CONNECTING THE DOTS:

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

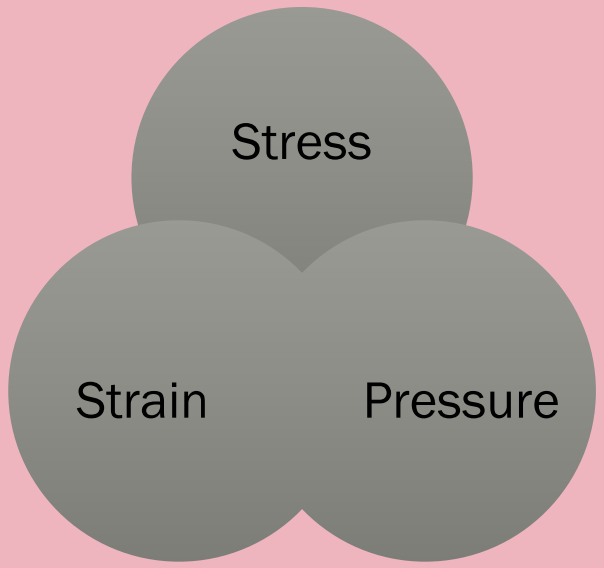
Southern California Alliance of POTWs
MAY 31, 2018

Click to Start

No good deed goes unpunished….

Dealing with the paradigm shift of water conservation in wastewater conveyance, treatment and reclamation

Challenges of the Triple Nexus



Stress

Resource Management

- Increased demand for energy & chemicals
- Increased energy density – kWh per mgd
- Decreased energy potential – digestion and gas production
- Increased labor attention – process & maintenance
- Increased process monitoring
- Increased laboratory support

Strain

Reliability

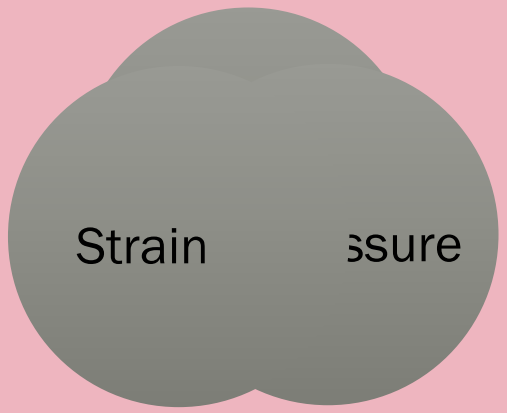
- Asset performance, availability and reliability
- Increased wear and tear on equipment
- Loss of redundancy
- Overload equipment design capacity
- Increased rate of failure
- Reduced expected life
- Increased replacement rate
- Increased labor burden – reactive vs. predictive

Pressure

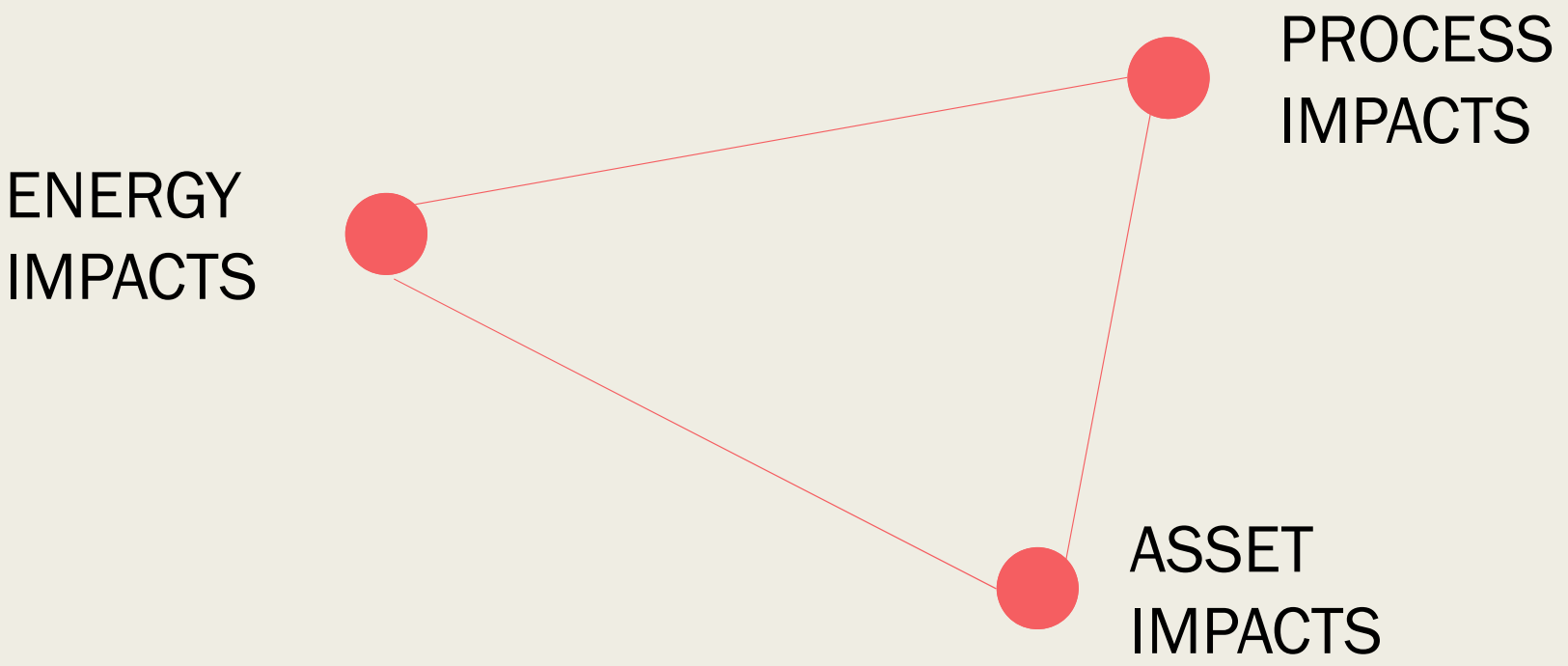
Infrastructure Planning

- Loss of infrastructure integrity
- Increased community impacts – odor and rates
- Loss of treatment capacity and function
- 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



