

Biowater Technology & Pivotal's Advanced Gasification

West Side Solutions

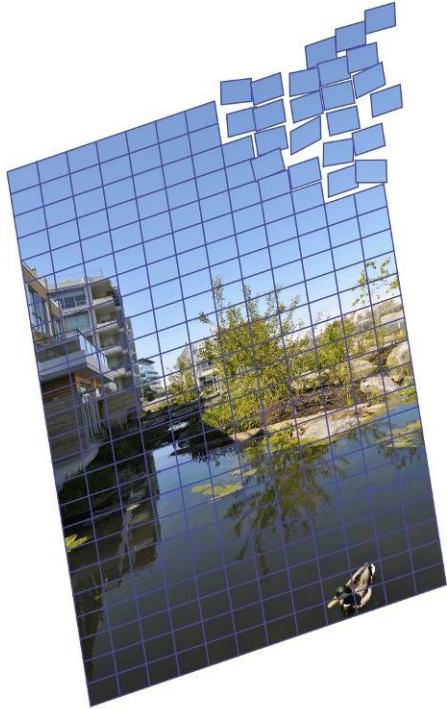
30 April, 2015

Graeme Bethell
Chris Corps
Laura Marcolini
Jack Gardiner

Introduction : Integrated Wastewater Treatment Solutions

- Wastewater Treatment
 - ◆ Liquid waste treatment
 - ◆ Norwegian
 - ◆ Fabricated in US, Canada, Norway
- Advanced Gasification
 - ◆ Turns sludge into energy & more
 - ◆ US, Austria & Italy
 - ◆ Fabricated in Sidney BC & the US
- Integrated Resource Management
 - ◆ Optimizes efficiencies, resource recovery
 - ◆ Combined business case





Biowater Technology

Continuous Flow Intermittent Cleaning

Liquid Waste Treatment

Proposed System

Primary Treatment

Salsnes Filter



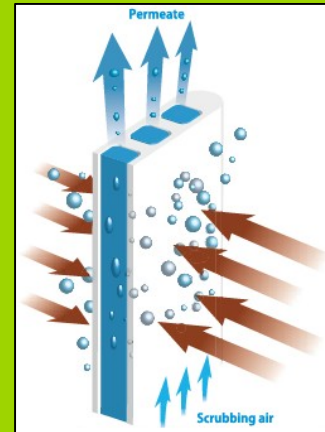
Secondary Treatment

CFIC[®] System



Tertiary Treatment

Ceramic Membranes



Sludge Management

Advanced Gasifier

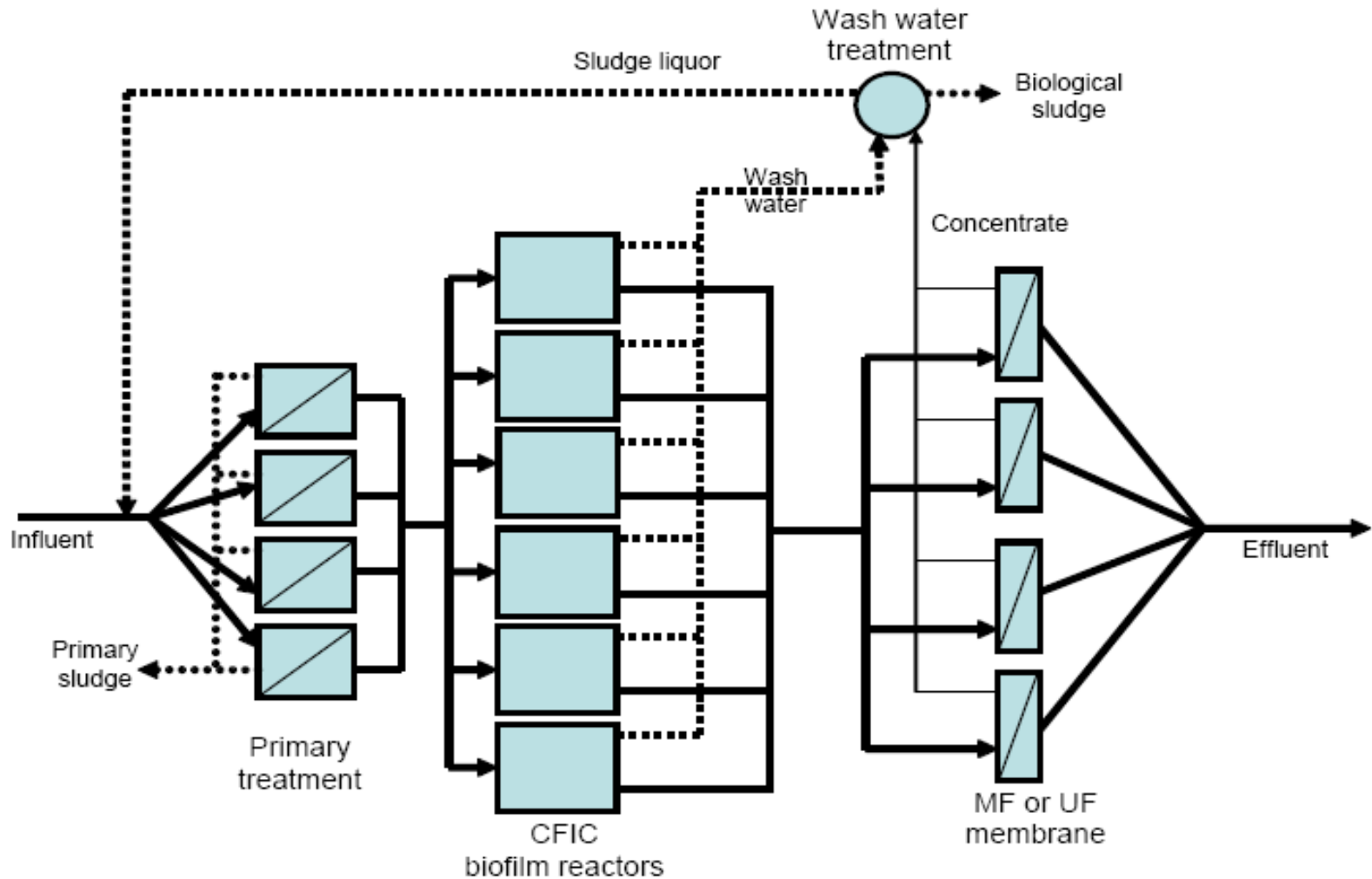


Process

- Grit and trash removed
- Primary treatment is screened to separate sludge and water
 - ◆ Designed for 4x avg. dry weather flow
- CFIC[®] biofilm cubes provide secondary treatment to remove organic material
 - ◆ Designed for 2x avg. dry weather flow
 - ◆ Removes nitrogen
 - ◆ Exceeds treatment standards
- Sludge → thickened → gasifier
- Tertiary treatment using ceramic membrane
 - ◆ Long life, low maintenance



