U.S. DEPARTMENT OF ENERGY

GUIDANCE FOR DEVELOPING A SITE-SPECIFIC RISK-BASED END STATE VISION

September 11, 2003

This Page Intentionally Left Blank

EXECUTIVE SUMMARY

In 2002, the Office of Environmental Management (EM) established a set of corporate projects to lead EM's response to the *Top to Bottom Review*. The Corporate Projects are intended to change the way EM, and in some cases, the Department, conducts business. One of these Corporate Projects, "A Cleanup Program driven by Risk-based End States Project" has resulted in the preparation of this guidance for site implementation.

The project and this guidance are focused on ensuring that the Department's cleanup strategy is driven by clearly defined, risk-based end states (RBES). This guidance provides "how-to" steps in preparing RBES Visions (or End State Visions) at sites where the Department of Energy is either conducting or is responsible for cleanup.

In order to support this new approach, the Department recently released DOE Policy 455.1, *Use of Risk-based End States* (dated July 15, 2003). The purpose of this guidance document is to support the implementation of DOE Policy 455.1 by developing a site-specific RBES Vision document for every site where cleanup is being conducted. The RBES Vision is the primary tool for communicating the individual site RBES to the involved parties (i.e., DOE, regulators, public stakeholders, Tribal Nations, etc.). The RBES Vision document is not a decisional document. If the Department decides to seek changes to the current compliance agreements, decisions, or statutory/regulatory requirements, those changes will be made in accordance with applicable requirements. The DOE intends to implement and institutionalize the RBES approach by building it into the Department's policies, orders, and procedures, including standardization of GIS systems and mapping protocols. The DOE has developed an implementation plan (draft) that outlines RBES implementation steps in accordance with Policy 455.1.

This guidance uses a standardized approach for generating and using site maps and conceptual site models to portray the RBES Vision. Historically, DOE sites have generated land use plans, site maps, and conceptual site models using a variety of tools and procedures. One goal of this project is to transform the varying applications and/or versions of these essential management tools into a single unified approach. Standardization will support DOE efforts to manage its real estate and environmental liability in a corporate manner.

The maps requested by this guidance are intended to present and allow comparisons between current and future land use and enable the graphical depiction of hazards, their associated risks, and the affected populations or receptors. In short, if prepared correctly, the maps can serve multiple purposes. These purposes include, but are not limited to:

- Serve as a decision-aiding tool for site management, the Landlord Program Secretarial Officer, and the Office of Environmental Management regarding cleanup and the sustainability of current and future missions;

- Serve as a communication and risk assessment tool for discussion with state and federal regulators regarding cleanup;

- Serve as a high level depiction of expected cleanup results and risk reduction; and

- Serve as a communication tool for public meetings regarding cleanup activities, current mission activities and requirements, and future land use.

Integral to the RBES approach to cleanup is the use of conceptual site models (CSM). These models are intended to communicate risk information to DOE managers, the regulatory community, and the general public. The CSM provide, in block diagram form, information regarding the hazards, pathways, receptors and the barriers (current or planned) between the hazards and the receptors. Sites currently use a variety of different CSM. Appendix C, Manual for Preparing Conceptual Site Models for Specific Hazard Areas of Concern, provides guidance for constructing these models. In addition, ASTM standard E 1689-95, *Standard Guide for Developing Conceptual Site Models for Contaminated Sites,* should be used for the creation of CSM. Current State and RBES Visions will be most useful when sites integrate map information with the CSM. This integration may be done at the site level for small sites with few and well defined hazards. Most sites may need to (depending on the size of the site and/or multiple hazard areas) integrate maps and CSM at the hazard-specific level. This will allow graphical depiction of the map-based information, with a block diagram of the conceptual site model, and associated narrative information.

DOE expects that there will be variances between the RBES vision and the current cleanup plans for many of the sites in the complex. It is also expected that there will be a high degree of variability in the scope and extent of those variances. It is anticipated that these variances will be identified through discussions with regulators, the affected governmental organizations, adjacent landowners, and the general public during the development of the RBES Visions. This guidance does not authorize actions to implement the variances that are inconsistent with existing agreements, decisions, and/or statutory requirements. If the Department decides to seek changes to the existing agreements, decisions or statutory or regulatory requirements, such changes will be made in accordance with applicable requirements. Information on reporting variances is provided in Appendix D, Guidance on Variances Reporting. The RBES Vision approved for implementation, however, must comply with all existing and applicable statutory and regulatory requirements.

In accordance with the DOE Policy 455.1, the RBES Vision will be formulated in cooperation with regulators, and in consultation with affected governments, Tribal Nations, and stakeholders (as appropriate). As shown in the draft implementation plan[1] (see Page 5, Figure 2, Site Risk-Based End State Implementation Process), sites should provide the draft RBES Vision document to regulators and stakeholders for review and comment at the same time the draft Vision document is submitted to HQ by October 30, 2003. Specifically, regulators should be asked to concur and affected and interested governments should be consulted in the development of the RBES Visions. In addition, site managers will establish communication approaches for working with stakeholders for the development of the RBES Vision and other phases of this effort.

[1] Draft implementation plan is available at http://www.em.doe.gov/rbes.

ACKNOWLEDGEMENT

The Department of Energy would like to recognize the contributions made by the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) and MSE Technology Applications, Inc. for their support in the preparation of this guidance document. Specifically, the conceptual approach and overall mapping structure that is presented in this document was drawn largely from CRESP report "Risk-Based End State Guidance: Geospatial Mapping Tool," and additional information can be obtained from its principal authors Henry Mayer, Roger Keren, Christine Danis, Michael Greenberg, Vikram Vyas, David Kosson, and Charles Powers. In addition the conceptual approach and overall design of the conceptual site model structure that is presented in the document was developed by CRESP, and additional information can be obtained from its principal authors Henry Mayer, Charles Powers, and Vikram Vyas. MSE Technology Applications, Inc. of the Western Environmental Technology Office in Butte, Montana contributed toward the preparation of the Mapping Manual, Fictitious Site Examples, and general editing.

This Page Intentionally Left Blank

TABLE OF CONTENTS

Page

This Page Intentionally Left Blank

1.0 INTRODUCTION

In 2002, the Office of Environmental Management (EM) established a set of corporate projects to lead EM's response to the *Top to Bottom Review*. The Corporate Projects are intended to change the way EM, and in some cases, the Department, conducts business. One of these Corporate Projects, "A Cleanup Program driven by Risk-based End States Project" has resulted in the preparation of this guidance for site implementation.

The project and this guidance are focused on ensuring that the Department's cleanup strategy is driven by clearly defined, risk-based end states (RBES). This guidance provides "how-to" steps in preparing RBES visions at sites where the Department of Energy is either conducting or is responsible for cleanup. This guidance was developed and is issued in accordance with Department of Energy Policy 455.1.

1.1 STATEMENT OF TASK

Sites should prepare the draft RBES Visions in accordance with this guidance by October 31, 2003. The final RBES Visions should be completed by January 30, 2004. The RBES Visions should be submitted to the Assistant Secretary for Environmental Management, or for sites not owned by EM, to the responsible Headquarters landlord, for review and concurrence. A description of any variances between the RBES Vision and cleanup baselines and/or regulatory agreements, as discussed in Section 4.0, should be provided in the RBES Vision document.

In accordance with DOE Policy 455.1, the Office of Environmental Management developed and issued this guidance with the concurrence of the affected Program Secretarial Offices and General Counsel. Funding for site execution of this guidance is covered within the funding provided by the Office of Environmental Management. DOE line management is responsible for implementation.

1.2 CURRENT STATE AND RISK-BASED RBES VISIONS

Risk-based end states are representations of site conditions and associated information that reflect the planned future use of the property and are appropriately protective of human health and the environment consistent with that land use. The time frame for the site specific RBES Vision is the current EM mission completion date for that site. During the preparation of the RBES Vision, sites are strongly encouraged to consider known or expected changes to the land use for the site and surrounding areas. Twenty years is the nominal land use planning horizon for most governmental organizations. Where formal land use plans by local, State, Federal, or Tribal governments exceed that time period, those plans should be included.

To assist DOE in evaluating current cleanup strategies and the associated risk reduction, sites are requested to document the Current State of the site, as well as the RBES Vision. The administrative approach for the Current State is identical to the RBES Vision in that it is based on a visual depiction and discussion of the site, the surrounding areas, and the hazards. However, the Current State is based on site conditions in 2003 rather than some point in the future. Detailed guidance for the format and structure of the Current State and RBES Visions is provided in Appendix A, Format for the RBES Vision Document.

1.3 RELATIONSHIP BETWEEN CLEANUP AND FUTURE LAND USE

The RBES Vision should be based on the planned future land use and be protective of human health and the environment for that land use. This risk-based end state approach attempts to gain a common acceptance of the site-wide post-remediation future prior to individual remedy evaluation and selection actions. It is recognized that the RBES Vision may not be consistent with the current Compliance

Agreement or existing requirements. Once sites develop their RBES Vision, they will reevaluate their cleanup activities and strategic approaches to determine if it is appropriate to change site baseline documents and renegotiate agreements. Sites will then work with their regulators in a cooperative manner to modify, as appropriate, their cleanup strategies, cleanup agreements and baselines. Additional discussion regarding the relationship between cleanup and future land use is provided in the DOE Policy 455.1.

1.4 CLASSIFICATION REQUIREMENTS AND CONSIDERATIONS

Sites should closely coordinate with their local Classification Office during the preparation of the site maps and conceptual models. It is intended that the RBES Vision be a public document and hence should not contain sensitive or classified information. In this regard, the guidance does not request, nor should it be interpreted to request, the level of detail normally associated with building footprint information or any information regarding security measures. Questions related to classification that cannot be addressed at the local level may be referred to Mr. John Lazor in the Office of Classified and Controlled Information Review. Mr. Lazor can be reached at (301) 903-3521.

1.5 TRAINING AND TECHNICAL SUPPORT ON MAPPING AND SITE CONCEPTUAL MODELS

Reference material related to the scope of this project in general, and this guidance in particular, is provided on the RBES website at http://www.em.doe.gov/rbes and in Appendix E. EM will provide training and technical support as needed for both the mapping and conceptual site model tasks.

2.0 MAPS AND CONCEPTUAL SITE MODELS

This guidance uses a standardized approach for generating and using site maps and conceptual site models to portray the RBES Vision. Historically, DOE sites have generated land use plans, site maps, and conceptual site models using a variety of tools and procedures. One goal of this project is to transform the varying applications and/or versions of these essential management tools into a single unified approach. Standardization will support DOE efforts to manage its real estate and environmental liability in a corporate manner. Detailed mapping guidance is provided in Appendix B, Risk-Based End State Mapping Manual.

2.1 HIERARCHY OF MAPS

Appendix B, Risk-Based End State Mapping Manual, outlines preparation of maps at three extents: regional context, site context, and hazard specific. Sites should provide maps at all three unless approved to do otherwise. Some smaller sites, with minimal residual risk, may be able to eliminate the hazard-specific maps if the relevant information can be provided at the site context level.

- The Regional Context maps place the site within the context of the larger surrounding region. For example, the Brookhaven National Laboratory would be depicted in its relationship to Suffolk County. The regional context should be large enough to show major watersheds, population areas, and significant external features (e.g., nuclear power plants, municipal landfills, etc.).

- The Site Context maps encompass the site and the lands adjacent to the site. This is the extent normally associated with DOE's more typical land-use plans, but specifically includes information on adjacent properties, as well as the land inside the site property boundary. This is also the first that provides information on Conceptual Site Models (CSM). In some cases, for sites that are not geographically contiguous, a site may need to repeat the site context map guidance to provide the level of detail that is required.

- Hazard-Specific maps provide the greatest level of detail. Hazard-specific maps are drawn for those portions of a site that contain hazards (disposal cells, landfills, entombed facilities, underground plumes, buried waste, etc.) that present risks to human health or the environment. Where hazards are located in close proximity, they may be represented on a single map. CSM should be provided for these hazard areas but not for each release site. A hazard area may contain multiple hazards. Appendix C, Manual for Preparing Conceptual Site Models for Site Specific Hazard Areas of Concern gives instructions on how CSM are to be developed/illustrated.

2.2 MAP ATTRIBUTES

Appendix B, Risk-Based End State Mapping Manual, provides detailed information about general map requirements; map descriptions and hierarchy; map content and cartographic style, integration of the maps and the conceptual site models; map layout and numbering; and sources of mapping information. Map content includes land use, demographics, infrastructure, and hazards. Various combinations of this information as described in Appendix B will allow a variety of depictions including physical and surface conditions, ecological land use, and human land use. As Appendix B was written for a generic DOE site, sites are encouraged to augment the requested set of maps with additional maps that depict information about the site that provides Current State and RBES Visions that are most useful.

2.3 USE OF THE MAPS ASSOCIATED WITH THE CURRENT STATE AND RBES VISIONS

The maps are intended to present and allow comparisons between current and future land use and to enable the graphical depiction of hazards, their associated risks, and the affected populations or receptors. In short, if prepared correctly, the maps can serve multiple purposes. These purposes include, but are not limited to:

- Serve as a decision-aiding tool for site management, the Landlord Program Secretarial Officer, and the Office of Environmental Management regarding cleanup and the sustainability of current and future missions;

- Serve as a communication and risk assessment tool for discussion with state and federal regulators regarding cleanup;

- Serve as a high level depiction of expected cleanup results and risk reduction; and

- Serve as a communication tool for public meetings regarding cleanup activities, current mission activities and requirements, and future land use.

2.4 GEOGRAPHICAL INFORMATION SYSTEMS

Sites should, to the greatest extent possible, build and depict the maps using data that conforms to the Federal Geographic Data Committee (FGDC) geospatial data standard and Spatial Data Standard for Facilities, Infrastructure, and Environment (SDSFIE) GIS data content standards, both of which are designed for use with ESRI products for map production. Additional general information on the FGDC and their contributions to the National Spatial Data Infrastructure (NSDI) can be found in Appendix B, Risk-Based End State Mapping Manual. Specific cartographic details and other general map conventions to be used for the RBES maps are also located in Appendix B.

2.5 CONCEPTUAL SITE MODELS

Integral to the RBES approach to cleanup is the use of CSM. These models are intended to communicate risk information to DOE managers, the regulatory community, and the general public. CSM provide, in block diagram form, information regarding the hazards, pathways, receptors and the barriers (current or planned) between the hazards and the receptors. Sites currently use a variety of different CSM formats. Appendix C, Manual for Preparing Conceptual Site Models for Specific Hazard Areas of Concern, provides guidance for constructing these models. In addition, ASTM standard E 1689-95, *Standard Guide for Developing Conceptual Site Models for Contaminated Sites*, should be used for the creation of CSM.

2.6 INTEGRATION OF MAPS AND CONCEPTUAL SITE MODELS

Current State and RBES Visions will be most useful when sites integrate map information with the CSM. This integration may be done at the site level for small sites with few and well defined hazards. Most sites may need to integrate maps and CSM at the hazard-specific level. This will allow graphical depiction of the map-based information, with a block diagram of the conceptual site model, and associated narrative information. Appendix B, Section 1.5.3, Mapping Numbering, provides guidance for integrating the Hazard-Specific Maps with CSM.

2.7 GUIDANCE ON RISK ASSESSMENT

The Department will achieve risk-based end states only if its required remediation approaches are shaped by regulatory risk methodologies that are both transparent and comprehensible. For this reason, DOE must work closely with its regulators and stakeholders to review land use plans and ensure that credible scenarios are devised that are consistent with that land use. For example, assuming a residential farmer in the middle of an industrial area is neither credible nor rational. Scenarios that consider reasonable pathways, rational timeframes, and the receptor population as a whole can provide a more accurate and credible basis for decision making.

Extensive guidance has been promulgated by the U.S. Environmental Protection Agency, the U.S. Nuclear Regulatory Commission, and the U.S. Department of Energy (Office of Environment, Safety and Health) regarding the conduct of risk assessments and related activities. Those guidance documents, including the Risk Assessment Guidelines for Superfund, are available on the Internet at the agency specific web sites provided in Appendix E, Reference List. CSM should reference and be consistent with the applicable risk assessment documents where they have been done.

3.0 EXTERNAL PARTICIPATION

In accordance with the DOE Policy 455.1, the RBES Vision should be formulated in cooperation with regulators and in consultation with affected governments, Tribal Nations, and stakeholders (as appropriate). Specifically, regulators should be asked to concur and affected and interested governments should be consulted in the development of RBES Visions. In addition, site managers should establish communications approaches for working with stakeholders for the development of the site's RBES Vision and other phases of this effort. It is recognized that sites may not be able to achieve concurrence from their regulators due to either time constraints or differences between existing agreements and assumptions associated with a risk-based end state.

3.1 PUBLIC OUTREACH AND INVOLVEMENT

Most sites have existing public outreach mechanisms and should use them to engage the public in the development of RBES documents. These may include site-specific advisory boards, scheduled meetings with local and tribal governments, public meetings or workshops, a web site, reading rooms, and/or other tools tailored to the specific public outreach needs. Sites are encouraged to review DOE Policy 141.2 Public Participation and Community Relations, and work with the Office of Intergovernmental and Public Accountability (EM-11) on specific issues that require Headquarters involvement.

3.2 REGULATORY INVOLVEMENT

DOE Policy 455.1 is intended to be consistent with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA) and the Atomic Energy Act. Specifically, these Acts either explicitly or implicitly authorize the consideration of future land use and risk in making cleanup decisions. However, the RBES Vision is not a regulatory document and therefore does not require regulatory approval. Nonetheless, the site should involve and seek to obtain the concurrence of the regulatory community in the development of the RBES Vision in a collaborative manner by the due date. This involvement will help to identify any variances between the RBES Vision and existing regulatory agreements or requirements. This guidance does not authorize actions to implement any variances that are inconsistent with existing agreements, decisions, and/or statutory requirements. The implementation of RBES, when approved for implementation, must comply with all existing and applicable statutory and regulatory requirements. If the Department decides to seek changes to the existing agreements, decisions and/or statutory requirements, such changes will be made in accordance with existing decision-making and rulemaking processes.

3.3 INTERESTED AND AFFECTED GOVERNMENT ORGANIZATIONS

In addition to the State and Federal regulators described in section 3.2, other interested and affected governments may also be involved in the development of the RBES Vision. These include Tribal Nations, local governments, other appropriate state agencies, and affected federal agencies. An RBES Vision is based on risk for the planned land use and may not be consistent with the requirements of existing arrangements, agreements, or Treaties which were previously executed on behalf of the DOE or the federal government as a whole. Involvement of various government groups will, at a minimum, also be useful in identifying any variances between the RBES Vision and existing requirements.

3.4 CURRENT AND PROSPECTIVE LANDOWNERS

Where DOE is the current landowner but has identified a new prospective owner of the site or portions of the site, the prospective owner(s) should be engaged in the development of the RBES Vision. Where

DOE is not the landowner but is conducting the cleanup work, the site should engage the owner of the property to the maximum extent possible.

3.5 SURROUNDING LAND OWNERS

Site personnel should work closely with individual landowners surrounding the site and appropriate local governments to ensure that legal ownership and planned land use projections are accurate and complete for both the surface and the subsurface. Sites should specifically engage the adjacent landowners in the development and portrayal of the end state map information. This is particularly relevant at the site context level and the hazard level where a DOE generated hazard had or has the potential to migrate off site.

4.0 DISCUSSION OF VARIANCES

DOE expects that there will be variances between the RBES vision and the current cleanup plans for many of the sites in the complex. It is also expected that there will be a high degree of variability in the scope and extent of these variances. It is anticipated that these variances will be identified through discussions with regulators, the affected governmental organizations, relevant and affected landowners, and the general public during the development of the RBES Visions (also, see Section 3.2). Variances needed to implement site's RBES Vision should be included in the RBES Vision document.

4.1 VARIANCE BETWEEN THE CURRENT CLEANUP BASELINE AND THE RBES VISION

For sites with approved Performance Management Plans and cleanup baselines, it is possible to have variances between the cleanup baseline and the RBES Vision. Sites in this category should discuss those variances by identifying what changes would have to be made to the site baseline to align the baseline with the RBES Vision.

4.2 VARIANCE BETWEEN REGULATORY REQUIREMENTS AND THE RBES VISION

Any variances between existing regulatory requirements (including, but not limited to Federal Facility Agreements, Records of Decision, and statutory requirements) and the RBES Vision should be included in the Vision document as an attachment. This discussion should clearly describe between existing regulatory requirements and the RBES Vision.

4.3 OTHER VARIANCES OR ISSUES OF SIGNIFICANCE

Sites should also discuss variances, if any, that are identified during the development of the RBES Vision that do not fall into one of the categories above, but are important to achieving a risk based end state. This discussion should be articulated in a manner that clearly describes the issue and conflict with the RBES Vision.

APPENDIX A

Format for the RBES Vision Document

This Page Intentionally Left Blank

EXECUTIVE SUMMARY

The executive summary should summarize the contents of the document but focus primarily on the planned land use for the site and how that land use is incorporated within the context of the surrounding land. This section should also highlight the major hazards that will remain the potential risks associated with those hazards, and the primary receptors. (~2 pages)

1.0 INTRODUCTION

The introduction should include relevant background information. It should include a brief discussion of the Top-to-Bottom Review and other relevant documents (e.g., land use plans, Environmental Impact Statements, etc.) or activities that place this document in context. (~2 pages)

1.1 ORGANIZATION OF THE REPORT

This section should include a brief discussion of how the report is organized. This should include a discussion of the three levels of maps and the integration of the maps, conceptual site models, and associated narrative.

1.2 SITE MISSION (~2 pages)

Briefly discuss the past, current and/or future site mission(s), if any. Briefly discuss the types of hazards and the extent of environmental contamination caused by the site's missions.

1.3 STATUS OF CLEANUP PROGRAM (~ 2 pages)

Briefly discuss site cleanup strategy, closure or EM completion date, priorities and remaining cleanup work.

2.0 REGIONAL CONTEXT RISK-BASED END STATE DESCRIPTION

This section should be developed in accordance with the guidance provided in Appendix B - RBES Mapping Manual (Section 2) to discuss the key information at the regional context level.

2.1 PHYSICAL AND SURFACE INTERFACE

Narrative should include discussion of: 1) key features that are not apparent from the maps or to supplement the information shown on the maps; and 2) discussions of the differences between the current state and the RBES.

A minimum of two maps (Map 2.1a and Map 2.1b) should be provided. See Appendix B Section 2.0 for specific mapping details for this section.

2.2 HUMAN AND ECOLOGICAL LAND USE

Narrative should include discussion of: 1) key features that are not apparent from the maps or to supplement the information shown on the maps; and 2) discussions of the differences between the current state and the RBES.

A minimum of two maps (Map 2.2a and Map 2.2b) should be provided. See Appendix B Section 2 for specific mapping details for this section.

3.0 SITE SPECIFIC RISK-BASED END STATE DESCRIPTION

This section should be developed in accordance with Appendix B - Risked-Based End State Mapping Manual (Section 3) to discuss the key information at the site context level.

3.1 PHYSICAL AND SURFACE INTERFACE

Narrative should include discussion of: 1) key features that are not apparent from the maps or to supplement the information shown on the maps; and 2) discussions of the differences between the current state and the RBES.

A minimum of two maps (Map 3.1a and Map 3.1b) should be provided. See Appendix B Section 3 for specific mapping details for this section.

3.2 HUMAN AND ECOLOGICAL LAND USE

Narrative should include discussion of: 1) key features that are not apparent from the maps or to supplement the information shown on the maps; and 2) discussions of the differences between the current state and the RBES.

A minimum of two maps (Map 3.2a and Map 3.2b) should be provided. See Appendix B Section 3 for specific mapping details for this section.

3.3 SITE CONTEXT LEGAL OWNERSHIP

Narrative should include legal ownership of the site and adjacent areas to the site for the current state and the end state.

A minimum of two maps (Map 3.3a and Map 3.3b should be provided. See Appendix B Section 3 for specific mapping details for this section.

3.4 SITE CONTEXT DEMOGRAPHICS

Narrative should include demographics information for the adjacent areas to the site and expected changes if known. Only population changes should be shown.

A minimum of two maps (Map 3.4a and Map 3.4b) should be provided. See Appendix B Section 3 for specific mapping details for this section.

4.0 HAZARD SPECIFIC DISCUSSION

- Two site level maps (Map 4.0a and 4.0b) should be provided prior to hazard area discussions. See Appendix B, Risk-Based End State Mapping Manual, Section 4 for specific details.

- For each hazard area, a separate chapter should be provided (e.g., Chapter 4.1 for hazard area 1 and Chapter 4.2 for Hazard Area 2).

4.1 HAZARD AREA 1[1] – include hazard area name

- Narrative should include discussion of: 1) key features that are not apparent from the maps or to supplement the information shown on the maps; 2) the differences between the current state map and the RBES map and 3) the differences between the current state CSM and the RBES CSM.

- 4 figures for each hazard area should be provided – current state map (Map 4.1a1), current state CSM (CSM 4.1a2), RBES map (Map 4.1b1) and RBES CSM (4.1b2). See Appendix B, Risk-Based End State Mapping Manual, Section 4 and Appendix C, Manual for Preparing Conceptual Site Models for Hazard Areas of Concern Section 3 for specific details.

4.2 HAZARD AREA 2 – same as above. Repeat as needed.

[1] For small sites, when all hazard areas can be shown clearly on the site-wide hazard maps, hazard area maps and CSM are not required. In such case, site -wide hazard CSM – current state (4.0a2) and site-wide hazard CSM – RBES (4.0b2) should be provided.

This Page Intentionally Left Blank

APPENDIX B

Risk-Based End State Mapping Manual

This Page Intentionally Left Blank

1.0 INTRODUCTION

The Risk-Based End State (RBES) guidance uses a standardized approach for generating and using site maps and conceptual site models to portray the RBES Vision. Historically, the U.S. Department of Energy (DOE) sites have generated land-use plans, site maps, and conceptual site models using a variety of tools and procedures. One goal of this project is to transform the varying applications and/or versions of these essential management tools into a single, unified approach. Standardization supports DOE efforts to manage its real estate and environmental liability in a corporate manner.

The timeframe for the site-specific RBES Vision is the current Environmental Management (EM) mission completion date with known or expected changes in land use for 20 years beyond that date. For example, the RBES Vision for fictitious Site X in the state of Montana should be 2006 (the site closure date) with consideration of known facts through 2026. An example of a known fact is that the Montana highway department is planning an extension of the highway to Site X in 2008 that might impact the RBES Vision. This planned highway should be shown on the appropriate RBES Vision maps. Sites are encouraged to seek out interested and affected governments to determine if they have future land use plans over the next 20 years.

This Appendix along with Appendix A, Format for the RBES Vision and Appendix C, Manual for Preparing Conceptual Site Models (CSM) for Site Specific Hazard Areas of Concern are the tools the site should use to complete the RBES vision. They are intended to be used together to ensure that the narrative specified in Appendix A, is matched by a map constructed by following directions in Appendix B and at the hazard level a conceptual site model constructed by following instructions in Appendix C.

1.1 MAP TYPES AND HIERARCHY

The maps requested by this manual are divided into two types: Current State and RBES. Each type is made up of three extents: Regional Context, Site Context, and Hazard-Specific maps, as described below.

1.1.1 Current State and RBES Map Types

The two types of maps are "Current State" and "RBES Vision." The maps are intended to present and allow comparisons between current and future land use and to enable the graphical depiction of hazards, their associated risks, and the affected populations or receptors. In short, if prepared correctly, the maps can serve multiple purposes. These purposes include, but are not limited to:

- serve as a decision-aiding tool for site management, the Landlord Program Secretarial Officer, and the Office of EM regarding cleanup and the sustainability of current and future missions;
- serve as a communication and risk assessment tool for discussion with state and federal regulators regarding cleanup;
- serve as a high-level depiction of expected cleanup results and risk reduction; and
- serve as a communication tool for public meetings regarding cleanup activities, current mission activities and requirements, and future land use.

The Current State map is a portrayal of a site as it exists in 2003 by mapping of its features at the regional, site, and hazard levels in accordance with this appendix. Current State maps should focus on effectively communicating the nature of existing hazards and the potential of those hazards to have an impact on human health or the environment.

The RBES vision is a portrayal of the site as it will be when final land use is determined and institutional controls and/or monitoring activities are in place, as defined in Section 1.2 (Page 1) of this Guidance.

The RBES maps should focus on communicating the nature of hazards and the potential of those hazards to have an impact on human health or the environment as envisioned under the RBES.

1.1.2 Regional Context, Site Context, and Hazard-Specific Map Hierarchy

The maps should be prepared in three extents: regional context, site context, and hazard specific. Most sites will be requested to provide maps at all three extents. Some smaller sites, with minimal residual risk, may be able to create site-wide hazard maps and CSM.

