# NPDES and GIS: 10 Years of Evolution from Inventory to Application



England-Thims & Miller, Inc.
Engineers • Planners • G.I.S. • Landscape Architects • Surveyors

# What Is NPDES?

- NPDES = National Pollutant Discharge Elimination System
- To reduce the amount of pollutants in storm water runoff in order to improve the quality of waters of the United States.

# History of NPDES

In 1990 the U.S. Environmental Protection Agency (EPA) developed Phase I of the federal National Pollutant Discharge Elimination System (NPDES) stormwater permitting program. Phase I applies to "large" and "medium" Municipal Separate Storm Sewer Systems (MS4s) located in incorporated places and counties with populations of 100,000 or more.

# The Permittees

- The City of Jacksonville, Florida (COJ)
- The Florida Department of Transportation District II (FDOT)
- **The City of Atlantic Beach*
- **The City of Neptune Beach*

** Permittees that later acquired separate NPDES Permits*

# Part 1 of the NPDES Permit

Requires a description of the municipality's current understanding of:

- The location of its MS4
- Existing quality of both runoff and surface waters
- Existing legal authority to enforce current controls on connections to that MS4

Particular attention is paid to providing a cursory initial assessment as to the location of discharge points to waters of the state.

# England-Thims & Miller, Inc.

The City of Jacksonville hired England-Thims & Miller, Inc. (ETM) in June of 1991.

ETM's Role:

- Researched existing infrastructure
- Provided water quality sampling
- Provided dry weather field screening
- Assisted in the development of Best Management Practices (BMPs)
- Ensured adequate legal authority
- Assisted in other issues related to obtaining an NPDES permit

# Part 1 of the NPDES Permit (cont.)

- Submitted to the EPA in November 1991
- Included the City of Jacksonville, FDOT, the City of Atlantic Beach, and the City of Neptune Beach
- Illustrated the major municipal separate storm sewer outfalls throughout the county as manually identified on quad maps
- Field screening was performed at 500 screening point
- Potential illicit connections were found using visual surveys of each drainage area
- Illicit connections were documented, photographed, and cataloged

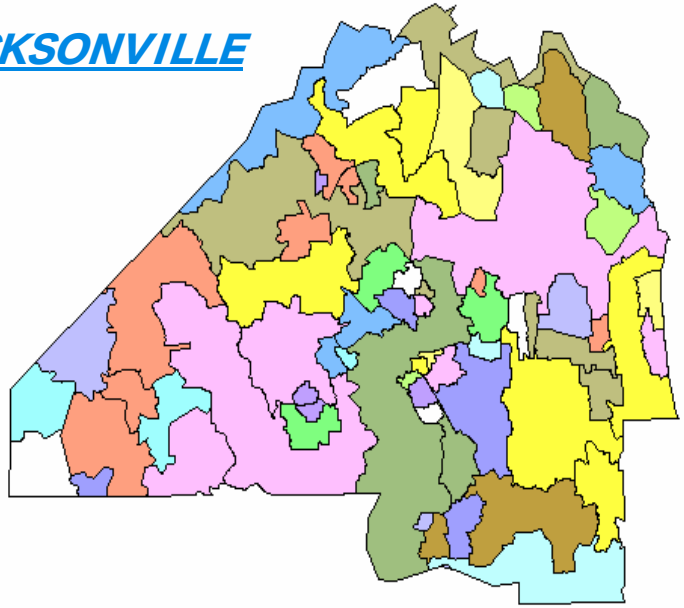
# Part 2 of the NPDES Permit

- Submitted to the EPA in November 1992
- Described the City's proposed Stormwater Management Program (SWMP)
- Assessed the controls for the City's proposed SWMP
- Provided:
  - Characterization data for representative outfalls (wet weather sampling)
  - Pollutant loading
  - Event mean concentrations
  - Proposed monitoring program
  - Identification of industrial discharges
  - Watershed identification
  - Locations of additional major outfalls

