# Appendix VI

# Corrective Action Strategy

Revision No.: 3

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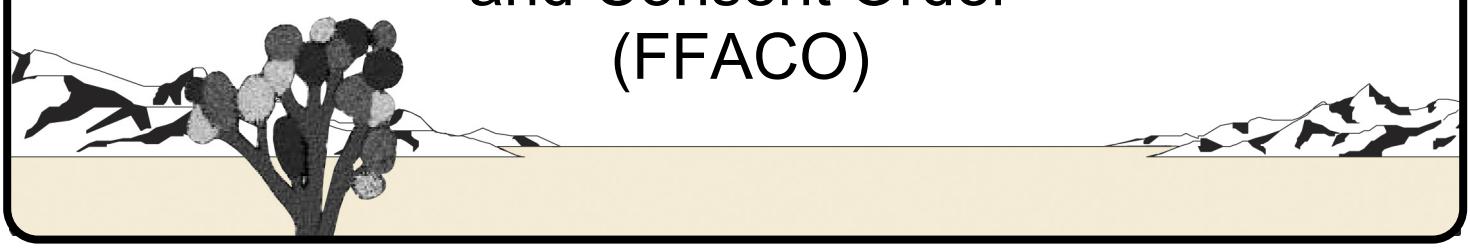
Federal Facility Agreement
and Consent Order
(FFACO)



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# List of Acronyms and Abbreviations

| | |
|---|---|
| 3-D | Three-dimensional |
| CAB | Community Advisory Board |
| CADD | Corrective Action Decision Document |
| CAI | Corrective Action Investigation |
| CAIP | Corrective Action Investigation Plan |
| CAP | Corrective Action Plan |
| CAS | Corrective Action Site |
| CAU | Corrective Action Unit |
| CFR | *Code of Federal Regulations* |
| CNTA | Central Nevada Test Area |
| CR | Closure Report |
| DoD | U.S. Department of Defense |
| DOE | U.S. Department of Energy |
| DOE/DP | U.S. Department of Energy/Defense Program |
| DOE/EM | U.S. Department of Energy/Environmental Management |
| DOE/LM | U.S. Department of Energy/Office of Legacy Management |
| ER | Environmental Restoration |
| DQO | Data Quality Objective |
| FFACO | *Federal Facility Agreement and Consent Order* |
| ft | Foot |
| FY | Fiscal Year |
| HSU | Hydrostratigraphic unit |
| LTHMP | Long-Term Hydrologic Monitoring Program |
| m | Meter |
| NAC | *Nevada Administrative Code* |
| NAD | North American Datum |
| NDEP | Nevada Division of Environmental Protection |
| NNSA/NSO | U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office |
| NRC | National Research Council |
| NTS | Nevada Test Site |
| NTTR | Nevada Test and Training Range |
| PCB | Polychlorinated biphenyl |
| PSA | Project Shoal Area |
| RCRA | *Resource Conservation and Recovery Act* |
| SAFER | Streamlined Approach for Environmental Restoration |
| SDWA | *Safe Drinking Water Act* |

## *List of Acronyms and Abbreviations (continued)*

| | |
|---|---|
| TTR | Tonopah Test Range |
| UGTA | Underground Test Area |
| UTM | Universal Transverse Mercator |
| VOIA | Value of information analysis |

# 1.0 Introduction

Appendix VI to the *Federal Facility Agreement and Consent Order* (FFACO) describes the strategy that will be employed to plan, implement, and complete environmental corrective action activities at facilities where nuclear-related operations were conducted in Nevada. The nuclear tests and associated support activities were conducted at the Nevada Test Site (NTS); parts of the Tonopah Test Range (TTR) and Nevada Test and Training Range (NTTR); and at the Project Shoal Area (PSA) and the Central Nevada Test Area (CNTA), located in northern and central Nevada, respectively. Agencies, herein referred to as parties, responsible for the activities described in this appendix are the U.S. Department of Energy (DOE), National Nuclear Security Administration, Nevada Site Office (NNSA/NSO); the U.S. Department of Defense (DoD); and the DOE/Office of Legacy Management (LM). These agencies will follow this strategy to accomplish corrective action investigations (CAIs) and corrective actions at the facilities specified in Appendix I (Description of Facilities) of this Agreement, as overseen by the Nevada Division of Environmental Protection (NDEP). The DoD's responsibilities are limited to those areas at the NTS where DoD has conducted activities. The DOE/LM's responsibilities are limited to the Nevada Offsites, which are comprised of the CNTA and the PSA.

The corrective action strategy is based on four steps: (1) identifying corrective action sites (CASs), (2) grouping the CASs into corrective action units (CAUs), (3) prioritizing the CAUs for funding and work, and (4) implementing the CAIs and/or corrective actions, as applicable.

CASs are broadly organized into four categories based on the source of contamination: (1) Industrial Sites, (2) Underground Test Area (UGTA) Sites, (3) Soils Sites, and (4) Offsites. CASs located on the NTS and TTR where activities were conducted that supported nuclear testing activities are grouped as Industrial Sites. CASs associated with underground nuclear tests that have resulted or might result in local or regional impacts to groundwater resources are grouped as the UGTA CAUs. CASs where tests resulted in extensive surface and/or shallow subsurface contamination are grouped as Soils Sites. Additional CASs associated with underground nuclear testing at PSA and CNTA, located in northern and central Nevada respectively, are grouped as Nevada Offsites. All nuclear tests shall be addressed under the above categories (2), (3), or (4).

## 1.1 Identifying Corrective Action Sites

The first step in the strategy is to identify CASs potentially requiring CAIs and/or corrective actions and place them into Appendix II (Corrective Action Sites/Units) of the Agreement. As CASs are identified, a literature search may be completed, and each CAS will be verified on aerial photographs or in the field to confirm the condition and location of the CAS. A data repository has been created containing or referencing all information currently available for each CAS. It includes, at a minimum, the CAS location, waste description, responsible agency, and information presented in Appendix II (Corrective Action Sites/Units).

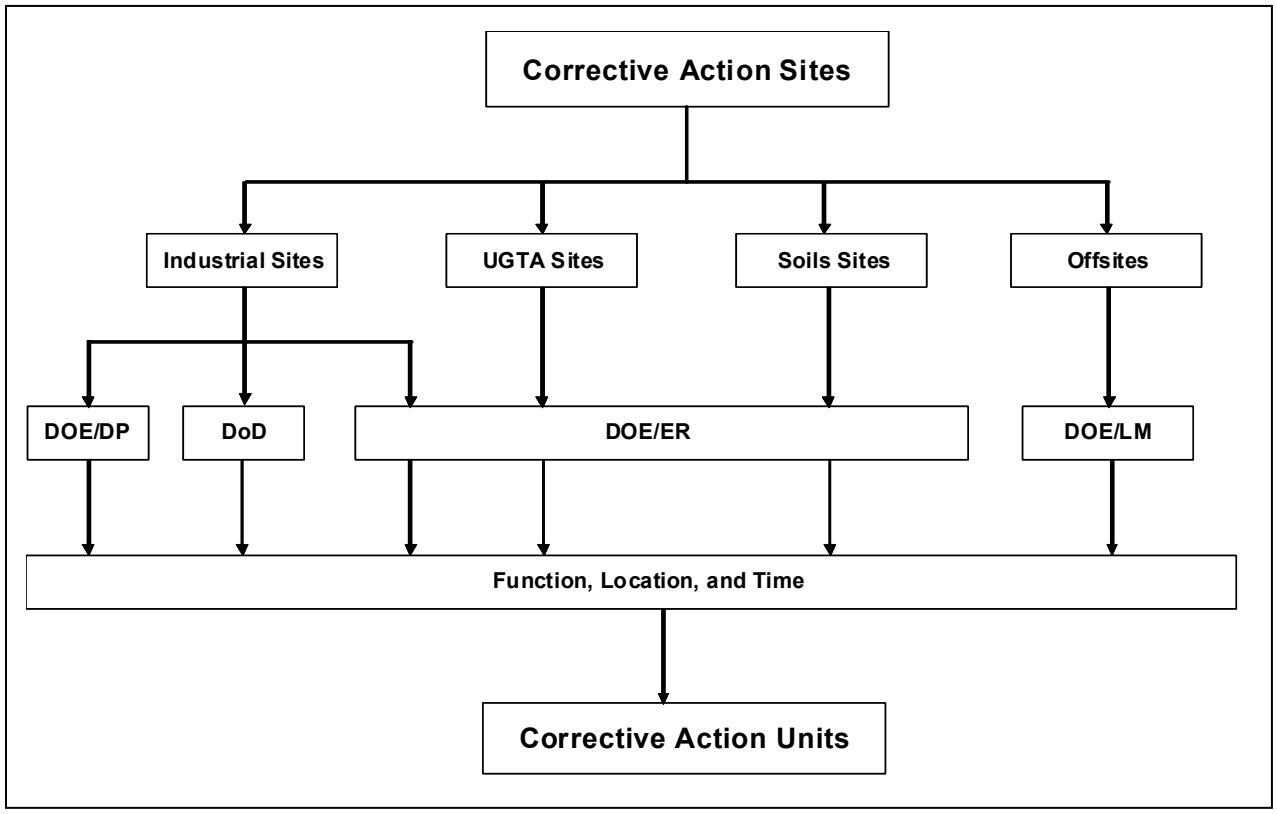


**Figure 1-1**
**Assignment of Corrective Action Sites to Corrective Action Units**

## 1.2 Grouping Corrective Action Sites

CASs will be grouped into CAUs following the process presented in Figure 1-1 and the criteria described below. Appendix II (Corrective Action Sites/Units) may contain CASs that have not

yet been grouped into CAUs, and it is possible that a CAU may contain only one CAS. Criteria for grouping CASs into CAUs include the following:

1. What is the potential source of contamination?
2. Which agency is responsible for cleanup of the CAS?
3. What was the function of the CAS and, therefore, the nature of the contamination?
4. Do the CASs have geographic commonality, or are the CASs located in close enough proximity to be investigated as a CAU?
5. Can investigation or cleanup of grouped CASs be accomplished within a similar time frame?

Appendix II (Corrective Action Sites/Units) of this Agreement will be reviewed periodically by NNSA/NSO, DoD, DOE/LM, and NDEP to determine whether CASs are appropriately organized into CAUs.

### *1.3 Prioritizing Corrective Action Units*

Prioritization of CAUs will be proposed by NNSA/NSO, DoD, and DOE/LM, as appropriate. The proposed priorities and explicit justifications will be presented to NDEP for review; NDEP may agree with the basis for the prioritization and the criteria specified, or suggest alternatives. CAUs will be reprioritized as applicable per the results of the NDEP review and discussions on issues and priorities held during scheduled semi-annual meetings. During the first semi-annual meeting of each Federal fiscal year (FY), NNSA/NSO, DoD, DOE/LM, and NDEP will review and reconsider established priorities, milestones, and associated due dates and deadlines for the current FY.

At the second semi-annual meeting, the parties will address the development of proposed CAU priorities for FY +2. The proposal will include milestones with associated due dates and deadlines. The proposed prioritization will then be presented to the public and the Community Advisory Board (CAB) for input. The NNSA/NSO, DoD, DOE/LM, and NDEP will subsequently develop a final prioritization of CAUs scheduled for CAIs and corrective actions within 30 days of receipt of the final proposed NNSA/NSO, DoD, or DOE/LM milestones for all prioritized CAU activities that must be incorporated into the FY +2 Budget Request.

During the second semi-annual meeting, NNSA/NSO, DoD, DOE/LM, and NDEP will review and reconsider established priorities, milestones, and associated due dates and deadlines for CAUs for FY+1.

This entire process is pursuant to paragraph XII.4 of this Agreement.

A listing of criteria (arranged alphabetically) that may be used to prioritize CAUs is presented in Table 1-1.

**Table 1-1**
**Potential Criteria for Prioritizing CAUs**

| Criteria | Description |
|---|---|
| Assessment of risk | Does the risk to workers, and/or the general public, and/or to the ecosystem require a CAI, a corrective action, or no further action? |
| Available technology | Are the technologies available for corrective action effective and not cost prohibitive? |
| Cost | Can the CASs within the CAUs be addressed within known or expected budget constraints? |
| Future use | What are the possible future land or resource uses? |
| Geographic location | Is the CAU located in an area that requires more immediate action than others? |
| Interdependency of action | Are planned or ongoing operations likely to have an effect on the priority of a CAI and/or corrective action? |
| Optimization of resources | Have all resources been analyzed and used to their fullest practical extent? |
| Priorities of the parties | What are the priorities of the parties for the CAUs? |
| Presence of cultural resources or sensitive species | Do CAUs contain CASs where cultural resources or sensitive species are known or expected to be encountered? Will these CAUs require additional time and cost for surveys and mitigation prior to or concurrently with the corrective action? |
| Regulatory requirements | Are some CAIs and/or corrective actions mandated by regulatory requirements to be accomplished first? Are there other regulatory requirements that must be met (for example, must a National Environmental Policy Act document be completed or a threatened and endangered species survey accomplished prior to the start of a CAI and/or corrective action)? |
| Schedule | Are CAIs and/or corrective actions scheduled to allow efficient utilization of resources such as labor and equipment? |
| Stakeholders' concerns | Do stakeholders have additional criteria, concerns, or alternatives to propose? |
| Time required to complete action | How long will it take to complete the CAI and/or corrective action? |
| Waste management concerns | Are facilities and technologies available to effectively manage the waste expected to be generated by corrective actions? |

### 1.3.1 Public Involvement

The public, particularly through the CAB for NTS Programs, has the opportunity to become involved early in the CAI/corrective action process.

