



Enterprise-Class Geospatial Database Development

Task 1 – Discovery: System Requirements

EXECUTIVE SUMMARY

The Task 1 – Discovery: System Requirements document describes NJTPA's business processes and a series of technology alternatives that would improve their efficiency. The fundamental finding of the discovery process is that the Enterprise Geographic Information System database (EGISd) should be implemented to support NJTPA's mission-critical business functions and associated work-flows. The requirements document outlines NJTPA's geodatabase needs, puts forth strategy alternatives to address them, and enumerates specific functional requirements that will serve as design guidelines for subsequent tasks within the overall EGIS development and implementation process.

The North Jersey Transportation Planning Authority (NJTPA) has undertaken the Enterprise Geographic Information System database (EGISd) project, contained in the agency's Unified Planning Work Program (UPWP) for 2009. The EGISd is envisioned to be a repository of Geographical Information Systems (GIS) data and related tabular data, implemented within a server-side IT architecture, and containing a variety of client-side data input and retrieval protocols. The project goals are listed below.

- Consolidate spatially oriented information from multiple sources into an enterprise-class Relational Database Management System (RDBMS)
- Develop tools and functions that will improve NJTPA's mission-critical business functions and associated work-flows
- Build the foundation for next-generation business and web-based applications

The EGIS project has several facets detailed throughout the course of the document. A central theme of the project will be to strengthen NJTPA as a regional hub for information sharing, and by extension, reinforce its commitment to meeting the mobility, economic, and quality of life goals of the region. Based on this objective, the discovery phase engaged the project's GIS Steering Committee and its constituents in a series of interviews to better understand data sharing alternatives. Accordingly, the EGIS project is largely about developing the IT infrastructure and support tools to more efficiently broker a variety of information among organizations throughout the state.

The envisioned EGIS system will center primarily on an Environmental Systems Research Institute (ESRI) software platform, containing two core components. First, the system will contain a database component that will use Microsoft's SQL Server 2008 for data storage and ESRI's ArcSDE for data brokerage of spatial data. Second the system will contain a GIS engine to perform a variety of distribution and data publishing functions using ESRI's ArcGIS Server software.



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Findings:

The key findings by organization are summarized below.

NJTPA Central Staff Divisions

1. Systems Planning, Data and Forecasting

- As there are multiple NJRTM model runs done each year, the periodic air quality conformity runs for given year, required by regulation (4 periods – AM Peak, Midday, PM Peak, and Evening = 4 data sets) represent the best model runs to be used for general consumption. Each model run output is considered a “loaded network.” Accordingly, these 4 data sets, as a requirement, will be loaded into the EGISd as appropriate.
- To support the model, the TAZ and MCD GIS layers will be loaded into the EGIS system to support general planning analysis.
- The Systems Planning, Data and Forecasting division uses and consolidates a variety of data sets from around the state. This division is regarded as the general keeper of data for which NJTPA uses to support several business processes. To support this requirement in the EGIS, a series of data transfer routines will be built to populate the SQL Server database. These transfers include data exchange arrangements with NJ Transit, PANYNJ, and NJDOT.
- In light of the physical design phase beginning in Task 3, the scope of this division’s data management responsibilities lends itself to the need for one (1) database schema containing regional systems planning business data.
- Need to develop a formal ArcSDE polygon layer that combines the Strategy Area, PDWP and TIP geometries. This layer will be the only ArcSDE layer in the EGIS system that is wholly created by to NJTPA. This overlaps with Capital Programming requirements.

2. Regional Planning

- Create one base-line map document (mxd) file that gives the division fast and easy access to a variety of data sets within a mapping environment that provides context.
- Create six (6) map (mxd) document files that will give the division and the agency a snap-shot view of the six regional progress indicators, such as environmental screens, within a mapping environment that provides context. These six indicators will be dynamically tied to the information that resides in the EGISd. The structure of these six indicators will be governed by thresholds denoted and monitored by the System Planning division.

3. Freight Planning

- The Transearch database tables should be stored in the EGISd, based on a straight data dump into the SQL Server database. Once the new release is available, the specific storage schema will be determined.

4. Capital Programming

- Microsoft Access has fundamental limitations when supporting enterprise-class business



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operations such as the NJTPA TIP program. Because the TIP is a mission-critical process and central to many data sharing points in the organization, orienting the data input, data management, and data reporting processes around a true RDBMS (SQL Server), will allow for multiuser access, integration with other data sets within NJTPA’s work-flow, and generate a more secure environment for the TIP data.

