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Geographic Information Systems (GIS)

An Introduction to Geospatial Analyses

ALBRECHT ENGINEERING INC

Thursday, May 29, 2014

Maryland Traffic Records Forum
The Conference Center at
The Maritime Institute

Introductions

- **Julie Spangler, GISP**
  - Senior GIS Analyst with JMT Technology Group, Baltimore, MD
  - Adjunct Faculty Member
    - Geospatial Applications Program, Community College of Baltimore County,
    - Environmental Science Program, McDaniel College
- **Candice Ottley-Francois, PMP, GISP**
  - GIS Project Manager with Albrecht Engineering, Inc., Baltimore, MD
  - Engineer by training, GIS Professional by trade
    - Focus on GIS for Transportation & Public Safety

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Objectives

- Offer a basic understanding of the technology and framework
- Highlight some uses and applications of GIS
- Investigate some of the primary sources for readily available data
- Discuss how to build a business case
- Discuss how to evaluate data prior to use
- Outline a course of action to learn more

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What is GIS?

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What is GIS?

- **Textbook Definition**
  - Acronym for *geographic information system*.
  - An integrated collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes. A GIS provides a framework for gathering and organizing spatial data and related information so that it can be displayed and analyzed.
  - **More simply: A computer based tool for problem solving and information management.**

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What is GIS?

- Computer system that captures, stores, analyzes, manages and presents data that are linked to location

"Shapes" to represent features; Tables with information about each feature

Tools to enter, edit, query, analyze and map data e.g. Google Maps

Computers, GPS devices, mobile devices

Technical specialists who design, maintain and use the system

Google Maps is a GIS Application!

Database management system; Analysis Software

Three key characteristics of GIS

- Features are **georeferenced**
- Features are organized in **layers**
- Features have **attributes**

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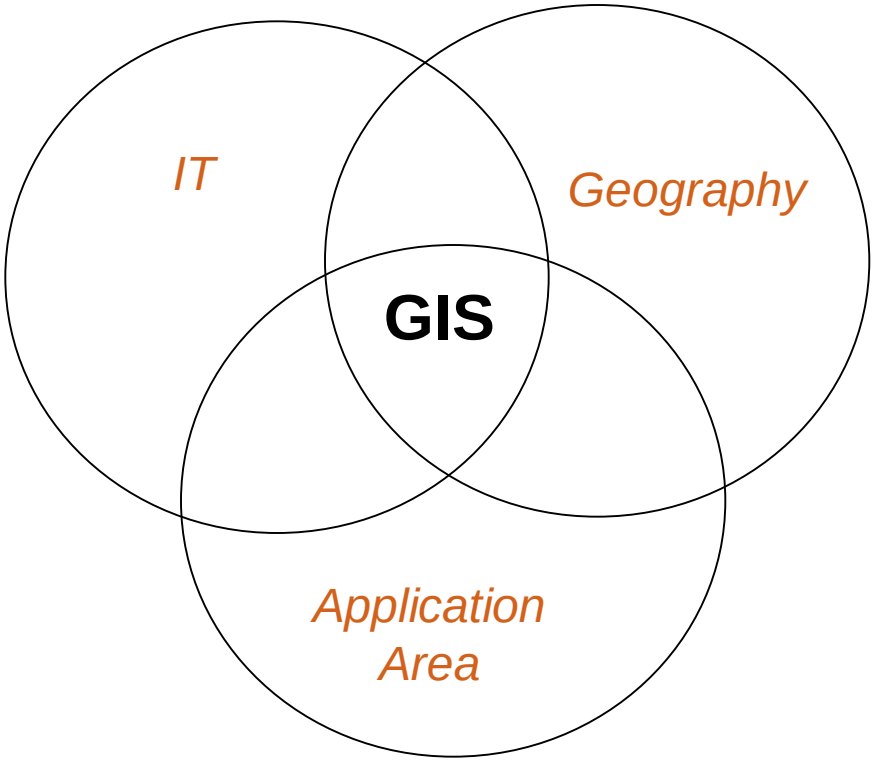
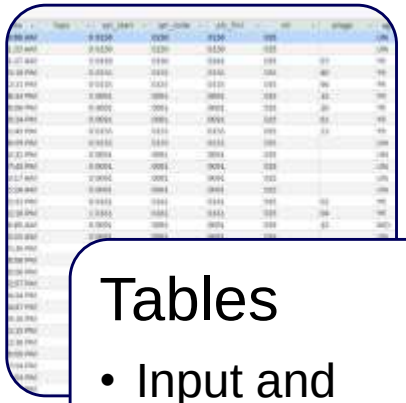
Why do we use GIS?

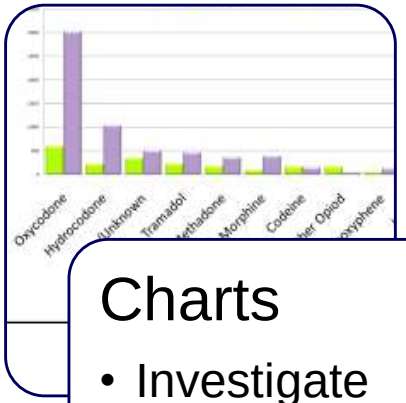


Why do we use GIS?



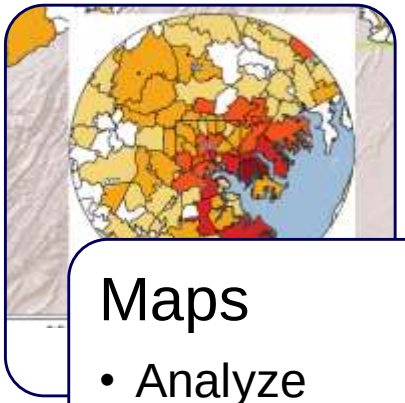
Tables

- Input and Manage Data



Charts

- Investigate Patterns



Maps

- Analyze Spatial Relationships

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Spatial Analysis

- **Allows a user to manipulate data to examine location, attributes and relationships of geographic features**
- **3 types of spatial relationships**
  - Proximity
    - How close one feature is to another
  - Direction
    - Relative and absolute relationships of one feature to another
  - Topology
    - Overlaps, adjacency, containment , connectivity, contiguity of features

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What can you do with GIS?

