IWFM and C2VSim: Modeling Tools to Aid GSAs Comply with SGMA Requirements

GRAC SGMA Conference:
Tools for Developing a GSP

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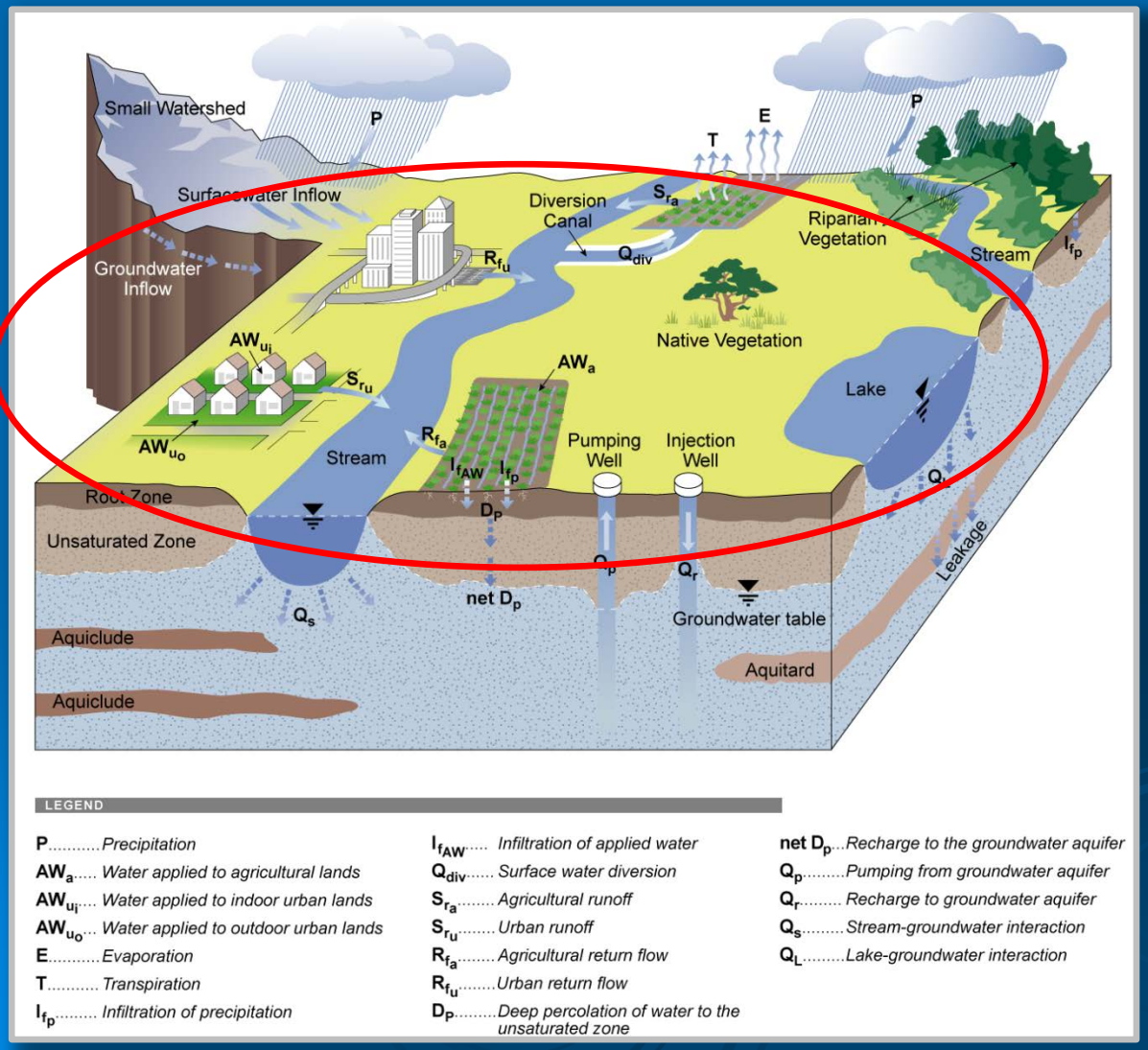
SGMA GSP Emergency Regulations

§ 354.18. Water Budget

- "*The Plan shall include a water budget for the basin … annual amount of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions …"*
- *" … water budget shall quantify …"*
  - ✓ All inflows (infiltration of precipitation, infiltration of applied water and from surface water system; subsurface groundwater inflow, etc.)
  - ✓ All outflows (ET, groundwater extraction, losses to streams, subsurface groundwater outflow, etc.)
  - ✓ Change in annual volume of groundwater storage
- *"The Department shall provide C2VSim and IWFM for use by Agencies in developing the water budget. Agencies may choose to use a different flow model."*

Integrated Water Flow Model (IWFM)



