

Master Plan Objectives

- Given Utility Kingston's interest in enhancing the management of biosolids and the utilization of biogas at the Cataraqui Bay and Ravensview WWTPs
- Given developments in Ontario regarding:
 - Consideration of wastes as resources within the context of a circular economy;
 - The more effective management of SSO (Single Stream Organics)
 - Opportunities to generate and use processed biogas as RNG (Renewable Natural Gas) .

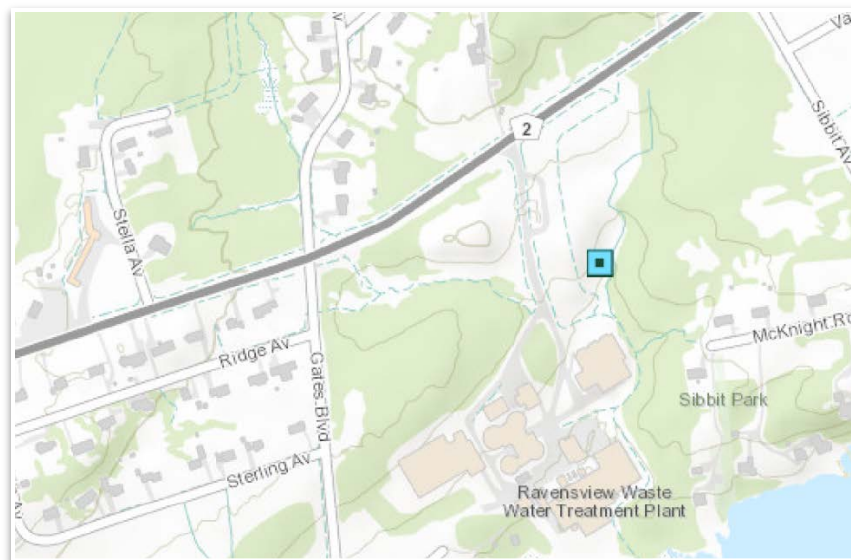
The key study objectives are:

- To identify alternative systems to manage biosolids and to enhance generation of biogas
- To evaluate alternative systems as well as alternative sites where the systems may be established
- To identify preferred systems at a preferred site(s) where biosolids would be managed and biogas used, potentially as a RNG, in an environmentally and financially sustainable manner.

