Water Environment Federation & AZ Waters Student Competition

Presentors: Khalid Abushousha, Shiqing Cai, Jacob Mitten, Wes Levin, Jocelyn Ramirez

Date: 4/24/2020

CENE 486C Final Presentation
Spring, 2020

Acknowledgements

The NAU 2020 WEF Student Design Competition Team would like to thank the people and organizations listed below for their help in our success!

- Dr. Jeffrey Heiderscheidt- Technical Advisor
- Nick Yonezawa- WEF Student Design Competition Coordinator
- AZ Water Association
- Water Environment Federation and WEFTEC
- NAU School of Civil and Environmental Engineering

Intro: Project Description

- **Purpose:** To retrofit the Kyrene Water Reclamation Facility (KWRF) from a 9MGD average capacity to a 3MGD
- **Client:** AZ Water & WEF
- **Location:** Tempe, Arizona
- **Stakeholders:** AZ Water, AZ Department of Environmental Quality, WEF, NAU, and the City of Tempe

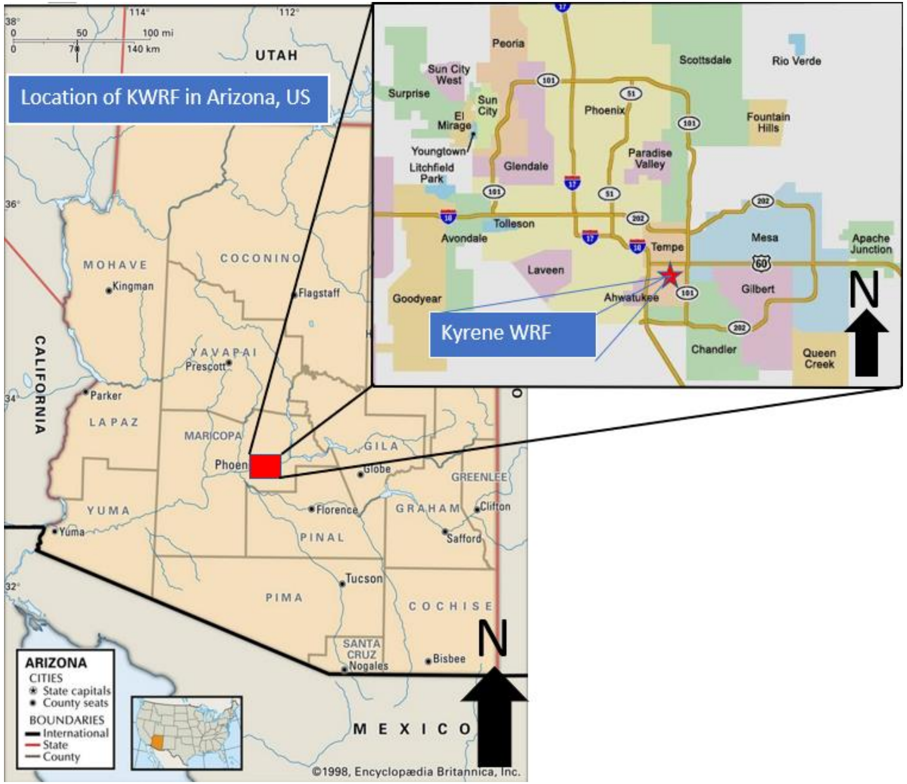

Figure 2: Site Location [1]

Objectives

Requirements

- **Reopen operations in 2025**
- **Reduce flow capacity from 9 MGD to 4 MGD**
- **Produce Class A+ Reclaimed Water Effluent**
- **Maintain Effluent Commitments to:**
    - Buckeye Water Conservation and Drainage District
    - Tres Rios
    - Palo Verde Nuclear Generating Station

Criteria

- **Optimize Energy Efficiency/Promote Green Energy**
    - Tempe City 2030 Goal: 100% Renewable Energy
    - Tempe City 2050 Goal: Carbon Neutral

Constraints

- **Site Dimensions**
- **Budget**
- **Permit Requirements**

Figure 3: Kyrene Plant Water Pumps (Team photo)

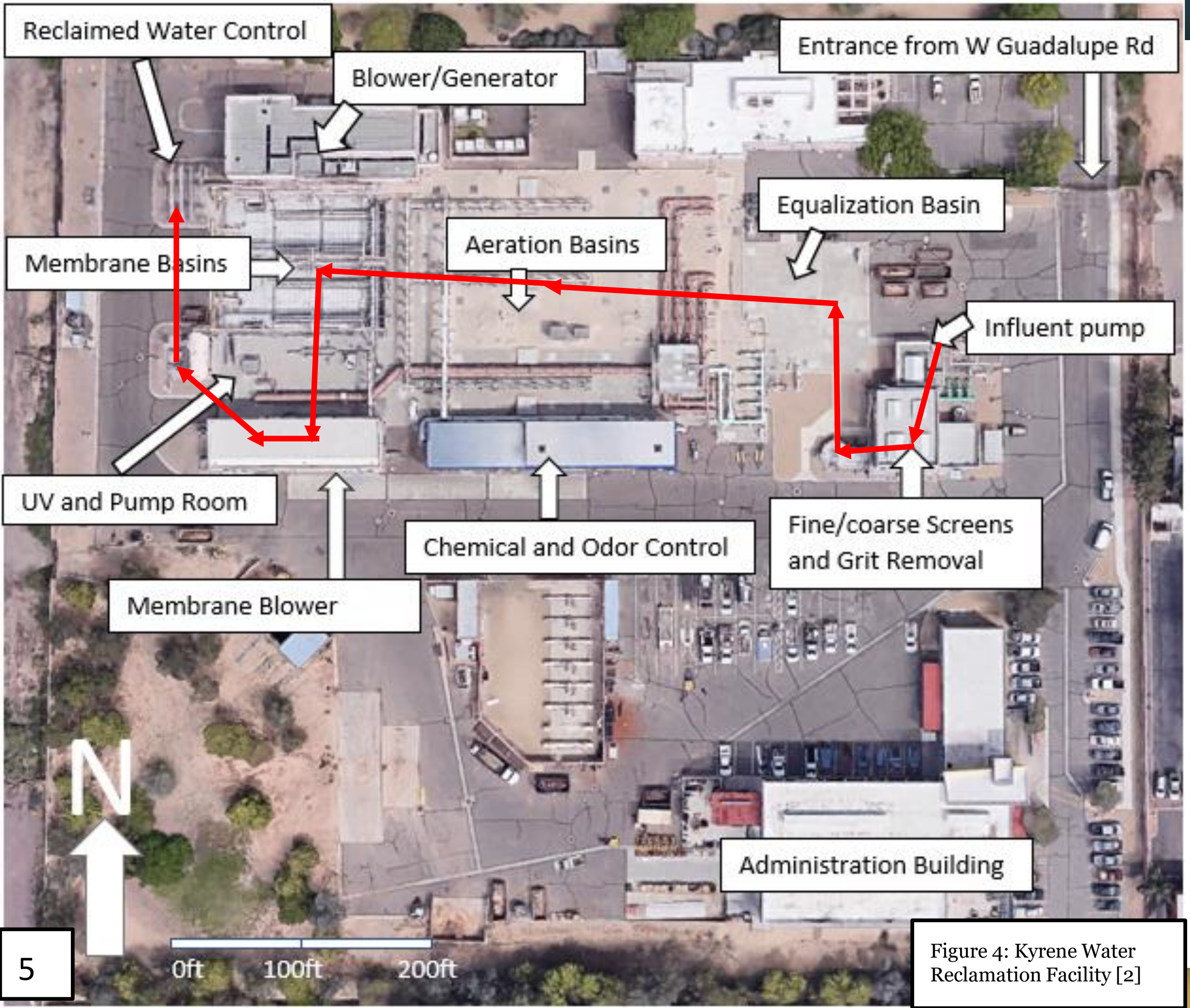

Figure 4: Kyrene Water Reclamation Facility [2]

Existing

Preliminary Treatment
- Influent Pump
- Fine/Coarse Screens
- Grit Removal

Primary Treatment
- Equalization Basin

Secondary Treatment
- Aeration Basin
- Membrane Basins

Advanced Treatment
- UV and Pump Room
- Reclaimed Water Control

Site Assessment
Site Visit/Research

Figure 5: Return Activated Sludge Pipes with Jocelyn for scale (Team Photo)

Figure 6: UV Light Treatment (Team Photo)

Figure 7: Jocelyn admiring UV Light Treatment (Team Photo)

Plant Requirements
Source Water Characteristics

- AZ Waters provided excel sheet of source water data
  - Collected between the years of 2004-2019
  - Two influent pipelines: Kyrene Rd & Rural Rd.