CONNECTING THE DOTS

CONSERVATION IMPACTS

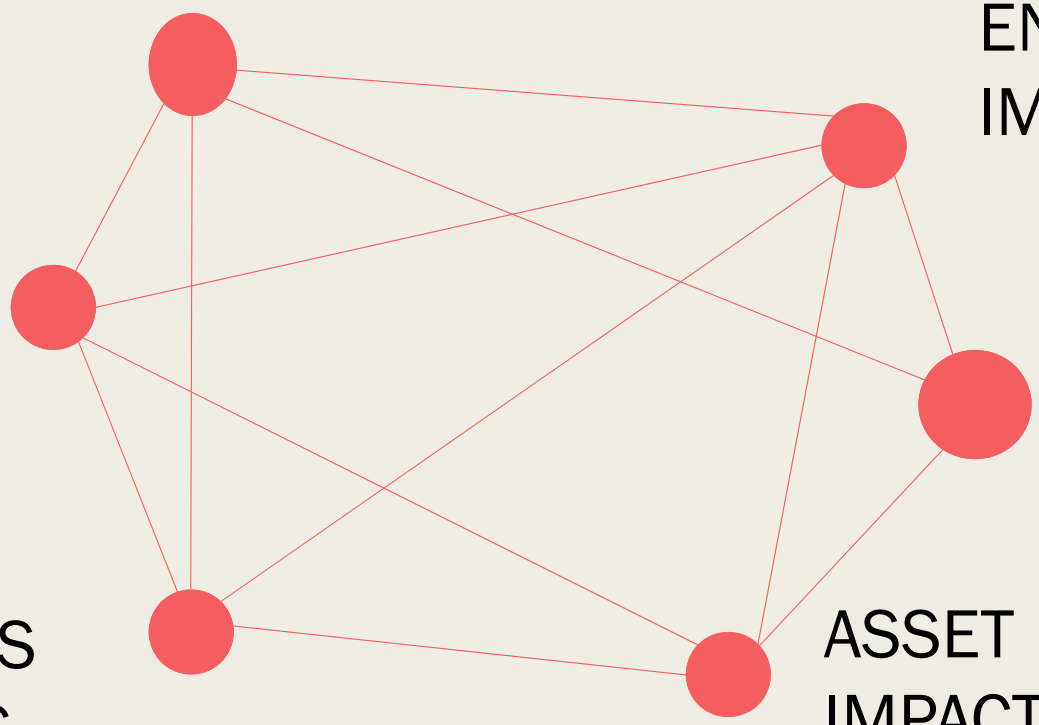
ENERGY/GHG IMPACTS

COLL SYS IMPACTS

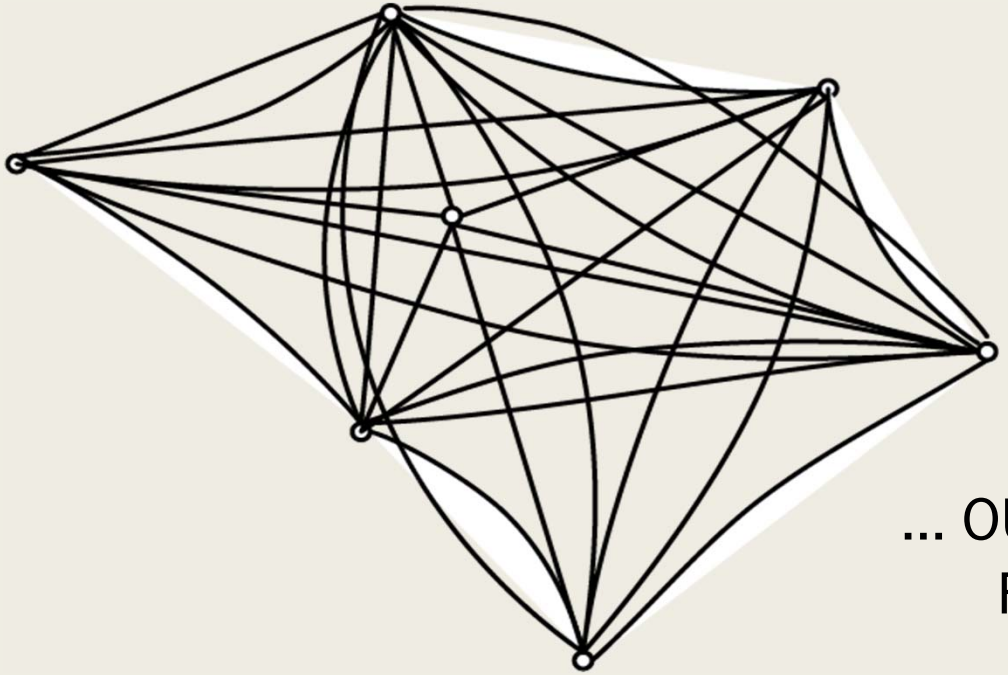
COMPLIANCE IMPACTS

PROCESS IMPACTS

ASSET IMPACTS



OPTIMIZATION AT THE NEXUS



REQUIRES A MAJOR SHIFT IN THINKING, PLANNING AND CULTURE

FIND THE BEST FIT CURVE OF RESOURCE MANAGEMENT

… OUR INDUSTRY NEEDS TO FIT THE NEW CURVE!

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.

BREAK

WYATT TROXEL

EnerVention Strategies

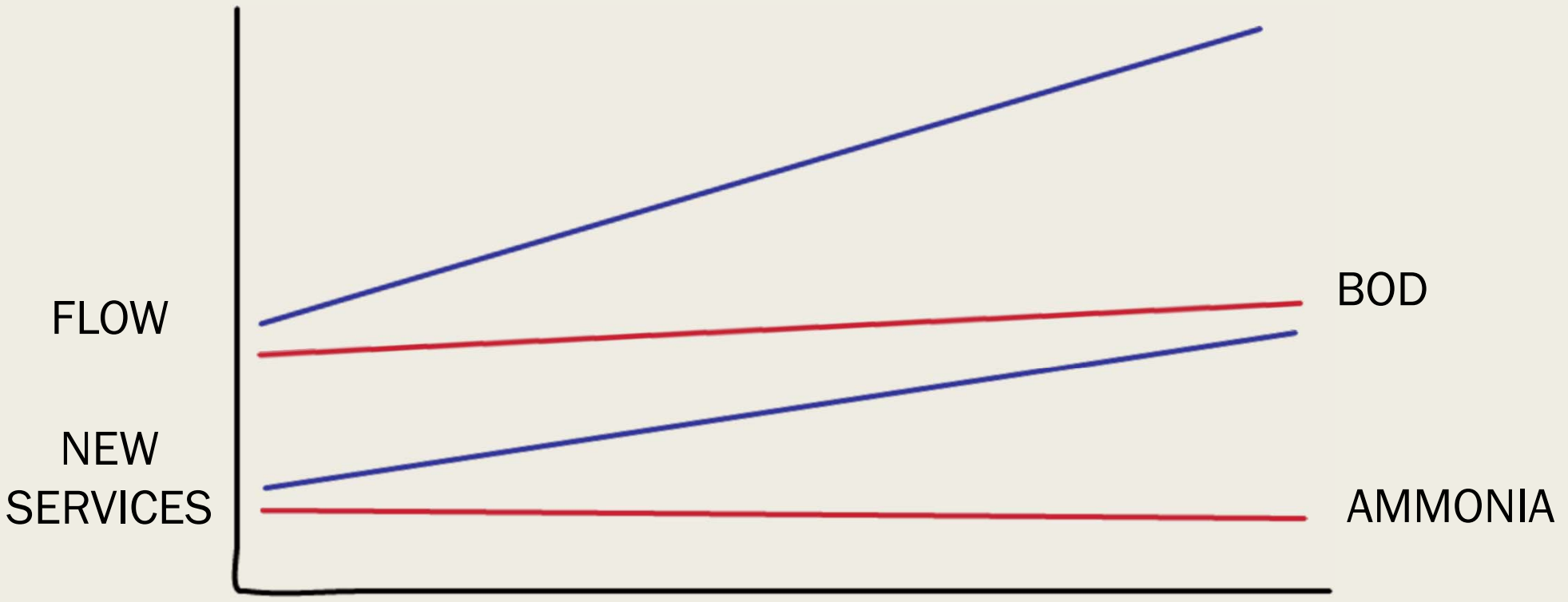
PROCESS IMPACTS OF WATER CONSERVATION – THE CASCADE EFFECTS

ESTABLISHING A NEW BASELINE

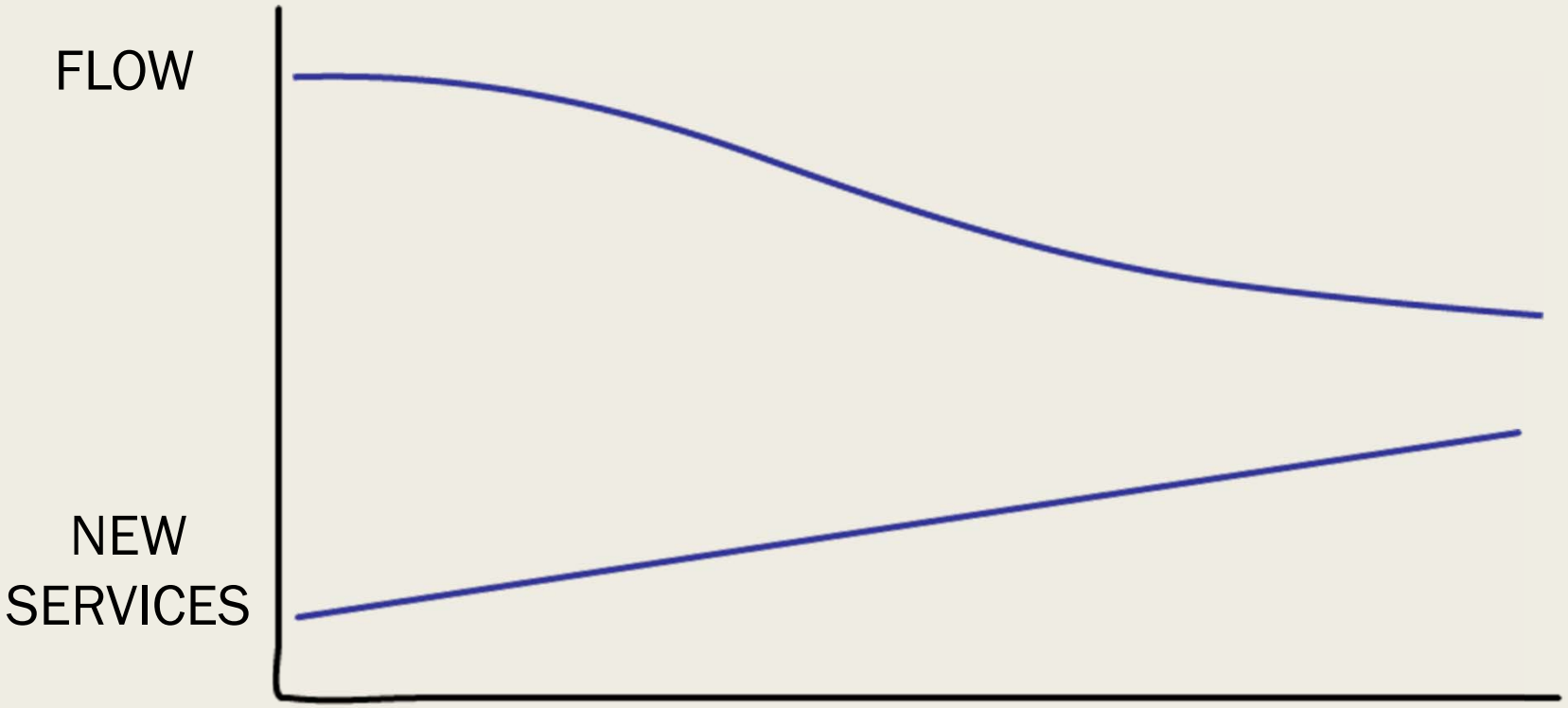
OUR FIRST STEPS IN MEETING A NEW CHALLENGE:

1. UNDERSTANDING WHAT HAS CHANGED.
2. THE IMPACTS ON COLLECTION AND TREATMENT PROCESSES.
3. THE IMPACTS ON DESIGN, OPERATIONS, ENERGY AND PLANNING.
4. STARTING A DIALOGUE AND SHARING INFORMATION.
5. DEVELOPING OPTIONS AND ALTERNATIVES.

