WASHINGTON STATE DEPARTMENT OF ECOLOGY

October 11, 2007
Reclaimed Water
Rule Advisory Committee

Technical Standards Revision and Development Focus: Water Quality

Part 1 – Initial Scoping and Input from RW -RAC

Reclaimed Water Quality

How should Washington State address the issue of

Reclaimed Water Quality

over the next 10-20 years?

Action Items from last RAC meeting

September 7, 2007

- Review of existing Washington State standards
  - What was the rationale for their development?
  - Are they consistent with where we are today?
  - How do they relate to drinking water standards?
  - How do they relate to surface and gw quality standards?
  - How to they relate to wastewater treatment standards?
- Review the technical standards from other states
- Provide an overview of compounds of emerging publicity (PPCP & EDC)
- Develop schedule for technical standards work plan

Technical Water Quality Standards

(RAC Comments 2007 - handout)

- General Preference for Use-Based Standards
- Consider Prescriptive Standards If:
  - Small systems, packaged treatment units
  - Lower costs, less monitoring
- Harmonize with other WQ Standards
- Also consider:
  - Source control
  - Compliance and Enforceability
  - Retaining flexibility
  - Address Risk (next slide)

Risk Management (RAC Comments)

From July 11, 2007 RAC Notes:

- Use technology, reliability and factors of safety to reduce and control risk.
- Define water quality in terms of use-based risk.
- Consider relative risk
- Address public perception of risk

Real or Potential Barriers – Tech Standards

(September 2007 RAC)

- Lack a clear set of technical standards
- Conflicts with other codes and statutes
- Evaluate quality achievable – technology vs. cost.
- Clarify content and purpose of rule vs. guidance
- What topics are off the table?

Policy - Thought Questions:

- How do these terms differ?
  - Prescriptive technology
  - Standard of treatment
  - Performance standard
  - Use-based standard
  - Best management practices
- Which works best ?
  - For who?
    - Regulators
    - Treatment utilities
    - Water purveyors
    - Water users
    - Public
  - When?
    - Source control
    - Treatment adequacy
    - Distribution
    - Use
  - Where?
    - Point of compliance?

Questions

End Task 1

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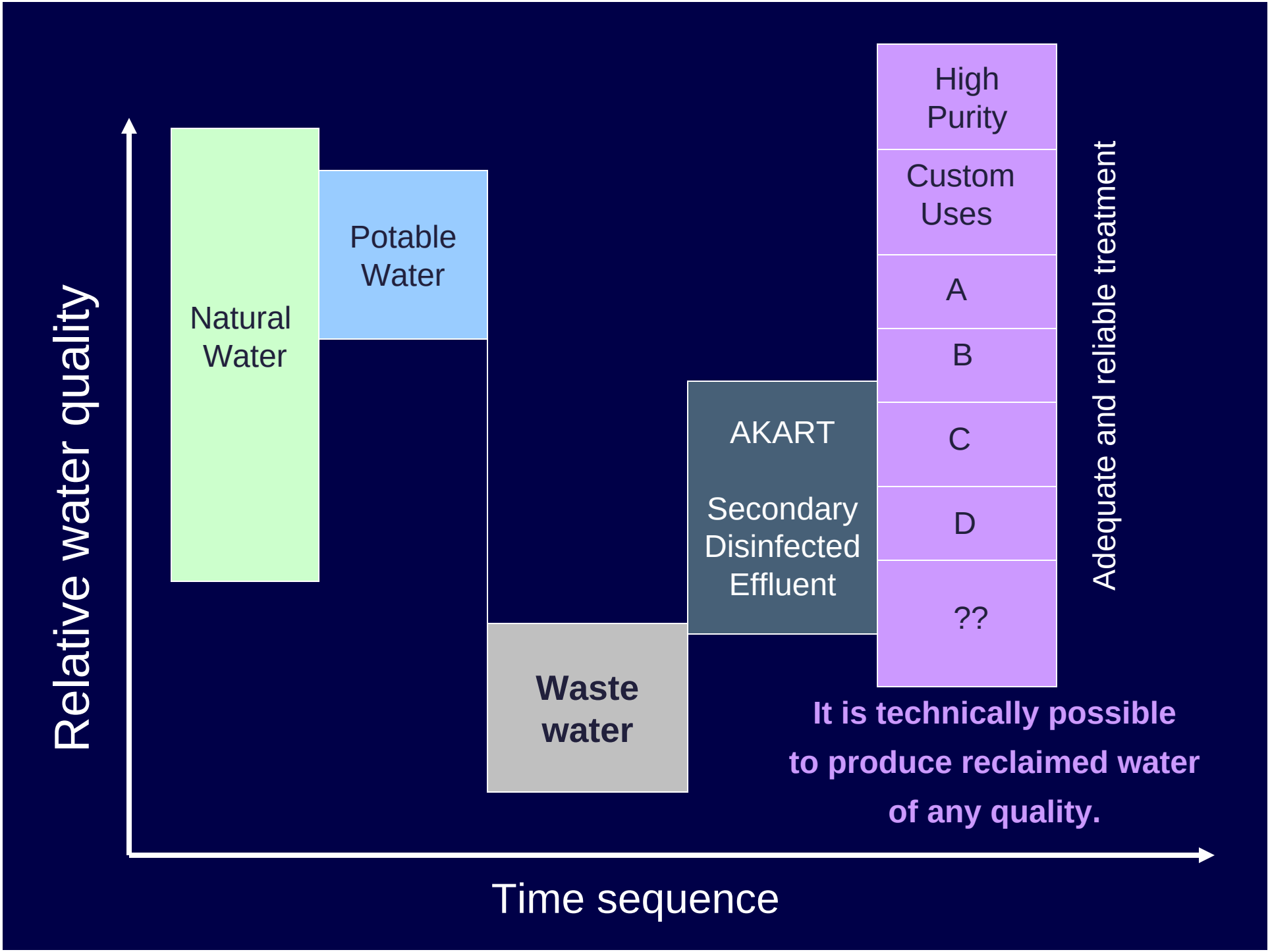
Part 2 - Background
Asking The Right Questions


