RESOLUTION 2014-08

A RESOLUTION TO AUTHORIZE STAFF TO ENTER INTO CONTRACT AMENDMENT NEGOTIATIONS WITH CDM SMITH FOR THE DESIGN OF THE BIOSOLIDS PROCESS COMPONENTS OF THE WATER RECLAMATION FACILITY UPGRADE AND EXPANSION PROJECT

WHEREAS, the Board of Mayor and Aldermen (BOMA) in 2009 determined that an Integrated Water Resources Plan (IWRP) was needed to provide for near and long term recommendations related to the operations, maintenance, policies, and capital investments for the City's water, sanitary sewer, reclaimed water and stormwater systems; and

WHEREAS, the IWRP Steering Committee has recommended a Preferred Plan that provides a list of projects and/or policies needed to implement the intent of the IWRP; and

WHEREAS, the BOMA on May 8, 2012 adopted Resolution 2012-18 adopting the IWRP priority projects and associated funding plan; and

WHEREAS, the adoption of Resolution 2012-18 did not entirely include funding for the biosolids facilities portion of the Wastewater Reclamation Facilities' upgrade and expansion; and

WHEREAS, it is necessary to fund design for the biosolids treatment and handling in order to provide for the necessary facilities to manage biosolids and to proceed with the liquid process design for the remaining portions of the Wastewater Reclamation Facility; and

WHEREAS, the BOMA desires the biosolids treatment processes to have the ability achieve a Class A biosolids material; and

WHEREAS, the BOMA, through evaluation of various alternatives presented to the BOMA, has determined to proceed with the biosolids process and handling design to include the thermal hydrolysis and drying processes; and

WHEREAS, the City has entered into a Professional Services Agreement (COF Contract No 2013-0001) with CDM Smith for the Franklin Wastewater Reclamation Facility Modifications and Expansion Project; and

WHEREAS, it is understood that any amendment to a design contract or Professional Services Agreement shall be approved by BOMA prior to any work being performed by contracted consultants.

NOW THEREFORE, BE IT RESOLVED by the Board of Mayor and Aldermen of the City of Franklin, Tennessee, that City staff shall be authorized to enter into contract amendment negotiations with CDM Smith for the design services associated with the biosolids process and handling to include thermal hydrolysis and drying as part of the wastewater treatment plant (Water Reclamation Facility) upgrade and expansion to sixteen million gallons per day (16MGD) in support of the IWRP.

IT IS SO RESOLVED AND DONE on this 14th day of January, 2014

ATTEST:

By:_____

Eric S. Stuckey
City Administrator

CITY OF FRANKLIN, TENNESSE

By:_____

Dr. Ken Moore
Mayor

Approved as to Form

By: _____

Shauna R. Billingsley
City Attorney

HISTORIC
FRANKLIN
TENNESSEE

MEMORANDUM

January 3, 2014

TO: Board of Mayor and Aldermen

FROM: Eric Stuckey, City Administrator
David Parker, City Engineering
Mark Hilty, Water Management Director

SUBJECT: **Consideration of Resolution 2014-08, A Resolution to Authorize Staff to Enter into Contract Negotiations with Selected Consulting Firm for the Design of the Biosolids Components of the Water Reclamation Facility Upgrade and Expansion Project to Include Thermal Hydrolysis and Drying**

Purpose

The purpose of this memorandum is to provide the Board of Mayor and Aldermen (BOMA) with information to consider adoption of Resolution 2014-08, pertaining to the design of biosolids processes to include thermal hydrolysis and drying in order to achieve a Class A biosolids material.

Background

The existing biosolids treatment process at the Water Reclamation Facility (WRF) has been identified in the Integrated Water Resources Plan (IWRP) as a process that requires upgrades and expansion due to operational inefficiencies, equipment age, and capacity. Most of the equipment has been in operation since 1996 with all facilities nearing the end of their useful lives.

To define a long-term, sustainable biosolids solution, the IWRP Steering Committee and City staff worked to identify alternatives that would reduce risk, improve operational efficiency, earn environmental/public acceptance, control odors, and ideally produce Class A biosolids.

On November 13, 2012, the Board of Mayor and Aldermen adopted Resolution 2012-58 authorizing staff to enter into contract negotiations with CDM Smith for the design services associated with the wastewater treatment plant (Water Reclamation Facility) upgrade and expansion to sixteen million gallons per day (16MGD) in support of the IWRP. These design services included the design of the biosolids treatment handling facilities up to the biosolids pressing process equipment in the biosolids treatment train. As such, City of Franklin Contract 2013-0001 with CDM Smith does not contain provisions for design of biosolids drying facilities.

During the design process to date, the alternatives identified during the IWRP were refined. Also, the concept of incorporating a thermal hydrolysis process (THP) to guarantee a Class A biosolids and to further reduce solids was evaluated and introduced to the BOMA. The following summary table presents the alternatives that have been carried forward to the BOMA for discussion and consideration.

Alternative	Product(s)	Biosolids Class
Alternative 1: Continue Current Treatment Process	Dewatered Sludge for Landfill Disposal	N/A
Alternative 2: Replace Thickening, Add Digestion & Screw Press Dewatering	Dewatered Biosolids for Restricte Agriculture	B
Alternative 3: Alternative 2 Plus Solar Drying	Dried Biosolids for Agriculture/Public Use	A
Alternative 3A: Alternative 3 with Partial Solar Drying	Dried Biosolids for Ag./Public, Dewatered Biosolids for Restricted Ag.	A (dried), B (dewatered)
Alternative 4: Alternative 3 Plus Thermal Hydrolysis	Dried Biosolids for Agriculture/Public Use	A
Alternative 4A: Alternative 4 with Partial Solar Drying	Dried Biosolids for Ag./Public, Dewatered Biosolids for Ag.	A

In order to proceed with the liquid process design work and to further establish information pertaining to biosolids management for consideration by the BOMA, it is necessary to refine design of biosolids drying processes. To date, staff and design consultants have held various information sessions with the BOMA and recommend that design work continue for Alternative 4A, providing for partial solar drying as an alternate during the bid process.

Alternative 4A includes thickening, THP, digestion dewatering and partial solar drying (alternate). The recommendation is based on efficiency of operations, energy considerations, sustainability, risk reduction, and the ability to achieve a Class A material in a cost effective manner. Since THP is a relatively non-traditional technology to municipal biosolids treatment and a concept not previously presented, Mr. Stuckey suggested that the THP be specifically acknowledged and approved by the BOMA as a viable alternative through Resolution 2014-08.

Financial Impact

The financial impact of the additional design services will be based on negotiations with CDM Smith. The professional services agreement will be presented to the BOMA at a future date for consideration.

Recommendation

Based on research performed during the IWRP and the ongoing work being performed as part of the preliminary design of the Water Reclamation Facility upgrade and expansion, staff recommends that the City amend CDM Smith's professional services agreement to include biosolids process design services for thermal hydrolysis as a means to achieve a Class A biosolids and for drying to reduce solids volume. In doing so, this will enable design to proceed with the liquid processes of the Water Reclamation Facility and provide for design of biosolids management facilities.

HISTORIC
FRANKLIN
TENNESSEE

ITEM #4
WRKS
12/10/13

MEMORANDUM

November 22, 2013

TO: Board of Mayor and Aldermen

FROM: Eric Stuckey, City Administrator
David Parker, City Engineer/CIP Executive
Mark Hilty, Water Management Director

SUBJECT: **Discussion and Consideration of Biosolids Handling Processes for the Water Reclamation Facility Modifications and Expansion Project (COF Contract No. 2013-0001)**

