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# LCR DATABASE ACTIVITIES SECOND QUARTER 1992 PROGRESS REPORT

Prepared for  
BUREAU OF RECLAMATION  
GLEN CANYON ENVIRONMENTAL STUDIES

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Prepared by  
NAVAJO NATURAL HERITAGE PROGRAM  
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**LCR DATA BASE ACTIVITIES  
SECOND QUARTER 1992  
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Prepared for the  
BUREAU OF RECLAMATION  
GLEN CANYON ENVIRONMENTAL STUDIES

Prepared by  
TOM GARRISON  
NAVAJO NATURAL HERITAGE PROGRAM

June 1992



This is a quarterly progress report for Objective Number One of the Cooperative Agreement for the Development of a Data Base for the Little Colorado River (LCR) Endangered Species Studies and Cultural Resources (Cooperative Agreement No. 1-FC-40-10520, Modification No. 1), hereafter referred to as the project. A synopsis of all activities since October 1 of 1991 will be presented. This will address the three work tasks of Objective 1 as well as the schedule of reports on work items as specified in the Memorandum UC-823 with attached Modification of Assistance Agreement (7\_2278 (4-90)) dated 6 February 1992. This report will cover activities and results through the June 30, 1992 quarter.

The work activities of the project are generally divided into work on the LCR bibliography and work on the geographic information system (GIS) for the LCR. The bibliography is the form chosen to compile information about the biology, geology and hydrology of the LCR basin. The GIS is a digital database created and maintained by specialized software (Environmental Systems Research Institute's Arc/Info) and will consist of standard GIS data layers developed from existing sources. The reports on work items will be a synopsis of the material compiled in the two groups and will not contain any original work.

A telegraph style summary of activities by quarter followed by a narrative of completed and ongoing work activities is presented.

#### **Summary of project activities by quarter:**

Last Quarter 1991 - October 1, 1991 to December 31, 1991.

Programmer Analyst hired. Initial design and development of LCR database. Software (dBase III+) selected and installed. Additions made to the purchase order for the GIS workstation made and the equipment ordered. Database structure created and documented. Review of existing literature and information on LCR and the development of the LCR project. Support databases and procedures developed to organize project effort. Phone calls to various tribal, local, state and federal agencies made to solicit information. Existing bibliographies obtained from previous workers from the GCES office and others. Program secretary recruited for data entry. Data base entry begun and worked on refinement of database structure and documentation. Development of documentation of needed GIS data layers, the logical structure of themes and individual coverages. Presentation of initial work progress and intended course of project to GCES LCR workgroup meeting at GCES office on October 24, 1991.

Meetings held with Arizona state offices to find additional information and literature. Data base entry continues. Development of data entry program to provide error checking and consistency in category field entry. Developed printing program. Began looking at applicants for Natural Resource technician to work on the bibliography.

Interviewed three candidates. Selected Claudia Willetto Dec 6, she started Dec 9. Began training technician on PC and dBase/database and procedures. Complications with tribal departments slow down the purchasing process of the GIS workstation. The GIS software received in late November. Jurisdiction of various state and federal agencies with regard to impacts to fish and fish habitat is researched. Jurisdiction and permitting process literature gathered. Modification of LCR project started. Jurisdictional flowchart to be included with December quarterly report. GIS workstation delivered 23 Dec. Christmas vacation. Sent quarterly report 30 Dec.

First Quarter 1992 - January 1, 1992 to March 31, 1992.

New Years and annual leave. Setup and configuration of workstation started 6 Jan. Installed all system software and Arc/Info. Factory configuration not sufficient. Began planning on repartitioning disk and reinstalling operating system kernel. Because of cost



cutting, printed manual not purchased. Online documentation a problem during reconfiguration when system is down. Preliminary list of needed equipment made and LCR equipment and supplies budget given to director. Continued training of technician. Data entry continues on bibliography and refinement of data entry program performed. System setup to my liking, new operating system software installed, disk repartitioned to provide modular backup of GIS files, home directory and the local system files. All ancillary software installed (wordprocessing, system utilities from UNM, programming/X11R4 files, videopix video capture software) and system administration scripts and protocols finished by late Jan.