The Regional Context maps places the site within the context of the larger surrounding region. For example, Brookhaven National Laboratory would be depicted in its relationship to Suffolk County. The regional context should be large enough to show major watersheds, population areas, and significant external features (e.g., nuclear power plants, municipal landfills, etc.).

The Site Context maps encompass the site and the lands adjacent to the site. This is the extent normally associated with DOE's more typical land-use plans, but specifically includes information on adjacent properties, as well as property inside the DOE property boundary. This is also the first extent that provides information on CSM. In some cases, for sites that are not geographically contiguous, a site may need to repeat the site context map guidance to provide detail.

The Hazard-Specific maps provide the greatest level of detail. Hazard-specific maps are drawn for those selected portions of a site that contain hazards (disposal cells, landfills, entombed facilities, underground plumes, buried waste, etc.) that present risks to human health or the environment. CSM should be prepared for these hazards areas but not for each release site. Appendix C, Manual for Preparing Conceptual Site Models for Site-Specific Hazards of Concern, gives instruction on how CSM are to be developed/illustrated.

1.2 MAP FEATURES AND ATTRIBUTES

The information to be communicated by the Regional Context, Site Context, and Hazard-Specific maps is classified in features and attributes. Details of features and associated attributes symbols, coding, and mapping can be found in Section 5.0 of this appendix.

- Features—A single entity that composes part of a landscape, such as a point, line, or polygon. The features for RBES vision documents are shown in Tables 2-1, 3-1, and 4-1 of this appendix.

- Attribute—A characteristic of a feature that contains a measurement or value for the feature. Attributes can be labels, categories, numbers, dates, standardized values, fields, or other measurements. An item for which data are collected and organized. A column in a table or data file. For example, the attributes of a census tract might include its area, population, and average per capita income. The attributes for RBES vision documents are shown in Tables 2-1, 3-1, and 4-1 of this appendix.

- Symbol—Is a graphical representation of a feature.

- Layer—A grouping of features and attributes, according to Tables 2-1, 3-1, 4-1, that should be shown together on a map. To produce maps from across the complex that are as consistent as possible, standard coding guidance and color schemes have been developed for use. Details of features and their symbols, coding, and color schemes can be found in Section 5.0 of this appendix.

1.3 CONCEPTUAL SITE MODELS

Integral to the RBES approach to cleanup is the use of CSM. The CSM are intended to communicate risk information to DOE managers, the regulatory community, and the general public. The CSM provide, in block diagram form, information regarding the hazards, pathways, receptors, and barriers (current or planned) between the hazards and the receptors. Sites currently use a variety of different CSM. Appendix C, Manual for Preparing Conceptual Site Models for Site-Specific Hazard Areas of Concern provides guidance on the construction of these models. In addition, ASTM Standard E 1689-95, *Standard Guide for Developing Conceptual Site Models for Contaminated Sites*, should be used for the creation of CSM.

1.4 INTEGRATION OF MAPS AND CONCEPTUAL SITE MODELS

Current State and RBES visions will be most useful when sites integrate map information with the CSM (see Appendix C for examples). This integration may be done at the site level for small sites with few and well-defined hazards. Most sites may need to integrate maps and CSM at the hazard-specific level depending on the size of the site and/or multiple hazards. This will allow graphical depiction of the map-based information, with a block diagram of the CSM, and associated narrative information. Section 1.5, Mapping Nomenclature, provides guidance for integrating the Hazard-Specific Maps with CSM.

1.5 MAPPING NOMENCLATURE

This section of Appendix B is intended to provide information on how maps are to be constructed, how to title and number them and to provide a summary of information sources for gathering the requested feature and attribute information.

1.5.1 Geographical Information Systems

The development of geospatial maps provides a means for integrating diverse databases and creating accurate visual presentations and descriptions of complex environmental, physical site and human health conditions. During remedial investigations, a significant amount of data of varying quality and formats are collected and compiled in a multitude of database structures. Other data, such as the site's topography, location of roads, streams and buildings, and land uses are similarly collected and stored in various databases and formats, including paper documents. Additional data such as satellite images, and information on land uses and populations outside the site boundaries may be downloaded from local, state and federal governments sites. Much of this data is georeferenced, or linked to specific geographic coordinates on the site, but some is not. The degree and consistency of the maps that would be developed from this data would therefore vary in accuracy, resolution, projection and scale.

The content standard for digital geospatial metadata in the federal government was promulgated in 1994 through Executive Order 12906. The purpose was to standardize procedures so the prospective user could determine the availability of a set of geospatial data, determine the fitness of the set of geospatial data for an intended use, determine the means of accessing the set of geospatial data, and successfully to transfer the set of geospatial data. In 1990, the federal government formed the interagency Federal Geographic Data Committee (FGDC) which not only developed the standards in the Executive Order, but under OMB Circular A-16, FGDC continues to promote the coordinated use, sharing, and dissemination of geospatial data on a national basis. One of its most important contributions to this effort is the development of the National Spatial Data Infrastructure (NSDI), in cooperation with organizations from state, local and tribal governments, the academic community, and the private sector. The NSDI encompasses policies, standards, and procedures for organizations to cooperatively produce and share geographic data. DOE Headquarters has been an active member of FGDC since its inception. In further

support of these efforts, the Department of Defense (DoD) established a multiagency Technology Center to coordinate facilities, infrastructure, and environmental use of CADD and GIS activities within DoD and with other participating governmental (federal, state, and local) agencies, and the private sector. One of the major initiatives of the Center was the development of the Spatial Data Standard (SDSFIE) for Facilities, Infrastructure, and Environment.

All DOE sites should adopt these widely used standards, except where otherwise noted in this document, in the preparation and maintenance of geospatial data used to prepare these maps.

Sites should build and depict the maps associated with this guidance using ESRI Products.

1.5.2 Map Construction

The mapping data layers used to produce the final maps should be in shapefile, coverage, raster, GRID, or other acceptable format supported by ESRI products. All mapping data layers should be in a common geographic or a projected coordinate system.

All maps should be drawn on an ANSI "A" paper size with a 1" margin on the binding side and 1" margin on all other sides with a frame around it. All text should be shown at a scale no less than 0.16" (11 pt).

Features and symbols shown on the maps should be consistent with the guidelines or standards in Section 5.0 of this appendix, Map Symbols, Icons, and Colors, which have been drawn from the ArcView 8.2 symbol library. If there is no representative symbol that accurately depicts a feature needed on your map, you should attempt to use other standard ESRI symbols. If no ESRI symbol exists, you should consult the online USGS symbol library. If no ESRI or USGS symbol exists, the site may select its own symbol. The **exception to this** are the symbols for "Area of Concern - Plume" and "Area of Concern - Soil," which are fixed at light blue for plume and brown for soil. This may require manipulation of the symbols from the ESRI library. Sites are strongly discouraged from creating their own symbols.

The land cover classification system used for these maps is modified from the National Land Cover Dataset Classification, which has been modified from the Anderson land-use and land-cover classification system. The purpose for the modification was for simplification of land cover categories that were thought to be more appropriate to the DOE mapping process (see Section 5.0).

The color-coding for features shown in Section 5.0 of this appendix is based on red-green-blue (RGB) values and will show a variance on different printers. If another color is needed to depict a feature or attribute, attempt to pick a color that is contrasting to colors already being used or use a hatch pattern to depict the feature or attribute.

1.5.3 Map Features

The following features should be visible on each map produced to ensure clarity and consistency to the reader.

- Title (subtitle optional)
- Author
- Data sources with dates
- Date of map completion
- North arrow
- Scale bar
- Scale text

- Legend
- Projection with coordinate system
- Additional text for clarification

1.5.4 Map Numbering

The maps developed for the RBES Vision document should be numbered and titled as shown in Table 1-1 of this appendix. This title and numbering scheme will allow for a continuity of map types across the complex. For example: Every map numbered 2.1a will be the Regional Physical and Surface Interface – Current State.

Table 1-1. Standardized figure names and numbers.

Extent	Mapping Manual Section	Number	Figure Name	Requested or Optional
Regional Context	2.0 (Page B-9)	2.1a	Regional Physical and Surface Interface – Current State	R
	2.0 (Page B-9)	2.1b	Regional Physical and Surface Interface – RBES	R
	2.0 (Page B-9)	2.2a	Regional Human and Ecological Land Use – Current State	R
	2.0 (Page B-9)	2.2b	Regional Human and Ecological Land Use – RBES	R
	2.0 (Page B-9)	2.3a[1]	As appropriate	O
	2.0 (Page B-9)	2.3b	As appropriate	O
Site Context	3.0 (Page B-16)	3.1a[2]	Site Physical and Surface Interface – Current State	R
	3.0 (Page B-16)	3.1b	Site Physical and Surface Interface – RBES	R
	3.0 (Page B-16)	3.2a	Site Human and Ecological Land Use – Current State	R
	3.0 (Page B-16)	3.2b	Site Human and Ecological Land Use – RBES	R
	3.0 (Page B-16)	3.3a	Site Legal Ownership – Current State	R
	3.0 (Page B-16)	3.3b	Site Legal Ownership – RBES	R
	3.0 (Page B-16)	3.4a	Site Demographics – Current State	R
	3.0 (Page B-16)	3.4b	Site Demographics – RBES	R
	3.0 (Page B-16)	3.5a	Site-Defined Custom Configuration Map – Current State	O
	3.0 (Page B-16)	3.5b	Site-Defined Custom Configuration Map – RBES	O
Hazard Specific	4.0 (Page B-27)	4.0a	Site-wide Hazard Map – Current State	R
	4.0 (Page B-27)	4.0b	Site-wide Hazard Map – RBES	R
	4.0 (Page B-27)	4.0a2[3]	Site-wide CSM – Current State	O
	4.0 (Page B-27)	4.0b2[3]	Site-wide CSM – RBES	O
	4.0 (Page B-27)	4.1a1	Hazard Area 1 (insert area name here) Map – Current State	R
	4.0 (Page B-27)	4.1b1	Hazard Area 1 (insert area name here) Map – RBES	R
	4.0 (Page B-27)	4.1a2	Hazard Area 1 (insert area name here) CSM – Current State	R
	4.0 (Page B-27)	4.1b2	Hazard Area 1 (insert area name here) CSM – RBES	R
	4.0 (Page B-27)	4.2a1[4]	Hazard Area 2 (insert area name here) Map – Current State	R
	4.0 (Page B-27)	4.2b1[4]	Hazard Area 2 (insert area name here) Map – RBES	R
	4.0 (Page B-27)	4.2a2	Hazard Area 2 (insert area name here) CSM – Current State	R
	4.0 (Page B-27)	4.2b2	Hazard Area 2 (insert area name here) CSM – RBES	R

1. Maps starting 2.3a and beyond are optional. Site should name the maps as appropriate using the numbering system provided in Mapping Manual Section 2, Figure 2-1.
2. For Site Context Maps, "map sets" are designed rather than single maps to provide sites with the flexibility to layer one to several feature categories.
3. For small sites, when all hazard areas can be shown clearly on the site-wide hazard maps, hazard area maps and CSM are not required. In such case, site-wide hazard CSM – current state (4.0a2) and site-wide hazard CSM – RBES (4.0b2) should be provided.
4. Continue to number for each hazard area 1 through x.

1.5.5 Sources of Mapping Information

State and federal governments and their agencies have developed a large amount of geospatial data that can be readily accessed via the Internet. Major contributors include USGS, the Bureau of Land Management, Department of Agriculture, Department of Housing and Urban Development, U.S. Census Bureau, the Environmental Protection Agency, and U.S. Park Service. In developing the regional maps, sites are expected to use external data sources (e.g., USGS, BLM, and U.S. Census Bureau). If conflicting information exists, sites should use the best judgment in developing the maps in consultation with appropriate parties.

Many states provide web access to more localized data, and others will make information available on CDs for a fee. Much of the data has also been converted into georeferenced maps, which are available for viewing and download over the internet using GIS software packages already owned by many DOE sites or through the use of free shareware, such as ESRI's free ArcExplorer software package for viewing. This free software can be found at http://www.esri.com/sofware/arcexplorer/indwx.html.

There are many web sites at which the required data can be located.

- *Geodata.gov -- The Geospatial One Stop Portal*. The Office of Management and Budget (OMB) has designed and just released an internet site intended to make it easier to locate and use geospatial data that has been developed by numerous federal and state government agencies. Initial participants include BLM, USGS, KGDC, NOAA, NASA, and the states of New Jersey, North Carolina, Delaware, Kansas, Minnesota, North Dakota, and Utah. The *Geodata.gov* portal is intended to accelerate the development and implementation of the NSDI discussed in Section 1.5.1 of the manual. Access to the site can be found at http:/www.geodata.gov.

- *Federal Geographic Data Committee/National Spatial Data Infrastructure*. This web site will direct users to developing national standards for geospatial data, processes, organizations, and technology. This site also has reports on national geospatial metadata, data content, and symbology standards. Access to the site can be found at www.fgdc.gov/index.html.

- The *Center for Advanced Spatial Technologies (CAST)* facility at the University of Arkansas maintains one of the most comprehensive and easy to use web sites. It is titled *Starting the Hunt: Guide to Mostly On-Line and Mostly Free U.S. Geospatial and Attribute Data-http://www.cast.uark.edu/local/hunt/index.html*. CAST has organized several hundred web-based data sources into two broad classifications: National Aggregations and State and Local Aggregations. The vast majority of these web sites require ArcView or other GIS software systems to view and download the data, but many provide data in Adobe Acrobat (pdf) or picture (jpg) formats.

Table 1-2 of this appendix provides additional resources that may be of assistance to the site for development of the RBES Vision document and associated maps.

Table 1-2. Summary of mapping resources.

Resource Location	Map Features
Local/State Library	Boundaries, highways, roads, railroads, dams, power plants, land cover, land use, watershed delineations, floodplains and wetlands,
U.S. Census Bureau	Population centers, population density
U.S. Geological Survey	Mountains, valleys, lakes, streams, rivers
Local Government	Legal Ownership-private, government,
DOE Site	Hazards-disposal cells, landfills, entombed facilities, underground plumes, buried waste, etc.
U.S. Fish and Wildlife	Conservation and ecological areas, biota habitat, endangered species

1.5.6 Example Maps

The example maps included in the manual were prepared with assistance from the GIS staff at Brookhaven National Laboratory on Long Island, New York. **These maps do not depict actual or proposed conditions at BNL or in the surrounding off-site areas, and are solely intended to be examples of how the various maps should appear.**

1.5.7 Technical Assistance

The DOE Grand Junction Office (GJO) will be providing assistance to fourteen sites in preparation of the maps for the RBES Vision document. The sites include Ashtabula, Battelle Columbus, Fernald, Weldon Spring, Mound, Rocky Flats, and the eight Nevada off-site locations (Amchitka, Gas Buggy, Gnome, Faultless, Shoal, Rio Blanco, Rulison, and Salmon). The GJO will work with the responsible DOE offices and site contractor staff to become familiar with the site, determine data availability, develop the GIS data sets required to complete the regional context and site context maps, and to produce the maps for the sites to include in the final RBES Vision document.

The points of contact are Tracy Plessinger (DOE-GJO) [(970) 248-6179] and Dan Collette (S.M. Stoller Corporation) [(970) 248-6513].

2.0 REGIONAL CONTEXT MAP

The Regional Context map is intended to place the site within its larger contiguous regional area and in relationship to the possible off-site pathways and ecological or human receptors that are of concern. The size and boundaries of the regional area shown on this map will differ somewhat from site to site because of their differences in land size and complexity, but also because of differences among nearby population centers, habitat and ecology areas, watersheds, and other areas that could be affected by contamination and other hazards on the site. As a guidance, the regional boundaries should not be a fixed number of miles from the site boundary, but rather they should follow the boundaries of all contiguous local and county governments, and tribal nations that surround the site. They should also encompass all watersheds, habitat and ecology areas, and other off-site areas that could be affected by site contamination. At some of the larger sites, the regional context may be hundreds of square miles and many counties, while at some small sites the regional context may be only a few square miles made up of the surrounding local government and perhaps a critical watershed. The three RBES maps should include any anticipated on- and off-site changes in human and ecological activities and land use. Figure 2-1 shows the numbering scheme for the Regional Context Maps.

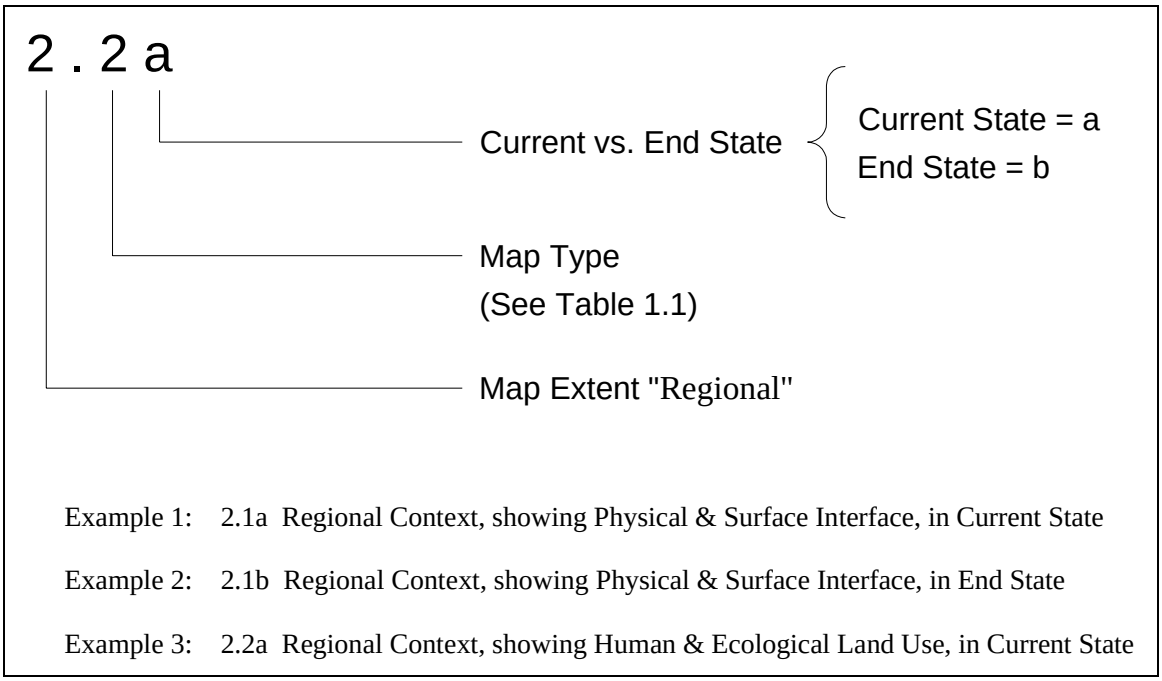


Figure 2-1. Numbering scheme for Regional Context Maps.

Regional Context Maps have three (3) subsets. Table 2-1 of this appendix gives a listing of the essential features to be portrayed. Figures 2.1a, 2.1b, 2.2a, and 2.2b show examples of the Regional Maps.

- Map 2.1a and 2.1b—Current and RBES Physical and Surface Interface Maps: Show features for: Administrative, Transportation and Infrastructure, Surface Configuration, and Hazard Areas of Concern.

- Map 2.2a and 2.2b—Current and RBES Human and Ecological Land Use Maps: Show features for: Human Activities, Land Cover, Ecological Activities, and Hazard Areas of Concern.

- Map 2.3a and 2.3b—Current and RBES Site Defined Custom Configuration (Optional): Additional maps, showing similar features as described above, along with any additional features desired by the user that present site-desired combinations (i.e., allows sites to mix and match) of any requested map features. Also, maps already generated by the site that show additional types of information (e.g., mapping of site ecological habitat types; populations of biota; other) are also permitted. The objective is to provide flexibility to the sites so additional maps that help them communicate the RBES, above and beyond the requested set of standardized maps, may be included.

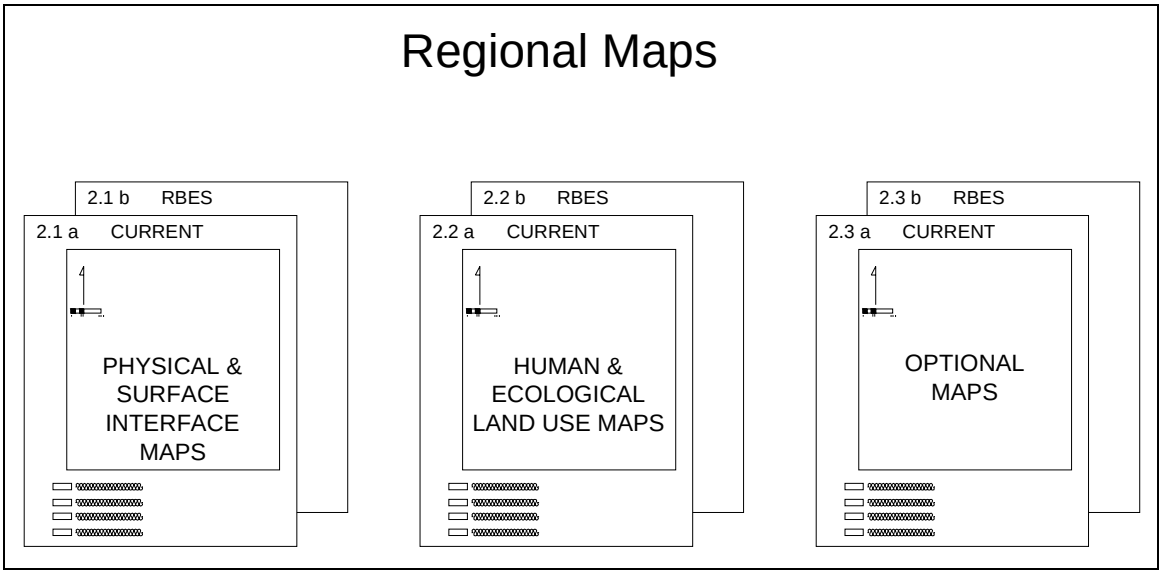


Figure 2-2. Example of Regional Context Map sets.

Figure 2-2 shows an example of the Regional Context Map sets.

Table 2-1. Map sets for RBES documents – Regional Context.

REGIONAL MAPS Note that hazard areas of concern are represented on each of the two maps	FEATURE CATEGORY	FEATURE
MAPS 2.1a and 2.1b: Physical and Surface Interface Map	Administrative	Boundaries of local and county governments, Tribal Nations, national wildlife and wilderness areas
		DOE Site boundaries
		Legal ownership (Identify private and government)
	Transportation and Infrastructure	MAJOR highways, roads, and railroads, as relevant and appropriate
		MAJOR infrastructure (dams, power plants) as relevant and appropriate
	Surface Configuration	MAJOR topography (e.g., mountains, valleys, lakes, streams, rivers) as relevant and appropriate
	Hazard Areas of Concern	MAJOR potential or actual hazards both onsite and offsite (e.g., NPL sites, landfills, groundwater plumes, coal and nuclear power plants, other sources of potential contamination)
MAPS 2.2a and 2.2b: Human and Ecological Land Use Map	Human Activities	Population centers (e.g., location of towns and cities)
	Land Cover	Residential, commercial, industrial, transportation, nonagricultural vegetated, agricultural wetlands, water, barren
	Ecological Activities	Conservation and ecological areas; watershed delineations; floodplains and wetlands; biota habitat areas of concern, as relevant and appropriate
	Hazard Areas of Concern	MAJOR potential or actual hazards both onsite and offsite (e.g., NPL sites, landfills, groundwater plumes, coal and nuclear power plants, other sources of potential contamination)
MAPS 2.3a and 2.3b: Site Defined Custom Configuration Map Any combination of Physical and Surface Interface Map Set Feature Categories, and Human and Ecological Land Use Map Set Feature Categories, as desired by the site.	Administrative, Transportation, and Infrastructure, Surface Configuration, Human Activities, Land Cover, Ecological Activities, Hazard Areas of Concern in Any Combination	Any combination of features previously used/listed within the Feature Categories listed to the left
Also, maps already generated by the site that show additional types of information (e.g., mapping of site ecological habitat types, populations of biota, or other) are also permitted. The objective is to provide flexibility to sites so they can also include additional maps that help them communicate their RBES above and beyond the requested set of standardized maps		Any maps previously developed by a site. Can show information different from standard feature categories and features described in this guidance

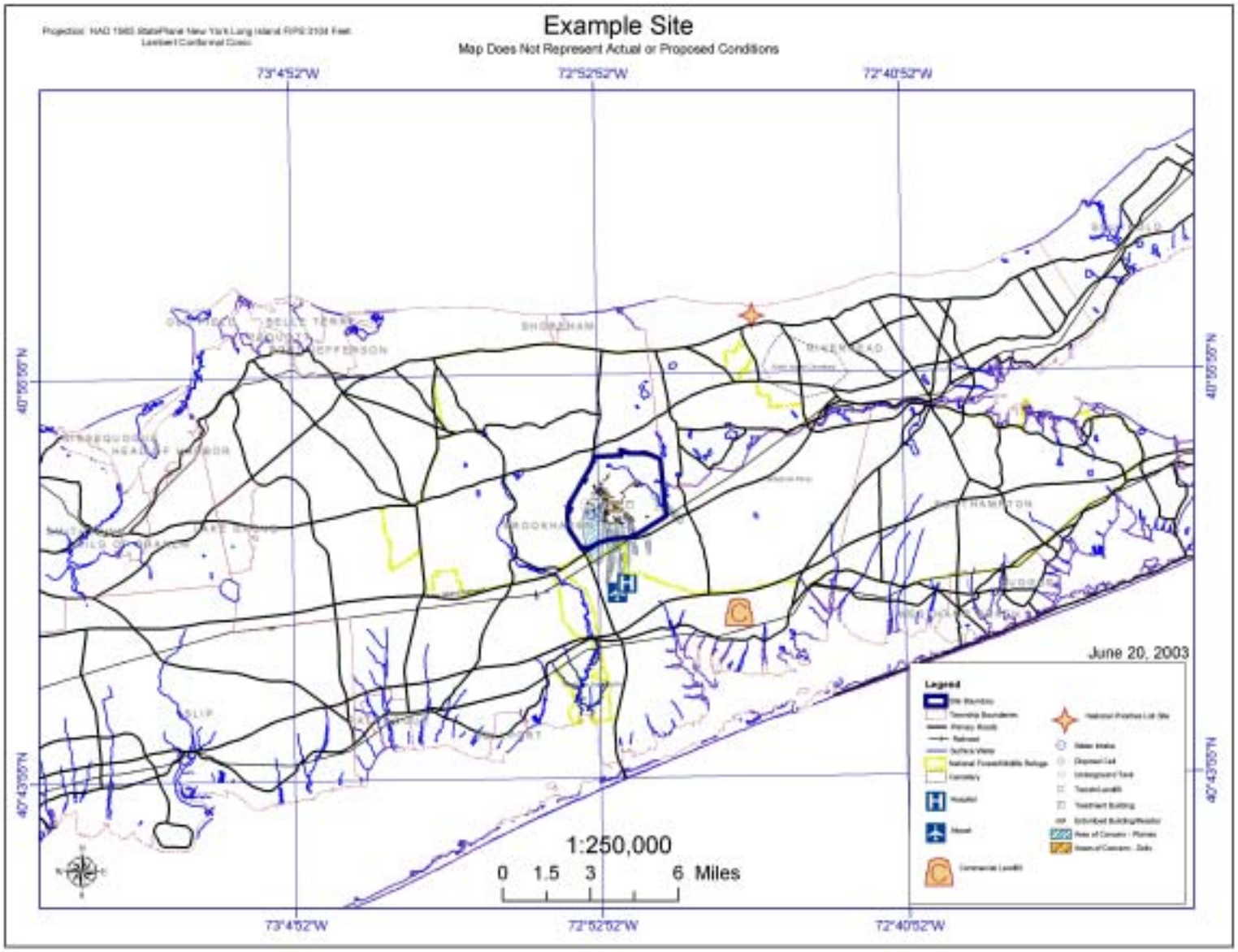


Figure 2.1a. Regional physical and surface interface – current state.