Relative water quality
Natural Water
Potable Water
Waste water
AKART
Secondary Disinfected Effluent
High Purity
Custom Uses
A
B
C
D
??
Adequate and reliable treatment
It is technically possible to produce reclaimed water of any quality.
Time sequence

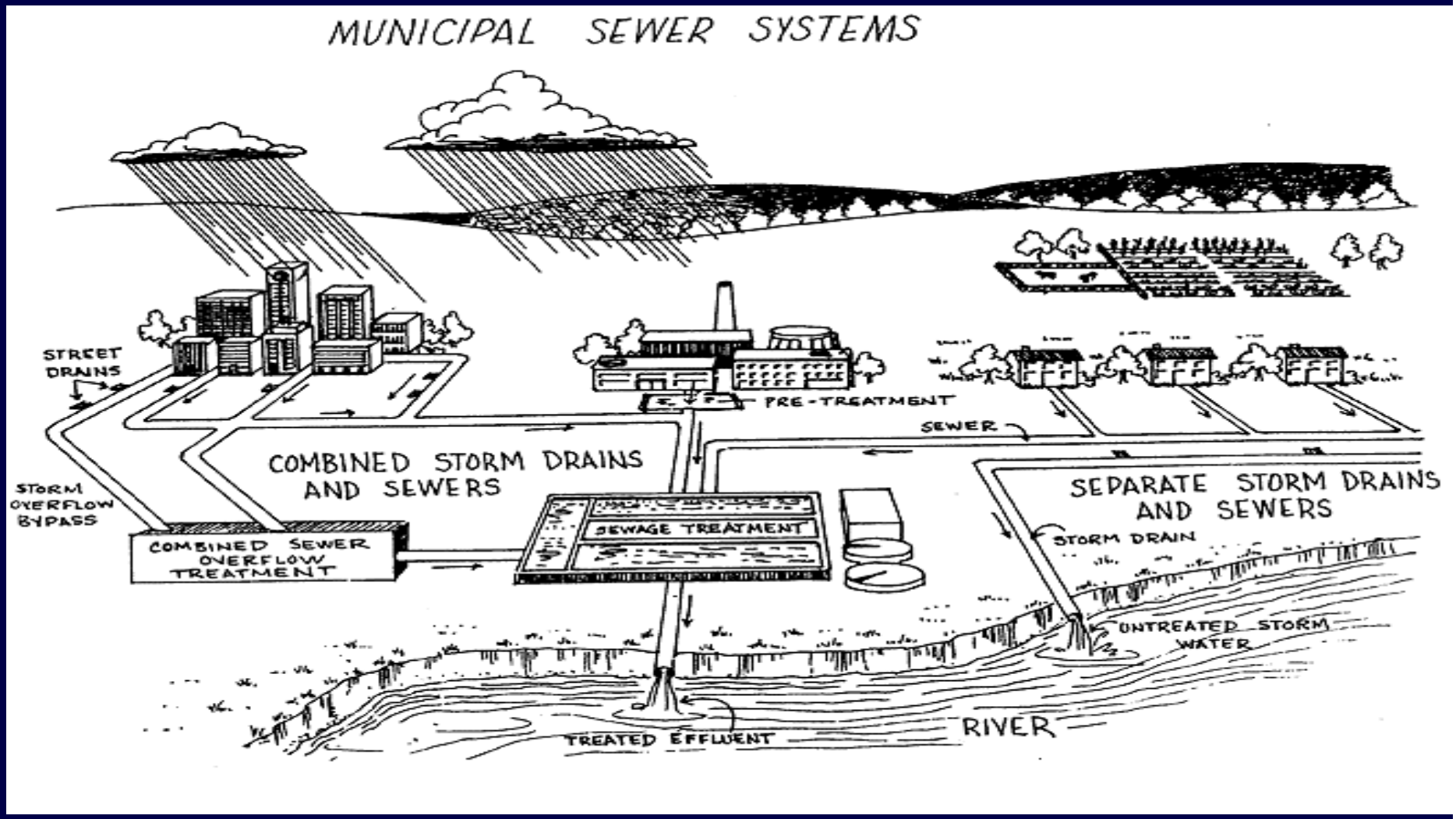
Focusing on the right questions:

- What is in the wastewater before treatment?
- How did it get there?
- What is removed through treatment?
- What factors affect suitability for use?
- Which parameters are the most important and why?
- How has Washington addressed rw water quality so far?
- How does this relate to other WA laws and regulations?
- How have other states addressed rw water quality and what are they looking at now?

Sources of Information

- Established practices
  - Existing standards
  - Implementation experiences
  - EPA and other states
- Available information
  - Literature review
  - Technological data - treatment processes
  - Epidemiological and toxicological data
  - Predictive Models
- Educated guesses

What is in the wastewater?
How did it get there?



Untreated Wastewater Composition

Parameter	Units	Range	Typical
Dissolved Solids	mg/L	250-860	500
Suspended Solids	mg/L	100-400	220
BOD_5	mg/L	100-400	250
COD	mg/L	200-1,000	500
Total Organic Carbon	mg/L	100-400	250
Volatile Organics (VOC)	mg/L	0.100- 0.400	250
Total Nitrogen	mg/L	15-90	40
Total Phosphorous	mg/L	5-20	12
Chloride	mg/L	30-85	50
Sulfate	mg/L	20-60	15
Alkalinity	mg/L	50-200	100
Grease	mg/L	50-150	100
pH	Units	5-9	6.5-8.5

From Natural Water

- Varies widely by geographic location, source
- Inorganic Substances
  - From dissolved rocks and minerals
  - Natural evaporation processes – concentrate
    - Cations – Calcium, magnesium, potassium, sodium
    - Anions – Bicarbonate, chloride, sulfate
    - Other – Iron, aluminum, silica, boron, copper …
- Organic Substances
  - Plants, algae, microorganisms, hydrocarbons.
  - Wastewater effluent, runoff
  - Activities in the watershed
- Atmospheric deposition (inorganic or organic)

From Public Water Supplies

- Inorganic
  - Residuals after treatment
  - Metals leaching from piping or plumbing
- Organic substances
  - Residuals after treatment
  - Chemical coagulants
  - Leaching from pipe coatings, linings, adhesives
  - Disinfection byproducts

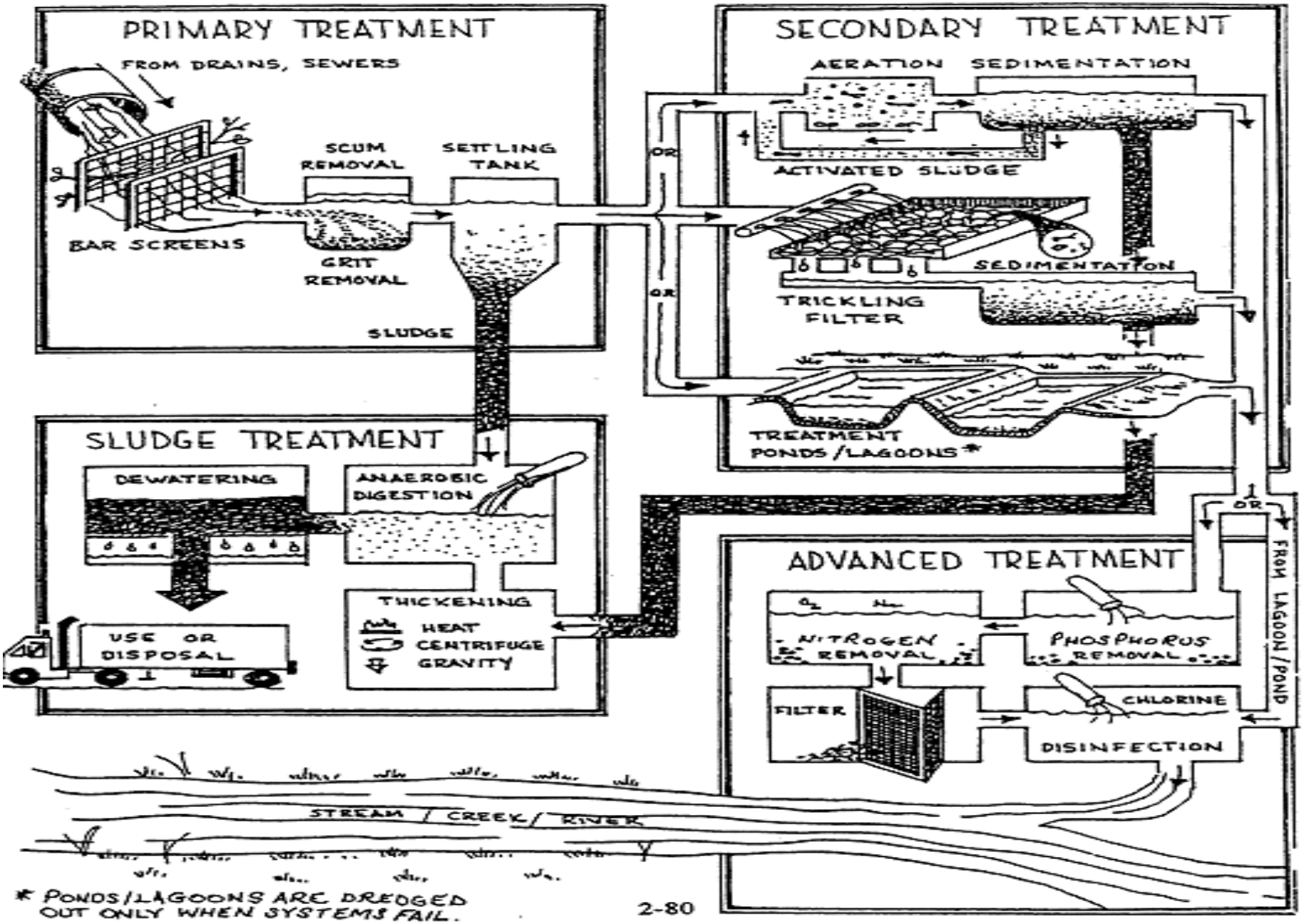
From Urban Wastewater

- Increased mineral content (TDS)
- Human organic matter
  - 40-60% proteins
  - 25-50% carbohydrates
  - 8-12% fats and oils
  - Urea
- Wide # of synthetic organic compounds.
  - Increasing industrial & commercial wastewater
  - 10,000 new chemicals each year.

