58-06

Thru Cdr
To BEC
Action

DEPARTMENT OF THE ARMY
U.S. ARMY ENVIRONMENTAL CENTER
ABERDEEN PROVING GROUND, MARYLAND 21010-5401

REPLY TO ATTENTION OF

S: 31 Aug 98

SFIM-AEC-ERA (50-6c)

07 AUG 1998

MEMORANDUM FOR Commander, Seneca Army Depot Activity, ATTN: SIOSE-CO (LTC Donald C. Olson), 5786 State Route 96, Romulus, NY 14541-5001

SUBJECT: Draft FY98 Peer Review Report for Seneca Army Depot Activity (SEDA)

1. The subject report (encl) has been produced as a result of the Peer Review technical assistance visit conducted on 18-21 May 98. The Peer Review Team (PRT) conducted a status review of projects from the FY97 Peer Review, reviewed those projects scheduled for FY97 which were not reviewed last year due to time constraints, and performed an initial review of new sites (SEAD 52, 115, and 105). Recommendations were developed for the projects that should assist SEDA in reducing costs associated with the cleanup program.

2. This Center would like to take this opportunity to commend SEDA on the significant progress made since the FY97 Peer Review meeting. In particular, our team was very pleased with the attendance and participation by SEDA, especially the Commander, during the meeting. Mr. Steve Absolom was extremely well prepared and helpful during the preliminary discussions and while the review was ongoing. Mr. Absolom was knowledgeable of the technical and political issues and provided significant insight to the regulatory viewpoints that were invaluable to the team.

3. Request SEDA review the subject draft report and, for each recommendation, provide a detailed plan for implementing the recommendations. If SEDA cannot implement the recommendation as written, but can implement a modified recommendation, request SEDA provide the detailed rationale for modifying the recommendation, and the plan for implementing the modified recommendation. If SEDA does not concur with the PRT's recommendations, request a detailed rationale be provided. The SEDA plan will be incorporated into a Final Peer Review Report.

4. In addition to responding to the recommendations, request SEDA identify the technical assistance or expertise that will be necessary, and is currently unavailable, to enable the implementation of the recommendations. Request a response be submitted to this Center by 31 Aug 98.

5. The POC for this effort is Ms. Joan Jackson at (410) 436-1513 (DSN 584).

Encl

EDWARD W. NEWING
Colonel, CM
Commanding

CF (w/encl):
HQDA(DAIM-BO/MS. ROBIN MILLS), ACSIM, 600 ARMY PENTAGON, ROOM 2D673, WASH DC 20310-0600

Commander, U.S. Army Materiel Command, ATTN: AMCEN-A (Mr. Pedro Cunanan), 5001 Eisenhower Ave., Alexandria, VA 22333-0001
Commander, U.S. Army Industrial Operations Command, ATTN: AMSIO-EQ (Mr. Robert Radkiewicz), Rock Island, IL 61299-6000
Commander, Seneca Army Depot Activity, ATTN: SIOSE-IE (Mr. Steve Absolom), 5786 State Route 96, Romulus, NY 14541-5001

SENECA ARMY DEPOT ACTIVITY (SEDA)

PEER REVIEW

DRAFT RECOMMENDATIONS REPORT

August 1998

Seneca Army Depot Activity (SEDA) Peer Review

Romulus, New York
May 18 – 21, 1998

DRAFT RECOMMENDATIONS REPORT

EXECUTIVE SUMMARY

A Peer Review Team (PRT), consisting of five independent technical experts in the field of environmental cleanup, visited Seneca Army Depot Activity (SEDA) from May 18-21, 1998. This was a follow-on review from FY 97 which included a status review of the sites from FY 97 as well as a review of 4 sites which were not discussed during the FY 97 review.

The FY 97 sites which were reviewed included:

- SEAD 5, Sewage Sludge Piles
- SEAD 59/SEAD 71, Fill and Paint Disposal Areas
- SEAD 16/SEAD 17, Deactivation Furnaces
- SEAD 25/SEAD 26, Fire Training Areas
- SEAD 3,6,8,14, and 15, Ash Landfill
- SEAD 4, Ammunition Washout Plant

The following sites were not reviewed from FY 97:

- SEAD 12 A and B, Radiation Burial Pits

The FY 98 sites which were reviewed included:

- SEAD 11, Old Construction Debris Landfill
- SEAD 13, Inhibited Red Fuming Nitric Acid Disposal Area
- SEAD 45/SEAD 115, Open Detonation Area/Open Burning Area
- SEAD 52/SEAD 60, Ammunition Breakdown Area

The team reviewed these projects in order to identify potential areas where changes in the overall technical approach could result in a more cost-effective implementation of Base Realignment and Closure (BRAC) responsibilities at the Depot. Projects from 1997 were discussed and 1998 status/recommendations are included in this report. A number of issues have been resolved since the 1997 meeting and are so indicated in the report. In addition to the site-specific topics selected for review, the PRT identified several overarching issues which affect the overall management and direction of the restoration activities at the base. Key observations, issues, and recommendations are presented below.

SITE SPECIFIC OBSERVATIONS-1998 REVIEW

SEAD 11, Old Construction Debris Landfill

Recommendation: The PRT recommends that SEDA proceed with an engineering evaluation/cost analysis (EE/CA) for capping as a presumptive remedy compared with other alternatives.

SEAD 13, Inhibited Red Fuming Nitric Acid Disposal Site

Recommendation: The PRT recommends that a no further action decision document for SEAD 13 be prepared by SEDA and presented to the BCT for approval.

SEAD 45, Open Detonation Area

Recommendation: The PRT recommends SEDA initiate the following activities in the order stated below:

1. Complete open detonation operations.
2. Address explosive safety concerns.
3. Address closure requirements regarding chemicals present.
4. To the extent that there is potential contamination in SEAD 45 not subject to RCRA closure, conduct either a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation (RI/FS) or a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI)/ Corrective Measures Study (CMS) while incorporating explosive safety precautions.
5. Pursuant to the Investigation and Study (Recommendation 4 above)regarding any areas in the OD area not included in RCRA closure, the PRT recommends the following approaches be incorporated:
    - Employ a phased sampling approach to guide the design
    - Conduct a risk assessment following EPA's Superfund Guidance. Specifically identify that a residential exposure scenario does not provide information that allows the selection of a remedial alternative. The only rationale to include a residential scenario is to satisfy a New York State Department of Environmental Conservation (NYDEC) request for information. Re-evaluate the appropriateness of using NYDEC bioaccumulation values to evaluate potential ecological risks from sediment exposure. There is not an identified ecological receptor, and EPA has not used bioaccumulation as a decision criterion to select a remedial alternative (EPA 1994).
    - Evaluate the effect of turbidity on the chemical analysis results (increased concentration) and the affect of turbidity on the risk assessment results (very turbid water would not be consumed by a resident).
    - Collect samples representing surface to subsurface, surface to source well on the downgradient site, and water at the pit.

- Evaluate the surface soils for potential risk to ecological and human receptors.

6. To the extent that there are any areas in SEAD 45 not addressed by the RCRA Permit closure requirements, negotiate a modification to the FFA schedule for the remediation of these remaining SEAD 45 areas.

SEAD 52, Ammunition Breakdown Area

Recommendation: The PRT recommends that the SEAD 52 and SEAD 60 be considered separately.

Recommendation: The PRT recommends that a limited scope Site Investigation be conducted to determine whether any explosive related compounds do indeed exist at SEAD 52.

Recommendation: The PRT recommends that SEDA prepare and submit an engineering evaluation and cost assessment (EE/CA) for SEAD-60 to the regulators for approval of a removal action for the oil-contaminated soil.

Site Specific Observations – 1997 Peer Review Follow-up

SEAD 5, Fill Area

Recommendation: The PRT recommends that the BCT consider more recent health risk assessment approaches to evaluate the potential health risk of receptor populations to lead in soil at SEAD 5.

SEAD 59 and SEAD 71, Fill Areas

Recommendation: The PRT has reviewed the additional field work done at this site since the 1997 review and concurs with the original recommendation to perform an expedited removal action.

SEAD 16, Abandoned Deactivation Furnace

97 Recommendation: The PRT recommends that plans for Building 311 be deferred pending formal response from the regulators on its use for thermal desorption of on-site soils. Should the requirements for use of Building 311 in that capacity be too onerous, a cost analysis should be developed comparing the cost and benefit of tearing down the building to comply with the 5X rule for unconditional release.

98 Recommendation: The PRT recommends SEDA compare the costs of decontaminating Building 311 to meet the 5x rule for unrestricted use with the cost of demolition and of-site disposal before selecting a course of action.

SEAD 17, Ammunition Deactivation Furnace

97 Recommendation: Do no removal actions until a cost benefit analysis on the feasibility to reactivate the onsite furnace is completed. A cost analysis should also be performed comparing the unit cost of soils treatment using the reactivated furnace and the unit cost associated with the leading treatment/disposal alternative. If the facility is refurbished, then there will be a need to institute management controls to ensure that new sources of contamination are not introduced into the area which may require investigation of this site in the future.

98 Recommendation: Since SEDA is still negotiating to use the furnace as a thermal desorption unit, the 1997 recommendation is still valid.

SEAD 3,6,8,14, and 15 -Ash Landfill

Recommendation: The PRT recommends that disposition of the debris piles be based on whether or not the debris piles are a solid waste or a hazardous waste.

Recommendation: PRT policy is to evaluate remedial requirements on the basis of protecting human health and the environment. SEDA's analyses indicate that potential health risks are acceptable . The PRT recommends no further action is required at the Ash Landfill .

Recommendation: If reasons other than human health or the environment drive remediation at the ash landfill, the PRT recommends that SEDA re-evaluate the current three trench design. The PRT recommends SEDA evaluate a two trench design for a funnel and gate system. The objective is to compare the effectiveness of a two trench and three trench design. In addition, the PRT suggests that the cost difference between the designs are greater than identified in the preliminary cost estimate.

SEAD 4, Ammunition Washout Plant

Recommendation. The PRT recommends that SEDA initiate data collection efforts at the ammunition washout plant in the form of an expanded site investigation (ESI) incorporating recommendations from the 1997 peer review when possible.

Overarching Issues

Recommendation: The PRT recommends SEDA review the evaluation and interpretation of the data collected for hot spots.

Recommendation: The PRT recommends Cost Benefit Analysis be conducted for sites at SEDA.

Recommendation: The PRT recommends that all new work plans be prepared using the DQO Process.

Recommendation: The PRT recommends that the following activities (conduct ESI, Perform Mini Risk Assessments, Perform Hot spot Analysis and Conduct RI/BRA) which are taken from the Decision Criteria Remediation Flowchart be planned using a decision-based strategy.

Ecological Risk Assessment Policy

Recommendation: The PRT recommends that SEDA take the lead and create a risk management team before planning an ecological risk assessment.

Recommendation: The PRT recommends including NYDEC, NYDOH, EPA, SEDA, local farmers, BLM, Fish and Wildlife, local citizens, and other future land users as risk management team members.

Recommendation: The BCT needs to define the valued ecological resources desired to be protected at SEDA.

Intrinsic Bioremediation Policy for Petroleum Sites

Recommendation: The PRT recommends that SEDA develop protocols that enable it to consider intrinsic bioremediation/natural attenuation as a presumptive remedy for petroleum sites.

TAGMs

Recommendation: The PRT recommends that SEDA continue to work with NYDEC on establishment of achievable cleanup levels.

Investigation Strategy

Recommendation: SEDA should continue to make use of field screening techniques, to the maximum extent possible.

Recommendation: The PRT recommends that when the existing and future sampling plans are revised or written that field screening, especially soil gas and X-Ray Fluorescence (XRF), be used to the greatest extent possible.

Recommendation: The PRT recommends that the sampling program be scheduled such that the results of the field screening decision criteria can direct the locations of some of the discrete soil samples through use of pre-arranged decision criteria.

Site-Specific Background

97 Recommendation: The PRT recommends that the background soil data be divided into two sets representing surface and subsurface soils. The resulting concentration data should be presented to the regulators for formal approval for use in place of TAGM values whenever background concentrations are higher than the corresponding TAGM value.

Deep Bedrock Wells

97 Recommendation: Re-evaluate the need to install deep wells at other areas across the site.

98 Recommendation: The PRT recognizes that deep is a relative term and understand that the SEDA "deep wells" are only 50 to 60 feet deep. However, this does not change our recommendation. The PRT does not understand the decision to be made using data from new deep wells.

1.0 PEER REVIEW PROCESS

1.1 Background of the U.S. Army's Environmental Restoration Peer Review

Peer Review (PR) is a mechanism by which Army headquarters and Army installations can obtain independent technical recommendations and technical applications assistance to substantiate that environmental restoration decisions provide an adequate level of risk reduction at reviewed sites, while ensuring the efficient and effective use of the Army's environmental restoration funds.

The peer review process was developed to address concerns expressed by senior Army leadership regarding the management of the Army's environmental budget. It is envisioned that, through the peer review process, environmental restoration funds can be used more efficiently, thus decreasing the need to divert funds from mission requirements to environmental restoration projects. Army leadership also hopes that peer review can help provide consistency in environmental decisions across restoration projects and serve as a tool for funding decision-makers to use to allocate limited funds to competing projects.

The objectives of peer review are:

- Promote the use of a risk-based approach for decision making,
- Ensure that remediation of chemical contamination is justified by a site specific risk assessment or regulatory requirement,
- Ensure consistency in decision making across the Army's environmental restoration program,
- Validate and enhance the decision making process,
- Ensure that all reasonable alternatives for risk mitigation are considered (including innovative remedial technologies),
- Validate that the most cost-effective solution which meets regulatory clean-up requirements is being implemented, and
- Promote early identification of issues that require policy and guidance, clarification, or the involvement of higher-level decision-makers.

To help meet these objectives, the Army has developed the peer review process to assist in identifying cost effective solutions to the Army's environmental challenges. To achieve this objective the Army has established a team of experts who are intimately familiar with Federal, state and private environmental restoration programs; as well as having familiarity with "state-of-the-art" technologies and methodologies for characterizing and remediating contaminated sites. The PRT evaluates (i) the decision making processes used by an installation to address environmental issues, (ii) the exit strategies used to accomplish site closure, and (iii) the technologies that will be applied to attain regulatory closure at a site.

1.2 Peer Review Process

The Peer Review process is presently being implemented. The Army's intent in FY98 is to complete peer reviews of all BRAC installations that meet the criteria outlined in the implementation plan. The final implementation plan dated 2 Sept 97 (encl. 1) outlines three proposed levels of review. The FY 98 projects at SEDA were selected to undergo a Level 1 Peer Review or technical assistance visit. The technical assistance visit consists of the following steps:

a. The installation representative(s) brief the Peer Review Team (PRT) on the subject project. The briefing consists of the site description, investigative efforts, available site data and its evaluation and interpretation, risk assessment findings, remedial technologies considered, and cost.

b. The project is openly discussed among the PRT and the installation representatives.

c. The PRT then identifies a series of issues that are developed into recommendations for possible project enhancement and cost efficiencies. These recommendations are provided in a report as overarching recommendations and site-specific recommendations. Each recommendation is supported by a discussion that may include where appropriate, the team's assumptions, the rationale for making their recommendations, and suggestions for implementing the recommendations.

d. A draft recommendations report is generally provided to the installation within six weeks of the peer review meeting. This draft report is also provided to the Army BRAC Office and the Major Command. This report will include recommendations regarding issues discussed during the review. Responses to these recommendations will be developed by the installation/ BRAC Cleanup Team (BCT) which will provide either plans for implementing the PRT's recommendations, or the rationale for modifying or rejecting the recommendations.

1.3 Panel Composition

See encl. 2 for the names and biosketches of the PRT members.

1.4 Overview of Seneca (SEDA) Peer Review Visit

The PRT visited Seneca Army Depot Activity from May 18-21, 1998 and reviewed both FY 97 and FY 98 projects. As preparation for the discussion, the PRT received project background materials provided by SEDA prior to the review. The PRT also received copies of the FY 97 Seneca Peer Review Report.

The peer review consisted of (i) a brief overview of the environmental restoration program by SEDA, (ii) a tour of the base, and (iii) a project specific briefing presented by the SEDA Cleanup Team. These briefings were interspersed with questions from the PRT intended to clarify the methodologies and thought processes utilized up to the present by the BRAC Cleanup team.

The PRT met at the end of each day to discuss information gained and to develop a list of potential issues regarding the projects discussed that day. These issues were developed into the recommendations presented in this report. The issues are characterized as either (i) overarching (those having an impact on the overall restoration program), or (ii) site-specific (those pertaining to one project).

1.5 Recommendation Basis

Views expressed in this report are based upon information provided by Seneca Army Depot Activity prior to and during the peer review meeting conducted May 18-21, 1998. The recommendations are based upon the best professional judgment and experience of the PRT members.

2.0 PEER REVIEW TEAM OBSERVATIONS

The Peer Review Team reviewed the following new projects during the visit to SEDA:

The FY 97 sites which were reviewed included:

- SEAD 5,Sewage Sludge Piles
- SEAD 59/SEAD 71, Fill and Paint Disposal Areas
- SEAD 16/SEAD 17, Deactivation Furnaces
- SEAD 25/SEAD 26, Fire Training Areas
- SEAD 3,6,8,14, and 15,Ash Landfill
- SEAD 4, Ammunition Washout Plant

The following sites were not reviewed from FY 97:

- SEAD 12 A and B, Radiation Burial Pits

The FY 98 sites which were reviewed included:

- SEAD 11, Old Construction Debris Landfill
- SEAD 13, Inhibited Red Fuming Nitric Acid Disposal Area
- SEAD 45/SEAD 115, Open Detonation Area/Open Burn Area
- SEAD 52/SEAD 60, Ammunition Breakdown Area

3.0 SITE SPECIFIC OBSERVATIONS

3.1 SEAD 11, Old Construction Debris Landfill

3.1.1 Recommendation: The PRT recommends that SEDA proceed with an engineering evaluation/cost analysis (EE/CA) for capping as a presumptive remedy compared with other alternatives.

Rationale: Further investigation and potential remediation are required at SEAD 11 because of the presence of contamination in excess of TAGMs. As a largely solid waste/construction debris landfill with no known deposits of significant quantities of hazardous waste, this landfill qualifies for capping as a presumptive remedy. Moreover, anticipated. If unacceptable risks are estimated using a likely exposure scenario, the cap design should mitigate those risks.

- Submit the EE/CA as a limited scope remedial investigation feasibility study and propose the action (or no action) stemming from the analysis contained therein.

3.2 SEAD 13, Inhibited Red Fuming Nitric Acid Disposal Site

3.2.1 Recommendation: The PRT recommends that a no further action decision document for SEAD 13 be prepared by SEDA and presented to the BCT for approval.

Rationale: The results of the ESI indicates that chemical residues are not present in concentrations that constitute an unacceptable risk to human health or the environment. Moreover, available data and historic information on the operation are consistent with a conceptual site model indicating the nitric and hydrofluoric acid discharges were likely neutralized and dispersed as salts in the groundwater.

Current pH measurements are consistent with the likelihood that the acids were neutralized upon discharge into the limestone lined beds at the disposal site. Residues from neutralization are highly soluble nitrates and fluorides that will not accumulate in soil or sediments. Both fluoride and nitrate concentrations in nearby groundwater are above drinking water standards. However, there are no wells in the affected aquifer, and hydraulic head data indicate that the site groundwater flows to the Duck Pond where it discharges. As a consequence, no off-site groundwater will receive or be affected by these salts. Concentrations of these constituents in the surface water are below levels of concern. The pits were dug into the shale, but there is a significant depth of competent rock beneath the pits which prevents vertical migration as witnessed by the dry holes obtained when monitoring wells were installed. Furthermore, observations made during operation indicate lateral convection when the pits were flooded because of the lack of a vertical pathway to accept the fluids.

Metal concentrations in the site groundwater are higher in background wells than they are in downgradient wells. Furthermore, subsurface soil data do not indicate any discernable metal concentration trend with depth, suggesting that neutralization was effective and prevented significant acid leaching of the soils.

Data suggest that the nitrate plume from the east beds is still in transit to the pond. It is not clear if the pits on the west end were ever operated. However, those pits have been inundated by the pond for the last 26 years. As such, the bulk of the nitrates and fluorides likely have been flushed into the pond at this point in time.

Implementation Option: A decision document should be prepared summarizing all the historic and site characterization data available on SEAD-13 and indicating how those data assure the acceptability of potential risk to human health and the environment and the non-exceedance of any Federal and State ARAR for groundwater and surface water. The document should indicate the site conceptual model and the likely transport mechanisms by which nitrate and fluoride residues are carried to the pond, dispersed, and reach a defined exposure point.

3.3 SEAD 45, Open Detonation Area

3.3.1 Recommendation: The PRT recommends SEDA initiate the following activities in the order stated below:

1. Complete open detonation operations.

Rationale: Potentially large quantities of ordnance/munitions remain on the installation which need to be treated at this RCRA interim-status treatment facility. Because of the possibility of kick-outs from each detonation, as well as releases of hazardous constituents into the soil from the detonation activities, any response activity conducted prior to completion of the RCRA operation would be affected. Specifically, the detonation activities could alter the site conditions such that the hazardous toxicity investigation would be impacted and any previous efforts would have to be redone.

2. Address explosive safety concerns.

Rationale: Until explosive safety concerns are addressed for remediation workers, other remedial activities cannot be safely performed.

3. Address closure requirements regarding chemicals present.

Rationale: Contamination of surface soils and sediments from releases of metals, nitroaromatic compounds, and SVOCs has occurred. (However, no adverse impacts to groundwater have been discovered.) RCRA closure requirements as set forth in the RCRA Part B Permit Application Closure Plan for the Open Detonation Area will be applicable requirements. The open detonation mound and surrounding area will be managed as a waste pile for the purpose of closure requirements, which are described in 40 CFR 264.258. If clean closure for a waste pile cannot be achieved, the OD Area will be closed pursuant to landfill closure and post closure requirements (40 CFR 264.310).

4. To the extent that there are any areas in SEAD 45 not addressed by the RCRA Permit closure requirements, conduct either a CERCLA Remedial Investigation (RI/FS) or a RCRA Facility Investigation (RFI)/ Corrective Measures Study (CMS) while incorporating explosive safety precautions.

Rationale: Because the parties negotiated to remediate the OB Grounds by means of a CERCLA action, rather than a RCRA corrective action, the parties are likely to take a similar approach at the OD Area. The FFA intends that RCRA corrective action obligations and CERCLA response obligations be integrated as long as the pertinent RCRA and CERCLA requirements are met, including the protection of human health and the environment. (See U.S. EPA, U.S. Department of the Army, and New York State Department of Environmental Conservation Federal Facility Agreement under CERCLA Section 120, in the Matter of Seneca Army Depot, Section 8., Statutory Compliance/RCRA-CERCLA Integration.)

According to the FFA, the Parties intend that covered activities will be deemed to achieve compliance with CERCLA, satisfy corrective action requirements of RCRA Sections 3004(u) and (v) for a RCRA permit, and RCRA Section 3008(h) for interim status facilities, and to meet or exceed all ARARs to the extent required by CERCLA Section 121. RCRA is considered an ARAR with respect to releases of hazardous waste covered by the agreement.

5. **Pursuant to the Investigation and Study (Recommendation 4 above)regarding any areas in the OD area not included in RCRA closure, the PRT recommends the following approaches be incorporated:**

   - Employ a phased sampling approach to guide the design
   - Conduct a risk assessment following EPA's Superfund Guidance. Specifically identify that a residential exposure scenario does not provide information that allows the selection of a remedial alternative. The only rationale to include a residential scenario is to satisfy a NYDEC request for information
   - Re-evaluate the appropriateness of using New York bioaccumulation values to evaluate potential ecological risks from sediment exposure. There is not an identified ecological receptor, and EPA has not used bioaccumulation as a decision criterion to select a remedial alternative (EPA 1994).
   - Evaluate the effect of turbidity on the chemical analysis results (increased concentration) and the affect of turbidity on the risk assessment results (very turbid water would not be consumed by a resident).
   - Collect samples representing surface to subsurface, surface to source well on the downgradient side, and water at the pit.
   - Evaluate the surface soils for potential risk to ecological and human receptors.

6. **To the extent that there are any areas in SEAD 45 not addressed by the RCRA Permit closure requirements, negotiate a modification to the FFA schedule for the remediation of these remaining SEAD 45 areas.**

Discussion/Rationale: The NYDEC is concerned about the delay of the remedial activities for the SEAD 45 area to the extent that part of the 60 acres may be outside the scope of the RCRA interim status permitted treatment unit. If this should be the case, the parties need to negotiate a modification to the FFA to allow sufficient time to complete the ordnance detonation activities prior to remediating any remaining area. Otherwise, the detonation activities could alter the site conditions of the surrounding area because of possible kickouts. In such an instance, the detonation activities could potentially affect the hazardous toxicity investigation, and all remedial activities conducted during the operation of the treatment unit could potentially require repeating.

The regulatory drivers for the OD Area are the RCRA closure requirements included in the SEDA Permit for RCRA interim status treatment facility for OD of munitions.

3.4 SEAD 52, Ammunition Breakdown Area

3.4.1Recommendation: The PRT recommends that SEAD 52 and SEAD 60 be considered separately.

Rationale: These sites are only geographically related. SEAD 60 can be handled immediately (see section 3.4.3 below). SEAD 52 requires further evaluation. During the PRT meeting it became apparent that the data submitted to the PRT for review was erroneous. The concentration values were expressed as ppm but were in fact ppb. Since most of the previous data were qualified values and below the reporting limit, the PRT feels that it is questionable as to whether any contamination has been identified which would be of concern.

