October 29, 2015

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Ms. Kathleen Lawson
North Carolina Department of Environmental Quality
Division of Waste Management - Hazardous Waste Section
1646 Mail Service Center
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Reference: Soil Risk Assessment
Safety-Kleen Service Center
2320 Yadkin Avenue
Charlotte, North Carolina
EPA ID No. NCD 079060059
Cardno Project No. SKCHARLOT1

Dear Ms. Lawson:

Cardno Inc. (Cardno) has prepared this Soil Risk Assessment report on behalf of Safety-Kleen Systems, Inc. (S-K) for the Charlotte, North Carolina S-K facility. This report documents calculations performed to evaluate whether remaining impacted soil at the site poses an unacceptable risk or meets the criteria for site closure. Background information and additional details regarding these calculations are documented in the sections that follow.

1.0 BACKGROUND INFORMATION

S-K currently operates a hazardous material storage facility at 2320 Yadkin Avenue in Charlotte, Mecklenburg County, North Carolina. The facility began operations on June 5, 1978, and currently maintains a Part B Resource Conservation and Recovery Act (RCRA) permit for hazardous waste storage. In the early 1980s, prior to installation of the current waste mineral spirits management system at the facility, used mineral spirits were placed into a 500-gallon underground storage tank (UST) and then into a 10,000-gallon capacity UST. The 500-gallon UST provided in-line solids settling for the waste mineral spirits prior to accumulation in the 10,000-gallon UST. The UST system was operated for a five-year period from 1980 until its removal in August 1985. The waste mineral spirits UST system constitutes the solid waste management units (SWMUs) that have been the focus of historical soil and groundwater investigation activities. SWMU-8 is the former 500-gallon waste mineral spirits settling tank and SWMU-9 is the former 10,000-gallon waste mineral spirits tank. Another 10,000-gallon mineral spirits UST was located immediately adjacent to the waste 10,000-gallon tank and was used to store virgin mineral spirits product. The virgin mineral spirits tank is not considered part of the SWMUs.

Several phases of assessment were conducted to investigate potential impacts around the waste mineral spirits UST system between 1998 and 2011. These investigations were documented in a Phase I RCRA Facility Investigation (RFI) report dated March 19, 1998, a Phase II RFI report dated January 9, 2001, a Deep Monitoring Well Installation report dated November 18, 2003, a Groundwater Sampling Event report dated January 15, 2009, and a Soil

and Groundwater Investigation Report dated February 22, 2011. The results of the assessment activities indicated the presence of soil and groundwater impacted by various volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) in the area of the former USTs and downgradient to the north-northeast.

On May 6, 2011, a Groundwater Sampling and Analysis Plan (SAP) and Corrective Measures Study (CMS) were submitted for the site. Both submittals were approved by the North Carolina Department of Environmental Quality (NCDEQ, formerly North Carolina Department of Environment and Natural Resources) in a letter dated June 3, 2011. Periodic groundwater monitoring was initiated following the SAP approval. The CMS recommended installation of a soil vapor extraction (SVE) system to remediate impacted soil and chemical injection to remediate impacted groundwater. The status of each of these remedial measures is addressed below.

An injection permit application for the chemical injection was submitted to the Underground Injection Control (UIC) Group of NCDEQ on August 19, 2011. Injection permit WI0300181 was subsequently issued by the UIC Group. A condition of the permit required replacement of upgradient monitoring well TW-5, since this well was typically dry. The well replacement and an initial injection event were completed in December 2011. Injection using direct-push technology was attempted during the initial injection event, but was generally unsuccessful due to the site geology and direct-push refusal depths. Based on data gathered during the initial event, a permit modification was requested to cover modifications to the scope and installation of permanent injection wells during the next event. Following UIC Group approval, permanent injection wells IW-1S through IW-6S and IW-1D through IW-6D were subsequently installed and a second injection event was conducted in March 2012. The injection fluids consisted of a mixture of sodium persulfate (Klozur) and hydrogen peroxide. The results of the injection activities were documented in the Semiannual Groundwater Monitoring Report dated May 9, 2012. Groundwater monitoring performed post-injection indicated concentrations reduced to below Title 15A NCAC 2L .0202 Groundwater Standards (2L Standards) within 18 months following the injection and have remained below 2L Standards during the most recent six sampling events performed since March 2013.

An SVE pilot test was completed and proposed design specifications for the SVE system were submitted to NCDEQ for review on September 28, 2011. The SVE design specifications were approved by NCDEQ in a letter dated October 31, 2011. The SVE system was constructed during June and July 2012 and started on July 12, 2012. Soil sampling was performed in January 2014 to monitor the progress of remediation. The results of the sampling indicated significantly reduced concentrations in comparison to pre-SVE concentrations, although some constituents remained at concentrations above closure goals for soil. As discussed during a meeting with Cardno, S-K, and NCDEQ representatives on May 6, 2014, in preparation for possible future risk assessment, the SVE system at the site was shut down on September 19, 2014, as approved by NCDEQ in a letter dated July 29, 2014.

Post-remediation soil sampling was performed on September 22, 2014. The results of the sampling indicated exceedances of Protection of Groundwater Preliminary Soil Remediation Goals (PSRGs) and/or Residential PSRGs in two soil samples. The soil sampling was documented in the Semiannual Monitoring Report dated November 19, 2014. This report documents risk calculations performed to evaluate whether the remaining impacted soil at the site poses an unacceptable risk or meets the criteria for site closure.

2.0 CURRENT EXTENT OF IMPACTED SOIL

As discussed in Section 1.0, an SVE system operated at the site from July 2012 through July 2014 to remediate impacted soil. The approved CMS dated May 6, 2011, specified collection of soil samples at the locations historically exhibiting concentrations above remedial goals in order to determine whether remediation is complete. The preliminary remedial goals currently used by the NCDEQ Hazardous Waste Section are the Protection of Groundwater and Residential PSRGs established by the NCDEQ Inactive Hazardous Sites Branch (IHSB). The locations historically exhibiting exceedances of PSRGs include former borings B-5 at 5 feet below ground surface (bgs), B-6 at 5 and 10 feet bgs, and B-7 at 5 and 10 feet bgs. In January 2014, soil samples were collected at these locations for analysis of VOCs by EPA Method 8260B and SVOCs by EPA Method 8270D. The results of the laboratory analyses indicated exceedance of PSRGs in samples collected from boring B-6 at 10 feet bgs and B-7 at 5 feet bgs. No exceedances of PSRGs were detected in samples collected from boring B-5 at 5 feet bgs, B-6 at 5 feet bgs, and B-7 at 10 feet bgs. The January 2014 sampling was documented in a Semiannual Monitoring Report submitted to NCDEQ on May 14, 2014. The report recommended shutdown of the SVE system followed by resampling at the locations showing exceedances in January 2014 (B-6 at 10 feet bgs and B-7 at 5 feet bgs). This scope of work was approved by NCDEQ in a letter dated July 29, 2014.

On September 22, 2014, borings B-6B and B-7B were advanced at the former locations of borings B-6 and B-7, respectively. Soil samples were collected at the pre-designated depth intervals (B-6 at 10 feet bgs and B-7 at 5 feet bgs) for analysis of VOCs by EPA Method 8260B and SVOCs by EPA Method 8270D. Duplicate samples were also collected at each location for laboratory quality assurance/quality control. Exceedances of PSRGs in the samples are summarized below:

- The sample collected from boring B-6B at 10 feet bgs contained naphthalene, 1,2,4-trimethylbenzene, and 1-methylnaphthalene at concentrations above the Protection of Groundwater PSRGs but below the Residential and Industrial PSRGs. The duplicate sample collected at this location also contained n-butylbenzene and 1,2-dichlorobenzene at concentrations above the Protection of Groundwater PSRGs but below the Residential and Industrial PSRGs. Note that concentrations were generally higher in the duplicate versus the original sample at this location. This variability is attributed to concentration differences in the specific portions of the soil column used for each sample.
- The sample collected from boring B-7B at 5 feet contained benzo(a)pyrene at a concentration above the Residential PSRG but below the Protection of Groundwater and Industrial PSRGs. Benzo(a)pyrene was the only constituent showing an exceedance in both the original and duplicate sample at this location.

Pre-remediation and post-remediation soil analytical data are summarized in ***Table 1***. Soil sampling locations and exceedances are depicted on ***Figure 1***. Refer to the Semiannual Monitoring Report dated November 19, 2014 for additional details regarding the September 2014 soil sampling event.

3.0 SOIL RISK ASSESSMENT

Impacted soil at the site was further evaluated using the procedures detailed in the document Guidelines for Establishing Remediation Goals at RCRA Hazardous Waste Sites prepared by

the NCDEQ Hazardous Waste Section dated December 11, 2013 (NCDEQ, 2013) (NC Guidelines). According to this document, soil contaminant concentrations should be compared to PSRGs as part of a preliminary screening to identify conditions that do not require further attention. However, if exceedances of PSRGs are identified, the risk associated with concentrations may be further evaluated as part of a site-specific risk assessment. The two primary exposure pathways that require evaluation for impacted soil are (1) protection of human health and (2) protection of groundwater. Details regarding risk assessment calculations for each of these exposure pathways are provided in the following sections.

3.1 Protection of Human Health

The protection of human health exposure pathway evaluates the risk associated with ingestion, inhalation of particulates, and dermal absorption by a resident or industrial worker. Risk is typically assessed initially using the more conservative assumption that the receptor is a resident, since an industrial worker assumption would require land-use controls limiting residential occupancy at the site.

For evaluation of risk associated with the soil direct-contact pathway, the NC Guidelines recommend following Environmental Protection Agency (EPA) risk assessment guidance. Accordingly, Cardno evaluated risk using the EPA Region 3 On-Line Regional Screening Level (RSL) calculator, which assesses risk in accordance with EPA Risk Assessment Guidance for Superfund (RAGS) (EPA, 1991). The EPA RSLs are also the basis for the NC Residential and Industrial PSRGs. The NC PSRGs for individual constituents are based on EPA RSLs calculated assuming a target carcinogenic risk of 10^{-6} and hazard quotient of 1. For a cumulative risk evaluation, NCDEQ will generally allow a cumulative carcinogenic risk of 10^{-4} and hazard index of 1. Cardno used the EPA RSL calculator to calculate the cumulative risk for the combined constituents of concern.

As discussed in Section 2.0, exceedances of Residential PSRGs at the site are limited to benzo(a)pyrene in the original and duplicate samples collected from boring B-7B at 5 feet bgs. ***Table 2*** summarizes the detected concentrations and constituents in this sample. For risk assessment purposes, the higher of the results between the original sample and the duplicate for each constituent was used. These concentrations are also summarized in ***Table 2***. Concentrations were entered for each constituent of concern into the EPA Residential RSL calculator. Other than site-specific concentrations, the default values for all inputs were used. The default values are also assumed in calculation of NC PSRGs. Note that site-specific values could have been entered for some parameters; however, the defaults are generally considered to be the most conservative assumption, so evaluation using site-specific values is generally warranted only if the calculator indicates exceedances using the default inputs.

The EPA calculator output sheets are included in ***Appendix A***. The results of the cumulative risk evaluation indicated the following:

- Residential cumulative carcinogenic risk for the combined constituents of concern is 1.84×10^{-6}, which is below the NCDEQ acceptable limit of 10^{-4}.
- Residential hazard index for the combined constituents of concern is 0.000581, which is below the NCDEQ acceptable limit of 1.

Since the results of the risk assessment using a simplistic approach of the EPA calculator with default inputs indicated no exceedances of the risk levels considered acceptable by NCDEQ, no further evaluation of the protection of human health pathway appears warranted. Furthermore, since concentrations meet residential risk levels, no non-residential land-use controls appear warranted.

3.2 Protection of Groundwater

Screening levels for protection of groundwater are determined by evaluating the potential for contaminants of concern in soil to leach sufficient to result in groundwater concentrations above 2L Standards. As discussed in Section 2.0, exceedances of Protection of Groundwater PSRGs at the site are limited to naphthalene, 1,2,4-trimethylbenzene, 1-methylnaphthalene, n-butylbenzene, and 1,2-dichlorobenzene in the original and/or duplicate samples collected from boring B-6B at 10 feet bgs. ***Table 3*** summarizes the detected concentrations and constituents in this sample. For risk assessment purposes, the higher of the results between the original sample and the duplicate for each constituent was used. These concentrations are also summarized in ***Table 3***. Note that there is no cumulative risk component to the soil leaching to groundwater equations. As such, evaluation for all detected constituents is not warranted and calculations were performed only for the constituents detected at concentrations above Protection of Groundwater PSRGs (naphthalene, 1,2,4-trimethylbenzene, 1-methylnaphthalene, n-butylbenzene, and 1,2-dichlorobenzene).

The Protection of Groundwater PSRGs are calculated using the transport modeling equations detailed in the EPA Soil Screening Guidance: User's Guide dated July 1996 (EPA, 1996) and the EPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites dated December 2002 (EPA, 2002). The NC Guidelines state that site-specific Soil Screening Levels (SSLs) protective of groundwater may be calculated using the EPA equations with site-specific parameter values. Cardno attempted these calculations for the subject site and found that soil concentrations exceed the calculated SSLs using this approach. However, this approach is clearly too conservative for the subject site based on historical groundwater analytical data. Monitoring well MW-4 is located within 10 feet of boring B-6B. ***Table 3*** contains a summary of concentrations detected in soil (B-6/B-6B at 10 feet bgs) versus groundwater (MW-4). As shown, the data show no exceedances of 2L Standards for n-butylbenzene and only minimal exceedances for 1,2-dichlorobenzene and naphthalene during the first one or two sampling events for well MW-4. These sampling events were performed shortly after the well installation and before remediation was complete. These data confirm that impacted soil in this location is not significantly leaching to groundwater. Cardno therefore evaluated other soil leaching to groundwater models to identify a model that is more representative of site conditions.

