The US Army Center for Health Promotion and Preventive Medicine (USACHPPM) has published the *CSEPP Recovery Sampling and Analysis Plan Protocol for Chemical Warfare Agents Accidents/Incidents, April 2008*. This publication supercedes the final draft released under the same title in January 2008. This protocol is provided as a tool to assist communities with recovery planning and complements the CSEPP Recovery Workbook.

Although this publication is titled final, we welcome comments and suggestions for improvement. If you would like to provide input or if you have any questions, please contact Mr. Ken Mioduski, USACHPPM, at tel: 410-436-5226 or email: kenneth.mioduski@us.army.mil

U.S. Army Center for Health Promotion and Preventive Medicine

USCHPPM

FINAL

CHEMICAL STOCKPILE EMERGENCY PREPAREDNESS PROGRAM
RECOVERY SAMPLING AND ANALYSIS PLAN PROTOCOL FOR CHEMICAL WARFARE AGENTS ACCIDENTS/INCIDENTS

APRIL 2008

Approved for public release; distribution unlimited.

CHPPM FORM 432-E (MCHB-CS-IPD), OCT 03

Readiness Thru Health

U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE

The U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) lineage can be traced back over 50 years to the Army Industrial Hygiene Laboratory. That organization was established at the beginning of World War II and was under the direct jurisdiction of The Army Surgeon General. It was originally located at the Johns Hopkins School of Hygiene and Public Health, with a staff of three and an annual budget not to exceed $3000. Its mission was to conduct occupational health surveys of Army operated industrial plants, arsenals, and depots. These surveys were aimed at identifying and eliminating occupational health hazards within the Department of Defense's (DOD) industrial production base and proved to be beneficial to the Nation's war effort.

Until 1995, it was nationally and internationally known as the U.S. Army Environmental Hygiene Agency or AEHA. Its mission is expanding to support the worldwide preventive medicine programs of the Army, DOD and other Federal Agencies through consultations/ supportive services; investigations and training.

Today, AEHA is redesignated the U.S. Army Center for Health Promotion and Preventive Medicine. Its mission for the future is to provide worldwide technical support for implementing preventive medicine, public health and health promotion/wellness services into all aspects of America's Army and the Army Community anticipating and rapidly responding to operational needs and adaptable to a changing work environment.

The professional disciplines represented at the Center include chemists, physicists, engineers, physicians, optometrists, audiologists, nurses, industrial hygienists, toxicologists, entomologists, and many other as well as sub-specialties within these professions.

The organization's quest has always been one of excellence and continuous quality improvement; and today its vision, to be the nationally recognized Center for Health Promotion and Preventive Medicine, is clearer than ever. To achieve that end, it holds ever fast to its values which are steeped in its rich heritage:

- *Integrity is the foundation*
- *Excellence is the standard*
- *Customer satisfaction is the focus*
- *Its people are the most valued resource*
- *Continuous quality improvement is its pathway*

The organization, which stands on the threshold of even greater challenges and responsibilities, has General Officer leadership. As it moves into the next century, new programs are being added related to health promotion/wellness, soldier fitness and disease surveillance. As always, its mission focus is centered upon the Army Imperatives so that we are trained and ready to enhance the Army's readiness for war and operations other than war.

It is an organization fiercely proud of its history, yet equally excited about the future. It is destined to continue its development as a world-class organization with expanded services to the Army, DOD, other Federal Agencies, the Nation and the World Community.

FINAL

CHEMICAL STOCKPILE EMERGENCY PREPAREDNESS PROGRAM RECOVERY SAMPLING AND ANALYSIS PLAN PROTOCOL FOR CHEMICAL WARFARE AGENTS ACCIDENTS/INCIDENTS

APRIL 2008

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CHAPTER 1 – INTRODUCTION

1-1. **Background.**

a. Initial Planning. Stockpile installations have "likely" Chemical Agent Incident (CAI) scenarios developed as part of their planning requirements listed under the U.S. Army's Chemical Agent Incident and Response and Assistance (CAIRA) Operations (Department of the Army Pamphlet (DA Pam) 50-6). These scenarios are used in CAIRA exercises to evaluate and improve the installations and local emergency response systems overall preparedness in the event of an actual release. Response during an exercise, or an actual event, will consist of two distinct phases: (1) immediate response and (2) recovery and re-entry. During the immediate response, all efforts are focused in determining what happened, the magnitude of the event, containing/controlling the event, and evacuating and administering aid to impacted persons. The second phase of the response, recovery and re-entry, begins once the initial threat has ended and/or has been contained. It is at this time that efforts begin to focus on allowing persons and activities to return to those areas that were identified as being impacted by the release. Areas identified as having been impacted are assessed to ascertain the presence of potential health concerns associated with the released material. In order to support the decision-making process, reliable information regarding potential health concerns resulting from the event must be generated and presented in a manner that demonstrates minimal to no health concerns and that justifies the decision to allow open access to maintain entry restrictions. Reliable information will typically be generated via the collection of various types of environmental samples as detailed within a site-specific Recovery Sampling and Analysis Plan (RSAP). The RSAP provides specific information and rationale regarding the number of samples to collect, the media to be sampled (i.e., soil, water, or air), and the locations from which samples are collected. When implemented, a well written RSAP will provide the technical basis to clear areas for re-entry and identify those potential areas of concern, which will require more detailed evaluations after the recovery and re-entry phase has ended. Due to the significant time and effort involved in developing and implementing an RSAP, it is critical that stockpile sites develop detailed RSAPs prior to a CAI.

b. Rationale. The following chapters of this protocol will discuss the rationale and identify the necessary information requirements of potential sampling strategies, data evaluation strategies, and supporting documentation that either requires preparation in conjunction with or that will be generated during the development and implementation of the RSAP. Each chapter describes certain issues, information, or procedures that should be considered and documented in a site/event-specific plan. Several types of sampling schemes are detailed along with media-specific sampling procedures. Users following the guidance within this protocol will be able to develop a site-specific sampling and analysis plan that with incorporation of incident-specific release information will result in an effective RSAP.

1-2. **Objectives of the Recovery Sampling and Analysis Plan.** The development and implementation of an effective RSAP will be necessary to address health-related and other concerns resulting from the release of chemical agents. Each event and location will have unique and specific challenges. While there is no one specific RSAP that will meet each of these challenges, there are several basic concepts and issues that will be common to all such events.

a. Human Health and Safety. The protection of human health and safety is the primary objective of the entire response for a CAIRA event. During the initial response to an event, efforts are focused on immediate health effects/consequences by minimizing and controlling exposure to chemical agents/degradation products. These efforts include establishing monitoring stations, implementing emergency evacuation and sheltering procedures, and identifying and controlling the release. The recovery and re-entry phase of the event focuses primarily on mid- to long-term exposure to chemical agents via the evaluation of environmental media, buildings and automobiles, and personal items that were potentially exposed to and subsequently contaminated by chemical agents. Once impacted areas/items are identified, remedial and mitigation efforts can be implemented to ensure potential health impacts are minimized and/or eliminated. The RSAP will be used to identify those areas/items that can safely be reentered and reused and those areas that have potentially been impacted by the release. Remedial and mitigation efforts will not be addressed within the context of this document.

b. Adaptability. Whatever plan of action is developed for response to a release, it must be able to utilize new information and intelligence and adapt as the situation develops. As the RSAP is implemented, response personnel will be required to continually reassess the situation and the Data Quality Objectives (DQOs) to: (1) reaffirm the current course of the action or (2) adjust the response strategy in direct response to new intelligence/information and public health concerns. Plans that are inflexible and entrenched within a specific scheme or format will in all likelihood fail.

c. Defensible Data. It is critical that defensible data be generated since the analytical data generated and decision-making process will be scrutinized at some point after all response activities have been concluded. The key to successfully generating defensible data is preparing a thoroughly written RSAP based on project DQOs. Well conceived data quality objectives will facilitate the generation of quality data and will incorporate all stakeholder concerns. Quality data will: (1) simplify the decision making process, (2) support the decision-making process, and (3) demonstrate its validity under extreme scrutiny. Data quality objectives will outline the study objectives, information needs, comparison/data criteria, data evaluation procedures, and decision-making tree. These elements are incorporated and used in the development, implementation, and close out of the RSAP. As such, analytical data generated using the RSAP satisfy stated information needs, utilized sample collection and analytical procedures that meet both quality and decision criteria requirements and be validated following established procedures.

d. Timelines. The expeditious execution of the RSAP: (1) supports the generation of quality data, (2) facilitates the decision-making process, (3) allows the timely return of displaced persons to cleared areas, and (4) increases confidence in the overall sampling process. The stability of chemical warfare agents (CWA) in the environment varies based on the compound in question and the environmental conditions at the time. In some instances, the environmental conditions will serve to facilitate the remedial process by accelerating the degradation of the compound to a less toxic form. Regardless of the stability of the compound and its rate of degradation in the environment, it is essential to demonstrate, as reasonably as possible, that a release did or did not impact a given area. Samples collected sometime after the event may only draw scrutiny with suggestions that sampling was purposely delayed to ensure no chemical agent residues were detected. Sampling conducted in a timely manner may preclude this argument recognizing that environmental conditions may render any sampling event a matter of formality.

e. Consistent and Comparable Data. All samples evaluated during the recovery and re-entry phase will need to use like methods. This will: (1) facilitate the evaluation of data, (2) generate greater confidence in data results, and (3) yield consistent and uniform data. The U.S. Environmental Protection Agency (EPA) has compiled a compendium of analytical procedures for laboratories to use to evaluate environmental samples for a number of media (EPA, 2007). Sites will need to develop or institute specific sample collection and management procedures that will be implemented by the field sampling teams. The ASTM International has also issued a number of standardized procedures specific to sample collection design and techniques (ASTM, 2007) that potential could be referenced for use.. A standardized process ensures that persons performing the procedures complete them in a like manner. In the event of a CAIRA release, a number of resources will likely be brought to the site and used to collect and evaluate environmental samples. As such, all sample collection personnel need to be trained and ready to use the methods described in the RSAP for sample collection, extraction, and analysis. If multiple techniques are used to process CAIRA samples, a myriad of results will be reported that will ultimately complicate data interpretation and, potentially, question the validity of the data.

f. Economic Considerations. Secondary to human health and safety will be the economic and financial implications of a confirmed release. This may occur in two forms: (1) impact to commercial businesses such as field crops, animals, and products derived from such; and (2) claimed damage to personal property such as houses, cars, and personal effects.

(1) *Damage and Loss of Personal Property*. Data collected in support of the re-entry and recovery phase can be used to support and disprove claims asserting damage and loss of personal property. Though the validity of such claims may or may not be an issue, the timely execution of an RSAP with well-defined DQOs will provide evidence supporting/disproving such claims. Damage and property loss concerns should not be the focus of the data collection within the RSAP; rather, human health and safety should be the focus. Analytical data resulting from re-entry sampling should be used in conjunction with physical and visual evidence to demonstrate the potential for properties to be affected. Analytical data collected sometime after an event

and/or not following the procedures delineated within the RSAP will be of minimal use against these claims.

(2) *Commercial Businesses*. A CAI event has the potential to impact a number of commercial activities. Of principle concern would be the impact to agricultural businesses located within the projected plume areas identified for evacuation. This would include produce, field crops, animals, and products derived from each. During the development of the RSAP, consideration will need to be given to assessing significant agricultural activities located within the area. Although field work may indicate that there was no potential for impact to agricultural activities, the stigma associated with chemical weapons may preclude this and still render them "tainted." Stakeholders will need to discuss concerns and issues regarding potentially contaminated agricultural items, specifically the benefits and use in evaluating such items since the stigma may extend beyond the local area. Once it is established how agricultural items will be managed and/or assessed, response resources can be more effectively utilized.

1-3. **Regulatory Implications and Requirements**. In 1988, the Chemical Stockpile Emergency Preparedness Program (CSEPP) was established in response to Public Law 99-145 which directed the Department of Defense (DOD) to destroy the stockpile of CWA. The DOD currently stockpiles CWA at seven U.S. Army installations located throughout the continental United States. With the anticipated increase in CWA activities at the stockpile sites, the CSEPP was initiated to enhance and prepare local community emergency response units for any CWA accident/incident which may occur at these installations. In 1997, CSEPP established the Off Post Monitoring Integrated Product Team (OPMIPT). The OPMIPT's role is to prepare guidance for establishing plans necessary to meet the CSEPP's mission.

a. Regulations Governing Response Activities. Response activities are guided by regulations at different levels of control. Since March 2004, the standard for response activities has been the National Incident Management System. This system is directed by the National Response Plan as the all-hazards approach to incident management. Federal regulations for CAIRA activities are found in the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, Superfund Amendments and Reauthorization Act of 1986 (SARA), Executive Order (EO) 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements, EO 12580, Superfund Implementation, and in the Resource Conservation and Recovery Act (RCRA) as amended by the Hazardous and Solid Waste Amendments of 1984. Worker protection is provided in Hazardous Waste Operations and Emergency Response found in Title 29, Code of Federal Regulations (CFR), Part 1910.120.

(1) *SARA*. SARA Title III and EO 12856 require information sharing and emergency planning between facilities and State and local governments.

(2) *CERCLA*. Under CERCLA, the DOD is authorized to take emergency action under the National Contingency Plan (NCP) to remove and provide remedial action for releases to

protect the public health, welfare, or the environment and is authorized to investigate the extent and source of the release in order to facilitate a response action. The DOD is also responsible under Section 211 of CERCLA to correct environmental damage which creates an imminent threat to public health, welfare, or the environment. CERCLA also provides for the listing of the property on the National Priorities List (NPL). Once listed, the DOD must conduct a remedial investigation/feasibility study (RI/FS) and enter into an agreement concerning the selected remedial actions. The remedial action must be in accordance with the NCP and meet all applicable or relevant and appropriate requirements (ARAR). These criteria are agreed upon between DOD and EPA.

(3) *RCRA*. The RCRA regulations covering releases and response activities require that in the event of a release the DOD would perform an RI, a corrective measure study to address the finding of the RI, amend the RCRA permit to authorize corrective actions, and perform the corrective action. While this process may be more streamlined than CERCLA, the interface between the two regulations will have to be negotiated between the DOD, State regulators, and EPA to ensure all parties are in agreement. Response activities performed under CERCLA or RCRA are a coordinated effort between DOD, State, and EPA authorities. An Interagency Agreement outlines the parties' involvement and actions to be taken by each party. This prevents duplicative effort and a more focused response.

b. Army Requirements. The Army has various regulations that address chemical warfare material management as well as emergency procedures that are enacted in the event of an emergency. The following are some of the documents the Army has prepared for use in such instances.

(1) *AR 385-40, Accident Reporting and Records*. This document describes the process for investigating and reporting accidents. Procedures are outlined specifically for chemical-related incidents.

(2) *AR 360-1, Army Public Relations Program*. This document describes the policies and procedures regarding public affairs and information dissemination as related to chemical agent events.

(3) *AR 50-6, Chemical Surety*. This document describes the CAIRA Operations program. The program is to be used to exercise emergency response to a chemical release, to minimize health and safety threats, as well as to protect the environment and property. The document also describes the process for reporting chemical-related events.

(4) *DA Pam 50-6, Chemical Accident or Incident Response and Assistance (CAIRA) Operations*. This document describes the process for implementing and elements of the CAIRA program.

(5) *AR 385-61, The Army Chemical Agent Safety Program*. This document describes the safety procedures and processes that will be implemented.

(6) *DA Pam 385-61, Toxic Chemical Agent Safety Standards*. The document describes the standards, criteria, and requirements for managing the agent safety program as directed by AR 385-61.

1-4. **References**.

a. American Society for Testing and Materials (ASTM). 2007. http://www.astm.org/cgi-bin/SoftCart.exe/index.shtml?E+mystore

b. Army Regulation 50-6, Chemical Surety, 26 June 2001.

c. Army Regulation 360-1, The Army Public Affairs Program, 15 September 2000.

d. Army Regulation 385-40, Accident Reporting and Records, 1 November 1994.

e. Army Regulation 385-61, The Army Chemical Agent Safety Program, 12 October 2001.

f. Department of the Army Pamphlet 50-6, Chemical Accident or Incident Response and Assistance (CAIRA) Operations, 26 March 2003.

g. Department of the Army Pamphlet 385-61, Toxic Chemical Agent Safety Standards, 27 March 2002.

h. Executive Order 12580, Superfund Implementation, 23 January 1987.

i. Executive Order 12856, Federal Compliance With Right-to-Know Laws and Pollution Prevention Requirements, 3 August 1993.

j. Public Law 94-580, Resource Conservation and Recovery Act (RCRA), 21 October 1980.

k. Public Law 99-145, Department of Defense Authorization Act, 1986.

l. Title 29, Code of Federal Regulations (CFR), Part 1910.120, Hazardous Waste Operations and Emergency Response.

m. Title 42, U.S. Code, Chapter 103, Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 1980.

n. Title 42, U.S. Code, Superfund Amendments and Authorization Act, amendment to CERCLA, Public Law 99-499.1986.

o. U.S. Environmental Protection Agency. 2007. *Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events*. Office of Research and Development, National Homeland Security Research Center. Revision 3.0. http://www.epa.gov/NHSRC/pubs/reportSAM030107.pdf

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CHAPTER 2 – NECESSARY COMPONENTS

2-1. **General.** The three concepts that will be critical and integral to the development of the RSAP will be the incorporation, use and understanding of the DQO process, the National Incident Management System (NIMS), and the Triad process. Therefore, the involvement of all stakeholders is critical to the development of the RSAP. In addition, the DQO process requires involvement and input from all stakeholders. The output of this process is a comprehensive plan that all stakeholders had a part in developing. The Triad approach or process allows for real-time decisions to be made using real-time data. The response to any release by its very nature will require expedited answers and solutions. Relying on the traditional means for evaluating a hazardous material release would potentially take months if not years to complete due to the articulated procedures that would be followed. An RSAP could be developed without addressing the above three concepts. However, by addressing these concepts, the DQO process will result in a greater buy-in from all stakeholders to the RSAP as well as to the data resulting from its implementation. Timely data will be generated using methods and procedures identified and/or developed based on project needs. Personnel developing the RSAP will understand their roles and how the RSAP will be implemented under an NIMS response. The following three paragraphs will detail the DQO process, concepts of the Triad approach, and detail how the plan may be implemented under a NIMS response.

2-2. **Data Quality Objective Process**. A DQO is a systematic planning process involving a series of logical and iterative steps used in planning a resource-effective collection of data necessary for making decisions that are scientifically and legally defensible. In using the DQO process, the Planning Team will clarify all study objectives and establish logic for data collection and decision making. The process also establishes performance and acceptance criteria that will serve as the basis for collecting data of sufficient quality and quantity to support decisions. Proper development and implementation of the DQO process is critical to fully defining and understanding project objectives. A well implemented DQO process will develop the framework for a comprehensive RSAP that provides for an optimum resource-efficient sampling design necessary for gathering defensible data to achieve project objectives. It also provides a means of communication and interaction amongst the technical experts, regulators, and stakeholders leading to a more clear understanding of the potential obstacles in meeting specific objectives. Incorporating the DQO process will expose potential vulnerabilities, data gaps, or issues (e.g., technical, philosophical, or budgetary) that are not otherwise transparent prior to developing or implementing the RSAP. Failure to utilize the DQO process in some capacity could substantially increase the misuse of resources, collection of unessential information, or generate insufficient quantities or quality of data that may result in the inability to ascertain whether areas are clear for re-entry.

a. Seven-Step DQO Process. Implementation of the DQO process involves developing and identifying—

(1) Clearly defined goals and objectives.

(2) Decision statements that clearly define the boundary between one outcome of the decision process along with alternative actions.

(3) Informational inputs necessary to resolve the decision statements (e.g., risk-based or technology-based criteria/action levels).

(4) Spatial and temporal boundaries, constraints, and a scale of decision making.

(5) Decision rules (i.e., condition statements).

(6) Performance and acceptance criteria for making decisions.

(7) Optimal resource and cost-effective sampling plan design.

The initial DQO steps set the foundation for developing the most resource-effective data collection and sampling design to achieve the investigation objectives. It helps facilitate the consensus and buy-in with all stakeholders, regulators, local officials, and project planners as to how data will be collected, analyzed, and measured before a release ever occurs.

b. Application of the DQO Process. The DQO process is a sequence of logical steps that fully address the sampling rationale, decision criteria, and approaches in selecting an appropriate sampling design. The DQO process assists in determining sample types, quantity of samples to be collected, and the quality of environmental data necessary for making decisions that are technically and legally defensible.

(1) *DQO Step 1 – State the Problem*. Step one of the DQO should establish a concise description of the problem; a conceptual site model (CSM) of the incident to be investigated along with a preliminary functional description of the potential pathways for source – receptor interactions (i.e., human or ecological); a defined list of stakeholders, regulators, and multidisciplinary experts that makeup the Planning Team and decision makers; and a summary of available resources, constraints, and timelines. An investigation for a CAI must determine whether or not a release has occurred, and if so, whether it poses an unacceptable risk to human health or the environment. The CSM for investigating and evaluating a CAI will identify all potential agent or agent by-product exposure scenarios that may pose an unacceptable risk to human health or the environment.

(2) *DQO Step 2 – Identify the Goals of the Study*. The decision statement is based on the determination of whether or not further action is required due to an unacceptable agent exposure. In order to reach that decision, the Project Team must identify the principal study question(s) to be answered and the alternative actions that may be taken based upon the possible outcomes from answering these questions.

(a) Study Question(s). The principal study question(s) must be clearly written and stated as specifically as possible because it will influence how all decisions and strategies progress from that point forward. Having principal study questions that are detailed and straight forward reduces the chance for misinterpretation between stakeholders, decision makers, and planners. It also eliminates assumptions that can potentially impact the cost of conducting the investigation, result in incorrect decisions, or impact the confidence in which decisions are made. The following are examples of generic study questions that could be addressed for a CAI, assuming a release had occurred.

- *Have chemical agents or breakdown components been detected in any of the samples collected within Clearance Zone X?*
- *Have chemical agents or breakdown components been detected at concentrations greater than the decision criteria?*
- *Have chemical agents or breakdown components been detected in surface soils samples?*
- *Do any concentrations of chemical agent or breakdown components in soil samples exceed the decision criteria?*

Multiple study questions will be necessary to account for various sample media or to further assess potential exposure areas. Study questions for individual sample media should always be addressed separately since each medium possess unique sample characteristics, variability, migration pathways, exposure routes, and sampling and analytical methodologies.

(b) Alternate Actions. There can be multiple alternative actions for an investigation study question. Alternative actions that may result from the conclusion or outcome of conducting sampling on potential migration and/or release pathways should be identified. The two likely actions could be:

- *Recommend area be cleared for re-entry (no further assessment required).*
- *Recommend further investigation be conducted to determine necessary recovery efforts or delineate potential human and/or ecological exposure.*

(c) Decision Rule(s). Decision rules will be developed and comprised of the principal study questions along with associated alternative actions. Due to the complexity of a CAI, there will be multiple study questions that should be organized in a sequential and logical manner (i.e., decision tree). Examples of a decision rule are:

- *If agent or agent breakdown components in surface wipe samples of-site are detected, further investigation should be performed to delineate potential human and/or ecological exposure. Otherwise, recommend no further assessment.*

- *If agent or agent breakdown component concentrations detected in surface soils offsite exceed risk-based or technology-based screening criteria, further investigation should be performed to determine necessary recovery efforts. Otherwise, area is cleared for re-entry.*

(3) *DQO Step 3 – Identify Information Inputs*.

(a) Information Needed for Making Decision(s). All of the information that is essential for making decisions must be clearly identified prior to the RSAP development. A measurement of agent or agent by-product concentrations in all sample media must be made from each of the delineated areas (i.e., exposure units) that have been identified in the CSM as having a potential source-receptor interaction. Action levels for making decisions must be established. A determination will need to be made as to whether risk-based or technology-based criteria/action levels are to be used for each agent or agent by-product. More importantly, selection of approved analytical methodologies that can detect the presence of agent or quantify agent concentrations at or below some criteria/action level must be established and accepted by all stakeholders.

(b) Additional Inputs. Additional inputs necessary to resolve decision rules will require the full understanding of the physical/chemical properties and the environmental persistence (i.e., fate and transport) and degradation characteristics for each agent and agent by-product in ambient conditions. It is also essential that potential matrix interferences that could affect data quality assurance (QA) and quality control (QC) measures be identified from previous datasets, so that planners are aware of the variables that may affect the performance and acceptance criteria.

(c) Sources of Information. The presence or concentration of agent or agent by-products within a delineated area will be determined by the collection and analysis of sample media. Proven field and laboratory analytical methodologies to be used in quantifying the presence of agent and agent by-products at or below a screening criteria or action level must be identified for each agent and agent by-product. Physical and chemical characteristics of chemical agents and its agent by-products within ambient conditions may be obtained from published literature.

(4) *DQO Step 4 – Define the Boundaries of the Study*.

(a) Target Population of Interest. Target populations for a recovery and re-entry investigation will likely focus on sampling multiple environmental media (i.e., surface soils, surface water, and air) or exterior and interior structural media (i.e., walls, windows, and floors). The investigation should assess each media that poses a risk for agent exposure to human and/or ecological receptors. A target population must take into consideration the CSM which defines the exposure pathways. All potential pathways must include a source, exposure medium, exposure routes (i.e., ingestion, inhalation, and dermal contact), and receptor. Potential pathways should also include any release mechanism and transport medium. If the CSM depicts no source pathway interaction for a particular medium, then there can be no exposure potential, and should be of no further concern.

(b) Define Spatial and Temporal Boundaries. The boundaries (i.e., spatial and temporal) for target populations must be identified. Spatial boundaries will include surface or geographical areas where exposure medium are present and sample media are to be collected, whereas temporal boundaries represent a time period being investigated or period in which sample data must be collected. This holds true when target populations may be exposed to varying concentrations of agent due to the rates of agent or exposure durations. Areas that have been identified through the CSM as having a potential for agent exposure or agent presence should be evaluated. The specific surface area or geographic boundary of a given area will be established based on site-specific conditions and should be clearly defined on site-specific maps.

(c) Practical Constraints on Collecting Data. Constraints that may impede or dictate the performance of data collection and evaluation must be identified. Such constraints may include site accessibility, weather, qualified manpower, and sample management (i.e., preservation, holding times, or shipping and handling). This may also include limitations with analytical capabilities. The technical capabilities of analytical procedures may not be able to achieve or meet established decision criteria. In such an event, stakeholders will need to determine how to proceed. That being, can existing procedures be modified to produce reliable/defensible data? Or will the decision criteria need to be adjusted to current technological capabilities? To successfully resolve this, time versus cost versus risk will need to be balanced in some manner.

(d) Scale of Decision Making. The scale of decision making is the smallest unit of area, volume, or time over which data will be collected, analyzed, and summarized for making re-entry decisions. The scale of decision making for the recovery and re-entry evaluation may be a defined or delineated area (i.e., sample grid) where there is a suspected presence of agent or agent by-product. A scale of decision for the presence or absence of agent or agent by-products within a large unpopulated area is to be much larger than that used for a scale of decision for a residential property, area within the facility fenceline, or a structural surface.

(5) *DQO Step 5 – Select an Analytical Approach*.

(a) Appropriate Population Parameter. A statistical parameter of interest is generally selected for the potential exposure area and is a descriptive measure (e.g., a mean, proportion, percentile, or maximum) that represents the characteristics or attributes of the sample population (i.e., strata or sample grid) that will be compared to a reference or risk screening criteria for making decisions. However, for a CAI, the population parameter could potentially be the single detection of chemical agent or agent by-product.

(b) Choosing an Action Level. As discussed earlier, a health- or technology-based action level should be selected for each parameter of concern. The action levels selected ultimately will be used to clear areas for re-entry. These levels will be the basis for selecting (or developing) analytical procedures to be used for assessing environmental samples and will feed into developing the decision rules when evaluating the data.

(c) Decision Rule(s) (If…Then…Statements). The decision rules are an integration of outputs from DQO Steps 2, 3, and 4 that are formed into single statements that describe the logic for choosing among alternative actions. The decision rules will generally take the form of "if…then" statements that contain two essential elements (i.e., condition and action). A series of sequential decision rules are provided below as an example.