Simple Modular Expansion



Project	Client	Nature	New/upgrade	Year/status	Country	Type	ML/day	BOD mg/L	Media Type/ Quantity m ³
1 Vike RA	Hof Kommune	Municipal	Upgrade	2009	Norway	A	1.68 MLd	182	BWT-X/30
2 Kimberly Clark	Haztec	Pulp, Paper	Upgrade	2009	Brazil	B	4.80 MLd	600	BWT35/10
3 Standard Process	Environmental Health	Food & Bev	Upgrade	2009	USA	D	0.77 MLd	1,500	BWT-X/35
4 Trysil RA	Municipality of Trysil	Municipal	New	2010	Norway	E	10.73 MLd	225	BWT-X/252
5 Vigor, Sao Paulo	Acqua Engenharia	Dairy	Upgrade	2010	Brazil	B	1.20 MLd	1,800	BWT35/246
6 Harestua RA	Municipality of Lunnar	Municipal	Upgrade	2011	Norway	F	1.92 MLd	180	BWT-X/58
7 Elverom RA	Norde Land Municipality	Municipal	Upgrade	2011	Norway	B	0.24 MLd	150	BWT-X/8
8 Medite	Evergreen Engineering	Pulp, Paper	Upgrade	2011	Ireland	B	1.20 MLd	2,000	BWT-X/143
9 Pachuca STP	Iberaltec	Municipal	Upgrade	2011	Mexico	D	8.64 MLd	350	BWT15/390
10 Sintek	Eco Digital	Electronics	Upgrade	2011	Taiwan	D	1.49 MLd	400	BWT35/380
11 Nordfjord Kjott	Nordfjord Kjott	Food & Bev	Upgrade	2011	Norway	C	0.58 MLd	1,650	BWT-X/57
12 Aaregau WWTP	JS Umwelttechnik	Municipal	Upgrade	2012	Switzerland	D	2.02 MLd	194	BWT15/84
13 Roros RA	Roros Kommune	Municipal	Upgrade	2012	Norway	A	4.80 MLd	186	BWTX/115
14 Flums	JS Umwelttechnik	Municipal	Upgrade	2012	Switzerland	D	3.60 MLd	200	BWT15/150
15 Wetico	Weitco	Industrial	New	2012	Saudi Arabia	A	2.02 MLd	250	BWTX/232
16 Kan PaK	Kan Pak	Food & Bev	New	2012	USA	A	0.98 MLd	2880	BWTX/300
17 Schoftland	JS Umwelttechnik	Municipal	Upgrade	2012	Switzerland	D	4.01 MLd	168	BWT15/205
18 Bloomingdale	Fleis & Vanderbrink Eng.	Municipal	Upgrade	2013	USA	A	0.46 MLd	575	BWTX/129
19 Barlidalen	Barlidalen Municipality	Municipal	Upgrade	2012	Norway	A	20.40 MLd	120	BWTX
20 Saignelegier	JS Umwelttechnik	Municipal	Upgrade	2012	Switzerland	A	1.44 MLd	233	BWT15/193
21 Langmatt	JS Umwelttechnik	Municipal	Upgrade	2012	Switzerland	D	28.70 MLd	91	BWT15/496
22 Teck Coal	H ₂ Flow	Mining	New	Under Constrn	Canada	A	7.90 MLd	40	BWTX/141
23 Johanna Foods	Johanna Foods	Food & Bev	Upgrade	Under Constrn	USA	G	1.51 MLd	4500	BWTX/561
24 RPM	H ₂ Flow	Plastics Recycling	New	Under Constrn	Canada	A	0.20 MLd	737	BWTX/9
25 Wickford Village	Ricci Drain-Laying Co., Inc.	Municipal Package Plant	New	2013	USA	D	0.10 MLd	12	BWTX/9
26 Garcia, Blummenau	Memphis Empreendimentos	Municipal	New	2013	Brazil	A	11.35 MLd	84	BWTX/120
27 Camp Neosa	Stephen Buckley	Municipal Package Plant	New	2013	USA	A	0.10 MLd	250	BWTX
28 Vitasoy	Vitasoy	Food & Bev	Upgrade	Under Constrn	USA	G	0.57 MLd	7,000	BWT-S
29 Givaudan Fragrance	Process Equipment Sales	Pharmaceutical New	New	New/Design	USA	G	0.15 MLd	5,000	BWTX
30 Waste Management	Aqua Tec	Leachate	Upgrade	2013	USA	A	0.04 MLd	500	BWTX
31 Vigor - Lima Duarte (MG)	Memphis	Food & Bev Dairy	Upgrade	2013-2014	Brazil	A	0.50 MLd	2,500	BWTX/108
32 Vigor - Santa Rita de Ibitipoca (MG)	Memphis	Food & Bev Dairy	Upgrade	2013-2014	Brazil	A	0.25 MLd	2,500	BWTX/54
33 Norsk Spesialolje	NSO AS	Industrial	New	2013	Norway	G	0.19 MLd	120	BWT X
34 Saulekilen RA	Sweco AS	Municipal	Upgrade	2014	Norway	A	25.44 MLd	200	BWT15

Type of technology

A CMFF®
B CMFF®(MBBR)
C CMFF®(MBBR)/Chemical Precip
D CFAS®
E CFAS®/ Flotation
F CFAS®/ Flotation (turnkey)
G CFIC®

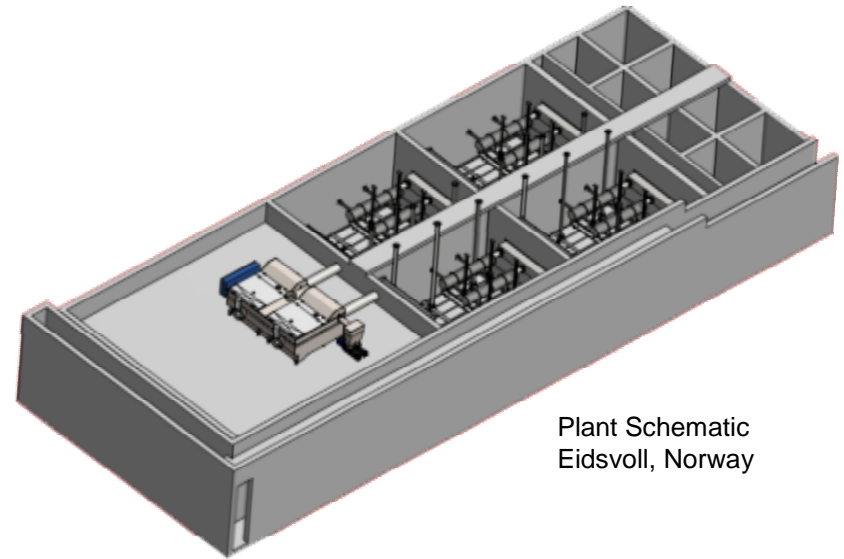
West Side Treatment Example

- CRD specification
 - ◆ 2x dry weather flow
 - ◆ Secondary treatment
 - ◆ Discharge to sea
- Biowater/Pivotal approach
 - ◆ 2x dry weather flow
 - ◆ Tertiary disinfected
 - ◆ Recycle water or recharge creeks
 - ◆ 25m x 50m footprint
- Differences
 - ◆ 2km outfall
 - ◆ Near-waterfront or waterfront siting
 - ◆ Footprint, just-in-time expansion
 - ◆ Capital & operating cost, debt impacts

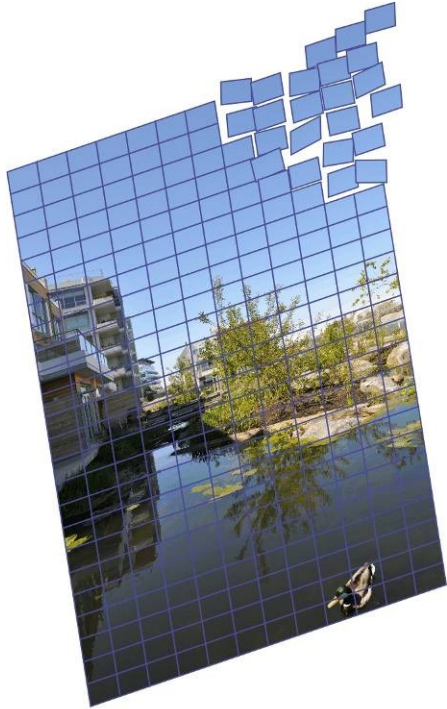


CFIC® System Benefits

- Enables distributed tertiary treatment
 - ◆ Low capital and operating costs
 - ◆ Highly scalable and compact
 - ◆ Modular design
- Avoids over-building large systems
 - ◆ Expand as/when/where needed
 - ◆ Minimizes taxpayer debt
- Dewateres sludge on-site
- Concentrates & manages hazardous & toxic compounds
- Reduce greenhouse gas emissions
- Maximizes resource recovery



