

1 **ABSTRACT**

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3 Under sponsorship from the USEPA and the American Society of Testing & Materials (ASTM), a nationwide study has
4 been completed to evaluate the impact of risk-based corrective action (RBCA) on the performance of state environmental
5 cleanup programs. The RBCA process for management of affected soil and groundwater sites was originally detailed in ASTM
6 Standard E-1739-95, *Standard Guidelines for Risk-Based Corrective Action at Petroleum Release Sites*, published in 1995 and
7 reissued in expanded form in 1998. With strong support from the USEPA, the RBCA process has been adopted by many state
8 agencies in the U.S in an effort to improve the management of environmental cleanup efforts, as needed to address increasing
9 case backlogs and rising costs associated with remediation of leaking underground storage tank sites. To evaluate the success
10 of these RBCA programs, the *Risk-Based Decision-Making (RBDM) Performance Assessment Study*, initiated in 1997, involved
11 detailed evaluation of five state environmental agencies that had implemented regulatory programs closely modeled on the
12 ASTM RBCA Standard. Comparison of pre-RBCA to post-RBCA program management statistics clearly demonstrates the
13 positive impact of RBCA in terms of faster case processing rates, reduced environmental cleanup costs, and more effective tar-
14 geting of resources toward higher-risk sites.

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16 Key Words: Risk-Based Decision Making, Risk-Based Corrective Action, RBCA, RBDM, Corrective Action, Performance
17 Measures, Underground Storage Tanks, Environmental Management Policy

1 **MANAGEMENT CHALLENGES POSED BY LEAKING UNDERGROUND STORAGE TANK FACILITIES**

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3 State and federal environmental regulations require owners and operators of underground storage tank facilities to in-
4 vestigate and remediate spills of petroleum products into the underlying soil and groundwater. Such fuel leaks can pose a con-
5 cern with regard to impacts on drinking water resources, as well as direct exposure to contaminated soils or vapors. The
6 USEPA estimates that more than 1 million underground storage tanks have been in service in the U.S., principally used for fuel
7 storage at gasoline service stations (USEPA 2000). Of these, more than 400,000 leaking underground storage tank (LUST) sites
8 have been identified to date, with new releases reported at rates of 500 to 1000 per week over the past decade. State environ-
9 mental regulatory agencies have worked hard to oversee the proper investigation and cleanup of LUST sites, completing more
10 than 240,000 case closures nationwide. Nevertheless, more than 160,000 LUST sites remain to be completed, and new releases
11 continue to be reported at a rate of approximately 20,000 per year, posing a chronic backlog of LUST sites for state regulatory
12 agencies.

13
14 At a median cost of more than \$100,000 to investigate and remediate each LUST site, this cleanup effort represents a
15 multi-billion dollar expense on a nationwide basis (Vermont DEC, 2000). Beginning in the late 1980's, in order to offset the
16 financial burden of LUST cleanups for site owners and operators, 48 states established assurance funds, providing partial to full
17 reimbursement for corrective action expenditures at eligible sites. These funds are principally financed by tank fees and gaso-
18 line taxes and are managed either by the state environmental regulatory agency or an independent fund authority established by
19 the state. However, throughout the past decade, claims have consistently exceeded available fund revenues, posing a chronic
20 financial crisis for many states and, in some cases, leading to fund insolvency. In response, many states are phasing out their
21 assurance funds and/or are seeking to reduce LUST expenditures through more stringent cost control measures, reduced reim-
22 bursement levels, and more cost-effective cleanup policies. In all cases, however, state environmental agencies are working to
23 achieve such cost controls without compromising protection of public health and the environment.

24
25 **DEVELOPMENT AND USE OF THE ASTM RBCA STANDARD**

26
27 To address the challenges posed by remediation of an ever-growing population of LUST sites, in 1993, the ASTM E-
28 50.01 Subcommittee on Storage Tanks began work on development of a streamlined process for assessment and response to
29 subsurface contamination associated with petroleum hydrocarbon releases. The subcommittee, composed of representatives
30 from the USEPA, state regulatory agencies, major oil companies, banking and insurance companies, academia, and environ-

1 mental consulting firms, identified a risk-based approach as the key to effective characterization, prioritization, and response to
2 soil and groundwater impacts. The ASTM ES 38-94 *Emergency Standard Guide for Risk-Based Corrective Action Applied at*
3 *Petroleum Release Sites*, released by the subcommittee as an emergency standard in July 1994, integrated risk assessment prac-
4 tices with traditional site assessment and remedy selection activities to determine cost-effective measures for protection of pub-
5 lic health and the environment. The standard was reissued in final form in December 1995 as ASTM E 1739-95 *Standard*
6 *Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* (ASTM 1995) and was later expanded and reissued
7 as ASTM PS 104-98 *Provisional Standard Guide for Risk-Based Corrective Action* (ASTM 1998), addressing all types of
8 chemical releases to the environment.

