Coastal Plain Aquifer Study

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U.S. Geological Survey

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Introduction

- The Maryland Coastal Plain region is, at present, largely dependent upon groundwater for its water supply.
- Decades of increasing pumpage have caused groundwater levels to decline by as much as 2 feet per year in some areas of southern Maryland.
- Continued declines could affect the long-term sustainability of groundwater resources in Maryland's heavily populated Coastal Plain communities and the agricultural industry of the Eastern Shore.

Regional Assessment

- In 2004, a report by the Advisory Committee on the Management and Protection of the State's Water Resources recommended a comprehensive study of the sustainability of the entire Atlantic Coastal Plain aquifer system in Maryland.
- Continuous funding since 2006, from Maryland Department of the Environment (MDE), Maryland Geological Survey (MGS), and USGS.

Assessment Plan

MGS and USGS have developed a science plan for a comprehensive assessment that will provide new scientific information and new data management and analysis tools for the State to use in allocating groundwater in the Coastal Plain.

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Assessment Goals

- Document the **geologic and hydrologic characteristics** of the aquifer system in the Maryland Coastal Plain and appropriate areas of adjacent states.
- Conduct **detailed studies** of the regional groundwater-flow system and water budget for the aquifer system.
- Improve documentation of **patterns of water quality** in all Coastal Plain aquifers, including the distribution of saltwater.
- Enhance groundwater-level, streamflow, and water-quality-**monitoring** networks in the Maryland Coastal Plain.
- Develop **science-based tools** to facilitate sound management of the groundwater resources in the Maryland Coastal Plain.

Implementation

IMPLEMENTATION PLANS		
PHASE I **(2006 – 2008)** *Getting Started and Building Partnerships*	**PHASE II** **(2008 – 2012)** *Filling in the Gaps and Building the Resource Management Tools*	**PHASE III** **(2010 – 2013)** *Using the Tools to Manage and Optimize the Resource*
• Develop an aquifer information system. • Refine the aquifer framework. • Determine management criteria. • Identify information gaps. • Develop plans for addressing gaps. • Build partnerships and inform the public.	• Develop and test ground-water-flow model. • Simulate flow system and conduct field studies of recharge and leakage. • Enhance ground-water-level and streamflow-monitoring networks. • Conduct water-quality studies.	• Develop optimization model. • Link flow and optimization models to create interactive management model. • Test water-management scenarios. • Inform partners and stakeholders.