Table 1: Source Water Characteristics

Major Characteristics Studied	
Flow	Total Kjedahl Nitrogen
Biochemical Oxygen Demand	Ammonia
Chemical Oxygen Demand	Nitrate
Total Suspended Solids	Minerals (i.e. CA^{2+})
Total Phosphorus	Heavy Metals (i.e. Arsenic)

Table 2: Sample of source water characteristics

KWRF Flow and Loading Summary				
Year	Flow Rate (MGD)	BOD (mg/L)	COD (mg/L)	TSS (mg/L)
2009	3.70	318.40	696.50	294.42
2010	3.33	373.38	813.00	377.69

Figure 8: 1 of 3 Distribution Pipelines (Team Photo)

Plant Requirements
Population Estimation

- Population growth is minimal
- Goal is independent of population
    - Old Capacity Flow: 9MGD
    - New Capacity Flow: 4MGD
    - New Average Flow: 3MGD

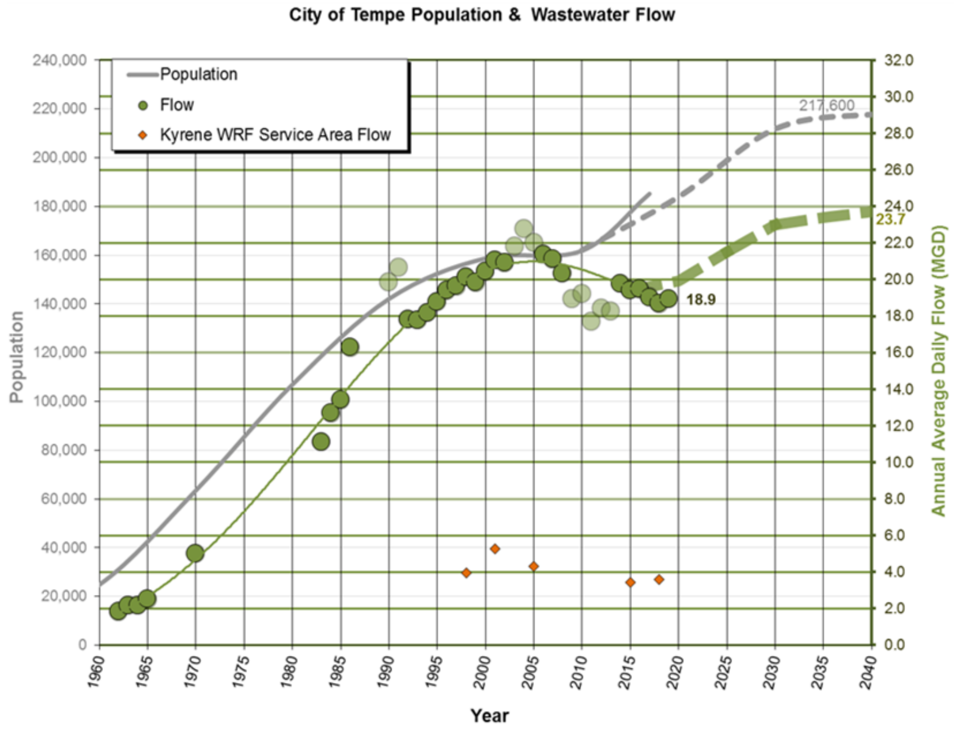

Figure 9: Population Chart [3]

Plant Requirements
Effluent Regulations

- Aim to produce Class A+ Effluent
- Regulations determine the effluent standards
  - Arizona Administrative Code (AAC), Title 18, Chapter 11

- Biosolids disposal regulations:
  - AAC Title 42, Chapter 2
  - AAC Title 18, Chapter 9
  - Clean Water Act

Table 3: Some Class A+ Effluent Requirements [4]

Parameter	Standard Level
Turbidity	2 or less NTUs (Daily Average)
	5 or less NTUs (Any time)
Fecal Coliform Organisms	23 FCU/100 ml (Single Sample)
Total Nitrogen	10 mg/L

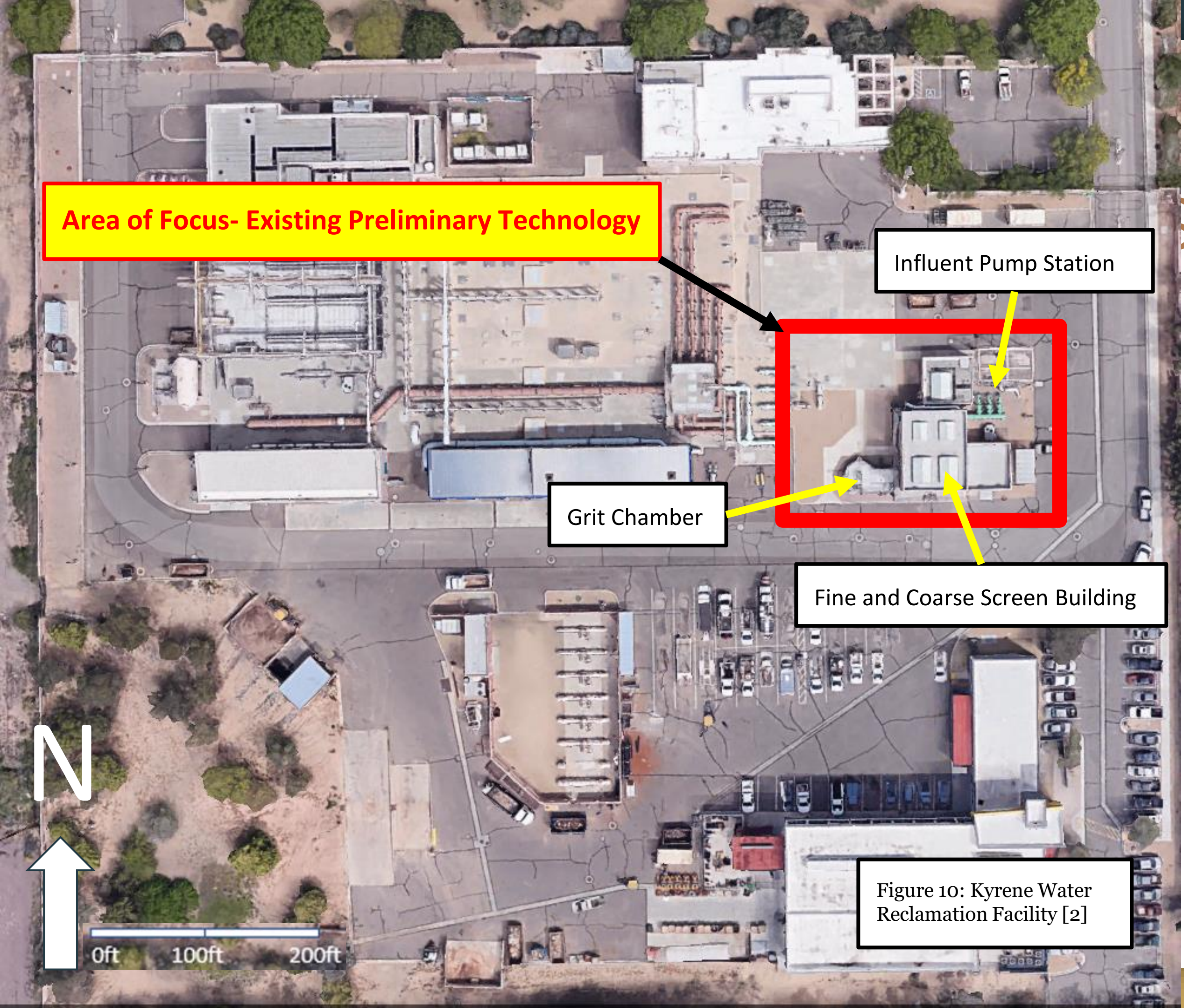

Figure 10: Kyrene Water Reclamation Facility [2]

Existing Preliminary Components

- Influent Pump Station w/ influent meter
- 3 Variable Frequency Drive (VFD) Submersible Pumps (Wet Well)
- 2 Coarse Screens
- 2 Fine Screens
- Grit Chamber (14.4 MGD Peak Flow)

