Sustainable Water Solutions

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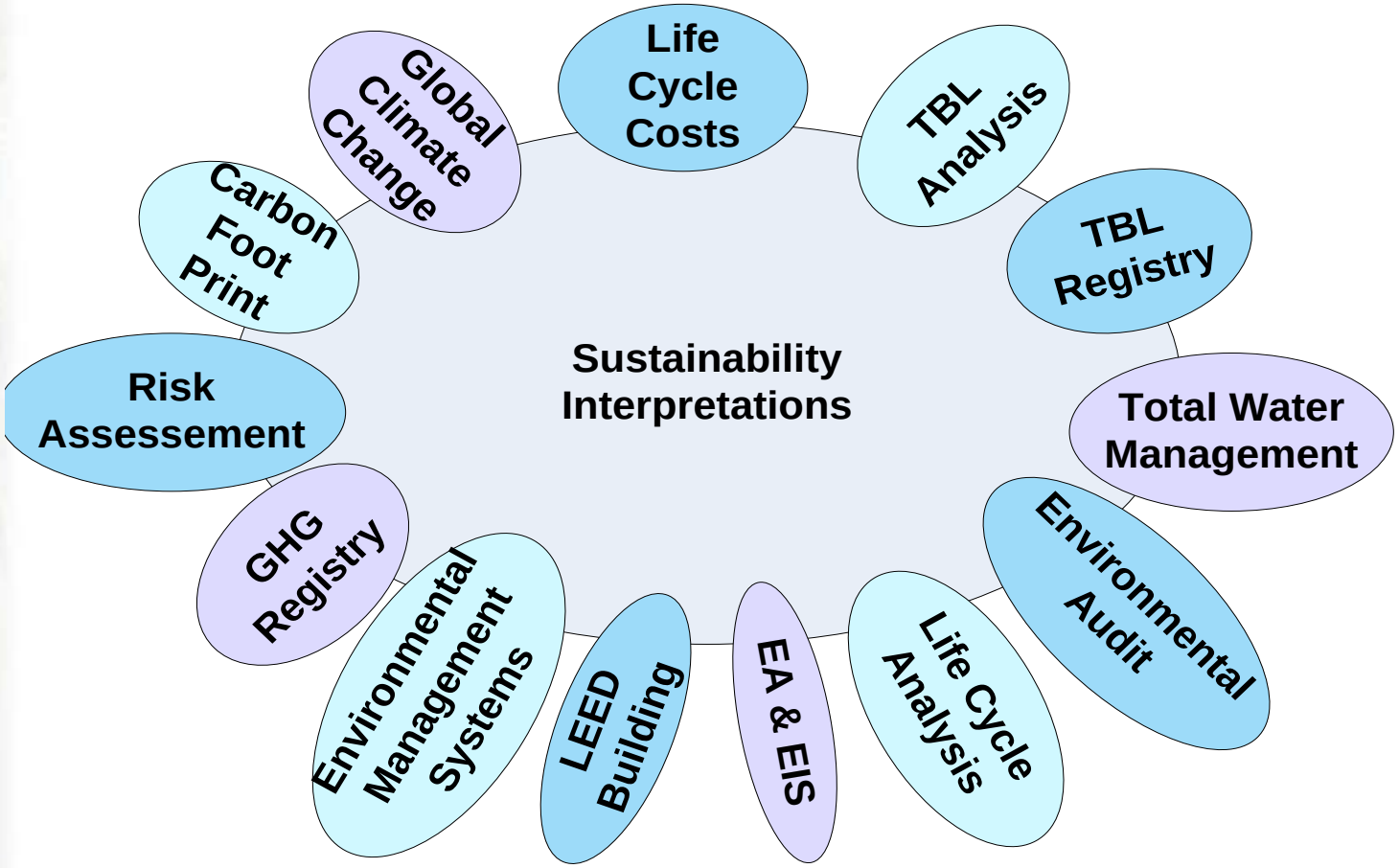
What is Different Now?

- Public health, Environmental issues, Water Scarcity, and Energy are rapidly converging in many areas in the US and regions of the world
- Consequently - The need for sustainable approaches to water resource management is becoming a greater imperative.

What is sustainability ?

Sustainability is universal in concept but local in interpretation



Visionary Definition of Sustainability

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

In report by the Brundtland Commission, established by UN in 1983

Not Actionable

The "Triple Bottom Line" Definition of Sustainability

TBL defines sustainability based on a full range of assessment criteria organized under 3 accounting categories designed to arrive at an appropriate balance:

SOCIETAL

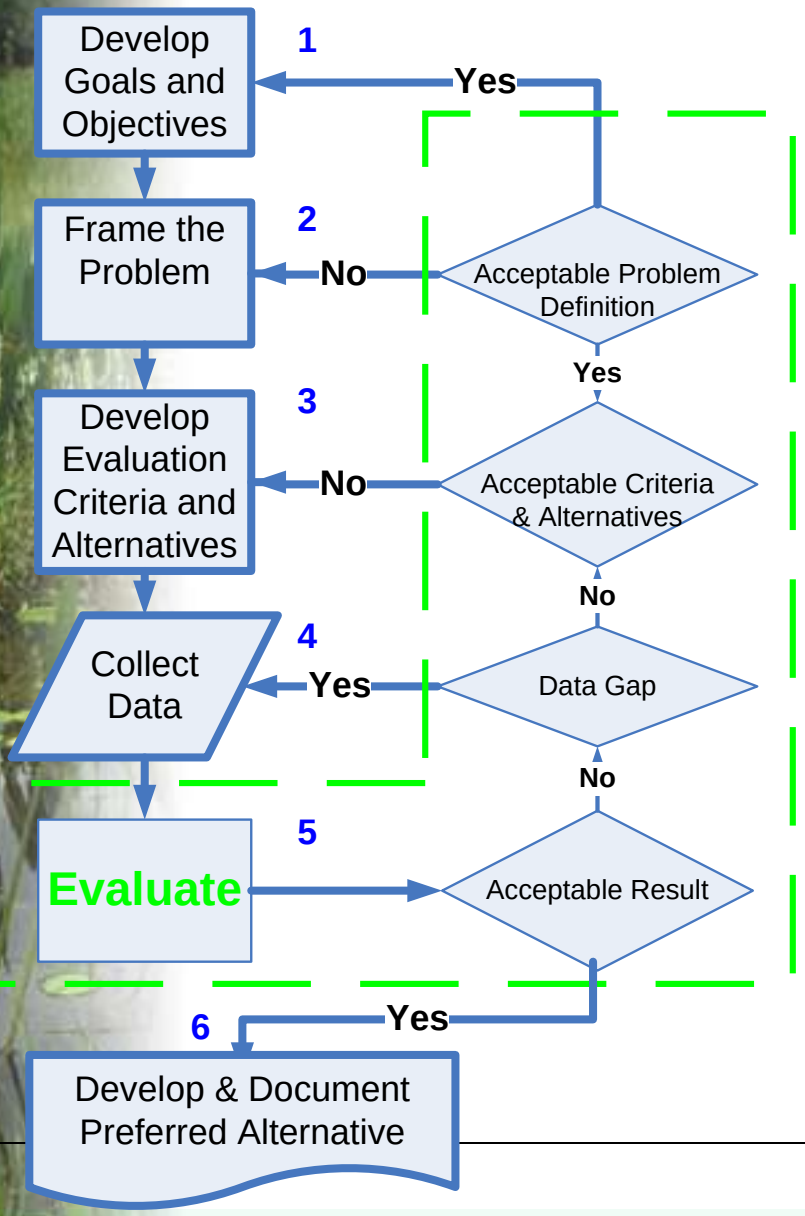
Actionable

Components of a Process for Developing Sustainable Solutions

- Well defined decision process that includes
  - Transparent and inclusive sustainability assessment methodology
  - Clear problem definition
  - Clear and measurable criteria to assess sustainability (Triple Bottom Line)
  - Full suite of alternatives for assessment
  - Consideration of up-steam and down-stream impacts (Macro considerations)

The process for developing sustainable solutions needs to be baked in not frosted on.

