

O&MBG GENERAL SERVICES

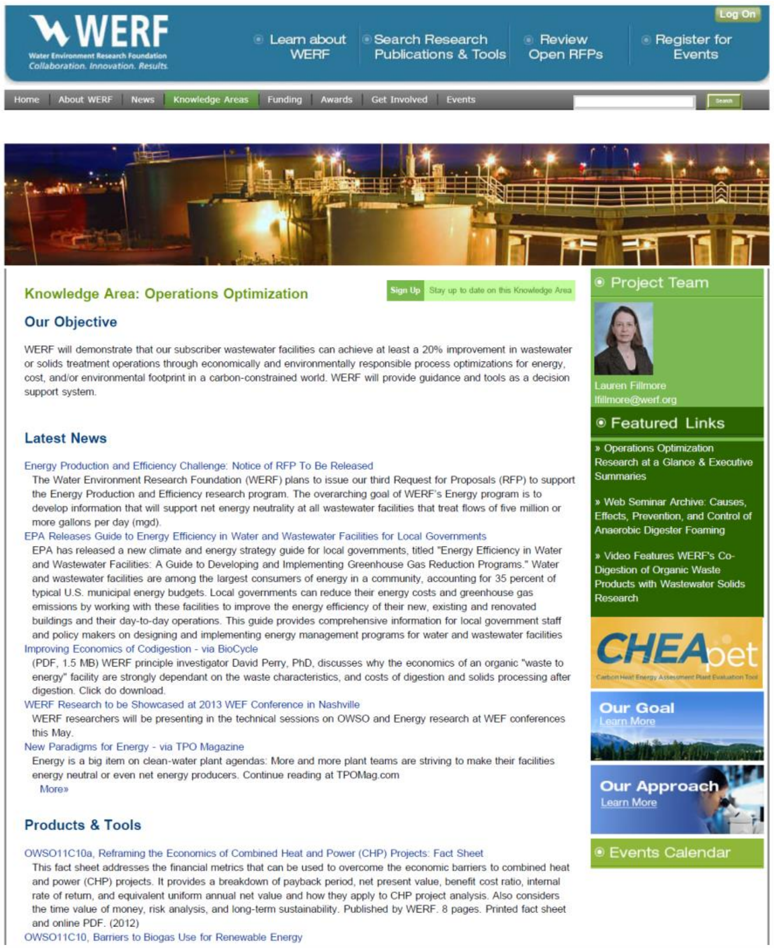
Process Optimization of Wastewater Treatment Plants

David Hackworth, P.E.

September 25, 2013

Many Resources Are Available to Assist You

Water Environment Research Foundation



WERF
Water Environment Research Foundation
Collaboration. Innovation. Results.

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Knowledge Area: Operations Optimization

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Our Objective

WERF will demonstrate that our subscriber wastewater facilities can achieve at least a 20% improvement in wastewater or solids treatment operations through economically and environmentally responsible process optimizations for energy, cost, and/or environmental footprint in a carbon-constrained world. WERF will provide guidance and tools as a decision support system.

Latest News

Energy Production and Efficiency Challenge: Notice of RFP To Be Released
The Water Environment Research Foundation (WERF) plans to issue our third Request for Proposals (RFP) to support the Energy Production and Efficiency research program. The overarching goal of WERF's Energy program is to develop information that will support net energy neutrality at all wastewater facilities that treat flows of five million or more gallons per day (mgd).

EPA Releases Guide to Energy Efficiency in Water and Wastewater Facilities for Local Governments
EPA has released a new climate and energy strategy guide for local governments, titled "Energy Efficiency in Water and Wastewater Facilities: A Guide to Developing and Implementing Greenhouse Gas Reduction Programs." Water and wastewater facilities are among the largest consumers of energy in a community, accounting for 35 percent of typical U.S. municipal energy budgets. Local governments can reduce their energy costs and greenhouse gas emissions by working with these facilities to improve the energy efficiency of their new, existing and renovated buildings and their day-to-day operations. This guide provides comprehensive information for local government staff and policy makers on designing and implementing energy management programs for water and wastewater facilities

Improving Economics of Codigestion - via BioCycle
(PDF, 1.5 MB) WERF principle investigator David Perry, PhD, discusses why the economics of an organic "waste to energy" facility are strongly dependant on the waste characteristics, and costs of digestion and solids processing after digestion. Click do download.