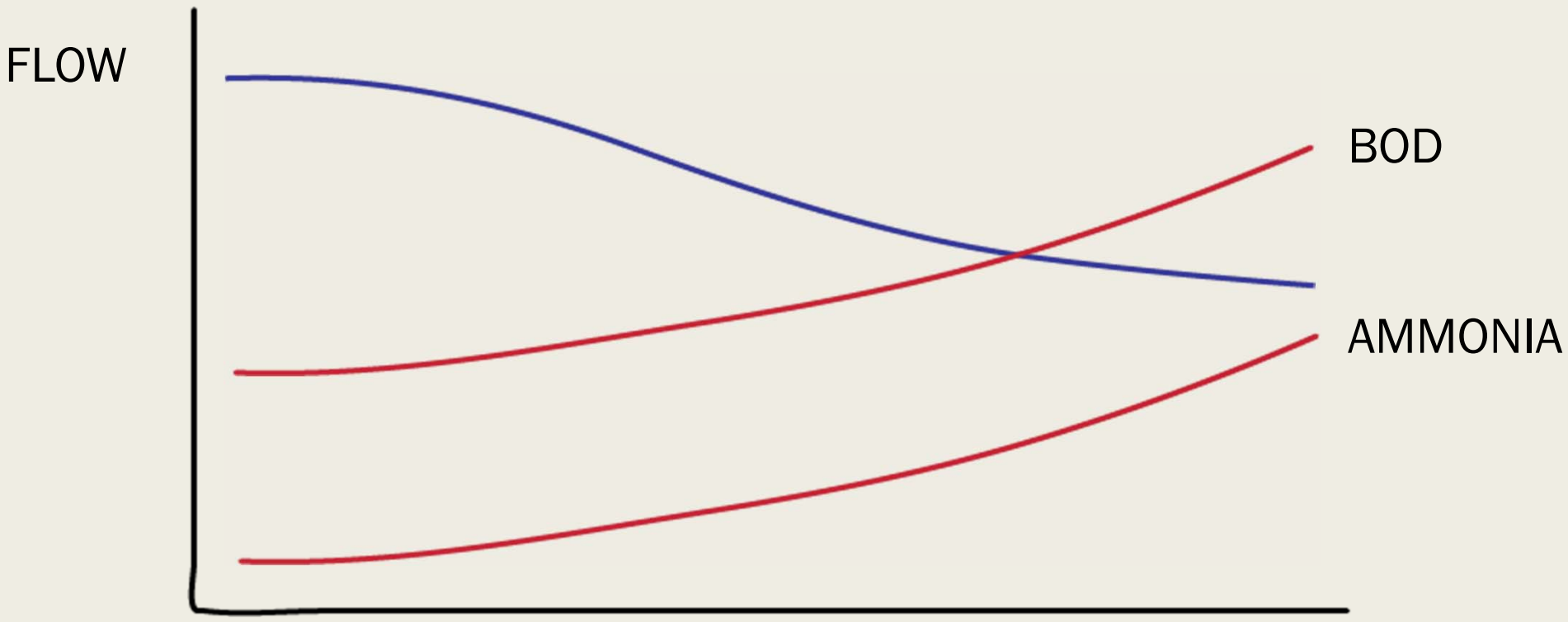
THE WAY IT WAS



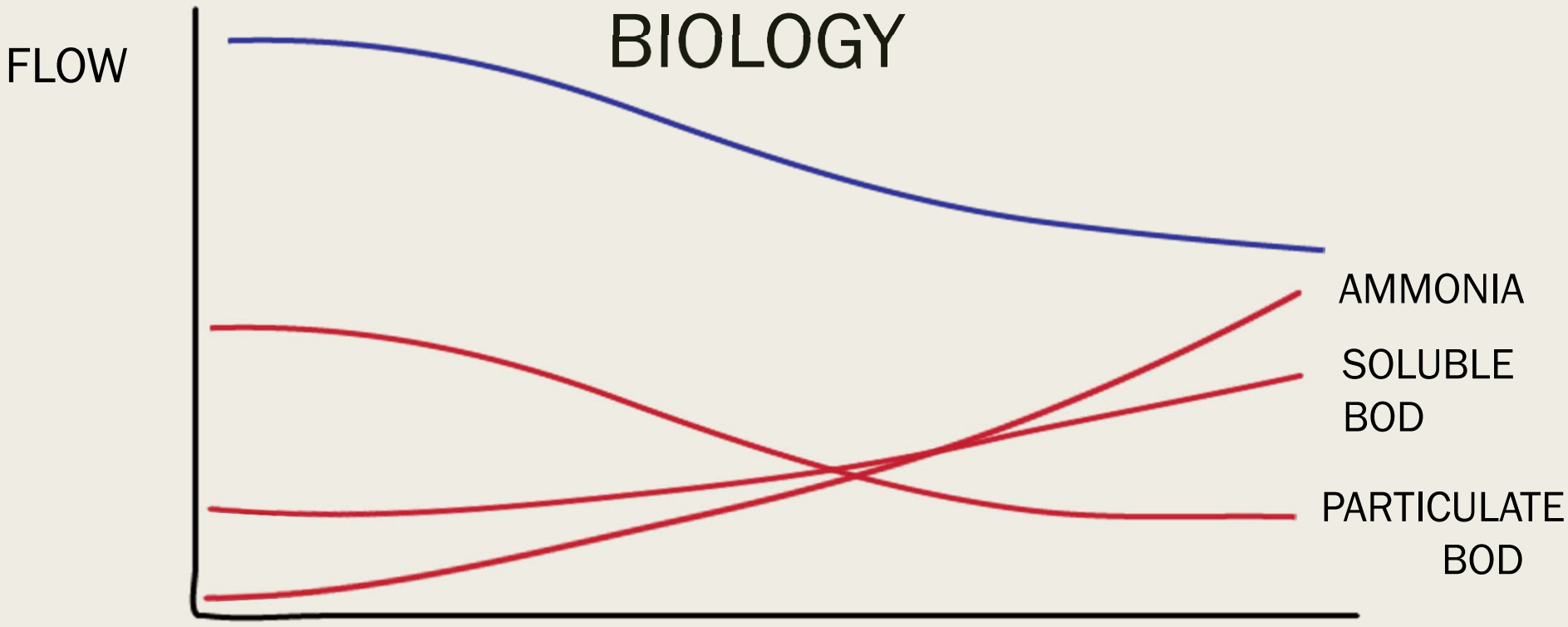
IMPACT OF WATER CONSERVATION



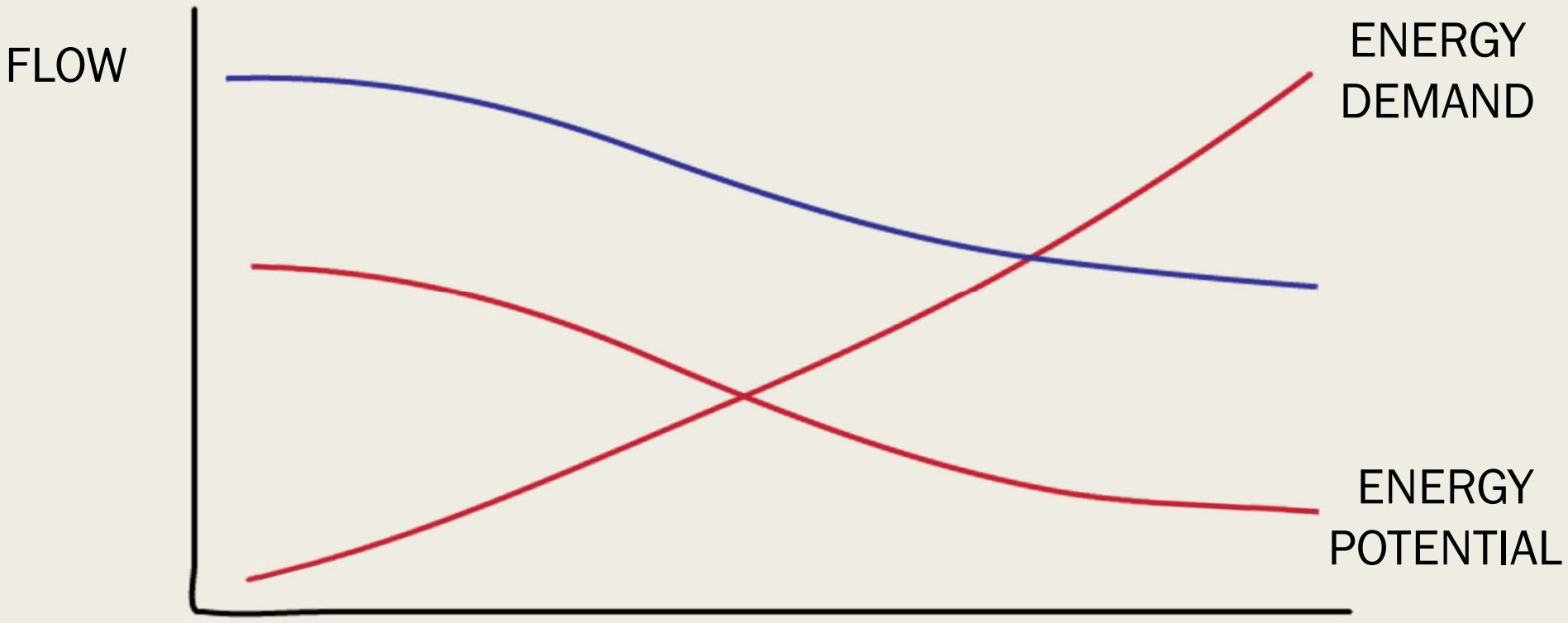
CHANGE IN DILUTION



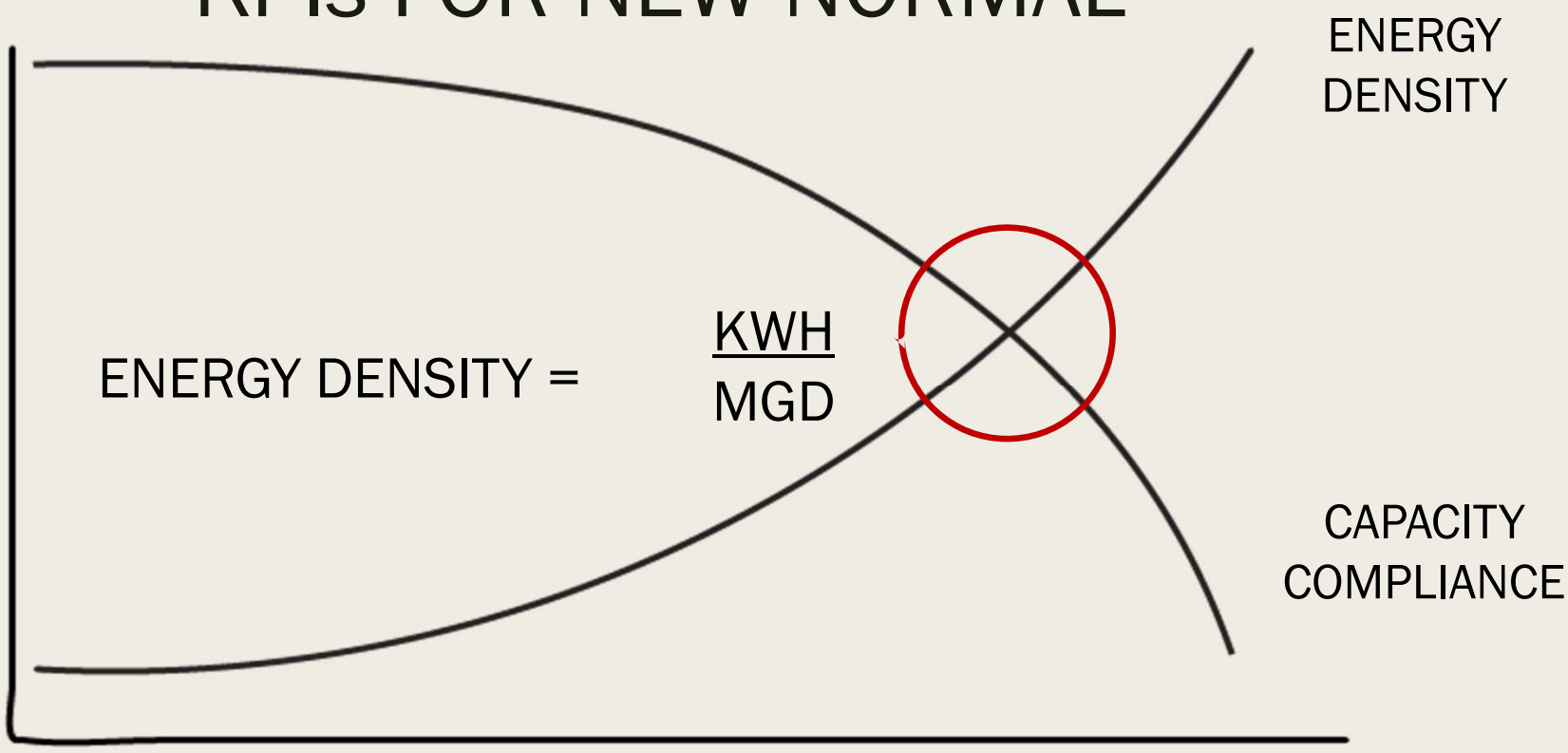
CHANGE IN COLLECTION SYSTEM BIOLOGY



WWTP ENERGY PROFILE

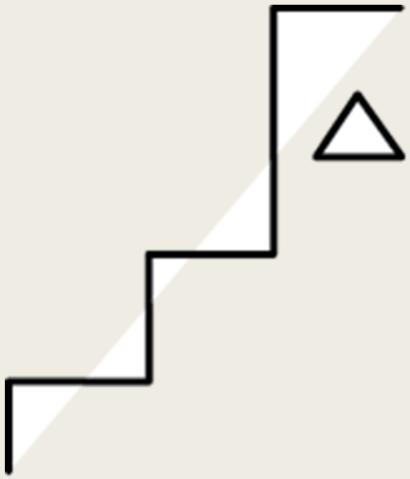


KPIs FOR NEW NORMAL



CHANGING CONDITIONS

STEP CHANGE

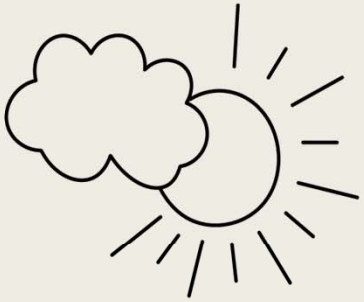


- WATER CONSERVATION
