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Engineering & Related Services
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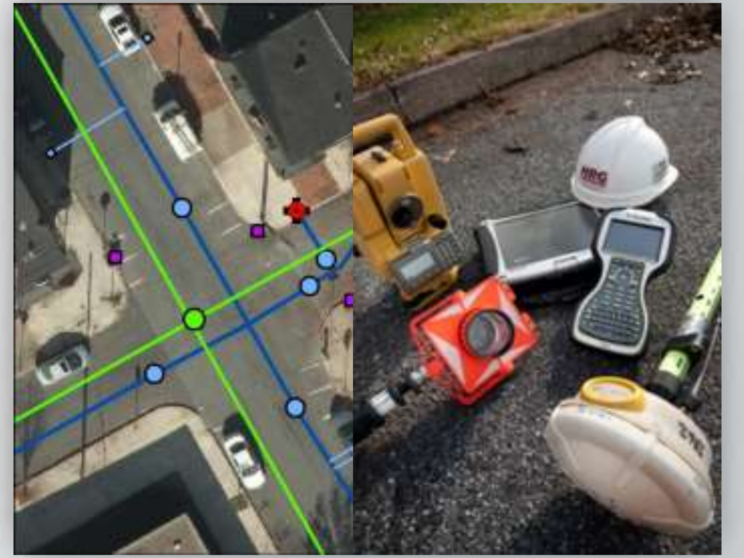
COUNTY ENGINEERS ASSOCIATION OF OHIO
CEAO

[BUILDING RELATIONSHIPS.
DESIGNING SOLUTIONS.]

Improving the Accuracy of your GIS - What's Good Enough?

2016 Ohio CCAO/CEAO Conference
December 6, 2016



Howard S. Hodder, Jr., MGIS, GISP
Matthew D. Warner, PLS
www.hrg-inc.com

AGENDA

1. Welcome and Introductions
2. Surveying defined?
3. GIS defined?
4. GIS Development Process
    1. Project Understanding
    2. Database Design
    3. Data Collection / Development
    4. Application Selection
    5. Implementation
    6. Growth and Support
5. Data Collection / Development (Expanded)
6. Applied Technologies
7. Metadata
8. “AIR”
9. Define the “Who”?
10. Project Example
11. Future?....Now!
12. Questions & Answers

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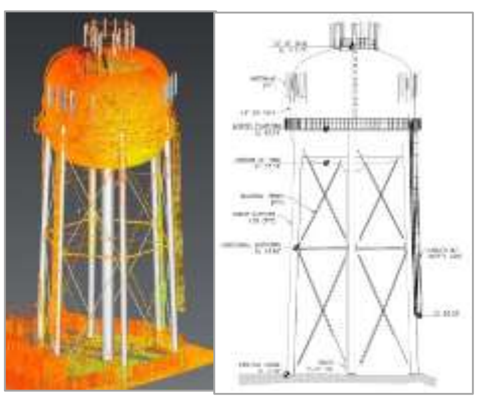
- **Founded in 1962 in Harrisburg, PA**
- **200+ employees**
- **50+ years of business**
- **7 Offices**
- esri Partner Network Silver

Professional **Engineers** | Professional **Land Surveyors** | Certified **GIS Professionals**

Professional **Geologists** | Registered **Landscape Architects**



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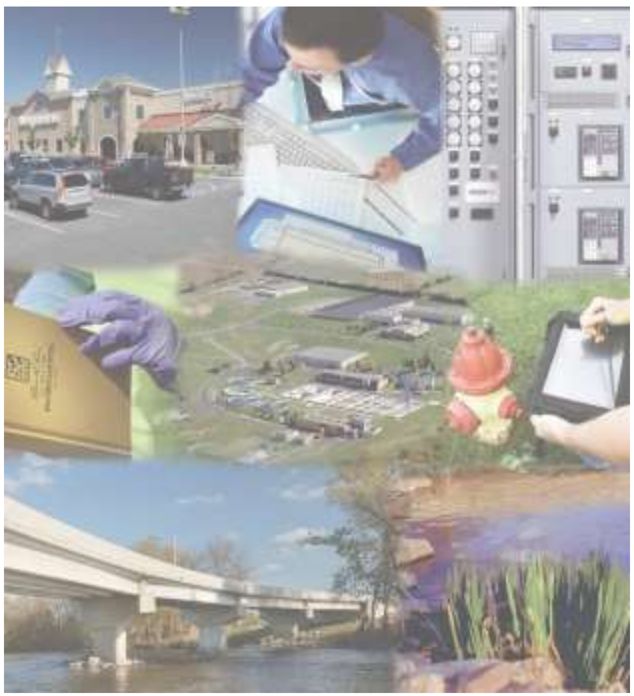
Full service engineering firm – able to fully support the growing and complex needs of our clients – from the initial planning and analysis of financing alternatives through final design, construction administration and operational guidance.

We specialize in providing one-on-one service to each of our clients – responding to your needs, anticipating challenges and delivering precise solutions.



- Water, Wastewater, Storm Water
- Geomatics
  - Geographic Information Systems (GIS)
  - Surveying (Conventional and GNSS/GPS technologies)
- Financial Services
- Transportation
- Land Development
- Electrical Engineering
- Water Resources/Environmental Studies and Design

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INTRODUCTION

Howard S. Hodder, Jr., MGIS, GISP

- Director of Geomatics
- Bachelor's degree in Geography from Bloomsburg University
- Master's degree in GIS from Penn State University (MGIS)
- Certified GIS professional (GISP)
- President (PA-MAPPS)
- Board Member – PA State Geospatial Coordinating Board
- Leadership Harrisburg Graduate (2011)
- 2016 Central Pennsylvania Forty under 40

INTRODUCTION

Matthew D. Warner, PLS

- Geomatics Regional Service Group Manager
- Associates degree in Land Surveying Technology & Bachelor's degree in Surveying from Penn State University
- Professional Land Surveyor (PLS) – PA, NY
- Board Member – PA State Geospatial Coordinating Board
- 12+ years of experience in the land surveying profession

SURVEYING

Surveying

From Wikipedia, the free encyclopedia

Jump to: navigation, search

This article is about measuring positions on Earth. For other uses, see Survey.

Surveying or **land surveying** is the technique, profession, and science of accurately determining the terrestrial or three-dimensional position of points and the distances and angles between them, commonly practiced by **surveyors**, and members of various engineering professions. These points are usually on the surface of the Earth, and they are often used to establish land maps and boundaries for ownership, locations like building corners or the surface location of subsurface features, or other purposes required by government or civil law, such as property sales.

Surveyors use elements of mathematics (geometry and trigonometry), physics, engineering and the law. Surveying equipment includes total stations, robotic total stations, GPS receivers, prisms, 3D scanners, radios, handheld tablets, digital levels, and surveying software.

GIS

Geographic information system
From Wikipedia, the free encyclopedia
(Redirected from GIS)
Jump to: navigation, search
"GIS" redirects here. For other uses, see GIS (disambiguation).
A **geographic information system** (**GIS**) is a computer system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data.
In a general sense, the term describes any information system that integrates, stores, edits, analyzes, shares, and displays geographic information. GIS applications are tools that allow users to create interactive queries (user-created searches), analyze spatial information, edit data in maps, and present the results of all these operations.[2][3] Geographic information science is the science underlying geographic concepts, applications, and systems.[4]
GIS is a broad term that can refer to a number of different technologies, processes, and methods. It is attached to many operations and has many applications related to engineering, planning, management, transport/logistics, insurance, telecommunications, and business.[3]

WHAT IS GIS?

- GIS is an abbreviation for Geographic Information System
  - Hardware
  - Software
  - Data
  - Methods
  - People

GIS LAYERS – 2D AND 3D

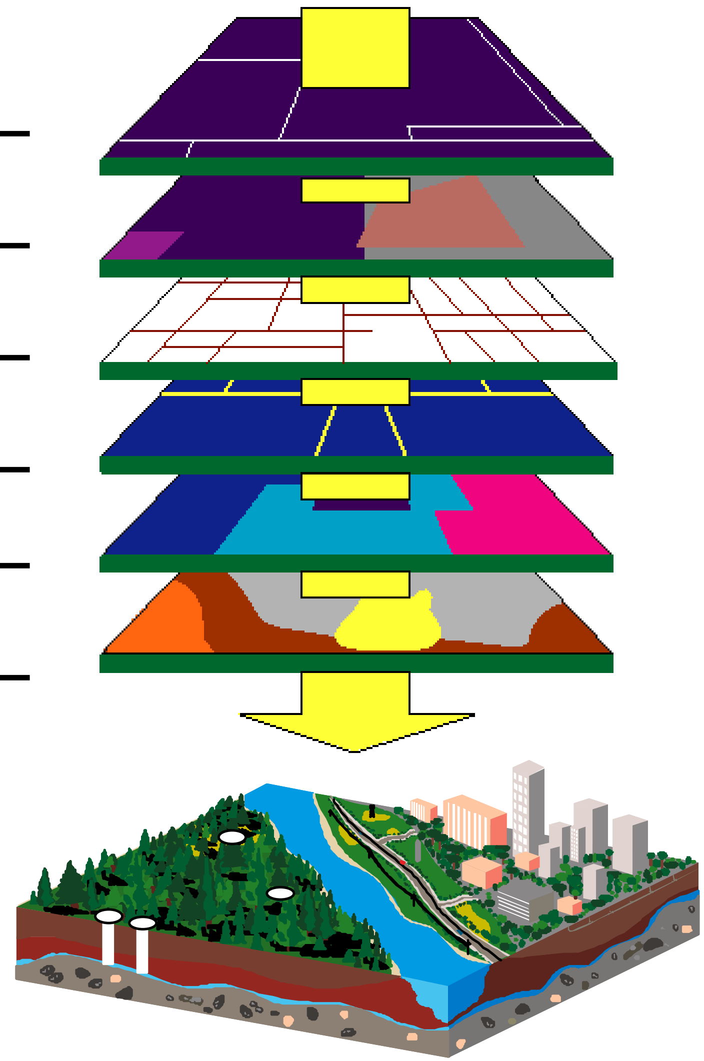
Social Factors

Land Use

Engineering

Parcels

Environmental Considerations



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SURVEYOR’S DEFINITION OF “GIS”