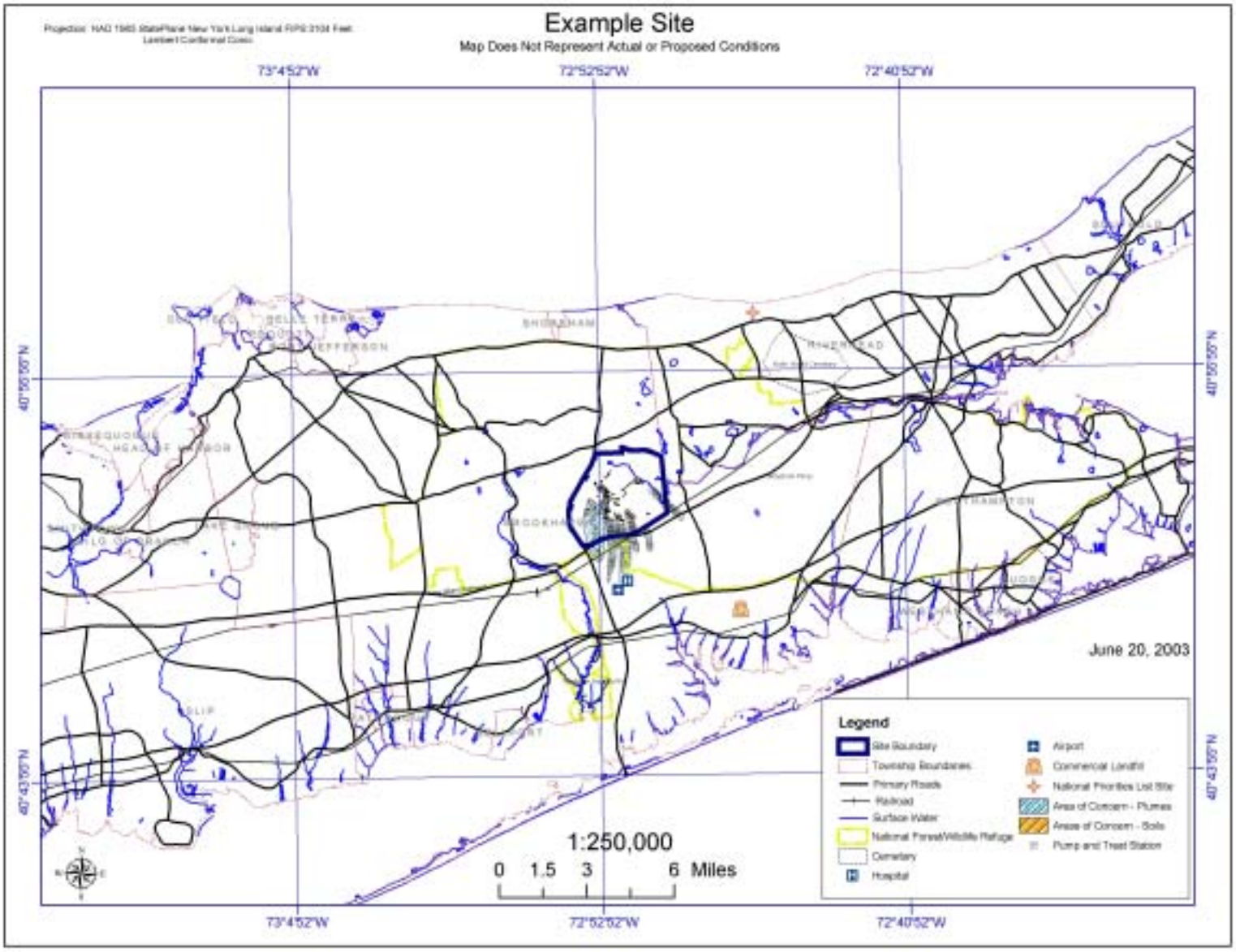


Figure 2.1b. Regional physical and surface interface – RBES.

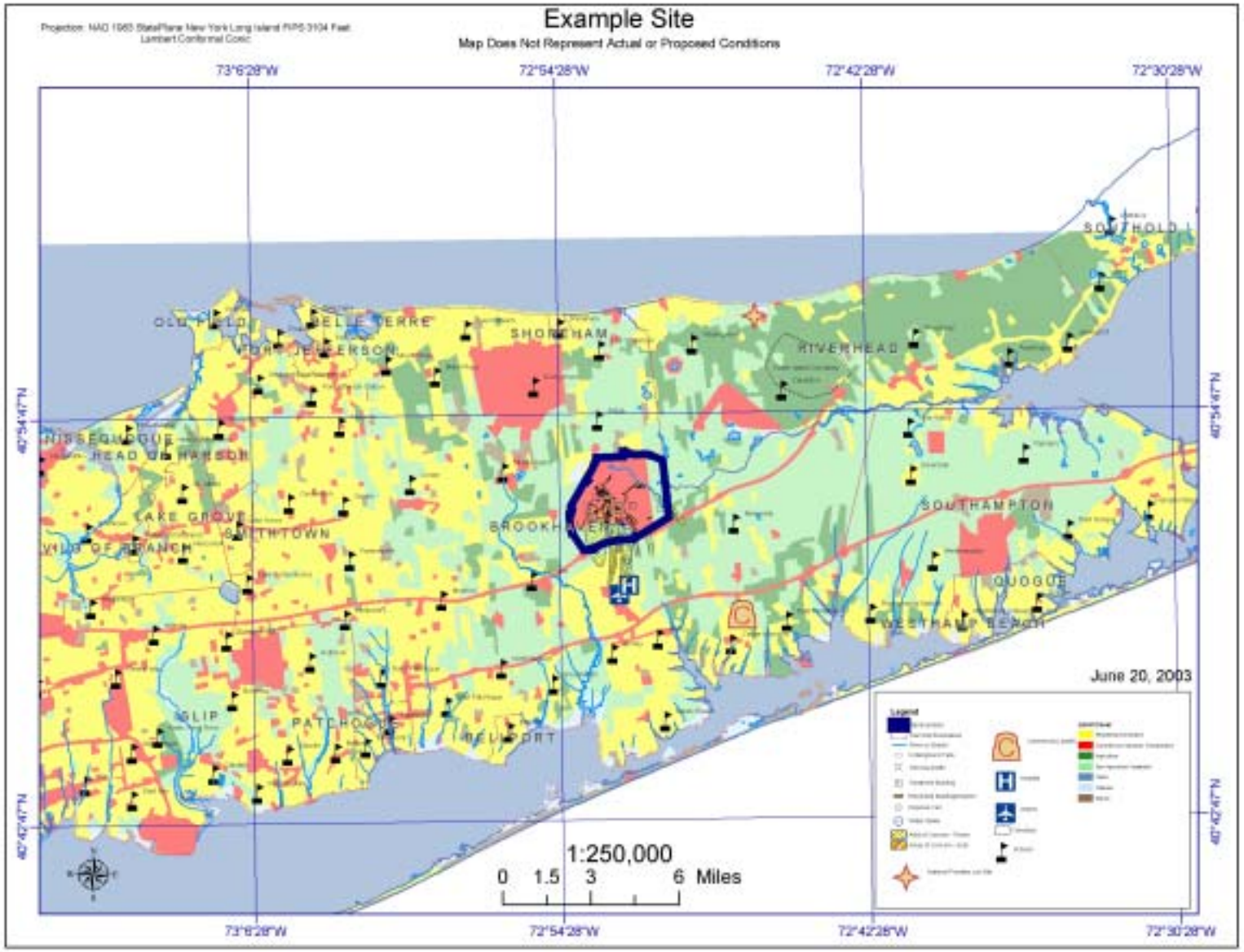


Figure 2.2a. Regional human and ecological land use – current state.

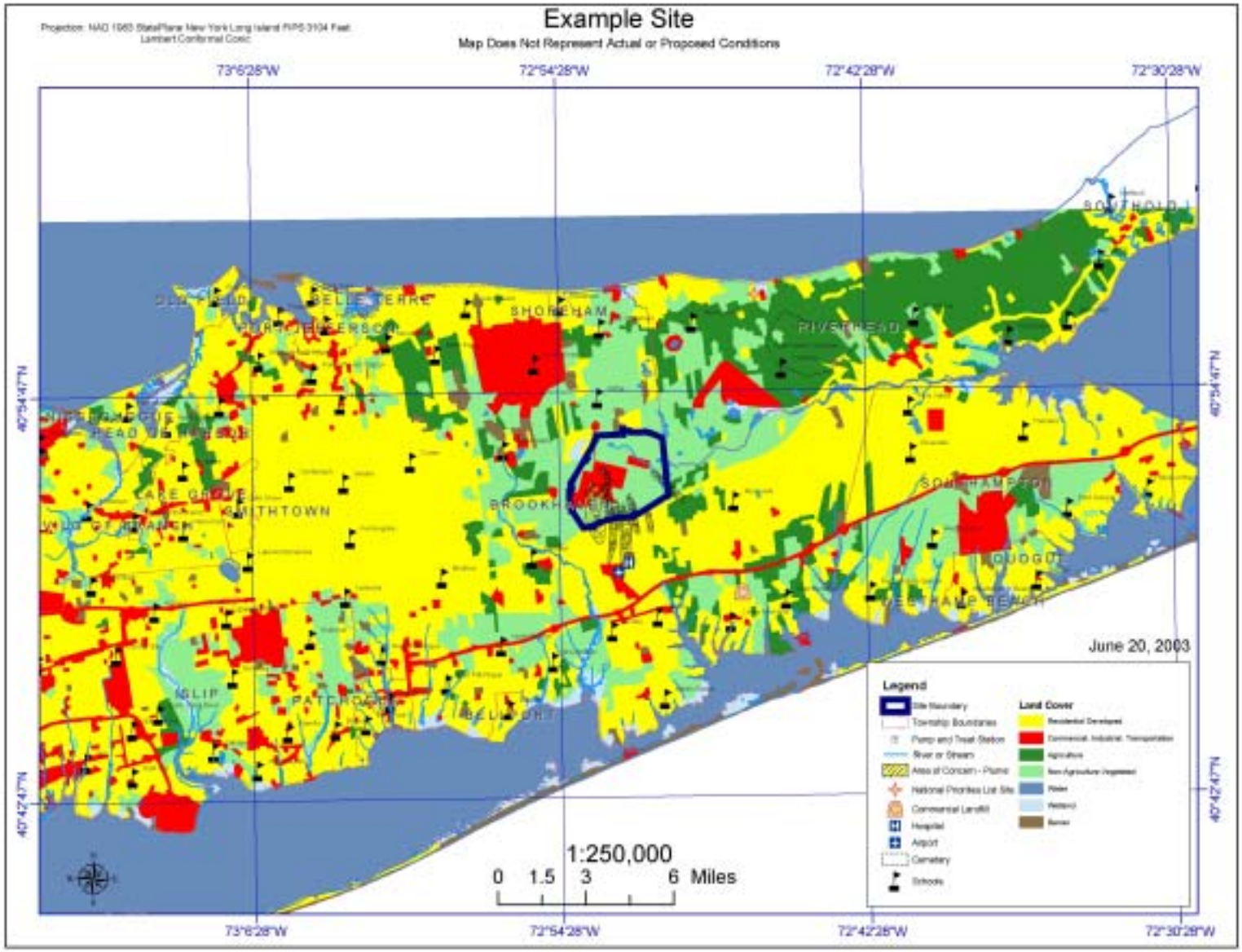


Figure 2.2b. Regional human and ecological land use – RBES.

3.0 SITE CONTEXT MAPS

Site Context maps are intended to show greater amounts of data and detail, including the location of hazardous conditions in relationship to environmentally sensitive areas, or to possible exposure and potential risk pathways and receptors. The boundaries for these maps should extend beyond the site to include all contiguous population and environmentally sensitive areas that might be affected by contamination on the site. Even in instances where the contamination is believed to be totally contained within the site boundaries, it is recommended that the Site Context maps show consideration and awareness of human and ecological areas in close proximity to the site. The five RBES maps should include any anticipated on- and off-site changes in human and ecological activities, land uses, population densities and ownership. Figure 3-1 shows the numbering scheme for the Site Context Maps.

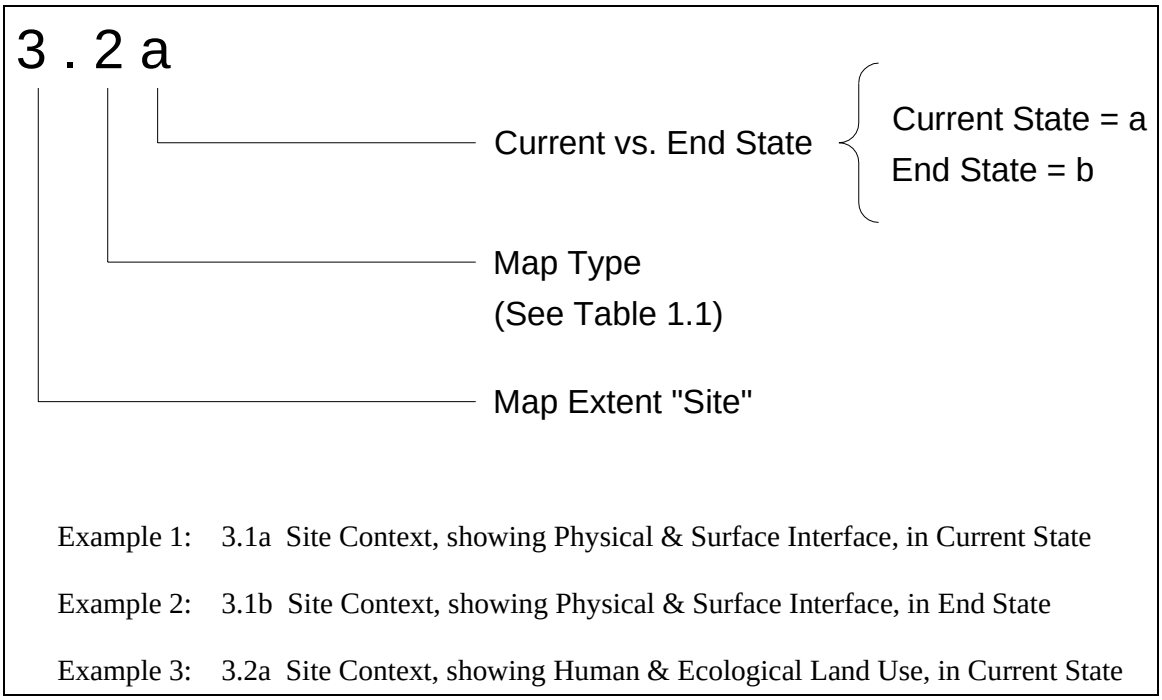


Figure 3-1. Numbering scheme for Site Context Maps.

Site Maps have five (5) subsets. Table 3-1 of this appendix provides a listing of the essential features to be portrayed. Figures 3.1a, 3.1b, 3.2a, 3.2b, 3.3a, 3.3b, 3.4a, and 3.4b are example Site Context Maps.

- Map Set 3.1a and 3.1b—Current and RBES Physical and Surface Interface Map Set: One to several maps that show the essential features for: Administrative, Transportation and Infrastructure, Surface Configuration, and Hazard Areas of Concern feature categories. Each feature category and its features can be layered on one to several maps that make up Map Set 1.

- Map Set 3.2a and 3.2b—Current and RBES Human and Ecological Land Use Map Set: One to several maps that show the essential features for: Human Activities, Land Cover, Ecological Activities, and Hazard Areas of Concern feature categories. Each feature category and its features can be layered on one to several maps that make up Map Set 2.

- Map Set 3.3a and 3.3b—Current and RBES Legal Ownership: One to several maps showing ownership features by the city, county, state, federal (both DOE and other), and private.

- Map Set 3.4a and 3.4b—Current and RBES Demographics: One to several maps showing population density. Population density and other demographic data and projections should be based upon U.S. Census 2000 data and other appropriate government sources.

- Map Set 3.5a and 3.5b—Current and RBES Site-Defined Custom Configuration Map Set (Optional): Additional maps, showing similar features as described above, along with any additional features desired by the user that present site-desired combinations (i.e., allows sites to mix and match) of any Physical and Surface Interface, and Human and Ecological Land Use information. Also, maps already generated by the site that show additional types of information (e.g., mapping of site ecological habitat types; populations of biota; other) are also permitted. The objective is to provide flexibility to the sites so they can also include additional maps that help them communicate their RBES.

Figure 3-2 shows an example of the Site Context Map sets.

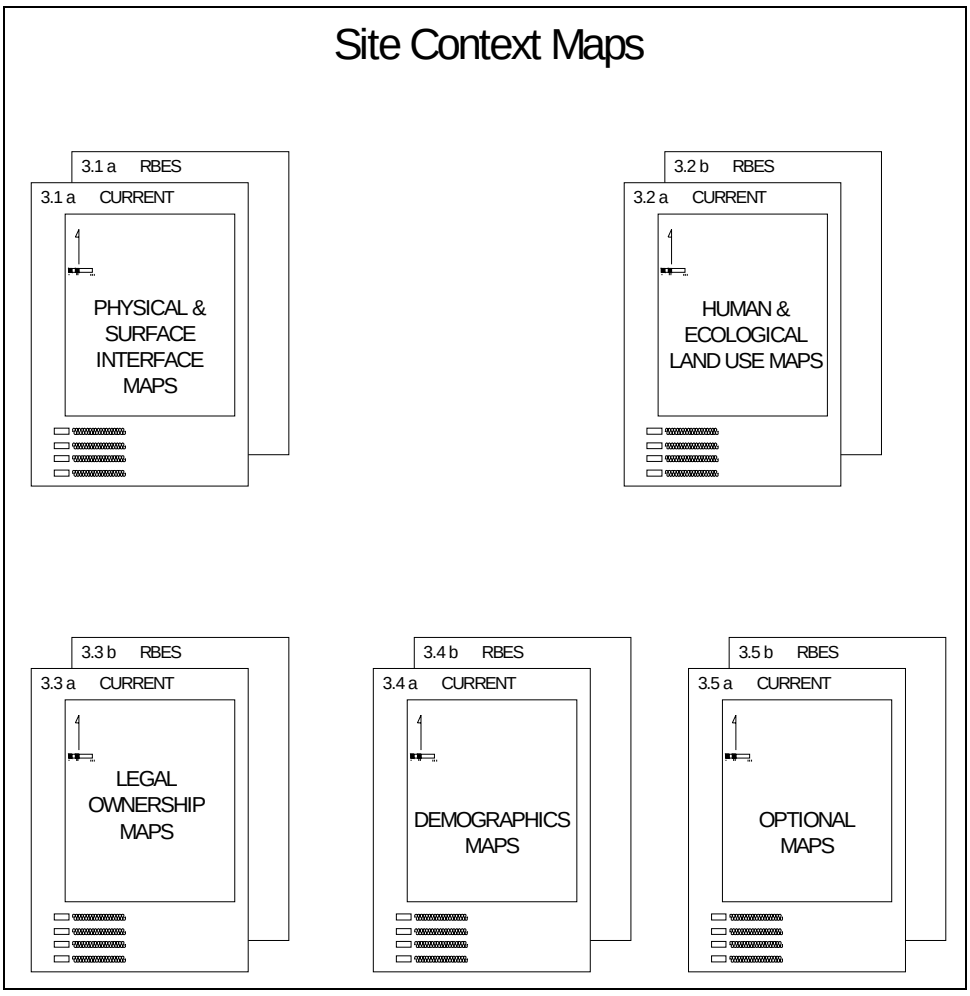


Figure 3-2. Example of Site Context Map sets.

Table 3-1. Map sets for RBES documents – Site Context.

SITE-CONTEXT MAPS	FEATURE CATEGORY	FEATURE
MAP SET 3.1a and 3.1b Physical and Surface Interface Map Set	Administrative	Boundaries of local and county government, Tribal Nations, national wildlife and wilderness areas that are contiguous to the site
		DOE site boundaries
		DOE fence lines
		Historic and cultural resources
		Ownership (surface and subsurface); identify private and government
	Transportation and Infrastructure	Highways, roads, and railroads, detailed as relevant and appropriate
		Surface (e.g., transmission lines) and subsurface (oil, gas, electric) utility lines, as relevant and appropriate
		Building footprints and infrastructure (e.g., DOE buildings, reactors, facilities, and waste sites; dams, water treatment plants, power plants as relevant and appropriate)
	Surface Configuration	Mountains, valleys, lakes, rivers, streams, watersheds, etc.
	Hazard Areas of Concern	Locations of contaminated surface water, ground water plumes (show flow direction and discharge locations if appropriate), sediments, and soils; DOE contaminated buildings, reactors, tanks, facilities, waste cells; wind rose information as relevant and appropriate. Show also any locations of monitoring wells and drinking water wells/potential interceptors, control points/institutional controls/no access points/buffer zones and other sources of potential contamination in the vicinity of DOE site boundaries as relevant and appropriate
MAP SET 3.2a and 3.2b Human and Ecological Land Use Map Set	Human Activities	Land use delineations (agricultural, residential, commercial, industrial/mining, open space/recreational, open space/ecological conservation/preservation, restricted human access). Include zoning if relevant and appropriate. Follow DOE codes aggregated from APA and other sources
		Drinking water supply source locations (aquifers; intakes)
	Ecological Activities	Conservation and ecological areas; watershed delineations; floodplains and wetlands; biota habitat areas of concern, as relevant and appropriate
	Hazard Areas of Concern	Locations of contaminated surface water, ground water plumes (show flow direction and discharge locations if appropriate), sediments, and soils; DOE contaminated buildings, reactors, tanks, facilities, waste cells; wind rose information as relevant and appropriate. Show also any locations of monitoring wells and drinking water wells/potential interceptors/control points/institutional controls/no access points/buffer zones and other sources of potential contamination in the vicinity of DOE site boundaries as relevant and appropriate
MAP SET 3.3a and 3.3b: Legal Ownership	Ownership	Ownership (surface and subsurface); identify private and government (states, DOE, other federal, and local)
MAP SET 3.4.a and 3.4b: Demographics	Demographic	Population density
MAP SET 3.5a and 3.5b: Site-Defined Custom Configuration Map Set (Optional)		
Any combination of Physical and Surface Interface Map Set Feature Categories, and Human and Ecological Land Use Map Set Feature Categories, as desired by the site. Multiple Maps within a Map Set as needed	Administrative, Transportation, and Infrastructure, Surface Configuration, Human Activities, Land Cover, Ecological Activities, Hazard Areas of Concern in Any Combination	Any combination of features previously used/listed within the Feature Categories listed to the left
Also, maps already generated by the site that show additional types of information (e.g., mapping of Site ecological habitat types, populations of biota, or other) are also permitted. The objective is to provide flexibility to sites so they can also include additional maps that help them communicate their RBES above and beyond the requested set of standardized maps		Any maps previously developed by a site. Can show information different from standard features described in this guidance

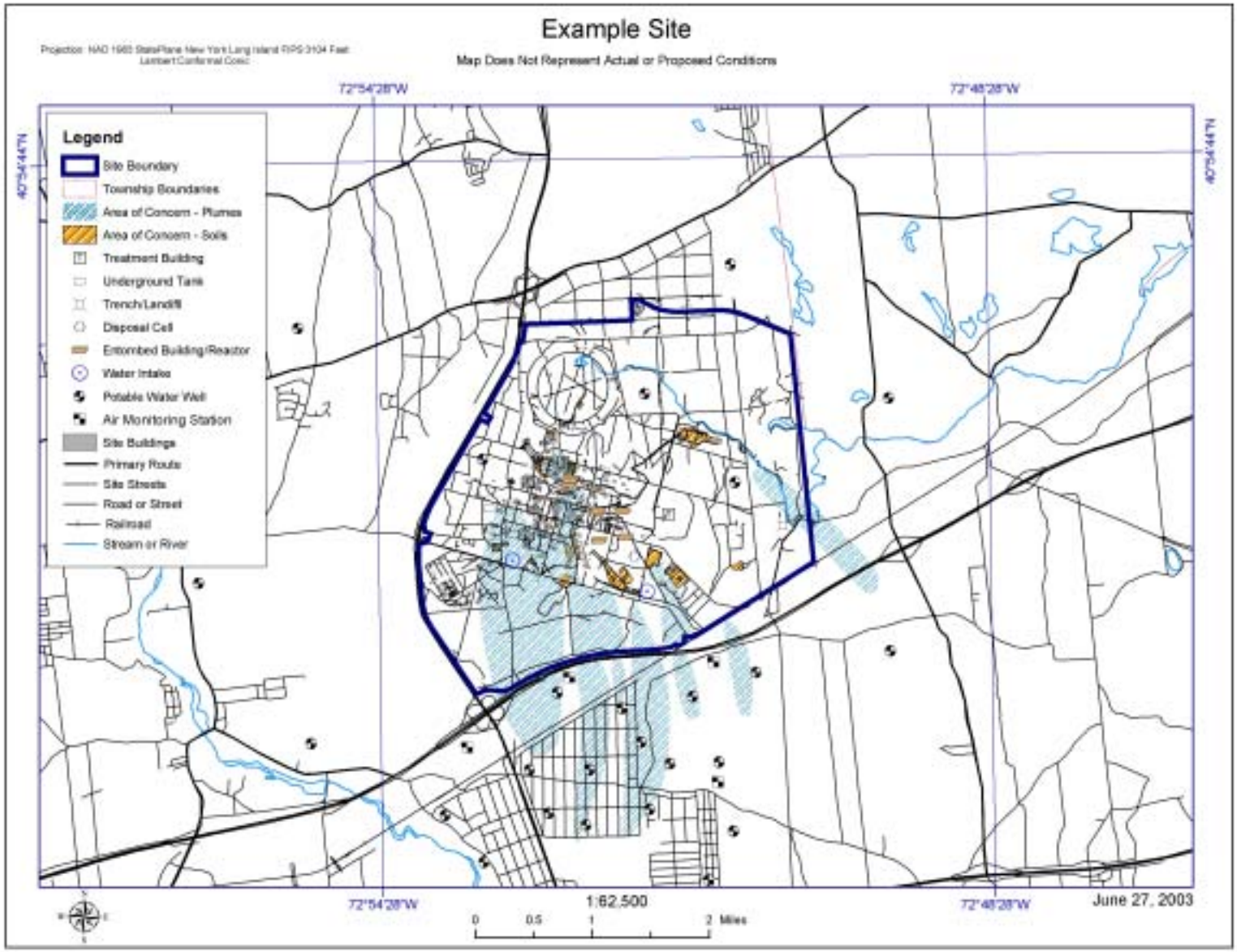


Figure 3.1a. Site physical and surface interface – current state.

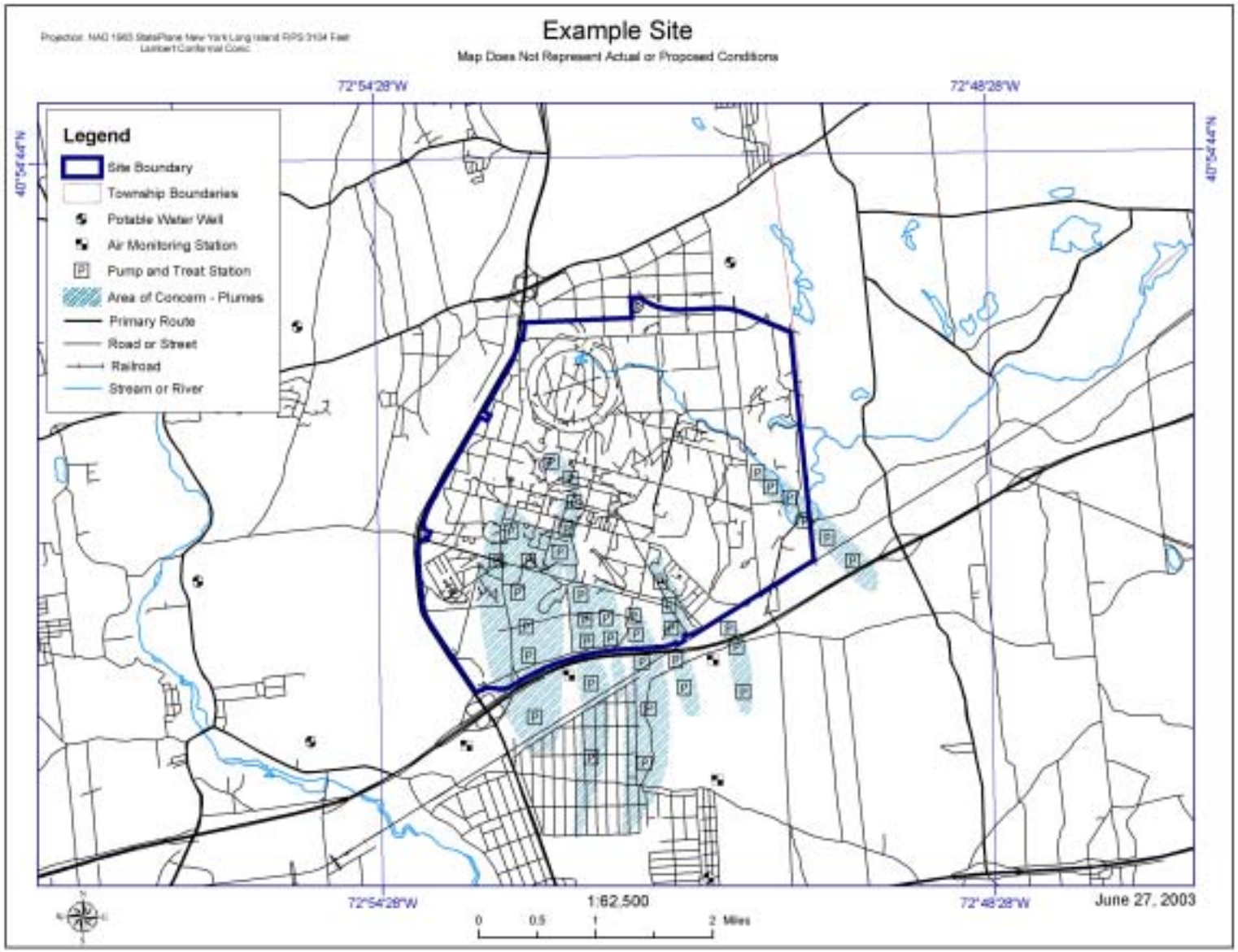


Figure 3.1b. Site physical and surface interface – RBES.

