High Value Resources from High Strength Wastes: Leveraging Food Production Byproducts to Reduce BNR Costs

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Chesapeake WEA | Plant Operations and Maintenance Committee's Educational Seminar

June 12, 2015 | Washington Suburban Sanitary Commission | Laurel, MD

Today’s Presentation discusses an innovative approach to procuring alternative carbon resources

- Nutrient Reduction Program at City of Richmond WWTP
  - Treatment requirements
  - Inherent nitrogen removal flexibility
- Opportunities presented by industrial products
  - Public Utilities as a catalyst for economic development
  - Screening of potential brewery byproducts of value
- The current process:
  - Product receiving and feeding implementation
  - Understanding holistic product value
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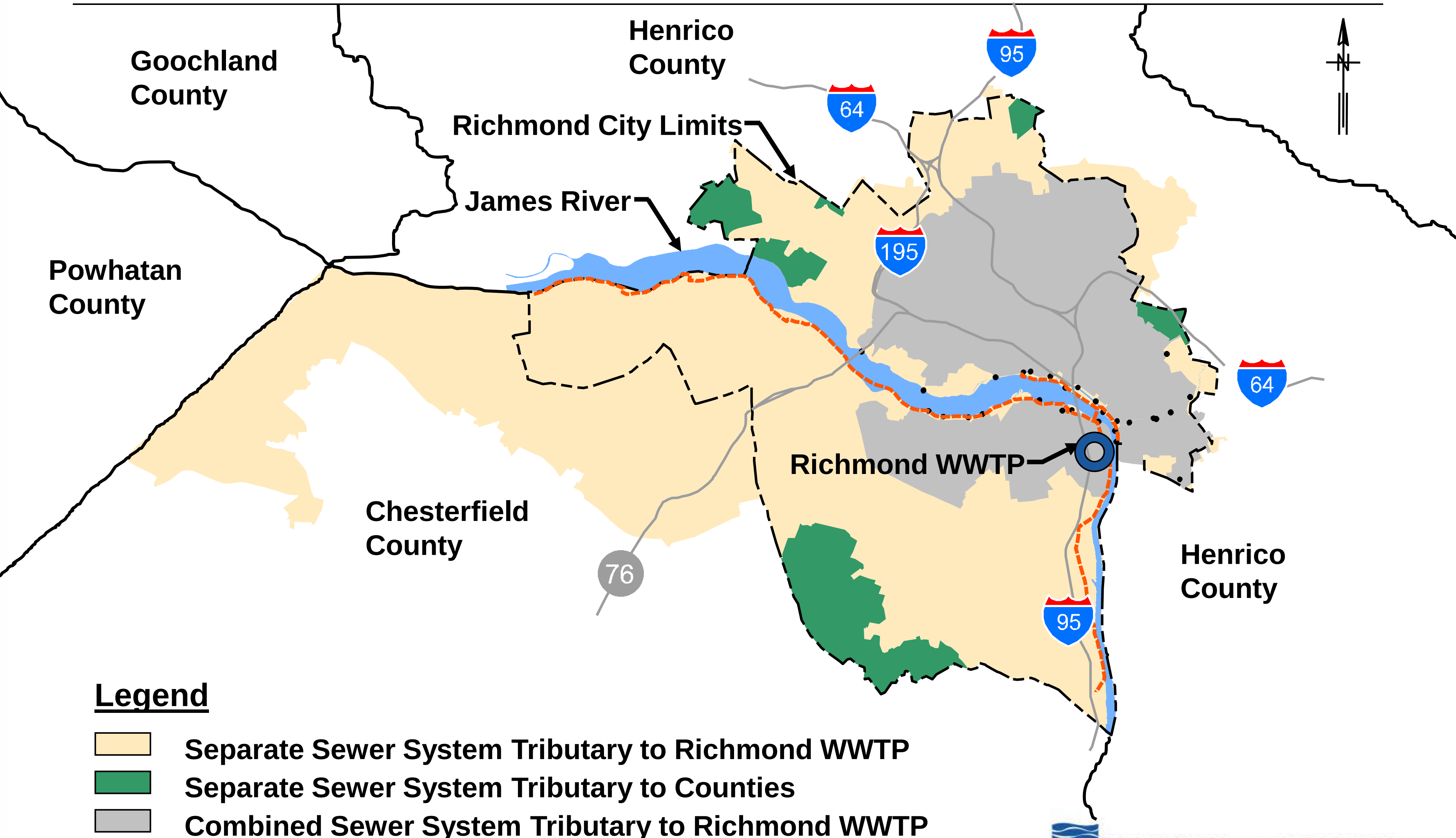
Richmond WWTP Service Area