From Wastewater Collection

- Reactions - chemical and biological
- Additives - odor and corrosion control and cleaning
- Stormwater - Infiltration and Inflow
  - Roadway runoff - oil, grease, tar, metals
  - Pesticides and herbicides
  - Fertilizers
  - Animal wastes
  - Decayed humic material
  - Salt and particulates
  - Other unknowns

TYPICAL WASTEWATER TREATMENT FACILITY



* PONDS/LAGOONS ARE DREDGED OUT ONLY WHEN SYSTEMS FAIL.

Primary Treatment

- **The** first stages of wastewater treatment remove settleable and floating solids.

- Generally removes
  - 40% of the suspended solids
  - 30-40% of the biochemical oxygen demand

Secondary Treatment

- **Converts** dissolved and suspended pollutants into a form that can be removed, producing a relatively highly treated effluent.

- Will remove approximately
  - 85% of the BOD
  - 85% of the TSS

Note: The minimum level of treatment for municipal wastewater

Typical Secondary Treatment Removal

Parameter	Units	Wastewater	Effluent	% Removal Typical
Dissolved Solids	mg/L	500	500	0%
Suspended Solids	mg/L	220	5-25	85%
BOD5	mg/L	250	5-25	85%
COD	mg/L	500	40 - 80	85%
Total Organic Carbon	mg/L	250	10-40	90%
Volatile Organics (VOC)	mg/L	250	10-40	90%
Total Nitrogen	mg/L	40	15-35	35%
Total Phosphorous	mg/L	12	4-10	40%

Secondary Plus Media Filtration

Parameter	Units	Wastewater	Effluent	% Removal Typical
Dissolved Solids	mg/L	500	500	**0%**
Suspended Solids	mg/L	220	2-5	98%
BOD5	mg/L	250	5-20	94%

