RCRA Showcase Pilot
Region I

Ten Most Wanted List
An Approach to Streamline Corrective Action

Overview

The EPA New England Regional Office has recently released a revised Ten Most Wanted List. The list, which was first issued in 1995 to support the region's voluntary RCRA Corrective Action initiative, is a compilation of the ten most common comments provided on RCRA Facility Investigation (RFI) work plans and reports.

In the New England Region of EPA, Corrective Action work on a voluntary basis is intended to be very performance-based. While the review time of work plans by EPA staff is often reduced, the quality of the final products are still expected to be as good as or better than work conducted under a permit or order. The Ten Most Wanted List is intended to be the RFI work plan comments issued to RCRA facilities *in advance* of the preparation of the work plan so that re-work after the submission of the RFI report is minimized or avoided altogether.

Description

- What makes this project innovative? (Does the project speed achievement of Environmental Indicators? Why will the pilot project/cleanup work?)

  Many project mangers have a sense of the comments they make repeatedly on numerous RFI work plans and reports. In Region I, we have pooled this experience and distilled it into our ten most wanted list of the topics we most often make comments on. This innovative "comment letter in advance" provides a tip sheet which minimizes generic flaws in work plans and other reports and accelerates the Corrective Action process.

- What are the benefits of this project (e.g., environmental, community, economic, other)?

  The benefits are economic and environmental. Providing facilities a tip sheet on the most common errors in their submittals to the agency helps them avoid these mistakes. Avoiding these mistakes shortens our review and their comment response time frames, saving the facility money and speeding the site more efficiently to meet the Environmental Indicator goals (i.e., unacceptable human exposures under control and migration of contaminated groundwater under control) and to meet the final remedy goals.

- How have you involved stakeholders in developing this project (for example; owner/operator, tribe, state/local agencies, local community, redevelopers, other interested parties)? Where applicable, please indicate the level of support of the owner/operator.

  There is no formal participation from outside stakeholders on this pilot; however, in its use and our interactions with facilities and the public, we continually update the document as we

encounter ambiguities or other fuzzy points in the document or as new sources of common error arise (e.g., each new guidance or newly recognized technical need (such as our current program wide re-examination of how we characterize indoor air) brings new sources of potential disagreement between EPA and other stakeholders.)

- Who are the pilot participants and what is their role (for example; states, tribes, local agencies, other federal agencies, regulated industry, and environmental and community groups)?

  Every facility we have initiated work with within the last three years is a participant in that they have received the ten most wanted list as part of our initial interaction.

- What is the potential for applying this innovative approach to other sites?

  This pilot is in use and has been provided to at least 40-50 facilities over the past several years.

- What are the proposed project milestones and associated dates?

  The Ten Most Wanted list is a tool in use at every site we initiate Corrective Action with. We continually update it and see no end to its use. Given the nature of this innovation there are no milestones associated with it.

- Provide a brief description of the pilot facility, including location and regulatory status if pilot addresses a specific facility.

  As noted above there is no single pilot facility.

- How and when will pilot progress be measured and reported?

  There is no specific measure or measurement point. This tool is one aspect of broader changes in how we approach and interact with facilities on the start up of Corrective Action. We have improved the pace at which we initiate and complete Corrective Action in our region and feel this tool has made a valuable contribution to that improvement.

- Who will oversee the pilot (State and/or Region)?

  Region.

- Who are the key Regional/State contacts responsible for managing the pilot project (name, phone, e-mail, affiliation)?

  Ernest Waterman
  617-918-1369
  waterman.ernest@epa.gov
  USEPA Region I

EPA New England Region's 10 Most Wanted List (revised July 6, 2001)

This list contains guidance on several of the most frequent recurring issues encountered when conducting an RCRA Facility Investigation (RFI) or discovered when reviewing an RFI.

- **Conceptual Site Model**

A Conceptual Site Model is an assimilation of known site history, general theoretical knowledge, and site specific sampling data into a picture or description of how releases of contaminants have or are likely to have been released at a site, where contaminants are expected to move, and what impacts such movements may have. It serves as a primary vehicle for organizing and communicating information and focusing resources on the contamination issues that represent the most significant problems at any given point in time. A good CSM is communicated through a variety of means to assure it serves as a common understanding of the site. It is revisited and revised as necessary as new data is generated at the site. When well developed the CSM serves as a tool which screens not only what is known and unknown, but identifies which unknowns must be resolved and when decisions can be made in the face of remaining uncertainty through provision of adequate contingency actions or other uncertainty management measures. The CSM will serve as a robust backdrop for design of study elements throughout the investigation process and will indicate when we have arrived at a sufficient level of site characterization to support a remedy decision.

As an example of the first use consider the problem of selecting sample parameters. Sampling parameters at each sampling site should reflect a consideration of facility processes and operations throughout the entire history of the site. The parameters selected should encompass all contaminants whose occurrence at the locale is plausible. An assumption of all plausible contaminants likely to have been released at any area of the site can also be supported by field screening (e.g. headspace analyses, soil gas survey, X-Ray Fluorescence (XRF)) and collection of samples for laboratory screening analyses (e.g. Total Petroleum Hydrocarbons (TPH), Total Organic Halogens (TOX), Total Organic Carbon (TOC)).

Given the uncertainty in site histories, the parameter assumptions should be confirmed by analyses for a wide range of hazardous constituents (e.g. Target Analyte List (TAL) and Target Compound List (TCL) of the Contract Laboratory Program (CLP) protocol or 40 CFR Part 264 Appendix IX) in at least some samples taken from the areas showing the highest degree of contamination. At some facilities gaps in historical knowledge or length and variety of site use will recommend greater use of broad spectrum analyses. As our understanding of a site evolves it may be possible to restrict the range of sample parameters.

In evaluating the completeness of our site characterization we might use the CSM as a guide through a set of questions similar to the following to evaluate our level of understanding of site conditions:

- Do I have data to address every known and reasonably expected source area?

