DRAFT WORK PRODUCT

Borrego Valley Groundwater Basin
Borrego Springs Subbasin
Borrego Valley Groundwater Model / Water Budget Update

Borrego Valley Groundwater Basin Sustainability Plan

October 26, 2017

DUDEK

Presentation Topics

1. Introduction
2. Groundwater Model
3. Water Budget and Groundwater Model Update
4. Groundwater Model Update Results and Uncertainty
5. Steps to Improve Groundwater Model Accuracy
6. Next Steps

Groundwater Sustainability Plan Process

Step 1
Water Budget Update (Sustainable Yield)

Step 2
Baseline Pumping Allocation

Step 3
Sustainability Goals and Objectives

Step 4
Identify Projects and Management Actions

Step 5
Develop an Implementation Plan Including Pumping Allocation Reductions to Achieve Sustainability

DUDEK

Groundwater Model: One-Water Hydrologic Flow Model

- **MODFLOW – developed by the USGS, MODFLOW is considered an international standard for simulating and predicting groundwater conditions.**
- **Farm Process (FMP) – Estimates dynamically integrated supply and demand components of irrigated agriculture in the absence of reported agriculture irrigation production data.**
- **One-Water Hydrologic Flow Model (MF-OWHM) – a MODFLOW-based model designed for the analysis of a broad range of integrated groundwater and surface water issues.**

Source: USGS 2017

Groundwater Model: USGS Numerical Model Development

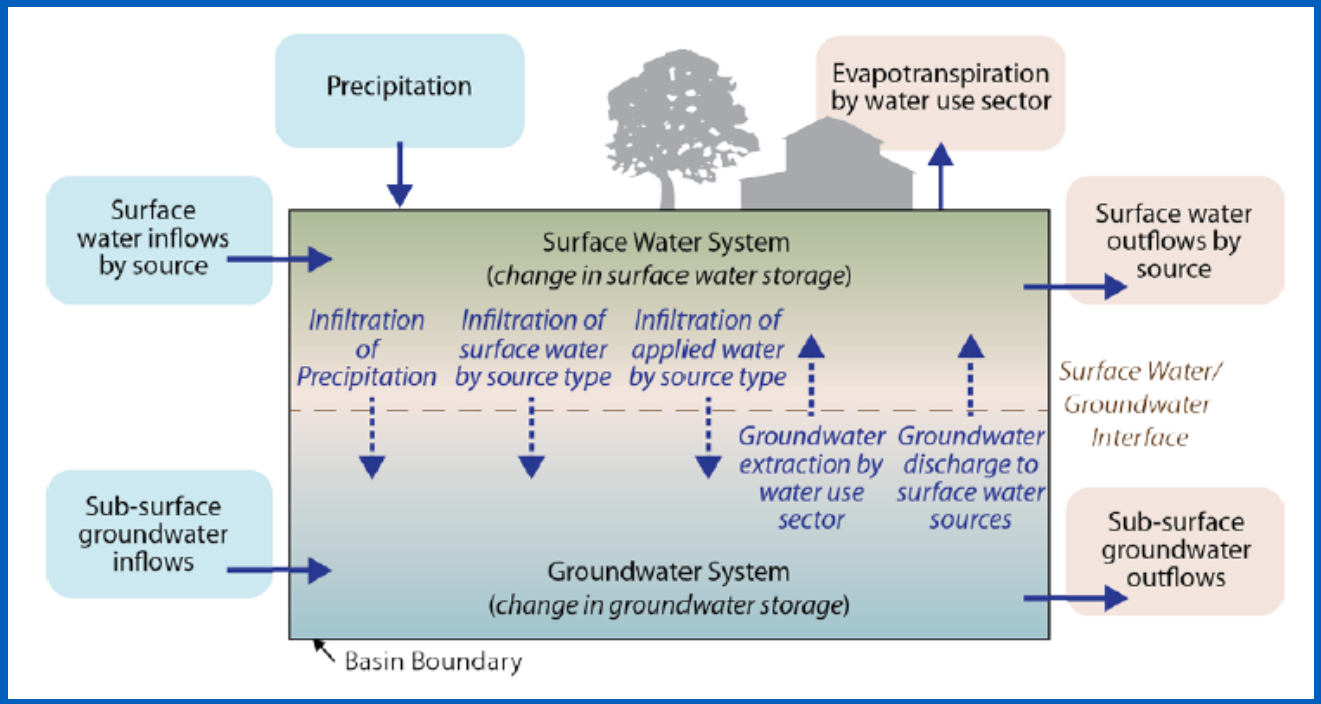
- OWHM is MODFLOW-2005 w/ unsaturated flow
- Finite-difference grid, center-node
- Simulated 1945 – 2010.
- Estimated most of Ag pumping via Farm Process.
- Assumed Specific yield (Sy) = 15% (ranged from 0.5% to 30%)
- Estimated Recharge
  - Used regional USGS Basin Characterization Model (BCM) to define precipitation and potential evapotranspiration (PET) in Borrego Valley and adjoining watersheds.
  - Runoff from adjoining watersheds to Borrego Valley simulated as streamflow entering at 24 entry points.

Water Budget and Groundwater Model Update: Dudek Numerical Groundwater Model Update

- **Update from 2011-2016**
  - **Precipitation and Evapotranspiration - Obtained precipitation (PPT) and potential evapotranspiration (PET) from Basin Characterization Model (BCM) data from USGS**
  - **Land Use - Update Land Use based on aerial imagery and water credit sites**
  - **Pumping - Updated recorded pumping**
  - **Stream Flow - Estimated stream flow based on historical data**

These updated data were incorporated into the groundwater model to account for the overall water budget of the Basin

Water Budget and Groundwater Model Update: Conceptual Model - What is a Water Budget?



Water Budget includes:

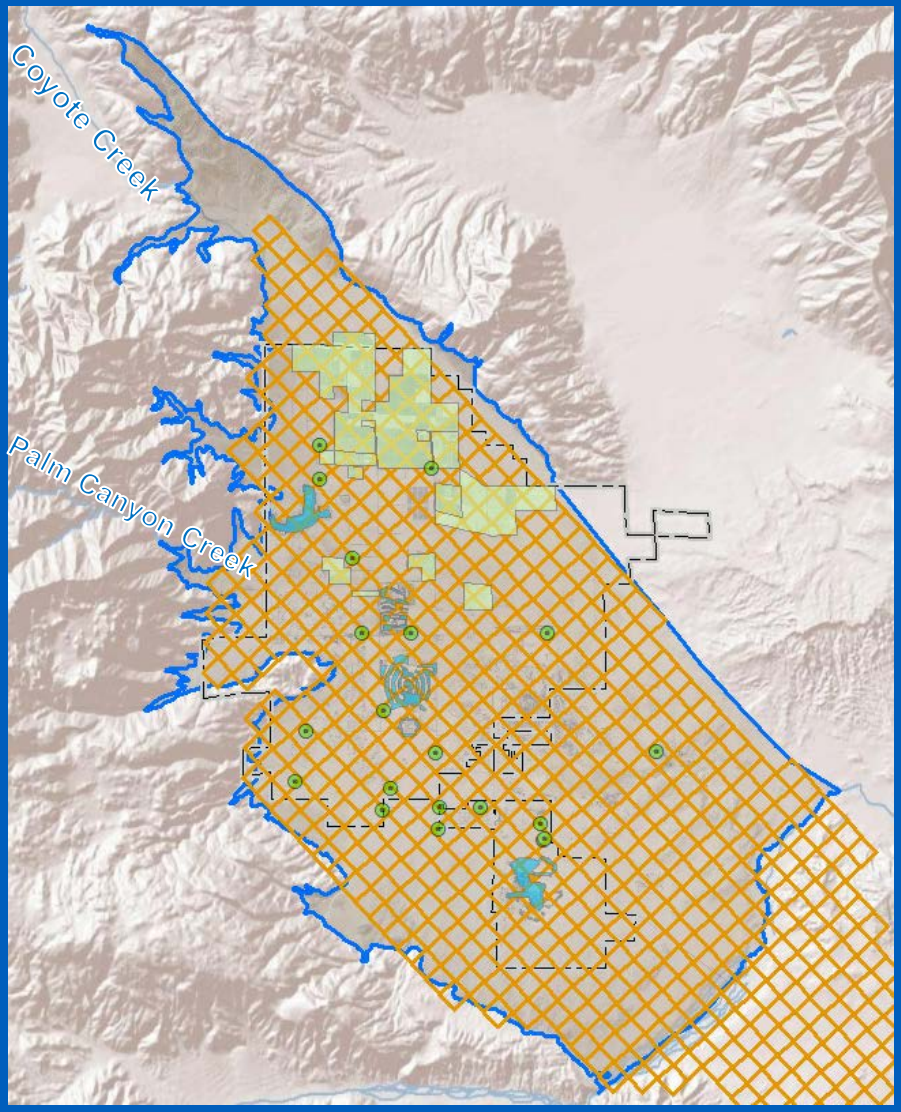
Inputs:
Streamflow leakage, precipitation, etc.

