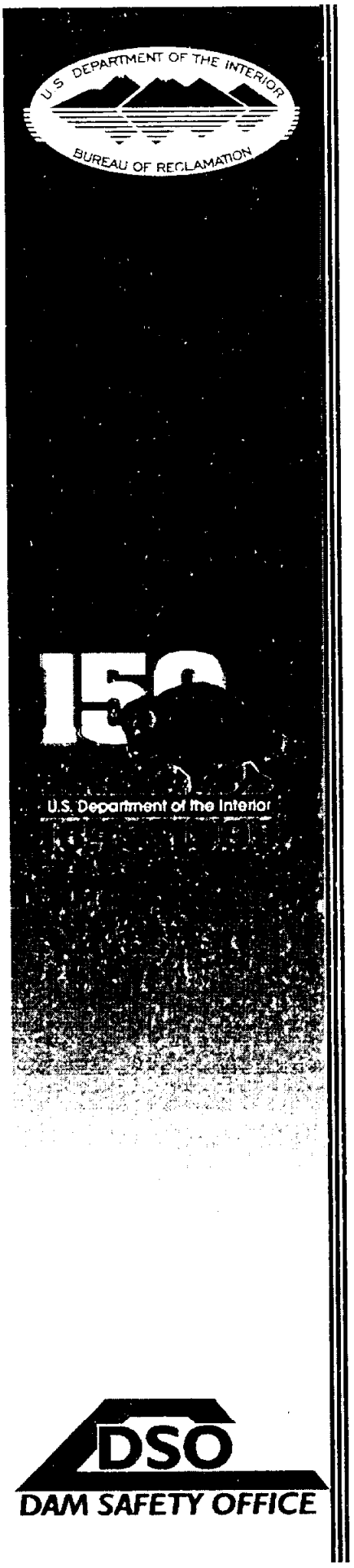

An Investigative Study and Evaluation of the Aggregate Database (Master's Thesis)

DSO-98-06

Materials Engineering and Research Laboratory

May 1997

An Investigative Study and Evaluation of the Aggregate Database
DSO-98-06

by
Jeff Morris
Forward by David W. Harris, Ph. D., P.E.

U.S. Department of Interior
Bureau of Reclamation
Dam Safety Office
Denver, Colorado

May 1997

Foreword

Concrete is primarily composed of three ingredients: aggregate, water, and cement. Aggregates constitute about 75% of any concrete mixture. Concrete is used in almost all Reclamation structures in some form.

To make quality, economical, concrete Reclamation has tested numerous aggregate sources throughout the western US. Over Reclamation's 90 plus years of making concrete and testing aggregate sources, the Materials Engineering and Research Laboratory group has compiled an extensive source of data on aggregate physical properties. Until recently, all the data was on paper and not readily available for comprehensive analysis.

An electronic data base was clearly desirable. The data base would be an effective way to store and rapidly access the data. It would also make performing comprehensive analysis and mapping aggregate statistics and locations much more practical. General trends and site specific characteristics were both desirable.

Reclamation established an electronic database, and began entering data. The Center for Aggregate Research at the University of Texas, Austin, Reclamation, and the Jefferson County JETS program formed a cooperative effort to organize and enter data into the data base. This volume provides an authorized copy of the Master's Thesis by Jeff Morris which documents efforts made in this cooperative effort

David W. Harris
Group Manager, Materials Engineering and Research Laboratory.

An Investigative Study and Evaluation of the Aggregate Database

by

Jeff Kent Morris, BSCE

Thesis

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Master of Science in Engineering

The University of Texas at Austin

May 1997

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by

Jeff Morris

1997

Jeff Morris
P.O. Box 21500
Denver, CO 80221

Rocky Mountain Prestress

March 27, 1998

Attn: Mr. Kurt von Fay D-8180
Bureau of Reclamation
P.O. Box 25007
Denver, CO 80225

Dear Mr. Von Fay:

I, Jeff Morris, hereby give the United States Bureau of Reclamation authorization to release my thesis entitled "An Investigative Study and Evaluation of the Aggregates Database" to whomever they wish.

Sincerely,

Jeff Morris
Engineer

An Investigative Study and Evaluation of the Aggregate Database

Approved by
Supervising Committee:

Dedication

This thesis is humbly dedicated to my parents, Kent and Judy Morris, without whom this thesis would not have been possible; and to my fiancee, Heather Kalb, who has loved and supported me during the duration of this project.

Acknowledgements

First and foremost, I would like to thank Jesus Christ for giving me the strength, endurance, and desire to write this thesis. His faithfulness and unconditional love have been a well-spring to my soul.

Much gratitude goes to my supervising committee consisting of Dr. David Fowler and Dr. Ramon Carrasquillo. Special thanks go to Dr. David Fowler for providing me with funding and for his invaluable suggestions, guidance, and advice.

Special thanks go to my fiancee, Heather Kalb, who has faithfully stood by my side for the past year. I would also like to thank my family, Kent and Judy Morris, Brian and Dana Morris, and my nephew Cameron for their love and support.

Thanks go to Kurt von Fay at the Bureau of Reclamation for his invaluable assistance and information. Great appreciation also goes out to those who I worked with at Reclamation.

Much gratitude goes to those who had to put up with me living in their homes or apartments: Pat and Gina Brown, John Jazesf, Larry and Diane Kalb, Jesse Davidson, Ben Thengvall, Carlos Martinez, and Jimmy and Patricia Mott.

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March 31, 1997

Abstract

An Investigative Study and Evaluation of the Aggregate Database

Jeff Kent Morris, MSE

The University of Texas at Austin, 1997

Supervisor: David Fowler

The United States Bureau of Reclamation has developed the first electronic library of aggregate data entitled the "Aggregate Database". The International Center for Aggregates Research (ICAR) at the University of Texas at Austin entered into a cooperative agreement with Reclamation and the Federal Highway Administration to further develop and maintain the Aggregate Database. The Aggregate Database is a relational database that consists of aggregate data including location of the aggregate source, physical properties of the aggregate, concrete data such as freezing and thawing and alkali-aggregate reactivity results, and petrographic results. The Aggregate Database is in its infancy and there are limitations and drawbacks. Therefore, ICAR distributed a survey to determine the

needs of professionals in the aggregates industry in terms of a database consisting of aggregate data, the effectiveness of the Aggregate Database in fulfilling those needs, and improvements that need to be made to the database. According to the results, users need a database of aggregate data to find suitable aggregate, have a listing of aggregate sources, and perform comprehensive analyses on the data. The results also show that the Aggregate Database is effective at meeting the needs of the user. However, there are many improvements that need to be made to the database to make it more effective and efficient. Therefore, a set of recommendations has been developed to provide ICAR and Reclamation with a comprehensive list of recommended improvements.

Table of Contents

List of Tables

List of Figures

Chapter One: Introduction

1.0 Introduction

Aggregates make up the largest component of concrete and asphalt structures and roadways. Many businesses and government organizations have thousands of aggregate quality records stored in file cabinets and notebooks around the world. Because considerable time, money, and effort go into finding these records, a comprehensive database would not only make it easier for engineers to find aggregate data, but would also aid in reducing the life cycle and maintenance costs of structures that contain a large amount of aggregate quality data.

The United States Bureau of Reclamation (Reclamation) has responded to this need by developing the first electronic library or Aggregate Database, in which aggregate quality records are stored in a computer. The International Center for Aggregates Research (ICAR) at the University of Texas at Austin (UT) has entered into a cooperative agreement with Reclamation and the Federal Highway Administration (FHWA) to further develop and maintain the Aggregate Database.

1.1 Statement of Problem

The Aggregate Database has the potential to be a very important, useful tool for those seeking aggregate quality data. Currently, however, the Aggregate Database is coming out of the "primordial slime" (Harris 1996). In other words, the database is in its infancy and needs time and effort to make it effective and efficient.

In order for this database to be efficient and effective, it is crucial that the database be user friendly and meet user needs. However, the database does not currently meet all the needs of the user. The database has limitations such as inefficient and difficult searches, ambiguous record references, nonexistent comprehensive analysis options, etc. These limitations not only deter users from using the database, but also hinder businesses and organizations from contributing their aggregate records to the database.

1.2 METHODOLOGY

The readily apparent limitations of the database necessitate the need to effectively evaluate it. The Aggregate Database has been evaluated by professionals in the aggregate industry. Surveys were sent out to twenty-seven professionals and there were 12 responses. The professionals were asked to subjectively rate the performance of the database in various areas such as navigation, practicality, and user friendliness and to answer general questions about databases and the uses of the Aggregate Database. From the results of the surveys, recommendations have been given to improve and modernize the database.

1.3 THESIS OBJECTIVES

The three objectives for this thesis are as follows:

- To document the existence of the Aggregate Database
- To evaluate the efficiency and effectiveness of the database
- To make recommendations that will improve and modernize the database

The background and development of the database will serve as a foundation for future work on the database by documenting the history, purpose, and methodology behind its creation. The results and recommendations will provide guidance and direction to those working to make the database more efficient and effective.

1.4 SCOPE

This thesis addresses and discusses issues and topics directly related to the Aggregate Database. Topics to be discussed include:

- Databases
- Relational databases
- History and methodology behind the Aggregate Database
- Survey methodology
- Evaluation and results of the survey
- Conclusions about the Aggregate Database
- Recommendations on ways to improve the Aggregate Database

The thesis provides a background through a discussion on databases and relational databases and the history and methodology behind the Aggregate Database. After the methodology section, the survey methodology and results are discussed. From the results of the survey, conclusions and recommendations are given to improve and modernize the Aggregate Database.

Chapter Two: Databases and the Aggregate Database

2.0 INTRODUCTION

Over the years databases have become a very important and effective data management tool. The Bureau of Reclamation (Reclamation), for instance, has begun to put all of their aggregate quality records into a database, titled the Aggregate Database. The Aggregate Database is a relational database that is an invaluable resource for the employees of Reclamation and could possibly be a useful tool for other organizations and businesses.

The purpose of this chapter is to discuss background topics relevant to the Aggregate Database. The topics are as follows:

- Qualities, advantages, and disadvantages of databases
- The relational model
- Key concepts of a relational table
- Structure of a relational database
- Function of a relational database management system (RDBMS)

The chapter begins with a discussion of databases and then narrows down to relational databases because the Aggregate Database is a relational database. This chapter discusses many key concepts and defines key words that are mentioned throughout the thesis. The next section defines a database and discusses qualities, advantages, and disadvantages of a database that are discussed with respect to the Aggregate Database in Chapter 5.

2.1 WHAT IS A DATABASE?

A database is simply an electronic filing cabinet (Date 1986). Wertz defines a database in the following manner: "a database is a logically organized and structured collection of interrelated data stored together without unnecessary redundancy to serve multiple applications and diverse and changing information requirements" (Wertz 1989). In other words, a database helps the user manage data.

Wertz's definition highlights some key qualities a database should possess to be effective and efficient. These qualities and others given by Saunders (1992) are summarized in the following section (Table 2.1).

2.1.1 Qualities of an Effective and Efficient Database

Table 2.1 Qualities of an Effective and Efficient Database (Wertz 1989, Saunders 1992)

Has a logical structure
Contains organized data
Is compact
Contains interrelated data
Is flexible
Has a user friendly interface
Is cost-effective
Is quick

- *Has a logical structure*

A logical structure saves the user time because the data is arranges in a self-explanatory manner. This allows the user to easily and quickly locate desired data. For example, the Aggregate Database is structured so that the main data form contains all the general information about an aggregate sample and provides links to test results of seven major categories. Figure 2.1 shows the main data form with the links at the bottom of the form. This format is logical because there are seven major categories of aggregate test results, and the results from all the tests cannot be placed on one form; therefore, there are links to forms that contain specific test data.

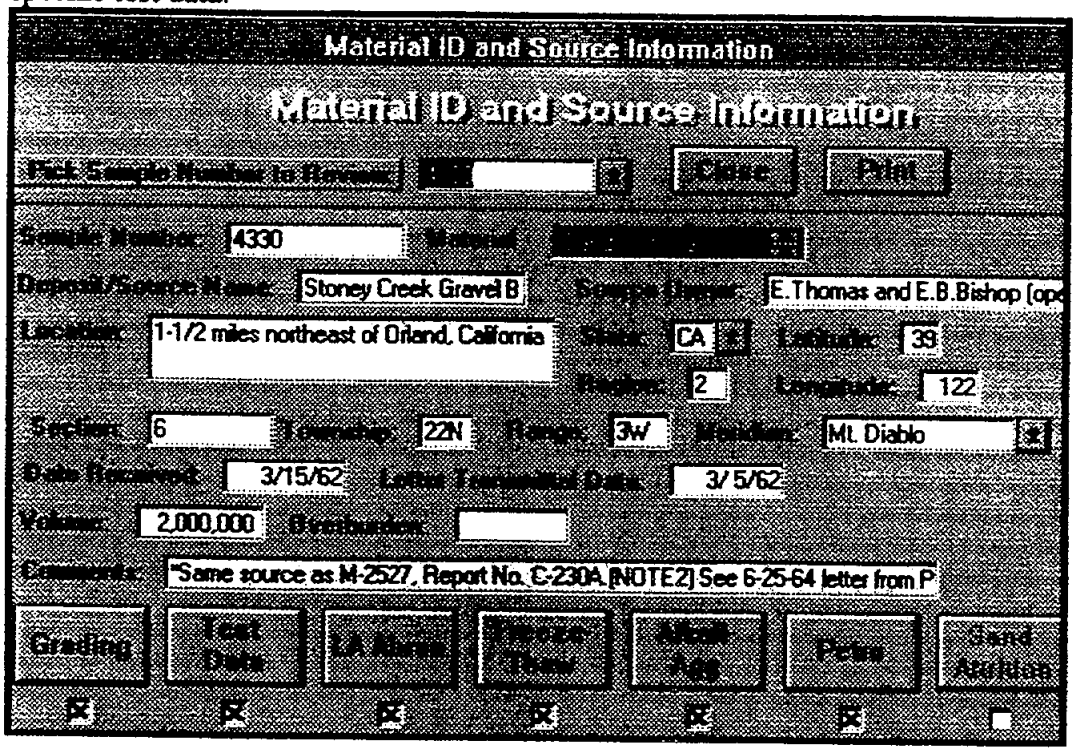


Figure 2.1 Main Data Form of the Aggregate Database

- *Contains organized data*

Organized data show the user the relationship among the data. For example, a user of the Aggregate Database can logically deduce that the buttons at the bottom of the main form are links to a distinct set of data about that specific sample number.

Organized data also save time in searching for specific data. For example, the *LA Abrasion* table, shown in Figure 2.2, is very organized and self-explanatory.

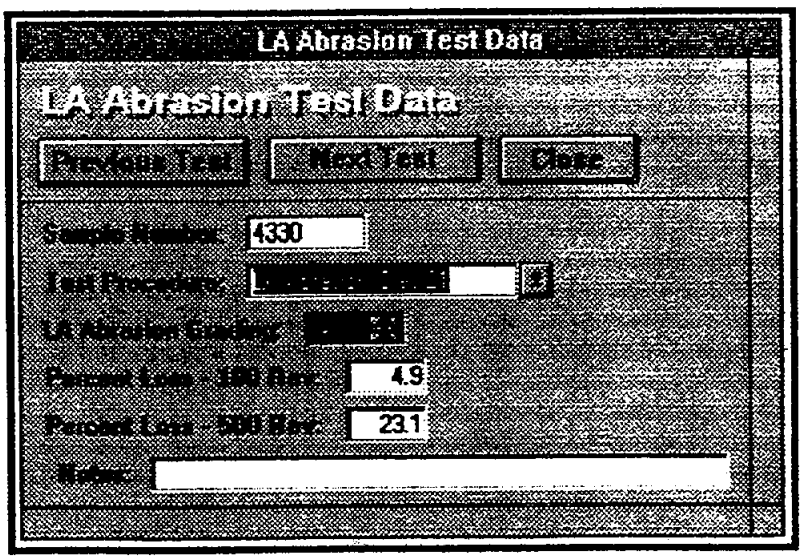


Figure 2.2 LA Abrasion Table of the Aggregate Database

- *Is compact*

A compact database will eliminate redundant data and minimize the storage of inconsistent data (Jackson 1988). Redundant data are multiple copies of the same data stored in a different location. Redundant data increase the size of the database and, therefore, increases the difficulty of locating specific data specified

by the user. For example, if the Aggregate Database contained two aggregate samples with the same sample number, the database would not know which one the user wanted.

Inconsistent data do not conform to the requirements laid down by the database designer. For example, entering the date as *January 1, 1997* may not be acceptable to the database, but the form, *010197*, may be acceptable.

- *Contains interrelated data*

The data contained in a database must be related. For example, the Aggregate Database only contains data that are related to the aggregate samples.

- *Is flexible*

A database must give the user as much freedom as possible. For example, the database must allow users to update data in existing files, add new files, delete files, retrieve data from existing files, etc.

- *Has a user friendly interface*

The database interface must be simple and easy for the user to understand. Schneiderman, in his book *Designing the User-Interface: Strategies for Effective Human-Computer Interaction* (Schneidermann 1987), says that a user-interface should have a consistent format, allow for use of shortcuts, give informative feedback, minimize user error, allow for reversal of actions, and minimize short-term memory load.

- *Is cost effective*

Creating a database, in most cases, is a long-term investment. A database requires maintenance on a continual basis in order to stay current with technology

and the ever-changing user demands. Therefore, the life cycle cost must be thoroughly analyzed to determine if the database yields more than the investment.

- *Is quick*

The database needs to disseminate information faster than the average person is willing to wait.

These key qualities should be represented in and by a database. Some of the qualities are intrinsic to the database such as logical structure and organized data while others are extrinsic to the database such as cost-effectiveness and usefulness. Nevertheless, all of these qualities combined will form an efficient and effective database.

Effective and efficient databases have advantages and disadvantages. The advantages are the reasons and justifications for the creation and continual operation of databases while the disadvantages are those items that database designers want to minimize. The following two sections discuss the advantages and disadvantages of databases.

2.1.2 Advantages of Databases

The advantages of a database are summarized on the next page (Table 2.2 for a summary).

- *Eliminates need for paper files*

Paper files and record collections can become quite extensive and demand considerable time to sort through. This problem is alleviated by an electronic library (database) that stores records and files. A database system reduces the amount of paper work and the space needed to store paper records and files.

- *Allows multiple users to view data*

Most databases allow many users to view data at the same time, thus reducing the hassles involved with having the database on one computer.

Table 2.2 Summary of the Advantages of Databases

Eliminates need for paper files
Allows multiple users to view data
Reduces amount of tedious work
Provides quick access to current information
Improves data management
Has comparatively low start-up costs
Provides users with capability to extract more information from the same amount of data
Allows data (files or records) to be easily updated and modified

- *Reduces amount of tedious work*

Database systems minimize tedious work such as filing records, hand writing records and data sheets, searching for files, cataloging files, etc.

- *Provides quick access to current information*

A database system provides the user with quick access to a large amount of data and current information. Once users become familiar with the database, searching for files and records is much faster and more convenient. A database system usually contains current information, depending on the organization and those in charge of the database system.

- *Improves data management*

A database system eliminates two data management issues: where to store the data and who is responsible for the data. The data will be stored in the database and the database coordinator will be responsible for all data input into the database. The database also allows the database coordinator to easily enforce data management issues, e.g. who can and can not view the data and what data are to be added, deleted, archived, etc.

- *Has comparatively low start-up costs*

The start-up cost of a database system is relatively small when compared to the long-term costs accrued by such a system. Start-up costs are associated with getting the database up and running. These expenses include hardware (computer, program, printer, etc.) and man-hours.

- *Provides users with the capability to extract more information from the same amount of data (Kroenke, 1983).*

Specific information can be gathered from a database system that would otherwise be difficult to obtain. For example, an employee of Reclamation has to find out the average percent silt on all the aggregate records Reclamation has in the state of Colorado. The employee goes to the Aggregate Database and runs a simple query; within seconds the number of Reclamation aggregate samples is displayed on the screen. If Reclamation did not have the Aggregate Database, the employee would spend hours and possibly days, searching through more than 2,200 records.

- *Allows data (files and records) to be easily updated and modified*

Clerical errors, on-going projects, and any changes made in the database system necessitate the need to easily update and modify data.

2.1.3 Disadvantages of Databases

The disadvantages of a database are summarized as follows (Table 2.3 for a summary):

- *Has potential to be very complex*

Many databases grow rapidly because users quickly see the potential of the database and continue adding more data and options. The database can quickly become very complex and hard to use.

- *Has increased vulnerability to failure*

As databases become larger and more centralized, more and more components are added to the system. As the number of components increases, the chances of a component failing increase. Failure of one component can lead to an entire system failure.

- *Requires users to be trained*

Databases can be difficult to use, and this necessitates the need to train individuals who will be using the database. Individuals using the database have to be taught the design methodology, contents of the database, shortcuts, and all options available to them as a user.

- *Requires long-term investment strategy*

A database is a long-term investment that needs to be developed and approved before the database is created.

Table 2.3 Summary of the Disadvantages of Databases

Has potential to be very complex
Has increased vulnerability to failure
Requires users to be trained
Requires long-term investment strategy
Requires considerable design and set-up time
Has potential for high operating and maintenance costs

- *Requires considerable design and set-up time*

Considerable time and thought are needed to develop an effective database. The design and implementation stage is perhaps the most intense part of a database development process. Most of the crucial decisions made concerning the methodology behind the creation of the database, occur during the design stage. The implementation stage involves a great deal of time to be invested in developing the database.

- *Has potential for high operating and maintenance costs*

Databases require care and upkeep for their entire lifetime because user and organization demands change. Therefore, databases have the potential for high operating and maintenance costs.

Although databases can be very valuable in managing a large amount of data and have many benefits, there are also many disadvantages, but with proper planning and design, these disadvantages can be minimized and sometimes eliminated. These advantages and disadvantages are discussed with respect to the Aggregate Database and discussed in detail in Chapter 5.

The Aggregate Database is a relational database, which has two distinct advantages over traditional flat file databases, such as hierarchial and network databases. Relational databases are easier to use and have more flexibility than the other types of databases and they follow the relational model. The following section describes the relational model and explains the key concepts of a relational table.

2.2 THE RELATIONAL MODEL

"The relational model is a way of looking at data" (Date and Darwen, pp 9, 1992). In other words, the relational model shows how data are represented in the database. The relational model is an implementation of the set theory and can be depicted by a Venn Diagram (Figure 2.3). As shown in Figure 2.3, data are contained in each Set (A, B, and C). Set A and Set B overlap indicating that these two sets have a common denominator and thus they are interrelated. The relationship between these two sets illustrates the principal behind the relational model. The relational model consist of two or more relations, all containing data.

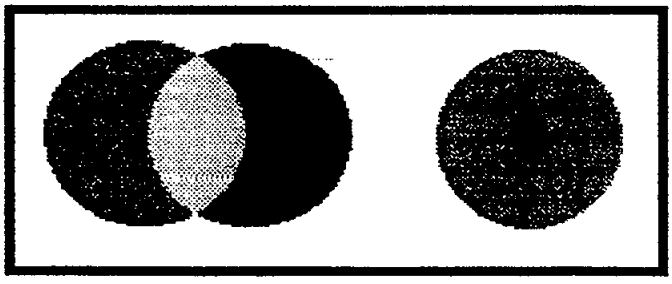


Figure 2.3 The Relational Model in Terms of Set Theory (Venn Diagram)

A relation or set of data is commonly stored in the form of a two-dimensional table that consists of a set of columns and rows. The next section defines and discusses the main components of a relational table.

2.2.1 Main Components of a Relational Table

- A *relational table* is a container for data in the form of columns and rows (Figure 2.4).
- A *record*, also called a row, contains unique data that relate to a specific object (Saunders 1992). For example, in Figure 2.4, M-1565 is the object of the data stored in that row. Each row is unique; therefore, no two rows in a relational table are identical. If the sample number M-1565 in Figure 2.4 were listed twice, then the database would not know how to distinguish between the two.

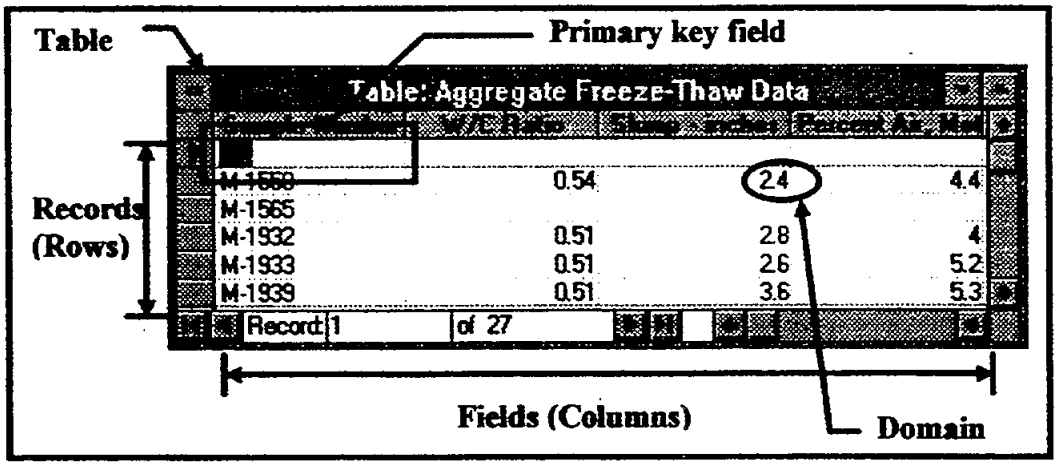


Figure 2.4 Relational Table (taken from the Aggregate Database)

- A *field*, also called a column, contains data that describe an attribute of the object in the row. For example, in Figure 2.4, "W/C Ratio" describes the data

contained in that field for the record M-1565. The field sequence in a relational database is insignificant (Fleming and Von Halle 1989), thus allowing users to retrieve data from fields in any order (Microsoft 1994). If the field sequence was important, then the data in these columns would be prioritized, thus making it difficult to retrieve data in a certain field.

- A *domain* is the specification or pool of values that can appear in a particular field. For example, in Figure 2.4, the circled value 2.4 represents a value in a specified domain. The domain of this field has been specified as any integer; therefore, only an integer can be placed in the *Slump-inches* field.
- A *primary key* is a field or set of fields that uniquely identifies each record stored in a table (Microsoft 1994). For example, the primary key in Figure 2.4 is the sample number field. The sample number field is the unique identifier of all records in the database, just as a social security number is a unique identifier of American citizens.

The record, field, domain, and primary key are the main components of a relational table, which is the basic component of a relational database. The next section defines and discusses relational databases.

2.3 Relational Database

A relational database consists of at least two relational tables that contain all the information in the database. All of the relational tables in a relational database are related, just as Sets A and B are in Figure 2.3. There are common denominators (relations) among the relational tables; Figure 2.5 shows the common denominators among the tables in the Aggregate Database.

