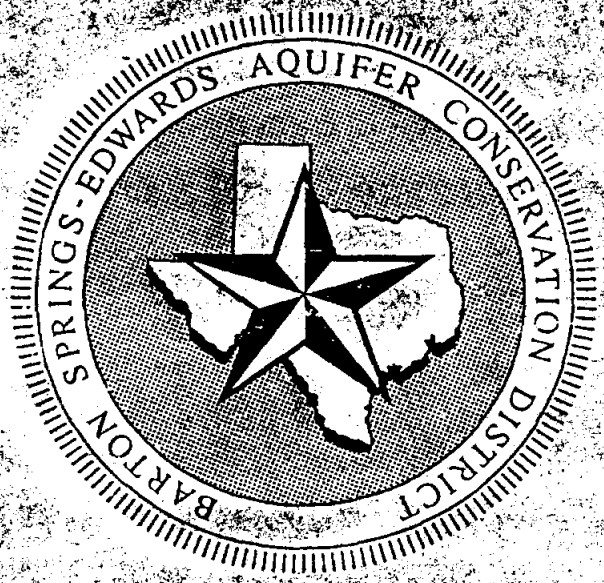
FINAL REPORT

TWDB GRANT No. 93-483-377

GIS DATABASE DEVELOPMENT



BARTON SPRINGS/EDWARDS AQUIFER CONSERVATION DISTRICT

Prepared By:

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GIS Coordinator

and

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GIS Analyst

August 31, 1994

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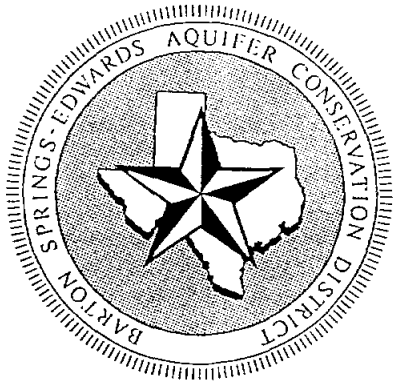

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BARTON SPRINGS/EDWARDS AQUIFER CONSERVATION DISTRICT

BOARD OF DIRECTORS

President - Pat Cox
Vice President - Jack Goodman
Secretary - Sue Johnson
Director - Don Turner
Director - Alton Laws

GENERAL MANAGER

Bill E. Couch, AICP

Table of Contents

I. INTRODUCTION

GIS is many things -- it is a LIS (land information system), a multi-purpose land cadastre, a land record system, a spatial information database and a geographic reference system. Simply stated, GIS is a computer-based data management system that integrates traditional tabular data sets with spatial information. With this expanded ability to collect, validate and quantify large quantities of complex temporal site data, Barton Springs/Edwards Aquifer Conservation District (District) personnel will better be able to monitor, analyze, and understand problems affecting groundwater quantity and quality. This, in turn, will expand the District's capability to design and test remedial alternatives and to communicate this information to diverse audiences.

The information generated by the District's GIS will help end-users to understand the relationships between various site features and management practices and to evaluate the impact man's activities are having on the Barton Springs segment of the Edwards Aquifer. As a management tool, GIS is used to form biological, physical, hydrological and geological profiles of the District in order to develop scientific principles to facilitate administrative and legislative decision-making. The collection, storage, maintenance, and dissemination of technical information will enable District elected officials, management and staff to make more defensible decisions, to develop effective water conservation and groundwater management decisions and construct various scenarios to compare and contrast alternative planning methodologies. GIS is an efficient way to develop, evaluate, and implement solutions to complex problems.

Perhaps the greatest benefit afforded by the new GIS will be the ability to offer improved and more efficient services to District constituents and to achieve a greater level of program success.

II. GIS ACQUISITION

A. History

The need to acquire a GIS system was identified by District management as the District first began to collect data and identify users. In December 1990, under RVE Contract No. 921524, District management contracted Richardson Verdoorn Ehrler, Inc. (RVE) to perform a comprehensive *Needs Assessment for Development of a Geographic Information System* . District Board members, management and staff were interviewed to determine and document the GIS needs of the District. A development plan was designed and work on an environmental database was initiated based on the responses from these interviews. A comprehensive evaluation of the PC ARC/INFO coverages developed as a result of this project is detailed later in this section.

Specific needs for the GIS were identified and include: the need to monitor the water quality and the water level of the aquifer; assist in education efforts; the identification of pollution sources; and equity in water use conservation and funding. At the time of the interviews, there was no majority opinion regarding importance of: well registration; emergency interconnects; and conservation and drought contingency planning. In general the GIS was needed to: provide for a greater efficiency in problem-solving; better access to more information (e.g., geographic, financial or operational data); and that the hardware should be integrated with the existing computer system so the entire organization benefits, as do its constituents.

Having determined the positive cost/benefit contribution GIS would afford the District, the District applied for and was awarded grant funds from the Texas Water Development Board (TWDB). Through TWDB Contract # 93-483-377, executed on August 19, 1993, the District received $27,000 in matching grant funds, approximately 40% of the estimated $68,000 necessary to pursue the project. The District committed up to $41,000 in cash and/or in-kind services to fund the remaining amount. Specifically, and pursuant to TWDB Contract # 93-483-377, the District GIS will be used for: remote sensing of water quality and quantity trends; to determine water quality impacts; to identify aquifer management strategies through data collection and interpretation; to more effectively analyze and address natural and artificial recharge impacts on aquifer levels and associated water quality results; mapping of aquifer boundaries, significant recharge features, and areas susceptible to point and non-point sources of pollution; and for the development of models, graphics and other management tools for aquifer management. The GIS will help the District to see context & substance more clearly, to deal with information more effectively, and to make decisions more efficiently.

After both determining the GIS needs of the District and having received funding to pursue GIS, an effort to acquire a system was initiated.

B. Letting of RFPs

The Barton Springs/Edwards Aquifer Conservation District let for bid a turnkey Geographic Information System Software and Hardware in Proposal No. 10-93 DP on Friday, October 15, 1993. The original deadline for vendors to submit proposals was 4:00 PM, Friday November 19, 1993, and was subsequently revised by memorandum until 4:00 PM, Friday, December 3, 1993.

C. Receipt of Proposals

Two vendors submitted proposals for review prior to the posted deadline -- Intergraph, Corp. and Environmental Systems Research Institute, Inc. (ESRI).

D. Evaluation Criteria and Selection Process

An outline of the general requirements to be addressed by each proposal was detailed in the District's RFP. The following items were to be addressed specifically for both software and the hardware within the proposal: a basic introduction; hardware/software specifications; training programs; technical support; maintenance and updates of the hardware/software; company description and experience; previous installations of GIS; delivery and installation; and documentation.

Vendor selection was based on the following criteria arranged by descending order of importance: commercial quality; stability and warranties; and price. District staff reviewed all available information from the evaluation criteria; interpreted data in the original RVE Needs Assessment; conducted staff interviews and solicited specific input concerning the application of GIS technology to each employees specific job tasks and responsibilities; evaluated and analyzed the content and format of in-house hardcopy references and electronic data; participated in governmental GIS and GPS management strategy and training sessions; visited a number of other state agency GIS departments; all of which is reflected in this District GIS Operating Plan. An evaluation of the proposals, a cost analysis and a component specifications analysis can be found in Tables 1-3 in the Appendix.

E. Design of Vendor Bench Tests

After determining the short-range goals of the GIS implementation, a series of tasks and routines were developed by the District staff that were representative of the normal, daily routines the new system would be required to perform. Existing data in PC ARC/INFO was supplied to the vendors three weeks prior to a proposed on-site visit by staff personnel. Each vendor was given equal opportunity to display their systems functionality and ability to achieve the level of performance required by the District RFP.

District staff visited ESRI - San Antonio on Friday, February 5, 1994, from 9:00AM - 6:00PM for the hardware/software bench test. The ESRI product line proved itself during the evaluation to be able to meet the GIS needs of the District. Likewise, ESRI staff was well prepared and able to address the concerns of the District during the test. A comprehensive review of the District criteria and test results are included in Table 4 in the Appendix.

Intergraph failed to provide the District with a demonstration of their product line.

III. VENDOR SELECTION

A. Criteria for Contract Award

The contract was to be awarded to the Offeror whose proposal best met the requirements and criteria set forth in the RFP and which would result in the most economical provision of required services to the District.

B. Staff Recommendations

Based on the comparative evaluations presented in this report and the results from the vendor bench tests, the District staff recommended entering into contract negotiations with ESRI. District staff is confident ESRI can provide the goods and services necessary for the successful implementation of the proposed GIS.

C. Contract Negotiations

The District initiated contract negotiations with ESRI after receiving approval from the District Board to do so at the February 10, 1994 Board meeting. Working closely with District legal counsel, Ann Benolken of Bickerstaff, Heath & Smiley, L.L.P., District staff successfully executed Geographic Information System Agreement No. 94S0524 and Software Evaluation Agreement No. 94E0524 on April 26, 1994.

IV. DATA ACQUISITION

As data is acquired and subsequently entered into the District GIS, GIS staff will document and verify the scale, accuracy, projection, attribute data, associated documentation, software platform, data exchange format, contact and source of the data. Insofar as possible, only primary data will be collected and used. Some data, however, can only be obtained through secondary and tertiary sources. In any event, the highest degree of scrutiny will be used to ensure that the integrity of collective GIS system is maintained through the data acquisition process.

