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EPA

User's Guide for the Industrial Waste Management Evaluation Model (IWEM): Tier 1 Look-up Tables and Tier 2 Neural Networks for Ground-water Model

DRAFT

DISCLAIMER

This model is in draft form and is not intended to be used in current waste management decision-making. All aspects of the model are undergoing peer review and public comment including:

1) the appropriateness of the Tier 2 model for a location adjusted analysis;
2) input values for sensitive parameters and liner scenarios; and
3) capabilities and user-friendliness of the model software.

We strongly encourage users to review the "Assessing Risk" section of Chapter 7 ("Protecting Ground Water") in the ***Guidance*** for a description of the model and discussion of key parameters and some critical issues that affect modeling results.

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User's Guide for the Industrial Waste Management Evaluation Model (IWEM): Tier 1 Look-up Tables and Tier 2 Neural Networks

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1.0 INTRODUCTION

The EPA has developed the ***Guide for Industrial Waste Management*** to facilitate evaluation of waste management units (WMU) that handle industrial solid waste. This voluntary guidance is designed to provide: 1) a compendium of information about developing a sound waste management system (including siting, facility design, operation, monitoring, and closure), and 2) tools to help you tailor management practices to a specific facility. The software described in this *Users' Guide*, called the Industrial Waste Management Evaluation Model (IWEM), is one such tool that was developed to support the guidance. The ***Guide for Industrial Waste Management*** is being distributed by the EPA on CD and in hard copy. The IWEM software is included on the CD and is also available on 3.5" floppy disks.

The IWEM software assists you in determining the most appropriate WMU design by evaluating one or more types of liners, the hydrogeologic conditions of the site, and the toxicity and expected leachate concentrations of the anticipated waste constituents. That is, this software helps you compare the ground-water protection afforded by various liner systems with the anticipated waste leachate concentrations, so that you can determine what the minimum recommended liner system is that will be protective of human health and groundwater resources (or in the case of land application units, determine whether or not land application is recommended). **However, users should note that this software and guidance is in draft form and is not intended to be used in current waste management decision-making.**

The anticipated users of the IWEM computer program are managers of proposed or existing units, state regulators, interested private citizens, and community groups. For example:

- **Managers of a proposed unit** could use the software to determine what type of liner would be appropriate for the particular type of waste that is expected at the WMU and the particular hydrogeologic characteristics of the site.

- **Managers of an existing unit** could use the software to determine whether or not to accept a particular waste at that WMU by evaluating the performance of the existing liner design.

- **State regulators** may wish to use the software in developing permit conditions for a WMU.

- **Interested members of the public or community groups** may wish to use the software to evaluate a particular WMU and participate during the permitting process.

The guidance for the groundwater pathway uses a tiered approach that is based on modeling the fate and transport of waste constituents through subsurface soils to a ground-water monitoring well to produce a liner recommendation (or a recommendation concerning land application) that protects human health and the environment. The successive tiers in the analysis incorporate more site-specific data to tailor protective management practices to the particular circumstances at the modeled site:

- **Tier 1:** a conservative analysis based upon national distributions of data
- **Tier 2:** a location-adjusted analysis using a limited set of the most sensitive waste and site-specific data
- **Tier 3:** a comprehensive and detailed site assessment

The IWEM software is designed to support the Tier 1 and Tier 2 analyses. The unique aspect of the IWEM software is that it allows the user to perform Tier 1 and Tier 2 analyses with minimal data requirements and instantaneously obtain liner recommendations. Users interested in a Tier 3 analysis are directed to the ***Guide for Industrial Waste Management*** (***Guidance***) (U. S. EPA, 1999a) for information regarding the selection of an appropriate ground-water fate and transport model to use in Tier 3.

1.1 Objectives

The objective of this *Users' Guide* is to provide the information necessary to perform Tier 1 and Tier 2 analyses for four types of WMUs using the IWEM software:

- **Landfill**
- **Waste Pile**
- **Surface Impoundment**
- **Land Application Unit** (which is also called a Land Treatment Unit)

This *Users' Guide* is organized as follows:

- Section 1 (this section) provides an introduction to the ***Guidance*** and the IWEM software.
- Section 2 summarizes the computer system requirement for the IWEM software.
- Section 3 provides instructions for installing the IWEM software.
- Section 4 presents background information necessary to understand the how the Tier 1 and Tier 2 recommendations are developed and also describes the Tier 1 and Tier 2 evaluations, including model input and output.

- Section 5 provides detailed instructions on how to run the IWEM software, guiding you step-by-step through a Tier 1 and a Tier 2 evaluation.
- Section 6 provides troubleshooting information for some commonly encountered problems.
- Section 7 provides some additional supporting information about using the IWEM software in the context of EPA's guidance.
- Section 8 lists all references cited.
- Appendix A presents the list of waste constituents and the default values for the constituent-specific inputs (decay coefficient and K_{oc}).
- Appendix B presents the Tier 1 and Tier 2 reports for the example evaluations presented in this document.

If you have a copy of the CD, you can open and read this *Users' Guide* on-screen while the IWEM software is running on your computer, however, we think you will find it easier to print out a copy of the *Users' Guide* and refer to this hard copy while you are learning to use the IWEM software.

1.2 Brief Overview of the Software

The IWEM software was developed on a Microsoft Windows™-based platform that can be run in Windows 3.x, Windows 95, or Windows NT and includes tools for the Tier 1 and Tier 2 evaluations.

For both evaluations, you are required to input waste-specific information consisting of the waste constituents of concern and the corresponding expected leachate concentration for each. These concentrations are to be determined by the Toxicity Characteristic Leaching Procedure (TCLP) or another appropriate analytical method (see the **Characterizing Waste Chapter** of the ***Guidance*** for further discussion). The Tier 1 user can choose from a list of 174 organic waste constituents and 16 metal species to evaluate the specific waste constituents that are associated with a given industrial waste. The list of constituents is provided in Appendix A. The Tier 2 user can perform an evaluation for any of the waste constituents that are included in Tier 1, but the Tier 2 user also has the option to include in the evaluation a waste constituent which is not on this list, if sufficient chemical-specific data are available (see Section 5.4.1.5).

The guidance concerning the ground-water pathway is based on calculation of the maximum allowable leachate concentrations that are considered to be protective of ground water down gradient of the WMU (i.e. beneath the WMU in the direction of ground-water flow). This maximum allowable leachate concentration is called the leachate concentration threshold value (LCTV). The LCTV for a given waste constituent is based on: 1) the effect of transport processes on its concentration in ground-water, and 2) the toxicity of the waste constituent.

The IWEM software Tier 1 evaluation (also known as the National Evaluation) allows you to construct an LCTV table that is specific to a particular waste. This LCTV table identifies for each waste constituent the maximum allowable leachate concentration for a given type of WMU with a specific liner-type and the liner recommendation can then be viewed on the computer screen and printed out in hard-copy. The assumptions that were used to develop the Tier 1 LCTVs are described in detail in the ***Technical Background Document for the Development of a Two-Tiered Approach for Evaluating WMU Liner Designs (Technical Background Document)*** (US EPA, 1999b). The Tier 1 LCTVs were developed for the following types of WMUs and liner designs:

Table 1.1 Tier 1 LCTVs

	Liner Type		
WMU Type	**No Liner (in-situ soil)**	**Single Clay Liner**	**Composite Liner**
Landfill	✔	✔	✔
Surface Impoundment	✔	✔	✔
Waste Pile	✔	✔	✔
Land Application Unit	✔	N/A	N/A

Only the no-liner scenario is evaluated for Land Application Units because liners are not typically used at this type of facility.

For a Tier 1 analysis, the IWEM software compares the expected leachate concentration for each waste constituent with the thresholds (LCTVs) calculated by a groundwater fate and transport model (using nation-wide data) for three standard liner types. The IWEM software compiles the results for all constituents expected in the leachate and then reports the minimum liner scenario that is protective for all constituents.

For Tier 2, you enter the expected leachate concentrations, as well as important WMU-specific characteristics such as:

- Area of the WMU,
- Depth to groundwater, and
- Aquifer thickness.

For a Tier 2 analysis, you can evaluate the adequacy of the in-situ soil and single liners simply by entering the geographic location of the WMU. In this case, the IWEM software reports the minimum liner scenario that is protective for all constituents. If you wish to evaluate a different liner configuration, enter the measured or calculated infiltration rate for that liner, and the IWEM software provides a recommendation on the adequacy of the given liner design.

This Tier 2 methodology allows you to consider site-specific factors to produce a "location-adjusted" LCTV, which generally has less uncertainty associated with it than the Tier 1 LCTV. This reduction in uncertainty is based on the fact that the Tier 2 LCTVs take into account WMU-specific values for a number of sensitive model inputs, whereas Tier 1 LCTVs are based on national data. In addition to allowing you to tailor management practices to a particular waste and environmental setting, the IWEM software also provides a quick and user-friendly way to perform these evaluations without requiring that you have any prior experience with groundwater modeling.

The IWEM software supports file saving and retrieval so that evaluations can be archived or retrieved later and modified. The software also has report generation capabilities to document in hard-copy the input values and resulting liner recommendations.

1.3 Limitations of Ground-Water Modeling

The tiered approach developed to evaluate WMU designs uses the latest available peer-reviewed ground-water modeling methodology incorporating sophisticated probabilistic techniques to account for the uncertainty. However, given the complex nature of the evaluations, a number of limitations and caveats must be delineated. These limitations are described in this section.

To perform the evaluations recommended by the ***Guidance***, mathematical models are used that are based on a number of simplifying assumptions to represent conditions that may potentially be encountered at waste management sites within the U.S. Efforts have been made to obtain representative nationwide data and account for the uncertainty in the data. However, as with all modeling evaluations, these simplifying assumptions potentially might not apply or may be inappropriate for evaluating a specific WMU design at a specific site with a unique combination of conditions that might not be accounted for with the available data. Therefore, where appropriate in Tier 1 and Tier 2, EPA used ranges of parameter values that result in a high estimate of risk to ensure the protection of ground water.

The ground-water modeling that forms the basis of this guidance was conducted using EPA's Composite Model for Leachate Migration with Transformation Products (EPACMTP). This model has modules that compute water flow and contaminant transport in the vadose and saturated zone. The model also can be run in a Monte Carlo mode for assessing the effect of uncertainty and variability in model input parameters on predicted contaminant concentrations in

a down-gradient ground-water well.

The EPACMTP code is capable of simulating the fate and transport of dissolved constituents from the point of release at the base of a WMU, through the unsaturated zone and underlying ground water, to a down-gradient monitoring well. The model accounts for the major mechanisms affecting contaminant migration including: transport by advection and dispersion, retardation due to reversible linear or non-linear equilibrium adsorption onto the soil and aquifer materials, and bio-chemical degradation processes.

As is true of any model, EPACMTP is based on a number of simplifying assumptions which make the model easier to use and ensure the computational efficiency of the model. These assumptions may make the use of the model inappropriate in certain circumstances. Therefore, before using this software, verify that the following assumptions are appropriate for the site you are evaluating in the IWEM software (See Section 3.3.1 of the ***Technical Background Document*** and U.S. EPA, 1999b for more information.):

1) The soil and aquifer are uniform porous media. The model does not account for the presence of preferential pathways such as fractures and macro-pores.

2) Flow in the unsaturated zone is in the vertical direction, whereas flow in the saturated zone is dominated by regional flow in the horizontal direction. The flow rates cannot vary over time, as might occur in reality if an engineered liner were to fail. The aquifer is unconfined, has a constant thickness, and has an impermeable lower boundary.

3) Contaminant transport is due to advection and dispersion and that the sub-surface is initially contaminant-free. The EPACMTP model can simulate both steady-state and transient contaminant transport, including the effects of linear and non-linear adsorption.

4) The dissolved phase is the only mobile phase and does not account for the presence of a non-aqueous phase liquid (NAPL). The model does not account for volatilization in the unsaturated zone or gas phase contaminant transport.

5) The EPACMTP model accounts for attenuation processes, including dilution, dispersion, adsorption, chemical hydrolysis, and biodegradation. Chemical and biological transformation processes are evaluated using a first-order decay coefficient. For the simulation of metals, EPACMTP utilizes one of two types of sorption isotherms -- generally, isotherms for metals which behave as cations in ground water were generated by the MINTEQA2 geochemical model and isotherms for metals which behave as anions are pH-dependent. For more information about EPACMTP modeling of the transport of metals, see U.S. EPA (1996c).

1.4 Application of Results to the Tiered Evaluation

The tiered approach described in this document is designed to be used as guidance for the selection of an appropriate WMU design or selection of a site for land application. Given the number of input parameters involved and the uncertainty of hydrogeologic characteristics of a specific site, you, the IWEM software user, and decision makers who are evaluating the results of a tiered analysis need to ensure that there is sufficiently documented and verifiable justification of site parameter values and any potential uncertainty or data gaps that may exist. This justification is especially necessary with respect to highly sensitive modeling parameters such as infiltration rate, WMU area, sorption and hydrolysis rates, and the distance to the monitoring well. Additional information about the uncertainty involved in the modeling and tiered approach is provided in the ***Technical Background Document*** (US EPA, 1999b).

The tiered approach presented in this document was developed by EPA in consultation with state regulatory agencies, representatives from industries, and other stakeholders. EPA has provided this guidance as a tool for states' regulatory agencies, who will have final authority on decisions regarding appropriateness of WMU designs.

2.0 SYSTEM REQUIREMENTS

This section summarizes the minimum and recommended installation and operating requirements.

2.1 Minimum Installation Requirements

The minimum system requirements for installing and running this software are as follows:

- PC: 486 CPU
- Operating System: Microsoft Windows™ 3.x
- System Memory: 16 Mb RAM
- Disk Storage Space: 6 Mb hard-disk space
- Other: CD-ROM

If you use this software in conjunction with the Win 3.x operating system, you may run into occasional problems (unexplained crashes, etc.) which we haven't been able to isolate and solve during our software testing. If you plan to use this software with the Win 3.x operating system, we recommend that you contact us for a specially compiled version which we believe will perform better with Win 3.1 than the standard version of software.

2.2 Recommended Installation Requirements

The recommended system requirements for installing and running this software are as follows:

- PC: Pentium 133 MHZ
- Operating System: Microsoft Windows™ 95
- System Memory: 32 Mb RAM
- Disk Storage Space: 6 Mb hard-disk space
- Other: CD-ROM

2.3 Installation on a LAN or Other Network

If you are installing this software on a PC that is connected to a Local Area Network (LAN), you should consult your LAN Administrator regarding requirements for installing software on a networked PC. See also Section 6.1.

3.0 IWEM SOFTWARE INSTALLATION

Prior to using the IWEM software for the first time, the program must be installed on your hard-drive from the CD entitled, ***Guide for Industrial Waste Management***. To install the program, click on the "Install Ground-water Tool" icon from the main menu of the IWEM Software and perform the following steps:

- Click on the setup icon.
- On the Welcome Screen, click OK.
- Select the destination directory on the hard-drive where the IWEM ground-water tool is to be installed (recommended: C:\Program Files\IWEM).
- When the installation is complete, click on the OK Button to exit the installation process.

For Microsoft Windows™ 3.x users, the program can be started by double-clicking on the IWEM software group, and then double-clicking on the *IndWaste.exe* file.

If installed on the C-drive as recommended, Microsoft Windows™ 95 users can start the program by selecting "Programs" from the Start menu (on the Windows™ tool bar at the base of your screen). Then select the IWEM software group, and click on the *IndWaste* program.

For installation on a PC connected to a LAN or other network, see Section 6.1.

4.0 BASIS FOR THE LINER RECOMMENDATIONS

This section of the *Users' Guide* describes the technical basis on which the recommendations for WMU liner are based. In general, to determine the recommended liner design, your entered leachate concentrations are compared to maximum allowable leachate concentrations that are calculated by the software. These maximum leachate concentrations are called Leachate Concentration Threshold Values (LCTVs).

Section 4.1 provides a summary of the groundwater modeling performed to develop LCTVs for each WMU scenario. Section 4.2 describes two types of toxicity reference levels (TRLs) that are used to develop LCTVs for each waste constituent. Section 4.3 discusses other considerations used to develop LCTVs. Sections 4.4 and 4.5 summarize the technical basis, required inputs, and application of results for Tier 1 and Tier 2, respectively.

4.1 EPACMTP Modeling

The Tier 1 and Tier 2 evaluations are both based on results of EPA's Composite Model for Leachate Migration with Transformation Products (EPACMTP), a probabilistic ground-water fate and transport model. This type of modeling is called probabilistic because the value of many of the input parameters are represented as a probability distribution (rather than as a single value for each input). In this case, probabilistic modeling is used to reflect the range of variation that may be encountered at waste sites across the country and the uncertainty that may be associated with the values of these parameters.

For the ground-water pathway, waste constituents in leachate emanating from the base of a WMU travel through the subsurface soils to the groundwater table, and then travel with ground water to an eventual down-gradient well. The effect of this transport from the base of the WMU (leachate concentration)to the well (groundwater concentration) is a decrease in concentration which is caused by dilution and attenuation. The degree of dilution and attenuation is expressed in terms of a dilution-attenuation factor (DAF). For this guidance, the DAF is determined by performing ground-water modeling with the EPACMTP model. The value of the DAF for a given constituent depends on both the geochemical characteristics of the waste constituent being modeled and the hydrogeologic setting being considered. That is, the fate and transport of waste constituents in the subsurface is affected by both chemical-specific data and hydrogeological data.

More information about the EPACMTP modeling methodology used for this guidance can be found in the ***Technical Background Document*** (U.S. EPA, 1999b). Additional information about the EPACMTP model and the regional, site-based methodology are available in a number of technical background documents (U.S. EPA, 1997, 1996a, 1996b, and 1996c).

Once the DAF value has been determined via modeling, the LCTV for a waste constituent generally can be calculated as follows:

$$LCTV = DAF \times TRL$$

where:

LCTV =	Leachate Concentration Threshold Value
DAF =	Dilution/Attenuation Factor
TRL =	Toxicity Reference Level (*e.g. MCL or HBN*)

4.2 Toxicity Reference Levels (TRLs)

Two Toxicity Reference Level (TRLs) are included in the IWEM software — Maximum Contaminant Levels (MCLs) are available for some waste constituents, whereas Health-Based Numbers (HBNs) are available for all waste constituents. Each type of TRL is described briefly below.

4.2.1 Maximum Contaminant Level (MCL)

For a number of constituents, the EPA has set Maximum Contaminant Levels (MCLs) as part of the National Primary Drinking Water Regulations. The MCL is the maximum permissible level of a contaminant in water which is delivered to any user of a public water system. For each contaminant to be regulated, EPA first sets a Maximum Contaminant Level Goal (MCLG) at a level that protects against health risks. EPA then sets each contaminant's MCL as close to it's MCLG as is feasible, taking costs and available analytical and treatment technologies into consideration. For the IWEM software, the MCL values were obtained from ***Drinking Water Regulations and Health Advisories*** (U.S. EPA, 1996d).

4.2.2 Health-Based Number (HBN)

All constituents included in the IWEM software have a Health-Based Number (HBN), which in this case is the maximum exposure concentration of a contaminant in drinking water which will not cause adverse health effects. Only health effects and assumptions about exposure are considered in the determination of the HBN, in contrast to the MCL which includes consideration of additional factors, such as the cost of treatment. The HBNs used in the IWEM software were developed in support of the 1995 proposed Hazardous Waste Identification Rule (HWIR) (U.S. EPA, 1995a and 1995b). The calculation of the HBN includes the assumptions that an adult weighs 70 kg and drinks 2 L of water per day (U.S. EPA, 1995b). The target risk

used to calculate the HBN for carcinogens is 10^{-6} (unitless). The target hazard quotient used to calculate the HBN for non-carcinogens is 1.0 (unitless).

4.2.3 Selection of TRL within the IWEM Software

Within Tier 1, both types of TRLs (MCLs and HBNs) are used to calculate the Tier 1 LCTVs. When you view the results of a Tier 1 evaluation on-screen, the IWEM software first presents the LCTV values which were calculated using MCLs (for those constituents that have an MCL). The following tabs present the LCTV values which are based on HBNs. Depending upon the waste constituents being evaluated and the appropriate TRL for each, you may have to create for yourself a final list of LCTV values and minimum liner recommendations, some based on MCLs and some based on HBNs. You should obtain direction from your state regulatory authority regarding which TRL should be used for the Tier 1 evaluation of a particular waste.

Within Tier 2, you can select which type of TRL (either MCL or HBN) is used to calculate the LCTV for each waste constituent being evaluated. Additionally, you can calculate the LCTV with any TRL that you choose. For instance, your state regulatory authority may want you to use an HBN that is calculated using a different target risk level or a different assumption regarding the weight of an adult. In this case, within the Tier 2 input screen, you would choose the option for a user-specified TRL and type in the appropriate value. (More complete instructions regarding the selection of the TRL and entering a user-specified TRL is provided in Section 5.4.1.6 of this *Users' Guide*.) There is no need to create outside of the IWEM software a final list of Tier 2 LCTVs and liner recommendations (as may be required for Tier 1 evaluation). The list of LCTVs for the waste being evaluated in Tier 2 contains only one LCTV for each waste constituent, and the overall liner recommendation is based on the appropriate TRL for each waste constituent.