Decision Process Uses Sustainability as Basis for Analysis (Multi-Criteria Analysis)



Step 1&2: Kick off meeting with development of Goals , Objectives, Problem Definition- early stakeholder involvement

Step 3: Workshop to develop evaluation criteria, weight criteria, and develop alternatives.

Step 4: Collect data and develop preliminary scoring of alternatives

Step5: Complete preliminary evaluation, identify data gaps, and plan subsequent data collection / testing (TBL analysis)

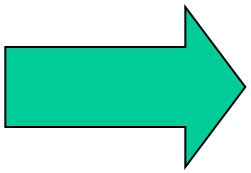
Repeat as necessary

Step 4: Collect additional data, bench or pilot if necessary

Step 6: Complete evaluation and identify preferred alternative(s). Develop concept report based on preferred alternative(s) include action plan

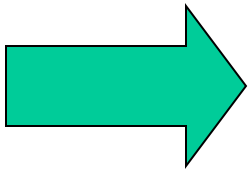
Criteria Selected for Process Evaluation (Cost/Benefit) *(Step 3, example)*

- Public Health Protection
- Environmental
- Operations & Maintenance



Non-economic Evaluation Criteria (e.g., Benefits)

- Capital Cost
- Operating Cost

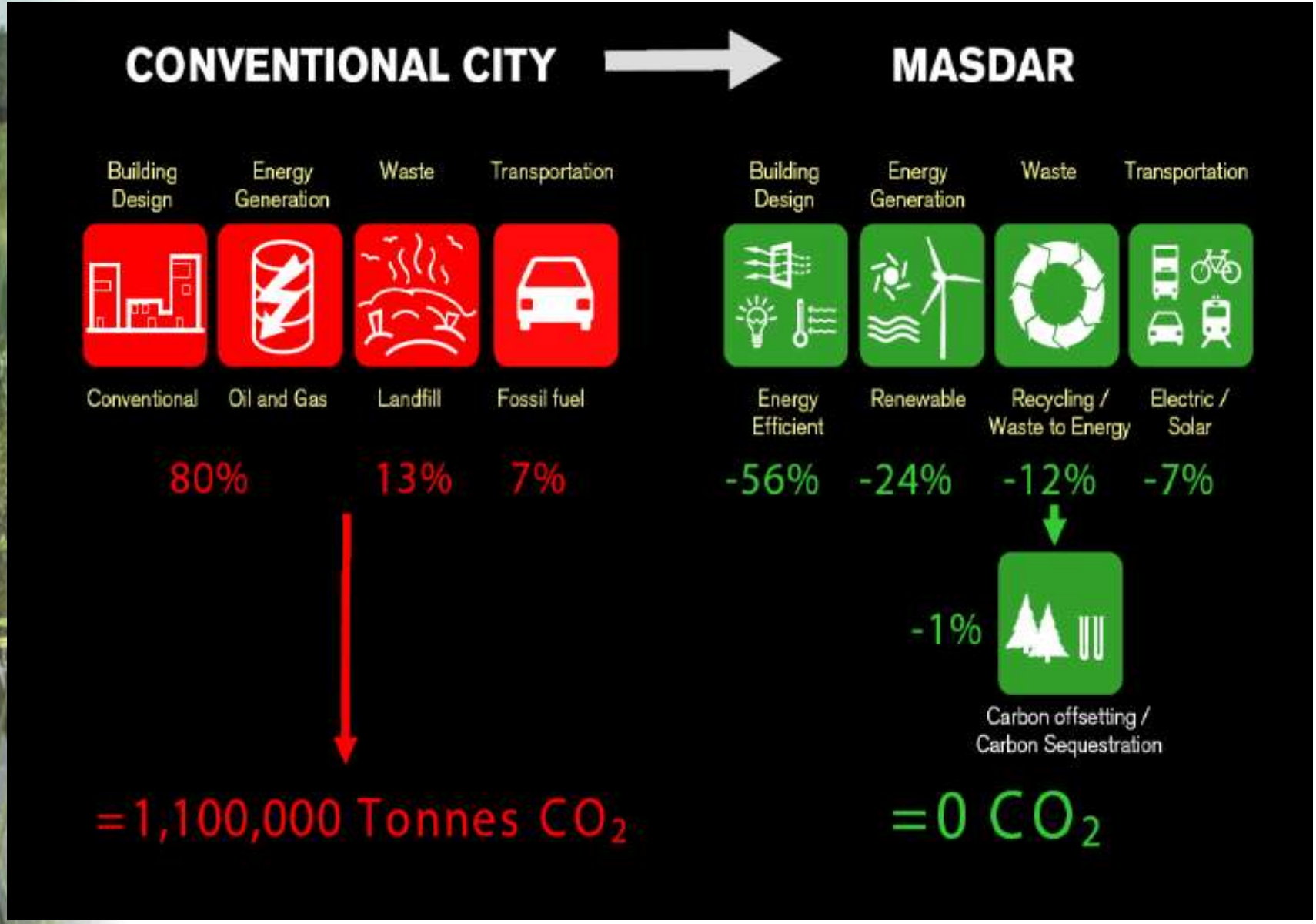


Economic Evaluation Criteria (e.g., Cost)

Environment – Evaluation Criteria

- Water
  - Receiving Water Quality: nitrogen, phosphorous, temperature, emerging contaminants, TDS, TOC, (e.g., contaminants of importance to the client, public, government agencies, etc.)
  - Liquid wastes: brine & contaminants in brine, etc.
- Atmospheric
  - Greenhouse gases, VOCs,
  - Particulates
- Land
  - Wetland impacts
  - Solid waste to land fill or other disposal
- Natural Resources
  - Non-renewable resources, chemicals
  - Renewable resource / recycle

Masdar – Carbon Neutral City


CONVENTIONAL CITY
MASDAR
Building Design
Energy Generation
Waste
Transportation
Conventional
Oil and Gas
Landfill
Fossil fuel
80%
13%
7%
=1,100,000 Tonnes CO_2
Building Design
Energy Generation
Waste
Transportation
Energy Efficient
Renewable
Recycling / Waste to Energy
Electric / Solar
-56%
-24%
-12%
-7%
-1%
Carbon offsetting / Carbon Sequestration
=0 CO_2

Societal – Evaluation Criteria

- Public health
  - Drinking water quality
  - Exposure to contaminants
- Safety
  - Public
  - Operator
- Public disruption
  - Traffic
  - Disruption of services
- Use of resources
- Visual
- Permitting