Plant Schematic
Eidsvoll, Norway

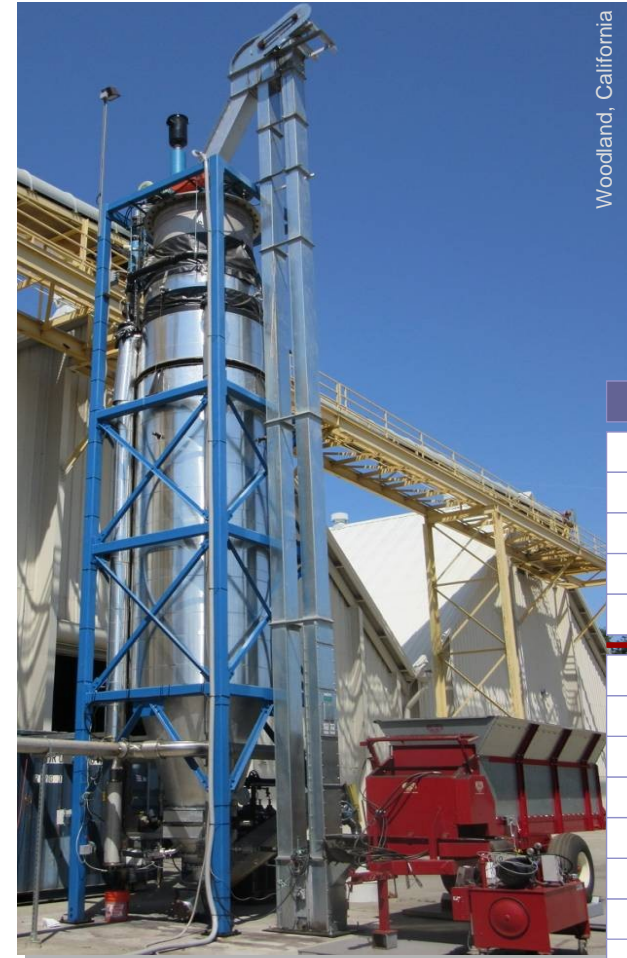


Pivotal IRM

Advanced Gasification

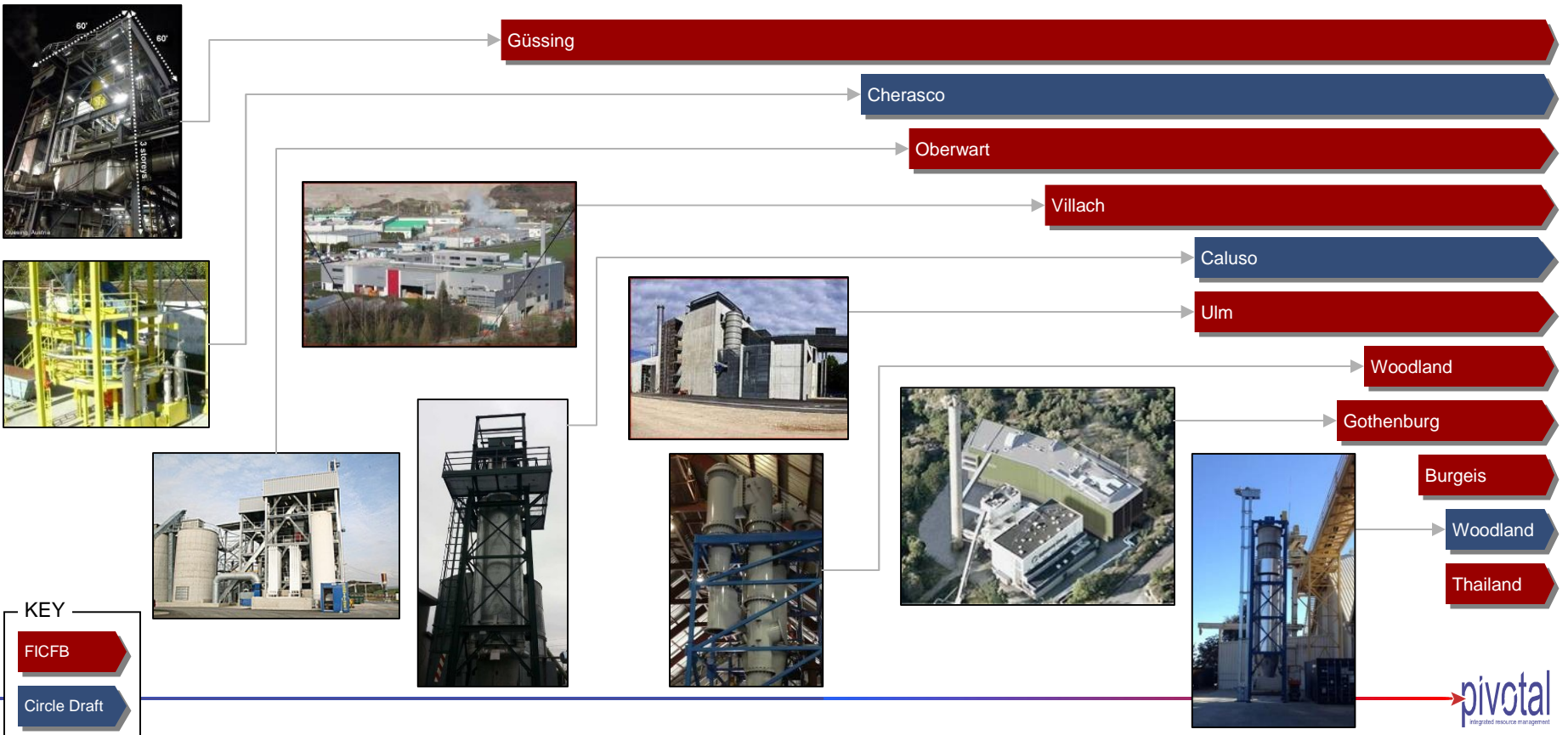
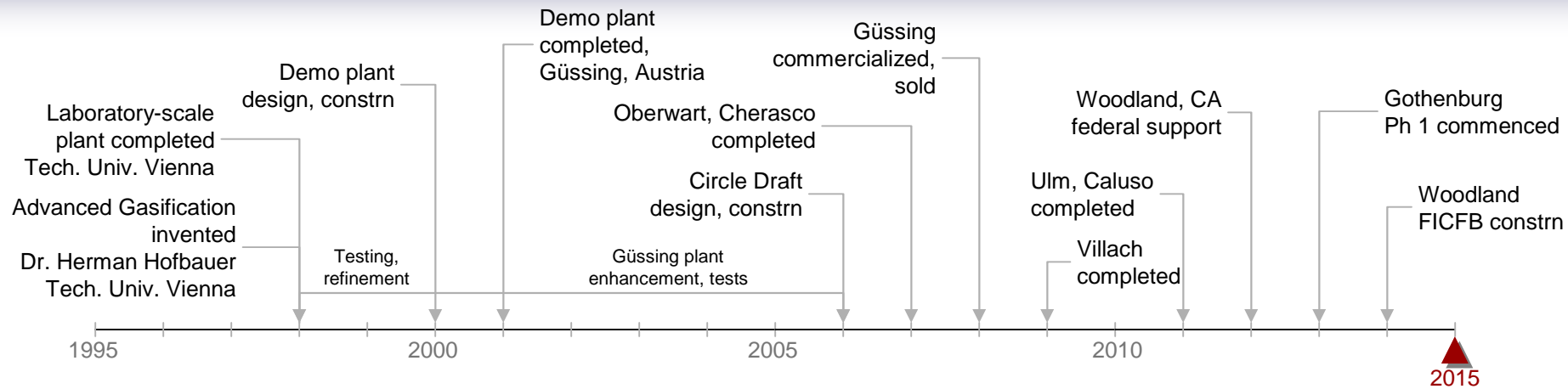
Technology