- *If a detectable concentration of agent or agent by-product in surface soils are reported, then the delineated area will be concluded as having been impacted by a chemical agent release; otherwise, no further assessment is necessary.*

- *If a delineated area is concluded as having been impacted by a chemical agent release above the risk-based screening criteria, then conduct further investigations to determine necessary recovery efforts; otherwise, the area may be cleared for re-entry.*

(d) Specification of Estimator. This element of Step 5 defines the populations that will be measured to develop an estimate of some parameter that will not be used to make a decision. In this incidence, the only data that may be collected that will not impact a clearance decision are data related to biological samples and animal health/plant surveys. Data from these samples and surveys will only be used to ascertain physiological distress/impacts that may suggest chemical agent exposure and possible treatment options. Environmental samples (i.e., air or soil bulk) will be used to determine the presence of chemical agents for the purpose of clearing zones for re-entry.

(6) *DQO Step 6 – Specify Performance or Acceptance Criteria*. In DQO Step 6, the planner must establish a level of acceptable tolerance of uncertainty in making an incorrect decision using the limited amount of data collected from a delineated area. The planner must weigh the consequences of falsely accepting or falsely rejecting a presumed baseline condition. Decision errors will exist because sample data are subject to different variability incurred through the collection and analysis of samples. The heterogeneity and natural variability of sample media combined with the inherent variability of sample collection and sample analysis create a measure of total study error (Table 2-1) that directly affects the potential for making decision errors. The possibility of making a decision error cannot be eliminated, although it can be minimized and controlled through the use of hypothesis testing. With hypothesis testing, the sample data are used in choosing between a presumed baseline condition and an alternative condition. The burden-of-proof is placed on rejecting the presumed baseline condition, because the test-of-hypothesis maintains that the baseline is true until overwhelming evidence is presented to indicate that the baseline condition is not true (EPA, 2006).

Table 2-1. Total Study Error (Total Variability).

Statistical Sampling Error (Field Variability)		**Measurement Error (Measurement Variability)**	
Inherent Variability	o Stratification o Homogenization	Physical Sample Collection	o Support Volume/mass o Sample Delineation o Sample Extraction
Sampling Design	o Sampling Frame Selection o Sampling Unit Definition o Selection Probabilities o Number of Samples	Sample Handling	o Preservation o Packaging o Labeling o Transport o Storage
		Analysis	o Preparation o Sub-sampling o Sample Extraction o Analytical Determination

Note: EPA QA/G-4, EPA/600/R-96/055, (EPA, 2000)

(a) Null Hypothesis. The burden-of-proof should be placed on rejecting the null hypothesis (i.e., baseline condition), because the test-of-hypothesis structure maintains the baseline condition as being true until overwhelming evidence is presented to indicate that the baseline is not true. The following is an example of…

Acceptance of the null hypothesis for CAI assumes that agent or agent by-products are present and may pose risk to human and/or ecological receptors. This will also prohibit site re-entry until further sampling and analysis can be performed. Whereas, rejection of the null hypothesis

assumes that chemical agent or its by-products are not present. Re-entry to the site (i.e., exposure unit) does not pose risk to human and/or ecological receptors.

(b) Consequences of Making an Incorrect Decision. Due to the uncertainties that result from sampling variation, decisions made using the hypothesis tests will be subject to errors. There are two types of decision errors: Type I (False Rejection) and Type II (False Acceptance). Each of these has different consequences based on the null hypothesis. A false rejection error occurs when the sample data lead you to believe the null hypothesis (baseline condition) is false, when in reality it is true. The false acceptance error occurs when the sample data are insufficient to change your assumption that the null-hypothesis is true, when in reality it is false. Examples of possible decision errors and consequences are:

(7) *DQO Step 6A – Specify Probability Limits for False Rejection and False Acceptance.*

- ***Type I or False Rejection (α)*** *- data results conclude that there is not a detectable presence of agent or agent by-products when in reality there is a detectable presence of agent or agent by-products. Consequences would result in potential human and/or ecological receptor exposure to agent or agent by-products. False rejection of the hypothesis is the more severe error type and could result in the potential exposure of agent or agent by-products if re-entry is allowed.*

- ***Type II or False Acceptance (β)*** *– data results conclude that there is a presence of agent or agent by-products when in reality there is no agent or agent by-product present. Consequences would result in further assessment and delay the re-entry into the area. (This is the less severe error in terms of human and ecological impact).*

(8) *DQO Step 6B – Specify Performance Metrics and Acceptable Levels of Uncertainty.*

(a) Range of Values Where Consequences Are Minor (Gray Region). The "gray region" is the range data values (i.e., sample concentrations) close to the action level where the data tend toward rejecting the null hypothesis, but the weight of evidence/data statistics is not sufficient enough to be overwhelming. The width of the gray region (Δ), sometimes termed as the "minimum detectable difference," controls the confidence in which decisions can be made based on data collected from the site. Gaining confidence in decision making or decreasing the chances of making false acceptance decision errors is controlled by the width of the gray region (i.e., area of uncertainty). Narrowing the area of uncertainty and reducing the chances of making the wrong decision can be done by increasing the sample size. However, the planner must weigh the potential consequences and severity of making the wrong decision with the feasibility of controlling the false acceptance decision errors (or false rejection decision errors) with the cost of additional sampling and analysis.

(b) Tolerable Limits on Decision Error Probabilities. One of the more difficult decisions will be establishing a tolerance for uncertainty and risk that can be assumed for making incorrect decisions. The consequences of both false rejection and false acceptance decision errors are generally not equally weighted and must be carefully balanced by the planner and all stakeholders. This is due to the severity of consequences in making a false rejection that would result in the potential agent exposure to human and/or ecological receptors or a false acceptance error that would result in expenditure of resources for conducting additional sampling and analysis and the delay of re-entry. Guidance in determining decision error limits for environmental data may be found in EPA's Guidance on Systematic Planning Using Data Quality Objectives Process (EPA, 2006).

(9) *DQO Step 7 – Develop Plan for Obtaining Data.*

(a) A review of the DQO performance criteria, established in Steps 1 thru 6, should be conducted so that a sample design for the collection and analysis of data can be developed. The design should be one that collects data that are representative of the site so that a defensible decision can be made about the delineated area as a single exposure unit. The optimal sample design will be one that is logistically practical, cost-effective, and can reasonably satisfy the decision criteria. There may be a need to adjust the DQO performance criteria or vary sampling strategies to develop the optimal sample design.

(b) There are two strategies (probabilistic and nonprobabilistic) that could be employed in conducting sampling. Each of these strategies has its own advantages and disadvantages (Table 2-2). Considerations for selecting the appropriate strategy take into account the feasibility of collecting samples, sample measurement performance criteria, and the complexity in the development and implementation of the sampling and analytical designs.

- ***Probabilistic*** *- A probabilistic sampling strategy must be considered when statistical inferences, having some degree of confidence and power, need to be made about a delineated area as a single exposure unit. This strategy makes use of randomization and allows for statements of probability to be made using sample data.*

- ***Nonprobabilistic*** *- A nonprobabilistic approach can be used but is considered an authoritative sampling design that does not allow for statistical conclusions to be made, but only qualitative inferences based on professional judgment. The major disadvantage to this strategy is that it does not maintain any statistical scientific theory. This methodology is highly dependent on the knowledge of the planner, and the validity of sample data that is used for decision-making is not defensible. Although valid data can be collected using this strategy, it is not recommended to make quantitative interpretations of data when the concentrations are near the action levels. However, strong qualitative decisions can be made when concentrations are outside the gray region.*

Table 2-2. Advantages and Disadvantages of Probabilistic and Nonprobabilistic Strategies.

	Probability-based	Authoritative
Advantages	o Provides ability to calculate uncertainty associated with estimates o Provides reproducible results within uncertainty limits o Provides ability to make statistical inferences o Can handle decision error criteria	o Can be less expensive than probabilistic designs. Can be very efficient with knowledge of the site. o Easy to implement
Disadvantages	o Random locations may be difficult to locate o An optional design depends on an accurate conceptual model	o Depends upon expert knowledge o Cannot reliably evaluate precision of estimates o Depends on personal judgment to interpret data relative to study objectives

Note: EPA-QA/G-5S, EPA/240/R-02/005, (EPA, 2002b).

The collection of samples can be conducted using one or a combination of sampling designs and methodologies. Greater detail about alternative sample designs and how they may be applied can be found in EPA sampling design guidance documents (EPA 1989, 1995, 2002a, and 2002b).

2-3. **Triad Approach**. The Triad approach used for evaluating or conducting an environmental investigation works on three basic principles: 1) Systematic Planning; 2) Dynamic Work Strategies; and 3) Real-Time Measurement Technologies (Crumbling, et al., 2003 and Interstate Technology & Regulatory Council (ITRC), 2003). These three concepts are necessary for an effective RSAP. Traditional site investigations involved the development plans for approval, the collection and evaluation of all samples, and the preparation of a final report delineating the path forward (i.e., no further action or more samples), with this cycle potentially repeating itself over the course of several years. The keys to an effective RSAP using the Triad approach are communication and involvement, the use of field analytical technologies, incorporation of field reports into response efforts, strong QA/QC (by utilizing standardized procedures, sound data validation processes, and use of a tiered review process), and use of a decision making strategy that will clear areas for re-entry in a sequential manner without having to wait for the collection of every sample that is identified within the RSAP. The following elements describe the Triad approach.

a. Systematic Planning. Systematic planning involves developing clear and consistent project objectives and strategies that will facilitate the generation of relevant, defensible data and decisions. The plans, criteria, CSM and decisions trees that are developed during and from the DQO process are essential for supporting the decision-making process and effectively evaluating

data generated during an event. The key to this process is communication and involvement. The need for effective planning will be most evident during an event when events do not occur without a hitch (i.e., field reports indicate potential contamination outside the model predictions, analytical data QA/QC results are dubious, and sampling teams are found using nonapproved methods). Effective planning will delineate the scope of the response effort and dictate that deviations from the RSAP be evaluated on an individual basis and incorporated into the overall response based on its relevance to the overall effort. Without effective planning, there is strong likelihood that the deviations to the RSAP will be made without consideration to the overall objectives resulting in resources being used in a detrimental manner. While intentions may have been good, the resulting additional work may or will not contribute to meeting the overall objective.

b. Dynamic Work Strategies. Dynamic work strategies allow for the RSAP to adopt and evolve as the event unfolds. During an event, real-time measurements, field reports, and situation updates will be received on a daily if not hourly basis. This information will be used to plan and prioritize sampling activities. Unforeseen events or issues may arise that will necessitate changes or reprioritization to the RSAP work plan/schedule. These events may complicate the response effort and possibly expand upon the level of effort required to assess or clear an area for re-entry. Conversely, the event may be determined to be significantly less complex than initially predicted, thus reducing the overall response that is required. In either event, the process by which the RSAP evolves, to include additional areas that require investigation or for drawing down sampling activities at an accelerated pace, must be a delineated process that has buy-in from all involved persons.

c. Real-Time Data. Real-time data allows for real-time decisions and is obtained by utilizing procedures, techniques, and methods that facilitate the collection and processing of samples in an expedited fashion. When developing the RSAP, there are five areas that should be evaluated for expediting the process: sample collection, sample management, analytical procedures, supporting laboratories, and data review.

(1) *Sample Collection*. To ensure timely collection of samples, a sufficient number of sample collection teams will need to be employed. The number to use will be based on three factors: the number of samples in which a team can collect in 1 day, the total number of samples to be collected, and the timeframe necessary to complete all sampling. The total number of samples collected can be projected based on the most likely scenario and the final sampling scheme that is selected. The number of samples collected in 1 day will be based on estimates provided by the sampling teams based on the media that are expected to be collected. The completion timeframe will be established by the stakeholders.

(2) *Sample Management*. Sample management begins from the time the sample is collected until it is received by the analytical laboratory. In developing the RSAP and implementing it under NIMS, it will be necessary to allot a sufficient number of personnel and

resources in the field for the management of environmental samples. This is crucial for ensuring that samples are organized, packed, and shipped to the laboratories in the most efficient manner.

(3) *Analytical Procedures*. The selection of analytical procedures will be based both on their ability to provide rapid, reliable results along with their ability to satisfy the decision criteria. Screening procedures that cannot be reliably confirmed in any manner should not be used.

(4) *Supporting Laboratories*. Field, mobile and fixed laboratories may all be potentially utilized. The number and capacity of each type will need to be determined to ensure each laboratory is capable of processing expected sample loads.

(5) *Data Review*. The data review process will need to be structured to facilitate a rapid review. This will entail staffing a sufficient number of the appropriate persons in each tier of the review. This will also include establishing the methods that will be used to transmit the final data reports from the field/mobile/fixed laboratories back to the operations area.

2-4. **National Incident Management System**. The NIMS will be part of any future response effort that occurs. NIMS is a process that facilitates the response effort among multiple government jurisdictions (i.e., Federal, State, tribal, and local agencies), non-government organizations, and the private sector by ensuring all parties involved in any way in the effort understand and know their role. In doing so, the resources brought to a response, be that persons, equipment, or money are used more effectively and efficiently.

a. Background. Homeland Security Presidential Directive-5 requires all Federal departments and agencies to adopt the NIMS. NIMS provides a standardized framework for all-discipline and all-hazard incidents that cross jurisdictional boundaries (DHS, 2004). The major components of NIMS are:

- Command and Management
- Preparedness
- Resource Management
- Communications and Information Management
- Supporting Technologies
- Ongoing Management and Maintenance

The Command and Management component provides two structures for incident management. The Incident Command System (ICS) is the on-scene management system. The Multiagency Coordination System is the coordination of multiagency resources into the ICS framework to support the incident response. The NIMS also requires preparedness in advance of an incident and continuous review of the NIMS and preparedness plans.

b. Incident Action Plan. A key feature of NIMS is the use of the Incident Action Plan (IAP). The IAP contains the overall incident objectives and activities required to support those objectives for a set period of time. In the initial stages of an incident, incremental objectives and activities will be typically developed for 12-hour intervals. Accomplishments, requirements, and resources needed are documented and provided back for planning for the next operational phase. The next operational phase timelines can be increased into 24-hour increments once the initial phase of the response effort is fully coordinated and in place. Persons implementing the RSAP will be required to provide daily objectives, accomplishments, and resource requirements to the Incident Commander (IC) as part of the IAP.

c. Command Structure. There are several command structures available within the ICS depending on the size of the incident and the number of responding agencies. Figure 2-1 is the standard local jurisdiction structure. Several agencies within a jurisdiction may respond to an incident, such as fire, emergency medical services, and public works. This structure has the ability to expand and contract based on the size and type of incident being addressed. For example, the Information and Intelligence Officer may only be necessary if the incident has been determined to be a crime scene and law enforcement officials are gathering evidence and information regarding the scene or suspects.

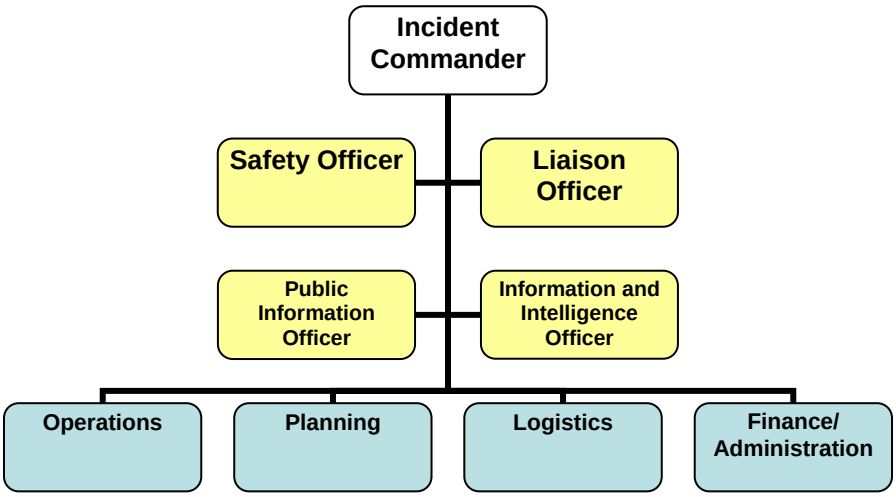

Figure 2-1. Incident Command System Structure.

(1) *Unified Command (UC)*. For incidents that cross political jurisdictional boundaries, another layer of command is added to the current structure. The Unified Command Structure (Figure 2-2) is designed to bring all levels of support into the planning and decision-making

process. Both structures allow for flexibility of response and provide unity of command. In the event of a CAI, it is likely that a UC will be implemented.

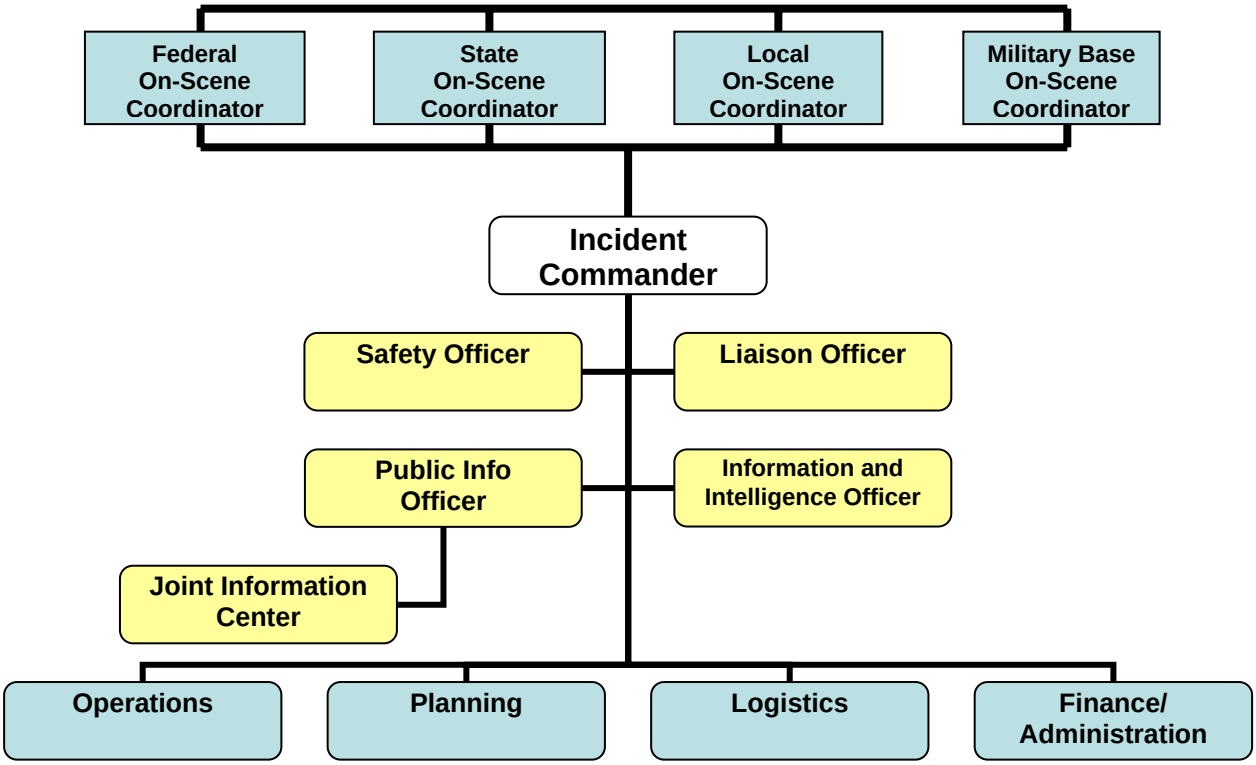

Figure 2-2. Unified Command Structure.

(2) *Command Staff*.

(a) Incident Commander/Unified Command. The IC/UC is responsible for the overall leadership of the incident response. They establish the incident objectives for the IAP, the necessary staff and structure of the ICS, and are responsible for all activities and functions until they are delegated to appropriate staff. The IC/UC is also responsible for coordinating with other responding agencies and the release of information to external and internal stakeholders.

(b) Safety Officer. The safety officer advises the IC/UC to ensure safety at the incident. This includes the responders and the public.

(3) *General Staff*. Recovery and re-entry objectives will be identified in the IAP. The Operations, Planning, and Logistics Sections of the command staff will coordinate the tasks necessary to achieve the IAP objectives. The Planning Section members who will be responsible

for determining the decision criteria should be composed of persons representing each of the major stakeholders to include: Federal/State environmental, State/local health, installation environmental, and other DOD components. Organizations that choose not to participate in the planning process should designate a proxy to represent their interests.

(a) Operations Section. The Operations Section directs and coordinates all tactical operations and develops the strategy to achieve the incident objectives that are identified in the IAP. The Operations Section will perform the actual field work and coordinate with the IC and the Logistics and Planning sections to provide input to the next IAP phase.

(b) Planning Section. The Planning Section maintains the situation status, develops the IAP, maintains resource status, and prepares the demobilization plan. The Planning Section Chief manages the planning process. The Planning Section will have the responsibility to develop the DQOs, the RSAP, and the site safety and health plan. The plans will outline sample collection efforts and data requirements necessary to achieve the recovery and re-entry objectives.

(c) Logistics Section. The Logistics Section is responsible for communications, medical and food support for incident responders, supplies, and facilities. The Logistics Section Chief contracts for goods and services needed at the incident and coordinates with the Planning Section. The Logistics Section will receive requests for sample supplies and sample collection teams. These requests will be processed based on the availability of resources. The Logistics Section will also be responsible for the receipt, storage, packing, and shipment of samples to laboratories designated for sample receipt.

(d) Finance/Administration Section. The Finance/Administration Section manages the timekeeping, cost analysis, contract negotiation, and monitoring and compensation claims. The Finance/Administration Section Chief works with the Logistics Section to ensure resources are obtained.

d. Training. All persons expected to be mobilized in response to a CAI will be required to demonstrate that they have been properly trained in NIMS for the purpose of understanding the NIMS system and their role in the process. These training courses are offered both on-line and in classroom format. There are three ICS courses that will need to be completed, two of which are required for all responders. The last two courses are more applicable to persons that will be tasked as a supervisor. Course descriptions are provided below (Federal Emergency Management Agency (FEMA), 2007a and 2007b).

(1) *ICS-100 Introduction to the Incident Command System*. The ICS 100 provides an introduction to the ICS and outlines the foundation for higher level ICS training. This course describes the history, features and principles, and organizational structure of the ICS. It also explains the relationship between ICS and the NIMS.

(2) *IS-700 National Incident Management System, an Introduction*. This course is an introduction to NIMS. It explains the purpose, principles, key components, and benefits of NIMS with the intention that each person learning/understanding the following:

(a) Identify the benefits of using ICS as the national incident management tool.

(b) Describe the key concepts and principles underlying NIMS.

(c) Describe when it is appropriate to institute an Area Command.

(d) Describe when it is appropriate to institute a Multiagency Coordination System.

(e) Describe the benefits of using a Joint Information System (JIS) for public information.

(f) Identify the ways in which NIMS affects preparedness.

(g) Describe how NIMS affects how resources are managed.

(h) Describe the advantages of common communication and information management systems.

(i) Explain how NIMS influences technology and technology systems.

(j) Describe the purpose of the NIMS Integration Center.

(3) *ICS-200 ICS for Single Resources and Initial Action Incidents*. ICS-200 is designed to enable personnel to operate efficiently during an incident or event within the ICS. The ICS-200 provides training on and resources for personnel who are likely to assume a supervisory position within the ICS.

(4) *ICS-300 Intermediate ICS for Expanding Incidents*. This course should only be taken by persons expecting to be designated as a mid-level supervisor within the NIMS framework. The course is designed to provide additional insight on NIMS Command and Management beyond what was described in ISC-100 and -200. The course will describe the development of the IAP.

(5) *FEMA IS-800A National Response Plan, an Introduction*. This course should only be taken by persons expecting to be designated as a mid-level supervisor within the NIMS framework. The course details how the Federal Government and DOD will interact with State and local governments in the event of an emergency.

e. Standing Operating Procedures (SOPs). All personnel designated to support sampling activities must be trained and familiar with the standardized sampling procedures and equipment that are to be used in response to a CAI. Ideally, all personnel supporting the response will be using similar resources (e.g., equipment and procedures). Otherwise, teams will need to be trained onsite which will likely result in response delays. Currently, the EPA Headquarters (HQ) is moving forward with the development of standardized procedures for the collection and analysis of chemical agents and resulting degradation products. It is unknown whether these new procedures will be mandated or recommended. In either case, EPA regions may not accept data generated from any methods which do not have any data to support their validity and ruggedness. Hence, by default, the EPA methods under development may be required. The EPA methods currently under development can be found at http://www.epa.gov/NHSRC/pubs/reportSAM030107.pdf.

f. Asset Management. Critical to operating under NIMS will be the management of resources –those that are available and those that are required inclusive of supplies and personnel. Properly trained personnel will be assigned to areas best suited for the skills and knowledge they possess. Because the sampling teams may consist of individuals who are unfamiliar with one another, it is essential that all training be completed from an NIMS/ICS perspective and from the perspective of executing the RSAP.

g. Teams. The Operations Section will need to be cognizant of the number of sampling teams needed to effectively implement the plan versus how many teams are available. Coupled with availability will be the need to determine how best to utilize the teams on hand with respect to work shifts, rest periods, equipment/vehicle breakdown, and reserving the ability to divert teams to investigate potential critical situations. The Planning Section will need to be aware of field observations/conditions as they pertain to having to modify the RSAP and interpretation/ review of analytical data that are being received. The following teams or groups will likely occur in some form within either the Operations Section and/or the Planning Section.

(1) *Planning Team*. The Planning Team will need to consist of persons associated with the Army, Federal, State, and local environmental and health agencies. It is essential that all agencies participate in the planning process whether directly or by proxy and, if possible, be part of the Planning Section when the RSAP is executed. This will ensure that Planning Team members are familiar with the plan from its inception and be able to draw upon the rationale used for various aspects of the plan once it is executed. All persons involved in the process of developing and executing the plan should realize the response effort is a cooperative process whereupon all parties work together to address reasonable concerns in a timely and efficient manner. The Planning Section Chief will make the final decisions in instances when the team encounters an obstacle that impedes progress.

(2) *Sample Team(s)*. Sample teams will be part of the Operations Section and will work closely with the Planning Section. These teams will likely consist of Army/DOD personnel trained in the use of air sampling equipment and sample techniques used for the collection of all other media. Persons who are non-Army/DOD should be designated to accompany one or more of these teams to observe field sampling techniques and sample management procedures. Sample teams may be accompanied by additional persons who will serve as field QA/QC officers. Their role will be to document and report all deviations from the RSAP to the Planning Section Chief as well as to the sampling team they are accompanying. This will ensure that deviations from the RSAP are corrected and documented. It will also provide a level of confidence within the stakeholder community that all environmental samples were being collected as prescribed by the RSAP and that deviations from the RSAP are being documented and reported accordingly.

(3) *Data Evaluation/Validation Team*. This team will consist of three or more persons conducting a tiered review and, if possible, should consist of persons from both the Planning and Operation Sections. The team will consist of laboratory personnel, non-laboratory Army/DOD personnel and Federal/State/local environmental regulatory persons. Depending on team/section makeup, the following teams/persons should conduct the following reviews:

(a) Laboratory personnel will be responsible for performing data verification.

(b) Nonlaboratory personnel will be responsible for performing the Tier 1 and 2 data validation as described later in this document.

(c) Section chiefs/team leaders and environmental regulators will be responsible for reviewing the results of the Level A/B validation and documenting their concurrence/nonconcurrence with the results

(4) *Logistics Section*. The Logistics Section will be responsible for receiving all samples, providing temporary storage, and preparing the samples for shipment to the appropriate laboratories when multiple laboratories are being used. They will also be responsible for storing any samples that will be used for archival purposes.

h. Standardization. Under NIMS, it is essential for all teams/persons utilized to respond to a particular event to be familiar with all equipment, procedures, and SOPs pertinent to the functions/roles they are to perform. Otherwise, personnel may end up using unfamiliar equipment and/or SOPs and in some instances use material/procedures completely different than everyone else. The key concern is to ensure that all analytical results were generated using like procedures, thus generating comparable data, and that all data were reviewed using the sample procedures/criteria. Variety in procedures, detection limits and/or analytical capabilities make data interpretation more complex and create additional issues in the event different procedures yield different results to the extent that data may have to be rejected and deemed unusable.

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CHAPTER 3 – PRE-EVENT SAMPLING AND ANALYSIS PLAN DEVELOPMENT

3-1. **Background**. This chapter describes activities and planning decisions that should be made prior to a release occurring. Waiting until a release has occurred will result in rushed and uninformed decisions, a scramble to determine what supplies are needed and available, and a frantic search for laboratories capable of processing some unknown number of samples of various types of media using methods that will achieve the decision criteria.