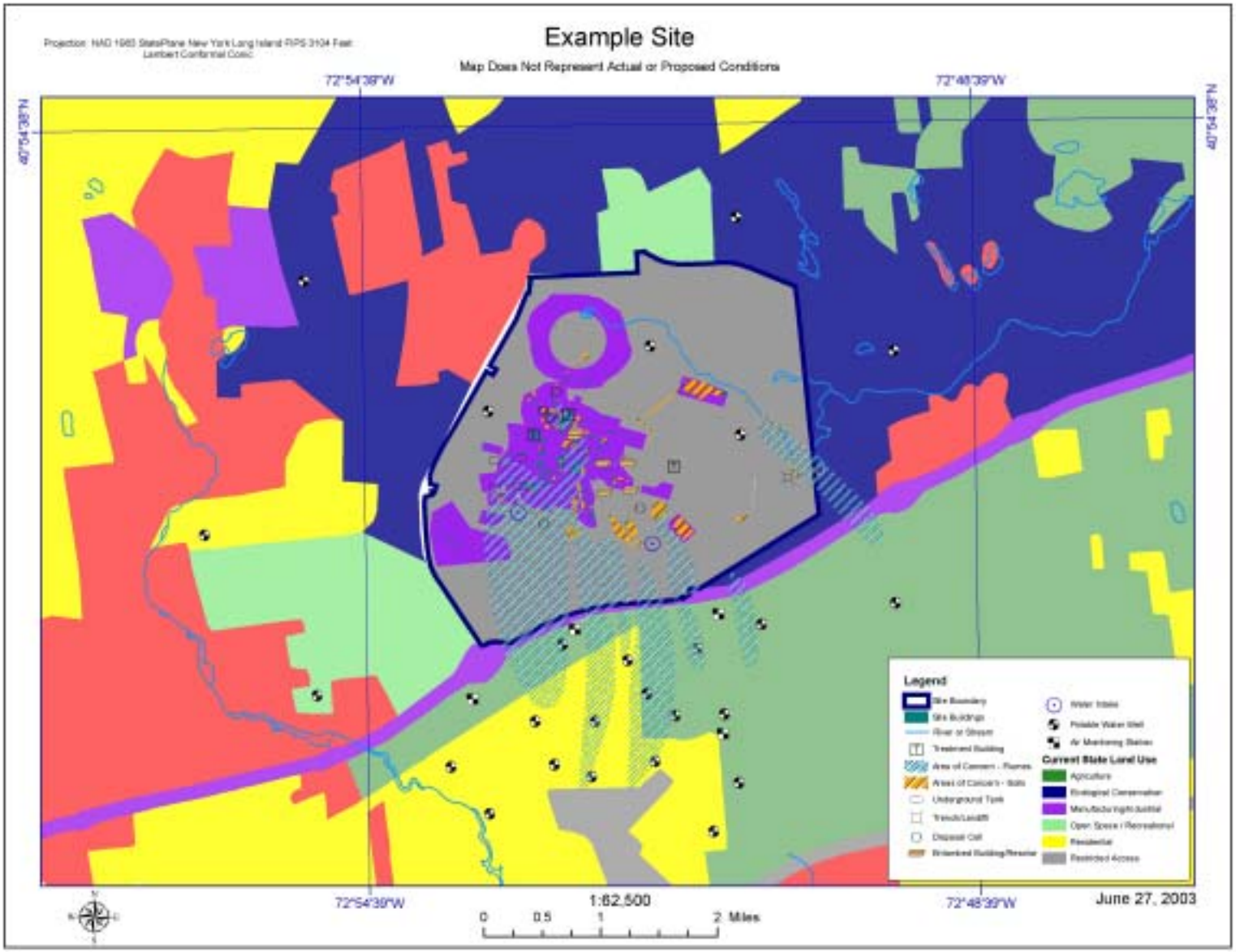


Figure 3.2a. Site human and ecological land use – current state.

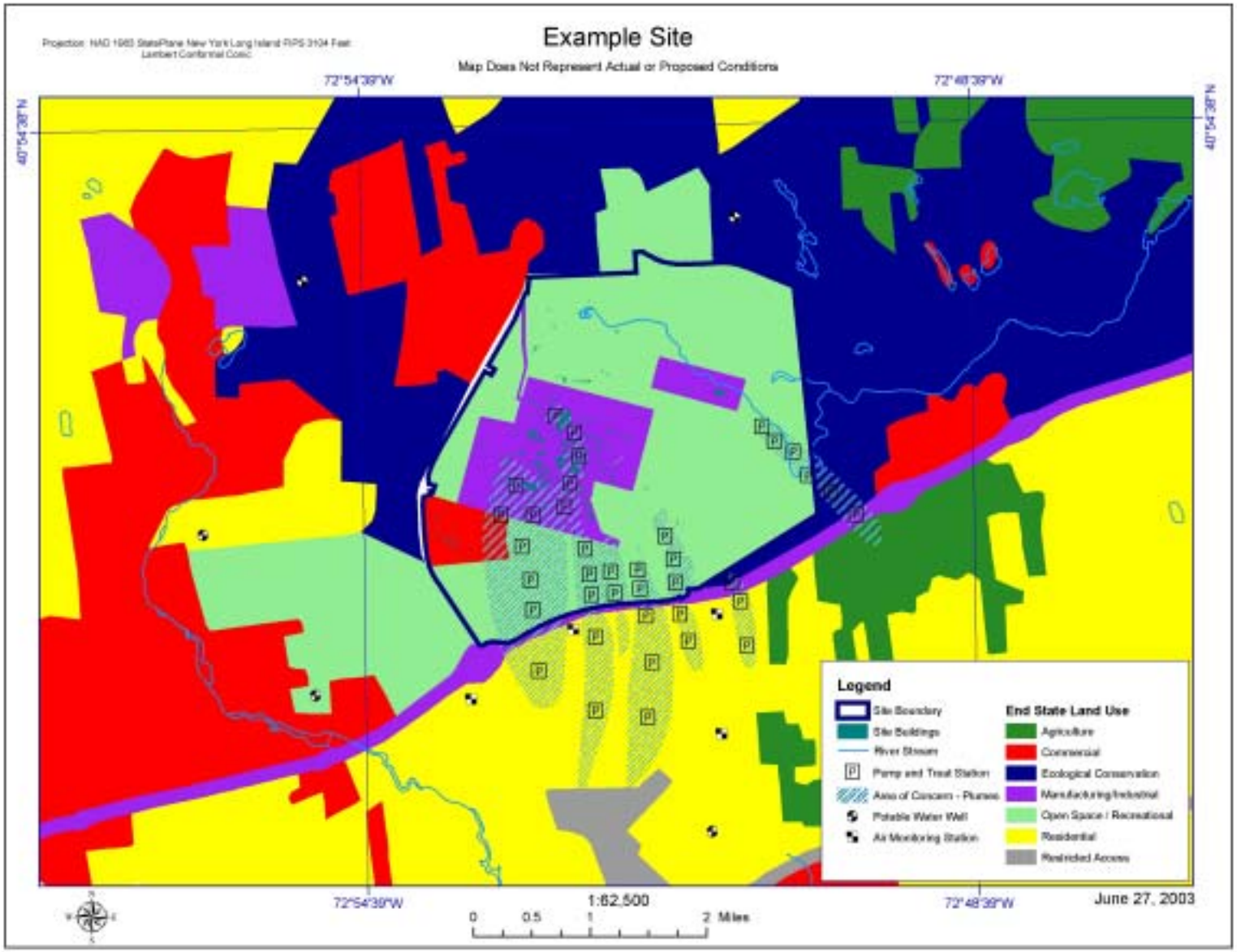


Figure 3.2b. Site human and ecological land use – RBES.

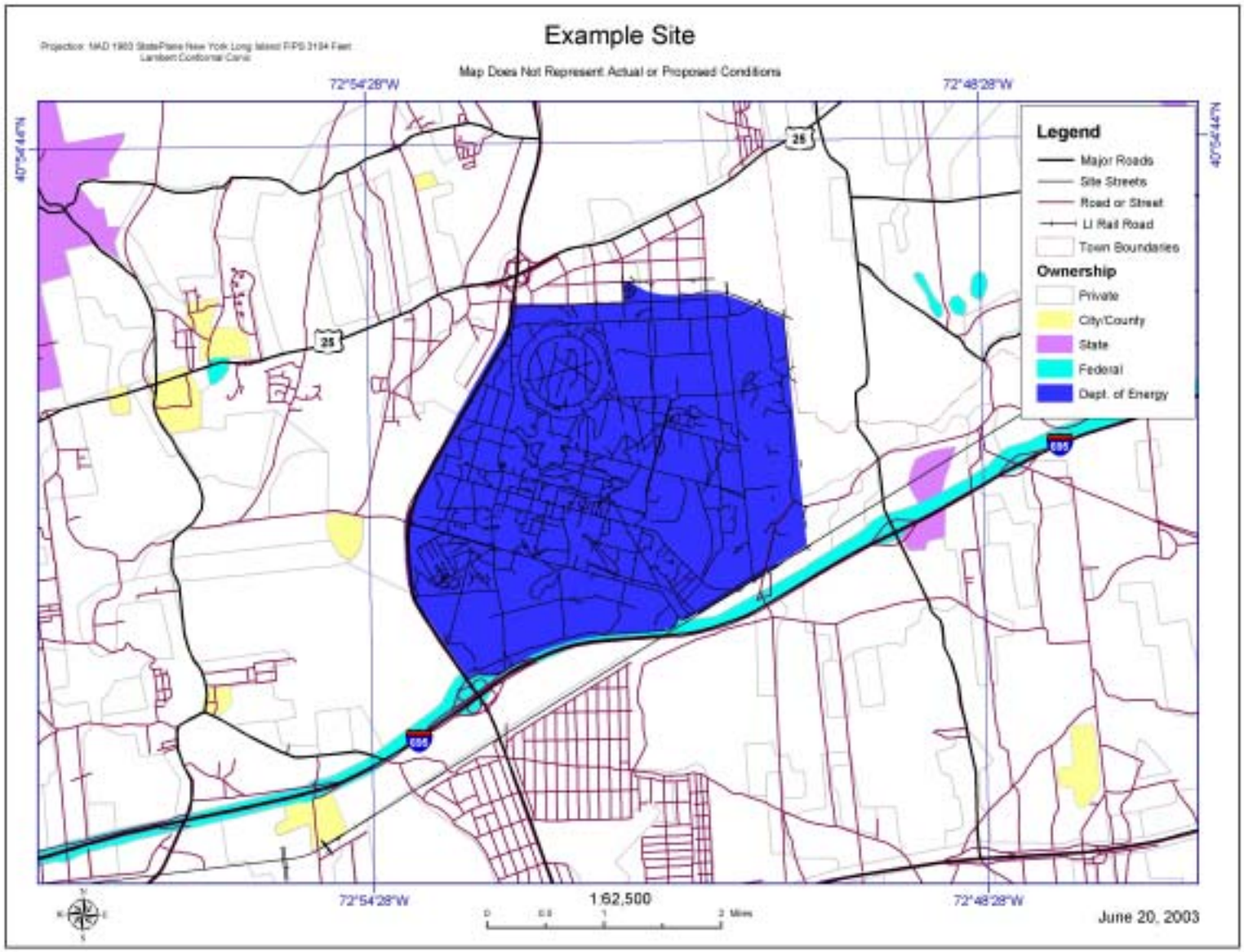


Figure 3.3a. Site legal ownership – current state.

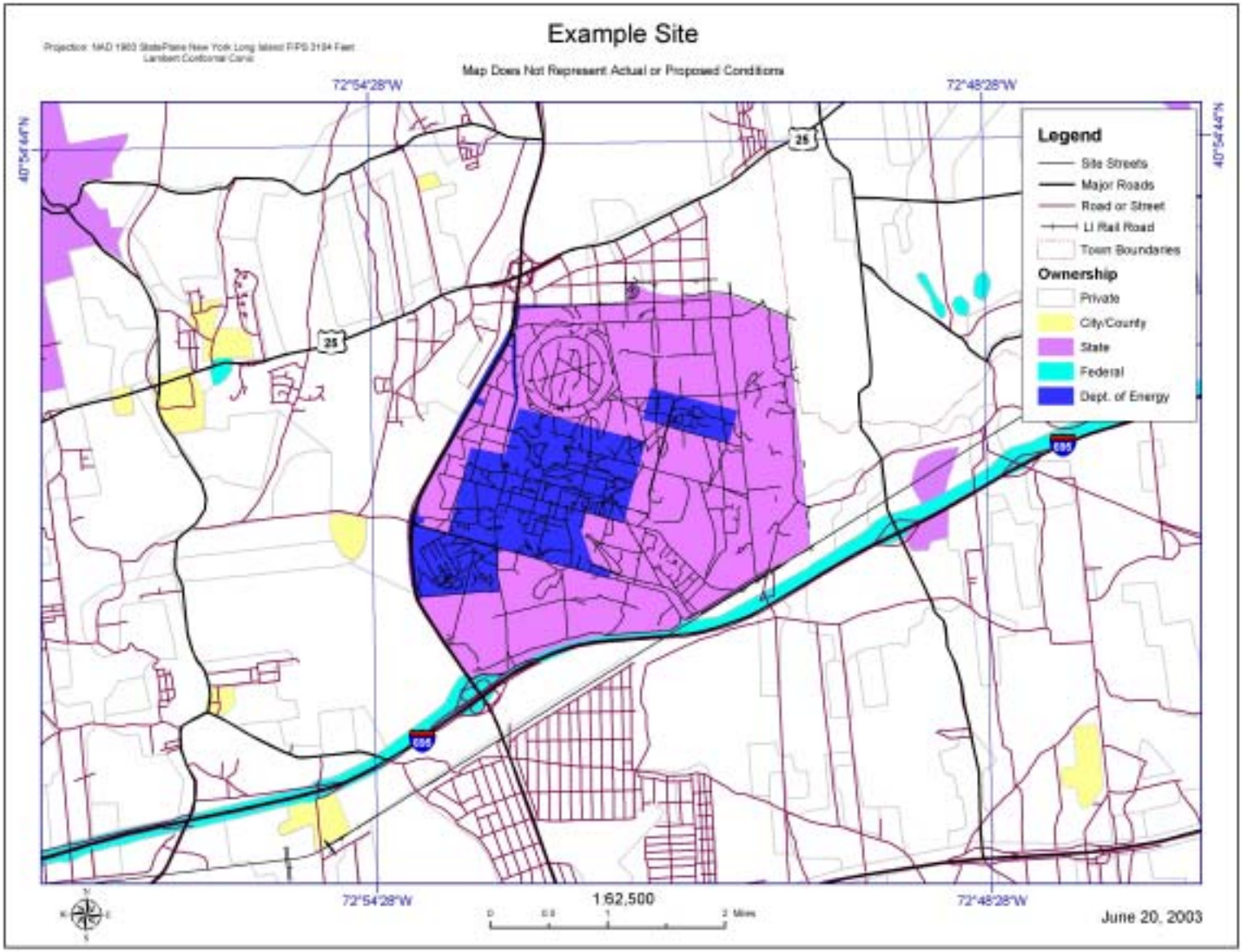


Figure 3.3b. Site legal ownership – RBES.

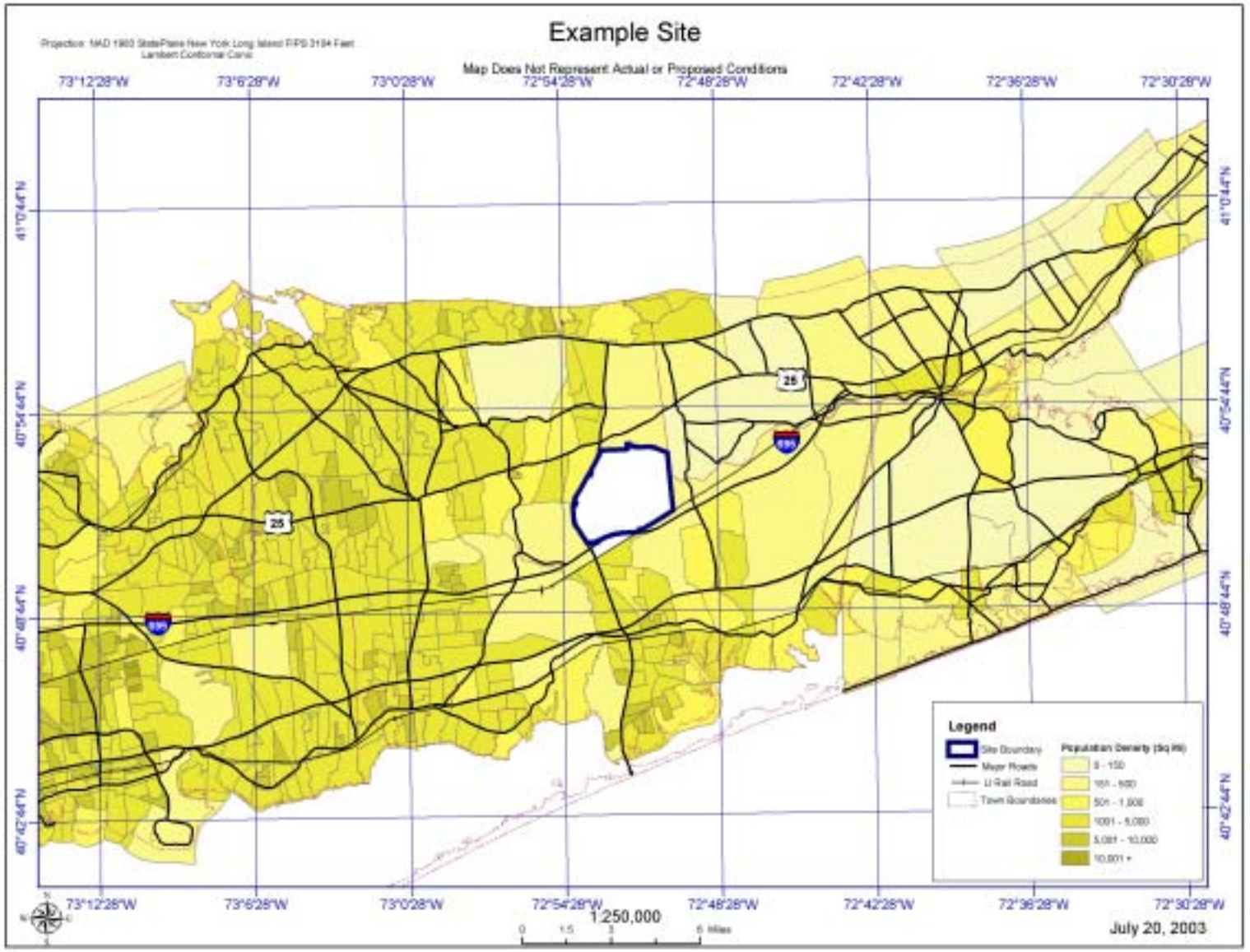


Figure 3.4a. Site demographics – current state.

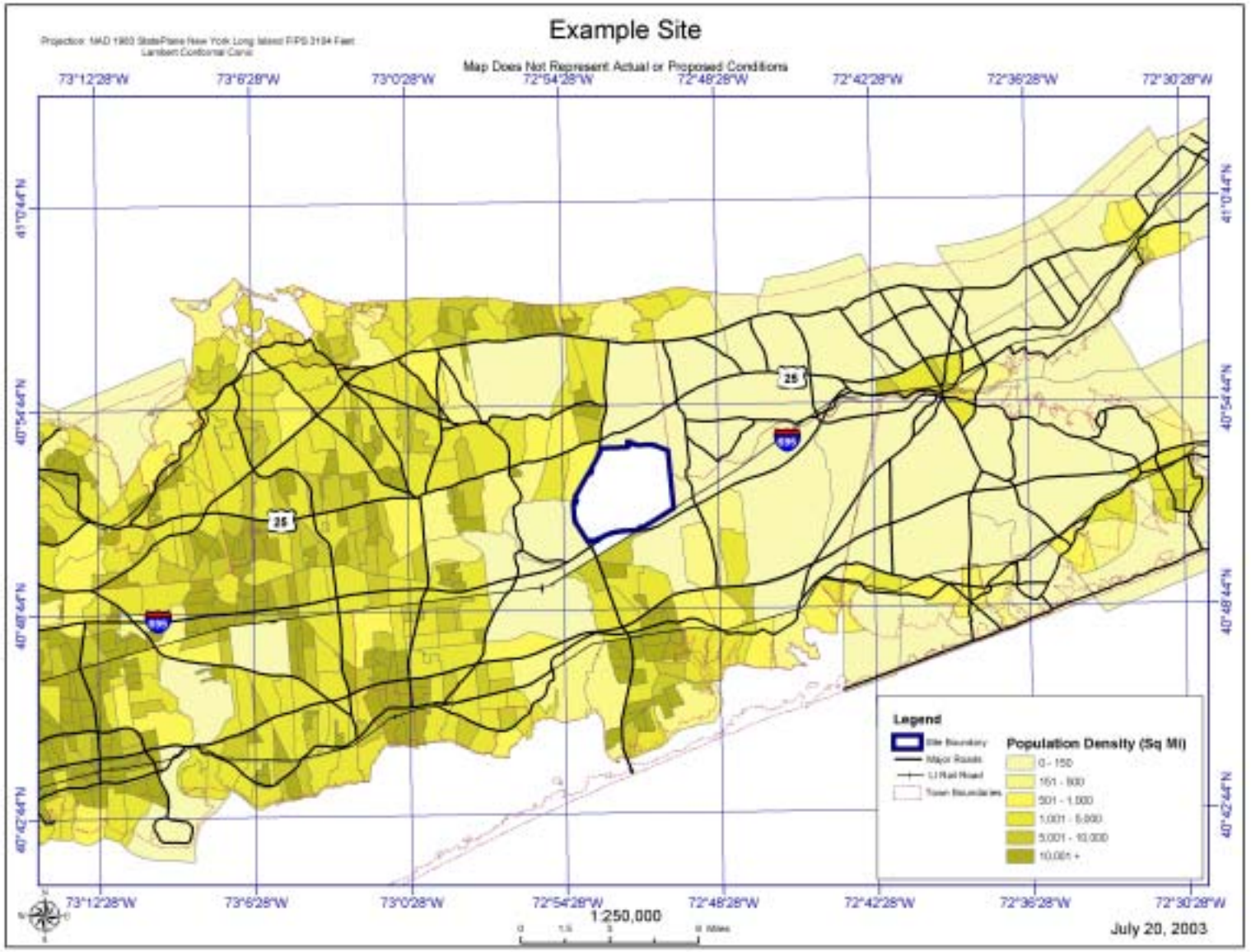


Figure 3.4b. Site demographics – RBES.

4.0 HAZARD SPECIFIC MAPS

Hazard Specific maps provide the greatest level of detail. Hazard Specific maps show greater detail and information for key Hazard Areas of Concern portrayed within the Regional and Site Context maps. Hazard Specific maps portray specific information that helps to qualify or quantify the nature of the hazard present, the potential of the hazard to have an impact (and if so, the degree of impact) on human health or the environment, and any mitigation of the hazard (e.g., through control, removal, and monitoring) such that the remaining hazard does not adversely impact human health or the environment. Physical and Surface Interface information and Human and Ecological Land Use information needed to help relate the location and mitigation of the hazard should also be shown as relevant and appropriate. Each RBES hazard map should include any anticipated on- and off-site changes in human and ecological activities and land use.

Figure 4-1 shows the numbering scheme required for the Hazard Specific Maps.

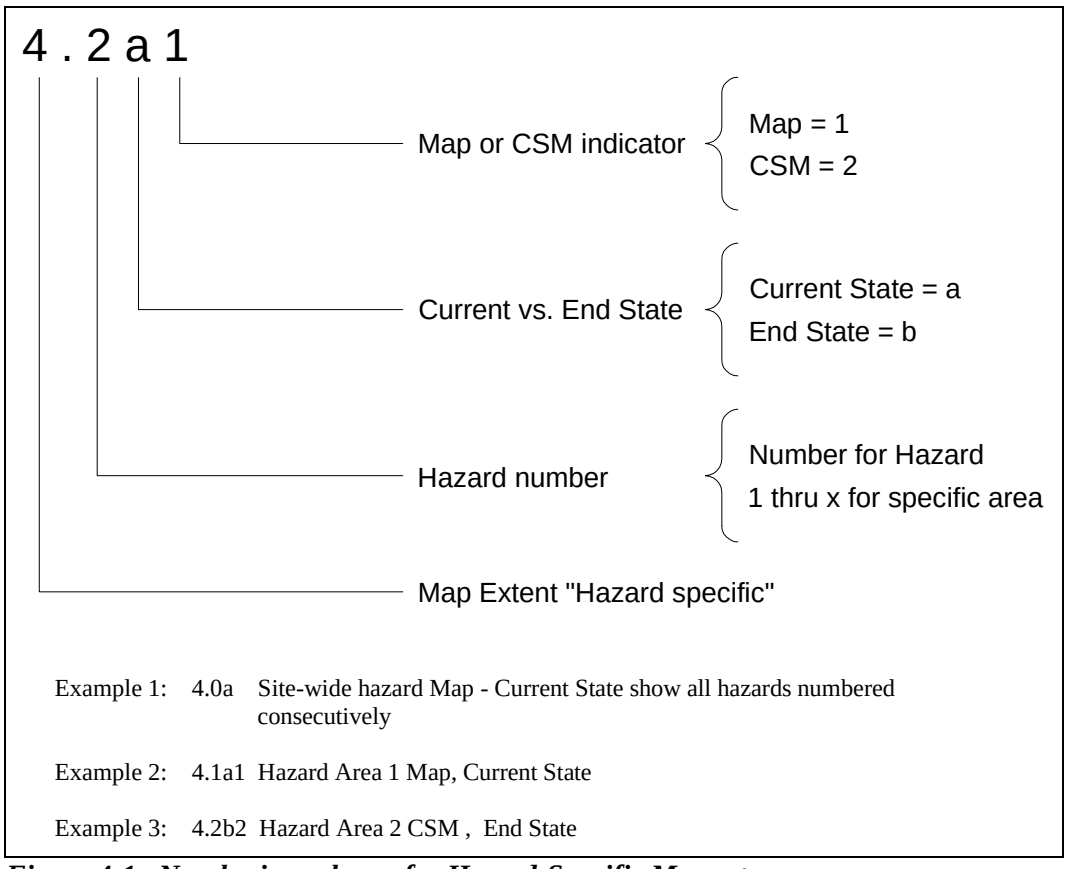


Figure 4-1. Numbering scheme for Hazard-Specific Map sets.

These map depictions can be augmented, where appropriate with:

- surface and subsurface contaminant concentration profiles for soil and groundwater;
- subsurface diagrams/cross-sections of contaminant plumes;
- current/future plume size and location;
- control mechanisms, barriers, and buffer zones (i.e., active and passive institutional controls);

- environmental monitoring and surveillance points such as monitoring wells; and
- facility disposition (current; end-state D&D).

Hazard Specific Maps have as many subsets as there are hazards to describe. Table 4-1 of this appendix provides a listing of the essential features that should be portrayed.

- Map 4.0a and 4.0b- Site-wide hazard map should be made showing locations of all hazard areas.
- Map 4.1a1 and 4.1b1- Hazard Area 1 location and type
- Map 4.2a1 and 4.2b1- Hazard Area 2 location and type
- Map 4.xa1 and 4.xb1-Hazard Area x location and type

Each Hazard Area should be shown on the site-wide hazard maps by a circle with a number (1-x) inside. These encircled numbers will correspond with the hazard area map (4.1a1, 4.1b1, 4.2a1, 4.2b1, 4.xa1, 4.xb1).

Each RBES hazard map should show the existence of current or future land use institutional controls necessary to ensure the protection of human health and the environment. Land use institutional controls are legally binding real estate agreements such as deed restrictions, zoning, covenants, and easements. Institutional controls should be shown on hazard maps by a triangle with an alphabetic designator in the center of the triangle, with each letter representing a distinct land use institutional control.