Outputs:
Pumping, evapo-transpiration, etc.

Source: DWR 2016

DUDEK

Water Budget and Groundwater Model Update: Model Characteristics



Major Inflow and Outflow

Inflow

Stream Flow: Coyote Creek, Palm Canyon

Outflow

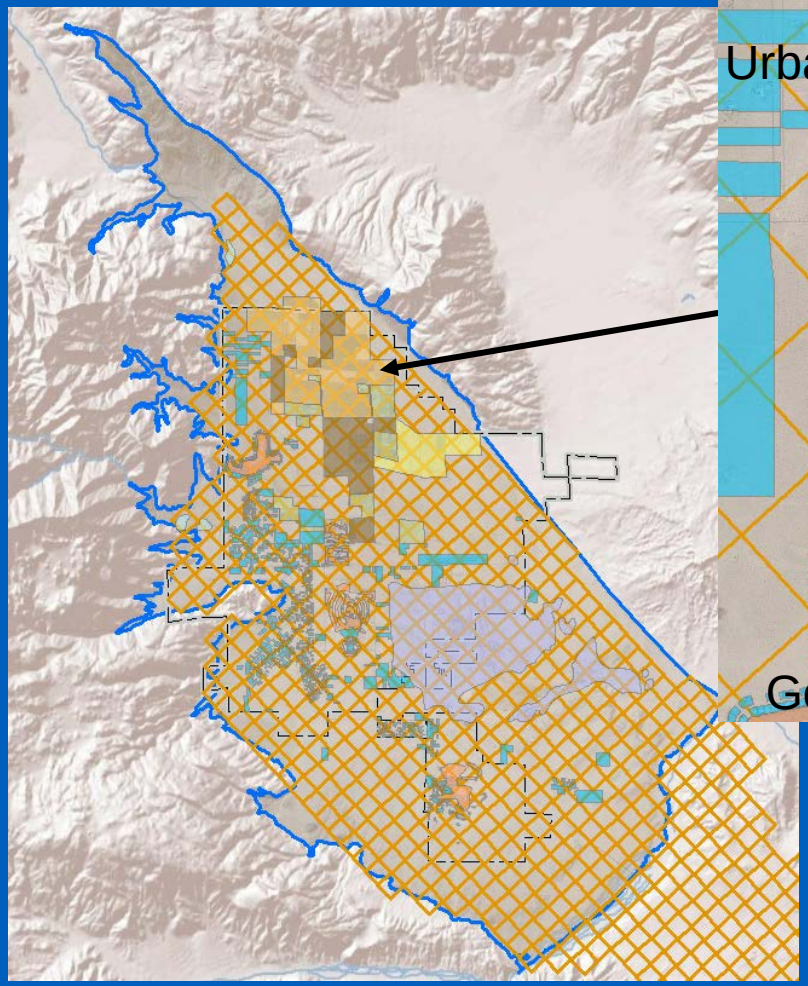
Pumping: Agriculture, BWD, Golf Courses

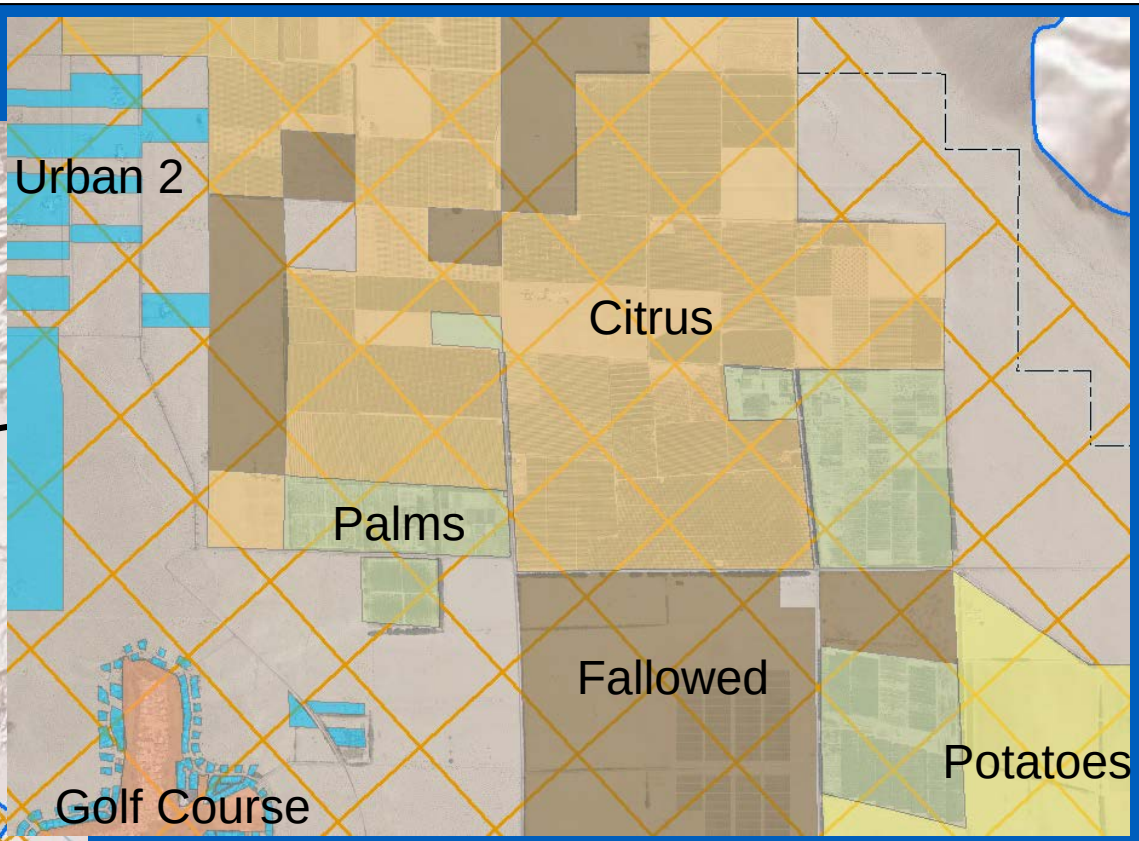
These data are applied to a grid which represents the Basin.