WERF Research to be Showcased at 2013 WEF Conference in Nashville
WERF researchers will be presenting in the technical sessions on OWSO and Energy research at WEF conferences this May.

New Paradigms for Energy - via TPO Magazine
Energy is a big item on clean-water plant agendas: More and more plant teams are striving to make their facilities energy neutral or even net energy producers. Continue reading at TPOMag.com
More»

Products & Tools

OWSO11C10a, Reframing the Economics of Combined Heat and Power (CHP) Projects: Fact Sheet
This fact sheet addresses the financial metrics that can be used to overcome the economic barriers to combined heat and power (CHP) projects. It provides a breakdown of payback period, net present value, benefit cost ratio, internal rate of return, and equivalent uniform annual net value and how they apply to CHP project analysis. Also considers the time value of money, risk analysis, and long-term sustainability. Published by WERF. 8 pages. Printed fact sheet and online PDF. (2012)

OWSO11C10, Barriers to Biogas Use for Renewable Energy

Project Team
Lauren Fillmore
lfillmore@werf.org

Featured Links
» Operations Optimization Research at a Glance & Executive Summaries
» Web Seminar Archive: Causes, Effects, Prevention, and Control of Anaerobic Digester Foaming
» Video Features WERF's Co-Digestion of Organic Waste Products with Wastewater Solids Research

CHEApet
Carbon Heat Energy Assessment Plant Evaluation Tool

Our Goal
Learn More

Our Approach
Learn More

Events Calendar

USEPA Energy Management Guidebook

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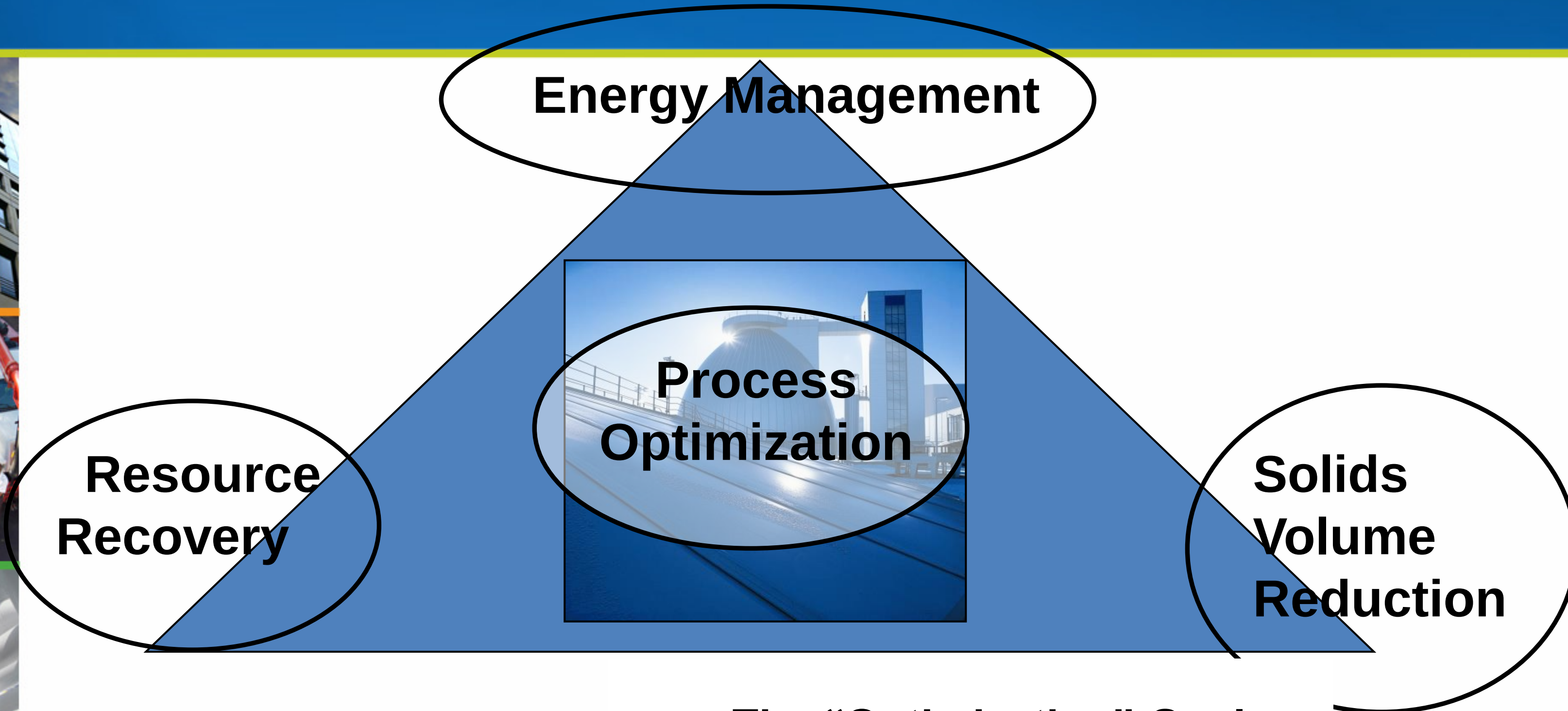
Overview – WERF CHEApet Optimization Challenge