3.4.2Recommendation: The PRT recommends that a limited scope Site Investigation be conducted at SEAD 52 to determine whether any explosive related compounds do indeed exist.

Rationale: This investigation should include wipe samples from inside the buildings to determine if any residual contamination of the structure exists. Also, if any explosive related material was deposited outside of the buildings, its most likely transport would be by runoff. The sampling program should target any streams in the area as the most likely site for contamination. A decision should be made after conducting a cost benefit analysis, to determine whether the buildings should be released for open use, cleaned up, or destroyed.

3.4.3 Recommendation: The PRT recommends that SEDA prepare and submit an engineering evaluation and cost assessment (EE/CA) for SEAD-60 to the regulators for approval of a removal action for the oil-contaminated soil.

Rationale: The ESI identified soil containing more than 2 percent oil. While the exact nature of the oil and the identity of individual chemicals has not been determined, it is likely that such high concentrations require remediation under CERCLA. Moreover, the cost of removal may be less than the cost of further investigation. The cost benefit analysis, comparing the cost of investigation and additional evaluation to remedial cost, is part of ASTMs Risk-Based Corrective Action (RBCA) process. When the new investigation (and related) cost is greater than the original remediation cost, additional data should not be collected.

The stained soil has been estimated to cover an area of 30 by 6 feet. If it penetrates to an average depth of 10 feet, it comprises a total volume of 67 cubic yards. With over excavation, the volume could be expanded to 100 cubic yards. At an average cost of $50 to $200 per cubic yard, the remedy can by implemented for less than $20,000.

Implementation Options: The EE/CA should evaluate possible options such as landfill disposal, off-site thermal desorption, incineration and blending at an asphalt plant, depending on which options are available within an economic transport distance. If the on-site thermal desorption option is approved, the soil should be treated in conjunction with other materials scheduled for treatment in that unit. Pursuant to NYDEC requirements for an RI/FS on all sites, the EE/CA should be presented as a focused RI/FS.

4.0 Site Specific Observations – 1997 Peer Review Follow-up

4.1 SEAD 5, Fill Area

4.1.1 Recommendation: The PRT recommends that the BCT consider more recent health risk assessment approaches to evaluate the potential health risk of receptor populations to lead in soil at SEAD 5.

Rationale: Assuming that the SEAD 5 Fill Area will be used for recreational purposes in the future, the likely receptor populations are recreational and occupational. The occupational receptors are assumed to be Fish and Wildlife workers. Occupational receptors have greater exposure to soil at a site than do recreational receptors, primarily due to the increased exposure duration. Several risk assessment models have been developed to protect a worker's fetus from exposure to lead. These models are based on the assumption that a fertile or pregnant female worker's blood lead level must be less than about 11 micrograms per deciliter (ug/dl) lead in blood. OSHA's acceptable blood lead level for all workers is 30 ug/dl. The difference in acceptable blood lead levels for working populations has not been resolved by the two agencies.

Implementation Options: Two of the blood lead models for occupational workers are included in this report. One model was developed by the California Department of Toxic Substances Control and the other model was developed by EPA. These simple models are intended to be protective of the unborn fetus. Copies of the spread sheets for these models are included in this report as Attachments 1 and 2. Electronic copies of these models are available. These models could be modified to reflect the estimated exposure frequency and exposure duration for recreational receptors at SEDA, however, there are limitations to the extrapolation of these models. Site-specific information, the existing blood lead levels of the Fish and Wildlife workers, could be inserted into the models.

4.2 SEAD 59 and SEAD 71, Fill Areas

4.2.1 Recommendation: The PRT has reviewed the additional field work done at this site since the 1997 review and concurs with the original recommendation to perform an expedited removal action.

Rationale: Sufficient data have been collected to support removal.

Implementation Options: An EE/CA will be needed to describe and obtain approval for a removal. Pursuant to NYDEC instructions, the EE/CA should be structured as a mini RI/FS.

4.3 SEAD 16, Abandoned Deactivation Furnace

97 Recommendation: The PRT recommends that plans for Building 311 be deferred pending formal response from the regulators on its use for thermal desorption of on-site soils. Should the requirements for use of Building 311 in that capacity be too onerous, a cost analysis should be developed comparing the cost and benefit of tearing down the building to comply with the 5X rule for unconditional release.

(98) Recommendation: The PRT recommends SEDA compare the costs of decontaminating Building 311 to meet the 5x rule for unrestricted use with the cost of demolition and off-site disposal before selecting a course of action.

Rationale: The PRT 's current understanding is that only SEAD 17, and not SEAD 16, is being considered for use as a low temperature thermal desorption unit to assist with environmental restoration efforts. There was some confusion in this regard in the 1997 report. As a consequence, Building 311 must be evaluated along with all other buildings that were used for explosives related activities. Specifically, any such buildings cannot be left in a position of unrestricted access unless they comply with the 5x rule. Since decontamination to 5x standards is costly, and with no apparent use for the buildings after closure, there does not appear to be a real benefit to decontamination unless it is the low cost alternative when compared to demolition and off-site disposal. As a consequence, a direct cost comparison between the two alternatives is in order.

Implementation Options: Conduct a comparison of costs for dismantling Building 311 to those for meeting the 5x rule under current conditions. Proceed with the low cost alternative for ultimate disposition of the building. Attachment 1 at the end of this report contains information discussed during the Peer Review meeting regarding lead risk assessments as performed by the California Department of Toxic Substances Control which may be of use in evaluating lead contamination issues around Building 311.

4.4 SEAD 17, Ammunition Deactivation Furnace

97 Recommendation: Do no removal actions until a cost benefit analysis on the feasibility to reactivate the onsite furnace is completed. A cost analysis should also be performed comparing the unit cost of soils treatment using the reactivated furnace and the unit cost associated with the leading treatment/disposal alternative. If the facility is refurbished, then there will be a need to institute management controls to ensure that new sources of contamination are not introduced into the area which may require investigation of this site in the future.

98 Recommendation: Since SEDA is still negotiating to use the furnace as a thermal desorption unit, the 1997 recommendations are still valid.

Rationale: The State has indicated that the request to allow Building 367 to be converted for use as a thermal desorption unit to treat on-site soils will likely be granted. An analysis of associated requirements should be made to ensure that those requirements do not eliminate any cost advantages with the proposed on-site processing. Contractors with mobile thermal desorption units are available and may be able to reduce overall cost of remediation if the permit conditions obligate SEDA to high levels of expenditure.

Implementation Options: Await formal State action on application for the thermal unit. If the application is accepted as currently indicated, closure requirements are likely to be specified as a part of the permit. If the application is not granted, Building 367 will need to be analyzed in the same manner as Building 311, i.e. a comparison of the cost of decontamination to meet the 5x rule with the cost of demolition.

4.5 SEAD 3,6,8,14, and 15-Ash Landfill

4.5.1Recommendation: The PRT recommends that disposition of the debris piles be based on whether or not the debris piles are a solid waste or a hazardous waste.

Rationale: If the debris piles pass a TCLP and have no other hazardous waste characteristics, it would be cost-effective, feasible, and technically appropriate to dispose these materials at a regional solid waste disposal site. If the debris piles fail a TCLP or otherwise contain characteristic hazardous wastes, it will be necessary to evaluate the risk drivers and identify other alternatives.

Implementation Options: Develop a valid sampling program for the debris piles to assure that analytical data are representative of the debris piles. It is appropriate to use a composite sample from each pile since the analysis is intended to represent the entire pile and not a subpart of the piles. TCLP analysis would be performed on each sample. Debris piles passing a TCLP may be segregated for disposal at a regional solid waste disposal site. Piles that fail a TCLP will require evaluation to determine whether on-site treatment is viable, or off-site treatment and/or disposal is necessary.

4.5.2 Recommendation: PRT policy is to evaluate remedial requirements on the basis of protecting human health and the environment. SEDA's analyses indicate that potential health risks are acceptable . The PRT recommends no further action at the Ash Landfill.

Rationale: In the Draft Proposed Remedial Action Plan (PRAP) it is stated that the results of the human health "risk assessment indicate that none of the receptors (designated in the text) are in danger of exceeding the EPA target risk range under current and expected receptor scenarios." In addition, the groundwater sampling performed during the past several years "has confirmed that the current off-site residents do not exhibit an increased risk of cancer in excess of the target risk range or adverse non-carcinogenic health threats." Finally, although potentially unacceptable risks may exist for future residents using groundwater for drinking, the land use plan does not include residential areas. The PRAP then goes on to state that it is "unreasonable to establish remedial action objectives and remediate to conditions inconsistent with such land use."

In addition, the scope of long-term groundwater monitoring can be dramatically curtailed from 30 wells to less than 15 wells, and sampled semi-annually rather than quarterly. It is unclear why current annual O&M cost for groundwater monitoring is as high as $44,800 unless 30 wells are monitored. (Note that there is a contradiction in the cost analysis that sampling would be performed biannually on seven monitoring wells. The PRT agrees with this proposal, but finds it even more inconsistent with the $44,800 annual O&M cost for monitoring.)

Implementation: Even when there are no human or ecological risks, it appears that SEDA is using ARARs to screen whether or not remedial methods are necessary. This is a site that requires no further action, based on the lack of human health or environmental risk and regulatory drivers.

4.5.3Recommendation: If reasons other than human health or the environment drive remediation at the ash landfill, the PRT recommends that SEDA re-evaluate the current three trench design. The PRT recommends SEDA evaluate a two-trench design for a funnel and gate system. The objective is to compare the effectiveness of a two trench and a three-trench design. In addition, the PRT suggests that the cost difference between the designs are greater than identified in the preliminary cost estimate.

Rationale: Data now indicate that concentrations have increased an order of magnitude near the western perimeter of the installation. Where previously PRT recommended (1997) using one trench, placed closer to the Ash Landfill, PRT now is recommending a two-trench system. The first trench would be placed perpendicular to the groundwater plume near the west fence line to intercept VOC concentrations that range from 10 to 100+ ppb. This trench would mitigate further migration of low levels of

VOCs west of the perimeter, and therefore ensure that downgradient groundwater will not be impacted

The second trench could be placed very close to the landfill. For example, north of a line that connects MW-45 to the north and PF-19 to the south. The second trench should be located so that it is intercepting and treating the plume at a location where concentrations of VOCs range from 1000 to 10,000 ppb. The second trench would significantly reduce the mass of VOCs during the migration of the plume. PRT is of the opinion that the two-trench system can effectively reduce the remediation time frame to approximately 15 years, rather than the 20 years predicted by SEDA. In addition, by reducing the number of monitoring wells, focusing sample analysis on VOCs and reducing the sampling frequency to semi-annual, further significant cost savings will result.

Implementation: SEDA should expand the modeling previously performed for the two-trench system, to optimize the location and design of the funnel and gate system. Because of the relatively low potential for ecological and human risk associated with this site, monitoring of groundwater should be minimal, and have two objectives: (1) Monitor the performance of the groundwater treatment program and (2) insure that the treatment program is achieving the objective of mitigating off-site migration of VOCs.

Finally, SEDA should re-evaluate the costs previously provided to PRT for the funnel and gate treatment system. PRT notes the following to facilitate this process:

- The treatability study cost ($75,000) appears to be 25 to 50% higher ($50,000 to $60,000) than experienced elsewhere. In addition, assuming the magnitude of the cost, the PRT suspects that this may involve a field pilot testing that should offset the capital investment for at least one trench.

- The PRT believes that the annual O&M cost of the trench at the toe of the plume will be significantly less than O&M costs for the trench closest to the source area. This presumption is based on the fact that there are more than two orders of magnitude difference in VOC concentrations between the two trenches.

- As discussed above, the PRT believes long term annual O&M costs for groundwater monitoring appears to be too high and should be re-evaluated.

4.6 SEAD 4, Ammunition Washout Plant

4.6.1 Recommendation: The PRT recommends that SEDA initiate data collection efforts at the ammunition washout plant in the form of an expanded site investigation (ESI) incorporating recommendations from the 1997 peer review when possible.

Rationale: During the 1997 peer review, it was noted that plans for characterization of the ammunition washout plant appeared to be geared towards a full remedial investigation even though there was no information available in some areas. Full-scale sampling and use of laboratory analyses were assumed. The PRT believes that an ESI would be more appropriate for this site as a means of determining the nature of any contamination that might exist and the level of characterization that will be required. Through use of screening tools and field analytical methods supplemented by laboratory confirmation, the contractor should be able to make real-time decisions on the need for and scope of sampling as the ESI proceeds. The utility of field analyses and the extent of confirmation required are addressed in an overarching recommendation from the 1997 peer review.

4.6.2Recommendation: The PRT believes that VOC analyses would be prudent both inside and outside the paint areas.

Rationale: Site-wide data suggest that VOC sources are not always evident from the limited historic information and can be anticipated in general use areas such as the ammunition washout plant because of unrelated activities. VOC screening provides an excellent example of where field methods such as soil vapor analysis can be used to reduce the cost and expand the utility of the ESI. It would be best if prior agreement can be reached with regulators with respect to the level of laboratory confirmation they require to validate the field analytical results.

The potential for background PAH concentrations to exceed TAGMs is very real at the ammunition washout plant. As a consequence, this site is one that will benefit from resolution of the overarching issue raised with respect to background concentrations for anthropogenic chemicals. For contaminants detected in background samples, the effective TAGM should be set at the higher of the two values.

Implementation Options. The BCT should prepare a scope of work for conduct of an ESI at the ammunition washout plant incorporating recommendations from the 1997 peer review on use of screening methods and evaluation of PAH background concentrations. In development of the work plan, an attempt should be made to determine the level of confirmational analyses the regulators will require in advance in hopes of reducing the number of iterations that may ensue for plan approval. The work plan should include VOC analysis inside and outside the paint areas. Where possible, the contractor should employ real-time decision criteria to expand or limit scope on the basis of results obtained in the field.

5.0 OVERARCHING ISSUES

5.1 Decision-Making Process

5.1.1 Recommendation: The PRT recommends SEDA review the evaluation and interpretation of the data collected for hot spots.

Rationale: The evaluation of hot spots and interpretation of the data was an issue at several of the SEDA sites. For example, SEAD 60 contained several small areas of contamination due to historical releases of oil. Apparently, these areas were identified visually. The data collection strategy was to sample surface soil from the stained areas, which is a judgmental or biased approach. It is not surprising that high concentrations of semi-volatile organic compounds (SVOCs) were identified. SEAD 45 contains "hot spots" of metals due to the open detonation area.

Often, judgmental samples are collected to identify sources. Source identification data are only useful to confirm that a source is present. Therefore, when judgmental samples are collected and some of the values exceed risk-based criteria, this does not automatically identify a potential to adversely affect human health, nor does it indicate a need to remediate. In addition, judgmental samples are not necessarily useful to estimate potential risk to human or ecological receptors. The potential for risk is based on the 95 percent upper confidence limit of the arithmetic mean (95UCL) over the exposure area because receptors are assumed to be exposed randomly over an exposure area.

For remedial investigations that support risk assessment, exposure area for the receptor(s) being evaluated needs to be considered. In the SEDA sites, judgmental samples were collected from identified hot spots that do not correspond well to the receptor's exposure area. The receptor's exposure area determines the appropriate size of a hot spot and is used to create a Sample and Analysis Plan (SAP). Residential land use leads to the most conservative exposure area that is defined by EPA guidance, which is one-quarter acre, the size of a residential yard. The exposure areas for other human receptor populations, occupational, recreational, trespassers, fish and wildlife workers, and Army personnel are significantly larger. Assuming a square grid, the minimum sample grid size required to identify a one-quarter acre hot spot at a 95 percent confidence level is 98 feet.

The ecological receptor's home range determines the area that needs to be characterized in an ecological risk evaluation. In addition to exposure area or home range for ecological species, an evaluation of the consequences of adversely affecting a receptor within a small area needs to be considered. For example, a mouse is often used as a "representative" mammalian species in risk assessment, even though the home range of a mouse is relatively small. The mouse is generally used because a large amount of toxicological data is available. When a mouse or other species with a small home range is used, the risk management decision must consider the environmental impact of the species evaluated. This evaluation considers the ecological effect of eliminating the mouse population over a small area when there is appropriate habitat nearby that supports populations. If a species can be harmed in a local area, but the overall population or the ecological system is not adversely affected, there is no need to evaluate small areas in the RI. Moreover, for soil contamination, the remedy will eliminate the population of mice thereby creating more impacts than benefit. There is no decision to be made. This rationale does not apply to threatened or endangered species, because protection of the individual threatened or endangered species is important.

5.1.2 Recommendation: The PRT recommends Cost Benefit Analysis be conducted for sites at SEDA.

Rationale: A cost benefit analysis is an appropriate tool to decide between remediating a site based on available Phase I data or continuing to a Phase II remedial investigation when the Phase I data show there are unacceptable risks to human health or the environment. It is assumed that additional data collection would support either taking no action or significantly reduced remedial cost. Based on the Phase I RI and the Feasibility Study, the cost of remediating to the Phase I decision criteria can be estimated.

Alternative 2, a Phase II RI, requires information from several sources. The sources include an estimated cleanup level that would result from additional site characterization and risk assessment, the probability that the agency would accept the higher cleanup level, the cost to remediate to the higher cleanup level, and the costs of the additional data collection, risk assessment, and agency negotiation. The total cost of alternative 2 (additional investigation) is compared to the cost of remediating to the Phase I cleanup levels. It is important that the probability that the agency will accept the higher cleanup levels is carefully evaluated. This analysis allows a knowledgeable decision to be made and provides documentation for obtaining funding.

5.1.3 Recommendations. The PRT recommends that all new work plans be prepared using the DQO Process.

Discussion. The DQO Process is not necessarily a robust statistical based design or strategic planning approach. Simple SAPs, based on making "obvious" decisions, only require straightforward documentation, using principles of the DQO Process. The DQO Process documents the professional judgment used to identify those data needed to make defined decisions. Identifying defined decisions minimizes the degree to which agencies or other interested parties ask "what if" questions. It is the responsibility of those asking questions to define the decisions they would like to make and the acceptable uncertainty in those decisions. They must use the DQO Process to document their rationale for data requests. If they do not or cannot define the question, decisions to be made and acceptable uncertainty, a data collection design cannot be prepared. The Army must assist the agency in defining the acceptable level of uncertainty. The decision-based approach effectively focuses the investigation on those pathways that need to be characterized during preparation of the SAP.

Implementation. The relationship among the risk assessment (and supporting data) and the Conceptual Site Model, selection of remedial alternatives, and corrective measures studies must be defined before data are collected to make related decisions. The basis for performing a risk assessment (or data collection) in an RI is to contribute to the selection of a remedial alternative. If the relationship between the data being collected and the selection of a remedial alternative (decision being made) is undefined, the data will not be useful to select the remedial alternative.

Implementation Options: The following are references for the DQO Process which can be utilized by the BCT.

EPA 1988, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, EPA/540/G-89/004, October, 1988 (page 2-3).

EPA, 1987, Data Quality Objectives for Remedial Response Activities, EPA/540/G-87/003, March 1987.

EPA, 1989, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, OSWER Directive 9285.7-01a, September 29, 1989 (Section 4.1.4).

EPA, 1993, Data Quality Objectives Process for Superfund, Interim Final Guidance, EPA540-R-93-971, OSWER Directive 9355.9-01, September 1993.

EPA, 1994, Guidance for the Data Quality Objectives Process, EPA QA/G-4, Final, September 1994.

EPA, 1997, Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final, June 5, 1997 (Chapter 4).

5.1.4 Recommendation: The PRT recommends that the following activities (conduct ESI, Perform Mini Risk Assessments, Perform Hot spot Analysis and Conduct RI/BRA) which are taken from the Decision Criteria Remediation Flowchart be planned using a decision-based strategy. The following discussion is intended to explain some of the approaches to apply a decision-based strategy.

Rationale: Seneca is to be complimented on the decision criteria flowcarts that have been prepared and incorporated into each of the investigations. This is clearly significant progress toward refining a program strategy. It is likely that these diagrams have helped to focus the strategies and assisted in communicating the program to regulatory agencies.

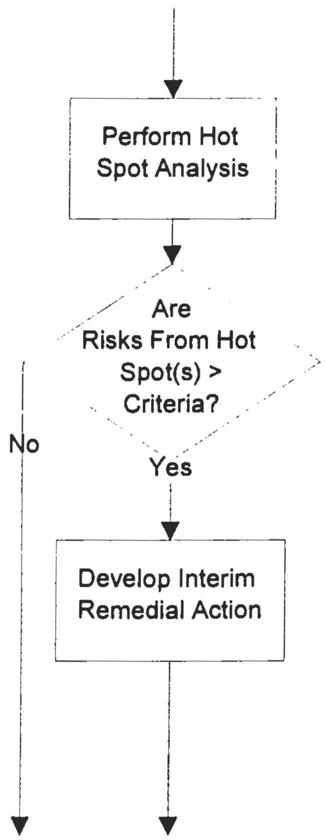
Implementation Options: The PRT is offering some additional information about the use of decision-based approaches to be used in investigations.

5.1.4.1 Conduct an Expanded Site Investigation (In the Preliminary Assessment Phase). The PRT assumes that the objective of an Expanded Site Investigation (ESI) is to verify that a source is present that has the potential to adversely affect human health or the environment. When a source is suspected to contain chemical concentrations sufficiently high, it is assumed that the objective to confirm the source and perform preliminary extent sampling. This type of sampling strategy is judgmentally based. Judgmental sampling strategies are not appropriate for risk assessment evaluations, except to estimate the highest potential risk. The comparison to TAGM or background concentrations would be a worst-case comparison, and would simply identify the need for additional evaluation when the decision criteria are exceeded.

5.1.4.2 Perform Mini Risk Assessments (In the Preliminary Assessment Phase). The PRT assumes that the mini risk assessment would be performed using standard EPA default exposure parameters and the actual concentrations detected for each constituent identified. The mini risk assessment could not use a statistically based concentration in the risk calculation. This is because the sample design was judgmental and there is no reason to believe that the chemical concentrations are from the same population. Because the chemical concentrations used in the risk calculation are maximum concentrations likely to be present at the site (judgmental source samples) the risk estimate is useful only as a conservative screening value. If the risk is acceptable, one can be confident that the overall area does not pose an unacceptable risk to human health or the environment. An important function of the mini risk assessment is to identify the inputs to the risk assessment that have the most uncertainty. This can be chemical concentrations, exposure parameters, or exposure population. These uncertainties help to identify the data required in the RI to make a more confident estimate of the potential risk. This exercise is identifying the data gaps.

5.1.4.3 Perform Hot Spot Analysis (In the Interim remedial Action Phase). There are several decisions to be made that affect the number of samples required to perform the hot spot analysis and the evaluation of potential risk from the hot spot. Identification of a hot spot analysis requires a systematic sampling plan. The systematic approach is generally a sampling grid. The typical systematic grids used are square or triangular. The choice between the two depends on the shape of the area being sampled and the size of the grid. The confidence of locating a hot spot can be identical for either grid type. The confidence of identifying the hot spot is directly related to the size of the grid (number of samples). The size of the hot spot to be identified also affects the total number of samples required over the entire area. Identifying smaller hot spots requires more samples (over the area being investigated) than identifying large hot spots.

The most conservative hot spot to be identified is for residential land use. EPA defines the size of a "residential hot spot" as one-quarter acre. One-quarter acre is the accepted size of a residential yard. Other land uses have different exposure areas or definitions of the exposure area. Light industrial land use is often one-half acre and heavy industry is larger. The exposure area for a recreational area can range from one-half acre in a park setting to several acres in a hiking or nature trail type scenario. Ecological risk-based decision criteria would be related to the size of the home range of the valued ecological resource being evaluated.



Assuming that the residential exposure area was used in an evaluation, The size of a square grid required to be 95 percent confident that a one-quarter acre hot spot was not missed would be a 98 –foot grid. This spacing assumes that the hot spot is a circular area. Other assumed shapes, which could depend on the site history and migration pathways for the contaminant, may require a smaller grid to retain the same confidence level.

To summarize, hot spot identification requires that the size of the hot spot is defined, the hot spot size must be related to an exposure area for a receptor, and the acceptable confidence level for missing a hot spot of a given size is identified,

5.1.4.4 Conduct RI/BRA (Remedial Investigation Phase). Preparing a sampling and analysis plan (SAP) for a remedial investigation requires incorporation of the entire Data Quality Objective (DQO) Process. The DQO Process is summarized in an attachment to this report.

5.2 Ecological Risk Assessment Policy

5.2.1 Recommendation: The PRT observed that the planning phase of the ecological risk assessment has not been well documented. It was not apparent

that a risk management team had been assembled to perform the initial planning phase of an ecological risk assessment.

Rationale: While older EPA ecological risk assessment guidance has identified the need for a planning phase, EPA's new guidance (EPA, 1998) emphasizes the importance of planning. Risk managers identify information they need to develop their decisions. Risk assessors ensure that science is effectively used to address ecological concerns. The risk assessors identify attributes of the identified valued ecological resources that can be scientifically evaluated. During planning, the risk managers identify the valued ecological resources they want to protect. The planning process is distinct from the science of the risk assessment. This distinction ensures that political and social issues, which help define the risk assessment objectives, do not introduce undue bias. Planning activities identify critical activities that influence why and how a risk assessment is conducted and how it will be used. The planning phase is where agreements are made about the management goals, the purpose for the risk assessment, and the resources available to conduct the work.

An important part of planning that is often neglected in a preliminary discussion of remedial alternatives. Ecological risk assessments are designed and conducted to provide information to risk managers about the potential adverse effects of different management decisions.

5.2.2 Recommendation: The PRT recommends that SEDA take the lead and create a risk management team before planning an ecological risk assessment.

