Metro-North Railroad's Enterprise GIS Program:
Yesterday, Today, and Tomorrow

Xiaojing Wei, *Alex Lu*, and *David Fogel*

GIS in Transit Conference

Washington, D.C.

September 2, 2015

Metro-North Railroad

- Three states, twelve county service area, 2,701 square miles.
- Five lines, three branches, 384 route miles, and 775 track miles.
- 1,072 bridges, 119 grade crossings, 77 substations.
- 124 stations, 1,258 railcars, 711 weekday departures carrying 284k customers.
- Full service commuter railroad with engineering responsibility for track, signals, power, structures, stations, and railcars.

Business Case

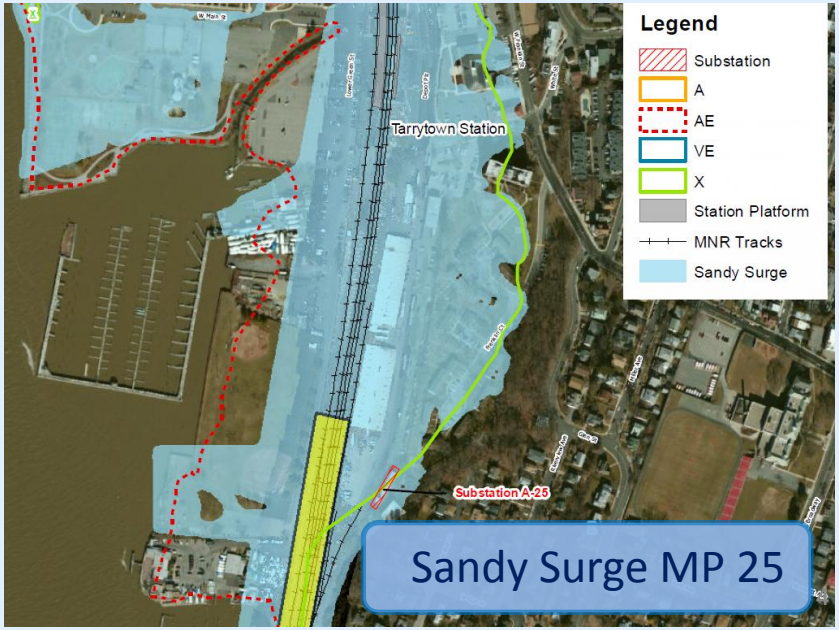
- Use company-wide survey instrument to generate interest in GIS
- **Benefits:**
  - Accurate mapping
  - Ensure uniform standard for capturing geographic data
  - Proximity analysis of assets belonging to different depts.
  - Integrate multiple mapping systems in use by different depts.
- **Strategy:**
  - Hire GIS Specialist, recruit via online GIS networks
  - Initiate Concept of Operations study, identify early action items
  - Sacrifice server resiliency/redundancy in the short-run to limit costs, but build-in expandable architecture
  - Leverage Enterprise virtual server infrastructure

GIS Need	% Respondents
Describing a location (at least monthly)	90%
Communicating a location (e.g. geocodes) to an outside entity	66%
Locate a fixed asset in the field	62%
Plot a map for sharing, reporting, etc.	34%
Count features within a geographic area	62%-66%

Trigger Events

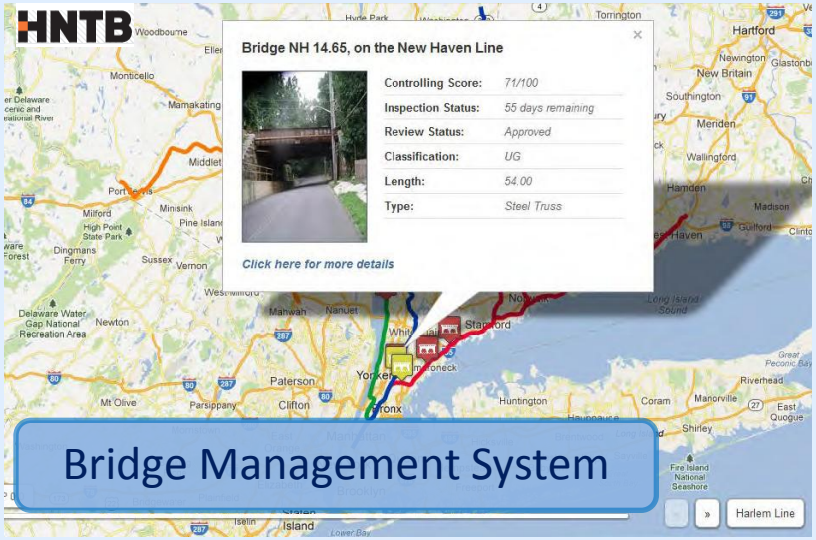
- **Identified GIS Needs**
  - Real-time incident management
  - Post-event reconstruction
- **Westport 1532** (2011-07-22)
  - Real-time train location
  - Emergency access to ROW
  - Fire/EMS jurisdictions
  - Milepost/catenary pole/ street address correlation
- **Hurricane Sandy** (2012-10-20)
  - Real-time storm tracking
  - Elevation of key rail assets
  - Post-event insurance claims
  - Mapping recovery efforts
  - Flood proofing future design

Hudson Line: “Water Level Route”

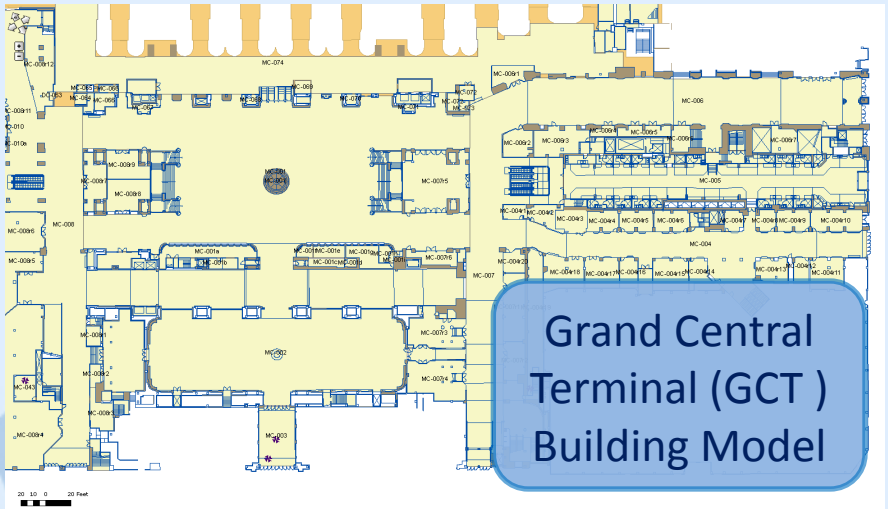


Early Action—Inventory Existing Condition

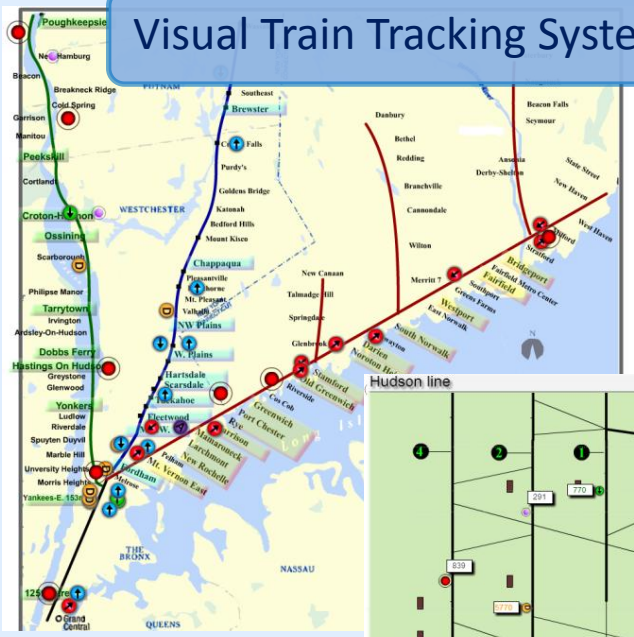
- Hardware and Software
- Existing Systems
- Data Sources
  - Past projects (e.g., Positive Train Control LiDAR)
  - Publicly available
- Business Processes
- User base and skills



Bridge Management System



Grand Central Terminal (GCT) Building Model



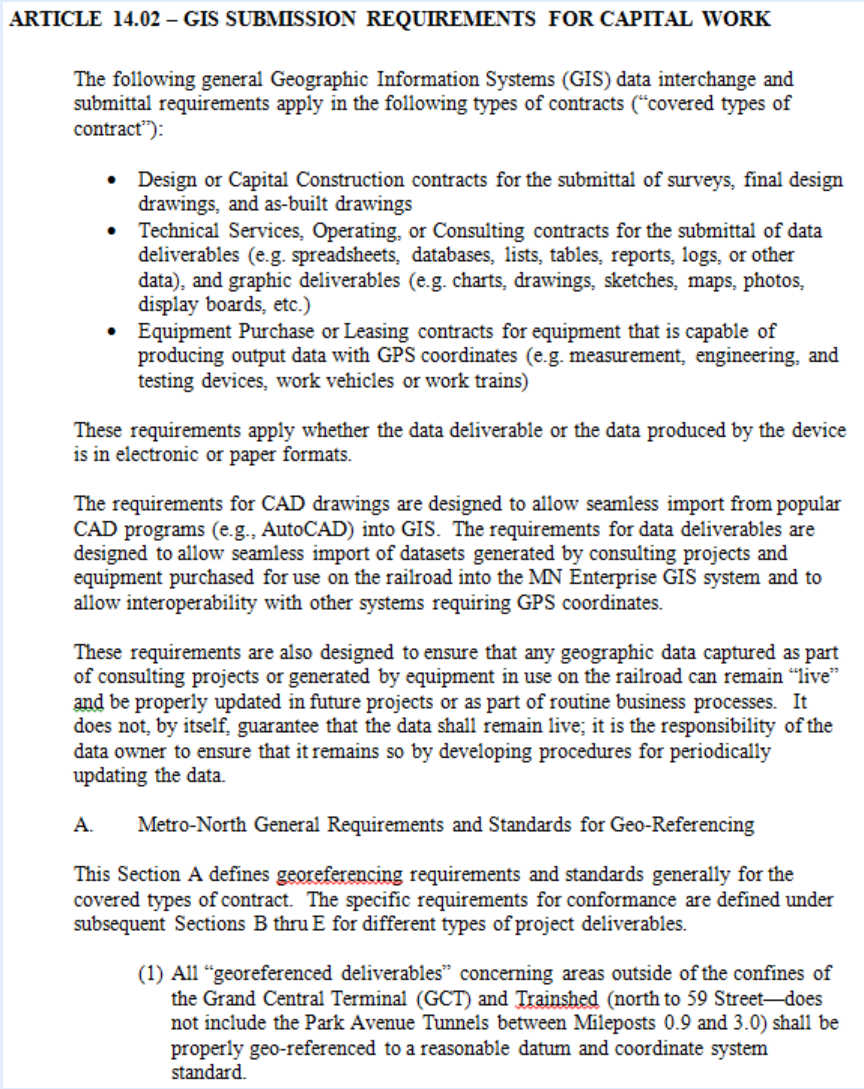
Visual Train Tracking System (VTTS)

Early Action—Policies

- **Human Capital:** GIS/CAD as "preferred skill" in job qualifications
- **Software:** Push users towards GIS web viewers; limit desktops
- **Procurement (Boilerplates):**

  Require GIS deliverable in all capital projects, i.e. As-built and other drawings, database outputs (track defect measurement system)
- **Data Security:** 3 levels of GIS Data
- **Data Hygiene:** Check-in/check-out, QA/QC procedures, etc.
- **Data Ownership and Update:**

  Working with ongoing Enterprise Asset Management (EAM) effort



ARTICLE 14.02 – GIS SUBMISSION REQUIREMENTS FOR CAPITAL WORK

The following general Geographic Information Systems (GIS) data interchange and submittal requirements apply in the following types of contracts ("covered types of contract"):

- Design or Capital Construction contracts for the submittal of surveys, final design drawings, and as-built drawings
- Technical Services, Operating, or Consulting contracts for the submittal of data deliverables (e.g. spreadsheets, databases, lists, tables, reports, logs, or other data), and graphic deliverables (e.g. charts, drawings, sketches, maps, photos, display boards, etc.)
- Equipment Purchase or Leasing contracts for equipment that is capable of producing output data with GPS coordinates (e.g. measurement, engineering, and testing devices, work vehicles or work trains)

These requirements apply whether the data deliverable or the data produced by the device is in electronic or paper formats.