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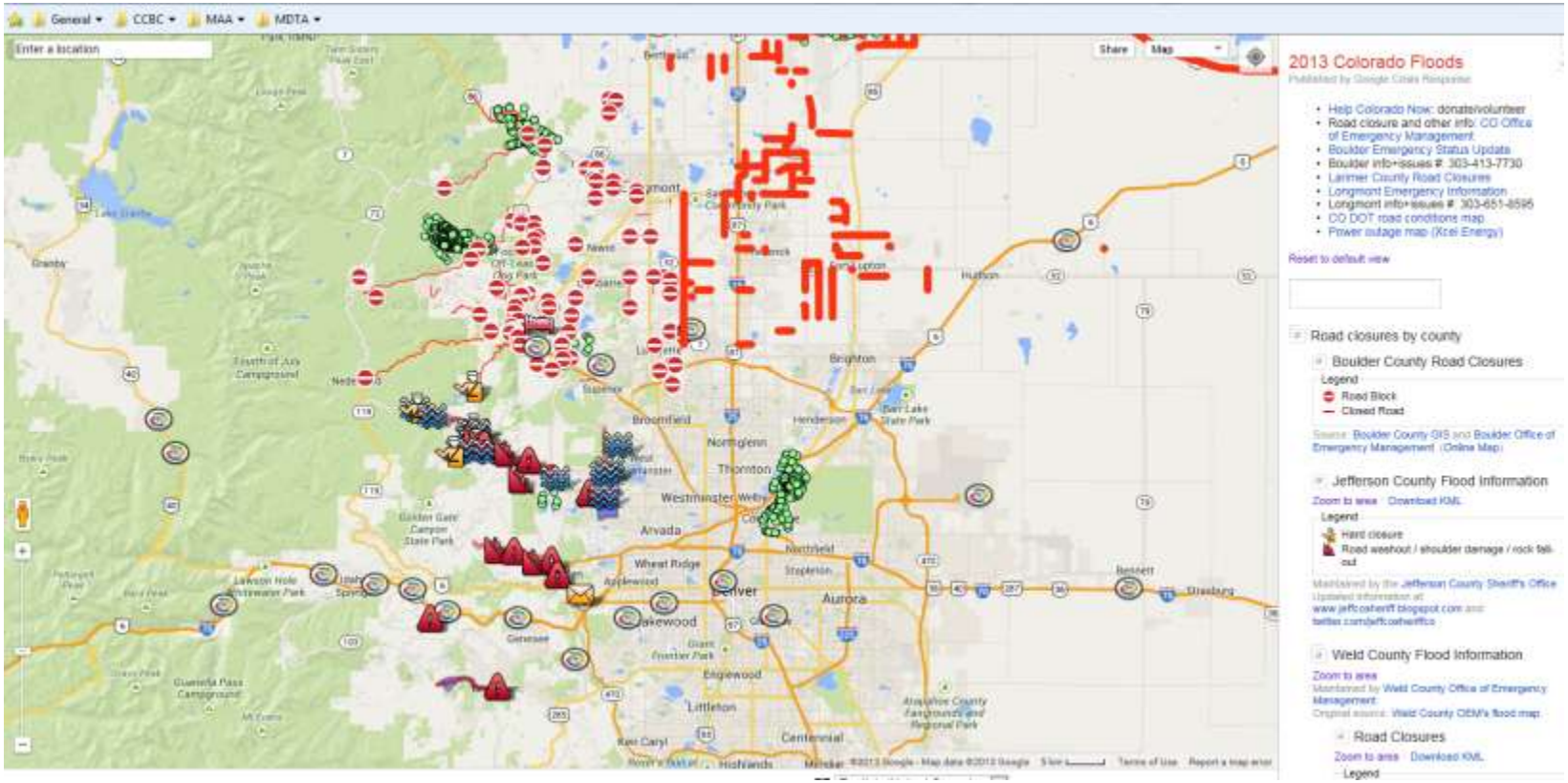
Map Where Things Are



2013 Colorado Floods Crisis Map

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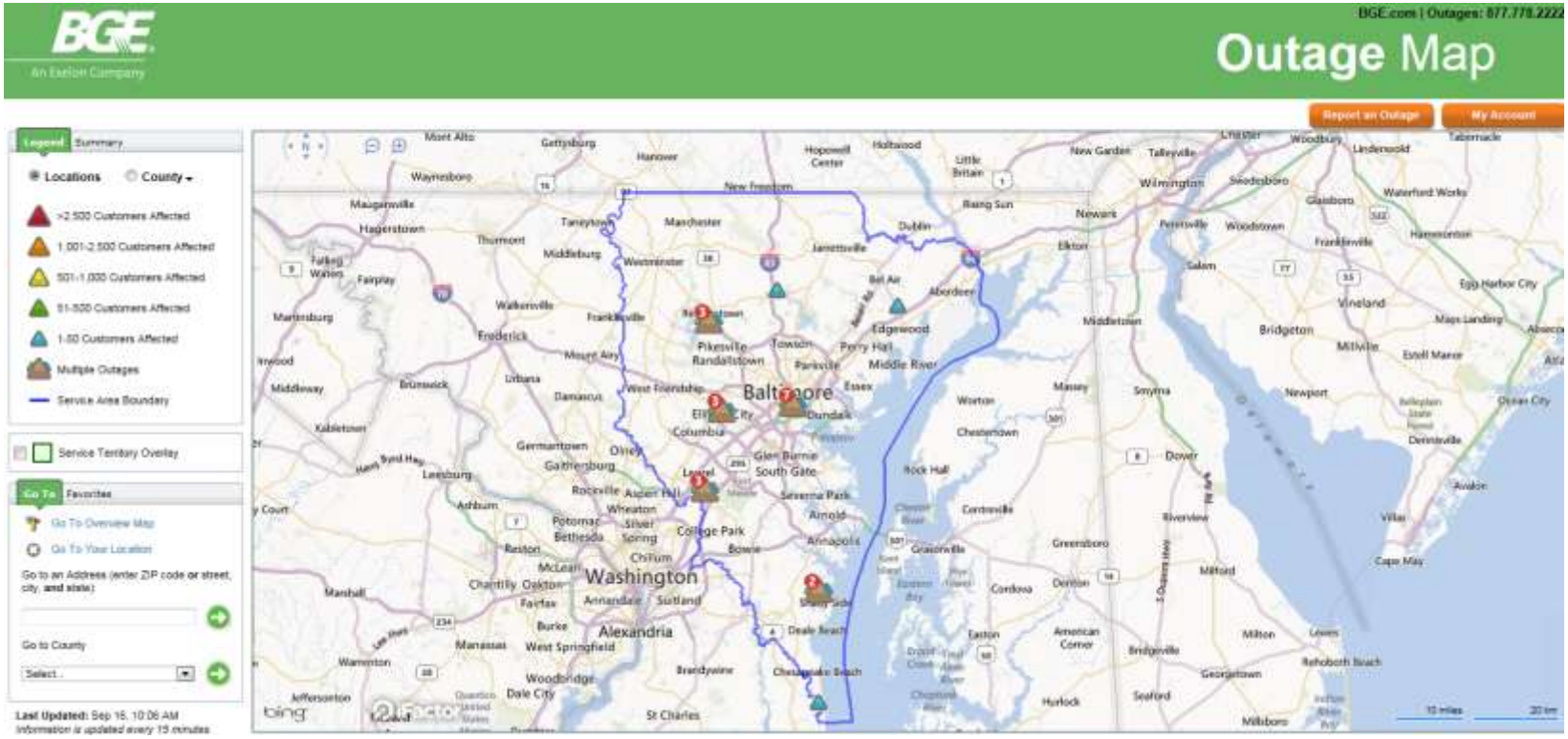
Map Quantities



