The Past, The Present & The Future
(Simple, Complicated & Complex?)

April 30, 2015
Jim Pyne – HRSD Chief of Small Communities
(But not much longer)
What makes it work?
Wastewater Treatment Model A
King William Treatment Plant
The Past
The Present
What makes it work?
What makes it work?
A Complex System (analogical) Model
A System consisting of many diverse and autonomous but interrelated and interdependent components or parts linked through many (dense) interconnections. Complex systems cannot be described by a single rule and their characteristics are not reducible to one level of description. They exhibit properties that emerge from the interaction of their parts and which cannot be predicted from the properties of the individual parts.

Adapted from the BusinessDictionary.com
<table>
<thead>
<tr>
<th>Complex Systems</th>
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<tbody>
<tr>
<td><strong>Number of Elements</strong></td>
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<tr>
<td><strong>Interactions Between Elements</strong></td>
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<tr>
<td><strong>Laws governing behavior</strong></td>
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Adapted from Jackson, 1991 *Systems Methodology for the Management Sciences*
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<td>System change over time</td>
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<td>System Boundaries</td>
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Adapted from Jackson, 1991 *Systems Methodology for the Management Sciences*
Complex Systems

Open to the environment

Emergent Behavior

YES

YES

Adapted from Jackson, 1991 Systems Methodology for the Management Sciences
The Water System
The Water System

Regulators
Stakeholders
Customers
Groundwater
Storm water
Drinking water
Wastewater
Financial Resources
Assets
Economy
Land Use Planning
A Complex System (conceptual) Model
System Flows (Tangible & Intangible)

- Effort (energy)
- Information
- Influence
- Money
- Raw material
- Intermediates
- Finished products
- Projects
- Services
- Decisions
General Systems Perspective: Essential Relationships of Sustainability

Source: Sustainable Water Resources Roundtable
What We Deal With

- Divergent Stakeholders
- Divisive Dynamics
- Conflicting Perspectives
- Ethical Conflict

- Rate of change
- Obsolescence
- Complexity
- Incompatibilities

- Shifting Demands
- Unstable Resources
- Unintended Consequences
- High Uncertainty
- Solution Urgency

- Ambiguous Boundaries
- Excessive maneuvering
- Demanding constituents
- Emergent Conditions
- Tacit power & influence
- Irrationalities in decision/action

- Misinformation/inaccurate
- Inadequacies
- Defensiveness
- Incomplete/Inaccessible
- Proliferation & Overload
- Security/Privacy
Faced With

Economy & financial uncertainty

Scarc resources & efficiency demands

Uncertainty of climate impacts

Regulatory changes

Information & technology proliferation

Perceptions from instantaneous access to information

Resilience of operations

Aging infrastructure

New & emerging contaminants

Workforce – aging, new skills

Water resource uncertainties – demand, adequacy
Sociotechnical System

People, Processes, Technology

Environment

Incose
Water-Sensitive Cities Framework

Urban water transition phases

Drivers
- Population growth
- Public health
- Population growth and development
- Social amenity and environmental health
- "Limits to growth"
- Intergenerational equity, resilience to climate change

Water Supply City
- Supply hydraulics

Sewered City
- Separate sewerage schemes

Drained City
- Drainage / flood protection

Waterway City
- Point source and diffuse (storm water) pollution management

Water Cycle City
- Diverse, fit-for-purpose sources and conservation promoting and linked with waterway protection

Water-sensitive City
- Adaptive and multi-functional infrastructures and landscapes reinforcing water-sensitive behaviors

Management response

System Governance

9 Governance Functions

- Strategic System Monitoring
- Policy & Identity
- System Context
- Learning & Transformation
- Environmental Scanning
- Operational Performance
- Information & Communications
- System Development
- System Operations

IMPACTS

System Capabilities to Address

- Complexity
- Uncertainty
- Emergence
- Ambiguity
This is the moment of embarking -- all auspicious signs are in place – GOOD LUCK!!