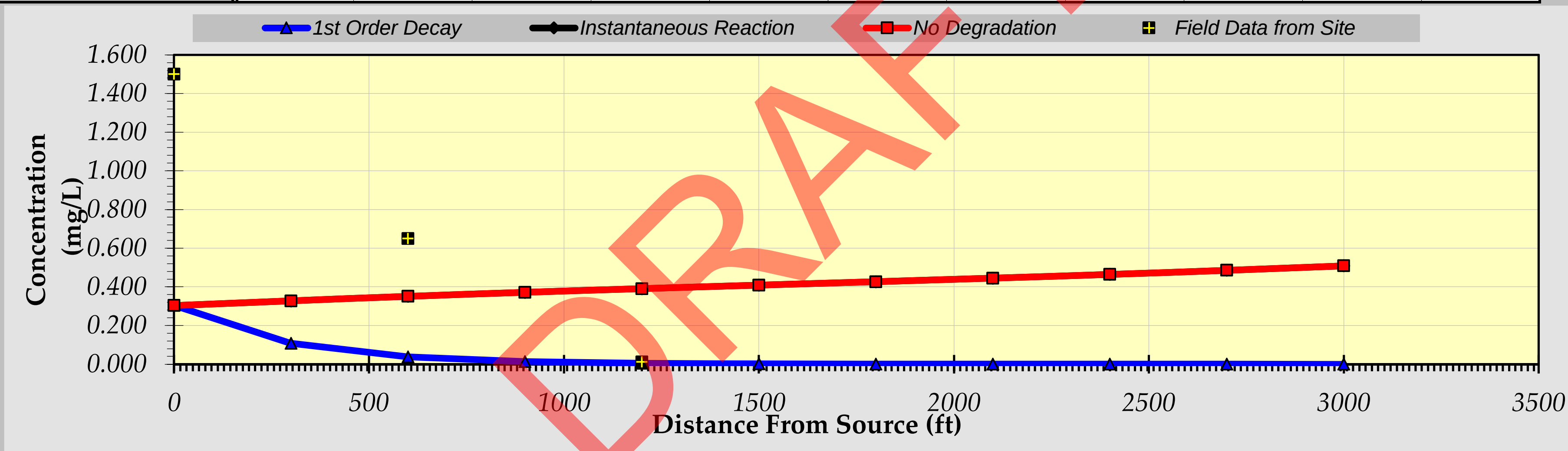
Return to

Recalculate This

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

Distance from Source (ft)

TYPE OF MODEL	0	300	600	900	1200	1500	1800	2100	2400	2700	3000
No Degradation	0.304	0.327	0.351	0.372	0.391	0.408	0.426	0.445	0.465	0.486	0.509
1st Order Decay	0.304	0.108	0.038	0.013	0.005	0.002	0.001	0.000	0.000	0.000	0.000
Inst. Reaction	0.304	0.327	0.351	0.372	0.391	0.408	0.426	0.445	0.465	0.486	0.509
Field Data from Site	1.500		0.650		0.012						



Replay Animation

Next Timestep

Prev Timestep

Time:

18.4 Years

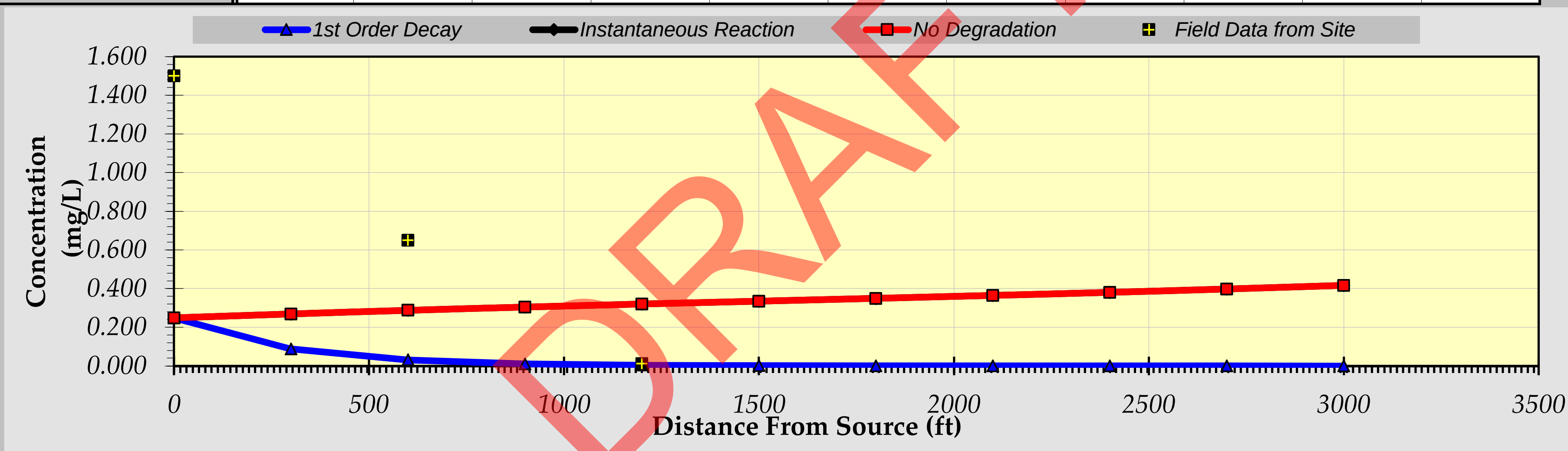
Return to

Recalculate This

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

Distance from Source (ft)

TYPE OF MODEL	0	300	600	900	1200	1500	1800	2100	2400	2700	3000
No Degradation	0.249	0.268	0.288	0.305	0.320	0.334	0.349	0.364	0.380	0.398	0.417
1st Order Decay	0.249	0.088	0.031	0.011	0.004	0.001	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.249	0.268	0.288	0.305	0.320	0.334	0.349	0.364	0.380	0.398	0.417
Field Data from Site	1.500		0.650		0.012						



Replay Animation

Next Timestep

Prev Timestep

Time:

20.7 Years

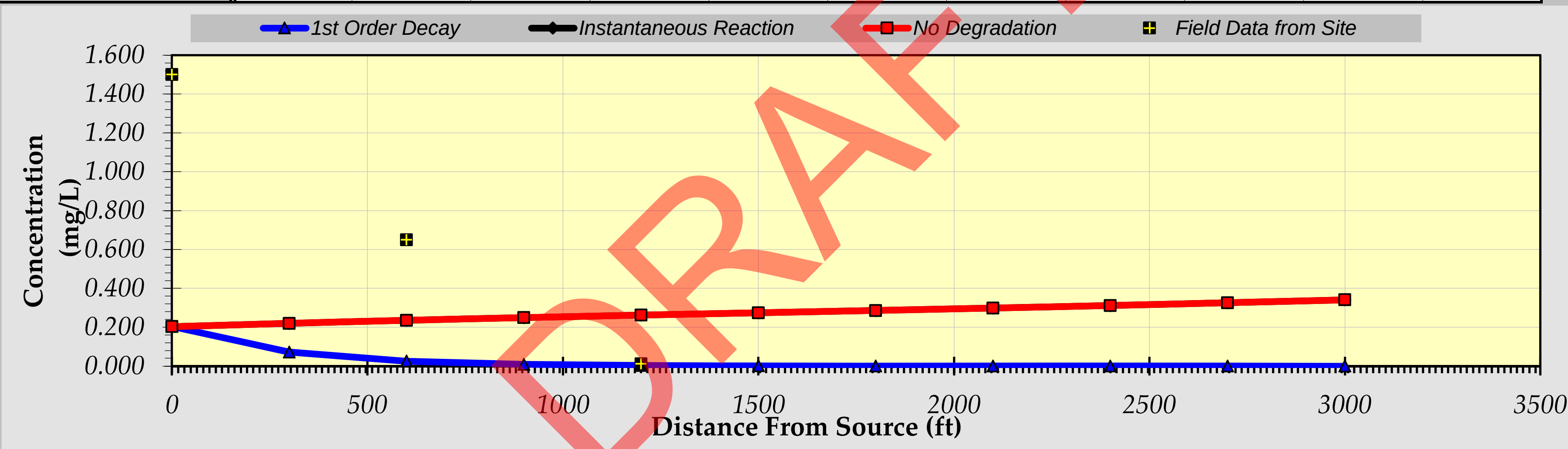
Return to

Recalculate This

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

Distance from Source (ft)

TYPE OF MODEL	0	300	600	900	1200	1500	1800	2100	2400	2700	3000
No Degradation	0.204	0.220	0.236	0.250	0.262	0.274	0.286	0.298	0.312	0.326	0.341
1st Order Decay	0.204	0.072	0.026	0.009	0.003	0.001	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.204	0.220	0.236	0.250	0.262	0.274	0.286	0.298	0.312	0.326	0.341
Field Data from Site	1.500		0.650		0.012						



