

U.S.-German Bilateral Workshop
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Systems Approach to Sustainability at U.S. EPA

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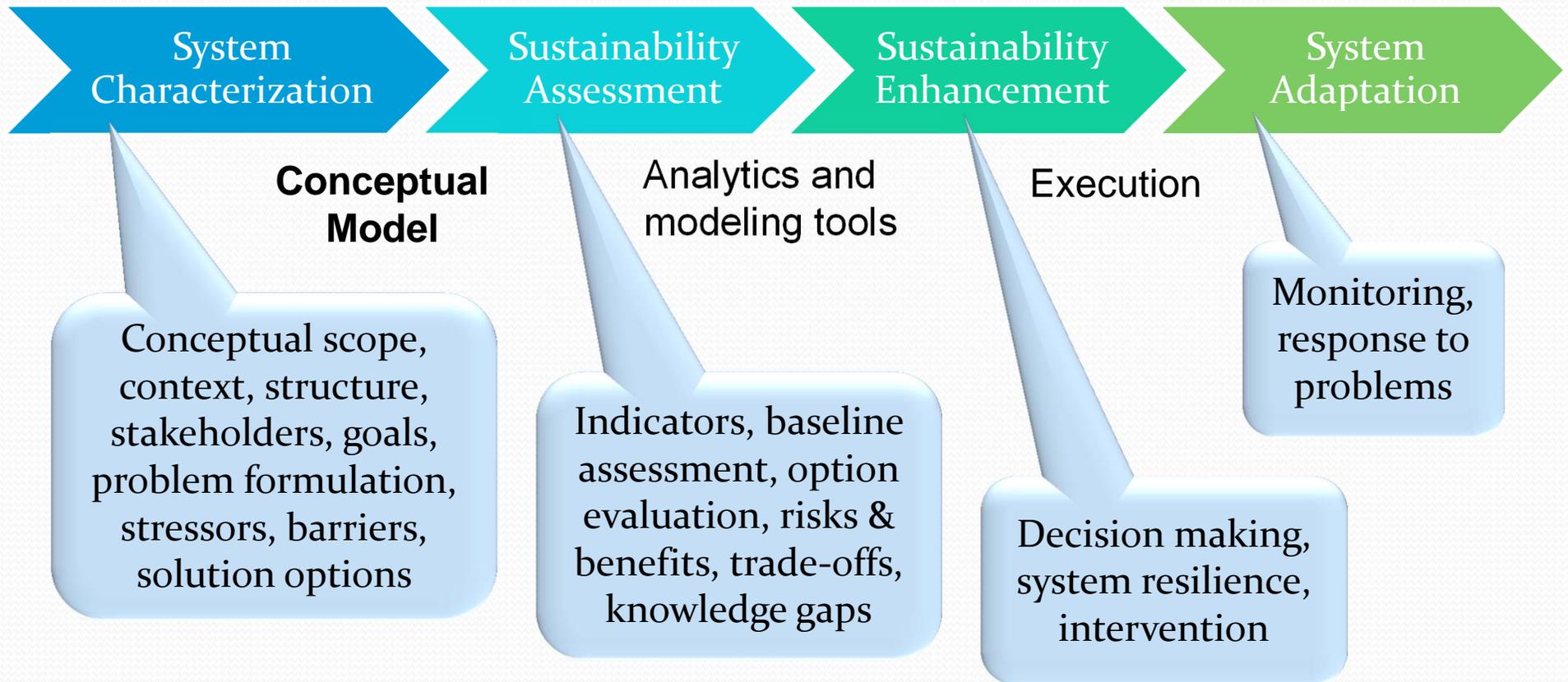


Systems Thinking Approach

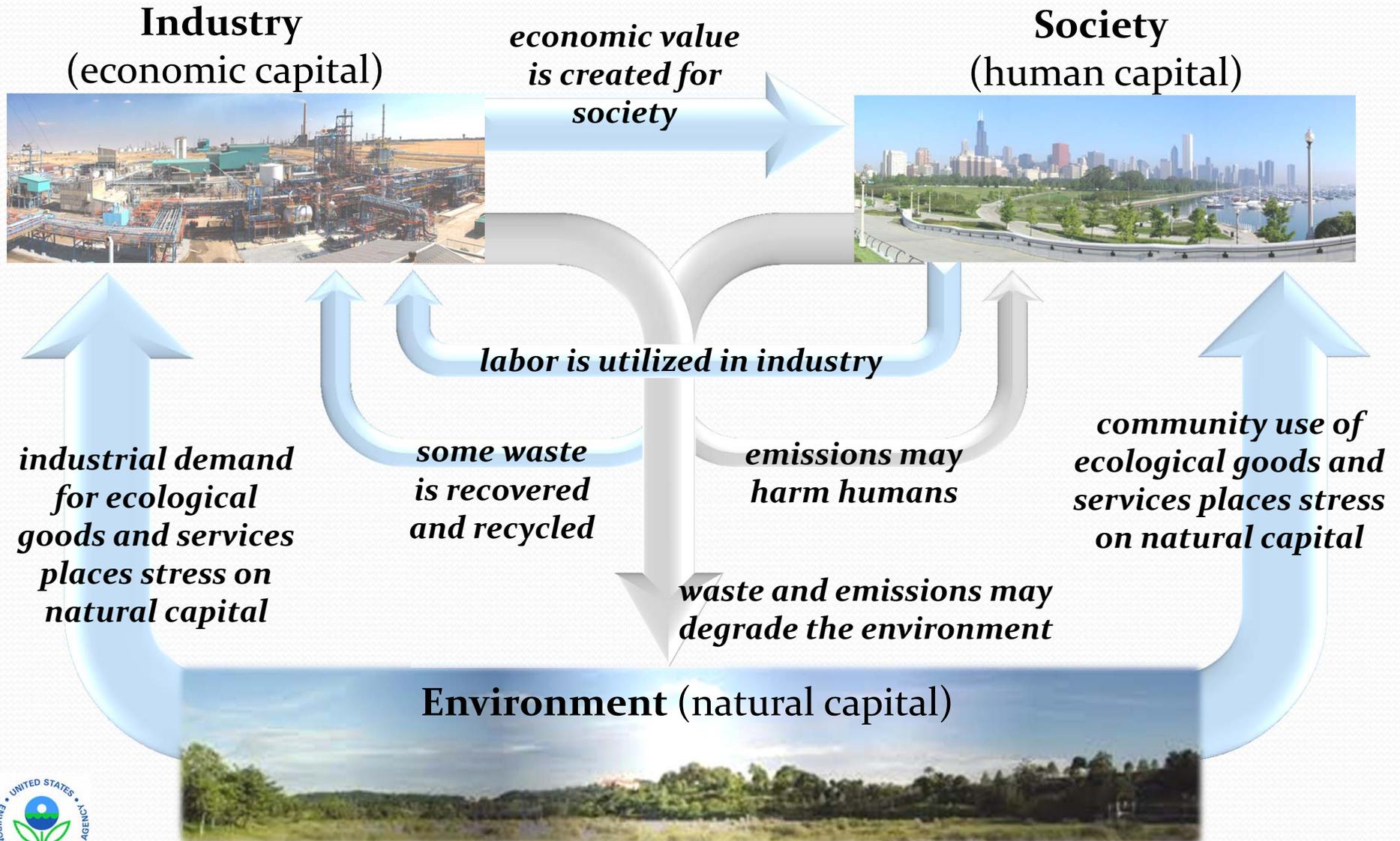
- Adopt a broad view of sustainability issues associated with various resource life cycles
- Identify key indicators of the health and resilience of resources, both natural and managed
- Characterize the important drivers of change, potential problems, and alternative solutions
- Identify critical knowledge gaps and potential research opportunities or external sources
- Use integrated modeling methods to leverage existing knowledge within a systems framework
- Exercise the models on behalf of EPA stakeholders to support policy and decision making