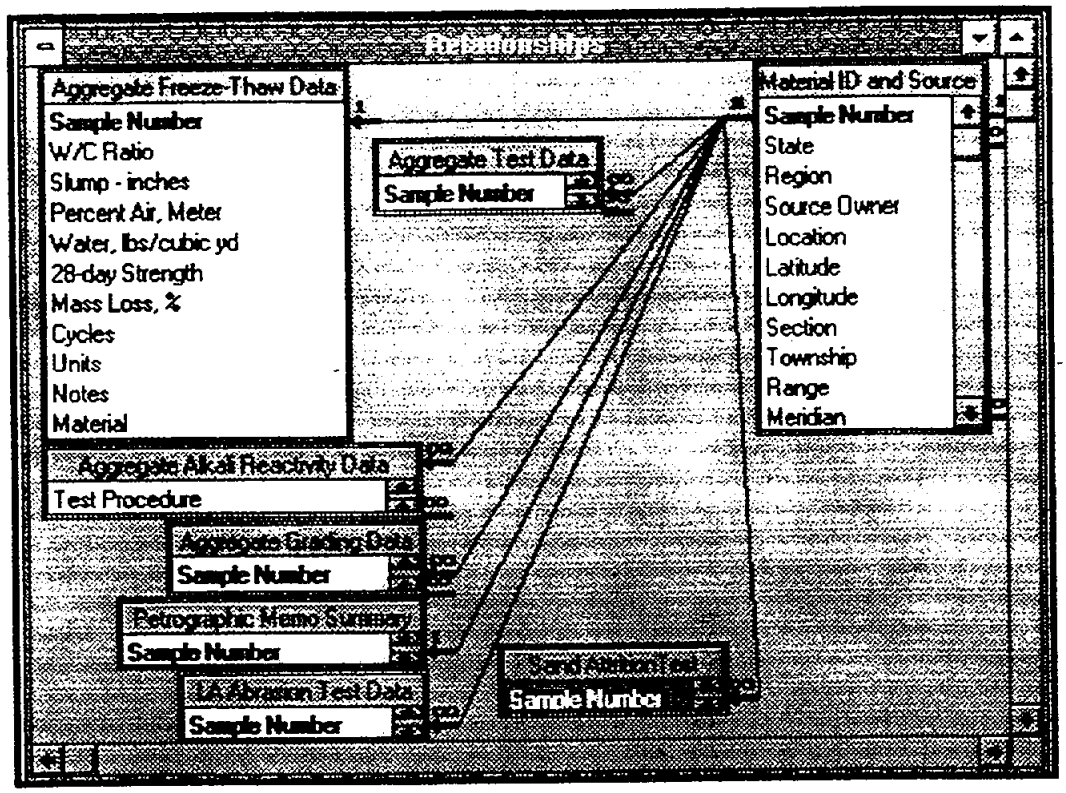


Figure 2.5 Example of Relations in a Relational Database (taken from the Aggregate Database)

The *Sample Number* field is the main common denominator between tables in the Aggregate Database. The *Material ID and Source* table and the *Aggregate Freeze-Thaw Data* table are related by a primary key field, the *Sample Number* field. If these two tables did not share the *Sample Number* field, then a relationship could not be established, and thus, the database would not be functional.

As seen from Figure 2.5, relational tables are the backbone of a relational database. The question arises, "How can information be extracted from the tables in the database?". The answer is a relational database management system

(RDBMS) allows the user to extract the information. The next section discusses the functions of a relational database management system and explains its interaction with the database and the computer.

2.4 Relational Database Management System (RDBMS)

A RDBMS is software that allows the user to communicate with the database (Delobel and Adiba 1985). The database stores all the data in computer format, and the RDBMS converts the data into a form that is meaningful to the user. The interaction among the RDBMS, database, and computer is shown in Figure 2.6.

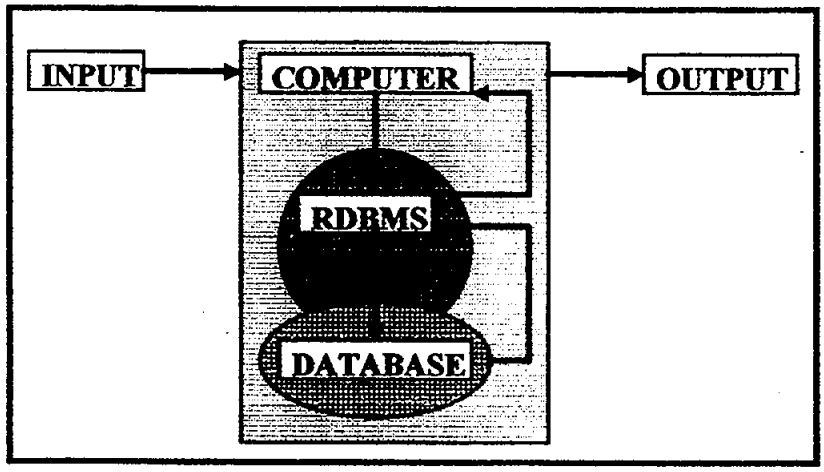


Figure 2.6 Graphical Representation of the Relationship Among the Computer, RDBMS, and Database.

The process begins when a user requests information from the computer. The computer then sends the request to the RDBMS, which extracts and organizes

the data from the database and sends the information to the computer to be displayed for the user.

A RDBMS performs other functions in addition to providing the communication link between the database and the user. All of the functions of a RDBMS are summarized in Table 2.4, with a brief description of each one except the first one.

Table 2.4 Important Functions of a Relational Database Management System (RDBMS)

Provides communication link between the database and the user
Enforces data integrity and security rules
Allows user to create data tables, modify existing data tables, and add, modify, delete, and retrieve data
Allows user to run queries and develop customized reports, screens, and summaries

- *Enforces data integrity and security rules*

Data integrity is "the accuracy and validity of data in an application relative to the requirements of the business" (Saunders, pp 14, 1992). The RDBMS must ensure that the data are valid and accurate. For example, when a date is entered in the format xx-xx-xx, the RDBMS has the responsibility to ensure that the characters entered are numbers and in that specific format. If the numbers entered are not in that format, then the RDBMS should reject the data and allow the user another opportunity to enter the date.

Data security is the control a RDBMS exerts over who has access to certain functions and information in the database (Saunders 1992). The RDBMS must restrict the number of users allowed to add, modify, and delete data. These restrictions are instrumental to maintaining accuracy, validity, and integrity of the data. Data entry and modification errors do happen, but these errors can be reduced by limiting those with access to the add, modify, and delete functions.

Information security is another restriction that has to be implemented and controlled by the RDBMS. "Right to access" must be enforced so that confidential information is only viewed by authorized personnel.

- *Allows user to create data tables, modify existing data tables, and add, modify, delete, and retrieve data*

These RDBMS functions allow the database to expand and change. A rigid RDBMS that does not include these functions will quickly render the database obsolete.

- *Allows the user to run queries and develop customized reports, screens, and summaries*

Queries, reports, screens, and summaries allow the user to obtain customized output, which is perhaps the most beneficial function of an RDBMS because it provides users with specific information quickly.

Microsoft Access is a RDBMS for the Aggregate Database that performs all of the functions already mentioned. Microsoft Access was chosen because it is inexpensive, powerful, and easy to use.

2.5 SUMMARY

Relational databases have become very valuable in this day and age. More and more companies and organizations, such as Reclamation are using relational databases to manage data more effectively. Reclamation has begun to place all of its aggregate quality records into the Aggregate Database, a relational database. Chapter 3 focuses on what Reclamation has done with the Aggregate Database by discussing the following topics: the history, structure, and contents of the database, and methodology used in designing and creating the database.

Chapter Three: Development of the Aggregate Database

3.0 History of the Aggregate Database

The idea for an Aggregate Database stemmed from a Reclamation (Bureau of Reclamation) study in which the MERL (Materials Engineering Research Laboratory at Reclamation) group had to compute the average of aggregate properties for a large set of aggregate data. This task proved to be very difficult and time consuming since the aggregate records (estimated to be over 3,000 records) were on data sheets located in seven volumes.

The Aggregate Database remained only an idea for five years, due to lack of funding and complex programming required to create such a database. However, in the fall of 1994, Reclamation recognized the improvement in database software packages and decided the time was right to create a database that would contain all of their aggregate records.

By the end of that year, the tables and input forms for data entry were completed. Unfortunately, due to a lack of funding, the Aggregate Database became an on-the-side project. At this time, Reclamation began looking for sources of funding for the project. As a result of their search, Reclamation entered into a joint partnership, in 1996, with the International Center for Aggregates Research (ICAR) at the University of Texas at Austin (UT) and the Federal Highway Administration (FHWA).

The partnership agreement divided the responsibilities between Reclamation and ICAR. The responsibilities set forth in the cooperative research

agreement (1996) are that "Reclamation would provide the major effort in the initiation of the project, database design, incorporation of Reclamation data, and evaluation of options to load data from other sources" and that the "University of Texas would provide the major effort in the long-term operation of the system, providing universal access and overall management of the project." The FHWA has provided funding to incorporate their aggregate data into the database, but the FHWA has no formal responsibilities towards the Aggregate Database.

The Aggregate Database was initially created to catalog Reclamation's vast amount of aggregate records, but the concept has since expanded to include aggregate data from any source. Reclamation has entered over 2,200 (out of an estimated 3,000+ aggregate records) of its own aggregate records and are currently incorporating the FHWA aggregate data. Reclamation and ICAR hope that aggregate data from the Corps of Engineers, state Departments of Transportation, and other organizations will be incorporated into the Aggregate Database.

3.1 Reasons for Reclamation Creating the Aggregate Database

The main goals that played a role in the creation of the Aggregate Database are as follows:

- Need to perform comprehensive analyses on a large set of aggregate data
- Reduction and possible elimination of boring and tedious work
- Cost savings realized by cataloging aggregate records in a database

These three goals can be illustrated in an example.

> An employee of Reclamation needs to determine the average specific gravity of all the aggregate records in the state of Colorado. The employee would go to the Aggregate Database and run a query asking the computer to create a list of all the samples in Colorado and their respective specific gravities. Seconds later, the list appears. The employee can now easily import this table into Microsoft Excel where the average can be determined.

If the Aggregate Database were not available to this employee, the employee would have to search through over 3,000 records to find all the aggregate records in Colorado and then have to hand copy all the specific gravity values. The database allows the user to easily perform a comprehensive analysis, eliminate the tedium of searching through thousands of records, and save Reclamation money by reducing the amount of man-hours necessary to complete the task.

3.2 Reclamation's Methodology Behind the Aggregate Database

When Reclamation decided to create the database, there were two primary questions that had to be addressed.

- What functions does this database need to have?
- What database model will adequately perform these functions?

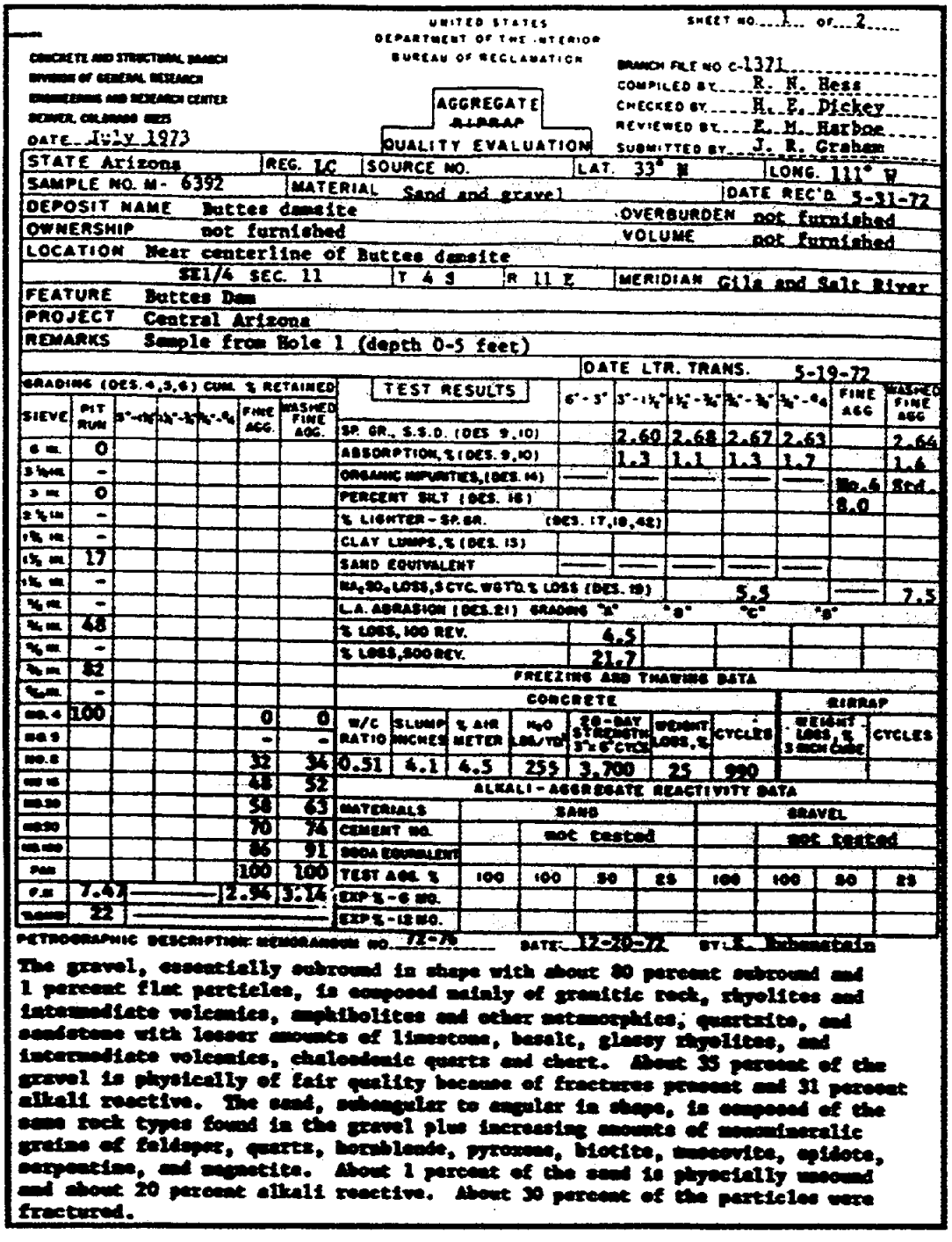
Reclamation wanted the database to store the aggregate data and allow easy retrieval in order to manipulate the data and perform statistical analyses. Reclamation decided that the aggregate data would best be represented in a relational database rather than in the traditional flat file database. In the relational

model, data can easily be sorted into logical tables and related through a common field, whereas in the flat file database, each record has to contain all the aggregate data because no relations can exist in the flat file structure (von Fay 1996). A flat file database would result in more blank space than actual aggregate data; therefore, the relational model was chosen for the Aggregate Database. Reclamation choose Microsoft Access because it is a powerful, inexpensive, and easy-to-use relational database software package.

3.2.1 Reclamation Aggregate Records

Reclamation aggregate records are fairly complex in that there is a lot of information on one page. Each aggregate record contains the following information (Figure 3.1):

- Reclamation information such as sample number and lab report number
- General information including the aggregate type, the producer, and the date the aggregate was analyzed
- Location of the aggregate source (state, region, latitude, longitude and in most cases, meridian, section, township, and range)
- Physical properties (specific gravity, absorption, organic impurities, percent silt, sodium sulfate loss, LA abrasion, and grading)
- In limited cases, concrete data (freezing and thawing resistance, alkali-aggregate test results)
- Petrography results



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

SHEET NO. 1 OF 2

CONCRETE AND STRUCTURAL BRANCH
DIVISION OF GENERAL RESEARCH
ENGINEERING AND RESEARCH CENTER
DENVER, COLORADO 80225

DATE July 1973

AGGREGATE
RIPRAP
QUALITY EVALUATION

BRANCH FILE NO C-1371
COMPILED BY R. N. Hess
CHECKED BY H. F. Dickey
REVIEWED BY E. M. Harboe
SUBMITTED BY J. R. Graham

STATE Arizona | REG. LC | SOURCE NO. | LAT. 33° N | LONG. 111° W
SAMPLE NO. M- 6392 | MATERIAL Sand and gravel | DATE REC'D 5-31-72
DEPOSIT NAME Buttes damsite | OVERBURDEN not furnished
OWNERSHIP not furnished | VOLUME not furnished
LOCATION Near centerline of Buttes damsite
SE1/4 SEC. 11 | T 4 S | R 11 E | MERIDIAN Gila and Salt River
FEATURE Buttes Dam
PROJECT Central Arizona
REMARKS Sample from Hole 1 (depth 0-5 feet)

DATE LTR. TRANS. 5-19-72

GRADING (DES. 4,5,6) CUML. % RETAINED

SIEVE	PIT RUN	3"-1½"	1½"-¾"	¾"-⅜"	⅜"-#4	FINE AGG.	WASHED FINE AGG.
6 in.	0						
3½ in.	-						
3 in.	0						
2½ in.	-						
1½ in.	-						
1½ in.	17						
1¼ in.	-						
⅞ in.	-						
¾ in.	48						
⅝ in.	-						
½ in.	82						
⅜ in.	-						
#4	100					0	0
#8						-	-
#16						32	34
#30						48	52
#50						58	63
#100						70	74
#200						86	91
Pan						100	100
F.M.	7.42					2.96	3.14
Sand Equiv.	22						

TEST RESULTS

	6"-3"	3"-1½"	1½"-¾"	¾"-⅜"	⅜"-#4	FINE AGG	WASHED FINE AGG
SP. GR., S.S.D. (DES 9,10)		2.60	2.68	2.67	2.63		2.64
ABSORPTION, % (DES. 9,10)		1.3	1.1	1.3	1.7		1.4
ORGANIC IMPURITIES, (DES. 14)	——	——	——	——	——	No. 4	Std.
PERCENT SILT (DES. 16)						8.0	
% LIGHTER - SP. GR. (DES. 17,18,48)							
CLAY LUMPS, % (DES. 15)							
SAND EQUIVALENT	——	——	——	——	——		
Na_2SO_4 LOSS, 5 CYC. WGTD. % LOSS (DES. 19)				5.5		——	7.5
L.A. ABRASION (DES. 21) GRADING "A" "B" "C" "D"							
% LOSS, 100 REV.		4.5					
% LOSS, 500 REV.		21.7					

FREEZING AND THAWING DATA

CONCRETE							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS./YD³	28-DAY STRENGTH 3"x6" CYLS.	WEIGHT LOSS, %	CYCLES	WEIGHT LOSS, % 3 INCH CUBE	CYCLES
0.51	4.1	4.5	255	3,700	25	990		

ALKALI-AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.	not tested				not tested			
EQUIVALENT								
TEST AGE, %	100	100	50	25	100	100	50	25
EXP. % - 6 MO.								
EXP. % - 12 MO.								

PETROGRAPHIC DESCRIPTION: HEADQUARTERS NO. 72-76 DATE: 12-20-72 BY: R. Rubenstein

The gravel, essentially subround in shape with about 80 percent subround and 1 percent flat particles, is composed mainly of granitic rock, rhyolites and intermediate volcanics, amphibolites and other metamorphics, quartzite, and sandstone with lesser amounts of limestone, basalt, glassy rhyolites, and intermediate volcanics, chalcedonic quartz and chert. About 35 percent of the gravel is physically of fair quality because of fractures present and 31 percent alkali reactive. The sand, subangular to angular in shape, is composed of the same rock types found in the gravel plus increasing amounts of monomineralic grains of feldspar, quartz, hornblende, pyroxene, biotite, muscovite, epidote, serpentine, and magnetite. About 1 percent of the sand is physically unsound and about 20 percent alkali reactive. About 30 percent of the particles were fractured.

Figure 3.1 Typical Reclamation Aggregate Data Sheet

Reclamation felt that the most logical method of representing the aggregate data sheets was to divide the data into eight sections: one section for general information and seven sections for the results of a specific test conducted on aggregate samples. Each section is represented by a relational table as shown in Figure 3.2. The *Material ID and Source Information* table contains the general

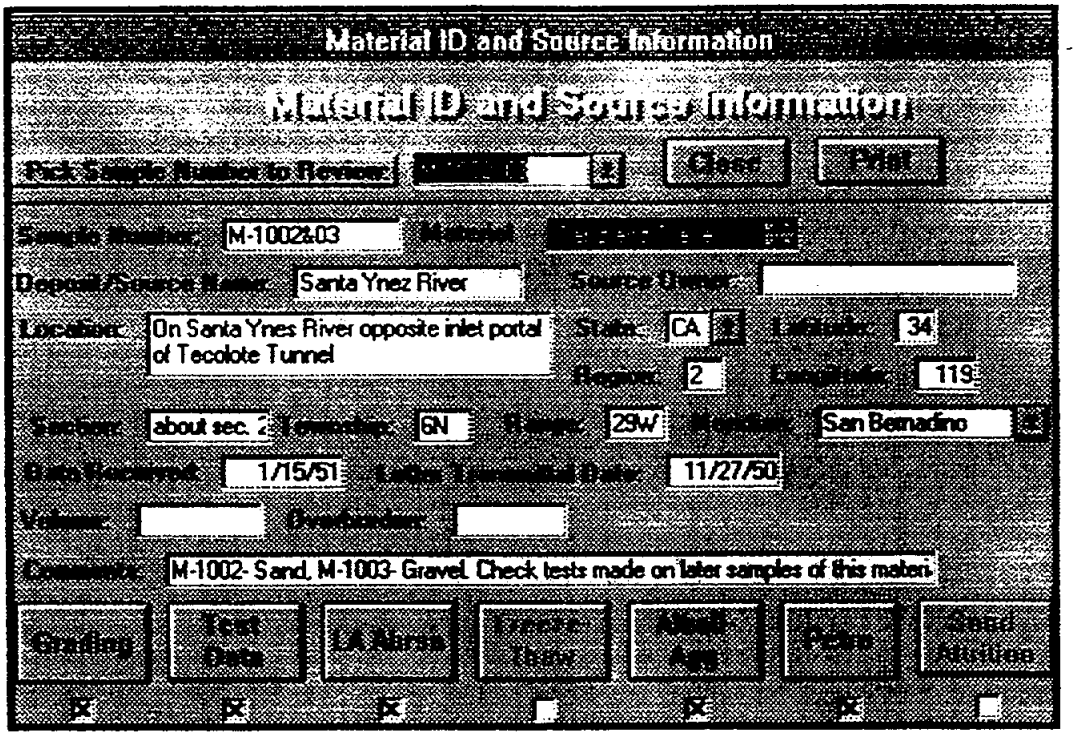


Figure 3.2 *Material ID and Source Information* Table in the Aggregate Database

information and links (located at the bottom of the form) to the other seven tables that contain specific test data. The following section discusses the relational tables in the Aggregate Database.

3.2.2 Relational Tables in the Aggregate Database

There are fifteen relational tables in the Aggregate Database which are categorized as primary and secondary tables, see Table 3.1. The primary tables contain aggregate data, and the secondary tables are lists for certain fields in the primary tables. The *Data Check* table, however, is classified as a secondary table but is not a list. The *Data Check* table provides a quick check to see what tests

Table 3.1 List of Primary and Secondary Tables

Primary Tables	Secondary Tables
1. Material ID and Source Information	1. States
2. Sand Attrition Test	2. Meridians
3. Aggregate Test Data	3. Test Procedures
4. Aggregate Grading Data	4. Aggregate Tests
5. Aggregate Alkali Reactivity Data	5. Type of Material
6. Aggregate Freezing Thawing Data	6. Type of Material1
7. LA Abrasion Test Data	7. Data Check
8. Petrographic Memo Summary	

have been conducted on an aggregate sample. The *Data Check* table lists all the sample numbers and indicates whether or not that sample number has test results for each of the seven tests.

The primary tables were created first, and then the secondary tables were created as needed. For example, after the *Material ID and Source Information*

form was created, it became apparent that, in order to expedite the data entry process, the *State* field in this form needed a list of all the states. The list that appears in the *State* field in the *Material ID and Source Information* form is stored in the *States* table (Figure 3.3). As shown in Figure 3.3, the data entry person selects the correct state, thus minimizing data entry error by eliminating the possibility of spelling errors and inconsistent entries.

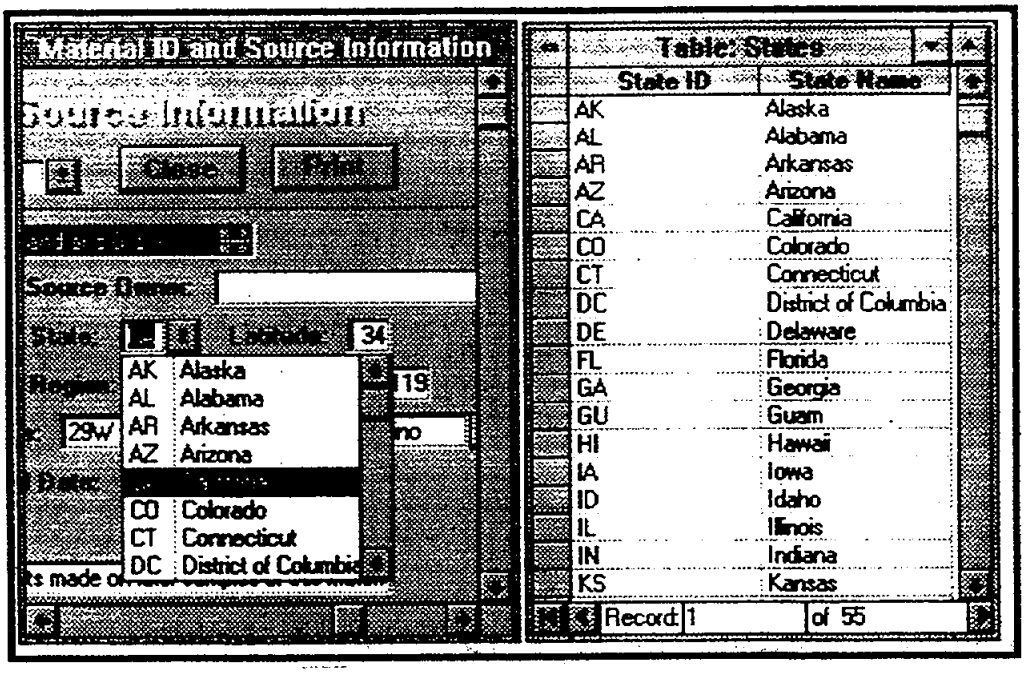


Figure 3.3 *States* Field of the *Material ID and Source Information* Form and the *States* Table.

3.2.2.1 Relationships

Every table in the Aggregate Database is linked to another table by a common field, thus creating a relationship (Figure 3.4). For example, the *Material*

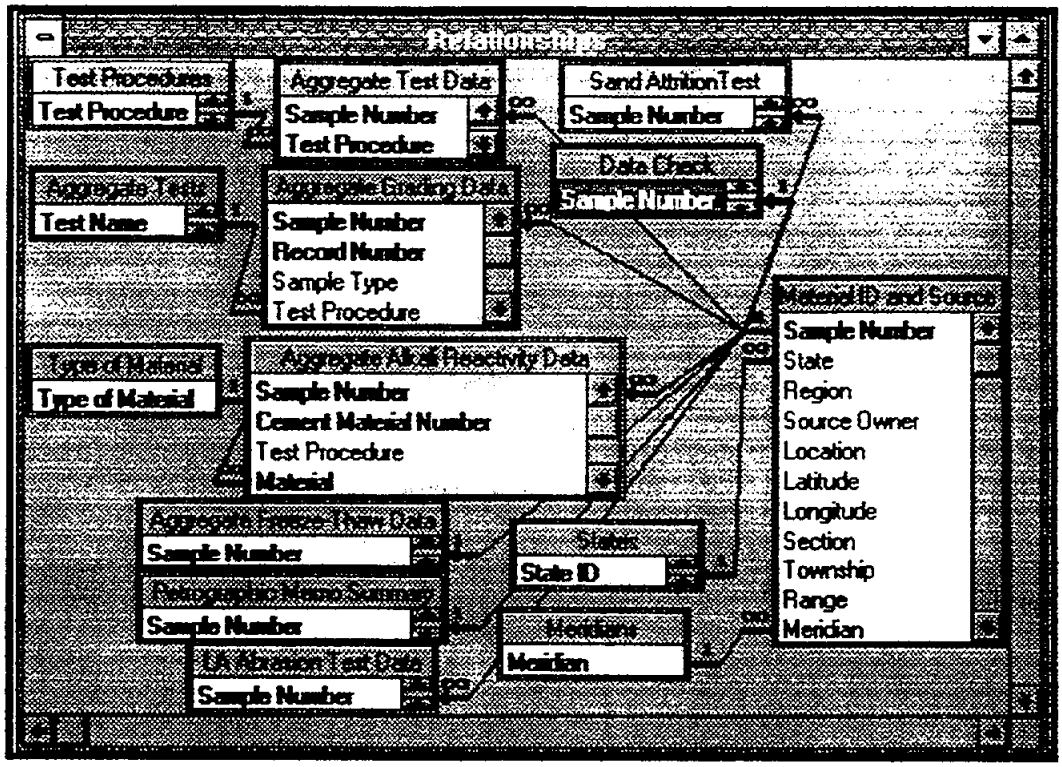


Figure 3.4 Relationships in the Aggregate Database

ID and Source Information table is linked to the *Aggregate Alkali Reactivity* table by the *Sample Number* field; thus, these two tables are interrelated.