The requirements for CAD drawings are designed to allow seamless import from popular CAD programs (e.g., AutoCAD) into GIS. The requirements for data deliverables are designed to allow seamless import of datasets generated by consulting projects and equipment purchased for use on the railroad into the MN Enterprise GIS system and to allow interoperability with other systems requiring GPS coordinates.

These requirements are also designed to ensure that any geographic data captured as part of consulting projects or generated by equipment in use on the railroad can remain "live" and be properly updated in future projects or as part of routine business processes. It does not, by itself, guarantee that the data shall remain live; it is the responsibility of the data owner to ensure that it remains so by developing procedures for periodically updating the data.

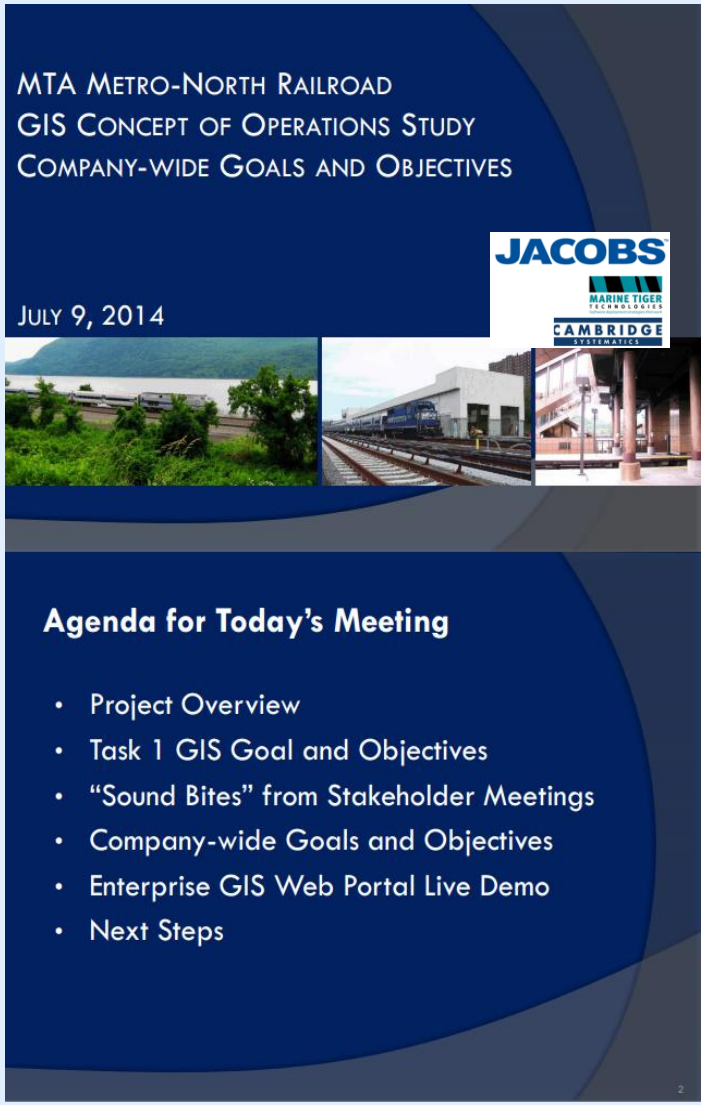
A. Metro-North General Requirements and Standards for Geo-Referencing

This Section A defines georeferencing requirements and standards generally for the covered types of contract. The specific requirements for conformance are defined under subsequent Sections B thru E for different types of project deliverables.

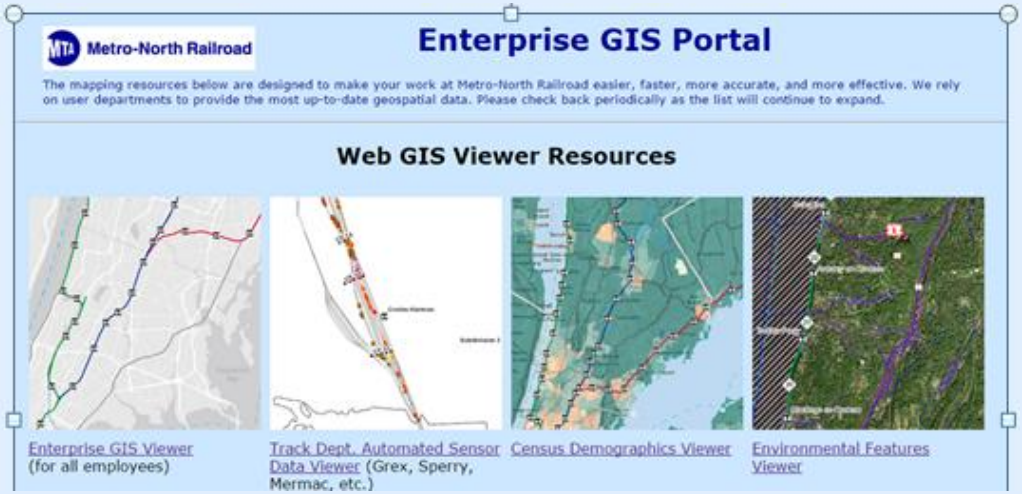
(1) All "georeferenced deliverables" concerning areas outside of the confines of the Grand Central Terminal (GCT) and Trainshed (north to 59 Street—does not include the Park Avenue Tunnels between Mileposts 0.9 and 3.0) shall be properly geo-referenced to a reasonable datum and coordinate system standard.

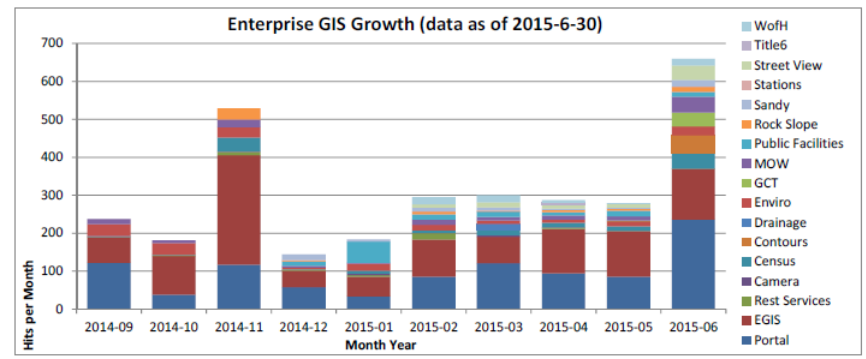
Concept of Operations (ConOps) Study

- **Goals and Objectives Meetings**
  - Co-opt senior management support
  - Loosely define user requirements
  - Find possible use cases
- **Data Inventory and Gap Analysis:** "Fishing expedition" to discover more data and resources
- **Business & Operational Processes:** "Institutionalization" of GIS
  - Straight Line Diagrams (SLD) Viewer
  - Integrated Property Boundary GIS (Yardi)
  - Plan Room Drawing Retrieval (CPRDRM)
  - Visual train tracking replacement
  - Ridership & Demographics Visualization
- **Staffing:** "Who's doing what?" Add new staff if nobody there!