Sustainability Realization Process

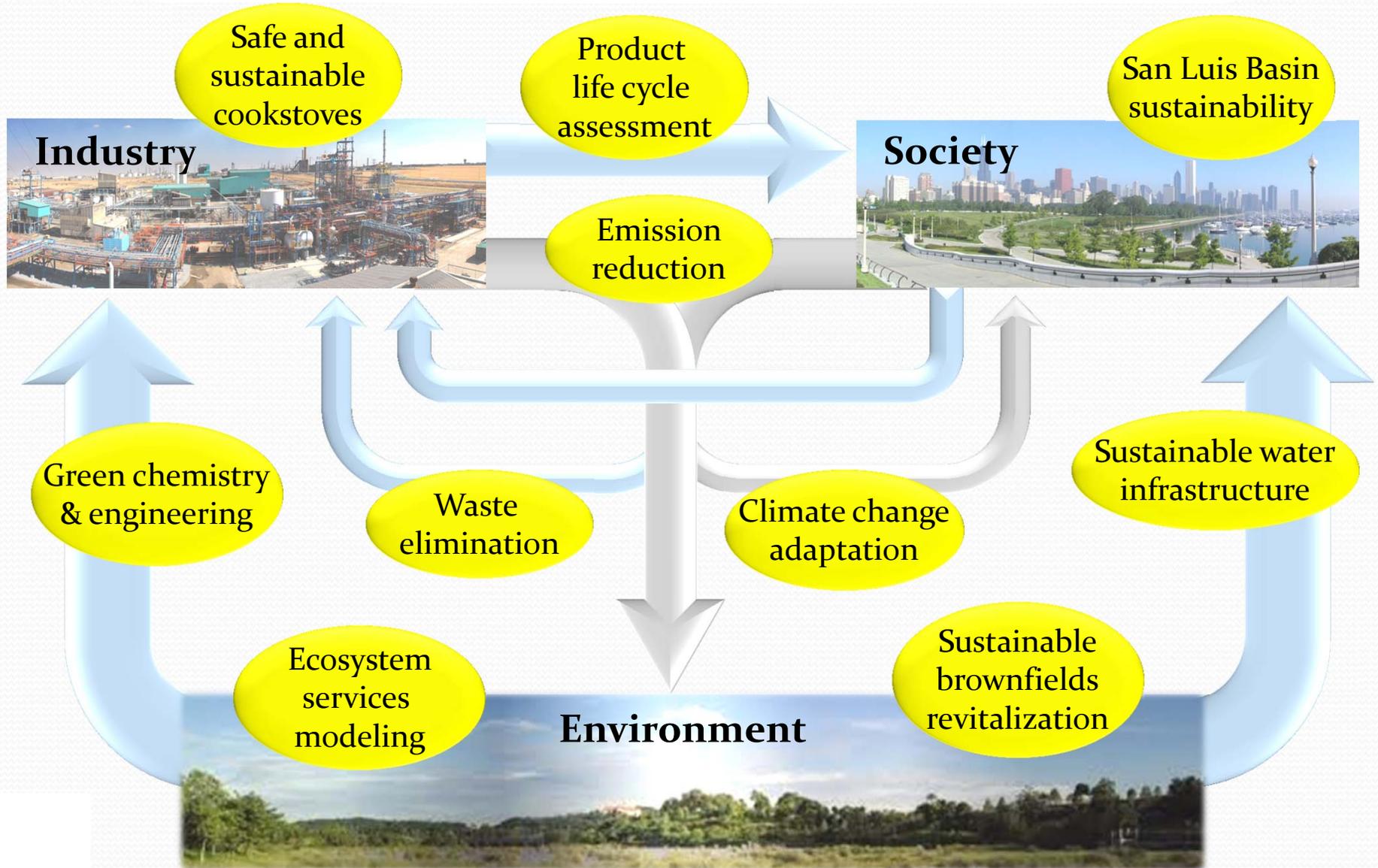


Fundamental Conceptual Model

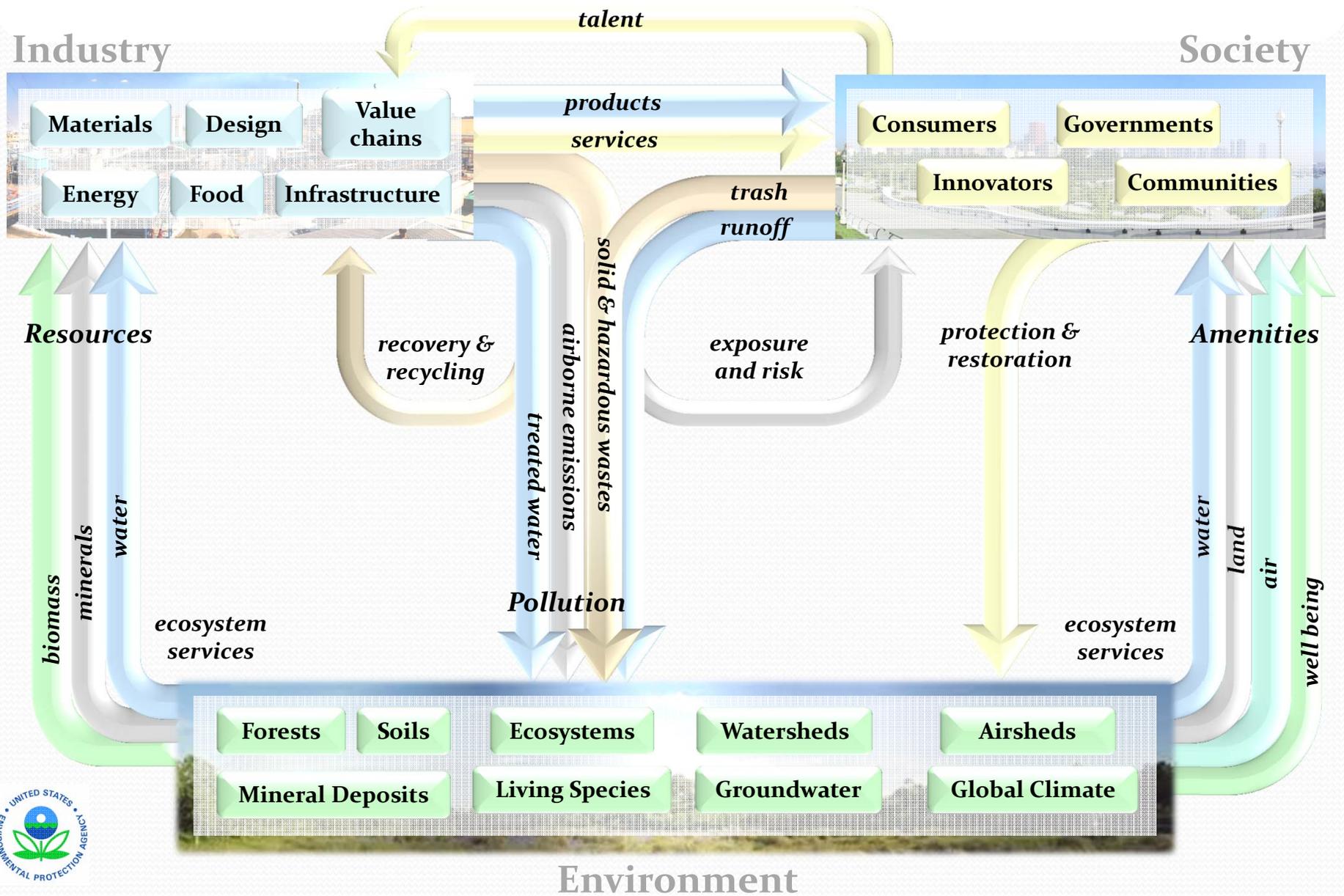


Adapted from: J. Fiksel, A Framework for Sustainable Materials Management, *Journal of Materials*, August 2006.