Secondary Plus Biological Nutrient Removal

Total Nitrogen	mg/L	40	3-6	90%
Total Phosphorous	mg/L	12	1-2	88%

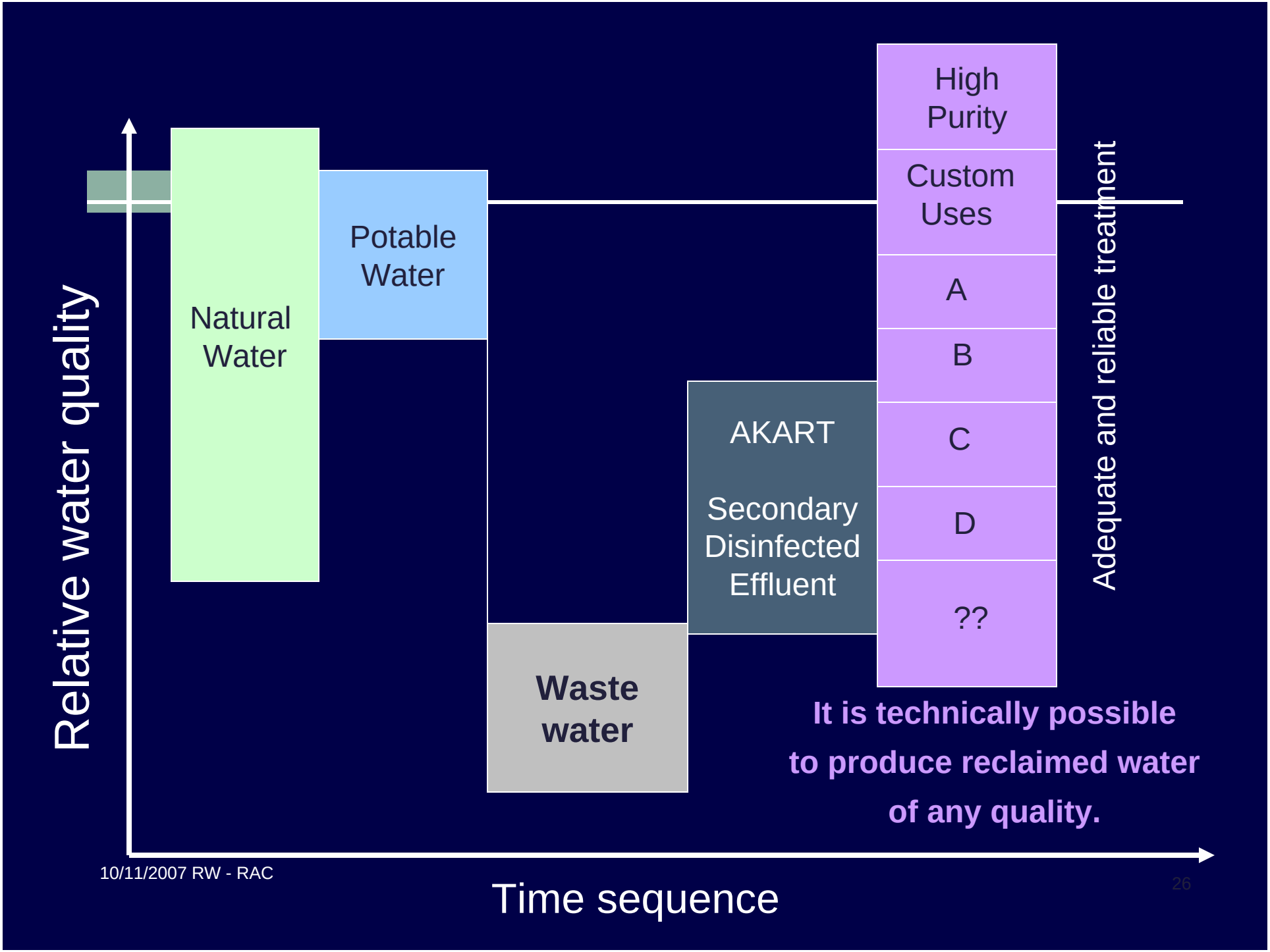
Advanced Treatment

- May be physical, chemical or biological
  - Nutrients
  - Particulate removal
  - Solids removal
  - Organic chemical removal

- Advanced Disinfection
  - Removal of virtually all pathogens

Removing Dissolved Solids

- Reverse Osmosis
- Nanofiltration
- Electrodialysis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BREAK -- Any Questions?

Next Topic: Begin Task 3

What factors affect suitability for use?

Uses of reclaimed water

- Urban uses
  - Business and industry
  - Non-irrigation uses – water features
  - Landscape irrigation

- Agricultural uses – irrigation
  - Food crops
    - Contact with water
    - Processed foods
  - Non-food crops

Environmental Contact Uses

- Groundwater recharge (and recovery)
  - surface percolation, vadose zone, direct recharge
- Wetlands
  - Creation including mitigation wetlands
  - Restoration or enhancement
- Streamflow augmentation
  - Effluent dominated or dependent waters
  - Water supply reservoirs (potable or nonpotable)
  - Downstream uses – instream flows

How the water is applied

- Infrastructure required
- Impact on soils, plants, aquifer, people
- Blending with other supplies
- Runoff and drainage
- Nutrient balances and fertilizer management

Agricultural Irrigation

- Type of crop – food or non-food
  - Impact on the crop
  - Impact on humans or animals eating crop
- Marketing of crops – public acceptance
- Worker or public exposure - aerosols
- Topography and soil characteristics
- Underlying groundwater
- How the water is applied

Urban (Landscape) Irrigation

- Public contract with the water and site
- Cross connection control – potable supplies
- Proximity to potable wells
- Type of landscape – plants, grass
- Topography and soil characteristics – impact on soils
- Underlying groundwater – impact on aquifer
- How the water is applied and application rates

Industrial and Commercial Uses

- Equipment compatibility
  - scaling, corrosion, bio-fouling
- Product compatibility – color, staining
- Health protection
  - Worker contact – public exposure - aerosols
  - Cross-connection control – dual plumbing
  - Dual distribution systems
- Quality in distribution and storage
- Cycles of concentration