Each primary table, with the exception of the *Material ID and Source Information* table, contains test results for a specific test performed on the aggregate source. For example, all the results of the Alkali-Aggregate Reactivity test are placed in the table entitled *Aggregate Alkali Reactivity Data*. The *Aggregate Test Data* table is the only exception to this rule. This table contains test results for several test procedures that determine various physical properties of the aggregate sample such as percent silt, specific gravity, etc.

As seen from Figure 3.4, the *Sample Number* field is shared by all of the primary tables. As mentioned in Chapter 2, the *Sample Number* field is the unique identifier of all the aggregate samples because it allows the user to view the general information of an aggregate sample in the *Material ID and Source Information* table as well as the test data for that specific sample number in the other seven tables.

These seven tables are linked to the *Material ID and Source Information* table, forming a "hub and spoke" pattern. Figure 3.5 shows the primary tables or spokes linked to the *Material ID and Source Information* table or hub.

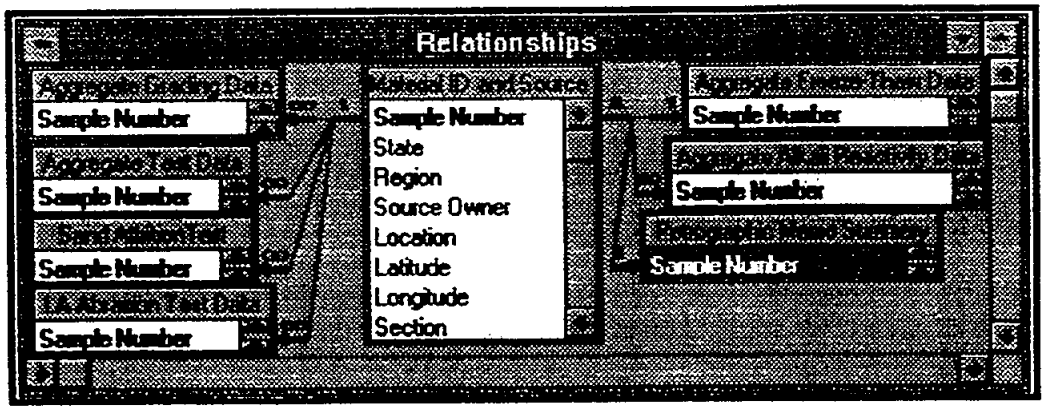


Figure 3.5 Hub and Spoke Pattern of the Aggregate Database

3.2.2.2 Fields

Each table in the Aggregate Database is comprised of many fields, all of which are listed with their respective table in Appendix A. The fields have been created for each data element contained in the original data sheet shown in Figure 3.1. For example, the petrographic test result on the data sheet has four data

elements containing information (Figure 3.6). The *Petrographic Memo Summary* table in the Aggregate Database has five fields (one element not shown in Figure 3.6 is the *Sample Number* field), each one representing one data element on the data sheet (Figure 3.7).

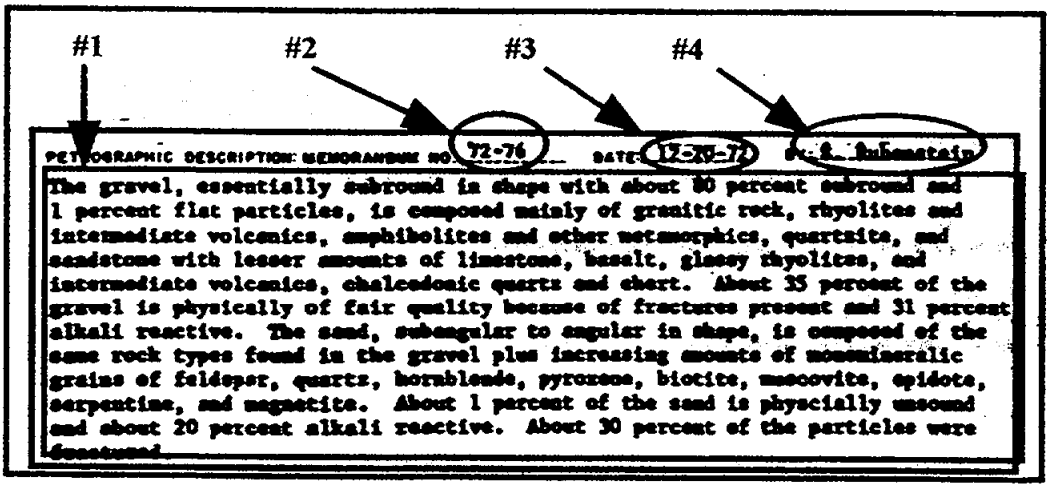


Figure 3.6 Petrographic Test Results on Data Sheet

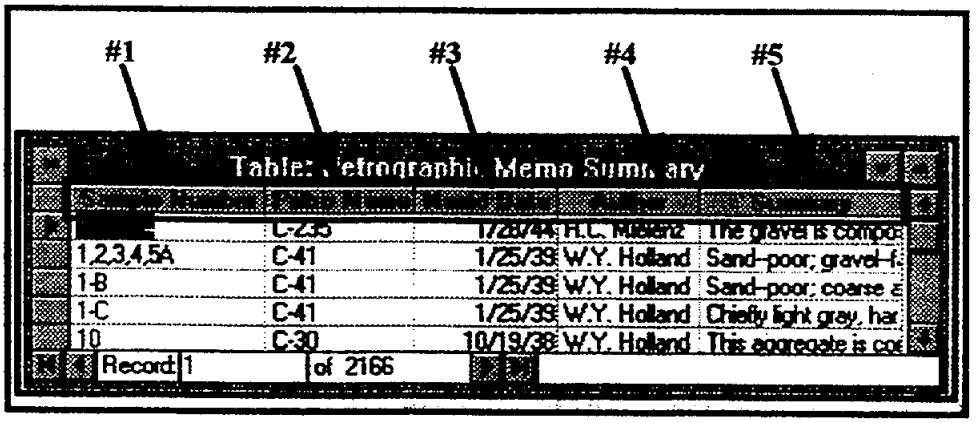


Figure 3.7 *Petrographic Memo Summary* Table in the Aggregate Database

Each field has a specified domain and description correlating to the type of data on the original data sheet. For example, the *Petro Number* field in the *Petrographic Memo Summary* table (Figure 3.8) has a "text" domain (called the "data type" in Microsoft Access) and a description stating that the field refers to the "ID number of Petrographic Memorandum."

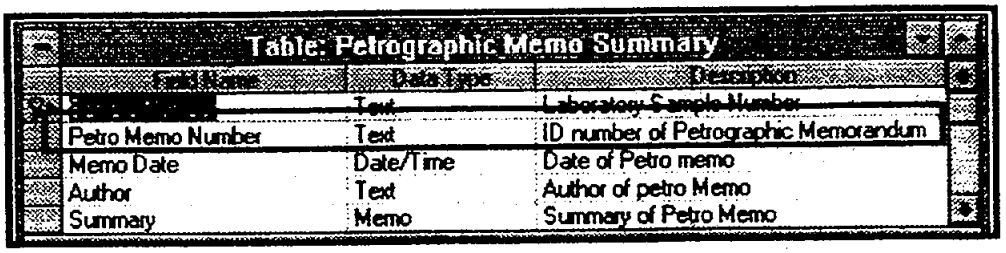


Figure 3.8 *Petrographic Memo Summary* Table with all the Fields, Domains, and Descriptions Listed.

3.2.3 Forms

Tables of data such as the *Aggregate Alkali Reactivity* table are suitable for the database but are very difficult for the user to comprehend (Figure 3.9).

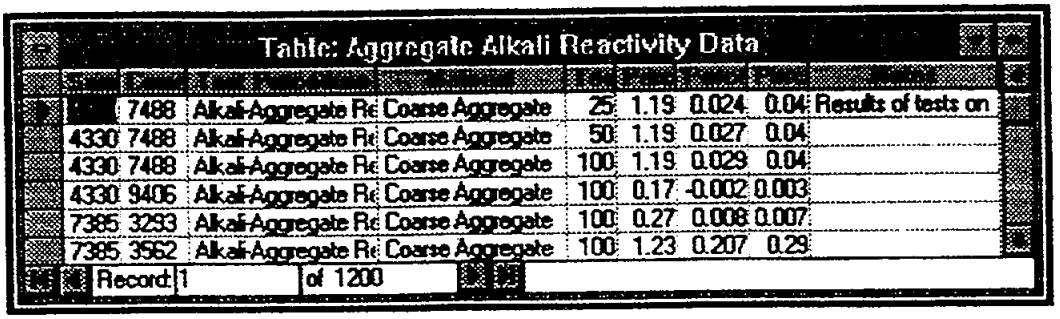


Figure 3.9 Table View of *Aggregate Alkali Reactivity* Test Results

Therefore, forms were created so that the user can view the data stored in the tables in a logical and consistent format (Figure 3.10).

All the forms in the Aggregate Database (listed in Appendix B) were created to closely resemble the structure of the original data sheet in order to expedite the data-entry process. For example, the fields in the *Aggregate Test Data* form are listed in the same order as on the data sheet, just rotated ninety degrees (Figures

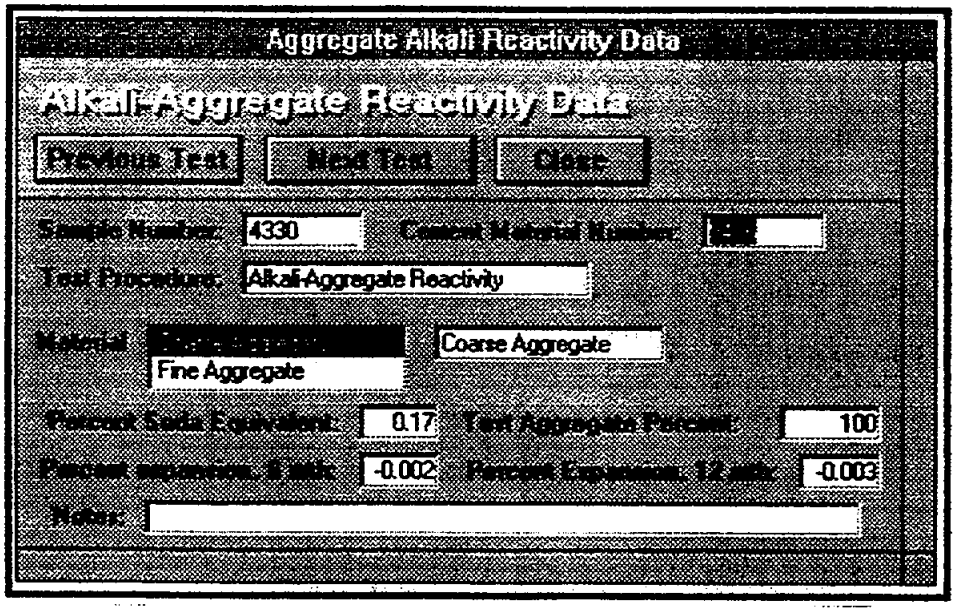
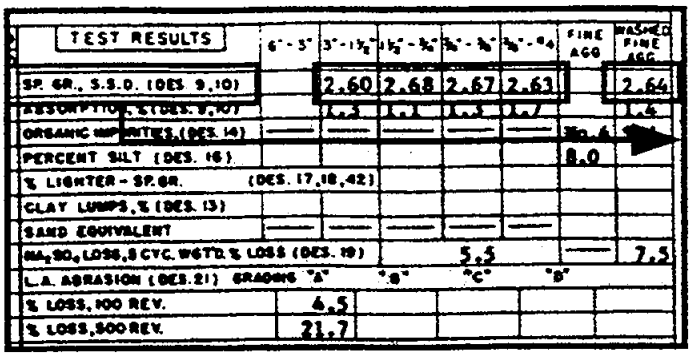


Figure 3.10 Form View of the *Alkali-Aggregate Reactivity* Test Results

3.11 and 3.12). The data-entry personnel read the type of test, enter the type of test in the form, read the next number, press the tab button to go to the corresponding field and then enter the data, and continue with the same procedure for the rest of the fields.



TEST RESULTS	6" - 3"	3" - 1½"	1½" - ¾"	¾" - ⅜"	⅜" - #4	FINE AGG	WASHED FINE AGG
SP. GR., S.S.D. (DES. 9, 10)		2.60	2.68	2.67	2.63		2.64
ABSORPTION, % (DES. 9, 10)		1.5	1.1	1.5	1.7		1.4
ORGANIC IMPURITIES (DES. 14)	—	—	—	—	—	No. 4	
PERCENT SILT (DES. 16)						8.0	
% LIGHTER - SP. GR. (DES. 17, 18, 42)							
CLAY LUMPS, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
$MgSO_4$ LOSS, 5 CYC. WGTD. % LOSS (DES. 19)				5.5		—	7.5
L.A. ABRASION (DES. 21) GRADING "A"		"B"		"C"		"D"	
% LOSS, 100 REV.	4.5						
% LOSS, 500 REV.	21.7						

Figure 3.11 Specific Gravity Results for M-6392 on Original Data Sheet

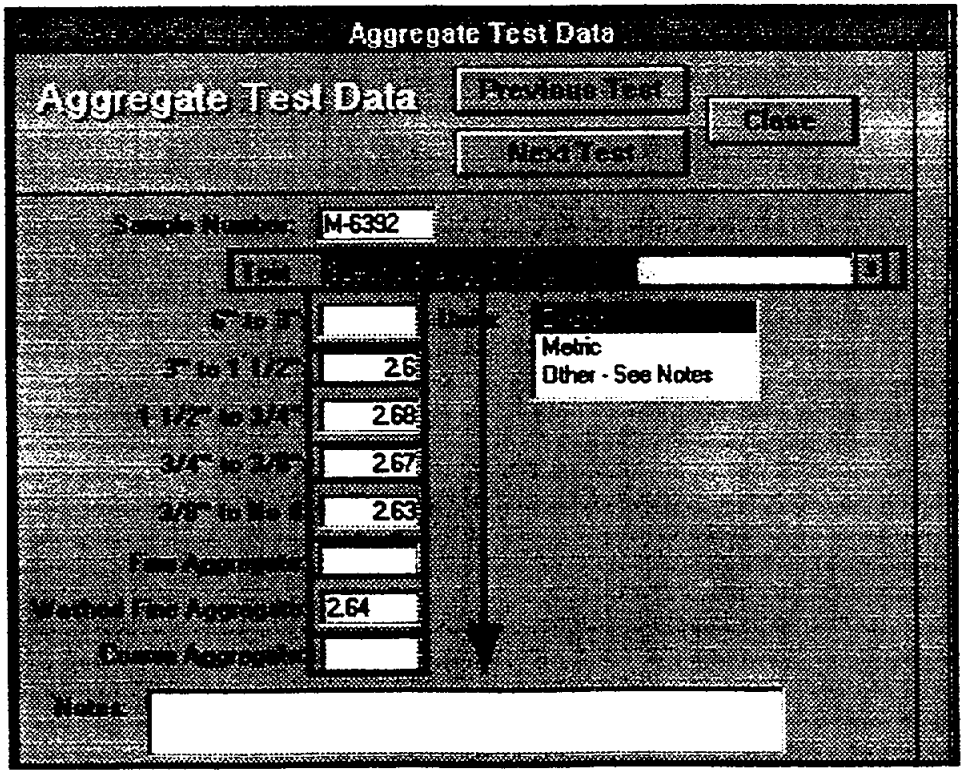


Figure 3.12 *Aggregate Test Data* Form

Forms represent tables; therefore, the forms also form a "hub and spoke" pattern (Figure 3.13). The *Material ID and Source Information* form is the hub and the seven forms representing test results are the spokes. If there is no particular test result for that sample number, then the button is disabled and no link is established. For example, the *Sand Attrition* button is disabled in Figure 3.13 because there was no sand attrition data for that particular sample number.

3.2.4 Reports

A database report is information that is organized and formatted to fit the user's specifications (Microsoft 1994). The option of creating reports offers the user the opportunity to obtain customized output tailored to the user's specific

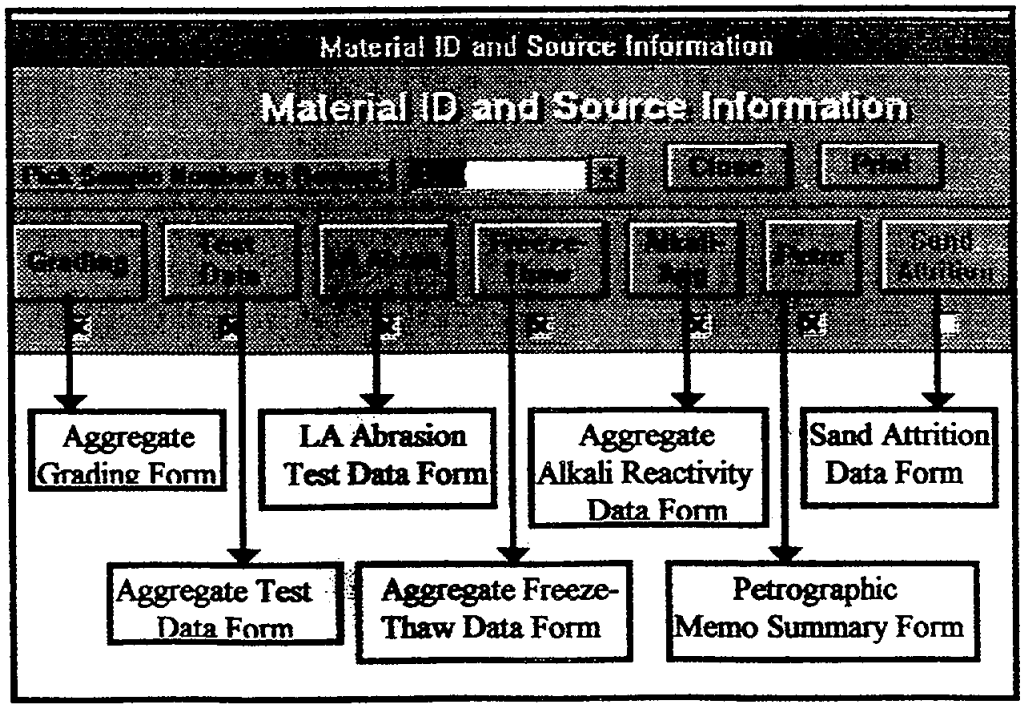


Figure 3.13 "Hub and Spoke" Pattern of Forms in the Aggregate Database

needs. Reclamation decided that the most useful reports were by sample number, state, and latitude longitude. The user can print out aggregate records by each sample number, all the samples in a given state, or all the samples within a specified latitude and longitude (Figure 3.14). The sample number report option is useful for Reclamation, but the state and latitude and longitude report option is more useful for other users of the database.

The report print-outs (Figure 3.15) contain all the information on an aggregate sample and are presented in a manner that is much easier to read than the original data sheet.

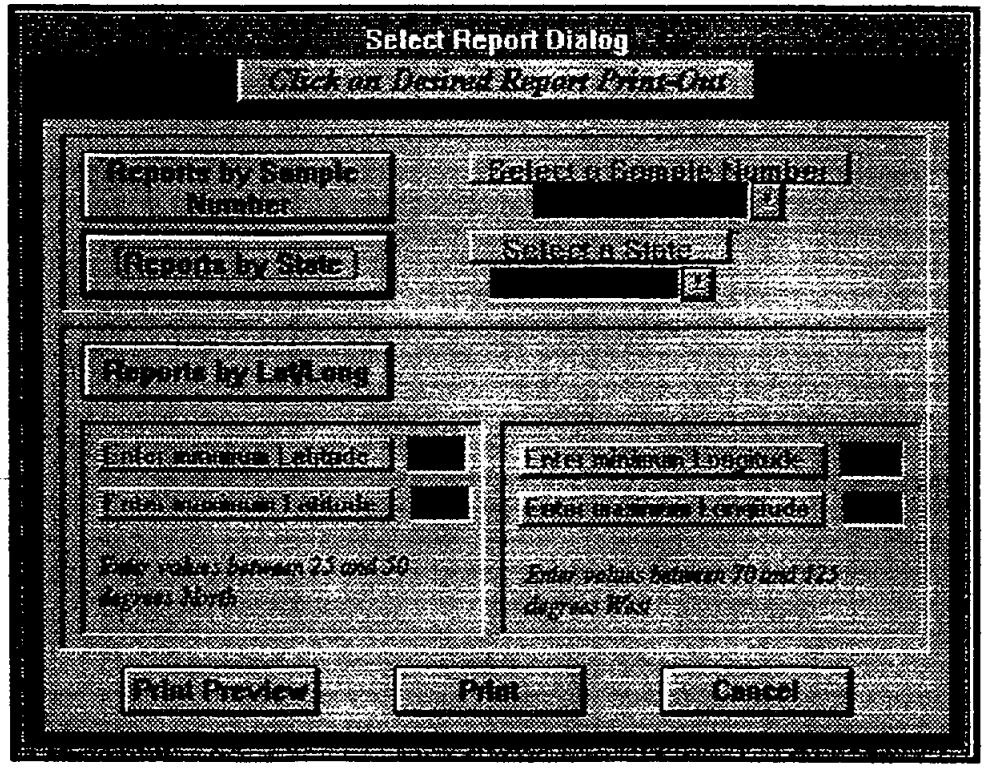
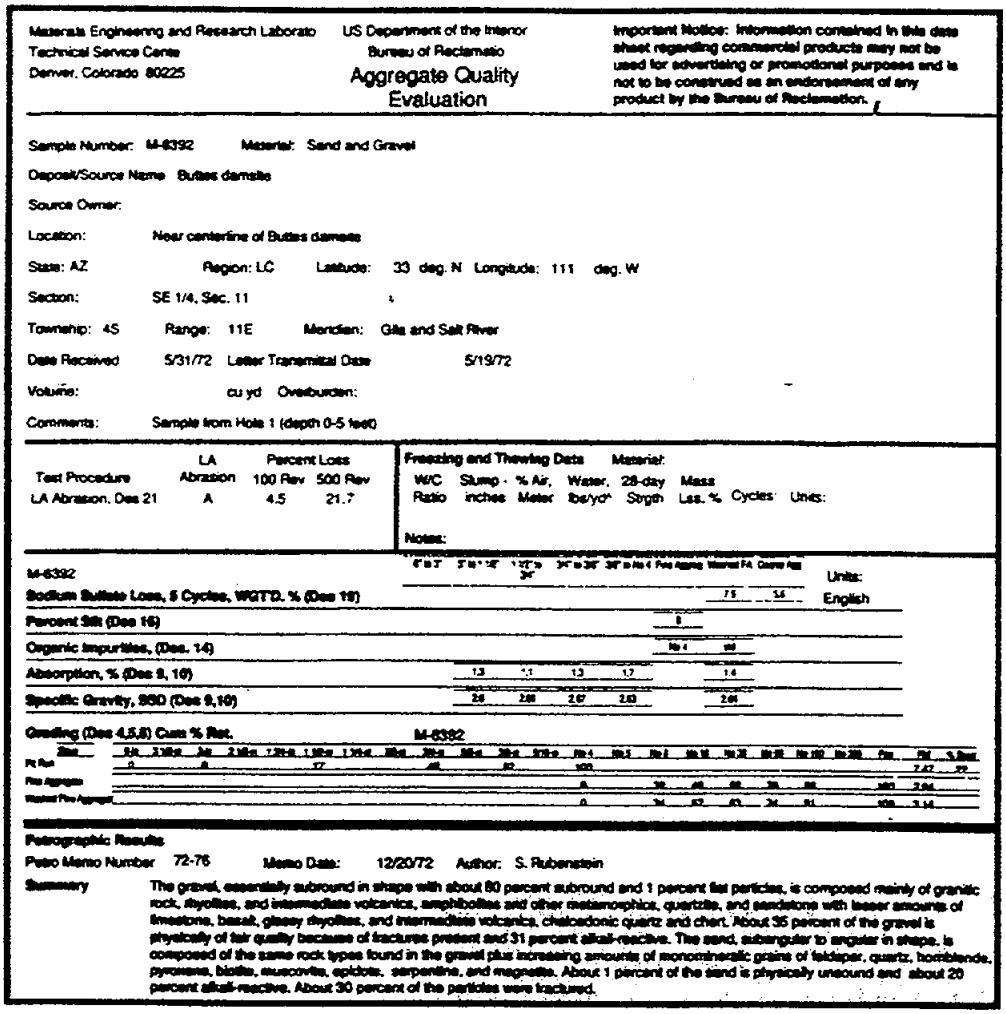


Figure 3.14 ***Select Report Dialog*** **Form in the Aggregate Database**



Materials Engineering and Research Laborato
Technical Service Cente
Denver, Colorado 80225

US Department of the Interior
Bureau of Reclamatio

Aggregate Quality Evaluation

Important Notice: Information contained in this data sheet regarding commercial products may not be used for advertising or promotional purposes and is not to be construed as an endorsement of any product by the Bureau of Reclamation.

Sample Number: M-6392 Material: Sand and Gravel

Deposit/Source Name: Buttes damsite

Source Owner:

Location: Near centerline of Buttes damsite

State: AZ Region: LC Latitude: 33 deg. N Longitude: 111 deg. W

Section: SE 1/4, Sec. 11

Township: 4S Range: 11E Meridian: Gila and Salt River

Date Received: 5/31/72 Letter Transmittal Date: 5/19/72

Volume: cu yd Overburden:

Comments: Sample from Hole 1 (depth 0-5 feet)

Test Procedure	LA Abrasion	Percent Loss 100 Rev	Percent Loss 500 Rev
LA Abrasion, Des 21	A	4.5	21.7

Freezing and Thawing Data Material:

W/C Ratio	Slump - inches	% Air, Mater	Water, lbs/yd³	28-day Strgth	Mass Loss, %	Cycles:	Units:

Notes:

M-6392

Units: English

Sodium Sulfate Loss, 5 Cycles, WGTD. % (Des 19)

Percent Silt (Des 16)

Organic Impurities, (Des. 14)

Absorption, % (Des 9, 10)

Specific Gravity, SSD (Des 9,10)

Grading (Des 4,5,8) Cum % Ret. M-6392

Petrographic Results

Petro Memo Number: 72-76 Memo Date: 12/20/72 Author: S. Rubenstein

Summary: The gravel, essentially subround in shape with about 80 percent subround and 1 percent flat particles, is composed mainly of granitic rock, rhyolites, and intermediate volcanics, amphibolites and other metamorphics, quartzite, and sandstone with lesser amounts of limestone, basalt, glassy rhyolites, and intermediate volcanics, chalcedonic quartz and chert. About 35 percent of the gravel is physically of fair quality because of fractures present and 31 percent alkali-reactive. The sand, subangular to angular in shape, is composed of the same rock types found in the gravel plus increasing amounts of monomineralic grains of feldspar, quartz, hornblende, pyroxene, biotite, muscovite, epidote, serpentine, and magnetite. About 1 percent of the sand is physically unsound and about 20 percent alkali-reactive. About 30 percent of the particles were fractured.

Figure 3.15 Report Print-Out of Sample Number M-6392 in Database

3.3 SUMMARY

Reclamation has created the Aggregate Database which could potentially be a useful for anyone seeking aggregate data; typically, pavement engineers, concrete and asphalt construction contractors, state DOT's and other government

organizations, suppliers, and possibly design firms. The Aggregate Database is the first of its kind in the aggregates industry and has many features even though it is not fully developed.

Reclamation and UT hope that the Aggregate Database will aid in reducing the costs of concrete and asphalt structures by giving those seeking aggregate quality data a comprehensive listing of most of the aggregate sources throughout the world. This hope will soon become a reality since there are plans to make the database more comprehensive, efficient, and easy-to-use.

