



MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY
WATER RESOURCES DIVISION

**GROUNDWATER MODELS AND FILES REQUIRED FOR
WATER USE ASSESSMENT UNIT GROUNDWATER MODEL REVIEWS**

The Department of Environment, Great Lakes, and Energy (EGLE), Water Resources Division, (WRD), Water Use Assessment Unit (WUAU) uses a variety of groundwater modeling programs for site-specific reviews (SSR), alternative analyses, or permit applications submitted under Part 327, Great Lakes Preservation, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA), or groundwater model reviews in support of permit applications submitted under other EGLE permitting programs, including Parts 301, Inland Lakes and Streams; 303, Wetlands Protection; 637, Sand Dune Mining; and 632, Nonferrous Metallic Mineral Mining, of the NREPA. The applicant or applicant's agent needs to verify that the software they are using is compatible with the software versions currently used by EGLE.

The following is a list of groundwater software EGLE can use for Part 327 or for Permits under Part 301, Part 303, Part 632, or Part 637. EGLE's model review will be expedited if the applicant or agent checks the appropriate boxes for the types of software used in support of the permit application, SSR, or alternative analysis.

EGLE MODFLOW Numerical Models Compatible with the Following:

- Groundwater Vistas Professional V8
- Visual MODFLOW Flex (VMF) Professional V7

EGLE Analytical Element Models Compatible with the Following:

- AquiferWin32 V6 Flow Models
- GFLOW V2.2.3

EGLE Analytical Models

- Hunt 1999
- Hunt 2003
- Ward & Lough 2011
- Boulton 1973

EGLE Related Support Software Compatible with the Following:

- Rockworks 2021
- Surfer V22
- Grapher V18
- Aqtesolv Professional V4.5
- Aquifer Win32 V6 Aquifer Test Analyses
- ArcGIS V10.7
- ArcGIS Pro

For any groundwater model review requested, WUAU requires all software input files, output files, project files, support data files, and base map files from each model run. The complete groundwater model files and information need to be submitted early enough to allow EGLE staff time to review the model before the permit, SSR, or alternative analysis decision deadline. The review time can vary depending on the complexity of the model, the number of separate models, or the number of simulations submitted. A minimum of 30 days should generally be allotted for the review once the complete model files are received. If the model is more complex, contact EGLE for the required time needed for the review.

A checklist of required model files and support data to be submitted for each MODFLOW groundwater model review requested based on the software used includes the following:

GROUNDWATER VISTAS

For each groundwater model simulation created in Groundwater Vistas, the following information must be supplied for the model to be considered complete. The model review will be expedited if the applicant or agent checks the appropriate boxes indicating the documentation that is being submitted in support of the permit application, SSR, or alternative analysis.

- The main GV (*.gww) groundwater model file.
- The model's real-world projected coordinate system [i.e., NAD 1983 HARN Michigan GeoRef (meters), NAD 1983 (US feet) etc.].
- The coordinate of the lower left corner of the model grid.
- All MODFLOW groundwater model input files (this includes files for multiple simulations). The files supplied will be used to rerun each model).
- Each groundwater model needs to be run successfully, and the resulting output files submitted for each simulation. These output files will be used to evaluate the site and compared with any model reruns.
- The models should include the completed PEST and Sensitivity Run(s)
- Shapefiles that provide the location of site features such as streams, rivers, wetlands, lakes, main roads, property boundaries, or any other important site feature for the project.
- All GV *.map files created from the above-referenced shapefiles.
- Aerial base map if available.
- The generation of cell-by-cell flow files need to be included in the simulations.
- Calibration statistics and graphs are to be included and reproducible in the models supplied.
- A report documenting:
 - The site location (County, Township, Town/Range/Section, City/Village).
 - Project goal.
 - The site geology and hydrogeology.
 - The conceptual model.
 - Explanation of each of the model runs in the project file if more than one was done.
 - Type of model runs, steady-state, transient, or both and why they meet the project goals.

- The model construction details (including the number of layers, layer thickness, initial heads, and aquifer properties, etc.).
 - Data sources for aquifer properties and assumptions.
 - Boundary conditions and rationale for location and type. Provide an explanation for any natural feature close to the site that is not selected as a boundary.
 - List of wells with latitude and longitude coordinates and pumping rates.
 - Calibration details.
 - List of calibration targets.
 - Model results, conclusions, and model limitations.
 - Any other relevant information to be considered in the model review.
- The applicant and agent will be contacted to supply any missing data that renders the model incomplete and prevents review of the model.

VISUAL MODFLOW FLEX (VMF)

VMF V7 can also import Visual MODFLOW V6 Classic files and may be backward compatible with select older versions. For each groundwater model simulation created in VMF V7 (or compatible versions) the following information must be supplied for the model to be considered complete. The applicant or agent should check the appropriate boxes indicating which documentation is being submitted in support of the permit application, SSR, or alternative analysis.

- The VMF project file. For version 7 it is the *.amd file. For Visual MODFLOW Classic it is the *.VMF file.
- The models real-world projected coordinate system (i.e., SPCS27 Michigan Southern Zone (ft), SPCS83 Michigan Southern Zone (ft), NAD 1983 HARN Michigan GeoRef (meters), NAD 1983 (US feet) etc.).
- The real-world coordinate of the lower left corner of the model grid.
- The water level or drawdown contours should be referenced to the projected coordinate system in the project file to allow import into ArcGIS 10.7 or ArcGIS Pro as needed.
- All MODFLOW groundwater model input files and support data (also called companion files) used to create the project file.
- Each VMF groundwater model needs to be run successfully within the project file and the resulting output files submitted for each simulation. These output files will be used to evaluate the site and compared with any model reruns.
- The models should include the completed PEST and Sensitivity Run(s)
- Shapefiles that provide the location of site features such as streams, rivers, wetlands, lakes, main roads, property boundaries or other important site feature for the project should be included in the project file and separately in the supporting data.
- The generation of cell-by-cell flow files need to be included in the simulations.
- Calibration statistics and graphs are to be included and reproducible in the project file.
- The project file should include an aerial photograph of the site area as a base map.
- Any raster image and associated world file used for model base maps, as appropriate.

- A report documenting:
 - The site location (County, Township, Town/Range/Section, City/Village).
 - Project goal.
 - The site geology and hydrogeology.
 - The conceptual model.
 - Explanation of each of the model runs in the project file if more than one was done.
 - Type of model runs, steady-state, transient, or both and why they meet the project goals.
 - The model construction details (including the number of layers, layer thickness, initial heads, and aquifer properties, etc.).
 - Data sources for aquifer properties and assumptions.
 - Boundary conditions and rationale for location and type. Provide an explanation for any natural feature close to the site that is not selected as a boundary.
 - List of wells with latitude and longitude coordinates and pumping rates.
 - Calibration details.
 - List of calibration targets.
 - Model results, conclusions, and model limitations.
 - Any other relevant information to be considered in the model review.
- The applicant and agent will be contacted to supply any missing data that renders the model incomplete and prevents review of the model.

If there are any questions regarding the files required for a specific groundwater model review, please contact Jill Van Dyke at VandykeJ1@Michigan.gov or 517-897-3600 or Lena Pappas at PappasL4@Michigan.gov or 517-245-8119.

If you need this information in an alternate format, contact EGLE-Accessibility@Michigan.gov or call 800-662-9278.

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This form and its contents are subject to the Freedom of Information Act and may be released to the public.