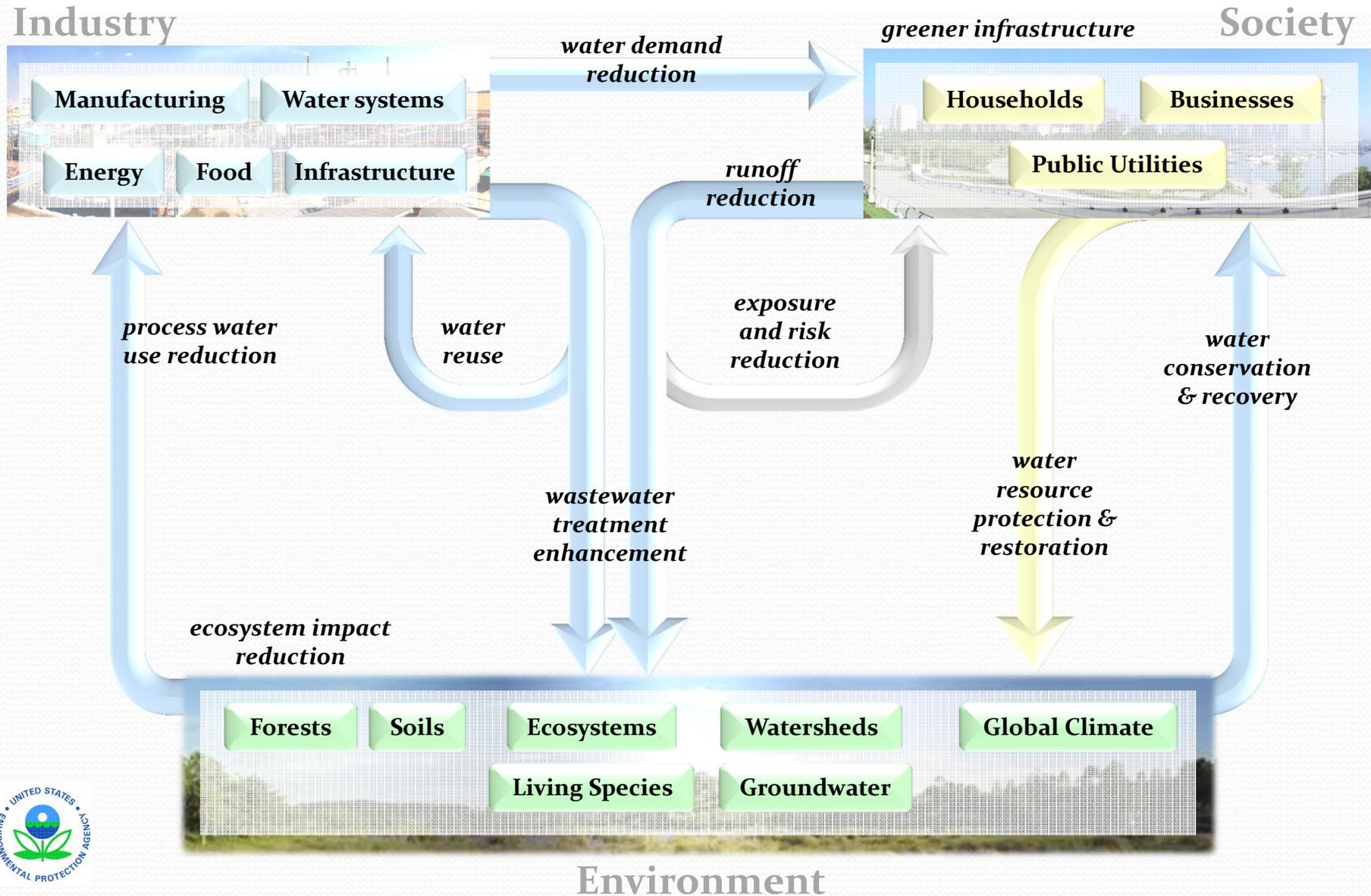
Examples of NRMRL Contributions



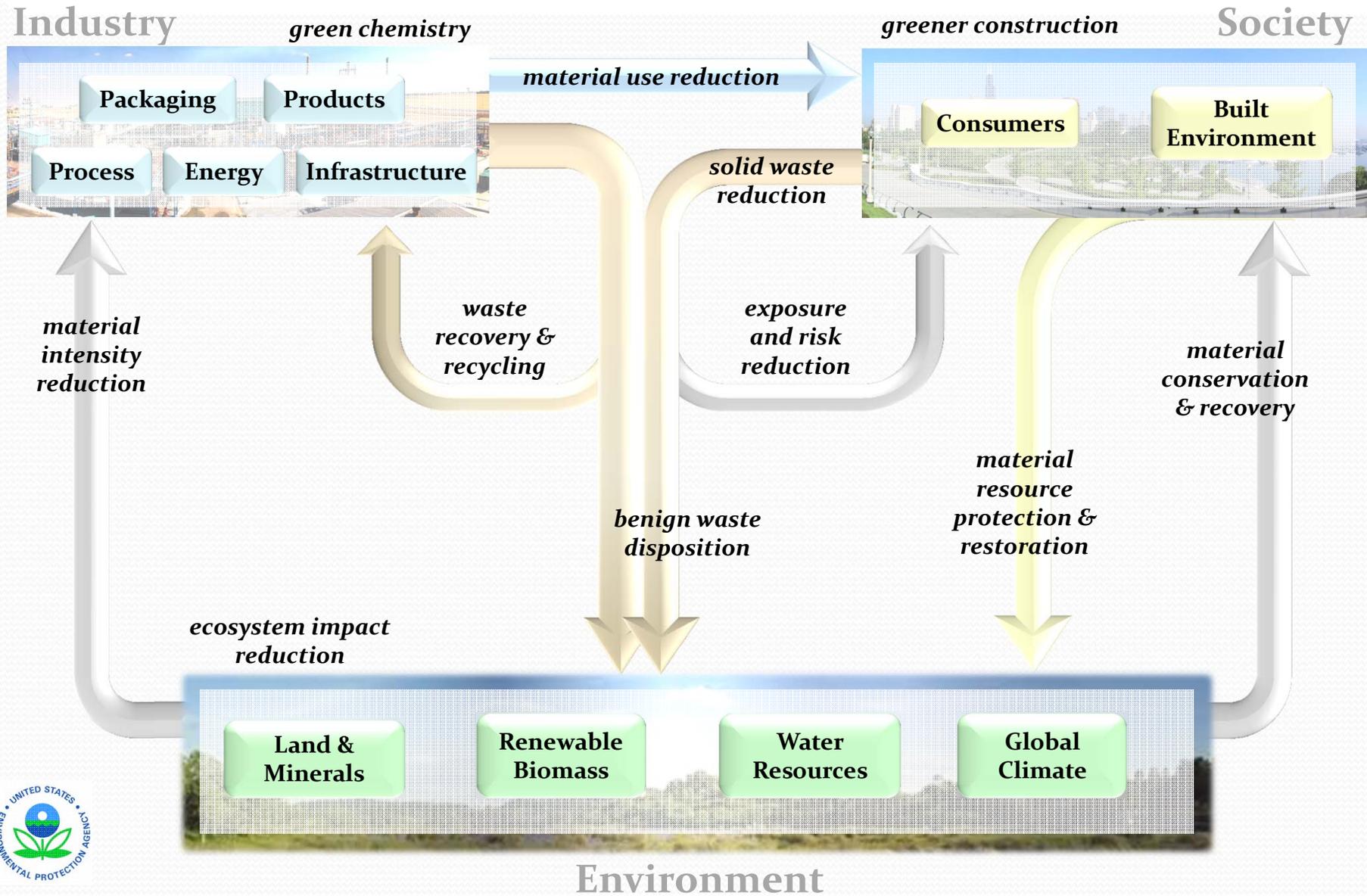
System Dynamics—Capital Stocks & Resource Flows