Standards developed at the Federal GIS level by the Federal Geographic Data Committee (FGDC) are currently under discussion for adoption by the Texas GIS Managers Subcommittee on Data Acquisition -- the District GIS Coordinator is an active member of said committee. Four such standards have been adopted and include: 1. the use of the *Internet* for data transfer and connectivity; 2. *Spatial WAIS* (wide-area information system) for networking; 3. *Metadata* for data documentation, and; 4. *SDTS* (standard data transfer system) as the proposed data format for compatibility. District staff has made sure the new GIS conforms to these standards and is working to comply through such activities as acquisition of and connection to the Internet.

As previously mentioned, RVE compiled an environmental database for the District beginning in December 1990 under RVE Contract No. 901329. This effort continued through February 1993 when RVE terminated the contract due to complications in data acquisition. During the contract period, RVE successfully completed the production of 8 (eight) and approximately 60% of one other PC ARC/INFO coverage.

RVE supplied digital data to the District in January 1994. This data included approximately 125 MB of data which included not only the final PC ARC/INFO coverages, but the original raw data used to construct the original coverages. After considerable efforts to retrieve the data from the original 1/4" tape, the tape was sent to ESRI where it was determined that the files were corrupted and would have to be restored from an original master back-up at RVE. The final PC ARC/INFO coverages were retrieved and exported to 3 1/2" diskette and converted to UNIX format at the Texas Parks & Wildlife GIS Lab. These coverages are detailed later in this section.

The final PC ARC/INFO coverages were shared with and subsequently modified by the TWDB. The modified versions of the original PC ARC/INFO coverages are also detailed below.

A. Existing Data

1. RVE Data

The following coverages were provided by RVE staff on 3 1/2" DOS floppy as PC ARC/INFO .E00 files. They were transferred to a Sun UNIX platform using the DOS2UNIX command and backed-up on 8mm tape at TPWD GIS Lab on Monday, May 9, 1994.

AUSTIN	BCSHD	BNDYSHD	BNDYSHD2
CHARGE	COUNTY	COUNTY2	DISTBNDY
DISTNSHD	DISTSHD	ETJ2	ETJ3
EWMT2	EWS	EWTMP	FAULTCL
FAULTS	GEO	GEOLOCL	GEOLOCL2
GEOLOCL3	GEOLOGY	GEOLOGY2	GEOLOGY3
GEOLOGY4	GEOLOGY5	H2OSHD	H2OSHD2
HYDRBNDY	HYDRO	HYDRO2	HYDRO3
INCPL	INCPLFIL	JUNKWELL	KARSTICS
PIPE	PIPE2	PUMP	PUMP2
RAILROAD	ROAD2	ROAD3	ROADBNDY
ROADS	SOILD	SOILD2	SOILD3
SUBDIV	TIC2	TICS	TICUTM3
WATSHD	WELLS		

2. RVE Maps

The following maps were generated based on the previously listed RVE data.

Watershed Boundaries
- watersheds, water supply - rural, suburban

Zones of Influence
- roads, streams, contributing, recharge, transition and extended service

Transportation Network and Political Subdivisions
- ETJs, roads, airports, incorporated areas, CCNs and Water Suppliers

Surface Hydrography
- watersheds, streams

Aquifer Hydrography
- Barton Springs boundary of the Edwards, bad water line, water well locations, recharge and transition zones

Surface Geology
- faults, geology groups

Soils
- soil groups

Recharge Features
- watersheds, caves, sinkholes

Surface Geology II
- faults, geology groups

3. ARC/INFO Coverages From TWDB (Those shown in bold face were supplied during the vendor benchmark)

AREA (AREA3) .pat - 76.6K - Area Of Total Watershed, Zone Borders & Service Areas With Labels

AUSTIN - 260.1K - ETJ boundary With Labels (not on TWDB hard drive)

BNDYSHD .aat .pat - 25.7K - only the contributing zone boundary, no border w/ recharge zone

CHARGE .aat .pat - 57.4K - Recharge Area of the Aquifer (made from AREA3)
Recharge Zone, Transition Zone, Bad Water line

COUNTY .pat - 82.8K - 5 County Area from TIGER w/ labels

DISTBNDY .aat .pat - 40.6K - Perimeter of BS/EACD - no Contributing Zone - no zone borders

DISTSHD .aat .pat - 54.4K - Perimeter of BS/EACD - with Contributing Zone - no zone borders

FAULTCL .aat .pat - 174.4K - Faults from Kenneth Alexander's Master's Thesis entitled *Correlation of Structural Lineaments and Fracture Traces to Water-Well Yields in the Edwards Aquifer, Central Texas*

FAULTS .aat .pat - 91.6K - Faults from USGS 1:250,000

GEOLOGY6 - (GEOLOGY) 230.5K - Surface Geology from USGS w/labels - ***DATA ERROR***

H2OSHD .aat .pat - 77.1K - Individual Watershed boundaries with labels

HYDRO (HYDRO4).aat .pat - 291.4K - Complete Hydrology Coverage from USGS DLG - no political boundaries

KARSTICS .pat - 13.1K .pat - Karstics: Caves, Sinkholes
point cover - features defined as Small, Medium and Large

MAJRDS .pat - 109.3K - Major Roadways w/ labels

PIPE (PIPE2) .aat .pat - 25.4K - Pipelines USGS DLG
- West of the Downdip Limit

RAILROAD .aat .pat - 5.7K - Railroads from USGS DLG w/ labels

SEPTIC .aat .pat - 20.3K - Areas of Septic Tank use >10-15 acres

SEWER .aat .pat - 4.4K - Major Wastewater Outfalls - incomplete

SOIL2 (SOILD3) .pat - 67.4K - Soil Associations with County Boundaries

SOIL (SOILD) .pat - 58.9K - Soil Associations without County Boundaries

SOURCES .aat .pat - 27.1K - Contamination Sources

SUBDIV .aat .pat - 103.3K - Incorporated Towns and Cities from TIGER w/ labels

WELLS (WELLSA) .pat - 52.8K - Data from 205 Wells - last update October 1991
WELLS.PAT

AREA
PERIMETER *(DEFAULT - USED BY ARC/INFO)*
WELLS#
WELLS_ID

Wellpre	- First 4 #S In The State Well # - Grid 58 Block 42
Number	- Last 3 #S In The State Well #
Type	- Taken From The Data Dictionary
Wellnum	- State Well #
Owner	- Well Owner
County	- County
Aquifer	- Aquifer
Date	- Of Testing
Inspector	- From BS/EACD
Water Level	- In Feet Below The Surface
Temperature	- Water Temperature In C
TDS	- mg/L
Conductivity	- moles / ohm
pH	- pH
Total Alkalinity	- ppm
Iron	- mg/L
Sulfate	- mg/L
Chloride	- mg/L
Nitrate	- mg/L
Fluoride	- mg/L

ROADSA.E00 - 793.7K - All Roads from USGS DLG
- Zipped as RDS.ZIP

B. New Data

The following data has been identified by District GIS staff to be collected as new information or to supplement existing District data. These new ARC/INFO coverages/tables will be prioritized in order to establish a work schedule for the long-term GIS project.

PHYSICAL
- Topography
- Vegetation
- Soils
- Karst / Recharge Features
- FEMA Floodplain
- Wetlands

- Property/Parcel Ownership
- Archeologically Significant Features
- Proposed / Existing Development
- Natural - Man-made hazards / potential
- Landmarks
- Community Services/Facilities
- Economic Development Plans and Activities
- Building Permits and Starts

DEMOGRAPHICS (1990 Census Data)

- Age
- Education
- Population Density - Block Data
- Population Total
- Household Income
- Tax Revenues
- Crime Statistics
- Voter Registration
- Student Profiles

ENVIRONMENTAL

- CEF - Critical Environmental Features
- Resource Condition Data
- Environmental Impact Assessments
- Endangered Species Habitat
- Endemic Wildlife Species
- Comprehensive Watershed Ordinances

INFRASTRUCTURE

- Water / Wastewater Treatment and Distribution
- Hazardous Waste Facilities
- Pipelines
- Over-land Hazardous Transportation Routes
- Existing and Proposed Roadways
- Septic Systems / Effluent Lines
- Electric Distribution Network
- Railroads
- Telephone/Cable
- Airports
- Fire Protection

PLANNING

- Land Use Plans
- Zoning
- Cultural Features / Resources
- Comprehensive Plans - ETJ
- Political Jurisdictions
- Voting Precincts
- Contingency
    - EMS /Spill Response
    - Drought Planning
- Subdivision Ordinances

POLLUTION

- WPAP - Water Pollution Abatement Plans
- Point - Nonpoint Source Pollution
- Potential And Existing Pollution Sources

- Landfills
- Hazardous Material Storage
- Wastewater Treatment Facilities
- Septic Systems
- Underground -Above Ground Storage Tanks
- Power Generating Facilities - Substations
- Tire - Battery Dumps

Discharge Sites
NPDES Discharge Points (Outfalls)
Contamination Sites
- Prior Accidents
- LUSTs
- Pipelines
- Superfund Sites

WATER
Edwards Aquifer
Trinity Aquifer
Water Quality Parameters
Historical Water Statistics
Water Sources
Water Rights Used - Water Rights Available
Depth To Groundwater
Artesian Zones
Riparian Corridors
Groundwater Profiles
- Water Movement
- Water Table
- Potentiometric Surfaces

Water Wells
- Locations
- Depths
- Plugged Wells
- Well Log Data

Sediment And Nutrient Loading - Transport
Monitoring Stations
Weather Stations
Climate And Meteorological Data
Water Use
Domestic
Industrial
Agricultural
PWS - Public Water Supply
CCNs (Certificates Of Convenience And Necessity) - Service Areas
Population
Number Of Connections
Service Areas
Service Company Interconnections
Permitting
Permittable Facilities
Currently Permitted Facilities
Stormwater Runoff Control - Drain Systems

Dams, Pump Stations, Detention And Retention Ponds

ACCOUNTING

Well Info
Pumpage
Customer Information

C. Data Sources

The following sources have been identified by District GIS staff that may be able to provide data to complete the initial data acquisition phase of the GIS implementation. There are certain omissions or other possible sources that need to be identified in the list for completion. Please add any additional contacts, or complete any missing data you may be able to supply.