4.3 Limits on the Leachate Concentration Threshold Value (LCTV)

While the majority of Leachate Concentration Threshold Values (LCTVs) are based on TRL × DAF, other factors were considered in developing LCTVs for some waste constituents. These are described in this section.

4.3.1 Toxicity Characteristic Rule (TC Rule) Regulatory Levels

For any waste constituent covered by the TC rule, the LCTV is capped at the TC Rule Regulatory Level. This level, also called the TC Rule Exit Level, is the leachate concentration above which the waste is considered to be characteristic hazardous waste (U.S. EPA, 1990). TC levels have been determined for the constituents listed in Table 4.1:

Table 4.1 Toxicity Characteristic Regulatory Levels

Waste Constituent	Chronic Toxicity Reference Level (mg/L)	Leachate Regulatory Level (mg/L)
Arsenic	0.05	5
Barium	1	100
Benzene	0.005	0.5
Cadmium	0.01	1
Carbon Tetrachloride	0.005	0.5
Chlordane	0.0003	0.03
Chlorobenzene	1	100
Chloroform	0.06	6
Chromium	0.05	5
o-cresol	2	200
m-cresol	2	200
p-cresol	2	200
2,4-D	0.1	10
1,4-dichlorobenzene	0.075	7.5
1,2-dichloroethane	0.005	0.5
1,1-dichloroethylene	0.007	0.7
2,4-dinitrotoluene	0.0005	0.13
endrin	0.0002	0.02
heptachlor	0.00008	0.008
hexachlorobenze	0.0002	0.13
hexachloro-1,3-butadiene	0.005	0.5
hexachloroethane	0.03	3
lead	0.05	5
lindane	0.004	0.4
mercury	0.002	0.2
methoxychlor	0.1	10
methyl ethyl ketone	2	200
nitorbenzene	0.02	2
pentachlorophenol	1	100
pyridine	0.04	5
selenium	0.01	1
silver	0.05	5
tetrachloroethylene	0.007	0.7
toxaphene	0.005	0.5
trichloroethylene	0.005	0.5
2,4,5-trichlorophenol	4	400
2,4,6-trichlorophenol	0.02	2
2,4,5-TP acid (silvex)	0.01	1
vinyl chloride	0.002	0.2

4.3.2 1,000 mg/L Cap

EPA does not expect leachate concentrations from units covered by this guidance to exceed 1,000 mg/L for a single constituent and, therefore, has limited the expected waste constituent leachate concentrations to be less than or equal to 1,000 mg/L.

Consequently, all Tier 1 and Tier 2 LCTVs have been capped at a maximum value of 1,000 mg/L.

However, EPA invites comment on the use of the 1,000 mg/L cap and whether it accommodates all realistic waste management scenarios and other regulatory requirements.

4.3.3 Constituents with Toxic Daughter Products

For waste constituents with hydrolysis daughter products (chemicals that result from the breakdown of a constituent by hydrolysis) that are included in the list of waste constituents for this guidance, the LCTV of the parent constituent has been capped at the LCTV of the toxic daughter product. That is, if the LCTV of the parent constituent is lower than that of the daughter, the LCTV of the parent remains unchanged. However, if the LCTV of the parent constituent is higher than that of the daughter, the LCTV of the parent is changed to the LCTV of the daughter. Additionally, if the daughter constituent has an MCL but the parent constituent does not, the MCL of the daughter product was used in calculating the parent constituent LCTV. This methodology is designed to be protective of down-gradient ground water in terms of both the parent waste constituent and its toxic daughter constituent.

In Tier 1, this process of capping the LCTV of parent constituents at the LCTV of their respective daughters is transparent to the user. The capping of LCTVs is done automatically by the software, and the Tier 1 user does not need to know which constituents hydrolyze to produce toxic daughter constituents. When performing a Tier 1 analysis, enter the expected leachate concentrations of the waste constituents in the waste being evaluated (no daughter products), and the resulting LCTVs will take into account the production of toxic daughter products, if necessary.

In a Tier 2 analysis, if you add a constituent which hydrolyzes to produce a toxic daughter constituent, you will see the daughter product automatically added in the bottom section of the chemical properties tab. The concentration of the daughter product is controlled by that of the parent constituent and cannot be edited. The K_{OC} and first-order decay coefficient of both the parent and daughter can be edited, if site-specific data are available. The LCTVs of all waste constituents and any toxic daughter constituents produced by hydrolysis are shown in the Tier 2 report.

4.4 National Evaluation (Tier 1)

For a given waste constituent, the degree of ground-water protection that a liner provides is characterized by the magnitude of the LCTV for that liner scenario. For instance, a single clay liner is (generally) more protective of groundwater than having no engineered liner at all. Looking at the Tier 1 LCTV tables confirms this -- for a given WMU and waste constituent, the

single-liner LCTV is always equal to or higher than the no-liner LCTV. The added protection of a single liner means that a waste with a higher leachate concentration can be safely disposed at the WMU with a single liner, whereas if the same waste was disposed at a WMU with no liner, the down gradient ground water might not be protected.

By comparing the estimated waste constituent leachate concentrations (based on results of the TCLP or another analytical procedure) to the calculated LCTVs in the appropriate Look-Up Table, you can determine which type of liner is recommended (or whether land application of this waste is appropriate) to protect ground water. For example, if the expected leachate concentrations for all constituents are lower than the corresponding no-liner LCTVs, then no liner is recommended as being sufficiently protective of ground water. If the expected leachate concentration for any constituent is higher than the corresponding no-liner LCTV, then a single clay liner is recommended. If any expected leachate concentration is higher than the corresponding single-liner LCTV, then a composite liner is recommended. For waste streams with multiple constituents, the most protective liner that is specified for any one constituent is the recommended liner design.

An electronic version of these look-up tables is included in this software as the National Evaluation (Tier 1), and a printed copy of the tables is included in ***Guidance*** (U.S. EPA, 1999a). The IWEM software allows you to enter the estimated leachate concentrations for waste constituents and compares the entered leachate concentrations to the corresponding LCTVs to produce a liner recommendation or determine whether land application is appropriate. The Tier 1 evaluation does not require site-specific data, and the resulting design recommendations are based solely on an evaluation of waste characteristics.

4.4.1 Tier 1 Required Input

For the National Evaluation (Tier 1) modeling, the modeling scenarios are the same for all constituents (see the ***Technical Background Document*** (U.S. EPA, 1999b) for detailed information on model input values), thus the waste constituent-specific parameters (K_{OC} and decay coefficient (λ) for organic constituents, and K_d for metals) determine the DAF for a given organic constituent for a given type of WMU and liner design. The waste constituent-specific parameters cannot be edited in Tier 1. Therefore, to conduct a Tier 1 evaluation, perform the following steps:

Tier 1 Analysis

1) Select WMU type
2) Select waste constituent(s)
3) Enter expected leachate concentration for each waste constituent

4.4.2 Tier 1 Output

The IWEM software queries a database containing the LCTV tables determined by EPACMTP modeling and retrieves the data for each selected constituent. These LCTV values are then compared to the entered leachate concentrations. The results are presented in a summary form that reports the minimum liner required for the input expected leachate concentrations (see Section 5.3.2.1 for a sample report). The first set of summary results are based on LCTVs which are calculated from MCLs. The second set of summary results are based on HBNs. Consult your state's regulatory agency for guidance on which toxicity reference level (TRL) should be used for each constituent of concern.

Following the summary results, a detailed presentation of results is shown in which the waste constituent-specific parameters (K_{OC} and decay coefficient for organics, K_d for metals), the expected leachate concentration, specified TRL (MCL, HBN, or user-specified level), and the resulting LCTVs are reported for each selected constituent. These detailed results allow you to understand how the LCTV values were calculated and how the liner design recommendations were developed.

The LCTV generally equals the DAF times the TRL, however, in certain cases the LCTV may be capped at a lower value. See Sections 4.3.1 to 4.3.3 of this *Users' Guide* for an explanation of these caps. In cases where the DAF is very large (DAF = 10^{30}), the reported LCTV is based upon that for the daughter chemical, the TC Rule limit, or a 1,000 mg/L cap.

Please note that the Tier 1 DAFs and LCTVs are presented in the "Assessing Risk" section of chapter 7 ("Protecting Ground Water") in the ***Guidance***.

4.4.3 Application of Tier 1 Results to the Design of a Waste Management Unit (WMU)

For the 190 waste constituents included in the database accompanying the IWEM software, all 190 constituents have an HBN value, and 51 of these constituents also have an MCL (see

Appendix A of this *Users' Guide* for a complete listing). To properly interpret the Tier 1 output, consult with the appropriate state regulatory agency to determine which TRL should be used for each constituent of concern. For wastes with multiple constituents of concern, you may need to construct a final list of liner recommendations, some from LCTVs based on MCLs and some from LCTVs based on HBNs.

If the expected leachate concentrations for all constituents are lower than the no-liner LCTVs, then no liner is recommended as being sufficiently protective of ground water. If any constituent is higher than the no-liner LCTV, then at least a single clay liner is recommended. If the expected leachate concentration for any constituent is higher than the single-liner LCTV, then at least a composite liner is recommended. For waste streams with multiple constituents, the most protective liner that is specified for any one constituent is the final Tier 1 recommended liner design.

4.5 Location-Adjusted Evaluation (Tier 2)

To assist you in risk-based decision making, the Location-Adjusted Evaluation (Tier 2) is also included in the IWEM software. If appropriate, you can proceed to the Location-Adjusted Evaluation (Tier 2) after performing a Tier 1 evaluation or begin directly with a Tier 2 evaluation. If the expected leachate concentration for any constituent is below the Tier 1 no-liner LCTV for that WMU type, then that constituent may not need to be examined in Tier 2. This is because the Tier 1 Evaluation is generally more conservative than Tier 2 (the conservative assumptions of Tier 1 are replaced with more realistic site-specific assumptions in Tier 2). However, since the incremental effort required to evaluate all constituents in Tier 2 that were examined in Tier 1 is minimal, the user is strongly encouraged to include all constituents in Tier 2 modeling that were examined for Tier 1.

The Tier 2 Evaluation uses a set of four artificial neural networks (one for each type of WMU), based on EPACMTP modeling results, which enables you to input certain site-specific data from a particular WMU. These values are then used to identify a recommended liner design for the given facility and waste or to determine whether land application at the given site is appropriate for the given waste.

Using a set of several thousand EPACMTP simulations, a neural network was trained for each type of WMU to estimate the DAFs that EPACMTP would have generated based on the values of the input parameters. You can vary input parameter values within the range of values in EPACMTP's nationwide distributions, and the neural network then quickly makes an accurate prediction of the results that an EPACMTP simulation would have generated. Thus, the Tier 2 evaluation provides an easy way to include a limited number of site-specific considerations without having to run EPACMTP or another ground-water fate and transport model. Additionally, the intuitive, windows-based user interface eliminates the need for you to have

training or extensive knowledge of artificial neural networks, the EPACMTP model, or statistics.

Similar to Tier 1, the expected waste leachate concentrations are compared to the Tier 2 LCTVs for the constituents of concern to determine the recommended liner system for the waste management unit or to determine whether land application of this waste is appropriate.

4.5.1 Tier 2 Input

To allow you to enter site-specific data on sorption and decay of modeled constituents, you can edit the organic carbon distribution coefficient (K_{OC}) and the first-order decay coefficient (chemical hydrolysis and/or observed bio-degradation) in Tier 2. For each constituent selected, default values are assigned for K_{OC} and the decay coefficient (U.S. EPA, 1993). The default decay coefficient represents degradation from chemical hydrolysis only, since biodegradation rates are often strongly influenced by site-specific factors. You should only increase the default decay coefficient if there is clear evidence of biodegradation occurring at a site and sufficient data to quantify biodegradation rates.

After selecting the waste constituents to be modeled, you can enter a value for each of the following site-specific parameters:

Tier 2 Required Input

1) Type of WMU
2) Expected leachate concentration for each waste constituent
3) Infiltration rate (or WMU location and soil type or impoundment characteristics for a surface impoundment)

Tier 2 Optional Input

1) Add a waste constituent (with known chemical properties) that is not currently on the list of constituents
2) First-order decay coefficient for each waste constituent (1/yr)
3) K_{OC} for each waste constituent (L/kg)
4) Toxicity reference level for each waste constituent (mg/L)
5) WMU area (m^2)
6) Depth to water table (depth to water) (m)
7) Aquifer thickness (m)
8) Radial distance to the down-gradient monitoring well (m)
9) Groundwater pH (only required if at least one waste constituent is a metal)

Note: If you don't have a site-specific value for any inputs, default values supplied by the IWEM software can be used.

The infiltration rate is defined as the rate (annual volume divided by WMU area) at which leachate flows from the bottom of the WMU (including any liner) into the unsaturated zone beneath the WMU. You can either specify the infiltration rate, or the program will estimate values for each of two general liner scenarios based on the WMU's geographic location (or impoundment characteristics for surface impoundments). However, you are not constrained to examine only these scenarios; given the resulting infiltration rate, any conceivable scenario can be evaluated (provided that the infiltration rate falls within the allowable range) by entering an infiltration rate directly. Specifically, if you wish to evaluate a composite liner and know the infiltration rate, the site-specific infiltration option may be selected.

The depth to the water table and aquifer thickness are parameters that may be known with relative certainty. However, if there is uncertainty or a known variation in these values, the model can be run three or more times to examine the sensitivity of this parameter on the results (e.g., once with the minimum value, once with the most probable value, usually a mean or median value, and once with the maximum value). Such a sensitivity analysis could then be the basis for deciding if it is important and cost-effective to gather more data, or whether the liner design evaluation should proceed using the most conservative value.

Consult with your state regulatory agency to determine the radial distance between the down-gradient edge of the WMU and the ground-water monitoring well that should be used for the Tier 2 analysis. Note that 150 m is used for the Tier 1 analysis. However, some states may wish to

adopt a different radial distance for use in Tier 2 based on regional hydrogeologic characteristics and land use patterns. Therefore, you should confirm the appropriate distance to use in Tier 2 with your state regulatory agency.

For Tier 2, the modeling scenario is designed to approximate the specific WMU being evaluated, and, therefore, the liner recommendation from a properly performed Tier 2 evaluation has less uncertainty associated with it than a Tier 1 evaluation of the same site. This reduction in uncertainty is achieved by including several types of site-specific data which are both easily measured and important to the model output. However, if site-specific data for any of the model inputs are not available, the suggested default values should be used.

For each type of WMU, there are two types of minimum and maximum values which are listed below in Tables 4.1 to 4.4. The allowable range of values for each input is listed in the tables below under the column header "Absolute Boundaries". However, there may be additional uncertainty in the model output associated with values near these extremes, therefore, the Tier 2 software will warn you when you have entered a value which is outside the range considered to be representative of most existing WMUs in the country. That is, for each input parameter, there is a relatively large range of allowable input values; but within this allowable range, there is a smaller range of input values for which we have a higher confidence in the model output.

The minimum and maximum values for the larger range of allowable inputs is listed in Tables 4.1 to Table 4.4 under the column header "Absolute Boundaries."

The minimum and maximum values for the smaller range of input values for which there is less uncertainty in the model output is listed in Tables 4.1 to Table 4.4 under the column header "Triggers Warning." This column header refers to the fact that if you enter a value which is between the minimum value listed under the "Triggers Warning" header and the minimum allowable value, a warning message appears on the screen to remind you about the increased uncertainty in modeling this scenario (which is outside the mainstream of sites for which this model was developed). Likewise, a similar warning message appears if you enter a value which is between the maximum value listed under the "Triggers Warning" header and the maximum allowable value. The values for the decay coefficient and K_{oc} do not trigger the warning message, even when the values are outside the 10^{th} to 90^{th} percentile range. These parameters are constituent-specific and are automatically input to the neural network. Other values for these parameters may be entered in the appropriate input screen, but no warning will be given if the values are outside the 10^{th} to 90^{th} percentile range, or outside the absolute boundary range.

> We invite users to provide comments to us on whether or not these ranges of values are sufficiently large to accommodate most existing and proposed WMUs.

Table 4.2 Ranges and Defaults for Inputs in a Tier 2 Landfill Evaluation

Landfill		IWEM Tier 2 Input				
		Triggers Warning		Absolute Boundaries		
Parameter	Units	Less than this value	Greater than this value	Less than this value	Greater than this value	Tier 2 Default
Area of WMU	m^2	980	1.5e+05	40	2.0e+06	1.90e+04
Infiltration rate	m/yr	0.024	0.45	1.0e-05	1.1	0.13
Depth to water table	m	2.0	31	0.3	610	5.3
Aquifer thickness	m	4.0	81	0.3	910	11
Radial distance to well	m	50	350	40	500	150
Decay coefficient	1/yr	0.0	0.5	0.0	1.0	N/A

Table 4.3 Ranges and Defaults for Inputs in a Tier 2 Surface Impoundment Evaluation

Surface Impoundment		IWEM Tier 2 Input				
		Triggers Warning		Absolute Boundaries		
Parameter	Units	Less than this value	Greater than this value	Less than this value	Greater than this value	Tier 2 Default
Area of WMU	m^2	110	4.0e+04	14	4.0e+06	2.70e+03
Infiltration rate	m/yr	0.084	0.50	0.007	1.9	0.16
Depth to water table	m	2.0	31	0.3	610	6.1
Aquifer thickness	m	4.0	84	0.3	910	11
Radial distance to well	m	50	350	40	500	150
Decay coefficient	1/yr	0.0	0.5	0.0	1.0	N/A
K_{OC}	L/kg	0.01	2.0e+04	0.0	5.0e+04	N/A

Table 4.4 Ranges and Defaults for Inputs in a Tier 2 Waste Pile Evaluation

Waste Pile		IWEM Tier 2 Input				
		Triggers Warning		Absolute Boundaries		
Parameter	Units	Less than this value	Greater than this value	Less than this value	Greater than this value	Tier 2 Default
Area of WMU	m^2	110	4.0e+04	7.0	1.4e+06	430
Infiltration rate	m/yr	0.13	0.50	0.0003	1.2	0.27
Depth to water table	m	2.0	31	0.3	610	6.5
Aquifer thickness	m	4.0	84	0.3	910	12
Radial distance to well	m	50	350	40	500	150
Decay coefficient	1/yr	0.0	0.5	0.0	1.0	N/A
K_{oc}	L/kg	0.01	2.0e+04	0.0	5.0e+04	N/A

Table 4.5 Ranges and Defaults for Inputs in a Tier 2 Land Application Unit Evaluation

Land Application Unit		IWEM Tier 2 Input				
		Triggers Warning		Absolute Boundaries		
Parameter	Units	Less than this value	Greater than this value	Less than this value	Greater than this value	Tier 2 Default
Area of WMU	m^2	2200	9.0e+05	20	8.0e+07	8.40e+04
Infiltration rate	m/yr	0.11	0.41	0.077	0.74	0.16
Depth to water table	m	2.0	34	0.3	610	7.0
Aquifer thickness	m	4.0	91	0.3	910	18
Radius	m	50	350	40	500	150
Decay coefficient	1/yr	0.0	0.5	0.0	1.0	N/A
K_{oc}	L/kg	0.01	2.0e+04	0.0	5.0e+04	N/A

4.5.2 Tier 2 Output

After appropriate input values have been chosen, the model is queried for each constituent of concern using the chosen waste constituent-specific and site-specific inputs. Any toxic daughter products produced by hydrolysis of the selected constituents are automatically added to the list, and the concentration of these daughter products is determined by the concentration of the parent constituents.

The form of results for the Tier 2 evaluation is determined by which option you chose to specify the infiltration rate (either a location-based estimate or a user-specified value). But whichever infiltration option you choose, the results are divided into two sets: summary results and detailed results. The first set of results is a results summary which reports liner recommendation for each constituent, and the overall liner recommendation based on all input expected leachate concentrations.

The second set of results, the detailed results, present all the data upon which the liner evaluation is based. This data includes the waste constituent-specific parameters (K_{OC} and decay coefficient), expected leachate concentration, DAF value, specified TRL, and the resulting LCTV value for each selected constituent. These detailed results allow you to understand how the LCTV values were calculated and how the liner design recommendations were developed.

If you choose to have the infiltration rate estimated automatically for the landfill, waste pile, or surface impoundment, your expected leachate concentrations are compared to the LCTVs calculated for in-situ soil and single clay liner. The final Tier 2 recommendation is the minimum liner design (of the two evaluated) which is protective of groundwater. If you choose to have the infiltration rate estimated automatically for the land application unit, your expected leachate concentrations are compared to the LCTVs calculated for the no-liner (in-situ soil) scenario. The final Tier 2 recommendation is whether or not land application of this waste will be protective of groundwater.

If you directly enter a value for infiltration (for any of the four types of WMUs), the entered leachate concentrations are compared to the LCTV calculated for this scenario. The results report whether the given scenario is recommended as being sufficiently protective of the ground water.

