REPORT

TECHNICAL ASSISTANCE
DELISTING RISK ASSESSMENT SOFTWARE
VERSION 4.0
USER MANUAL

Task 5: Development of Delisting Risk Assessment Software

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For:

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TABLE OF CONTENTS

Page

TABLE OF CONTENTS (continued)

Page

LIST OF FIGURES

Page

LIST OF TABLE

Page

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LIST OF ACRONYMS AND ABBREVIATIONS

COC	constituent of concern
DL	detection limit
DLL	dynamic link library
DRAS	Delisting Risk Assessment Software
EPA	U.S. Environmental Protection Agency
GUI	graphical user interface
HGL	HydroGeoLogic, Inc.
OS	operating system
RCRA	Resource Conservation and Recovery Act
TCLP	toxicity characteristic leaching procedure
VB	Visual Basic
WMU	waste management unit

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TECHNICAL ASSISTANCE
DELISTING RISK ASSESSMENT SOFTWARE (DRAS)
VERSION 4.0

1.0 INTRODUCTION

The Delisting Risk Assessment Software (DRAS) is an efficient tool developed by U.S. Environmental Protection Agency (EPA) Region 6 to provide a multipath risk assessment for the evaluation of Resource Conservation and Recovery Act (RCRA) hazardous waste delistings. EPA Regions, numerous authorized states, and facilities' consultants have been using DRAS to evaluate delisting petitions. The 2008 version (DRAS 3.0) has problems running on newer operating systems (OS) as it was on a platform that is now obsolete. EPA Region 7 tasked HydroGeoLogic, Inc. (HGL) to provide technical assistance to EPA Region 5 relating to the new release of DRAS.

1.1 OBJECTIVES

The objective of this Task Order is to prepare, test, and document the new release of DRAS, DRAS version 4.0. DRAS methodology will be updated, additional constituents will be added to the database, and sortable tables and the ability to add custom chemicals will be included.

1.2 REPORT ORGANIZATION

Background information relating to DRAS is presented in Section 2. User's guide is provided in Section 3. References are given in Section 4. An application example is given in Appendix A.

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2.0 BACKGROUND

This section presents a brief review of the current DRAS (version 3) and a comparison between DRAS 3 and DRAS 4. The current DRAS and its shortcomings are presented and discussed in Section 2.1. Improvements of DRAS are discussed in Sections 2.2 and 2.3.

2.1 DELISTING RISK ASSESSMENT SOFTWARE VERSION 3 (DRAS 3.0)

The EPA Region 6 Delisting Program developed a computer-based program called DRAS (EPA, 2008) to evaluate delisting petitions in a timely manner. DRAS performs two types of analyses to analyze the multi-pathway risks and hazards posed by the constituents of a waste petitioned for delisting: screening-level analyses and aggregate risk and hazard analyses. The screening-level analyses compute chemical-specific exit values or "delisting levels" for multi-year delistings. The aggregate risk and hazard analyses compute the aggregate carcinogenic risk and noncarcinogenic hazard indices for a waste petitioned for a one-time delisting. The delisting levels and aggregate risk and hazard estimates are calculated using modeled, medium-specific chemical concentrations and standard EPA exposure assessment and risk characterization algorithms. The results of these analyses may be viewed on screen, imported directly to word processing software, or printed in document-ready form to allow end users to incorporate the results into their documents and/or archive the results.

DRAS 3.0 is a Windows-based desktop application. It was developed based on the legacy Visual Basic (VB) 6.0 code. DRAS has three distinct components: a Graphical User Interface (GUI), a database, and a risk computational engine that comprises several risk components. The GUI and the risk computational engine are coded in VB 6.0. The database, which is based on Microsoft Access, contains constituent-specific biological, physical, and chemical properties and risk-related parameters for different types of receptors. DRAS users input site information and select chemicals of concern (COCs) through the GUI. The site information and selected COCs are stored in the database. Risk analyses are then performed using the imbedded VB computational risk engine. New constituents (constituents not in the database) can be appended to the COC database. Results are viewable on screen. An electronic report is generated at the end of each analysis.

The current DRAS has several weaknesses, listed below:

- Incompatible with newer Windows OSs (Windows versions after Windows XP) and Windows XP with different Microsoft Service Packs at some sites.
- Lacks the capability to sort rows and columns of the database through the GUI.
- Developed based on VB 6.0, which has the following disadvantages:
    - Obsolete and no longer supported by Microsoft.
    - Requires many dynamic link libraries (DLLs) to be present. Some of the DLLs may conflict with those required by other software. The DLLs required by different software may have conflicting names and versions in Windows Registry.
    - Computationally inefficient.

2.2 DELISTING RISK ASSESSMENT SOFTWARE VERSION 4 (DRAS 4.0)

2.2.1 Features of DRAS 4.0

To ensure the longevity of the new DRAS, each of its components (GUI, database, and risk computational engine) is now independent so that it can be maintained and updated independently. The attributes of each component of DRAS 4.0 are summarized below.

Graphical User Interface (GUI)

- Independent of the database and the risk computational engine,
- Allows the users to input site and COC information and sort the database, and
- Developed based on the Python language that is widely adopted in current development by major software companies and will not be obsolete in the near future.

Risk Computational Engine

- Independent of the GUI and the database,
- Provides output that can be verified step-by-step, and
- Developed based on the Fortran language that is suitable for scientific computing.

Data Store

- Independent of the GUI and the risk computational engine,
- Based on a technology, SQLite, that is in the public domain, widely used and well supported,
- Possesses sufficient features, and
- Has suitable scalability and stable performance.

2.2.2 Changes in Risk Engine

There is one change in calculating atmospheric emission risk due to surface impoundments. Based on the plug-flow theory, the relationship between the initial concentration, C_i, and liquid concentration, C_L, at time t is (from Equation (5-9) in EPA (1994)):

$$C_L = C_i exp\left(\frac{-KAt}{V_{si}}\right) \quad (2\text{-}1)$$

where:

C_L	=	equilibrium liquid concentration in the surface impoundment (m/L^3),
C_i	=	initial liquid concentration to the surface impoundment (m/L^3),
K	=	overall mass transfer coefficient (m/T),
A	=	surface impoundment surface area (L^2),
t	=	time (T), and
V_{si}	=	volume of surface impoundment (L^3).

Mass left in the tank after time *t* is $C_L\ V_{si}$, therefore, the total volatilized mass is:

$$(C_i - C_L)V_{si} = C_i\left(1 - exp\left(\frac{-KAt}{V_{si}}\right)\right)V_{si} \quad (2\text{-}2)$$

Equating total mass over a period of T, using Equation (2-2), one obtains

$$C_i\left(1 - exp\left(\frac{-KAT}{V_{si}}\right)\right)V_{si} = Q_vT \quad (2\text{-}3)$$

where:

Q_v = maximum permissible volatile emission rate (m/T)

which leads to:

$$C_i = \frac{Q_vT}{V_{si}\left(1-exp\left(\frac{-KAT}{V_{si}}\right)\right)} \quad (2\text{-}4)$$

T is determined from the following conditions:

$$t_r = \frac{V_{si}}{Q} \quad (2\text{-}5)$$

$$t_f = -\ln(0.01)\ \frac{V_{si}}{KA} \quad (2\text{-}6)$$

$$T = Min\ (t_f, t_r) \quad (2\text{-}7)$$

where:

t_r = retention time (T)

t_f = time at which $exp\left(\frac{-KAT}{V_{si}}\right)$ (Equation (2-1)) is equal to 0.01 (T).

Q = surface impoundment exfiltration rate at the bottom (L^3/T).

C_i is equivalent to $C_{dl\text{-}air\text{-}si}$, delisting inflow concentration due to atmospheric emission from surface impoundment in Equation (4-58) in EPA (2008). The exfiltration rate per unit area in Equation (2-5) is set at 0.0972 m^3/year/m^2 which is a geometrical average of the 95th percentile of exfiltration rates from three types of surface impoundment liner (unlined, single-lined, and composite-lined) in EPA (2003).

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3.0 DRAS 4 SOFTWARE: OVERVIEW AND USER'S GUIDE

DRAS was specifically designed to help determine whether a waste meets the conditions under Title 40 Code of Federal Regulations 40 CFR §261.11(a)(3) (*Criteria for Listing Hazardous Waste*), a requirement for evaluating proposed hazardous waste exclusions (delisting). DRAS also assists in evaluating other factors pertinent to the waste including chemical constituents other than those for which the waste was listed that could cause the waste to remain hazardous. DRAS 4 will assist the user in applying DRAS to evaluate petitions to delist hazardous wastes submitted under (40 CFR) §260.22.

DRAS performs a multi-pathway and multi-chemical risk assessment to evaluate the acceptability of a petitioned waste to be disposed in a Subtitle D landfill or surface impoundment instead of under RCRA Subtitle C requirements. For landfills, DRAS models a mismanagement scenario at an unlined Subtitle D landfill where releases to groundwater are not controlled and 30 days of waste is always left uncovered at the surface, subject to air emission and runoff. DRAS uses leachate analysis of the waste to model exposure of nearby residents to impacted groundwater via ingestion, shower-inhalation, and dermal exposure. Using totals analysis of the waste, DRAS models exposure of nearby residents to surface water and fish ingestion impacted by runoff, inhalation of particulate and volatile emissions from the uncovered waste, and incidental ingestion of residential soil contaminated by settled particulate emissions from the waste.

For surface impoundments, DRAS models a subtitle D surface impoundment with uncontrolled volatile emissions and groundwater releases. DRAS uses leachate analysis of the waste to model exposure of nearby residents to impacted groundwater via ingestion, shower-inhalation, and dermal exposure. DRAS also uses leachate analysis of the waste to model exposure of nearby residents to volatile emissions from the surface of the impoundment. No totals concentrations are required for evaluating surface impoundments.

DRAS executes both *forward-* and *back-calculations*. The *forward-calculation* uses chemical concentrations exhibited by the petitioned waste and the annual volumetric rate of waste generation to estimate cumulative carcinogenic risks and noncarcinogenic hazards from disposal as a non-hazardous waste. The *back-calculation* uses target risk and hazard criterion set by the regulatory authority to estimate chemical concentrations in the petitioned waste that would not pose an unacceptable increase in risk and hazard.

DRAS 4 was developed in such a way that it is simple to apply by users with little background in risk assessment. The user enters a few simple input parameters, selects COCs from a list, and enters COC concentrations. Then after running a few steps (see Section 3.3.2), the program generates output with *forward-calculations* of risk and hazard and *back-calculations* of maximum allowable concentrations. DRAS can also be used as a tool to establish analytical reporting limits for use in the delisting petitioner's quality assurance project plan and/or sampling plan. Even with no actual data available, DRAS can be run with zeros entered for concentrations. Maximum allowable concentrations based on the target risk and hazard will be derived for the most conservative limiting pathway and can be used a basis for determining detection limits. Specifically, DRAS output Table 8, Limiting Pathways, identifies the most conservative maximum allowable concentrations and can be used for determining target detection limits for a delisting petitioner's quality assurance project plan and/or sampling plan.

An overview and a user's guide of DRAS 4 are given in this section. An application example is presented in Appendix A.

3.1 DRAS 4 DEPLOYMENT

DRAS 4 can be easily installed by copying the DRAS 4 executable to a working directory. The DRAS 4 executable can be activated from any working directory. By double clicking on DRAS_4.exe (or executing from a command line), a window with two tool bars as shown in Figure 3.1 will appear.

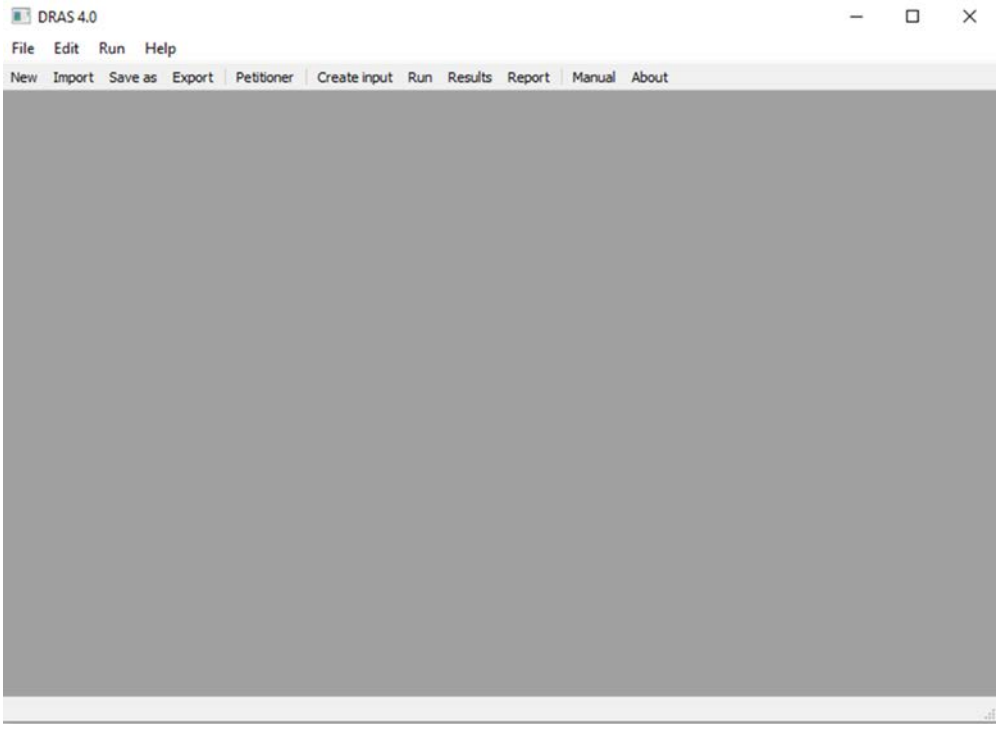


Figure 3.1 DRAS 4 Main Window

3.2 DRAS 4 TOOLBARS

As shown in Figure 3.1, the DRAS 4 upper toolbar has the following options:

- *File*
- *Edit*
- *Run*
- *Help*

3.2.1 File Options

The overall approach to project files in DRAS 4 is structured around establishing project-specific file folders. Some of the interim files needed to run and document DRAS are auto-generated with

the same name for every run and cannot be customized while in use. These include the DRAS 4 input file, *DRAS.IN*, the output file, *DRAS.OUT*, and some of the output reports. If the user wishes to save unique copies of these files for reuse, these files must be stored in unique project folders.

In the dropdown menu shown in Figure 3.2, *File* has the following options:

- *New*
- *Import*
- *Save as*
- *Export*
- *Exit*

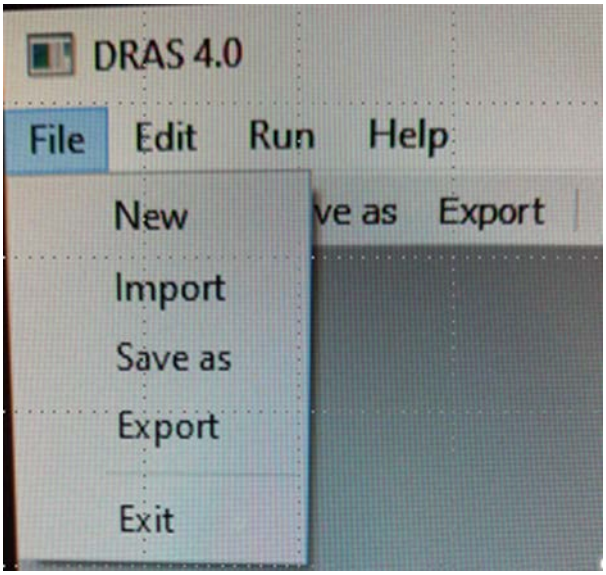


Figure 3.2 Dropdown Menu of *File*

New Choosing *New* opens a worksheet into which waste manage unit information is entered.