1. GIS Personnel

AIMS	John Yeager	512-454-2467
COA - ECSD	Wayne Painter	512-499-2905
DIR	Roddy Seekins	512-463-6581
	Marc Berryman	
EOSAT	Brenda Burroughs	407-856-7828
ESRI	Chitra Subramaniam-Bryson	210-340-5762
	Cecil Lamb	
	Devon Humphrey	
EUWD	Anna Riniker	210-222-2204
GLO	Scot Friedman	512-463-5144
	Lee Smith	
LCRA	Beate Sterrenberg	512-473-3333 #7813
Loomis & Assoc.	Mat Hollon	512-327-1180
PUC	Mel Echoff	512-458-0120
RRC	Lorelei Weitzel	512-463-7244
RVE	Philip Wanke	512-480-0032
Signet Partners	Bill Games	512-343-4565
Sun Microsystems	Tom Bettes	512-502-3804
TDCJ	Marilyn Beckham	409-348-3751 #266
TNRCC	Jeff Blass	512-475-4620
TNRIS	Drew Decker	512-463-8338
TPWD	Craig Scofield	512-389-8070
	Kim Ludeke	
	Jane Chang	
Trimble	Dave Ross	713-363-4700
TWDB	Richard Wade	512-463-8403
	Phil Nordstrom	512-445-1434
TxDOT	James Zach	512-465-7412
USFWS	Rich Szlemp	512-482-5436
UTBEG	Thomas Tremblay	512-471-1534

2. Data Source Check List

Federal Agencies

EPA - Dallas		(214)655-6548

FEMA		
USBC (Census)		(301)763-4100
USCOE		
USDE (Energy) - Washington		(202)260-2080
USDOA - ASCS	Mark Daniel	(512)454-2571
USDOA - FHA	Daniel Torres	(415)863-8518
USDOA - SCS	Michael Ranay	(512)482-5591
USFWS		
USGS - Water Resources		(512)873-3000
State Agencies		
GLO	Scot Friedman	(512)463-5144
PUC	Mel Echoff	(512)458-0120
Railroad Commission	Lorelei Weitzel	(512)463-7244
Legislative Council		
TDA		(512)463-7476
TDC - Research & Planning	Bill Kean	(512)472-5059
TDH - Bureau of Automated Data Services	Joe Coffey	(512)458-7261
Texas Agricultural Experiment Station		
TNRCC	Jeff Blass	(512)475-4620
TNRIS	Drew Decker	(512)463-8338
TPWD	Craig Scofield	(512)389-8070
TSSWCB	Melvin Bain	(210)398-2710
TWDB	Richard Wade	(512)463-8403
TxDOT	Jack Howell	(512)465-7942
Division of Transportation Planning	Alvin Luedecke	(512)465-7346
Local Government Agencies		
Note: See City and County Contact Sections		
Political Subdivisions		
BS/EACD		
CAPCO	Don Stence	(512)443-7653
Capital Area Rural Transportation System	Vivian Jackson	(512)478-7433
Capital Metro	Anthony Kouneski	(512)389-7400

EUWD	Anna Riniker	(210)222-2204
LCRA	Beate Sterrenberg	(512)473-3333
Private Firms & Organizations		
Austin Geological Society		
Barton Creek Properties		
EOSAT	Brenda Burroughs	(407)856-7828
Law firms		
Bickerstaff, Heath, and Smiley		(512)472-8012
Oil companies		
Consultants		
RVA	Philip Wanke	(512)480-0032
Loomis & Associates	Mat Holland	(512)327-1180
	Tom Loomis	
Engineering Firms		
Carlson Engineering & Associates	Tommy Carlson	(512)280-5160
Donald G. Rauschuber & Assoc.	Don Rauschuber	(512)328-3253
Espey, Huston &Associates Inc.	Danny Martin	(512)327-6840
Fugro-McClelland Inc.	John Wooley	(512)444-3233
Horizon Environmental Services	Lee Sherrod	(512)328-2430
Jack H. Holt & Associates Inc.	Linda Holt	(512)447-8166
Lichliter/Jameson & Assoc.	David Ruehlman	(512)474-5500
Murfee Engineering	Pete Malone	(512)327-9204
Southwestern Laboratories	John Dupont	(512)447-9081
Trinity Engineering Testing Corp.	Ken Holcomb	(512)926-6650
Utilities		
GTE		(409)764-9131
PEC		(210)868-7155
SW Bell		(512)345-6480
Universities		
St. Edwards		(512)448-8400
SWTSU	Dr. Rudnicki	(512)245-2170
TAMU	Robert Maggio	(409)845-5069
UT-Austin, Bureau of Economic Geology	Thomas Tremblay	(512)471-1534

UT@SA Water Resources Research Center	Dr. Hammond	
UT - Architecture and Planning	Dr. Kent Butler	
MUDs		
Austin MUD #1	Sue Littlefield	(512)499-3600
Austin MUD #2	Jay Mckinney	(512)651-0111
Austin MUD #3	Thomas Kroll	(512)499-3600
Circle C MUD #3	Randy McEachern	(512)499-3600
Circle C MUD #4	David Bodenman	(512)499-3600
Davenport Ranch MUD #1	Robert V. Reim	(512)499-6238
Hurst Creek MUD	Haskell Wotkyns, Jr.	(512)261-6522
Lakeway MUD	D. E. Iburg	(512)327-6243
Lost Creek MUD	Adrian Huckabee	(512)327-6243
Maple Run at Austin MUD	Kempe C. Hayes	(512)477-7161
Moore's Crossing MUD	Dianne Hill	(512)499-3600
North Austin MUD #1	Steve D. Pena	(512)499-3600
Northtown MUD	Texana Kowis	(512)477-7161
Northwest Austin MUD #1	Chester Collinsworth	(512)499-3600
Northwest Austin MUD #2	Walter G. Jenkins	(512)499-3600
Northwest Travis County #1	Kevin Tombs	(512)258-3550
Northwest Travis County #2	Gary Potts	(512)219-9225
South Austin Growth Corridor #1	Amtex Corporation	
Southland Oaks MUD #1	Hank Guerrero	(512)499-3600
Southwest Travis County MUD #1	Gary B. Black	(512)280-6622
Tanglewood Forest MUD	Joseph Babb	(512)263-2707
Travis County MUD #2	Howard N. Richards	(713)880-3800
Travis County MUD #14	Joe Vickers	
Travis County MUD #19	Mike Willat	
Village at Western Oaks MUD	Steve Matthews	(512)499-3600
Wells Branch MUD	William Glass	(512)499-3600
West Travis County MUD #1	John C. Lewis	(512)499-3600
West Travis County MUD #2	John S. Lloyd	(512)499-3600
WCIDs		
Friendship Ranch WCID	Mike Willatt	

Travis County WCID #10	Clif W. Drummond	(512)327-2230
Travis County WCID #14	Joe Vickers	(512)288-2537
Travis County WCID #17	James Spence	(512)266-1111
Travis County WCID #18	Robert Alden	(512)263-2707
Travis County WCID #20	Robert Richardson	(512)499-3600
Travis County WCID #21	Gary W. Bechtol	(512)499-3600
Travis County WCID Point Venture	H. W. Wentz	(512)267-1641
SWCDs		
Caldwell-Travis SWCD #304	Melvin Bain	
Bastrop County SWCD #340	Jim Mogonye	
Hays County SWCD #351	Frank Zimmerman	
PWSs		
Barton Properties	Cyndy	(512)474-8857
Bowen, George	George Bowen	(512)295-3631
Chaparral Water Company	James Benoit	(512)280-5000
Cimarron Park Water Company Inc.	Byron T. Townsend	(512)295-2583
City of Austin	David Johns	(512)499-2781
City of Buda	Allen Lindeman	(512)295-6331
City of Sunset Valley	Jamye Foley	(512)892-1383
Copper Hills Water System	Byron Townsend	(512)295-2583
Creedmoor-Maha Water Supply Corp.	Charles P. Laws	(512)243-2113
Dellana Hills Water System	Ardith Kiefer	(512)327-2102
Estate Utilities Water Supply Corp.	Corine Taylor	(512)295-4792
G & J Water District	Carol Baldwin	(512)335-7580
Goforth Water Supply Corp.	Terry Wright	(512)398-5695
Hays Hills Baptist Church	David Sweet	(512)295-3132
Hicks, Harold and Al Schuster	Harold Hicks	(512)441-3837
Huntington Estates Water Supply Co.	Darrel Valdes	(210) 693-2905
Janssen Water System	Dawn Janssen	(512)282-2223
Malone, J.D.	J. D. Malone	(512)282-1306
Marbridge Foundation	Darlene Means	(512)258-7021
Mooreland Water System	J.F. Hovey	(512)282-5947
Mountain City Oaks Water System	John Anderson	(512)268-9751