- The TIP data needs to reside inside the EGIS database, SQL Server, and conform to relational database management norms to maximize the benefits of a DBMS. Proper data storage inside SQL Server is independent of the data input source structure. The TIP data can be managed in a normalized schema inside the DBMS, independent of the format submitted by NJDOT and NJ Transit. Normalized data inside SQL Server will allow the agency to better leverage the data in relation to integration with other business tables and processes such as GIS operations.
- Working under the assumption that the TIP data management process will occur within SQL Server, the EGIS project presents an opportunity to develop a single-point application user interface application to the back-end data. Such an application would contain all of the tools required to generate the TIP, including output reports that are identical to present submission requirements
- NJTPA needs to develop a projects polygon ArcSDE layer that represents locations of Strategy Areas and TIP project areas. Each polygon will have an identifier that links to the database, contains all necessary attributes, and has a defined maintenance plan that is the responsibility of the Systems Planning, Data Forecasting division. This overlaps with Systems Planning requirements.
- The nature of the TIP data management process lends itself to the need for one (1) database schema in the EGIS physical data design.

5. Information Technology

#	Variable	Description
1	Organization – Central Staff	+/- 60 persons
2	ArcGIS Licenses (Central Staff and Subregions)	8
3	MapInfo Licenses	8
4	Maximum general Geodatabase participants (Central Staff and Subregions)	+/- 100 indirect users
5	Maximum direct simultaneous geodatabase users (GIS)	+/- 20 direct users
6	Data Editing (features classes in ArcSDE database)	3-10 feature-classes
7	Potential business table editors	+/- 20 users
8	Peak-period NJTPA web-site visits	400 / hour
9	Estimated requested map displays per hour, per person	40
10	Peak-period web map displays per hour	16,000

6. Finance & Administration, Public Affairs, and External Affairs

- These divisions are evaluating the need for a more robust document management system. This system should have better integration with other data sets in the agency, such as links to NJTPA pipeline projects.
- Responding to the needs of a document management systems are beyond the scope of the EGIS project.
- AECOM will assist NJTPA in developing a “wish list” of items that would be desirable elements of a document management system and will provide suggested approaches to achieving these goals. The design of the EGIS system will consider the needs of a future



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document management system. For example, as an approach to the TIP interface is being evaluated, consideration will be given to SharePoint and Livelink platform options so that the two systems would be more compatible

- In support of a future document management system, a high-level concept data model will be developed to advance the implementation of a future document management system

NJTPA Subregions

- NJTPA and the subregions will begin a series of formal quarterly data exchange programs, initially via ftp drop off
- Subsequently, as experience with ArcGIS Server's replication and geodata services increases, and once the NJTPA geodata model is in place, the NJTPA GIS user community will be in a better position to take advantage of a more defined data replication platform.

New Jersey State Agencies

1. New Jersey Department of Transportation (NJDOT)

- NJDOT's SLD feature class is sufficiently accurate to act as the spatial reference for all GIS data loading into the EGIS database
- The initiation of a data exchange program involving NJDOT's management system data will likely require approval of the Asset Management division's data stewards and its governing policies. These discussions are currently in progress.

2. New Jersey Office of Information Technology (NJOIT)

- Data exchange involving the system management data will require consideration by the NJDOT Data Stewardship body
- The implementation of any data exchange program related to NJDOT's management system data will likely require the support of NJOIT's technical staff, specifically the Data Management Group.
- In order to technically initiate a data exchange program involving the management system data, NJTPA will have to define its needs in relation to the overall Data Warehouse data model developed with the IRWIN data modeling software.

3. New Jersey Department of Environmental Protection (NJDEP)

- Due to the large size of NJDEP's data sets and relative infrequency of their updates, the current distribution method via NJDEP website periodic downloads is a sufficient way for NJTPA to continue to receive NJDEP data.

NJTPA should subscribe to the NJDEP list-serv, to be kept abreast of the data updates.

4. New Jersey Department Transit (NJ Transit)

- NJ Transit will evaluate the preparation of a spreadsheet prepared quarterly that contains ridership information. The spreadsheet(s) would be made available in the EGIS via a data exchange application.
- Each record in the spreadsheet will require a special identifier that is consistent with the agency's prevailing GIS layer.