Import This option allows the user to import information from a previous analysis, saved as an SQLite file. Note: to successfully run an imported saved file, a new DRAS 4 session must be initiated by exiting the software (if open for previous runs) and restarting.

Save as This option saves the current analysis as an SQLite file.

Export This option exports the current analysis in csv files. Csv, or *comma separated values* files, are easily imported into spreadsheets such as MS Excel. The export function generates four csv files:

- *[filename]_Wmu.csv* Includes the waste management unit inputs like volume, unit type, years active, etc.;

- *[filename]_Sitecocs.csv* Includes the concentrations and detection limit status for all site COCs;
- *[filename]_Petitionerinfo.csv* Includes all the information from the petitioner information tab; and
- *[filename]_Cuscocs.csv* Includes all parameter information for user-generated customized chemicals of concern.

HINT: the [filename]_Cuscocs.csv file can be used to import user specific COCs (often chemicals that are not already in the DRAS4 database) into new projects.

Exit This option allows the user to exit the current analysis/project.

The above four options: *New, Import, Save as,* and *Export,* are also accessible from the lower toolbar.

3.2.2 Edit Option

In the dropdown menu shown in Figure 3.3, *Edit* has one option:

- Petitioner

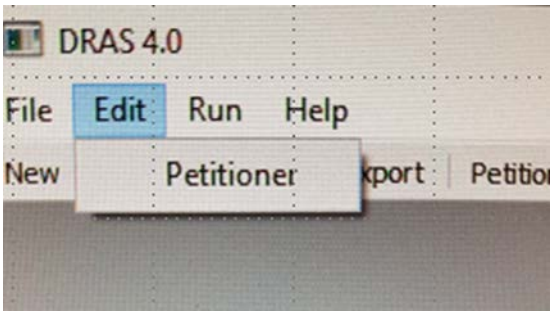


Figure 3.3 Dropdown Menu of *Edit*

Petitioner Choosing the *Petitioner* tab allows the user to enter information relating to petitioner and waste stream. This includes EPA Region, a unique petition number (if used), petitioner's name and address, a description of the waste and identification of RCRA waste codes, and information about the DRAS 4 user including name and pertinent dates. A comment box is also provided.

The information in the *Petitioner* tab is optional and DRAS 4 will run without any entries here. The information is recommended as it provides important project details for generated project reports that may be used in the rue-making docket in support of a delisting decision.

The above option is also accessible from the lower toolbar.

3.2.3 Run Options

In the dropdown menu shown in Figure 3.4, *Run* has the following options:

- *Create input*
- *Run*
- *Results*
- *Report*

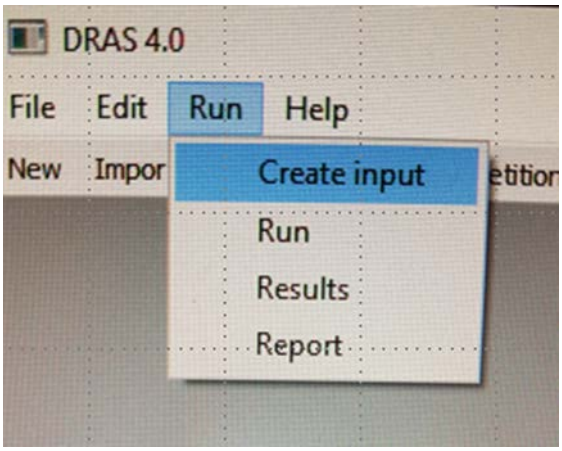


Figure 3.4 Dropdown Menu of *Run*

Create input This option creates input file DRAS.IN for the analysis. Note: this filename cannot be changed before using the *Run* option below. This option will require selection of a folder where the DRAS.IN file will be stored. Each time the C*reate input* option is selected, it will overwrite any existing DRAS.IN file in the selected folder.

Run This option allows the user to run the analysis based on the generated input file. The option will require selection of a folder where the DRAS.OUT file will be stored. Each time the *Run* option is selected, it will overwrite any existing DRAS.OUT file in the selected folder.

Results This option allows the user to generate results in ten tables. Details about the output tables are provided in Section 3.3.2.8.

Report This option allows the current analysis to be output in .pdf or .html formats. Note: The reports generated by the *Report* tab will be limited to project input information unless the *Results* tab has been opened at least once in the current run. Please run the *Results* tab option before selecting *Results* to get complete .pdf and .html reports.

The above four options are also accessible from the lower toolbar.

3.2.4 Help Options

In the dropdown menu shown in Figure 3.5, *Help* has the following options:

- *Manual*
- *About*

Manual This option allows the user to access the Delisting Technical Support Document and the User's Guide.

About This option provides information relating to DRAS 4.

The above two options are also accessible from the lower toolbar.

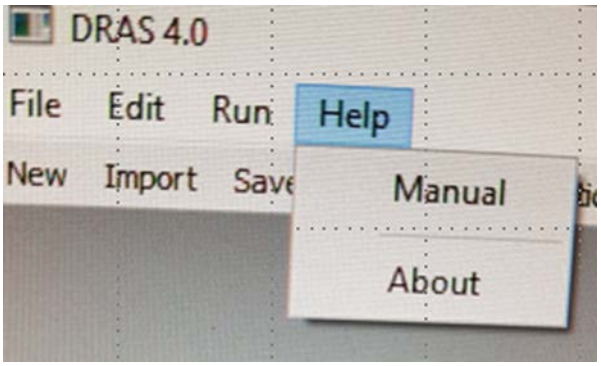


Figure 3.5 Dropdown Menu of *Help*

3.3 DRAS 4 USER'S GUIDE

3.3.1 Starting the DRAS 4 software.

Installation of DRAS 4

DRAS 4 can be simply installed by copying DRAS_4.exe to a working folder where the executable can be run.

Launching of DRAS 4

DRAS 4 can be then launched by double clicking on the executable file or executing it from a command line window. The main window will appear as shown in Figure 3.1.

3.3.2 Set Up a New Project and Run DRAS 4

3.3.2.1 Set Up a New Project

New Project

A new project is initiated by clicking on *New* from the toolbar or selecting *File* > *New* from the dropdown menu. A window in the DRAS 4.0 dialog, shown in Figure 3.6, will appear.

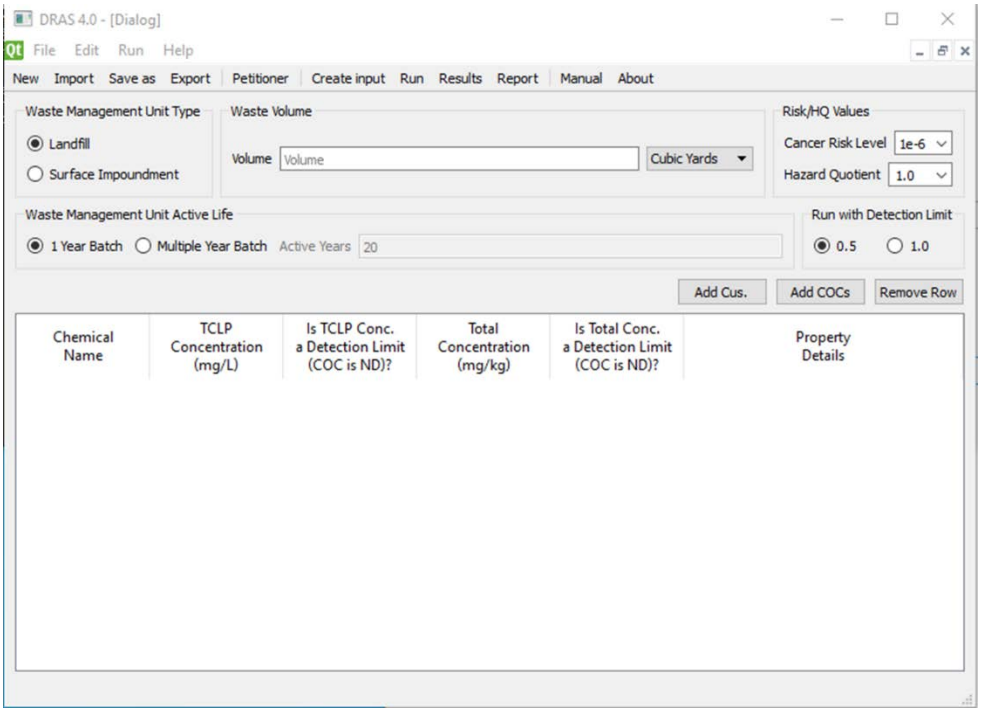


Figure 3.6 New Project Window

3.3.2.2 Enter Waste Management Unit (WMU) Properties

WMU Properties

WMU properties are entered using the upper portion of the new project window in Figure 3.7 (demarcated by the upper dashed box). The following information is required:

- WMU type:
  - Landfill
  - Surface impoundment
- Waste volume, and select volume unit (Note: If the waste volume is not entered or is equal to zero, the project to be terminated and the DRAS 4 session will end when attempting to run.)

- WMU active life: 1-year or multiple-year batch with number of years of active life in the case of multiple years. (Note: If waste management unit *active years* field is blank at any time, the DRAS 4 session will be terminated. We recommend that any intended changes to the *active years* field be entered first adjacent to the existing value before those numerals are deleted.) DRAS 4 default values for waste management unit *active years* of 20 years for landfills and 50 years for surface impoundments are discussed in the Delisting Technical Support Document.
- Target cancer risk and noncancer hazard quotient values (determined by the delisting regulatory authority). These values are used in the *back-calculation* of maximum allowable concentrations. They will likely also be used separately by the delisting regulatory authority to assess the overall risk posed by the waste stream.
- As an option, the user can select a detection limit (DL) multiplier for including non-detected constituents in the risk assessment. The options are to evaluate non-detected constituents at either the full detection limit or one half of the detection limit (0.5 or 1.0) in the forward calculation of risk and hazard. The inclusion of risk estimates from non-detected constituents can provide a more conservative assessment of the petitioned waste and serve as a qualitative check on the overall adequacy of the sampling and analysis. If there is very little difference between the aggregate risk results from detected values only and the aggregate risk including non-detects, then detection limits were likely adequate. If aggregate risks are much higher when including non-detects, then it is likely that some detection limits were not sensitive enough to assess the waste.

3.3.2.3 Set Up Site Chemicals of Concern (COCs)

Site COCs are determined by following the steps below, using the lower portion of the new project window in Figure 3.7 (demarcated by the lower dashed box).

1. To add COCs from the default database:

   Click the *Add COCs* button (see Figure 3.7 lower dashed box), a new dialog box containing all default COCs will be displayed (Figure 3.8). Select all applicable COCs by checking the boxes in Column 3 - "Chemical name" - to select the project COCs.

   Click the *Save* button to add the COCs to the main window.

   Other Buttons on the Toolbar:

   Clicking on *Select All* will select all the chosen COCs shown in the third box of the toolbar (the pull-down field preceded by "in").

   Clicking on *Clear All* will deselect all the chosen COCs shown in the third box of the toolbar.

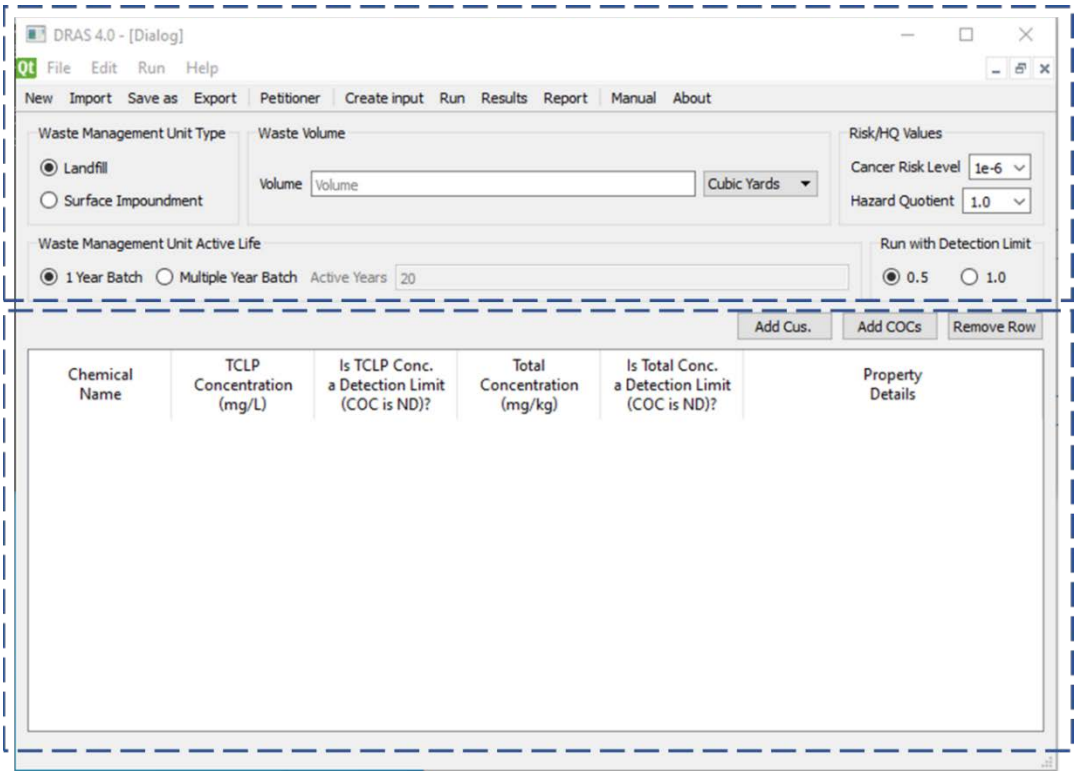
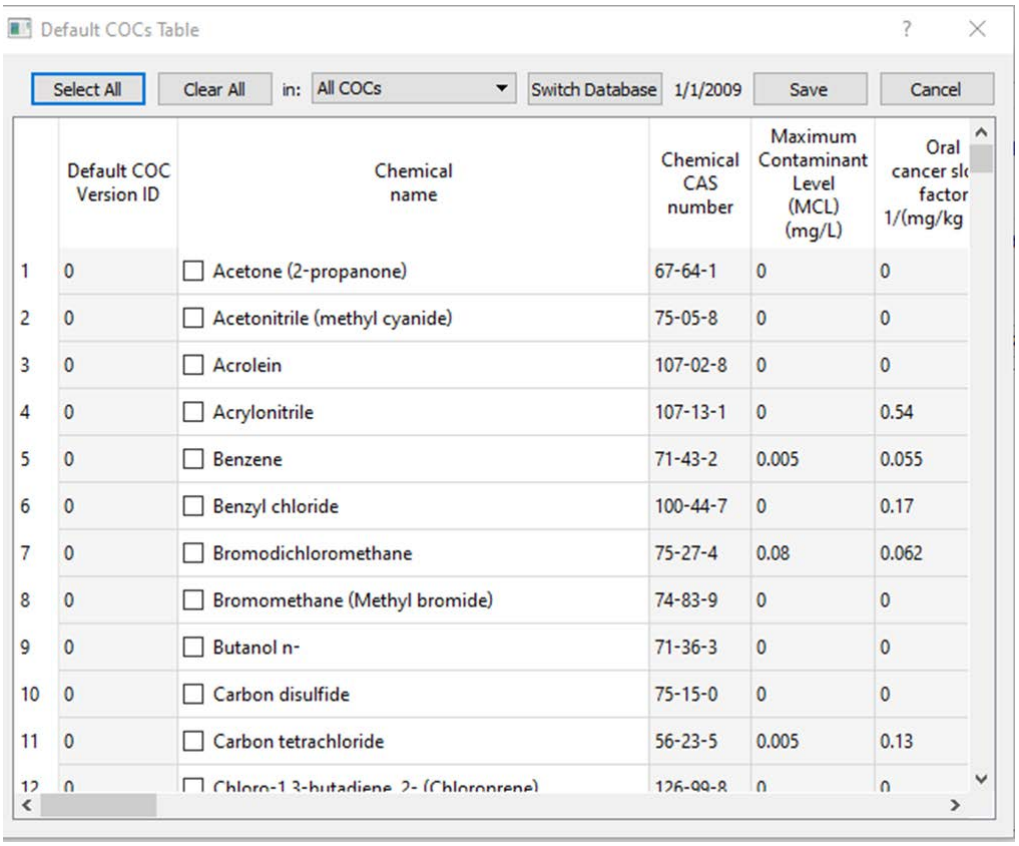


Figure 3.7 Upper and Lower Panes of the New Project Window



	Default COC Version ID	Chemical name	Chemical CAS number	Maximum Contaminant Level (MCL) (mg/L)	Oral cancer slo factor 1/(mg/kg
1	0	Acetone (2-propanone)	67-64-1	0	0
2	0	Acetonitrile (methyl cyanide)	75-05-8	0	0
3	0	Acrolein	107-02-8	0	0
4	0	Acrylonitrile	107-13-1	0	0.54
5	0	Benzene	71-43-2	0.005	0.055
6	0	Benzyl chloride	100-44-7	0	0.17
7	0	Bromodichloromethane	75-27-4	0.08	0.062
8	0	Bromomethane (Methyl bromide)	74-83-9	0	0
9	0	Butanol n-	71-36-3	0	0
10	0	Carbon disulfide	75-15-0	0	0
11	0	Carbon tetrachloride	56-23-5	0.005	0.13
12	0	Chloro-1,3-butadiene, 2- (Chloroprene)	126-99-8	0	0

Figure 3.8 Default COC Database Window

Chemical types (or all chemicals) for the *Select All* or *Clear All* buttons may be chosen in the third box of the tool bar. Clicking on the button a dropdown menu will be displayed.