- Circle Draft Advanced Gasifier
 - ◆ Steam reformer – not incineration
 - ◆ Modified updraft gasification process
 - ◆ Developed since 2007
- Modular system
 - ◆ Single unit: 11 tonnes biomass/waste per day
 - Multi-unit systems for CRD
 - ◆ Feedstock: wood, MSW/RDF, sludge, etc
 - ◆ ≈12 months delivery
- Output
 - ◆ Energy
 - Heating, cooling
 - 500 kW electricity and 790 kW heat (ea.)
 - ◆ Biochar and ash
 - ◆ Distilled water
 - ◆ Emissions: ≈natural gas boiler



Woodland, California

Composition	
H ₂	20-33%
CO	16-47%
CH ₄	~2-4%
CO ₂	~0-14%
H ₂ :CO	1:1
C ₂ H ₄	2-3%
C ₂ H ₆	~0.5%
C ₂ H ₂	~0.4%
O ₂	< 0.1%
N ₂	1-3%
C ₆ H ₆	~8g/m ³
C ₇ H ₈	~0,5g/m ³
C ₁₀ H ₈	~2g/m ³
TARS	~20mg/m ³

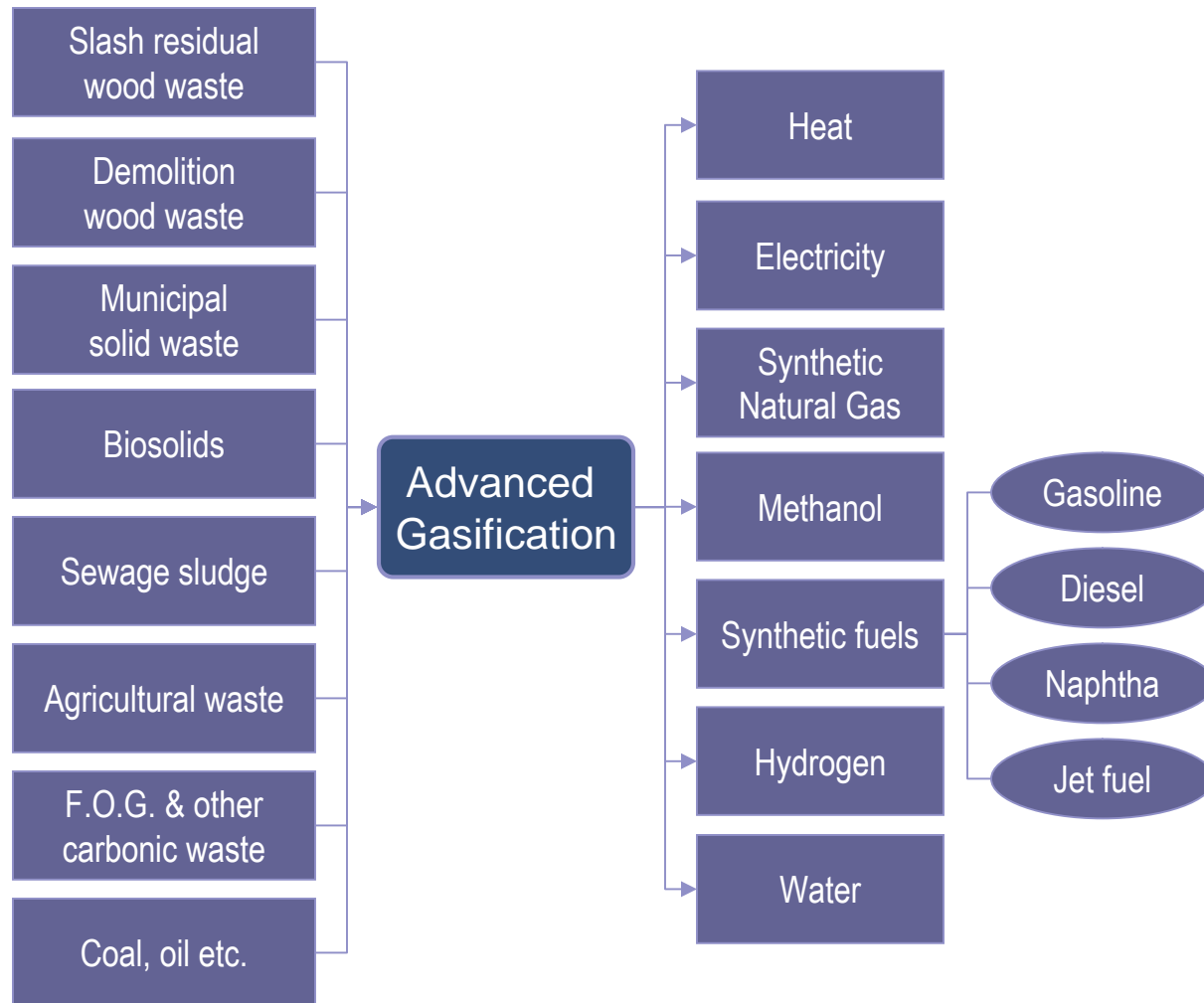


Sludge Options – Circle Draft Advanced Gasifier

- Three operating plants
 - ◆ Cherasco & Caluso, Italy – 2007, 2011
 - ◆ Woodland, CA – Under commissioning
 - ◆ **50/50 mix of sludge/biomass**
 - ◆ Several more in planning/development
- Benefits
 - ◆ Extremely small, nearly silent, safe
 - ◆ Low Capital and Operating costs
 - ◆ Generate green energy
 - Heating, cooling & power
 - Clean as natural gas
 - Complies with Clean Energy Act
 - ◆ Increases recycling
 - ◆ Address ≈60% of Hartland's volume



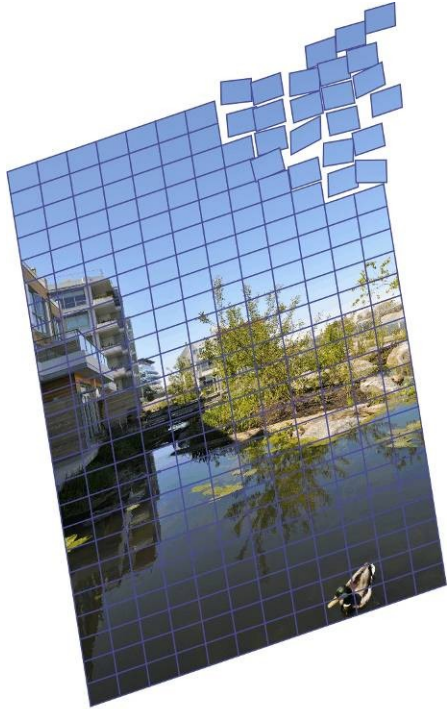
Inputs/Outputs: Polygeneration



Advanced Gasification Benefits

- Highly scalable, compact & modular
- Fraction of the cost of anaerobic digestion
- Destroys drug resistant bacteria, micro plastics and fibres, endocrine disruptors
- Reduces greenhouse gas emissions
- Maximizes resource recovery, improves recycling, maximizes diversion
- Stimulates economic development
 - ◆ Local jobs
 - ◆ Local energy, R&D, manufacturing
 - ◆ Training and education
 - ◆ Tourism
- Flagship for green energy/sustainability