Cardno selected the RBCA Toolkit for Chemical Releases Version 2 (RBCA Toolkit) produced by GSI Environmental Inc. (GSI, 2007) to model soil leaching to groundwater at the subject site. The guidance document for the RBCA Toolkit references the source of these equations as the American Society for Testing and Materials (ASTM) Standard Guide for Risk-Based Corrective Action Standard E 2081-2000 (ASTM, 2000). However, the equations are identical to the equations specified in the EPA Soil Screening Guidance: User's Guide dated July 1996 (EPA, 1996) and the EPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites dated December 2002 (EPA, 2002). The RBCA Toolkit calculations vary from the standard EPA equations in that a Soil Attenuation Model (SAM) option can be selected, which modifies the equations to account for attenuation of constituent concentrations through

application of first-order decay rates (Connor et al, 1997). Initially, Cardno ran the model with the goal of calibrating the first-order decay rates to match existing site conditions. Once the model was determined to be properly calibrated, Cardno ran the model a second time to evaluate soil leaching to groundwater under future conditions.

For the calibration model run, Cardno initially developed a model that depicts historical site conditions. Source soil concentrations were entered as average concentrations of the identified constituents of concern pre-remediation in boring B-6 at 5 and 10 feet bgs. Values for the size of the soil source area, physical soil characteristics, and hydrogeology were entered based on site-specific estimates, as summarized in ***Table 4***. The model was used to predict groundwater concentrations directly underlying the soil source area (distance to point of exposure of 0 feet). The values for first-order decay constants were then varied until the model predicted groundwater concentrations at the POE that were approximately equal to the maximum concentrations actually measured in well MW-4, which is located within 10 feet of boring B-6. Note that determining first-order decay constants using site-specific analytical data is generally the method preferred by the EPA. Modeling documentation for the calibration run is provided in ***Appendix B***.

Once Cardno had developed a calibrated model that accurately represented historical site conditions, the model was used to represent future conditions. For the future model run, source soil concentrations were entered as concentrations of COCs post-remediation in boring B-6B at 10 feet bgs. The size of the soil source area was modified to represent post-remediation conditions. The infiltration rate parameter was also modified to reflect no surface cover, since the surface cover over the source area could potentially be removed in the future and might result in greater leaching. The remaining modeling parameters were the same as those entered in the model calibration run. The results of the future model run indicated no exceedances of 2L Standards in groundwater directly underlying the soil source area. Model input values are summarized in ***Table 4***. Modeling documentation for the future run is provided in ***Appendix C***.

Based on the modeling results data, Cardno concludes that soil leaching to groundwater in the area of remaining impacted soil at the site is not likely to result in exceedances of 2L Standards. Therefore, no further action is recommended with regard to this exposure pathway.

4.0 CONCLUSIONS

Based on the results of the risk calculations presented in this report, the calculated human health risk associated with exposure of a resident or non-residential worker to the remaining impacted soil does not exceed the cumulative risk levels considered acceptable by NCDEQ. In addition, soil leaching to groundwater in the area of remaining impacted soil is not likely to result in exceedances of NC 2L Standards for groundwater. Therefore, Cardno recommends no further action at the site with regard to impacted soil.

With regard to impacted groundwater, Cardno understands that groundwater concentrations must remain below NC 2L Standards for three years to achieve no further action status under the NCDEQ Hazardous Waste Section. Groundwater concentrations have remained below 2L Standards since March 2013. As such, closure under the NCDEQ Hazardous Waste Section would require on-going monitoring showing no exceedances of 2L Standards through March 2016. The current GW SAP requires monitoring on a semiannual schedule. Based on the date of the most recent sampling event in June 2015, the next sampling event will be performed in December 2015 and will represent the final sampling event prior to the close of the three-year

post-remediation monitoring period in March 2016. Therefore, if the results of the December 2015 sampling event show no exceedances of 2L Standards, S-K will request no further action status for the site under the NCDEQ Hazardous Waste Section.

S-K previously considered applying for site closure under the risk-based remediation statutes specified in North Carolina General Statutes (NCGS) NCGS 130A-310.65 to 310.77. However, based on the data presented in this report, the site appears eligible for closure in the near future under the standard NCDEQ Hazardous Waste Section corrective action rules. Therefore, there does not appear to be a significant benefit to applying for risk-based remediation under NCGS 130A-310.65 to 310.77. For confirmation, S-K requests that NCDEQ review these recommendations and provide concurrence regarding our understanding of closure requirements.

5.0 REFERENCES

American Society for Testing and Materials. Standard Guide for Risk-Based Corrective Action, ASTM E-2081-00. 2000 (Reauthorized 2004).

Connor, J. A., R. L. Bowers, S. M. Paquette and C. J. Newell. Soil Attenuation Model for Derivation of Risk-Based Soil Remediation Standards, Proceedings of NGWA Petroleum Hydrocarbons Conference. 1997.

EPA. Regional Screening Level Calculator Website. http://www2.epa.gov/risk/regional-screening-table. September 2015.

EPA. Risk Assessment Guidance for Superfund, Volume I – Human Health Evaluation Manual, Part B - Development of Risk-based Preliminary Remediation Goals. 1991.

EPA. Soil Screening Guidance: User's Guide. 1996.

EPA. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. 2002.

NCDEQ, Division of Waste Management, Hazardous Waste Section. Guidelines for Establishing Remediation Goals at RCRA Hazardous Waste Sites. 2013.

Cardno and S-K appreciate the NCDEQ's assistance in this matter. If you have questions or require additional information, please contact Robert Schoepke (Safety-Kleen Project Manager) at (847) 468-6733 or Genna Olson (Cardno Project Manager) at (919) 871-0999.

Sincerely,

Cardno Inc.

Ashley Winkelman, P.G.
Project Manager

Genna K. Olson, P.G.
Senior Project Manager

NORTH CAROLINA LICENSED SEAL 1660 GEOLOGIST GENNA K. OLSON

Attachments: Certification Page

Figure 1 – Post-Remediation Soil Analytical Data Map

Table 1 – Soil Analytical Data
Table 2 – Soil Analytical Data Used for Protection of Human Health Evaluation
Table 3 – Soil and Groundwater Analytical Data Used for Protection of Groundwater Evaluation
Table 4 – Summary of Model Input Paramters

Appendix A – Protection of Human Health Modeling Documentation
Appendix B – Protection of Groundwater Modeling Documentation – Calibration Model Run
Appendix C – Protection of Groundwater Modeling Documentation – Future Model Run

cc: Robert Schoepke, S-K; Todd Blake, – SK; Facility File

Safety-Kleen Facility\Charlotte, NC

CERTIFICATION PAGE

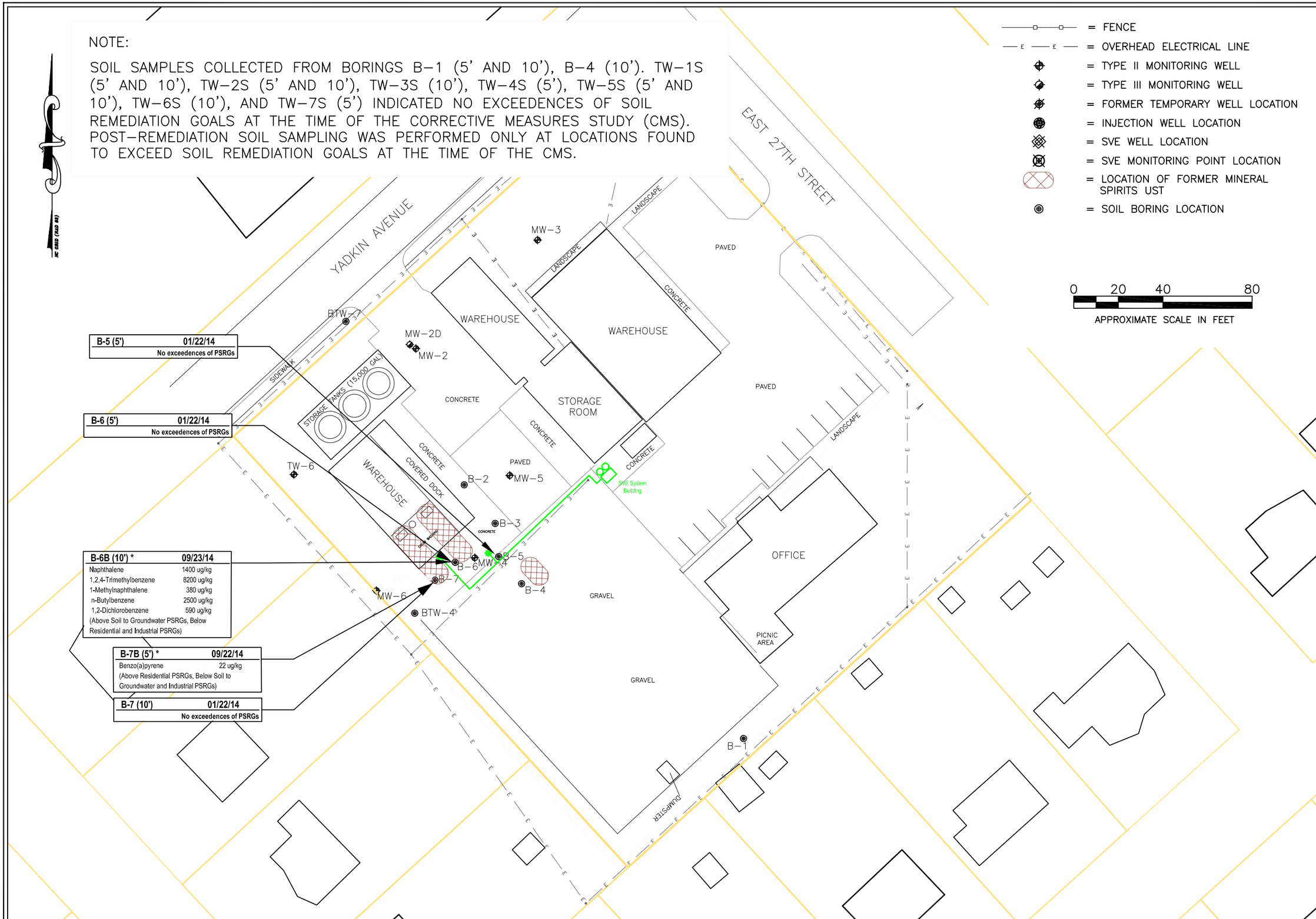
I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Robert A. Schoepke., P.G.
Director - Remediation
Safety-Kleen Systems, Inc.

FIGURE

NOTE:

SOIL SAMPLES COLLECTED FROM BORINGS B–1 (5' AND 10'), B–4 (10'). TW–1S (5' AND 10'), TW–2S (5' AND 10'), TW–3S (10'), TW–4S (5'), TW–5S (5' AND 10'), TW–6S (10'), AND TW–7S (5') INDICATED NO EXCEEDENCES OF SOIL REMEDIATION GOALS AT THE TIME OF THE CORRECTIVE MEASURES STUDY (CMS). POST–REMEDIATION SOIL SAMPLING WAS PERFORMED ONLY AT LOCATIONS FOUND TO EXCEED SOIL REMEDIATION GOALS AT THE TIME OF THE CMS.



NOTES:
1. PSRGs = Preliminary Soil Remediation Goals established by NC Inactive Hazardous Sites Branch dated September 2014.
2. * = Concentrations shown are the higher of original sample versus duplicate.

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TITLE FIGURE 1
POST-REMEDIATION SOIL ANALYTICAL DATA MAP
SAFETY-KLEEN
2320 YADKIN AVENUE
CHARLOTTE, NC