Clicking on *Cancel* will close the window.

DRAS 4 can include multiple versions of the COC database. A user may wish to revisit an older project and test DRAS 4 with the most recent database as well as the database originally used in the project. The desired COC database may be chosen by clicking on the *Switch Database* button. By clicking on this button, the following dialog box will be displayed (Figure 3.9). A desired version of database may be chosen from the dropdown menu. Click *OK* to select the chosen database. The most recent version of the database will be the default database when using the *Add COCs* button.

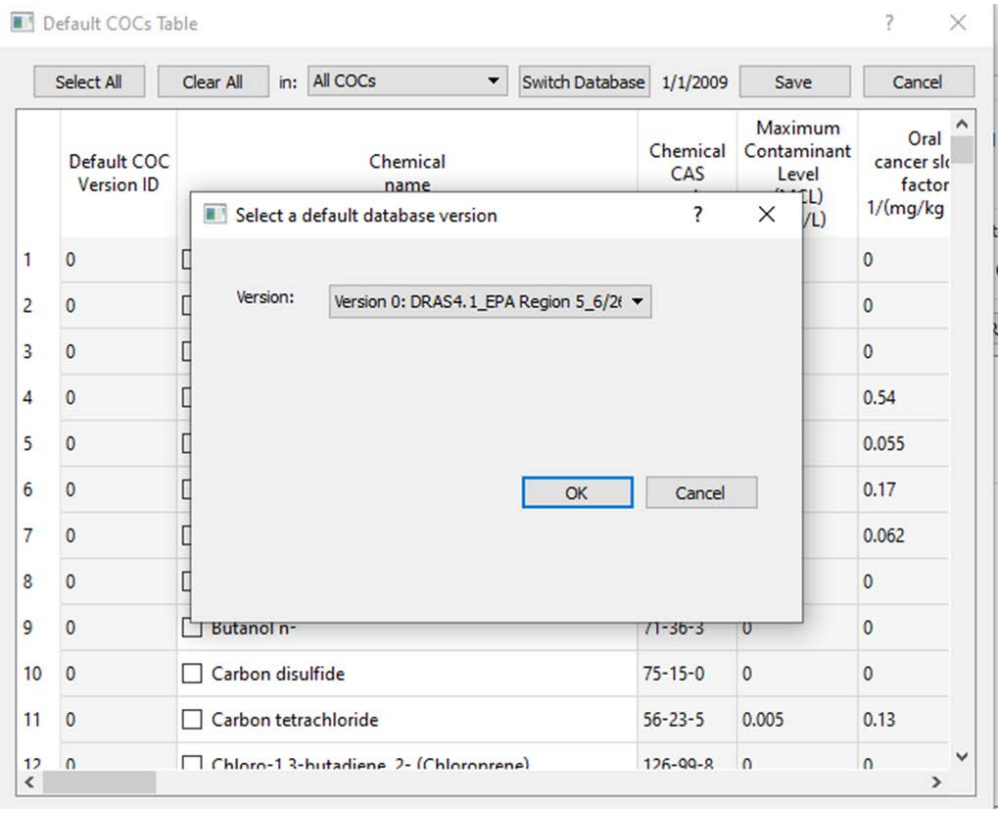


Figure 3.9 Pop-Up Dialog Box for Selecting Database Version (by Clicking on *Switch Database* on the Toolbar)

2. (*Optional*) To add new COCs with customized properties to site COCs, click on *Add Cus*. (See more details in Section 3.3.4).

3. To enter site COC concentrations, place the cursor on an empty table cell (Figure 3.10) and click on the target cell. Note that the concentration cells are preloaded with a zero (0) entry. DRAS 4 will run with zeros for concentrations. For COCs with zero as the concentration, *back-calculated* maximum allowable concentrations will be generated normally. *Forward-calculations* of risk and hazard will be run at an automatically

substituted concentration of 1E-10 (mg/kg or mg/L) in order to avoid an internal error in the code when processing zeros. Concentrations of 1E-10 mg/kg or mg/L are expected to be below any level of concern.

4. To specify whether the input concentrations of a COC toxicity characteristic leaching procedure (TCLP) and total concentration are estimated from their detection limits (such as when the COC was not detected), check the box in Columns 3 and/or 5 (Figure 3.10) for *Yes*, and the selected multiplier (0.5 or 1.0) will be used. The default values for the two boxes are *No*.

5. To remove a row, highlight the desired row and click on *Remove Row*.

   (*Optional*) To examine or edit the properties of each site COC, click the cell of the target COC in *Property Details* (see the dashed box in Figure 3.10). Once the cell is clicked on the property table of the chosen COC will be displayed (Figure 3.11). The user can now edit the required properties. If the properties of any COC are edited, that COC will be saved as a customized COC. Again, note that the default properties cannot be modified by the user without the COC becoming classified as a customized COC. Changes to the default parameters will only happen when new versions of the default database are added to new versions of the DRAS 4 software by EPA personnel.

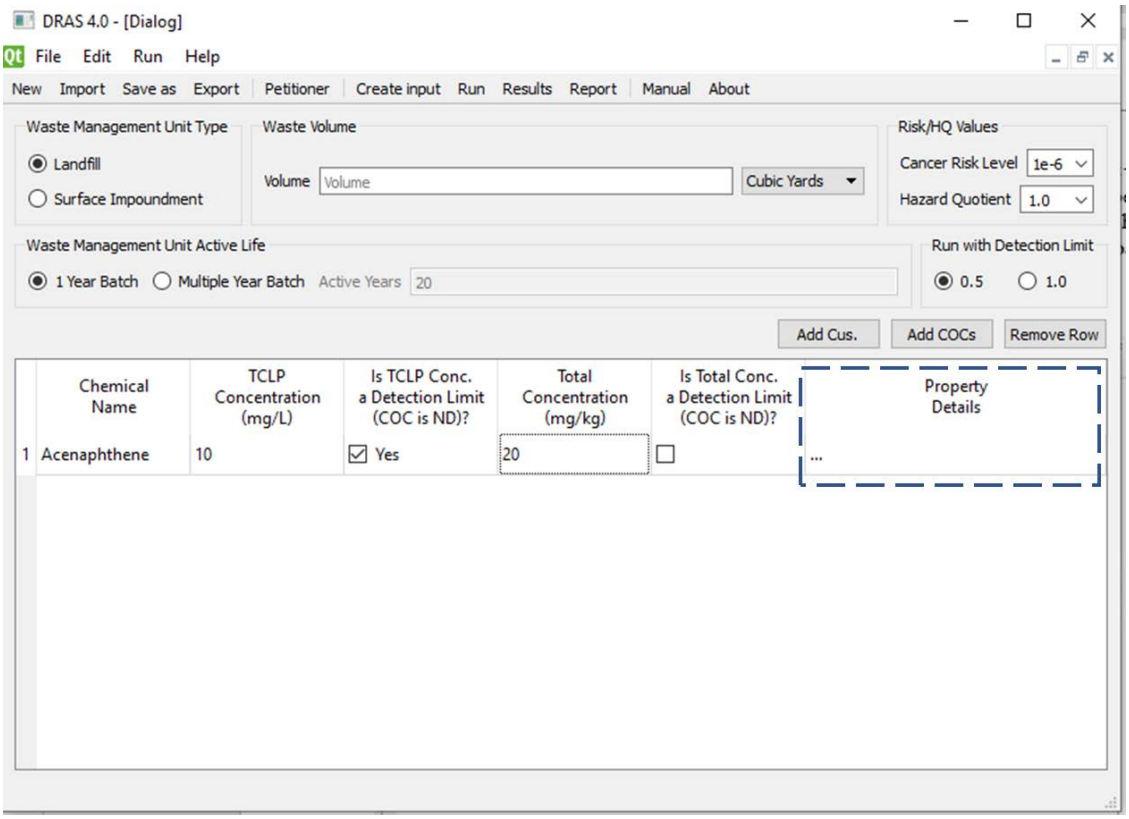


Figure 3.10 Site TCLP and Total Concentrations are Entered in Columns 2 and 4. COC Properties may be Inspected by Clicking on the Three Dots in the Dashed Area.

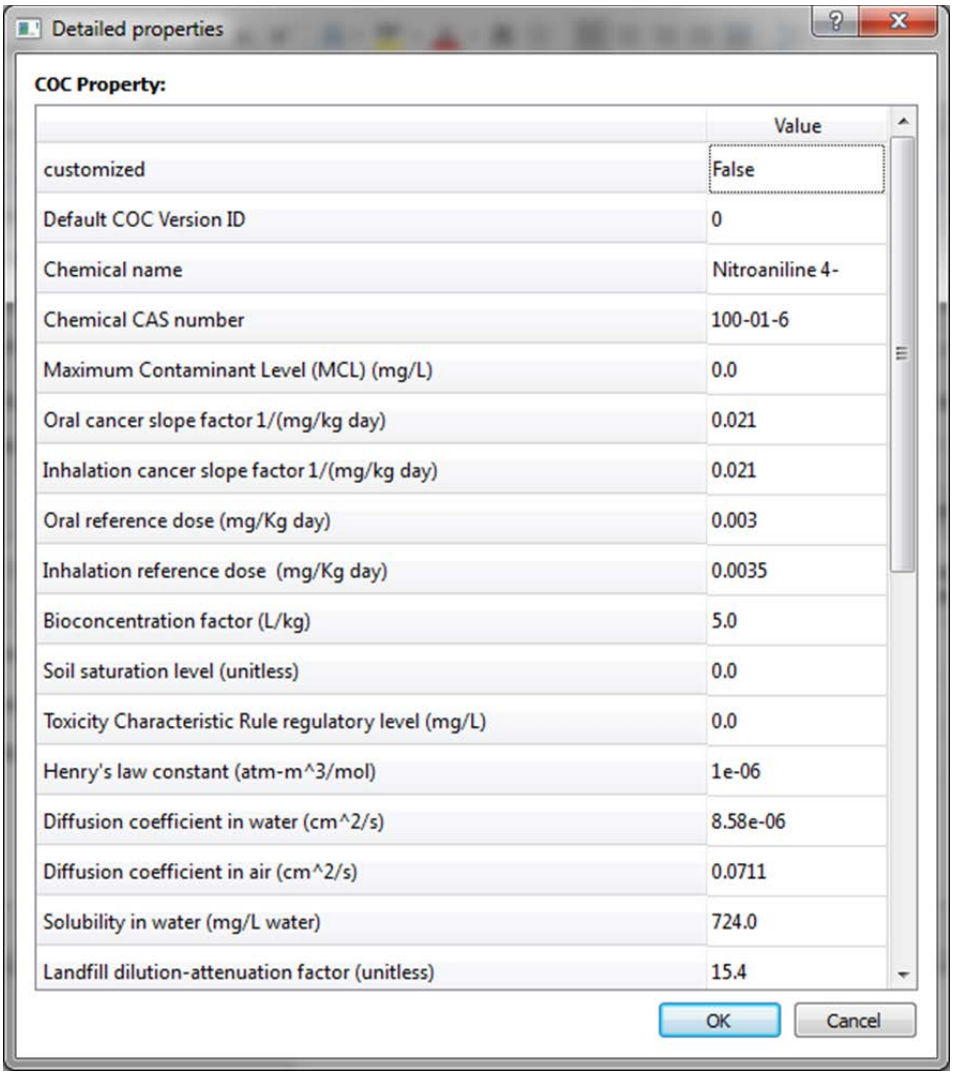


Figure 3.11 Pop-Up Dialog Box Showing Editable COC Properties

3.3.2.4 Save the Project Database at a User-specified Location

The project database is saved under a default Windows temporary file location, if *Save as* (on the toolbar or *File* > *Save as*) is not invoked. It is recommended that the *Save as* option be used. Click on the *Save as* button then navigate to a user-desired location, type the user's project database name, and click on *Save* (Figure 3.12). Note that once *Save as* is invoked the data base changes subsequent to the invocation will be automatically saved to the new location.

If successful, a confirmation message below will appear. Click *OK* (Figure 3.13).