The CAB's comments will be strongly considered before final prioritization of corrective actions. In addition, a public participation working group made up of representatives from NNSA/NSO, DoD, the State of Nevada, and the CAB will meet two times a year to discuss upcoming environmental restoration activities and the level of public involvement required. These meetings will focus on the quarterly progress reports and priority-setting activities established under the Agreement. Detailed public involvement opportunities are outlined in Appendix V (Public Involvement Plan).

### 1.3.2 Historic CASs and New Releases

The historic *Resource Conservation and Recovery Act* (RCRA) sites governed by Section V of DOE's RCRA permit number NEV HW0021 will be prioritized with the CAUs regulated by this Agreement. However, closure of these sites shall be in accordance with the appropriate requirements of Title 40 *Code of Federal Regulations* (CFR) 265, as adopted by *Nevada Administrative Code* (NAC) 444.8632 and 444.8634, inclusive.

Contamination caused by new spills or releases from operational activities will not be covered under this Agreement. Priorities established in Appendix III (Corrective Action Investigations/ Corrective Actions) may be reconsidered based upon the circumstances involving new releases.

## 1.4 Corrective Action Investigation and Corrective Action Documents

A series of documents will be prepared to plan and guide CAI and corrective action activities.

- Corrective Action Investigation Plan (CAIP): A document that provides or references all the specific information for planning investigation activities associated with corrective action units. A CAIP may reference information in the optional CAU work plan or other applicable documents. If a CAU work plan is not developed, then the CAIP must include or reference all the management, technical, quality assurance, health and safety, public involvement, field sampling, and waste management information needed to conduct the investigations in compliance with established procedures and protocols.

- Corrective Action Unit Work Plan: An optional planning document that provides information for a CAU or a collection of CAUs where significant commonality exists.

This plan may be developed to eliminate redundant CAU documentation and may contain management, technical, quality assurance, health and safety, public involvement, field sampling, and waste management information. This common information will be referenced in appropriate CAIPs.

- Corrective Action Decision Document (CADD): A document that provides the corrective action that is selected as the result of investigation activities and the rationale for its selection. The rationale consists of an analysis of the possible alternatives and may reflect a decision ranging from no action to clean closure.

- Corrective Action Plan (CAP): A document that provides the plan for implementing the selected corrective action alternative. This plan shall contain a detailed description of the proposed actions that will be taken to achieve the degree of containment set forth in the NDEP-approved CADD.

- Corrective Action Decision Document/Corrective Action Plan (CADD/CAP). A document that combines the function of the CADD and CAP. The CADD/CAP will describe the corrective action and the plan for implementing the corrective action.

- Streamlined Approach for Environmental Restoration (SAFER) Plan: A document that provides a plan for initiating and completing corrective actions at CAUs where enough information exists to predict the appropriate corrective action before completing a CAI. The plan will incorporate the essential elements of the CAIP, the CADD, and the CAP to allow work to proceed directly from the CAI to the corrective action.

- Closure Report (CR): A document that states that the completed corrective action was conducted in accordance with the approved CAP or CADD/CAP, and provides to NDEP all necessary support data to confirm that the appropriate corrective action took place.

- Notice of completion: An NDEP-issued document signifying the completion of the CAU corrective action in accordance with the approved plans.

### *1.5 Implementing Corrective Action Investigations and Corrective Actions*

If a CAU is prioritized for a CAI or corrective action within the three-year planning window, that CAU and associated CASs will be transferred from Appendix II (Corrective Action Sites/Units), to Appendix III (Corrective Action Investigations/Corrective Actions). A preliminary characterization will be performed based on existing data. The data will be used to develop

conceptual models to determine appropriate investigative and corrective action tasks, as well as to select a corrective action process.

Data Quality Objectives (DQOs) will be incorporated throughout the corrective action process. The DQO process is a series of planning steps designed to ensure that environmental data used in decision making are appropriate. The DQOs are qualitative and quantitative statements that help guide CAPs and decisions. These statements will help assure that data are of sufficient quality and quantity to support defensible decisions and at the same time reduce data collection costs by eliminating unnecessary, duplicative, or overly precise data. The DQOs will be developed by the parties with NDEP participation, to assist in development of appropriate work scope.

Assessment of risk to the affected resource (a special application of environmental risk assessment) may be used as needed, along with other appropriate evaluations, to help in establishing appropriate action and/or cleanup levels, particularly where no regulatory levels have been established or where multiple contaminants complicate the evaluation.

When required, interim corrective actions will be carried out where immediate risk exists to workers, the public, and/or the environment. Sufficient data must exist at these CAUs to demonstrate that actions can be taken to stabilize, minimize, or mitigate the contamination until the final corrective action can be completed.

The process for implementing CAIs and/or corrective actions has been subdivided into three flowpaths that are based on the existing CAS data and on-site conditions: the housekeeping process, the SAFER process, and the complex process. Figure 1-2 describes the generic corrective action processes that will be used to determine appropriate CAU activities.

### *1.5.1 Housekeeping Process*

The housekeeping process will be used for CASs that do not require further investigation prior to completing the corrective action. At these CASs, data gathered during records searches and field verification activities sanction the removal of source materials, directly impacted soil, and subsequent confirmatory sampling without additional investigation. A work plan containing developed procedures for conducting these activities will be written and revised as needed in coordination with NDEP. Documentation of the source removal and confirmation sampling, if required, will be through a CR.

### 1.5.2 SAFER Process

The SAFER process will be employed at CAUs where the parties agree that enough information exists about the nature and extent of contamination to propose an appropriate corrective action prior to the completion of a CAI. This process combines elements of the DQO process and the observational approach to help plan and conduct corrective actions. The DQOs will be used to define the type and quality of data needed to complete the investigation phase of the process. The observational approach will provide a framework for managing uncertainty and planning decision making.

The purpose of the investigation in the SAFER process will be to document and verify the adequacy of existing information; to affirm the decision for either clean closure, closure in place, or no further action; and to provide sufficient data to implement the corrective action. Actions and decisions for this process are governed by SAFER Plans. These plans incorporate the required elements of CAIPs, CADDs, and CAPs to allow work to proceed directly from the CAI to the corrective action. The plans will identify decision points where NNSA/NSO and/or DoD will reach consensus with NDEP prior to beginning the next phase. Following completion of SAFER activities, or if the selected remedy is no further action, a CR will be prepared and submitted to NDEP.

### 1.5.3 Complex Process

The complex process will be used for those CAUs where additional information is needed for the evaluation of possible corrective action alternatives. The CAIPs for CAUs following the complex process will focus on the investigation tasks required to prepare the CADD or CADD/CAP, and will include the DQO process. As part of this process, conceptual models for CASs will evolve as data are collected and reviewed. When the investigation is complete, a CADD or CADD/CAP will be prepared to evaluate corrective action alternatives and to identify the selected corrective action.

Following NDEP approval of the selected corrective action outlined in the CADD, a CAP will be developed. This plan will be the document guiding the CAU corrective action. After completion of the corrective action, or if the selected corrective action is no further action, a CR will be developed and submitted to NDEP.

NDEP will issue a notice of completion upon approval of the completion of a corrective action, and the CAU may be transferred from Appendix III (Corrective Action Investigations/Corrective Actions) to Appendix IV (Closed Corrective Action Units). If long-term monitoring is

necessary, the monitoring requirements for CASs or CAUs on facilities subject to the RCRA Permit will be incorporated into the Permit. Long-term monitoring requirements for CASs or CAUs on facilities not subject to the RCRA Permit will be outlined in CRs.

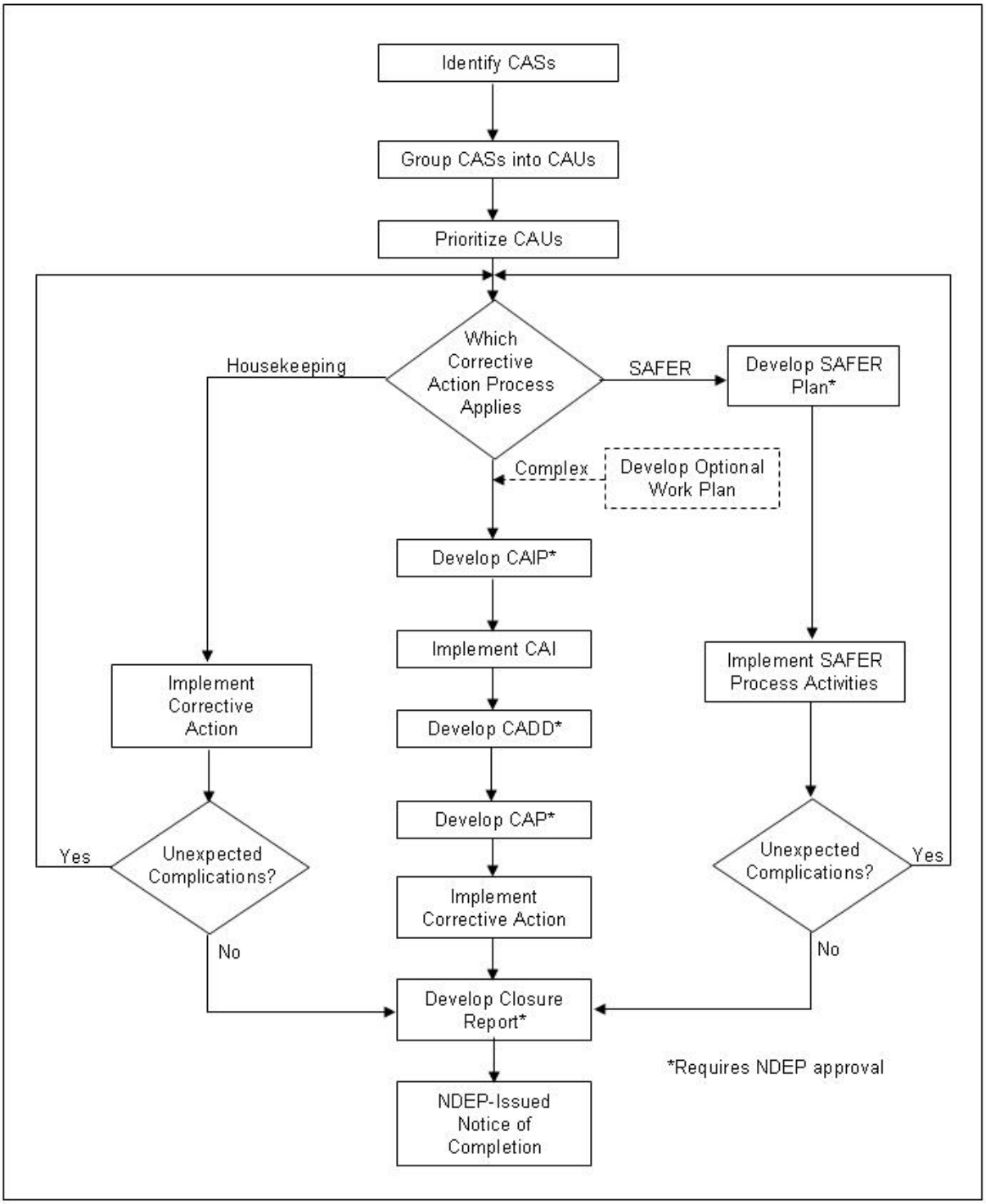


**Figure 1-2**
**Generic Correction Action Process**

# 2.0 Industrial Sites

The current inventory of environmental restoration CASs at the NTS, TTR, and NTTR indicates a widespread distribution of approximately 1,852 Industrial Sites that may require some level of investigation and corrective action.

## 2.1 Corrective Action Units

Industrial Sites CASs will be grouped into CAUs based on four criteria: (1) responsible party, (2) site function, (3) geographic location, and (4) length of time needed to complete the action. CASs will first be assigned to CAUs based on the agency responsible for the investigation and/or corrective action. CASs will then be grouped by function when they share similar technical issues and waste types. CASs with similar functions may be grouped geographically with other CASs to facilitate corrective actions. It is possible that the cleanup of a specific geographic area, such as a portal tunnel area, will be considered a priority, in which case a CAU may contain CASs with a variety of functions. Finally, CASs will be grouped into CAUs according to the length of time needed to complete the corrective actions.

Table 2-1 contains a listing of functional categories that represent the types of CASs normally considered as Industrial Sites. These categories range from landfills, mud pits, leachfields, etc., with or without radiological contamination, to discarded or abandoned materials such as drums, batteries, and lead materials. CASs with materials that are easily disposed of are considered to be housekeeping sites, and account for approximately one-third of all Industrial Sites CASs.

## 2.2 Corrective Action Strategy

Corrective actions for Industrial Sites CAUs will range from no action to clean closure. The types of corrective actions may be as simple as small, isolated housekeeping site source removals to large-scale, multi-faceted projects addressing shallow groundwater and subsurface soil contamination. To further define the corrective actions for the wide range of Industrial Sites, the overall corrective action process has been subdivided into three possible process flowpaths: (1) the housekeeping process, (2) the SAFER process, and (3) the complex process. Decisions to use specific processes are based on the complexity of the CAS conditions and the possibility of choosing corrective action alternatives before investigations are complete. Each of these processes and their respective flowpaths are described further in Section 2.3.