- Land
  - Transfer of land usage (e.g., Farm land to other uses)
  - Site constraints, land availability
- Operations
  - Operations complexity
  - Maintenance
  - Seasonal operations (startup an shutdown)
  - Flexibility

Weighting Criteria & Scoring Alternatives Against Criteria

- Provide a documentable method for weighting criteria
- Provide a transparent well defined method for scoring alternatives against each other
  - Quantifiable where possible
    - *Greenhouse gases – Tons of CO_2e*
    - *Wetlands impacted - acres*
  - Use of surrogate measures
    - *Public safety = number of trucks delivering chemicals/yr*
    - *Schedule = cubic yards of concrete for construction*
    - *Maintenance complexity = number of electro mechanical devices*
- Use sensitivity analyses to assess alternative weighting and relative importance of criteria – enhance stakeholder involvement

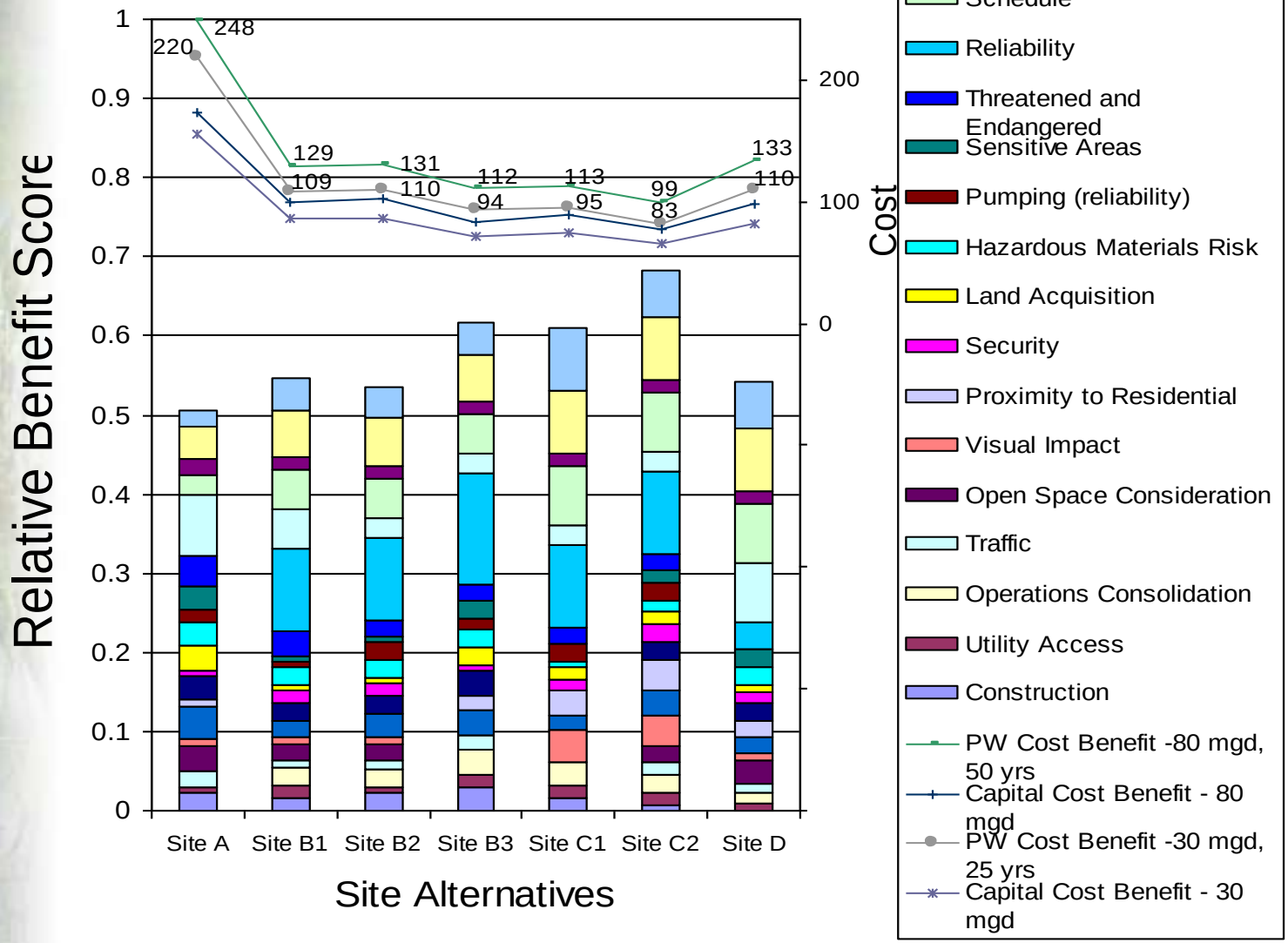
Example: Evaluation / Scoring

City of Longmont Evaluation Criteria – Preliminary Scoring by Integra/CH2M HILL

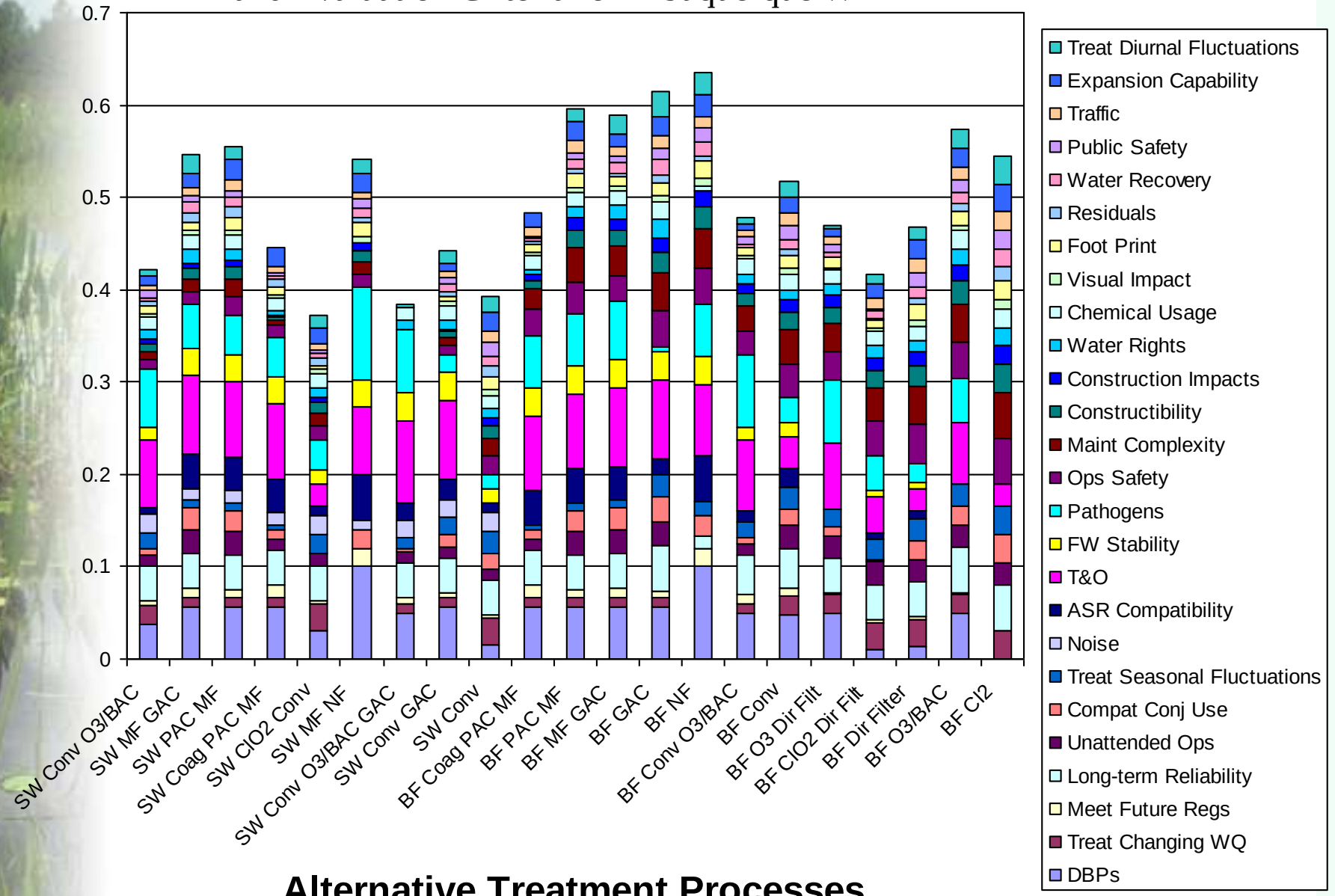
Water Treatment Evaluation Criteria