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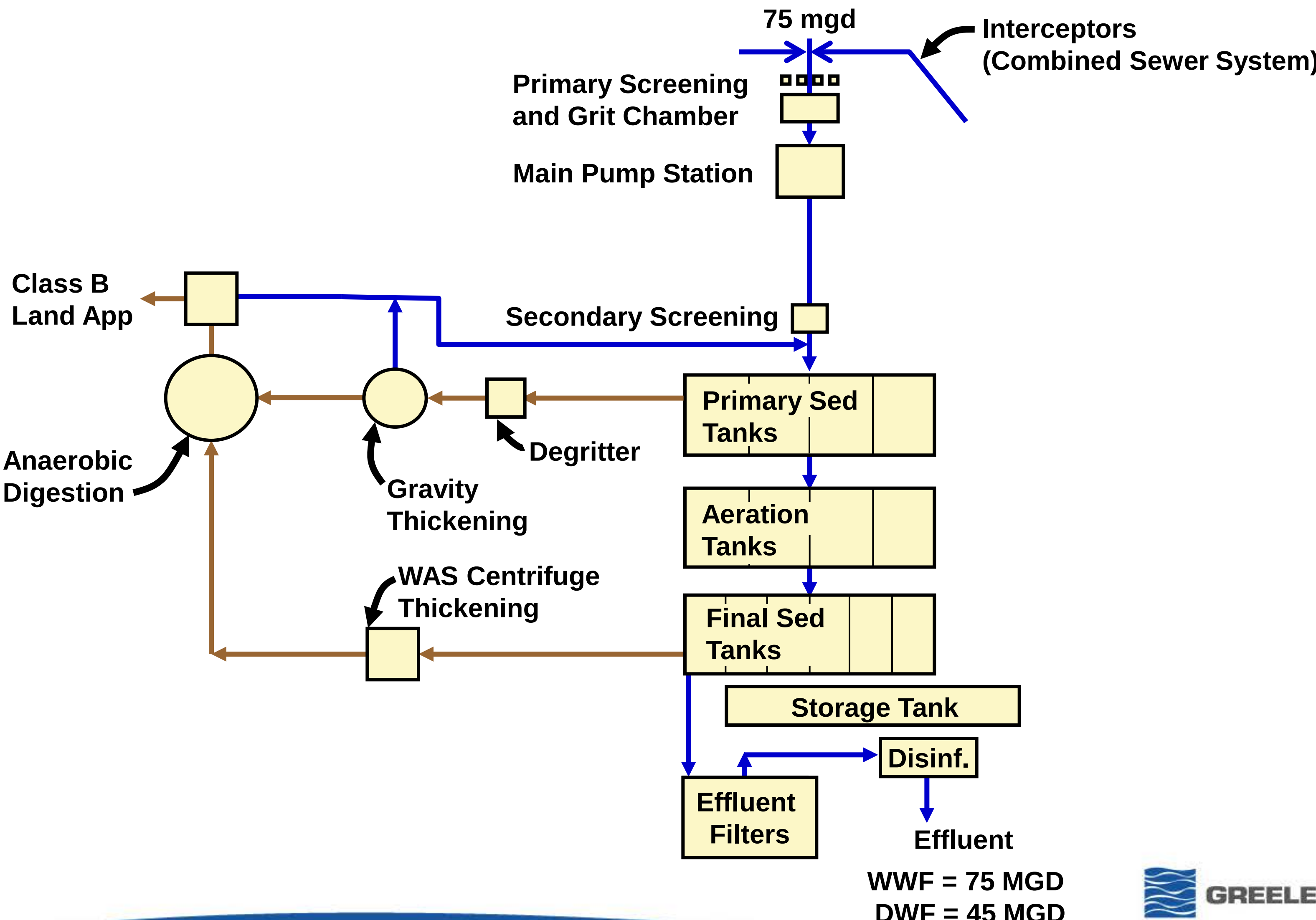
Pre-Upgrade Process Diagram
45 MGD Dry / 75 MGD Wet Weather Capacity



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Nutrient Reduction Program
Reliably Meet TN/TP Discharge Requirements

Dry Weather Flow Capacity (MGD)	Total Nitrogen WLA		Total Phosphorus WLA	
	WLA Based on Conc mg/L	Yearly Load lbs/yr	WLA Based on Conc mg/L	Yearly Load lbs/yr
45	8.0	1,096,402	0.50	68,525

New Water Quality Standards are in effect as of January 1, 2011

Note from General Permit Registration List Regarding Reporting: ***"Waste load allocations for localities served by combined sewers are based on dry weather design flow capacity. Reported discharge loads for the Richmond WWTP shall include the loads associated with the first 45 MGD of flow on each day."***

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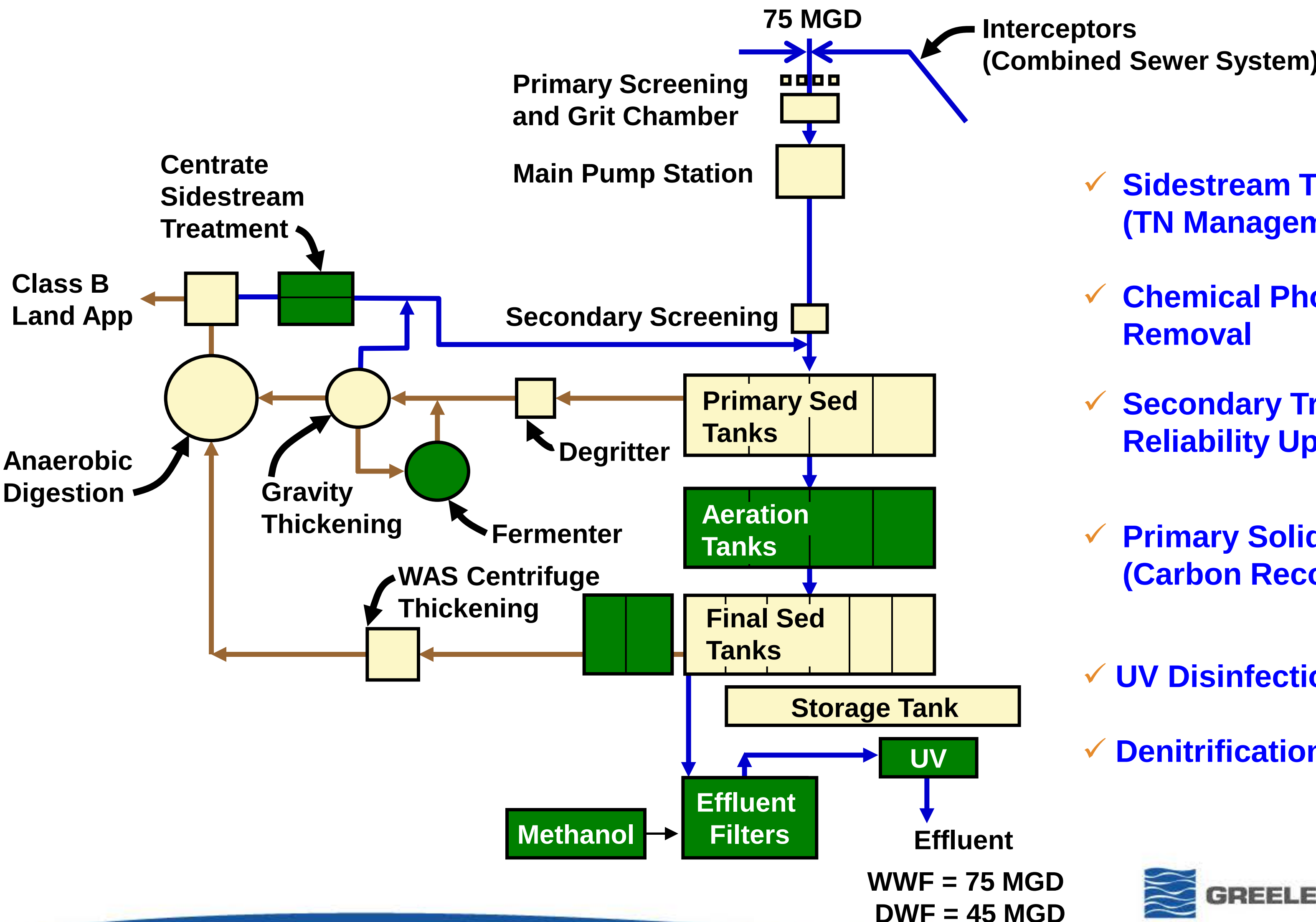
Post-Nutrient Upgrade Process Diagram



