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**STATE ASSISTANCE
WITH
RISK-BASED DATA MANAGEMENT**

PHASE I:

**INVENTORY AND NEEDS ASSESSMENT
OF
25 STATE CLASS II
UNDERGROUND INJECTION CONTROL PROGRAMS**

Prepared for

The Underground Injection Practices Research Foundation
827 Northwest 63rd Street
Suite 103
Oklahoma City, Oklahoma 73116

Prepared By

CH2M HILL
2701 North Rocky Point Drive
Suite 800
Tampa, Florida 33607

Digital Design Group, Inc.
1045 Lincoln Street
Suite 302
Denver, Colorado 80203

MASTER

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CONTENTS

<u>Section</u>	<u>Description</u>	<u>Page</u>
	LIST OF EXHIBITS	ii
	ACKNOWLEDGEMENTS	iii
	EXECUTIVE SUMMARY	v
1	INTRODUCTION	1-1
	1.1 Project Goals and Objectives	1-1
	1.2 An Overview of RBDMS and Previous Efforts	1-2
	1.3 Overview of the Inventory and Needs Assessment	1-7
	1.4 Overview of Remaining Project Phases	1-10
2	INTRODUCTION TO ENVIRONMENTAL RISK MANAGEMENT METHODOLOGIES	2-1
	2.1 Environmental Risk-Based Decisionmaking	2-1
	2.2 Methodology and Approach	2-2
	2.3 Risk Probability Analysis	2-3
	2.4 Feasibility of RBDMS	2-10
3	SURVEY FINDINGS AND RESULTS	3-1
	3.1 Introduction	3-1
	3.2 Individual State Surveys	3-1
	3.3 Survey Evaluation Results	3-45
4	DATA MANAGEMENT REQUIREMENTS	4-1
	4.1 Introduction	4-1
	4.2 General System Requirements	4-6
5	RECOMMENDATIONS	5-1
6	REFERENCES CITED	6-1
<u>Appendixes</u>		
A	Sample Questionnaire and Communication	
B	Spreadsheet of Survey Results - Module 2	
C	Spreadsheet of Survey Results - Module 3	
D	Spreadsheet of Survey Results - Module 4	
E	Spreadsheet of Survey Results - Module 5	
F	Spreadsheet of Survey Results - Module 6	

LIST OF EXHIBITS

<u>Exhibit</u>	<u>Description</u>	<u>Page</u>
1	States Participating in the RBDMS Inventory and Needs Assessment	1-8
2	Implementation Qualifying Criteria	3-47
3	Inventory and Data Management Information	3-49
4	Completion Types by State	3-50
5	Specific Priorities by State	3-52
6	Accepted Internal Mechanical Integrity Tests	3-57
7	Accepted External Mechanical Integrity Tests	3-58

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Executive Summary

Introduction

As discussed in Section 1 of the attached report, state agencies must decide where to direct their limited resources in an effort to make optimum use of their available manpower and address those areas that pose the greatest risk to valuable drinking water sources. The Underground Injection Practices Research Foundation (UIPRF) proposed a risk-based data management system (RBDMS) to provide states with the information they need to effectively utilize staff resources, provide dependable documentation to justify program planning, and enhance environmental protection capabilities.

Previous Efforts

The UIPRF's RBDMS project stems from three previous projects conducted by the American Petroleum Institute (API) and the Research Foundation. The first study, completed in February 1988 for the API, was titled "Oil and Gas Industry Water Injection Well Corrosion". It included a methodology for assessing the probability of contaminating underground sources of drinking water (USDWs) via Class II injection well operations. The report also evaluated the potential risk to several oil and gas producing basins throughout the country.

Following the API study, the Research Foundation conducted a pilot study to investigate the feasibility of using a RBDMS in the Williston Basin, incorporating information from North Dakota, South Dakota, and Montana. After that study was completed, a follow-up project was conducted in the Dorr Field waterflood project in Rooks County, Kansas, extending the earlier work into an existing Underground Injection Control (UIC) regulatory program. The Dorr field pilot study resulted in a data base which is compatible with the forms, procedures, reports, software, and hardware currently being used in the Kansas UIC program.

Results from the above studies showed that:

- The risk-based approach to managing UIC operations is a practical method of prioritizing and/or re-directing personnel and funds

toward those activities with the greatest potential risk of contaminating USDWs.

- The data necessary to carry out the risk approach to managing a UIC program are generally available.
- Efforts to incorporate the risk management approach into existing UIC programs may range from the development of a complete system to the comprehensive enhancement of an existing system.
- A survey of state and Environmental Protection Agency (EPA) managed UIC programs should be funded to determine the status of existing data management capabilities and areas in need of enhancing.
- Class II UIC data management programs can be enhanced by including selected elements of the risk management practices developed in the Williston Basin and Dorr Field studies.

Overview of the Inventory and Needs Assessment

The UIPRF structured its approach regarding environmental risk management to include data and information from production, injection, and inactive wells in its RBDMS project. Data from each of these well types is critical to the complete statistical evaluation of environmental risk and selected automated functions. This comprehensive approach allows state UIC programs to effectively evaluate the risk of contaminating a USDW, while alleviating the additional work and associated problems that often arise when separate data bases are used.

The UIPRF retained two specialized firms to implement its RBDMS project. CH2M HILL is a consulting engineering firm with over 4,000 employees in more than 50 offices nationwide. CH2M HILL has offices in most of the states participating in the RBDMS project and has significant experience in performing inventory and needs assessments, and designing and developing

large electronic data management systems. CH2M HILL is familiar with both state and federal UIC programs and has extensive experience in comprehensive groundwater management and evaluation.

CH2M HILL is supported in this project by Digital Design group, Inc. (DDG), located in Denver, Colorado. DDG has considerable experience with the design and development of electronic data management systems for state oil and gas agencies. DDG has successfully developed electronic data management systems for several of the states participating in the RBDMS project.

CH2M HILL and Digital Design Group, through a DOE grant to the UIPRF, completed an inventory and needs assessment of 25 state Class II UIC programs. States participating in the RBDMS project include both primacy and direct implementation programs. The states selected for participation by the UIPRF were generally chosen based on interest and whether an active Class II injection well program was in place. The inventory and needs assessment provided an effective means of collecting and analyzing the interest, commitment, design requirements, utilization, and potential benefits of implementing a RBDMS in individual state UIC programs.

During the inventory and needs assessment, 25 states were surveyed on a number of issues concerning the integration of environmental risk management practices into their existing Class II UIC program. Personal contacts were made with representatives from each state to discuss the applicability of a RBDMS in their respective state.

Future Project Phases

The next phase of the project, after the inventory and needs assessment is the implementation phase. The implementation phase will generally involve:

- Funding to assist states with the purchase of computer hardware and/or software
- A comprehensive, user friendly, personalized, and environmentally sensitive risk-based electronic data management system that will be versatile and compatible with other systems (e.g., WATERS, GIS, etc.)

- Pilot testing of the system, including loading data on one field (or pool of wells), assuring proper operation, and performing data element validation
- Training for system users plus a personalized RBDMS users manual
- Presentation of results to state oil and gas associations, state boards, and/or other agencies or organizations

In order for states to participate in the implementation phase of the project, they must meet the following criteria:

- States must have completed the inventory and needs assessment survey questionnaire.
- States must have expressed their desire to participate in implementation of RBDMS and commit to completing the project.
- States seeking to upgrade, enhance, or complete existing data management systems must demonstrate how UIPRF participation will further enhance UIC data management and environmental risk assessment/evaluation in their state.
- States will be required to quantify their commitment of personnel and financial resources to the implementation of a RBDMS.
- States will be required to demonstrate their ability to maintain the system once it is installed.
- Each state's readiness to participate in the program will be considered and the consequences of delay will be reviewed.

