Using GIS to Meet Distribution Integrity Management Program (DIMP) Requirements

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Robert McElroy – New Century Software

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Presentation Outline

• Brief Overview of DIMP
• Role of GIS
• Data Model Requirements
• Other Data
• Spatial Risk Assessment Using GIS
• Using Risk Valuations in GIS
• Monitor Results and Continually Improve
• Integrating Data to Make Informed Decisions
• Five Things to Do Right Now
What is Distribution?

- 9,221 Operators
  - Large
  - Small
  - Master Meter
  - LPG
- 1,138,000 Miles of Main
- 750,578 Miles of Service (est.)
- 60,970,000 Services

http://ops.dot.gov/regs/small_ng/images/Chapter1_img_1.png
DIMP Requirements

Required by Proposed Federal Regulations

The Seven Elements:
1. Knowledge of infrastructure
2. Identification of threats
3. Evaluation and prioritization of risks
4. Mitigation of risks
5. Measuring and monitoring of performance
6. Periodic evaluation and improvement
7. Reporting of results
Element 1
Know Your System

• Assemble as complete an understanding of infrastructure as possible
  – Use the best information available
• IM program should identify gaps
  – Address through normal activities
  – Record data from any new installations, maintenance, and exposures
• GPTC: Current data maintenance practices may be good enough
  – ...or they may need modification
Element 1
Know Your System

Where is your data now???

- Leak data
  - Is it attached to pipe/facilities?
- External force damage
  - 3rd party
  - Construction activity
  - Geo-hazzards
- Corrosion and CP data
- Pipe and facility data
  - Mechanical fittings
  - Reconditioned pipe
  - Cast Iron / problem pipe
- Compliance and Inspection data

- Is this data available in GIS?
- Is it geo-located?
- Can it be accessed from GIS?
- Is it all in separate systems and databases?
Role of GIS

• GIS provides spatial and tabular means to collect, merge, store, display, analyze, report, and validate data
  – Facility geometry + attributes + relationships
  – Landbase geometry + attributes + relationships

• May need to gather, convert, or migrate data to meet full requirements

• If you don’t have a GIS, you’ll be at a disadvantage
Data Model Requirements

• DIMP does not imply a fixed data model
• Standard Data Models mostly sufficient
  — Example: ArcGIS Gas Distribution Data Model
  • Provides **template** for building your model
  — Great deal of variation in GIS implementations
• Assumes non-stationed data in a geometric network
Data Model Attributes

• Do you have a Transmission / HP model with HP Distribution Pipe?
  – APDM
  – PODS

• Must be considered for DIMP
Data Model Attributes

- Recommended attributes in facility data
  - Distribution Main and Service Pipe

<table>
<thead>
<tr>
<th>Subtype(s)</th>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Pipe</td>
<td>Diameter, Depth of Cover, Above Ground Indicator, Installation Date, Connection Type, Pipe Grade, SMYS, Design Pressure, SOP, SOP Range</td>
</tr>
<tr>
<td>Steel Pipe</td>
<td>Material, Coating, Cathodic Protection, Wall Thickness</td>
</tr>
<tr>
<td>Plastic Pipe</td>
<td>Material, SDR, Pipe Manufacturer, Product Name, Resin Manufacturer, Resin Name, Pipe Color, (Print Line data)</td>
</tr>
</tbody>
</table>
## Data Model Attributes

- **Recommended attributes in facility data**

<table>
<thead>
<tr>
<th>Feature Class</th>
<th>Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed Pipe Inspection</td>
<td>Coating Condition, Corrosion Indicators (Pitting Depth), Date (Questar Gas uses FAR Report)</td>
</tr>
<tr>
<td>Pipe Test Data</td>
<td>Pressure Test Date, Pressure Test PSIG (link to pipe directly or through work order)</td>
</tr>
<tr>
<td>Pipeline Markers</td>
<td>Location</td>
</tr>
<tr>
<td>Leak Reports or Leak Repairs</td>
<td>Leak Class, Leak Cause, Date</td>
</tr>
</tbody>
</table>
Element 2
Identify Threats

• GIS: aggregates multiple data sources
  – Facility data covers system components and operations
  – Other data sources are input to analysis (e.g., threats and consequences)
• Risk analysis involves simultaneously considering many factors
  – Use GIS to consolidate and quantify them
• Regulation provides example threats
Role of GIS