Marketing

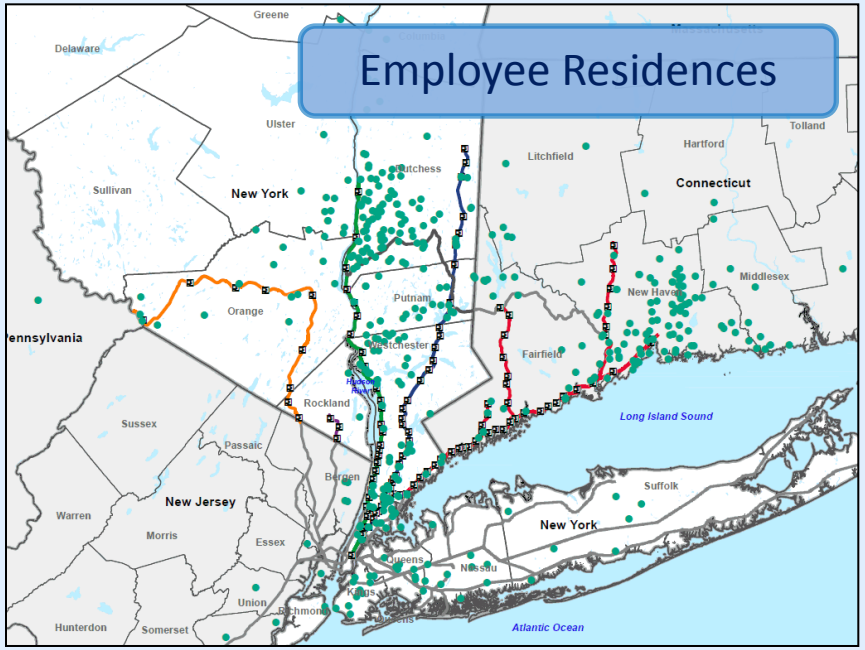


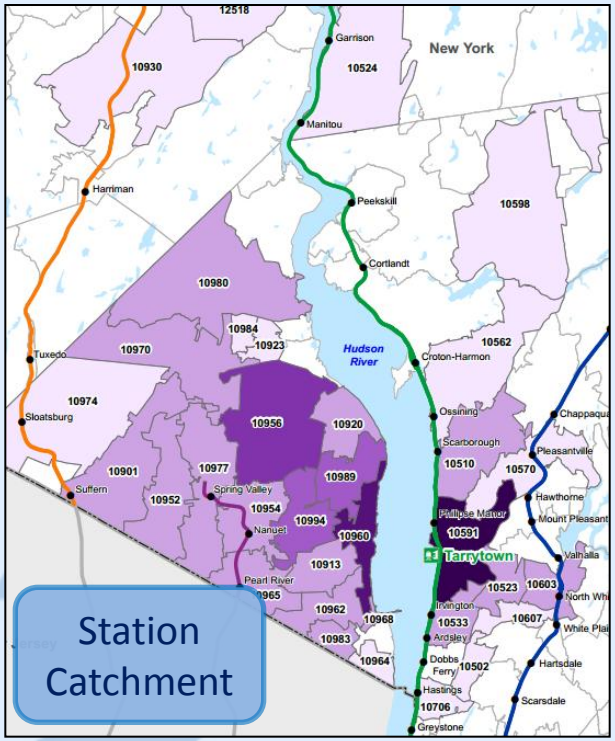


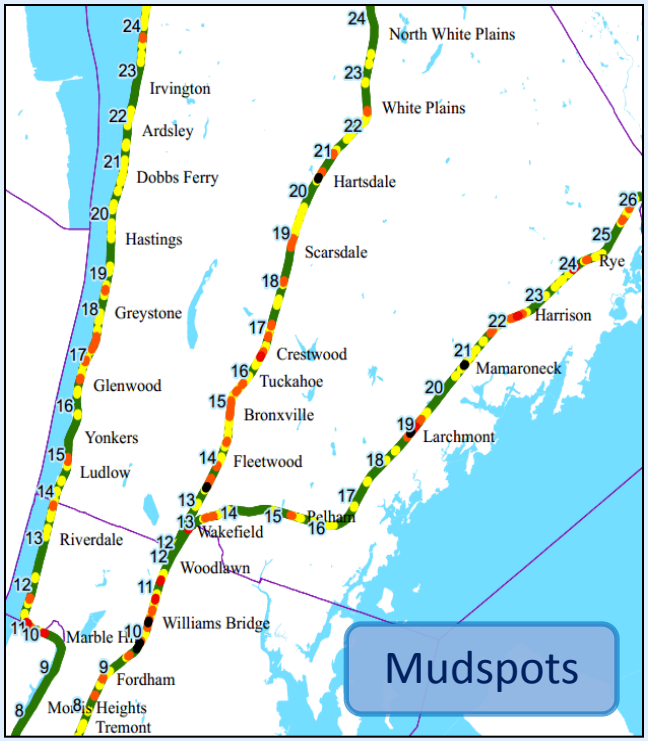
- **Portal:** "at a glance" GIS resources webpage
- **REST Services Directory:** wide open (on purpose)
- **Email Blasts:** exec. level "this is what GIS can do"
- **"Infomercial" Videos:** like home shopping…
- **Roadshows:** visit regular departmental meetings or set up special targeted sessions
- **Ask Project Manager to Approve:** when receiving data, always circle back to PM (more for education than for review)
- **Early Products:** use 3D visualization, heat maps, BigData, etc., and circulate example map to generate interest

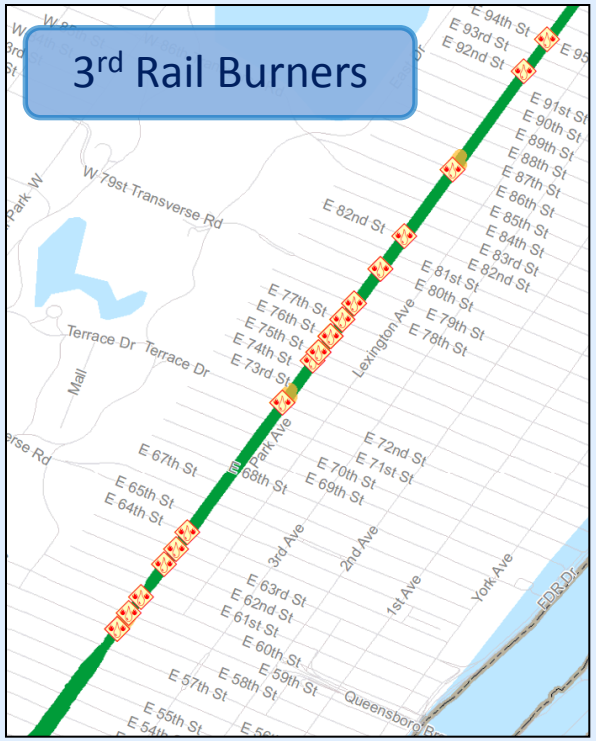
Early Data Products

- **Employee Residences** to estimate commute time
- **Station Catchment** to estimate feeder demand
- **Third Rail Burner** and **Mud Spot** tracking for maintenance



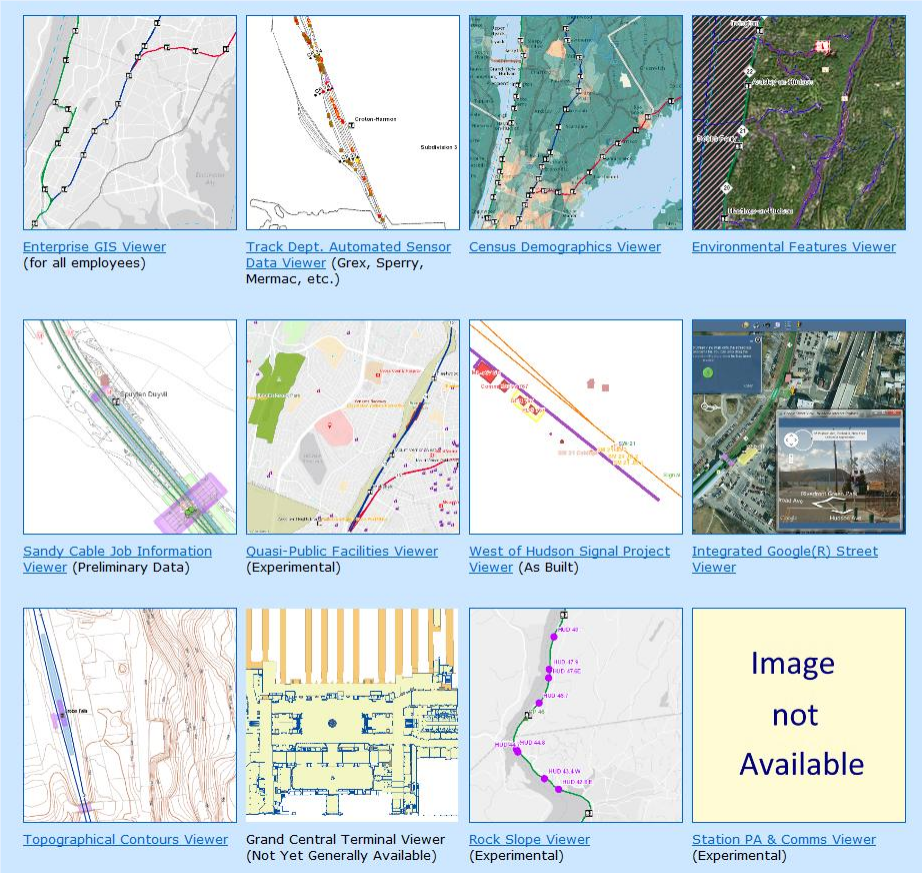






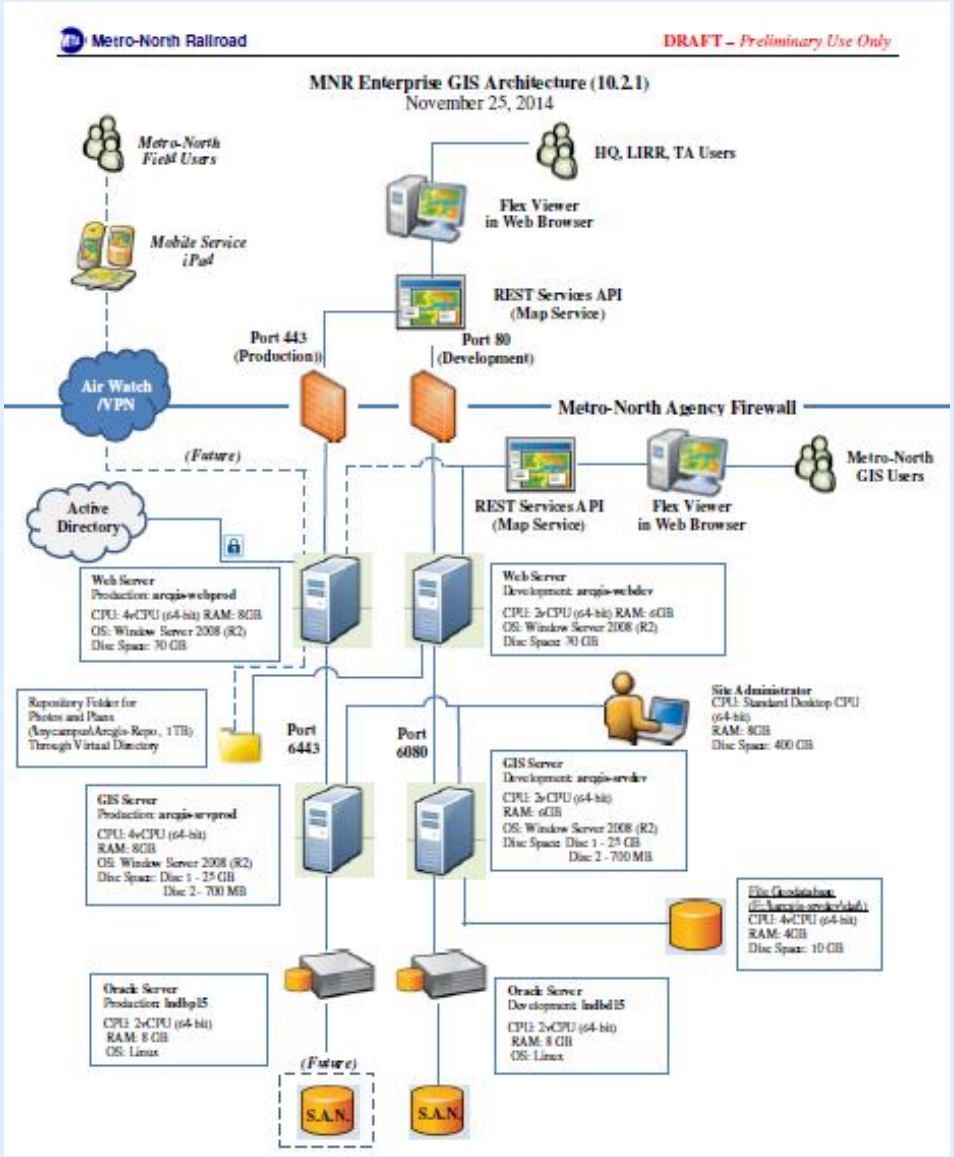
Enterprise GIS Web Viewers

- Map railroad features on web application to improve data access
- Publicly available GIS layers overlaid with railroad locations
  - Census Demographics
  - Environmental features
  - FEMA flood information; Public and Quasi-Public facilities, etc.
- Link existing PDF maps into viewer as repository of drawings
  - Signal block plans, Power sectionalizing diagrams, Val maps, etc.
  - Avoids labor intensive Georeferencing for now
- Google Maps and Street View Integration at critical points