Mystic Oak Water Co-Op	Don Turner	(512)282-0685
Oak Forest Highlands	Leon Griffen	(512)282-3686
Plum Creek Water Co.	Glen Lewis	(512)326-1311
Shady Hollow Estates Water Company	Widdie Wigley	(512)327-8526
Slaughter Creek Acres Water Supply	Mike Dorsey	(512)282-4251
Southwest Territory Water Supply	James Benoit	(512)280-5000
St. Albans Episcopal Church	Vicki Meldrum	(512)282-5631
Stenger Ridgewood Village Water System	Mike Ciccarelli	(512)441-5236
Suburban Austin Water System	Glenn Mitchell	(512)288-5080
Village of San Leanna	Byron Townsend	(512)280-3890

3. City Contacts

	Police	Fire	Tax Assessor	W/WW	Court Clerk &/or Secretary.	Tax Assess ISD	Planning & Development	Public Works
Buda		Chuck Lewis 512-295-6331	Annette Chambers 512-295-6331	Allen Lindeman 512-295-6331	Annette Chambers 512-295-6331			
Dripping Springs					Lyndia Olive 512-858-4725	Analee Parten 512-858-7809		
Hays					Jo Burdette (R) 512-295-3082	Appraisal Dist. 512-392-8167	Bill Couch	Corrine Taylor
Kyle	David Young 512-268-5341	Aubrey Bales 512-268-5341		J. F. Montague 512-268-5341				
Mountain City					James Hill (R) 512-268-0775			
Niederwald					Sarah Wright			
Creedmoor					Martha Click (R) 512-243-2202			
Mustang Ridge	Greg Quebe 512-243-7200				Martha Kyser 512-243-1775			
Rollingwood	Roger Dean 512-328-7200	Andy Adams 512-327-9405			Cindy Selman 512-327-1838			
San Leanna				Byron Townsend	Vivian Caldwell 512-280-3898			
Sunset Valley	G. Scott Kniffen 512-8921-1384	Randolph Walker 512-282-3600		Ernest Robles 512-892-1383	Jayne Foley 512-892-1383			
West Lake Hill	Carl Drost 5121-327-1195		Don Fisher 512-329-3608		Linda Winn 512-327-3628			
Austin	Elizabeth Watson 512-480-5009	Bill Roberts 512-477-5784		Randy Goss 512-322-0101	James Aldridge 512-499-2210	Clint Schuhmacher 512-499-1700	Jim Smith 512-499-6406	William Stockton 512-499-7058

4. COUNTY CONTACTS

	BASTROP Pct. 3	CALDWELL Pct. 4	TRAVIS Pct. 3,4	HAYS Pct. 2,4	BLANCO Pct. 4
Sheriff	Fred Hoskins 512-321-8200	Mike Bading 512-398 4353	Terry Keel 512-473-9770	Paul Hastings 512-396-6166	Harry Carpenter 512-868-7104
Tax Assessor	Barbara Brinkmeyer 512-321-2580	Mary Smith 512-398-1830	Nelda Spears 512-473-9473	Ruth Clayton 512-392-8167	Hollis Boatright 512-868-7178

Appraisal	Dana Ripley 512-321-3925	Russell Sarders 512-398-2391	Art Cory 512-834-9317	Bill Backus 512-754-7400	Hollis Petri 512-868-4624
ISD	Marilyn Kuhn 512-321-5101	Russell Sarders 512-398-2391	*see Austin		Jeanette Leese 210-833-4414
County Road Administration.		Fred Burfiend 512-398-7269	Shyre Darr 512-472-7483		
County Surveyor	Dale Olson 512-321-5476			Kelley Kilber 512-353-3335	
Election Administration.					
Chamber of Commerce (CC)	Susan Crowe 512-321-2419		Capital City CC: Jordan Whitfield 512-459-1181 Greater Austin CC Glenn West 512-478-9383	Dripping Springs Patty Hastings 512-858-4740	Jim Schimpf 512-833-5101
Extension Agencies	Ronald Lindsey 512-321-2184	Glenn Holub 512-398-3122	James Smith 512-473-9611	Clifford Caskey 512-353-4120	Todd Swift 512-868-7167

V. NEW TASKS

The following tasks have been identified by District GIS staff as steps necessary to realize a comprehensive and successful implementation of the new GIS. District staff is working to complete this list and to help prioritize these assignments for the most effective and efficient use of the new GIS.

A. Short-Term Activities

1. Complete GIS Pilot Project
2. Complete GIS Training
3. Supplement Existing Data/Acquire Additional Data
4. Data Management
   - Inventory & Analysis
     - Of Existing and Proposed Covers
     - Of Attribute Data
   - Update District Well Data
5. Field Verify Existing Data
6. Map-Making, Cartography and Report Writing
   - Generate Status Reports
   - Document Methodology
   - Presentation Of The Digital Information - Maps, Graphs and Charts
7. ARC/INFO Coverage/Data Generation
   - Revised Sensitivity Index
     - Develop Rating Criteria
   - Joint Venture With USGS
     - Geologic Mapping Study
   - Treatment Opportunities Mapping
     - Appropriate Management Techniques
     - Selection Of Priority Treatment Areas
8. Education
   - Supply Graphics For District Newsletter, Promotions and Other Literature
9. Model-Making
   - Dynamic 3D Models
     - Surface Geology/Topography
     - Subsurface Geology
     - Surface Hydrography
       - Inventory And Monitor Surface Water Quality And Quantity
       - Electric Logs, Drillers Notes, Geophysical Log Curves
     - Subsurface Hydrography
       - Aquifer Levels And Trends
       - Water Quality And Trends
       - Aquifer Profile
     - Pumpage Drawdown
     - Recharge Enhancement
     - Pollution Contamination Plumes
       - Air And Water
       - Contaminant Particle Tracking

- Volume Modeling And Analysis

Predictive Modeling
- Urban Growth
- Site Suitability Analysis
- Flood Management
- Erosion Control
  - Wind, Water
- Wildfire Control
- Mining Reclamation Projects
- Dye Tracing
- Best Management Practices (BMPs)

B. Long-Term Or On-Going Activities

1. Data Acquisition
2. Data Management
3. Identify and Obtain Grant/Funding Alternatives
4. Generation Of New Data Layers/Information
5. Development Of Presentation Quality Graphics
6. Participation In State-Wide GIS Coordination Efforts

VI. DATABASE DESIGN

The GIS database will integrate the data and information needed to realize the District mission -- to preserve, protect and enhance the Barton Springs segment of Edwards Aquifer. The database will contain five primary components: cartographic layers; feature attribute tables; annotation; lookup tables and map library.

A. Data Exchange

According to the source of the data, District data can be separated into "in-house" and "external" source data. Most of the in-house data is well information which was collected by the District staff. Most of the "external" data is information collected by other agencies. Since the District will exchange data with other agencies from time to time, data standardization will be a critical factor for using data effectively and efficiently.

Adopting a data standard that meets the needs of the District is an important aspect of database design. For in-house data, most of the data is in the standard set by the TWDB and EPA. For "external" data, we will adopt the standards used by the majority of entities we will be sharing data with, which is in fact the EPA standard. Data from outside sources will be in various formats, units and accuracy; therefore, it will be necessary to create a data exchange interface in order to convert data from/to the standard of our database. This will be necessary because after interviewing several of the agencies we will exchange data with, there has not been a standard format adopted. We have found that each agency has found it easier to create its own front-end for their database for data exchange than to reconfigure the format of their existing database.

A Metadata (the data directory) will be created to explain all of the data elements. This directory will include the attribute name, attribute definition, source agency name, attribute type, attribute format, unit and accuracy, attribute category presentation and how to represent absent data. Data that conforms to such standards will ensure the continuity and usefulness of the data in the future.

B. Basic Layers and Attributes

The database will include at least thirty basic layers of data and information about topographic features; geologic features; soil features; hydrology; vegetation; transportation; parcel boundaries; voting precincts; political boundaries; district boundary and sub-boundaries; well locations; potential pollution sources; census data and land use.

Graphic Layer	Attribute Items	Annotation	Coverage Type
The five county topo maps	elevation of each contour line	elevation of each contour line	arc
Surface geology (geologic formation)	Surface exposure; age; geochemistry	geologic units - group - formation - member	polygon

Surface geology (structural features)	structural features; strike; dip; throw; relative offset (up / down); criteria (breccia, offset in beds / bedding change, slicken lines / fracture trace, springs / caves)	structural features	arc
Karstic features (Surface structure)	Lat/Long location; Type (sinkhole, honeycombed, solution enlarged fracture, cave, bedding plane); opening size; drainage area (diameter); depth; azimuth and distance; mapped (Y/N)	Name	point
Karstic feature (Sub-surface structure)	Cave survey measurements; station inclination; azimuth and distance; air flow (none, high, in or out); potential water recharge / flow; measured recharge / flow; water quality; air quality	Names	arc / polygon
Lineament / Fracture Trace	Direction; Length; Width		arc
Soil	Type; Profile; Depth; Features	Association	polygon
Vegetation	Structure; Feature; Major species	Name of community	polygon
Surface Hydrology	Flow Rate; Segments' feature; Drainage area	Name	arc
Aquifer (surface features)	Flow direction; Thickness; Surface exposure (recharge zone); Confirmed & unconfirmed portions	Name	arc
Aquifer (re/discharge features)	Major recharge location; Major discharge location; Major pumping Centers;	Name	point / polygon
Counties	Population	County Name	polygon
Cities and ETJ's	City Population	City Name	polygon
Water Supply Service	Population (or households) served; Capacity of Supply; Amount of water supplied	Name	polygon
WCID, MUD, PUD, SWCD		Name of entities	polygon
Property Maps	Owner; Well (Y/N)		polygon
Roads	Type of Road; # of Lanes	Name	arc (network)
Railroads		Name	arc
Pipelines	Type (Gas, Oil or others), material, depth	Company name	arc (network)
Wells	Well Drillers Log, Well Identifiers, Well Descriptors, Geographic Descriptors, Sample Descriptors	State well number	point
Sewer lines; Lift stations and man-holes	Diameter; Capacity; Pressurized or gravity; age; TNRCC approved date (for SCS); number houses served; material; Concrete encasement; Date of last inspection or test; Cement interval		arc & point (link) or network
Septic Tanks	Address; Lat/Long location; Contamination Description, Perk-test		point