3-2. **Pre-Event Planning and Preparations**. To facilitate response to a CAIRA event, a significant amount of resources are dedicated to educating and training responders, developing response plans, purchasing necessary equipment, and bolstering current emergency care/response networks. Pre-event preparations exercise the response system and identify weaknesses that can be remedied prior to an actual event. Although the RSAP cannot be fully developed until an event occurs, a significant portion of the plan can be prepared ahead of time thereby reducing considerable delays between the beginning of the re-entry and recovery phase and the implementation of the RSAP. The following paragraphs detail what portions of the RSAP that can and should be prepared in advance of an event.

a. Planning.

(1) *Clearly Define Questions*. Overall, it might seem rather obvious what the response study objectives are and what needs to be done. Without defining the study questions and objectives, the potential for mission creep to occur is great. Mission creep will result in resources being diverted from their original mission/intention to conduct work that may not provide relevant or timely information and/or be useful in achieving the stated objectives. Unforeseen issues will likely occur and should not be ignored, but should be addressed in a systematic process that allows for the proper evaluation and incorporation into the response effort (Crumbling et al., 2003; EPA, 2006; and ITRC, 2003).

(2) *Stakeholders*. As described in the DQO/Triad discussion, all primary stakeholders who should and intend to provide input to the development of the RSAP will need to be identified. It is essential that these persons are involved and represented in some manner from the plan's conception until the plan is implemented. In doing so, key issues and concerns will have been identified, and hopefully resolved upfront prior to the event occurring. This will expedite the decision-making process and eliminate the need to make rushed decisions that may conflict with the interests of any potential stakeholders or require an in-depth review.

(3) *Data Quality Parameters*. These data quality parameters relate to decision performance criteria that are established in Step 6 of the DQO process. In order to prepare the RSAP and implement selected sampling schemes, several data quality parameters will need to be

established. These parameters will then be used when developing the sample strategies and determining sample size. Typical parameters include the confidence level (probability), power, and expected variance. The decision criteria is also defined as a parameter but is discussed separately.

(a) Confidence Level (1-α). Alpha (α) is the probability of falsely rejecting the null hypothesis (i.e., the null hypothesis assumes the site to be contaminated). In other words, deciding that an area is clean when indeed it is contaminated. Falsely rejecting the null hypothesis is defined as a Type I error (α) under the DQO discussion and would be considered worse than a Type II error since contaminated areas may be cleared prematurely, potentially resulting in additional exposures. For the purpose of this protocol, the confidence level should be set at 90-95% or higher, implying that the Type I error, α is 5-10%. It should be recognized that as the value of the confidence level increases and approaches 100%, the number of samples required (calculated) will increase significantly.

(b) Power (1-β). Beta (β) is the probability of falsely accepting the null hypothesis (i.e., deciding that an area is contaminated when it is clean). Falsely accepting the null hypothesis results in more resources being spent on further evaluation and/or performing remediation on areas that are not contaminated. Falsely accepting the null hypothesis is considered a Type II error (β) under the DQO discussion. While not desired due to the additional resources being spent on unnecessary evaluation, persons are not exposed to any additional risks. For the purpose of this protocol, the power should be similar to the confidence level (90-95%), implying that the Type II error, β is 5-10%. Once again, as the power increases and approaches 100%, the number of samples required will increase significantly.

(c) Variance. Variance is the measure of total study error associated with the data generation. Variance may result from contaminant distribution, field sample procedures deficiencies, and/or laboratory error. The estimated error is used to determine the size of the gray area (i.e., the uncertainty area where a measurement is equal to, greater than or less than a given decision level). Low variance corresponds to a small gray area while, conversely, high variance corresponds to a large gray area. Variance is typically estimated when developing the sampling plan, while variance from the collected data is used to evaluate and validate the sample data. For planning purposes, it is recommended that an estimated variance of 25-30% be used for soil, water, and sediment samples and an estimated variance of 15-20% be used for wipe and air samples.

(4) *Decision Criteria*. Critical to the development of the RSAP is determining the criteria by which the data will be evaluated. It is essential that all stakeholders are aware of and agree on the criteria for making decisions and that there is concurrence on the procedures/techniques that will be used for the data collection and analysis. Based upon the analytical capabilities currently available, the decision criteria to be used will be either health-based or technology-based.

(a) Target Analytes. Target analytes being evaluated should be those chemical agents and related breakdown compounds that are directly related to the materials currently being stored at the site. Table 3-1 lists stockpiled materials and associated breakdown compounds that should be reviewed and considered for evaluation.

Table 3-1. Target Analyte List.

Compound	Parent Compound	CAS #
Arsenic	Lewisite	7440-41-7
2-Chlorovinylarsonnous acid	Lewisite	85090-33-1
Mustard sulfur/Mustard gas (HD)	-	505-60-2
2-Chlorovinyldichloroarsine (Lewisite)	-	541-25-3
1,2-Dichloroethane	-	107-06-2
Sarin (GB)	-	107-44-8
Disipropyl methylphosphonate (DIMP)	GB	1445-75-6
1,4-Dithiane	HD	505-29-3
Diisopropylaminoethylmethylthiolophosphonate (EA2192)	VX	73207-98-4
O-ethyl-S-(2-diisopropylaminoethyl)methyl-phophnothiolate (VX)	-	50782-69-9
Ethyl methylphosphonic acid (EMPA)	-	1832-53-7
Isopropyl methylphosphonic acid (IMPA)	GB	1832-54-8
Lewisite oxide	Lewisite	1306-02-1
Methylphosphonic acid (MPA)	GB, VX	993-13-5
Thiodiglycol	HD	111-48-8
1,4-Thioxane	HD	15980-15-1

(b) Health-Based Decision Criteria. These criteria are established using current risk assessment techniques that encompass chemical-specific data (e.g., reference doses, physical properties, and chemical properties), site-specific exposure data (e.g., duration of exposure, population characteristics, and environmental conditions), and safety factors that account for uncertainties inherent in the reference doses and exposure assumptions that are used. Based on these data, a site-specific health-based standard (decision criteria) can be calculated that would be protective of human health particularly for small children and persons more susceptible to illness. Concentrations of chemicals below these standards would be considered safe to a significant portion of the population. There are a number of health-based criteria that can be

considered. However, the applicability of the criteria vary and they do not comprehensively address each of the compounds of interest or the media that requires evaluation.

i. Airborne Exposure Limits (AELs). Several AELs exist for specific inhalation scenarios. These include Immediately Dangerous to Life/Health (IDLH), Short-Term Exposure Limit (STEL), Worker Population Limit (WPL), and General Population Limit (GPL). Each of these AELs addresses a specific exposure scenario with respect to civilian workers, DOD personnel, and the general population exposure to airborne concentrations of chemical agents over a given period of time.

ii. Acute Exposure Guideline Levels (AEGLs). These levels were developed for use in emergency planning and response to a CAI. Used in conjunction with air dispersion modeling, chemical agent concentration Tiers/Levels are used to identify areas of the greatest risk and facilitate the decision-making process with respect to what level of response is required.

iii. Provisional Advisory Levels (PALs). These levels are currently being developed for air and water for a variety of compounds that may be associated with a Chemical, Biological, Radiological and Nuclear (CBRN) event. These values are similar to AEGLs in the sense that concentration Tiers/Levels are to be developed that will be used for making decisions regarding re-entry into potentially contaminated areas. It is uncertain how these numbers will compare to AEGLs.

iv. Military Exposure Guidelines (MEGs). The MEGs were specifically developed for evaluating chemical exposure for troops in deployment scenarios. MEG values were developed for a variety of chemical agents and associated breakdown products that may be found in air, water, and/or soil.

v. EPA Regional Values. Several EPA regions have developed health-based criteria for performing preliminary data evaluations of potentially contaminated sites for air, water, and soil. Typically, the compounds listed do not include chemical agents or all associated breakdown compounds. The protocols and techniques used for the compounds that are listed could be used to develop chemical agent specific criteria.

vi. State Criteria. Like the EPA, some states have developed health-based criteria for performing preliminary data evaluations of potentially contaminated sites. As with the EPA regions, the compounds listed do not include chemical agents or associated breakdown compounds.

vii. Site-Specific Criteria. These criteria would be developed specific to the site in question. EPA/State/MEG values represent criteria using standard default values and inputs that fit a general exposure scenario. Site-specific values would tailor the criteria to the conditions

specific to the site. This would avoid applying criteria applicable to highly congested areas to remote desert areas and vice versa.

(c) Technology-Based Decision Criteria. These criteria are set based on the detection capabilities of the analytical procedures/techniques/equipment to be used. These criteria should only be used when health-based criteria cannot be achieved using current analytical procedures. Technology-based criteria may serve as a place holder in these cases until advances and improvements are made with current analytical capabilities. Concentrations of chemicals below these standards may not necessarily be considered safe to any portion of the population.

(d) Analytical Procedures.

i. The analytical procedures to be used during an event will need to be determined in conjunction with the use of risk-based or technology-based decision criteria. Determining analytical procedures after an event has occurred creates an environment for generating unusable data. It would be in the best interest of all parties and major stakeholders that all analytical procedures used for analyzing each of the target analytes and sample medium be approved/ accepted for use by all parties prior to an incident occurrence since all decisions will be based on data generated by these very same procedures. In this way, the decision regarding what analytical methods to use will not occur after an event foregoing the possibility that the available procedures will not be able to meet decision criteria or laboratories being not able to perform/execute the work. Procrastinating method selection may also result in: delays in processing samples with respect to sample shipment and analysis; implementing field screening methods that utilize varying methods, procedures, and reporting limits; confusion over appropriate analytical procedures for particular agent degradation products; and no procedure/laboratory in place to process a particular media and/or analyte in any capacity.

ii. Currently, there are no analytical procedures for CWA that are mandated by regulating agencies. The majority of the procedures available and currently being used are ones that were developed by the Army or contractors working at their behalf. However, EPA HQ is in the process of developing a compendium of standardized analytical methods that can be used in environmental remediation efforts in response to homeland defense events (EPA, 2007). Though these methods will not be mandated, there is the possibility that the various EPA regions will adopt and require these methods prior to reviewing and/or accepting data related to a CWA event. Any analytical procedures that are selected for use will have to satisfy data quality requirements for evaluating the health/technology decision criteria as well as demonstrate method validity to regulating agencies.

(e) Background Samples. Background samples do not need to be collected at every stockpile location. For locations that store lewisite, knowledge of the arsenic concentration indigenous to the soil types located in the area and within untreated water would be beneficial

since lewisite analysis is based on the presence of total arsenic. For soil, this information may already be known and can be obtained via a literature search of available scientific papers.

(5) *Consensus*. Whether health-based or technology-based criteria are used, a consensus will need to be reached regarding which criteria will be used to evaluate data and clear areas for re-entry. There should be a realization within the group that time and resources will need to be balanced with the realization that samples cannot be collected everywhere. Using select criteria, the developed RSAP will be a probabilistic plan that will cover all potentially impacted areas. Decisions made regarding a particular area will be done so using data and information from a number of data points and sources. While 100% sampling would be ideal, it is not necessary or practical given the additional time and resources that would be required for minimally increased benefits.

(6) *Resources*. Critical to implementing the RSAP will be the availability of resources necessary to collect, analyze, and ship the samples and knowing what resources are critical to sustaining the effort.

(a) Project Requirements. Based on the most likely scenario, the resources needed to operate for the entire duration of the event should be projected out. Based on these projections and the ability for these resources to be acquired in a timely manner, the Planning Team will then need to determine what percentage of these resources will need to be acquired beforehand to foresee critical supply needs during the initial stages of the event until the logistics plan can be set in motion to ensure necessary resources are replenished or replaced in a reasonable timeframe. The Planning Team will need to be cognizant of material shelf live and the ability to store/monitor/inventory staged materials to ensure their durability/availability when preparing for these projections.

(b) Daily Usage. Operations personnel will be required to monitor resources on a daily basis and identify potential short falls prior to them becoming critical or limiting factors that could impede sampling activities or daily operations. Based on the total response resource projections and the amount of material to be staged, the Planning Team will be able to project their daily resource requirements. When implementation of the RSAP begins, the resources required beyond those that were staged can be formally requested as the event evolves. The Planning Team should be cognizant to the fact that the response effort will be a dynamic effort and materials/items not initially projected may now be required.

b. Conceptual Site Model. Based on site-specific information that is evaluated during the DQO process, a CSM must be developed to determine potential health impacts due to direct and indirect exposures to CWA and associated agent breakdown products. The CSM is a visual depiction of contaminant sources, migration pathways, and exposure pathways that could possibly be complete for each receptor under consideration during a CAI. A completed pathway has a source-receptor interaction (i.e., a contaminant source, a migration pathway, and a

mechanism for the contaminant to enter the body). The CSM evolves with the event and will be used to support sampling and information gathering decisions (Triad Resource Center (TRC), 2007) as well as support the clearance of impacted area.

(1) *Contaminant Sources*. The contaminant source for an event will be evident, but the number of source locations may vary depending on what initiates the event and the stockpile material involved. Depending on these variables, one or more CWAs may be released into the environment from a single localized area or from multiple locations over a large area. If it were determined that a release did not occur, then there would be no contaminant sources. Hence, there would be no potential for a source-receptor interaction and no need to collect samples.

(2) *Migration Pathways*. Migration pathways are routes in which persons, animals, and to a degree residential properties can be potentially exposed to a given chemical of concern. In the case of a CAI, a plume of CWA may be released to the surrounding area. As the plume passes over a given area and dissipates, CWA may volatilize in the air and never come into contact with any receptors or properties. CWA may also precipitate from the plume and contaminate a given area by depositing onto buildings, vehicles, trees, or crops. By evaluating these potential pathway scenarios in the development stage of the CSM, we determine the migration pathways of greatest concern and potential for impacting the general population. In doing so, potential exposure media that may require sampling are identified. For a CAI, the following media will likely exist: soil, structural surfaces (exterior and interior), surface water, air, and biological. In most events, a plume of some form would be expected to occur that would ultimately pass over some given area. In doing so, a number of potential migration pathways would result. For some events, a release may occur; however, the existing environmental conditions at the time may have resulted in the CWA having not traveled any significant distance (i.e., no migration). In this situation, there would be no completed exposure pathways and no need to collect samples.

(a) Soil. Human and ecological receptors routinely come in contact with surface soil whether from physically manipulating the soil or merely walking across it. Since deposition may occur over a large area, various types of activities such as hunting, farming, and recreation may be impacted. Surface soils may be collected and analyzed in order to evaluate this pathway. These samples will need to be collected from a cross section of the impacted area to ensure a representative set of samples are collected. Sample points should be determined with the use of a sample grid.

(b) Exterior Surfaces. Coupled with potential deposition on surface soils will be deposition on the exterior surfaces of vehicles or buildings. Exterior surfaces include those associated with residential dwellings, office buildings, commercial activities, and government facilities. This is a critical source of potential exposure since some of the surfaces exposed to CWA will absorb little, if any, of the material. Instead, deposited quantities will remain in place until a person comes into contact with it or it is washed/removed via decontamination processes,

naturally degraded, or washed off via environmental processes. Wipe samples will be collected from nonporous surfaces. Areas from which these samples will be collected will be determined statistically but the sample location will be judgmentally determined using criteria listed within the RSAP.

(c) Interior Surfaces. Plumes may also pass through buildings and vehicles and may result in the deposition of CWA on interior surfaces. Within structures, particularly residential and those associated with sensitive populations, deposition may occur on both porous and nonporous surfaces. Nonporous surfaces will be evaluated in the same manner as exterior surfaces. Porous surfaces will be evaluated by collecting small porous items such as stuffed animals and small pillows (i.e., items that will likely be in close proximity to a person's face).

(d) Surface Water. Existing weather conditions will play a major role in determining the location and the number of water samples to collect. Surface water may occur in two states – lotic and lentic. Lotic describes fast-moving, nonstationary water (e.g., rivers and streams). Lentic describes stationary, nonmoving water (e.g., ponds, marshes, and puddles). For lotic waters, obtaining a representative sample will be difficult (EPA, 1989). Any CWA deposited on the surface of lotic water will be swept downgradient and likely intermixed with water. The sheer volume of water will serve to dilute the CWA to levels well below any detectable concentrations. Exposure via lotic waters should be considered potentially complete, but a minor source given the dilution that will occur. Greater consideration should be given to evaluating lotic water when a drinking water intake and/or recreational facility are located within a short distance from the area of potential deposition. For lentic waters, CWA deposited on the surface may be diluted, hydrolyzed, and/or form a film on the surface. The number of surface water samples collected will be statistically determined while the actual sample locations will be judgmentally determined.

(e) Air. In-place sheltering will be the primary means of protection if a CWA release was to occur. Persons will be instructed to remain in place until such time that they are informed it is safe to exit or they are instructed by rescue personnel to exit the building and proceed to a subsequent evacuation point. Air sampling will be used to assess both indoor and outdoor air. Outdoor air will be evaluated at set locations based on the phase of the response.

(f) Contaminated Food/Resources. Though commercial products that are located on store shelves and dwellings may be impacted, these items will not be sampled since these products will all be rendered unusable. Attention should focus on items such as livestock, commercial fisheries, and wildlife that are typically harvested for food (e.g., deer or ducks). If deposition occurs and results in the death of animals, a representative sample of these animals should be collected and stored until a thorough analysis/evaluation of the cause of death can be determined. If deposition occurs with no apparent impact to the animals, study personnel will need to resort to evaluating other media in the immediate area (e.g., air, soil, and water) to establish potential impacts.

(g) Miscellaneous. The migration pathways listed above should identify the prevalent pathways for most sites and release scenarios. Each site will need to evaluate any pathways that may be unique to its location. If additional pathways are identified, special attention will need to be given to ensure that these are adequately addressed within the DQO process and the RSAP.

(3) *Exposure Pathways*. Exposure pathways are routes in which persons or animals can be potentially exposed to a given chemical. These pathways include the three modes by which a chemical contaminant may enter the human body: ingestion, inhalation, and dermal absorption. For all potentially complete exposure pathways, there is an expectation that a person would be exposed by one or more of the three exposure mechanisms.

(4) *Visual Depiction of Conceptual Site Model*. Figures 3-1 and 3-2 illustrate the results of evaluating contaminant sources and the migration/exposure pathways. These figures merely provide a visual depiction of the event and facilitate the DQO process and development of the sampling and analysis plan. The CSM shown in Figures 3-1 and 3-2 may be applicable to all sites; however, each site should review each component of the CSM to determine if all, some or additional media/receptors need to be incorporated into the CSM.

c. Event Activities.

(1) *Define Impacted Area*. Critical to responding to an event is the ability to identify the areas potentially impacted by the release. In some cases, these areas can be easily identified by visual indicators. In other areas where the impacts are not as obvious, computer simulations will be used to aid in predicting the extent of potential contamination. One element that all response personnel should be cognizant of is that a computer simulation is just a simulation. Response personnel will need to be ready to adjust as the situation evolves.

(a) Modeling. All initial response efforts will be based on projected plumes, areas of deposition, and field reports provided to the Response Team. The numbers and types of samples to be collected will be based on these initial projections and reports. As the event evolves and more information arrives, the footprint of the plume and area of deposition will evolve requiring the Response Team to adjust in size and team composition. Sample collection prioritization will also be impacted.

(b) Vapor Plumes. When a CAI event occurs, dispersion modeling is conducted to predict the areas most likely impacted by a plume using the Web-PUFF™ software developed by Innovative Emergency Management (IEM), Inc., Baton Rouge, Louisiana. Web-PUFF projects the size, speed, duration, and concentration of the release plume based on meteorological conditions from the time of the initial CWA release until the release is contained. It has the ability to incorporate the local topography and current meteorological conditions into the modeling of the plume to provide a more reasonable prediction of the plume track than other

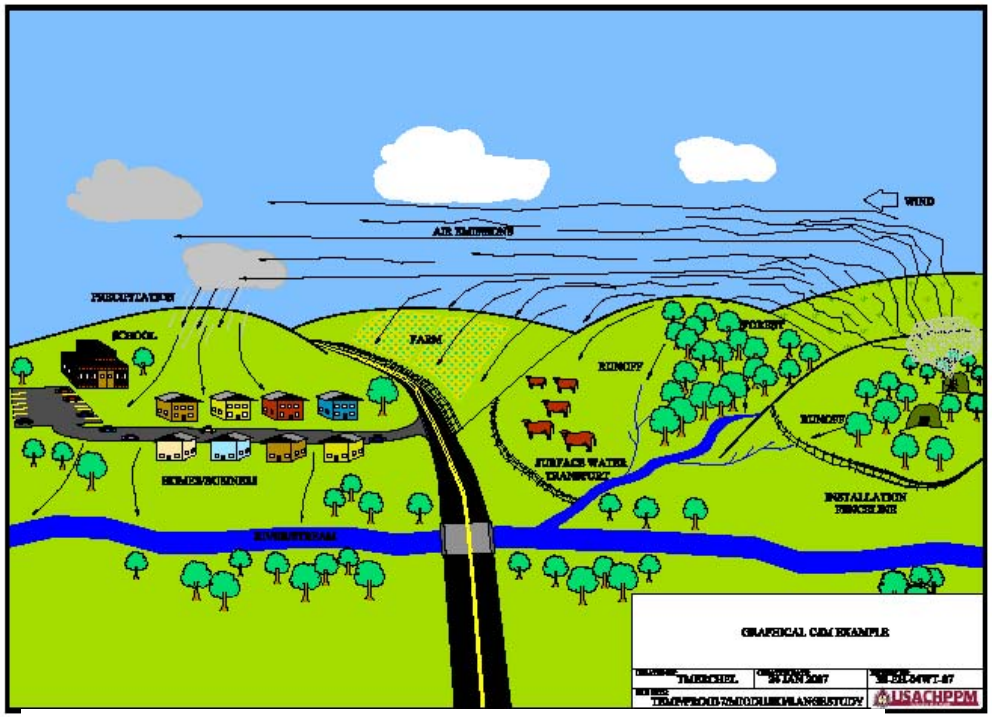

Figure 3-1. Visual Depiction of the Conceptual Site Model.

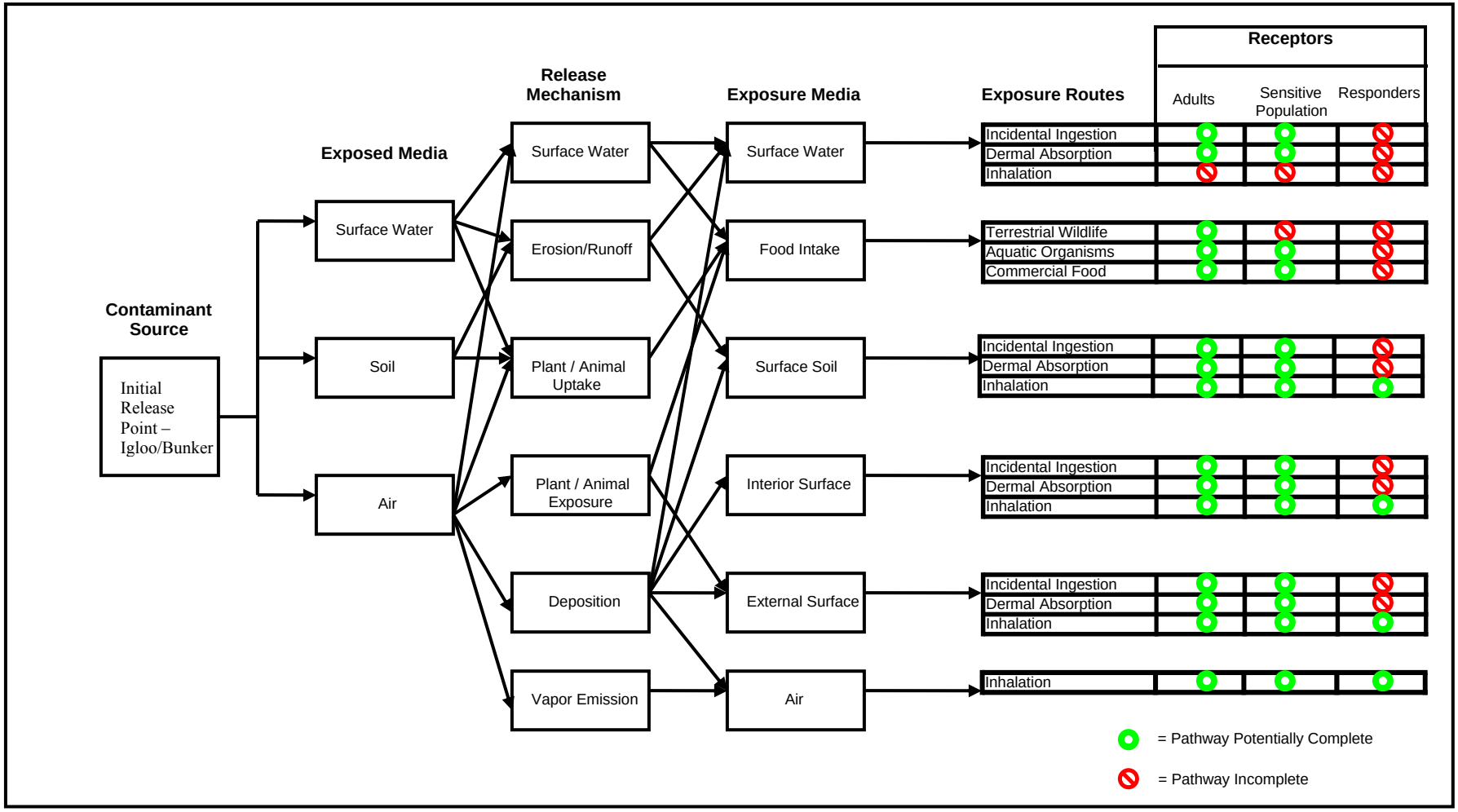

Figure 3-2. Graphical Depiction of the Conceptual Site Model.

programs that project mere linear progressions based on wind speed. Using these projections, the emergency response plans are activated and necessary communities and emergency personnel are notified based on predicted AEGL contours. The plume model will depict several AEGL contours (i.e., AEGL 1, 2 and 3). These contours represent concentration ranges over the given area (USACHPPM, 2003). AEGLs 2 and 3 represent CWA concentrations where moderate to severe health effects will be observed. AEGL 1 represents a CWA concentration where mild to no health effects will be observed. Web-PUFF is capable of projecting plumes under a number of meteorological conditions that can result in a number of plume sizes and shapes. Sample projected plumes are shown for three typical weather conditions in Figures 3-3 thru 3-5. The plumes represent projections of a chemical accident involving GB agent in a fire. The only difference in plume projections results from the meteorological conditions; Figure 3-3 represents a plume on a sunny, warm, breezy day (Scenario B, Pasquill Stability Category B/unstable); Figure 3-4 represents a cloudy, breezy day (Scenario D, neutral stability); and Figure 3-5 represents a cool, calm, and clear night (Scenario F, stable atmosphere). As can be seen from the figures, the size and distance the plume travels can vary significantly. The reliability of a model diminishes when precipitation is falling and during extreme weather conditions such a hurricane or tornado event. The RSAP will focus on areas represented by AEGLs 2 and 3 and associated risk envelope.

(2) *Field Reports*. Response personnel will need to be cognizant of field reports regarding possible CWA deposition/plumes located outside the initial areas identified as having been impacted. Each report should be plotted on the map and physically visited if possible. Based on physical evidence, emerging trends, and new data, it may be determined that areas outside the initial response area will need to be incorporated into the RSAP and sampled accordingly based on the media types located within those impacted grids.

(3) *Recovery Sampling and Analysis Plan Changes*. As the recovery and re-entry phase progresses, new information, preliminary data results, field observations, and sampling requests will be received by the Sampling Team. On a daily basis, the team coordinator will need to prepare reports regarding the status of the RSAP execution. It is within these reports that recommendation regarding modifications to the RSAP will be presented to the Planning Team and ultimately to the IC/UC for approval.

(4) *Review and Request Assets*. Based on the areas tentatively identified as having been impacted and the media to be assessed, the Planning Team Chief in coordination with the Operations Team Chief will project how many field sampling teams will be required based on the time constraints given by the IC/UC. This projection must then be forwarded to the Logistics Team who will then determine what resources are available to the Sampling Team (if not already known). The Operations/Planning Team Chiefs will, on a daily basis, project daily operations for the next 24 hours to ensure all resource requirements have been determined and requested in the event that the IC/UC will need to request additional assets.