4.5.3 Application of Tier 2 Results to the Design of a WMU

To properly perform a Tier 2 evaluation, consult with the appropriate state regulatory authority about which TRL should be used for each constituent of concern in the waste being evaluated.

If you choose to have the infiltration rate estimated by the model based on the WMU location,

then the results are presented in terms of the standard types of liners: no liner (in-situ soil) and single clay liner. If the expected leachate concentrations for all constituents are lower than the no-liner LCTVs, then no liner is recommended as being sufficiently protective of ground water. If any constituent is higher than the no-liner LCTV, then at least a single clay liner is recommended. If the expected leachate concentration for any constituent is higher than the single-liner LCTV, then the scenario is determined to be not protective. For waste streams with multiple constituents, the most protective liner that is specified for any one constituent is the recommended liner design.

If you have a measured or calculated value for infiltration rate, that value can be entered directly as input for Tier 2. In this case, the expected leachate concentrations are compared to the LCTV calculated for this scenario. The modeling results are then presented which tell you whether the given scenario is recommended as being sufficiently protective of the ground water.

In instances where the scenario is not protective, you will be directed to consider pollution prevention, treatment, or a more protective liner design. See Part IV of the ***Guidance*** for further discussion.

5.0 RUNNING THE IWEM SOFTWARE

5.1 How do I start the IWEM software?

To use the program for the first time, you must install the software from the CD to the hard-drive (see Section 3.0).

After installation, Microsoft Windows™ 95 and NT users can launch the program by choosing "Programs" from the "Start" menu (at the lower left corner of the screen) and then choosing "IWEM" program group and the program "IndWaste". Alternately, you can create a create short-cut to the "IndWaste" program and move it to the desktop. In this case, the program can be launched by double-clicking on the "IndWaste" icon on the desktop.

Microsoft Windows™ 3.x users can launch the program by double-clicking on the "IWEM" program group from the Program Manager and then clicking on the program "IndWaste.exe."

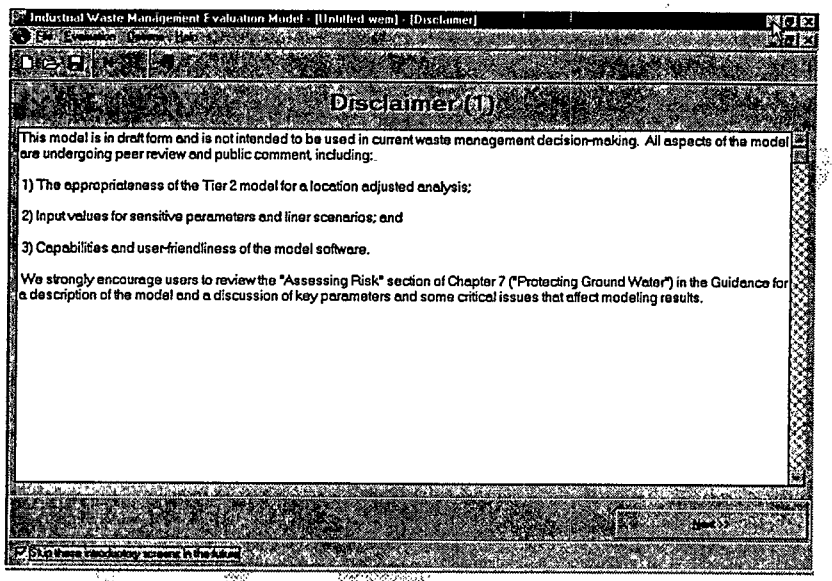
5.2 What are the features of the IWEM software?

The IWEM software has a user-friendly point-and-click interface which is designed to operate in accordance with Microsoft Windows™ conventions. The first screen that you see after launching the program is the Start-Up Screen which will appear only while the program is loading.

The first time the IWEM software is run, the Start-Up Screen will disappear after a few seconds and will be replaced by the main program window which will display the first of several Introductory Screens. After reading the text on each screen, click the "Next" button at the bottom right of the screen to proceed to the next screen. After reading this introductory information, you can click in the check-box at the bottom of the screen to prevent these screens from being displayed the next time the program is run. This introductory information can be viewed at any time by choosing ***Introduction*** from the ***Help*** menu.

Note the following features of the main program window:

- **Title Bar** at the top displays the software title and the name of the current file
- **Pull-Down Menus** allow you to perform common file operations
- **Tool Bar** also allows you to quickly perform common operations



From the pull-down menus in the main program window, you can select among the following menu items:

- ***File:*** perform general file operations such as open and save
- ***Evaluation:*** proceed directly to either the National Evaluation (Tier 1) or the Location-Adjusted Evaluation (Tier 2)
- ***Options:*** customize the appearance of the software, such as font size for the introductory screens and the window colors
- ***Help:*** display the introductory screens, definitions of key terms, contact information for technical support or the "About" dialog box (which gives general information about the software).

Using the toolbar is a quick way to perform common operations:

Clicking here begins a "New Evaluation".

Clicking here launches the "Open File" dialog box to select the previously saved evaluation file to be opened.

Clicking here launches the "Save File" dialog box to select the evaluation file to be saved.

Clicking here begins the National Evaluation (Tier 1).

Clicking here begins the Location-Adjusted Evaluation (Tier 2).

Clicking here exits you from the IWEM software.

If you forget the function of any of the toolbar buttons, you can display "Tool tips" (which identifies the button's function) for each button by placing the cursor on top of the button.

How do I navigate through the IWEM software?

The software is set up as a series of screens through which you can navigate to enter data and view results. Some screens consist of several tabs which all have a common function. For instance, the Tier 1 Data Input Screen consists of three tabs on which you enter your leachate data; the Tier 1 Summary Results Screen consists of two tabs (MCL and HBN) on which the analysis results are presented.

You can move through the program using three different methods:

- Clicking on one of the toolbar buttons or clicking on the ***Evaluation*** menu,
- Clicking on the "Next" or "Back" buttons at the bottom of the screen, or
- Clicking on one of the labeled tabs located at the top of the data entry and results screens.

How do I get help if I have a problem or a question?

If you have a copy of the CD, you can open and read this *Users' Guide* on-screen while the IWEM software is running on your computer, however, you will find it easier to print out a copy of the *Users' Guide* and refer to this hard copy while you are learning to use the IWEM software. Note that Section 5 of this Users' Guide contains screen-by-screen instructions on how to use the software.

A dialog box containing a definition can be displayed by clicking on any underlined text in the Data Requirements Screen (one of the introductory screens). These dialog boxes can also be displayed at any time by choosing ***Definition Window*** from the ***Help*** menu.

Win 3.x users and anyone with a technical question about installing or running the software should contact:

Virginia Colten-Bradley (US EPA Office of Solid Waste, EMRAD)

phone: 703-308-8613

fax: 703-308-0509

email: COLTEN-BRADLEY.VIRGINIA@EPAMAIL.EPA.GOV

How do I begin a Tier 1 or a Tier 2 evaluation?

Following the Introductory Screens, you are asked to choose which type of evaluation to perform: either the National (Tier 1) Evaluation or the Location-Adjusted (Tier 2) Evaluation. Generally, you should perform the National Evaluation first and then proceed on to the Location-Adjusted Evaluation, if appropriate.

You can choose to begin an evaluation with any of the following methods:

- Click on the ***Evaluation*** menu,
- Click on one of the toolbar buttons, or
- Click on "National Evaluation" button or "Location-Adjusted Evaluation" button at the bottom of the last introductory screen.

5.3 National Evaluation (Tier 1)

The Input Screen for Tier 1 consists of three tabs:

- WMU Type
- Waste Chemical List
- Leachate Concentration

The Summary Results Screen for Tier 1 consists of two tabs:

- MCL Summary
- HBN Summary

The Detailed Results Screen for Tier 1 consists of six tabs:

- MCL Results for No Liner
- MCL Results for Single Liner
- MCL Results for Composite Liner
- HBN Results for No Liner
- HBN Results for Single Liner
- HBN Results for Composite Liner

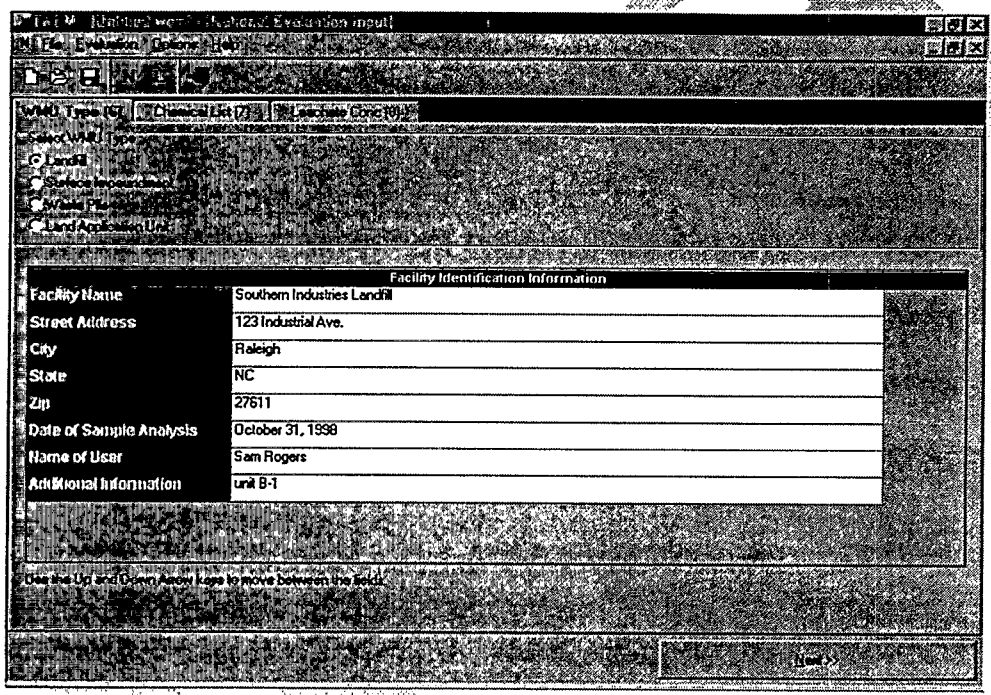
The overall Tier 1 result is then displayed on the National Evaluation Summary Screen.

The available options and data displayed on each of these tabs is explained in the following sections.

5.3.1 Tier 1 Input Screen

5.3.1.1 Tab 1: Waste Management Unit Type

User Input: Select WMU Type
Enter Facility Identification Information



In the WMU Type tab of the Tier 1 Data Input Screen, first select one of the following types of WMU's (selection can be made by clicking on the appropriate option button):

- Landfill
- Surface Impoundment
- Waste Pile
- Land Application Unit

Then, in the text boxes located in the lower half of the screen, enter the following information about the WMU being evaluated:

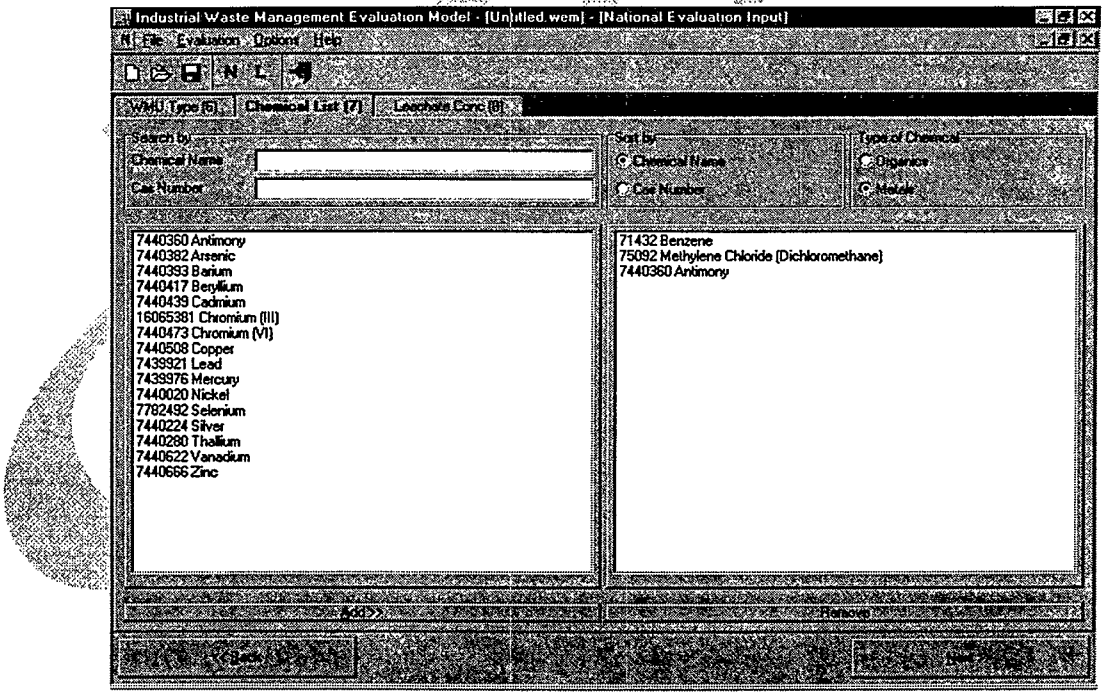
- Facility Name
- Address of the WMU (street, city, state, zip)
- Date of waste constituent analysis
- Your name (name of the person performing the liner evaluation)
- Any additional identifying information that you would like to include

Please note that these text fields cannot contain quotation marks (") or apostrophes ('). All information entered in these text boxes will be included on the printed Tier 1 and Tier 2 Evaluation Reports.

5.3.1.2 Tab 2: Chemical List

User Input: Select constituents expected in leachate using the following options:

- Search by Constituent Name or CAS Number
- Sort by Constituent Name or CAS Number
- Type of Constituent (Display Organics or Metals)



What waste constituents can I enter in IWEM software?

In the Chemical List tab, you will find a list of waste constituents. The list of constituents includes 174 organics and 16 metal species. These waste constituents and the default values for the waste constituent-specific properties are presented in Appendix A.

How do I find and select a waste constituent?

You can display either the list of organic constituents or the list of metals by clicking one of the options within the frame titled "Type of Chemical." Although only one type of constituent is displayed in the list at the same time, you can have both organics and metals in the expected leachate from the modeled waste.

Each constituent appears with its common name and Chemical Abstract Service Registry Number (CAS #) in the list in the lower left of the screen. You can determine whether the constituents are sorted by name or by CAS # by clicking one of the options within the frame titled "Sort by."

You can move through the displayed list to select a particular constituent by using one of these methods:

To move through the list of waste constituents:

1) Use the scroll bar at the right of the displayed list

2) Use the arrow keys on the keyboard (once one constituent in the list is selected)

3) Type in the constituent name or CAS # in the appropriate text box within the frame titled "Search by"

When using the "Search by" option, as soon as you have typed in enough information to identify one of the listed constituents, that waste constituent will be highlighted in the list. You can then use the arrow keys on the keyboard to move up or down in the list if the highlighted constituent is not exactly the one you intended to select.

Once the appropriate constituent is highlighted in the list (on the left of the screen), you can click the "Add" button at the bottom of the screen to transfer it to your list of constituents expected in the leachate (on the right side of the screen). Similarly, you can click the "Remove" button to delete a highlighted constituent from the your list of selected constituents. A waste constituent

can also be added quickly to your list by double-clicking on it in the list on the left.

How do I select more than one waste constituent at a time?

The following keyboard functions simplify the selection of more than one waste constituent:

- To add a number of constituents that are listed sequentially in the list (that is, one after another without any non-selected constituents in the middle), click on the first waste constituent, press down the "Shift" key, and then click on the last waste constituent. All waste constituents listed between the first and last chosen constituents should now be highlighted.

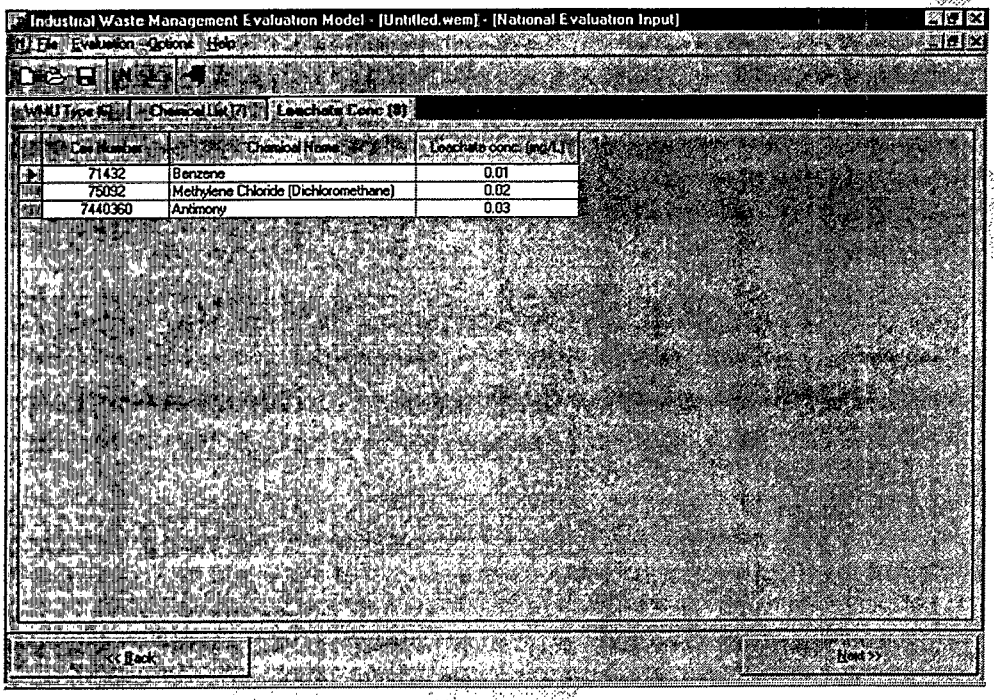
- To add a number of constituents that not are listed sequentially in the list, click on the first waste constituent, and then hold down the "Control" (Ctrl) key while selecting additional constituents using the mouse.

Once your selection is complete, use the "Add" button at the bottom of the screen to transfer all the highlighted constituents to your list.

Once your list of waste constituents is complete, you can proceed with the Tier 1 evaluation by clicking on either the tab titled "Leachate Concentration" or click the "Next" button at the bottom of the screen.

5.3.1.3 Tab 3: Leachate Concentration

User Input: Enter the expected leachate concentration for each selected waste constituent



The National Evaluation (Tier 1) cannot be performed until an expected leachate concentration is entered for each selected waste constituents.

How do I determine what my expected leachate concentrations are?

Please see the chapter on Waste Characterization in the ***Guidance*** for information on analytical procedures that can be used to determine expected leachate concentrations for waste constituents.

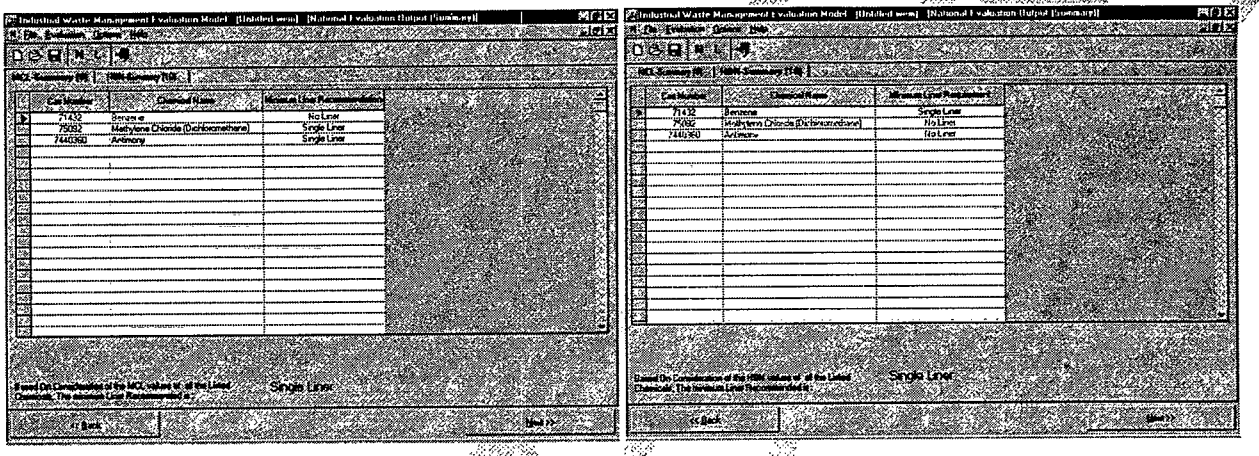
How do I enter my expected leachate concentrations?

This table is similar to a spreadsheet. Using the mouse, click on the first empty cell in the column titled "Leachate Concentration," and type in your expected leachate concentration. Then click on the cell below to enter the next concentration. Repeat this process until you have entered expected leachate concentrations for all waste constituents.

How do I perform the Tier 1 evaluation?

Simply click on the Next button at the bottom right of the screen to perform the Tier 1 evaluation and view your results.

5.3.2 Tier 1 Summary Results Screen



Why are there two tabs in the Summary Results Screen?

