

A CMS Energy Company

Date: June 7, 2018

To: Operating Record

From: Harold D. Register, Jr., P.E. ^{HAR}

RE: Selection of Statistical Procedures Professional Engineer Certification, §257.93(f)(6)
DE Karn Power Plant, Karn Lined Impoundment

Professional Engineer Certification Statement [40 CFR 257.93(f)]

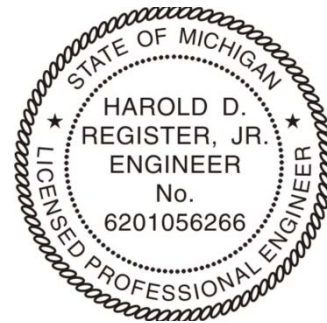
I hereby certify that, having reviewed the attached documentation and being familiar with the provisions of Title 40 of the Code of Federal Regulations §257.93 (40 CFR Part 257.93), I attest that this Groundwater Statistical Evaluation Plan has been prepared to include a narrative description of the statistical method selected to evaluate the groundwater monitoring data for Karn Lined Impoundment in accordance with the requirements of 40 CFR 257.93.

Harold D. Register, Jr.
Signature

June 7, 2018
Date of Certification

Harold D. Register, Jr., P.E.
Name

6201056266
Professional Engineer Certification Number



06/07/2018

ENCLOSURES

TRC Environmental Corporation (October 2017). "Groundwater Statistical Evaluation Plan, DE Karn Power Plant Lined Impoundment."



Groundwater Statistical Evaluation Plan

DE Karn Power Plant Lined Impoundment

Essexville, Michigan

June 2018



Groundwater Statistical Evaluation Plan

DE Karn Power Plant Lined Impoundment

Essexville, Michigan

June 2018

*Prepared For
Consumers Energy Company
Jackson, Michigan*

A handwritten signature in blue ink that reads "Darby Litz".

Darby Litz, P.G.
Project Hydrogeologist

A handwritten signature in blue ink that reads "Graham Crockford".

Graham Crockford
Senior Project Geologist

*TRC | Consumers Energy Company
Groundwater Statistical Evaluation Plan
Final*

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Section 1

Introduction

1.1 Regulatory Framework

On April 17, 2015, the United States Environmental Protection Agency (USEPA) published the final rule for the regulation and management of Coal Combustion Residuals (CCR) under the Resource Conservation and Recovery Act (RCRA) (the CCR Rule). The CCR Rule, which became effective on October 19, 2015, applies to newly constructed CCR units.

Consumers Energy Company (CEC) operates a coal fired power generation facility at the DE Karn (DEK) site located in Essexville, Michigan. CEC is planning to remove CCRs and close their existing bottom ash basin CCR unit in 2019. In order to manage future CCR bottom ash, DEK designed and constructed a lined bottom ash impoundment (Karn Lined Impoundment – KLI) CCR unit. The KLI CCR unit is designed with a double composite liner system, with the primary and secondary composite liners consisting of HDPE overlying a geosynthetic clay liner. A secondary collection system collects liquids from between the primary and secondary liner systems. The KLI CCR unit is scheduled to initiate receipt of bottom ash in June 2018.

Pursuant to the CCR Rule, the owner or operator of a CCR unit must develop the groundwater sampling and analysis program to include selection and certification of the statistical procedures to be used for evaluating groundwater in accordance with §257.93. This certification must include a narrative description of the statistical method that will be used for evaluating groundwater monitoring data.

TRC Environmental Corporation (TRC) prepared this Groundwater Statistical Evaluation Plan (Statistical Plan) for the KLI on behalf of CEC. This Statistical Plan was prepared in accordance with the requirements of §257.93 and describes how data collected from the groundwater monitoring system will be evaluated. As part of the evaluation, the data collected during detection monitoring events (post KLI CCR unit operations beginning June 2018), are evaluated to identify statistically significant increases (SSIs) in detection monitoring parameters (Appendix III of the CCR Rule) to determine if concentrations in detection monitoring well samples exceed background levels.

The CCR Rule is not prescriptive with regards to the actual means and methods to be used for statistically evaluating groundwater data, and there is flexibility in the method selection, as long as specific performance metrics are met. A description of statistical methods that meet the performance objectives of the CCR Rule are described in *USEPA's Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance (Unified Guidance, USEPA, 2009)*.