BGE Power Outage Map

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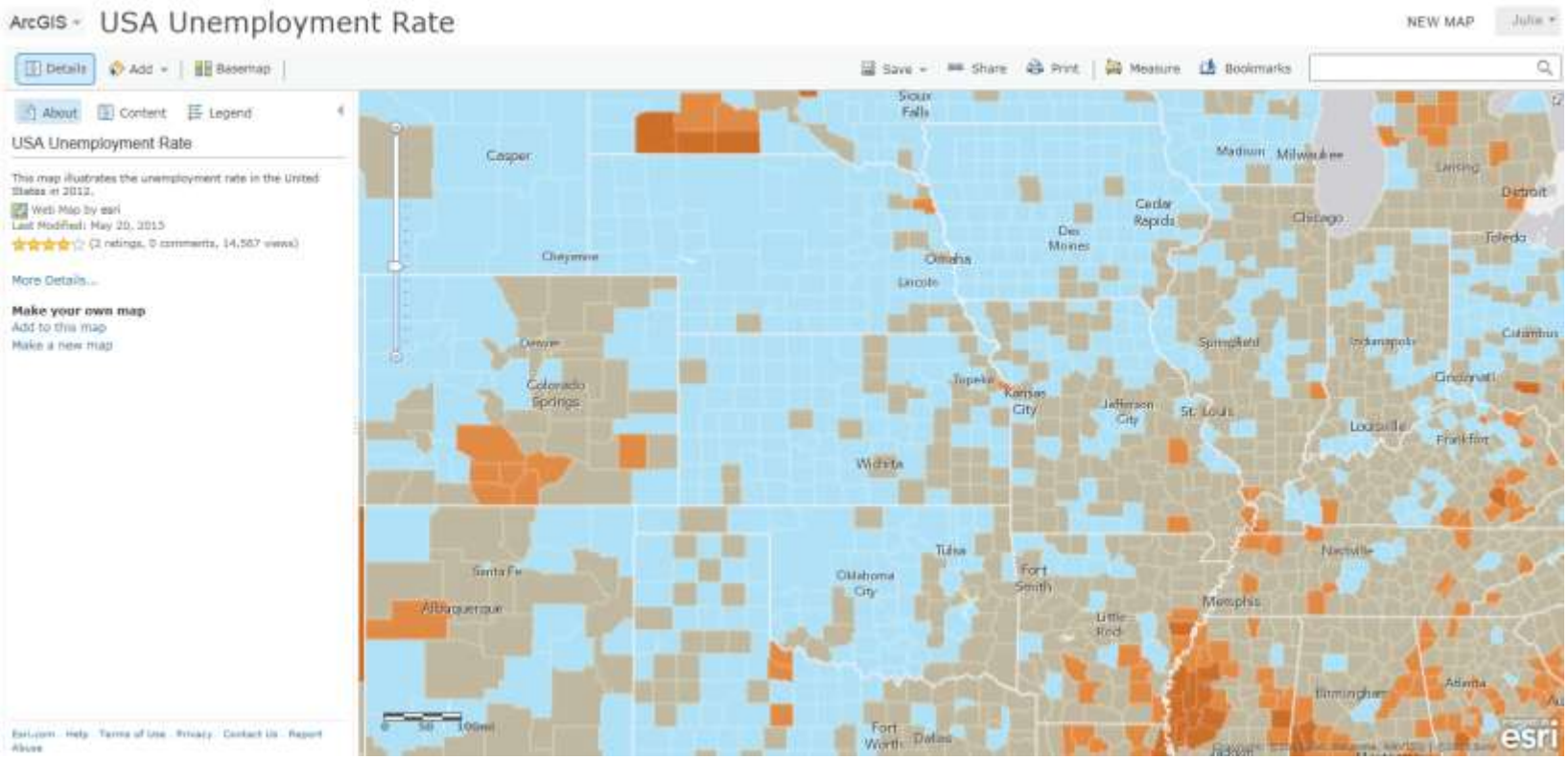
Map Densities



ArcGIS.com (Free Login Required)

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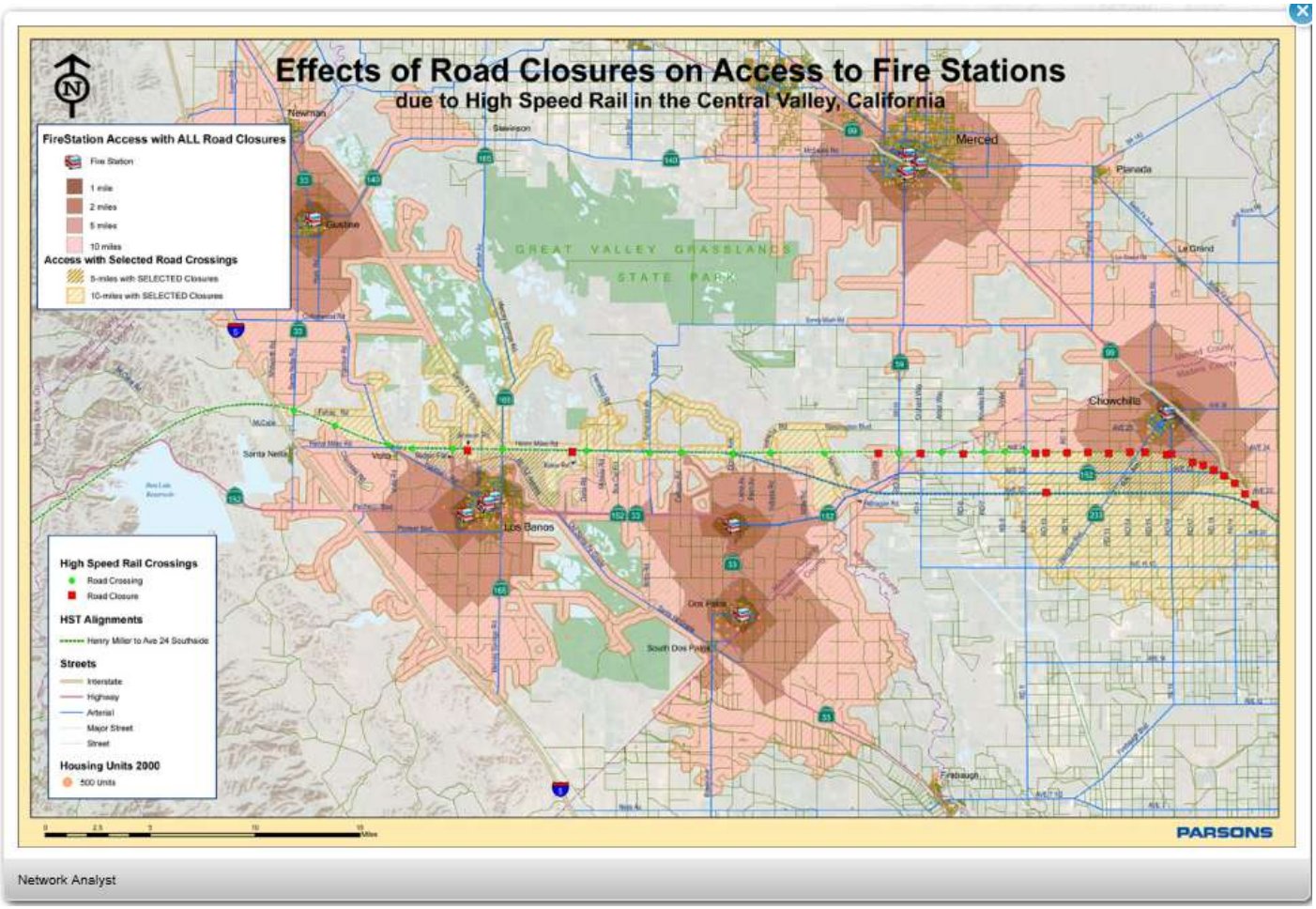
Find What's Inside



Case Study: Impacts of High Speed Rail on Fire Station Access

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Find What's Nearby

PETCO Improves Location Selection

950-store (and growing) PETCO Animal Supplies relies on statistics and data — not intuition — to select new sites.

by Matt Pillar

In the context of a discussion about PETCO Animal Supplies' use of GIS (geographic information systems) technology for store site selection, Shawn Hanna is quick to point out that the chairman of his company is an ace at picking winning spots at which to build. "We've historically managed a site selection committee that boasts many decades of combined experience making field-level site selection

PETCO mitigates the risk associated with opening new locations by using ESRI Business Analyst for site selection solution.

also be significant, and in a changing economy that can introduce considerable uncertainty in the selection process."