- Do I have a "best fit" explanation of the data that works far better than any other interpretation?

- Do I have data which doesn't fit into this best fit and does it suggests further problems which require additional characterization (e.g. an unexpected source area)?

- What other uncertainties do I have? What limits can I place on them?

- Are these unexplained data and other uncertainties significant (i.e can they change my picture of what needs to be cleaned up or how it can be cleaned up)?

- Can I control any significant uncertainties without answering them now (e.g. a modified remedy option or a contingency plan renders the uncertainty insignificant).

- **Quality Assurance Project Plans and Data Validation**

Every study conducted for EPA in support of RCRA Corrective Action activities requires a Quality Assurance Project Plan (QAPP) which outlines why data is being collected, what data quality is necessary to meet the objectives of the data collection, and what quality assurance/quality control procedures will be instituted to demonstrate the necessary quality has been achieved.

As stated in the Preface to The Region I, EPA-New England Compendium of Quality Assurance Project Plan Requirements and Guidance:

> "The Region I, EPA-New England Quality Assurance Unit has restructured its Quality Assurance Project Plan (QAPP) Program in response to the recently reissued EPA Order 5360.1 CHG 1, July1998. Among other requirements, this "QA Order" requires the development, review and approval of QAPPs for all environmental data operations performed by or on behalf of EPA. The term "environmental data operations" refers to activities involving the collection, generation, compilation, analysis, evaluation and use of environmental data. In addition, these requirements are incorporated into voluntary, consentual or unilateral enforcement agreements, decrees and orders. The Region I, EPA-New England Compendium of Quality Assurance Project Plan Requirements and Guidance and its attachments implement within EPA-NE the national QAPP requirements specified in "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations", EPA QA/R-5, October 1998, or most recent revision, and the "EPA Quality Manual for Environmental Programs", 5360, July 1998.
> As a Regional implementation document, the Region I, EPA-New England Compendium of Quality Assurance Project Plan Requirements and Guidance;
> -outlines a Regional systematic planning process to ensure project quality objectives are appropriately identified
> -defines a minimum set of project QA/QC activities and procedures to ensure that data collected for this Region are of known and documented quality and can be used in environmental decision making

-specifies project information that must be compiled and included in a QAPP to document that project activities have been properly planned
-and, assigns roles and responsibilities to project management/personnel and to EPA-NE to establish accountability."

Data Validation is a review process at the tail end of data collection to verify compliance with the QAPP and document the quality of the collected data. Because we will make reference to differing degrees of data validation elsewhere in this document here is a brief overview of EPA-New England's three tiers of data validation:

- Tier I: A completeness evidence audit is performed, in accordance with the Region I CSF Completeness Evidence Audit Program, dated 7/3/91, to ensure that all laboratory data and documentation are present.

- Tier II: A Tier I completeness evidence audit is performed, and, in addition, the results of all Quality control checks and procedures are evaluated and used to assess and qualify sample results. Tier II data validation is performed in accordance with the Region I Laboratory Data Validation Functional Guidelines. Tier II validation takes approximately 50% of the time required to perform a Tier III validation.

- Tier III: A full data validation is performed. Tier III includes Tier I and Tier II procedures plus an in-depth examination of all raw data to check for technical, calculation, analyte identification/analyte quantitation, and transcription errors. Tier III data validation is performed in accordance with the Region I CSF Completeness Evidence Audit Program and the Region I Laboratory Data Validation Functional Guidelines.

At a minimum, all laboratory data should be carried through Tiers I or II. For data which will be used in the risk assessment, a minimum of Tier II data validation should be conducted. As long as Tiers I or II have been completed, full validation (Tier III) can always be performed at a later date. All biota should be validated at Tier III and it is highly recommended that sediment samples receive Tier III. It is preferable to have some Tier III data validation for other media. A limited number of samples may be acceptable depending upon the quality of the other lab results. Each new sampling round for each medium should also have performance evaluation samples included.

- **Presentation of Data**

Typical data presentations and tabulations that facilitate joint understanding of site data and its significance are presented below. EPA also strongly encourages submission of data in electronic form as an aid to EPA's review and interpretation of the data and preparation of comments. Until written procedures and requirements for electronic data submissions are formalized, please contact the RCRA facility manager for your facility to discuss specifics regarding electronic data deliverables.

- Figures -- Site data should be presented graphically to the extent practicable. Graphics should be legible, consistent, to scale, contain sufficient detail to show the data they are based on and to clearly show they are supported by the data. Examples of information to be presented graphically include but are not limited to:
  - Locus Plan
  - Site Plan (including abutters)
  - Site Plan with Areas of Concern (AOC's)\Solid Waste Management Units (SWMU's)
  - Site Plan indicating Sampling Locations
  - Soil Borings
  - Wells
  - Surface Water
  - Geological Cross-Sections
  - Groundwater Contours
  - Overburden and Piezometric Head Contours
  - Flow Lines
  - Contaminant Plume Contours
  - Soil, GW and Soil Gas
  - Graphical presentations of the vertical and horizontal extent of contamination in each media
  - Groundwater plume contours
  - Soil gas plume contours
  - Maps of contaminant in sediments

- Tables -- Tables should include appropriate units and regulatory media protection criteria (if appropriate).
  - Summary of Well Installations:
    - ID,
    - Screen Interval,
    - Construction Details
  - Groundwater Results:
    - Groundwater Level Measurements and Field Sampling Results,
    - Results of Hydrogeological Characterizations,
    - Slug Tests, Pump Tests
  - Sample Analytical Results:
    - Soil Analyses--Field Headspace and Laboratory
    - Groundwater Laboratory Analyses
    - Soil Gas Analyses
  - Risk Assessment Tables
  - References

- Appendices –
  - Boring Logs
  - Standard Operating Procedures
  - Hydrogeological Data

- Raw Data
- Modeling Input Parameters and Assumptions
- Modeling Output
- Laboratory Analytical Results
  - Lab Reports
  - QA/QC Program and Results
  - Chain of Custody Reports
- Risk Assessment (These can be stand alone documents submitted after the RFI)
  - Human Health
  - Ecological

- **Establishing Ground Water Investigation Programs**

Ground water investigation programs are required to assess the nature and extent of contamination in aquifers, water supply wells, and other receptor areas. Well placement, installation, design, construction, development, and sampling must be conducted in a manner which defines the nature and extent of contamination and maximizes representativeness of groundwater samples. Fully defining the extent of contamination will likely require phased well placement. Commonly missed points include:

- Well placement should reflect consideration of the probable transport pathways of contaminants.