Criteria	Sub-criteria	Lamella Anthracite Chlorine	Ballastd Anthractie Chlorine	Lamella BAC Ozone	Ballast BAC Ozone	Lamella BAC Chlorine	Ballest BAC Chlorine	Lamella BAC UV	Ballested BAC UV	Micro-filter Chlorine	Micro-filer Ozone BAC	Micro-filter GAC	Micro-filter, Nano-filter
Environ-mental, Resident & Permitting Issues	**Greenhouse**	2	2	2	2	2	2	2	2	4	5	5	2
	Chemical usage	3	3	3	3	3	3	3	3	4	5	5	5
	Visual	3	3	2	2	3	3	3	3	4	3	4	4.5
	Traffic	3	3	2	2	3	3	3	3	4	3	3.5	4
	Other potential 1041 issues	3	3	3	3	3	3	3	3	4	3	3	4
	Public Safety	3	3	2	2	3	3	3	3	4	2	4	4
	Noise	3	3	3	3	3	3	3	3	3	3	3	3
Potable Water Quality	**Disinfection Byproducts**	2	2	4	4	3	3	3	3	1	2	4.5	5
	Pathogens	1	1	3	3	1	1	4	4	4.5	4.5	4.5	5
	Aesthetics	1	1	4	4	3	3	3	3	1	4	4.5	4.5
	Synthetic Organic Treatment	1	1	4	4	3	3	3	3	1	4	5	4.5
	Reliability	3	3	2	2	3	3	3	3	4	3	3.5	2
	Operability	3	3	1	1	2	2	2	2	5	2	3	3
	Flexibility	1	1	3	3	2	2	2	2	3.5	4	4.5	5
	Maintenance	4	4	2	2	3	3	3	3	4	3	3	2
	Safety	3	3	1	1	2	2	2	2	4	1	3	4

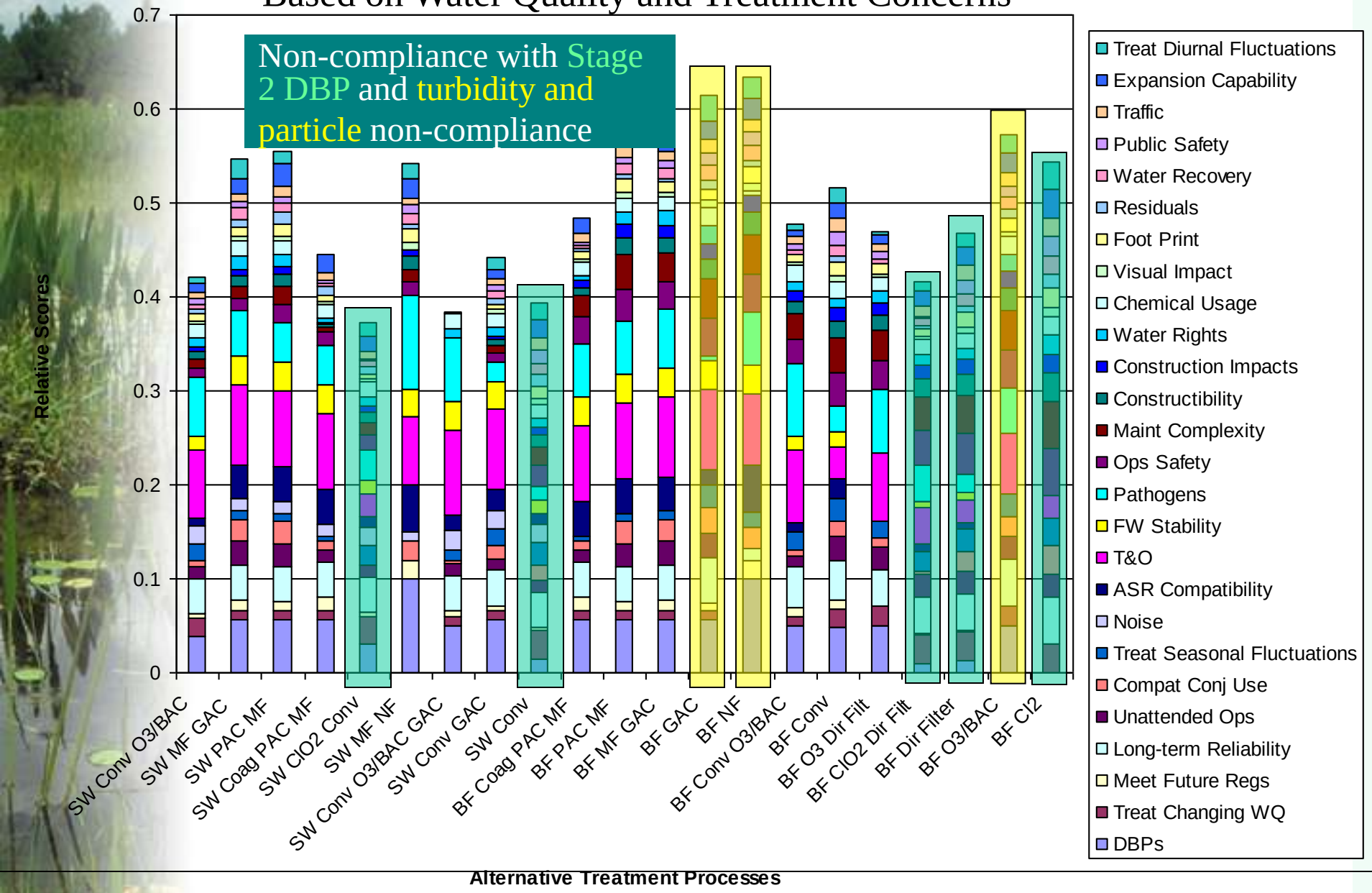
Longmont Water Treatment Plant Siting Study
Cost Benefit Summary



