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REPORT

on the review of

ALTERNATE CONCENTRATION LIMIT GUIDANCE

together with

TWO CASE STUDIES DEMONSTRATING THAT GUIDANCE

by the

Environmental Engineering Committee

Science Advisory Board

U. S. Environmental Protection Agency

February, 1986

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

May 8, 1986

OFFICE OF
THE ADMINISTRATOR

Honorable Lee M. Thomas
Administrator
U. S. Environmental Protection Agency
401 M Street, S. W.
Washington, D.C. 20460

Dear Mr. Thomas:

In June, 1985, the Office of Solid Wastes (OSW) asked the Science Advisory Board (SAB) to review draft Agency guidance for the establishment of Alternate Concentration Limits (ACL) for RCRA facilities to protect human health and the environment. The review was assigned to the SAB's Environmental Engineering Committee. In October, 1985, OSW also requested the Committee to review two case studies demonstrating applications of that guidance.

The Committee has completed its preliminary review, and is forwarding its report to you. The Committee identified, at this time, only obvious technical errors or omissions; OSW has informed us that it will seek a more comprehensive scientific review when it prepares a final draft of the ACL guidance.

The Committee has made a number of specific technical recommendations for improving both the guidance and the case studies. We would appreciate an Agency response to this advice.

Thank you for the opportunity to present our views on these issues.

Sincerely,

Raymond C. Loehr
Chairman, Environmental
Engineering Committee
Science Advisory Board

Norton Nelson
Chairman, Executive Committee
Science Advisory Board

cc: J. Winston Porter
Marcia Williams
Vernon Myers
Terry Yosie

SECTION I

INTRODUCTION

Background

The Resource Conservation and Recovery Act (RCRA) regulations require that the owner/operator of a hazardous waste disposal facility delineate any plume of contamination that has entered the ground water from a regulated unit. This includes identifying the concentration of each Appendix VIII constituent in the plume. If any of the hazardous constituents are present in concentrations which exceed established concentration limits (Interim Primary Drinking Water Standards) or background levels, then a corrective action plan must be submitted. The owner/operator is not required, however, to submit this plan if he can demonstrate that alternative concentration limits (ACL) at the point of compliance will protect human health and the environment.

EPA has been developing, for several years, guidance on how these ACL's can be determined. In August, 1984, Mr. John Skinner, then the Director of the Office of Solid Waste, asked the Science Advisory Board (SAB) to review drafts of this guidance as soon as it was prepared by his Office, as well as several case studies demonstrating applications of the proposed guidance.

The Environmental Engineering Committee of the SAB was assigned the task of conducting the review. Several information briefings were given to the Committee by Mr. Vernon Myers, the project officer, but the draft guidance was not delivered to the Committee until June, 1985, at which time they were asked to make only a cursory review of the guidance and to inform the Agency if there were any glaring problems which needed immediate resolution. It was understood that a more complete review of the guidance would be done when the Notice of Availability of the document was published in the Federal Register.

In October of 1985, Mr. Myers sent the first two case studies to the Committee for detailed review. This report is the results of both a cursory review of the draft ACL guidance, and of the detailed review of the first two case studies.

Committee Review Procedures

A Subcommittee of the Environmental Engineering Committee, consisting of Mr. Richard Conway (Chairman), Dr. Donald O'Connor, Dr. Ben Ewing, Dr. Mitchell Small and Dr. Joseph T. Ling, was organized to conduct the review. The initial briefing on the Guidance was presented to the Committee by Mr. Burnell Vincent, Office of Solid Waste, at a meeting on August 16-17, 1984 (the meeting was announced in the Federal Register on July 31, 1984, page 30596). Subsequent status briefings were given by Mr. Vernon Myers, the ACL project officer at regularly scheduled meetings of the EEC on February 26-27, 1985 (announced in the Federal Register February 11, 1985, page 5672) and on June 13-14, 1985 (announced in the Federal Register May 29, 1985, page 21936. The draft guidance was furnished to the Subcommittee in June 1985. On October 15, 1985, Mr. Myers also furnished the Subcommittee copies of two case studies intended to demonstrate application of the guidance, and to serve as models to aid in implementing the June, 1985, draft of the guidance. The Subcommittee held a meeting on December 3, 1985 (announced in the Federal Register, November 13, 1985, page 46829) to review both the draft guidance and the two case studies. The public had been invited to comment on the proposed guidance and the case studies, but only one organization, the law firm of Heron and Burchette, Washington, D. C., availed themselves of the opportunity.