- Generally, no more than 10 feet of screen length should be used for wells which are screened across the surface of the water table (with approximately half the screen set below the average expected water table) and wells below the water table should depend on the site stratigraphy and have screen lengths no greater than 5 - 10 feet.

- All wells must be fully developed (pumped) to assure that sediment is removed and that the water quality of the well reflects the ambient aquifer and not contaminant artifacts.

- Particular attention should be made to wells installed in silt or clays as the installation method/procedure can often result in a decreased permeability bias. For instance, during installation of wells in clays using hollow-stem augers, the constant scrapping of the auger against the side of the borehole can cause smearing of the clay. This smearing can cause a decrease in the effective permeability of the well--this permeability bias may go undetected and result in erroneous conclusions about the soil unit.

- Split spoon sampling conducted during installation of the well provides valuable information as to the soil type, delineation of soil heterogeneity, and contaminant distribution. Generally, in order to obtain accurate information regarding the continuity of geologic conditions at a site, continuous split spoon sampling should be performed at a representative set of wells.

- Mud rotary or other drilling methods that introduce foreign materials into the well should

be avoided.

- Avoid cross-contamination between aquifers along well bore.
- Sampling of wells by the low-flow methodology is generally preferred.

- **Characterization for Non-Aqueous Phase Liquids (NAPLs)**

Materials which are insoluble or poorly soluble in water will tend to form separate phases in the saturated zone of the subsurface. When the materials are lighter than water, the separate phase will float on top of the water table. These materials are called light non-aqueous phase liquids (LNAPLs).

When the material is denser than water, the separate phase will sink down through the saturated zone until a relatively impermeable boundary is encountered. These materials are called dense non-aqueous phase liquids (DNAPLs). DNAPL can migrate in directions other than that of groundwater flow. Chlorinated solvents are the DNAPL forming material most commonly encountered by RCRA Corrective Action. DNAPL can migrate in directions other than that of groundwater flow (e.g., flow along bedrock topography).

Detection of NAPLs at facilities where materials likely to form plumes may have been released requires particular planning for well placement and sampling. It also requires examining the well sampling data obtained at the site for particular clues to NAPL presence. When the likelihood of NAPL presence has been established, special field screening techniques may also be applicable for use at the Facility.

- **Background Sampling**

At many facilities some of the Media Protection Standards for remedy selection will be based upon the background levels of hazardous constituents. This will occur whenever background levels are above risk based goals or applicable standards. Knowledge of background levels will always be an issue for heavy metals and other naturally occurring materials. Background levels of synthetic organic compounds should only be an issue at sites where sources of contamination outside the facility exist.

Regional values or other background estimates available in the literature may not be relied on in setting Media Protection Standards. Regional values are too highly variable for use in this context though they may be useful guides early in the investigation process. Site specific sampling must be conducted to determine background levels.

Background samples to establish background levels must meet the stringent objective of representing what site conditions were before facility releases occurred. Knowledge of site history, geology, hydrology and meteorology must be used to select sample locations that present environmental setting conditions that are similar to areas of concern but are not impacted by releases. At many sites this will require off-site samples. Meeting this objective will often end

up involving more than one round of sample site selection. In some settings (e.g. estuaries) no true background will exist and background will have to be established using reference stations. Selection of background sampling locations and review of background sampling results should be coordinated with EPA.

- **Receptors and Exposure Assessment in Risk Characterization**

A principal element of all risk assessments is the proper identification of the potential receptors (i.e. the populations of human and animal life that is potentially exposed to hazardous constituents in the environment). The assessed populations should include an analysis of the more susceptible groups as well as the general population. Key to this is an understanding of the potential pathways of hazardous waste through the groundwater/surface water, soils, and air and the identification of those pathways that pose significant risk. The HERA SOW is the best reference on this topic. RCRA risk assessments use Superfund guidances whenever possible.

Points to Remember When Looking at Human Receptors:

- EPA Risk Assessment Guidances and when to use them:
  - Use EPA guidances listed in the Human Health and Environmental Risk Assessment(HERA) Statement of Work (SOW),
  - Make sure to receive the most current version of the SOW from the EPA RCRA Facility Manager,
  - The baseline risk assessment examines the risks at a site before any remedial action takes place (Risk Assessment Guidance for Superfund 'RAGS', Part A),
  - Risk assessment may estimate clean-up goals before remediation(RAGS part B) and verify the appropriateness of these goals after completion of the baseline risk assessment.
  - Risk assessment may qualitatively evaluate how much risk may be reduced by a given remedial action (RAGS part C). A facility can compare the risks from remedial alternatives as an addendum to a baseline risk assessment. (Examples of remedial alternatives are bioremediation, containment, excavation, institutional controls, and natural attenuation.)

- Selecting Chemicals of Concern (COC's):
  - If certain contaminants present on the site are not being considered as Chemicals of Concern (COC's), explain why.
  - Shorten the list of COC's using the Region IX Preliminary Remediation Goals Tables the EPA Soils Screening Levels Guidance or screening levels calculated in a similar way.
  - Comparisons between site contaminants and background concentrations cannot be used to eliminate chemicals as COC's in the risk assessment.