# GIS Meets NPDES (WooHoo!)

- 1996 – Contract for pilot NPDES GIS Mapping Stage 1 program
- ETM inventoried three representative sections of Duval County
  - Grove Park – Suburban area
  - Newtown – Urban area
  - White House – Rural area
- ETM developed GPS data collection standards based on information obtained through the pilot project
- 1998 – Contract is amended to extend services thru Nov. 2002
- Main tasks for new contract:
  - Collection of entire stormwater drainage system for all of Duval County
  - Development of a GIS application
  - Additional NPDES related tasks (priority industry, illicit connections)

***JACKSONVILLE***



- **Over 70 Watersheds**
- **Largest Municipal Area in Lower 48 (874 Mi. Sq.)**

## ***MS4 Features***

- Inlets
- Control Structures
- Endwalls
- Ditches
- Retention Ponds
- Potential Illicits
- Manholes
- Pipes
- Field Screening Points

# New Approaches

- Since the beginning, the City of Jax, FDOT and ETM have worked closely to incorporate innovative approaches!
- ETM began using sub-meter GPS to map the location and collect data in the field in 1997.
- In 2003 access to the NPDES by authorized City and FDOT staff was provided via ArcIMS.
- In 2006 ETM incorporated GeoAge's FAST tools to investigate and map potential illicit connections.

# Stormwater Drainage Data Collection

Initial Collection Method

- Drainage structures collected street-by-street, basin-by-basin
- Attribute data and GPS data was collected separately
- Palmtop computers were used to collect attribute data
  - Unique IDs were marked on each structure and on the field maps
  - Attribute data was collected and downloaded daily
- GPS crews used paper maps and field markings to collect the location of each structure
- Attributes were linked to the GPS points in the GIS

# Stormwater Drainage Data Collection

Current Collection Method

- New GPS units were acquired
- Attribute data and GPS data collected at same time
- One crew can collect both GPS and attribute data
- Reduced error and expedited the collection process
- Field maps still used to assist in the QA/QC process

# End Result Is a bunch of Data!

## ***Base Layers***

- Aerial Photographs
- Drainage Basins
- Floodzones
- Hazardous Waste Sites
- Hydrography
- Landuse
- EPA Sites
- Street Centerlines
- Tax Parcels
- Topography
- Treatment Facilities
- Wetlands
- DRG Quads

## ***NPDES Layers***

- Control Structures
- Closed Conveyances (Pipes)
- Open Conveyances (Ditches)
- Endwalls
- Inlets
- Management Facilities/Treatment Facilities (Ponds)
- Manholes
- Pumps
- Natural Drainage Features

# NPDES Structures Collected

## As of Feb 2007

- 9,997 Manholes
- 26,848 Endwalls
- 58,012 Inlets
- 1,848 Control Structures
- 1,285 Miles of Pipes
- 2,156 Potential Illicit Connections (PICs)

# Current Tasks

- Completed initial field data collection in 2002
- 2003 – Started maintenance of the MS4 inventory data
  - Geodatabase Development
  - Quality Control and Quality Assurance
- Illicit connection investigation and resolution
- Priority industry identification
- Annual report support