Surface Water Uses

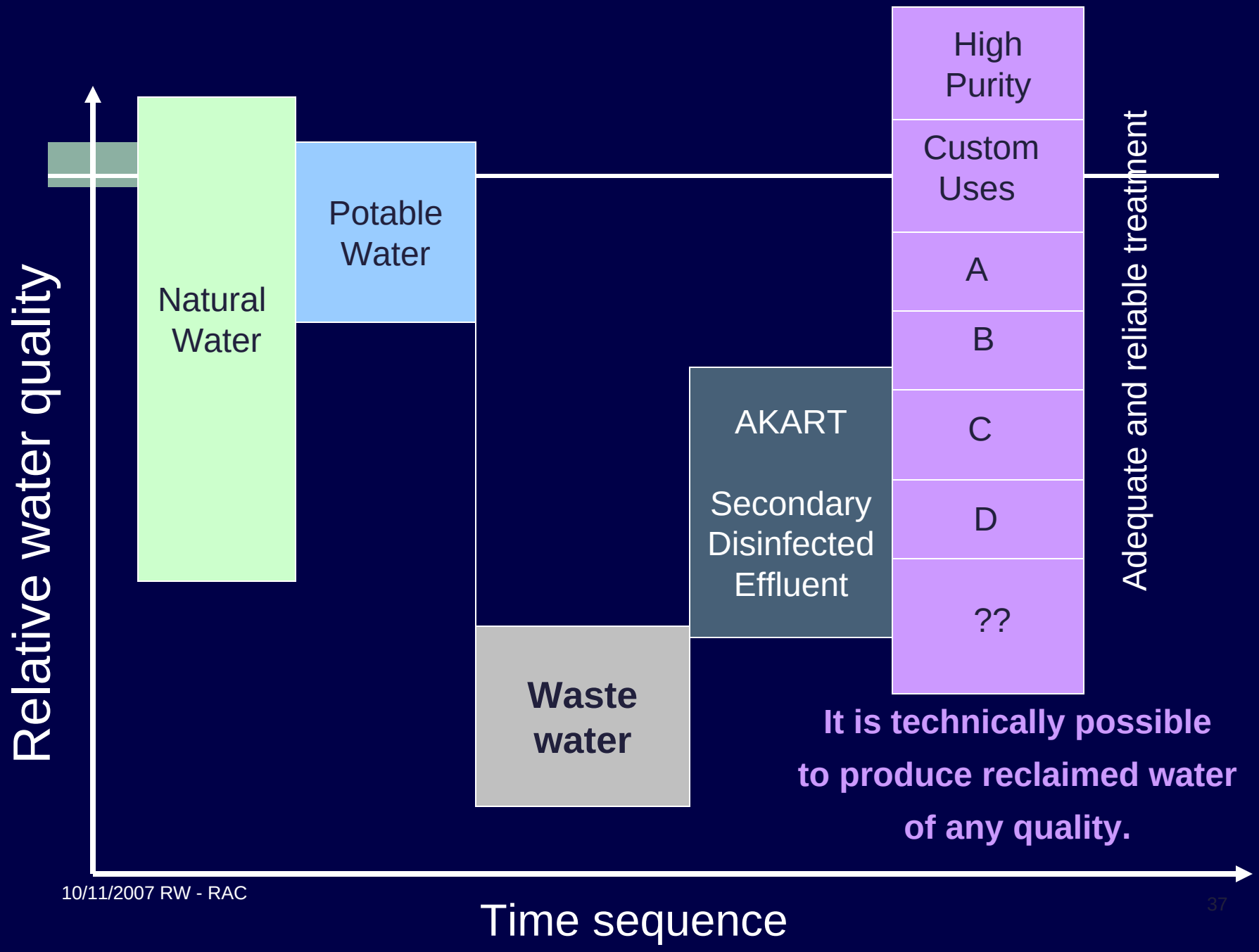
- Type of water body and downstream uses
- Degree of public contact – health protection
- Biodiversity, fish and wildlife protection
- Surface water quality standards
- NPDES requirements
- Existing water quality - antidegradation
- Supply and demand management
  - Hydroperiod, water rights, ramping of flows

Groundwater Recharge

- Point of recharge (surface, vadose, direct)
- Topography and soil characteristics
- Underlying groundwater
- Groundwater quality standards
- Existing water quality – antidegradation
- Storage and recovery – type of use
- Distance and travel time to wells

Direct Potable Use

- Pipe to pipe
- No environmental buffer
- Meet drinking water standards or better.
- Reliability
- Safety
- Public acceptance
- Currently not allowed.