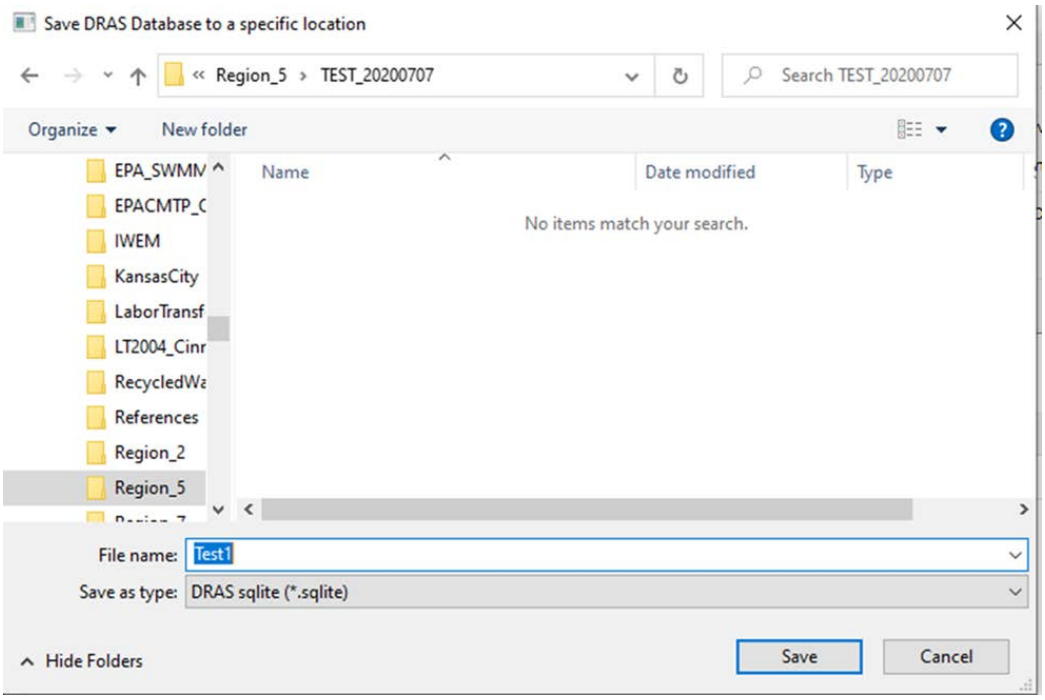


Figure 3.12 Pop-Up Dialog Box for Saving Project File

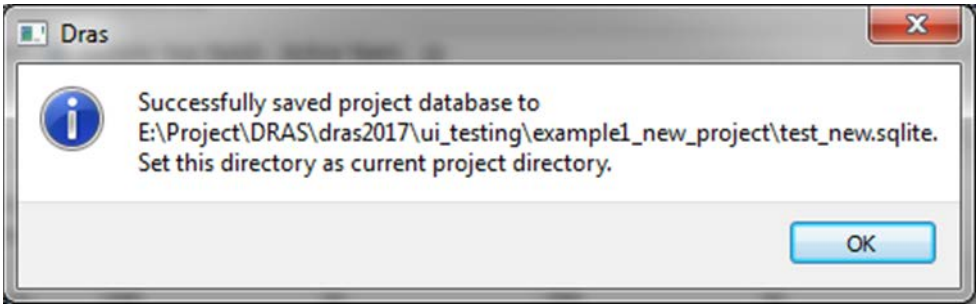


Figure 3.13 Confirmation of Successful Saving of Project D

3.3.2.5 Input Petitioner's Information

This step is optional. Click on *Petitioner* on the toolbar to input petitioner's information. Enter all the required information (see Figure 3.14) then click on *OK* to save the information to database. Although optional, the *Petitioner* tab is very useful in preparing documentation of the DRAS 4 run for the rulemaking docket. The information entered in this tab will be reproduced on output tables, serving to clearly identify the petitioned waste, the facility, date, and identify of the person performing the analysis. Click on *Save as* to save the entered information.

3.3.2.6 Create Input for the Risk Computational Engine

The user is now ready to generate input for the DRAS risk computational engine. Click on *Create input* (lower toolbar in Figure 3.7) to create the risk-computational engine input file called "DRAS.IN" in the current directory. If the project has been saved to a user-specified directory in the *Save as* procedure, the current directory will be the user-specified directory, otherwise, the

temporary directory will be used to store the file. Click *Select Folder* to save the "DRAS.IN" file. Note that "DRAS.IN" is an editable text-based file.

If successful, a confirmation message below will appear. Click on *OK* (Figure 3.15).

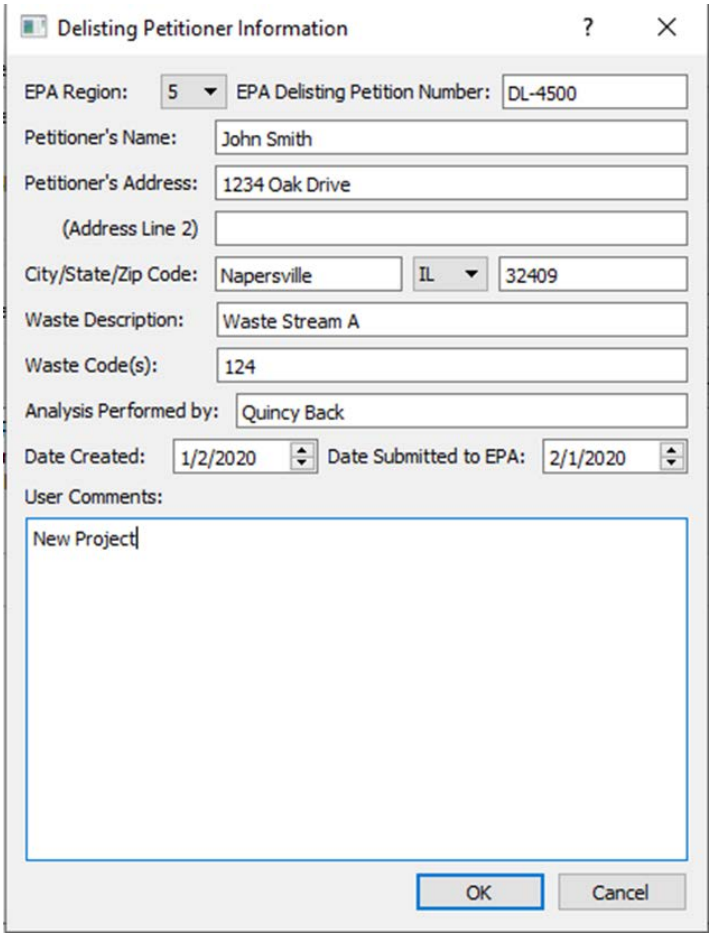


Figure 3.14 Dialog Box for Entering Petitioner's Information

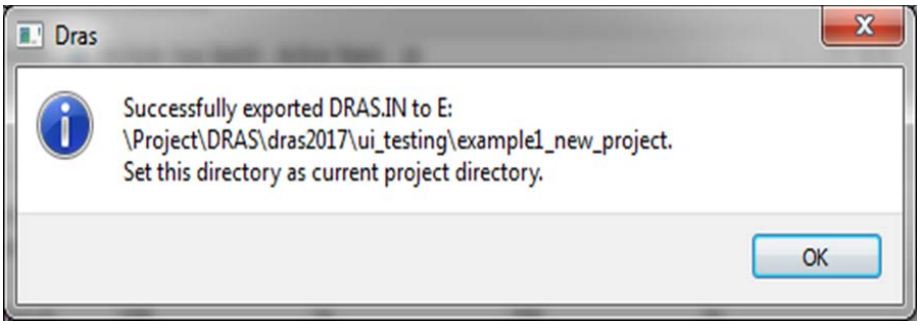


Figure 3.15 Confirmation of Successful Creation of Input File for the Risk Computational Engine

3.3.2.7 Run the Risk Computational Engine

Click on *Run* (lower toolbar in Figure 3.7) to execute the risk computational engine. Note that if the waste volume is not entered or is equal to zero, the Risk Computational Engine will cause the project run to be terminated and exit from DRAS 4.

The default working directory is where "DRAS.IN" is saved in the previous procedure. A user may also navigate to any folder that contains "DRAS.IN" and execute the risk computation engine in that directory.

If successful, a confirmation message below will appear. Click on *OK* (Figure 3.16).

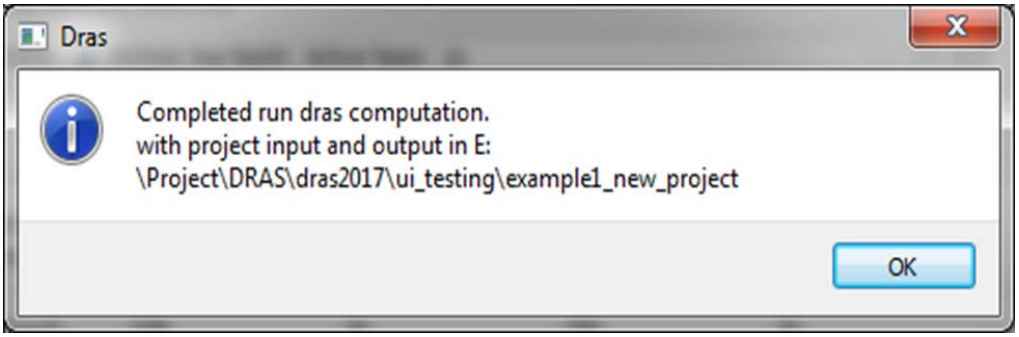


Figure 3.16 Confirmation of Successful Run of Risk Computational Engine

3.3.2.8 Generate Tabulated Results

Click on *Results* (lower toolbar in Figure 3.7) to import the results from the risk computational engine. An output file called "DRAS.OUT" is generated by the risk computational engine after each run and is stored in the current working directory (Figure 3.17). "DRAS.OUT" is a text file that contains ten output tables from the risk computational engine. Opening the "DRAS.OUT" file using the *Results* tab will display Tables 1-10 in pop-up dialog boxes (Figure 3.18).

The tables within the *Results* tab can be printed to .pdf or .csv as individual tables or all tables. Note that the print to file option in the *Results* tab functions like screen grabs or snapshots and the print file may appear truncated. Tables and columns can be resized to a degree within the *Results* tab prior to printing to .pdf or .csv to minimize formatting issues. In addition, all 10 tables will be printed if the user chooses to print a report in the *Report* tab. The tables generated in .pdf and .html format from the *Report* tab are preformatted for display and printing as described below in Section 3.3.2.9. A description of the 10 tables is presented in Table 3.1.

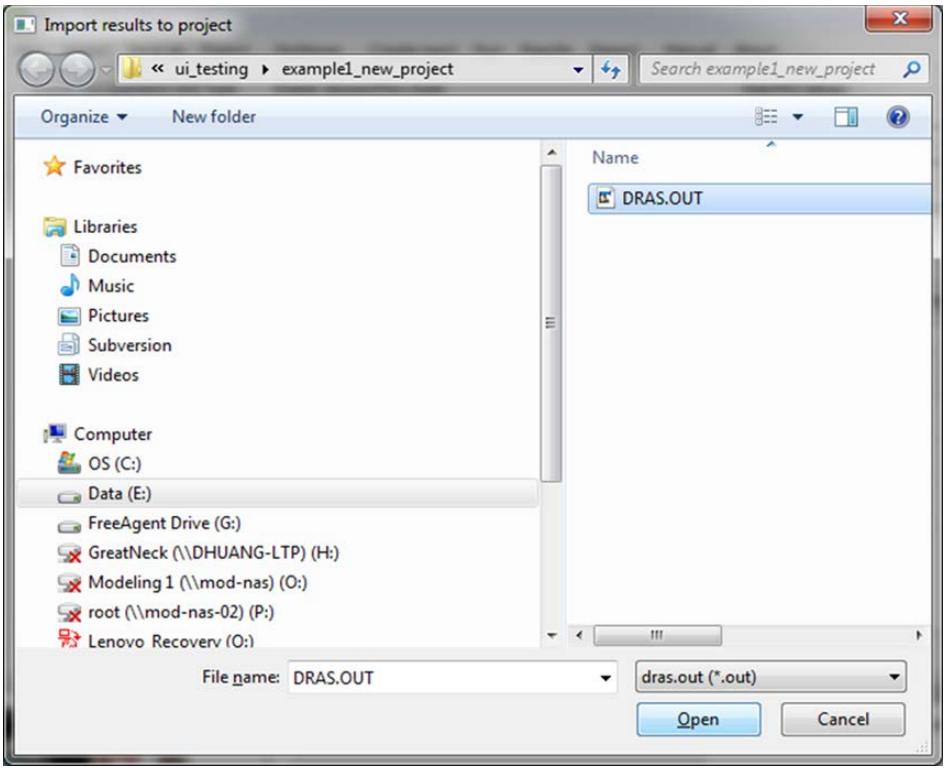


Figure 3.17 Dialog Box for Importing DRAS.OUT for Post Processing

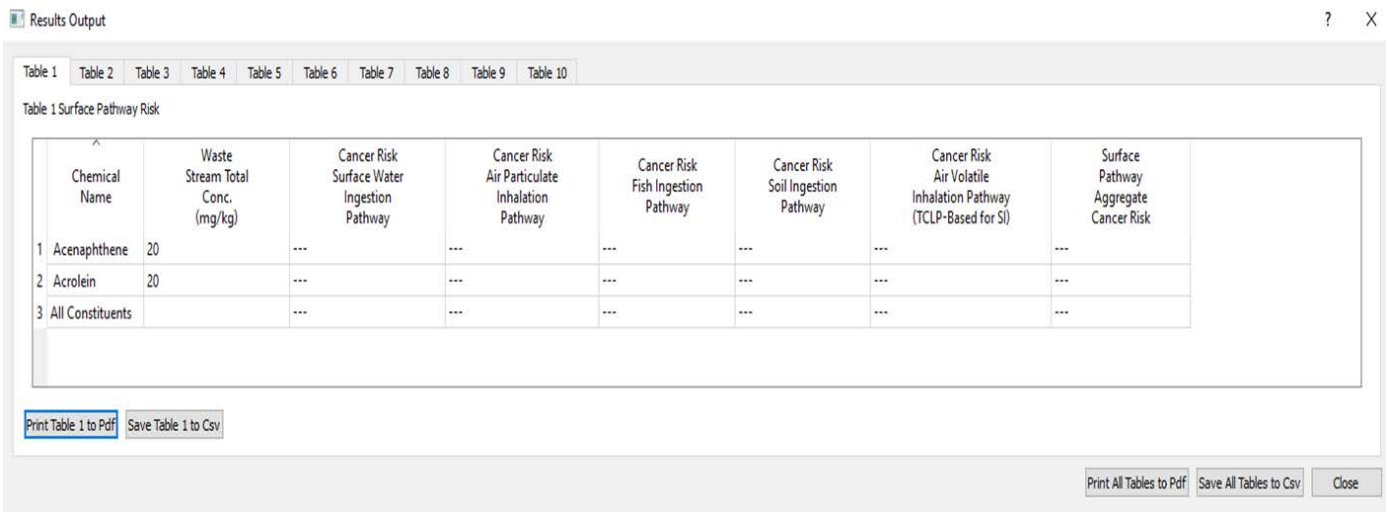


Figure 3.18 Dialog Box Showing Tables 1 to 10 of the Risk Analysis Results

Table 3.1 Description of Tables in the DRAS-Generated Report

Table Name	Description
Table 1 - Surface Pathway Risk	*Forward-calculation* of cancer risks due to releases from the surface of the waste management unit. Displays risk by individual pathway (fish ingestion, volatile inhalation, etc.) as well as an aggregate risk by chemical and overall. Risk estimated from concentrations in petitioned waste.
Table 2 - Groundwater Pathway Risk	*Forward-calculation* of cancer risks due to a release to groundwater from the waste management unit. Displays hazard by individual pathway (groundwater ingestion, groundwater inhalation, etc.) as well as an aggregate risk by chemical and overall. Risk estimated from concentrations in petitioned waste.
Table 3 - Surface Pathway Hazard Quotient	*Forward-calculation* of noncancer health effects (hazard) due to releases from the surface of the waste management unit. Displays hazard by individual pathway (fish ingestion, volatile inhalation, etc.) as well as an aggregate risk by chemical and overall. Hazard estimated from concentrations in petitioned waste.
Table 4 - Groundwater Pathway Hazard Quotient	*Forward-calculation* of noncancer health effects (hazard) due to a release to groundwater from the waste management unit. Displays risk by individual pathway (groundwater ingestion, groundwater inhalation, etc.) as well as an aggregate risk by chemical and overall. Hazard estimated from concentrations in petitioned waste.
Table 5 - Maximum Allowable Concentrations for Surface Pathways	*Back-calculation* of maximum allowable concentrations due to releases from the surface of the waste management unit. Displays hazard by individual pathway (fish ingestion, volatile inhalation, etc.). Maximum allowable concentrations estimated based on target risk and hazard criterion set by the regulatory authority. Entered waste concentrations are not used in these calculations. Concentrations will be mg/kg total for landfills and mg/L leachate for surface impoundments.
Table 6 - Maximum Allowable TCLP Concentration Groundwater Pathways	*Back-calculation* of maximum allowable leachate concentrations, in mg/L, from releases to groundwater from the waste management unit. Displays hazard by individual pathway (groundwater ingestion, groundwater inhalation, etc.). Maximum allowable concentrations estimated based on target risk and hazard criterion set by the regulatory authority. Entered waste concentrations are not used in these calculations.
Table 7 - Aggregate Risk and Hazard Quotient Results	*Forward-calculation* of aggregate cancer risk and hazard summed across all pathways and all chemicals. Includes one sum of risk and hazards limited to COCs that were detected and another sum of risk and hazard that includes estimates based on the detection limits for COCs that were not detected. **This table summarizes the overall potential risk from the petitioned waste from COC concentrations in the waste.**
Table 8 - Limiting Pathways	*Back-calculation* of the limiting maximum allowable concentrations based on target risk and hazard criterion set by the regulatory authority. The individual limiting pathway is also identified (groundwater ingestion, air particulate inhalation, etc.). **This table is the most concise summary of maximum allowable concentrations.** Note that for surface impoundments, there will be a maximum allowable leachate concentration in mg/L for both surface and groundwater pathways.
Table 9 - Pathways Exceeding the Delisting Limits	This table is a combination of *forward-* and *back-calculations* from DRAS. Although all COCs are included in the table, COCs with waste concentrations that exceed limiting values are identified when the table also includes the limiting maximum concentration and pathway.