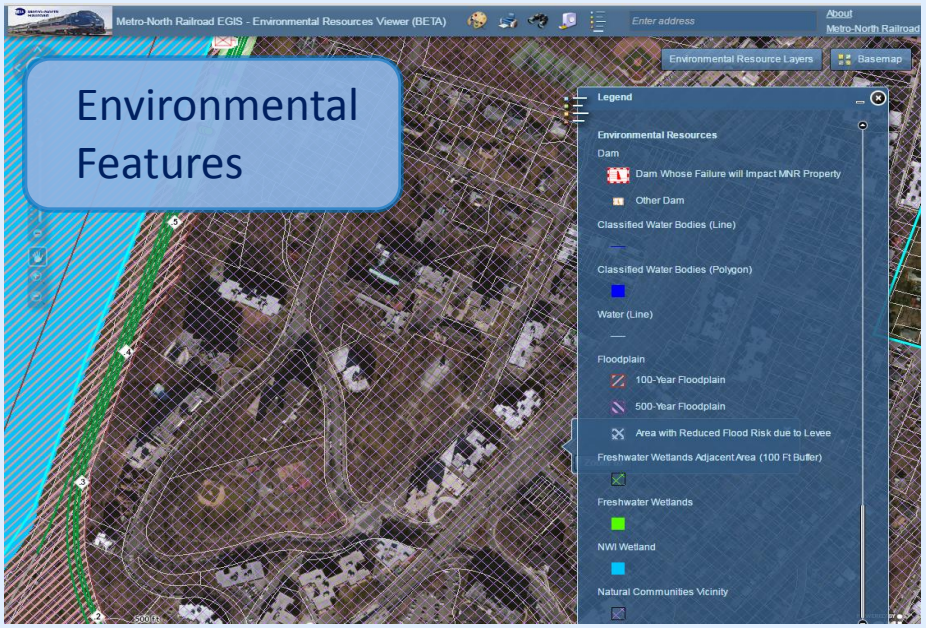


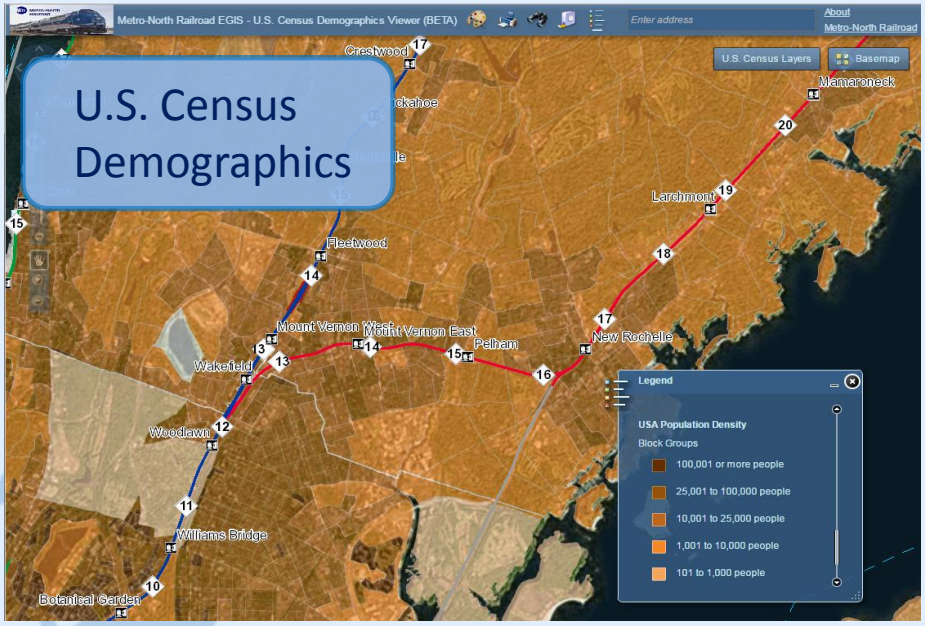
Enterprise GIS Architecture

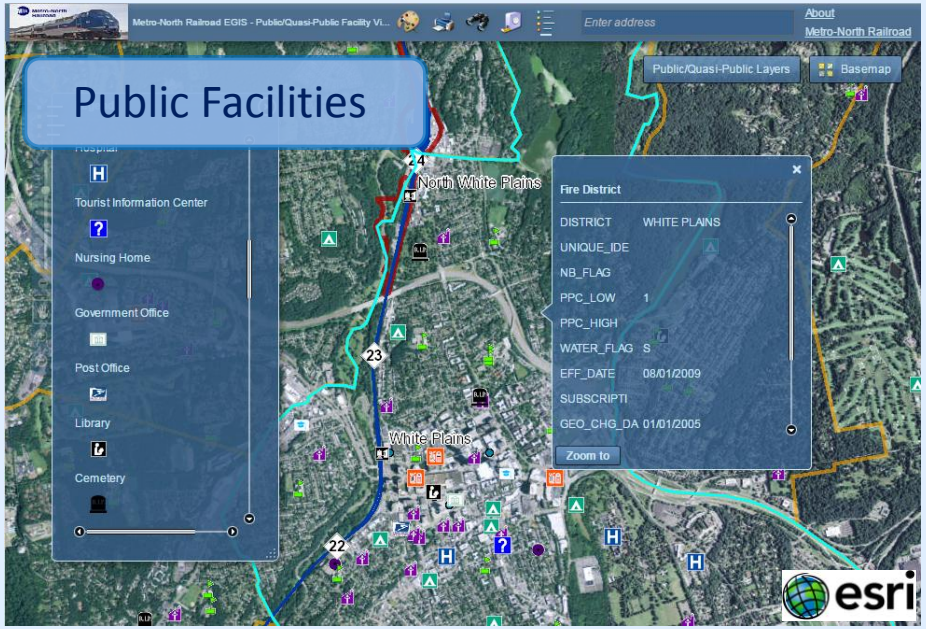
- ESRI ArcGIS for Server 10.2
  - with Web Adaptor
  - Access via web viewers and REST services (intranet only)
- File geodatabase on server
  - Migrating to Oracle
  - Effectively read-only for now
  - Power users on Desktops
  - GIS Manager is gatekeeper
- Mobile access via tablets with AirWatch software
- Inter-agency (MTA, LIRR, TA) access via selected opening in the firewall



Metro-North Enterprise GIS Web Viewers







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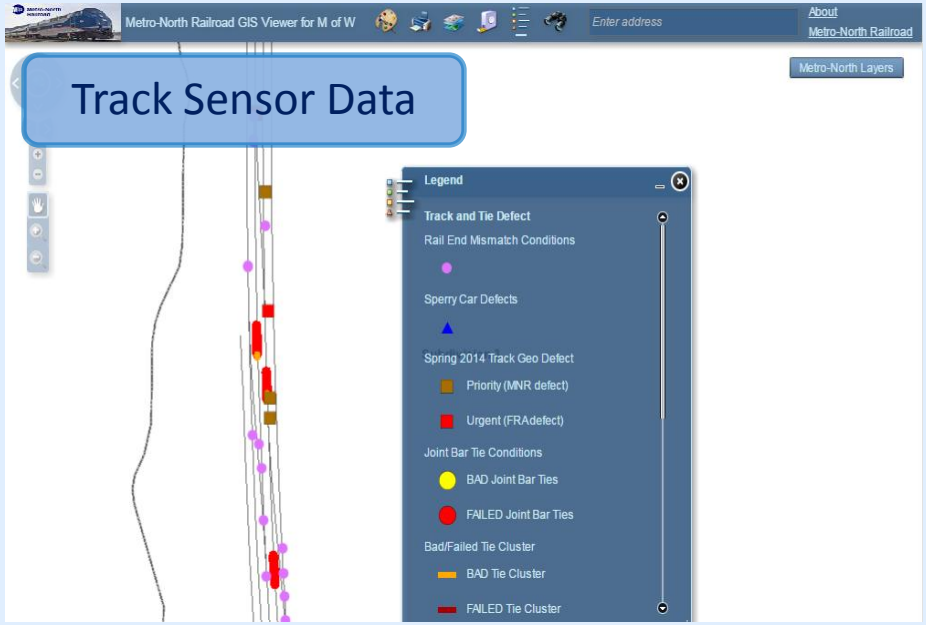