Introduction to Environmental Risk-Based Decisionmaking

Section 2 of the report presents data pertaining to the UIPRF's approach to implementing risk based decisionmaking into a State Class II UIC program.

This section of the report presents risk probability calculations and potential capabilities related to environment risk management of a RBDMS. In general, the DOE-funded RBDMS project provides states with the opportunity to develop and implement a relational data base system which provides many benefits including:

- Direction of limited resources to those areas posing the greatest risk of contamination to USDWs
- Prioritizing workloads and simplifying schedules
- Documentation of program implementation decisions by state UIC directors and staff
- Substantiation of additional program funding from either the state or EPA
- Justification to save inactive wells in low risk areas from being unnecessarily plugged
- Readily accessible data and information to complete EPA quarterly reporting requirements with the flexibility to automate reporting if desired.
- Automation of many standard program functions currently being performed manually.
- Thorough standardization of reporting requirements and improved regulatory efficiency implementation of RBDMSs in states may facilitate reduced production taxes on industry and simplify reporting requirements. Additionally, comprehensive data bases eventually may be made available for use by private industry.

Methodology and Approach

An environmental risk management approach and methodology has already been developed for use in a Class II injection well data management system (Michie, 1988). It combines the statistical evaluation of MIT results with injection well construction types. This approach has been successfully pilot-tested in the Williston Basin of North Dakota and the Dorr field of

Kansas. The method was generally considered applicable for injection wells completed with a tubing and packer assembly.

When considering this methodology for use on a much larger scale, such as the UIPRF's current effort, additional well construction types and related factors that have not yet been considered will need to be addressed. Therefore, during full-scale implementation of the UIPRF's RBDMS, the existing approach to evaluating environmental risk should be re-evaluated and expanded as appropriate.

Risk Probability Analysis

The statistical analysis methodology used in the UIPRF's RBDMS incorporates actual percentages of record tubing and casing leaks over a specified period. The method also includes the theoretical failure rate of an injection well's surface casing. Previous theoretical calculations regarding estimation of surface casing corrosion probabilities have been based upon comparisons of the resistance of corroding areas adjacent to saline aquifers with that of a corroding area adjacent to a USDW. Specific details pertaining to risk probability analyses are presented in Section 2.3 of the report.

Feasibility of RBDMS

After consideration of previous RBDMS efforts and completion of the inventory and needs assessment, the overall concept of implementing RBDMSs in Class II State UIC programs continues to appear practical. The majority of states which participated in the inventory and needs assessment currently utilize an electronic data management system to varying extents. For those states which do not currently utilize some sort of electronic data management system, a RBDMS will have to be developed from scratch and can be specifically tailored to fulfill the state's data management needs.

The complexity of implementing a RBDMS may vary significantly among states. In states having few wells and frequent site inspections, using a RBDMS to assist in prioritizing site inspections may not be a high priority item. However, in states with numerous wells and few field personnel, it may be desirable for the

RBDMS to assist with scheduling and prioritizing of field activities based on specified criteria (e.g., risk).

Survey Findings and Results

Section 3 of the report presents findings and results gathered through the survey questionnaire, telephone interviews, and detailed site visits to five states. Results are presented individually for each state and comparatively for all 25 states surveyed. Individual state summaries include general information and information pertaining to the existing data management system, financial and personnel resources, potential benefits, and special considerations.

Individual State Survey Highlights

- In the original UIPRF proposal to the DOE, 21 states expressed interest in participating in the RBDMS project. Since that time, an additional four states expressed interest in the project including three states where the United States EPA is currently directly implementing the Class II UIC program.
- The three direct implementation states, i.e., Montana, Kentucky, and New York, each expressed a high interest in RBDMS and, among other functions hope to utilize the RBDMS as a means of obtaining primacy over their state's Class II UIC program
- North Dakota, Mississippi, Nebraska, Alaska, and Texas showed an above-average interest in participating in the RBDMS project. Detailed site visits were conducted in addition to the inventory and needs assessment surveys for these states.
- Other states seeking to be early participants in the RBDMS project include Arkansas, Utah, Nevada, New Mexico, West Virginia, Indiana, Montana, New York, and California.
- Alabama, Colorado, Kansas, Missouri, Ohio, Wyoming, South Dakota, Kentucky, and Louisiana have expressed a less immediate interest in participating in the RBDMS project. However, they are supportive of the

system, but need additional time to evaluate the system's capabilities prior to adoption.

- Illinois is the only state that has decided not to participate in the RBDMS project at this time because of a lack of staff to implement and maintain it. However, Illinois does support the RBDMS concept and may participate when more staff become available.

Survey Evaluation Results

Twenty-four out of twenty-five states surveyed expressed interest in participating in the RBDMS project. This overwhelming positive response was much greater than originally anticipated by the UIPRF. As a result, existing grant funds from the DOE will not be adequate for full implementation of RBDMSs in all the states interested in participating in the project. In addition, many states have requested that the capabilities of the RBDMS be expanded to include all program functions. The Research Foundation should evaluate the ultimate goal of implementing a RBDMS in as many as 24 states and consider seeking additional grant funding from the DOE.

Finally, many states expressed a high interest and immediate need for an RBDMS. However, the Research Foundation should reverify each state's interest and readiness prior to initiating Phase II of the project. This can be accomplished by preparing a conceptual implementation plan (CIP) for each state prior to implementation. The CIP should be mutually agreed to by the state and UIPRF and will assure that each state's needs will be fully achieved.

Data Management Requirements

Section 4 of the report discusses data management requirements identified during the inventory and need assessment. One of the primary functions of the Risk Based Data Management System is to estimate the potential risk of USDW pollution by Class II injection wells. To do so, information on permits, wells, USDW's, inspections, MIT's, MI failures, injection volumes, corrosivity data, water quality data, and other data must be entered and stored in well-designed computer data bases such that sophisticated query generated reports can be prepared.

During the process of meeting with and surveying states with Class II primacy, many states expressed a strong interest in the development of a data management system that not only estimates risk, but addresses all data processing requirements in a comprehensive and well-integrated manner. State oil and gas commissions want to avoid the acquisition of a multitude of independent, stand-alone systems that require the entry and maintenance of redundant, and at times inconsistent, data. Consequently, this study included defining the data processing requirements for both UIC and non-UIC functions performed by each agency.

General System Requirements

The comprehensive RBDMS must be able to automate all or specific portions of the following functions:

UIC and UIC Related Functions

- UIC permitting
- Collecting and maintaining information on UIC well completions, re-completions, and status
- UIC well inspections
- MIT data
- Enforcement and compliance
- Accounting for monthly injection pressures and volumes of injected fluids
- Tracking water from producing to injection wells
- Maintaining information on USDW's
- Oil and gas well permitting functions
- Collecting and maintaining information on oil and gas well completions, re-completions, and status
- Inspections of oil and gas wells
- Monitoring of inactive and idle wells
- Addressing, inspecting, and maintaining information on complaints and spills
- Monthly accounting for production and disposition of oil, gas, and water
- Promulgated rules, regulations, and board orders
- Maintaining information on operators, drillers, oil transporters, gas gatherers, water haulers, casing pullers, and other companies and individuals

- Maintaining information on oil fields, geologic formations, and pools
- Financial Assurance (UIC)

Non-UIC Functions

- Permitting earthen pits
- Tracking incidents of gas flared
- Enforcing bonding and proof of financial responsibility requirements (non-UIC)
- Maintaining publication mailing lists
- Collecting and accounting for severance tax and conservation levies
- Proration

Recommendations

Given the data and information obtained during the inventory and needs assessment, including direct conversations with state agency personnel, representatives of the Research Foundation, and the Ground Water Protection Council (GWPC), the following recommendations seem to be most appropriate for proceeding with the initial stages of RBDMS implementation. The final determination regarding RBDMS implementation in states will be made by the UIPRF. Details regarding project recommendations are presented in Section 6 of the report. However, condensed versions of the recommendations presented in Section 6 of the report are presented below.