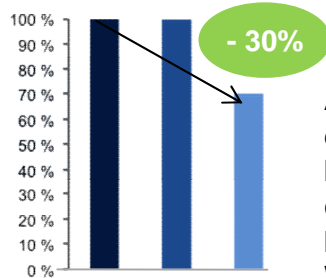


Putting It All Together

Why Integration Pays

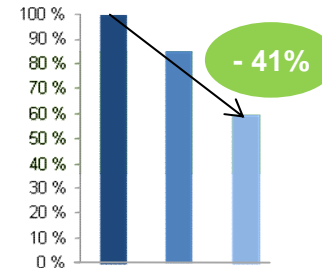
Biowater Benefits

Energy consumption



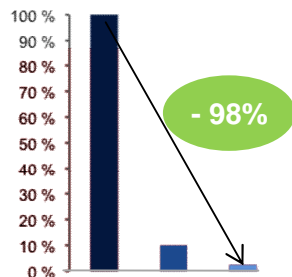
A higher oxygen transfer rate, due to a longer lifetime of the air bubbles, leads to lower energy consumption for air sparging. The biological treatment stage of a WWTP accounts for 2/3 of its total power consumption.

CAPEX



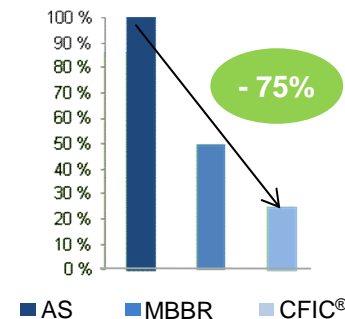
CFIC® can be integrated into existing WWTP, utilising many of the existing infrastructure.

Solids in effluent



CFIC® produces lower total suspended solids (TSS) concentrations than MBBR process, even at higher significantly higher wastewater loading rates.

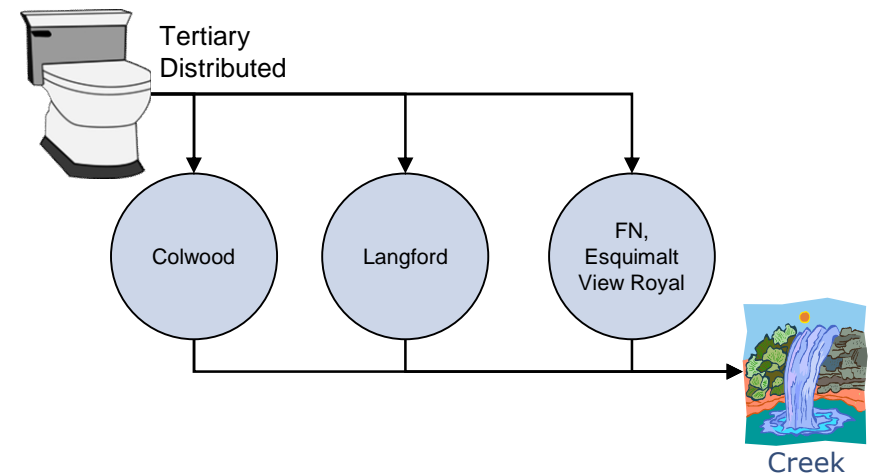
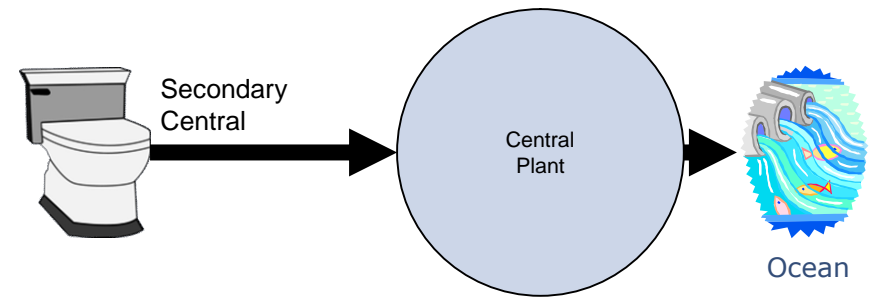
Space required



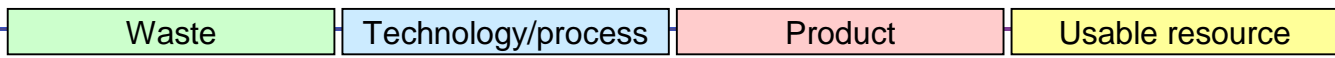
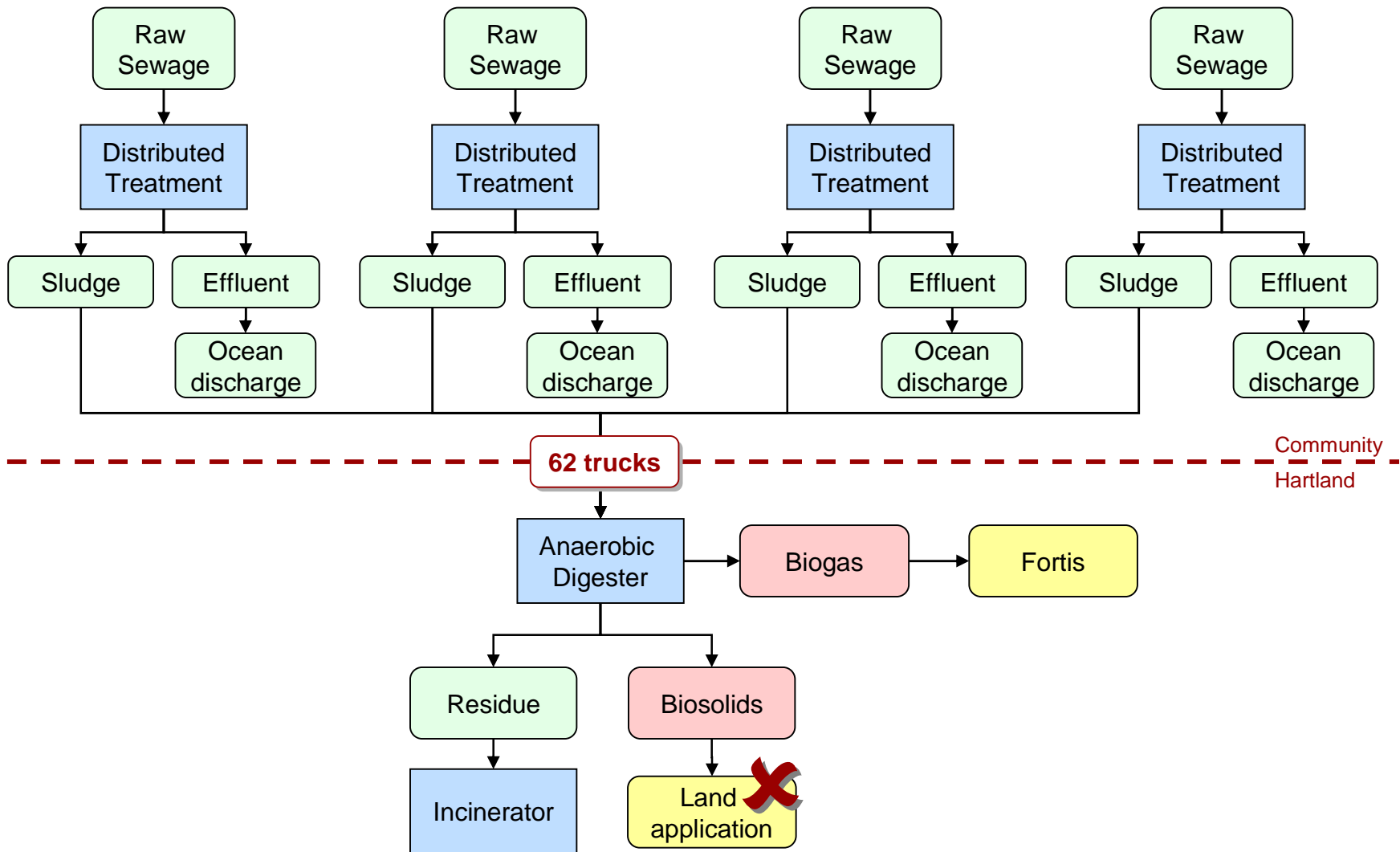
CFIC® allows 20% more compact bioreactors compared to MBBR due to its optimized process and biocarrier design.