- ✓ Sidestream Treatment (TN Management)
- ✓ Chemical Phosphorus Removal
- ✓ Secondary Treatment Reliability Upgrades
- ✓ Primary Solids Fermentation (Carbon Recovery)
- ✓ UV Disinfection
- ✓ Denitrification Filters

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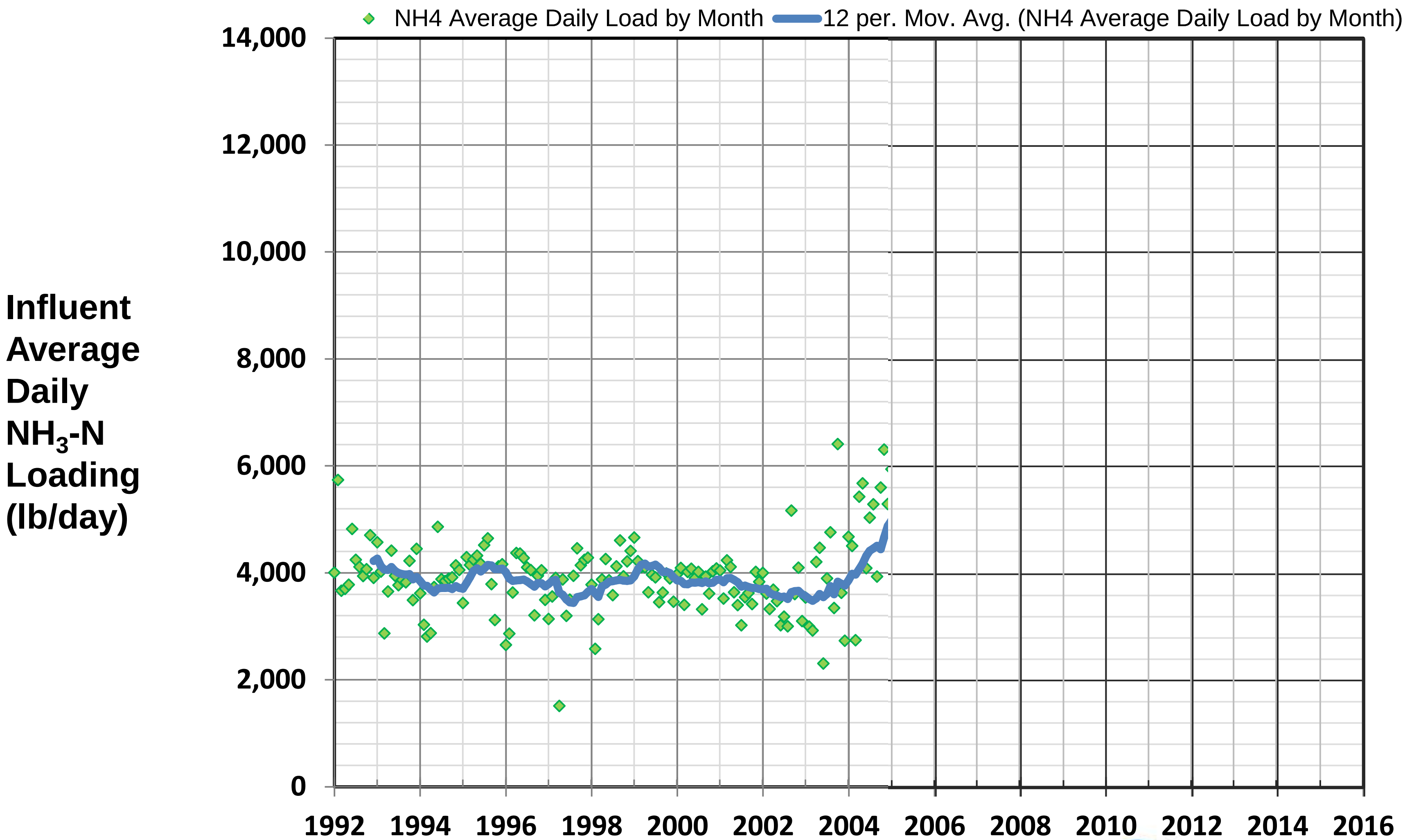
Influent ammonia loading had been relatively stable from 1992 to 2005



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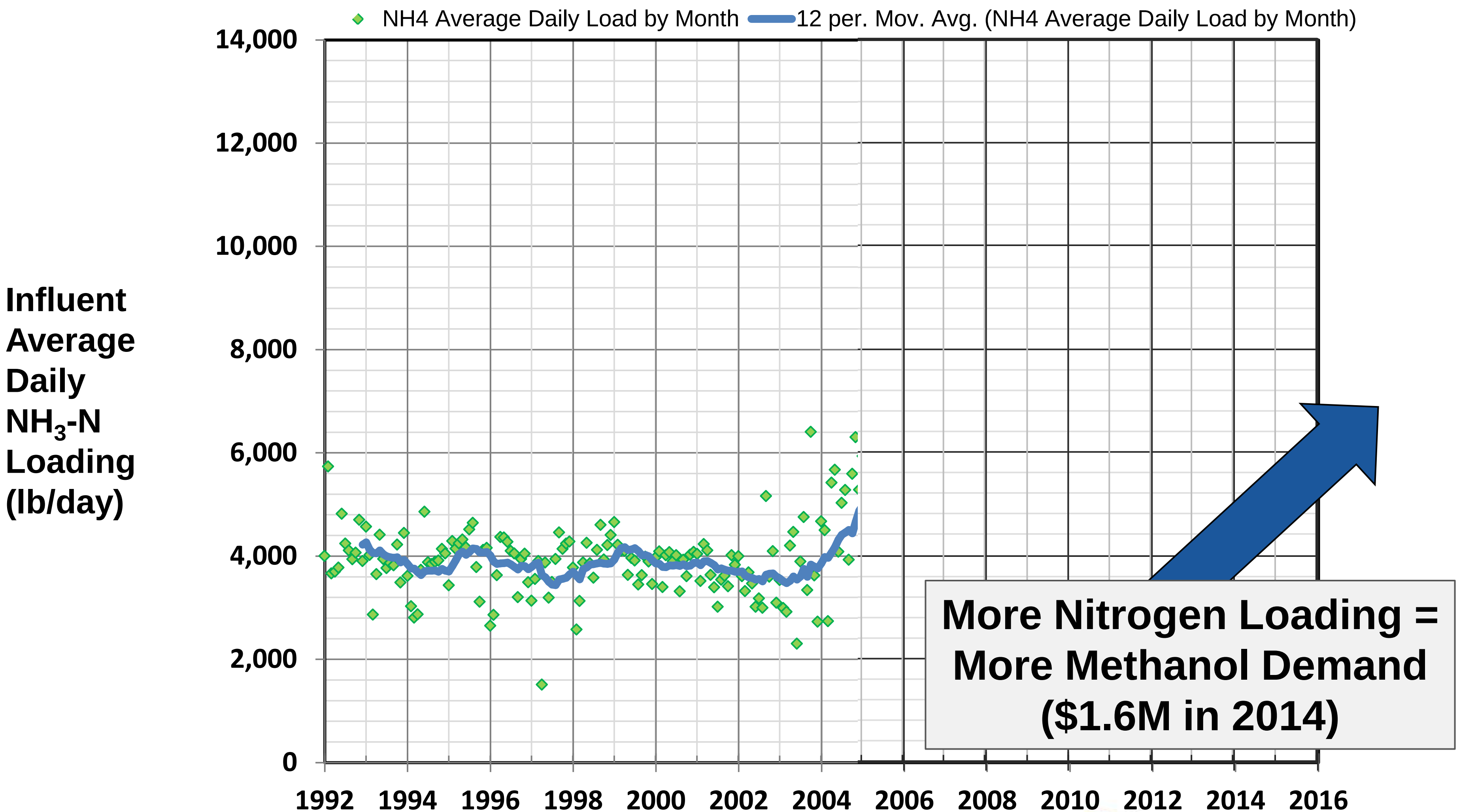
Since 2005, influent ammonia loading has Increased significantly - by more than 100%



