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Spatial Technologies Assessing Rural Septic Systems

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Spatial Technologies Assessing Rural Septic Systems

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- Student work by Venu Kanaparthy and Katy Wright

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Abstract

Many Mississippi residents depend on septic systems to dispose of household waste water. Septic system failure is particularly a problem in rural areas. The Spatial Technologies Assessing Rural Septic Systems (STARSS) project is developing technologies to locate and map these systems and related problems using mobile computing, field mapping, and GIS technologies.

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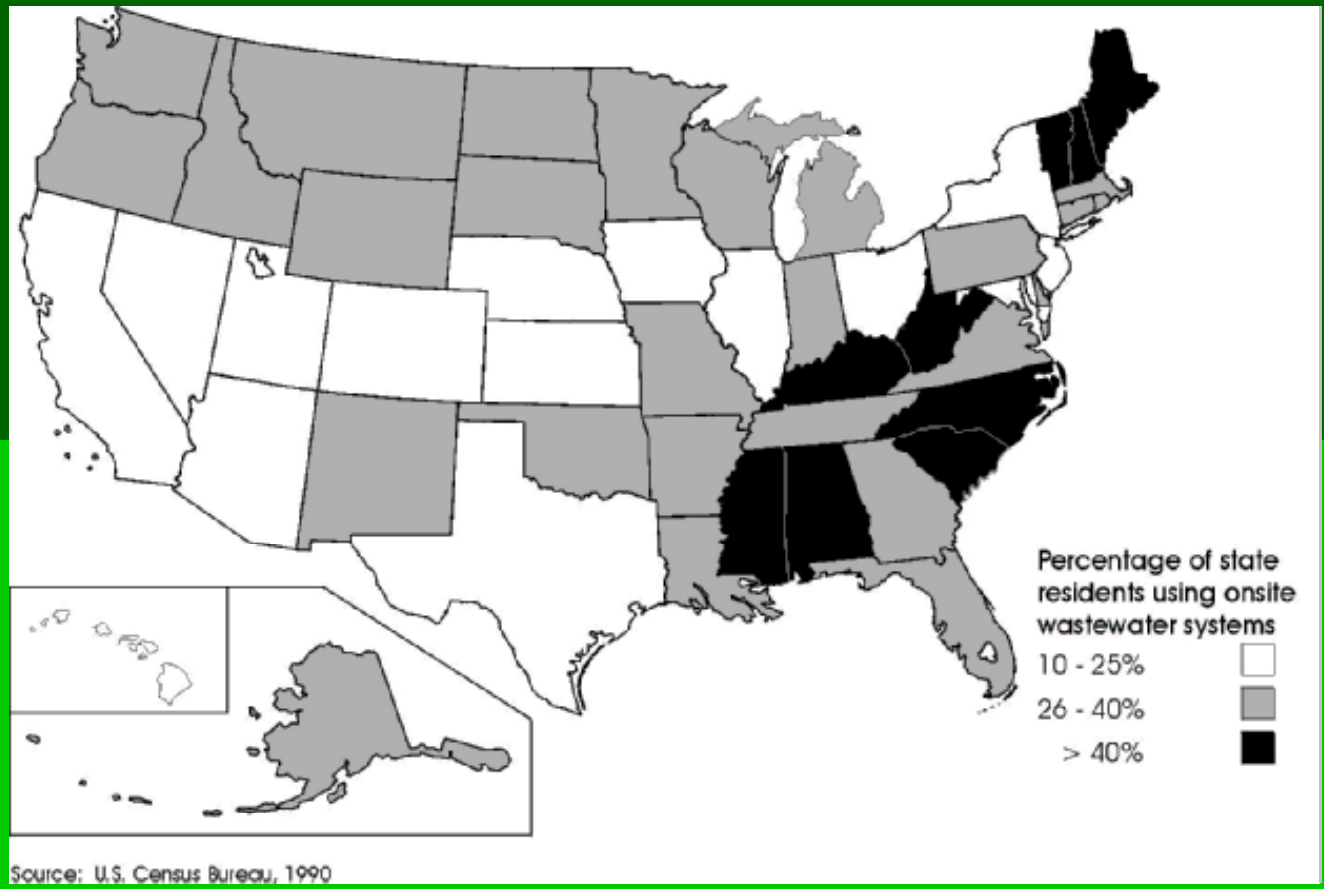
Onsite Treatment Systems in the United States



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Poorly Maintained Septic Systems: A National Water Quality Issue

In the National Water Quality Inventory, 1996 Report to Congress, state agencies designated the top ten potential contaminant sources which threaten their ground water resources. The second most frequently cited source is septic systems. The report states that "improperly constructed and poorly maintained septic systems are believed to cause substantial and widespread nutrient and microbial contamination to ground water."

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Purpose of STARSS

In many cases the locations of rural septic systems are poorly mapped and documented. The STARSS pilot project effort will develop a GIS/GPS field application for septic system mapping, inspection, and fault reporting. The intended product is a simple, user friendly, portable application to help locate and map septic systems.