# Database Design Equation

ESRI Free GDB Models

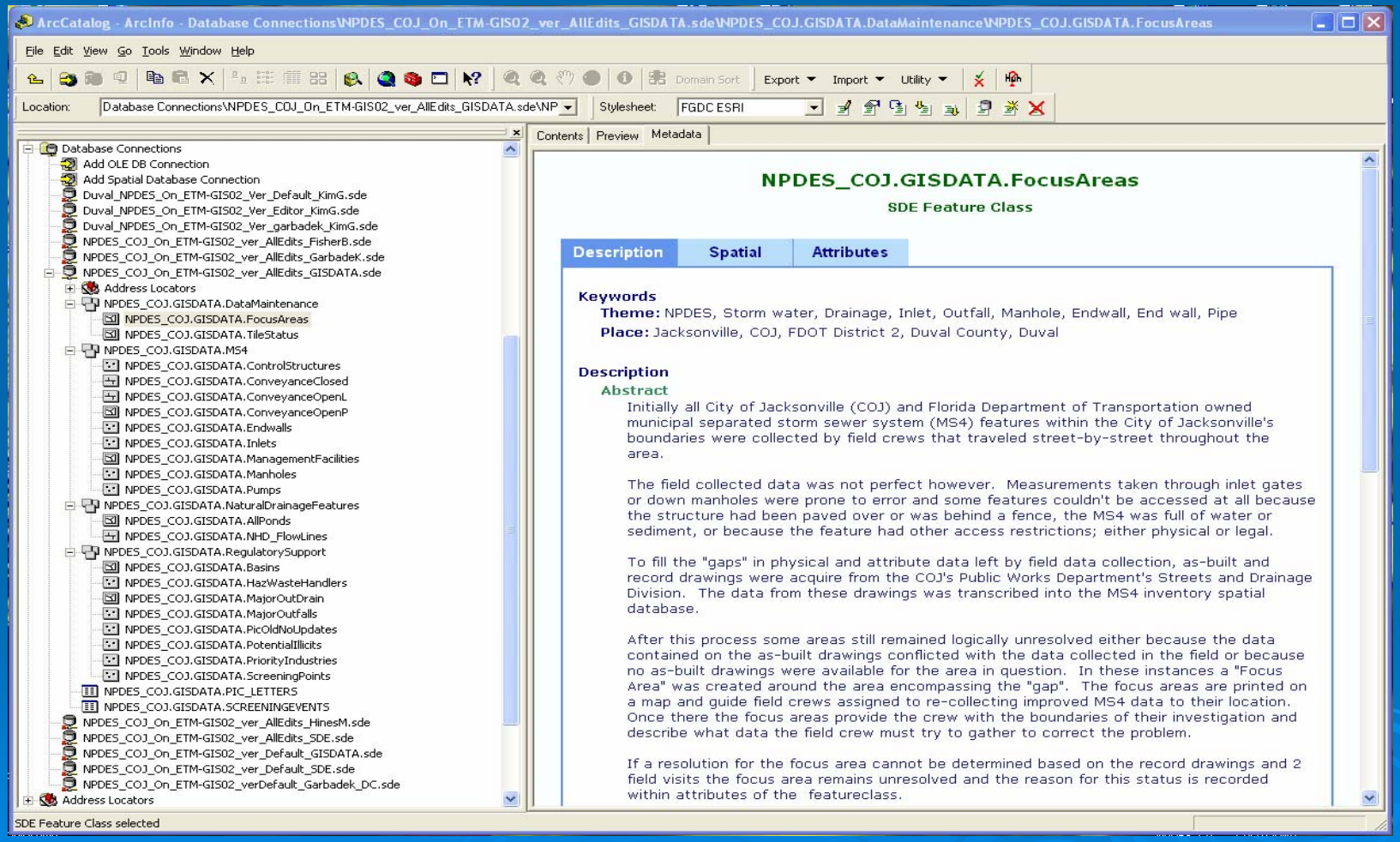
(Water Utilities/Hydro)