Began going to tribal departments with tapes to get coverages. Sent tapes and letters to all federal (USGS) and state agencies (ALRIS) for GIS layers. System needs/deficiencies (particularly disk space) identified and LCR equipment budget finalized. The GIS/system printer suffers shipping delays. Obtained ancient line printer from tribal Resource Information Management (tribal GIS group) and after a bit of work got it working. Natural resource technician continued data entry, researching potential sources of information and sending requests for information, proofread existing bibliography, and traveled to Albuquerque to begin to make copies of citations. Began installing coverages obtained from tribal groups. Problems with documentation of source, accuracy, and consistency (scale, fit on overlay) of layers from various tribal agencies.

Began to investigate of cost of obtaining new digital line graphs from USGS at various scales. Meeting with the Rural Addressing office for McKinley Co. and got 1990 Precensus tiger line files on CD. Small problems with Arc/Info and format of CD. Wrote program to process files correctly. Decide on 1:100,000 as best scale for GIS layers. Talk to GIS user group about obtaining post-census tiger files. Some had thought of it already. Was asked if program could pitch in money to purchase them. Said ok but as it turned out cost was covered by others. So the tiger files were ordered. Received GIS coverages from USGS in Tucson on Feb 20.

Project modification requires full review by tribal procedures with signature approval sheet (SAS process). Submit requisition for the additional disk drive, serial port expansion to hook up the requested digitizer, and 8mm tape drive for more efficient data backup. Purchase order for Spot image at Nature Conservancy discount price came back disapproved because of no money in the account. All activity on LCR account put on hold until SAS process complete. Master tic and boundary coverage, abandoned mine sites, geographic names, hydrologic unit code, cities, reservation boundary and chapter boundaries coverages complete. Most of coverages in system. Natural resource technician left at end of temporary employment period on Feb 28. Tektronix printer came in Feb 28.

Printer required work to get connected. Virtually no support for connecting to a unix workstation. Once the needed printcap entry was found it worked. Attended GCES GIS overview in Phoenix Mar 4. Natural Resource technician re-advertised. Got new HP laser jet cartridge to use with bibliography print module. Data entry and sending requests for additional information on LCR continues. Received GIS coverages from Arizona Land Dept.'s resource information system (ALRIS) on Mar 16. Received first Tiger files Mar 17 from Navajo water dept. Coverage processing has left little room. Fill up the disk on first try at processing the tiger files. Edited coverage layers and deleted those that were duplicates of the coverages recieved from ALRIS. Deleted all ALRIS coverages to make room for processing. All coverages backed up onto tape for archival. Continued work on rest of coverages. Received and installed the new Arc/Info 6.0.1 upgrade Mar 19. Reprocessed the tiger files, still bombs. Called ESRI. Apparently a software bug in Arc/Info 6.0.1. Tried the suggested workaround and it worked. Printed out several sample images and tried printing satellite images and worked on setup and printer configuration. Attended several mandatory tribal employee training sessions. Began coverage inventory and editing. Attended EOSAT gis/remote sensing workshop in Denver, Co. (March 30-April 1). All paper work on the project is tied up in the SAS process. In retrospect have missed the March quarterly report.



Second Quarter 1992 - April 1, 1992 to June 31, 1992.

Prepared and presented overview of program to the Arizona Riparian Council in Cottonwood, AZ April 10. Trip to Albuquerque to acquire image processing software and to check on possible coverage availability. Meetings with GIS users group to discuss standards and documentation procedures for tribal coverages and to check on status of tiger file acquisition. Work with Tribal Forestry to convert 9-track image files of commercial forest land on reservation to 1/4" tape in return for access to images. Discussed need to get another person working on bibliographic database and problem of getting qualified personnel. Selected technician who had good organizational and clerical skills 16 April. Began training on dBase/database requirements. Continued inventory of coverages acquired and assessed quality and suitability of coverages to project. New building put for Heritage Program use. Move office and equipment around 30 April.

