7.0 Understanding Your IWEM Results

After completing an analysis, IWEM provides a recommendation for a liner design for a WMU or the appropriateness of land application. Section 7 provides guidance on how IWEM may assist you in answering the following questions:

- What kind of liner will be necessary to safely manage my waste in a landfill, surface impoundment or waste pile?
- Is land application appropriate for my waste?
- What are the maximum allowable leachate concentrations for all constituents in a waste for a particular type of WMU and liner design?
- Should you consider a Tier 3 assessment?

The IWEM liner recommendations and determination of maximum allowable leachate concentrations are based on protective ground-water concentrations at wells. In Tier 1, IWEM uses the tabulated LCTV values that represent protective national screening values. In Tier 2, IWEM calculates LCTVs to provide guidance on what leachate levels need to be achieved, for instance through treatment, to safely allow disposal in a particular WMU design. To help you understand the IWEM results, we will discuss LCTVs first.

7.1 Leachate Concentration Threshold Values (LCTVs)

An LCTV is the maximum concentration of a constituent in the waste leachate that is protective of ground water. That is, if the concentration in the leachate does not exceed the LCTV, then the concentration in ground water at the well will not exceed the RGC. IWEM uses the EPACMTP fate and transport model to calculate LCTVs. EPACMTP is a fate and transport model that simulates the concentration of a constituent in ground-water, as a function of the constituent's concentration in the waste leachate. The LCTV is determined by comparing the predicted well concentration against a selected RGC, i.e., an MCL or HBN. By definition, the LCTV is the value of the leachate concentration for which the well concentration is equal to the RGC. LCTVs depend on: 1) the combined effects of WMU design characteristics and hydrogeological fate and transport processes; and 2) the effect of constituent-specific regulatory standards such as an MCL and constituent toxicity represented by the HBN.

Tier 1 LCTVs are different from Tier 2 LCTVs. LCTVs from the Tier 1 analysis are generally applicable to sites across the country. Tier 2 LCTVs on the other hand, are based on site-specific data for several sensitive parameters and are not applicable to other sites.

7.2 Limits on the LCTV

While the LCTVs are based on fate and transport modeling, and regulatory and risk-based ground-water standards, EPA also considered other factors in developing final LCTV values for some waste constituents. These are described in this section.

7.2.1 Toxicity Characteristic Rule (TC Rule) Regulatory Levels

Section 6.2

TBD

In 1990, EPA adopted the Toxicity Characteristic (TC) Rule making wastes containing certain constituents at or above listed leachate concentrations a hazardous waste.

For any waste constituent included in the TC rule, we capped the LCTV at the TC Rule Regulatory Level. This level is the leachate concentration above which the waste is considered to be a hazardous waste (U.S. EPA, 1990). TC levels have been determined for the constituents listed in Table 7.1.

7.2.2 1,000 mg/L Cap

Section 6.2

TBD

EPA does not expect leachate concentrations from WMUs 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. One of the reasons to cap the leachate concentration in IWEM is that the fate and transport assumptions in IWEM may not be valid at high concentrations. For instance, high leachate concentrations may indicate the presence of a free organic phase. Consequently, all Tier 1 and Tier 2 LCTVs are capped at a maximum value of 1,000 mg/L.

Table 7.1 Toxicity Characteristic Leachate Levels

Waste Constituent	TC Rule Leachate Regulatory Level (mg/L)	Waste Constituent	TC Rule Leachate Regulatory Level (mg/L)
Arsenic	5	Hexachloro-1,3-butadiene	0.5
Barium	100	Hexachloroethane	3
Benzene	0.5	Lead	5
Cadmium	1	Lindane	0.4
Carbon Tetrachloride	0.5	Mercury	0.2
Chlordane	0.03	Methoxychlor	10
Chlorobenzene	100	Methyl ethyl ketone	200
Chloroform	6	Nitrobenzene	2
Chromium	5	Pentachlorophenol	100
o-cresol	200	Pyridine	5
m-cresol	200	Selenium	1
p-cresol	200	Silver	5
2,4-D	10	Tetrachloroethylene	0.7
1,4-dichlorobenzene	7.5	Toxaphene	0.5
1,2-dichloroethane	0.5	Trichloroethylene	0.5
1,1-dichloroethylene	0.7	2,4,5-trichlorophenol	400
2,4-dinitrotoluene	0.13	2,4,6-trichlorophenol	2
Endrin	0.02	2,4,5-TP acid (silvex)	1
Heptachlor	0.008	Vinyl chloride	0.2
Hexachlorobenze	0.13		