21 Treatment Alternatives and Evaluation Criteria for Albuquerque WTP



Elimination of Alternatives
Based on Water Quality and Treatment Concerns

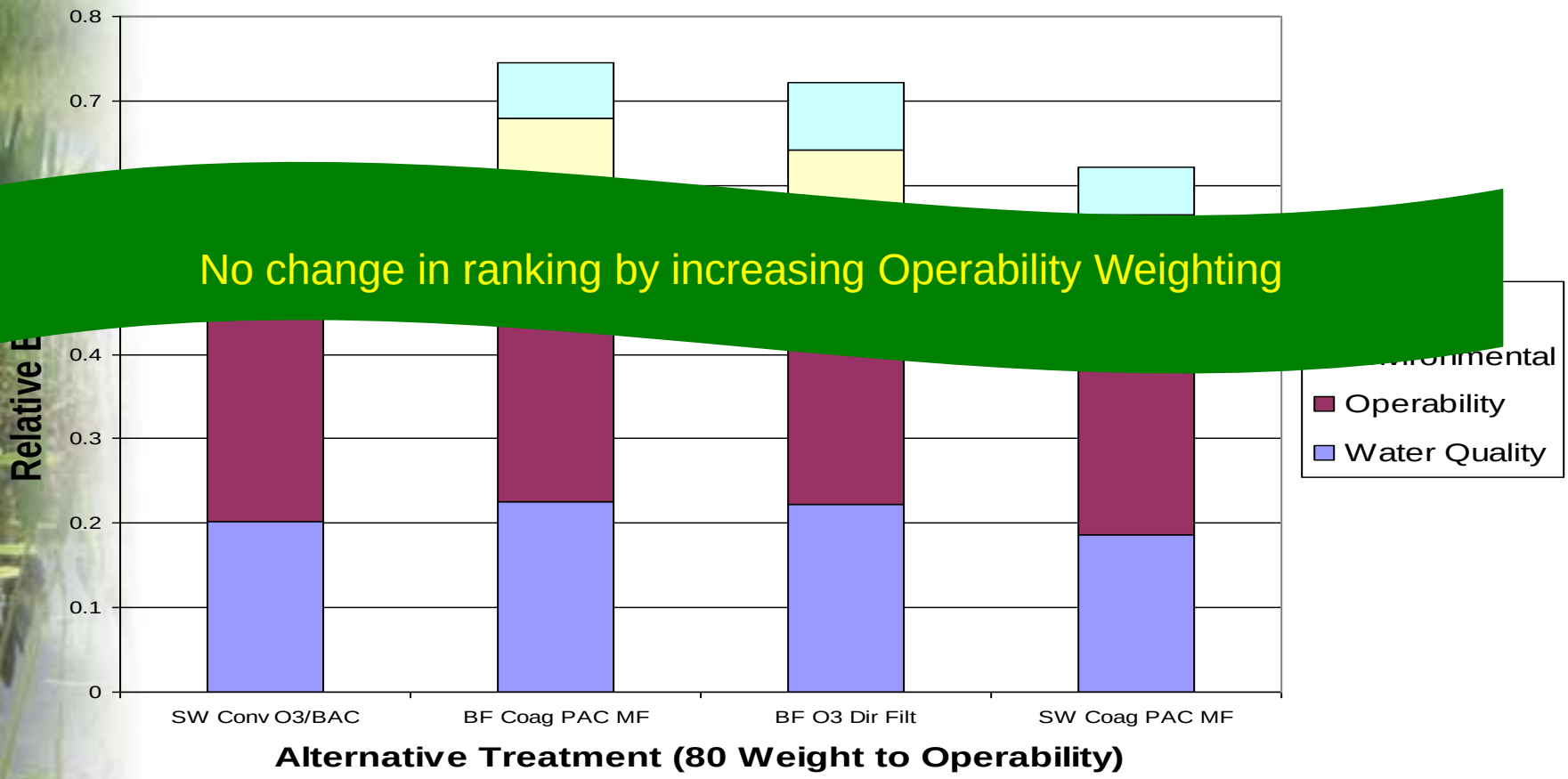


Elimination of Alternatives 21 to 4 Alternatives

- Reasons for elimination of alternatives
  - 8 non compliant for turbidity of DBPs
  - 2 environmentally unacceptable
  - 3 too expensive for limited environmental and operational improvements
  - 2 redundant without full flexibility
  - 2 unnecessarily complex

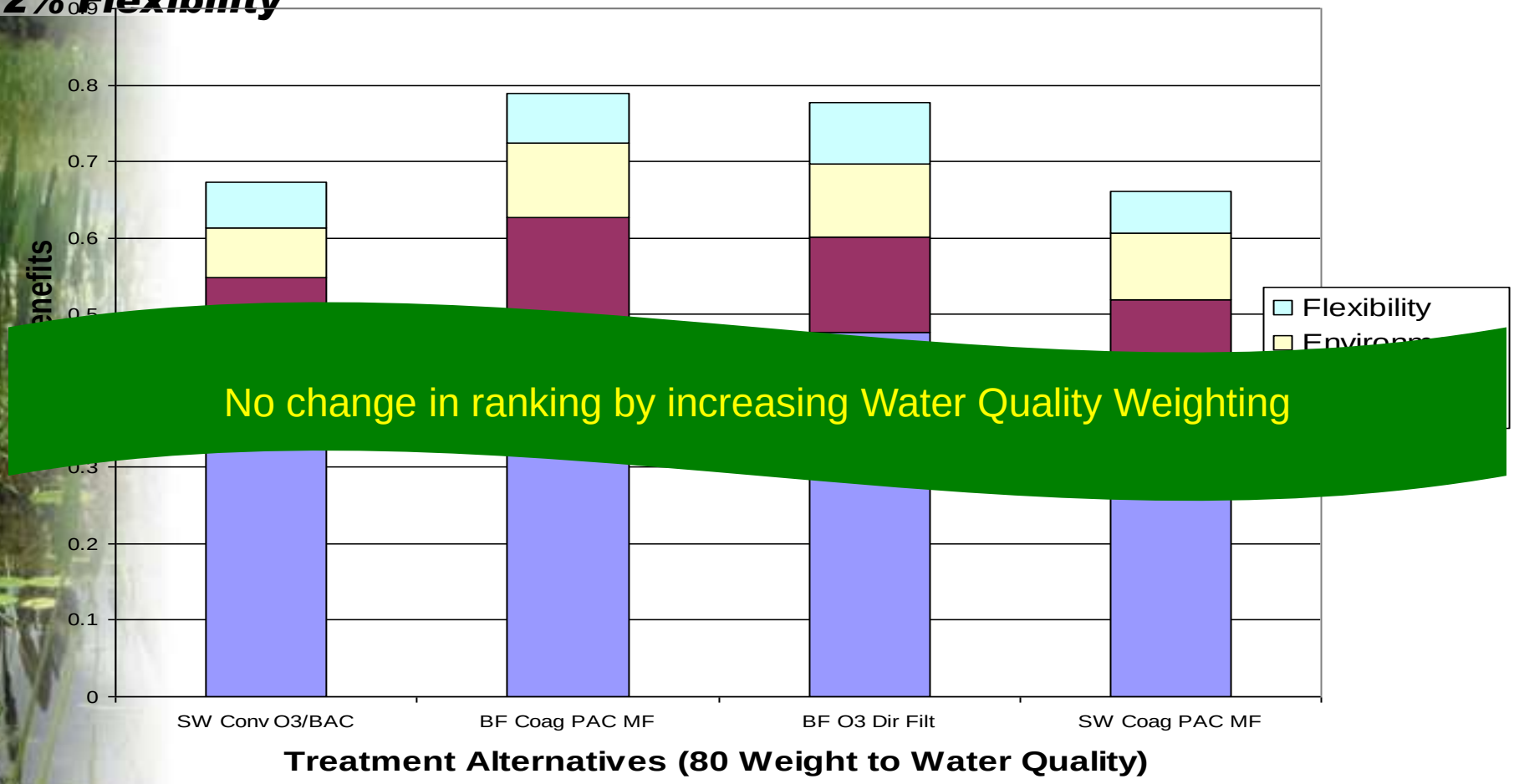
Sensitivity Analysis Albuquerque WTP

26.67% Water Quality; 53.33% Operability; 13.33% Environmental; 6.67% Flexibility