Began documentation of what coverages I could from notes taken from meetings with tribal personnel. Printer is a postscript printer and only prints postscript files. Researched what postscript information I could find and wrote a C program and installed it as a printcap input filter to print ASCII files. Purchase order received by vendor on May 15. Asked her wait a little on order while researched differences between 8mm and 4mm DAT tape drives and to insure compatibility with other departments and agencies. Chose the 4mm drive 19 May. Migration of project files, memos, etc from the PC's to the SUN. Continuation of editing and moving coverages into permanent data directory. All tiger files on CD for Arizona, New Mexico, Utah and Colorado arrived at various tribal programs and departments. Meeting on 20 May with tribal departments of Forestry, Water Rights, Utility Authority, Navajo/Hopi relocation, and Land Administration and discussed use of tiger files for reservation wide base coverages, the attributes needed, use of 1990 census data, and division of labor in processing. As the person with system level experience I accepted the initial processing of files from CD and initial separation of layers and transfer to other media for distribution to others for final processing, mostly attribute additions and error checking. As part of the SAS process for the project the modification went through the Justice and Water Rights departments. They attached several comments and signed off on the SAS.

Backed up and deleted extraneous files to make additional work space on system. Worked on bibliographic database. Quality control work on various files used by technicians for data entry and merged into master file. Ran programs to check for duplication in database. Edited database and tried to reconcile various styles of abbreviation and interpretation of bibliographic formats entered from newly acquired citations and existing papers and other information sources. SAS process on Project Modification completed on 11 June. Revised LCR budget entered in Tribal Contract Accounting system. Many accounts in the red. Went over budget and put budget into a Lotus 123 spreadsheet, will maintain from now on. Began work on June quarterly report and FY 93 budget proposal.

#### **Narrative of project activities:**

Work began on the project in October of 1991 with the hiring of myself, Tom Garrison, as a Computer Programmer Analyst. Suggested additions to the purchase order, for which the vendor and model of computer (a SUN IPX workstation) had already been chosen, was made and the equipment was ordered. In the absence of the workstation, activities were concentrated on the development of the LCR bibliographic database. During this period, all correspondence and other material concerning the project were reviewed and organized in chronological order



and filed. Database software was chosen based on availability, use by other agencies, support for the database file format, and familiarity. Dbase III+ had already been purchased, was in use by the GCES office, is a very popular software package and is supported by a wide variety of other database software, and was familiar to myself. Design of the database structure was guided by common bibliographic structure and the criteria specified in the project agreement. This structure has been presented during a previous LCR work-group meeting and included in earlier reports to the Glen Canyon Environmental Studies office. Since there have been modifications and in the interest of completeness, it is included here.

The field names, type, width and description of the database structure is as follows:

Field	Name	Type	Width	
1	RN	Character	12	Reprint number. Indicates that a copy is available in the library. Copies are maintained in reprint order.
2	AU	Character	136	Author(s). Authors after the 4th will be referred to as et al.
3	YR	Character	5	Year
4	TI	Character	253	Title.
5	T2	Character	68	Title Continuation
6	PB	Character	164	Where/Who published. Will not include statements like, 'in cooperation with', 'with the assistance of', etc.
7	KW	Character	140	Key words. Jargon, and technical and specific terminology used in abstract or summary (see below).
8	CT	Character	128	Category. Will use a restricted set of key words loosely based on scientific disciplines. Will at least contain the broad categories, geology, hydrology, biology, or environmental (see below).
9	AN	Memo	10	Annotation of citation. Cannot be searched.
10	SL	Logical	1	Selected field. Use in database operations as a flag.