How To Choose A Site Selection Solution

While Hanna had experience with portfolio valuation of institutional real estate investments, retail site selection was new to him. Nonetheless, his department was tasked with determining the best way to offer an independent assessment of potential new PETCO retail

Case Study: Petco Improves Location Selection

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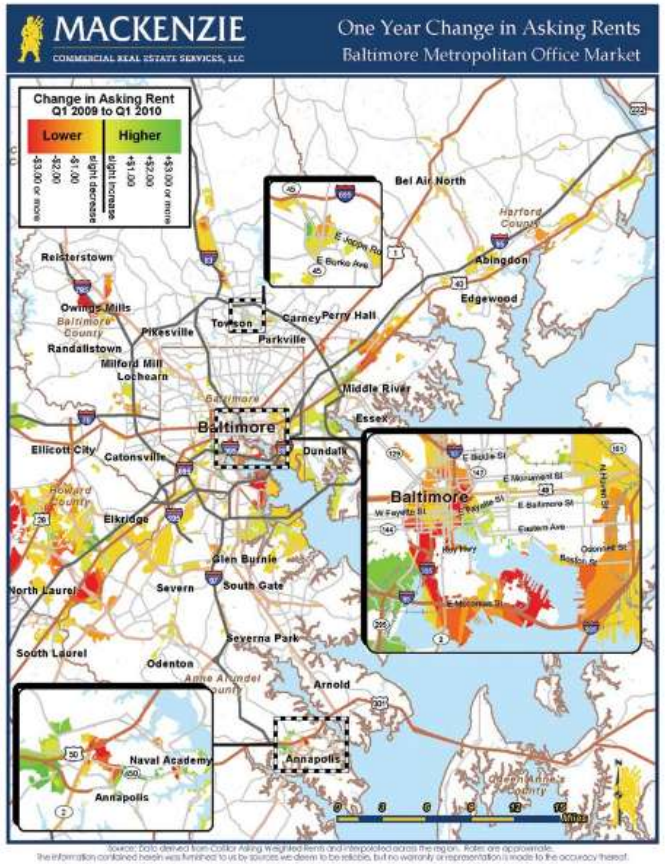
Map Change



One-year changes in asking rents for Baltimore.

Case Study: One year changes in asking rents for Baltimore

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Who uses GIS?

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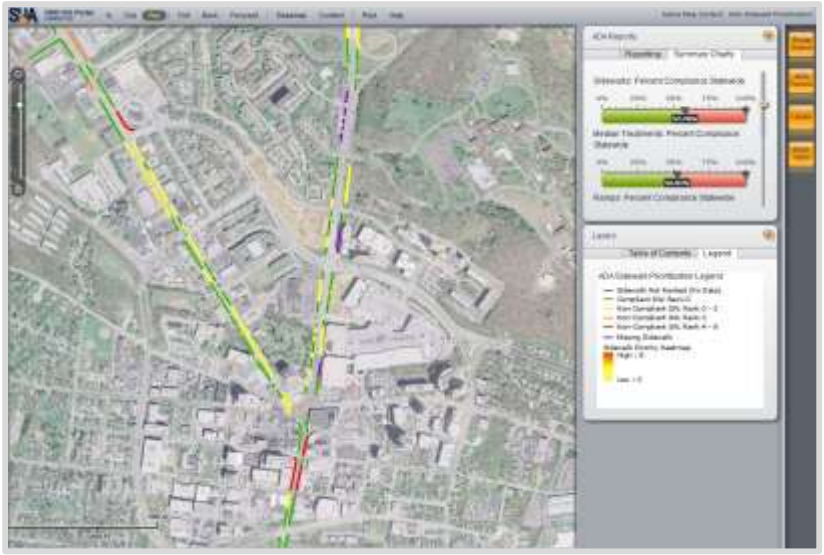
Roadwork Planning

- **Maryland State Highway Administration**
  - Office of Highway Design (OHD)
- **Assess and Report ADA Compliance**
- **ADA Prioritization System**
  - Non-Compliant Sidewalk
  - Trip Generators
  - Crash Data
- **Roadway Projects**



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Safety Improvement Studies

- **Maryland State Highway Administration**
  - Office of Preliminary Planning and Engineering (OPPE)
- **Identify candidates for safety improvements**
- **Analyze crash history**
  - PDF Reports
  - Line diagrams
  - GIS data aggregated to street segment
- **Perform field observations to analyze existing conditions**
- **Make recommendations for remediation**
- **Forecast congestion impact of recommendations**

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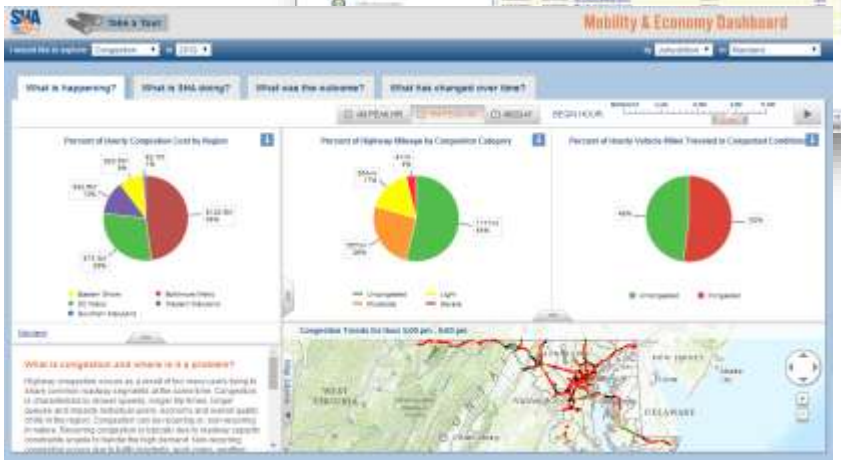
Mobility Performance Indicators

- **Maryland State Highway Administration**
  - Office of Preliminary Planning and Engineering (OPPE)
- **i-TMS**
  - Traffic volume (counts)
  - Historical data
  - Truck percentages
- **Mobility Dashboard**
  - Traffic Performance Metrics
    - Congestion
    - Reliability
    - Volume
  - Based on INRIX data



Transit Planning Studies

- **Maryland Transit Administration**
- **Baltimore Red Line**
  - Demographic Analysis
  - Employment Analysis
  - Land Use Analysis
  - Population Build Out
    - Forecasts to 2030

Figure 1: Red Line Corridor - Alternative C

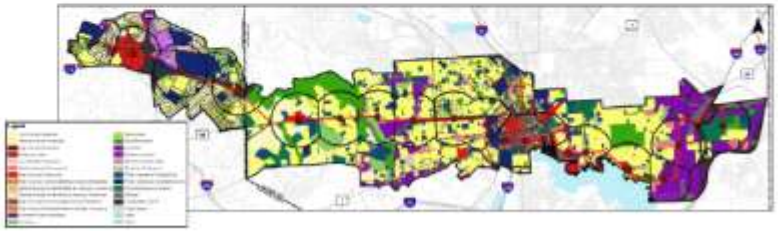


Figure 2: Red Line Corridor Existing Land Use

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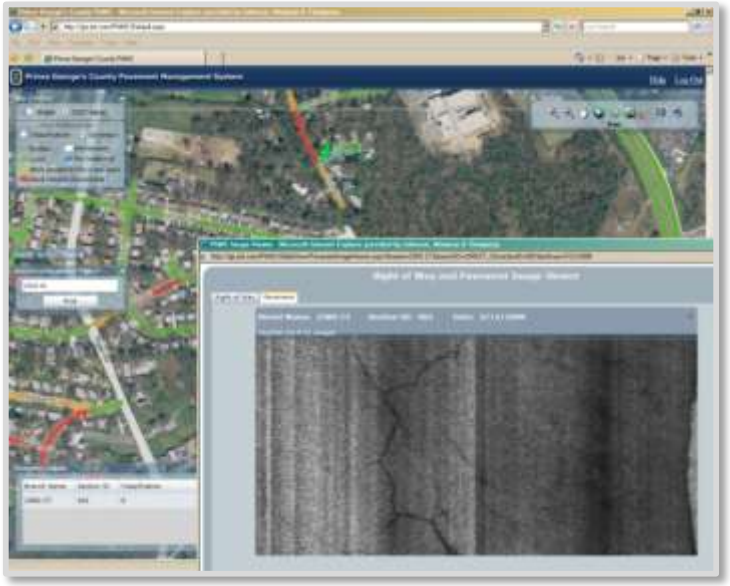
Asset Management