It is technically possible to produce reclaimed water of any quality.

Questions on Topic Covered?

Next Topic:

What parameters are of highest concern and why?

Parameters of concern

- Pathogens (more next month)
  - Public health protection - humans
  - Domestic animals and livestock health
  - Fish and wildlife health

- Other microbiological organisms
  - Deposits - biofilms
  - Fouling/plugging of equipment
  - Corrosion – Biofilm shielding
  - Interference with heat transfer
  - Taste and odor

Parameters of concern

- Particulates (suspended solids)
  - Shields microorganisms from disinfectants
  - May react with disinfectants
  - Clog irrigation systems
  - Deposits

- Cations, anions, minerals - hardness
  - Scale potential – calcium, magnesium, sulfate, phosphate, silica, fluoride, combinations
  - Alkalinity – foaming, deposits, corrosion

Parameters of concern

- Color – iron, manganese
  - Staining, react with dye processes
- pH
  - Effects disinfection efficiency, coagulation, metal solubility, alkalinity of soils.
- Heavy metals
  - Bio-accumulation in crops
  - Phyto-toxicity

Parameters of concern

- Biodegradable organics
  - Aesthetics, nuisances, toxicity – all uses
- Fats, oils and grease
- Nutrients (nitrogen and phosphorus)
  - Nitrate leaches to groundwater
  - Deplete oxygen
  - Promote biological activity (good or bad)
  - Process interference – some industries

Parameters of concern

- Dissolved solids - salts
  - Soil build-up
  - Foliar toxicity
  - Corrosion, scaling, deposits
  - Environmental water quality
- Trace constituents
  - Environmental water quality
  - Human and aquatic life toxicity
  - Soil build-up – unknowns?

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Questions?

Next: Indicators and Surrogate Measurements of Parameters

Measuring these parameters

- Indicator - Quantifiable individual or bulk parameter relevant to fate and transport of a target parameter during treatment that provides a conservative assessment of removal of the target parameter.
  - Number or concentration

- Surrogate: Quantifiable change of a bulk parameter that can measure the performance of individual unit processes or operations regarding their removal of target parameter.
  - Δ or % removal

Indicators and Surrogates

- Biodegradation of organic material
  - Common - not predictive of very low levels
    - Dissolved oxygen
    - Biochemical oxygen demand - BOD
    - Chemical oxygen demand
    - Total organic carbon or Δ TOC
  - Potential to be more predictive of very low levels
    - Biodegradable DOC (BDOC)
    - Hydrophobic/Hydrophilic DOC
    - NH4-N, NO2-N, NO3-N
    - Fluorescence intensity
    - UV absorbance

Indicators and Surrogates

- Particulate removal
  - Common – limited on particle size measurement
    - Total Suspended Solids
    - Turbidity
  - Particle size distributions
    - Serial filtration
    - Electronic analyzers – counters
    - Direct observation - microscope

Indicators and Surrogates

- Pathogen removal - common
  - Total or fecal coliform bacteria, e-coli
  - Disinfectant dose
  - Chlorine residual
  - UV intensity, transmittance

Indicators and Surrogates

- Nutrient reduction
  - NO3, TKN, Total Nitrogen, Δ ammonia
  - PO4, Total phosphorus

Indicators and Surrogates

- Dissolved solids removal
  - Δ conductivity, total dissolved solids (TDS)

- Environmental life impacts
  - acute or chronic fish bioassays
  - Δ vegetative cover or plant diversity
  - Δ fish, macroinvertebrate and amphibian biomass
  - Δ wildlife density and species

Questions?

Transitioning to ……..

Existing Reclaimed Water Standards

Introduction

A Few Definitions

Instructions: 1997 Standards - Read

- Introduction (page 5)
- Definitions – (page 7)
- AKART
- Reclaimed Water
- Class A,B,C and D
- Oxidized
- Coagulated
- Filtered

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To be continued next time……..

Questions

Do these classes work?

Are the definitions clear?

to be continued . . .