- PROCESS COMPLIANCE
- ENERGY USAGE
- EQUIPMENT FAILURE
- TECHNOLOGY

CLIMATE CHANGE WEATHER FORECAST

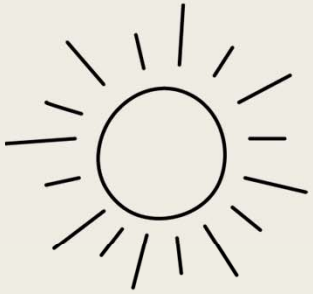
WINTER RAIN

2005



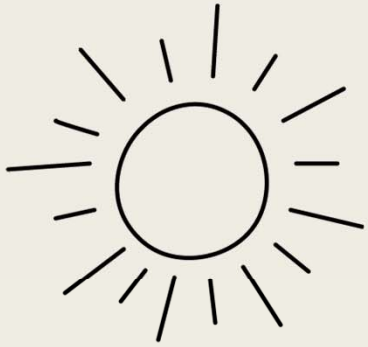
REDUCED RAIN

2008



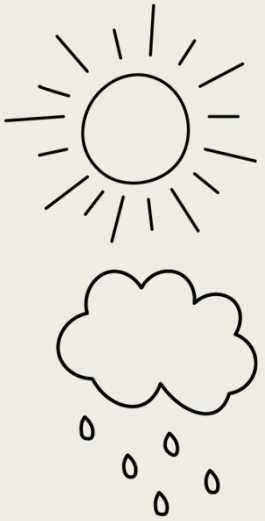
DROUGHT

2010



PROLONGED DROUGHT

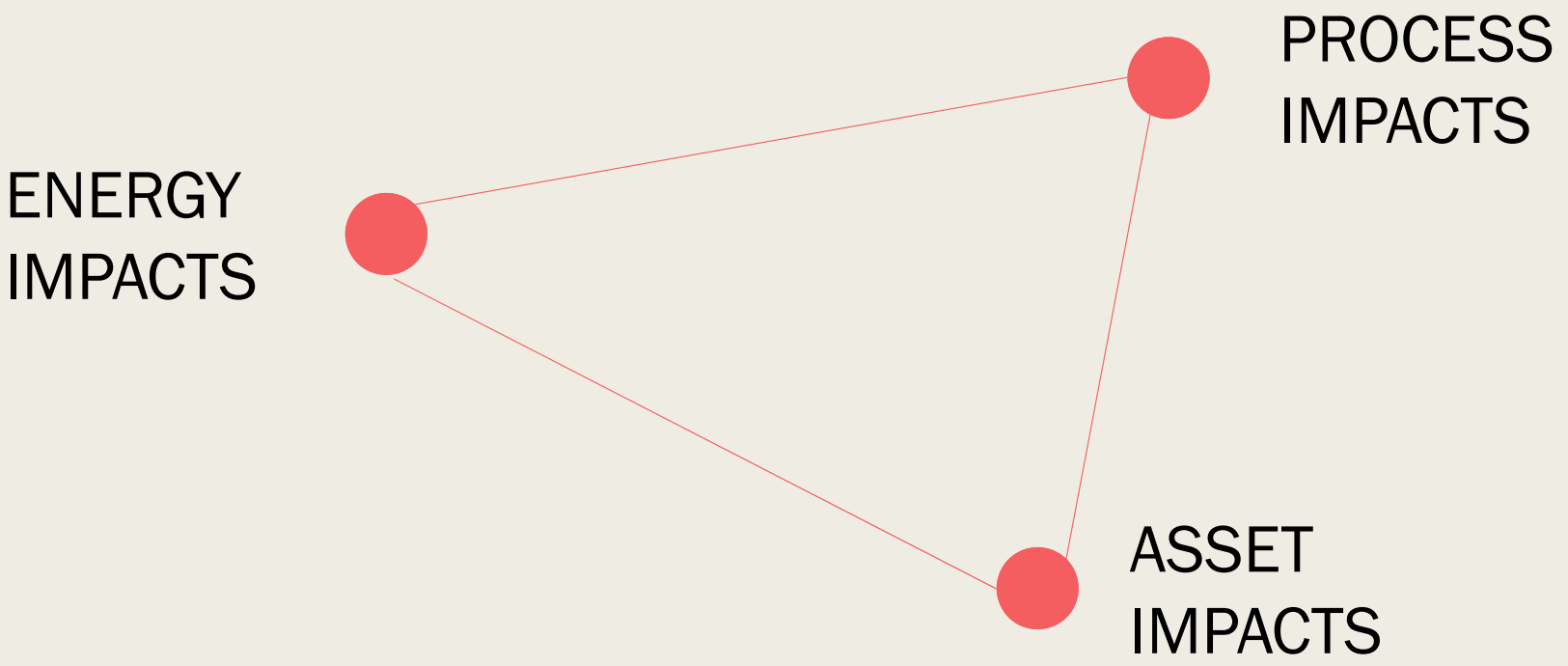
2015



VOLATILE WEATHER

"THE NEW NORMAL"

CONNECTING THE DOTS



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