CHEApet
Carbon Heat Energy Assessment Plant Evaluation Tool

The "Optimization" Goal

To develop and demonstrate economical and environmentally responsible processes that improve wastewater and solids treatment operations efficiencies and costs by at least 20%:

- **20% less energy**
- **20% more resource recovery**
- **20% less solids produced**

These goals can be achieved at most WWTPs…

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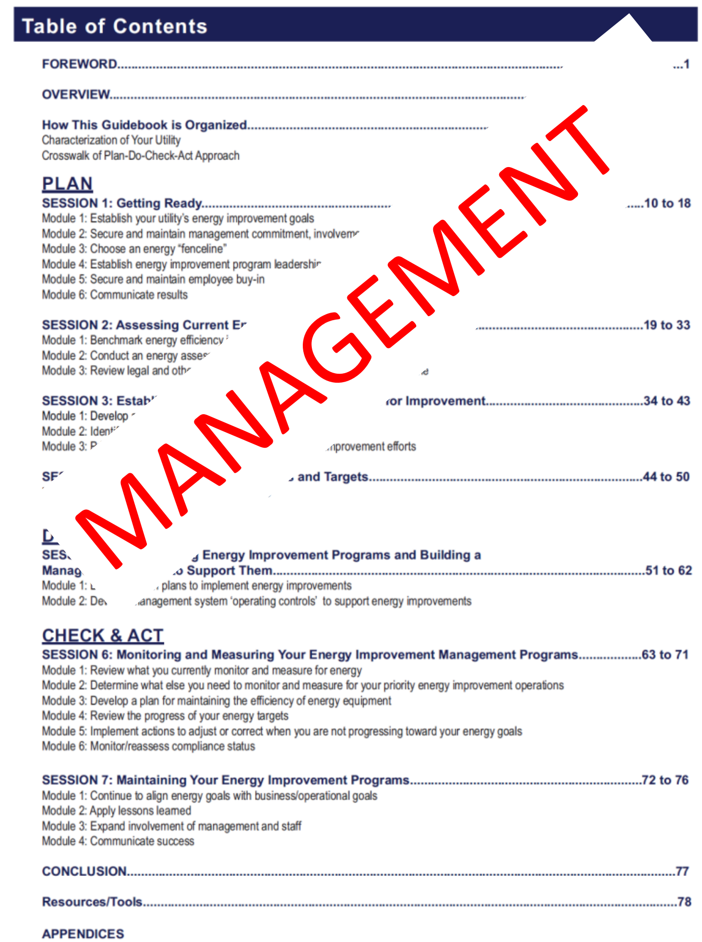
Water Environment Research Foundation

USEPA Energy Management Guidebook



Benefits of Process Optimization

- Reduce Operating Costs
- Reduce Environmental Impact
- Improve Water Quality/Performance
- Customer Satisfaction
- Operator Satisfaction

Every worthwhile opportunity comes with risks

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Risks associated with Process Changes

- Increased costs
- Permit Violations
- Customer Complaints
- Operator Stress

Our goal is to find the appropriate balance of reward/risk.