The results of the National Evaluation (Tier 1) are first presented on-screen in summary form. The summary results are divided into two tabs, based on which toxicity reference level (TRL) is used to calculate the leachate concentration threshold value (LCTV) -- one for LCTVs based on Maximum Contaminant Levels (MCLs), and one for LCTVs based on Health-Based Numbers (HBNs).

Are results for all my waste constituents on both tabs?

Please note that not all waste constituents have both an MCL and an HBN, therefore, results for all constituents may not be on both tabs. The MCL summary tab provides a minimum liner recommendation for each of the selected constituents that have an MCL. Likewise, the HBN tab presents a minimum liner recommendation for each of the selected constituents that have an HBN. These recommendations are based on a comparison of the expected leachate concentration for that constituent to the calculated LCTV using the waste constituent-specific MCL or HBN. The bottom of the tab displays an overall minimum liner recommendation which is based on consideration of all waste constituents that are included on that tab.

How do I use these two sets of LCTVs?

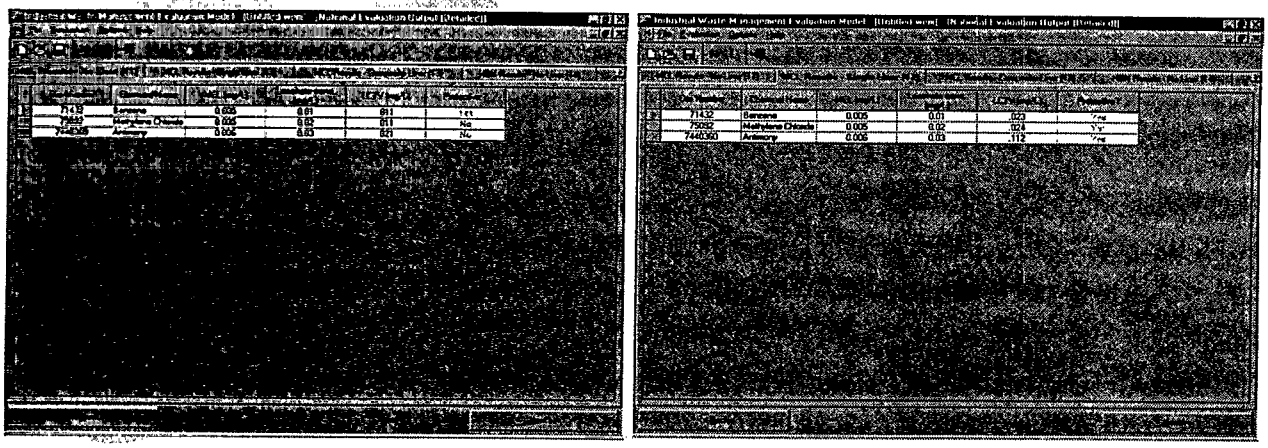
Please note that the overall liner recommendation may depend upon whether HBNs or MCLs are being used. Depending upon the waste constituents being evaluated and the appropriate TRL for each, you may have to create for yourself a final list of LCTV values and minimum liner recommendations, some based on MCLs and some based on HBNs. You should obtain direction from your state regulatory authority regarding which TRL should be used for the Tier 1 evaluation of a particular waste.

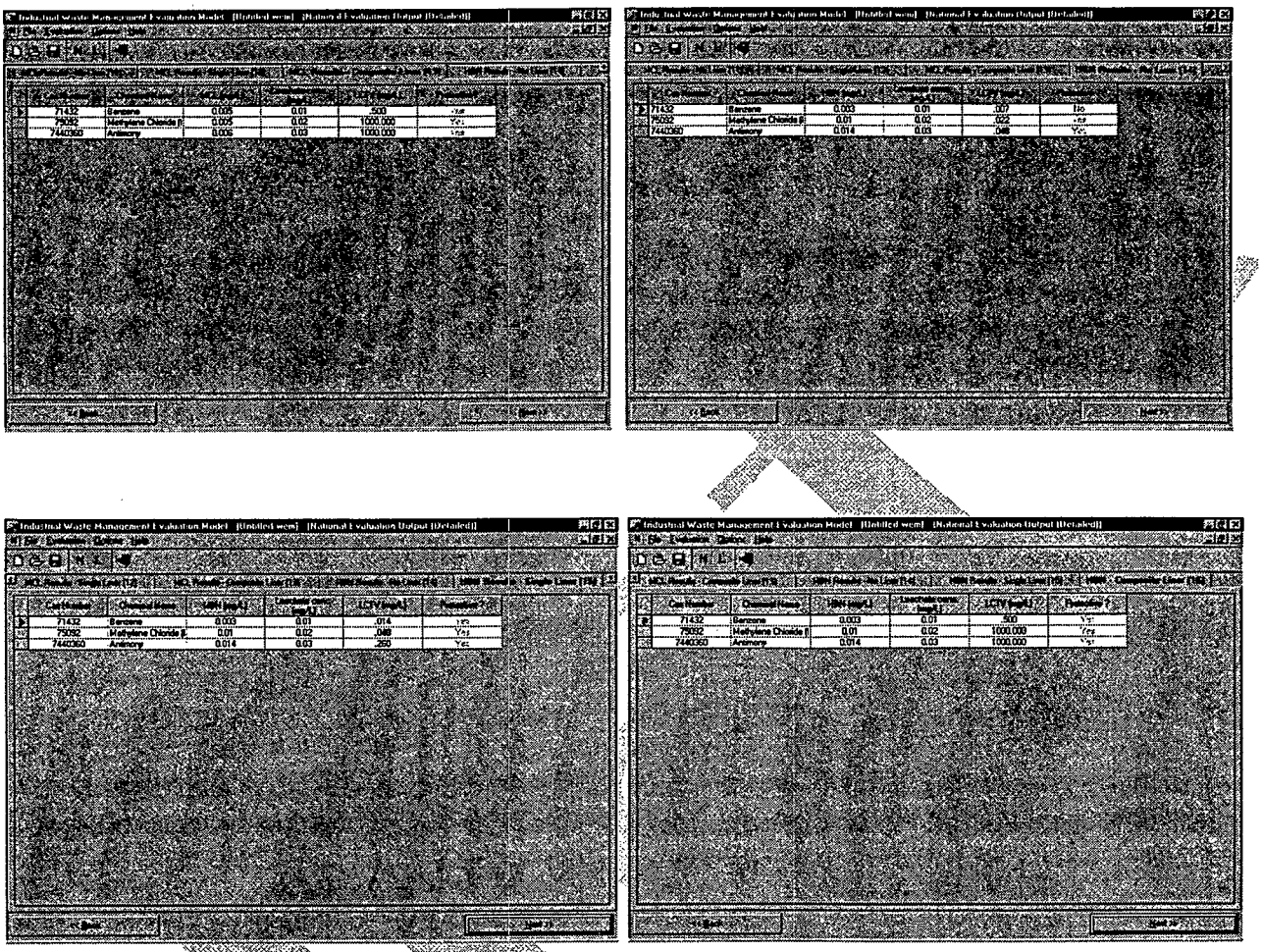
What does the colored text mean?

For a Tier 1 evaluation, results for which no liner is recommended are displayed in green text. Results for which a single liner is recommended are displayed in blue text. Results for which a composite liner is recommended are displayed in red text. Results for which a composite liner is not recommended as sufficiently protective of ground water are also displayed in red text. Results for which the LCTV is not calculated because the TRL is not available are displayed in black text.

5.3.3 Tier 1 Detailed Results Screen

Clicking the "Next" button leads you to the detailed results of the National Evaluation (Tier 1). Detailed results are presented first for MCLs and then for HBNs for each liner type (No Liner, Single Liner, Composite Liner).





What data are presented in the Tier 1 Detailed Results tabs?

The table at the top of each tab presents the data on which the liner recommendation is based for each selected chemical. The last column in the table (with the header "Protective?") tells you whether or not the specified liner is protective of groundwater for that constituent. This determination is made by comparing the entered leachate concentration with the LCTV. If the expected leachate concentration is greater than the LCTV, the liner is not recommended as being protective ("No"), whereas, if the expected leachate concentration is less than the LCTV, the liner is recommended as being protective ("Yes"). If the LCTV is not calculated for that constituent because the TRL is not available, "NA" (not applicable) is displayed in this cell.

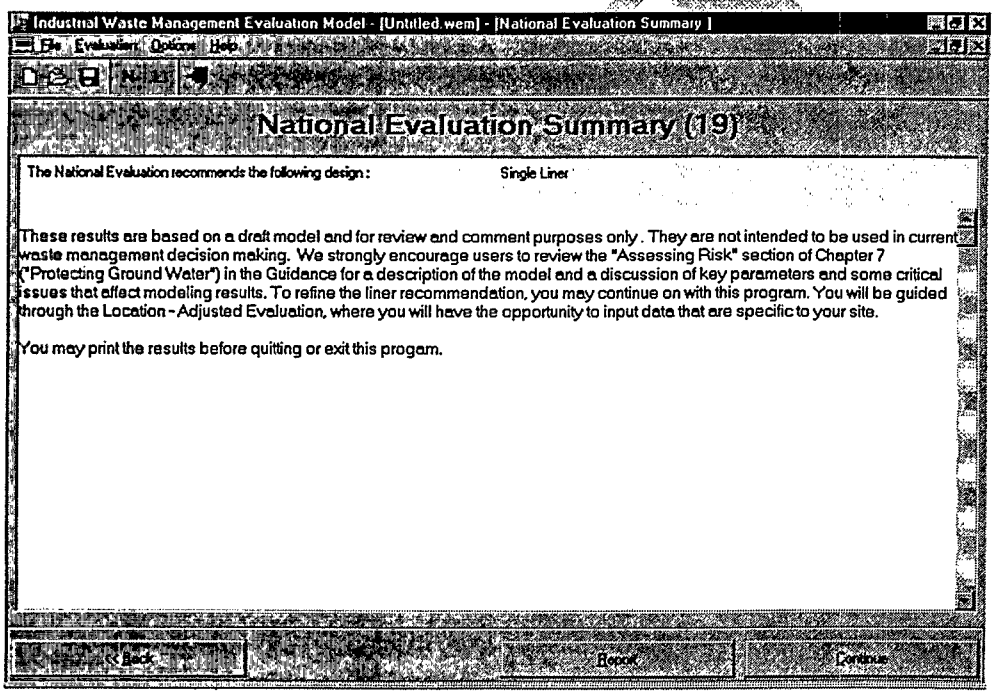
To properly interpret the results of the National Evaluation, you must consult with the appropriate state regulatory agency to determine which human health toxicity benchmark should be used for each constituent of concern. For wastes with multiple constituents of concern, you

may need to construct a final list of liner recommendations, some from LCTVs based on Maximum Contaminant Levels (MCLs) and some from LCTVs based on Health-Based Numbers (HBNs).

For waste streams with multiple constituents, the most protective liner specified for any one constituent is the overall recommended liner type.

5.3.4 Tier 1 Evaluation Summary

The "Next" button brings up a screen containing a summary of the Tier 1 evaluation results, instructions for proceeding on to a Tier 2 evaluation, and where you can find additional information in the ***Guidance***.



After reviewing your Tier 1 results on-screen, you have three options to continue within the IWEM software:

- Go back to the previous screens of the Tier 1 results by clicking on the "Back" button,
- View the Tier 1 report by clicking the "Report" button, or
- Begin a Tier 2 Evaluation by clicking the "Continue" button.

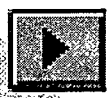
At this point, you can also choose to save your results or to exit the IWEM software — these options will be explained after describing the Tier 1 Report.

How do I view and print the Tier 1 Report?

Clicking on the "Report" button in the National Evaluation Summary screen displays the Tier 1 report on-screen. You can then view the report or choose one of the following options:

Print the report; the "Print" dialog box then appears where you can adjust printer setting or choose to print selected pages.

Save the report to a file; a dialog box then appears where you can specify the file type, and then select the file name and directory. The file types in this list are dependent upon what software you have installed on your PC, but not all of these options are currently functional. Most users will find that the option for Word for Windows works, however, some minor formatting in Word may be required to produce a document-ready report.



View the next page of the report

View the previous page of the report

Tier 1 Report Includes:

1) List of selected waste constituent(s) and constituent specific-values
2) Minimum liner requirement based on MCLs
3) Minimum liner requirement based on HBNs
4) Data used to calculate the LCTV for each liner

Please note that an example Tier 1 report is included in this *Users' Guide* in Appendix B.

How do I save the input and results of the Tier 1 evaluation?

There are several ways to save the Tier 1 evaluation input:

- Click on the "File" menu and choose "Save" or "Save As." A dialog box will then open which prompts you for the file name and directory location, as appropriate. You can choose any filename you want, but you must use the file extension "wem" in order to later open a saved evaluation. Please note that you cannot save any files to the cd-rom, so you must specify a directory on your hard-drive or a floppy disk as the location to which the file should be saved.

- Click on the "Save" button on the toolbar. If you are editing a previously saved evaluation, the file will be automatically updated. If you have created a new evaluation, the "Save As" dialog box will open, as described above.

- Click on the "Cancel" button in the very top right corner of the screen. (The "Cancel" button is the one with the "X" on it.)

If you forget to save before trying to exit the IWEM software, a dialog box will pop up, asking if you want to save before exiting the software.

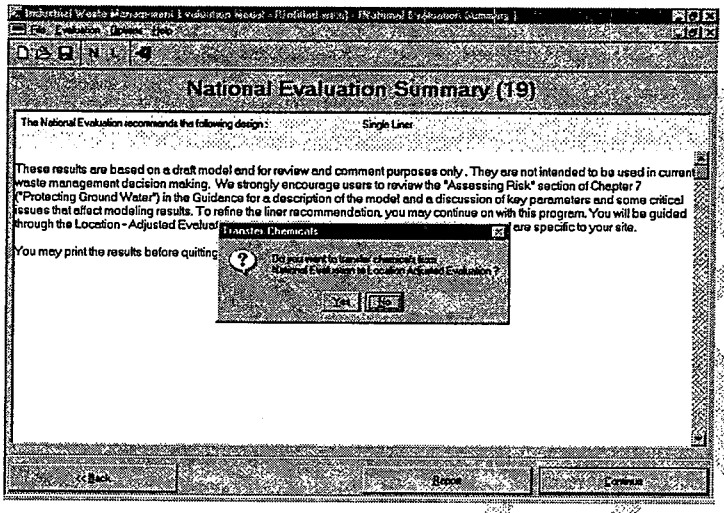
How do I exit the IWEM software?

You can exit the IWEM software by clicking on the "File" menu, and choosing "Exit".

You can also click on the exit button on the tool bar to exit the IWEM software.

How do I proceed to Tier 2?

Clicking on the "Continue" button at the bottom of the screen launches the Location-Adjusted Evaluation (Tier 2).



When you proceed to a Tier 2 evaluation after performing a Tier 1 evaluation, a message box appears asking if you want to transfer the selected constituents and expected leachate concentrations from the Tier 1 analysis to the Tier 2 analysis. Click on the "Yes" button to continue on to Tier 2 with the current list of waste constituents.

5.4 Location-Adjusted Evaluation (Tier 2)

The Input Screen for Tier 2 consists of seven tabs:

- WMU Type
- Location Parameters
- Infiltration
- Chemical List
- Chemical Properties
- Toxicity Standards
- Input Summary

The Tier 2 results are then presented on the Summary Results Screen.

The Detailed Results Screen for the Location-Adjusted Evaluation varies according to the option you chose for the infiltration rate. When using a **location-based estimate of infiltration**, the Detailed Results Screen for Tier 2 consists of two tabs:

- No Liner Results
- Single Liner Results

When using a **user-specified infiltration rate**, the Detailed Results Screen for Tier 2 consists of only one tab:

- User-Defined Liner Results

The overall Tier 2 result is then displayed on the Location-Adjusted Evaluation Summary Screen.

The available options and data displayed on each of these tabs is explained in the following sections.

5.4.1 Tier 2 Input Screen

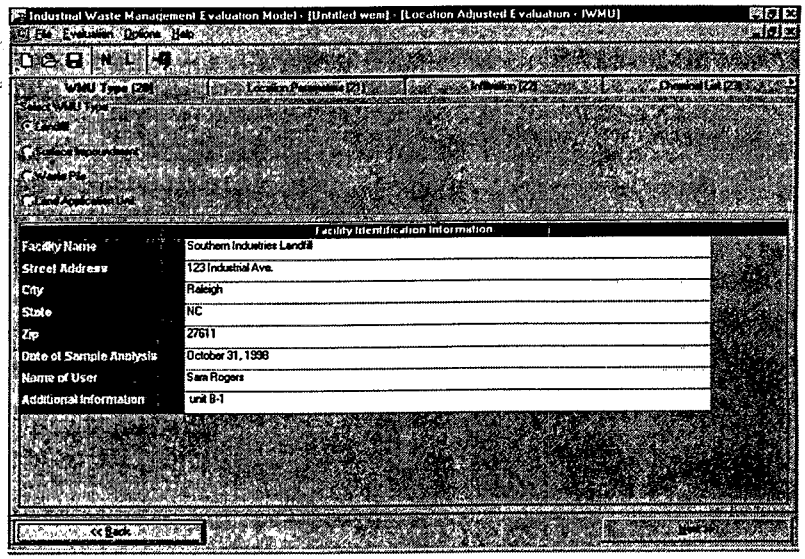
If you begin with the Tier 1 Evaluation and then proceed to the Tier 2 Evaluation with the same selected constituents, the WMU type, list of waste constituents, and the expected leachate concentrations specified in Tier 1 can be transferred to Tier 2 for your convenience. However, these values can be edited in Tier 2, if appropriate.

5.4.1.1 Tab 1: Waste Management Unit Type

The first tab of the Tier 2 Data Input Screen, WMU Type, is identical to the Tier 1 WMU Type tab.

How do I enter WMU data?

- Using the option buttons, select the type of WMU to be evaluated.
- Enter the facility information in the text boxes at the bottom of the screen.
- The information entered in these text boxes will be included on the printed report for Tier 2.

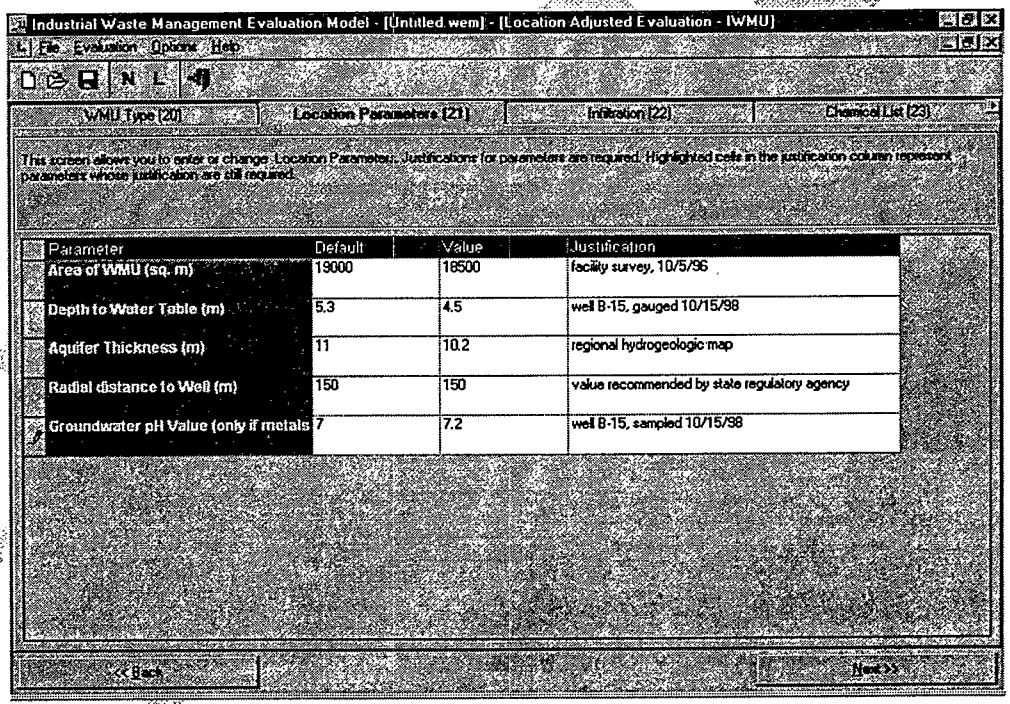


5.4.1.2 Tab 2: Location Parameters

User Input:

Area of the waste management unit
Depth to the water table
Aquifer thickness
Radial distance to the monitoring well
Groundwater pH (only for wastes containing metals)
Brief justification for each site-specific value

This tab is where you enter your site-specific data. If you don't have a site-specific value for any inputs, default values supplied by the IWEM software can be used. However, you must type in a value for each input: either the default value or your site-specific value. The default values are generally the median values from the distributions of values used in the Tier 1 evaluation (See Section 4.5.1).



For all input parameters for which you enter site-specific values, remember to type in a brief justification of this value. This justification will be included in the printed report.

5.4.1.3 Tab 3: Infiltration

User Input: Choose one of the following options for specifying infiltration rate:

- Use site-specific data (i.e., a measured, modeled, or calculated value)
- No site-specific data available (the model will estimate values for you based on the soil type and geographic location of the WMU site)

Displayed at the top of this tab is the following question:

"Do you have a site-specific value for infiltration rate?"