1.2 Site Hydrogeology

The majority of the KLI CCR unit area is comprised of surficial CCR and sand fill. USGS topographic maps and aerial photographs dating back to 1938, in addition to field descriptions of subsurface soil at the site, indicate that the site was largely developed by reclaiming low-lands through construction of perimeter dikes and subsequent ash filling.

The surficial fill consists of a mixture of varying percentages of ash, sand, and clay-rich fill ranging from 5 to 15 feet thick. Below the surficial fill, native alluvium and lacustrine soils are present at varying depths. Generally, there is a well graded sand unit present to depths of 10-30 feet below ground surface (ft-bgs) overlying a clay till which is observed at depths ranging from 25 to 75 ft-bgs. A sandstone unit, which is part of the Saginaw formation, was generally encountered at 80-90 ft-bgs.

The site is bound by several surface water features (Figure 1): the Saginaw River to the west, Saginaw Bay (Lake Huron) to the north and east, and a discharge channel to the south. In general, shallow groundwater is encountered at a similar or slightly higher elevation relative to the surrounding surface water features. Groundwater flow in the upper aquifer is largely controlled by the surface water elevations of Saginaw River and Saginaw Bay. In the vicinity of the existing DEK Bottom Ash Pond CCR unit and new KLI CCR unit, the shallow groundwater flow is generally radial, flowing outward from the groundwater mound toward the surrounding surface water bodies. As the sluice water is diverted to the KLI CCR unit and Bottom Ash Pond closure activities commence (i.e., dewatering), the local groundwater flow regime will be altered. Once the bottom ash removal activities are complete and groundwater elevations re-equilibrate, groundwater flow in the new, lined impoundment area will be driven by Saginaw Bay to the north and by the Saginaw River to the west in the absence of the hydraulic head from the former Bottom Ash Pond groundwater mound.

Section 2

Groundwater Monitoring System

2.1 Groundwater Monitoring System

In accordance with 40 CFR 257.91, CEC has developed a groundwater monitoring system for the new KLI CCR unit. Because of the site hydrogeology and presence of affected groundwater due to the history of CCR-related operations throughout the DE Karn Site, an intra-well statistical approach is recommended for detection monitoring. However, there is currently insufficient data from wells in the KLI monitoring well system to support intra-well statistical methods, and based on hydrogeologic conditions, the frequency of sampling to collect data to support the intra-well methods will take several years (see Section 3.2 of the SAP; TRC, 2018). Establishing background in a six-month time period, per the CCR rule, does not allow for collection of sufficient statistically independent samples. Therefore, for an interim period, CEC will perform inter-well statistics using DEK-MW-15003 as the upgradient/background well (eight independent groundwater samples were collected from DEK-MW-15003 as part of previous CCR unit sampling related to the existing bottom ash basin) until sufficient data are collected from all the KLI CCR unit wells to support intra-well statistical procedures. The groundwater monitoring system for the KLI unit, as shown on Figure 1, consists of:

Background:

DEK-MW-15003

Downgradient:

OW-12

DEK-MW-18001

OW-10

Supplemental Data Analysis¹:

OW-11

Background sample collection for DEK-MW-15003 has been initiated and background will be established prior to the November 2018 detection monitoring sampling event, as described in the statistical evaluation plan (TRC 2018). In accordance with 40 CFR 257.94(b), groundwater samples will be collected and analyzed for Appendix III constituents on a semiannual frequency during the active life of the CCR unit and post-closure period. The KLI CCR unit monitoring well network will be initially sampled for Appendix III and Appendix IV constituents on a quarterly basis for two years to evaluate the potential for an intra-well statistical program for detection

¹ OW-11 will be sampled to be potentially utilized in a future intra-well statistical evaluation program.

monitoring. Once sufficient sample data are collected from the five (5) KLI groundwater monitoring system wells for intra-well analysis, CEC will evaluate these data and determine alternative strategies for statistical evaluation of groundwater data.