Preliminary Treatment Decision Matrix

Detailed Preliminary Decision Matrix										
Criteria		**Weight**	Existing - 3 VFD submersible pumps, 2 coarse screens, 2 fine screens, Pista 360 Grit Chamber		Alt 1 - 2 VFD submersible pumps, 2 coarse screens, no fine screens, Mectan V Grit Chamber		Alt 2 - 2 VFD turbine pumps (dry well), 2 coarse screens, no fine screen, Pista 360 Grit Chamber		Alt 3 - 2 VFD submersible pumps (wet well), 1 grinder, Aerobic Grit Chamber	
			Input	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score
Feasibility	Area (m2)	10%	265.5		265.5		265.5		250.0	
	Final Score		**4.7**	**0.5**	**4.7**	**0.5**	**4.7**	**0.5**	**5.0**	**0.5**
O&M	Operational Cost ($/yr)	20%	1012326		89896		85968		96000	
	Life Span (yr)		25.0		25.0		25.0		22.5	
	Staffing		2.0		2.5		3.0		2.0	
	Initial Score		1.8		2.8		3.0		2.5	
	Final Score		**2.9**	**0.6**	**4.6**	**0.9**	**5.0**	**1.0**	**4.1**	**0.8**
Environmental/Social Impacts	Power (kW-hr/yr)	30%	16595510		1087834		1023437		1356000	
	By-Products		1.0		1.5		2.0		1.3	
	Initial Score		0.6		1.7		2.0		1.4	
	Final Score		**1.4**	**0.4**	**4.2**	**1.3**	**5.0**	**1.5**	**3.4**	**1.0**
Lifecycle Costs	Capital Cost ($)	10%	26921200		8230300		10230300		6500000	
	Final Score		**1.2**	**0.1**	**3.9**	**0.4**	**3.2**	**0.3**	**5.0**	**0.5**
Contaminant Removal Efficiency	Debris Rem. (%)	30%	100%		80%		80%		95%	
	Grit Rem. (%)		95%		75%		95%		75%	
	Initial Score		2.0		1.6		1.8		1.7	
	Final Score		**5.0**	**1.5**	**4.0**	**1.2**	**4.5**	**1.4**	**4.3**	**1.3**
Total Score				3.1		4.3		4.6		4.2
Selected Technology								**Best**		

Preliminary Treatment Design Recommendations

Figure 11: RakeFlex Screens [5]

$$v = \frac{1}{n} R^{2/3} S^{1/2}$$

2 Coarse Screens:
-RakeFlex Duperon
- Power: 136 kW-hr/yr
-Headloss: 1.5 inches

Screening Channel
-Each channel capacity is fit for peak flow (6 MGD)
-Concrete material

Channel Dimensions
Slope (S) = 0.001 m/m
Width (W) = 0.75m
Depth (D) = 0.9

Figure 12: Pista Vortex Grit Chamber [6]

1 Pista 360-degree Vortex Grit Chamber
-7 MGD capacity
-Removes 95% of grit 150μm and higher
-45,269 kW-hr/yr

Channel Requirements

Table 4: Great Lakes Upper Mississippi River Board (GLUMRB) Requirements Comparison [7]

GLUMRB Requirements			
Variable	**Requirement**	**Designed Value**	**Pass/Fail**
Avg. velocity	>0.4 m/s	0.52 m/s	Pass
Peak velocity	<0.9 m/s	0.84 m/s	Pass
Channel approach length : water depth	10:1	10:1	Pass
Freeboard	0.6 m	0.6 m	Pass
Redundancy	One Redundancy	One Redundancy	Pass

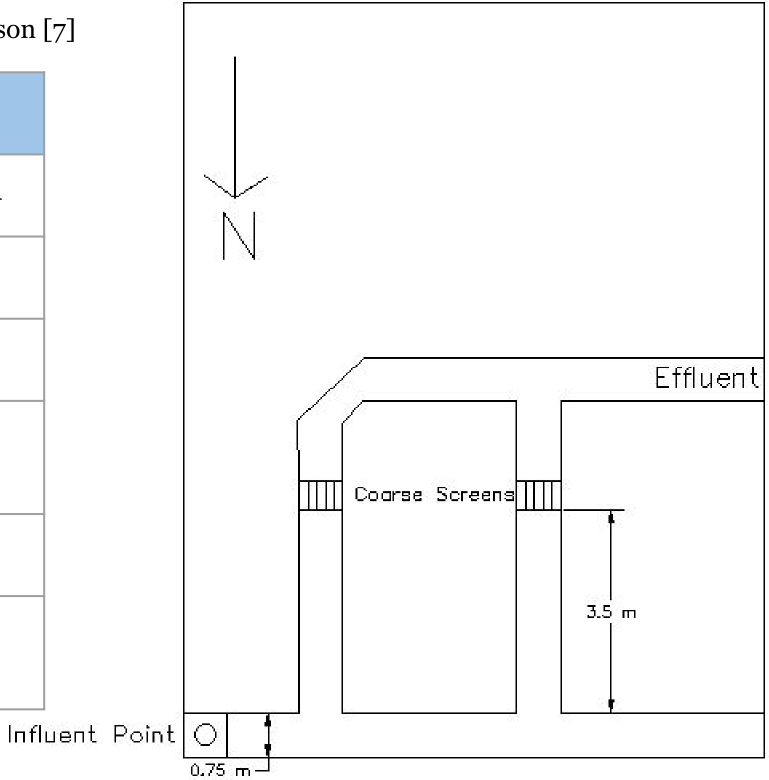

Figure 13: Diagram of Screening Room

Preliminary Treatment Design Recommendations

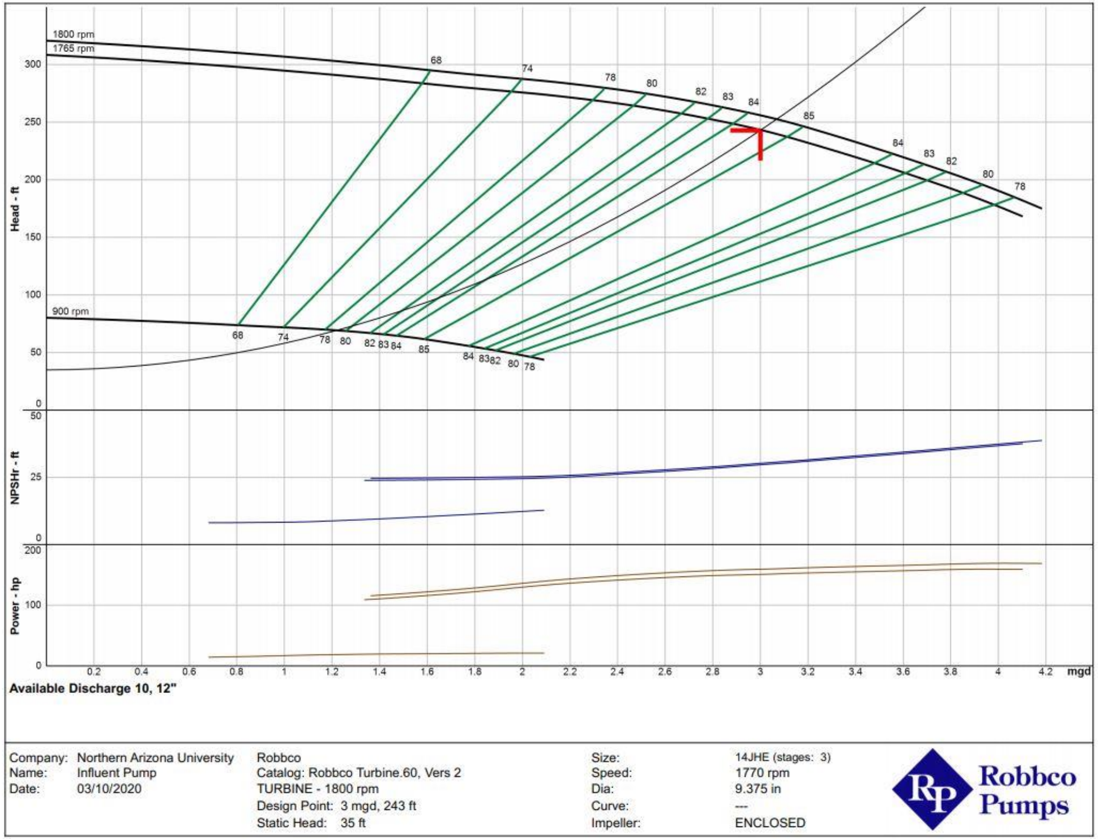

Figure 14: Pump Curve

Influent Pump Station

Table 5: Influent Pumps

Pump No.	1	2
Flow (MGD)	1.5	1.5
Total Head (ft)	60	60
RPM	900	900
Efficiency	84%	84%
Power (hp)	112	112

Existing Primary Components

- Flow Equalization Structure
- Equalization Basin (Captures Flows in Excess of 11.7 MGD)
- 3 VFD Equalization Pumps
- Coarse Bubble Diffusers
- 2 Equalization Blowers