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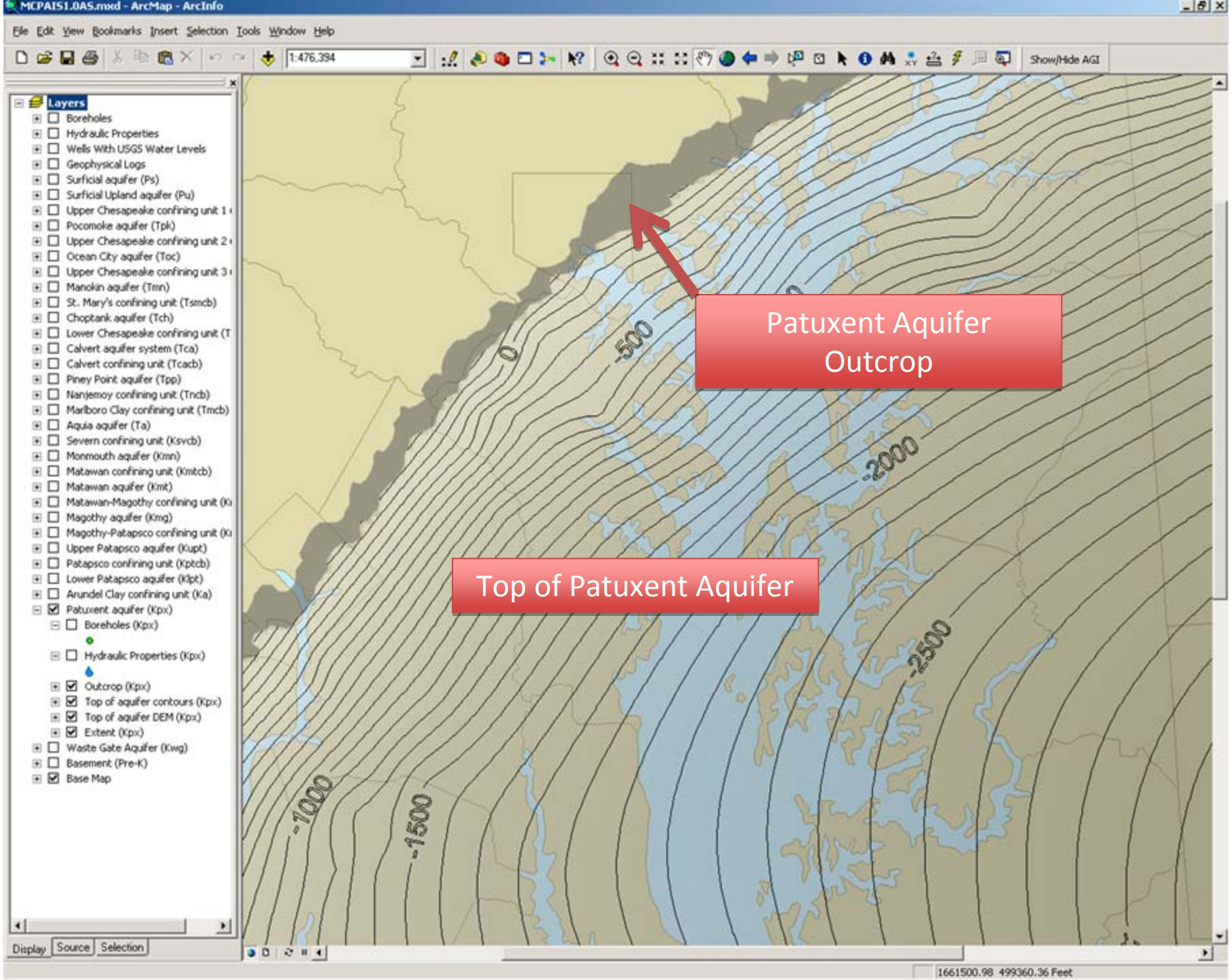
Aquifer Information System (AIS)

- Spatial data on hydrogeologic framework created by MGS
  - Stored in a geodatabase that uses the Arc Hydro Groundwater Data Model
- Data on wells (GWSI), water use (SWUDS), and hydraulic properties
- A suite of tools for working with the data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Show/Hide AGI
Layers
Boreholes
Hydraulic Properties
Wells With USGS Water Levels
Geophysical Logs
Surficial aquifer (Ps)
Surficial Upland aquifer (Pu)
Upper Chesapeake confining unit 1
Pocomoke aquifer (Tpk)
Upper Chesapeake confining unit 2
Ocean City aquifer (Toc)
Upper Chesapeake confining unit 3
Manokin aquifer (Tmn)
St. Mary's confining unit (Tsmcb)
Choptank aquifer (Tch)
Lower Chesapeake confining unit (T
Calvert aquifer system (Tca)
Calvert confining unit (Tcacb)
Piney Point aquifer (Tpp)
Nanjemoy confining unit (Tncb)
Marlboro Clay confining unit (Tmcb)
Aquia aquifer (Ta)
Severn confining unit (Ksvcb)
Monmouth aquifer (Kmn)
Matawan confining unit (Kmtcb)
Matawan aquifer (Kmt)
Matawan-Magothy confining unit (Ku
Magothy aquifer (Kmg)
Magothy-Patapsco confining unit (Ku
Upper Patapsco aquifer (Kupt)
Patapsco confining unit (Kptcb)
Lower Patapsco aquifer (Klpt)
Arundel Clay confining unit (Ka)
Patuxent aquifer (Kpx)
Boreholes (Kpx)
Hydraulic Properties (Kpx)
Outcrop (Kpx)
Top of aquifer contours (Kpx)
Top of aquifer DEM (Kpx)
Extent (Kpx)
Waste Gate Aquifer (Kwg)
Basement (Pre-K)
Base Map
Display
Source
Selection
Patuxent Aquifer Outcrop
Top of Patuxent Aquifer
0
-500
-2000
-2500
-1000
-1500
1661500.98 499360.36 Feet