Step 1- Charter the team (Define project goals and responsibilities)

- Financial Objectives (operational, capital, ROI)
- Risk Tolerance
- Risk Mitigation
- Communication Plan

Step 2 – Collect Data

- Power
  - Demand
  - Use
  - Power Factor
  - Submetering
- Chemicals
  - Coagulants
  - Polymers (coagulant aid and dewatering)
  - Odor Control
- Process Data
  - Influent/Effluent/Process concentrations
  - Treatment removal efficiencies
  - Sludge yields
  - Mass Balances
  - Recycle streams

Step 3 – Develop Models and Key Performance Indicators

- Develop Models
  - Spreadsheet Tools
  - Plant Hydraulics
  - Process (Biowin, CHEAPET)

Dewatering Centrifuge Operating Cost Tool

Centrifuge Cake Solids																						Yearly Costs Multiplied by Dry Tons		Yearly Costs Multiplied by Dry Tons	
18.00	$243	$245	$246	$248	$249	$251	$252	$254	$255	$257	$258	$260	$261	$263	$264	$266	$267	$269	$270	$272	$273	Cost/Ton	Yearly Cost	Cost/Ton	Yearly Cost
18.25	$241	$242	$244	$245	$247	$248	$250	$251	$253	$254	$256	$257	$259	$260	$262	$263	$265	$266	$268	$269	$271	$203.3	$1,260,325.22	$238.2	$1,476,565.94
18.50	$238	$240	$241	$243	$244	$246	$247	$249	$250	$252	$253	$255	$256	$258	$259	$261	$262	$264	$265	$267	$268	$205.0	$1,271,137.25	$239.9	$1,487,377.98
18.75	$236	$237	$239	$240	$242	$243	$245	$246	$248	$249	$251	$252	$254	$255	$257	$258	$260	$261	$263	$264	$266	$206.8	$1,281,949.29	$241.6	$1,498,190.01
19.00	$233	$235	$236	$238	$239	$241	$242	$244	$245	$247	$248	$250	$251	$253	$254	$256	$257	$259	$260	$262	$263	$208.5	$1,292,761.33	$243.4	$1,509,002.05
19.25	$231	$233	$234	$236	$237	$239	$240	$242	$243	$245	$246	$248	$249	$251	$252	$254	$255	$257	$258	$260	$261	$210.3	$1,303,573.36	$245.1	$1,519,814.09
19.50	$229	$231	$232	$234	$235	$237	$238	$239	$241	$242	$244	$245	$247	$248	$250	$251	$253	$254	$256	$257	$259	$212.0	$1,314,385.40	$246.9	$1,530,626.12
19.75	$227	$228	$230	$231	$233	$234	$236	$237	$239	$240	$242	$243	$245	$246	$248	$249	$251	$252	$254	$255	$257	$213.7	$1,325,197.43	$248.6	$1,541,438.16