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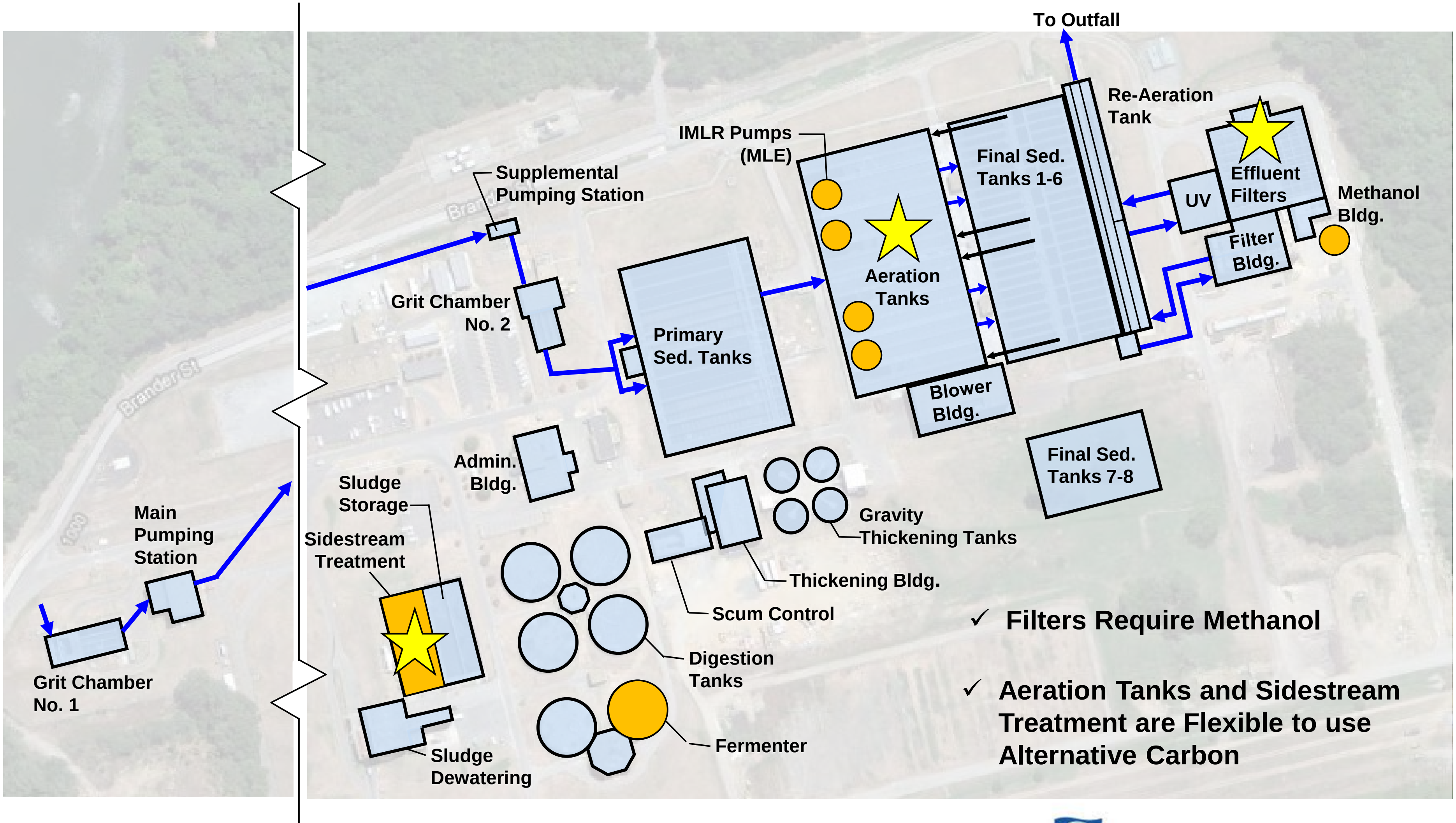
Three Flexible Nitrogen Removal Facilities



- ✓ **Filters Require Methanol**
- ✓ **Aeration Tanks and Sidestream Treatment are Flexible to use Alternative Carbon**