DUDEK

Water Budget and Groundwater Model Update: Land Use Types

Land Use

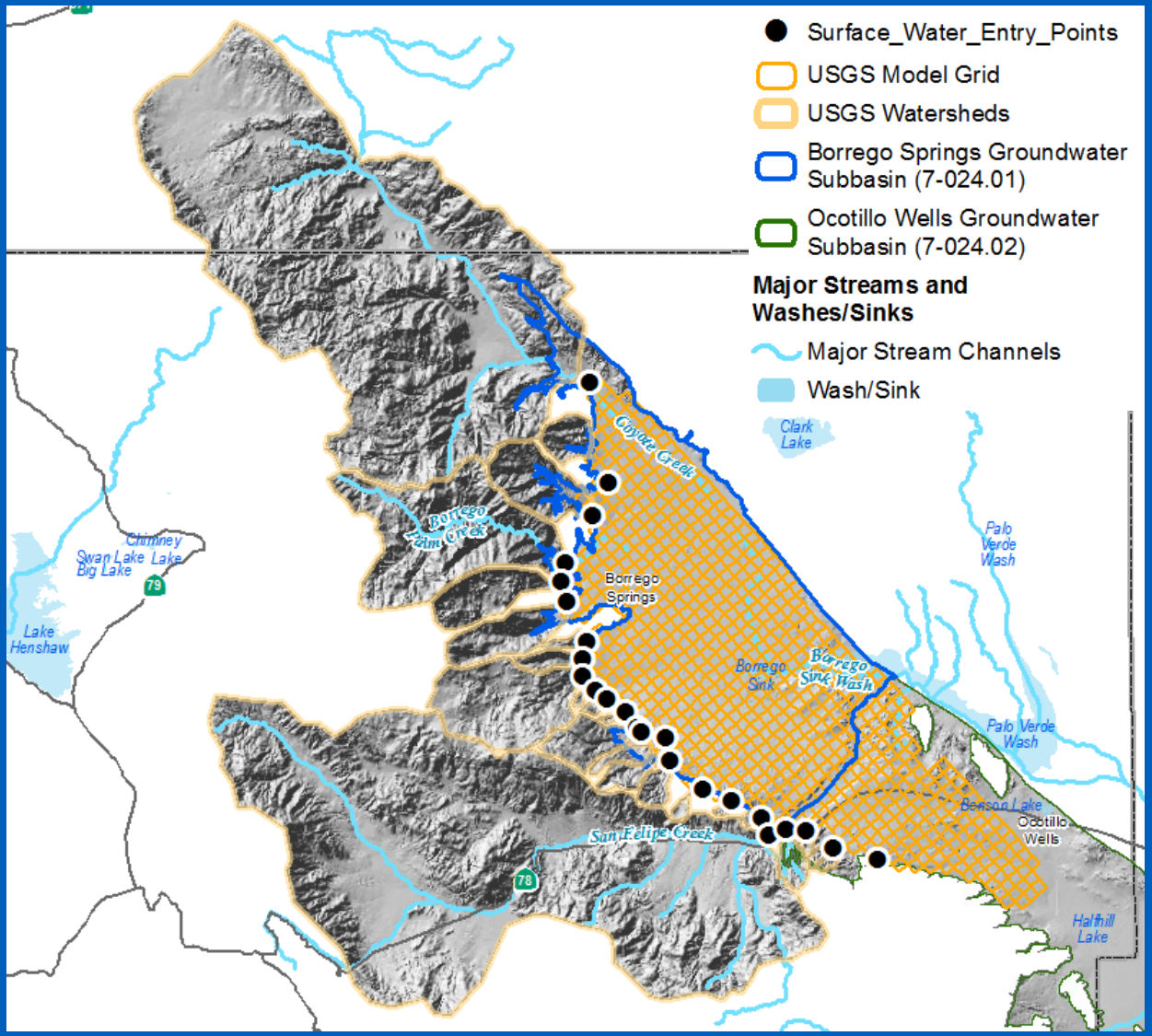




Land use types were updated based on documented fallowed water credit sites and aerial imagery.
Each characteristic of land use is applied to its respective grid cell.

DUDEK

Water Budget and Groundwater Model Update: Surface Water Entry Points



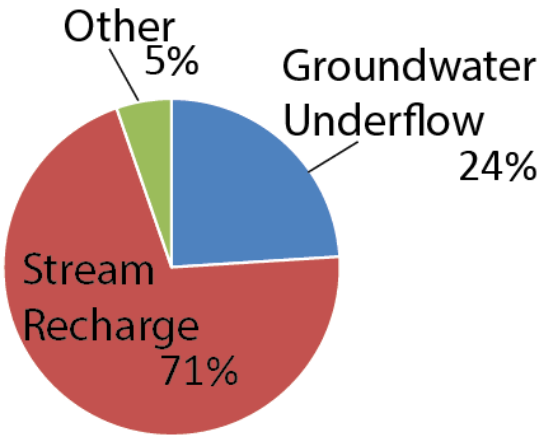
Streamflow

Basin Characterization Model (BCM) estimates runoff outside of the One-Water Hydrologic Flow Model (OWHM) domain

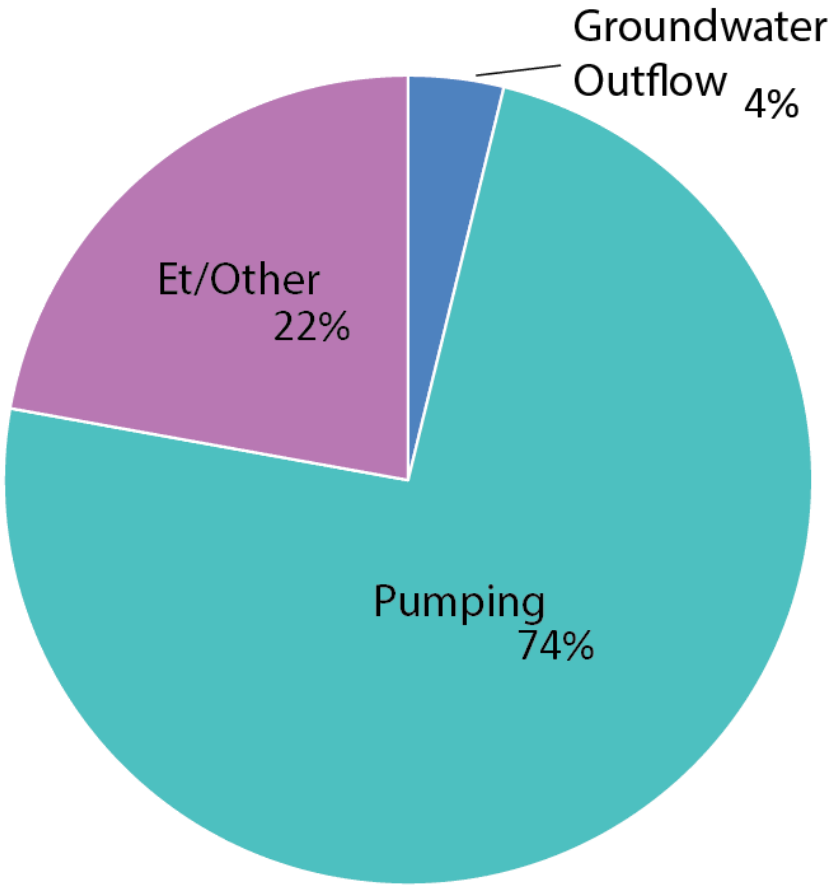
Streamflow ultimately plays the largest role in recharge to the basin

DUDEK

Groundwater Model Update Results and Uncertainty: Average Annual Water Budget (1945 – 2010)

