

USE OF DATABASES IN CHARACTERIZATION AT MINE SITES¹

Virginia T. McLemore², Gretchen K. Hoffman, Maureen Wilks, J. Steven Raugust, and Glen R. Jones

Abstract: Mining companies and their consultants generate large amounts of data at mine sites today. One of the most effective tools to enter, store, report, and utilize these data are by relational databases. The New Mexico Bureau of Geology and Mineral Resources has developed a database, the Mine Rock Pile database, to incorporate the characterization of mine rock piles for potential acid-mine drainage and rock pile stability. This database is being applied to an investigation at Molycorp's Questa mine in New Mexico. There are six main tables in the database: Samples, Drillholes, Test pits, Analytical data, Photographs and Bibliography, with more than 100 supporting tables. The data to be incorporated in this database includes locational data, climatic data, mineralogy, chemical analyses, geologic data on drill holes and test pits, historical and recent photographs, and other data. Existing data as well as newly collected data will be incorporated into the database. The purposes of this database are 1) to provide easy access to computerized data that will aid in the physical, mineralogical, chemical, and geotechnical characterization of the mine rock piles and 2) to create links to other databases at the mine and at NMBGMR. Forms allow for standard collection and input of data in the field and laboratory. Standard Operating Procedures (SOPs) are incorporated throughout the database to insure acceptable quality of sample collection and laboratory procedures. Once the data are entered into the database with locations, the data can easily be converted to GIS format for displaying on maps. The data can be imported into spreadsheets and used in most commercial software for data manipulation and interpretation.

Additional Key Words: chemistry, mineralogy, databases, Molycorp, Questa

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²Virginia T. McLemore, PhD. is Senior Economic Geologist and Minerals Outreach Liaison for the New Mexico Bureau of Geology and Mineral Resources (NMBGMR), New Mexico Institute of Mining and Technology (NMIMT), Socorro, NM 87801, ginger@gis.nmt.edu
Gretchen K. Hoffman is the Senior Coal Geologist and Database Manager at NMBGMR
Maureen Wilks, PhD. is the Geological Librarian at NMBGMR
Glen R. Jones is the Assistant Director of Computers/Internet Services at NMBGMR
J. Steven Raugust is a Geotechnical Lab Associate at NMBGMR
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Introduction

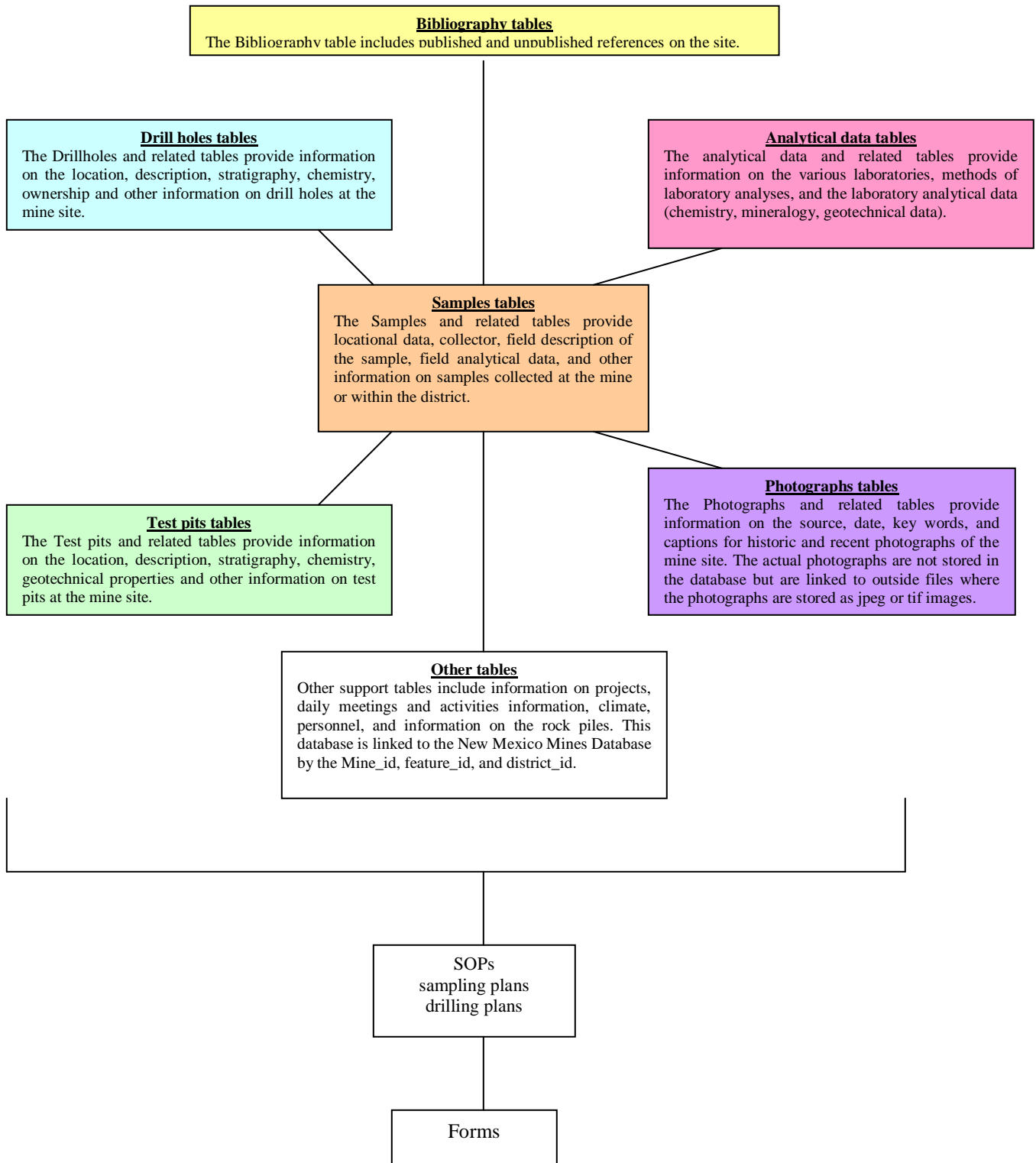
Mining companies and their consultants generate large amounts of data at mine sites today. One of the most effective tools to enter, store, report, and utilize these data are by relational databases. A database is a place where data are stored (Harrington, 1998). A relational database is a database where the data are organized into similar entities that are related to one another by a common, unique identification number (called a primary key). The relationships between the data are stored in the database along with the data and the definitions of the data, called metadata. Relational databases facilitate effective management of a large amount of investigation data by eliminating duplication and maintaining consistency of the data.