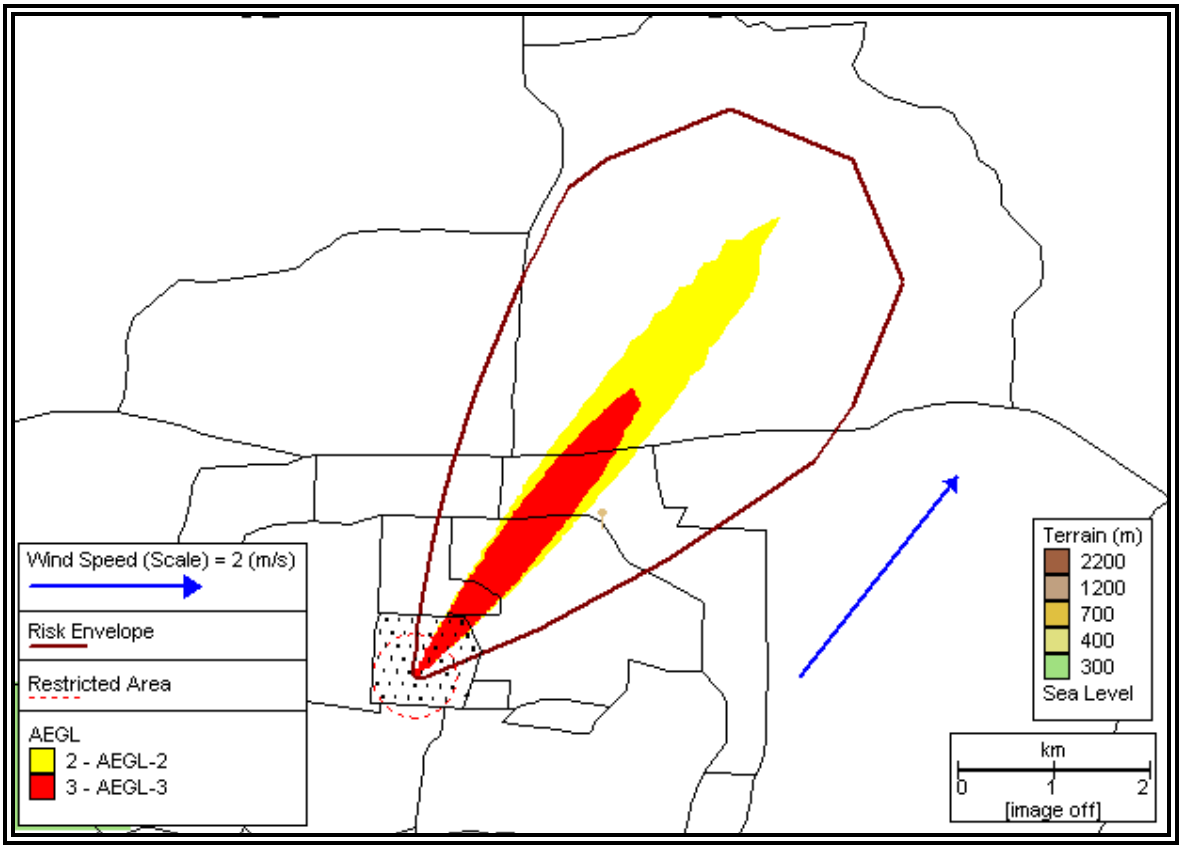

Figure 3-3. Web-PUFF Modeled Plume Scenario B.

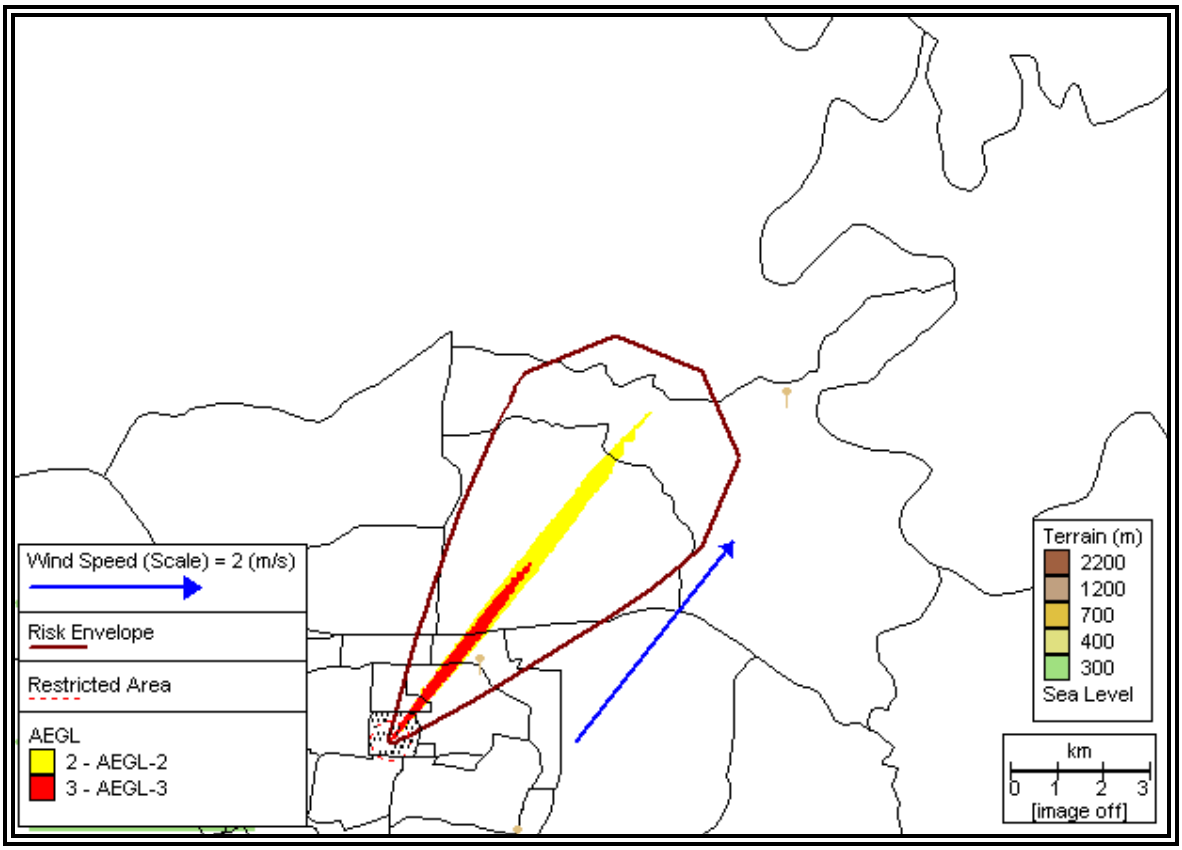

Figure 3-4. Web-PUFF Modeled Plume Scenario D.

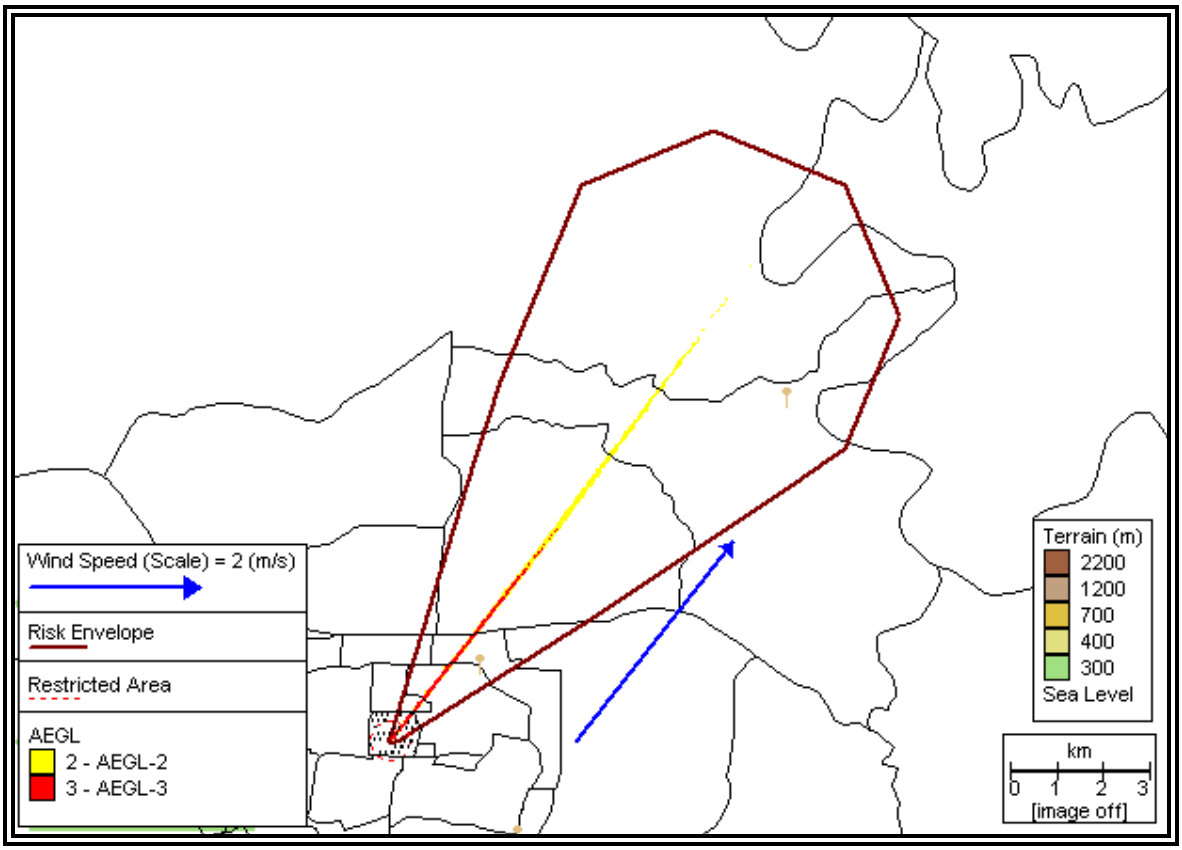

Figure 3-5. Web-PUFF Modeled Plume Scenario F.

d. Exercise the Plan. It is essential that, once the RSAP is developed in draft form, a CAI event simulation exercise should be performed to ensure the feasibility of the plan and to identify information/response gaps that were not anticipated during the plan preparation. This exercise may also identify aspects of the plan that are not critical or needed.

(1) *Transportation/Access Corridors*. The RSAP will likely identify a number of sample locations that will need to be accessed during a response. A large percentage of these samples will likely fall near a main road, hence accessing these locations may pose only minor accessibility issues. For more remote locations, response personnel may need to evaluate the site accessibility for sample personnel and equipment. It may be warranted to adjust the sample location if accessing the location during an event would consume too much time and/or potentially jeopardize response resources.

(2) *Confirm Map Coordinates*. Critical grid coordinates, if not all coordinates, should be confirmed to ensure the accuracy of the coordinates relative to the Geographic Information System (GIS)/maps used to make them and the Global Position Satellite (GPS) units that will be

used to locate them. Building locations, sample points, monitoring locations, and plume data will be input into a GIS to facilitate the response efforts by visually depicting them relative to other physical and geographical features and locations. A GPS will be used to navigate to points that do not have any unique features associated with them and to record grid coordinates of each sample location. Confirming the coordinates will demonstrate that the map registry is accurate and that potential users of the GPS are capable of independently locating coordinates in a timely manner. Incorrect sample coordinates will result in samples being collected in the incorrect location, possibly in areas outside of the project plume/risk envelope. Persons unfamiliar with operating a GPS unit will add significant delays to the sample collection process.

(3) *Equipment Inventory*. After the RSAP has been developed, an inventory of equipment will need to be prepared. This inventory will detail the equipment currently on hand, equipment that will need to be procured, and equipment from other locations that can be made available within a 24-hour notice. This inventory will also be used for determining and justifying resource requests during an event.

(4) *Concurrence*. Just as with the development of the decision criteria (health risk vs. technology based), the final form of the RSAP, less the incident specific information, needs concurrence from all parties. Each party must realize this is the plan that will be initiated at the time of the event. As such, it will be crucial to include these same persons on the Planning Team when the plan is put into action and modifications are needed as the plan evolves with the event. The introduction of new personnel late in the process or at the time of an event may impede the timely execution of the RSAP.

e. Document Development. There are several support documents that should be prepared in conjunction with the RSAP.

(1) *Quality Assurance Project Plan (QAPP)*. The QAPP describes the activities performed within the laboratory that are used in the process of acquiring environmental data. In doing so, the data quality requirements are defined. Adherence to the QAPP assures that the level of quality required for the data generation, acceptance, and use are maintained within each step of the process. QAPPs are typically laboratory specific and may be captured within the laboratory's Quality Management Plan (QMP). The QMP can be used in lieu of the QAPP assuming that the procedures, systems, etc., meet the data requirements of the project. If not, project-specific requirements will either need to be incorporated into the Quality Assurance Manual (QAM) or a QAPP will need to be prepared. If only a handful of laboratories are to be used, a single QAPP can be prepared that will be inclusive of all laboratory requirements. If a significant number of laboratories are to be used, individual QAPPs may be in order. In some form or manner, all screening and analyses performed by sampling teams in the field will need to be captured within the QAPP. Details for the preparation of laboratory-specific QAPPs can be found in EPA QA/G-5 – Guidance for Quality Assurance Project Plans (EPA, 2002). Table 3-2 lists the basic elements that should be found in a QAPP.

Table 3-2. Basic Elements of a Quality Assurance Project Plan.

Basic Elements of a QAPP
Quality Assurance Policy
Chain-of-Custody Procedures
Preventive Maintenance Schedules/Documentation
Data Management Procedures
Archiving Procedures
Instrument Calibration Procedures
Corrective Action Procedures
Performance/System Audits

(2) *Training Plan*. A training plan will need to be developed that addresses training requirements for all persons involved in sample collection, conducting field screening/analyses, managing samples, and performing data reviews. This will ensure that all persons conducting such work are familiar with the procedures and that they are capable of performing these functions in a manner that will ensure data quality goals are met. Training should focus on those activities that occur in the field. Individual laboratory training requirements will be covered by the QAPPs/QAMs. By implementing a training plan, all response efforts with respect to the RSAP will be executed in a timely and consistent manner thus ensuring data quality and comparability.

(3) *Sample Reports*. All data will likely be provided in preliminary and final form. Preliminary data will likely be forwarded electronically via e-mail or fax. Data in final form will be delivered in hard copy (printed report) and electronic form, and is typically provided in the form of a spreadsheet. To minimize the potential for data misinterpretation, all laboratory data will be reported using one standard format. The data contained within each report whether from a field or fixed laboratory will be the same. These will contain, at a minimum, the following information:

(a) Date of Collection – the date the sample was collected in the field.

(b) Date Received – the date the sample was received by the laboratory.

(c) Date of Extraction – the date the laboratory prepared the sample for analysis.

(d) Date of Analysis – the date the laboratory analyzed the sample.

(e) Results of Analysis – laboratory results for each target analyte.

(f) Reporting Limits – reliable quantitation limits of the analytical procedure.

(g) Analysts – the names of laboratory personnel who performed the analysis.

(h) Reviewer – the names of laboratory personnel who reviewed and released the data.

(i) QA/QC Results (matrix spikes, laboratory spikes, and surrogate spikes) – data for all QA/QC samples analyzed in conjunction with the sample. These may be presented as a data package where one set of QA/QC data pertains to one or more sample results.

(j) QA/QC Acceptance Criteria – the criteria for evaluating QA/QC for the purpose of demonstrating method efficiency.

(k) Date Reported – the date the sample results were released.

(l) Sample Batch – as pertains to the QA/QC data, a list of samples and QA/QC samples extracted and analyzed as a group.

3-3. **Basic Background Information**. The accumulation of general site background information is critical in developing the RSAP. This information will be used to develop sampling strategies related to the prioritization of sampling activities, establish sampling grids, and determine judgmental sample locations.

a. General Site Description and Location. Site location directly impacts the extent of sampling that will be required. The number of samples to be collected is dependent on the size of the CAI and on the surrounding locale (i.e., number of dwellings, land usage, nearby towns/cities, industry, and agricultural centers). The number of dwellings will not only impact the number of samples, but can also impact the priority in which samples are collected and the type of media from which samples are collected. Sites located in more isolated areas may need to focus primarily on potentially contaminated environmental media such as surface soils and water resources. Whereas, sites located in more populated and developed areas may need to focus more on surface wipes, air quality, and miscellaneous sampling activities. The RSAP should include a site map and describe the general characteristics and locations of special features of the surrounding area. Specifically, actual agent storage locations in relationship to the installation boundaries, nearby towns/cities, significant agricultural centers, sensitive populations/schools, and surface water features should be depicted. Additional items may need to be considered based on site-specific issues.

b. Local Demographics and Land Usage. A discussion of the general population and activities surrounding the site will provide insight into where sampling activities may need to be

focused or at least need to be accommodated when developing the RSAP. Specifically, the following information should at least be summarized and documented:

(1) Total number of dwellings located within each grid.

(2) Location of all schools, nursing homes, and medical facilities with beds.

(3) Number and locations of all daycare facilities both commercial and private.

(4) Commercial agricultural activities.

(5) Recreational areas.

(6) Public water treatment plants or source water intakes.

c. Populations of Concern. The RSAP should include a discussion of the various communities and/or activities that may be impacted to include specific subpopulations of particular concern and/or susceptibility to chemical agents such as elderly groups (i.e., retirement communities, nursing homes), daycare facilities, and schools.

d. Key Land Areas/Uses of Concern. In addition to populations and specific activities that may impact sampling decisions, other land uses such as farming and specific agricultural use activities and recreational areas should be identified. As discussed in other CSEPP guidance (CSEPP, 2003), it is particularly essential that CSEPP sites be prepared to demonstrate that key agricultural producers and land use areas have not been impacted by a release. The ramifications of potential 'embargoes' and land use restrictions on such resources could be quite significant, even if chemical agent deposition/contamination had not occurred. To avoid 'perception- based' reactions, sampling design should ensure stakeholder concerns are incorporated into the design of the RSAP, methodologies and procedures are standardized, and that the RSAP is implemented in a timely manner. If these concepts are incorporated into the RSAP, the resulting data will support claims of no-risk and/or no-contamination.

e. Other Political/Public Concerns. Consideration will need to be given to specific concerns that community and regional stakeholders might have. During the development of the RSAP, persons representing these stakeholders will need to solicit and express 'reasonable' concerns regarding the rationale for including noncritical areas within the RSAP. It may be prudent to demonstrate to the stakeholders how the RSAP will address their concerns via the sampling rational, the locations of potential samples, QA/QC measures to be implemented, and how local/State/Federal regulatory/health officials will be involved in the implementation of the RSAP.

f. Chemical Warfare Agents and Stockpile Characteristics. Stockpile sites are required to assess potential hazards and dangers associated with specific chemical agent and munitions operations located on that installation. This entails reviewing what chemical agents are maintained on the installation and how they are handled and stored. The RSAP will be prepared such that it will address all stockpile chemical agents that are determined to be present. Specific information regarding chemical agent (e.g,. toxicity, chemical characteristics, physical properties, signs and symptoms of exposure, and environmental fate) should be identified within the RSAP. This can be accomplished by referencing key documents for the CWA of interest such as Material Safety Data Sheets (MSDS) that can be obtained from the U.S. Army Edgewood Chemical Biological Center via searching the Army Knowledge Online Web site for the chemical agent of interest.

g. Environmental Setting.

(1) *Climate*. The affects of climatic conditions on the sampling activities will only be known when and after the CAI has occurred. 'Likely' scenarios have been developed that take into account typical prevailing weather conditions for the given area. Air dispersion models are used to identify potentially impacted areas, estimate concentrations of chemical warfare agent at specified ground-level receptors surrounding the point of release, and to be used for conducting mock training exercises. For preplanning purposes, these dispersion models facilitate the projection of the number and types of samples that may need to be collected. Unfortunately, changing ambient/climatic conditions do not always follow a 'likely' scenario. As such, extreme climatic conditions (e.g., thunderstorm, tornado, and hurricane) may dramatically impact the implementation of the RSAP. The most significant impact would be the delay and interference of sample collection.

(2) *Topography*. Locale terrain features may impact the CAI dispersion models. High points such as hills, mountains and forested areas may channel agent plumes. Low lying areas such as gullies, valleys, and basins may also serve to channel agent plumes and, potentially of greater concern, serve as a sink where plume material can collect and reside long after the main plume has passed over the area. The sampling scheme utilized will cover the general area of concern, but terrain features such as these will deserve special attention since these terrain features may not be identified within the plume model utilized. It will be necessary to evaluate these areas during the development of the RSAP to ensure these areas are identified and have been given due consideration with respect to being incorporated into the RSAP.

(3) *Surface Water*. In the event of a CAI, it will be necessary to evaluate the impact on large, significant surface water locations located in the surrounding area. These will include rivers, large streams and lakes with special emphasis being placed on water resources being used for recreational and commercial activities where there is potential for dermal contact or incidental ingestion is greatest. Chemical agents are not expected to persist in water for any period of time since they undergo rapid hydrolysis once dissolution in water occurs

(USACHPPM, 1999). Even so, a general concern will occur regarding the potential of the release to impact drinking water sources. Regardless of the potential for drinking water contamination, surface water resources will likely require evaluation in some capacity to allay any concerns of the public and local government officials. Testing should be limited to water resources used as recreational areas and for generating drinking water. Water already in the 'system' will not be impacted and will not require testing.

(4) *Ground Water*. It is even more unlikely that ground water would be impacted. In the process of being transported from the surface through the soil to underlying ground water, the chemical agents will likely undergo rapid hydrolysis. Even in the event chemical agents were to reach ground water, they will in all likelihood not pose an immediate or long-term threat due to the advection-dispersion properties that control the fate and transport of contaminants within the subsurface. All potential ground-water contamination must be evaluated on a very limited, site-specific basis.

(5) *Soil Types*. The types of soil found in the outlying areas surrounding the stockpile installation will not bear any immediate impact on the RSAP. The chemical agents that are maintained will impact what information is needed with respect to background sampling. In general, background sampling will not be needed since chemical agents and their breakdown products are unique enough that false positives resulting from interferences will be minimal. For those stockpile sites where lewsite is still stored, the concentration of arsenic in soils will need to be determined in the soils surrounding the area since the current analytical procedures used to measure lewsite are based on the total concentration of arsenic within the sample. Background concentrations of arsenic may already be documented in scientific literature, thereby, eliminating the need for the collection of background samples.

3-4. **Sample Types**.

a. Rationale for Sample Collection. Samples should only be collected if the resulting data can and will be used to provide input to answering the overall study objectives. Samples collected outside the confines of the study objectives will take manpower and resources away from necessary field activities. Samples should be collected from only those media and sample locations defined within the RSAP.

b. Sample Matrices. In order to clear a given area of CWA hazards, it will likely be necessary to collect a number of samples of various media types. The types and number of samples collected will be determined by the specifics of the area being cleared (e.g., number of dwellings that are present, and number of water locations), the phase of the operation, and the desired confidence level.

(1) *Soils*. Soil sampling will focus on exposed surface soil versus that which is covered by vegetation. Preferable locations would be around playgrounds/play areas, walking paths, school grounds, public grounds, and meeting areas.

(2) *Surface Water*. Water samples will focus on locations involving commercial activities, public facilities, and municipalities. Samples will be collected both from standing/slow-moving water (lentic) where the chemical agent may not hydrolyze and from fast moving waters (lotic) where the chemical agent should be effectively hydrolyzed due to the inherent mixing associated with moving/turbulent water.

(3) *Air*. Air samples will be collected both within and outside the impacted area to evaluate air quality and to monitor for additional releases. These samples will be used to evaluate the inhalation pathway. Preferred locations for judgmental samples are schools, daycare facilities, residential dwellings, medical facilities, and retirement communities.

(4) *Surface Samples (Wipes)*. These samples will be collected from nonporous surfaces to evaluate surface deposition. Preferable locations will be in family dwellings, social centers, schools, daycare facilities, medical facilities, and retirement communities.

(5) *Bulk Headspace*. These samples consist of light, airy objects that are porous or permeable and can be compressed thereby decreasing the volume of air contained therein such as pillows, or stuffed animals. Suitable sample material would merely be collected and placed into a CWA impermeable bag, sealed and labeled. The headspace of each bag would then be analyzed for CWA and/or degradation products to determine the presence/absence of CWA. Ideally, one sample would consist of several items collected from one particular grid or set of grids. Preferable locations will be residential dwellings, daycare facilities, medical facilities, and retirement communities.

(6) *Biological.* These samples will consist of dead animals and plants/crops located in the impacted area. The locations of these types of samples will be judgmentally determined.

(7) *Miscellaneous*. Miscellaneous samples are reserved for site-specific unique samples that may occur either by chance or as a result of the incident that do not fall under one of the above categories. Examples of such type samples might be food products, components or pieces of buildings (e.g., concrete, wood, and siding material) furniture, or electronic equipment. Ideally, these types of samples would not need to be collected since the analytical procedures used to collect and analyze the target analytes would more than likely be ad hoc procedures that were developed as needed.

3-5. **Sample Strategy – Phased Approach**. Any number of strategies can be employed to clear areas for re-entry. These may range in complexity from being very simplistic plans that involve little to no sampling to the rather bulky, mammoth plans that require tens of thousands of

samples and man-hours to implement. The basic focus of any sampling is to fill in the information gaps identified during the DQO/Systematic Planning process necessary to meet the objectives of the recovery and re-entry response effort. Assuming environmental media will be sampled in some capacity, the following basic questions need to be answered: (1) What should be sampled?; (2) Where should samples be collected?; (3) How will samples be collected?; and (4) When should the samples be collected?. Each event should be addressed following a phased approach. Each phase of recovery and re-entry will be used to address specific issues necessary for the successful implementation of the RSAP. In essence, the phases will prioritize specific actions of the response that are to be completed sequentially prior to initiating the next phase even though some overlap will occur. Work within each specific phase of the response effort will be prioritized by the stakeholders based upon site-specific information. Each event will be broken down into the following phases:

- Phase I – Monitoring Stations and Corridors
- Phase II – Clearance Sampling
- Phase III – Commercial Activity Sampling
- Phase IV - Redeployment

a. Phase I – Monitoring Stations and Corridors. After a majority of persons have been removed from the impacted area, response efforts will begin to shift over to clearing areas for re-entry. Personnel associated with this portion of the response will monitor evacuation routes and traffic corridors through the course of the re-entry and recovery process. Monitoring of specific locations and corridors will be maintained until such time that an area has been cleared via clearance samples. Again, these samples will not solely be used to clear areas for re-entry; rather, they will be used to demonstrate that the airborne concentrations of the chemical of concern do not pose a health threat. Data from these samples may be used in conjunction with other samples if these samples coincide with a grid node or dwelling designated for sampling.

b. Phase II – Clearance Sampling. Clearance screening will consist of selecting and collecting samples of various types of media from predetermined sample locations identified in the RSAP (i.e., grid nodes and residential dwellings located in clearance zones). Clearance sampling should be intent on clearing the outer zones of a designated risk envelope first and then progressively clearing (collapsing) towards the initial release point. Any areas that were not cleared for re-entry, based on the presence of CWA, will be flagged for further evaluation at the conclusion of RSAP activities.

c. Phase III – Commercial Activity Sampling. Phase III will focus on significant commercial assets located within the impacted area, and to some degree, those located outside of the impacted area. Commercial assets consist of permanent facilities such as factories or large agricultural operations that produce crops and/or animal products. Samples collected during this phase will be used to evaluate potential impacts to buildings where goods are manufactured, processed and/or stored, commercial crops, and large concentrations of livestock. If smaller

commercial activities are to be evaluated, a representative number of locations should be evaluated in the same manner as residential dwellings are evaluated. Otherwise, the resources necessary to evaluate all locations would be considerable. Though there are no immediate health impacts associated with these types of sample locations/media, the social-economical impacts may be significant.

(1) *Biological Samples*. Animals which are found dead or behaving uncharacteristically and plants/vegetation which are discolored or wilted should be collected, inventoried, and stored for future evaluation. Data from these samples will be used in conjunction with other environmental data to establish whether or not deposition occurred. Scheduled sampling efforts may ultimately yield data which indicates the material was not impacted by CWA. However, this determination will be made by Health and Safety Officials after all recovery and re-entry sampling has been completed in order for them to evaluate the data from the entire release event.

(2) *Animal Health/Plant Surveys*. It may be beneficial for veterinarians and wildlife biologists to participate in the recovery and re-entry phase. These surveys would be initiated during the recovery and re-entry phase and completed sometime after it has ended and would consist of visual and medical assessments of farm animals and crops for evidence of having been impacted by the released CWA. These surveys would not be used for making decisions regarding re-entry. Rather, these surveys would be used to facilitate property loss/damage issues.

(3) *Commercial Buildings*. Large commercial activities can be evaluated using the same types of samples collected in Phase II – air and surface wipes. Samples should be collected in areas where the working population spends a majority of their time and from the surfaces of finished products. Water samples would not need to be considered a media of concern unless the facility produces its own potable water source onsite.