- Data and sampling issues:
  - Data for the risk assessment should be CLP-type or equivalent.
  - The sampling should include the EPA standard lists of chemicals (TAL/TCL) and

or Appendix IX and any unusual chemicals that are unique to a given facility.

- For air, soils, sediments, and surface water, calculate risk based on the 95% upper confidence limit of the mean. EPA recommends collecting a minimum of 10-20 samples per exposure area to make this calculation.
- For groundwater, calculate the average concentration using wells in the center of the plume of contamination; if there is no plume use contaminated wells. Use only unfiltered groundwater for the risk assessment. EPA prefers low-flow sampling for the metals and long-chain volatiles.
- For surface soils, collect samples from a 0 to 1 foot depth for risk assessment. (EPA will accept 0-3" or 0-6" sampling if the facility shows that the contamination did not extend as far as one foot.) If an excavation or construction worker scenario is appropriate for the site, soils should be collected from 0 depth to the depth at which exposure is reasonable (the default value is 10 feet).
- Hot spots may need less sampling than general contamination. If a removal is planned, hot spots are treated separately in the risk assessment.

- Information on human receptors:
  - Include information about populations at risk, people living adjacent to the site, and special populations near the site. Include maps showing schools, day care facilities, homes, recreational areas, agricultural land, prevailing wind directions, contaminant plumes, public water supplies, and drinking water wells.
  - Indicate whether contaminants leave the site and come into contact with these populations. Indicate whether workers at the facility contact site contaminants.
  - All potential routes of exposure should be covered adequately (e.g. inhalation of gases or particulates, incidental ingestion of soils, dermal contact with soils, ingestion of groundwater).
  - If people live near the site and could potentially contact site contaminants, a residential scenario should be used rather than an industrial scenario.
  - Each risk assessment must include point estimates for risk at central tendency and high end exposure scenarios. Monte Carlo analysis(optional) should only be used for describing uncertainty.

- **Development of Media Protection Standards (MPSs):**

MPSs are contaminant concentration levels in the affected media (e.g., soil, water, air) designed to protect human health and the environment from exposure to the contaminant. MPSs are also designed to prevent contaminant transfer to another media (through leaching, run-off, volatilization, etc.) that would result in unsafe levels for human health and the environment. MPSs guide selection of final remedies. Remedies must be able to prevent exposure to media containing hazardous constituents in excess of the established MPS.

Draft proposed MPSs are initial cleanup goals that are protective of human health and the environment. They are developed early in the investigation/remediation process based on readily available information (such as state remediation goals or other risk-based concentrations) and can be modified to reflect results of a baseline risk assessment. They usually represent a point of

departure of 10^{-6} for cancer risk or a hazard index of 1 for non-cancer risk in humans. These risks are calculated based on the latest toxicity data, considering assumptions appropriate for current and future land uses at the RCRA Corrective Action facility. They consider the cumulative risks to humans from multiple pathways of exposure. Initially, they are based on considerations of risk alone with limited consideration of practicability or technical feasibility. If toxicity information is lacking for a particular chemical, draft MPSs are developed after consultation with EPA.

MPSs designed to protect ecological receptors can be established through risk management decision-making based on the results of an ecological risk assessment. As part of the ecological risk assessment, *assessment endpoints* are identified, in concert with EPA and other stakeholders. Assessment endpoints are explicit expressions of the actual environmental value that is to be protected and include both a valued ecological entity and an attribute of that entity that is important to protect (e.g., aquatic community composition and structure in the portion of a stream or river downstream from a site, reproduction and population maintenance of bass in an on-site pond, etc.). Because assessment endpoints generally refer to characteristics of populations, communities, and ecosystems, changes in these characteristics may be difficult to measure. Therefore, *measures of effect* (also known as measurement endpoints), which are measurable ecological characteristics, may be selected to measure the response of the assessment endpoint to a stressor (e.g., percent mortality in laboratory toxicity testing of benthic organisms and percent mortality of caged bass in the on-site pond could be respective measures of effect selected to evaluate the assessment endpoint examples presented above). MPSs are then established at a level that prevents adverse effects to the assessment endpoint.

Ecological risk assessment will only proceed to the point of establishing MPSs if the results of the problem formulation stage and any subsequent ecological assessment suggest that unacceptable ecological risk is occurring. The problem formulation stage is the stage of the ecological risk assessment during which assessment endpoints are identified; a conceptual model of potential exposure pathways, ecological receptors, and ecological effects is developed; and an analysis plan for evaluating the relationship between contaminant levels and ecological effects is assembled.

Final proposed MPSs are chemical-specific proposed cleanup levels documented in the Corrective Measures Study. They may differ from proposed draft MPSs because of modifications resulting from consideration of various uncertainties, technical and exposure factors, and considerations of the remedy chosen. For example, the modifications could consider the naturally occurring background concentration of the substance, established regulatory limits, or technological limitations (e.g., analytical detection limits). EPA's policy is to select remedies that can achieve MPSs for the more protective end of the cancer risk range of 10^{-6} to 10^{-4} and to maintain a hazard index below 1. The final proposed MPSs combine considerations of both human and ecological risks for all appropriate pathways.

Many states, including some in New England, have developed state remediation regulations which include numerical remediation standards. EPA-New England has not endorsed any one set of numerical standards for use at all RCRA Corrective Action facilities. Use of such standards

may be appropriate to use as MPSs for a given facility. However, the pathways, scenarios, and toxicity information on which the standards are based must be evaluated to ensure that the standards will adequately protect human health and the environment.

- **Field Oversight**

A significant percentage of site characterization errors originate in the field as sampling errors. Sampling standard operating procedures (SOPs) are often broadly and ambiguously written and not reflective of variable conditions which will be encountered in the field. Sampling personnel are often inexperienced and poorly versed in the procedures they are using and the acceptable adaptations of these conditions allowable to meet field conditions.

