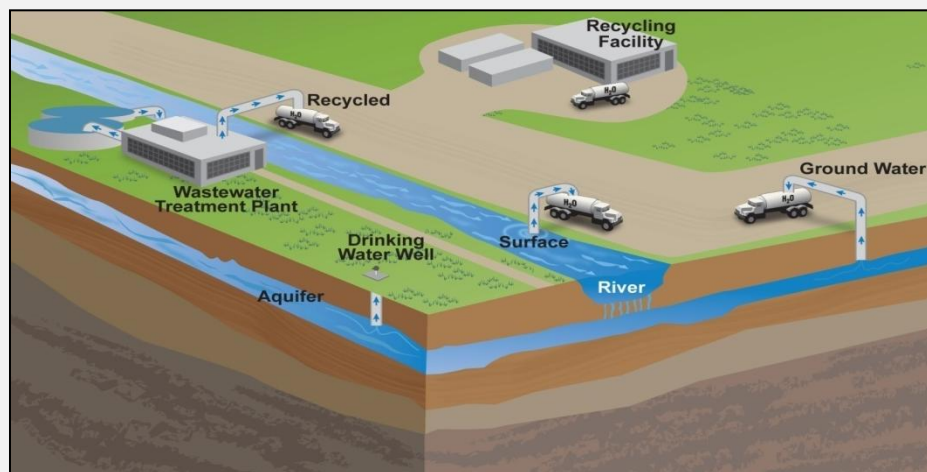


Evaluating Scenarios of Potential Impact of Water Acquisition

*Technical Workshop Series:
Water Acquisition Modeling: Assessing Impacts Through
Modeling and Other Means*



Stephen R. Kraemer
EPA-Arlington, VA • June 4, 2013

