



CONNECTING THE DOTS:

UNINTENDED IMPACTS
OF WATER CONSERVATION
ON
WASTEWATER CONVEYANCE,
TREATMENT, REUSE AND
ORGANIZATION

BACWA
SEPT 24, 2018

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No good deed goes unpunished....

Dealing with the paradigm shift as water conservation affects

wastewater conveyance

treatment

reclamation

economy

and behavior of organizations.

ESTABLISHING A NEW BASELINE

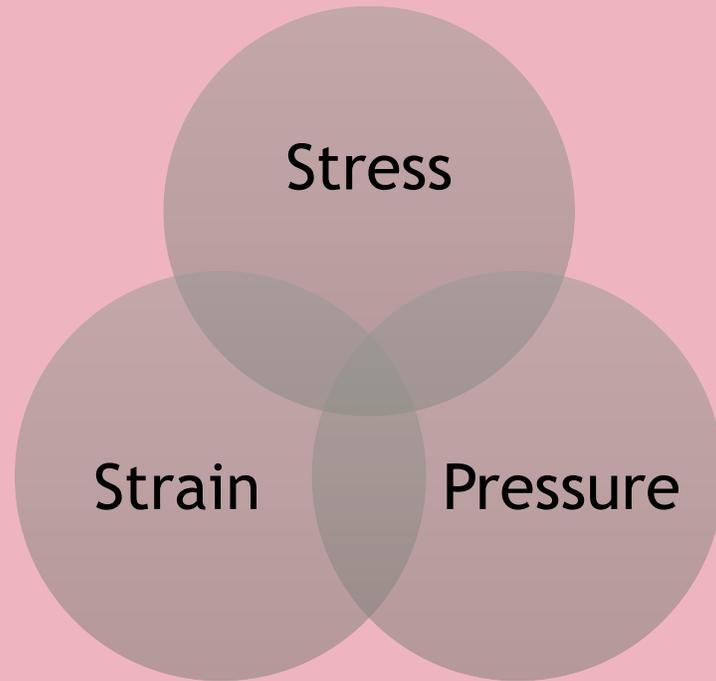
Aggressive water conservation is challenging infrastructure integrity, conditions of sewage conveyance, reliability and economy of treatment.

It is seriously challenging the ability of many facilities to meet stringent discharge requirements and maintain reuse water quality.

It needs new design approaches and technologies.

It requires a change-minded, learning organization.

Challenges of the Triple Nexus





Stress

Resource Management

- Change in source water and influent quality
- Increased demand for energy & chemicals
- Increased energy density - kWh per mgd
- Decreased energy potential - digestion and gas production
- Challenges operations knowledge and capabilities
- Increased labor attention- process & maintenance
- Increased process monitoring
- Increased laboratory support



Strain

Reliability

- Asset performance, availability and reliability
- Increased wear and tear on equipment
- Loss of redundancy
- Overload equipment design capacity
- Increased rate of failure
- Reduced expected life
- Increased replacement rate
- Increased labor burden - reactive vs. predictive
- Reduced quality and quantity of reuse water

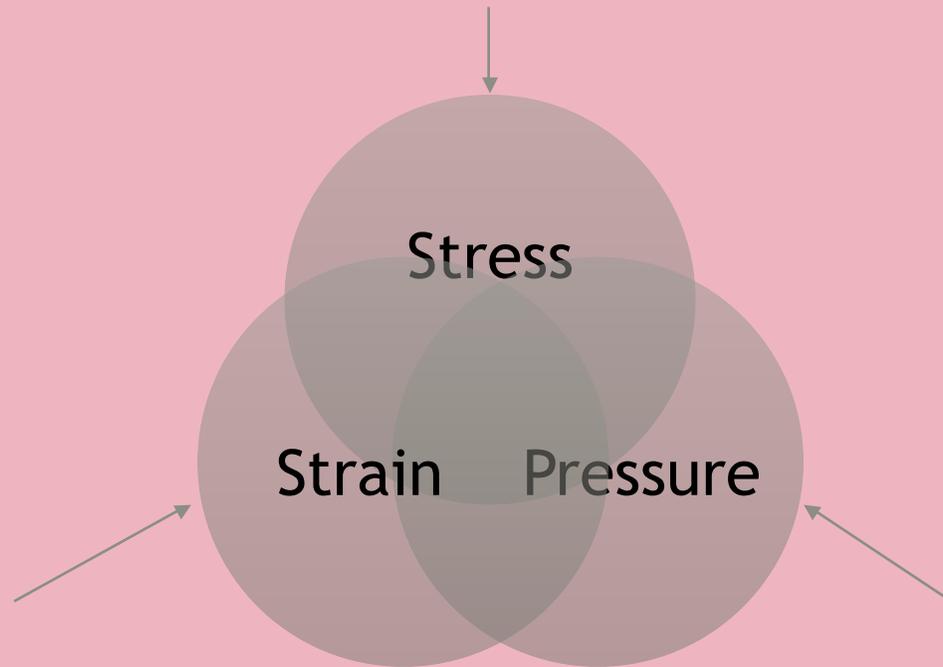


Pressure

Infrastructure and Organizational Planning

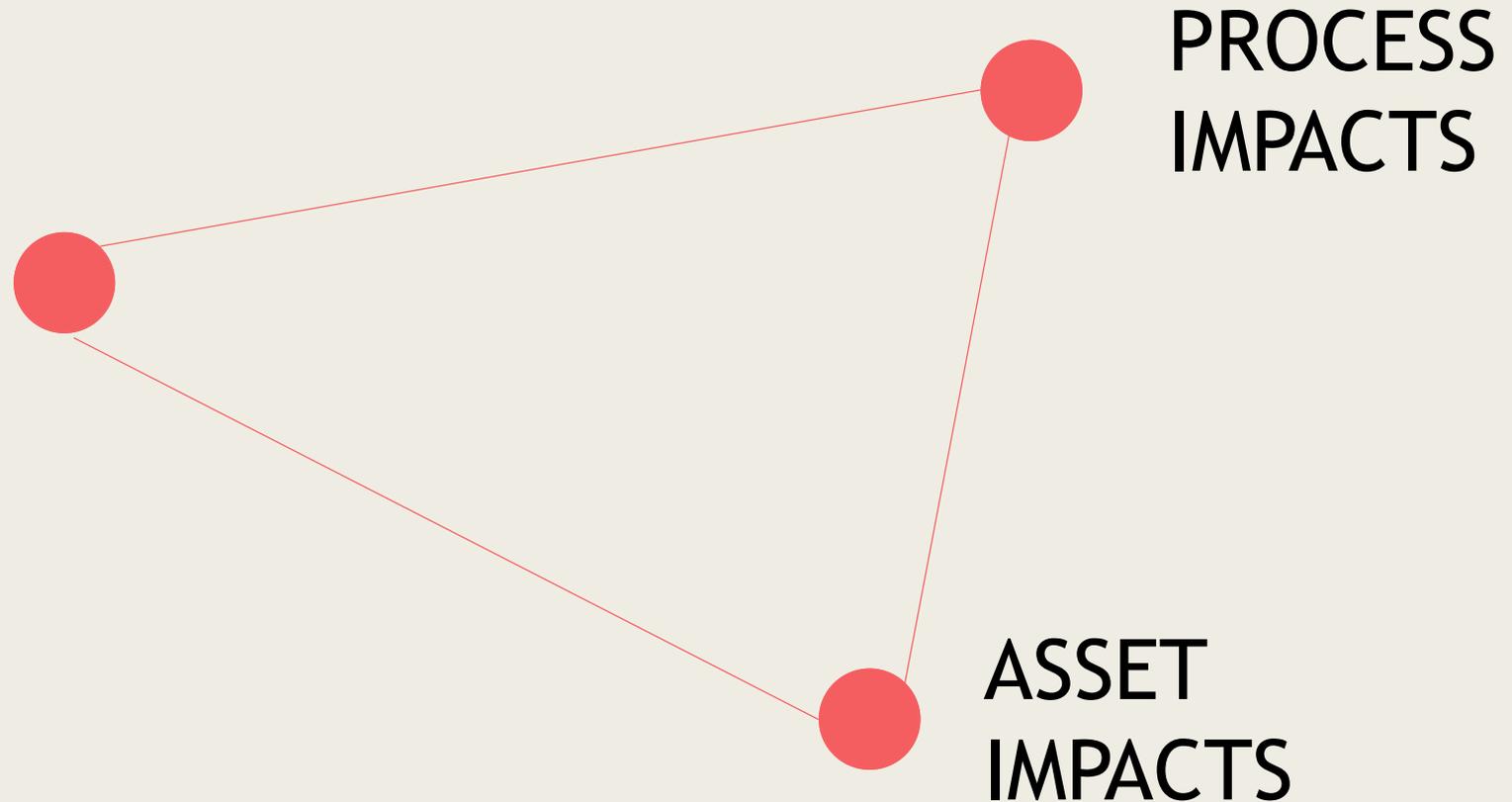
- Loss of infrastructure integrity
- Increased community impacts - odor and rates
- Loss of treatment capacity and function
- Change in organizational pressure and culture
- Change in CIP schedule
- Increased engineering load
- Shift in financial plan and resource demand
- Loss of co-gen output
- Increase in energy purchase