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Layers
- Boreholes
- Hydraulic Properties
- Wells With USGS Water Levels
- Geophysical Logs
- Surficial aquifer (Ps)
- Surficial Upland aquifer (Pu)
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  - Hydraulic Properties (Kpx)
  - Outcrop (Kpx)
  - Top of aquifer contours (Kpx)
  - Top of aquifer DEM (Kpx)
  - Extent (Kpx)
- Waste Gate Aquifer (Kwg)
- Basement (Pre-K)
- Base Map

Display Source Selection

Aquifer Info System Toolbar

Virtual Log | Show water-level data | Borehole Data | Hydrologic Properties

Virtual Log Tool

Virtual Log Form

Unit Name	Elev.(ft)
Land surface bathy	54.8
Surfical aquifer (Ps)	31.8
Monmouth aquifer (Kmn)	-0.1
Matawan confining unit (Kmtcb)	-93.5
Magothy aquifer (Kmg)	-153.7
Magothy-Patapsco confining unit (K...	-177.6
Upper Patapsco aquifer (Kupt)	-279
Patapsco confining unit (Kptcb)	-510.7
Lower Patapsco aquifer (Klpt)	-668.7
Arundel Clay confining unit (Ka)	-944.3
Patuxent aquifer (Kpx)	-1045
Basement (Pre-K)	-1409.3

Use These Values

Save to Text File

Cancel

Available Draw Down Text

NAVD 88 Vertical Feet

Map Coordinate Picked:
X: 1577553
Y: 598609.2

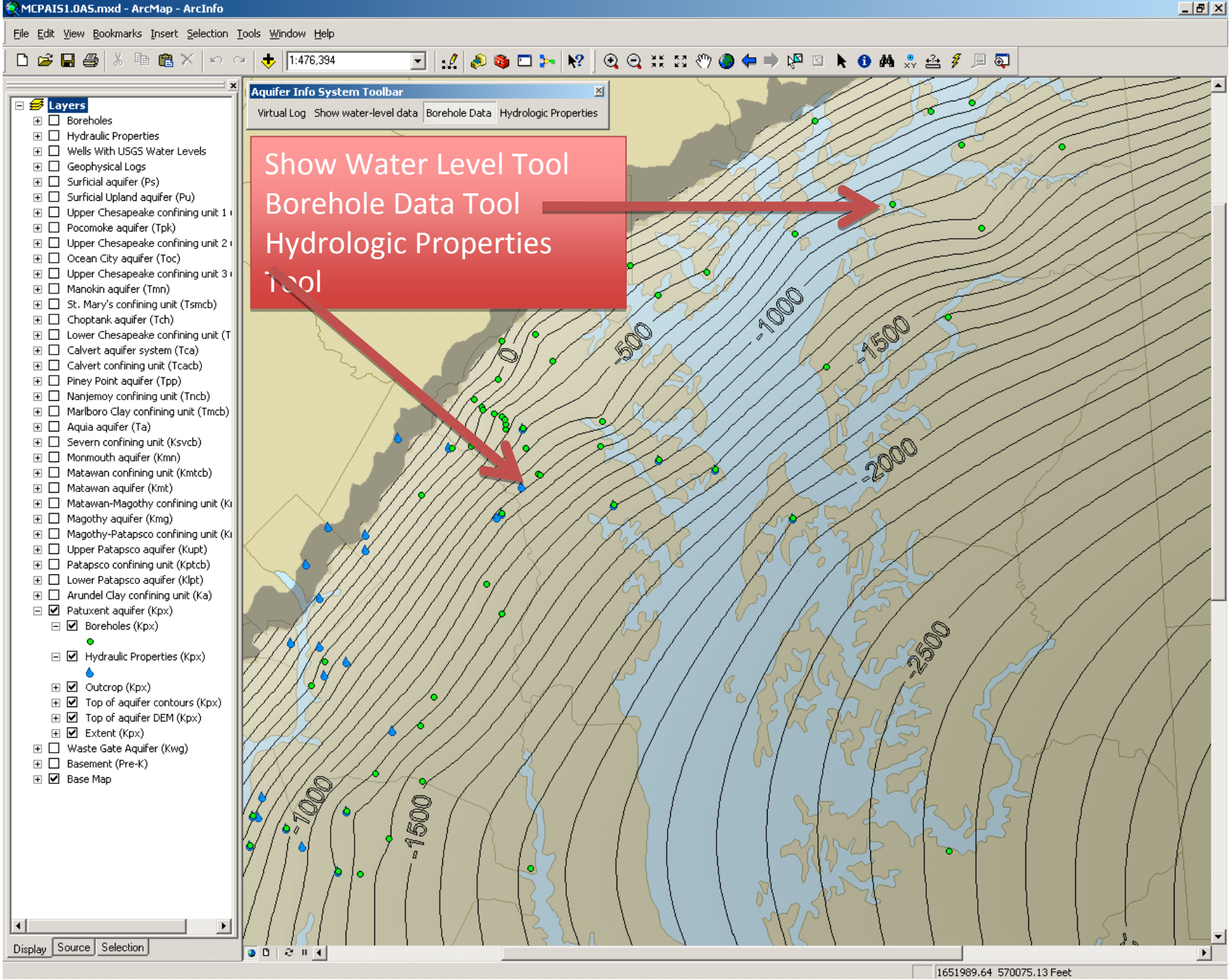
Log Title:

725
157

NAD_1983_StatePlane_Maryland_FIPS_1900_Feet

-1000 -1500 -2500

1676388.3 594887.32 Feet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Selection
-0
-500
-1000
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-2000
-2500
-1000
-1500
1651989.64 570075.13 Feet

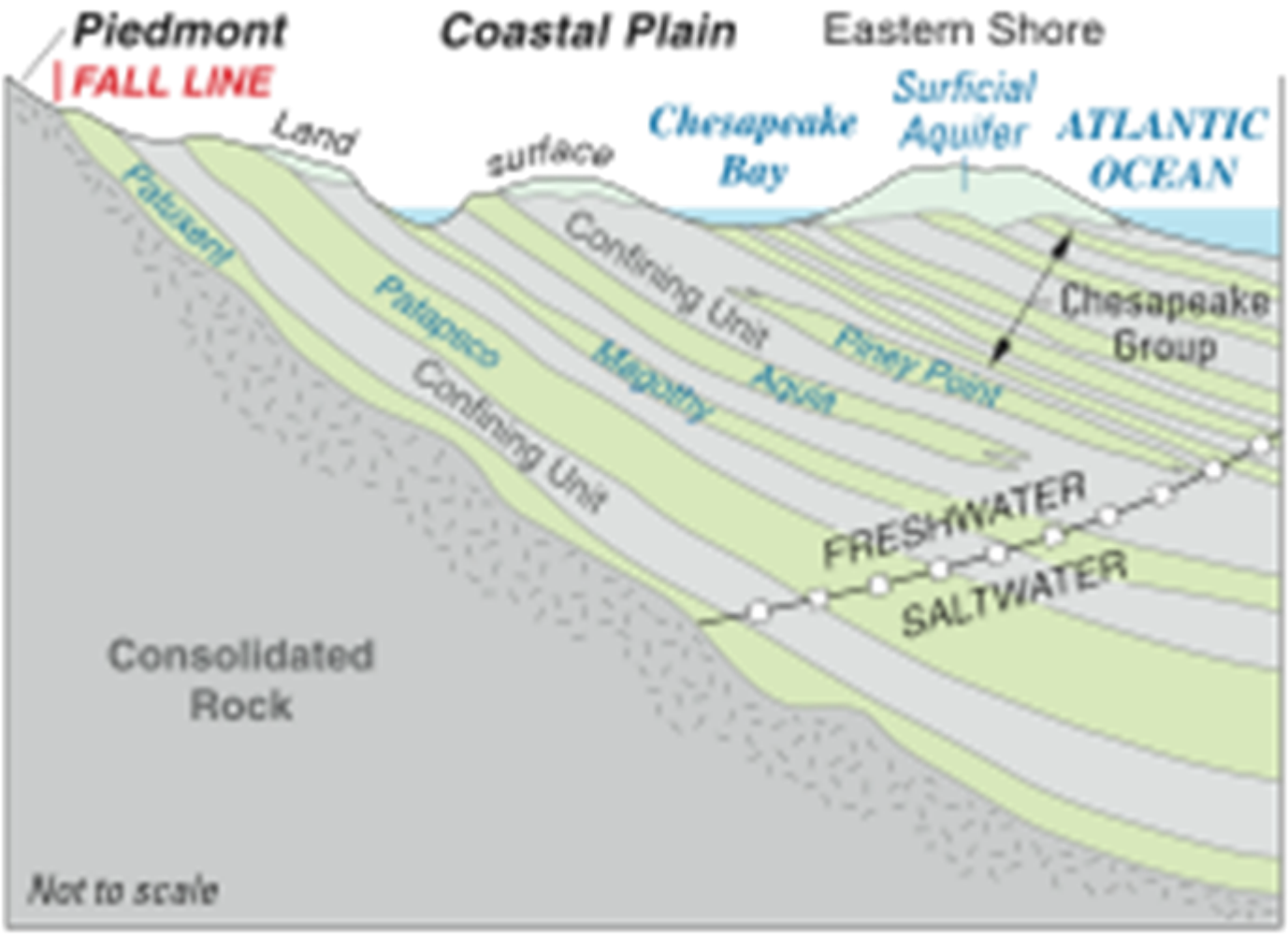
Groundwater Model

- Groundwater-flow models can be used to investigate the flow system and the water budget of the aquifer system and to estimate the effects of increased withdrawals on water levels in the system.
- Goal: Construct and calibrate a regional digital groundwater-flow model that is compatible with the AIS, which can also be used as the basis for optimization models for groundwater management.

Hydrogeologic Features

- Internal aquifer heterogeneity/transitions, facies changes
- Pinchouts
- Subsidence
- Subcropping, outcropping
- Impermeable boundaries/faults/offsets
- Confining unit storage
- Boundary conditions including specified head, specified flux (e.g., recharge), seawater (variable-density), water-table
- Spatially and temporally variable recharge
- Wells (confined and unconfined)
- Streams and rivers