Rationale: EPA guidance states that a risk manager may be a decision-maker within an agency, but risk managers may include a diverse group of interested parties who also have the ability to take action to reduce or mitigate risk. Risk management teams may include decision officials in Federal, State, local, and tribal governments; commercial, industrial, and private organizations, leaders of constituency groups; and other sectors of the public such as property owners. Interested parties are commonly called stakeholders. The older nomenclature for members of the risk management team was "Natural Resource Trustees" (EPA, 1988). The risk management team must address and provide answers to the following types of questions (EPA, 1998):

- What is the nature of the problem and the best scale for the assessment?
- What are the management goals and decisions needed and how will risk assessment help?
- What are the ecological values (e.g., entities and ecosystem characteristics)of concern?
- What are the policy considerations (law, corporate stewardship, societal concerns, environmental justice, and intergenerational equity)?
- What is the context of the assessment (e.g., industrial site, recreational area)?
- What resources (e.g., personnel, time, and money) are available? and,
- What level of uncertainty is acceptable?

5.2.3 Recommendation: The PRT recommends including NYDEC, NYDOH, EPA, SEDA, local farmers, BLM, Fish and Wildlife, local citizens, and other future land users as risk management team members.

Rationale: This is the first step in performing an ecological risk assessment at SEDA. The intent of risk assessment planning is to identify and provide the data required to perform the problem formulation step of the ecological risk assessment

Performing the risk assessment tasks ensures that the correct data are identified and collected to support problem formulation. Problem formulation uses the DQO Process to identify data needed to support decision making. Data needs are identified by using existing data in an ecological risk assessment and then identify the additional data that are necessary to make defined decisions at the level of acceptable uncertainty identified by the risk management team.

Note: The ecological importance of the size of an area affected was discussed in section 5.1.1.

5.2.4 Recommendation: The BCT needs to define the valued ecological resources desired to be protected at SEDA.

Rationale: A significant task during the risk management team's planning is selecting the valued ecological resources to be protected. Many of these are likely to be of societal value, for example the white deer and turkey populations. These are valued for observing and hunting. These values are not ecologically driven, but are important to future land users and the public. The attributes for these resources may be a viable population that is sufficient for hunting or observing. These attributes are not based on ecological principals and are not supported "scientifically". The decision criteria and acceptable uncertainty used to determine a potentially adverse affect on these populations are different than a population that occupies a critical ecological "niche" in an ecosystem.

At the other end of the spectrum are receptors that are commonly used to screen for potential ecological risk at a site. An example is mouse populations. Because mice have a relatively small home range, it is possible that a small contaminated area could have an adverse affect on the very local population. However, a localized decrease in the mouse population may not result in an unacceptable risk to the ecosystem. A physical example would be paving a small area with concrete. The mouse population would be eliminated in that area, but the overall affect to the larger ecosystem would likely be acceptable. This type of rationale needs to be considered by the risk management team during the planning phase of the ecological risk assessment.

References for this section are EPA, 1998, Federal Register, Vol 63, No. 93/Thursday, May 14, 1998. 26846.

5.3 Intrinsic Bioremediation Policy for Petroleum Sites

5.3.1 Recommendation: The PRT recommends that SEDA develop protocols that enable it to consider intrinsic bioremediation/natural attenuation as a presumptive remedy for petroleum sites. (Supplement to Sec. 2.3 of the PRT, 1997 Recommendations Report). The most important natural attenuation mechanism for hydrocarbon contaminated sites is biodegradation.

Rationale: Studies performed by Lawrence-Livemore National Laboratories and others have demonstrated that in general, contamination caused by petroleum, oils, and lubricants (hydrocarbons) have relatively limited affect on the environment. Migration of separate phase hydrocarbon (product) in the subsurface is minimal and migration of dissolved phase hydrocarbons (in groundwater) is generally limited to several hundred feet. These observations resulted in more detailed analyses which have demonstrated that under most subsurface conditions attenuative processes are occurring which limit the migration of petroleum hydrocarbons. Most notable of these processes is biological degradation. Today, many states including Wisconsin, Iowa, and California consider intrinsic bioremediation along with a risk-based analysis in a determination as to whether or not active site remediation is required. The decision to remediate is based on a determination of whether intrinsic bioremediation will reduce dissolved phase POLs to below MCLs before the contaminant plume reaches potential receptors.

Although the Army now has a policy requiring inclusion of a National Attenuation alternative in its remediation decision analysis, it is the Air Force that has proceeded with the development of protocol for implementing bioremediation in concurrence with groundwater monitoring at sites impacted by petroleum hydrocarbons.

Implementation: Evaluating the effectiveness of bioremediation requires the quantification of groundwater flow and solute transport processes, including the rate of biodegradation. Quantification of contaminant migration and degradation rates requires completion of the following steps:

- Review existing site data.
- Develop a preliminary conceptual model for the site, and assess the potential significance of intrinsic remediation.
- Perform site characterization in support of intrinsic remediation.
- Refine the conceptual model based on site characterization data, complete premodeling calculations, and document indicators of intrinsic remediation.
- Model intrinsic remediation using numerical fate and transport models that allow incorporation of a biodegradation term (e.g., Bioplume II or Bioplume III).

- Conduct an exposure assessment.

- Prepare a long-term monitoring plan, long-term monitoring wells at the site, and point-of compliance wells.

- Present findings to regulatory agencies, and obtain approval for the intrinsic remediation with long-term monitoring option.

These steps are also illustrated in the Intrinsic Remediation Flow Chart" developed by AFCEE and incorporated into their protocol. Rather than develop new protocol, the PRT recommends adopting AFCEE Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring Option for Dissolved-Phase Fuel Contamination in Ground Water, Draft Report, March 1994.

In 1996, as an outgrowth of recommendations made in a report by the U.S. Army Science Board. (Remediation of Contaminated Army Sites: Utility of Natural Attenuation on) the ACSIM issued a statement that all Army facilities were to consider Natural Attenuation in evaluation of remedial alternatives for contaminated sites. This policy statement incorporates POL sites, and as previously stated, the most notable attenuation process at POL sites is biodegradation.

It should not be assumed that biodegradation or intrinsic bioremediation is going to be either the most cost effective or the expedient remediation methodology. If there is no imminent risk to human health and environment, then it is a viable alternative. However, it should be recognized that although active remediation may not be required, long-term monitoring and detailed site characterization will often be necessary to demonstrate to the regulatory community that biodegradation is occurring. At small POL sites, which can be remediated by removal actions or air sparging/vapor extraction, intrinsic bioremediation may not be cost effective over the length of the monitoring period in comparison to the low level effort and expedient nature of some other remedial alternatives. Therefore, a cost-benefit analysis must be performed to compare the present-worth cost of intrinsic bioremediation as compared to other viable remediation alternatives. Such analyses are particularly important at SEDA because of low cost disposal sites and the potential that a thermal desorption unit will be available on site.

5.4 TAGMs

5.4.1 Recommendation: The PRT recommends that SEDA continue to work with NYDEC on establishment of achievable cleanup levels.

Rationale: TAGM 4046 provides a process for developing soil cleanup objectives by the Technology Section of the NYDEC Division of Hazardous Waste Remediation. Since these values do not appear to be promulgated or enforceable, they are TBC guidance and do not have the status of ARARs for cleanup pursuant to CERCLA. However, no ARARs otherwise exist for remediation of soils at SEDA, so the parties must turn to TBC guidance. In light of this, NYDEC has as much authority to encourage the utilization of their own non-promulgated values as the Army does to use the non-promulgated values developed from EPA guidance (RAGS). Therefore, because the NYDEC appears to want to work with the Army regarding cleanup objectives for soil, this would appear to be the best initial plan of action. However, If the Army is not able to arrive at achievable cleanup levels by negotiating with the NYDEC, the Army should consider its legal position with regard to these objectives and proceed to dispute resolution to resolve the issue, in order to be able to go forward with remediation activities, closure and transfer.

Objectives derived using NYDECs Technical and Administrative Guidance Memorandum (TAGM) 4046 are risk-based criteria based on different assumptions from EPA's PRGs. The TAGM values are calculated for instances where achievement of pre-release conditions is not possible. An alternative cleanup value that can be utilized is "background." According to James Quinn of NYDEC at the Peer Review meeting, TAGMs are a goal. At the meeting, both Dr. Marsden Chen of NYDEC and Mr. Quinn indicated that there is flexibility in applying TAGMs to site-specific situations. The State interpretation of TAGMs is that the Army must meet the TAGM value; however, if the Army cannot meet the TAGM value, the State regulators present indicated that the State will talk with the Army about the site-specific circumstances. However, first and foremost, the State wants the Army to try to meet the TAGM values. The State also wants to maintain ample flexibility to evaluate site-specific facts. This partially means not having the Army impose their values, i.e., PRGs which seem quite large to the NYDEC, on the State. Their position seems to be that if and when the Army is unable to achieve either background or TAGMs, the State will discuss the development of new criteria. The State regulators fear that if NYDEC accepts a PRG at one site, the State then is locked into accepting it at every site. This would negate their flexibility.

At least part of the authority that NYDEC uses in advancing the use of its cleanup objectives is 6 NYCRR 375-1. This regulation states that ∀[t]he goal of the program for a specific site is to restore that site to pre-disposal conditions, to the extent feasible and authorized by law. At a minimum, the remedy selected shall eliminate or mitigate all significant threats to the public health and to the environment presented by hazardous waste disposed at the site....[6 NYCRR 375-1.10(b).] This language leaves opportunity for the interpretation that the Army must clean up to pre-disposal conditions *to the extent feasible* and to eliminate *significant threats*. It can be argued that contaminants that cause no risk can hardly be considered significant threats. Likewise, the phrase *to the extent feasible* can be variously interpreted. To make a full-fledged argument along this line would require a review of case law to determine how the courts may have defined or interpreted these phrases. The New York State law, especially the New York Environmental Conservation Law, should be investigated to determine whether that law contains language that supports the implementing regulations or provides the basis for a counter argument by SEDA.

5.5 Investigation Strategy

5.5.1Recommendation: SEDA should continue to make use of field screening techniques, to the maximum extent possible.

Rationale: It is obvious that SEDA has been and is using field screening during its site investigations. However better and/or greater use can be made. It was observed that during some investigations, soil gas sampling was used to determine possible VOCs in soil. But the discrete soil-sampling program proceeded independently of the results of the field screening. The two procedures should be linked to better define the potential nature and extent of contamination.

In most cases, field screening is not meant to be a definitive analytical tool. It is best used early in investigations when little is known about a site and the possible extent of contamination. As used previously, the results could only provide a basis to determine that more investigation is needed, which is hardly a constructive outcome. The tool should be used to aid in locating discrete sampling locations so that a site can be eliminated from further consideration, if possible, but at least to identify source areas. Field screening is a good tool to quickly investigate a large geographic area with many samples.

5.5.2 Recommendation: The PRT recommends that when the existing and future sampling plans are revised or written that field screening, especially soil gas and X-Ray Fluorescence (XRF), be used to the greatest extent possible.

Rationale: Both the soil gas and XRF provide real-time output on volatile and metal concentrations, respectively. By contouring results in the field, the contractor can collect more data in less time and either determine that a site is clean or identify problematic areas for more intense analysis without having to wait for lengthy off-site laboratory turnaround times.

5.5.3 Recommendation: The PRT recommends that the sampling program be scheduled such that the results of the field screening decision criteria can direct the locations of some of the discrete soil samples through use of pre-arranged decision criteria.

Rationale: The power of field analyses and screening methods is their ability to reduce field mobilization and de-mobilization required when there are long delays in obtaining results. In order to realize the value of screening methods, sample plans must be phased with clear decision criteria so that contractors can proceed in a seamless fashion in the field. In order to operate in this mode, the work plan must clearly indicate what is to be done if a sample or set of samples are found to exceed a threshold concentration value. That value is the decision criterion.

5.6 Regional Groundwater Strategy

The PRT **concurs** with SEDA that since groundwater contamination seems to be only occurring at a few discrete sites that an overall regional groundwater clean up strategy is not warranted. But, if future investigation relates groundwater contamination from multiple sites within a similar geographic area, a regional groundwater strategy should be revisited.

5.7 Site-Specific Background

97 Recommendation: The PRT recommends that the background soil data be divided into two sets representing surface and subsurface soils. The resulting concentration data should be presented to the regulators for formal approval for use in place of TAGM values whenever background concentrations are higher than the corresponding TAGM value.

Rationale: Current background soil samples include those collected from surface soils and those collected from subsurface soils. Even when surface and subsurface soils are derived from the same host rock materials, they often differ in chemical composition because of differing rates of weathering and deposition of chemicals from wind and precipitation. As a consequence, the combination of surface and subsurface soils in a single set for determining background concentrations will understate the concentration for one depth of soil and over state it for the other. By segregating the data between surface and subsurface soils, samples can be compared to the appropriate background.

Since it has been agreed upon that whenever background levels exceed the TAGM value for a chemical, the background sample will be used in lieu of the TAGM value, it is important to get formal concurrence from the regulators on the background values.

Implementation Options: The background data report should be reworked to split the surface and subsurface soil data into two discrete sets. The report should then be submitted formally to the regulators with an approval signature plate to document their concurrence with the methodology and results.

5.8 Deep Bedrock Wells

Recommendation (1997): Re-evaluate the need to install deep wells at other areas across the site.

Rationale (1997):

- Competent shale underlying the site appears to be a satisfactory aquitard in preventing contaminant transport to the lower aquifer based on actual data collected for this site.

- All deep wells at the installation are clean, even at sites where there are high concentrations of constituents in the surfical aquifer. Currently, all data support the conclusion that contaminant impact is restricted to the zone of weathered bedrock.
- Any contamination within the deeper bedrock would be limited in its ability to migrate.
- It would most likely be, from a hydraulic perspective, technically impractical to remediate the deep bedrock.

SEDA Response, July 30, 1997: "...It is unclear to the BCT whether the Peer Review Team understood the wells that are in question were only being installed at depths of 50 to 60 feet."

5.8.1Recommendation (98): The PRT recognizes that deep is a relative term and understand that the SEDA "deep wells" are only 50 to 60 feet deep. However, this does not change our recommendation. The PRT does not understand the decision to be made using data from new deep wells.

Rationale: The hydraulic conductivity of the deeper bedrock is very low, and there is no evidence of shallow contamination having reached beyond a depth of 30 feet. Although it is possible under certain hydrogeologic and contaminant conditions for the contaminant plumes to vertically migrate into deeper portions of an aquifer, the Long Island example presented at the meeting at SEDA is not characteristic of conditions at SEDA. Landfill leachate flow on Long Island is not analogous to the hydrogeologic conditions at SEDA. The Upper Glacial Aquifer system on Long Island is composed predominantly of glacial outwash material which has a relatively high hydraulic conductivity and has minimal lateral or vertical variation. The density difference between leachate and groundwater allowed the leachate to migrate down through the saturated zone until it either had become diluted to the point that its density could no longer overcome the influence of the horizontal hydraulic gradient or it encountered a unit of lower hydraulic conductivity. At SEDA the zone of highest hydraulic conductivity is encountered at or near the till/bedrock interface. The hydraulic conductivity of the shale rapidly decreases as one gets below the zone of weathered rock. All the existing groundwater quality data indicate that groundwater contamination resides at the top of rock and not at depth. However, the PRT does recognize that there may be discrete localities where vertical fractures may permit deeper contaminant migration, and that at some localities where contaminant concentrations near the surface are extremely high the BCT may believe that it is prudent to install a deep well verify that vertical migration of contaminants is limited.

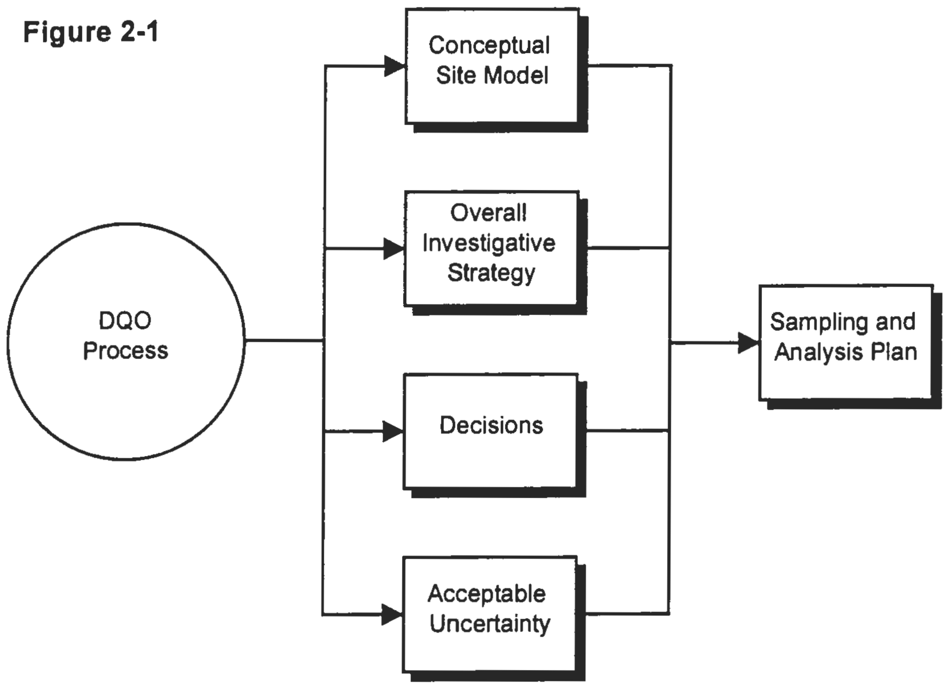
Implementation Options: Under such circumstances, BCT should consider whether there is any local evidence of "significant" vertical fracturing, the significance of the contaminant concentration and whether the compounds present could represent a health or ecological risk (are there any receptors or groundwater users), and if such conditions truly represent a potential for high risk then PRT would concur that one deep well may be appropriate to objectively determine whether an impact can be observed to the deeper portions of the aquifer. PRT emphasizes that, if needed at all, the use of deep wells should be limited and used only when prudent.

ATTACHMENT A

Use of the Data Quality Objective (DQO) Process in All Future Work Plans

The DQO Process is EPA guidance that explains how to identify and collect the data needed to make defensible decisions. The DQO Process has seven steps that are discussed individually below. Figure 2-1 identifies the fundamental functions of the DQO Process in developing a Sampling and Analysis Plan (SAP). The primary functions are to create and evaluate a conceptual site model (CSM), document the overall investigation strategy, identify decisions to be made, and define the acceptable uncertainty for each decision to be made. This information supports and documents the professional judgment and rationale used to prepare the SAP.

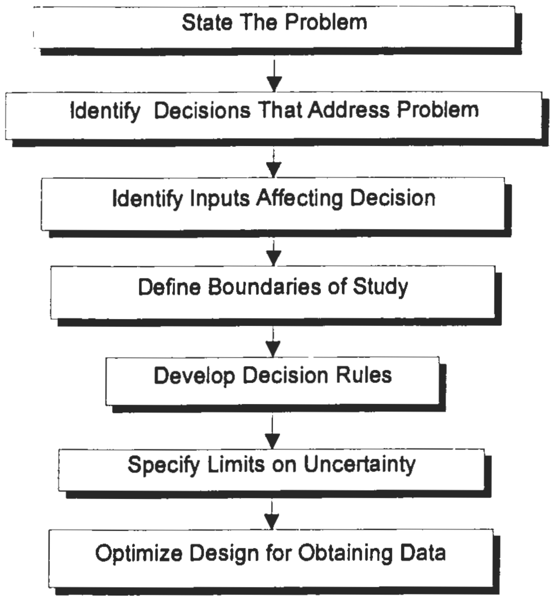
Figure 2-1



OVERVIEW OF THE DQO PROCESS

The EPA DQO Process guidance explains how to identify and collect the data needed to make defensible decisions. The DQO Process is a planning process and is the EPA's interpretation and application of the scientific method. This guidance states that the agency's (and regulated community's) objective "....is to minimize expenditures related to data collection by eliminating unnecessary, duplicative, or overly precise data. At the same time, the data collected should have sufficient quality and quantity to support defensible decision making"(EPA 1993, 1994). One interpretation of the EPA goal is to design sampling and analysis plans that only collect those data that support making previously defined decisions. The DQO Process could also be defined as "documenting the obvious" or "documenting professional judgment". Defining the decisions to be made is part of the planning (DQO) process. The DQO Process has seven steps shown schematically in Figure 2-2.

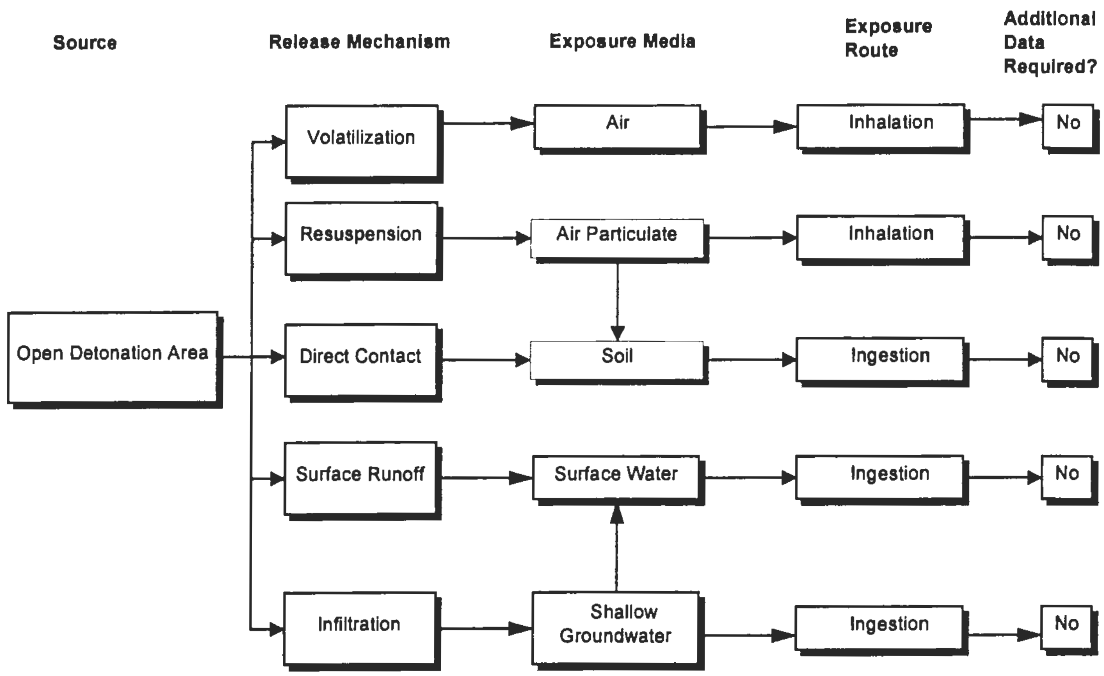
Figure 2-2. Steps in the DQO Process



1. State the Problem

Stating the problem should be a simple description of the issues at the site that are cause for concern. For example, "Preliminary investigation of the Detonation area, SEAD 45, has determined that 15 chemicals exceed NY SDEC TAGM screening levels and 4 chemicals exceed ecological PRG concentrations. This indicates the need for an evaluation of potential health risk to humans and ecological receptors." The problem statement should not be longer than one page, but should contain sufficient detail to inform a reader of the significant issues at the site. A conceptual site model (CSM) is prepared when defining the problem statement. An example is shown in Figure 2-3. This CSM is appropriate to identify the pathways by which chemical releases can result in potential exposure to identified human or ecological receptors.

Figure 2-3. Conceptual Site Model For SEAD 45

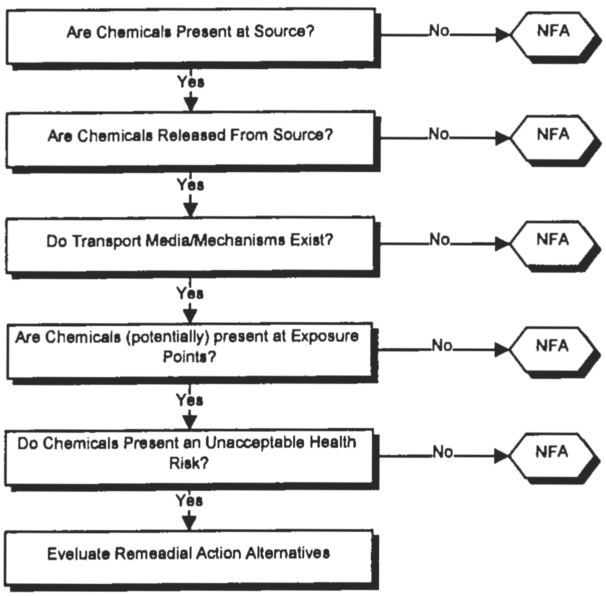


2. Identify Decisions That Address the Problem.

The next step in the DQO Process is to define the decisions that will address issues identified in the problem statement. These decisions can be specific or more generic, and use the CSM to define decisions that are appropriate for the problem statement and site-specific conditions. Site-specific conditions may include, for example, current and future land use. The CSM similar to that shown in Figure 2-3 is a basis for defining remedial investigation decisions. Decisions can be identified for the source, each release mechanism of potential concern, each transport medium, and each identified exposure point. A typical decision for a source may be "Is barium present at the source area of SEAD 45 in concentrations that are potentially harmful to human health or the environment?" Decisions for determining whether or not a specific release mechanism exists can also be identified. A basic release decision may be stated as; "is barium being released from SEAD 45 sources in amounts that are potentially harmful to human health or the environment." There can be no releases from sources that have been removed or remediated. A removal action makes the pathway incomplete. The need to evaluate a specific release mechanism depends on many factors. For example, a volatilization release mechanism would not be evaluated for barium, because barium is not released by this mechanism. Data would not be collected to make a VOC release decision. The volatilization pathway would be evaluated if it were known that the source contained volatile chemicals (VOCs in subsurface soil or groundwater) in concentrations that are potentially harmful. Pathway-specific decisions are also identified for transport media in each chemical transport pathway. This type of decision can be expressed as; "is barium transported in concentrations that are potentially harmful to human health or the environment." A final decision to be made relates to the potential exposure of receptors, and may be stated as; "Are barium concentrations at identified exposure points harmful to human health or the environment?"