- 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

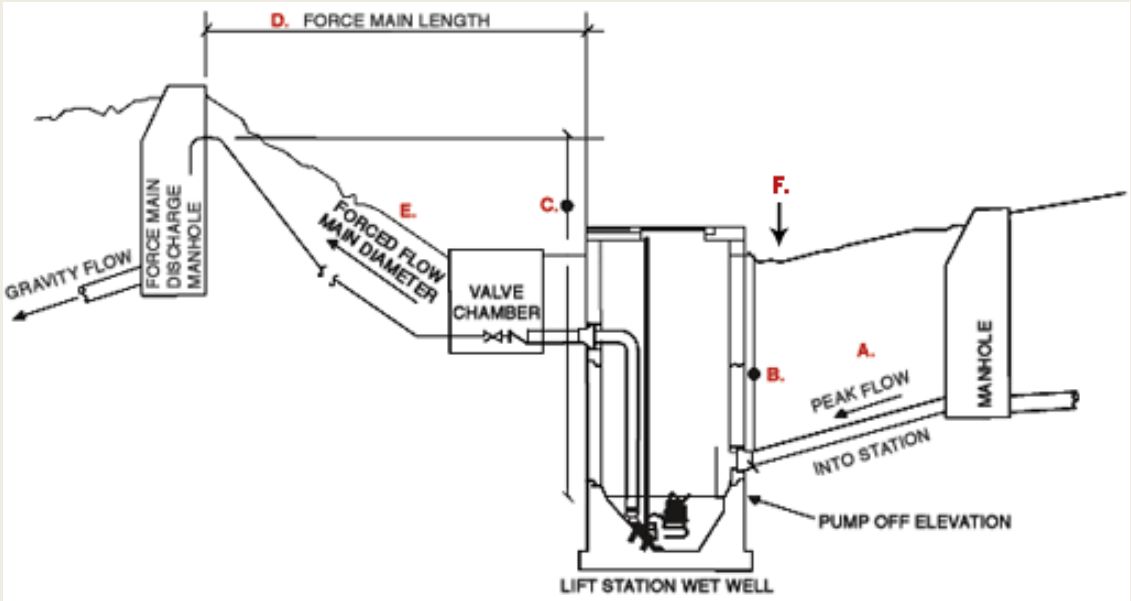
TERTIARY FILTRATION

EFFLUENT DISINFECTION

RECYCLING & REUSE

COLLECTION SYSTEM ISSUES
PIPING AND PUMP STATIONS

- REDUCED FLOW RATES AND HIGHER CONCENTRATIONS
- INCREASED SULFIDE GENERATION
- INCREASED ODORS, TOXICITY & CORROSION
- OVERSIZED PUMPS AND INCREASED CYCLING
- INCREASED ENERGY CONSUMPTION
- INCREASED RISK OF FAILURES AND SPILLS

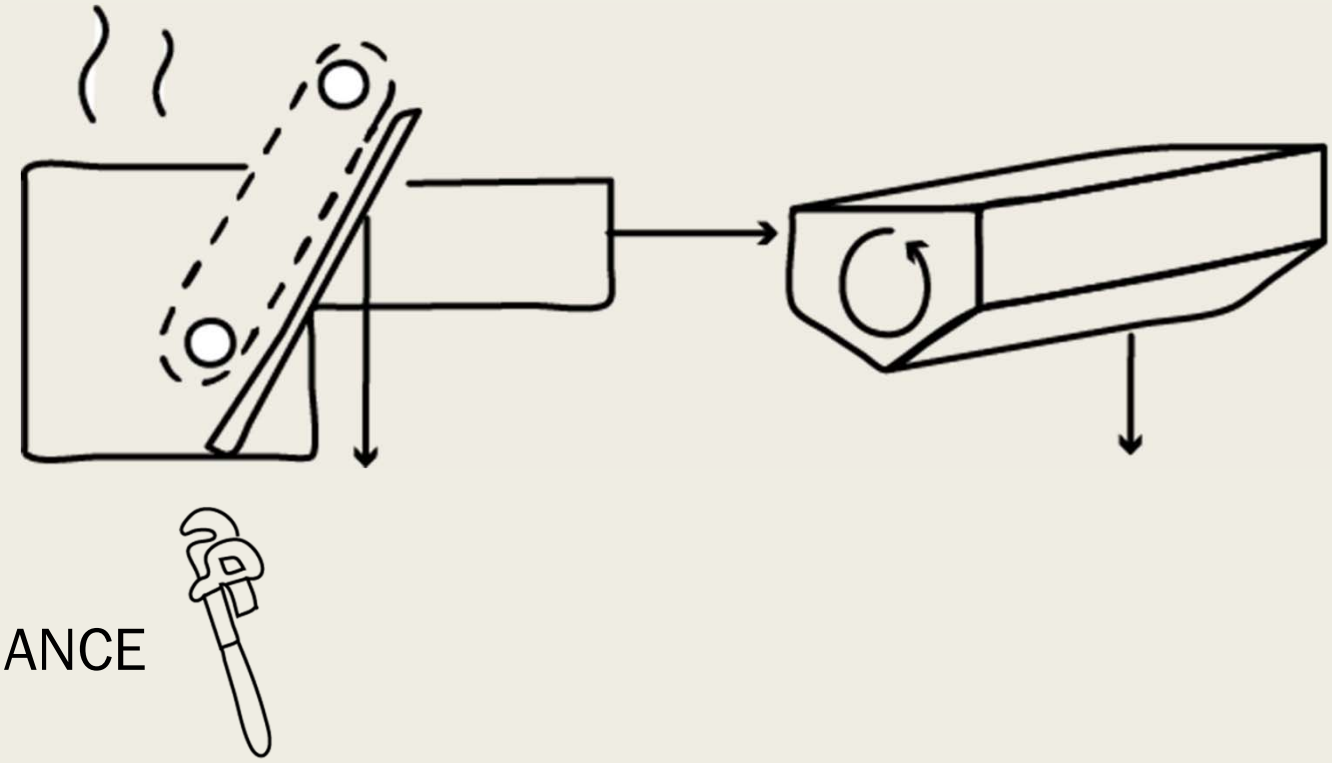


PROCESS CONTROL ISSUES

HEADWORKS

INCREASED SULFIDE ODOR, CORROSION, CHEMICALS

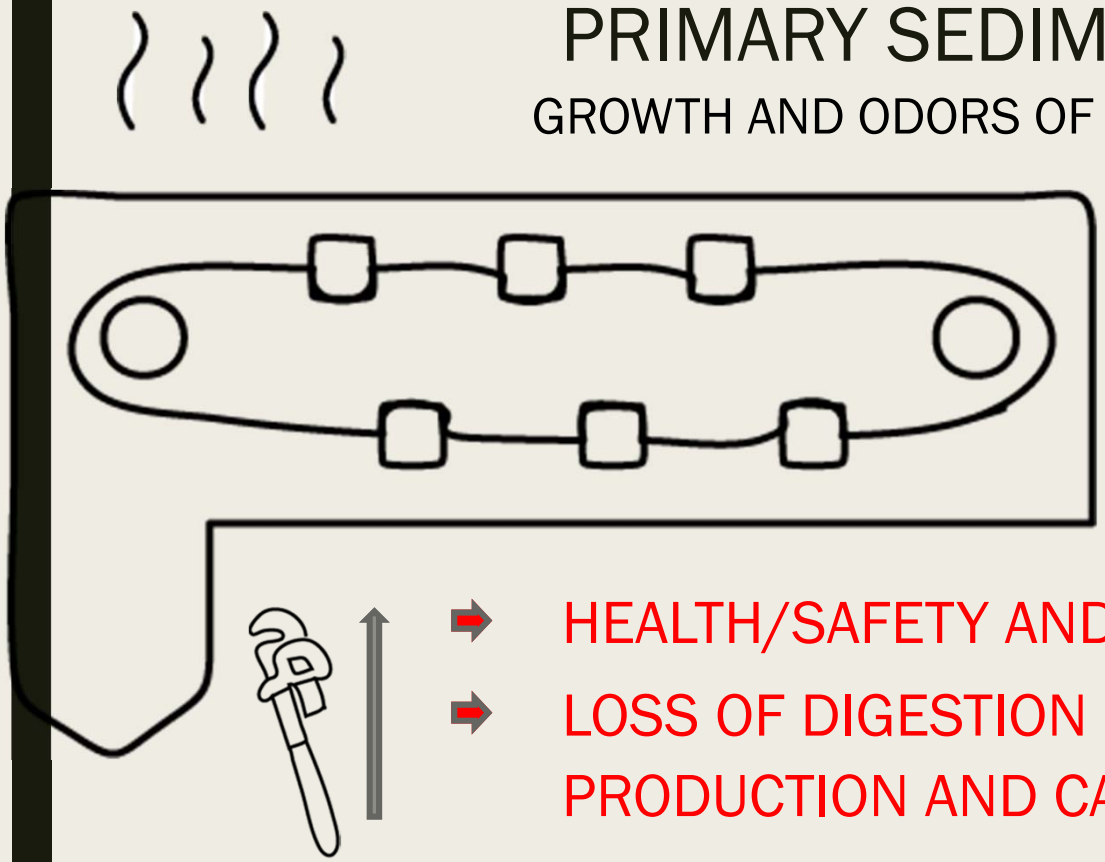
- IMPACTS FROM SLOUGHING SOLIDS
- PERIODIC OVERLOAD OF GRIT SYSTEM
- INCREASED MAINTENANCE