Table 4-1. Map sets for RBES documents – Hazard Specific.

HAZARD-SPECIFIC MAPS	FEATURE CATEGORY	FEATURE
Location-Specific Hazards Map Set A set of maps that show greater detail and information for key Hazard Areas of Concern portrayed in the Regional and Site Context Maps.		
MAPS 4.0a and 4.0b Site Wide Hazard Map showing all hazard locations number consecutively from 1 to x.	Hazard	Location of all Hazards types (i.e., contaminated soil, plume, underground tank, trench/ landfill, disposal cell, entombed building, treatment building on the site.
	Institutional control	For the purposes of the maps, an institutional control is a legally binding land use agreement such as a deed restriction, use restriction, covenant, easement.
MAPS 4.1a1 and 4.1b1 Hazard 1 Map	Hazard/institutional control	Location of Hazard 1 and its type and institutional control if appropriate
MAPS 4.1a2 and 4.1b2 Hazard 2 Map	Hazard/institutional control	Location of Hazard 2 and its type and institutional control if appropriate
MAPS 4.xa1 and 4.xb2 Hazard x Map	Hazard/institutional control	Location of Hazard x and its type and institutional control if appropriate

Figure 4-6 shows examples of Hazard-Specific Map sets.

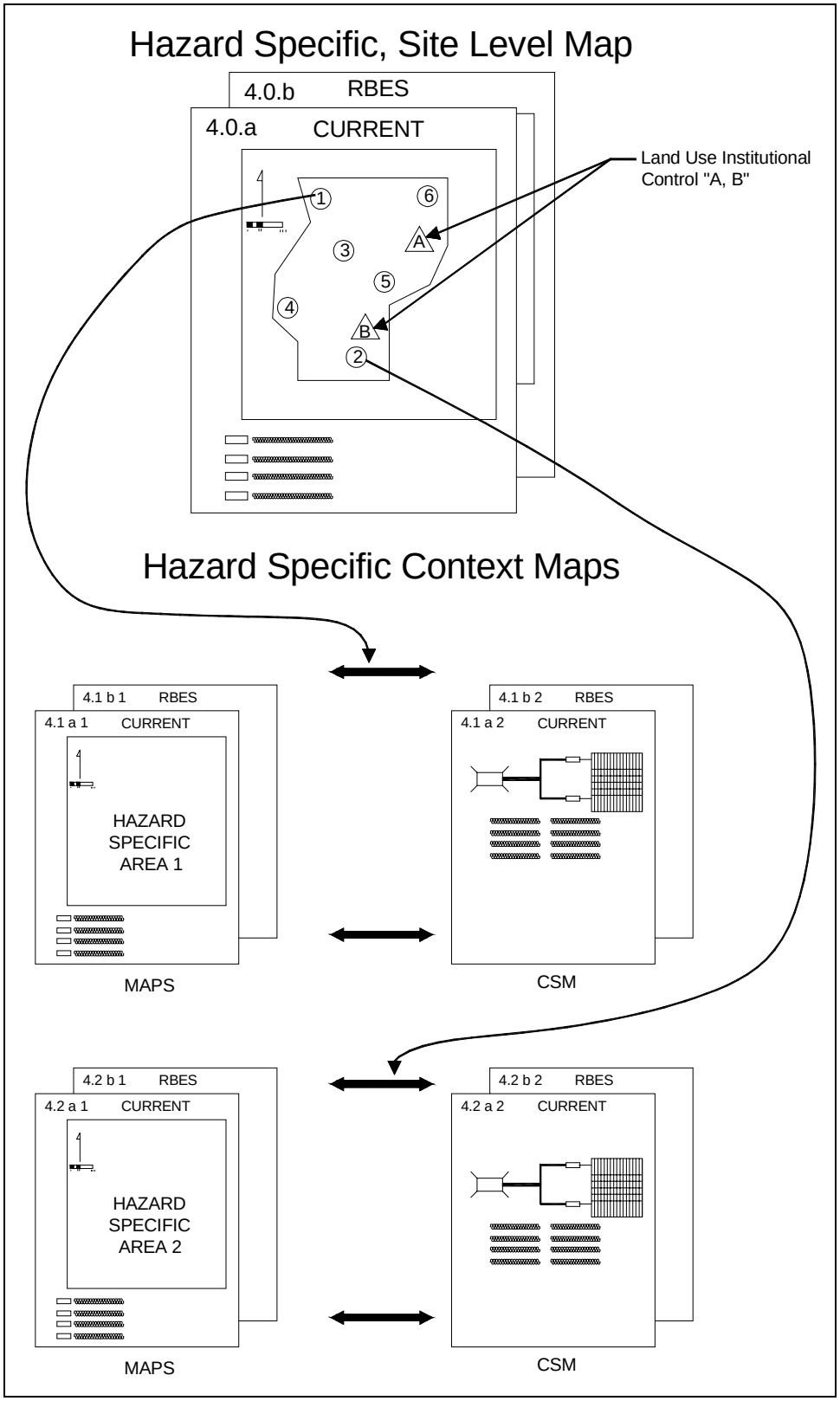


Figure 4-6. Example of Hazard-Specific Map sets.

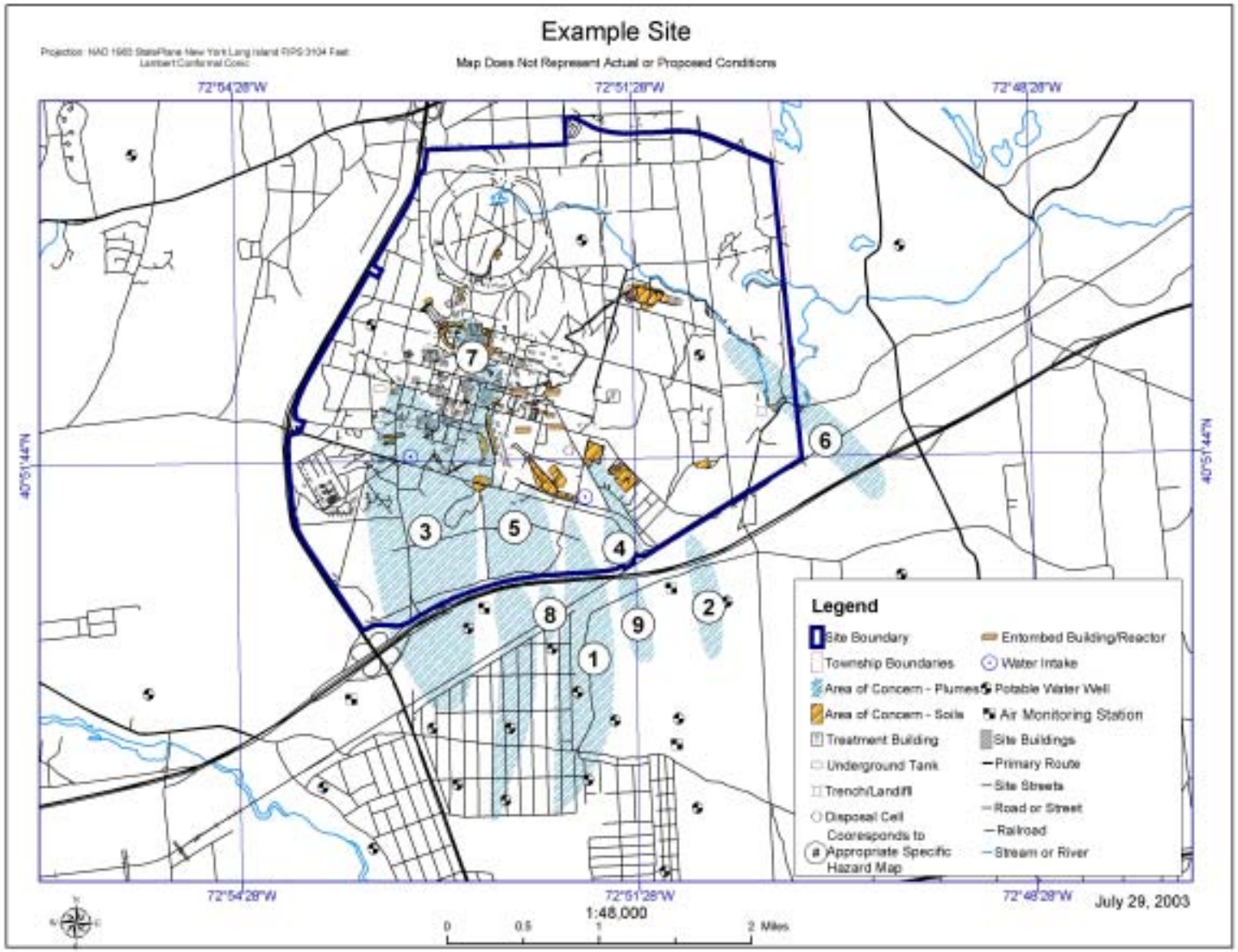


Figure 4.0a. Site-wide hazard map – current state.

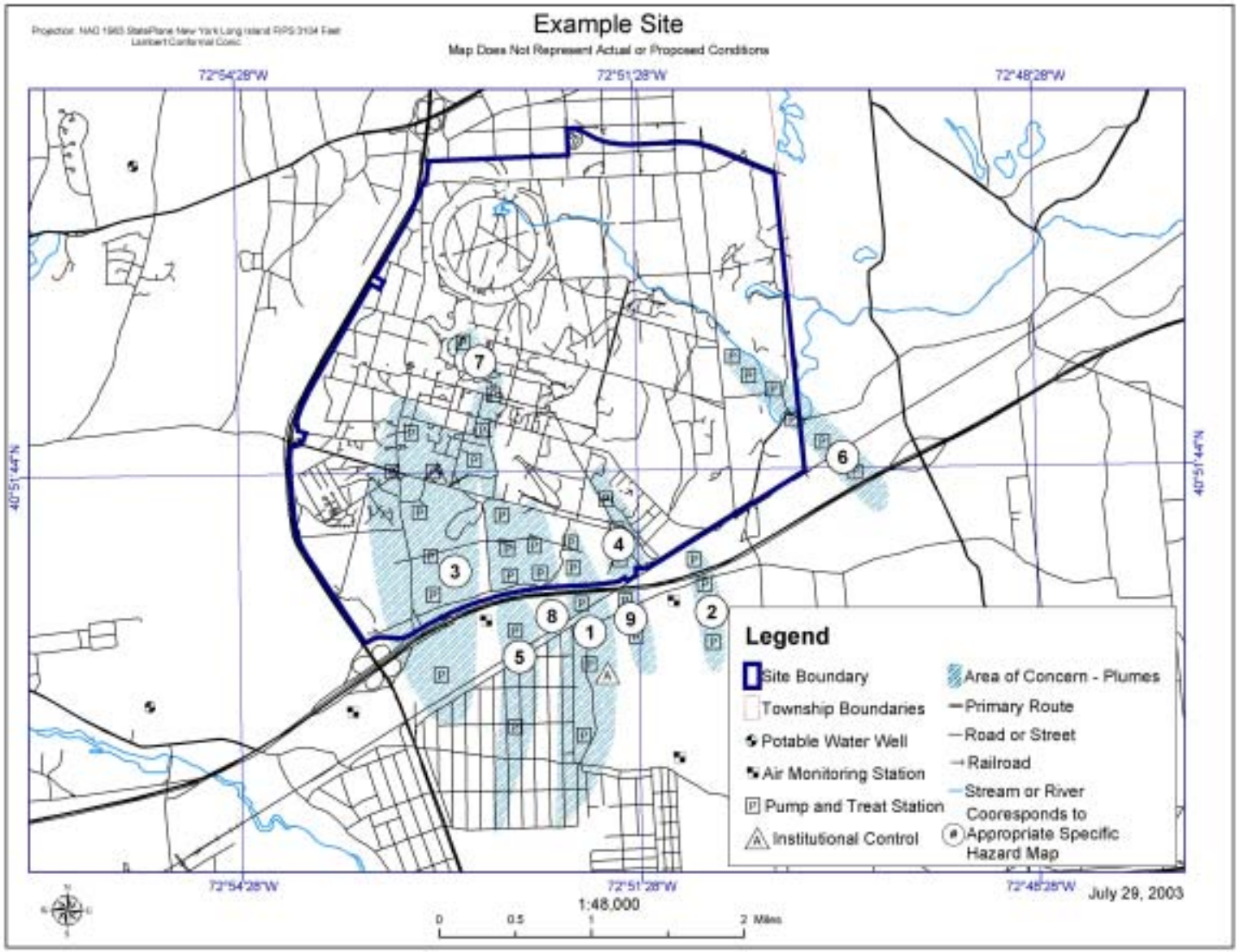


Figure 4.0b. Site-wide hazard map – RBES.

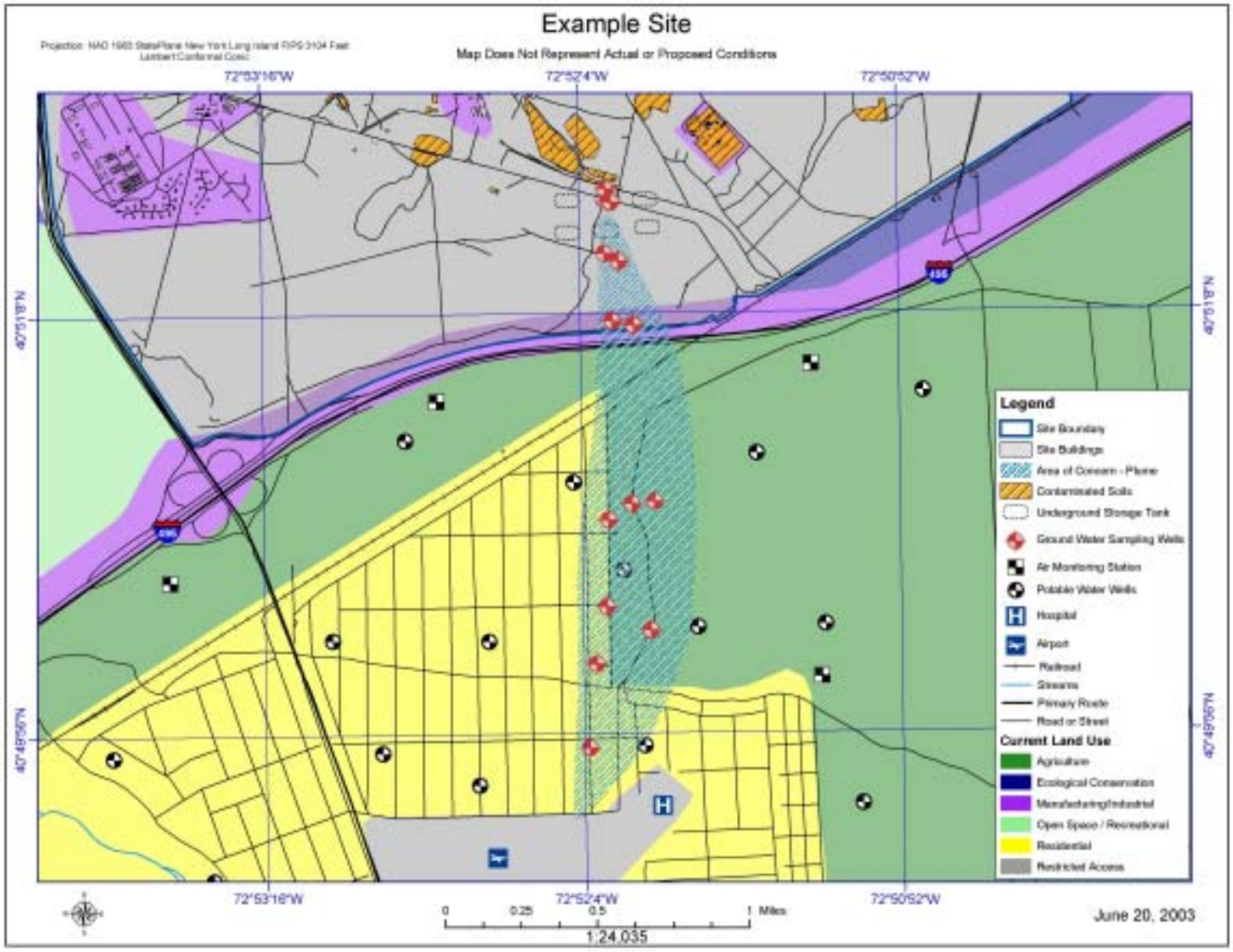


Figure 4.1a1. Hazard Area 1 map – current state.

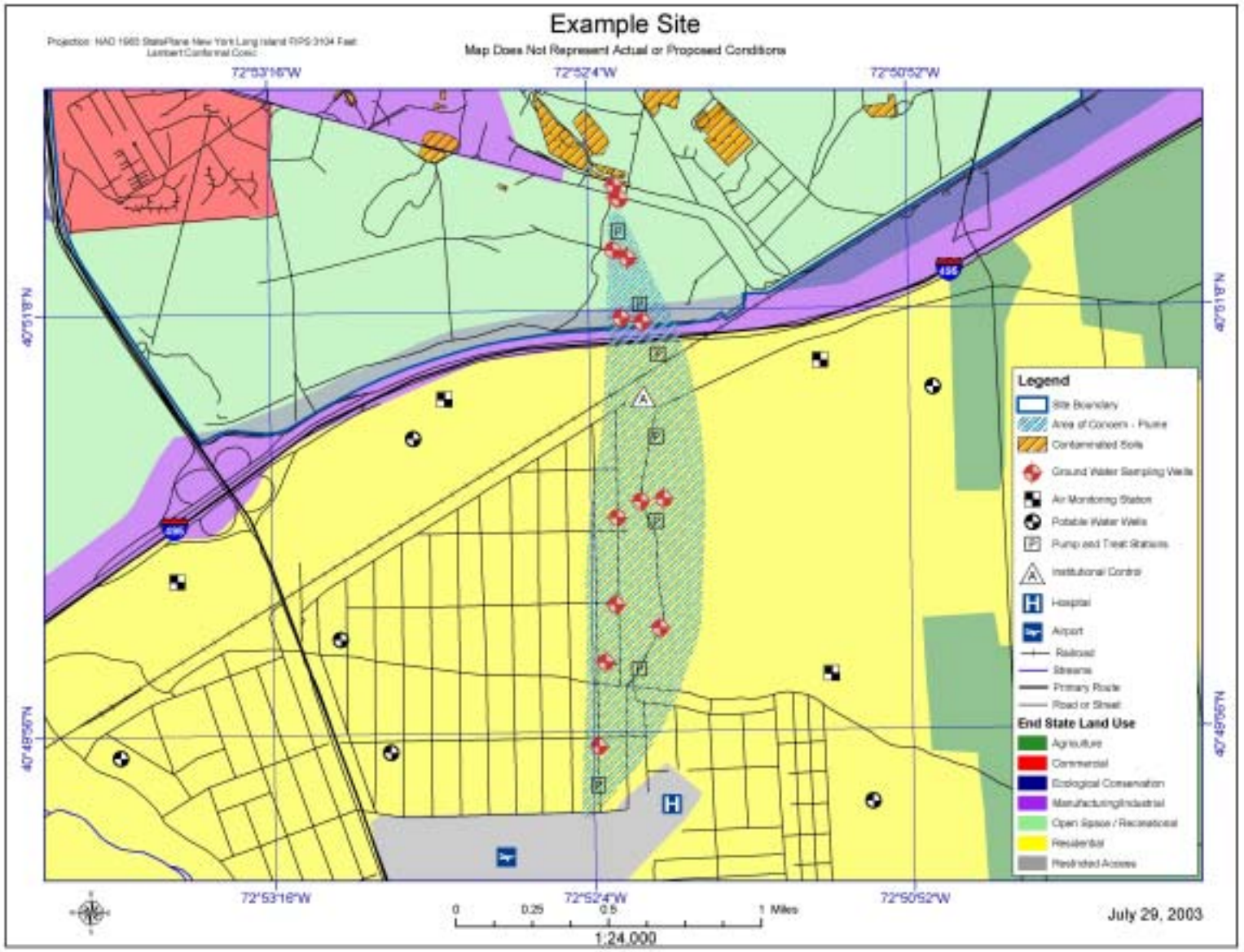


Figure 4.1b1. Hazard Area 1 map – RBES.

5.0 MAP COLOR, SYMBOL, AND ICON SPECIFICATIONS

The Subset of Industry Standard Symbols was selected from ESRI ArcGIS 8.2 style symbol library and is standard to ESRI. These symbols have been developed by ESRI and do not necessarily reflect industry standards.

ESRI products and most standard mapping products come equipped with numerous style libraries, which can be used to add unique visual representation to points, lines, and polygons. While each symbol's appearance can be altered, these symbols represent the default appearance as they appear in ESRI ArcGIS 8.2.

Symbol—The symbol represents the visual depiction of physical or administrative parameters that appears or is applied to the earth's surface.

Description—This is the DOE description of physical or administrative parameters.

Shape—GIS recognized three basic shapes: point, lines, and polygons. The symbol applied is directly linked to one of these shapes.

Style Library—The style library contains a series of symbols grouped by a common theme. Using ArcGIS 8.2, these libraries are accessed by double clicking the theme shape on the table of contents. The symbol selector window will appear. Left clicking the "more symbols" button will open a pull down menu with numerous style libraries.

Symbol Name—Within each style library are numerous symbols to choose from. Under each symbol will appear the symbol name, which uniquely identifies the symbol. The symbol name was developed by ESRI and does not necessarily reflect industry standards.

Indicators of Map Projection—Maps should indicate map projection and coordinate system, such as latitude/longitude. There should also be a grid and/or reference point. Finally, every map should have an orientation and scale.

5.1 COLOR SPECIFICATIONS

The color specifications reflect the colors and RGB values for the different land uses, land covers, population densities, land ownership, and area of concern.

5.1.1 Land Use

Color Chart	Land Use	RGB Value
	Residential	255,255,0
	Commercial	255,0,0
	Manufacturing & Industrial	160,32,240
	Agricultural	34,139,34
	Restricted Access	156,156,156
	Open Space/Ecological/Preservation	0,0,139
	Open Space/Recreational	144,238,144
	Water	102,140,190

5.1.2 Land Cover

Color Chart	Land Cover	RGB Value
	Residential	255,255,0
	Commercial, Industrial, Transportation	255,0,0
	Non-Agricultural Vegetated	144,238,144
	Agricultural	34,139,34
	Wetlands	201,230,249
	Water	102,140,190
	Barren	137,112,68

5.1.3 Population Density

Color Chart	Population Density	RGB Value
	Population 10,001 +	179,176,20
	Population 5,001-10,000	207,204,37
	Population 1,001-5,000	235,232,52
	Population 501-1,000	252,247,86
	Population 151-500	252,249,136
	Population 0-150	250,249,182

5.1.4 Land Ownership

Color Chart	Land Ownership	RGB Value
	Private	255,255,255
	Local Government	255,255,153
	State Government	223,127,254
	Federal Government	0,255,240
	DOE	45,45,255
	Other	250,150,50

5.1.5 Areas of Concern

For "Area of Concern - Plume," light blue should be used (RGB Value 115,233,255). For "Area of Concern - Soil," brown should be used (RGB Value 255,170,0).

Color Chart	Area of Concern	RGB Value
	Plume	115,223,255
	Soil	255,170,0

The symbols for areas of concern, plumes and soil, can be found in ArcGIS 8.x default Hazmat symbol library. For plumes the user will use Chemical Overlay and change the yellow RGB value to the blue RGB value above through the properties function. For soil the user will use Radiation Overlay as is.

5.2 SYMBOLS AND ICONS

A subset of industry standard symbols was selected from ESRI ArcGis 8.2 style symbol library. If a symbol is not shown for a given feature, an alternate unique symbol from this library can be used. Sites are strongly discouraged from creating their own symbols.

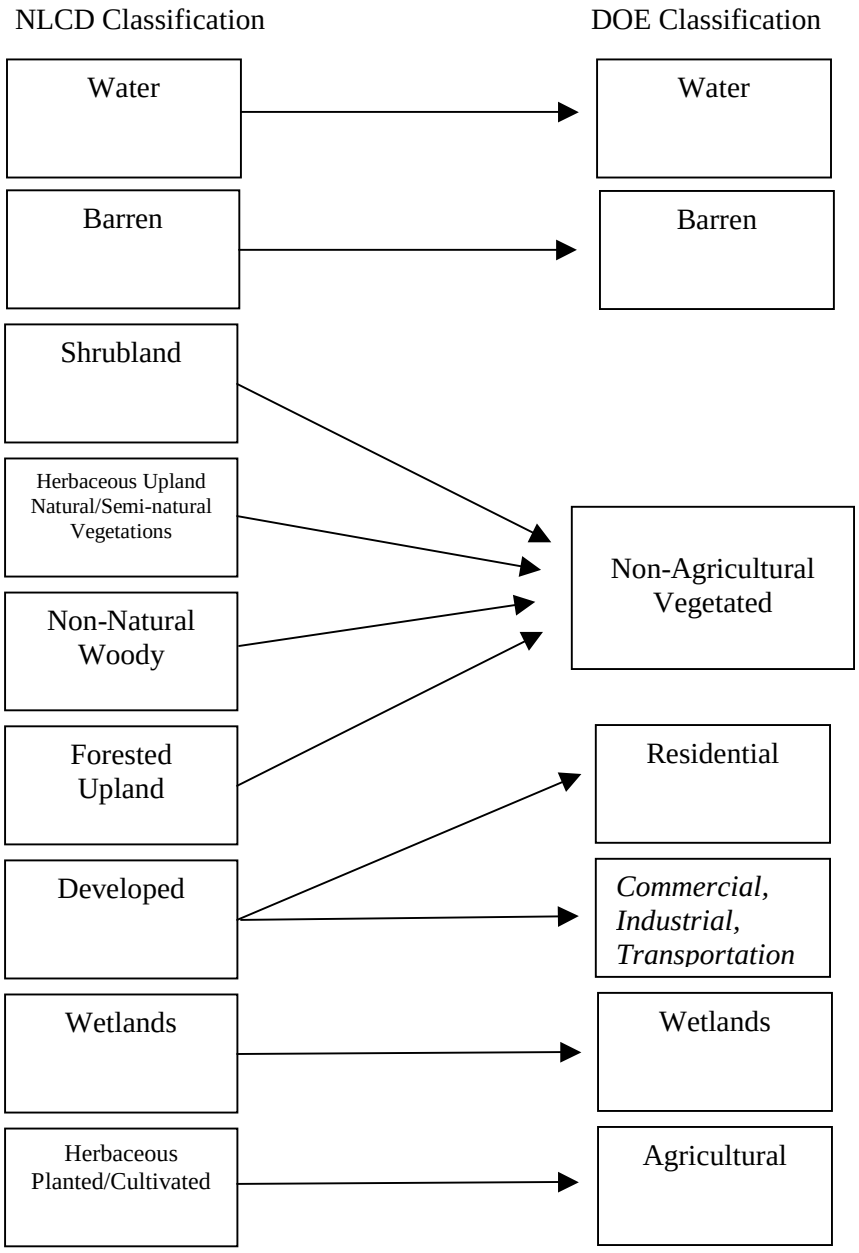
Color Charts, Legends, and Symbols for RBES Mapping Guidance

Subset of Industry Standard Symbols*

Symbol	Description	Shape	Style Library	Symbol Name
	North Direction Indicator	Legend	Legend	ESRI North 7
	State Boundary	Line	ESRI	Boundary, State
	County Boundary	Line	ESRI	Boundary, County
	City, Village, Town, or Hamlet Boundary	Line	ESRI	Boundary, City
	Boundary for Wildlife, Parks, National Forest, Indian or Military Reservation	Line	Conservation	IUCN 1a: Strict Nature Reserve
	Federal Site Boundary	Line	Real Estate	Federally Owned
	Primary Route	Line	ESRI	Major Road
	Road or Street	Line	ESRI	Arterial Street
	Road Symbols	Point	ESRI	Interstate HWY 1, U.S. Route 1, Circle 4
	Railroad	Line	ESRI	Railroad
	Air Monitoring Station	Point	Water Wastewater	Air Control
	Airport	Point	Public Signs	Airport
	Building	Polygon	ESRI	Grey
	Cemetary	Polygon	ESRI	Dashed 2:1
	Contour	Line	ArcScene Basic	Contour, Topographic, Index
	Dam	Point	Utilities	Saddle Fitting
	Fence	Line	Survey	Fence Line
	Golf Course	Point	Civic	Golf Course 1
	Groundwater Flow Direction	Line	ESRI	Arrow at End
	Hospital	Point	Public Signs	Hospital
	Landfill	Point	Environmental	Landfill, Commercial
	National Priority Lists Site	Point	Environmental	RCRA
	Power Plant	Point	Environmental	Air Facility
	Parks	Point	ESRI	Picnic Area 1
	Quarry, Gravel Pit, Mining	Point	ESRI	Mining
	School	Point	ESRI	School 1
	Stream, River	Line	ESRI	River
	Water Intake	Point	IGL$_{ESRI}$	Municipal 404
	Well	Point	Survey	Guaging Station
	Area of Concern - Plume	Polygon	Hazmat	Chemical Overlay
	Area of Concern - Soil	Polygon	Hazmat	Biohazard Overlay
	Underground Tank (UST)	Point	Hazmat	Tank Underground
	Trench/Landfill	Point	IGL	Plotter 29
	Disposal Cell	Point	Utilities	Regulator Phase 1
	Treatment Building	Point	Utilities	Turbine Meter
	Entombed Building/Reactor	Point	Environmental	Storage/Frac Tank
	Institutional Control	Point	ESRI, Triangle 4 + add Font Arial (Western), Character "A" with Symbol Property Editor	
	Corresponds to Appropriate Hazard Map	Point	ESRI	Circle 2

5.3 MODIFIED LAND COVER CLASSIFICATIONS

The land cover classification system used for these maps is modified from the National Land Cover Dataset Classification, which has been modified from the Anderson land-use and land-cover classification system. The purpose for the modification was for simplification of land cover categories that were thought to be more appropriate to the DOE mapping process.