In an effort to make the Aggregate Database more efficient and effective, surveys were sent out to professionals in the aggregates industry. The next chapter discusses the research methodology of obtaining feedback from professionals on the Aggregate Database.

Chapter Four: Research Methodology

4.0 Introduction

The Aggregate Database is in its initial stages and will quite likely be improved over time. A survey was conducted to elicit comments and suggestions from professionals in the aggregates industry. This chapter discusses the research methods and explains how information and feedback were obtained from professionals so that it was possible to evaluate the effectiveness and efficiency of the Aggregate Database.

4.1 Scope of the Survey

This survey was designed to determine the effectiveness and efficiency of the Aggregate Database from a user's point of view. More specifically, the survey focused on the user's specific need for aggregate data, the usefulness and performance of the database in terms of understandability, relaying desired information, practicality, structure, user friendliness, ease of navigation, efficiency, etc., and the proposed ideas for enhancing the database such as putting the database on the World Wide Web.

This survey does not take an in-depth look into the technical aspects of the Aggregate Database. Given the small size of the Aggregate Database and today's computer technology, it was felt that the focus of this survey should be on making the database better meet the needs of potential users rather than on technical issues

such as the programming, speed of queries, speed of the database, the optimal structure, etc.

4.2 Data Gathering

Members of American Concrete Institiute (ACI) Committee 126 on Database Formats for Concrete and ACI Committee 221 on Aggregates and two civil engineers were contacted. Twenty-seven people agreed to evaluate the Aggregate Database by using the database or reading a paper describing the Aggregate Database and then filling out a brief survey. Twenty of the twenty-seven were able to view the Aggregate Database on a computer. For the remaining seven who were not able to view the Aggregate Database on a computer, a packet was mailed to them which included a seven- page paper (Appendix E) describing the database and how it works, a poster board fold-out containing a screen capture of all the forms in the Aggregate Database, and a survey. Two of the twenty evaluators who could view the database on a computer had previously seen and used the Aggregate Database, and the remaining twenty-five had never seen the database. Therefore, the evaluators who had never seen the database were given copies of the database file or instructed to download the file from the World Wide Web.

There were two versions of the survey (Appendix C), one for respondents who saw the database and another for those who did not see the database. Table 4.1 contains a list of the questions that appeared on the two survey versions.

The questions focused on determining the user's need for a database of aggregate data, the usefulness and performance of the Aggregate Database, and

the evaluators' opinions about future plans for the Aggregate Database. Because the Aggregate Database is specifically tailored for Reclamation's aggregate data, it was important to determine what specific needs there are for a database of aggregate data (Questions 3-5 Table 4.1). The next line of questions (6-14 Table 4.1) deal with the usefulness and performance of the Aggregate Database in many areas such as practicality, efficiency, overall performance, etc. and the final set of questions (16-20 Table 4.1) deal with two proposed ideas for improving the Aggregate Database; an Internet-GIS interface and on-line queries through the World Wide Web. The answers to all the questions are discussed in Chapters 5 and 6.

Table 4.1 List of Questions on Both Survey Versions

Questions	#1	#2
1. What is your occupation?	X	X
2. Do you know of anyone who has a database similar to the "Aggregate Database"? If yes, who?	X	X
3. Why would you use a database of aggregate data?	X	X
4. Is there a need for a database like the "Aggregate Database"?	X	X
5. Rank the following aggregate data categories in terms of value to you? (1 – greatest; 6 – least). ____ Grading ____ Freeze-Thaw ____ LA Abrasion ____ Alkali-Aggregate Reactivity ____ Petrographic ____ Physical Properties (specific gravity, absorption, etc.)	X	X

6. Is the "Aggregate Database" a useful tool for you and your company or organization? If yes, why? If no, how could we make the "Aggregate Database" a useful tool for you?	X	X
7. Would you like to see your company's or organization's aggregate records in the "Aggregate Database"?	X	X
8. Will you use the "Aggregate Database" in the future? If yes, why? If no, why not?	X	X
9. Have you encountered any difficulties while using the "Aggregate Database"? If yes, please elaborate.	X	
10. Is the "Aggregate Database" effective at relaying the desired information? If no, please explain.	X	
11. Are the forms, tables, and print-outs easy to understand? If no, please explain.	X	X
12. Please rate your level of experience in Microsoft Access. (1 -- no experience; 10 -- expert)	X	
13. Please circle the number that best represents your experience with the "Aggregate Database". Efficiency (1 -- poor; 10 -- excellent); User friendliness (1 -- poor; 10 -- excellent); Layout/Structure (1 -- poor; 10 -- excellent); Navigation (1 -- difficult; 10 -- easy); Practicality (1 -- not practical; 10 -- very practical); Useful Information (1 -- not useful; 10 -- very useful); Overall Performance (1 -- poor; 10 -- excellent)	X	
14. How could the "Aggregate Database" be improved?	X	X

15. Do you know anyone that would be interested in looking at the "Aggregate Database"? If so, we would greatly appreciate it if you could provide us with their names and phone numbers.	X	X
16. We are planning to put the Aggregate Database on the web so that the user will be able to do on-line searches through the data. Do you think this is something worthwhile to pursue? Why or why not?	X*	X
17. Would you use the Aggregate Database more if you could do on-line searches? Why or why not?	X*	X
18. We are planning to have a GIS interface built into the database that will allow the user to select a geographic area and view only the aggregate data from that area. Do you think this is something worthwhile to pursue? Why or why not?	X*	X
19. Would you use the Aggregate Database more if it had this feature? Why or why not?	X*	X
20. Would this feature aid in your search for aggregate data?	X*	X

* Indicates that these questions were added to the survey after many had already been sent out.

A total of twelve people have responded to date. Of those who responded, six viewed the database on a computer and filled out the first version, two did not view the database on a computer but answered most of the questions on the second version, and the remaining four read the paper, looked at the forms on the poster board and filled out the second version of the survey.

4.3 LIMITATIONS OF THE SURVEY

There are several limitations to this survey (Table 4.2). The first limitation is that this survey does not go into depth on the technical issues as mentioned in the Scope of the Survey section. Another limitation is that the results, conclusions, and recommendations of this survey only apply to the Aggregate Database.

Table 4.2 Limitations of the Survey

Does not go into technical issues
Only applicable to the Aggregate Database
Sample size is small
Sample size is of a narrow audience
The data is subjective

The sample size is small and of a narrow audience. The sample size is only twelve and although this appears to be a very small sample, the information and feedback from the evaluators was very helpful. The sample size is of a narrow audience consisting of civil engineers who are on the database formats and aggregates committee for ACI. Computer and database experts were not included in the sample because the focus of this survey is on making the database more suitable to those who will use the database frequently rather than on the technical aspects of the Aggregate Database.

Another limitation of this survey is that there are no objective data. The data or survey results are all subjective. However, in this case, subjective data are

more valuable than objective data because the Aggregate Database is in its infancy stages and opinions from industry professionals are perhaps the best data available. By making the survey subjective, it was possible to obtain the evaluators' opinions on the Aggregate Database. When analyzing the survey results, care was taken so as to not misrepresent or distort the comments made by the evaluators.

4.4 Processing Survey Results

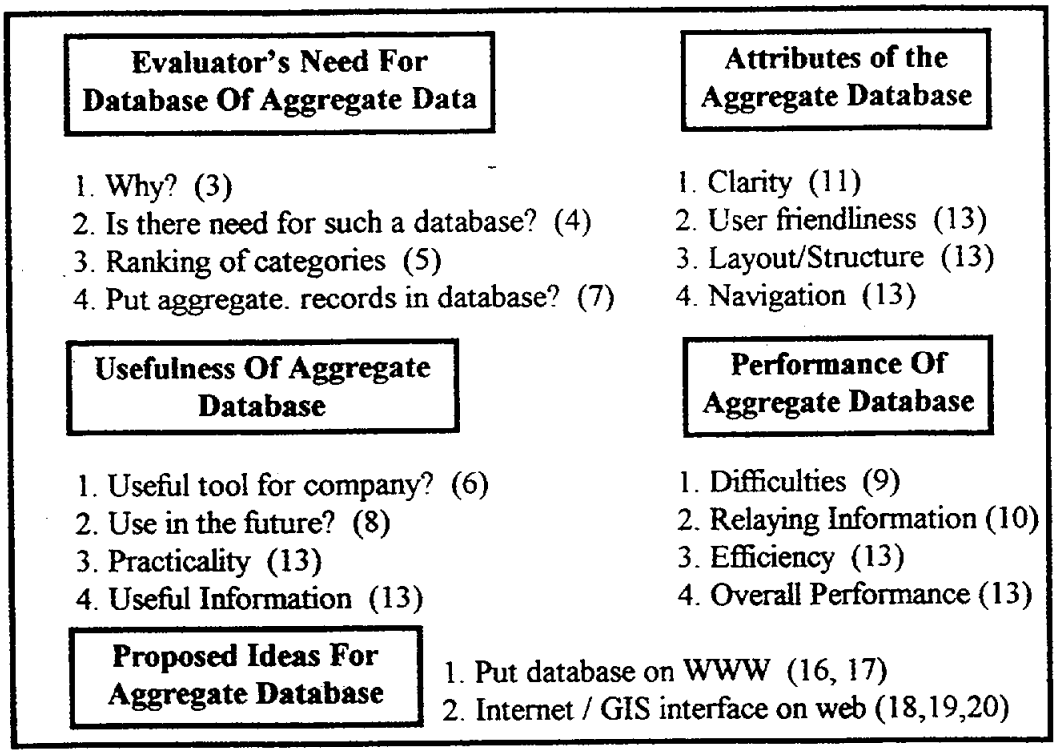
In order to simplify the processing of survey results, the questions on the survey were subdivided into five main categories, each having sub-categories. Figure 4.1 on the next page shows the main categories and sub-categories with the corresponding question number from Table 4.1 in parentheses.

Chapter 5 discusses in detail the results and comments from the survey in the same format as in Figure 4.1. The survey responses are in Appendix D.

When reviewing the comments and answers to the questions on the survey, it became apparent that there are two issues that could influence the evaluators' answer and comments and thus need to be addressed. It is possible, however, that these issues may not have affected the evaluators when filling out the survey, nonetheless, the issues need to be addressed in order to maintain the integrity of this survey.

The first issue is that the evaluators have varying degrees of experience with Microsoft Access, and this introduces biases in the ratings of the Aggregate Database. For example, evaluators with considerable experience in Microsoft Access have a better understanding of the Aggregate Database and will tend to have higher ratings in categories like user friendliness, ease of navigation, etc. than

those who are not familiar with Microsoft Access. Therefore, in order to minimize this problem, the results of the performance ratings and the evaluators' level of experience with Microsoft Access are shown in Chapter 5.



( ) Question number from Table 4.1

Figure 4.1 Main and Sub-Categories of Survey Results

The second issue is that some of the results and comments are from evaluators who could not use the Aggregate Database on a computer; instead, they were limited to reading a seven-page paper and looking at a cardboard fold-out. As a result, the comments from these evaluators do not focus on performance of the Aggregate Database; rather, the comments focus on the evaluators' need for

aggregate data, the usefulness of the Aggregate Database, and the content of the database. In order to minimize the possible implications of this issue, the computer experience of the evaluators is always given. Although these precautions have been taken, the comments and feedback given by those who did not use the database are just as valuable as those who did use the database.

4.5 SUMMARY

Surveys were sent out to professionals in the aggregates industry to obtain feedback on the performance, usefulness, and effectiveness of the Aggregate Database. Twelve surveys were returned with comments and suggestions in regards to the Aggregate Database. Inherent in the survey and the data gathering process were limitations such as sample size, sample audience, lack of objective data, and lack of discussion on technical issues. Inherent in the distribution of the surveys were two issues that could have influenced the data. These issues are the evaluators having varying degrees of experience with Microsoft Access and the fact that six (half) of the evaluators could or did not use the database on a computer. Though there were limitations and issues, measures were taken to minimize their effects when analyzing the results. The next chapter discusses in detail the results of the survey and the comments and suggestions made by the evaluators.

Chapter Five: Evaluation of the Aggregate Database

5.0 Introduction

This study is the first attempt to gather feedback from professionals in the aggregates industry on the Aggregate Database. The purpose of this study was to determine the usefulness, performance, and effectiveness of the Aggregate Database. Therefore, the survey focused on five areas: the user's need for aggregate data, the usefulness, attributes, performance, and proposed ideas for the Aggregate Database.

This chapter begins with a discussion of the advantages and disadvantages of databases listed in Chapter 2 as related to the Aggregate Database and ends with a discussion of the survey results.

5.1 "Advantages and Disadvantages of Databases" and the Aggregate Database

Databases have advantages and disadvantages that are common to most databases as discussed in Chapter 2. This section discusses these advantages and disadvantages and how they relate to the Aggregate Database. These advantages and disadvantages are not results from the survey.

5.1.1 Advantages of Databases and the Aggregate Database

- Eliminates the need for paper files

The Aggregate Database aids in reducing the amount of paper files and can eliminate the need for paper files, but it is a good idea to have a back up copy of

the database and even hard copies in case there is a computer malfunction that can damage or erase the database file.

- Allows multiple users to view the data

This advantage focuses more on multiple users in the same organization viewing the database. The Aggregate Database does allow multiple users to view the data. Though multiple users can view the data, it is important to ensure that only one person is able to add, modify, or delete data in the Aggregate Database. Microsoft Access, which is the database format for the Aggregate Database, has the password protection feature that ensures that only certain people have access to the add/modify/delete functions.

- Reduces the amount of tedious work

The Aggregate Database reduces the amount of filing, cataloging, searching for files, and hand writing records or data sheets, but the database does require someone to enter the data and this task is very tedious. Although the Aggregate Database requires someone to input the data, once the data are in the database, minimal time will be needed to modify the data in the future.

- Provides access to current information

Databases provide access to current information; however, in the Aggregate Database, this is not true. The average age of an aggregate record is 1958. The Aggregate Database does allow users access to current information, but there is only a small number of current aggregate records in the Aggregate Database.

- Has potential for low start-up costs

The Aggregate Database has been fairly inexpensive to create when compared to the long-term costs that can be accrued by this database. The expenses to date are time required to create the database and a computer to serve as a web server for the database. The long-term costs of the Aggregate Database will be discussed in the next section, the disadvantages of databases.

- Improves data management

The Aggregate Database does improve data management by providing a central location for all the aggregate data and by having password protection so that only selected individuals can view the data and add, modify, or delete data.

- Allows data to be easily updated or modified

Microsoft Access allows the user to easily update and modify data and aids in reducing the amount of clerical errors by allowing the user to specify the type of data such as numbers or text that can be entered in a certain field.

- Provides users with the capability to extract more information from the same amount of data

Microsoft Access allows users to run queries which can extract more information from the same amount of data. A user of the Aggregate Database can easily find all the riprap sources in Colorado by submitting a query with the appropriate specifications (riprap and Colorado).

In summary, between the database and Microsoft Access, most of these advantages are reflected in the Aggregate Database. There are a few areas such as the need for current information, lack of elimination of paper files, and small reduction of tedious work that need to be given attention in the future. Although

the Aggregate Database has a number of advantages, there are also a few disadvantages that many databases have in common including the Aggregate Database. These disadvantages are discussed in the next section.

5.1.2 Disadvantages of Databases and the Aggregate Database

- Has potential to be very complex

Currently the Aggregate Database is not very complex because there is only Reclamation aggregate data, and the number of options has been kept to a manageable level. As the database grows, the ability to access data and the number of options will quickly increase making the database more complex and more difficult to use.

- Has increased vulnerability to failure

This disadvantage has to do with the addition of components as the database increases in size. The Aggregate Database will become more complex, but there are no foreseeable addition of components. There are plans, however, to have a Web server for the database and this will increase the chances of a system failure because of strain put on the computer when there is a large volume of user requests.

- Requires users to be trained

The Aggregate Database does require users to have some training in order to fully utilize the database. The responses to the surveys indicate that some people had trouble understanding how to use the database. Thus, training or a tutorial would be helpful for those who do not know how to use the database. The responses to the survey will be discussed in more detail later in the chapter.

- Requires considerable design and set-up time

The Aggregate Database also required a lot of time to design the layout and set-up and will demand even more time when aggregate sources from other organizations are added. In the near future, the FHWA aggregate records will be added to the Aggregate Database and their data may not be suitable for the current design of the database. Therefore, time must be invested in developing a design that will allow users to easily access to both Reclamation and FHWA aggregate records as well as be user friendly.

- Requires a long-term investment strategy

The Aggregate Database does require a long-term investment strategy. Without a long-term investment strategy, the database will quickly become out-dated and useless. ICAR, Reclamation, and FHWA need to establish a long-term investment strategy that will enable the Aggregate Database to grow and become a centralized source of aggregate data.

- Has potential for high operating and maintenance costs

The Aggregate Database does have the potential to have relatively (as compared to the initial costs) high operating and maintenance costs. This database, as already stated is a continuous on-going project that will require time and capital from ICAR, Reclamation, and the FHWA, in order to remain state-of-the-art and useful to those in the aggregates industry.

In summary, the Aggregate Database is small and does not exhibit a lot of these disadvantages that are common to a lot of databases. However, as the Aggregate Database grows and becomes more powerful, the chances of these problems developing are much greater. Therefore, it would be very beneficial for

the database designers and developers to consider these disadvantages as they are adding more aggregate records from different sources and making the database more powerful through the addition of better searches and reports. The next section discusses the results of the survey sent to professionals in the aggregates industry.

5.2 SURVEY RESULTS

The feedback on the survey was and is very valuable for the Aggregate Database. The evaluators answered questions about the need for a database of aggregate data, the usefulness, attributes, and performance of the database, and proposed ideas for improving the Aggregate Database. This section discusses the occupations of the evaluators, the existence of other databases, and results of the survey and comments and suggestions made by the evaluators. The results are presented in the format illustrated in Chapter 4 (Figure 4.1) with five main categories and eighteen sub-categories.

5.2.1 The Evaluators' Occupations

As mentioned in Chapter 4, the survey respondents were members of ACI Committee 126 on Database Formats for Concrete and ACI Committee 221 on Aggregates and two other civil engineers who had previously downloaded the Aggregate Database. Eleven of the twelve evaluators are civil engineers specializing in concrete, cement, geology, or pavements; the other evaluator is a physicist at the National Institute of Standards and Technology who has a need for aggregate data. The evaluators' occupations are very narrow in scope, but as mentioned in Chapter 4, they are representative of those who need aggregate data

and are the best suited to give feedback on the usefulness, content, and performance of the Aggregate Database.

5.2.2 Existence of Databases Similar to the Aggregate Database?

There were eleven responses to this question; three said there were databases similar to the Aggregate Database and the remaining eight did not know of any databases. Those three evaluators said Shilstone Companies Inc, the U.S. Army Corps of Engineers, Minnesota DOT and North Dakota DOT, and the Construction Materials Market Research had databases similar to the Aggregate Database and one evaluator thought that "each state has some of this data". These databases need to be obtained, evaluated, and compared to the Aggregate Database. These databases may have features that should be incorporated into the Aggregate Database.

These results show that there are databases like the Aggregate Database and many people do not know that there are databases of aggregate data. This suggests that these databases are "in-house", meaning that they are specifically tailored for a particular company or organization and do not contain aggregate records from outside sources. Therefore, the Aggregate Database is the first attempt to develop a comprehensive database consisting of aggregate data from many companies and organizations. The next section discusses in detail the need for a database of aggregate data.

5.2.3 Evaluators' Need For Database of Aggregate Data

This section focuses on determining if there was a need for a database like the Aggregate Database, why the evaluator would use a database of aggregate

data, what aggregate data are the most important, and if the evaluators would like to see their company's or organization's aggregate data in the Aggregate Database. These four areas were covered in four questions, one for each area.

5.2.3.1 Why would you use a database of aggregate data?

This question was asked to determine why those in the aggregates industry use the Aggregate Database so that ICAR can tailor the database to better suit the needs of potential users. There were nine responses that mainly centered around having a comprehensive library of aggregate data in order to find suitable aggregate, have a listing of aggregate sources, and perform comprehensive analyses to develop correlations of aggregates and performance. Some of the responses are as follows: "Find aggregate with specific characteristics for a test", "select materials for the design of...cement", "find suitable aggregate available in an area", "correlate the pavement performance with aggregate sources...", "reduce testing by developing correlations among properties or test results", and "to gain information about highway aggregates around the country." There was only one response that did not fit into this mold, and that evaluator wanted to use a database of aggregate data "as an example of a comprehensive materials property database management system."

ICAR and Reclamation are responsible for the Aggregate Database and thus need to try to satisfy the needs of potential users of the database. In light of the responses to this question, ICAR and Reclamation need to focus on gathering and inputting more recent data in order to develop a current listing of all aggregate sources in the United States, increase the number of aggregate records, add fields

that contain the performance of the aggregate, and stress to the organizations and companies the importance of record-keeping so that the records in the database will be complete and not missing vital information like the aggregate source, and location of the aggregate source.

5.2.3.2 Is there a need for a database like the Aggregate Database?

There were twelve responses; eleven said that there is a need and one said there was not a need. Thus, these results show that a database like the Aggregate Database is a need and a worthwhile venture for ICAR and Reclamation.

5.2.3.3 Rank the following aggregate data categories from 1-6 (1, valuable; 6, least valuable) in terms of value to you -- Grading, Freeze-Thaw, LA Abrasion, Alkali-Aggregate Reactivity, Petrographic, Physical Properties

The results show that all the categories of data are in demand. Table 5.1 lists the average ranking for each category and the frequency of the top two and last rankings by the evaluators.

The average rankings vary between 2 (Physical Properties) and 4.1 (LA Abrasion). This shows that all the categories are valuable, but the physical properties category is slightly more valuable because of the high frequency of #1 and #2 rankings (28% and 33%, respectively) and the low frequency of #6 rankings (0%). Grading had the highest frequency of #1 rankings (33%) and tied for the highest number of #6 rankings (4). Of the four that ranked grading as the least valuable, two were geologists and one was a geotechnical engineer, and each of them ranked petrography either #1 or #2. Thus, geologist and geotechnical engineers have a much greater interest in petrography than grading. Of the six that ranked grading number #1, all of them were research engineers, aggregate

engineers, or technical service engineers, all dealing primarily with concrete or pavements. These results show that all of the data categories are important and there should not be an emphasis on populating the database with certain aggregate data such as grading over other physical properties such as LA Abrasion.

Table 5.1 Ranking of Categories of Aggregate Data

Categories	Average Ranking *	Frequency of #1 Ranking (%)	Frequency of #2 Ranking (%)	Frequency of #6 Ranking (%)
[illegible]	3	33	8	36
[illegible]	3.4	6	17	0
[illegible]	4.1	6	0	18
[illegible]	3.5	6	25	9
[illegible]	3.3	22	17	36
[illegible]	2	28	33	0

* The ranking of the categories was from 1-6; 1 being the most valuable and 6 being the least valuable.

5.2.3.4 Would you like to see your company's aggregate records in the Aggregate Database?

This question was asked to determine if there were individuals interested in having their aggregate records put in the database. There were twelve responses, six of which either did not have aggregate records or their records were already in or in the process of being entered into the Aggregate Database. Of the remaining six, five said they would like to see their aggregate records in the database and one did not. This further indicates that the Aggregate Database is needed and is

worthwhile, and the evaluators would like to have their own aggregate data entered into the Aggregate Database.

In summary, the evaluators stated that there is a need for a database like the Aggregate Database so that they can locate suitable aggregates and sources and perform comprehensive analyses on the data to develop correlations between aggregate and performance. In order to meet these needs, ICAR and Reclamation need to do the following:

- Input more recent aggregate data
- Include search mechanisms of certain fields on the user-interface
- If possible, offer options that analyze the data
- Stress to organizations and businesses that contribute data the benefits of complete aggregate records

The results also show that all the categories of aggregate data are equally important and that there are companies and organizations that are interested in having their aggregate data input into the Aggregate Database. ICAR and Reclamation need to contact these individuals and obtain their aggregate records to input in the Aggregate Database.

This section focused on the needs of the evaluators and the next couple of sections discuss the effectiveness of the Aggregate Database at fulfilling those needs.

5.2.4 Usefulness of Aggregate Database

This section focuses on determining if the Aggregate Database could be a useful tool for the evaluator's company or organization, if and why the evaluators

would use the database in the future, and the evaluators' ratings of the database in terms of its practicality and if it contains useful information. These three areas were covered in three questions.

5.2.4.1 Is the Aggregate Database a useful tool for you and your company? Why or why not?

This question was asked to determine if and why the Aggregate Database is a useful tool. There were ten responses, eight of which stated that the Aggregate Database is a useful tool because it has organized data, "simplifies search for aggregate sources", "gives an idea of aggregate types in a particular area", "gives an overall view of national and regional aggregate properties", and allows the user to predict "performance of end products and compare test results of similar rock types in other regions." Two of the ten responses said that the Aggregate Database is not a useful tool with one evaluator stating that the database does not "provide meaningful information on service record of individual aggregates sources."

Overall, the results show that the Aggregate Database is a useful tool and aids those who need aggregate data. In light of the responses to this question, one way to improve the Aggregate Database would be to incorporate a field designed for the service record of the aggregate. This would enable users to see how the aggregate has performed in its service life and could possibly allow researchers to develop correlations between the test results and performance of aggregates.

5.2.4.2 Will you use the Aggregate Database in the future? Why?

This question was asked to determine if and why the evaluators would use the Aggregate Database in the future and, more importantly, the reasons for using

it in the future. There were ten responses, eight were "yes", one was "maybe" and one was "no". The majority of the evaluators stated that they will use the Aggregate Database in the future and the reasons are very similar to those discussed in the "Why would you use a database of aggregate data?" section. Some of the responses are as follows: "it is a very useful tool", "to search for specific aggregate", there is "an increase in demand for information contained in the database as the demand for longer lasting pavements continues", and "allow... to respond to local and national inquiries." The sole negative response had to do with the lack of service record information mentioned in the previous section. These comments further show that the Aggregate Database is a useful tool and will be used by those in the aggregates industry.

5.2.4.3 Circle the number (1-10) that best describes your experience with the Aggregate Database in terms of practicality and useful information.

This question was asked to gather some subjective ratings of the Aggregate Database in terms of the practicality of the database and whether or not the database contains useful information. There were six responses and the average of those responses in both categories is shown in Table 5.2. This shows that the database is very practical and contains data that are beneficial to those in the aggregates industry.

Improvements can be made to the Aggregate Database to make it more practical and useful. Some improvements are to have the database on the World Wide Web (WWW) with a GIS-Internet interface (discussed in more detail in section 5.2.7) that allows the user to select a particular region and obtain aggregate data for that region, to "include ballast as a category", and develop a

listing of all aggregate sources even if there is no aggregate data available from those sources.

Table 5.2 Averages of the Usefulness Categories

Category	Average*
Practicality	9/10
Useful Information	9/10

* The numbers in this column were rounded off to the nearest whole number.

In summary, the results of these three questions show that the Aggregate Database is very practical and useful, but there is room for improvement. Improvements that will increase the usefulness and practicality of the Aggregate Database that were not mentioned in the previous section are as follows:

- Develop a comprehensive listing of all aggregate sources throughout the country
- Adding fields about performance of the aggregate during its service life
- Including ballast as a category
- Putting the database on the World Wide Web
- Incorporating a GIS-Internet interface

The next section discusses the results of the survey on the attributes of the Aggregate Database.

5.2.5 Attributes of the Aggregate Database

This section focuses on several attributes of the Aggregate Database. These attributes are the clarity of forms, tables, and print-outs, user friendliness,

layout/structure, and ease of navigation. These four issues were covered in two questions, one for clarity and one for the latter three.

5.2.5.1 Are the forms, tables, and print-outs easy to understand?

There were ten responses, eight said "yes", one said "maybe", one said "no". The evaluators that said "maybe" and "no" stated that "it is very difficult to work with the database when terms and their meanings are not defined...what is a sample number, what info does it provide, and how is it used during a search?", "the definition of the *Material* (field in the *Alkali-Aggregate Reactivity* form) is unclear, and the units for the *volume* and *overburden* field on the *Material and ID Source Information* form were not given.