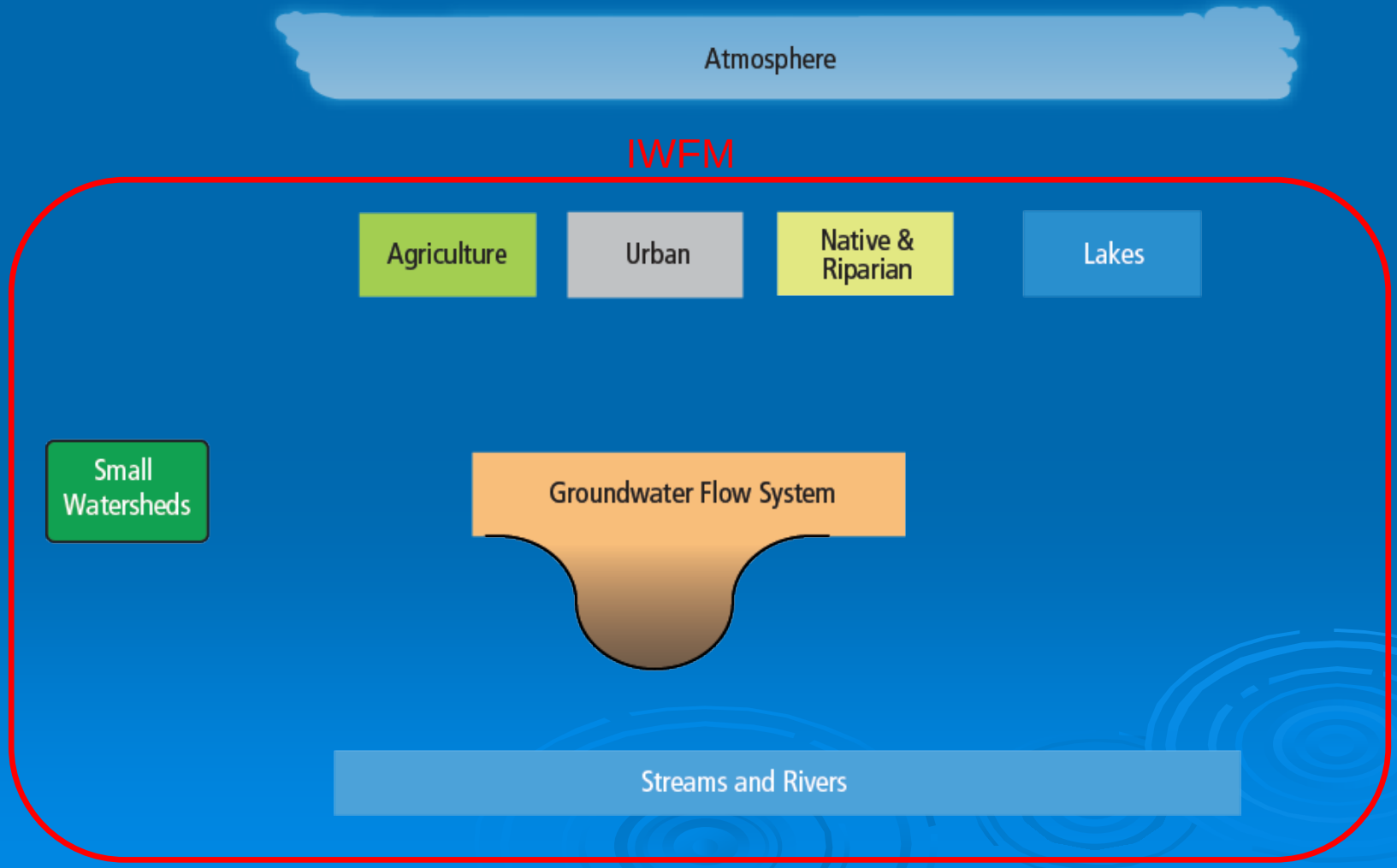
IWFM Features in Support of SGMA

- Computation of agricultural water demand as a function of crop types and areas, climate (precipitation and ET), soil parameters, and farm water management parameters
- Representation of many agricultural practices; e.g. management of rice fields, pre-irrigation, regulated deficit irrigation, over-irrigation for leaching, reuse of agricultural return flow
- Computation of urban water demand as a function of population and per-capita water use; indoor and outdoor water demand separation
- Linkage between groundwater, streams and root zone processes through percolation (eventual recharge to groundwater), root water uptake from groundwater, pumping, diversions, irrigation return flow, rainfall runoff
- Automatic adjustment of water supply to meet water demand
- Root zone component (IDC) can be run as a separate program

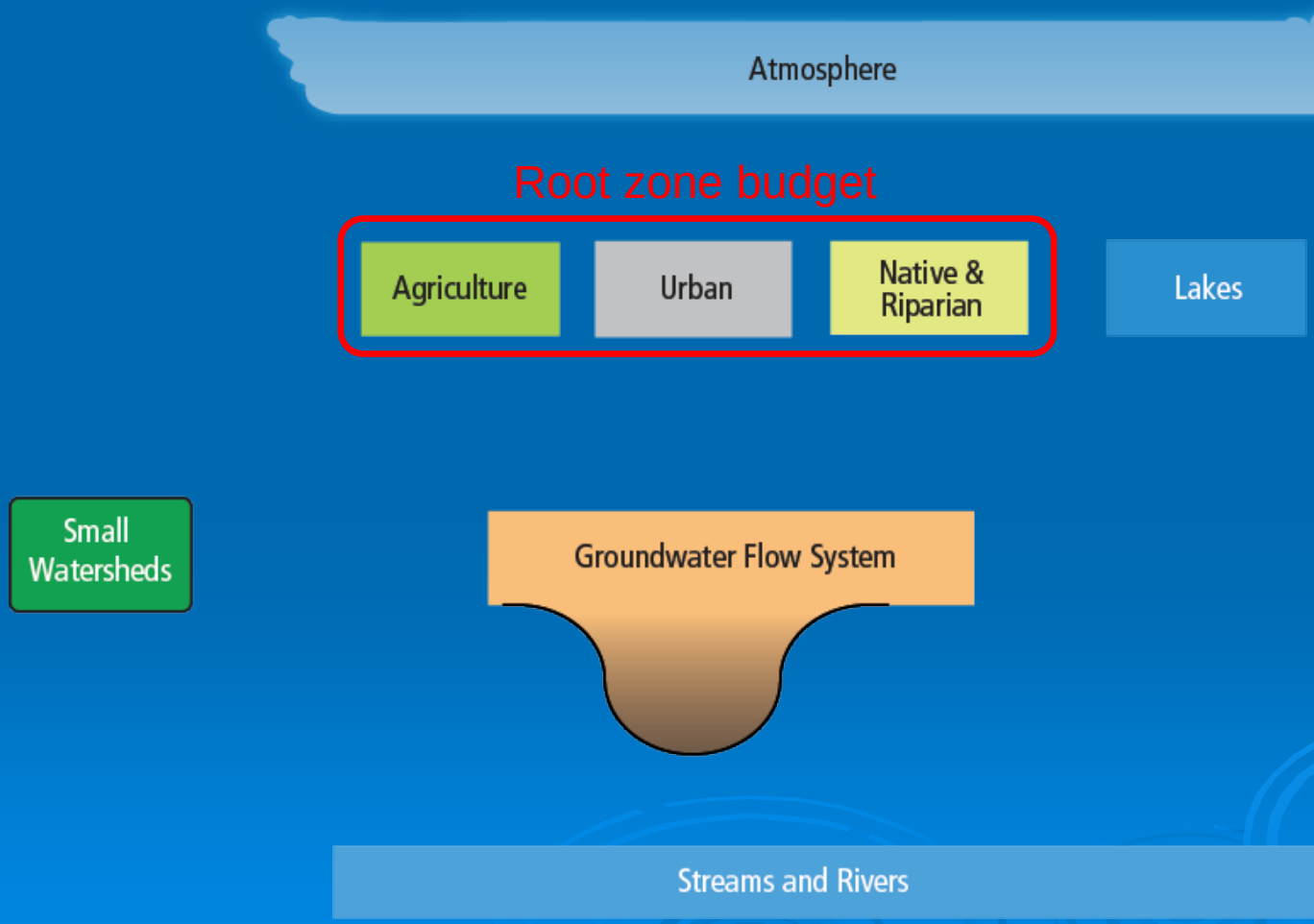
IWFM Features in Support of SGMA

- Usual output options: groundwater heads, stream flows, boundary flows, subsidence, etc. at user-specified locations
- Extensive water budget output for all simulated hydrologic components:
  - Groundwater budget
  - Stream flow budget
  - Root zone budget
  - Land and water use budget (comparison of water demand and supply)
  - Unsaturated zone budget
  - Small watershed budget (ungauged watersheds contributing surface and subsurface boundary inflows)