Gas Stations	Address; Lat/Long. location; Contamination Description	Name	point
Landfill Locations, Discharge of Wastewater	Contamination Description; quantity/volume	Name	point
The District Boundaries		Name of zones	polygon
County Precincts		Precinct number	polygon
District Voting Precincts		Precinct number	polygon
Census Tract & Block	Population variables	Variable identifier	polygon
Land use	Type	Label	polygon
Zones	Recharge, Artesian, Contributing	Name	polygon
Monitor Wells	All District data	State well number	points

C. Pilot Project/Well Attributes

We have initiated a pilot project which will help to bring the District GIS on-line. We have developed an ARC/INFO coverage that represents the wells used in the District's Water-*Research Study of the Barton Springs Segment of the Edwards Aquifer* (TWDB Grant Contract No. 93-483-346). Tables associated with this graphics coverage will incorporate the water quality data being presented in the above report. This pilot project is quite appropriate for the current stage of development of the system. It is a small enough representation of the wells within the District to be able to manage, yet complex enough of a database management problem to help the District GIS staff to identify and overcome many potential GIS/database management problems. The results from this pilot study will not be available to include in the final submission of the District's Water-*Research Study of the Barton Springs Segment of the Edwards Aquifer* but is indicative of the utilization of the GIS for similar efforts in the future. Ultimately, the GIS will be able to provide not only the necessary graphics, but will be able to process and synthesize the raw data to display, manage and organize the data for such reports.

Most in-house data is about wells in the District. Though there is still some hardcopy data, most of the well data is in electronic format. Before transferring this data to the GIS system, the respective well attribute files needed to be designed (See Table 7 - BSEACD Pilot Project Design). The needs of the District concerning data input and output was considered throughout the design process. Although this can easily be accomplished in theory, practical application is considerably more difficult. Because we are still in a data inventory/analysis stage, the final ARC/INFO attribute tables will only be realized through practical application and experience.

Well data with the same or similar update frequency will be grouped in order to increase efficiency. This information can be divided to three categories based on update frequency -- fixed information, occasionally changed information, time-change information.

a) Fixed information

Well Identifiers:	State well no., Previous owner,
Well Locators:	Well location (lat/long), Well address, Aquifer, County, elevation
Well Drilling Log:	Date drilled, Date plugged, Well bore diameter, Well depth, Casing diameter, Casing height, Unscreened casing depth, Pump setting

b) Occasionally changed information:

Owner information:	Owner name, contact person, mailing address, contact phone
Well information:	Well type, Number of wells, Annual pumpage

c) Time-change information	Date of sampling (inspecting), Depth to water, Water level and all other parameters of water quantity and quality.

The majority of well data comes from well inspections and sampling. Data from inspections is concerned about physical characteristics of wells, while data from sampling is concerned with the quantity and quality of water in the wells. An exempt well usually is inspected only once during its construction; however, permitted wells are inspected annually or semi-annually. The physical characteristics of a well are fixed data, and require no time sequence analysis. If any change occurs (e.g., another inspection is performed for a well), the most recent information will be entered as a new record while any and all old records will be kept to provide temporal information.

The data from sampling events is time sensitive and must be associated with the specific sample time. However, well sampling occurs on an irregular basis. Data collecting frequency varies from none to twice a year or more, according to District needs. The monitor wells are regularly measured -- once a week -- data is collected hourly with the maximum reading recorded daily. Since most well are sampled infrequently, data should be stored in files that represent similar sampling frequency. However, as previously stated, the final database design will only evolve through practical experience. All temporal attribute tables will be related (ARC/INFO RELATE command) to the wells coverage.

It will be more helpful for using and retrieving data to group the data with the same or similar usage. The data can be grouped according to use as either administrative data, operational data, well construction data, management data, etc..

A) Administrative Data

Well Identifiers: State Well Number, Previous Owner,

Well Locators: Well Location (Lat/Long), Well Address, Aquifer, County

Owner Information: Owner Name, Contact Person, Mailing Address, Contact Phone

Well Information: Type, Quantity Of Wells, Water Level, Annual Pumpage

B) Operational Data

Meter Information: Type, Brand, Serial Number, Distance To Well, Size, Reading, Fixed Zeros, Of All Points Of Use

Pumping Devices: Type, Size, Rate, Depth Of Casing, Casing Diameter, Screened Interval

Storage Information: Capacity(1), Capacity(2), Type, Operation Pressure, Number Of Connection

Measurement Device: E-Line Access, Airline, Sampling Spigot

Well Drilling Log: Date Drilled, Date Plugged, Well Bore Diameter, Well Depth, Casing Diameter, Casing Height, Unscreened Casing Depth, Pump Setting

C) Management Data

Conservation Programs, Field Drought Plans, (Pumpage) Flow Rate, Treatment Type, Treatment Capacity, Leaking Detection

D) Data From Lab.

All Water Quality Data

The effort to combine both updating frequency and usage categories into an integrated database will represent a substantial portion of the initial GIS staff work/time-allocation.

D. Map Library

After the basic database has been established, a map library can be built on the standardized data. The map library would allow users to access the integrated data system-wide to obtain information through the methods provided by the network.

In fact, the map library can also be used for data management and data collection. Our map library in the database will be based on the USGS quad sheet rectangular grid system. Using this system as the framework for our database design will enable us to build the map library at the same time we build our database inventory. On finishing the database inventory, the map library will also be close to completion.

The map library system is based on one of the most important well attributes --- State Well Number. Wells will be one of the major components of the District GIS. The state well number will provide the link that District staff can use to access the database through the map library.

VII. GOALS AND OBJECTIVES (Past and Present)

Goal 1 - *Provide the District with GIS capability.*

Objectives -

1. Secure funding for District GIS program by August 1993.
2. Prepare and submit RFP for District GIS by October 1993.
3. Evaluate GIS vendor proposals and award GIS contract by February 1994.
4. Conclude contract negotiations by April 1994.
5. Take delivery and bring on-line District GIS by June 1994.

Goal 2 - *Prepare for the delivery of the GIS.*

Objectives -

1. Request software documentation for review prior to delivery.
2. Identify and compile in digital form all relevant in-house data for data dump to GIS by June 1994.
3. Develop a GIS Operating Plan by June 1994 -- including: procedures and format for documentation of data entry, accuracy and related items; protocols for encoding data and identification of confidence levels in accordance with state/federal standards.
4. Identify and collect applicable outside digital data for District programs by June 1994.
5. Design necessary graphic data layers and database sets by June 1994.
6. Organize the office space and purchase necessary furniture.
7. Purchase any additional hardware/software or peripheral devices which will be used with the GIS.

Goal 3 - *Integrate GIS functionality into routine District operations.*

Objectives -

1. Install existing District data in GIS upon delivery.
2. Develop presentation quality maps to support District programs by August 1994.
3. Work with District staff to apply GIS in each applicable project area.
4. Use GPS to improve accuracy of spatial data collection and encoding.
5. Develop a Geodetic Control Network based on GPS field data verification.

6. Develop models and profiles of the District as described in Section V of this report.
7. Keep District staff apprised of GIS development and integration efforts.
8. Implement the GIS Operating Plan.

Goal 4 - *Provide the GIS staff with the skills necessary to implement the District GIS.*

Objectives -

1. Complete Intro to and Advanced ARC/INFO staff training by August 1994.
2. Complete GRID and AML staff training by October 1994.
3. Attend and participate in the annual ESRI User Conference.
4. Attend other applicable lectures, meetings, seminars and conferences.
5. Develop an on-going education program to keep GIS staff abreast of changes in the GIS industry -- specifically as they apply to ARC/INFO and other relevant District hardware/software.

Goal 5 - *Provide for the administration of the District GIS.*

Objectives -

1. Develop an anticipated FY 95 GIS departmental budget by May 1994.
2. Monitor FY 95 expenditures for hardware/software, sundries and staff time to revise FY 96 budget.
3. Comply with TWDB grant requirements -- including the preparation and submittal of timely status reports.
4. Perform routine preventative maintenance on the District GIS as required.

Goal 6 - *Provide for on-going District GIS development.*

Objectives -

1. Continue to work with other state, local, federal agencies to assure compatibility of data and data transfer, to ensure our products are error-free and to benefit from the experience of others (e.g., EUWD, TNRIS, TWDB) in the development of GIS.
2. Identify and solicit grant funds to help support, upgrade and expand our GIS capabilities (goal is $ 100,000 to $ 250,000).

3. Continue to upgrade District GIS through perpetual data management and acquisition.
4. Maintain the flexibility to address changing District needs and objectives.

