Marquette University

Student Design Competition

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Design Team

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Bijagua, Costa Rica

Background Information

Problem and Specifications

Problem:	*Tasks:*
• Private septic tanks for wastewater treatment leak contamination	• 3 alternative treatment solutions • 3 treatment site locations • Provide analysis for a collection system

Project Goals

1)	Meet effluent requirements
2)	Sustainable: Environmental, Economic, Cultural
3)	Create room for future growth
4)	Minimize system cost and complexity

Factors of Design

Design Simplicity

Operations & Maintenance

Community Pride

Tropical Climate

Land Cost

Design Parameters

Bijagua Population: 6,800 people

- Most Conservative Projection: Exponential Growth

Design Flow

Treatment Requirements

Concentrations:			
	Influent	**Effluent**	**% Removal**
BOD_5 (mg/L)	280	50	82
COD (mg/L)	550	150	73
TSS (mg/L)	220	50	77
Total Nitrogen (mg/L)	50	40	20
Total Phosphorus (mg/L)	20	10	50
Fecal Coliform (MPN/100mL)	5E7	1000	X

Alternatives Analysis

Alternatives Analysis

- **Highest Weighted Factors:**
  - Treatment Removals
    - *BOD*
    - *TSS*
    - *Fecal Coliform*
    - *Nitrogen and Phosphorus*
  - Operations and Maintenance Cost
  - Limit Electricity Cost
  - Odor Minimization
  - Design Simplicity

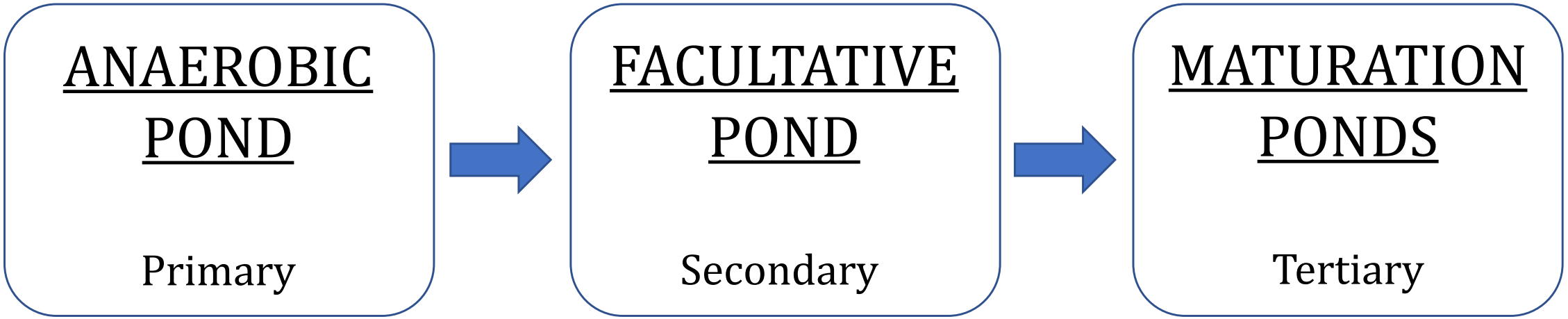
System Analysis

Treatment Alternative 1: Waste Stabilization Ponds

Anaerobic Pond, Facultative Pond, Maturation Ponds

Treatment Alternative 1: Waste Stabilization Ponds

Anaerobic Pond, Facultative Pond, Maturation Ponds



Treatment Alternative 1: **Waste Stabilization Ponds**

Positives:

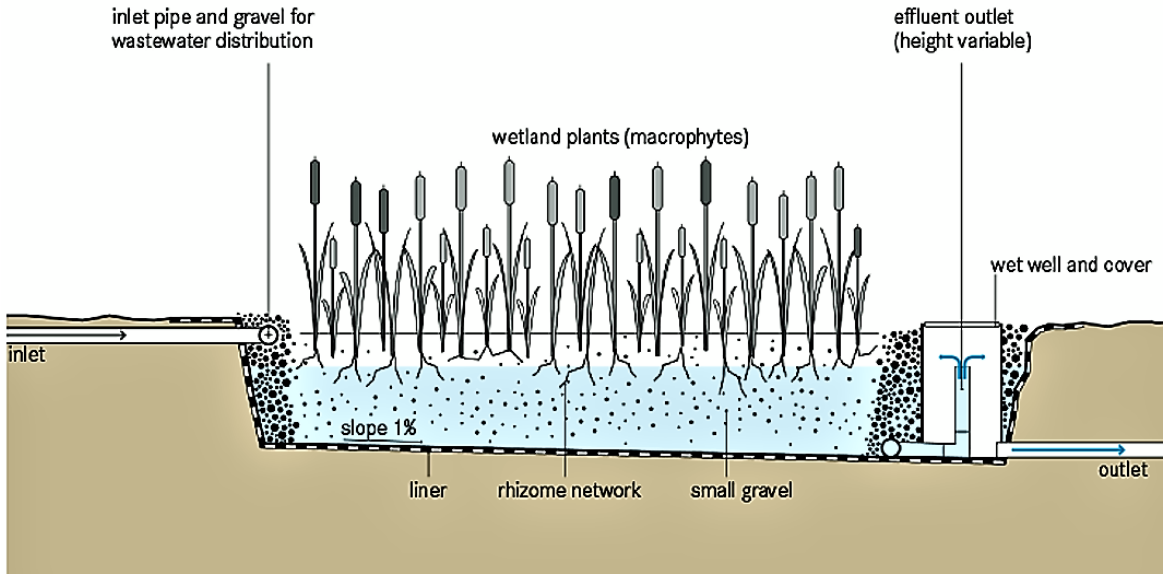
- No energy required
- Relatively simple O&M
- Accommodates fluctuations in flow

Negatives:

- Potential odor and insect concerns
- Less efficient/long retention times
- Land intensive

Treatment Alternative 2: Constructed Wetland

Anaerobic Pond, Constructed Wetland, Maturation Ponds



Treatment Alternative 2: Constructed Wetland

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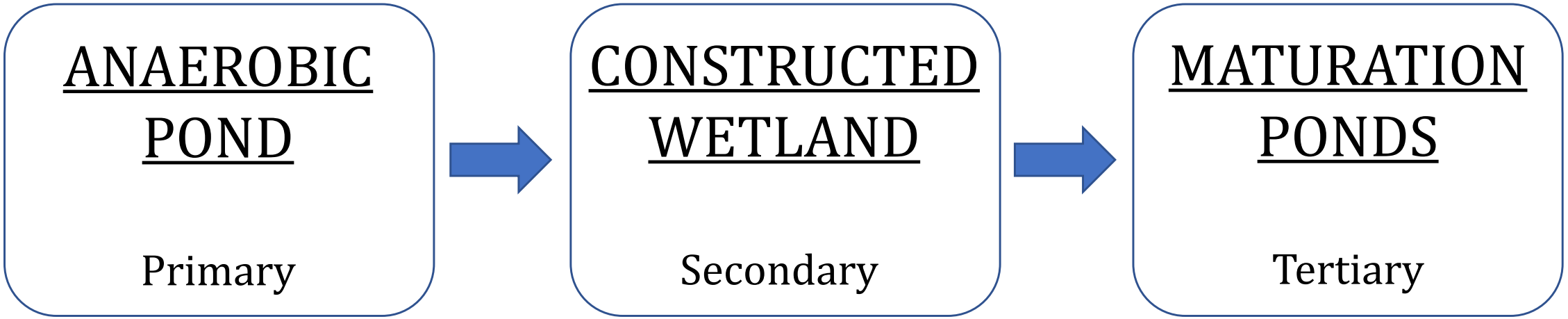