Existing Data
- Shapefiles
- Coverages
- Excel
- SQL Server
- Access

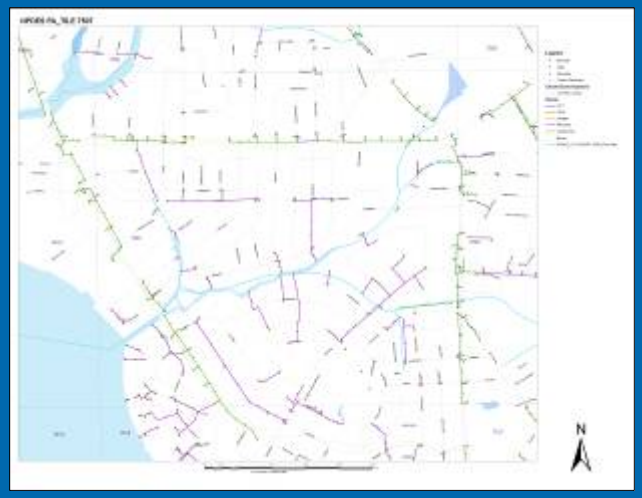
Design Methodology

- Conceptual Design
  - Identify information products
  - Identify key thematic layers based on these products
  - Specify scale and spatial representation
  - Group layers into datasets
- Logical Design
  - Define tabular structure
  - Define spatial properties
  - Draft geodatabase design
- Physical Design
  - Implement, prototype, review and refine
  - Design work flows for maintenance
  - Testing
  - Documentation

# Equals…..Organization



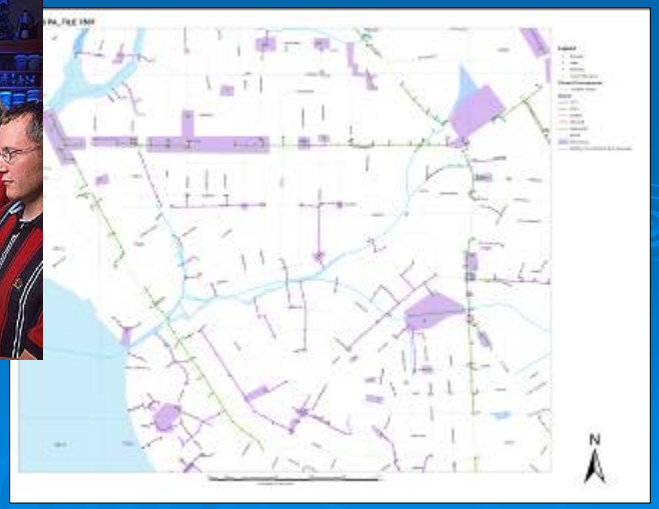
# Quality Assurance Process



1. Tile of NPDES data is plotted

2. FDOT and City As-Builts are pulled for the area and compared

3. Tile is marked up for data corrections



4. Data corrections are made and field focus areas defined (purple areas)

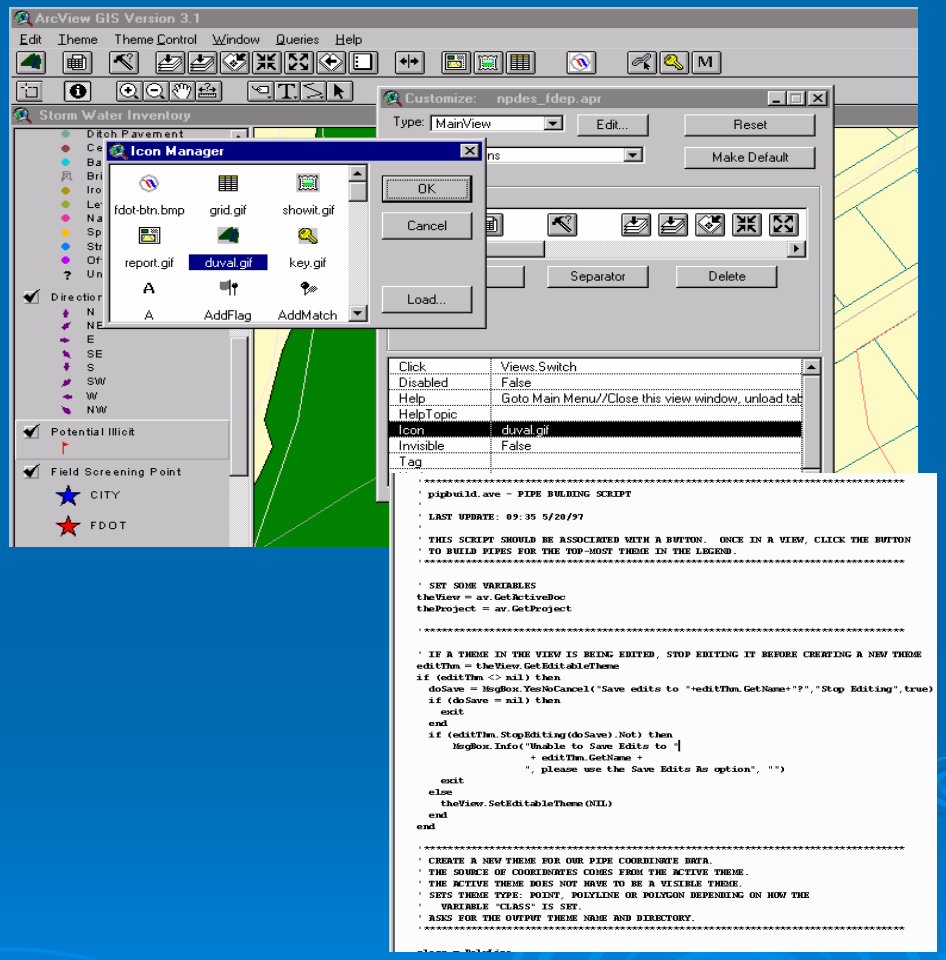
# Quality Assurance Process (cont.)

5. Tile is plotted with aerial for field verification

6. Final corrections are made to the database

# Programming: Interface & Utilities

- Developed Based on End-User Needs
- Interface Geared Toward Data
- Specific Queries Can Be Developed for Fast Analysis
- Develop Utilities to Streamline Common Tasks - Pipe Builder
- Meta Data Viewer: Data about the Data



# GIS Application

Initial Application

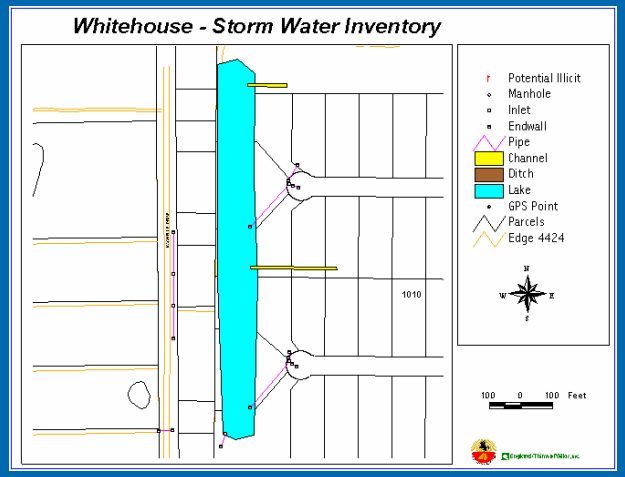
- Developed using ESRI's ArcView 3.x
- Completed in 1998
- Spatial data stored in shapefile format
- Attribute data stored in MS Access database
- Photos stored in bitmap format in a structured file directory
- Additional functionality was added

Updated Application

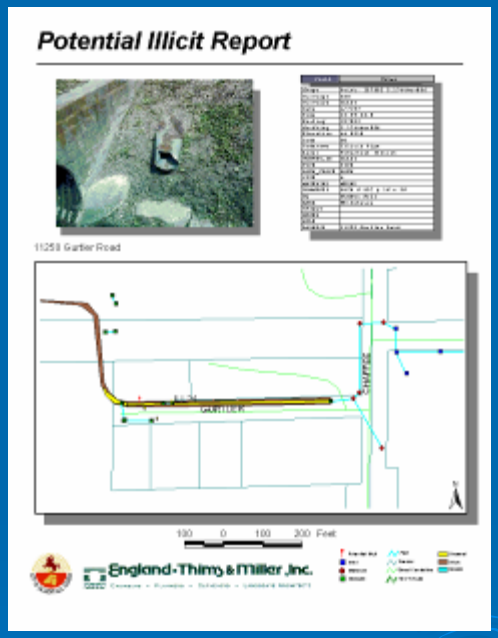
- Developed using ESRI's ArcGIS 8.x
- Completed in March of 2003
- Additional functionality was rewritten to work in new software

# Report Generation


***Attribute Data Report***




***Spatial Data Report***




***Spatial & Attribute Data Report***

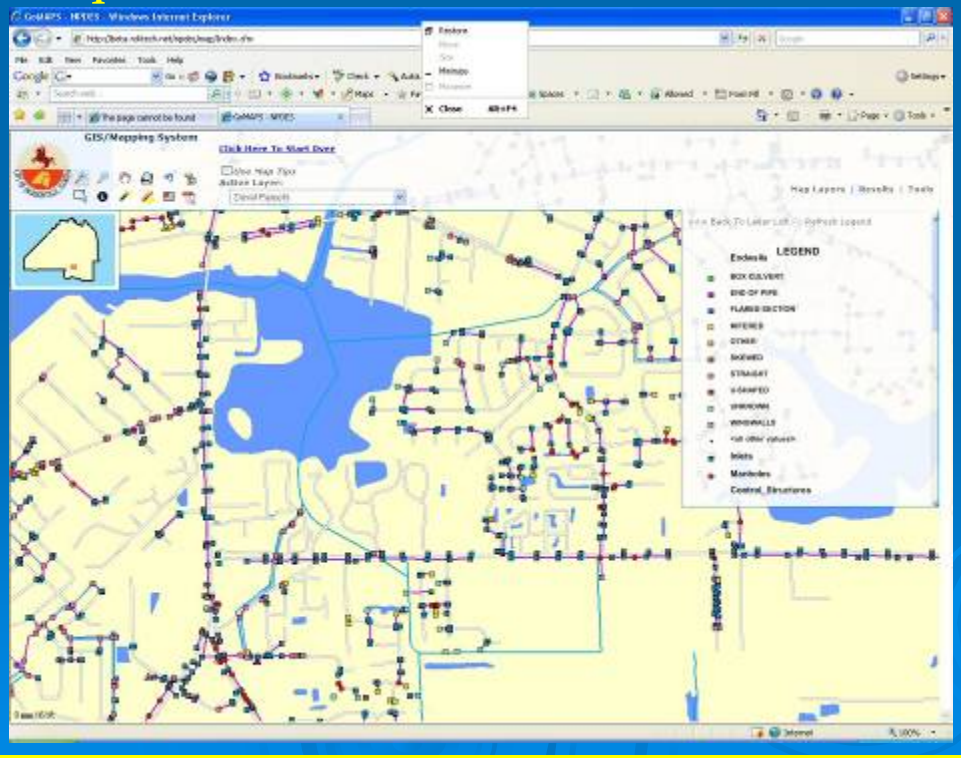
# GIS Application

Additional functionality

- Specialized tools and buttons were created to provide:
  - Basin Query
  - Structure Query
  - FDOT Roadway Query
  - Street Centerline Query
  - Address Finder
  - Show Photo Tool
  - Report Maker Tool
  - Application Settings Dialog
  - View Bookmarks

# GIS Web Application

- Developed using ESRI's ArcIMS 4.x and ColdFusion MX
- Provides same functionality as desktop application
- Browser based application provides enterprise access to data
- Does not require an ESRI ArcGIS license to use



# Success

- The MS4 spatial database coupled with field screening, illicit connection, priority industry, parcel, land use, hydrologic and wetland coverages has been instrumental in the City's ability to pass each and every annual inspection since receiving its NPDES permit in 1997.

# Future Plans to Add Value

- Continue the adoption of innovative practices and technology
- Include interfacing with Maximo; the City's work management system
- Linking the GIS to scanned as-built drawing
- Adopting digital submission standards and practices to streamline update of the MS4 spatial database

# Lessons Learned

- Education of field crews beyond “Here’s how to use the equipment, now go get structures.”
- Geodatabase = Good Thing!
  - Centralization/Organization/Never having to ask “Which control structures shapefile are we talking about?”
- As-builts are important.  Accuracy checks and digital submissions are recommended.
- Technology is great but data is forever.
- Use ESRI development environment to create “Smart Tools”.