

**Environmental Data Warehouse and  
Geographic Information System  
Interface  
For the Paducah Gaseous Diffusion Plant**

May 6, 2021

## Background

The Paducah Gaseous Diffusion Plant has an ever-growing set of environmental information that requires a systematic approach to retrieve and display analytical data, maps, hydrological data, and geophysical information. The information includes analytical sample results from various environmental media, restoration reports and supporting documents, maps, facility drawings and photography for environmental locations managed by Paducah. The analytical data is stored in the Oak Ridge Environmental Information Management System (OREIS) supported in an ORACLE® database on a server located in Oak Ridge, TN. Paducah electronic geospatial data are in various Geographic Information System (GIS) and Computer Aided Design (CAD) formats. The source geospatial data are also stored in various spatial coordinate systems. The Paducah project managers and scientists require daily access to sampling data for hundreds of investigative wells and sampling events, Solid Waste Management Units (SWMUs), and site specific GIS features for all of their environmental sites. Many times the data retrieved from OREIS have to be reformatted for use within GIS and modeling software. This reformatting requires much effort and time. A secure internet accessible website is desired to provide managers and scientists access to the data to support groundwater modeling and risk assessment needs.

The Portsmouth Gaseous Diffusion Plant has developed a site-wide environmental data warehouse that includes geospatial and geoscience data. A web based system was developed for project managers and scientists to retrieve data in prescribed formats. This data warehouse utilizes a rule-based process to deliver data in the formats required by Portsmouth end users. It is the desire of the Paducah plant to re-use the Portsmouth environmental data warehouse model as a template for its own use.

## Specific Scope of Work

The scope of work will fall into three activities: The first is website customization, the second is data warehouse development and the last is training. The specific scope of work elements are as follows:

- Website Modification and Development
  - GeoData Query Design
  - Data Visualization and Download
- Data Warehouse Development
  - Geospatial Data Warehouse Development
    - Planimetric Data
    - Topographical Data
    - Raster Data
  - Environmental Data Warehouse Development
    - Sample and Analytical Data
    - Field Measurement Data
  - Geoscience Data Warehouse Development
    - Geoscience Data
    - Soil Borings and Well Logs
    - Well Development Data
    - Geological Data
    - GeoScience Logs
- Training

## Website Modification and Development

The Portsmouth website will be used as a model and will be modified to meet the requirements for Paducah. The Paducah requirements will be developed by starting with the Portsmouth website as the current configuration, determine the required configuration by interviewing Paducah end users and managers, perform a gap analysis between the “as-is” and the “to-be” processes, develop a design, and then implement the design.

The Paducah website will allow management and technical staff to query the analytical, geospatial and geoscience data warehouse. The geospatial queries will display the analytical query results on web-based maps.

The initial web home page will allow users to specify the type of data that they would like by clicking links to pages that allow the user to select the type of information to be viewed (e.g., documents, data, maps, boring logs, etc.).

The data-driven web pages will provide access to analytical data, well and borehole information and geoscience information. The following types of data-driven web pages will be required:

- A page that allows the user to select environmental sample analytical data from multiple dynamic menus/lists. This will allow the user to specify the area, SWMU, sample locations, media, analytical parameter, qualifier (i.e., detect, non-detect, all) and depths. These data can be displayed in a web page. For groundwater results, a temporal trend can be dynamically graphed or the data can be downloaded via an Excel<sup>®</sup> spreadsheet for further manipulation.
- A page that allows the user to select well and borehole information. This will allow the user to specify a well and retrieve well logs or well development information. This page will also allow the user to specify a well and retrieve groundwater potentiometric surface data. The groundwater potentiometric surface data can be displayed in a web page and the hydrograph dynamically graphed or the data can be downloaded via an Excel<sup>®</sup> spreadsheet for further manipulation.
- A page that allows the user to select geoscience data, geological data and geoscience logs from dynamic lists/menus. The geoscience page will allow the user to specify location, geoscience event, geoscience parameter and geoscience category. The data can be displayed in a web page or downloaded via an Excel<sup>®</sup> spreadsheet for further manipulation. The geological technical data (i.e., geologist well and borehole “picks”) can be displayed and sorted dynamically in a web page or downloaded via an Excel<sup>®</sup> spreadsheet for further manipulation. The geoscience logs (i.e., geotechnical logs and hydrological logs) can be displayed and downloaded as well by selecting the well or borehole from a dynamic menu/list.