• **Identifying Threats:** Sample GIS Data Sources

<table>
<thead>
<tr>
<th>Threat</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrosion</td>
<td>Facility Database:</td>
</tr>
<tr>
<td></td>
<td>• Main and Fitting attributes</td>
</tr>
<tr>
<td></td>
<td>• Leak attributes</td>
</tr>
<tr>
<td></td>
<td>• CP readings</td>
</tr>
<tr>
<td></td>
<td>Natural Resources Databases:</td>
</tr>
<tr>
<td></td>
<td>• Soils Data</td>
</tr>
<tr>
<td>Outside Forces</td>
<td>Natural Resources Databases:</td>
</tr>
<tr>
<td></td>
<td>• Soils Data</td>
</tr>
<tr>
<td></td>
<td>• Seismic Zones / Geo-hazards</td>
</tr>
<tr>
<td></td>
<td>• Flood plains, snow/ice slope</td>
</tr>
<tr>
<td>Excavation Damage</td>
<td>Census Bureau:</td>
</tr>
<tr>
<td></td>
<td>• Areas of growth and trends</td>
</tr>
<tr>
<td></td>
<td>Local Government:</td>
</tr>
<tr>
<td></td>
<td>• Building permit applications</td>
</tr>
<tr>
<td></td>
<td>• One Call ticket density</td>
</tr>
</tbody>
</table>
## Role of GIS

<table>
<thead>
<tr>
<th>Threat</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Outside Forces</td>
<td>Roads Database:</td>
</tr>
<tr>
<td></td>
<td>• Streets, Road types</td>
</tr>
<tr>
<td></td>
<td>Facility Database:</td>
</tr>
<tr>
<td></td>
<td>• Above-ground pipe indicators</td>
</tr>
<tr>
<td>Material or Welds</td>
<td>Facilities Database:</td>
</tr>
<tr>
<td></td>
<td>• Pipe Material, Plastic</td>
</tr>
<tr>
<td></td>
<td>• Resin/Manufacturer/Lot</td>
</tr>
<tr>
<td></td>
<td>• Connection Type Used</td>
</tr>
<tr>
<td></td>
<td>• Leak Frequency</td>
</tr>
<tr>
<td>Equipment Malfunctions</td>
<td>Facilities Database:</td>
</tr>
<tr>
<td></td>
<td>• Leak Repair records</td>
</tr>
<tr>
<td></td>
<td>• Maintenance records</td>
</tr>
<tr>
<td>Operations</td>
<td>Maintenance Records:</td>
</tr>
<tr>
<td></td>
<td>• Failures due to not following procedures,</td>
</tr>
<tr>
<td></td>
<td>safety practices, workmanship?</td>
</tr>
</tbody>
</table>
Role of GIS

- Determining **Consequences**: Sample GIS Data Sources

<table>
<thead>
<tr>
<th>Consequence Factor</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas Pressure and Volume</strong></td>
<td>Facility Database:</td>
</tr>
<tr>
<td></td>
<td>• Distribution Main Operating Pressure</td>
</tr>
<tr>
<td></td>
<td>• Distribution Main Diameter</td>
</tr>
<tr>
<td><strong>Buildings, Business Districts</strong></td>
<td>Local/State Government Databases:</td>
</tr>
<tr>
<td></td>
<td>• Shapefiles</td>
</tr>
<tr>
<td></td>
<td>• Engineering &quot;planimetrics&quot;</td>
</tr>
<tr>
<td><strong>Surface Cover</strong></td>
<td><strong>2001 NLCD</strong></td>
</tr>
<tr>
<td></td>
<td><strong>TerraServer, Google Earth</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Local/State Government Databases</strong></td>
</tr>
</tbody>
</table>
Other Data Sources

• GIS offers ability to leverage government and 3rd-party data
• Examples:
  – USGS, FEMA, Census Bureau, USDA/NRCS, National Agriculture Image Program
  – County Assessor and Tax Offices
  – US DOT for County Roads
  – ESRI on-line services
  – National Pipeline Mapping System (NPMS)
  – Unusually Sensitive Areas (USAs – PHMSA)
  – One Call ticket densities
Role of GIS

• One Call ticket densities
  – Questar Gas Example

• Excellent way to analyze construction activity around pipelines and facilities

• The biggest threat to pipelines
Role of GIS

ArcGIS/ArcFM Data Model
- Pipe Geometry and Attributes
- Related Objects (Pressure System, CP System)
- Leak Reports/Repairs
- Exposed Pipe Inspection
- Pipeline Markers

Other/Landbase and digital data
- Soil Types
- Roadways
- One-Call Tickets
- Building Footprints
- Other Threats
- SME Input
Element 3
Evaluate and Prioritize Risk