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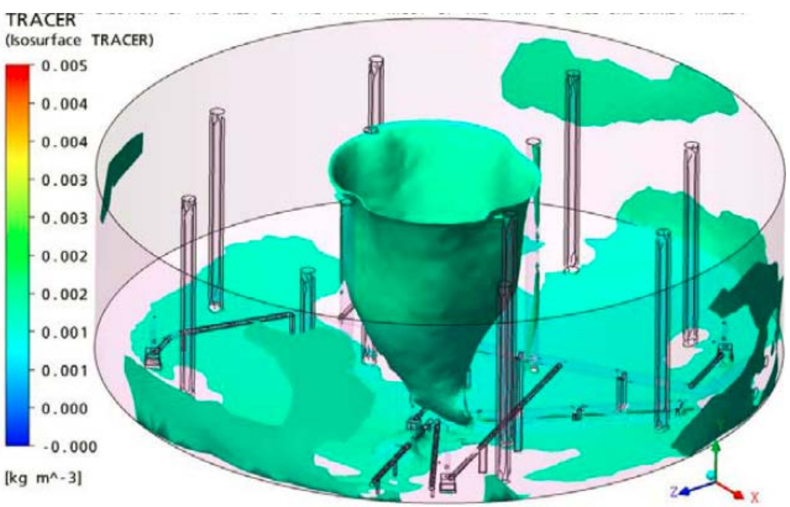
- Richmond, VA competitively selected
  - 40 cities, 3 finalists
- 500,000 barrel per year production
- Destination Restaurant
- 288 Jobs
- $74M Capital Investment
- $1.2M/year tax revenue

Inherent flexibility facilitated opportunities for the WWTP and the City

- Initial primary sludge fermentation design adaptable to future high strength wastes
- Identification of brewery waste product – leveraged value to WWTP to attract industry to the City



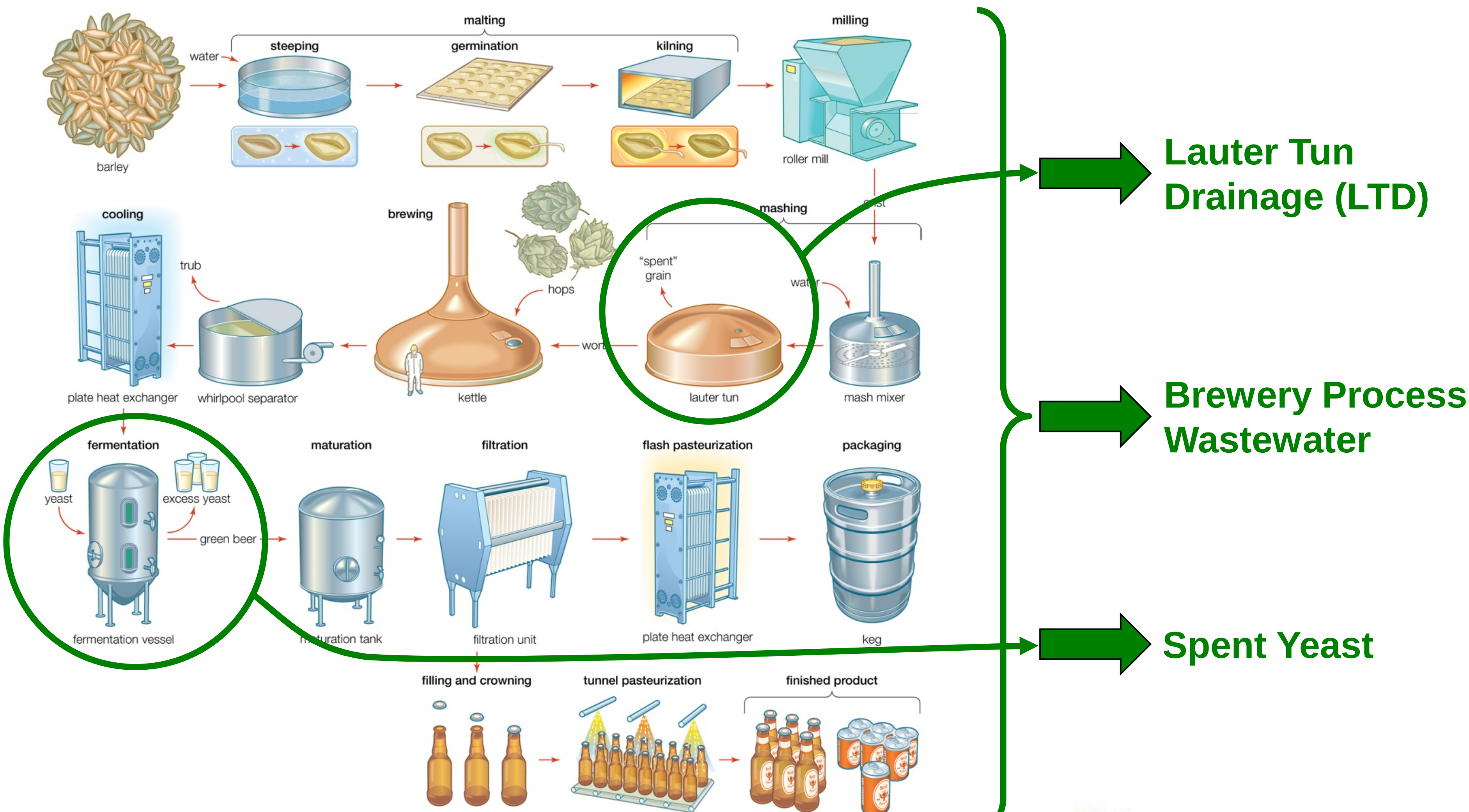
Mixing evaluation of high-rate fermenter

Brewery selected Richmond VA, in part because of partnership opportunity with public utilities

Three waste streams were screened for their applicability as products at WWTP

- City reviewed value of 3 by-products of large scale beer production:
  - Brewery Process Wastewater (low strength, sewered)
  - ‘LT DRIP’ Lauter Tun drainage (high strength, trucked)
  - Spent Yeast (very high strength, trucked)

The brewing process creates several distinct waste streams that were evaluated



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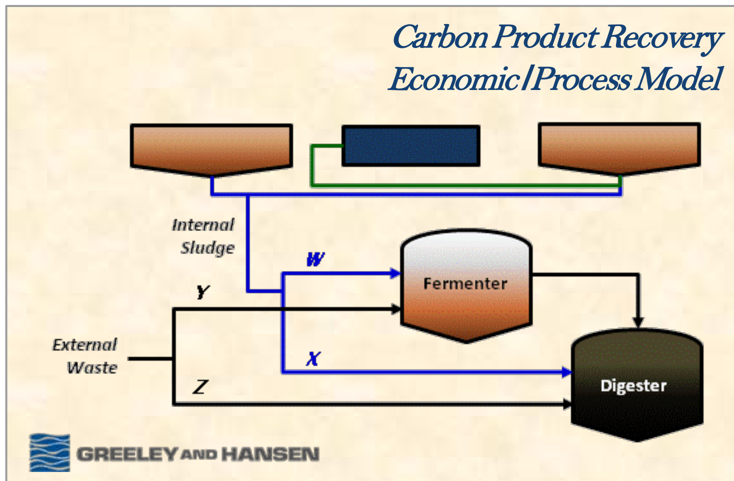
Rapid screening of brewery products revealed the value proposition of each product

HSW Character

Sludge Character

Process Stoichiometry

Energy/Commodity Data



Capital Facility Req's

Energy Product

Commodity Product

Biosolids Impacts

BNR Impacts

Σ = Descriptive life cycle economics and external fee requirements

Background of brewery product evaluation for use at Richmond WWTP

- City reviewed value of 3 by-products of large scale beer production:
  - Brewery Process Wastewater (low strength, sewered)
  - 'LT DRIP' Lauter Tun waste (high strength, trucked)
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- Outcomes of product screening, City will…
  - Receive brewery process wastewater
    - Industrial discharge to sewer, received with raw influent
    - Subject to high strength waste surcharges
  - Not accept spent yeast
    - Too high pCOD
    - Impacted biosolids more than corresponding value
  - Procure lauter tun drainage based on net methanol offset value
    - Focus for remainder of presentation

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Variable characteristics of Lauter Tun Drainage; consistently high sCOD content

Parameter	Unit	Individual Grab Sample Analyses				
		Barley Wine	IPA	IPA	IPA	Session IPA
Total Kjeldahl Nitrogen	mg N/L	1,000	1,700	1,920	585	540
Phosphorus, Total	mg P/L	300	300	441	76	22
Total Suspended Solids	mg TSS/L	44,000	20,000	21,800	53,122	13,000
Volatile Suspended Solids	mg VSS/L	-		20,730	50,878	-
Chemical Oxygen Demand	mg COD/L	140,000	100,000	139,350	190,600	95000
Soluble Chemical Oxygen Demand	mg COD/L	-	93,000	100,850	120,300	-
Biochemical Oxygen Demand	mg BOD/L	47,000	54,000	61,800	-	48,000
Soluble Biochemical Oxygen Demand	mg BOD/L	43,000	50,000	52,033	-	39,000
pH	NA	5.40	5.47	5.40	5.70	5.55

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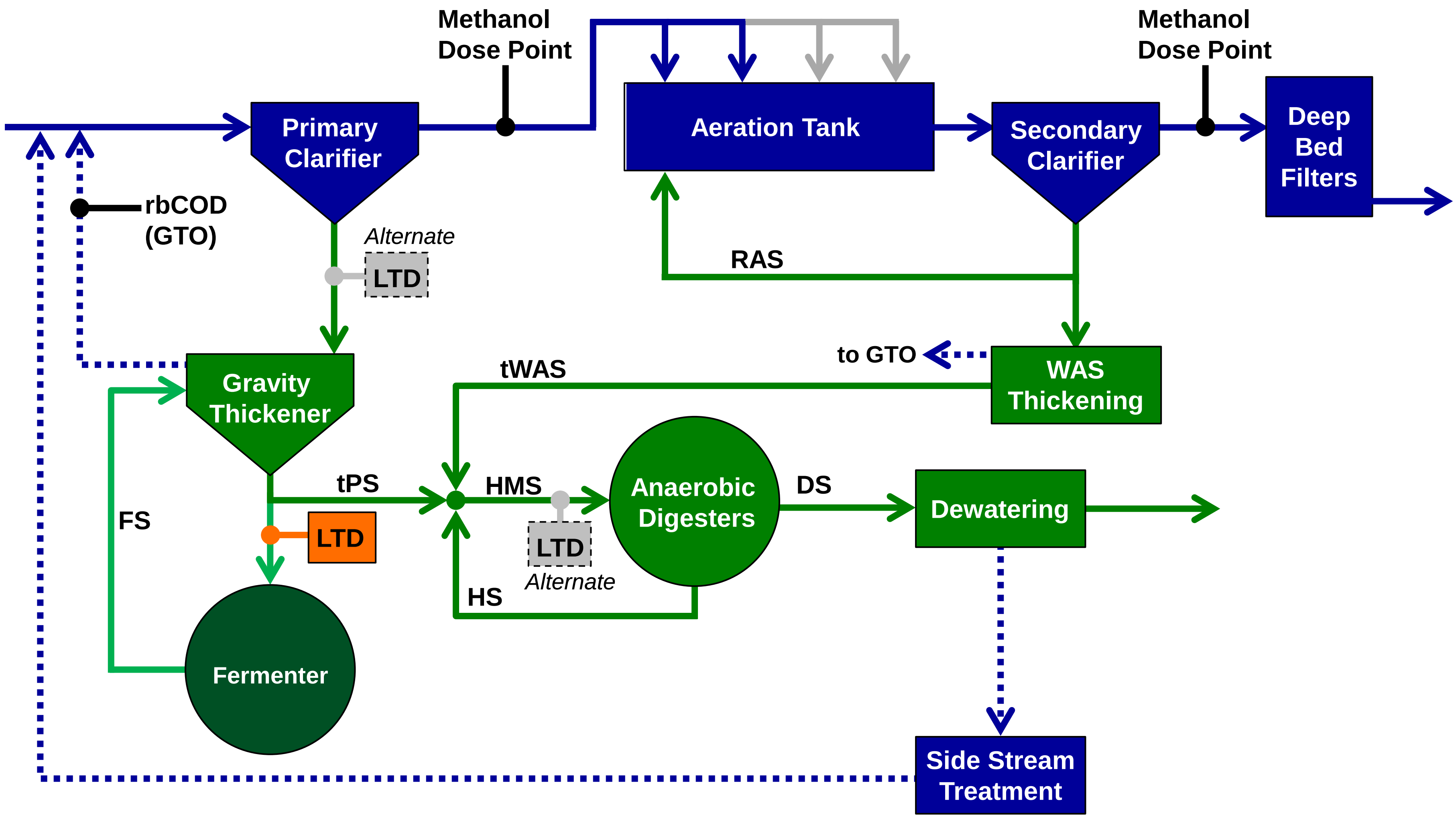
Soluble and Particulate COD will behave differently in the WWTP & have differing values

- Soluble Sugars
  - Readily fermentatable
  - Directly elutriated if not fermented
- Soluble Complex
  - Fermentable
  - Directly elutriated if not fermented
- Particulate Solids
  - Limited conversion in fermenter
  - Mostly degraded in anaerobic digester



LEGEND

LTD Lauter Tun Drainage (Brewery Byproduct) Discharge Point

LTD Alternate Lauter Tun Drainage (Brewery Byproduct) Discharge Point

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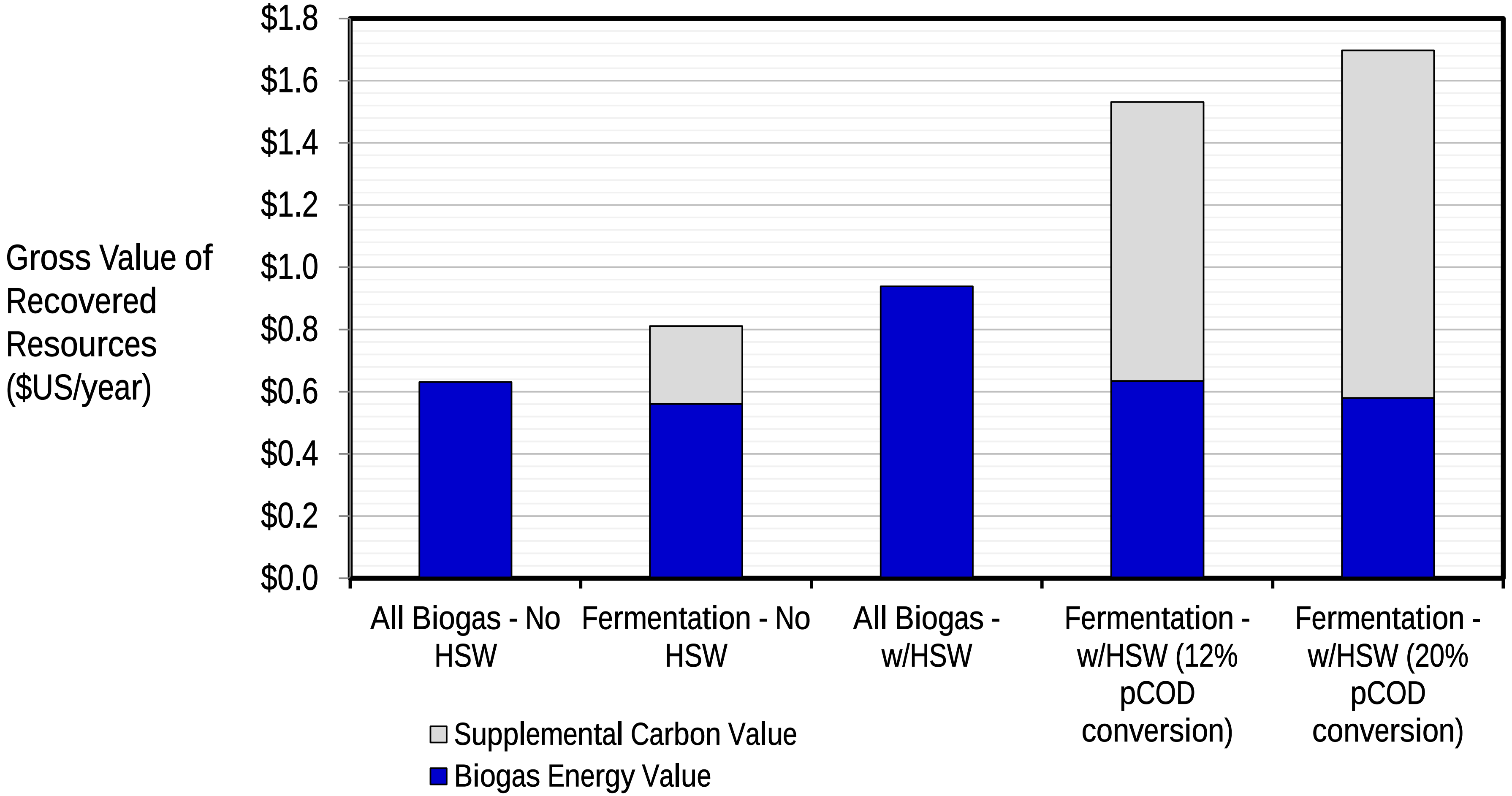
Elutriation is the primary mode of recovery for soluble COD.

Assumed 85% recovery of sCOD based on overflow/underflow ratio of gravity thickeners

12% conversion to sCOD in fermenter, remainder (up to VSR limit) degraded in digester

