Hazen

Reviewing the Options:
Treatment Alternatives Evaluation for Tempe's Kyrene WRF

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WateReuse of Arizona Annual Symposium **July 27, 2021**

Project team

- City of Tempe
- Hazen and Sawyer
  - **Engineering studies, design services**
- EUSI, Inc.
  - **Condition assessment, operations considerations**
- PCL Construction
  - **Condition assessment, cost estimating, constructability**

Kyrene Water Reclamation Facility

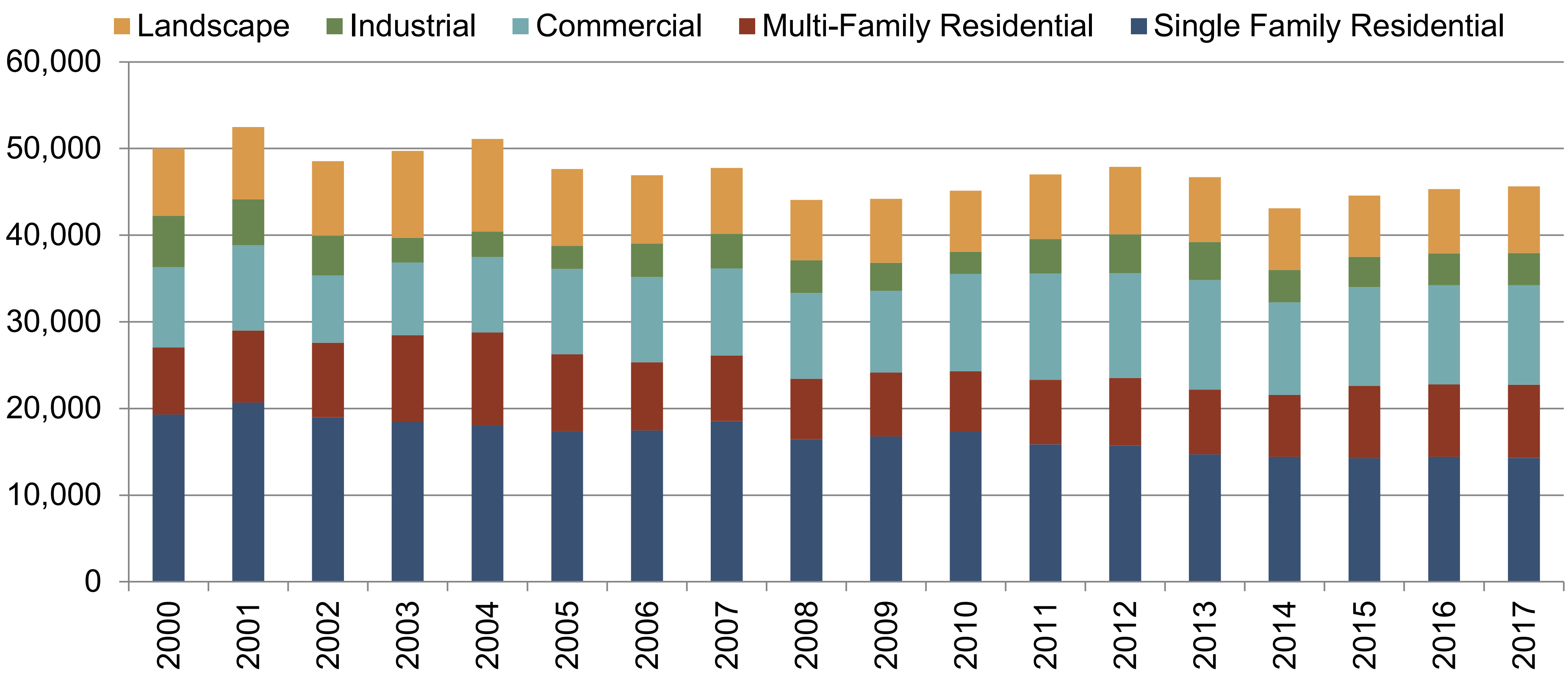
- 9 mgd membrane bioreactor (MBR)
  - Converted from conventional 4.5 mgd MLE circa 2004
  - Tight site, good-neighbor issues important
- Scalping plant – no solids processed on site
  - Tempe is a member of Subregional Operating Group (SROG)
  - Majority of Tempe's wastewater was still treated at 91st Ave WWTP
  - All KWRF residuals returned to the SROG system, go to 91st Ave.
- KWRF shut down in year 2010
  - Cost-saving measure during the downturn
  - 91st Ave more cost-effective in terms of treatment
  - Tempe has sufficient capacity at 91st Ave. for all of its flows
- Tempe has continued to grow
  - Flows have not increased
  - Strength has increased

Kyrene Water Reclamation Facility - Restart

Goals

- Create a cost-effective renewable water resource in accordance with City policies/ goals
  - **Direct reuses (Kiwanis Park, Ken McDonald GC, SRP Kyrene power plant)**
  - **Capture long-term storage credits (LTSCs) for City's water portfolio or potential exchange with others**
- Bring facility back online at 4.5 MGD
  - **Approx. max month for area tributary to KWRF**
  - **Other potential capacities will be considered later in project**
- Produce class A+ water for direct reuse, recharge the rest
- BADCT / APP compliance and minimized ASR well fouling
- Plant will not discharge: no AZPDES permit
- Consider energy impacts, other sustainability criteria

City of Tempe - Metered water demand by customer class

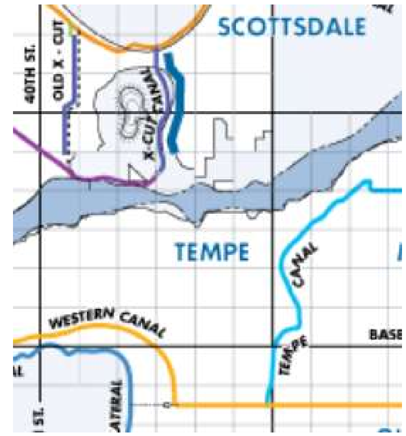


Tempe's water resources portfolio

- Most of the City is on-Project (SRP)
  - **Former farmland**
  - **Most reliable water supply available**
- Off-Project areas:
  - **Downtown Tempe***
  - **Along Salt River bed***
  - **Tempe Town Lake**

*major growth areas

- Additional water resources
  - **Central Arizona project**
  - **Roosevelt Dam new conservation storage**
  - **White Mountain Apache Tribe settlement**
  - **Groundwater**
    - **Long-term storage credits support groundwater pumping for resource and operational needs**



Additional KWRF considerations

- Cost effective technologies
- Potential larger capacity
  - **Recapture all reclaimed water not committed elsewhere**
  - **Would require a pump-back system at added cost**
- Incorporate/repurpose existing infrastructure and equipment
- Low-energy configuration
  - **Look at true energy footprint, including external factors**
  - **Minimize greenhouse gas emissions**
  - **Recapture energy value of the waste? [no]**
  - **Supplemental solar or other on-site energy generation? [no]**

Project scope

Upgrades and Improvements - Treatment Process and Capacity Evaluation

Part 1: Additional Process Analyses and Pre-Design Evaluations

- Evaluation of alternative wastewater treatment processes to be considered for the re-started KWRF *beyond* just the existing membrane bioreactor (MBR) and other unit processes at KWRF

Part 2: Reclaimed Water Market Analysis

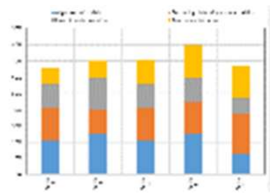
- Assess the existing and potential value of reclaimed water produced at the KWRF, for use by Tempe or potentially in partnership with other utilities or entities

Approach for selecting treatment process for design

World of Options

Conceptual Screening

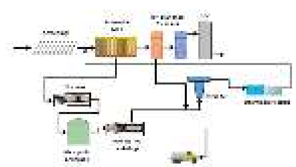
Eliminate alternatives that are clearly not competitive



Screening to arrive at 10 to 12 alternatives for next phase

Final Screening

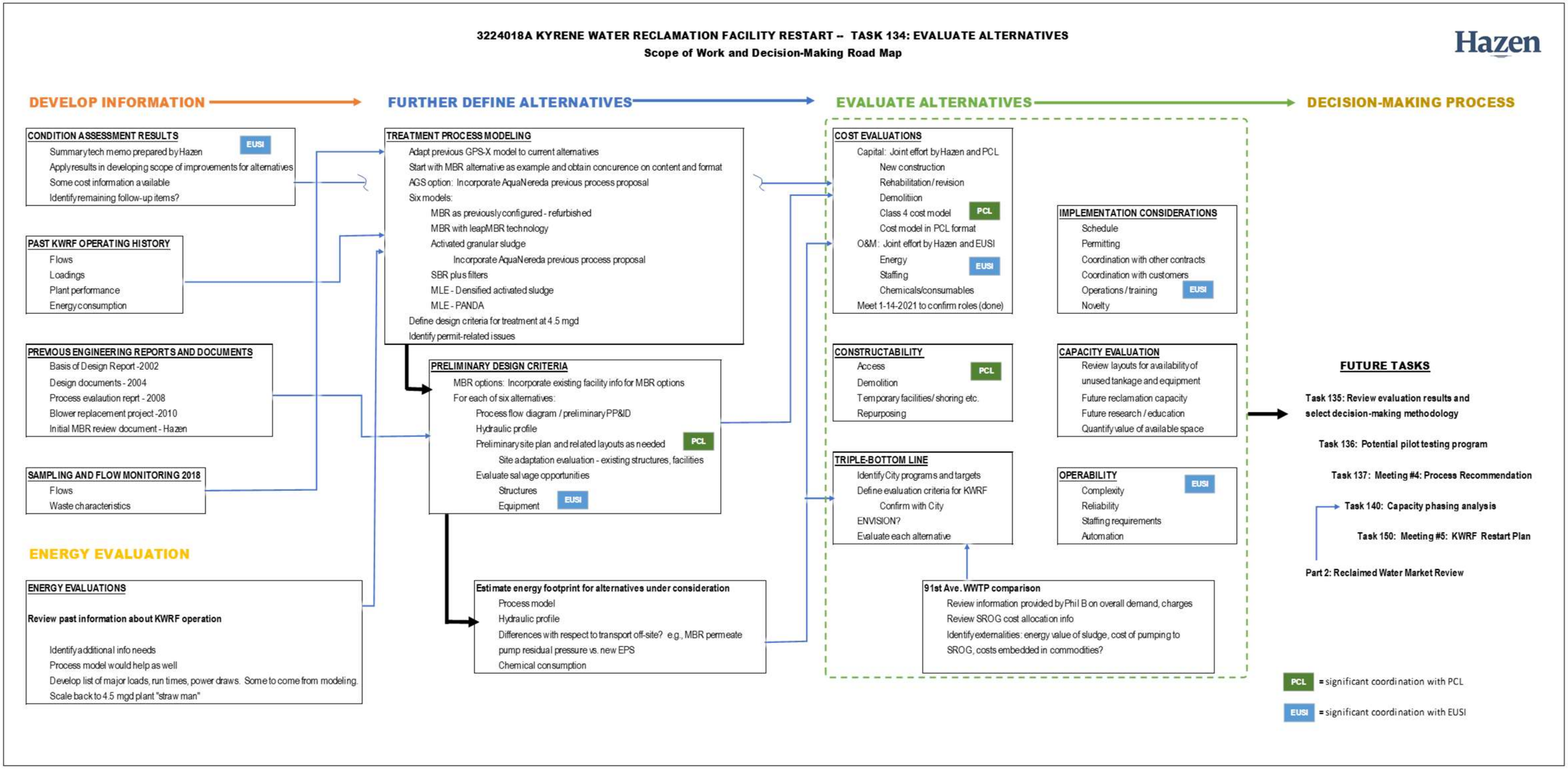
Develop final list of alternatives using qualitative metrics



