

**PROJECT TITLE: Data Base Management System**

**STATUS:** Ongoing

**ESTIMATED COST:**

**DURATION:** One and one half years

**Purpose:** The need for a comprehensive database for maintaining this information was recognized by the National Academy of Sciences in their initial review of the GCES Program in 1987, and reinforced during a second review in 1990. Extensive data and information currently exists in the GCMRC collections relating to resource conditions, quality, and relationships to other resources. Potentially equal amounts of data and information exist within museums, universities, agencies, etc. However, much of this information has not been organized, managed or integrated into an analysis of the interrelationship among various resources and dam operations. Currently, an ARC/INFO based Geographic Information System (GIS) is used for spatial data storage, analysis, and data transfer of information to users. In conjunction, a centralized integrated, relational database will be developed to facilitate exchange of information among projects. The software selected for this relational database is Oracle. The data base management project is a 18 month project that began in 2001 and is scheduled to be completed in 2003.

**Objectives:** The objective of this task is to provide the GCMRC with a conceptual design, physical design and development of an Oracle 8 relational database integrated with an Arc/Info geographic information system

**Project Timeline 2001 – 2003**

	2001	2002	2003		
Conduct needs assessment and conceptual framework	August-October				
Program pilot database	November-December				
Validate database design and interface with the GIS		January-February			
Populate the database with legacy GCMRC and GCES data sets		March-May			
Document database design, maintenance, and use		June-August			
Develop graphical user interfaces (GUI) for internal staff		September-October			
Develop web interfaces for external PI's and stakeholders		November-December			
Conduct training and workshops			January-March		
Completed			Completed		

**PROJECT TITLE: Internet Map Server**

**STATUS: Ongoing**

**ESTIMATED COST:**

**DURATION: Three years**

**Purpose:** To develop an easy-to-use, internet-accessible, graphic interface to the GCMRC monitoring and research GIS layers and Oracle database files. The Internet Map Server (IMS) runs inside a standard Internet browser allowing a broad range of users, from GCMRC staff to cooperators to the general public, to display, query, and download GIS layers and Oracle database tables. This project is intended to increase the accessibility, usability, and value of the existing and future GCMRC data collection efforts. This is a three year project scheduled to begin in FY2002.

**Objectives:** The objectives of the IMS are to:

1. Distribute data to cooperators, GCMRC staff, AMWG/TWG members, and the general public in a cost-effective, efficient, and simple manner using conventional Internet practices.
2. Allow creation of maps from GCMRC datasets over the Internet.
3. Allow simple query and analysis of GCMRC datasets over the Internet.
4. Allow downloading of GCMRC datasets for more intensive analysis or cartographic efforts.
5. Make available legacy, present, and future datasets in a GIS environment that allows overlaying, mapping, and simple geo-analysis techniques over the Internet.

**Project Timeline 2002 – 2004**

	2002	2003	2004	2006	2007
Develop GIS/Oracle database using Spatial Database Engine (SDE), geodatabase model, and Oracle RDBMS engine	January-December				
Deploy pilot IMS project with limited number of datasets available with limited mapping, query, and downloading functionality		January-December			
Expand deployment of IMS to include all GCMRC datasets (where possible)			January-December		

**PROJECT TITLE: Aerial Photography Scanning**

**STATUS: New**

**ESTIMATED COST:**

**DURATION: Four years**

**Purpose:** The Grand Canyon Monitoring and Research Center's library collection includes almost 26,000 aerial photographs of the Colorado River spanning a period of 65 years. Of all of the types of media available in the library, including reports, photos, videotapes, slides, and maps, the aerial photos get the most use by researchers. Repeated use has degraded the quality of the photographs; some have been damaged and others have been lost. While some of the negatives are available through the various contractors who have collected the data, others are not. Presently, the photo collection is at risk because it is not stored under fireproof and waterproof conditions. Transferring these images into a digital format will provide greater accessibility to researchers and better preservation of the original media. Photographs, including both black and white and color infrared images would be selected, scanned, compressed, and archived onto GCMRC electronic data systems and DVD. The aerial photography scanning project is a four year project that is scheduled to begin in 2003 and continue through 2006.

**Objectives:** The objective of the project is to digitize the entire hard copy collection of aerial photography contained within the GCMRC library. The project will provide the following benefits to the GCMRC:

- 1) Digital imagery will allow the use of computers and modern image processing software for data analysis. Imagery users can then use GIS programs such as ArcView and ArcInfo to perform analysis upon the data and more than one researcher can use the data at the same time.
- 2) The original photos would no longer need to leave the library and risk damage or loss while in the field.
- 3) Original and one-of-a-kind photos can be stored at the National Archives and Records Administration (NARA) in a temperature and humidity controlled, waterproof and fireproof environment. It would still be possible for GCMRC to retrieve the photographs and more storage space would be available locally.
- 4) The distribution of images will be automated through an electronic distribution system over the Internet. Alternatively, images can be copied to CD-ROM or DVD at the GCMRC library.
- 5) Imagery users would be free to mark up their hard copies as needed to facilitate their study objectives.