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5. Port Authority of New York and New Jersey (PANYNJ)

- PANYNJ will evaluate the preparation of a spreadsheet prepared quarterly that contains ridership information. The spreadsheet(s) would be made available in the EGIS via a data exchange application.
- Each record in the spreadsheet will require a special identifier that is consistent with the agency's prevailing GIS layer.

Regional MPO's

1. New York Metropolitan Transportation Council (NYMTC)

- FTP is the best exchange platform for NYMTC at this time
- NYMTC's enterprise-class information system project, the Transportation Information Gateway (TIG), will commence in the fall of 2009. This project will share many of the EGIS project goals.

2. Delaware Valley Regional Planning Commission (DVRPC)

- FTP is the best exchange platform for DVRPC at this time

3. South Jersey Transportation Planning Organization (SJTPO)

SJTPO has not participated in the NJTPA EGIS project to date

Requirements:

Based on the findings of the discovery process, a series of functional requirements were developed for the EGIS system, enumerated in the following table.

#	Requirement	Design Approach	Source
1	Store one (1) series of demand model / conformity runs per 1-2 year (4 loaded networks) in the EGIS. This is equal to four (4) period data sets: AM Peak, afternoon, PM peak, and evening for a given build year. Other model runs can be uploaded to the EGISd adhoc.	Alternatives: 1) Copy directly the 4 shp file, loaded networks from CUBE into the EGIS 2) SQL Server Integration Services (SSIS): transfer loaded model output business tables into the EGIS and join to the model network or SLD feature class via an ArcSDE view	NJTPA



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2	<p>Develop one (1) polygon ArcSDE layer that includes Strategy Areas, and one (1) line ArcSDE layer that includes PDWP and TIP geometry and attributes. A maintenance program must be put into place to support these layer, to be lead by the Systems Planning division.</p>	<p>Create ArcSDE feature class with attributes in EGIS using ArcGIS</p> <p>Alternatives:</p> <ol style="list-style-type: none"> 1) Feature Class with attributes in the geodatabase 2) Feature Class (geometry) in the geodatabase, business data in non geodatabase; join via an ArcSDE view (cross data base) <p>Alternative 2 is more in conformity with database normalization</p>	NJTPA
3	<p>Develop one (1) base-line map document (mxd) file for the Regional Planning division</p>	<p>Develop in ArcMap using EGIS data</p>	NJTPA
4	<p>Develop six (6) map document (mxd) files for the division, reflective of the regional progress indicators contained in the publication <u>Are We There Yet?</u></p> <p>Each indicator will be post processed based on available agency data exchange programs and inputs; Indicators and Goals:</p> <ol style="list-style-type: none"> 1) Emissions (Requirement 1 and or Air Conformity Consultant outputs) 2) NJ Transit Ridership (Requirement 15) 3) PANYNJ Inputs (Requirement 16) 4) Congestion Management (Requirement 12) 5) Safety (Requirement 12) 6) Land use and growth – from Socio-Economic forecasts and other source data 	<p>Indicators will be based on SQL select statements against base tables; to create a series of database views. The base tables may be loaded into the EGISd via a SQL Server Integration Services (SSIS) and or other means, to transfer the Excel-based data inputs into the database. The base tables will be based, in concept, on the Regional Indicator spread sheet, but may require other baseline inputs.</p>	NJTPA
5	<p>TIP Interface: Develop application that supports data management for the TIP process. Application will consist of two (2) modules:</p> <ol style="list-style-type: none"> 1) Data Management <ol style="list-style-type: none"> a. data storage – conformity with DBMS standards 	<p>Alternatives:</p> <p>The following represents potential development platforms for the TIP interface.</p> <ol style="list-style-type: none"> 1) Microsoft Access project file user interface 	NJTPA