The method used to index the LCR Bibliography by subject will use a category and key word field. The category field is indexed with a bi-level hierarchical system arranged in the following manner:

{level}-[category]:[sub-category]:[detail-category]... {level}-[category]:[sub-category]:[detail-category]...

The levels represent whether the category is the primary or secondary topic. The current categories are, **biology**, **geology**, **hydrology**, and **environmental**.

Within each major category there is a restricted number of general sub-categories roughly corresponding to sub-disciplines or fields with the major category. Terminology is meant to be semi-technical, yet using the most common phrase and avoiding jargon. The aim is to supply a minimum inclusive categorization. The key word field supplies



topic specific information such as species, technical terminology, geographic area covered, specific mention of type of work, methodology, etc.

The sub-categories currently recognized for each major category are:

### **biology**

agriculture  
anthropology  
archaeology  
biogeography  
birds  
botany  
ecology

fish  
forestry  
invertebrates  
limnology  
mammals  
paleoecology  
paleontology

physiology  
recreation  
socioecology  
systematics  
wildlife

### **geology**

geochemistry  
geochronology  
geomorphology  
geohydrology

geophysics  
lithology  
maps  
minerals

mining  
soils  
physiography

### **hydrology**

contamination  
erosion  
floods  
geohydrology  
groundwater

hydrodynamics  
paleohydrology  
radiological  
sediments  
surfacewater

waterquality  
watersheds  
watersupply  
maps

### **environmental**

management  
regulatory

For example, a paper on fish habitat that correlates the habitat with geomorphology of the streambed and water quality would be indexed with a category field as: 1-biology:fish:ecology 2-geology:geomorphology 2-hydrology:waterquality.

This translates to a biology paper about fish ecology (as opposed to fish physiology), with the secondary topics being geology within the discipline geomorphology, and hydrology with water-quality issues. If the geomorphology and biology were judged as having equal weight the level for both might be level 1, or alternately, if all three had equal weight, the all three levels would be 1. This situation would normally be rare, however with only two category topics, such as geology and hydrology, it would be common for both categories to be considered primary topics. The issue of primary or secondary topics can be avoided by searching for -biology or -biology:fish. This would find all papers concerning biology and fish, respectively. Hopefully, this will provide some utility in the category scheme with so many hydrology papers talking about water-bearing rocks in terms of the geology of the area. With different people entering data, the primary purpose of the category field is to try to impose some consistency to the keywords



used to characterize the citation or other source. The data entry module does this by only allowing categories and sub-categories that are predetermined. This set of keywords can be modified easily. The use of the primary and secondary designation is used for two reasons. The first is to provide a simple mechanism to differentiate the category 'hydrology' and the sub-category 'geohydrology'. The second reason is that as the database grows, the amount of data produced and the time it takes to produce will get larger and the penalty for being too general in selecting records will become more severe. I think that the judicious use of the primary and secondary designations when entering individual citations can result in more efficient and faster retrieval of information. Secondary topics are only mentioned briefly or are summarized with citations to the authorities on the subject.

Most of the sub-categories are self explanatory. There are several factors that have caused the inclusion of many citations that are not as easily categorized. The major factors are; the overlap in hydrology and geology with respect to the basin; the directive to include information about impacts to the basin with respect to the fish; the occurrence of rich mineral deposits in the basin; and the 1979 failure of a United Nuclear Corporation's Church Rock uranium milling pond dam and the subsequent discharge of radiological contaminants into the Puerco river, a tributary of the Little Colorado river. These factors are responsible for the addition of the environmental category and the sub-categories of geochemistry, geophysics, minerals, and mining within the geology category, and contamination, hydrodynamics, radiological, and sediments within the hydrology category. It is also the reason the geology and hydrology categories have two sub-categories in common, maps and geohydrology. Since, the hydrology is the more important to the chub, all citations dealing with the geologic aspects of hydrology whether it is primarily a geology or hydrology paper and also irrespective of the use of the words geohydrology or hydrogeology within the title or text of the work, will be categorized using the sub-category geohydrology.