The purpose of this paper is to describe a relational database, the Mine Rock Pile database (Fig. 1), developed by the New Mexico Bureau of Geology and Mineral Resources (NMBGMR) to incorporate information obtained during the characterization of mine rock piles for potential acid-mine drainage, weathering, and rock pile stability. This database is being applied to an investigation at Molycorp's Questa mine in New Mexico and can be used at any mine site. Existing data as well as newly collected data will be incorporated into the database. The purposes of this database are to 1) store and provide easy access to computerized data that will aid in the physical, mineralogical, chemical, and geotechnical characterization of the mine rock piles, 2) link to other databases at the mine and at NMBGMR, 3) provide data in a format to be used in computer programs and models such as SoilVision, Geochemists Workshop, WinStat, and others, 4) link data to the sample and drilling plans and standard operating procedures (SOPs), and 5) management of the project.

Description of the Molycorp database

The data to be incorporated in this database includes locational data, climatic data, mineralogy, chemical analyses, geologic data on drill holes and test pits, historical and recent photographs, and other data. Locational data includes both surveyed points and GPS (global positioning system) data. There are six main tables in the database: Samples, Drillholes, Test pits, Analytical data, Photographs, and Bibliography, and more than 100 supporting tables (Fig. 1). Each of these main tables is linked to each other, where appropriate, and all of the supporting

FIGURE 1. Simplified design of the Mine Rock Pile database.



tables are linked to one or more of the main tables. The database is linked to additional data in other file formats outside of the database, such as photographs, reports, laboratory scans, etc.

The *Samples* and related tables provide locational data, collector, field description of the sample, field analytical data, and other information on samples collected at the mine or within the district. Field_id is the primary key for the samples table and is a unique field identification number. Sample_id is the primary key for the sample prep table and is a unique sample identification number assigned when the sample is prepared in the laboratory for laboratory analyses. Some samples are split into two or more fractions after collection, thus requiring a separate unique sample identification number, but each split has the same field identification number. The sample_id will follow the sample throughout the various analyses. Chain-of-custody and request for analytical data are included in the database. The samples table is linked to the Drillholes, Test pits, Analytical data, Photographs, and Bibliography tables.

The *Drillholes* and related tables provide information on the location, description, stratigraphy, chemistry, ownership and other information on drill holes at the mine site. The Drillholes table is linked to Samples, Analytical data, Photographs, and Bibliography tables. Drillhole logs are incorporated into the database and offer a means of storing lithologic and other data collected while logging the core or cuttings. Hole_id is the primary key and is a unique identification number for each drillhole.

The *Test pits* and related tables provide information on the location, description, stratigraphy, chemistry, geotechnical properties and other information on test pits, trenches, and highwalls at the mine site. The Test pits table is linked to Samples, Analytical data, Photographs, and Bibliography tables. Logs of test pits are incorporated into the database and offer a means of storing lithologic and other data collected while logging of the test pits, trenches, and high walls. Test_pits_id is the primary key and is a unique identification number for each test pit, trench, or highwall.

The *Analytical data* tables provide information on the various laboratories, methods of laboratory analyses, and the analytical data (chemistry, mineralogy, geotechnical data). Links to other analytical data not in the database are provided. These tables are linked to the Samples, Drill holes, Test pits, Photographs, and Bibliography tables. Laboratory_id is the primary key and is linked to the other tables by the sample_id.

The *Photographs* and related tables provide information on the source, date, key words, and captions for historic and recent photographs of the mine site. Photographs are linked to Test pits, Drill holes, and Samples, when appropriate. The actual photographs are not stored in the database but are linked to outside files where the photographs are stored as jpg or tif images.