G et

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S urveyed

PROJECT PROCESS OVERVIEW

Project Understanding / Requirements

- Project Kick-Off
- Stakeholder Discussions
- Data Review
- Hardware / Software Review

Database Design

- Table Structures
- Data Relationship Development
- Schematic Development
- "Final" Database Structure

Data Collection

- GPS Collection
- Attribute Input
  - Field Data Collection
  - Paper Map and Existing Databases
  - QA / QC

Data Conversion / Migration

- Data Migration
- QA / QC

Application Selection / Development

- Desktop
- Web-based
- Mobile

Installation / Implementation

- Database Delivery
- Application(s) Installation
- Training

Continued System Support / Growth

- Troubleshooting
- Q & A
- Future Database Updates and Additions
- Additional Project(s)
  - Data Layer Development
  - Custom Application(s)
  - External Database Connections
  - Etc.

PROJECT UNDERSTANDING

- What is the want *vs* need *vs* required?
  - Short-Term vs Long-term Goals
  - Education of Client – Technologies, Software, Uses, Who?, Etc.
- Involved Stakeholders?
  - Managers and Workers
  - Group and Individual Discussions
- Timeframe?
- Budget?
- Existing Information?
  - Data Sources
  - Existing Data Review

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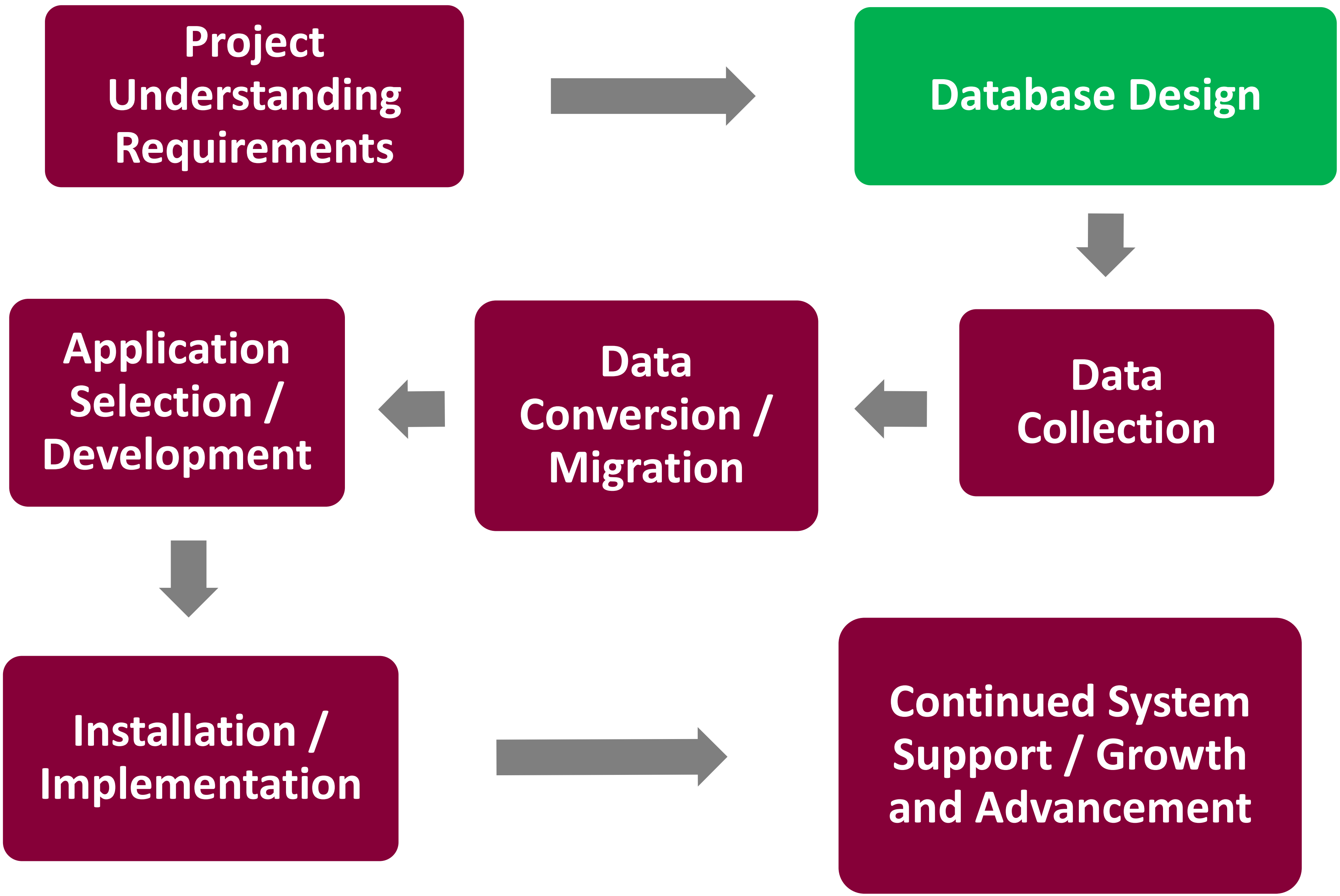
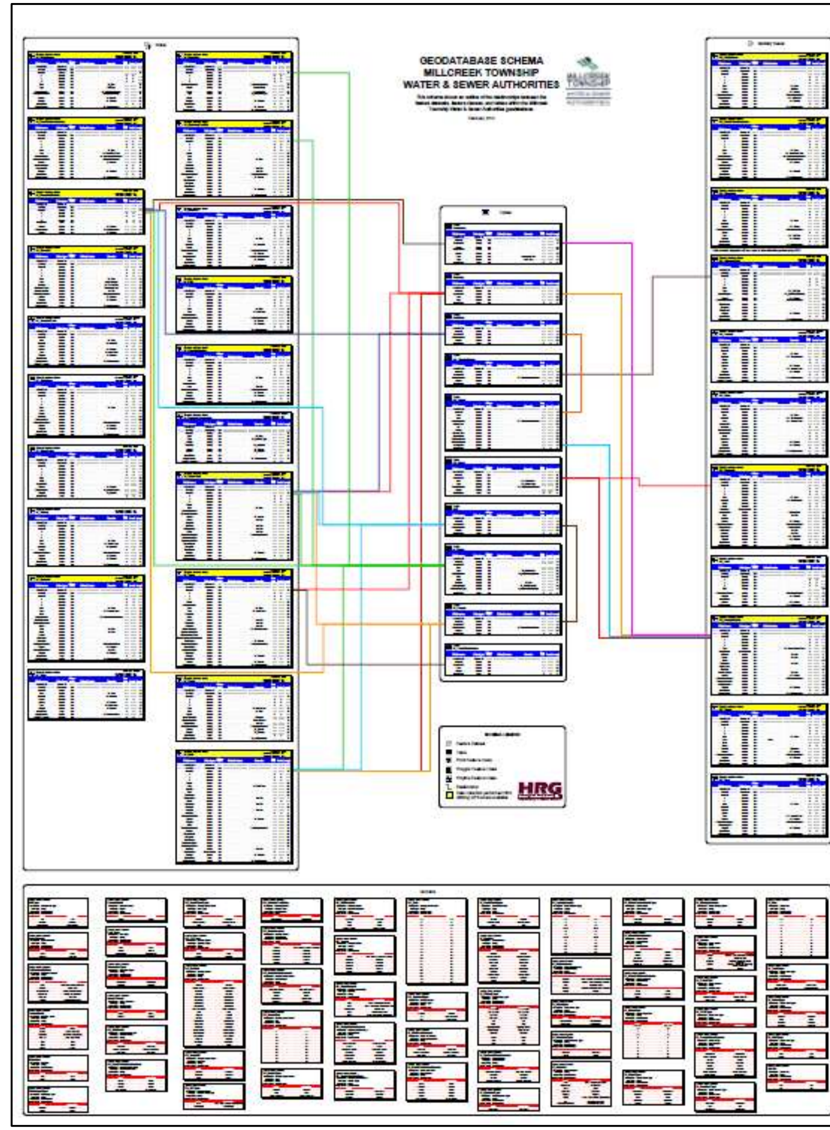
GIS DEVELOPMENT PROCESS OVERVIEW