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Proposed Solution

New technologies are available for developing easy-to-use, inexpensive, portable applications that can be used for field mapping, GPS, and GIS integration. This application will allow field personnel to accurately locate, map, and provide attribute information for septic facilities and/or to map locations where problems exist.

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Overall Objective

To develop a custom application that integrates hand held PDA technology, GPS, and GIS software for mapping septic facilities in selected rural areas.

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STARSS Application

The application will leverage PDA, GIS, and GPS technologies, will integrate selected basemap information, and will have custom menus and interfaces that meet user needs.

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Beginning the STARSS Project
Phase 1

State agencies, stakeholders, extension personnel, and researchers met to discuss the project and select locations for collaborative work. For areas selected, geospatial data will be compiled for use as basemap layers. PDA and GPS equipment have been acquired for use in the project. An application framework design was developed through user and data needs assessment.

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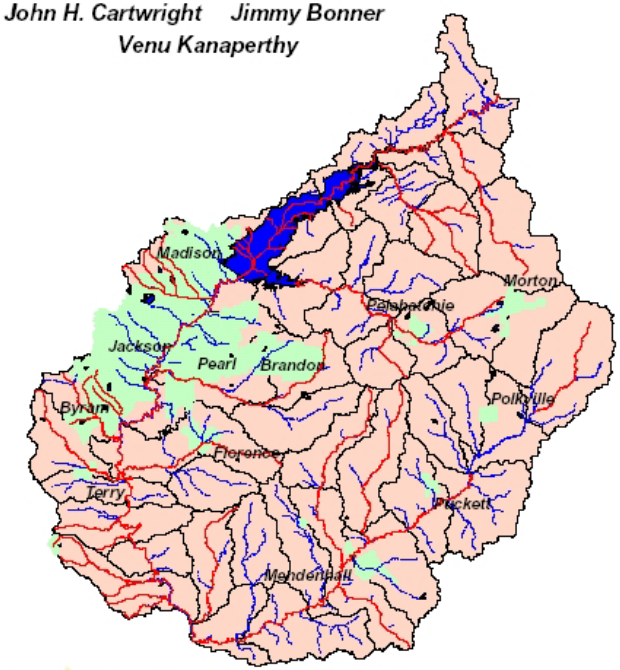
Location Planning

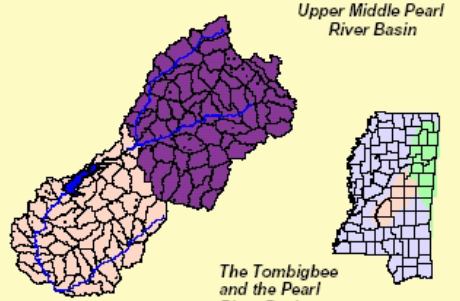
STARSS Team:

Dr. Chuck O'Hara Katy Wright
John H. Cartwright Jimmy Bonner
Venu Kanaperthy

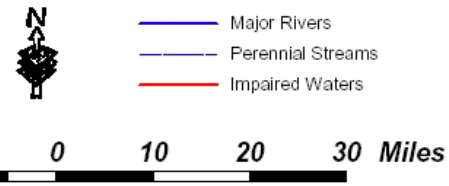
Pearl River Basin Pilot



Location



Upper Middle Pearl Watershed



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Map prepared by Katy Wright and John Cartwright.

