Wastewater Treatment Plant of the Future - Decision Analysis Approach for Increased Sustainability

Glen T. Daigger, Ph.D. P.E., DEE
Senior Vice President

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New Technology Provides Expanded Wastewater Management Options:

• Reuse Rather Than Discharge
  – Effluent Quality for Discharge Appropriate for Reuse
  – Value of Reclaimed Water As Water Resource

• Centralised versus Decentralised versus Hybrid Configurations
  – Treatment/Practices Protect Public Health
  – Reduced Conveyance Costs
  – Facilitates Reuse

• Source Separation
  – Potential for Very Different Environmental Impacts
One Example is the High Quality Effluent (Reuse) Plant

Flow Equalisation

- Preliminary Treatment
- Primary Clarification
- Membrane Bioreactor
- Post Treatment
- Ultraviolet Disinfection

- Digestion
- Post Treatment
- Reuse
Advantages and Disadvantages for High Quality Effluent (Reuse) Plant

• Advantages:
  – Effluent Suitable for Wide Range of Uses, Including Indirect Potable
  – Compact Facility – Easy to Address Aesthetics and Odors
  – Automatic Control and Unattended Operation Quite Possible
  – Moderate Operating Costs
  – Modest Opportunities for Resource Recovery.

• Disadvantages:
  – Relatively Capital Intensive
  – Relatively Equipment Intensive
  – Energy Intensive
Another Example is the Low Energy Consumption Plant

- Preliminary Treatment
- Anaerobic Treatment
- Aerobic Treatment
- Disinfection
- Anaerobic Digestion
- Reuse
Advantages and Disadvantages for Low Energy Consumption Plant

• Advantages:
  – Good Quality Effluent
  – Low Energy Costs – Could be Net Energy Producer
  – Automatic Control and Unattended Operation Quite Possible
  – Modest Operating Costs
  – Aesthetic and Odor Concerns Can be Addressed

• Disadvantages:
  – Nutrient Removal Capability Reduced Due to Carbon Removal in Anaerobic Treatment
  – Relatively Equipment Intensive
Final Example is the Natural Treatment System Plant

1. Preliminary Treatment
2. Anaerobic Lagoon
3. Aerobic Lagoon
4. Disinfection
5. Wetland

Periodic De-Sludging → Reuse
Advantages and Disadvantages for Natural Treatment System Plant

- **Advantages:**
  - High Quality Effluent Can be Produced
  - Low Operation and Maintenance Costs
  - Modest Capital Costs
  - Significant Opportunities to Create Recreational, Wildlife Habitat, and Open Space Benefits
  - Mechanically Simple

- **Disadvantages:**
  - Relatively Large Land Requirements, Especially in Comparison to Other Options
  - Potential for Odor, Vectors, and Other Nuisances
Sustainable Development Provides Philosophical Basis for Deciding

Knowledge... Commitment... Integrity... at Your Service
Overall Decision Process Built on Stakeholder Concerns and Values

1. Identify Stakeholders
2. Frame the Issues
3. Establish Decision Criteria and Value System
4. Identification of Project Alternatives
5. Evaluation of Project Alternatives
6. Alternative Selection
7. Develop Implementation Plan
Proper Stakeholder Identification Facilitates Project Implementation

- Identify Stakeholders
- Frame the Issues
- Establish Decision Criteria and Value System
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- Evaluation of Project Alternatives
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- Develop Implementation Plan
Stakeholders are Groups or Individuals Who:

- Are Affected by the Decisions to be Made, or
- Can Have a Significant Impact on the Outcome
Framing the Issues Makes Subsequent Steps More Efficient

- Identify Stakeholders
- Frame the Issues
- Establish Decision Criteria and Value System
- Identification of Project Alternatives
- Evaluation of Project Alternatives
- Alternative Selection
- Develop Implementation Plan
Issue is Framed by Guiding Principals, Values, Goals/Objectives

• Example Guiding Principals:
  – Wastewater Treatment is Component of Overall Water Management System
  – Wastewater Management System is Community Asset
  – System Selection Determined by Community Values
  – Source Control Superior to Treatment
Issue is Framed by Guiding Principals, Values, Goals/Objectives

• Example Guiding Principals:
• Example Community Values:
  – Value Creation:
    • Creation of Enhanced Recreational Opportunities
    • Value of Water Reused
    • By-Product Recovery, Including Biosolids, Energy, and Nutrients
    • Contribution to Regional and Global Environmental Issues, Such as Nutrient Discharges and Greenhouse Gases
Issue is Framed by Guiding Principals, Values, Goals/Objectives

• Example Guiding Principals:

• Example Community Values:
  – Value Creation:
  – Public Impacts:
    • Affordable, Reasonable, Predictable Utility Rates
    • No or Minimal Nuisances (i.e. Odors, Overflows, Truck Traffic, Aesthetics)
    • Absence of Hazards
    • Equity
Issue is Framed by Guiding Principals, Values, Goals/Objectives