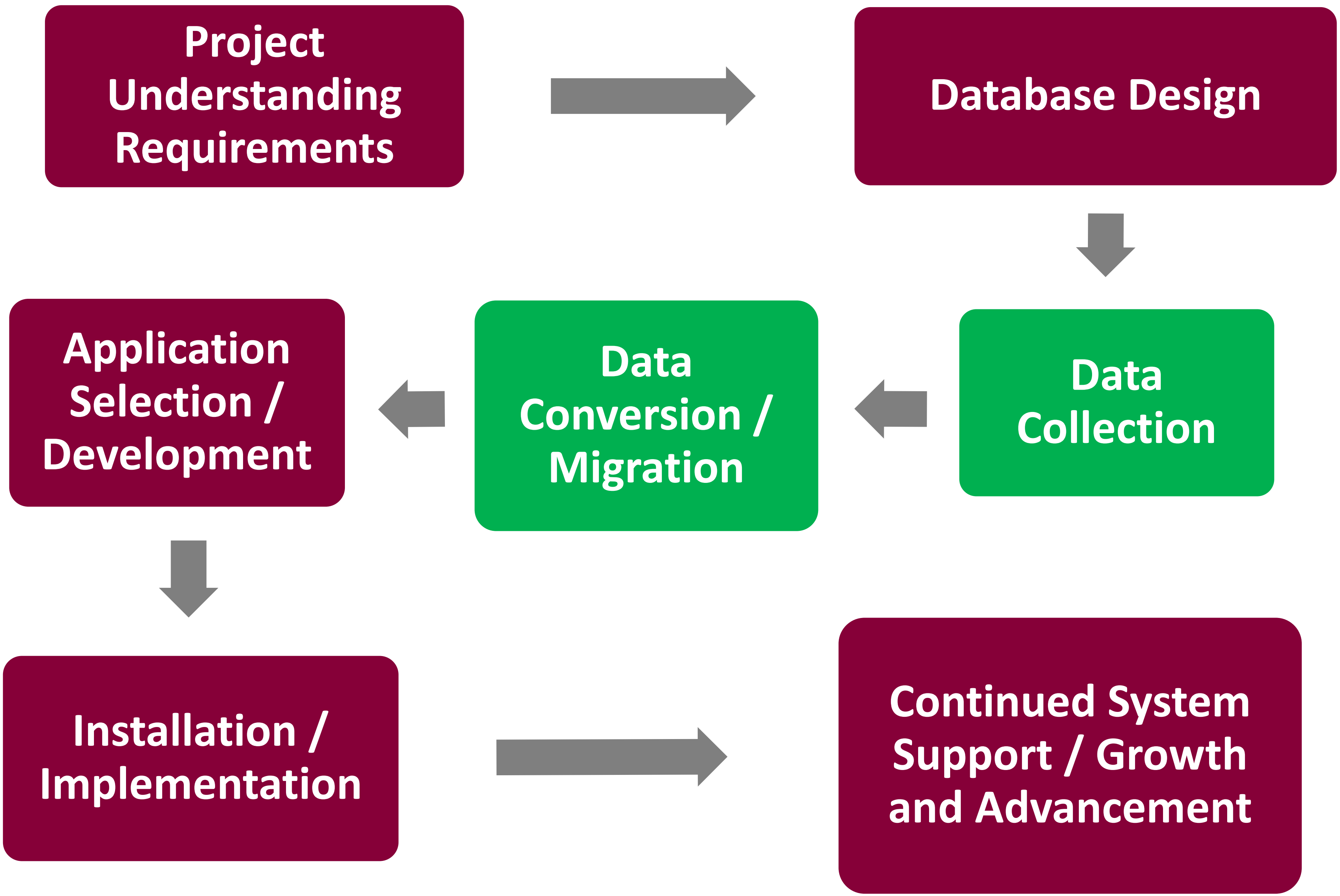


GIS DATABASE DESIGN

- Feature Structures
- Table Structures
- Domains
- Data Relationship Development
- Schematic Development
- “Final” Database Structure
- Responsibility Definitions



GIS DEVELOPMENT PROCESS OVERVIEW



DATA COLLECTION / DEVELOPMENT – FACTORS

Questions to Consider:

(Define proper data collection / development techniques according to specific client needs and project requirements.)

- Budget / Schedule?
- How accurate must the data be?
- What is the immediate need?
- What will be the future use / analysis of the data?
- Who will conduct field data collection / process the data?
- Is Elevation Important?
- Etc., etc., etc……

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DATA COLLECTION / CONVERSION / MIGRATION

Data Collection

- Heads-Up Digitizing
- GPS (Carrier vs Code)
- Conventional Survey
- Terrestrial/Mobile/Airborne LiDAR
- Attribute Input
  - Field Data Collection
  - Paper Map and Existing Databases
  - QA / QC

Data Conversion / Migration

- Data Migration
  - Field Data
  - Existing Digital Data Layers/Databases
  - Hard Copy Information Sources
- QA / QC

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DATA COLLECTION – IT DEPENDS……

The client must be the final judge as to what type of data collection best suites their circumstances and who will perform the collection, but, in my opinion, it is the consultants' duty to educate the client / prospective client on the different options available so they are able to make that informed decision.

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SURVEYOR’S DEFINITION OF “GPS”

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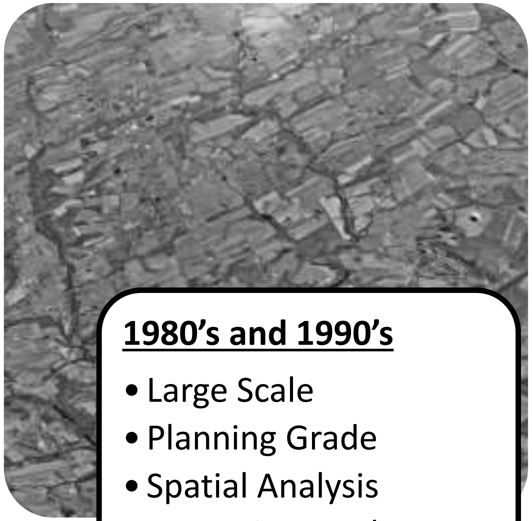
DATA TREND

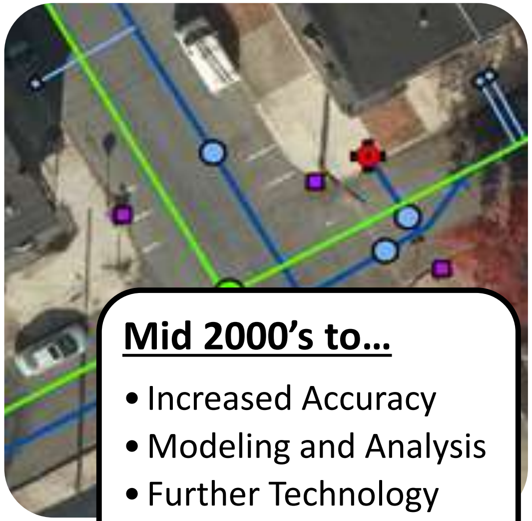


1980's and 1990's

- Large Scale
- Planning Grade
- Spatial Analysis
- Expensive Hardware, Software, Data
- 2D

1990's and 2000's

- Move Towards Smaller Scale
- More Detailed Spatial Analysis
- Technology Advancements
- 2D moving toward 3D



Mid 2000's to…

- Increased Accuracy
- Modeling and Analysis
- Further Technology Advancements
  - Hardware
  - Software
- 2D, 3D, 4D and 5D

TERRESTRIAL LIDAR/LASER SCANNING

- Captures millions of closely spaced measurements in a matter of minutes.
- Increased Speed & Accuracy
- Non-intrusive means of rapidly collecting detailed and accurate “As-Is” data.
- Data can be viewed, navigated and analyzed much like a 3D model in traditional CAD systems.

Accuracy of single measurement @ 200 Meter Range
Position – 6 mm (1/4”)
Distance – 4 mm (1/6”)
Angle – 60 microradians

Scan Once: Reuse Often

- Building Information Models (BIM)
- Space Utilization
- As-Built Documentation
- Geographic Information Systems (GIS)
- Engineering Analysis
- Conflict/Interference Identification
- Change Detection
- Security Planning/Threat Analysis
- Historic Preservation Documentation

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TERRESTRIAL LIDAR/LASER SCANNING

Types of Scanners

Phase-Based
Close Range *(80 meters)*
Speed: 3 to 9 min per scan

Accuracy 1-2mm

Ideal for Interiors
and Confined Spaces

Time-of-Flight
Long Range *(200 meters)*
Speed: 15 to 30 min per scan

Accuracy 3-6mm

Ideal for Tall Structures,
Corridors and Small Campus

Mobile
Longest Range *(up to 750 meters)*
Multiple Scanners,
High Speeds
Accuracy +/- 30mm