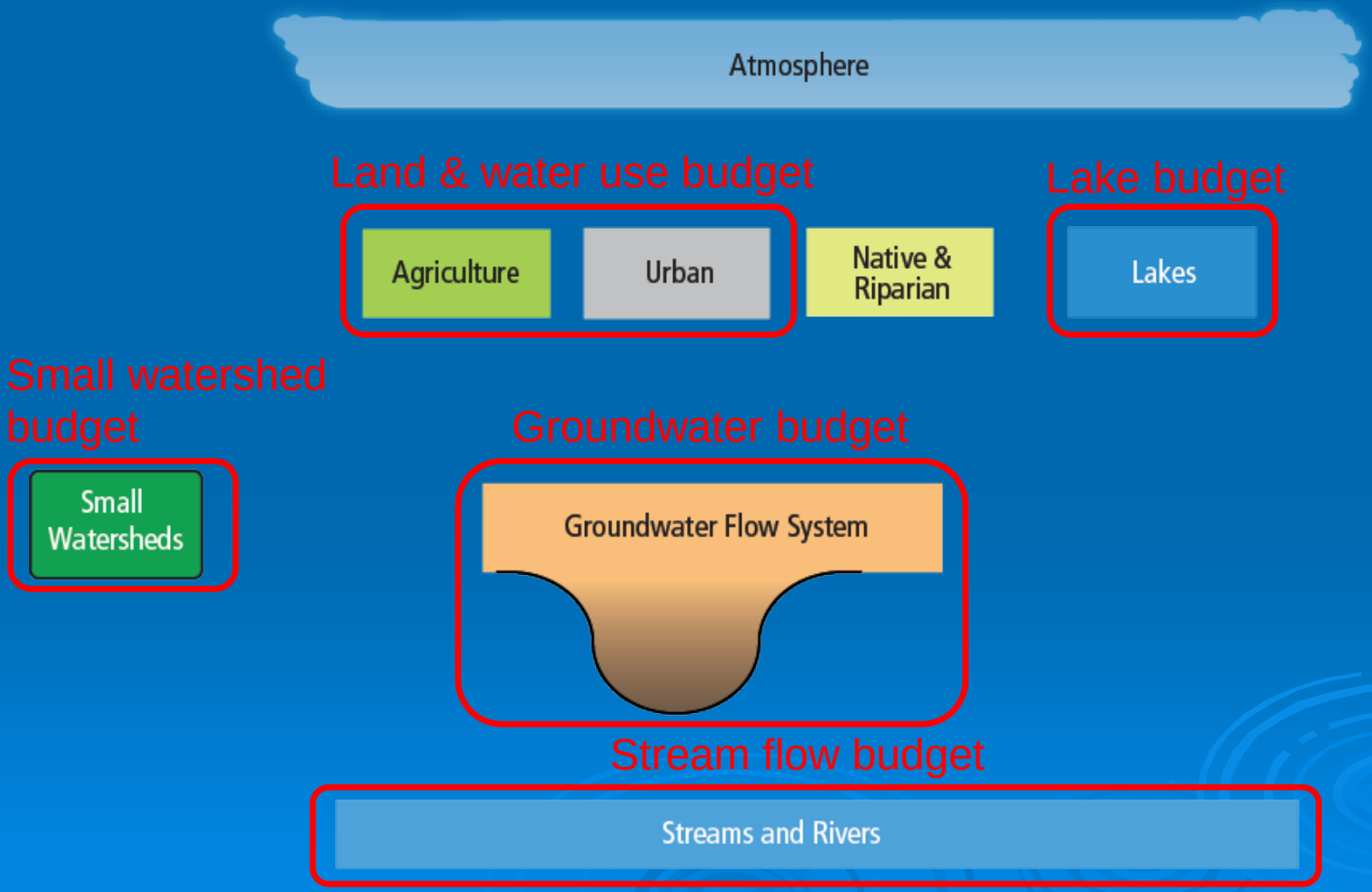
Water Budgets in IWFM



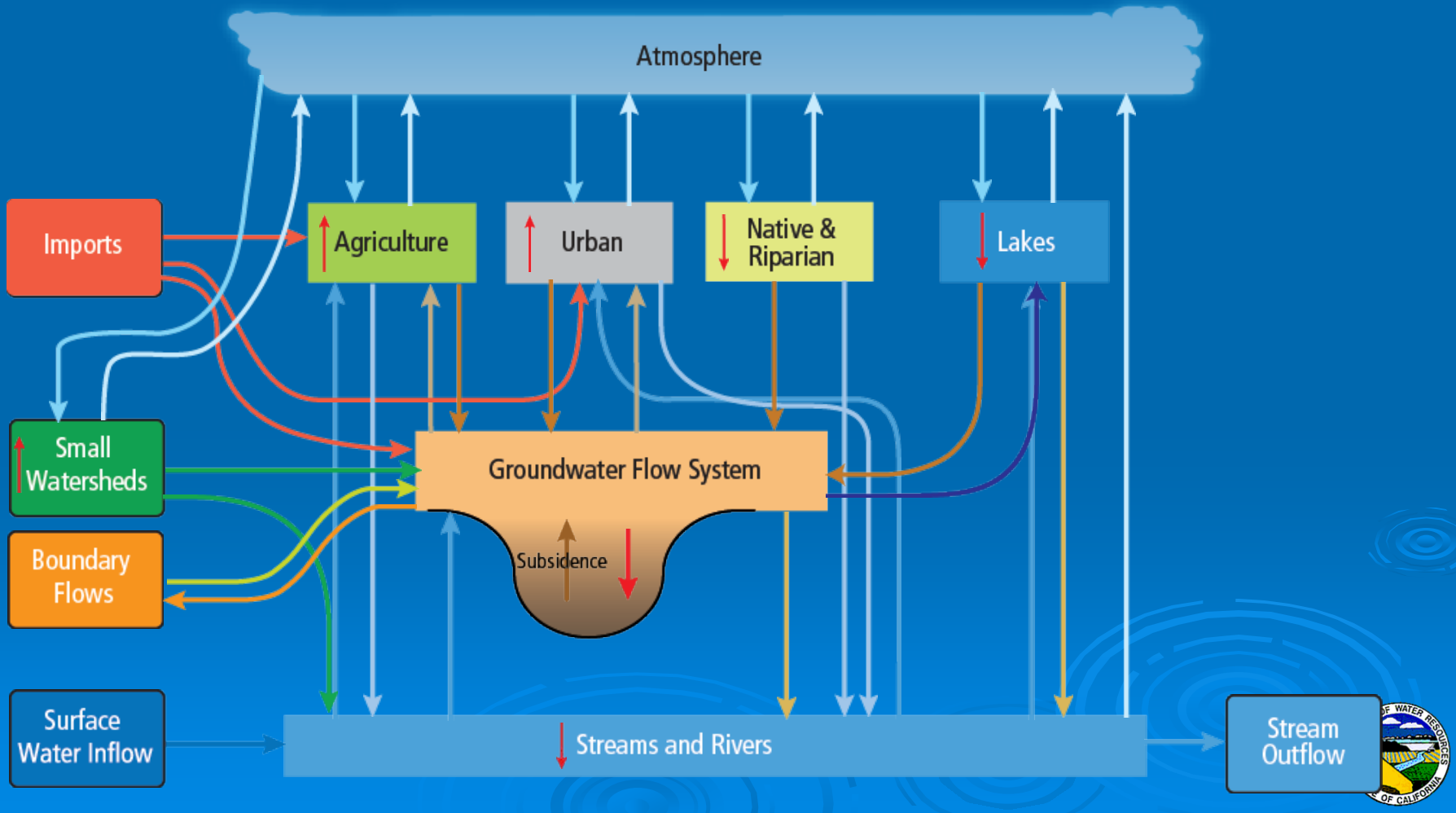
Water Budgets in IWFM



Water Budgets in IWFM



Water Budgets in IWFM

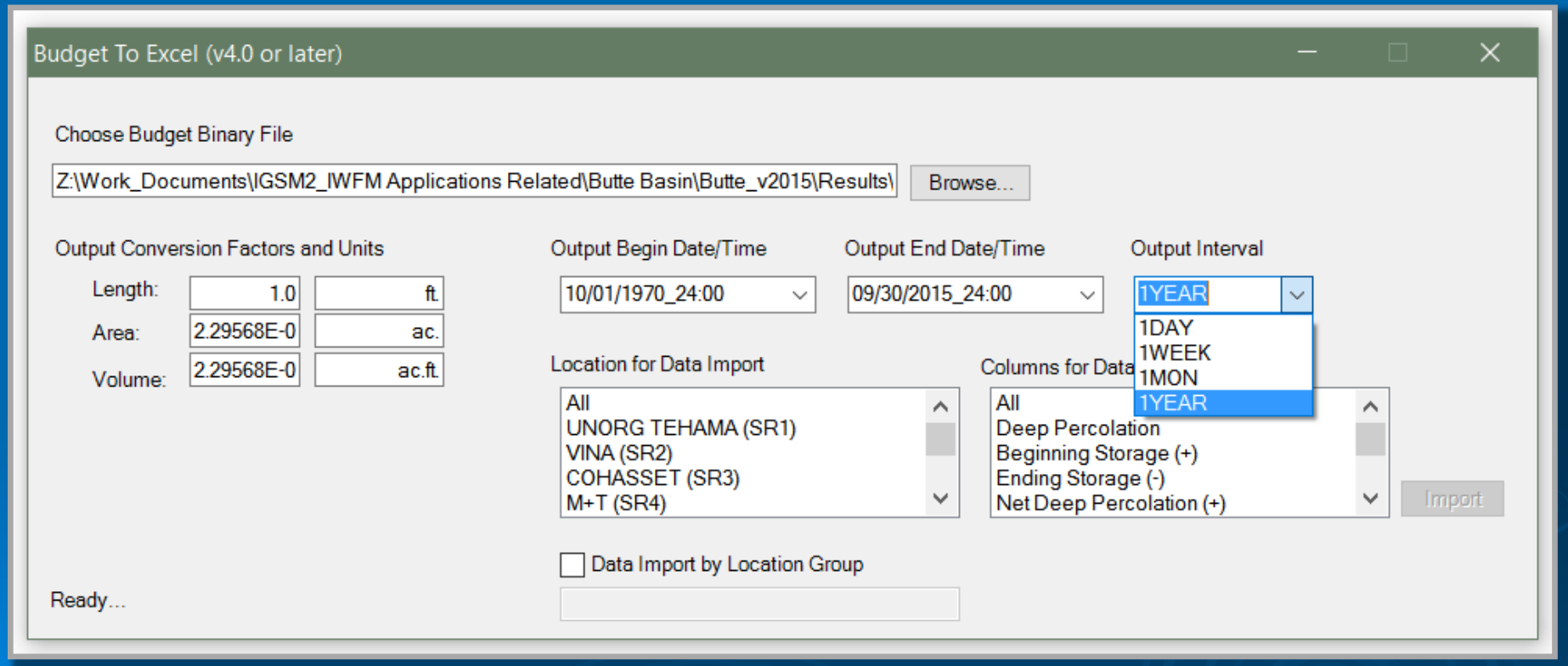


Water Budgets in IWFM

- Use of clear terminology
- Consistent terminology among budget tables
- Mass balance with selected convergence creteria is shown
- Consistent units among budget tables
- Inflows to and outflows from a hydrologic component are clearly designated using “+” (inflows) and “–” (outflows)
- Easy to traverse between budget tables to track water within the system
- Post-processing tools available to import budget tables into Excel for effective analysis and visualization