- **Prince George's County, MD**
  - Department of Public Works & Transportation
  - Department of Inspections, Permitting & Enforcement
- **Pavement Assessment & Management System (PAMS)**
  - Condition Survey
  - Pavement Rating
  - Needs Lists
  - Project Formulation
  - Work Coordination
  - Cost Estimation



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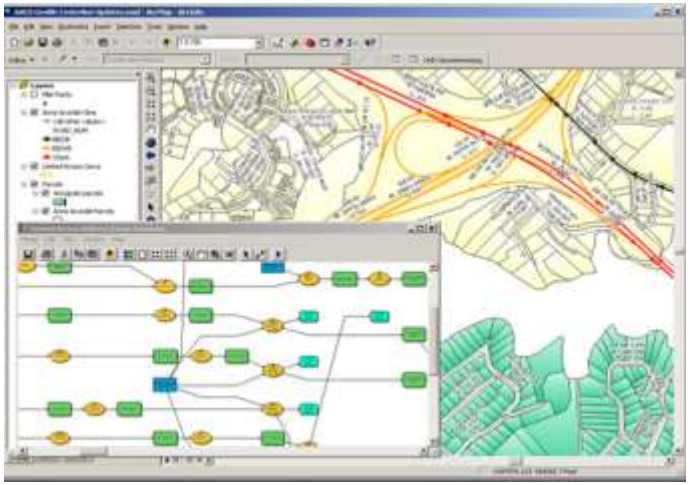
E911 Routing

- **Anne Arundel County, MD**
- **Structure Address Verification**
  - Physical location for every address in County
  - Physical location for every phone number in County
- **Routable Street Centerline for E911 Computer Aided Dispatch System**
  - Address Ranges
  - Speeds
  - Limited Access/One Ways
  - Elevation
  - Travel Cost



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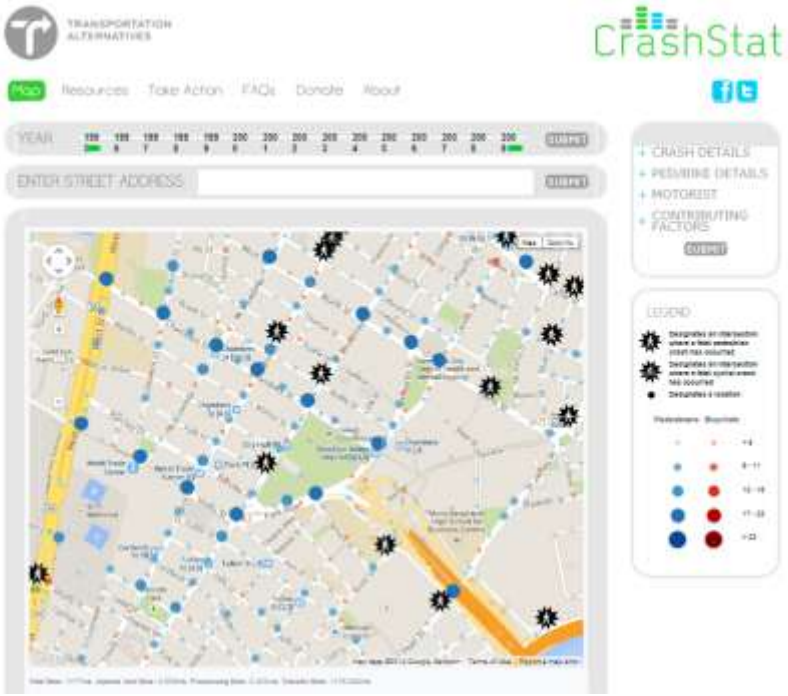
Crash Reporting - CrashStat

- **Transportation Alternatives, New York, NY**
  - View locations of pedestrian and bicyclist crashes on a map
  - Query or Filter crashes
    - Location
    - Type of Crash
    - Year
    - Demographics (age/sex)
    - Crash Details
    - Contributing Factors
  - Generate Reports



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How do I build my business case?

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Define The Question

- **What are you trying to model?**
  - Ask questions about what things go where?
  - Quantify an existing pattern to better understand it?
  - Examine relationships between different events?
  - Identify trends, clusters or hotspots?
  - Show how things change through time?
  - Predict or forecast something?
  - Find best places, routes or scenarios for a type of activity?
- **Remember: All traffic activities involve a location**

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Identify Data Needs

- **What types of data do you need?**
  - Crash data, volume data, roadway characteristics, trip generators, demographics
  - Base data – boundaries, parcels, street centerline, edge of pavement, street names, buildings, utility data
- **What level of detail do you need?**
  - How aggregated or disaggregated?
  - What type of location identifier?
    - County, Street Address, Intersections, Routes and Mile Points
  - What attributes do you need?

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Identify Data Needs

- **What data format do you need?**
  - Points
  - Lines
  - Polygons
  - Table that includes a location field
- **Note: Data can be manipulated to the format that your model requires**
  - E.g. Tabular data with well-defined locations can be converted to GIS data!
  - E.g. Points can be aggregated to polygons

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Frame The Data Request

- **Clearly state your objectives**
  - What are you studying? What are you using the data to do?
- **Be specific about the location of interest**
  - Statewide, District, County, ADC Grids, Corridor, Intersection, Radius around a location
- **What type of data do you need?**
- **What type of attributes do you need?**
- **How detailed or generalized should the data be?**

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Sample Data Request Form

Creating a Clear Data Request

From the options listed below select all applicable answers for EACH:

How am I going to use this data?

- ☐ Plan an educational program
- ☐ Presentation
- ☐ Evaluate a program
- ☐ Assist with legislation
- ☐ Plan enforcement
- ☐ Media
- ☐ Other
- ☐ Please specify:_____

Gender / Age

- ☐ Male
- ☐ Female

Please specify age(s) range:

Specific age_____ or

Ages from _____ through _____

Priority Area

- ☐ Bicycle
- ☐ Large Truck/Tractor Trailer
- ☐ Motorcycle
- ☐ Passenger Car
- ☐ Pedestrian
- ☐ Pick-Up Truck
- ☐ SUV
- ☐ Van

Race / Ethnicity

Hispanic or Latino

- ☐ Yes
- ☐ No

Specific Race/Ethnicity

- ☐ American Indian/Alaskan Native
- ☐ Asian
- ☐ Native Hawaiian/Pacific Islander
- ☐ African American/Black
- ☐ White

Weather

- ☐ Clear
- ☐ Rain
- ☐ Snow
- ☐ Ice
- ☐ Othe

Month / Day / Time

Please specify range(s) for each:

Specific mon _____ or

Months _____ through _____

_____ or

_____ through _____

time _____ or

Type of Road

- ☐ County
- ☐ State
- ☐ Other, please specify: _____

Contributing Factors

- ☐ Speed
- ☐ Drugs/Alcohol
- ☐ Cell Phone
- ☐ Seatbelt
  - ☐ Yes
  - ☐ No
- ☐ Other, please specify: _____

Other Available Data

of Stay in Hospital

ta

ism

otal # Issued

% found guilty

ion of violator's residence

sh victims living in county vs.

Examples

Good Data Request:

Subject: Citation Data
How Data will be Used: legislative request
Data Needed: please provide 5 years of citation figures for restraint codes 22412.2 D, E and G.