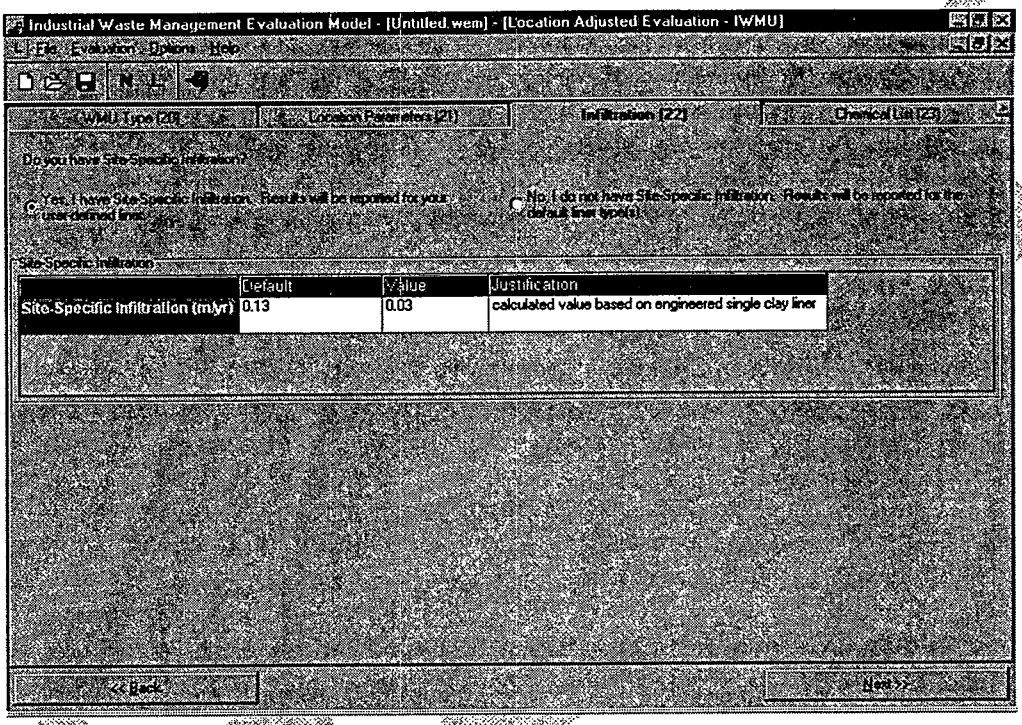
To answer this question, click on one of the two option buttons:

- **"Yes, I have a site-specific infiltration rate"; or**
- **"No, I do not have a site-specific infiltration rate."**

If you choose yes, the Tier 2 results will be reported in terms of the liner at the modeled unit, this liner scenario is referred to as a "user-defined liner". Your entered leachate concentrations will be compared to the LCTV calculated for this liner, and the model will recommend whether or not your liner design will be protective for all the listed waste constituents. This would be the option to choose if you are evaluating the composite liner scenario and you know the infiltration rate.

If you choose no, the Tier 2 results will be reported for the default liner type(s). There are two liner types for landfills, surface impoundments, and waste piles (no liner/in-situ soil and single clay liner). There is only one liner scenario for land application units because engineered liners are not usually used at these types of facilities. Your entered leachate concentrations will be compared to the LCTV for each of these liner types, and the model will recommend the minimum liner type which is protective for all the listed waste constituents.

If you click on the "Yes, I have a site-specific infiltration rate" option button, the tab will appear like this for an evaluation of a landfill, surface impoundment, or waste pile (only the no-liner infiltration rate will be given for an evaluation of a land application unit):

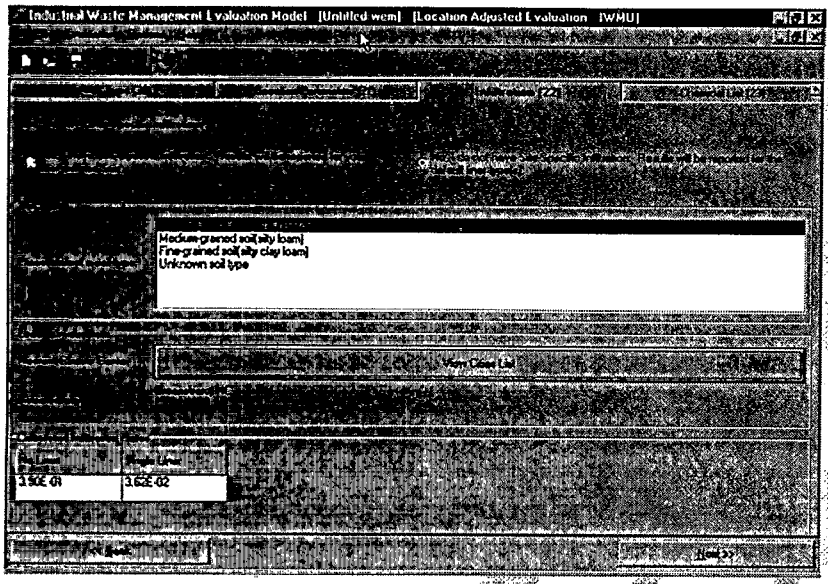


Now, enter the infiltration rate and a brief justification in the appropriate cells. Note that the default infiltration rate is the median infiltration rate (based on EPACMTP modeling using OSW survey data) for the specified type of WMU. This value is provided just to give you an idea of what is considered to be a typical infiltration rate for your type of unit, however, climate and other site-specific factors will likely cause the infiltration for the modeled site to be different from the default value displayed by the software.

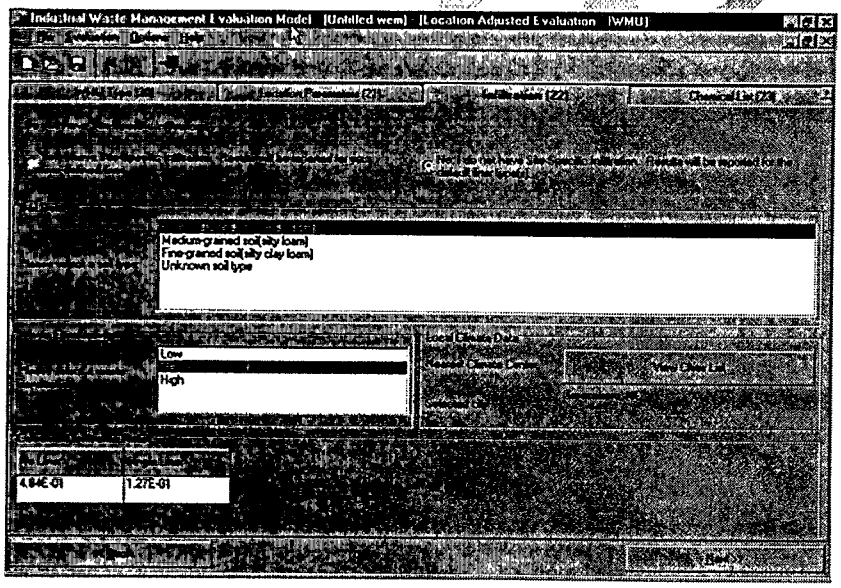
If you enter an infiltration rate which is between the 90th and the 100th percentile values for the no-liner scenario or which is between the 0th and the 10th percentile value for the single-liner scenario (based on the OSW survey data for the type of WMU being modeled), a dialog box will pop up which informs you that there is increased uncertainty in model output based on this type of extreme value of infiltration. However, you will be allowed to continue with the analysis.

If you enter an infiltration rate which is larger than the 100th percentile value for the no-liner scenario or which is smaller than the 0th percentile value for the single-liner scenario (based on the OSW survey data for the type of WMU being modeled), a dialog box will pop up which informs you that this value is beyond the allowable input range. In this case, you will not be allowed to continue with the analysis unless you change this input to an acceptable value.

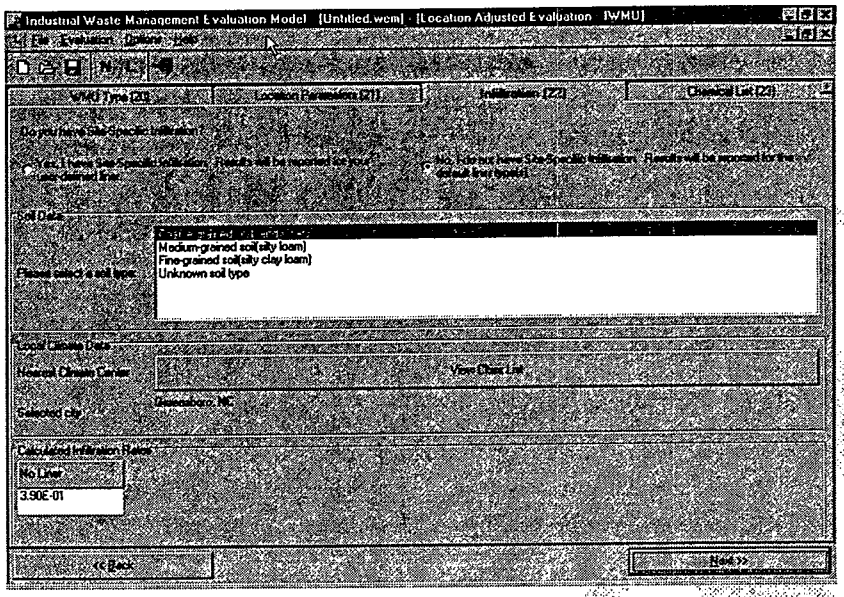
If you click on the "No, I do not have a site-specific infiltration rate" option button, the tab will appear like this:



Landfill Evaluation



Waste Pile Evaluation



Land Application Unit Evaluation

The infiltration rate tab for the surface impoundment scenario is slightly different, and is described later.

For an evaluation of a landfill, waste pile, or land application unit, you now need to specify the soil type and geographic location of the WMU. The model will then estimate the resulting infiltration rate for your site for the standard liner scenario(s) (only the no-liner scenario is evaluated for a land application unit). This estimate is based on water-balance modeling conducted for 97 climate centers around the country (See Section 3.1 in the ***Technical Background Document*** (U.S. EPA, 1999b) for more information.).

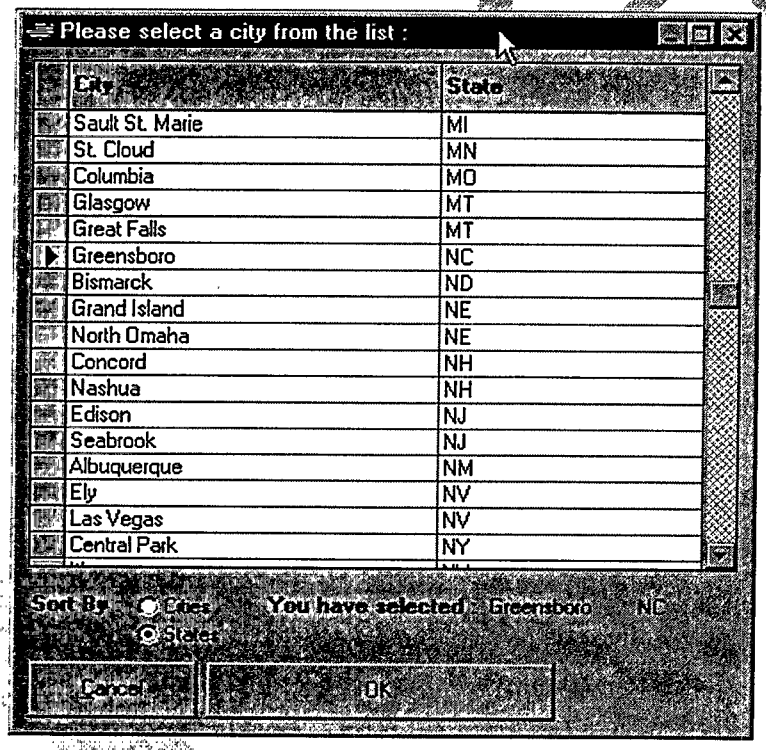
First, select one of the following choices for soil type by clicking on it:

- Coarse-grained soil
- Medium-grained soil
- Fine-grained soil
- Unknown soil type

If you choose unknown soil type, the model will use the infiltration rate for the coarse grained soil type (which is generally the most conservative case). Note that for a waste pile, you must also specify the conductivity of the waste (this value is used in determining the single-liner infiltration rate). There are three choices for waste conductivity: high (4.1×10^{-2} cm/sec), medium (4.1×10^{-3} cm/sec), and low (5.0×10^{-5} cm/sec). These values are thought to be typical of wastes disposed in waste piles (ABB Environmental Services, 1995).

Infiltration rates for 97 different cities or "climate centers" around the country have been calculated based on meteorological data and soil type. By choosing the climate center closest to modeled WMU site, you can use the infiltration rate for this climate center as an estimate of the infiltration rate expected at your site.

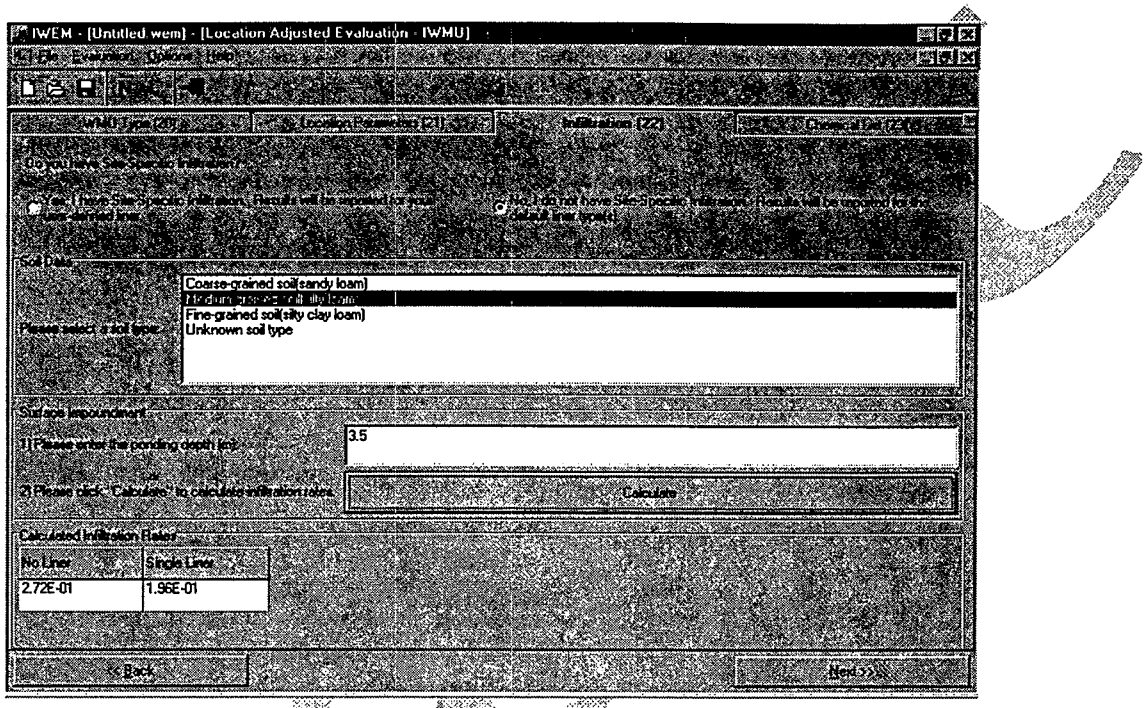
Notice that the infiltration rates for Fresno, CA appear in the table at the bottom of the tab because Fresno, CA is the default choice for climate center. To choose another location, click on the "View Cities List" button. The following dialog box will appear:



By choosing one of the options under the title "Sort by," you can sort the climate centers alphabetically by city or by state. You can then move through the list using the arrow keys on the keyboard until the appropriate city is highlighted. Then click the "OK" button.

Once you have selected soil type and the nearest climate center, the model can estimate the infiltration rates for each of two standard liner scenarios (no liner/in-situ soil and single liner) for your WMU site. The resulting values are listed in the table at the bottom of the infiltration tab.

If you click on the "No, I do not have a site-specific infiltration rate" option button, the tab will appear like this for an evaluation of a surface impoundment:



In order for the model to calculate an infiltration rate for a surface impoundment, you must select the soil type which is beneath the impoundment and type in the ponding depth. This value is the average depth of liquid which is present in the impoundment. The default value for the ponding depth is the median value from OSW survey data. Once you have entered these data, click the "Calculate" button to display the calculated infiltration rates in the text boxes at the bottom of the screen.

The no-liner infiltration rate is calculated by assuming that there is two feet of sludge at the base of the surface impoundment which has a conductivity of 1×10^{-7} cm/sec. The single-clay-liner infiltration rate is calculated by assuming that the clay liner consists of three feet of clay with a conductivity of 1×10^{-7} cm/sec.

The next three tabs of the Tier 2 Data Input Screen contain waste constituent-specific data.

5.4.1.4 Tab 4: Chemical List

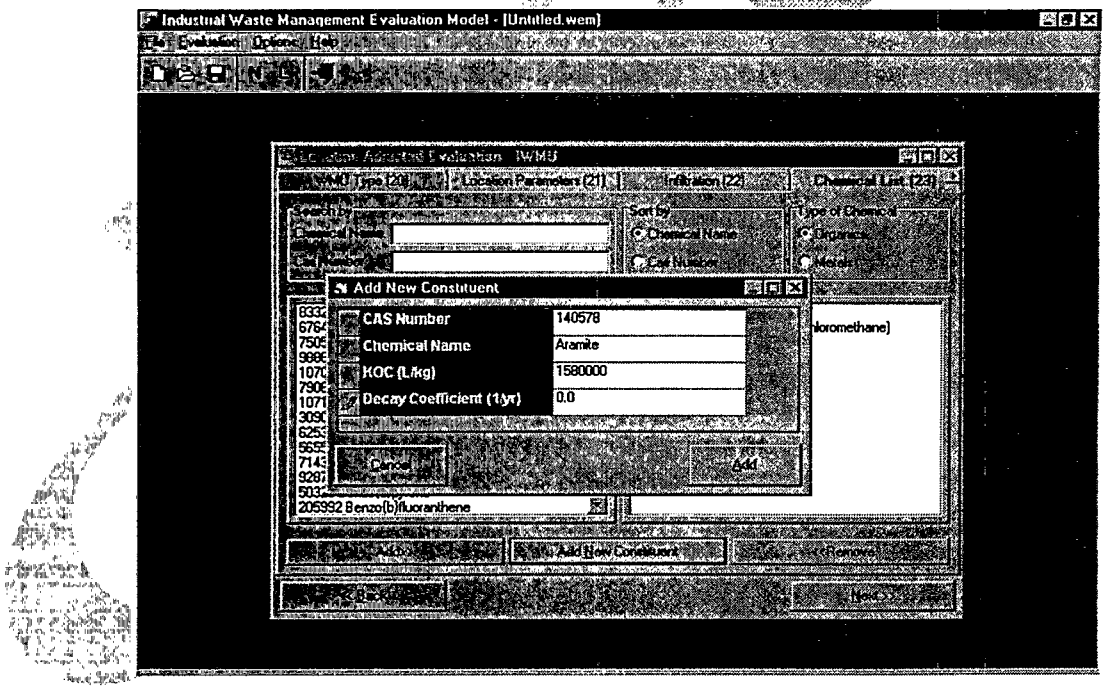
User Input: Select constituents expected in leachate using the following options:

- Search by Constituent Name or CAS#
- Sort by Constituent Name or CAS#
- Type of Constituent (Display Organics or Metals)

The Chemical List tab for Tier 2 is identical to the Tier 1 Chemical List tab, and the options and controls on this tab work exactly the same as the ones on the Tier 1 Chemical List tab. You can choose any of the 174 organic waste constituents and 16 metal species included in Tier 1 (see Appendix A). (Refer to Section 5.3.1.2 for instructions on finding and selecting waste constituents.) However, unlike Tier 1, in Tier 2 you can add a constituent not in this list.

How do I add a waste constituent?