This report was drafted by members of the ACL Subcommittee, with some additional background information provided by Mr. Harry C. Torno, Executive Secretary to the Environmental Engineering Committee. It was then reviewed and approved by the Committee after modification.

SECTION II

REVIEW OF THE DRAFT ACL GUIDANCE AND CASE STUDIES A AND B

Draft ACL Guidance Document

The SAB was requested to review the early draft (dated June 1985) of this guidance document; only obvious omissions or errors were sought, as a more detailed review of the final draft destined for the Federal Register will be requested from the SAB.

While the draft ACL guidance is in general well done, the following improvements are recommended:

1. *Executive Summary:* An addition to the list of considerations regarding surface water should be: "Surface water models that predict factors like initial mixing zone, final dilution, partitioning, bed effects" (p. E-3).

2. Introduction: The concept that "all Agency published exposure levels for the protection of human health or the environment can be used as ACLs" should be modified to include those Agency-approved values that have been peer reviewed or subjected to public comment (p. 5).

3. Chapter III-"Hydrogeologic Characteristics": Consideration should be given to allowing a simplified approach of using worst-case assumptions of hydraulic conductivity and porosity instead of detailed laboratory and field testing of each stratigraphic unit. For example, assume a complex situation has a conductivity of sand and a porosity of clay. This will reduce study costs, but still be protective of the environment.

4. Chapter IV-"Ground-Water Flow Direction": Consider allowing the assumption without detailed study that flow on a long term net basis will be toward surface water in obvious cases like a peninsula.

5. Chapter VII-"Proximity of Surface Water and Groundwater Users": Many ACLs rest upon the dilution afforded by down-gradient surface waters. Consequently the discussion of surface water models should be expanded to explain factors like the applicability of mixing zones, the selection of low flow rate, partitioning to suspended solids, benthos toxicity, resuspension of deposited solids and transformation.

6. Chapter X-"Potential Health Risks": Consider allowing this part of the study to be omitted when the proposed ACL is less than existing properly published health-based water quality criteria. However, the inhalation pathway specified on page 58 should not be overlooked when it has a significant chance of contributing to the daily intake.

Some general guidance is needed to encourage applicants for ACLs to concentrate their effort in the critical areas and not spend efforts on factors of low sensitivity.

Case Studies A and B

General

These case studies are intended to assist applicants for alternate concentration limits (ACL) in the preparation of the ACL demonstration in accordance with ACL Guidance Criteria, Part 1. They may also be used by permit writers for guidance in review of applications. Although the case studies are based on real situations, they are intended to be hypothetical ACL demonstrations which exemplify the organization, the logic and the detail required for supporting information. Most important in these case studies is the methodology used in the assessment of the health and ecological risks associated with proposed contaminant concentration levels.

Case Study A and Case Study B represent cases which are so straightforward that the minimal nature of the health and ecosystem risks is virtually self-evident. In such circumstances, an ACL demonstration should not require such elaborate documentation. The preface for each case study should make the point that the case study is intended to be an example of the procedure for preparing an ACL application for situations which may not be so self-evident.

Case Study A

Case Study A represents an extreme situation selected to demonstrate how the ACL Guidance Criteria procedures under S264.94(b) would be applied in arid hydrogeological and meteorological conditions. It involves a hazardous waste treatment, storage and disposal site in the western US where evapotranspiration exceeds precipitation, where groundwater is too saline for use as drinking water, and where the site is so remote that there is no human exposure.

The contaminant transport modeling is valid based on a simplified worst-case model; this is adequate to demonstrate the premise that groundwater transport will be very slow (8×10^{-1} ft/yr, conservatively) and degrading constituents will degrade to negligible concentrations before traveling even a short distance from the site.

The Introduction, Section 1, should indicate clearly the ACL sought by the applicant. It was not until Section 6, Alternate Concentration Limits, of Case Study A that the reader learns that the request is for establishing the ACL at the limit of solubility for each contaminant (see p. 40). This is appropriate for organic compounds (if co-solvent effects can be neglected), but Table 2-1 lists 10 metals which are hazardous constituents suspected to be present at the site. The solubility of metals depends on other chemical species. The solubility that will be used in setting the ACL in the case of these metals needs to be specified.