Poor Data Request:

Subject: Citation Data
How Data will be Used: Prgrm Development
Data Needed: 3 - 5 year trends for my County

My Data Request Question

e is only used to guide you in creating a good data request. You are NEITHER limited NOR bound to these categories***

This template is only used to guide you in creating a good data request. You are NEITHER limited NOR bound to these categories

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Evaluate The Data

- **Quality and Currency**
  - Acquire and review any metadata from source
  - How frequently is the data updated?
  - What lag time is expected from the time of the actual event until it is published as data for analysis?
  - How accurate is the data?
- **Suitability for Analysis**
  - If the data is a sample, how well does it represent the population?
  - Are there known outliers?

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Evaluate The Data

- **Very important to evaluate data in context**
  - Data will likely have inherent bias
    - Who created it and for what purpose?
  - Be wary of assumptions that have already been made
    - Just because a dataset is common doesn't mean it has clean capture rules
  - Understand the short comings of the dataset to have an appropriate confidence level
  - Not all data is collected the same way—individual counties may have different policies
  - Appreciate the idea that sometimes datasets will really be "close enough"

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Develop Your Model

- What is the analytical approach?
- What are some of the tools and techniques that apply?
  - Reclassify, Overlay, Intersect, etc.
  - Weighted analysis
  - Proximity analysis
- What are the assumptions?
- How likely is it that the independent variables are actually causing the changes to the dependent variable?

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Develop Your Model

- **Considerations**
  - Different conceptualizations of spatial relationships will yield different results
  - Near things are more alike than far away things—spatial dependence
  - Effects of sample size
  - Effects of boundaries
  - What is significant at one spatial scale may not be significant at another
  - Clustering based on space, clustering based on space and time

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Where can I get data?

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Data Sources

- **Local**
  - Cities, Counties, Educational Facilities (e.g. UMD, Towson University)
- **State**
  - Department of Information Technology, MDOT Agencies
- **Regional**
  - Regional Planning Commissions
- **Federal**
  - National Atlas, Census, FHWA
- **Commercial**
  - Esri, INRIX

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Local Example: MCTSA Data Services

- **Maryland Center for Traffic Safety Analysis**
  - Census data
  - Crash data
  - Citation data

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Local Example: UMD CATT Lab - RITIS

- Center for Advanced Transportation Technology Lab
- Available to Public Safety & DOT employees
  - No Cost
  - Historical Data
  - Live events
  - Incidents
  - Traffic
  - Weather

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Local Example: Open Data Baltimore

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State Example: MD iMap

- Comprehensive List of Data Sources in MD

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State Example: CHART

- **Coordinated Highways Action Response Team**
  - Feeds Dynamic Messaging Signs

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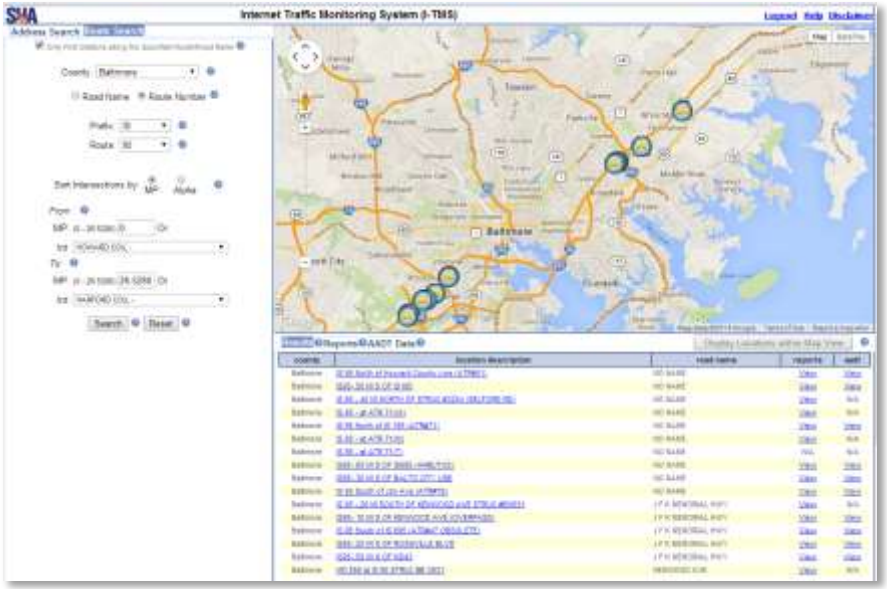
State Data: iTMS

- Traffic Count reports in PDF or Excel Format



- Data also available in GIS format: http://www.sha.maryland.gov/pages/GIS.aspx?PageId=838

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Federal Example: FHWA Resources

U.S. Department of Transportation
Federal Highway Administration

About Programs Resources Briefing Room Contact Search FHWA

Office of Planning, Environment, & Realty (HEP)
Planning · Environment · Real Estate

HEP | Events | Guidance | Publications | Glossary | Awards | Contacts

GIS in Transportation

HOME | About this Site | GIS Applications | Resources | Links | FHWA Contacts | Geospatial Data Collaboration

GIS Data | GIS Software | GIS-Related Organizations | Other Federal Agencies

GIS Data

FHWA Data Resources

- Binational Transportation Planning and Program Process - A website providing contact information for transportation professionals, highway network reports, and transportation GIS coverages for the U.S. and Mexico. Most files are available in ARC/INFO© interchange (.e00) format, but the U.S. state boundaries are available in ArcView Shape© (.shp) format.
- Census Transportation Planning Package - Attribute data of special tabulations from the decennial census designed for transportation planners are available on this site in spreadsheet and plain text formats. From the homepage, click on "Data Products" in the left navigation bar.
- National Bridge Inventory (NBI) - FHWA's NBI offers a wealth of tabular data about bridges across the U.S. From the homepage, click on "Tables of Frequently Requested NBI Information" to locate spreadsheet data.
- National Highway Planning Network (NHPN) - The NHPN is a database that contains line features representing just over 450,000 miles of current and planned highways in the U.S. The NHPN consists of interstates, principal arterials, and rural minor arterials. Files are available in ARC/INFO © Interchange (.e00) format.