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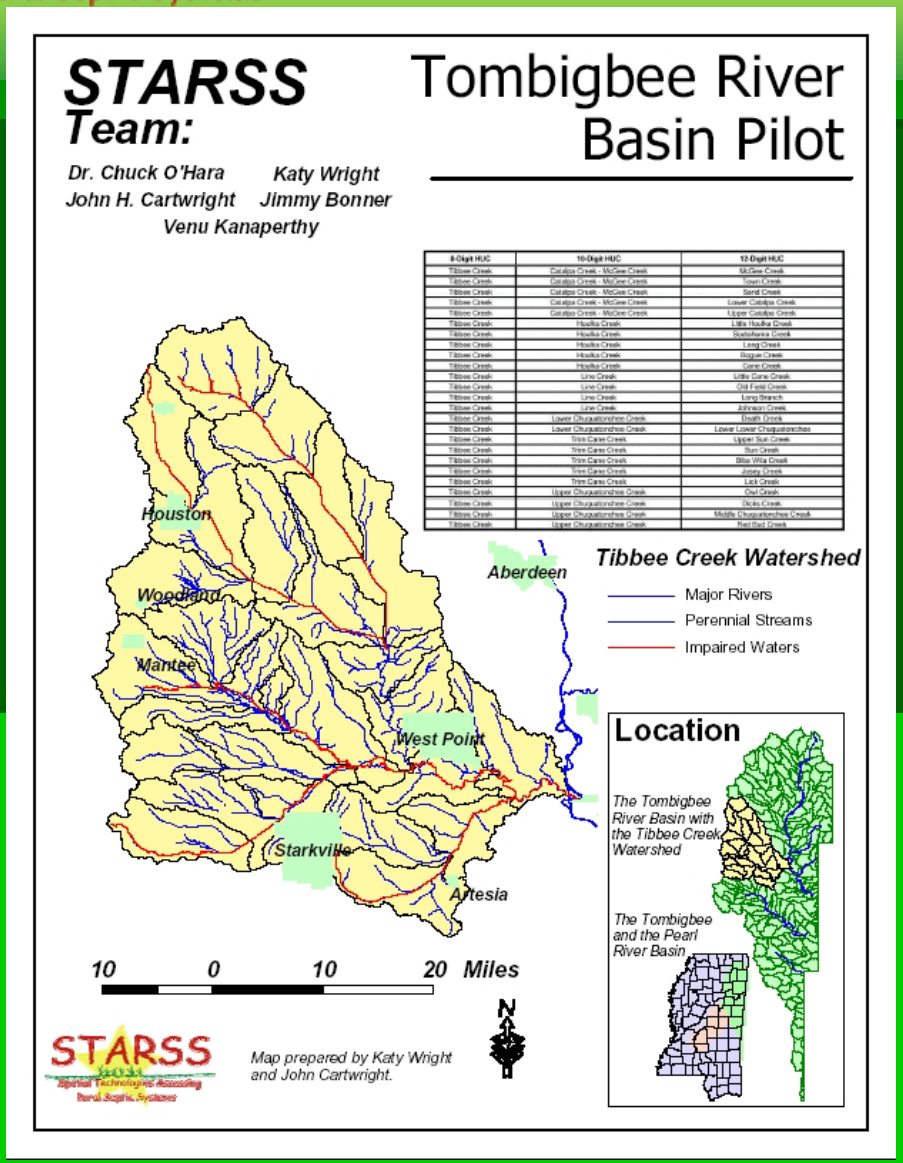
Location Planning



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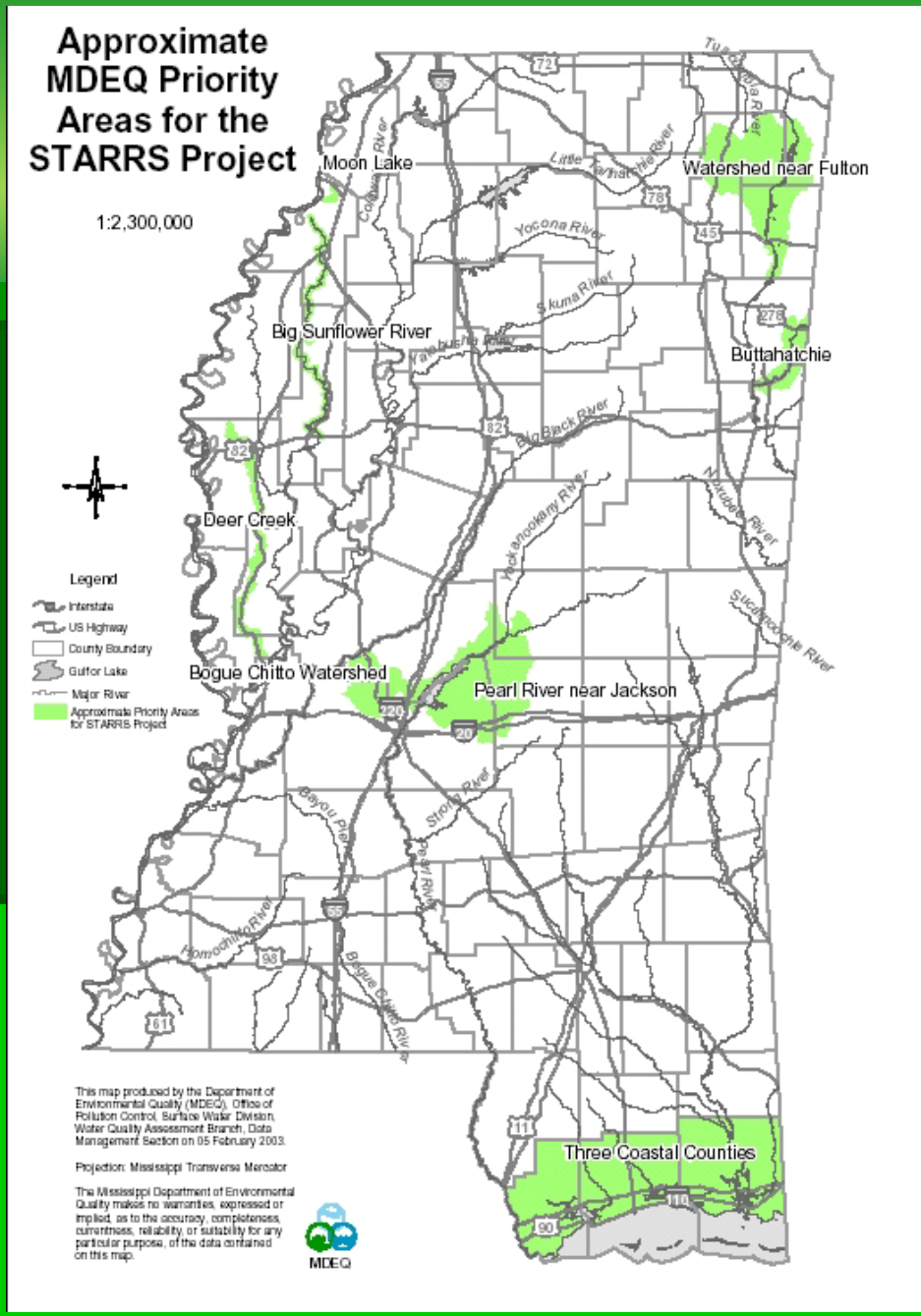
MS DEQ Priorities