PROJECT NO.	DATE	SCALE	REV. BY	PREP. BY	CAD FILE
045.16031.0007	10/29/14	AS SHOWN	GO	SMA	1254087.DWG

TABLES

TABLE 1

SOIL ANALYTICAL DATA

SAFETY-KLEEN SERVICE CENTER
2320 YADKIN ROAD
CHARLOTTE, NORTH CAROLINA

COMPOUND	TIMEFRAME		Pre-SVE	Post-SVE	Pre-SVE	Post-SVE	Pre-SVE	Post-SVE	Post-SVE	Post-SVE	Pre-SVE	Post-SVE	Post-SVE	Post-SVE	Post-SVE	Pre-SVE	Pre-SVE	Post-SVE	Protection of Groundwater PSRG	Residential PSRG	Industrial PSRG
	BORING		B-5	B-5	B-6	B-6	B-6	B-6	B-6B	B-6B (DUP)	B-7	B-7	B-7 (DUP)	B-7B	B-7B (DUP)	B-7	B-7 (DUP)	B-7			
	DEPTH (ft.)		5'	5'	5'	5'	10'	10'	10'	10'	5'	5'	5'	5'	5'	10'	10'	10'			
	Method	Units	12/22/10	1/22/14	12/22/10	1/22/14	12/22/10	1/22/14	9/23/14	9/23/14	12/22/10	1/22/14	1/22/14	9/22/14	9/22/14	12/22/10	12/22/10	1/22/14			
VOLATILE ORGANICS																					
Acetone	8260	ug/kg	<160	<100	<5100	<110	<6200	2.6J	17J	16J	41J	<100	<94	<97	13	<5500	<4600	40J	24,000	12,000,000	100,000,000
n-Butylbenzene	8260	ug/kg	2.7J	2.2J	**4,400**	<11	**24,000**	72	170	**2,500**	33	<10	<9.4	2.7J	2.1J	**8,200**	**10,000**	9.9J	2,400	110,000	110,000
sec-Butylbenzene	8260	ug/kg	2.9J	1.7J	1,500	4.2J	**7,200**	24	34	760	24	2.3J	2.1J	1.4J	0.9J	**3,600**	**3,500**	4.2J	2,200	150,000	150,000
tert-Butylbenzene	8260	ug/kg	0.4J	<10	190J	2.0J	650	4.3	4.6J	21	5.3J	<10	<9.4	0.6J	<11	380J	360J	<15	1,700	180,000	180,000
Carbon Disulfide	8260	ug/kg	<16	<10	<510	<11	<620	<11	0.8J	0.5J	<11	<10	<9.4	<9.7	<11	<550	<460	<15	3,800	150,000	700,000
Chlorobenzene	8260	ug/kg	0.7J	<10	**530**	<11	**2,000**	<11	<12	<12	120	<10	0.2J	0.4J	<11	**1,100**	**870**	<15	440	56,000	260,000
Chloroethane	8260	ug/kg	<8.1	<5.2	<260	<5.3	<310	<5.4	<6.1	<5.8	1.0J	<5.1	<4.7	<4.8	<5.4	<280	<230	<7.7	16,000	2,100,000	2,100,000
2-Chlorotoluene	8260	ug/kg	<16	<10	<510	<11	<620	<11	<12	<12	2.9J	<10	<9.4	<9.7	<11	<550	<460	<15	1,200	320,000	910,000
4-Chlorotoluene	8260	ug/kg	<16	<10	<510	<11	<620	<11	<12	<12	<11	<10	<9.4	<9.7	<11	31J	33J	<15	280	250,000	250,000
1,2-Dichlorobenzene	8260	ug/kg	3.1J	<10	**1,100**	0.4J	**920**	27	43	**590**	7.1J	<10	0.3J	1.3J	0.4 J	100J	55J	2.9J	240	360,000	380,000
1,3-Dichlorobenzene	8260	ug/kg	<16	<10	190J	<11	860	3.3J	5.1J	25	3.6J	0.2J	0.6J	0.7J	<11	320J	330J	0.6J	2,400	NE	NE
1,4-Dichlorobenzene	8260	ug/kg	1.1J	<10	**590**	0.2J	**2,000**	8.1J	14	65	21	1.0J	2.1J	0.6J	0.3 J	**1,000**	**940**	1.9J	70	2,600	11,000
1,1-Dichloroethane	8260	ug/kg	3.2J	<5.2	<260	<5.3	<310	<5.4	<6.1	<5.8	<5.4	<5.1	<4.7	<4.8	<5.4	<280	<230	<7.7	30	3,600	16,000
cis-1,2-Dichloroethene	8260	ug/kg	2.8J	<5.2	<260	<5.3	<310	<5.4	<6.1	<5.8	4.6J	<5.1	<4.7	<4.8	<5.4	<280	<230	<7.7	360	32,000	460,000
Ethylbenzene	8260	ug/kg	1.3J	<5.2	530	<5.3	2,300	0.8J	<12	10	20	<5.1	<4.7	<4.8	<5.4	480	450	<7.7	8,100	5,800	25,000
Isopropylbenzene	8260	ug/kg	2.1J	<10	670	<11	**3,300**	7.2J	<12	89	23	<10	<9.4	<9.7	<11	1,200	1,200	3.2J	1,300	270,000	270,000
p-Isopropyltoluene	8260	ug/kg	1.4J	<10	**1,500**	2.6J	**7,200**	27	39	160	9.6J	0.4J	0.3J	2.6J	2.9J	93J	<460	2.4J	680	NE	NE
Methylene Chloride	8260	ug/kg	0.4J	0.4J	**26J**	<11	**30J**	0.2J	<12	<12	<11	0.5J	0.3J	<9.7	<11	**23J**	19J	0.4J	23	57,000	640,000
Methyl Ethyl Ketone	8260	ug/kg	<160	<100	<5100	<110	<6200	<110	3.9 J	6.6J	12J	<100	<94	<97	<110	<5500	<4600	3.0J	16,000	5,400,000	38,000,000
Naphthalene	8260	ug/kg	4.0J	<10	**2,200**	4.4J	***10,000***	**670CN**	**1,400**	**1,400**	34	<10	4.0J	1.5J	1.6 J	**3,000**	**2,900**	18	210	3,800	17,000
n-Propylbenzene	8260	ug/kg	2.5J	<10	**1,800**	<11	**7,400**	150	17	750	38	<10	<9.4	0.3J	<11	**3,600**	**3,600**	1.9J	1,500	260,000	260,000
Tetrachloroethene	8260	ug/kg	1.5J	<5.2	<260	<5.3	<310	<5.4	<6.1	<5.8	<5.4	<5.1	<4.7	<4.8	<5.4	<280	<230	<7.7	5	16,000	78,000
Toluene	8260	ug/kg	<8.1	0.1J	NA	<5.3	NA	0.2J	<6.1	<5.8	NA	0.2J	0.1J	<4.8	0.3J	NA	NA	0.3J	5,500	820,000	820,000
1,2,3-Trichlorobenzene	8260	ug/kg	NA	NA	NA	1.5J	NA	1.8J	<12	<12	NA	<10	<9.4	<9.7	<11	NA	NA	<15	NE	13,000	190,000
1,2,4-Trichlorobenzene	8260	ug/kg	<16	<10	28J	2.4J	45J	4.1J	<12	<12	<11	<10	<9.4	<9.7	<11	<550	<460	<15	2,200	12,000	52,000
Trichlorofluoromethane	8260	ug/kg	0.7J	<10	<510	<11	<620	<11	<12	<12	0.6J	<10	<9.4	<9.7	<11	<550	<460	<15	24,000	146,000	620,000
1,2,4-Trimethylbenzene	8260	ug/kg	32	0.8J	***13,000***	7.1J	***52,000***	1,300	**8,200**	**7,700**	81	1.1J	1.7J	3.6J	3.3J	490J	<460	25	6,700	11,600	48,000
1,3,5-Trimethylbenzene	8260	ug/kg	7.2J	0.2J	2,700	1.7J	**20,000**	88	150	2,700	9.3J	<10	0.5J	1.1J	<11	72J	<460	6.6J	6,700	156,000	182,000
Vinyl Chloride	8260	ug/kg	<16	<10	<510	<11	<620	<11	<12	<12	**1.0J**	<10	<9.4	<9.7	<11	<550	<460	<15	0.19	59	1,700
Total Xylenes	8260	ug/kg	2.5J	<5.2	300	<5.3	1,700	<5.4	<6.1	92	3.5J	<5.1	<4.7	<4.8	<5.4	<280	9.7J	0.8J	6,000	130,000	258,000
SEMIVOLATILE ORGANICS																					
Anthracene	8270	ug/kg	<380	<12	<380	<12	<390	<12	<12	<11	<380	3J	NA	<11	<11	<390	<390	<11	660,000	3,600,000	46,000,000
Benzo(a)anthracene	8270	ug/kg	18	<12	17	4	<12	14	<12	11QI-02,J	130	29	NA	19	19	23	34	<11	180	160	2,900
Benzo(a)pyrene	8270	ug/kg	*18*	<12	10J	4	<12	*16QI-02*	<12	<11	***130***	*33QI-02*	NA	*22*	*16*	*24*	*28*	6J	59	16	290
Benzo(b)fluoranthene	8270	ug/kg	27	<12	19	7	<12	25J	19QI-02	<11	*200*	45QI-02	NA	35	26	35	45	<11	600	160	2,900
Benzo(ghi)perylene	8270	ug/kg	<380	<12	<380	<12	<390	8QI-02,J	<12	<11	<380	13QI-02	NA	<11	10J	<390	<390	<11	7,800,000	NE	NE
Benzo(k)fluoranthene	8270	ug/kg	12	<12	<11	<12	<12	<58	10QI-02,J	<11	63	25QI-02	NA	11	10J	13	20	<11	5,900	1,600	29,000
Chrysene	8270	ug/kg	<380	<12	<380	7	<390	21	24QI-02	17QI-02	<380	45	NA	27	26	<390	<390	4J	18,000	16,000	290,000
Dibenzo(a,h)anthracene	8270	ug/kg	<12	<12	<11	<12	<12	<12QI-02	<12	<11	*17*	<12QI-02	NA	<11	<11	<12	<12	<11	190	16	290
1,2-Dichlorobenzene	8270	ug/kg	<380	<390	**510**	<380	<390	<380	<400	<380	<380	<390	NA	<380	<360	<390	<390	<350	240	360,000	380,000
Bis(2-ethylhexyl)phthalate	8270	ug/kg	<380	<390	450	280	270J	850	630	640	<380	<390	NA	580	520	280J	330J	260J	7,200	39,000	160,000
Fluoranthene	8270	ug/kg	<380	<12	<380	8	<390	41	40	31	280J	74	NA	42	36	<390	<390	4J	330,000	480,000	6,000,000
Indeno(1,2,3-cd)pyrene	8270	ug/kg	15	<12	<11	<12	<12	7QI-02, J	<12	<11	47	12QI-02	NA	11	9J	12J	11J	<11	2,000	160	2,900
1-Methylnaphthalene	8270	ug/kg	NA	<12	NA	<12	NA	**170**	**140**	**380**	NA	<12	NA	<11	<11	NA	NA	<11	55	18,000	73,000
2-Methylnaphthalene	8270	ug/kg	<380	<12	560	<12	**2,900**	110	180	390	<380	<12	NA	<11	<11	560	560	<11	1,600	48,000	600,000
Naphthalene	8270	ug/kg	<380	<12	**1,600**	<12	***7,900***	**210**	**480**	**940**	**210J**	<12	NA	<11	<11	**1,400**	**1,100**	2J	210	3,800	17,000
Phenanthrene	8270	ug/kg	<380	<12	<380	3	<390	73	53	59	280J	18	NA	8J	5J	<390	<390	<11	68,000	NE	NE
Pyrene	8270	ug/kg	<380	<12	<380	8	<390	41	38	36QI-02	270J	91	NA	44	42	<390	<390	6J	220,000	360,000	4,600,000

NOTES:

1. Table only shows pre-SVE data for samples exhibiting exceedences of soil remediation goals.
2. ug/kg = micrograms per kilogram.
3. "<" = Not detected above method detection limit. Table shows "< reporting limit".
4. NA = Not analyzed.
5. PSRGs = Preliminary Soil Remediation Goals established by NC Inactive Hazardous Sites Branch dated September 2015.
6. NE = Not established.
7. J = Estimated result less than the reporting limit but above the method detection limit.
8. CN = Sample was analyzed at both medium level (methanol extraction) and low level (water extraction) with greater than expected variability between the two results due to suspected variability between the two aliquots tested and/or greater extraction efficiency with the methanol extracted sample. The higher of the two values is reported in the table.
9. QI-02 = Internal standard recoveries outside control limits biased low due to matrix interference.
10. **BOLD** = Concentrations above Protection of Groundwater PSRGs.
11. = Concentrations above Residential PSRGs.
12. = Concentrations above Industrial PSRGs.

TABLE 2

SOIL ANALYTICAL DATA USED FOR PROTECTION OF HUMAN HEALTH EVALUATION

SAFETY-KLEEN SERVICE CENTER
2320 YADKIN ROAD
CHARLOTTE, NORTH CAROLINA

COMPOUND	BORING			B-7B	B-7B (DUP)		Concentration Used for Cumulative Risk Calculations*
	DEPTH (ft.)			5'	5'		
	Method	Units		9/22/2014	9/22/2014		
VOLATILE ORGANICS							
Acetone	8260	ug/kg		<97	13		13
n-Butylbenzene	8260	ug/kg		2.7J	2.1J		2.7
sec-Butylbenzene	8260	ug/kg		1.4J	0.9J		1.4
tert-Butylbenzene	8260	ug/kg		0.6J	<11		0.6
Chlorobenzene	8260	ug/kg		0.4J	<11		0.4
1,2-Dichlorobenzene	8260	ug/kg		1.3J	0.4 J		1.3
1,3-Dichlorobenzene	8260	ug/kg		0.7J	<11		0.7
1,4-Dichlorobenzene	8260	ug/kg		0.6J	0.3 J		0.6
p-Isopropyltoluene	8260	ug/kg		2.6J	2.9J		2.9
Naphthalene	8260	ug/kg		1.5J	1.6 J		1.6
n-Propylbenzene	8260	ug/kg		0.3J	<11		0.3
Toluene	8260	ug/kg		<4.8	0.3J		0.3
1,2,4-Trimethylbenzene	8260	ug/kg		3.6J	3.3J		3.6
1,3,5-Trimethylbenzene	8260	ug/kg		1.1J	<11		1.1
SEMIVOLATILE ORGANICS							
Benzo(a)anthracene	8270	ug/kg		19	19		19
Benzo(a)pyrene	8270	ug/kg		22	16		22
Benzo(b)fluoranthene	8270	ug/kg		35	26		35
Benzo(ghi)perylene	8270	ug/kg		<11	10J		10
Benzo(k)fluoranthene	8270	ug/kg		11	10J		11
Chrysene	8270	ug/kg		27	26		27
Bis(2-ethylhexyl)phthalate	8270	ug/kg		580	520		580
Fluoranthene	8270	ug/kg		42	36		42
Indeno(1,2,3-cd)pyrene	8270	ug/kg		11	9J		11
Phenanthrene	8270	ug/kg		8J	5J		8
Pyrene	8270	ug/kg		44	42		44
Cumulative Carcinogenic Risk for a Resident							**1.84E-06**
Cumulative Hazard Index for a Resident							**0.00581**

NOTES:

1. ug/kg = micrograms per kilogram.
2. "<" = Not detected above method detection limit. Table shows "< reporting limit".
3. J = Estimated result less than the reporting limit but above the method detection limit.
4. * = The concentration used for risk assessment is the higher value between the original sample and the duplicate sample.
5. Refer to Appendix A for risk assessment calculations.