Other Data Resources

- Federal Geographic Data Committee (FGDC) - The FGDC's website is aimed at developing the National Spatial Data Infrastructure (NSDI). The site provides news, publications, a calendar of GIS events, and access to vast volumes of data stored on approximately 100 servers registered with the NSDI. To search for data on this site, go to the clearinghouse listed on the left hand navigation bar.
- FWS Regional Ecosystem Coverages - Spatial ecosystem data for each of the 7 FWS Regions, Puerto Rico, Hawaii, and the lower 48 are provided.
- The GeCommunity Data Catalog - The Data Catalog provides many types of data that users can download free of cost or for a nominal fee. This service offers statewide and county-level data such as Digital Elevation Models, Digital Orthophoto Quadrangles, National Wetland Inventory, and land use data. International data is also available. Users will need to create a GeoCommunity Account to download files.
- Geodata.gov - This site is a subsite of the Geo-one-stop Initiative, and is the U.S. Government's web-based portal for one-stop access to maps, data, and other geospatial services. The site hosts data in 17 different categories, including, among others, political boundary, cadastral, and transportation network coverages.
- Geospatial Data for Public Use Roads and Parking Lots - During 2000 and 2001, FWS and the Federal Lands Highways (FLH), Central Federal Lands Division collected geo-spatial data on all roads and parking lots for use with geographic information systems. This information is available for use by other federal agencies, state agencies, local governments and the public.
- Geo-one-stop Initiative - The Federal gateway to shared spatial data, offering links to existing data layers and to GIS clearinghouse websites in all 50 states.
- Migratory Bird Data Center of FWS - The site links to bird population and habitat databases.
- The National Atlas of the United States® - This Internet Mapping Server offers several different categories of map layers, which users can download free of charge. Agriculture, climate, geology, transportation, and water features are among the types of layers available. Vector files are in shapefile format. Image files are in georeferenced tagged image file format (GeoTIFF).
- National Oceanic and Atmospheric Administration (NOAA) - The NOAA's National Ocean Service (NOS) site provides users access to downloadable US bathymetric and hydrographic data.
- National Wetlands Inventory (NWI) of the Fish and Wildlife Service (FWS) - NWI produces and provides spatial information on the characteristics, extent, and status of the Nation's wetlands and deepwater habitats and other wildlife habitats.
- National Park Service (NPS) GIS - NPS's GIS site provides access to data, training opportunities, and detailed descriptions of modeling applications occurring nationwide.
- NatureServe - NatureServe is a non-profit conservation organization that provides the scientific information and tools needed to help guide effective conservation action. NatureServe also provides data on ecological systems and the distribution of animal populations throughout the Americas.
- U.S. Army Corps of Engineers (USACE) Geospatial Data Clearinghouse Node - USACE's Geospatial Data Clearinghouse offers metadata for dam and military boundary coverages.
- U.S. Census Bureau - The U.S. Census Bureau's website sharing a range of GIS data, including census maps, cartographic boundary files, and school district boundaries.
- U.S. Environmental Protection Agency (EPA) - The EPA's GIS website offering links to a geospatial data clearinghouse, software downloads, and an Enviro facts Data Warehouse.
- U.S. Geologic Survey (USGS) - The USGS website providing information about the physical landscape of the United States. The site hosts high-quality, downloadable data layers and the National Map, a tool for maintaining consistent nationwide GIS data.
- USDA Forest Service Geodata Clearinghouse - The FSGeodata Clearinghouse provides download access to selected geospatial information and metadata held by the Forest Service for National Forest System lands, including feature data such as roads and streams, map images, and fire mapping information.

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Federal Example: National Atlas

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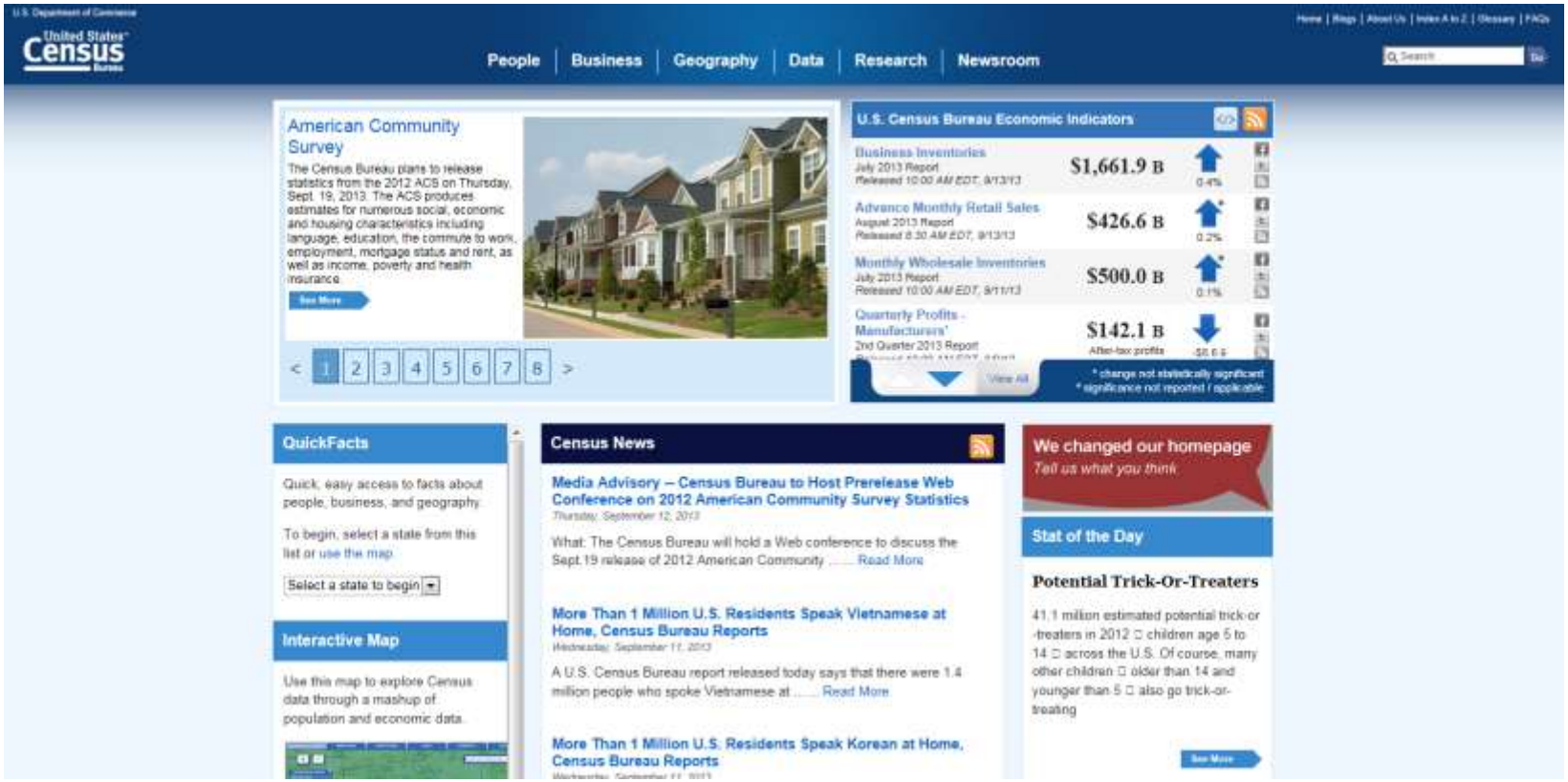
Federal Example: Census



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Commercial: Esri Data Products

Demographics and Lifestyle Data

Analyze markets, evaluate competitors, and identify opportunities. Get demographics and lifestyle data using any of these methods:

Map Services
ArcGIS Online Map Services use the latest available data to give you access to demographic and lifestyle maps for the United States and several other countries.

Business Analyst
Business Analyst provides reports and maps to help you with market planning, territory design, and customer segmentation.

Community Analyst
Community Analyst provides people working in government agencies or involved with public planning with reports and maps to help optimize and allocate resources.

DVD
Demographic, Consumer, and Business Data DVDs are available. Select the data you need and at what level of details, such as by ZIP code.

Imagery

Access high-resolution global satellite imagery and Global Land Survey (GLS) datasets. Get imagery in one of the following ways:

Map Service
ArcGIS Online World Imagery map service gives one meter or better satellite and aerial imagery in many parts of the world.