APPENDIX C

Manual for Preparing Conceptual Site Models for Hazard Areas of Concern

This Page Intentionally Left Blank

1.0 INTRODUCTION

Integral to the risk-based end states (RBES) approach to cleanup is the use of Conceptual Site Models (CSM). These models are intended to communicate risk information to DOE managers, the regulatory community and the general public. The CSM provide, in block diagram form, information regarding the hazards, pathways, receptors and the barriers (current or planned) between the hazards and the receptors. Sites currently use a variety of different CSM. This guidance requires use of ASTM standard E 1689-95, *Standard Guide for Developing Conceptual Site Models for Contaminated Sites,* to initiate the creation of conceptual site models. The ASTM emphasis on the six activities associated with developing a conceptual site model and its set of procedures for moving from assemblage of information to portrayal of the elements of model on the diagrams themselves. (See all of Section 6 in the *Standard* – 6.1 through 6.6.2.)

The CSM described in this guidance incorporates but is not limited to the ASTM guidance, because it addresses additional issues to achieve a broader purpose than the CSM described by ASTM. The purpose of depicting both the existing and risk-based end-state risk exposure scenarios is specifically to depict for the reader the fact that many hazardous areas of concern at DOE sites currently have in place mechanisms, such as containment and restricted access, that address the potential exposure pathways to receptors. These depictions of the status of current exposure pathways and the steps being taken to address them provides the baseline, on a hazard area by hazard area basis, for comparison with the more sustainable mechanisms the site plans to have in place to achieve its risk-based RBES Vision. In sum, the models not only depict what pathways to receptors need to be addressed but also portray what is currently in place and/or what must be done to more adequately address them. The diagrams seek to depict the single or multiple ways in which the RBES would assure sustainable protection or safety for the receptors depicted for each hazard area of concern. The purpose of the CSM is not only to help risk assessors know what to worry about, but also to clarify what has already been done and what needs to be done to manage those potential risks when the DOE site achieves its RBES. When supported by the narrative that will accompany the diagrams and the linkages made between the CSM and the hazard specific maps, readers of the RBES vision materials will know how site managers anticipate completing a path to risk-based end states in respect of the areas of hazardous concern at their sites. The CSM guidance in this section augments the ASTM standard to achieve this broader purpose.

2.0 CONCEPTUAL SITE MODEL STRUCTURE

CSM are intended to provide a visual presentation of site exposure conditions that currently connect a source of contamination to possible human and ecological receptors, and when used in conjunction with the End-State Vision, to show how these current exposure conditions would be eliminated, mitigated or controlled. Current conditions and end-state visions will be most useful when sites integrate map information with the CSM. This integration may be done at the site-wide hazard level for small sites with few and well defined hazards. These sites should prepare CSM portraying the entire site if feasible and appropriate. Some sites may choose to show multiple hazards on a CSM in order to draw attention to the geographically concentrated exposure pathways that may threaten a specific at-risk receptor (e.g., groundwater plumes from multiple sources running together). Most sites, however, will be requested to integrate maps and CSM at the individual hazard area of concern level. Individual current and end-state CSM should be developed for each hazard area of concern, and should be directly linked to the hazard maps as created by the Guidance and Appendix B, Risk-Based End State Mapping Manual. Care should be taken to ensure that the CSM and related hazard map are consistent in their depiction of current and proposed end-state site exposure conditions, and that both are consistent with the site's RBES Vision document. Specific guidance regarding development of all hazard maps is described in Section 4.0 of Appendix B, Risk-Based End State RBES Mapping Manual.

2.1 CONCEPTUAL SITE MODEL ELEMENTS

Current state and RBES Conceptual Site Model should have six major elements: 1) A description of the hazard area of concern being depicted in the attached diagram; 2) Identification of the primary and secondary sources of contamination; 3) Identification of the current and potential future release, transport and exposure mechanisms; 4) Identification of the current potential future receptors believed to be at risk; 5) Identification of current or proposed future barriers or intervention mechanisms used to prevent or limit potential exposure to the at-risk receptor; and 6) A narrative that provides additional information about the both the current and the RBES release, transport and exposure mechanisms. The end-state CSM narrative should also include a detailed description of the mechanisms envisioned in the RBES vision that will ensure sustainable protection or safety for at-risk receptors, and the uncertainties or risks of failure that could adversely affect this assumption.

2.1.1 Description

Each Conceptual Site Model should begin with a description of the hazard area of concern. This should include, where appropriate, the historical use of the area; a description of the specific contaminants, including quantity and mass; where they originated from; where the contamination is currently located and in what concentrations; whether it is contained by natural or man-made barriers; whether it is moving through soils and/or groundwater, and if it has already or is expected to be taken up in an ecological (plant/animal/food) web; and, why it is considered a current or potential future risk and to what human or ecological receptors. It should also include a description of any mitigation, containment or protection measures already implemented and how they are removing, reducing or controlling the potential exposure risk to the current and/or potential future receptors in question. The current state CSM will identify what pathways to current potential receptors need to be addressed, but also portray what temporary barriers or other interventions are being used to minimize potential exposure. The RBES CSM will describe and depict the more sustainable mechanisms that the site's RBES vision intends to employ to ensure adequate long-term protection or safety for potential future at-risk receptors. Distinctions should be made in each CSM between current pathways, mitigation measures and receptors, and potential future pathways, mitigation measures and receptors, and appropriate narrative clarifications should be provided.

2.1.2 Primary and Secondary Sources

A primary source is the location where the contaminant was produced, deposited, released or disposed. Primary sources include a reactor, storage tank, landfill, trench or other area attributable to current or past use of the area. A secondary source is where the contaminant has migrated to, as a result of one of the release mechanisms. These might include soils, sediment, surface water, groundwater and air.

2.1.3 Release, Transport and Exposure Mechanisms

Release mechanism refers to the manner in which the contaminant moves from the source to an environmental medium. These would include runoff, leaching, volatilization, leak, spill, infiltration, plant root penetration of caps, and soil erosion. Exposure mechanism refers to manner in which the contaminant, which has been released from the source and transported to an environmental medium, is able to come into direct contact with human or ecological receptors. These would include dermal contact, ingestion, absorption, root uptake, gill uptake, and inhalation. Often one transport or exposure mechanism leads to another (e.g., a human or animal touches a contaminate source and then ingests it by licking the contaminated area. The food web is another common means of transporting the contaminant to a source, such as a plant or animal that may be eaten. Where the contaminant is thought to be contained through physical or other means, and/or where access by current and/or potential future receptors is prevented or limited, these release, transport and exposure mechanisms represent the potential pathways that the contaminant would follow if there were a failure of these barriers or interventions.

2.1.4 Temporary Barriers or Controls

Many hazard areas of concern at DOE sites currently have in-place mechanisms, such as containment and restricted access, which address the potential exposure pathways to current at-risk receptors. These depictions of the status of current exposure pathways and the steps being taken to address them provides the baseline, on a hazard area by hazard area basis, for comparison with the more sustainable mechanisms the site plans to have in place to achieve its RBES vision.

2.1.5 Remediation, Mitigation and Other Interventions

The end-state CSM should depict the sustainable barriers or interventions proposed under the RBES vision, such as remediation or removal of the contaminant; conversion of the contaminant into a different and less hazardous material; moving the contaminant to more permanent containment facilities on or off-site; blockage of release and transport pathways through entombment or capping; removing groundwater contamination through long-term pump and treat operations; removing access to secondary sources, closing and plugging all wells that may be using groundwater that is or may be contaminated; and using institutional controls to ensure that future land use is more consistent with any residual contaminants that may be present. Although they are not equal in their ability to block exposure pathways, they are all barriers or interventions to those pathways in one form or another. Often, however, more than one barrier or intervention will be required to assure sustainable protection or safety for the potential future receptors depicted for each hazard area of concern. Where possible, reference should be made to where and how these mechanisms can be found on the related hazard-specific map.

Consideration should also be given to possible exposure from fire, explosion, and radiation not associated with dermal contact, inhalation or ingestion, and what barriers and other mechanisms have or are intended to be put in place to minimize or prevent these types of possible exposure to current and potential future receptors.

2.1.6 Receptors

A receptor is the human or ecological species that is potentially exposed to, or adversely affected by, the contaminant. These can include human workers, residents, visitors or trespassers, and aquatic and terrestrial species.

2.1.7 Additional Information

The CSM diagram is made of a number of boxes and lines, and thus provides little room for a full explanation of secondary sources, release, transport and exposure mechanisms and pathways, or the degree to which each receptor may be adversely affected. Where appropriate, a narrative should be attached to the diagram that more fully describes these elements.

2.2 RECOMMENDED SOFTWARE

The conceptual site models use a narrative, supported by a diagram made up of a combination of standard shapes and lines, to describe and depict the contaminant, pathways, exposure mechanisms, and possible human and ecological receptors. There are a number of software packages that could be used to develop and prepare these CSM, including several specialized flow diagram software packages. However, to ensure greater consistency in the CSM structure and portrayal of exposure conditions across all DOE sites, you are requested to use Microsoft Word. This software offers an excellent drawing tool; significant room for a textual description or explanation of the contaminant, pathways, exposure mechanisms, and possible receptors; strong technical support; and is already widely used within DOE.

3.0 BUILDING THE CONCEPTUAL SITE MODEL

3.1 CONCEPTUAL SITE MODEL[1]

CSM should be prepared for each of the current state hazard area maps, which are identified as Maps 4.1a1, 4.2a1, 4.3a1, and so forth, and for each RBES hazard area map, which are identified as Maps 4.1b1, 4.2b1, 4.3b1, and so forth, as spelled out in Table 1-1 in Appendix B – RBES Mapping Manual. Each CSM should be linked to a hazard area map through a related numbering system. As an example, the CSM related to Map 4.1a1 shall be identified as CSM 4.1a2, and the CSM for Map 4.1b1 should be identified as CSM 4.1b2. Refer to Table 3-1 in Section 3.2 of this appendix for full details.

3.1.1 Hazard Area Summary

Each Conceptual Site Model should begin with a description of the hazard area of concern being depicted. This should include, where appropriate, the historical use of the area; a description of each specific contaminant, including quantity and mass; where it originated from; where the contaminated is currently located and in what concentrations; whether it is contained by natural or man-made barriers; whether it is moving through soils and/or groundwater, and if it has already or is expected to be taken up in an ecological (plant/animal/food) web; and why it is considered a current or potential future risk, and to what human or ecological receptors. It should also include a description of any mitigation or control measures already implemented and how they are removing, reducing or controlling the potential exposure risk to the current and/or potential future receptors in question. The RBES CSM should include a detailed description of the sustainable mechanisms the site's RBES vision intends to utilize to remove, mitigate or control the exposures identified in the current state CSM. Distinctions should be made in each CSM between current pathways, mitigation measures and receptors, and potential future pathways, mitigation measures and receptors, and appropriate narrative clarifications should be provided. Where possible, reference should be made to where these features, pathways and potential receptors can be found on the related hazard map.

3.1.2 Primary Contaminant Source

Each primary contaminant source should be identified in a separate rectangular box on the far left side of the CSM. A primary source is the location where the contaminant was produced, deposited, released or disposed. That might be a reactor, storage tank, landfill or other area attributable to current or past use of the area. Each box should contain a textual identification of the source and the contaminant of concern. Example: *Landfill, containing chemical and radiological contaminants*.

3.1.3 Primary Release or Transport Mechanism

One or more lines, representing primary release or transport mechanisms, should be drawn from the Primary Source box to a box representing a Secondary Source. Italicized text should accompany each line to identify the mechanism, such as runoff, leaching, volatilization, spill, and infiltration. Where appropriate, a narrative should be attached that more fully describes these release mechanisms.

[1] For small sites, when all hazard areas can be shown clearly on the site-wide hazard maps, hazard area maps and CSM are not required. In such case, site-wide hazard CSM – current state (4.0a2) and site-wide hazard CSM – RBES (4.0b2) should be provided.

3.1.4 Primary Exposure Mechanism

One or more lines, representing primary exposure mechanisms, should be drawn from the Primary Source box directly to the table representing ultimate receptors. Exposure of the receptor by the Primary Source is generally limited to direct contact, as all other pathways involve a second environmental media such as air or water. Italicized text should accompany each line to identify the mechanism, such as wind dispersion, direct contact, or food uptake. Where appropriate, a narrative should be attached that more fully describes these exposure mechanisms.

3.1.5 Secondary Contaminant Source

Each Secondary Contaminant Source should be identified in a separate rectangular box to the right of the Primary Source box. A secondary source is the environmental media that the contaminant has migrated to, as a result of one of the release mechanisms. These might include soils, sediment, surface water, groundwater and air. In certain situations, a secondary source may interact with another environmental media, thereby creating another possible contaminant and exposure pathway. It should be identified by a rectangular box located either the right, below or above the first secondary source box. Each box should contain a textual identification of the secondary source and the contaminant of concern. Example: *Groundwater, containing chemical and radiological contaminants*.

3.1.6 Secondary Exposure Mechanism

One or more lines, representing secondary exposure mechanisms, should be drawn from the Secondary Source box directly to a table representing the ultimate receptors. Italicized text should accompany each line to identify the mechanism, such as wind dispersion, food uptake, and direct contact. Where appropriate, a narrative should be attached that more fully describes these exposure mechanisms.

3.1.7 Receptor

A table should be added along the far right side of the diagram to identify current and potential future receptors, and how each is exposed or put at-risk. The table should have a column for each receptor and sufficient rows to provide a connection with each primary or secondary exposure line drawn. A heading "Potential Receptor Exposed" should be placed at the top of the table headings identifying each of the receptors impacted – worker, resident, visitor/trespasser, aquatic or terrestrial species – should be inserted at the top of each of the columns. How each receptor would be exposed should be indicated in the row where an exposure line intersects with the table. There are five potential exposure mechanisms and a single letter should identify each:

Inhalation	=	I
Ingestion	=	F
Dermal Contact	=	D
Radiation (Noncontact Exposure)	=	R
Accident	=	A

Accident refers to possible exposure from fire or explosion, or a fall or other accident A narrative should be attached to describe each situation where a receptor may be exposed, and what the expected impact might be.

3.1.8 Barriers to Exposure

Heavy vertical and horizontal lines should be used to depict the blockage of individual release, transport and exposure pathways, or other intervention mechanisms, which are already in place or which would be accomplished under the RBES vision. These would include, but not be limited to, physical containment of the contaminant, use of security and other mechanisms to control access to the Primary or Secondary source; blockage of release and transport pathways through entombment or capping; removing access to secondary sources, closing and plugging all wells that may be using groundwater that is or may be contaminated; and using institutional controls to restrict future land use so that it is more consistent with any residual contaminants that may be present in the soils. Although they are not equal in their ability to block or effectively intervene in preventing exposure, they are all barriers exposure of the receptor in one form or another. As such, the common symbol for one of these barriers is a heavy vertical or horizontal line, which should be drawn across the pathway it is intended to break.

Where the primary source contaminant has been removed, the rectangular box should be changed from one of solid lines to one made of dashed lines.

As shown in the attached example: When the contaminant wastes in an underground tank are removed, the box is made dashed. Additional barriers are needed in this case as well, because a large amount of contamination has found its way into soil and groundwater over a large area outside the boundaries of the site. Thus additional barrier lines are inserted to depict the closing and plugging of all wells that might come into contact with the groundwater, and land use is changed on the site to non-recreational open space that will not attract large numbers of human visitors.

3.1.9 Numbering System and Narrative

A number is to be attached to each barrier line drawn on the diagram, and a detailed narrative for each should be provided as part of each CSM. The numbers should be sequential, begin on the Current CSM, and continue forward in sequence onto the RBES CSM. A detailed narrative should be provided on the RBES CSM for all new barrier mechanisms depicted, as well as an explanation of Current CSM barriers that would be replaced by a more sustainable mechanism under the RBES vision. In addition to fully describing the characteristics of the barrier that would be put in place under the RBES vision, the narrative should address the sustainability of that mechanism. It should identify any uncertainties regarding the nature and characteristics of the contaminant thought to be under control and potential threats to the stability of the barrier, and describe any failure analyses performed to support these findings. It should also discuss the need and cost for ongoing maintenance of the system.

3.1.10 Pathway Line Changes

In addition to using a heavy line to depict a barrier or intervention mechanism, all release, transport and exposure pathways impacted by the barrier are to be changed from solid lines to dashed lines.

3.2 Organization Table of CSM and Hazard Maps

CSM should be prepared for each of the Current State and RBES Hazard Maps prepared pursuant to Section 4 of the Guidance Executive Summary and Appendix B, Risk-Based End State Mapping Manual. Each CSM should be linked to a specific hazard map through the following related numbering system.

Table 3-1. Standardized figure names and numbers.

Extent	Mapping Manual Section	Number	Figure Name	Requested or Optional
Hazard Specific	Hazard Specific	4.0a	Site-wide map – Current State	R
	Hazard Specific	4.0b	Site-wide map – RBES	R
	Hazard Specific	4.0a2[1]	Site-wide CSM – Current State	O
	Hazard Specific	4.0b2[1]	Site-wide CSM – RBES	O
	Hazard Specific	4.1a1	Hazard Area 1 Map – Current State	R
	Hazard Specific	4.1b1	Hazard Area 1 Map – RBES	R
	Hazard Specific	4.1a2	Hazard Area 1 CSM – Current State	R
	Hazard Specific	4.1b2	Hazard Area 1 CSM – RBES	R
	Hazard Specific	4.2a1[2]	Hazard Area 2 Map – Current State	R
	Hazard Specific	4.2b1[2]	Hazard Area 2 Map – RBES	R
	Hazard Specific	4.2a2[2]	Hazard Area 2 CSM – Current State	R
	Hazard Specific	4.2b2[2]	Hazard Area 2 CSM – RBES	R

1. For small sites, when all hazard areas can be shown clearly on the site-wide hazard maps, hazard area maps and CSM are not required. In such case, site -wide hazard CSM – current state (4.0a2) and site-wide hazard CSM – RBES (4.0b2) should be provided.
2. Continue for each hazard area.

4.0 CONCEPTUAL SITE MODEL EXAMPLES

Two types of CSM examples are provided to show how the Primary and Secondary sources, the release, transport and exposure pathways, receptors, and barriers are to be depicted on current state and RBES. These diagrams are intended to be illustrative of the conditions at DOE sites and to demonstrate elements of the process of end-state planning. They are not intended to depict all of the paths that will need to be explored and the analyses that will need to be accomplished in preparing a conceptual site model.

4.1 LINKING CSM WITH HAZARD MAPS

The first set of examples utilize the Current State Hazard Area 1 Map (Figure 4.1a1) and its related RBES Hazard Area 1 Map (Figure 4.1b1), that are included in Appendix B – RBES Mapping Manual. The CSM diagrams and narrative that follow each map, Current State CSM (Figure 4.1a2) and RBES CSM (Figure 4.1b2), are examples of how the hazard maps and CSM are to be linked and presented within the site RBES Vision document.

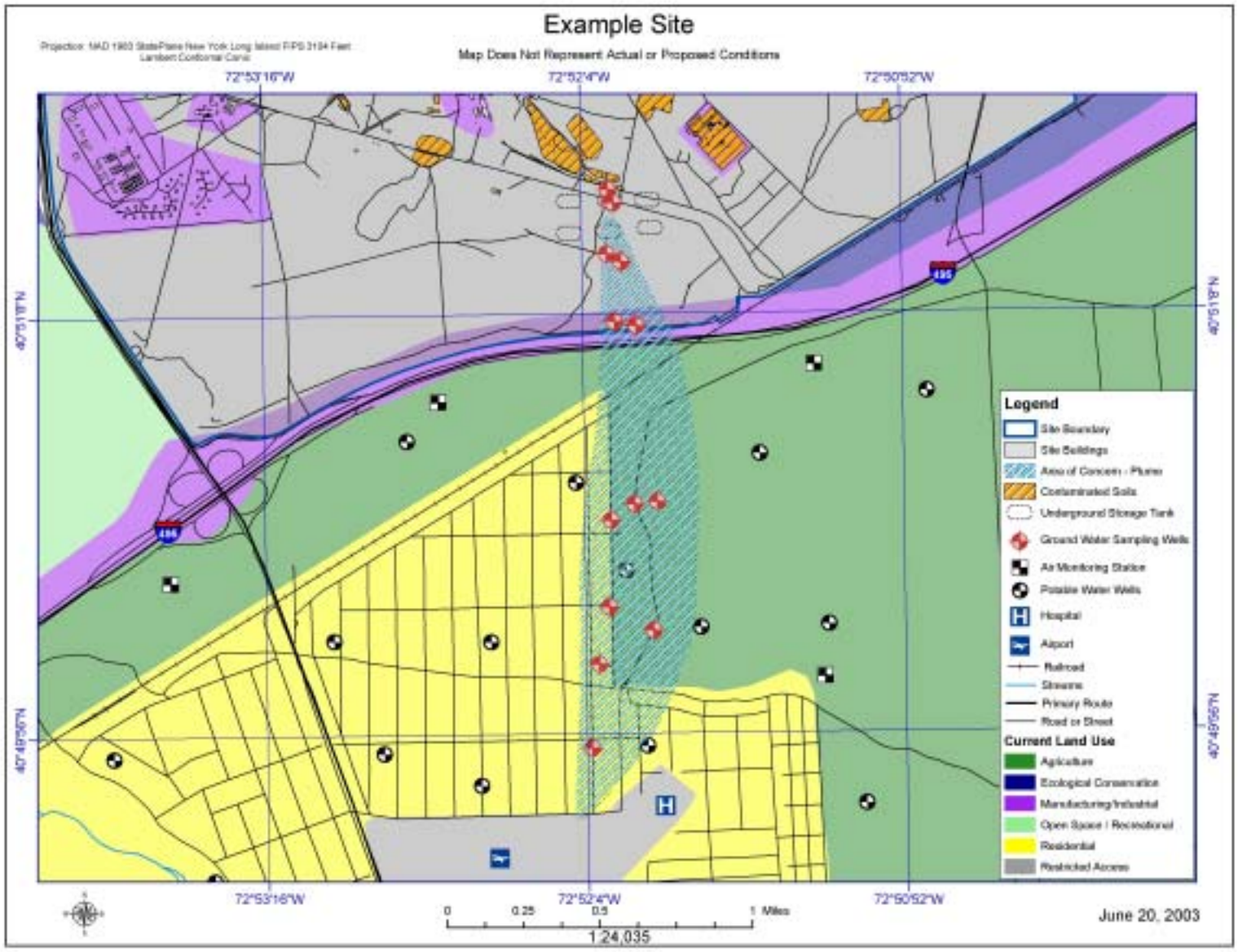
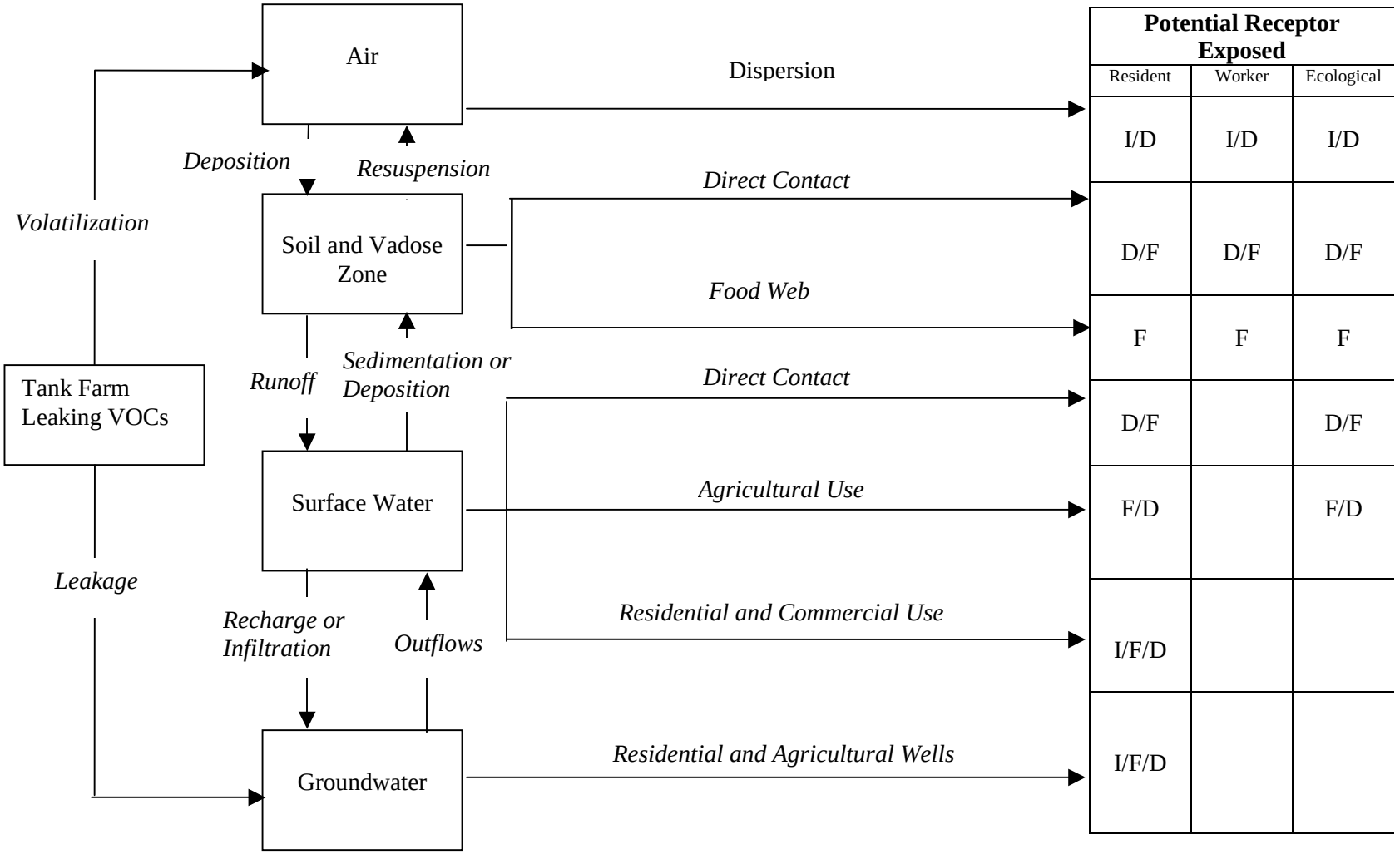


Figure 4.1a1. Hazard Area 1 map – current state.

Figure 4.1a2. Hazard Area 1 CSM – Current State



The information depicted on this diagram is illustrative and is not meant to be a complete reporting of all the pathways and other complexities (e.g., uncertainties, maintenance requirements, and institutional controls) of the actual hazard area.

Key:

Transport, uptake, or exposure pathway

I Inhalation
D Dermal contact
F Ingestion

Narrative – Primary Source:

This is a simplified conceptual model of the environmental transport and exposure pathways for a hypothetical leaking underground storage tank farm that stores VOCs. The leakage has been ongoing and has created an extensive groundwater plume, as shown in Map 4.1a1.

The predominant release mechanism to the environment is leakage from the tank, accompanied by volatilization from the tank farm as well as the plume. The groundwater plume extends into off-site residential and farming areas that draw water from the aquifer for domestic and agricultural use. Besides the formation of a groundwater plume and volatilized vapors, the contaminants released into the environment are likely to flow between different environmental media such as air, surface soil, surface water and groundwater due to interconnecting mechanisms such as runoff, deposition, infiltration, etc. These inter-compartmental flows result in formation of secondary sources such as contaminated surface water bodies.