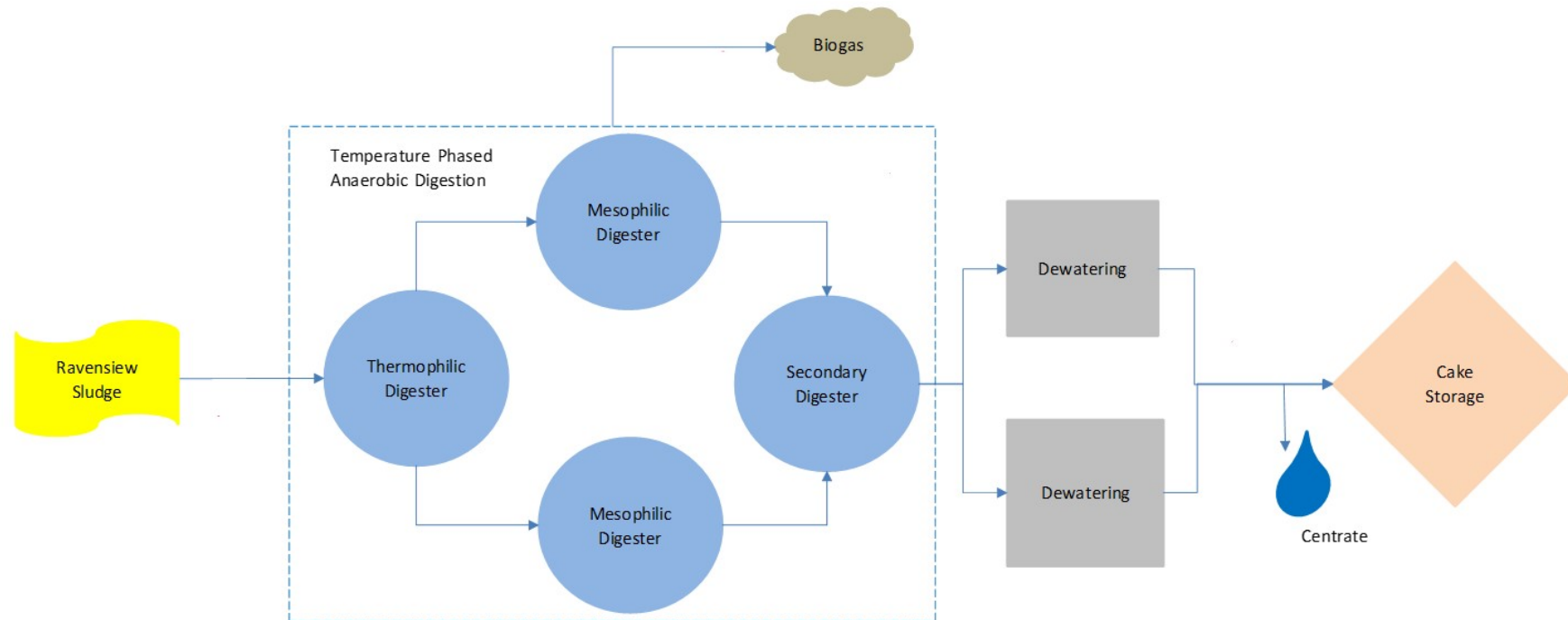
Current Sites

Ravensview WWTP

- Constructed in 1957, rated capacity 95,000 m³/d
- A new biologically aerated filter (BAF) process was commissioned in 2009
- Co-thickened primary sludge sent to temperature phased anaerobic digestion (**TPAD**)
- ~1,600 dt/yr of biosolids
- ~850,000 m³/yr of biogas



Current Solids Process at Ravensview WWTP



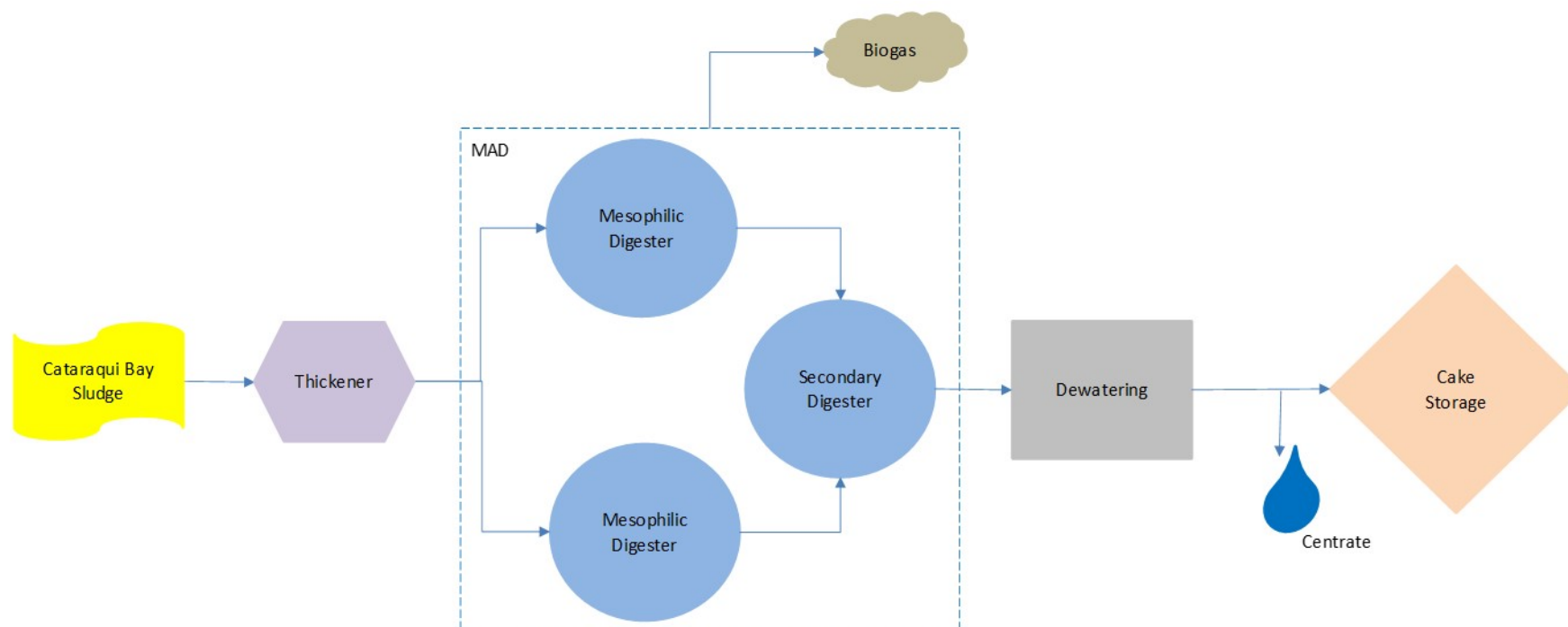
Current Sites

Cataraqui Bay WWTP

- Constructed in 1962, with rated capacity 38,800 m³/d
- Conventional Activated Sludge (Current) upgraded to biologically aerated filter (BAF) process
- Both primary and wasted sludge sent to mesophilic anaerobic digestion (MAD)
- ~800 dt/yr of biosolids
- ~600,000 m³/yr of biogas