Treatment Alternative 2: Constructed Wetland

Positives:

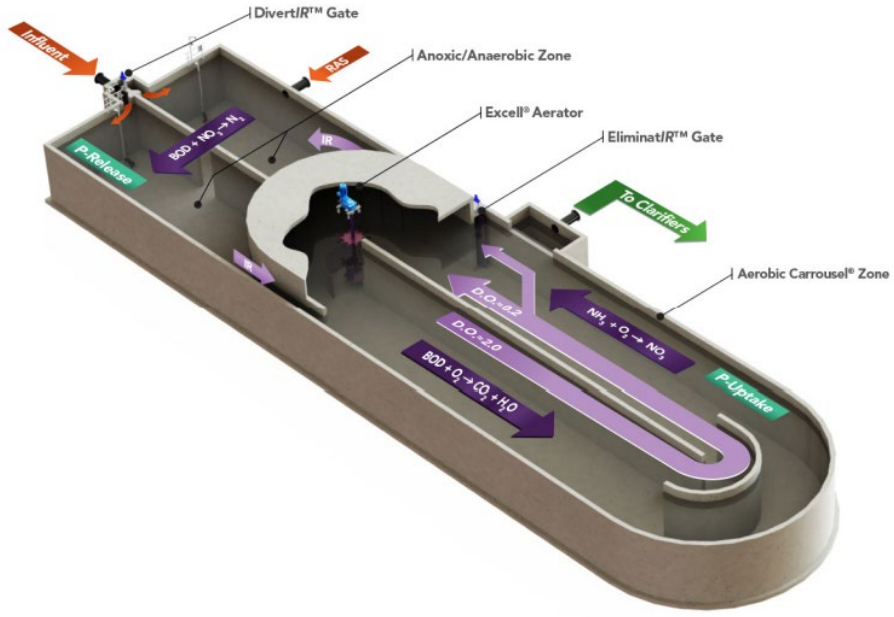
- No energy required
- Simple and infrequent O&M
- Mimics natural environment
- Minimizes odor and mosquitos
- Accommodates fluctuations in flow

Negatives:

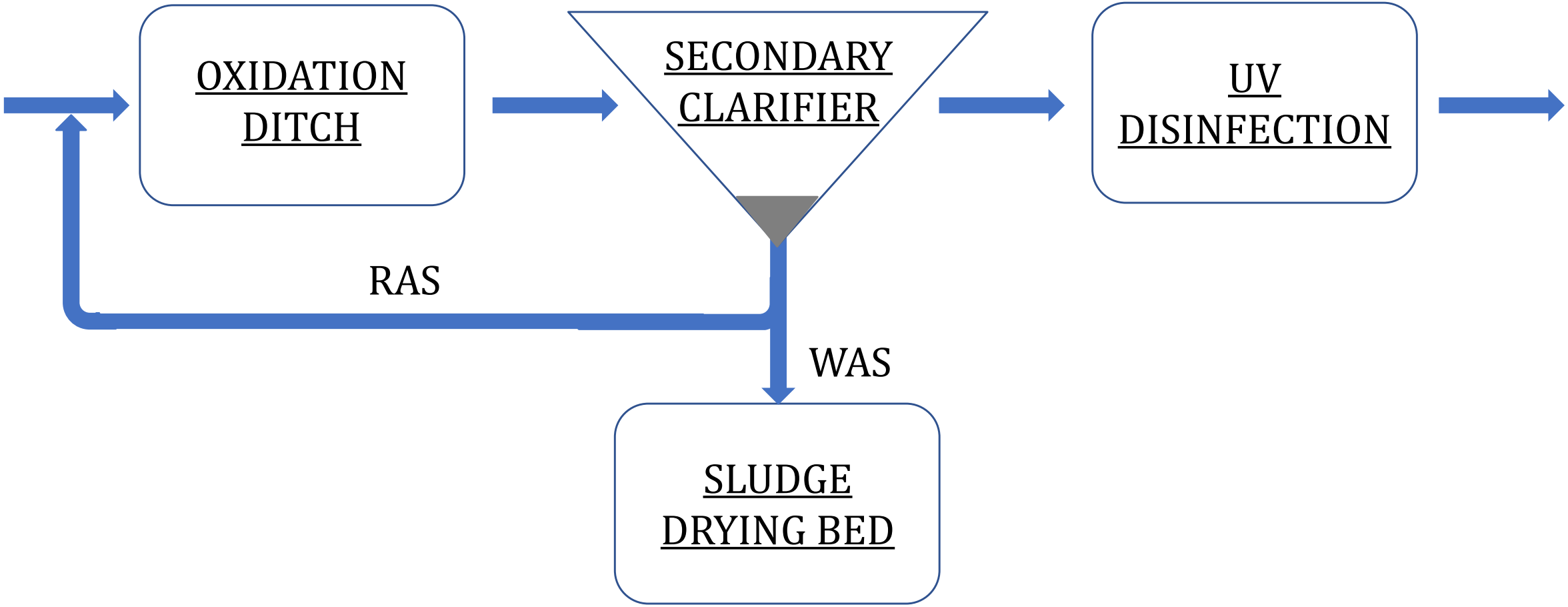
- Land intensive
- Less efficient/long retention times
- Infrequent bed media replacement

Treatment Alternative 3:

Oxidation Ditch



Treatment Alternative 3: Oxidation Ditch



Treatment Alternative 3: Oxidation Ditch

Positives:

- Small footprint
- Efficient process
- Minimizes odor and insect concerns

Negatives:

- High energy requirement and cost
  - *Aeration, pumps*
- Costly, complex, and regular O&M
- Material replacement/availability

Cost for Each Alternative

Treatment Option	Capital Cost (USD)	O+M Cost (USD)
		(per resident per month)
Waste Stabilization Ponds	$10.5 M	$0.50
Constructed Wetlands	$10.7 M	$0.50
Oxidation Ditch	$10.3 M	$19.50

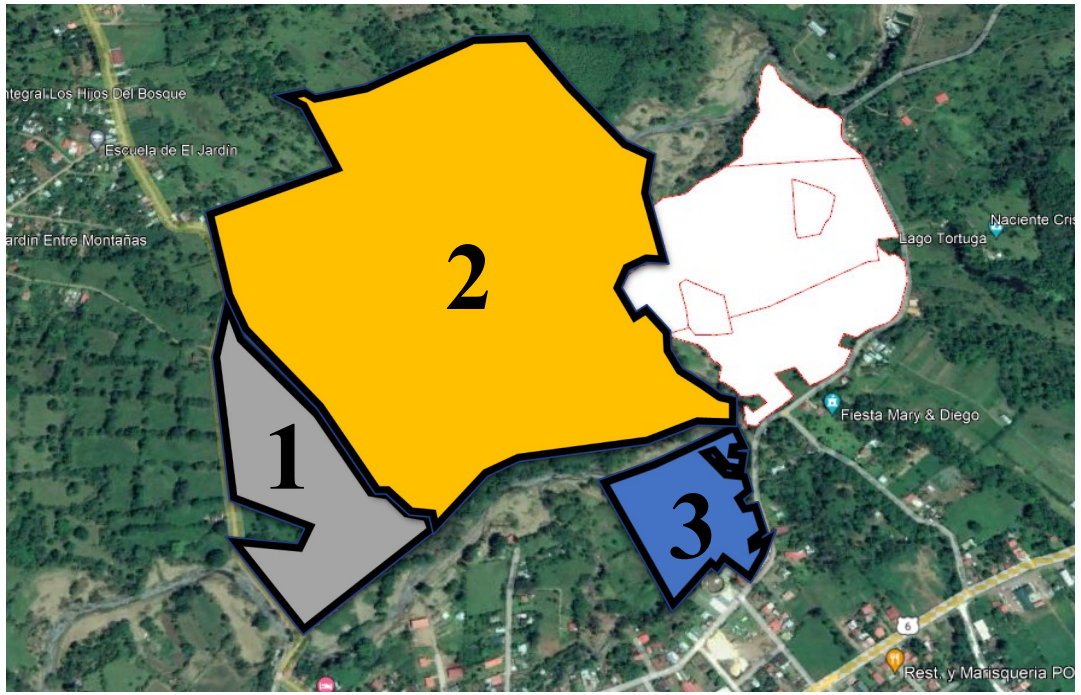
Max O&M budget for this project is $18.25 per resident per month (USD)