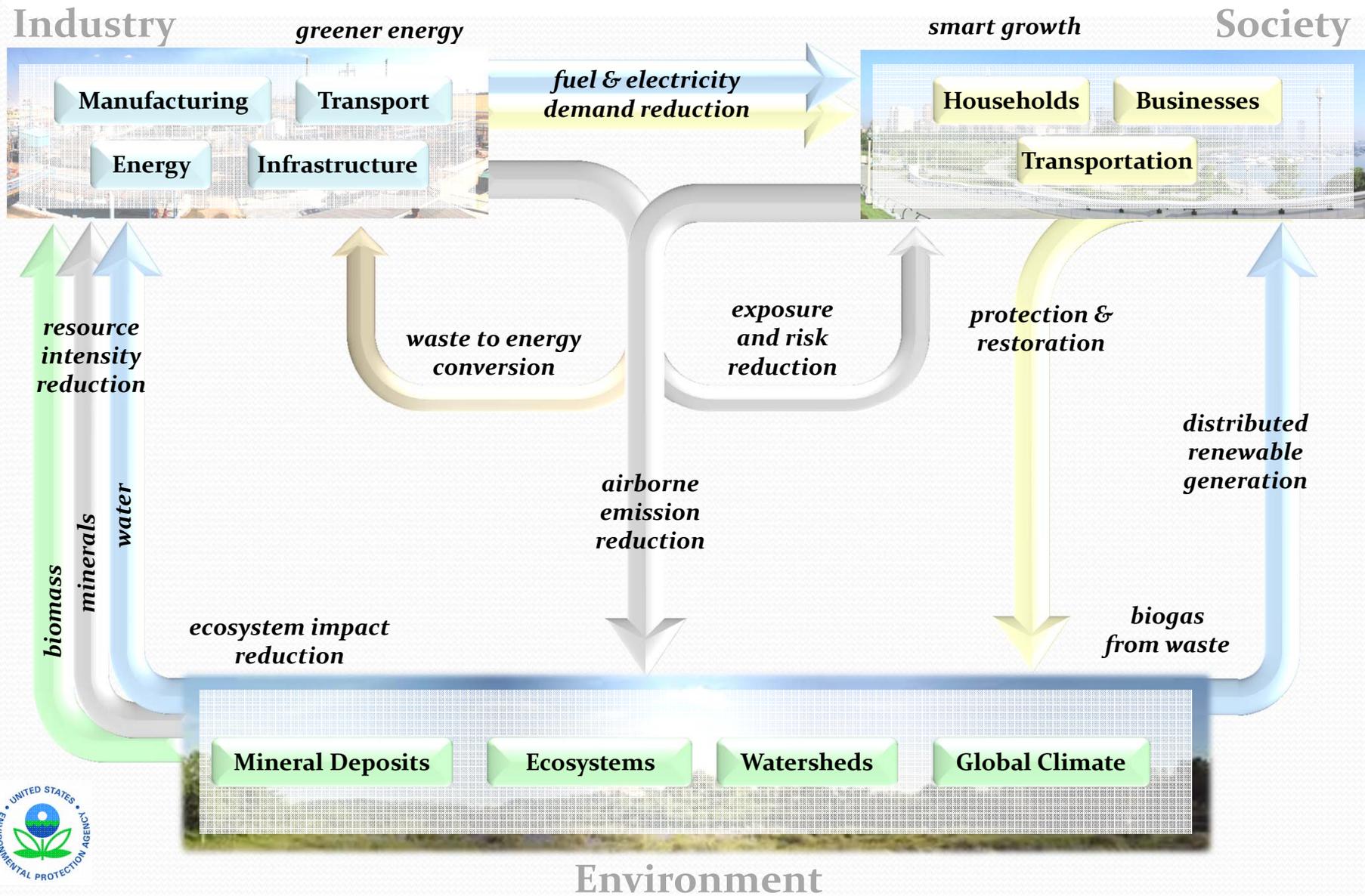
System Dynamics—Water Life Cycle



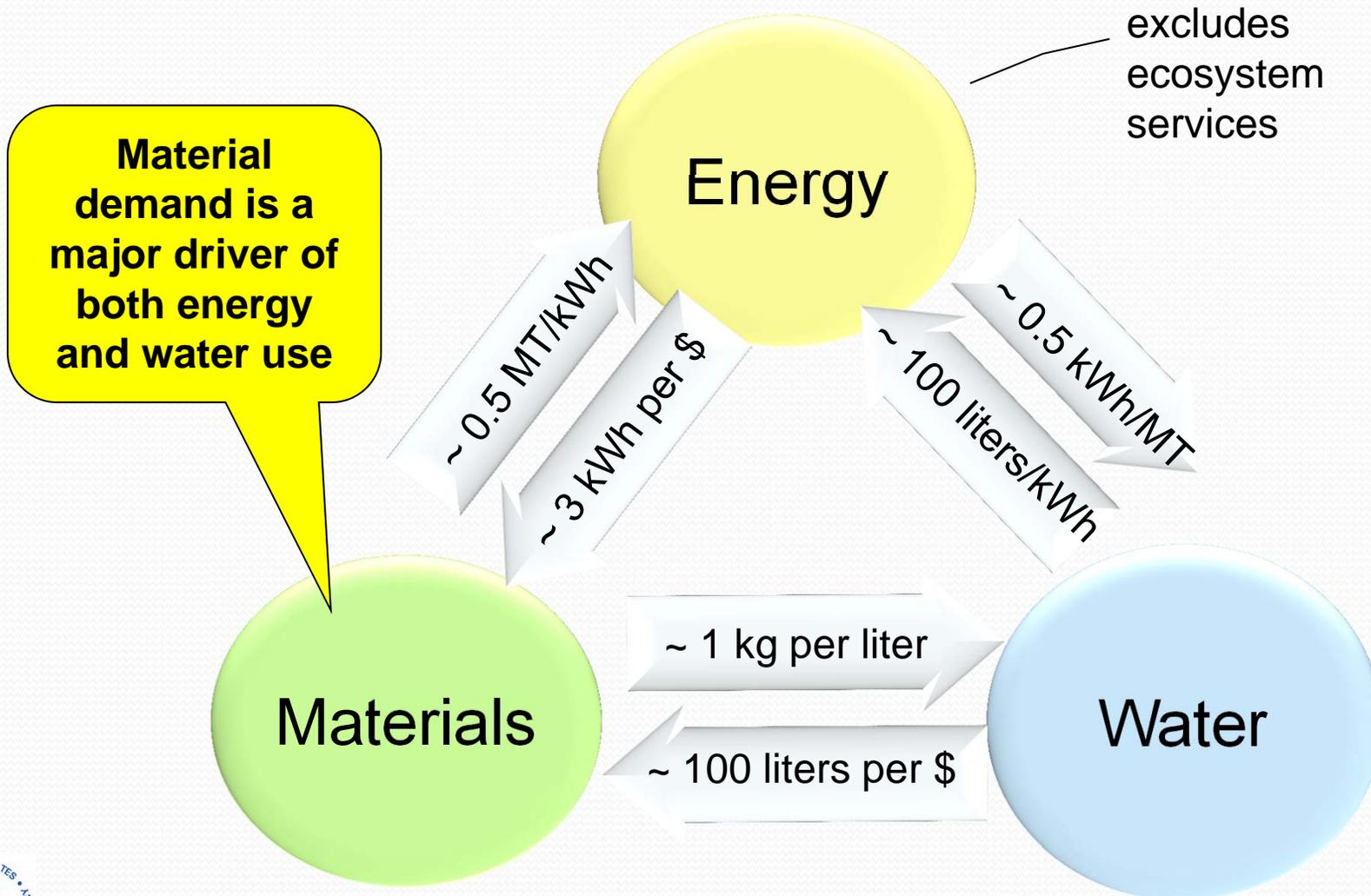
System Dynamics—Material Life Cycle



System Dynamics—Energy Life Cycle



The Material-Energy-Water Nexus



Source: J. Fiksel, "Evaluating Supply Chain Sustainability,"
Chemical Engineering Progress, May 2010.

Science & Policy Questions

- What are the interdependencies among resource flows in the materials/energy/water nexus?
- How might future trends in the fundamental drivers (e.g., economic growth, lifestyle changes) influence potential human and environmental impacts?
- How can we measure natural capital capacity and resource pressures at different geographic scales?
- What are the critical tensions between fulfillment of human needs and availability of resources?
- What are the benefits (and/or unintended consequences) of alternative policy or technology options?

Bridging Science and Policy