Current Solids Process at Cataraqui Bay WWTP



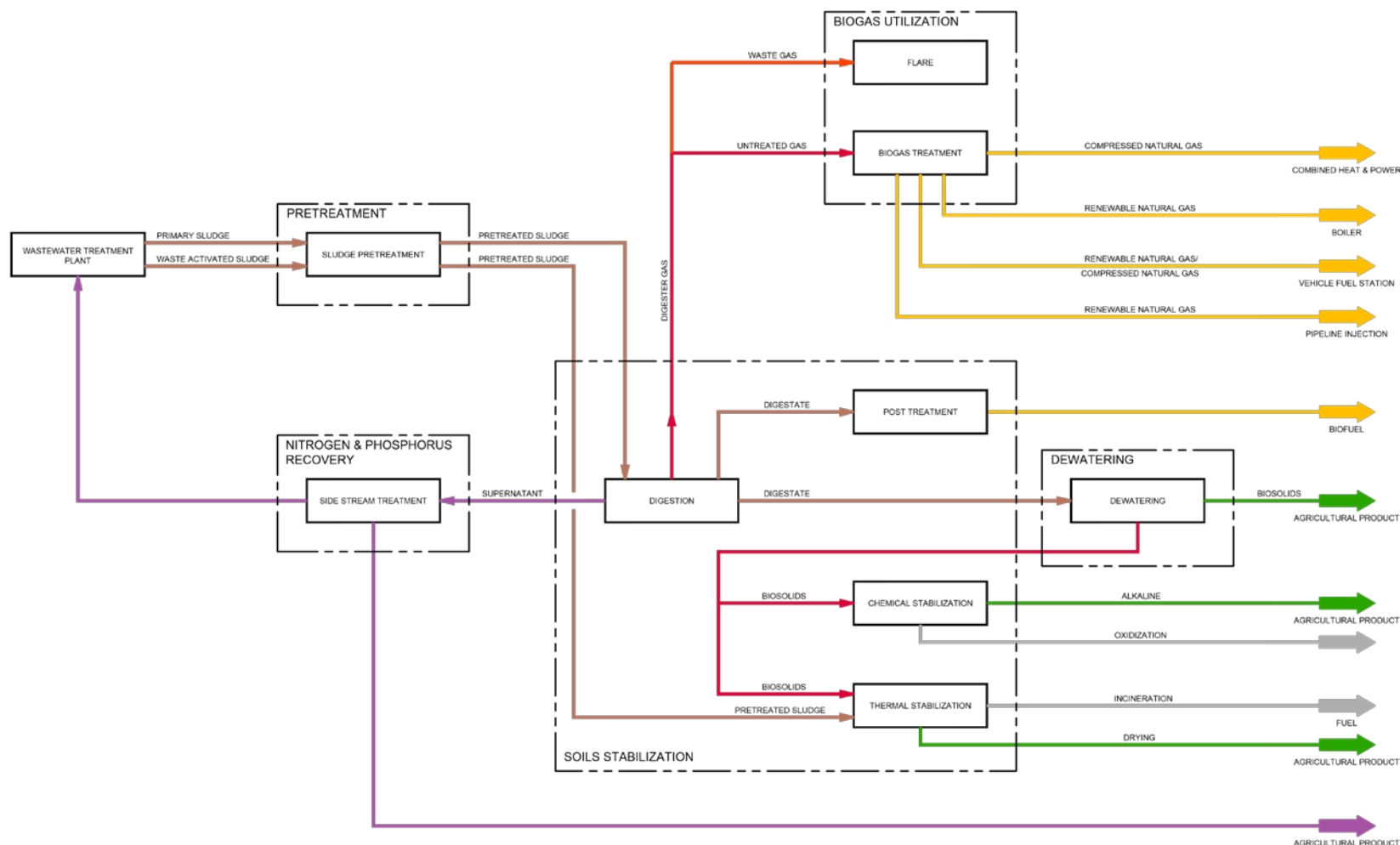
Biosolids Practice

Treated Biosolids stabilized and used as Agricultural Nutrient

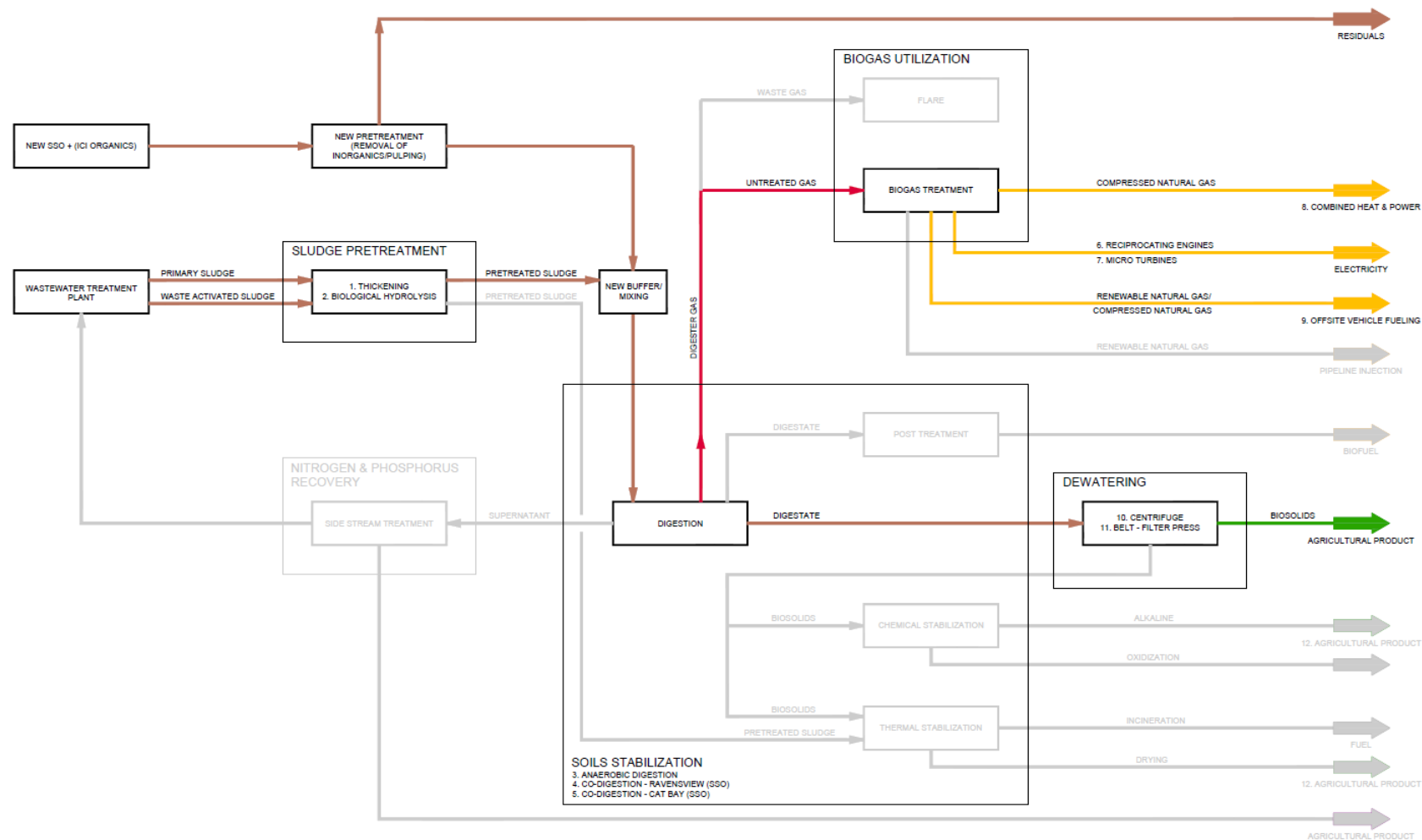
- Beneficial Reuse
- Accepted by Agricultural Community
- Meets provincial regulations
- Least Cost



Evaluation of Existing Operations



Final Systems for Detailed Assessment



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Business Case with Shortlisted Biosolids Management Options

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Shortlisted Biosolids Management Options