Ideal for Large Campus
or Corridors

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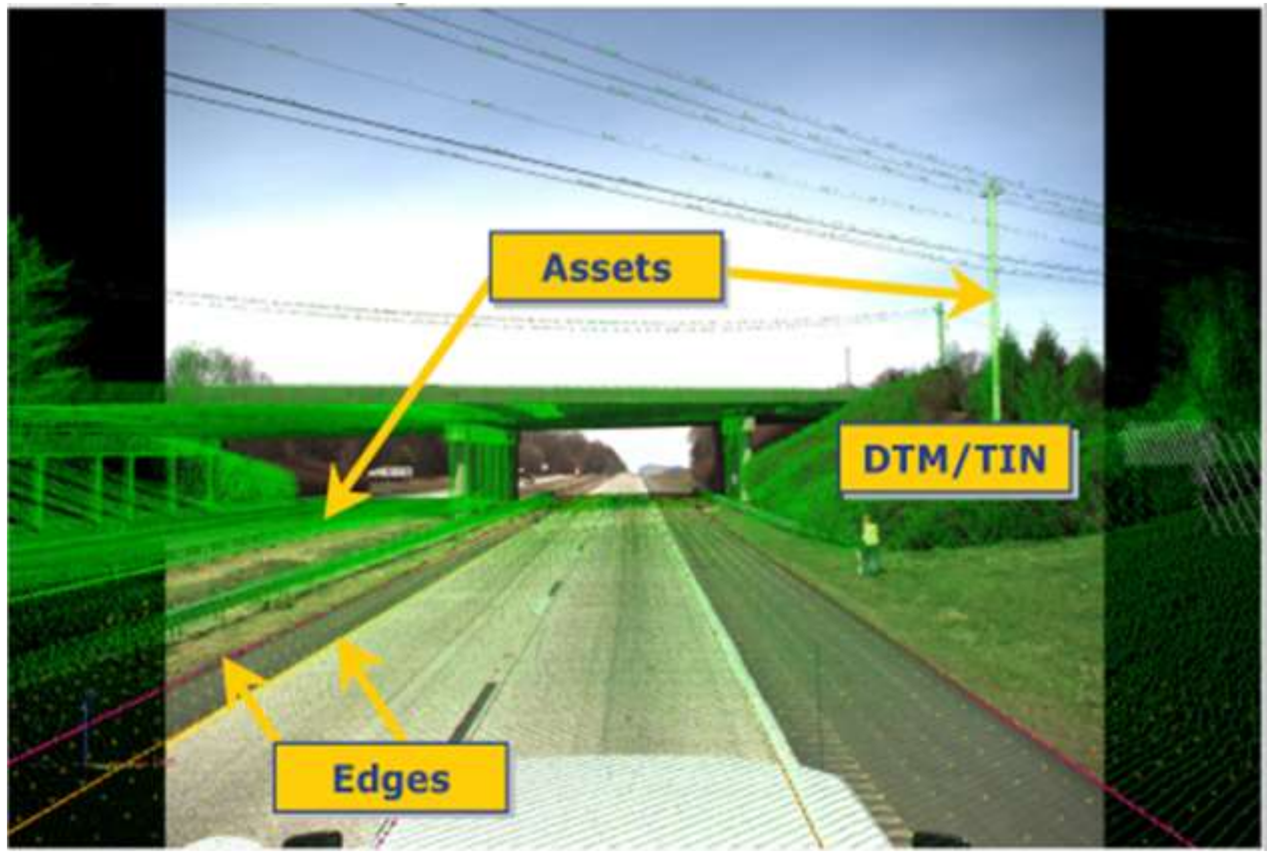
FEATURE EXTRACTION

- Curb cuts
- Edge of pavement
- Sidewalks
- Ramps
- Handrails
- Building corners
- Fences
- Retaining walls
- Fire hydrants
- Manholes
- Light / Power Poles
- Signs / Billboards
- Guardrail
- Trees
- Pavement DTM features (EP, C&G, Travel Lane Lines, Crowns)
- Transmission Lines
- **....Any physical feature you can detect from data set**



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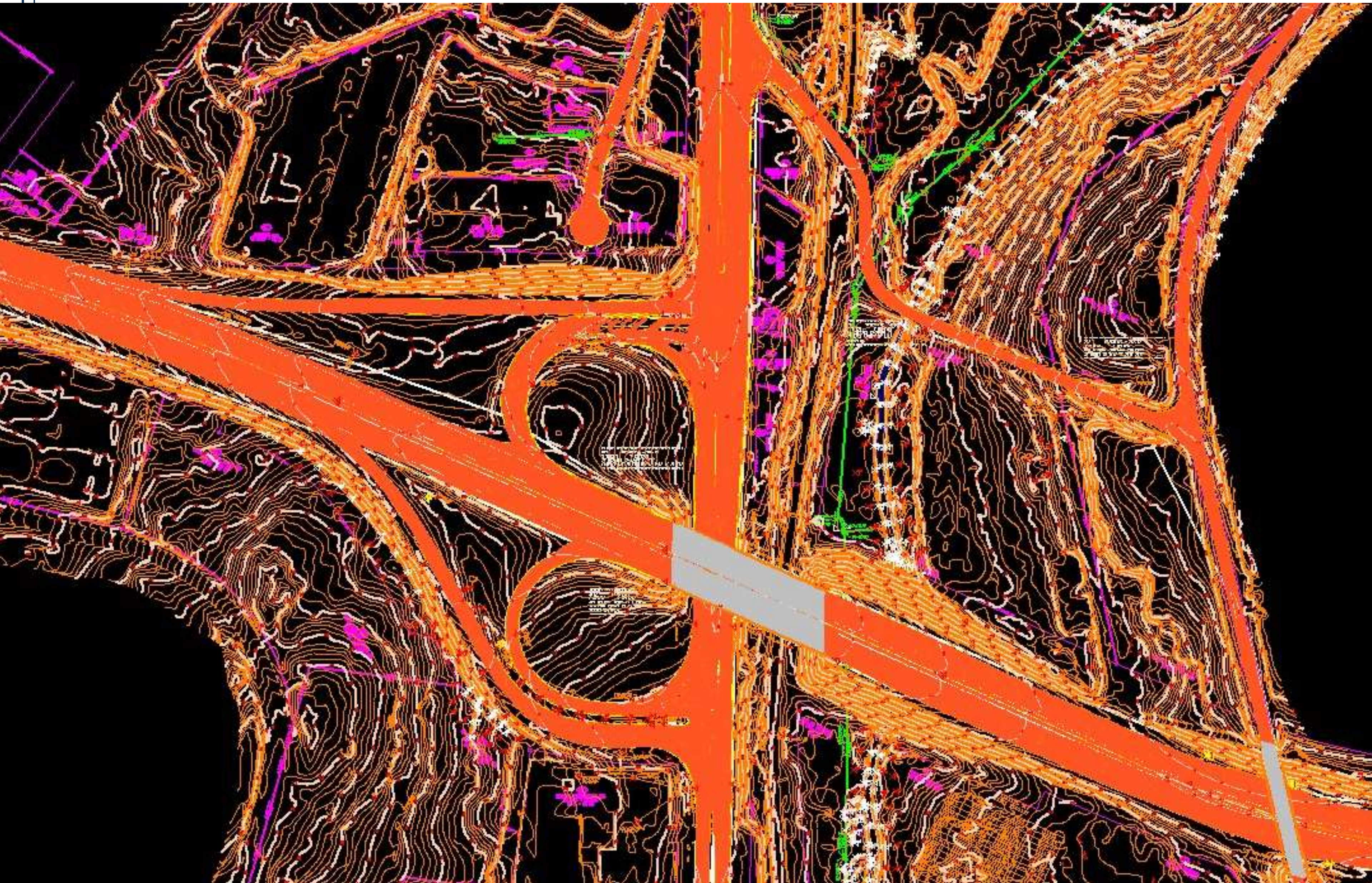
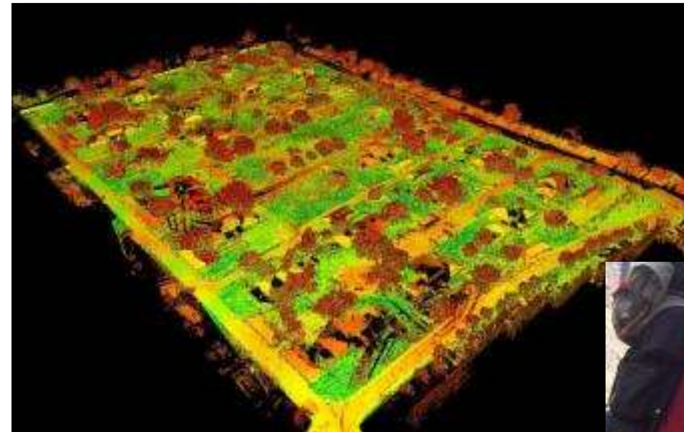
AIRBORNE/MOBILE/TERRESTRIAL DATA FUSION



APPLIED TECHNOLOGIES

Advanced Data Acquisition

- Terrestrial LiDAR/Laser Scanning
- Global Positioning Systems
- Subsurface Feature Identification
- Mobile-GIS/CAD
- Feature Recognition & Extraction
- Thermal Imagery
- Building System Sensors



Laser Scanning, GPS and Mobile-GIS tools ensure accuracy and standardization of geospatial asset inventories