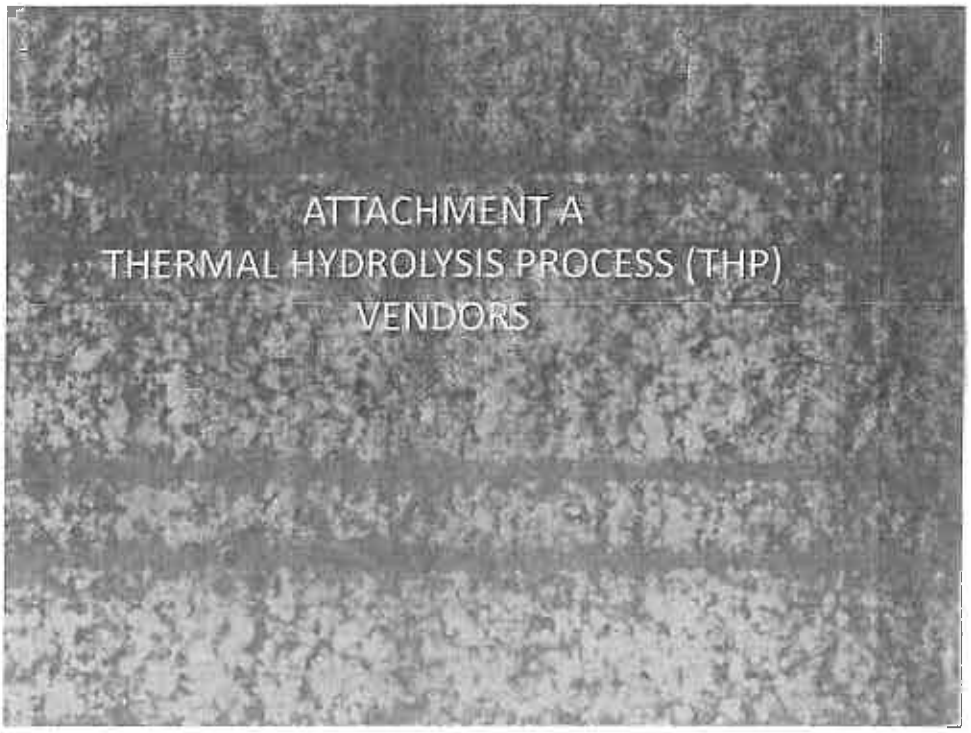
The purpose of this memorandum is to provide the Board of Mayor and Aldermen (BOMA) with information regarding biosolids treatment alternatives for the Water Reclamation Facility Modifications and Expansion Project. Based on staff's understanding of BOMA's requests, this memorandum provides information on the following:

- Thermal hydrolysis vendors and installations – Attachment A
- Examples of other class A biosolids technologies – Attachment B
- Biosolids alternatives cost breakdowns – Attachment C
- Solids alternatives projected output – Attachment D

Consultants and staff are continuing to work through two pieces of information requested by the BOMA. This includes:

- Estimates for capital costs and operations and maintenance costs for the additional examples of other class A biosolids technologies and
- Estimates for the sanitary sewer rate impacts related to the alternatives

Staff expects to have this information available early next week and recognizes BOMA may not have adequate time to review the materials for a detailed discussion. That being said, the materials will be made available to BOMA as soon possible for discussion at the November 26, 2013 Work Session and/or future meetings as necessary. In order to keep the design process moving forward, we plan to discuss these option at both the November 26th and December 10th work session. Having a consensus around the design approach (especially as it relates to drying and producing a class A solid) will allow the design process to continue.



Thermal Hydrolysis Process (THP) Vendors

- CAMBI
  - Based in Asker, Norway
  - U.S. headquarters in Jasper, Alabama

- I. Krüger (Subsidiary of Veolia Water Solutions & Technologies)
  - Based in Copenhagen, Denmark
  - U.S. headquarters in Cary, North Carolina
  - Two types of THP:
    - EXELYS™: continuous process
    - BioTHELYS®: batch process

CAMBI Plants in Operation

- Hamar, Norway
- Chertsey, UK
- Sarspborg, Norway
- Aberdeen, UK
- Lillehammer, Norway
- Dublin, Ireland
- Fredericia, Denmark
- Niigata, Japan
- Bydgoszcz, Poland
- Brisbane, Australia
- Brussels, Belgium
- Milton Keynes, UK
- Verdal, Norway
- Norwich, UK
- Abo/Turku, Finland
- Tees Valley, UK
- Geiselbullach, Germany
- Wales, UK
- London, UK
- Vilnius, Lithuania
- Santiago, Chile
- Drammen, Norway
- Manchester, UK
- Newcastle, UK
- Oslo, Norway

- Capacities ranging from 1,300 to 100,000 DT/year

CAMBI Plants in Design or Construction

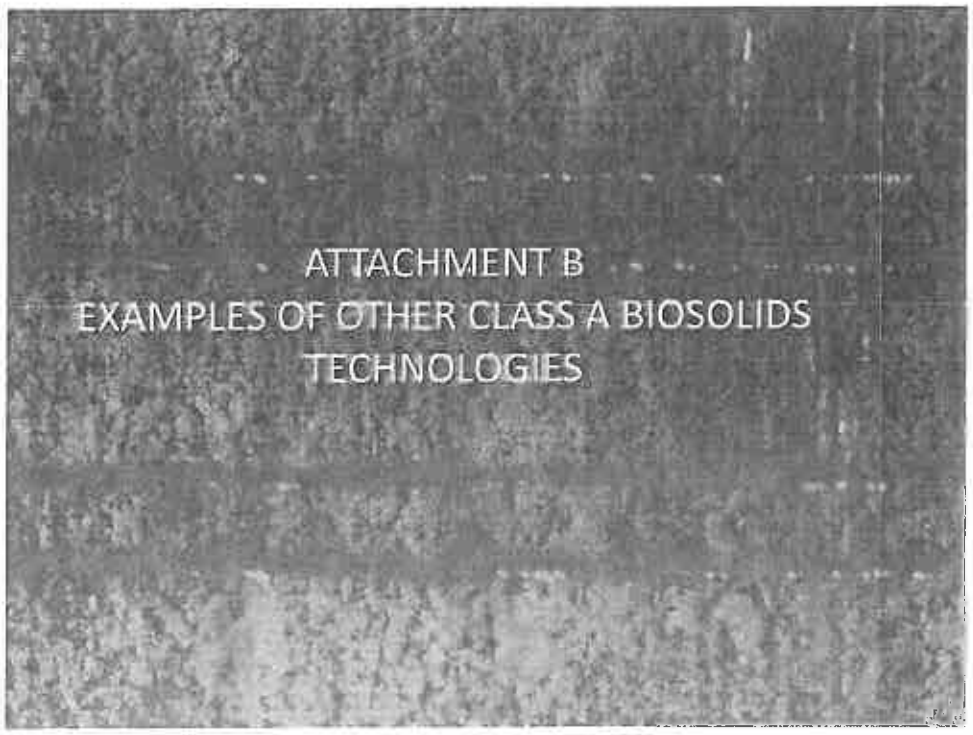
- Washington, DC
- Tilburg, Holland
- London, UK
  (3 Thames Water plants)
- Vaxjo, Sweden
- Vigo, Spain
- West Sussex, UK
- Stavanger, Norway
- Edinburgh, Scotland

- **Washington, DC, installation will be world's largest**
  (143,000 DT/year)
- Approximately 75% complete

Krüger THP Installations

- BioTHELYS® (batch process)
  - Saumur, France
  - Chateau Gontier, France
  - Le Pertuiset, France
  - Tergnier, France
  - Monza, San Recco, Italy
  - Esholt, UK
  - Oxford, UK
- EXELYS™ (continuous process)
  - Versailles, France
  - Lille, France
  - Grinstead, Denmark
  - Bonneuil en France, France (Demonstration)
  - Hillerod, Denmark (Demonstration)

- Capacities ranging from 1,100 to 36,000 DT/year

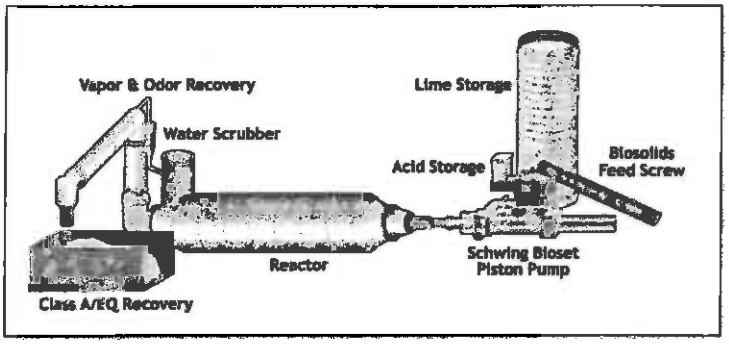


Other Class A Biosolids Technologies

- Alkaline Stabilization
- Pre-Pasteurization
- Advanced Anaerobic Digestion
- Composting
- Thermal Drying

Alkaline Stabilization – Proprietary Systems

- RDP
- N-Viro: Cement kiln dust with subsequent drying
- Bioset Process
  - Uses quicklime & sulfamic acid to raise pH & temperature
  - No external heat source – heat generated by chemical addition