Table 3.1 Description of Tables in the DRAS-Generated Report (continued)

Table Name	Description
Table 10 - Toxicity Characteristic Soil Saturation and Ecological Values	This table presents comparisons to alternative criteria. The leachate concentration of the petitioned waste is compared to the Toxicity Characteristic Leachate Procedure concentrations from 40 CFR Part 261.24. TCLP leachate concentrations that exceed the regulatory values would remain hazardous regardless of the results of the DRAS model. Total concentrations in the waste that exceed an estimated soil-saturation concentration indicate that some of the assumptions used in this assessment may not apply and the user may need to make additional evaluations of the waste. Predicted surface water concentrations based on a release from the surface of the waste management unit are compared to ambient water quality criteria for protection of aquatic life.

3.3.2.9 Print Results

Click on *Report* (toolbar) to print the results to files in the .pdf and .html formats. The default report directory is the user-specified project directory. The user may also choose to navigate to another folder. A pop-up window (Figure 3.19) will appear when the report is ready. Note that the *Results* tab must have been accessed at least once in the current run in order to include output results in the generated reports under the *Report* tab.

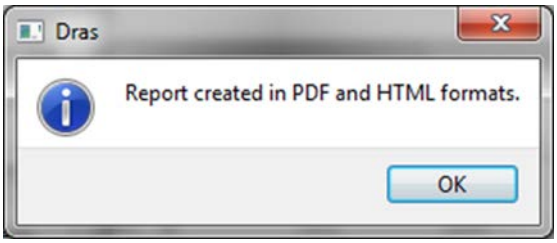


Figure 3.19 Confirmation of Successful Generation of PDF- and HTML-Formatted Reports

3.3.2.10 Output Files

Navigate to the project directory to examine output files (Figure 3.20). The user will see two report files: “dras_report.html” and “dras_report.pdf” generated in the previous step. The pdf file is generated for a quick review of the results. The html file may be opened in a browser to set customized printing options or it may be copied to MS Word for additional formatting.

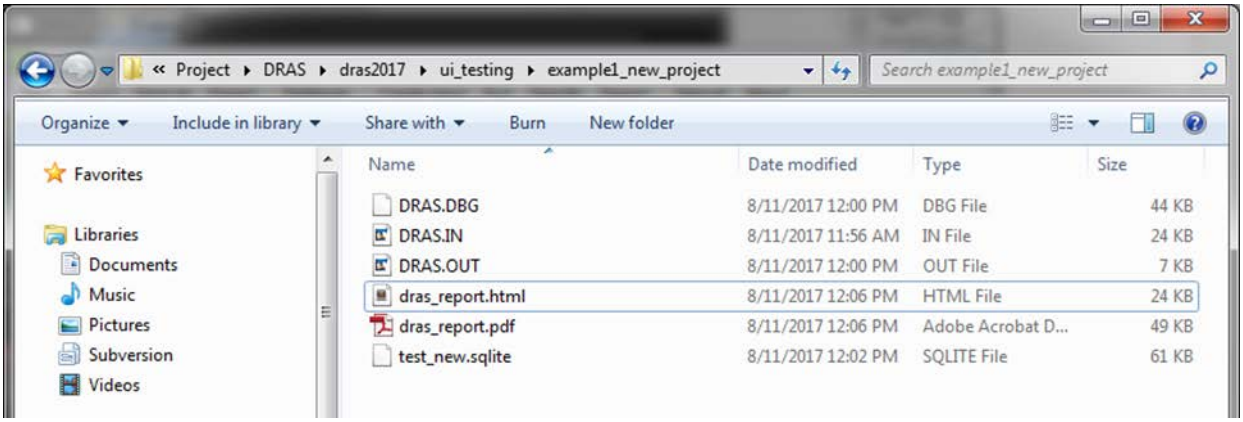


Figure 3.20 Location of PDF- and HTML-Formatted Reports

3.3.2.11 Close Current Project

Click on the X icon (or choose *File>Exit*) at the upper right corner to close the current project (Figure 3.21). The main window does not support multiple projects. Therefore, the current project must be closed prior to starting a new project or importing an existing project.

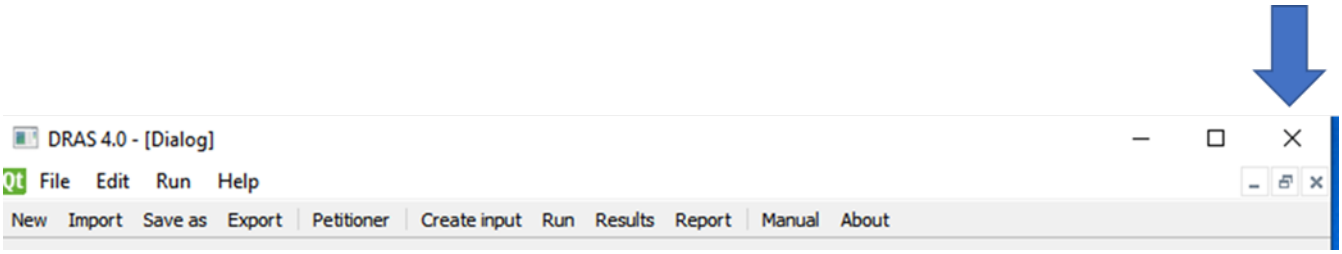


Figure 3.21 Exiting the Project by Clicking on the X Icon (see Arrow)

3.3.3 Import an Existing Project and Run DRAS

3.3.3.1 Importing an Existing Project File

Click on *Import* in the toolbar or choose *File>Import* from the toolbar. Note: to avoid incompatibilities between current project runs and imported projects, users must initiate a fresh user session for project imports. If DRAS 4 is already running other projects, you must exit the software and restart to load an existing project by the *import* function.

A file dialog box (Figure 3.22)will appear to allow the user to navigate to a previous project database (in .sqlite format). Select the database file and click oin *Open* in the file dialog box.

A message box below will pop-up if the file import is successful. (Figure 3.23)

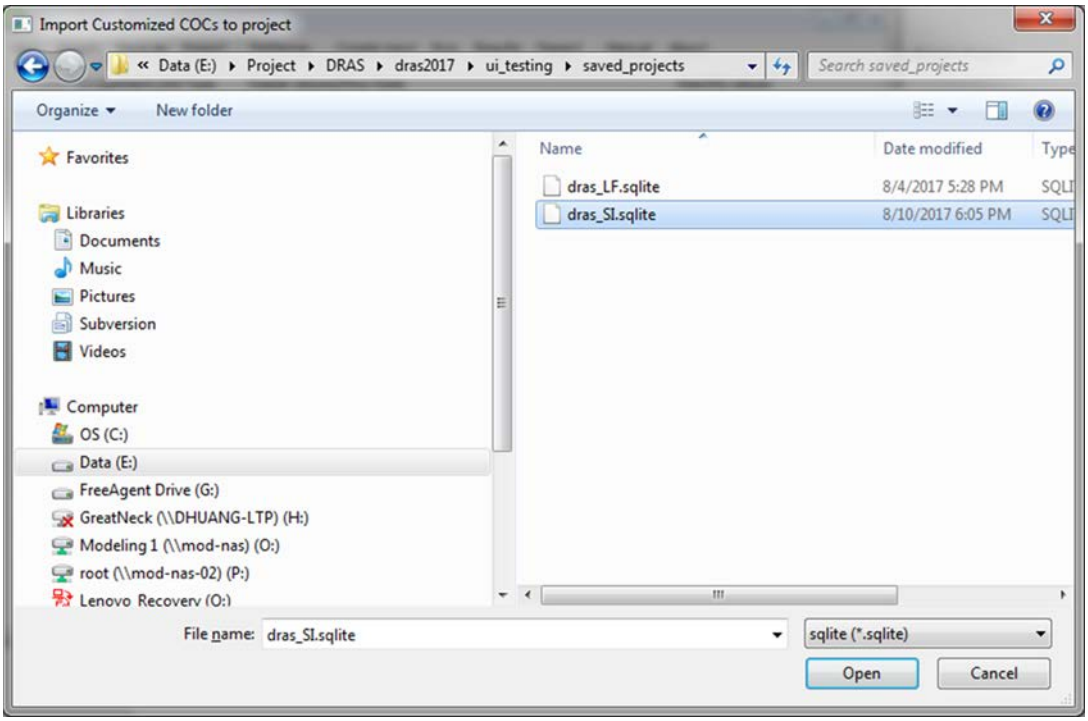


Figure 3.22 Previous Project Databases

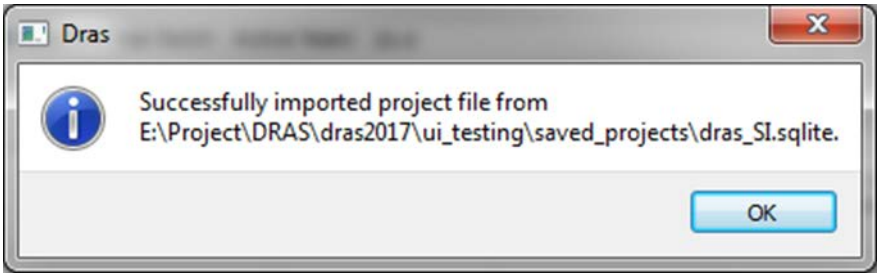


Figure 3.23 Confirmation of Successful File Import

3.3.3.2 Save the Revised Project File

Click on *Save as* on the toolbar or choose *File>Save as* from the dropdown menu.

Save the imported project in a different directory to avoid overwriting the existing project file. Using a new project file name in the existing directory is also permitted. However, the "DRAS.IN" and "DRAS.OUT" files will be overwritten.

Note that once *Save as* is invoked the data base changes subsequent to the invocation will be automatically saved.

3.3.3.3 Make Revision and Save the Revised Project File

To make a revision to the project and rerun the analysis, follow steps in Section 3.3.2.2 to 3.3.2.11.

3.3.4 Customized Chemicals of Concern

Customized COCs are those that are not available in the data base. There are three methods that can be used to incorporate customized COCs into the project.

- Using available DRAS 4 databases, Section 3.3.4.1.
- Using user-prepared databases, Section 3.3.4.2.
- Directly entering COC identification and properties manually, Section 3.3.4.3.

The process begins by clicking on the *Add Cus*. button (see the lower dashed frame in Figure 3.8) to display the window shown in Figure 3.24.

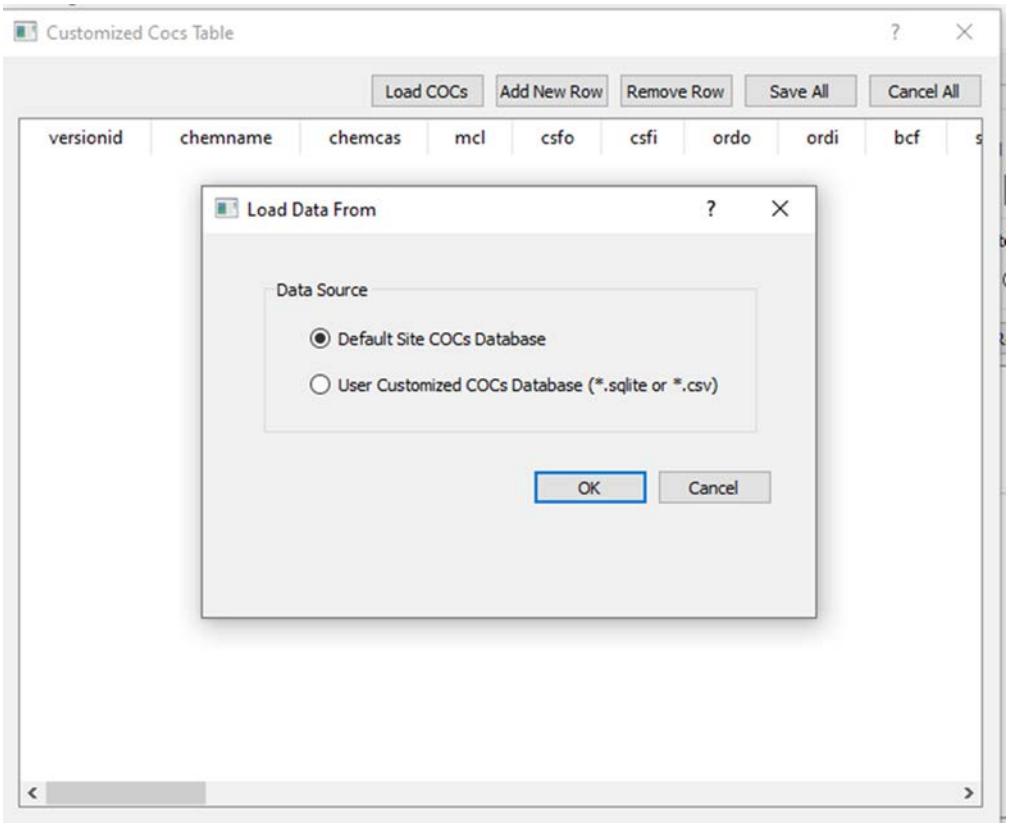
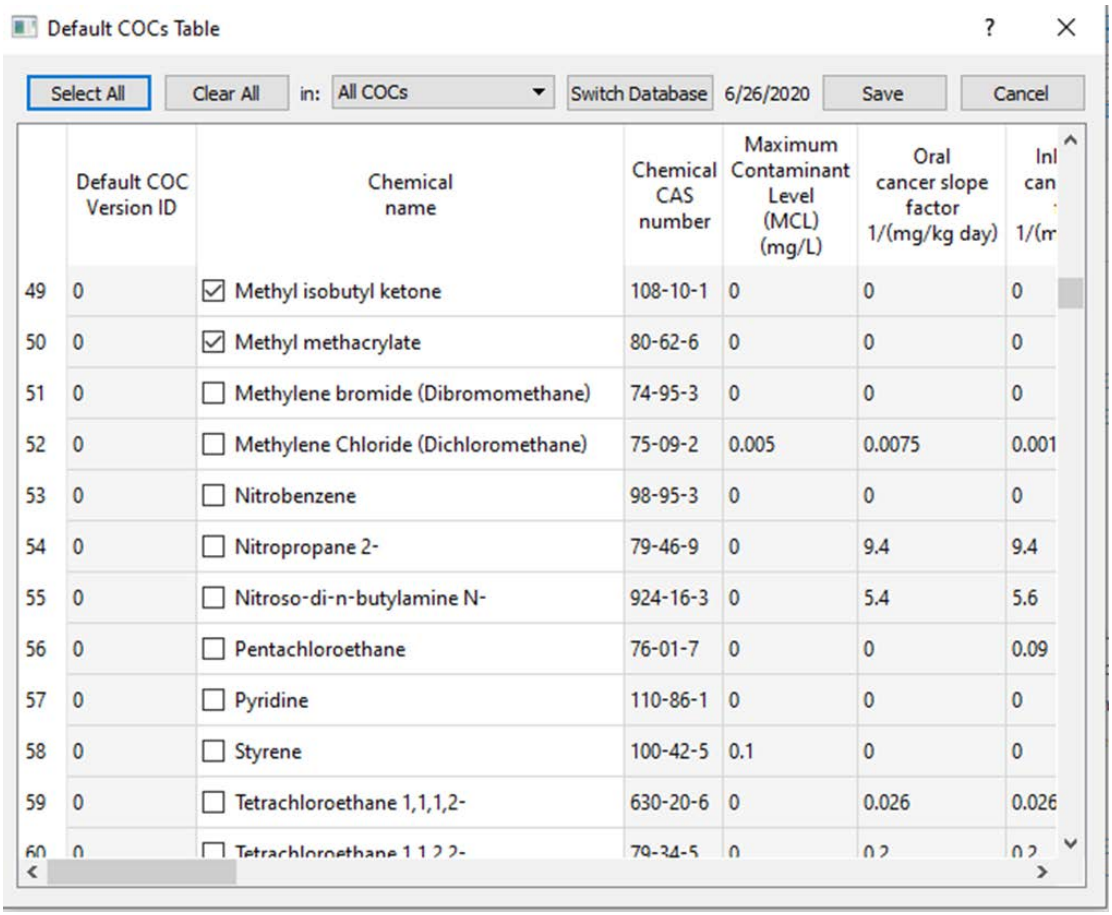