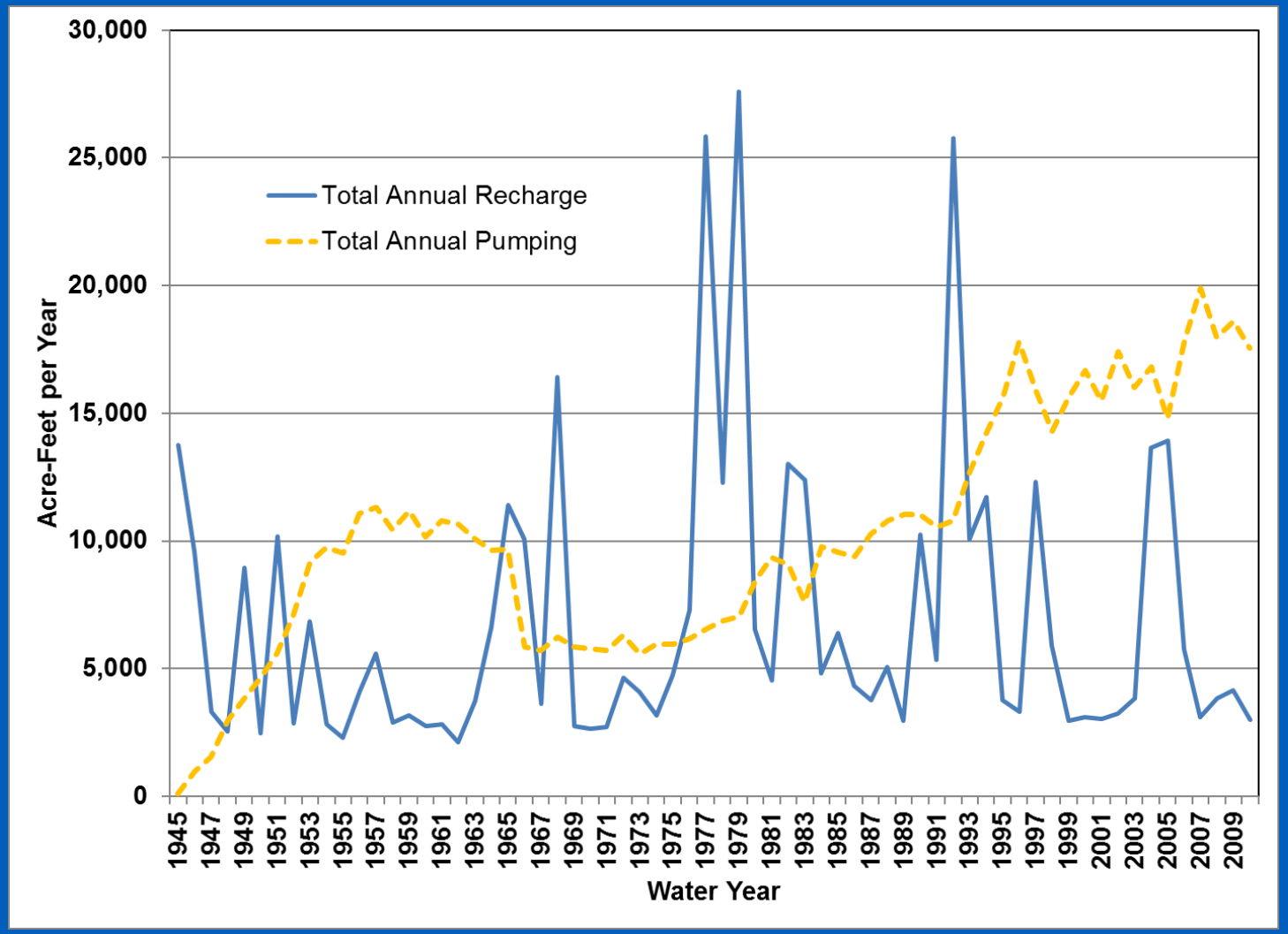


Inflows
(5,700 AFY)

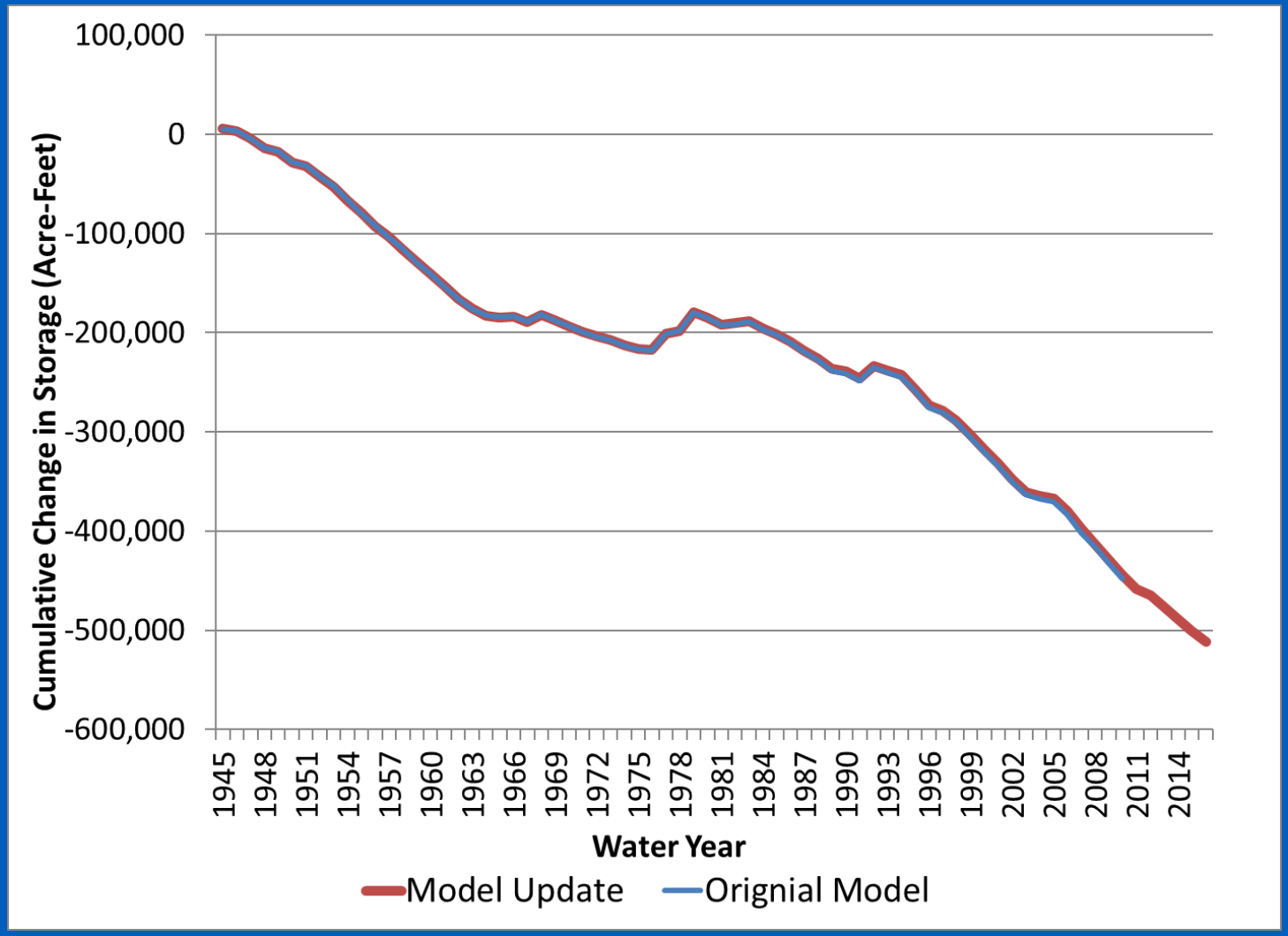


Outflows
(13,700 AFY)

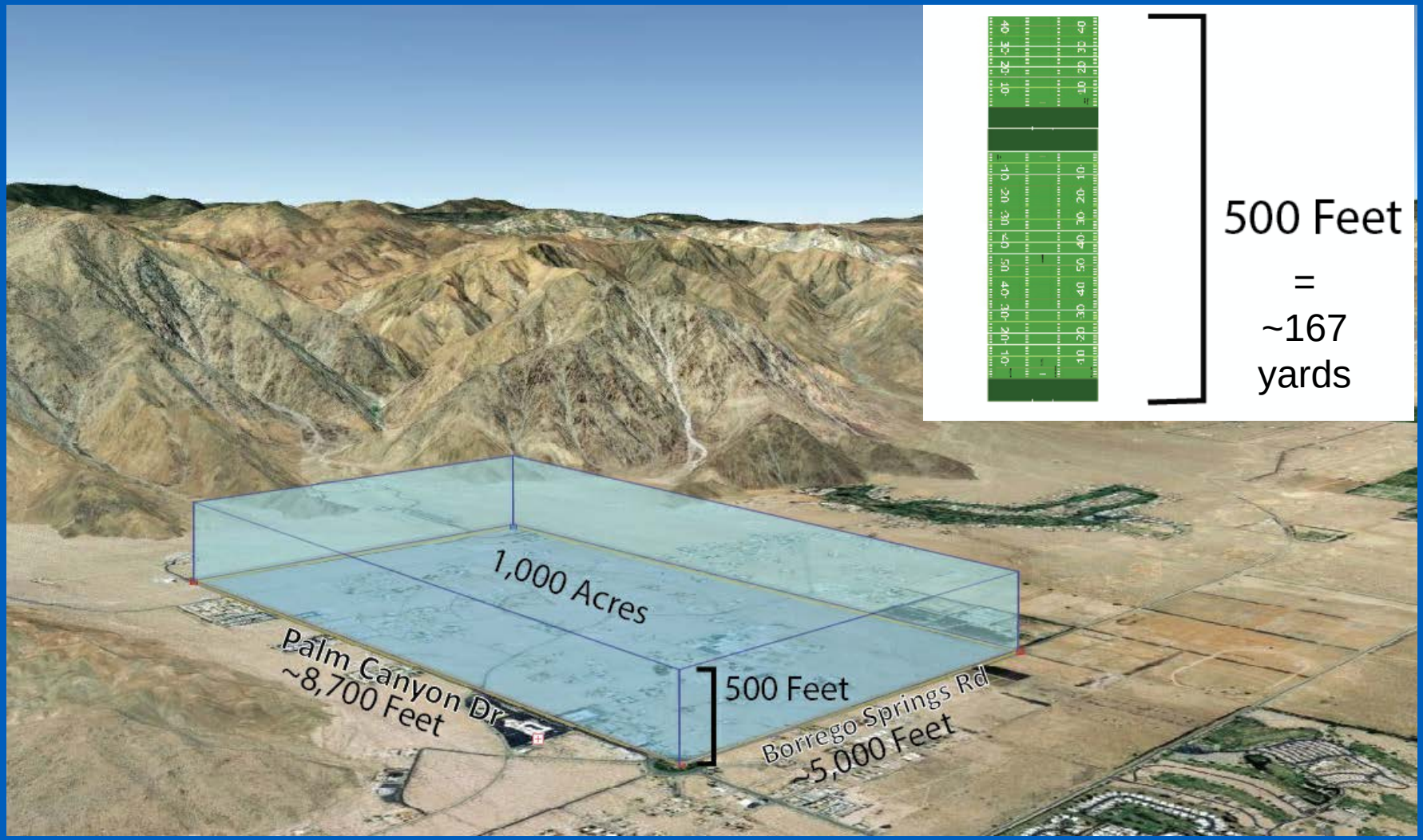
Total Annual Recharge and Total Annual Pumping