Alkaline Stabilization Advantages & Disadvantages

Advantages

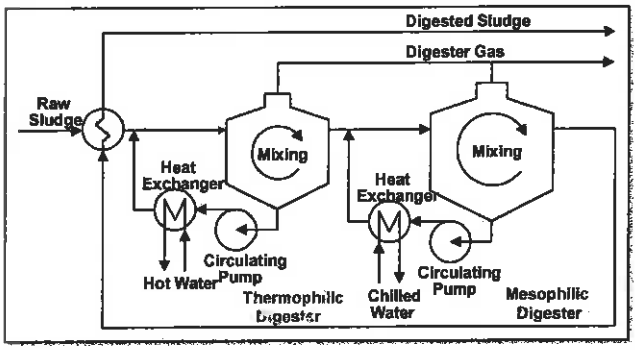
- Low capital cost
- Simple & flexible
- Small footprint
- Established demand for stabilized product

Disadvantages

- Odor potential (ammonia release)
- Produces dust
- High O&M costs
- Increased mass/volume due to lime addition

Advanced Anaerobic Digestion

- Thermophilic Anaerobic Digestion
- Temperature Phased Anaerobic Digestion (TPAD)
- Numerous installations in the U.S., mostly in the Midwest (DuPage County, IL)



Advanced Anaerobic Digestion Advantages & Disadvantages

Advantages

- Increased pathogen reduction
- Increased volatile solids reduction & biogas production
- Can reduce foaming

Disadvantages

- Higher capital costs
- Greater operational complexity
- Increased heat demand due to higher operating temperature
- Increased dewatering polymer consumption
- Increased nutrients (N and P) in recycle streams

Pre-Pasteurization

- Heat treatment of sludge before conventional anaerobic digestion
- Reliable Class A pathogen reduction
- Not shown to enhance digestibility of the sludge
- Proven, but not widely used

Pre-Pasteurization
Advantages & Disadvantages

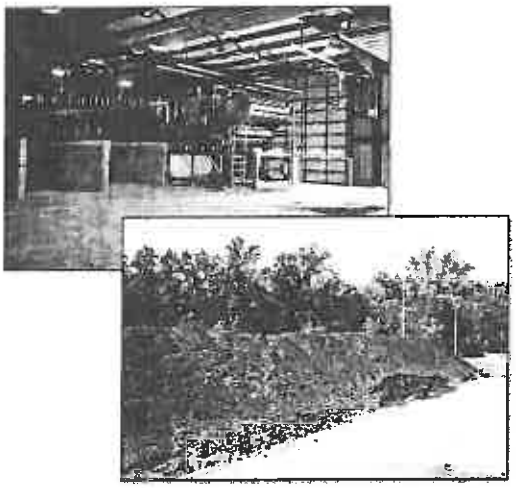
Advantages

- Reliable "add-on" to conventional digestion produces Class A biosolids

Disadvantages

- System must be designed to handle thicker sludges
- Added operational complexity
- Safety risks associated with hot equipment
- High energy consumption (heat recovery can minimize)

Composting



- Three types:
  - Aerated static pile
  - Windrow
  - In-vessel process
- Requires bulking agent/amendment
  - Wood wastes
  - Typically requires additional grinding, screening
- Raleigh, NC markets as "Raleigh Plus"

Composting
Advantages & Disadvantages

Advantages

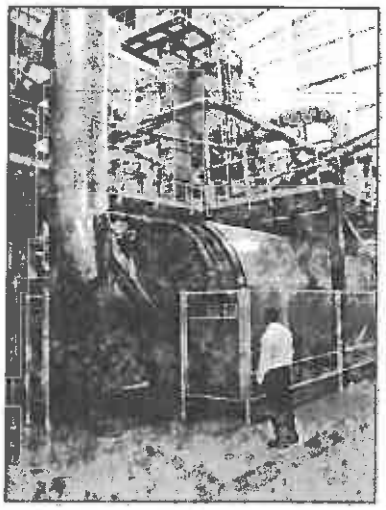
- Simple process
- Product is easily stored
- Low initial cost (excluding in-vessel systems)

Disadvantages

- Requires large land area
- Requires bulking agent & carbon source
- Odor control is difficult
- High O&M cost
- In-vessel systems have high capital cost

Thermal Drying

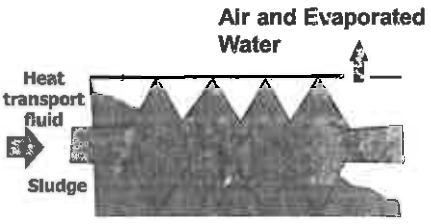
- Dries product to >90% TS
- Dried product can be used as fertilizer or fuel for kilns/boilers
- Direct (convection) & indirect (conduction) systems available
- Better suited to digested biosolids
  - Higher quality product
  - Energy synergy with biogas
  - Fewer safety concerns



Thermal Drying

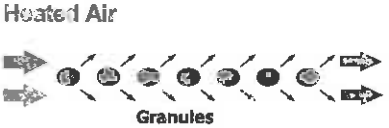
Direct (Convection)

- Heat is transferred directly to sludge particles
- Examples:
  - Paddle dryer (Paragould, AR; Rahway, NJ)



Indirect (Conduction)

- Heat is conducted through metal surface to sludge
- Examples:
  - Belt dryer (Buffalo, MN)
  - Rotary drum dryer (Cary, NC; Nashville, TN)



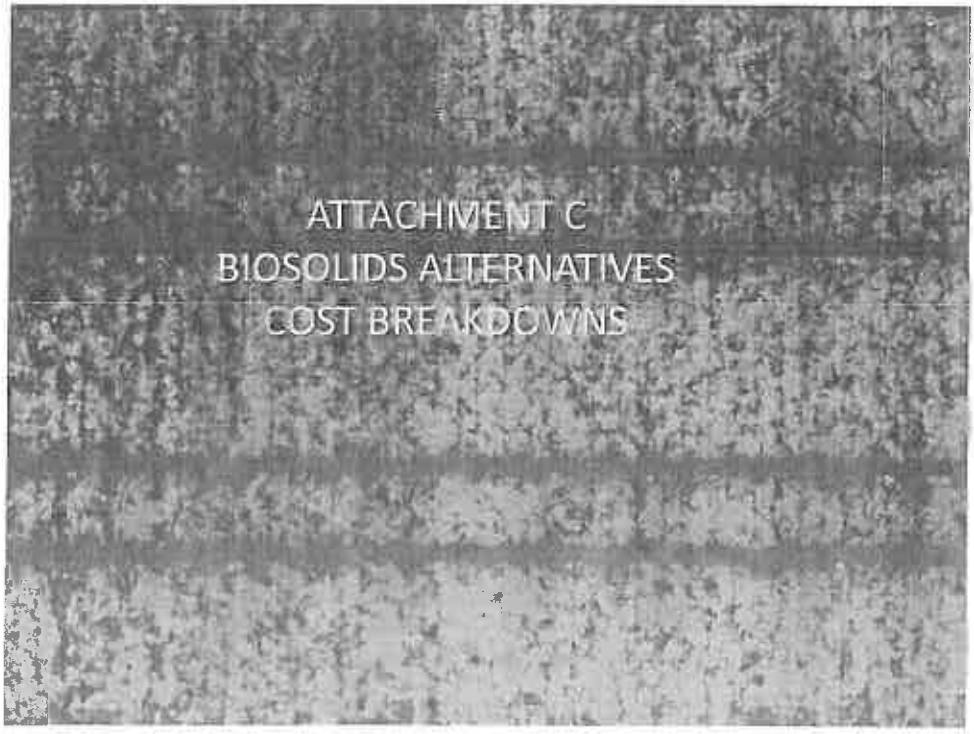
Thermal Drying
Advantages & Disadvantages

Advantages

- Small footprint
- High quality product
- Good mass reduction

Disadvantages

- High capital cost
- High O&M cost (energy intensive)
- Dust control is required to reduce safety risk