Much of the information and reports on the hydrology and impacts to the water supply of the basin that could affect the humpback chub have originated with local, state, and federal agencies concerned with human health and other economic issues. This information has been included in the database. However, the articles do not say anything about the hydrology or geology of the area but report findings and results in terms of state and federal water quality and other environmental standards. If the citation deals directly with standards of this kind it is categorized as regulatory. Otherwise, if it is concerned with more general environmental issues or management policy like permitting or land use within riparian corridors it is categorized as management. Papers on conservation, whether of riparian areas or wildlife, that are concerned with policy or guidelines are treated as environmental management and are categorized as such. Biological conservation papers where conservation is dealt with in terms of species diversity, landscape ecology, or the effect of anthropogenic factors on the reproductive ecology or habitat use are categorized as biology papers with the sub-categories referencing the taxonomic group and ecology, physiology, socioecology, or wildlife. The marriage of geology and hydrology in many of the papers are caused by the mining industries demand for water, the importance of groundwater as a surface water source, and the current adjudication of water rights within the basin. This last factor has also created a heightened sensitivity to hydrologic issues. Some of the more recent information and reports on the hydrology and geohydrology of the basin are not available due to their being confidential attorney-witness work products.

The type or species of fish would be listed in the key words field. For example, possible keywords might be: native fish, freshwater, Cyprinidae, Gila cypha, New Mexico, Arizona, Little Colorado River.



To track all agencies and individuals contacted for information an additional database was created to provide a log of contacts with address, phone and summary of contact. To date, 87 individuals have been contacted in various commercial, state, and federal agencies. There are additional contacts and agencies that have been sent requests for information by mail with a copy of the memo on file that have not been entered into this data base. A solicitation for information was given to the members and guests of the Little Colorado River Plateau Resource Conservation and Development Council at a quarterly meeting held in Winslow, AZ on January 22, 1992. A slide presentation was given at the sixth annual meeting of the Arizona riparian council held in Cottonwood, AZ on 10 April 1992. This consisted of an overview of the project and a solicitation for information. Meetings have been held with personnel from McKinley County rural addressing office, New Mexico Geographic Council, New Mexico Environmental Improvement Division, NASA Technology Application Center, U.S. Geological Survey offices in Albuquerque, NM and Phoenix, AZ, University of Arizona Arid Lands Studies Office, Arizona Depart of Land, Arizona Department of Water Resources, Arizona Department of Environmental Quality, U.S Forest Service at Phoenix, Arizona Fish and Game Department, and the Arizona State Highway Department.

Currently, there are 1144 citations in the database. There are approximately 200 citations that are currently being entered. Of these we have 259 copies that have been given program numbers and are filed. The numbering and filing system has been adopted from the Nature Conservancy system used for the Heritage database. The reprint number consists of a 12 character string in the following form: GnnABCxxNNUS. Where G is a group category and is the character 'N', 'A', or 'U'; 'N' is a published book, 'A' is a published article, and 'U' is an unpublished paper or report from any source. The last two numbers of the year are coded in the characters 'nn'. 'ABC' is the first three characters of the authors last name. 'xx' is a sequential number to break a tie between two entries with the first 6 characters the same. 'NNUS' is a literal string that will occur in all entries. It signifies that the copy resides with the Navajo Nation Heritage Program in the United States. For example the reprint number A90GAR01NNUS is a article published in 1990 by an author whose last name starts with 'Gar'. Papers are filed within groups alphabetically and by year.

A set of integrated dBase III programs are being developed for data entry, query and printing of citations from the database. The data entry and printing modules have been functionally completed. Both are being further developed for ease of use and to support additional data validation and error checking and to generate multiple report formats. Currently all queries and filters is accomplished through dBase commands. We are beginning to type in abstracts for each citations that we have copies for. To date only a few have been entered.