To add a new waste constituent, click on the "Add New Constituent" button at the bottom of the Chemical List. The following text box will appear:



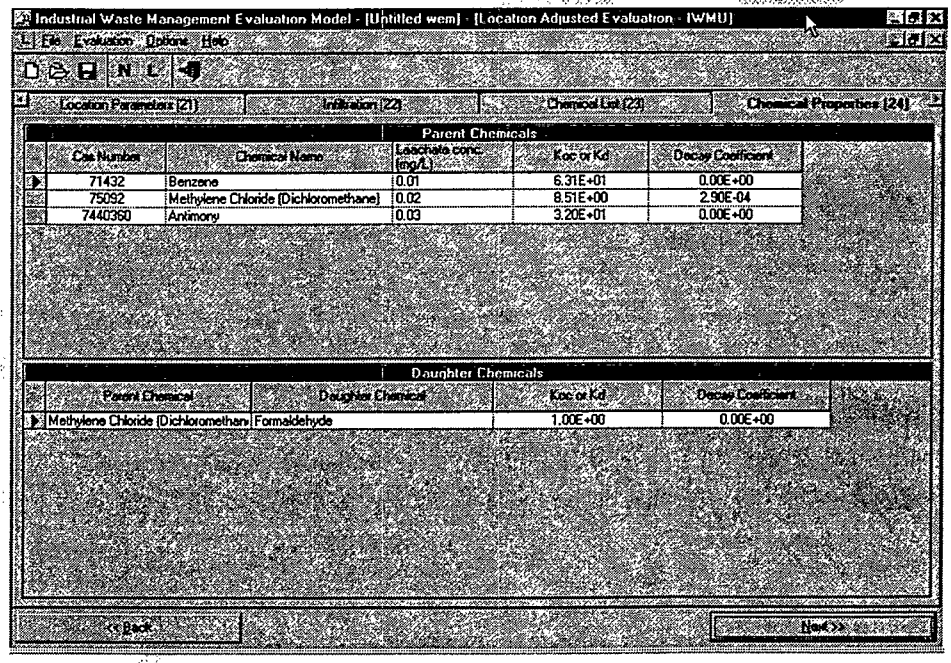
Now type in the information about your new chemical and click the "Add" button. Note that the CAS Number must be entered and it must be a number that is not already in use by one of the listed constituents. If a CAS Number is not available or you don't know what this number is for

your constituent, any number can be used here, as long as it is a unique number. If you do not enter a value for the K_{OC} and decay coefficient (λ), the default value of zero will be used for each of these parameters.

5.4.1.5 Tab 5: Chemical Properties

Required User Input: Expected leachate concentration

Optional User Input (for organics): Organic carbon distribution coefficient (K_{OC}), and First order decay coefficient (λ) (chemical hydrolysis and/or bio-degradation)



The properties for each waste constituent are listed in a table at the top of the tab. If you performed a Tier 1 evaluation immediately prior to performing a Tier 2 evaluation, the waste constituents considered in Tier 1 can be imported to Tier 2 for your convenience. In this case, the expected leachate concentrations will also be imported, however, this concentration can be edited, if appropriate. For each constituent, default values are assigned for K_{OC} (K_d for metals) and the decay coefficient (See constituent list in Appendix A), however, you can change the values of these parameters to site-specific values if site-specific data are available. The default

decay coefficient represents degradation from chemical hydrolysis only, since biodegradation rates are often strongly influenced by site-specific factors. You should only increase the default decay coefficient if there is clear evidence of biodegradation occurring at a site.

If any of the selected waste constituents degrade to form toxic daughter products, these constituents are automatically added to the table at the bottom of the tab. The concentration of a toxic daughter product is determined by the concentration of its parent constituent, thus, the expected leachate concentration of daughter products are not editable. The K_{OC} and decay coefficient of the daughter products are editable parameters.

The Tier 2 Evaluation cannot be performed until the expected leachate concentration is entered for each selected waste constituent.

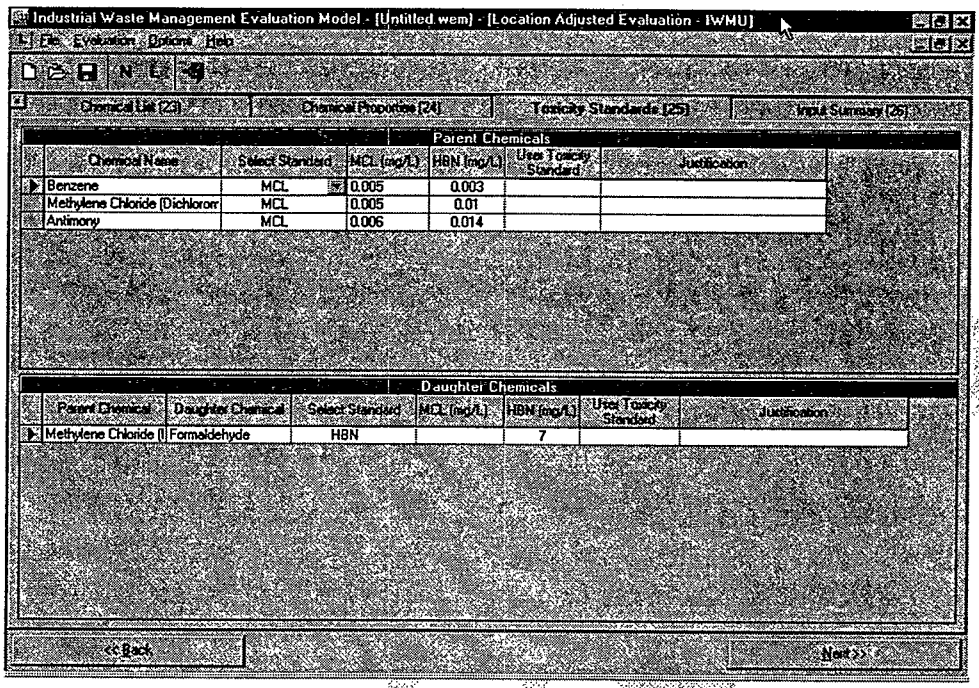
Once your list of waste constituents and expected leachate concentrations is complete, click on the Toxicity Reference Levels tab or the "Next" button to specify a standard to be used for each of the selected constituents.

5.4.1.6 Tab 6: Toxicity Reference Levels (TRLs)

User Input: Select one of the following toxicity reference levels for each waste constituent:

- Maximum Contaminant Level (MCL)
- Health-Based Number (HBN)
- User-specified TRL (this can be any value and is generally determined by your state regulatory authority)

Like the previous tab, this tab is divided into two sections: parent waste constituents (at the top) and toxic daughter products (at the bottom). You can specify which TRL to use for both parent and daughter constituents.



To Select the TRL for each constituent:

1) Click in the cell in the "Select Standard" column to reveal an arrow button

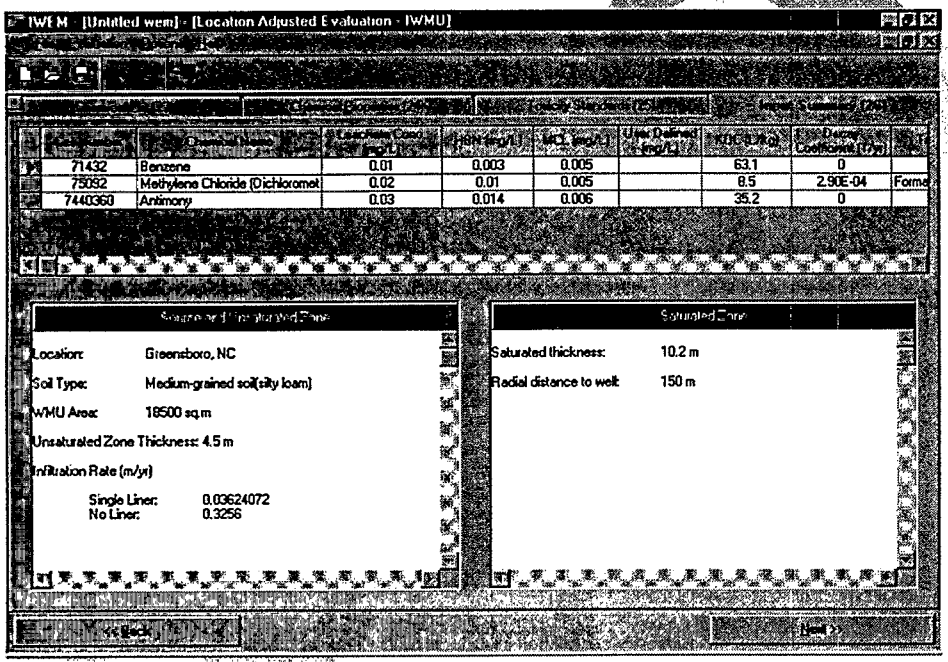
2) Click on the arrow button to activate the pull-down list

3) Select the appropriate TRL and hit the "Enter" key

Note: If you select a user-specified TRL for any waste constituents, be sure to provide a brief explanation of this value in the "Justification" column.

5.4.1.7 Tab 7: Input Summary

You cannot enter or edit data on the Input Summary tab, rather its purpose is to consolidate into one place all the data you have entered for the Tier 2 evaluation. If you notice that you have entered any data incorrectly, use the "Back" button or click on the tab name to go back to the appropriate tab on the Tier 2 Data Entry Screen.



The input summary screen has three sections: 1) waste constituent-specific data, 2) source and unsaturated zone data, and 3) saturated zone data. Each section has a scroll bar which can be used to view information which doesn't fit on the screen.

The first section contains a table of the selected constituents, listing their CAS#, common name, expected leachate concentration, the type and value of the selected TRL, waste constituent specific parameters (K_{OC}, K_d), and toxic daughter product, if applicable.

Below this table, the selected values for the source and unsaturated zone parameters are detailed in a text box on the left side of the screen. To the right, the selected values for the saturated zone parameters are listed.

How do I perform a Tier 2 Evaluation?

After you have verified that all Tier 2 inputs are correct, click the "Next" button from the Input Summary tab to perform the Tier 2 evaluation and display the results.

In a Tier 2 evaluation, the model is queried for each constituent of concern using the chosen waste constituent-specific and site-specific inputs. Any toxic daughter products produced by hydrolysis of the selected constituents are also evaluated.

Please note that the LCTVs for Tier 2 are determined by feeding your input values to the appropriate neural network. Although the neural networks are based on probabilistic EPACMTP model runs (see Appendix A of the ***Technical Background Document*** for the details of neural network training), only the most important EPACMTP input parameters are used as inputs to the neural networks. Therefore, even if the Tier 2 input values are similar to the median values of the distributions used in the Tier 1 modeling, the results from Tier 2 will be different from the Tier 1 results. For a given constituent, the DAF obtained in a Tier 2 analysis may be higher or lower than the DAF obtained in a Tier 1 analysis. For instance, in a Tier 2 analysis for a given constituent, if you use the default infiltration rates based on the geographic location of the modeled facility, the Tier 2 results may be higher or lower than the Tier 1 results for that same constituent. This difference will be in part due to the fact that in Tier 1, the infiltration rate is varied over a nation-wide distribution, whereas in Tier 2, the infiltration rate is constant.

The exact format of the liner recommendation for the Tier 2 evaluation is determined by which option you chose to specify the infiltration rate (either a location-based estimate or a user-specified value). But whichever infiltration option you choose, the results are divided into two sets: summary results and detailed results.

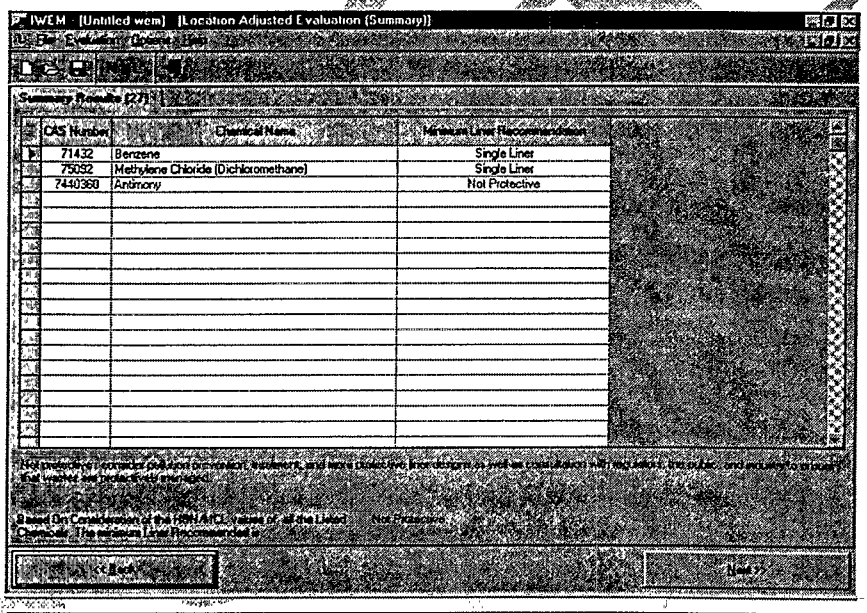
The first set of results is a summary which reports liner recommendation for each constituent, and the overall liner recommendation based on all input expected leachate concentrations.

The second set of results, the detailed results, present all the data upon which the liner evaluation is based. This data includes the waste constituent-specific parameters (K_{OC} and decay coefficient), expected leachate concentration, DAF value, specified TRL, and the resulting LCTV value for each selected constituent. These detailed results allow you to understand how the LCTV values were calculated and how the liner design recommendations were developed.

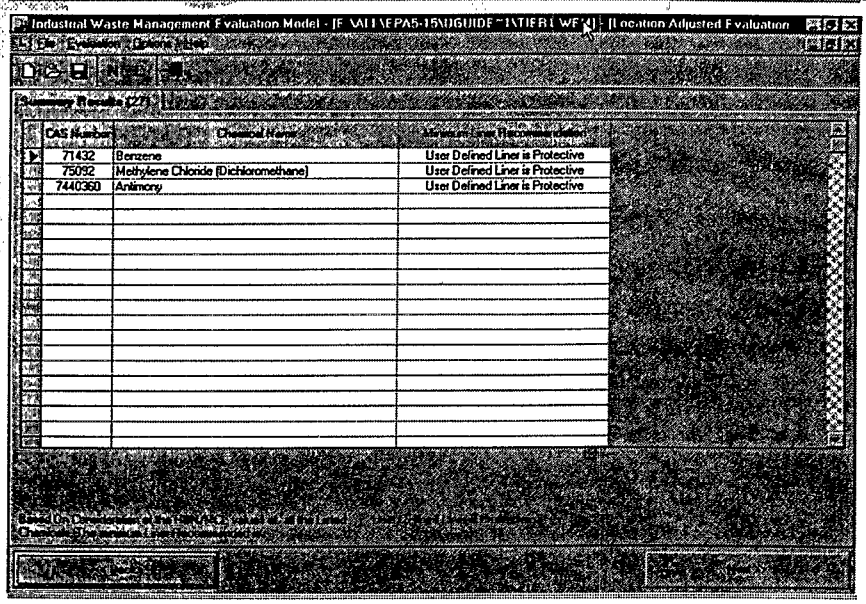
5.4.2 Tier 2 Summary Results

The results of the Location-Adjusted Evaluation are first presented on-screen in summary form. The Summary Results screen provides a liner recommendation for each of the selected constituents which are listed by name and CAS#. The recommendation is based on a comparison of the expected leachate concentration for that constituent to the calculated Leachate Concentration Threshold Value (LCTV) using the specified TRL.

If you used a location-based estimate of the infiltration rate, the liner recommendation is the minimum recommended liner of the two types that are evaluated (no liner/in-situ soil, and single clay liner).



If you have entered an infiltration rate, then the liner recommendation is whether or not the modeled liner type is recommended as being protective of groundwater.



The bottom of the screen displays an overall liner recommendation which is based on considerations of all input constituents.

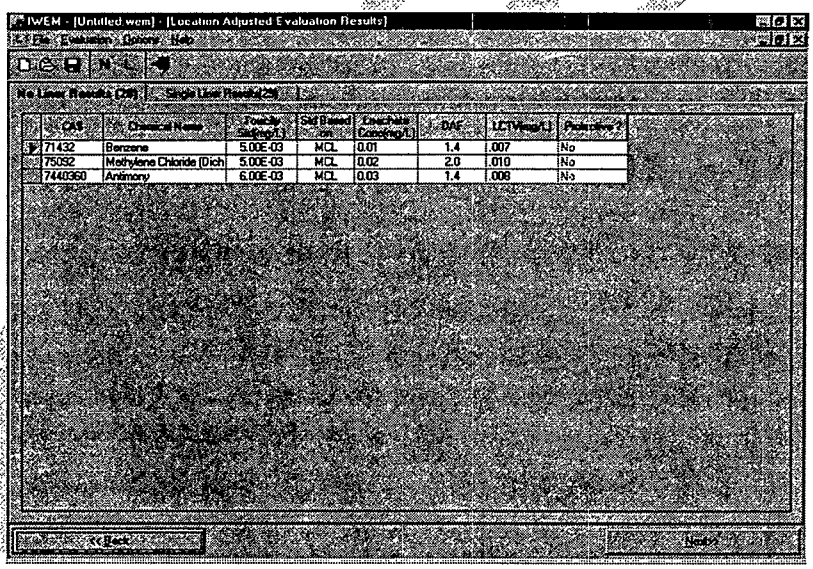
What does the colored text mean?

For a Tier 2 evaluation, results for which no liner is recommended are displayed in green text. Results for which a single liner is recommended are displayed in blue text. Results for which a single liner is not recommended as being protective of ground water are displayed in red text.

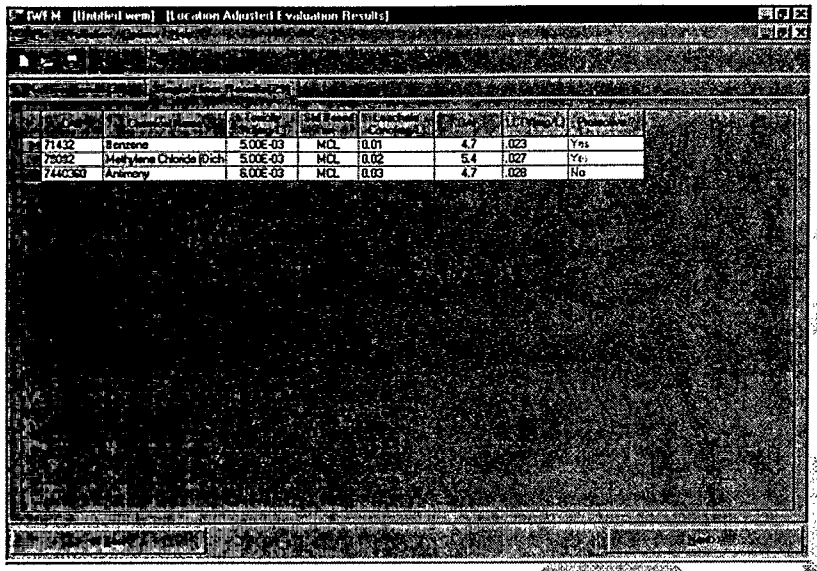
5.4.3 Tier 2 Detailed Results for Location-Based Estimate of Infiltration

If you choose to have the infiltration rate estimated automatically for a landfill, waste pile, or surface impoundment, your expected leachate concentrations are compared to the LCTVs calculated for each of two scenarios (in-situ soil and single clay liner). The final Tier 2 recommendation is the minimum liner design (of the two evaluated) which is protective of groundwater for all selected waste constituents.

If you choose to have the infiltration rate estimated automatically for a land application unit, your expected leachate concentrations are compared to the LCTVs calculated for the no-liner (in-situ soil) scenario. The final Tier 2 recommendation is whether or not land application of this waste at this site will be protective of groundwater.



Detailed results for the landfill no-liner scenario



Detailed results for the landfill single-liner scenario

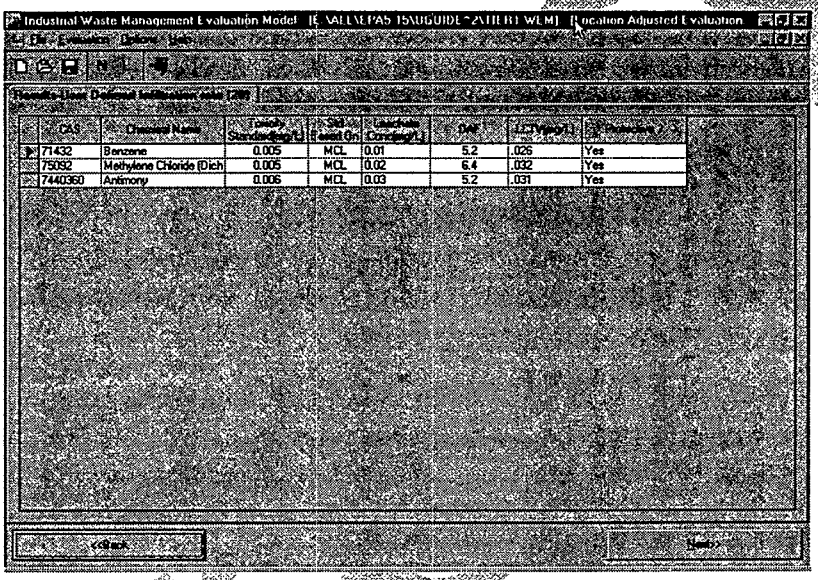
The results table for each liner type presents all data on which the liner recommendation is based. This information includes the CAS#, waste constituent name, TRL type and value (mg/L), the expected leachate concentration (mg/L), the Leachate Concentration Threshold Value (LCTV), and text explaining whether or not the liner is recommended as being protective of groundwater.

If the expected leachate concentrations for all constituents are lower than the no-liner LCTVs, then the no liner scenario is recommended as being sufficiently protective of ground water. If any constituent is higher than the no-liner LCTV, then at least a single clay liner is recommended. If the expected leachate concentration for any constituent is higher than the single-liner LCTV, then consider pollution prevention, treatment, and more protective liner designs, as well as consultation between regulators, the public, and industry to ensure such wastes are protectively managed. See part IV of the ***Guidance*** for further discussion.