1. Several state Directors and other regulatory staff have said that a RBDMS must be comprehensive and address all agency needs to be effective and consideration should be given to inclusion of desired functions.
2. The UIPRF should pursue expanding its current method of analyzing potential environmental risk to allow for adaptation to an individual well and to multiple well completion types.
3. Efforts to coordinate the continued development of the UIPRF's RBDMS with the EPA's WATERS should be pursued.

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4. Development of a RBDMS in Montana should be coordinated with RBDMS implementation in Mississippi, Nebraska, and Alaska, since these states do not have an existing electronic data management system for their Class II UIC programs.
 5. North Dakota was the first state to pilot test the concept of implementing environmental risk based decisionmaking into a Class II UIC program (Michie, 1989). However, the system developed for North Dakota was not compatible with their existing electronic data management system. Since the North Dakota Oil and Gas Division (NDOGD) is still extremely interested in implementing a RBDMS to enhance their existing system, a CIP to determine the exact functional requirements, additional data elements needed, estimated funding requirements, potential benefits, and a schedule for implementation should be prepared.
 6. Initiate implementation of RBDMS in Mississippi, Nebraska, and Alaska at the same time.
 7. The specific needs identified during the Texas site visit should be reviewed in detail by the Research Foundation and representatives of the Railroad Commission of Texas (RRC) to determine the extent of assistance the UIPRF is able to provide for enhancing the RRC's system as part of the RBDMS project.
 8. Several other states expressed interest in pursuing implementation of a RBDMS on both an immediate and long-term basis. The UIPRF's approach to implementation in these remaining states should be addressed conceptually at future meetings so that appropriate grant funding from the DOE may be pursued.
 9. Twenty-four of twenty-five states were identified during the inventory and needs assessment as being interested in implementing a RBDMS in their state. This response was significantly higher than expected by the Research Foundation. Due to higher than expected response and the needed enhancements to the existing RBDMS, the Research Foundation should consider pursuing additional funding from the DOE for full project implementation. Full implementation of the RBDMS in state UIC programs will not be possible with existing available funds.
 10. Many states have expressed a high interest and immediate need for an RBDMS. However, the Research Foundation should reverify each state's interest and readiness prior to initiating Phase II of the project. This can be accomplished by preparing a conceptual implementation plan (CIP) for each state prior to implementation. The CIP should be mutually agreed to by the state and UIPRF and will assure that each state's needs will be fully achieved.

Section 1 Introduction

1.1 Project Goals and Objectives

The ultimate goal of the Underground Injection Practices Research Foundation (UIPRF) for the RBDMS project is the implementation of effective risk based data management systems (RBDMSs) in Class II Underground Injection Control (UIC) programs. The UIPRF's RBDMS project is designed to provide interested states with a useable and effective RBDMS, either as an enhancement to an existing system or as an entirely new system, depending on state-specific needs. In order to determine the overall interest and needs of each state, the UIPRF decided to conduct a nationwide inventory and needs assessment of interested states.

The goals and objectives for the inventory and needs assessment were developed from the results of two previous Research Foundation studies, and for this phase of the project include:

- Determining the interest regarding integrating environmental risk management practices into existing UIC programs.
- Determining the willingness and capability of each state to implement a RBDMS and continue utilization/maintenance of such a system if installed.
- Evaluating anticipated training needs that may be required during the implementation phase of the project.
- Identifying potential benefits states would accrue by implementing the UIPRF's RBDMS.
- Providing estimates of both personnel and financial resources that states could provide or be willing to seek during development, start-up, and continued operation of a RBDMS.
- Gathering information pertaining to the existing data management system in each state, and if an electronic data management system is used, determining what type of data elements are stored.
- Gathering data regarding each state's UIC program's existing hardware and software utilized for data management purposes.
- Determining the special needs that should be taken into consideration by the Research Foundation when addressing Phase II of the project.

- Gathering inventory information such as the number of injection and production wells, well completion types, allowable MITs, etc.

In addition to determining the above general needs through means of a survey questionnaire and telephone interviews, the Research Foundation also decided to determine the specific needs of the five states that expressed an early interest and substantial support of the project. The Research Foundation determined that detailed site visits should be conducted in these states and felt that these site visits would provide insights for the remaining states.

1.2 An Overview of RBDMS and Previous Efforts

Prior to the Research Foundation's inventory and needs assessment survey, a substantial amount of work pertaining to the risk posed by Class II injection wells had been done through the American Petroleum Institute (API) and the UIPRF (formerly the UICRF). Through previous studies, areas throughout the country with substantial corrosion problems were delineated; methodologies for evaluating environmental risk for Class II injection wells were developed; pilot tests were conducted to evaluate the feasibility of a RBDMS; and recommendations regarding future aspects of the RBDMS concept were made.

Abbreviated summaries and significant findings from these studies have been prepared. The studies include the 1988 API report titled: "Oil and Gas Industry Water Injection Well Corrosion", the 1989 UICRF report titled: "Evaluation of Injection Well Risk Management Potential in the Williston Basin", and the 1991 UICRF report titled: "Pilot Test of the Kansas Corporation Commission Injection/Production Data Management System". Summaries and significant findings from these reports follow:

"Oil and Gas Industry Water Injection Well Corrosion"

A report titled "Oil and Gas Industry Water Injection Well Corrosion" was prepared in February, 1988 for the API by Michie & Associates, Inc. The API commissioned the study to address comments made by EPA to Congress in a 1987 report. In this report, EPA assumed a 100 percent probability of simultaneous failures of all levels of protection in injection wells resulting in direct contamination of underground sources of drinking water (USDWs).

The purpose of the API study was to determine the realistic probabilities of simultaneous failures of all levels of protection against corrosion in injection wells. The objectives include:

- Identifying areas of the U.S. where the potential for corrosion-related failures that could allow a release of injected fluid into a USDW existed
- Developing a method to analyze and examine failure frequency data

- Developing an upper limit for potential contamination frequency to substitute for EPA's 100 percent failure probability for use in subsequent risk analyses to be performed by API

The results of the area identification part of the study showed that the U.S. injects into 39 geologic basins. Twenty of these basins have minor casing corrosion and minimal potential for polluting a USDW. Nineteen of the 39 basins have potential for external casing corrosion that is categorized as possible or significant. These 19 basins contain 48 percent of the injection wells in the U.S. and contribute 64 percent of the total water injected.

Michie (1988) assumed that several independent events must occur simultaneously for the injected water to reach a USDW. Simultaneous undetected leaks would have to occur in the tubing, production casing, and surface casing, along with the unlikely occurrence of water moving long distances up the borehole past saltwater aquifers to reach a USDW.

Failure frequency data for tubing and production casing leaks were analyzed for 132 fields. An upper limit on potential releases that could reach USDWs was determined by combining failure experience with calculated theoretical corrosion rates. While accumulating the failure frequency data, it was noted that operators had been installing cathodic protection and internally coated tubing in existing wells and raising cement tops and lowering surface casings in new wells to counteract subsurface corrosion problems.