EPA Hydraulic Fracturing Study – research questions

Chemical Mixing

Well Injection

Produced Water

Waste and Wastewater

Water Acquisition

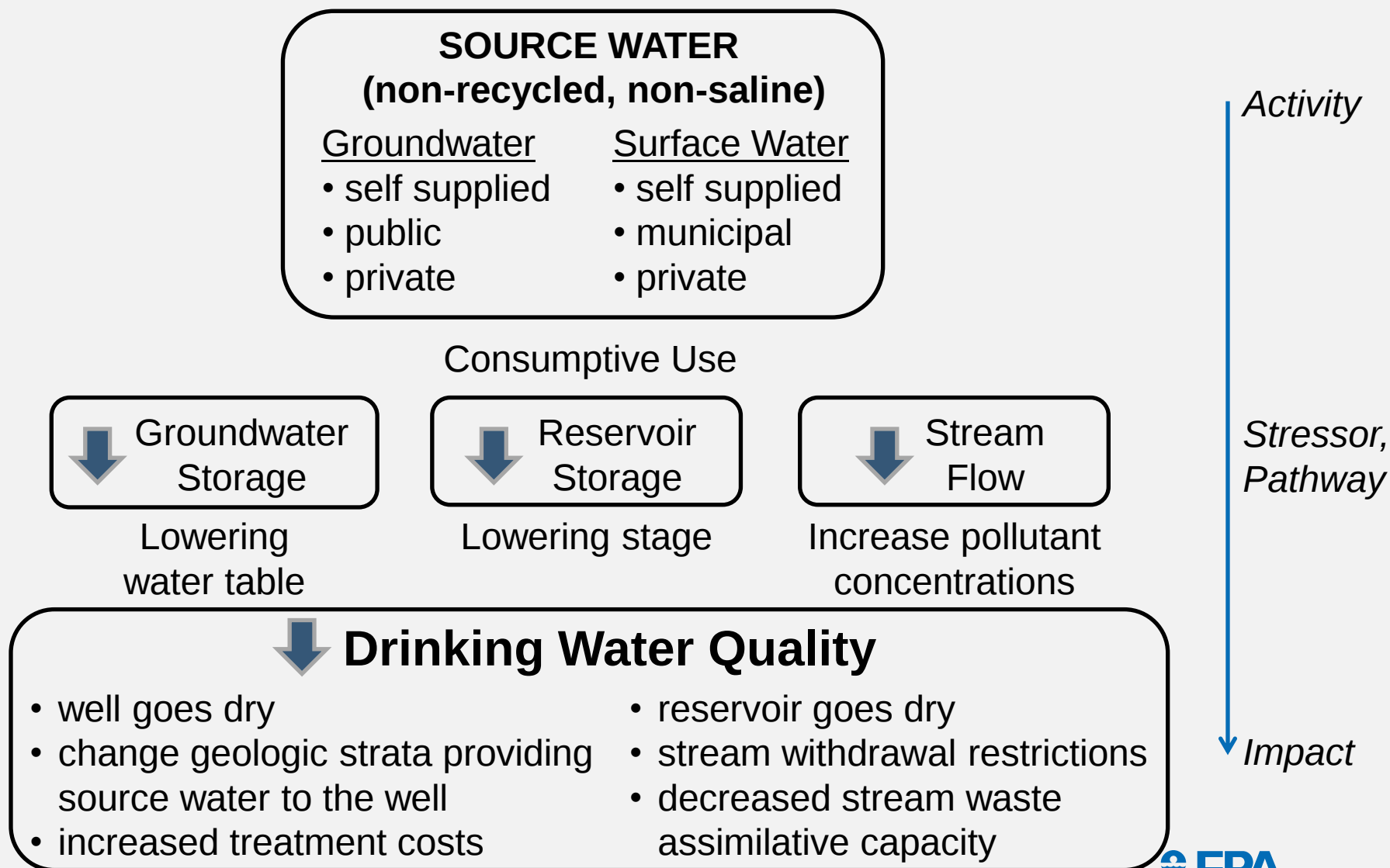
What are the possible impacts of large water withdrawals from ground and surface waters on drinking water resources?