Overall, most of the evaluators understood the forms, tables, and print-outs, but a few had difficulty understanding what some of the fields represented. It would be beneficial to provide documentation in the database that explains the meaning of the data in the fields and the test procedures used in obtaining the aggregate test data, widening the *volume* and *overburden field* on the *Material and ID Source Information* form so that the units are shown, and having search mechanisms that do not rely on the sample number (given by Reclamation). One evaluator suggested using a "multiple character, coded, alphanumeric identifier (instead of the sample number)...to help distinguish one aggregate from another." This may be helpful, but it would be more beneficial to have searches that do not require the user to have knowledge of the sample number and are only used as a unique identification number strictly for the database and the database management system.

5.2.5.2 Circle the number (1-10) that best represents your experience with Microsoft Access and with the Aggregate Database in the following categories: User Friendliness, Layout/Structure, and Navigation.

This question was asked to obtain some subjective ratings of the Aggregate Database in terms of user friendliness, layout/structure, and ease of navigation. There were six responses and the average of these responses are shown in Table 5.3.

Table 5.3 Averages of the Attribute Categories

Category	Average*
[illegible]	3/10
[illegible]	7/10
[illegible]	7/10
[illegible]	8/10

* The numbers in this column were rounded off to the nearest whole number.

The evaluators did not have a lot of experience in Microsoft Access as evidenced by the average rating of three. Although this rating is fairly low, it appears from the high averages of the ratings in the attribute categories that the evaluators' lack of experience in Microsoft Access did not have a major influence on their ratings of the Aggregate Database. This indicates that the attributes of user friendliness, layout/structure, and ease of navigation were sufficient enough to overcome the evaluators' lack of experience in Microsoft Access, thus explaining the high ratings. Although these categories received fairly high ratings, there is room for improvement in all four categories.

Improvements that can lead to a higher rating in the user friendliness category are providing a "brief introduction to the database describing what types of data it contains, how the data are organized, and ways that the data can be presented", having "it's own user interface without relying on MS Access tool bars and menus", providing more search mechanisms that do not rely on the *Sample Number* field, having "an example built into the program (coach) to follow how a typical record(s) might be analyzed", having "an index map showing general source locations within a state", and possibly splitting "the database into several (five or six)...regions of the country".

Improvements that can lead to a higher rating in the layout/structure category are eliminating unnecessary fields like the *letter transmittal date* field in the *Material ID and Source Information* form and condensing the data into a few screens or having a form where the user selects only the data he/she wishes to view. There is not a lot of room for improvement on the layout/structure of the Aggregate Database, but when Reclamation adds the FHWA aggregate data it will become a major issue.

As long as the Aggregate Database is in Microsoft Access, then the navigation in and around the database has to be intuitive and self-explanatory to the user. Two ways to make the database more intuitive and easier to navigate in are to change the names of the forms and buttons to make them more descriptive and self-explanatory and include links to other data forms at the bottom of all the data forms. By including links at the bottom of the data forms, the user will be able to easily go from one form to another without always having to go back to the *Material ID and Source Information* form, the main form. In the future, when the

Aggregate Database is on the WWW and has on-line search capabilities and does not rely on Microsoft Access, navigation will be an even greater issue that has to be given much thought when designing the web pages and the search mechanisms.

In summary, the attributes of the Aggregate Database, clarity, user friendliness, layout/structure, and navigation were rated fairly high, but improvements need to be made in each of these categories. These improvements consist of the following:

- Making minor changes to some of the fields, i.e. including units
- Providing documentation of the database
- Eliminating the need of the *Sample Number* field for searches
- Adding more search mechanisms
- Providing tutorials in the database
- Having its own user-interface; not relying on Microsoft Access tool bars
- Having an indexed map showing location of aggregate within a state
- Breaking the database up into five or six regions
- Eliminating unnecessary fields
- Condensing the data into fewer forms
- Allowing the user to select exact data to view
- Making the names of the forms and buttons more descriptive
- Providing links to other data forms in each of the data forms

The next section discusses the performance of the Aggregate Database in several areas.

5.2.6 Performance of the Aggregate Database

This section discusses the evaluators' responses to questions dealing with the performance of the Aggregate Database. The performance of the database was determined by three questions that focused on difficulties encountered while using the database, the effectiveness of the database at relaying desired information, and the ratings of the database in two categories: efficiency and overall performance.

5.2.6.1 Have you encountered any difficulties while using the Aggregate Database?

This question was asked to determine if the user experienced difficulties while using the Aggregate Database and exactly what were the difficulties. There were seven responses, four said "yes" and three said "no". Those that experienced difficulties were either not very familiar with Microsoft Access or not able to use certain features. The evaluators could not use certain features because some features were locked so that the data could not be changed, although one evaluator stated that some of the data could be changed. One evaluator that experienced difficulty stated "the lack of a general description about the database management system and the types of data that it contains makes it difficult to quickly learn to access the data that are available. Without knowing what is stored, it is impossible to use the information efficiently from the start."

These results show that over half the evaluators experienced difficulty and although most of the difficulties they experienced were attributed to not knowing the Microsoft Access software, this points out two weaknesses of the database. First, the user needs a copy of Microsoft Access and has to know how to use it.

Second, the database is not as self-explanatory or user friendly as originally assumed. Ways to improve this issue are the same as those listed in the previous section.

5.2.6.2 Is the Aggregate Database effective at relaying desired information?

This question was asked to determine if the Aggregate Database was effective at relaying desired information. There were six responses, four said "yes", one said "maybe", and one said "no". The evaluator who said maybe stated that "the test procedure needs to be clearly specified" and the evaluator who said no stated "the meaning of various headings is not always obvious...more detail or definitions need to be provided to guide the user through the database."

The Aggregate Database does contain useful information and is fairly effective at relaying that information, but there are areas for improvement. As some of the evaluators pointed out, the test procedures are not given and some of those procedures are only recognized by Reclamation. A help key or documentation of these test procedures would be very beneficial to those who use other test methods.

5.2.6.3 Circle the number (1-10) that best represents your experience with the Aggregate Database in the following categories: Efficiency, Overall Performance?

This question was asked to get a subjective rating of the performance of the database in two categories: efficiency and overall performance. There were six responses and the averages of the responses are given in Table 5.4 for each category including the evaluators' self-ranking of experience with Microsoft Access.

The efficiency and overall performance of the database received fairly high ratings. These ratings were surprising given all the comments and suggestions made on the survey, but nonetheless these results show that the evaluators were satisfied with the efficiency and the overall performance of the database.

Table 5.4 Averages of the Performance Categories

Category	Average*
Experience with Microsoft Access	3/10
Efficiency	7/10
Overall Performance	8/10

* The numbers in this column were rounded off to the nearest whole number.

In summary, from the results of the past three questions, the majority of the evaluators experienced difficulty while using the Aggregate Database, the database is fairly efficient and effective at relaying the desired information and performs very well. The results were very good, but as seen by the difficulties experienced by the evaluators, there are problems and limitations that need to be minimized. There are no new ideas for improvements presented in this section because all the other improvements listed in the previous sections affect the performance of the database. When these improvements are made, the performance ratings of the database should increase. The next section discusses the results from the survey questions dealing with the proposed ideas of putting the Aggregate Database on the WWW and incorporating a GIS-Internet interface.

5.2.7 Proposed Ideas for the Aggregate Database

This section focuses on determining whether or not putting the Aggregate Database on the WWW and incorporating a GIS-Internet interface into the Aggregate Database would aid the user in searching for aggregate data. These two areas were covered in five questions; two for the WWW and three for the GIS-Internet interface.

5.2.7.1 Is it worthwhile to put the Aggregate Database on the web so the user can perform on-line searches? Would you use the Aggregate Database more if it were on the web?

There were five responses to these questions: four were "yes" and one was "no". Some of the responses were "I think that the user should not have to download the DB to search it. If the search is online than he/she will be assured that only the latest version is available. It is easy to maintain it.", "easy to access", "WWW is the research tool of the future", "simplify field work", "CD-ROM is instantly outdated. Paper can not be manipulated", and "No. We are not in the work of needing to select the information now included."

These results and comments show that it would be very worthwhile to put the Aggregate Database on the web with on-line search capability. The sole negative response was given because that evaluator did not have a need for the aggregate data in the Aggregate Database. As mentioned earlier in this chapter, the Aggregate Database would be much more efficient and useful if it were on the Web. This would eliminate the need for users to have Microsoft Access and have knowledge of the software.

5.2.7.2 *Is it worthwhile to have a GIS interface built into the Aggregate Database so the user can search by geographic location? Would you use the Aggregate Database more and would it aid in your search for aggregate data if it had this feature?*

There were five responses, four were "yes" and one "no". The sole negative response was again because that evaluator did not have a need for aggregate data. Two responses were "this would be essential for a materials search" and "wider access will access data faster. Some smaller search areas may not have any data, thereby requiring use to research another adjacent specific area, which may be hit or miss."

These results show that it is worthwhile to incorporate a GIS-Internet interface because it would aid users in their search for aggregate data. The GIS-Internet interface would allow users to select a region of the United States and obtain the aggregate data for that region. It would beneficial to incorporate a GIS interface that allows the user to select from several search mechanisms such as by state, latitude/longitude, section/township/range, or by county. This would help ensure that all users would be able to access data for the region they desire, whether it be a state, a range of latitude and longitude, or a particular range.

In summary, putting the database on the web and incorporating a GIS-Internet interface would be very beneficial and will greatly aid those in finding particular aggregate data. These additions would eliminate many of the problems with the Aggregate Database because the two biggest drawbacks of the database are that the primary search mechanism relies on the sample number unique to Reclamation and that users' need a copy of Microsoft Access and need to know how to use the software.

5.3 SUMMARY

The Aggregate Database exhibits many of the advantages and surprisingly few of the disadvantages that are common to most databases. The advantages common to many databases, in particular the Aggregate Database, are as follows: reduces the amount of paper files needed, allows multiple users to view the data, reduces the amount of tedious work, improves data management, has inexpensive start-up costs, allows data to be easily modified or updated, and provides users with the capability to extract more information from the same amount of data. The disadvantages common to many databases, in particular the Aggregate Database, are as follows: contains aggregate records with an average date of 1958, requires some training in Microsoft Access and in how the database operates, requires considerable design and set-up time especially when records from other organizations will be added, requires a long-term investment strategy and has the potential for high operating and maintenance costs.

The scope of this study was to focus on making the database better suit the needs of the user and not on the technical aspects of the Aggregate Database. Therefore, the survey was distributed to a very narrow audience that consisted of those in the aggregates and concrete industry because The responses of the evaluators were valuable and appropriate to the focus of this study.

The survey began with a question about the existence of databases similar to the Aggregate Database and the evaluators stated that there were databases like the Aggregate Database. If these databases are indeed similar to the Aggregate Database, then it will be easy for ICAR and Reclamation to incorporate the data

contained in those databases into the Aggregate Database. Therefore, ICAR and Reclamation need to contact these organizations and try to gather their aggregate records and incorporate them into the Aggregate Database.

The survey then focused on determining the needs of the users and the effectiveness of the Aggregate Database at fulfilling those needs. The evaluators were asked to evaluate the database in terms of usefulness, attributes, performance, and proposed ideas for improving the database: Overall the results show that the Aggregate Database was effective at satisfying the evaluators' needs, but as evidenced by comments and suggestions made by the evaluators, the database has limitations and drawbacks.

There are many improvements that need to be made to the Aggregate Database in order for it to be more effective at fulfilling the users' needs. Some of the major improvements that need to be made are as follows: building search mechanisms that do not require Reclamation's sample number, putting the database on the WWW for on-line searches, incorporating more recent aggregate data, and developing a comprehensive listing of all aggregate sources. These improvements and others are discussed in Chapter 6.

Chapter Six: Conclusions and Recommendations

6.0 INTRODUCTION

Reclamation developed a relational database consisting of Reclamation aggregate records. Reclamation and ICAR entered into a cooperative research agreement where ICAR is responsible for the long-term operation of the system. This database was originally designed specifically for Reclamation aggregate records and Reclamation employees, but now the scope of the Aggregate Database has been expanded to include aggregate data from other sources such as FHWA, and to be used by anyone seeking aggregate data. This research concentrated on determining the needs of potential users of the Aggregate Database and the effectiveness of the database at fulfilling those needs. This chapter focuses on stating conclusions from the research and developing a set of recommendations that will light the path for transitioning the Aggregate Database from a Reclamation database to a database that can be used by anyone seeking aggregate data.

6.1 CONCLUSIONS

6.1.1 Description of Aggregate Database

The Aggregate Database is the first of its kind in the aggregates industry. The database contains over 2,200 Reclamation aggregate records with the following data: grading, physical properties, LA Abrasion, freezing and thawing, alkali-aggregate reactivity, sand attrition, and petrographic. The database allows

the user to generate reports consisting of aggregate data in a particular state or latitude/longitude and by the sample number. If these reports do not generate useful information then the user can develop specific queries to obtain specific information.

The unique search field in the Aggregate Database is the *Sample Number*, which was assigned to the aggregate records by Reclamation. Therefore, the database is suited to meet the needs of Reclamation and not those in the aggregates industry. In order for the database to be more useful, queries and reports need to be developed that do not search the *Sample Number* field.

Currently, the Aggregate Database is fairly small and contains a lot of out-dated information. Because of this, there are plans to incorporate FHWA's aggregate data and plans to contact state DOTs, businesses, and organizations with aggregate data. By adding more data, the database will be more comprehensive and thus more useful to the user. The database is very useful, but has many limitations. The next section lists conclusions drawn from the survey results and the following section gives a list of recommendations aimed at alleviating the limitations of the Aggregate Database.

6.1.2 Results From the Survey

The Aggregate Database is in its beginning stages, but surprisingly the results show that it is more effective than originally thought. The conclusions from the survey are as follows:

- There is a need for a database like the Aggregate Database and it is a worthwhile venture for ICAR and Reclamation.

- The basic needs indicated by the evaluators are as follows: find suitable aggregate, have a listing of aggregate sources, and perform comprehensive analyses on the data.
- All aggregate data currently in the database are important and desired by users.
- There are databases similar to the Aggregate Database, but more limited in scope.
- There are companies and organizations who would like to have their aggregate data input in the Aggregate Database.
- The Aggregate Database is practical, contains useful information, is a useful tool, is easy to understand and navigate in (these items correspond to a rating of 8 or 9 out of 10).
- The Aggregate Database is moderately user friendly, efficient, and effective at relaying desired information and has a fairly good layout/structure (these items correspond to a rating of 7 out of 10).
- The Aggregate Database should be on the WWW with a GIS-Internet interface for on-line searches.
- Although the results are good, there are many improvements that need to be made to the Aggregate Database to make it more effective and better suit the needs of the user.

The results show that overall, the evaluators were satisfied with the content and performance of the Aggregate Database; however, most of the evaluators offered suggestions on ways to improve it. These suggestions along with limitations of the database that became apparent when analyzing the results of the survey are the subject of the next section. The next section discusses in detail the

changes and improvements that need to be made in order for the Aggregate Database to be more efficient and effective at meeting user needs.

6.2 RECOMMENDATIONS

This report discussed in detail the reasons that professionals in the aggregates industry need a database of aggregate data, the effectiveness of the Aggregate Database at fulfilling those needs, and improvements that need to be made in order for the database to be more effective and efficient. From the conclusions and the comments and suggestions made by the evaluators on the survey, the recommendations are as follows:

1) Put the database on the WWW with on-line search capabilities. This will eliminate the need for and knowledge of Microsoft Access and provide easier access to those seeking aggregate data.
2) Incorporate a GIS-Internet interface to allow the user to search for aggregates in certain areas of the United States. This feature will greatly aid the user in finding suitable aggregate within a particular area. It would be beneficial to allow the user to search from a variety options including state, county, latitude/longitude, or section/township/range.

6.2.1 Aggregate Database on the WWW

If the Aggregate Database can be placed on the WWW with a GIS interface within the near future, the recommendations are as follows:

- Develop an on-line tutorial demonstrating the data contained in the database and the various ways of accessing this data. This feature will minimize

confusion about information the database contains and ways to access that information.

- Develop on-line documentation of the Aggregate Database describing the data and the test procedures used in obtaining that data. This will minimize any confusion about what the data represents and how the data was obtained.
- Incorporate search mechanisms in addition to the GIS-Internet interface mechanisms such as searches by specific aggregate properties. For example, if a user needs an aggregate with specific grading data, the user would enter the preferred grading data in a form, and the database would find the closest match and send that data back to the user. This item will most likely require research to determine if it is possible.
- Incorporate statistical analysis options over the WWW that would enable the user to receive statistical results over the WWW versus having to download a set of aggregate data. This item will most likely require research to determine if it is possible.
- Add more recent records that will provide current data for those seeking aggregate data.
- Develop a comprehensive listing of all the current aggregate sources in the United States. This will be an extremely useful resource for those seeking aggregate sources.

6.2.2 Aggregate Database Not on the WWW

If the database can not be put on the WWW in the near future then the recommendations are as follows:

- Develop a tutorial in the Aggregate Database as mentioned in the previous list. This will feature will tell the user the contents of the database and the ways of accessing the data. This item will most likely require research to determine if it is possible.
- Develop documentation of the Aggregate Database as mentioned in the previous list.
- Develop a help key that will serve the same purpose as the documentation except that it is in the database and the user does not need a hard copy of the documentation. This item will most likely require research to determine if it is possible.
- Incorporate search mechanisms that eliminate the need for Reclamation's sample number and do not rely on Microsoft Access toolbars or menus. This would enable the user to perform searches without having an in-depth knowledge of Microsoft Access.
- Incorporate statistical analysis options as mentioned in the previous list. This item will most likely require research to determine if this is possible within Microsoft Access or if it is possible to incorporate a statistical software package in Access.
- Add more recent records as mentioned in the previous list.
- Develop a comprehensive listing of all aggregate sources throughout the country as mentioned in the previous list.
- Incorporate data about the performance of the aggregate during its service life. This feature will enable the user to draw correlations between the aggregate data and the performance of the aggregate over time.

- When the database has a large amount of aggregate records, it may be beneficial to break it up into five or six regions to enable quicker access to the data.
- When the database has more current records, have a feature that shows where the source is on a road map so that users can easily find exactly where the aggregate source is located.

6.2.3 Minor Recommendations

The following recommendations are minor and are small ways of making the Aggregate Database more efficient and user friendly.

- Eliminate unnecessary fields, queries, forms, and tables.
- Change the names of forms and buttons to make them more self-explanatory.
- Include links to other data forms at the bottom of each aggregate data form. This item will most likely require research to determine if it is possible.
- Condense the aggregate data into a fewer number of forms.
- Allow the user to select specific data to view. This item will most likely require research to determine if it is possible.
- Have an indexed map showing location of aggregate within a state.

6.2.4 Aggregate Database Issues

The following recommendations are issues, not recommended ways of improving the database, that ICAR and Reclamation should consider in the near future.

- Purchase a zip-drive so that the database can be backed-up periodically.

- Contact the companies and organizations that stated an interest in having their aggregate data placed in the Aggregate Database. Also, contact the state DOTs and gather and input their aggregate data. This will increase the number of current aggregate records in the database and thus make it more useful.
- Seek funding for the Aggregate Database. Currently there is no funding for the database and without a financial commitment, the Aggregate Database is more likely to remain a Reclamation database.
- Stress to companies and organizations that contribute aggregate data the importance of keeping good complete records so that there will not be any incomplete fields. For example, no one wants to find a suitable aggregate and discover that the record does not have the location of the aggregate source.

6.2.5 Recommended Areas of Research

Recommended areas of future research are as follows:

- Research the technical aspects of the Aggregate Database and improve the database in terms of computer programming and structure.
- Further research user needs with a larger sample.
- Research the items listed throughout this section to determine if they feasible.

6.3 SUMMARY

The Aggregate Database is a very useful tool, but has some limitations. The recommendations given in this chapter are aimed at minimizing the drawbacks and limitations of the Aggregate Database. Now that a set of recommendations have been given, ICAR and Reclamation need to focus on implementing some of

the ideas mentioned in this thesis in order to improve the Aggregate Database and to make it more effective for users in the aggregates industry.

Appendix A

PRIMARY TABLES

Table A.1 Screen Capture of the *Aggregate Alkali Reactivity Data* and *Aggregate Freeze-Thaw Data* Tables

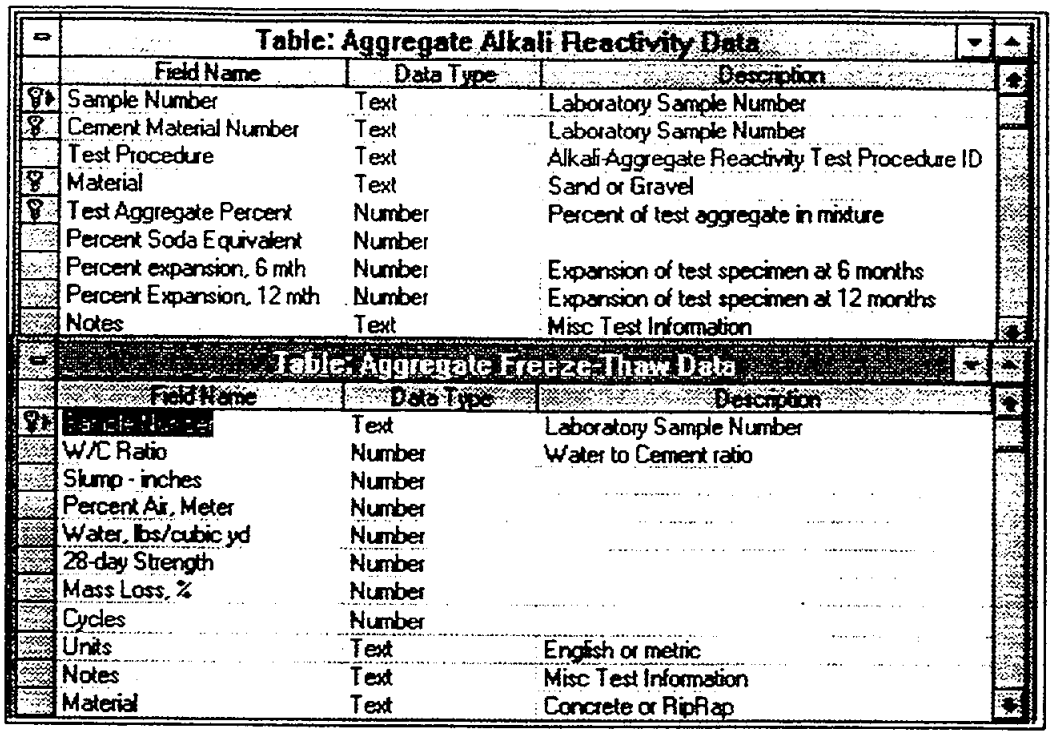


Table: Aggregate Alkali Reactivity Data

Field Name	Data Type	Description
Sample Number	Text	Laboratory Sample Number
Cement Material Number	Text	Laboratory Sample Number
Test Procedure	Text	Alkali-Aggregate Reactivity Test Procedure ID
Material	Text	Sand or Gravel
Test Aggregate Percent	Number	Percent of test aggregate in mixture
Percent Soda Equivalent	Number	
Percent expansion, 6 mth	Number	Expansion of test specimen at 6 months
Percent Expansion, 12 mth	Number	Expansion of test specimen at 12 months
Notes	Text	Misc Test Information

Table: Aggregate Freeze-Thaw Data

Field Name	Data Type	Description
Sample Number	Text	Laboratory Sample Number
W/C Ratio	Number	Water to Cement ratio
Slump - inches	Number	
Percent Air, Meter	Number	
Water, lbs/cubic yd	Number	
28-day Strength	Number	
Mass Loss, %	Number	
Cycles	Number	
Units	Text	English or metric
Notes	Text	Misc Test Information
Material	Text	Concrete or RipRap

Table A.2 Screen Capture of the *Aggregate Test Data* and *LA Abrasion Test Data* Tables

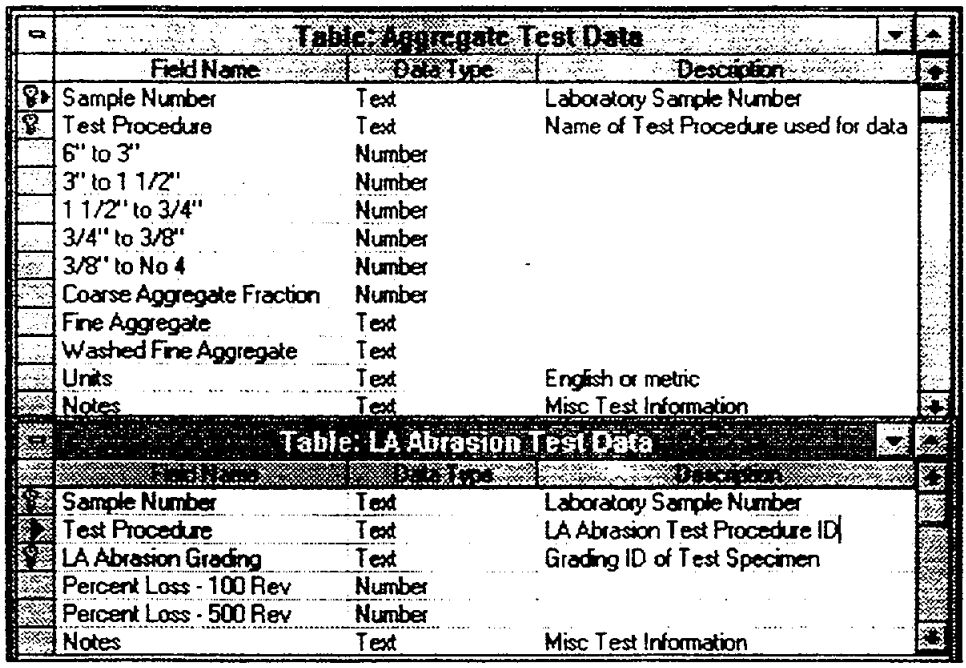


Table: Aggregate Test Data

Field Name	Data Type	Description
Sample Number	Text	Laboratory Sample Number
Test Procedure	Text	Name of Test Procedure used for data
6" to 3"	Number	
3" to 1 1/2"	Number	
1 1/2" to 3/4"	Number	
3/4" to 3/8"	Number	
3/8" to No 4	Number	
Coarse Aggregate Fraction	Number	
Fine Aggregate	Text	
Washed Fine Aggregate	Text	
Units	Text	English or metric
Notes	Text	Misc Test Information

Table: LA Abrasion Test Data

Field Name	Data Type	Description
Sample Number	Text	Laboratory Sample Number
Test Procedure	Text	LA Abrasion Test Procedure ID
LA Abrasion Grading	Text	Grading ID of Test Specimen
Percent Loss - 100 Rev	Number	
Percent Loss - 500 Rev	Number	
Notes	Text	Misc Test Information

Table A.3 Screen Capture of the *Material ID and Source Information* Table

Table: Material ID and Source Information

Field Name	Data Type	Description
[illegible]	Text	Laboratory Sample Number
State	Text	State Name
Region	Text	Region where sample is located
Source Owner	Text	Name of owner of source of aggregate
Location	Text	Location description of material source
Latitude	Number	
Longitude	Number	
Section	Text	Section Number of Source
Township	Text	Township of Source
Range	Text	
Meridian	Text	
Material	Text	Type of material, such as aggregate, cement
Date Received	Date/Time	Date material received in labs
Deposit/Source Name	Text	
Overburden	Text	Depth of overburden
Volume	Number	Estimated volume of source
Letter Transmittal Date	Date/Time	Date of Letter of Trasnmittal
Comments	Text	Misc information about the source