Screening to arrive at 5 alternatives for next phase

Evaluate Final 5 Alternatives

“Road map”


3224018A KYRENE WATER RECLAMATION FACILITY RESTART – TASK 134: EVALUATE ALTERNATIVES
Scope of Work and Decision-Making Road Map
Hazen
DEVELOP INFORMATION
FURTHER DEFINE ALTERNATIVES
EVALUATE ALTERNATIVES
DECISION-MAKING PROCESS
CONDITION ASSESSMENT RESULTS
EUSI
Summary tech memo prepared by Hazen
Apply results in developing scope of improvements for alternatives
Some cost information available
Identify remaining follow-up items?
PAST KWRF OPERATING HISTORY
Flows
Loadings
Plant performance
Energy consumption
PREVIOUS ENGINEERING REPORTS AND DOCUMENTS
Basis of Design Report -2002
Design documents - 2004
Process evaluation rept - 2008
Blower replacement project -2010
Initial MBR review document - Hazen
SAMPLING AND FLOW MONITORING 2018
Flows
Waste characteristics
ENERGY EVALUATION
ENERGY EVALUATIONS
Review past information about KWRF operation
Identify additional info needs
Process model would help as well
Develop list of major loads, run times, power draws. Some to come from modeling.
Scale back to 4.5 mgd plant "straw man"
TREATMENT PROCESS MODELING
Adapt previous GPS-X model to current alternatives
Start with MBR alternative as example and obtain concurence on content and format
AGS option: Incorporate AquaNereda previous process proposal
Six models:
MBR as previously configured - refurbished
MBR with leapMBR technology
Activated granular sludge
Incorporate AquaNereda previous process proposal
SBR plus filters
MLE - Densified activated sludge
MLE - PANDA
Define design criteria for treatment at 4.5 mgd
Identify permit-related issues
PRELIMINARY DESIGN CRITERIA
MBR options: Incorporate existing facility info for MBR options
For each of six alternatives:
Process flow diagram / preliminary PP&ID
Hydraulic profile
Preliminary site plan and related layouts as needed
PCL
Site adaptation evaluation - existing structures, facilities
Evaluate salvage opportunities
Structures
Equipment
EUSI
Estimate energy footprint for alternatives under consideration
Process model
Hydraulic profile
Differences with respect to transport off-site? e.g., MBR permeate pump residual pressure vs. new EPS
Chemical consumption
COST EVALUATIONS
Capital: Joint effort by Hazen and PCL
New construction
Rehabilitation / revision
Demolition
Class 4 cost model
PCL
Cost model in PCL format
O&M: Joint effort by Hazen and EUSI
Energy
EUSI
Staffing
Chemicals/consumables
Meet 1-14-2021 to confirm roles (done)
IMPLEMENTATION CONSIDERATIONS
Schedule
Permitting
Coordination with other contracts
Coordination with customers
Operations / training
EUSI
Novelty
CONSTRUCTABILITY
Access
PCL
Demolition
Temporary facilities/ shoring etc.
Repurposing
CAPACITY EVALUATION
Review layouts for availability of unused tankage and equipment
Future reclamation capacity
Future research / education
Quantify value of available space
TRIPLE-BOTTOM LINE
Identify City programs and targets
Define evaluation criteria for KWRF
Confirm with City
ENVISION?
Evaluate each alternative
OPERABILITY
EUSI
Complexity
Reliability
Staffing requirements
Automation
91st Ave. WWTP comparison
Review information provided by Phil B on overall demand, charges
Review SROG cost allocation info
Identify externalities: energy value of sludge, cost of pumping to SROG, costs embedded in commodities?
FUTURE TASKS
Task 135: Review evaluation results and select decision-making methodology
Task 136: Potential pilot testing program
Task 137: Meeting #4: Process Recommendation
Task 140: Capacity phasing analysis
Task 150: Meeting #5: KWRF Restart Plan
Part 2: Reclaimed Water Market Review
PCL = significant coordination with PCL
EUSI = significant coordination with EUSI

Existing condition summary

1 = excellent, 2 = good, 3 = average, 4 = fair, 5 = poor

Zone #	Process	Average Condition Score	Total # of Assets	Total Assets with Fair or Poor Score
Preliminary Treatment				
1	Influent Pump Station	4.1	29	21
2	Screens	3.4	57	18
3	Grit	3.1	14	3
4	Equalization	2.6	115	18
5	Odor Control	3.5	225	96
Biological Treatment				
6	AB Blowers	2.8	43	0
7	Aeration Basins	3.3	95	35
8	Membrane Blowers	2.9	47	7
9	Membranes	3.4	782	156
11	Membrane Air Compressors	2.9	119	49
Disinfection/Reclaimed Water Pumping				
10	UV Treatment	3.3	150	48
12	Recycle Pump Station	2.8	101	29
13	Effluent Pump Station	2.9	295	42
Support Systems				
14	Storm Water	2.7	58	3
15	Sump Pump Station	3.4	36	8
16	Plant Water System	2.7	95	2
17	Chemical Feed/Storage	3.2	110	22
18	Potable Water System	2.7	83	7
19	Plant Air System	3.8	53	30
20	Electrical Equipment	NA	32	NA

CA results -- Future application of existing KWRF components

Preliminary Treatment

- Can be restored with a moderate rehabilitation.
- Fine screening rehabilitation required.
- EQ rehabilitation needed.
- Existing capacity exceeds 4.5-mgd capacity.

- **Not a differentiating consideration**, disregarded in evaluating biological and disinfection process alternatives.

Biological Treatment

- Bioreactor basins area are not a constraint at 4.5-mgd.
- Bioreactor basins might not provide sufficient volume for non-intensified processes beyond 4.5-mgd.
- Aeration diffusers and piping rehabilitation required.
- RAS pump station could be repurposed as an IMLR pump station.
- For non-MBR alternatives, filters and/or clarifiers required.

- **Differentiating consideration**

CA results -- Future application of existing KWRF components

Disinfection and Pumping

- Requires substantial rehabilitation but would provide sufficient capability at 4.5-mgd.
- The permeate pump station might not be repurposed for effluent pumping in non-MBR processes.
- **Not a differentiating consideration**, other than repurposing effluent pump station.

Support Systems

- Rehabilitation needed in these areas.
- **Not a differentiating consideration**, consistent across alternatives.

Secondary Treatment Process Alternatives

World of Options

Conventional BNR

- MLE
- Oxidation Ditch
- SBR
- Multi-Stage BNR
- Step-Feed BNR
- Two-Sludges

Intensified BNR

- IFAS
- MABR
- Biomag
- BIOCOS
- Granular Sludge
- MBR
- DAS

Next Generation N-Removal

- Simultaneous Nit - Denit
- Nitritation/Denitritation
- Mainstream Deammonification
- PANDA

Organization of process alternatives

- Biological ("Secondary") Treatment
  - **Conventional biological nutrient removal (BNR)**
  - **Intensified BNR**
  - **Next-generation BNR processes**
  - **Solids separation (clarification / filtration) will be considered to the extent applicable to each biological process**
- Tertiary Treatment
  - **Tertiary biological treatment**
  - **Tertiary advanced treatment**
- Disinfection

Secondary Treatment			
Conventional BNR	**Intensified BNR**	**Next-Generation Nitrogen Removal**	**Secondary Solids Separation**
Modified Ludzack-Ettinger	Membrane Bioreactor	Simultaneous Nitrification and Denitrification	Clarifier
Oxidation Ditch	Integrated Fixed Film Activated Sludge	Nitritation/ Denitritation	Filter
Multi-stage BNR	Membrane Aerated Biofilm Reactor	Mainstream Deammonification	Microfiltration
Step-Feed BNR	BioMag	Partial Denitritation Anammox	
Two-Sludge Activated Sludge	Biological Combined Systems		
Sequencing Batch Reactor	Aerobic Granular Sludge		
	Densified Activated Sludge		

Advanced Treatment	
Tertiary Biological	**Tertiary Advanced**
Moving Bed Biofilm Reactor	Flocculation/Sedimentation
Denitrification Filters	Ozone/BAC
Fluidized Bed Reactors	Post-Filtration GAC
Microalgae	Reverse Osmosis
Biocatalysts	Ion-Exchange

Disinfection
UV Disinfection
UV AOP
Chlorination
Ozonation
Peracetic Acid

Initial screening criteria

"Pass/fail" criteria -- Applied for initial conceptual screening

Technology Maturity

- How well-developed is the technology?
- Technology that has not yet been successfully employed at full-scale is eliminated.