**What do we know today?
What are the unknowns?**

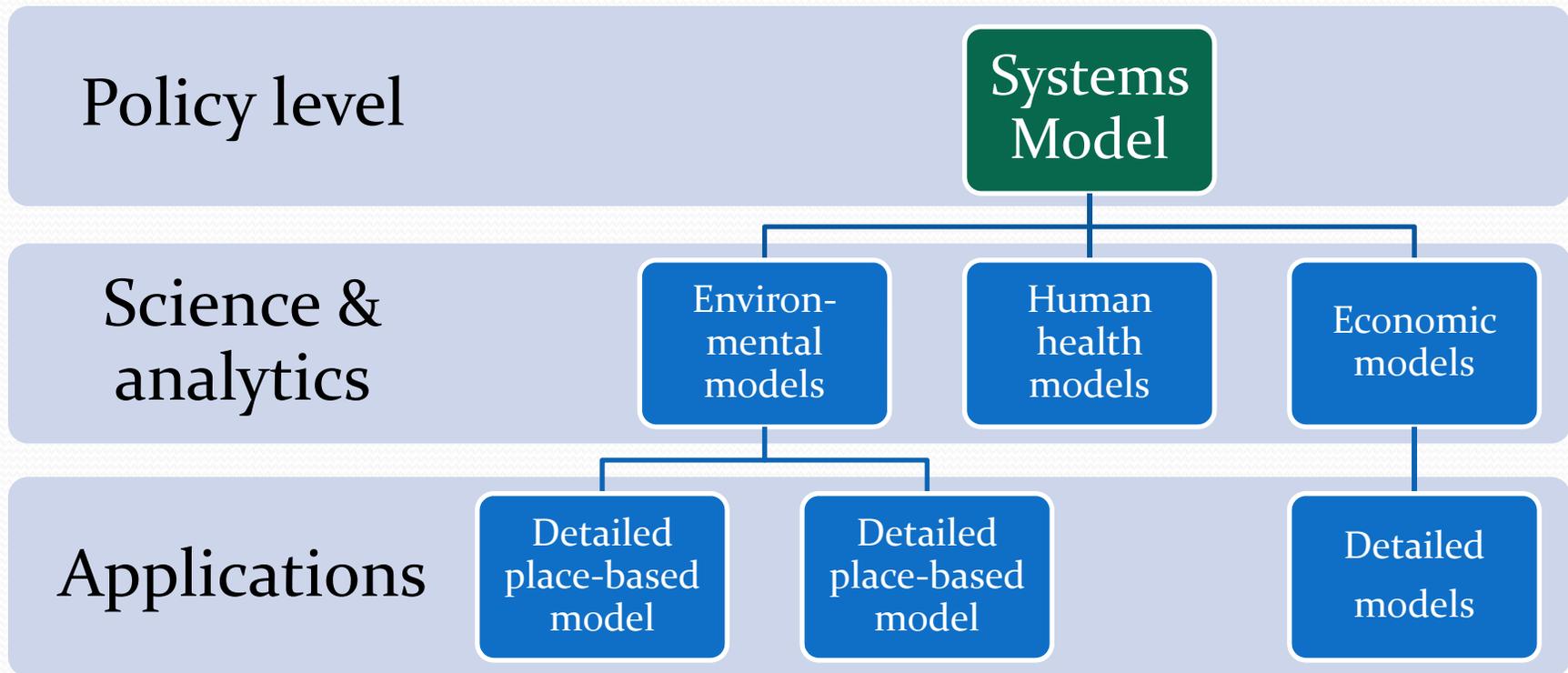
**What are our goals?
What are the options?**

**Systems
Model**

**How should we
proceed given the
uncertainties?**



Overview of Modeling Approach



There is no single model that can address all the needs of decision makers and stakeholders at multiple scales

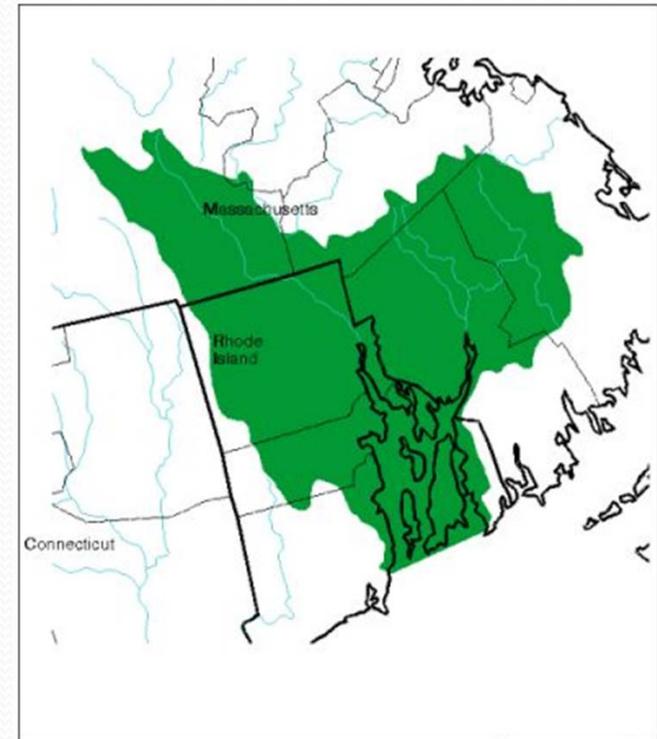
Application to Nutrient Pollution

- Concentrations of Nitrogen (N) and Phosphorus (P) in many U.S. waterways have increased greatly due to human sources, e.g., municipal wastewater treatment, agricultural & stormwater runoff, airborne emissions
- These excess nutrients result in algal blooms and degraded aquatic ecosystems, adversely impacting drinking water, fishing, recreation, and tourism
- N and P are difficult to control or remove because the sources are broadly dispersed, the environmental pathways and mechanisms are complex, and the removal technologies are costly