Sampling SOPs should be clear, comprehensive, and up to date. Facilities or their contractors should maintain logs which record all sampling event data required in the relevant SOPs and general conditions of all sampling events (e.g. weather conditions). They should conduct internal audits to verify compliance with sampling SOPs and, at least for major field efforts or over the course of extended investigations, should arrange some third party oversight of sampling procedures. Provisions for unscheduled visits by EPA or our state agency counterparts can fulfill this third party oversight need.

- **Indoor Air**

The following provides EPA New England Region's RCRA Corrective Action Program's policy with respect to indoor air risk and the use of OSHA Permissible Exposure Levels (PEL).

- For purposes of RCRA Corrective Action, indoor air risk may be described as the impact or potential impact to human health of the inhalation of volatile organic compounds (VOC) as a result of the physical/chemical migration of VOCs from soils and/or groundwater into buildings. Two factors make the characterization of indoor air risk by direct empirical evidence difficult.
  - First, very low concentrations of some volatile organic constituents (*e.g.*, 1,1-dichloroethylene, vinyl chloride) have been demonstrated to drive unacceptable inhalation risk in indoor air; these low concentrations challenge sampling and state-of-the-art analytical detection methods.
  - Second, the often severe spatial and temporal variability of air-phase VOC concentrations within a building - compounded by potential sources of indoor air bias - makes characterization of accurate and precise average conditions by 'direct' sampling of indoor air difficult.

- Accordingly, at any given site, conclusions or recommendations on indoor air risk and characterization must be technically defensible and based on reasonable and appropriate assumptions. To meet this standard for purposes of the Environmental Indicators, EPA New England recommends:
  - indoor air characterization include an adequate site conceptual model (e.g, nature and extent of groundwater contamination, geology and hydrology, exposure

pathways, extent and nature of man-made subsurface preferential pathways),

- direct sampling of indoor air by Summa® Cannister methods may be appropriately supplemented - occasionally replaced - by a 'toolbox' of direct and/or 'indirect' characterization methods (described below),
- application of a tool is to be scientifically appropriate under the conditions suggested by the site conceptual model, and
- the results of the application of these tool(s) must tend to corroborate the site conceptual model and/or one another in support of proposed indoor air conclusions or recommendations.

- Sampling and analysis tools include, among others: direct indoor air sampling and/or screening, soil vapor sampling/screening, passive diffusion sampling, surface flux measurements, soil and/or groundwater sampling and indoor air modeling. For technical information on:
  - direct indoor air sampling *See* the State of Massachusetts' Draft February 1, 2001 *Indoor Air Sampling and Evaluation Guide*, www.state.ma.us/dep/new.htm; USEPA, *Compendium of Methods for the Determination of Air Pollutants in Indoor Air*, EPA/600/4-90-010; Shigehisa Uchiyama and Shuji Hasegawa, *Investigation of a Long-Term Sampling Period for Monitoring Volatile Organic Compounds in Ambient Air*, Environ. Sci. Technol. 34: 4656-4661 (2000) (an intriguing evaluation of a mass flow-controlled adsorption sampling system for measuring long-term average VOC concentrations in ambient air).
  - soil vapor sampling *See generally*, USEPA, *Soil Vapor Extraction Technology: Reference Handbook*, EPA/540/2-91/003, February 1991. As a general matter, anticipated soil vapor concentrations should be calculated to, among other things, gauge sampling depth, anticipate effects of non-steady state influences (*e.g.*, atmospheric pumping, variations in surface cover form and permeability) and to identify the best sampling and analytical technique(s). Whenever possible, sampling depth should be at least as deep as building foundations. Three-dimensional profiling is recommended.
  - passive diffusion sampling and related technologies *See* Environmental Technology Verification Report, *Soil Gas Sampling Technology*, W.L. Gore & Associates, Inc., GORE-SORBER Screening Survey, EPA/600/R-98/095; Environmental Technology Verification Report, *Soil Gas Sampling Technology*, EMFLUX Soil Gas System. EPA/600/R-98-096. Guidance for passive diffusion sampling for dissolved-phase VOCs in groundwater wells has recently been published in draft form: *see* USGS, Water-Resources Investigation Report, Parts 1 and 2: *User's Guide for Polyethylene-based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells*. Part 1 (USGS WRI report 01-4060) is entitled, "Deployment, Recovery, Data Interpretation, and Quality Control and Assurance." Part 2 (USGS WRI Report 01-4061) is entitled, "Field Tests." This guidance is anticipated to be available soon at the following web sites: www.itrcweb.org and www.frtr.gov.
  - surface flux measurements *See* USEPA, *Procedures for Conducting Air Pathway Analyses for Superfund Activities, Interim Final Documents: Volume 2 - Estimation of Baseline Air Emissions at Superfund Sites*, EPA-450/1-89-002a (NTIS PB90-

270588), August 1990; USEPA, *Measurement of Gaseous Emission Rates from Land Surfaces Using an Emission Isolation Flux Chamber - User's Guide*, EPA 600/8-86-008 (NTIS PB86-223161), February 1986; Bart Eklund, *Practical Guidance for Flux Chamber Measurements of Fugitive Volatile Organic Emission Rates*, J. Air Waste Manage. Assoc. 42:1583-1591 (Dec 1992).

- indoor air modeling *See* Paul C. Johnson, Robert A. Ettinger, *Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings*, Environ. Sci. Technol. 25:1445-1452 (1991). The Johnson-Ettinger model is generally accepted among technical and risk experts as the appropriate model to evaluate vapor intrusion; it may be used in either abbreviated or more complex forms (as conditions warrant) to substantiate in whole, or support in part, indoor air findings and/or recommendations. *See* EPA's Superfund Risk Assessment webpage entitled, *Subsurface Vapor Intrusion into Buildings* at www.epa.gov/superfund/programs/risk/airmodel/johnson_ettinger.htm (series of screening level spreadsheets for site-specific application of the Johnson-Ettinger model (developed by Craig Mann for EPA)).