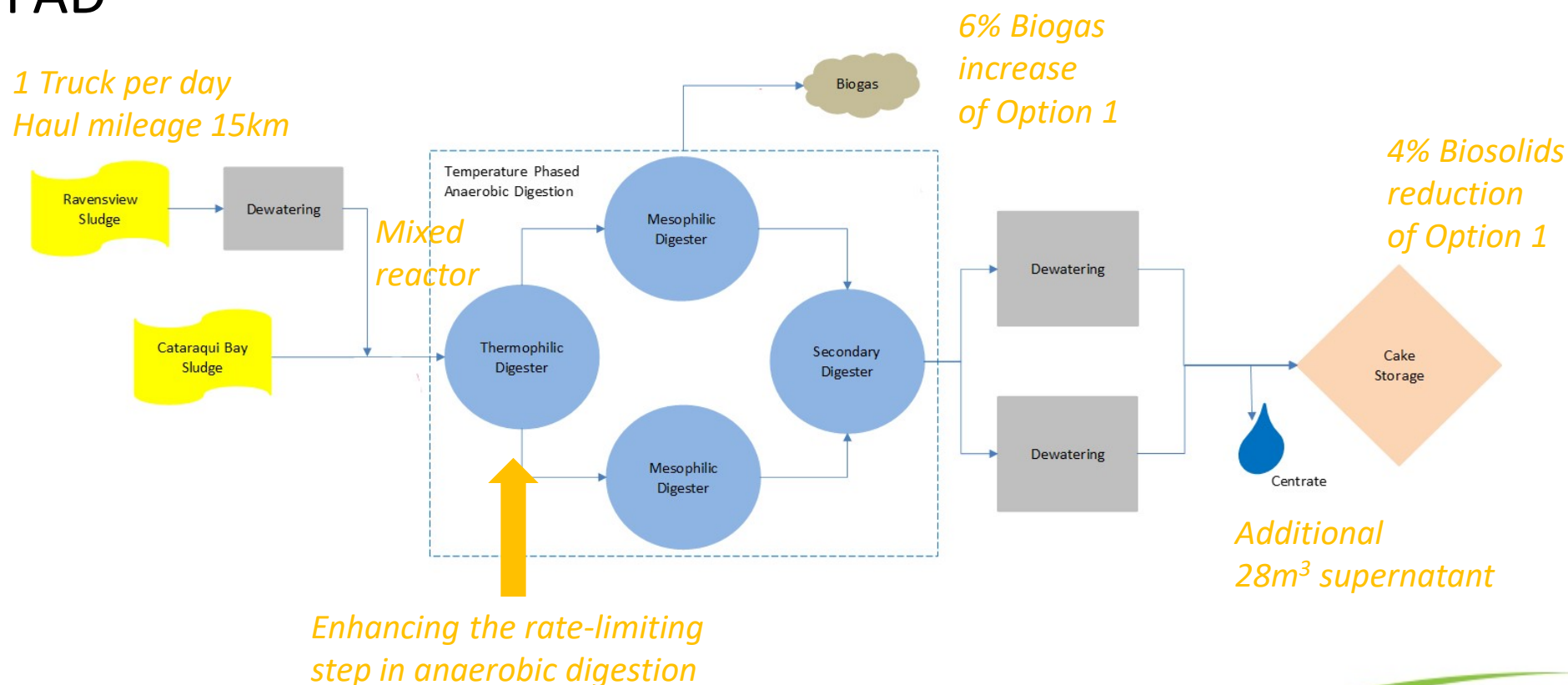
- Option 1 – Do Nothing
- Option 2 –Optimized Infrastructure at Ravensview
- Option 3 – New and Optimized Solid Treatment Facility at Cataraqui Bay
- Option 4 – Incorporate SSO into New Facility at Cataraqui Bay
- Option 5 – Integrated Biosolids and SSO Treatment Facility at new Location

Evaluation Criteria

- General cost implications
- Space availability
- Operations compatibility
- Environmental impacts
- Class EA impacts

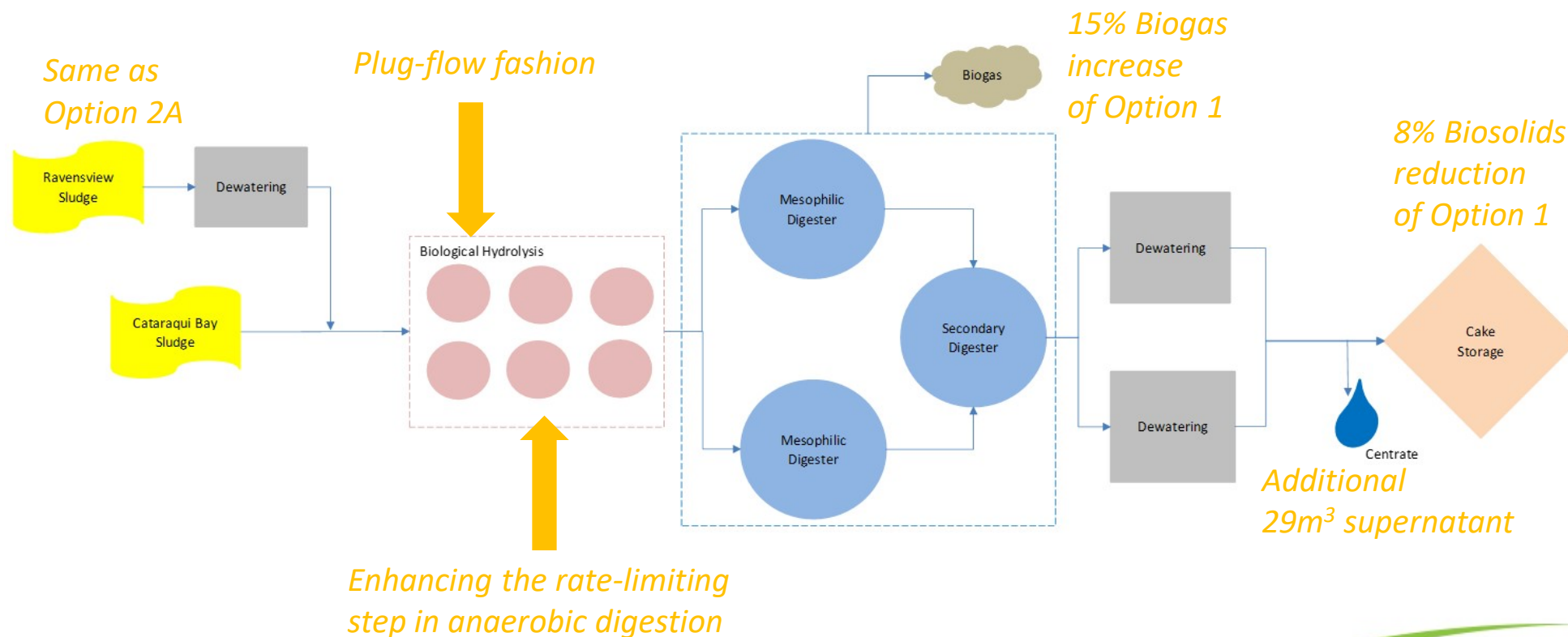
Temperature Phase Anaerobic Digestion

- Expansion of the existing MAD process with the capability to operate in TPAD



MAD with Biological Hydrolysis

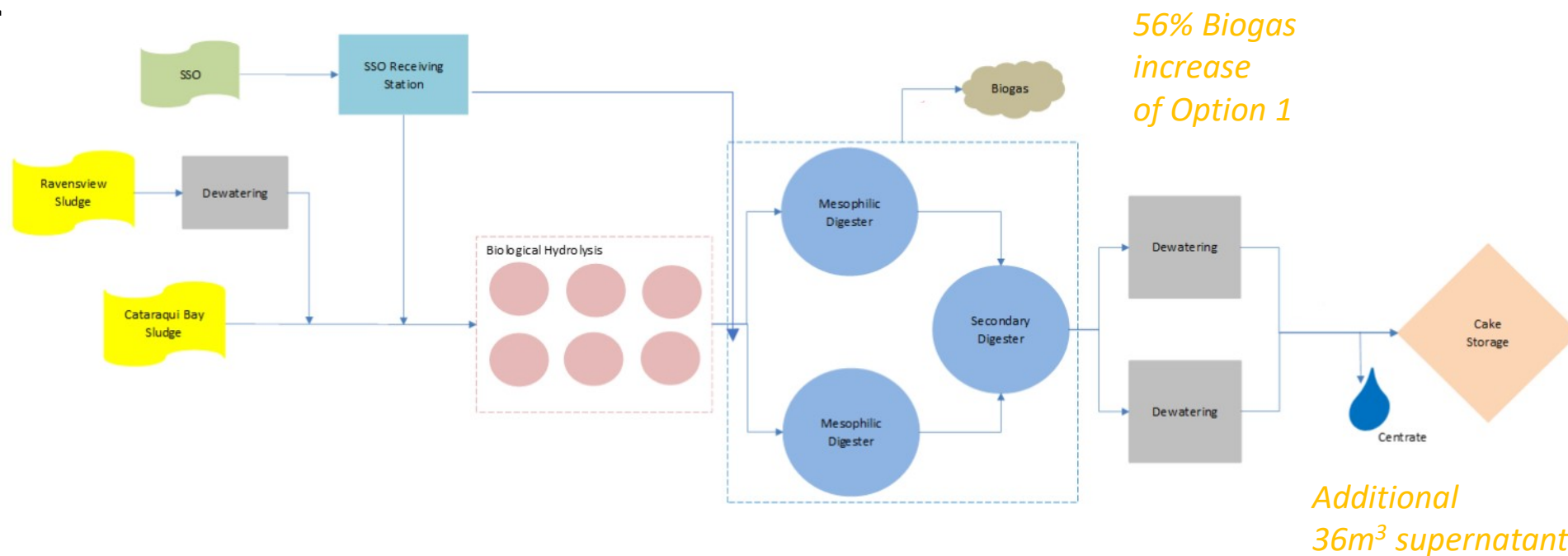
- Expansion of the existing MAD process with the inclusion of Biological Hydrolysis (BH) upfront of MAD