Distributed vs. Centralized

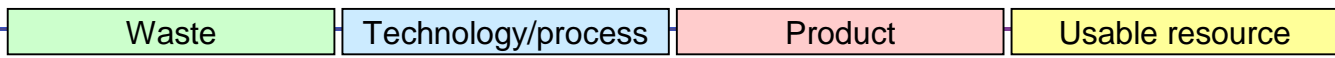
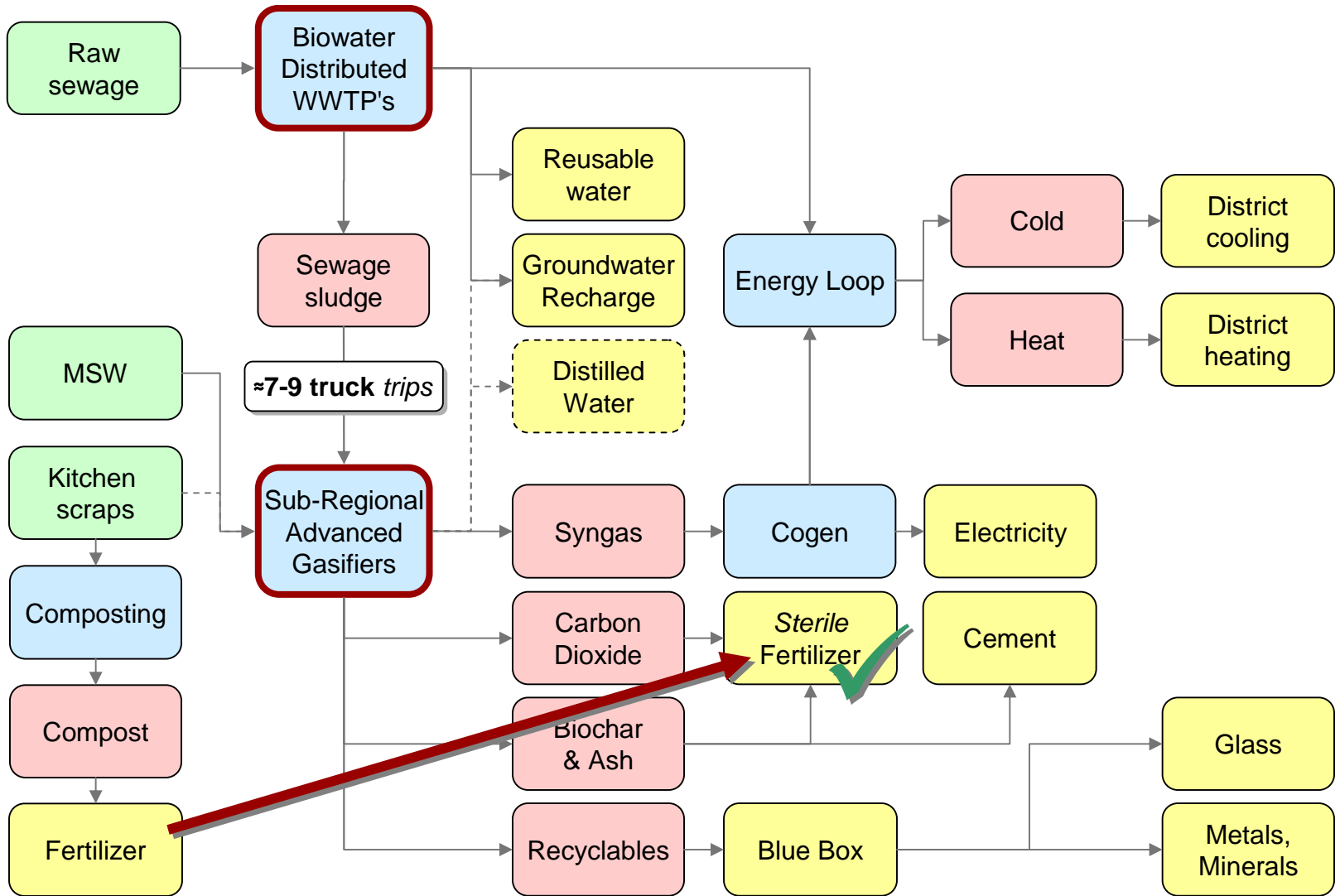
- Technologies suitable for either
- Distributed has advantages
 - ◆ Little difference in cost
 - ◆ Resilience & risk management
 - ◆ Localized expansion as/when/where needed
 - ◆ Reduced initial capital cost
 - ◆ Reduced operating cost
 - ◆ Reduced taxpayer charges and debt load
 - ◆ Considerably lower developer cost
 - ◆ Minimal site impact – locate in spare land
- Plus: public process