9
10 The RBCA process, as defined in the ASTM Standard, is a flexible, science-based, decision management framework
11 that may be customized by individual regulatory agencies to design or revise their corrective action programs. In simple
12 terms, the RBCA process entails: i) identification of applicable risk factors on a site-specific basis and ii) implementation of
13 appropriate corrective measures in a timeframe necessary to prevent unsafe conditions. As defined in the ASTM Standard,
14 the RBCA process involves three key elements (GSI 1995):

- 15
- 16 • ***Risk-Based Site Prioritization:*** Characterize risk drivers at each site and prioritize response actions based on the timing
17 and magnitude of potential impacts to human health and the environment.
 - 18
 - 19 • ***Site-Specific, Risk-Based Remediation Goals:*** Determine risk-based concentration limits for affected environmental media
20 designed to prevent impacts on human health and the environment. To provide for economical use at both small and large
21 facilities, RBCA employs a tiered approach to development of risk-based cleanup goals, designed to match the site assess-
22 ment effort to the relative complexity of each site. Tier 1 remediation goals represent generic concentration limits, based on
23 conservative default assumptions. Under Tier 2 and Tier 3, the user may derive site-specific concentration limits based on
24 additional site data and increasingly sophisticated methods of data analyses. In addition to a Tiered process for develop-
25 ment of numerical cleanup goals, a RBCA program may include non-numeric “exit criteria” for case closure which include
26 which include consideration of factors such as demonstration of groundwater plume stability and distance from groundwa-
27 ter plume to a drinking water well or other receptor.
 - 28

- 1 • **Remedy Selection:** Minimize risk by preventing exposure to unsafe levels of site chemicals. Options for management of
2 contaminated soil and groundwater include removal/treatment, containment, natural attenuation, institutional controls, or
3 some combination thereof.
4

5 The USEPA has strongly endorsed the application of risk-based corrective action principles for remediation of under-
6 ground storage tank sites, as detailed in Office of Solid Waste and Emergency Response Directive 9610.17 *Use of Risk-Based*
7 *Decision Making in UST Corrective action Programs* (USEPA 1996). In 1996, The USEPA Office of Underground Storage
8 Tanks (OUST), through a cooperative agreement with ASTM and a public-private partnership organization, Partners in RBCA
9 Implementation (PIRI), initiated a nationwide RBCA Training Program designed to familiarize state regulatory agencies with
10 the ASTM RBCA framework and support development of state RBCA regulatory programs customized to local needs. To date,
11 more than 43 states have received ASTM RBCA training, 25 states are in the process of developing RBCA regulatory pro-
12 grams, and 16 states have RBCA programs in place.
13

14 **THE RBCA PERFORMANCE ASSESSMENT STUDY: OBJECTIVES AND PROCEDURES**

15

16 States implementing RBCA regulatory programs share the common goal of protecting human health and the envi-
17 ronment from impacts associated with releases from LUST sites. Toward this end, the specific program management goals
18 identified by these state agencies include:
19

- 20 • **Risk Reduction:** Reduce risks posed to human health and the environment by releases from LUST sites.
- 21 • **Expedited Site Evaluation, Remediation, and Closure:** Streamline the site assessment process to expedite the remediation
22 of sites posing significant concerns and close cases presenting no significant risks.
- 23 • **Cost Control/Resource Allocation:** Without compromising protection of human health and the environment, reduce the cost of
24 the corrective action program, by streamlining the report submittal/review process, targeting resources toward higher-risk sites,
25 and reducing administrative oversight costs.
26

27 In order to measure the progress of state RBCA programs toward achieving these management goals, the RBDM Per-
28 formance Assessment Study was initiated in December 1997 under a cooperative agreement between USEPA OUST and
29 ASTM. This evaluation was designed to achieve three principal objectives: i) develop practical, quantitative measures for

1 evaluating the impact of RBCA on achieving state agency management goals, ii) apply these measures to five state agencies
2 with RBCA-based programs to evaluate program performance, and iii) provide general guidelines for other state or territorial
3 environmental agencies interested in tracking the benefits of their RBCA programs. Although the Performance Assessment
4 Study focused on the impact of RBCA on LUST corrective action programs, many state RBCA programs cover other types of
5 corrective action sites in addition to LUST sites.