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	<p>b. application interface – direct data updates and business reporting</p> <p>2) Data Integration (provides data exchange functions)</p>	<p>2) SQL Server Reporting Services developed in Microsoft Visual Studio / Business Intelligence Development Studio, within the ASP.NET framework</p> <ol style="list-style-type: none"> a. Windows Application b. Web Application <p>Design decisions will be made in the design phase of the EGIS project</p>	
6	<p>Develop an automated clip mechanism for specific geographies (i.e. clip by County and Municipality)</p>	<p>Alternatives</p> <ol style="list-style-type: none"> 1) Use attribute criteria as the mechanism to execute the clip/extract via ArcSDE views and or Query Definitions in ArcGIS; <u>this option is the preferred because it generates less geometry load on the database</u> 2) Develop a generic clip tool in ArcGIS Model Builder 	NA
7	<p>Develop data exchange portal. The application will serve as the primary data exchange tool, and contain any other EGIS utility functions. This requirement overlaps with the TIP interface requirements.</p>	<p>Alternatives:</p> <p>The following represents potential development platforms for the data exchange interface.</p> <ol style="list-style-type: none"> 1) Microsoft Access project file user interface 2) SQL Server Reporting Services developed in Microsoft Visual Studio / Business Intelligence Development Studio, within the ASP.NET framework <ol style="list-style-type: none"> c. Windows Application d. Web Application <p>The data exchange mechanism may happen based on user instruction, based on a scheduled service, or a hybrid of the two.</p> <p>Design decisions will be made in the design phase of the EGIS project</p>	NA
8	<p>Develop one (1) ArcGIS Server web application using a lightweight platform i.e. FLEX, Javascript, or</p>	<p>Integrate an ArcGIS Server application and map service with ArcGIS online common gateway downloads.</p>	NA



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	Silverlight. The application will contain out-of the box functionality using select NJTPA ArcSDE layers.		
9	Develop NJTPA GIS Portal based on EGISd data model and data inventory template using out of the box tools and design templates	ESRI ArcGIS Server GIS Portal Toolkit	NA
10	Load Subregion GIS-based data into EGISd	Transfer initially via ftp and direct loading into the ArcSDE database; at a future date, data transfer may occur via ESRI replication	Subregion
11	Develop a data replication program with NJDOT to support the exchange of information with DOT's 8 management systems. (<i>Note: Requires agreement with NJDOT Data Stewardship program and technical partnering with NJOIT</i>)	Alternatives 1) Data base exchange (e.g. Oracle to SQL Server) via desktop data exchange application / interface, or further automated process such as a Window service 2) ESRI replication exchange via ArcGIS Server	NJDOT/ NJOIT
12	Transfer NJDEP-based GIS data into the EGISd to be available for consumption and integration	Data loading via ArcCatalog using NJDOT SLD centerline road network as the primary spatial reference	Various
13	Ensure that bridge location and associated data is in the EGIS. Requirement overlap with 5.1.2.6	Alternatives: 1) Direct feature-class data load 2) Data replication as part of an agreement with NJDOT and NJOIT through a possible "Data Mart" arrangement	NJDOT
14	Develop one or more SQL Server Integration Services (SSIS) to transfer NJ Transit quarterly, ridership oriented, EXCEL-based spreadsheet data into the SQL Server database	Execute data transfer via desktop data exchange application / interface, or further automated process such as a Window service	NJ Transit
15	Develop one or more SQL Server Integration Services (SSIS) to transfer PANYNJ, ridership oriented, EXCEL-based spreadsheet data into the SQL Server database	Execute data transfer via desktop data exchange application / interface, or further automated process such as a Window service	PANYNJ
16	Load MPO spatial data into the EGISd	Transfer initially via ftp and direct loading into the ArcSDE database; at a future date, data transfer may occur via ESRI replication	MPO
17	Develop one or more SQL Server Integration Services (SSIS) to transfer Transportation Management	Execute data transfer via desktop data exchange application / interface, or further automated process such as a	TMA's