**Project Timeline 2003 – 2006**

	2003	2004	2005	2006	2007
Pilot study	July-December				
Scan photos collected in 1935-1990		January-December			
Scan photos collected in 1991-1995			January-December		

Scan photos collected in 1996-1999 and miscellaneous photos				January- December	
Completed				December	

**PROJECT TITLE: Decision Support System**

**STATUS: New**

**ESTIMATED COST:**

**DURATION: Three to five years**

**Purpose:** GCMRC provides objective, scientific information to the AMWG for use in making recommendations to the Secretary of the Interior regarding the effects of dam operations on the Colorado River ecosystem (CRE). In support of this effort, GCMRC is developing: (1) a conceptual (i.e., computer) model of the CRE, (2) a detailed map of the CRE, (3) GIS overlays for the CRE, and (3) an integrated Oracle database of research on the CRE. Missing from this equation is the decision-support system (DSS) overlay that can act to integrate these various efforts and support the AMWG in examining various management actions / policy changes that they may wish to recommend to the Secretary. The decision support system development and implementation is a three to five year project that will begin in 2003 and continue until 2005-2007 depending on contracting needs.

**Objectives:** The GCMRC decision support system will utilize the infrastructure provided by the DBMS, GIS, and electronic library to organize and deliver information contained therein to AMP managers in an intuitive and pragmatic way. The decision support system will be targeted towards managers and stakeholders within the GCAMP.

**Project Timeline 2003 – 2005/7<sup>1</sup>**

	2003	2004	2005	2006	2007
Conduct needs assessment	January-March				
Evaluate existing tools and approaches	April-September				
Develop tools and interfaces where non exist	October-December	January-December			
Document use and maintenance			January-September		
Conduct workshops and training			October-December		
Completion			December		

<sup>1</sup>If the development phase requires RFP's and contractors, the project will require an additional 12 to 18 months to complete.

**PROJECT TITLE: Survey Control Network**

**STATUS:** Ongoing

**ESTIMATED COSTS:**

**DURATION:** Five years

**Purpose:** The survey control network is fundamental to spatially positioning all scientific data collected as part of the GCDAMP. Currently, only about a quarter of the CRE has adequate geographic control that meets the needs of near and long-term monitoring and research plan (river mile -15 to river mile 72). Survey control is required throughout the remainder of the CRE to fully implement the monitoring and research plan.

Accurate spatial positioning of scientific data facilitates integration across resource areas by providing common geographic framework to store and analyze data. Many resource monitoring programs depend upon changes in the spatial distribution of resources as the basis of their monitoring strategy. Spatial analysis tools such as a GIS depend upon accurate geo-referencing of data to provide meaningful analysis. Without geographic control, geo-referencing of resource data and subsequent spatial analysis is impractical. The survey control network project is a five year project that began in 2000 and is scheduled to be complete in 2004.

**Objectives:** The objective of this project is to develop a high-precision control network throughout the CRE. Control monuments will be established at a line-of-sight interval depending upon terrain. The products of the CRE control network project will be:

- 1) A network of survey control points established at line-of-sight intervals in the CRE from the GCD to the headwaters of Lake Mead.
- 2) A report describing the methods, its construction, and control identifiers and locations.
- 3) An index map showing the location of control points using the 2000 orthophotography as a backdrop.

Control points will be established using two industry standard survey methods, GPS and conventional survey practices

**Project Timeline 2003 – 2007**

	2000	2001	2002	2003	2004
RM 72-89	January-December				
RM 99-120		January-December			
RM 120-145			January-December		
RM 145-180				January-December	
RM 180-280					January-September
Completed					December

**PROJECT TITLE: Hydrographic Channel Mapping**

**STATUS:** Ongoing

**ESTMATED COSTS:**

**DURATION:** Five years

**Purpose:** The hydrographic mapping program is intended to facilitate all monitoring efforts requiring sub-aqueous measurements. The two areas of hydrographic mapping consist of an ongoing system-wide channel map and a repeatable reach monitoring for annual change detection. Hydrographic mapping is the only method currently available to measure sub-aqueous topography. Hydrographic technology is used in the Grand Canyon primarily to measure changes in the river channel. The primary changes that occur are due to the movement of sediment. These changes are monitored by hydro-acoustic measurements that are accurately positioned over the course of the river channel. The hydrographic data collection method is designed to develop required monitoring and research products such as topographic maps, digital terrain models, sediment aggregation and degradation, hydrologic stage discharge modeling, and cross-section analysis. These products support the following projects: system wide channel mapping, fine-grained sediment storage, coarse-grained sediment, streamflow and fine-grained sediment transport, modeling reach-averaged sand bar evolution, and aquatic bio-monitoring. The hydrographic channel mapping project is a five year project that began in 2000 and is scheduled to be complete in 2004.