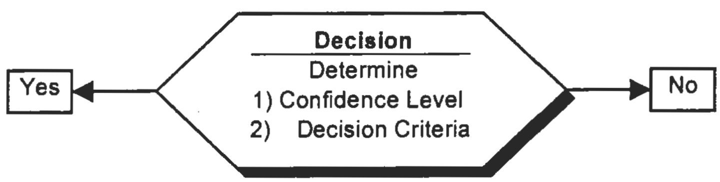
The typical decision types that can be identified for each chemical transport pathway shown in the CSM discussed above are shown schematically in Figure 2-4. It is important to identify the potential action that will be taken if the decision is answered in one way and that no further action will be taken when the identified decision is answered differently. When a no further action decision is made, there are no additional data collection needs for the specific pathway being evaluated.

Figure 2-4. Generic Decisions



It is important that the specific decision definition is stated so there are only clear yes or no answers. This situation is shown schematically in Figure 2-5 for a single decision. The decision in Figure 2-5 could represent any of the decisions illustrated in Figure 2-4. Any possible answer that is not yes or no means that additional data collection will not contribute to decision making. Decisions must be redefined and restated until only a yes or no answer is possible. When additional data needs are identified to support the decision, the additional data are identified in the SAP to ensure that the decision can be made using the proposed data. Any possible answer to a decision statement other than yes or no means that the decision is not adequately defined to plan data collection and additional planning is required.

Figure 2- 5. Typical Decision Process



3. Inputs that Effect Decisions

This phase of the Process identifies the specific data needed to make or support a decision. For example, if we are identifying inputs for the decision, "Are Chemicals Released From Source?" (Figure 2-4) and the pathway being considered is infiltration/percolation, it is likely that an input would be chemical concentrations in subsurface soil beneath (or adjacent to and "downgradient" of) the source. The data input is chemical concentration in subsurface soil. The input also identifies the horizontal and vertical location of the sample. For example, adjacent to the source at a depth of five feet below the disposed wastes. Each release mechanism for each evaluated chemical transport pathway would have specific samples (data) identified to support a decision related to release.

4. Define Study Boundaries

There are many study boundaries to be considered. The primary example of a study boundary given in EPA's DQO guidance is funding limitations. Other boundary conditions include; physical limitations of sampling, time constraints (agency or facility schedule), materials migrating on site from off-site sources, agency policy, public opinion, Army policy, and permission to sample off site locations. Each of these boundary conditions focuses the investigation and often affects the confidence in decision-making (acceptable uncertainty).

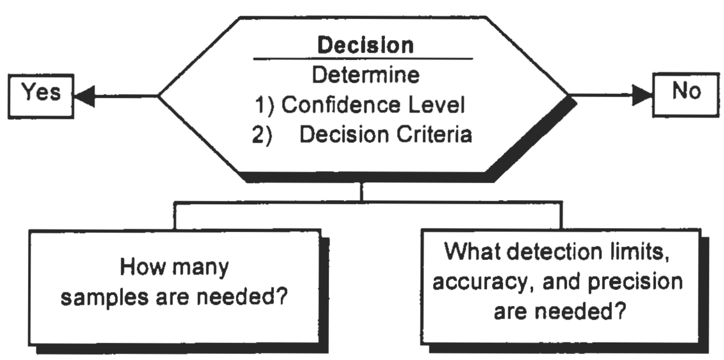
5. Develop Decision Rules

Decision rules are developed for the decisions identified in step 2. The decision rule can be considered a statement of the hypothesis to be tested. Data are collected to confirm or reject the hypothesis. For example, a decision in Figure 2-4 was "Are Chemicals Released From Source?" This decision can be changed to the form of a decision rule, which is an "If.... then.." statement. An example decision rule is; "If a chemical is released from the source in concentrations greater than the decision criteria, then the transport media for this pathway will be investigated to determine if the pathway is complete." Or, stated in a chemical and sample specific manner, the decision rule would be; "If the concentration of barium in a subsurface soil sample is greater than 92 ppm, then additional investigation will be performed to determine the potential transport of barium by groundwater." The decision criterion would be a value that is protective of human health and the environment (92ppm).

6. Specify Limits on Uncertainty

The confidence level needed for the defined decision is the "acceptable uncertainty" in EPA guidance. Acceptable uncertainty is a necessary concept in SAPs, because one cannot collect enough data to be one hundred percent confident of a decision or to eliminate uncertainty. Figure 2-6 shows that the confidence level is related to the quantity of data collected and the quality of the data collected is related to the decision criterion. It is important to understand the limitations of quantity and quality. Even if 100 percent of a population were measured, sample handling and measurement error introduce uncertainty. There is always some uncertainty about values calculated from measured data and how confidently they represent the "true" population. Therefore, a level of confidence or acceptable uncertainty must be identified when planning data collection. When the decision-maker

Figure 2- 6. Typical Decision Process

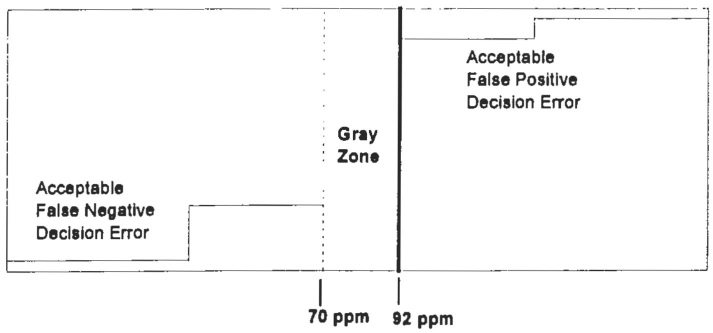


defines acceptable uncertainty, it is important that the decision-maker understands that there is always uncertainty in measured data used to support decision making. If uncertainty is not acceptable to the decision-maker, it must be understood that even sampling the entire population will not remove sample handling and measurement uncertainty. EPA's 1988 RI/FS guidance states "The objective of the RI/FS process is not the unobtainable goal of removing all uncertainty, but rather to gather information sufficient to support an informed risk management decision regarding which remedy appears to be most appropriate for a given site."

It is important that the level of acceptable uncertainty is established for the decision being made and not for uncertainty in the collected data. The confidence level (acceptable uncertainty) is directly related to the question of "How many samples are needed?" Higher confidence requires more samples. The SAP must include defined decisions, confidence levels for the decision, and decision criteria to ensure that the risk manager understands the defensibility of making a decision. The decision criteria are generally, but not necessarily, numerical values related to the decision being made. Often the decision criteria are related to concentrations that are protective of human health or the environment. Numerical decision criteria determine the quality of data needed to make the decision. Generally, the lower the decision criterion, the higher the quality of data required. These criteria can be health based screening levels (e.g., EPA soil screening levels), MCLs, regulatory criteria for various media, negotiated criteria, or remedial design criteria. The decision criteria determine the analytical measurement accuracy and precision needed for each defined decision.

The decision-makers (agencies, Army, others) must identify the acceptable uncertainty for each decision to be made to prepare a SAP. Generally the decisions compare collected data with identified decision criteria. An example was given for barium in SEAD 45 source soil, earlier in the "develop decision rule" paragraph. In that case, the hypothesis was; H_o = barium concentrations in subsurface soil are greater than 92 ppm. This hypothesis assumes that there is reason to believe that the site is "dirty". The power curve for this hypothesis is shown in Figure 2-7. Figure 2-8 shows the power curve for the hypothesis; H_1 = barium concentrations in subsurface soil are less than 92 ppm (it is assumed that the site is clean). These power curves are taken from EPA's DQO guidance. Defining the acceptable uncertainty depends on several factors. Acceptable uncertainty is directly related to the consequences of decision errors. The false positive error for H_o is that an area would not be remediated when it is potentially harmful to human health or the environment. The related false negative error is that areas that are not potentially harmful to human health would be unnecessarily remediated. The consequences of these decision errors are potential health effects to receptors and spending resources unnecessarily, respectively.

Figure 2-7. Power Curve Ho: Site is Dirty



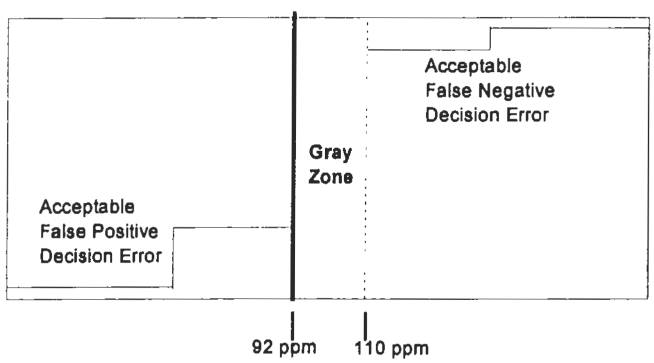
EPA's goal in protecting health is that 95 percent of the population must be protected. Assuming that this is also the case for SEDA, the acceptable decision error for a false positive would be 0.05. The acceptable false negative decision error depends on the availability of Army funds to perform unnecessary remediation.

The consequence of a false negative decision error is that excessive resources are used to characterize and remediate areas that do not pose an acceptable health risk. In this example, areas would be remediated when the actual barium concentration in source-related soil was less than 92 ppm. This hypothesis means that in a dirty site area with concentrations greater than 70 and less than 92 ppm barium would either be remediated or investigated further.

When a false positive decision error is made, there would be subsurface soil with barium concentrations greater than 92 ppm left in subsurface soil at the site. The decision-makers must evaluate the health consequences of leaving barium in subsurface soil. What greater amount can be left in the soil without having an unacceptable consequence? Decision-makers rarely perform this important function when making decisions.

Figure 2-8 shows the power curve to be used when there is no existing evidence that a site is contaminated. This power curve should be applied to chemical concentrations at SEDA when there are no reasons to suspect the site has been contaminated by barium. In this case, the consequences of missing subsurface soil at a concentration of 110 ppm barium is acceptable, because there is no reason to believe that the site is contaminated with barium. Another approach to explain this is that a hit of 110 ppm at a site with no history of barium use would not provoke an extensive investigation designed to select a remedial alternative. This hypothesis means that soil containing greater than 92 but less than 110 ppm barium would not be investigated further or remediated. The acceptable decision error is identified during the planning phase.

Figure 2-8. H_1: Site is Clean

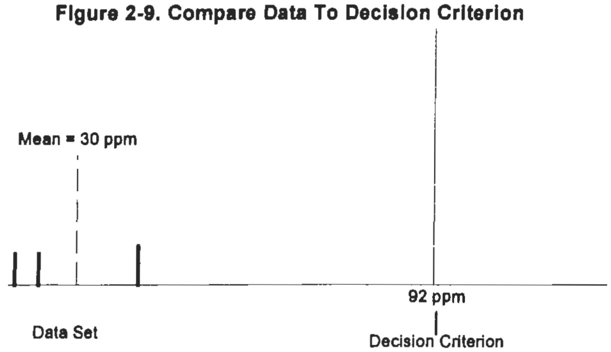


Determining the acceptable decision error has not been performed or considered (or at least not reported) for data collection at SEDA. This is an effort that needs to be lead by the Army and agreed upon by the agencies.

The width of the gray zone is not established using a technical or scientific approach. It is derived by negotiation or professional judgement combined with an evaluation of the consequences of a decision error. The gray zone width is not used in decision making; it is only used to plan data collection. A combination of the acceptable False Negative decision error, the False Positive decision error, and the width of the gray zone defines the number of samples to be collected. Decision making depends on the actual data collected. For example, in Figure 2-7, if the cost of cleaning up small identified areas is low compared to additional data collection, it may be cost effective to remediate areas that are clean. If the remedial cost is prohibitive, it is likely that additional investigation with a lower acceptable false positive error is appropriate. For example, when the cost of remediating subsurface soil with barium concentrations of 85 ppm are not acceptable, these sites should not be remediated and additional investigation should be considered. Depending on the risk management decision-making, no further action may be appropriate. There are similar considerations for the decision to be made when H_1= Site is clean, as shown in Figure 2-8.

The quality of the collected data is not always directly related to the uncertainty in decision making. For example, one can have a minimal data set with a relatively large variance and still make a confident decision. Figure 2-9 shows a hypothetical situation where the data set has a large variance. However, because the mean of the data is very small compared to the decision criterion, one can be more than 95 percent confident that the site concentrations do not exceed the decision criterion. This highly confident decision can be made even though one does not have high confidence that the data set mean of 30 ppm is representative of the true population for subsurface soil. The objective of the decision maker is to make confident decisions and, not to be confident that the collected data are a "true" representation of the sampled population.

Figure 2-9. Compare Data To Decision Criterion



LEAD RISK ASSESSMENT SPREADSHEET

CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

INPUT / **OUTPUT**

MEDIUM	LEVEL		percentiles 50th	90th	95th	98th	99th	PRG-99 (ug/ g)	PRG-95 (ug/ g)
LEAD IN AIR (ug/m^3)	0.1								
LEAD IN SOIL (ug/g)	274.0	BLOOD Pb, ADULT (ug/dl)	2.6	4.1	4.7	5.4	6.0	891.7	1309.3
LEAD IN WATER (ug/l)	15	BLOOD Pb, CHILD (ug/dl)	5.7	8.9	10.1	11.6	12.8	140.3	270.8
PLANT UPTAKE? 1=YES 0=N(	1	BLOOD Pb, PICA CHILD (ug/dl)	19.8	31.1	35.2	40.8	44.9	21.3	41.1
RESPIRABLE DUST (ug/m^3)	50	BLOOD Pb, INDUSTRIAL (ug/dl)	2.0	3.1	3.6	4.1	4.5	4361.5	6405.5

EXPOSURE PARAMETERS

	units	residential adults	residential children	residential children with pica	industrial adults
General					
Days per week	days/wk	7	7	7	5
Dermal Contact					
Skin area	cm^2	3700	2800	2800	5800
Soil adherence	mg/cm^2	0.5	0.5	0.5	0.5
Route-specific constant	(ug/dl)/(ug/day)	0.00011	0.00011	0.00011	0.00011
Soil ingestion					
Soil ingestion	mg/day	25	55	790	25
Route-specific constant	(ug/dl)/(ug/day)	0.0176	0.0704	0.0704	0.0176
Inhalation					
Breathing rate	m^3/day	20	10	10	20
Route-specific constant	(ug/dl)/(ug/day)	0.082	0.192	0.192	0.082
Water ingestion					
Water ingestion	l/day	1.4	0.4	0.4	1.4
Route-specific constant	(ug/dl)/(ug/day)	0.04	0.16	0.16	0.04
Food ingestion					
Food ingestion	kg/day	2.2	1.3	1.3	2.2
Route-specific constant	(ug/dl)/(ug/day)	0.04	0.16	0.16	0.04
Dietary concentration	ug/kg	16.2	16.2	16.2	10.0
Lead in produce	ug/kg	123.3	123.3	123.3	

PATHWAYS, ADULTS

Pathway	Residential Blood Pb ug/dl	Residential percent of total	Industrial Blood Pb ug/dl	Industrial percent of total	Concentration in medium
SOIL CONTACT:	0.05	2%	0.06	3%	274 ug/g
SOIL INGESTION:	0.12	5%	0.09	4%	274 ug/g
INHALATION:	0.19	7%	0.13	7%	0.11 ug/m^3
WATER INGESTION:	0.84	32%	0.84	42%	15 ug/l
FOOD INGESTION:	1.43	54%	0.88	44%	16.2 ug Pb/kg diet

PATHWAYS, CHILDREN

Pathway	Typical Blood Pb ug/dl	Typical percent of total	with pica Blood Pb ug/dl	with pica percent of total	concentration in medium
SOIL CONTACT:	0.04	1%	0.04	0%	274 ug/g
SOIL INGESTION:	1.06	19%	15.24	77%	274 ug/g
INHALATION:	0.22	4%	0.22	1%	0.11 ug/m^3
WATER INGESTION:	0.96	17%	0.96	5%	15 ug/l
FOOD INGESTION:	3.38	60%	3.38	17%	16.2 ug Pb/kg diet

Site: Site Name
Receptor: Adult Construction Worker, RME Exposure Parameters
Exposure Point Concentration: 95 UCL

If the site-specific $PbB_{adult,\ central}$ exceeds the EPA default $PbB_{adult,\ central,\ goal}$, the childhood risk of blood lead values exceeding 10 ug/dL exceeds 5%.

$$PbB_{adult,\ central} = PbB_{adult,0} + \frac{Pb_S \times BKSF \times IR_S \times AF_S \times EF_S \times ED_S}{AT}$$ (Equation 1, EPA, 1996)

EPA DEFAULT MODELING ASSUMPTIONS:

Parameter	Value	Units	Definition
$PbB_{adult,\ central,\ goal}$	3.89	ug/dL	Goal for central estimate of blood lead concentration in adult women. The goal is intended to ensure that fetal blood lead concentrations do not exceed 10 ug/dL. The value of 3.89 derived per equation 3, assuming a GSD of 1.89 for non-Hispanic white women.
$PbB_{adult,\ central}$	Calculated	ug/dL	Central estimate of blood lead concentrations in adults (i.e., women of child bearing age) that have site exposures to soil lead at concentration PbS
$PbB_{adult,0}$	2	ug/dL	Typical blood lead concentration in adults (i.e., women of child-bearing age) in the absence of exposure to the site that is being assessed
BKSF	0.4	(ug/dL) / (ug/day)	Biokinetic slope factor relating (quasi-steady state) increase in typical adult blood lead concentration to average daily lead uptake
AF_S	0.12	unitless	Absolute gastrointestinal absorption fraction for ingested lead in soil and lead in dust derived from soil

SITE-SPECIFIC EXPOSURE ASSUMPTIONS:

Parameter	Value	Units	Definition
Pb_S	161	ug/g (mg/kg)	Soil lead concentration (ug/g) (appropriate average concentration for individual).
IR_S	0.48	g/day	Intake rate of soil, including both outdoor soil and indoor soil-derived dust
EF_S	50	days/year	Exposure frequency for contact with assessed soils and/or dust derived in part from these soils; may be taken as days per year for continuing, long term exposure
ED_S	5	years	Exposure duration for contact with soils
AT	1825	days	Averaging time; the total period during which soil contact may occur

RESULTS:	**2.51 ug/dL**	Calculated adult blood lead concentration based on site-specific exposure assumptions and EPA default adult blood lead modeling parameters
	3.89 ug/dL	Adult blood lead goal intended to ensure that fetal blood lead concentrations do not exceed 10 ug/dL
	599 ug/g (mg/kg)	Estimated soil lead concentration protective of the fetus based on the site-specific exposure assumptions and EPA default adult blood lead modeling parameters

CONCLUSION: **Exposure of nonresidential adults (i.e., women of child-bearing age) to lead in soil at the site is not expected to be associated with fetal blood lead concentrations exceeding 10 ug/dL.**

Source: EPA, 1996. Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. Technical Review Workgroup for Lead.

2 Sept 97

FY98
PEER REVIEW
IMPLEMENTATION PAPER
Final

SFIM-AEC-ER

SUBJECT: U.S. Army Technical Peer Review For Environmental Restoration Projects

1.0. INTRODUCTION.

1.1. Peer Review is a mechanism through which Army installations obtain independent technical recommendations to ensure: (a) an appropriate level of risk reduction at a site, and (b) the efficient use of the Army's Environmental Restoration Funds. This independent input may be used to facilitate the project decision-making process.

1.2. The focus of Peer Review in FY98 is Base Realignment and Closure (BRAC) restoration projects. Pilot tests of the peer review process at selected active sites are also planned for FY98. Peer reviews may be expanded in FY99 to include more active sites, and may ultimately be used to review other Department of the Army Environmental Programs (e.g., Formerly Used Defense Sites (FUDS), Compliance, Pollution Prevention, Conservation).

2.0. PURPOSE.

The purpose of the Restoration Technical Peer Review is:

2.1. To validate and enhance the credibility of the decision-making process.

2.2. To validate the rationale used to scope and select remedial actions.

2.3. To ensure the use of a risk-based approach as a remediation decision tool, as well as the incorporation of a properly conducted, site-specific, risk assessment.

Encl 1 to Encl 1

2.4. To promote a risk management approach to provide cost-benefit balance.

2.5. To evaluate the technical ability of the proposed remedial action to achieve stated remediation goals.

2.6. To identify opportunities to use accelerated removal actions, presumptive remedies, and innovative technologies.

2.7. To ensure that the most cost-effective approaches are employed in order to conserve Army environmental funds.

2.8. To refine cost estimates for budget submission requirements.

2.9. To establish consistency of restoration decisions across the Army.

2.10. Provide "lessons learned" to the field and headquarters.

3.0. RECOMMENDED ARMY PEER REVIEW APPROACH.

3.1. The Army already has an integrated Environmental Restoration Oversight Program which is managed at the U.S. Army Environmental Center (USAEC). This continuous oversight program provides budgetary, management and, to a lesser extent, technical assistance to both the Base Realignment and Closure (BRAC) and Installation Restoration (IR) Environmental Programs.

3.2. Peer review complements and enhances the Army's Restoration Oversight Program. Through conscientious implementation of the Peer Review Program, significant cost savings are achieved. The greatest benefit is obtained by making expert technical assistance available for formulating or improving upon solutions. Another primary benefit of peer review is the provision of independent expert technical opinions, when needed, to aide in negotiations with regulators and/or Restoration Advisory Boards.

3.3. The Army Peer Review Process consists of three phases: Phase 1 - Project Selection; Phase 2 - Peer Review and Recommendation Report Preparation; and Phase 3 - Peer Review Recommendation Implementation.

4.0. PHASE 1 - PROJECT SELECTION/INFORMATION REQUIREMENTS.

4.1. PROJECT SELECTION.

4.1.1. Only selected restoration projects undergo review. Since there are limited resources which may be used for peer review, it is important to maximize the benefit of peer review and focus on those projects with the greatest potential return on investment. It is also important to note that the listed project selection criteria are recommended to serve as general guidelines and not "hard and fast" requirements. The following criteria are used to consider a site for peer review:

4.1.1.1. Site Type: In FY98, the site must be located on a BRAC installation where BRAC funds are being utilized. As stated in the introduction, the initial focus of peer review will be on BRAC restoration projects. However, sites at two active installations will undergo pilot peer reviews. In FY99, the technical peer reviews may be expanded to include full review of Installation Restoration projects. The peer review concept may ultimately also be used to review other Department of the Army environmental programs (e.g., FUDS, Compliance, Pollution Prevention, Conservation).

4.1.1.2. Project Phase: Projects through FY+2, from strategic planning to the optimization of O&M, are subject to peer review.

4.1.1.3. Funding Requirement: Projects with a life cycle cost in excess of $2M will be subject to peer review. This dollar threshold was selected for two basic reasons. First, there are 30 BRAC installations with more than 100 sites having a cost-to-complete in excess of $2M. In FY98, peer review cannot practically be accomplished on a greater number of projects. Secondly, decision document signature authority resides at the MACOM for restoration projects greater than $2M and less than $6M while HQDA retains signature authority on restoration projects greater than $6M. Therefore, all actions requiring authorization above the installation commander may be selected for peer review.

4.1.1.4. If the project does not meet the funding requirement criteria, but the Department of the Army BRAC Office (HQ BRACO), the MACOM, the installation, or the USAEC oversight project manager believes that a project could benefit from an independent third party evaluation, any of those parties can nominate it. If the regulators are pushing for an inappropriate action, peer review results could help the installation in negotiations.

4.2. INFORMATION REQUIREMENTS.

4.2.1. Once projects at an installation have been selected for Peer Review, the installation is required to complete and submit information in a timely manner so that the peer review team can gain a basic understanding of the projects prior to the meeting. The information required on each individual project undergoing review include a project summary and executive summaries, figures, and tables from any pertinent documents associated with the project. To minimize installation efforts, the installation should utilize the executing activity and the USAEC oversight project manager in providing project narratives and collecting the necessary information. The installation is ultimately responsible for completing and submitting the information to the peer review coordinator with copy furnished to their MACOM and DA BRACO.

4.2.2. Information requirements consist of the following:

4.2.2.1. Project summary includes:

- history of site
- status of work (completed to date and planned).
- funding, including dollars spent to date and funds planned
- summary of decision drivers, e.g. screening criteria, ARARs, PRGs, regulatory guidance and policies, land re-use
- summary of risk assessment information; e.g., exposure pathways, land use, receptors, COCs, concentrations, calculated risk numbers.
- description of alternatives analysis performed and proposed remedial actions.

4.2.2.2. BRAC Cleanup Plan (BCP) and most recent BCP abstract or Installation Action Plan.

4.2.2.3. Location maps, boring maps with data, well maps with data, potentiometric surface maps, geologic maps, etc.

4.2.3.4. Data tables - data tables include data that is considered to be a driver for additional work, risk, or clean-up.

5.0. PHASE 2 - PEER REVIEW FORUM/PANEL DESCRIPTION.

The appropriate review structure will be established based on a three-level approach. This will ensure that the level of peer review applied to all installations with projects exceeding the cost threshold is consistent with the number of projects, project complexity, and potential return on investment.

5.1. Level 1 - Level 1 reviews are conducted at the installation whose projects are being reviewed. This would typically be applied to installations where four or more projects will be reviewed. Based on the level of review required for such installations, site visits are considered cost effective and necessary.