**Table 2-1**
**Industrial Sites Functional Category**

| Functional Category | Functional Category |
|---|---|
| Aboveground Storage Tank | Mud Pit |
| Abandoned Chemicals | Oil/Fuel Spills (nonhousekeeping) |
| Boiler | Other Ponds/Lagoon |
| Building | Other Spill Sites |
| Buried Ordnance Site | Radiologically Contaminated Area |
| Burn Cage | Sanitary Landfill |
| Cable Hole | Septic Tank |
| Chemical Storage | Sewage Lagoon |
| Conditional Release Storage Yard | Shaft |
| Construction Waste Landfill | Shaker Plant |
| Decontamination Pad | Sludge Burial Pit |
| Decontamination & Decommissioning Facility | Solid Propellant Burn Site |
| Depleted Uranium Surface Debris Area | Steam Cleaning Facility |
| Drillback Sump/Cellar | Tunnel |
| Drillhole | Tunnel Pond |
| Fire Training Area | Tunnel Portal Area |
| Generator | Underground Discharge Point |
| Hazardous Waste Accumulation Site | Underground Storage Tank |
| Housekeeping Site[a] | Vent Hole |
| Injection Well | Waste Disposal Trench |
| Leachfield | Waste Disposal Site |
| Lead (nonhousekeeping) | Waste Dump |
| Magazine/Bunker | Miscellaneous |
| Muckpile | |

[a]Examples of wastes at housekeeping sites are hazardous constituents such as abandoned chemicals, drums/barrels, lead shielding, other spill sites; petroleum sites such as epoxy tar sites, oil/fuel spills; others such as batteries, buckets/cans, compressed gas cylinders; miscellaneous; transformers/polychlorinated biphenyls (PCBs); trash/debris.

The preparation of plans and their contents will correspond with the complexity of each CAU and the chosen corrective action process. If appropriate, each CAS will have a CAIP. The CAIP will contain or reference all necessary management and technical information. Optional CAU work plans may be written and referenced if information applies to all CASs in a CAU, or if CAUs are sufficiently similar to facilitate the use of common information.

CADDs, CAPs, and CRs will be prepared, as necessary, to guide and document corrective action decisions and activities. If sufficient information exists at a particular CAU to plan the

corrective actions prior to completion of the investigation, a SAFER Plan may be prepared. This plan will contain all the necessary elements usually found in CAIPs, CADDs, and CAPs.

## 2.3 Implementing Corrective Action Investigations and Corrective Actions

CAUs will be prioritized for corrective action and listed in Appendix III (Corrective Action Investigations/Corrective Actions). A preliminary characterization will be performed based on existing data. These data will be used to develop conceptual models to determine appropriate investigation and corrective action tasks, as well as to select a corrective action process. DQOs will be developed by DOE and/or DoD as appropriate, with NDEP participation, to assist in the development of work scope. Stakeholder input may be required depending upon the nature of the work scope.

One of three corrective action processes will be selected as appropriate for the CAU based on site conditions. The following sections describe the work flow process and decision points necessary to implement corrective actions for Industrial Sites (Figure 2-1).

### 2.3.1 Housekeeping Process

CAUs that may be closed through the housekeeping process are distinguished from other Industrial Sites CAUs because they do not require further investigation prior to closure. Hundreds of housekeeping CASs are anticipated to have sufficient data, gathered during records searches and field verification activities, to warrant removal of source materials and confirmatory sampling or to warrant recommendation for closure, if materials have already been removed. Source removal, waste disposition, and appropriate confirmatory sampling will be conducted in accordance with established work plans.

Documentation of the source removal and confirmatory sampling, if required, will be through a CR, which will represent the formal, “no further action” recommendation for each CAS within a housekeeping site CAU. If a housekeeping CAS proves more complex than anticipated, such as finding an unexpected waste type, the CAS will be recommended for inclusion into a different CAU that will follow another process flowpath.

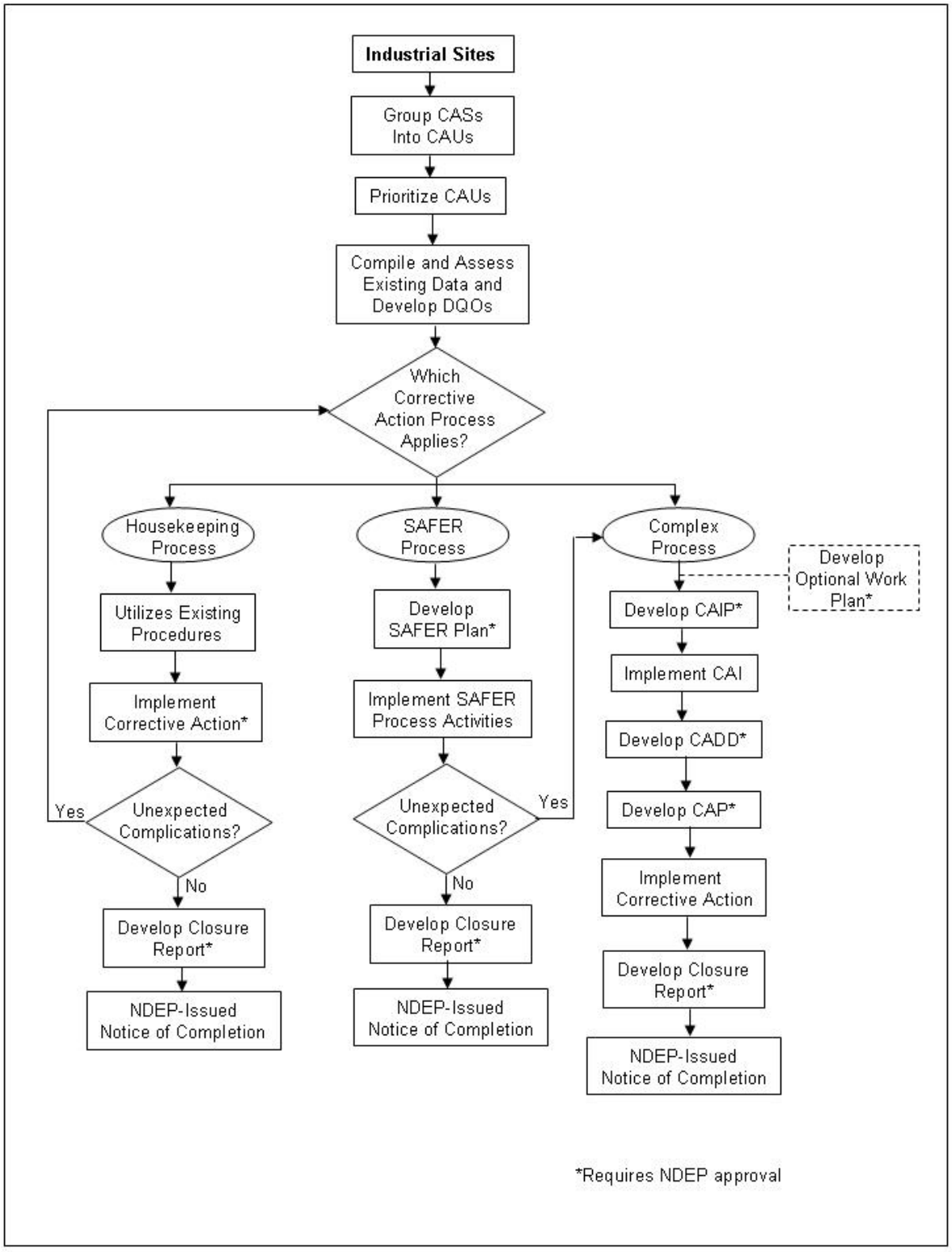


**Figure 2-1**
**Industrial Sites Corrective Action Process**

CASs falling into the housekeeping site functional category are widespread, especially at the NTS. Although many of these CASs have already been identified and are being closed through the housekeeping process as part of the Environmental Restoration Sites Inventory, new housekeeping CASs may regularly be identified as part of everyday operational activities at the NTS. When previously unidentified materials fitting into the housekeeping category are encountered in the field, they will be identified and marked as a new CAS and added to Appendix II (Corrective Action Sites/Units).

Newly identified recyclable or sanitary waste materials, when not associated with visible staining and when not located in a known contamination area, will be noted and tallied. They will not be identified as a new CAS or marked in the field. A list of these sites will be compiled and updated regularly for inclusion in periodically scheduled NTS cleanup activities of nonhazardous waste types. Examples of the types of materials that will not be staked as new CASs include empty drums; empty cans or buckets; intact batteries, construction debris such as untreated lumber, rebar, or concrete; and recyclable materials such as cable, steel, drill pipe, empty gasoline cans, empty gas cylinders, and nuts and bolts.

### *2.3.2 SAFER Process*

CAUs that may be closed through the SAFER process have conceptual corrective actions that are clearly identified. Consequently, corrective action alternatives can be chosen prior to the completion of an investigation given anticipated CAI results.

The SAFER process requires some degree of investigation to determine whether the appropriate corrective action will be a clean closure, closure in place, or no further action. The purpose of the investigation will be to document and verify the adequacy of existing information; to affirm the decision for either clean closure, closure in place, or no further action; and to provide sufficient data to implement the corrective action. Risk assessment requirements and criteria will be formulated by the parties with NDEP participation, prior to the submittal of the SAFER Plan.

The SAFER Plan will be the primary document governing actions and decisions at CAUs employing the SAFER process. The plan will incorporate required CAIP, CADD, and CAP elements to allow work to proceed directly from the CAI to the corrective action. The plans will identify decision points, developed in cooperation with NDEP, where DOE and/or DoD will reach consensus with NDEP prior to beginning the next phase of work. If specific conditions or findings fall outside the bounds of the SAFER Plan, the CAS will be transferred into an appropriate CAU and the complex process used. SAFER Plans may require stakeholder review

prior to implementation. Following the completion of SAFER activities, a CR will be prepared and submitted to NDEP.

### *2.3.3 Complex Process*

The complex process differs from the SAFER process because the CAU corrective action alternatives cannot be chosen before the CAI has been completed. The CAIPs for these CAUs will focus on investigation tasks required to prepare CADDs and will include the DQO process. When data have been collected and the investigation is complete, a CADD will be prepared to evaluate corrective action alternatives and the selection of the appropriate corrective action.

Following NDEP approval of the CADD, a CAP will be developed and the corrective action initiated. A CR will be developed to document the completion of corrective action activities and submitted to NDEP. After approval of the corrective action, NDEP will issue a notice of completion and the CAU will be moved to Appendix IV (Closed Corrective Action Units).

Risk assessment requirements for CAUs which follow the complex process will be identified in the DQO process. Many of the CAUs following the complex process may be dominated by contaminants without established regulatory levels. In addition, the location of the site and intended future land use may require assessment of risk as an element in the evaluation of closure activities.

# 3.0 Underground Test Area

A total of 908 nuclear detonations occurred in shafts or tunnels at the NTS. They are categorized into 879 CASs assigned to the UGTA Sub-Project. These CASs are grouped into five CAUs based primarily on geographically distinct areas of underground testing (basins of Yucca and Frenchman Flat, tunnel beds of Rainier Mesa and Shoshone Mountain, and highlands of Central and Western Pahute Mesa). Any ambiguity resulting from different language used in this subpart of Appendix VI versus the body of the FFACO shall be resolved in favor of terms and conditions found in the body of the FFACO.

## 3.1 Corrective Action Units

The UGTA Sub-Project comprises the following CAUs, shown in Figure 3-1:

- Frenchman Flat (CAU 98) consists of 11 CASs located in the northern part of Area 5 and the southern part of Area 11 within the Frenchman Flat topographic basin. These detonations were conducted in both vertical emplacement holes and mine shafts primarily in thick deposits of basin-fill alluvium.

- Western Pahute Mesa (CAU 102) consists of 18 CASs along the western edge of Area 20. These detonations were conducted in vertical emplacement holes in volcanic aquifers and confining units. The CAU is separated from Central Pahute Mesa by the Boxcar Fault; it is combined with the Central Pahute Mesa CAU in current UGTA studies.

- Central Pahute Mesa (CAU 101) consists of 64 CASs in Areas 19 and 20. These detonations were all conducted in vertical emplacement holes in similar volcanic units as the Western Pahute Mesa CAU.

- Yucca Flat/Climax Mine (CAU 97) consists of 717 CASs located in Areas 1, 2, 3, 4, 6, 7, 8, 9, 10, and 3 CASs located in Area 15. These detonations were conducted in vertical emplacement holes and tunnels in alluvium, vitric and zeolitic tuff, fractured granite (Climax Mine), and carbonate rocks.

- Rainier Mesa/Shoshone Mountain (CAU 99) consists of 60 CASs on Rainier Mesa and 6 CASs on Shoshone Mountain, located in Areas 12 and 16. These detonations were conducted above the water table in tunnels constructed in bedded and non-welded vitric and zeolitized volcanic tuff.