(4) *Special Considerations*. There may be instances where the local stakeholder wishes to have specific locations sampled that do not fit into the overall sampling scheme. These should be one of the last areas sampled during the process. If the IC or UC decides otherwise, these would need to be worked into the sampling scheme. Examples of these types of locations are historical landmarks, government institutions, museums, distinguished persons residence, and religious sites.

d. Phase IV – Redeployment. This phase involves a systematic review of work accomplished to ensure all samples that were to be collected were indeed collected. This would also include any samples that were required to be recollected due to one of many of reasons (e.g., sample misplaced, container broken, or compromised sample). Sample teams can be deactivated thereby allowing them to conduct equipment and supply inventories.

3-6. **Sampling Scheme**. The sampling scheme used to assess a release will encompass a majority of the release scenarios and it will need to have the ability to adapt to the release scenario as the event and information evolve during the process. Additionally, evolutions to the plan need to conform to all RSAP, QAPP, and DQO requirements without compromising sample integrity/defensibility and incorporating mission creep. The two schemes best suited for use during a release utilize multiple sampling grids. The first uses static sampling grids having set dimensions and fixed nodes and are determined prior to an event. The second scheme uses adaptive sampling grids that are determined after a release has occurred and the specifics of the CAI have been determined. Grids can either be rectangular or triangular. Triangular grids are preferred since these grids have a greater probability of finding a hot spot in comparison to the rectangular grids (Pacific Northwest National Laboratory (PNNL), 2005; EPA 1995). Additionally, these grids allow more flexibility in sampling design and data analysis. Paragraph 3-2a(3) discusses the recommended data quality parameters that will be needed to utilize the following sampling schemes.

a. Static Grid. A static sample grid uses grids of predetermined size (area) overlaying the area that is potentially impacted by a release based on projected likely release scenarios. The size and shape of each grid are based on the probability of identifying an area of deposition of a given size and shape. At each grid node, potential sample points are determined based on the identified media pathways and receptors. The grid nodes that would be sampled during an event would only be those identified as having been potentially impacted by the plume. Two ways in which static grids can be generated are using Visual Sampling Plan (VSP) software or via the use of GIS mapping. Grid generation is not limited to the above two tools if additional mapping/graphics software are identified and capable of supporting the sampling scheme decided upon.

(1) *Visual Sampling Plan*. VSP utilizes the EPA DQO planning process for data collection and decision-making. Users of VSP apply the inputs from DQO Steps 1-6 to generate an optimal sample design. VSP can select an appropriate sample size and provide sample location(s) for a delineated area or stratum of noncontiguous areas to ensure that the results of statistical tests provide defensible input to the decisions (DQO Steps 5 and 6) with the required confidence and performance. With the use of digital maps, VSP will randomly determine the sample coordinates over the given sample area and plot them on the figure provided. The number of sample locations is calculated based on the data quality parameters entered into the VSP software. The VSP software and User Guide may be obtained online (http://dqo.pnl.gov/vsp/index.htm). Grid nodes that would require sampling are those grid areas that are overlapped and intersected by the risk envelope based on projected likely release scenarios using Web-PUFF. Grids not intersected by the risk envelope would not be sampled.

(2) *GIS Mapping*. GIS is a mapping system that utilizes layered information thereby allowing the user to customize the information provided in each map. Each layer contains a set of data/information attributes that are geographically linked to the map. A sampling grid can be

developed and added to the map as an additional layer. The sampling grid can be developed by inputting specific information regarding the size and shape of each grid based on likely plume size and shape. Once the grid is added as a layer, the location or coordinates of each grid node are known along with any other response-specific information planners want to incorporate into the map. To develop the sampling grid within GIS requires some customized programming; however, several extensions to the GIS software have been developed which may simplify this process. Figure 3-6 displays the results of a customized sampling scheme developed using GIS. Potential, or likely, sample locations (e.g., grid nodes and locations within each grid) are inventoried prior to an event. The colored grid areas correspond to projected plume concentrations (AEGL 1, AEGL 2, and AEGL 3), size, and shape as depicted in Figure 3-3. The sizes of the grids within each color zone again are based on the projected plumes size and shape. Grid nodes that would require sampling are those grid areas that are overlapped and intersected by the risk envelope based on projected likely release scenarios using Web-PUFF. Grids not intersected by the risk envelope would not be sampled. As can be seen in Figure 3-6, the density of samples is constant within each colored layer of the grid.

b. Adaptive Grid. An adaptive sample grid uses grids in much the same way as static sample grids except that the size, shape, and location of each grid are determined after the event has occurred and are based on plume modeling. Once an event has occurred, release-specific information is inputted into Web-PUFF. This information would include the amount of agent potentially released, the meteorological conditions at the time of the release, and the meteorological conditions since the release. From this information, a model of the plume is projected over the potentially impacted area. Using Web-PUFF, a grid is then projected over the impacted area which is specific to the size and shape of the projected plume (Figure 3-7). Grids that would require sampling are those grid areas that are overlapped and intersected by the risk envelope. Grids not intersected by the risk envelope would not be sampled. The density of samples becomes greater as one approaches those areas projected to have the higher concentrations of CWA.

c. Clearance Zones. Clearance Zones will be the foundation for clearing areas for re-entry or in other words the decision unit. These may be defined by preexisting physical, topographical, civic and/or census boundaries or artificially developed. These will also be used for determining the number of residential dwellings and commercial activities that will be sampled. Clearance Zones will be used with static or adaptive grid schemes. With static grids, Clearance Zones will directly overlay and encompass a number of grid nodes. Both sets of grids will blend together and, in some instances, the Clearance Zone will be identical to the static grids (Figures 3-8 and 3-9). With adaptive grids, the Clearance Zone will also overlay the adaptive grid, but it will not blend with the adaptive grid giving an appearance of the grids being askew (Figures 3-10 and 3-11). Data obtained from each Clearance Zone will be used for determining whether or not an area may be cleared for re-entry. The data used to facilitate this decision will be a compilation of data obtained from grid nodes located along the perimeter and data collected from within each Clearance Zone that would also include residential dwellings and commercial

activities located within the zone. For the purpose of this discussion, 1 kilometer triangular grids were used as Clearance Zones within this protocol. The size of the Clearance Zone is set at 1 kilometer to facilitate the logistics of controlling access to each area. Individual sites may decide to alter the size and shape of these grids, but will need to be cognizant that this will have a direct impact on the dwellings/commercial activities sample numbers.

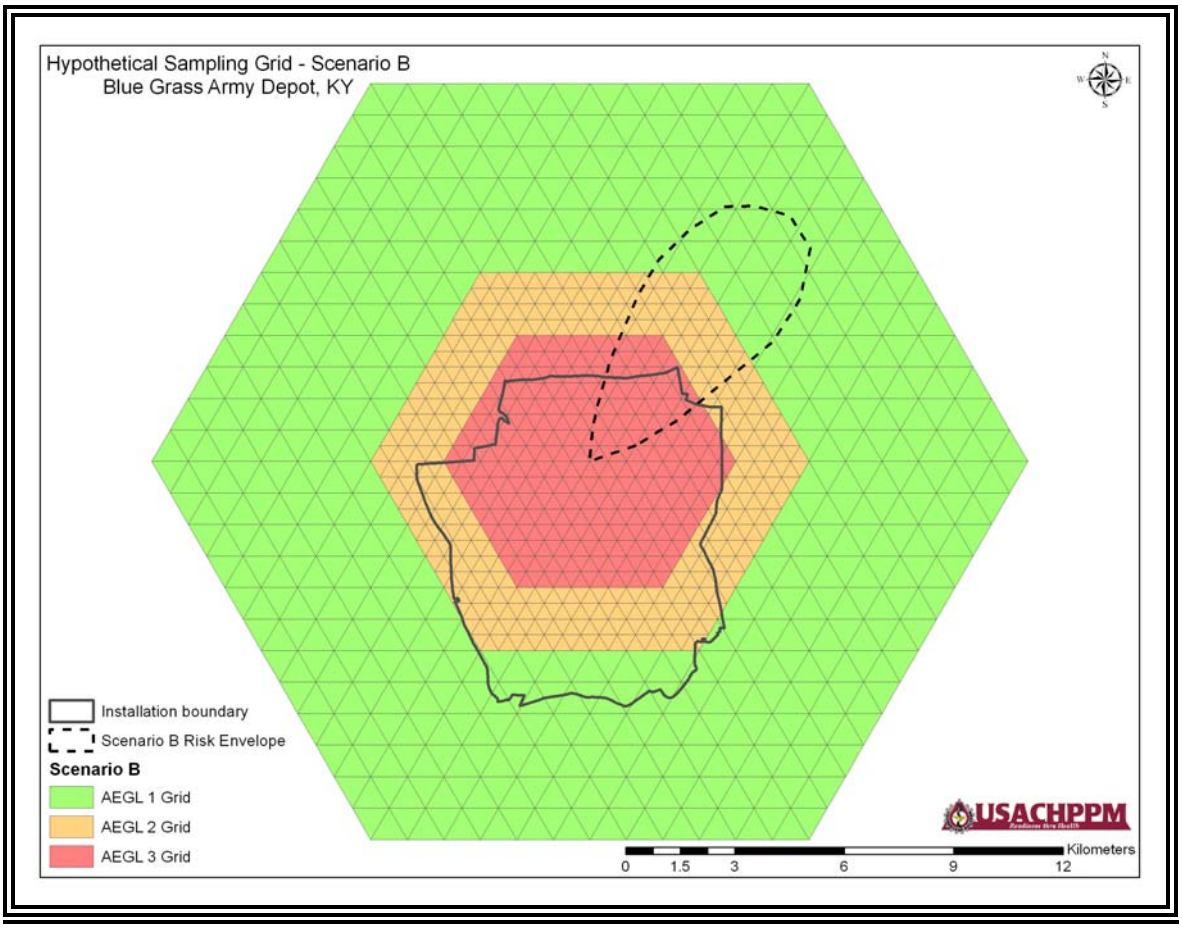

Figure 3-6. GIS Grid Scheme Based on Scenario B Plume.

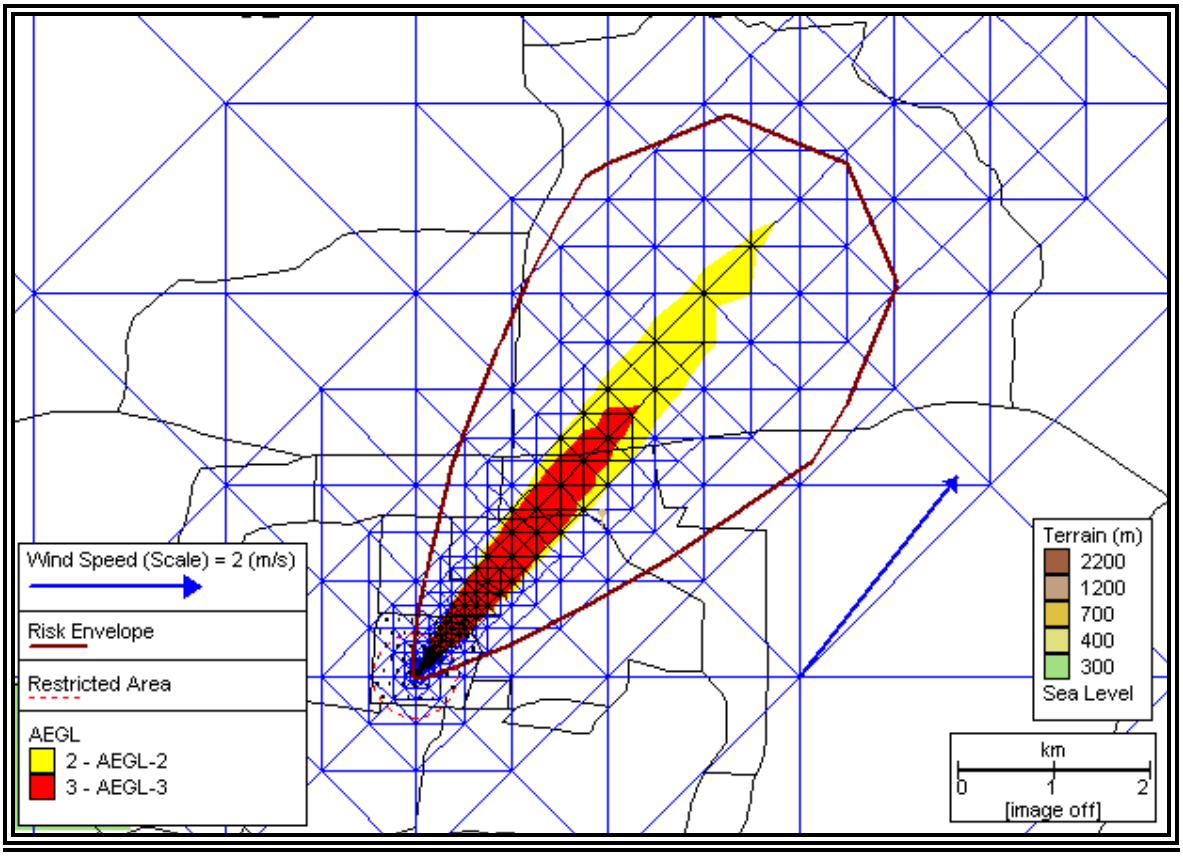

Figure 3-7. Adaptive Grid Scheme Generated by Web-PUFF for Scenario B.

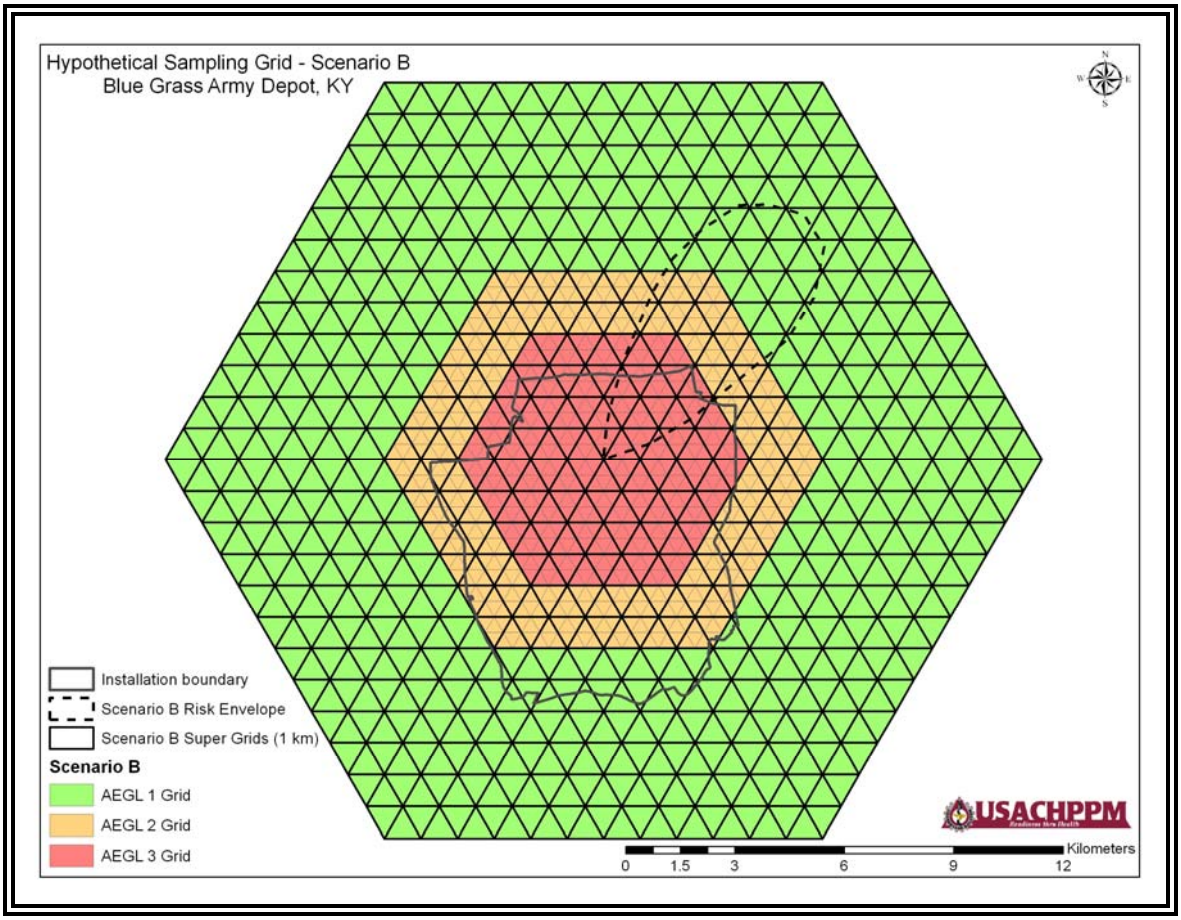

Figure 3-8. Clearance Zones Overlain on Static Grid Scheme for Scenario B.

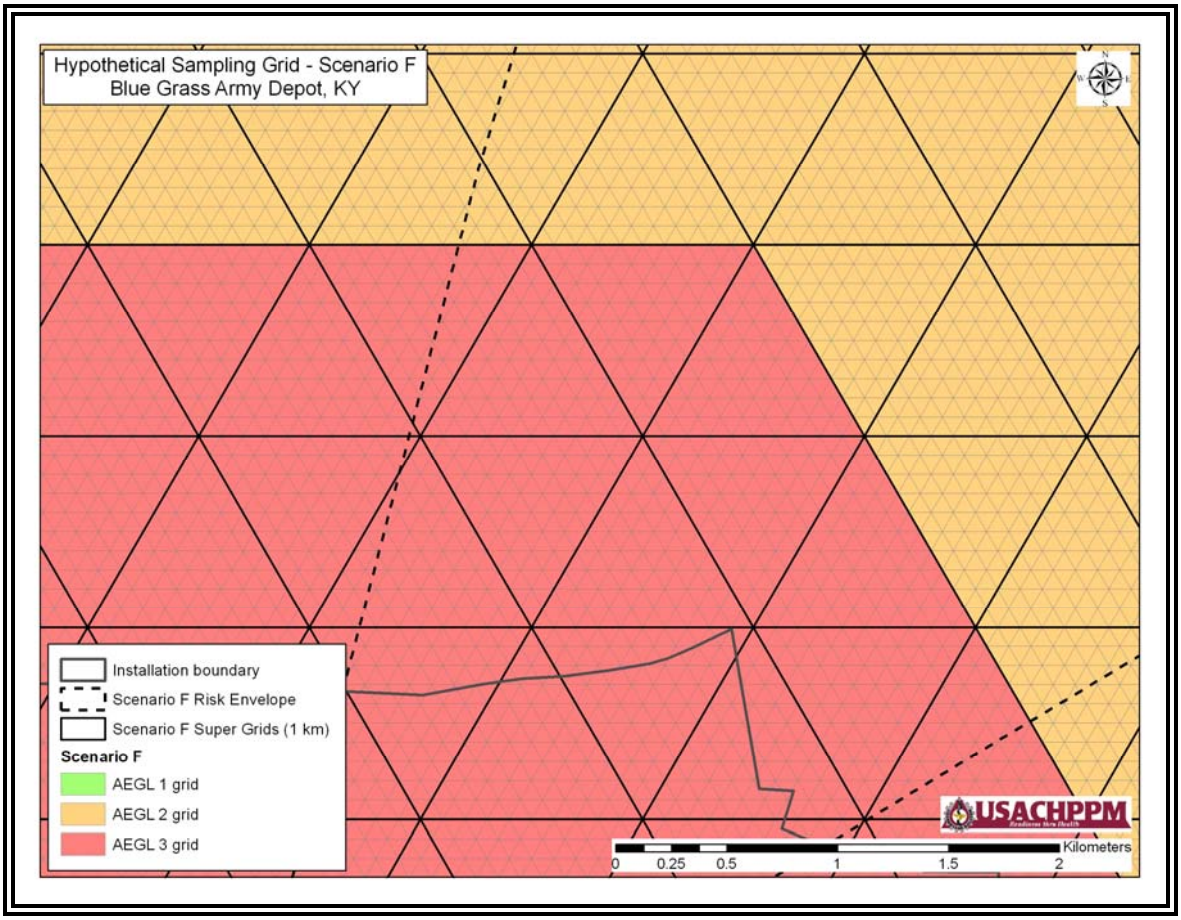

Figure 3-9. Zoom In on Clearance Zones Overlain on Static Grid Scheme for Scenario F Depicting Interlocking Grids.

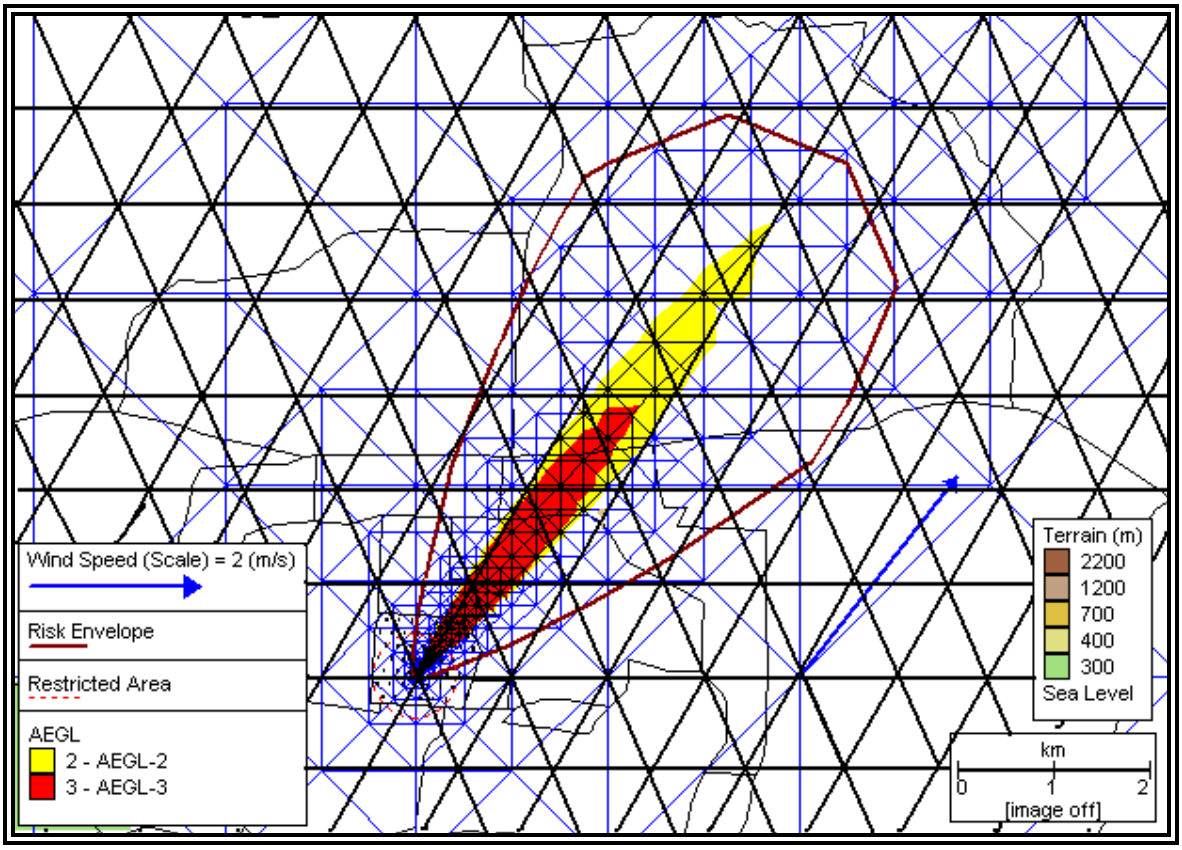

Figure 3-10. Clearance Zones (Black) Overlain on Adaptive Grid Scheme for Scenario B.

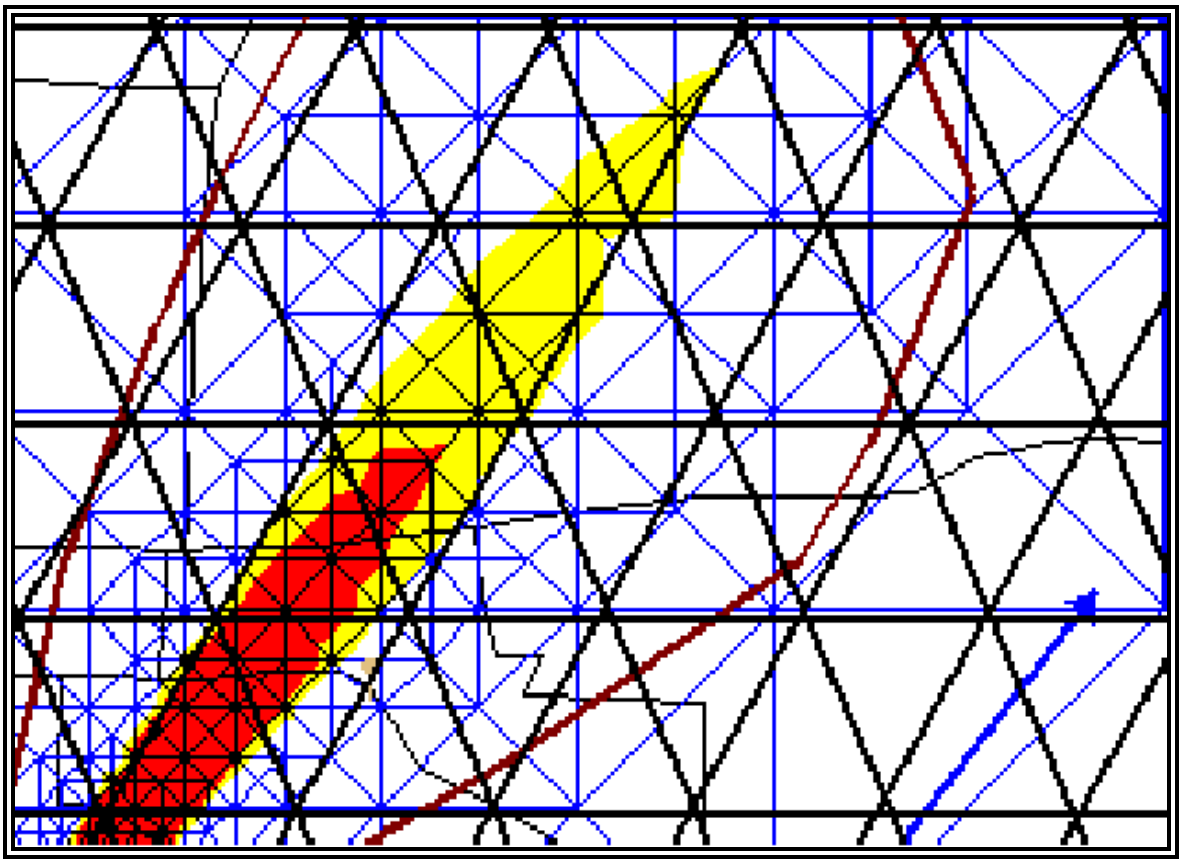

Figure 3-11. Zoom In of Clearance Zones (Black) Overlain on Adaptive Grid Scheme for Scenario B.

d. Grid Nodes Samples. Regardless of the grid scheme being utilized, samples will be collected from static and adaptive grid nodes located in or immediately adjacent to the projected plume area. Depending on the phase of the response that is occurring, air, wipe and soil samples will be collected. Water samples would also be collected if the predominant topographical feature in the immediate area is a lake, river or wetland.

(1) *Locations*. Grid node locations will be identified using the coordinates available from the digital maps used in conjunction with grid/plume generation. The coordinates generated should be compatible with GPS units. GPS units will be the primary navigation tool for sampling teams when locating sampling points. Additionally, GPS units will be used to record nongrid node sample points that are collected.

(2) *Samples*. One air, soil, wipe, and water sample (if applicable) will be collected at each grid node location. Each sample will be collected within 100 feet of the grid node with an applicable description of the overall site and the location of the sample with respect to the node center point.

e. Interior Grid Samples. Interior grids may potentially contain residential dwellings and other locations containing sensitive populations, commercial businesses, and agricultural facilities. The types of samples collected at each location will vary due to potential exposure pathways that exist at these locations.

(1) *Residential Dwellings and Sensitive Populations*. Samples types collected from residential dwellings and sensitive populations (e.g., residential housing, schools, and retirement communities) include air, wipes, and bulk headspace samples Air samples will be collected in the family room. Wipe samples will be collected from automobile windshield and kitchen/bathroom surfaces. The bulk headspace sample will be an item(s) used within the family or bedroom. In dwellings with small children, this item will be collected from one or more children's bedrooms.