Figure 3.24 Selecting Customized COC Input by Clicking on *Add Cus*

3.3.4.1 Set Up Customized COCs using DRAS 4 Databases

Users can select a default COC with older database parameters as a customized COC. (Note that multiple COCs using the exact same name cannot be selected so you cannot have an older and more recent version of a COC with the same name run at the same time). By clicking on the *Load COCs* button on the toolbar, the user will see the *Load Data From* dialog box. By choosing the *Default Site COCs Database* option and clicking on *OK* the user will see a COC table shown in Figure 3.25. The user can change the database by clicking on *Switch Database*. Each database is identified by the date on which it was created shown to the right of the *Switch Database* button.

COCs can be selected by checking the boxes to the left of respective COCs. Once all the required COCs are selected, click on *Save*.



	Default COC Version ID	Chemical name	Chemical CAS number	Maximum Contaminant Level (MCL) (mg/L)	Oral cancer slope factor 1/(mg/kg day)	Inl can 1/(m
49	0	☑ Methyl isobutyl ketone	108-10-1	0	0	0
50	0	☑ Methyl methacrylate	80-62-6	0	0	0
51	0	☐ Methylene bromide (Dibromomethane)	74-95-3	0	0	0
52	0	☐ Methylene Chloride (Dichloromethane)	75-09-2	0.005	0.0075	0.001
53	0	☐ Nitrobenzene	98-95-3	0	0	0
54	0	☐ Nitropropane 2-	79-46-9	0	9.4	9.4
55	0	☐ Nitroso-di-n-butylamine N-	924-16-3	0	5.4	5.6
56	0	☐ Pentachloroethane	76-01-7	0	0	0.09
57	0	☐ Pyridine	110-86-1	0	0	0
58	0	☐ Styrene	100-42-5	0.1	0	0
59	0	☐ Tetrachloroethane 1,1,1,2-	630-20-6	0	0.026	0.026
60	0	☐ Tetrachloroethane 1,1,2,2-	79-34-5	0	0.2	0.2

Figure 3.25 Default Site Database (Note: *Switch Database* (see toolbar) can be Used to Navigate between Databases)

3.3.4.2 Set Up Customized COCs using User-Prepared Databases

By clicking on the *Load COCs* button on the toolbar, the user will see the *Load Data From* dialog box. By choosing the *User Customized COCs Database* option and clicking on *OK* (Figure 3.26), the user will see a dialog box shown in Figure 3.27. Clicking the *Switch Database* button, the user will see the *Import Customized COCs to Project* dialog box. The user must then navigate to the folder where the database resides. Two database formats are available in DRAS 4, SQLite and csv (Figures 3.28, and 3.29). The chosen database is imported by clicking on *Open*. COCs can be selected by checking the boxes to the left of respective COCs (Figure 3.30). Once all the required COCs are selected, click on *Save*.

This feature allows the User to import customized chemicals from other projects. The easiest way to do so is to use the *Export* function (see File Options section 3.2.1) in the other project. One of the files exported will be *[filename]_Cuscocs.csv*. This file contains all the customized chemicals and will include all the parameters needed to run. We recommend that User's maintain this file to

include all their customized chemicals, so they are available for import to any project. This file could also be easily shared via e-mail to other users.

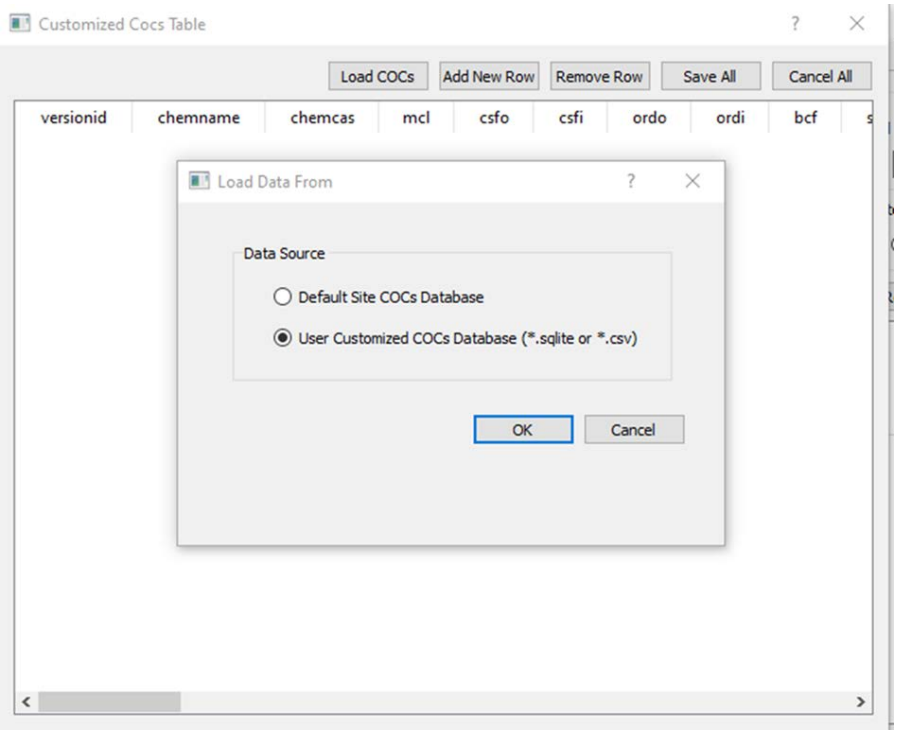


Figure 3.26 Selecting Customized COC Input from User-Prepared Databases

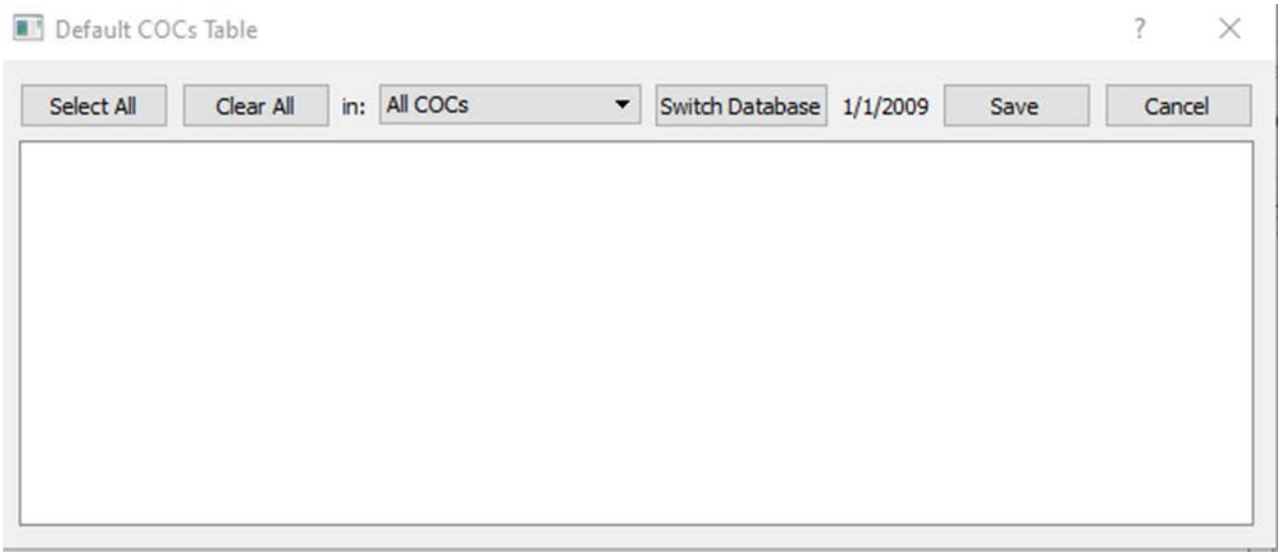


Figure 3.27 Dialog Box for Inputting User-Prepared Databases

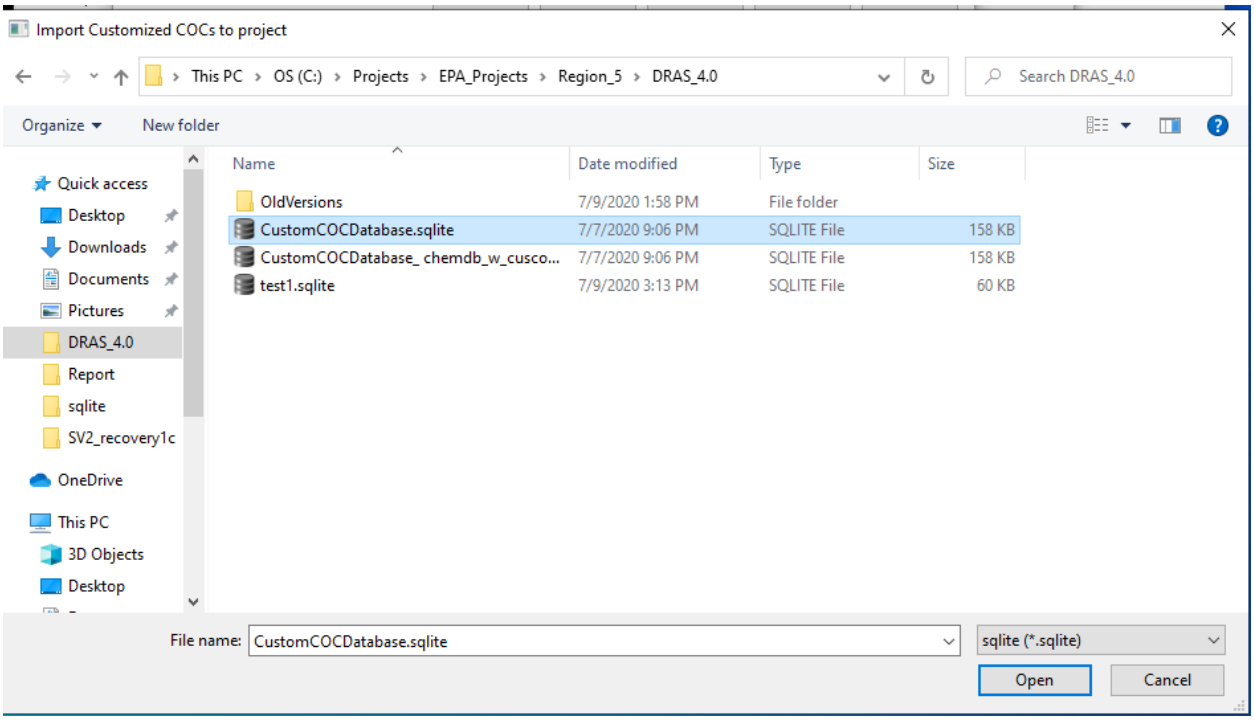


Figure 3.28 Selecting a User-Prepared SQLite-Formatted Database

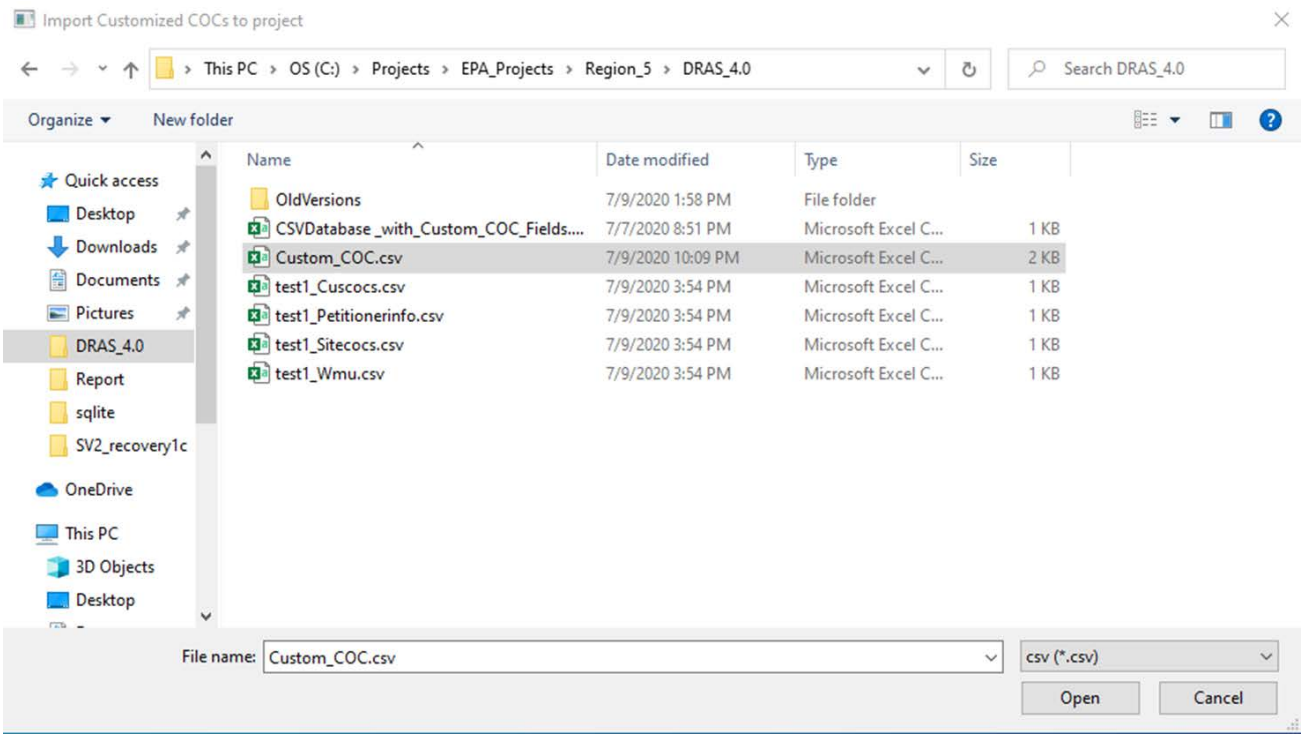
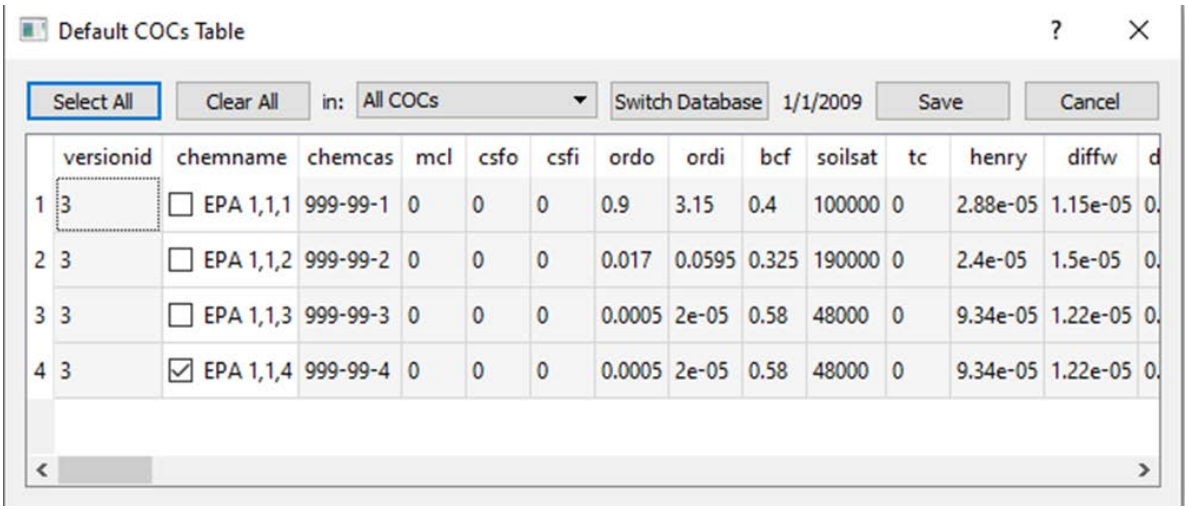