TABLE 3

SOIL AND GROUNDWATER ANALYTICAL DATA USED FOR PROTECTION OF GROUNDWATER EVALUATION

SAFETY-KLEEN SERVICE CENTER
2320 YADKIN ROAD
CHARLOTTE, NORTH CAROLINA

COMPOUND	REMEDIATION TIMEFRAME	SOIL ANALYTICAL DATA				GROUNDWATER ANALYTICAL DATA														
		Pre-SVE	Post-SVE	Post-SVE	Post-SVE	Pre-SVE	Pre-SVE	Pre-SVE	Pre-SVE	Pre-SVE	During SVE	During SVE	During SVE	During SVE	During SVE	Post-SVE	Post-SVE	Post-SVE	Post-SVE	Post-SVE
		Pre-Inj	Post-Inj	Post-Inj	Post-Inj	Pre-Inj	Pre-Inj	Pre-Inj	Pre-Inj	Post-Inj	Post-Inj	Post-Inj	Post-Inj	Post-Inj	Post-Inj	Post-Inj	Post-Inj	Post-Inj	Post-Inj	Post-Inj
	SAMPLE ID	B-6	B-6	B-6B	B-6B (dup)	MW-4	MW-4	MW-4 (dup)	MW-4	MW-4	MW-4	MW-4	MW-4	MW-4	MW-4	MW-4	MW-4	MW-4	MW-4	MW-4 (dup)
		10'	10'	10'	10'															
	DATE	12/22/10	1/22/14	9/23/14	9/23/14	12/27/10	6/29/11	6/29/11	12/5/11	6/14/12	9/19/12	12/14/12	3/14/13	9/20/13	3/18/14	9/22/14	12/18/14	3/12/15	6/29/15	6/29/15
	UNITS	ug/kg	ug/kg	ug/kg	ug/kg	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
n-Butylbenzene		**24,000**	72	170	**2,500**	15	<5	<5	0.7J	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
1,2-Dichlorobenzene		**920**	27	43	**590**	**20**	**20**	**24**	8.7	11	1.8	0.6J	<1	2.3	<1	1.3	0.4 J	0.6J	1.6	1.6
Naphthalene*		**10,000**	**670CN**	**1,400**	**1,400**	**11**	<5	4.6J	5.3	1.0J	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
1,2,4-Trimethylbenzene		**52,000**	1,300	**8,200**	**7,700**	230	16	33	8.7	9.6	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
1-Methylnaphthalene		NA	**170**	**140**	**380**	NA	<1	<1	<1	<0.9	<0.8	<1	<0.94	<1	<1	<1	<1	<1	<0.94	<0.94

SOIL AND GROUNDWATER DATA USED FOR CALIBRATION MODEL RUN

COMPOUND	SAMPLE ID	B-6	B-6	Soil Concentration Entered Into Model*	MW-4	Model Predicted Groundwater Concentration
		5'	10'			
	DATE	12/22/10	12/22/10		12/27/10	
	UNITS	ug/kg	ug/kg	ug/kg	ug/L	ug/L
n-Butylbenzene		4,400	24,000	14,200	15	15
1,2-Dichlorobenzene		1,100	920	1,010	20	20
Naphthalene*		2,200	10,000	6,100	11	11
1,2,4-Trimethylbenzene		13,000	52,000	32,500	230	230
1-Methylnaphthalene		NA	NA	1,482**	<1	1

SOIL DATA USED FOR FUTURE MODEL RUN AND MODEL PREDICTED GROUNDWATER CONCENTRATIONS VERSUS 2L STANDARDS

COMPOUND	SAMPLE ID	B-6B***	Soil Concentration Entered Into Model	2L Standard	Model Predicted Groundwater Concentration
		10'			
	DATE	9/23/14			
	UNITS	ug/kg	ug/kg	ug/L	ug/L
n-Butylbenzene		2,500	2,500	70	<1
1,2-Dichlorobenzene		590	590	20	1.8
Naphthalene*		1,400	1,400	6	<1
1,2,4-Trimethylbenzene		8,200	8,200	400	<1
1-Methylnaphthalene		380	380	1	<1

NOTES:
1. ug/kg = micrograms per kilogram.
2. ug/L = micrograms per liter.
3. "<" = Not detected above method detection limit. Table shows "< reporting limit".
4. NA = Not analyzed.
5. J = Estimated result less than the reporting limit but above the method detection limit.
6. CN = Sample was analyzed at both medium level (methanol extraction) and low level (water extraction) with greater than expected variability between the two results due to suspected variability between the two aliquots tested and/or greater extraction efficiency with the methanol extracted sample. The higher of the two values is reported in the table.
7. * = Only EPA Method 8260 results are shown for naphthalene since these concentrations have been consistenly higher than those reported via EPA Method 8270 analysis.
8. For the upper table, soil concentrations shown in **bold** are above Protection of Groundwater Preliminary Soil Remediation Goals established by NC Inactive Hazardous Sites Branch dated September 2015.
9. For the upper table, groundwater concentrations shown in **bold** are above Title 15A NCAC 2L .0202 Groundwater Standards.
11. * = Soil concentration entered for the calibration model run is equal to the average of the samples collected at 5 feet and 10 feet from boring B-6.
10. ** = Well MW-4 was not analyzed for 1-methylnaphthalene during the pre-remediation soil sampling event. For the other constituents of concern, concentrations pre-remediation were an average of 3.9 times higher than concentrations pre-remediation. Therefore, the post-remediation concentration of 1-methylnaphthalene in boring B-6B was multiplied by 3.9 to calculate an estimated pre-remediation concentration. Note that this estimated concentration was used only for model calibration to estimate first-order decay rates. Since 1-methylnaphthalene has never been detected above the 2L Standard in well MW-4 it is considered a less important constituent for modeling purposes compared to the other constituents.
11. *** = The higher of the concentration between the original sample and the duplicate was used in modeling.
12. 2L Standard = Title 15A NCAC 2L .0202 Groundwater Standard
13. Refer to Appendices B and C for modeling calculations.

TABLE 4

SUMMARY OF MODEL INPUT PARAMETERS

SAFETY-KLEEN SERVICE CENTER
2320 YADKIN ROAD
CHARLOTTE, NORTH CAROLINA

Parameter	Model Run	Value Used in Model	Justification
Distance to Point-of-Exposure (POE)	Same value used for calibration and future model runs	0 ft	A value of 0 ft was used for both model runs in order to evaluate projected groundwater concentrations directly underlying the soil source area.
Source Area Soil Concentrations	Calibration Model Run	See modeling documentation.	For the calibration model run, the average of pre-remediation concentrations detected in the samples collected at 5 ft below ground surface (bgs) and 10 ft bgs from boring B-6 in December 2010 were used. The averages were used in order to model average concentrations throughout the affected soil zone depth entered into the model.
	Future Model Run	See modeling documentation.	For the future model run, maximum post-remediation concentrations detected in boring B-6B at 10 ft bgs in September 2014 were used.
Constituent Decay Rates	Calibration Model Run	See modeling documentation.	For the calibration model run, the decay rates were determined via the calibration process. Values were modified until the model predicted groundwater concentrations that matched actual data for well MW-4.
	Future Model Run	See modeling documentation.	The decay rates determined during the calibration model run were also used for the future model run.
Depth to Water Bearing Unit	Same value used for calibration and future model runs	18 ft	A value of 18 ft bgs was used for both model runs based on the average depth to groundwater in well MW-4.
Depth to Top of Affected Soils	Calibration Model Run	2.5 ft	Prior to remediation, impacts were identified in boring B-6 at a depth of 5 ft bgs in December 2010, and samples were not collected at a more shallow depth. Based on the nature of the source (underground storage tank system), pre-remediation impacts are estimated to have occurred at a minimum depth of 2.5 ft bgs.
	Future Model Run	7.5 ft	Post-remediation soil samples collected from boring B-6/6B showed exceedences of Protection of Groundwater Preliminary Soil Remediation Goals (PSRGs) at 10 ft bgs (September 2014), but not at 5 ft bgs (January 2014). Based on these data, the a mid-range value of 7.5 ft bgs was entered into the model.
Depth to Base of Affected Soils	Calibration Model Run	17.75 ft	The constituents of concern (COCs) being evaluated have either never been detected above Title 15A NCAC 2L .0202 Groundwater Standards (2L Standards) in well MW-4, or were detected only during the initial one or two sampling events after the well was drilled, which implies concentrations may be associated with smearing of impacts along the borehole wall during the drilling process. A value of 17.75 ft bgs was conservatively used for the calibration model run, which is 0.25 ft above the average depth to groundwater.
	Future Model Run	13 ft	The COCs being evaluated have not been detected above 2L Standards in well MW-4 for over four years, which suggests impacts do not reach the seasonal high water table. A value of 13 feet was used, which is mid-range between the depth of impacts (at least 10 ft bgs) and the seasonal high groundwater table (16 ft bgs).
Length of Affected Soil Parallel to Assumed GW Flow Direction	Calibration Model Run	25 ft	Based on the pre-remediation extent of impacted soil, an estimated value of 25 ft was used for the length of the affected soil zone parallel to groundwater flow.
	Future Model Run	10 ft	Based on the pre-remediation extent of impacted soil, which is limited to boring B-6B, an estimated value of 10 feet was used for the length of the affected soil zone parallel to groundwater flow.
Volumetric Water Content in Vadose Zone	Same value used for calibration and future model runs	0.17	Soil samples were collected at depths of 5-foot bgs and 10-foot bgs from background boring B-1 in February 1998. Analysis of these samples for moisture content indicated values of 0.19 and 0.14, respectively. A mid-range value of 0.17 was used for both model runs.
Volumetric Water Content in Capillary Fringe	Same value used for calibration and future model runs	0.441	For both model runs, volumetric water content in the capillary fringe was assumed to be equal to 90% of the total porosity (see porosity value below).
Total Porosity	Same value used for calibration and future model runs	0.49	A Shelby tube was collected from boring B-2 at 4 to 6 feet bgs in February 1998. Analysis of the Shelby tube for total porosity indicated a value of 0.49. This value was used for both model runs.
Dry Bulk Density	Same value used for calibration and future model runs	1.5 kg/L	Samples have not been collected for analysis of dry bulk density. Therefore, an EPA default value[1] of 1.5 kilogram per liter (kg/L) was used for both model runs.
Vertical Hydraulic Conductivity	Same value used for calibration and future model runs	0.34 ft/d	A Shelby tube was collected from boring B-2 at 4 to 6 ft bgs in February 1998. Analysis of the Shelby tube for vertical hydraulic conductivity indicated a value of 0.34 feet per day (ft/d). This value was used for both model runs.

TABLE 4

SUMMARY OF MODEL INPUT PARAMETERS

SAFETY-KLEEN SERVICE CENTER
2320 YADKIN ROAD
CHARLOTTE, NORTH CAROLINA

Parameter	Model Run	Value Used in Model	Justification
Vapor Permeability	Same value used for calibration and future model runs	1.08E-12 ft^2	This parameter is shown as a required entry in the RBCA Toolkit, but is not actually used in the soil leaching to groundwater calculations. The model default value was used for both model runs.
Capillary Zone Thickness	Same value used for calibration and future model runs	1.56 ft	Based on EPA published references[2], the thickness of the capillary fringe ranges from 0.82 ft for sandy loam to 2.23 cm for silt loam. A mid-range value of 1.56 feet was entered into the model.
Net Rainfall Infiltration	Calibration Model Run	2.18 in/yr	According to the State Climate Office of North Carolina website, the average annual rainfall in Charlotte, NC is 43.5 inches per year. Net rainfall infiltration varies according to the type of surface cover. The pre-remediation impacted soil area was located beneath concrete pavement, but was immediately adjacent to a gravel topped area. Based on this cover, a value of 5 percent of rainfall (2.18 inches per year [in/yr]) was used for the model calibration run.
	Future Model Run	8.70 in/yr	According to the State Climate Office of North Carolina website, the average annual rainfall in Charlotte, NC is 43.5 inches per year. Net rainfall infiltration varies according to the type of surface cover. An estimated value of 20% of rainfall was used for the future model run based on the worst-case assumption that the surface cover currently overlying the soil source area could be removed in the future.
Fraction Organic Carbon (foc)	Same value used for calibration and future model runs	0.002	Soil samples were collected at depths of 5 ft bgs and 10 ft bgs from background boring B-1 in February 1998. Analysis of these samples for foc indicated no detections above the laboratory detection limit of 0.000083. However, these values are low for this region and contradictory to typical foc values measured for other sites in the region. Cardno suspects a possible error in the laboratory data. Therefore, an EPA default value[1] of 0.002 was assumed for both model runs.
Soil/Water pH	Same value used for calibration and future model runs	6	Soil samples were collected at depths of 5 ft bgs and 10 ft bgs from background boring B-1 in February 1998. Analysis of these samples for pH indicated values of 6.27 and 6.45, respectively. Measurements of pH for groundwater samples collected from well MW-4 historically range from 5.43 to 6.87. A pH of 6 was used for both model runs based on the combined range for these soil and groundwater measurements.
Horizontal Hydraulic Conductivity (ft/d)	Same value used for calibration and future model runs	3.4 ft/d	A Shelby tube was collected from boring B-2 at 4 to 6 ft bgs in February 1998. Analysis of the Shelby tube for vertical hydraulic conductivity indicated a value of 0.34 ft/d. Vertical hydraulic conductivity is commonly assumed to be 10% of horizontal hydraulic conductivity, so the vertical estimate of 0.34 ft/d converts to a horizontal estimate of 3.4 ft/d. Based on published references (Fetter, 2001[3]), this value is within the range of typical values for silty sand (which is the primary soil type in the saturated zone) and is therefore considered reasonable. The same value was used for both model runs.
Horizontal Hydraulic Gradient	Same value used for calibration and future model runs	0.035 ft/ft	Based on a review of historical groundwater elevation measurements, the horizontal hydraulic conductivity across the site generally ranges from 0.02 to 0.06, with values most commonly in the 0.03 to 0.04 range. A mid-range value of 0.035 feet per foot (ft/ft) was used for both model runs.
Effective Porosity	Same value used for calibration and future model runs	0.2	Effective porosity is equivalent to specific yield for unconfined aquifers. Based on published values (Fetter, 2001[3]) for specific yield for silty sand (which is the primary soil type in the saturated zone), an estimated value of 0.2 was used for both model runs.
Aquifer Saturated Thickness	Same value used for calibration and future model runs	10 ft	Bedrock was encountered at a depth of 25 ft bgs in well MW-2D. An average value of 10 ft was used for both model runs based on the depth to bedrock minus the seasonal high water table depth in well MW-4 (16 ft bgs).
Chemical Data (see discussion)	Same values used for calibration and future model runs	See modeling documentation.	The RBCA Toolkit incorporates a chemical database with multiple default parameters. The only parameters used in the equations performed for the subject site are Henry's law constant (H) and carbon-water sorption coefficient (koc). For these parameters, Cardno either confirmed or modified values to be sure they match the latest chemical database on the EPA RSL website[4].