Table A.4 Screen Capture of the *Aggregate Grading Data* Table

Field Name	Data Type	Description
[redacted]	Text	Laboratory Sample Number
Record Number	Number	Counter for Number of Samples
Sample Type	Text	Type of sample, such as gravel, washed sand
Test Procedure	Text	Sieve Analysis Test Procedure ID
Passing Size	Number	Maximum Size of coarse aggregate fraction
Retained Size	Text	Minimum size of coarse aggregate fraction
6-inch	Number	Cummulative % Retained on the sieve.
3 1/2-inch	Number	Cummulative % Retained on the sieve.
3-inch	Number	Cummulative % Retained on the sieve.
2 1/2-inch	Number	Cummulative % Retained on the sieve.
1 3/4-inch	Number	Cummulative % Retained on the sieve.
1 1/2-inch	Number	Cummulative % Retained on the sieve.
1 1/4-inch	Number	Cummulative % Retained on the sieve.
7/8-inch	Number	Cummulative % Retained on the sieve.
3/4-inch	Number	Cummulative % Retained on the sieve.
5/8-inch	Number	Cummulative % Retained on the sieve.
3/8-inch	Number	Cummulative % Retained on the sieve.
5/16-inch	Number	Cummulative % Retained on the sieve.
No 4	Number	Cummulative % Retained on the sieve.
No 5	Number	Cummulative % Retained on the sieve.
No 8	Number	Cummulative % Retained on the sieve.
No 16	Number	Cummulative % Retained on the sieve.
No 30	Number	Cummulative % Retained on the sieve.
No 50	Number	Cummulative % Retained on the sieve.
No 100	Number	Cummulative % Retained on the sieve.
No 200	Number	Cummulative % Retained on the sieve.
Pan	Number	Cummulative % Retained on the sieve.
FM	Number	
Percent Sand	Number	
Notes	Text	Misc Test Information

Table A.5 Screen Capture of the *Sand Attrition Test* and *Petrographic Memo Summary* Tables

Table: Sand AttritionTest

Field Name	Data Type	Description
Sample Number	Text	Laboratory Sample Number
Test Number	Number	Test Number for gradation
Sample Grading	Text	Type of sample grading, such as original,
Test Procedure	Text	Sieve Analysis Test Procedure ID
No 8	Number	
No 16	Number	
No 30	Number	
No 50	Number	
No 100	Number	
No 200	Number	
Attrition Silt	Number	
FM	Number	
FM Decrease	Number	
Percent Fm Change	Number	
Notes	Text	Misc Test Information

Table: Petrographic Memo Summary

Field Name	Data Type	Description
Sample Number	Text	Laboratory Sample Number
Petro Memo Number	Text	ID number of Petrographic Memorandum
Memo Date	Date/Time	Date of Petro memo
Author	Text	Author of petro Memo
Summary	Memo	Summary of Petro Memo

SECONDARY TABLES

Table A.6 Screen Capture of the *Aggregate Tests, Data Check,* and *Meridians* Tables

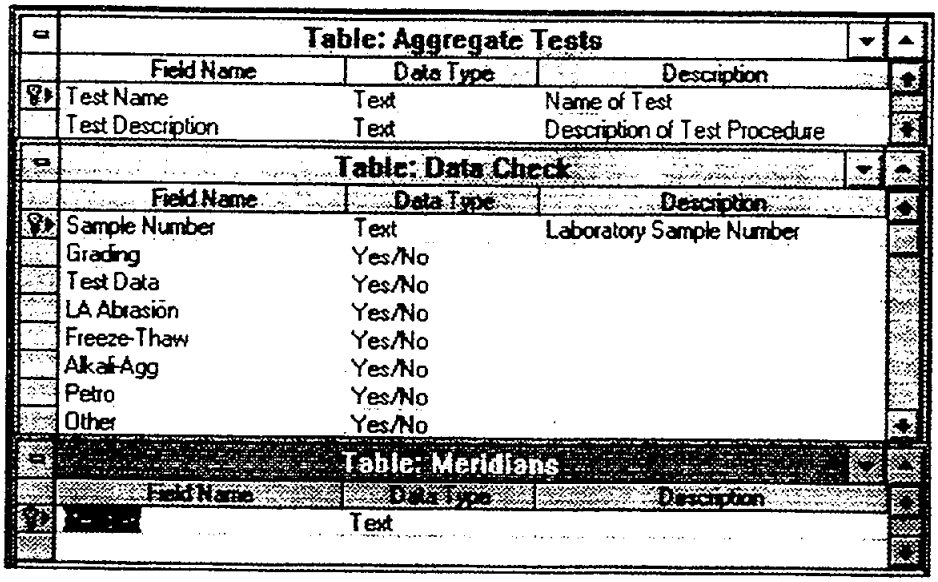


Table: Aggregate Tests

Field Name	Data Type	Description
Test Name	Text	Name of Test
Test Description	Text	Description of Test Procedure

Table: Data Check

Field Name	Data Type	Description
Sample Number	Text	Laboratory Sample Number
Grading	Yes/No	
Test Data	Yes/No	
LA Abrasion	Yes/No	
Freeze-Thaw	Yes/No	
Alkali-Agg	Yes/No	
Petro	Yes/No	
Other	Yes/No	

Table: Meridians

Field Name	Data Type	Description
[redacted]	Text	

Table A.7 Screen Capture of the *States, Type of Material1, Type of Material,* and *Test Procedures* Tables

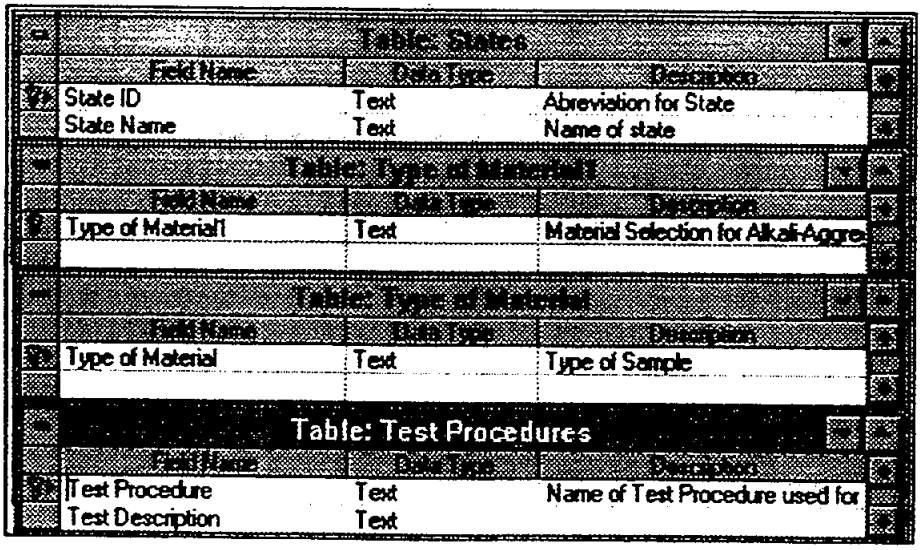


Table: States

Field Name	Data Type	Description
State ID	Text	Abreviation for State
State Name	Text	Name of state

Table: Type of Material1

Field Name	Data Type	Description
Type of Material1	Text	Material Selection for Alkali-Aggre

Table: Type of Material

Field Name	Data Type	Description
Type of Material	Text	Type of Sample

Table: Test Procedures

Field Name	Data Type	Description
Test Procedure	Text	Name of Test Procedure used for
Test Description	Text	

Appendix B

FORMS

Table B.1 Screen Capture of the *Main Form*

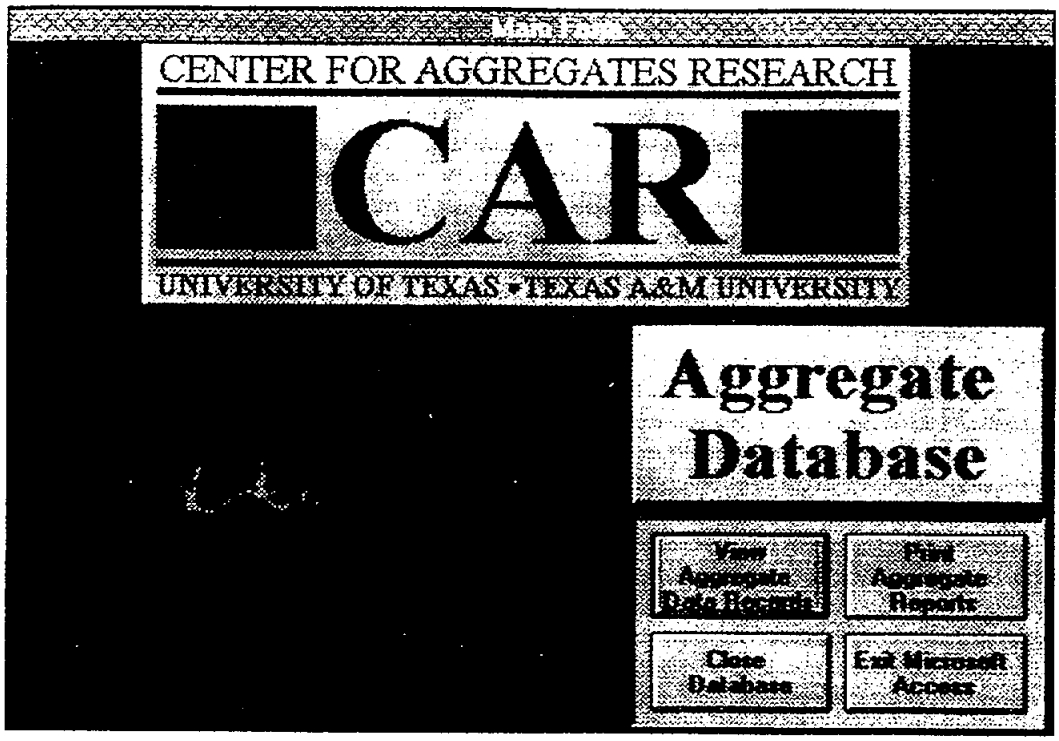


Table B.2 Screen Capture of the *Material ID and Source Information* Form

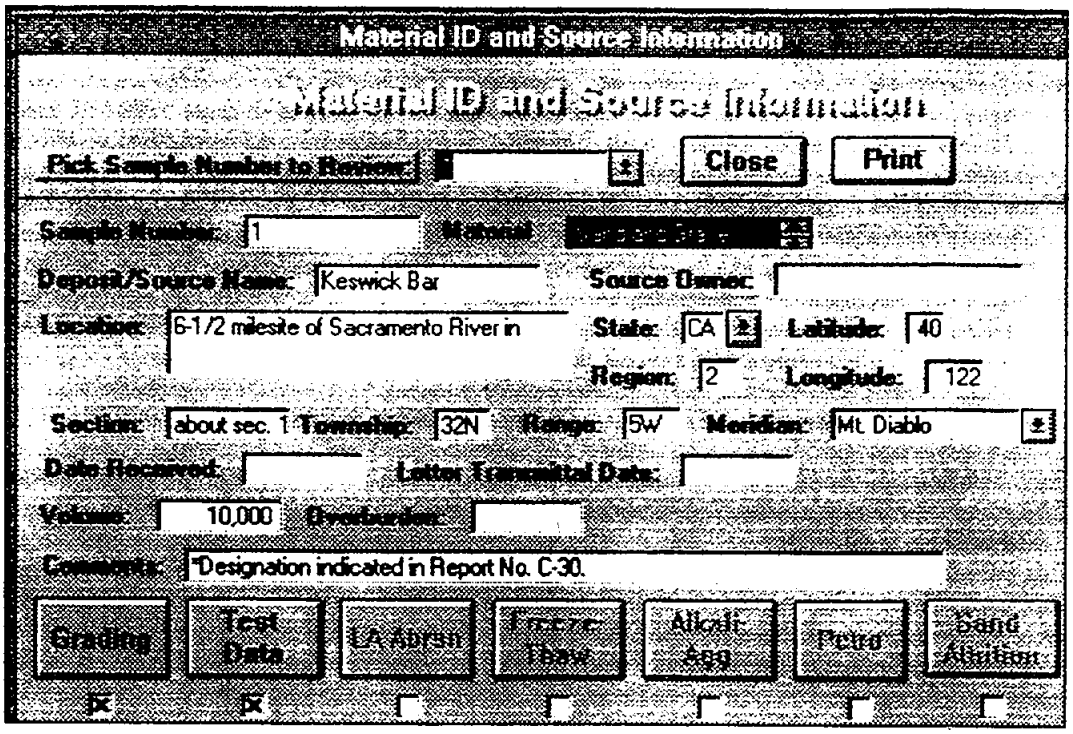


Table B.3 Screen Capture of the *Aggregate Grading Data* Form

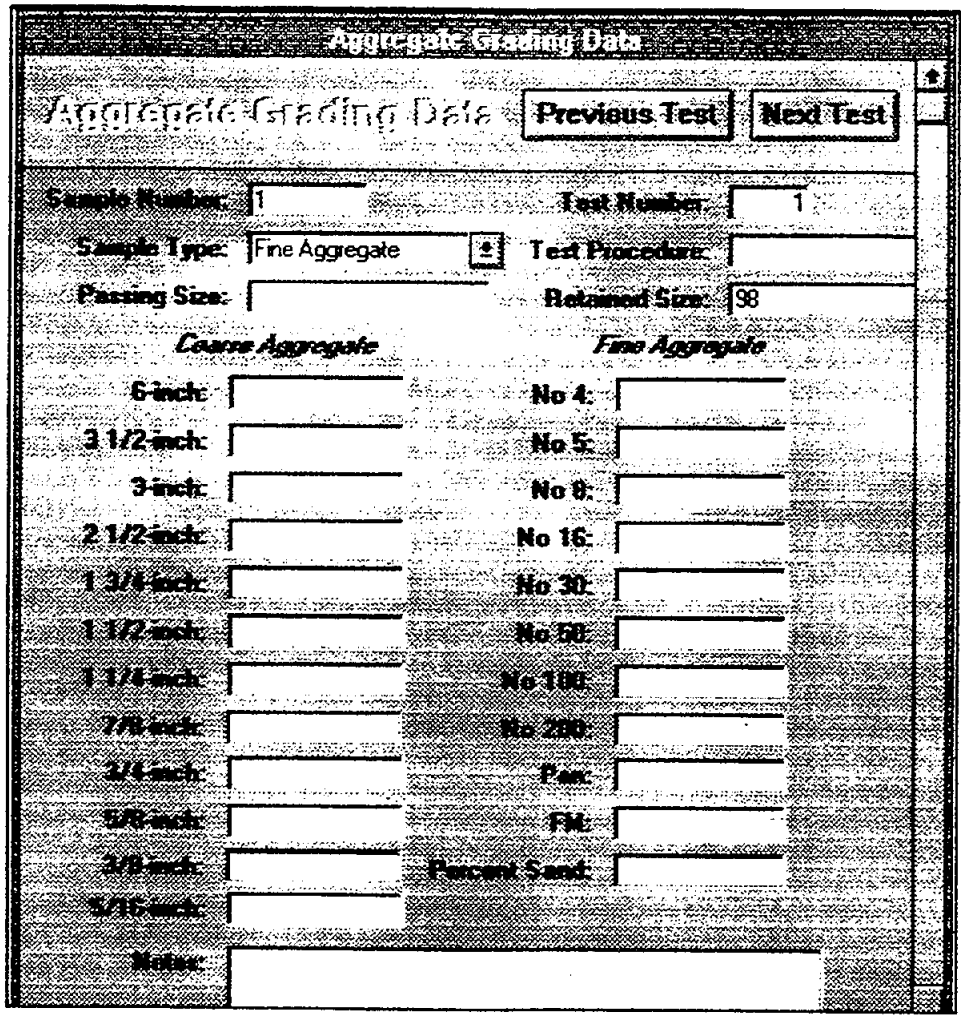


Table B.4 Screen Capture of the *Aggregate Test Data* Form

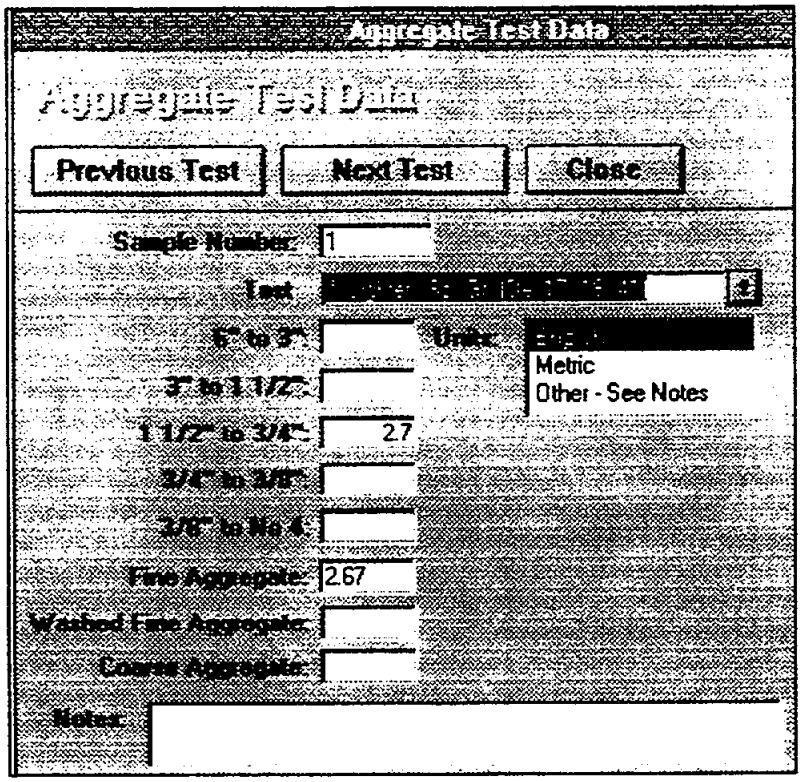


Table B.5 Screen Capture of the *Aggregate Freeze-Thaw Data* Form

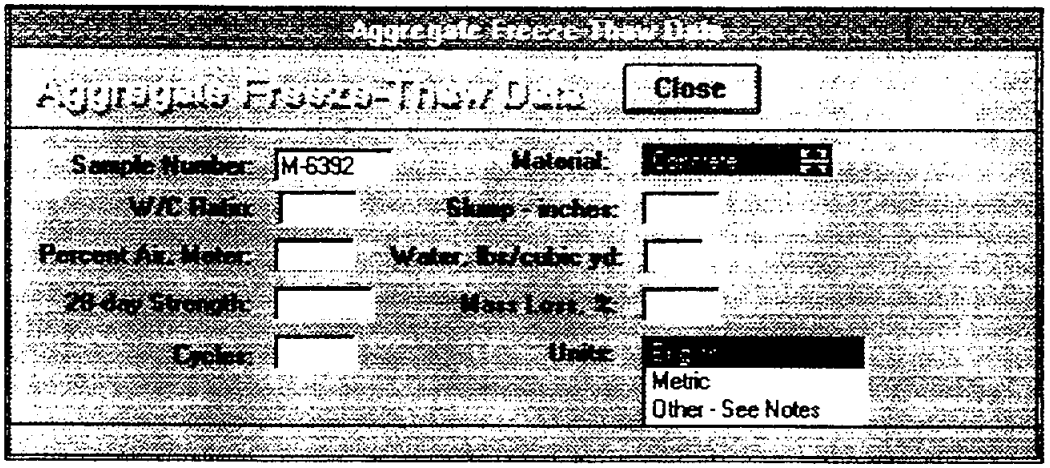


Table B.6 Screen Capture of the *Petrographic Memo Summary* Form

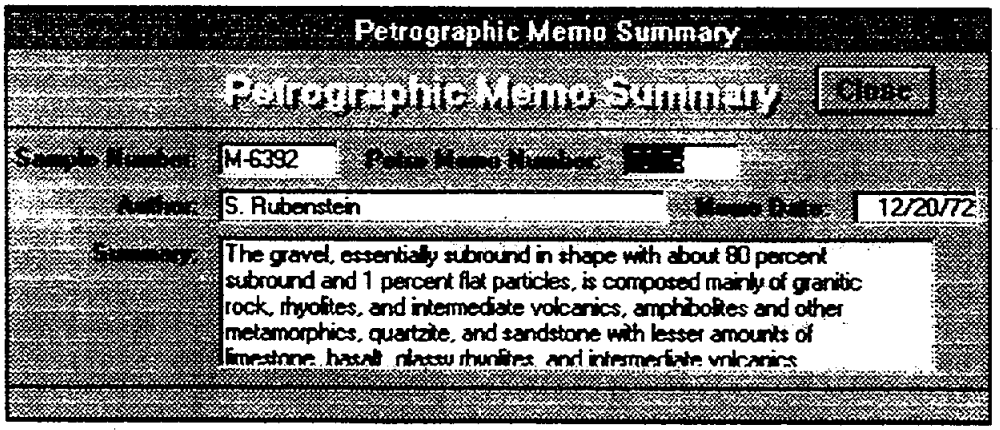


Table B.7 Screen Capture of the *Sand Attrition Test* Form

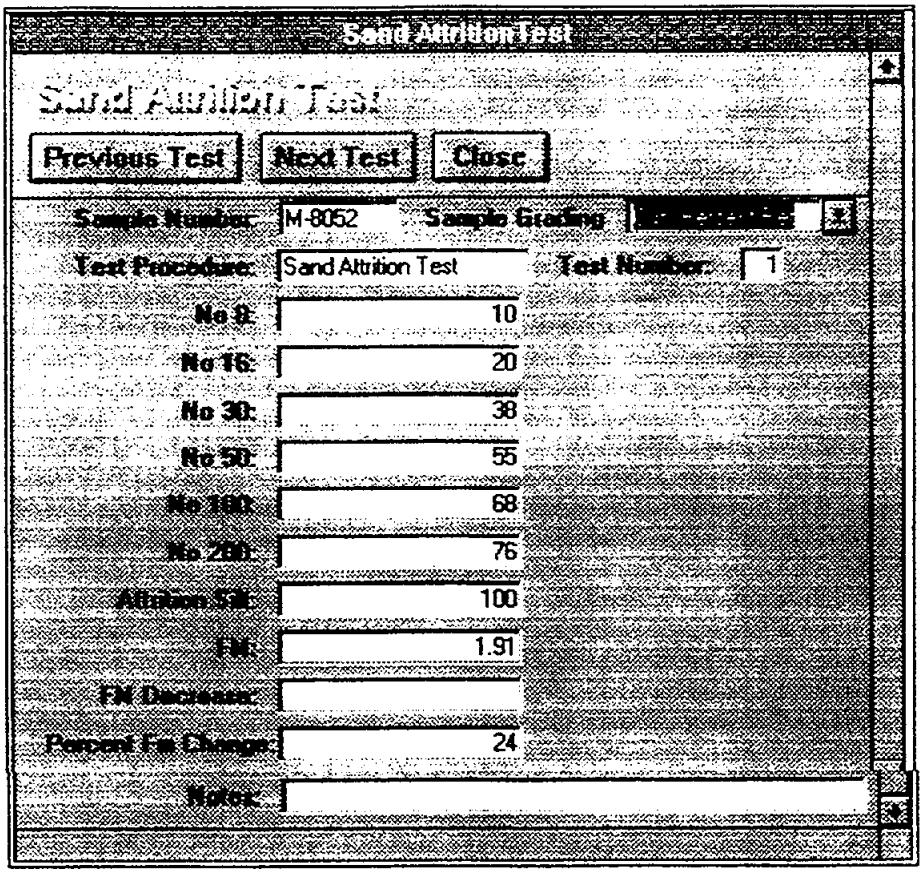


Table B.8 Screen Capture of the *LA Abrasion Test Data* Form

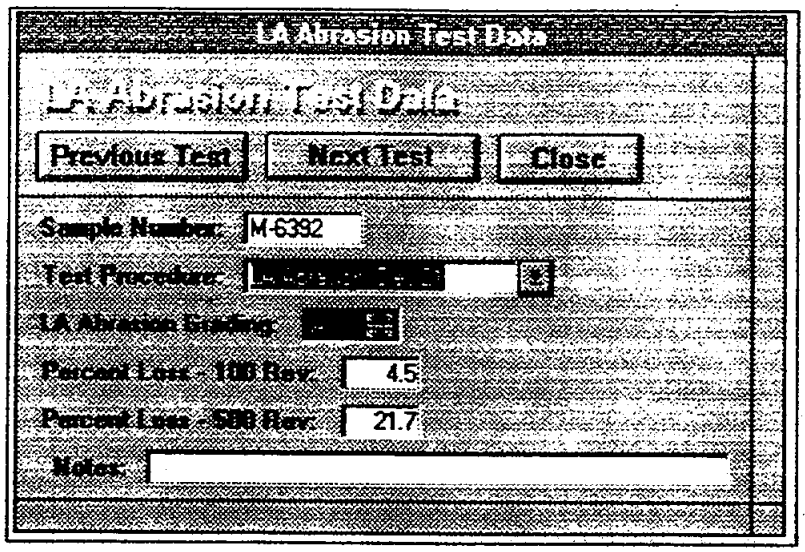


Table B.9 Screen Capture of the *Aggregate Alkali Reactivity Data* Form

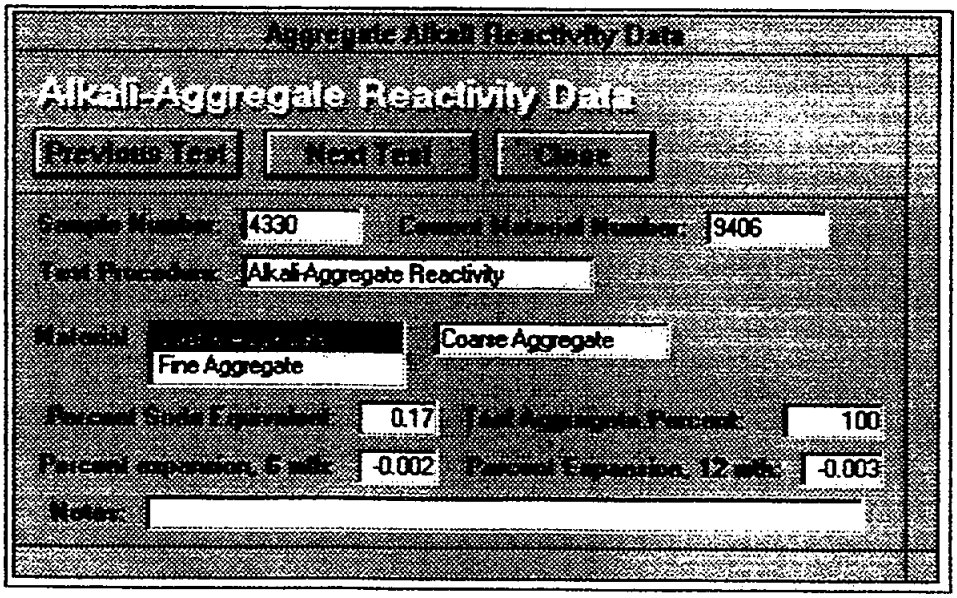
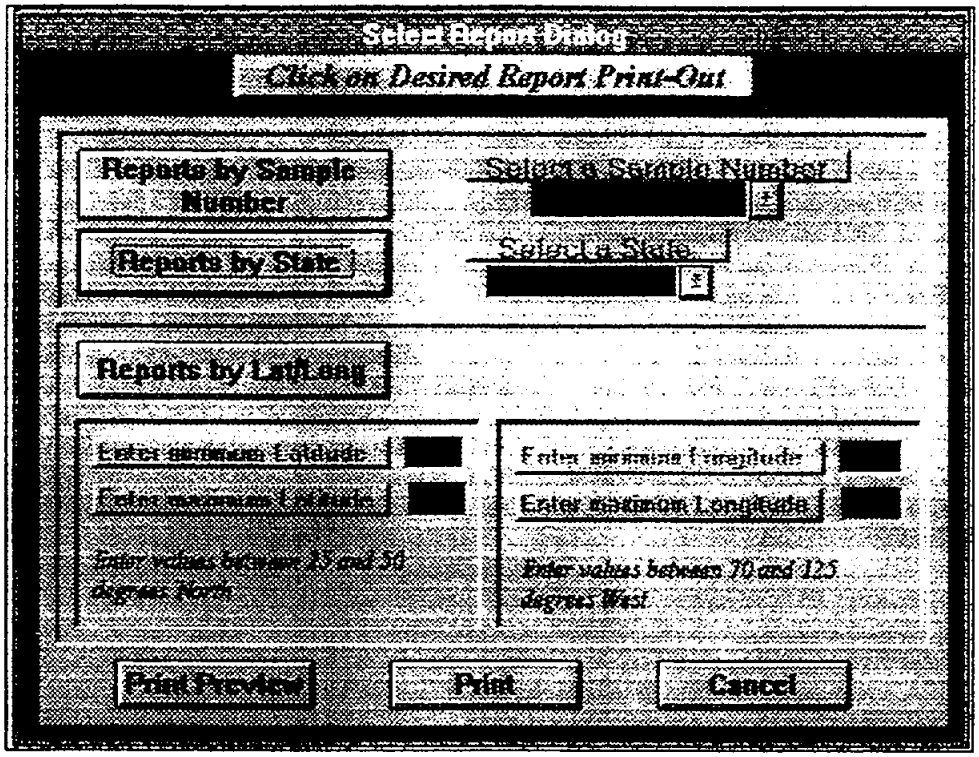


Table B.10 Screen Capture of the *Select Report Dialog* Form



Appendix C

AGGREGATE DATABASE SURVEY

FIRST COPY--FOR THOSE WHO COULD VIEW THE DATABASE ON A COMPUTER

What is your occupation?