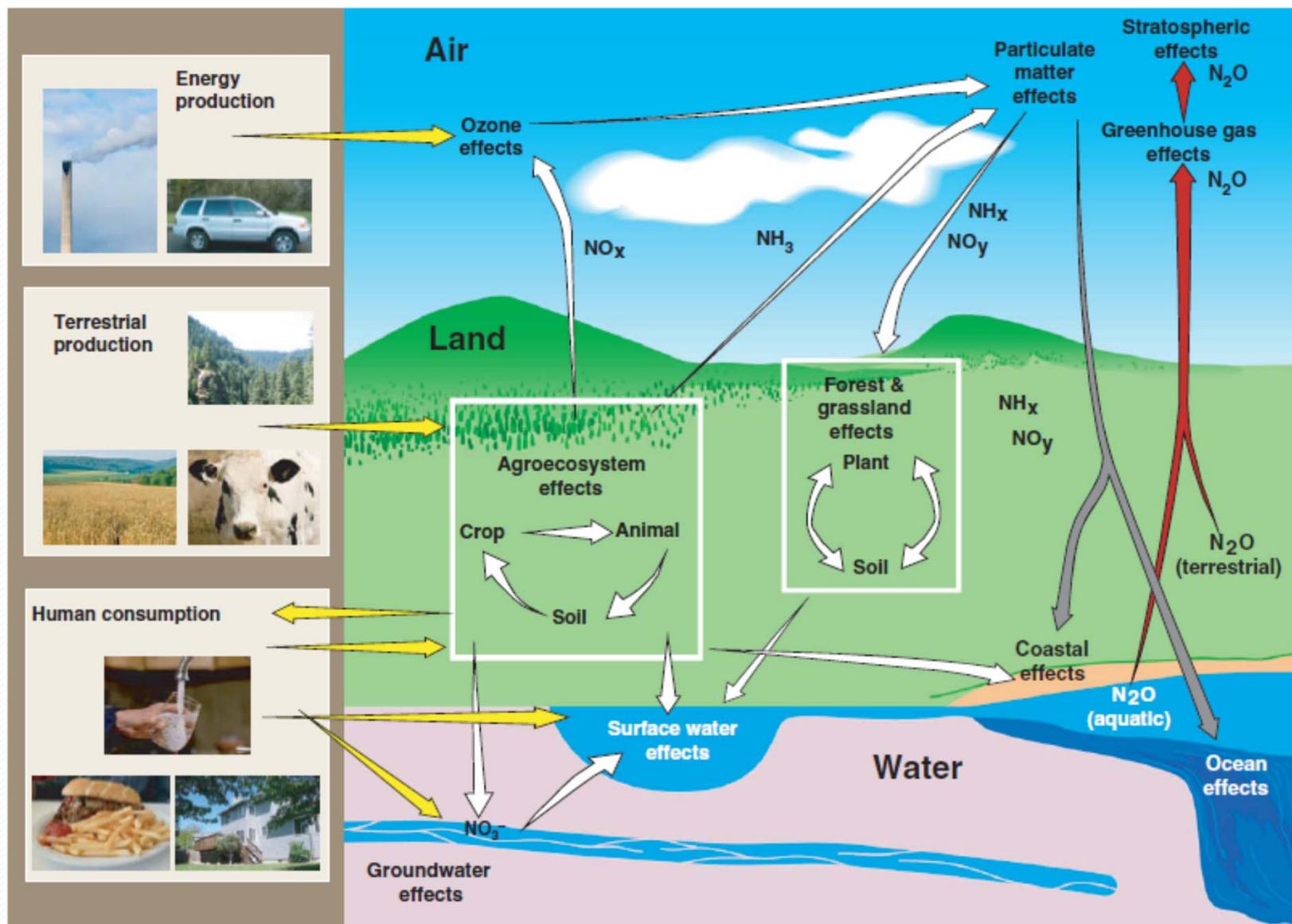
Narragansett Pilot Project

- Apply “systems thinking” to the problem of nitrogen and phosphorus pollution in New England waters
- Collaborate with stakeholders to address the full spectrum of sustainability goals
- Explore integrated strategies for nutrient mitigation
 - Regulatory influence
 - Voluntary innovation
- Provide a replicable approach for other EPA Regions



Narragansett Bay Watershed

Systems View of the Nitrogen Cycle



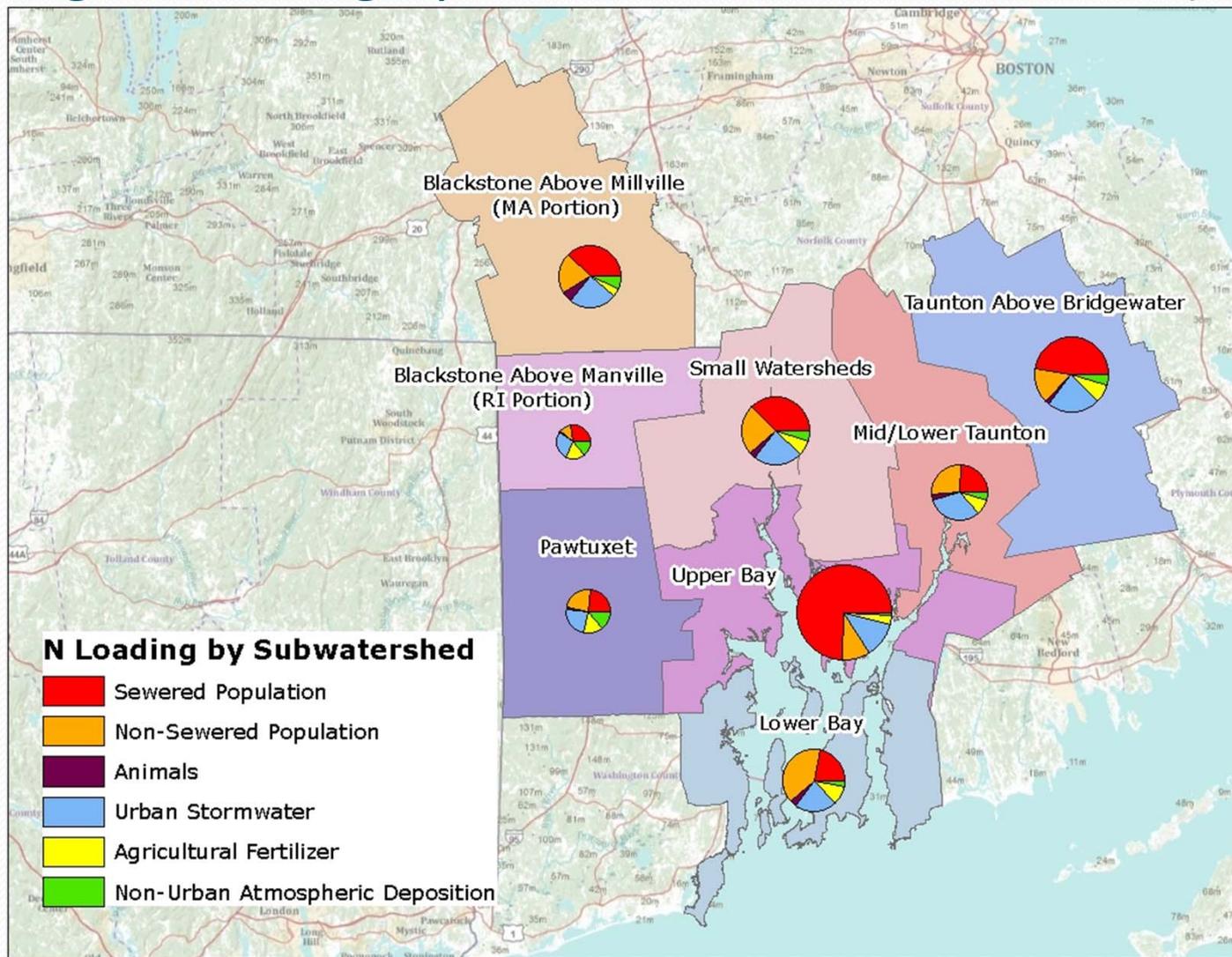
Triple Value Simulation (3VS)