6
7 Five state environmental regulatory agencies which had previously implemented RBCA programs volunteered to
8 participate as RBCA pilot states for the purpose of this study:

- 9
- 10 • **Illinois:** Illinois Environmental Protection Agency, Leaking Underground Storage Tank Section, which implemented the
11 Tiered Approach to Corrective Action Objectives (TACO) program in January 1997 (Illinois EPA 1997) that covered
12 LUST, Resource Conservation and Recovery Act (RCRA), and Site Remediation Program sites;
 - 13 • **Iowa:** Iowa Department of Natural Resources, Underground Storage Tank Section, which released their RBCA guidance
14 specific to LUST sites in January 1997 (Iowa DNR 1996a,b);
 - 15 • **North Carolina:** North Carolina Department of Environment and Natural Resources, Groundwater Section, which imple-
16 mented their RBCA guidelines for LUST sites in January 1998 (North Carolina DENR 1998a,b);
 - 17 • **Texas:** Texas Natural Resource Conservation Commission, Remediation Division, which implemented a LUST-specific
18 RBCA program in June 1993 (TNRCC 1994) and expanded the program with publication of additional risk-based exit cri-
19 teria in February 1997 (TNRCC 1997); and
 - 20 • **Utah:** Utah Department of Environmental Quality, Division of Environmental Response and Remediation, which published
21 Tier 1 RBCA guidelines in September 1995 (Utah DEQ 1995), followed by a Tier 2 RBCA guidance document in June
22 1998 (Utah DEQ 1998). Both guidance documents are specific to LUST sites.

23
24 These five states provide a broad geographic distribution (e.g., no more than one state per USEPA Region) and rep-
25 resent a variety of state-customized RBCA program policies. For this study, each state provided access to their LUST case
26 databases and other available information used to record the progress of remediation sites through the regulatory process. In
27 addition, the pilot states provided input on the goals of their individual programs, the performance measures currently utilized
28 in their state, and the utility and feasibility of the RBCA performance criteria developed for this study. Although the RBCA

1 programs in four of the five pilot states cover only LUST corrective action sites, some of the pilot states (e.g., Texas) have
2 separate risk-based programs which cover other types of corrective action sites.

3
4 Quantitative measures of RBCA program performance corresponding to each of the principal program management
5 goals identified by state agencies (i.e., risk reduction, expedited remediation/closure, and cost control) are listed in Table 1.
6 In order to evaluate the impact of RBCA, individual state data were compiled into a Microsoft Access© database and pro-
7 grammed queries were applied to characterize trends in these performance metrics over the period of 1990 through 1999,
8 encompassing the time period before and after RBCA was implemented in each state. Pre-RBCA and post-RBCA trends
9 were then compared to identify changes in case backlog, processing rates, and other key performance parameters.

11 **KEY FINDINGS FROM THE PERFORMANCE ASSESSMENT STUDY**

12
13 Results from the RBCA Performance Assessment Study for each pilot state are summarized in Table 2 and illustrated
14 in Figures 1 through 5. The results of this study support the following general findings with regard to the common program
15 management goals:

16
17 • ***Expedited Site Evaluation, Remediation, and Closure:*** Immediately following implementation of their RBCA program, 4
18 of the 5 pilot states observed a dramatic spike in case closures per year and a stabilization or decrease in case backlog (see
19 Table 2). In Texas, many of the RBCA policies were implemented in the year prior to the formal adoption of the RBCA
20 program. As a result, the spike in case closures also occurred in the year prior to the formal adoption of the RBCA pro-
21 gram (see Figure 1). In the first year of the Utah RBCA Tier 1 program (1995), the number of case closures increased by
22 120%, indicating that a Tier 1 process of generic screening criteria can significantly impact program performance (see Fig-
23 ure 1). In Iowa, 77% of RBCA Tier 1 and 28% of Tier 2 site assessments resulted in case closure, indicating that the
24 RBCA process has been effective at identifying sites for closure or remediation (see Figure 2). In general, following
25 RBCA implementation, the average age of a LUST case at the time of case closure was observed to increase (see Figure 3),
26 which, in combination with the increase in case closure rates, indicates that many older cases which had been in the regula-
27 tory process for many years were now being addressed. As a result of the increased closure rate, the case backlog (the
28 number of cases remaining in the regulatory process) was also observed to decrease or stabilize following RBCA imple-
29 mentation (see Figure 4)