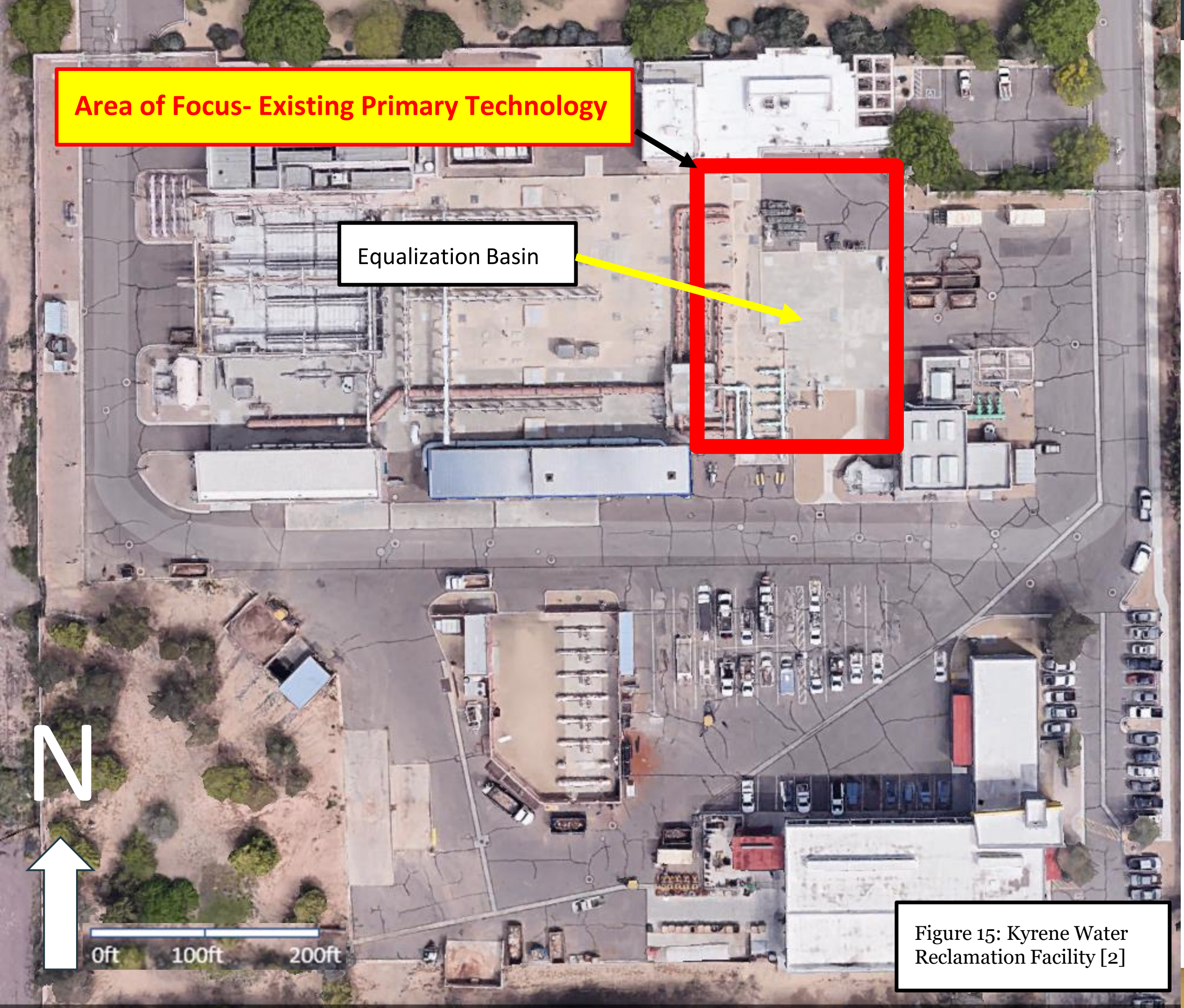

Figure 15: Kyrene Water Reclamation Facility [2]

Primary Treatment Decision Matrix

Detailed Primary Decision Matrix										
Criteria		Weight	Existing		Alt. 1 Rect. Clarifier		Alt. 2 Microsand Clarifier		Alt. 3 Reduced EQ Basin	
			Input	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score
Feasibility	Area (m2)	10%	1275.9		538.8		445.3		425.2	
	Final Score		**1.7**	**0.2**	**3.9**	**0.4**	**4.8**	**0.5**	**5.0**	**0.5**
O&M	Operational Cost ($/yr)	20%	100000		104000		149549		100000	
	Life Span (yr)		20.0		19.0		30.0		30.0	
	Staffing		3.0		1.0		1.0		3.0	
	Initial Score		2.7		1.9		2.0		3.0	
	Final Score		**4.4**	**0.9**	**3.2**	**0.6**	**3.3**	**0.7**	**5.0**	**1.0**
Environmental/Social Impacts	Power (kW-hr/yr)	20%	1143180		431060		16848466		381060	
	By-Products		3.0		2.0		2.0		2.0	
	Initial Score		1.3		1.6		0.7		1.7	
	Final Score		**4.0**	**0.8**	**4.7**	**0.9**	**2.1**	**0.4**	**5.0**	**1.0**
Lifecycle Costs	Capital Cost ($)	10%	441000		2113000		323253		220500	
	Final Score		**2.5**	**0.3**	**0.5**	**0.1**	**3.4**	**0.3**	**5.0**	**0.5**
Contaminant Removal Efficiency	Particle Rem. (%)	40%	0%		75%		90%		0%	
	BOD Rem. (%)		0%		27%		80%		0%	
	Initial Score		0.0		1.2		2.0		0.0	
	Final Score		**0.0**	**0.0**	**2.9**	**1.2**	**5.0**	**2.0**	**0.0**	**0.0**
Total Score				2.1		3.2		3.9		3.0
Selected Technology								**Best**		

Primary Treatment Design Recommendations

- Downsize EQ basin from 1.5MG to 0.5MG
- Pipes designed to bend to induce proper mixture
- Ballasted Clarifier with a footprint of 15 m^2
- 180 lb/day of sand is introduced
- Wastewater fed with alum

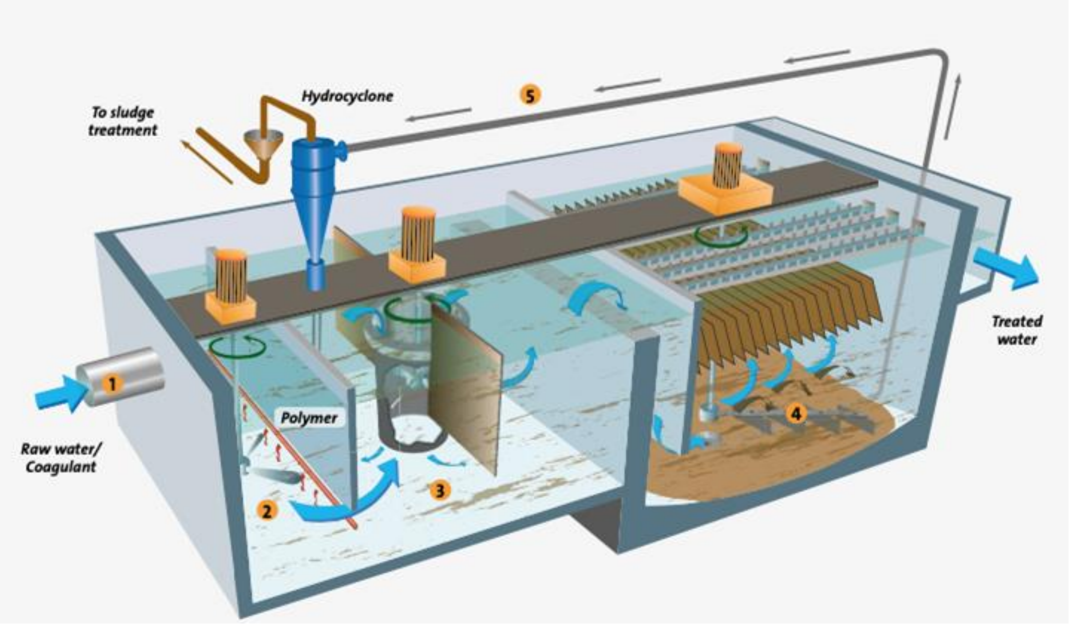

Figure 16: Diagram of ACTIFLO®PACK [8]

Primary Treatment Design Recommendations

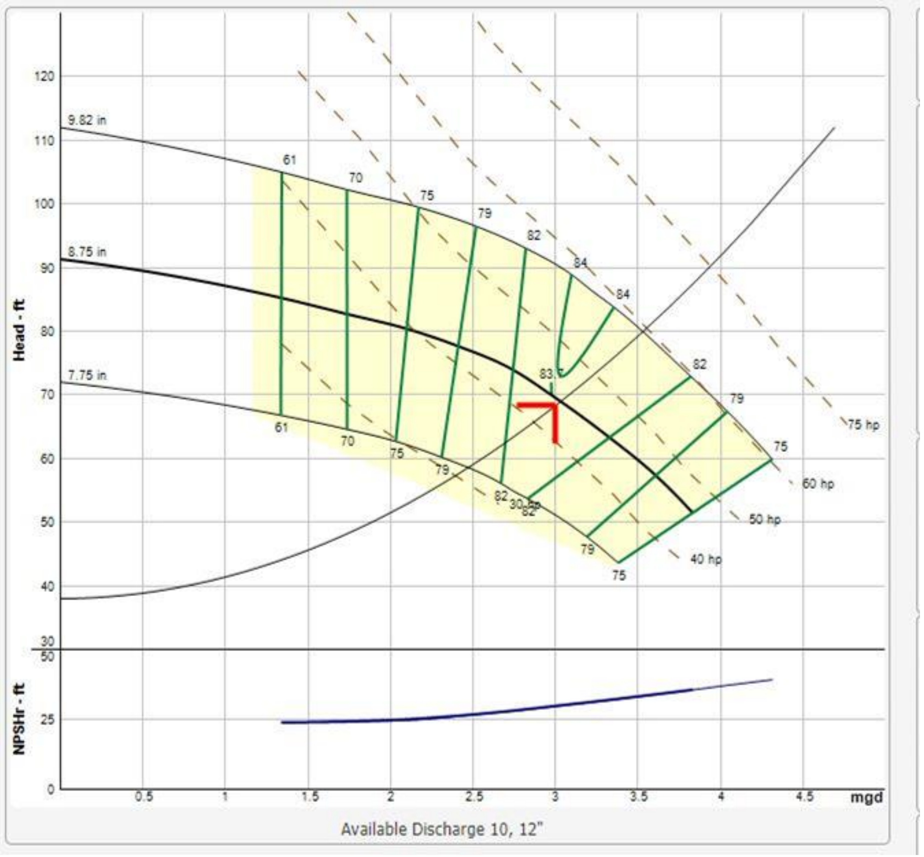

Figure 17: Pump Curve

Flow Equalization Station

Table 6: Flow Equalization Pumps

Pump No.	1	2	3
Flow (MGD)	1	1	1
Head (ft)	68.9	68.9	68.9
RPM	1770	1770	1770
Efficiency	83.4%	83.4%	83.4%
Power (hp)	43.9	43.9	43.9

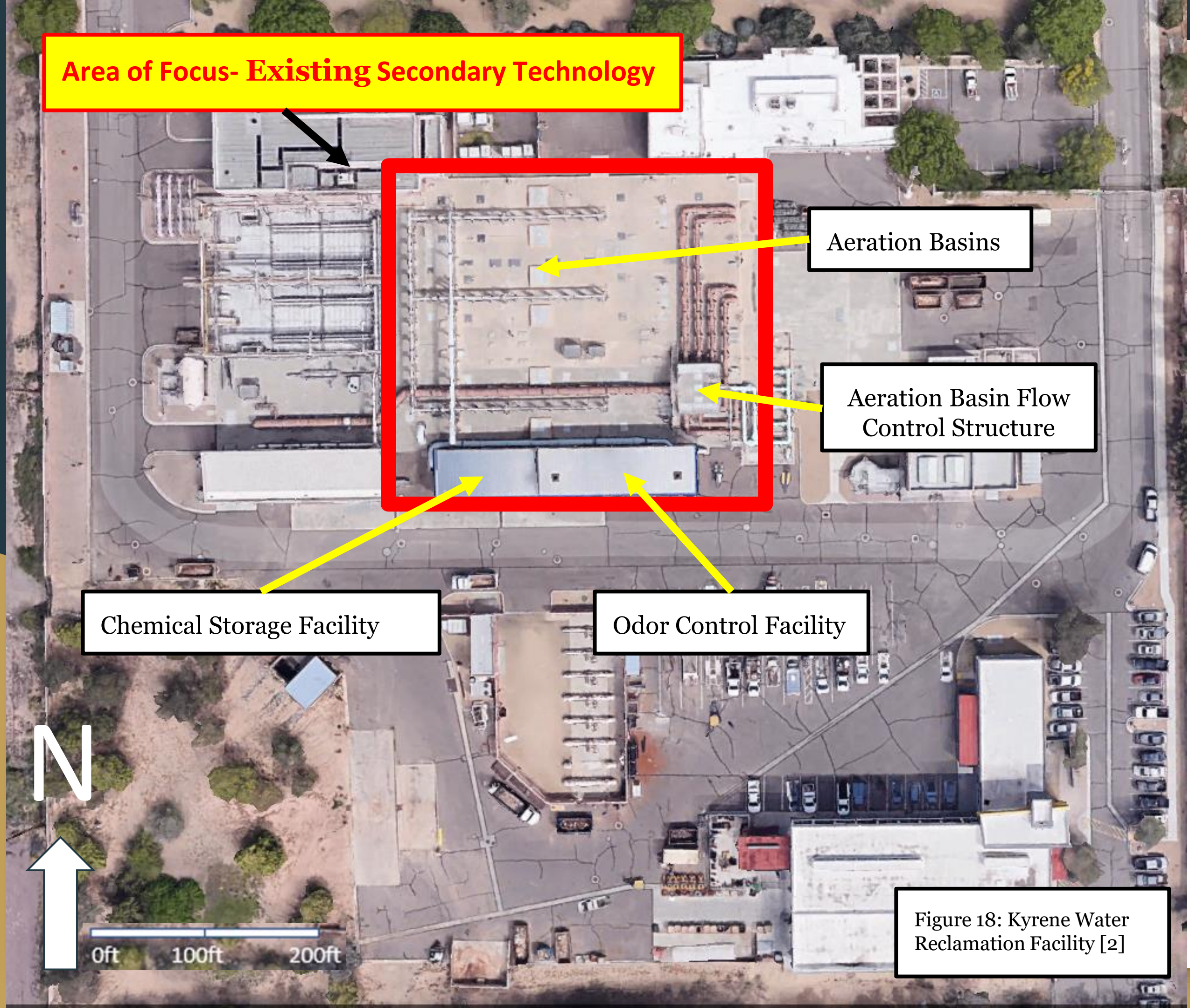

Figure 18: Kyrene Water Reclamation Facility [2]

Existing Secondary Components

- Concrete Aeration Basin (4.5 MGD Capacity)
- 6 Aeration Basins
- Jet Aeration System
- Covered

Secondary Treatment Decision Matrix

Detailed Secondary Decision Matrix

Criteria		Weight	Existing		Alt. 1 Microalgae Syst.		Alt. 2 Ammanox Reactor		Alt. 3 Biomembrane Reactor	
			Input	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score
Feasibility	Area (m2)	25%	2065.7		200000.0		874.0		1020.0	
	Final Score		**2.1**	**0.5**	**0.0**	**0.0**	**5.0**	**1.3**	**4.3**	**1.1**
O&M	Operational Cost ($/yr)	20%	2396012		8861600		671600		1939478	
	Life Span (yr)		8.0		11.0		15.0		8.0	
	Staffing		1.0		2.0		2.0		1.0	
	Initial Score		1.3		1.8		3.0		1.4	
	Final Score		**2.2**	**0.4**	**3.0**	**0.6**	**5.0**	**1.0**	**2.3**	**0.5**
Environmental/Social Impacts	Power (kW-hr/yr)	20%	57396		1755757		1359105		1972350	
	By-Products		3.0		2.0		1.0		2.0	
	Initial Score		2.0		0.7		0.4		0.7	
	Final Score		**5.0**	**1.0**	**1.7**	**0.3**	**0.9**	**0.2**	**1.7**	**0.3**
Lifecycle Costs	Capital Cost ($)	5%	2780012		89000000		22710400		24352485	
	Final Score		**5.0**	**0.3**	**0.2**	**0.0**	**0.6**	**0.0**	**0.6**	**0.0**
Contaminant Removal Efficiency	BOD Rem. (%)	30%	85%		83%		85%		99%	
	Tot. N Rem. (%)		97%		82%		95%		99%	
	Initial Score		1.8		1.7		1.8		2.0	
	Final Score		**4.6**	**1.4**	**4.2**	**1.3**	**4.6**	**1.4**	**5.0**	**1.5**
Total Score				3.6		2.2		3.8		3.4
Selected Technology								**Best**		

Secondary Treatment Design Recommendations

Table 7: Anammox Reactor Design Parameters

Anammox Reactor Parameters	
Hydraulic Retention Time (hr)	0.6
Wet Sludge Produced (kg/day)	36.9
Volume (m3)	266
Dimension	24ftx24ftx17ft
Required Air (kg/day)	11146