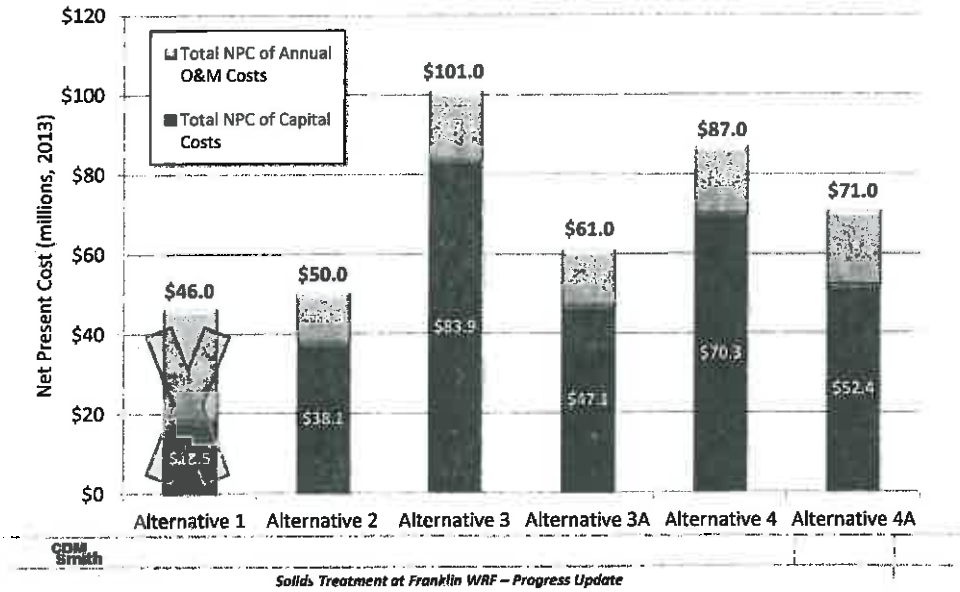


Economic Analysis – Capital Cost

Process Train	Estimated Capital Cost at Each Phase (millions)			Net Present Capital Cost of Three Phases (millions)
	Phase I (2018-2023)	Phase II (2024-2031)	Phase III (2032-2080)	
~~Alternative 1: Continue Current Treatment Process~~	~~$18.0~~	~~$1.4~~	~~$0.0~~	~~$19.0~~
Alternative 2: Replace Thickening, Add Digestion	$33.0	$11.6	$1.6	$38.0
Alternative 3: Alternative 2 Plus Solar Drying	$67.0	$21.0	$22.0	$84.0
Alternative 3A: Alternative 3 with Partial Solar Drying	$41.0	$12.0[2]	$5.0[2]	$47.0[2]
Alternative 4: Alternative 3 Plus Thermal Hydrolysis	$64.0	$15.0	$6.0	$70.0
Alternative 4A: Alternative 4 with Partial Solar Drying	$52.0	$6.0[2]	$3.0[2]	$52.0[2]

[1] 2013 dollars. [2] Does not include Phase II or III solar dryer expansion.

Economic Analysis – Net Present Cost (2013 Dollars)

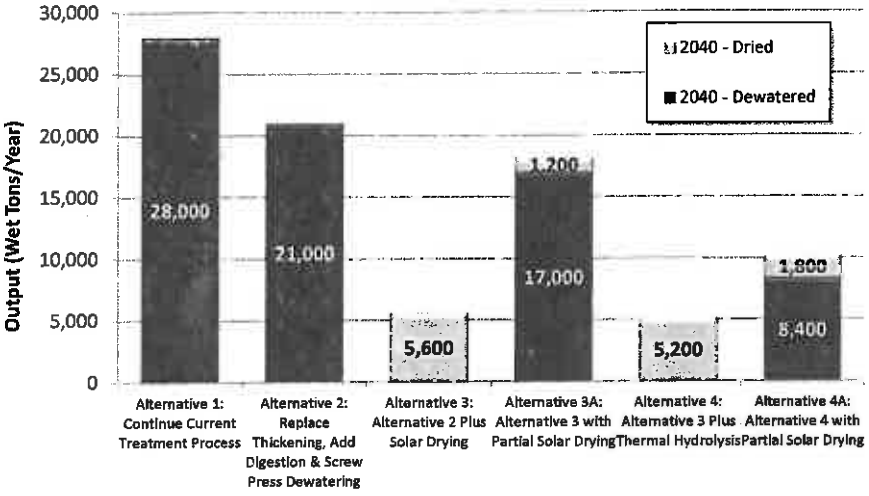


Solids Alternatives Projected Output

Alternative	Product(s)	Biosolids Class
Alternative 1 Continue Current Treatment Process	Dewatered Sludge for Landfill Disposal	N/A
Alternative 2. Replace Thickening. Add Digestion & Screw Press Dewatering	Dewatered Biosolids for Agriculture	B
Alternative 3: Alternative 2 Plus Solar Drying	Dried Biosolids for Agriculture/Public Use	A[1]
Alternative 3A: Alternative 3 with Partial Solar Drying	Dried Biosolids for Ag./Public, Dewatered Biosolids for Ag.	A[1] (dried), B (dewatered)
Alternative 4. Alternative 3 Plus Thermal Hydrolysis	Dried Biosolids for Agriculture/Public Use	A
Alternative 4A: Alternative 4 with Partial Solar Drying	Dried Biosolids for Ag./Public, Dewatered Biosolids for Ag.	A

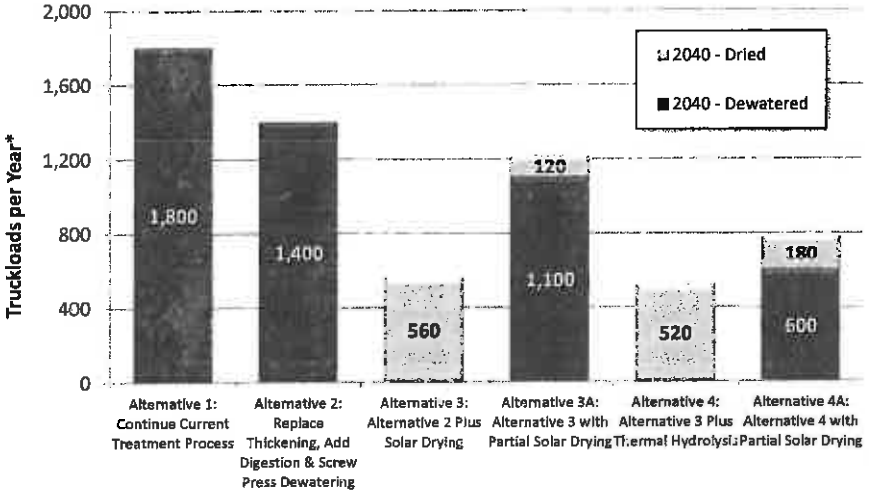
[1] Subject to approval by TDEC.

Solids Alternatives Projected Output



Current hauling: approximately 11,000 WT/year.

Solids Alternatives Projected Output



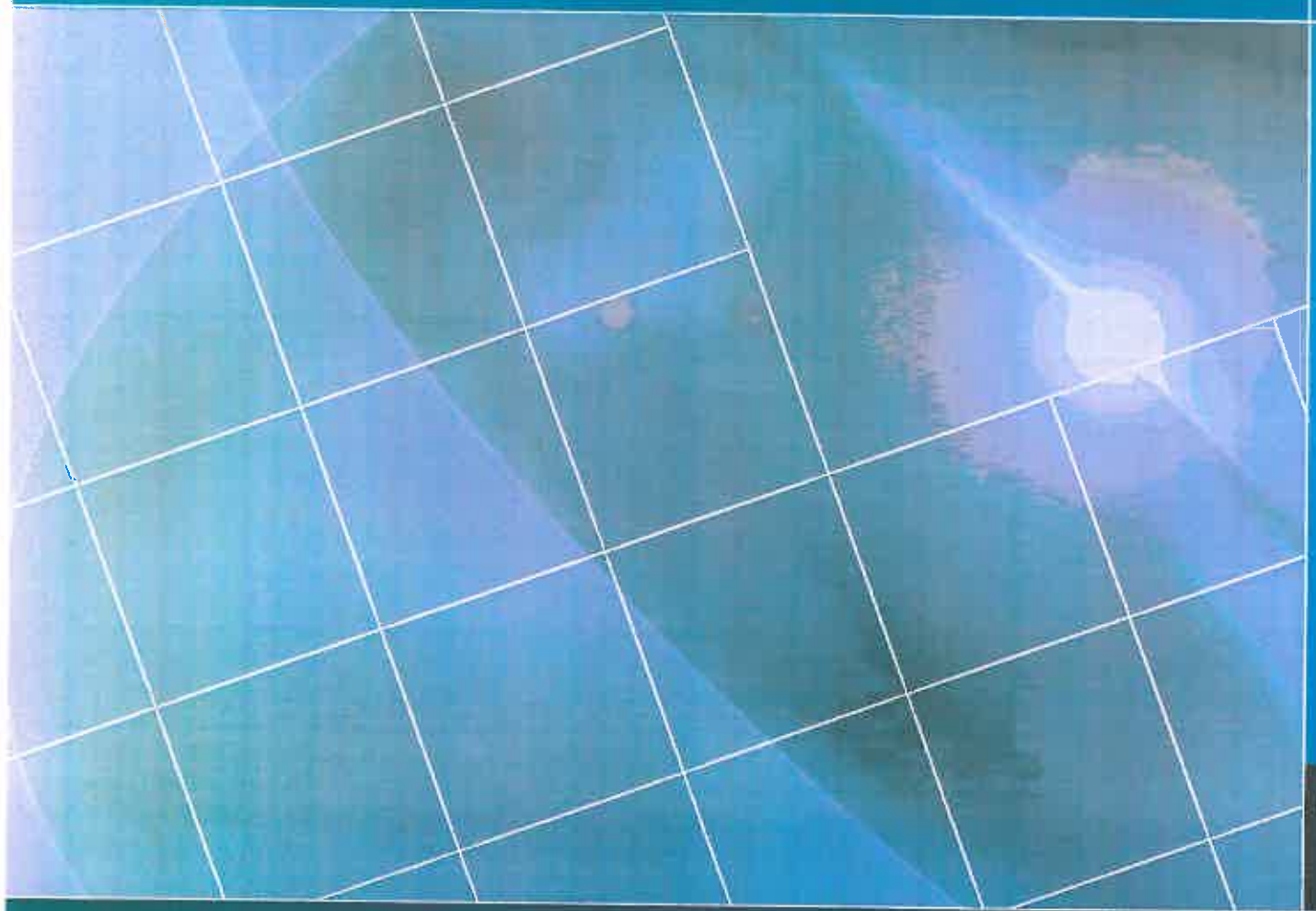
* Based on 20-CY truckload.