VIII. APPLICATION OF GIS TO THE DISTRICT MISSION

Based on the ***Two Year Management Plan*** adopted by the District Board on December 10, 1992, GIS can be integrated into the identified *Management Plan Components* in the following ways.

REGISTRATION:

1. Identification of well locations through interpretation of digital maps (DOQs).
2. Identification of well locations through digital datasets (appraisal information).
3. By cross-referencing existing District well information with other databases (TWDB).
4. Evaluate site assessments and suitability based on existing GIS data prior to field visits.

EDUCATION:

1. Develop applicable graphics -- including maps, charts and graphs to be used in educational literature.
2. Provide statistical analysis of District data (e.g., water quality and quantity) for District reports, Public Service Announcements (PSAs), etc.
3. Participate in District activities to educate the public about the integration of GIS in District programs.

SAMPLING:

1. Display sampling results through user-friendly graphics for easy interpretation.
2. Develop predictive models of contamination to identify sampling needs.
3. Monitor remedial activities and develop alternative management scenarios.

LEGISLATIVE:

1. Develop graphics necessary to support District proposals.
2. Develop pollution scenarios that emphasize the need for regulatory control in the contributing zone.
3. Provide the data analysis necessary to defend District decision and policy-making efforts.

RECHARGE:

1. Provide data analysis and scenario simulations for proposed recharge projects.
2. Work with other applicable entities in developing GIS models for regional planning.

CONSERVATION AND DROUGHT:

1. Develop predictive planning scenarios to determine the extent of drought conditions.
2. Develop alternative conservation plans based on the results of drought models.

3. Display conservation and drought variables graphically to emphasize the potential of the problem.

POINT SOURCE/NON-POINT SOURCE POLLUTION:

1. Identify sources of pollution through digital data and develop pollution contamination models.
2. Develop pollution mitigation alternative planning scenarios.
3. Evaluate alternative management techniques.
4. Monitor a joint Wellhead Protection Program.

GRANTS:

1. Provide support materials for grant proposals.

ADMINISTRATION:

1. Use the UNIX machine for file storage and data management through an inter-office computer network.
2. Support administrative activities through the production of quality graphic and support materials for inclusion in reports and correspondence, for meetings, and for routine daily tasks.

IX. APPENDICES

TABLE 1 - PROPOSAL EVALUATION

Reviewer	Stovy	Bowlin	Shu	Liang
Vendors - ESRI and Intergraph	**ESRI**	**IG**	**ESRI**	**IG**
Software	**SCORE**		**SCORE**	
Part I - General Information	15	15	14	0
Part II - Software Specifications	105	63	99	15
Part III - Training	8	4	6	8
Part IV - Technical Support	8	8	4	5
Part V - Maintenance	5	5	4	4
Part VI - Company History	15	15	10	8
Part VII - Previous Installations	5	5	4	3
Part VIII - Delivery/Installation	5	3	5	2
Part IX - Documentation	5	5	5	0
Part X - Cost	9	11	14	13
Part XI - Customer Reference	5	5	N/A	N/A
Software Total	**185**	**139**	**165**	**58**
Hardware				
Part I - General Information	25	21	18	17
Part II - Software Specifications	34	40	26	26
Part III - Training	8	6	6	9
Part IV - Technical Support	8	8	8	8
Part V - Maintenance	5	5	3	4
Part VI - Company History	15	15	9	9
Part VII - Previous Installations	5	5	17	16
Part VIII - Delivery/Installation	5	5	3	3
Part IX - Documentation	5	5	5	0
Part X - Cost	13	11	10	12
Part XI - Customer Reference	5	5	N/A	N/A
Hardware Total	**128**	**126**	**105**	**104**
Software Total	**185**	**139**	**165**	**58**
Grand Total	**313**	**265**	**270**	**162**
% Total	**54%**	**46%**	**62%**	**38%**

TABLE 2 - PROPOSAL COST ANALYSIS

	ESRI			INTERGRAPH		
ITEM	**RETAIL**	**W/DISC.**	**%**	**RETAIL**	**W/DISC.**	**%**
Software	$ 25,650.00	$ 10,850.00	58%	$ 41,950.00	$ 1,440.00	97%
Hardware	$ 48,020.00	$ 34,315.00	29%	$ 40,580.00	$ 33,664.00	17%
Operating System	$ 0.00	$ 0.00	0%	$ 0.00	$ 0.00	0%
Training	$ 9,600.00	$ 8,500.00	11%	$ 9,000.00	$ 9,000.00	0%
Maintenance	$ 1,761.00	$ 1,761.00	0%	$ 11,720.00	$ 11,720.00	0%
Delivery/Installation	$ 5,520.00	$ 5,520.00	0%	$ 181.00	$ 181.00	0%
Total	$ 90,551.00	$ 60,946.00	33%	$103,431.00	$ 56,005.00	46%
District Budget		$ 44,000.00			$ 44,000.00	
Over Budget		$ 16,946.00	39%		$ 12,005.00	27%
Delivery		60-90 Days			90 Days	

TABLE 3 - COMPONENT SPECIFICATIONS

HARDWARE

COMPONENT	RFP SPECIFICATIONS	ESRI	INTERGRAPH
BACKUP DEVICES			
	150 MB SCSI 1/4" Tape	150 MB 1/4"	150 MB 1/4"
	COST	$1,700.00	$1,300.00
INPUT / INTERFACE DEVICES			
CD-ROM (optional)		644 MB	600 MB
	COST	$995.00	$650.00
Digitizers	COST	$6,084.00	$7,000.00
			$1,500.00 controller
	16 Button - Free Floating Cursor	16 button	12 button
	36" x 48"	36" x 48"	36" x 48"
	+/- .005" Accuracy	+/- .005"	+/- .003"
	Backlit (optional)	non-backlit	non-backlit
Serial Interface	Network Compatible	Controller	Multiplexer
	COST	$900.00	$2,500.00
OPERATING SYSTEM			
	4.3/4.2 BSD or AT&T System V	no spec.	no spec.
	Compilers	C,C++,Fortran	
	Network Interface Protocol		NFS
OUTPUT DEVICES			
Printer/Plotter	Color Ink-Jet w/ Drivers	no spec.	Design Jet 650C
	COST		$8,995.00
	24" Wide		E size
	300 DPI		300 DPI
		Thermal Wax	Paint Jet
	COST	$6,995.00	$4,100.00
		B size	B size
		300 DPI	300 DPI
	Pen Plotter	CalComp	DraftPro
	COST	$5,995.00	$5,995.00
	8 Pen	8 Pen	8 Pen
	Drum or Flatbed	Flatbed	Flatbed

	34" Wide	E size	E size
	Electrostatic (optional)		
	COST		$42,000
WORKSTATION COMPONENTS			
CPU		Sun Sparc10	IP 2430
	COST	$18,995.00	$6,000.00
	32 MB RAM up to 250 MB	32 MB	32 MB
	Disk (see below)	1.05 GB	426 MB
	25 MIP or 20 SPECmarks	101.6 MIP	33 SPEC 36 MIP
	Ethernet compatible		15 Pin AUI I/F
Disk Storage	800 MB up to 7 GB (Internal and external combined)		
	internal (included in CPU cost)	1.05 GB	426 MB
	external		1 GB
	COST		$2,000.00
Monitor & Terminal	16" High Resolution	16"	19" single
	1152 x 900		1184 x 884

SOFTWARE

COMPONENT	**RFP SPECIFICATIONS**	**VENDOR PACKAGE / COST**	
ESRI			
Basic GIS		ARC/INFO	$18,000.00
Conversion		ARC/INFO	
SQL RDBM (optional)			
Analysis		ARC/INFO	
Modeling		TIN	$ 2,550.00
		GRID	$ 2,550.00
Indexing		ARC/INFO	
Reports		ARC/INFO	
Networking			
Georeferencing		COGO	$ 2,550.00
MISCELLANEOUS			
Training		Intro to ARC/INFO - 5 days	
		2 @ $1,500.00	$ 3,000.00
		Customizing w/ AML - 5 days	
		2 @ $1,500.00	$ 3,000.00

	OPTIONAL (price excluded)	Advanced ARC/INFO - 5 days	
		1 @ $ 1,500.00	$ 1,500.00
		Using GRID - 5 days	
		1 @ $ 1,500.00	$ 1,500.00
		TIN & COGO - 2 days	
		1 @ $ 600.00	$ 600.00
Software Installation			$ 2,500.00
Shipping			$ 35.00
Options (price excluded)		ARC View	$ 995.00
		Sub-total	**$34,185.00**
		Less Discount	**$14,800.00**
		Total	**$19,385.00**

COMPONENT	RFP SPECIFICATIONS	VENDOR PACKAGE / COST	
INTERGRAPH			
Basic GIS		MicroStation 32	$ 3,450.00
		MGE Nucleus	$ 7,000.00
		MGE ASCII Loader	$ 2,000.00
Conversion		MGE Projection	$ 5,000.00
		MGE GIS Translator	$ 3,000.00
SQL RDBM (optional)		Informix Engine	$ 1,800.00
		RIS UNIX Informix	$ 200.00
Analysis		MGE Analyst	$ 5,000.00
Modeling		MGE Terrain Model	$ 5,000.00
Indexing			
Hard Copies		MGE Raster Editor	$ 4,000.00
		IP Metafile Interpret	$ 5,000.00
Networking		NFS	$ 500.00
		Sub-total	**$41,950.00**
MISCELLANEOUS			
Training		2 @ $ 4,500.00	$ 9,000.00
		5 days	
Software Installation			$ 0.00
Shipping			$ 35.00

Sub-total	**$51,131.00**
Less Discount	**$26,434.70**
Total	**$24,696.27**

TABLE 4 - BENCH TEST RESULTS

ESRI - Friday, February 5, 1994, 9:00AM - 6:00PM

General Comment: ESRI had prepared a comprehensive demonstration based on the routines we said we wanted to see. When they found out we had designed a bench test of our own, they scrapped the original demo and were quite receptive to the idea of performing our tasks with the data we had supplied. The technicians were knowledgeable and were able to articulate the processes they were invoking to complete the requested routines. The test went quite well and was conducted in a professional manner. What difficulties they did encounter, they explained and had the perseverance to work them out. Recent software revisions have provided pull-down menus and "point and click" functionality. This has created a very user friendly interface with speed and access ARC/INFO users have not had before.