Operational decisions can greatly impact the gross value of recovered resources



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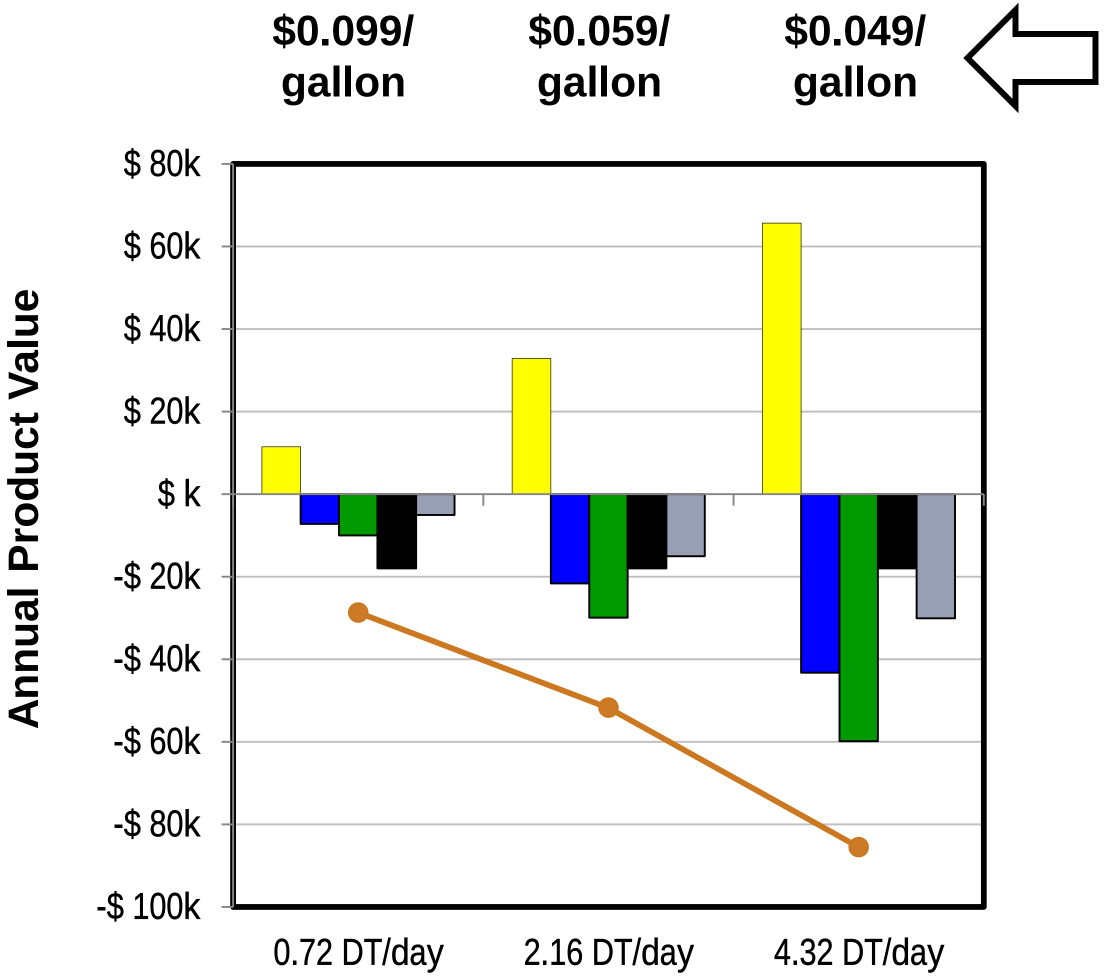
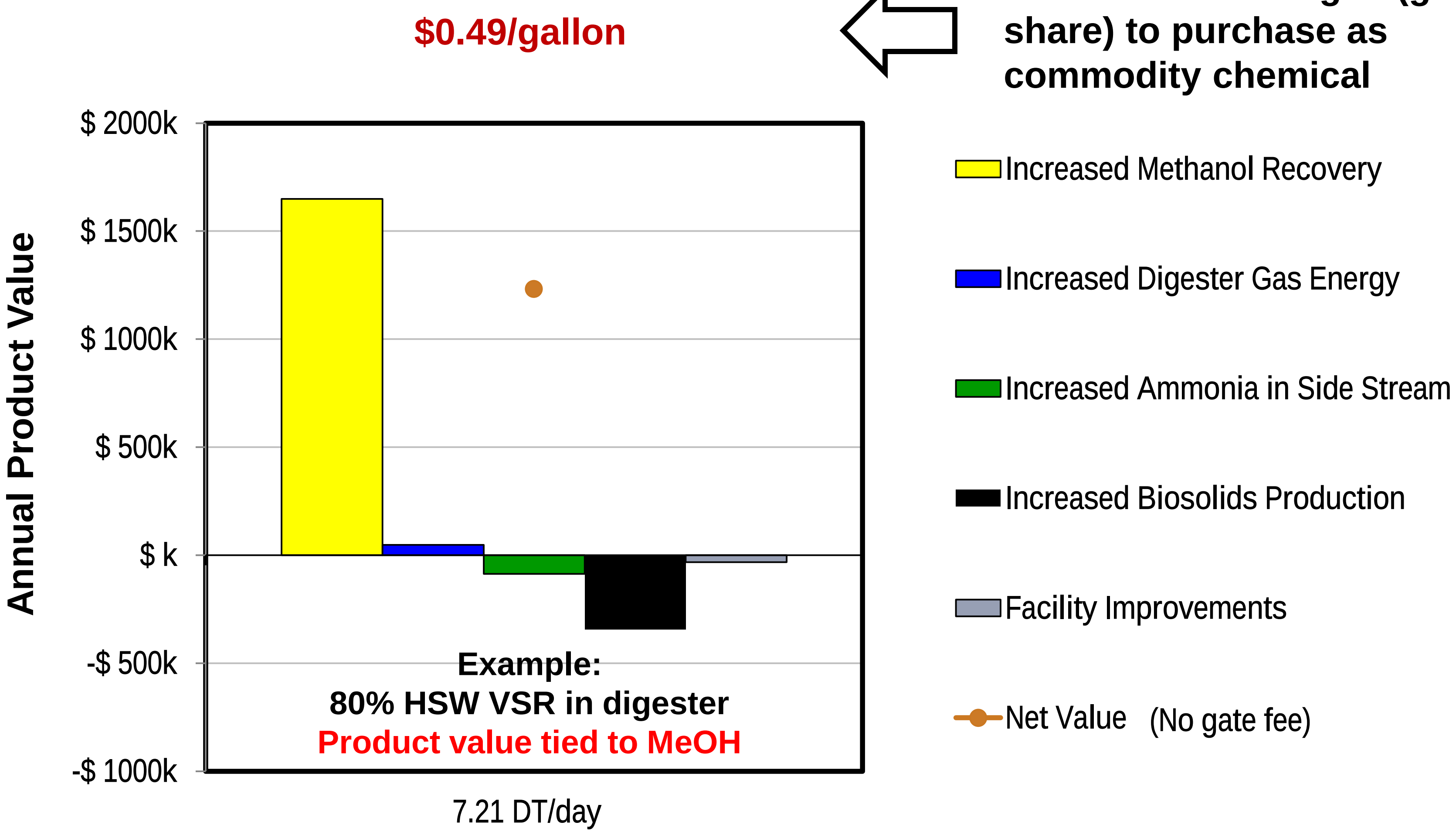
Example: Conventional Co-digestion
Spent Brewers Yeast Assessment



Remember: Richmond's goal is to develop net value from brewery product receipt to justify purchasing as commodity chemical

Example: Co-fermentation to recover rbCOD
Lauter Tun Drainage Evaluation

Value to be leveraged (gain share) to purchase as commodity chemical



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In summary, recovery of high value products enhances resource recovery opportunities

- The Conceptual Utility of the Future considers the holistic value of resources and waste streams
  - Identification of holistic value allowed Richmond to justify purchase of waste product
  - Partial cost reduction for supplemental carbon
  - Contributed to large economic win for the City by attracting large industrial facility

In summary, recovery of high value products enhances resource recovery opportunities

- The intrinsic flexibility of the WWTP allowed the City to take advantage of the highest value opportunity
  - Multiple ways to remove nitrogen
  - No sunk cost in energy recovery actually helped justify recovery of higher value (per BTU) products, e.g. VFA

- If we believe in recovering and reusing resources contained in environmental waste streams then seeking and developing strategies to extracted higher value products is critical
  - Entrepreneurialism that benefits served communities is a key aspect of the Utility of the Future!!!

THANK YOU

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RICHMOND VIRGINIA

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