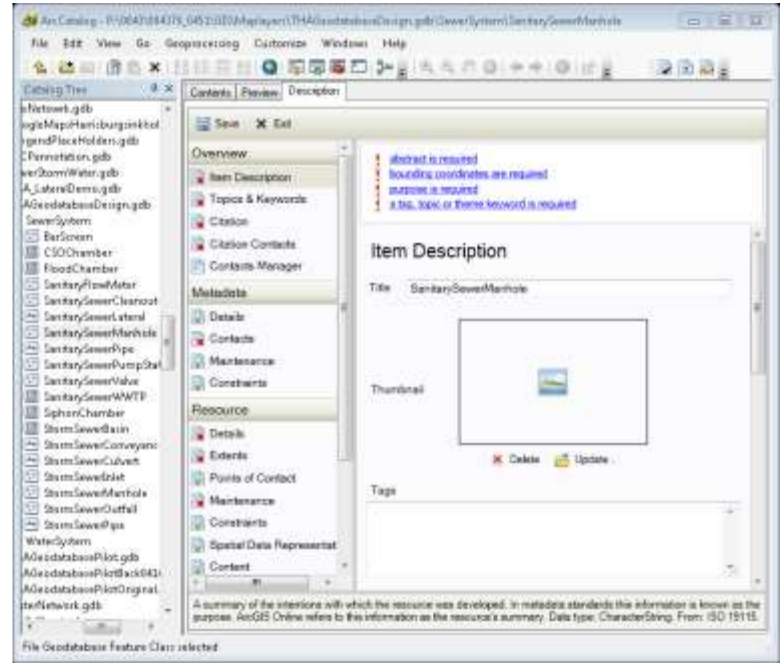
Integration Technologies

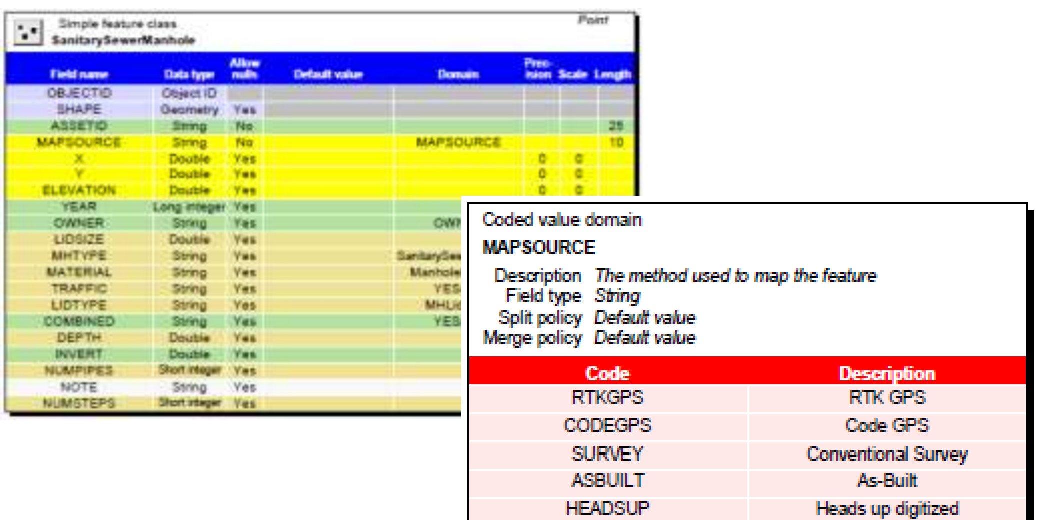
- Geographic Information Systems
- Building Information Models
- Real Property System
- Enterprise Resource Planning
- Computerized Maintenance Management Systems
- Computerized Facility Management Systems
- Web-Based Management Dashboards
- Visualization/4D Simulation

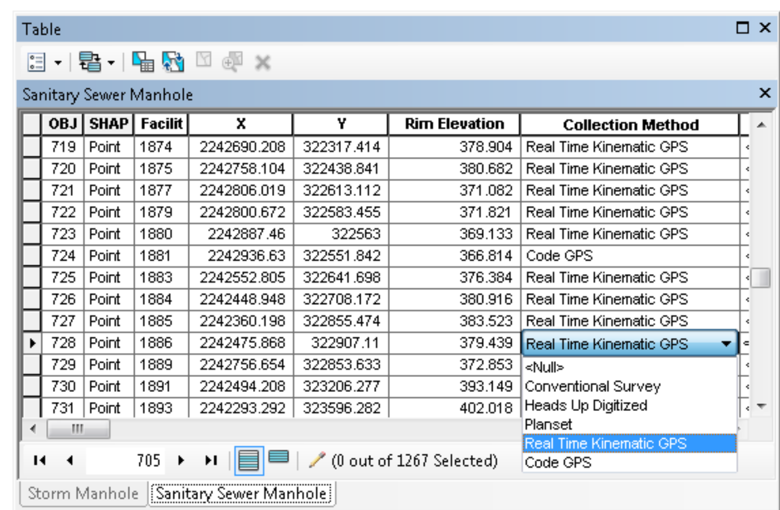
Integration of data and existing systems enables sound decision making

METADATA

- "Data About Data"
- Assists end users with more precise and defined information regarding the data development and planned use(s)
- Important for managing data quality and integrity during integration, migration and maintenance
- Provides information such as defined extents, projection, scale, attribute field definitions, precision, accuracy, etc.



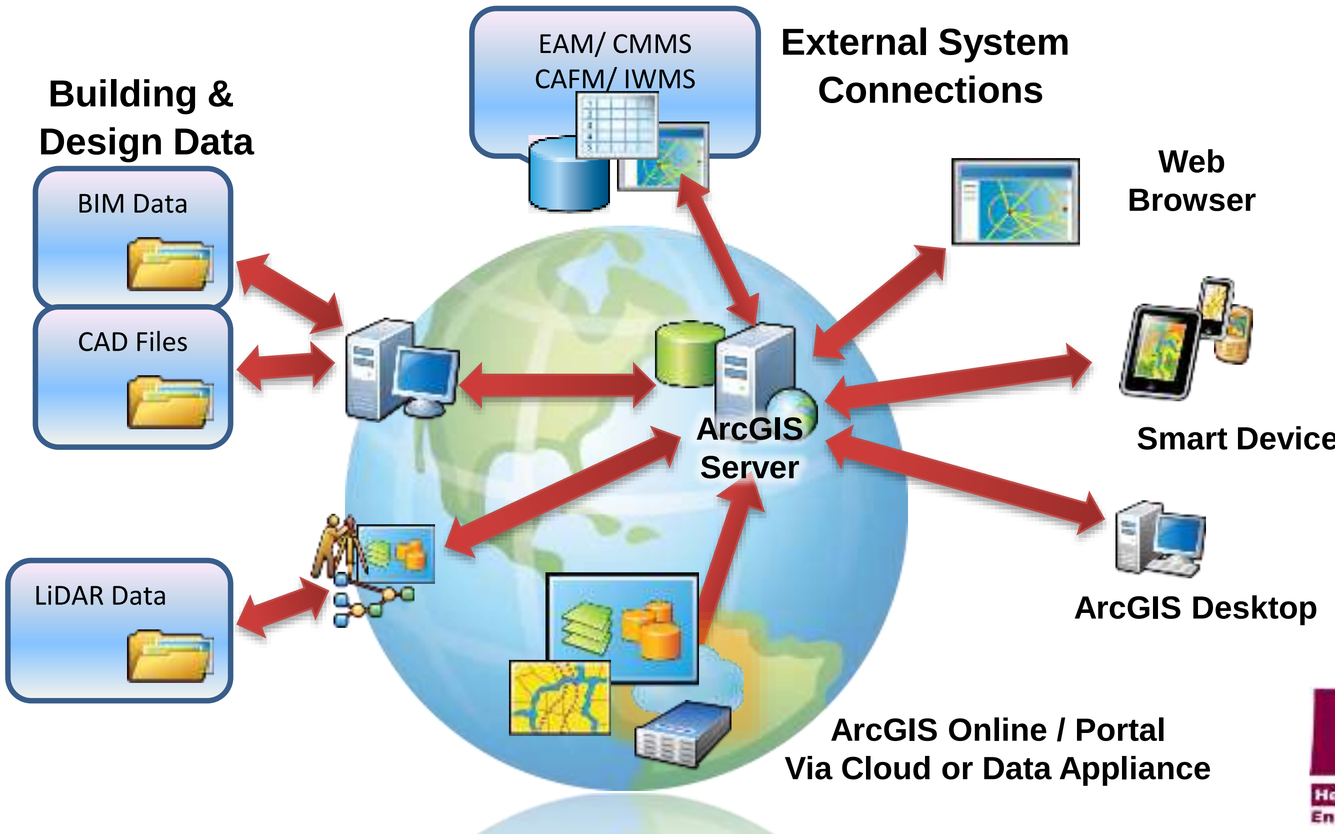




"AIR" – ASSET INFORMATION REPOSITORY

Asset Information Repository (*AIR*):

- NOT a custom developed or single commercially available software
- A practice of capturing and preserving data throughout the life cycle
- An application of industry embraced software, best-data-practices and standards
- An integration of varied data sources into a common geospatial environment
- An approach to presenting information visually and virtually to support the facility & asset specific operational and strategic decision making activities



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PLANNING AND CONCEPT DESIGN

Terrestrial LiDAR & Mass Modeling enable visualization of Master Plans and Concept Designs

DEFINING THE “WHO”?

– When is a licensed surveyor “needed” for data collection?

(Licensed Surveyor, or supervised by licensed surveyor)

– Who should put the data together in the office?

(GISP – GIS Certification Institute, or supervised by GISP)

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DEFINING THE "WHO"?

- GPS\GNSS data collection should be performed by licensed surveyor(?)
  - **SURVEYING** - the practice of measuring angles and distances on the ground so that they can be accurately plotted on a map
    [http://wordnet.princeton.edu/perl/webwn?s=surveying]
  - Importance of data quality and assurance (Surveyor's Seal)
    - Precise Locations Important, Elevations Important
  - "True Understanding" of data collection
    - Projection, Datum, Error Calculations
    - Not just know how to use hardware
  - Required by Local / State / Federal Mandates

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DEFINING THE “WHO”?

- GIS Certification
  - Still very controversial – Mixed Opinions

    Is there a GIS “profession”?- Multiple uses for GIS

    [Making the case for GIS Professional Certification, GeoSpatial Matters, Wayne, Lynda, Huxhold, William, and Grams, Scott. www.geoplace.com/hottopics/giscertification/ProCertification.asp]

    [A Critical Perspective on GIS Professional Certification, GeoSpatial Matters, Cordova, Henry. www.geoplace.com/hottopics/giscertification/AntiCertification.asp]

    GIS Art or Science? – Is it certifiable?