Current hauling: approximately 550 truckloads/year.

Biosolids Process Selection at the Franklin WRF

Presented to
Board of Mayor
and Aldermen

December 10, 2013



CDM Smith

BACKGROUND
WHERE WE ARE-WHERE WE CAME FROM

Existing Solids Treatment Process

- Most equipment in operation since 1996 upgrades
- All facilities are at the end of their useful lives
- Thickening equipment requires frequent maintenance & repairs

- Two full-time drivers haul solids to landfill 100+ miles away
- Additional capacity needed to handle future wastewater flows

Goals Defined New Solids Treatment Process

During the IWRP, one of the primary nine goals was a long-term, sustainable biosolids process. To better define the best solution, the following goals were defined by the Steering Committee & Staff:

- Reduce risk
- Improve operational efficiency
- Earn environmental/public acceptance
- Control odors
- **Produce Class A biosolids**

Class A Biosolids Options

Potential Class A Technologies	Similar System
Alkaline Stabilization	Hollywood, FL
Advanced Anaerobic Digestion	DuPage County, IL Lakeland, FL
Composting	Raleigh, NC
Thermal Drying – Rotary Drum	Nashville, TN Bowling Green, KY Cary, NC
Thermal Drying- Belt Dryer/No Digestion	Buffalo, MN
Solar Drying	Okeechobee, FL Carmel, IN
Thermal Hydrolysis	UK, Denmark, France (Thermal hydrolysis)

Evaluation Criteria

Based on these goals, the myriad of **Class A processes** were evaluated based on:

1. Efficiency of operations
2. Energy consumption
3. **Sustainability**
4. **Reliability**
5. **Risk Reduction**
6. Odor Control
7. Expandability for Growth

SOLIDS ALTERNATIVES DISPOSAL OPTIONS

Solids Alternatives Projected Output

Alternative	Product(s)	Biosolids Class
Alternative 1: Continue Current Treatment Process	Dewatered Sludge for Landfill Disposal	N/A
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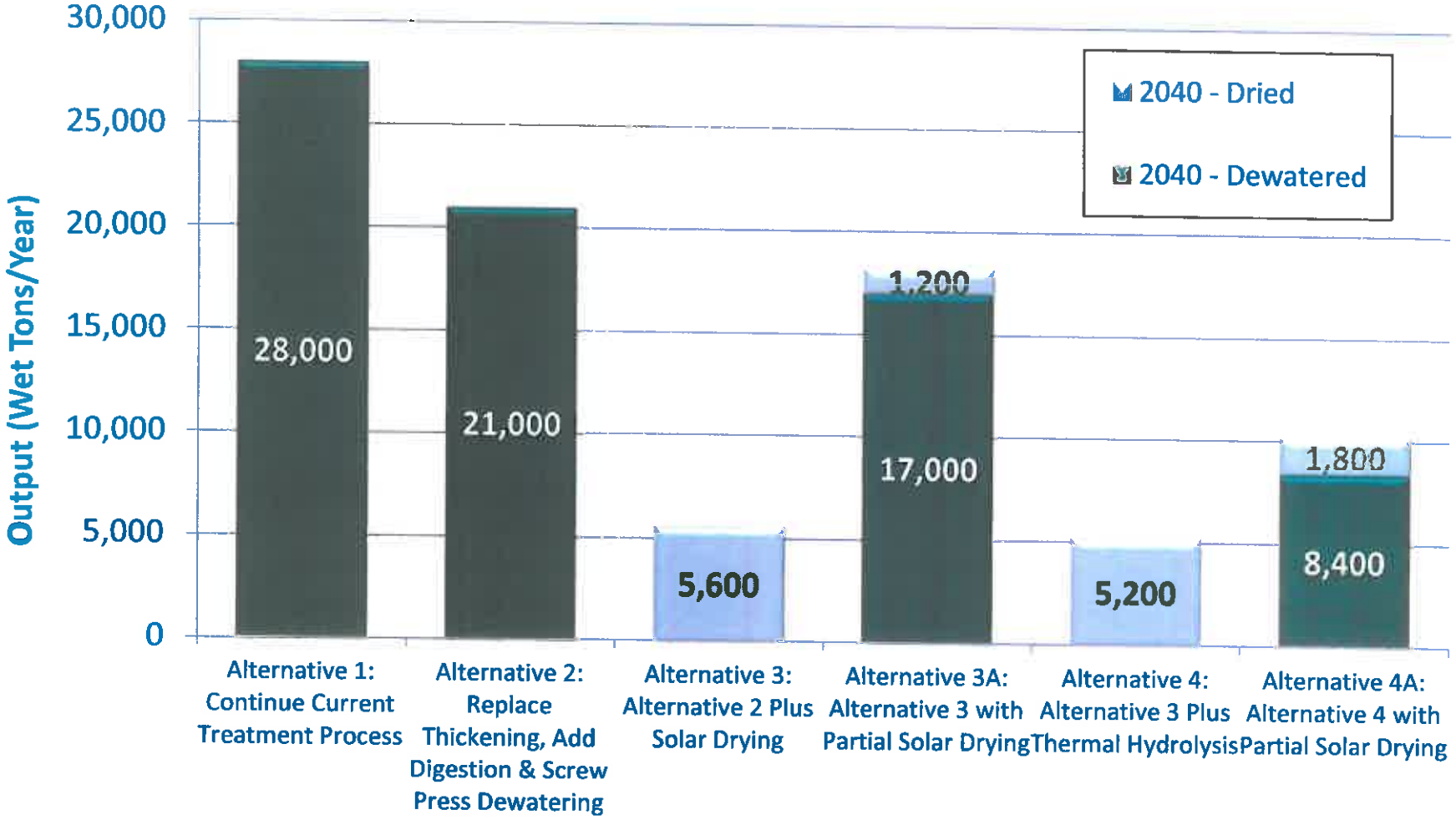
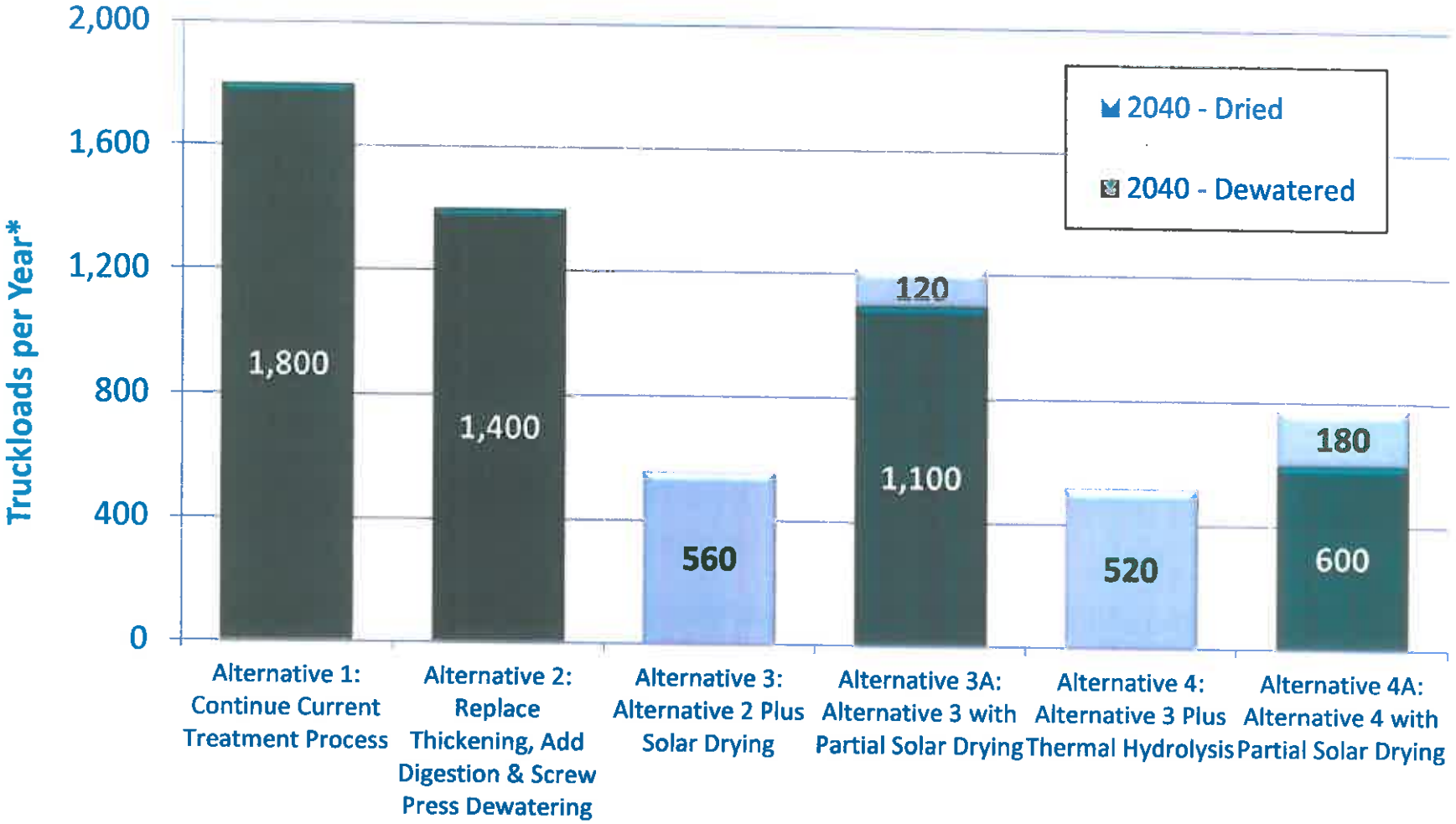
Solids Alternatives Projected Output