- Human health risk may be substantiated by site-specific risk calculations or by comparison to appropriate numerical criteria. Specific regulatory provisions, risk assessment procedures or numerical criteria which have been promulgated or are recommended by other Regions or States may help to guide an environmental indicator determination. The States of Massachusetts, Connecticut, Michigan and Colorado have been at the forefront of developing procedures and/or numerical criteria for indoor air. *See generally*, Massachusetts Department of Environmental Protection, *Background Documentation for the Development of the MCP Numerical Standards* (April 1994); Connecticut Department of Environmental Protection, Regulations of Connecticut State Agencies, 22a-133k-1 *et seq.*; Michigan Department of Environmental Quality, *Part 201: Generic Groundwater and Soil Volatilization to Indoor Air Inhalation Criteria Technical Support Document* (Aug. 31, 1998).

- EPA's Indoor Air Workgroup is currently working on developing and consolidating technical guidance and policy on indoor air. This policy may be updated as new information becomes available.

- OSHA PELs--To determine if indoor air is an exposure pathway with unacceptable risk to human health under current industrial use (*i.e.*, under current ownership which operates the facility with full, actively maintained knowledge that releases from current and past operations exist which may contribute to current indoor air concentrations) EPA New England Region will use the lowest value available within Occupational Safety and Health Administration (OSHA) regulations (*i.e.*, Permissible Exposure Levels (PEL) and guidance (*i.e.*, Recommended Exposure Levels set by the National Institute for Occupation Safety and Health and Threshold Limit Values set by the American Conference of Governmental Industrial Hygenists)).

- To account for the added response time which may be necessary to gain control of an

environmental source of air contamination (*e.g.*, solvent releases into shock adsorbent flooring, or sub-floor soils) EPA-New England recommends cutting the OSHA standards and guidance by a factor of 100, thus using 1% of the OSHA levels as the screening level to determine achievement of environmental indicators.

- Remediation of soils cannot be implemented as quickly as repairing a faulty blower or fume hood and provides no recourse to definitively effective controls (such as controlling an operational source by shutting down operations until new equipment can be installed). EPA New England Region anticipates that timely actions triggered at these concentration levels will prevent any exceedences of OSHA standards and guidance from changes in indoor air quality. EPA New England Region expects that the use of OSHA standards and guidance as interim standards will be accompanied by the observance of all OSHA controls with respect to monitoring, training, employee awareness of hazards, etc.

- Please note that EPA New England Region will not use OSHA standards and guidance as a reference point for selecting media cleanup standards for contaminated soils or groundwater. Long-term remediation must achieve standards reflective of the risk assessment protocol followed by the EPA New England Region RCRA Corrective Action Program and which will provide protection of human health and the environment under current and any reasonably foreseeable future use of the facility.

APPENDIX
GUIDANCE DOCUMENTS FOR RCRA CORRECTIVE ACTION

The following is an index of several guidance documents to follow when conducting RCRA Corrective Action. The names of the documents in this appendix are grouped according to the task for which they are designed to provide assistance. The documents on this list are generally applicable to most RCRA Corrective Action facilities. However, there are numerous other guidance documents available for specific technical or policy issues which are not listed below. Such documents may be found through the EPA website at http://www.epa.gov.

Copies of the national EPA guidance documents listed below may be downloaded from EPA's website at http://www.epa.gov/rcraonline or requested through the RCRA Hotline at (800) 424-9346 or (703) 412-9810 or through the National Technical Information Service (NTIS) at 703/487-4650. Some of the EPA risk assessment guidance documents listed below are available from EPA's website at http://www.epa.gov/ORD. EPA New England Region guidance documents or non-EPA guidance documents may be requested from your EPA RCRA Facility Manager. To be placed on the mailing list for EPA New England Region Risk Updates, contact your RCRA Facility Manager.

GENERAL RCRA CORRECTIVE ACTION:

Corrective Action for Solid Waste Management Units (SWMUs) at Hazardous Waste Management Facilities (Subpart S Proposed Rule), Federal Register, Volume 55, No. 145, July 27, 1990, pp. 30798 - 30884. (Note this must be used in light of: *Partial Withdrawal of Rulemaking Proposal*, Federal Register, Volume 64, No. 194, October 7, 1999, pp 54604-54607.)

Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities (Advanced Notice of Proposed Rulemaking for Subpart S), Federal Register, Volume 61, Number 85, May 1, 1996, pp. 19432 - 19464, available through http://www.epa.gov/EPA-WASTE**.** (Note this must be used in light of: *Partial Withdrawal of Rulemaking Proposal*, Federal Register, Volume 64, No. 194, October 7, 1999, pp 54604-54607.**)**

U.S. Environmental Protection Agency, 1994, RCRA Corrective Action Plan, OSWER Directive 9902.3-2A, EPA520-R-94-004, May 1994.

U.S. Environmental Protection Agency, 1999, Documentation of Environmental Indicator Determination, Interim Final February 5, 1999.

FUTURE LAND USE:

U.S. Environmental Protection Agency, 1995, Land Use in the CERCLA Remedy Selection Process, OSWER Publication 9355.7-04, May 25, 1995, PB95-963234.

U.S. Environmental Protection Agency Region I, 1998, Future Land Use Policy for RCRA Corrective Action Sites, memorandum dated June 29, 1998.

Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups, EPA 540-F-00-005, OSWER 9355.0-74FS-P, dated September 2000.