20.00	$225	$226	$228	$229	$231	$232	$234	$235	$237	$238	$240	$241	$243	$244	$246	$247	$249	$250	$252	$253	$255	$215.5	$1,336,009.47	$250.4	$1,552,250.20
20.25	$223	$224	$226	$227	$229	$230	$232	$233	$235	$236	$238	$239	$241	$242	$244	$245	$247	$248	$250	$251	$253	$217.2	$1,346,821.51	$252.1	$1,563,062.23
20.50	$221	$222	$224	$225	$227	$228	$230	$231	$233	$234	$236	$237	$239	$240	$242	$243	$245	$246	$248	$249	$251	$219.0	$1,357,633.54	$253.9	$1,573,874.27
20.75	$219	$220	$222	$223	$225	$226	$228	$229	$231	$232	$234	$235	$237	$238	$240	$241	$243	$244	$246	$247	$249	$220.7	$1,368,445.58	$255.6	$1,584,686.30
21.00	$217	$218	$220	$221	$223	$224	$226	$227	$229	$230	$232	$233	$235	$236	$238	$239	$241	$242	$244	$245	$247	$222.5	$1,379,257.62	$257.3	$1,595,498.34
21.25	$215	$217	$218	$220	$221	$223	$224	$226	$227	$229	$230	$232	$233	$235	$236	$238	$239	$241	$242	$243	$245	$224.2	$1,390,069.65	$259.1	$1,606,310.38
21.50	$213	$215	$216	$218	$219	$221	$222	$224	$225	$227	$228	$230	$231	$233	$234	$236	$237	$239	$240	$242	$243	$225.9	$1,400,881.69	$260.8	$1,617,122.41
21.75	$212	$213	$215	$216	$218	$219	$220	$222	$223	$225	$226	$228	$229	$231	$232	$234	$235	$237	$238	$240	$241	$227.7	$1,411,693.72	$262.6	$1,627,934.45
22.00	$210	$211	$213	$214	$216	$217	$219	$220	$222	$223	$225	$226	$228	$229	$231	$232	$234	$235	$237	$238	$240	$229.4	$1,422,505.76	$264.3	$1,638,746.49
22.25	$208	$210	$211	$213	$214	$216	$217	$219	$220	$222	$223	$225	$226	$228	$229	$231	$232	$234	$235	$237	$238	$231.2	$1,433,317.80	$266.1	$1,649,558.52
22.50	$206	$208	$209	$211	$212	$214	$215	$217	$218	$220	$221	$223	$224	$226	$227	$229	$230	$232	$233	$235	$236	$232.9	$1,444,129.83	$267.8	$1,660,370.56
22.75	$205	$206	$208	$209	$211	$212	$214	$215	$217	$218	$220	$221	$223	$224	$226	$227	$229	$230	$232	$233	$235	$234.7	$1,454,941.87	$269.5	$1,671,182.59
23.00	$203	$205	$206	$208	$209	$211	$212	$214	$215	$217	$218	$220	$221	$223	$224	$226	$227	$229	$230	$232	$233	$236.4	$1,465,753.91	$271.3	$1,681,994.63
Polymer Dose	20.00	20.50	21.00	21.50	22.00	22.50	23.00	23.50	24.00	24.50	25.00	25.50	26.00	26.50	27.00	27.50	28.00	28.50	29.00	29.50	30.00				