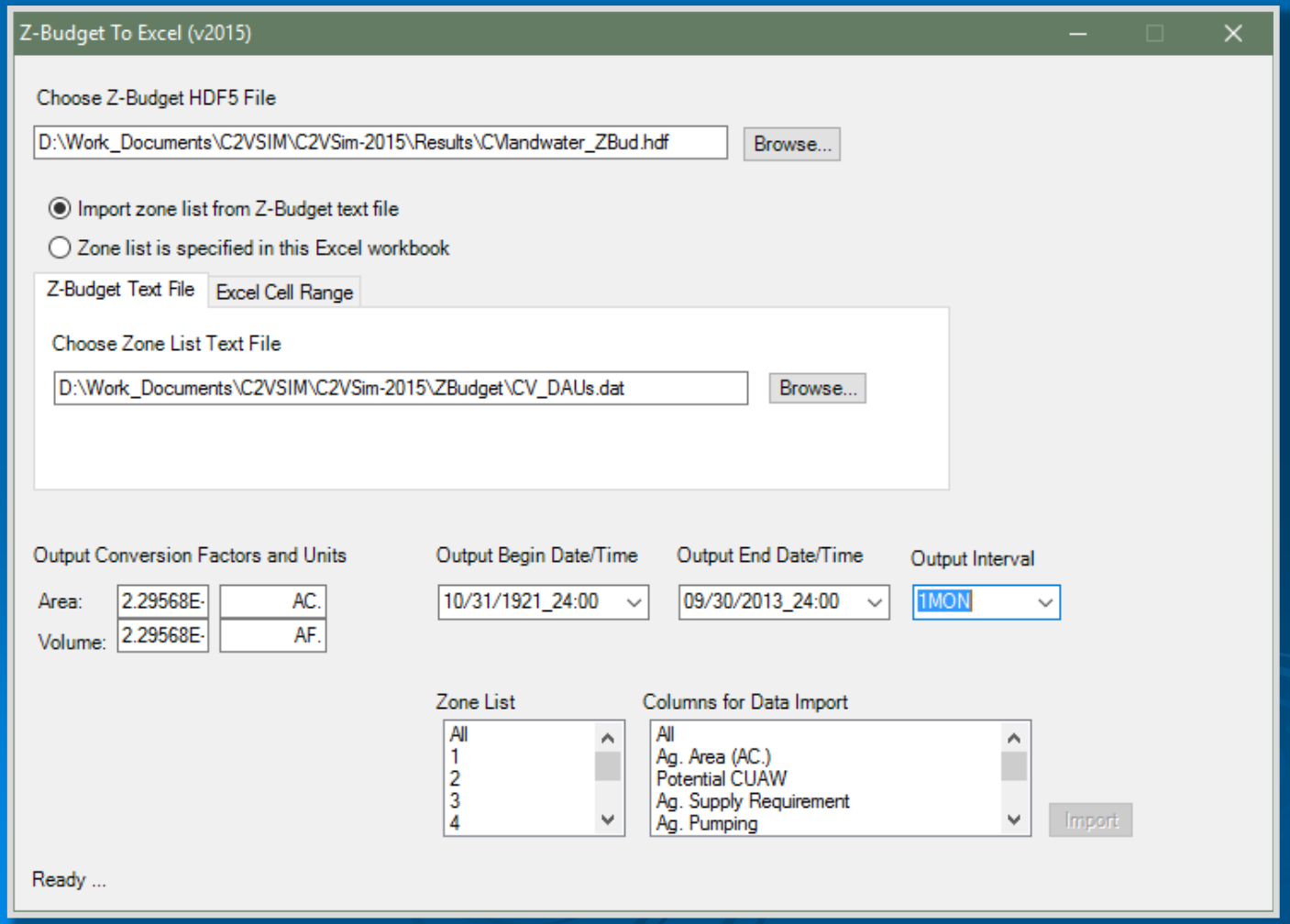
Water Budgets in IWFM

- Budget data import with IWFM Excel add-in

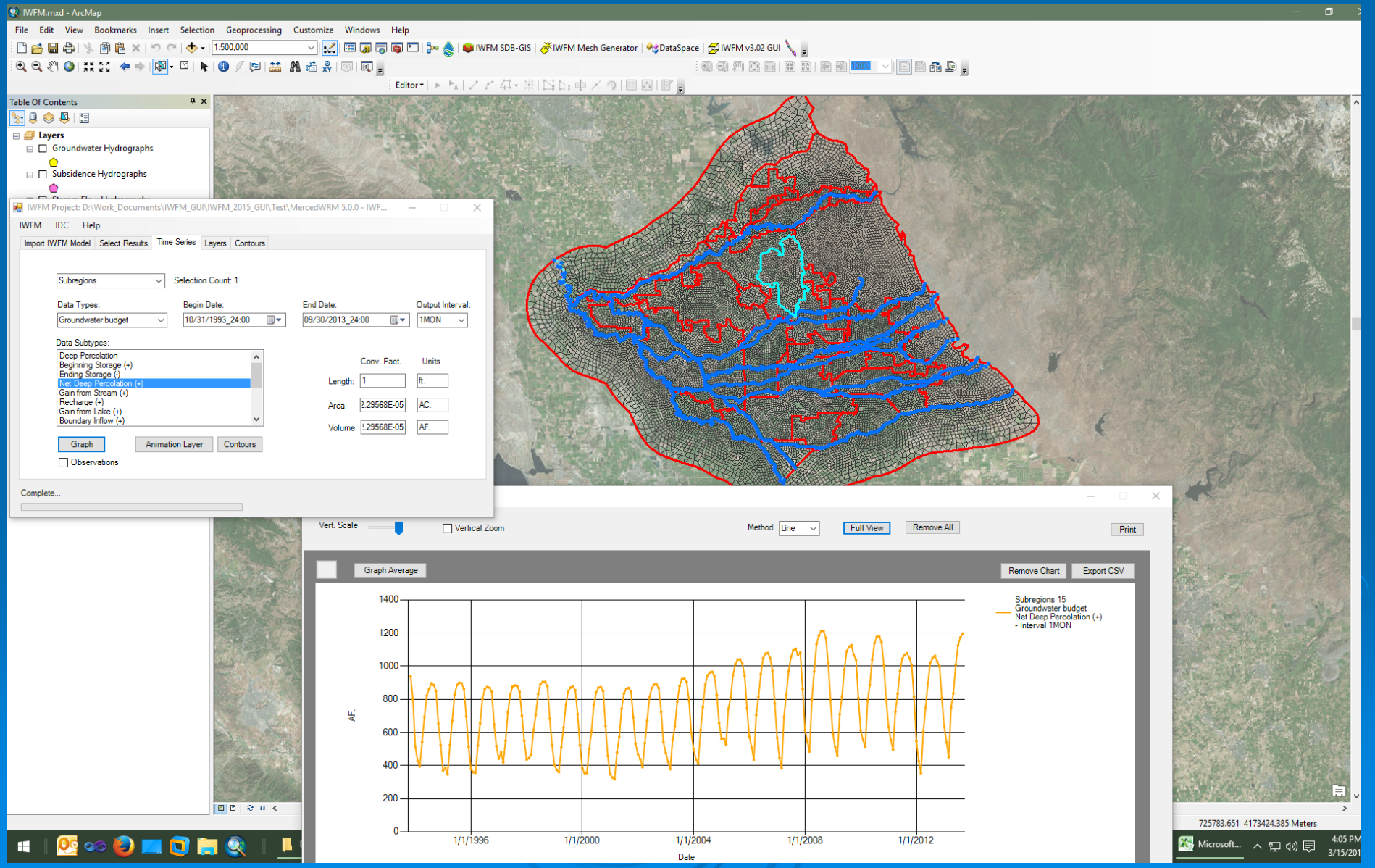


Water Budgets in IWFM

- ZoneBudget Data Import with IWFM Excel Add-in



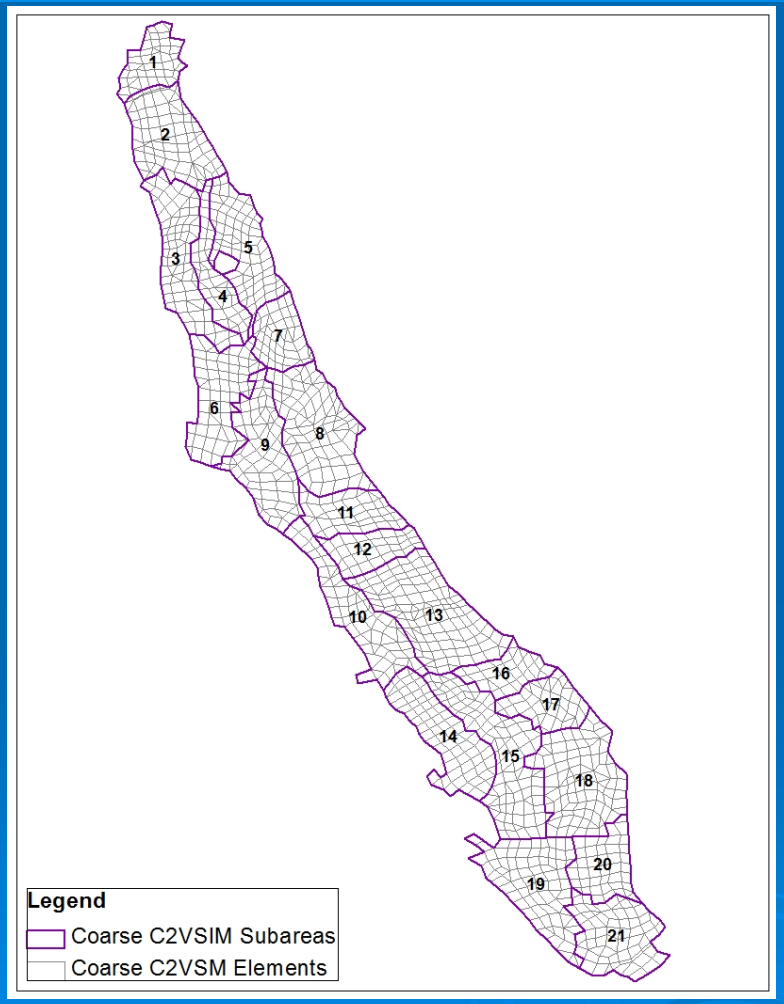
IWFM ArcGIS GUI (*expected release June 2017*)