For waste streams with multiple constituents, the most protective liner specified for any one constituent is the overall recommended liner design.

5.4.4 Tier 2 Detailed Results for User-Specified Infiltration Rate

If you directly enter a value for infiltration (for any of the four types of WMUs), the entered leachate concentrations are compared to the LCTV calculated for this scenario. The results report whether the given scenario is recommended as being sufficiently protective of the ground water.

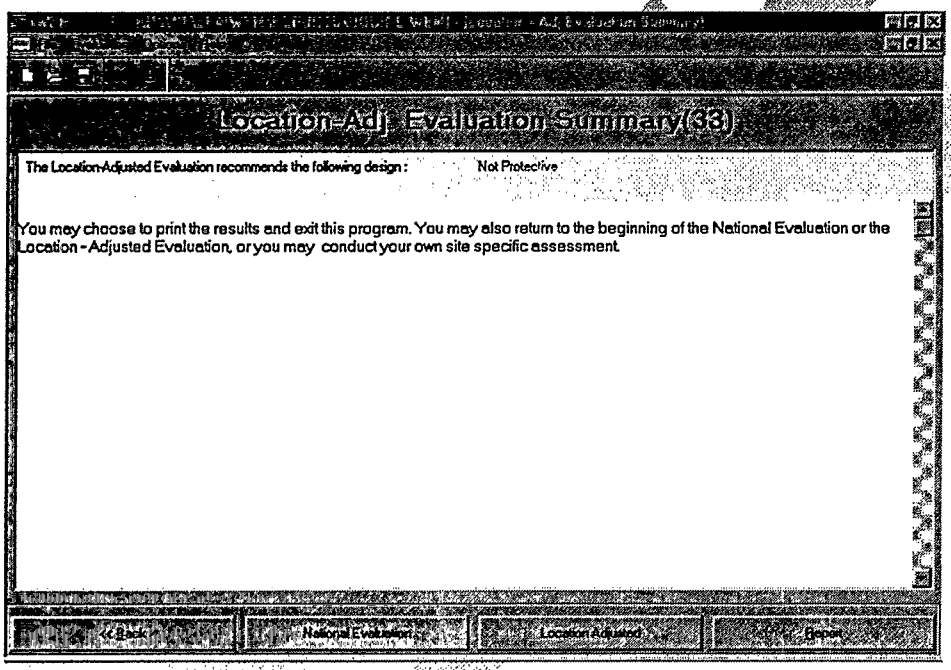


The results table presents all data on which the liner recommendation is based. This information includes the CAS#, waste constituent name, TRL type and value (mg/L), the expected leachate concentration (mg/L), the Leachate Concentration Threshold Value (LCTV), and text explaining whether or not the liner is recommended as being protective of groundwater.

Clicking on the "Next" button brings you to the Tier 2 Evaluation Summary screen.

5.4.5 Tier 2 Evaluation Summary

The Location-Adjusted Evaluation Summary Screen identifies the overall Tier 2 liner recommendations and gives instructions on how to exit the program or go back to the Tier 1 or Tier 2 evaluation.



After reviewing your Tier 2 results on-screen, you have four options to continue within the IWEM software:

- Go back to the previous screens of the Tier 2 results by clicking on the "Back" button,
- Go to the beginning of the Tier 1 Evaluation by clicking the "National Evaluation" button,
- Go to the beginning of the Tier 2 Evaluation by clicking the "Location-Adjusted Evaluation" button, or
- View the Tier 2 report by clicking the "Report" button.

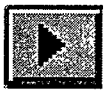
At this point, you can also choose to exit the IWEM software or conduct a Tier 3 Evaluation using another groundwater fate and transport model. For more information about Tier 3 Evaluations, see the "Assessing Risk" section of Chapter 7 ("Protecting Ground Water") in the ***Guidance.***

How do I view and print the Tier 2 Report?

Clicking on the "Report" button in the Tier 2 Recommendation screen displays the Tier 2 report on-screen. You can then view the report or choose one of the following options:

Print the report; the "Print" dialog box then appears where you can adjust printer setting or choose to print selected pages.

Save the report to a file; a dialog box then appears where you can specify the file type, and then select the file name and directory. The file types in this list are dependent upon what software you have installed on your PC, but not all of these options are currently functional. Most users will find that the option for Word for Windows works, however, some minor formatting in Word may be required to produce a document-ready report.



View the next page of the report

View the previous page of the report

Tier 2 Report Includes:

1) List of selected waste constituent(s) and constituent specific-values, including any toxic daughter products
2) Input value and justification for each location parameter
3) Minimum liner requirement based the selected TRL for each waste constituent
4) Data used to calculate the LCTV for each liner

Please note that an example Tier 2 report is included in this *Users' Guide* in Appendix B.

How do I save the input and results of the Tier 2 evaluation?

There are several ways to save the Tier 2 evaluation input:

- Click on the "File" menu and choose "Save" or "Save As." A dialog box will then open which prompts you for the file name and directory location, as appropriate. You can choose any filename you want, but you must use the file extension "wem" in order to later open a saved evaluation. Please note that you cannot save any files to the cd-rom, so you must specify a directory on your hard-drive or a floppy disk as the location to which the file should be saved.

- Click on the "Save" button on the toolbar. If you are editing a previously saved evaluation, the file will be automatically updated. If you have created a new evaluation, the "Save As" dialog box will open, as described above.

- Click on the "Cancel" button in the very top right corner of the screen. (The "Cancel" button is the one with the "X" on it.)

If you forget to save before trying to exit the IWEM software, a dialog box will pop up, asking if you want to save before exiting the software.

How do I exit the IWEM software?

You can exit the IWEM software by clicking on the "File" menu, and choosing "Exit".

You can also click on the exit button on the tool bar to exit the IWEM software.

6.0 PROBLEM SOLVING

Win 3.x users and anyone with a technical question about installing or running the software should contact:

Virginia Colten-Bradley (US EPA Office of Solid Waste, EMRAD)
phone: 703-308-8613
fax: 703-308-0509
email: COLTEN-BRADLEY.VIRGINIA@EPAMAIL.EPA.GOV

6.1 Installation

Networked PCs

If you are experiencing difficulties installing and are linked to a network version of Microsoft Windows™, it may be necessary to use your local version of MS Windows™. Check with your local network administrator to determine the best option for installation.

6.2 Running the Software

If your monitor is set to use 256 or fewer colors, the toolbar icons and buttons may flicker. To solve this problem, access the display/monitor settings and increase the number of colors or use the True Colors setting.

This program has been developed on a 16-bit platform to allow Microsoft Windows™ 3.x users to be able to use the software. However, we have noticed that on computers running MS Windows™ 95 or NT, there appear to be some conflicts between the IWEM software and WordPerfect. For this reason, we recommend that users do not have both of these applications open at the same time.

If you experience problems using the IWEM software (the software abruptly closes or displays an error message), first try closing all other applications and attempt to repeat your analysis in IWEM. If this doesn't help, then try re-booting your computer and try to repeat your analysis in IWEM. If you still have the same problem after re-booting your computer, please call Virginia Colten-Bradley for technical assistance (see Section 6.0. for contact information).

7.0 SUPPORTING INFORMATION

7.1 Justification/Documentation of Location-Adjusted Input Values

While you are allowed to enter location-adjusted input parameter values, you will be required to document and justify the source of the input parameter values.

7.2 *Guide for Industrial Waste Management*

Refer to the supporting documentation provided on the CD entitled ***Guide for Industrial Waste Management (Guidance)***.

8.0 REFERENCES

ABB Environmental Services, 1995. *Estimation of Leachate Rates from Industrial Waste Management Facilities*. August, 1995.

Bonaparte, R., J.P. Giroud, and B.A. Gross, 1989. *Rates of Leakage through Landfill Liners*, Conference Proceedings, Vol. I, Geosynthetics '89 Conference, San Diego, CA, February 23.

U.S. EPA, 1999a. *Guide for Industrial Waste Management*. Office of Solid Waste, Washington, DC. (EPA530-R-99-001)

U.S. EPA, 1999b. *Technical Background Document for the Development of a Two-Tiered Approach for Evaluating WMU Liner Designs*. Office of Solid Waste, Washington, DC. (EPA530-R-99-002)

U.S. EPA, 1997. *EPACMTP User's Guide*. Office of Solid Waste, Washington, DC. (Docket # F-95-WHWP-FFFFF)

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U.S. EPA, 1996b. *EPACMTP Background Document for the Finite Source Methodology*. Office of Solid Waste, Washington, DC. (Docket # F-95-WHWP-FFFFF.)

U.S. EPA, 1996c. *EPACMTP Background Document for Metals. Volume 1: Methodology*. Office of Solid Waste, Washington, DC. (Docket # F-95-WHWP-FFFFF)

U.S. EPA, 1996d. *Drinking Water Regulations and Health Advisories*. Office of Water, Washington, DC. October (EPA 822-B-96-002).

U.S. EPA, 1995a. *Hazardous Waste Identification Rule, Background Document for Groundwater Pathway Results*, Office of Solid Waste, Washington, DC. (Docket # F-95-WHWP-FFFFF)

U.S. EPA, 1995b. *Technical Support Document for the Hazardous Waste Identification Rule: Risk Assessment for Human and Ecological Receptors*, Volume 1. Office of Solid Waste, Washington, DC. August. (Docket # F-95-WHWP-FFFFF)

U.S. EPA, 1993. *Environmental Fate Constants for Organic Chemicals under Consideration for EPA's Hazardous Waste Identification Projects*. Compiled and edited by Heinz Kollig. Environmental Research Laboratory, Office of Research and Development, Athens, GA. (Docket # F-95-WHWP-FFFFF)

U.S. EPA, 1990. Toxicity Characteristic Final Rule. 55 FR 11796. March 29, 1990.

Appendix A

List of Waste Constituents and Default Values

Ground Water Pathway
List of Waste Constituents

Common Name	CAS#	Health Effect C = carc. NC = non-carc.	K_{oc}	R	λ (yr^{-1})	HBN (mg/L)	MCL (mg/L)
Acenaphthene	83329	NC	5.6e+03	1.6e+01	0.0e+00	2.0e+00	
Acetone (2-propanone)	67641	NC	2.6e-01	1.0e+00	0.0e+00	4.0e+00	
Acetonitrile (methyl cyanide)	75058	NC	1.9e-01	1.0e+00	8.2e-07	2.0e-01	
Acetophenone	98862	NC	1.8e+01	1.0e+00	0.0e+00	4.0e+00	
Acrolein	107028	NC	6.0e-01	1.0e+00	1.9e+08	7.0e-01	
Acrylamide	79061	C	1.0e-01	1.0e+00	5.2e-03	2.0e-05	
Acrylonitrile	107131	C	8.2e-01	1.0e+00	1.2e-04	2.0e-04	
Aldrin	309002	C	1.5e+06	4.0e+03	0.0e+00	5.0e-06	
Aniline (benzeneamine)	62533	C	3.9e+00	1.0e+00	0.0e+00	1.0e-02	
Benzene	71432	C	6.3e+01	1.2e+00	0.0e+00	3.0e-03	5.0e-03
Benzidine	92875	C	1.8e+01	1.0e+00	0.0e+00	4.0e-07	
Benzo[a]pyrene	50328	C	6.3e+05	1.7e+03	0.0e+00	1.0e-05	2.0e-04
Benzo[b]fluoranthene	205992	NC	6.3e+05	1.7e+03	0.0e+00	7.1e-05	
Benzyl alcohol	100516	NC	6.0e+00	1.0e+00	0.0e+00	1.0e+01	
Benzyl chloride	100447	C	6.9e+02	2.8e+00	1.2e+02	5.0e-04	
Benz[a]anthracene	56553	C	2.2e+05	5.8e+02	0.0e+00	7.7e-05	
Bis(2-chloroisopropyl)ether	39638329	C	2.5e+02	1.7e+00	0.0e+00	1.0e-03	
Bis(2-chloroethyl)ether	111444	C	6.3e+00	1.0e+00	6.7e-02	8.0e-05	
Bis(2-ethylhexyl)phthalate	117817	C	1.4e+07	3.6e+04	7.2e-10	6.0e-03	6.0e-03
Bromodichloromethane	75274	C	5.9e+01	1.2e+00	7.9e-04	1.4e-03	8.0e-02
Bromomethane (degrades to Methanol)	74839	NC	5.8e+00	1.0e+00	2.7e+00	5.0e-02	
Butanol	71363	NC	3.2e+00	1.0e+00	0.0e+00	4.0e+00	
Butyl-4,6-dinitrophenol, 2-sec- (Dinoseb)	88857	NC	1.1e+02	1.3e+00	0.0e+00	4.0e-02	7.0e-03
Butyl benzyl phthalate	85687	NC	1.7e+04	4.6e+01	4.8e-05	7.0e+00	
Carbon tetrachloride	56235	C	2.6e+02	1.7e+00	4.9e-03	7.0e-04	5.0e-03

Common Name	CAS#	Health Effect C = carc. NC = non-carc.	K_{oc}	R	λ (yr^{-1})	HBN (mg/L)	MCL (mg/L)
Carbon disulfide	75150	NC	6.9e+01	1.2e+00	4.9e-04	4.0e+00	
Chlordane	57749	C	7.8e+05	2.1e+03	3.3e-10	7.0e-05	2.0e-03
Chloro-1,3-butadiene 2-(Chloroprene)	126998	NC	5.5e+01	1.1e+00	0.0e+00	7.0e-01	
Chloroaniline p-	106478	NC	4.1e+01	1.1e+00	0.0e+00	1.0e-01	
Chlorobenzene	108907	NC	3.8e+02	2.0e+00	0.0e+00	7.0e-01	1.0e-01
Chlorobenzilate	510156	C	1.1e+04	3.0e+01	1.7e-03	3.0e-04	
Chlorodibromomethane	124481	C	8.1e+01	1.2e+00	3.8e-04	1.0e-03	8.0e-02
Chloroform	67663	C	3.8e+01	1.1e+00	7.5e-05	1.0e-02	8.0e-02
Chloromethane	74873	C	8.1e+00	1.0e+00	0.0e+00	6.6e-03	
Chlorophenol 2-	95578	NC	6.6e+01	1.2e+00	0.0e+00	2.0e-01	
Chloropropene, 3- (Allyl Chloride)	107051	NC	1.4e+01	1.0e+00	1.2e+01	1.8e+00	
Chrysene	218019	NC	2.2e+05	5.8e+02	0.0e+00	2.7e-03	
Cresol m-	108394	NC	5.8e+01	1.2e+00	0.0e+00	2.0e+00	
Cresol p-	106445	NC	5.8e+01	1.2e+00	0.0e+00	2.0e-01	
Cresol o-	95487	NC	5.8e+01	1.2e+00	0.0e+00	2.0e+00	
Cumene	98828	NC	2.5e+03	7.7e+00	0.0e+00	1.0e+00	
DDD	72548	C	7.8e+05	2.1e+03	7.3e-03	4.0e-04	
DDE	72559	C	4.4e+06	1.2e+04	0.0e+00	3.0e-04	
DDT, p,p'-	50293	C	3.9e+06	1.0e+04	1.7e-02	3.0e-04	
Di-n-butyl phthalate	84742	NC	2.3e+04	6.3e+01	3.5e-05	4.0e+00	
Di-n-octyl phthalate	117840	NC	4.0e+07	1.1e+05	9.0e-08	7.0e-01	
Diallate	2303164	C	1.5e+04	4.0e+01	2.9e-02	1.0e-03	
Dibenz[a,h]anthracene	53703	C	3.3e+06	8.8e+03	0.0e+00	1.1e-05	
Dibromo-3-chloropropane1,2-	96128	C	8.7e+01	1.2e+00	2.9e-03	6.0e-05	2.0e-04
Dichlorobenzene1,2-	95501	NC	1.2e+03	4.2e+00	0.0e+00	3.0e+00	6.0e-01
Dichlorobenzene1,4-	106467	C	1.1e+03	4.0e+00	0.0e+00	4.0e-03	7.5e-02
Dichlorobenzidine3,3'-	91941	C	2.1e+03	6.6e+00	0.0e+00	2.0e-04	

Common Name	CAS#	Health Effect C = carc. NC = non-carc.	K_{oc}	R	λ (yr^{-1})	HBN (mg/L)	MCL (mg/L)
Dichlorodifluoromethane (Freon 12)	75718	NC	1.5e+02	1.4e+00	0.0e+00	7.0e+00	
Dichloroethane 1,1-	75343	C	2.9e+01	1.1e+00	3.3e-03	9.0e-04	
Dichloroethane1,2-	107062	C	1.4e+01	1.0e+00	2.8e-03	9.0e-04	5.0e-03
Dichloroethylene cis-1,2-	156592	NC	5.0e+01	1.1e+00	0.0e+00	4.0e-01	7.0e-02
Dichloroethylene trans-1,2-	156605	NC	4.0e+01	1.1e+00	0.0e+00	7.0e-01	1.0e-01
Dichloroethylene1,1- (Vinylidene chloride)	75354	C	6.2e+01	1.2e+00	0.0e+00	1.0e-04	7.0e-03
Dichlorophenol 2,4-	120832	NC	3.1e+02	1.8e+00	0.0e+00	1.0e-01	
Dichlorophenoxyacetic acid 2,4-(2,4-D)	94757	NC	4.8e+00	1.0e+00	0.0e+00	4.0e-01	
Dichloropropane 1,2-	78875	C	4.7e+01	1.1e+00	1.3e-02	1.0e-03	5.0e-03
Dichloropropene cis-1,3-	10061015	C	6.3e+01	1.2e+00	1.2e+01	5.0e-04	
Dichloropropene trans-1,3-	10061026	C	6.3e+01	1.2e+00	1.2e+01	5.0e-04	
Dichloropropene 1,3- (mixture of isomers)	542756	C	2.7e+01	1.1e+00	0.0e+00	5.0e-04	
Dieldrin	60571	C	1.2e+05	3.2e+02	1.8e-02	5.0e-06	
Diethyl phthalate	84662	NC	9.8e+01	1.3e+00	4.5e-03	3.0e+01	
Diethylstilbestrol	56531	C	1.2e+04	3.4e+01	0.0e+00	2.0e-08	
Dimethoate	60515	NC	1.4e+00	1.0e+00	5.7e-01	7.0e-03	
Dimethoxybenzidine 3,3'-	119904	C	3.1e+01	1.1e+00	0.0e+00	6.0e-03	
Dimethyl phthalate	131113	NC	1.6e+01	1.0e+00	3.2e-02	4.0e+02	
Dimethylbenzidine 3,3'-	119937	C	3.6e+02	1.9e+00	0.0e+00	9.0e-06	
Dimethylbenz[a]anthracene 7,12-	57976	NC	4.4e+06	1.2e+04	0.0e+00	3.0e-06	
Dimethylphenol 2,4-	105679	NC	2.0e+02	1.5e+00	0.0e+00	7.0e-01	
Dinitrobenzene 1,3-	99650	NC	2.0e+01	1.1e+00	0.0e+00	4.0e-03	
Dinitrophenol 2,4-	51285	NC	8.1e-01	1.0e+00	0.0e+00	7.0e-02	
Dinitrotoluene 2,4-	121142	NC	4.8e+01	1.1e+00	0.0e+00	7.0e-02	
Dinitrotoluene 2,6-	606202	NC	2.5e+01	1.1e+00	0.0e+00	4.0e-02	

Common Name	CAS#	Health Effect C = carc. NC = non-carc.	K_{oc}	R	λ (yr^{-1})	HBN (mg/L)	MCL (mg/L)
Dioxane 1,4-	123911	C	1.5e-01	1.0e+00	0.0e+00	8.0e-03	
Diphenylamine	122394	NC	2.0e+03	6.3e+00	0.0e+00	9.0e-01	
Disulfoton	298044	NC	8.7e+02	3.3e+00	6.7e-01	1.0e-03	
Endosulfan (Endosulfan I and II, mixture)	115297	NC	3.6e+03	1.0e+01	6.4e-01	2.0e-01	
Endrin	72208	NC	4.0e+04	1.1e+02	1.6e-02	1.0e-02	2.0e-03
Epichlorohydrin	106898	C	3.0e-01	1.0e+00	9.0e+00	9.0e-03	
Ethoxyethanol 2-	110805	NC	2.9e-01	1.0e+00	0.0e+00	1.0e+01	
Ethyl methanesulfonate	62500	C	5.4e-01	1.0e+00	3.6e+02	3.0e-07	
Ethyl acetate	141786	NC	2.2e+00	1.0e+00	6.3e-02	3.0e+01	
Ethyl methacrylate	97632	NC	1.9e+01	1.0e+00	1.9e-02	3.0e+00	
Ethyl ether	60297	NC	3.6e+00	1.0e+00	0.0e+00	7.0e+00	
Ethylbenzene	100414	NC	1.0e+03	3.7e+00	0.0e+00	4.0e+00	7.0e-01
Ethylene thiourea	96457	C	0.0e+00	1.0e+00	0.0e+00	7.2e-04	
Ethylene dibromide (1,2-Dibromoethane)	106934	C	2.6e+01	1.1e+00	1.8e-01	1.0e-06	5.0e-05
Fluoranthene	206440	NC	4.3e+04	1.1e+02	0.0e+00	1.0e+00	
Fluorene	86737	NC	8.1e+03	2.3e+01	0.0e+00	1.0e+00	
Formaldehyde	50000	NC	5.0e-02	1.0e+00	0.0e+00	7.0e+00	
Formic acid	64186	NC	2.0e-03	1.0e+00	0.0e+00	7.0e+01	
Furan	110009	NC	1.0e+01	1.0e+00	0.0e+00	4.0e-02	
HCH alpha-	319846	C	2.7e+03	8.2e+00	3.1e-01	1.0e-05	
HCH beta-	319857	C	2.7e+03	8.2e+00	0.0e+00	5.0e-05	
HCH (Lindane) gamma-	58899	C	2.5e+03	7.7e+00	3.1e-01	7.0e-05	2.0e-04
Heptachlor	76448	C	1.6e+05	4.3e+02	1.8e+01	2.0e-05	4.0e-04
Heptachlor epoxide	1024573	C	7.9e+04	2.1e+02	1.8e-02	9.0e-06	2.0e-04
Hexachloro-1,3-butadiene	87683	C	2.9e+04	7.8e+01	0.0e+00	1.0e-03	
Hexachlorobenzene	118741	C	2.6e+05	6.9e+02	0.0e+00	5.0e-05	1.0e-03
Hexachlorocyclopentadiene	77474	NC	5.3e+04	1.4e+02	7.2e+00	3.0e-01	5.0e-02