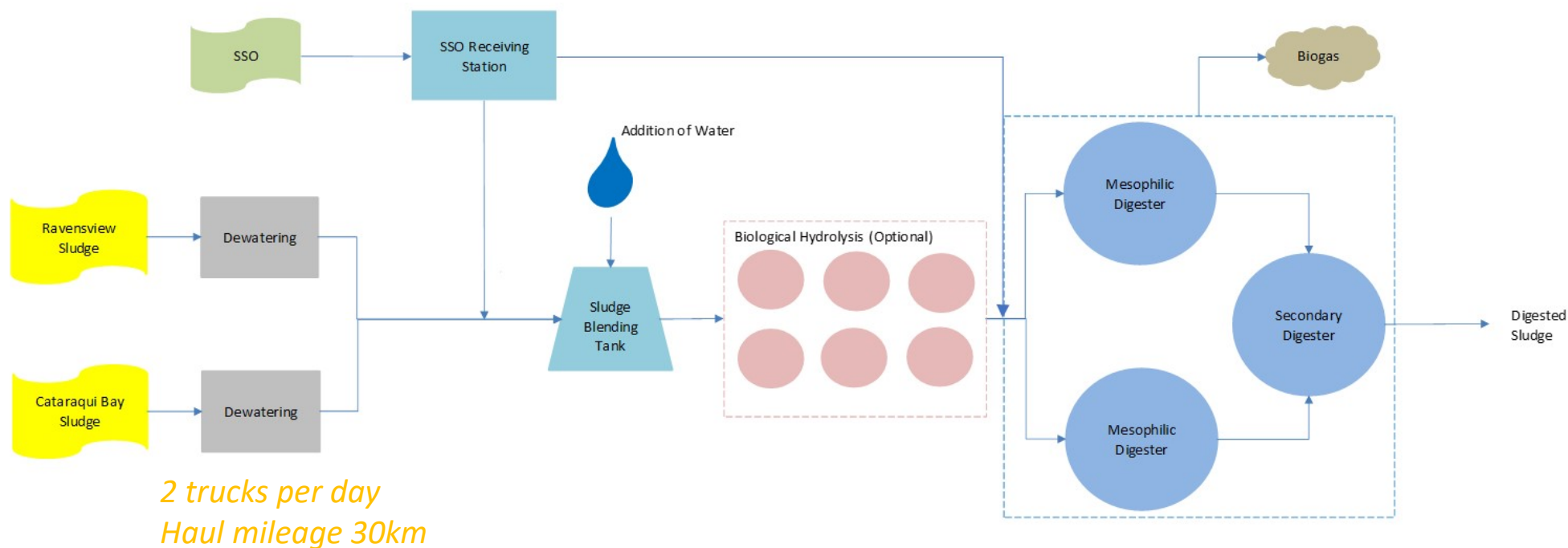
Co-digestion with SSO

- Incorporating 4000 wt/yr of SSO collected through green bin program
- Industrial organic wastes, other WWTP raw sludges, other SSO

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Option 5 Integrate Processing of Biosolids and SSO at New Site



Assumptions for Developing Alternatives

- Convertible COD in VS
 - Primary sludge: 1.65 kg COD/ kg VS
 - WAS: 1.47 kg COD/ kg VS
 - SSO: 1.35 kg COD/ kg VS
- Volatile sludge deduction rate
 - 40% for conventional MAD
 - 50% for TPAD
 - 54% for Biological Hydrolysis – Anaerobic Digestion (BH-AD)
- CH₄ converted from COD under anaerobic conditions is 0.4 L CH₄/g COD
- 65% CH₄ in total gas flow

