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A Framework for Watershed Modeling & The Need for an Integrated Urban Water System Model

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50 Years of Watershed Modeling Conference
September 24-26, 2012
Engineering Conferences International
Boulder, CO

A Modeling Framework

WERF

Stormwater Challenge (06-SW-1)

Linking BMP Systems Performance to Receiving Water Protection to Improve BMP Selection and Design

Development Team

Colorado State University
AC Rowney, LLC
Geosyntec
CDM-Smith

Goal of SW Challenge 06-SW-1

To link BMP control effectiveness for specific pollutants and flow to receiving water loadings, impacts and water quality objectives to improve selection and design of BMP systems.

Focus Areas of the Challenge

- Build a Modeling Framework that allows users to link the watershed model of their choice to the receiving water model of their choice
  - Include BMP performance algorithms that are practical and represent the water quality behavior of BMPS
  - Include uncertainty in pollutant removal estimates for BMPs and resulting uncertainty in receiving water concentrations
  - Include Decision Support Tools to help users evaluate the relative effectiveness of alternative stormwater management scenarios

Urban Water Resources Management

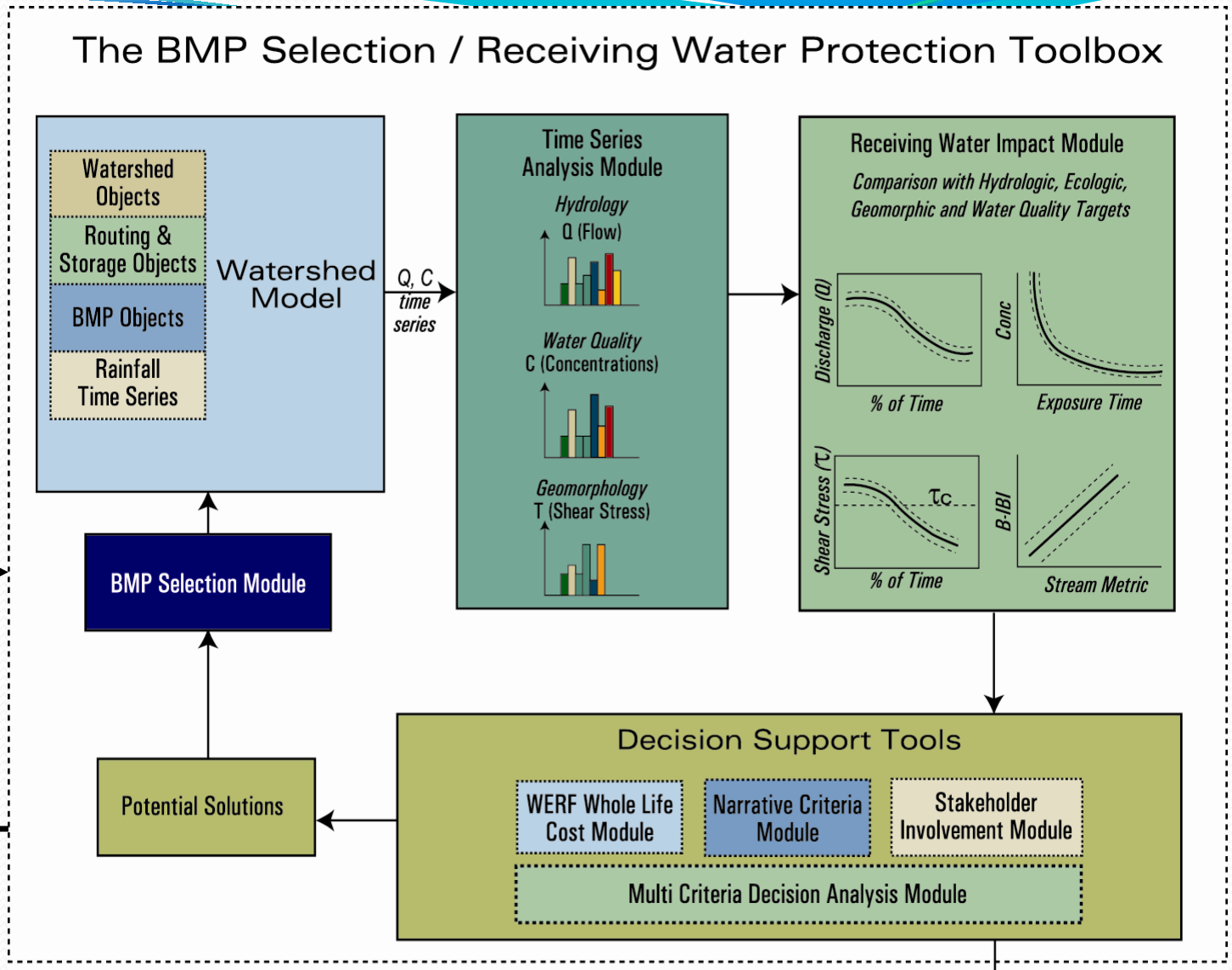
Define Goals:
Water Quality, Biologic, and Geomorphic

Select Parameters:
Water Quality, Biologic, and Geomorphic

Evaluate Land Use Patterns & Stormwater Controls

Assess Impacts:
Water Quality, Biologic, and Geomorphic

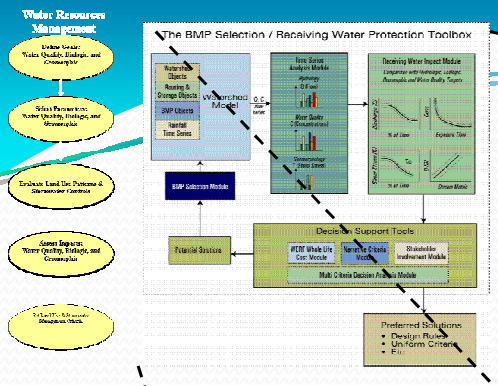
Set Land Use & Stormwater Management Criteria

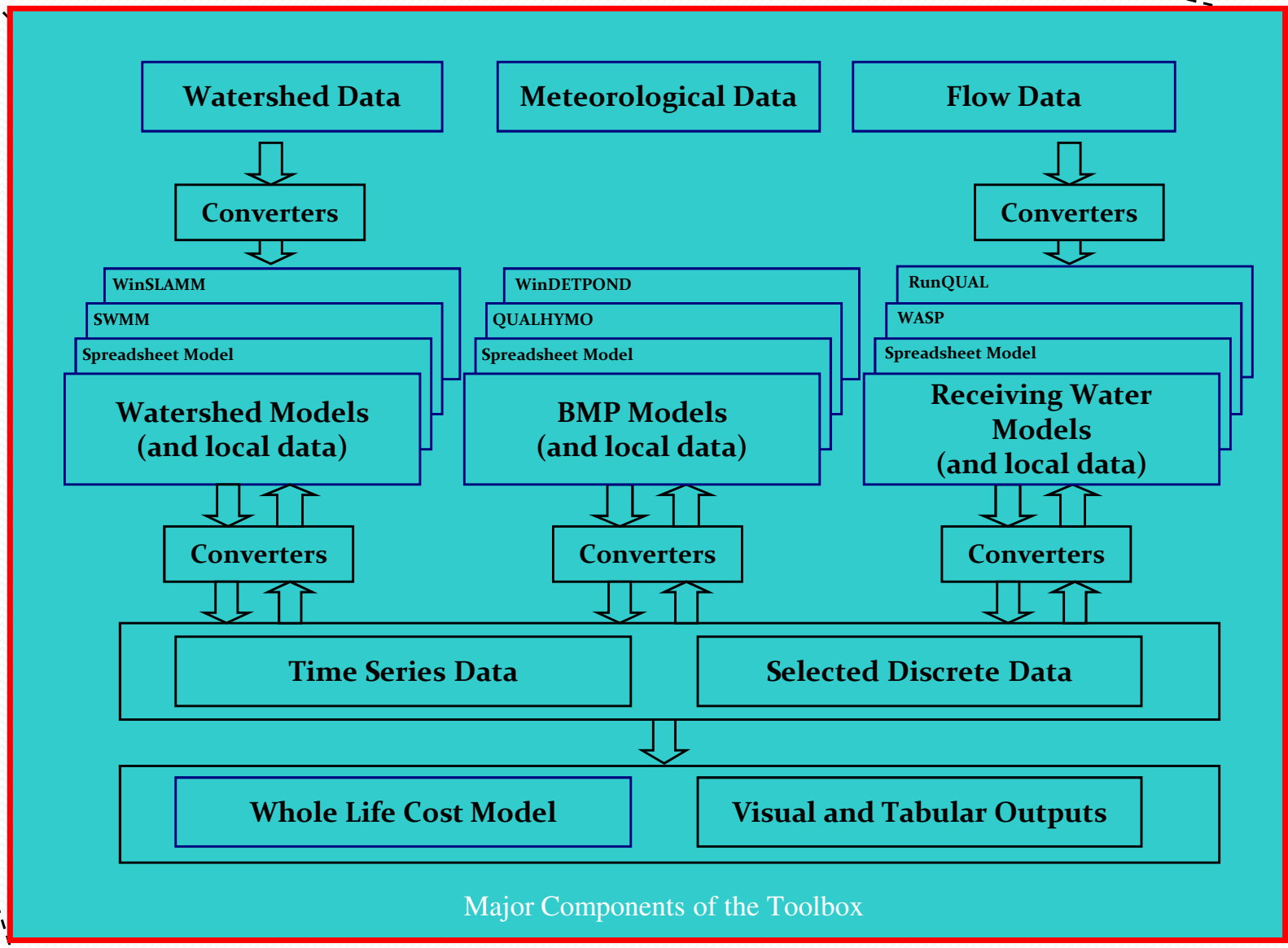


The Concept of the Framework

Preferred Solutions
- Design Rules
- Uniform Criteria
- Etc.