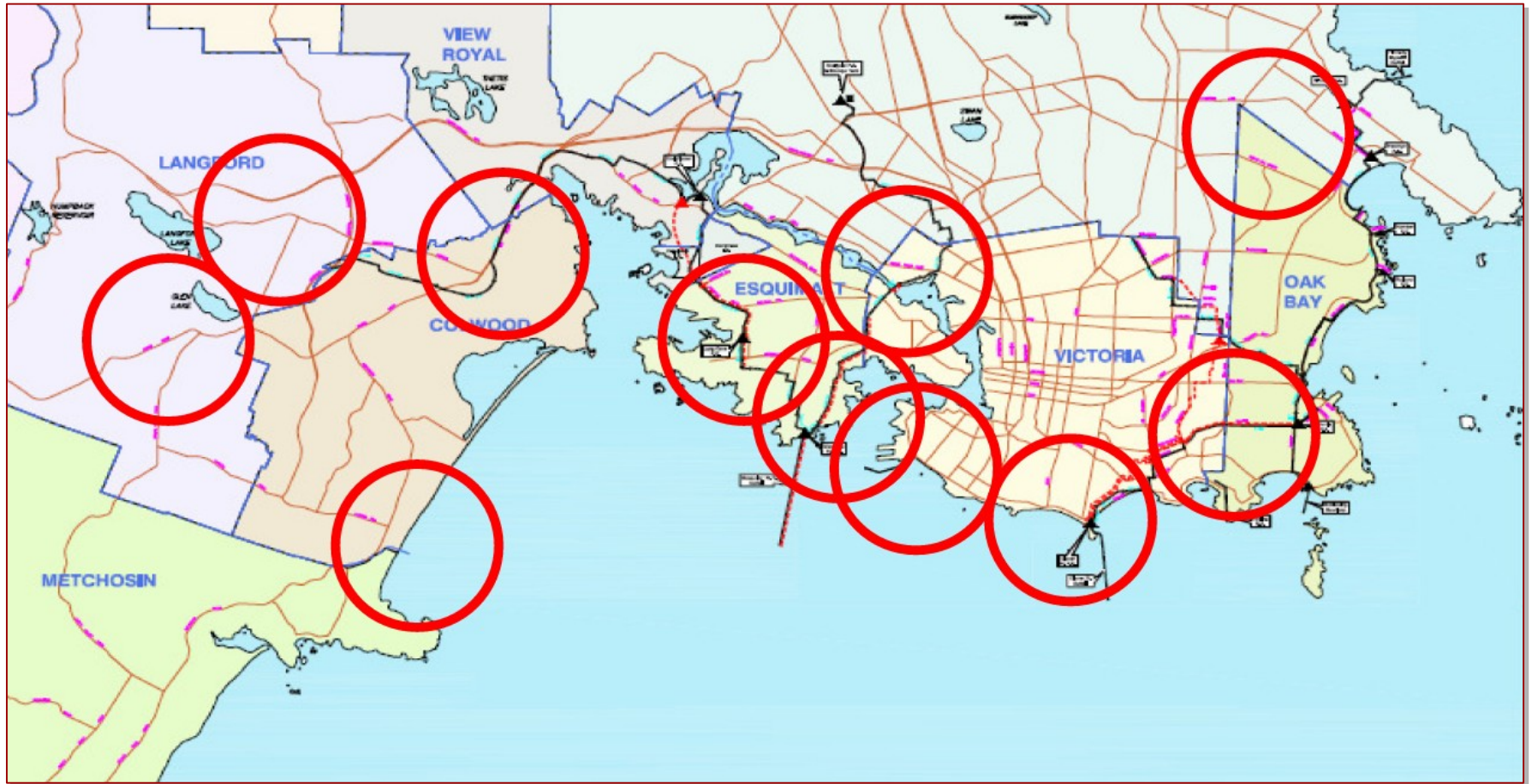
Distributed Variant of CRD Plan



Distributed Treatment & Advanced Gasification



CRD Distributed Site Options



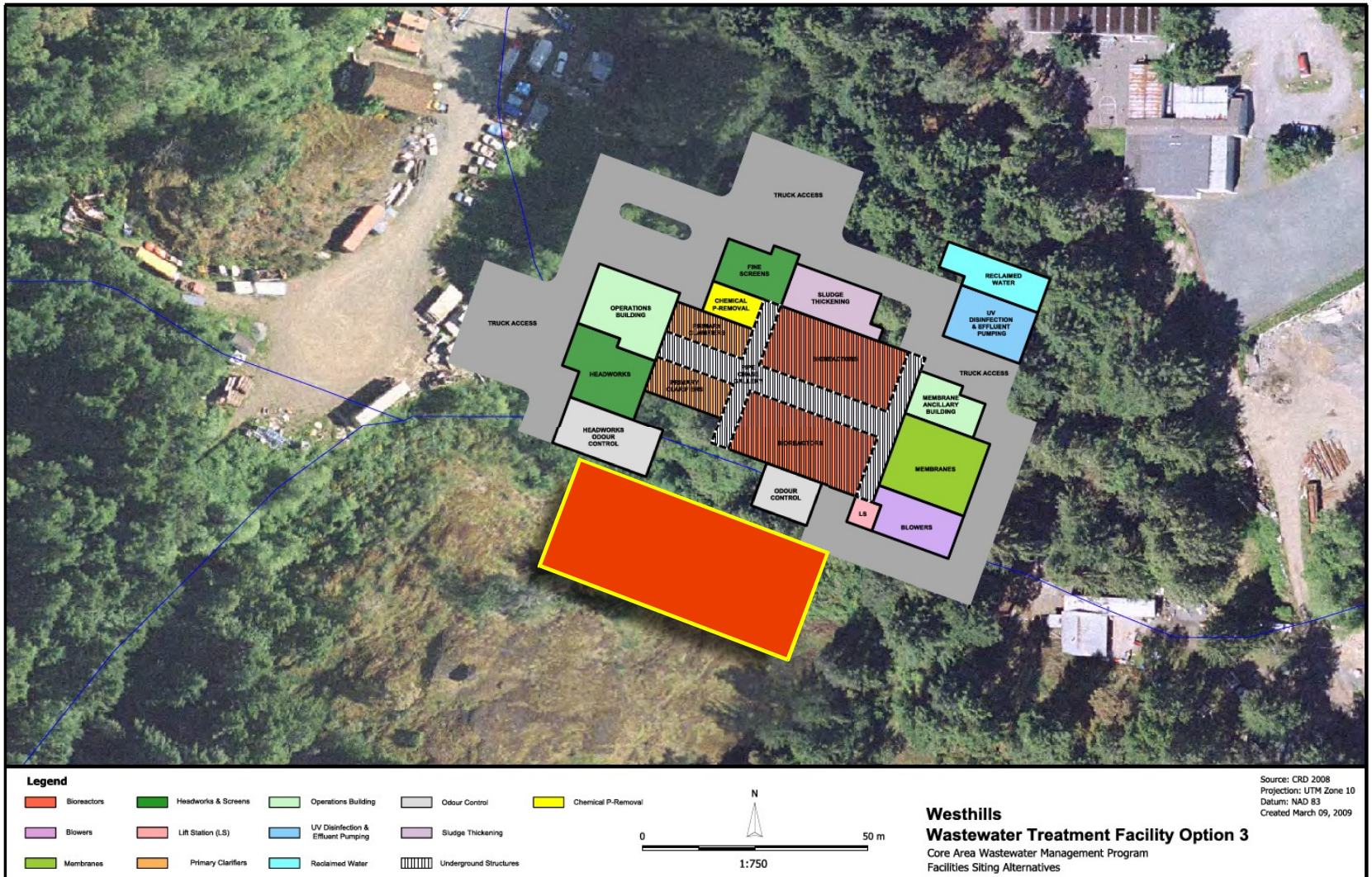
Source: CRD 036-DP-01/02

Plant Size



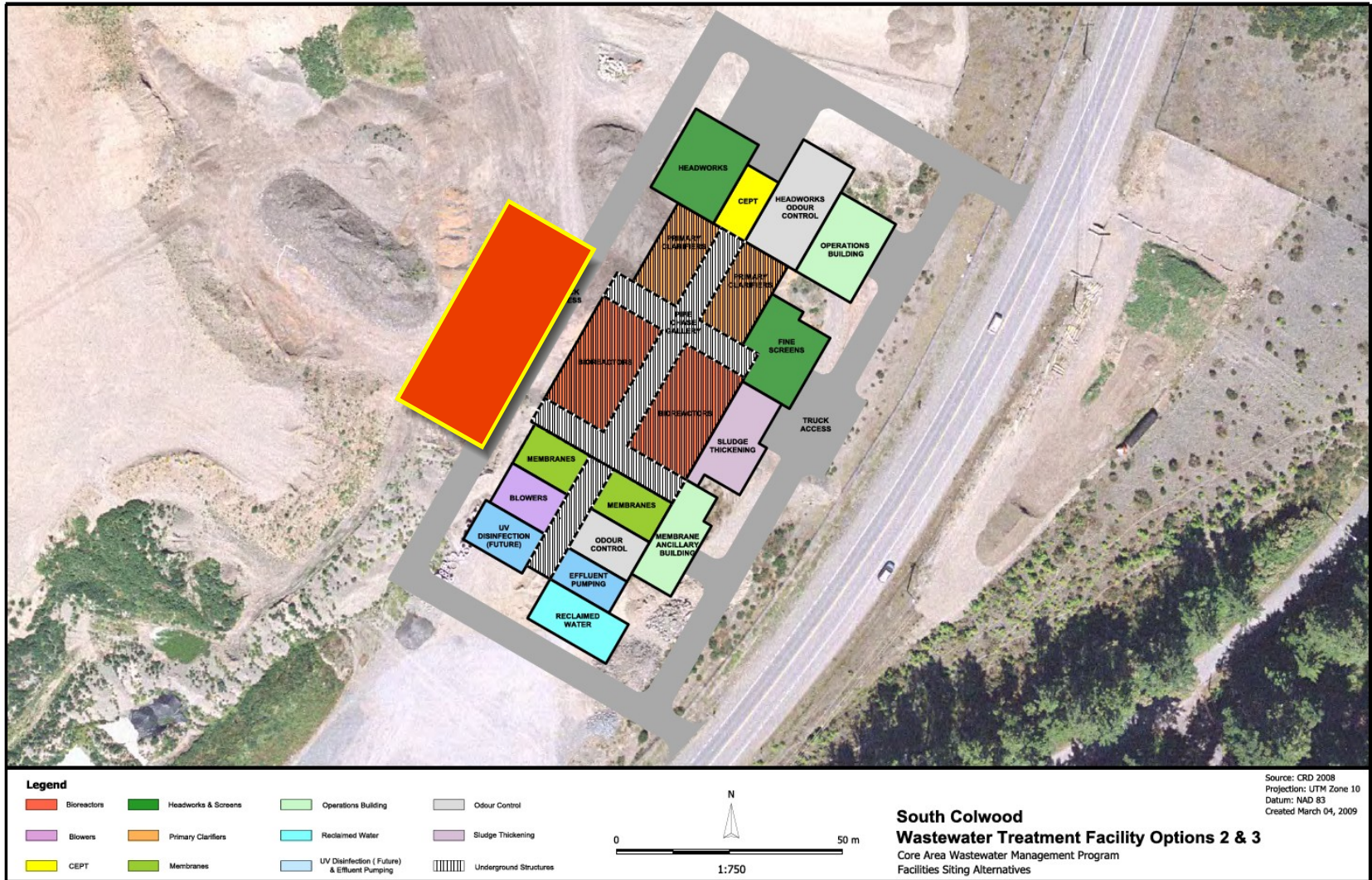
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Plant Size