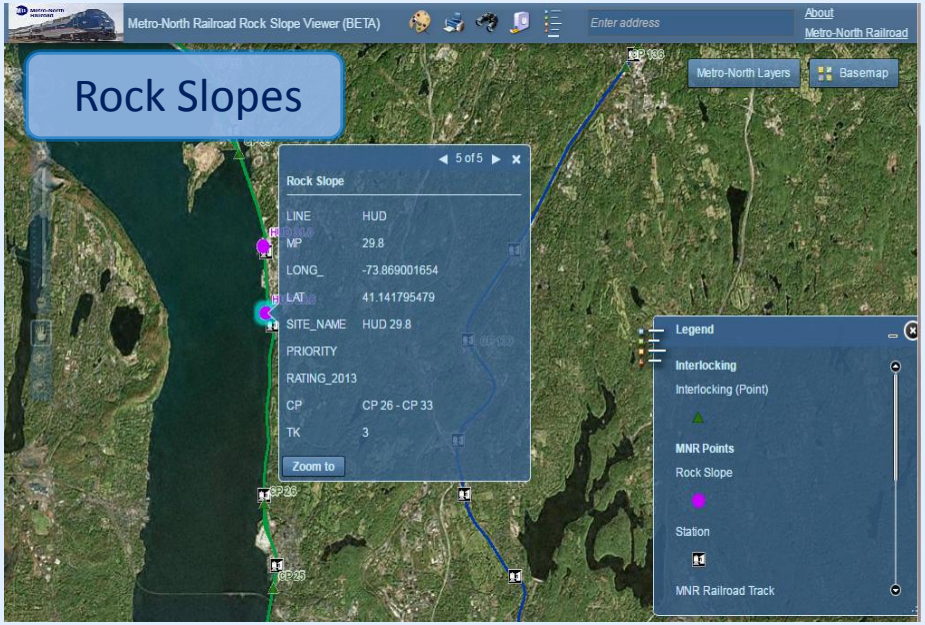

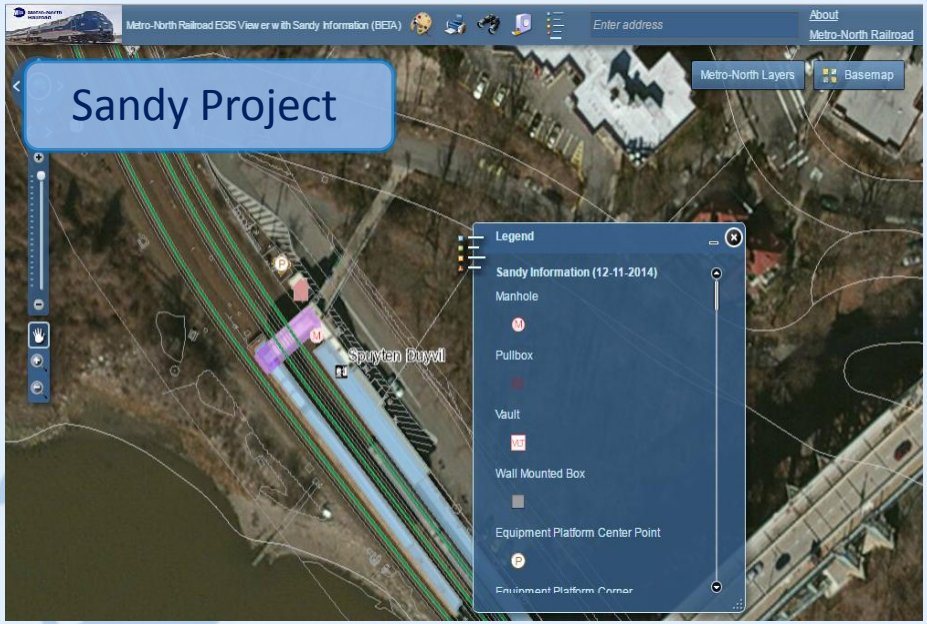

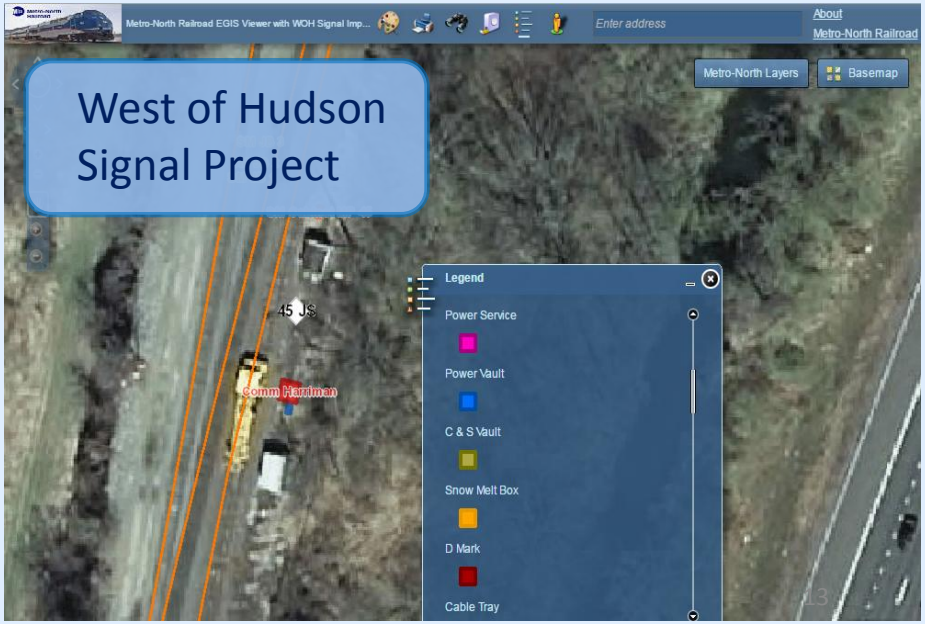

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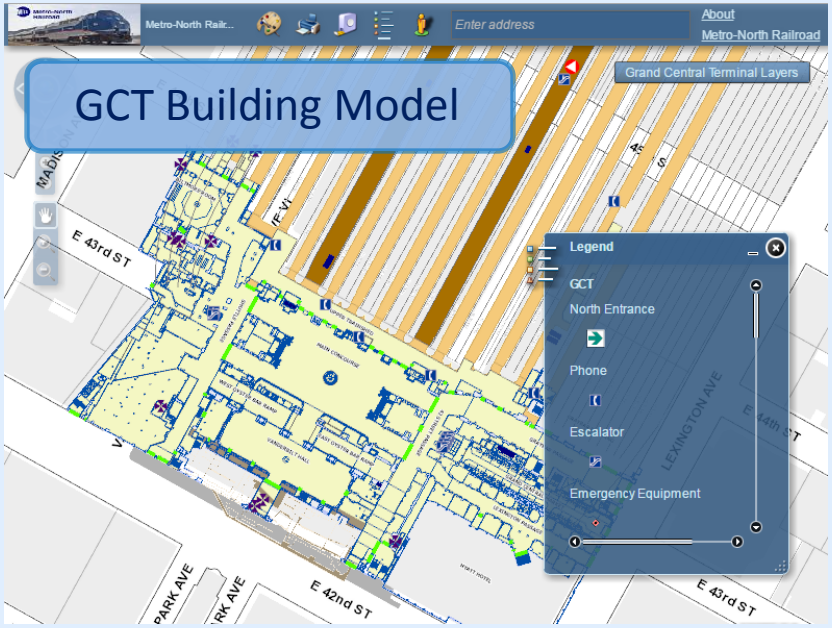
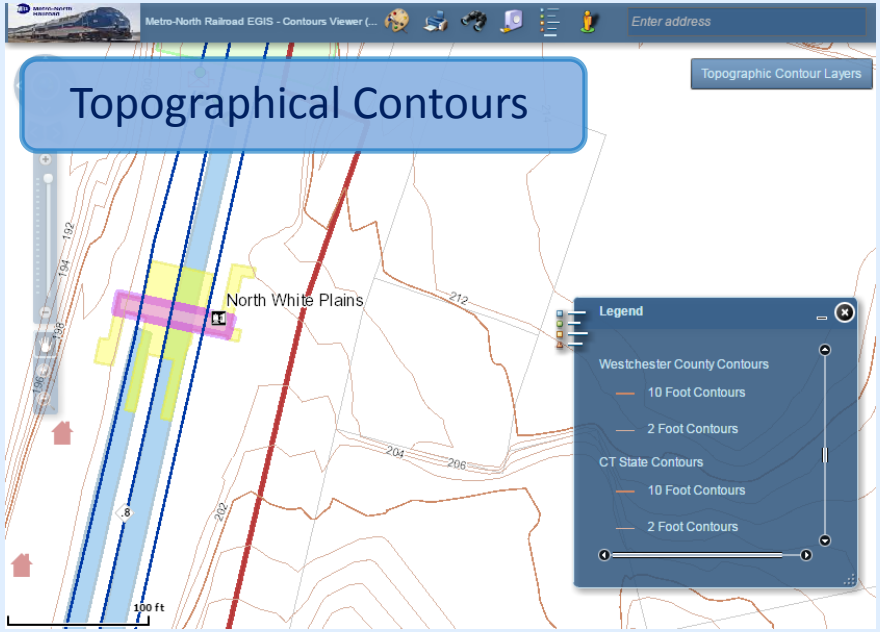
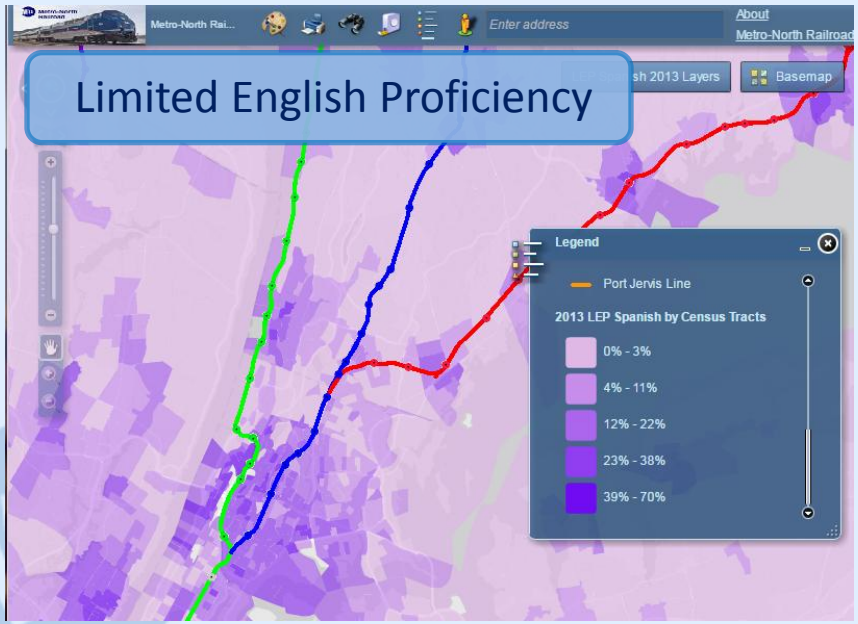
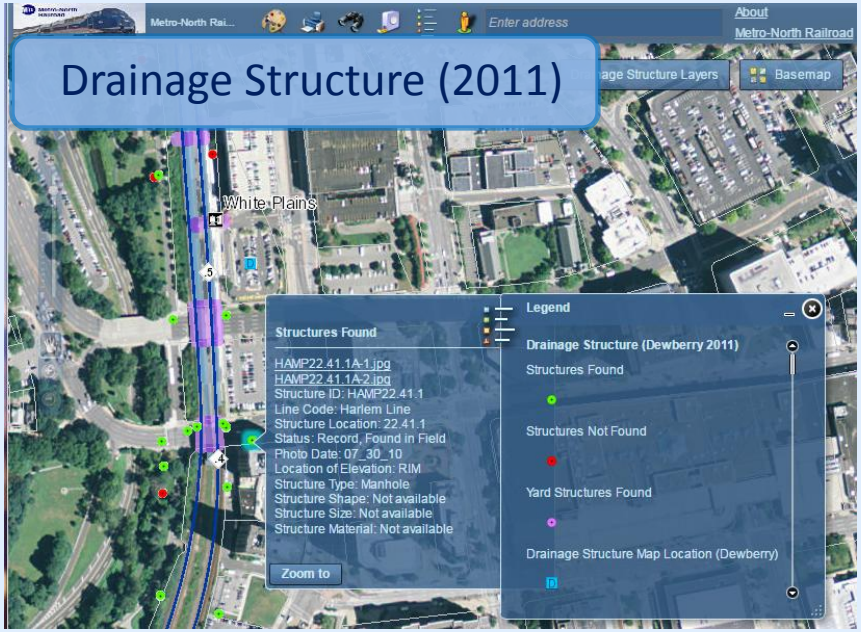
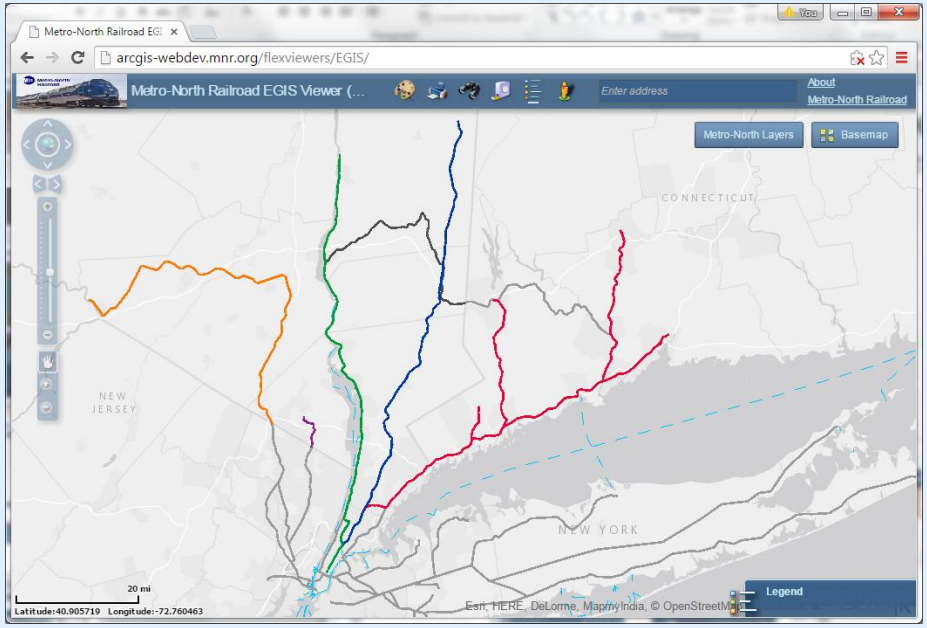