There are two general formats for annotated bibliographies. The first is a alphabetical, cross-referenced list by category and sub-category. The second is a numbered alphabetical list of the whole database with an category index that references the citation by number. A program for the first format has been written and the second is under development. The intention is to provide programs that will produce both formats directly without the need to bring a file into a word processor to provide formatting. Though that option is supported by the ability to produce a ASCII file of the database.

As there has been considerable work on the database a condensed, sorted version is provided. Additional copies can be provided upon request. What would help at this point is to allow researchers in the various fields review the pertinent section of the bibliography and critique the citations included, the keywords used to categorize the citation, and to provide additional citations that we may have missed. For instance, I have an idea of the difference between geomorphology and physiography but a geologist



may have a different understanding of the terms from within the field. I would encourage distribution and comment on this draft version.

SUN IPX Unix workstation arrived December 23, 1992. Setup and configuration of the workstation and organization of the GIS side of the project took up most of January. A overview of suggested layers was presented at the LCR workgroup meeting in Flagstaff on Oct 24, 1991. It has been used, to the extent possible, as a guide to the coverages that have been sought out. The following is the original list:

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<b>Template</b>	- Registration base maps.
<b>Boundary</b>	- various boundaries (Res, Parks, Forests, Monuments etc).
<b>Trans</b>	- transportation, including power, pipe and rail lines.
<b>Hydrology</b>	- includes subsurface and stream chemistry and geomorphology, possibly historic use.
<b>Geology</b>	- the same
<b>Archeology</b>	- includes Navajo sacred and historic sites
<b>Hypsography</b>	- the same
<b>Landuse/status</b>	- includes development (diversions, water quality, effluent discharge location, etc.)
<b>Recreation</b>	- user days, trails
<b>Vegetation</b>	- general (i.e, Brown and Lowe 1980, Brown, Lowe, and Pase, 1980 (NPS standard), or whatever is used by GCES)
<b>Biology</b>	- detailed mapping of chub habitat, includes large scale vegetation mapping, micro-habitat, submerged vegetation, sub-populations, migration, other wildlife, T&E species etc. Data transfer from field work to GIS needs to be worked out.
<b>Sites</b>	- sampling/research sites, may include project specific benchmarks

The Arizona Geographic Information Council (AGIC) does not at this time have a publication that specifies a set of standards and protocols for development, maintenance, and documentation of GIS data bases. Gary Irish, director of Arizona Land Resource Information System (ALRIS) indicated that AGIC is currently evolved with the development of such a document that should be completed with a year.

In the interim, it is suggested that the GIS Data base of coverages follow that of the Standards and Guidelines for Geographic Information Systems in New Mexico which has been recommended by the New Mexico GIS Advisory Committee and submitted to the Information Systems Council (ICS) of New Mexico.

The following is a listing of the items from the standards and guidelines suggested for documenting the LCR GIS data layers. It includes additional information to facilitate the administrative management of the various data layers. These in combination represent a Data Quality Report that will be maintained for each GIS data set. Unfortunately, virtually all the coverages received from all sources lacked some or all of the information needed to compile a complete coverage data quality report. Data quality reports for all coverages will be maintained to the extent possible. This is an ongoing effort. The elements of the data report will be fields in a database and are given in the following list.