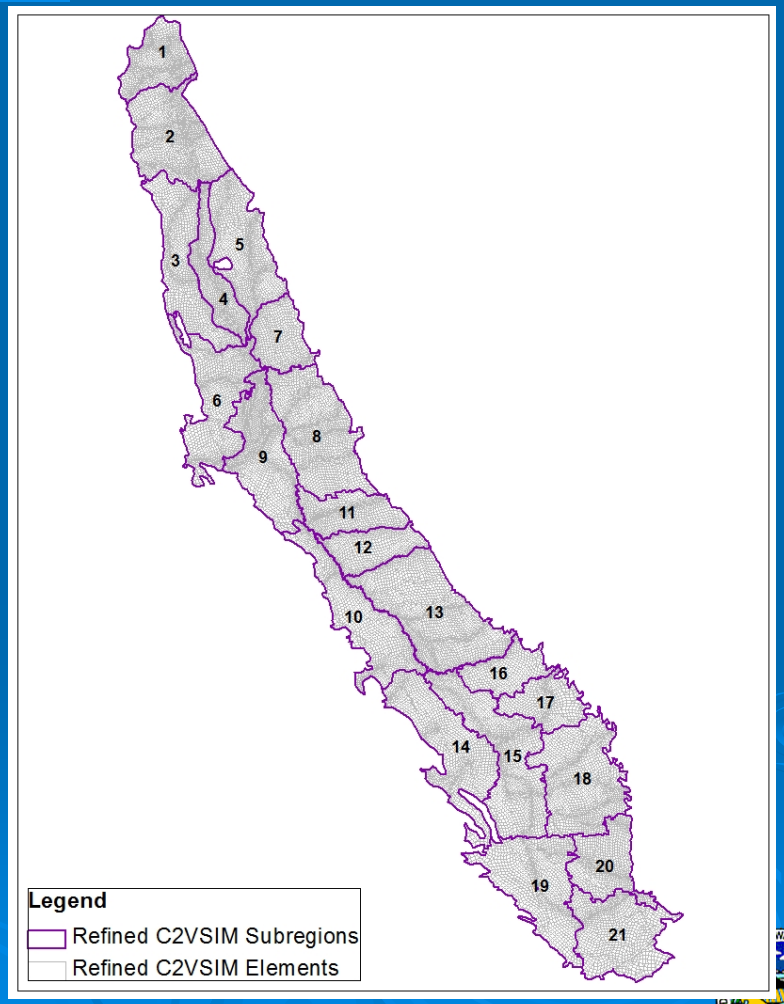
California Central Valley Groundwater-Surface Water Simulation Model (C2VSim)

- Application of IWFM to California's Central Valley
- Derived from the CVGSM model
  - WY 1922-1980 Boyle & JM Montgomery (1990)
  - WY 1981-1998 CH_2M Hill
- Steady improvements/modifications
  - DWR took ownership in 2000
  - Development began in 2001
  - Datasets reviewed and refined
  - Moved model to IWFM engine
  - Simulation period WY 1922-2009
  - Publicly available since 2013