Why would you use a database of aggregate data?

Rank the following aggregate data categories in terms of value to you? (1 -- greatest; 6 -- least).

____ Grading
____ Freeze-Thaw
____ LA Abrasion
____ Alkali-Aggregate Reactivity
____ Petrographic
____ Physical Properties (specific gravity, absoprtion, percent silt, etc.)

	Yes	No
Do you know of anyone who has a database similar to the "Aggregate Database"? If yes, who?	___	___
Is there a need for a database, like the "Aggregate Database"?	___	___
Is the "Aggregate Database" a useful tool for you and your company or organization? If yes, why? If no, how could we make the "Aggregate Database" a useful tool for you?	___	___
Would you like to see your company's or organization's aggregate records in the "Aggregate Database"?	___	___
Will you use the "Aggregate Database" in the future? If yes, why? If no, why not?	___	___
Have you encountered any difficulties while using the "Aggregate Database"? If yes, please elaborate.	___	___
Is the "Aggregate Database" effective at relaying the desired information? If no, please explain.	___	___
Are the forms, tables, and print-outs easy to understand? If no, please explain.	___	___

Please rate your level of experience in Microsoft Access.

1 2 3 4 5 6 7 8 9 10 (1 -- no experience; 10 -- expert)

Please circle the number that best represents your experience with the "Aggregate Database".

Efficiency	1	2	3	4	5	6	7	8	9	10 (1 -- poor; 10 -- excellent)
User-Friendliness	1	2	3	4	5	6	7	8	9	10 (1 -- poor; 10 -- excellent)
Layout/Structure	1	2	3	4	5	6	7	8	9	10 (1 -- poor; 10 -- excellent)
Navigation	1	2	3	4	5	6	7	8	9	10 (1 -- difficult; 10 -- easy)
Practicality	1	2	3	4	5	6	7	8	9	10 (1 -- not practical; 10 -- very practical)
Useful Information	1	2	3	4	5	6	7	8	9	10 (1 -- not useful; 10 -- very useful)
Overall Performance	1	2	3	4	5	6	7	8	9	10 (1 -- poor; 10 -- excellent)

How could the "Aggregate Database" be improved?

Do you know anyone that would be interested in looking at the "Aggregate Database"? If so, we would greatly appreciate it if you could provide us with their names and phone numbers.

QUESTIONS ADDED TO THE FIRST COPY

	Yes	No
We are planning to put the Aggregate Database on the web so that the user will be able to do on-line searches through the data. Do you think this is something worthwhile to pursue? Why or why not?	___	___
Would you use the Aggregate Database more if you could do on-line searches? Why or why not?	___	___
We are planning to have a GIS interface built into the database that will allow the user to select a geographic area and view only the aggregate data from that area. Do you think this is something worthwhile to pursue? Why or why not?	___	___
Would you use the Aggregate Database more if it had this feature? Why or why not?	___	___
Would this feature aid in your search for aggregate data?	___	___

SECOND COPY -- FOR THOSE WHO COULD NOT VIEW THE DATABASE ON A COMPUTER

What is your occupation?

Why would you use a database of aggregate data?

Rank the following aggregate data categories in terms of value to you? (1 -- greatest; 6 -- least).

____ Grading
____ Freeze-Thaw
____ LA Abrasion
____ Alkali-Aggregate Reactivity
____ Petrographic
____ Physical Properties (specific gravity, absorption, percent silt, etc.)

	Yes	No
Do you know of anyone who has a database similar to the "Aggregate Database"? If yes, who?	___	___
Is there a need for a database, like the "Aggregate Database"?	___	___
Do you think the "Aggregate Database" could be a useful tool for you and your company or organization in the future? If yes, why? If no, how could we make the "Aggregate Database" a useful tool for you?	___	___
Would you like to see your company's or organization's aggregate records in the "Aggregate Database"?	___	___
Based on what you have read and seen, will you use the "Aggregate Database" in the future? If yes, why? If no, why not?	___	___
Are the forms and print-outs easy to understand? If no, please explain.	___	___

How could the "Aggregate Database" be improved?

We are planning to put the Aggregate Database on the web so that the user will be able to do on-line searches through the data. Do you think this is something worthwhile to pursue? Why or why not?

	Yes	No
Would you use the Aggregate Database more if you could do on-line searches? Why or why not?	___	___
We are planning to have a GIS interface built into the database that will allow the user to select a geographic area and view only the aggregate data from that area. Do you think this is something worthwhile to pursue? Why or why not?	___	___
Would you use the Aggregate Database more if it had this feature? Why or why not?	___	___
Would this feature aid in your search for aggregate data?	___	___

Do you know anyone that would be interested in evaluating the "Aggregate Database"? If so, we would greatly appreciate it if you could provide us with their names and phone numbers.

Appendix D

RESPONSES TO SURVEY

E-mail from Richard Meininger
NRMCA-NAA
900 Spring Street
Silver Spring, MD 20910
(301) 587-1400 x 125
(301) 585-4219 (fax)
rmeininger@nrmca.org

I can see one issue already. The test data is reported for BuRec test numbers. Some of these would be essentially the same as ASTM and/or AASHTO Tests. Others may not be. Therefore, Some statement about each test may be required when comparing results from different agencies. TexDOT for example uses a different series of sieves than ASTM for aggregates. US BuRec I think does the sulfate soundness test or weighting calculation differently than ASTM. These are some of the things that need to be considered.

E-mail from Barry Oland
Oak Ridge National Laboratory
P.O. Box 2009/9204-1 MS 8056
Oak Ridge, TN 37831-8056
(423) 574-0659
(423) 574-0651 (fax)
olandcb@ornl.gov

What is your occupation?
Research Engineer involved in application of concrete technology to energy and power production. I am also Chairman of ACI Committee 126 on Database Formats for Concrete Materials Properties.

Why would you use a database of aggregate data? As an example of a comprehensive materials property database management system.

Rank the following aggregate data categories in terms of value to you? (1 -- greatest; 6 -- least).

__1__ Grading
__5__ Freeze-Thaw
__6__ LA Abrasion
__3__ Alkali-Aggregate Reactivity
__4__ Petrographic
__2__ Physical Properties (specific gravity, absoprtion, percent silt, etc.)

Do you know of anyone who has a database similar to the "Aggregate Database"? No.

Is there a need for a database, like the "Aggregate Database"? Yes.

Is the "Aggregate Database" a useful tool for you and your company or organization? No.

If no, how could we make the "Aggregate Database" a useful tool for you? The database could be useful as a research tool to provide questions about aggregate-related issues.

Would you like to see your company's or organization's aggregate records in the "Aggregate Database"? We do not develop data for aggregates.

Will you use the "Aggregate Database" in the future? Maybe I may refer to the database as an example of how data on other concrete constituents could be presented, but I do not specify or purchase aggregates for use in construction applications.

Have you encountered any difficulties while using the "Aggregate Database"? Yes. Although I am not familiar with Microsoft Access software, the lack of a general description about the database management system and the types of data that it contains makes it difficult to quickly learn to access the data that are available. Without knowing what is stored, it is impossible to use the information efficiently from the start.

Is the "Aggregate Database" effective at relaying the desired information? No
If no, please explain. The meaning of the various headings is not always obvious. For example, what is "grading(Des 4,5,6)Cum%Ret" and what does it mean? More detail is required or definitions need to be provided to guide the user through the database. A tutorial could be helpful.

Are the forms, tables, and print-outs easy to understand? No. If no, please explain. It is very difficult to work with the database when terms and their meanings are not defined. For example, what is a sample number, what information does it provide, and how is it used during a search? Unique material identification is very important, but one or two character identifiers are not very useful. A multiple character, coded, alphanumeric identifier could be developed to help distinguish one aggregate from another.

Please rate your level of experience in Microsoft Access. 1 (1 -- no experience; 10 -- expert)

Please circle the number that best represents your experience with the "Aggregate Database".

Efficiency	7	(1 -- poor; 10 -- excellent)
User-Friendliness	7	(1 -- poor; 10 -- excellent)
Layout/Structure	7	(1 -- poor; 10 -- excellent)

Navigation	7	(1 -- difficult; 10 -- easy)
Practicality	10	(1 -- not practical; 10 -- very practical)
Useful Information	10	(1 -- not useful; 10 -- very useful)
Overall Performance	7	(1 -- poor; 10 -- excellent)

How could the "Aggregate Database" be improved?
Provide a brief introduction to the database describing what types of data it contains, how the data are organized, and ways that the data can be presented.

Do you know anyone that would be interested in evaluating the "Aggregate Database"? If so, we would greatly appreciate it if you could provide us with their names and phone numbers. I do not know anyone.

Fax from Tommy Nantung
INDOT
Division of Research
1205 Montgomery Street
P.O. Box 2279
West Lafayette, IN 47906-2279
(317) 463-1521
(317) 497-1665

What is your occupation? Special Project Engineer (Concrete section)

Why would you use a database of aggregate data? Keep track of sources and properties of aggregates.

Rank the following aggregate data categories in terms of value to you? (1 -- greatest; 6 -- least).

__2__ Grading
__3__ Freeze-Thaw
__5__ LA Abrasion
__6__ Alkali-Aggregate Reactivity
__4__ Petrographic
__1__ Physical Properties (specific gravity, absoprtion, percent silt, etc.)

Do you know of anyone who has a database similar to the "Aggregate Database"? Yes. James Shilstone.

Is there a need for a database, like the "Aggregate Database"? Yes.

Is the "Aggregate Database" a useful tool for you and your company or organization? Yes. We can predict the performance of end products.

Would you like to see your company's or organization's aggregate records in the "Aggregate Database"? Yes .

Will you use the "Aggregate Database" in the future? Yes. It is a very useful tool.

Have you encountered any difficulties while using the "Aggregate Database"? Yes. The drop-down menu "TEST" in the "Aggregate Test Data" screen cannot be

"clicked". Using the "Next Test" button can not go further than the "sodium sulfate loss."

Is the "Aggregate Database" effective at relaying the desired information? Yes.

Are the forms, tables, and print-outs easy to understand? Yes.

Please rate your level of experience in Microsoft Access. 9 (1 -- no experience; 10 -- expert)

Please circle the number that best represents your experience with the "Aggregate Database".

Efficiency	9	(1 -- poor; 10 -- excellent)
User-Friendliness	9	(1 -- poor; 10 -- excellent)
Layout/Structure	9	(1 -- poor; 10 -- excellent)
Navigation	9	(1 -- difficult; 10 -- easy)
Practicality	9	(1 -- not practical; 10 -- very practical)
Useful Information	9	(1 -- not useful; 10 -- very useful)
Overall Performance	9	(1 -- poor; 10 -- excellent)

How could the "Aggregate Database" be improved? All of the drop-down menu do not work (to be checked). Create its own user's interface without relying to MS Access tool bars and menus.

Mail from Chiara Ferraris
United States Department of Commerce
NIST (National Institute of Standards and Technology)
Gaithersburg, MD 20899-0001
Bldg. 226, rm. B350
(301) 975-6711
(301) 990-6891 (Fax)
chiara.ferraris@nist.gov

Comments from letter dated 1-22-97
"I looked at your database and I completed the questionnaire enclosed. It is a great work and well constructed. Nevertheless, I have some comments that may improve it:

- It is hard to read the WEB page because the background is too dark at least on my computer.
- In some of the fields of the database, I can scroll down and change the results. For instance, I could change the rating of the Abrasion test or the type of aggregates. It will be safer if all the fields were locked.
- The test procedure needs to be clearly specified. The minimal information must be the Standard organization (as ASTM) the test designation and year of approval of the test, for instance ASTM C 227-95. In some cases, the test is specified but it seems that an internal method of designation was used. In that case, either the help key or documentation should have the description of that test. Otherwise, the exportability of the data is diminished.
- In the ASR screen, you report expansion at 6 months and 1 year. I assume that ASTM C227 was used, but aggregates can be also tested using ASTM C1260 that yields results in 14 days. The test used need to be stated. Your screen does not seem to allow other tests to be recorded.
- Also in the ASR screen, the definition of "Material" is not clear. We see both a scroll field with either coarse or fine highlighted and also another field with a type of aggregate. Why two fields? What are they referring too?
- The rapid selection of a sample number is not operational, I cannot scroll or type a number to go the aggregate desired.
- In the first screen there is a field labeled "volume". What are the units used?
- In some screens it seems that a lot of the fields are empty. Is it an error or all data were yet entered in the database?
- Although a major effort was made to define uniquely an aggregate, I am not sure what will happen if your database was merged with another. How will the

sample numbers avoid being duplicate? Is there a criteria to assign the sample number?"

What is your occupation? Physicist at NIST.

Why would you use a database of aggregate data?
Find aggregate with a specific characteristic for a test.

Rank the following aggregate data categories in terms of value to you? (1-- greatest; 6 -- least).

__1__ Grading
__4__ Freeze-Thaw
__6__ LA Abrasion
__2__ Alkali-Aggregate Reactivity
__2__ Petrographic
__1__ Physical Properties (specific gravity, absoprtion, percent silt, etc.)

Is there a need for a database, like the "Aggregate Database"? Yes.

Is the "Aggregate Database" a useful tool for you and your company or organization? Yes. Need to search existing data.

Would you like to see your company's or organization's aggregate records in the "Aggregate Database"? No. We do not have such records.

Will you use the "Aggregate Database" in the future? Yes. To search for specific aggregate.

Have you encountered any difficulties while using the "Aggregate Database"? No.

Is the "Aggregate Database" effective at relaying the desired information? Maybe, see attached comments.

Are the forms, tables, and print-outs easy to understand? Maybe, see attached comments.

Please rate your level of experience in Microsoft Access. 5 (1 -- no experience; 10 -- expert)

Please circle the number that best represents your experience with the "Aggregate Database".

Efficiency	8	(1 -- poor; 10 -- excellent)
User-Friendliness	8	(1 -- poor; 10 -- excellent)
Layout/Structure	10	(1 -- poor; 10 -- excellent)
Navigation	10	(1 -- difficult; 10 -- easy)
Practicality	8	(1 -- not practical; 10 -- very practical)
Useful Information	6	(1 -- not useful; 10 -- very useful)
Overall Performance	6	(1 -- poor; 10 -- excellent)

We are planning to put the Aggregate Database on the web so that the user will be able to do on-line searches through the data. Do you think this is something worthwhile to pursue? Why or why not? Yes. I think that the user should not have to download the DB to search it. If the search is online than he/she will be assured that only the latest version is available. It is easy to maintain it.

Would you use the Aggregate Database more if you could do on-line searches? Why or why not? Yes.

We are planning to have a GIS interface built into the database that will allow the user to select a geographic area and view only the aggregate data from that area. Do you think this is something worthwhile to pursue? Why or why not? Yes.

Would this feature aid in your search for aggregate data? Yes.

Mail from Jim Schmitt
Edward Kramer and Sons
One Plain View Road
Plain, WI 53577

What is your occupation? Vice President of Mining and Technical Services. I am a professionally trained geologist.

Why would you use a database of aggregate data? Yes.

Rank the following aggregate data categories in terms of value to you? (1 -- greatest; 6 -- least).
__4__ Grading
__2__ Freeze-Thaw
__3__ LA Abrasion
__5__ Alkali-Aggregate Reactivity
__6__ Petrographic
__1__ Physical Properties (specific gravity, absoprtion, percent silt, etc.)

Do you know of anyone who has a database similar to the "Aggregate Database"? No.

Is there a need for a database, like the "Aggregate Database"? Yes.

Is the "Aggregate Database" a useful tool for you and your company or organization? Yes. It would help me in searching for new sources of aggregate and to get an idea of aggregate types in a particluar area.

Would you like to see your company's or organization's aggregate records in the "Aggregate Database"? Yes.

Will you use the "Aggregate Database" in the future? Yes.

Are the forms, tables, and print-outs easy to understand? Yes.

How could the "Aggregate Database" be improved?
1. I would be more interested in sulfate soundness than sand attrition data. Sand attrition is a test more widely used in western U.S. Many midwestern and eastern states don't use it. However, sulfate soundness is used throughout out the U.S.

2. I would rather search and locate and print by section, township, and range, rather than latitiude and longitude.
3. Include ballast as a category
4. Microsoft Access is not a program commonly obtained for most PC's, find another software.

We are planning to put the Aggregate Database on the web so that the user will be able to do on-line searches through the data. Do you think this is something worthwhile to pursue? Why or why not? Yes.

Would you use the Aggregate Database more if you could do on-line searches? Why or why not? Yes. Easy to access.

We are planning to have a GIS interface built into the database that will allow the user to select a geographic area and view only the aggregate data from that area. Do you think this is something worthwhile to pursue? Why or why not? Yes. Wider access will access data faster. Some smaller search areas may not have any data, thereby requiring use to research another adjacent specific area, which again may be hit or miss.

Would you use the Aggregate Database more if it had this feature? Yes. See above.

Would this feature aid in your search for aggregate data? Yes.

Fax from Colin Arrand
Vulcan Materials Company
P.O. Box 530187
Birmingham, AL 35253
(205) 877-3218
(205) 877-3779 (Fax)

What is your occupation? Technical Services Engineer.

Why would you use a database of aggregate data?
Selecting materials for the design of portland cement or asphalt cement mixes.

Rank the following aggregate data categories in terms of value to you? (1 -- greatest; 6 -- least).
__1__ Grading
__5__ Freeze-Thaw
__3__ LA Abrasion
__4__ Alkali-Aggregate Reactivity
__6__ Petrographic
__2__ Physical Properties (specific gravity, absoprtion, percent silt, etc.)

Do you know of anyone who has a database similar to the "Aggregate Database"? No.

Is there a need for a database, like the "Aggregate Database"? Yes.

Is the "Aggregate Database" a useful tool for you and your company or organization? Yes.
If yes, why? Compare competition and above
If no, how could we make the "Aggregate Database" a useful tool for you?
You should also include unit wts (c.a), other superpave properties, direction to get to quarry from a major hwy.

Would you like to see your company's or organization's aggregate records in the "Aggregate Database"? Yes.

Will you use the "Aggregate Database" in the future? Yes. See above.

Have you encountered any difficulties while using the "Aggregate Database"? No.

Is the "Aggregate Database" effective at relaying the desired information? Yes.

Are the forms, tables, and print-outs easy to understand? Yes.

Please rate your level of experience in Microsoft Access. 2 (1 -- no experience; 10 -- expert)

Please circle the number that best represents your experience with the "Aggregate Database".

Efficiency	8	(1 -- poor; 10 -- excellent)
User-Friendliness	7	(1 -- poor; 10 -- excellent)
Layout/Structure	8	(1 -- poor; 10 -- excellent)
Navigation	9	(1 -- difficult; 10 -- easy)
Practicality	8	(1 -- not practical; 10 -- very practical)
Useful Information	8	(1 -- not useful; 10 -- very useful)
Overall Performance	7	(1 -- poor; 10 -- excellent)

How could the "Aggregate Database" be improved? Include more data, unit wt of c.a., superpave prop.

Do you know of anyone that would be interested in evaluating the "Aggregate Database"? If so, we would greatly appreciate it if you could provide us with their names and phone numbers. R.S. Quire (502) 223-3254.

E-mail from Bruce Vandre
Bvandre@aol.com

What is your occupation? Geotechnical Engineer, pavement management engineer

Why would you use a database of aggregate data?
Develop evaluation indexes for durability; reduce testing by developing correlations among properties or test results; identify anomalies in test results; predict performance of aggregate mixes.

Rank the following aggregate data categories in terms of value to you? (1 -- greatest; 6 -- least).

__6__ Grading
__3__ Freeze-Thaw
__5__ LA Abrasion
__4__ Alkali-Aggregate Reactivity
__2__ Petrographic
__1__ Physical Properties (specific gravity, absoprtion, percent silt, etc.)

Do you know of anyone who has a database similar to the "Aggregate Database"? No.

Is there a need for a database, like the "Aggregate Database"? Yes.

Would you like to see your company's or organization's aggregate records in the "Aggregate Database"? After we enter them in a data base.

Will you use the "Aggregate Database" in the future? Yes. In response to specific project questions.

Have you encountered any difficulties while using the "Aggregate Database"? I have accessed the database once. I plan to become more familiar with it in the future.

How could the "Aggregate Database" be improved? Include performance data, i.e. roadway base, asphalt or concrete mix properties, observed field performance.

E-mail from James Pierce
U.S Bureau of Reclamation
jpierce@borworld.usbr.gov

What is your occupation?
Civil Engineer.

Why would you use a database of aggregate data?
Use of the database would be for finding suitable aggregate available in an area.

Rank the following aggregate data categories in terms of value to you? (1 -- greatest; 6 -- least).
I believe all of the data categories are of greatest value because you need all of the data to evaluate the material.

Do you know of anyone who has a database similar to the "Aggregate Database"?
I do not know of any other similar databases.

Is there a need for a database, like the "Aggregate Database"? Yes, I believe there is a need.

Is the "Aggregate Database" a useful tool for you and your company or organization? The database organizes the data that Reclamation has and therefore is a useful tool. Reclamation needs to reference available data in a given project location.

Would you like to see your company's or organization's aggregate records in the "Aggregate Database"? You've already done it.

Will you use the "Aggregate Database" in the future? I am not likely to use the Aggregate Database in my present position. I certainly would use it if I was doing any consulting.

Have you encountered any difficulties while using the "Aggregate Database"? The only difficulty was my unfamiliarity with MS Access.

Is the "Aggregate Database" effective at relaying the desired information? Yes, the database is effective at relaying the desired information.

Are the forms, tables, and print-outs easy to understand? Yes, the forms etc were easy to understand.

Please rate your level of experience in Microsoft Access. (1 -- no experience; 10 -- expert) I had not used MS Access before this trial.

Please circle the number that best represents your experience with the "Aggregate Database".

Efficiency	8	(1 -- poor; 10 -- excellent)
User-Friendliness	8	(1 -- poor; 10 -- excellent)
Layout/Structure	7	(1 -- poor; 10 -- excellent)
Navigation	9	(1 -- difficult; 10 -- easy)
Practicality	10	(1 -- not practical; 10 -- very practical)
Useful Information	10	(1 -- not useful; 10 -- very useful)
Overall Performance	8	(1 -- poor; 10 -- excellent)

How could the "Aggregate Database" be improved? I don't have any suggestions for improvement.

E-mail from Mike Kamnikar
mike.kamnikar@dot.state.mn.us

What is your occupation? Aggregate Engineer

Why would you use a database of aggregate data? To correlate pavement performance with aggregate sources used during construction. To also aid us in determining areas to search for new aggregate deposits.

Rank the following aggregate data categories in terms of value to you? (1 -- greatest; 6 -- least).
_1___ Grading
_5__ Freeze-Thaw
_4___ LA Abrasion
_3___ Alkali-Aggregate Reactivity
_6___ Petrographic
_2___ Physical Properties (specific gravity, absoprtion, percent silt, etc.)

Do you know of anyone who has a database similar to the "Aggregate Database"? Yes. Minnesota Dept. of Transportation, North Dakota Dept. of Transportation, Construction Market Research, Pittsburgh, PA, contact Jane Snyder @ 412-241-3244.

Is there a need for a database, like the "Aggregate Database"? Yes.

Is the "Aggregate Database" a useful tool for you and your company or organization? Yes. To compare test results of similar rock types in other regions with data that we collect. I also compare overburden #'s, quantity #'s, etc.

Would you like to see your company's or organization's aggregate records in the "Aggregate Database"? Yes.

Will you use the "Aggregate Database" in the future? Yes. I see an increase in demand for information contained in the database as the demand for longer lasting pavements continues.

Have you encountered any difficulties while using the "Aggregate Database"? No.

Is the "Aggregate Database" effective at relaying the desired information? Yes.

Are the forms, tables, and print-outs easy to understand? Yes

Please rate your level of experience in Microsoft Access. 1 (1 -- no experience; 10 -- expert)

Please circle the number that best represents your experience with the "Aggregate Database".

Efficiency	4	(1 -- poor; 10 -- excellent)
User-Friendliness	5	(1 -- poor; 10 -- excellent)
Layout/Structure	8	(1 -- poor; 10 -- excellent)
Navigation	8	(1 -- difficult; 10 -- easy)
Practicality	10	(1 -- not practical; 10 -- very practical)
Useful Information	10	(1 -- not useful; 10 -- very useful)
Overall Performance	8	(1 -- poor; 10 -- excellent)

How could the "Aggregate Database" be improved?
Due to my lack of experience with the Access database, it would be nice to have an example built into the program (coach) to follow how a typical record(s) might be analyzed. An index map showing general source locations within a state would also be beneficial.

Do you know anyone that would be interested in evaluating the "Aggregate Database"? If so, we would greatly appreciate it if you could provide us with their names and phone numbers. Mr. Henk Dahlberg, Minnesota Dept. of Natural Resources, (218)262-6767.

E-mail from Stephen Forster
Federal Highway Administration
6300 Georgetown Pike/HNR-20
McLean, VA 22101-2296
(703) 285-2073
(703) 285-3105 (fax)
steve.forster@fhwa.dot.gov

What is your occupation? Research geologist.

Why would you use a database of aggregate data? To gain information about highway aggregates around the country; particularly where performance problems were being investigated.

Rank the following aggregate data categories in terms of value to you? (1 -- greatest; 6 -- least).
_6___ Grading
_4__ Freeze-Thaw
_5___ LA Abrasion
_2___ Alkali-Aggregate Reactivity
_1___ Petrographic
_3___ Physical Properties (specific gravity, absoprtion, percent silt, etc.)

Do you know of anyone who has a database similar to the "Aggregate Database"? No similar database that I know of.

Is there a need for a database, like the "Aggregate Database"? There is a need.

Is the "Aggregate Database" a useful tool for you and your company or organization? Don't know, couldn't download.

Would you like to see your company's or organization's aggregate records in the "Aggregate Database"? FHWA's records are supposed to be being entered.

Will you use the "Aggregate Database" in the future? Don't know; see difficulties/improvements, below.

Have you encountered any difficulties while using the "Aggregate Database"? Microsoft Access required to look at the file; downloading of the file takes some time.

Is the "Aggregate Database" effective at relaying the desired information? Don't know.

Are the forms, tables, and print-outs easy to understand? Don't know.

Please rate your level of experience in Microsoft Access. 1 (1 -- no experience; 10 -- expert)

Please circle the number that best represents your experience with the "Aggregate Database". Experience ratings - N/A.

How could the "Aggregate Database" be improved?
Improvements - these comments were provided by a computer-literate member of my staff:
1. locate the database in a stand alone file; then there is no need to download to look at it.
2. if 1. is not possible, split the database into several (5 or 6) according to regions of the country. This would decrease the download time, and allow searchers to concentrate on a portion of the country, if desired.