How much water is used in hydraulic fracturing operations, and what are the sources of this water?

How might water withdrawals affect short- and long-term water availability in an area with hydraulic fracturing activity?

What are the possible impacts of water withdrawals for hydraulic fracturing operations on local water quality?

Activity – Stressor/Pathway – Impact



Water Availability Modeling

OBJECTIVE:

to evaluate possible impacts of large-volume consumptive water withdrawals supporting hydraulic fracturing in comparison to water availability in representative basins under hypothetical yet possible future scenarios.

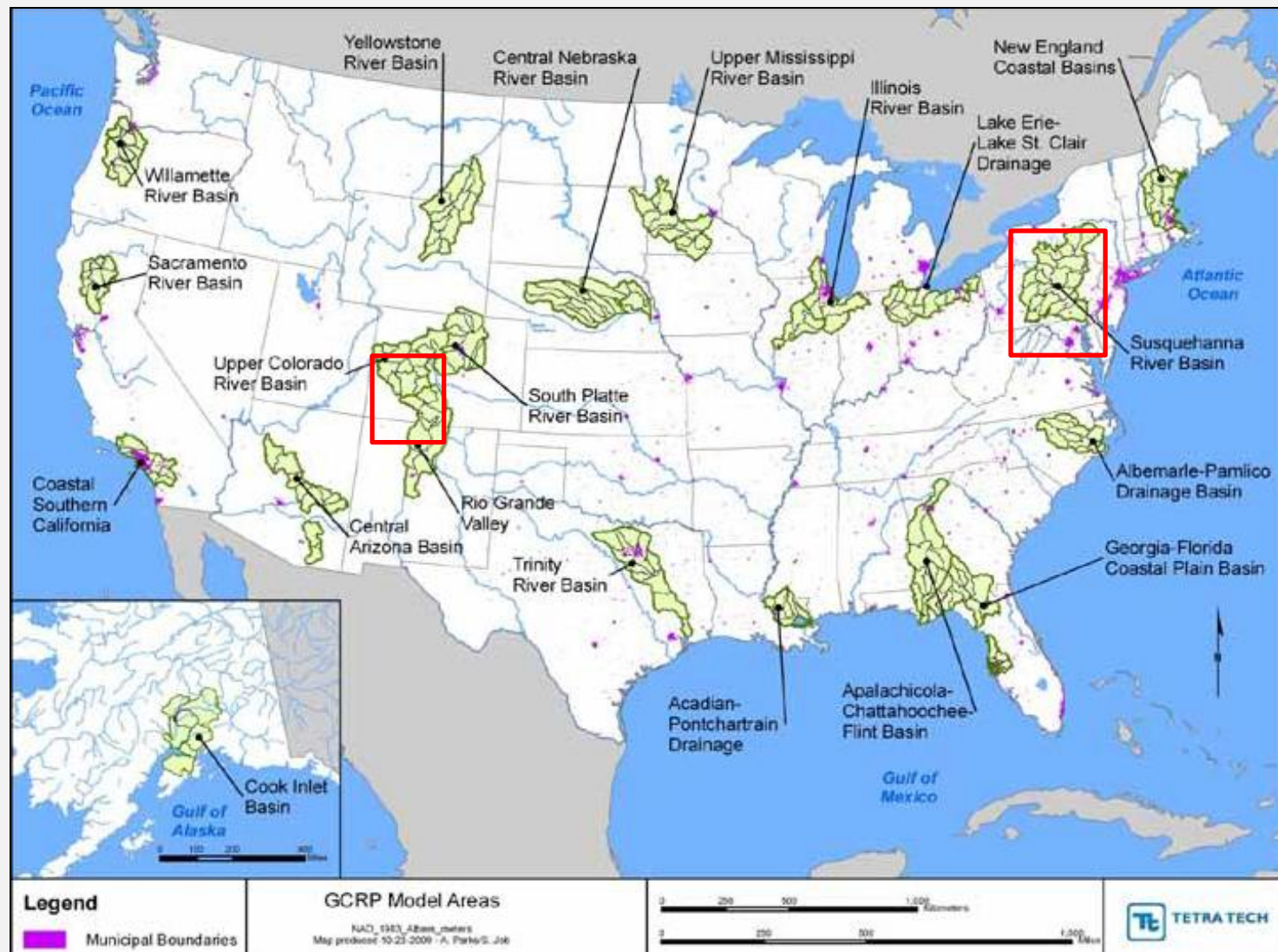
APPROACH:

1. Select representative watersheds.
2. Establish baseline hydrological conditions.
3. Modify baselines to include recent water withdrawals including hydraulic fracturing.
4. Design future scenarios.
5. Run the simulations.
6. Investigate impact.

Watershed Selection ...