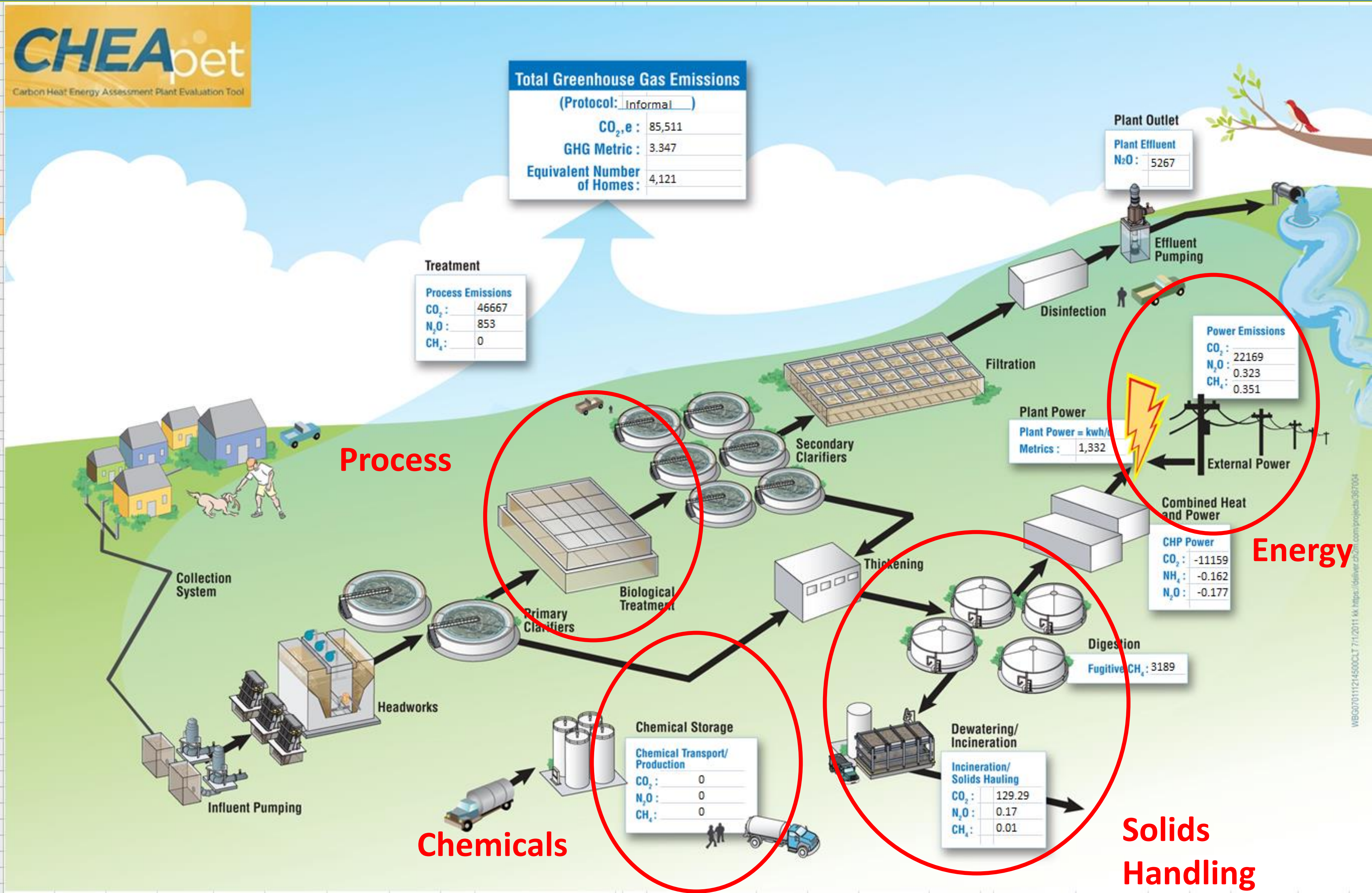
Polymer Dosage Units - Lbs/Dry Ton

To use the tool manipulate the 3 variables (S30-S32) to reflect actual values.

Legend
Undesirable Range
Adequate Range
Desired Range

39	
Disposal Cost/Ton	$33
Polymer Cost/Lb	$2.99
Dry Tons/Year	6200

Process Model Example



Develop Holistic Approach

Safety

Safety

- Review current operation and maintenance practices NOT JUST " ELECTRICAL"

Baseline information on all aspects of the facilities from:

  - Process data and permit limits
  - Electrical usage and rate structures
  - Chemical usage and cost
  - Assets
  - HVAC systems
  - Storage capacities
  - Solids handling
  - Natural gas or Bio gas usage

Safety

Safety

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Step 3 (cont) -Key Performance Indicators