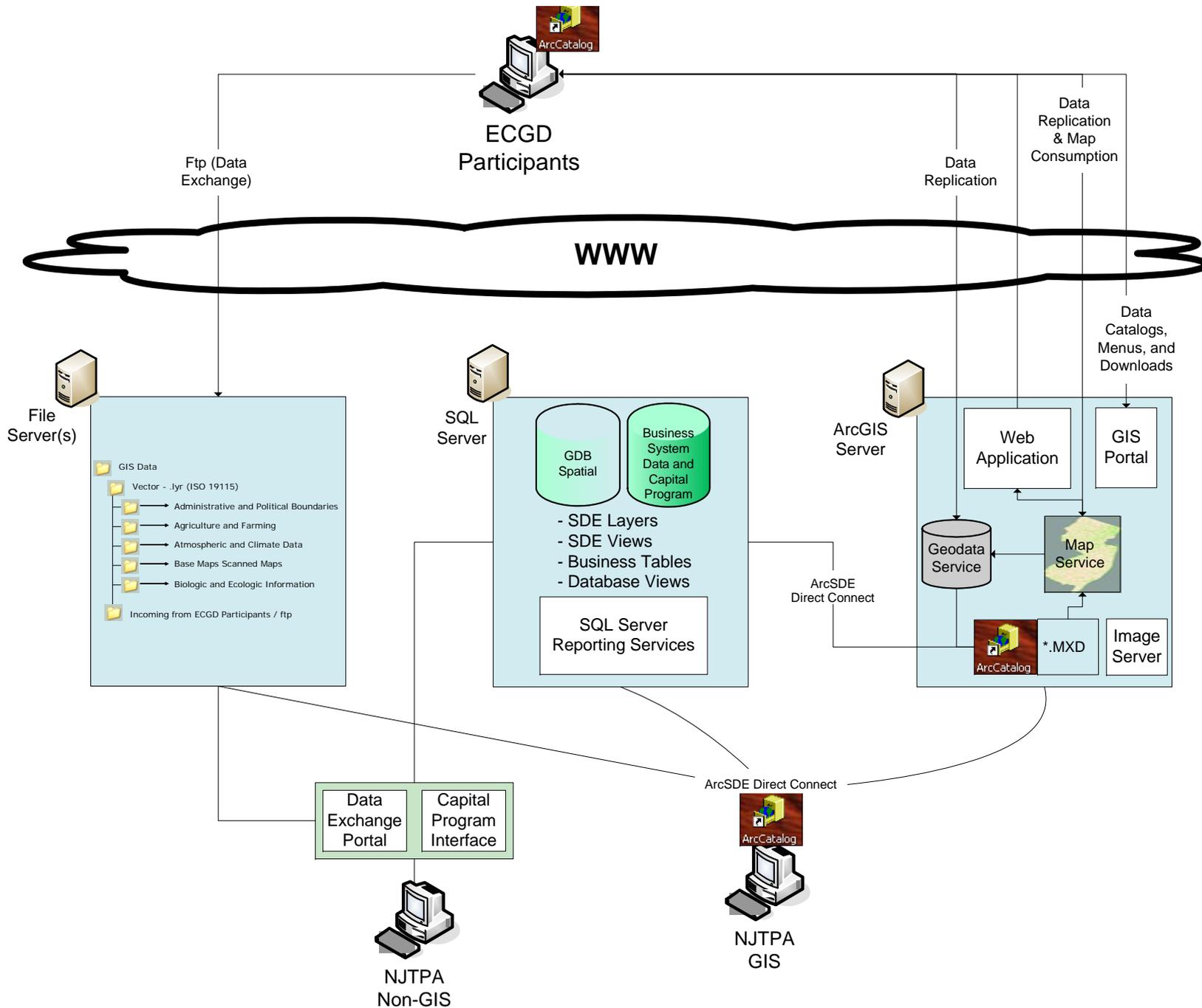
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	Association (TMA) data into the SQL Server database (<i>Source content or format has not been determined</i>)	Window service	
18	Develop one or more SQL Server Integration Services (SSIS) to transfer US Census, annual EXCEL-based spreadsheet data into the SQL Server database. These files come from the Standard American Community Survey.	Execute data transfer via desktop data exchange application / interface, or further automated process such as a Window service	US Census
19	Transfer the HIS Global Insight data into a SQL Server database in the EGISd, to be available for consumption and integration.	This data transfer will be a straight data dump into a SQL Server database, as the HIS Global Insight data will be updated approximately every five (5) years.	HIS Global Insight
20	Transfer ESRI-based GIS data into the EGISd to be available for consumption and integration	Data loading via ArcCatalog using NJDOT SLD centerline road network as the primary spatial reference	ESRI

Concept Design:

Based on the requirements identified during the discovery process, a conceptual design was developed to lay the foundation for Tasks 3 and 4 Database design and Application design respectively. The conceptual design is presented below.





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GIS Portal:

One of key features of the EGIS system will be its presentation to outside users related to data access and data sharing. Accordingly, the EGIS system will leverage ArcGIS Server GIS Portal web interface as platforms for data exchange and as a way to browse and consume NJTPA GIS data and resource. A picture of what the GIS portal might look like, as taken from the New York Department of Environmental Protection, is shown below.