PUBLIC INVOLVEMENT:

U.S. Environmental Protection Agency, 1996, RCRA Public Participation Manual, EPA530-R-96-007, September 1996. available through http://www.epa.gov/epaoswer/hazwaste/permit/pubpart/manual.htm

RCRA FACILITY INVESTIGATION:

U.S. Environmental Protection Agency, 1989, RCRA Interim Facility Investigation Guidance, Interim Final; Volume I: Development of RFI Work Plan and General Considerations for RCRA Facility Investigations; Volume II: Soil, Groundwater, and Subsurface Gas Releases; Volume III: Air and Surface Water Releases; Volume IV: Case Study Examples, OSWER Directive 95-02.00D, EPA 530/SW-89-031, May 1989.

U.S. Environmental Protection Agency, 1992, Characterizing Heterogeneous Wastes: Methods and Recommendations, EPA/600/R-92/033, February 1992.

U.S. Environmental Protection Agency, 1997, Field Analytical and Site Characterization Technologies, Summary of Applications, EPA542/R-97/001, November 1997.

U.S. Environmental Protection Agency, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA SW-846.

Groundwater Investigation:

U.S. Environmental Protection Agency, 1991, *Dense Nonaqueous Phase Liquids--A Workshop Summary,* Ground Water Issue Paper, EPA/540/4-91-002.

U.S. Environmental Protection Agency, 1991, Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells, EPA/600/4-89/034, March, 1991.

U.S. Environmental Protection Agency, 1992, *Dense Nonaqueous Phase Liquids*, Ground Water Issue Paper, EPA/600-R-92/030.

U.S. Environmental Protection Agency, 1992, *Estimating the Potential for Occurrence of DNAPL at Superfund Sites*. Memorandum, OSWER Directive 9355.4-07.

U.S. Environmental Protection Agency, 1992, Handbook of RCRA Ground-Water Monitoring Constituents: Chemical and Physical Properties, EPA/530/R-92/022, September 1992.

U.S. Environmental Protection Agency, 1992, RCRA Groundwater Monitoring Draft Technical Guidance, EPA 530-R-93-001, PB93-139350, November 1992.

U.S. Environmental Protection Agency, 1996, *Ground Water Issue: Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*, Ground Water Issue Paper, EPA/540/S-95/504, April 1996.

U.S. Environmental Protection Agency Region I, 1996, Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells, July 30, 1996.

Quality Assurance:

U.S. Environmental Protection Agency, 1987, OSWER Directive 9335.0-7B, Data Quality Objectives for Remedial Response Activities, EPA/540/G-87/003 & 004, March 1987.

U.S. Environmental Protection Agency, 1998, EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, EPA QA/R-5, External Review Draft Final, October 1998 as implemented in EPA Region I by the:

Region I, EPA-New England Compendium of Quality Assurance Project Plan Guidance, and Attachment A: *Region I, EPA-New England Quality Assurance Project Plan Manual*, Draft, September 1998.

U.S. Environmental Protection Agency Region I, 1996, Data Validation Functional Guidelines for Evaluating Environmental Analyses, December 1996.

RISK ASSESSMENT

Both Human Health and Ecological Risk Assessments:

U.S. Environmental Protection Agency Region I, 1995, Health and Environmental Risk Assessment (HERA) Statement of Work, 'SOW,' for Risk Assessment, August 18, 1995.

U.S. Environmental Protection Agency Region I, Risk Updates (periodic EPA-Region I, New England bulletins which provide current guidance).

Http://www.epa.gov/superfund/programs/risk

http://www.epa.gov/NCEA

Human Health Risk Assessments:

U.S. Environmental Protection Agency, 1989, Air/Superfund National Technical Guidance Study Series, Volumes I, II, III, and IV, EPA 450/1-89-001,002,003,004, July 1989.

U.S. Environmental Protection Agency Region IX Preliminary Remediation Goals at http://www.epa.gov/region09/waste/sfund/prg/index.htm

U.S. Environmental Protection Agency, 1991, Role of the Baseline Risk Assessment in Superfund Remedy Decisions, OSWER Directive 9355.0-30, April 22, 1991.

U.S. Environmental Protection Agency, 1991, Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors," OSWER Directive 9285.6-03, March 25, 1991.

U.S. Environmental Protection Agency, 1992, Calculating the Concentration Term: Supplemental Guidance to RAGS, EPA Publication 9285.7-08I, May 1992.

U.S. Environmental Protection Agency, 1992, Dermal Exposure: Principle and Applications, EPA/600/8-91/011B, January 1992.

U.S. Environmental Protection Agency, 1992, Guidance for Data Useability in Risk Assessment, Part A, EPA Publication 9285.7-09A, April 1992, PB92-963356.

U.S. Environmental Protection Agency, 1992, Guidelines for Exposure Assessment, 57FR22888 - 57FR22938, May 29, 1992.

U.S. Environmental Protection Agency, 1993, Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children, OERR, Publication Number 9285. 7-15-1, PB93-963510.

U.S. Environmental Protection Agency, 1993, Integrated Exposure Uptake Biokinetic Model (IEUBK), Version 0.99d, OERR, Publication Number 9285.7-15-2; PB93-963511.

U.S. Environmental Protection Agency, 1995, *New Policy on Evaluating Health Risks to Children*, Memorandum from Carol M. Browner, Administrator, and Fred Hanson, Deputy Administrator, EPA, October 20, 1995.

U.S. Environmental Protection Agency, 1996, PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures, September 1996.

U.S. Environmental Protection Agency, 1996, Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil EPA Technical Review Workgroup for Lead, December, 1996.

U.S. Environmental Protection Agency, 1996, Soil Screening Guidance: Technical Background Document, OSWER Directive 9355.4-17A, EPA 540/R-96/018, PB96-963502
U.S. Environmental Protection Agency, 1996, Soil Screening Guidance: User's Guide, OSWER Directive 9355.4-23, PB96-963505.

U.S. Environmental Protection Agency, 1997, Exposure Factors Handbook (Vols. I, II, and III), EPA/600/P-95/002Fa, August 1997.

U.S. Environmental Protection Agency, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, (RAGS HHEM).

- (Part A) interim final, EPA 540/1-89/002, December 1989.