Based on these complex interconnecting transport mechanisms, potential human exposure mechanisms are: use of well water for residential, gardening, and agricultural purposes; ingestion of crops and vegetables grown using contaminated water; consumption of contaminated fish or wildlife; direct contact with contaminated soils; and possibly inhalation of vapors in close proximity of tank farm. Actual magnitudes of individual or population exposures would additionally be determined by factors such as physical properties of the geological formation, meteorological factors, physical properties of leaking contaminants, local land use patterns, demography of population, physiology and activity profiles or individuals, and microenvironment characteristics.

The ecological exposure mechanisms are likely to be ingestion of contaminated water, ingestion of plants grown using contaminated water, secondary ingestion of aquatic organisms that uptake contaminants through sediments or water, direct contact with contaminated soils, and direct inhalation of vapors in proximity of tank farm.

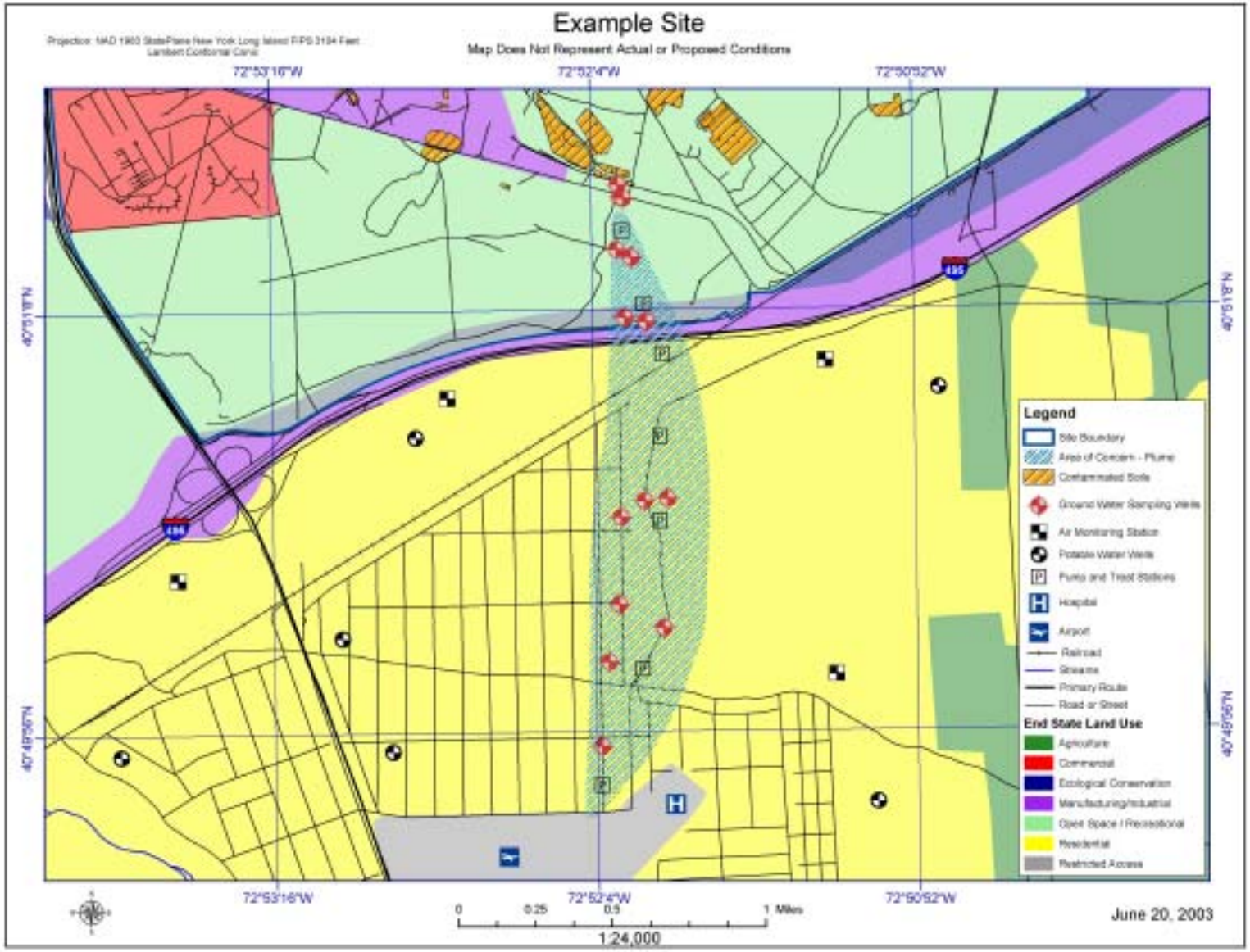
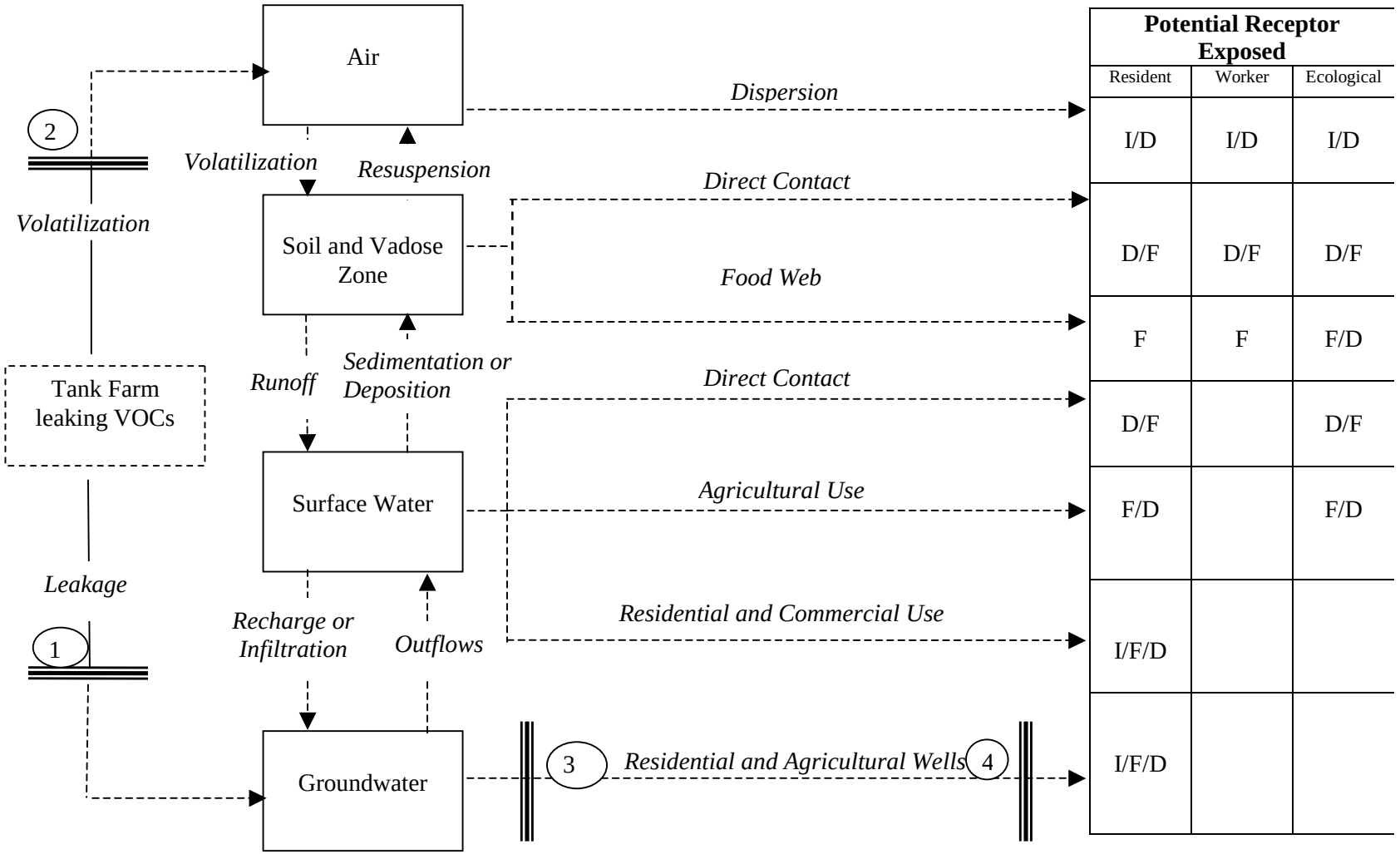


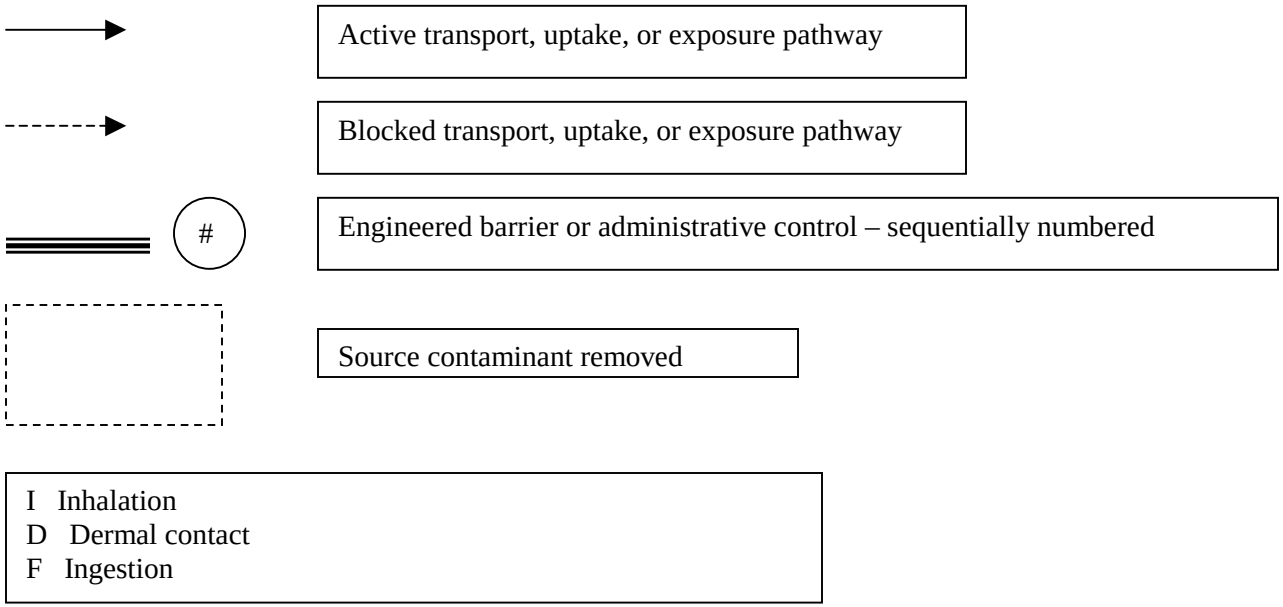
Figure 4.1b1. Hazard Area 1 map – RBES.

Figure 4.1b2. Hazard Area 1 CSM – RBES.



The information depicted on this diagram is illustrative and is not meant to be a complete reporting of all the pathways and other complexities (e.g., uncertainties, maintenance requirements, and institutional controls) of the actual hazard area.

KEY



Narrative – Primary Source:

This is a simplified conceptual model of the environmental transport and exposure pathways for a hypothetical leaking underground storage tank farm that stores VOCs. The leakage has been ongoing and has created an extensive groundwater plume, as shown in Map 4.1a1.

The predominant release mechanism to the environment is leakage from the tank, accompanied by volatilization from the tank farm as well as the plume. The groundwater plume extends into off-site residential and farming areas that draw water from the aquifer for domestic and agricultural use. Besides the formation of a groundwater plume and volatilized vapors, the contaminants released into the environment are likely to flow between different environmental media such as air, surface soil, surface water and groundwater due to interconnecting mechanisms such as runoff, deposition, infiltration, etc. These inter-compartmental flows result in formation of secondary sources such as contaminated surface water bodies.

Narrative – RBES Barriers/Interventions:
The steps taken to mitigate or remove these hazards are as follows:

1. The Underground Storage Tanks (USTs) in the tank farm are cleared of wastes and removed, and the contaminated soil immediately below USTs that indicate contaminant concentrations above a predetermined level is removed. The site is then capped with clean soil and a water resistant cap to limit infiltration near the origin of the contaminant plume. This step will block the primary release mechanism for the contaminants. The water resistant cap would be vulnerable to vegetative, animal and human intrusion, and to erosion.

2. Vapor collectors to trap and treat vapors are installed near areas characterized as having high residual concentrations of volatile contaminants. This step will substantially but not entirely block the atmospheric release of volatilized fractions, and will reduce the atmospheric concentrations of volatilized fractions to safe levels. This engineered barrier involves continued operation and maintenance of vapor collectors. The need for this barrier would diminish over time, as the concentrations of volatilized fractions will go down exponentially with reduction of groundwater plume concentrations and blocking of primary release mechanism.

3. Pump and treat or in-situ bioremediation methods are used to remove residual plume. This engineered hazard reduction step will have to be implemented over a span of several decades, to reduce residual plume concentrations to safe levels. Pulsed pump and treat methods may be used to make the process less expensive. This barrier will block exposure mechanisms arising out of direct or indirect ingestion of contaminated water. The barrier is susceptible to administrative actions that may diminish the magnitude of remediation effort or halt it entirely. Excessively heavy rainfall events/seasons during the remediation period may cause an increase in the amount of contaminated groundwater flowing out to surface waters, and thus diminish the efficiency of this engineered barrier.

4. Capping of residential and agricultural wells affected by plume. This step would block usage of contaminated water for residential, gardening, and agricultural purposes, and thereby prevent exposure through ingestion of contaminated water and food. The blocking effect of the step may be reversed if the capped wells are reopened for residential or commercial use, or if new wells are drilled in their proximity.

4.2 EXAMPLES OF OTHER CONCEPTUAL SITE MODELS

The following diagrams and narratives are additional illustrative examples of RBES CSM. The two examples described on pages C-17 through C-21 are similar to the RBES CSM described above (Figure 4.1b2), in that they depict residual contaminations in surface and subsurface soils, but the exposure pathways and potential future receptors differ because of their locations and intended future land use. The examples depicted on pages C-22 through C-25, provide illustrations of the possible exposure mechanisms and pathways associated with radionuclide contaminants. These example CSM are intended to be illustrative of conditions at DOE sites and to demonstrate elements of the process of end-state planning. They are not intended to depict all of the paths that will need to be explored and the analyses that will need to be accomplished in preparing actual conceptual site models.

KEY for all 4.Xb2 Conceptual Site Models

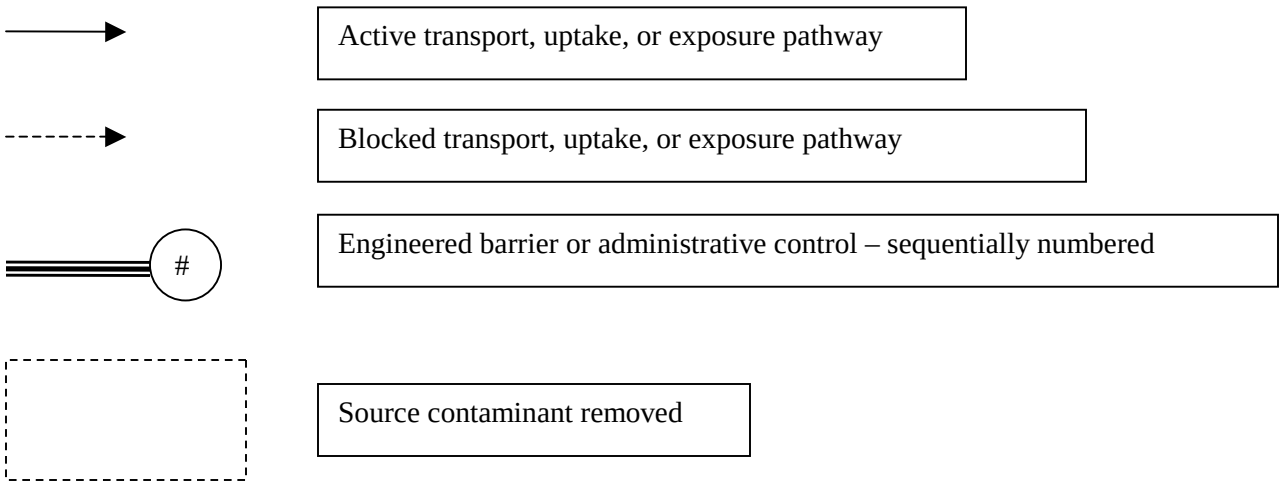
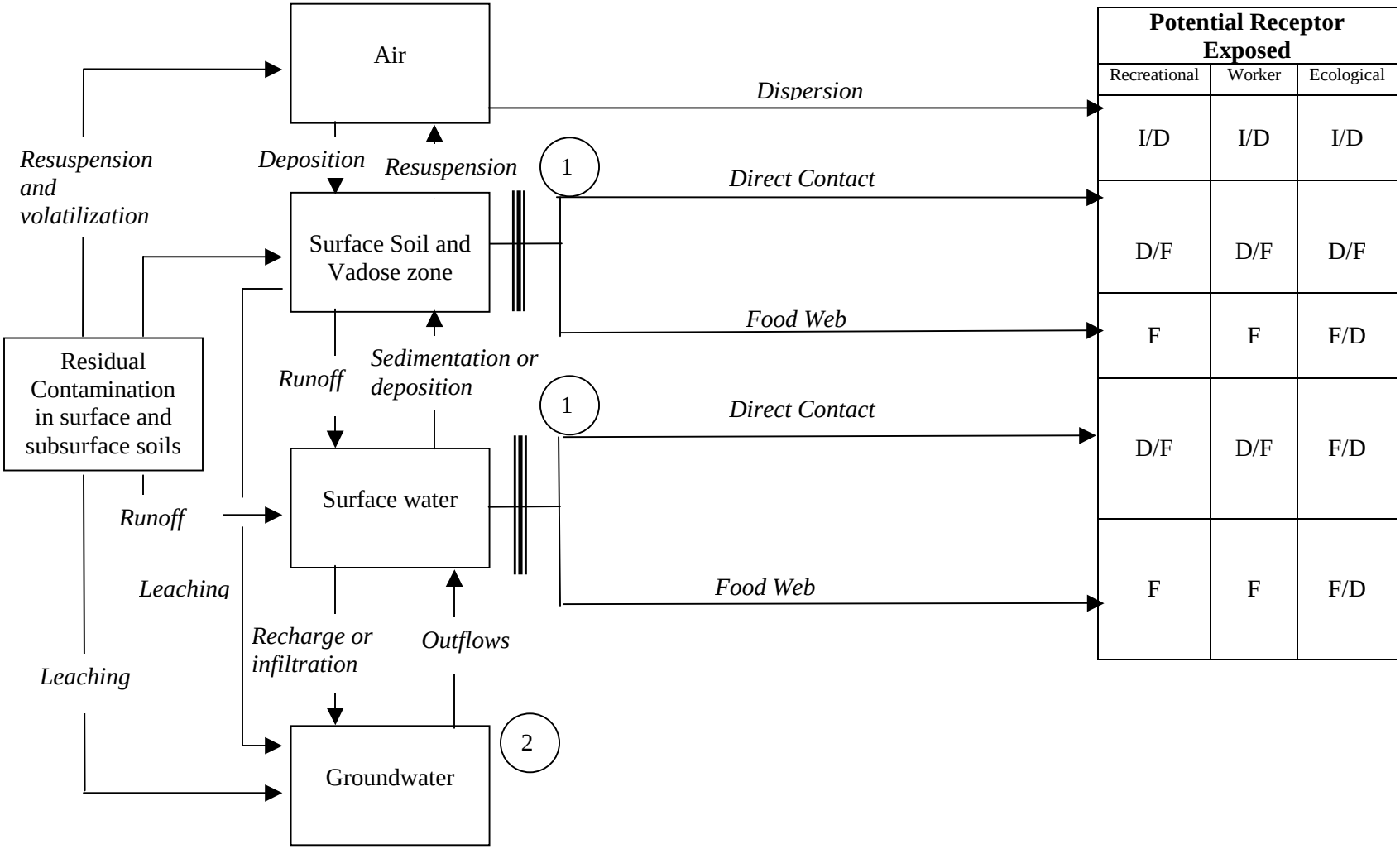


Figure 4.1b2. Hazard Area A CSM - RBES: Public Recreational Use.



The information depicted on this diagram is illustrative and is not meant to be a complete reporting of all the pathways and other complexities (e.g., uncertainties, maintenance requirements, and institutional controls) of the actual hazard area.

Narrative – Primary Source:

This is a simplified conceptual model of the environmental transport and exposure pathways for hypothetical residual contamination at a remediated site. It is assumed that the primary source of the plume has been removed, and that the residual contamination will be subject to monitored natural attenuation. Residual contamination of surface soil, vadose zone, and subsurface soil/groundwater is assumed. In this case, a public golf course is assumed to have been developed at a remediated site with residual contamination.

The predominant release mechanisms to the environment are (a) resuspension of contaminated particulate matter, (b) volatilization of exposed chemical residuals, (c) erosion and surface runoff to surface water bodies, and (d) leaching of residual contamination into groundwater. No commercial, agricultural or residential use of water is envisaged. Besides release through primary mechanisms, the contaminants introduced into the environment are likely to flow between different environmental media such as air, surface soil, surface water and groundwater due to interconnecting mechanisms such as runoff, deposition, infiltration, etc.

Based on these interconnecting transport mechanisms, potential human exposure mechanisms are: inhalation of volatilized vapors and resuspended particulate matter, and direct contact with contaminated soil or surface water. Actual magnitudes of individual or population exposures would additionally be determined by factors such as physical properties of the geological formation, meteorological factors, physical properties of contaminants, physiology and activity profiles or individuals, and microenvironment characteristics. Grounds keepers and caddies, because they are at the site on a regular basis, would have the highest potential for exposure. Utility or other workers doing subsurface digging or trenching may also cause resuspension of contaminated particulate matter into the air and/or come into direct contact with contaminates.

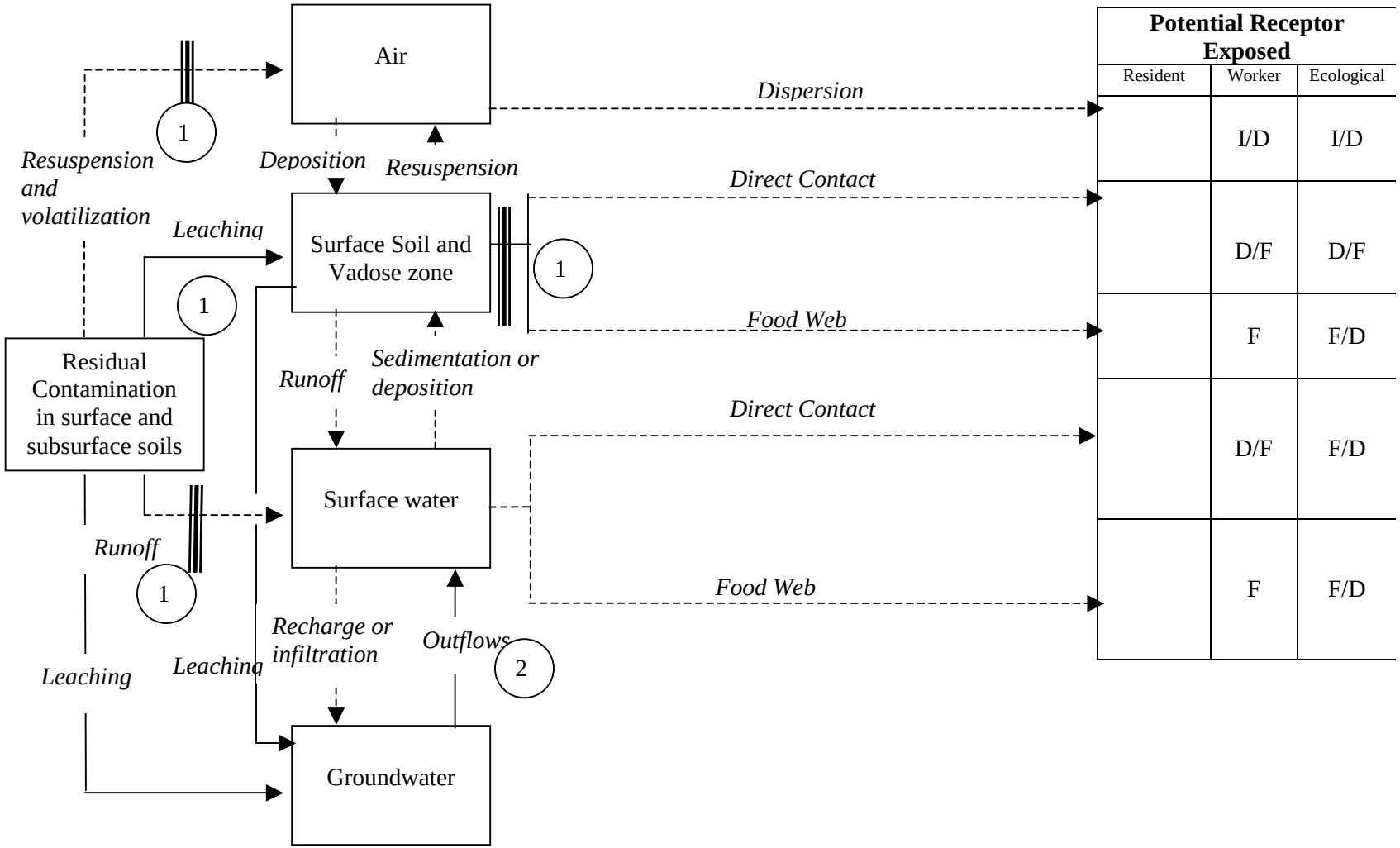
The ecological exposure mechanisms are likely to be inhalation of volatilized vapors and resuspended particulate matter, ingestion of contaminated water, ingestion of plants grown using contaminated water, secondary ingestion of aquatic organisms that uptake contaminants through sediments or water, direct contact with contaminated soils or water.

Narrative – RBES Barriers/Interventions:
The steps taken to mitigate potential exposure are as follows:

1. Land use restrictions in the surrounding areas are in place to ensure that the land is not used for residential purposes. Additional institutional controls and signage is in place to prevent digging, drilling or trenching in known areas of subsurface soil contamination.

2. These steps will not block residual contamination in the groundwater, however, if no wells are drilled, any seepage from groundwater into surface waters will constitute a minor and negligible secondary transport mechanism because of natural attenuation processes.

Figure 4.2b2. Hazard Area B CSM - RBES: Private Industrial Use.



The information depicted on this diagram is illustrative and is not meant to be a complete reporting of all the pathways and other complexities (e.g., uncertainties, maintenance requirements, and institutional controls) of the actual hazard area.

Narrative – Primary Source:

This is a simplified conceptual model of the environmental transport and exposure pathways for hypothetical residual contamination at a remediated site. It is assumed that the primary source of the plume has been removed, and that the residual contamination will be subject to monitored natural attenuation. Residual contamination of surface soil, vadose zone, and subsurface soil/groundwater is assumed. In this case, the site is retained for industrial use, with the building footprints, roads and parking areas providing impervious surface caps over much of the residual contaminant areas.

The predominant potential release mechanisms to the environment are (a) resuspension of contaminated particulate matter, (b) volatilization of exposed chemical residuals, (c) erosion and surface runoff to surface water bodies, and (d) leaching of residual contamination into groundwater. No commercial, agricultural or residential use of water is envisaged. Besides release through primary mechanisms, the contaminants introduced into the environment are likely to flow between different environmental media such as air, surface soil, surface water and groundwater due to interconnecting mechanisms such as runoff, deposition, infiltration, etc.

Based on these interconnecting transport mechanisms, potential human exposure mechanisms are: inhalation of volatilized vapors and resuspended particulate matter, and direct contact with contaminated soil or surface water. Actual magnitudes of individual or population exposures would additionally be determined by factors such as physical properties of the geological formation, meteorological factors, physical properties of contaminants, physiology and activity profiles or individuals, and microenvironment characteristics. Workers will also be potentially exposed during construction of the industrial buildings and roads.

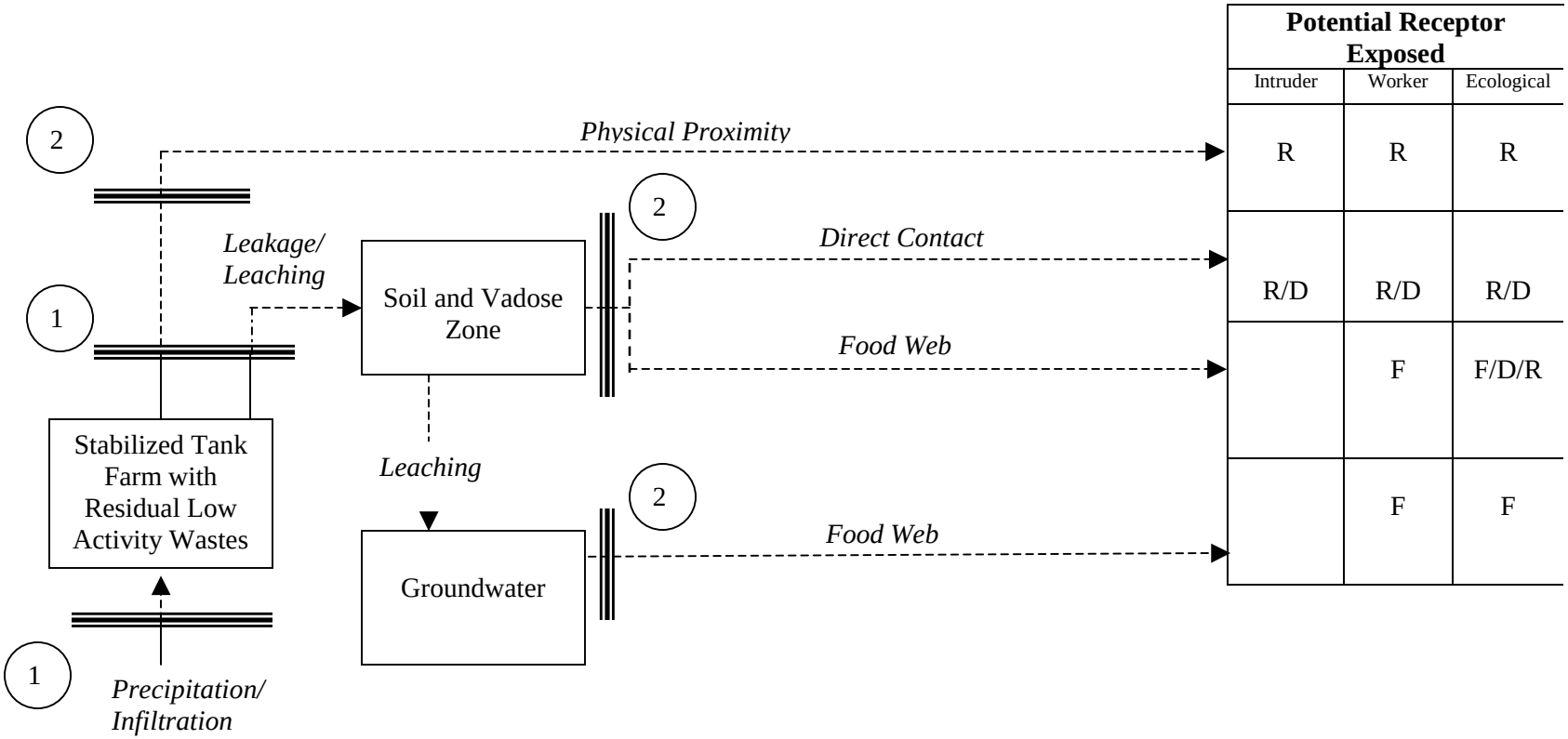
The potential ecological exposure mechanisms are likely to be inhalation of volatilized vapors and resuspended particulate matter, ingestion of contaminated water, ingestion of plants that uptake contaminated water, secondary ingestion of aquatic organisms that uptake contaminants through sediments or water, and direct contact with contaminated soils or water.

Narrative – RBES Barriers/Interventions:
The steps taken to mitigate potential exposure are as follows:

1. This brownfields site will be redeveloped into an industrial complex with buildings, roads, and parking lots. These structures will be designed as impermeable surfaces and thus will serve to act as a barrier for preventing release of residual contamination into the environment through resuspension or erosion. Institution land use restrictions in the surrounding areas will be imposed to ensure that no wells draw water from the potentially impacted aquifer, and institutional controls and signage will be in place to prevent digging, drilling or trenching in known areas of subsurface soil contamination.

2. These steps will not block residual contamination in the groundwater, however, if no wells are drilled, any seepage from groundwater into surface waters will constitute a minor and negligible secondary transport mechanism because of natural attenuation processes.

Figure 4.3b2. Hazard Area C CSM - RBES: Industrial Continuing Mission Site



Potential Receptor Exposed		
Intruder	Worker	Ecological
R	R	R
R/D	R/D	R/D
	F	F/D/R
	F	F

The information depicted on this diagram is illustrative and is not meant to be a complete reporting of all the pathways and other complexities (e.g., uncertainties, maintenance requirements, and institutional controls) of the actual hazard area.

Narrative – Potential Environmental Release Mechanisms:

This is a simplified conceptual model of potential environmental release mechanisms and exposure pathways for a hypothetical subsurface tank farm containing stabilized low-activity radionuclide wastes. Approximately 90 percent of the radionuclide wastes have been removed, and the remaining low-activity wastes have been grouted in place. A steel reinforced concrete intruder barrier has been constructed over the tanks, which in turn has been covered with several feet of soil. Shallow root vegetation will be permitted to grow on the surface to reduce potential infiltration from rainfall. The site is part of a larger DOE property that will remain in federal ownership in perpetuity and which for the foreseeable future will have a continuing industrial type mission.

The potential release mechanisms that might expose workers, intruders and animals, or degrade water sources are: (a) leakage to subsurface soils, (b) radiation exposure from direct contact with contaminated materials in the soils, (c) radiation exposure through physical proximity to the low-level radionuclide materials, (d) leakage from the tanks into soils and vadose zone; and (e) uptake into the food web and ingestion by humans and animals. Besides release through primary mechanisms, the contaminants introduced into the environment are likely to flow between different environmental media such as subsurface soils and groundwater due to interconnecting mechanisms such as infiltration, etc.

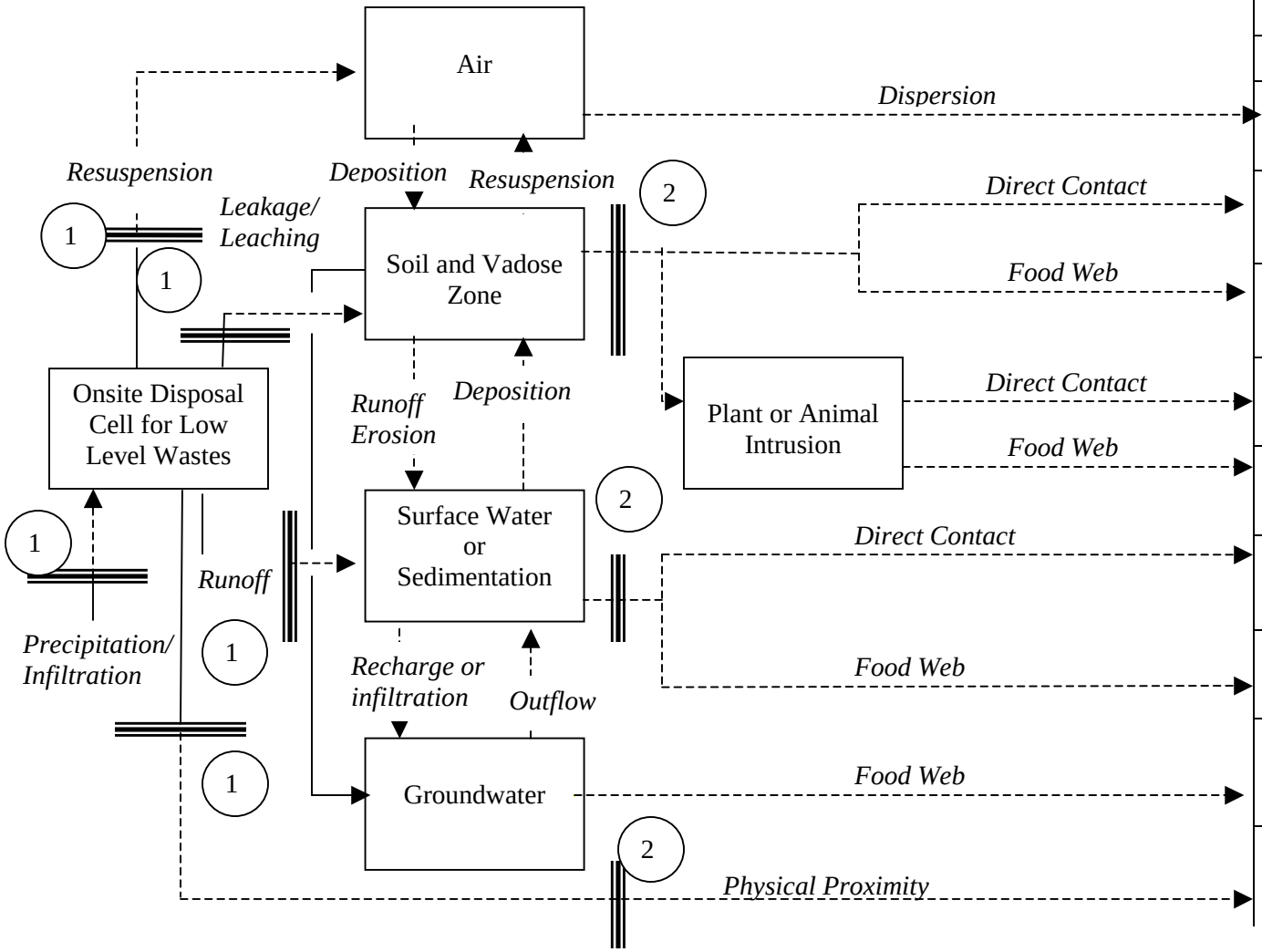
Actual magnitudes of individual or population exposures would additionally be determined by factors such as physical properties of the geological formation, meteorological factors, physical properties of construction material and residual contaminants, local land use patterns, demography of population, physiology and activity profiles or individuals, and microenvironment characteristics.

Narrative – RBES Barriers/Interventions:
The steps taken to mitigate potential exposure are as follows:

1. Ninety percent of the radionuclide wastes have been removed, and the remaining low level wastes have been stabilized through in-situ grouting. A steel reinforced concrete intruder barrier has been constructed over the tanks, which in turn has been covered with several feet of soil. The concrete cap has been designed to withstand the maximum credible earthquake scenarios, to minimize infiltration and deter an aggressive intruder. The soil cover and shallow root vegetation will minimize infiltration from rainfall, and thus minimize penetration of the cap, breakdown of the grout material, and renewed leakage of low level wastes outside the tanks to surrounding soils and vadose zone.

2. In addition, restricted access and other institutional controls (including environmental monitoring and security) to this federally owned property and on-going mission facility would be maintained.

Figure 4.4b2 – Hazard Area D CSM - RBES: Federally Owned Ecological Site



Potential Receptor Exposed		
Intruder	Worker	Ecological
I	I	I
R/D	R/D	R/D
F/R	F/R	F/R/D
R/D	R/D	R/D
F	F	F/R/D
	D	F/D
F	F	F/D
F	F	F/D
R	R	R

The information depicted on this diagram is illustrative and is not meant to be a complete reporting of all the pathways and other complexities (e.g., uncertainties, maintenance requirements, and institutional controls) of the actual hazard area.

Narrative – Potential Environmental Release Mechanisms:
This is a simplified conceptual model of potential environmental release mechanisms and exposure pathways for a hypothetical large engineered disposal cell containing soil, debris, concrete, metal with a high volume but low content of uranium, metals, and/or other long lasting contaminants. While no release to the environment is assumed, this model considers potential release and exposure pathways, in order to identify additional barriers and interventions that may need to be employed to prevent human and ecological exposure to wastes.

The potential release mechanisms to the environment are (a) resuspension of contaminated particulate matter, (b) surface runoff, (c) leakage or leaching to subsurficial soils from the facility, and (d) rupture of cap from settlement, plant intrusion, animal burrowing or erosion. Besides release through primary mechanisms, the contaminants introduced into the environment are likely to flow between different environmental media such as air, surface soil, surface water and groundwater due to interconnecting mechanisms such as runoff, deposition, infiltration, etc.

Based on these complex interconnecting transport mechanisms, potential human exposure mechanisms are: ingestion of plants grown using contaminated water; consumption of possibly contaminated fish and wildlife; direct contact with contaminated soils; possibly inhalation of resuspended particulate matter; and physical proximity to gamma emitting radionuclides. In addition to exposure pathways associated with environmental releases, direct exposure due to inadvertent intrusion is also considered as a significant hazard. Actual magnitudes of individual or population exposures would additionally be determined by factors such as physical properties of the geological formation, meteorological factors, physical properties of construction material and leaking contaminants, local land use patterns, demography of population, physiology and activity profiles or individuals, and microenvironment characteristics.

The potential ecological exposure mechanisms are likely to be ingestion of contaminated water, ingestion of plants grown using contaminated water, secondary ingestion of aquatic organisms that uptake contaminants through sediments or water, direct contact with contaminated soils, and inhalation of vapors or suspended particulate matter. There may also be a possibility of direct exposure to gamma emitting radionuclides due to inadvertent intrusion.

Narrative – RBES Barriers/Interventions:
The steps taken to mitigate potential exposure are as follows:

1. A steel reinforced concrete intruder barrier has been constructed over the disposal cell, which in turn has been covered with several feet of soil. The concrete cap has been designed to reduce radiation emissions, and withstand the maximum credible earthquake scenarios, to minimize infiltration and deter an aggressive intruder. The soil cover and shallow root vegetation will minimize infiltration from rainfall, and thus minimize penetration of the cap and renewed leakage of low level wastes outside the tanks to surrounding soils, vadose zone and ground water.

2. Structural inspections will be conducted annually to ensure that erosion, plant intrusion or animal burrowing are not penetrating walls or causing physical deterioration, and groundwater monitoring will be maintained. A security fence, located 200 feet out from the cell's perimeter, surrounds the site, and restricted access to this federally owned property will be maintained.

This Page Intentionally Left Blank

APPENDIX D

Guidance for Variances Reporting

This Page Intentionally Left Blank

GUIDANCE ON VARIANCES REPORTING

As discussed in Section 4 of this guidance document, DOE expects that there will be variances between the RBES vision and the current cleanup plans for many of the sites in the complex. These variances are expected to be identified through discussions with regulators, the affected governmental organizations, adjacent landowners, and the general public during the development of the RBES Visions. Variances should be included as an attachment to the Vision document.

The variance report should include a minimum of four key attributes and two maps. The key attributes include: description of variances; description of impacts in terms of scope, cost, schedule and risk; barriers in achieving RBES; and recommendations/next steps. In addition, two maps should be developed: one to depict the end state based on the current requirements and another to depict the end state based on the RBES. The latter map should also highlight the differences between the two. Each variance should be labeled on the map and in the report as V-1, V-2, etc. An example of a suitable report is provided on Page D-2. Other information, if deemed necessary in explaining the variances, should also be included.

Description of Variance – For each variance, describe the variance in detail. In many cases, the variance will represent differences between the RBES and the current baseline, PMP, and/or regulatory agreements with regulators. In some cases, it may represent an internal disagreement within DOE organizations (e.g., EM vs. landlord organization).

Description of Impacts – Discuss impacts of the variance in terms of cost, schedule, and scope, as well as risk (ES&H risk, if known) implications. The reporting should clearly state expected cost differences (in constant 2003 dollars). Otherwise, specify schedule differences (in years and/or months) and the differences in scope and risk. List and attach any supporting documents to the variance report.

Barriers in Achieving RBES – For each variance, discuss issues and barriers associated with achieving the RBES. The discussion should include affected organizations that the Department needs to work with in order to achieve the RBES, as well as their views regarding each variance.

Recommendation/Next Steps – Discuss recommended path forward. The discussion should include to whom the action should be assigned and the recommended time frame for initiation and/or completion of the action.

Any other supporting information such as letters from regulators and concerned stakeholders should be provided as well.

Variance Report				
ID No.	**Description of Variances**	**Impacts (in Terms of Scope, Cost, Schedule and Risk)**	**Barriers in Achieving RBES**	**Recommendations**
V-1	The current agreement with state requires cleanup of area x to residential cleanup standard. Based on RBES vision, the area x is to be used as recreational areas. Area x is located in the middle of site and is approximately 30 acres.	Cleaning to residential standard will require additional 10,000 cubic meters of soil to be excavated. Remediation of additional 10,000 cubic meters of soil will cost $50 million dollars (including excavation, treatment and disposal fees). Remediation will take additional 6 months to complete the project. Risk assessment has not been completed for RBES.	State regulators insist cleaning up to residential standard per agreement. Local stakeholders are not fully onboard with RBES process and have not accepted new cleanup strategy for area x.	Requires EM-1's involvement with state regulators and EPA Region x. **Action**: Site manager will arrange a meeting between state regulator and EPA Region x Administrator.
V-2	The current baseline assumes D&D and complete removal of buildings xx to xxx. Based on the RBES, the area 2 where the buildings are located will be a restricted area with heavy industrial use to support the future mission by landlord organization (NE). Based on this, D&D and complete removal buildings is not RBES. Based on future use of the land, RBES supports entombment of the buildings in place.	D&D and complete removal of buildings xx and xxx will require $300 million dollars (validated 2002 baseline). Entombment of buildings is expected to cost $150 million dollars (estimated cost). It is expected to generate 20,000 cubic meters of LLW and MLLW. Entombment will greatly reduce the amount, but will require long-term institutional controls (annual cost of $100,000). Entombment can be completed by 2005 vs. D&D/removal schedule of 2008. No risk analysis has been performed to compare the two options.	State regulators insist D&D and complete removal of buildings xx to xxx level per DOE's previous agreement. However, preliminary discussion with State regulators regarding RBES, they have indicated that they are willing to discuss the issue. Landlord PSO (NE) has indicated that the entombment of buildings are acceptable based on expected future use of the site by NE. Local stakeholders are not fully onboard with RBES process and have not accepted the "entombment" concept.	Requires EM-1's involvement with state regulators and EPA Region x. **Action 1** – Site manager will arrange a meeting between state regulator and EPA Region x representative. **Action 2 --** **Action 3 --**
V-3	Continue for each variance.	Continue for each variance.	Continue for each variance.	Continue for each variance.

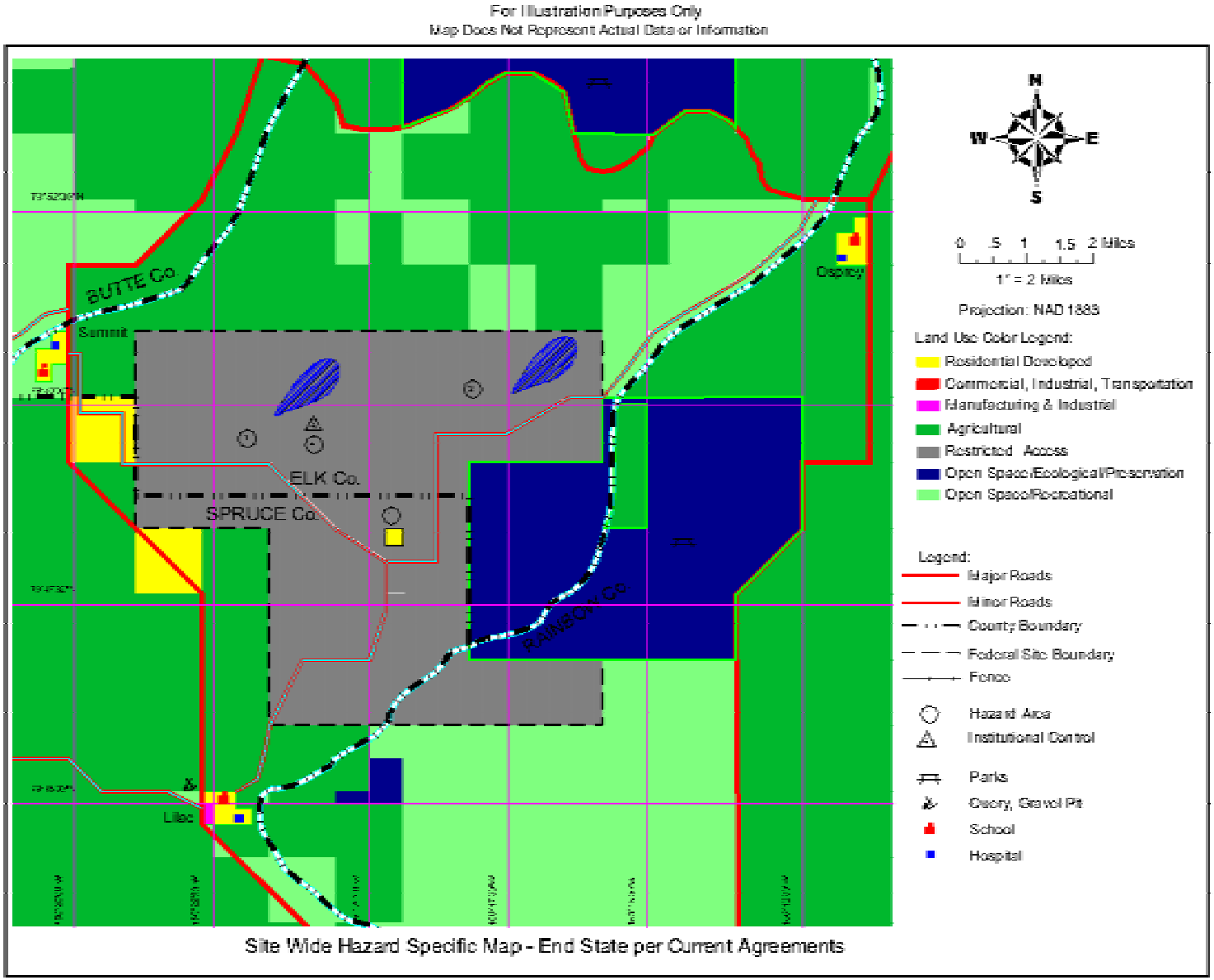


Figure 1. Site wide hazard specific map - end state per current agreements.

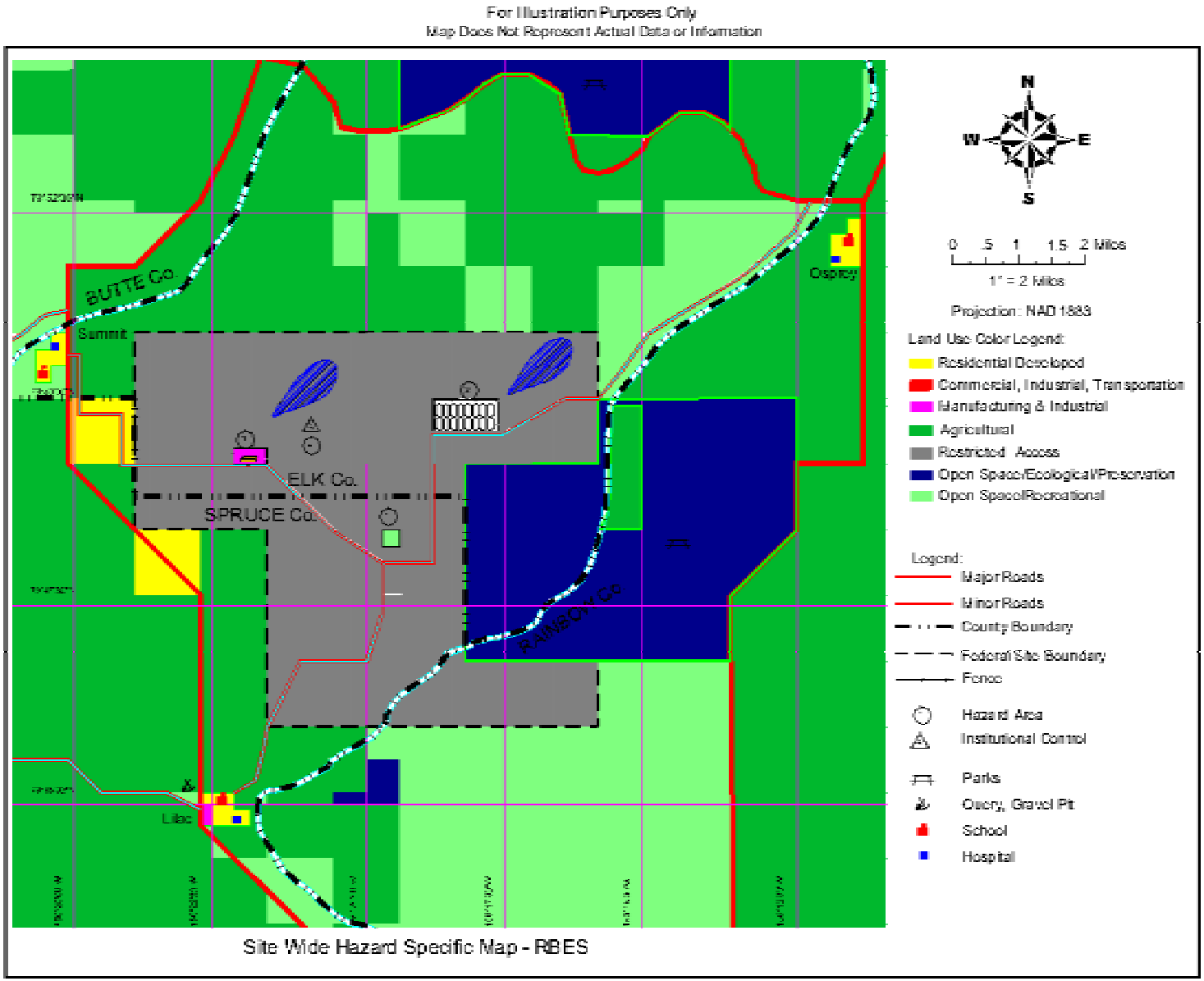


Figure 2. Site wide hazard specific map - RBES.

APPENDIX E

Reference List

This Page Intentionally Left Blank

ENVIRONMENTAL PROTECTION AGENCY

The single page on the EPA web site that opens the most relevant EPA documents related to risk and to risk assessment on Superfund and other waste site is on the Internet at: http://www.epa.gov/superfund/programs/risk/tooltrad.htm.

Special attention on this page should be given to the Risk Assessment Guidelines for Superfund (RAGS) that are found by scrolling down to Guidance and Policy on this same page: Risk Assessment Guidance for Superfund (RAGS): Volume 1 -- Human Health Evaluation Manual.

Part A of RAGS describes how to conduct a site-specific baseline risk assessment. The information in Part A is necessary background for Part D. Part B provides guidance for calculating risk-based concentrations that may be used, along with applicable or relevant and appropriate requirements (ARARs) and other information, to develop preliminary remediation goals (PRGs) during project scoping. Note that Chapter 4 of Part B of RAGS has been updated with the electronic calculator entitled: "Radionuclide Preliminary Remediation Goals (PRGs) for Superfund", which may be found at: http://epa-prgs.ornl.gov/radionuclides/ PRGs (and final remediation levels set in the Record of Decision) can be used throughout the analyses in Part C to assist in evaluating the human health risks of remedial alternatives. Part D complements the guidance provided in Parts A, B, and C and presents approaches to standardize risk assessment planning, reporting, and review. Part D guidance spans the CERCLA remedial process from project scoping to periodic review of the implemented remedial action. Part D guidance applies to all Superfund Risk Assessments starting after January 1, 1998.

The final reference on the Internet page cited above focuses on risk assessment for radioactively contaminated sites and is found at: http://www.epa.gov/superfund/resources/radiation/radrisk.htm.

The page providing an overview of risk assessment for Superfund is found on the Internet at: http://www.epa.gov/superfund/programs/risk/ragsd/. For those seeking to assess differences among key risk assessment methodologies for contaminated sites, a recent EPA summary and comparison of single point and probabilistic techniques is found in the in RAGS Volume 3 Part A: December 31, 2001. It is on the Internet at: http://www.epa.gov/superfund/programs/risk/rags3adt/pdf/chapters1_2.pdf.

DOE OFFICE OF ENVIRONMENTAL COMPLIANCE AND GUIDANCE

The key compliance and guidance for site the Department of Energy is on a wide-ranging EH web site at: http://tis.eh.doe.gov/oepa/.

The specific site that provides access to dose and risk information, and also provides useful links to a variety of organizations that are or have been related to the Department including the Center for Risk Excellence, the EH Dose and Risk Resources Web Page at: http://homer.ornl.gov/oepa/risk/.

NUCLEAR REGULATORY COMMISSION

A similar page for the Nuclear Regulatory Commission is found at: http://www.nrc.gov/reading-rm/basic-ref.html#key.

DEPARTMENT OF DEFENSE

A DoD page that addresses Policy on Land Use Controls Associated with Environmental restoration activities is found on a pdf file at: http://www.em.doe.gov/ftplink/guidance/dodjanpol.pdf.

CONSORTIUM FOR RISK EVALUATION WITH STAKEHOLDER PARTICIPATION

Peer-reviewed literature on planning and implementing a risk based end state program for contaminated sites is found at: http://www.cresp.org/rbes/start.html.