Common Name	CAS#	Health Effect C = carc. NC = non-carc.	K_{oc}	R	λ (yr^{-1})	HBN (mg/L)	MCL (mg/L)
Hexachloroethane	67721	C	4.1e+03	1.2e+01	0.0e+00	6.0e-03	
Hexachlorophene	70304	NC	1.0e+05	2.7e+02	0.0e+00	1.0e-02	
Indeno[1,2,3-cd]pyrene	193395	C	1.8e+06	4.8e+03	0.0e+00	2.1e-04	
Isobutyl alcohol	78831	NC	2.8e+00	1.0e+00	0.0e+00	1.0e+01	
Isophorone	78591	C	7.9e+01	1.2e+00	0.0e+00	9.0e-02	
Kepone	143500	C	1.4e+04	3.9e+01	0.0e+00	2.0e-06	
Methacrylonitrile	126987	NC	1.7e+00	1.0e+00	1.2e-04	4.0e-03	
Methanol	67561	NC	8.3e-02	1.0e+00	0.0e+00	2.0e+01	
Methoxychlor	72435	NC	7.9e+04	2.1e+02	2.0e-01	2.0e-01	4.0e-02
Methyl methacrylate	80626	NC	5.5e+00	1.0e+00	3.4e-02	3.0e+00	
Methyl isobutyl ketone	108101	NC	7.4e+00	1.0e+00	0.0e+00	2.0e+00	
Methyl parathion	298000	NC	3.0e+02	1.8e+00	8.1e-01	9.0e-03	
Methyl ethyl ketone	78933	NC	9.3e-01	1.0e+00	0.0e+00	2.0e+01	
Methylcholanthrene 3-	56495	C	1.0e+07	2.7e+04	0.0e+00	3.0e-06	
Methylene Chloride (Dichloromethane)	75092	C	8.5e+00	1.0e+00	2.9e-04	1.0e-02	5.0e-03
Methylene bromide (Dibromomethane)	74953	NC	1.6e+01	1.0e+00	0.0e+00	4.0e-01	
N-Nitrosodiphenylamine	86306	C	6.9e+02	2.8e+00	0.0e+00	2.0e-02	
N-Nitrosodiethylamine	55185	C	9.3e-01	1.0e+00	0.0e+00	6.0e-07	
N-Nitrosodimethylamine	62759	C	2.8e+00	1.0e+00	0.0e+00	2.0e-06	
N-Nitrosopyrrolidine	930552	C	2.7e-01	1.0e+00	0.0e+00	4.0e-05	
N-Nitrosopiperidine	100754	C	9.6e-01	1.0e+00	0.0e+00	2.0e-06	
N-Nitrosomethylethylamine	10595956	C	1.1e+01	1.0e+00	0.0e+00	4.0e-06	
N-Nitroso-di-n-propylamine	621647	C	1.1e+01	1.0e+00	0.0e+00	1.0e-05	
N-Nitroso-di-n-butylamine	924163	C	1.2e+02	1.3e+00	0.0e+00	2.0e-05	
Naphthalene	91203	NC	1.3e+03	4.4e+00	0.0e+00	1.0e+00	
Nitrobenzene	98953	NC	3.2e+01	1.1e+00	0.0e+00	2.0e-02	

Common Name	CAS#	Health Effect C = carc. NC = non-carc.	K_{oc}	R	λ (yr^{-1})	HBN (mg/L)	MCL (mg/L)
Octamethyl pyrophosphoramide	152169	NC	3.1e-01	1.0e+00	8.8e-05	7.0e-02	
Parathion (ethyl)	56382	NC	1.4e+03	4.8e+00	7.1e-01	2.0e-01	
Pentachlorobenzene	608935	NC	2.5e+05	6.5e+02	0.0e+00	3.0e-02	
Pentachloronitrobenzene (PCNB)	82688	C	3.7e+04	1.0e+02	0.0e+00	3.0e-04	
Pentachlorophenol	87865	C	1.2e+03	4.1e+00	0.0e+00	7.0e-04	1.0e-03
Phenol	108952	NC	1.7e+01	1.0e+00	0.0e+00	2.0e+01	
Phenyl mercuric acetate	62384	NC	0.0e+00	1.0e+00	0.0e+00	2.8e-03	
Phenylenediamine, 1,3-	108452	NC	5.0e-01	1.0e+00	0.0e+00	2.0e-01	
Phorate	298022	NC	4.4e+02	2.2e+00	1.8e+01	7.0e-03	
Polychlorinated biphenyls (Aroclors)	1336363	C	1.6e+06	4.1e+03	0.0e+00	1.0e-05	5.0e-04
Pronamide	23950585	NC	4.3e+02	2.1e+00	2.1e-05	3.0e+00	
Pyrene	129000	NC	8.3e+04	2.2e+02	0.0e+00	1.0e+00	
Pyridine	110861	NC	2.2e+00	1.0e+00	0.0e+00	4.0e-02	
Safrole	94597	C	2.2e+02	1.6e+00	0.0e+00	5.0e-04	
Strychnine and salts	57249	NC	7.9e+01	1.2e+00	0.0e+00	1.0e-02	
Styrene	100425	NC	6.9e+02	2.8e+00	0.0e+00	7.0e+00	1.0e-01
TCDDioxin 2, 3, 7, 8-	1746016	C	1.3e+06	3.3e+03	0.0e+00	6.0e-10	3.0e-08
Tetrachlorobenzene 1,2,4,5-	95943	NC	1.9e+04	5.2e+01	0.0e+00	1.0e-02	
Tetrachloroethane 1,1,2,2-	79345	C	1.2e+02	1.3e+00	2.2e-01	4.0e-04	
Tetrachloroethane 1,1,1,2-	630206	C	5.1e+02	2.4e+00	4.1e-03	3.0e-03	
Tetrachloroethylene	127184	NC	1.6e+02	1.4e+00	0.0e+00	4.0e-01	5.0e-03
Tetrachlorophenol 2,3,4,6-	58902	NC	2.1e+02	1.6e+00	0.0e+00	1.0e+00	
Tetraethyl dithiopyrophosphate (Sulfotep)	3689245	NC	3.2e+03	9.6e+00	2.4e+01	2.0e-02	
Toluene	108883	NC	2.7e+02	1.7e+00	0.0e+00	7.0e+00	1.0e+00
Toluenediamine 2,4-	95807	C	1.1e+00	1.0e+00	0.0e+00	3.0e-05	
Toluidine p-	106490	C	1.7e+01	1.0e+00	0.0e+00	4.0e-04	

Common Name	CAS#	Health Effect C = carc. NC = non-carc.	K_{oc}	R	λ (yr^{-1})	HBN (mg/L)	MCL (mg/L)
Toluidine o-	95534	C	1.7e+01	1.0e+00	0.0e+00	4.0e-04	
Toxaphene (chlorinated camphenes)	8001352	C	2.0e+04	5.5e+01	2.0e-02	8.0e-05	3.0e-03
Tribromomethane (Bromoform)	75252	C	1.1e+02	1.3e+00	1.4e-04	1.0e-02	1.0e-01
Trichloro-1,2,2-trifluoro- ethane 1,1,2-	76131	NC	9.3e+02	3.5e+00	0.0e+00	1.0e+03	
Trichlorobenzene 1,2,4-	120821	NC	9.1e+03	2.5e+01	0.0e+00	4.0e-01	7.0e-02
Trichloroethane 1,1,1-	71556	NC	1.5e+02	1.4e+00	2.2e-01	1.2e+00	2.0e-01
Trichloroethane 1,1,2-	79005	C	5.4e+01	1.1e+00	8.0e-04	1.0e-03	5.0e-03
Trichloroethylene (1,1,2-Trichloroethylene)	79016	C	1.3e+02	1.3e+00	0.0e+00	8.0e-03	5.0e-03
Trichlorofluoromethane (Freon 11)	75694	NC	1.3e+02	1.3e+00	0.0e+00	1.0e+01	
Trichlorophenol 2,4,-	95954	NC	8.5e+02	3.3e+00	0.0e+00	4.0e+00	
Trichlorophenol 2,4,6-	88062	C	1.8e+02	1.5e+00	0.0e+00	8.0e-03	
Trichlorophenoxy)propionic acid 2-(2,4,5- (Silvex)	93721	NC	5.5e+01	1.1e+00	0.0e+00	3.0e-01	
Trichlorophenoxyacetic acid 2,4,5-	93765	NC	2.7e+01	1.1e+00	0.0e+00	4.0e-01	
Trichloropropane 1,2,3-	96184	NC	4.6e+01	1.1e+00	5.0e-03	2.0e-01	
Trinitrobenzene, sym- (1,3,5-Trinitrobenzene)	99354	NC	1.1e+01	1.0e+00	0.0e+00	2.0e-03	
Tris (2,3-dibromopropyl) phosphate	126727	C	1.6e+03	5.1e+00	2.7e-02	9.0e-06	
Vinyl chloride	75014	NC	1.1e+01	1.0e+00	0.0e+00	4.0e-05	2.0e-03
Xylenes (total)	1330207	NC	1.2e+03	4.2e+00	0.0e+00	7.0e+01	1.0e+01
Antimony	7440360	NC	NA	NA	0.0e+00	1.4e-02	6.0e-03
Arsenic	7440382	C	NA	NA	0.0e+00	5.7e-05	5.0e-02
Barium	7440393	NC	NA	NA	0.0e+00	3.0e+00	2.0e+00
Beryllium	7440417	C	NA	NA	0.0e+00	4.0e-03	
Cadmium	7440439	NC	NA	NA	0.0e+00	2.0e-02	5.0e-03
Copper	7440508	NC	NA	NA	0.0e+00	1.0e+00	

Common Name	CAS#	Health Effect C = carc. NC = non-carc.	K_{OC}	R	λ (yr^{-1})	HBN (mg/L)	MCL (mg/L)
Chromium III	16065381	NC	NA	NA	0.0e+00	4.0e+01	
Chromium VI	7440473	NC	NA	NA	0.0e+00	1.8e-01	1.0e-01
Lead	7439921	C	NA	NA	0.0e+00	1.5e-02	
Mercury	7439976	NC	NA	NA	0.0e+00	1.1e-02	2.0e-03
Nickel	7440020	NC	NA	NA	0.0e+00	7.0e-01	1.0e-01
Selenium	7782492	NC	NA	NA	0.0e+00	1.8e-01	5.0e-02
Silver	7440224	NC	NA	NA	0.0e+00	2.0e-01	
Thallium	7440280	NC	NA	NA	0.0e+00	0.0e+00	2.0e-03
Vanadium	7440622	NC	NA	NA	0.0e+00	3.0e-01	
Zinc	7440666	NC	NA	NA	0.0e+00	1.0e+01	

Abbreviations and Symbols

CAS# = Chemical Abstract Service Registry Number
C = Carcinogen
NC = Non-carcinogen
K_{OC} = Organic carbon partition coefficient
NA = Not Applicable
R = Retardation Coefficient
λ = First Order Decay Rate (Only chemical hydrolysis is considered, since biodegradation rates can vary widely from one site to another.)
HBN = Health-Based Number
MCL = Maximum Contaminant Level

Appendix B

Sample Reports from Tier 1 and Tier 2

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National Evaluation (Tier I) Results

Recommendation: Single Liner

This model is in draft form and is not intended to be used in current waste management decision-making. All aspects of the model are undergoing peer review and public comment including :
1) The appropriateness of the Tier 2 model for a Location Adjusted analysis.
2) Input values for sensitive parameters and liner scenarios.
3) Capabilities and user-friendliness of the model software.

Facility Type	Landfill
Facility Name	Southern Industries Landfill
Street Address	123 Industrial Ave.
City	Raleigh
State	NC
Zip	27611
Date of Sample Analysis	October 31, 1998
Name of User	Sam Rogers
Additional Information	unit B-1

List of chemicals selected by the user

CAS Number	Chemical Name	Leachate Concentration
71432	Benzene	1.0E-02
75092	Methylene Chloride (Dichloromethane)	2.0E-02
7440360	Antimony	3.0E-02

Minimum Liner Recommendation Based on MCL

CAS Number	Chemical Name	Minimum Liner Recommendation
71432	Benzene	No Liner
75092	Methylene Chloride (Dichloromethane)	Single Liner
7440360	Antimony	Single Liner

Minimum Liner Recommendation Based on HBN

CAS Number	Chemical Name	Minimum Liner Recommendation
71432	Benzene	Single Liner
75092	Methylene Chloride (Dichloromethane)	No Liner
7440360	Antimony	No Liner

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In the following tables, for each constituent LCTV is calculated as DAF * TRL. If the groundwater concentration is exceedingly low, no DAF is given, but instead the DAF is denoted with an asterisk. In these cases, the LCTV is capped at the LCTV of the toxic daughter product, the TC Rule Level, or 1,000 mg/L. See the Guidance for more details.

Detailed Results Based on MCL - No Liner

CAS Number	Chemical Name	Leachate Conc. (mg/L)	LCTV (mg/L)	DAF	MCL (mg/L)	Protective ?
71432	Benzene	1.0E-02	1.1E-02	2.2E+00	0.005	Yes
75092	Methylene Chloride (Dichloromethane)	2.0E-02	1.1E-02	2.2E+00	0.005	No
7440360	Antimony	3.0E-02	2.1E-02	3.5E+00	0.006	No

Detailed Results Based on MCL - Single Liner

CAS Number	Chemical Name	Leachate Conc. (mg/L)	LCTV (mg/L)	DAF	MCL (mg/L)	Protective ?
71432	Benzene	1.0E-02	2.2E-02	4.5E+00	0.005	Yes
75092	Methylene Chloride (Dichloromethane)	2.0E-02	2.4E-02	4.8E+00	0.005	Yes
7440360	Antimony	3.0E-02	1.1E-01	1.9E+01	0.006	Yes

Detailed Results Based on MCL - Composite Liner

CAS Number	Chemical Name	Leachate Conc. (mg/L)	LCTV (mg/L)	DAF	MCL (mg/L)	Protective?
71432	Benzene	1.0E-02	5.0E-01	4.1E+05	0.005	Yes
75092	Methylene Chloride (Dichlorome	2.0E-02	1.0E+03	4.7E+08	0.005	Yes
7440360	Antimony	3.0E-02	1.0E+03	*	0.006	Yes

Detailed Results Based on HBN - No Liner

CAS Number	Chemical Name	Leachate Conc. (mg/L)	LCTV (mg/L)	DAF	HBN (mg/L)	Protective?
71432	Benzene	1.0E-02	6.6E-03	2.2E+00	0.003	No
75092	Methylene Chloride (Dichlorometh	2.0E-02	2.2E-02	2.2E+00	0.01	Yes
7440360	Antimony	3.0E-02	4.8E-02	3.5E+00	0.014	Yes

Detailed Results Based on HBN - Single Liner

CAS Number	Chemical Name	Leachate Conc. (mg/L)	LCTV (mg/L)	DAF	HBN (mg/L)	Protective ?
71432	Benzene	1.0E-02	1.4E-02	4.5E+00	0.003	Yes
75092	Methylene Chloride (Dichloromethane)	2.0E-02	4.8E-02	4.8E+00	0.01	Yes
7440360	Antimony	3.0E-02	2.6E-01	1.9E+01	0.014	Yes

Detailed Results Based on HBN - Composite Liner

CAS Number	Chemical Name	Leachate Conc. (mg/L)	LCTV (mg/L)	DAF	HBN (mg/L)	Protective?
71432	Benzene	1.0E-02	5.0E-01	4.1E+05	0.003	Yes
75092	Methylene Chloride (Dichlorometh	2.0E-02	1.0E+03	4.7E+08	0.01	Yes
7440360	Antimony	3.0E-02	1.0E+03	*	0.014	Yes

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Location Adjusted Evaluation (Tier II) Results

Recommendation: Not Protective

This model is in draft form and is not intended to be used in current waste management decision-making. All aspects of the model are undergoing peer review and public comment including :
1) The appropriateness of the Tier 2 model for a Location Adjusted analysis
2) Input values for sensitive parameters and liner scenarios, and
3) Capabilities and user-friendliness of the model software.

Facility Type	Landfill
Facility Name	Southern Industries Landfill
Street Address	123 Industrial Ave.
City	Raleigh
State	NC
Zip	27611
Date of Sample Analysis	October 31, 1998
Name of User	Sam Rogers
Additional Information	unit B-1

Location Parameters

Parameter	Default Value	Value Entered	Justification
Area of WMU (sq. m)	1.9E+04	1.8E+04	facility survey, 10/5/96
Depth to Water Table (m)	5.3E+00	4.5E+00	well B-15, gauged 10/15/98
Aquifer Thickness (m)	1.1E+01	1.0E+01	regional hydrogeologic map
Radial distance to Well (m)	1.5E+02	1.5E+02	value recommended by state regulatory agency
Groundwater pH Value (only if metals are	7.0E+00	7.2E+00	well B-15, sampled 10/15/98

Infiltration Rate

NoLiner	SingleLiner
3.3E-01	3.6E-02

Chemical Toxicity Standards

CAS Number	Chemical Name	TRL (mg/L)	TRL Based On
71432	Benzene	5.0E-03	MCL
75092	Methylene Chloride (Dichloromethane)	5.0E-03	MCL
7440360	Antimony	6.0E-03	MCL

Daughter Chemical Toxicity Standards

Parent Chemical	Daughter Cas #	Daughter Chemical	TRL (mg/L)	TRL Based On
Methylene Chloride (Dichloromethane)	50000	Formaldehyde	7.0E+00	HBN

Chemical Properties

CAS Number	Chemical Name	KOC or KD	Decay Coef. (1/yr)	Leachate Con. (mg/L)
71432	Benzene	6.3E+01	0.0E+00	1.0E-02
75092	Methylene Chloride (Dichloromethane)	8.5E+00	2.9E-04	2.0E-02
7440360	Antimony	3.2E+01	0.0E+00	3.0E-02

Daughter Chemical Properties

Parent Chemical	Daughter Chemical	KOC or KD	Decay Coef. (1/yr)
Methylene Chloride (Dichloromethane)	Formaldehyde	1.0E+00	0.0E+00

Detailed Results -- No Liner

Chemical Name	DAF	Daughter DAF	TC Rule Level (mg/L)	LCTV Cap*	Final LCTV (mg/L)	Leachate Conc (mg/L)	Protective?
Benzene	1.4E+00		5.0E-01		7.0E-03	1.0E-02	No
Methylene Chloride (Dich	2.0E+00	1.4E+00			9.9E-03	2.0E-02	No
Antimony	1.4E+00				8.4E-03	3.0E-02	No

* For each Constituent LCTV = DAF * TRL
Unless the LCTV has been capped as noted by one of the following

D -- LCTV Capped at Daughter Chemical LCTV.
T -- LCTV Capped at TC Rule Level.
L -- LCTV Capped at 1000 mg/L.

Detailed Results -- Single Liner

Chemical Name	DAF	Daughter DAF	TC Rule Level (mg/L)	LCTV Cap*	Final LCTV (mg/L)	Leachate Conc (mg/L)	Protective?
Benzene	4.7E+00		5.0E-01		2.3E-02	1.0E-02	Yes
Methylene Chloride (Dic	5.4E+00	4.7E+00			2.7E-02	2.0E-02	Yes
Antimony	4.7E+00				2.8E-02	3.0E-02	No

* For each Constituent LCTV = DAF * TRL
Unless the LCTV has been capped as noted by one of the following

D -- LCTV Capped at Daughter Chemical LCTV.
T -- LCTV Capped at TC Rule Level.
L -- LCTV Capped at 1000 mg/L.