The conclusion reached in Case Study A that the ACL's should be the saturation level is essentially based on the assertion or "demonstration" that there is no present or future use of the groundwater.

Hence there would be no reason that potential pollution of the groundwater at any level could have a significant health or ecological impact. However, the saturation concentration for dieldrin cited on page 40 is extremely high

(0.5 percent). The calculations based on the presumed transport conditions indeed demonstrate that negligible concentrations of this compound (10-43 ppb) would occur in the groundwater. There may be, however, real reasons to be wary of setting the ACL at such high concentrations as the saturation level. Other health or ecological risks not foreseen in this analysis could be devasting with such high concentrations. If hydrologic and geologic factors change, or future use of groundwater not now foreseen should develop, these computations could be drastically changed. The case study should incorporate a warning that such high concentrations ought to be subjected to other tests of reasonableness. Perhaps a factor of safety should be applied to allow for unforeseen conditions. Alternately an ACL might be based on a concentration level which is reasonably attainable under current conditions even though it may be some orders of magnitude less than the saturation level. It just does not seem prudent to accept such a high value for an ACL on the basis of a single calculation or scenario.

The discussion of the transport and the health risk is insufficient insofar as metals are concerned. The document emphasizes that the case is not based on delay in hazard to humans or the environment. Since metals are not degraded and their transport is retarded but not prevented (breakthrough would eventually occur), the principal protection is based on the presumption that the highly saline groundwater can never be used for drinking water. The case could be strengthened by further discussion of the metals. It is conceivable that future population migration into this currently remote region together with new technology for desalinization could lead to some future use of the saline groundwater. Discussion of the effect of desalinization processes in the removal of metals would make the case stronger More attention to the nondegraded metals and the effect of chemical reactions which may change the species solubility is recommended.

In this example ACLs for only organics are sought, as perhaps the metals will be limited to background or drinking water levels. If so, this should be stated.

The computation is based on a conservative "worst-case" estimate of the inflow flux of contaminant to the aquifer (p. 31) but does not make clear how this value is used in the steady state transport model. Was it assumed that the entire contaminant content of the landfill was instantaneously inserted into the groundwater flow? If so, how can this instantaneous event be incorporated into a steady-state transport model? What is the sustained rate of input for the initial condition in the steady-state model? Or, was the inflow flux assumed to be the product of the groundwater flow rate and the saturation concentration of the contaminant, as is also suggested by the discussion on page 31? If so, how reasonable is this assumption in view of the total contaminant inventory within the landfill? Why are some of the available unsaturated flow models for vertical distribution not used for estimating the flux of contaminant from the landfill to the groundwater? The assumption that the initial concentration in the groundwater is the saturation value represents a worst-case assumption, but it may be so unrealistic that the solution to the problem is meaningless.

This analysis considers the landfill disposal unit but ignores the 200-acre land treatment units. The combined effect of the land treatment units in addition to the landfill on the groundwater pollution risk should at least be discussed. The analysis is also based on groundwater consumption for drinking water as the exposure pathway. No other pathways are considered. Inhalation of airborne contaminants may be a significant human exposure in the case of the land treatment units. To what extent must multiple exposure pathways be considered in ACL demonstrations?

The Case Study is strongly based on the arid meteorology, the remote location, and the saline character of the groundwater. In view of the near-permanence of groundwater pollution, there is some need for consideration of possible future changes in land use (population in-migration, industrial plant location with possible groundwater utilization, etc.) or future changes in water use (new desalinization technology, etc.).

Some more specific comments follow:

- Ownership of the surrounding land by the US Government is stated (p. 3). Who owns the 800-acre site?

- Evaporation rates are estimated at 60x precipitation rate (p. 7). This does not seem to agree with Table 3-1.

- The permeability value selected is cited as being conservative (p. 31); all results should be presented, not just the one selected, to allow this selection to be evaluated.

- Only one transformation and retardation value is given (p. 32); the less conservative values should be cited and referenced.

- The effect of the high salt content on transformation and retardation should be discussed (p. 32-38).

- The effect of acclimation on transformation should be discussed as well as specifying whether the half-life constants were obtained with acclimated or unacclimated microorganisms (p. 37).

- The reporting of computed concentrations at infinitesimally small values (e.g., 10^{-43} ppm or ppb on p. 37 and 40; 10^{-59} ppb on p. 41; 10^{-532} on p. 63) may imply to some that there exists an ability to compute and differentiate between these values, some of which may require dilution volumes exceeding the dimensions of the solar system. Anything below 10^{-6} ppb should simply be called "less than one ppq".

- Table 5-2 on p. 36 requires clarification. The indicated values are actually "adsorption" (or "distribution", or "partition") coefficients, not "retardation" coefficients as indicated in the title. Also, it should be noted that computation of Kd from K_{oc} assumes a fraction of organic carbon in the soil of f_{oc} = 0.001, i.e.,

$$Kd = f_{oc} K_{oc}$$

Was the assumed f_{oc} of the soil at the site ever specified?

With the provisos expressed above, especially those concerning the selection of solubility limits, the report is a scientifically sound evaluation of potential groundwater problems at the indicated waste disposal site. The level of detail and impact criteria selected appear to be appropriate, given the essential absence of a beneficial use for the aquifer surrounding the site. The selection and implementation of the predictive model and identification of parameters appear to be reasonably well founded. With the improvements recommended, it can be useful in demonstrating how the ACL Guidance document (Part I) can be applied in a specific case.

Case Study B

This document presents an example of the arguments used by Facility B for Alternative Concentration Limits (ACLs) under 40 CFS 264.94 for five hazardous constituents that have been detected in the groundwater near the facility. The five constituents are o-dichlorobenzene, p-dichlorobenzene, ethylbenzene, toluene, and chlorobenzene. The concentration limits for all other hazardous constituents will be background concentrations or, where applicable, the maximum concentration levels specified in Table 1 of 40 CFS 264.94.

Facility B is located in the Piedmont region of the southeastern United States, at the confluence of River A and Creek B. The report presents a summary of the hydrogeology, exposure pathways, contaminant levels, contaminant transport and Proposed ACLs.

This review is primarily directed to the contaminant levels and transport and the proposed ACLs, the determination of which was based on the hydraulic and contaminant transport in the groundwater and river.

- The groundwater flow and transport model, which is vertically integrated and two dimensional, is appropriately applied to reproduce groundwater levels. Although approximations were necessarily made to simplify the systems, the computed water levels are in qualitative agreement with those observed, from which is determined the flow to each of the compliance wells and to the river and creek, which are boundaries for the area. The general conformance of observed and computed water levels indicates that reasonable values of the various coefficients (e.g., conductivity, permeability, porosity, and recharge) were assigned. The difficulty of assigning precise values of these parameters is recognized, considering the heterogeneous composition of the aquifer. Although the observed and computed groundwater levels are in qualitative agreement, it would be advisable to present a more direct comparison in order to provide a more quantitative validation of the hydrodynamic model.

- The next phase of the analysis presents a discussion of the relevant characteristics and constituents, i.e., electrical conductivity and the organic chemicals. Although the Appendix contains the appropriate models for calculation of the spatial distribution of these constituents, no such model runs were conducted. The observed distribution of total dissolved solids (TDS) is particularly suitable to use for further independent validation of the groundwater transport model.

- The section on the contaminant transport model provides the necessary background information and input data, but does not present any model runs of the spatial distribution of the organic chemicals. The observations of the total chlorobenzenes provide a good basis for the calibration of the contaminant transport model. As in the case of TDS, when such data are available it should be mandatory to use these observations for the purpose of calibration/validation of the model's when such distribution is critical to the ACL application (which is not the situation in Case B, but will be true at other times). This counsel should be added to Part I of the guidance document.

- The crux of the analysis lies in the mass balance relation (Equation 6-1). This equation contains the flows and concentrations of both surface and subsurface regimes, all of which are assignable with the exception of the groundwater flow. The manner in which this flow is computed is valid and relevant, but obviously subject to significant variation depending on the coefficients assigned to the groundwater model. Any variation in the groundwater flow inversely affects the ACL in a linear fashion. Since the other terms in Equation 6-1 are directly specified, the concentration is sensitive only to the groundwater flow.

- In the final analysis, there is no need in this case for extensive modelling of the groundwater. The problem is essentially concerned with conditions in the surface water, which serves as a source of potable water and a fishery resource. As indicated in the previous section, the critical factor in the calculation of the ACLs is the ground water flow. This flow may also be determined from a hydraulic balance of measured river flows at two locations in the river. The incremental flow (cfs/mile), which varies with the magnitude of the river flow, may be evaluated from published flow records for the various hydrologic regions of the country. The determination of the flow therefore does not necessarily require a groundwater calculation. It is, however, desirable to carry on both analyses to provide an interlocking check on the flow balance.

- Since the problem is essentially concerned with water quality conditions in the river, it would be appropriate to direct more attention to a contaminant transport model in that type of surface water system. Factors such as partitioning to suspended and bed solids, decay and volatilization, and lateral and vertical mixing, should be considered. Depending on the dimensions of the river and the distance downstream to nearest water use, a mixing zone model may have to be developed, in which both transverse and vertical variations are considered. If these considerations are relevant in a given case, the ACLs would be lower because the entire cross-sectional area may not be available for dilution, resulting in a more conservative assessment.

- The statement "there is no evidence that surficial groundwater flows under the river," should be further substantiated and explained with respect to the possible contamination of the groundwater west of the river.

- The allowable portion of ACL is a major component in the calculation of maximum concentration for each of the constituents. These percentages are allotted based on "prevalence" of the contaminants (p. 4-8). It would be appropriate to justify more fully this proportioning, which has a direct effect on the alternate concentration limits.

- The following items are noted for improvement and correction:

  1. Equation 4-4 (p. 4-7) has a typographical error

  $$H_1 = E_1/Al_1 + ..$$

  2. The equations (unnumbered) on the top of p. 5-3 are typed incorrectly. Rather than $Q_x = 0 =$ etc. and $Q_x = L =$ etc., it should read Q(at x=o) = etc , and Q(at x=L) = etc. Also, it should be noted that positive Q means flow in the +x direction, and negative Q means flow in the -x direction.

  3. Equation (6-1) on p. 6-3 is written incorrectly, but the correct version appears to have been used for the calculations. It should read:

  $$ACL = \frac{C_a(Q_u + Q_{gw}) - Q_u C_u}{Q_{gw}}$$

  4. The isopleth map on p. 2-12 does not seem consistent with the data in Table 2-2 (p. 2-10).

In summary, the document reflects an understanding of the necessary elements of a determination of ACLs and presents a satisfactory analysis of the groundwater flow and human exposure concentrations, but an inadequate assessment of the TDS and contaminant concentrations. More attention should be directed to the river conditions; otherwise this report generally is a good engineering study with sufficiently realistic and conservative assumptions.

SECTION III

SUMMARY/CONCLUSIONS

I. Part I: Information Required in ACL Demonstrations

The general guidance document is well done for an early draft; the suggested improvements the SAB noted include more emphasis on surface-water modeling as it often is a sensitive factor, peer review of Agency-published acceptable exposure levels, and encouraging the utilization of conservative assumptions in areas of low sensitivity rather than spending resources to develop high-reliability estimates.

II. Part II: Case Studies A and B

Both Case Study A and B represent generally useful demonstrations of implementation of the ACL Guidance Document, although both are in need of improvement before issuance. Because of the particular extreme circumstances of the two case studies, the full range of models demonstrated may not have been necessary for these evaluations, but they do serve to demonstrate the methodologies. There are a number of technical problems, including omission of necessary information and discussion in certain instances (such as the identification of the inflow flux rate assumed in Case Study A), the need for more (and earlier) emphasis on critical components of the analysis (such as the stream model calculation in Case Study B), inconsistencies in certain tables and figures, and typographical errors in both reports. These are detailed in the reviews of each study. These problems should be relatively easy to correct, and the resulting reports should provide clear and effective guidance for the ACL implementation.

There is one additional area of concern raised by the reports. In both cases, derived concentrations of the organic chemical ACL for the sites are very high. These are based on the high level of dilution and (for Case Study A) decay provided by the surrounding aquifer or stream. The result is that the ground water immediately below or adjacent to the site is permitted to be thoroughly degraded by the ACL chemicals. We question this approach, even though the narrowly stated goal of the ACL, to protect human health and the environment, is apparently satisfied. This concern is compounded by the possibility of future changes in land use or other unforseen circumstances that may make these ground waters more accessible to human or ecosystem exposure. The suggestion is that there may be some minimum level of protection which should be afforded to all ground waters, even those without direct beneficial use. We recognize that this is more an issue of social or political choice, rather than scientific credibility, and as such may be outside the province of the SAB. However, there is a concern that this important social issue may be masked and hidden by the scientific methodology developed for the ACL process. The Agency is encouraged to recognize this possibility when finalizing the ACL requirements.