A. PC ARC/INFO Coverages Supplied to ESRI

1. AREA
2. COUNTY
3. DISTSHD
4. FAULTS
5. HYDRO
6. KARSTICS
7. ROADSA
8. WELLS

Comment: All covers displayed properly and were georeferenced.

B. FileMaker Pro and ASCII Text Databases (MAC)

1. Water Quality Information - File Maker Pro (.DAT)
    a. >10/1/91
    b. <10/1/91
2. Water Quality Information - ASCII (.TXT)
    a. >10/1/91
    b. <10/1/91

Comment: Only the ASCII text files were needed -- the Mac files could have been loaded via the inter-office network. They were able to overcome minor configuration and naming convention problems quite rapidly.

C. Laptop Data

1. Monitor Wells
2. Weather Data
3. GPS Data

Comment: Data from Shawn's disks were imported without incident. They were able to create a hardware link with the laptop quite fast and subsequently downloaded data into the UNIX box. Comma delimited ASCII files (CSV) appeared to be the most rapidly converted format.

Bench Test Questions and Routines

1. Explain the process of preparing for this Bench Test.

a. How did you import our data?
b. How long did the process take?
c. Identify any problems encountered and your solution (e.g. - Septic, Sources, Sewer).

Comment: Points were sufficiently addressed.

2. Create a new cover from each of the new water quantity/quality database files. Name them WELLS2, WELLS3, WELLS4, WELLS5.
   a. Display parameter changes between WELLS and WELLS2.
   b. Display parameter changes between WELLS2 and WELLS3.
      1. Draw isolines that represent 5' changes in WATER_LEVEL.
      2. Display wells that indicated an increase in Conductivity >20 µ/cm.
      3. Graph the solutions.
      4. Compare and contrast analysis between sampling events for Sulfates and Nitrates.
      5. Display all wells that show an increase in concentration levels for the above parameters with a graduated symbology.

Comment: In general, each task was addressed sufficiently. They offered better alternatives that creating individual covers for each dataset. Their solution to querying the system was to reference the datasets and generate the information through the INFO side. The datasets we wanted to query were configured in text format, not integer format -- our problem. The demo they were able to produce showed the system functionality. This will certainly be an important function of our system, and I'm satisfied that the functionality for these routines is adequate.

3. Buffer all wells 150' and display where any of the buffered areas overlap.

Comment: Easily accomplished.

4. Clip COUNTY with AREA to produce a new coverage named AREA2.

Comment: Easily accomplished.

5. Extract Hays County from COUNTY to create HAYS1.

Comment: Easily accomplished. They performed the task different ly than I had envisioned. They extracted the County coverage from the database rather than through graphic -- an easier solution than mine.

6. Clip HYDRO with HAYS1 to create HYDRO1.

Comment: Easily accomplished.

7. Buffer FAULTS 150' and KARSTICS 150' and merge the two covers into a file called GEO1.

Comment: Easily accomplished.

8. Overlay HAYS1 with GEO1 to define karstic areas in Hays County. Create a new cover from the union of these two files called HAYS2.

Comment: Easily accomplished.

9. Display ROADSA
   a. Clip ROADSA with AREA2 to create ROADS2.
   b. Design an aesthetically pleasing map.
      - Header
      - Legend
      - Border
      - Date
      - Scale
      - North Arrow
   c. Generate a 24" x 32" color hardcopy of ROADS2 on two separate devices.
      - 8-pen plotter
      - Ink jet printer

Comment: They encountered several apparent problems in map-making. We discovered that maps were more easily generated in ARC VIEW 2 than in ARC TOOLS. The plotter problems could be attributed to the lack of familiarity with the hardware. Maps were sent Federal Express the following Tuesday and were high quality outputs.

10. Export ROADS2 to the following storage medium.
    a. 3.5" diskette
    b. 1/4" tape
    c. 4 or 8 mm cassette
    d. 9 mm reel-to-reel

Comment: The only storage devices they had networked were the 3.5" disk drive and a 4 mm tape. Storage and retrieval was routine.

11. Import ROADS2 from each of these different devices.

Comment: Easily accomplished.

12. Import water level data directly from the laptop.

Comment: Easily accomplished after the hardware link.

13. Import GPS data from both the laptop and the diskette.
    a. import GPS data in DXF and ARC/INFO formats.
    b. derive an average 2D or 3D location for each set of GPS data.
    c. import weather station data and link to weather station location.
    d. chart or graph rainfall data and water level data (obtained from the laptop) and draw any correlations between the two.
    e. perform this same routine for barometric pressure.

Comment: Easily accomplished.

14. What-If Scenarios?

1. a. an oil spill has occurred in a pipeline at Slaughter Lane between FM 1826 and South Loop 1. Spill amounts and plume directions are unknown.
   b. which wells/features will be effected within a 1-mile radius.
2. a. a hydrogeological report is to be completed for Cimmaron Park Well #2.
   b. all well owners within a 2 mile radius must be notified.
   c. highlight these wells and print a tabular list of all well owners, phone numbers and addresses.

Comment: These routines virtually replicated the tasks performed during the earlier demonstration. We moved on to the 3d model and the plotting routine due to time constraints -- I was confident that what I had seen earlier was sufficient to allow the bypass of this scenario.

15. Request demonstration of a pre-packaged 3-D model.

Comment: The aquifer demonstration was quite impressive. It was interactive and could display graphically the changes made to the corresponding database. The visual representation of the surface and subsurface characteristics were very high quality and represented the ability of the system to complete the tasks we will want for the BS/EACD.

TABLE 5 - BS/EACD GIS CONFIGURATION (Pursuant to ESRI Contract No. 94S0524)

ESRI Software

1. ARC/INFO
2. NETWORK
3. TIN
4. COGO
5. GRID
6. ArcView2 for Sun-4
7. ArcView2 for Windows
8. ArcView2 for Macintosh

ESRI Training

1. Introduction to ARC/INFO (5 days - 2 persons)
2. Advanced ARC/INFO (5 days - 2 persons)
3. Customizing ARC/INFO with AML (5 days - 2 persons)
4. Using GRID with ARC/INFO (5 days - 2 persons)

Hardware

1. Sun SPARCstation 20 Model 50
2. Sun USA Country Kit
3. Sun Serial Port Splitter
4. Sun Centronics Compatible Parallel Adapter Cable
5. Sun Audio/AUI Adapter Cable
6. Sun Desktop Disk Pack - 1.05 External Hard Drive, CD ROM, 4mm Tape Drive
7. Sun Solaris Media Kit
8. Sun SPARC NeWSprinter 20
9. CalComp Drawingboard III
10. HP DesignJet 650C

Sun Training

1. Fundamentals of Solaris (Video/Workbook)
2. Open Windows for Users (Video/Workbook)

TABLE 6 - BSEACD GIS Pilot Project Design - Wells/WQ Database

I. Feature Attribute Table Items

ITEM NAME	INPUT WIDTH	OUTP WIDTH	DATA TYPE	DEC PLACE	PRESENTATION
1. Basic Attributes for **Wells.PAT**					
State Well Number	11	11	C		NN-NN-NNN
Owner (Name)	30	30	C		*Last, First MI or Commercial - Company Name*
Well Location	4	4	C		XN *(50" grid ID)*
Latitude	7	7	I		NNNNNN
Longitude	7	7	I		NNNNNN
Elevation	7	7	N	2	NNNN.NN
County	10	10	C		*County Name*
Classification	15	15	C		*See: III. Classification*
2. Administration Attributes for **Permit.DAT**					
State Well Number	11	11	C		NN-NN-NNN
Permit Number	10	10	C		YY-NNN-NN
Contact Name	30	30	C		*Last, First MI*
Contact Phone	13	13	C		NNN-NNN-NNNN
Emergency Phone	13	13	C		NNN-NNN-NNNN
* Street Number	5	5	I		NNNNN
* Street Name	30	30	C		*Street Name*
* Suite Number	5	5	C		NNNNN
* City	10	10	C		*City*
* State	2	2	C		TX
* Zip Code	10	10	I		NNNNN-NNNN
Mailing Address	90	90	C		*includes above 6 * items*
Permit Pumpage	9	9	I		NNNNNNNNN
Annual Pumpage	9	9	I		NNNNNNNNN
Permit Period	8	8	D		DD/MM/YY
Number of Wells	2	2	I		NN
3. Physical Attribute 1 for **Log.DAT**					
State Well Number	11	11	C		NN-NN-NNN