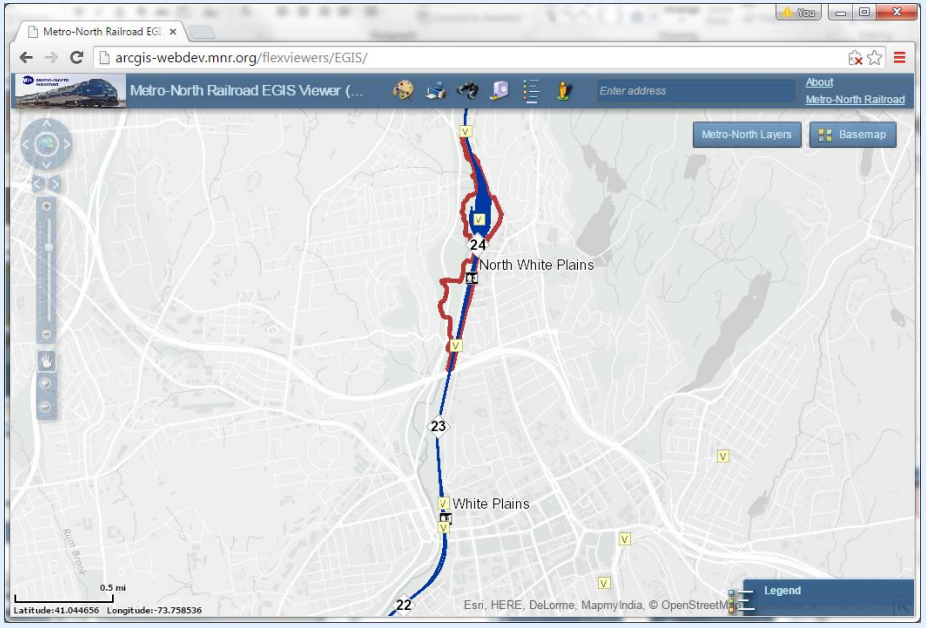


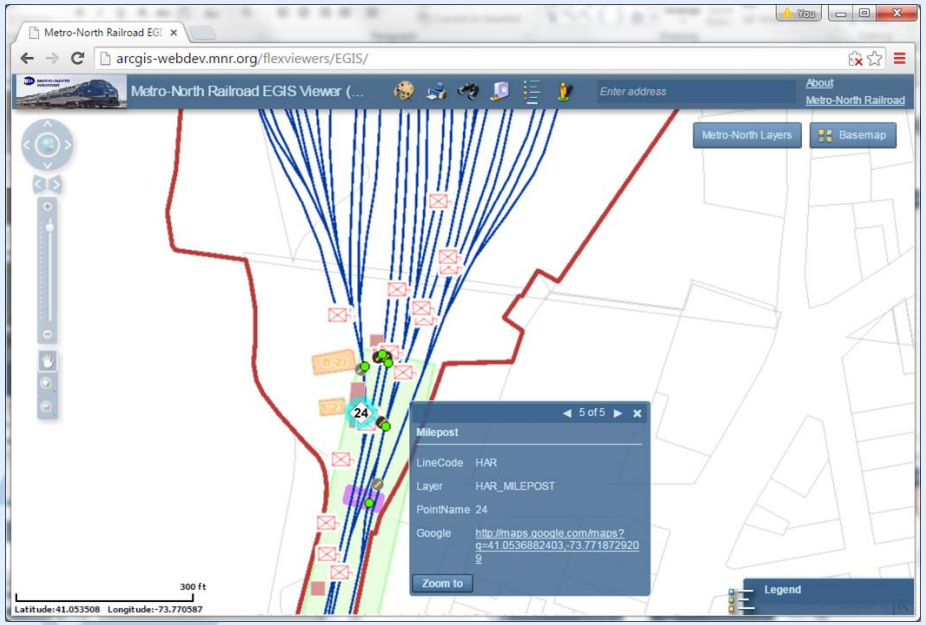


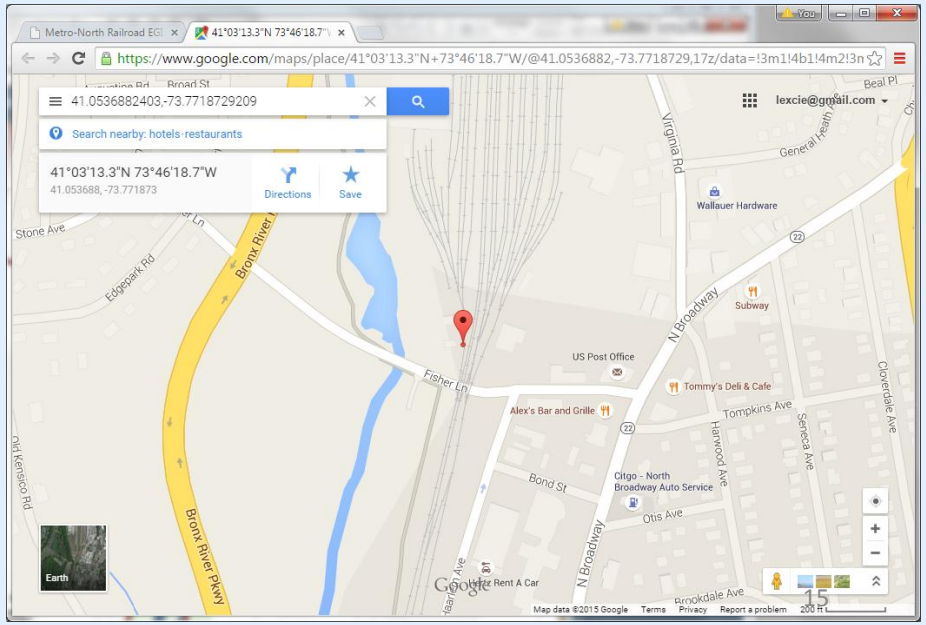


Metro-North EGIS: Asset Locations

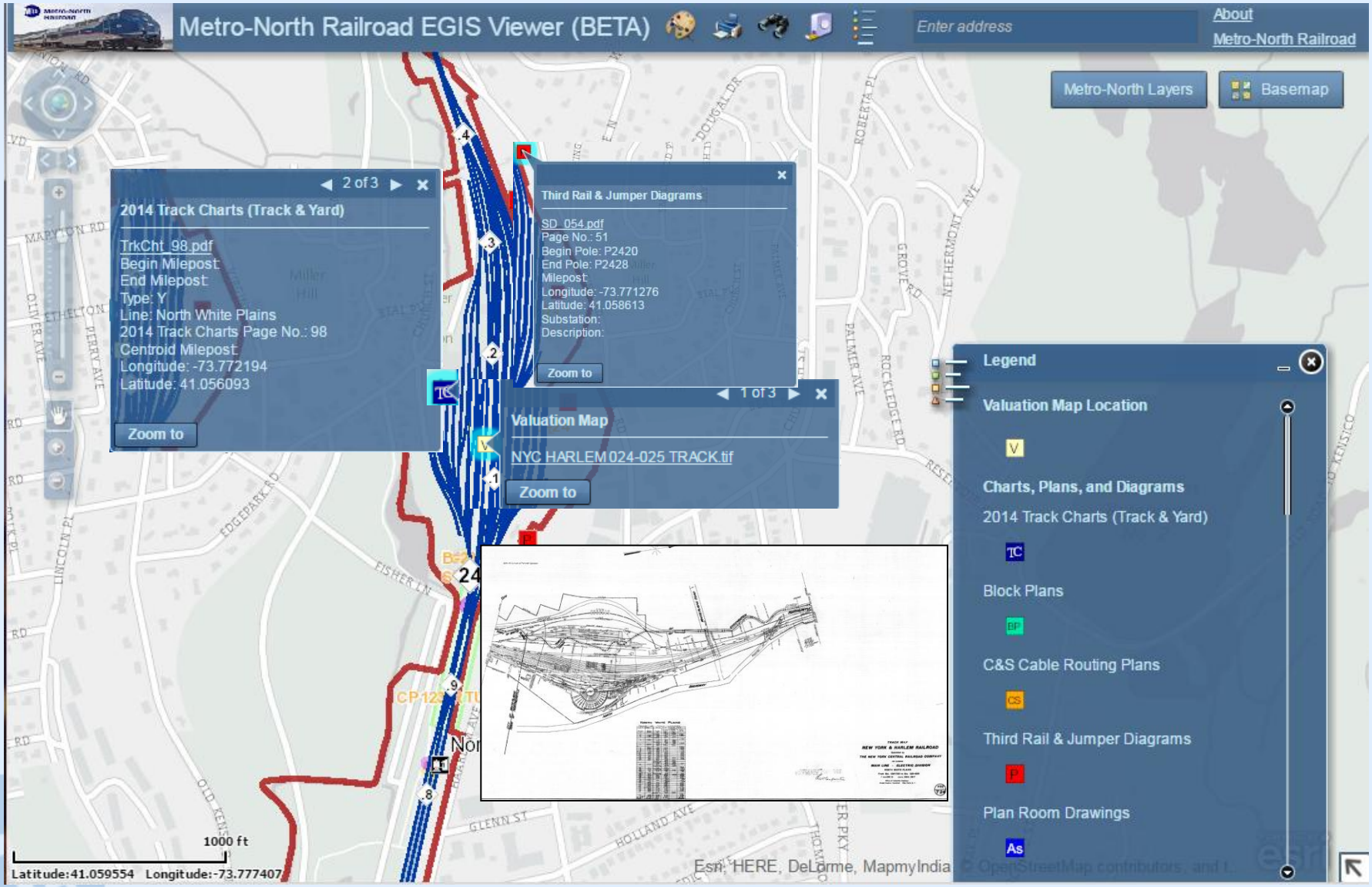




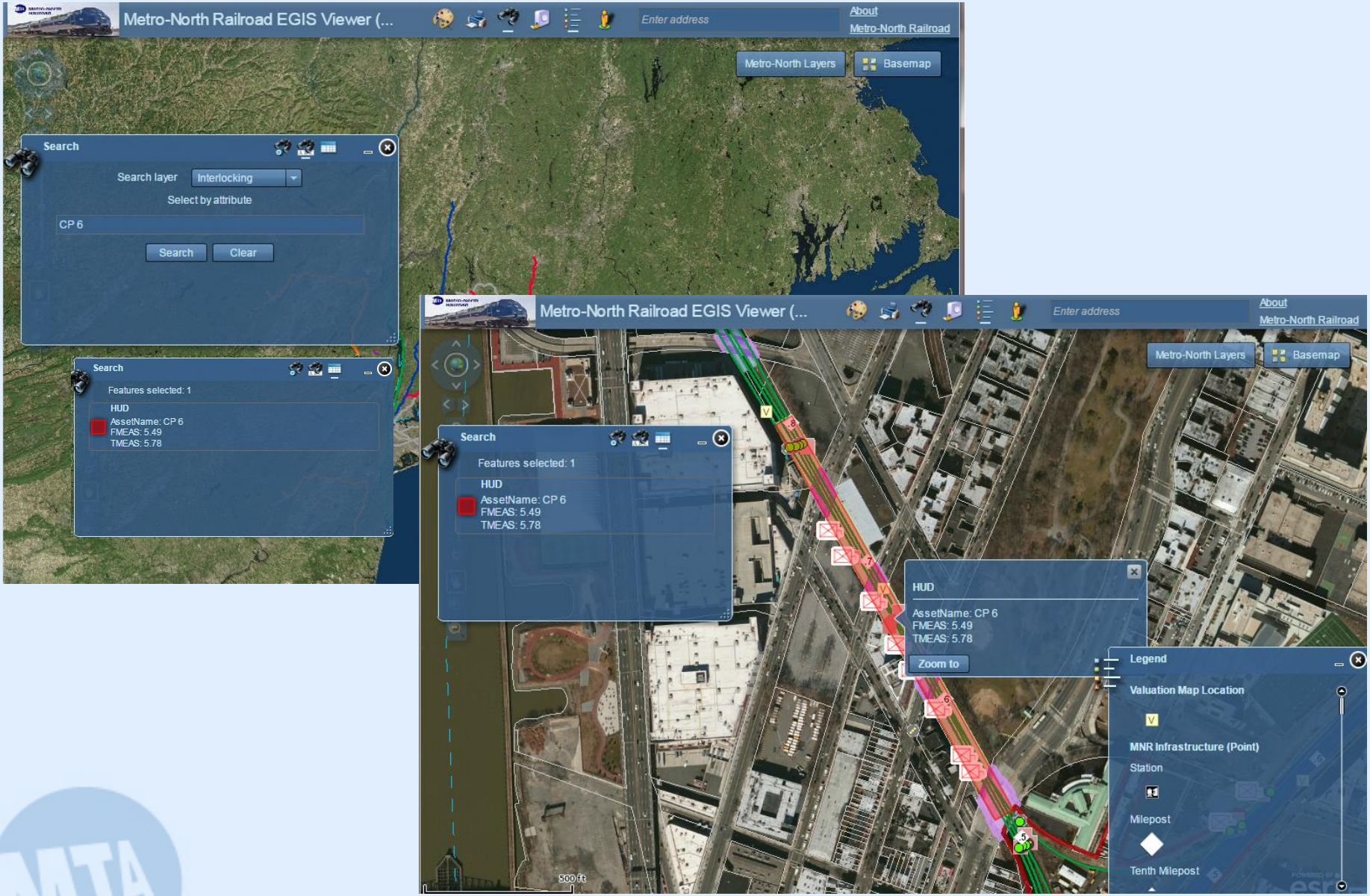




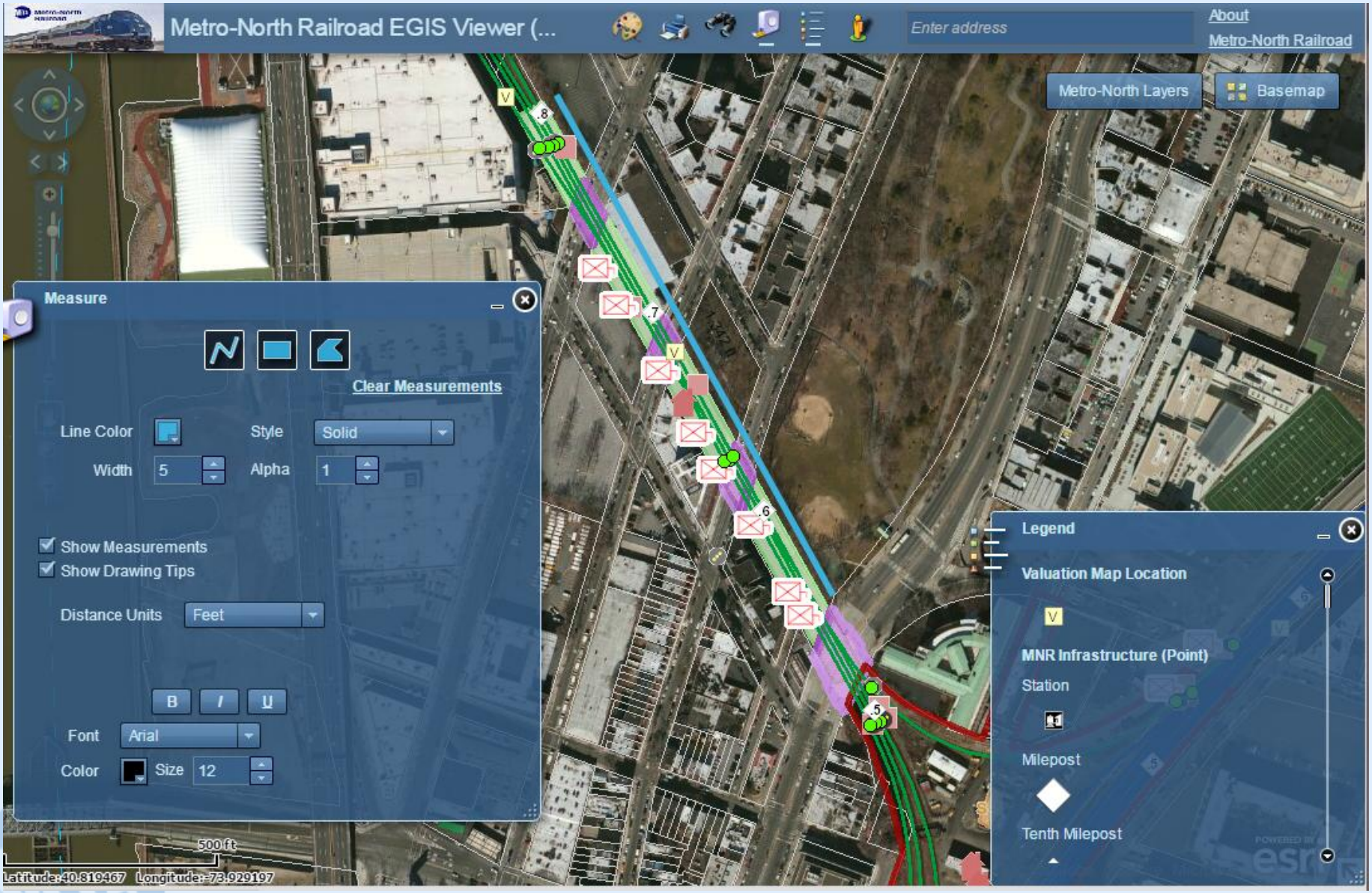
Charts, Plans, Val Maps, and Power Diagram



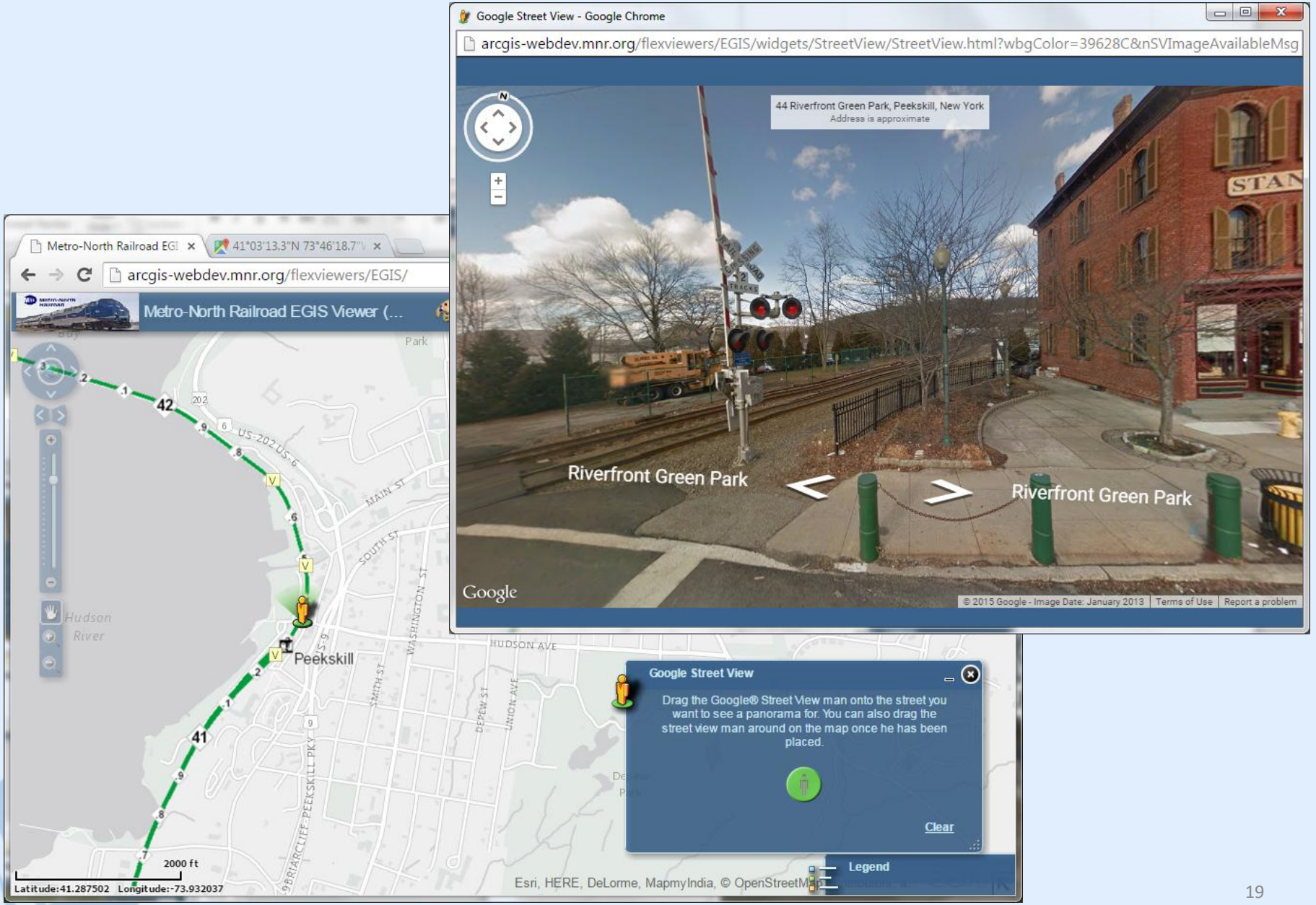
Metro-North EGIS Tools: Search



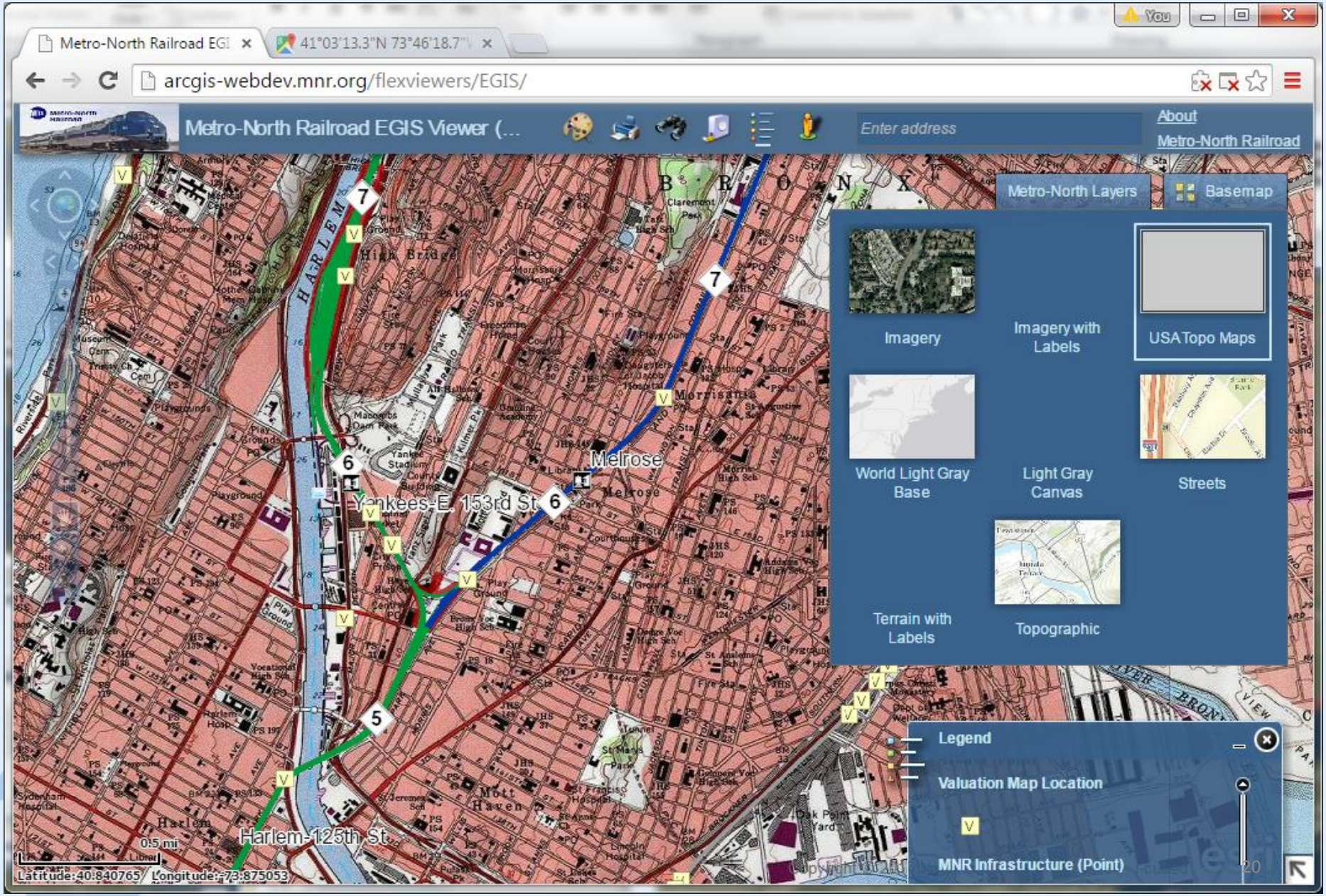
Enterprise GIS Tools: Measure Distance



Enterprise GIS Tools: Google Street View



Enterprise GIS Base Map Choices



EGIS Next Steps

- **Migration Issues**
  - ArcGIS 10.2 to 10.3
  - Dev/Prod Resiliency
- **Implement Five Baseline Applications**
- **GIS Staffing Roles**
  - SLD Engineer
  - Licensed Surveyor
  - Drawing Archivist/CADD
  - GIS App Developer
  - Demographer
- **In House Training**
- **Other Applications**
  - GIS Viewer for Security Management
  - Sustainability “Green” GIS
  - GIS Viewer for Emergency Management Application

Questions?
Data Request?