Results of the failure frequency analysis showed that the upper bounds for contamination were about 1/100,000 potential contamination events per well-year where surface casings covered USDWs and 1/1,000 where surface casings did not cover USDWs. The majority of failures were found to occur well below the bottom of USDWs. The Permian Basin was used as an example. Of the 25,000 wells in the basin, the upper bound number of wells potentially leaking into a USDW in one year was 0.07, assuming 100 percent of the wells have surface casing covering the USDWs. Michie's calculations assumed that monthly injection monitoring was carried out in accordance with current regulations.

"Evaluation of Injection Well Risk Management Practices in the Williston Basin"

A report titled "Evaluation of Injection Well Risk Management Potential In the Williston Basin" was prepared for the UICRF by Michie & Associates in September, 1989. The purpose of the Williston Basin Study was to test the feasibility of constructing a risk-based data management system and to evaluate the risk approach as a supplement to existing UIC regulatory programs. The Williston Basin was chosen because it contained a manageable number of injection wells (731) and had a significant potential for external casing corrosion. Also, North Dakota and South Dakota had

primacy over the UIC programs while the EPA administered the program for Montana. This differentiation allowed the identification of the positive and negative aspects of a RBDMS for primacy and non-primacy states.

The main objective of the Williston Basin Study was to define requirements and to investigate the feasibility of incorporating risk management into administration of the UIC program. The general reporting requirements of UIC regulatory and compliance activities were not addressed, but the information required to complete these activities was included in the pilot program.

The first step of the project was to develop a data base of information on Class II injection wells. After developing the data base, specific queries were designed to address risk. In order to incorporate risk analysis into a UIC data base, Michie (1989) determined that the following list of raw data was a minimum requirement:

• Well Identification	• Leak History
• Completion Data	• Workover History
• MIT Data	• USDW Data
• Injection Volumes	• API Numbers

Michie (1989) also concluded that existing UIC programs usually collect the minimum data sets needed to initiate a RBDMS. Injection well monthly monitoring data and the lowermost USDW needed to be added at each well. Corrosive zones, injection formations, salt water disposal zones, leak data including tubing leaks and casing leaks, and workover data had to be added to the general data sets. However, most of the information collected is generally not stored electronically.

In addition, the study addressed the computer requirements for implementation of a RBDMS, including mainframe systems, PC computer systems, and combination mainframe/PC systems. State computer needs range from managing a UIC program with less than 100 Class II injection wells in South Dakota to managing greater than 50,000 Class II wells in Texas. Commercial hardware and software requirements, field office capabilities, and EPA reporting requirements were discussed.

Data base queries were developed from the results of a survey of 27 UIC regulators, interested operators, and from site visits to five different UIC regulatory agencies. Query and reporting capabilities of the data base provide a powerful tool for administering a UIC program. A summary of the data base queries developed in this study included:

- Tubing leak data
- Casing leak data
- Probabilities of USDW contamination
- Surface casing depth in relation to the base of the USDW
- Presence of intervening saltwater aquifer

- MIT data for the last five years
- Shut-in wells

The Williston Basin study resulted in the following conclusions:

- Risk-based UIC regulatory programs are viable
- Risk analysis concepts developed in the API study are practical
- Implementation of UIC risk management should be a five-year goal
- Implementation requirements are different for each state ranging from starting from the beginning for states that plan to or have recently assumed administration of the program to the addition of selected risk elements for mature programs
- Off-the-shelf computers can handle hardware requirements; commercially available software is preferred
- Early involvement of UIC staff is critical
- Phased implementation is practical

The study developed the following implementation steps:

- Select personnel
- Purchase computer hardware
- Define file structure and purchase data management and reporting software
- Establish a system for obtaining, verifying, and entering data
- Develop data base backup procedures
- Collect basic well identification information
- Collect and track wellbore completion information and MIT tests
- Identify USDWs to be protected
- Collect and track injection monitoring data, field parameters, and wellbore failure histories
- Provide user-friendly analysis, enforcement and reporting capabilities

The Williston Basin Study recommended:

- A five-year goal of enhancing UIC data management systems to incorporate risk
- An inventory of data management capabilities
- State/Federal funding for risk programs
- Monitoring frequency should be tied to risk
- Casing/tubing annulus pressure monitoring (APM) should be employed in all states
- Monitoring reports of potential leaks should be included in the UIC data base
- Data bases should be tailored to accommodate individual state requirements
- Electronic transfer of data should be encouraged
- Montana should evaluate a risk management UIC data base
- North Dakota should consider adding selected risk elements to UIC data base

***"Pilot Test of the Kansas Corporation Commission
Injection/Production Data Management System"***

A pilot test of the Kansas Corporation Commission Injection/Production Data Management System was conducted by Michie & Associates; and a report documenting the pilot test was prepared in March 1991. The objectives of the pilot test were to design, implement, and test a basic data base that would incorporate risk-based decision-making into the Kansas UIC program. The long-term goal was to provide the data and analytical tools necessary to rapidly identify potential USDW contamination problems so that preemptive actions could be taken to decrease the probability of environmental damage. The Kansas pilot study was a follow-up project to the Williston Basin study which incorporated the concept of environmental risk management practices into the regulation of underground injection operations. The Kansas pilot test included the design of a data base compatible with the forms, procedures, reports, software, and hardware used by the Kansas UIC program.

The pilot test involved designing a relational data base that incorporated injection well, production well, and field reservoir data necessary to evaluate the risk of contaminating

a USDW. In order to incorporate risk into the system, data elements such as well identifiers, well completion data, MIT results, injection volumes, injection pressures, the base and top of the deepest USDW, tubing and casing failure history, and field reservoir definition including corrosive zones and saltwater aquifers, were included. When incorporated into a relational data base, the risk approach will assist managers in allocating available personnel and funds to those areas posing the greatest risk of contaminating a USDW.

For the pilot study, data from the Dorr field were used. The field was in the mature stages of waterflooding with 15 active injection wells and 25 active producing wells. The key risk elements used in the study were depths to the base of the deepest USDW and bottom of surface casings, plus tubing leak history and casing leak history. Results of the study showed a minimum potential for leaks, approximately 0.02 leaks per well-year. The upper-bound probability of an injection well developing simultaneous tubing and production casing leaks that go undetected and allow water to reach a USDW was determined to be four chances in ten thousand well-years.

The report recommended the necessary hardware and software to fully implement the risk-based data management system in Kansas. The implementation phases and associated costs were detailed. The total cost of fully implementing a relational risk-based data management system for Kansas over a five-year period was estimated to be \$990,000.

1.3 Overview of the Inventory and Needs Assessment

Based upon the project goals and objectives developed by the UIPRF, an approach for conducting Phase I of this project was developed and approved by the Research Foundation prior to initiation. The first step in implementing the inventory and needs assessment was identifying those states potentially interested in the RBDMS project. Initially, 21 states were identified; however, four additional states expressed interest and were added to the project, resulting in a total of 25 participating states. Each of the participating states, the state regulatory agency, and the State UIC director are shown in Exhibit 1.

The inventory and needs assessment was performed through a pre-planned sequence of events that posed the least amount of unanticipated burden on state personnel yet fully achieved the goals of the project's first phase. The actual project execution sequence included preparation and submittal of an information and notification letter to advise states of the upcoming survey questionnaire; identification of the potential advantages that a RBDMS could provide; and provision of general information pertaining to the RBDMS project (Appendix A). The information and notification letter was followed by telephone contacts with personnel from each state.