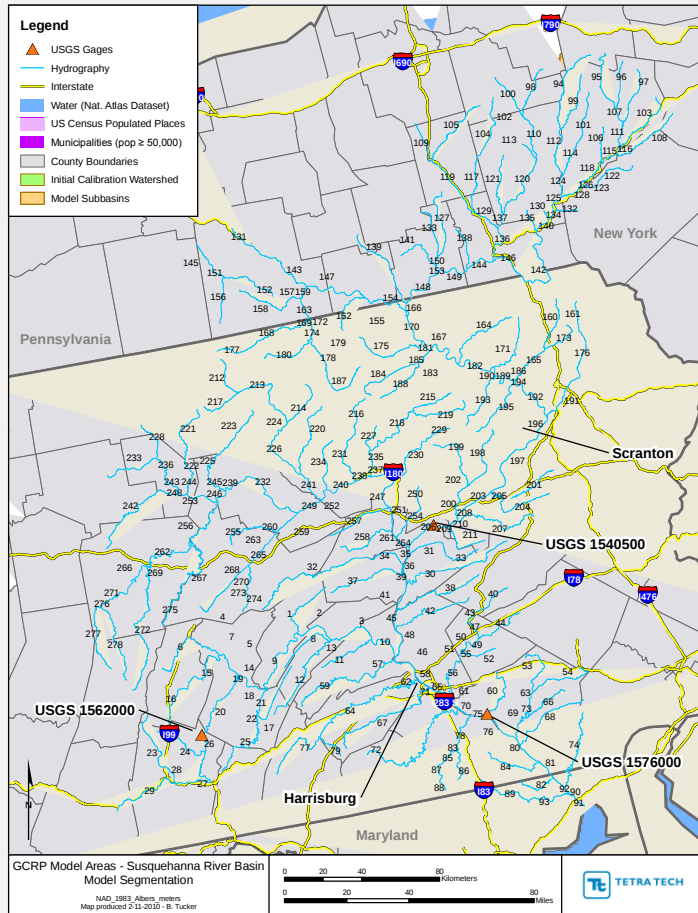
... Watershed Selection



Watershed Models: spatial structure/segmentation

EPA HSPF

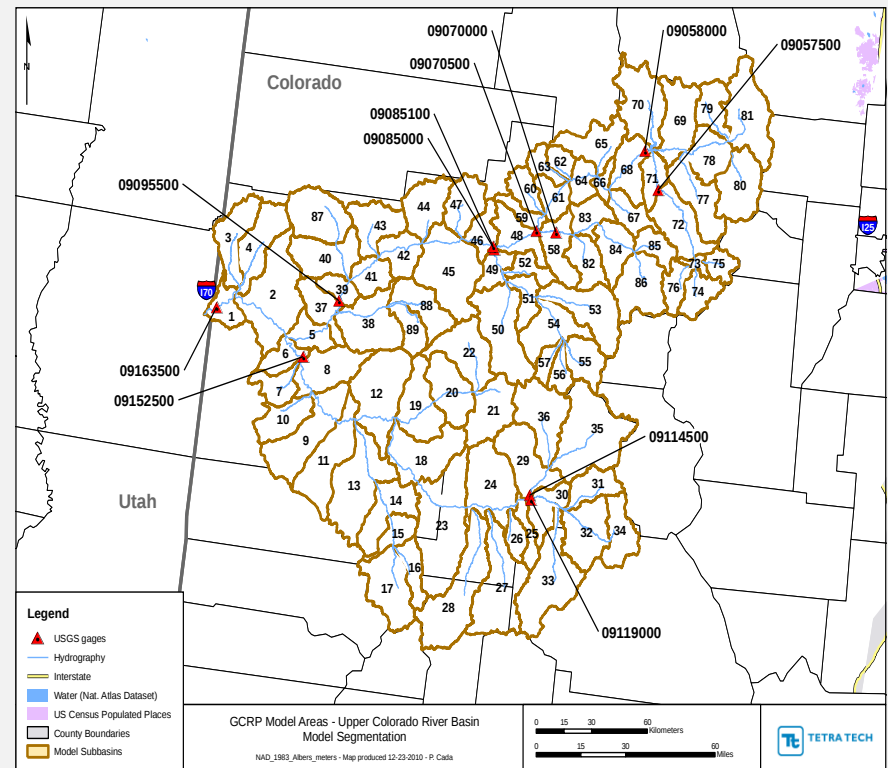
(hydrological simulation program fortran)



Susquehanna (27,0000 sq mi)

USDA SWAT

(soil water assessment tool)



Upper Colorado (17,800 sq. mi.)