    [Stay on Your Own Side, Where is the line between surveying and mapping?. Al Butler, AICP, 2000]
  - Usefulness of Certification
    - Professionalism / Experience
    - QA / QC
    - Standards / Values
    - Code of Ethics

GIS Certification Institute

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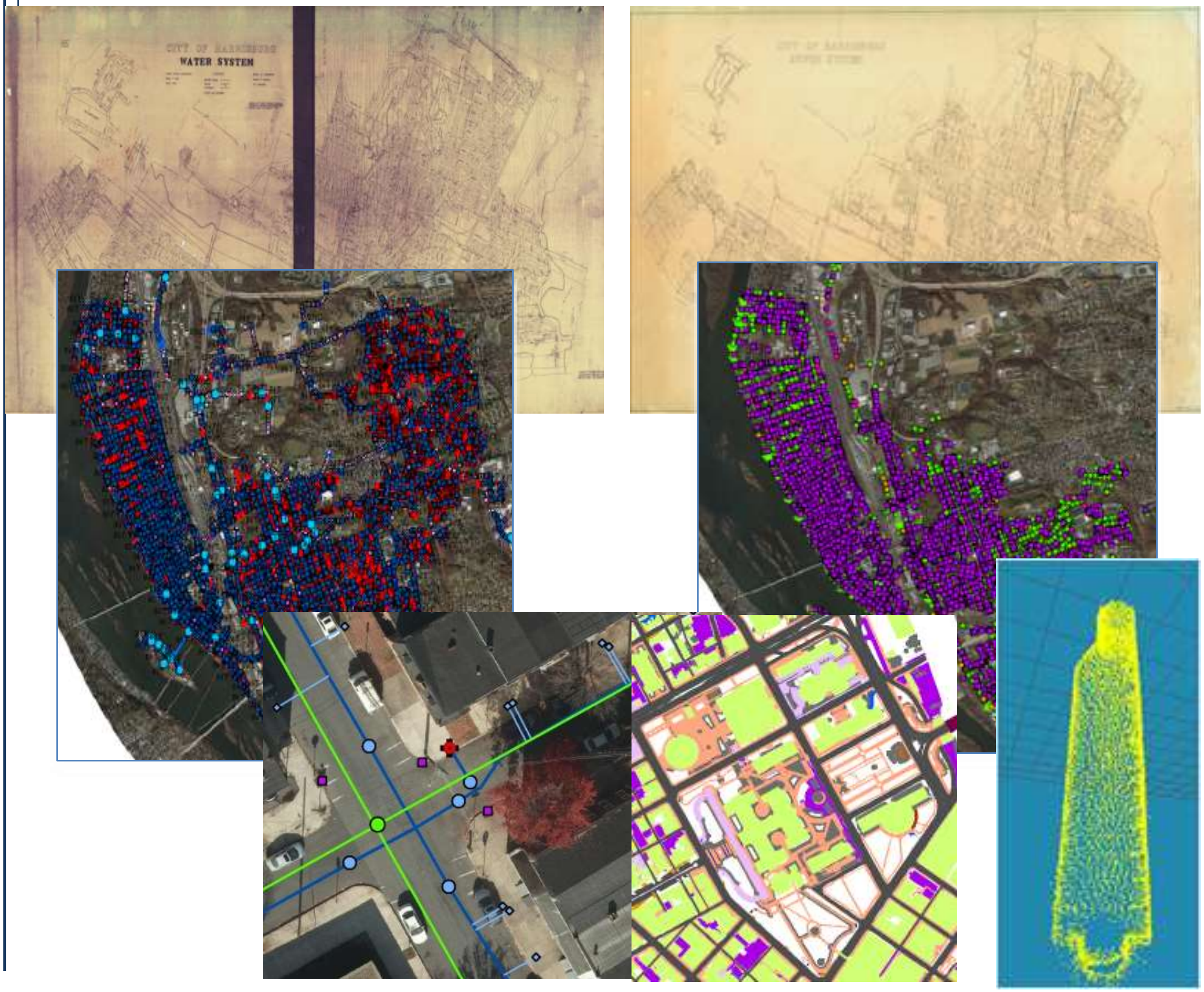
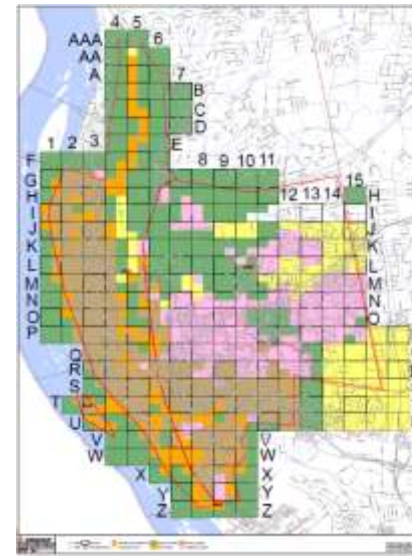
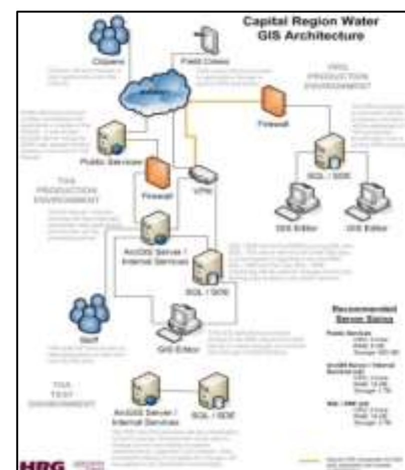
DEFINING THE "WHO"?

- Importance of Survey License and GIS Certification
  - I believe many are unaware of importance of the need for a licensed individual to complete or QA/QC field GPS feature collection and final GIS data development and analysis.
  - Mixed results and opinions for both GIS Certification and GPS Survey by Licensed Surveyor.