Notes:
1. EPA. Soil Screening Guidance: User's Guide. July 1996.
2. EPA. User's Guide for the Johnson and Ettinger Model for Subsurface Vapor Intrusion Into Buildings. 1997.
3. Fetter, C.W. Applied Hydrogeology. 2001.
4. EPA. Regional Screening Level Calculator Website. http://www2.epa.gov/risk/regional-screening-table. October 2015.
5. This table shows all of the parameters that require entry in the RBCA Toolkit model for the soil leaching to groundwater calculations for thoroughness and clarity when reviewing the model input sheets. However, note that some of these parameters may not actually be used in the equations for the site-specific scenario (vapor permeability for example) or may have limited sensitivity related to the model results.

APPENDIX A

PROTECTION OF HUMAN HEALTH MODELING DOCUMENTATION

REFERENCE: EPA REGIONAL SCREENING LEVEL CALCULATOR
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm

Site-specific
Resident Equation Inputs for Soi
Page 1 of 2

Variable	Value
TR (target cancer risk) unitless	0.000001
THQ (target hazard quotient) unitless	0.2
LT (lifetime - resident) year	70
ET_{ress} (exposure time) hour	24
ET_{ressc} (child exposure time) hour	24
ET_{ressa} (adult exposure time) hour	24
ED_{ress} (exposure duration) year	26
ED_{ressc} (exposure duration - child) year	6
ED_{ressa} (exposure duration - adult) year	20
ED_{0-2} (mutagenic exposure duration) year	2
ED_{2-6} (mutagenic exposure duration) year	4
ED_{6-16} (mutagenic exposure duration) year	10
ED_{16-26} (mutagenic exposure duration) year	10
BW_{ressc} (body weight - child) kg	15
BW_{ressa} (body weight - adult) kg	80
BW_{0-2} (mutagenic body weight) kg	15
BW_{2-6} (mutagenic body weight) kg	15
BW_{6-16} (mutagenic body weight) kg	80
BW_{16-26} (mutagenic body weight) kg	80
SA_{ressc} (skin surface area - child) cm^2/day	2373
SA_{ressa} (skin surface area - adult) cm^2/day	6032
SA_{0-2} (mutagenic skin surface area) cm^2/day	2373
SA_{2-6} (mutagenic skin surface area) cm^2/day	2373
SA_{6-16} (mutagenic skin surface area) cm^2/day	6032
SA_{16-26} (mutagenic skin surface area) cm^2/day	6032
EF_{ress} (exposure frequency) day/year	350
EF_{ressc} (exposure frequency - child) day/year	350
EF_{ressa} (exposure frequency - adult) day/year	350
EF_{0-2} (mutagenic exposure frequency) day/year	350
EF_{2-6} (mutagenic exposure frequency) day/year	350
EF_{6-16} (mutagenic exposure frequency) day/year	350
EF_{16-26} (mutagenic exposure frequency) day/year	350
$IFS_{res-adj}$ (age-adjusted soil ingestion factor) mg/kg	36750
$IFSM_{res-adj}$ (mutagenic age-adjusted soil ingestion factor) mg/kg	166833.33
IRS_{ressc} (soil intake rate - child) mg/day	200
IRS_{ressa} (soil intake rate - adult) mg/day	100
IRS_{0-2} (mutagenic soil intake rate) mg/day	200
IRS_{2-6} (mutagenic soil intake rate) mg/day	200

REFERENCE: EPA REGIONAL SCREENING LEVEL CALCULATOR
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm

Site-specific
Resident Equation Inputs for Soi

Variable	Value
IRS_{6-16} (mutagenic soil intake rate) mg/day	100
IRS_{16-26} (mutagenic soil intake rate) mg/day	100
AF_{ressa} (skin adherence factor - adult) mg/cm^2	0.07
AF_{ressc} (skin adherence factor - child) mg/cm^2	0.2
AF_{0-2} (mutagenic skin adherence factor) mg/cm^2	0.2
AF_{2-6} (mutagenic skin adherence factor) mg/cm^2	0.2
AF_{6-16} (mutagenic skin adherence factor) mg/cm^2	0.07
AF_{16-26} (mutagenic skin adherence factor) mg/cm^2	0.07
$DFS_{res-adj}$ (age-adjusted soil dermal factor) mg/kg	103390
$DFSM_{res-adj}$ (mutagenic age-adjusted soil dermal factor) mg/kg	428260
City (Climate Zone) PEF Selection	Default
A_s (acres)	0.5
Q/C_{wp} (g/m^2-s per kg/m^3)	93.77
PEF (particulate emission factor) m^3/kg	1359344438
A (PEF Dispersion Constant)	16.2302
B (PEF Dispersion Constant)	18.7762
C (PEF Dispersion Constant)	216.108
V (fraction of vegetative cover) unitless	0.5
U_m (mean annual wind speed) m/s	4.69
U_t (equivalent threshold value)	11.32
F(x) (function dependant on U_m/U_t) unitless	0.194
City (Climate Zone) VF Selection	Default
A_s (acres)	0.5
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18
foc (fraction organic carbon in soil) g/g	0.006
ρ_b (dry soil bulk density) g/cm^3	1.5
ρ_s (soil particle density) g/cm^3	2.65
θ_w (water-filled soil porosity) L_{water}/L_{soil}	0.15
T (exposure interval) s	819936000
A (VF Dispersion Constant)	11.911
B (VF Dispersion Constant)	18.4385
C (VF Dispersion Constant)	209.7845
City (Climate Zone) VF_{ml} Selection	Default
VF_s (volitization factor) m^3/kg	.
Q/C_{vol} (g/m^2-s per kg/m^3)	68.18365
A_s (acres)	0.5
T (exposure interval) yr	26
d_s (depth of source) m	.
ρ_b (dry soil bulk density) g/cm^3	1.5
A (VF Dispersion Constant - Mass Limit)	11.911
B (VF Dispersion Constant - Mass Limit)	18.4385
C (VF Dispersion Constant - Mass Limit)	209.7845

REFERENCE: EPA REGIONAL SCREENING LEVEL CALCULATOR
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm

Site-specific
Resident Screening Levels (RSL) for Soil
Page 1 of 2

ca=Cancer, nc=Noncancer, ca* (Where nc SL < 100 x ca SL),
ca** (Where nc SL < 10 x ca SL), max=SL exceeds ceiling limit (see User's Guide), sat=SL exceeds csat
Smax=Soil SL exceeds ceiling limit and has been substituted with the max value (see User's Guide)
Ssat=Soil inhalation SL exceeds csat and has been substituted with the csat
CSAT substitution for soil inhalation pathway has been enabled.
Substitution for threshold maximum in soil has been enabled.

Chemical	CAS Number	Mutagen?	VOC?	Ingestion SF (mg/kg-day)$^{-1}$	SFO Ref	Inhalation Unit Risk (ug/m^3)$^{-1}$	IUR Ref	Chronic RfD (mg/kg-day)	Chronic RfD Ref	Chronic RfC (mg/m^3)	Chronic RfC Ref	GIABS	ABS	RBA	Volatilization Factor (m^3/kg)	Soil Saturation Concentration (mg/kg)	Particulate Emission Factor (m^3/kg)
Acetone	67-64-1	No	Yes	-		-		9.00E-01	I	3.09E+01	A	1	-	1	1.37E+04	1.14E+05	1.36E+09
Benz[a]anthracene	56-55-3	Yes	Yes	7.30E-01	W	1.10E-04	C	-		-		1	0.13	1	4.41E+06	-	1.36E+09
Benzo[a]pyrene	50-32-8	Yes	No	7.30E+00	I	1.10E-03	C	-		-		1	0.13	1	-	-	1.36E+09
Benzo[b]fluoranthene	205-99-2	Yes	No	7.30E-01	W	1.10E-04	C	-		-		1	0.13	1	-	-	1.36E+09
Benzo[g,h,i]perylene	191-24-2	No	No	-		-		-		-		1	0.13	1	-	-	1.36E+09
Benzo[k]fluoranthene	207-08-9	Yes	No	7.30E-02	W	1.10E-04	C	-		-		1	0.13	1	-	-	1.36E+09
Bis(2-ethylhexyl)phthalate	117-81-7	No	No	1.40E-02	I	2.40E-06	C	2.00E-02	I	-		1	0.1	1	-	-	1.36E+09
Butylbenzene, n-	104-51-8	No	Yes	-		-		5.00E-02	P	-		1	-	1	8.14E+03	1.08E+02	1.36E+09
Butylbenzene, sec-	135-98-8	No	Yes	-		-		1.00E-01	S	-		1	-	1	7.35E+03	1.45E+02	1.36E+09
Butylbenzene, tert-	98-06-6	No	Yes	-		-		1.00E-01	S	-		1	-	1	7.36E+03	1.83E+02	1.36E+09
Chlorobenzene	108-90-7	No	Yes	-		-		2.00E-02	I	5.00E-02	P	1	-	1	6.45E+03	7.61E+02	1.36E+09
Chrysene	218-01-9	Yes	No	7.30E-03	W	1.10E-05	C	-		-		1	0.13	1	-	-	1.36E+09
Dichlorobenzene, 1,2-	95-50-1	No	Yes	-		-		9.00E-02	I	2.00E-01	H	1	-	1	1.17E+04	3.76E+02	1.36E+09
Dichlorobenzene, 1,3-	541-73-1	No	Yes	-		-		-		-		1	-	1	9.93E+03	2.97E+02	1.36E+09
Dichlorobenzene, 1,4-	106-46-7	No	Yes	5.40E-03	C	1.10E-05	C	7.00E-02	A	8.00E-01	I	1	-	1	1.04E+04	-	1.36E+09
Fluoranthene	206-44-0	No	No	-		-		4.00E-02	I	-		1	0.13	1	-	-	1.36E+09
Indeno[1,2,3-cd]pyrene	193-39-5	Yes	No	7.30E-01	W	1.10E-04	C	-		-		1	0.13	1	-	-	1.36E+09
Isopropyltoluene, p-	99-87-6	No	Yes	-		-		-		-		1	-	1	8.53E+03	1.62E+02	1.36E+09
Naphthalene	91-20-3	No	Yes	-		3.40E-05	C	2.00E-02	I	3.00E-03	I	1	0.13	1	4.63E+04	-	1.36E+09
Phenanthrene	85-01-8	No	Yes	-		-		-		-		1	0.13	1	6.43E+05	-	1.36E+09
Propyl benzene	103-65-1	No	Yes	-		-		1.00E-01	S	1.00E+00	S	1	-	1	6.99E+03	2.64E+02	1.36E+09
Pyrene	129-00-0	No	Yes	-		-		3.00E-02	I	-		1	0.13	1	2.38E+06	-	1.36E+09
Toluene	108-88-3	No	Yes	-		-		8.00E-02	I	5.00E+00	I	1	-	1	4.29E+03	8.18E+02	1.36E+09
Trimethylbenzene, 1,2,4-	95-63-6	No	Yes	-		-		-		7.00E-03	P	1	-	1	7.91E+03	2.19E+02	1.36E+09
Trimethylbenzene, 1,3,5-	108-67-8	No	Yes	-		-		1.00E-02	S	-		1	-	1	6.61E+03	1.82E+02	1.36E+09

REFERENCE: EPA REGIONAL SCREENING LEVEL CALCULATOR
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm

Site-specific
Resident Screening Levels (RSL) for Soil

ca=Cancer, nc=Noncancer, ca* (Where nc SL < 100 x ca SL),
ca** (Where nc SL < 10 x ca SL), max=SL exceeds ceiling limit (see User's Guide), sat=SL exceeds csat
Smax=Soil SL exceeds ceiling limit and has been substituted with the max value (see User's Guide)
Ssat=Soil inhalation SL exceeds csat and has been substituted with the csat
CSAT substitution for soil inhalation pathway has been enabled.
Substitution for threshold maximum in soil has been enabled.

Ingestion SL TR=1.0E-6 (mg/kg)	Dermal SL TR=1.0E-6 (mg/kg)	Inhalation SL TR=1.0E-6 (mg/kg)	Carcinogenic SL TR=1.0E-6 (mg/kg)	Ingestion SL Child HQ=0.2 (mg/kg)	Dermal SL Child HQ=0.2 (mg/kg)	Inhalation SL Child HQ=0.2 (mg/kg)	Noncarcinogenic SL Child HI=0.2 (mg/kg)	Ingestion SL Adult HQ=0.2 (mg/kg)	Dermal SL Adult HQ=0.2 (mg/kg)	Inhalation SL Adult HQ=0.2 (mg/kg)	Noncarcinogenic SL Adult HI=0.2 (mg/kg)	Screening Level (mg/kg)
-	-	-	-	1.41E+04	-	8.80E+04	1.21E+04	1.50E+05	-	8.80E+04	5.55E+04	1.21E+04 nc
2.10E-01	6.29E-01	4.05E+01	1.57E-01	-	-	-	-	-	-	-	-	1.57E-01 ca
2.10E-02	6.29E-02	1.25E+03	1.57E-02	-	-	-	-	-	-	-	-	1.57E-02 ca
2.10E-01	6.29E-01	1.25E+04	1.57E-01	-	-	-	-	-	-	-	-	1.57E-01 ca
-	-	-	-	-	-	-	-	-	-	-	-	
2.10E+00	6.29E+00	1.25E+04	1.57E+00	-	-	-	-	-	-	-	-	1.57E+00 ca
4.97E+01	1.77E+02	1.59E+06	3.88E+01	3.13E+02	1.32E+03	-	2.53E+02	3.34E+03	7.90E+03	-	2.35E+03	3.88E+01 ca**
-	-	-	-	7.82E+02	-	-	7.82E+02	8.34E+03	-	-	8.34E+03	7.82E+02 sat
-	-	-	-	1.56E+03	-	-	1.56E+03	1.67E+04	-	-	1.67E+04	1.56E+03 sat
-	-	-	-	1.56E+03	-	-	1.56E+03	1.67E+04	-	-	1.67E+04	1.56E+03 sat
-	-	-	-	3.13E+02	-	6.72E+01	5.53E+01	3.34E+03	-	6.72E+01	6.59E+01	5.53E+01 nc
2.10E+01	6.29E+01	1.25E+05	1.57E+01	-	-	-	-	-	-	-	-	1.57E+01 ca
-	-	-	-	1.41E+03	-	3.76E+02	2.97E+02	1.50E+04	-	3.76E+02	3.67E+02	2.97E+02 Ssat
-	-	-	-	-	-	-	-	-	-	-	-	
1.29E+02	-	2.67E+00	2.61E+00	1.10E+03	-	1.74E+03	6.72E+02	1.17E+04	-	1.74E+03	1.52E+03	2.61E+00 ca
-	-	-	-	6.26E+02	2.03E+03	-	4.78E+02	6.67E+03	1.22E+04	-	4.31E+03	4.78E+02 nc
2.10E-01	6.29E-01	1.25E+04	1.57E-01	-	-	-	-	-	-	-	-	1.57E-01 ca
-	-	-	-	-	-	-	-	-	-	-	-	
-	-	3.83E+00	3.83E+00	3.13E+02	1.01E+03	2.90E+01	2.59E+01	3.34E+03	6.08E+03	2.90E+01	2.86E+01	3.83E+00 ca**
-	-	-	-	-	-	-	-	-	-	-	-	
-	-	-	-	1.56E+03	-	2.64E+02	2.26E+02	1.67E+04	-	2.64E+02	2.60E+02	2.26E+02 Ssat
-	-	-	-	4.69E+02	1.52E+03	-	3.59E+02	5.01E+03	9.12E+03	-	3.23E+03	3.59E+02 nc
-	-	-	-	1.25E+03	-	8.18E+02	4.95E+02	1.33E+04	-	8.18E+02	7.71E+02	4.95E+02 Ssat
-	-	-	-	-	-	1.16E+01	1.16E+01	-	-	1.16E+01	1.16E+01	1.16E+01 nc
-	-	-	-	1.56E+02	-	-	1.56E+02	1.67E+03	-	-	1.67E+03	1.56E+02 nc