- Development of Risk-Based Preliminary Remediation Goals (Part B) EPA Publication 9285.7-01B, December 1991, PB92963333.

- Risk Evaluation of Remedial Alternatives (Part C), EPA Publication 9285.7-01C, December 1991, PB92-963334.

- Standardized Planning, Reporting, and Review of Superfund Risk Assessments (Part D), January 1998, PB9285.7-01D.

Guidelines for:

- Carcinogen Risk Assessment (51 FR 33992, September 24, 1986);
  - Mutagenicity Risk Assessment (51 FR 34006, September 24, 1986);

- The Health Risk Assessment of Chemical Mixtures (51 FR 34014, September 24, 1986); and

- The Health Assessment of Suspect Developmental Toxicants (51 FR 34028, September 24, 1986); and Exposure Assessment (57 FR 22887, 1992).

U.S. Environmental Protection Agency, Health Effects Assessment Summary Tables (HEAST), Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment: Office of Research and Development, Cincinatti, OH (most

current version).

U.S. Environmental Protection Agency, Integrated Risk Information System, (most current version), http://www.epa.gov/iris.

Ecological Risk Assessments:

Calabrese, E.J. and L.A. Baldwin, 1993, Performing Ecological Risk Assessments. Lewis Publishers, Chelsea, MI. 257 pp.

Code of Federal Regulations (CFR), Title 40, Chapter 1, Subchapter D, Part 131, Water Quality Standards. As amended through December 22, 1992, FR 60910.

Jaagumagi, R., 1992, Development of the Ontario Provincial Sediment Quality Guidelines for Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Mercury, Nickel, and Zinc. Water Resources Branch. Ontario Ministry of the Environment.

Jaagumagi, R., 1992, Development of the Ontario Provincial Sediment Quality Guidelines for PCBs and the Organochlorine Pesticides. Water Resources Branch. Ontario Ministry of the Environment

Long, Edward R., Donald D. MacDonald, Sherri L. Smith and Fred D. Calder, 1995, *Incidence of Adverse Biological Efects Within Ranges Of Chemical Concentrations In Marine and Estuarine Sediments*. Environmental Management. 19: 81-97.

Maughan, J. T., 1993, Ecological Assessment of Hazardous Waste Sites. Van Nostrand Reinhold. New York, New York. 352 pp.

Persaud, D., R. Jaagumagi and A. Hayton, 1992, (Revised 1993) *Guidelines For The Protection and Management Of Aquatic Sediment Quality In Ontario*. Water Resources Branch, Ontario Ministry of the Environment.

Rand, G.M. (editor), 1995, Fundamentals of Aquatic Toxicology: Effects, Environmental Fate, and Risk Assessment. Second Edition. Taylor and Francis, Washington, DC. 1125 pp.

Suter, G.W., 1993, Ecological Risk Assessment. Lewis Publishers, Chelsea, MI. 538 pp.

U.S. Environmental Protection Agency,1989. Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual, March 1989, (EPA/540/1-89/001).

U.S. Environmental Protection Agency, 1989, Ecological Assessment of Hazardous Waste Sites, A Field and Laboratory Reference: Environmental Research Laboratory, Corvallis, Oregon, EPA/600/3-89-013

U.S. Environmental Protection Agency, 1992, Risk Assessment Forum, February 1992. Framework for Ecological Risk Assessment (EPA/630/R-92/001).

U.S. Environmental Protection Agency, 1992- , EcoUpdate: Intermittent Bulletins, supplemental guidance to RAGS, Vol. II, EPA Publication 9345.0-05I, Volume 1, Numbers 1, 2, 3, 4, and 5, 1991-1992; Volume 2, Numbers 1, 2, 3, and 4, 1994; Volume 3, Numbers 1 and 2, 1996.

U.S. Environmental Protection Agency, 1993, Wildlife Exposure Factors Handbook, EPA/600/R-93/187a, December 1993.

U.S. Environmental Protection Agency, 1994, Ecological Risk Assessment Issue Papers, Office of Research and Development, EPA/630/R-94/009

U.S. Environmental Protection Agency, 1998, Guidelines for Ecological Risk Assessment. Office of Research and Development, Risk Assessment Forum, Washington, D.C. EPA/630/R-95/002f. May 1998.

U.S. Environmental Protection Agency, 1997, Ecological Risk Assessment Guidance For Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final. Environmental Response Team, Edison New Jersey. June 5, 1997. (EPA540-R-97-006).

ENVIRONMENTAL INDICATORS/ STABILIZATION

U.S. Environmental Protection Agency, Documentation of Environmental Indicator Determination, Interim Final, February 5, 1999.

REMEDIAL TECHNOLOGIES

Information on remedial technologies is available on the following EPA website addresses:

http://www.epa.gov/swertio1
http://www.epa.gov/attic/index.html

MANAGEMENT OF REMEDIATION WASTE

Corrective Action Managment Units and Temporary Units; Corrective Action Provisions Under Subtitle C; Final Rule, Federal Register, Volume 58, No. 29, February 16, 1993, pp. 8658 - 8685.

U.S. Environmental Protection Agency, 1996, Memorandum from Shapiro, Luftig, and Clifford to EPA Regions re: Use of AOC Concept During RCRA Cleanups, (SOC 1996-3 FB 11954) March 13, 1996.

U.S. Environmental Protection Agency, 1998, Management of Remediation Waste Under RCRA (EPA 530-F-98-026) October 1998, available at http://www.epa.gov/osw.

Hazardous Remediation Waste Management Requirements (HWIR-Media); Final Rule, Federal Register, Volume 63, No. 229, February 16, 1993, pp. 65873-65947, also available at http://www.epa.gov/osw.

POST-REMEDIATION SAMPLING

U.S. Environmental Protection Agency, 1989, Methods for Evaluating Attainment of Cleanup Standards Volume 1: Soils and Solid Media (EPA 230/02-89-042) February 1989.