INTEGRATING ISSUES AND EFFORTS
THROUGH
SITUATIONAL AWARENESS AND CULTURE SHIFT



CONNECTING THE DOTS

ENERGY &
CHEMICAL
IMPACTS



CONNECTING THE DOTS

CONSERVATION
IMPACTS

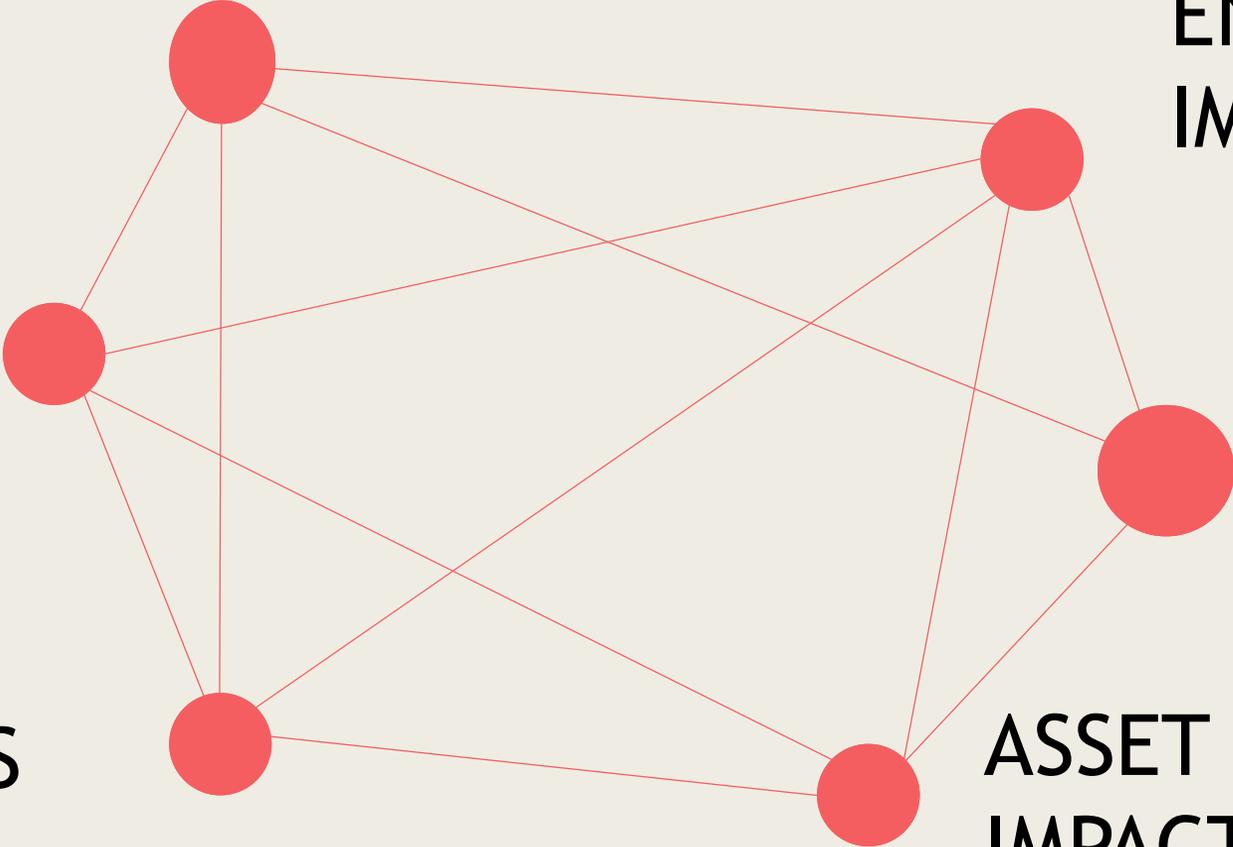
ENERGY/GHG
IMPACTS

COLL SYS
IMPACTS

COMPLIANCE &
QUALITY
IMPACTS

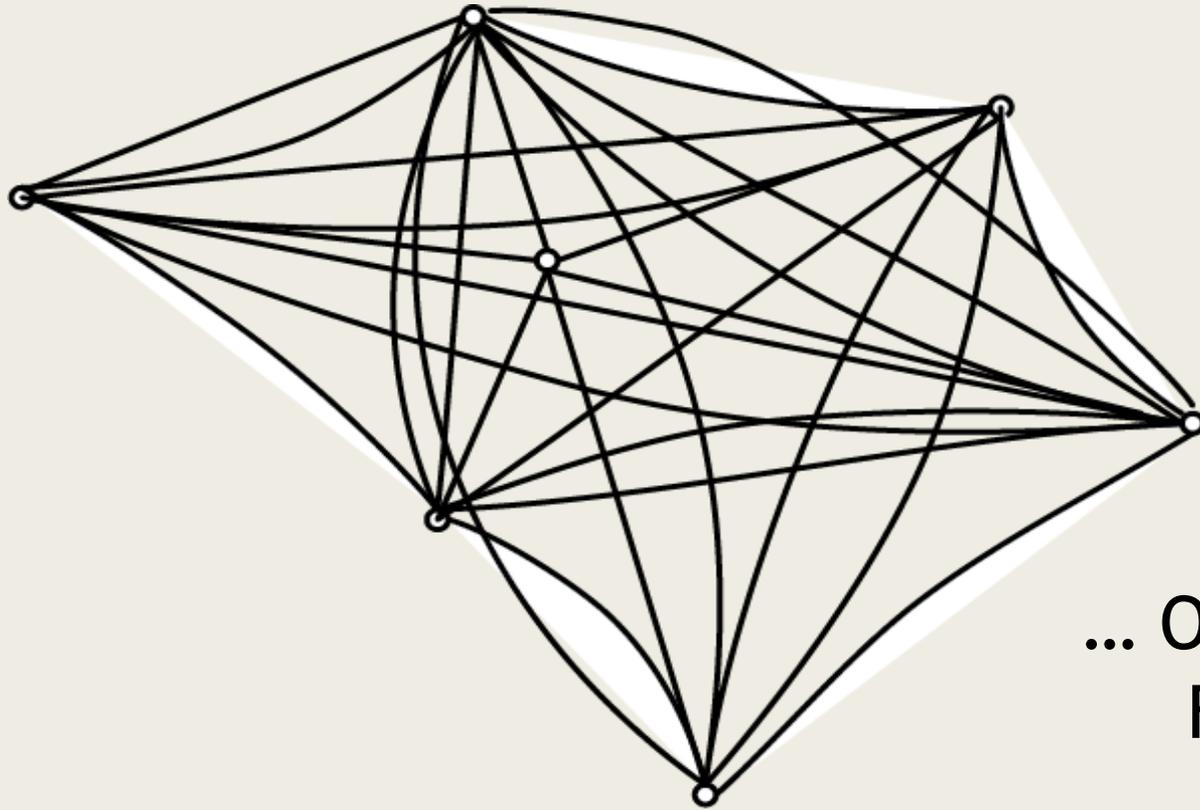
PROCESS
IMPACTS

ASSET
IMPACTS



OPTIMIZATION AT THE NEXUS

COLLABORATION, LEADERSHIP & ACTION



REQUIRES A MAJOR SHIFT IN
SCIENCE KNOWLEDGE,
THINKING, PLANNING AND
CULTURE

FIND THE BEST FIT CURVE OF
RESOURCE MANAGEMENT

... OUR INDUSTRY NEEDS TO
FIT THE NEW CURVE!

Today's Task

- Listen
- Learn
- Contribute
- Act

Lets' talk about TDS

The killer of civilizations....

WYATT TROXEL

EnerVention Strategies



***PROCESS IMPACTS OF WATER CONSERVATION -
THE CASCADE EFFECTS***

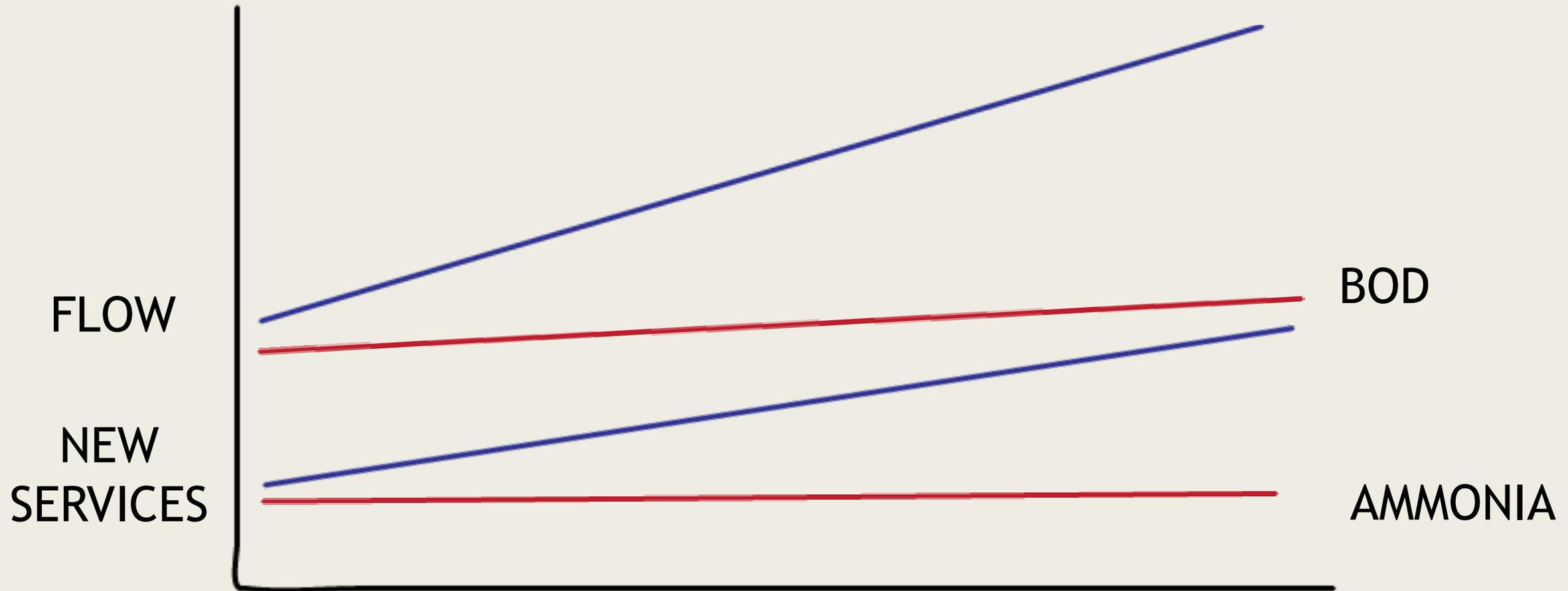
BIO-CHEMISTRY - INFRASTRUCTURE - ORGANIZATION

ESTABLISHING A NEW BASELINE

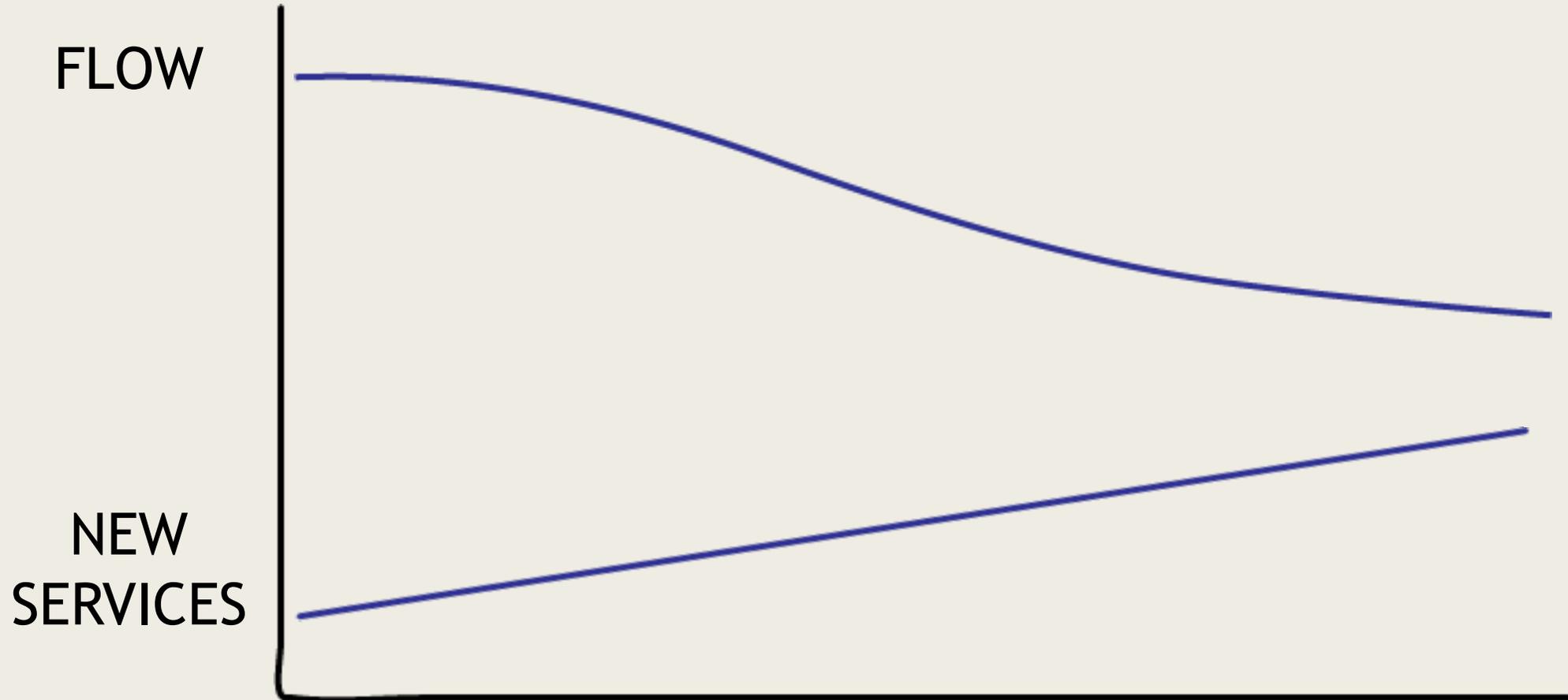
OUR FIRST STEPS IN MEETING A NEW CHALLENGE:

1. DEFINE WHAT HAS CHANGED AND IS STILL CHANGING
2. MEASURE IMPACTS ON COLLECTION AND TREATMENT PROCESSES
3. DEFINE CHANGES FOR DESIGN, OPERATIONS, ENERGY AND PLANNING
4. CHANGE IN REUSE WATER COST, QUALITY AND QUANTITY
5. START A DIALOGUE AND SHARE INFORMATION
6. DEVELOP OPTIONS AND ALTERNATIVES
7. TAKE PROGRESSIVE ACTION

THE WAY IT WAS

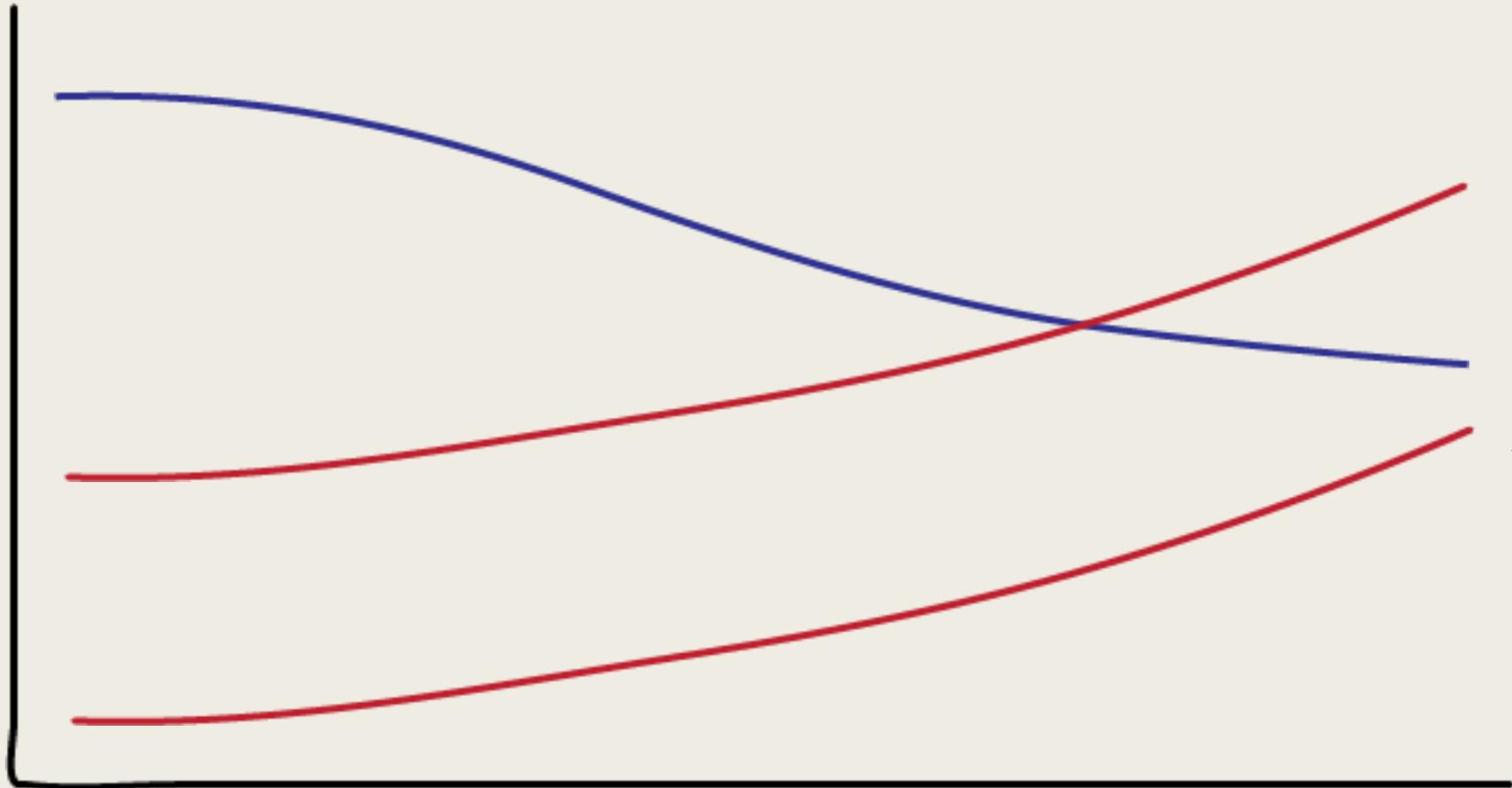


IMPACT OF WATER CONSERVATION



EXPECTED CHANGE IN DILUTION

FLOW

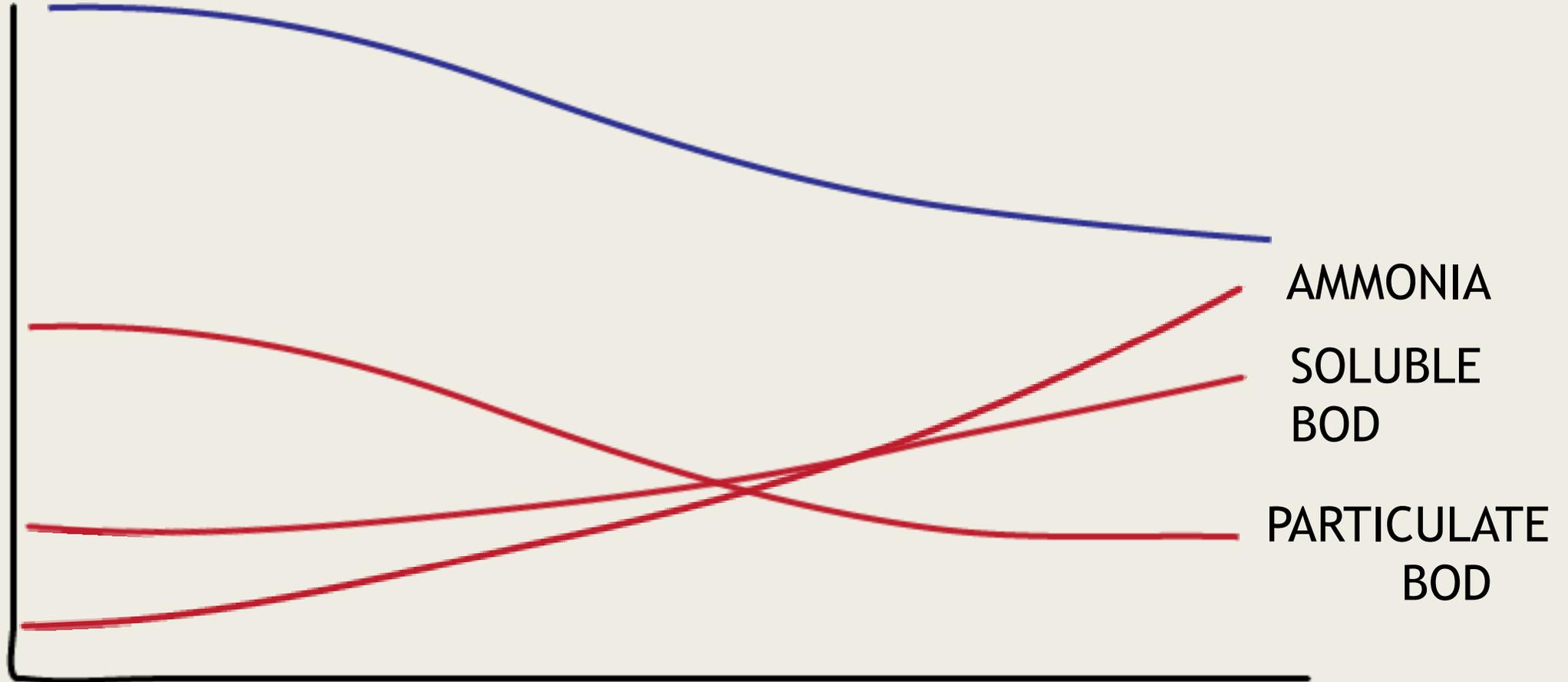


BOD

AMMONIA

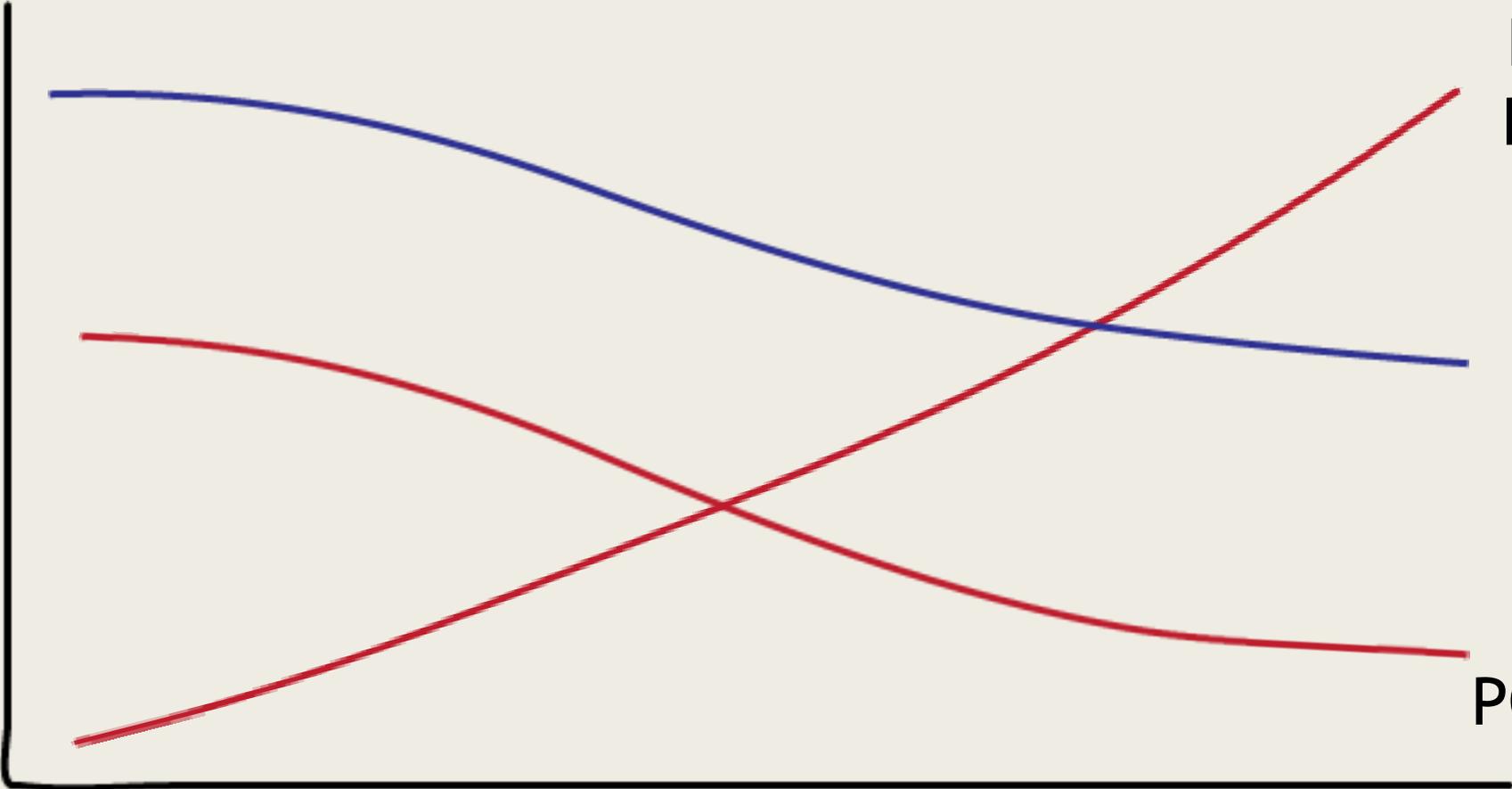
ACTUAL CHANGE IN COLLECTION SYSTEM BIOLOGY

FLOW



WWTP ENERGY PROFILE - CURVE

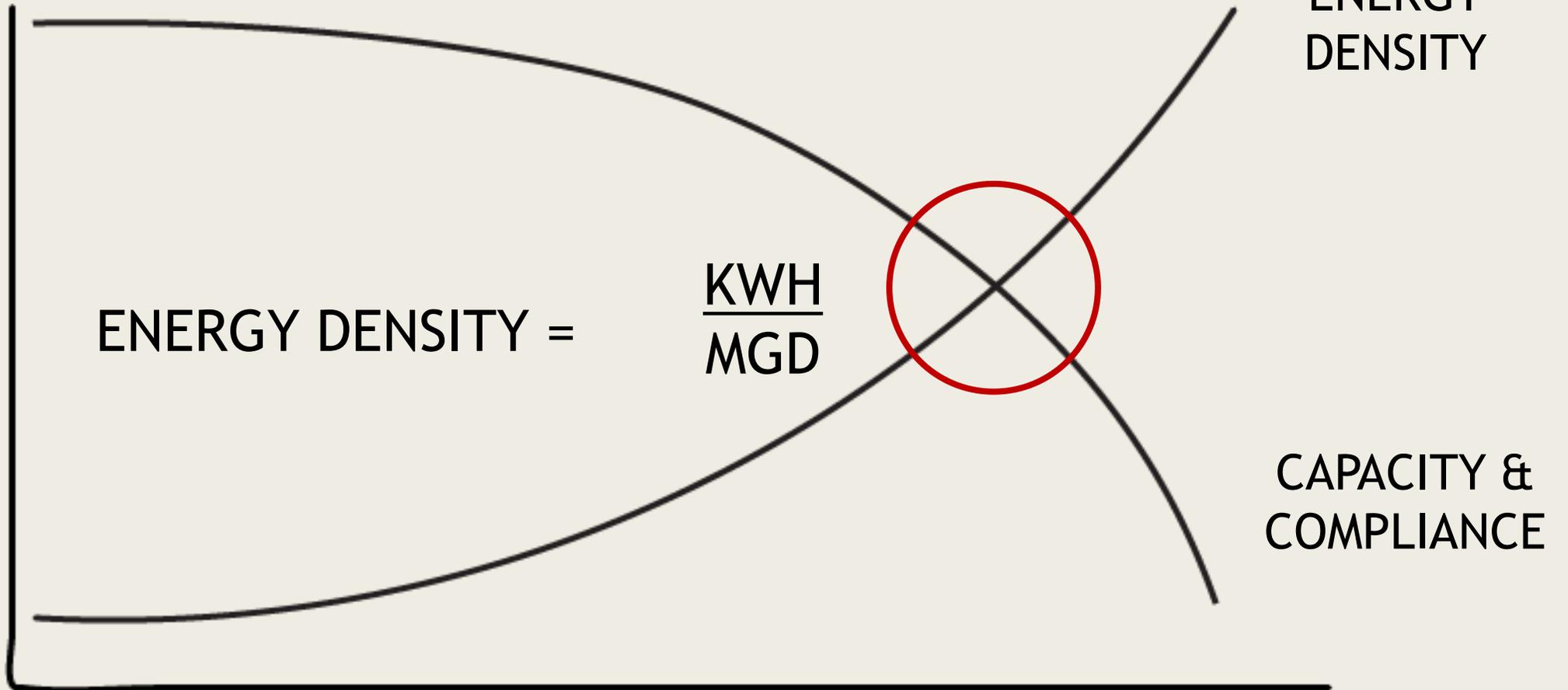
FLOW



ENERGY
DEMAND

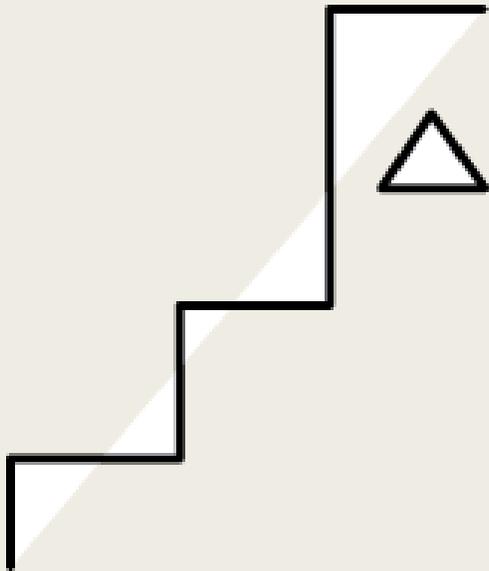
ENERGY
POTENTIAL

KPIs FOR NEW NORMAL



CHANGING CONDITIONS REQUIRES AWARENESS & MANAGEMENT OF CHANGE

STEP CHANGE



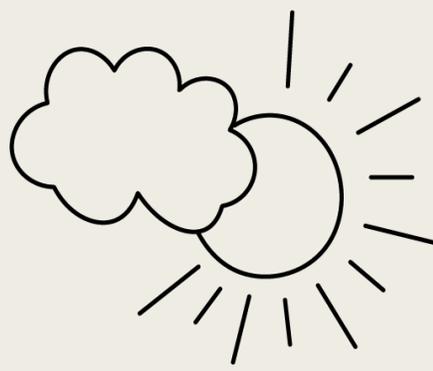
- WATER CONSERVATION
- PROCESS COMPLIANCE
- ENERGY USAGE
- EQUIPMENT FAILURE
- TECHNOLOGY
- DESIGN STANDARDS

CLIMATE CHANGE WEATHER FORECAST



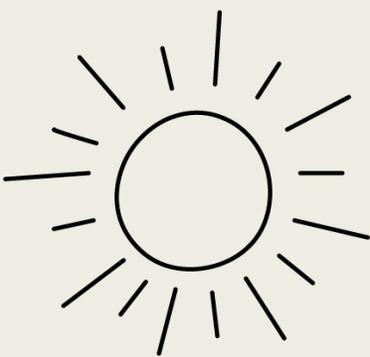
WINTER
RAIN

2005



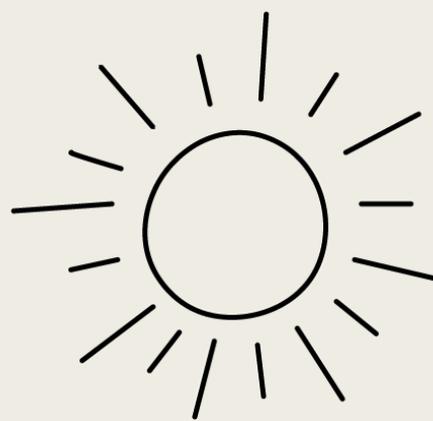
REDUCED
RAIN

2008



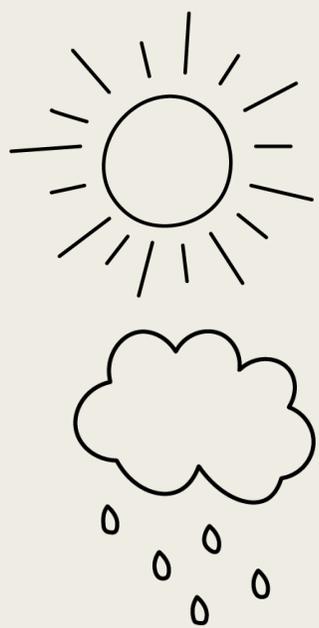
DROUGHT

2010



PROLONGED
DROUGHT

2015

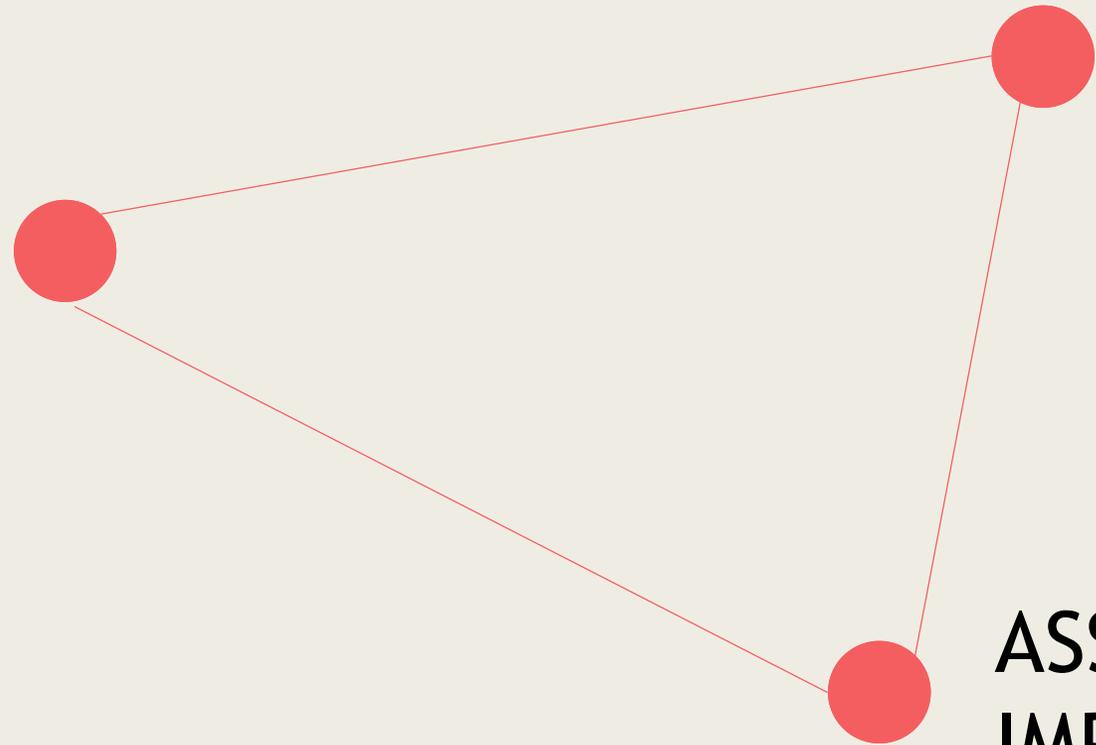


VOLATILE
WEATHER

**“THE NEW
NORMAL”**

CONNECTING THE DOTS

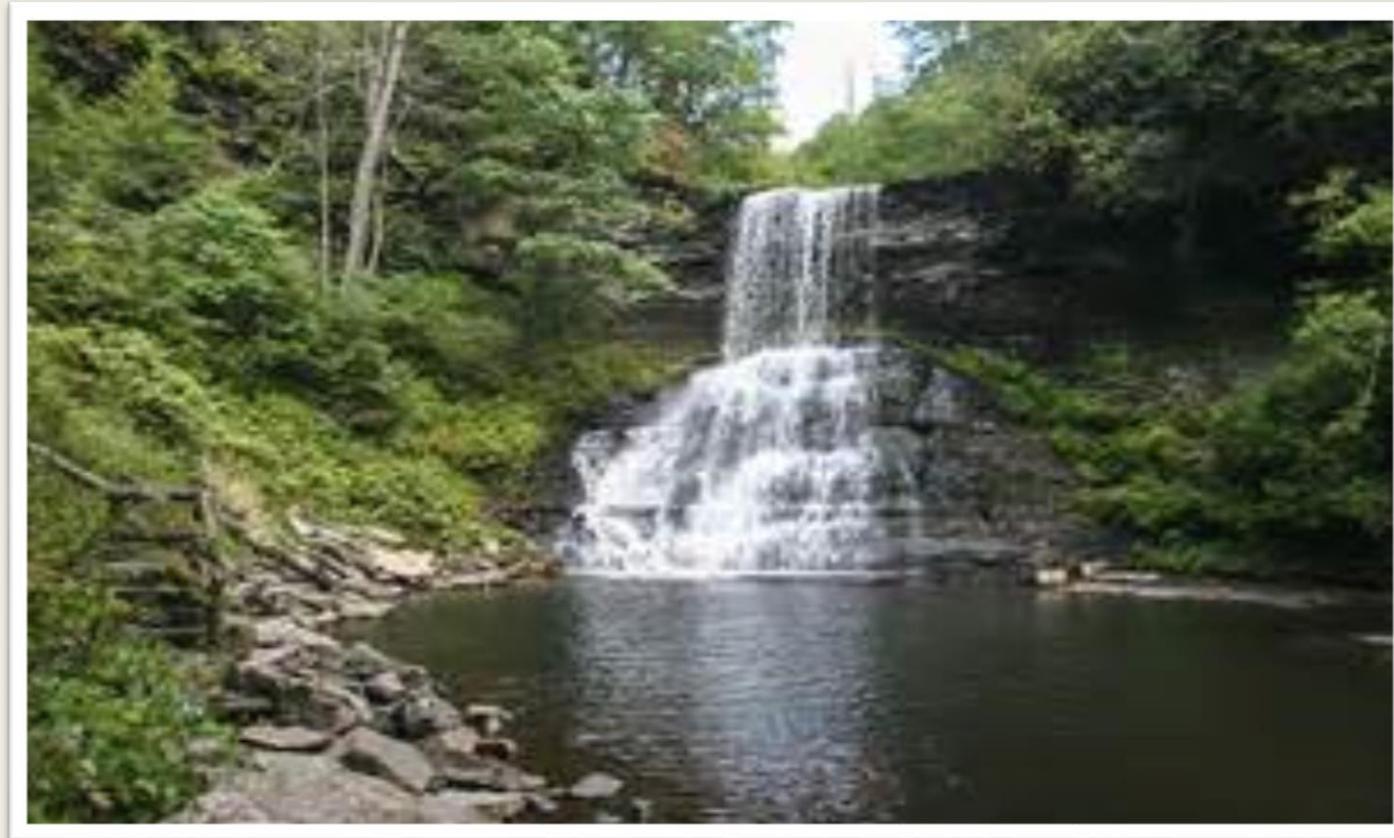
ENERGY &
RESOURCE
IMPACTS



PROCESS
IMPACTS

ASSET
IMPACTS

PROCESS CONTROL ISSUES THE CASCADE EFFECT



PROCESS CONTROL ISSUES THE CASCADE EFFECT

WHAT HAPPENS IN THE SEWER...

DOESN'T STAY IN THE SEWER...

AFFECTS EVERYTHING

PROCESS CONTROL ISSUES

THE CASCADE EFFECT

DO YOU KNOW WHAT SULFIDE IS?

- *HOW DO YOU MEASURE IT?*
- *WHAT DOES IT DO TO INFRASTRUCTURE?*
- *IS IT A ROOT-CAUSE, OR SYMPTOM?*
- *IS IT ACTING ALONE, OR DOES IT HAVE FRIENDS?*
- *WHAT ELSE DO THEY DO TO YOU?*

PROCESS CONTROL ISSUES

THE CASCADE EFFECT

- MAIN CULPRITS:

- *HIGH CONCENTRATION*

 - BOD, TSS, TDS, TKN, Ammonia-N, etc.*

- *TIME*

- *TEMPERATURE*

- *DECOMPOSING PROTEIN*

- HYDROGEN SULFIDE

- VOLATILE ACIDS (SOLUBLE BOD)

- AMMONIA FROM TKN (PROTEIN)

PROCESS CONTROL ISSUES THE CASCADE EFFECT

COLLECTION SYSTEM

HEADWORKS

PRIMARY SEDIMENTATION

THICKENING & DIGESTION

SECONDARY TREATMENT

TERTIARY FILTRATION

EFFLUENT DISINFECTION

RECYCLING & REUSE

PROCESS CONTROL ISSUES THE CASCADE EFFECT

Do you recognize any of the downstream
consequences and symptoms?

Let's take a look....

COLLECTION SYSTEM ISSUES PIPING AND PUMP STATIONS

REDUCED FLOW RATES AND HIGHER CONCENTRATIONS

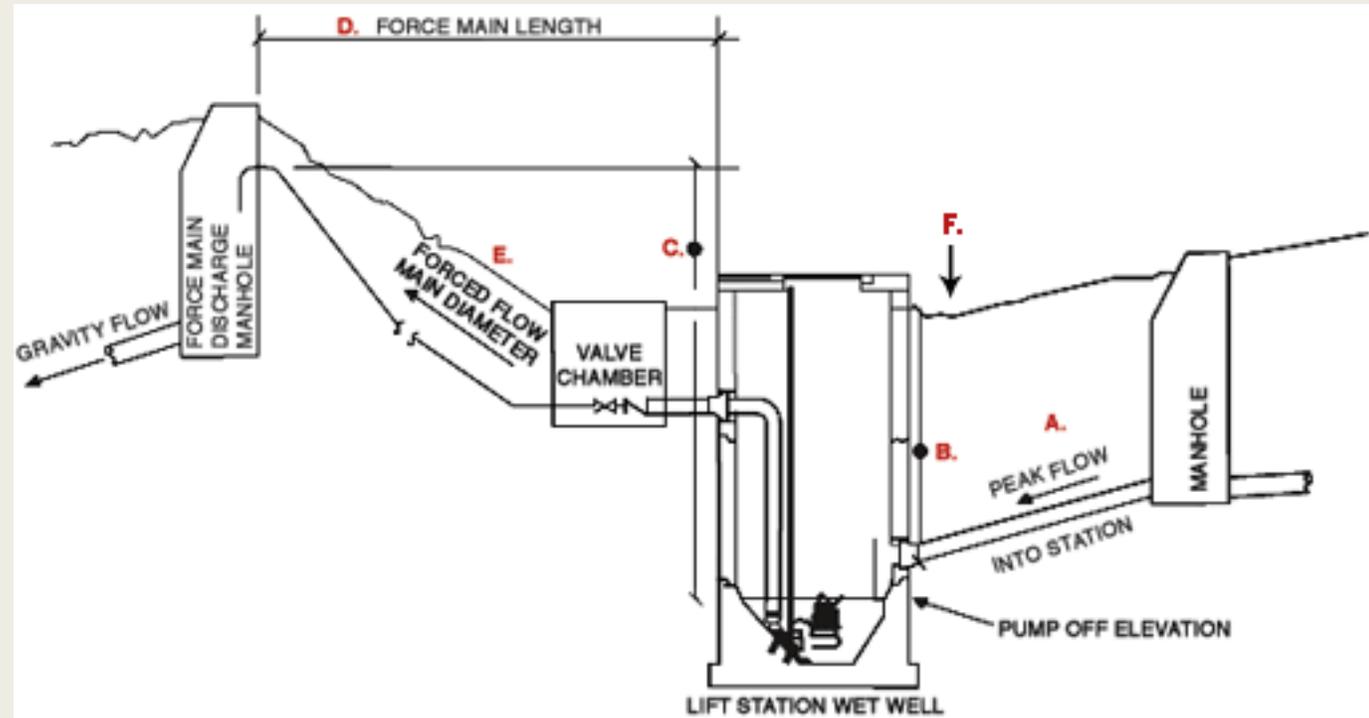
INCREASED SULFIDE GENERATION,
CHEMICAL DOSE AND TDS

INCREASED ODORS, TOXICITY & CORROSION

OVERSIZED PUMPS AND INCREASED CYCLING

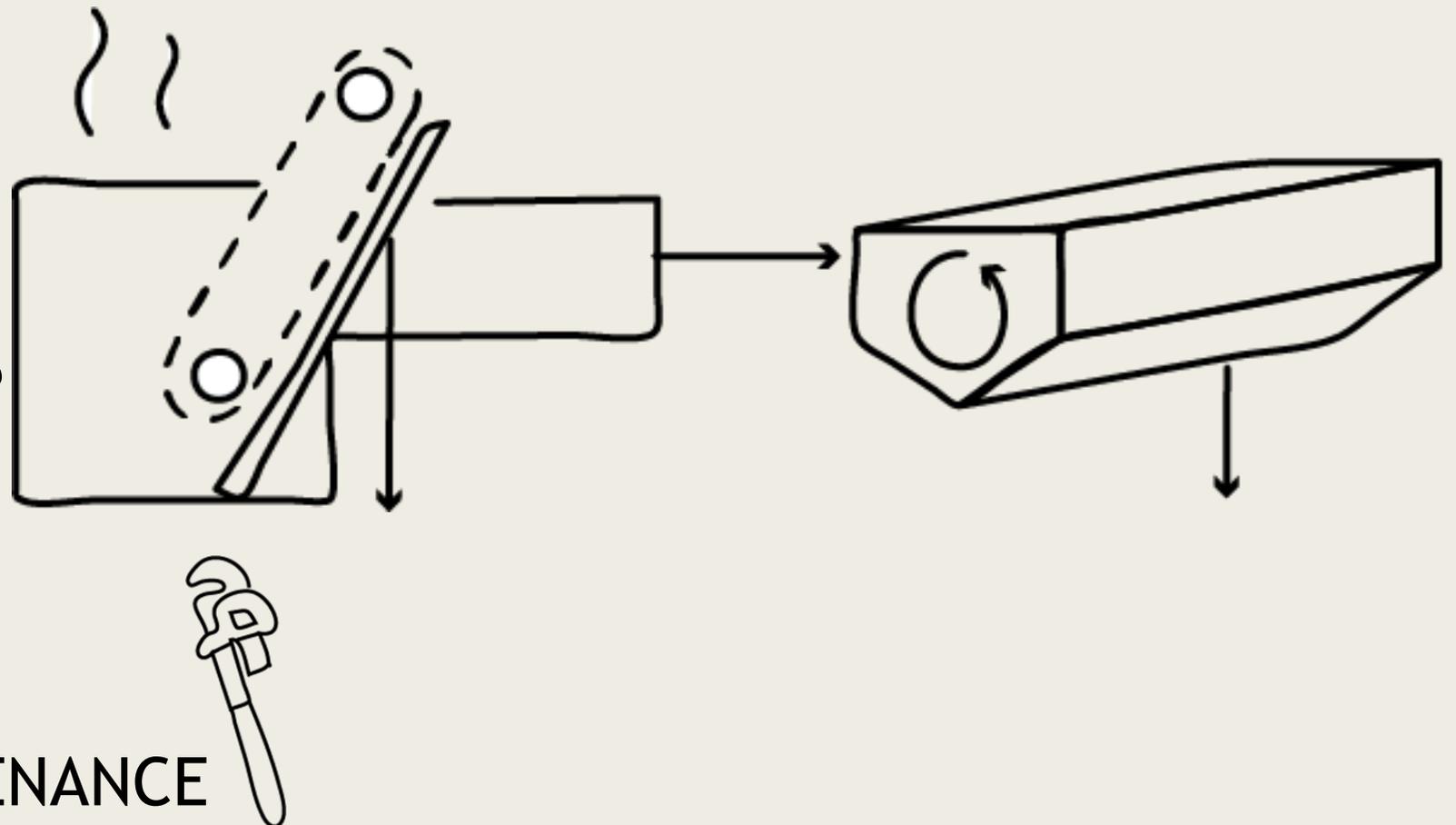
INCREASED ENERGY CONSUMPTION

INCREASED RISK OF FAILURES AND SPILLS



PROCESS CONTROL ISSUES HEADWORKS

- INCREASED SULFIDE ODOR, CORROSION, CHEMICALS
- IMPACTS FROM SLOUGHING SOLIDS
- PERIODIC OVERLOAD OF GRIT SYSTEM
- INCREASED MAINTENANCE

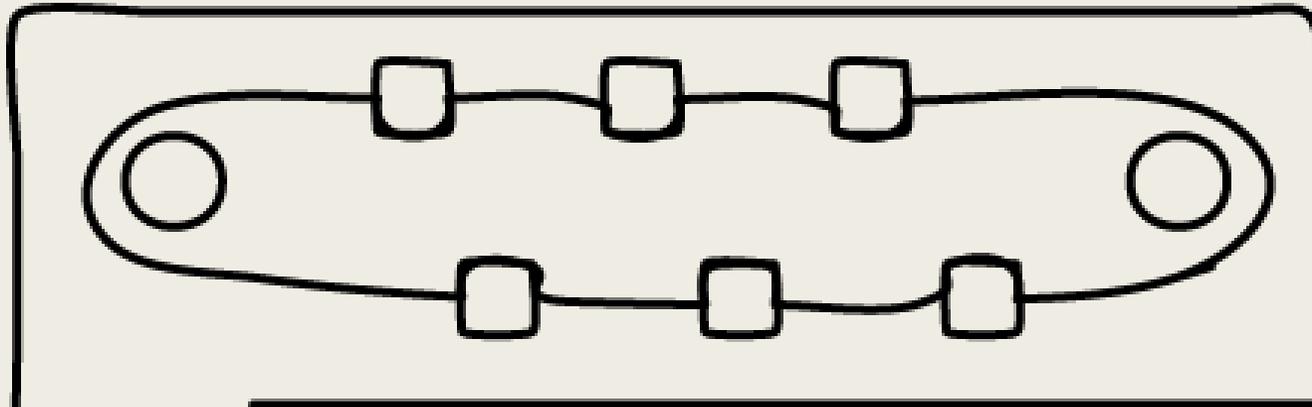


PROCESS CONTROL ISSUES

PRIMARY SEDIMENTATION



- GROWTH AND ODORS OF SULFUR FIXING BACTERIA



- BOD REMOVAL EFFICIENCY
- TSS REMOVAL EFFICIENCY
- SLUDGE SETTLING & GASIFICATION

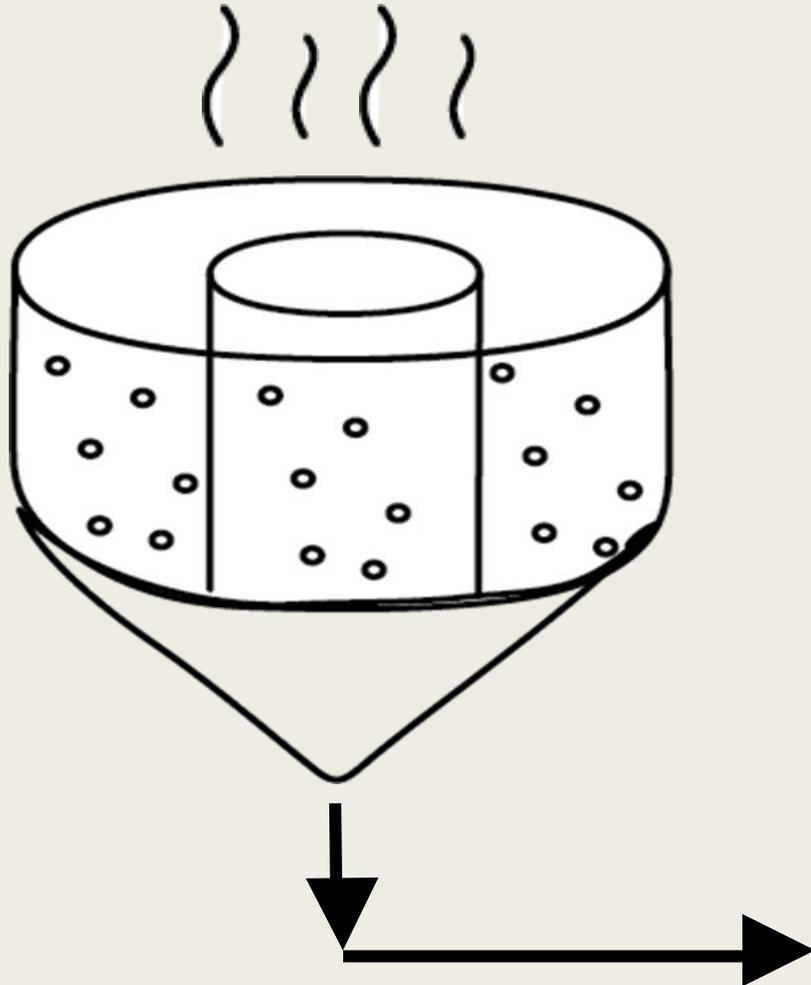


- HEALTH/SAFETY AND CORROSION PROTECTION
- LOSS OF DIGESTION & ENERGY PRODUCTION
- PRODUCTION AND CARRY-OVER OF VFA, HS & NH₃