7.2.3 Constituents with Toxic Daughter Products

Section 6.2

TBD

A number of the constituents included in the IWEM constituent database can be transformed in soil and ground water into one or more toxic daughter products as a result of hydrolysis reactions. For these constituents, the LCTVs are calculated such that they accommodate both the parent constituent as well as any toxic daughter products. For instance, if a parent waste constituent rapidly hydrolyses into a persistent daughter product, the ground-water exposure caused by the parent itself may be minimal (it has already degraded before it reaches the well), but the final LCTV for this constituent would be based on the exposure caused by the daughter product, under the protective assumption that the parent compound fully transforms into the daughter product. If an IWEM constituent has more than one toxic daughter product, the final LCTV is based on the LCTV for the most protective compound in the parent-daughter sequence. If the

LCTV of the parent constituent is lower than that of the daughter, the LCTV of the parent remains unchanged. Additionally, if the daughter constituent has a particular RGC but the parent constituent does not, the RGC of the daughter product is used to determine the parent constituent LCTV. This methodology is designed to be protective of downgradient ground water in terms of both the parent waste constituent and its daughter constituent(s).

The IWEM constituent database includes information on the toxic daughter products associated which each hydrolyzing constituent, and the user does not need to know which constituents transform into toxic daughter products. In Tier 1, the 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 are flagged in the Tier 1 tables and reports.

In a Tier 2 evaluation, if you select a waste constituent that hydrolyses, the IWEM software will automatically add any toxic daughters products associated with that constituent to the evaluation. In the Tier 2 input screens, daughter products are listed immediately after their parent(s) in the Toxicity Standards Screen (Screen 22, see Figure 5.23). Constituents that are included because they are daughter products of constituents in the waste, are identified as such in the input screens. In the Tier 2 reports, the results of all waste constituents and any toxic daughter constituents produced by hydrolysis are shown in the Tier 2 report. Daughter products are listed separately from parent constituents, but for each daughter product, the parent waste constituent from which it originated is identified.

Due to the chemical transformation of waste constituents, it is possible the same constituent is included more than once in the evaluation. A constituent can be selected because it is present in the waste, but it can also be added by the IWEM software because it is produced as the result of hydrolysis transformations on one or more other waste constituents. IWEM evaluates each occurrence of the constituent separately, and the same constituent may lead to different liner recommendations in the same Tier 2 evaluation. For instance, assume that a constituent is present at low concentration in the waste itself, but this compound is also produced as the result of hydrolysis of a second waste constituent which is in the waste at a much higher concentration. IWEM will first evaluate the constituent as an original waste constituent. In this example, we assumed that the concentration in the waste is low, and the IWEM software in that case may recommend a no-liner design as being protective. Next, IWEM will evaluate the ground-water impact of the same constituent as a daughter product resulting from the transformation of the second waste constituent. Because this second waste constituent (the parent) is present in the waste at high concentrations, its transformation may cause the ground-water concentration of our constituent of concern (which is now evaluated as a daughter product) to be so high that IWEM determines that a no-liner design is not

protective. This example would lead to a result in which the same constituent has two different liner recommendations.

Even though the chemical compound is the same, IWEM treats these two instances as if they were different constituents. One of the reasons EPA chose to do this, is that it allows the user to make waste management decisions in terms of the constituents that are actually present in the waste. In the example described here, an option may be to treat the waste to reduce constituent concentrations to acceptable levels. In our example, the goal should be not to reduce the level of the constituent of concern in the waste (it is only present at low levels), but rather to reduce the concentration of its parent constituent. Doing this will automatically reduce the ground-water impact of its daughter product(s).

7.3 IWEM Liner Recommendations

Section 6.3
TBD

IWEM makes liner recommendations by identifying the minimum design that is protective of ground water for all waste constituents. In Tier 1, a liner design is protective if the expected leachate concentrations for all waste constituents are less than the LCTV determined by IWEM for the same constituents. In the case of LAUs, land application of waste is considered appropriate if the leachate concentrations of all constituents do not exceed LAU LCTVs.

The IWEM Tier 1 software automatically performs the comparisons of leachate concentration to all of the LCTVs for each waste constituent and liner scenario. The results of the evaluation are presented in terms of a MCL summary and a HBN summary. The HBN summary reflects the liner recommendation based on the most protective, that is the lowest, HBN available for each constituent. The recommendation also takes into account the possible formation of toxic daughter products, as discussed in Section 7.2.3.