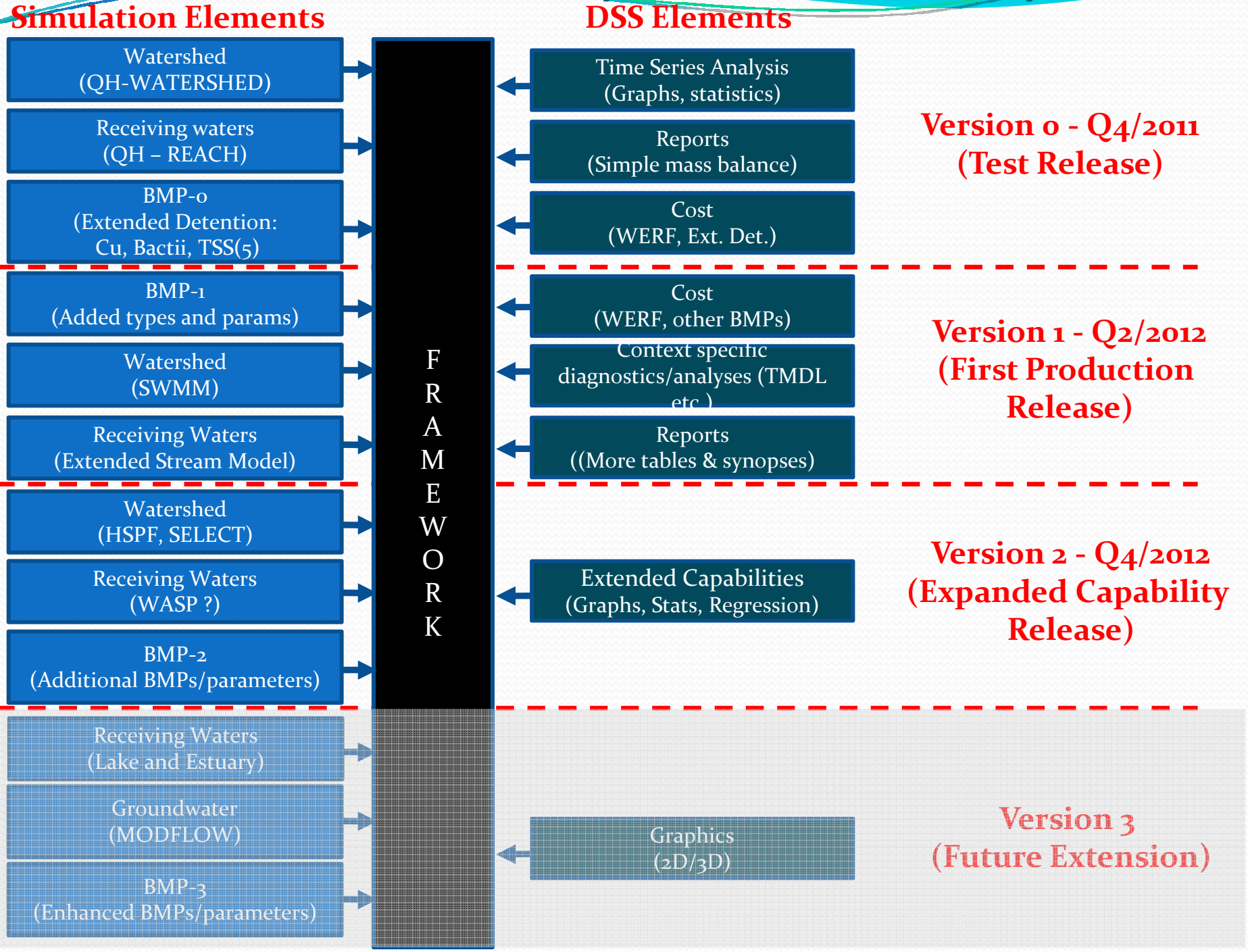
ToolBox Functional Representation





Major Components of the Toolbox

Over All Model Development Pathway



Note:

- The product will be freely available and open code
- There is no proprietary software or coding
- The product will be documented
- A Beta version is currently available and we would love to have you try it

We need an Integrated Urban Water System Model

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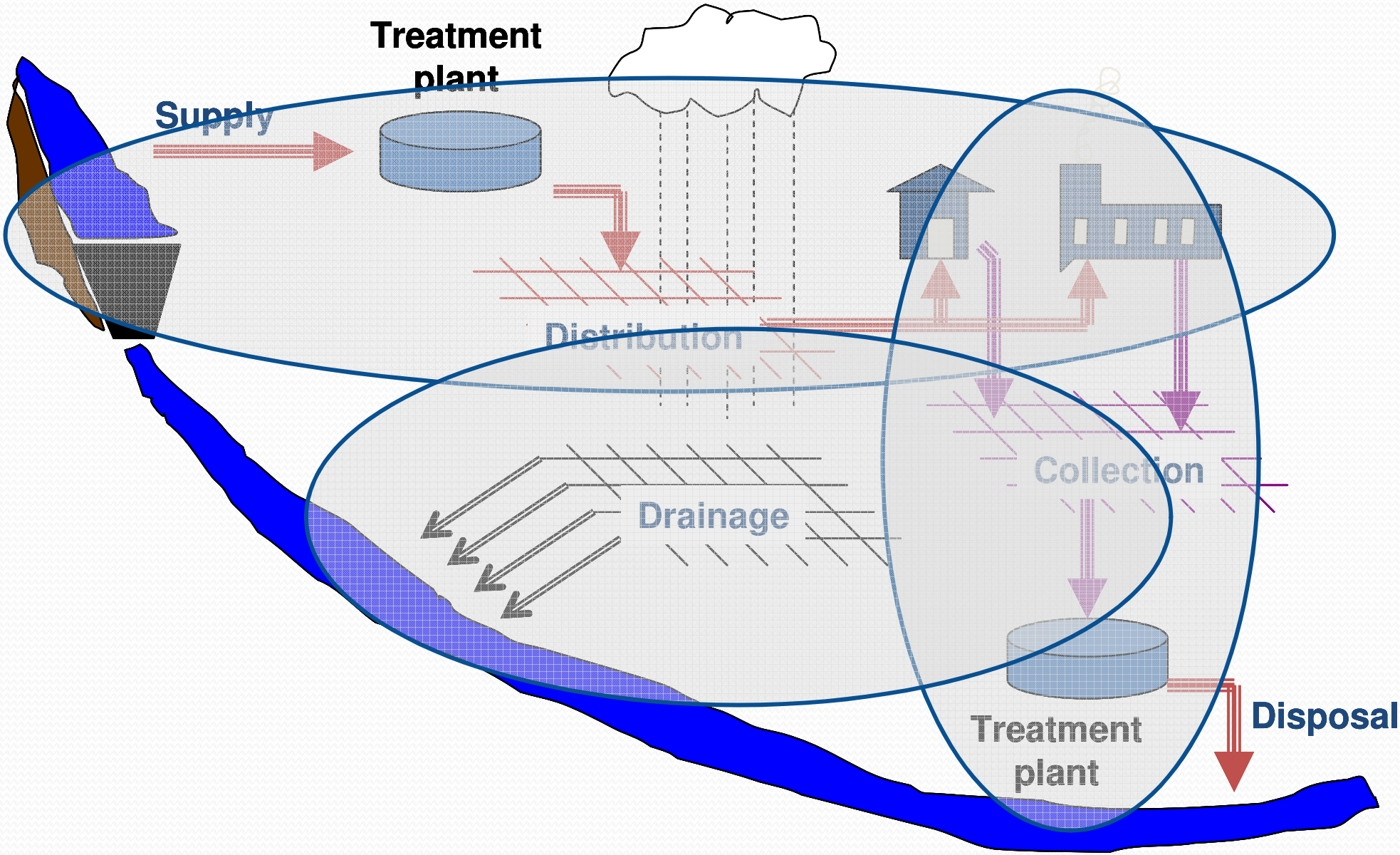
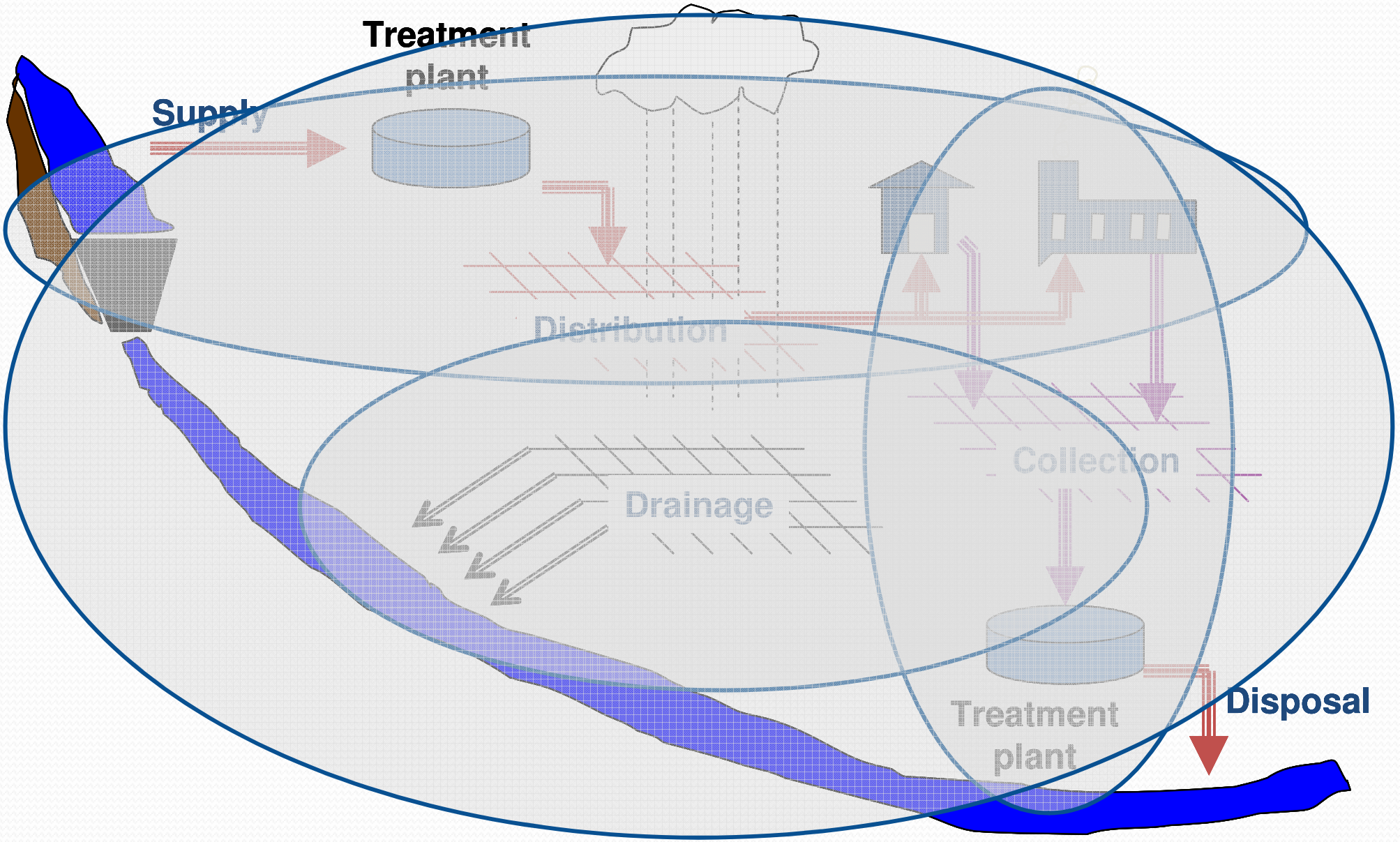
The Urban Water System