Current hauling: approximately 11,000 WT/year.

Solids Alternatives Projected Output



* Based on 20-CY truckload.

Current hauling: approximately 550 truckloads/year.

RATE IMPACTS

Economic Analysis – Capital Cost

Process Train	Estimated Capital Cost at Each Phase (millions)			Net Present Capital Cost of Three Phases[1] (millions)
	Phase I (2018-2023)	Phase II (2024-2031)	Phase III (2032-2040)	
Alternative 1: Continue Current Treatment Process	$18.0	$3.4	$0.0	$19.0
Alternative 2: Replace Thickening, Add Digestion	$33.0	$11.6	$1.6	$38.0
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[1] 2013 dollars. [2] Does not include Phase II or III solar dryer expansion.

Rate Criteria/Assumptions

- Funding all improvements with debt
- Initial 16-mgd facility (75% existing rate payer funded/25% development funded)
- 2.819% Interest rate amortized over 20 years (per SRF letter)
- 3.0% growth rate
- Based on an average 7,000 gallons/month residential customer
- Assumes the estimated O&M costs for the current operation continue for the increasing demands

Estimated Rate Impacts
(change per month for average residential user)

	Alternative 1	Alternative 2	Alternative 3A	Alternative 4A
2018 (per month rate impact including debt service)	$ 2.99	$ 3.48	$ 5.11	$ 7.60
2040 (Per month Operations/Maint cost compared to Alt 1)	$ 0.00	$ -4.16	$ -3.90	$ -2.94

Rate Impact by Wastewater/Biosolid Treatment Alternative

CDM - Franklin IRWP
Wastewater Alternative 1
Monthly

Alternative 1 - Base								
Year	O&M Costs	Volumes (kgal)	Base O&M Cost/kgal	Monthly Cost/Avg Res.		Capital Impact/ Bill	Net Impact	
2017						$ 1.28	$ 1.28	
2018	$ 1,696,000	2,923,384	$ 0.58	$ 4.06		$ 2.99	$ 2.99	
2019	$ 1,803,000	3,033,285	$ 0.59	$ 4.16		$ 2.90	$ 2.90	
2020	$ 1,914,000	3,143,187	$ 0.61	$ 4.26		$ 2.82	$ 2.82	
2021	$ 2,030,000	3,253,088	$ 0.62	$ 4.37		$ 2.74	$ 2.74	
2022	$ 2,152,000	3,341,010	$ 0.64	$ 4.51		$ 2.66	$ 2.66	
2023	$ 2,278,000	3,450,911	$ 0.66	$ 4.62		$ 2.58	$ 2.58	
2024	$ 2,370,000	3,560,813	$ 0.67	$ 4.66		$ 2.51	$ 2.51	
2025	$ 2,499,000	3,670,715	$ 0.68	$ 4.77		$ 2.43	$ 2.43	
2026	$ 2,634,000	3,780,616	$ 0.70	$ 4.88		$ 2.36	$ 2.36	
2027	$ 2,775,000	3,890,518	$ 0.71	$ 4.99		$ 2.29	$ 2.29	
2028	$ 2,921,000	4,000,420	$ 0.73	$ 5.11		$ 2.23	$ 2.23	
2029	$ 3,073,000	4,088,341	$ 0.75	$ 5.26		$ 2.16	$ 2.16	
2030	$ 3,232,000	4,198,242	$ 0.77	$ 5.39		$ 2.10	$ 2.10	
2031	$ 3,397,000	4,308,144	$ 0.79	$ 5.52		$ 2.04	$ 2.04	
2032	$ 3,569,000	4,418,046	$ 0.81	$ 5.65		$ 1.98	$ 1.98	
2033	$ 3,748,000	4,527,947	$ 0.83	$ 5.79		$ 1.92	$ 1.92	
2034	$ 3,934,000	4,637,849	$ 0.85	$ 5.94		$ 1.86	$ 1.86	
2035	$ 4,128,000	4,747,751	$ 0.87	$ 6.09		$ 1.81	$ 1.81	
2036	$ 4,330,000	4,857,652	$ 0.89	$ 6.24		$ 1.76	$ 1.76	
2037	$ 4,540,000	4,945,574	$ 0.92	$ 6.43		$ 0.99	$ 0.99	
2038	$ 4,758,000	5,055,475	$ 0.94	$ 6.59		$ -	$ -	
2039	$ 4,985,000	5,165,377	$ 0.97	$ 6.76		$ -	$ -	
2040	$ 5,221,000	5,275,279	$ 0.99	$ 6.93		$ -	$ -	