2.2 Constituents for Detection Monitoring

§257.94 describes the requirement for detection monitoring for Appendix III parameters. Detection monitoring will be performed at least semiannually unless an alternative frequency is made on a site-specific basis. The detection monitoring parameters are identified in Appendix III of §257.94 and consist of the following:

Boron	Calcium	Chloride
Fluoride	pH	Sulfate
Total Dissolved Solids (TDS)		

2.3 Constituents for Assessment Monitoring

Assessment monitoring per §257.95 is required when a SSI over background has been detected for one or more of the constituents identified in Appendix III to Part 257 – Constituents for Detection Monitoring. In the event that assessment monitoring is triggered through the statistical evaluation of detection monitoring parameters, the following assessment monitoring parameters will be sampled:

Antimony	Arsenic	Barium
Beryllium	Cadmium	Chromium
Cobalt	Fluoride	Lead
Lithium	Mercury	Molybdenum
Selenium	Thallium	Radium 226 and 228 (combined)

Section 3

Statistical Analysis

Groundwater sampling and analytical requirements are described in §257.93. The owner or operator of the CCR unit must select a statistical method specified in §257.93(f) to be used in evaluating groundwater monitoring data. The test shall meet the performance standards outlined in §257.93(g). The goal of the statistical evaluation plan is to provide a means to formulate an opinion or judgement as to whether the CCR unit has released contaminants into groundwater. This plan describes the statistical procedures to be used to determine if a statistical significant increase (SSI) or in the case of pH, a statistically significant difference (SSD), indicating that data is from a different population than background. This plan was developed using applicable guidance, including the *Unified Guidance*. In addition to using applicable guidance documents, commercially available statistical evaluation tools will be applied to the KLI CCR Unit groundwater data to develop statistically derived limits so that detection monitoring results can be compared to background.

The CCR Rule allows a variety of methods for conducting statistical evaluations. The specific procedure for a given data set depends on several factors including the proportion of the data set with detected values and the distribution of the data. These will not be known until the data are collected. It is generally anticipated, however, that the tolerance or prediction interval procedure will be the preferred method of conducting detection monitoring data evaluation to the extent that the data support the use of that method. This statistical procedure is described below in this section of the plan and in detail in the *Unified Guidance*.

3.1 Establishing Background

In accordance with §257.94(b), samples for each background well must be collected and analyzed for the constituents listed in Appendices III and IV to this part during the first six months of sampling for new CCR impoundments. Per §257.93(d), the owner or operator of the CCR unit must establish background groundwater quality in hydraulically upgradient or background well(s). The development of a groundwater statistical evaluation program for detection monitoring involves the proper collection of background samples, regardless of whether an inter-well or intra-well monitoring strategy is implemented. Background may be established at wells that are not located hydraulically upgradient from the unit if it meets the requirement of §257.91(a)(1). A determination of background quality may include sampling of wells that are not hydraulically upgradient of the CCR management area where:

- i. Hydrogeologic conditions do not allow the owner or operator of the CCR unit to determine what wells are hydraulically upgradient; or

- ii. Sampling at other wells will provide an indication of background groundwater quality that is as representative as or more representative than that provided by the upgradient wells.

The purpose of obtaining adequate background groundwater data is to approximate, as accurately as possible, the true range of ambient concentrations of targeted constituents. Background groundwater data should eliminate, to the extent possible, statistically significant concentration increases not attributable to the CCR unit. Specifically, the owner or operator of a CCR unit must install a groundwater monitoring system that consists of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit. The sampling frequency should be selected so that the samples are physically independent. These background groundwater parameters can be adequately qualified by doing the following:

- Collecting the minimum number of samples that satisfy the requirements of the statistical methods that are used (i.e., that result in adequate statistical power);
- Incorporating seasonal and/or temporal variability into the background data set; and

Incorporating the spatial component of variability into the background data set (i.e., the variability that comes with obtaining samples from different locations within the same groundwater zone).

The initial background/baseline sampling period is at least eight independent events collected over a six month period for new CCR units. This provides a minimal background data set to initiate statistical comparisons. Over time, the short baseline period may result in a high risk of false positive statistical results. However, eight independent groundwater samples were collected from DEK-MW-15003 (the KLI CCR unit background well) as part of previous CCR unit sampling related to the existing bottom ash basin in 2016/2017; therefore, the background data for the KLI CCR unit has already been collected. The facility may periodically update background data to account for variability in background conditions. The *Unified Guidance* recommends that background data be updated every 4 to 8 measurements (i.e., every two to four years if samples are collected semi-annually, or one to two years if samples are collected quarterly). The background data will be reviewed for trends or changes that may necessitate discontinuation of earlier portions of the background data set.