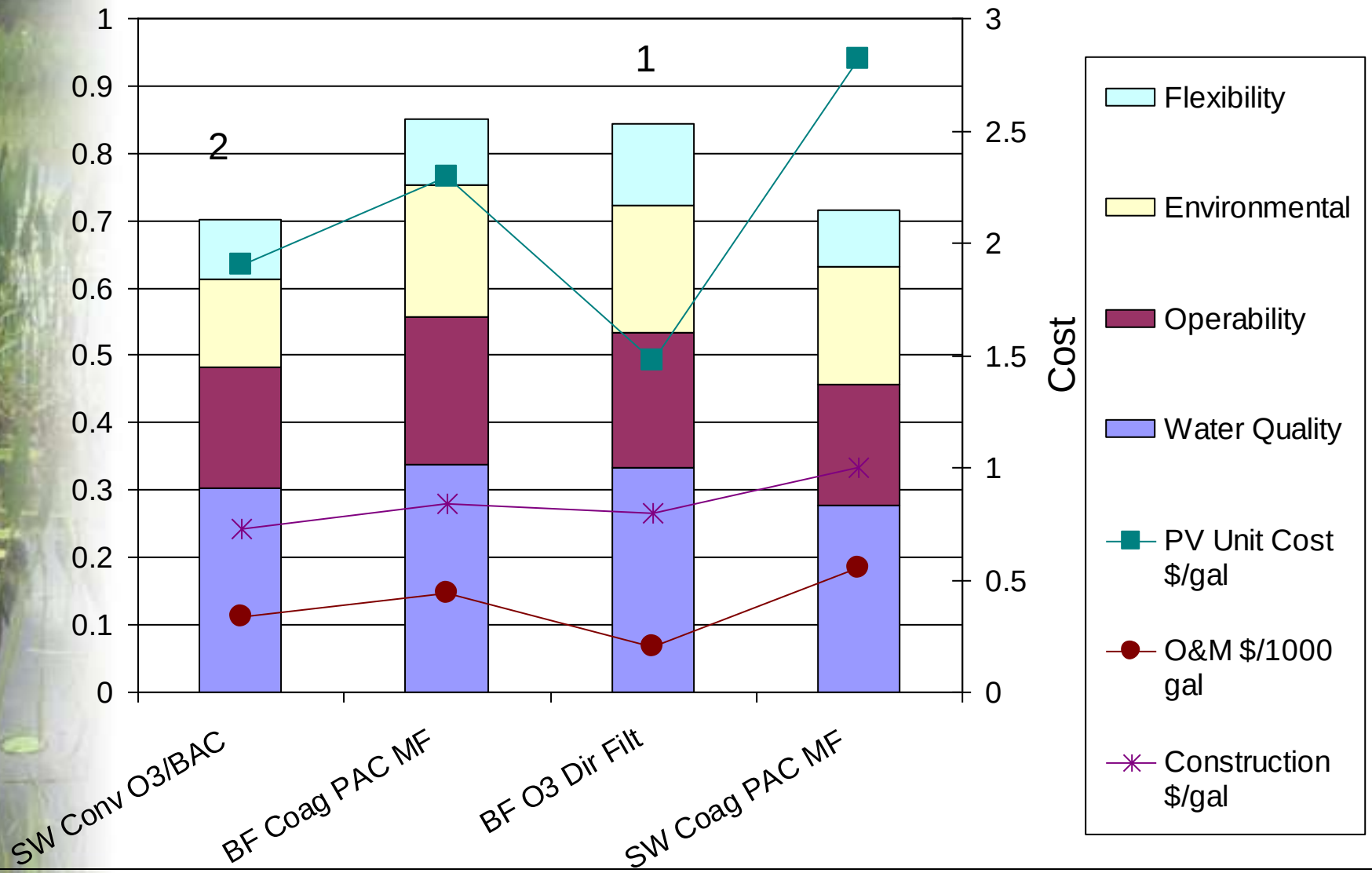
Sensitivity Analysis Albuquerque WTP

57% Water Quality; 21.5% Operability; 14.3% Environmental; 7.2% Flexibility



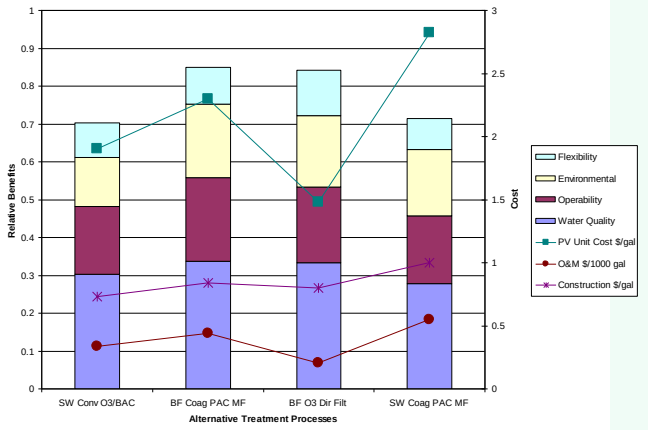
No change in ranking by increasing Water Quality Weighting

Relative Cost/Benefit Analysis Results



Relative Cost/Benefit Analysis

- Bank filtration was found to be hydrogeologically and environmentally infeasible
- Regardless of source water delivery mechanism, membrane costs for this size WTP were relatively high based on raw water quality.
- Surface water-conventional-ozone-biological activated carbon alternative became the most sustainable solution.