PROCESS CONTROL ISSUES

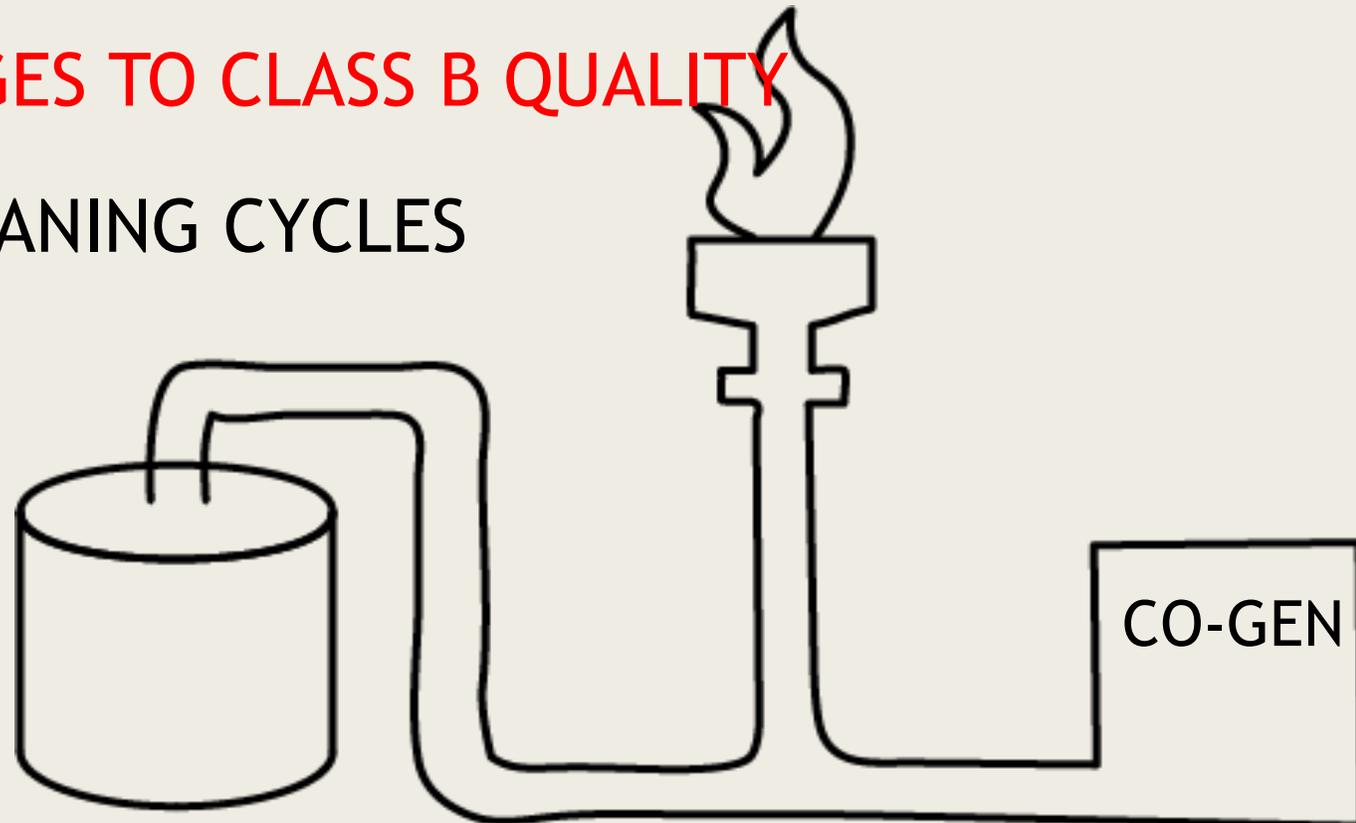
PRIMARY SLUDGE THICKENING



- ADDITIONAL HS PRODUCTION
- POOR GT SETTLING AND SOLIDS RECIRCULATION TO HEADWORKS
- EXCESS WATER
- REDUCED VOLATILE MASS TO DIGESTION

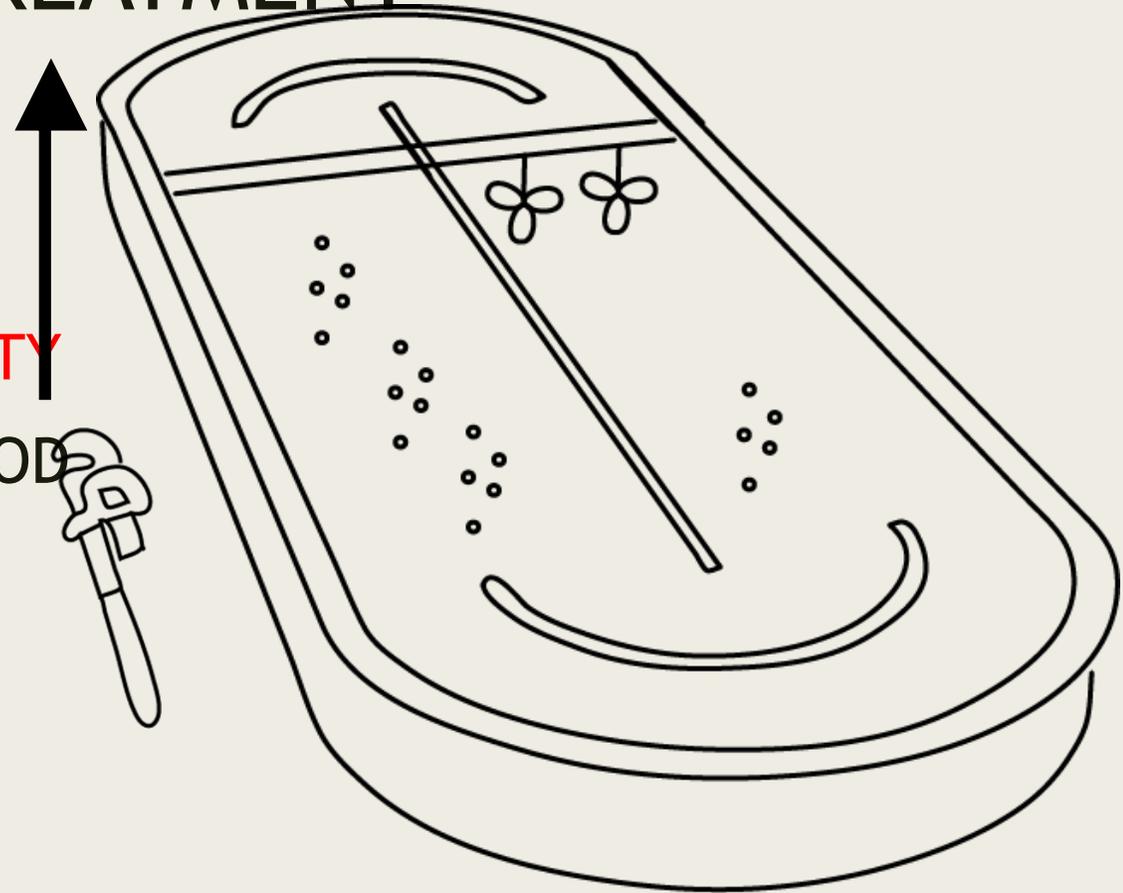
PROCESS CONTROL ISSUES ANAEROBIC DIGESTION

- REDUCED GAS PRODUCTION AND ENERGY RECOVERY
- REDUCED VSR & CHALLENGES TO CLASS B QUALITY
- IMPACTS ON DIGESTER CLEANING CYCLES
- INCREASED PUMP & COMPRESSOR ATTENTION

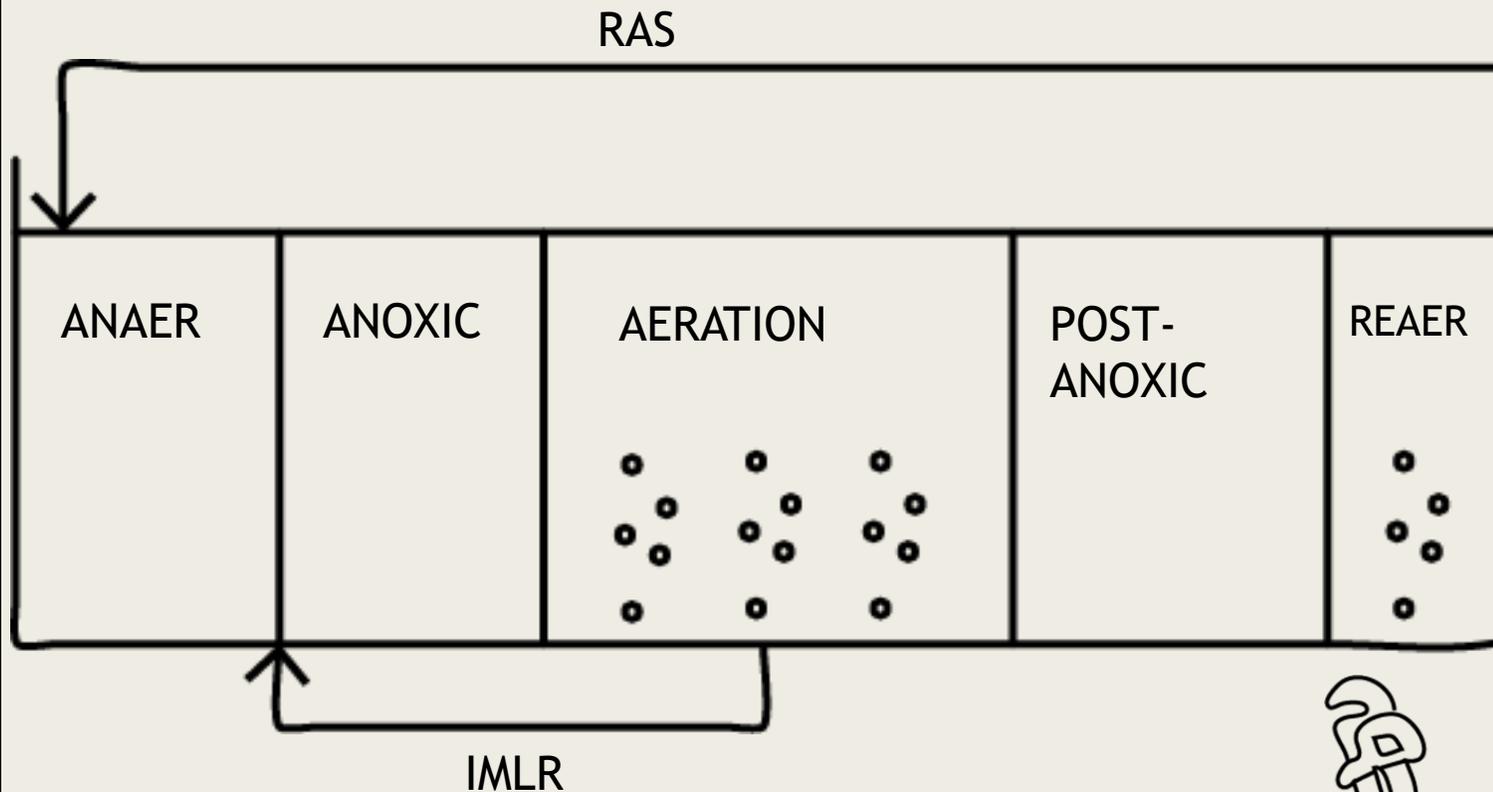


PROCESS CONTROL ISSUES SECONDARY TREATMENT

- MAJOR INCREASE IN ENERGY DEMAND
- POOR PERFORMANCE DUE TO HS TOXICITY
- INCREASED TF SLOUGHING AND POOR BOD EFFICIENCY
- INCREASED BLOWER AND DIFFUSER ATTENTION
- NITROGEN REMOVAL FAILURE & BREAKTHROUGH



PROCESS CONTROL ISSUES BIOLOGICAL NUTRIENT REMOVAL



- **OVERLOAD & REDUCED TREATMENT CAPACITY**
- pH SHIFT & ELEVATED SVI DUE TO POLYSACCHARIDES
- **MLE FAILURE DUE TO IMLR OVERLOAD**
- LOSS OF REDUNDANCY
- **INCREASED EFFLUENT TIN**
- INCREASED IMLR & RAS PUMPING ENERGY
- INCREASED MAINTENANCE ATTENTION

PROCESS CONTROL ISSUES BIOLOGICAL NUTRIENT REMOVAL

HIDDEN REASON FOR BNR FAILURES

Modified Ludzack-Ettinger (MLE) Process

Internal Mixed Liquor Return (IMLR) pumping
isn't designed to handle
increased ammonia concentration

$$Q_{mlr} = (Q_{inf})(N_i/N_e) - Q_i - Q_r$$

PROCESS CONTROL ISSUES BIOLOGICAL NUTRIENT REMOVAL

MLR sizing based upon ammonia concentration

Influent flow = 30 mgd

Effluent TIN = 7 mg/L

RAS @ 100% = 30 mgd

MLR @ 4Q design = 120 mgd

Influent NH₃-N

25 mg/L

35 mg/L

45 mg/L

55 mg/L

MLR Capacity

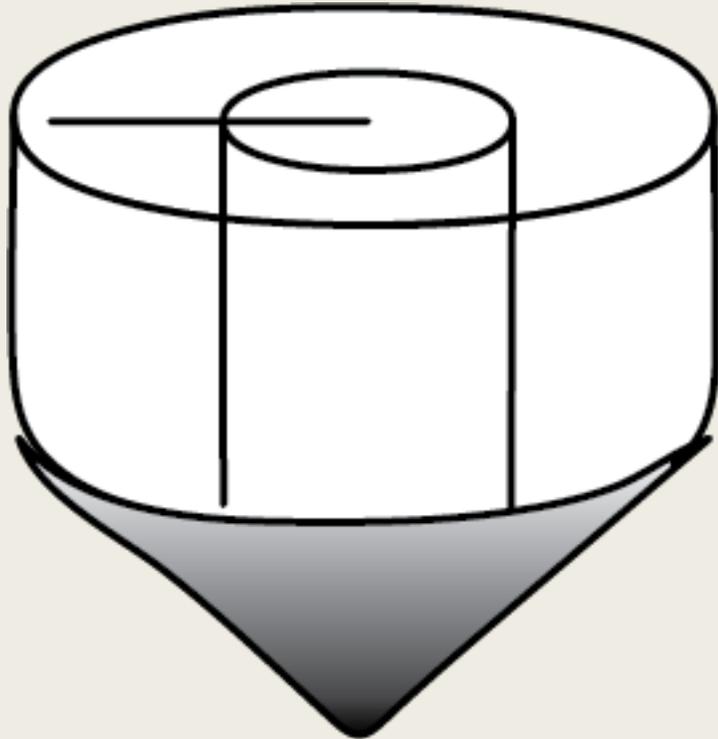
47 mgd

90 mgd

133 mgd

176 mgd

PROCESS CONTROL ISSUES SECONDARY CLARIFICATION



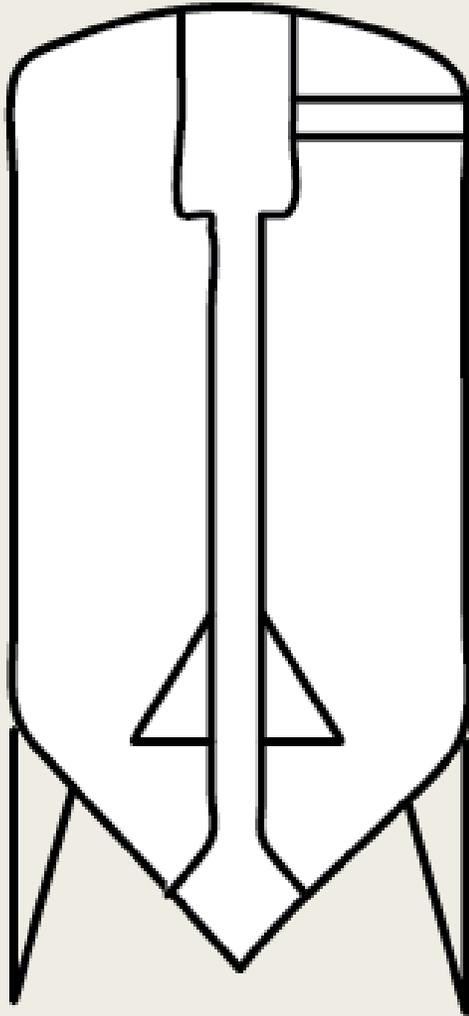
- INCREASED SLR
- INCREASED BLANKET LEVEL
- INCREASED RAS PUMPING
- INCREASED HOUSEKEEPING
- FOAMING



- REDUCED TSS CONTROL
- REDUCED CAPACITY RATING



PROCESS CONTROL ISSUES TERTIARY FILTRATION

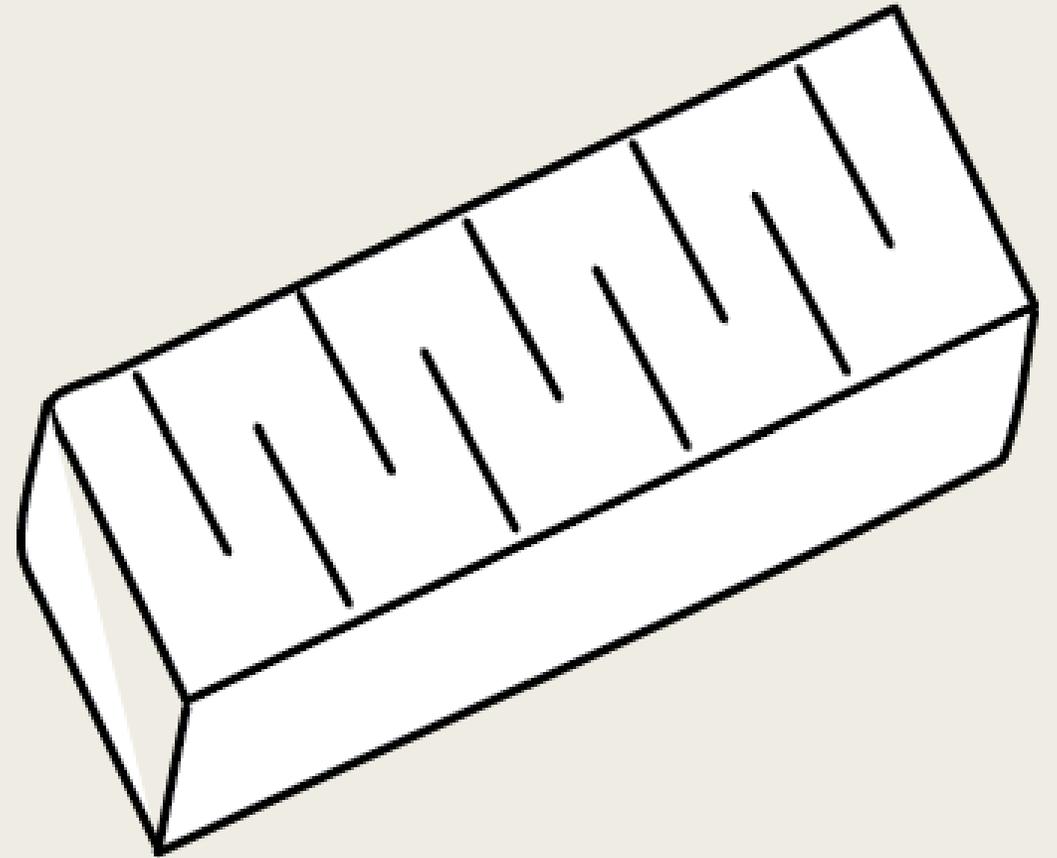
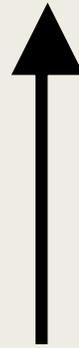


- INCREASED LOADING
- INCREASED ENERGY & RECYCLES
- INCREASED TURBIDITY
- DECREASED THROUGHPUT
- INCREASED COAGULANT DOSE



PROCESS CONTROL ISSUES CHLORINE DISINFECTION

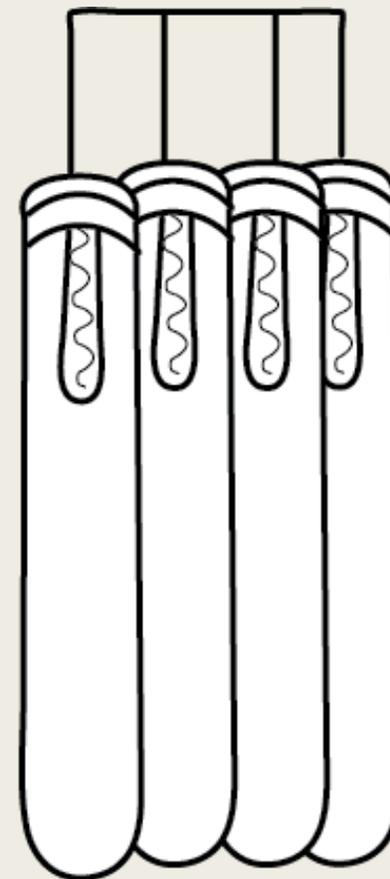
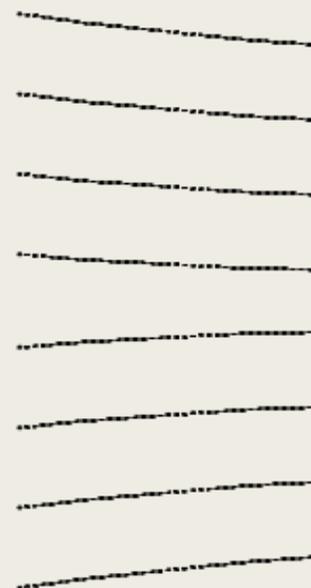
- INTERRUPTED EFFICIENCY
- INCREASED CHEMICAL DOSE & COST
- INCREASED TDS
- INCREASED COLIFORM
- INCREASED SO_2 DEMAND



PROCESS CONTROL ISSUES

UV DISINFECTION

- REDUCED UV TRANSMITTANCE
- INCREASED ENERGY DEMAND
- INCREASED CLEANING AND BULB MAINTENANCE



WANTED: SITUATIONAL AWARENESS

NEW TECHNOLOGIES, BETTER INFORMATION, &
SUPPORT FOR NEW STRATEGIES

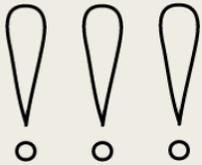
WHEN LOTS OF THINGS CHANGE, *EVERYTHING* NEEDS TO CHANGE
THIS WILL TAKE MORE THAN BETTER TOYS (OR TOOLS)



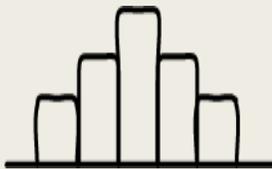
RELIABILITY REDUCTION DUE TO CONDITIONS CREATED BY CONSERVATION



- OPTIMIZE MAINTENANCE BASED ON NEW CONDITIONS
- USE OPPORTUNITY TO IMPROVE MAINTENANCE AND OPERATION STRATEGIES



- CRAFT NEW OPERATIONAL STRATEGIES TO DEAL WITH CHANGING CONCENTRATION LOAD AND HYDRAULIC CONDITIONS



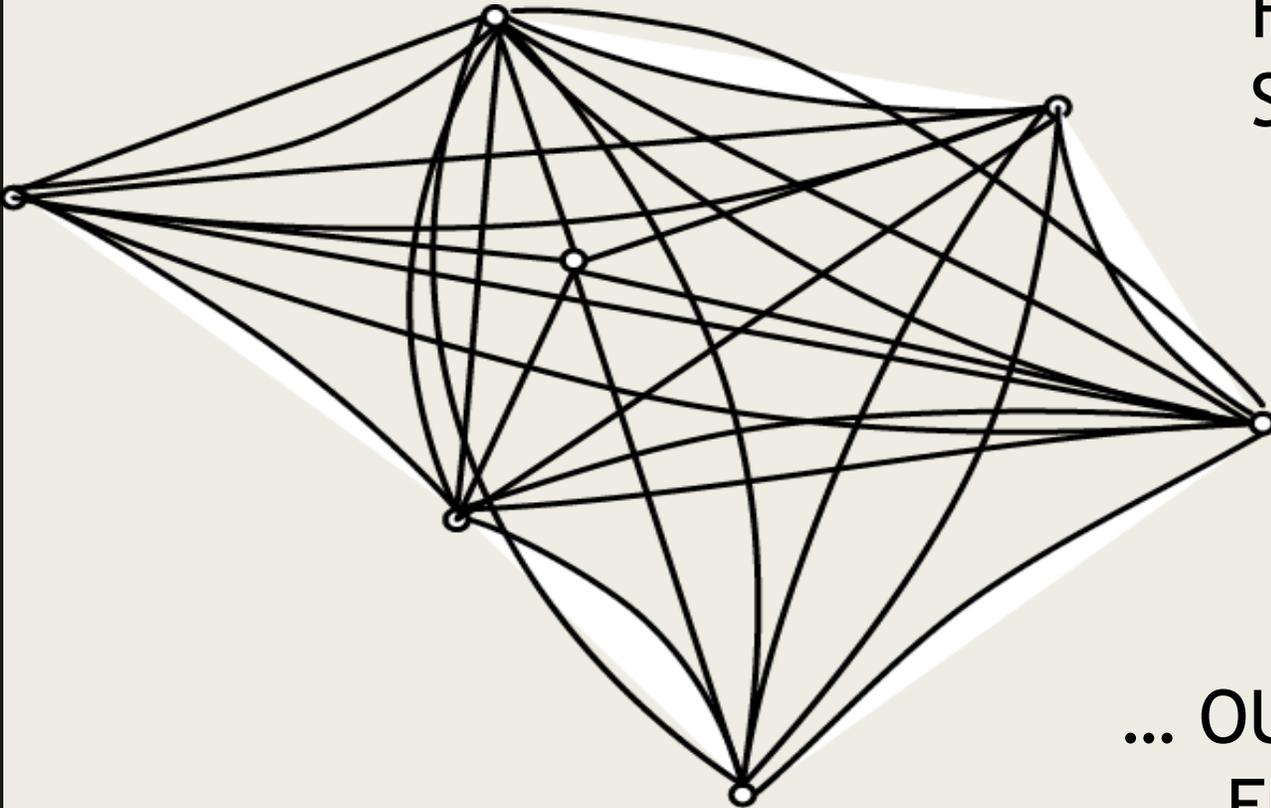
- CHANGES DESIGN & TYPE OF EQUIPMENT/PROCESSES

OPTIMIZATION AT THE NEXUS

REQUIRES A MAJOR SHIFT IN
HOW & WHYs OF COLLECTION
SYSTEM OPERATION

FIND THE BEST FIT CURVE OF
DESIGN & ENERGY USED TO
WORK PERFORMED

... OUR INDUSTRY NEEDS TO
FIT THE NEW CURVE!