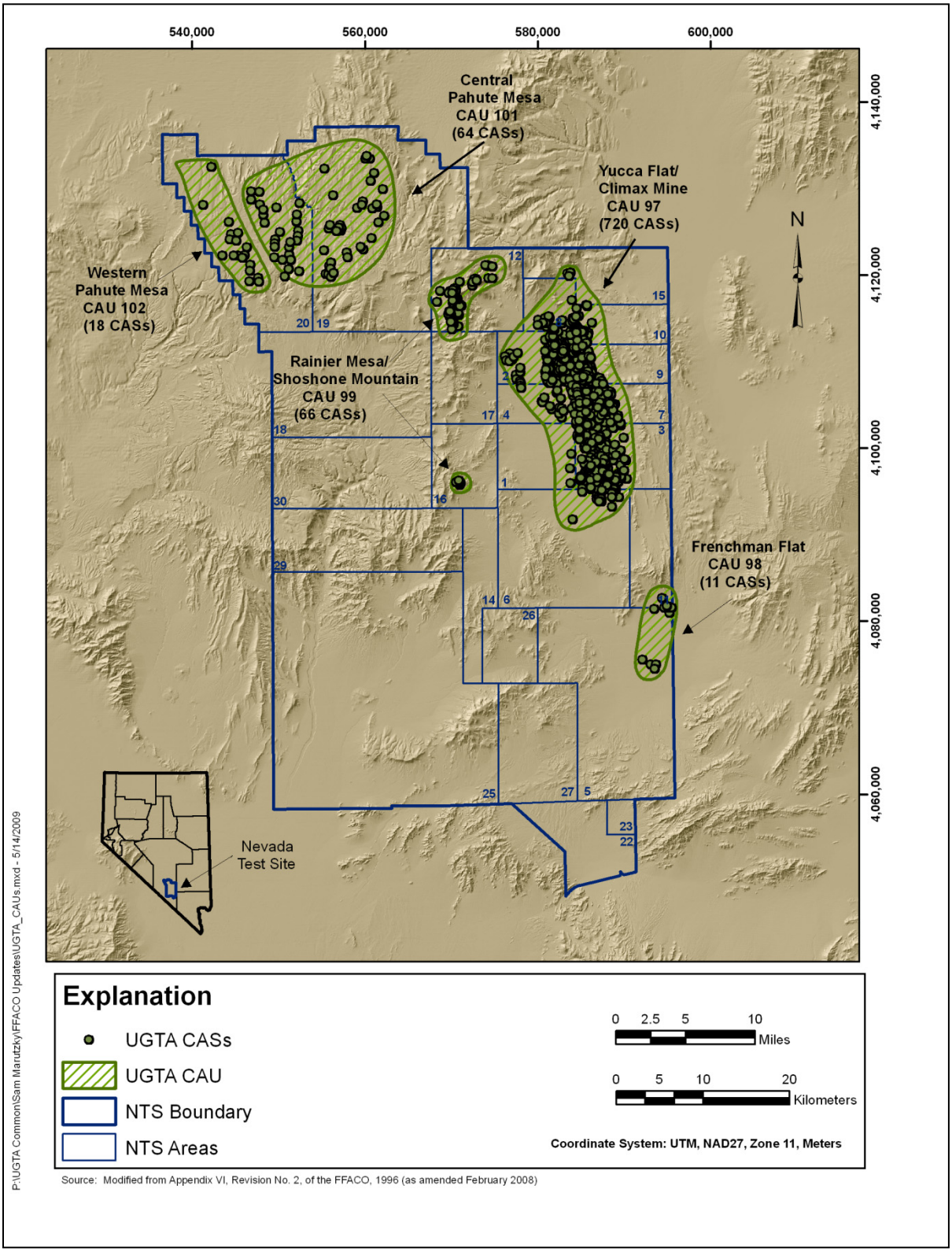


**Figure 3-1**
**Underground Test Area Corrective Action Units**

The process outlined in Section 1.3 was used for the initial prioritization of UGTA CAUs. Assessments of future radionuclide transport will be conducted for all CAUs with an emphasis on identification of areas of anticipated migration of contaminants off of the institutionally controlled boundaries of the NTS.

### *3.2 Corrective Action Strategy*

The corrective action strategy for UGTA follows the four steps identified in the introduction to Appendix VI of the FFACO (Section 1.0) with the UGTA Sub-Project focused on ". . . local or regional impacts to groundwater resources . . . ." The implementation of the corrective action strategy for UGTA is through corrective action activities, which include four stages:

1. The CAIP stage
2. The CAI stage
3. The CADD/CAP stage
4. The CR stage

The execution of these corrective action stages is referred to as the UGTA strategy and is illustrated on Figure 3-2. Three assumptions for the UGTA strategy are described in the *Nevada Test Site Environmental Management End State Vision* (DOE, 2006 [p. 52]). First, groundwater technologies for removal or stabilization of subsurface radiological contamination are not cost-effective. Second, because of these high remediation costs, closure in place with monitoring and institutional controls is the only likely corrective action. Finally, the important potential risks from radiological contamination of groundwater are to workers, the public, and the environment, and exposure to these risks requires access to groundwater.

The technical basis for achieving the UGTA strategy is through an evaluation of each CAU using a combination of approaches, including:

1. Data collection consisting of but not limited to drilling exploration, hydrologic testing, and field and laboratory studies designed to characterize the hydrogeological setting.

2. Modeling of the hydrogeological setting, the radiological source term, and flow and contaminant transport to forecast areas of current and future contamination for 1,000 years.

3. Iterative model evaluations and monitoring of groundwater near and downgradient of areas of past underground testing.

4. Identification and documentation of land-use policies (institutional controls) designed to restrict future public access to groundwater contaminated by underground testing.

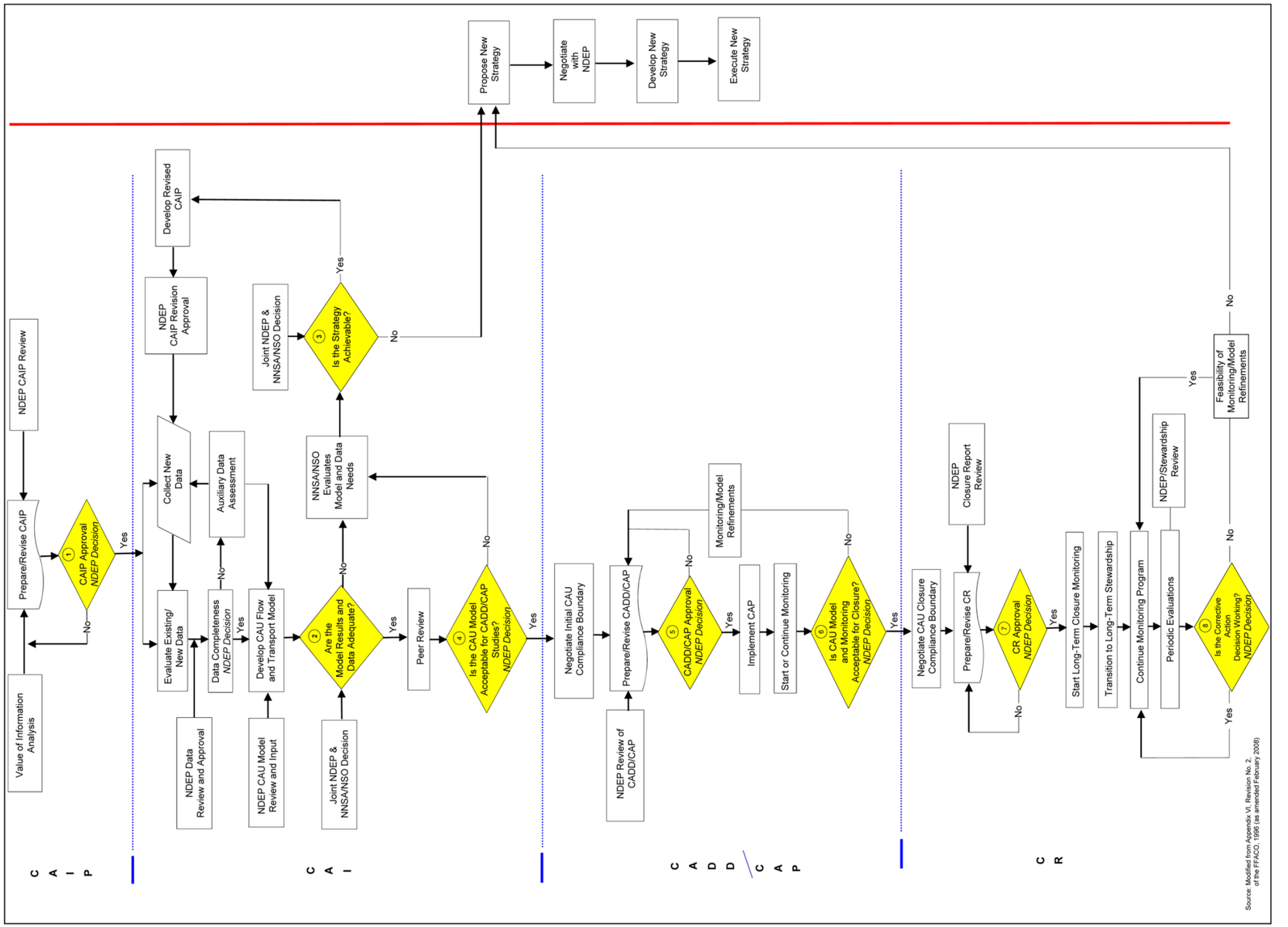


**Figure 3-2**
**UGTA Strategy Flowchart**

This four-component approach is used to accomplish the primary objective of the UGTA strategy, which is defining perimeter boundaries for each CAU over the next 1,000 years. The perimeter boundaries will enclose areas potentially exceeding the radiological standards of the *Safe Drinking Water Act* (SDWA) (CFR, 2007). Confidence in model results will be developed through monitoring studies, and the uncertainty in model forecasts will be managed through institutional control of areas of groundwater contamination.

The goal of the four combined approaches is to provide the data, model forecasts and confidence in the model results to facilitate informed regulatory decisions by NDEP and NNSA/NSO. The goal of regulatory decisions is to protect the public from the risk of radiologically contaminated groundwater. Risk to human health and safety in this context is defined as the combined probability of exposure to groundwater contamination, which is identified through model forecasts of probabilistic contaminant boundaries, and the consequences of this exposure. The consequences of exposure will be based on the radiological standards of the SDWA, which may or may not be supplemented with radiological dose calculations using acceptable exposure scenarios. The integration and balancing of modeling studies, monitoring, and institutional controls provides the foundation of a risk-informed strategy for regulatory decision-making. This approach is consistent with the guidance by the National Research Council (NRC) on the use of models in environmental regulatory decision making (NRC, 2007).

NNSA/NSO and NDEP will evaluate technological advances in groundwater remediation during the life cycle of the UGTA Sub-Project and significant changes in technology and/or the cost of remediation alternatives could lead to a reevaluation of the assumptions of the UGTA strategy.

### *3.2.1 Concepts and Definitions for the UGTA Strategy*

The modeling forecasts of contaminant transport provide the fundamental basis for identifying contaminant boundaries and negotiating a compliance boundary for each CAU. The term *forecast* is used instead of *prediction* to denote the methods and uncertainty of evaluating contaminant boundaries. Transport modeling simulations are used to compute radionuclide concentrations in time and space within a CAU. These three-dimensional (3-D) concentration data are integrated into probabilistic forecasts of the likelihood of groundwater exceeding or remaining below the radiological standards of the SDWA. Contaminant boundaries are not discrete *predictions* of the location or concentration of contaminants but instead are spatial representations of the probability of exceeding the SDWA radiological standards. The *forecasts*

provide planning tools to facilitate regulatory decisions designed to protect the health and safety of the public.

A ***contaminant boundary*** is formally defined as the model-forecast perimeter and a lower hydrostratigraphic unit (HSU) boundary that delineates the extent of radionuclide-contaminated groundwater from underground testing over 1,000 years. The contaminated groundwater is a volume (3-D), and this volume is projected upward to the ground surface to define a two-dimensional ***contaminant boundary*** perimeter. Contaminated groundwater is defined as water exceeding the radiological standards of the SDWA. Simulation modeling of contaminant transport will be used to forecast the location of ***contaminant boundaries*** within 1,000 years and must show the 95$^{th}$ percentile of the model results (boundary outside of which only 5 percent of the simulations exceed the SDWA standards).

The CAU models will use the inventory and inventory uncertainty from the *Nevada Test Site Radionuclide Inventory, 1951-1992* (Bowen et al., 2001) as the initial radiological source term used to predict the hydrological source term incorporated into transport models. The complex geological setting and groundwater pathways for the NTS combined with limitations in obtaining characterization data for these systems results in significant uncertainty in the model studies and forecasts of ***contaminant boundaries.*** The uncertainty includes both statistical (variability and parametric or knowledge uncertainty) and structural uncertainty (numerical model and conceptual model uncertainty). The multiple components of uncertainty will be evaluated through development of multiple alternative model approaches that are integrated with Monte Carlo simulations of contaminant transport. These multiple alternative approaches will require multiple sets of Monte Carlo transport simulations and produce an ensemble of contaminant boundary forecasts for each CAU. Additional results showing individual radionuclide contributions to the SDWA standard, the ***contaminant boundary*** configurations at different time intervals and other percentiles of the SDWA standards (for example, 50$^{th}$ or 75$^{th}$ percentiles) may also be used.