Sustainability through Multi Criteria Analyses (MCA) - Guidance

- Get stakeholder involvement from the very beginning and involve organizations to enhance institutional memory
- Limit the number of Major Criteria to those that demonstrate an impact
- Use quantitative measures whenever possible
- Apply sensitivity analyses (optimization) to answer all the inevitable “what if” and “had you thought about” questions

Possible Constraints to Implementation of Sustainable Concepts (Historical Perspective)

- Lack of coordination among experts on environmental and social issues
- Conflicting environmental guidance and regulations
- Extreme mitigation requirements (the “Precautionary Principle”)
- Diversity of organizations and difficulty in developing consensus
- Optimization at project scale instead of at macro scale

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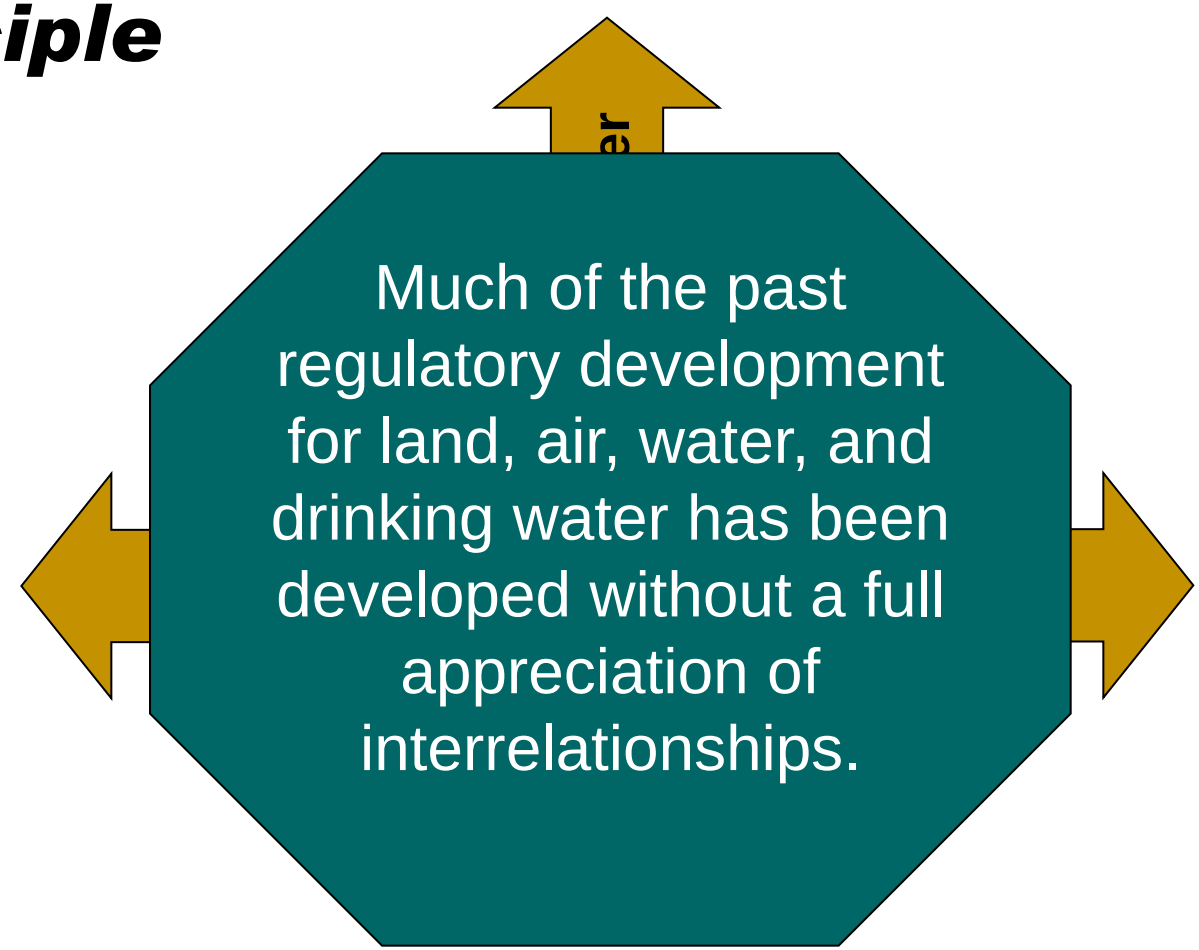
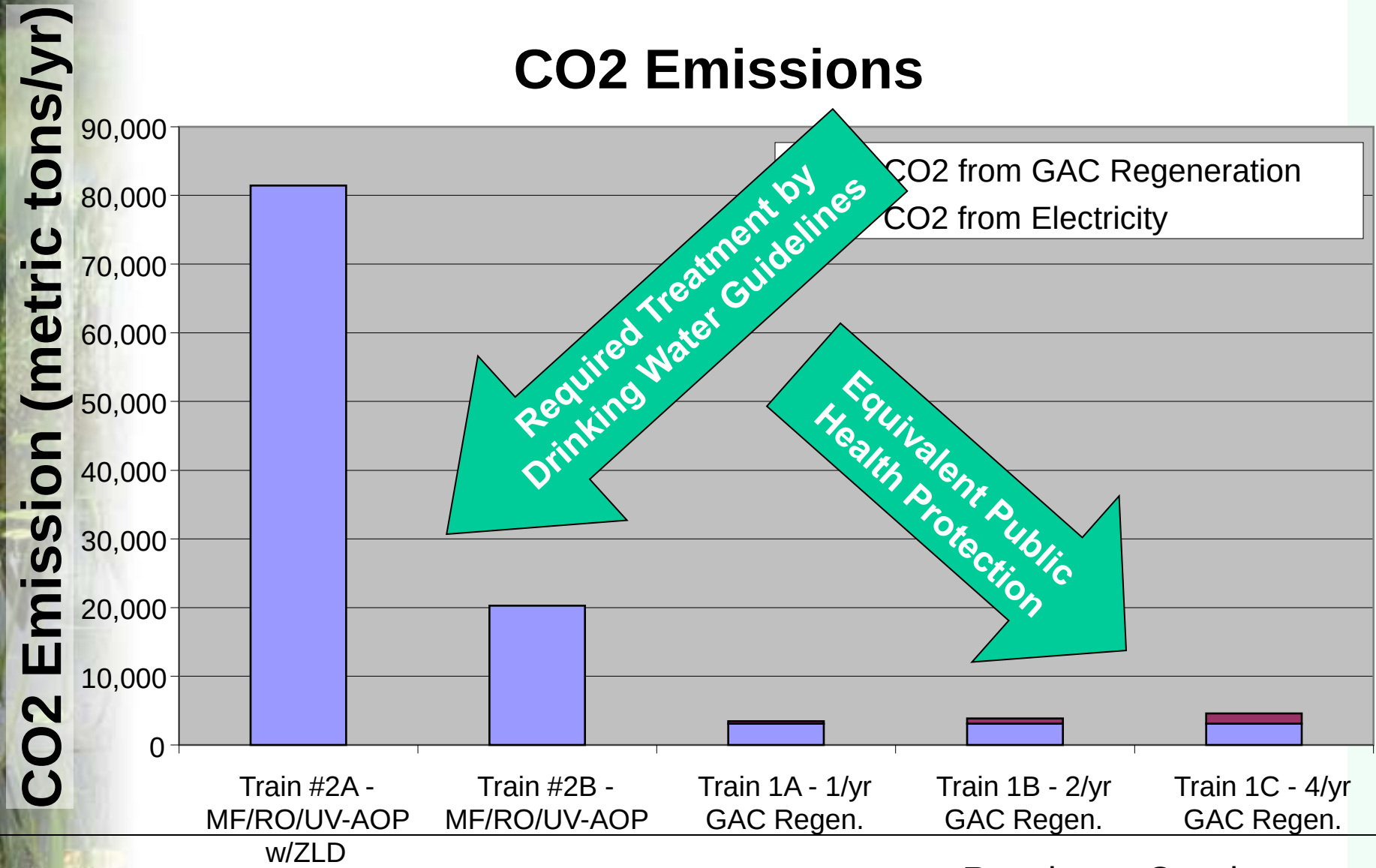
Partial Constraint to Sustainability:

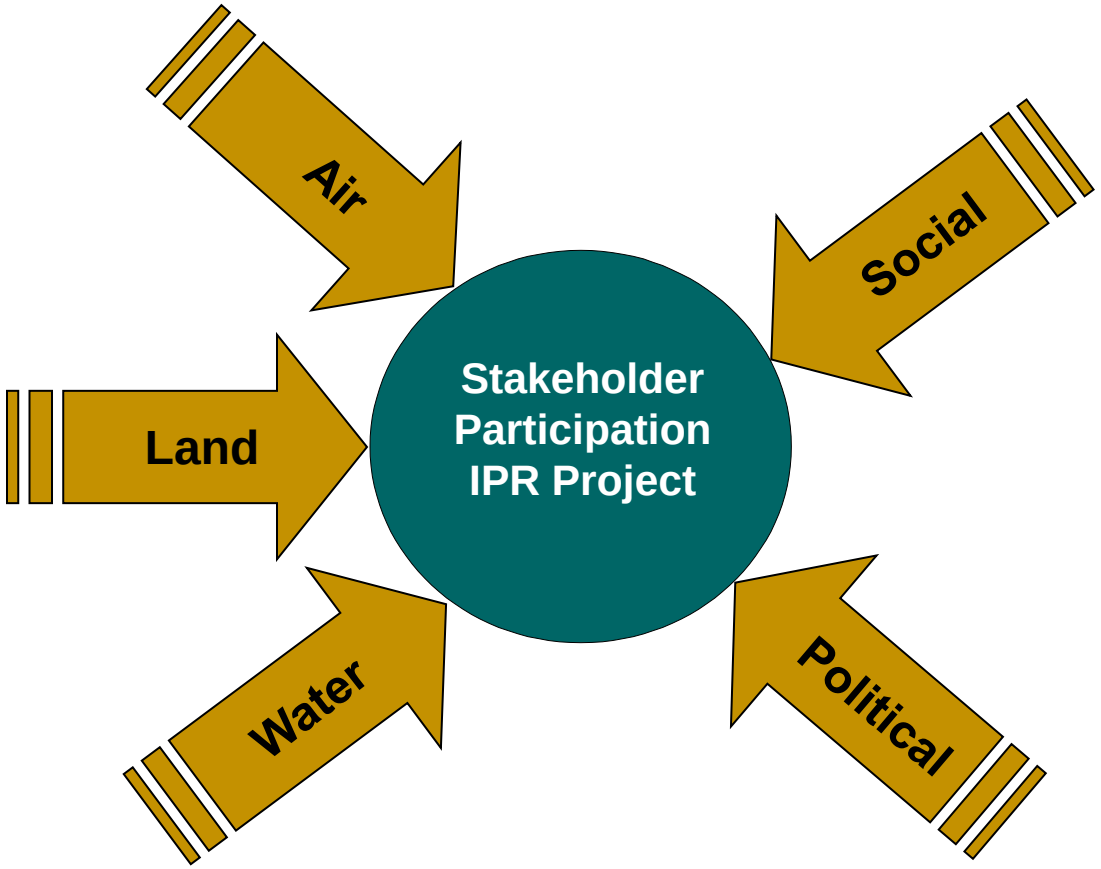
Legacy of Divergent Environmental Guidance and the Precautionary Principle



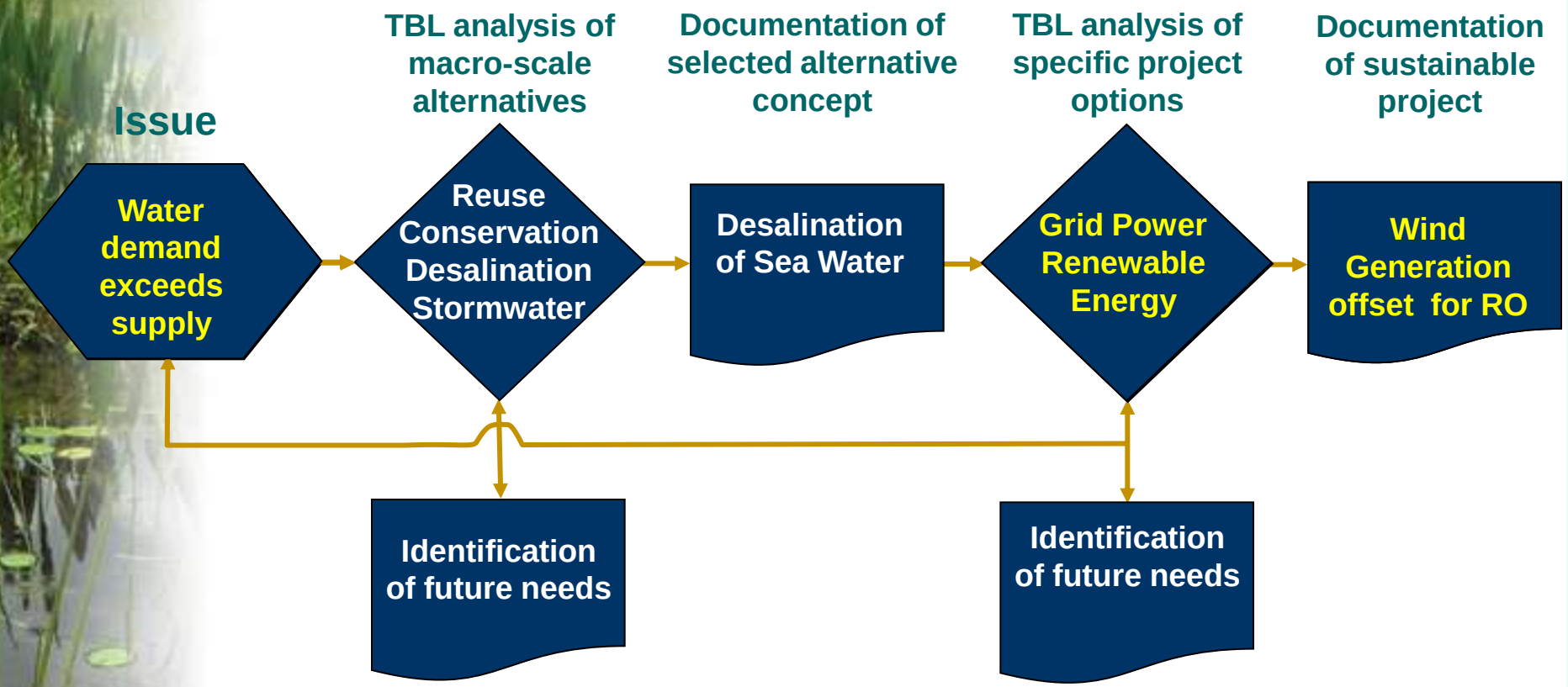
Indirect Potable Reuse Example of Non-sustainable Regulations (Brisbane Aus, California)



Early Involvement of All Stakeholders



A Macro- to Project-Scale Decision Process



In Conclusion…

- Include all stakeholders in the development and analysis of alternatives
- Consider macro-scale sustainability before beginning a specific project…look back
- Approaches that accept preconceived ideas without assessing with Triple Bottom Line may be less than sustainable

  (sub-optimized)

In Conclusion…

- Question the “Precautionary Principle”
- Apply new and evolving approaches, not just existing technologies
- Assist in development of sustainable approaches

Discussion