(2) *Commercial Buildings*. Sample types that will be collected in commercial buildings (e.g., mall business, office complex, and store) include air and wipe samples. The number of samples collected within each unit will be dependent on the total area of the commercial activity. Samples will be collected in office areas and worker focal points.

(3) *Agricultural Facilities*. Sample types that will be collected at these locations include biological, soil, and water. For significant agricultural activities located on land, soil and vegetation samples will be collected. For agricultural activities involving or located on water, such as a fish farm, water and/or sediment samples will be collected. Dead animals should also be collected based on their location and the number that are observed.

(4) *Judgmental Samples*. Judgmental samples are collected at locations based on decisions made by the Sample Team. Locations selected using this rationale are typically not part of the planned sample scheme. Reasons for this may be the inherent uniqueness of the location, special requests, or an instinctive need to sample based on professional judgment. Possible locations where judgmental samples might be collected include low lying areas such as drainage ditches, areas surrounding suspicious, unknown pools of liquid, areas around large animal die off, areas around severely impacted vegetation, and other suspicious locations. The sampling teams in consultation with the Operations Team will determine where and when these samples will be collected.

3-7. **Number of Samples**. The total number of samples collected will be dependent upon the size and shape of the plume, the sampling scheme being used, and the number of dwellings/commercial activities located within each Clearance Zone. Though the decision criteria will be relevant when evaluating the data, it will not be a factor in determining grid size or the number of samples collected within each grid. Grid size will be based on the size of the plume relative to the areas of the plume categorized as AEGL 2 and AEGL 3. The sampling scheme used will be a matter of preference between how the static and adaptive grids are implemented. Sampling of Clearance Zones will be based on a hypergeometric distribution which is based on the number of contaminated dwellings/activities within a given area, not the magnitude of the contamination.

a. Phase I Samples. The number of samples collected that are related to Phase I operations will be directly related to the size and shape of the plume and location of the traffic corridor. Large grids that are cleared for re-entry quickly will have significantly fewer samples than small grids cleared slowly. Monitoring stations will be setup along corridors at intervals that are equivalent to the grid spacing particular to that area. These stations will remain in place until the Clearance Zone each monitoring station is located in has been cleared for re-entry.

b. Grid Nodes. The number of grid nodes that will potentially need to be sampled will be based on the grid scheme being utilized (static or adaptive). In each case, only those grid nodes that are part of grids that have been intersected or enveloped by the risk envelope will initially be of interest. There are several options that can be implemented to effectively evaluate the area. These include comprehensive, transect, systematic, and random sampling. There are a variety of ways to implement the schemes. The ones described below are examples on how these might be implemented. The best scheme to utilize will be based on the preference of persons developing and implementing the RSAP.

(1) *Comprehensive Sampling*. Comprehensive sampling would entail sampling every grid node located within the risk envelope. The number of samples vary depending on the type of plume that occurs. For plumes that are relatively short and wide, the number of samples will be considerably less than if the plume is long and narrow. This is seen in Figures 3-12 through 3-16 using both a static and adaptive grid. Figures 3-12 and 3-13 depict a short, wide plume as

compared to Figures 3-14 through 3-16 that depict a long, narrow plume. While comprehensive sampling will give the most complete coverage, it will also be the most resource intensive of the schemes.

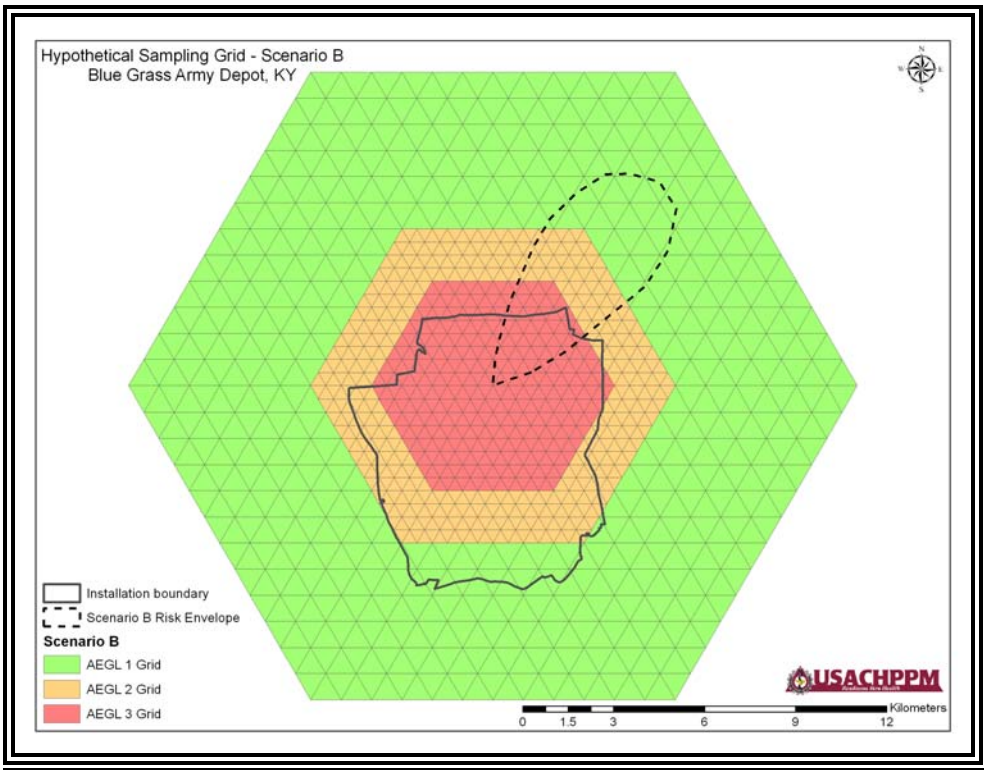

Figure 3-12. Static Grid for a Short, Wide Plume.

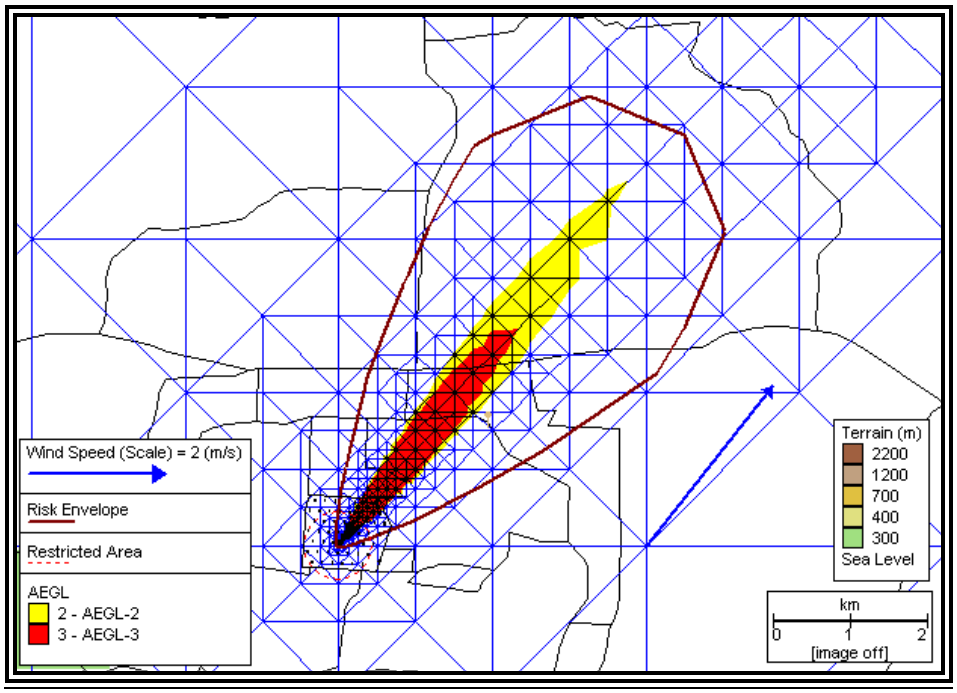

Figure 3-13. Adaptive Grid for a Short, Wide Plume.

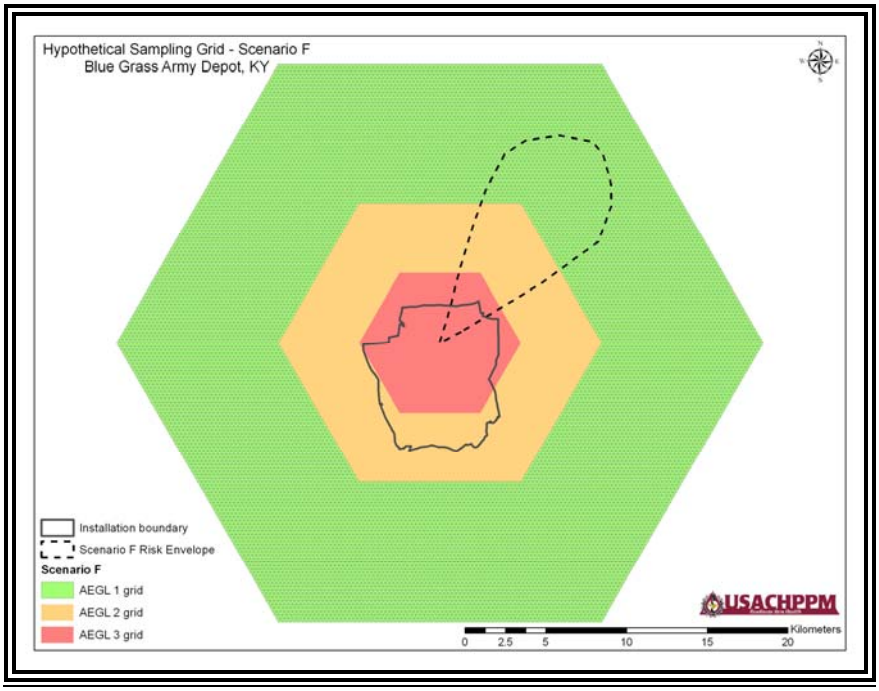

Figure 3-14. Static Grid for a Long, Narrow Plume.

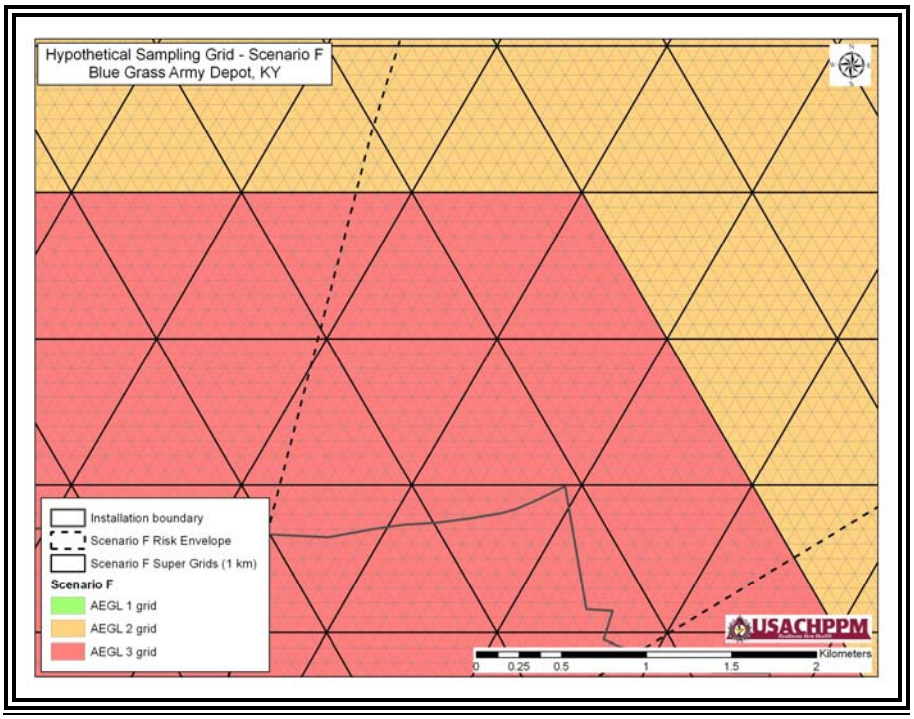

Figure 3-15. Closeup of Static Grid with a Long, Narrow Plume.

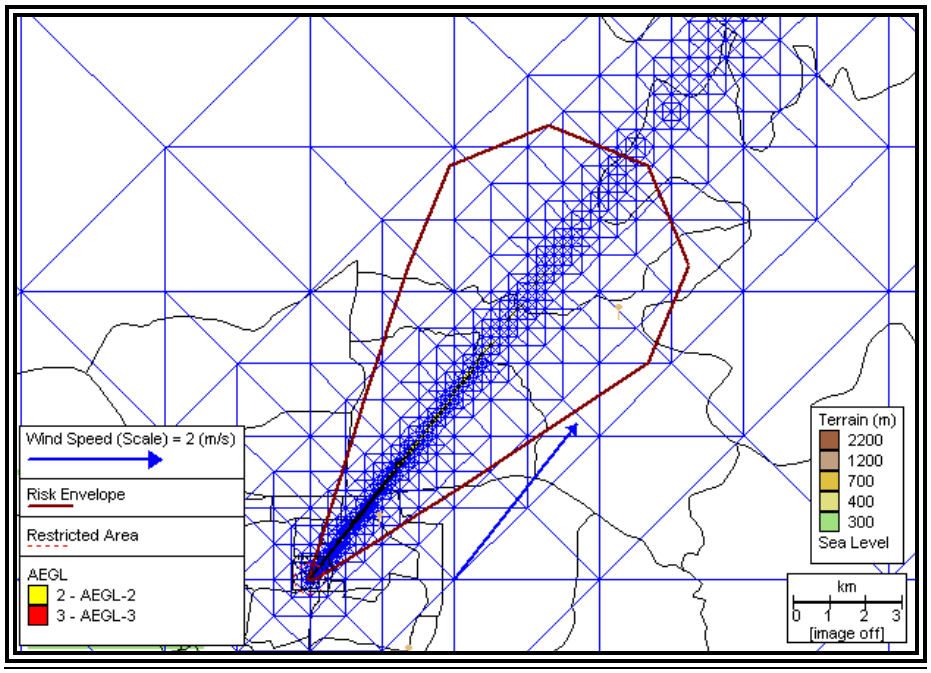

Figure 3-16. Adaptive Grid for a Long, Narrow Plume.

(2) *Transect Sampling*. Transect sampling consists of sampling along specific lines of the grid at regimented intervals. In doing so, all areas of the grid are sampled in some capacity. Transects should crisscross the risk envelope every 1 kilometer. For static grids, these could be laid out to correspond with the boundaries of the Clearance Zones that blend with the static grid nodes. For adaptive grids, transect lines will likely not correspond with the Clearance Zones. While the size and shape of the plume will impact the number of samples collected along the length of each transect, the spacing of transects from each other would remain the same. As can be seen in Figures 3-17 and 3-18, the transect lines will only reduce the sample load in those instances when the grid size is less than 0.5 kilometer.

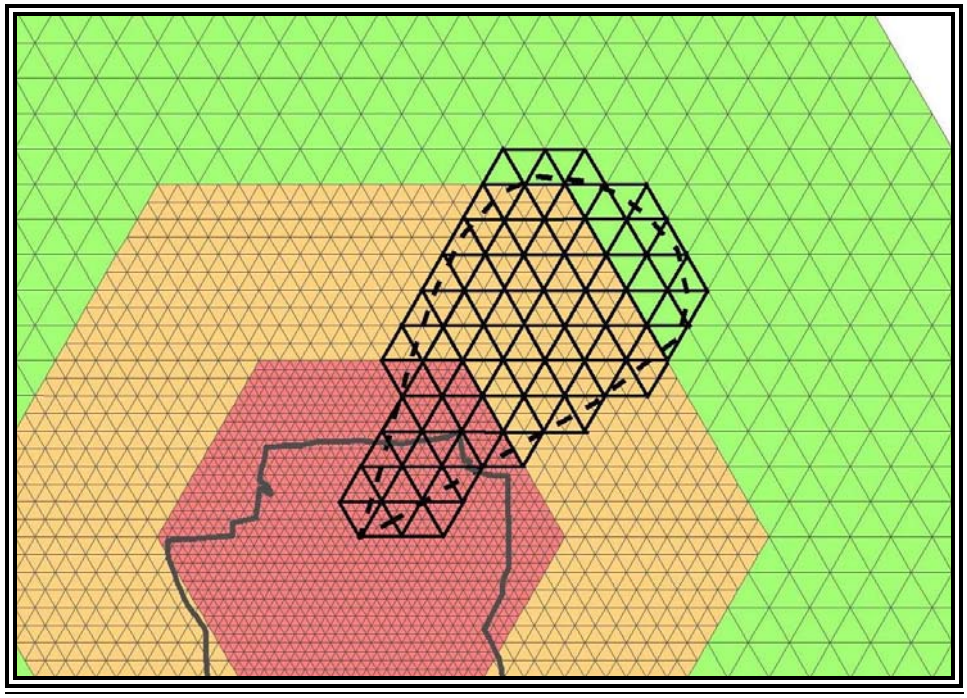

Figure 3-17. Static Grid with Transect Lines.

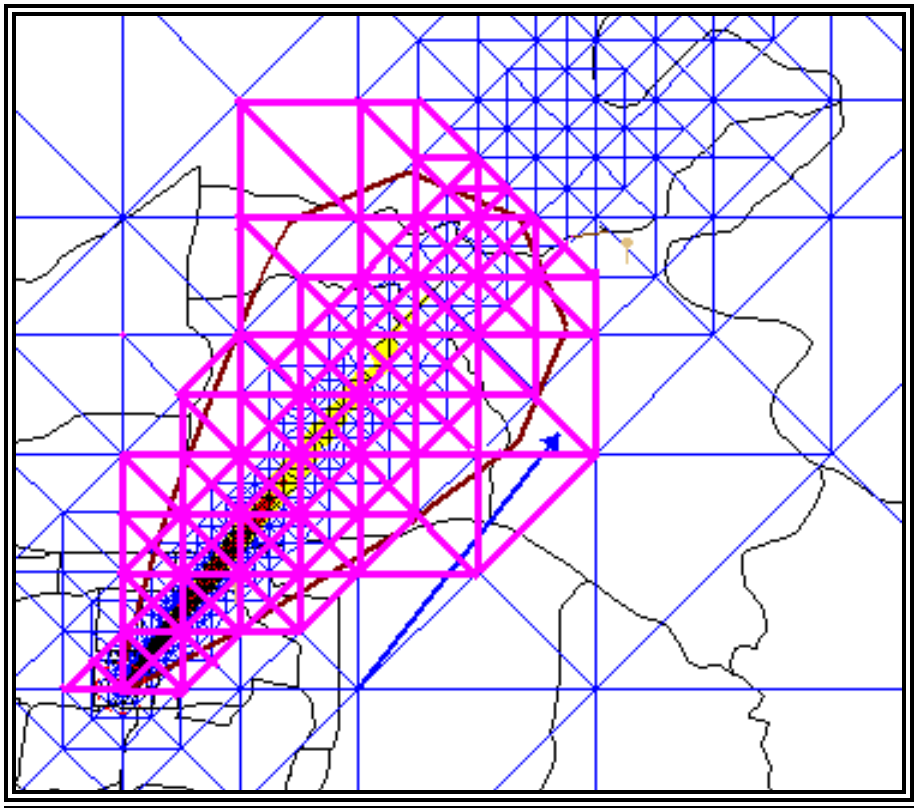

Figure 3-18. Adaptive Grid with Transect Lines.

(3) *Random Sampling*. Random sampling consists of collecting a set number of samples from grid nodes randomly selected from within a given area. As with systematic sampling, this technique is more easily implemented using a static grid. This technique is similar to that used to assess residential dwellings/commercial activities (see Clearance Zone Sample Size Determination for a more detailed explanation of this process). The number of grid nodes sampled will be dependent on the total number of grid nodes that are present of specific grid sizes (i.e., number of grids with sides measuring 100 meters or number of grids with sides measuring 1 kilometer). The total number of grid nodes for each grid size would then be used to calculate the total number of grid nodes to sample within each grouping. The grid nodes to be sampled would then be randomly determined within each grouping. Figure 3-19 illustrates this process.

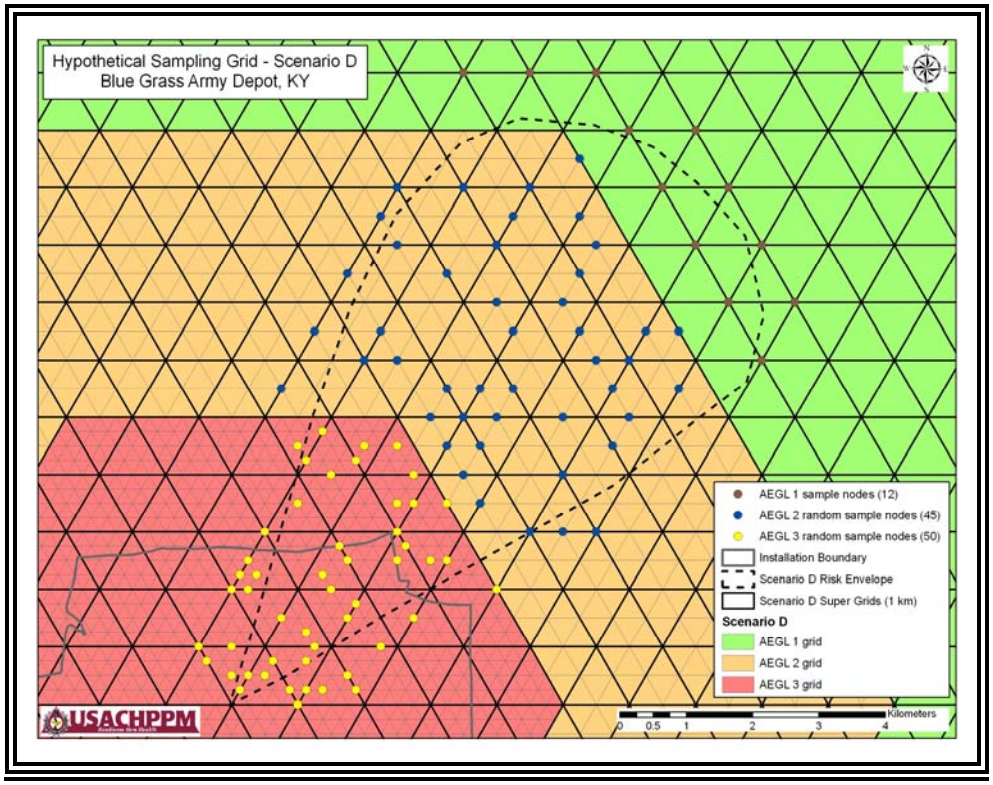

Figure 3-19. Sampled Grid Nodes Using Random Sampling.

(4) *Systematic Sampling*. Systematic sampling consists of sampling at specified intervals or spaces. The starting point or center of the grid scheme should be located within the storage area and not necessarily focused on any particular storage location; the middle or central location within the storage area would be ideal. Rather than sample every grid node within the risk envelope, specific grid nodes are sampled following a distinct pattern designed in conjunction with the Clearance Zones. The number of grid nodes sampled could be identical to the number determined for using the random sampling scheme. Using the systematic sampling scheme, the number of grids to be sampled would be evenly distributed amongst each of the corresponding Clearance Zones. Another option is to base the number of grid nodes sampled on the number of grid nodes associated with each Clearance Zone. Though systematic sampling could be performed using an adaptive grid, due to the grid layouts that result, it is not as easily implemented as with a static grid. Figure 3-20 depicts a scheme where specific grid nodes within each Clearance Zone are sampled.

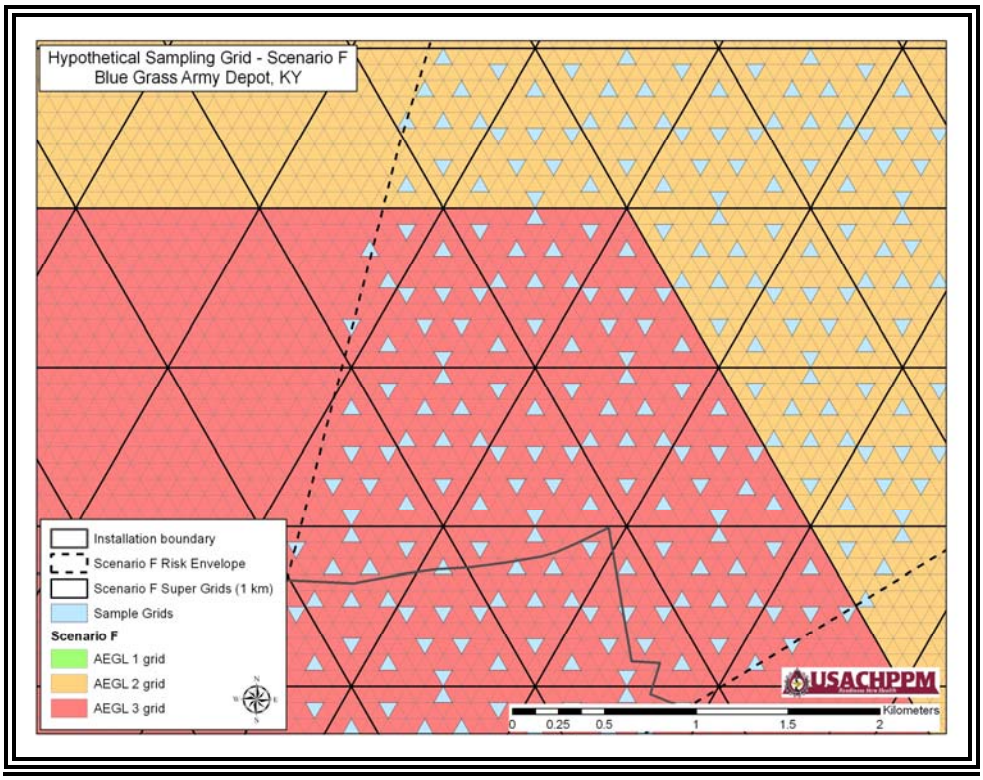

Figure 3-20. Sampled Grids Using Systematic Sampling.

c. Clearance Zone Sample Size Determination. Clearance Zone sample numbers will be determined using a nonparametric process using a hypergeometric distribution. CWA data reporting will be based on the presence or absence of CWA associated compounds at or above the given decision criteria, the concentration at which the CWA is reported above the criteria is not a factor. As previously discussed, the higher the confidence level desired, the greater the number of samples that will be required. This process will be used for determining the number of air and wipe sample locations within a given Clearance Zone. For water locations, (i.e., lakes, ponds, and significant streams), it should be used for determining total number of locations to sample within the entire impacted (plume) area.

(1) *Sample Number Calculations*. The underlying assumption for calculating the number of samples to be collected is that some unknown number of contaminated dwellings/commercial activities are located within each Clearance Zone. The number of units sampled will be dependent on the number of units present within each Clearance Zone and the probability desired that at least one contaminated unit would be captured within the number of samples collected using a hypergeometric distribution. The hypergeometric distribution describes the number of dwellings that need to be reported as not contaminated in order to demonstrate the dwellings are not contaminated at a given level of confidence. A failure would be one or more samples that

are reported to contain CWA above the decision criteria. In utilizing this strategy, an assumption must be made regarding the percentage of contaminated units that are thought to be present. For the purpose of sampling, it will be assumed that 5% or more of the units within each Clearance Zone are potentially contaminated. This value can vary based on stakeholder input. However, if the basic concern becomes finding the single contaminated dwelling/activity within a given Clearance Zone, every dwelling/activity unit will need to be sampled. In Clearance Zones with a small number of dwellings/activities, a majority and possibly all of the units will need to be sampled assuming 1% or 5% of the total number of units are contaminated. As the number of dwellings/activities increases, the overall percentage that must be sampled decreases. Table 3-3 presents several iterations of sample sizes assuming a hypergeometric distribution at various probability levels. The probability level is the likelihood that a contaminated unit would be detected within the given sample size assuming 5% or more of the units were contaminated. For comparison sake, the sample size needed to detect a contaminated unit assuming 1% or more of the units were contaminated is also included. The probability of detection should equal the confidence level discussed or decided upon in the DQO process. Based upon the sample numbers presented in Table 3-3, it is evident that grids with a lower number of units will achieve a higher level of confidence. Table 3-3 values were generated using a web-based hypergeometric sample size calculator (http://Stattrek.com).

Table 3-3. Clearance Zone Sample Numbers Based on a Hypergeometric Distribution.