- Buttahatchie
- Fulton
- Pearl River
- Bogue Chitto
- Coastal Counties



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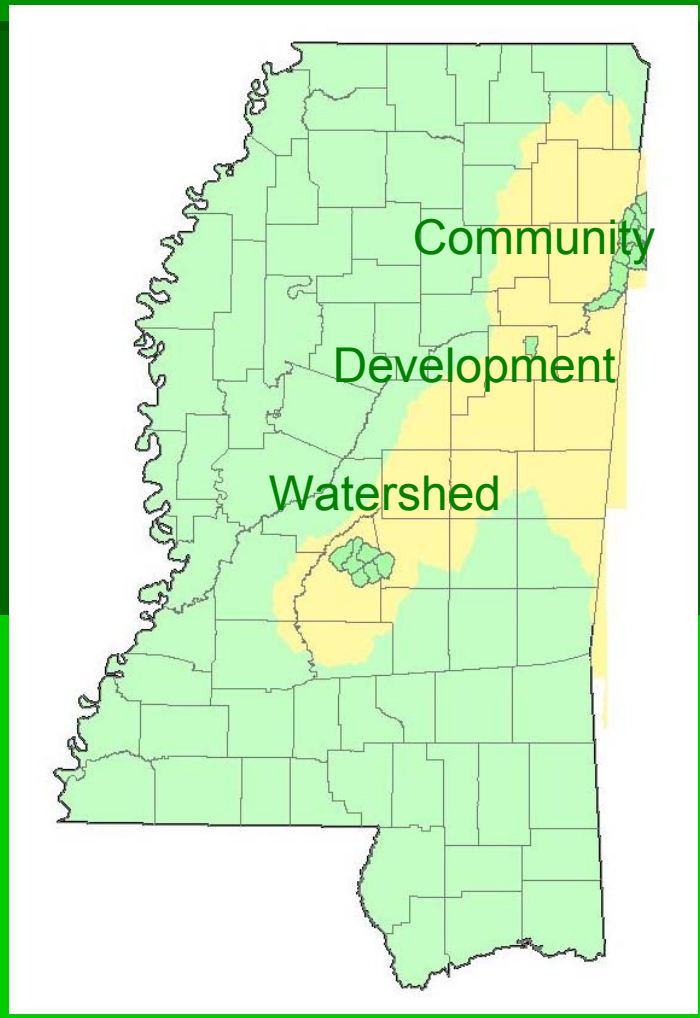
During early stakeholder meetings, multiple scales of study were discussed including watershed, community, and development. Pilot sites were selected for each scale:

Watershed Scale – Pelahatchie Creek and the Pearl River

Community Scale – Caledonia in the Buttahatchie River watershed

Development Scale – Selected small developments in the vicinity of Starkville



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Phase 2

User and data needs were compiled and used to develop application requirements. A prototype is being developed and tested. Based upon testing and input from users, application requirements will be modified and incorporated into the application design.

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Phase 3

Data are being compiled for selected areas and the application will be field tested. Feedback on usability and overall effectiveness of the application will be used to generate a list of final modification requirements.

Complaint and Inspection Work Flow Requirements

Tasks	Data needed	Function needed
•Input customer address, parcel information (housing type, zoning, occupant name) and complaint history	• Parcels layer • Complaints table • Occupants table	Query for parcel info and get complaints history at the current address.
•Input parcel code and output features (such as sewerlines, manholes, meters) near the parcels.	• Sewer layers (sewerlines , manholes, meters)	Query for sewer features near the parcel and return the features.
• Input sewer features and output feature characteristics.	• Sewer features characteristics table	Query sewer characteristics for a feature
• Redline (select) features to be inspected in the field and create work order	•Sewer layers (sewerlines , manholes, meters)	Save redlined features ID and attribute information.
•Input field operator name in mobile client and output work order.	•Sewer layers (sewerlines , manholes, meters) along with redlined features	Query work order and download tasks and support data (spatial) required to mobile device
• Post completed work order and output the updated status.	• Updated features •(sewerlines, maholes) in field	Update the edited features (in field) to geodatabase.