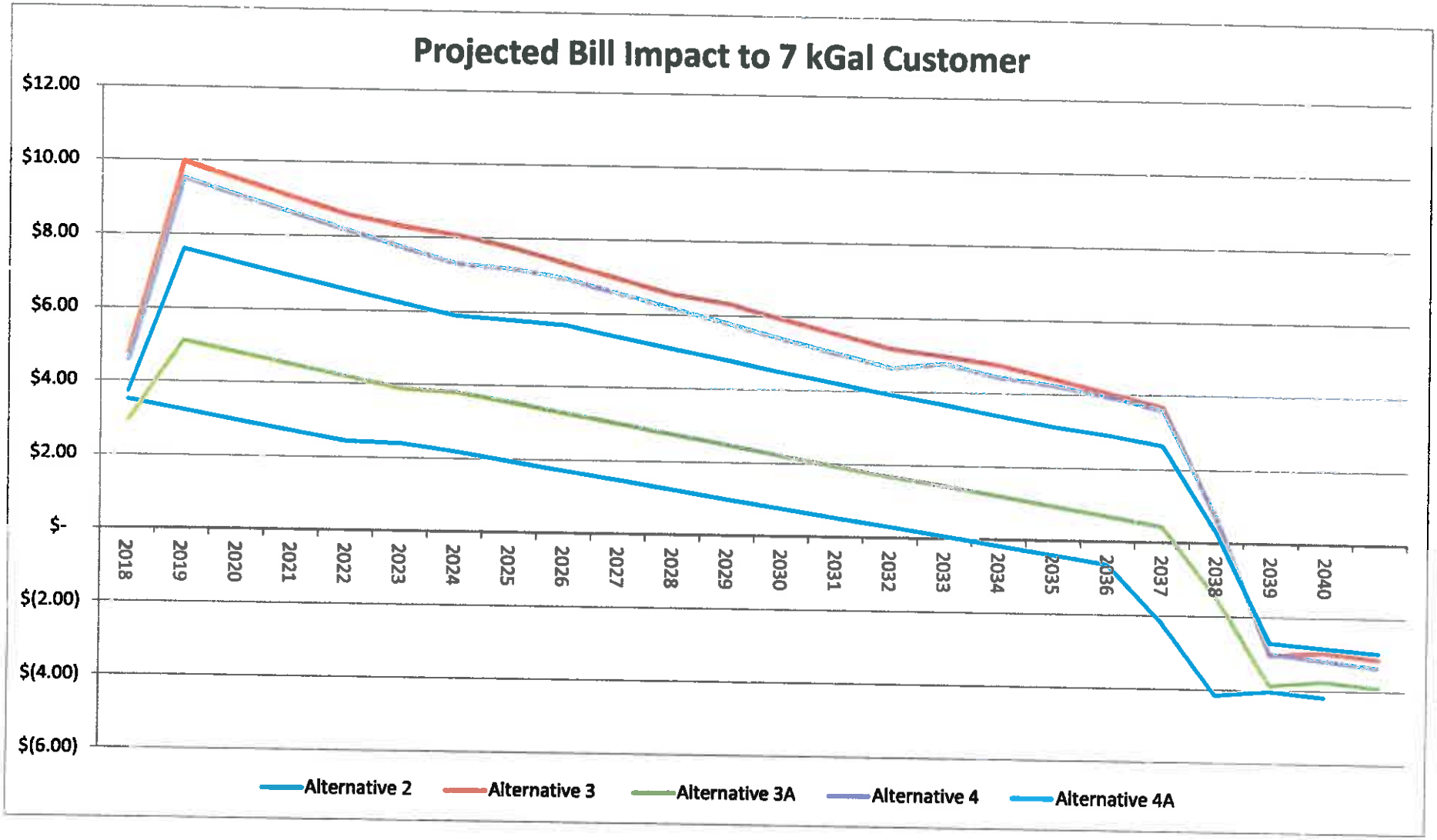
Alternative 2								
	O&M Costs	Cost/kgal	Cost/Avg Res.		Monthly O&M Savings	Capital Impact/ Bill	Net Impact	
2017						$ 2.35		
2018	$ 861,000	$ 0.29	$ 2.06		$ 2.00	$ 5.48	$ 3.48	
2019	$ 892,000	$ 0.29	$ 2.06		$ 2.10	$ 5.32	$ 3.22	
2020	$ 916,000	$ 0.29	$ 2.04		$ 2.22	$ 5.17	$ 2.95	
2021	$ 948,000	$ 0.29	$ 2.04		$ 2.33	$ 5.02	$ 2.69	
2022	$ 982,000	$ 0.29	$ 2.06		$ 2.45	$ 4.87	$ 2.42	
2023	$ 1,118,000	$ 0.32	$ 2.27		$ 2.35	$ 4.73	$ 2.38	
2024	$ 1,140,000	$ 0.32	$ 2.24		$ 2.42	$ 4.59	$ 2.18	
2025	$ 1,176,000	$ 0.32	$ 2.24		$ 2.52	$ 4.46	$ 1.93	
2026	$ 1,214,000	$ 0.32	$ 2.25		$ 2.63	$ 4.33	$ 1.70	
2027	$ 1,253,000	$ 0.32	$ 2.25		$ 2.74	$ 4.20	$ 1.46	
2028	$ 1,293,000	$ 0.32	$ 2.26		$ 2.85	$ 4.08	$ 1.23	
2029	$ 1,334,000	$ 0.33	$ 2.28		$ 2.98	$ 3.96	$ 0.98	
2030	$ 1,377,000	$ 0.33	$ 2.30		$ 3.09	$ 3.85	$ 0.75	
2031	$ 1,420,000	$ 0.33	$ 2.31		$ 3.21	$ 3.73	$ 0.52	
2032	$ 1,473,000	$ 0.33	$ 2.33		$ 3.32	$ 3.63	$ 0.31	
2033	$ 1,519,000	$ 0.34	$ 2.35		$ 3.45	$ 3.52	$ 0.07	
2034	$ 1,566,000	$ 0.34	$ 2.36		$ 3.57	$ 3.42	$ (0.16)	
2035	$ 1,615,000	$ 0.34	$ 2.38		$ 3.71	$ 3.32	$ (0.39)	
2036	$ 1,665,000	$ 0.34	$ 2.40		$ 3.84	$ 3.22	$ (0.62)	
2037	$ 1,718,000	$ 0.35	$ 2.43		$ 3.99	$ 1.82	$ (2.17)	
2038	$ 1,770,000	$ 0.35	$ 2.45		$ 4.14	$ -	$ (4.14)	
2039	$ 2,022,000	$ 0.39	$ 2.74		$ 4.02	$ -	$ (4.02)	
2040	$ 2,083,000	$ 0.39	$ 2.76		$ 4.16	$ -	$ (4.16)	

	Alternative 3							
	O&M Costs	Cost/kgal	Cost/Avg Res	Monthly O&M Savings	Capital Impact/Bill	Net Impact
2017					$ 4.77	$ 4.77
2018	$ 1,213,000	$ 0.41	$ 2.90	$ 1.16	$ 11.13	$ 9.98
2019	$ 1,240,000	$ 0.41	$ 2.86	$ 1.30	$ 10.81	$ 9.51
2020	$ 1,260,000	$ 0.40	$ 2.81	$ 1.46	$ 10.50	$ 9.04
2021	$ 1,286,000	$ 0.40	$ 2.77	$ 1.60	$ 10.19	$ 8.58
2022	$ 1,389,000	$ 0.42	$ 2.91	$ 1.60	$ 9.89	$ 8.29
2023	$ 1,522,000	$ 0.44	$ 3.09	$ 1.53	$ 9.60	$ 8.07
2024	$ 1,572,000	$ 0.44	$ 3.09	$ 1.57	$ 9.33	$ 7.76
2025	$ 1,604,000	$ 0.44	$ 3.06	$ 1.71	$ 9.05	$ 7.34
2026	$ 1,637,000	$ 0.43	$ 3.03	$ 1.85	$ 8.79	$ 6.94
2027	$ 1,671,000	$ 0.43	$ 3.01	$ 1.99	$ 8.53	$ 6.55
2028	$ 1,795,000	$ 0.45	$ 3.14	$ 1.97	$ 8.29	$ 6.32
2029	$ 1,833,000	$ 0.45	$ 3.14	$ 2.12	$ 8.04	$ 5.92
2030	$ 1,872,000	$ 0.45	$ 3.12	$ 2.27	$ 7.81	$ 5.54
2031	$ 1,911,000	$ 0.44	$ 3.11	$ 2.41	$ 7.58	$ 5.17
2032	$ 2,063,000	$ 0.47	$ 3.27	$ 2.39	$ 7.36	$ 4.98
2033	$ 2,208,000	$ 0.49	$ 3.41	$ 2.38	$ 7.14	$ 4.76
2034	$ 2,253,000	$ 0.49	$ 3.40	$ 2.54	$ 6.94	$ 4.40
2035	$ 2,299,000	$ 0.48	$ 3.39	$ 2.70	$ 6.74	$ 4.04
2036	$ 2,346,000	$ 0.48	$ 3.38	$ 2.86	$ 6.54	$ 3.68
2037	$ 2,395,000	$ 0.48	$ 3.39	$ 3.04	$ 3.70	$ 0.66
2038	$ 2,564,000	$ 0.51	$ 3.55	$ 3.04	$ -	$ (3.04)
2039	$ 2,815,000	$ 0.54	$ 3.81	$ 2.94	$ -	$ (2.94)
2040	$ 2,875,000	$ 0.54	$ 3.81	$ 3.11	$ -	$ (3.11)