5.2. Level 2 - Level 2 reviews are conducted at a central location (e.g., MACOM or major subordinate command (MSC)) and will cover multiple installations. Installations involved in Level 2 reviews will typically have fewer than four projects to be reviewed. With fewer projects per installation, several. installations can be reviewed during the course of the peer review, thereby maximizing the use of the peer review panel.

5.3. Level 3 - Level 3 reviews will be conducted via telephone conference where an installation may not have projects which meet the minimum criteria but which require an independent evaluation.

5.3.1. In order to be successful, the peer review process should also be as "installation-friendly" as possible and should provide technical assistance to the installation. Using the three-level approach, site visits can be made where a high level of review is needed, and the remainder of the reviews can be conducted at central locations. The level 3 reviews are handled on a case-by-case basis to meet the needs of the installations and MACOMs.

6.0. PEER REVIEW PANEL AND TEAM MEMBER COMPOSITION.

6.1. The technical peer review panel is selected based on a broad knowledge of all aspects of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conserva-tion and Recovery Act (RCRA) programs, as well as specific expertise in the remedial technologies under consideration. Expertise areas include chemistry, cost estimation, environmental engineering, geology, hydrogeology, project management, remedia-tion technologies, environmental law, and risk assessment. The panel consists of technical experts identified from state and Federal regulatory agencies and laboratories, academia, and consultants. The U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), the Army Research Laboratory (ARL), and the U.S. Army Corps of Engineers

(USACE), including USACE laboratories, are also sources of technical experts.

6.2. In addition to the peer review panel, there are a number of people from within the Army who make up the peer review team. These people have the responsibility of administering a uniform approach to the peer review process, from planning, to implementation, to reporting, and to follow-up:

6.2.1. Peer Review Coordinator - The overall coordinator for the peer review. This coordinator oversees the entire peer review process; coordinates planning, organization, scheduling, and implementation of the peer review process, determines appropriate project-specific team composition; ensures adequacy of the peer review information package; ensures completion and distribution of the peer review recommendations; and consolidates and distributes lessons learned. Peer review recommendations and lessons learned will be distributed to the installation, the MACOM and DA BRACO. The coordinator will also be responsible for briefing the MACOM and/or DA BRACO on the results of the peer review, as requested.

6.2.2. Peer Review Facilitator - The peer review coordinator will either serve as the facilitator or select another individual to serve as facilitator. As moderator, the peer review facilitator will ensure an "on task" and "on time" schedule. The facilitator will direct the peer review team and will not allow it to be "derailed" by other subjects.

6.2.3. Core Peer Review Team Members - The Chief, Environmental Restoration Division, USAEC, will identify core members from the disciplines of engineering, environmental law, geology, hydro-geology, remediation technology, and risk assessment. Team members will not be allowed to serve on the review panels for projects with which they are directly associated to ensure unbiased recommendations.

6.2.4. The USAEC Restoration Oversight Managers - In addition to the USAEC peer review implementation team, USAEC Restoration Oversight Managers (ROMs) play a central role in the peer review process at installations for which they perform oversight. The ROMs will have the primary responsibility for gathering up-front information about their installation. This information will be relayed to the Peer Review Panel prior to the review in order to establish baseline knowledge of a given restoration program. Because many ROMs have been working with their oversight installations for years, they may already have much of the needed information at their disposal. By submitting such information themselves, the ROMs can save a great deal of time and effort for many involved in the process. The ROMs will attend and participate in the review and assist the peer review team with on-site logistics (e.g., media needs, phone, fax).

6.2.4.1. Because time is such a limiting factor in the success of a Peer Review, the ROM is a critical resource that must be utilized to the full extent of their capability throughout the process. The ROMs shall assist the installation in the preparation of written responses to the draft recommendation report (see section 9.2). The ROM will also be vital in ensuring that Army-accepted recommendations are properly implemented.

6.2.5. Project-specific Member - The Peer Review Coordinator will determine special technical expertise that may be required to adequately review project-specific issues and provide construc-tive input to recommended solutions. Special technical expertise that may be required for various technical issues include:

6.2.5.1. Groundwater Modeling.

6.2.5.2. Unexploded Ordnance.

6.2.5.3 Applicable or Relevant and Appropriate Requirements (ARARs).

6.2.5.4. Innovative Technology.

6.2.5.5. Chemistry.

6.2.5.6. Radiology.

7.0. REGULATOR INVOLVEMENT.

7.1. The state and Federal Environmental Regulatory Agency representatives play an integral role in the success of peer review. Dialogue with the regulators is critical during the review. Through this communication, the regulators can articulate their position on specific issues and gain insight into the perspective brought forth by the peer review team members. Regulatory participation also avoids the perception of the Peer Review process as a biased process designed to promote Army positions at the expense of the environment. Therefore, regulator participation is strongly recommended during the entire process.

8.0. PHASE 3 - PEER REVIEW TEAM RECOMMENDATIONS/RESULTS.

8.1. The peer review meetings are performed year-round as an integral part of the restoration oversight effort and as needed in support of the upcoming funding cycle. The peer review team will provide advice and recommendations to the installation, MACOM, and DA BRACO. The current decision-makers will continue to decide whether a project warrants funding.

8.2. The peer review panel focuses on the technical merit of the project at hand. Although technical merit is the primary goal of peer review, it is recognized that other factors may have a significant role in the decision making process. For example, interpretation of regulations, state requirements or guidance policies, etc., generally have a substantial impact on site decisions. The peer review team considers the effect these other factors are having on restoration decisions. Technical issues are specified in the peer review recommendation report, along with a discussion about other factors that are controlling the decision making process, and the impact that these factors are having on risk management and cost-benefit balance.

8.3. The recommendations of the peer review panel are consistent with written Army policy, where available. If formal Army policy does not exist, the peer review team will make recommendations based on Army policy as best understood by the peer review team. If conflicts arise between the peer review panel and the managers of the projects undergoing review regarding the nature or interpretation of Army policy, the peer review coordinator shall ensure that the report clarifies these issues.

9.0. PEER REVIEW RECOMMENDATIONS REPORT.

9.1. The peer review team provides the draft recommendation report to the installation, the MACOM (and MSC, if applicable) and DA Headquarters. This report identifies issues that the team considers to be "over-arching" issues, or those that affect many aspects of the program. For example, if a clean-up goal is based on an ARAR (e.g. an MCL) and is not developed from a risk assessment which incorporates site-specific exposure pathways and receptors, this approach affects all projects at an installation for which clean-up goals are being developed, and is therefore considered to be over-arching. For each project evaluated, the group will also identify site-specific issues that are pertinent only to the project being reviewed. For each over-arching and site-specific issue identified, the report summarizes the status of the project as understood by the peer review team, as well as the recommendation being made. The peer review team provides a rationale for why the recommendation is being made, the assumptions on which the recommendation is based, and options the installation can consider to help implement the recommendation.

9.2. The installation will be required to prepare written responses to the draft report, detailing how the recommendations will be implemented. The response should include a detailed plan outlining the necessary steps to implement the recommendation, an associated timeline for these steps to occur, underlying assumptions, and the revised, estimated cost of the project with the recommendation implemented. The cost estimate should be made using the same tool utilized to generate the budget requirement estimate (e.g. RACER, Cost-to Complete module, Feasibility Study, Remedial Design estimate). If the installation feels that a recommendation cannot be implemented, the rationale must be laid out. The peer review panel may then provide written comments on the response to the recommendations. A conference call can be conducted at any time between the installation, the peer review coordinator, and if possible, select members of the peer review panel to discuss any issues that are not clear or that the installation believes cannot be implemented. After these issues are discussed and resolved, the peer review team issues the final report. The final report will be sent to the installation, the MACOM, and headquarters.

10.0. CONCLUSION.

The Peer Review is a mechanism through which Army installations can obtain independent technical recommendations to ensure (a) an appropriate level of risk reduction at a site, and (b) the efficient use of the Army's environmental restoration funds. This independent input will facilitate the project decision-making process.

10.1. The FY98 focus of peer review is BRAC restoration projects. Pilot tests of the peer review process are also being conducted on selected Installation Restoration projects at two active sites in FY98. Depending on the results of the pilot tests of the active sites, the technical peer reviews may be expanded in FY99 to include more active sites and may ultimately be used to review other Department of the Army environmental programs (e.g., Formerly Used Defense Sites (FUDS), Compliance, Pollution Prevention, Conservation).

SENECA ARMY DEPOT ACTIVITY
TECHNICAL ASSISTANCE TEAM BIOSKETCHES

R. Merril Coomes, Ph.D.

Dr. Coomes has more than 20 years of professional experience evaluating the potential health effects of chemical substances released into the work place and environment. He is also experienced in performing human health and environmental risk assessments. Dr. Coomes has managed projects to assess toxicological properties, the identities of released substances, environmental release and potential exposure pathways, exposure point concentrations, appropriate protective measures, and medical surveillance requirements. These projects have included a wide range of activities including manufacturing processes, waste treatment, petroleum refining, hard rock mining, Resource Conservation and Recovery Act (RCRA) hazardous waste management, including site closure and 3008(h) corrective actions, solid waste disposal, Superfund remedial actions and risk assessments, and community involvement programs. He has hands-on experience with U.S. Environmental Protection Agency's (EPA's) biokinetic lead model and blood lead studies of potentially exposed children. At Harding Lawson Associates, Dr. Coomes is presently responsible for a nationwide risk assessment and toxicology program. In this position, he maintains the quality and evaluates and ensures the performance in these areas. Dr. Coomes has a Ph.D. in Environmental Chemistry from Colorado State University, a M.S. in Organic Chemistry and a B.S. in Chemistry each from Utah State University.

Tyler E. Gass, C.P.G., PG, PHg

Mr. Gass has worked professionally as a hydrogeologist for over 25 years. Since 1973, Mr. Gass has been involved in the investigation of hazardous waste in the environment. He is recognized as an expert in the fate and transport of chemical constituents, including petroleum hydrocarbons and other types of volatile organic chemical constituents. Since 1985, he has been involved with the design, evaluation, and implementation of groundwater and soil remediation programs. He has served as a neutral technical expert in matters that have been successfully mediated pertaining to a wide variety of technical issues, including the fate and transport of organic compounds, the efficacy and cost-effectiveness of remediation programs, and cost allocation among potentially responsible parties (PRPs). Currently, Mr. Gass is a Chair of an Issue Group for the U.S. Army Science Board, and evaluates pending and ongoing remediation programs at Army facilities throughout the United States. Specifically, this Issue Group will make recommendations related to the performance and effectiveness of ongoing remediation operations, and modification and/or termination of such programs. He is also an expert in the design and application of innovative remediation technologies.

Jean Pearson, J.D.

Ms. Pearson received a Doctorate of Jurisprudence in 1991 from the University of Tennessee College of Law and has been licensed to practice law since May 1992. For the past seven years she has provided regulatory support to the U.S. Army installations on the National Priority List. She has participated in cleanup efforts through the Army Environmental Center at installations in Minnesota, Tennessee, Alabama, Missouri, Pennsylvania, Hawaii, Texas, Illinois, Massachusetts, Indiana, Utah, and New Jersey. After identifying federal and state cleanup requirements (ARARs) for inclusion in CERCLA reports such as remedial investigations, removal action documents, feasibility studies, and records of decision, she has served in an advisory capacity to the Army in presenting the Army's perspective to state and federal regulators. Other projects have included ARARs determinations for DOE, regulatory support for DOE decontamination and decommissioning efforts, and comparative analyses of state radiation regulations to NRC radiation standards and requirements for the Nuclear Regulatory Commission Office of State Programs. She serves on the Program Development Council for the Superfund Conference held annually in Washington, D.C., and is a member of national, state, and local bar associations and evnironmental section.

BCT AGENDA

August 18-19, 1998
1330 – 1630 August 18, 1998
0830 – 1230 August 19, 1998
NCO CLUB

→ Ash Landfill PRAP and Treatability Update

→ Project Updates

SEAD 4 – Munitions Washout Plan

SEAD 11, 64 - Old Construction Debris Landfill

SEAD 63 - Misc Components Burial Site

SEAD 59/71 - Paint Disposal Areas

SEAD 16/17 - Deactivation Furnace

→ Peer Review Report

Meeting Summary
Base Closure Team Meeting, Part 1
Tuesday, August 18, 1998

Attendees:
Steve Absolom - SEDA
Randy Battaglia - NY District COE
Thomas Enroth - NY District COE
Janet Fallo - NY District COE
Robert Scott - NYSDEC - Avon
Keith Hoddinott - USACHPPM
Dan Geraghty - NYSDOH
Jacqueline Travers - Parsons ES
James Quinn - NYSDEC
Patricia Jones - Seneca County IDA
Carla Struble - USEPA - by conference call
Bruce Nelson - USEPA - by conference call
Mark Maddaloni - USEPA - by conference call
Jeanna Ferrar - USEPA - by conference call
Kevin Healy - USACOE - Huntsville

ASH LANDFILL

- It was decided that the Ash Landfill would be separated into two operable units, one for soil and one for groundwater, since there was disagreement on the action to be taken for soil at the site. By separating groundwater and soil, the action for groundwater will be expedited.
- Parsons ES was awarded contract to proceed with the full-scale funnel and gate installation at the edge of the government's property. This will be installed as a treatability study, but will be integrated with one to two other trenches for the final remedy, if successful.
- NYSDEC questioned why this technology needs to be demonstrated prior to signing a ROD. The concerns are that data will take a long time to collect and ROD will be delayed. EPA confirmed that a treatability study does need to be done. However, the proposed plan may be written with an alternate technology in place, in the event that treatability study is not successful. This way, required documents will not be delayed.
- Bruce Nelson from EPA asked if a laboratory study was planned. Parsons ES responded that it was not.
- **Action Item:** Army will submit design documents to EPA to review.
- Overall concerns from agencies are the applicability of the technology and groundwater fluctuations in the area.
- NYSDEC concerned over the number of trenches being placed at the landfill. Questioned whether number of trenches was documented. [Post meeting note: Three

trenches was specified in the existing PRAP. PRT recommends only two trenches. **Action Item:** Determine the number and location of trenches.]

- It was suggested that a "if, then"-type of ROD be done for the soils at the Ash Landfill. NYSDEC is concerned about the applicability of the cleanup goals and that Fish and Wildlife may not sign the ROD unless either Fish and Wildlife's numbers are used for clean-up goals or biota sampling is done to support a different number for clean-up. It was unclear which values are referred to here. Jim Quinn is waiting for information from Fish and Wildlife on what their clean-up values are. The question of clean-up goals may further support doing two RODs for this site, for two operable units, soil and groundwater.

SEAD 16/17 - DEACTIVATION FURNACE

- Discussion on SEAD 16/17 focused on the action level for lead in soil. The action level had previously been set at 500 ppm for residential use. Mark Maddaloni from EPA presented "Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil". EPA developed a range of values presented in Figure 2 of this report. The action level for lead based on this report is between 750 and 1750 ppm. Mark suggested using 750 ppm, the conservative value, as a screening level. Suggested that if screening level were to be increased, Army should use site specific values to determine if higher screening value appropriate. However, after further review, it was concluded that there was not a lot of flexibility in recalculating the screening level, without extensive risk studies.
- Carla Struble mentioned that the RCRA clean-up level for lead at the OB Grounds was 500 ppm. However, the Army pointed out this was for residential scenarios which are not the case now.
- Steve asked for agreement that residential scenario is not appropriate at the site. Army believes the document referenced above supports establishing a new clean-up number. Army would like to agree on a number. Army does not want to evaluate several alternatives for several clean-up goals as the State suggests. Army feels that the higher screening level (1750 ppm) is appropriate for the future use of the site and population of the area. The Army proposed this value in a letter to EPA and the State dated July 30, 1998. Army would consider using 1250 ppm as a compromise.
- **Action Item**: NYSDEC, NYSDOH, and USEPA will respond to Army's letter dated July 30, 1998.

SEAD-4, MUNITIONS WASHOUT PLAN

- The RI for this work has been funded.
- Army would like to take a phased approach to this site as in SEAD 59/71. Real-time sampling will be incorporated and the existing approved work plan will be used.
- The State and EPA requested that they be notified prior to conducting work at the site and that they be given a letter with a schedule of planned events at the site.

- **Action Item:** Army will submit letter to the agencies with schedule of documents to be produced for this phased project.

SEADs 11 and 64, OLD CONSTRUCTION DEBRIS LANDFILLS

- Army recommends doing an EE/CA as a streamlined RI/FS at this site with some additional sampling. This is recommended since the site is a landfill and there are really only three remedies for a landfill: no action, capping, or removal. The currently approved work plan would not be used for this site.
- **Action Item:** NYSDOH requested that notification stating the reasons an EE/CA should be done rather than an RI/FS be submitted along with the justification to do additional sampling.
- EPA requested that the contaminant migration issues raised in the scoping plan be addressed in EE/CA.
- **Action Item:** A field work and document schedule should be sent to agencies. In addition, if the sampling protocol will differ from that in the generic workplan, approval must be sought first.

SEAD 63, MISCELLANEOUS COMPONENTS BURIAL SITE

- The burial area is well defined and removal action is appropriate at this site. Preliminary work at the site defined specific areas where components are located. Scoping workplans which were developed for this site were updated for SEAD-12. SEAD-63 was not updated.
- **Action Item:** Army will submit schedule and plan for SEAD-63 to the agencies.
- **Action Item:** Agencies requested report on hot spot removals at SEAD-12.

SEAD 59/71, PAINT DISPOSAL AREAS

- Additional site work at SEAD 59/71 indicated specific areas within the two SEADs which require action. Army proposes to proceed with an EE/CA and do interim removal actions. After removal action is complete, groundwater sampling would be conducted to either justify an RI/FS for groundwater or no further action. As was the case at the Ash Landfill, the groundwater condition changed drastically once source was removed.
- State commented that doing EE/CA's may not be that much easier than conducting RI/FS because with an EE/CA you do not have regulatory approval until after something is done. The RI/FS process is a more direct process.
- Army stated that funding is easier to get for removal actions, therefore, EE/CA's may be advantageous.
- EPA feels that action sooner is better than action later.
- **Action Item:** Agencies shall respond to Phase I RI conducted at SEAD 59/71 and concur that IRM is appropriate.

Meeting Summary
Base Closure Team Meeting, Part 2
Wednesday, August 19, 1998

Attendees:

Steve Absolom - SEDA
Randy Battaglia - NY District COE
Thomas Enroth - NY District COE
Janet Fallo - NY District COE
Robert Scott - NYSDEC - Avon
Dan Geraghty - NYSDOH
Jacqueline Travers - Parsons ES
James Quinn - NYSDEC
Carla Struble - USEPA - by conference call
Bruce Nelson - USEPA - by conference call
Jeanna Ferrar - USEPA - by conference call
Kevin Healy - USACOE - Huntsville
John Buck - USAEC Aberdeen

Action Item: EPA requested an updated RAB member list.

Focus of meeting - Response to Peer Review Comments.

PEER REVIEW

SITE SPECIFIC OBSERVATIONS

SEAD 11, Old Construction Debris Landfill

- Agencies agree to consider proceeding with an EE/CA at this site as suggested by the Peer Review Team (PRT).

SEAD 13, Inhibited Red Fuming Nitric Acid Disposal Site

- Army will pursue No Further Action at this site since there is no risk according to the PRT.
- Army agreed to do a mini-risk assessment in conservation area. EPA would like to review the SI data first.

Deep Bedrock Wells

- The generic work plan and scoping plans called for these wells. PRT's comment to re-evaluate the need to install deep wells was from last year. The Army's position is that they will install deep wells if there is a need on a case-by-case basis. Agencies agreed.

SEAD 45, Open Detonation Area

- It was agreed that nothing should be done at this area until open detonation operations are completed as suggested by the PRT.
- Both NYSDEC and NYDOH disagree with the 2nd sentence, 2nd bullet of the PRT's 5th comment. These agencies do not agree that pre-existing conditions can be ignored. NYSDEC's request for residential risk scenario is more than academic
- NYSDEC objects to PRT's comment regarding turbidity (3rd bullet of 5th comment), rationalizing that since water is turbid, it should not need to be cleaned up since won't be used as drinking water. They do not disagree with the affect turbidity has on results.
- As PRT discusses in comment 6, it may be necessary to re-evaluate timeline for this project since the work plan has already been written for this site. Agencies do not object to this.

SEAD 52, Ammunition Breakdown Area

- PRT recommends that sites 52 and 60 be separated, since SEAD 60 may be addressed quickly with an EE/CA. SEAD 52 is more complex.
- NYSDOH had concerns that in creating more sites, we are making things more complex.
- Army, however, agrees removal action projects are easier to fund, so the process is actually expedited by segregating the sites.
- NYSDEC suggested that if groundwater is clean at SEAD 60, Army should consider doing a ROD at SEAD 60 rather than an EE/CA.

SEAD 5, Fill Area

- SEAD 5 is the Sludge Piles, not the Fill Area as defined by the PRT. There seems to be confusion on the PRT's part as to which area is being discussed.
- NYSDOH feels that SEAD-5 does not need to be re-evaluated. The decision to remove the sludge piles was not based solely on risk, but on a desire to take action at this site.

SEAD 59/71, Fill Areas

- Army wishes to pursue an EE/CA as recommended by the PRT. The agencies reserved concurrence until after they review the Phase I RI.
- NYSDEC still concerned that if there is a remedial action, a ROD is needed and if a ROD is needed, an RI/FS is needed.

SEAD 16, Abandoned Deactivation Furnace

- SEAD 16 (Bldg. 311) is not being considered for use as a low temperature thermal desorption unit (LTTD). The PRT was confused about this.
- The 5 x rule which the PRT refers to, is an Army guideline. The 5x rule must be implemented for unrestricted use, according to the Army. "Unrestricted use" has a different meaning for the Army explosive rules than it does for the agencies.
- Overall, the Army concurs with the PRT's comments regarding SEAD 16.

SEAD 17, Ammunition Deactivation Furnace

- NYSDEC would consider the LTTD at SEAD-17, if the LTTD met the substantive requirements of RCRA.
- Parsons ES and the Army are currently negotiating a treatability study for the LTTD.
- The Army agrees with PRT's recommendation that a cost analysis of refurbishing the LTTD versus bringing in smaller mobile treatment units be performed. It was suggested that the quantity of waste where using the LTTD is more cost effective than bringing in mobile units be determined.
- NYSDEC will discuss with Army the internal review which was performed by NYSDEC RCRA group concerning what would be necessary to upgrade the LTTD.
- NYSDOH would like to pursue on site treatment if it is cost effective.
- It was agreed that remediation of SEAD 17 would occur after implementation of the LTTD, if implemented.

SEAD 3,6,8,14, and 15 - Ash Landfill

- It is unclear if the PRT's comments apply only to soils at the Ash Landfill or both soil and groundwater. The assumption is that the PRT comments apply to the soils and that the PRT agrees with Army's action for groundwater. The Army will ask for clarification.
- The Army will use portions of its letter to the agencies dated July 30, 1998 regarding the No Action Alternative at the Ash Landfill to respond to the PRT recommendations.
- **Action Item:** Jeanna Ferrar from EPA is investigating EPA's interpretation of the May 14, 1998 guidance in the Federal Register for conducting risk assessments in response to the Army's July 30, 1998 letter.
- Parsons ES recommended clarification from the PRT on their issues with the cost estimate for the trench.

SEAD 4, Ammunition Washout Plant

- Army suggests that work at SEAD-4 be conducted in a phased approach similar to SEADs 59/71 and as recommended by the PRT.
- **Action Item:** Army will notify agencies of which portions of the approved work plan will be conducted and when prior to conducting field work.

OVERARCHING ISSUES

Data Collection for Hot Spots

- NYSDEC and NYSDOH disagree with PRT's comments that collection of samples from visually identified contaminated areas is a judgmental approach. The agencies believe that contaminant areas identified visually should be focused on. The Army does see some merit in the PRT's comments.
- The Army agrees with PRT that data from these hot spots should not be used in risk assessments.
- NYSDOH believes these data from hot spots should be used for the risk assessment. However, their relevance can be discussed after risk assessment is performed.
- **Action Item:** The Army will formally request NYSDOH's input on this issue to formulate response to PRT.

Cost Benefit Analysis

- The Army agrees with the PRT's recommendation to conduct cost benefit analysis. However, the Army believes this should be performed on case-by-case basis and not be mandatory at every site.

Data Quality Objectives

- Army agrees with the PRT's comment, but believes it has been implementing the DQO Process all along. Army will send PRT the Generic Work Plan to demonstrate this.

Decision Criteria Remediation Flowchart

- The agencies maintain that the action at each site shall be made on a case-by-case basis. NYSDEC in particular refuses to acknowledge the validity of the Decision Criteria Remediation Flowchart and considers this an internal Army document.

Ecological Risk Assessment Policy

- All parties agree that a risk management team, which the PRT suggests is formed, has already been established. The Seneca IDA, Land Reuse Authority, Fish and Wildlife, RAB and others are all involved.
- The Army is in the process of determining the valued ecological resources at SEDA. PRT's concern is that all ecological receptors are being considered, rather than pinpointing those that are valued by a "risk management team" to focus remedial action objectives. The Army has initiated this process with the agencies in their letter to them dated July 30, 1998.
- **Action Item:** The Army awaits response from the agencies on their July 30, 1998 letter and their interpretation of the May 14, 1998 guidance on risk assessments.

Bioremediation Policy

- The Army maintains that they will consider bioremediation on a site-by-site basis.
- NYSDEC disagrees that bioremediation should be considered a presumptive remedy at all petroleum sites. Bioremediation should be considered on a site-by-site basis.