- Example Guiding Principals:
- Example Community Values:
  - Value Creation:
  - Public Impacts:
  - Employee Development
    - Competitive Compensation Package
    - Professional Development Opportunities
    - Workplace Empowerment
Issue is Framed by Guiding Principals, Values, Goals/Objectives

• Example Guiding Principals:
• Example Community Values:
  – Value Creation:
  – Public Impacts:
  – Employee Development
• Goals and Objectives Begin to Quantify Principals:
  – Compliance with Established Standards
  – Exceed Established Standards
Decision Analysis Provides Basis for Assessing Relative Sustainability

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Value Hierarchy Structures Criteria to be Used for Decision-Making

Sustainability

Social Performance
- Public Health
- Values and Beliefs
- Cultural Resources
- Public Involvement
- Aesthetics
- Community Development

Economic Performance
- Affordability
- Ability to Finance
- Ability to Maintain
- Ability to Sustain
- Economic Development

Environmental Performance
- Surface Water Quality and Quantity
- Ground Water Quality and Quantity
- Aquatic Eco-Systems
- Land Eco-Systems
- Soil Quality
- Air Quality
- Energy Use

Technical Performance
- Knowledge Base
- Site Impacts
- Implementation

Public Health Values and Beliefs
Cultural Resources
Public Involvement
Aesthetics
Community Development
Affordability
Ability to Finance
Ability to Maintain
Ability to Sustain
Economic Development
Surface Water Quality and Quantity
Ground Water Quality and Quantity
Aquatic Eco-Systems
Land Eco-Systems
Soil Quality
Air Quality
Energy Use

Knowledge... Commitment... Integrity... at Your Service
Utility Scales Allow Technical Analysis of Alternatives vs Criteria

<table>
<thead>
<tr>
<th>Compliance with Standards</th>
<th>Utility</th>
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<tr>
<td>Cannot Meet Current or Future</td>
<td>0</td>
</tr>
<tr>
<td>Meets Current Not Future</td>
<td>4</td>
</tr>
<tr>
<td>Meets Current/Modified for Future</td>
<td>7</td>
</tr>
<tr>
<td>Meets Current and Future</td>
<td>9</td>
</tr>
<tr>
<td>Exceeds Current and Future</td>
<td>10</td>
</tr>
</tbody>
</table>
Utility Scales Allow Technical Analysis of Alternatives vs Criteria

Availability of Institution to Provide Needed Service

- Not Possible to Meet Need
- Introduction of New Institution Needed
- Use Available But Unfamiliar Institution
- Needs Only Currently Available Institutions

Utility Scale:

0 1 2 3 4 5 6 7 8 9 10
Decision Analysis Approach Separates Technical/Value Roles

- **Stakeholder Roles:**
  - Review Value Hierarchy
  - Weight Criteria in Expression of Values
  - Review Utility Scales
  - Cooperate with Other Stakeholders to Select Alternative
  - Support Implementation

- **Technical Professional Roles:**
  - Manages Overall Process
  - Creates Value Hierarchy:
    - Creates
    - Reviews
    - Ensures Independence
  - Performs Technical Analysis
  - Computes Scores
Several Techniques Used to Identify Project Alternatives

1. Identify Stakeholders
2. Frame the Issues
3. Establish Decision Criteria and Value System
4. Identification of Project Alternatives
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Several Techniques Can Be Used to Identify Alternatives

- Experience
- Other, Similar Solutions
- Brainstorming Sessions
- Strategy Table
Data Gathering and Analysis Driven by Selected Decision Methodology

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2. Identification of Project Alternatives
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Knowledge... Commitment... Integrity... at Your Service
Select Alternative or Recycle for More Refined Analysis

- Identify Stakeholders
- Frame the Issues
- Establish Decision Criteria and Value System
- Identification of Project Alternatives
- Evaluation of Project Alternatives
- Alternative Selection
- Develop Implementation Plan

Knowledge... Commitment... Integrity... at Your Service
Two Key Points:

• Collect Data Necessary to Discriminate Between Options (to Make Decision)
  – Use of Existing or Easily Obtainable Data Often Creates Data Bias
  – Decisions Can Often be Made Based on Less But More Useful Data

• Stakeholders Do Not Have to Agree on Values (Relative Weights), Only on Selected Alternative

• Iterate as Necessary to Achieve Consensus to Produce Supportable Solution
Effective Stakeholder Involvement Facilitates Project Implementation

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2. Frame the Issues
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In Summary, Sustainable Development Evaluated Using Decision Analysis

- Alternative Selection Supported by Technical Analysis but Determined by Values
- Engagement of Stakeholders Increases Project Implementation Success
- Decision Analysis Structures Stakeholder and Technical Professional Roles
- Stakeholders Need Not Agree on Values But Need to Agree on Selected Plan
- Technical Analysis Determined by Decisions to be Made
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