- Interactive **system dynamics** model based on the **T21** platform from Millennium Institute
 - Explores how strategic options affect overall sustainability outcomes
 - Helps create portfolio of interventions to maximize stakeholder benefits
- Current status of model development
 - Phase 1 prototype completed in November 2011
 - Coarse disaggregation by subregions of the watershed
 - Extensive involvement of regional stakeholder groups
 - Phase 2 will analyze specific decision scenarios

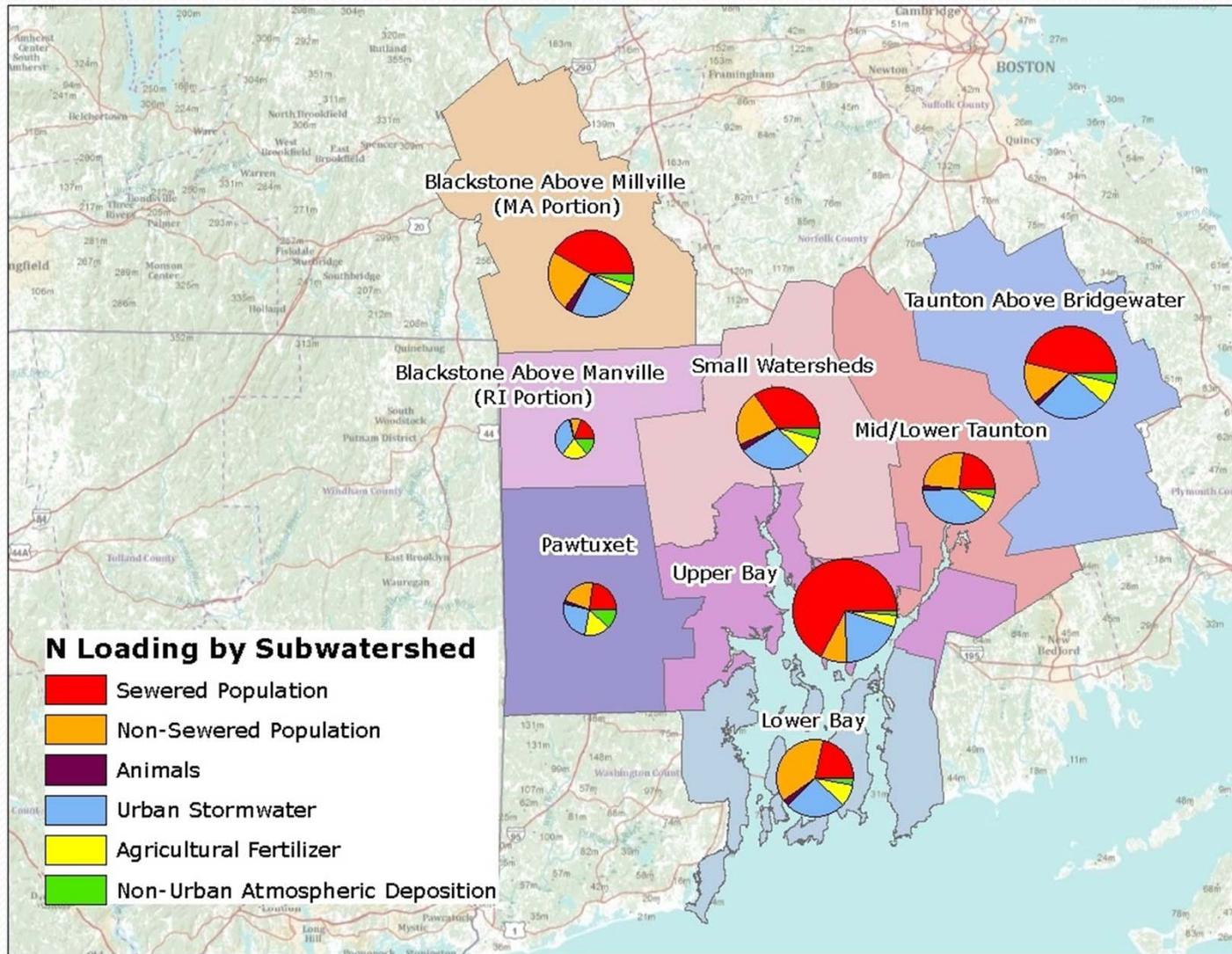


“All models are wrong, but some models are useful”

Nitrogen Loading by Source and Subwatershed (2011)



Nitrogen Loading by Source and Subwatershed (2030)