STARSS Component Features

Server – GeoTools

- Uses Open Source software – GeoTools.
- Supports retrieving spatial data using WKB (Well Known Binary) format.
- Supports creating and rendering ESRI shapefiles.
- Does not limit clients (desktop & mobile) and server to a programming language or development platform or location.
- Data exchanged between client and server components is in XML format and can be converted to desired format.

Desktop Client – VB

- Query and view spatial data.
- Create/update work orders.
- Redline features for inspection in field.
- Modify spatial data.

Mobile Client – Arcpad

- Query and view work orders and spatial data.
- Modify and transport updates to geodatabase.

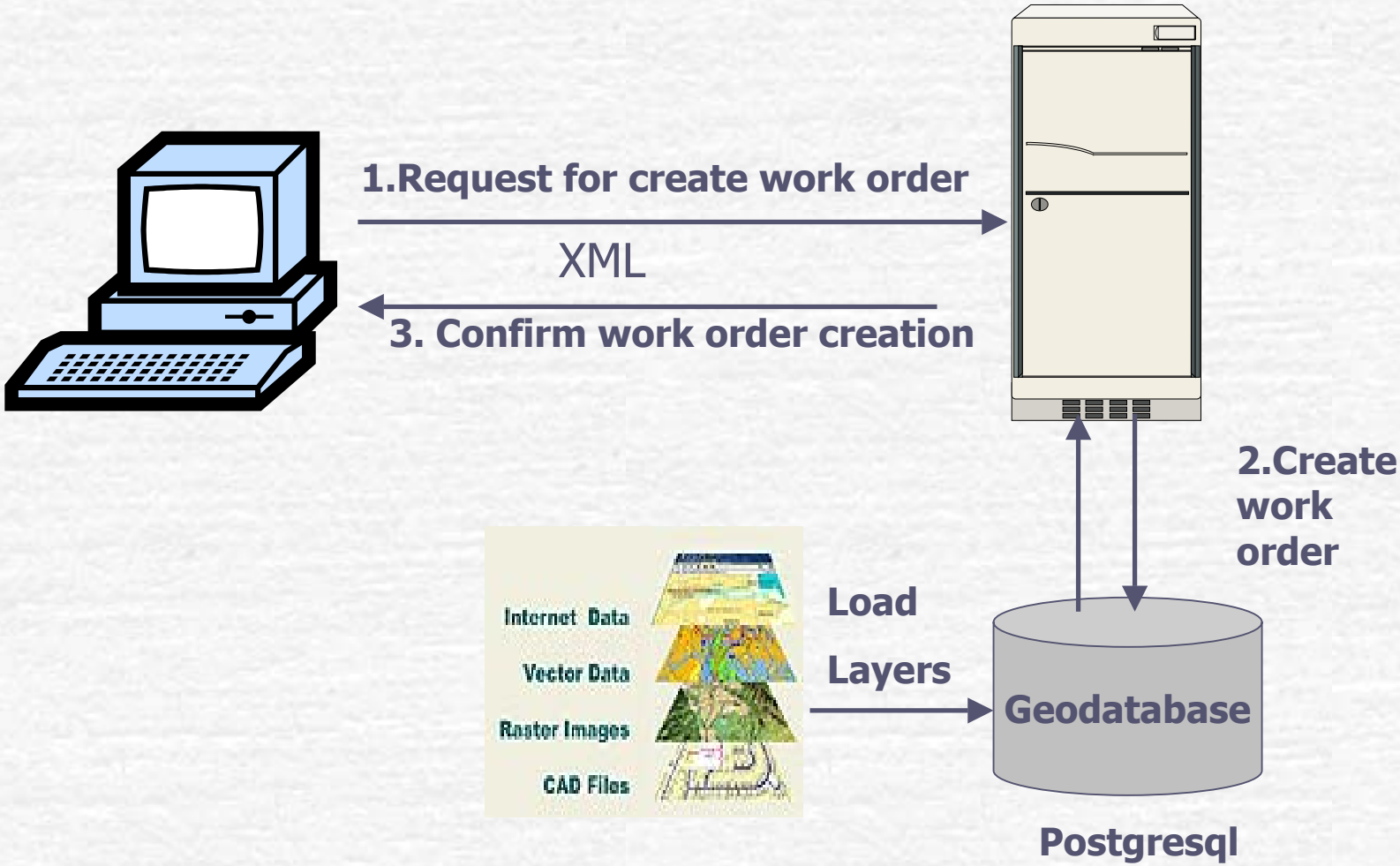
Database - Postgresql

- Uses open source geodatabase.
- Supports storing, retrieving and updating spatial data.
- Supports spatial queries (buffer, intersect).
- Performance comparable to Oracle.
- Can be accessed over ODBC (Visual basic clients) and JDBC (Java clients).