PROJECT EXAMPLE – CAPITAL REGION WATER

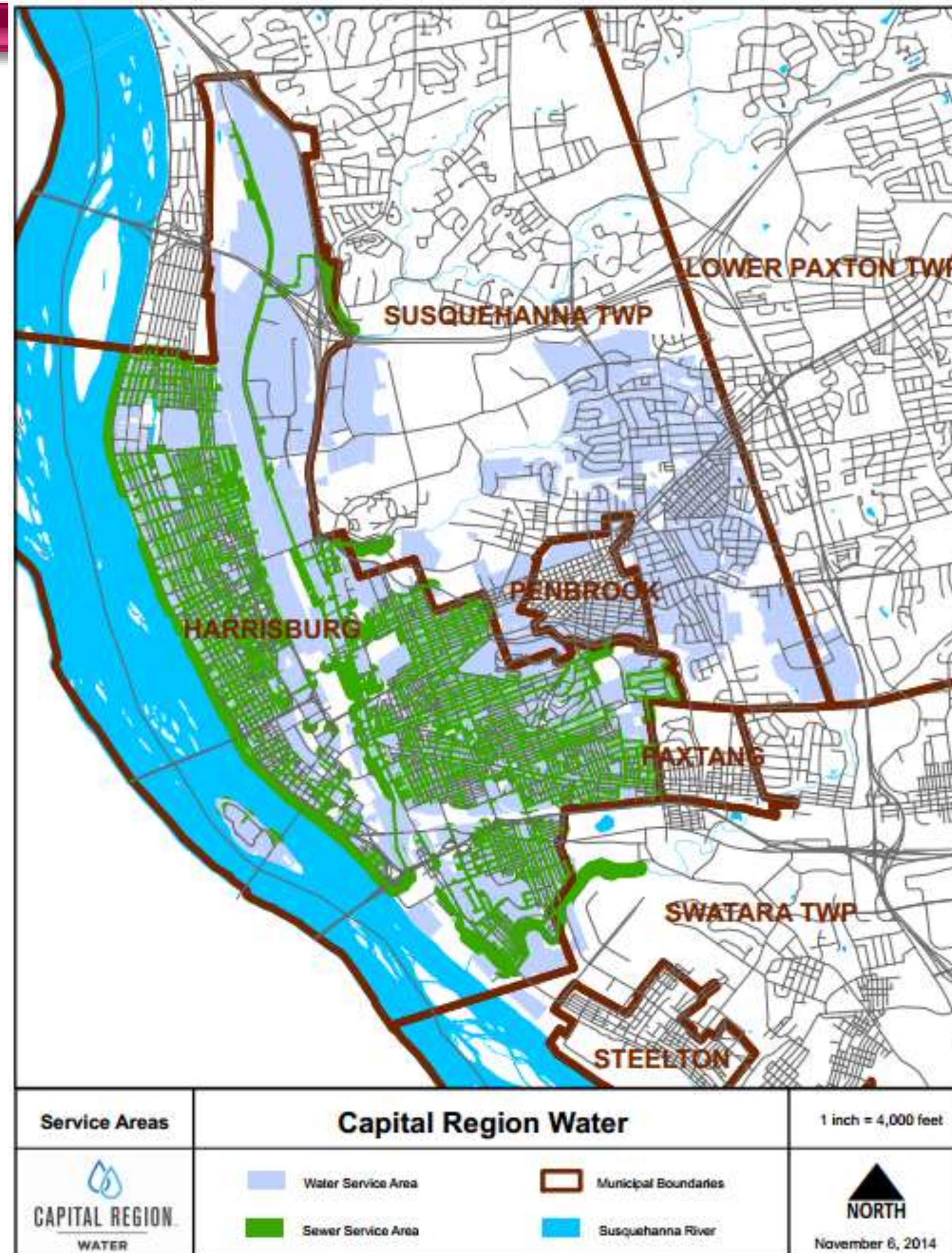






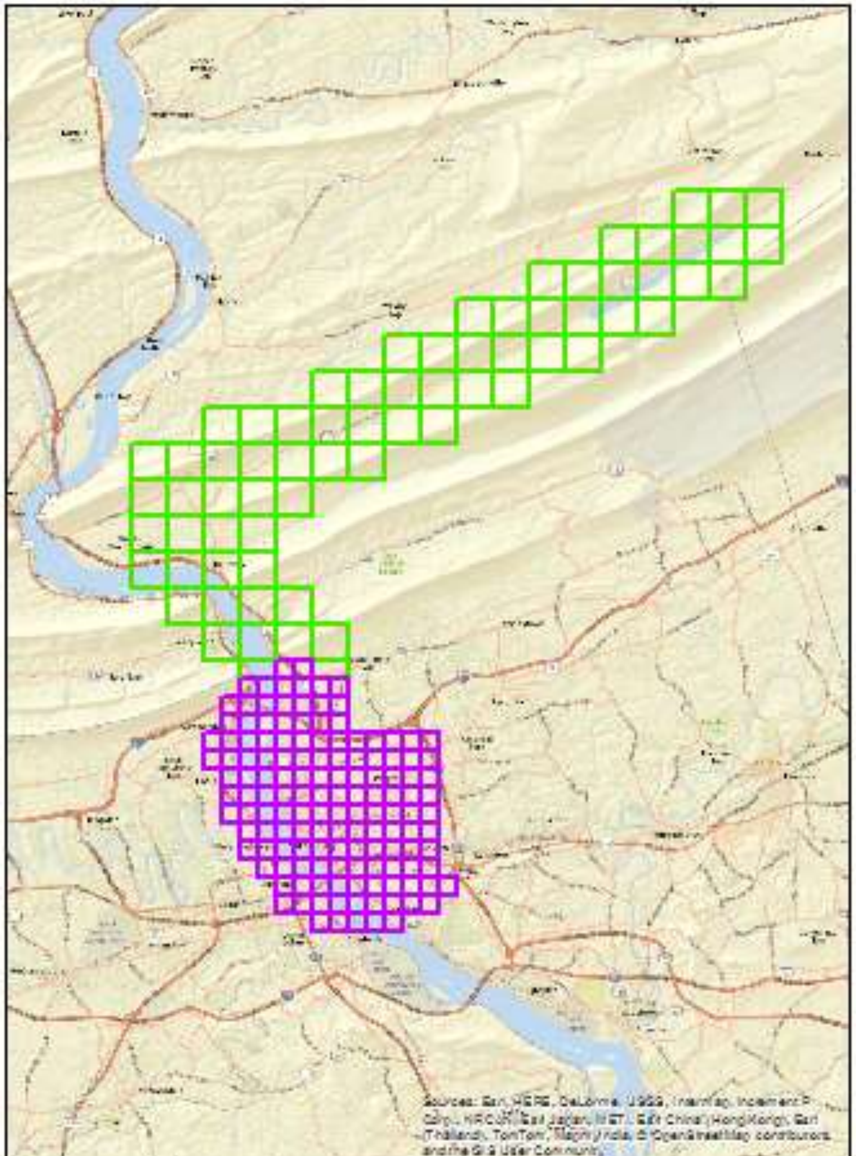
CRW SERVICE AREAS

- >200 Miles of Water Distribution Pipes
- >20,000 Water Service Connections
- ~4,000 Storm Water Inlets
- ~134 Miles of Sanitary Sewer Pipes
- ~20% Separate Storm Water and ~80% Combined Sewer



BASEMAP DEVELOPMENT

T3 GLOBAL STRATEGIES INC



- 1”=50’ Scale
- Digital Color Orthophotography
  - .25’ and .5’ pixel resolution
- Impervious Surfaces
- 2’ Contours

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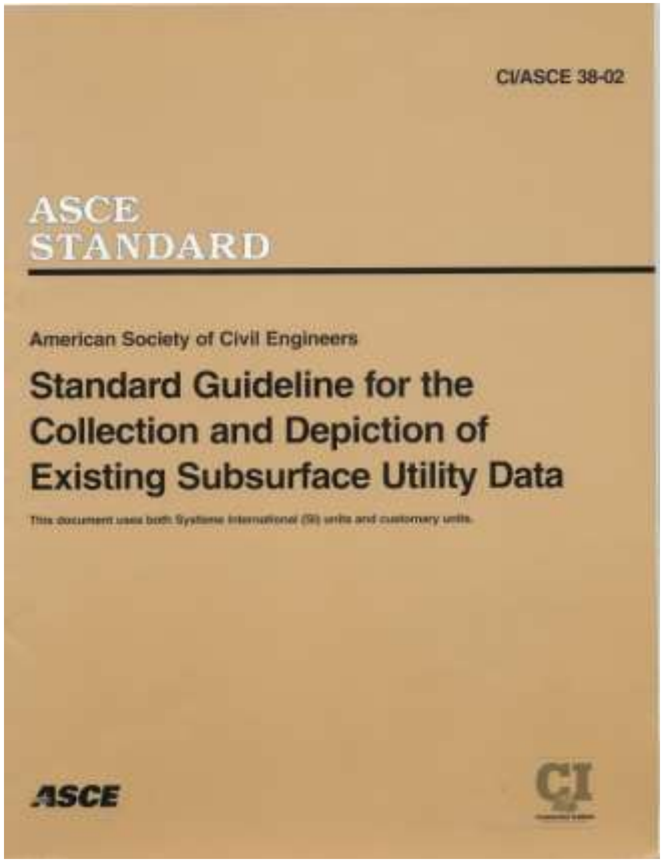
SUE – SUBSURFACE UTILITY ENGINEERING



- The ASCE defined the practice of **Subsurface Utility Engineering (SUE)** as a branch of engineering practice that involves managing certain risks associated with utility mapping at appropriate quality levels, utility coordination, utility relocation design and coordination, utility condition assessment, communication of utility data to concerned parties, utility relocation cost estimates, implementation of utility accommodation policies, and utility design.
- Quality Levels of information ranging from records only to utility exposure and precise measurements

D > C > B

A

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SUE QUALITY LEVELS B & A

- Electromagnetic Locating (Level B)
- Ground Penetrating Radar (Level B)
- Vacuum Excavating (Level A)

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DESIGNATION AND TEST HOLES

MᶜKIM&CREED **Test Hole Data Sheet**

Project Name:	Capitol Region Water	Surface Material:	Asphalt
Client Project ID:		Hole filled:	Yes
M&C Project ID:	64740001	Surface Restored:	Yes
SUE Crew Inits:	TP, ZR	Date Surveyed:	
Date:	9/15/2014	Location:	Redwood & Union Deposit
Truck Number:	2013		
Marker Ball Type and Indent.Number	000-155-0736		

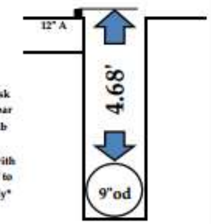
M & C Test Hole ID	Plat Page	Soil Type	Pipe Age	Pipe Condition	Type of Test Hole Marker Set	Utility Type	Quantity	Size	Material	Measure Down (Feet)	Measure Down (Meters)
146		Dirt	Unk	Fair	N & D	WTR	1	9"od	CI	4.68'	

Cross Sectional View

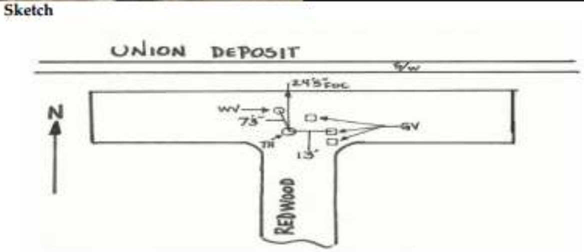
Road Thickness

Nail & Disk
Cap & Rebar
Wood Hub

Hub is placed inline with utility, Shown here off to side to show depth only



Sketch



Notes By:________________ Date: __________
Checked By: ______________ Date: __________

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PROJECT DATA COLLECTION METHODS

- Conventional Survey and GNSS/GPS
- >140,000 Survey Locations Collected
- ESRI Collector App
  - Water Meter Battery Replacement
  - USACE Storm Water Investigations