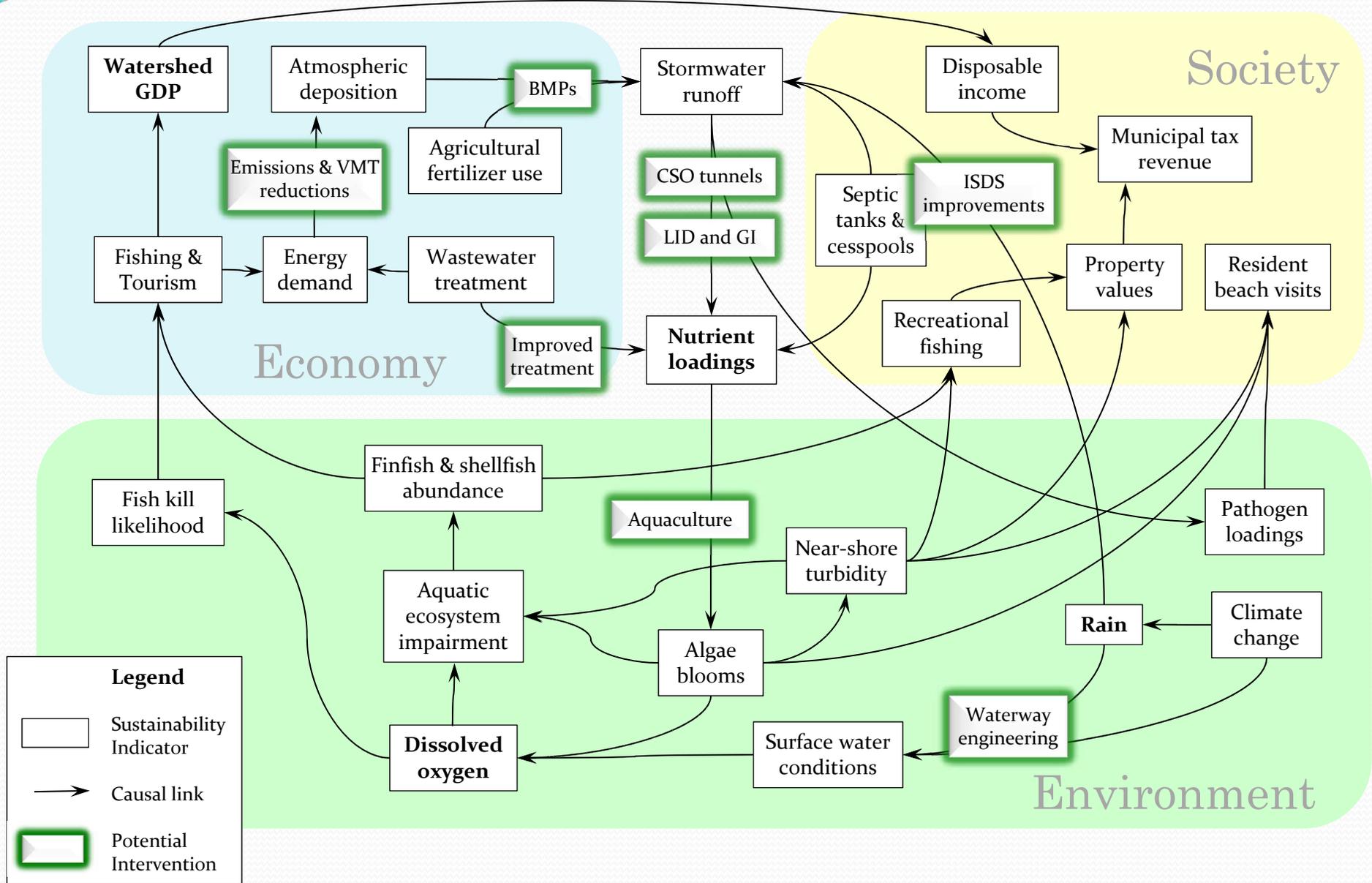


Policy Interventions Considered

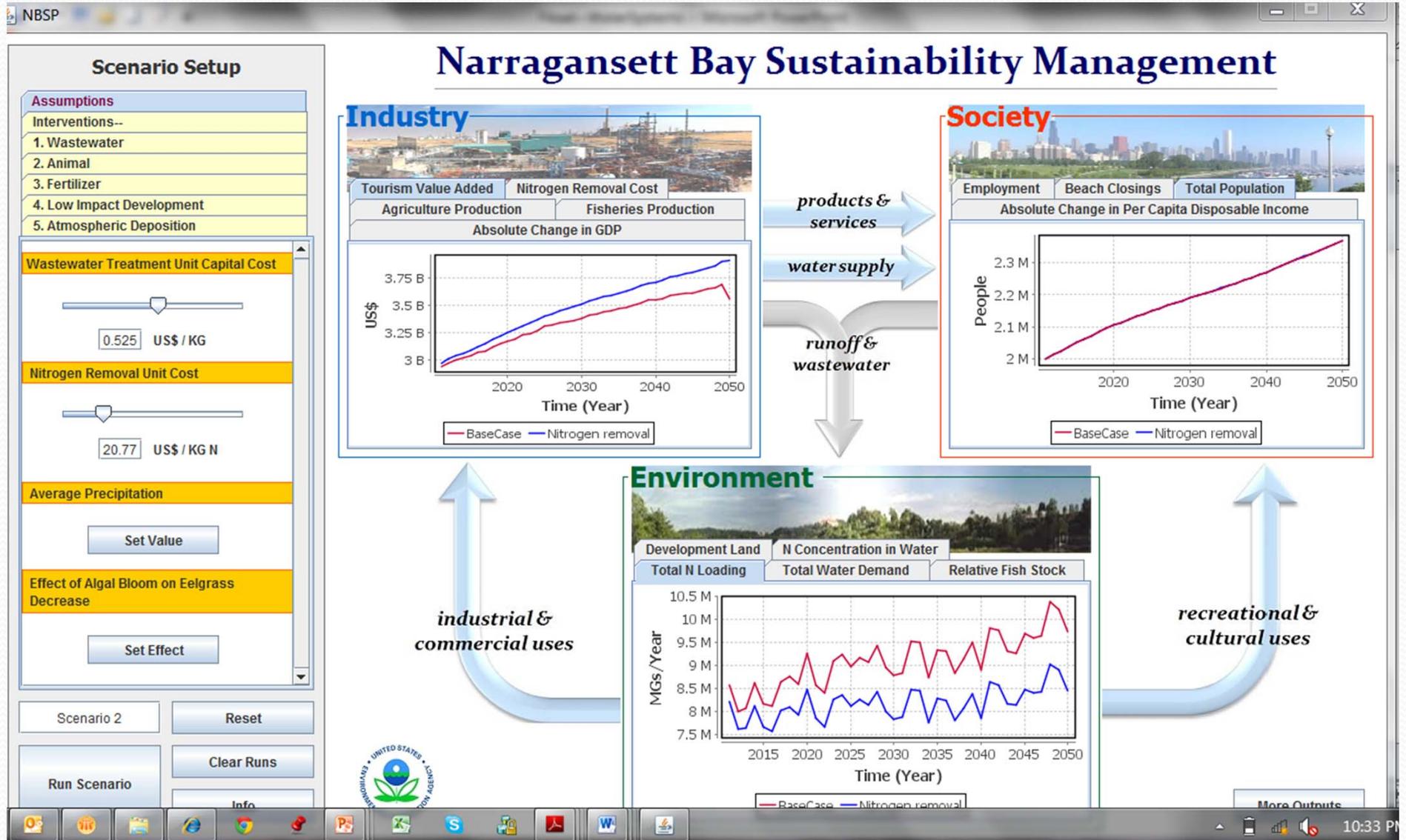
- Enforcement of MS4/Stormwater Phase II requirements
- Subsequent phases of Fields Point CSO Abatement Project and CSO projects in Falls River and Worcester
- Restoration, construction, and maintenance of wetlands, salt marshes, and riparian buffers
- Green infrastructure and low impact development (LID) practices to reduce runoff volume and pollutant loadings
- Development and implementation of sustainable land care practices through BMPs (best management practices)
- Development and enforcement of TMDLs (total maximum daily loads)
- Further upgrades to sewer infrastructure via State Revolving Funds.
- Enforcement of “no discharge” boating on the Bay
- Improvement/enforcement of NOx controls on local air pollution
- Nitrogen permit trading program for WWTFs (e.g., Long Island Sound)
- Bioharvesting of shellfish and algae



Causal Relationships in the System Model

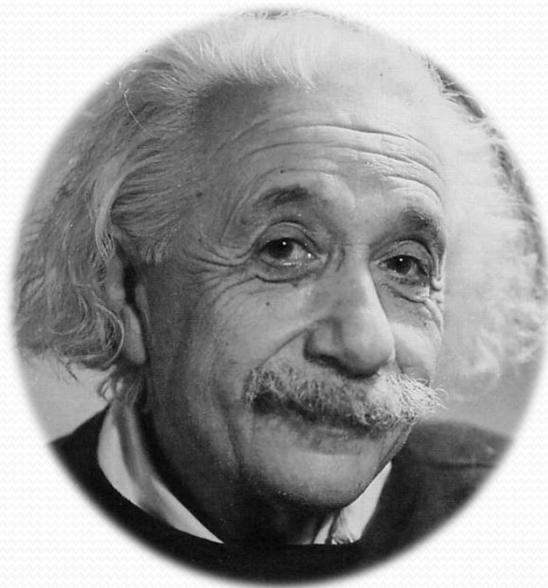


Graphical Interface



Final Thought

“We cannot solve our problems with the same thinking we used when we created them.”



Albert Einstein

1879-1955