- 1 • **Risk Reduction:** Available information regarding risk-based site classification (Texas and North Carolina) indicates that
2 most of the LUST site cases closed by these state RBCA programs are low-risk sites (see Figure 5). These data suggest
3 that RBCA programs are effectively meeting the state program objective of closing low-risk cases while retaining higher-
4 risk cases for further evaluation and/or remediation.
- 5 • **Cost Control/Resource Allocation:** Cost data in the LUST site databases provided by the pilot states were not sufficient to
6 measure the cost impacts of RBCA programs at this time. However, the significant reductions in case backlog reported by
7 some states clearly correspond to reduced program cost liabilities. An internal cost survey was conducted by the Texas
8 Natural Resource Conservation Commission to determine the impact of RBCA implementation on the cost of site remedia-
9 tion (Clarke 1999). Between 1994 and 1998, remediation/closure costs were reduced by 70% for soil-impact-only sites
10 (median cost reduced to \$24,000/site from \$80,000/site), and by 58% for low-risk groundwater impact sites (median cost
11 reduced to \$107,000 from \$250,000/site).

12
13 In addition to the five pilot states evaluated for this study, the Michigan Department of Environmental Quality
14 (DEQ), Storage Tank Division, has independently evaluated the performance of their LUST management program following
15 the implementation of RBCA in April 1995. In 1996, Michigan DEQ reported a 61% increase in LUST case closures com-
16 pared to the average case closure rate for 1990 to 1995. In addition, Michigan DEQ achieved a 30% decrease in case backlog
17 from 1995 to 1998. Implementation of the RBCA program resulted in a 24% average reduction in total remediation/closure
18 costs for UST sites, representing a \$39,000 cost savings per site (Michigan DEQ 1996).

19
20 It is important to note that, concurrent with RBCA, some states have implemented additional management initiatives
21 (e.g., privatization of case reviews in Texas, phase-out of assurance fund in Michigan, etc.) that have contributed to improved
22 case processing rates and reduced program costs. At the same time, the 1998 federal regulatory deadline for UST upgrades
23 (e.g., installation of new tanks and/or leak detection systems) contributed to discovery of additional UST releases in recent
24 years, serving to counteract backlog reductions in some states. Nevertheless, the significant increase in case closure rates for
25 low-risk sites coincident with RBCA implementation, as observed consistently in all five pilot states, does demonstrate clear
26 benefits of the RBCA with regard to key program management goals.

27
28 Another important factor that could have had a significant impact on LUST program performance is state resources
29 applied to review and processing of LUST cases. None of the pilot states recorded allocation of state resources or staffing to
30 LUST case review, precluding a direct analysis of this factor on program performance. However, based on interviews with

1 LUST program managers from the pilot states, changes in resources and staffing were not significant during the study time
2 period. Unlike states such as Massachusetts, none of the pilot states have privatized case closure authority. Therefore, this
3 privatization is not a potential confounding for the observed results.

5 **FUTURE GUIDELINES FOR RBCA PERFORMANCE MONITORING**

6 In addition to quantifying the past performance of selected state RBCA programs, the RBDM Performance Assess-
7 ment Study included development of guidelines for future monitoring of corrective action program performance. Review of
8 the LUST site databases for the five states suggests that most states do maintain sufficient electronic records to track the per-
9 formance of their regulatory program with regard to key management objectives. However, additional data relevant to risk
10 reduction or cost control is available in individual site reports but is often not recorded electronically in the state database. In
11 many cases, minor modifications of database parameters may be required to incorporate the quantitative performance meas-
12 ures identified in this study (see Table 1). Customizing a state program for the purpose of a RBCA performance assessment
13 involves the following steps: i) selecting relevant performance measures from the suggested list provided in Table 1, ii) re-
14 viewing the current state database to determine whether required data is currently recorded, and iii) modifying the current
15 state database to include the missing data fields. In addition to these general guidelines, the results of this study indicate that
16 the following database parameters warrant special attention in order to track RBCA performance over time:

17
18 **1) Basis for Closure:** As a supplement to the time to closure measure, a “Basis for Closure” field can be used to record the
19 reason that the case qualified for closure (for example “active remedy completed” or “Tier 2 assessment with no active rem-
20 edy”). Tracking the reason for case closure would assist in identifying the types of LUST sites being managed efficiently
21 under RBCA, as well as those for which achieving closure is still difficult. To assist in analysis of this performance data, the
22 reason for closure should be based on defined categories.