Source Lineage  
1. Name  
2. Source Scale  
3. Capture Scale  
4. Source Author

5. Source Projection  
6. Datum  
7. Compilation Date  
8. Last Revision Date  
9. Source Media

10. Media Quality  
11. Category of data  
12. Capture Date  
13. Capture Author  
14. Contractor



lcr/bnd/states  
lcr/bnd/winbnd  
lcr/bnd/jbox  
lcr/bnd/nm75quads  
lcr/bnd/az75quads  
lcr/template/lcrtmpit  
lcr/template/15mquadgrid  
lcr/template/7.5mquadgrid  
lcr/template/100kquadgrid  
lcr/template/250kquadgrid  
lcr/template/7.5mquadtic  
lcr/template/15mquadtic  
lcr/template/100kquadtic  
lcr/template/250kquadtic  
lcr/hydr/genhydr

lcr/hydr/basin  
lcr/hydr/gen\_hydr  
lcr/hydr/subbasins  
images/spoti  
images/fullscn  
images/spotmap  
images/regist  
gnis/gnis  
mines/minres  
mines/mine-lines  
mines/pbcm  
mines/ur-mins  
mines/og  
trans/glencanyon  
trans/holbrook

trans/kayenta  
trans/pinon  
trans/chelly  
trans/payson  
trans/cameron  
trans/flagstaff  
trans/winslow  
trans/ganado  
trans/polacca  
trans/aztrans  
trans/gallup  
trans/stjohn  
trans/tubacity  
trans/catron  
trans/nutrioso

trans/toadlena  
trans/zuni  
trans/fencelake  
trans/sanders  
trans/sedona  
trans/showlo  
trans/sprgrville  
trans/lcraztr  
trans/nmtrans  
trans/lcrnmtr  
trans/quemado  
trans/lcrquem  
tgr90az/document  
tgr90az/001

Virtually all the existing data has been obtained from tribal departments using GIS, Arizona State Land Department Land Resource Information System (ALRIS), and the USGS office in Tucson, AZ. Most of the larger state coverages that tribal departments had were also from ALRIS. The rest of the coverages concerned regional data sets on the reservation. Some, as a result of the adjudication (which made some coverages unavailable) and time and cost restraints, were hybrid coverages like that depicted in Figure 1 occur that are virtually useless for a basin wide coverage. A problem with some of the coverages from the state agencies are the age of the coverages and the fact that some of them lack information on the Navajo Reservation. A good example is the public land survey system coverage from ALRIS. Figure 2 shows the coverage with the Navajo Reservation neatly excised. Many state wide coverages of Arizona that have been received from other organizations are the same for the simple reason that they have all got the

General Soil's Map of the Navajo Reservation within the Little Colorado River Basin

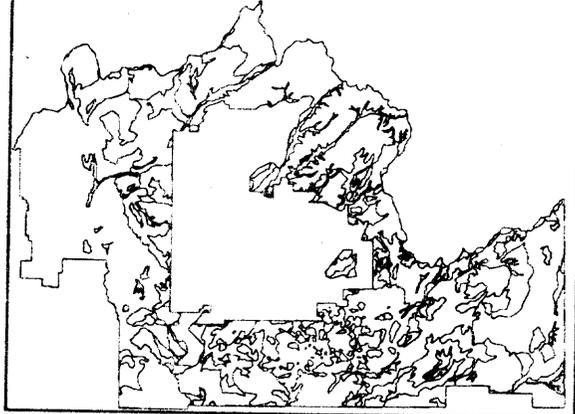


Figure 1 Soils coverage showing how tribal coverages are for specific purposes and are not suitable for basin wide coverages.

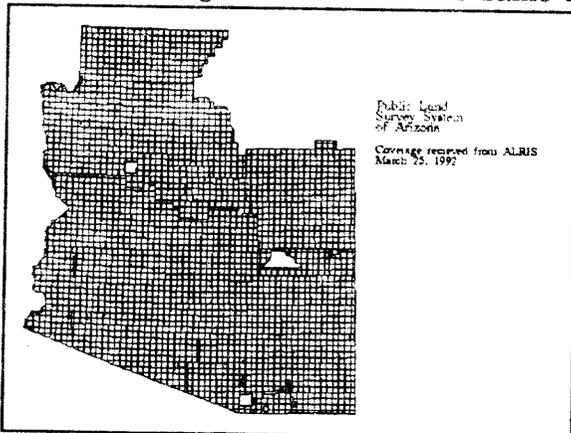


Figure 2 Coverage Showing missing Navajo Reservation area.