C2VSim: Two Model Grids



C2VSim-CG

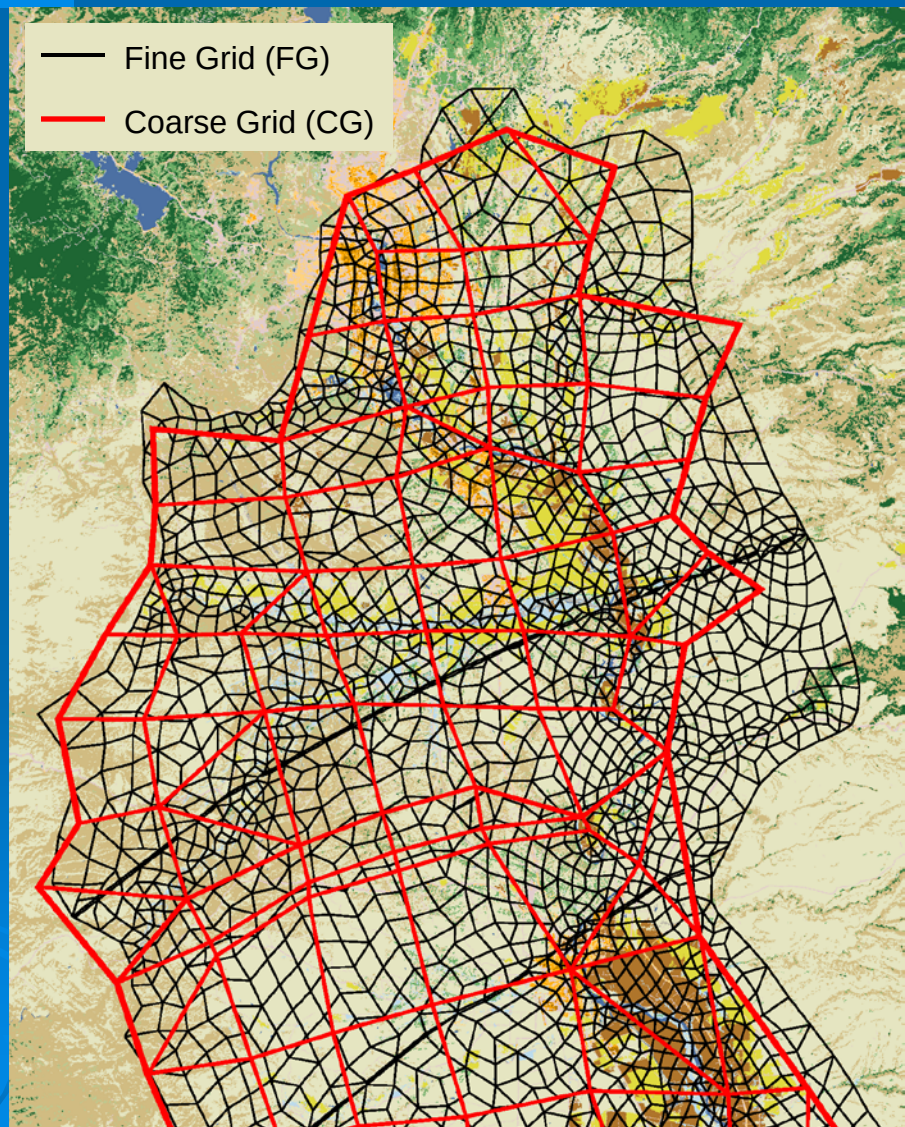


C2VSim-FG

C2VSim: Two Model Grids

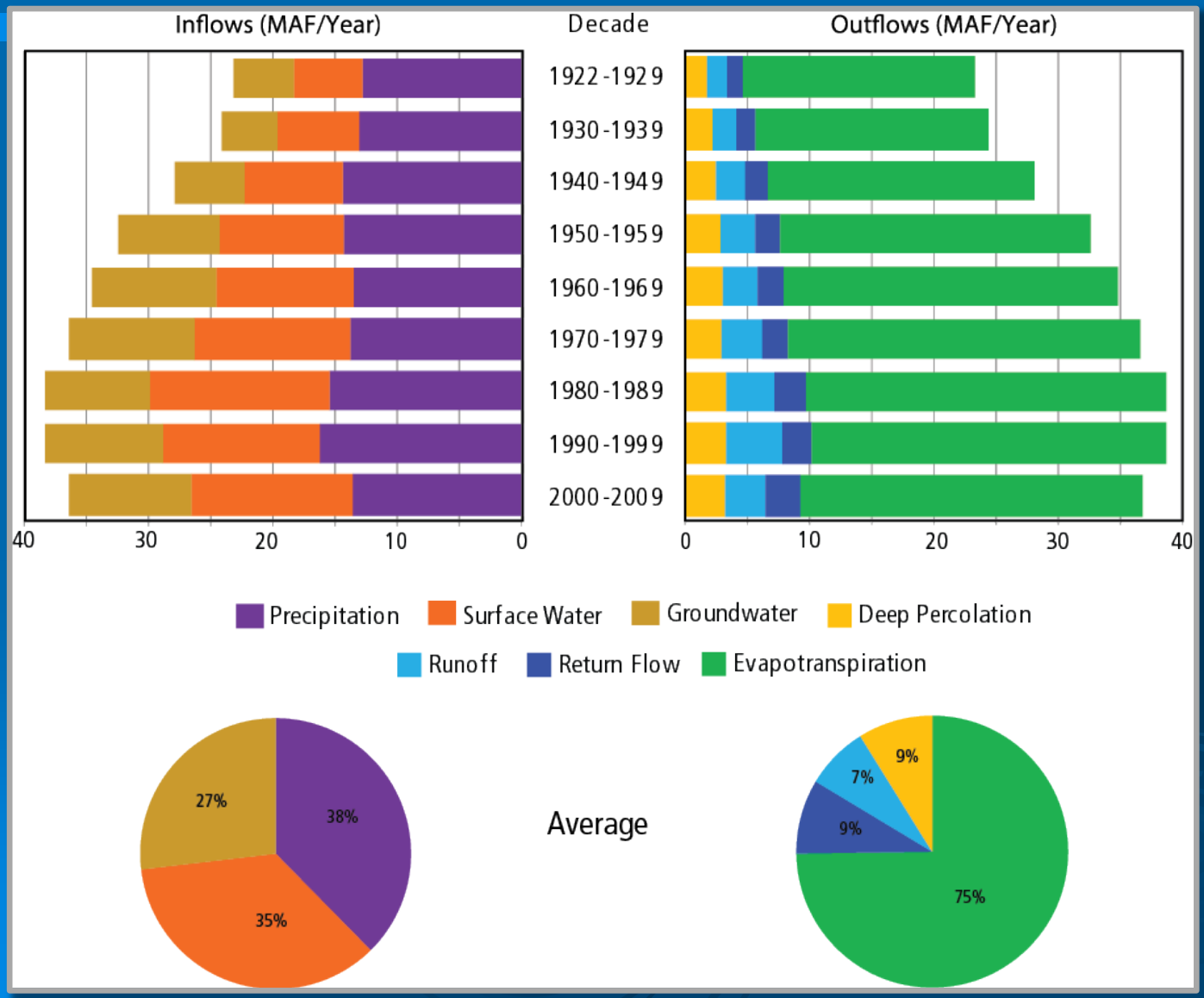
	Fine	Coarse
Nodes	30,179	1,393
Elements	32,537	1,392
River Nodes	4,529	449
Node Spacing (mi)	0.6-1.5	5
Cell Area (mi^2)	0.6	14

- Suggested uses
  - **CG:** Regional-scale analysis
  - **FG:** Local-scale analysis, development of initial datasets and boundary conditions for local SGMA models