Applicability to KWRF current needs

- Ability to meet current reclaimed water requirements at KWRF?
- Some processes provide benefits that might be useful in the future but are not necessary at the present time.

Processes from original group – eliminated by initial screening

BIOCOS	Nitritation / dentitritation (nitrite shunt)	Mainstream deammonification
Moving bed bioreactor (MBBR)	Denitrification filters	Fluidized bed reactor
Microalgae	Biocatalysts	Ozone/BAC
Post-filtration GAC	Reverse osmosis	Ion exchange
	Advanced oxidation processes (AOP)	

Evaluation criteria

1 = excellent, 2 = good, 3 = average, 4 = fair, and 5 = poor

Capital cost

- Repurposing of existing structures
- Construction for rehabilitations based on CA
- Construction of new process units, equipment
- Demolition or abandonment of components
- Licensing fees for proprietary processes

Energy efficiency

- Energy included in O&M cost
- Also evaluated separately because of City's energy-efficiency and climate-related goals.

Expandability

- Leaves existing components available for future use.

Ease of permitting

- Well-accepted processes - approval is straightforward

O&M cost

- Equipment maintenance
- Operator labor
- Energy consumption
- Chemical consumption

Solids separation requirements

- Secondary clarifiers required for most biological treatment processes are not present at KWRF
- Intensified BNR may allow excess BNR basins to be used as clarifiers
- Secondary clarifiers also require tertiary filtration.

Difficulty of implementation

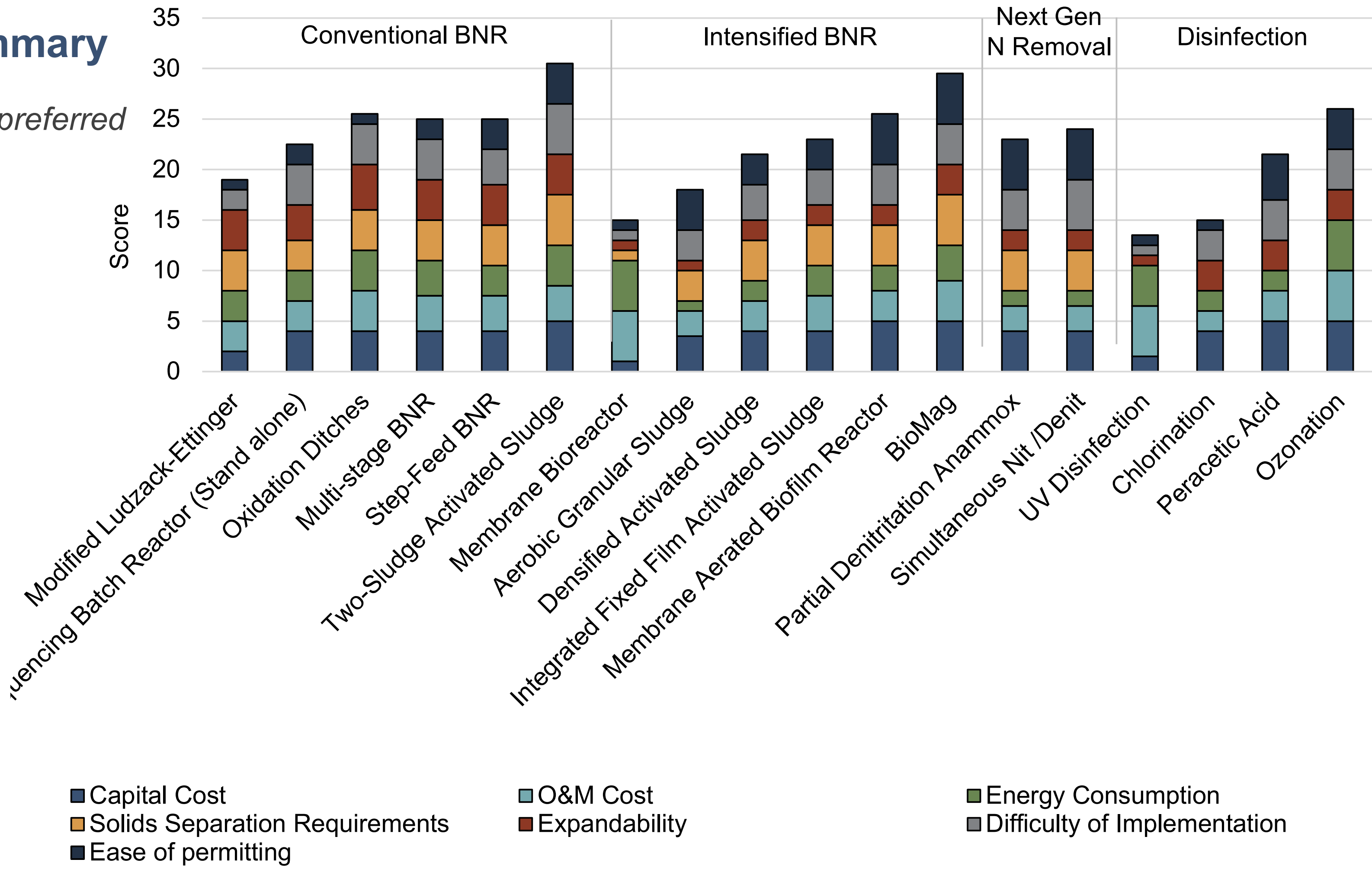
- Requires extensive changes to the existing facility.

Adaptability

- Ability to meet potential requirements, such as ECs.

Scoring Summary

Lower scores are preferred



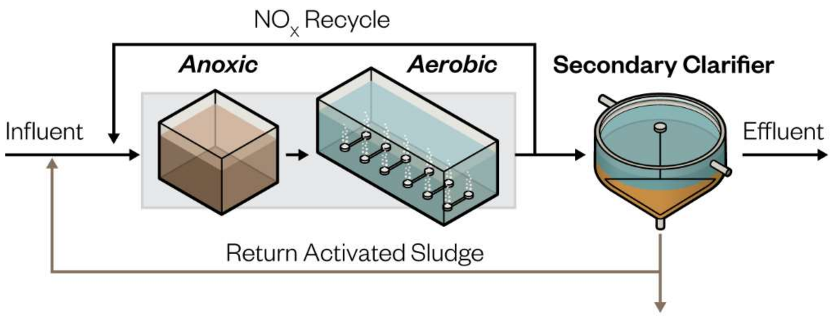
Biological / BNR Alternative Criteria Scoring

1 = Most favorable, 3 = Neutral, and 5 = Least favorable

Technology	Capital Cost	O&M Cost	Energy Consumption	Solids Separation Requirements	Expand-ability	Difficulty of Implementation	Ease of permitting	Adapt-ability	Average Score
Conventional BNR									
MLE	2	3	3	4	4	2	1	3	**2.75**
SBR	4	3	3	3	3.5	4	2	2.5	**3.13**
Ox Ditch	4	4	4	4	4.5	4	1	5	3.81
Multi-stage BNR	4	3.5	3.5	4	4	4	2	3	3.50
Step-Feed BNR	4	3.5	3	4	4	3.5	3	3	3.50
Two-Stage Activated Sludge	5	3.5	4	5	4	5	4	3	4.19
Intensified BNR									
MBR w/ MLE	1	5	5	1	1	1	1	1	**2.00**
AGS	3.5	2.5	1	3	1	3	4	3	**2.63**
DAS (MLE w/ Clarifiers)	4	3	2	4	2	3.5	3	3	**3.06**
IFAS	4	3.5	3	4	2	3.5	3	3	3.25
MABR	5	3	2.5	4	2	4	5	3	3.56
BioMag	5	4	3.5	5	3	4	5	3	4.06
Next-Generation Nitrogen Removal									
PANDA	4	2.5	1.5	4	2	4	5	3	**3.25**
Simultaneous Nit-Denit	4	2.5	1.5	4	2	5	5	3	3.38

Modified Ludzack-Ettinger process

1 = Most favorable, 3 = Neutral, and 5 = Least favorable

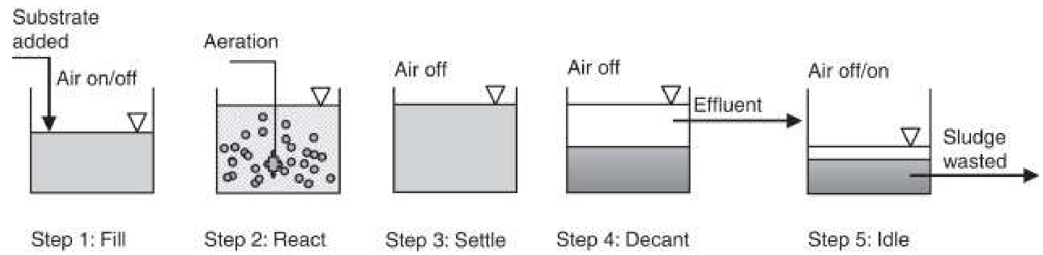


Capital cost:	2	*Treatment basins already configured for MLE but need clarifiers and filters*
O&M cost:	3	*Moderate operating cost*
Energy efficiency:	3	*IMLR pumping; AX basin mixing; aeration for complete nitrification*
Solids separation:	4	*Need new clarifiers and filters unless coupled with MBR*
Expandability:	4	*Will consume most bioreactor capacity for 4.5 mgd. Does not require EQ*
Difficulty:	2	*Well-understood process, but need new solids basins on crowded plant site*
Ease of permitting:	1	*Well-recognized process, meets BADCT*
Adaptability:	3	*Neutral*

1 = excellent, 2 = good, 3 = average, 4 = fair, and 5 = poor

Sequencing Batch Reactor

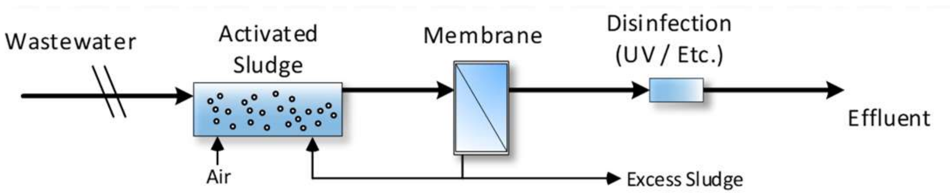
1 = Most favorable, 3 = Neutral, and 5 = Least favorable