Exhibit 1 States Participating in the RBDMS Inventory and Needs Assessment		
State	Regulatory Agency	UIC Director
Alabama	State Oil and Gas Board of Alabama	David Bolin
Alaska	Alaska Oil and Gas Conservation Commission	Lonnie Smith
Arkansas	Arkansas Oil and Gas Commission	Marty Perdue
California	California Division of Oil and Gas	Mike Stetner
Colorado	Colorado Oil and Gas Conservation Commission	Dennis Bicknell
Illinois	Illinois Department of Mines and Minerals	Lawrence Bengal
Indiana	Indiana Oil and Gas Division	To Be Named
Kansas	Kansas Corporation Commission	Bill Bryson
Kentucky	Kentucky Division of Oil and Gas	Michael Wallen
Louisiana	Louisiana Department of Natural Resources, Office of Conservation	James Welsh
Mississippi	Mississippi State Oil and Gas Board	Dick Henderson
Missouri	Missouri Department of Natural Resources	Ira Satterfield
Montana	Montana Board of Oil and Gas Conservation	Tom Richmond
Nebraska	Nebraska Oil and Gas Conservation Commission	Paul Roberts
Nevada	Nevada Department of Environmental Protection	Marcia Greybeck
New Mexico	New Mexico Oil Conservation Division	David Catanach
North Dakota	North Dakota Industrial Commission, Oil and Gas Division	Charlie Koch
New York	New York Division of Mineral Resources	John Harmon

Exhibit 1 States Participating in the RBDMS Inventory and Needs Assessment		
State	Regulatory Agency	UIC Director
Ohio	Ohio Department of Natural Resources, Division of Oil and Gas	Dennis Christ
Oklahoma	Oklahoma Corporation Commission	Tim Baker
South Dakota	South Dakota Department of Water and Natural Resources	Fred Steece
Texas	Railroad Commission of Texas, Underground Injection Control Division	Jerry Mullican
Utah	Utah Division of Oil, Gas, and Mining	Gil Hunt
West Virginia	West Virginia Oil & Gas Division	Michael Lewis
Wyoming	Wyoming Oil and Gas Conservation Commission	Dan Basko

Following initial contacts, an inventory and needs assessment survey (INAS) package, which included a transmittal letter, Fact Sheet, and six survey modules, was developed and forwarded to state agencies for completion. The INAS was prepared in a modular format to enable separate specialty personnel within each state to complete different sections of the survey. The six individual survey modules included in the INAS were:

- No. 1 - Survey Instruction Module
- No. 2 - State Implementation Module
- No. 3 - Data Management Module
- No. 4 - UIC Data Module
- No. 5 - Production Data Module
- No. 6 - Data Elements Module

Appendix A includes a sample of each of the INAS modules.

State agency personnel were contacted and state-specific data management needs were discussed in greater detail and all questions were answered. States with more immediate needs were identified, and in some cases were asked to provide additional information to expedite the implementation phase of the project.

Five states were visited by project team members and a detailed data gathering effort was made. During each of these site visits, as many as ten state program staff members were present to discuss the project at any one time. Following each site visit, a summary of findings identified during the site visit was prepared and reviewed by state agency personnel prior to finalizing. Site visit summaries were prepared and distributed to state agency personnel and the UIPRF separately from this report.

After the survey questionnaires were completed and returned to the project office, compilation and evaluation of data and information derived from the surveys was initiated. As part of this effort, a spreadsheet of state responses for each survey module was prepared (see Appendices B through F). Additional related data was evaluated and prior to finalization, the inventory and needs assessment report was reviewed by members of the UIPRF and the GWPC.

1.4 Overview of Remaining Project Phases

The RBDMS project consists of three major phases. The first phase of the project, the inventory and needs assessment, is summarized in this report. The second and most significant phase involves implementation of RBDMSs in state Class II UIC programs. The third phase involves the transfer of technology to those interested or affected parties at a UIPRF Class II injection well symposium.

The specific anticipated project approach for Phase II consists of several separate but integrally related sub-tasks. General descriptions of each potential sub-task for Phase II are described below; however, due to the differences in data management needs

among individual states, the actual performance and/or requirements for each of the specified sub-tasks may vary from what is shown.

- **Build Conceptual Implementation Plan (CIP)**—A CIP will be prepared for each state based on results of the inventory and needs assessment and detailed site visit. The CIPs will define needed data elements necessary for RBDMS implementation; functional requirements; an implementation schedule and cost estimate; potential state-specific benefits of implementing a RBDMS; and other factors which must be considered by the UIPRF for RBDMS implementation. CIPs may vary depending on many factors including the availability of information and funding, the status of the existing data management system(s), and available funding from the DOE. By using a phased approach, the CIPs will accommodate the limitations and complexities of the implementation effort and should be mutually agreed to by both the state and the Research Foundation.
- **Enhance Hardware Capabilities**—Data management varies significantly from state to state. Hardware enhancements will be recommended based on the information obtained from Phase 1 and from the CIP. The recommendations will be accompanied by documented purchase specifications for each component of the hardware recommended. The specific timing of proposed purchases also will be recommended.
- **Enhance Software Capabilities**—Implementation states may require software enhancements depending on when and how risk-based decision-making will be incorporated into their respective Class II programs. Software enhancements are generally divided into two categories. The first category involves the adoption of basic program software (e.g., Dbase IV, WordPerfect, etc.) upon which a RBDMS system could be constructed. The second category involves either modifying or expanding the state's existing data management system to incorporate risk-based decision modules, the EPA WATERS program, or other programs. In addition, those states without a data management system could adopt the UIPC RBDMS in its entirety, or adopt the EPA WATERS, or choose a combination of systems that would provide the most effective means of implementing a RBDMS.
- **Load and Pilot Test One Field**—In an effort to verify proper performance of the risk-based system, data management information and risk-based data elements will be loaded for one pool in each state. The pool chosen may be a current oil field that is undergoing secondary recovery operations, such as a waterflood, or a field that has significant enhanced oil and gas recovery potential. After the data has been loaded and verified, the software will be tested to confirm the system's proper operation.

- **Document System**—A RBDMS user manual can be prepared for those states currently without a complete or partial user manual. In those states that already have user manuals, the manual can be reviewed and modified as necessary to incorporate whatever changes or modifications have been made to the current in-house system.
- **Define Future Needs**—The future needs will be assessed for each of the participating states. The assessment will include defining required personnel and expenditures, as well as developing a long-term conceptual schedule for implementation of the RBDMS for the entire state.
- **Train Users**—A critical element of any successful data management system is its users (technical and administrative). For a system to be effective, all users must be familiar with all phases of the system. All of the potential users of the system will be trained in the operation and use of each system through seminars and/or other teaching forums as mutually agreed to by the state and the Research Foundation.
- **Present Results**—As appropriate, the results of the RBDMS project will be presented to state oil and gas associations, the DOE, or other state or federal agencies.

The objective of the third and final phase of the project, technical transfer, is to present a forum in which technology concerning the application of environmental risk management to Class II UIC programs, data management of injection/production well data, and environmental issues pertaining to Class II injection wells, can be exchanged. A symposium is presently scheduled for November 1992.

Section 2

Introduction to Environmental Risk Management Methodologies

2.1 Environmental Risk-Based Decisionmaking

The assessment of potential environmental risks to USDWs is a significant element in implementing a Class II injection well regulatory program. State, technical, field, and managerial staff commonly evaluate potentials for risk in an assortment of drilling, completion, conversion, operating, and plugging activities for Class II injection wells. Many states implement environmental risk-based decisionmaking on a relatively informal basis. For instance, it is common for field personnel to expend the majority of their efforts on those wells with histories of problems or non-compliance with state regulatory requirements. It also has been the practice of technical staff to routinely make decisions regarding a variety of issues that may not be "specifically" addressed by in-place regulations such as construction or completion requirements, area of review investigations, mechanical integrity testing requirements, and operating limitations for Class II injection wells in a variety of settings, and others.