Do you know anyone that would be interested in evaluating at the "Aggregate Database"? Other potential evaluator - David Fowler was recently supplied with the roster for the TRB Aggregates Committee. Many of these people should have an interest in the database.

Mail from Charlie Pryor
caprvor@DGS dgsvs.com

Why would you use a database of aggregate data? Yes.

Rank the following aggregate data categories in terms of value to you? (1 -- greatest; 6 -- least). *Hard to rank. If the particular category fails a spec, then it is #1

__1__ Grading
__4__ Freeze-Thaw
__3__ LA Abrasion
__5__ Alkali-Aggregate Reactivity
__6__ Petrographic
__2__ Physical Properties (specific gravity, absoprtion, percent silt, etc.)

Do you know of anyone who has a database similar to the "Aggregate Database"? Yes. I think each state has some of this data. Also US Army Corp of Engrs.

Is there a need for a database, like the "Aggregate Database"? Yes.

Is the "Aggregate Database" a useful tool for you and your company or organization? Yes. To give NSA a view of national and regional prop.

Would you like to see your company's or organization's aggregate records in the "Aggregate Database"? N/A (I am an association).

Will you use the "Aggregate Database" in the future? Yes. Allow me to: 1. Respond to local inquiries 2. Respond to national inquiries.

Are the forms, tables, and print-outs easy to understand? Yes.

How could the "Aggregate Database" be improved? Make avail over Internet as a generic format.

Do you know of anyone that would be interested in evaluating the "Aggregate Database"? If so, we would greatly appreciate it if you could provide us with their names and phone numbers.
Dr. Chuck Marek-- Vulcan-- (205) 877-3217.
Mr. Randy Weingardt -- Luck Stone (804) 784-6345.

Mr. Val Tepordai -- USGS (703) 648-7728.
Mr. Bob Drake -- Rock Products (330) 497-6034
Dr. Steve Forster -- FHWA (703) 285-2073.

We are planning to put the Aggregate Database on the web so that the user will be able to do on-line searches through the data. Do you think this is something worthwhile to pursue? Why or why not? Yes. WWW is the research tool of the future.

Would you use the Aggregate Database more if you could do on-line searches? Why or why not? Yes. CD ROM is instantly outdated. Paper cannot be manipulated.

We are planning to have a GIS interface built into the database that will allow the user to select a geographic area and view only the aggregate data from that area. Do you think this is something worthwhile to pursue? Why or why not? Yes. Not certain--need to know more.

Would you use the Aggregate Database more if it had this feature? Yes. Think so.

Would this feature aid in your search for aggregate data? Yes. Think so.

Mail from unknown evaluator

What is your occupation? Civil Engineer -- consultant on concrete and concrete materials.

Why would you use a database of aggregate data? Yes. For construction materials survey.

Rank the following aggregate data categories in terms of value to you? (1 -- greatest; 6 -- least).

__6__ Grading
__2__ Freeze-Thaw
__3__ LA Abrasion
__5__ Alkali-Aggregate Reactivity
__1__ Petrographic
__4__ Physical Properties (specific gravity, absoprtion, percent silt, etc.)

Do you know of anyone who has a database similar to the "Aggregate Database"? No.

Is there a need for a database, like the "Aggregate Database"? Yes.

Is the "Aggregate Database" a useful tool for you and your company or organization? Yes. Simplify search for material sources .

Would you like to see your company's or organization's aggregate records in the "Aggregate Database"? Yes. But have none.

Will you use the "Aggregate Database" in the future? Yes. If it can be retreived from internet without special software.

Are the forms, tables, and print-outs easy to understand? Yes. No problem reading information.

How could the "Aggregate Database" be improved? If this is an operating source, products that are, or might be available from source.

We are planning to put the Aggregate Database on the web so that the user will be able to do on-line searches through the data. Do you think this is something worthwhile to pursue? Why or why not? Yes. Definitely.

Would you use the Aggregate Database more if you could do on-line searches? Why or why not? Yes. Simplify field work.

We are planning to have a GIS interface built into the database that will allow the user to select a geographic area and view only the aggregate data from that area. Do you think this is something worthwhile to pursue? Why or why not? Yes. This would be essential for a materials search.

Would you use the Aggregate Database more if it had this feature? Yes. Definitely.

Would this feature aid in your search for aggregate data? Yes.

Mail from unknown evaluator

What is your occupation? Geologist, cement and concrete consultant.

Why would you use a database of aggregate data? No.

Rank the following aggregate data categories in terms of value to you? (1 -- greatest; 6 -- least).

__6_ Grading
__3_ Freeze-Thaw
__5__ LA Abrasion
__2__ Alkali-Aggregate Reactivity
__1__ Petrographic
__4__ Physical Properties (specific gravity, absoprtion, percent silt, etc.)

Do you know of anyone who has a database similar to the "Aggregate Database"? No.

Is there a need for a database, like the "Aggregate Database"? No.

Is the "Aggregate Database" a useful tool for you and your company or organization? No. Provide meaningful information on service record of individual aggregate sources. However, I believe this is an almost impossible project.

Would you like to see your company's or organization's aggregate records in the "Aggregate Database"? No.

Will you use the "Aggregate Database" in the future? No. It would not appear to contain the most important information needed.

Are the forms, tables, and print-outs easy to understand? Yes.

How could the "Aggregate Database" be improved? Same above.

Do you know of anyone that would be interested in evaluating the "Aggregate Database"? If so, we would greatly appreciate it if you could provide us with their names and phone numbers. Not at the present time.

We are planning to put the Aggregate Database on the web so that the user will be able to do on-line searches through the data. Do you think this is something worthwhile to pursue? Why or why not? No. We are not in the work of needing to select the information now intended.

Would you use the Aggregate Database more if you could do on-line searches? Why or why not? No. Same as above.

We are planning to have a GIS interface built into the database that will allow the user to select a geographic area and view only the aggregate data from that area. Do you think this is something worthwhile to pursue? Why or why not? No. Same as above.

Would you use the Aggregate Database more if it had this feature? No Same as above.

Would this feature aid in your search for aggregate data? No.

Appendix E

Paper Sent to Those Who Could Not Access the Aggregate Database

Purpose of the Aggregate Database

The purpose of the Aggregate Database is to have a central source of aggregate information which will be available to anyone who has a need for it.

What is a Database?

A database is simply an electronic record-keeping system. Instead of having thousands of records on paper, all the information is stored in a computer database in a uniform, consistent format.

A relational database, like the aggregate materials database, is one type of database model. The relational model stores data in separate tables. Tables are linked together by creating a relationship between key fields in different tables. For example, in the aggregate database, the aggregate grading data (in one table) and the general aggregate information (in another table) are linked together by the Reclamation sample number. The sample number is the common link between these two tables (Figure 1).

This database is the first of its kind in the aggregates industry. Initially, the aggregate database was created by Reclamation so that thousands of forms and data sheets could be replaced with an electronic library. This electronic library has made it easier to both find records and to perform comprehensive analyses on the data. The concept behind this database has grown from an in-house Reclamation database to one which will eventually have all the sources in the United States recognized by state DOT's, producers, and other aggregate sources.

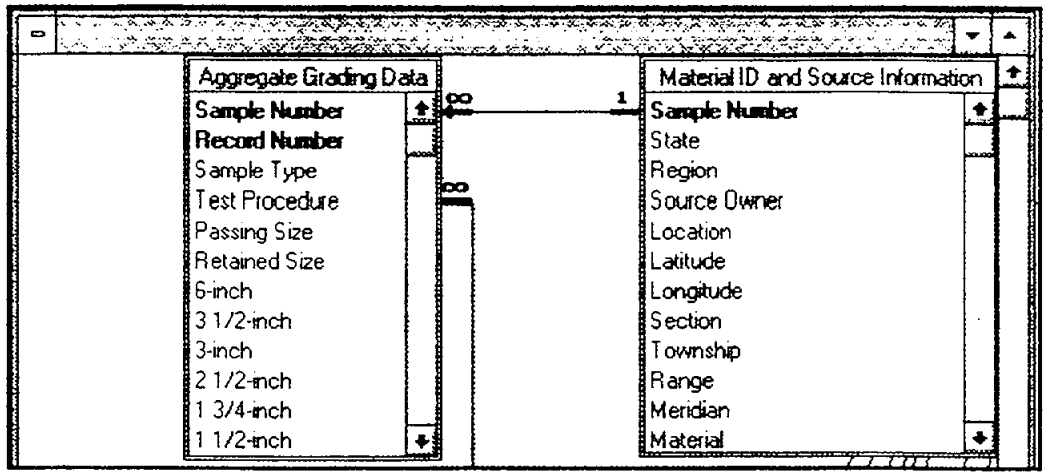


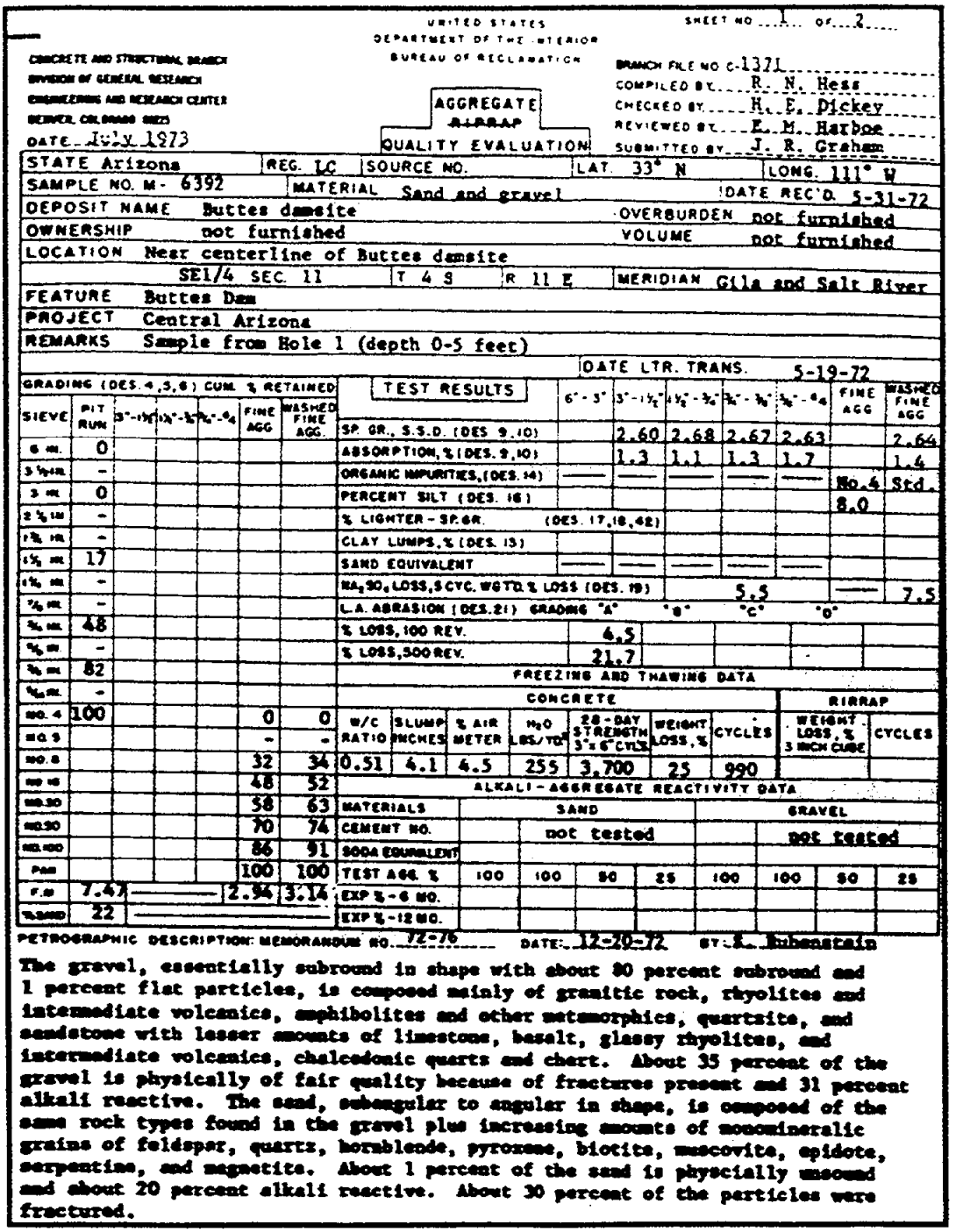
Figure 1. This shows the relationship between the aggregate grading data and general information. They are linked together by the sample number.

What is in the Aggregate Database?

The database currently contains data on more than 2,200 Reclamation aggregate sources located throughout the western United States. Each record can contain the following information:

- General information including the aggregate type, the producer, and the date the aggregate was analyzed.
- Location of the aggregate source (state, region, latitude, longitude and in most cases, meridian, section, township, and range).
- Physical properties (specific gravity, absorption, LA abrasion, grading, etc.).
- In limited cases, concrete data (freeze-thaw, alkali-aggregate test results).
- Petrography results

Figure 2 is a sample printout of an aggregate record in the database.



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

SHEET NO. 1 OF 2

CONCRETE AND STRUCTURAL BRANCH
DIVISION OF GENERAL RESEARCH
ENGINEERING AND RESEARCH CENTER
DENVER, COLORADO 80225

DATE July 1973

AGGREGATE
RIPRAP
QUALITY EVALUATION

BRANCH FILE NO C-1371
COMPILED BY R. N. Hess
CHECKED BY H. E. Dickey
REVIEWED BY E. M. Harboe
SUBMITTED BY J. R. Graham

STATE Arizona	REG. LC	SOURCE NO.	LAT. 33° N	LONG. 111° W
SAMPLE NO. M- 6392	MATERIAL Sand and gravel		DATE REC'D. 5-31-72
DEPOSIT NAME Buttes damsite		OVERBURDEN not furnished	
OWNERSHIP not furnished		VOLUME not furnished	
LOCATION Near centerline of Buttes damsite			
SE1/4 SEC. 11	T 4 S	R 11 E	MERIDIAN Gila and Salt River
FEATURE Buttes Dam			
PROJECT Central Arizona			
REMARKS Sample from Hole 1 (depth 0-5 feet)			

DATE LTR. TRANS. 5-19-72

GRADING (DES. 4,5,6) CUM. % RETAINED

SIEVE	PIT RUN	3"-1½"	1½"-¾"	¾"-¼"	FINE AGG	WASHED FINE AGG.
6 in.	0					
3½ in.	-					
3 in.	0					
2½ in.	-					
1¾ in.	-					
1½ in.	17					
1¼ in.	-					
⅞ in.	-					
¾ in.	48					
⅝ in.	-					
½ in.	82					
⅜ in.	-					
NO. 4	100				0	0
NO. 8					32	34
NO. 16					48	52
NO. 30					58	63
NO. 50					70	74
NO. 100					86	91
PAN					100	100
F.M.	7.47				2.54	3.14
%SAND	22					

TEST RESULTS

	6"-3"	3"-1½"	1½"-¾"	¾"-⅜"	⅜"-¼"	FINE AGG	WASHED FINE AGG
SP. GR., S.S.D. (DES. 9,10)		2.60	2.68	2.67	2.63		2.64
ABSORPTION, % (DES. 9,10)		1.3	1.1	1.3	1.7		1.4
ORGANIC IMPURITIES, (DES. 14)	——	——	——	——	——	No. 4	Std.
PERCENT SILT (DES. 16)						8.0	
% LIGHTER - SP. GR. (DES. 17,18,48)							
CLAY LUMPS, % (DES. 15)							
SAND EQUIVALENT	——	——	——	——	——		
Na_2SO_4 LOSS, 5 CYC. WGTD. % LOSS (DES. 19)			5.5			——	7.5
L.A. ABRASION (DES. 21) GRADING "A"		"B"		"C"		"D"	
% LOSS, 100 REV.		4.5					
% LOSS, 500 REV.		21.7					

FREEZING AND THAWING DATA

CONCRETE							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STRENGTH 3"x6" CYLS.	WEIGHT LOSS, %	CYCLES	WEIGHT LOSS, % 3 INCH CUBE	CYCLES
0.51	4.1	4.5	255	3,700	25	990		

ALKALI - AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.	not tested				not tested			
SODA EQUIVALENT								
TEST AGE, %	100	100	50	25	100	100	50	25
EXP % - 6 MO.								
EXP % - 12 MO.								

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. 72-76 DATE: 12-20-72 BY: E. Eubanks

The gravel, essentially subround in shape with about 80 percent subround and 1 percent flat particles, is composed mainly of granitic rock, rhyolites and intermediate volcanics, amphibolites and other metamorphics, quartzite, and sandstone with lesser amounts of limestone, basalt, glassy rhyolites, and intermediate volcanics, chalcedonic quartz and chert. About 35 percent of the gravel is physically of fair quality because of fractures present and 31 percent alkali reactive. The sand, subangular to angular in shape, is composed of the same rock types found in the gravel plus increasing amounts of monomineralic grains of feldspar, quartz, hornblende, pyroxene, biotite, muscovite, epidote, serpentine, and magnetite. About 1 percent of the sand is physically unsound and about 20 percent alkali reactive. About 30 percent of the particles were fractured.

Figure 2. Sample Print-Out From the Aggregate Database

What does the Aggregate Database look like?

The layout of the Aggregate Database is very simple; there are only 10 different screens. These screens follow the pattern shown on the cardboard. At this point, I kindly ask that you would pull out the poster board sheets and place them together (Figure 3).

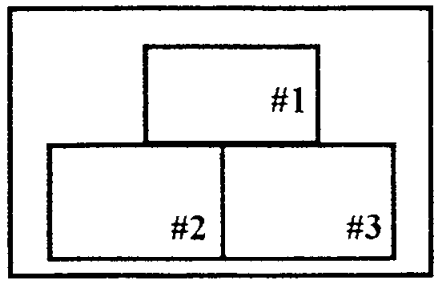


Figure 3. Layout of poster board.

and look carefully at the forms and the data contained in each one. The poster board sheets will be a useful reference as you read the rest of this paper.

How do you use the Aggregate Database?

Once the database is open, the user clicks the *View Aggregate Data Records* button on the *Main Form*. This action brings up the *Material ID and Source Information* form which contains links to the aggregate quality data (at the bottom of the form), the type of material, location and name of the aggregate source, date of the sample, volume of sample, etc. After the *Material ID and Source Information* form is open, the user then clicks the arrow (Figure 3) next to the *Pick Sample Number to Review* field to select the specific sample number he wants to view.

The sample number is the unique identifier (much like a social security number) of all the aggregate records. These sample numbers were given to the

aggregate samples by the Bureau of Reclamation. Therefore, the user has to know the specific sample number of a specific aggregate sample in order to view the data. Just as a social security number allows the government to distinguish between United States citizens; the sample number field allows the Aggregate Database to distinguish between aggregate samples.

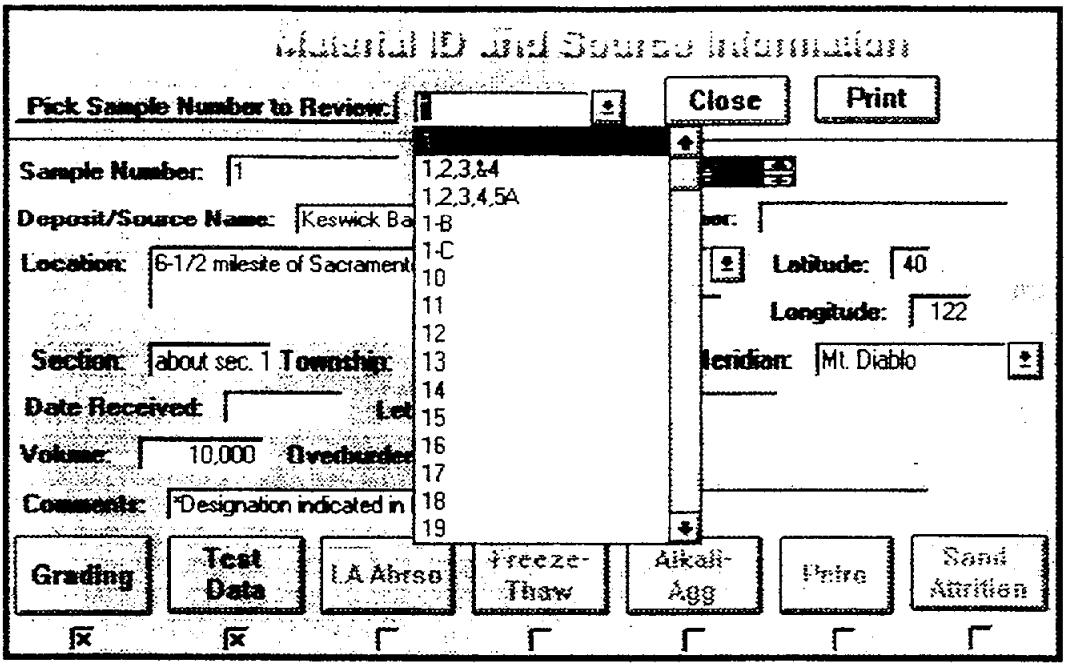


Figure 3. This shows the list of sample numbers that appears when the user clicks the arrow next to the *Pick Sample Number to Review* field.

You may be asking yourself how do I, as the user, know the sample number? You don't; that's one problem we are trying to overcome. If the user does not know the sample number of the aggregate record he wishes to view, which is almost always the case, then the user has to set up a query (this requires

knowledge of the Microsoft Access software package). With a query, you ask the computer a question about the data.

For example, assume you wanted to find a riprap source in Colorado. The user sets up a query that asks the computer to find all the riprap sources in Colorado that are in the Aggregate Database. Figure 4 shows the results of this query. The query found and listed all the riprap sources in Colorado and listed the sample number (so the user can view that record if he wishes), source owner, and the deposit/source name.

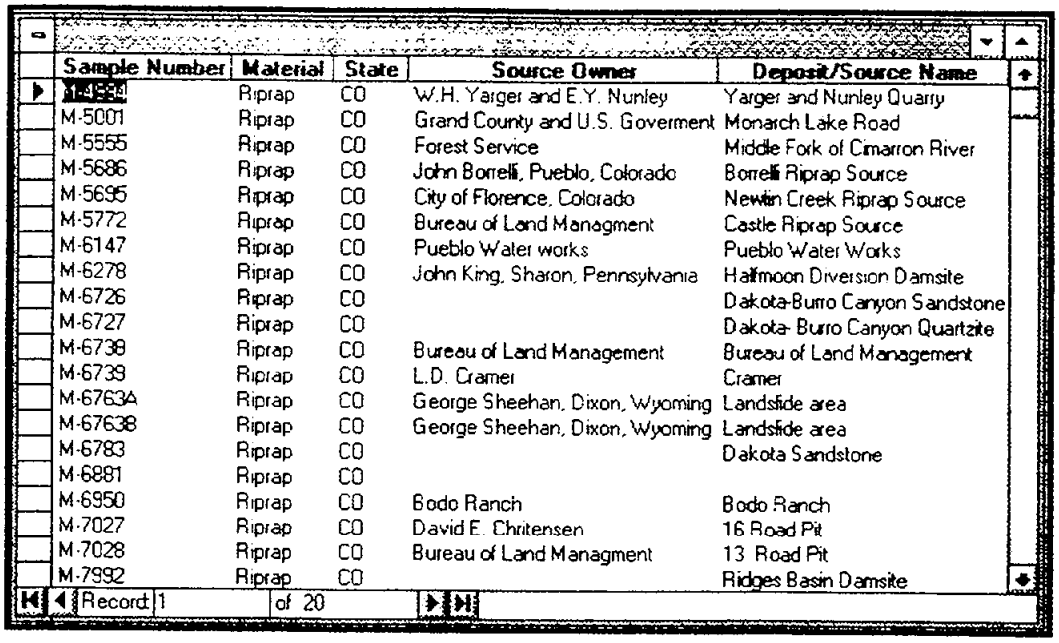
How do you print out aggregate records?

The user can print out aggregate records either by selecting a specific sample number or state, or by entering a specified range of latitude and longitude. The user can print out a single record either by clicking the *Print* button on the *Material ID and Source Information* form or by selecting the sample number option on the *Select Print Dialog* form. The *Select Print Dialog* form also allows the user to print out every record in the database for a single state or a specified range of latitude and longitude.

What do I need to view this database?

You need a copy of Microsoft Access 2.0 or 95 to view the database. If you obtain Access 2.0 or 95, then we can mail you a copy of the database. If you would like to receive a copy of the database, send me an e-mail or a letter at the address specified on the cover letter. If you have Access 2.0 or 95 and access to the Internet, you can download the file at the following site:

http://www.usbr.gov/merl/concrete/aggtests.html



Sample Number	Material	State	Source Owner	Deposit/Source Name
M-5001	Riprap	CO	W.H. Yarger and E.Y. Nunley	Yarger and Nunley Quarry
M-5001	Riprap	CO	Grand County and U.S. Goverment	Monarch Lake Road
M-5555	Riprap	CO	Forest Service	Middle Fork of Cimarron River
M-5686	Riprap	CO	John Borrelli, Pueblo, Colorado	Borrelli Riprap Source
M-5695	Riprap	CO	City of Florence, Colorado	Newlin Creek Riprap Source
M-5772	Riprap	CO	Bureau of Land Managment	Castle Riprap Source
M-6147	Riprap	CO	Pueblo Water works	Pueblo Water Works
M-6278	Riprap	CO	John King, Sharon, Pennsylvania	Halfmoon Diversion Damsite
M-6726	Riprap	CO		Dakota-Burro Canyon Sandstone
M-6727	Riprap	CO		Dakota- Burro Canyon Quartzite
M-6738	Riprap	CO	Bureau of Land Management	Bureau of Land Management
M-6739	Riprap	CO	L.D. Cramer	Cramer
M-6763A	Riprap	CO	George Sheehan, Dixon, Wyoming	Landslide area
M-6763B	Riprap	CO	George Sheehan, Dixon, Wyoming	Landslide area
M-6783	Riprap	CO		Dakota Sandstone
M-6881	Riprap	CO		
M-6950	Riprap	CO	Bodo Ranch	Bodo Ranch
M-7027	Riprap	CO	David E. Chritensen	16 Road Pit
M-7028	Riprap	CO	Bureau of Land Managment	13 Road Pit
M-7992	Riprap	CO		Ridges Basin Damsite

Record: 1 of 20

Figure 4. The results of the query that found all the riprap sources (in the database) in Colorado.

We are planning to put the Aggregate Database on the web so that users will not need a copy of Microsoft Access. Instead, the user would need a web browser such as: Netscape, Microsoft Internet Explorer, or NCSA Mosaic. We envision a web-site that will allow the user to do on-line queries in the database and have standardized forms that will allow users to upload data into the database.

Future of Aggregate Database

The future of the Aggregate Database is very promising. More and more Reclamation records are being added, the database is being optimized, and work is underway to add FHWA records. Future developments for the Aggregate Database include:

- Optimizing and streamlining the database -- Reducing search and run time, incorporating searches for samples by pertinent properties, reducing the number of fields, optimizing the design, etc.
- As already mentioned, providing an Internet interface for on-line queries and data forms to upload aggregate data. This will allow users to access and use the database on the World-Wide Web.
- Providing an Internet-GIS (Geographic Information Systems) interface. This would allow users to click on a region in the United States and pull up aggregate quality reports for that region.
- Incorporating aggregate quality data from FHWA, COE, state DOT's, and other organizations.
- Distributing the aggregate quality data on CD-ROM.

Summary

ICAR, FHWA and Reclamation have entered into a partnership to create an aggregate materials database. This relational database is the first of its kind in the aggregate industry. The database currently contains data on more than 2,200 Reclamation aggregate sources. It is available to the aggregate industry, at no charge, on the World-Wide Web. The database tells you the source of the aggregate and quality of the aggregate (durability, strength, physical properties, etc.). The future is very promising for the aggregate materials database. We are making many changes and additions so that the database will be more effective and efficient.

If you have any questions or comments regarding the aggregate database, please don't hesitate to contact one of the following: