Integrating Geographic Information Systems (GIS) into NPDES Monitoring

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GIS = “Geographic Information Systems”

- GIS is used to **capture, manage, analyze** and **display** geographic information
- GIS helps reveal **relationships, patterns** and **trends**
- Can help with **NPDES permit compliance**:  
  - Tracking minimum measures
  - Solving problems
  - Answering questions
Benefits of GIS

- Cost Savings
- Better Decision Making
- Improved Communications
- Better Record Keeping
- Managing Geographically

Note: UNC uses Esri ArcMap products

from: [http://www.esri.com/what-is-gis](http://www.esri.com/what-is-gis)

Bring various sources of information together to create a comprehensive, more accurate and useful map
Benefits of GIS

Put maps in the hands of all who need them

UNC – Chapel Hill

- Located in Chapel Hill, Orange County
- About 30,000 students
- Over 800 acres in Central Campus
- More than 400 buildings
- Usually 3 – 6 concurrent projects requiring NDENR ESC Permits
History of GIS at UNC
Stormwater Management

- **Stormwater Master Plan** (2001)
  - Stormwater inventory (2001 – 2003, approx)

- Stormwater inventory **migrated into Enterprise GIS** (2005)
  - Moved data from individual sources into GIS database
  - Allows multiple people to view and edit GIS data

- **NPDES Phase II Permit** (2008)

First, UNC gathered **stormwater infrastructure** data

- **External Data Collection** (Contractors)
  - Rose Group
  - RK&K

- **Internal Data Collection & Maintenance** (UNC Staff)
  - Energy Services
  - Grounds
  - EHS
  - Facilities Services Engineering Information Systems (GIS)
History of GIS at UNC
Stormwater Management

- **Types of structures inventoried:**
  - Pipes
  - Grates
  - Manholes/Junctions
  - Inlets
  - Outlets & Outfalls

- **Information collected:**
  - Size of structure
  - Material
  - Age
  - Condition
  - Connectivity
  - Inverts
  - Location
  - ID Numbers

UNC’s NPDES Phase II Permit
UNC’s NPDES Phase II Permit

Six Minimum Measures

- Post-Construction Runoff Control
- Pollution Prevention & Good Housekeeping
- Illicit Discharge Detection & Elimination
- Public Participation & Involvement
- Public Education and Outreach

UNC’s NPDES Phase II Permit
UNC’s NPDES Phase II Permit

Six Minimum Measures

- Construction Site Runoff Control
- Post-Construction Runoff Control
- Pollution Prevention & Good Housekeeping
- Public Education and Outreach
- Public Participation & Involvement
- Illicit Discharge Detection & Elimination

Illicit Discharge Detection & Elimination
Section D.2.a

- Outfall inspection, sampling & maintenance
- Detection & elimination of illicit discharges, spills & illegal dumping
- Reporting & Recordkeeping
- Training & Development
- Implementation of BMPs
The Tale of the Odiferous, Mysterious, Mid-Summer Day’s Illicit Discharge
A routine outfall inspection on a mid-summer’s day...

During one weekly inspection, we discovered an unsightly, smelly substance in the stream.

Observation and testing indicated a possible sewage leak.
An investigation begins...

**Desk Work**
Used GIS to *create map* of area surrounding outfall where sewage was observed.

**Field Work**
Used printed copy of GIS map to *follow the path of storm drain pipes* to upstream manholes.

**Desk Work**
Used GIS as a *communication tool* to update customers throughout investigation.

First, create map of area surrounding outfall where sewage was observed.

![Zoomed-in area where leak was discovered](image)
Next, change map symbology to make it easier to see the different features...

Storm drain pipes:
- thicker green lines

Sanitary sewers:
- dashed green lines

...change map symbology to make it easier to see the different features.

Legend
- Drain
- Main
- SewerLaterals
- GravitySewerMains
- UNCSewerLaterals
- UNCGravitySewerMains
- UNCAbandonedSewerMains

It can be helpful to use bright colors for the different types of pipes. Color-coding can improve field work efficiency.
Intersections of storm and sanitary pipes:

- **Low risk**
- "Need more info"

(more on this later in presentation)

Check for cross-connections

Follow path of storm drain pipes to upstream manholes

- At each manhole/inlet, we did a visual observation to check for odors or solids in the storm pipes.
- If odors or solids were detected, we lowered ammonia test papers into storm drain to measure magnitude of ammonia.
- We then used pole cameras to view insides of pipes to check for signs of damage.
Follow path of storm drain pipes to upstream manholes, continued...

Circles indicate manholes/inlets tested for ammonia. If still present, we went up the line. If not present, the sewage leak was between that point and the last manhole/inlet, or came from a different section of pipe.

Follow path of storm drain pipes to upstream manholes, continued...

- **Red arrows** - higher levels of ammonia
- **Blue arrows** - decreased or no ammonia
Text was added to GIS map to provide detailed information to UNC managers and OWASA (Orange Water And Sewer Authority).

Add text and send out periodic updates.

Final Result
IDDE investigation summary

- The map created in GIS enabled us to **efficiently track** the path of the contamination.
- **Text and drawings** were easily added to maps to tell the investigation story and keep folks informed.
- The **final map** was sent to OWASA, and they used their specialized equipment to verify the location of the broken pipe and conduct repairs.

![Map Image]

Tracking IDDE Events

![GIS Map Image]
Instructions for how to look up information on a specific incident in ArcMap

Illicit Discharge Detection & Elimination
Section D.2.d: Detection and Elimination

- Dry weather outfall inspections
  - Inspect 1/5 of geographic area or community per year during dry weather conditions, test flows found at discharge points as needed

- Maintain outfall inspection database:
  - Inspection date
  - Tests conducted
  - Findings
  - Corrective actions
Illicit Discharge Detection & Elimination
Section D.2.d: Detection and Elimination

A mapbook is useful for scheduling inspections.

Mapbooks allow the GIS user to create a single template for multiple geographic locations.
Illicit Discharge Detection & Elimination

Section D.2.d: Detection and Elimination
Illicit Discharge Detection & Elimination
Section D.2.d: Detection and Elimination

Outfall inspections

Illicit Discharge Detection & Elimination
Section D.2.e: Storm Sewer System Mapping

- Maintain a storm sewer map showing outfalls and the receiving body of water.
- Visual inspections of the storm sewer system including outfalls
- Maintain an inventory of drainage structures and storm sewer system maps.
- Categorize outfalls by the receiving water

Information included:
- Location
- Reference number
- Size and type of structure
- Condition
- Dry-weather flow
Illicit Discharge Detection & Elimination
Section D.2.e: Storm Sewer System Mapping

- Identify and potential cross-connections
- Cross-connections are where storm and sanitary pipes are in close proximity
- High risk of SW and SS liquids intermingling
- Risk determined by pipe age, material & vertical placement

Illicit Discharge Detection & Elimination
Section D.2.g: Local Wastewater Program

- Low risk
- High risk
- Need more info
Construction Site Runoff Control
Section E.2.c: Sediment and Erosion Control Plan (Sites greater than 1 acre)

- All construction projects that impact greater than one acre must submit a Sediment and Erosion Control Permit application to NC DENR Land Quality for review and approval.

- ESC Permit must contain:
  - Site size
  - Location of infrastructure
  - Location of natural areas

- Permit is required prior to start of construction!
Construction Site Runoff Control
Section E.2.c: Sediment and Erosion Control Plan (Sites greater than 1 acre)

- Use GIS to delineate size of projected construction site
- Calculate area, add text, use color to clarify information

Construction Site Runoff Control
Section E.2.c: Sediment and Erosion Control Plan (Sites greater than 1 acre)

- Use GIS to determine location and magnitude of erosion & sediment control measures
- Can add contours, elevations, barriers, etc.

Stormwater inlets requiring inlet protection
Drilling project
Construction Site Runoff Control
Section E.2.c: Sediment and Erosion Control Plan (Sites greater than 1 acre)

- Use GIS to delineate stream buffers
- Add natural areas:
  - Conservation Areas
  - Wetlands
  - Flood Plains
  - Natural Heritage Program Sites

50 ft Stream buffer

Building Addition

Post-Construction Runoff Control
Section F.2.a: Standards and Policies on BMPs for Post-Construction Controls

- Post-construction BMP Inspections:
  - Inspect for structural or functional deficiencies & determine follow-up actions
  - Identify specific preventive maintenance
  - Identify potential retrofits

Inspector is required to have current NCSU BMP Inspection & Maintenance Professional certification
Post-Construction Runoff Control

Section F.2.a: Standards and Policies on BMPs for Post-Construction Controls

- BMP inspections conducted **annually** (some quarterly)
- Inspections **documented using forms and photos**, then added to ArcMap
- In the future, hope to use **apps to collect data**
- BMP inspection data is stored in a **related table** and joined with **stormwater geodatabase**
Post-Construction Runoff Control
Section F.2.a: Standards and Policies on BMPs for Post-Construction Controls

- **Storm Drain Preventive Maintenance:**
  - Inspect each inlet and junction **annually**
  - Check for structural or functional **deficiencies** & determine **follow-up** actions
  - Identify specific **preventive maintenance**
  - Identify **potential retrofits**
  - **Update geodatabase** with corrections and updates

- Energy Services maintains storm drain mapping and database
- Data exported to **Work Management System**
- Stormwater Maintenance team uses **mapbook and Esri Explorer app** in the field
- Corrections and updates are sent back to Energy Services to **update in GIS**
Pollution Prevention & Good Housekeeping
Section G.2.b: Spill Prevention and Response

- The University shall maintain storage procedures that include:
  - Provision of secondary containment
  - Development of spill prevention
  - Spill containment, control and countermeasure plans and/or safety plans (SPCC Plan)
  - Preferred sheltering of all chemicals and other hazardous substances

Pollution Prevention & Good Housekeeping
Section G.2.e: Storm Sewer System Maintenance

- Storm Sewer System Maintenance
  - Inlet and catch basin cleaning
  - Pipe cleaning
  - Curbside leaf removal
  - Parking lot and road sweeping
  - Planting and mulching of erosion-prone areas
Pollution Prevention & Good Housekeeping
Section G.2.g: BMP Inspection and Maintenance

- Non-Structural BMP Inspection and Maintenance
  - Evaluate non-structural BMPs annually
  - Implement more stringent BMPs where needed
  - Develop written program:
    - Inspection and maintenance requirements
    - Frequency of inspections
    - “How-to” instructions for maintenance
    - Inspection and maintenance tracking system

Pollution Prevention & Good Housekeeping
Section G.2.h: Waste Management

Dumpsters, recycling, kitchen waste, and animal recycling locations are tracked in GIS
Public Participation and Involvement
Section C.2.a: Faculty and Student Involvement

- **Stencil** minimum of 100 storm drain inlets annually
  - Student worker installs storm drain markers
  - Uphill battle keeping them installed (weather, scavenger hunts)
  - Marked drains documented in GIS

- **Research projects** involving faculty and grad students
  - Capstone class
  - Battle Grove 319 Grant (Regenerative Stormwater Conveyance)

So, how can your organization get started?

Crawl → Walk → Run
So, how can your organization get started?

- Get management support
- Create sample map  
  - Use GIS to solve a problem
- What's already available?
  - Basemap:  
    - Aerial photography
    - Buildings
    - Streams & watersheds
    - Start easy: outfalls

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So, how can your organization get started?

- Software & Apps  
  - Does your organization already have a program & site license?  
  - Or, look into open source (free)
- Partnerships  
  - County GIS Department
  - Schools
So, how can your organization get started?

- **Funding**
  - GIS is a budget item
- Building a **program**
  - Internal
  - Hire a GIS consultant
- **GIS is institutionalized**
  - Other departments “want in”
  - Multiple users
  - Workload efficiency improved with GIS

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So, how can your organization get started?

- **Funding**
  - GIS program is funded
  - Enough GIS staffing
  - Resources to outsource big projects
- **GIS Users Groups**
  - Involve different departments
- **Organization** sees GIS as a valuable resource
- Publish maps on your **website**
Resources and Training

- Find someone in your department already using GIS
- ArcGIS online: free! arcgis.com
- esri.com: free, excellent training!
- FEMA training: free! Do online search for “GIS for Emergency Managers”
- Google Earth and Google Pro: free!
- Take a GIS class at local college or university

Where can you find GIS data?

- Government Websites:
  - Federal
  - State: NC OneMap is a great start
  - County
  - Municipal
  - Local
- University GIS Libraries
- Esri and other mapping services
- Some non-profit agency websites
Conclusion

- GIS is an excellent tool for **NPDES permit compliance**:
  - Tracking minimum measures
  - Solving problems
  - Answering questions

- Using GIS to **capture, manage, analyze** and **display** geographic information will help your organization **measure and maintain** compliance goals

- Once your organization is using GIS, you will wonder how you managed without it!

Questions?

When you wash your car in the driveway, you aren’t just washing your car in the driveway.

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