PROCESS CONTROL ISSUES

PRIMARY SEDIMENTATION

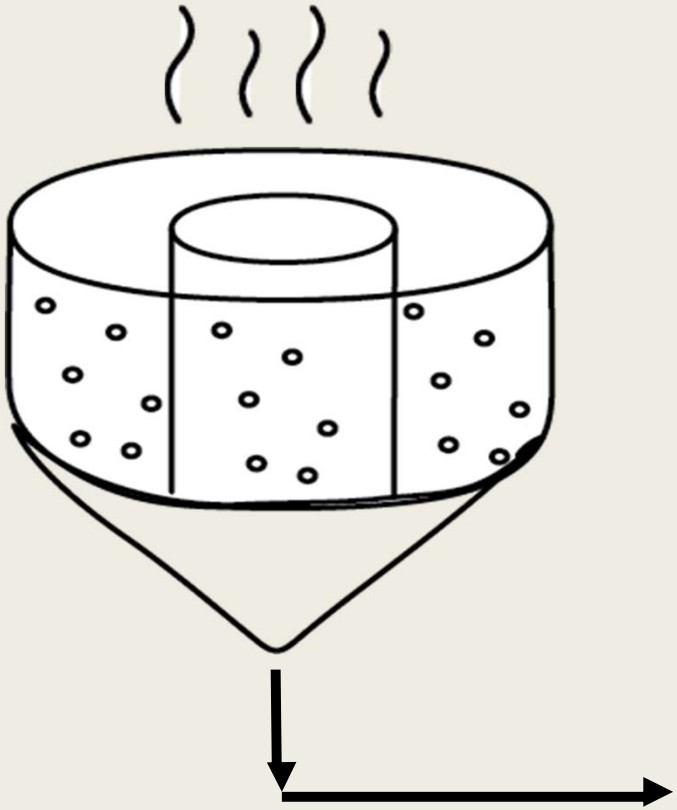
GROWTH AND ODORS OF SULFUR FIXING BACTERIA



- 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 & NH_3

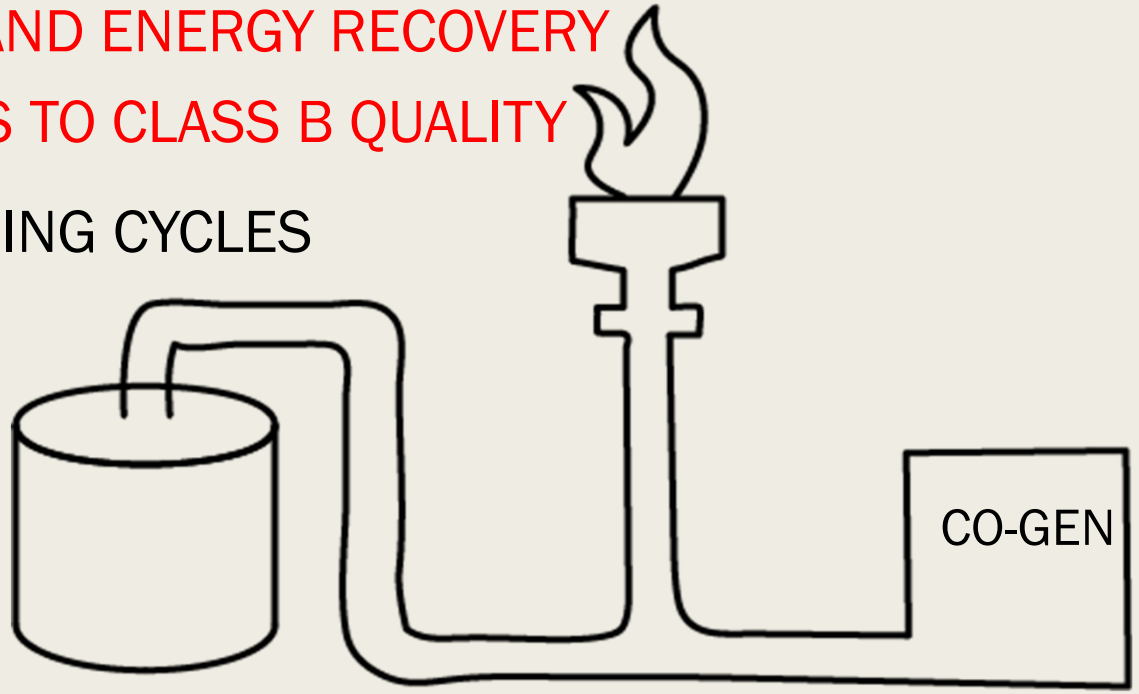
PROCESS CONTROL ISSUES
PRIMARY SLUDGE THICKENING



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

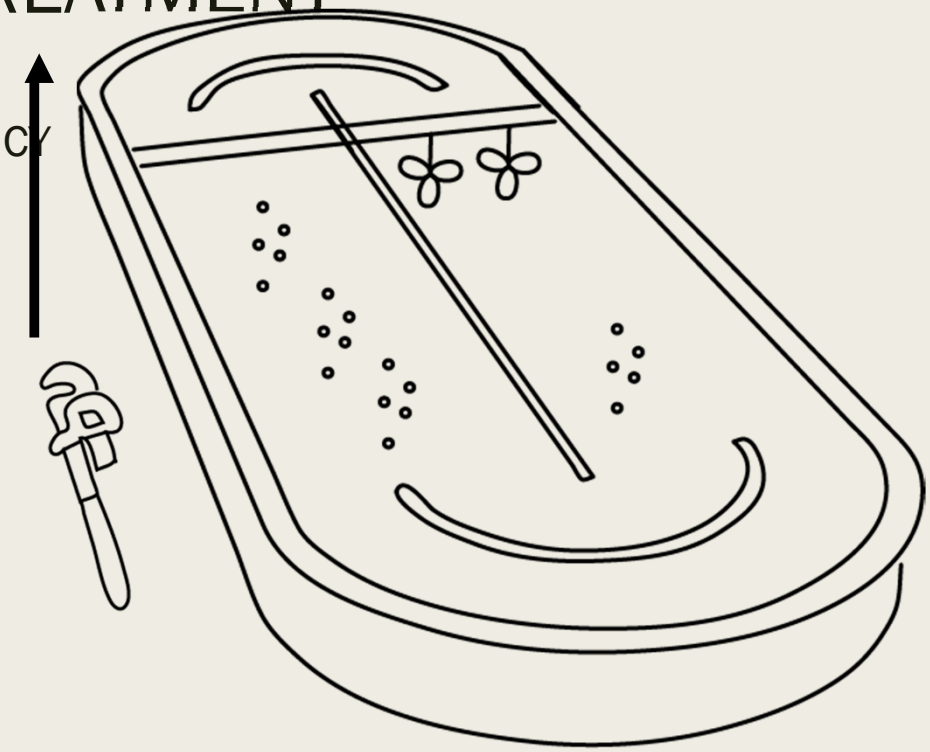
PROCESS CONTROL ISSUES
ANAEROBIC DIGESTION

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

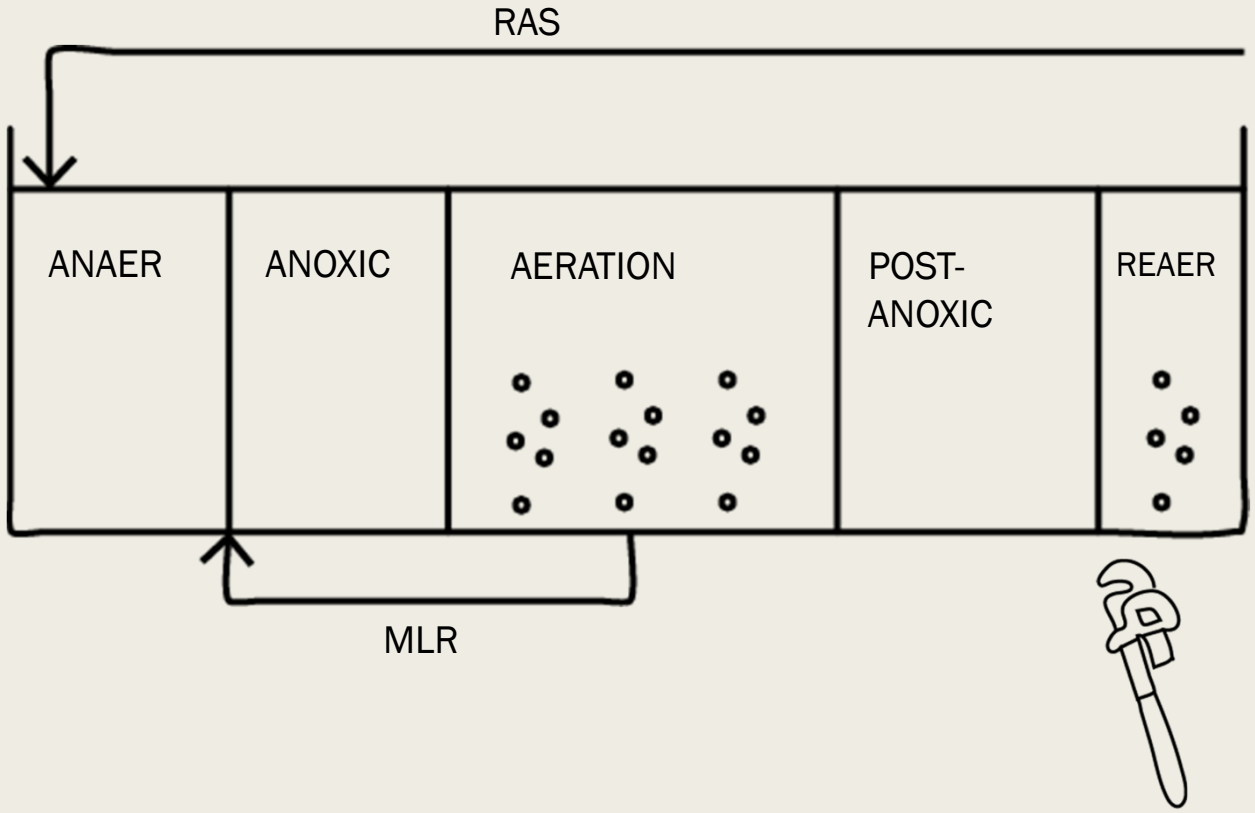


PROCESS CONTROL ISSUES
SECONDARY TREATMENT

- INCREASED ENERGY DEMAND
- INCREASED TF SLOUGHING AND POOR BOD EFFICIENCY
- INCREASED BLOWER AND DIFFUSER ATTENTION
- POOR PERFORMANCE DUE TO HS TOXICITY
- 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

In the MLE Process

Mixed Liquor Return (MLR) pumping can't 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

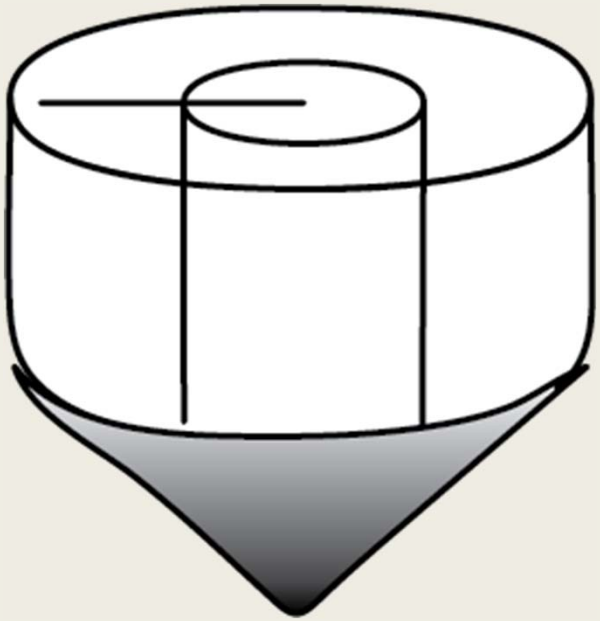
Effluent TIN = 7 mg/L

RAS @ 100% = 30 mgd

MLR @ 4Q design = 120 mgd

Influent NH3-N	MLR Capacity
25 mg/L	47 mgd
35 mg/L	90 mgd
45 mg/L	133 mgd
55 mg/L	176 mgd