Hydrostratigraphy



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CP.mxd - ArcMap - ArcInfo

File Edit View Bookmarks Insert Selection Tools Window Help

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Show/Hide AGI

Layers
- Fall Line (Pre-K Outcrop)
- Cell2D
- Base Map

Display | Source | Selection

MODFLOW Name File

C:\MODELS\CP\CP.nam

Browse | New Model

Model loaded from C:\MODELS\CP

MODFLOW | GIS | Options | MODPATH

Name File | Run Modflow | PostProcessing

Save Name File | Revert To Saved | View Saved As Text

Packages

View/Edit | Comment | Remove | New Package

Type	Unit	File Name
DIS	2	CP.dis

Data Files

View/Edit | Comment | Remove | New Data File

Type	Unit	File Name

Comments

Add Comment | UnComment | Remove

Comment

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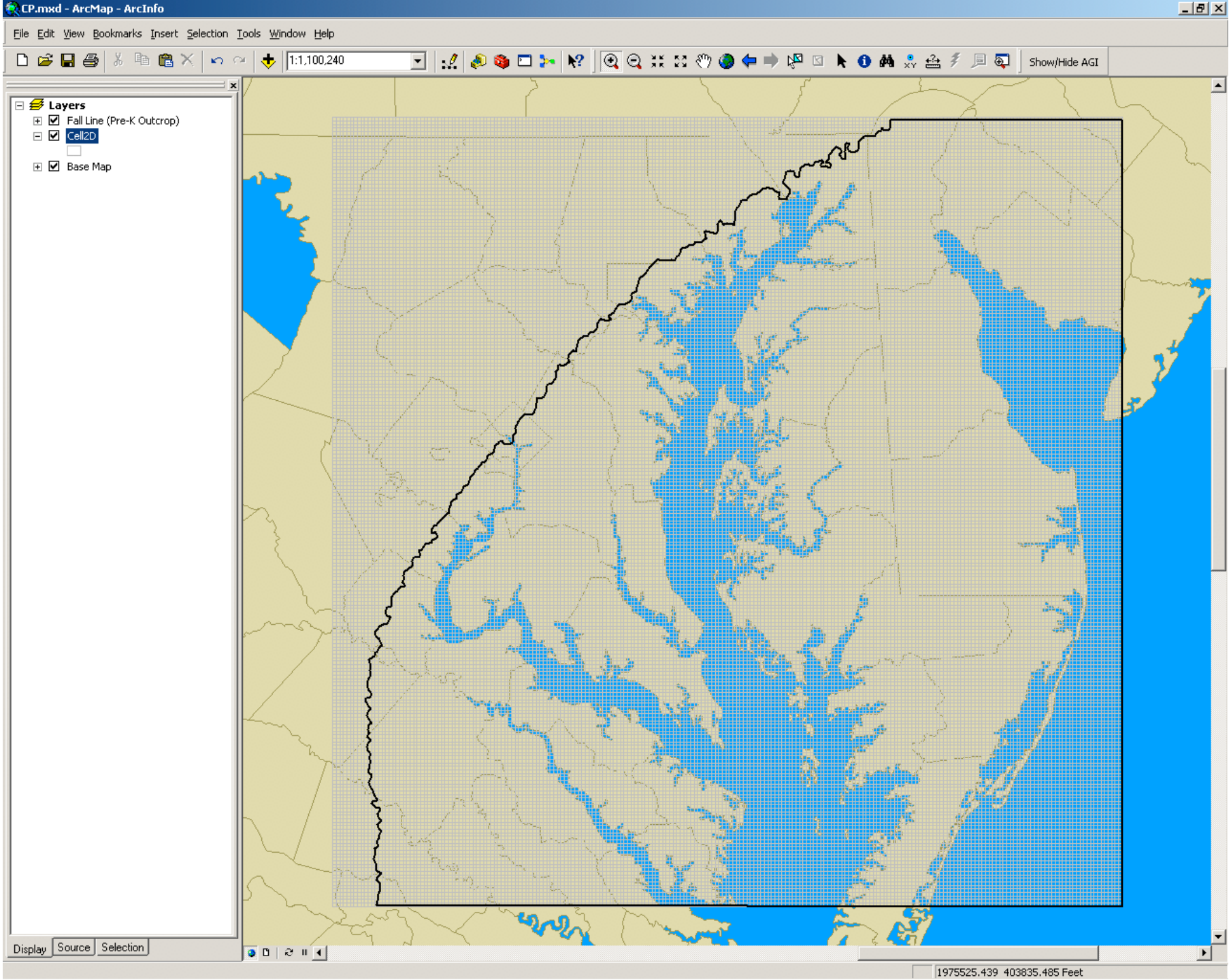
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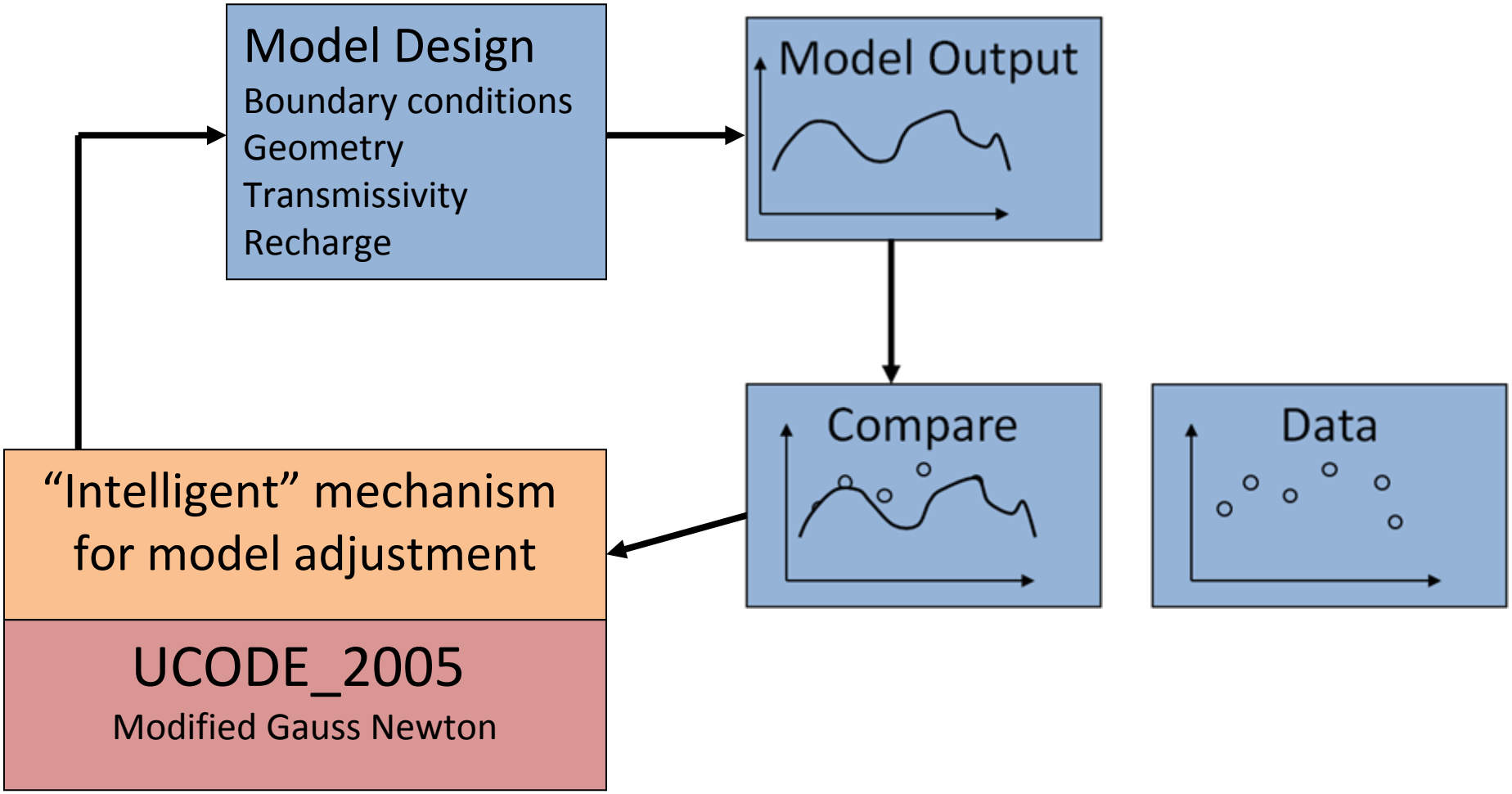
Show/Hide AGI
Layers
Fall Line (Pre-K Outcrop)
Cell2D
Base Map
Display
Source
Selection
1975525.439 403835.485 Feet

