Introduction to Wastewater Treatment

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Overview

- What is wastewater?
- Why are we concerned about wastewater?
- The big picture.
- Goals for wastewater treatment are evolving
- How do we implement our infrastructure?
- Wastewater Treatment Processes – The end result is based upon your design
- Existing systems need upgrades to meet new requirements: onsite and centralized options

Wastewater Infrastructure

- All facilities serving people generate wastewater
- How to meet these needs in an economical manner?
- Options:
  - On-site
  - Clustered
  - Centralized collection and treatment

Wastewater Constituents

- Organic matter – Biochemical Oxygen Demand – indicator
- Solids – TSS
- FOG – Fats, Oil & Grease
- Nutrients – Nitrogen, Phosphorous
- Pathogens
- Medications
- Chemicals
- Metals

Public Health

- Wastewater can contain disease causing Pathogens
  - Bacteria
  - Viruses

Environmental Protection

Treat contaminants before they reach Surfacewater or Groundwater

- Nutrients
  - Phosphorus
  - Nitrogen
- Organic Loading
  - BOD_5
- Bacteria - Pathogens

The Big Picture

- In order to be an effective, long-term sustainable part of the wastewater infrastructure, onsite, cluster or centralized wastewater treatment systems must be properly sited, designed, installed, operated and maintained.
- We must have professionals who can provide system management services
- Trained professionals for all scales of infrastructure: onsite, cluster, & centralized.

Permitting Dispersal Systems

- TCEQ, Chapter 285, 5000 gallons per day or less
  - On-site sewage facility, OSSF - TCEQ
  - Septic system - Public
  - On-site wastewater treatment system, OWTS – National
- TCEQ, Chapter 317, Greater than 5000 gallons per day.
- Additional requirements for 317 Permits
  - Potential groundwater impact due to water quality and mounding potential
  - Detailed soil analysis
  - Location of water wells within ½ mile
  - Uniformity of effluent distribution

Onsite Wastewater Treatment System

Centralized Treatment System

Malfunctioning Onsite System

Malfunctioning Centralized System

Malfunction

- **Malfunctioning OSSF** – An on-site sewage facility that is causing a nuisance or is not operating in compliance with the 285 OSSF regulations.

Hard Malfunction

SOFT MALFUNCTION

Nuisance

- sewage, human excreta, or other organic waste discharged or exposed in a manner that makes it a potential instrument or medium in the transmission of disease to or between persons
- an overflow from a septic tank or similar device, including surface discharge from or groundwater contamination by a component of an on-site sewage facility; or
- a blatant discharge from an OSSF.

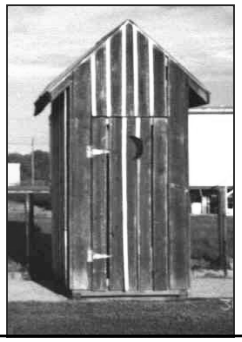
Evolution of Wastewater Management

Evolution of wastewater treatment goals

- From outdoor plumbing to water reuse

Outdoor plumbing: the pit privy

- Goal: designated place
- No carrier needed to convey waste
- Waste applied directly to the soil
- Public health concerns addressed
- Management: relocate

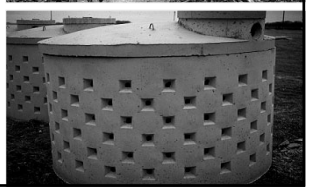


Indoor plumbing

- Convenience
- Water carrier to convey waste out of facility
- 'Collection system'
- Public health and pathogens
- Management: keep pipe flowing
- Where does it go?
  - Onsite
  - Sewer

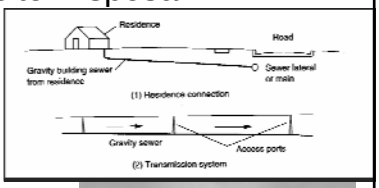
On-site Disposal

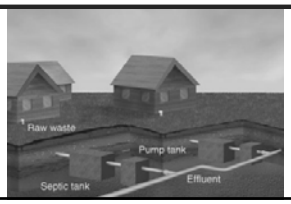
- Goal: limit human contact
- Keep wastewater below ground
- Disposal options
- Public health
  - "Disposing" of pathogens
  - Treatment or dilution?
- Environment: groundwater contamination
- Management: install, flush and forget



Off-site Disposal

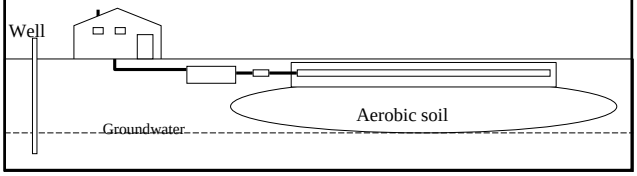
- Centralized sewer
  - Collection piping from houses
  - Cluster
  - Community
- Type of sewer
  - Gravity
  - Vacuum
  - Small diameter
  - STEP /STEG
- Treatment?





Septic tank and soil treatment area

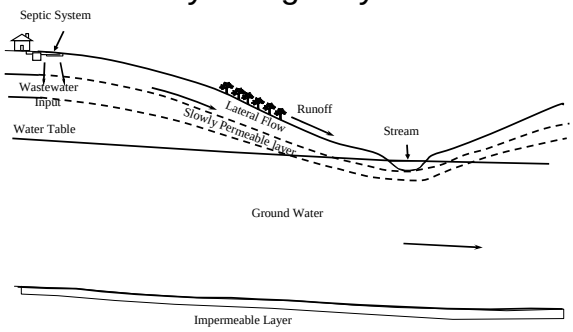
- Evolving goal:
  - Disposal: effluent goes away versus treatment
  - Dispersal: TREATMENT
- Public health AND environmental issues addressed
- Management:
  - Disposal: often none at all;
  - Dispersal: System management is critical



Goal: TREATMENT AND DISPERSAL

- Starting to address both environmental concerns in addition to public health concerns
- Technological advancements now allow removal of:
  - Pathogens
  - Solids
  - Nutrients
- System management is vital to treatment
- Goal is now DISPERSAL
  - Hydrologic cycle

Hydrologic Cycle

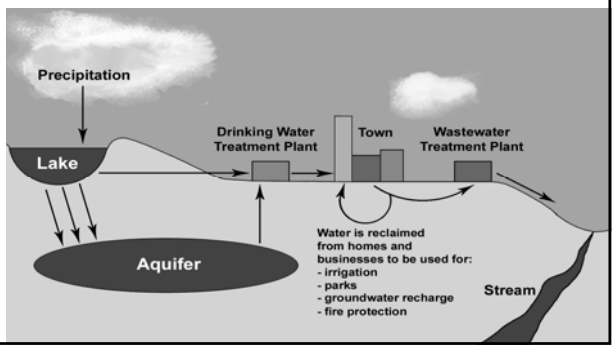


Off-Site Treatment and Dispersal

- Convey wastewater to central point.
- Contaminants removed?
  - Primary
  - Secondary
  - Tertiary
- Treatment for removal of specific contaminants
- Discharge to surface water resources

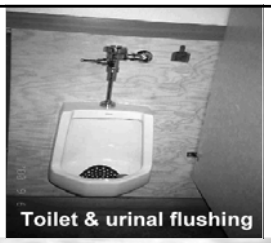
Durham County North Carolina WWTP

Centralized System & Hydrologic Cycle



Water Reuse

- Goal: careful use of a valuable resource
- Wastewater vs. water
- Potable vs. Non-potable uses
  - Landscape reuse
  - Toilet flushing
  - Tough to meet potable quality
- Management: O&M is even more critical



Evolution of Wastewater Goals

- Outdoor plumbing
- Indoor plumbing - Remove wastewater from the home.
- Disposal On-site - Prevent wastewater from surfacing in the yard.
- Disposal Off-site – Prevent contact at facility and convey to stream.
- Treatment / Dispersal On-site - Provide effective treatment before effluent reaches surface or groundwater resources.
- Treatment / Dispersal Off-site – Provide effective treatment before discharging to stream.
- Reuse - Reclaim the water.

Varying rates of evolution

- Vary across the country
- Driving forces for change
  - Limited water resources
  - Environmental concerns
    - TMDL program
    - CZMP program
    - Source water protection
  - Watershed Protection Plans

TMDL Defined

TMDL = PS-LA + NPS-LA + MOS

TMDL = Total Maximum Daily Load
PS-LA = Waste Load Allocation (PS)
NPS-LA = Load Allocation
(Anthropogenic NPS + Natural Sources)
MOS = Margin of Safety
(plus Margin for Growth?)

Changes in Goals means:

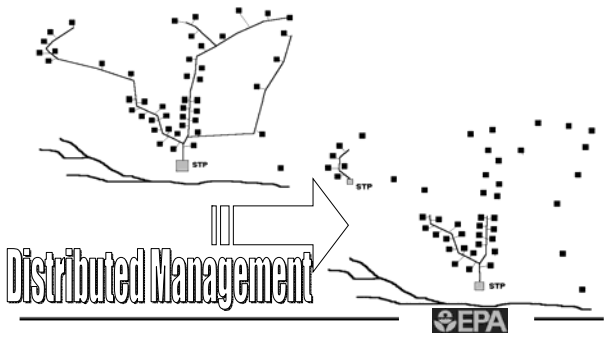
- Approach must also change
  - Siting requirements
  - Choice of treatment components and systems
  - System O&M
  - Management program
  - Industry needs

Education

Decentralized wastewater treatment system:

- Collection, treatment, and dispersal/reuse of wastewater from individual homes, clusters of homes, isolated communities, industries, or institutional facilities, at or near the point of waste generation.
- Onsite, cluster and centralized. Most cost effective for the site conditions.

Decentralized Approach

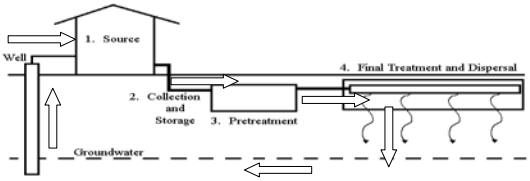


Distributed management:

- Method used to manage wastewater infrastructure where a responsible management entity (RME) combines onsite, cluster and centralized treatment in a cost effective and sustainable structure.

What is an Onsite Wastewater Treatment System?

1. Wastewater Source
2. Collection and Storage
3. Pretreatment components
4. Final Treatment and Dispersal components



Wastewater source

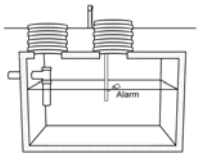
- User
  - Domestic
  - Commercial
  - Industrial

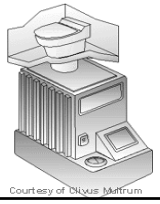
Collection

- Piping from facility with cleanout
  - Blackwater
  - Graywater

Collection Options

- Holding tanks
- Composting toilets
- Incinerating toilets

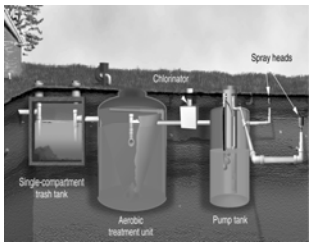




Courtesy of Dr. Jus Mukrum

Pretreatment

- Septic tanks
- Aerobic treatment units
- Media filters
- Constructed wetlands
- Membrane bioreactors
- Disinfection



Final Treatment and Dispersal Components

- Trench and bed distribution
- Evapotranspiration beds
- Low pressure distribution
- Drip field
- Spray field

What is a Central Sewer System?

- Same components
  - Source
  - Collection
  - Pretreatment
  - Advanced Treatment
  - Disinfection
  - Dispersal – mostly discharge
- Responsible management Entity

City of Cadillac, Michigan

How do we make the on-site wastewater treatment system work?

- Evaluate the wastewater source
- Evaluate site
  - Wastewater treatment
  - Wastewater acceptance
- Choose a final treatment and dispersal component
- Choose the appropriate pretreatment system
- Operation and Maintenance

Roles with Septic System Management

- Site evaluation
- Design
- Installation
- Startup
- Inspection
- Operation
- Maintenance
- Monitoring
- Pumping
- Point of Sale Inspection

Site Evaluation

- Comprehensive evaluation of soil and site conditions for a given land use.

Site Evaluator

Design

Designer

- The process of selecting, sizing, locating, specifying and configuring treatment train components that match site characteristics and facility use as well as creating the associated written documentation.
- A design is also the written documentation of size, location, specification and configuration.

Installation

- The assembly and placement of components of a system, including final grading and establishment of an appropriate cover

Installer

Startup

Installer

- The process of setting operational controls, verifying component function and documenting initial operating conditions of a system

Inspection

- The evaluation of and reporting on the status of a wastewater treatment system

Designated Representative

Operation

- The action of assessing whether <u>each</u> component of the system is functioning properly
- Each component must be operational if the system as a whole is to achieve the desired performance

Maintenance Provider/Technician

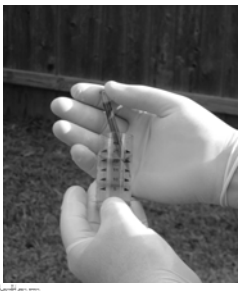
Maintenance

- The action of conducting required or routine planned performance checks, examinations, upkeep, cleaning, or mechanical adjustments to an onsite system.
- Includes Replacement of pumps, filters, aerator lines, valves or electrical components.

Maintenance Provider/Technician

Monitoring

- The action of verifying performance for a regulatory authority or a manufacturer



Maintenance Provider/Technician

Pumping

- The action of removing septage from a wastewate treatment system component

Pumper

Point of Sale Inspection

- Inspect the treatment system at the time of property sale.
- Chance to upgrade the wastewater treatment system if needed.
- Must have trained professionals.
- No licensing in Texas for this person.

Repair

- Is the action of fixing or replacing substandard or damaged components.
  - Required repairs
  - Recommended repairs
  - Upgrades

Fixing a Problem

Fixing a Problem

Why Perform Operation and Maintenance?

- Keep systems functioning properly
- Maintain effluent quality
- Early detection of problems
- Public Health
- Environmental Protection
- System Reliability
- Customer Satisfaction

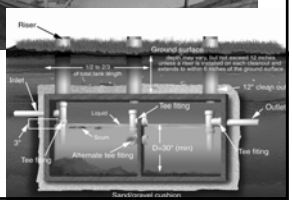
What quality do you desire?

- Primary treatment
  - Gross solids removal
- Secondary treatment
  - BOD & TSS
- Disinfection
  - Pathogen removal
- Tertiary treatment
  - Nitrogen and phosphorous

King County Washington, Vashon

Primary Treatment Components

- Septic Tank
- Bar screen
- Primary clarifier



Secondary Treatment Components

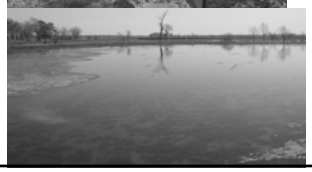
- Soil
- Aeration – Aerobic treatment
- Secondary clarifier
- Sludge return to aeration
- Membrane bioreactors

Disinfection Methods

- Soil
- Chlorine
- Ultraviolet Light
- Ozone

Tertiary Treatment Components

- Dilution
- Soil & Plants
- Nitrogen removal
  - Denitrification
- Phosphorous removal
  - Chemical addition
  - Precipitation



North Central Texas

Water Quality Project

Watershed Protection Planning for the Cedar Creek Watershed

Evaluation of Point Source Loads

Robert F. Adams, P.E.
Alan Plummer Associates, Inc.

TARRANT REGIONAL WATER DISTRICT

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Water Quality Project

Cedar Creek Watershed

- Point Source Discharges
  - Terrell
  - Willis Point
  - Kaufman
  - Kemp
  - Mabank
  - Eustace
  - Athens
  - East Cedar Creek
  - Cherokee Shores

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Water Quality Project

Objectives

- Evaluate permitted point source nutrient loads in the Cedar Creek Reservoir watersheds
- Identify significant sources of nutrients
- Quantify both current and long-term impacts
- Evaluate treatment practices available for maintaining and improving water quality
- Address costs of implementing those practices

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Water Quality Project

Approach

- Each plant was assessed for the ability to properly treat projected 2050 flows under three sets of discharge limits for nutrients.
  - **Level I**: Existing permit conditions
  - **Level II**: Phosphorus limit of 1 mg/L
    Total nitrogen limit of 10 mg/L
  - **Level III**: Phosphorus limit of 0.5 mg/L
    Total nitrogen limit of 5 mg/L

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Water Quality Project

Approach

- Plant effluent quality data collected, evaluated, and characterized for current treatment level.
- Field assessment and permit review to develop potential facilities upgrades and conceptual level cost estimates
- Plant and total nutrient loads were estimated for current, Level I, Level II and Level III conditions.

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Water Quality Project

Data Sources

- For Existing Plant Capacity and Condition
  - Field evaluations
  - Permit review
  - Discussions with plant staff
  - Surveys (when completed)
- For Current Treatment Capability
  - Review of Discharge Monitoring Reports (DMRs)
  - Nutrient testing done by the cities for TRWD
- For Projected Flows
  - Calculated primarily from projected populations at 100 gpd/ per capita
- For Projected Populations
  - Texas Water Development Board
  - Provided by facility

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Water Quality Project

Nutrient Removal Using Physical/Chemical Processes

Example:

- Level I — Current permit with 2050 flows (no changes or plant expansion)
- Level II
  - Denitrifying filters
  - Alum addition for phosphorous removal
  - Additional solids handling capacity
- Level III
  - Level II
  - Begin feeding a carbon source (methanol) for denitrificaton
  - Increase alum feed rate

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Water Quality Project

Nutrient Loads* Associated with Each Level Upgrade (2050 Loads vs. Current)

City or Facility	Total Nitrogen Load (lbs/day)			
	Current Permitted Flow	2050 Flows		
		Level I	Level II	Level III
Athens	116	129	95	48
Cherokee Shores	47	57	15	8
East Cedar Creek	122	312	133	67
Eustace	25	25	11	5
Kaufman	135	186	138	69
Kemp	24	14	9	5
Mabank	39	51	43	22
Terrell	740	947	480	240
Wills Point	80	51	43	21
Total Loads	1,328	1,771	967	484
Increase or (Decrease) from Current Load lb/day		443	(361)	(844)
tons/yr		81	(66)	(154)

*Current and Level I loads based on average effluent concentration determined by nutrient testing done by the cities

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Water Quality Project

Nutrient Loads* Associated with Each Level Upgrade (2050 Loads vs. Current)

City or Facility	Total Phosphorous Load (lbs/day)			
	Current Permitted Flow	2050 Flows		
		Level I	Level II	Level III
Athens	24	27	10	5
Cherokee Shores	5	6	2	0.8
East Cedar Creek	11	29	13	7
Eustace	5	5	1	0.5
Kaufman	29	39	14	7
Kemp	5	3	0.9	0.5
Mabank	13	17	4	2
Terrell	151	194	48	24
Wills Point	18	11	4	2
Total Loads	261	332	97	48
Increase or (Decrease) from Current Load lbs/day		70	(164)	(212)
tons/yr		13	(30)	(39)

*Current and Level I loads based on average effluent concentration determined by nutrient testing done by the cities

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Water Quality Project

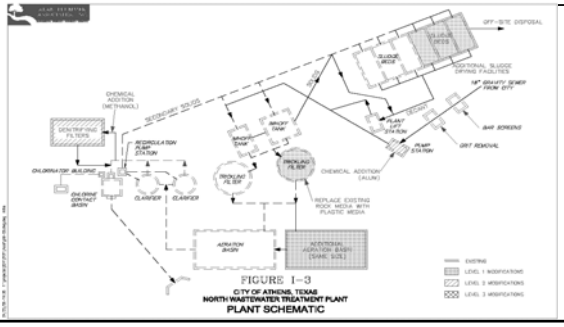

FIGURE I–3
CITY OF ATHENS, TEXAS
NORTH WASTEWATER TREATMENT PLANT
PLANT SCHEMATIC

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Water Quality Project

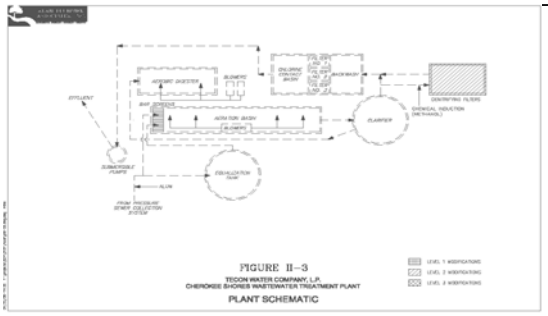

FIGURE II–3
TECON WATER COMPANY, L.P.
CHEROKEE SHORES WASTEWATER TREATMENT PLANT
PLANT SCHEMATIC

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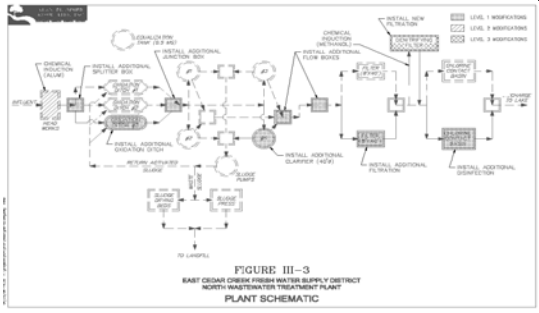

FIGURE III–3
EAST CEDAR CREEK FRESH WATER SUPPLY DISTRICT
NORTH WASTEWATER TREATMENT PLANT
PLANT SCHEMATIC

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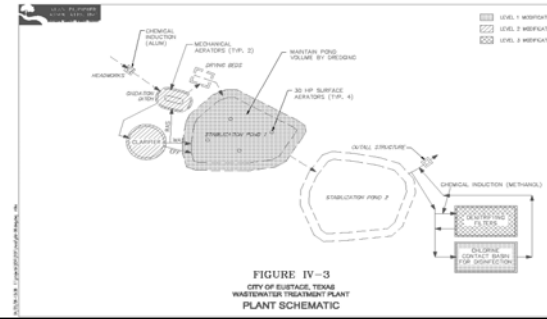

FIGURE IV–3
CITY OF EUSTACE, TEXAS
WASTEWATER TREATMENT PLANT
PLANT SCHEMATIC

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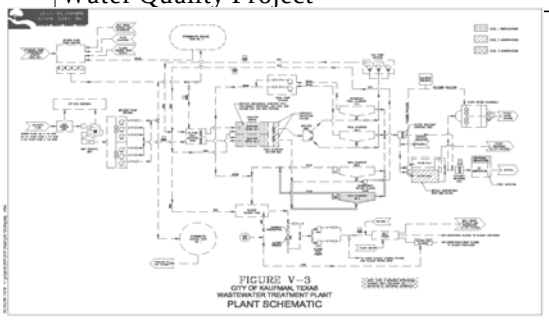

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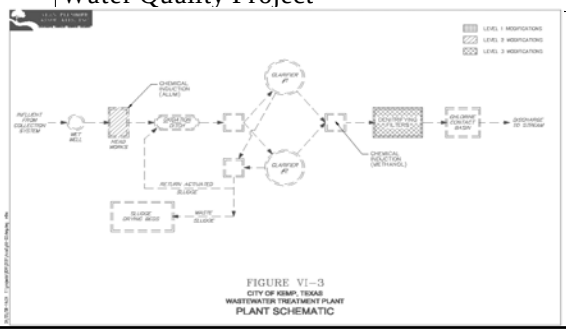

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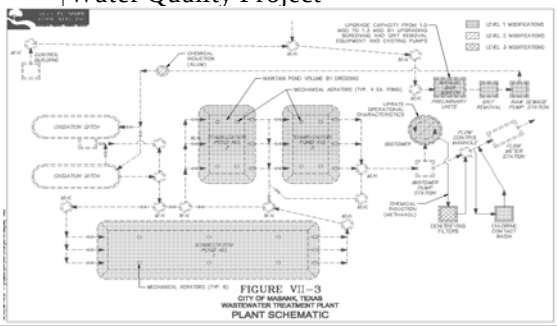

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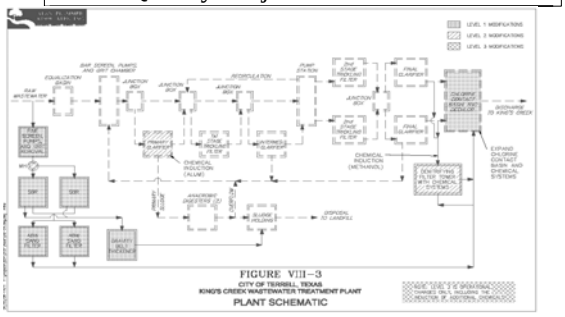

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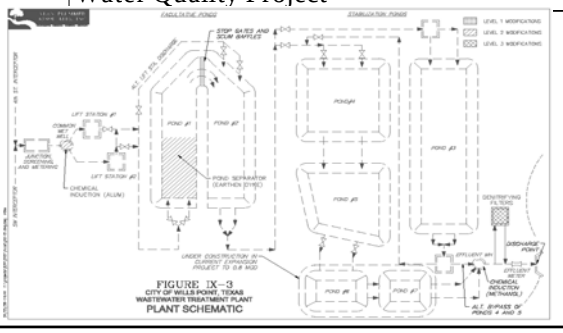

North Central Texas

Water Quality Project

City or Facility	*Costs Associated with Upgrades*		
	Level I	**Level II**	**Level III**
Athens	$3,428,914	$893,743	$76,507
Cherokee Shores	$0	$592,351	$64,915
East Cedar Creek	$4,915,008	$127,512	$912,290
Eustace	$217,930	$51,005	$549,461
Kaufman	$2,088,878	$1,659,974	$92,736
Kemp	$0	$51,005	$537,869
Mabank	$635,242	$127,512	$835,783
Terrell	$7,416,562	$3,192,437	$146,059
Wills Point	$0	$231,840	$835,783
Total Costs	**$18,702,534**	**$6,927,379**	**$4,051,403**

Summary

- Wastewater management will play a vital role in our future infrastructure needs.
- Technologies are available for removing the constituents of concern.
- Environmental regulations will continue to be more stringent.
- Environmental health is ultimate form of public health protection.

Summary

- A site evaluation is critical to determining the potential for a site to treat wastewater.
- Advanced pretreatment and final treatment and dispersal technologies are available for most situations.
- Select the most appropriate technology and scale of system for your site.
- Operation and maintenance is critical for long-term function