Replay Animation

Next Timestep

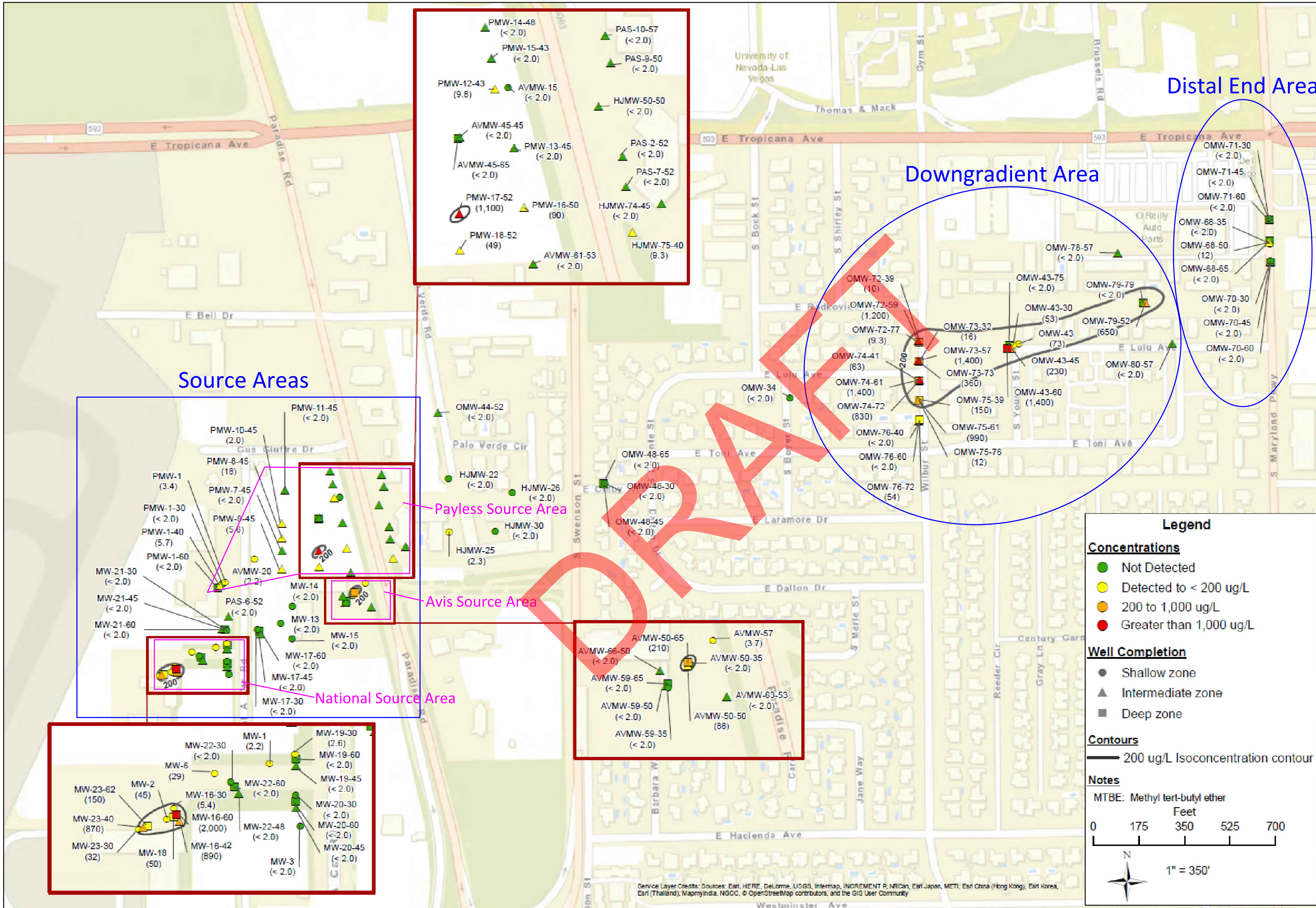
Prev Timestep

Time:

23.0 Years

Return to

Recalculate This



Z:\PROJECTS\McCarran\GIS\Events\20171219_2017Q4\mxd CE2 Corp 1/23/18

FIGURE 1

Former Car Rental Facilities
McCarran International Airport
Las Vegas, Nevada

Site Map with Fourth Quarter 2017 MTBE Results

OGI ENVIRONMENTAL, LLC

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