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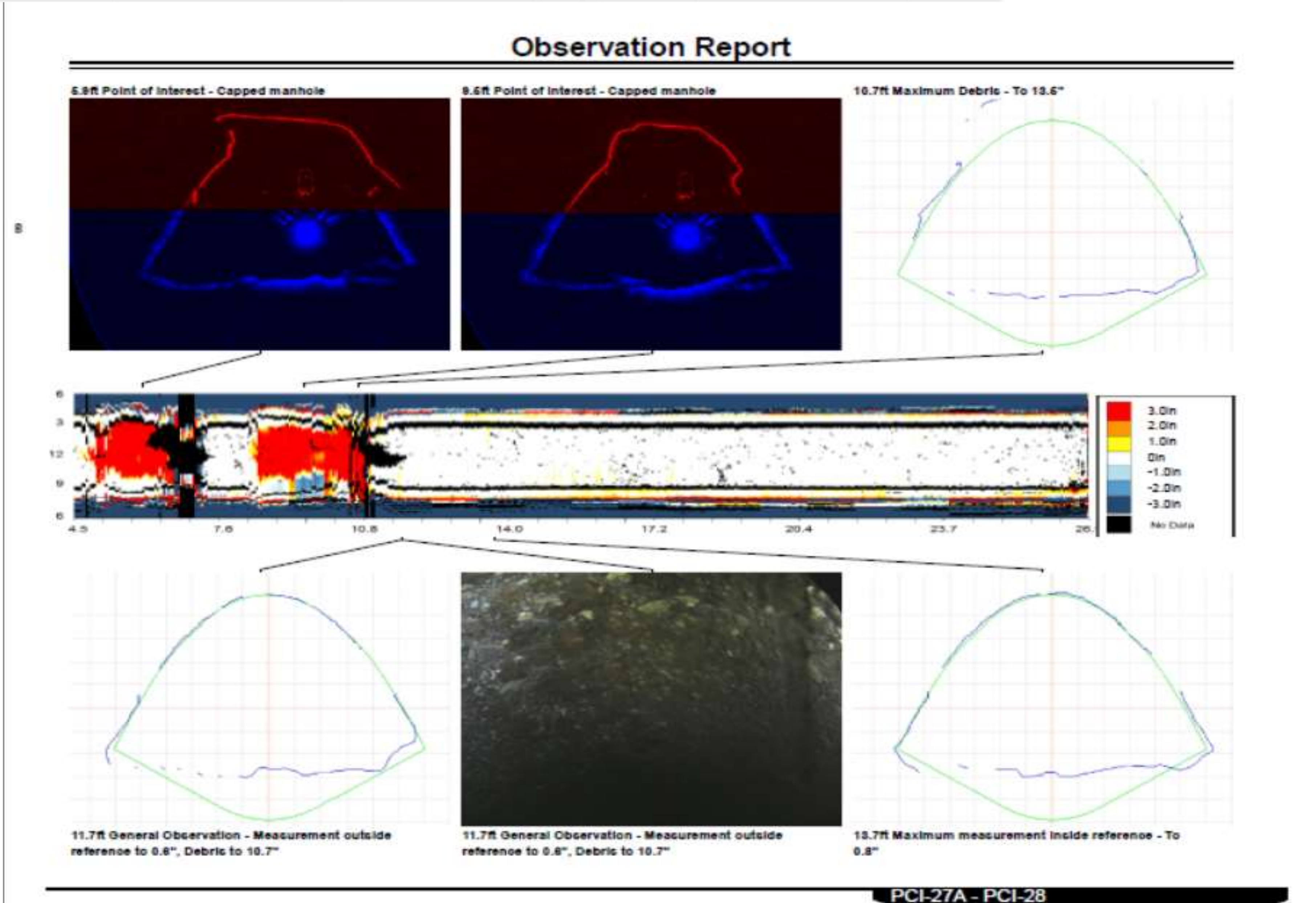
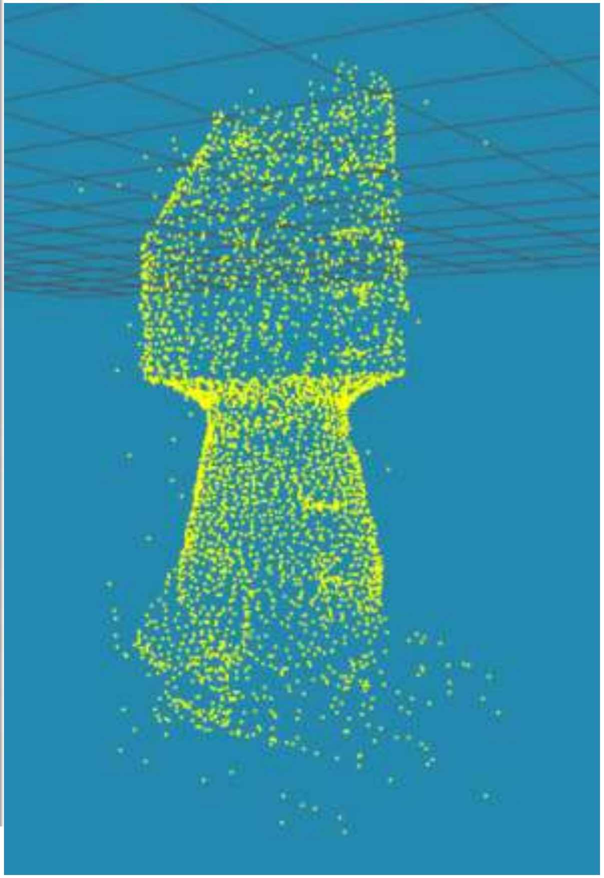
SEWER INSPECTION – MULTI SENSOR INSPECTION



INFRASTRUCTURE INVESTIGATION TECHNIQUES

- Sewer System Technology
  - Manholes
    - Digital Optical Manhole Scanner

MANHOLE INSPECTION – MH SCANNER



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SEWER INSPECTION EQUIPMENT - CCTV

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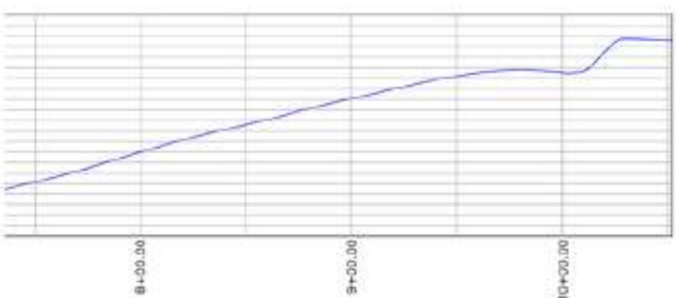
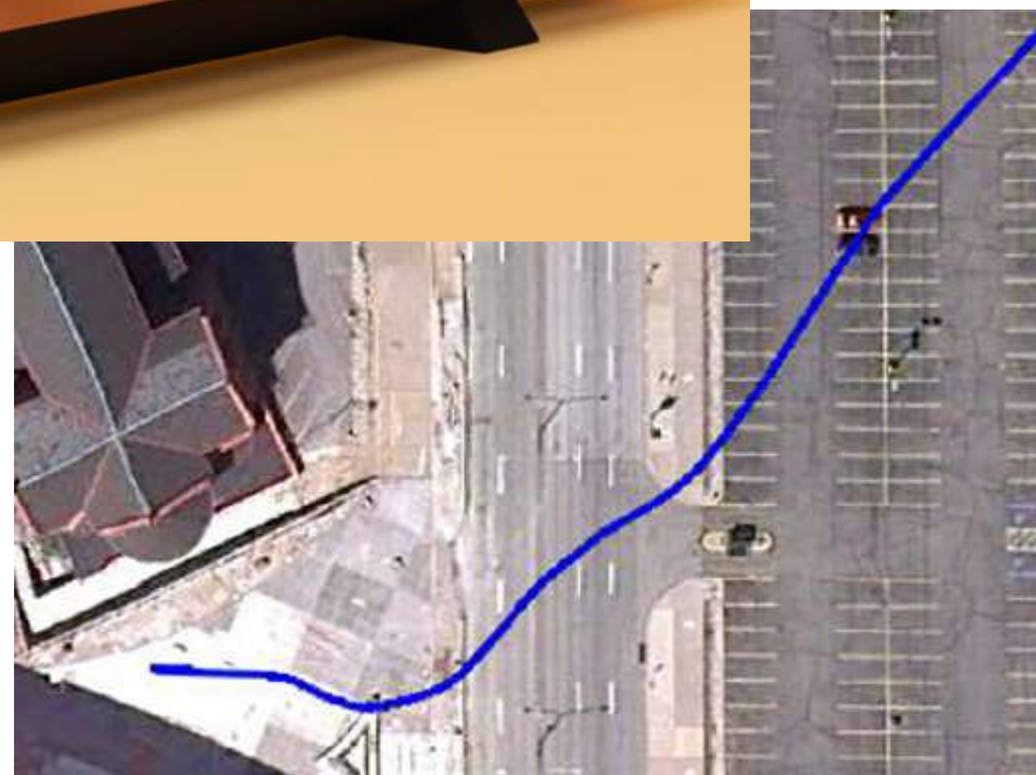
GYROSCOPIC MAPPING PROBE





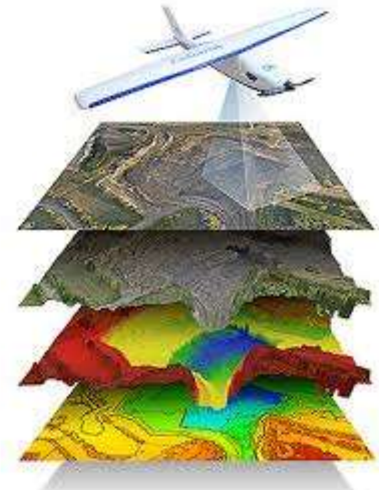
FUTURE?.......NOW!

- Web-Based GIS
  - Share information across the internet
  - Live field updates to existing data
  - Greater “Transparency”
- Mobile – view and/or update remotely
  - Tablet devices
  - Mobile phones
- Centralized GIS databanks / Servers
  - Reduce data redundancy
  - Provide access to more people
  - Enhanced Analysis
- 3D, 4D, 5D?
  - Above and below ground
  - Analysis / Modeling
  - Temporal Information

FUTURE?.......NOW!

- UAV / UAS – Unmanned Aerial Vehicles



- Internal Building Routing


- Your Imagination and Budget...........

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DISCUSSIONS – THANK YOU FOR YOUR TIME

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