23
24 **2) Risk Reduction:** Surveying the risk-based site classification of the LUST site population over time can serve as a con-
25 venient measure of risk reduction. If the RBCA program is effectively reducing risk, the site classification profile should
26 reflect a general shift toward low-risk categories from year to year. However, to measure risk reduction, the site classifica-
27 tion system must be based on the magnitude and immediacy of potential impacts on human or ecological receptors, using
28 criteria similar to those employed in the ASTM RBCA site classification system (ASTM 1995). Classification systems based
29 on physical site characteristics (e.g., soil type, groundwater velocity, chemical contaminants, etc.) do not reflect the change in

1 risk conditions as remediation progresses and risks are mitigated. Furthermore, to quantify risk reduction, both the initial and
2 the current risk classification must be recorded for each site. The initial risk classification remains fixed; however, the cur-
3 rent risk classification can change as site remediation progresses. Using this approach, total risk reduction over time for the
4 full LUST case population can be quantified.

5 **3) Remediation Cost:** Information on the cost of site remediation is typically recorded in a database separate from the other
6 program performance data. In addition, cost data is often limited to reimbursed costs for sites eligible for state funded reme-
7 diation. The addition of a “Total Remediation Cost” field to the primary state database would allow an analysis of remedia-
8 tion costs for all sites regulated under the state corrective action program. This cost data could be collected by requesting an
9 estimated total remediation cost, inclusive of site assessment and response action costs, as part of the final request for case
10 closure.

12 CONCLUSIONS

13 The results of the RBDM Performance Assessment Study clearly suggest the benefits of the RBCA framework and
14 the ASTM RBCA Standard to state environmental regulatory agencies in terms of more cost-effective management of envi-
15 ronmental impacts associated with LUST sites. For the majority of pilot states, implementation of a RBCA program resulted
16 in an immediate increase in LUST case closures and a stabilization or decrease in case backlog. Such case backlog reduc-
17 tions represent a decreased administrative burden for the agency as well as a substantial reduction in cost liabilities, allowing
18 staff and funding resources to be focused on remediation of higher-risk sites. Average case age at time of closure generally
19 increased under RBCA which, combined with the increase in case closures, indicates that many older cases, that had been
20 stalled in the regulatory process for many years, are now being addressed. Evaluation of site risk classifications in the back-
21 log population indicates that the RBCA programs are effectively targeting low-risk sites for closure, while retaining higher-
22 risk sites for further action. This finding is critical to the state objective of streamlining the corrective action process without
23 compromising protection of human health and the environment. Additional study is needed to determine the impact of
24 RBCA on the remediation and closure of those higher-risk sites which have been retained for further evaluation and/or reme-
25 diation under these state RBCA programs.

26
27 State environmental agencies, with support from USEPA, have made significant progress toward assessing and
28 remediating the over 400,000 LUST cases reported to date nationwide. However, over 160,000 known LUST sites remain to
29 be addressed and new releases continue to be reported at a rate of approximately 20,000 per year. As state financial assur-

1 ance programs are phased out in coming years, remediation costs will increasingly shift to tank owners or operators or other
2 insurance mechanisms. Consequently, cost-effective management of LUST site assessment and remediation will remain a
3 critical need for years to come, and many regulatory agencies may continue look to ASTM RBCA as an effective model for
4 addressing this challenge.

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14 www.epa.gov/swerust1/rbdtm (ASTM 1999a; ASTM 1999b).