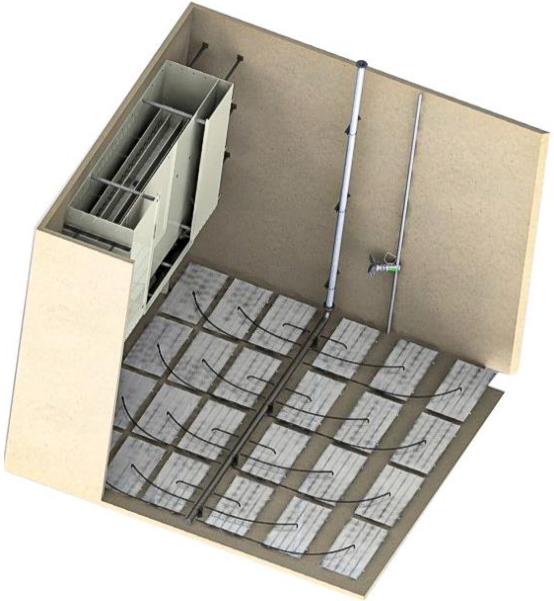

Figure 19: Demon® Anammox Reactor [9]

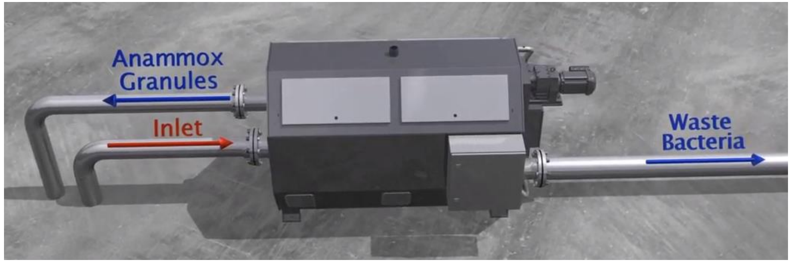

Figure 20: Micro screen [9]

Secondary Treatment Design Recommendations

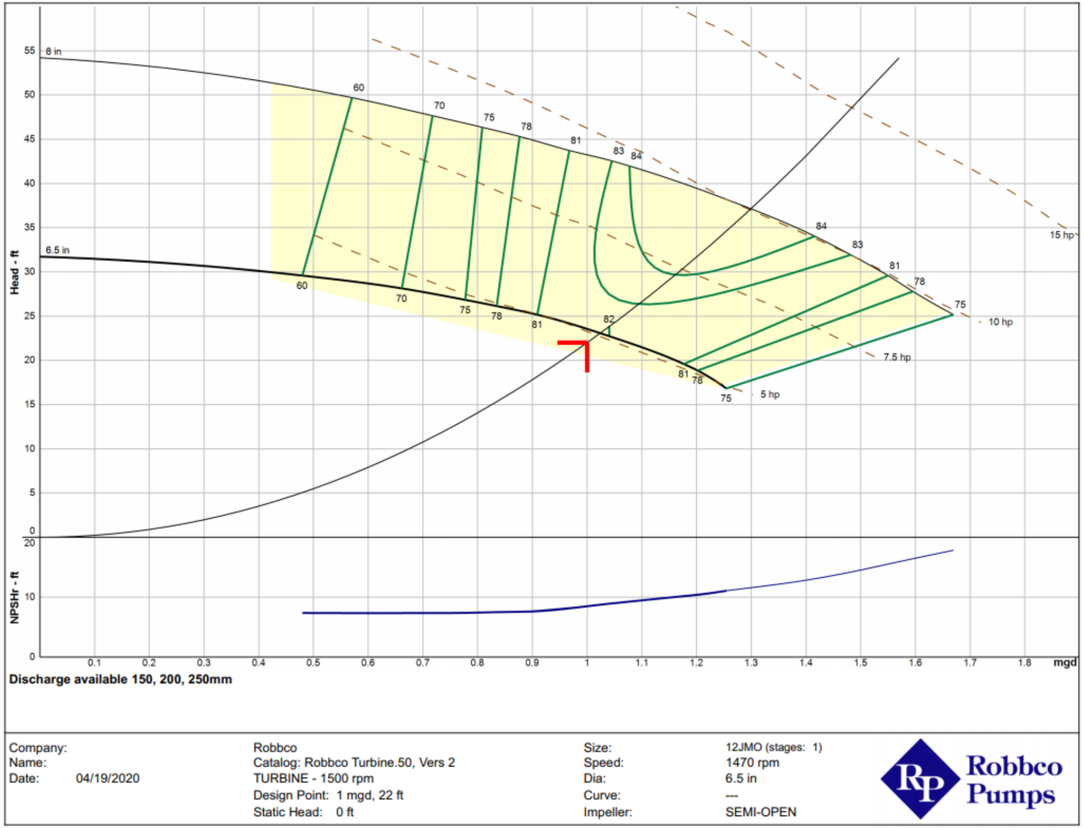

Figure 21: Pump Curve

Recycle Pump Station

Table 8: Recycle Pump Station Pumps

Pump No.	1	2	3
Flow (MGD)	1	1	1
Head (ft)	22	22	22
RPM	1470	1470	1470
Efficiency	81.9%	81.9%	81.9%
Power (hp)	5.05	5.05	5.05

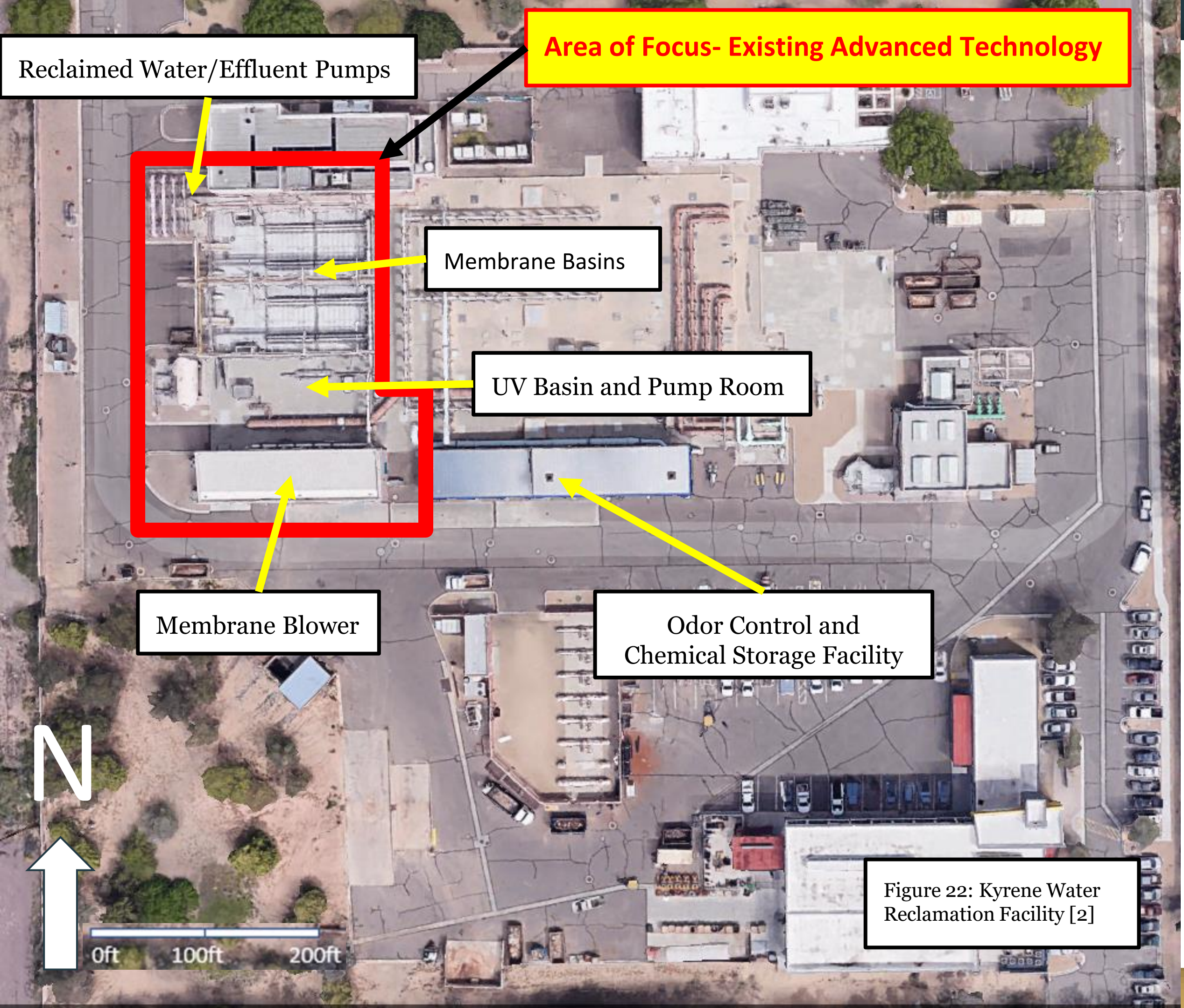

Figure 22: Kyrene Water Reclamation Facility [2]

Existing Advanced Treatment Components

- 7 UV Reactor Trains
- 6 VFD Permeate Pumps
- 3 Effluent Pumps
  - 1/4th of Effluent to SRP Power Plant
  - 1/4th of Effluent to Ken McDonald Golf Course
  - ½ of Effluent to Storm Sewer

Advanced Treatment Decision Matrix

Detailed Advanced Treatment Decision Matrix

Criteria		Weight	Existing		Alt. 1 Reverse Osmosis		Alt. 2 VigorOX WWTII + UV		Alt. 3 Chlorine	
			Input	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score
Feasibility	Area (m2)	10%	45.0		34.4		30.0		212.4	
	Final Score		**3.3**	**0.3**	**4.4**	**0.4**	**5.0**	**0.5**	**0.7**	**0.1**
O&M	Operational Cost ($/yr)	20%	19190		120000		280000		85600	
	Life Span (yr)		10.0		13.0		25.0		20.0	
	Staffing		3.0		2.0		3.0		2.0	
	Initial Score		2.4		1.3		2.1		1.7	
	Final Score		**5.0**	**1.0**	**2.8**	**0.6**	**4.3**	**0.9**	**3.5**	**0.7**
Environmental/Social Impacts	Power (kW-hr/yr)	30%	27027		61320		15000		1096	
	By-Products		3.0		2.0		3.0		1.0	
	Initial Score		1.0		0.7		1.1		1.3	
	Final Score		**3.9**	**1.2**	**2.6**	**0.8**	**4.0**	**1.2**	**5.0**	**1.5**
Lifecycle Costs	Capital Cost ($)	10%	244000		10000000		515000		1497333	
	Final Score		**5.0**	**0.5**	**0.1**	**0.0**	**2.4**	**0.2**	**0.8**	**0.1**
Contaminant Removal Efficiency	Colifrom Rem. (%)	30%	98%		97%		100%		99%	
	Particle Rem. (%)		20%		95%		75%		65%	
	Initial Score		1.2		2.0		1.8		1.7	
	Final Score		**3.0**	**0.9**	**5.0**	**1.5**	**4.5**	**1.4**	**4.2**	**1.3**
Total Score				**3.9**		**3.3**		**4.2**		**3.6**
Selected Technology								**Best**		

Advanced Treatment Design Recommendations- VigorOX

- Placed in-line before UV Reactor Trains
- VigorOX with UV proven to be 50% more efficient
- Produces Class A+ Effluent that is eligible for groundwater recharge
- By products of VigorOX WWTII:
  - Water
  - Oxygen
  - Vinegar

Table 9: Advanced VigorOX Design Table

VigorOX WWTII	
Parameter	Result
Chemical Makeup	15% Peracetic Acid (PAA) 23% Hydrogen Peroxide
EPA and NCPED Approved	Requirement Met
Levels of Disinfection Byproducts (DBP)	None
pH Range	4.1-8.9 ±
E. Coli Inactivation %	100%
PAA Amount Required to Meet Permit	2 mg PAA/L
Area (sq. m)	17.21
Dimensions (m)	3.5m x 1.5m x 2m (LxWxH)
Amount of VigorOX WWTII per Day	23 GPD
Amount of Chemical Usage for a Chlorine System per Day	235 GPD

Advanced Treatment Design Recommendations- UV

Table 9: Advanced Design for Current and Proposed

Attributes	Current UV System	Proposed UV System
# of Reactor Trains	7	4
Type	Mercury Arc Lamps	Mercury Arc Lamps
Average Designed Flow (MGD)	9	3
Dosage (μW-s/cm^2)	80000	80000
UV Transmittance	70%	70%
Effluent Quality	Class A+	Class A+
Germicidal Wavelength (nm)	253.7	253.7
Chemical Cleaning System	Citric Acid	Citric Acid and VigorOX
Area(m2)	208.7	120
Power (kW)	68	39
Dimensions	7.9mx8.1mx3.96m	4.5mx4.6mx3.96m

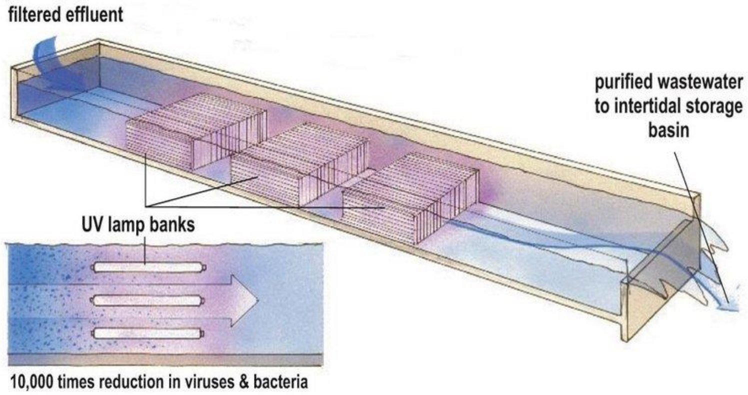

Figure 23: UV Disinfection [10]

Effluent Pump Design Recommendations

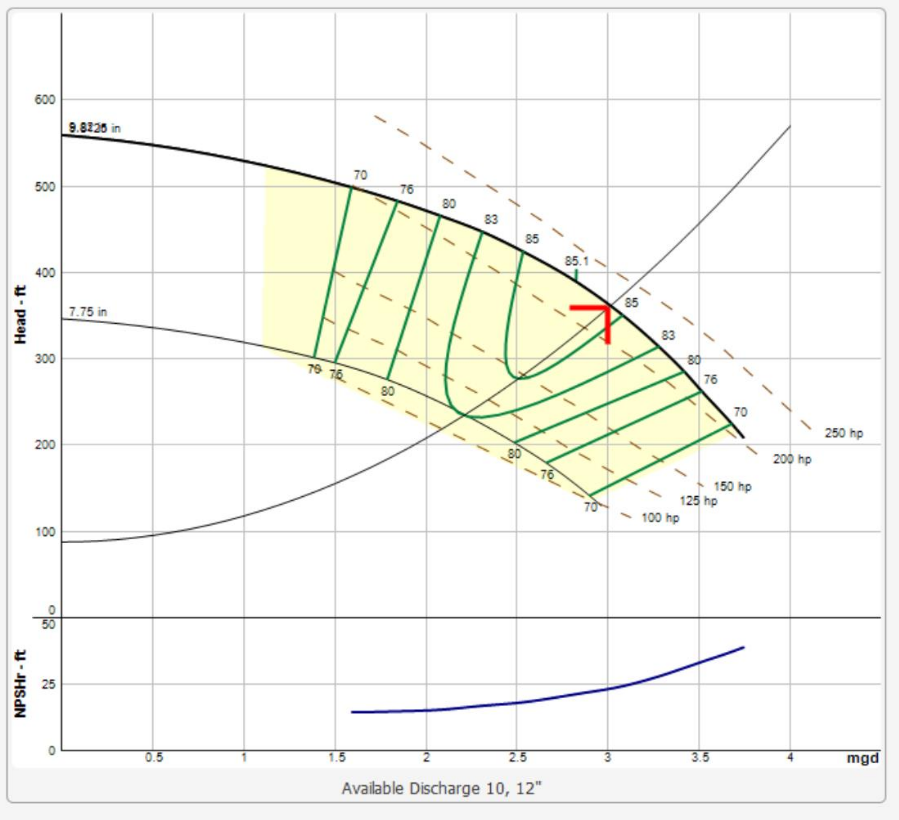

Figure 24: Pump Curve

Effluent Pump Station

Table 10: Effluent Pump Station Pumps

Pump No.	1	2	3
Flow (MGD)	1	1	1
Head (ft)	175	175	175
RPM	1770	1770	1770
Efficiency	84%	84%	84%
Power (hp)	39.2	39.2	39.2

Biosolids Handling Decision Matrix

Detailed Biosolids Handling Decision Matrix												
Criteria		**Weight**	Existing		Alt. 1 Bio-Fix		Alt. 2 Centrysis Thickener & Centrifuge		Alt. 3 Gravity Belt & Anaerobic Digester		Alt. 4 Thermal Hydrolysis Process Reactor	
			Input	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score
Feasibility	Area (m2)		0.0		32.5		125.0		200.0		400.0	
	Final Score	5%	**5.0**	**0.25**	**0.0**	**0.00**	**0.0**	**0.00**	**0.0**	**0.00**	**0.0**	**0.00**
O&M	Operational Cost ($/yr)		0.0		271896		488354		453809		475000	
	Life Span (yr)		0.0		25.0		15.0		20.0		30.0	
	Staffing		3.0		2.0		3.0		2.0		4.0	
	Initial Score		1.8		1.3		1.3		1.2		2.0	
	Final Score	10%	**4.4**	**0.4**	**3.3**	**0.3**	**3.1**	**0.3**	**2.9**	**0.3**	**5.0**	**0.5**
Environmental/Social Impacts	Power (kW-hr/yr)		0.0		49579		75432		69789		65000	
	Wet Sludge (ton/day)		0.0		23.2		12.2		10.4		14.0	
	Initial Score		2.0		0.2		0.4		0.4		0.3	
	Final Score	25%	**5.0**	**1.3**	**0.5**	**0.1**	**0.9**	**0.2**	**1.1**	**0.3**	**0.8**	**0.2**
Lifecycle Costs	Capital Cost ($)		0.0		1500000		3457600		4074000		3000000	
	Final Score	10%	**5.0**	**0.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Contaminant Removal Efficiency	Class of Biosolids		0.0		4.00		3.00		3.00		2.00	
	Final Score	50%	**0.0**	**0.0**	**5.0**	**2.5**	**3.8**	**1.9**	**3.8**	**1.9**	**2.5**	**1.3**
Total Score				2.44		2.96		2.42		2.44		1.96
Selected Technology						**Best**						