But Who is Thinking about the System?

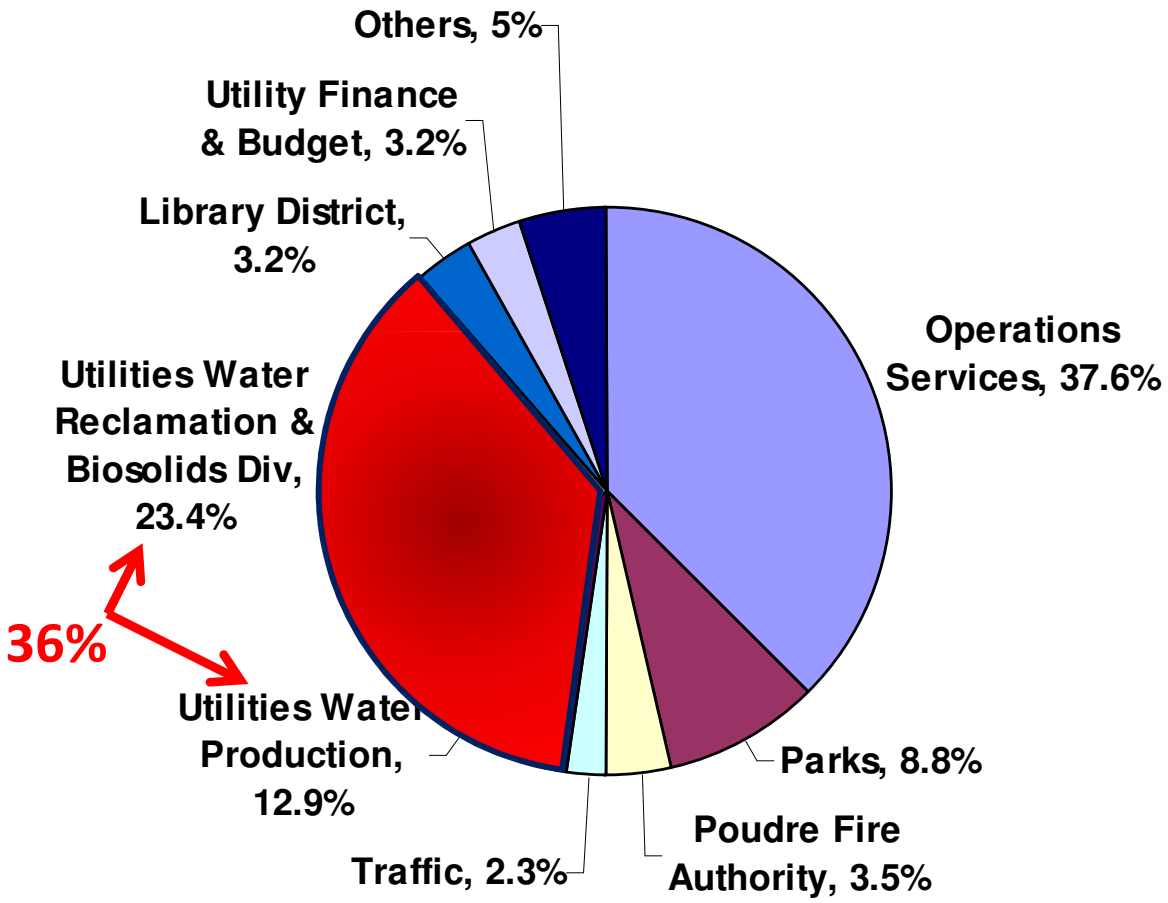


Problems with our current systems

- First, they are old, and in a deteriorated condition
- Water Supply systems
  - Water loss due to leakage
  - Maintaining water quality at the tap (?bottled water?)
  - Most drinkable water is used for non-potable uses
- Wastewater systems
  - Rainfall related inflow and infiltration
  - Costly wastewater treatment
- Stormwater systems
  - System deterioration
  - Increased flooding downstream
  - Public and aquatic health threats from CSOs and untreated stormwater

System operation is expensive

-- Energy use by the City of Fort Collins



2009 Data

Source: City of Fort Collins Open Book Project

Ideas for Reducing:

-- Water use
-- Utility Costs and
-- Energy Requirements

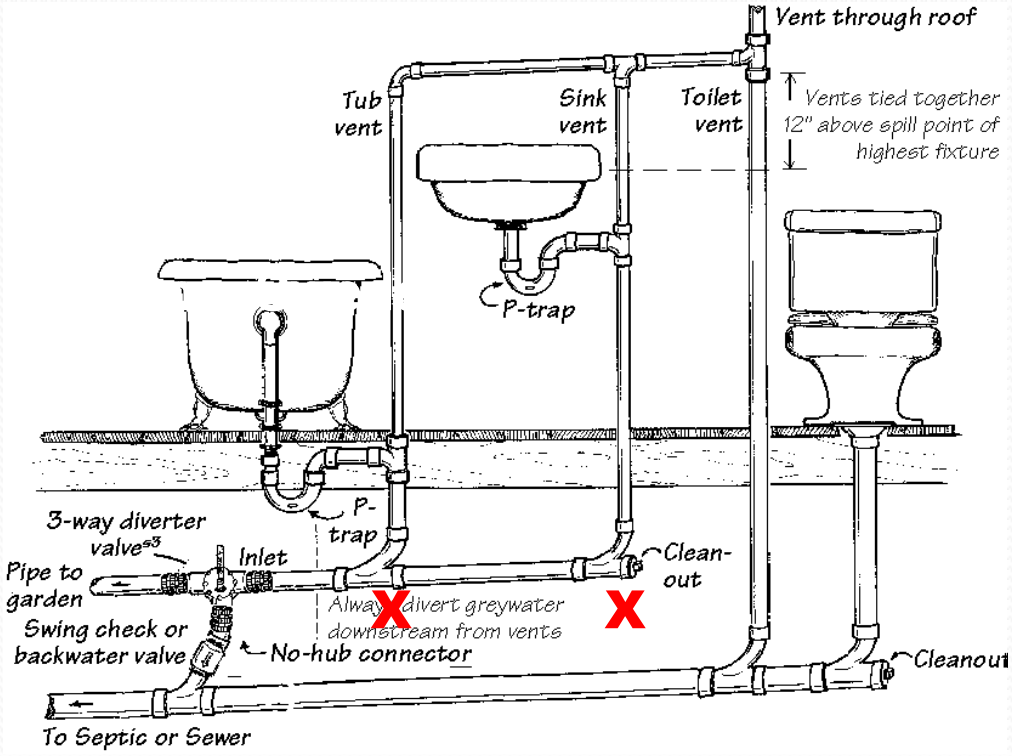
What is Graywater (Greywater)

- Graywater is water from sinks, showers, bathtubs and laundry machines
- It does not include water from kitchen sinks

Graywater Quality

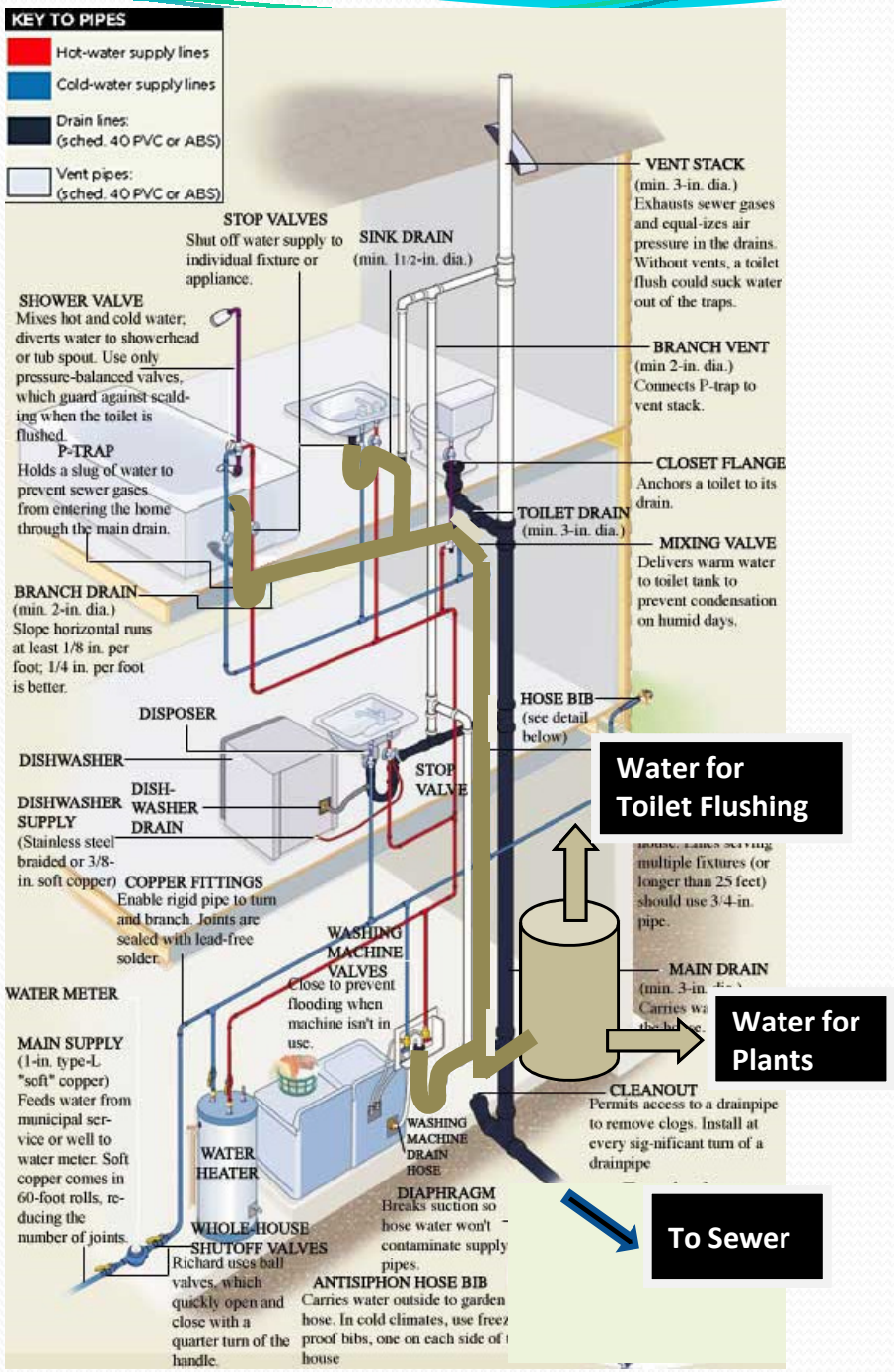
- Graywater contains soap products and anything washed from body or clothes
  - Organics
  - Bacteria
    - Minimal compared to blackwater
- Considerations for reuse
  - Nutrients
  - Salts
  - Pathogens

Plumbing aHousehold Graywater System



Note: A graywater system also includes the clothes washer

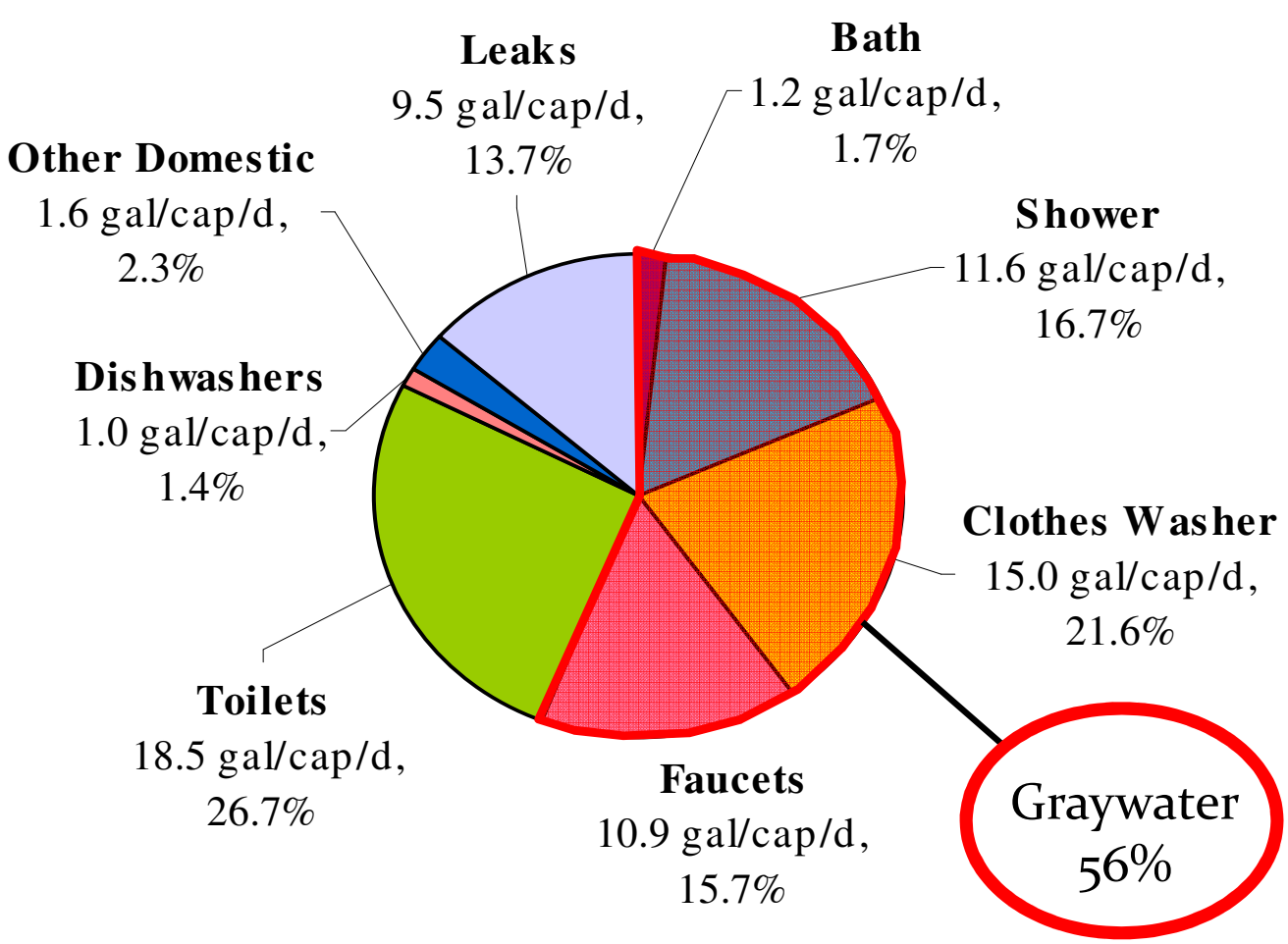
Apartment or office building graywater system



Places Using Graywater

- Australia – extensive use
  - Landscape irrigation and toilet flushing in apartments
- Singapore, Hong Kong- extensive use
- Europe – scattered use
  - Toilet flushing
- United States
  - Extensive use for landscape irrigation in California, New Mexico, Arizona, Texas
  - Pilot applications for apartments in several states

Graywater production in the USA



Source: AWWARF

Household Graywater Production
(family of four, gpd)

- Bath	4.8
- Shower	46.4
- Washer	60.0
- Faucets	43.6
- Other	6.4
TOTAL	**161 gpd**
	1128 g/wk
- Toilets	74 gpd
	518 g/wk
- Irrigation	610 g/wk

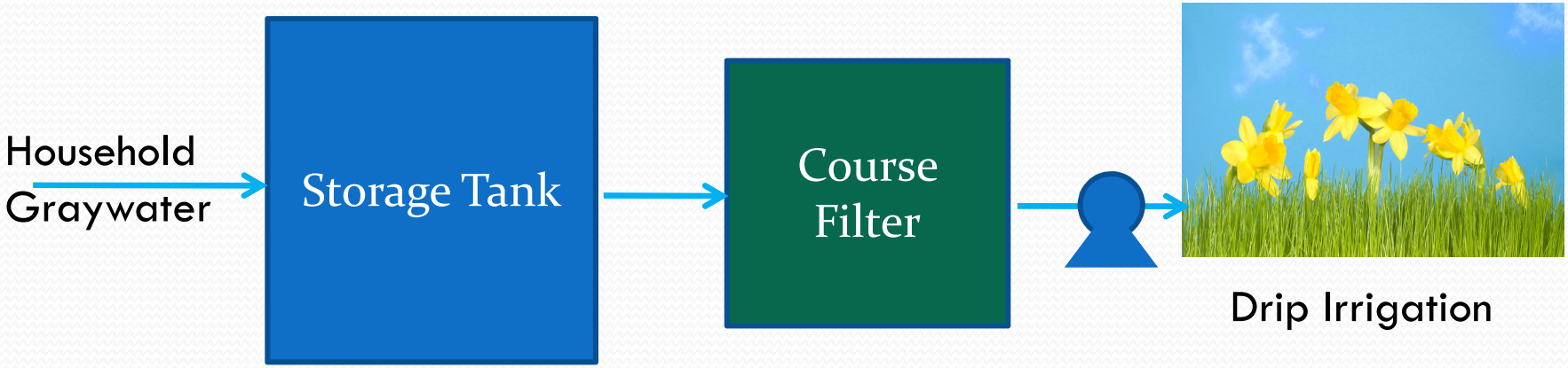
(waters 300 plants or 1000 ft^2 of grass)

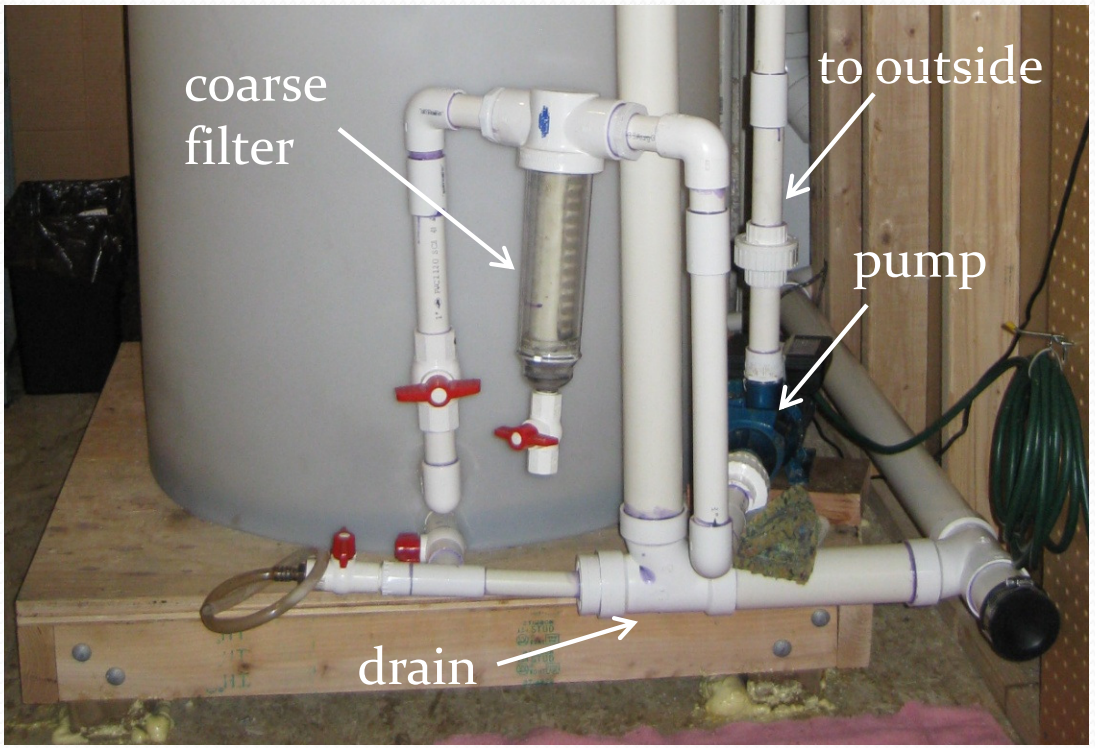
Advantage of Graywater Reuse

- Potential to reduce potable water demand by 50%
- Potential to reduce wastewater flows by 50%
- Potential to treat the more highly concentrated blackwater with Anaerobic Digestion rather that Aerobic changing wastewater treatment from an energy consuming process to an energy producing process!

A Residential Application

Roesner Graywater System





Graywater Irrigation

Graywater Quality

Consituent	Graywater Range (mg/L)	Blackwater Range (mg/L)	Domestic WW Range (mg/L)
COD	77 – 240	806 - 3138	250 - 800
BOD	26 – 130	410 - 1400	160 - 300
TSS	7 – 207	920 - 4340	390 - 1230
Total-N	1 - 20	130 - 180	20 - 70
Tot-P	0.28 – 0.779	21 - 58	4 - 12

Sources: Palmquist & Hanæus 2004 & Eriksson et al. 2003

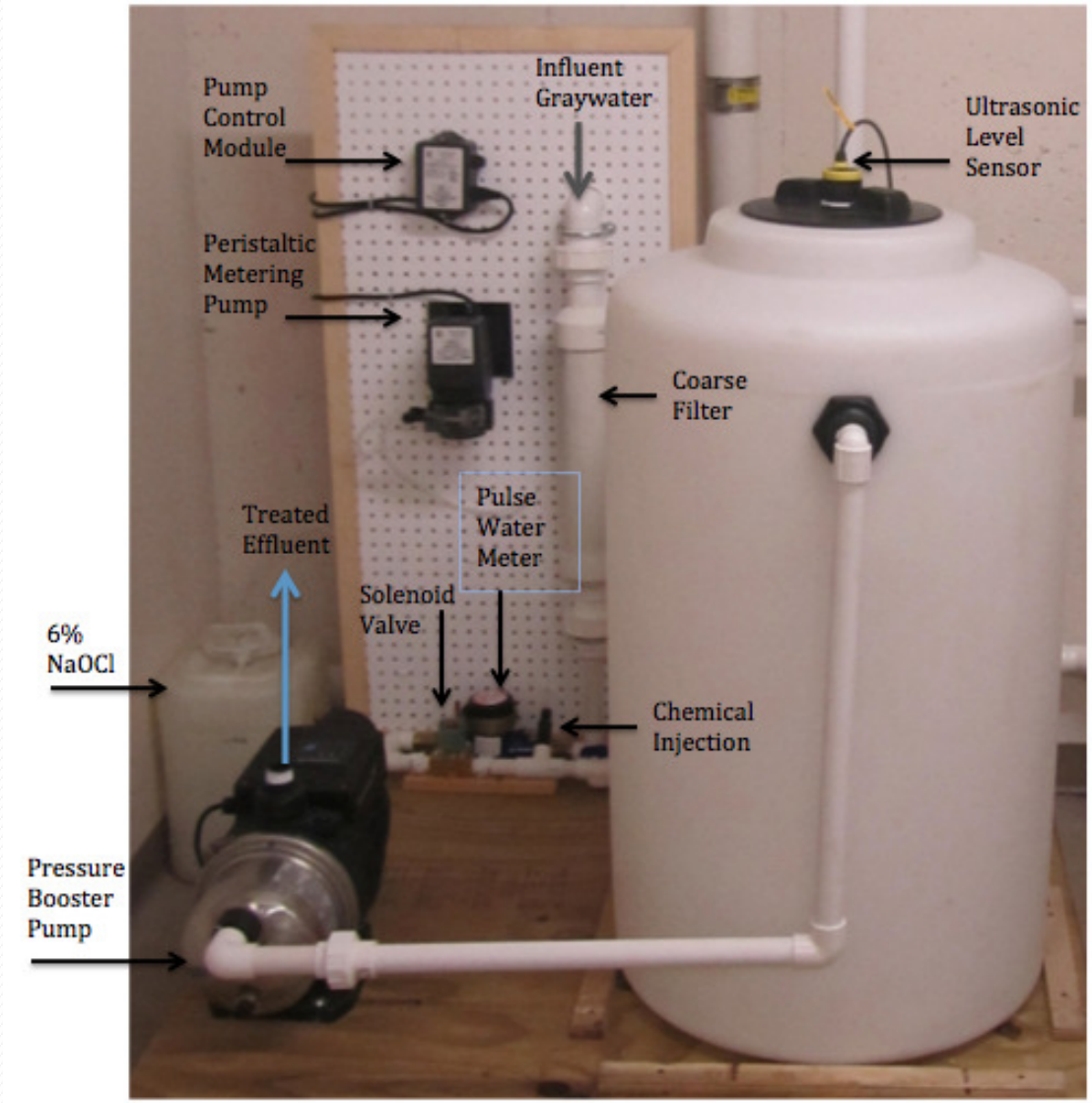
Larger Scale Applications

Multi-Family Residences

Apartment Buildings

University Dorms

Evolved Graywater System for Toilet Flushing


Pump
Control
Module
Influent
Graywater
Ultrasonic
Level
Sensor
Peristaltic
Metering
Pump
Coarse
Filter
Pulse
Water
Meter
Treated
Effluent
Solenoid
Valve
6%
NaOCl
Chemical
Injection
Pressure
Booster
Pump

Neighborhood Scale Applications

Neighborhood Scale Water and Wastewater Treatment

-- Eliminates potable water deterioration in distribution system

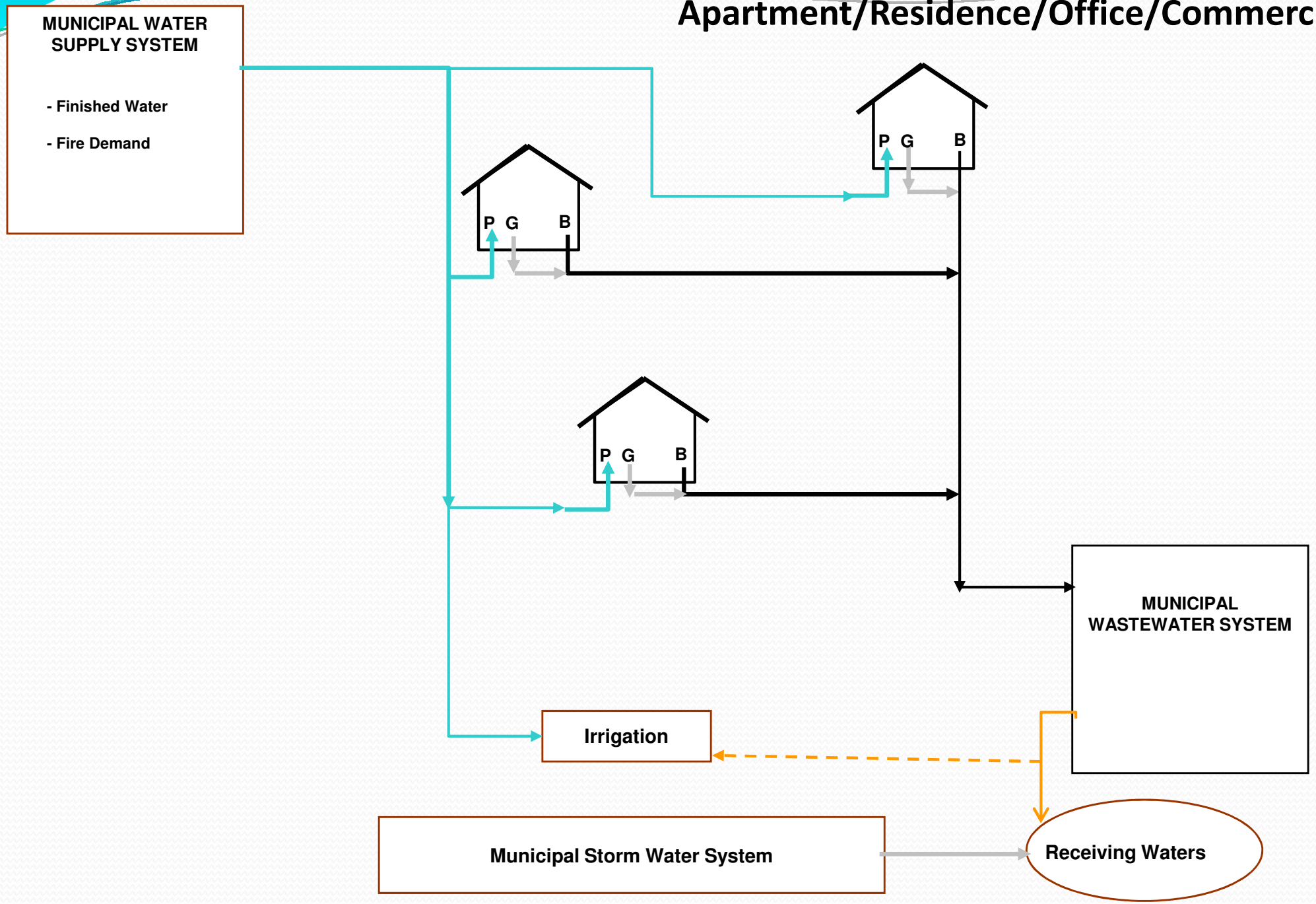
-- Reduces (eliminates) combined sewer overflows

-- Provides opportunity for an energy producing wastewater system rather than energy consuming

-- May reduce water infrastructure maintenance costs

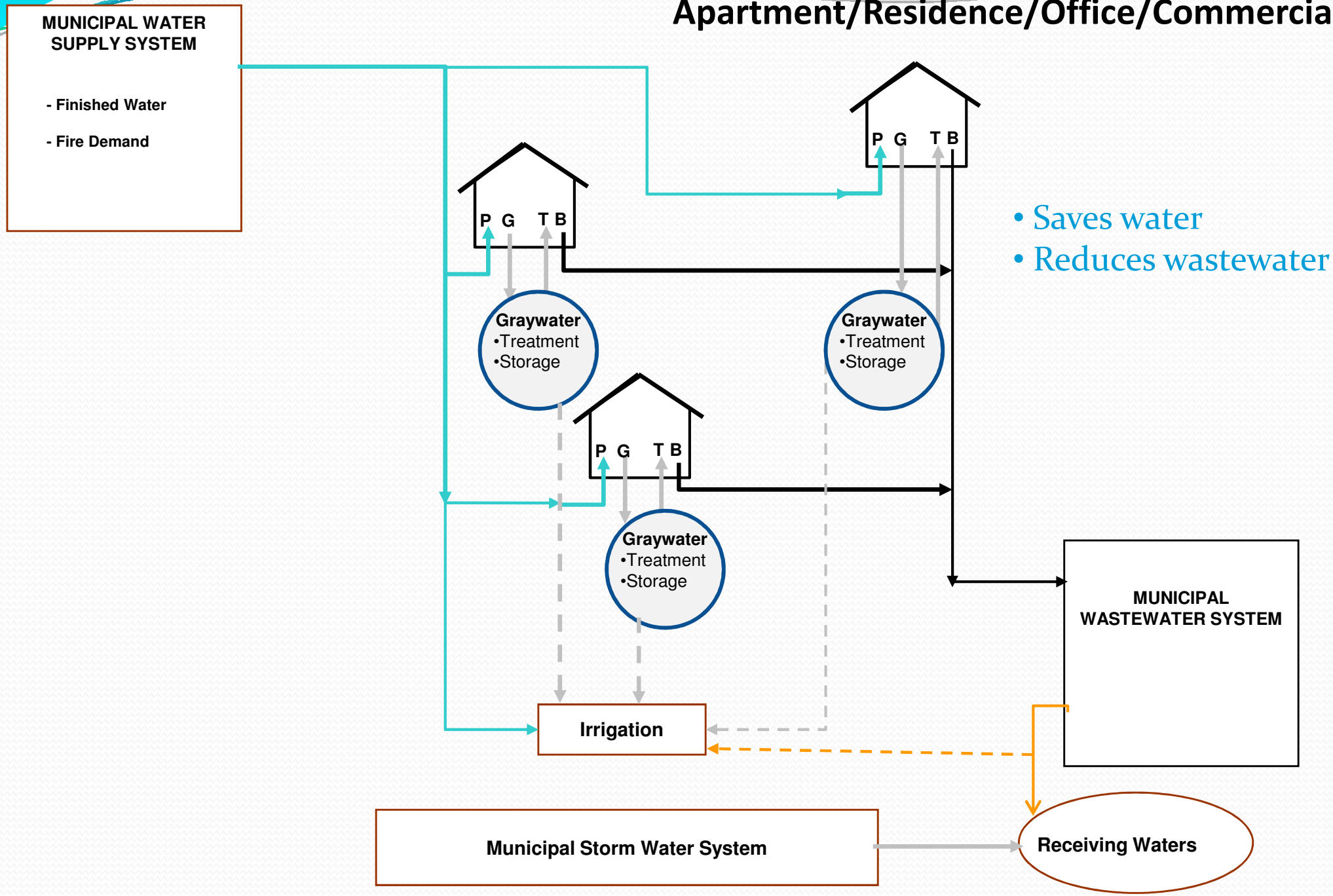
Conventional Urban Water System

Apartment/Residence/Office/Commercial



Decentralized Graywater Reuse

Apartment/Residence/Office/Commercial

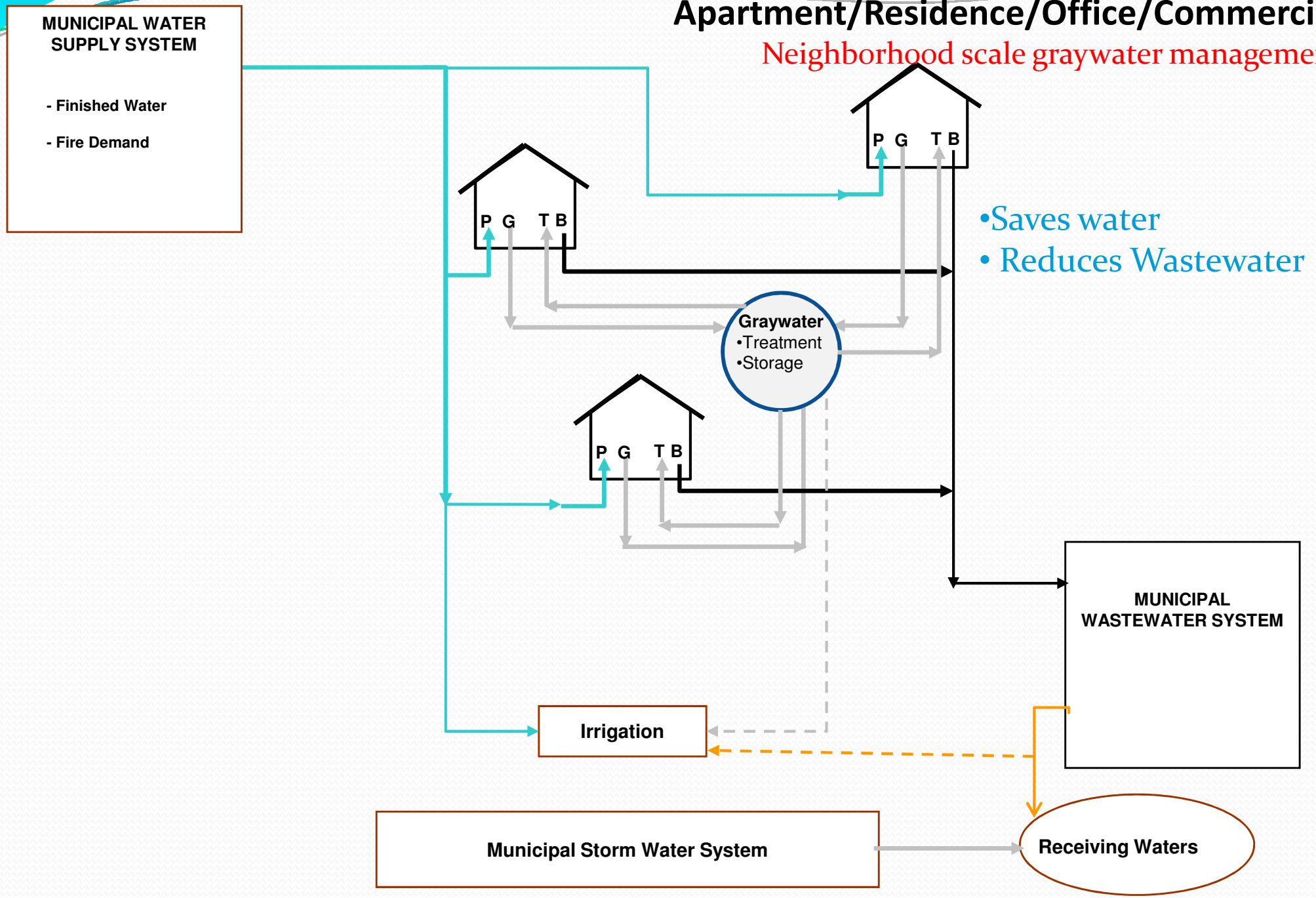


- Saves water
- Reduces wastewater

Centralized Graywater Reuse

Apartment/Residence/Office/Commercial

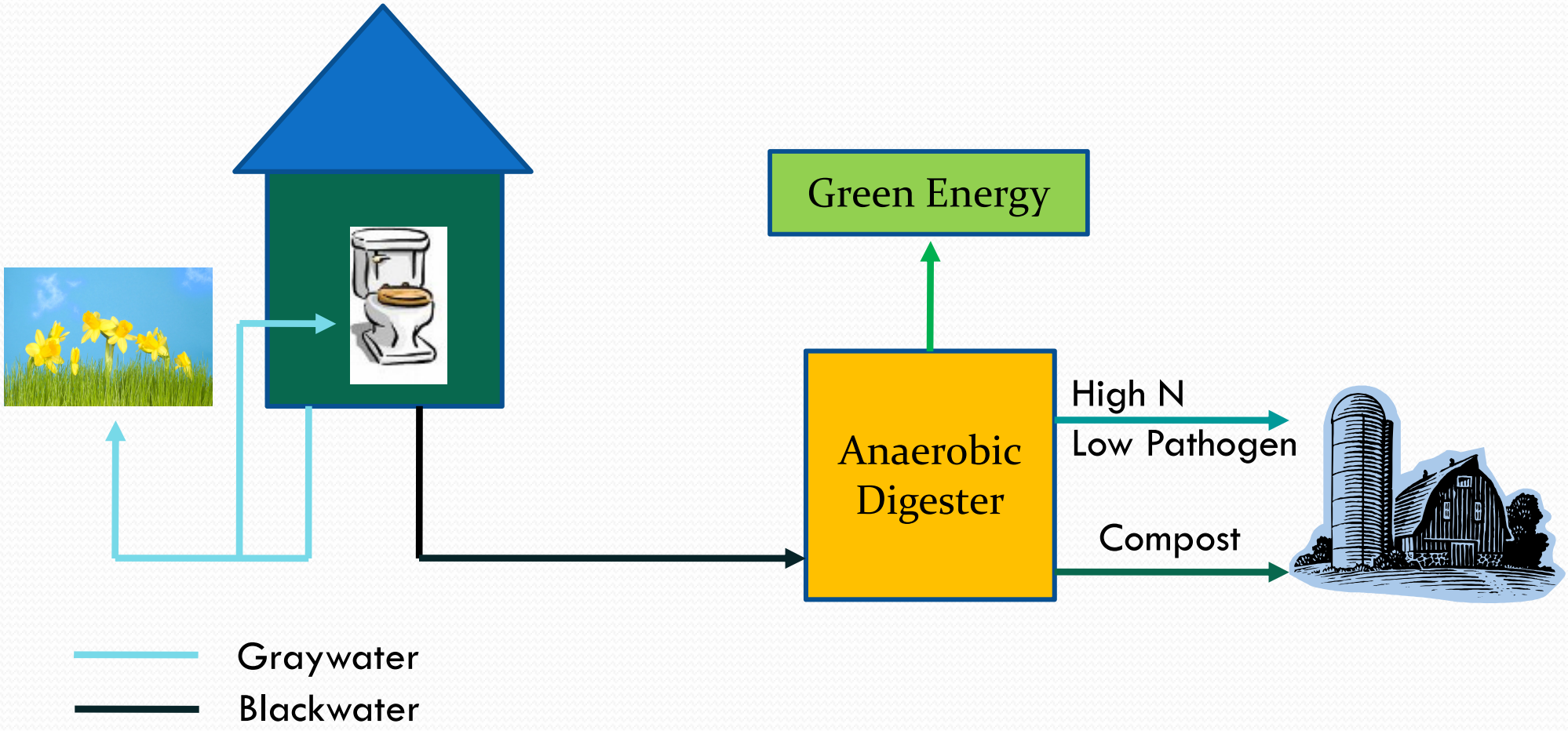
Neighborhood scale graywater management



Advanced Ideas

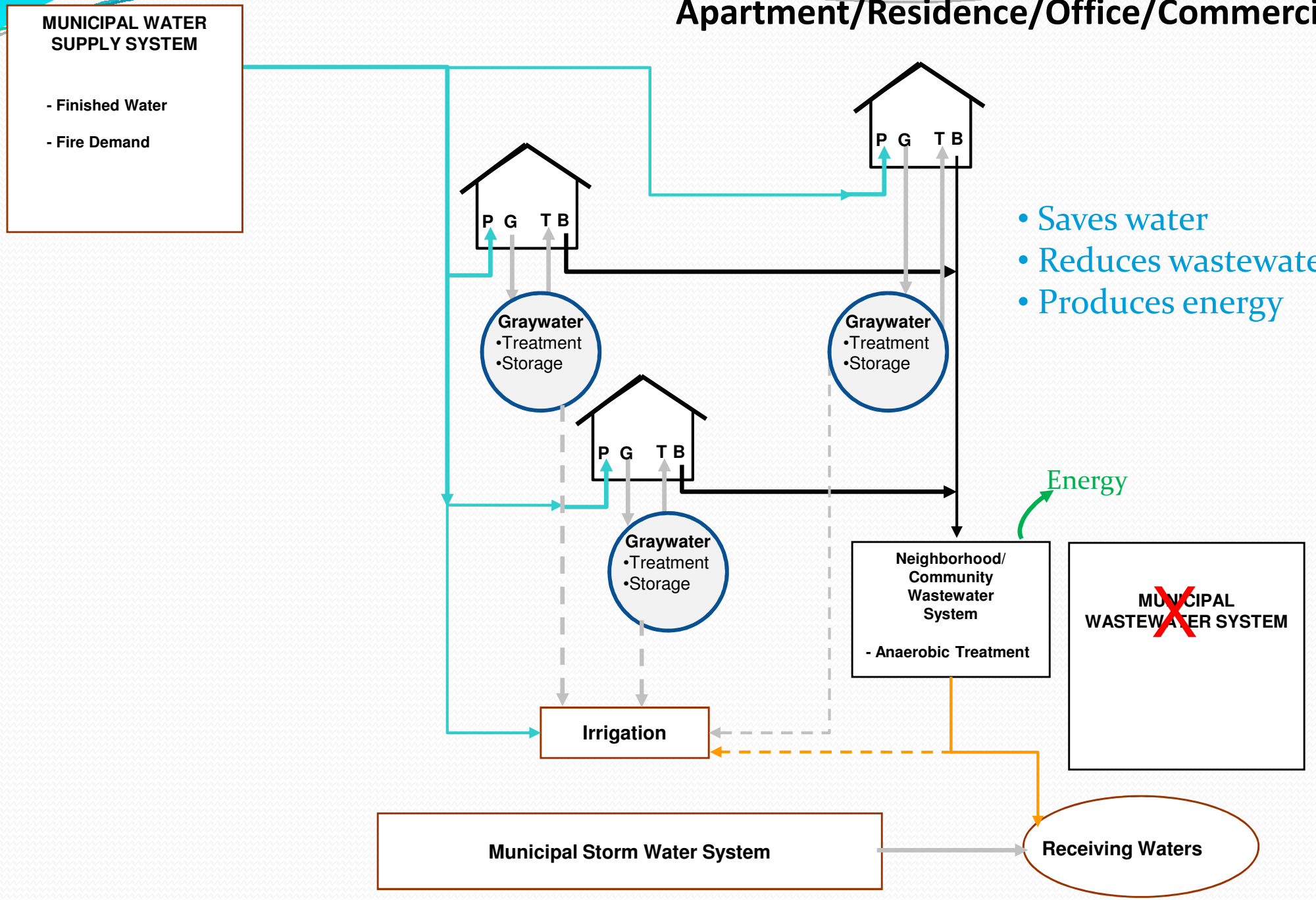
- Anaerobic treatment of black water (toilets and kitchen sinks)
  - Produces energy rather than consume it!
  - Pilot testing is being conducted at Colorado State University.

Graywater Separation with Anaerobic Treatment of Blackwater



Decentralized Graywater Reuse

Apartment/Residence/Office/Commercial

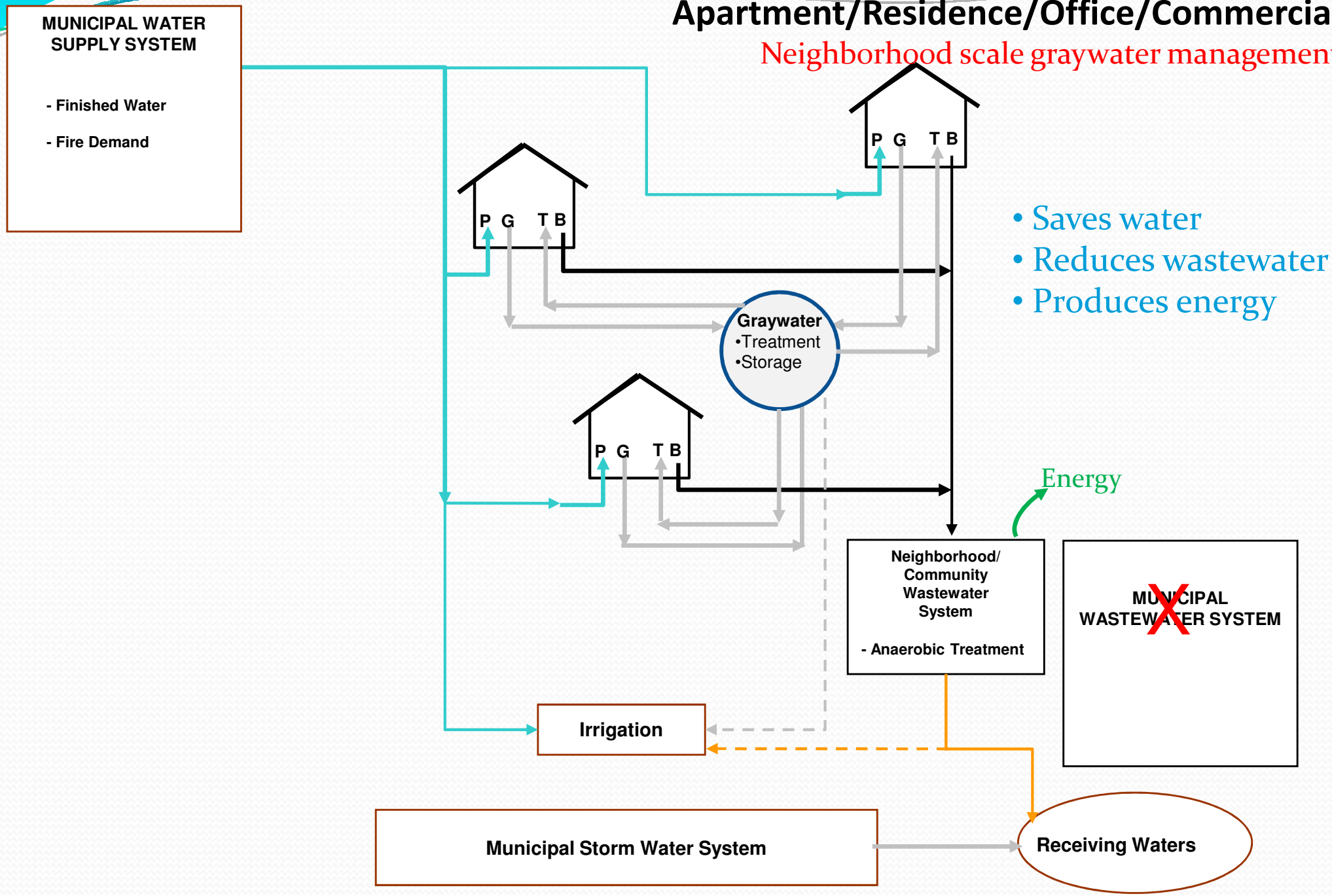


- Saves water
- Reduces wastewater
- Produces energy

Centralized Graywater Reuse

Apartment/Residence/Office/Commercial

Neighborhood scale graywater management

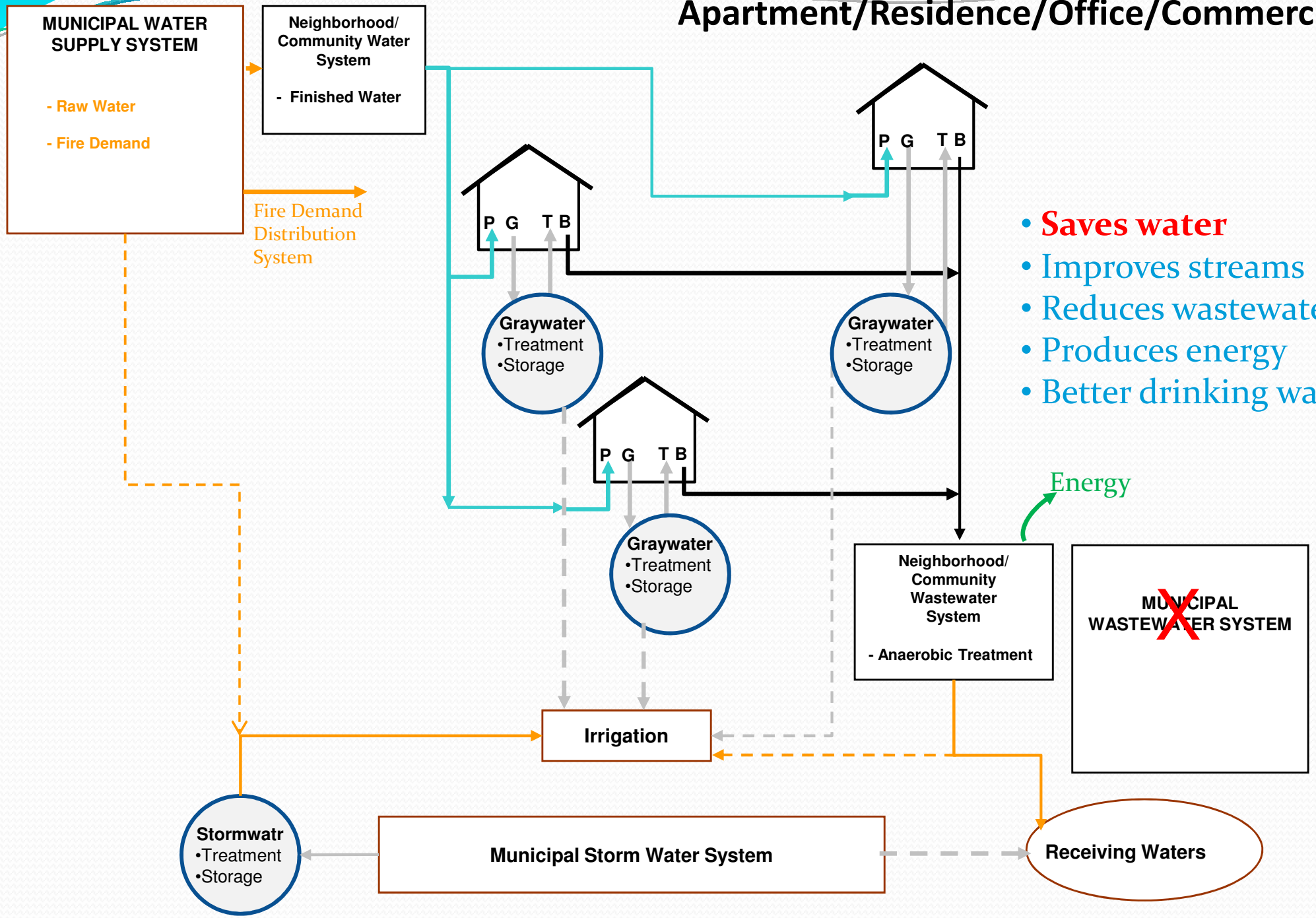


- Saves water
- Reduces wastewater
- Produces energy

Fully Integrated Water System

Fully Integrated Water System - Decentralized

Apartment/Residence/Office/Commercial

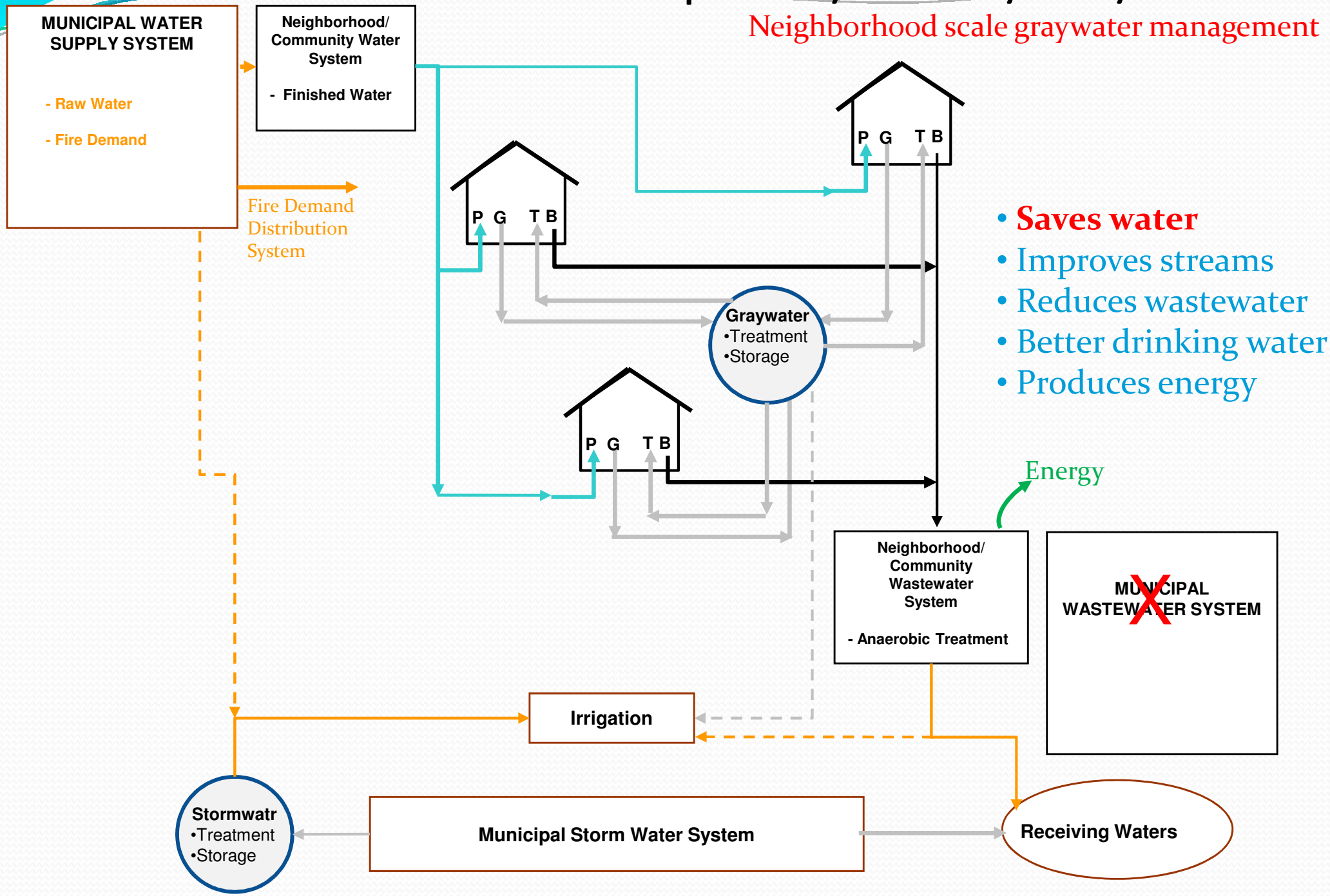


- **Saves water**
- Improves streams
- Reduces wastewater
- Produces energy
- Better drinking water

Fully Integrated Water System - Centralized

Apartment/Residence/Office/Commercial

Neighborhood scale graywater management



- **Saves water**
- Improves streams
- Reduces wastewater
- Better drinking water
- Produces energy

But we also need a cost model (Whole Live Cost)

- Treatment Costs – (capital and O&M)
  - Water
  - Graywater
  - Wastewater
  - Stormwater
- Transmission/Collection Systems
  - Water, Wastewater
  - Stormwater

Questions?