Capital cost:	4	*Extensive basin modifications, re-equipping*
O&M cost:	3	*Additional operational complexity, energy moderate-see next item*
Energy efficiency:	3	*Moderate energy cost, single tank approach eliminates IMLR and AX mixing*
Solids separation:	3	*Clarifiers not required, need to add filtration*
Expandability:	3.5	*Consumes bioreactor capacity, could convert to AGS; requires EQ basin*
Difficulty:	4	*Significant basin modifications*
Ease of permitting:	2	*Well-understood but more complicated*
Adaptability:	2.5	*Could convert to AGS later when added capacity is needed*

Membrane Bioreactor

1 = Most favorable, 3 = Neutral, and 5 = Least favorable



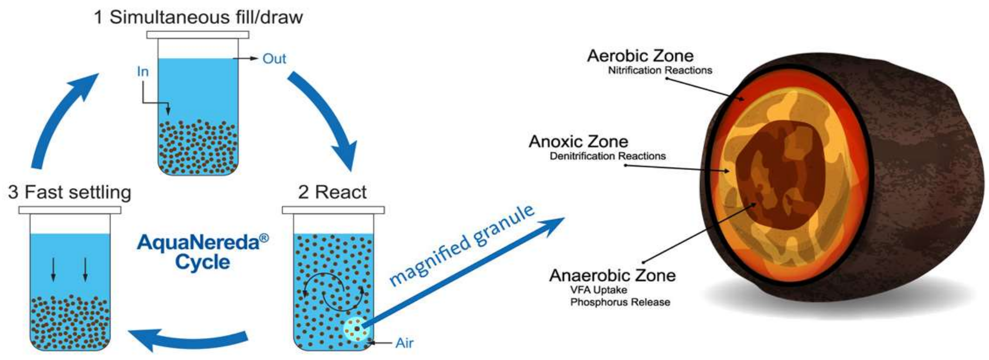
Capital cost:	1	*Existing process components to remain nearly intact other than rehabilitation*
O&M cost:	5	*Energy-intensive process, periodic membrane replacements, vendor issues*
Energy efficiency:	5	*Requires aeration for complete nitrification, membrane scouring*
Solids separation:	1	*No modifications needed*
Expandability:	1	*Compact process, existing facilities already capable of the max 9 mgd*
Difficulty:	1	*Minimal changes needed*
Ease of permitting:	1	*Renewal of already-permitted plant*
Adaptability:	1	*Membrane-quality effluent best for feed to RO or other advanced processes*

Two subalternatives: (1) Restore MBR as it exists (500C)

(2) Update to current “leapMBR” aeration (500D) – or other current technology

Aerobic Granular Sludge

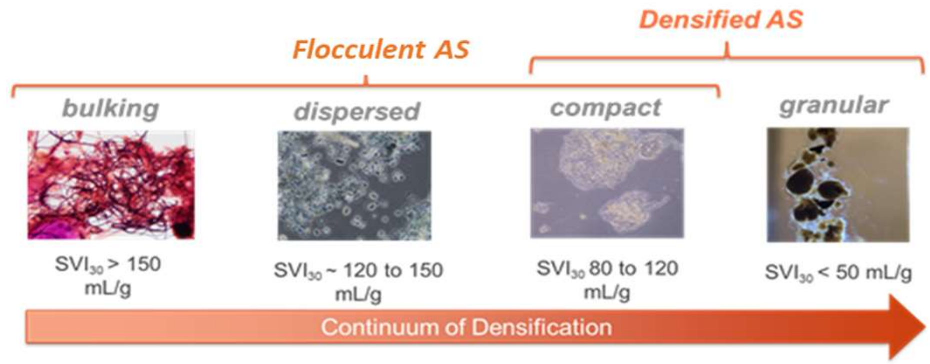
1 = Most favorable, 3 = Neutral, and 5 = Least favorable



Capital cost:	**3.5**	*Requires reconfiguring bioreactors, constructing filtration, and license fee*
O&M cost:	**2.5**	*Energy efficient, no clarifier to operate, added operator attention to process*
Energy efficiency:	**1**	*Significantly more energy-efficient than typical BNR processes*
Solids separation:	**3**	*Clarifiers not required, need to add filtration*
Expandability:	**1**	*Intensified process would leave ample space for expansion. Needs EQ*
Difficulty:	**3**	*Significant modifications to bioreactors*
Ease of permitting:	**4**	*New process, no local history but gaining credibility*
Adaptability:	**3**	*Neutral*

Densified Activated Sludge

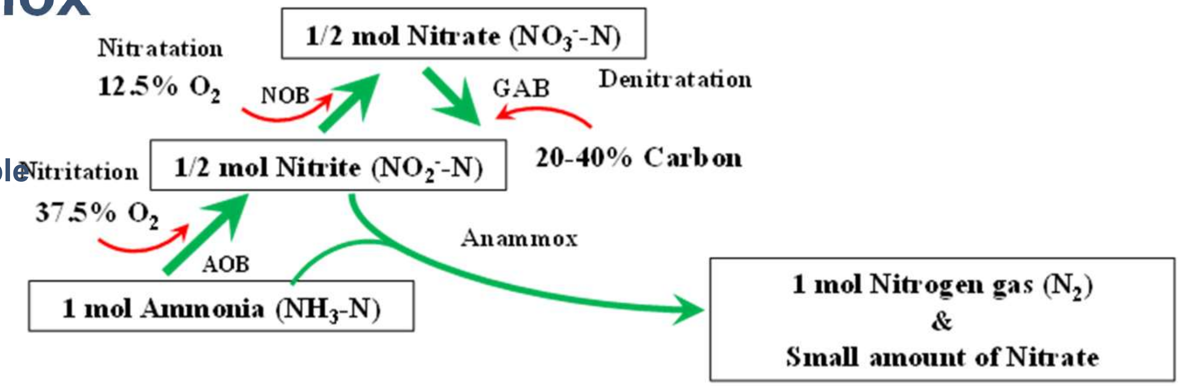
1 = Most favorable, 3 = Neutral, and 5 = Least favorable



Capital cost:	4	*Reconfiguring bioreactors, constructing clarifiers / filtration, no license fee*
O&M cost:	3	*Energy efficient, added operator attention to process*
Energy efficiency:	2	*Biological process much more energy efficient*
Solids separation:	4	*Need new clarifiers and filtration*
Expandability:	2	*Intensified process leaves expansion space. Need clarifiers, filtration space*
Difficulty:	3.5	*Significant modifications to bioreactors plus addition of clarifiers, filtration*
Ease of permitting:	5	*New process, no local history*
Adaptability:	3	*Neutral*

Partial Denitritation Annamox (PANDA)

1 = Most favorable, 3 = Neutral, and 5 = Least favorable



Capital cost:	4	*Requires reconfiguring bioreactors, constructing clarifiers and filtration*
O&M cost:	2.5	*Low energy consumption, increased operator effort and complexity*
Energy efficiency:	1.5	*Eliminates much aeration demand*
Solids separation:	4	*Need new clarifiers and filtration*
Expandability:	2	*Intensified process-- leaves expansion space. Need space for clarifiers/ filtration*
Difficulty:	4	*New process but requires less-fine process control*
Ease of permitting:	5	*New process, no history*
Adaptability:	3	*Neutral*

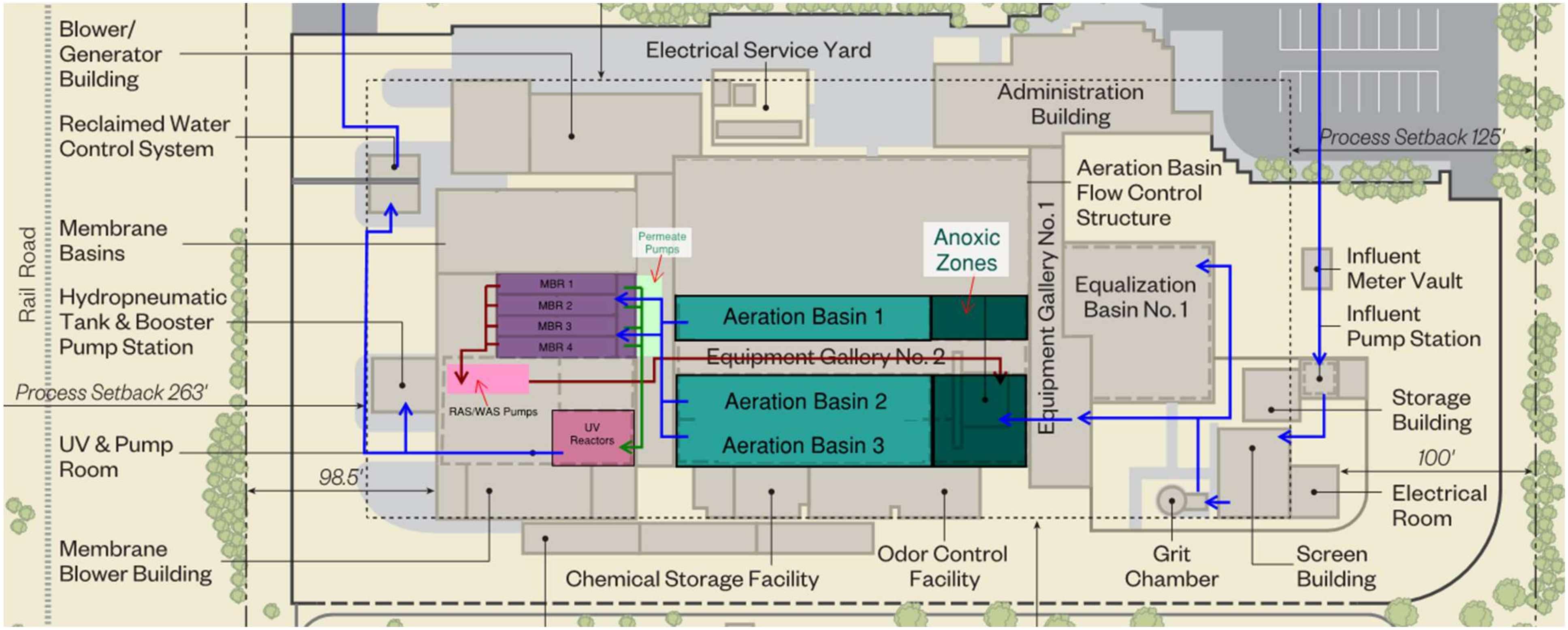
Proposed treatment trains for further evaluation

Complete treatment trains

Train	Preliminary Treatment	Biological Treatment	Additional Treatment	Disinfection	Comments
1	Existing Headworks with rehabilitation	MLE	• PANDA • New clarifiers • New filters	UV (best score) or Chlorination (lowest energy)	
2		MLE	• DAS • New clarifiers • New filters		
3		MLE	• Refurbished MBR		• Best score. Most energy-intensive
4		MLE	• New MBR		• Best score. Most energy-intensive
5		SBR	• New filters		• Lowest energy consumption.
6		SBR	• AGS • New filters		• Lowest energy consumption.