		Total Number of Dwellings/Activities			
		20	50	100	500
		Samples Needed			
Probability of Detecting at Least One Contaminated Dwelling/Activity (5% plus contaminated Dwellings/Activities)	90	18	27	36	43
	95	19	32	45	55
	99	20	39	59	82
		Total Number of Dwellings/Activities			
		20	50	100	500
		Samples Needed			
Probability of Detecting at Least One Contaminated Dwelling/Activity (1% plus contaminated Dwellings/Activities)	90	18	45	90	185
	95	19	48	95	225
	99	20	50	99	300

(2) *Residential Dwelling Sample Number Determination*. For sample number determination, a residential dwelling was assumed to measure 5,000 square feet (sq ft) or less. Most residential houses should fall under this category. For those locations that are greater than 5,000 sq ft, additional dwellings should be counted for each additional 10,000 sq ft over 5,000. A single house of 4,000 sq ft would be considered one dwelling. A row of town homes containing four residential units of 1,500 sq ft would be considered four dwellings. A retirement community consisting of 200,000 sq ft would be considered 20 dwellings.

(3) *Commercial Activity Size Sample Number Determination*.

(a) Buildings. The number of samples collected at commercial facilities will be determined in a manner similar to residential dwellings. The number of samples will be based on the number of commercial activities that are present. One sample will be collected from each commercial activity with an area of 10,000 sq ft or less. For those locations that are greater than 10,000 sq ft, one additional sample should be collected for each multiple of 15,000 sq ft over 10,000 sq ft.

(b) Agricultural Operations. Significant agricultural operations will vary in size and capacity depending on the operation occurring (i.e. commercial crops, poultry, cattle, hogs, or breed stock). Sampling of activities such as these should be limited to larger operations which have a significant economical impact to the area as determined during the DQO process. In the event that sampling will occur, sample efforts should focus on major aspects of the operation – poultry houses, feed pens, or produce storage areas. In lieu of, or in conjunction with sampling, an animal health/plant survey should be performed to ascertain whether any physiological effects are observable or have occurred.

(4) *Sample Distribution*. Ideally, sample locations will be randomly determined. However, determining sample locations in this manner allows for clusters to occur potentially in a manner that will skew all sample locations to one portion of a grid. Efforts should be made to minimize the impacts of clustering to ensure some portions of the samples are collected from dwellings/activities located throughout the grid.

(5) *Judgmental Samples*. The number of judgmental samples collected will be incident and site specific. These types of samples will predominately be those collected from low lying areas that may serve as contaminant sinks and from locations that biological samples are collected (e.g., where dead animals are found). The types of media that may be collected will be location specific and may include the following: air, biological, exterior surface water, wipes, and soils. Sampling teams will consult with the Operations Team prior to collecting any judgmental samples. This will ensure adequate supplies are available for scheduled sampling and minimize the spontaneous collection of judgmental samples by each of the sample teams.

3-8. **Sample Collection**.

a. Sample Container, Storage, and Preservation Requirements. Proper management of samples is necessary to ensure sample integrity is maintained from sample collection to sample analysis. Table 3-4 lists the requirements for each media type sampled. The requirements listed in Table 3-4 are to serve as guidelines for establishing site-specific sample management requirements though it would be best to make these as uniform from site to site as possible.

Table 3-4. Sample Container and Preservation Requirements.

Media	Container	Volume Required	Preservation	Maximum Holding Time (days)
Soil	4 oz glass bottle with Teflon®-lined cap	2 x 100 g	4±2°C	7
Water	100 mL amber glass bottle with Teflon-lined cap	4 x 100 mL	pH < 2 4±2°C	ASAP
Wipe	40 mL glass vial with Teflon- lined cap	2” x 2” wipe	4±2°C	7
Air	DAAMS Tube	8-hr sample	4±2°C	ASAP
Snow	4 oz glass bottle with Teflon-lined cap	Lab dependent	< 0°C	7
Bulk Headspace	CWA Impermeable Plastic Bag	n/a	4±2°C	7
Biological	CWA Impermeable Plastic Bag	n/a	< 0°C	Indeterminate

Notes:
Based on guidance provided in SW-846 (EPA, 2004) and DA Pam 385-61.
Teflon® is a registered trademark of E.I. Dupont de Nemours & Co., Inc., Wilmington, Delaware.

b. Sample Collection Priority. The primary focus of sample collection will be to collapse the impacted area as quickly as possible. Sampling will focus on the outside areas first working in towards the areas potentially impacted the greatest. This will facilitate clearing outer areas where minimal impacts are expected down to those areas of greater concern. Given a shortage of manpower and/or equipment, Table 3-5 provides a recommended list for use in prioritizing sample collection.

Table 3-5. Recommended Sample Collection Priority.

Priority
Emergency Evacuation Routes
Outer Perimeter of Deposition Area
Field Report of CWA Located Outside Reported Impacted Area
Sensitive Populations – Schools, Hospitals, Daycare Facilities, Retirement Communities
Residential Dwellings
Commercial Businesses
Significant Agricultural Facilities

c. Sample Collection Techniques.

(1) *Soil*. Soil samples should be collected within 100 feet of the sample coordinate or location of concern. When selecting the specific sample point, the site should be free and devoid of surficial matter such as leaves, twigs, trash, or any other organic matter that might be covering the surface, open bare soil being the ideal condition (e.g., such as around swing sets, ball fields, or highly traveled areas). Any organic matter in the sample may adversely affect the laboratory analysis by facilitating the degradation of target analytes and/or by introducing interferences into the sample analysis process. Soil samples are collected using a stainless steel/Teflon scoop or spatula. Using the scoop/spatula, scrape and collect surface soil to a depth of no more than ½ inch. Place the sample directly in the sample container. Fill the container such that there is no headspace (soil fills the jar to the rim). Tightly close and label the container. The sample should not be mixed or homogenized in the field. This may potentially accelerate the degradation/vaporization of target analytes and skew sample results to the low side.

(2) *Water*. There are two types of surface waters that may be collected – lentic (slow moving) and lotic (fast moving). The procedure for collecting each type of sample will vary slightly in order to minimize facilitating agent hydrolysis.

(a) Lentic Water. Water samples collected at lentic water locations will be collected from shallow areas located along the edge of the site. The sample container will be gently lowered

into the water to facilitate water flow and minimize turbulence. The container should not be completely filled; otherwise, the potential for leakage exists if the sample undergoes any pressure changes while being shipped.

(b) Lotic Water. Water samples collected at lotic water locations will be collected from shallow, calm locations along the edge of the site. Such locations will likely occur in bends or where a dock or tree project out into the water creating an area of little turbulence and currents. Once the sample location has been determined, the sample will be collected in the same manner as a lentic water sample. The sample container will be gently lowered into the water to facilitate water flow and minimize turbulence. The container should not be completely filled; otherwise, the potential for leakage exists if the sample undergoes any pressure changes while being shipped.

(c) Sediment. In lieu of water samples, sediment samples from along the edge or from very shallow locations along the edge of either type of water can be collected. These should be collected in a manner very similar to soil samples. Sediment samples should be collected along the water line in calm areas where minimal wave action occurs. In such locations, the mixing, dilution and hydrolysis of chemical agents would expect to be minimized. As with soils, the sample should be collected to a depth of no more than ½ inch and each sample container should be completely filled with minimal to no mixing prior to filling each container.

(3) *Air*. The methods for collecting and processing of air samples are described in DA Pam 385-61.

(4) *Wipes*. Wipe samples are collected using an acrylic or nonreactive swab that has been wetted with an appropriate collection solvent. The collection solvent serves to facilitate absorption and retention of the target analyte to the wipe when it is passed over the sample area. The laboratory performing the analyses will specify the wetting agent to be used. After removing the wipe from the sample container with a gloved hand, the wipe is passed over a measured area (typically 10 cm by 10 cm) in an up-and-down motion. After folding the wiped side onto itself, the wipe is then passed over the same area in a back-an-forth motion. The wiped side is folded onto itself again whereupon the outer perimeter of the sample area is wiped. The wipe is then placed back in the sample container, tightly closed, and labeled. The area to be wiped is typically collected using a premeasured template to speed up the collection process. The total area wiped can be of any area (e.g., 100 cm^2 or 1 sq ft) so long as the same area is used consistently and is recorded for each sample. No more than one wipe sample can be collected from each sampled location. Additional wipe samples need to be collected either adjacent to or at some other distance from the initial sample. Table 3-6 delineates suitable wipe sample locations.

Table 3-6. Suitable Surfaces for Wipe Sample Collection.

Locations
Automobile Windshields
Window Panes
Kitchen/Bathroom Sinks and Bathtubs
Tile Kitchen/Bathroom Countertops/Floors
Ventilation Ducts/Inlets/Outlets

(5) *Biological*. For the most part, biological sample material (e.g., birds, insects, small mammals, and leafy plants) will simply consist of collecting the specimen and placing it within a labeled sample container. Preferably, samples will be collected using a set of tongs or other grasping device and placed in a CWA impermeable bag. For a larger animal, it may be necessary to collect a specimen from the carcass.

(6) *Bulk Headspace*. Collection of samples will basically consist of ensuring the sample container is not overfilled and that all sample locations and items are properly documented. Each item collected will be placed in a large CWA impermeable bag; the location and a brief description of each bulk headspace item collected shall be recorded in a field notebook. Depending on the size of the items, one bag can be used to collect multiple areas from within the same area/grid, but no more than 20 items should be collected per bag. The bag should be tightly closed between each sample to minimize the air exchange into and out of the bag. The laboratory will then process these samples and obtain a headspace reading to determine whether CWA are present in measurable quantities. The results from a bag of samples would be applicable to entire area they were collected from. Bulk samples can be combined from multiple Clearance Zone areas with the understanding that reported results good or bad are applicable to each area that was sampled.

(7) *Snow*. For some sites, the potential for snow to be present during an event exists. In this event, soil and wipe sampling may be rendered unnecessary since the outdoor surfaces that would normally be sampled would be snow covered. In this event, rather than collect either soil or wipes, snow samples are to be collected. If the event occurs during a snow event with no previous snow deposition, snow cores with a 3-inch diameter will be collected. If the depth of the snow is insufficient, additional core samples will be collected until the sample container is full. If snow was present prior to the CAI, collect snow from the top 2 inches or less until the sample container is full. Snow samples should be stored at a temperature of 0 degrees Centigrade (°C) or less or such that the samples remain frozen. Allowing the sample to melt may accelerate the degradation/hydrolysis process and skew the results low. Snow samples will be processed in the laboratory using water procedures. For the purposes of analysis, the laboratory may require additional sample containers to be collected to ensure an adequate sample size.

d. Analytical Methods. The specific analytical methods that are to be used will be determined by the decision criteria that are selected. It should be restated though that the EPA HQ is currently in the process of validating several methods for analyzing chemical agents in various environmental media (EPA, 2007). Though these methods will only be recommended, the individual EPA regions may require these methods to be used to ensure data acceptance unless alternative methods presented have strong and sufficient evidence to demonstrate their validity for use with these compounds. If EPA standards have not been verified, validation studies for the methods listed in DA Pam 385-61 might be necessary (at the programmatic level) for these methods to be considered valid.

e. Documentation. Properly documenting the work activities, decisions, and events that occur during the course of the response is essential for the success of any project.

(1) *Sample Numbering Scheme*. Due to the number of samples that will potentially be involved and the diversity of sample teams and laboratories that might be utilized, it will be necessary to establish a standardized sample number scheme. The numbering scheme will need to take into account Clearance Zones, grid nodes, dwelling/commercial activity locations, and media. It would also be prudent to number the sample teams and incorporate this number into the numbering scheme. When designing a sample number scheme, use the European numbers and letters and refrain from using letter and numbers that can be mistaken for each other. Below is an example of a numbering scheme that might be used.

(a) For Interior Clearance Zone Samples:

- Clearance Zone # - Dwelling/Commercial Activity # - Media – Team Number – Sample # from location

  Z-DW001-SL-12-005

This number describes the fifth soil sample collected by Sample Team 12 at dwelling #1 located in Clearance Zone Z. If composite samples are collected, the dwelling/commercial activity components can be removed to reflect the data from the sample being applicable to the entire grid. The dwellings and commercial activities represented by a composite sample will be annotated in the field notebook.

(b) For Grid Node Samples:

- Grid Node # - Media – Team Number – Sample # from location

  20-AR-11-001

This number describes the first air sample collected by Sample Team 11 at grid node 20. It will be incumbent of the Planning and Operation Teams to understand the relationship between the grid node samples and the Clearance Zones to which they pertain to since the data from some grid node samples will be relevant to multiple Clearance Zones.

(2) *Field Notes*. Field notes are used to document information and events that occur in the field that may or will be relevant for interpreting the sample results. Accurate and complete field notes are essential for generating defensible data.

(a) Entries. Field notes will be maintained in a legal bound notebook using an indelible pen. All entries into the notebook should be legible. The following information will be recorded for each sample collected.

- Sample Number
- Media Sampled
- Sample Technique Utilized
- Analyses Required
- Time Collected
- Sampler
- Sample Description
- Volume of Sample per Bottle (approximate)
- Site Description
- Sketch of Site With Sample Location(s)
- GPS Coordinates
- Field Conditions
- Serial Numbers of Sample Bottles (if applicable)
- Changes or Modifications Made From the Sampling and Analysis Plan

(b) Corrections. Any corrections or invalid entries should be lined out, initialed, dated, and marked with a reason code. The following reason codes are recommended for use. Other codes can be used but should be defined within the RSAP.

- RE – Recording Error
- CE – Calculation Error
- TE – Transcription Error
- SE – Spelling Error
- CL – Changed for Clarity
- DC – Original Sample Description Changed
- NI – Not Initialed at Time of Entry
- WO – Write Over
- OB – Not Recorded at Time of Initial Observation

(3) *Chain-of-Custody*. An effective chain-of-custody (CoC) program is essential for demonstrating sample integrity and security has not been compromised. CoC is accomplished by ensuring that all samples are under the control of the sampling team or laboratory team. An effective CoC program will take some time and effort. The benefits of the CoC program will be evident when, and if, the validity of the analytical data is challenged. CoC procedures should be fully addressed and defined within the RSAP and QAPP.

(a) Sample Control. Control is defined as having the samples in one's possession at all times in a manner that prevents unauthorized access to the sample. The Sample Team will maintain CoC in the field possessing and/or visually observing the sample at all times. During those occasions when the team cannot do either, the samples will be secured. The laboratory team will maintain CoC by limiting access to sample storage and processing areas to essential personnel. CoC procedures may vary between laboratories. In the event that unauthorized persons gained access to a given sample, this will be made evident by various security devices (i.e., locks, secure areas, or CoC tape) having been compromised.

(b) Documentation. When sample control is transferred from one team to another, a CoC form will be completed and signed by both the person transferring and accepting control of the sample. The person accepting control of the samples will then be responsible for maintaining CoC from then on. CoC responsibility for the samples will be passed to each person who accepts control of the samples. An example of a CoC form is provided in Appendix F. A copy of each current and completed CoC form should be maintained at all times from a CoC perspective and for sample tracking purposes.

(4) *Decision-Making*. A detailed account of information and specific actions and decisions should be maintained throughout the entire recovery process. This documentation will detail the why's and when's of decisions and requests that are made while implementing and making any modifications to the RSAP during an event. Both the Planning and Operations Team Chiefs should maintain daily logs of the day's events along with any significant decisions that are rendered. It may be in the format of a continuously updated document or a compilation of notes, memos, etc. This will facilitate the preparation of reports and briefings that will be presented to the IC/UC and after action reports that will be completed at the conclusion of all the recovery and re-entry activities.

(5) *Sample Locations*. All sample locations will be thoroughly documented with the use of GPS coordinates, street address, digital pictures that include a date/time stamp, and any other relevant materials/information the Planning Team deems relevant. This information will be archived along with any sample data generated from samples collected at the locations.

f. Field Quality Assurance/Quality Control Samples. Field QA/QC samples are used to assess assumptions used when developing the sampling and analysis plan and to assess the

overall sampling techniques that are used to collect samples. The two types of QA/QC samples that will be collected are duplicate and split samples.

(1) *Duplicate Samples*. Duplicate samples are used to assess the homogeneity of the contaminants within a given area. One of the underlying assumptions used within the sampling and analysis plan is that potential deposition of CWA within a given area will be homogeneous. Duplicate samples evaluate this assumption by comparing the concentration of contaminants within a specific area. Concentrations that are not statistically significantly different affirm the distribution assumption. Concentrations that are statistically significantly different imply that the distribution assumption may not be valid. In such instances, additional samples may be required. Duplicate samples are collected in an area immediately adjacent to the sample to which it is to be compared. The distance between the two samples can vary, but should be separated by a distance ranging from 10 to 50 feet. Whatever distance is used should be used consistently for all duplicate samples collected. The number of duplicate samples collected should number approximately 5% of the total number of samples collected per media. If possible, duplicate samples should collected though the duration of the sampling event to avoid collecting all duplicate samples at one time and location. This sample collection scheme may require the Operations Team to randomly select what locations duplicate samples will be collected on daily basis to ensure representativeness across the impacted area.

(2) *Split Samples*. Split samples are used to assess field sampling techniques. These samples are also used to assess the precision and accuracy of laboratory methods in a manner that is blind to the laboratory personnel. Split samples are used in conjunction with any split samples the laboratory may internally prepare themselves from submitted samples. Split samples are collected by placing an additional sample aliquot into a second set of sample containers. Concentrations that are not significantly different affirm that sampling and laboratory techniques were properly implemented. Concentrations that are statistically significantly different indicate techniques were not properly implemented. In such instances, samples may need to be recollected and/or reanalyzed. The number of split samples collected should number approximately 5% of the total number of samples collected per media. If possible, split samples should be collected though the duration of the sampling event to avoid collecting all split samples at one time and location. This sample collection scheme may require the Operations Team to randomly select what locations split samples will be collected on a daily basis to ensure representativeness across the impacted area. Consideration should be given to sending all split samples to a laboratory other than the one receiving the bulk of the samples. In this way, split samples can identify systematic trends within a laboratory that adversely impact data.

g. Archiving Samples. All samples that are collected and not consumed during the extraction and analysis process along with sample extracts will be kept in cold storage for a minimum of 3 years regardless of whether they were analyzed or not. Soil, biological, snow, and bulk samples will be maintained at a temperature of less than 0 °C. Water samples will be

maintained at a temperature of 2 – 6 °C. Sample extracts will be maintained at a temperature of 0 °C. See Chapter 6 for….

h. Weather Effects.

(1) *Rain*. When light to moderate precipitation is falling, sampling should initially be limited to the collection of air and indoor surface samples. CWA deposition occurring on wet surfaces or under wet conditions will impact the sample collection process. Depending on the amount of precipitation that has already fallen, CWA deposited on these surfaces may already have been washed off, diluted and/or hydrolyzed. Wipe samples would be particularly difficult to collect from wet surfaces since the wetting agent used is water soluble promoting CWA hydrolysis and diluting the sample. If soil and wipe samples are collected under wet conditions, efforts should be made to collect these samples from the driest location possible with emphasis being placed on the analysis for CWA degradation products.

(2) *Snow*. For some locations, a CAI may occur when snow is present or being deposited on the surface. In this event, soil and outdoor wipe sampling may be rendered unnecessary since potentially impacted surfaces would be covered and any resulting deposition would occur on snow. In this event, rather than collect soil or wipe samples, snow samples are to be collected. If the CAI occurs during a snow event with no previous snow deposition, snow cores with a 3-inch diameter should be collected. If the depth of snow is insufficient, additional cores should be collected until the sample container is full. If snow was present prior to the CAI, collect snow from the top 2 inches (or less) until the sample container is full.

(3) *Extreme Weather*. In the event of a CAI which is caused by or occurs under extreme climatic conditions such as a tornado, hurricane, or heavy rainstorm, sampling activities will be initially limited to the grids closest to the release point. If field reports indicate the presence of CWA outside the immediate release point, those areas can be incorporated into the sampling scheme. Models for air dispersion will not be able to accurately model these types of events. The sampling approach for these types of CAI will be a wait and see, with limited sampling unless or until otherwise indicated. If soil and wipe samples are collected under wet conditions, efforts should be made to collect these samples from the driest location possible with emphasis being placed on the analysis for CWA degradation products.

3-9. **Sample Management**. A dedicated team of personnel should be specifically assigned to managing all samples that are collected. These persons will be responsible for receiving and cataloging all samples collected by the sample teams. The Sample Management Team will be responsible for ensuring that all samples are stored properly, labeled, and shipped to the appropriate laboratory in an expeditious, controlled and safe manner. Improper management of samples will impact data quality potentially to the extent that the data is not usable. Resampling will likely not be an option. With most other types of environmental studies, samples can potentially be recollected in the event of an accident and/or the mismanagement of samples after

they are collected. With CWA events however, the chemicals in question may disperse, hydrolyze, degrade, or become diluted between the time of initial sampling and any subsequent sampling that may occur. It is crucial that sample management be given proper attention to ensure the generation of valid defensible data. The Sample Management Team will consist of persons from the Logistics, Operations, and Planning Teams.

a. Shipping. Critical to shipping will be ensuring the correct media and sample type are shipped to the appropriate laboratory. A number of sample types may potentially be collected that may necessitate the use of two or more laboratories which will each be tasked to analyze samples for specific components of CWA. Samples that are shipped to the wrong location will likely result in the sample holding times being exceeded thereby requiring the data to be qualified or rendered unusable. The Logistics Team will be responsible for packaging samples for shipment to the appropriate laboratories. The lead sample manager will maintain a log of sample shipments and notify each laboratory with respect to the number of samples and coolers shipped and the analyses being requested.

b. Storage. Proper sample storage is critical in all phases of the operation. From sample collection until the time the sample is analyzed, each sample will be required to be stored in a manner to ensure sample integrity from a security/tampering perspective and preservation of chemical parameters of interest. Improper storage from either perspective would require the data results to be qualified in some manner or rendered unusable. The Logistics Team will be responsible for receiving and storing samples until such time they are shipped to the appropriate laboratory. They will also maintain any samples that are collected for archival purposes.

c. Sample Tracking. There is the potential for a significant number of samples to be collected. As a result, it will be necessary to track the status of samples. Sample tracking would begin the moment the samples are collected by the sampling teams to the point the analytical results are validated during the final review process. In this way, the Sample Management and Operations Teams will be aware of the current status and location of each sample within the sample management/analysis train. Failure to track samples in any manner will likely result with lost samples, exceeded holding times, shipping/storage/container issues, and the inappropriate use/waste of critical resources. Sample tracking will be maintained by persons working in conjunction with the Logistics, Operations, and Planning Teams since elements of each team will be monitoring specific steps of the sample train.

d. Data Management. A significant number of samples may be collected in a short period of time. Sample analysis will be conducted onsite and at one or more set laboratories located across the country. Additionally, there will be several layers of data interpretation and review. Effective management of data will ensure all data results are accounted for and have been through the proper review chains thus allowing the command to make effective and timely decisions regarding the status of given areas that have been impacted by the event.

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CHAPTER 4 – POST-EVENT SAMPLING AND ANALYSIS PLAN DEVELOPMENT

4-1. **Background**. This chapter describes several activities that must be initiated after a release has occurred and prior to RSAP implementation. Completing post-event activities in a timely manner is highly dependent on having an RSAP in place with the realization that the RSAP may need to be modified to address unforeseen events and to make procedural adjustments based on field reports.

4-2. **Post-Event Activities**. Once an event has occurred, it will be necessary to finalize portions of the RSAP that could not be completed prior to the event. These portions can be completed during the emergency response phase of the event or shortly thereafter, since there will be some lag time between the event occurring and the readying plans, sample teams, and supplies for the first initial stages of recovery and re-entry sampling. Key elements that will need to be addressed, updated, and reviewed are listed below and are discussed in more detail in the following paragraphs.

a. Impacted Grids – whether using static or adaptive

b. Projected Sample Load – types and numbers based on the grids that are activated

c. Parameters to be Evaluated

d. Prevailing Weather

e. Sample Timeline

f. Laboratory Notifications

4-3. **Identify Impacted Grids**. The Web-PUFF model will be used to project the areas impacted by the plume. Based on the grid scheme being used, the impacted grids and Clearance Zones can be determined.

a. Static Grid Scheme. Using a static grid scheme, the modeled plume will be projected over pre-existing static grids that are laid out radially from the point of release. Any grid that intersects any portion of the plume and risk envelope is considered to have been impacted and will require sampling.

b. Adaptive Grid Scheme. Using an adaptive grid scheme, grids are generated by the D2PUFF™ model and are projected over areas that encompass the modeled plume and risk

envelope. Any grid that intersects any portion of the plume and risk envelope is considered to have been impacted and will require sampling.

c. Clearance Zones. Using either the static or adaptive grid, the modeled plume will be projected over the Clearance Zones in the same manner as static grids. Each Clearance Zone that intersects with the plume and risk envelope will be considered to have been impacted. The number of units to sample within each Clearance Zone will be based on the total number of units present with the grid. Although the units to be sampled are determined randomly, there should be some biased effort to ensure that some units located in the area that intersects the plume/risk envelope are included as part of the sampling scheme.

4-4. **Prevailing Weather**. Existing and forecasted weather conditions can play a vital role in sample collection. Events that occur during inclement weather will require sampling teams to collect samples relevant to the current weather conditions. Weather predictions will need to be monitored daily, particularly if adverse weather conditions are forecasted, as this may directly impact the sample collection prioritization.

4-5. **Projected Sample Load**. Once the impacted grids (static/adaptive/super) have been identified, the number and types of samples to be collected will need to be projected. The projected sample load will be based on existing and forecasted weather conditions, available sample supply inventories, the number of available sample teams, and laboratory capabilities.

4-6. **Parameters to be Evaluated**. The chemical of concern will only be a concern in those instances where more than one type of chemical warfare agent/munitions is stored. Once it has been established which type of chemical warfare agent has been released, the primary sample manager can ensure the appropriate laboratories are notified and relevant analytical methods are requested for sample analysis.

4-7. **Sampling Timeline**. Once all the variables have been assessed, a projected sample timeline and schedule can be tentatively prepared. Modifications can be made once the numbers of sample teams and supply replenishment channels have been firmly established and all laboratories have been notified.

4-8. **Laboratory Notifications**. Once the RSAP has been initiated and sample loads, media types and timelines have been established, all laboratories that are listed within the RSAP will be notified that an event has occurred. The notification will include the projected number of samples, the expected method/detection limits for each method that will be requested, and the expected arrival of the first shipment of samples. Ideally, the primary sample manager on the Operations Team will be the person contacting each of the laboratories. When notified, each laboratory will provide the name of the primary and secondary points of contact along with contact information (phone and e-mail). Conversely, the laboratory will also be provided with the same information. Each laboratory will be notified via fax and e-mail when samples have

been shipped, the number of samples shipped, the number of containers shipped, and the analyses being requested. Telephonic communication will not be relied upon due to the potential for losing information during the exchange and there being no means to confirm the information that was exchanged. The laboratory will notify the sample manager when each sample shipment has been received along with the condition of the samples upon receipt.

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CHAPTER 5 – DATA EVALUATION AND VALIDATION

5-1. **General**.

a. Important to the entire sample collection and analysis process is the requirement that the sample collection process and analytical data reports undergo a thorough review. This review ensures that the proper procedures were used to collect and analyze the samples and the corresponding analytical data represents the conditions as occurred in the field as accurately as possible. The ultimate goal of data evaluation/validation is to establish data usability (i.e., to determine that analytical data is of the necessary type and quality to scientifically support decisions made based the analytical results). The data quality evaluation process begins prior to sample collection by determining the level of data quality review required to support project decisions. This level of data quality review is developed during the DQO process and identified, along with the documentation requirements necessary to perform the review, within the project QAPP or RSAP. Project-specific field and laboratory measurement quality objectives (MQOs) are also identified and documented during the DQO process to determine the data quality.

b. Data verification and validation is the process by which data usability is evaluated, qualified, and documented. Failure to verify or validate data could lead to incorrect decisions and consequently costly errors and project schedule delays. Guidance regarding the data verification and data validation process is provided in Guidance on Environmental Data Verification and Data Validation, EPA QA/G8 (EPA, 2002).

5-2. **Data Verification**. Data verification assesses data quality by evaluating how closely laboratory and field sampling activities followed established method, procedural, or contract requirements and by identifying potential failure to meet analytical and field sampling requirements. Data verification should occur throughout the project lifecycle to identify and correct any field sampling or analytical discrepancies that may affect data quality and usability. The data verification process evaluates data for completeness, correctness, consistency, and conformance/compliance against method, procedural, and/or contractual and supporting documentation requirements identified within project-specific planning documents (EPA, 2002). The primary source of laboratory verification records is often provided through the laboratory Electronic Data Deliverables (EDD) or through the Laboratory Information Management System (LIMS). When data reviewers begin the review process, the following four areas will be evaluated:

- Correctness - indicates that the reported results are based on properly documented and correctly applied algorithms.