REFERENCE: EPA REGIONAL SCREENING LEVEL CALCULATOR
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm

Site-specific
Resident Risk for Soil

Chemical	Ingestion SF $(mg/kg\text{-}day)^{-1}$	SFO Ref	Inhalation Unit Risk $(ug/m^3)^{-1}$	IUR Ref	Chronic RfD (mg/kg-day)	Chronic RfD Ref	Chronic RfC (mg/m^3)	Chronic RfC Ref
Acetone	-		-		0.9	I	30.9	A
Benz[a]anthracene	0.73	W	0.00011	C	-		-	
Benzo[a]pyrene	7.3	I	0.0011	C	-		-	
Benzo[b]fluoranthene	0.73	W	0.00011	C	-		-	
Benzo[g,h,i]perylene	-		-		-		-	
Benzo[k]fluoranthene	0.073	W	0.00011	C	-		-	
Bis(2-ethylhexyl)phthalate	0.014	I	0.0000024	C	0.02	I	-	
Butylbenzene, n-	-		-		0.05	P	-	
Butylbenzene, sec-	-		-		0.1	S	-	
Butylbenzene, tert-	-		-		0.1	S	-	
Chlorobenzene	-		-		0.02	I	0.05	P
Chrysene	0.0073	W	0.000011	C	-		-	
Dichlorobenzene, 1,2-	-		-		0.09	I	0.2	H
Dichlorobenzene, 1,3-	-		-		-		-	
Dichlorobenzene, 1,4-	0.0054	C	0.000011	C	0.07	A	0.8	I
Fluoranthene	-		-		0.04	I	-	
Indeno[1,2,3-cd]pyrene	0.73	W	0.00011	C	-		-	
Isopropyltoluene, p-	-		-		-		-	
Naphthalene	-		0.000034	C	0.02	I	0.003	I
Phenanthrene	-		-		-		-	
Propyl benzene	-		-		0.1	S	1	S
Pyrene	-		-		0.03	I	-	
Toluene	-		-		0.08	I	5	I
Trimethylbenzene, 1,2,4-	-		-		-		0.007	P
Trimethylbenzene, 1,3,5-	-		-		0.01	S	-	
**Total Risk/HI*	-		-		-		-	

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REFERENCE: EPA REGIONAL SCREENING LEVEL CALCULATOR
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Site-specific
Resident Risk for Soil
Page 2 of 3

GIABS	ABS	RBA	Volatilization Factor (m^3/kg)	Soil Saturation Concentration (mg/kg)	Particulate Emission Factor (m^3/kg)	Concentration (mg/kg)	Ingestion Risk TR=1.0E-6	Dermal Risk TR=1.0E-6	Inhalation Risk TR=1.0E-6	Carcinogenic Risk TR=1.0E-6
1	-	1	13700	114000	1360000000	0.013	-	-	-	-
1	0.13	1	4410000	-	1360000000	0.019	9.06E-08	3.02E-08	4.69E-10	0.000000121
1	0.13	1	-	-	1360000000	0.022	0.00000105	0.00000035	1.76E-11	0.0000014
1	0.13	1	-	-	1360000000	0.035	0.000000167	5.57E-08	2.79E-12	0.000000223
1	0.13	1	-	-	1360000000	0.01	-	-	-	-
1	0.13	1	-	-	1360000000	0.011	5.24E-09	1.75E-09	8.78E-13	6.99E-09
1	0.1	1	-	-	1360000000	0.58	1.17E-08	3.29E-09	3.65E-13	0.000000015
1	-	1	8140	108	1360000000	0.0027	-	-	-	-
1	-	1	7350	145	1360000000	0.0014	-	-	-	-
1	-	1	7360	183	1360000000	0.0006	-	-	-	-
1	-	1	6450	761	1360000000	0.0004	-	-	-	-
1	0.13	1	-	-	1360000000	0.027	1.29E-09	4.29E-10	2.15E-13	1.72E-09
1	-	1	11700	376	1360000000	0.0013	-	-	-	-
1	-	1	9930	297	1360000000	0.0007	-	-	-	-
1	-	1	10400	-	1360000000	0.0006	4.66E-12	-	2.25E-10	2.3E-10
1	0.13	1	-	-	1360000000	0.042	-	-	-	-
1	0.13	1	-	-	1360000000	0.011	5.24E-08	1.75E-08	8.78E-13	6.99E-08
1	-	1	8530	162	1360000000	0.0029	-	-	-	-
1	0.13	1	46300	-	1360000000	0.0016	-	-	4.18E-10	4.18E-10
1	0.13	1	643000	-	1360000000	0.008	-	-	-	-
1	-	1	6990	264	1360000000	0.0003	-	-	-	-
1	0.13	1	2380000	-	1360000000	0.044	-	-	-	-
1	-	1	4290	818	1360000000	0.0003	-	-	-	-
1	-	1	7910	219	1360000000	0.0036	-	-	-	-
1	-	1	6610	182	1360000000	0.0011	-	-	-	-
-	-	-	-	-	-	-	*0.00000138*	*0.000000459*	*1.13E-09*	*1.84E-06*

Cardno Note: Cumulative carcinogenic risk is referenced here (incorporates child and adult exposure).

REFERENCE: EPA REGIONAL SCREENING LEVEL CALCULATOR
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm

Site-specific
Resident Risk for Soil

Ingestion Risk Child HQ=0.2	Dermal Risk Child HQ=0.2	Inhalation Risk Child HQ=0.2	Noncarcinogenic Risk Child HI=0.2	Ingestion Risk Adult HQ=0.2	Dermal Risk Adult HQ=0.2	Inhalation Risk Adult HQ=0.2	Noncarcinogenic Risk Adult HI=0.2
0.000000185	-	2.95E-08	0.000000214	1.73E-08	-	2.95E-08	4.68E-08
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
0.000371	0.000088	-	0.000459	0.0000348	0.0000147	-	0.0000494
0.00000069	-	-	0.00000069	6.47E-08	-	-	6.47E-08
0.000000179	-	-	0.000000179	1.68E-08	-	-	1.68E-08
7.67E-08	-	-	7.67E-08	7.19E-09	-	-	7.19E-09
0.000000256	-	0.00000119	0.00000145	0.000000024	-	0.00000119	0.00000121
-	-	-	-	-	-	-	-
0.000000185	-	0.000000533	0.000000718	1.73E-08	-	0.000000533	0.000000551
-	-	-	-	-	-	-	-
0.00000011	-	6.89E-08	0.000000178	1.03E-08	-	6.89E-08	7.91E-08
0.0000134	0.00000414	-	0.0000176	0.00000126	0.000000691	-	0.00000195
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
0.00000102	0.000000316	0.000011	0.0000124	9.59E-08	5.26E-08	0.000011	0.0000112
-	-	-	-	-	-	-	-
3.84E-08	-	4.11E-08	7.95E-08	3.6E-09	-	4.11E-08	4.47E-08
0.0000188	0.00000578	-	0.0000245	0.00000176	0.000000965	-	0.00000272
4.79E-08	-	1.34E-08	6.14E-08	4.49E-09	-	1.34E-08	1.79E-08
-	-	0.0000623	0.0000623	-	-	0.0000623	0.0000623
0.00000141	-	-	0.00000141	0.000000132	-	-	0.000000132
0.000407	*0.0000982*	*0.0000752*	*0.000581*	*0.0000382*	*0.0000164*	*0.0000752*	*0.00013*

Cardno Note: Cumulative hazard index for child is referenced here. The child value is higher than the adult value and is therefore used as the most conservative estimated risk.

Cardno Note: Cumulative hazard index for adult is referenced here. The adult value is not used since the child value is more conservative.

APPENDIX B

PROTECTION OF GROUNDWATER MODELING DOCUMENTATION CALIBRATION MODEL RUN

Main Screen

RBCA Tool Kit for Chemical Releases
Version 2.52 © 2009 GSI Environmental Inc.

1. Project Information

Site Name:	Safety-Kleen Systems, Inc. - Calibration Model Run
Location:	2320 Yadkin Avenue, Charlotte, NC
Completed By:	Cardno Inc.
Date:	26-Oct-15
Job ID:	SKCHARLOT1

2. Which Type of RBCA Analysis?

○ **Tier 1** — Risk-Based Screening Levels

◉ **Tier 2/3** — Site-Specific Target Levels

3. Calculation Options

Affects which input data are required

☑ ***Baseline Risks (Forward mode)***

☑ ***RBCA Cleanup Levels (Backward mode)***

○ Individual Constituent Risk Goals Only
◉ Individual and Cumulative Risk Goals

☐ Apply Source Depletion Algorithm
Time to Future Exposure 0 *(yr)*

4. RBCA Evaluation Process

Prepare Input Data
Data Complete? (■= yes, ■= no)

- ■ Exposure Pathways
- ■ Constituents of Concern (COCs)
- ■ Transport Models
- ■ Soil Parameters
- ■ GW Parameters
- Air Parameters

Review Output

- Exposure Flowchart
- COC Chem. Parameters
- Input Data Summary
- User-Spec. COC Data...
- Transient Domenico Analysis...
- Baseline Risks...
- Cleanup Levels...

5. Commands and Options

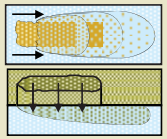
New Site | Load Data... | Save Data As... | User Chemical Database
Set Units | Print Sheet | Print Report
Help | Quit

Exposure Pathway Identification

Site Name: Safety-Kleen Systems, Inc. - Calibration Model Run
Location: 2320 Yadkin Avenue, Charlotte, NC
Compl. By: Cardno Inc.
Job ID: SKCHARLOT1 Date: 26-Oct-15

1. Groundwater Exposure

Groundwater Ingestion/ Surface Water Impact



	On-site	Off-site1	Off-site2
Receptor:	MCL	None	None
Distance:	0	0	0 (ft)

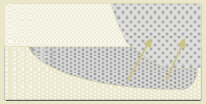
Source Media:

- [ ] Affected Groundwater
- [x] Affected Soils Leaching to Groundwater

Option:

- [x] Apply MCL value as ingestion RBEL (backward mode only)

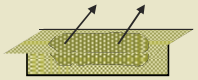
GW Discharge to Surface Water Exposure



- [ ] Swimming
- [ ] Fish Consumption
- [ ] Specified Water Quality Criteria

Enter Criteria

2. Surface Soil Exposure



	On-site
Receptor:	None

Construction Worker [ ]

Combined Exposure

Source Media:

- [ ] Direct Ingestion
- [ ] Dermal Contact
- [ ] Inhalation (vol+part)
- [ ] Vegetable Ingestion

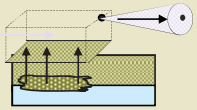
Veg Options

Option:

- [ ] Apply UK (CLEA) SGV as soil concentration limit

3. Air Exposure

Volatilization and Particulates to Outdoor Air Inhalation

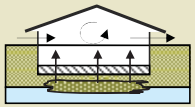


	On-site	Off-site1	Off-site2
Receptor:	None	None	None
Distance:	0	0	0 (ft)

Source Media: Construction worker [ ]

- [ ] Affected Soils--Volatilization to Ambient Outdoor Air
- [ ] Affected Groundwater--Volatilization to Ambient Outdoor Air
- [ ] Affected Surface Soils--Particulates to Ambient Outdoor Air

Volatilization to Indoor Air Inhalation



	On-site	Off-site1	Off-site2
Receptor:	None	None	None
Distance:	0	0	0 (ft)

Source Media:

- [ ] Affected Soils--Volatilization to Enclosed Space
- [ ] Affected Soils Leaching to GW--Volatilization to Enclosed Space
- [ ] Affected Groundwater--Volatilization to Enclosed Space

Bldg Options

4. Commands and Options

Main Screen | Print Sheet | Set Units | Help

Exposure Factors & Target Risks | Exposure Flowchart

Site Name: Safety-Kleen Systems, Inc. - Calibration Model Run | Job ID: SKCHARLOT1
Location: 2320 Yadkin Avenue, Charlotte, NC | Date: 26-Oct-15
Compl. By: Cardno Inc.