The *Bibliography* table includes published and unpublished references on the site. *Other support tables* include information on projects, daily safety meetings, field activities, climate, personnel, training records, and information on the mine rock piles. Reports can be designed and imported into Word or other formats. Two tables are linked throughout the database as drop down tables, personnel and SOPs, and they provide information on personnel involved with the project and information on the SOPs as well as any deviation from the SOP. The Mine Rock Pile database is linked to the New Mexico Mines Database (McLemore et al., 2003) by the Mine_id, feature_id, and district_id.

Use of the database

The Mine Rock Pile database is designed for entering, storing, reporting, and using data collected during the characterization phase of the Molycorp Rock Pile Weathering and Stability Study. Forms allow for standard collection and entering data in the field and laboratory. SOPs are incorporated throughout the database to insure acceptable quality and consistency of sample collection and laboratory procedures. Since the database includes location information, dbf files can be exported for use in GIS projects and incorporated with other GIS layers and databases, such as geologic maps, topography, geophysical data, remote sensing, New Mexico Mines Database (McLemore et al., 2003), New Mexico Geochron database, and the New Mexico Bibliography database. The Mine Rock Pile data can be exported into spreadsheets and used in most commercial software for data manipulation and interpretation.

Available data

The data for the Mine Rock Pile database is from a variety of published and unpublished reports, miscellaneous files (mostly consultant reports), and proposed newly collected data. It includes information on location, geology, geochemistry (rock, water, etc.), drill hole data, test pit data, historical and recent photographs, and other data.

Data input

Data entry is on specially designed forms that combine one or more tables. Fields used in the database are fully explained and documented in the database and are referred to as metadata. Metadata documents contain documentation on methods used, sources of data, and any pertinent information that would call into question the data collected, such as special handling procedures. Look up or drop down tables are used throughout the database as appropriate to standardize data input and make data entry easier, quicker, and more efficient.

Quality control

The most difficult task is maintaining quality control of both the data being entered into the database and structure of the database. Quality control (QC) is a system of procedures, checks, audits, and corrective actions to ensure that data are collected, stored, and analyzed in an acceptable manner, and that technical aspects and reporting are adequate. The main objectives of the QC program for the Mine Rock Pile database are summarized below.

- Document the procedures for data collection, preparation, and analysis.
- Determine completeness and accuracy of the data.
- Define the decision-making process to be used.
- Document Standard Operating Procedures (SOPs), field sampling plans, and drill plans.
- Provide a chain-of-custody of samples.
- Provide assurance as to precision and accuracy of chemical analyses using replicate samples, cross-laboratory checks, and certified reference materials.
- Define an acceptable magnitude of error on chemical analyses.
- Provide information regarding data analysis and interpretation.

All of these objectives are met with this database.

Students and NMBGMR staff will enter data into the database, which can then be converted into GIS format. NMBGMR staff will check the database as it is being developed and filled to make sure that data are being entered accurately. NMBGMR staff will check the locations of the samples, drill holes, test pits, and other features using USGS topographic quadrangle maps and GIS software.

Misuse of data

Chemical data provided in the database must be used with extreme caution. Although we attempted to provide as accurate and complete data as possible, problems may still exist. Many of the chemical data reported represent select samples from the mine collected for specific ongoing research purposes and are not always representative of the mineral deposit, environmental impacts, or relevant for regulatory requirements. When other agencies or individuals have collected some of these data, this information will be entered and cited as appropriate.

Environmental Applications

Goals of the database, with respect to environmental applications are:

- provide a history of previous study including the nature and extent of work conducted at the mine site
- quickly guide an investigator to relevant information regarding the site
- provide the information necessary to focus the study on the most relevant issues to maximize time and expenditure
- provide a medium where accumulated data may be of use for numerous purposes not limited to permit applications, environmental assessments, human and ecological risk assessments, mine closure, mine plans of operation, academic research, and industrial evaluation.

The suitability of the data should be evaluated in the context of the purpose of the investigator. The NMBGMR has and is compiling data from the numerous sources at its disposal. The user is responsible for understanding the specific QA/QC and other documentation requirements of the investigation being conducted and the data should be used appropriately. Numerous references used in the development of the database are available in the New Mexico Bibliography kept by the NMBGMR. This provides an opportunity for the investigator to locate reports for further consulting, if desired.

Summary

The Mine Rock Pile database is a relational database that is designed to enter, store, report, and use data that has been and will be collected for the characterization phase of the Molycorp Rock Pile Weathering and Stability Study. The design of the database can be modified for use at any site. The data to be incorporated in this database includes locational data, climatic data, mineralogy, chemical analyses, geologic data on drill holes and test pits, historical and recent photographs, and other data. Existing data as well as newly collected data will be incorporated into the database. The purposes of this database are to 1) store and provide easy access to computerized data that will aid in the physical, mineralogical, chemical, and geotechnical characterization of the mine rock piles, 2) link to other databases at the mine and at NMBGMR, 3) provide data in a format to be used in computer programs and models such as SoilVision, Geochemists Workshop, WinStat, and others, and 4) link data to the sample and drilling plans and standard operating procedures (SOPs).

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