Figures 3-3 and 3-4 illustrate how modeling uncertainty in radionuclide transport can be expressed as probability contour maps where the contours are equivalent to percentiles on a cumulative distribution function of exceeding the SDWA radiological standards. Probability contours on Figure 3-3 enclose areas where the probability of exceeding the SDWA is greater than or equal to the contour value. For example, there is a 90 percent probability that the water inside the red contour of Figure 3-3 is greater than or equal to the SDWA standards during the next 1,000 years. Conversely, and a more useful regulatory perspective, there is a 90 percent or

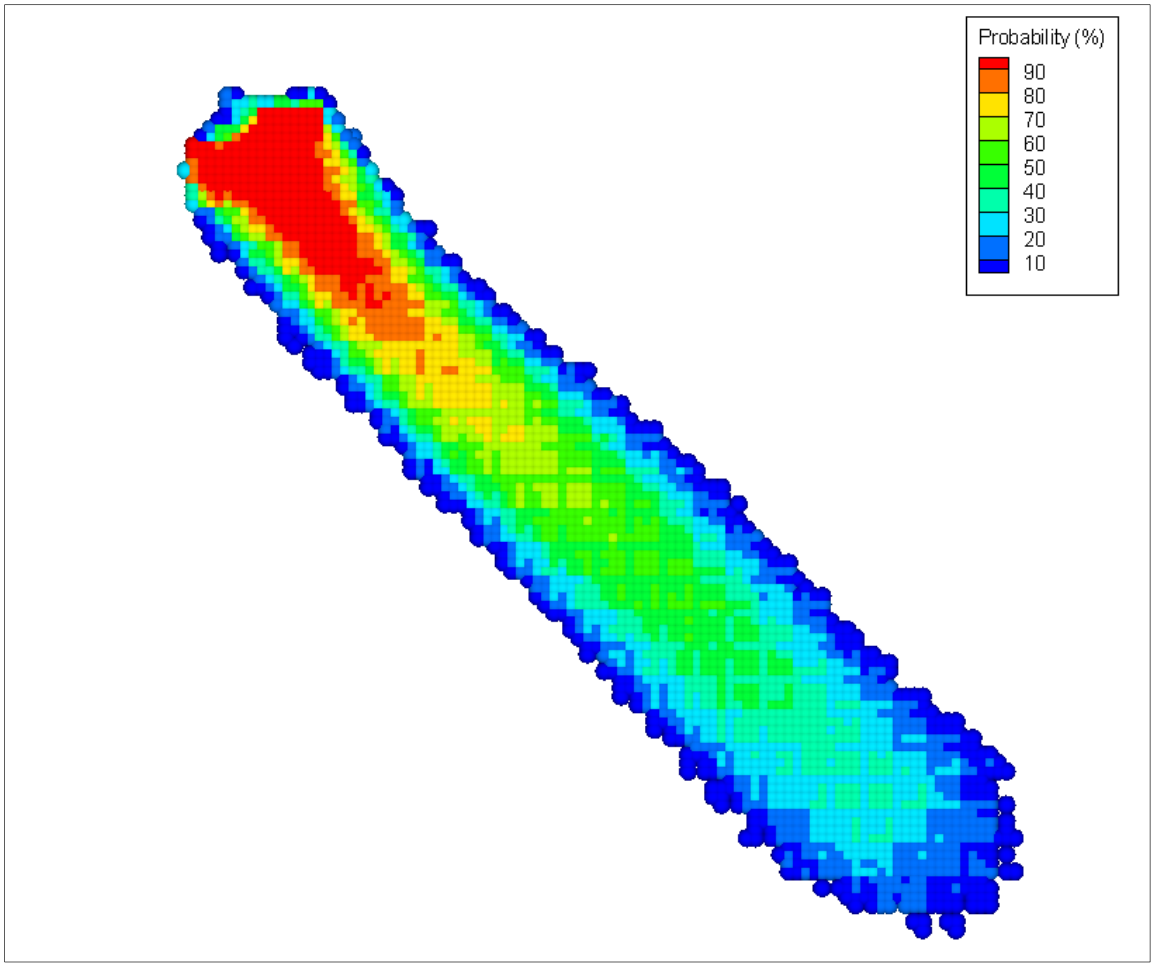


**Figure 3-3**
**Example of a Contaminant Boundary Forecast for a Single Underground Detonation in a Groundwater Flow Field**

(Detonation is located at the upper left top of the diagram.) The color contours represent the probability of exceeding the radiological standards of the SDWA. The probability of not exceeding these standards (groundwater outside an individual contour) is equal to or less than 1 – *P* where *P* is the contour value of the probability of exceedance (shown on the figure legend).

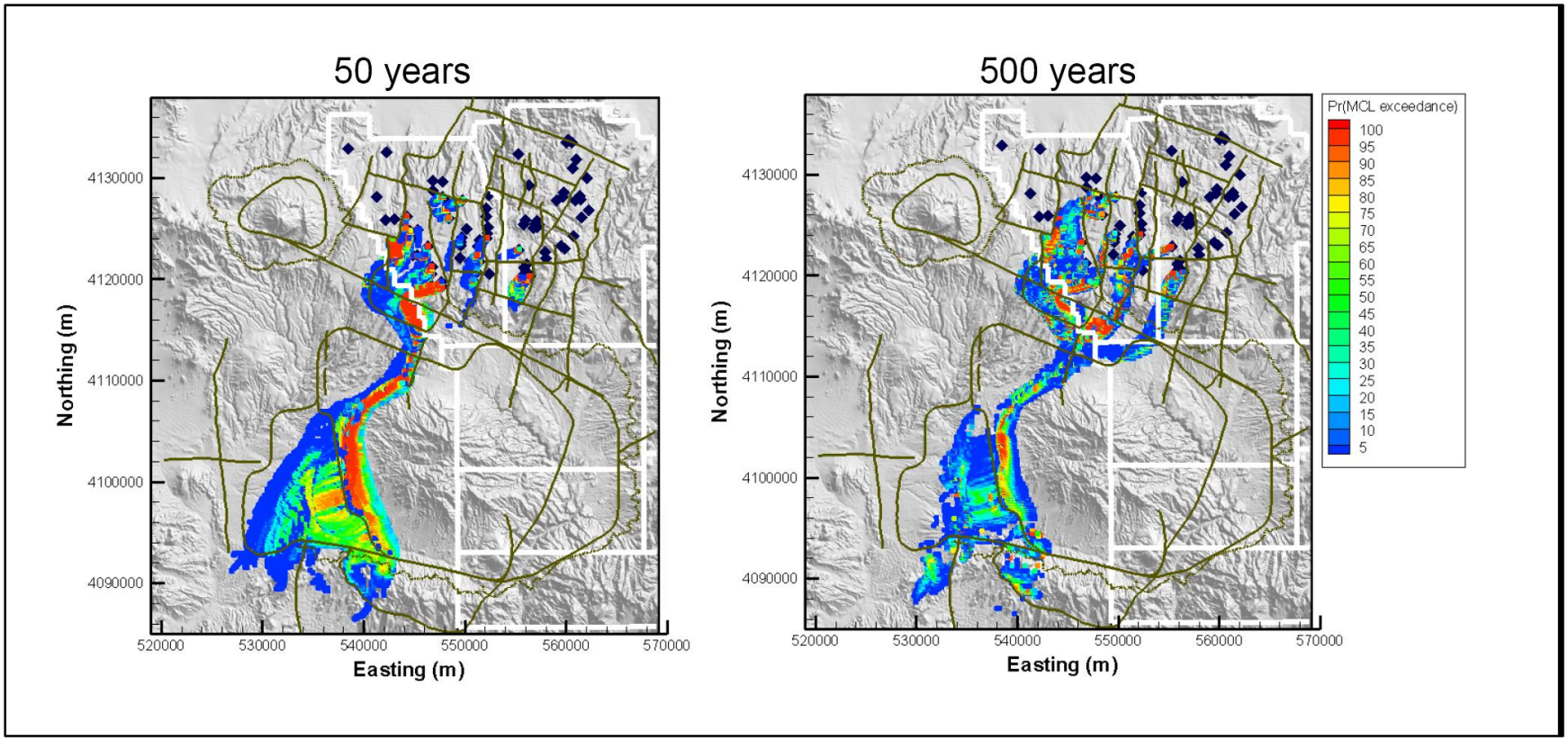


**Figure 3-4**
**Examples of Contaminant Boundary Forecasts at Different Time Intervals for a Composite of Underground Detonations**

The blue diamonds locate underground detonations, and the color-coded contours are probability contours of contaminant boundary forecasts at 50 and 500 years for radionuclide transport for the Pahute Mesa CAU. This figure is adapted from the Phase I transport model of Pahute Mesa (SNJV, 2009) and does not represent a formal contaminant boundary forecast.

greater probability that groundwater *outside* the 10-percentile contour will remain less than the SDWA standards during the next 1,000 years and only a 10 percent probability or less that groundwater will exceed the SDWA standards. Alternative definitions of probability values from Figures 3-3 and 3-4 can be used to define ***contaminant boundaries*** dependent on the degree of certainty required by decision makers for identifying contaminated and uncontaminated groundwater. ***Contaminant boundaries*** will be assembled for individual underground detonations (Figure 3-3) or for a composite of underground detonations (Figure 3-4).

A ***compliance boundary*** will be negotiated between NDEP and NNSA/NSO for each CAU where the ***compliance boundary*** represents a regulatory-based distinction between groundwater contaminated or not contaminated by the effects of underground testing. The ensemble of contaminant boundary forecasts for a CAU will provide the initial technical basis for negotiation of the ***compliance boundary***. NNSA/NSO must demonstrate with an acceptable level of confidence (reasonable expectation) gained through implementation of the UGTA corrective action strategy, that groundwater *outside* the ***compliance boundary*** meets the radiological standards of the SDWA.

The areas of potentially contaminated groundwater *inside* the ***compliance boundary*** are expected to require institutional controls to restrict access. These controls may be in the form of legal restrictions on land use or access to groundwater, processes and procedures for monitoring compliance to restrictions, and maintenance of boundaries or deterrents to support restrictions. The considerable depth to groundwater throughout most areas of the NTS effectively restricts surface exposure to contaminated groundwater. NNSA/NSO and the long-term stewardship organization will be responsible for establishing and ensuring compliance with the institutional controls. The ***compliance boundary*** can but does not have to coincide with either an individual contaminant boundary forecast or an ensemble of contaminant boundary forecasts; it will be negotiated by NDEP and NNSA/NSO. An initial ***compliance boundary*** will be established at the start of the CADD/CAP stage of the UGTA strategy, and a second iteration of the ***compliance boundary*** will be established at the start of the CR stage before developing a CAU closure report. The ***compliance boundary*** could change, subject to NNSA/NSO and NDEP negotiations, during the iterative process of model evaluation, model acceptance, and testing/corroboration of model forecasts through the monitoring and closure programs.

Regional models of groundwater flow within the NTS and the Death Valley Regional Groundwater Flow system of Nevada and California have been completed (DOE/NV, 1997;

Belcher et al., 2004). These regional models may be used to establish boundary conditions, groundwater boundary flows and the uncertainty in these flows for individual CAUs.

The CAU models are based on steady state conditions (local exceptions include, for example, transient effects of long-term pumping of the CAMBRIC site and water-level transients from underground testing in Yucca Flat). The potential effects of transient conditions will be considered for individual CAUs in consultation with NDEP after acceptance of the steady state models.

Flow and transport models for each CAU will be constructed and will consider at a minimum:

1. Alternative hydrological framework models of the CAU modeling domain.
2. Uncertainty in the radiological and hydrological source term.
3. Alternative models of recharge.
4. Alternative boundary conditions and groundwater flows.
5. Multiple permissive sets of calibrated flow models.
6. Probabilistic simulations of transport using plausible sets of alternative framework and recharge models, and boundary and groundwater flows from calibrated flow models.
7. Ensembles of forecasts of contaminant boundaries for the CAU.
8. Sensitivity and uncertainty analysis of the model outputs.

Saturated conditions are expected to be modeled for all CAUs. For CAUs where unsaturated conditions may be important (Rainier Mesa/Shoshone Mountain CAU, Yucca Flat/Climax Mine CAU, and possibly the Frenchman Flat CAU), unsaturated flow and transport modeling may be conducted. This modeling will be at appropriate scales and levels of model complexity to evaluate flow and radionuclide transport from the unsaturated zone to the water table.

Model ***acceptance*** by NDEP is required at two decision points of the UGTA strategy (Figure 3-2) for each CAU. Model ***acceptance*** is defined as a joint decision by NNSA/NSO and NDEP that there is sufficient credibility/reliability of model studies to use the transport modeling forecasts as the basis for regulatory decisions leading to protection of the health and safety of the public.

Model ***acceptability*** is achieved through a process of building confidence in model results through overlapping processes of model ***verification***, ***calibration,*** and model ***evaluation*** during

the iterative stages of data gathering, model refinements, and monitoring. The acceptance and terminology of modeling "validation" for the hydrological sciences remains a controversial topic (Anderson and Bates, 2001). The following terms are used in the UGTA correction action strategy for consistency and transparency.

- Model ***verification*** includes evaluations to ensure the code is programmed correctly and the algorithms are implemented properly with no assumption errors or program bugs.

- ***Calibration*** refers to demonstration that a model adequately simulates observed hydraulic conditions (calibration values consisting mostly of field-measured hydraulic heads and estimated boundary flows) within an acceptable range of error throughout a model domain.

- The concept of model ***evaluation*** is used as a replacement for model validation which is recognized as a largely unobtainable goal. Model ***evaluation*** refers to the iterative process of testing whether model output makes sense using a range of measures of model adequacy. Model ***evaluation*** for the UGTA strategy involves development of increased confidence in the reliability of model outputs through successive efforts to test and extend the model using multiple alternative approaches designed to assess the impact of uncertain model components. Successful ***evaluation*** of a model is achieved through a demonstrated inability to disprove a model for a range of modeling and monitoring studies conducted during the CAI, CADD/CAP, and CR stages of the UGTA strategy. The NRC (2007) recognizes model evaluation as a process of assessing whether a model is suitable for its intended purpose with model evaluation serving to build confidence in model applications and in understanding the strengths and limitations of a model. The U.S. Environmental Protection Agency defines model evaluation as ". . . the process used to generate information to determine whether a model and its analytical results are of a quality sufficient to serve as the basis for a decision" (EPA, 2009 [p. 19]). They recognize model evaluation as a continuing process that is conducted over the life cycle of a project, a concept that is consistent with the UGTA strategy of Figure 3-2.

Model ***verification*** will be documented in the CADD/CAP report; model ***calibration*** is documented in the CAU flow and transport report. Model ***evaluations*** continue through all stages of the UGTA strategy, and results of these evaluations are described in the CAU transport document and reports for the CADD/CAP and CR stages.

Model ***acceptability*** is decision dependent, and model ***acceptance*** by NDEP is required at two steps in the UGTA strategy: 1) at the end of the CAI stage of the UGTA strategy after a joint NNSA/NSO and NDEP review of adequacy of model results and data and peer review of the model, and 2) at the end of the CADD/CAP stage before starting the CR stage of the UGTA strategy.

### 3.3 Implementing the UGTA Corrective Action Strategy, Stages, and Steps

Figure 3-2 is a flowchart of the major steps for the four stages of the UGTA strategy, which are designed to implement the corrective action strategy of Appendix VI of the FFACO. Successful completion of the stages of the UGTA strategy will lead to closure of CAUs and initiation of a long-term closure monitoring program.

There are two types of NNSA/NSO and NDEP interactions illustrated on the UGTA Strategy Diagram (Figure 3-2). These include review and approval requirements (boxes on Figure 3-2) and decision points within the UGTA strategy (decision diamonds on Figure 3-2). Data and document review and approval requirements are implemented through written review comments by NDEP and written responses by NNSA/NSO to resolve the NDEP comments. The written comments are focused on technical and programmatic issues that generally do not significantly change the program progression illustrated on the strategy diagram. In contrast, decision points occur at major transitions in the UGTA strategy and establish whether the UGTA Sub-Project continues through the strategy.

There are eight decision points shown on Figure 3-2. Seven of the decision points are within the UGTA strategy; the eighth decision point is under long-term stewardship after completion of the UGTA Sub-Project. Three of the UGTA decision points are at the transition between stages of the UGTA strategy. Non-approval of decision points by NDEP affects the program progression and can lead to a reassessment of whether the UGTA strategy is achievable (Figure 3-2).

The CAIP stage includes completion of a value of information analysis (VOIA) and preparation of individual CAU investigation plans including review comments and responses leading to the first decision point: NDEP must approve the CAIP before proceeding to the CAI (Figure 3-2).

The CAI stage includes data collection, data evaluation and analysis, and development of CAU-specific numerical models of flow and transport using CAU-specific data; analogue data from appropriate HSUs of the NTS and data from the hydrological literature may also be used to supplement site-specific data. NDEP provides review comments and approves the CAI data assessments through the process of comment resolution.

When all data documents are approved, NDEP will assess the completeness of data collection and data evaluation before modeling studies begin (Figure 3-2). The goal of this assessment is to identify whether there are significant gaps in existing data that could affect the efficiency of the modeling studies. If no gaps are identified, NNSA/NSO will initiate modeling studies. If gaps

are identified, NNSA/NSO and NDEP will conduct a joint evaluation of two questions: 1) Could the data gaps be addressed through focused data collection or 2) Do the data gaps require modeling studies to assess their impacts and develop cost-effective approaches to data collection? If the answer to question 1) is yes, the program will immediately conduct the required data collection activities without the requirements of assessing the achievability of the UGTA strategy and developing a revised CAIP. This step in the CAI stage provides flexibility to respond to obvious data gaps without significant schedule and cost impacts. The data collection activities will be identified and negotiated through a memorandum of agreement by NNSA/NSO and NDEP. If the answer to question 2) is yes, the program will start modeling studies and follow the standard steps of the CAI stage of the UGTA strategy. NNSA/NSO will emphasize required work in the modeling studies to resolve the identified data gaps.

The CAU modeling studies of the CAI stage will assess the eight modeling topics described in Section 3.2.1 with the objective of evaluating future migration of contaminants to forecast contaminant boundaries that encompass the uncertainty of current and future contaminant migration. NDEP will review reports of the CAU flow and transport models and approve the documents through the process of comment resolution with NNSA/NSO (Figure 3-2).

The second major decision point of Figure 3-2 is a joint NNSA/NSO and NDEP decision of the adequacy of the data and results for the flow and transport model, a judgment whether there is sufficient confidence in the model results to progress to the third stage of the UGTA strategy. If CAU-specific modeling is not successful in achieving CAU objectives, NDEP and NNSA/NSO will evaluate model alternatives leading to the third decision point): Is the UGTA corrective action strategy achievable? If the answer is no, new strategies will be evaluated (outside of and separate from the corrective action process described in this document). If the data are inadequate but the strategy is judged by NNSA/NSO and NDEP to be achievable, the modeling results will be used to develop a CAIP revision, and a new cycle of data collection and refinement of flow and transport modeling will be initiated.

If the model results and data are judged adequate, a peer review of the transport model results will be conducted before proceeding to the fourth decision point at the end of the CAI stage of the UGTA strategy. This decision point addresses model acceptance for the following question: Is there sufficient confidence in the CAU model results to proceed to the CADD/CAP stage of the UGTA strategy with implementation of monitoring activities? If the answer is yes, the studies will move to the CADD/CAP stage of the UGTA strategy. If the answer is no, the

project will remain in the CAI stage described in the previous paragraph and return to an evaluation of model and data needs and the achievability of the UGTA strategy.

An initial CAU compliance boundary will be negotiated between NNSA/NSO and NDEP at the start of the CADD/CAP stage (Figure 3-2). The goal of this negotiation is to establish NNSA/NSO and NDEP perspectives on the compliance boundary and enable preliminary assessments of how the compliance boundary could be affected by model evaluation and monitoring studies.

After negotiation of the initial compliance boundary, the CADD/CAP will be developed and will include identification of a monitoring design strategy to:

1. Continue the process of model evaluation with an increased focus on assessing the reliability of model forecasts of contaminant boundaries.
2. Test model output and contaminant boundary forecasts through additional drill-hole exploration and focused testing and sampling.
3. Develop an initial monitoring network that may transition to a long-term closure design. The monitoring part of the CADD/CAP will include design criteria for initial monitoring wells that could become part of long-term closure monitoring.

The CADD/CAP will be reviewed through comment resolution by NDEP and NNSA/NSO. If the CADD/CAP document is approved at the fifth decision point of the UGTA strategy, the CAP will be implemented, including the installation of a monitoring network. If the CADD/CAP is not approved, it will be revised and resubmitted to NDEP.

The installation of the monitoring network leads to the sixth decision point of the UGTA strategy (Figure 3-2). Data gathered from monitoring wells will be used to refine model evaluations leading to the following question: Is there sufficient confidence in the CAU modeling results and the monitoring strategy to proceed to CAU closure? If the answer is no, monitoring studies will continue including assessment of new data from the monitoring wells with model refinements and assessment of revised model results, if required. If new information requires changes in the monitoring program, these changes will be incorporated into a revised CADD/CAP and submitted for review and approval to NDEP. Monitoring will continue at existing and/or new wells with the purpose of gathering data to increase confidence in the reliability of model results. This iterative process of monitoring, and model refinements will continue until model and monitoring acceptance by NDEP at the end of the CADD/CAP stage

(Figure 3-2). After acceptance, the project will progress to the closure stage of the UGTA strategy.

The first step of the closure stage will be the second evaluation of the compliance boundary through negotiations by NDEP and NNSA/NSO. Following this step, the closure report will be prepared. It will describe development of a long-term closure monitoring program, the approaches and policies for institutional controls, and a design plan for transition of the UGTA Sub-Project to long-term stewardship. The CR will be reviewed through comment and resolution by NDEP and NNSA/NSO. If the CR is approved at the seventh and final decision point of the UGTA strategy, the long-term closure monitoring program will be implemented. If the CR is not approved, it will be revised and resubmitted to NDEP until agreement is obtained.

The eighth and final decision point on Figure 3-2 is a recurring periodic evaluation of the long-term closure monitoring program under long-term stewardship, a joint evaluation conducted by NDEP and long-term stewardship. The results of long-term closure monitoring will be evaluated for consistency with the CAU conceptual models of flow and transport, the forecasts of contaminant boundaries and the negotiated compliance boundary. They will additionally assess consistency with the corrective action decision, and ensure institutional controls are fully protective of human health and the environment. If the corrective action decision remains consistent with monitoring results, the organization responsible for long-term stewardship will evaluate monitoring results for data changes, assess whether new information requires refinements in CAU modeling studies, evaluate requirements for new and/or replacement monitoring wells, and continue the monitoring program. If the monitoring results invalidate the corrective action decision, NDEP and the long-term stewardship organization will evaluate whether it is technically feasible to reassess modeling studies and the closure monitoring program while remaining consistent with the corrective action design. If the answer is yes, proposed changes in the monitoring program will be negotiated with NDEP. If NDEP approves the changes, the monitoring program will continue subject to continued periodic evaluations. If the answer is no, the monitoring program will be suspended and a new strategy evaluated (Figure 3-2).

### *3.3.1 Dictionary of Steps in UGTA Stages, Review and Approval, and Decision Points*

Work elements required to conduct the UGTA stages of the corrective action strategy for each of the UGTA CAUs are identified in Figure 3-2 and are briefly described below. These descriptions form the basis for establishing milestones for these CAUs. If activities other than

those described herein are determined to be necessary to achieve closure of the CAUs, the milestones will be reevaluated in accordance with negotiated terms and conditions established by NNSA/NSO and NDEP.

The following dictionary (Table 3-1) defines the steps within each of the four UGTA strategy stages, the review and approval requirements for each step in the stages, and the eight decision points of the UGTA Strategy Diagram for UGTA CAUs (see Figure 3-2). The dictionary is presented in tabular form and identifies and describes each of the stages which implement the strategy. The table presents the strategy stage of each step, a descriptor of each step, and a definition of each strategy step.

**Table 3-1**
**Process Flow Diagram Dictionary for the Underground Test Area Corrective Action Units**
(Page 1 of 6)

| STRATEGY STAGE | STEP DESCRIPTOR | DEFINITION OF THE STRATEGY STEP |
|---|---|---|
| **VOIA** | **Value of Information Analysis** | Before developing and preparing the CAIP for each CAU, NNSA/NSO will conduct a VOIA to help prioritize data collection activities. The VOIA will develop cost-benefit metrics for evaluating site characterization activities regarding contaminant boundary forecasts and parametric uncertainty. The results of the VOIA will be used to plan CAIP development. NDEP will review and provide comments on the VOIA. |
| **CAIP** | **Prepare/Revise CAIP** | NNSA/NSO will develop and prepare the CAIP. The CAIP will be structured as mutually agreed to by NNSA/NSO and NDEP before document preparation. While developing and preparing the CAIP, NNSA/NSO will keep NDEP informed and updated in order to expedite NDEP's review and approval. Each strategy step described in the following steps of Table 3-1 that requires reports submitted to and reviewed by NDEP assumes the reports will be structured and expedited by NNSA/NSO and NDEP. NDEP will review versions of the CAIP and identify any deficiencies. NNSA/NSO will resolve deficiencies through a comment/response process. |
| | **CAIP Approval NDEP Decision Point** | NDEP approval of the CAIP is required before any CAI-related activities are initiated. If the CAIP is not approved by NDEP, NNSA/NSO will revise the document to resolve NDEP concerns and initiate a revised cycle of document revisions for submittal to NDEP for further assessment and/or approval. |
| **CAI** | **Collect New Data** | NNSA/NSO will collect new data to address deficiencies in existing data and attempt to reduce model uncertainty. The data collection activities will be described in the CAIP or a revision to the CAIP. |
| | **Evaluate Existing/New Data** | NDEP will evaluate the new and existing data provided through program briefings, data documents, and reports. They will provide written comments to NNSA/NSO for comment resolution. |
| | **Data Completeness** | NDEP will review CAU data for completeness before CAU flow and transport modeling begins. The NDEP review will focus on high-level perspectives of whether there are significant data gaps before the start of flow and transport modeling. This review recognizes that the results of the flow and transport modeling work will provide the primary basis for assessing data adequacy in a subsequent step of the UGTA strategy. If there are significant data gaps, NNSA/NSO will conduct a data assessment. If there are no significant data gaps identified by NDEP, the flow and transport modeling studies will begin. |

**Table 3-1**
**Process Flow Diagram Dictionary for the Underground Test Area Corrective Action Units**
(Page 2 of 6)

| STRATEGY STAGE | STEP DESCRIPTOR | DEFINITION OF THE STRATEGY STEP |
|---|---|---|
| **CAI (continued)** | **Data Assessment** | NNSA/NSO will review data gaps identified by NDEP and assess whether these gaps can be resolved through focused data collection. If NNSA/NSO concludes additional data collection is cost-effective and can potentially resolve data gaps, they will develop plans for collecting data and start collecting new data. Data-collection plans will be developed by NNSA/NSO and negotiated through a memorandum of agreement by NNSA/NSO and NDEP. If the data gaps require modeling studies to assess their impacts, modeling studies will be initiated and follow the standard CAI steps. NNSA/NSO will emphasize required work in the modeling studies to resolve the identified data gaps. Modeling plans will be developed by NNSA/NSO and negotiated through a memorandum of agreement by NNSA/NSO and NDEP. |
| | **Develop CAU Flow and Transport Model** | NNSA/NSO will develop flow and transport models for each CAU that incorporate the eight major topics described in Section 3.2.1 of this report. NNSA/NSO will provide periodic briefings to NDEP as work progresses. The flow and transport results may be written as two reports or incorporated into a single report. NDEP will review and provide written comments on the modeling report(s), and NNSA/NSO will provide responses to resolve the comments. |
| | **Decision Point: Are the Model Results and Data Adequate?** | The model results and data will be evaluated jointly by NDEP and NNSA/NSO to assess whether there is sufficient confidence in the model results to proceed with the UGTA corrective action strategy. If both NNSA/NSO and NDEP agree that the model results and data are **adequate**, the answer to this question is yes. If either party determines that the model results and data are **not adequate**, the answer is no. |
| | **Evaluate Model and Data Needs** | If the model results and data from the flow and transport studies are **inadequate**, NNSA/NSO will evaluate deficiencies, and identify model and data needs using the results of the modeling studies and sensitivity and uncertainty analysis to guide the evaluations. NNSA/NSO will provide written documentation to NDEP of the identified needs and the likelihood of successfully obtaining adequate model results and data. |
| | **Decision Point: Is the Strategy Achievable?** | The model results and the evaluation of model and data needs will be used to assess whether the UGTA strategy is achievable. This is a joint decision by NDEP and NNSA/NSO, and both parties must agree. |

**Table 3-1**
**Process Flow Diagram Dictionary for the Underground Test Area Corrective Action Units**
(Page 3 of 6)

| STRATEGY STAGE | STEP DESCRIPTOR | DEFINITION OF THE STRATEGY STEP |
|---|---|---|
| **CAI (continued)** | **Propose New Strategy** | If the strategy is **not achievable**, NNSA/NSO and NDEP will negotiate development of a new strategy to replace the corrective action strategy described in Section 3.0 of Appendix VI. This negotiation is outside the currently defined UGTA strategy, and the steps for developing and implementing a new strategy are not described. |
| | **Develop Revised CAIP** | If there is agreement that the model results and data are **inadequate** but the strategy is **achievable**, NNSA/NSO will develop and prepare a revision to the CAIP. The CAIP revision will address the identified needs using the current model results, how these needs are translated to requirements, and what additional work activities will be conducted to address and/or satisfy these requirements. The CAIP revision will be reviewed and approved by NDEP. |
| | **NDEP CAIP Revision Approval** | NDEP reviews the CAIP revision and provides written comments. NNSA/NSO will provide written responses to the comments for resolution. NDEP approval of the CAIP revision is required before initiating or continuing CAI activities. |
| | **Peer Review** | If the model results and data from the flow and transport studies are **adequate**, an external peer review of the model results and data will be conducted. The results of the peer review will be documented in a formal report. |
| | **Decision Point: Is the CAU Model Acceptable for CADD/CAP Studies?** | After the peer review is completed, NDEP will determine whether the model is acceptable for completing the CAI stage of studies and initiating the CADD/CAP stage. This decision is a regulatory assessment whether there is sufficient confidence in the model forecasts of the contaminant boundaries to initiate model evaluations, start CAU monitoring, and evaluate an initial compliance boundary. |
| | **Progress to the CADD/CAP Stage of the UGTA Strategy** | If the model is accepted by NDEP, the UGTA studies will progress to the CADD/CAP stage of the UGTA strategy. |
| | **Return to the Decision Point: Is the Strategy Achievable?** | If NDEP does not accept the CAU model, the program returns to the above described step descriptor of evaluating model results and data needs before initiating a joint assessment by NDEP and NNSA/NSO whether the UGTA strategy is achievable. |

**Table 3-1**
**Process Flow Diagram Dictionary for the Underground Test Area Corrective Action Units**
(Page 4 of 6)

| STRATEGY STAGE | STEP DESCRIPTOR | DEFINITION OF THE STRATEGY STEP |
|---|---|---|
| **CADD/CAP** | **Negotiate Initial CAU Compliance Boundary** | NDEP and NNSA/NSO will negotiate an initial CAU compliance boundary at the start of the CADD/CAP activities. The purpose of this step is to establish NNSA/NSO and NDEP perspectives on a CAU compliance boundary and assess how the compliance boundary would be affected by model evaluations and monitoring studies. |
| | **Prepare/Revise CADD/CAP** | The scope of the CADD/CAP is to document the results of the CAI stage, document the negotiated compliance boundary, and develop the corrective action plan. The CAP will include: (1) model evaluations of results from the CAI stage focusing on testing concepts and model results for the contaminant boundary forecasts from the transport mode, (2) design of the long-term closure monitoring network, and (3) description of the institutional controls required to ensure long-term public restrictions to contaminated groundwater. Results of the CAI are summarized in the CADD/CAP, which identifies recommended corrective action decisions for the CAU. |
| | **Decision Point: NDEP Approval of the CADD/CAP** | NDEP reviews the CADD/CAP document and provides written comments. NNSA/NSO will provide written responses to NDEP comments for resolution. NDEP approval of the CADD/CAP is required before the CAP is implemented. If the CADD/CAP is not approved, NNSA/NSO will revise the document to resolve NDEP concerns and initiate a revised cycle of document revision for further assessment and/or approval. |
| | **Implement CAP** | NDEP acceptance of the CADD/CAP will initiate implementation of the CAP. |
| | **Start or Continue Monitoring** | The focus of the CADD/CAP stage of monitoring will be on model evaluations designed to increase confidence in the model results. The monitoring results will also be used to refine models, if appropriate, and evaluate a design strategy that could evolve into a long-term closure monitoring network. |

**Table 3-1**
**Process Flow Diagram Dictionary for the Underground Test Area Corrective Action Units**
(Page 5 of 6)

| STRATEGY STAGE | STEP DESCRIPTOR | DEFINITION OF THE STRATEGY STEP |
|---|---|---|
| **CADD/CAP (continued)** | **Decision Point: Is the CAU Model and Monitoring Acceptable for Closure?** | The initiation of the monitoring program starts an iterative phase of assessing confidence in the CAU model for progressing to the CR stage of the UGTA strategy. This decision recognizes that the justification for CAU closure will be based on integration of modeling studies, monitoring design, and institutional controls to restrict public access to groundwater. The monitoring phase of the CADD/CAP is a confidence-building iterative loop consisting of location and development of monitoring wells, evaluation of new data from monitoring, evaluation of the impact of new data on model forecasts and assessment of the acceptability of the model forecasts, and model results for progressing to CAU closure. If the modeling and monitoring results are not acceptable to NDEP, NNSA/NSO will evaluate and refine the CAU model, identify locations and objectives of additional monitoring wells to attempt to increase confidence in the model results, revise the CADD/CAP (if required), and submit the revised report to NDEP for review and approval. |
| | **Progress to the CR Stage of the UGTA Strategy** | If the CAU model and monitoring results are accepted by NDEP, the UGTA studies will progress to the CR stage of the UGTA strategy. |
| **CR** | **Negotiate CAU Closure Compliance Boundary** | NDEP and NNSA/NSO will negotiate an updated compliance boundary at the start of the CR stage. This boundary will be used to prepare the CR and develop the long-term closure monitoring program. |
| | **Prepare/Revise CR** | The CR will describe the closure approach for each CAU, establish the long-term closure monitoring objectives and requirements, identify and describe options for maintaining institutional controls, and describe the required actions for transfer of program responsibilities from the NNSA/NSO UGTA Sub-Project to long-term stewardship. |
| | **Decision Point: NDEP Approval of CR** | NDEP must approve the CR before starting a long-term closure monitoring program. If the CR is not approved, NNSA/NSO will revise the document to resolve NDEP concerns and initiate a revised cycle of document revisions for submittal to NDEP for further assessment and/or approval. |
| | **Start Long-Term Closure Monitoring** | NNSA/NSO develops the closure monitoring objectives and the monitoring design, and develops the monitoring wells that initiate the long-term closure monitoring program as specified in the CR. NNSA/NSO and NDEP will review the monitoring design and initial monitoring results to establish the basis and timing of transition to long-term stewardship. |

**Table 3-1**
**Process Flow Diagram Dictionary for the Underground Test Area Corrective Action Units**
(Page 6 of 6)

| STRATEGY STAGE | STEP DESCRIPTOR | DEFINITION OF THE STRATEGY STEP |
|---|---|---|
| **CR (continued)** | **Transition to Long-Term Stewardship** | The transition to long-term stewardship concludes the UGTA Sub-Project responsibilities for individual CAUs. |
| | **Continue Monitoring Program** | The long-term closure monitoring program will continue for a duration negotiated between NDEP and the organization responsible for long-term stewardship. |
| | **Periodic Evaluations** | Long-term stewardship will conduct periodic reviews of the results of the long-term closure monitoring program; the interval for the periodic evaluations will be negotiated between NDEP and the long-term stewardship organization. The periodic evaluations will review the results of the monitoring for consistency with CAU model forecasts of contaminant boundaries and the negotiated compliance boundary. These periodic evaluations will additionally assess the suitability of the monitoring results with respect to the corrective action decision. The long-term stewardship organization will assess whether model refinements are needed and whether any changes in the monitoring program are required. They will submit a written report on the results of monitoring activities and required changes in model and monitoring studies for review by NDEP. NDEP will review and provide written comments on the report. The long-term stewardship organization will provide responses to resolve the NDEP comments. |
| | **Decision Point: Is the Corrective Action Decision Working?** | The long-term stewardship organization and NDEP will, after each periodic evaluation, assess whether the corrective action decision specified in the CR continues to be adequate for protecting the health and safety of the public. |
| | **Feasibility of Model Refinements/Monitoring Changes** | If the corrective action decision is not supported by monitoring data, the long-term stewardship organization will assess whether it is technically feasible to modify the CAU model and/or monitoring programs and remain consistent with the corrective action decision. If changes are technically feasible, the long-term stewardship organization will document required model and monitoring changes and obtain NDEP approval to continue monitoring. If modeling and monitoring changes cannot be made, the long-term stewardship organization will suspense monitoring and propose a new strategy. |
| | **Propose New Strategy** | If the corrective action decision is not working, NDEP and the long-term stewardship organization will negotiate a new strategy following the steps shown in Figure 3-2. This negotiation is outside the UGTA strategy of Section 3.0 of Appendix VI, and the steps for developing and implementing a new strategy are not described. |

## *3.4 References*

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DOE/NV, see U.S. Department of Energy, Nevada Operations Office.

EPA, see U.S. Environmental Protection Agency.

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# 4.0 Soils Sites

Soils Sites CAUs consist of surface and shallow subsurface soil contamination resulting from various types of nuclear experiments or testing. If a CAS contains significant quantities of contaminated debris in addition to soil, it will be investigated and remediated as an Industrial Sites CAS.

## 4.1 Corrective Action Units

The following CAUs have been identified as Soils Sites:

- Ninety-four of the atmospheric tests conducted at the NTS — including airburst, air drop, balloon, rocket, surface and tower types — are currently grouped into Atmospheric Test CAUs based on geographic location. Resolution of scientific and engineering corrective action issues for the Atmospheric Test CAUs will provide a technical basis to subdivide the CAU. The CAUs are:

  - Areas 1, 3, 4, 7 South Yucca Flat Atmospheric Sites
  - Areas 2, 8, 9, 10 North Yucca Flat Atmospheric Sites
  - Areas 5, 11 Frenchman Flat Atmospheric Sites
  - Area 18 Buckboard Mesa Atmospheric Sites
  - Small Boy

- Safety experiments and storage-transportation tests that created surface contamination were conducted at five locations on the NTTR, including the TTR; at Plutonium Valley in NTS Area 11; and at GMX in NTS Area 5. Contamination from these CAUs is limited to surface soils. The depth of contamination may vary among CASs, but it is not expected to exceed 1 foot at any site. The CAUs are:

  - Double Tracks Plutonium Dispersion (NTTR)
  - Clean Slate 1 Plutonium Dispersion (TTR)
  - Clean Slate 2 Plutonium Dispersion (TTR)
  - Clean Slate 3 Plutonium Dispersion (TTR)
  - Project 57 No. 1 Plutonium Dispersion (NTTR)
  - Area 11 Plutonium Valley Unit Safety Shots
  - Area 5 GMX Unit Safety Shots

- Six CAUs resulting from cratering and plowshare tests are included in the Soils Sites. The cratering and plowshare tests consisted of using nuclear devices to excavate large volumes of earth. Contamination from these tests includes subsurface impacts (less than

300 meters [m] [984 ft] deep) and impacts to surface soils caused by material expelled during testing. The CAUs are:

- Area 10 Sedan, Ess and Uncle Unit Craters
- Area 30 Buggy Unit Craters
- Area 20 Cabriolet/Palanquin Unit Craters
- Area 20 Schooner Unit Crater
- Area 18 Johnnie Boy Unit Crater
- Area 18 Danny Boy Unit Crater

- The Hydronuclear CAU consists of four CASs. Most of these CASs have impacted shallow subsurface soils of depths less than 30 m [98 ft]. No surface soil impacts are expected.

Figure 4-1 is a map of currently identified Soils Sites CAUs.

## 4.2 Corrective Action Strategy

The corrective action strategy for Soils Sites will be based on either the SAFER or complex corrective action process. The decision regarding which process is most appropriate depends on CAU DQOs and the amount of existing knowledge and data. If the existing knowledge is sufficient to allow the selection of a corrective action alternative before completing a CAI, then the SAFER process will be employed. If there is not enough knowledge to propose a corrective action, then the complex process will be used.

Corrective actions will be performed at surface and subsurface Soils Sites. Surface soil remedies will include removal of materials located in small selected areas following *in situ* identification. Larger areas will require the use of mechanical excavation devices to remove contaminated materials, such as size separators or other physical processes to reduce waste volumes. Subsurface remedies will range from clean closure to closure in place.

Corrective action alternatives will be based on applicable regulatory standards or proposed cleanup levels, if no standards apply. Proposed levels will be based on pertinent factors including but not limited to assessment of risk, current and projected land use, resource management, and technical feasibility.

## 4.3 Implementing Corrective Action Investigations and Corrective Actions

Figure 4-2 presents the corrective action approach for Soils Site CAUs. CASs will be grouped into manageable CAUs, prioritized for corrective action, and a preliminary characterization

performed based on existing data. These data will be used to guide appropriate investigation and corrective action tasks, as well as to select a corrective action process. The DQOs will be established by the parties with NDEP participation to assist in the development of work scope. Stakeholder input may be required depending on the nature of the work scope.

Either the SAFER or complex corrective action process will be selected for Soils Sites CAUs, based on site conditions. The following sections describe the work flow process and decision points necessary to implement corrective actions for Soils Sites.

### *4.3.1 SAFER Process*

Many of the Soils Sites CAUs have a sufficient amount of historical data and contamination characterization available to provide adequate information to propose a corrective action alternative without completing a CAI. At these CAUs, the SAFER process may be employed. Investigation will be necessary at these CAUs to document and verify the adequacy of existing information, to affirm the selected corrective action, and to provide sufficient data to implement the corrective action. Corrective action activities may progress during the CAI.

If regulatory standards do not exist for the identified contaminants, it may be necessary to evaluate appropriate factors, including risk, to develop proposed cleanup levels. The pertinent factors and subsequent evaluation will be formulated in cooperation with NDEP prior to the completion of the SAFER Plan.

A SAFER Plan will be developed, incorporating the essential elements of a CAIP, CADD, and CAP and will be used to guide both CAU actions and decisions. The document will include contingency plans if site conditions are other than expected. If specific conditions or findings fall outside the bounds of the SAFER Plan, the CAS will be transferred to another CAU and the complex process used. Following completion of SAFER process activities, a CR will be prepared and submitted to NDEP.

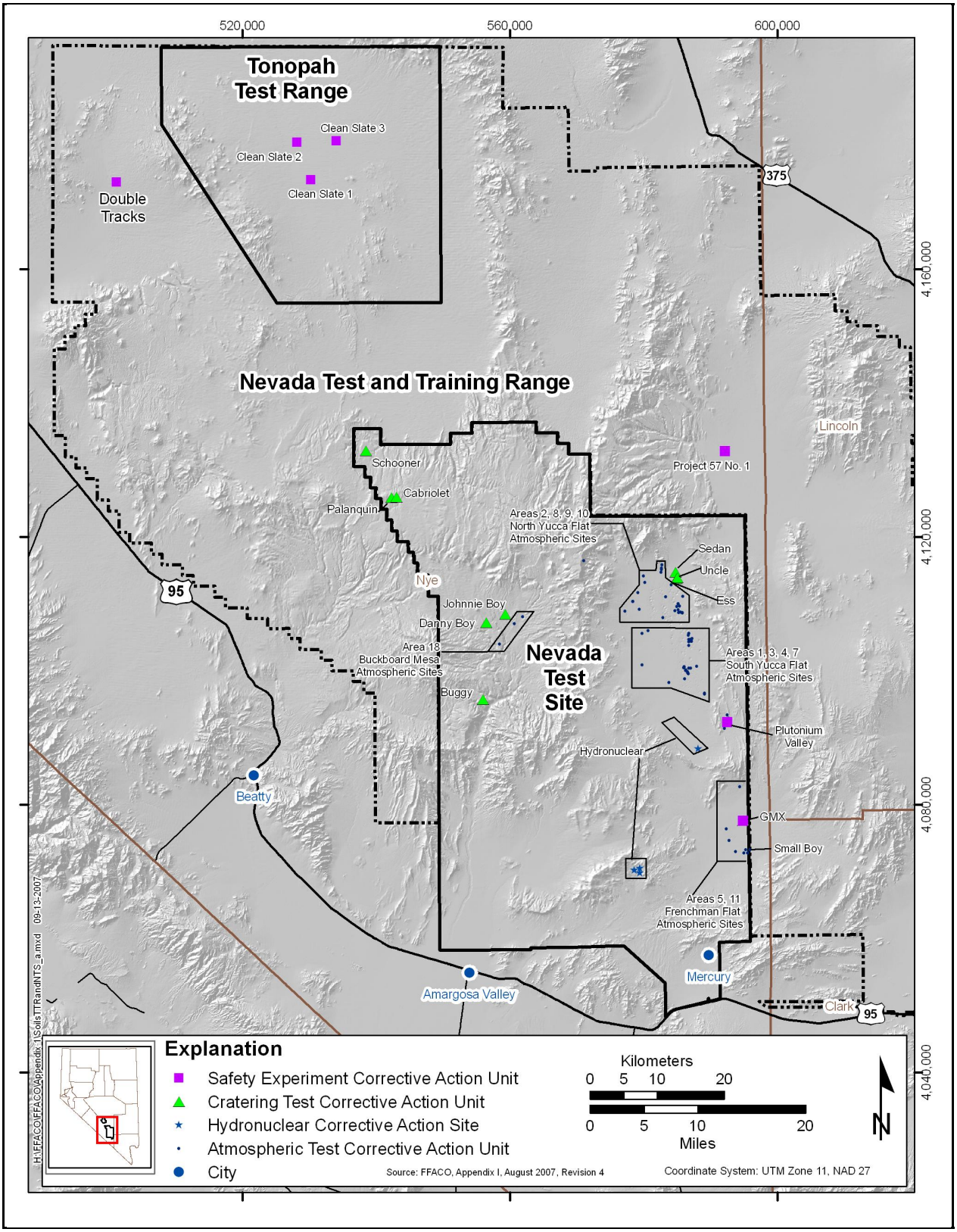


**Figure 4-1**
**Soils Sites Corrective Action Units**

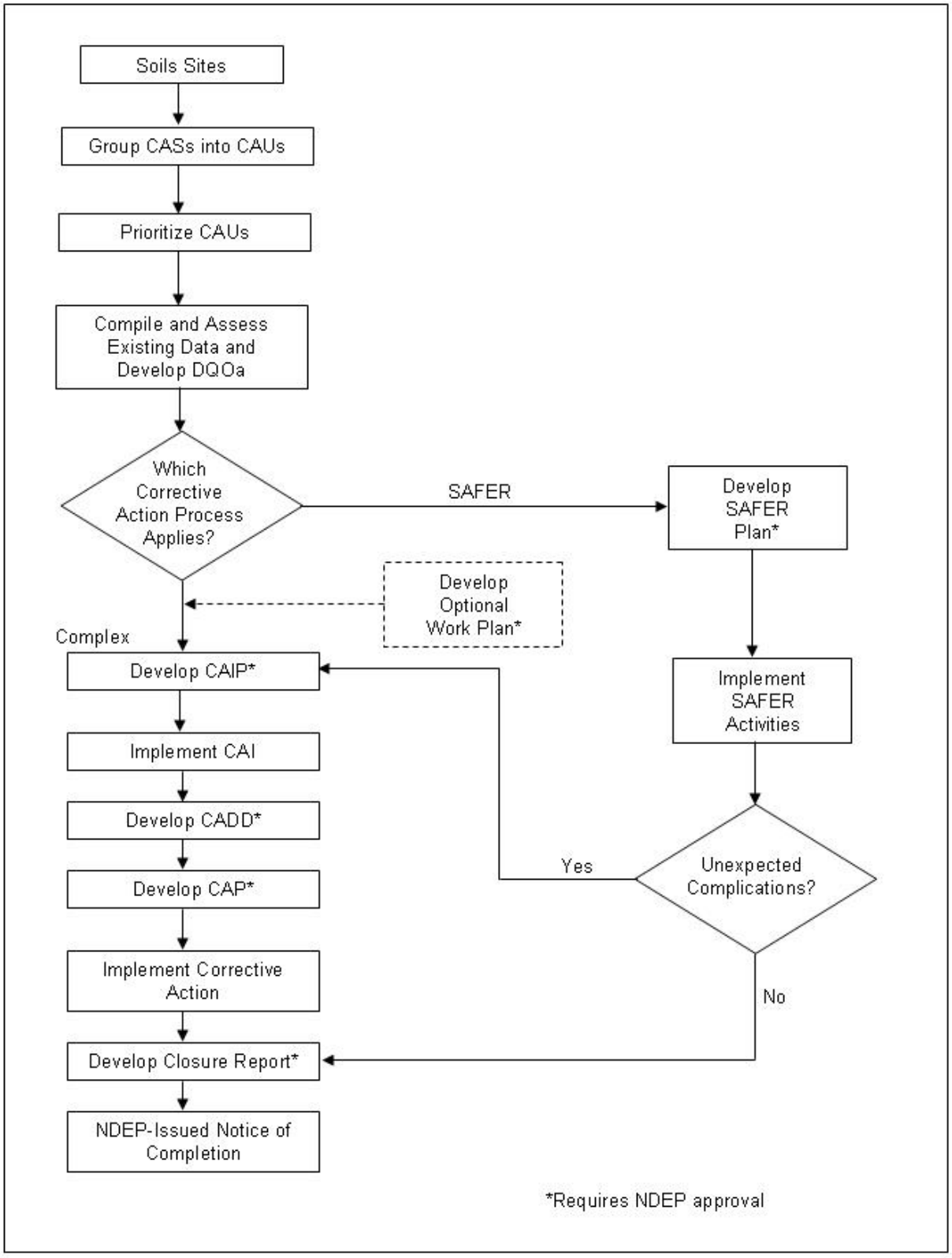


**Figure 4-2**
**Soils Sites Corrective Action Process**

### *4.3.2 Complex Process*

If existing CAU knowledge is inadequate to propose a corrective action alternative, the complex process will be used. A CAIP will be prepared to guide investigative tasks to acquire necessary data to complete a CADD. The DQOs will be incorporated into the CAIP to ensure that collected data will be used in evaluating corrective action alternatives.

Corrective action alternatives will be evaluated in a CADD and a corrective action proposed. The development of the CAP and the implementation of the corrective action will begin after NDEP approval of the CADD. A CR will document the completion of corrective action activities and submitted to NDEP. After approval of the completion of the corrective action, NDEP will issue a notice of completion and the CAU will be moved to Appendix IV (Closed Corrective Action Units).

# 5.0 Offsites

Offsites within the State of Nevada consist of the PSA and the CNTA, each considered a separate CAU based on geographic location. In August 2006, a modification to the FFACO was completed to transfer the responsibility for the Nevada Offsites from the DOE/Environmental Management (EM) to the DOE/LM. Starting on October 1, 2006 (FY 2007), all responsibility was assumed by LM for future work done at the Nevada Offsites.

## 5.1 Corrective Action Units

CASs associated with the PSA and the CNTA include an underground nuclear test and sites associated with drilling activities.

## 5.2 Corrective Action Strategy

Corrective action strategies for surface and shallow subsurface sites at the PSA and the CNTA CAUs are identical to the Industrial Sites corrective action process, as shown in Figure 2-1. Efforts to compile existing data at these CAUs are under way, and these data will be used to develop conceptual models and provide the basis to apply DQOs for data collection and evaluation. The selection of a corrective action process will be based on site-specific information and conditions.

The concepts being developed for the UGTA CAUs will be applied on a more limited scale to groundwater at the Offsites. Each was the site of one underground nuclear test. The strategy will be to characterize groundwater flow and contamination transport through modeling utilizing CAU-specific hydrologic data. The focus will be on tritium, because based on presently available data, it is the most mobile of the potential radiological contaminants. Maximum use will be made of existing data, including monitoring data collected from the Long-Term Hydrologic Monitoring Program (LTHMP) well networks at each area. If the results of the hydrologic studies so indicate, then a decision will be made to evaluate the need for source control or containment and implement as appropriate, or continue the monitoring program. If the modeling results are acceptable, then the monitoring program will be continued. LTHMP sampling has been performed annually at the PSA and the CNTA since 1972.

## 5.3 Implementing Corrective Action Investigations and Corrective Actions

Surface and shallow subsurface CASs will follow the corrective action processes described in Section 2.3.

If the areas of potential groundwater contamination are not adequately bounded by the present LTHMP networks, or if there are potential exposure pathways not presently monitored, additional sampling points could be added to the LTHMP networks. As of the effective date of this Agreement, no specific, proven cost-effective technologies, as known by the parties individually, have been previously demonstrated to either remove radioactive contaminants from the groundwater, stabilize them, or remove the source of the contaminants. Such technologies may be perfected in the future, which may perhaps alter the choice of corrective actions at that time. In addition it may be necessary to institute use restrictions on groundwater in a buffer zone surrounding the CAS to further protect against potential human exposure. The CR will also establish long-term monitoring requirements for the CAU, including contingency plans for actions to be taken if long-term monitoring results are not acceptable.