Evaluation of Shortlisted Alternatives

	Base Case	Shortlisted Alternatives							
	Do Nothing	BH-AD at Ravensview	TPAD at Cataraqui Bay	BH-AD at Cataraqui Bay	BH-AD + SSO at Cataraqui Bay		BH-AD + SSO at New Site		
	Feedstock								
	Sludge	Sludge	Sludge	Sludge	Sludge	SSO	Sludge	SSO	H ₂ O
Volume (m³/d)	238	176	116	116	116	9	40	9	75
TS Loading (kg/d)	10,051	10,051	10,051	10,051	10,051	2,192	10,051	2,192	-
VS Loading (kg/d)	7,285	7,285	7,285	7,285	7,285	7,285			
	Biosolids								
Volume (m3/d)	27	24	26	24	27		27		
% Decrease based on Do Nothing	0	8%	4%	8%	0%		0%		
TS (kg/d)	7,788	6,117	6,498	6,117	6,643		6,643		
VS in Cake (kg/d)	3,887	3,351	3,642	3,351	3,767		3,767		
Nitrogen in Cake (kg/d)	233	184	192	184	199		199		
Phosphorous in Cake (kg/d)	85	67	70	67	73		73		
	Centrate								
Additional Centrate (m³/d)	209	4	28	29	36		98		
Additional Nitrogen Loading (kg/d)	47	168	113	121	160		207		
Additional Phosphorus Loading (kg/d)	63	91	86	89	88		121		
	Biogas								
Biogas (m³/d)	3,831	4,408	4,071	4,408	5,969		5,969		
Methane in Biogas (m³/d)	2,207	2,865	2,346	2,865	3,880		3,880		
% Increase based on Do Nothing	-	15%	6%	15%	56%		56%		

Evaluation of Existing Operations

Biogas Utilization - Biogas Flow Summary



- Cataraqui Bay's total biogas flow (flare and boiler) varies from about 1,000 to 3,000 m³ per day (or 25 to 75 cfm) and is highly variable with consistently more biogas collected in the spring of the year.
- Ravensview total biogas flow (generator, flare, and boiler) varies from about 1,000 to 4,000 m³ per day (or 25 to 100 cfm) is also highly variable with consistently more biogas collected in the spring of the year.

Methane Generation – All Options

	Do Nothing	BH-AD at Ravensview	TPAD at Cataraqui Bay	BH-AD at Cataraqui Bay	BH-AD + SSO (4000 tpy) at Cataraqui Bay	BH-AD + SSO (4000 tpy) Alternative Site
Methane Generation m ³ /day	2,201	2,865	2,346	2,865	3,880	3,880

Methane Generation with SSO

	No SSO	4000 tpy	5000 tpy	6000 tpy	8000 tpy	10,000 tpy	12,000 tpy
Methane Generation m ³ /day	2,201	3,880	4,133	4,387	4,895	5,402	5,910

Study Outcomes

- Reset of Final Goal
 - Elimination of Cap and Trade
 - Trade with other jurisdictions
- End of Pipeline issues
- Assume that all finished sludge would be moved to one facility
- Need for Digester Upgrade at Cataraqui Bay or build new Digester at new location

Financial Outcomes – Assumptions

- Financial Comparison With Capex and Opex Changes
- Best Case – lowest Capex/Opex Costs with Highest Revenue
- Lowest Case – highest Capex/Opex with Lowest Revenue
 - +/- 15% Capex used
 - \$2,500,000 needed for pipeline injection
 - 10% Engineering Costs (on Capex)

Financial Review

Scenario	Capital Costs +/-15%	Net Present Value Range	Biogas @57% CH ₄ m ³ /d	RNG as % of City Avg. Day NG
Status Quo	\$14.6 million	-\$13.8 million to -\$2.9 million	3881	0.79%
Ravensview BH-AD	\$14.0 million	-\$9.4 million to +\$1.8 million	4408	0.91%
Cataraqui Bay TPAD	\$12.9 million	-\$9.5 million to \$0.0 million	4071	0.84%
Cataraqui Bay BH-AD	\$12.9 million	-\$10.8 million to \$0.0 million	4408	0.91%
Cataraqui Bay BH-AD includes 4000 tonne SSO	\$21.9 million	-\$12.5 million to +\$1.9 million	5969	1.23%
Cataraqui Bay BH-AD includes 12000 tonne SSO	\$21.9 million	\$7.4 million to +\$26.9 million	9091	1.87%
New Site BH-AD includes 4000 tonne SSO *	\$27.0 million	-\$18.5 million to -\$2.7 million	5969	1.23%

BH -Biological Hydrolysis
TPAD - temperature phased
anaerobic digestion

* Includes new Digester

Alternative Site



Knox Farm

- Owned by City
- Currently not used
- Room for expansion

Study Outcomes

Other Options considered

- Ravensview as Interim Digestion Facility
- UK operating its own vehicles (Green Fuel) or selling combined Renewable Natural Gas with Natural Gas for other Transporters
- Generating more electricity
- Alternative Technologies to BH-AD may be considered as they become available