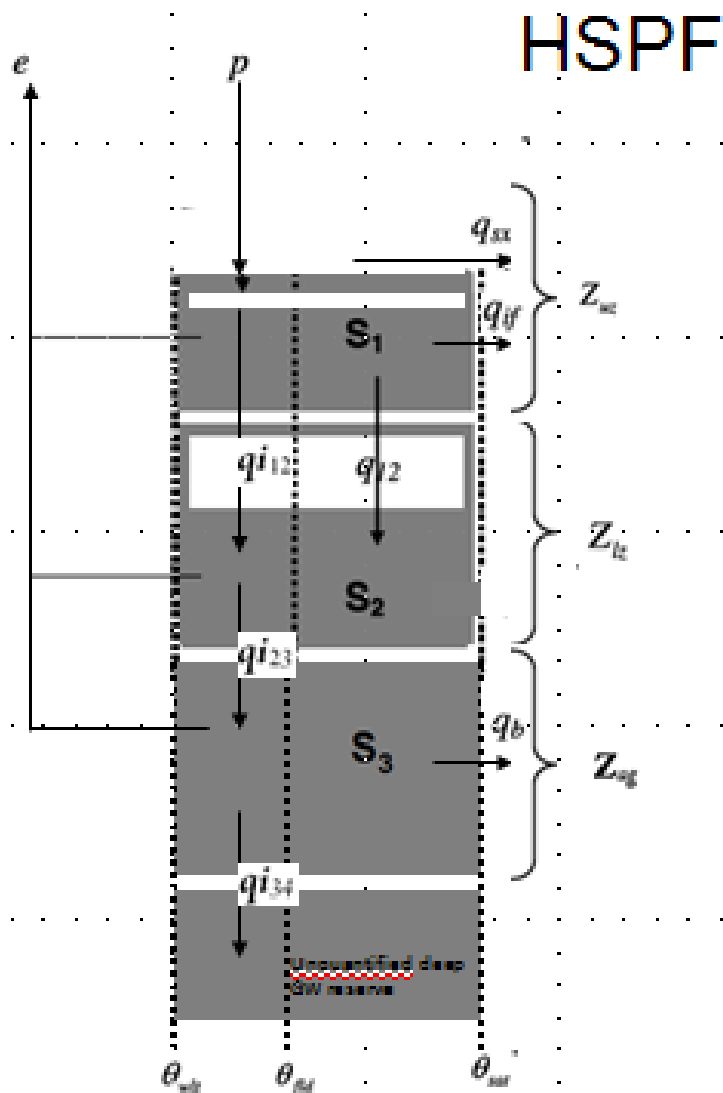
Basin, Sub-basins

Hydrological Response Units

(unique combination of land use, soil, slope)

River segments

Model Structures – *fill and spill*



- e = evaporation
- p = precipitation
- q_{sx} = surface runoff
- q_{if} = interflow
- q_b = base flow
- q_{i2} = percolation to lower zone
- q_{i12} = infiltration to lower zone
- q_{i23} = infiltration to active GW
- q_{i34} = infiltration to deep GW
- S_1 = total water content in upper layer
- S_2 = total water content in lower layer
- S_3 = water content in active GW
- Z_{uc} = depth of upper layer
- Z_{la} = depth of active GW layer
- Z_{ag} = depth of lower layer
- θ_{wilt} = soil moisture at wilting point
- θ_{fld} = soil moisture at field capacity
- θ_{sat} = soil moisture at saturation