From a program management standpoint, decisions regarding the allocation of scarce personnel and financial resources must be made on a continuous basis. Such decisions are generally made on the basis of personal experience or through input from technical and field staff in determining high priority issues (e.g., non-compliance, MIT failures, complaints, etc.). These decisions also may be influenced by the perceived magnitude of environmental risk in a specific area; environmentally sensitivity issues; a history of excessive MIT failures; and the presence of USDWs which may be more susceptible to contamination than those in other areas of the state. In many of the states in which surveys were conducted, no formal method of environmental risk management was being implemented. Some states, however, did implement risk-based decisionmaking on an informal basis and tracked a number of risk related data elements.

The GWPC and UIPRF have had the opportunity to become familiar with state program needs on a first-hand basis. In addition, the two previous studies conducted by Michie (1989 and 1991) along with other projects conducted by the UIPRF (e.g., Peer Reviews of state Class II UIC programs), have identified some of the potential benefits a comprehensive RBDMS can offer. On the basis of this knowledge, the Research Foundation has pursued continuation of the RBDMS project through DOE grant funding for state programs. The project's successful early efforts have encouraged the DOE to continue its funding, however, ongoing DOE funding will likely depend on the success of the additional project phases (including implementation and technology transfer).

The UIPRF approaches environmental risk-based decisionmaking with an eye toward potential automation of several routine program functions to lessen the workload

burden on field, technical, and program management staff. This approach enables state resources to be shifted to areas which are environmentally sensitive or have a greater potential impact on the environment.

2.2 Methodology and Approach

A risk management methodology has already been developed for a Class II injection well data management system. It combines the statistical evaluation of MIT results with injection well tubing and casing leak histories in relation to the location of USDWs and well construction types. This approach was previously pilot tested in the Williston Basin of North Dakota and the Dorr Field in Kansas. The method was generally considered applicable for wells completed with both a tubing and packer assembly and a surface casing. This assumption was valid considering the areas where the pilot tests were performed.

However, when considering this methodology for use on a much larger scale, additional well construction types must be considered. For instance, in areas of southeastern Kansas, slimhole completions (i.e., without a tubing and packer assembly and sometimes without a surface casing) are common and in Ohio, annular disposal wells are common. Therefore, during full scale pilot testing of the UIPRF's RBDMS, the applicability of the previously developed probability analyses should be re-evaluated for the various well types in each state. Depending on results from this evaluation, modifications to the methodology may need to be considered.

Several data querying options were identified during previous RBDMS pilot tests. Through the inventory and needs assessment, functions that could be performed by sophisticated querying capabilities were a priority with state regulatory agencies. Some of the identified and potential querying options include:

- Use of leak records to identify corrosive zones for possible modification of drilling and workover practices.
- Prioritization of MITS on wells can be performed.
- Wells that have had a workover, but have not had a follow-up MIT can be identified.
- List of wells that have been shut-in (or inactive) for a specified length of time.
- Comparison of permitted versus reported or witnessed injection pressures and flow rates for identification of wells that may be operating in non-compliance.

- Comparison of casing and cementing depths for a single well or multiple wells as compared to the location or overall relationship to USDWs or corrosive zones.
- Preparation of area-of-review (AOR) evaluation reports which could be automated to perform a number of comparisons depending upon available data elements maintained. Some of these include:
 - Comparison of casing and cementing depths for injection (or production) wells within a specified area or radius from a well being evaluated. Comparisons could be made to standard state construction requirements or to field specific rules or orders
 - Comparison of various construction parameters to geologic data, including USDW and potential intervening aquifer information
 - Identification of improperly plugged or constructed wells within the AOR
 - Comparison of proposed or actual injection flow rates and pressures to allowables for the well, area, or field being investigated
- Additional queries pertaining to AOR could be incorporated depending upon other miscellaneous criteria which may be specified on a state-specific basis.
- Identification of injection wells requiring site visits. Criteria for prioritizing site visits may be based upon the presence of an emergency situation (e.g., blowout, fire, etc.), predefined state inspection schedules, receipt of a complaint from a landowner or other party, or results from statistical risk analyses performed by the RBDMS.

2.3 Risk Probability Analysis

The statistical risk analysis methodology which has been incorporated into the UIPRF's RBDMS was developed in the API report (Michie & Associates, February 1988). The method incorporates both the percentage of tubing (P_t) and casing (P_c) leaks per year for a specified group of wells. By multiplying these factors together, a resultant probability of simultaneous leaks occurring in both the tubing and casing (P_{tc}) can be calculated. For example:

$$P_t \times P_c = \text{Probability of simultaneous casing/tubing leaks}$$

Therefore,

$$P_t \times P_c = P_{tc} \text{ (leaks per well-year)}$$

The percentage of tubing leaks per well-year (P_t) can be identified as the total number of tubing leaks per year (L_t) for a specified number of wells (X_w) in a predetermined area of interest (e.g., within a state, basin, field, pool, etc.) and over a specified number of years (N). Similarly, P_c can be identified as the total number of casing leaks per well-year (L_c) for a specified number of wells in a predetermined area of interest. Both P_t and P_c can be calculated as shown below:

$$\frac{L_t}{X_w \times N} = \text{Number of tubing leaks/well-year} = P_t$$

$$\frac{L_c}{X_w \times N} = \text{Number of casing leaks/well-year} = P_c$$

After calculating the probability for potential tubing and casing leaks to occur simultaneously, it is feasible to estimate the theoretical probability of water from an injection well reaching a USDW in a given year (P_w). However, prior to calculating this theoretical occurrence, various potential scenarios for contamination to occur must first be considered. Although several scenarios may exist depending on the construction of specific wells, two likely scenarios were chosen (Michie, 1988). These scenarios include:

- Wells having surface casing set and cemented through the base of the lowermost USDW
- Wells in which the surface casing is absent or inadequate (i.e., surface casing is not set through the base of the lowermost USDW)

The general determination for choosing these two scenarios is primarily based upon whether or not corrosion to the surface casing needs to be considered for purposes of probability calculations. For instance, if surface casing is not set through the base of the lowermost USDW, surface casing corrosion would not have to occur in order for injected fluids from a leaking well to enter the USDW. In cases where information regarding multiple aquifers within a USDW are available (e.g., the location of the base of the 3,000 mg/l TDS interface), it may be prudent to consider scenarios with wells

having casing set through the 3,000 mg/l TDS interface, but not through the 10,000 mg/l TDS interface. However, only two scenarios will be addressed at this time.

Estimating the upper bound probability of water from injection reaching a USDW for the above scenarios is similar to calculating the upper bound probability of simultaneous tubing and casing leaks occurring. The following factors must be considered:

For wells having surface casing set through the base of the lowermost USDW:

**P_w = Probability of injectate water reaching
a USDW in a given well-year**

**P_{tc} = Probability of simultaneous tubing/casing
leaks occurring per well-year**

**P_{sc} = Theoretical number of surface casing leaks
occurring per well-year**

$$P_w = P_{tc} \times P_{sc}$$

For wells without adequate surface casing:

$$P_w = P_{tc} \quad (\text{i.e., } P_{sc} = \text{NA})$$

P_{sc} must first be estimated to determine the theoretical probability of water from an injection well reaching a USDW in a given year for the scenario including wells having surface casing set through the lowermost USDW. Unfortunately, since the ability to physically evaluate the integrity of a well's surface casing is limited in most cases, a theoretical P_{sc} is needed to complete the prediction.