Biosolid Handling Tech Recommendation

- Alkaline Stabilization Process
  - Bio-Fix by Synagro
- Produces Class A+ Biosolids
- Requires pH of 12 and temp. Of 70 degrees Celsius for 30 min. to pass as class A
- Class A Biosolids sells for avg. $15/ton
  - ~$130,000/year for profit

Table 11: Bio-Fix Parameters

Bio-Fix Parameters	
Dry Ton Produced (ton/day)	4.35
Wet Sludge Produced (ton/day)	23.28
Power (kW-hr/yr)	49,579.16
Area (SQ. FT)	350
Dimensions (LxWxH) (ft)	29x12x17
Required CaO (ton/day)	6.53

Figure 25: Alkaline Stabilization Pit [11]

Addition of Solar Power

- Capital includes:
  - Cost of Equipment
  - Cost of Installation
- Investment has a payback cost in about 7.1 years

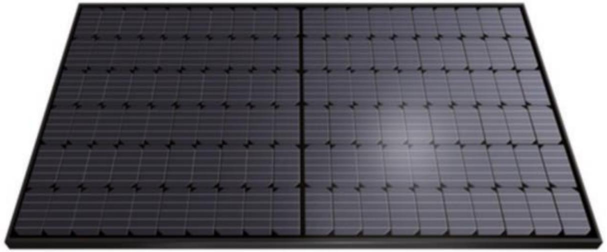

Figure 26: Axitec Solar Panel [12]

Table 12: Solar

Manufacture	Location	Area (ft^2)	Power (kW)	Capital Cost ($)	Life Span (yr)	Annual Savings ($)
Axitec	Parking Lot	16,200	250	$327,600	25	$70,000
Axitec	Admin Building	14,440	250	$271,600	25	$62,395
Total	**N/A**	**30,640**	**500**	**$599,200**	**N/A**	**$132,395**

Final Design

Table 13: Final Effluent Analysis

Parameter	Effluent Results
BOD5	8.40 mg/L
Total Nitrogen	0.46 mg/L
Ammonia (as N)	1.90 mg/L
Settleable Solids	1.0 mg/L
Suspended Solids	14.81 mg/L
Fecal Coliform	Non-detectable in 4 of 7 samples
Turbidity	Less than 2.0 NTU

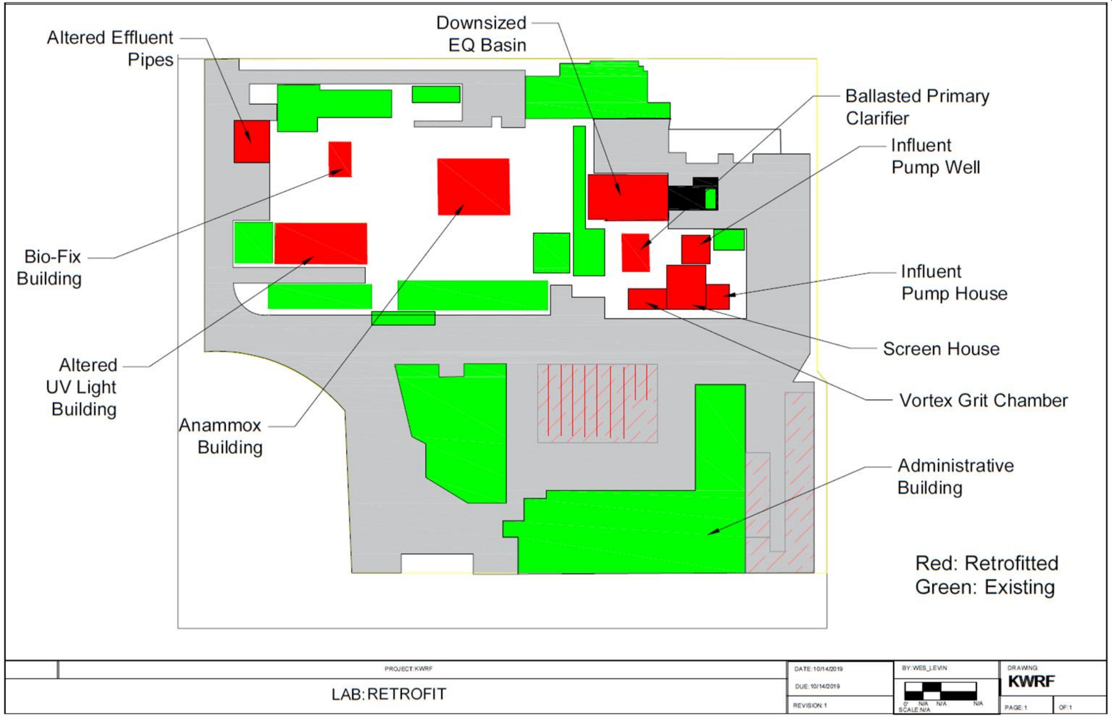

Figure 27: Layout of Retrofit Design

Staffing Estimates

Table 14: Staffing Estimations

Staffing Estimations	
Estimated Annual Hours of O&M	5039.25
Estimated Required Staff	4
Specialized Staff Members	4
Total Estimated Staff	8

- 5 Major areas of work:
  - basic operations, maintenance, lab operations, sludge handling, and yard work
  - 4 Employees Necessary for this work
- Specialized Positions:
  - i.e. Managers, Inspections, machinist, etc.
  - 4 more staff-members necessary

NEIWPCC

THE NORTHEAST GUIDE FOR ESTIMATING STAFFING AT PUBLICLY AND PRIVATELY OWNED WASTEWATER TREATMENT PLANTS (24/7 Plant)

Plant Name: Kyrene Reclamation Facility

Design Flow: 3 MGD Actual Flow: N/A

FINAL ESTIMATES	
Chart #	**Annual Hours**
1 – Basic and Advanced Operations and Processes	2007.5
2 – Maintenance	894.25
3 – Laboratory Operations	1726.5
4 – Biosolids/Sludge Handling	91.25
5 – Yardwork	320
Estimated Operation and Maintenance Hours	5039.25
Estimated Operation and Maintenance Staff	4
Estimated Additional Staff from Chart 7	4
Total Staffing Estimate	8

Figure 28: Required Staff Form [13]

Cost of Recommendations

- Capital includes:
  - Cost of Equipment
- O&M includes:
  - Power
  - Chemicals/Additions
  - Maintenance
  - Replacements
- Projected Cost for opening year 2025
  - Assumes 2% interest

Table 15: Proposed Recommendation Cost

Proposed Recommendation Costs				
Process	**Year 2020 (Present)**		**Year 2025**	
	Capital Cost ($)	**O&M ($/yr)**	**Capital Cost ($)**	**O&M ($/yr)**
Preliminary	$7,054	$100,196	$7,788	$110,624
Primary	$1,511,581	$390,477	$1,668,908	$431,118
Secondary	$1,311,781	$483,988	$1,448,312	$534,362
Advanced Treatment	$379,000	$135,386	$418,447	$149,477
Biosolids Handling	$1,500,000	$272,024	$1,656,121	$300,337
Construction Costs	$12,697,200	N/A	$14,018,735	N/A
Solar Electricity	$599,200	$14,800	$661,565	$16,340
Total	**$18,005,816**	**$1,396,870**	**$19,879,876**	**$1,542,257**

Impacts

- Environmental
  - Negative: fossil fuels consumption and depletion cause global warming
  - Positive: production of biosolids/land application, and renewable energy usage, recharge groundwater
- Social
  - Negative: odor pollution, noise pollution, stigma of chemical and biosolids storage
  - Positive: Apportion the distribution of wastewater, increase recreation, save water costs, create jobs, increase economy revenue, more housing
- Economic
  - Negative: expensive expenditure, disrupt the local economy equilibrium
  - Positive: stimulate the construction and wastewater technology industries, provide regular employment, create jobs in the transportation industry

Questions?

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