Date Drilled	8	8	D		DD/MM/YY
Driller	40	40	C		*Last, First MI, Company Name*
Well Depth	7	7	N	2	NNNN.NN *(feet)*
Well Bore Diameter	4	4	N	1	NN.N *(inches)*
Casing Height	3	3	N	1	N.N *(feet)*
Casing Diameter	5	5	C		N N/N *(inches)*
Casing Depth	5	5	N	1	NNN.N *(feet)*
Pump Setting	5	5	N	1	NNN.N *(feet)*
Pumping Rate	4	4	I		NNNN *(GPM)*
Operating Pressure	3	3	I		NNN *(PSI)*
E-line Access	1	1	C		Y, N
Airline	1	1	C		Y, N
Sampling Spigot	1	1	C		Y, N
Available Log	20	20	C		*See IV. Available Well Logs*
Photos	1	1	C		Y, N

4. Physical Attributes 2 for **Inspect.DAT** (temporal sequence)

State Well Number	11	11	C		NN-NN-NNN
Date of Inspection	8	8	D		DD/MM/YY
Inspector	3	3	C		XXX *(First,Middle,Last initials)*
Meter Reading	9	9	I		NNNNNNNNN
Serial Number	9	9	C		*NNN-XXX*

5. Water Level Attributes for **Level.DAT** (temporal sequence)

State Well Number	11	11	C		NN-NN-NNN
Water Level	6	6	N	2	NNN.NN *(Above MSL)*
Date of the Level	8	8	D		DD/MM/YY
Depth to Water	6	6	N	2	NNN.NN *(From TOC)*

6. Water Quality Attributes 1 for **Inlab.DAT** (temporal sequence)

State Well Number	11	11	C		NN-NN-NNN
Sample Date	8	8	D		DD/MM/YY
Sample Time	4	4	I		NNNN *(Military Time)*
Sampled By	3	3	C		XXX *(First,Middle,Last initials)*
Sample Purpose	3	3	C		XXX *(See: V. Sampling Purposes*

Test Date	8	8	D		DD/MM/YY
Tested By	3	3	C		XXX *(First,Middle,Last initials)*
Alkalinity	3	3	I		NNN *(mg/L)*
Chloride	6	6	N	2	NNN.NN *(mg/L)*
Conductivity	5	5	I		NNNNN *(microSemeins/cm)*
Dissolved Oxygen	5	5	N	2	NNNNN *(mg/L)*
E. Coli	4	4	I		+, -
Fecal Coliform	1	1	C		+, -
Fluoride	5	5	N	2	NN.NN *(mg/L)*
Iron	4	4	N	2	NN.NN *(mg/L)*
Nitrate	5	5	N	1	NNN.N *(mg/L)*
pH	4	4	N	2	N.NN
Sulfate	6	6	N	1	NNNN.N *(mg/L)*
Total Coliform	1	1	C		+, -
Temperature	4	4	N	1	NN.N (°C)
Turbidity	4	4	I		NNNN *(NTU)*

7. Water Quality Attribute 2 for **Outlab.DAT** (temporal sequence)

State Well Number	11	11	C		NN-NN-NNN
Lab	3	3	C		XXX *(See: Lab Names)*
Sample Date	8	8	D		DD/MM/YY
Sampled By	3	3	C		XXX *(First,Middle,Last initials)*
Sample Purpose	3	3	C		XXX *(See: V. Purposes)*
Ammonia Nitrogen	4	4	N	2	N.NN *(mg/L)*
Benzene	6	6	N	2	NNN.NN *(mg/L)*
$CaCO_3$	4	4	I	1	NNN.N *(mg/L)*
Chloride	5	5	N	1	NNN.N *(mg/L)*
Dissolved Calcium	5	5	N	2	NNN.NN *(mg/L)*
Dissolved Magnesium	4	4	N	1	NN.N *(mg/L)*
Dissolved Potassium	5	5	N	2	NN.NN *(mg/L)*
Dissolved Selenium	5	5	N	3	N.NNN *(mg/L)*
Ethylbenzene	6	6	N	2	NNN.NN *(mg/L)*
Fecal Coliform	6	6	I		NNNNNN *(colonies/100ml)*
Fecal Strep	6	6	I		NNNNNN *(colonies/100ml)*
Fluoride	5	5	N	2	NN.NN *(mg/L)*

Gross Alpha	4	4	N	2	N.NN *(pCi/L)*
HCO_3	4	4	I	1	NNN.N *(mg/L)*
Kjeldahl Nitrogen	4	4	N	2	N.NN *(mg/L)*
Nitrate Nitrogen	5	5	N	2	NN.NN *(mg/L)*
Nitrite Nitrogen	5	5	N	3	N.NNN *(mg/L)*
Oil/Grease	6	6	N	2	NNN.NN *(mg/L)*
Ortho Phosphorous	4	4	N	2	N.NN *(mg/L)*
Silica	4	4	N	1	NN.N *(mg/L)*
Sulfate	3	3	N	1	N.N *(mg/L)*
Suspended Solids	4	4	N	1	NN.N *(mg/L)*
Toluene	6	6	N	2	NNN.NN *(mg/L)*
Total Aluminum	6	6	N	4	N.NNNN *(mg/L)*
Total Arsenic	7	7	N	5	N.NNNNN *(mg/L)*
Total Barium	4	4	N	2	N.NN *(mg/L)*
Total Boron	4	4	N	2	N.NN *(mg/L)*
Total Cadmium	6	6	N	1	NNNN.N *(mg/L)*
Total Chromium	5	5	N	3	N.NNN *(mg/L)*
Total Coliform	6	6	I		NNNNNN *(colonies/100ml)*
Total Copper	5	5	N	3	N.NNN *(mg/L)*
Total Dissolved Solids	6	6	N	2	NNN.NN *(mg/L)*
Total Hardness	4	4	I	1	NNN.N *(mg/L)*
Total Iron	3	3	N	2	N.NN *(mg/L)*
Total Lead	6	6	N	4	N.NNNN *(mg/L)*
Total Manganese	4	4	N	2	N.NN *(mg/L)*
Total Mercury	6	6	N	4	N.NNNN *(mg/L)*
Total Organic Carbon	5	5	N	2	NN.NN *(mg/L)*
Tot_Petro_Hydrocarbon	6	6	N	2	NNN.NN *(mg/L)*
Total Phosphate	5	5	N	3	N.NNN *(mg/L)*
Total Silver	5	5	N	3	N.NNN *(mg/L)*
Total Sodium	6	6	N	2	NNN.NN *(mg/L)*
Total Strontium	5	5	N	2	NN.NN *(mg/L)*
Total Zinc	5	5	N	3	N.NNN *(mg/L)*
Xylene	6	6	N	2	NNN.NN *(mg/L)*

NOTE:

.PAT, for Point Attribute Table, is an attribute table for the point feature coverage, such as Wells.
.DAT, for Data Attribute Table, is a regular data table which will be linked to the .PAT.
DATA TYPE:

C -- Character
D -- Date
I -- Integer
N -- Number

II. Attribute Table Descriptions

The Basic Attribute Table (**Wells.PAT**) contains information that is fixed or will only change occasionally.

The Administration Attributes Table (**Permit.DAT**) is for permitted well information. Some items in the table will change. Since the data may be renewed on an annual basis, the data will be arranged into annual tables so as to keep track of historical data.

The Physical Attribute Table 1 (**Log.DAT**) contains the well data that will rarely change.

The Physical Attribute Table 2 (**Inspect.DAT**) contains data from inspections. The data may be updated occasionally; therefore, this table will also be organized by year.

Water Quality Attribute 1 (**Inlab.DAT**) and Water Quality Attribute 2 (**Outlab.DAT**) contain temporal data. A new record will be created for each new sampling event. Therefore, for each State Well Number, there will be multiple entries -- each one representing an individual sample.

All the tables have a same item "State Well Number". The State Well Number will be used to link all the tables together.

III. Classification: Water Usage/Well Types

ABD -- **AB**an**D**oned well
AGR -- **AGR**icultural water supply
CAV -- **CAV**e
CLP -- Closed Loo**P**
COM -- **COM**mercial water supply
CDM -- Commercial **D**o**M**estic water supply
DOM -- **DOM**estic water supply
EXE -- **EXE**mpt well
IND -- **IND**ustrial water supply
IRR -- **IRR**igation water supply
PLG -- **PL**u**G**ged well
PWS -- Public Water Supply
SPG -- **SPR**ing
UNU -- **UNU**sed well
CMW -- Commercial Monitor Well
DMW -- District Monitor Well
UMW -- USGS Monitor Well

IV. Available Well Logs

Geophysical Logs

- **GR** -- Gamma Ray
- **GG** -- Gamma Gamma
- **NU** -- Neutron
- **RS** -- Resistivity
- **SP** -- Spontaneous Potential
- **SV** -- Sonic Velocity
- **TP** -- Temperature
- **CA** -- Caliper

Other Logs

- **DL** -- Drillers Log
- **TV** -- Downhole Camera
- **DG** -- Depth Gauged
- **PL** -- Plug Log

V. Sampling Purposes

- **WB** - TWDB Grant Samples
- **WQ** - Water Quality Assessment
- **WI** - Well Inspection
- **GL** - Geophysical Logging
- **BS** - Biological Sampling
- **WL** - Water Level Measurement
- **DT** - Dye Trace

VI. Lab Names

- **LCR** - LCRA - Lower Colorado River Authority
- **EAR** - EARDC - Edwards Aquifer Research and Data Center
- **AMT** -AMT - Applied Microbial Technology
- **NET** - NET - National Environmental Testing