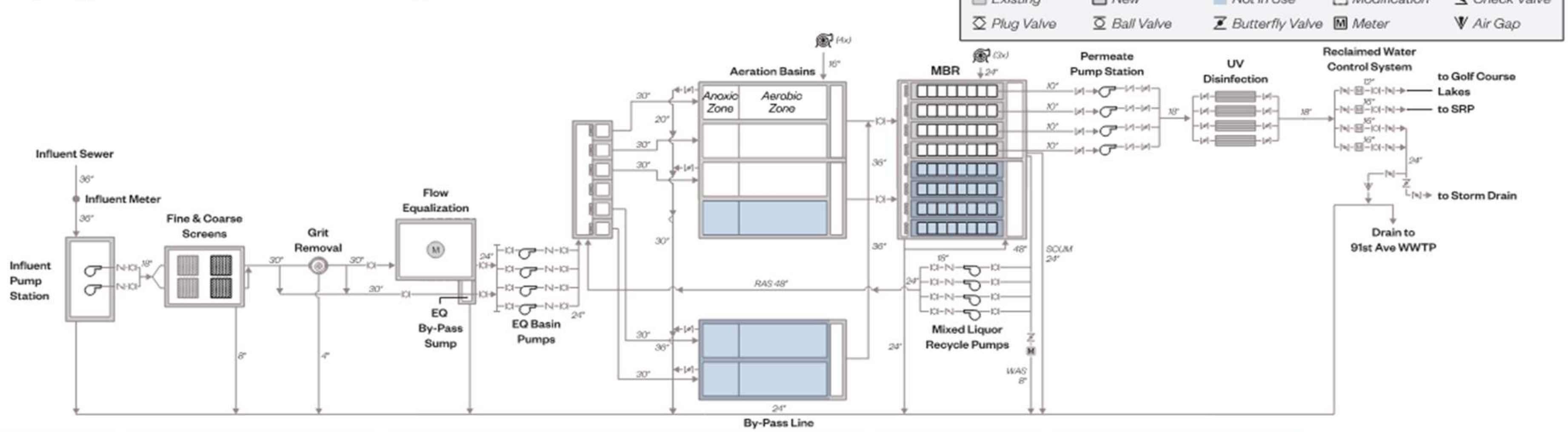
Site Layout – Alternatives 3 & 4

MLE + MBR



Ultimate treatment capacity ~ 9.0 mgd

Process, Piping, and Instrumentation Diagram



INFLUENT PUMP STATION

DESIGN PARAMETERS

Submersible Pumps: 2X 70 HP with VFDs
Configuration: N+1
Firm Capacity: 7.5 mgd @ 40 ft of H_2O

INSTRUMENTATION

Flow	●
Level	●
Pressure	●
Temperature	●
pH	●
Ammonia	●
Turbidity	●
DO	
TSS	●
UVT/UTI	
Nitrate	

SCREENING

DESIGN PARAMETERS

Coarse Screen
Coarse Screen: 2X @ 3mm
Configuration: N+1
Firm Peak Hour Flow: 14.4 mgd
Max Headloss: 18"

Fine Screen
Fine Screen: 2X @ 2mm
Configuration: N+1
Firm Peak Hour Flow: 5.4 mgd
Max Headloss: 18.5"

INSTRUMENTATION

Flow	
Level	●
Pressure	
Temperature	
pH	
Ammonia	
Turbidity	
DO	
TSS	
UVT/UTI	
Nitrate	

GRIT REMOVAL

DESIGN PARAMETERS

Vortex Grit: 1X
Configuration: N with bypass
Peak Hour Flow: 14.4 mgd
Max Headloss: 0.25'

INSTRUMENTATION

Flow	
Level	●
Pressure	●
Temperature	
pH	
Ammonia	
Turbidity	
DO	
TSS	
UVT/UTI	
Nitrate	

EQUILIZATION

DESIGN PARAMETERS

Basins
Basin Volume: 0.5 MG Total
Configuration: N with bypass
Mixing: Vertical Shaft Mixers

Equalization Pumps
Anoxic Pumps: 4X @ 25 HP with VFDs
Configuration: N+1
Firm Capacity: 5.4 mgd @ x 38 ft of H_2O

INSTRUMENTATION

Flow	●
Level	●
Pressure	●
Temperature	
pH	
Ammonia	
Turbidity	
DO	●
TSS	
UVT/UTI	
Nitrate	

AERATION BASINS

DESIGN PARAMETERS

Basins
Basin Volume: 3X 1.3 MG Total
- Anoxic 0.2 MG
- Aerobic 1.1 MG
Configuration: N
Aeration: Fine Bubble Diffused Aeration
Firm Capacity: 2.8 mgd

Blowers
Blowers: 4X 175 HP with VFDs
Configuration: N+1
Firm Capacity: 7,800 SCFM @ 6.7 psi

INSTRUMENTATION

Flow	
Level	●
Pressure	
Temperature	
pH	●
Ammonia	●
Turbidity	
DO	●
TSS	●
UVT/UTI	
Nitrate	●

MBR BASINS

DESIGN PARAMETERS

Basins
Basin Volume: 4X @ 0.035 MG (0.14 MG Total)
Configuration: N with bypass
Cassettes/Train: 15
Total Membrane Surface Area: 288,000 sf
Firm Capicity: TBD

Mixed Liquor Recycle Pumps
Mixed Liquor Recycle Pumps: 4X @ 75 HP with VFDs
Configuration: N+1
Firm Capacity: 3Q @ x 15 ft of H_2O

Blowers
Blowers: 3X @ 100 HP with VFDs
Configuration: N+1
Firm Capacity: 3,000 SCFM @ 5 psi

INSTRUMENTATION

Flow	●
Level	
Pressure	●
Temperature	●
pH	●
Ammonia	●
Turbidity	●
DO	●
TSS	●
UVT/UTI	
Nitrate	

PERMEATE PUMP STATION

DESIGN PARAMETERS

Pumps: 4X @ 100 HP with VFDs
Configuration: N+1
Firm Capacity: 5.4 mgd @ 143 ft of H_2O

INSTRUMENTATION

Flow	●
Level	
Pressure	●
Temperature	●
pH	●
Ammonia	●
Turbidity	
DO	●
TSS	●
UVT/UTI	
Nitrate	

UV DISINFECTION

DESIGN PARAMETERS

Trains: 4X Trojan - Chamber ASSY72AL75A
Configuration: N+1
Dosage: 80,000 uwattsec/cm²
UV Transmittance: 70%
Firm Capacity: 5.4 mgd

INSTRUMENTATION

Flow	●
Level	
Pressure	●
Temperature	
pH	
Ammonia	
Turbidity	
DO	
TSS	●
UVT/UTI	●
Nitrate	

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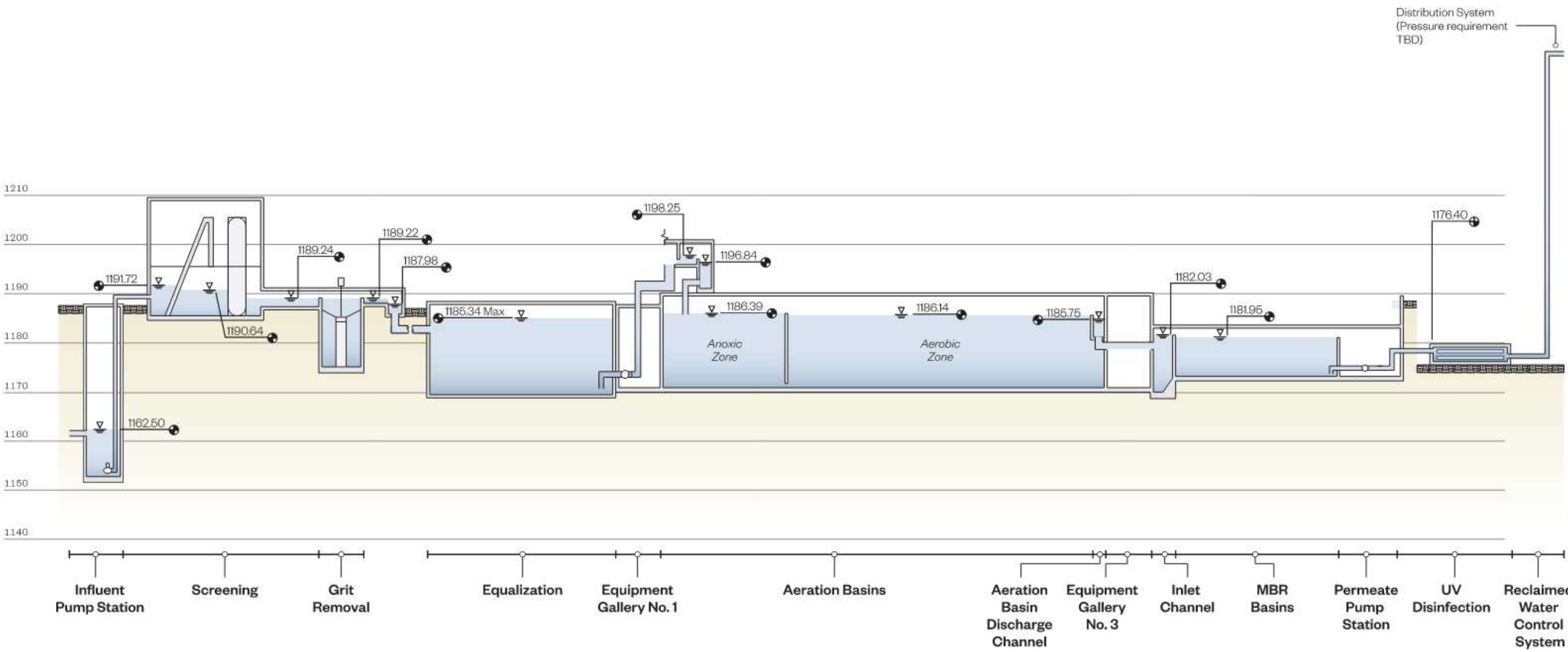
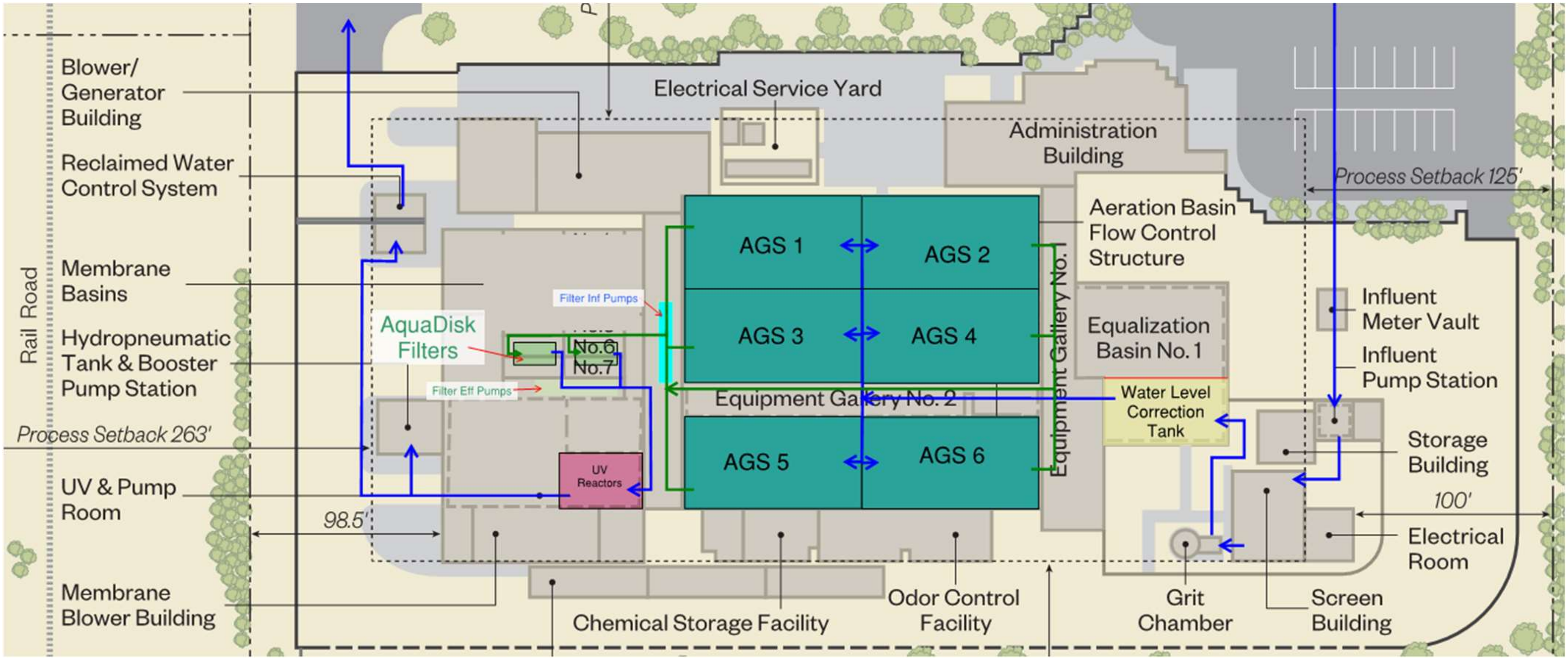


Hydraulic Profile

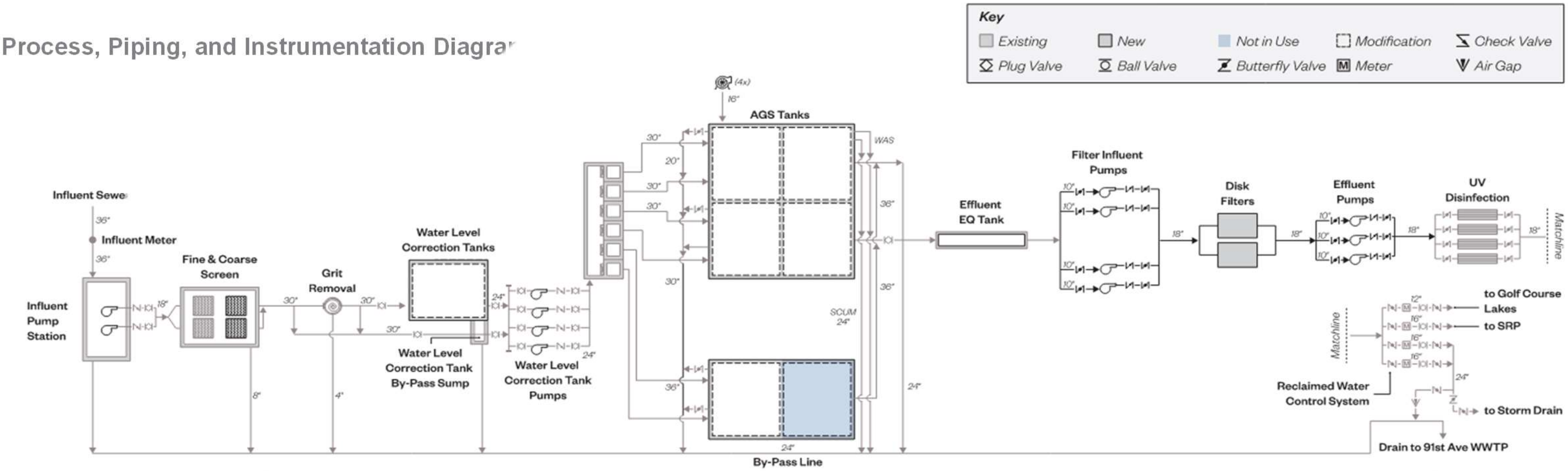
Site Layout – Alternative 6

AGS + Tertiary Filters



Ultimate treatment capacity ~ 6 mgd

Process, Piping, and Instrumentation Diagram



INFLUENT PUMP STATION

DESIGN PARAMETERS

Submersible Pumps: 2X 70 HP with VFDs
Configuration: N+1
Firm Capacity: 7.5 mgd @ 40 ft of H_2O

INSTRUMENTATION

Flow	●
Level	●
Pressure	●
Temperature	●
pH	●
Ammonia	●
Turbidity	●
DO	
TSS	●
UVT/UTI	
Nitrate	

SCREENING

DESIGN PARAMETERS

Coarse Screen
Coarse Screen: 2X @ 3mm
Configuration: N+1
Firm Peak Hour Flow: 14.4 mgd
Max Headloss: 18"

Fine Screen
Fine Screen: 2X @ 2mm
Configuration: N+1
Firm Peak Hour Flow: 5.4 mgd
Max Headloss: 16.5"

INSTRUMENTATION

Flow	
Level	●
Pressure	
Temperature	
pH	
Ammonia	
Turbidity	
DO	
TSS	
UVT/UTI	
Nitrate	

GRIT REMOVAL

DESIGN PARAMETERS

Vortex Grit: 1X
Configuration: N with bypass
Peak Hour Flow 14.4 mgd
Max Headloss: 0.25"

INSTRUMENTATION

Flow	
Level	●
Pressure	●
Temperature	
pH	
Ammonia	
Turbidity	
DO	
TSS	
UVT/UTI	
Nitrate	

WATER LEVEL CORRECTION TANK

DESIGN PARAMETERS

Basins
Basin Volume: 0.5 MG Total
Configuration: N with bypass
Mixing: Vertical Shaft Mixers

Equalization Pumps
Anoxic Pumps: 4X @ 25 HP with VFDs
Configuration: N+1
Firm Capacity: 5.4 mgd @ x 38 ft of H_2O

INSTRUMENTATION

Flow	●
Level	●
Pressure	●
Temperature	
pH	
Ammonia	
Turbidity	
DO	●
TSS	
UVT/UTI	
Nitrate	

AGS TANKS

DESIGN PARAMETERS

Basins
Basin Volume: 5X 2.1 MG Total
Configuration: N
Aeration: Fine Bubble Diffused Aeration
Firm Capacity: 3.4 mgd

Blowers
Blowers: 4X 200 HP with VFDs
Configuration: N+1
Firm Capacity: 9,600 SCFM @ 6.7 psi

INSTRUMENTATION

Flow	
Level	●
Pressure	
Temperature	
pH	●
Ammonia	●
Turbidity	
DO	●
TSS	●
UVT/UTI	
Nitrate	●

EFFLUENT EQ TANK

DESIGN PARAMETERS

Basin Volume: 0.48 MG

INSTRUMENTATION

Flow	●
Level	
Pressure	●
Temperature	●
pH	●
Ammonia	●
Turbidity	
DO	●
TSS	●
UVT/UTI	
Nitrate	

FILTER INFLUENT PUMP STATION

DESIGN PARAMETERS

Pumps: 4X @ 25 HP with VFDs
Configuration: N+1
Firm Capacity: 5.4 mgd @ 5 ft of H_2O

INSTRUMENTATION

Flow	●
Level	
Pressure	●
Temperature	●
pH	●
Ammonia	●
Turbidity	
DO	●
TSS	●
UVT/UTI	
Nitrate	

DISK FILTERS

DESIGN PARAMETERS

Filters: 2X
Configuration: N+1
Firm Capacity: 5.4 mgd

INSTRUMENTATION

Flow	
Level	●
Pressure	●
Temperature	
pH	
Ammonia	
Turbidity	
DO	
TSS	
UVT/UTI	
Nitrate	

EFFLUENT PUMPS

DESIGN PARAMETERS

Pumps: 3X @ 125 HP
Configuration: N+1
Firm Capacity: 5.4 mgd

INSTRUMENTATION

Flow	
Level	●
Pressure	●
Temperature	
pH	
Ammonia	
Turbidity	
DO	
TSS	
UVT/UTI	
Nitrate	

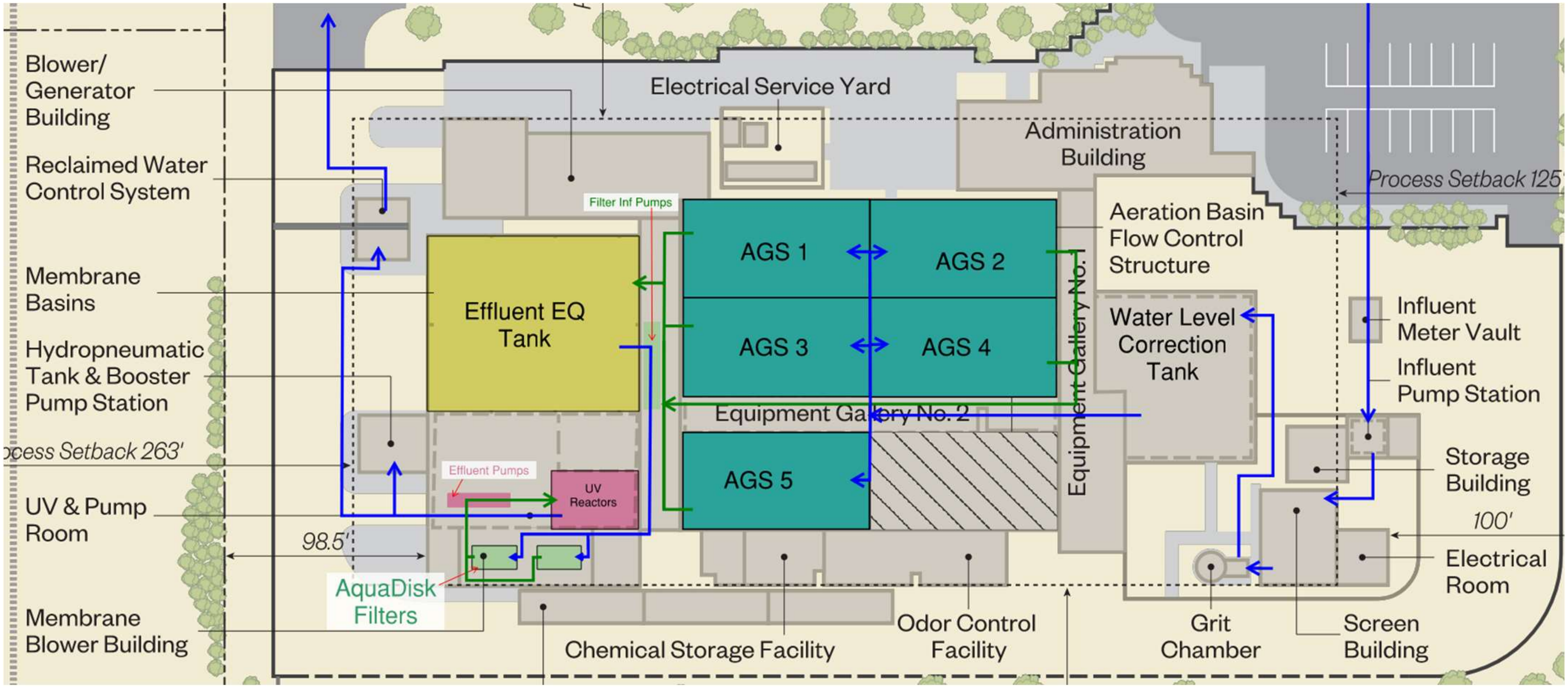
UV DISINFECTION

DESIGN PARAMETERS

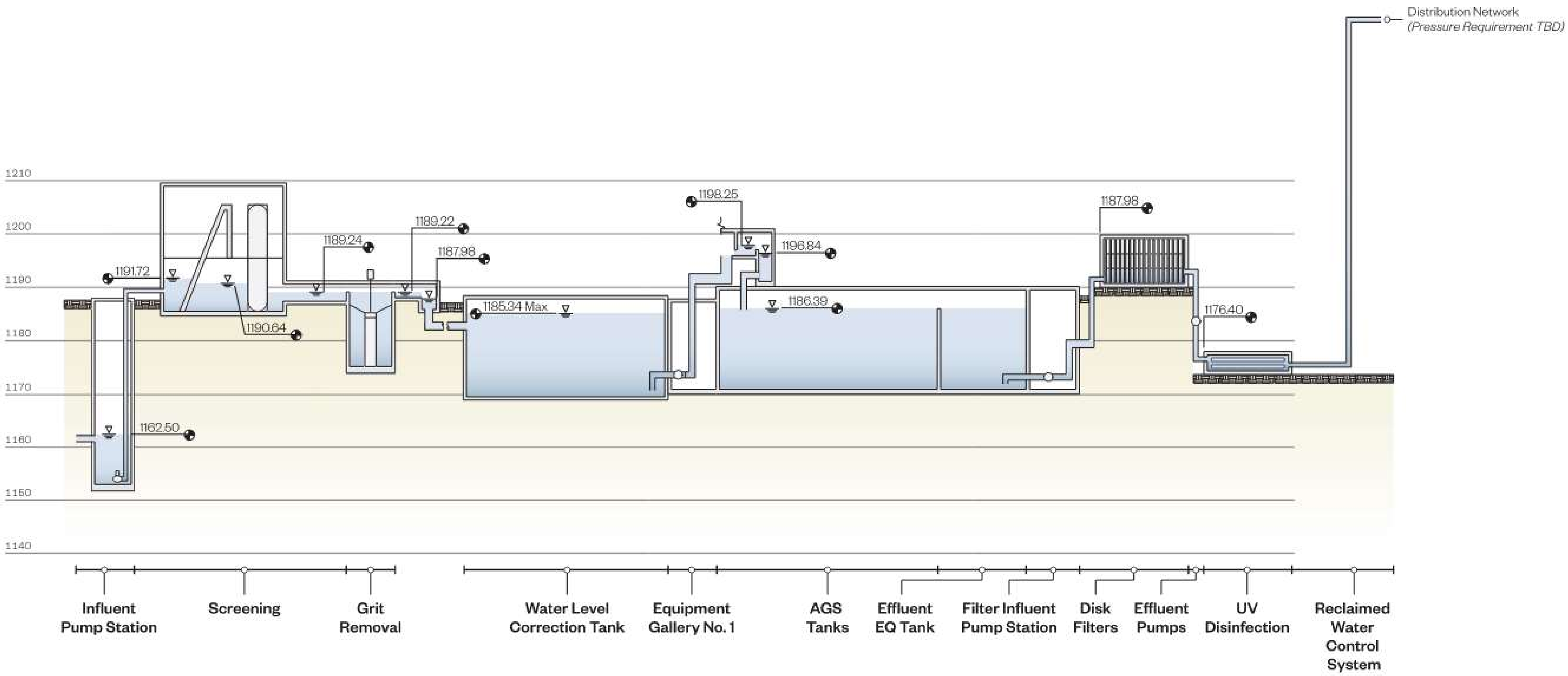
Trains: 4X Trojan - Chamber ASSY72AL75A
Configuration: N+1
Dosage: 80,000 uwattsec/cm²
UV Transmittance: 70%
Firm Capacity: 5.4 mgd

INSTRUMENTATION

Flow	●
Level	
Pressure	●
Temperature	
pH	
Ammonia	
Turbidity	
DO	
TSS	●
UVT/UTI	●
Nitrate	



Site Plan, Constructability, and Operability



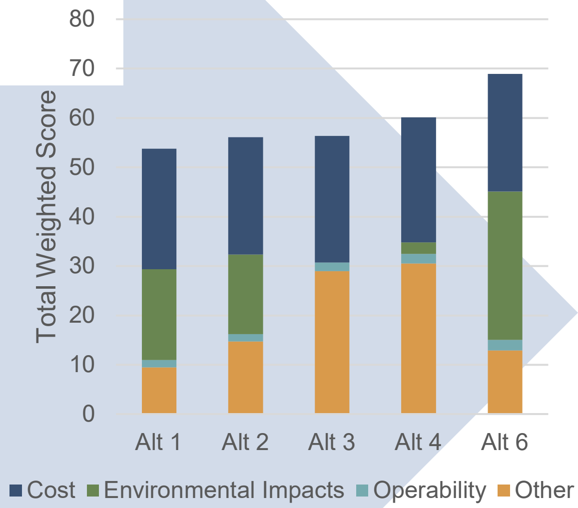
Hydraulic Profile

Alternatives Evaluation

Category	Criteria	Weighting	Category Weighting
Cost	Capital Cost	15%	30%
	25-Year O&M Cost	15%	
Environmental Impacts	Energy Consumption	10%	30%
	GHG Emissions	20%	
Operability	Staffing/FTE	1%	5%
	Operability	1%	
	Shock Load	1%	
	Automation	1%	
	Maintainability	1%	
Other	Reliability/Redundancy	5%	35%
	Ultimate Treatment Capacity	5%	
	Permitting	5%	
	Effluent/Water Quality	5%	
	Proprietary Product	5%	
	Performance History	5%	
	Research	5%	

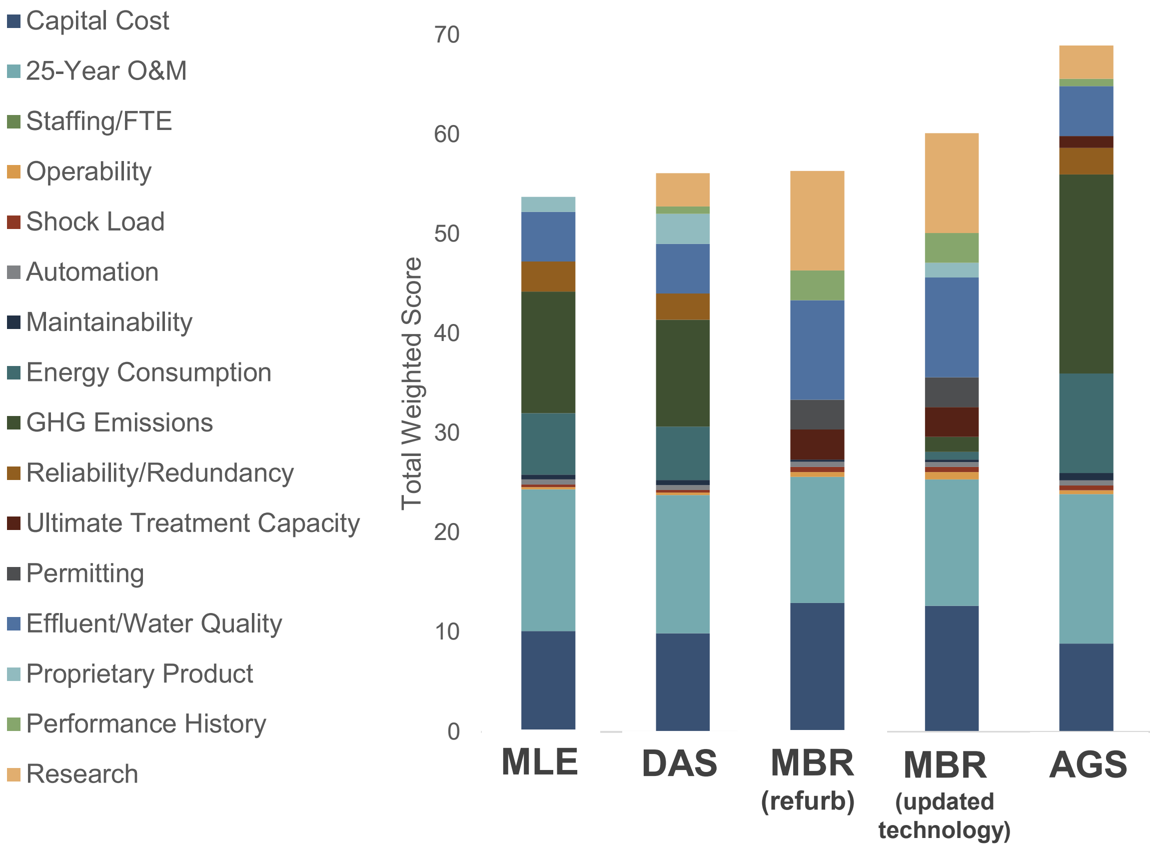
HazenConverge
Multi-Criteria Decision Tool

- Score each alternative across criteria
- Normalize and aggregate scores with weightings
- Review ranking, strengths, weakness of alternatives



Evaluation results – *ROUND 1*

Weighted Results (Cost 30%, Environmental Impact 30%); higher score is better



MLE – Modified Ludzack-Ettinger process. Typical AZ denitrification process

DAS – Densified activated sludge High MLSS to intensify process

MBR – Membrane bioreactor. Existing KWRF process. Sub-alternatives: existing and updated

AGS – Aerobic granular sludge. Intensified process with simultaneous nitrification/ denit

AGS (Alt 6) has best score among alternatives due to lowest energy consumption and lowest environmental impacts

MBR alternatives rank best for capital cost. Worst score re: environmental impacts due to energy consumption

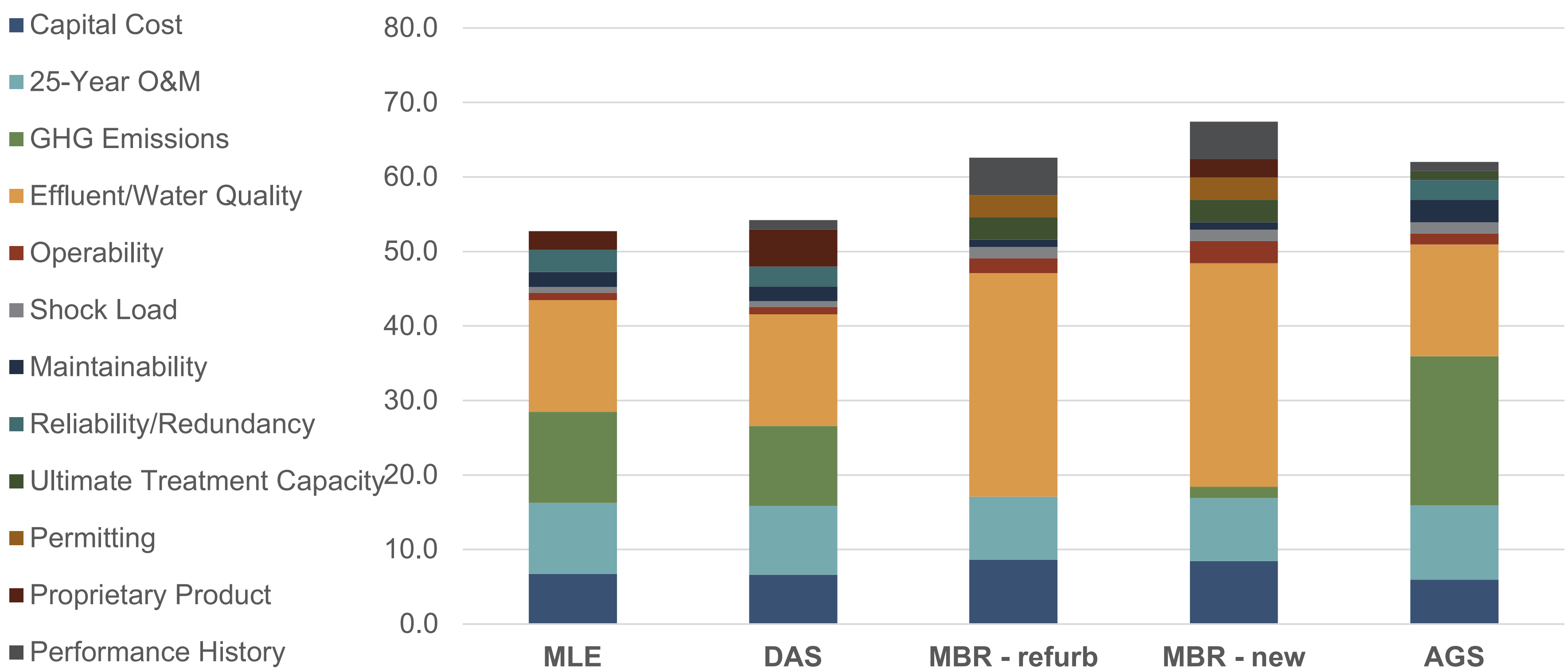
Energy use contributes to 25% of the total score

“Right answer” depends upon what is deemed most important

- Weighting factors
- Evaluation range for each variable
- Multiple related/overlapping variables
- This is not “cooking the books” or “garbage in - garbage out”
- Important to be attentive to what is really important and be sure it is weighted and scaled accordingly

Evaluation results – *ROUND 2*

More emphasis placed on capital cost and finished water quality, expandability



Details…

Criteria	Category	Relative Criteria Weight	Category Weight	Raw Scores					Normalized Scores (Unweighted)					Weighted Scores				
				MLE	DAS	MBR – refurb	MBR - new	AGS	MLE	DAS	MBR - refurb	MBR - new	AGS	MLE	DAS	MBR - refurb	MBR - new	AGS
Capital Cost	Cost	10%	20%	$26,610,000	$26,950,000	$22,080,000	$22,520,000	$28,610,000	0.68	0.66	0.86	0.84	0.59	6.8	6.6	8.6	8.4	5.9
25-Year O&M	Cost	10%		$25,654,000	$26,295,000	$28,795,000	$28,774,000	$24,336,000	0.95	0.93	0.85	0.85	1.00	9.5	9.3	8.5	8.5	10.0
GHG Emissions	Environmental Impacts	20%	50%	2,134	2,195	2,616	2,557	1,828	0.61	0.54	0.00	0.08	1.00	12.2	10.7	0.0	1.5	20.0
Effluent/Water Quality	Environmental Impacts	30%		3	3	5	5	3	0.50	0.50	1.00	1.00	0.50	15.0	15.0	30.0	30.0	15.0
Operability	Operability	4%	11%	4	4	3	2	4	0.25	0.25	0.50	0.75	0.38	1.0	1.0	2.0	3.0	1.5
Shock Load	Operability	3%		4	4	3	3	3	0.25	0.25	0.50	0.50	0.50	0.8	0.8	1.5	1.5	1.5
Maintainability	Operability	4%		3	3	4	4	2	0.50	0.50	0.25	0.25	0.75	2.0	2.0	1.0	1.0	3.0
Reliability/Redundancy	Other	3%	19%	1.2	1.2	1.5	1.5	1.2	1.00	0.88	0.00	0.00	0.88	3.0	2.6	0.0	0.0	2.6
Ultimate Treatment Capacity	Other	3%		4.2	4.2	8.4	8.4	5.9	0.00	0.00	1.00	1.00	0.40	0.0	0.0	3.0	3.0	1.2
Permitting	Other	3%		0	0	1	1	0	0.00	0.00	1.00	1.00	0.00	0.0	0.0	3.0	3.0	0.0
Proprietary Product	Other	5%		2	3	1	2	1	0.50	1.00	0.00	0.50	0.00	2.5	5.0	0.0	2.5	0.0
Performance History	Other	5%		1	2	5	5	2	0.00	0.25	1.00	1.00	0.25	0.0	1.3	5.0	5.0	1.3

Modernized MBR is the recommended process for the restart of the KWRF

- Best finished water quality
- Capital cost is lower – make use of existing facilities
- Most intensified process, can gain most capacity from tight site
- More energy intensive, but…
  - **New MBR system and reconfigured plant will use much less energy per unit of flow treated than the previous KWRF**
- GHG generation is a criterion and was given substantial weight, but it was not decisive
- Next steps: evaluate potential for additional capacity for potential shared water resources project with other entities

Thank you!

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