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DuPage River Salt Creek Workgroup

Phosphorus Removal Feasibility Studies & Phosphorus Discharge Optimization Plans

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Approach and Lessons Learned

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Scott Trotter, P.E., BCEE
Chris Marschinke, P.E.

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- **Phosphorus Discharge Optimization Plan**
  - ✓ Influent Reduction Strategy
  - ✓ Effluent Reduction Strategy

- **Phosphorus Removal Feasibility Study**
  - ✓ Evaluation of Existing WWTP
  - ✓ Phosphorus Removal Methods
  - ✓ Evaluation of Alternatives
  - ✓ Recommendations and Financial Impacts

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Phosphorus Discharge Optimization Plan

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Phosphorus Discharge Optimization Plan

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➢ Influent Reduction Strategy

✓ Define "Significant Contributor" of Phosphorus

- > 1% Daily Influent Phosphorus Load

✓ Identify Potential High Phosphorus Contributors

- Review Water Billing Data
- Identify Large Users and Potential High P Contributors
- Categorize Users by Potential (Low, Medium & High)
- Sample Potential High Contributors
- Discuss with the Community Impacts of Restrictions

PHOSPHORUS DISCHARGE OPTIMIZATION PLAN

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Summary of Phosphorus Sources

Year: 2016			Glendale Heights		Users over 5000 gpd		Assessment
Businesses	Type of Facility	Phosphorus sources	Average Daily Flow (MGD)	Average Influent Phosphorus (mg/L)	Flow (GPD)	Phosphorus Required 1% of loading (mg/L)	Reduction potential high, medium, low
Target	Retail/Food Service	Cleaning products in food service areas.	3.6	4.4	5767	27.5	low
LA Fitness	Fitness	Shower facilities	3.6	4.4	8937	17.7	low
Jewel Osco	Grocery	Cleaning Products	3.6	4.4	6107	25.9	low
Cornelius, Inc.	Beverage Dispenser Manufacturer	Cleaning Products	3.6	4.4	4952	32.0	low
Portillos	Food Service	Cleaning Products	3.6	4.4	7511	21.1	low
Hibachi Grill	Food Service	Cleaning Products	3.6	4.4	5811	27.3	low
Universal Beauty Products	Packaging	None	3.6	4.4	5144	30.8	low
Laundry World	Laundry	Detergents	3.6	4.4	7389	21.4	medium
Express Coin Laundromat	Laundry	Detergents	3.6	4.4	12278	12.9	medium
Spraying Systems	Spray Nozzle Manufacturer	Water	3.6	4.4	20074	7.9	medium
Medefil Ink-260	Pharmaceutical Manufacturer	Cleaning Products	3.6	4.4	8314	19.1	medium
Hudapack Metal	Heat treat metals	???	3.6	4.4	6070	26.1	medium
Armanda Hotel	Hotel	Detergents and Cleaning Products	3.6	4.4	9656	16.4	medium
1400 Oakmont Dr.	Apartments	Detergents/Laundry	3.6	4.4	12600	12.6	medium
Fresinus Medical	Medical	Detergents and Cleaning Products	3.6	4.4	11637	13.6	high
Kronos Foods	Food Manufacturer	Food manufacturing and Cleaning Products	3.6	4.4	39989	4.0	high
Adventist Glen Oaks Hospital	Medical	Detergents and Cleaning Products	3.6	4.4	25963	6.1	high
Bucky's	Gas Station/Car Wash	Car wash chemicals/soaps	3.6	4.4	5616	28.2	high

PHOSPHORUS DISCHARGE OPTIMIZATION PLAN

		Sampling Round						Max	Min	Average
		1st	2nd	3rd	4th	5th	6th			
LOW	Cornelius	10.30	6.65					10.30	6.65	8.48
	Hibachi	3.97	1.52					3.97	1.52	2.75
	Jewel	6.45	4.16					6.45	4.16	5.31
	LA Fitness	3.91	9.94					9.94	3.91	6.93
	Portillos	8.31	11.60					11.60	8.31	9.96
	Target	7.86	5.18					7.86	5.18	6.52
	Universal Beauty	6.94	1.72					6.94	1.72	4.33
MEDIUM	Apts - 1400 Okamont	5.06	3.12	4.02				5.06	3.12	4.07
	Armada Hotel	5.19	4.56	0.71				5.19	0.71	3.49
	Express Coin Laundry	1.51	3.38	6.34				6.34	1.51	3.74
	Hudapak	2.37	2.99	1.37				2.99	1.37	2.24
	Laundry World	0.34	0.55	0.77				0.77	0.34	0.55
	Medefil Inc. - 260	9.59	2.36	9.79				9.79	2.36	7.25
	Spraying Systems	4.23	5.54	1.87				5.54	1.87	3.88
HIGH	Adventist Glen Oak	7.70	2.11	6.03	7.08	4.40		7.70	2.11	5.46
	Bucky's - 600 North	1.49	4.23	1.04	6.94	1.03		6.94	1.03	2.95
	Fresinus Medical	2.10	2.87	3.43	2.28	3.32		3.43	2.10	2.80
	Kronos Foods	0.73	0.52	0.26	0.33	0.39	0.23	0.73	0.23	0.41

PHOSPHORUS DISCHARGE OPTIMIZATION PLAN

February 1st, 2018

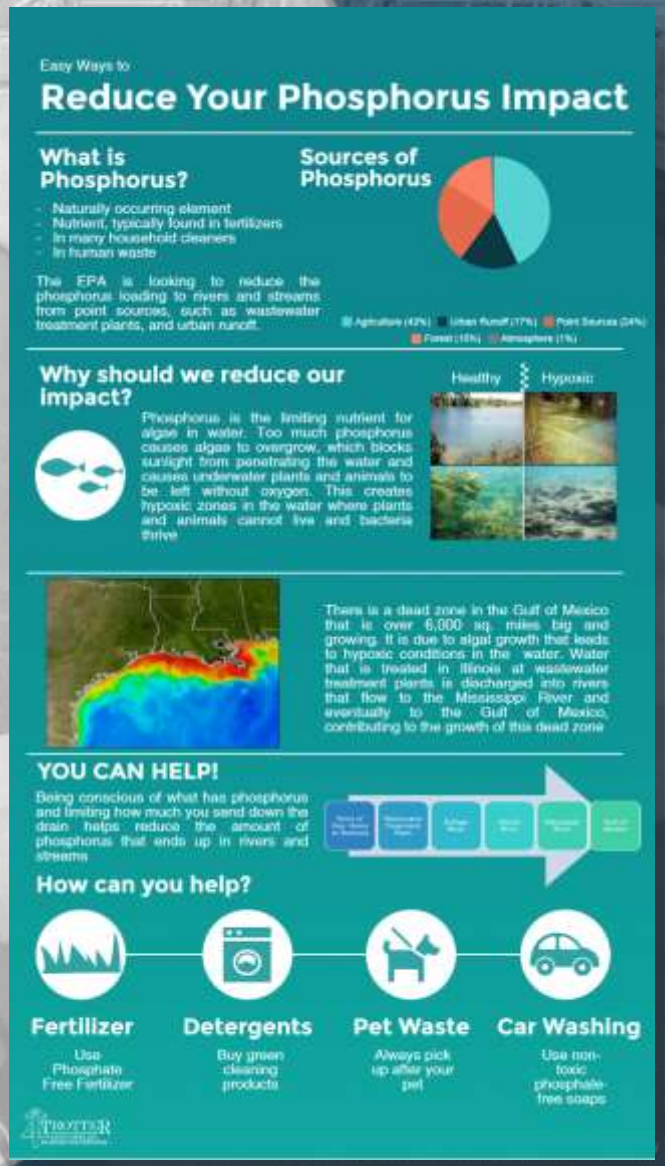
Summary of Phosphorus Sources

Users over 5,000 gpd					Assessment	Sampling	
Businesses	Type of Facility	Phosphorus sources	Flow (GPD)	Phosphorus to Generate 1% of loading (mg/L)	Reduction potential (High, Medium, Low)	Actual Effluent Phosphorus (mg/L)	Exceeds 1% Loading?
Target	Retail/Food Service	Cleaning products in food service areas.	5767	27.5	Low	7.86	-
LA Fitness	Fitness	Shower facilities	8937	17.7	Low	9.94	-
Jewel Osco	Grocery	Cleaning Products	6107	25.9	Low	6.45	-
Cornelius, Inc.	Beverage Dispenser Manufacturer	Cleaning Products	4952	32.0	Low	10.3	-
Portillos	Food Service	Cleaning Products	7511	21.1	Low	11.6	-
Hibachi Grill	Food Service	Cleaning Products	5811	27.3	Low	3.97	-
Universal Beauty Products	Packaging	None	5144	30.8	Low	6.94	-
Laundry World	Laundry	Detergents	7389	21.4	Medium	0.77	-
Express Coin Laundromat	Laundry	Detergents	12278	12.9	Medium	6.34	-
Spraying Systems	Spray Nozzle Manufacturer	Water	20074	7.9	Medium	5.54	-
Medefil Ink-260	Pharmaceutical Manufacturer	Cleaning Products	8314	19.1	Medium	9.79	-
Hudapack Metal	Heat treat metals	???	6070	26.1	Medium	2.99	-
Armanda Hotel	Hotel	Detergents and Cleaning Products	9656	16.4	Medium	5.19	-
1400 Oakmont Dr.	Apartments	Detergents/Laundry	12600	12.6	Medium	5.06	-
Fresinus Medical	Medical	Detergents and Cleaning Products	11637	13.6	High	3.43	-
Kronos Foods	Food Manufacturer	Food manufacturing and Cleaning Products	39989	4.0	High	0.73	-
Adventist Glen Oaks Hospital	Medical	Detergents and Cleaning Products	25963	6.1	High	7.7	✓
Bucky's	Gas Station/Car Wash	Car wash chemicals/soaps	5616	28.2	High	6.94	-

Phosphorus Discharge Optimization Plan

➢ Influent Reduction Strategy

- ✓ Review Existing Sewer Use Ordinance
  - Cost Effective Analysis of Implementing Local Limits
- ✓ Public Education Campaign
  - Post Information about Impacts of Phosphorus in Municipality Newsletters and on Websites



Phosphorus Discharge Optimization Plan

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Effluent Reduction Strategy

- ✓ Define "Low Cost"
  - ≤ 5% of Annual Operating Budget
- ✓ Develop BioWin™ Model using Record Drawings for Existing Plant
  - Calibrate Utilizing Historical Data for Previous Three Years
- ✓ Optimize Phosphorus Removal in Existing Plant
  - Reduce SRT
  - Implement anaerobic/anoxic zone
  - Change basin configuration
  - Reduce DO in process
  - Activate primary clarifiers
  - **Sidestream chemical treatment**

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Phosphorus Discharge Optimization Plan

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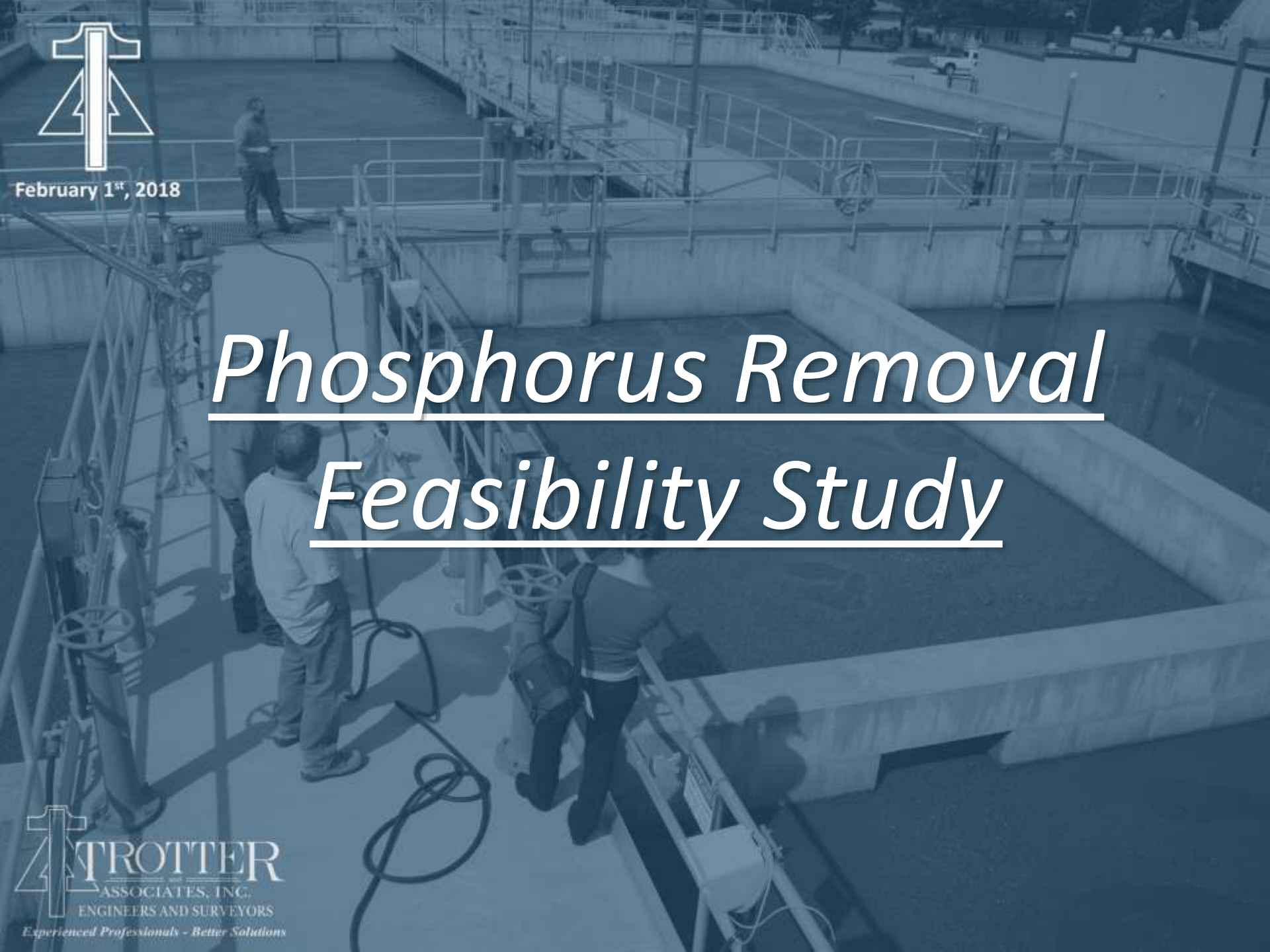
➢ Effluent Reduction Strategy

✓ Optimize Phosphorus Removal in Existing Plant

- Reduce SRT
  - Potential for Seasonal Improvement (Summer Only)
- Implement anaerobic/anoxic zone
  - High Capital Cost (Exceeded 5% Threshold)
- Change basin configuration
  - Not Feasible (In Plants Reviewed by TAI)
- Reduce DO in process
  - Negligible Effect (Not Practical Due to Turndown Issues)
- Activate primary clarifiers
  - Negligible Effects
  - Operation and Odor Concerns
- **Sidestream Chemical Treatment**
  - **Highest Potential for Impact – Both Aerobic & Anaerobic Systems (10-20% Reduction)**



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Phosphorus Removal Feasibility Study

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PHOSPHORUS REMOVAL FEASIBILITY STUDY

February 1st, 2018

Project Organization and Report Layout

TABLE OF CONTENTS

1. Executive Summary
2. General Background
3. Evaluation of Existing Wastewater Treatment Facility
4. Phosphorus Removal Methods
5. Evaluation of Phosphorus Removal Alternatives
6. Recommendations and Cost Considerations

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PHOSPHORUS REMOVAL FEASIBILITY STUDY

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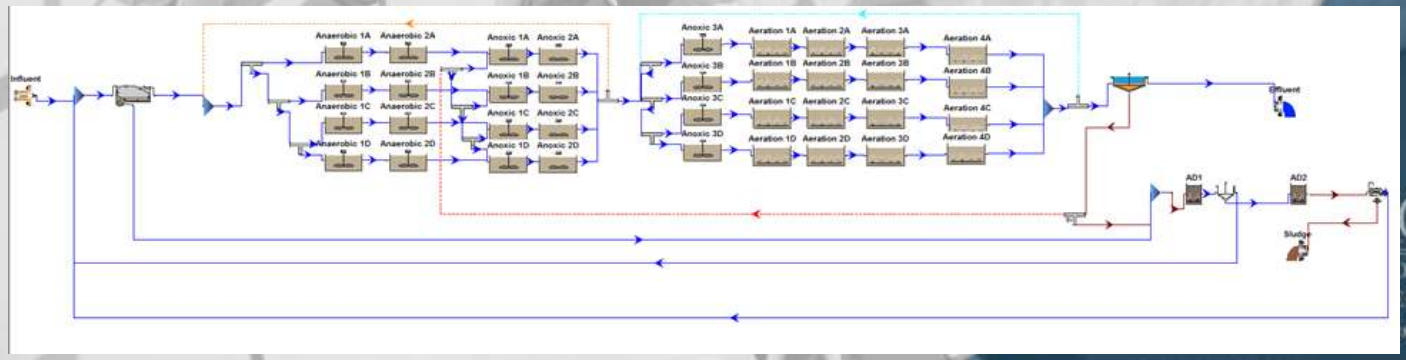
Evaluation of Existing Facility

- ✓ Influent Flows and Pollutant Loadings
- ✓ Effluent Water Quality
- ✓ Wastewater Treatment Processes
  - Influent Pumping… Aeration Basins… Disinfection
  - Sludge Stabilization… Sludge Disposal
  - Sidestreams – Septage, Leachate Receiving, Centrate/Filtrate
- ✓ Methods of Analysis
  - Work Sessions with Operational/Lab Staff for Data Collection
  - Laboratory Analysis
  - Mass Balance – Loadings & Recycle Streams
  - BioWin™ Modeling



PHOSPHORUS REMOVAL FEASIBILITY STUDY

February 1st, 2018

Biological Process Modeling

✓ Calibration & Validation – Requires Good Data

- Influent, Effluent, Operational & Recycle Flows

✓ Limitations of Modeling

- Steady-State Models are inaccurate due to compounding impact of recycle flows
- Dynamic modeling provides better results, but typically simulates consistent influent flow patterns over an extended period of time (weeks and months)
- Allows modeler to check stability at boundary conditions
- Far more complex to simulate real-world range of operational conditions
- Accuracy/reliability of the model is directly proportionate to the level of effort invested

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Phosphorus Removal Feasibility Study

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Phosphorus Removal Methods

- ✓ Chemical Phosphorus Removal
  - Chemical Alternatives
  - Jar Testing Procedures
- ✓ Biological Nutrient Removal
  - BOD/TP Ratio
  - Impact of Bio-P on Digestion and Compounding Phosphorus
  - Process Evaluations (AO, A2O, UCT, Johannesburg, Bardenpho, etc.)
  - Comparison of Alternatives
- ✓ Sidestream Treatment
  - Phosphorus and/or Ammonia Reduction

	1.0 mg/L			0.5 mg/L			0.1 mg/L		
	Annual	Seasonal	Monthly	Annual	Seasonal	Monthly	Annual	Seasonal	Monthly
Chemical	✓	✓	✓	✓	✓	✓	✓ *	✓ *	✓ *
Biological	✓	✓	X	X	X	X	X	X	X
Combo	✓	✓	✓	✓	✓	✓	✓ *	✓ *	✓ *
	*Only feasible with advanced physical treatment								

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PHOSPHORUS REMOVAL FEASIBILITY STUDY

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➢ Phosphorus Removal Alternatives

✓ Methods for Achieving 1.0 mg/L Phosphorus

- Chemical Phosphorus Removal
  - Reliable, Predictable, Cost Effective
  - Simple to Implement
  - Commodities Subject to Inflationary Risk

- Biological Phosphorus Removal
  - Work Session with Staff to Define Goals & Expectations
  - Selection of BPR/BNR Process Dependent on Plant Configuration
  - Modeling of AO, A2O, and other Processes to Achieve 1.0 mg/L
  - Top Two Processes Optimized & Tested for Boundary Conditions

- Combination Methods
  - Based on Reliability at Boundary Conditions, Chemical Polishing was Recommended for all Plants (Seasonal & Monthly)
  - Chemical Polishing Increases Capital Expense

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PHOSPHORUS REMOVAL FEASIBILITY STUDY

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➢ Phosphorus Removal Alternatives

✓ Methods for Achieving 0.5 mg/L Phosphorus

- Chemical Phosphorus Removal
  - Reliable, Predictable, **but Less Cost Effective**
  - Simple to Implement
  - Commodities Subject to Inflationary Risk

- Biological Phosphorus Removal
  - Work Session with Staff to Define Goals & Expectations
  - Selection of BPR/BNR Process Dependent on Plant Configuration
  - Modeling of ~~**AO**~~, A2O, and other Processes to Achieve 0.5 mg/L
  - Top Two Processes Optimized & Tested for Boundary Conditions
  - **Consider Future TN Requirements**

- Combination Methods
  - Based on Reliability at Boundary Conditions, Chemical Polishing was Recommended for **all Plants**
  - Chemical Polishing Increases Capital Expense

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PHOSPHORUS REMOVAL FEASIBILITY STUDY

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➢ Phosphorus Removal Alternatives

✓ Methods for Achieving 0.1 mg/L Phosphorus

- Chemical Phosphorus Removal
  - Reliable, Predictable, **but Not Cost Effective**
  - Simple to Implement
  - Commodities Subject to Inflationary Risk

- ~~Biological Phosphorus Removal~~
  - Top Two Processes Optimized & Tested for Boundary Conditions
  - **Optimized Carbon Utilization within Process**
  - **Considered Carbon Augmentation (Fermenting, Methanol, etc.)**
  - **Evaluated Sidestream Treatment Technologies (Anammox, etc.)**
  - **Consider Future TN Requirements**

- **Combination Methods**
  - **Combination Recommended for all Plants**
  - **Advanced Filtration/Tertiary Treatment Required**

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PHOSPHORUS REMOVAL FEASIBILITY STUDY

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Recommendations and Decisions

✓ Final Alternative Selection

- Work Sessions with Staff to Discuss & Evaluate Alternatives
- Economic Factors (Capital, O&M, etc.)
- Non-Economic Factors (Public Acceptance, Environmental, etc.)

Description	Weight Factor (1-12)	AO	AO Score	A2O	A2O Score	Chem-P	Chem-P Score
Economic Factors							
Capital	11	1	11	0	0	2	22
O&M	10	2	20	1	10	0	0
Life Cycle Cost	12	2	24	0	0	2	24
20-Year Residual Value	9	1	9	2	18	1	9
Operational Simplicity	7	1	7	0	0	2	14
Inflationary Risk	8	2	16	2	16	0	0
Economic Factors Sub Total			**87**		**44**		**69**
Non-Economic Factors							
Quality of Sludge	2	1	2	2	4	0	0
Effluent Quality	6	0	0	2	12	1	6
Future TN	3	1	3	2	6	0	0
Disruption in Operations	1	1	1	0	0	2	2
Public Acceptance	5	1	5	2	10	0	0
Environmental Impacts	4	1	4	2	8	0	0
Non-Economic Factors Sub Total			**15**		**40**		**8**
			102		**84**		**77**

PHOSPHORUS REMOVAL FEASIBILITY STUDY

February 1st, 2018

➢ Recommendations and Decisions

✓ Financial Impact Evaluation

- Developed Realistic, Detailed Capital Cost Estimates
- Projected O&M Costs including:
  - Chemical
  - Power
  - Solids Handling & Disposal
  - Labor
- Develop Life-Cycle Costs for Selected Alternatives
  - Capital
  - O&M
  - Replacement & Salvage
- Calculate Impacts to User Rates

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