ASSESSING CONDITIONS

KNOWING HOW AND WHY ENERGY AND PROCESS OBJECTIVES
ARE CONNECTED
(INTERCONNECTEDNESS)

- WHAT NEEDS TO BE DONE?
 - HOW IS IT BEING DONE?
 - CAN IT BE DONE BETTER?
 - DOES IT CHANGE RISK AND CONSEQUENCE OF FAILURE?
- FUNCTIONAL ANALYSIS
 - CONDITION ASSESSMENT
 - TECHNOLOGY/KNOWLEDGE GAP ANALYSIS
 - RISK ANALYSIS

“Houston, we have a problem....”

Now, what are YOU going to do?

What do WE need to do together?

Let's talk

RESERVE SLIDES

CASE STUDIES: WWTP #1

OPPORTUNITIES

- MODIFIED COLLECTION SYSTEM MANAGEMENT PLAN
 - *CHEMICAL & BIOLOGICAL MITIGATION*
- HEADWORKS AND PRIMARY SULFIDE CONTROL
- MODIFIED BNR PROCESS STRATEGY
 - *AMMONIA-BASED BLOWER & MLR CONTROL*
 - *SIMULTANEOUS NITRIFICATION/DENITRIFICATION*
 - *SEQUENCED LARGE BUBBLE MIXING*

CASE STUDIES: WWTP #1

APPROACH

- ROOT CAUSE ANALYSIS
- PROCESS OPERATION STRATEGIES TO MEET CURRENT CONDITIONS
- CHEMICAL USE OPTIMIZATION TO REDUCE COSTS
- ENERGY OPTIMIZATION TO REDUCE COSTS
- RELIABILITY CENTERED MAINTENANCE TO IMPROVE ASSET PERFORMANCE

CASE STUDIES: WWTP #1

LESSONS LEARNED

- USE CURRENT DATA
- ANALYZE DATA TRENDS
- DESIGN FOR FUTURE CONDITIONS
- UPGRADE AWARENESS OF MODERN TECHNOLOGIES
- FOCUS ON MONITORING AND CONTROL
- USE ON-GOING CONDITION ASSESSMENT FOR DECISIONS

CASE STUDIES: WWTP #2

FAST FACTS

- LOCATION: CENTRAL CALIFORNIA
- DESIGN: BIOLOGICAL NUTRIENT REMOVAL SYSTEM
- FLOW: 100,000 GPD DESIGN FLOW, DECREASED TO 5,000 GPD
- HISTORICAL DETAILS:
 - RECENT PLANT EXPANSION AND UPGRADE IN 2008
 - PERIODIC SEASONAL PROCESS UPSETS
 - GOLF COURSE COMMUNITY RAN OUT OF WATER
 - MAJOR UPSET IN 2015
 - VIOLATION OF TIN, BOD, TSS

CASE STUDIES: WWTP #2

CHALLENGES

- HISTORIC DROUGHT CONDITIONS
- PROPERTY VALUES DECREASED SIGNIFICANTLY
- A GHOST TOWN - MOST OF THE PROPERTY OWNERS ABANDONED THEIR HOMES
- GOLF COURSE FACILITIES HAVE BEEN CLOSED
- LOW FLOW CONDITIONS IMPACTED COLLECTION SYSTEM DETENTION TIMES
- LIFT STATION OPERATIONS IMPACTED
- LACK OF CARBON AT THE HEAD OF THE PLANT IMPACTED BNR PERFORMANCE
- NITRIFICATION AND SETTLABILITY IMPACTED

CASE STUDIES: WWTP #2

OPPORTUNITIES

- COMMUNICATE WITH THE REGIONAL BOARD - SHOW THEM THE DROUGHT IMPACTS
- CONVINCING THE REGIONAL BOARD TO RELAX ON THE PERMIT REQUIREMENTS
- NEGOTIATE NOV_s AND FINES BASED ON CONDITIONS

CASE STUDIES: WWTP #2

APPROACH

- INVITE THE BNR OEM FOR A VISIT
- LOOK FOR OPPORTUNITIES TO MODIFY THE OPERATIONAL STRATEGIES FOR DROUGHT
- CONVINCING THE BOARD TO MOVE THE PERMIT POINT DOWNSTREAM OF THE STRAINERS
- UTILIZE THE STORAGE PONDS FOR EVAP AND AVOID DISPOSAL
- AS A LAST RESORT CONSIDER USING A CARBON SUPPLEMENT (MICRO-C)

CASE STUDIES: WWTP #2

LESSONS LEARNED

- LISTEN CLOSELY TO THE OPERATORS - THEY'RE YELLING AT YOU FOR A REASON
- INVOLVE THE REGIONAL BOARD - THEY'RE HERE TO HELP US
- GET YOUR VENDORS INVOLVED - THEY HAVE A LOT AT STAKE
- USE PROCESS EXPERTS LIKE WYATT

CASE STUDIES: WWTP #3

FAST FACTS

LOCATION: CENTRAL CALIFORNIA

REGIONAL FACILITY UNDERGOING UPGRADE DESIGN

DESIGN: BIOLOGICAL NUTRIENT REMOVAL SYSTEM

FLOW: 140-180 MGD

HISTORICAL DETAILS:

CURRENT PLANT EXPANSION UNDER DESIGN

IMPLEMENTING BNR WITH 2010 DATA

POTENTIAL PROCESS CAPACITY FAILURE & CONSTRAINTS

CONCERN OVER VIOLATION OF TIN & AMMONIA

CASE STUDIES: WWTP #3

CHALLENGES

- CONTINUED DROUGHT CONDITIONS
- LOW FLOW CONDITIONS IMPACTED COLLECTION SYSTEM DETENTION TIMES
- PRIMARY SEDIMENTATION IMPACTED
- NITRIFICATION/DENITRIFICATION CAPACITY IMPACTS
- SECONDARY SETTLEABILITY IMPACTS
- OPERATORS NOT EXPERIENCED WITH BNR & CHLORINE DISINFECTION IMPACTS

CASE STUDIES: WWTP #3

OPPORTUNITIES

- RE-EVALUATE DESIGN CRITERIA
- RE-EVALUAATE BASIC TECHNOLOGIES
- IMPROVE MONITORING AND CONTROL FOR OPERATIONS
- IMPLEMENT RELIABILITY CENTERED MAINTENANCE OF CRITICAL ASSETS
- TRAIN STAFF IN BNR TECHNOLOGIES
- AVOIDED NOV_s AND FINES

CASE STUDIES: WWTP #3

APPROACH

- EVALUATE POTENTIAL FOR COLLECTION SYSTEM STRATEGY TO REDUCE AMMONIA LOAD
- LOOK FOR OPPORTUNITIES TO MODIFY THE OPERATIONAL STRATEGIES FOR DROUGHT
- EVALUATE ALTERNATIVE BNR CONTROL TECHNOLOGIES
- INVESTIGATE OPPORTUNITIES FOR DESIGN CHANGES PRIOR TO CONSTRUCTION

CASE STUDIES: WWTP #3

LESSONS LEARNED

- USE CURRENT DATA
- ANALYZE DATA TRENDS
- DESIGN FOR FUTURE CONDITIONS
- UPGRADE AWARENESS OF MODERN TECHNOLOGIES
- FOCUS ON MONITORING AND CONTROL
- USE ON-GOING CONDITION ASSESSMENT FOR DECISIONS

CASE STUDIES: WWTP #4

FAST FACTS

LOCATION: INLAND EMPIRE

DESIGN: INTERNAL MLR TO RECOVER LOST CAPACITY

FLOW: 28 → 30 MGD

- NEED CAPACITY FOR RECYCLED WATER DEMAND
- HISTORICAL DETAILS:
 - TREATMENT CAPACITY DOWNGRADED DUE TO BNR CONSTRAINTS
 - REDUCED BNR FLOW TO COMPLY WITH TIN LIMITS
 - INFLUENT AMMONIA HAS INCREASED OVER 30% IN RECENT YEARS
 - NO AUTHORITY OR CONTROL OF COLLECTION SYSTEMS

CASE STUDIES: WWTP #4

CHALLENGES

- CONTINUED DROUGHT CONDITIONS
- LOW FLOW CONDITIONS IMPACTED COLLECTION SYSTEM DETENTION TIMES
- PRIMARY SEDIMENTATION IMPACTED
- NITRIFICATION/DENITRIFICATION CAPACITY IMPACTS
- SECONDARY SETTLEABILITY IMPACTS
- OPERATORS NOT EXPERIENCED WITH DESIGN CONSTRAINTS

CASE STUDIES: WWTP #4

OPPORTUNITIES

- RE-EVALUATE DESIGN CRITERIA
- RE-EVALUAATE BASIC MASS BALANCE & TECHNOLOGIES
- IMPROVE MONITORING AND CONTROL FOR OPERATIONS
- IMPLEMENT RELIABILITY CENTERED MAINTENANCE OF CRITICAL ASSETS
- AVOIDED NOV_s AND FINES
- INCREASE RECYCLED WATER PRODUCTION

CASE STUDIES: WWTP #4

APPROACH

- EVALUATE POTENTIAL FOR COLLECTION SYSTEM STRATEGY TO REDUCE AMMONIA LOAD
- LOOK FOR OPPORTUNITIES TO MODIFY THE OPERATIONAL STRATEGIES FOR DROUGHT
- EVALUATE ALTERNATIVE BNR/MLR CONTROL TECHNOLOGIES

CASE STUDIES: WWTP #4

LESSONS LEARNED

- USE CURRENT DATA
- ANALYZE DATA TRENDS
- DESIGN FOR FUTURE CONDITIONS
- PERFORM MASS-BALANCE ANALYSIS OF TIN CONTROL
- UPGRADE AWARENESS OF MODERN TECHNOLOGIES
- FOCUS ON MONITORING AND CONTROL
- USE ON-GOING CONDITION ASSESSMENT FOR DECISIONS



DEVELOPING SOLUTIONS (ROUND TABLE)

NEW TECHNOLOGIES

NEW TECHNOLOGIES

- AMMONIA SENSING AND CONTROL TECHNOLOGIES
 - BLOWERS
 - ML RECYCLE PUMPING
 - CHEMICAL FEED FOR DISINFECTION

NEW TECHNOLOGIES

- SEQUENTIAL, LARGE BUBBLE MIXING
 - WET WELL MIXING
 - ANOXIC MIXING
 - ENHANCED SOTE IN OXIC MIXING

NEW TECHNOLOGIES

- FACULTATIVE BIO-AUGMENTATION
 - SEWER CONTROL OF BIOLOGY AND PRODUCTS
 - ENHANCED CONTROL OF SULFIDE, AMMONIA, & VOLATILE ACIDS

NEW TECHNOLOGIES

- ORGANIC RANKIN-CYCLE POWER GENERATION
 - ELIMINATE FLARES AND ICE CO-GEN ISSUES
 - CONTINUOUS POWER PRODUCTION
 - WASTE HEAT RECOVERY AND DIGESTER HEATING