Figure 3.29 Selecting a User-Prepared CSV-Formatted Database



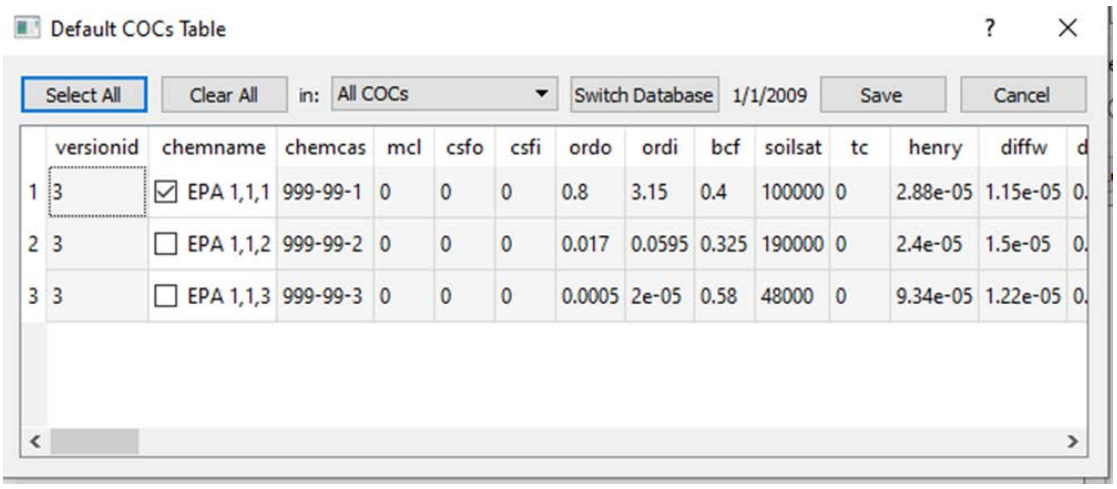
	versionid	chemname	chemcas	mcl	csfo	csfi	ordo	ordi	bcf	soilsat	tc	henry	diffw	d
1	3	☐ EPA 1,1,1	999-99-1	0	0	0	0.9	3.15	0.4	100000	0	2.88e-05	1.15e-05	0.
2	3	☐ EPA 1,1,2	999-99-2	0	0	0	0.017	0.0595	0.325	190000	0	2.4e-05	1.5e-05	0.
3	3	☐ EPA 1,1,3	999-99-3	0	0	0	0.0005	2e-05	0.58	48000	0	9.34e-05	1.22e-05	0.
4	3	☑ EPA 1,1,4	999-99-4	0	0	0	0.0005	2e-05	0.58	48000	0	9.34e-05	1.22e-05	0.

Figure 3.30 Example of a User-Prepared Database

3.3.4.3 Enter COC information Manually

Each time the user clicks on *Add New Row* on the *Customized COCs* toolbar in Figure 3.24, a blank line will appear. COC information can then be entered by the user as shown in an example in Figure 3.31. COCs can be selected by checking the boxes to the left of respective COCs. Once all the required COCs are selected, click on *Save*. Only the chosen COCs will be saved in the project file.

If the user does not have a dilution-attenuation factor (DAF) for the customized chemical, entering zeros for both the landfill DAF (DAFLF) and surface impoundment DAF (DAFSI) will prompt DRAS 4 to automatically substitute the most conservative (minimum) DAFs from the default COC database, 15.1 for DAFLF and 3.18 for DAFSI.



	versionid	chemname	chemcas	mcl	csfo	csfi	ordo	ordi	bcf	soilsat	tc	henry	diffw	d
1	3	☑ EPA 1,1,1	999-99-1	0	0	0	0.8	3.15	0.4	100000	0	2.88e-05	1.15e-05	0.
2	3	☐ EPA 1,1,2	999-99-2	0	0	0	0.017	0.0595	0.325	190000	0	2.4e-05	1.5e-05	0.
3	3	☐ EPA 1,1,3	999-99-3	0	0	0	0.0005	2e-05	0.58	48000	0	9.34e-05	1.22e-05	0.

Figure 3.31 Example of Manually Input COC Data

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4.0 REFERENCES

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EPA, 2003. EPA's Composite Model for Leachate Migration with Transformation (EPACMTP), Parameters/Data Background Document. USEPA Office of Solid Waste, Washington, DC, EPA530-R-03-003.

EPA, 2008. RCRA Delisting Technical Support Document, USEPA Region 6, Dallas, TX.

EPA, 2010. User's Guide, Delisting Risk Assessment Software (DRAS) Version 3.0, USEPA Region 5, Chicago, IL.

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APPENDIX A

APPLICATION EXAMPLE

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APPENDIX A

APPLICATION EXAMPLE

A.1 Overview

The example shown below is that of a proposed waste stream with three COCs for landfills. The application consists of three stages: data input (Section A.2), running the risk computational engine (Section A.3), and result output/reporting (Sections A.4 and A.5). For each stage, relevant instructions in Section 3 are referred to.

A.2 Enter WMU and COC information

Following the instructions in Sections 3.3.2.1 to 3.3.2.3 for the WMU and the first two COCs, and the instructions in Section 3.3.4 for the last COC (EPA 1,1,3) results in the populated window shown in Figure A.1.

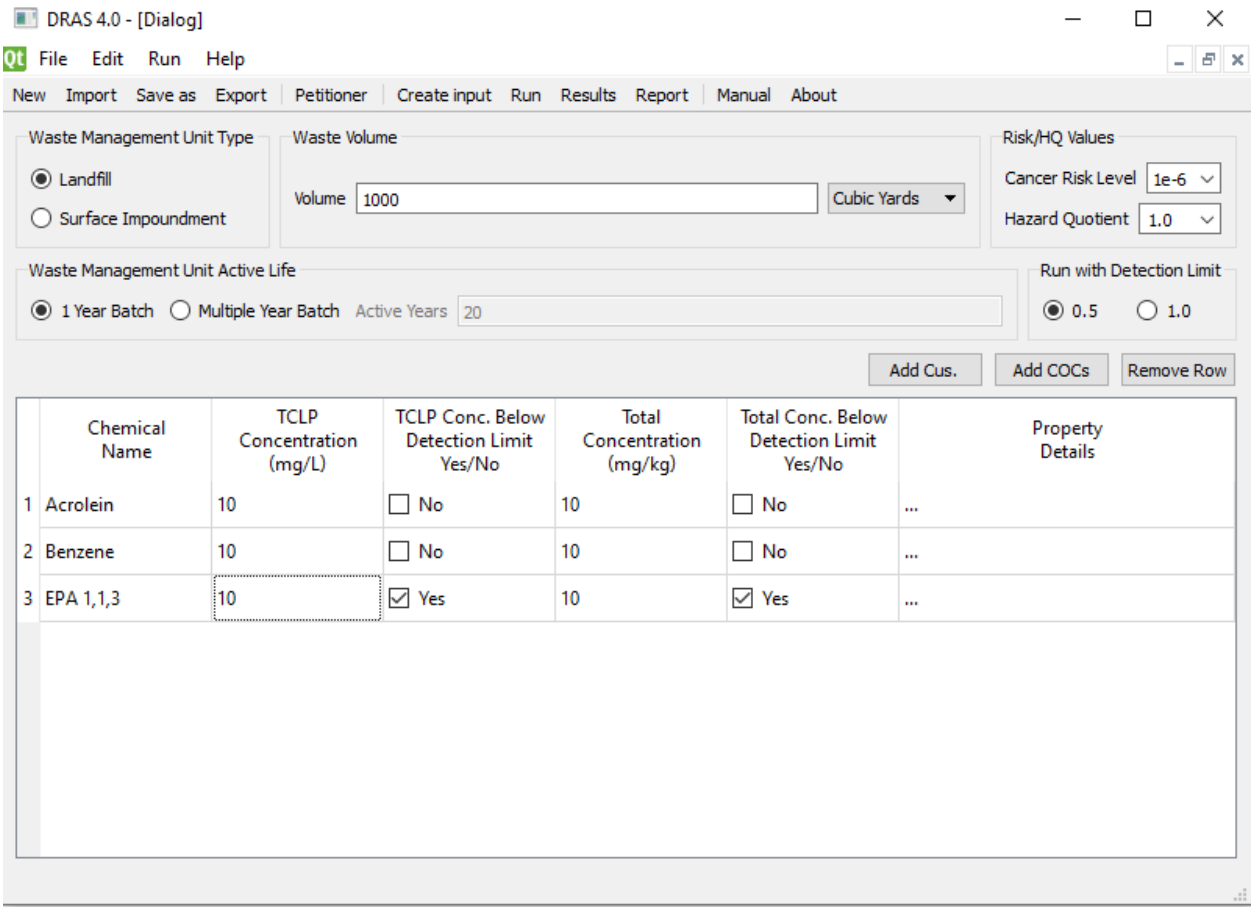


Figure A.1 WMU and COC Information Input

Following the instructions in Section 3.3.2.5, petitioner's and other related information is entered resulting in the window shown in Figure A.2.

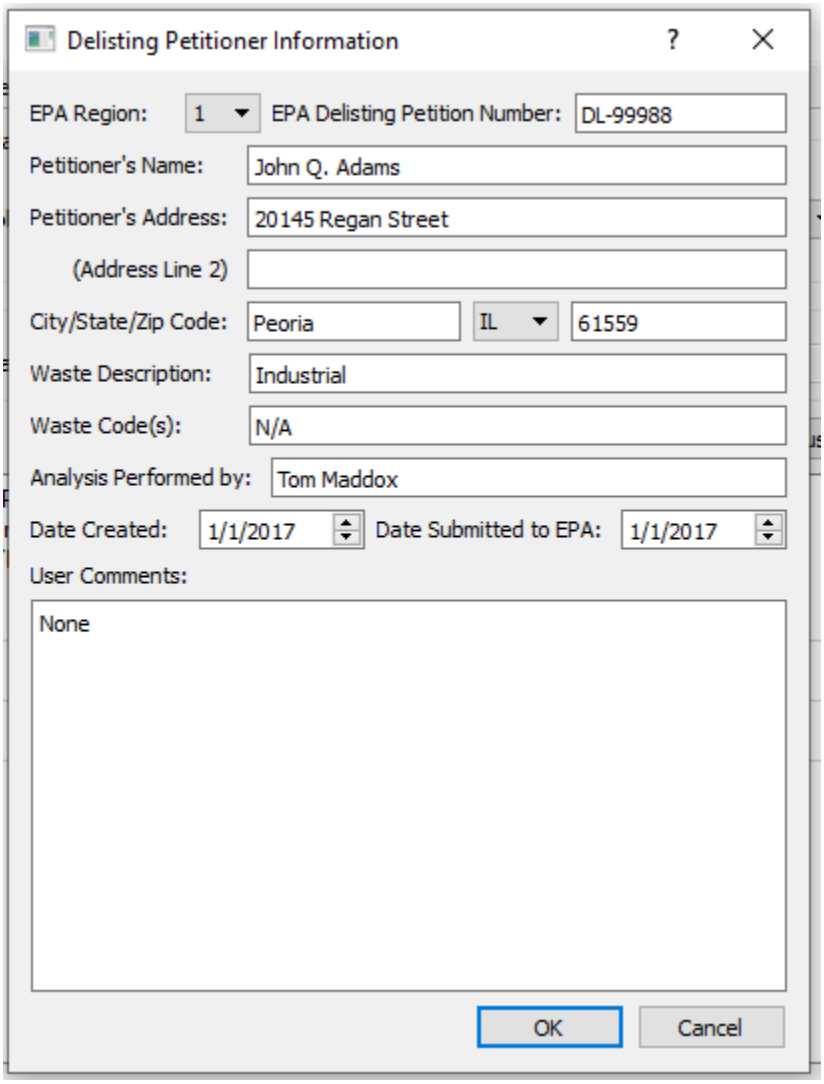


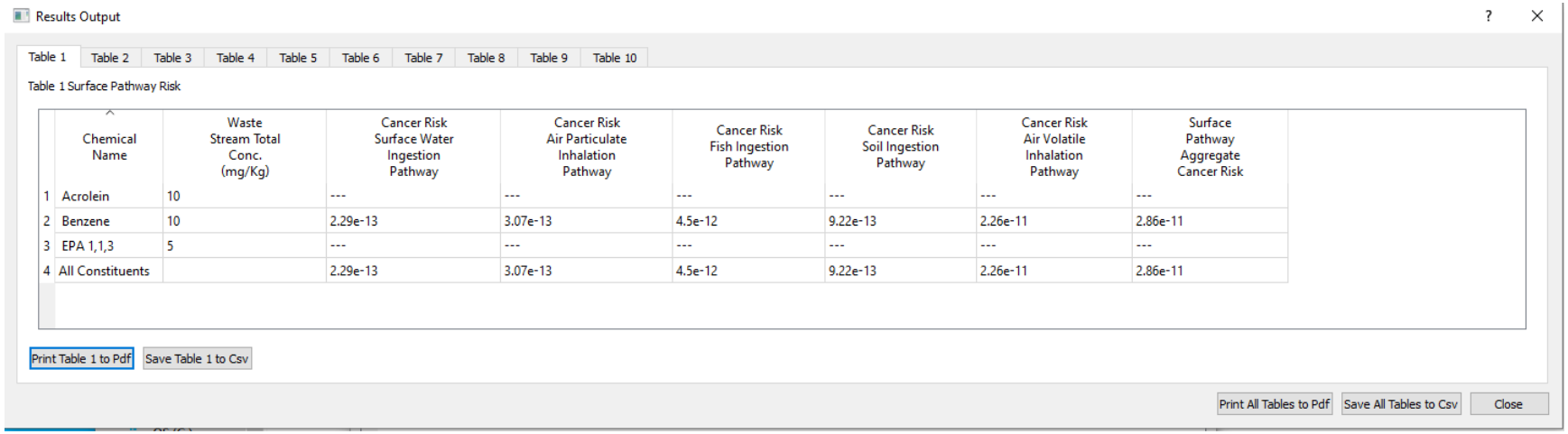
Figure A.2 Petitioner's and Waste's Information

A.3 Create Input File and Run

The DRAS.IN file (input file for the risk computational engine) is then created based on the instructions in Section 3.3.2.6. Following the instructions in Section 3.3.2.7, the risk computational engine is run to create the DRAS.OUT file. The results are ready to be post-processed.