Image Services
ArcGIS Online Image Services offer you the best continuous

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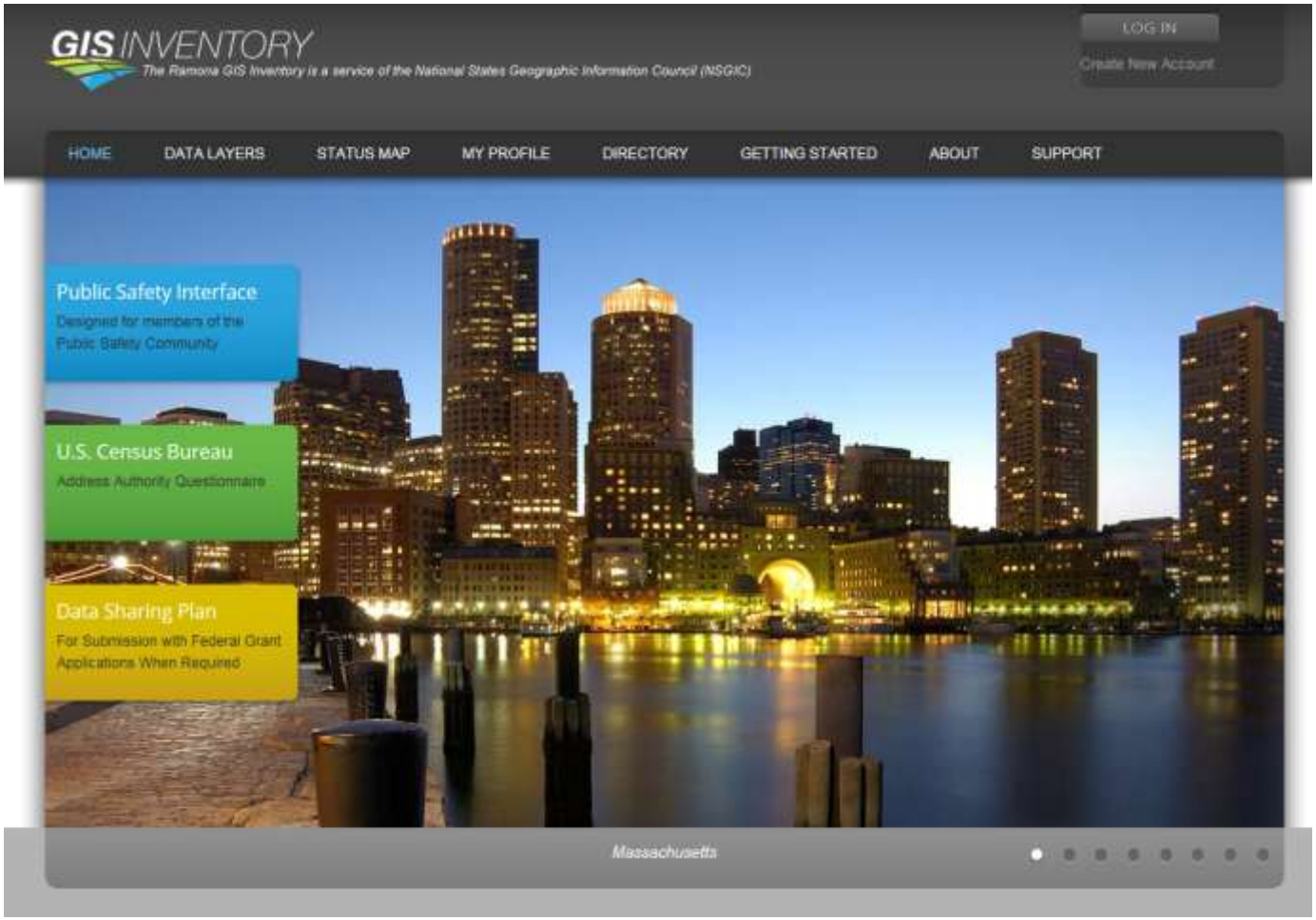
Ramona GIS Inventory



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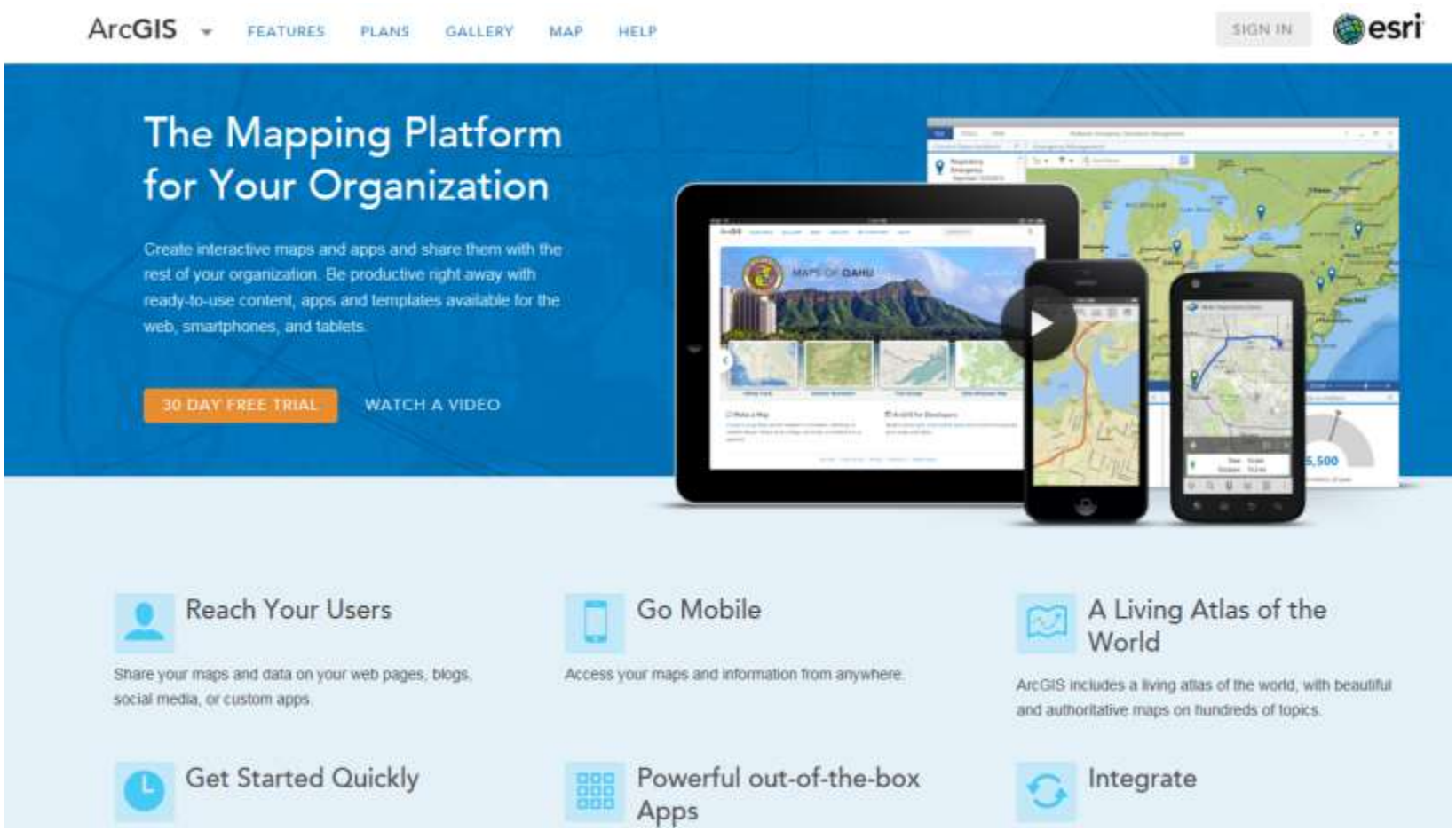
ArcGIS.com



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What training opportunities exist?

Thursday, May 29, 2014

Maryland Traffic Records Forum
The Conference Center at
The Maritime Institute

Training Opportunities

- **Review Case Studies**
  - Magazines, Journals, Websites
- **Technical Guidance**
  - ArcUser Magazine
- **How To Books**
  - Getting to Know ArcGIS
  - GIS Tutorial
- **Online Training Opportunities**
  - Esri Free Training
  - Esri Paid Training
  - MIT Open Courseware
- **Formal Classes**
  - Online
    - Penn State World Campus
  - In the Classroom

- **Meetings**
  - Local GIS groups
  - MSGIC
  - Esri MUG
  - Esri CMUG
  - MAGTUG
- **Conferences**
  - Esri Events
  - FOSS4G
  - Where
  - GIS-T

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Questions?

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