Previous theoretical calculations regarding estimation of surface casing corrosion probabilities have been based upon comparison of the resistance of corroding areas adjacent to a saline aquifer with that of a corroding area adjacent to a typical USDW. Michie (1988) calculated this ratio for a typical saline zone having a TDS concentration of approximately 105,000 mg/l and a typical USDW zone having a TDS concentration of approximately 3,000 mg/l. For this example, a ratio of the corrosion rate adjacent to the brine zone as compared to the corrosion rate of the USDW water was determined to be approximately 37 (Michie, 1988). In other words, it would take approximately 37 times longer for the surface casing (adjacent to the USDW zone) to have a corrosion hole form than it would for the production casing adjacent to the saline zone.

Using these results, P_{sc} can be estimated as follows:

$$P_{sc} = P_{ic} \times \frac{P_c}{37} \text{ (leaks per well-year)}$$

Considering that the estimate of P_{sc} is a theoretical calculation, a rough approximation also could be used by simply comparing actual concentrations of TDS at selected intervals of the surface casing and production casings. Depending on the specific TDS concentrations considered, actual comparisons of ratios of corrosion rates for surface and production casings could be much less than 37. For instance, if evaluating the surface casing for a well near the base of the lowermost USDW and comparing that data to the rate of corrosion adjacent to an aquifer having only 50,000 mg/l TDS, the ratio of the corrosion rate adjacent to the brine zone as compared to the corrosion rate of the USDW zone may only be approximately 5 to 10 (i.e., much less than previously estimated).

Therefore, to more conservatively estimate P_{sc} , knowledge of both TDS and resistivities of suspected corrosion intervals are needed. The inventory and needs assessment survey showed that none of the states inventoried maintain this degree of detail regarding formation water quality characteristics. Therefore, it seems practical to provide a conservative estimate of the ratio of corrosion rates for production and surface casings. Considering the current lack of easily obtainable data, a conservative ratio of approximately 5 appears to be reasonable and provides a more conservative theoretical estimate than previously developed by Michie (1988).

Using the above conservative approach, P_w will be calculated as follows:

$$P_w \text{ (Theoretical)} = P_{ic} \times \frac{P_c}{5}$$

NOTE: It should be noted that this is a conservative theoretical approximation, and if readily available, actual information should be used.

For purposes of example only, mechanical integrity testing statistics were obtained for the state of Michigan from a recent report prepared by the Cadmus Group (December 4, 1991) as part of an EPA Work Assignment (No. 0-0-15). The statistics used include data from a five year MIT testing cycle throughout the state for both enhanced recovery wells and salt water disposal wells. The applicable statistics from the above referenced report are as follows:

Testing Period:

- May 1985 through May 1990

Total Number of MITs Conducted:

- 1074 total wells tested
- 486 were for type 2D wells (45.25 percent)
- 588 were for type 2R wells (54.75 percent)

Total Number and causes of Failures:

- 114 - total failures (or 10.6 percent of the total wells tested).
- 58 - total number of MIT failures with the cause of failure known (51 percent). Therefore, of the 114 well failures noted, the cause of MIT failure remains unknown for 56 of these wells.
- 26 - total number of wells where the casing was noted as the cause of the MIT failure.
- 24 - total number of wells where the tubing or packer was noted as the cause of the MIT failure.
- 8 - total number of wells where the wellhead was noted as the cause of the MIT failure.

Unfortunately, the cause of failure was not noted for 56 of the 114 total MIT failures. Therefore, for example purposes only, failure data was manipulated so estimated theoretical data from all 114 wells could be used. If the same distribution of failure types is assumed for the wells the where failure causes were given opposed to the remaining wells where the failure cause was reported as unknown, the overall distribution of MIT failure causes would be as follows (approximately):

Casing failures:	51.3 wells (45 percent)
Tubing/Packer failures:	46.7 wells (41 percent)
Wellhead failures:	16.0 wells (14 percent)

Total failures: 114 wells

These statistics are the only official results of MITs. The EPA Regional data management system used to obtain information for the Cadmus study in Michigan, only maintains the results from the most recent MIT. Historical MIT data was therefore not available for consideration.

The Cadmus report (1991) estimated that 4.5 to 5.4 percent of the total number of wells tested have had mechanical integrity failures and were repaired and pre-tested prior to official testing. In Michigan, official testing is witnessed by an EPA representative (Cadmus Group, December 1991). In addition, the Cadmus study did not consider failures identified through annulus pressure monitoring because a formal MIT was not conducted. In a separate report prepared by the EPA (SMC Martin, Inc., August 1987), it was noted that one waterflood project in north-central Michigan experienced approximately 90 mechanical integrity failures in a single year. This statistic would result in higher MIT failure percentages than noted in the Cadmus report (1991).

The total number of MI failures may be higher than was estimated in the above study (Cadmus Group, 1991) and used in this example. Complete and accurate data on MI failure histories (including formal/informal MIT results, results from APM, or other utilized mechanisms for testing a well's MI) will need to be maintained by states for this method of analysis to be effective.

The above example shows a total failure rate of approximately 10.6 percent; the actual MI failure rate may more accurately be approximately 15.5 percent based on the EPA's estimate of total pre-MITs (or approximately 166 MI failures over a five year period opposed to the 114 reported).

Combining both failed MITs and MI failures and the same percentage breakdown as presented above, the overall distribution of failures to be used is:

Casing failures:	74.70 wells (45 percent)
Tubing/Packer failures:	68.06 wells (41 percent)
Wellhead failures:	23.24 wells (14 percent)
Total failures:	166 wells (estimated)

Therefore, excluding the MI failures contributed to wellhead failures, the upper bound probability of water from an injection well reaching a USDW in a given year is shown below:

$$P_c = \frac{L_c}{\chi_w \times N} = \frac{74.7}{1074 \times 5} = 0.0139 \text{ leaks/well-year}$$

$$P_t = \frac{L_t}{\chi_w \times N} = \frac{68.06}{1074 \times 5} = 0.0127 \text{ leaks/well-year}$$

Therefore,

$$P_{\text{ic}} = P_c \times P_r = 0.0139 \times 0.0127 = 0.00018 \text{ leaks/well-year}$$

And, for wells with surface casing set through the lowermost USDW;

$$P_w = P_{\text{ic}} \times P_{\text{sc}} = P_{\text{ic}} \times \left(\frac{P_c}{5}\right)$$

$$P_w = 0.00018 \times \left(\frac{0.0139}{5}\right) = 5 \times 10^{-7} \text{ occurrences/well-year}$$

For wells with inadequate surface casings;

$$P_w = P_{\text{ic}} = 0.00018 \text{ occurrences/well-year}$$

Considering these theoretical calculations, the probability of water from an injection well reaching a USDW in a given year ranges from approximately 1.8×10^{-4} to 5×10^{-7} occurrences per well-year. This range applies to wells without adequate surface casings and to those having adequate surface casings. However, these calculations are based on theoretical data that may be incomplete. Although these probabilities are extremely low, they are based on incomplete data. Also, wells with substandard completions would have substantially higher probabilities of causing contamination to a USDW.

The previous example demonstrates the methodology developed for and utilized in previous RBDMS efforts (Michie, 1989 and 1991). However, the methodology does not consider several significant factors relating to the potential contamination of a USDW by a Class II injection well. These factors (or considerations) include:

- For both the initial API study and the two pilot tests, the probability calculations were only applied to multiple wells in a specified area. The methodology was not developed for application to a single well. Therefore, states will not be able to determine the risk posed by an individual Class II injection well. However, after specifying a designated area, states can assess the risk of a specific type of Class II well based on the type of completion.