The GIS web pages will display two scales of maps: Site and Region. The first will be the Paducah Site GIS Viewer that will allow the site map to be used to select specific areas, sample locations or query environmental sample analytical data by passing information to the following pages:

- A page that allows the user to select buildings or land areas, plume areas, named streams or water bodies from dynamic lists/menus. The GIS map page will dynamically zoom to the requested selection.
- A page that allows the user to select sample locations from a dynamic list/menu. The GIS map page will dynamically zoom to the requested selection.
- A page that allows the user to select environmental sample analytical data from a dynamic list/menu. The page will allow the user to specify which analytical parameter and a result criteria of all, detects or concentration to exceed. The analytical results for the query will be displayed in a web page and the locations matching the criteria will be dynamically displayed on the site map.

The Site GIS Viewer will include basic map tools for zoom-in; zoom-out; zoom-extents; zoom-last; pan; hyperlink; identify feature; find; measure distance; set units; buffer; select by line/polygon; select by

rectangle; and print. All site GIS features will be available to be displayed by toggling them on or off. An overview map will be utilized and be toggled on and off as needed.

The second map scale will be the Paducah Regional GIS Viewer. This viewer will be limited to viewing, identifying and toggling various regional map features off and on. Map tools will include zoom-in; zoom-out; zoom-extents; zoom-last; pan; identify feature; measure distance; and print.

The website will also have the following general requirements:

- The website home page will utilize standardized logos that identify the Paducah site.
- Access to the website will not require any additional software to be loaded on the manager or scientist's computer, assuming the user has a web browser already installed. Browser plug-ins may need to be installed.
- The home page will include buttons linked to the following major subsections:
  - Analytical Data Queries for display and download
  - Paducah Site GIS Viewer
  - Paducah Regional GIS Viewer
  - Well and Borehole Information
  - Geoscience Information

### **Geospatial Data Warehouse Development**

A Paducah Geospatial Data Warehouse will be developed by creating the GIS datasets noted in Table 1. These GIS datasets are currently maintained in various electronic GIS and CAD formats and coordinate systems. Site related GIS datasets incorporated into the geospatial data warehouse will be converted to ArcGIS® geodatabase format and maintained in the Paducah Gaseous Diffusion Plant coordinate system based on the North American Datum of 1927 in feet. Regional GIS datasets incorporated into the geospatial data warehouse will be converted to ArcGIS® geodatabase format and maintained in the Kentucky State Plane Coordinate System (West) based on the North American Datum of 1983 in feet.

















































Existing plant map layers generated by Paducah Environmental Department staff and contractors will be collected. The Paducah Plant GIS layers and regional 50-mile radius map layers (created and developed from the Risk Based End State project) will be loaded into ESRI ArcGIS® geodatabase format via the ArcCatalog® tool which is a part of ESRI's ArcGIS® software. The sample location features for investigative wells, soil samples, surface water, waste water and National Pollution Discharge Elimination System (NPDES) will be converted into ArcSDE® point features from the easting and northing coordinates currently maintained in OREIS.




















The ArcGIS® geodatabase will allow the greatest functionality for Paducah. Some of the features include:

- Layer versioning;
- Raster data loading;
- Dynamic linking of features to the analytical data warehouse; and
- Multi-user access.

The last feature, multi-user access, is important, as all Paducah web users will see the most up to date map features.

The layers in Table 1 will be available in the geodatabase:

| Table 1. GIS Datasets   |  | Source* |
|---|--|---------|
| Feature Name  |  |         |
| <b>Paducah Site Features</b>  |  | P       |
| <ul style="list-style-type: none"> <li> <b>Paducah Gaseous Diffusion Plant</b></li> <li> <b>Buildings</b> <ul style="list-style-type: none"> <li> BUILDING LAND AREA</li> <li> REGIONAL HOSPITALS</li> </ul> </li> <li> <b>Cadastre</b> <ul style="list-style-type: none"> <li> COUNTY BOUNDARIES</li> <li> DOE BOUNDARY</li> <li> MUNICIPAL BOUNDARIES</li> <li> QUAD BOUNDARIES</li> <li> REGIONAL LAND OWNERSHIP</li> </ul> </li> <li> <b>Common</b> <ul style="list-style-type: none"> <li> COORDINATE GRID</li> </ul> </li> <li> <b>Cultural</b> <ul style="list-style-type: none"> <li> ARCHAEOLOGICAL AREAS</li> </ul> </li> <li> <b>Demographics</b> <ul style="list-style-type: none"> <li> COUNTY DEMOGRAPHICS</li> <li> MUNICIPAL DEMOGRAPHICS</li> </ul> </li> <li> <b>Ecology</b> <ul style="list-style-type: none"> <li> HABITAT</li> </ul> </li> <li> <b>Env Hazards</b> <ul style="list-style-type: none"> <li> DMSA</li> <li> HAZARDOUS WASTE AREAS</li> <li> PLUME_AREAS</li> <li> TCE-CONCENTRATION PLUMES</li> </ul> </li> <li> <b>Flora</b> <ul style="list-style-type: none"> <li> TREE LINE</li> </ul> </li> <li> <b>Future Projects</b> <ul style="list-style-type: none"> <li> CANDIDATE SITES</li> </ul> </li> <li> <b>Geology</b> <ul style="list-style-type: none"> <li> FILL</li> <li> CROSS SECTION LINES</li> </ul> </li> <li> <b>Hydrography</b> <ul style="list-style-type: none"> <li> HYDROGRAPHY</li> <li> NAMED_STREAMS</li> <li> NAMED_WATER_BODIES</li> <li> REGIONAL HYDROGRAPHY</li> <li> REGIONAL WATERSHED</li> <li> WATER BODIES</li> </ul> </li> <li> <b>Images</b> <ul style="list-style-type: none"> <li> AERIAL PHOTO-1994</li> <li> USGS QUAD MAP</li> </ul> </li> <li> <b>Improvements</b> <ul style="list-style-type: none"> <li> AIR_MONITORING_STATIONS</li> <li> FENCE</li> <li> PIPES TRENCHES SLURRY WALL AND HORIZONTAL WELLS</li> <li> SAMPLE_STATIONS</li> </ul> </li> <li> <b>Land Status</b> <ul style="list-style-type: none"> <li> REGIONAL LAND COVER</li> </ul> </li> </ul> |  |         |

| <b>Table 1. GIS Datasets</b>  |  |                |
|---|--|----------------|
| <b>Feature Name</b>   |  | <b>Source*</b> |
| <ul style="list-style-type: none"> <li>[-]  <b>Landform</b> <ul style="list-style-type: none"> <li> LAND SURFACE CONTOURS</li> <li> REGIONAL SURFACE ELEVATION HILLSHADE</li> <li> SURFACE ELEVATION HILLSHADE</li> </ul> </li> <li>[-]  <b>Transportation</b> <ul style="list-style-type: none"> <li> RAILROAD</li> <li> REGIONAL AIRPORTS</li> <li> REGIONAL ROADS</li> <li> ROADS</li> </ul> </li> <li>[-]  <b>Utilities</b> <ul style="list-style-type: none"> <li> GAS LINES</li> <li> POWERLINE EASEMENT</li> <li> POWERLINES</li> <li> PRCL</li> <li> RECIRCULATION COOLING WATER (RCW) LINES</li> <li> SANITARY SEWER LINES</li> <li> STORM SEWER LINES</li> <li> WATER SUPPLY LINES</li> <li> WATER SUPPLY WELLS</li> </ul> </li> </ul> |  |                |
| <b>Environmental Sampling Features</b>  |  |                |
| Groundwater sampling locations  |  | OREIS          |
| Soil sampling locations   |  | OREIS          |
| Surface water sample locations  |  | OREIS          |
| Sediment sample locations   |  | OREIS          |
| All other sample locations  |  | OREIS          |
| NPDES locations   |  | OREIS          |
| <b>50-mile radius Map Layers</b>  |  |                |
| Geocoded Street Addresses (Counties)  |  | TIGER          |
| Roads (Offsite)   |  | TIGER          |
| Railroads (Offsite)   |  | USGS           |
| Hydrology (Offsite)   |  | USGS           |
| Topography  |  | USGS           |
| Digital Raster Graph (USGS Quads)   |  | USGS           |
| Orthophotos (USGS DOQQs)  |  | USGS           |
| Soils (Surrounding Counties)  |  | KY             |
|   |  |                |