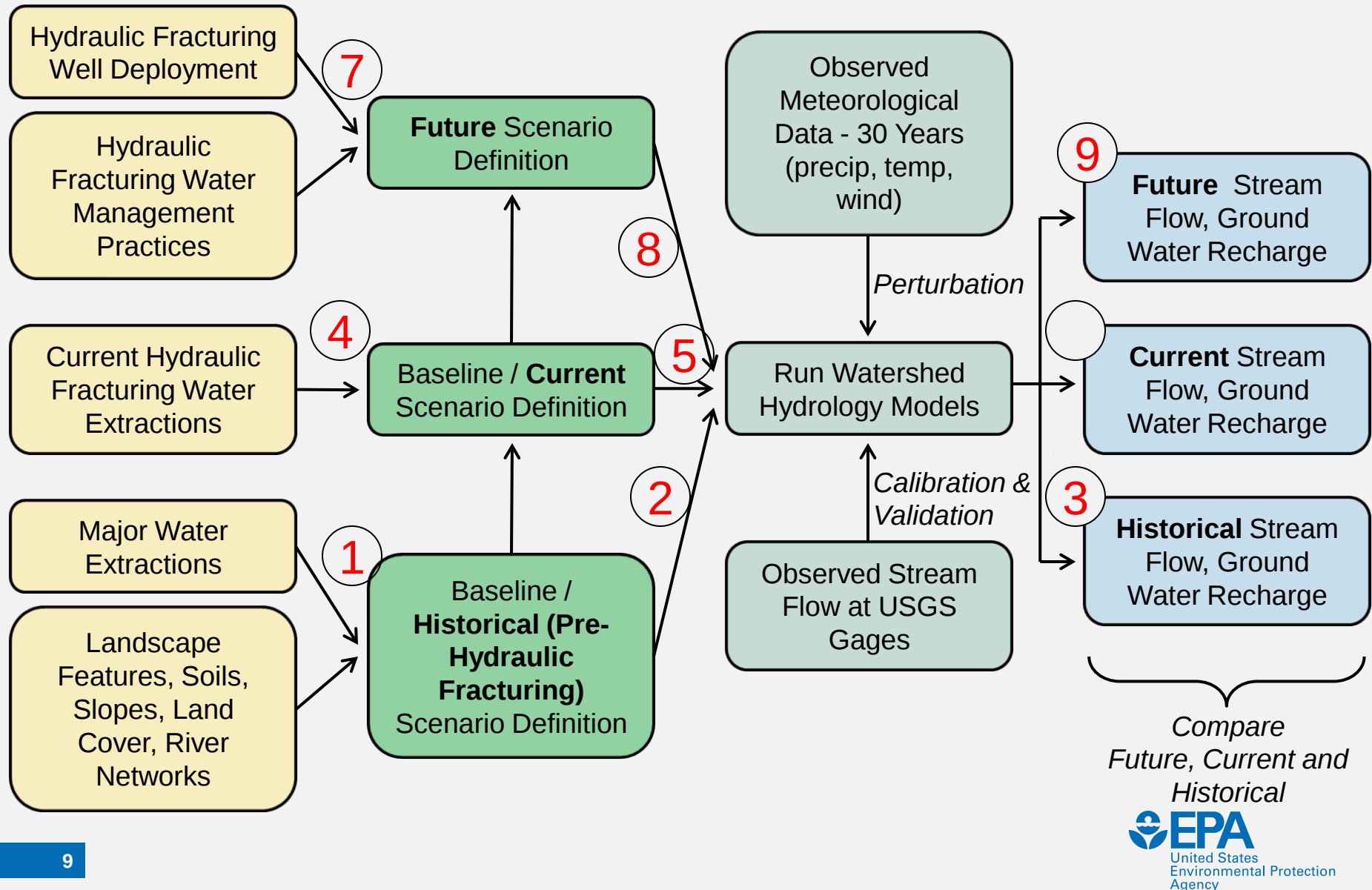
after (Clark et al., 2008)

Future Scenarios: Model Assumptions

MODEL ASSUMPTIONS	FUTURE SCENARIOS		
	Business as Usual	Energy Plus	Recycling Plus
Projected number of wells (peak yr)	Average projected*	High-end projected*	Average projected*
Projected water use per well	Average observed	Average observed	Lower observed**

* Based on US Energy Information Administration and US Geological Survey projections

Critical Path for Modeling Approach



Science Advisory Board Meeting (5/7/13)

Selected Comments from Panelists

Several panelists suggested broadening the scale of the assessments and increasing granularity.

Specifically:

- hierarchical spatial scales - zero order (ephemeral), 1st order (perennial), 2nd order, 3rd order streams, etc. and the associated catchments
- temporal scale - annual, seasonal, monthly, daily water balances

Session 2 Presentations

- **EPA Scenario Modeling Water Availability** *Steve Kraemer, US EPA*
- **Mapping Water Availability and Cost in the Western United States**
Vincent Tidwell, Sandia National Laboratory
- **Integrated, Collaborative Water Research in Western Canada**
Ben Kerr, Foundry Spatial Ltd
- **Water Need and Availability for Hydraulic Fracturing in the Bakken Formation, Eastern Montana** *Mitch Plummer, Idaho National Laboratory*

Session 2

Discussion Questions

- What would a more generalized, conceptual model look like for assessing hydraulic fracturing impacts in different areas of the US and at different scales?
- What factors should be included in a generalized model?