- Both existing and potential threats
- Distribution Systems vary widely
  - Different information available
  - Different threats
  - May assign different values during risk ranking
- Use or obtain all available data or develop means to capture data over time
Distribution System Risks

Source: PHMSA Significant Incidents Files October 14, 2008
3rd-Party Damage Risk

Source: Common Ground Alliance analysis of 2004 - 2006 data submitted to DIRT
Risk Assessment

• Overall Risk = Probability of Failure (PoF) X Consequences of Failure (CoF)

• Consider
  – Probability of Failure (frequency)
  – Consequences of Failure (extent of potential damage)

• Use SME or mathematical method

• Scores determine relative risk
Role of GIS

• Risk on pipe is a spatial question
  – Must consider many factors simultaneously to arrive at risk value
  – Risk applications must perform numerous techniques to determine risk rating values
  – GIS plays key role
Element 4
Mitigation of Risks

Once you’ve established risk for pipe segments...

• Sort by risk and attack highest first

• Manage Risk by
  – Reducing the probability of a problem occurring
  – Lessening the consequences of a potential problem.

• Pursue prevention, remediation, mitigation, and A/A Actions
Role of GIS

- GIS can support grouping of pipe into projects.
- Some considerations:
  - Do clusters of high-risk pipe exist?
  - Where do risk scores support upgrade of an entire low-pressure system to medium pressure?
  - Where are other utilities planning road excavations?
  - Where are exclusion zones or “moratorium” areas?
  - What technology is to be used?
    - Trench and replace?
    - Trenchless (slipline, poly woven hose)
Element 5
Monitor Results

• Measures should reflect your specific risk management practices
  – Examples:
    • Number of leaks, grouped by cause and by material
    • Number of excavation damages
    • Number of excavation tickets
    • Number of EFVs
  – Should track back to identified threats
  – Evaluate data being collected
    • Format (digital data, linked to facilities, location?)
    • Consistent measurement techniques (e.g., leak type)
Element 6
Periodic Review

• Written plan

• Review the effectiveness of the program
  – A complete re-evaluation required every five years
  – Which practices are producing results?
    • Tie technique or practice to specific risk
    • Is it producing results?
    • Can you tell yet?
Element 6
Continual Improvement

- **Improve data**
  - Better data $\rightarrow$ less uncertainty $\rightarrow$ lower risk

- **Are performance measures still valid?**
  - Have risks changed?

- **Adjust Risk Model**
  - Threats in one location relevant to other areas?
  - Evaluate predictive value of each parameter
Element 7
Report Results

• Measure
  – Performance factors

• Report
  – Report four of the required performance factors each March
  – Retain records for 10 years
How Distribution Operators Can Integrate Data to Make Informed Decisions

What geospatial solutions provide:
- Compliance with DIMP
- Improved knowledge of system
- Integrated data
- Relative risk assessment for risk-based decision-making
- Reduced costs associated with incidents
- Risk based adjustment of frequency for prescription inspections

What else could data be used for:
- Operational efficiency
- Resource allocation
- Outage management
- Knowledge portal
- Accurate asset inventory
- Market analysis
- Supply modeling and planning
- Improved system planning
- Integration with utility and paving work
- Mergers & acquisitions
- Geographic expansions
- Integrate replacement with growth plans
- Organic growth projects
- Shorter project schedule
- Reliability and dependability
- Customer retention
- Probabilistic risk analysis
Five Things To Do Now

1. Assess the state of your GIS data
   – Facility data complete, consistent, accurate, and well attributed?
   – Leak data in GIS, repairs tied to facility?
   – Exposed pipe inspections in GIS, tied to pipe?
   – Pressure Tests linked to pipe directly or through work order?
   – CP test points in GIS? Reads linkable to pipe?
   – Data well aligned with landbase? Conflate?
   – External data sources being used? Research what is available (from local gov’t, other agencies)
Five Things To Do Now

2. Develop workflows to capture and maintain data
   – Examples: Include leak reports and exposed pipe in GIS
   – Determine if CP test read data is linked or linkable to facility database

3. Leverage existing processes to address formal, structured requirements of DIMP
   – You’re doing many things already—need to formalize
   – Develop written plan to document that
Five Things To Do Now

4. Identify effectiveness measures
   – Start collecting data if not doing so
   – Migrate data to digital format to support reporting

5. Prepare your organization to embrace the process
   – Change management may be hardest part
   – Train and educate participants
   – Focus on benefits to organization
For More Information

- DIMP Frequently Asked Questions, 7/28/08
- PHMSA Joint work/study group Report of Phase 1 Investigations, Published 12/2005
Thank you for your participation.

Questions?