- Consistency - indicates that values are the same when they appear in different reports or transcribed from one report to another. Consistency further ensures that samples

used for comparison (e.g., background samples collected for comparison to study samples) are collected and analyzed using similar field sampling and analytical techniques.

- Completeness - indicates that all required information is present–both hard copy and electronic documentation. The primary source of laboratory verification records is often provided through the laboratory EDD or through the LIMS.

- Compliance - indicates that the data pass numerical QC tests based on parameters or limits specified in a contract or in an auxiliary document (e.g., Federal or State permits or records of decision (RODs); statements of work (SOWs) or contractual agreements; laboratory SOPs; and/or methods or procedures identified in a project-specific QAPP or DQOs).

a. Data Verification Requirements and Documents. As the data collection effort progresses from sample collection through sample analysis, field and laboratory personnel produce a series of records that can be verified. An initial step in data verification is to identify the type of project planning documents that are required for comparison and to determine the criteria or specification against which the documents will be compared, such as sampling protocols, analytical methods, contractual requirements or ROD. Data verification is primarily an evaluation of performance against predetermined requirements given in such documents as laboratory SOPs, contracts, or a project-specific QAPP or RSAP. The project-specific QAPP or RSAP documents what data are to be reported, the level of detail that is required, and the format (paper, electronic, or both) in which the data should be presented. Table 5-1 provides a list of documents that may be reviewed for data verification.

b. Field Data Verification. Field data verification evaluates sampling performance to minimize potential field sampling error that could affect the representativeness of analytical data results.

(1) *Internal and External Data Verification*. "Real-time" or near real-time field data verification should be performed by project personnel in order to correct data quality issues, ensure sample representativeness, and maintain data quality throughout the sample collection process. An external or "third party" data verification may be performed after completion of the sample collection and analytical process to document corrective actions that were taken to prevent data quality issues from reoccurring, to identify deviations from sample protocols and their affect on data usability, and to provide a statement certifying the data have been verified.

Table 5-1. Types of Field and Laboratory Verification and Validation Documents.

Operation	Common Records	Source for Record Specifications	DQI (PARCCs)
Sample collection	Daily field logs, sample equipment calibration logs, sample collection logs, chain-of-custody (CoC) forms, shipper's copy of air bill, surveys	QAPP or RSAP, SOPs for sample collection, preprinted CoC instructions	Completeness
Sample receipt	CoC forms from sampler, receiver's copy of air bill, internal laboratory receipt forms, internal laboratory CoC forms, laboratory refrigerator or freezer logs	QAPP or RSAP, laboratory SOP for sample receipt, preprinted CoC instructions	Completeness, Representativeness
Sample preparation	Analytical services requests, internal laboratory receipt forms, internal laboratory CoC forms, laboratory refrigerator or freezer logs, preparation logs or bench notes, manufacturer's certificates for standards or solutions	QA Project Plan or RSAP, reference method (EPA or other), laboratory SOP for preparation method, preprinted instructions on internal forms	Accuracy, Representativeness, Comparability
Sample analysis	Analytical services requests, internal laboratory receipt forms, internal laboratory CoC forms, laboratory refrigerator or freezer logs, manufacturer's certificates for standards or solutions, instrument logs or bench notes, instrument readouts (raw data), calculation worksheets, QC results	QA Project Plan or RSAP, reference method (EPA or other), laboratory SOP for analysis method, preprinted instructions on internal forms and worksheets	Precision, Accuracy, Comparability
Records review	Internal laboratory checklists	QA Project Plan or RSAP, laboratory SOP for analysis method or laboratory QA plan	Representativeness, Accuracy

Legend:
DQI = data quality indicators
PARCC = precision, accuracy, representativeness, comparability, and completeness
Note: EPA, 2002

(2) *Field Data Verification Records*.

(a) Field data verification consists of comparing documentation of actual field sample collection activities against project-specific requirements to determine and document the extent to which deviations in field sampling activities affect data quality and sample representativeness. The types of records required for data verification should be identified within project-specific planning documents (e.g., QAPP, RSAP, or SOW). Data verification of sample collection

activities should include a review of field log books, CoC forms, and equipment calibration, maintenance, and decontamination records. Records that provide inputs to data verification may be in hard copy or electronic format, and may consist of entering sample collection notes in weatherproof, bound field notebooks, or hand-held electronic devices.

(b) The type of sample collection information that should be documented in field log books for data verification includes, but is not limited to: date of sample activity; site entry and exit times; site name and locations; weather conditions; sample personnel present; sample numbers, locations, depths, and times of collection; sample matrix and volume of sample; sample analytes; name of sampler; name and signature of person making entries in the field notebook or daily activity log; names of visitors; description of any deviations from project planning documentation; and any unusual events or conditions (EPA, 2002).

c. Laboratory Data Verification. Analytical data should be verified prior to being released from the laboratory. Laboratory data verification consists of a review of editorial (e.g., identify transcription errors) and technical validity.

(1) *Laboratory Data Qualifiers*. Laboratory data qualifiers, referred to as flags, are applied to analytical datasets to alert the data validator and the data end user of quality problems that may impact the usability of the data (e.g., QC acceptance limits that were not met). Data qualifiers are applied by the laboratory chemist to sample results that do not meet the program's QA objectives (data quality criteria identified in the project QAPP or RSAP) because the QC analytical results fell outside of project-specific acceptance limits developed during the DQO process and identified within the project QAPP or RSAP. Note: samples sent to a subcontract laboratory for analysis must meet all project analytical and document requirements.

(2) *Established Laboratory Quality System*.

(a) Analytical laboratories performing analyses for determining chemical agent release should have an established and documented laboratory quality system that complies with the DOD Quality Systems Manual for Environmental Laboratories. Laboratories should also be accredited for the applicable test method(s), in accordance with ISO/IEC 17025, by a state or nationally recognized, laboratory accreditation body (e.g., American Association for Laboratory Accreditation (AALA) or National Environmental Laboratory Accreditation Program (NELAP). Based upon successful completion of the accreditation process, laboratories are granted accreditation or certification and issued a scope of accreditation that lists the test methods for which they are accredited. This process provides initial assurance of a laboratory's competency to perform work.

(b) The selected laboratory's parameter/analyte lists must include all compounds/ elements of concern (e.g., GB, VX, HD, L and associated breakdown components) for each type of matrix sampled (e.g., soil, sediment, water, air, wipe). Ideally, the selected method would be

approved by EPA, ASTM, or other recognized authority on analytical methods (used for the parameters of interest). However, method approval by these organizations can be slower than the development of new methods and instrumentation, and superior methods may be available that better meet the analytical requirements of the project (relative to the approved methods). Care must be taken to ensure the method selected has been fully validated by the laboratory performing the method, and that the method offers sufficient accuracy and precision to help meet project DQOs. Careful method selection will also result in comparability of data benefits between projects. If a rugged method is selected that helps to meet project DQOs, this method can be used from project to project. As stated earlier, the EPA HQ is in the process of developing and identifying methods for consideration in Homeland Security Events. Once these methods are established, individual EPA regions may require their use in order for data to be considered valid. This will be known early in the RSAP development process.

(3) *Analytical Laboratory Quality Control Measures (LQCM)*. This section identifies the QC procedures, checks, and samples, and their respective acceptance limits, that will be used during the project to monitor the quality of field and laboratory procedures. The list of analytical QC samples typically includes:

- Laboratory Reagent/Method Blanks
- Instrument Blanks
- Matrix Spikes (MS)
- Matrix Spike Duplicates (MSD)
- Laboratory Control Samples (LCS)
- Surrogate Spikes
- Laboratory Fortified Blanks (LFB)
- Instrument Performance Check Samples
- Initial Calibration and Continuing Calibration Verification Checks

Analytical LQCMs and/or SOPs should be identified within the project QAPP appendix. These will in turn identify QC activities for the fixed laboratories. The fixed laboratory analytical QC acceptance criteria are found in specific analytical SOPs provided in the appendix, the standard analytical methods, and/or are provided separately by the fixed analytical laboratory.

5-3. **Data Validation**. Data validation is the process of determining the "reasons for any failure to meet method, procedural, or contractual requirements, and an evaluation of the impact of such failure on the overall data set" (EPA, 2002). Data validation is most often performed by a third-party (data validator), independent of the analytical laboratory that generates the data set and project personnel, and occurs before conclusions are drawn from the data. The data validator must be familiar with the project MQOs and specified DQIs. The level of data validation required is specific to each project and may be comprised of a standardized data review (routine data validation) and/or a problem-specific data review (focused data validation). Like data verification, data validation initially begins with the identification of project planning

documents that identify field sampling and laboratory analytical requirements. This process includes a complete review of laboratory analytical and field sampling records and data against project, method, or procedural MQOs and identified DQIs (PARCCs) to determine the effect(s) any deviations, failures, or discrepancies identified during the data verification process may have had on the overall quality of the data. The data validator, through the use of data validation qualifiers, identifies the extent to which data may be used in the decision-making process.

a. Third-Party Qualification/Flagging. Though similar to internal laboratory data qualification, third-party qualification is performed by a party independent of the laboratory or project personnel that produced the data and includes an assessment of field and laboratory DQOs and MQOs. Data qualification, or flagging, is performed to alert the data end user of problems that impact data usability. The data validator compares field and laboratory records and documentation to predetermined data quality goals to determine the extent that failure to meet such goals has on the usability of the data. The following EPA guidelines are useful for data qualification: Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA, 1999); Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA, 2004); and Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (EPA, 2007). Table 5-2 identifies the typical data flags. However, if project-specific data qualification flags are used, they should be identified within the project planning documents. During an event, State and Federal regulators would be considered third-party reviewers. Other response team personnel located within the Planning and Operations sections would be responsible for performing the initial data verification and validation reviews.

b. Tier Review. Data validation typically consists of a tiered review. Using a tiered approach, a set percentage of data is reviewed with each tier being more detailed and probing than the prior tier. The level and percentage of tier review that is to be performed should be identified in project planning documents (e.g., 20% Tier 2, 80% Tier 1).

(1) *Tier 1 Review*. This review may include, but is not limited to: review of the data package for completeness; review of CoC forms (against laboratory reported information) for signatures, sample condition upon receipt by the laboratory, and sample preservation; review of holding times; review of QC summaries; review of field and laboratory blank results for possible contamination; random checks of reported results against raw data; and random checks of raw data for interference problems or system control problems (e.g., baseline anomalies or baseline drifts).

(2) *Tier 2 Review*. This review, in addition to a tier 1 review may include, but is not limited to: review of laboratory electronic data deliverables for completeness, review of laboratory QC samples (i.e., surrogate recovery, matrix spike recovery, duplicate sample precision), and performance checks of a majority of calculations used in the data set.

Table 5-2. Typical Data Qualifiers/Flags.

Flag	Data Qualifier Definitions
U	The analyte was not detected above the reported sample quantitation limit.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
J-	The analyte is present but the reported numerical result is an estimate that is believed to be *biased low* (e.g., the actual concentration in the environmental sample is believed to be *greater* than the reported concentration).
J+	The analyte is present but the reported numerical result is an estimate that is believed to be *biased high* (e.g., the actual concentration in the environmental sample is believed to be *less* than the reported concentration).
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification."
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
UJ	The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
R	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

(3) Tier 3 Review. This review, in addition to tier 1 and 2 reviews, includes: randomly checking (percentage determined by the professional judgment of the data validator on a project-specific basis) all of the various calculations in the data set (e.g., verifying and recalculating concentrations of standards including checking of expiration dates of standards from standard preparation logs, confirming calibration criteria were met, and verifying QC sample results were as stated), reviewing raw data for correct integration, confirming chromatographs and mass spectra instrument traces, assessing interference problems or system control problems (e.g., baseline anomalies or baseline drifts), reviewing performance evaluation samples, and reviewing field and laboratory logbooks. These checks would be conducted in the context of project DQOs.

c. Data Validation Report. The data validation report is the final output of the data validation process and consists of a case narrative including, but not limited to: an overall summary of data acceptability and comparison to DQOs and the DQI-PARCCs; a list of recommended changes; a summary of all laboratory contacts, in which communications with the laboratory, if any, would be identified; and any other problems associated with the actual analysis which might impact the sample integrity or data quality. During an event, the data validation report may consist merely of signing off on a routing slip to indicate each step of the review has been completed in case the data were determined to be acceptable. If data are

determined to be unacceptable, additional verbiage explaining the faults of the data would be required.

5-4. **Measurement Quality Objectives/Data Quality Indicators**. MQOs are acceptance thresholds or goals for project data quality criteria established for each matrix, analytical method, and analyte that are used to determine whether project DQOs have been met. DQIs are specific attributes or performance criteria identified to determine whether data meet project MQO. The DQIs precision, accuracy/bias, representativeness, comparability, sensitivity/quantitation limits, and completeness are used to qualitatively and quantitatively measure field and laboratory data quality. These are referred to as PARCCS parameters and are often identified during DQO process Step 6 Specify Performance or Acceptance Criteria and defined in the project QAPP or RSAP. The DQIs precision, accuracy/bias, completeness, and sensitivity are measured quantitatively. Representativeness and comparability are assessed qualitatively. Guidance regarding DQIs is provided in Guidance on Data Quality Indicators, EPA QA/G-5i (EPA, 2001). Project managers and stakeholders should work closely with laboratory QC managers to determine the project, analytical method, and analyte-specific MQOs. Project managers must ensure, prior to a CAI event, that all laboratories used in the analytical process are able to meet project-defined MQOs.

a. Precision. Precision is the measurement of agreement among repeated measurements of the same property under identical, or substantially similar, conditions. Field duplicate (or collocated) samples and laboratory duplicate samples are used to measure precision. Precision can be impacted by activities performed both in the field and laboratory. Standardized and validated procedures performed by trained personnel will serve to maximize the precision of the procedures.

$$\% \ RPD = \left(\frac{S_1 - S_2}{\left(\frac{S_1 + S_2}{2} \right)} \right) \times 100$$

Where:

%RPD = Relative percent difference between the amount measured in the original field or laboratory sample and the amount measured in the field duplicate or laboratory duplicate sample
S1 = Original field or laboratory sample (e.g., matrix spike sample)
S2 = Field or laboratory duplicate sample (e.g., matrix spike duplicate sample)

b. Accuracy. Accuracy is defined as the closeness of agreement between a "true" or standard value and an associated measurement result. Accuracy is expressed as the percent recovery of a measured value to a standard value (e.g., materials of known composition). Assuming a representative sample is collected, accuracy will be impacted by laboratory operations. Again, use of validated procedures will serve to maximize the accuracy of the procedures. The following is used when matrix spiked samples are used to measure accuracy:

$$\% R = \left[\left(\frac{X_s - X_u}{K} \right) \right] \times 100$$

Where:

%R = Percent recovery. The amount measured as compared to the "true" value, expressed as a percentage
X_s = Measured value of the spiked sample (e.g., laboratory control spike)
X_u = Measured value of the unspiked sample
K = Known amount of spike in the sample

c. Bias. Bias is the systematic or persistent distortion of a measurement process that causes errors in either a positive (high) or negative (low) direction from the true value. Sample bias may result from calibration errors, response factor shifts, unaccounted for interferences, or chronic sample contamination. Bias is normally estimated from testing the measurement system against a specimen with known properties (e.g., matrix spike sample, reference material, or calibration, preparation or field blank sample). Bias measurements are calculated either as a percent difference or percent recovery. Bias will be influenced by field and laboratory procedures and to a degree the individual persons performing the work. Again, use of standardized and validated procedures by trained personnel will minimize bias.

$$\% D = \frac{1}{k} \sum_{j=1}^{k} \left(\frac{Y - X}{X} \right) \times 100$$

Where:

%D = Percent difference. The difference between the amount measured and the "true" value, expressed as a percentage
Y = Measured value
X = True value
k = Number of valid comparisons

d. Completeness. Completeness is defined as the percentage of valid data points relative to total possible data points. This can be based on the total number of valid data points for a particular compound or the total number of samples collected for a particular media (i.e., soil, water, and air). Typical sampling projects strive for 95% or greater completeness. However, loss of all samples from a particular grid or area or a particularly prime location will necessitate samples to be recollected.

$$\% C = \left[1 + \left(\frac{Y - X}{X} \right) \right] \times 100$$

Where:

%C = Percent completeness
Y = Number of valid data points collected
X = Total planned number of data points

e. Representativeness. EPA guidance document QA/G-5 defines representativeness as "a measure of the degree to which data accurately and precisely represent a characteristic of a population parameter at a sampling point or for a process condition or environmental condition. Representativeness is a qualitative term that should be evaluated to determine whether in situ and other measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the media and phenomenon measured or studied." This is typically evaluated by statistically determining whether or not the number of samples collected was adequate to characterize the area (or decision unit) for the compound in question. It is entirely possible for the number of samples collected to be sufficient for all but several compounds. A reevaluation of the data would then focus only on those compounds in question.

f. Comparability. Comparability is a qualitative term that expresses the measure of confidence that two or more data sets can contribute to common interpretation and analysis. Data comparability is essential to the decision-making process where samples are collected over an extended period of time or are collected at the same time by different sampling teams from different locations. The key to comparability is consistency of approach, which applies to both field and laboratory methods and procedures (i.e., same field sampling methods, analytical procedures, detection limits, and analyte list). Use of standardized procedures as necessitated under NIMS would greatly reduce the potential for data acceptability issues resulting from a variety of sample collection and analysis methods being used.

5-5. **Data Assessment**. Data assessment is the process of determining whether project objectives and sampling design produce data that is of the quality and quantity to statistically

support project decisions. Data assessment is necessary where a decision maker wants to ensure that a percentage of the contamination levels are below a fixed risk level (e.g., 90%, 95%, or 99%). The following EPA guidance documents are useful for performing data quality assessments: Data Quality Assessment: Statistical Methods for Practitioners (EPA, 2006a) and Data Quality Assessment: A Reviewer's Guide (EPA, 2006b).

5-6. **Data Interpretation**. Data interpretation only begins after data quality has been determined using the review processes listed earlier. For the purpose of clearing areas, a standardized flow chart or decision tree should be used as a cross check to ensure all steps of the data chain process have been properly incorporated and documented. Figure 5-1 illustrates the basic steps of the data interpretation process.

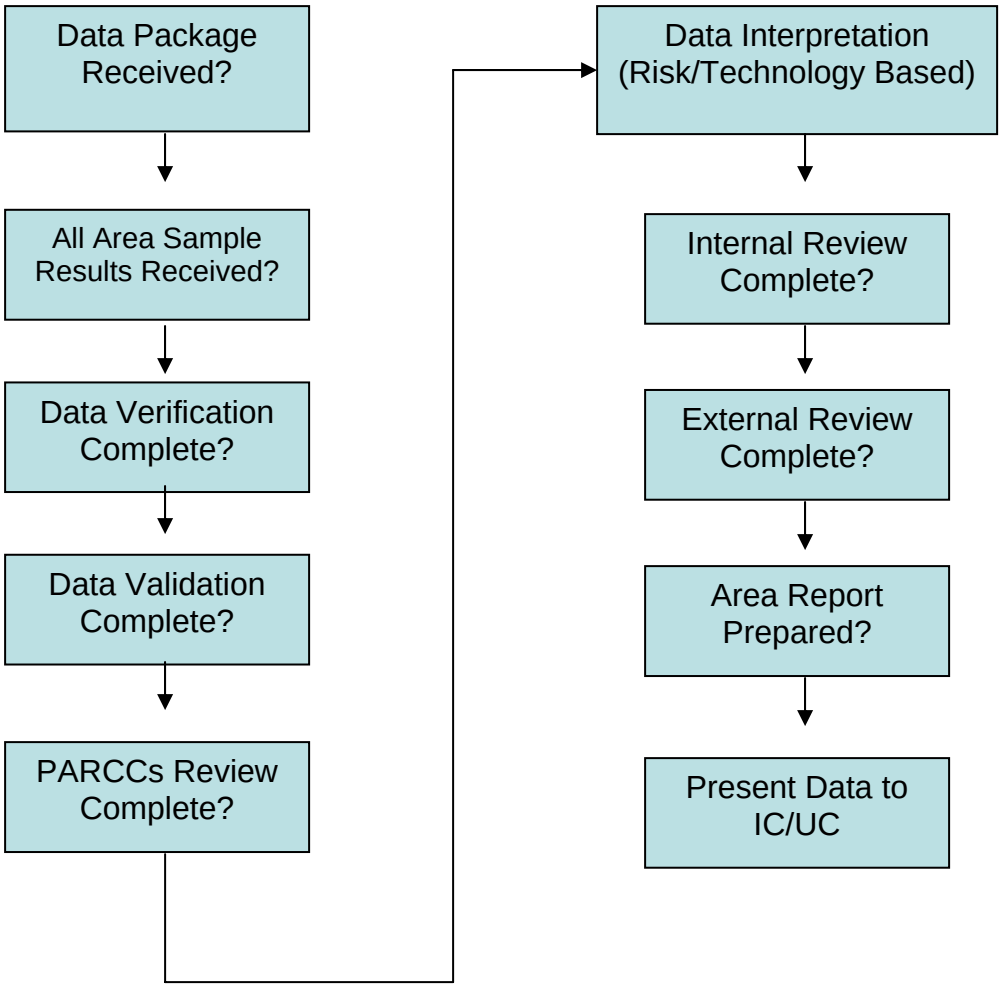

Figure 5-1. Basic Steps of the Data Interpretation Process.

Based on this process, the data presented to the IC/UC upon completing the review process will be one of the following: 1) No CWA or agent degradation products (ADPs) were detected at or above the established criteria, 2) CWA/ADPs were detected at or greater than the established criteria, or 3) data is inconclusive/incomplete. Data may be inconclusive/incomplete due to QA/QC issues identified during the review process even though all sample results were received. For data packages of this type, the Operations Team should be prepared to resample or conduct additional analytical tests on the remaining samples to remedy the QA/QC issue at hand.

a. Clearing Areas. Only those areas where all data were reported at concentrations less then the criteria coupled with reviews that affirm the validity and quality of the data will be eligible for clearance. If any portion of the review process was not completed, the data package will be reincorporated into the review process. For any areas where some portion of the data were reported at or greater than the criteria, these areas will not be considered eligible for clearance and will be designated for future evaluation after the recovery and re-entry efforts have concluded.

b. Biased Data. Biased data may be identified during the data review process where the QA/QC is shown to bias the results to one extreme or the other. In most cases, a result may be reported below a specific criteria; however, the variance associated with the QA/QC data may cause the result to potentially be greater than the criteria due to the error range. In these instances, the data will need to be reevaluated and samples possibly recollected with the expectation that the QA/QC data will be acceptable.

c. Defining Suspect Areas. Suspect areas will be defined by the outer grid coordinates of the Clearance Zones based on the data and information obtained from that specific area. Once these areas have been identified, no additional sampling will occur. Subsequent evaluation of these areas will be conducted at the conclusion of all other recovery and re-entry activities.

d. Comparison of Resample Data. Care should be taken when comparing data that is collected from the same area but on different days or under different environmental conditions. The CWA/ADPs that are to be evaluated may or may not be stable and/or persistent under the environmental conditions that exist prior, during or after the event occurs. If one set of results indicate the presence of CWA/ADPs while a second set of data indicate otherwise, the reviewers should err on the side of conservancy and assume the positive results represent the current conditions until further evaluations can be completed after all recovery and re-entry activities have ceased.

5-7. **References**.

a. Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories, DoD Environmental Data Qaulity Workgroup, Final Version 3, January 2006.

b. ISO/IEC 17025, General Requirements for the Competence of Calibration and Testing Laboratories, ISO/IEX Guide 25, ISO 17025:2005.

c. U.S. Environmental Protection Agency. 1999. EPA-540/R-99-008, OSWER Directive 9240.1-05A-P. *Contract Laboratory Program National Functional Guidelines for Organic Data Review*. Office of Emergency and Remedial Response.

d. U.S. Environmental Protection Agency. 2001. EPA QA/G-5i. *Guidance on Data Quality Indicators, Peer Review Draft*. Office of Environmental Information.

e. U.S. Environmental Protection Agency. 2002. EPA QA/G-8, EPA/240/R-02/004. *Guidance on Environmental Data Verification and Data Validation*. Office of Environmental Information.

f. U.S. Environmental Protection Agency. 2004. EPA 540-R-04-004, OSWER Directive 9240.1-45. *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*. Office of Emergency and Remedial Response.

g. U.S. Environmental Protection Agency. 2006a. EPA QA/ G-9S, EPA/240/B-06/003. *Data Quality Assessment: Statistical Methods for Practitioners*. Office of Environmental Information.

h. U.S. Environmental Protection Agency. 2006b. EPA QA/G-9R, EPA/240/B-06/002. *Data Quality Assessment: A Reviewer's Guide*. Office of Environmental Information.

i. U.S. Environmental Protection Agency. 2007. EPA-540-R-07-003, OSWER Directive 9240.1-46. *Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*. Office of Emergency and Remedial Response.

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CHAPTER 6 – CONCLUDING EVENT ACTIVITIES

6-1. **Background**. The final activity to be performed as part of the response effort will be the proper documentation and preservation of information and data generated during the response. Missing information will need to be reconstructed, properly completed, and/or documented as missing.

6-2. **Document Archiving**. Critical to completing the overall response process is ensuring the proper storage and archiving of information and plans/protocols. All documents and records associated with the event will be scanned, inventoried and cataloged to facilitate records retrieval. A minimum of three sets of records should be made. One set will be maintained locally at the installation. The second set will be maintained at the Command that maintains the installation (i.e., Installation Management Command). The last set of records should be maintained by the State Environmental Office. These documents will be maintained for future reference, response efforts, and for any potential legal actions resulting from the event. All documents relevant to establishing the validity of the data will be archived.

a. Field Notes. At the conclusion of all field activities, all field notebooks will be collected, inventoried, and cataloged by sample team. These should all be traceable via sample team number and/or dates of usage.

b. Chain-of-Custody Forms. All CoC forms will be collected and inventoried to ensure all sample transfers are accounted for via the paper trail. All these forms should be traceable via sample numbers and/or date(s) of transfer.

c. Decision-Making Records. Though many decisions will be made during the recovery and response phase, the document reference will be those specific to the management of the sampling teams. These may include daily logs listing sampling team schedules, personnel and supply requests, and directives from incident command. These records should be inventoried and cataloged by date.

d. Recovery Sampling and Analysis Plan. A copy of the initial RSAP to include all revisions made during the response effort will be prepared. This plan should include any maps that have been prepared or used during the course of the event. Revisions or edits made to the RSAP as the event progressed should be cataloged by date.

e. Quality Assurance Project Plan. A copy of the QAPP used by each laboratory should be obtained and archived. This plan should include all analytical procedures as well as routine laboratory procedures that are relevant to actions described in the QAPP such as instrument calibration, review procedures, and trouble-shooting procedures. These documents should

include all field analysis procedures used in the field by the sample collection and mobile laboratories.

f. Sample Data. A copy of all laboratory sample reports, field analysis results, and data validation reports will be inventoried and cataloged. All data will be traceable via sample numbers and/or date of collection.

(1) *Sample Archiving and Management*. All samples and sample extracts will be maintained for a minimum of 3 years using proper CoC and sample preservation techniques to ensure sample integrity. Samples will be maintained by the laboratory that performed the initial analysis on the samples. In the event that sample data are called into question via an audit, after action review, and/or legal process, the samples and extracts will be made available for re-extraction/re-analysis. Water samples will be maintained in cold storage at a temperature of 2 – 6 °C. All solid samples and extracts will be maintained in cold storage at a temperature of less than -20 °C or a temperature that is deemed appropriate by the archiving facility.

(2) *Areas Not Cleared for Re-Entry*. As the recovery and re-entry phase comes to a conclusion, there may be several areas that were confirmed to contain measurable quantities of CWA or agent degradation products at concentrations exceeding the risk/technology-based criteria. There may also be circumstances where the data is inconclusive. In either case, these areas will undergo a focused evaluation to determine the specific locations where CWA-related compounds occurred. This protocol does not address the process by which these areas will be evaluated once the recovery and re-entry phase has been completed. To facilitate the process, it may be prudent to a degree to preplan some of the procedures and methods to be implemented to ensure their acceptability, availability, practicality, and cost effectiveness of those evaluated.