3.2 Data Evaluation and Data Distributions

CEC will evaluate the groundwater data for each constituent included in the groundwater monitoring program using intra-well tolerance or prediction limits. The tolerance or prediction interval statistical procedure establishes an interval that bounds the ranges of expected

concentrations representative of unaffected groundwater using the distribution of background data. The upper tolerance or prediction limit of that interval is then used for comparison to the concentration level of each constituent in each compliance well. Development of the tolerance or prediction limits used for comparison during detection monitoring will be conducted in accordance with the *Unified Guidance*. The following is a summary of descriptive statistics and tolerance or prediction limit choices.

3.2.1 Background Determination

Statistical limits will be calculated after the collection of sufficient independent samples per the statistical methodology. In some cases that is no fewer than four events, but typically eight sampling events. The analytical results from the eight “background” samples will be used to determine the statistical limits for each individual parameter. For intra-well, the background data set is comprised of the historical data set established at each individual monitoring well.

The background dataset (and hence the prediction limits) will be updated as appropriate (as discussed above in Section 3.1) to maintain necessary statistical sensitivity. New data will be compared to the existing background data set to determine if there are outlier values, and whether the data are statistically similar. If there are no outliers and the data are statistically similar, the new data will be added to the existing background data set.

3.2.2 Outlier Evaluation

Outliers and anomalies are inconsistently large or small values that can occur as a result of sampling, analytical, or transcription errors; laboratory or field contamination; or shelf-life exceedance; or extreme, but accurately detected environmental conditions (e.g., spills). Data will be reviewed graphically using tools such as time concentration trend plots, box and whisker plots and/or probability plots to illustrate and identify outliers, trends, or otherwise unusual observations at each monitoring location. This will be accomplished prior to further in-depth review of the data sets to identify any obvious field or laboratory anomalies. Data points that are determined to be non-representative will be ‘flagged’ for further detailed evaluation prior to removing from the background data or designating as an outlier.

3.2.3 Testing for Normality

Statistical tests often assume that data are normally distributed or that data can be normalized by various standard methods. The assumption of normality can be tested in various ways. Formal normality testing such as utilizing the Shapiro-Wilk test (for $n < 50$) or the Shapiro-Francia Test (for $n > 50$) or calculation of a coefficient of skewness may be

utilized in accordance with the *Unified Guidance*. Alternatively, graphing data on a probability plot can also be used to test for normality. If the data appear to be non-normal, mathematical transformations of the data may be utilized such that the transformed data follow a normal distribution (e.g., lognormal distributions). Alternatively, non-parametric tests may be utilized when data cannot be normalized.

The following are guidelines for decision making during normality testing:

1. If the original data show that the data are not normally distributed, then apply a natural log-transformation to the data and test for normality using the above methods.
2. If the original or the natural log-transformed data confirm that the data are normally distributed, then apply a normal distribution test.
3. If neither the original nor the natural log-transformed data fit a normal distribution, then apply a distribution-free test.

3.2.4 Evaluation of Non-Detects

Background concentrations that are reported as less than the practical quantitation limit (PQL) (herein referred to as non-detects) will be evaluated differently, depending upon the percentage of non-detects to the reported concentrations for a given parameter at a given monitoring well. The evaluation of non-detects was as follows:

Less Than 15% Non-detects

For data that was normally or lognormally distributed and less than 15% non-detects, one-half the value of the method detection limit will be used to calculate the prediction limit. If normally or lognormally cannot be met using one-half of the method detection limit, and if the method detection limits were equal, alternating zero with the value of the method detection limit will be considered in order to determine the normality of the data set.

15% to 50% Non-detects

If more than 15% but less than 50% of the overall data are less than the detection limit, either Aitchison's adjustment, or Cohen's adjustment, or the Kaplan Meijer adjustment will be used to determine the statistical limits in accordance with the *Unified Guidance*.

51% to 100% Non-detects

For data sets that contain greater than 50% non-detects, the non-parametric statistical limits will be utilized as described below.