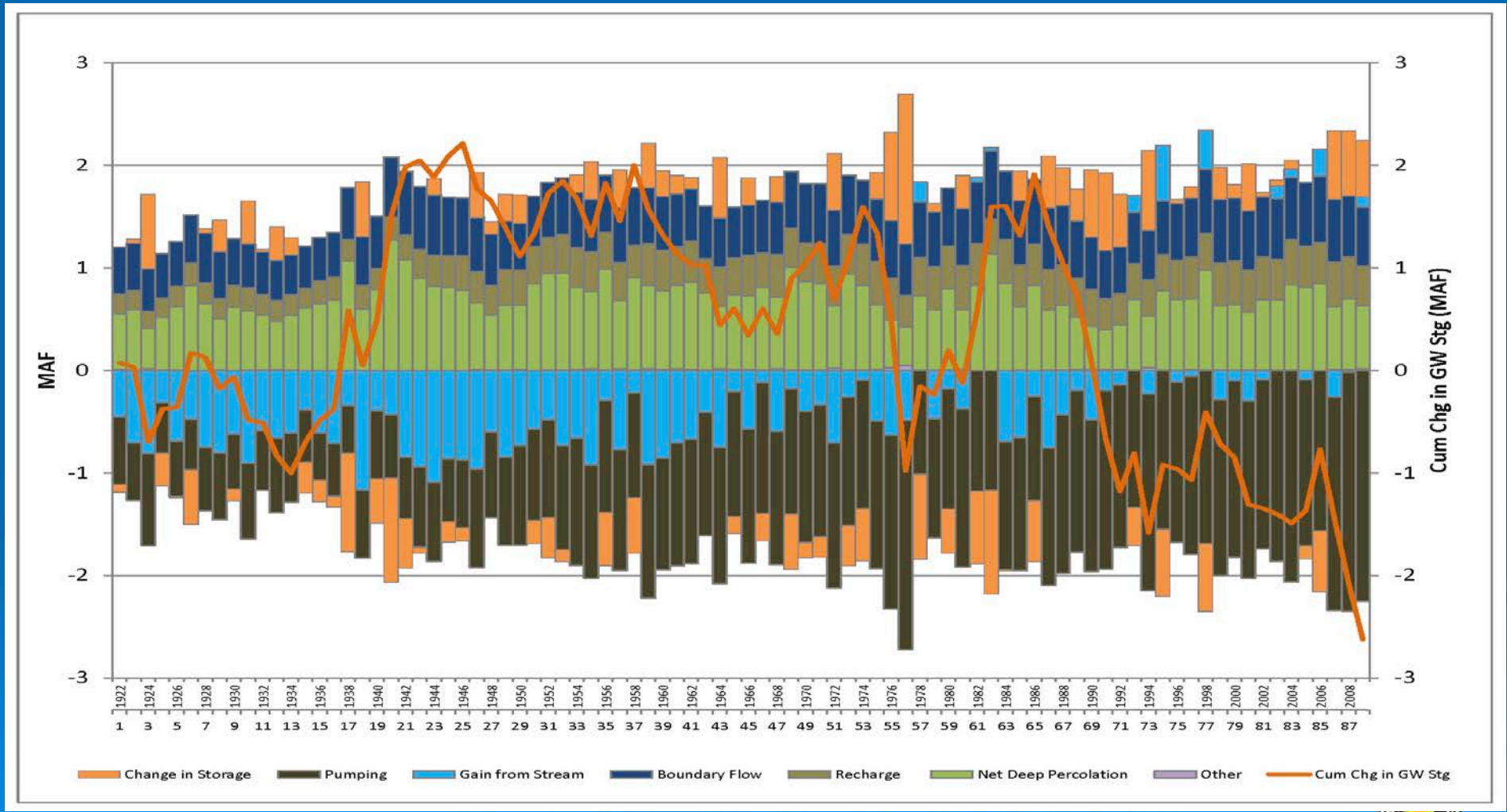


C2VSim: Root Zone Budget

(*Source: DWR C2VSim Technical Memorandum*)



C2VSim: Historical GW Budget in Sacramento Valley



Courtesy of RMC Water and Environment

C2VSim: On-going Development

- Simulation period and input datasets being extended through September 2015
- Migrate model to the IWFM-2015 engine
- Water budgets at user-defined groups of cells (zone budget)
- Data development and re-calibration of CG and FG models through the rest of 2017
- Documentation, QA/QC, tools, public release expected by November 2017 (CG) and December 2017 (FG)

Technical Support

- Free technical support on IWFM and C2VSim by DWR staff
- Help jump-start user models through face-to-face meetings
- Regular training workshops (at least once a year)
- User Group meetings (once a year)
- Regular updates to IWFM engine, pre- and post-processor tools
- More information on IWFM and C2VSim web sites (google “IWFM” and “C2VSim”)

Thank You!

IWFM ROOT ZONE PACKAGE (v3.02.0096)

ROOT ZONE MOISTURE BUDGET IN ac.ft. FOR DSA 58 (SR1)

SUBREGION AREA: 328274.82 ac.

Agricultural Area

Beginning Storage (+)	Net Gain from Land Expansion (+)	Infiltration (+)	Other Inflow (+)	Actual ET (-)	Deep Percolation (-)	Ending Storage (-)	Discrepancy (=)
2900.7	0.0	4461.5	0.0	4353.9	126.4	2881.8	0.0
2881.8	0.0	1428.7	0.0	2118.5	32.2	2159.9	-0.0
2159.9	0.0	1500.0	0.0	1390.5	69.4	2200.0	0.0
2200.0	0.0	1661.8	0.0	1293.8	144.5	2423.5	0.0
2423.5	0.0	1606.4	0.0	1981.2	53.4	1995.3	0.0
1995.3	0.0	4271.1	0.0	3593.0	165.0	2508.5	0.0
2508.5	0.0	16211.4	0.0	5150.7	8985.1	4584.0	0.0
4584.0	0.0	17560.9	0.0	6656.6	10814.8	4673.5	0.0
4673.5	0.0	16513.2	0.0	8553.0	8098.0	4535.8	-0.0
4535.8	0.0	18395.8	0.0	9166.6	9170.7	4594.4	-0.0
4594.4	0.0	17032.0	0.0	7713.3	9311.2	4601.8	-0.0
4601.8	0.0	16713.8	0.0	6004.8	10645.2	4665.6	-0.0
4665.6	23.6	7811.1	0.0	4662.1	3288.1	4550.2	-0.0
4550.2	0.0	1291.7	0.0	2268.4	215.8	3357.6	-0.0
3357.6	0.0	1495.7	0.0	1516.4	176.9	3160.0	0.0
3160.0	0.0	1601.4	0.0	1391.1	212.8	3157.5	0.0
3157.5	0.0	1393.1	0.0	2208.0	29.7	2312.8	-0.0
2312.8	0.0	4573.6	0.0	3936.4	157.4	2792.6	0.0
2792.6	0.0	6108.5	0.0	5568.4	234.9	3097.8	-0.0
3097.8	0.0	16593.9	0.0	7045.2	7679.7	4966.7	0.0
4966.7	0.0	18102.6	0.0	9148.5	8877.4	5043.4	0.0
5043.4	0.0	18862.6	0.0	9771.8	9079.3	5054.8	-0.0
5054.8	0.0	18996.1	0.0	8233.9	10676.6	5140.3	0.0
5140.3	0.0	16781.2	0.0	6380.3	10413.8	5127.5	-0.0
5127.5	-330.0	13379.1	0.0	4362.0	8992.0	4822.6	-0.0
4822.6	0.0	792.8	0.0	2122.4	221.4	3271.5	0.0
3271.5	0.0	1341.4	0.0	1418.8	151.9	3042.2	0.0

Unsaturated Zone Budget

IWFM (v2015.0.0432)
UNSATURATED ZONE BUDGET IN ac.ft. FOR DSA 58 (SR1)
SUBREGION AREA: 328274.82 ac.

Time	Beginning Storage (+)	Ending Storage (-)	Deep Percolation (+)	Net Deep Percolation (-)	Discrepancy (=)
10/31/1972 24:00	1675643.1	1674883.5	127.9	887.5	-0.0

Groundwater Budget

IWFM (v2015.0.0432
GROUNDWATER BUDGET IN ac.ft. FO
SUBREGION AREA: 328274.

Beginning Storage (+)	Ending Storage (-)	Net Deep Percolation (+)	Gain from Stream (+)	Recharge (+)	Gain from Lake (+)	Boundary Inflow (+)
43656040.5	44311782.6	887.5	-31706.3	217.9	0.0	709109.3

Stream Flow Budget

IWFM STREAM PACKAGE (v4.0.0075)
STREAM FLOW BUDGET IN ac.ft. FOR REACH 1

Tributary Inflow (+)	Tile Drain (+)	Runoff (+)	Return Flow (+)	Gain from Groundwater (+)	Gain from Lake (+)	Riparian ET (-)
45313.4	0.0	2457.4	6687.3	-10494.1	0.0	0.0