Groundwater Model Update Results and Uncertainty: Cumulative Change in Storage



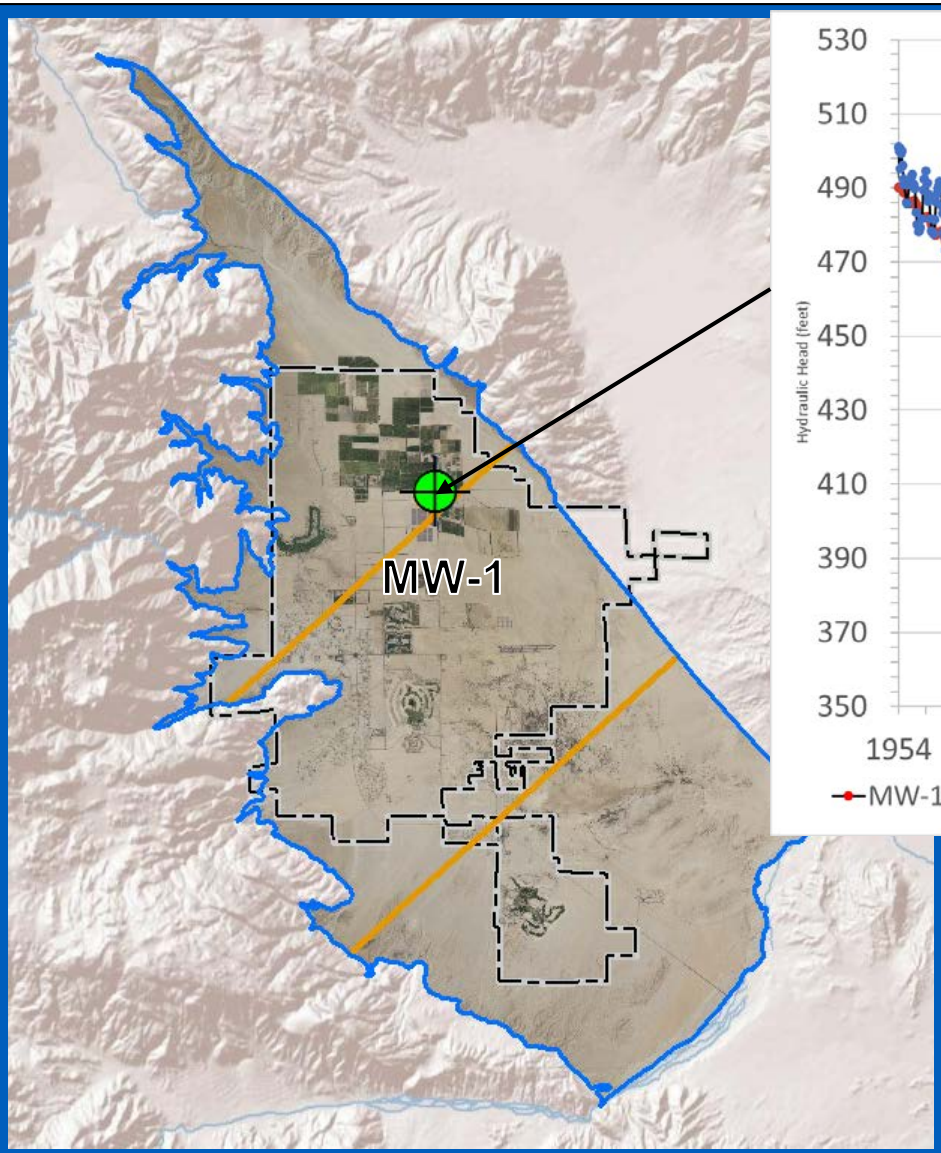
Groundwater Model Update Results and Uncertainty: Conceptual Graphic - 500,000 Acre Feet