Reasons for Constructed Wetland

- *Fits with community value*
- *Low continued cost*
- *No energy needed*
- *Less space than Waste Stabilization Ponds*
- *Minimizes mosquito concerns*
- *Reduce odors*
- *Adjusts to flow fluctuations*

Location Alternatives

Alternative	Name	Area (m^2)
1	Triangle with Road Access	*89,000*
2	Largest Room for Growth	*520,000*
3	City Parcel	*47,000*

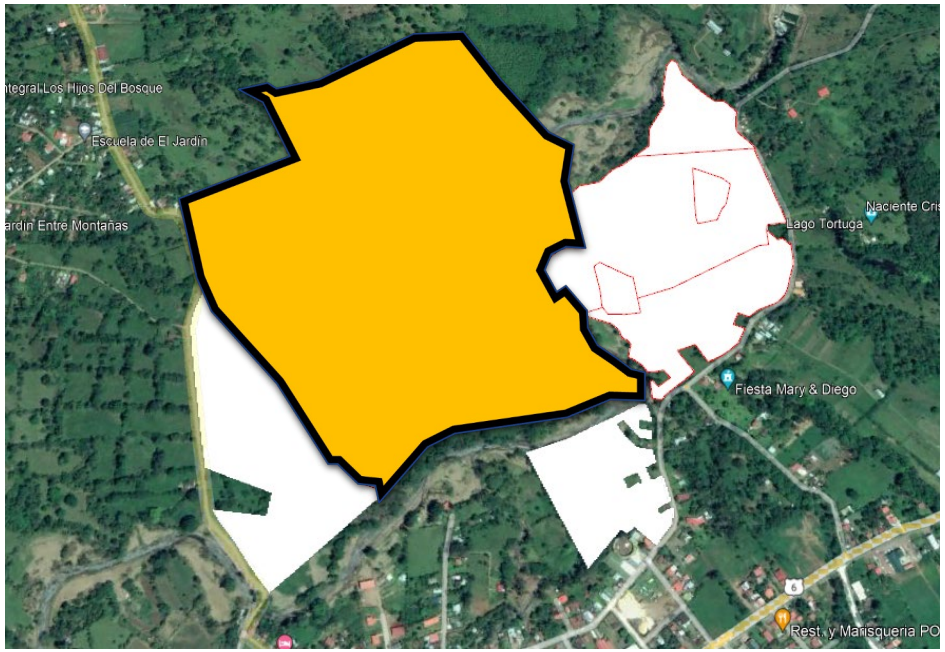


Location Alternatives

Triangle with Road Access

Parcel 2: Largest Room for Growth

- Fit recommended treatment design
- Provides adequate room for growth
- Distance from city



Recommended Final Design

Recommended Final Design

Collection System

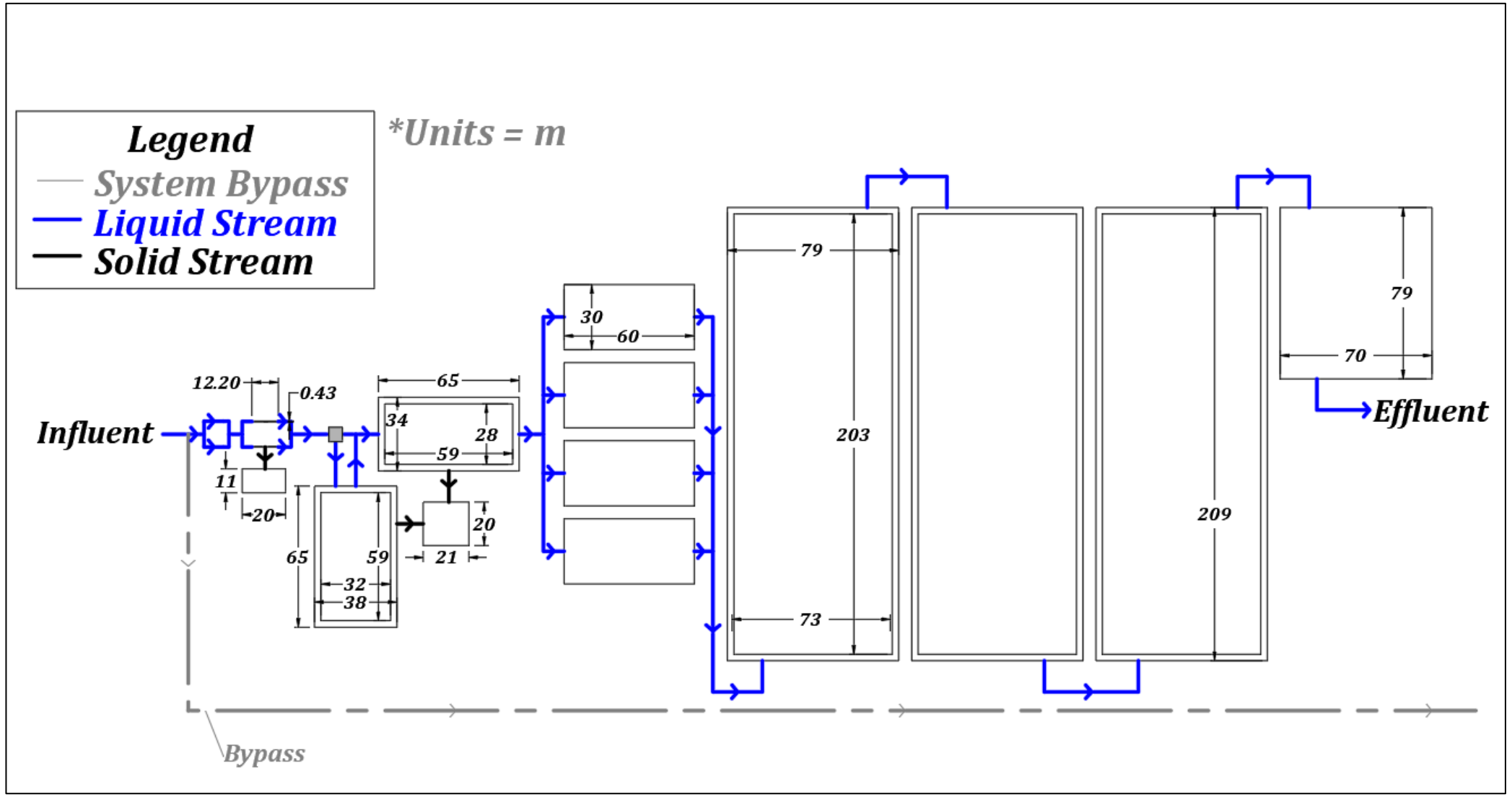
Collection System Analysis

- 3 lift stations
- Min diameter of 20 cm
- System consisting of :