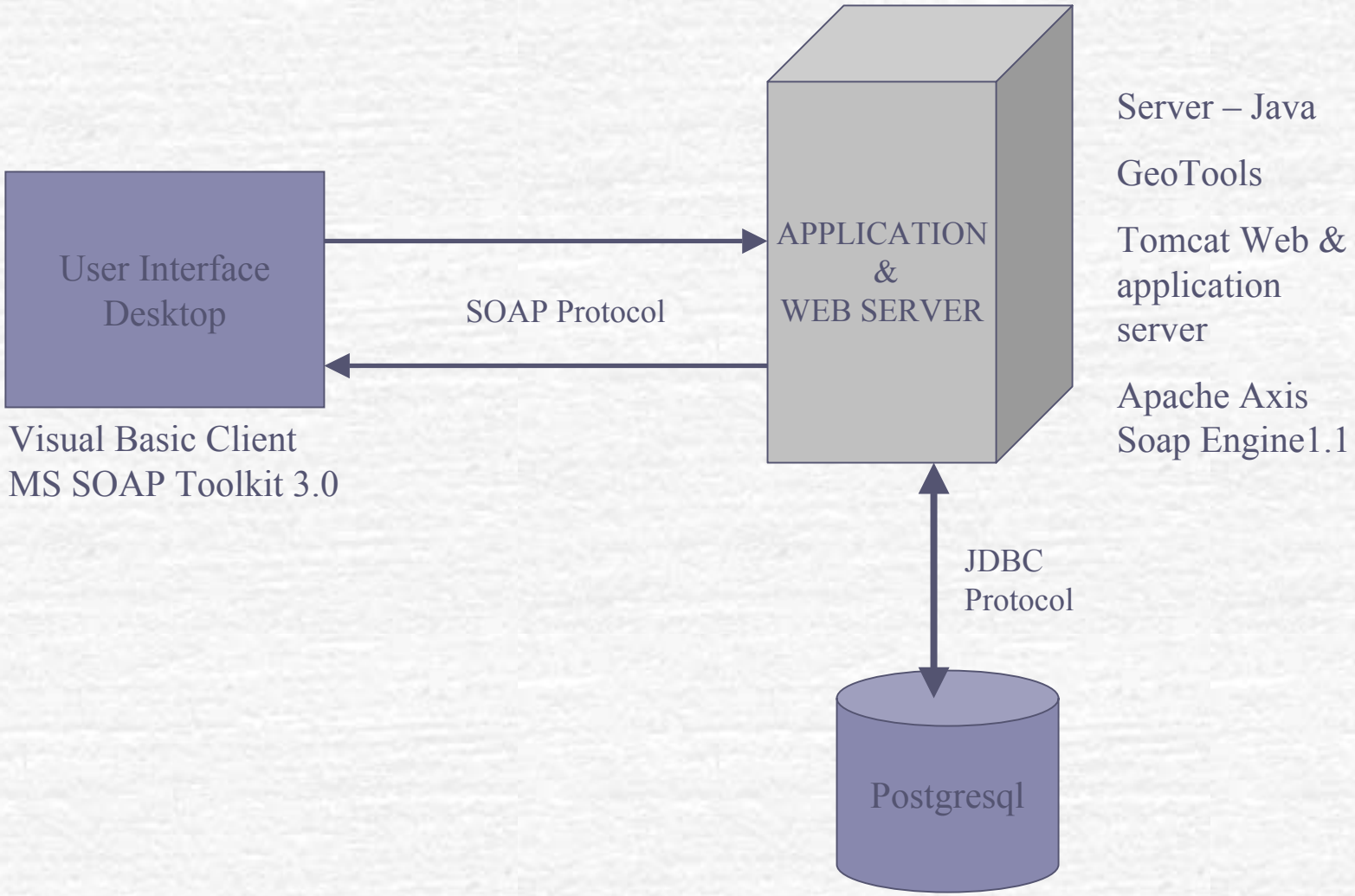
Data Model

- ESRI Water Utilities Model for representing features
- ESRI model extended (with work management model).