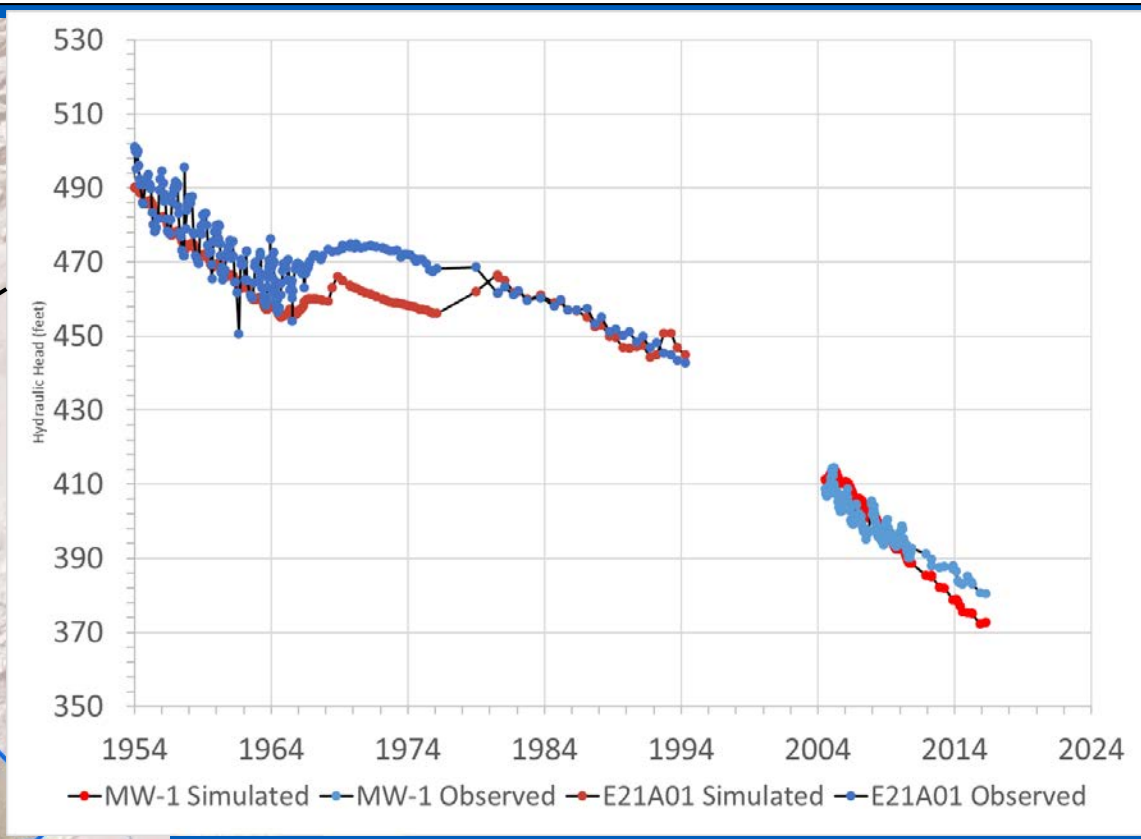


Source: Google Earth

DUDEK

Groundwater Model Update Results and Uncertainty: Observed vs. Simulated Heads

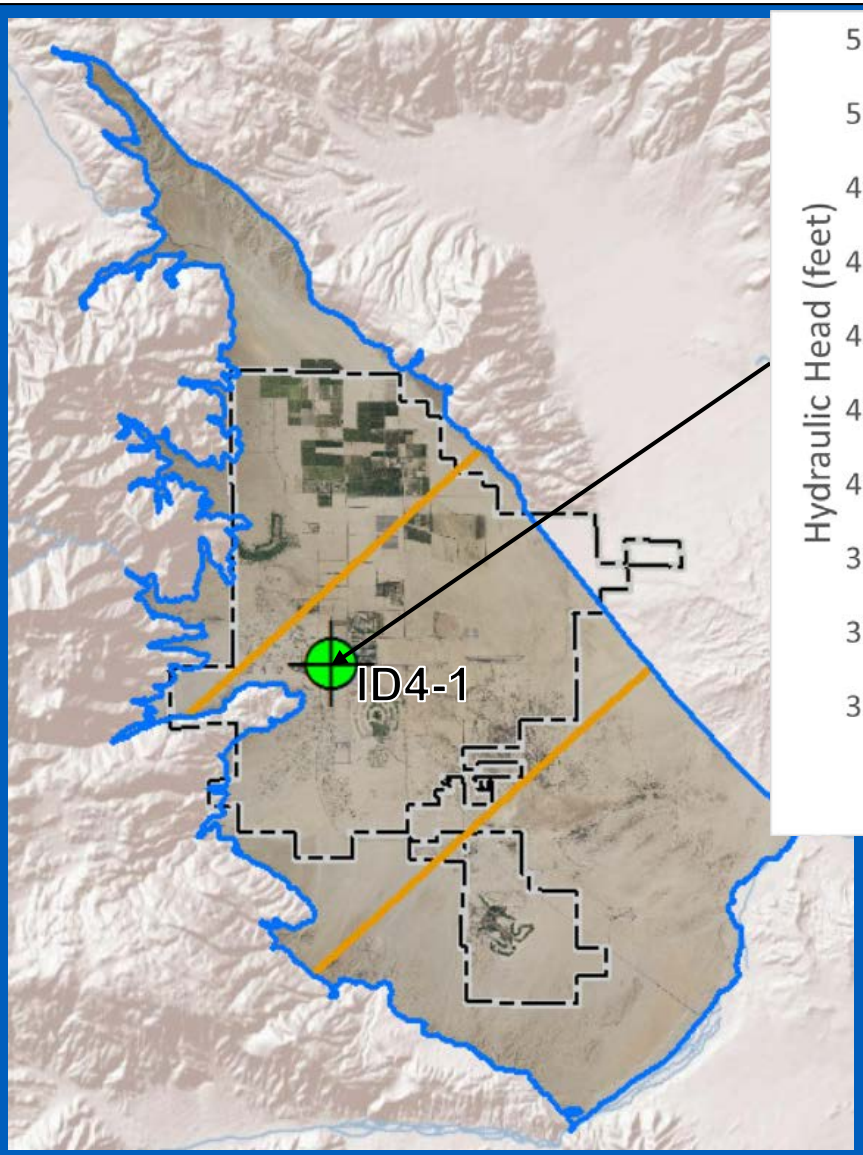


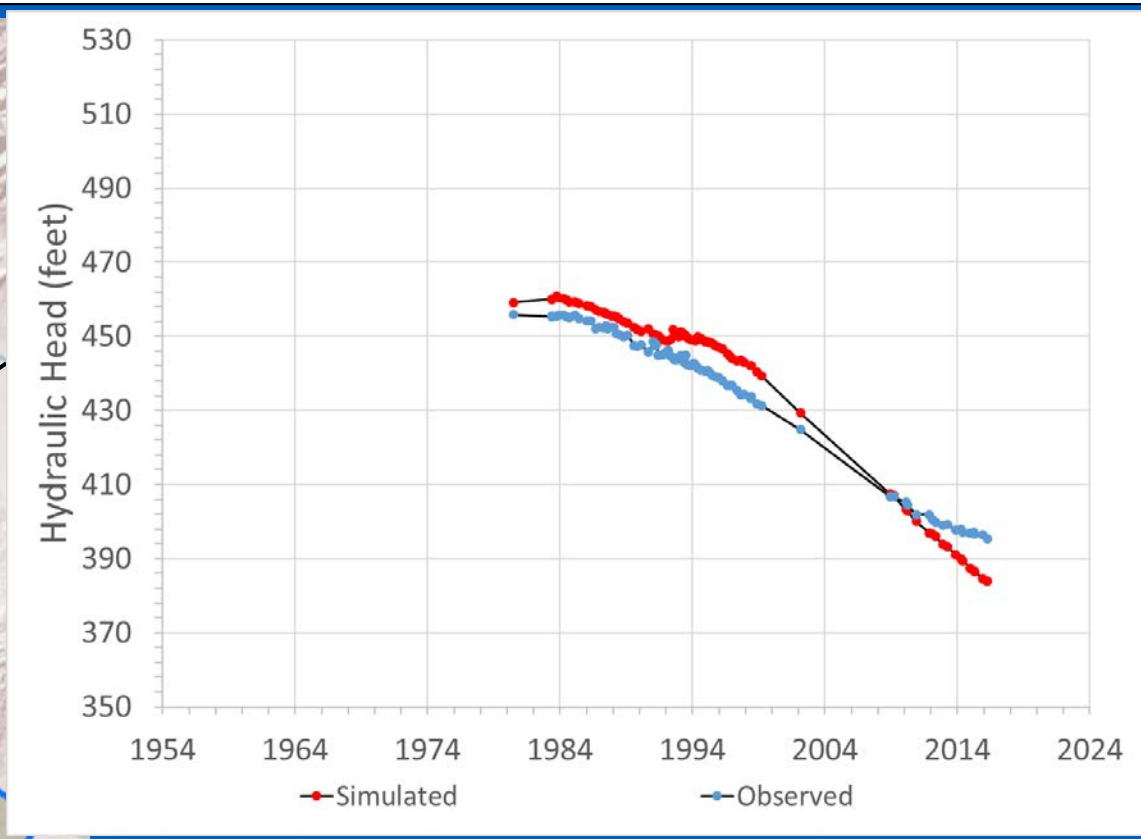


North Management Area - MW-1/21A01

DUDEK

Groundwater Model Update Results and Uncertainty: Observed vs. Simulated Heads

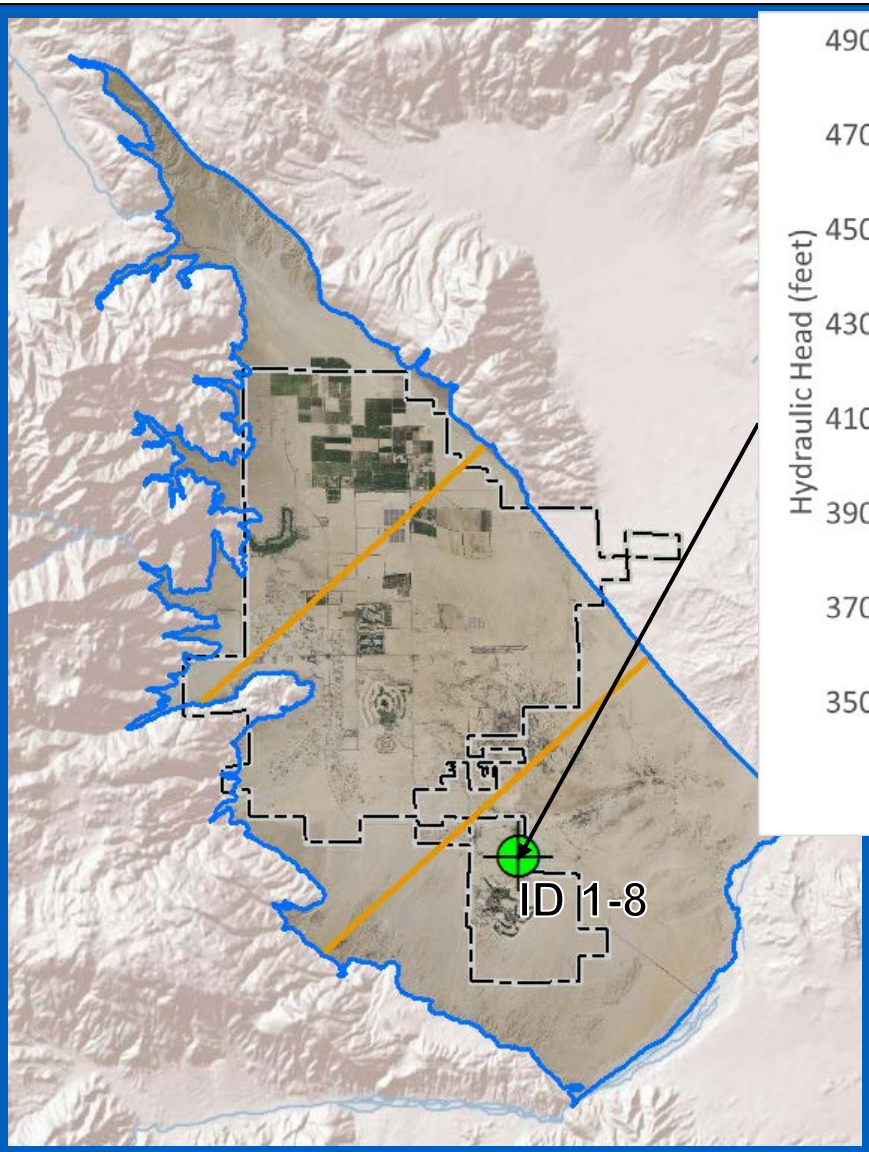


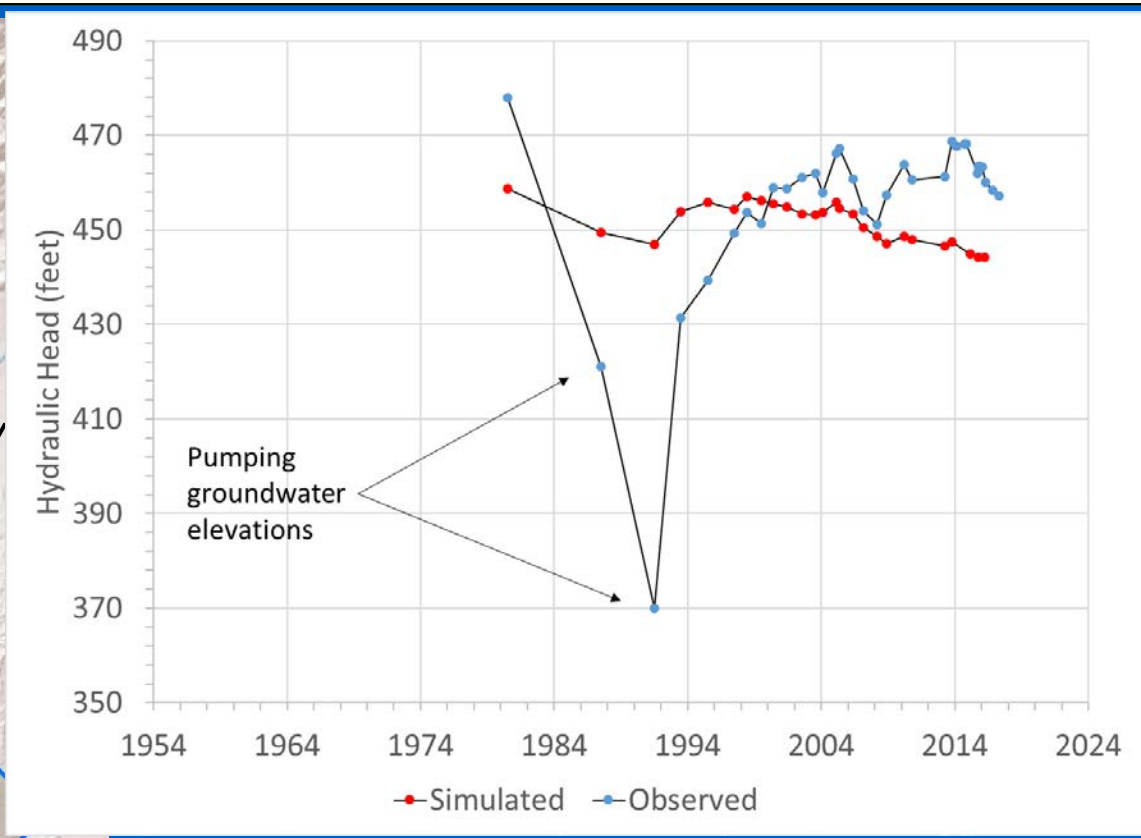


Central Management Area
Well ID4-1

DUDEK

Groundwater Model Update Results and Uncertainty: Observed vs. Simulated Heads

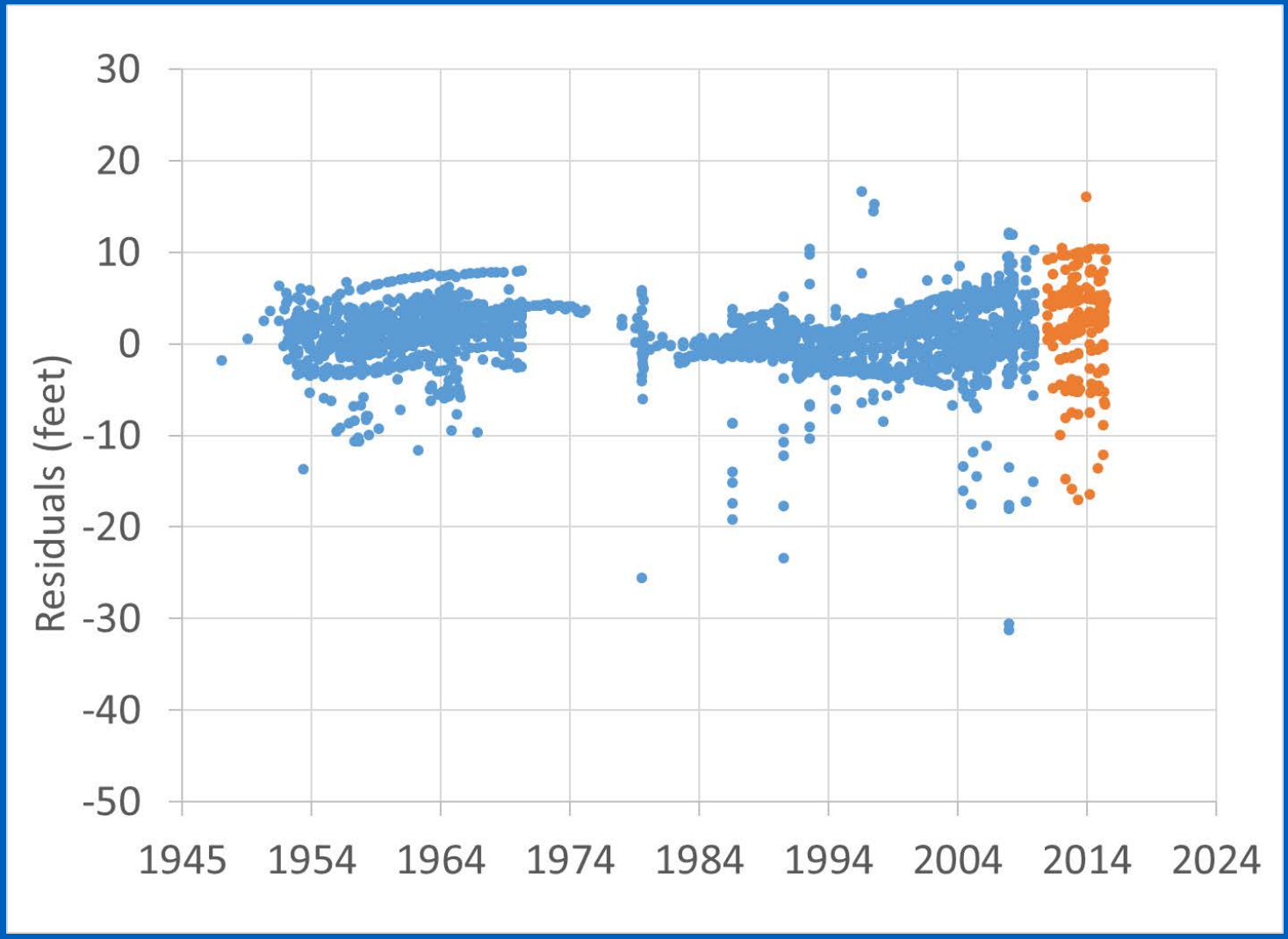




South Management Area
Well ID1-8

DUDEK

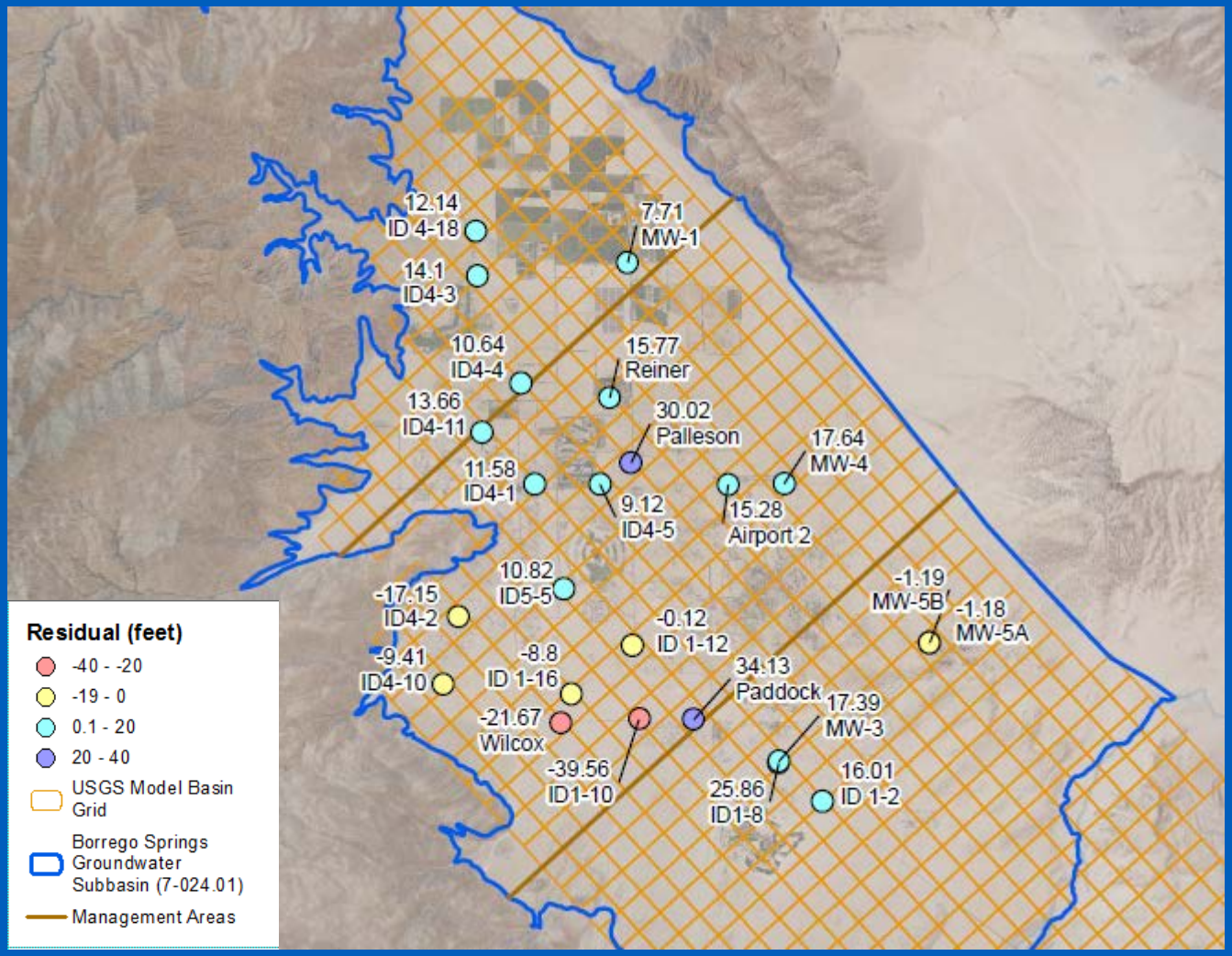
Groundwater Model Update Results and Uncertainty: Residuals