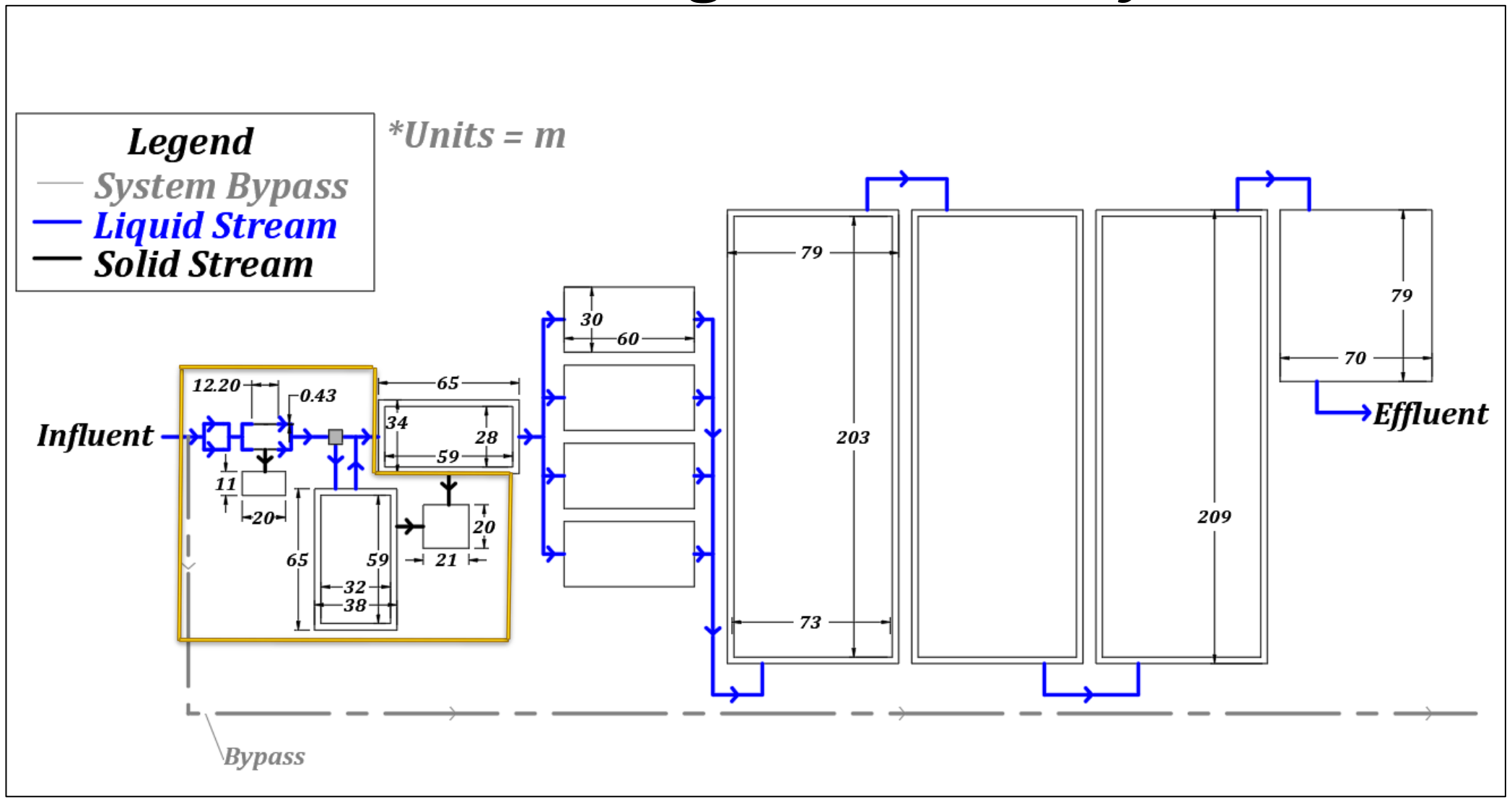
Diameter of Pipe (cm)	20	46	91
Length (m)	17,000	3,700	3,700

- Placed on side of road
  - 3.5 m or more of clearance

Treatment Site Drawing

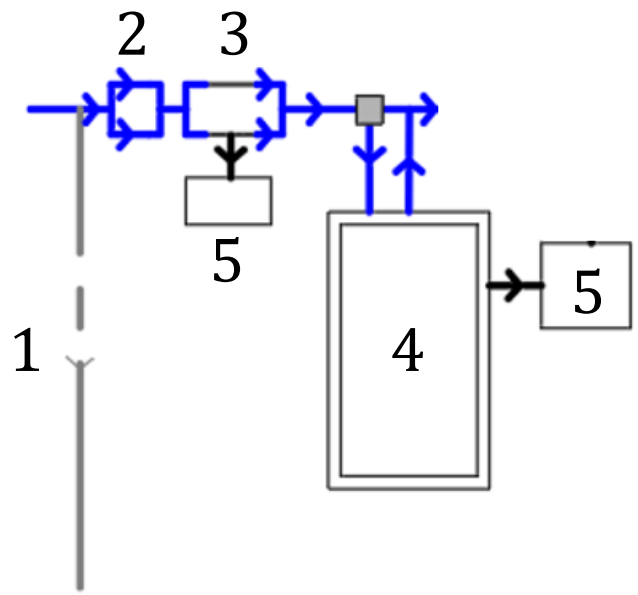


Treatment Site Drawing – Preliminary Treatment

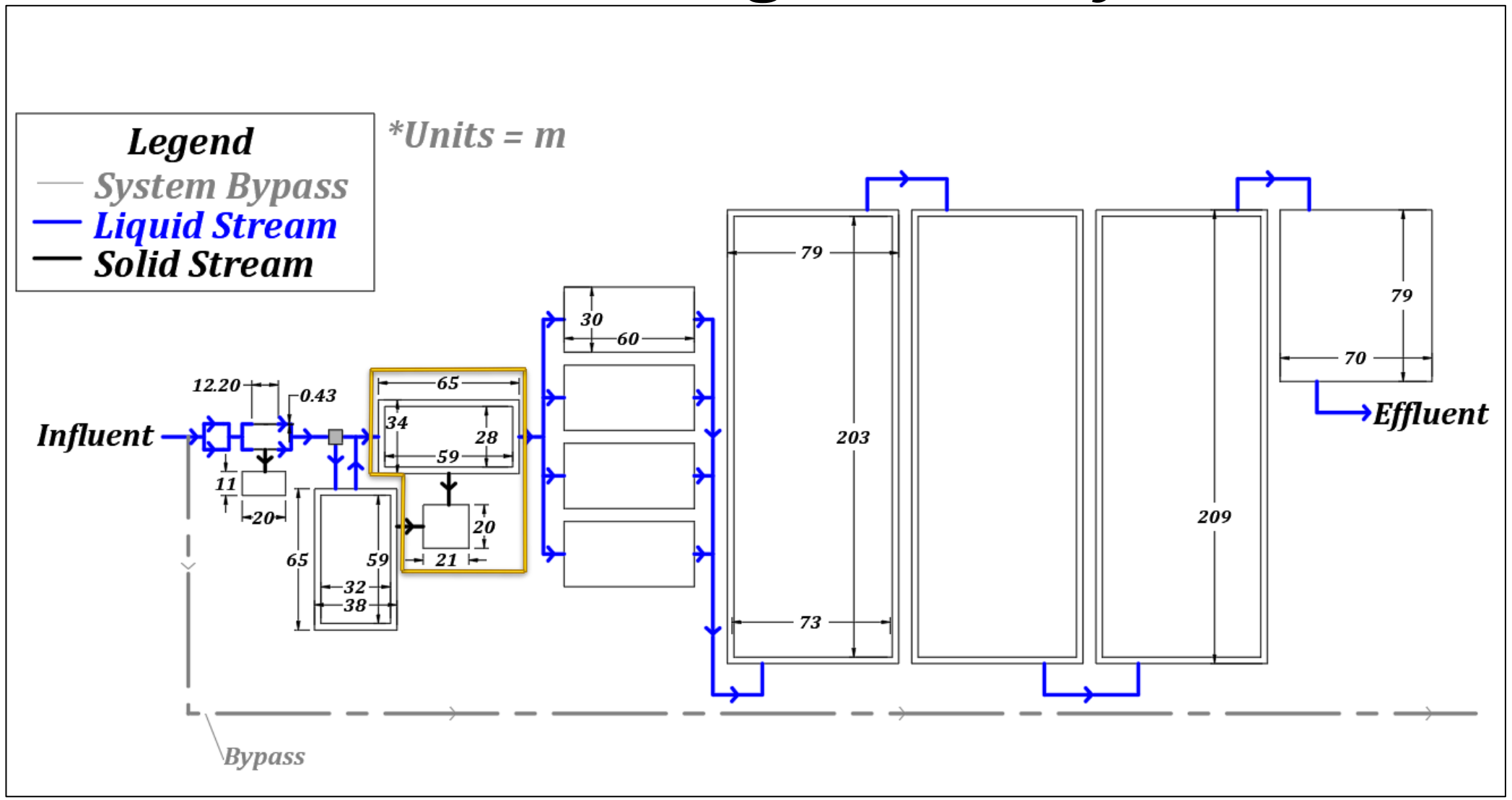


Preliminary Treatment

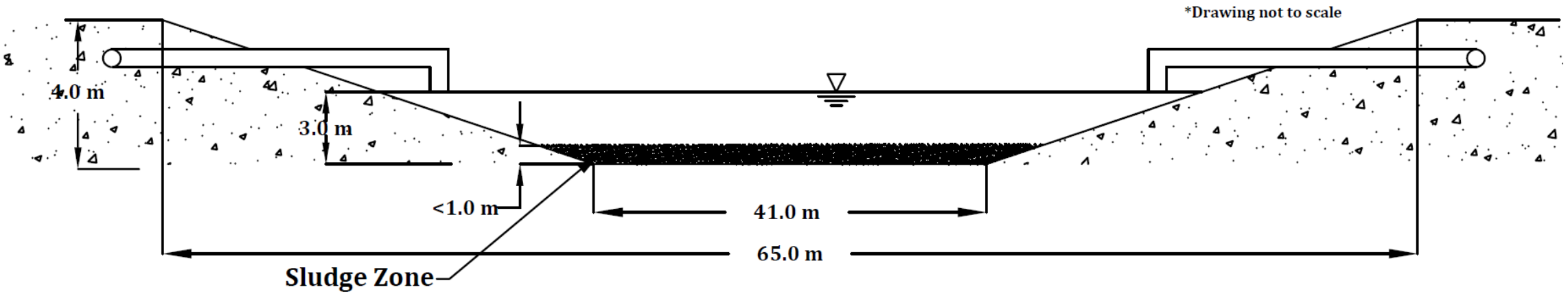
1. Bypass Structure
2. Bar Screens
3. Grit Chambers
4. Peak Flow Storage
5. Sludge Drying Beds



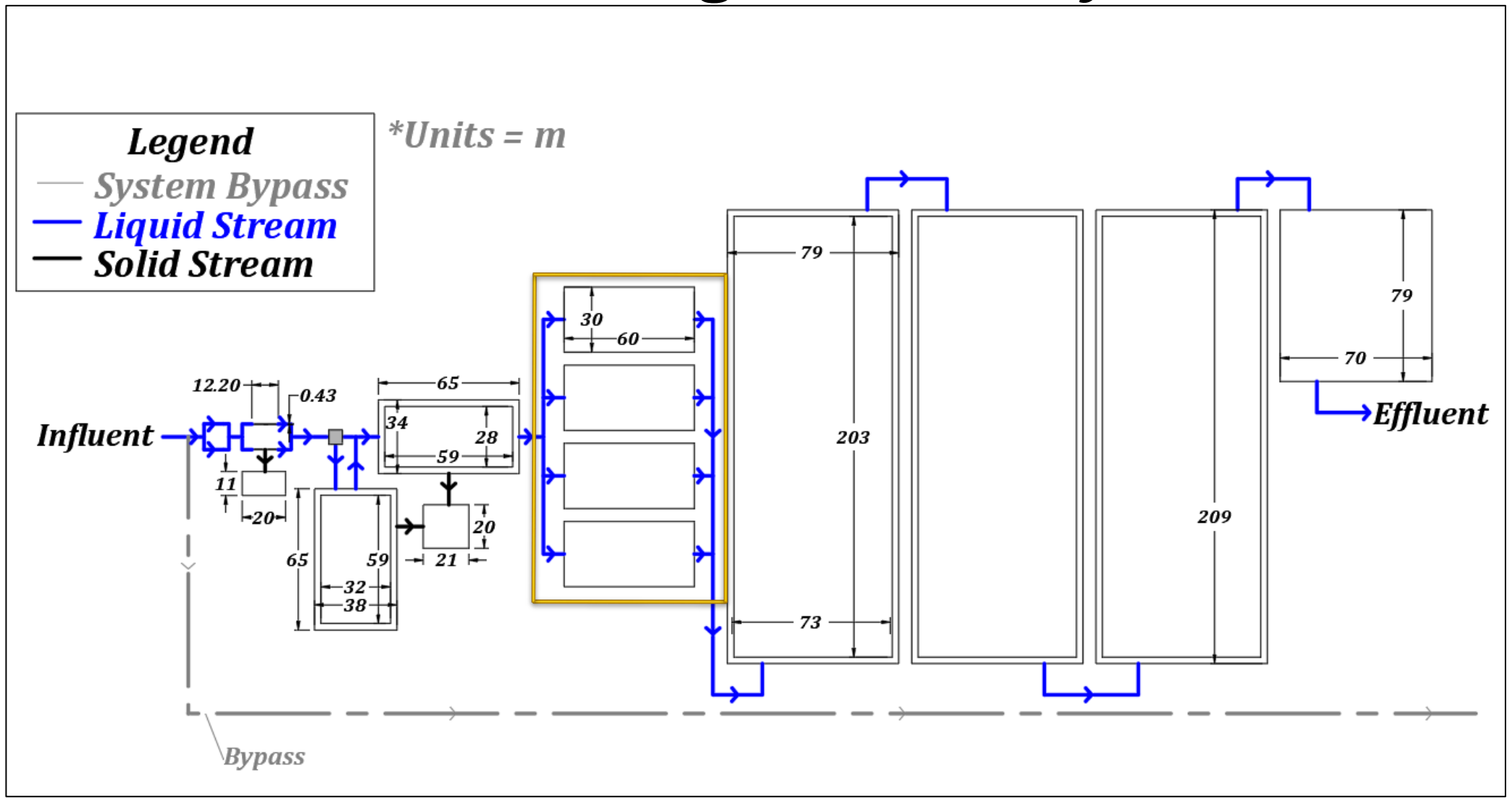
Treatment Site Drawing – Primary Treatment