Commands and Options

Main Screen | Print Sheet | *Help*

Source Media Constituents of Concern (COCs)

Apply Raoult's Law ?

Selected COCs ?

COC Select: Add/Insert, Delete

Sort List: Top, MoveUp, Bottom, MoveDown

Representative COC Concentration ?

Selected COCs	Groundwater Source Zone (mg/L)	Groundwater Source Zone note	Soil Source Zone (mg/kg)	Soil Source Zone note	Mole Fraction in Source Material (-)
Naphthalene			6.1E+0	B-6, average 5' & 10', 12/22/10	
Trimethylbenzene, 1,2,4-			3.3E+1	B-6, average 5' & 10', 12/2	
Methyl naphthalene, 1-			1.5E+0	B-6, average 5' & 10', 12/2	
Butylbenzene, n-			1.4E+1	B-6, average 5' & 10', 12/22/10	
Dichlorobenzene, 1,2-			9.2E-1	B-6, average 5' & 10', 12/22/10	

Enter Directly | Enter Site Data

Enter Directly | Enter Site Data

View Chemical Parameters

Transport Modeling Options

Site Name: Safety-Kleen Systems, Inc. - Calibration Model Run Job ID: SKCHARLOT1
Location: 2320 Yadkin Avenue, Charlotte, NC Date: 26-Oct-15
Compl. By: Cardno Inc.

1. Vertical Transport, Surface Soil Column

Outdoor Air Volatilization Factors

- ○ Surface soil volatilization model only — ASTM Model
- ○ Combination surface soil/Johnson & Ettinger models
  - Thickness of surface soil zone: 3.28 (ft)
- ○ User-specified VF from other model — Enter VF Values

Indoor Air Volatilization Factors

- ○ Johnson & Ettinger model for soil and groundwater volatilization
- ○ Johnson & Ettinger for soil, Mass Flux model for groundwater
- ○ User-specified VF from other model — Enter VF Values

Soil-to-Groundwater Leaching Factor

- ◉ ASTM Model
  - ☑ Apply Soil Attenuation Model (SAM)
  - ☑ Allow first-order biodecay — Enter Decay Rates
- ○ User-specified LF from other model — Enter LF Values

Modeling Options

- ☐ Disable Mass Balance Limit
- ☐ Apply Dual Equilibrium Desorption Model

2. Lateral Air Dispersion Factor

- ○ 3-D Gaussian dispersion model
- ○ User-Specified ADF

Off-site 1	Off-site 2	
1.00E+0	1.00E+0	(-)

3. Groundwater Dilution Attenuation Factor

Calculate DAF using Domenico Model

- ○ Domenico equation with dispersion only (no biodegradation)
- ○ Domenico equation first-order decay — Enter Decay Rates
- ○ Modified Domenico equation using electron acceptor superposition — Enter Site Data

Biodegradation Capacity: NC (mg/L)

— or —

User-Specified DAF Values

- ○ DAF values from other model or site data — Enter DAF Values

4. Chemical Decay and Source Depletion

C

Enter Decay Rates

Enter Source Mass

5. Commands and Options

Main Screen | Print Sheet | Help

Site Name: Safety-Kleen Systems, Inc. - Calibration Model Job ID: SKCHARLOT1
Location: 2320 Yadkin Avenue, Charlotte, NC Date: 26-Oct-15
Compl. By: Cardno Inc.

Commands and Options

Return | Print Sheet | Paste Default Values | *Help*

Constituent Decay Rates

Constituent	Saturated Zone Half-Life (day)	Saturated Zone First-Order Decay Coefficient (1/day)	Unsaturated Zone Half-Life (day)	Unsaturated Zone First-Order Decay Coefficient (1/day)
Naphthalene	9.0E+2	7.7E-4	9.0E+2	7.7E-4
Trimethylbenzene, 1,2,4-	5.6E+2	1.2E-3	5.6E+2	1.2E-3
Methyl naphthalene, 1-	1.2E+3	5.9E-4	1.2E+3	5.9E-4
Butylbenzene, n-	7.4E+2	9.4E-4	7.4E+2	9.4E-4
Dichlorobenzene, 1,2-	7.5E+2	9.2E-4	7.5E+2	9.2E-4

Site-Specific Soil Parameters

Site Name: Safety-Kleen Systems, Inc. - Calibration Model Run Job ID: SKCHARLOT1
Location: 2320 Yadkin Avenue, Charlotte, NC Date: 26-Oct-15
Compl. By: Cardno Inc.

1. Soil Source Zone Characteristics

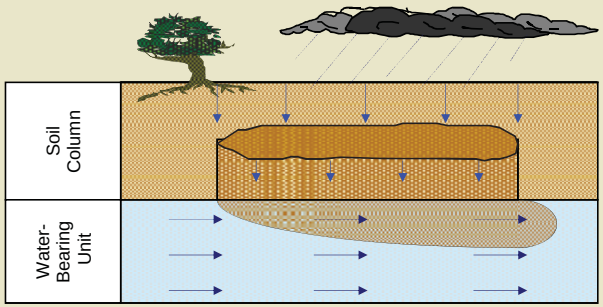
Hydrogeology

Depth to water-bearing unit	18	(ft)
Capillary zone thickness	1.56	(ft)
Soil column thickness	16.44	(ft)

Affected Soil Zone

Depth to top of affected soils	2.5	(ft)
Depth to base of affected soils	17.75	(ft)
Length of affected soil parallel to assumed GW flow direction	25	(ft)

	Res/Com	Construction	
Affected soil area	2025		(ft^2)
Length of affected soil parallel to assumed wind direction	45	45	(ft)



2. Surface Soil Column

Predominant USCS Soil Type

Enter Directly

	Vadose Zone	Capillary Fringe	
Volumetric water content	0.17	0.441	(-)
Volumetric air content	0.32	0.049	(-)
Total porosity	0.49		(-)
Dry bulk density	1.5		(kg/L)
Vertical hydraulic conductivity	0.34		(ft/d)
Vapor permeability	1.08E-12		(ft^2)
Capillary zone thickness	1.56		(ft)

Net Rainfall Infiltration

Net infiltration estimate	2.18	(in/yr)
or (Enter Directly)	or	
Average annual precipitation	0	(in/yr)

Partitioning Parameters

Fraction organic carbon - entire soil column	0.002	(-)
Fraction organic carbon - root zone	0.01	(-)
Soil/water pH	6	(-)

3. Commands and Options

Main Screen | Use/Set Default Values | Print Sheet
Set Units | Help

Site-Specific Groundwater Parameters

Site Name: Safety-Kleen Systems, Inc. - Calibration Model Run — Job ID: SKCHARLOT1
Location: 2320 Yadkin Avenue, Charlotte, NC — Date: 26-Oct-15
Compl. By: Cardno Inc.

1. Water-Bearing Unit

Hydrogeology

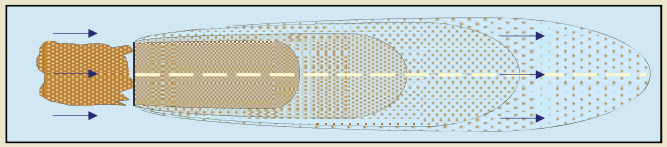
Groundwater Darcy velocity	1.2E-1	(ft/d)
Groundwater seepage velocity	6.0E-1	(ft/d)
or — Calculate	or	
Hydraulic conductivity	3.4E+0	(ft/d)
Hydraulic gradient	0.035	(-)
Effective porosity	0.2	(-)

Sorption

Fraction organic carbon--saturated zone	0.002	(-)
Groundwater pH	6	(-)

2. Groundwater Source Zone

Groundwater plume width at source	45	(ft)
Plume (mixing zone) thickness at source	2.74945961	(ft)
Calculate	or	
Saturated thickness	10	(ft)
Length of source zone	25	(ft)



3. Groundwater Dispersion

Model: ASTM Default

	GW Ingestion		GW to Indoor Air		
	Off-site 1	Off-site 2	Off-site 1	Off-site 2	
Distance to GW receptors	0	0	0	0	(ft)
Calculate					
Longitudinal dispersivity					(ft)
Transverse dispersivity					(ft)
Vertical dispersivity					(ft)

4. Groundwater Discharge to Surface Water

	Off-site 2	
Distance to GW/SW disharge point	NA	(ft)
Plume width at GW/SW discharge	0	(ft)
Plume thickness at GW/SW discharge	0	(ft)
Surface water flowrate at GW/SW discharge	0.0E+0	(ft^3/s)

5. Commands and Options

Main Screen | Use/Set Default Values | Print Sheet
Set Units | Help

CHEMICAL DATA FOR SELECTED COCs

Physical Property Data

Yellow = One or more parameter differs from RBCA Tool Kit default

Orange = One or more parameter differs from User Chemical Database

Constituent	CAS Number	Type	Molecular Weight (g/mole)		Aqueous Solubility (@ 20 - 25 C) (mg/L)		Soil Saturation Limit Calculated (mg/kg)	Vapor Pressure (@ 20 - 25 C) (mm Hg)		Henry's Constant (@ 20 - 25 C) (unitless)		log (Koc) or log (Kd) (@ 20 - 25 C) log(L/kg)		
Naphthalene	91-20-3	O	***128.18***	***EPA-13***	***31***	***EPA-13***	9.75E+01	8.89E-02	TX11	***1.80E-02***	***EPA 15***	***3.18E+00***	Koc	***EPA 15***
Trimethylbenzene, 1,2,4-	95-63-6	O	***120.2***	***EPA-13***	***57***	***EPA-13***	7.96E+01	1.59E+00	TX11	***2.52E-01***	***EPA 15***	***2.79E+00***	Koc	***EPA 15***
Methyl naphthalene, 1-	90-12-0	O	142.2	***EPA-13***	***25.8***	***EPA-13***	1.33E+02	6.62E-02	TX11	***2.10E-02***	***EPA 15***	***3.40E+00***	Koc	***EPA 15***
Butylbenzene, n-	104-51-8	O	134.22	***EPA-13***	***11.8***	***EPA-13***	3.87E+01	8.14E-01	TX11	***6.50E-01***	***EPA 15***	***3.18E+00***	Koc	***EPA 15***
Dichlorobenzene, 1,2-	95-50-1	O	***147***	***EPA-13***	***156***	***EPA-13***	1.40E+02	1.36E+00	TX11	***7.80E-02***	***EPA 15***	***2.58E+00***	Koc	***EPA 15***

Site Name: Safety-Kleen Systems, Inc. - Calibration Model Run
Site Location: 2320 Yadkin Avenue, Charlotte, NC
Job ID: SKCHARLOT1
Date Completed: 26-Oct-15
Completed By: Cardno Inc.

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

GROUNDWATER EXPOSURE PATHWAYS ■ **(Checked if Pathway is Complete)**

SOILS (2.5 - 17.8 ft): LEACHING TO GROUNDWATER INGESTION

	1) Source Medium	2) NAF Value (L/kg) Receptor			3) Exposure Medium Groundwater: POE Conc. (mg/L) (1)/(2)		
Constituents of Concern	Soil Conc. (mg/kg)	On-site (0 ft) None	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None	On-site (0 ft) None	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Naphthalene *	6.1E+0	5.5E+2			1.1E-2		
Trimethylbenzene, 1,2,4- *	3.3E+1	1.4E+2			2.3E-1		
Methyl naphthalene, 1- *	1.5E+0	1.4E+3			1.0E-3		
Butylbenzene, n- *	1.4E+1	9.3E+2			1.5E-2		
Dichlorobenzene, 1,2- *	9.2E-1	4.7E+1			2.0E-2		

* = Chemical with user-specified data

NOTE: NAF = Natural attenuation factor POE = Point of exposure

Site Name: Safety-Kleen Systems, Inc. - Calibration Model Run
Site Location: 2320 Yadkin Avenue, Charlotte, NC
Completed By: Cardno Inc.

Date Completed: 26-Oct-15
Job ID: SKCHARLOT1

APPENDIX C

PROTECTION OF GROUNDWATER MODELING DOCUMENTATION
FUTURE MODEL RUN

Main Screen

RBCA Tool Kit for Chemical Releases
Version 2.52 © 2009 GSI Environmental Inc.

1. Project Information

Site Name:	Safety-Kleen Systems, Inc. - Future Model Run
Location:	2320 Yadkin Avenue, Charlotte, NC
Completed By:	Cardno Inc.
Date:	26-Oct-15
Job ID:	SKCHARLOT1

2. Which Type of RBCA Analysis?

○ **Tier 1** — Risk-Based Screening Levels

◉ **Tier 2/3** — Site-Specific Target Levels

3. Calculation Options

Affects which input data are required

☑ ***Baseline Risks (Forward mode)***

☑ ***RBCA Cleanup Levels (Backward mode)***

○ Individual Constituent Risk Goals Only
◉ Individual and Cumulative Risk Goals

☐ Apply Source Depletion Algorithm
Time to Future Exposure 0 *(yr)*

4. RBCA Evaluation Process

Prepare Input Data

Data Complete? (■= yes, ■= no)

- ■ Exposure Pathways
- ■ Constituents of Concern (COCs)
- ■ Transport Models
- ■ Soil Parameters
- ■ GW Parameters
- Air Parameters

Review Output

- Exposure Flowchart
- COC Chem. Parameters
- Input Data Summary
- User-Spec. COC Data...
- Transient Domenico Analysis...
- Baseline Risks...
- Cleanup Levels...