	Alternative 3 A					
	O&M Costs	Cost/kgal	Cost/Avg Res	Monthly O&M Savings	Capital Impact/Bill	Net Impact
2017					$ 2.92	$ 2.92
2018	$ 984,000	$ 0.34	$ 2.36	$ 1.70	$ 6.81	$ 5.11
2019	$ 1,017,000	$ 0.34	$ 2.35	$ 1.81	$ 6.61	$ 4.80
2020	$ 1,044,000	$ 0.33	$ 2.33	$ 1.94	$ 6.42	$ 4.49
2021	$ 1,078,000	$ 0.33	$ 2.32	$ 2.05	$ 6.23	$ 4.18
2022	$ 1,115,000	$ 0.33	$ 2.34	$ 2.17	$ 6.05	$ 3.88
2023	$ 1,254,000	$ 0.36	$ 2.54	$ 2.08	$ 5.88	$ 3.80
2024	$ 1,268,000	$ 0.36	$ 2.49	$ 2.17	$ 5.71	$ 3.54
2025	$ 1,307,000	$ 0.36	$ 2.49	$ 2.27	$ 5.54	$ 3.26
2026	$ 1,348,000	$ 0.36	$ 2.50	$ 2.38	$ 5.38	$ 3.00
2027	$ 1,389,000	$ 0.36	$ 2.50	$ 2.49	$ 5.22	$ 2.73
2028	$ 1,433,000	$ 0.36	$ 2.51	$ 2.60	$ 5.07	$ 2.47
2029	$ 1,476,000	$ 0.36	$ 2.53	$ 2.73	$ 4.92	$ 2.19
2030	$ 1,523,000	$ 0.36	$ 2.54	$ 2.85	$ 4.78	$ 1.93
2031	$ 1,569,000	$ 0.36	$ 2.55	$ 2.97	$ 4.64	$ 1.67
2032	$ 1,640,000	$ 0.37	$ 2.60	$ 3.06	$ 4.51	$ 1.45
2033	$ 1,690,000	$ 0.37	$ 2.61	$ 3.18	$ 4.37	$ 1.19
2034	$ 1,741,000	$ 0.38	$ 2.63	$ 3.31	$ 4.25	$ 0.94
2035	$ 1,794,000	$ 0.38	$ 2.65	$ 3.44	$ 4.12	$ 0.68
2036	$ 1,848,000	$ 0.38	$ 2.66	$ 3.58	$ 4.00	$ 0.43
2037	$ 1,904,000	$ 0.38	$ 2.69	$ 3.73	$ 2.26	$ (1.47)
2038	$ 1,961,000	$ 0.39	$ 2.72	$ 3.87	$ -	$ (3.87)
2039	$ 2,217,000	$ 0.43	$ 3.00	$ 3.75	$ -	$ (3.75)
2040	$ 2,283,000	$ 0.43	$ 3.03	$ 3.90	$ -	$ (3.90)

	Alternative 4					
	O&M Costs	Cost/kgal	Cost/Avg Res.	Monthly O&M Savings	Capital Impact Bill	Net Impact
2017					$ 4.56	**$ 4.56**
2018	$ 1,230,000	$ 0.42	$ 2.95	**$ 1.12**	$ 10.64	**$ 9.52**
2019	$ 1,254,000	$ 0.41	$ 2.89	**$ 1.27**	$ 10.33	**$ 9.06**
2020	$ 1,277,000	$ 0.41	$ 2.84	**$ 1.42**	$ 10.03	**$ 8.61**
2021	$ 1,300,000	$ 0.40	$ 2.80	**$ 1.57**	$ 9.73	**$ 8.16**
2022	$ 1,325,000	$ 0.40	$ 2.78	**$ 1.73**	$ 9.45	**$ 7.72**
2023	$ 1,353,000	$ 0.39	$ 2.74	**$ 1.88**	$ 9.17	**$ 7.30**
2024	$ 1,494,000	$ 0.42	$ 2.94	**$ 1.72**	$ 8.91	**$ 7.19**
2025	$ 1,604,000	$ 0.44	$ 3.06	**$ 1.71**	$ 8.64	**$ 6.94**
2026	$ 1,634,000	$ 0.43	$ 3.03	**$ 1.85**	$ 8.40	**$ 6.54**
2027	$ 1,666,000	$ 0.43	$ 3.00	**$ 2.00**	$ 8.15	**$ 6.16**
2028	$ 1,698,000	$ 0.42	$ 2.97	**$ 2.14**	$ 7.92	**$ 5.78**
2029	$ 1,730,000	$ 0.42	$ 2.96	**$ 2.30**	$ 7.68	**$ 5.38**
2030	$ 1,763,000	$ 0.42	$ 2.94	**$ 2.45**	$ 7.46	**$ 5.01**
2031	$ 1,796,000	$ 0.42	$ 2.92	**$ 2.60**	$ 7.24	**$ 4.64**
2032	$ 2,148,000	$ 0.49	$ 3.40	**$ 2.25**	$ 7.03	**$ 4.78**
2033	$ 2,193,000	$ 0.48	$ 3.39	**$ 2.40**	$ 6.82	**$ 4.42**
2034	$ 2,346,000	$ 0.51	$ 3.54	**$ 2.40**	$ 6.63	**$ 4.23**
2035	$ 2,437,000	$ 0.51	$ 3.59	**$ 2.49**	$ 6.43	**$ 3.94**
2036	$ 2,489,000	$ 0.51	$ 3.59	**$ 2.65**	$ 6.25	**$ 3.60**
2037	$ 2,542,000	$ 0.51	$ 3.60	**$ 2.83**	$ 3.54	**$ 0.71**
2038	$ 2,595,000	$ 0.51	$ 3.59	**$ 2.99**	$ -	**$ (2.99)**
2039	$ 2,649,000	$ 0.51	$ 3.59	**$ 3.17**	$ -	**$ (3.17)**
2040	$ 2,704,000	$ 0.51	$ 3.59	**$ 3.34**	$ -	**$ (3.34)**

	Alternative 4A					
	O&M Costs	Cost/kgal	Cost/Avg Res.	Monthly O&M Savings	Capital Impact Bill	Net Impact
2017					$ 3.70	**$ 3.70**
2018	$ 1,261,000	$ 0.43	$ 3.02	**$ 1.04**	$ 8.64	**$ 7.60**
2019	$ 1,305,000	$ 0.43	$ 3.01	**$ 1.15**	$ 8.39	**$ 7.24**
2020	$ 1,351,000	$ 0.43	$ 3.01	**$ 1.25**	$ 8.15	**$ 6.89**
2021	$ 1,399,000	$ 0.43	$ 3.01	**$ 1.36**	$ 7.91	**$ 6.55**
2022	$ 1,449,000	$ 0.43	$ 3.04	**$ 1.47**	$ 7.68	**$ 6.20**
2023	$ 1,501,000	$ 0.43	$ 3.04	**$ 1.58**	$ 7.45	**$ 5.88**
2024	$ 1,625,000	$ 0.46	$ 3.19	**$ 1.46**	$ 7.24	**$ 5.77**
2025	$ 1,784,000	$ 0.49	$ 3.40	**$ 1.36**	$ 7.02	**$ 5.66**
2026	$ 1,843,000	$ 0.49	$ 3.41	**$ 1.46**	$ 6.82	**$ 5.36**
2027	$ 1,905,000	$ 0.49	$ 3.43	**$ 1.57**	$ 6.62	**$ 5.06**
2028	$ 1,969,000	$ 0.49	$ 3.45	**$ 1.67**	$ 6.43	**$ 4.77**
2029	$ 2,035,000	$ 0.50	$ 3.48	**$ 1.78**	$ 6.24	**$ 4.46**
2030	$ 2,104,000	$ 0.50	$ 3.51	**$ 1.88**	$ 6.06	**$ 4.18**
2031	$ 2,175,000	$ 0.50	$ 3.53	**$ 1.99**	$ 5.88	**$ 3.90**
2032	$ 2,264,000	$ 0.51	$ 3.59	**$ 2.07**	$ 5.71	**$ 3.65**
2033	$ 2,341,000	$ 0.52	$ 3.62	**$ 2.18**	$ 5.54	**$ 3.37**
2034	$ 2,421,000	$ 0.52	$ 3.65	**$ 2.28**	$ 5.38	**$ 3.10**
2035	$ 2,544,000	$ 0.54	$ 3.75	**$ 2.34**	$ 5.23	**$ 2.89**
2036	$ 2,631,000	$ 0.54	$ 3.79	**$ 2.45**	$ 5.08	**$ 2.63**
2037	$ 2,720,000	$ 0.55	$ 3.85	**$ 2.58**	$ 2.87	**$ 0.30**
2038	$ 2,813,000	$ 0.56	$ 3.89	**$ 2.69**	$ -	**$ (2.69)**
2039	$ 2,909,000	$ 0.56	$ 3.94	**$ 2.81**	$ -	**$ (2.81)**
2040	$ 3,008,000	$ 0.57	$ 3.99	**$ 2.94**	$ -	**$ (2.94)**


Projected Bill Impact to 7 kGal Customer
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Alternative 2
Alternative 3
Alternative 3A
Alternative 4
Alternative 4A