Current work is concentrated on putting together coverages that cover the extent of the basin; continue coverage editing and quality control; updating of coverage attributes; documentation of datalayers; and programming ARC/INFO AML modules. Processing the 1990 Census TIGER files for transportation, hydrography, political and legal boundaries, and some census tract information will be an immediate priority. Putting the coverages from ALRIS back on the system to more thoroughly evaluate what they have will be next. Now that some coverages have been finalized and moved to the permanent and other coverages are currently undergoing that process, I will begin

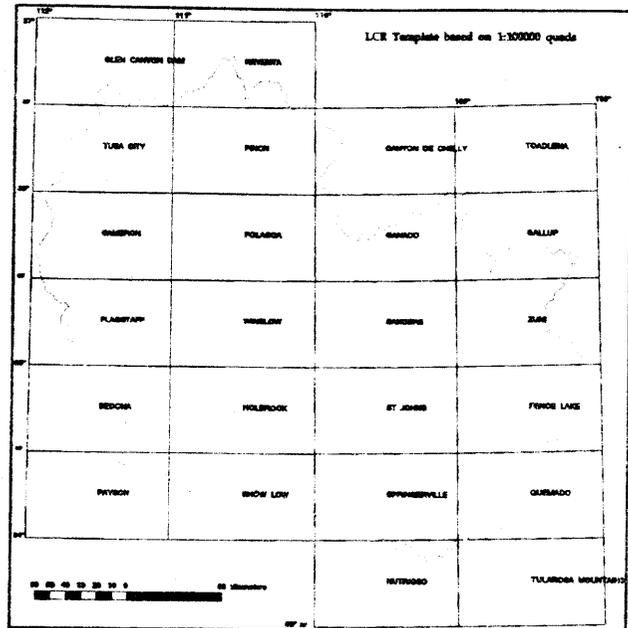
to compose and compile the maps to be incorporated into the workbook and final reports.



As part of that process, ARC/INFO macros and menus will be developed that will, to a large extent, automate access, display, and the creation of maps and figures from the data themes and individual coverages.

The map extent of the data layers has been based on those 1:100,000 USGS quads that are needed to cover the LCR basin. In fact the scale used for all basecoverages for the LCR basin will be 1 to 100,000. Twenty four USGS 1:100000 quads are required to cover the basin. Figure 3 shows the template cover for the LCR project. Registration ties for the coverage are the USGS 7.5 minute series corner tics. Tic id's for the coverage follow the convention used by the Navajo Heritage Program. This will allow easy registration of any 7.5 USGS quad in the basin for a specific digitization project. The SAS requirement for the Modification 001 of the agreement has delayed some equipment purchases. A manual lift/tilt Calcomp 9500 digitizer has been ordered. It will be used to input data that is not available as digital data from other sources. Examples are locations of power generation stations, water diversions, pumping stations, dumpsites, etc, and a fair amount of geologic and hydrologic information from papers and thesis' that is mainly concerned with the lower part of the LCR.

The Little Colorado River basin comprises an area of approximately 26,964 square miles. It lies in seven (7) counties and two (2) states. Land ownership is divided between the Navajo, Hopi, Zuni, and White Mountain Apache (a small area), state trust lands of both Arizona and New Mexico, Federal land (National Forests, BLM, National Parks), thousands of private farmers, several large irrigation companies, municipalities, and several large corporate entities (Salt River Project, Phelps Dodge, Arizona Public Service Company, etc). Compiling a comprehensive GIS and technical database on as large and diverse area as the LCR basin is an enormous undertaking. The focus has and will be on developing the database at this large scale as discussed at the LCR and the GIS workgroup meetings.



**Figure 3** Template coverage for the LCR project.