**Objectives:** The objective of the project is to develop a complete hydrographic base map of the Colorado River within CRE. The products of the hydrographic channel-mapping project will be:

- 1) A complete hydrographic channel map of the Colorado River within the CRE.
- 2) A complete DEM of the Colorado River channel within the CRE.
- 3) A report describing the hydrographic mapping and data processing methods used in the map and DEM production.

Products will be integrated with terrestrial base maps produced as part of the FY2000 terrestrial mapping project (i.e., the LIDAR mapping). The combined terrestrial and hydrographic maps and DEM's will provide the most accurate three-dimensional canyon geometry obtained so far.

**Project Timeline 2000 – 2004**

	2000	2001	2002	2003	2004
RM 72-89	January-December				
RM 99-120		January-December			
RM 120-145			January-December		
RM 145-180				January-December	
RM 180-280					January-September
Completed					December

**PROJECT TITLE: Remote Sensing Evaluation**

**STATUS:** Ongoing

**ESTIMATED COST:**

**DURATION:** Three years

**Purpose:** The purpose of the remote sensing evaluation is explore and to capitalize on new remote sensing technologies and data processing techniques in order to provide the research and monitoring projects supporting data that have the following characteristics: non-invasive data acquisition; sufficient spatial resolution; broadest application across all research disciplines; broader area coverage; high accuracy, long-term reliability (reproducibility); and cost-effectiveness. The evaluation of remote sensing technologies is intended to address monitoring and research needs of the biological, cultural, and physical resource programs at the GCMRC. If successful, remotely-sensed data sets could be utilized for multiple monitoring and research projects and provide spatial integration of multiple resource parameters. The remote sensing evaluation project is a three year project that began in 2000 and is scheduled to be completed in 2002.

**Objectives:** GCMRC proposed the evaluation of ground-based and airborne remote sensing technologies with the goal of finding technologies and protocols that would result in a long-term monitoring program that is:

- Cost-effective (reduced costs over conventional approaches)
- Less intrusive (the monitoring doesn't have a greater effect on the system than normal dam operations)
- Expanded spatial coverage (has the ability to capture denser spatial data than can be gathered by field-based efforts)
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Ground-based and Airborne Remote Sensing Technologies will be identified, tested, and evaluated relative to these objectives.

**Project Timeline 2000 – 2003**

	2000	2001	2002	2003	2004
Conduct needs assessment of GCMRC programs	January-March				
Identify potential technologies to address	January-June				
Evaluate potential technologies through literature reviews and expert opinion	April-June				
Conduct pilot field tests of selected technologies and evaluate the results of those field tests	March-December	January-December			
Complete reporting and make recommendations to chief			January-June		



Develop the needed protocols and implement program			July-December		
Completed			December		

**PROJECT TITLE: Multispectral Digital Imagery and LIDAR Data Collection**

**STATUS:** Ongoing

**ESTIMATED COST:**

**DURATION:** Annually

**Purpose:** The GCMRC has been collecting annual aerial photography of the CRE for over ten years in support of biological, cultural, and physical research and monitoring activities related to the operations of the Glen Canyon dam. Until recently, the photography product delivered has been a nine by nine inch contact prints of black and white or color infrared film at an approximate scale of 1/4800. Photographs have been delivered without any rectification or geopositioning information. While useful for many past monitoring and research activities in the CRE, these products are largely being supplanted by high resolution multispectral digital products that include pointing and positioning parameters that allow convenient rectification and geopositioning. These products have much more utility and allow improved image analysis using automated computerized techniques. In addition, with the addition of LIDAR equipment, high accuracy topographic information can be acquired simultaneously in areas where volume information is desired.

The GCMRC remote sensing initiative is in the process of evaluating these technologies and will shortly be making recommendations as to their application to the revised long term monitoring projects in the CRE. Based upon preliminary data, it is anticipated that multispectral digital imagery and LIDAR will be a part of these recommendations. Aerial imagery and LIDAR data will be collected on or near the Memorial Day weekend on an annual basis to support biological, cultural, and physical monitoring projects of the CRE.

It is anticipated that multispectral digital imagery and LIDAR data sets will support the following projects:

- 1) Sediment monitoring
- 2) Sediment modeling
- 3) Campsite beach monitoring
- 4) Channel morphology
- 5) Terrestrial vegetation monitoring
- 6) Cultural mitigation

These data sets will likely have application for additional future projects as well.

**Project Timeline 2003 – 2007**

	2003	2004	2005	2006	2007
Collect aerial imagery and LIDAR	May-June	May-June	May-June	May-June	May-June
Delivery of imagery and LIDAR products	August-September	August-September	August-September	August-September	August-September