TAGMs

- The Army does continue to work with NYSDEC on establishment of achievable clean up goals, as recommended by the PRT.
- To date, nothing at the site has been remediated to TAGMs.
- NYSDEC stated that although TAGMs are not promulgated, the State will not agree to any other values as a screening level.
- The Army stated that the main issue is that the Army's policy is to only evaluate to risk levels established by the Land Reuse Authority (LRA). Since the LRA's plan doesn't include residential use at most areas, the Army cannot consider residential areas. The Ash Landfill was evaluated based on residential use scenario, however, this was pre-BRAC and prior to landuse decisions. Now that these decisions are in place, future land use will be considered by the Army.
- NYSDEC maintained that the law says that remediation should be performed to establish pre-release conditions where economically practicable. The Army must evaluate clean-up to pre-existing conditions. Furthermore, the Army must evaluate clean-up to residential or unrestricted use conditions as a programmatic requirement for NYSDEC. The Army disagrees with this later requirement.
- State is concerned that deed restrictions on property which would be required for restricted use are not easily executed. If it only costs an incremental amount more to remediate to pre-existing conditions, then why create Brownfields.
- It was concluded that this issue would need to be taken to higher authority to resolve and that the PRT did not address the real legal issue at hand.

Investigation Strategy

- The Army does not agree with PRT that field screening has never been performed independently of sample collection.
- **Action Item:** Parsons ES and Kevin Healy should review ESI projects to determine number of projects where field screening was performed to determine the nature and extent of contamination. They would find examples where field screening also determined where areas were clean.
- It was noted that PRT is somewhat ambiguous. On one hand, PRT recommends grid sampling for collection of risk assessment data so that sample collection will not be biased. On the other hand, they recommend field screening which does bias the samples which are collected for laboratory analysis.
- **Action Item:** Army will request in writing input from NYSDEC and NYSDOH on this issue, as mentioned above.

Site-Specific Background

- The Army will separate the background soil values into surface soil and subsurface soil values as recommended by PRT. However, Army will ask PRT for clarification on the applicability of separating the site-specific soil background concentration. The issue may have to do with anthropogenic compounds (e.g. PAHs) and the PRT's view that these compounds may have background concentrations which exceed TAGMs.
- **Action Item:** Kevin Healy will investigate the applicability of another site he is familiar with regarding this issue.

Other Comments

- **Action Item:** The agencies asked the Army to look into recent report for SEAD 16/17 regarding increasing mercury and PAH concentrations in the downwind (NW) direction. This trend is not mentioned in the report since industrial scenarios were used. However, this area is in the conservation area and this trend should be discussed.
- Next BCT/RAB meeting will be held on September 15 and 16, 1998.

United States Environmental Protection Agency

Technical Review Workgroup for Lead

December 1996

Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

*SRC·GLD·F0187-236·**DRAFT**·11/8/96*

Preface

This report includes a fact sheet, *Technical Review Workgroup for Lead (TRW) Recommendations for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil* along with an Appendix, *Equations and Rationale for Default Values Assigned to Parameters in the Slope Factor Approach and Exposure Model for Assessing Risk Associated with Adult Exposures to Lead in Soil*, which discusses in greater detail the equations and parameters used in the methodology.

1. INTRODUCTION

This report describes a methodology for assessing risks associated with non-residential adult exposures to lead in soil. The methodology focuses on estimating fetal blood lead concentration in women exposed to lead contaminated soils. This approach also provides tools that can be used for evaluating risks of elevated blood lead concentrations among exposed adults. The methodology is the product of extensive evaluations by the Technical Review Workgroup for Lead (TRW) which began considering methodologies to evaluate nonresidential adult exposure in 1994 (Balbus-Kornfeld, 1994; U.S. EPA, 1994a). In 1995, the TRW reviewed a methodology developed by EPA Region 8 for deriving risk-based remediation goals (RBRGs) for nonresidential soil at the California Gulch NPL site (U.S. EPA, 1995). A TRW committee on adult lead risk assessment was formed in January, 1996 to further develop the ideas and information gathered as part of these previous efforts into a generic methodology that could be adapted for use in site-specific assessments.

This report provides technical recommendations of the TRW for the assessment of adult lead risks using this methodology. An overriding objective in the development of this methodology was the immediate need for a scientifically defensible approach for assessing adult lead risks associated with nonresidential exposure scenarios. The TRW recognizes that other adult lead models may provide useful information. In particular, models providing more detailed representations of lead kinetics may be useful in supporting more detailed predictions about the time course of blood lead concentrations among individuals who receive brief acute exposures to lead or whose exposures otherwise change markedly with time. The methodology presented here uses a simplified representation of lead biokinetics to predict quasi-steady state blood lead concentrations among adults who have relatively steady patterns of site exposures (as described in this report). The TRW believes that this approach will prove useful for assessing most sites where places of employment are (or will be) situated on lead contaminated soils. This information is expected to promote consistency in assessments of adult lead risks. The methodology described in this report is an interim approach that is recommended for use pending further development and evaluation of integrated exposure biokinetic models for adults. The TRW is undertaking review of other models and will provide reviews on other approaches as appropriate. The Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children (U.S. EPA, 1994b,c) is the recommended approach for assessing residential lead risks.

The recommended approach for assessing nonresidential adult risks utilizes a methodology to relate soil lead intake to blood lead concentrations in women of child-bearing age. It is conceptually similar to a slope factor approach for deriving RBRGs that had been proposed by Bowers et al. (1994) and which was adapted for use at the California Gulch NPL site in Region 8 (U.S. EPA, 1995). This report describes the basic algorithms that are used in the methodology and provides a set of default parameter values that can be used in cases where high quality data are not available to support site-specific estimates. The rationale for each parameter default value is provided in the Appendix.

2. OVERVIEW OF THE APPROACH

The methodology described in this report relates soil lead concentrations to blood lead concentrations in the exposed population according to the algorithms described below. Note that the algorithms may consist of variables that include superscripts and/or subscripts. The convention adopted in this report is to use superscripts as exponents (i.e., a mathematical operation), whereas subscripts represent key words that provide additional information to distinguish between similar variables. The basis for the calculation of the blood lead concentration in women of child-bearing age is the algorithm given by Equation 1:

$$PbB_{adult,\ central} = PbB_{adult,0} + \frac{PbS \bullet BKSF \bullet IR_S \bullet AF_S \bullet EF_S}{AT}$$

where:

$PbB_{adult,\ central}$ = Central estimate of blood lead concentrations (µg/dL) in adults (i.e., women of child-bearing age) that have site exposures to soil lead at concentration, PbS.

$PbB_{adult,\ 0}$ = Typical blood lead concentration (µg/dL) in adults (i.e., women of child-bearing age) in the absence of exposures to the site that is being assessed.

PbS = Soil lead concentration (µg/g) (appropriate average concentration for individual).

BKSF = Biokinetic slope factor relating (quasi-steady state) increase in typical adult blood lead concentration to average daily lead uptake (µg/dL blood lead increase per µg/day lead uptake).

IR_S = Intake rate of soil, including both outdoor soil and indoor soil-derived dust (g/day).

AF_S = Absolute gastrointestinal absorption fraction for ingested lead in soil and lead in dust derived from soil (dimensionless).

EF_S = Exposure frequency for contact with assessed soils and/or dust derived in part from these soils (days of exposure during the averaging period); may be taken as days per year for continuing, long term exposure.

AT = Averaging time; the total period during which soil contact may occur; 365 days/year for continuing long term exposures.

The basis for the RBRG calculation is the relationship between the soil lead concentration and the blood lead concentration in the developing fetus of adult women that have site exposures. As a health-based goal, EPA has sought to limit the risk to young children of having elevated blood lead concentrations. Current Office of Solid Waste and Emergency Response (OSWER) guidance calls for the establishment of cleanup goals to limit childhood risk of exceeding 10 µg/dL to 5% (U.S. EPA, 1994a). Equation 2 describes the estimated relationship between the blood lead concentration in adult women and the corresponding 95th percentile fetal blood lead concentration ($PbB_{fetal, 0.95}$), assuming that $PbB_{adult, central}$ reflects the geometric mean of a lognormal distribution of blood lead concentrations in women of child-bearing age. If a similar 95th percentile goal is applied to the protection of fetuses carried by women who experience nonresidential exposures, Equation 2 can be rearranged to reflect a risk-based goal for the central estimate of blood lead concentrations in

$$PbB_{fetal, 0.95} = PbB_{adult, central} \bullet GSD_{i, adult}^{1.645} \bullet R_{fetal/maternal}$$

adult women using Equation 3:

$$PbB_{adult, central, goal} = \frac{PbB_{fetal, 0.95, goal}}{GSD_{i, adult}^{1.645} \bullet R_{fetal/maternal}}$$

where:

$PbB_{adult, central, goal}$ = Goal for central estimate of blood lead concentration (µg/dL) in adults (i.e., women of child-bearing age) that have site exposures. The goal is intended to ensure that $PbB_{fetal, 0.95, goal}$ does not exceed 10 µg/dL.

$PbB_{fetal, 0.95, goal}$ = Goal for the 95th percentile blood lead concentration (µg/dL) among fetuses born to women having exposures to the specified site soil concentration. This is interpreted to mean that there is a 95% likelihood that a fetus, in a woman who experiences such exposures, would have a blood lead concentration no greater than $PbB_{fetal, 0.95, goal}$ (i.e., the likelihood of a blood lead concentration greater than 10 µg/dL would be less than 5%,for the approach described in this report).

$GSD_{i, adult}$ = Estimated value of the individual geometric standard deviation (dimensionless); the GSD among adults (i.e., women of child-bearing age) that have exposures to similar on-site lead concentrations, but that have non-uniform response (intake, biokinetics) to site lead and non-uniform off-site lead exposures. The exponent, 1.645, is the value of the standard normal deviate used to calculate the 95th percentile from a lognormal distribution of blood lead concentration.

$R_{fetal/maternal}$ = Constant of proportionality between fetal blood lead concentration at birth and maternal blood lead concentration (dimensionless).

The soil lead concentration associated with a given exposure scenario and $PbB_{adult, central, goal}$ can be calculated by rearranging Equation 1 and substituting $PbB_{adult, central, goal}$ for $PbB_{adult, central}$:

$$RBRG = PbS = \frac{(PbB_{adult, central, goal} - PbB_{adult,0}) \bullet AT}{(BKSF \bullet IR_S \bullet AF_S \bullet EF_S)}$$

It is this form of the algorithm that can be used to calculate a RBRG where the RBRG represents the soil lead concentration (PbS) that would be expected to result in a specified adult blood lead concentration ($PbB_{adult, central, goal}$) and corresponding 95th percentile fetal blood lead concentration ($PbB_{fetal, 0.95, goal}$).

Equations 1-4 are based on the following assumptions:

1. Blood lead concentrations for exposed adults can be estimated as the sum of an expected starting blood lead concentration in the absence of site exposure ($PbB_{adult, 0}$) and an expected site-related increase.

2. The site-related increase in blood lead concentrations can be estimated using a linear biokinetic slope factor (BKSF) which is multiplied by the estimated lead uptake.

3. Lead uptake can be related to soil lead levels using the estimated soil lead concentration (PbS), the overall rate of daily soil ingestion (IR_S), and the estimated fractional absorption of ingested lead (AF_S). The term "soil" is used throughout this document to refer to that portion of the soil to which adults are most likely to be exposed. In most cases, exposure is assumed to be predominantly to the top layers of the soil which gives rise to transportable soil-derived dust. Exposure to soil-derived dust occurs both in outdoor and indoor environments, the latter occurring where soil-derived dust has been transported indoors. Other types of dust, in addition to soil-derived dust, can contribute to adult lead exposure and may even predominate in the occupational setting; these include dust generated from manufacturing processes (e.g., grinding, milling, packaging of lead-containing material), road dust, pavement dust, and paint dust. This methodology, as represented in Equations 1 and 4, does not specifically account for site exposure to dusts that are not derived from soil. However, the methodology can be modified to include separate variables that represent exposure to lead in various types of dust. This approach is discussed in greater detail in the Appendix.

4. As noted above, exposure to lead in soil may occur by ingesting soil-derived dust in the outdoor and/or indoor environments. The default value recommended for IR_S (0.05 g/day) is intended for occupational exposures that occur predominantly indoors.

More intensive soil contact would be expected for predominantly outdoor activities such as construction, excavation, yard work, and gardening.

5. A lognormal model can be used to estimate the inter-individual variability in blood lead concentrations (i.e., the distribution of blood lead concentrations in a population of individuals who contact similar environmental lead levels).

6. Expected fetal blood lead concentrations are proportional to maternal blood lead concentrations.

The primary basis for using Equation 4 to calculate a RBRG is that fetuses and neonates are a highly sensitive population with respect to the adverse effects of lead on development and that 10 µg/dL is considered to be a blood lead level of concern from the standpoint of protecting the health of sensitive populations (U.S. EPA, 1986, 1990; NRC, 1993). Therefore, risk to the fetus can be estimated from the probability distribution of fetal blood lead concentrations (i.e., the probability of exceeding 10 µg/dL), as has been the approach taken for estimating risks to children (U.S. EPA, 1994a,c). Equation 4 can be used to estimate the soil lead concentration at which the probability of blood lead concentrations exceeding a given value (e.g., 10 µg/dL) in fetuses of women exposed to environmental lead is no greater than a specified value (e.g., 0.05).

The methodology can be modified to accommodate different assumptions or to estimate RBRGs for different risk categories. For example, a RBRG could be estimated for risks to adults (e.g., hypertension) by substituting an appropriate adult blood lead concentration benchmark. Similarly, other exposure scenarios can be incorporated into the assessment. Alternative methods for estimating soil lead risk by partitioning soil into outdoor soil and indoor dust components are discussed in the Appendix.

Recommended default values for each of the parameters in Equations 1 - 4 are presented in Table 1. These defaults should not be casually replaced with other values unless the alternatives are supported by high quality site-specific data to which appropriate statistical analyses have been applied and that have undergone thorough scientific review. Examples of the output from the methodology are presented in Figures 1 and 2, which show plots of the calculated $PbB_{fetal,\,0.95}$ as a function of PbS when different combinations of default parameter values are used. The rationale for each default value listed in Table 1 is summarized in the Appendix.

Table 1. Summary of Default Parameter Values for the Risk Estimation Algorithm (Equations 1 - 4)

Parameter	Unit	Value	Comment
$PbB_{fetal, 0.95, goal}$	µg/dL	10	For estimating RBRGs based on risk to the developing fetus.
$GSD_{i,adult}$	--	1.8 2.1	Value of 1.8 is recommended for a homogeneous population while 2.1 is recommended for a more heterogeneous population.
$R_{fetal/maternal}$	--	0.9	Based on Goyer (1990) and Graziano et al. (1990).
$PbB_{adult,0}$	µg/dL	1.7-2.2	Plausible range based on NHANES III phase 1 for Mexican American and non-Hispanic black, and white women of child bearing age (Brody et al. 1994). Point estimate should be selected based on site-specific demographics.
BKSF	µg/dL per µg/day	0.4	Based on analysis of Pocock et al. (1983) and Sherlock et al. (1984) data.
IR_S	g/day	0.05	Predominantly occupational exposures to indoor soil-derived dust rather than outdoor soil; (0.05 g/day = 50 mg/day). 20 - 50
EF_S	day/yr	219	Based on U.S. EPA (1993) guidance for average time spent at work by both full-time and part-time workers (see Appendix for recommendations on minimum exposure frequency and duration).
AF_S	--	0.12	Based on an absorption factor for soluble lead of 0.20 and a relative bioavailability of 0.6 (soil/soluble).

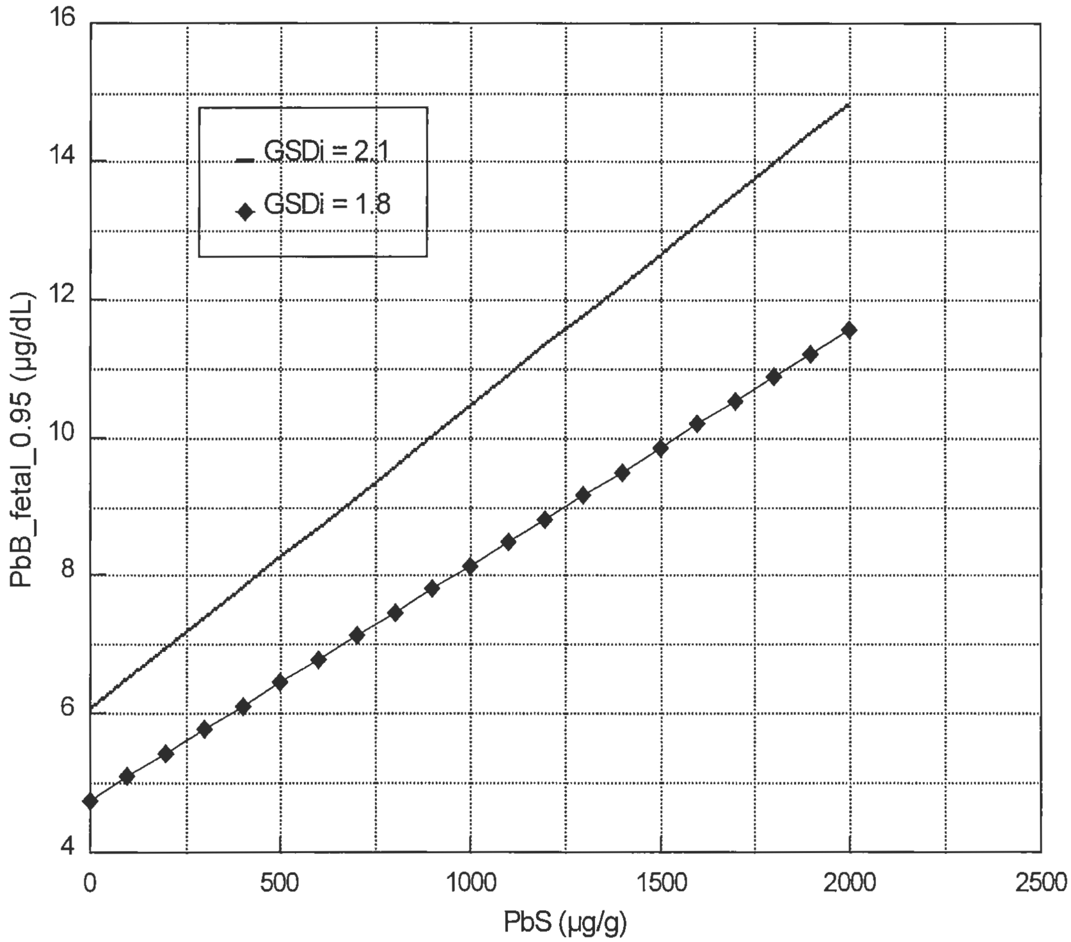
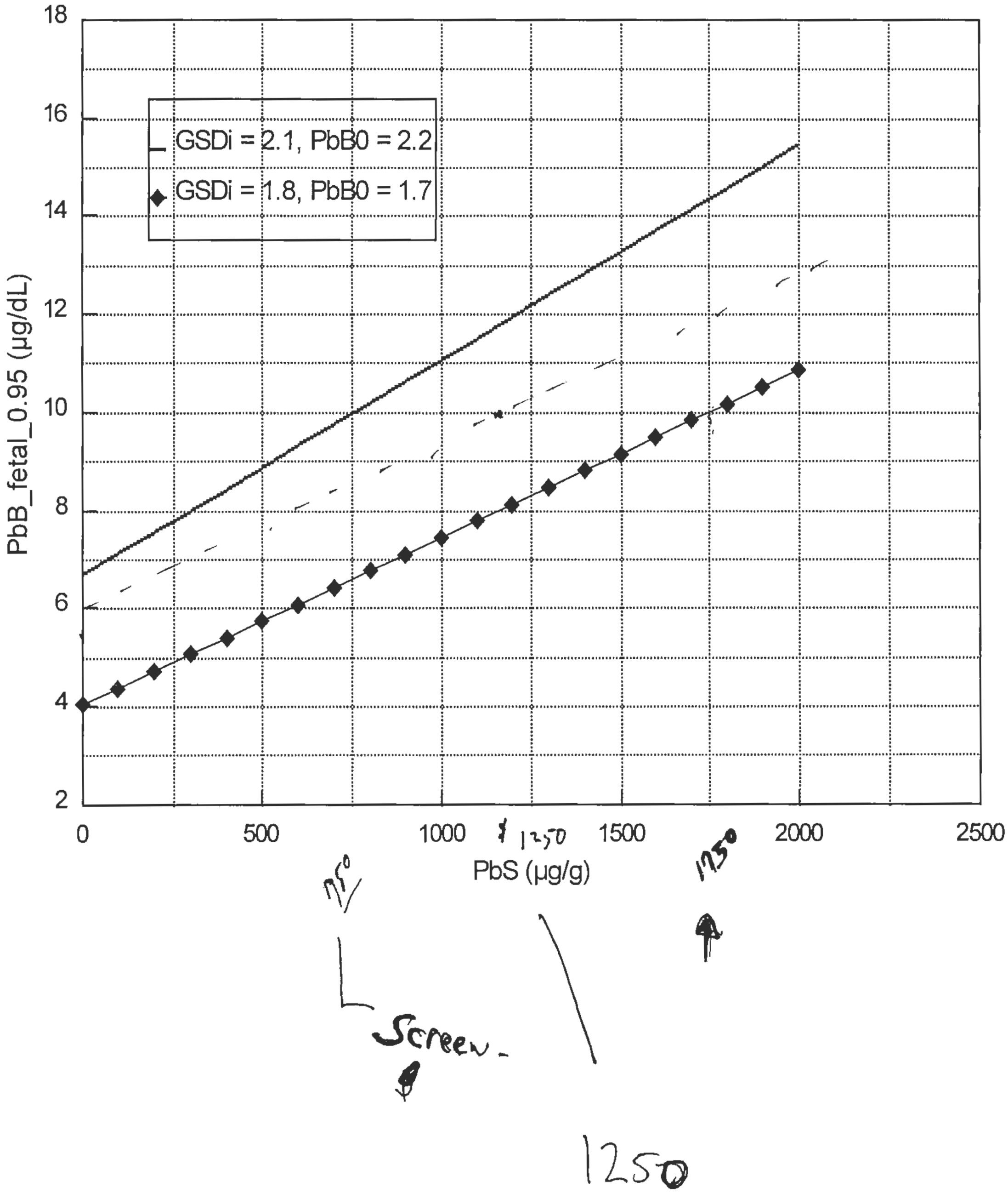

GSDi = 2.1
GSDi = 1.8
PbB_fetal_0.95 (μg/dL)
PbS (μg/g)
16
14
12
10
8
6
4
0
500
1000
1500
2000
2500

Figure 1. Example output of risk estimation algorithm (Equation 4) assuming a $PbB_{adult, 0}$ of 2.0 μg/dL (mixed racial) and a $GSD_{i, adult}$ of either 1.8 (homogeneous population) or 2.1 (heterogeneous urban population).



GSDi = 2.1, PbB0 = 2.2
GSDi = 1.8, PbB0 = 1.7
PbB_fetal_0.95 (µg/dL)
PbS (µg/g)
18
16
14
12
10
8
6
4
2
0
500
1000
1500
2000
2500
Screen
1250

Figure 2. Example output of risk estimation algorithm (Equation 4) assuming plausible default minimum and maximum values of $PbB_{adult, 0}$ (1.7 and 2.2 μg/dL) and $GSD_{i, adult}$ (1.8 and 2.1).

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APPENDIX

Equations and Rationale for Default Values Assigned to Parameters in the Slope Factor Approach and Exposure Model for Assessing Risk Associated with Adult Exposures to Lead in Soil

Equations and Rationale for Default Values Assigned to Parameters in the Slope Factor Approach and Exposure Model for Assessing Risk Associated with Adult Exposures to Lead in Soil

1. Equations for the Adult Lead Model

The format of the equations used in the adult lead methodology follows the approach used in the IEUBK Model for Lead in Children (IEUBK Model). Note that the equations may consist of variables that include superscripts and/or subscripts. The convention adopted in this report is to use superscripts as exponents (i.e., a mathematical operation), whereas subscripts represent key words that provide additional information to distinguish between similar variables. The term "soil" refers to that portion of the soil to which adults are most likely to be exposed. In most cases, exposure is assumed to be predominantly to the top layers of the soil which gives rise to transportable soil-derived dust. Exposure to soil-derived dust occurs both in outdoor and indoor environments, the latter occurring where soil-derived dust has been transported indoors. Other types of dust, in addition to soil-derived dust, can contribute to adult lead exposure and may even predominate in some occupational settings; these include dust generated from manufacturing processes (e.g., grinding, milling, packaging of lead-containing material), road dust, pavement dust, and paint dust.

Exposure to lead from soil (direct and through indoor soil-derived dust) and lead intake:

$$INTAKE = \frac{PbS \bullet IR_S \bullet EF_S}{AT}$$

INTAKE = Daily average intake (ingestion) of lead from soil taken over averaging time AT (µg/day).

PbS = Soil lead concentration (µg/g) (appropriate average concentration for individual).

IR_S = Intake rate of soil, including outdoor soil and indoor soil-derived dust (g/day).

EF_S = Exposure frequency for contact with assessed soils and/or dust derived in part from these soils (days of exposure during the averaging period); may be taken as days per year for continuing, long term exposures.

AT = Averaging time; the total period during which soil contact may occur; 365 days/year for continuing long term exposures.

Lead uptake:

$$UPTAKE = AF_S \bullet INTAKE$$

UPTAKE = Daily average uptake of lead from the gastrointestinal tract into the systemic circulation (µg/day).

AF_S = Absolute gastrointestinal absorption fraction for ingested lead in soil and lead in dust derived from soil (dimensionless).

Central estimate of adult blood lead concentration:

$$PbB_{adult,central} = PbB_{adult,0} + BKSF \bullet UPTAKE$$

$PbB_{adult,central}$ = Central estimate of blood lead concentrations (µg/dL) in adults (i.e., women of child-bearing age) that have site exposures to soil lead at concentration, PbS.

$PbB_{adult,0}$ = Typical blood lead concentration (µg/dL) in adults (i.e., women of child-bearing age) in the absence of exposures to the site that is being assessed.

BKSF = Biokinetic slope factor relating (quasi-steady state) increase in typical adult blood lead concentration to average daily lead uptake (µg/dL blood lead increase per µg/day lead uptake).

Distributional model for adult blood lead:

In this methodology, variability in blood lead concentrations among a population is mathematically described by a lognormal distribution defined by two parameters, the geometric mean (GM) and the geometric standard deviation (GSD):

$$PbB_{adult} \_ Lognormal(GM, GSD)$$

PbB_{adult} = Adult blood lead concentration (which is a variable quantity having the specified probability distribution).

GM = Geometric mean blood lead concentration (µg/dL) for adults having site exposure.

The central estimate of adult blood lead, $PbB_{adult,central}$, constructed in Equation A-3 is treated as a plausible estimate of the geometric mean.

GSD = Geometric standard deviation for blood lead concentrations among adults having exposures to similar on-site lead concentrations, but having non-uniform response (intake, biokinetics) to site lead and non-uniform off-site lead exposures. The individual blood lead concentration geometric standard deviation, GSD_i, is substituted for GSD. As described below (Section 2 of the Appendix), GSD_i is assumed to address sources of variability in blood lead concentrations among the exposed population.

Parameter estimates for the geometric mean (GM) and geometric standard deviation (GSD) of the lognormal distribution are described below. Note that blood lead concentrations for site exposures can be quantified at any percentile of the population using these parameters. For example, the 95th percentile blood lead concentration can be calculated by Equation A-4:

$$PbB_{adult,0.95} = PbB_{adult,central} \bullet GSD_i^{1.645}$$

$PbB_{adult,\ 0.95}$ = 95th percentile blood lead concentration (µg/dL) among individuals having exposures to the specified site soil lead concentrations. This is interpreted to mean that there is a 95% likelihood that an adult exposed to the specified soil lead concentrations would have a blood lead concentration less than or equal to $PbB_{adult,0.95}$.

Distributional model for fetal blood lead:

$$PbB_{fetal} = R_{fetal/maternal} \bullet PbB_{adult}$$

PbB_{fetal} = Fetal blood lead concentration (µg/dL) (which, like PbB_{adult}, is a variable quantity having the specified probability distribution).

$R_{fetal/maternal}$ = Constant of proportionality between fetal and maternal blood lead concentrations.

PbB_{adult}= Adult blood lead concentration (µg/dL), estimated with parameters appropriate to women of child bearing age.

Note that this relationship implies a deterministic (non-random) relationship between maternal and fetal blood lead concentrations. This assumption omits a source of variability (varying individual-specific ratios of fetal to maternal blood lead) that would tend to increase the variance of fetal blood lead concentrations. The assumption of proportionality implies that fetal blood lead concentrations also are lognormally distributed:

$$PbB_{fetal} \_ \ Lognormal(GM,\ GSD)$$

GM = Geometric mean blood lead concentration (μg/dL) for fetuses, equal to $R_{fetal/maternal}$ multiplied by $PbB_{adult,central}$.

GSD = Geometric standard deviation of blood lead concentration among adults, GSD_i (Section 2 of the Appendix).

Similarly, percentiles of the fetal blood lead distribution can be estimated (for fetuses carried by women exposed to the specified concentration of lead at the assessed site). For example:

$$PbB_{fetal,0.95} = R_{fetal/maternal} \bullet PbB_{adult,central} \bullet GSD_{i,adult}^{1.645}$$

$PbB_{fetal,0.95}$ = 95th percentile blood lead concentration (μg/dL) among fetuses born to women having exposures to the specified site soil lead concentrations. This is interpreted to mean that there is a 95% likelihood that a fetus born, in a woman who experiences such exposures, would have a blood lead concentration no greater than $PbB_{fetal,0.95}$.

Note that when the expressions for $PbB_{adult,central}$, INTAKE, and UPTAKE (Equations A-1, A-2 and A-3) are substituted into Equation A-6, we obtain the complete expression for $PbB_{fetal,0.95}$ that is

$$PbB_{fetal,0.95} = R_{fetal/maternal} \bullet GSD_i^{1.645} \bullet \left[\frac{(PbS \bullet BKSF \bullet IR_S \bullet AF_S \bullet EF_S}{AT}\right.$$

presented in the fact sheet (Overview of the Approach, Equations 1 and 2):
Equation A-7 represents variability in blood lead concentration arising from two main factors: 1) exposure variables, including inter-individual variability in activity-weighted ingestion rates, and 2) inter-individual variability in physiology, including factors affecting lead biokinetics.

2. Individual Blood Lead Geometric Standard Deviation (GSD_i)

The GSD_i is a measure of the inter-individual variability in blood lead concentrations in a population whose members are exposed to the same nonresidential environmental lead levels. Ideally, the value(s) for GSD_i used in the methodology should be estimated in the population of concern at the site. This requires data on blood lead concentration and exposure in a representative sample of sufficient size to yield statistically meaningful estimates of GSD in subsamples stratified by nonresidential exposure level. In the absence of high quality data for the site, GSD_i may be extrapolated from estimates for other surrogate populations. In making such extrapolations, factors that might contribute to higher or lower variability in the surrogate population than among similarly exposed individuals in the population of concern, should be evaluated. These factors include variability in exposure (level and pathways), and biokinetics (see Section 6 of Appendix), socioeconomic and ethnic characteristics, degree of urbanization and geographical location. Such extrapolations, therefore, are site-specific and are a potentially important source of uncertainty in the methodology.

GSD values measured in populations (GSD_p) reflect the combined effect of 1) variability in environmental concentration levels; and 2) activity-weighted exposures and lead biokinetics. Thus, estimates of GSD_p can be considered a surrogate for estimating the GSD_i. Site data on blood lead concentrations collected from populations of varying homogeneity may be useful for establishing a plausible range of values of GSD_i , provided that the data are of adequate quality and can be stratified by nonresidential exposure level. The lowest values of GSD_p are expected among homogeneous populations (e.g., individuals with similar socioeconomic and ethnic characteristics living within a relatively small geographic area) exposed to a single, dominant source of lead (e.g., lead mining or smelter sites). For example, a GSD_p of 1.8 was recently calculated among adult women living in Leadville, CO (U.S. EPA, 1995). This relatively low GSD is consistent with an analysis of blood lead concentration data in mining communities in the United States and Canada, which suggest that GSD_p ranges from 1.6 - 1.8 at active mining sites where blood lead concentrations are less than 15 µg/dL (U.S. EPA, 1992). By contrast, higher values of GSD_p might be expected from a national survey. Although lead exposures among the general population are likely to be more greatly impacted by diet than soil (e.g., compared with populations exposed at a waste site), the national population is very heterogeneous, in that it includes individuals with different socioeconomic and ethnic characteristics living in distinct geographic areas.

The TRW has conducted a preliminary analysis of blood lead concentration data collected in NHANES III Phase 1 from 1988 to 1991 and found that the GSD_p for women ages 17 to 45 years may range from 1.9 - 2.1 (Table A-1). Because of the complex survey design used in NHANES III (e.g., large oversampling of young children, older persons, black persons, and Mexican-Americans), this analysis used sampling weights included in the NHANES III Phase 1 data file to produce population estimates for blood lead concentration. The weighting factor "WTPEXMH1" was used to reflect the non-random sampling of individuals in both the mobile examination units (MEC) and the home examinations. The analysis did not account for the design effects associated with the selection of strata and primary sampling units (PSUs), which may result in an underestimation of sampling variance. Since this bias is not likely to greatly impact the GSD_p (Brody, personal communication), the amount of underestimation of the GSD_p by the values given in Table A-1 is likely to be small. Geometric mean blood lead concentrations listed in Table A-1 are within 0.2 µg/dL of these reported in Brody et al. (1994).

The TRW estimates that 1.8 - 2.1 is a plausible range for GSD_i, based on an evaluation of available blood lead concentration data for different types of populations. In cases where site-specific data are not available, a value within this range should be selected based on an assessment as to whether the population at the site would be expected to be more or less heterogeneous than the U.S. population with respect to racial, ethnic, cultural and socioeconomic factors that may affect exposure.

Table A-1. NHANES III Phase 1 Summary Statistics for Blood Lead Concentration Among U.S. Women by Age and Ethnic/Racial Characteristics[a].

Age Group	Non-Hispanic White			Non-Hispanic Black			Mexican American		
(years)	No.	GM	GSD	No.	GM	GSD	No.	GM	GSD
20 - 49	728	1.9	1.90	622	2.3	2.01	729	2.1	2.10
50 - 69	476	3.2	1.88	256	4.2	1.80	255	3.3	2.12
> 69	562	3.5	1.82	135	4.1	1.86	75	2.9	2.03
20 +	1,766	2.4	2.01	1,013	2.7	2.07	1,059	2.3	2.14
17 - 45	**742**	**1.7**	**1.89**	**658**	**2.1**	**1.98**	**763**	**2.0**	**2.10**

[a]Analysis of data weighted by MEC and home weighting factor (WTPEXMH1), excluding samples missing data on blood lead concentration or age. GM PbB (μg/dL) = $\exp(\mu_{ln})$; GSD PbB = $\exp(\sigma_{ln})$.

3. Fetal/Maternal Blood Lead Concentration Ratio ($R_{fetal/maternal}$)

The TRW recommends a default value of 0.9 based on studies that have explored the relationship between umbilical cord and maternal blood lead concentrations (Goyer, 1990; Graziano et al., 1990). The Goyer (1990) estimate of an average fetal/maternal blood lead concentration ratio of 0.9 is supported by a large body of data that has been summarized in Agency documents (U.S. EPA, 1986, 1990). Graziano et al. (1990) compared maternal and umbilical cord blood lead concentrations at delivery in 888 mother-infant pairs who were between 28 and 44 weeks of gestation. The relationship was linear with a slope of 0.93 μg/dL cord blood per μg/dL maternal blood; the correlation coefficient was 0.92. The slope of 0.93 from the Graziano et al. (1990) study supports 0.9 as a point estimate for $R_{fetal/maternal}$.

Although average fetal/maternal blood lead concentration ratios, as reflected in cord blood, tend to show consistent trends (Goyer, 1990; Graziano et al., 1990), the trends may not reflect significant inter-individual variability in maternal and possibly fetal blood lead concentrations due to physiological changes associated with pregnancy. For example, mobilization of bone lead stores during pregnancy may be more substantial in some women, and iron and calcium deficiency associated with poor nutritional status, as well as pregnancy, may enhance gastrointestinal absorption of lead (U.S. EPA, 1990; Franklin et al., 1995). Conversely, maternal blood lead concentration may decrease during the later stages of pregnancy because of the dilution effect associated with a 30% rise in plasma volume, as well as an increased rate of transfer of lead to the placenta or to fetal tissues (Alexander and Delves, 1981). These changes may give rise to fetal/maternal blood lead concentration ratios that are different from 0.9.

4. Baseline Blood Lead Concentration ($PbB_{adult,0}$)

The baseline blood lead concentration ($PbB_{adult,0}$) is intended to represent the best estimate of a reasonable central value of blood lead concentration in women of child-bearing age who are not exposed to lead-contaminated nonresidential soil or dust at the site. In this analysis, geometric mean blood lead concentrations are used for this purpose. Ideally, the value(s) for $PbB_{adult,0}$ used in the methodology should be estimated in the population of concern at the site. This requires data on blood lead concentrations in a representative sample of adult women who are not exposed to nonresidential soil or soil-derived dust at the site, but who may experience exposures to other environmental sources of lead that are similar in magnitude to exposures experienced by the population of concern. This would include exposure to lead in food and drinking water as well as residential soil and dust (dust derived from soil and all other non-site related sources). The sample must be of sufficient size to yield statistically meaningful estimates of $PbB_{adult,0}$.

In the absence of high quality data for the site, $PbB_{adult,0}$ may be extrapolated from estimates for other surrogate populations that would be expected to have a similar $PbB_{adult,0}$ distribution as that of the population of concern. In making such extrapolations, factors that might contribute to differences between the geometric mean $PbB_{adult,0}$ in the surrogate population and population of concern should be evaluated. These factors include differences in the residential exposure (level and pathways), socioeconomic, ethnic and racial demographics, housing stock, degree of urbanization, and geographical location. Such extrapolations, therefore, are site-specific.

In cases where site-specific extrapolations from surrogate populations are not feasible, the TRW recommends 1.7 - 2.2 µg/dL as a plausible range, based on the results of Phase 1 of the NHANES III as reported by Brody et al. (1994). Table A-2 summarizes the analysis of blood lead concentrations from a sample of 2,083 women ages 20 - 49, and stratified into the three ethnic and racial categories.

Table A-2. NHANES III Phase 1 Summary Statistics for Blood Lead Concentration Among Different Populations of U.S. Women Ages 20 - 49 (Brody et al., 1994).

Population	No.	GM (95% CI)
Mexican American women	732	2.0 (1.7 - 2.5)
non-Hispanic black women	623	2.2 (2.0 - 2.5)
non-Hispanic white women	728	1.7 (1.6 - 1.9)
Total	2,083	

The TRW recommends that the estimates from Table A-2 be used in combination with data on the ethnic and racial demographics of the population of concern to select the most appropriate point estimate from within the plausible range of 1.7 - 2.2 µg/dL. For example, if the population at the site was predominantly Mexican American, 2.0 µg/dL might be selected as the point estimate. The plausible range is based on surveys of large samples of the national population and may not encompass central tendencies estimated from smaller regional or site-specific surveys, either because of bias associated with the smaller sample or because of real differences between the surveyed population and the national population. This needs to be evaluated in deciding whether or not to use data from small surveys that yield point estimates for $PbB_{adult,0}$ that fall outside of the plausible range.

5. Biokinetic Slope Factor (BKSF)

The BKSF parameter relates the blood lead concentration (µg Pb/dL) to lead uptake (µg Pb/day). The TRW recommends a default value of 0.4 µg Pb/dL blood per µg Pb absorbed/day for the BKSF parameter based on data reported by Pocock et al. (1983) on the relationship between tap water lead concentrations and blood lead concentrations for a sample of adult males, and on estimates of the bioavailability of lead in tap water (see Section 6 of the Appendix).

Pocock et al. (1983) analyzed data on lead concentrations in first draw tap water and blood lead concentrations in a population of 910 adult males. A linear model imposed on the data yielded a slope of 0.06 (µg/dL per µg/L first draw water) for water lead concentrations equal to or less than 100 µg/L (a lower slope was applied to the data for higher water concentrations). Pocock et al. (1983) also obtained data on lead concentrations in flushed water (and "random daytime") samples, in addition to first draw samples. Given the following assumptions, it is possible to derive a slope factor for ingested water lead (INGSF) from the Pocock et al. (1983) data:

- The lead concentration of flushed water was 25% of the concentration of first draw water ($C_{f/1st} = 0.25$) (U.S. EPA, 1995).

- Daily water intake consisted of 30% first draw and 70% flushed ($F_{1st} = 0.3$, $F_f = 0.7$) (U.S. EPA, 1992).

- Daily water ingestion (including tap water and beverages made with tap water) was 1.4 L/day ($IR_W = 1.4$) (U.S. EPA, 1989).

Based on the above assumptions, a INGSF of 0.09 µg/dL per µg intake/day is estimated as follows:

$$INGSF = \frac{0.06}{IR_W \bullet (F_{1st} + (C_{f/1st} \bullet F_f))}$$

$$INGSF = \frac{0.06}{1.4 \bullet (0.3 + (0.25 \bullet 0.7))}$$

$$INGSF = 0.09$$

This suggests that the product of the BKSF, reflecting the slope for absorbed rather than ingested lead, and the absorption factor for lead in drinking water (AF_w) should be approximately 0.09 if it is to match the estimate of INGSF based on the Pocock et al. (1983) study:

$$INGSF = BKSF \bullet AF_w$$

Values of AF_w within the range 0.20 - 0.25 would correspond to a range for BKSF of 0.36 - 0.45, or approximately 0.4 µg/dL per µg/day (rounded to one significant figure). A range of 0.20 - 0.25 for AF_w is supported by data from numerous lead bioavailability studies (see Section 6 of the Appendix for a more detailed discussion of these studies).

The above estimate of 0.4 µg/dL per µg/day for the BKSF can be compared with the approach described by Bowers et al. (1994), who used the same data set along with different assumptions and arrived at essentially the same estimate of the BKSF, 0.375 or approximately 0.4 µg/dL per µg/day. Bowers et al. (1994) assumed a daily tap water intake of 2 L/day and 8% absorption of lead ingested in tap water; and did not make adjustments for a mixture of first draw and flushed water intake in the Pocock et al. (1983) study.

Several uncertainties should be considered in applying the default value of 0.4 µg/dL per µg/day to any specific population. Since it is based on the Pocock et al. (1983) data, it represents an extrapolation from adult men to women of child bearing age. Physiological changes associated with pregnancy may affect the value of the BKSF (see Section 6 of the Appendix); therefore, some uncertainty is associated with applying the default value to populations of pregnant women.

An additional uncertainty concerns the assumption of linearity of the relationship between lead intake and blood lead concentration. The Pocock et al. (1983) study provides data on a large sample population of adult men whose members were exposed to relatively low drinking water lead levels; 898 subjects (97%) were exposed to first draw water lead concentrations less than 100 µg/L and 473 (52%) to 6 µg/L or less. A smaller study of adult women exposed to higher concentrations was reported by Sherlock et al. (1982, 1984); out of 114 subjects, 32 (28%) had flush drinking water lead concentrations less than 100 µg/L and only 13 (11%) less than 10 µg/L. Sherlock et al. (1982, 1984) used a cube root regression model, rather than a linear model, to describe the relationship between drinking water and blood lead concentration. Given the much larger sample size in the Pocock et al. (1983) study, particularly towards the low end of the distribution for water lead concentration, greater confidence can be placed in the estimated slope of the linear regression model from the Pocock et al. (1983) study than in the cube root regression model of Sherlock et al. (1982, 1984). Nevertheless, it is useful to compare the output of the two models because they were applied to the different sexes and because they differ so fundamentally in the treatment of the blood lead - water lead slope; the slope is constant in the linear model and decreases in the cube root model as water lead concentration increases. Figure A-1 compares the output of the two models and shows the output of a linear regression of the unweighted output of the Sherlock et al. (1984) model. Three observations can be made from this comparison that are relevant to the BKSF:

1. Both the Pocock et al. (1983) and Sherlock et al. (1984) models predict higher blood lead concentrations than would be expected in the average U.S. population today as

suggested from NHANES III. This is indicative of higher lead intakes in the study populations which may have contributed to the apparent nonlinearities observed (e.g. above 100 µg/L in Pocock et al.(1983) and at lower concentrations in Sherlock et al. (1984).

2. The cube root regression model of Sherlock et al. (1984) predicts lower blood lead concentrations than the linear model of Pocock et al. (1983). This may reflect greater lead intakes from sources other than drinking water in the Pocock et al. (1983) population (see Section 6 of the Appendix for further discussion).

3. The linear approximation of the Sherlock et al. (1984) and the linear model from Pocock et al. (1983) have similar slopes; 0.08 and 0.06 µg/dL per µg/L, respectively. Thus, although the Sherlock et al. (1984) study casts some degree of uncertainty on the assumption of linearity of the blood lead - drinking water lead relationship both at low (<10 µg/L) and high (> 100 µg/L) tap water lead concentrations, a linear model with a constant slope of 0.06 µg/dL per µg/L appears to approximate the output of the nonlinear model of Sherlock et al. (1984) reasonably well for water lead concentrations less than100 µg/L.

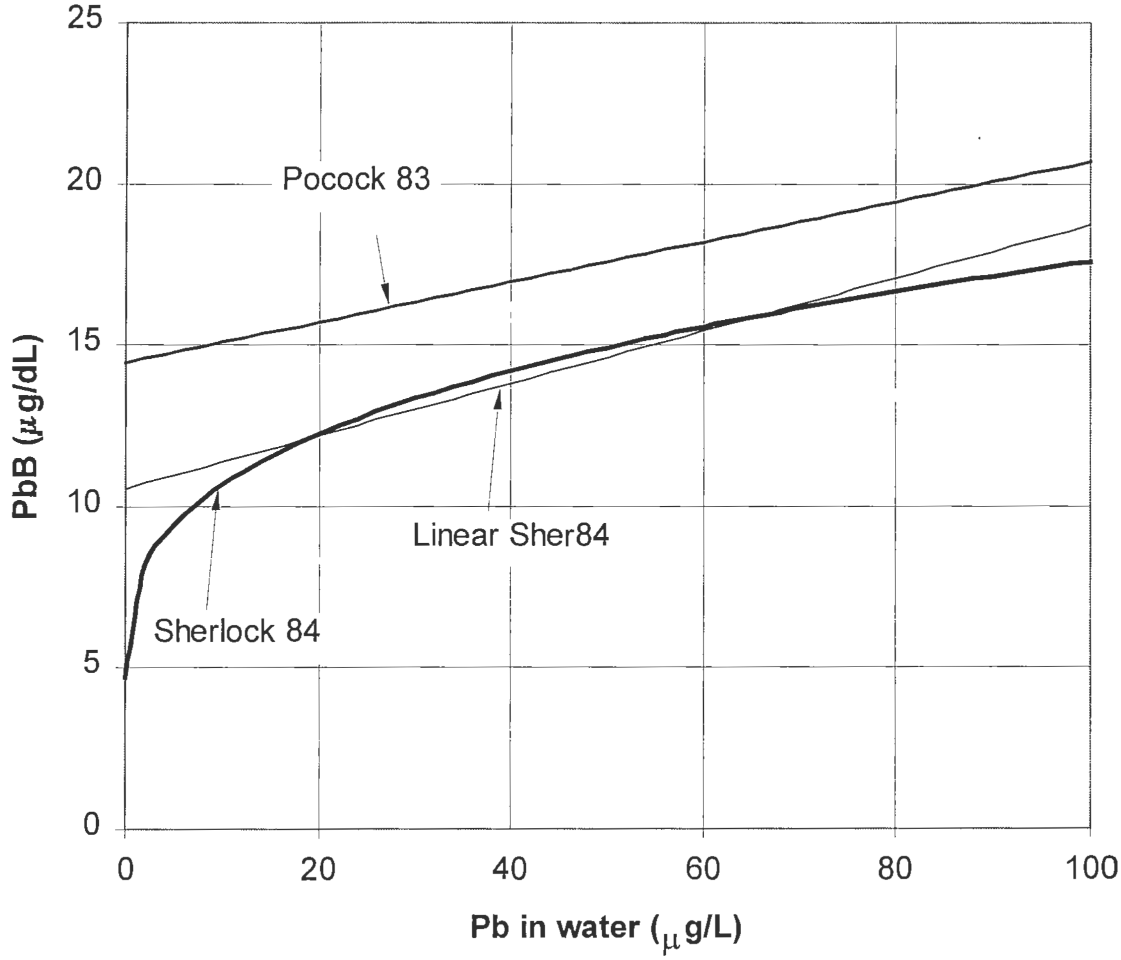

Figure A-1. Comparison of linear model of Pocock et al. (1983) with cube root model of Sherlock et al. (1984) and a linear model imposed on the unweighted output of the Sherlock model over the water lead range 0 - 100 μg/L (linear Sher84). The slope of the linear Sher84 model is 0.08 μg/dL per μg/L. The slope of the Pocock et al. (1983) model is 0.06 μg/dL per μg/L.

Experimental data on the pharmacokinetics of lead in adult humans support the default value of 0.4 (µg/dL per µg/day absorbed lead) for BKSF estimated from Pocock et al. (1983). Several distinct kinetic pools of lead are evident from observations of the rate of change of blood lead isotope with time after a period of daily dosing in which lead is abruptly terminated (Rabinowitz et al., 1976). A rapid exchange pool, denoted pool 1, includes the blood and a portion of the extracellular fluid, and is the physiological pool from which urinary and hepatobiliary excretion of blood lead occurs. Several estimates of the size of pool 1 (V_1) and the residence times for lead in pool 1 (T_1) have been derived from experiments in which human subjects were administered tracer doses of stable isotopes of lead from which pool 1 clearances (C_1) have been estimated; these estimates are summarized in Table A-3.

Table A-3. Summary of Experimental Studies with Humans to Assess Clearance Rates of Lead from Blood and Extracellular Fluid.

Subject	V_1[a] (dL)	T_1[b] (day)	$T_{½}$[c] (day)	C_1[d] (dL/day)	Reference
A	77	34	24	2.3	Rabinowitz et al., 1974
B	115	50	35	2.3	
A	74	34	24	2.2	Rabinowitz et al., 1976
B	100	40	28	2.5	
C	101	37	26	2.7	
D	99	40	28	2.5	
E	113	27	19	4.2	
ACC	70[e]	29	20	2.4	Chamberlain et al., 1978
DN	94[e]	39	27	2.4	
PL	85[e]	40	28	2.1	
ACW	94[e]	48	33	2.0	
MJH	97[e]	41	28	2.4	
ANB	95[e]	40	28	2.4	
Mean ± SD	93 ± 14	38 ± 6	27 ± 4	2.5 ± 0.5	

[a]The reported volume of pool 1, which refers to blood and rapidly exchangeable extracellular fluid compartment.
[b]The reported residence time for lead in pool 1.
[c]The half life of lead in pool 1; $T_{½} = (T_1) \times \ln(2)$.
[d]Clearance of lead from pool 1; $C_1 = V_1/T_1$.
[e]Estimated assuming $V_1 = V_{blood} \times 1.7$ (Rabinowitz et al., 1976).

The above experiments support a value for C_1 of 2.5 dL/day. At steady state, the clearance is equivalent to the rate of uptake of lead into pool 1 per unit of blood lead concentration (µg/day per µg/dL). Theoretically, this should correspond to a slope factor of 0.40 µg/dL per µg/day absorbed lead (i.e., the reciprocal of the clearance estimate). Thus, the default value for the BKSF parameter of 0.4 µg/dL per µg/day absorbed lead derived from the population survey data of Pocock et al. (1983) is consistent with the clearance estimates from experimental studies.

6. Soil Lead Absorption Factor (AF_S)

The AF_S parameter is the fraction of lead in soil ingested daily that is absorbed from the gastrointestinal tract. The TRW recommends a default value of 0.12 based on the assumption that the absorption factor for soluble lead ($AF_{soluble}$) is 0.2 and that the relative bioavailability of lead in soil compared to soluble lead ($RBF_{soil/soluble}$) is 0.6:

$$AF_S = AF_{soluble} \bullet RBF_{soil/soluble}$$

$$AF_S = 0.2 \bullet 0.6 = 0.12$$

The default value of 0.2 for $AF_{soluble}$ in adults represents a weight of evidence determination based on experimental estimates of the bioavailability of ingested lead in adult humans with consideration of three major sources of variability that are likely to be present in populations, but are not always represented in experimental studies; these are variability in food intake, lead intake, and lead form and particle size.

Effect of food on lead bioavailability. The bioavailability of ingested soluble lead in adults has been found to vary from less than 10% when ingested with a meal to 60 - 80% when ingested after a fast (Blake, 1976; Blake et al., 1983; Blake and Mann, 1983; Graziano et al., 1995; Heard and Chamberlain, 1982; James et al., 1985; Rabinowitz et al., 1976, 1980). The general consensus is that constituents of food in the gastrointestinal tract decrease absorption of ingested lead, although the exact mechanisms by which this occurs are not entirely understood. Lead intake within a population would be expected to occur at various times with respect to meals. Therefore, the central tendency for lead absorption would be expected to reflect, in part, meal patterns within the population and to have a value between the experimentally determined estimate for fasted and fed subjects.

An estimate of a "meal-weighted" $AF_{soluble}$ can be obtained from the data reported by James et al. (1985) and certain simplifying assumptions. James et al. (1985) assessed the effects of food on lead bioavailability by measuring the fraction retained in the whole body of adult subjects 7 days after they ingested a dose of radioactive lead either after a fast or at various times before or after a meal. The total lead dose was approximately 50 µg (fasted) - 100 µg (with food). Lead retention was 61 ± 8.2 (SD)% when lead was ingested on the 12th hour of a 19-hour fast and decreased to 4% - 16% when lead was ingested between 0 and 3 hours after a meal; retention was further reduced (3.5 ± 2.9%) when lead was ingested with a meal (breakfast) (the bioavailability may have been more than these retention estimates since some absorbed lead would have been excreted during the 7 day interval between dosing and measurement of whole-body lead). Since ingested material may be retained in the human stomach or at least 1 hour (Hunt and Spurrel, 1951; Davenport, 1971), lead bioavailability also may be reduced when lead is ingested 1 hour before a meal. The average "meal-weighted" bioavailability can be estimated based on the average number of waking hours during the day, the number of meals eaten, the bioavailability of lead ingested within 1 hour before a meal, the bioavailability of lead ingested within 0 to 3 hours after a meal, and the bioavailability of lead at other times during the day. For example, if it is assumed that people eat three meals each day and, based on the James et al. (1985) study, the bioavailability of lead ingested within 1 hour before a meal or 0 to 3 hours after a meal is approximately 0.1, and the bioavailability of lead ingested at all other times in a 16 hour day is 0.6, then the average "meal-weighted" bioavailability during a 16 hour day is approximately 0.2:

$$\frac{(0.1 \bullet 12\ hrs) + (0.6 \bullet 4\ hrs)}{16\ hrs} = 0.23$$

This example suggests that the use of 0.2 as a default value for $AF_{soluble}$ is plausible for populations in which soil lead intake occurs throughout the day, interspersed with meals. This may not apply to all members of a population. For example, the average bioavailability would be higher if less than three meals were consumed each day (e.g., using a similar calculation it can be shown that the average bioavailability for one meal each day would be 0.5). Average bioavailability also may be greater than 0.2 if lead intake was to occur predominantly in the early morning, before the first meal of the day.

Although lead bioavailability may be lower in individuals whose soil lead ingestion coincides with meals, the TRW cautions against the use of a value less than 0.2 for several reasons. Iron and calcium deficiency associated with poor nutritional status may enhance absorption (U.S. EPA, 1990). In addition, numerous factors may affect the absorption, distribution, excretion, and mobilization of lead during pregnancy: increased plasma volume (i.e., hemodilution); decreased hematocrit; previous exposure history of the mother (i.e., bone lead sequestration); changes in nutritional status; significant loss of body weight or depletion of fat stores; hormonal modulation; age; race; administration of drugs; and illness (Silbergeld, 1991). There is likely to be significant inter-individual variability in these factors, and studies of women at different stages of pregnancy have not shown clear trends in effects on blood lead concentration (Gershanik et al., 1974; Alexander and Delves, 1981; Baghurst et al., 1987; Silbergeld, 1991). While there is evidence to support 0.2 as a reasonable estimate of $AF_{soluble}$ for women of child-bearing age, there is still some basis for concern regarding potentially elevated absorption during pregnancy. However, a potential increase in lead absorption during pregnancy would be expected to occur dynamically with changes in bone mobilization, blood volume and glomerular filtration rate. Thus, the TRW cautions against adjusting the value for $AF_{soluble}$ (or BKSF) based on assumptions regarding the effects of pregnancy on blood lead concentration.

Nonlinearity in blood lead concentration. Another reason for caution in adopting values for $AF_{soluble}$ less than 0.2 derives from uncertainty about the relationship between blood lead concentration, lead intake, and lead absorption. Several studies have shown that the relationship between environmental lead levels (e.g., drinking water lead concentration) and blood lead concentration is nonlinear and suggest the possibility that fractional absorption of ingested lead is dose-dependent, and decreases as lead intake (and blood lead concentration) increases. Pocock et al. (1983) reported a nonlinear relationship between blood lead concentration and water lead that could be approximated by two linear equations: a slope of 0.06 µg/dL per µg/L was estimated for water lead concentrations equal to or less than 100 µg/L and a slope of 0.01 was estimated for water lead concentrations above 100 µg/L. Sherlock et al. (1982, 1984) used a cube root regression model to relate blood and water lead concentrations; however, over the range of water lead concentrations of 100 µg/L or less, the slope of 0.06 µg/dL per µg/L water lead from Pocock et al. (1983) approximates the relationship observed in the Sherlock et al. (1982, 1984) study (Figure A-1). The linear relationship between water lead and blood lead in the Pocock et al. (1983) study extends from a blood lead concentration range of 14 to 20 µg/dL. Based on these data, the value of $AF_{soluble}$ of 0.2 may be considered a reasonable default estimate if applied to exposure scenarios in which the estimates of blood lead concentration do not exceed 20 µg/dL. At blood lead concentrations greater than this, absorption of soluble lead may be less than the default value.

An appropriate value of $AF_{soluble}$ also can be supported by estimating the range of daily lead intake that is likely to result in a linear relationship between intake and blood lead concentration. Data represented in Figure A-1 suggest that if water lead concentrations are less than 100 µg/L, the blood lead - water lead relationship is approximately linear. If assumptions regarding the magnitude of first draw and flushed water intakes and lead concentrations are applied (see Equations A-8 and A-9 and discussion of BKSF), a first draw water lead concentration of 100 µg/L in the Pocock et al. (1983) study represents a water lead intake of approximately 70 µg/day:

$$100 \bullet 1.4 \bullet (0.3 + (0.25 \bullet 0.7)) \approx 70$$

We do not know with certainty the total lead intake in the Pocock et al. (1983) population, although we can be certain that it exceeded the above estimated intake from drinking water since intake from diet and other sources, including occupational, would have occurred; this is consistent with the higher blood lead concentrations that were observed in the male population. Sherlock et al. (1982) estimated that, in their study population of adult women, the dietary contribution to total lead intake was equal to that from drinking water when the water lead concentration was 100 µg/L, and that the contribution of lead from sources other than diet and water was very small. If the same assumption is applied to the Pocock et al. (1983) study, it is likely that total lead intake in the male population was at least 140 µg/day (70 µg/day from drinking water and 70 µg/day from diet; the Pocock et al., 1983 study included 40 households from the Sherlock et al., 1982 study site), and may have been higher because of occupational exposure in the male population. A crude estimate of the relative magnitudes of the non-water lead intakes in the two studies can be obtained by comparing the predicted water lead concentration required to achieve the same blood lead concentration in the two populations. For example, a water lead concentration of 100 µg/L corresponded to a predicted blood lead concentration of approximately 18 μg/dL in the female population (Sherlock et al., 1984); the same blood lead concentration corresponded to a water lead concentration of 50 μg/L in the male population (Pocock et al., 1983). Therefore, the non-water lead intakes in the male population may have been twice that in the female population. If it is assumed that drinking water and diet contributed equally to lead intake in both studies, then a drinking water lead concentration of 100 μg/L in the Pocock et al. (1983) study translates to a total lead intake of approximately 300 μg/day:

$$I_{total} = I_{water} + I_{diet} + I_{other}$$
$$I_{total} = 70 + 70 + 140 \approx 300 \, \mu g / day$$

Thus, the departure from linearity observed in the Pocock et al. (1983) study may have occurred at lead intakes at or above 300 μg/day. In the various experimental assessments of lead bioavailability, subjects ingested lead in amounts that varied among the studies but were all within the range 100 - 300 μg (Blake, 1976; Blake et al., 1983; Blake and Mann, 1983; Graziano et al., 1995; Heard and Chamberlain, 1982; James et al., 1985; Rabinowitz et al., 1976, 1980), which is within the approximate linear range, if the extrapolation from the Pocock et al. (1983) and Sherlock et al. (1982) studies is reasonable. Based on these considerations, the value of $AF_{soluble}$ of 0.2 is considered to be a reasonable default value if applied to exposure scenarios in which lead intakes are less than 300 μg/day. At intakes greater than this, absorption of soluble lead may be less than the default value; however, it can be similarly argued that, based on the Sherlock et al. (1984) regression model, the default $AF_{soluble}$ may underestimate absorption by some degree at low exposures.

Effect of lead form and particle size on lead bioavailability. The default value of 0.2 for $AF_{soluble}$ applies to soluble forms of lead in drinking water and food and would be expected to overestimate absorption of less soluble forms of lead in soil. Experimental studies have shown that the bioavailability of lead in soil tends to be less than that of soluble lead. Weis et al. (1994) assessed the relative bioavailability of lead in soil compared to water soluble lead (acetate) in immature swine and estimated that the relative bioavailability of lead in soil from Leadville, CO was 0.6 to 0.8. Ruby et al. (1996) reported estimates of the relative bioavailability of lead in a variety of soils from mining sites and smelters as assessed in the Sprague-Dawley rat; the estimates ranged from 0.09 to 0.4. Maddaloni et al. (1996) reported preliminary data from a study in which 6 fasted human subjects were administered a single dose of lead-contaminated soil. The dose was 250 μg lead normalized to a 70 kg body weight; the concentration of lead in the soil was 2850 μg/g and the amount of soil administered to each subject was generally a little less than 100 mg. The average estimate of lead absorption in the six subjects was 26%. If the absorption factor for soluble lead in fasted adults is assumed to be 0.6 (James et al., 1985), then the Maddaloni et al. (1996) estimate suggests a relative bioavailability of 0.5 (i.e., 0.3/0.6) for lead in soil.

Based on the above evidence, the TRW considers 0.6 to be a plausible default point estimate for the relative bioavailability of lead in soil compared to soluble lead ($RBF_{soil/soluble}$) when site-specific data are not available. Such data are highly desirable as variation in relative bioavailability is expected for different species of lead and different particle sizes (Barltrop and Meek, 1975, 1979), both of which may vary from site to site. For example, the bioavailability of metallic lead has been shown to decrease with increasing particle size (Barltrop and Meek, 1979), therefore, the default value for $RBF_{soil/soluble}$ may overestimate absorption of lead if applied to soils contaminated with large lead particles such as firing range debris or mine tailings. Here again, the TRW cautions against the use of a lower value for the $RBF_{soil/soluble}$, unless it can be supported by experimental assessments of relative bioavailability.

The default value of 0.6 for $RBF_{soil/soluble}$, coupled with the default value of 0.2 for $AF_{soluble}$, yields a default value of 0.12 for AF_S ($0.6 \cdot 0.2$). The TRW considers 0.12 to be a plausible point estimate for the absorbed fraction of ingested soil lead for use in assessments in which site-specific data on lead bioavailability are not available. The default value of 0.12 takes into account uncertainties regarding the possible nonlinearity in the relationship between lead intake and absorption and should be adequately protective in scenarios in which predicted blood lead concentrations are less than 20 µg/dL. The use of the default value for populations that have substantially higher blood lead concentrations may result in an overestimate of lead uptake, and conversely, lead uptake may be underestimated at lower exposures.

7. Daily Soil Ingestion Rate (IR_S)

The TRW recommends a default value of 0.05 g/day as a plausible point estimate of the central tendency for daily soil intake from all occupational sources, including soil in indoor dust, resulting from non-contact intensive activities. This would include exposures that are predominantly indoors. More intensive soil contact would be expected for predominantly outdoor activities such as construction, excavation, yard work, and gardening (Hawley, 1985). Site-specific data on soil contact intensity, including potential seasonal variations, should be considered in evaluating whether or not the default value is applicable to the population of concern and, if not, activity-weighted estimates of IR_S that more accurately reflect the site can be developed.

In adopting the single IR_S parameter to describe all sources of ingested soil, the methodology remains consistent with recommendations of the Superfund program and their implementation for risk assessment; specifically, the 0.05 g/day value used for adult soil ingestion addresses all occupational soil intake by the individual, whether directly from soil or indirectly through contact with dust (U.S. EPA, 1993). This value specifically applies to the assessment of soil lead risk, and not risks associated with non-soil sources of lead in dust. In making soil ingestion exposure estimates under the Risk Assessment Guidelines for Superfund (RAGS) framework, no specific assumptions are needed about the fraction of soil intake that occurs through dust.

An alternative approach was needed in the IEUBK Model because childhood lead exposures are often strongly influenced by indoor sources of lead in dust (e.g., indoor paint) (U.S. EPA, 1994b). In a situation where indoor sources of dust contamination are important, an exposure estimate that addresses only soil exposures (including the soil component of dust) would be incomplete. The IEUBK Model assigns separate values to outdoor soil and total indoor dust ingestion and partitions the indoor dust into soil-derived and non-soil-derived sources. At a minimum, paired soil and indoor dust samples should be collected to adequately characterize exposure to lead where indoor sources of dust lead may be significant.

Alternate method for calculating soil and dust ingestion as separate exposure pathways. In this alternate approach, separate estimates are made of lead intake from the direct ingestion of outdoor soil and from the ingestion of indoor dust (which may contain lead from soil and as well as from indoor sources such as deteriorated lead based paint). Exposure to lead from soil (outdoor contact) can be calculated using Equation A-12, while exposure to lead from indoor dust can be calculated using Equation A-13.

$$INTAKE_{S,\,outdoors} = \frac{PbS \bullet IR_{S,\,outdoors} \bullet EF_{Site}}{AT}$$

$INTAKE_{S,\,outdoors}$ = Daily average intake (ingestion) of lead from soil ingested outdoors (µg/day).

$$INTAKE_{D,\,indoors} = \frac{PbD \bullet IR_{D,\,indoors} \bullet EF_{Site}}{AT}$$

$INTAKE_{D,\,indoors}$ = Daily average intake (ingestion) of lead from dust ingested indoors (µg/day).

PbS	=	Soil lead concentration (µg/g) (average concentration in assessed individual exposure area).
PbD	=	Indoor dust lead concentration (µg/g).
$IR_{S,\,outdoors}$	=	Intake rate (ingestion) of outdoor soil (g/day).
$IR_{D,\,indoors}$	=	Intake rate (ingestion) of indoor dust (g/day).
EF_{Site}	=	Exposure frequency at site (days of exposure during the averaging period); may be taken as days per year for continuing, long term exposures.
AT	=	Averaging time, the total period during which the assessed exposures (from all sources) occur (days). May be taken as 365 days per year for continuing, long term exposures.

Note that, in Equations A-12 and A-13, exposure frequency refers to the number of days that an individual is present at the site and does not partition between periods of indoor and outdoor exposures. The intake rate is a long term average value appropriate for that media and is influenced by both the duration of outdoor (or indoor) exposures and the intensity of those exposures.

Calculation of $IR_{S,\,outdoors}$ and $IR_{D,\,indoors}$ from total intake of soil and dust (IR_{S+D}). Intermediary calculations may be needed to generate estimates of the parameters in the intake equations. An estimate of the total intake of soil and dust materials (IR_{S+D}) serves as a starting point. Note that IR_{S+D} differs from $IR_{S,}$ which was discussed above, because IR_{S+D} includes not only the total mass of soil ingested (both directly and as a component of indoor dust), but also the ingested mass of non-soil derived dust components including various materials of indoor origin. Since a substantial fraction of the mass of indoor dust comes from sources other than outdoor soils, an estimate of IR_{S+D} will be higher than the corresponding estimate of $IR_{S.}$ Secondly, an estimate of the fraction the total soil and dust intake that is ingested directly as soil is needed ($Weighting_{soil}$). This estimate needs to take into account the intensity and duration of the outdoor soil intake and the indoor dust intake. Equations A-14 and A-15 can be used to derive media-specific ingestion rates from IR_{S+D} and $Weighting_{soil}$.

$$IR_{S,\ outdoors} = Weighting_{soil} \bullet IR_{S+D}$$

$$IR_{D,\ indoors} = (1 - Weighting_{soil}) \bullet IR_{S+D}$$

$Weighting_{soil}$ = Fraction of total soil and dust intake that is directly ingested as soil (dimensionless).

IR_{S+D} = Total daily average intake of outdoor soil and indoor dust (all dust components) (g/day).

Data are needed to generate separate estimates of the concentrations of lead in outdoor soil and in indoor dust. A site assessment using this alternate methodology would generally be based on direct measurement data for both soil and dust at the facilities of concern. For comparison with exposure estimates based on total soil ingestion (the primary approach presented in this paper), Equation A-16 may be utilized to estimate the ratio of dust lead concentration to soil lead concentration.

$$PbD = PbS \bullet K_{SD}$$

K_{SD} = Ratio of indoor dust lead concentration to soil lead concentration (dimensionless).

Assuming that the same absorption fraction is applicable to both soil and dust, Equation A-17 may be used to estimate the uptake of lead from these two sources.

$$UPTAKE = AF_{S,D} \bullet (INTAKE_{S,\ outdoors} + INTAKE_{D,\ indoors})$$

UPTAKE = Daily average uptake of lead from the gastrotintestinal tract into the systemic circulation; soil and dust sources (μg/day).

$AF_{S,D}$ = Absolute gastrointestinal absorption fraction for ingested lead in soil and dust (dimensionless).

Comparison of lead intake estimated from principal and alternate approaches. It is helpful to compare exposure estimates derived using our principal approach based on total soil intake (including soil present in ingested dust) with the results of the disaggregated pathway analysis for soil and dust. We will consider the case in which there are not important indoor sources of lead in dust. We can then compare the total lead intake estimates from the two approaches.

Under the model based on total soil ingestion (which we re-label as $IR_{S,total}$ for clarity):

$$INTAKE = \frac{PbS \bullet IR_{S,\,total} \bullet EF_{Site}}{AT}$$

By contrast, using the disaggregated soil and dust model, Equations A-14, A-15, A-16, and A-18 may be combined to give Equation A-19:

$$INTAKE = \frac{PbS \bullet IR_{S+D} \bullet (Weighting_{soil} + K_{SD} \bullet (1 - Weighting_{soil})) \bullet}{AT}$$

When applied to the same exposure assessment problem, the two approaches should give equivalent estimates of lead intake. The estimates will be equivalent when:

$$IR_{S+D} \bullet (Weighting_{soil} + K_{SD} \bullet (1 - Weighting_{soil})) = IR_{S,\,total}$$

8. Exposure Frequency (EF_S)

The TRW recommends a default value of 219 days/year. This is the same as the central tendency occupational exposure frequency recommended by U.S. EPA (1993) Superfund guidance, which is based on 1991 data from the Bureau of Labor Statistics. This estimate corresponds to the average time spent at work by both full-time and part-time workers engaged in non-contact intensive activities (U.S. EPA, 1993). Site-specific data on exposure frequency should be considered in evaluating whether or not the default value is applicable to the population of concern. In evaluating site-specific data, it should be kept in mind that exposure frequency and daily soil ingestion rate (IR_S) may be interdependent variables, particularly in contact-intensive scenarios; therefore, the assignment of a site-specific value to EF_S should prompt an evaluation of the applicability of the default value for IR_S to the population of concern (see Section 7 of the Appendix for further discussion).

Nonresidential exposure scenarios in which exposure frequency would be substantially less than 219 days/year are frequently encountered. Examples include trespassing and recreational use of a site. Important methodology constraints on exposure frequency and duration must be considered in assigning values to EF_S that would represent infrequent contact with the site; these constraints relate to the steady state assumptions that underlie the BKSF. The BKSF derived from the Pocock et al. (1983) data applies to exposures that result in a quasi-steady state for blood lead concentration; that is, an intake over a sufficient duration for the blood lead concentration to become nearly constant over time. Based on estimates of the first order elimination half-time for lead in blood of approximately 30 days for adults (Rabinowitz, et al., 1974, 1976; Chamberlain et al., 1978), a constant lead intake rate over a duration of 90 days would be expected to achieve a blood lead concentration that is sufficiently close the quasi-steady state. This is the minimum exposure duration to which this methodology should be applied.

Infrequent exposures (i.e., less than 1 day per week) over a minimum duration of 90 days would be expected to produce oscillations in blood lead concentrations associated with the absorption and subsequent clearance of lead from the blood between each exposure event. Based on the above assumptions about the elimination half-time lead in blood, the TRW recommends that this methodology should not be applied to scenarios in which EF_S is less than 1 day/week.

9. Applying Monte Carlo Analysis to the Adult Lead Methodology

Recent EPA guidance (Browner, 1995) recommends that risk assessments include a clear and transparent discussion of variability and uncertainty. The lead risk assessment methodology presented here develops explicit estimates of the variability of blood lead levels among adults who are exposed to specified concentrations of environmental lead. This analysis relies on data from a large number of studies (baseline blood lead levels, variability of blood lead levels, contact rates with environmental media, lead bioavailability, and lead biokinetics) to support a predictive probabilistic (lognormal) model for adult and fetal blood lead concentrations. Important issues regarding the uncertainty in parameter inputs and the mathematical form of the model are discussed in the sections of this Appendix. The TRW recognizes that there is considerable scientific interest in the different analytical approaches that may be applied to aid in the analysis of variability and uncertainty in risk assessments. In particular, under appropriate circumstances, Monte Carlo methods may provide a useful approach for developing quantitative estimates of the variability, uncertainty (or both) in risk predictions.

The TRW chose not to pursue application of Monte Carlo or other stochastic simulation methods in this effort addressing adult lead risk assessment. Several factors went into this decision. First, the TRW understood the needs of EPA Regions for a risk model that could be developed relatively rapidly and which Regional lead risk assessors could apply easily with limited need for additional study or training. These considerations made it advantageous to focus on models that are conceptually similar to the IEUBK model for children in terms of applying a parametric lognormal modeling approach to address distributions for blood lead levels. Secondly, the TRW recognized that there would be substantial scientific issues associated with developing widely applicable stochastic simulation models for adult lead risk assessment. These difficulties primarily relate to the absence of reliable distributional data for a variety of important variables in the assessment. As one example, very limited data are available on soil ingestion rates in adults and a distributional choice for this key parameter would depend heavily on individual judgement with little Agency precedent for support. Additionally, in a stochastic assessment, a greater complexity would arise due to likely correlations among the variables in the adult lead risk assessment. Stochastic analyses need to explicitly account for important correlations among variables if the simulations are to provide realistic distributions of risk. As an example, dependence is likely to exist between the starting (non-site related) blood lead concentrations for individuals and their site-related increases in blood lead. This dependence may result from individual patterns of behavior and from biological factors associated with lead pharmacokinetics. However, data on this dependence are sparse or absent, and the necessary statistical estimates of the correlation strength would depend heavily on personal judgement.

The TRW does encourage further efforts to better define the distributional data on which stochastic simulations of lead risks might rest. Further attention to these data can provide useful insights for lead risk assessment. The TRW also recognizes that Regions may be presented with lead risk assessments based on Monte Carlo modeling. In order to facilitate review of Monte Carlo analyses, some EPA Regions have found it important to establish requirements for the orderly development and review of these assessments. Borrowing on this approach, the TRW recommends that:

- A plan for the use of Monte Carlo analysis in a lead risk assessment should be submitted to responsible Regional personnel and accepted by them before the Monte Carlo analysis is undertaken.

- In general, it is expected that site-specific exposure related parameters that are supported with site-specific information will provide the basis for proposed Monte Carlo simulations.

- Scientific review is needed to determine that the risk assessment conformed to the plan and to evaluate the reliability of the results.

These recommendations are designed to ensure that assessments can provide meaningful results that can be understood and evaluated. If analyses are submitted in a format that is difficult to understand, the utility of the analysis will be diminished. We recommend that Regional staff seek advice from the TRW as a resource in this process.

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