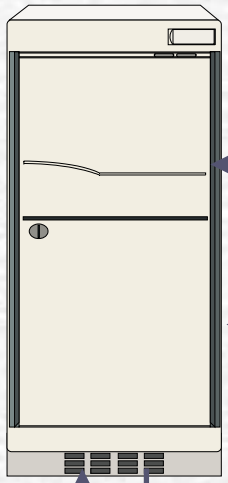
Work Flow from Desktop to Geodatabase



Data flow from desktop client to the database

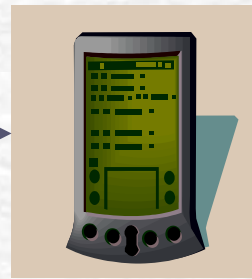


Work Flow from Mobile to Geodatabase



1. query work order

4. download work order



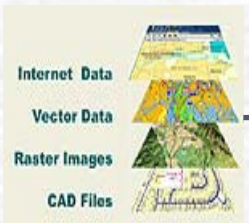
2.Query work orders

3. Package support data

6. submit completed work

5. Complete work order in field (viewing and editing spatial data)

7. Update (changes to spatial data)

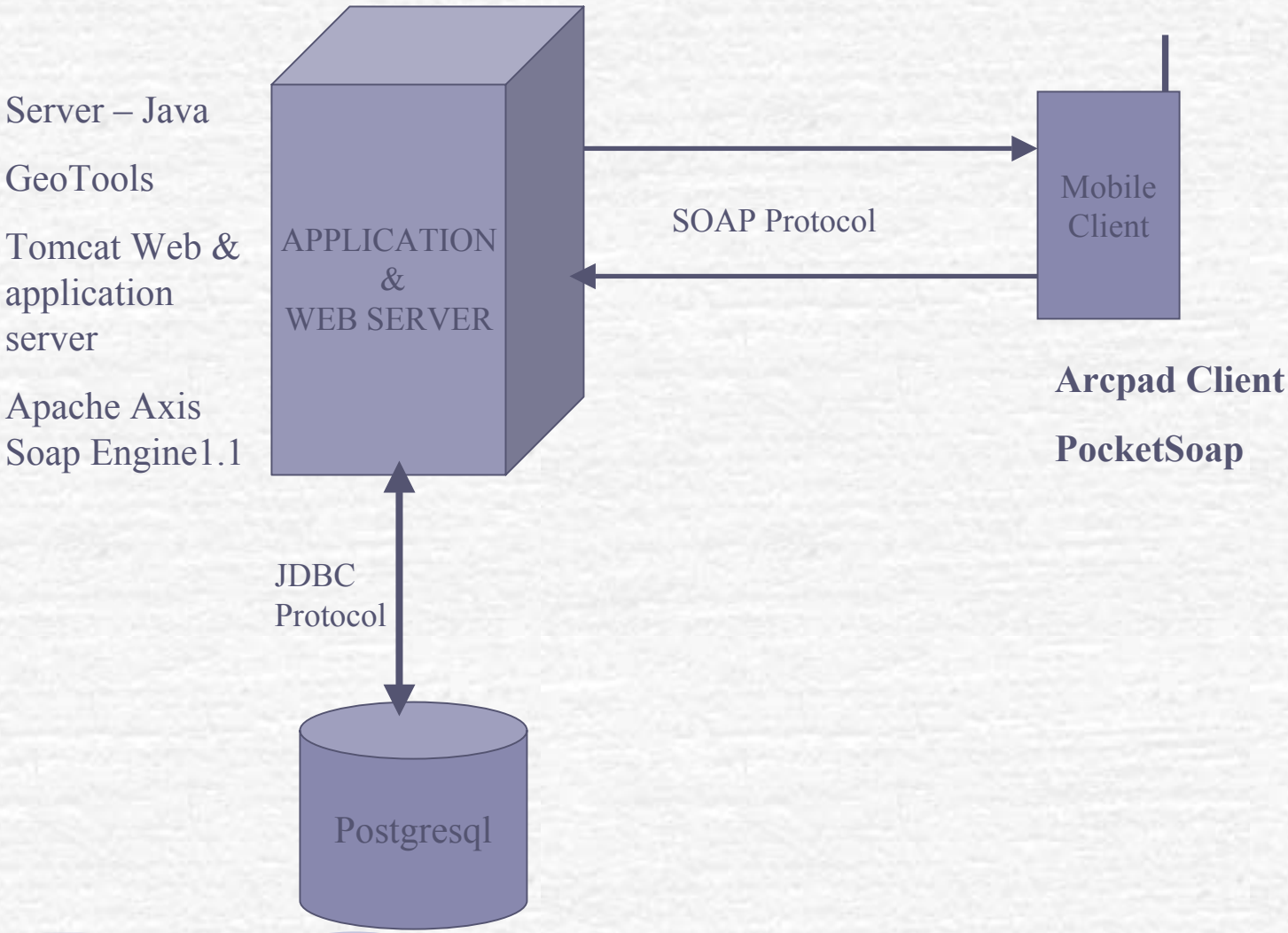


Geodatabase

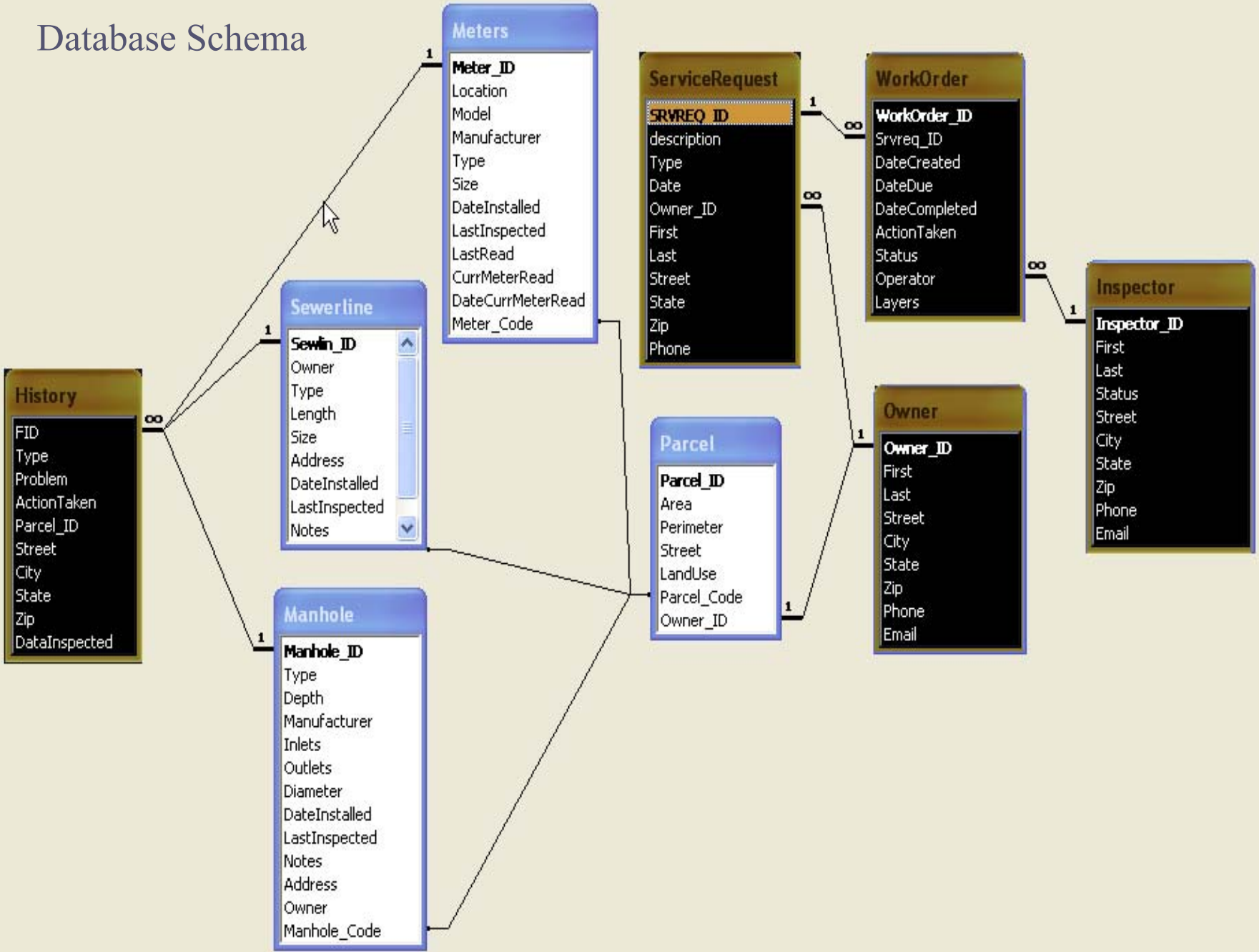
- Data transport between iPAQ and server is in XML format.

Distributed GIS

Data flow from database to and from the mobile client



Database Schema



Example: Work Order description (XML)

```
<?xml version="1.0" encoding="UTF-8" ?>
- <Job xmlns="http://example.org/mytypes" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:gml="http://www.opengis.net/gml" xmlns:xlink="http://www.w3.org/1999/xlink"
    xsi:schemaLocation="http://www.erc.msstate.edu/~venu FieldData.xsd" jobid="1202">
    <description>Perform Pipleline Inspection</description>
    <date>2003-06-06</date>
    <duration>60minutes</duration>
    <dueDate>2003-06-16</dueDate>
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      <city>Starkville</city>
      <state>MS</state>
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            <gml:Y>60.9</gml:Y>
          </gml:coord>
        </gml:LineString>
      </linearGeometry>
      <classification>Pipleline</classification>
      <number>11</number>
    </Location>
  + <Map>
  </Job>
```

References

- Work Flow – Thinking About GIS – Roger Tomlinson
- GeoTools – www.geotools.org
- Postgresql – www.postgresql.org
- Arcpad - www.esri.com
- Water utilities data model - www.esri.com

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Phase 4

The final application will be presented to project partners, practitioners, and researchers. The user and data needs assessment, the design document, the application, the html user guide, and other reports will be developed and delivered as final products of the effort.

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The Client-Side

The application is a proof of concept technology integration and development research effort. This effort will produce a mobile “client-side” application. To be fully effective, the client will require basemap data, database information, and geospatial information from a server.

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The Server-Side

A data server application is needed to automate the steps to assemble, format, and provide the needed information for field mapping activities. Also, the server application should allow the results of field mapping and information compilation to be "uploaded" and incorporated into the database.

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Benefits

- The application will provide methods for developing and serving geospatial data to improve information about rural septic system infrastructure.
- Improved information leads to enhanced ability to plan, operate, manage, and service the systems as well as to assess potential problem areas by using GIS analysis to overlay the system on other geospatial layers.

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