\*Sources: P = Internal Paducah, OREIS = Oak Ridge Environmental Information System, USGS=United States Geological Survey, TIGER=US Census TIGER data; KY=State of Kentucky

## Environmental Data Warehouse Development

The geospatial data will be interfaced with analytical data for all media to individual sampling locations. The analytical data will be queried from OREIS, verified for completeness using jointly-developed rules and placed in appropriate environmental data warehouse tables. Analytical results will be represented spatially since all results are linked to a master sample location feature table in the geodatabase. From prior experience with OREIS, it is anticipated that quality issues of the existing Paducah OREIS data will need to be addressed prior to updating the data warehouse. These deficiencies will be identified and conveyed to Paducah. A joint effort between Paducah and the data warehouse team will produce the optimal rule-based queries to achieve the greatest benefit from OREIS. Activities will include but are not limited to defining standards for analytical parameter names, parameter units, depth units, sample dates, location types and redundant or missing data.

Field measurement data will be queried from OREIS, verified for completeness using jointly-developed rules and placed in appropriate environmental data warehouse tables. Groundwater potentiometric surface data are the key field measurement data to be included in the environmental data warehouse. Other field measurements will be considered on an as needed basis.

## Geoscience Data Warehouse Development

### Geoscience Data

Paducah geoscience reports will be retrieved from Paducah environmental department staff or contractors where the geotechnical and hydrologic data from these reports will be extracted and placed into the geoscience data warehouse. Table 2 below includes possible geoscience data that will be retrieved and catalogued into the geoscience data warehouse. The well or borehole location and sample event or report will be associated with each geoscience parameter.

| <b>Table 2. Potential Geotechnical and Hydrologic Parameters</b> |                          |
|--|--------------------------|
| % Fine   | Natural Moisture Content |
| Aquifer Thickness  | Opt Moisture             |
| Assumed Flow   | Optimum Moisture Content |
| Atterberg LL   | Permeability             |
| Atterberg PI   | Porosity                 |
| Atterberg PL   | Pumped Well              |
| Clay   | Pumping Rate             |
| Coarse   | Resistivity              |
| Coarse Sand  | Sand                     |
| Conductivity   | Silt                     |
| Density  | Soil Class               |
| Dry Unit Weight  | Specific Gravity         |
| Fine Sand  | Storage Coefficient      |
| Gallia Thickness   | Storativity              |
| Gravel   | Transmissivity           |
| InSituMoisture   | Water Content            |
| Moisture Content   | Wet Unit Weight          |
| Moisture_Deviation   |                          |

### Geological Data

Geotechnical lithologic data will be retrieved from Paducah environmental department staff or contractors. This information is not currently managed in OREIS. The geotechnical lithologic data will be stored in the appropriate geoscience data warehouse tables. These data include the borehole/well location, easting, northing, source, ground elevation, top and bottom lithologic unit elevations, and top and bottom lithologic unit depths.

### Soil Borings and Well Logs

As many as possible electronic Paducah soil-boring and well construction logs in Adobe Acrobat® PDF format will be retrieved from Paducah environmental department staff or contractors. Remaining paper-based Paducah soil-boring and well construction logs will be converted or scanned into Adobe Acrobat® PDF format. Each PDF document will be associated (or hot-linked) to each boring and/or well location. By clicking on each point, individual log information will be readily displayed.

### Well Development Data

Well development data will be retrieved from Paducah environmental department staff or contractors. This information is not currently managed in OREIS. The well development data will be stored in the appropriate geoscience data warehouse tables. These data include the borehole/well location name, alias name, easting, northing, land surface elevation, measuring point elevation, top and bottom well component elevations, and top and bottom well component depths, and miscellaneous well characteristics such as slot size, casing diameters and materials.

### GeoScience Logs

As many as possible electronic Paducah geoscience logs will be retrieved in Adobe Acrobat® PDF format from Paducah environmental department staff or contractors. Remaining paper-based Paducah geoscience logs will be converted or scanned into Adobe Acrobat® PDF format. Each PDF document will be associated (or hot-linked) to each boring and/or well location. By clicking on each point, individual log information will be readily displayed.

### **GIS Training**

A one-day training session will be provided to Paducah personnel on the operation of the Paducah Data Warehouse and GIS. Training will include GIS map display, data query, data export and map printing.