Ms. Xiaojing Wei, GISP
GIS Manager
MTA Metro-North Railroad

420 Lexington Avenue,
12th Floor,
New York, N.Y. 10170-1200

212.340.4828
Wei (at) mnr (dot) org

or Alex Lu
Lu (at) mnr (dot) org

Metro-North Railroad's Enterprise GIS Program:
Yesterday, Today, and Tomorrow

Appendix: Extra ConOps Slides

Xiaojing Wei, *Alex Lu*, and *David Fogel*

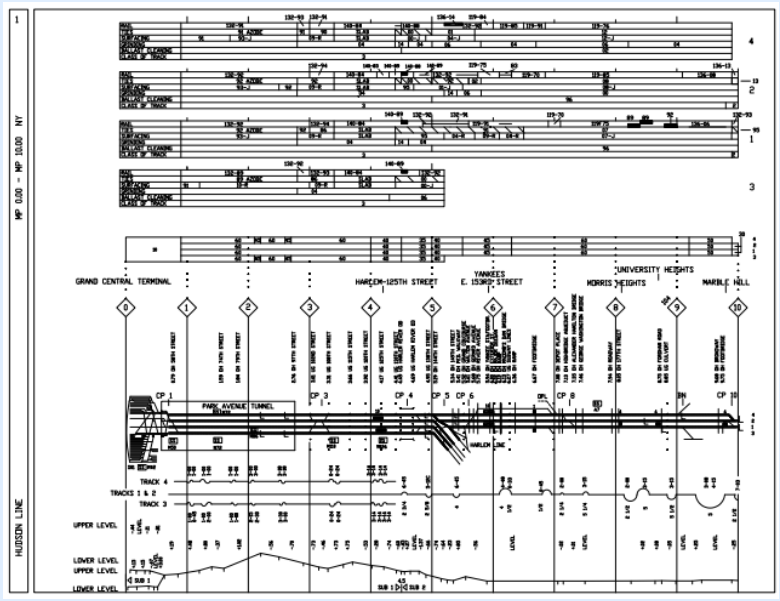
GIS in Transit Conference

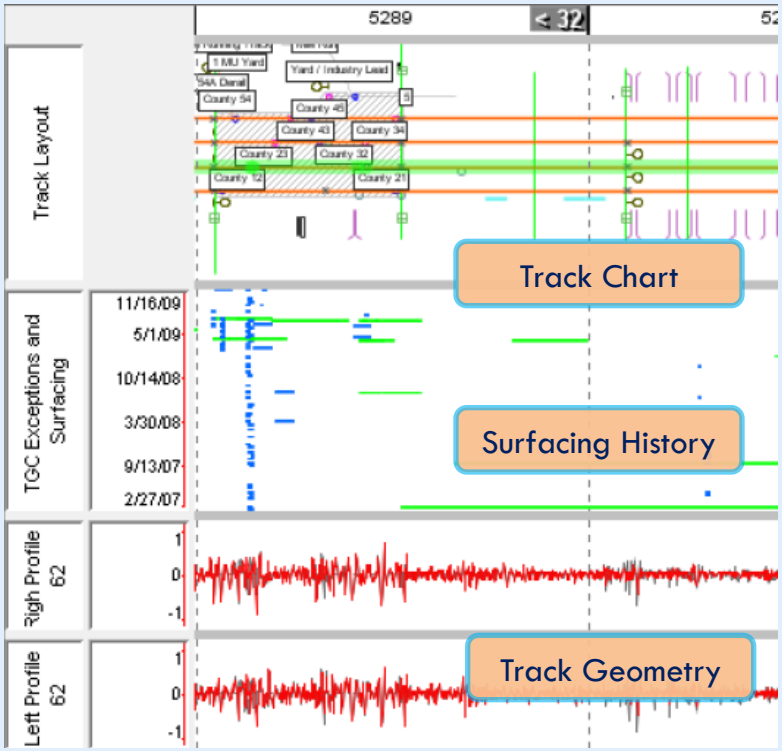
Washington, D.C.

September 2, 2015

Straight Line Diagrams

- Plot GPS coordinates, milepost, locations on a straight line diagram (SLD) like track chart
- Overlay data on marked-up track chart: slow orders, outages, tonnages, track geometry, signal/power/buried utility, etc.
- Replaces current laborious process of producing track charts
- Enables interdisciplinary information & intelligence sharing
- Improved capability & speed in identifying defects
- Vastly improve field data accessibility over paper

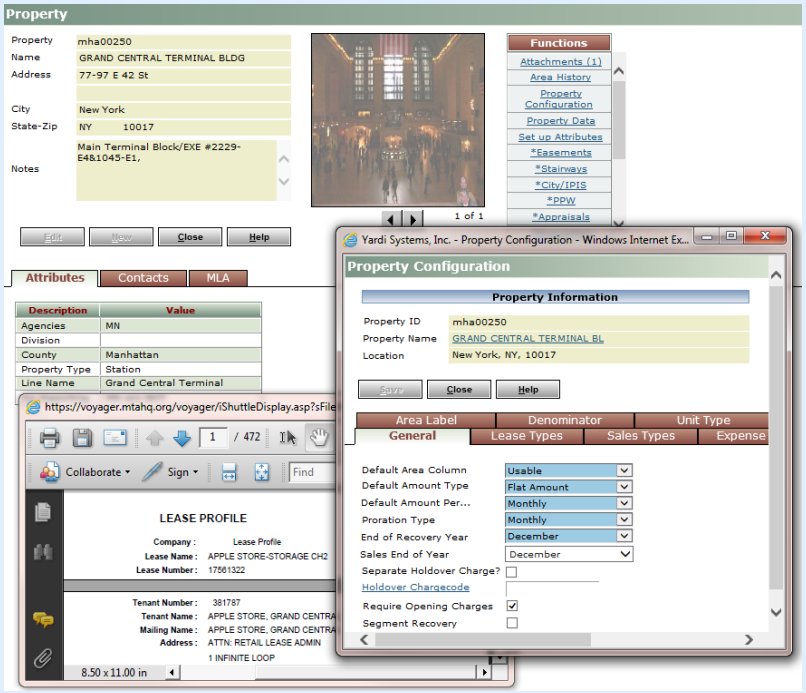


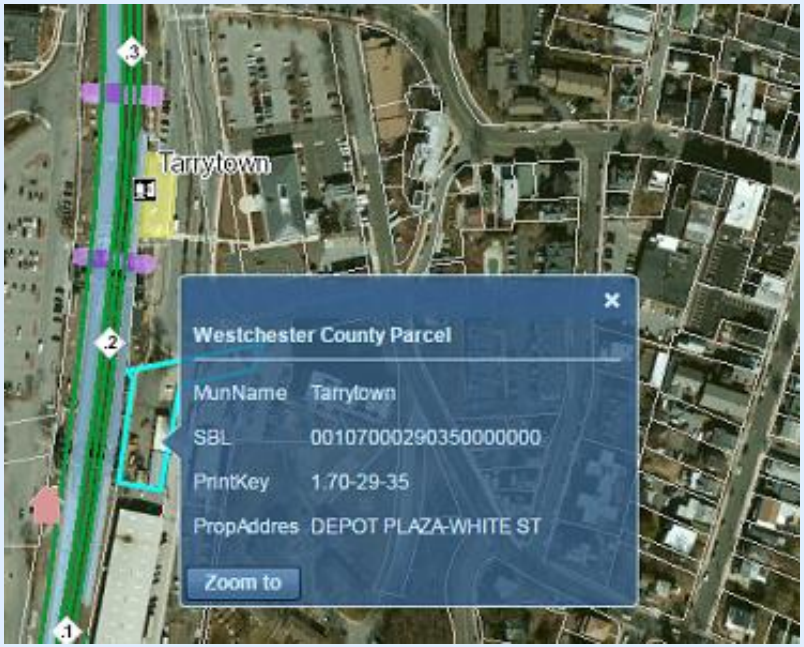


Metro-North Railroad

Property Management GIS Integration

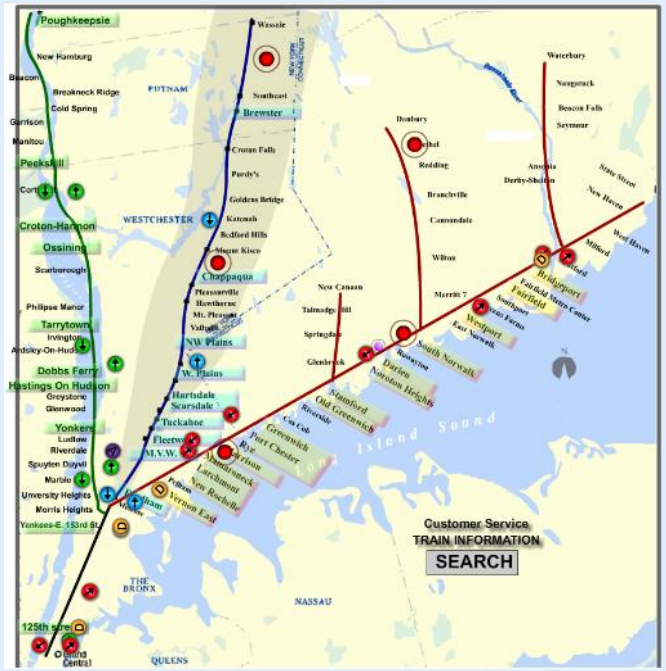
- Provide accurate, surveyed property lines of Metro-North rights of way, yards, leases, etc.
- Integrate with proprietary tenant management system
- Supports capital project planning, asset maintenance, operations, and emergency management
- Support entry permit process
- Support rent collection process and lease requests from utilities





Virtual Train Tracking System Replacement

- Display live train locations in near real-time on a diagrammatic map, line chart, as a colorized delay diagram, and allowing drill-downs into additional and historical data
- Display train movements relative to location features & infrastructure
- Delay visualization on mobile devices
- More accurate prediction of delays
- Better data for trainmasters making real-time assignments due to tight integration with crew and consist management systems



Plan Room Drawing Retrieval Mapper

- Recently scanned 100,000+ as-built drawings to PDF
- Allow user to visually look for drawings “by map”—self service drawing retrieval
- Geo-reference and improve indices by keyword/discipline
- Strikes balance between fully digitizing versus text-based location descriptions only
- Allows archivist to focus on minority of exception cases