KPI Summary Sheet WWTP

Table 1 Basis Line Values WWTP

Parameter	Base Line Value	Discription
Flow ML/Year	17468.241	Base Q Annual
Flow ML/Year	8433	Base Q PO4 6 month
cBOD (mg/l)	254.42	Base Line cBOD
TSS (mg/l)	378.76	Base Line TSS
PO4 (mg/l)	7.39	Base Lin[illegible]
WWTP Power kWh/ML	599.11	Ba[illegible]
kWh/ kg cBod	1[illegible]	[illegible]
kWh/ kg TSS	[illegible]	[illegible]
Ratio kg TSS/kg cBOD	[illegible]	[illegible]
kg cBOD (annual)	[illegible]	[illegible]OD
kg TSS (Annual)	[illegible]	[illegible]ine kg TSS
kg PO4 (6 Summer months)	[illegible],330	Base Line kg PO4
Alum usage kg/ML	40.03	Base Line Alum Flow usage KPI
Alum usage kg/ mg/l PO4	5.42	Base Line Alum load usage KPI
Wet Tonnes of Solids / Ton cBOD	2.7213	Base lne Tonnes of Solids/Ton cBOD KPI
Wet Tonnes of Solids / Ton TSS	1.82790	Base lne Tonnes of Solids/ Ton TSS KPI
kg Dewatering-Polymer/kg cBOD	6.889543139	Base line kg D-Polymer / kg cBOD KPI
kg Thickening-Polymer/kg cBOD	1.119923703	Base line kg T-Polymer / kg cBOD KPI
kg Dewatering-Polymer/kg TSS	4.627855047	Base line kg D-Polymer / kg TSS KPI
kg Thickening-Polymer/kg TSS	0.752276959	Base line kg T-Polymer / kg TSS KPI

KPI's need to be site specific

Other plants can provide useful reference points

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Step 4 – Indentify Opportunities and Prepare Business Case Evaluations

- Opportunities
  - Operational change
  - Minor Capital Improvement
  - Major Capital Improvement
- Business Case Evaluation
  - Capital Costs
  - Operational and Maintenance Costs
  - Risks
  - Non Economic Benefits

Example

WERF Tool to assist in BCE

LCAMER

LIFE CYCLE ASSESSMENT MANAGER FOR ENERGY RECOVERY

- Evaluates alternatives and associated benefits and costs in planning and early design stages
- Evaluates "what-if" scenarios including Sensitivity Analyses
- Estimates GHG emissions and carbon foot print evaluation
- Facilitates discussions with regulatory agencies and project stake holders

- MS Excel Based Tool with Built-In Worksheets
  - Regional temperature and emission factors
  - Volatile solids reduction model
  - Parametric costs
  - Process and cost analysis functions
    - Internal combustion engines (ICE)
    - Gas turbines
    - Microturbines
    - Stirling Engines
    - Fuel cells

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Step 5 – Prioritize and Develop Implementation Plan

- Priorities
  - Priority 1 – Recommended to achieve majority of energy savings
  - Priority 2 – Would provide additional energy savings but have a longer pay back period
  - Priority 3 – Would provide for fine tuning of process and some additional power savings
- Implementation Plan
  - Category I—Immediate
  - Category II—Short Term 1-3 years or
  - Category III—Long Term 3-5 years

Opportunities for Energy Efficiency

High Energy Using Operations	Energy Savings Measures
Pumping	•Reduce load •Manage load •Water to wire efficiency •Pump selection •Automated control
Aeration	•Fine bubble •Improved surface aerators •Premium motors •High efficiency motor drive •Blower Control •Automatic DO control

High Energy Using Operations	Energy Savings Measures
Lighting	•Motion sensors •T5 low and high bay fixtures •Pulse start metal halide •Indirect fluorescent •Comprehensive control for large buildings
Heating, Ventilation, Air Conditioning (HVAC)	•Water source heat pumps •Custom incentives for larger units •Low volume fume hoods •Occupancy controls •Heat pump for generator oil sump

Understand Your Power Bill

Power Bill Components:

- Demand
- Ratchet Demand
- Use
- Power Factor
- Fuel
- Time of Use

Meet with your local power provider to understand your rate structure and develop strategies to reduce costs

IP&L BILLING INFORMATION (PROVIDED BY IP&L)

```
MEHC01M              M E S - D E M A N D   H I S T O R Y             01/24/2013
RATE DEPARTMENT                                                       10.55.19
ACCOUNT   1540826 ACC-NAME WASTEWATER SOUTHPORT AWT                   RAY91LJ
SERVICE    275330 RDG-DIST 13 MTRS 06 RATE H1     STATUS AC       SNOTE
3800 W SOUTHPORT RD, INDIANAPOLIS IN 46217
KWH-MTR 0004987        READ-BY 0  CONNCT-DT 08/26/2011 RATE-EFFCT-DT 02/01/1983
                 TAX-EXEMPT-CD    CONN-LOAD    8607   CONN-LTNG-LOAD
```