3.3 Parametric Tolerance or Prediction Limits

Tolerance and prediction intervals are similar approaches to establish statistical ranges constructed from background or baseline data. However, tolerance limits define the range of data that fall within a specified percentage with a specified level of confidence (where a proportion of the population is expected to lie), whereas prediction limits involve predicting the upper limit of possible future values based on a background or baseline data set and comparing that predicted limit to compliance well data.

Inter-well tolerance or prediction limits are calculated using the pooled background data set. The tolerance or prediction limit will be calculated in accordance with the *Unified Guidance*. If the data set is log-normally distributed the tolerance or prediction limits will be calculated using the log-normally transformed data, and subsequently un-transformed to normal units.

In §257.93(g)(2), it states that for multiple comparisons, each testing period should have a Type I error rate no less than 0.05 while maintaining an individual well Type I error rate of no less than 0.01. Per §257.93(g)(4), these Type I limits do not apply directly to tolerance intervals or prediction intervals; however, the levels of confidence for the tolerance or prediction limit approach must be at least as effective as any other approach based on consideration of the number of samples, distribution, and range of concentration values in the background data set for each constituent.

3.4 Non-Parametric Tolerance or Prediction Limits

Parameters that consist of mainly non-detect data usually violate the assumptions needed for normal based parametric tolerance or prediction intervals. Therefore, as recommended in the *Unified Guidance*, the non-parametric tolerance or prediction limit method will be chosen.

A non-parametric upper tolerance or prediction limit is constructed by setting the limit as a large order statistic selected from background (e.g., the maximum background value). This method has lower statistical power than parametric methods; therefore, it is important to control outliers within the dataset to maintain adequate statistical power that this method can provide. Due to the lack of statistical power of this method, it will only be used when other methods are not available.

3.5 Double Quantification Rule

The double quantification rule is discussed in Section 6.2.2 of the *Unified Guidance*. In the cases where the background dataset for a given well is 100% non-detect, a confirmed exceedance is registered if any well-constituent pair exhibits quantified measurements (i.e., at or above the reporting limit) in two consecutive sample and resample events. This method will be used for non-detect data sets.

3.6 Verification Resampling

In order to achieve the site-wide false positive rates (SWFPR) recommended in the *Unified Guidance*, a verification resampling program is necessary. Without verification resampling, the SWFPR cannot be reasonably met, and much larger statistical limits would be required to achieve a SWFPR of 5% or less. Furthermore, the resulting false negative rate would be greatly increased. Under these circumstances, if there is an exceedance of a tolerance limit or prediction limit for one or more of the parameters, the well(s) of concern will be resampled within 30 days of the completion of the initial statistical analysis. Only constituents that initially exceed their statistical limit (i.e., have no previously recorded SSIs) will be analyzed for verification purposes. This verification sampling must be performed within the same compliance period as the event being verified. If the verification sample remains statistically significant, then statistical significance will be considered. If the verification sample is not statistically significant, then no SSI will be recorded for the monitoring event.

Section 4

Evaluation of Detection Monitoring Data

4.1 Statistical Evaluation during Detection Monitoring

According to §257.94(e), if the facility determines, pursuant to §257.93(h), that there is a statistically significant increase (SSI) over background levels for one or more of the Appendix III constituents, the facility will, within 90 days of detecting a SSI, establish an assessment monitoring program <or> demonstrate that:

- A source other than the CCR unit caused the SSI, or
- The SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.

The owner or operator must complete a written demonstration (i.e., Alternative Source Demonstration, ASD), of the above within 90 days of confirming the SSI. If a successful ASD is completed, a certification from a qualified professional engineer is required, and the CCR unit may continue with detection monitoring.

If a successful ASD is not completed within the 90-day period, the owner or operator of the CCR unit must initiate an assessment monitoring program as required under §257.95, described further in Section 5. The facility must also include the ASD in the annual groundwater monitoring and corrective action report required by §257.90(e), in addition to the certification by a qualified professional engineer.