PROCESS CONTROL ISSUES
SECONDARY CLARIFICATION

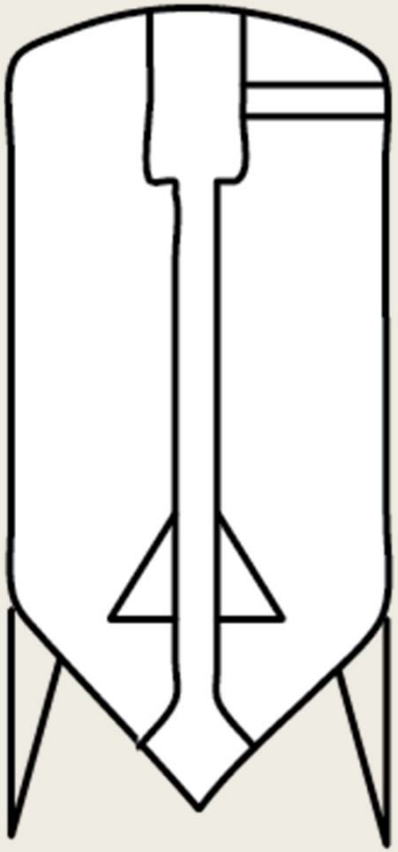


- INCREASED SLR
- INCREASED BLANKET LEVEL
- INCREASED RAS PUMPING
- INCREASED HOUSEKEEPING
- FOAMING

- REDUCED TSS CONTROL
- REDUCED CAPACITY RATING

PROCESS CONTROL ISSUES

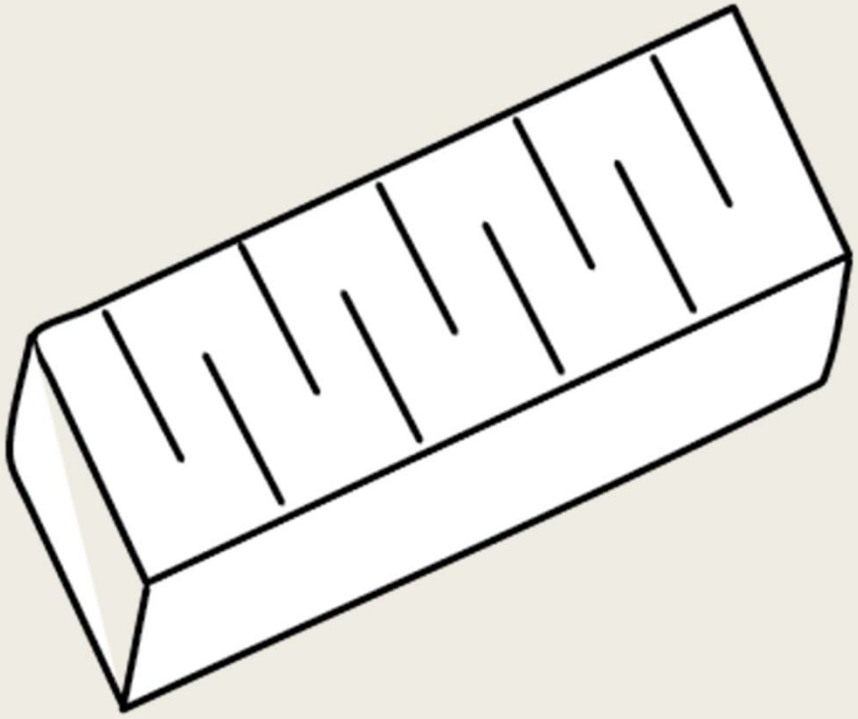
TERTIARY FILTRATION



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

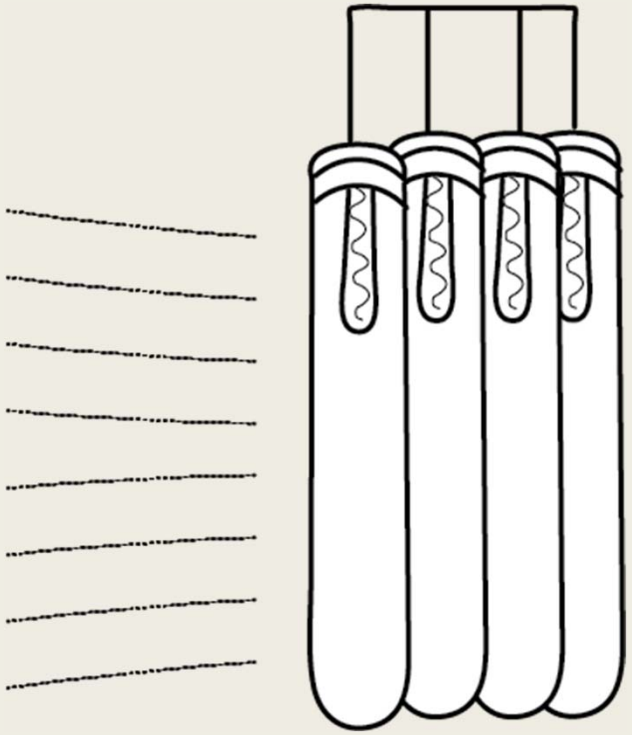
PROCESS CONTROL ISSUES
CHLORINE DISINFECTION

- INTERRUPTED EFFICIENCY
- INCREASED CHEMICAL DOSE & COST
- 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)

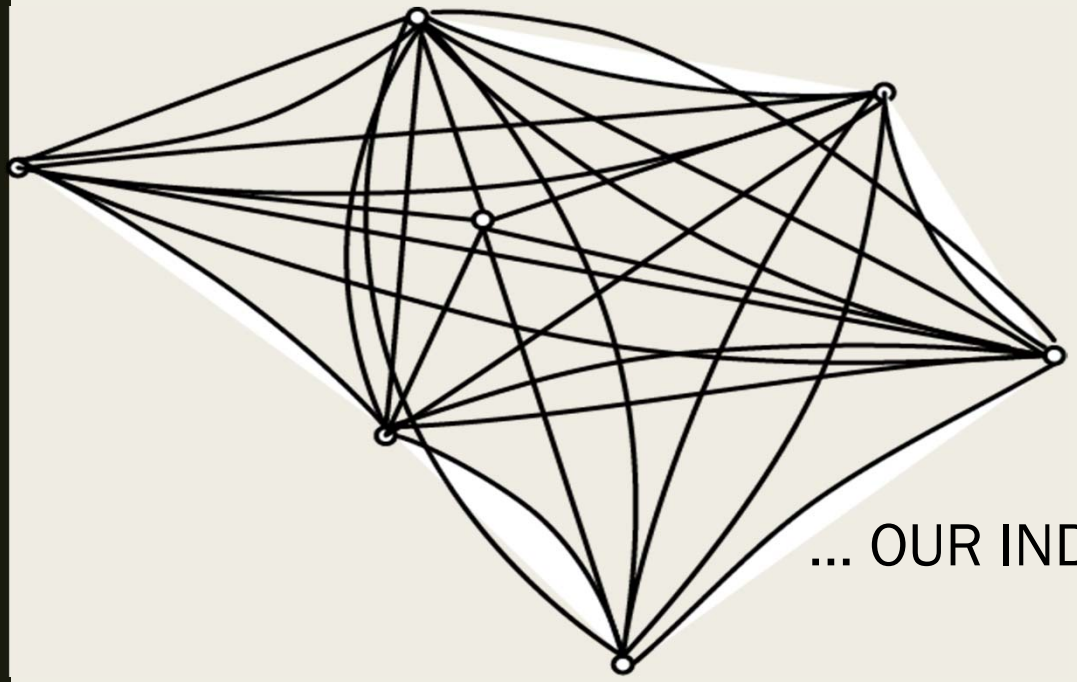
RELIABILITY IN DROUGHT CONDITIONS

- 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 PROCESS AND ENERGY USE

FIND THE BEST FIT CURVE OF ENERGY USE TO WORK PERFORMED …

… OUR INDUSTRY NEEDS TO TAKE ACTION - FIT THE NEW CURVE!

ASSESSING CONDITIONS

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

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

What's Next?
Alternative Solutions in the New Paradigm

- Increased Monitoring & Awareness
- Collection System Management
- Enhanced Source Control Management
- Bio-chemical Pretreatment
- Modified Primary and Anaerobic Treatment
- Modified Secondary Treatment
  - Chemical Augmentation
  - Biological Augmentation
  - Modified BNR Design
- TDS Management Plan
  - System Audit
  - Treatment Plant Audit

END

THANK YOU!

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 SIGNIFICANLTY
- A GHOST TOWN - MOST OF THE PROPERTY OWNERS ABONDONED 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 SETTLEABILITY IMPACTED

CASE STUDIES: WWTP #2 OPPORTUNITIES

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

CASE STUDIES: WWTP #2 APPROACH

- INVITE THE BNR OEM FOR A VISIT
- LOOK FOR OPPORTUNTIES TO MODIFY THE OPERATIONAL STRATEGIES FOR DROUGHT
- CONVINCE 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/DENTIRIFICATION 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 NOVs AND FINES

CASE STUDIES: WWTP #3 APPROACH

- EVALUATE POTENTIAL FOR COLLECTION SYSTEM STRATEGY TO REDUCE AMMONIA LOAD
- LOOK FOR OPPORTUNTIES 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/DENTIRIFICATION 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 NOVs AND FINES
- INCREASE RECYCLED WATER PRODUCTION

CASE STUDIES: WWTP #4 APPROACH

- EVALUATE POTENTIAL FOR COLLECTION SYSTEM STRATEGY TO REDUCE AMMONIA LOAD
- LOOK FOR OPPORTUNTIES 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 PRODUCITON
  - WASTE HEAT RECOVERY AND DIGESTER HEATING