If the leachate concentrations for all constituents are lower than the corresponding no-liner LCTVs, then no liner is recommended as being sufficiently protective of groundwater. If any leachate concentration is higher than the corresponding no-liner LCTV, then a minimum of a single clay liner is recommended. If any leachate concentration is higher than the corresponding single clay liner LCTV, then a minimum of a composite liner is recommended. If any concentration is higher than the composite liner, consider pollution prevention, treatment, or additional controls. For waste streams with multiple constituents, the recommended liner design is the most protective minimum recommended liner.

After conducting a Tier 1 analysis, you can choose to implement the Tier 1 recommendation by designing the unit based on the liner recommendations given by the IWEM software. If you choose to implement the Tier 1 recommendation, consultation

with state authorities is recommended to ensure compliance with state regulations, which may require more protective measures than the Tier 1 lookup tables recommend. Alternatively, if the waste has one or very few "problem" constituents that call for a more stringent and costly liner system (or which make land application inappropriate), evaluate pollution prevention, recycling, and treatment efforts for those constituents.

If, after conducting the Tier 1 analysis, you are not satisfied with the resulting recommendations, or if site-specific conditions seem likely to support the use of a liner design different from the one recommended (or suggest a different conclusion regarding the appropriateness of land application of a waste), then you may conduct a Tier 2 analysis or a site-specific groundwater fate and transport analysis (Tier 3).

In a Tier 2 evaluation, IWEM uses the EPACMTP fate and transport model to determine the ground-water exposure concentration that is expected for each waste constituent given its leachate concentration. IWEM uses the technique of *Monte Carlo analysis* to develop a probability distribution of ground-water well exposure concentrations for each constituent and liner scenario. Analogous to Tier 1 (which uses a 90^{th} percentile LCTV value), IWEM uses the 90^{th} percentile of the ground-water well exposure concentration in Tier 2 to make liner recommendations. The software compares the 90^{th} percentile ground-water exposure concentration to the RGC(s) for that constituent. IWEM first makes this evaluation for the no-liner scenario. If the ground-water exposure concentration is less than the applicable RGC(s), then the no-liner scenario is protective for that constituent. IWEM evaluates all waste constituents in this manner. If the 90^{th} percentile ground-water exposure concentrations of all waste constituents are below their respective RGCs, then IWEM recommends the no-liner scenario as being protective and the evaluation is complete. However, if the ground-water exposure concentrations of one or more waste constituents exceed their RGCs, then the no-liner scenario is not protective, and IWEM will evaluate the single clay liner scenario (unless the WMU is a LAU). If the single clay liner scenario is protective for all constituents, IWEM will recommend this design. If any waste constituents fail the single clay liner design, then IWEM will recommend at least a composite liner.

In a Tier 2 evaluation, IWEM also calculates LCTVs. The Tier 2 LCTVs are different from the Tier 1 values; they represent location-adjusted thresholds. While the Tier 2 LCTVs are not directly used in IWEM to make liner recommendations, they are displayed on the detailed results screen, and printed in the IWEM reports. These LCTVs can be used in the same manner as in Tier 1 to identify pollution prevention, recycling, or treatment alternatives to reduce the leachate concentrations of "problem" constituents to levels that allow disposal of a waste in a less stringent WMU design.

The Monte Carlo simulations required for a Tier 2 evaluation can be computationally demanding, and an evaluation of multiple liner designs for a single waste constituent can take several hours. In order to optimize the computational process, IWEM will first perform the liner evaluations from least protective (no-liner) to most protective (composite liner). If during this process, IWEM identifies a liner design that is protective for all constituents (for instance, a single clay liner), it will stop the evaluation process, and not evaluate more protective designs (in the example case, it would skip the composite liner evaluation).

After conducting the Tier 2 Evaluation, you can choose to implement the Tier 2 recommendation by designing the unit based on the liner recommendations given by the IWEM software or continue to a Tier 3 analysis. If you choose to implement the Tier 2 recommendation, consultation with state authorities is recommended to ensure compliance with state regulations, which may require more protective measures than the Tier 2 results recommend.

If after conducting the Tier 2 Evaluation, you are not satisfied with the resulting recommendations or if site-specific conditions seem likely to support the use of a liner design different from the one recommended (or suggest a different conclusion regarding the appropriateness of land application of a waste), then you may conduct a fully site-specific groundwater fate and transport analysis (Tier 3).