Preparing for the Regional Model

- Develop a prototype (or prototypes)
  - of similar scale and shape as the real problem,
  - incorporates all features, and
  - allows us to test all packages/processes, but without spatial detail.
- Perform other simple modeling experiments to test approaches.

MODFLOW and UCODE_2005



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UCODE_2005 and Related Programs

- Sensitivity analysis (fit-independent)
- Parameter estimation and model calibration
- Evaluation of model fit
- Parameter uncertainty and sensitivity analyses
- Evaluation of model predictions and prediction uncertainty

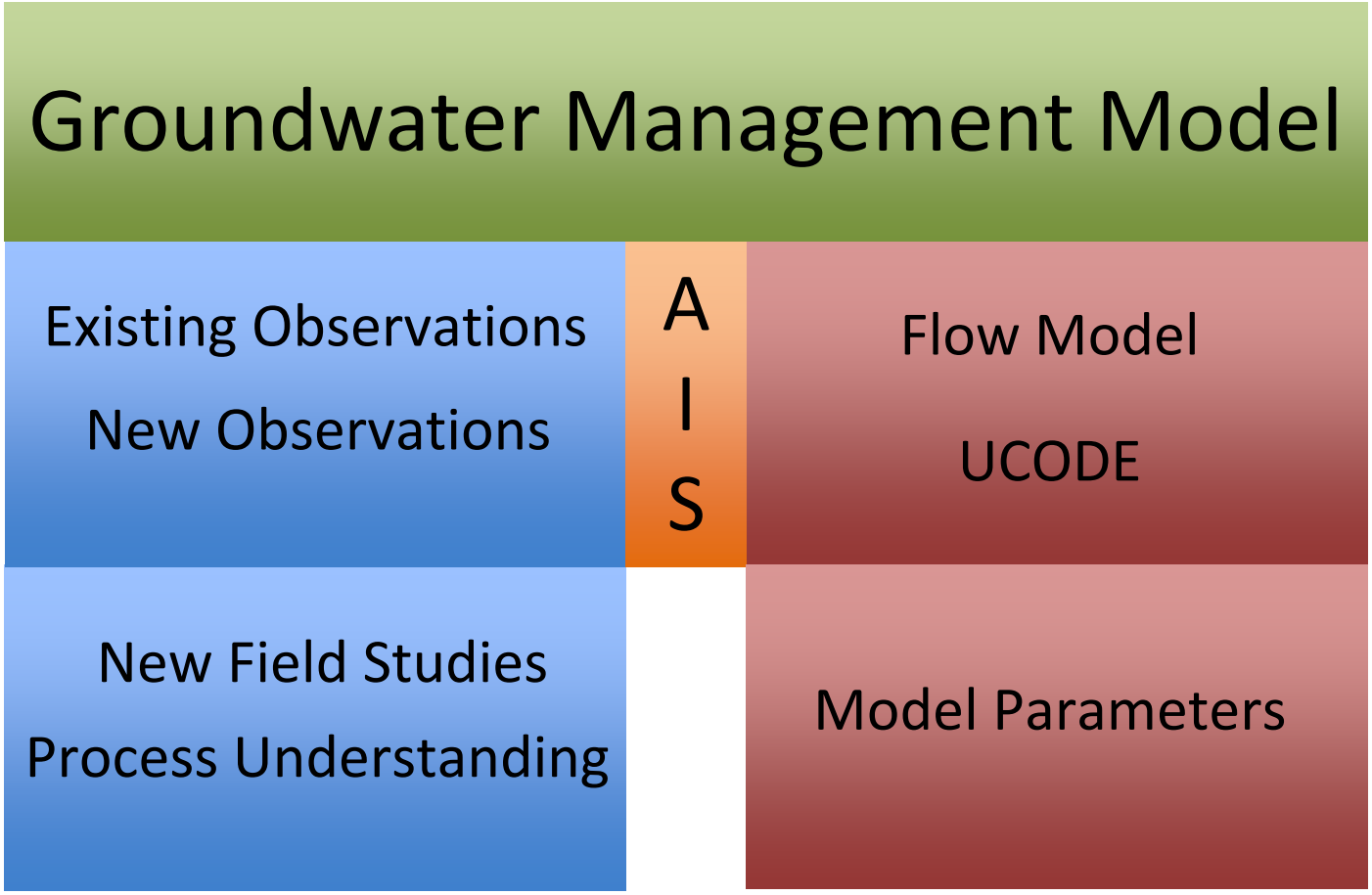
Optimization

- Ground-water simulation models have been linked with optimization-modeling techniques to determine optimal management strategies from among many possible strategies.
- Optimization models explicitly account for water-resource management objectives and constraints, and have been referred to as **management models**.

GWM

- GWM, Groundwater management process for MODFLOW, can be applied to a broad range of groundwater management problems, such as
  - limiting groundwater-level declines or streamflow depletions,
  - managing groundwater withdrawals, and
  - conjunctively using ground water and surface water.

Science-Based Tools for Management



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