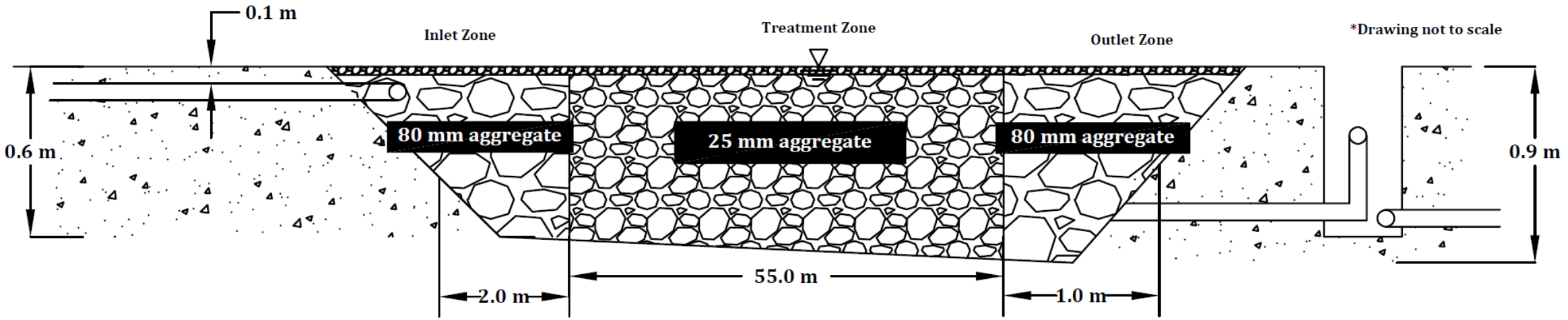
Primary Treatment – Anaerobic Pond



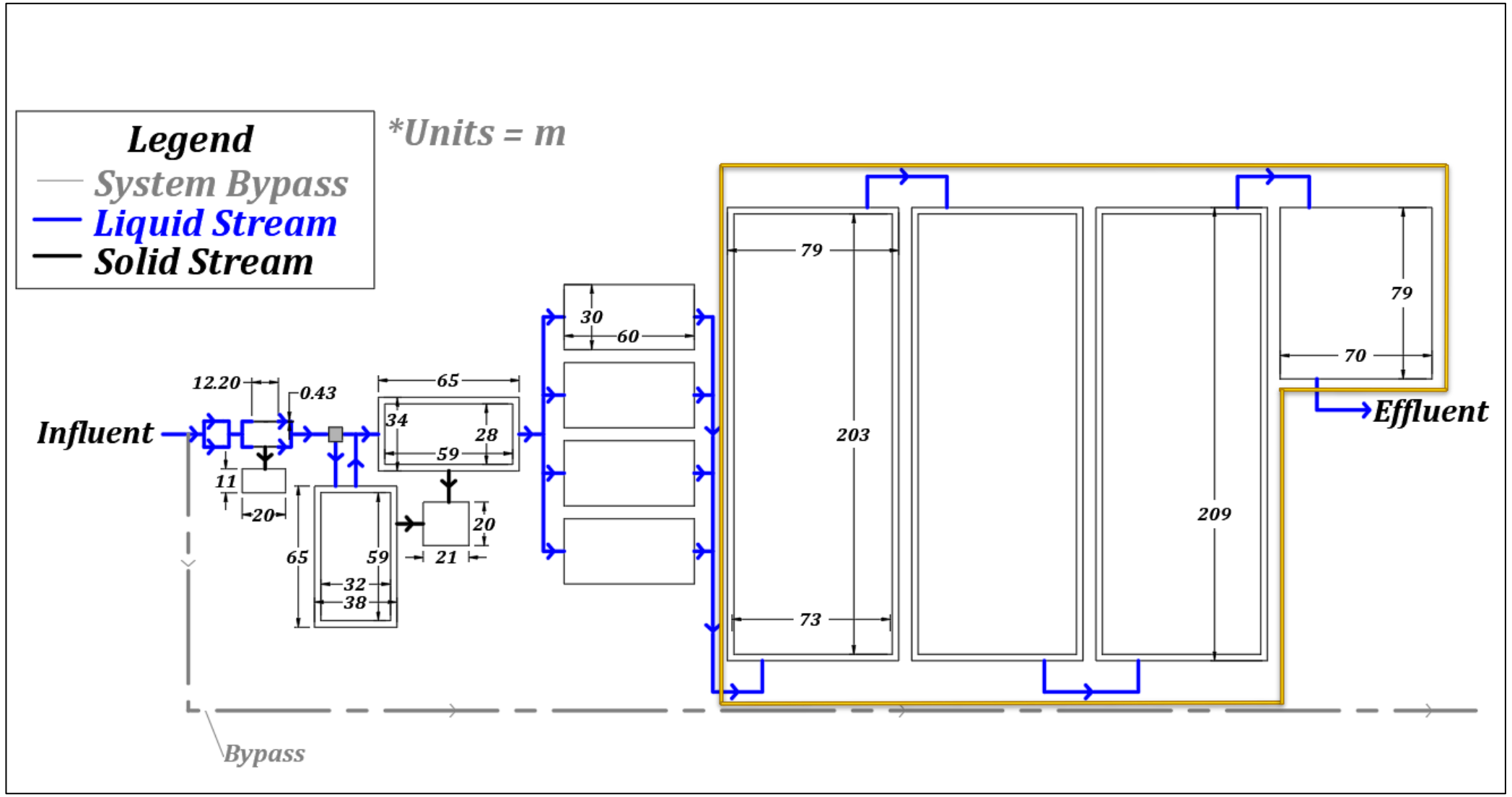
Treatment Site Drawing – Secondary Treatment



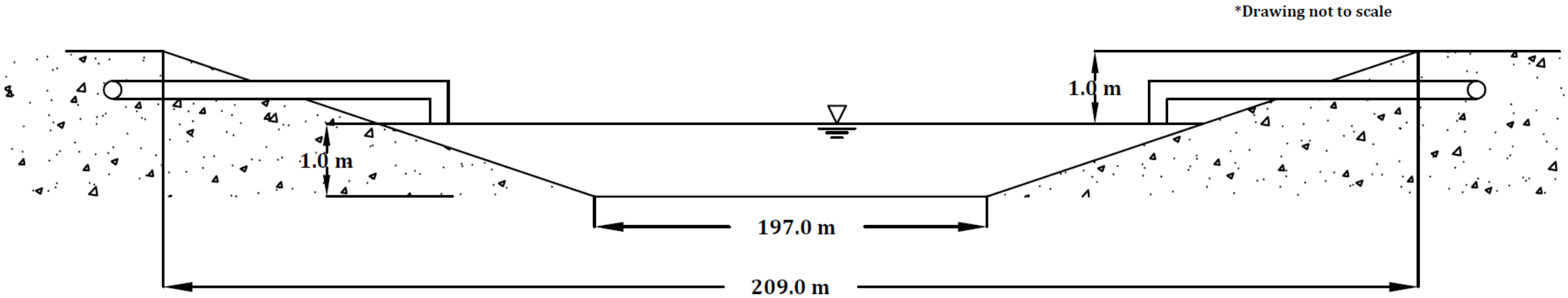
Secondary Treatment – Constructed Wetlands



Treatment Site Drawing – Tertiary Treatment



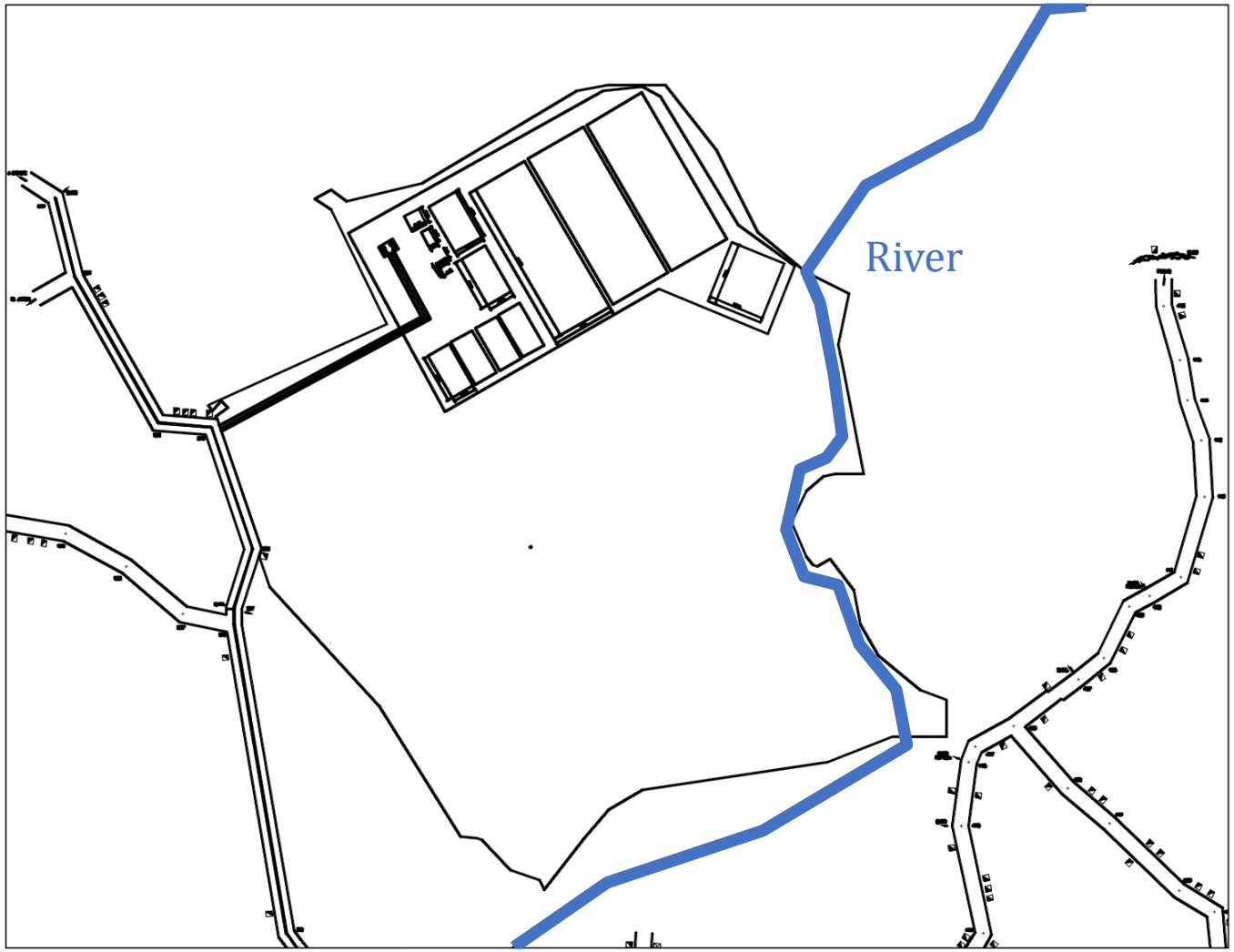
Tertiary Treatment – 3 Maturation Ponds



Treatment Removals

Percent Removal (%)					
	Required Removal (%)	**Anaerobic Pond**	**Constructed Wetland**	**Maturation Ponds**	**Cumulative Removal Met?**
BOD_5	**82**	66	82	91	✓ **Yes**
COD	**73**	57	70	85	✓ **Yes**
TSS	**77**	50	91	91	✓ **Yes**
Total Nitrogen	**20**	-	19	89	✓ **Yes**
Total Phosphorus	**50**	-	31	65	✓ **Yes**
Fecal Coliform (MPN/100mL)	**1000**	9.16E+06	1.52E+06	112	✓ **Yes**

Final Site Plan



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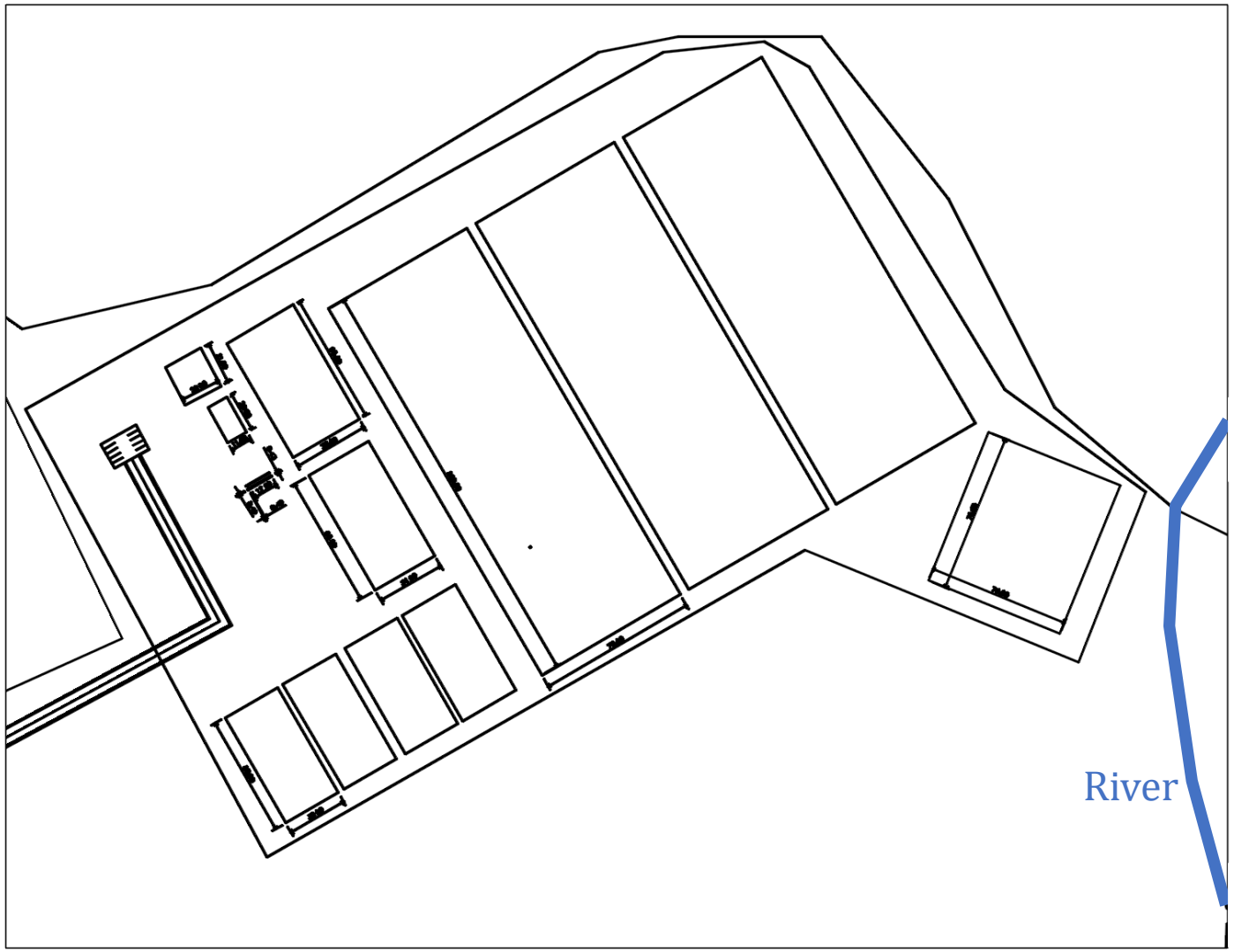
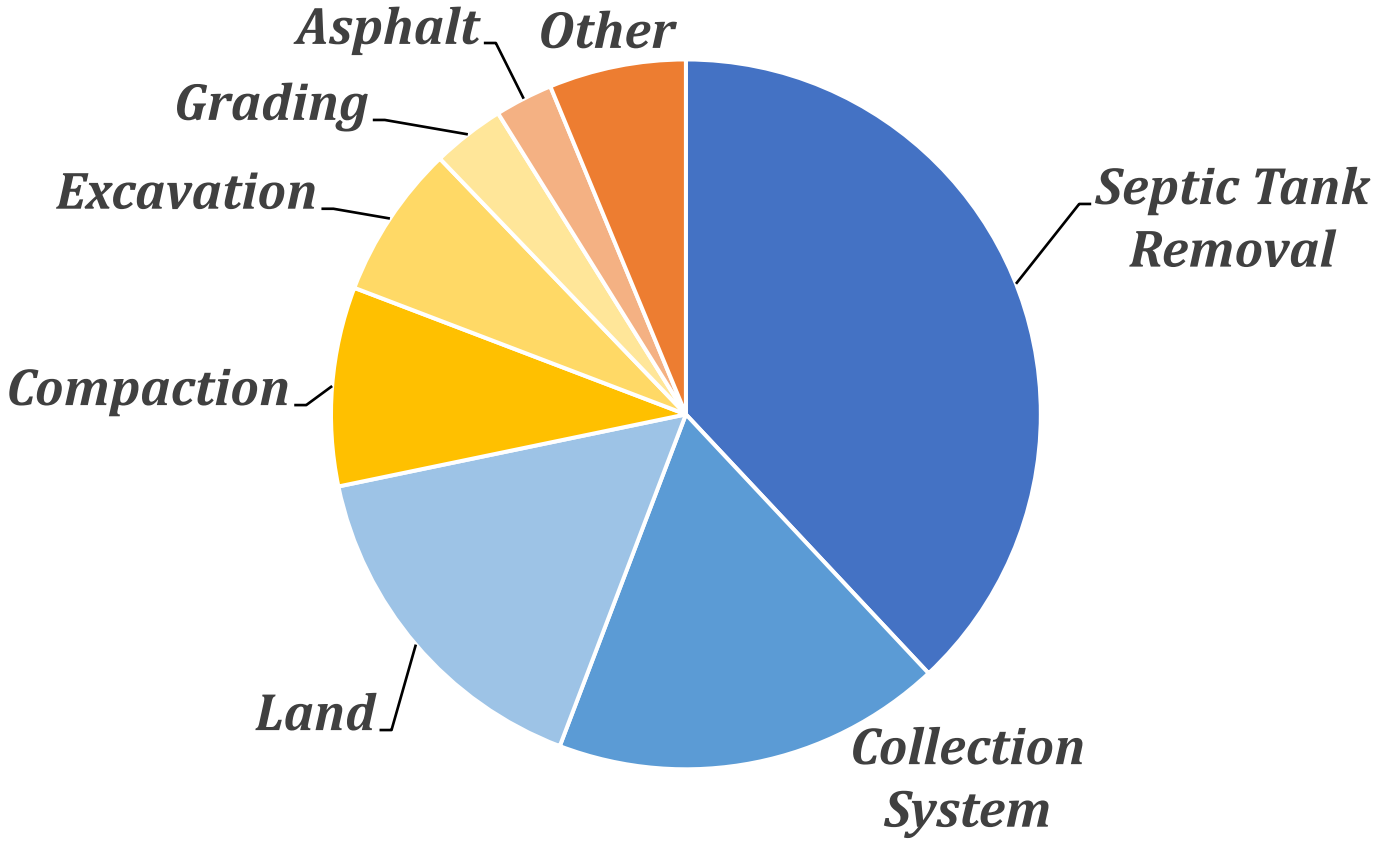


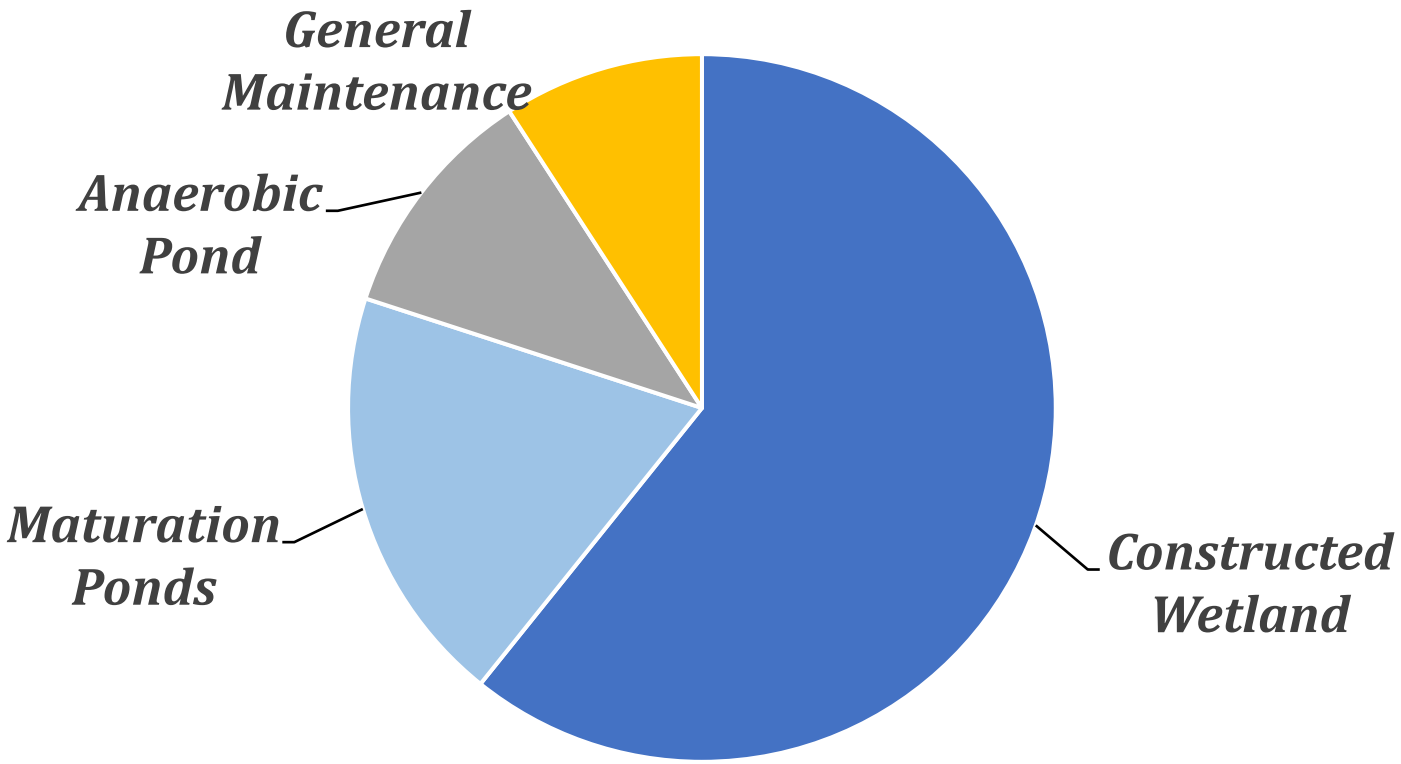
Costs

Capital Costs



Total Capital Cost = $10.7 Million USD

Operation and Maintenance Cost



O&M Cost per person per month = $0.50 USD
O&M Cost with Fund = $2.00 USD

Conclusion

1) Meets effluent requirements

- Water use for farming application

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