5. Commands and Options

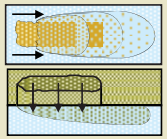
New Site | Load Data... | Save Data As... | User Chemical Database
Set Units | Print Sheet | Print Report
Help | Quit

Exposure Pathway Identification

Site Name: Safety-Kleen Systems, Inc. - Future Model Run
Location: 2320 Yadkin Avenue, Charlotte, NC
Compl. By: Cardno Inc.
Job ID: SKCHARLOT1 Date: 26-Oct-15

1. Groundwater Exposure

Groundwater Ingestion/ Surface Water Impact



	On-site	Off-site1	Off-site2
Receptor:	MCL	None	None
Distance:	0	0	0 (ft)

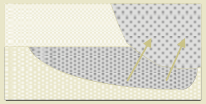
Source Media:

- [ ] Affected Groundwater
- [x] Affected Soils Leaching to Groundwater

Option:

- [x] Apply MCL value as ingestion RBEL (backward mode only)

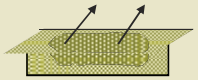
GW Discharge to Surface Water Exposure



- [ ] Swimming
- [ ] Fish Consumption
- [ ] Specified Water Quality Criteria

Enter Criteria

2. Surface Soil Exposure



	On-site
Receptor:	None

Construction Worker [ ]

Combined Exposure

Source Media:

- [ ] Direct Ingestion
- [ ] Dermal Contact
- [ ] Inhalation (vol+part)
- [ ] Vegetable Ingestion

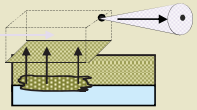
Veg Options

Option:

- [ ] Apply UK (CLEA) SGV as soil concentration limit

3. Air Exposure

Volatilization and Particulates to Outdoor Air Inhalation

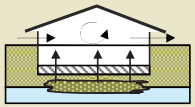


	On-site	Off-site1	Off-site2
Receptor:	None	None	None
Distance:	0	0	0 (ft)

Source Media: Construction worker [ ]

- [ ] Affected Soils--Volatilization to Ambient Outdoor Air
- [ ] Affected Groundwater--Volatilization to Ambient Outdoor Air
- [ ] Affected Surface Soils--Particulates to Ambient Outdoor Air

Volatilization to Indoor Air Inhalation



	On-site	Off-site1	Off-site2
Receptor:	None	None	None
Distance:	0	0	0 (ft)

Source Media:

- [ ] Affected Soils--Volatilization to Enclosed Space
- [ ] Affected Soils Leaching to GW--Volatilization to Enclosed Space
- [ ] Affected Groundwater--Volatilization to Enclosed Space

Bldg Options

4. Commands and Options

Main Screen | Print Sheet | Set Units | Help

Exposure Factors & Target Risks | Exposure Flowchart

Site Name: Safety-Kleen Systems, Inc. - Future Model Run | Job ID: SKCHARLOT1
Location: 2320 Yadkin Avenue, Charlotte, NC | Date: 26-Oct-15
Compl. By: Cardno Inc.

Commands and Options

Main Screen | Print Sheet | *Help*

Source Media Constituents of Concern (COCs)

Apply Raoult's Law ?

Selected COCs ?

COC Select: Add/Insert, Delete

Sort List: Top, MoveUp, Bottom, MoveDown

Representative COC Concentration ?

Selected COCs	Groundwater Source Zone (Enter Directly) (mg/L)	Groundwater Source Zone note	Soil Source Zone (Enter Directly) (mg/kg)	Soil Source Zone note	Mole Fraction in Source Material (-)
Naphthalene			1.4E+0	B-6B, 10', 1/22/14	
Trimethylbenzene, 1,2,4-			8.2E+0	B-6B, 10', 1/22/14	
Methyl naphthalene, 1-			3.8E-1	B-6B (DUP), 10', 1/22/14	
Butylbenzene, n-			2.5E+0	B-6B (DUP), 10', 1/22/14	
Dichlorobenzene, 1,2-			5.9E-1	B-6B (DUP), 10', 1/22/14	

Enter Site Data

View Chemical Parameters

Transport Modeling Options

Site Name: Safety-Kleen Systems, Inc. - Future Model Run Job ID: SKCHARLOT1
Location: 2320 Yadkin Avenue, Charlotte, NC Date: 26-Oct-15
Compl. By: Cardno Inc.

1. Vertical Transport, Surface Soil Column

Outdoor Air Volatilization Factors

- ○ Surface soil volatilization model only — ASTM Model
- ○ Combination surface soil/Johnson & Ettinger models
  - Thickness of surface soil zone: 3.28 (ft)
- ○ User-specified VF from other model — Enter VF Values

Indoor Air Volatilization Factors

- ○ Johnson & Ettinger model for soil and groundwater volatilization
- ○ Johnson & Ettinger for soil, Mass Flux model for groundwater
- ○ User-specified VF from other model — Enter VF Values

Soil-to-Groundwater Leaching Factor

- ◉ ASTM Model
  - ☑ Apply Soil Attenuation Model (SAM)
  - ☑ Allow first-order biodecay — Enter Decay Rates
- ○ User-specified LF from other model — Enter LF Values

Modeling Options

- ☐ Disable Mass Balance Limit
- ☐ Apply Dual Equilibrium Desorption Model

2. Lateral Air Dispersion Factor

- ○ 3-D Gaussian dispersion model
- ○ User-Specified ADF

	Off-site 1	Off-site 2	
	1.00E+0	1.00E+0	(-)

3. Groundwater Dilution Attenuation Factor

Calculate DAF using Domenico Model

- ○ Domenico equation with dispersion only (no biodegradation)
- ○ Domenico equation first-order decay — Enter Decay Rates
- ○ Modified Domenico equation using electron acceptor superposition — Enter Site Data

Biodegradation Capacity: NC (mg/L)

— or —

User-Specified DAF Values

- ○ DAF values from other model or site data — Enter DAF Values

4. Chemical Decay and Source Depletion

C

Enter Decay Rates

Enter Source Mass

5. Commands and Options

Main Screen | Print Sheet | Help

Site Name: Safety-Kleen Systems, Inc. - Future Model Run Job ID: SKCHARLOT1
Location: 2320 Yadkin Avenue, Charlotte, NC Date: 26-Oct-15
Compl. By: Cardno Inc.

Commands and Options

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Constituent Decay Rates

Constituent	Saturated Zone Half-Life (day)	Saturated Zone First-Order Decay Coefficient (1/day)	Unsaturated Zone Half-Life (day)	Unsaturated Zone First-Order Decay Coefficient (1/day)
Naphthalene	9.0E+2	7.7E-4	9.0E+2	7.7E-4
Trimethylbenzene, 1,2,4-	5.6E+2	1.2E-3	5.6E+2	1.2E-3
Methyl naphthalene, 1-	1.2E+3	5.9E-4	1.2E+3	5.9E-4
Butylbenzene, n-	7.4E+2	9.4E-4	7.4E+2	9.4E-4
Dichlorobenzene, 1,2-	7.5E+2	9.2E-4	7.5E+2	9.2E-4

Site-Specific Soil Parameters

Site Name: Safety-Kleen Systems, Inc. - Future Model Run — Job ID: SKCHARLOT1
Location: 2320 Yadkin Avenue, Charlotte, NC — Date: 26-Oct-15
Compl. By: Cardno Inc.

1. Soil Source Zone Characteristics

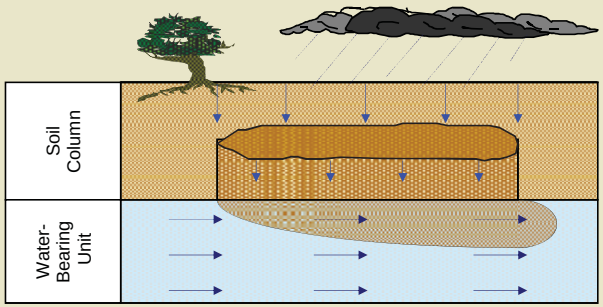
Hydrogeology

Depth to water-bearing unit	18	(ft)
Capillary zone thickness	1.56	(ft)
Soil column thickness	16.44	(ft)

Affected Soil Zone

Depth to top of affected soils	7.5	(ft)
Depth to base of affected soils	13	(ft)
Length of affected soil parallel to assumed GW flow direction	10	(ft)

	Res/Com	Construction	
Affected soil area	2025		(ft^2)
Length of affected soil parallel to assumed wind direction	45	45	(ft)



2. Surface Soil Column

Predominant USCS Soil Type

Enter Directly

	Vadose Zone	Capillary Fringe	
Volumetric water content	0.17	0.441	(-)
Volumetric air content	0.32	0.049	(-)
Total porosity	0.49		(-)
Dry bulk density	1.5		(kg/L)
Vertical hydraulic conductivity	0.34		(ft/d)
Vapor permeability	1.08E-12		(ft^2)
Capillary zone thickness	1.56		(ft)

Net Rainfall Infiltration

Net infiltration estimate	8.70	(in/yr)
or (Enter Directly)	or	
Average annual precipitation	0	(in/yr)

Partitioning Parameters

Fraction organic carbon - entire soil column	0.002	(-)
Fraction organic carbon - root zone	0.01	(-)
Soil/water pH	6	(-)

3. Commands and Options

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Site-Specific Groundwater Parameters

Site Name: Safety-Kleen Systems, Inc. - Future Model Run — Job ID: SKCHARLOT1
Location: 2320 Yadkin Avenue, Charlotte, NC — Date: 26-Oct-15
Compl. By: Cardno Inc.

1. Water-Bearing Unit

Hydrogeology

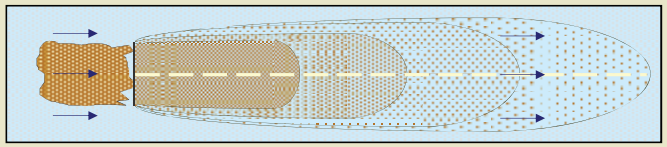
Groundwater Darcy velocity	1.2E-1	(ft/d)
Groundwater seepage velocity	6.0E-1	(ft/d)
or — Calculate	or	
Hydraulic conductivity	3.4E+0	(ft/d)
Hydraulic gradient	0.035	(-)
Effective porosity	0.2	(-)

Sorption

Fraction organic carbon--saturated zone	0.002	(-)
Groundwater pH	6	(-)

2. Groundwater Source Zone

Groundwater plume width at source	45	(ft)
Plume (mixing zone) thickness at source	1.22371839	(ft)
Calculate	or	
Saturated thickness	10	(ft)
Length of source zone	10	(ft)



3. Groundwater Dispersion

Model: ASTM Default

	GW Ingestion		GW to Indoor Air		
	Off-site 1	Off-site 2	Off-site 1	Off-site 2	
Distance to GW receptors	0	0	0	0	(ft)
Calculate					
Longitudinal dispersivity					(ft)
Transverse dispersivity					(ft)
Vertical dispersivity					(ft)

4. Groundwater Discharge to Surface Water

	Off-site 2	
Distance to GW/SW disharge point	NA	(ft)
Plume width at GW/SW discharge	0	(ft)
Plume thickness at GW/SW discharge	0	(ft)
Surface water flowrate at GW/SW discharge	0.0E+0	(ft^3/s)

5. Commands and Options

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CHEMICAL DATA FOR SELECTED COCs

Physical Property Data

Yellow = One or more parameter differs from RBCA Tool Kit default

Orange = One or more parameter differs from User Chemical Database

Constituent	CAS Number	Type	Molecular Weight (g/mole)		Aqueous Solubility (@ 20 - 25 C) (mg/L)		Soil Saturation Limit Calculated (mg/kg)	Vapor Pressure (@ 20 - 25 C) (mm Hg)		Henry's Constant (@ 20 - 25 C) (unitless)		log (Koc) or log (Kd) (@ 20 - 25 C) log(L/kg)		
Naphthalene	91-20-3	O	***128.18***	***EPA-13***	***31***	***EPA-13***	9.75E+01	8.89E-02	TX11	***1.80E-02***	***EPA-15***	***3.18E+00***	Koc	***EPA-15***
Trimethylbenzene, 1,2,4-	95-63-6	O	***120.2***	***EPA-13***	***57***	***EPA-13***	7.96E+01	1.59E+00	TX11	***2.52E-01***	***EPA-15***	***2.79E+00***	Koc	***EPA-15***
Methyl naphthalene, 1-	90-12-0	O	142.2	***EPA-13***	***25.8***	***EPA-13***	1.33E+02	6.62E-02	TX11	***2.10E-02***	***EPA-15***	***3.40E+00***	Koc	***EPA-15***
Butylbenzene, n-	104-51-8	O	134.22	***EPA-13***	***11.8***	***EPA-13***	3.87E+01	8.14E-01	TX11	***6.50E-01***	***EPA-15***	***3.18E+00***	Koc	***EPA-15***
Dichlorobenzene, 1,2-	95-50-1	O	***147***	***EPA-13***	***156***	***EPA-13***	1.40E+02	1.36E+00	TX11	***7.80E-02***	***EPA-15***	***2.58E+00***	Koc	***EPA-15***

Site Name: Safety-Kleen Systems, Inc. - Future Model Run
Site Location: 2320 Yadkin Avenue, Charlotte, NC
Job ID: SKCHARLOT1
Date Completed: 26-Oct-15
Completed By: Cardno Inc.

RBCA SITE ASSESSMENT

TIER 2 EXPOSURE CONCENTRATION AND INTAKE CALCULATION

GROUNDWATER EXPOSURE PATHWAYS ■ **(Checked if Pathway is Complete)**

SOILS (7.5 - 13 ft): LEACHING TO GROUNDWATER INGESTION

	1) Source Medium	2) NAF Value (L/kg) Receptor			3) Exposure Medium Groundwater: POE Conc. (mg/L) (1)/(2)		
Constituents of Concern	Soil Conc. (mg/kg)	On-site (0 ft) None	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None	On-site (0 ft) None	Off-site 1 (0 ft) None	Off-site 2 (0 ft) None
Naphthalene *	1.4E+0	4.7E+5			3.0E-6		
Trimethylbenzene, 1,2,4- *	8.2E+0	1.5E+4			5.4E-4		
Methyl naphthalene, 1- *	3.8E-1	8.4E+6			4.5E-8		
Butylbenzene, n- *	2.5E+0	5.7E+6			4.4E-7		
Dichlorobenzene, 1,2- *	5.9E-1	3.3E+2			1.8E-3		

* = Chemical with user-specified data

NOTE: NAF = Natural attenuation factor POE = Point of exposure

Site Name: Safety-Kleen Systems, Inc. - Future Model Run
Site Location: 2320 Yadkin Avenue, Charlotte, NC
Completed By: Cardno Inc.

Date Completed: 26-Oct-15
Job ID: SKCHARLOT1