Section 5

Assessment Monitoring

As discussed in Section 4, the facility must begin assessment monitoring for the CCR unit if a SSI is identified, and the SSI cannot be attributed to an ASD. Per the CCR Rule, assessment monitoring must begin within 90 days of identification of a SSI that is not attributed to an alternative source. During the 90-day period, wells included in the groundwater monitoring system will be sampled for Appendix IV constituents pursuant to §257.95(b). Within 90 days of obtaining the results from the first assessment monitoring event, all of the wells will be sampled for Appendix III and the detected Appendix IV parameters in the initial assessment monitoring event.

If assessment monitoring is triggered pursuant to §257.94(e)(1), data are compared to Groundwater Protection Standards (GPSs) or background groundwater quality. The CCR Rule [§257.95(h)] requires GPSs to be established for Appendix IV constituents that have been detected during baseline sampling. The GPS is set at the EPA maximum contaminant level (MCL) or a value based on background data. The MCLs will be the GPSs for those constituents that have MCLs unless the background concentration is greater than the MCL, which in that case, the statistically-determined background values becomes the GPS. For all other parameters that do not have MCLs, the GPS defaults to a statistically-based limit developed using background data. For GPSs that are established using background, tolerance limits are anticipated to be used to calculate the GPS. The background will be updated every two years, along with the resulting GPS, consistent with the *Unified Guidance*. If additional assessment monitoring parameters become detected during the assessment monitoring, GPSs will be developed for those parameters in the same manner as the initial parameters.

Consistent with the *Unified Guidance*, the preferred method for comparisons to a fixed standard will be confidence limits. An exceedance of the standard occurs when the 95 percent lower confidence level of the downgradient data exceeds the GPS. Confidence intervals will be established in a manner appropriate to the data set being evaluated (proportion of non-detect data, distribution, etc.). If the statistical tests conclude that an exceedance of the GPS or background has occurred, verification resampling may be conducted by the facility. Once the resampling data are available, the comparison to the GPS or background will be evaluated.

Additionally, it is noted in §257.95(e) that if the concentrations of all constituents listed in Appendices III and IV are shown to be at or below background values using statistical procedures in §257.93(g) for two consecutive sampling events, the owner or operator may return to detection monitoring of the CCR unit. A notification must be prepared stating that the detection monitoring is resuming for the CCR unit.

Section 6

References

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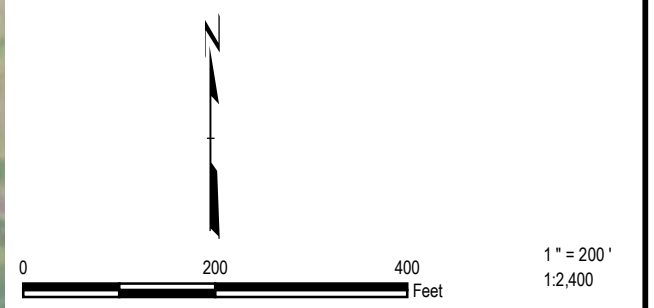
Figure



LEGEND

- DEK BOTTOM ASH POND MONITORING WELL
- DECOMMISSIONED WELL
- BOTTOM ASH POND & LINED IMPOUNDMENT MONITORING WELL
- DEK LINED IMPOUNDMENT MONITORING WELL
- MONITORING WELL
- EXTENT OF GEOSYNTHETICS

- NOTES**
1. BASE MAP IMAGERY FROM USDA – NATIONAL AGRICULTURE IMAGERY PROGRAM, 7/10/2016.
 2. WELL LOCATIONS SURVEYED BY ROWE PROFESSIONAL SERVICES COMPANY ON 11/4/2015.
 3. NOAA/NATIONAL OCEANIC SERVICE GREAT LAKES GAUGING STATION, ESSEXVILLE, MI (ID: 9075035).



PROJECT:		CONSUMERS ENERGY COMPANY DE KARN POWER PLANT ESSEXVILLE, MICHIGAN	
TITLE:			
		KARN LINED IMPOUNDMENT AREA	
DRAWN BY:	S. MAJOR	PROJ NO.:	290804-001
CHECKED BY:	D. LITZ	FIGURE 1	
APPROVED BY:	G. CROCKFORD		
DATE:	JUNE 2018		
		1540 Eisenhower Place Ann Arbor, MI 48108-3284 Phone: 734.971.7080 www.trcsolutions.com	
FILE NO.:		290804-001-001.mxd	