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1 **Table 1.** Suggested performance measures for evaluation of LUST programs

PROGRAM GOAL	PERFORMANCE MEASURE	TRACKING DESCRIPTION	SITE DATA REQUIRED
Risk Reduction	Composite Site Classification Profile	Distribution of risk-based site classification ratings or sum of site classification scores through time	Initial site classification, Current site classification, Site score (i.e., high score for high risk)
	Composite Constituent Reduction Factor (CRF) Profile	Distribution or sum of individual site CRFs (CRF is max site concentration / site cleanup goal)	Initial and current site constituent concentrations, Applicable site-specific cleanup standard
	Cleanup Completed	Number of corrective actions resulting in case closure	Closure date
Expedited Evaluation, Remediation, Closure	Case Backlog	Number of sites currently managed by the state program	Incident reporting date, Closure date
	No Action Sites	Percentage and overall number of sites not requiring corrective action following risk-based site evaluation	Closure date, Basis for closure
	Action Plans Not Requiring Agency Approval	Percentage and overall number of new sites not requiring agency approval of action plan (e.g., Response Action Plan)	Date of self-implementation notice, Action Plan approval date
	Time to Action Plan Approval	Time from incident reporting to state approval of a corrective action plan	Incident reporting date, Action Plan approval date
	Time to Closure	Time from incident reporting to site closure	Incident reporting date, Closure date
Cost Control / Resource Allocation	Administrative Oversight	Resource allocation for program management per case closure, per active site, and for overall program	Program labor costs, Program head count, Case backlog, Total site closures per year
	Remediation Cost	Total expense from incident reporting to case closure for the responsible party or for the state reimbursement fund	Site remediation cost (including assessment and closure costs), Remediation cost reimbursed by state fund

2

1 **Table 2.** Results for pilot state corrective action program performance evaluation

STATE / AGENCY	RBCA PROGRAM IMPLEMENTATION	DATABASE	PERFORMANCE MEASURES		
			LUST SITE REMEDIATION/ CLOSURE	RISK REDUCTION	COST CONTROL
Texas Texas Natural Resource Conservation Commission, Remediation Division	Risk-Based Corrective Action for Leaking Storage Tank Sites, January 1994 (in use in 1993) Exit Criteria, September 1997.	Responsible Party Remediation Database	<ul style="list-style-type: none"> • 46% increase in case closures 1996 to 1997. • 31% decrease in case backlog 1994 to 1998. 	Preferential closure of low-risk cases, remediation of higher-risk cases.	58 to 70% decrease in remediation cost for low-risk soil or groundwater sites.
Utah Department of Environmental Quality, Division of Environmental Response and Remediation	Risk-Based Corrective Action Tier 1, September 1995 (in use 1/95) Risk-Based Corrective Action Tier 2, June 1998.	Leaking Underground Storage Tank Database	<ul style="list-style-type: none"> • 120% increase in case closures 1994 to 1995. • 53% decrease in case backlog 1994 to 1998. 	ID	ID
North Carolina Department of Environment and Natural Resources, Groundwater Section	Risk-Based Corrective Action for UST sites, January 1998.	Incident Management Database	<ul style="list-style-type: none"> • 46% increase in case closures 1997 to 1998. • 1% decrease in case backlog 1997 to 1999. 	Preferential closure of low-risk cases, remediation of higher-risk cases.	ID
Iowa Department of Natural Resources, Underground Storage Tank Section	Risk-Based Corrective Action, January 1997.	UST/LUST Database	<ul style="list-style-type: none"> • 134% increase in case closures '94-'96 to '97-'99. • 14% decrease in case backlog 1996 to 1999. 	ID	ID
Illinois Illinois Environmental Protection Agency, Leaking Underground Storage Tank Section	Tiered Approach to Corrective Action Objectives, January 1997.	Leaking Underground Storage Tank Database	<ul style="list-style-type: none"> • 8% decrease in case closures 1996 to 1997. • 8% increase in case backlog 1996 to 1998. 	ID	ID

2 ID = Insufficient Data

- 1 **Figure 1.** Impact of Risk-Based Corrective Action on Case Closure Rate in Pilot Study States
- 2 **Figure 2.** Impact of Risk-Based Corrective Action on Report Approvals in Iowa
- 3 **Figure 3.** Impact of Risk-Based Corrective Action on Average Age at Time of Case Closure in Pilot Study States
- 4 **Figure 4.** Impact of Risk-Based Corrective Action on Case Backlog in Pilot Study States
- 5 **Figure 5.** Impact of Risk-Based Corrective Action on Case Backlog for High Risk Sites and Low Risk Sites
- 6