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Plant Size



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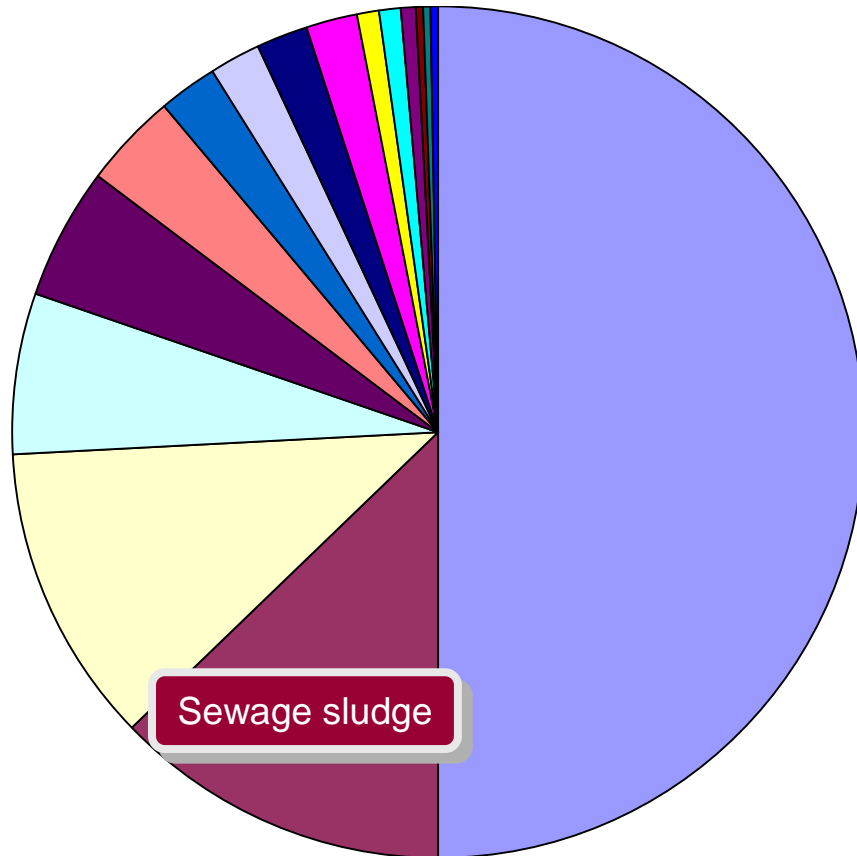
Plant Size



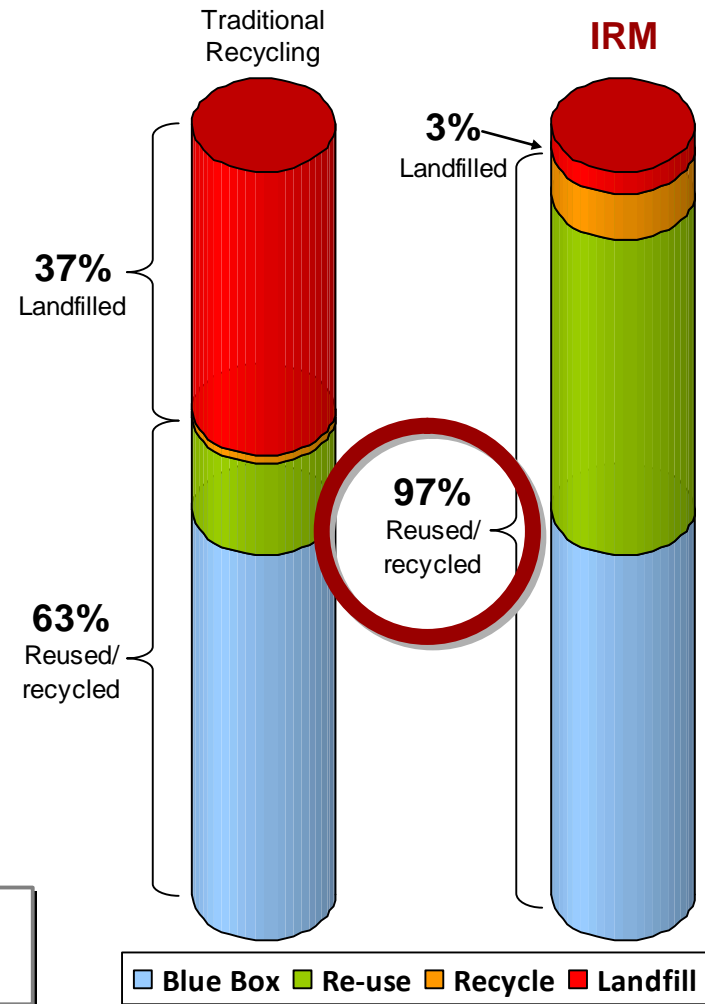
Source: CRD 036-DP-01/02

Incidental Benefit : 97% Maximum Diversion

Hartland Landfill Composition Study, 2011



Blue Box program	Sewage sludge	Organic Waste	Paper and Paperboard
Plastics	Wood and Wood Products	Construction and Demolition	Textiles
Composite Products	Other	Ferrous Metal	Glass
Electronics	Hazardous Waste	Rubber	Non-Ferrous Metal



Summary & Conclusions

- Technologies are proven & stable
- Small plant size empowers & enables options
- "Future proof"
 - ◆ Fast, economic technologies that exceed all environmental and financial standards
 - ◆ Scalable, J-I-T solutions
 - ◆ Simple to expand; reduces both current taxpayer and developers' costs
- Driven by a combined financial & environmental business case
 - ◆ *Focus: taxpayer & environmental value*



Woodland, California



Trysil, Norway

Questions



Thank you



UC San Diego

UC DAVIS
UNIVERSITY OF CALIFORNIA