Residuals = Observed - Simulated Hydraulic Heads

DUDEK

Groundwater Model Update Results and Uncertainty: Residuals in Spring 2016

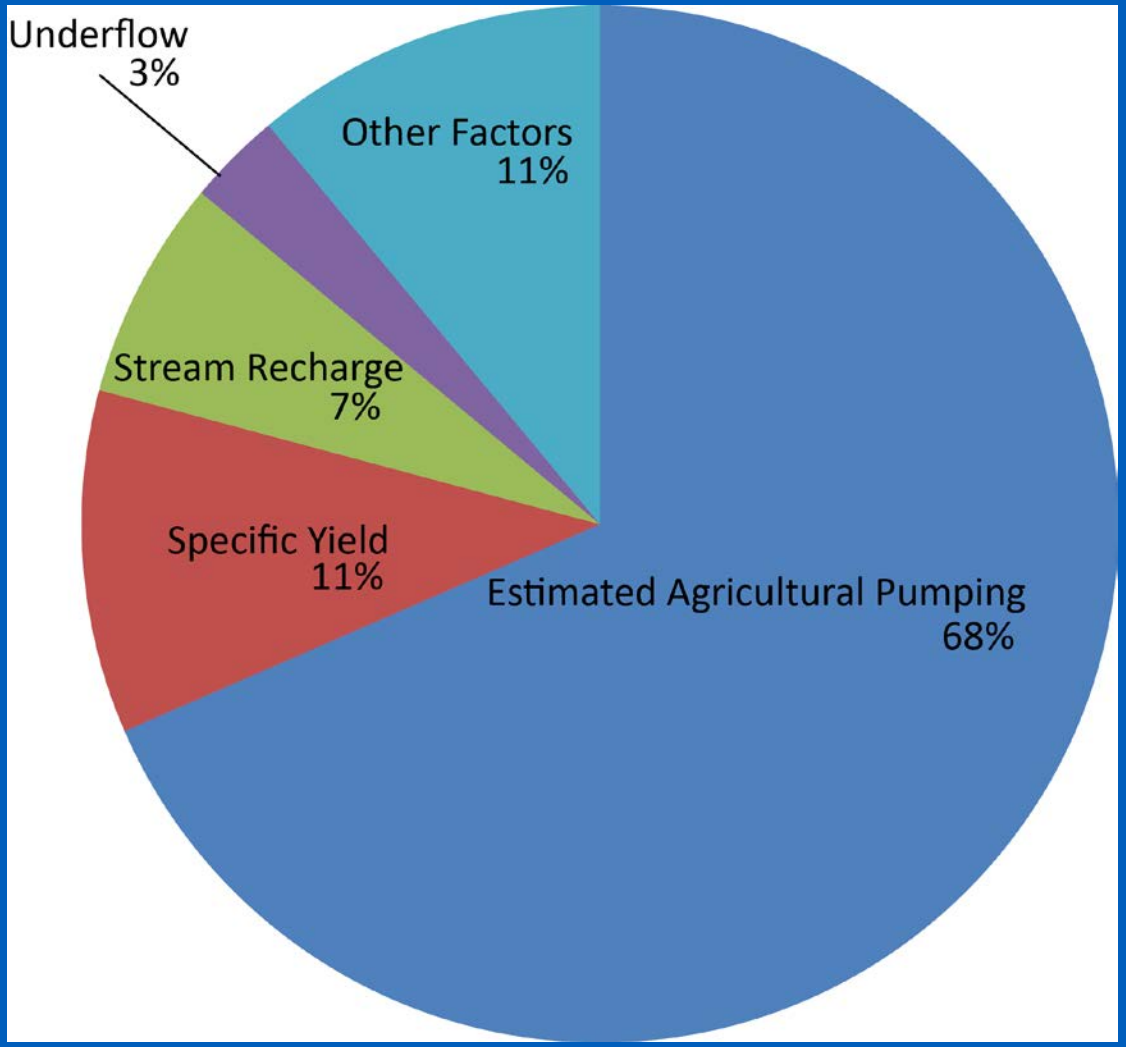


Residuals = Observed - Simulated Hydraulic Heads

Map indicates areas which may require model refinement

DUDEK

Steps to Improve Groundwater Model Accuracy: Model Sensitivity



Steps to Improve Groundwater Model Accuracy: Recommendations to Refine Model

- Dudek proposes incorporating new data to refine the numerical model and reduce uncertainty over next 5 years
- Three main areas to refine:
  - **Pumping** – Model estimates agricultural pumping using Farm Process. Metered agricultural pumping will markedly reduce uncertainty in model simulations
  - **Specific Yield** – Future aquifer tests will refine aquifer storage properties in the model
  - **Recharge** – The addition of stream gauges in distinct areas within the Basin will refine recharge estimates and reduce uncertainty

Conclusions and Next Steps

- The USGS model has been updated to year 2016.
- The model appears to show good representation of actual conditions in the Basin
- Uncertainty has been identified and will be quantified by Dudek as part of the GSP process
- GSP must identify criteria for sustainable indicators (i.e. groundwater levels in key wells which must not exceed defined levels, decline in groundwater storage, etc.)
- The model can be used to evaluate predictive simulations of alternative projects and management actions.