A.4 Tabulated Output

Following the instructions in Section 3.3.2.8, tabulated results shown in Figure A.3 are created.



	Chemical Name	Waste Stream Total Conc. (mg/Kg)	Cancer Risk Surface Water Ingestion Pathway	Cancer Risk Air Particulate Inhalation Pathway	Cancer Risk Fish Ingestion Pathway	Cancer Risk Soil Ingestion Pathway	Cancer Risk Air Volatile Inhalation Pathway	Surface Pathway Aggregate Cancer Risk
1	Acrolein	10	---	---	---	---	---	---
2	Benzene	10	2.29e-13	3.07e-13	4.5e-12	9.22e-13	2.26e-11	2.86e-11
3	EPA 1,1,3	5	---	---	---	---	---	---
4	All Constituents		2.29e-13	3.07e-13	4.5e-12	9.22e-13	2.26e-11	2.86e-11

Figure A.3 Result Tables 1 to 10.

A.5 Tabulated Output

Following the instructions in Sections 3.3.2.9, and 3.3.2.10, two report files (dras_report.html and dras_report.pdf) are created in the working directory. A pdf file can also be created by saving the html file as a pdf file. An example of such file is appended to the end of this section.

DRAS Report

Petitioner Information

EPA Region	5
EPA Delisting Petition Number	DL-9949
Name	John Q. Adams
Address	2202 Sleep Hollow Road
Address Line 2	
City	Odell
State	IL
Zip Code	60460
Waste Description	Industrial
Waste Code	W-1234
Analysis Performed by:	Matt Mendoza
Date Created:	1/1/2017
Date Submitted to EPA	1/1/2017
User Comments	

WMU Information

Unique Site Identifier	0
Landfill (LF) or Surface Impoundment (SI)	LF
Risk Factor	1e-06
Hazard Quotient Factor	1.0
Annual Waste Volume	1000.0
Units for Waste Volume 0-yd^3 1-ft^3 2-m^3	0
Active Life of the Waste Management Unit (years)	1.0
Run Detection Limit at Half (0.5) or Full Level(1.0)	1.0

Table 1 Surface Pathway Risk

Chemical Name	Waste Stream Total Conc. (mg/kg)	Cancer Risk Surface Water Ingestion Pathway	Cancer Risk Air Particulate Inhalation Pathway	Cancer Risk Fish Ingestion Pathway	Cancer Risk Soil Ingestion Pathway	Cancer Risk Air Volatile Inhalation Pathway (TCLP-Based for SI)	Surface Pathway Aggregate Cancer Risk
Acrolein	1.000E+01	---	---	---	---	---	---
Benzene	1.000E+01	2.290E-13	3.190E-13	4.500E-12	9.220E-13	2.350E-11	2.950E-11
EPA 1,1,3	1.000E+01	---	---	---	---	---	---
All Constituents		2.290E-13	3.190E-13	4.500E-12	9.220E-13	2.350E-11	2.950E-11

Table 2 Groundwater Pathway Risk

Chemical Name	Dilution Attenuation Factor (DAF)	Waste Volume Adjusted DAF	Waste Stream TCLP Conc. (mg/L)	Cancer Risk Groundwater Ingestion Pathway	Cancer Risk Groundwater Inhalation Pathway	Cancer Risk Groundwater Dermal Absorption Pathway-Adult	Cancer Risk Groundwater Dermal Absorption Pathway-Child	Groundwater Pathway Aggregate Cancer Risk
Acrolein	---	---	1.000E+01	---	---	---	---	---
Benzene	1.540E+01	2.140E+03	1.000E+01	3.520E-06	3.390E-06	4.060E-07	1.770E-07	7.320E-06
EPA 1,1,3	---	---	1.000E+01	---	---	---	---	---
All Constituents				3.520E-06	3.390E-06	4.060E-07	1.770E-07	7.320E-06

Table 3 Surface Pathway Hazard Quotient

Chemical Name	Waste Stream Total Conc. (mg/kg)	Hazard Quotient Surface Water Ingestion Pathway	Hazard Quotient Air Particulate Inhalation Pathway	Hazard Quotient Fish Ingestion Pathway	Hazard Quotient Soil Ingestion Pathway	Hazard Quotient Air Volatile Inhalation Pathway (TCLP-Based for SI)	Surface Pathway Aggregate Hazard Quotient
Acrolein	1.000E+01	1.620E-08	3.990E-06	9.700E-09	2.970E-07	7.410E-04	7.450E-04
Benzene	1.000E+01	2.030E-09	2.660E-09	5.120E-08	3.710E-08	1.970E-07	2.890E-07
EPA 1,1,3	1.000E+01	1.620E-08	3.990E-06	9.700E-09	2.970E-07	7.410E-04	7.450E-04
All Constituents		3.450E-08	7.990E-06	7.060E-08	6.310E-07	1.480E-03	1.490E-03

Table 4 Groundwater Pathway Hazard Quotient

Chemical Name	Waste Stream TCLP Conc. (mg/L)	Dilution Attenuation Factor (DAF)	Waste Volume Adjusted DAF	Hazard Quotient Groundwater Ingestion Pathway	Hazard Quotient Groundwater Inhalation Pathway	Hazard Quotient Groundwater Dermal Absorption Pathway-Adult	Hazard Quotient Groundwater Dermal Absorption Pathway-Child	Groundwater Pathway Aggregate Hazard Quotient
Acrolein	1.000E+01	---	---	3.840E-30	2.000E-28	1.970E-32	4.280E-32	2.040E-28
Benzene	1.000E+01	1.540E+01	2.140E+03	3.120E-02	2.830E-02	4.610E-03	1.010E-02	6.960E-02
EPA 1,1,3	1.000E+01	---	---	3.840E-30	1.480E-28	1.970E-32	4.280E-32	1.510E-28
All Constituents				3.120E-02	2.830E-02	4.610E-03	1.010E-02	6.960E-02

Table 5 Maximum Allowable Concentrations for Surface Pathways

Chemical Name	Waste Stream Total Conc. (mg/kg)	Delisting Level: Limiting Maximum Allowable Total Conc. (mg/kg) for LF and TCLP Conc. (mg/L) for SI	Max Allowable Total Conc. Surface Water Ingestion Pathway (mg/kg)	Max Allowable Total Conc. Air Particulate Inhalation Pathway (mg/kg)	Max Allowable Total Conc. Fish Ingestion Pathway (mg/kg)	Max Allowable Total Conc. Soil Ingestion Pathway (mg/kg)	Max Allowable Total Conc. (mg/kg) for LF and TCLP Conc. (mg/L) for SI. Air Volatile Inhalation Pathway
Acrolein	1.000E+01	1.350E+04	6.160E+08	2.510E+06	1.030E+09	3.370E+07	1.350E+04
Benzene	1.000E+01	4.250E+05	4.360E+07	3.140E+07	2.220E+06	1.080E+07	4.250E+05
EPA 1,1,3	1.000E+01	1.350E+04	6.160E+08	2.510E+06	1.030E+09	3.370E+07	1.350E+04

Table 6 Maximum Allowable TCLP Concentration Groundwater Pathways

Chemical Name	Waste Stream TCLP Conc. (mg/L)	Limiting Maximum Allowable Receptor Conc. (mg/L)	Dilution Attenuation Factor (DAF)	Waste Volume Adjusted DAF	Delisting Level: Limiting Maximum Allowable TCLP Conc. (mg/L)	Max Allowable Receptor Conc. Groundwater Ingestion Pathway (mg/L)	Max Allowable Receptor Conc. Groundwater Inhalation Pathway (mg/L)	Max Allowable Receptor Conc. Groundwater Dermal Absorption Pathway-Adult (mg/L)	Max Allowable Receptor Conc. Groundwater Dermal Absorption Pathway-Child (mg/L)	Max Allowable Receptor Conc. MCL (mg/L)
Acrolein	1.000E+01	3.600E-04	---	---	4.990E+28	1.880E-02	3.600E-04	3.670E+00	1.680E+00	---
Benzene	1.000E+01	1.330E-03	1.540E+01	2.140E+03	2.840E+00	1.330E-03	1.380E-03	1.150E-02	2.650E-02	5.000E-03
EPA 1,1,3	1.000E+01	4.890E-04	---	---	6.780E+28	1.880E-02	4.890E-04	3.670E+00	1.680E+00	---

Table 7 Aggregate Risk and Hazard Quotient Results

Chemical Name	Chemical CAS number	Aggregate Hazard Index Groundwater Pathways	Aggregate Hazard Index Surface Pathways	Total Aggregate Hazard Index	Aggregate Cancer Risk Groundwater Pathways	Aggregate Cancer Risk Surface Pathways	Total Aggregate Cancer Risk
Acrolein	107-02-8	2.040E-28	7.450E-04	7.450E-04	---	---	---
Benzene	71-43-2	6.960E-02	2.890E-07	6.960E-02	7.320E-06	2.950E-11	7.320E-06
EPA 1,1,3	999-99-3	1.510E-28	7.450E-04	7.450E-04	---	---	---
Sum-Detected COCs Only		6.960E-02	7.460E-04	7.030E-02	7.320E-06	2.950E-11	7.320E-06
Sum-with Non-Detected COCs		6.960E-02	1.490E-03	7.110E-02	7.320E-06	2.950E-11	7.320E-06

Table 8 Limiting Pathways

Chemical Name	Chemical CAS number	GW Path Limiting TCLP Conc. (mg/L)	Limiting GW Pathway	Surface Path Limiting Conc. (mg/kg Total for LF, mg/L TCLP for SI)	Limiting Surface Pathway
Acrolein	107-02-8	4.990E+28	GW Inhalation	1.350E+04	Air Volatile Inhalation
Benzene	71-43-2	2.840E+00	GW Ingestion	4.250E+05	Air Volatile Inhalation
EPA 1,1,3	999-99-3	6.780E+28	GW Inhalation	1.350E+04	Air Volatile Inhalation

Table 9 Pathways Exceeding the Delisting Limits

Chemical Name	Chemical CAS number	Waste Stream TCLP Conc. (mg/L)	GW Path Limiting TCLP Conc. (mg/L)	Limiting GW Pathway	Surface Path Waste Conc. (mg/kg Total for LF, mg/L TCLP for SI)	Surface Path Limiting Conc. (mg/kg Total for LF, mg/L TCLP for SI)	Limiting Surface Pathway
Acrolein	107-02-8	1.000E+01	---	--	1.000E+01	---	--
Benzene	71-43-2	1.000E+01	2.840E+00	GW Ingestion	1.000E+01	---	--
EPA 1,1,3	999-99-3	1.000E+01	---	--	1.000E+01	---	--

Table 10 Toxicity Characteristic Soil Saturation and Ecological Values

Chemical Name	Chemical CAS number	Allowable Toxicity Characteristic Conc. (mg/L)	Waste Stream TCLP Conc. (mg/L)	Allowable Soil Saturation Conc. (mg/kg)	Surface Path Waste Conc. (mg/kg Total for LF, mg/L TCLP for SI)	Allowable Aquatic Conc. (mg/L)	Predicted Ambient Conc. (mg/L)
Acrolein	107-02-8	---	1.000E+01	4.800E+04	1.000E+01	2.100E-03	3.140E-08
Benzene	71-43-2	5.000E-01	1.000E+01	9.000E+02	1.000E+01	4.600E-02	3.140E-08
EPA 1,1,3	999-99-3	---	1.000E+01	4.800E+04	1.000E+01	2.100E-03	3.140E-08

Site COCs - Part I

Chemical name	TCLP Concentration (mg/L)	Is TCLP Conc. a Detection Limit (COC is ND)?	Total Concentration (mg/kg)	Is Total Conc. a Detection Limit (COC is ND)?	Property Details	Default COC Version ID	Version Description	Created Date	Creator
Acrolein	10.0	No	10.0	No	0	0			
Benzene	10.0	No	10.0	No	0	0			
EPA 1,1,3	10.0	Yes	10.0	Yes	cus_3	3	Imported from C:/Projects/EPA_Projects/Region_5/DRAS_4.0/Custom_COC	2020-07-30 22:51:08	dguvanasen

Site COCs - Part II

Chemical name	Maximum Contaminant Level (MCL) (mg/L)	Oral cancer slope factor 1/ (mg/kg day)	Inhalation cancer slope factor 1/ (mg/kg day)	Oral reference dose (mg/kg day)	Inhalation reference dose (mg/kg day)	Bioconcentration factor (L/kg)	Soil saturation level (unitless)	Toxicity Characteristic Rule regulatory level (mg/L)
Acrolein	0.0	0.0	0.0	0.0005	2e-05	0.58	48000.0	0.0
Benzene	0.005	0.055	0.02808	0.004	0.03	24.48	900.0	0.5
EPA 1,1,3	0.0	0.0	0.0	0.0005	2e-05	0.58	48000.0	0.0

Site COCs - Part III

Chemical name	Henry's law constant (atm-m^3/mol)	Diffusion coefficient in water (cm^2/s)	Diffusion coefficient in air (cm^2/s)	Solubility in water (mg/L water)	Landfill dilution-attenuation factor (unitless)	Surface impoundment dilution-attenuation factor (unitless)	Time to skin permeability (hr/event)	Skin permeability constant (cm/hr)
Acrolein	0.00014	1.22e-05	0.11	213000.0	1e+30	1e+30	0.46	0.00085
Benzene	0.0059	9.8e-06	0.088	1750.0	15.4	3.18	0.63	0.021
EPA 1,1,3	9.34e-05	1.22e-05	0.11	213000.0	1e+30	1e+30	0.46	0.00085

Site COCs - Part IV

Chemical name	Lag time (hr)	Bunge constant (unitless)	Flag 1= organic 0= metal/inorganic	Bioaccumuation factor (L/kg)	Chronic ecological value (mg/L)	Flag (Carcinogen/ Noncarcinogen)	Molecular weight (g/mol)	Vapor pressure (atm)	Suspended sediment-surface water partitioning coefficient (mL/g)	Logarithmic value of octanol/water partitioning coefficient (log (mL/g))	Chemical Class	Analytical Method
Acrolein	0.19	9.8e-05	1	0.0	0.0021	Noncarcinogen	56.1	0.35	0.0882	-0.01	VOC	8260D, 8015C
Benzene	0.26	0.013	1	0.0	0.046	Carcinogen	78.1	0.125	4.65	2.13	VOC	8260D, 8015C, 8021B
EPA 1,1,3	0.19	9.8e-05	1	0.0	0.0021	Noncarcinogen	56.1	0.35	0.0882	-0.01	VOC	8260D 8015C