- These calculations are not meant to be a substitute (or replacement) for regular mechanical integrity tests.
- Although simultaneous holes in the tubing and production (or injection) casing may allow injected fluids to move outside the well casing, simultaneous holes may, in some cases, allow fluids to move into the well. This would not cause endangerment to USDWs.
- The probability calculations shown above assume that if simultaneous holes in the tubing, production casing, and surface casing were to occur, contamination would result. In actuality, many other factors would have to exist for this to be possible. For instance, a channel would have to exist or be created in the well annulus, sufficient pressure would need to be present to overcome hydrostatic pressures and other resistances for fluid to actually enter a USDW.
- The calculations do not account for the possibility of the presence of an intervening aquifer with sufficient permeability to accept all or part of any fluid leaving the injection well.
- The calculations do not account for the probability of fluid from an overpressured formation above the injection zone causing upward migration into a USDW or allowing a mechanism for fluid escaping from an injection well to travel to a USDW.

2.4 Feasibility of RBDMS

After consideration of previous RBDMS efforts and completion of the inventory and needs assessment survey (INAS), the overall concept of implementing RBDMSs in Class II UIC state programs continues to appear practical. The majority of the states which participated in the INAS currently utilize electronic data management to varying extents. Only a limited number of states continue to function without relying upon an electronic data management system (i.e., Mississippi, Nebraska, Alaska, Nevada, and the Direct Implementation states of Montana and Kentucky).

For those states that do not currently utilize some sort of electronic data management system, a RBDMS can be developed and specifically tailored to fulfill the state's data management needs. Data entry for these states will need to include those data elements that are required by the state, the EPA minimum data set (EPA, August 1987), and those data elements associated with environmental risk assessment or other potentially automated functions needed by the state (e.g., AOR investigations).

States having existing electronic data management systems may have several options depending on the capabilities of the existing system. Available options may include:

- Enhancing the existing system to incorporate data elements and functions required for environmental risk management and other needed capabilities.
- Abandoning a portion (or all) of the in-place system and adopting the UIPRF's RBDMS.
- Creating a separate, but relational, RBDMS to interact with the in-place system.

Although many similarities were noted during the inventory and needs assessment among state electronic data management systems (EDMSs), significant differences in complexity and utilization were also noted. Many of the variations appear to be based on the differences in the types of operations performed in the different states, the overall number of wells, the requirements of the rules or regulations being implemented, the activity within each state, the extent of environmental concerns or complexities, and the overall experience or background of state regulatory staff. However, many states have similar deficiencies regarding data management.

For instance, although significantly different in size, Texas and New Mexico share some of the same needs regarding the RBDMS project. Both states have a central office operating from combined mainframe/PC systems with multiple District offices having stand-alone PC based systems. Additionally, the states of Alaska, Mississippi, Montana, and Nebraska do not currently have access to an electronic data management system for the Class II UIC program. Because implementation of a RBDMS will begin from scratch, implementation of a RBDMS in these states could be structured so that the states share a base system.

The complexity of implementing a RBDMS may vary significantly among states. For instance, in states having few wells and frequent site inspections (e.g., Alabama), using RBDMS to assist in prioritizing scheduling of site inspections may not be a high priority. In states with numerous wells and few field personnel (Mississippi), it may be desired for the RBDMS system to assist in scheduling and prioritization of field and other activities based on varying criteria, including environmental risk.

As is evident, the specific desired uses of an RBDMS system can range from the simple (i.e., including probability analyses on MIT results and leak histories alone) to the highly complex. The complex systems could include probability calculations (i.e., analysis of MIT results, leak/failure histories, and well workover/plugging results), scheduling and prioritization of permitting, site inspections, MITs, file reviews, well pluggings, area of review investigations, plus other functions.

Many state regulatory personnel expressed the need to evaluate the potential for environmental risk posed by a single well. This technique is not directly available through the UIPRF's existing approach. In the current RBDMS approach, probability calculations can be applied to a specified area (or group of wells) and additional queries could be conducted in order to evaluate a particular well. However, due to the many requests expressed by state personnel, the UIPRF should consider expanding the current utilized approach of probability calculations. For example, an expanded approach could be developed to evaluate the environmental risk posed by a single well using specific data and information from the well being evaluated (i.e., without using data and information from other injection wells in the area).

Section 3

Survey Findings and Results

3.1 Introduction

The UIPRF's inventory and needs assessment survey (INAS) was designed to determine the interest and needs for potential implementation of a RBDMS in Class II UIC programs. The INAS, included in Appendix A, was specifically tailored to evaluate state needs in the combined areas of electronic data and environmental risk management.

The UIPRF selected five states (Alaska, Mississippi, Nebraska, North Dakota, and Texas), that had expressed an early interest in the concept of RBDMS and supported the idea of implementing environmental risk management practices into their state's UIC program. Detailed site visits of the five participating states were conducted and detailed summaries of each site visit were prepared and submitted to both the participating state and the UIPRF following the visit.

Section 3.2 contains individual details of each state's regulatory program with summaries of potential state-specific benefits; availability/commitment of personnel and financial resources; existing data management information; hardware and software information; and special needs that may exist.

Section 3.3 presents the results of INAS evaluations and applicable qualifying criteria for all the participating states. The results identify which states are interested in participating in implementation of a RBDMS; their willingness and capabilities to participate; overall anticipated training requirements; general presentation of state data management systems; and state inventory information. The presentation of the INAS data and information in this manner facilitates the evaluation of states' needs on both an individual and comparative basis.

3.2 Individual State Survey Results

The data management needs of the 25 states are summarized below. Information was derived from the INAS, telephone calls to the state oil and gas directors and technical staff, and detailed site visits to five states.

These summaries are not intended to be a detailed plan or conceptual implementation plan (CIP) for Phase II of the project, but rather a general discussion of applicable findings gathered during the inventory and needs assessment phase of the RBDMS project.

Phase 2 of this project will include the building of a detailed CIP for each state prior to implementation. The CIPs will include detailed cost estimates, specific data management needs, a schedule to implement the RBDMS, potential program benefits, and co-funding agreements. The CIPs should include a description of exactly what will be provided to each state during the implementation process. Development of a CIP will require detailed site visits with input from each state and the UIPRF.

Alabama

The Class II UIC program in Alabama is administered by the Alabama State Oil and Gas Board (ASOGB). Current inventories in Alabama include approximately 200 active Class II injection wells, 4,265 production wells, and 1,810 abandoned wells in Alabama. State-specific findings from the inventory and needs assessment follow.

Existing Data Management System Information

The ASOGB currently utilizes a PC based electronic data management system that incorporates some aspects of environmental risk management. The Alabama system currently tracks internal and external MIT data, compliance schedules for MITs, construction data and wellbore schematics for all Class II and oil and gas wells (including depths of injection intervals), types and volumes of fluids injected, annulus and injection pressure data, and maximum allowable injection pressures. The ASOGB also plans to incorporate data on USDWs and possibly confining zones into the system.

Regional ASOGB offices maintain duplicate paper file information for wells within their jurisdiction. However, all electronic well files are maintained in the Board's home office. Regional offices do not have access to the electronic data management system in Tuscaloosa, Alabama.

Resource Commitment

The ASOGB did not complete the portion of the survey regarding commitment of personnel or financial resources that would be available to assist with implementation of a RBDMS. Alabama currently has an estimated 1.2 full-time equivalents (FTEs) (approximately) committed to the UIC program and does not appear to have an immediate need for a RBDMS system.

Potential Benefits

- The existing electronic data management system utilized by the ASOGB currently meets the majority of the state's needs. However, the state would like to participate in the RBDMS project to enhance (or expand) their existing system to include additional aspects of environmental risk management.
- RBDMS implementation could provide a means of enhancing the existing system to allow for electronic data transfer from operators.

Special Considerations

- The ASOGB has expressed an interest in participating in the RBDMS project.