R-DATE	ACT-DEM	BIL-DEM	BIL-KWH	PF%	RATE	FUEL	OTHER-ADJ	TOT-NET-BIL	CODE
011813	7244	7244A	3528000	96	H1	.0204030	.0072130	243,701.42	
121812	5302	5541T	3169600	95	H1	.0204030	.0073080	210,060.67	
111612	6429	6429A	3192000	96	H1	.0179450	.0066180	209,702.27	
101812	6254	6254A	3080000	98	H1	.0179450	.0066180	202,202.98	
091912	7388	7388A	3438400	97	H1	.0179450	.0066180	229,985.66	
081812	6544	6544A	3427200	97	H1	.0173810	.0066180	218,999.96	
071912	5470	5514T	3147200	98	H1	.0173810	.0066180	195,929.50	
062012	6012	6012A	3673600	99	H1	.0173810	.0064300	222,941.73	
051912	6797	6797A	3371200	100	H1	.0198380	.0064300	225,607.86	A
041812	7352	7352A	3931200	94	H1	.0198380	.0064300	259,613.65	
031712	6559	6559A	3382400	91	H1	.0198380	.0063220	227,100.57	
021712	7001	7001A	3337600	92	H1	.0174590	.0063220	221,169.07	
012012	6758	6758A	4065600	95	H1	.0174590	.0063220	249,223.44	
121711	6848	6848A	3472000	94	H1	.0174590	.0056690	222,295.69	
111711	6042	6042A	2587200	96	H1	.0173670	.0056690	174,920.47	
101811	6000	6000A	2497600	96	H1	.0173670	.0056690	170,645.59	

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Energy Savings – Operational Changes

Demand Management – Shed equipment during peak energy use.

Energy Reduction– Monitor DO in aeration basins and maintain at 2 mg/l or less

Time of Use – Consider shifting activities during night shift

Develop benchmarks and closely monitor

Energy Savings – Minor Capital Improvements

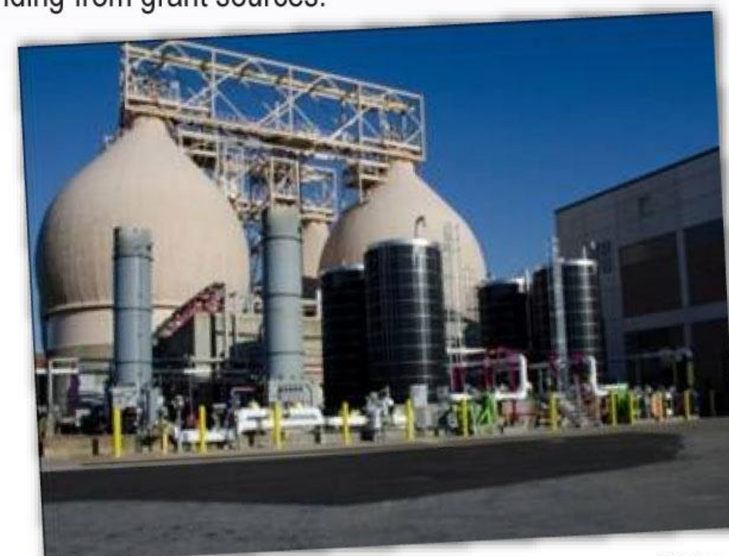
- Demand Management – Automation routines to shed non vital equipment
- Energy Reduction – Automated DO control for aeration basins
- Power Factor – Install capacitor banks to increase PF

Energy Savings – Major Capital Replacements

- Replace Aeration Diffusers
- Replace Blowers
- Replace Pumps
- Replace Motors
- Install Cogeneration System
- System Wide (real time) Energy Optimization Systems

Cogeneration and Fog Project At F. Wayne Hill WRC In Gwinnett County, Ga

CH2M HILL worked in partnership with Gwinnett County DWR on the implementation of a cogeneration and FOG receiving facility at the F. Wayne Hill WRC and assisted in the identification in up to $8.5 million in funding from grant sources.



120_Metro_PM_02

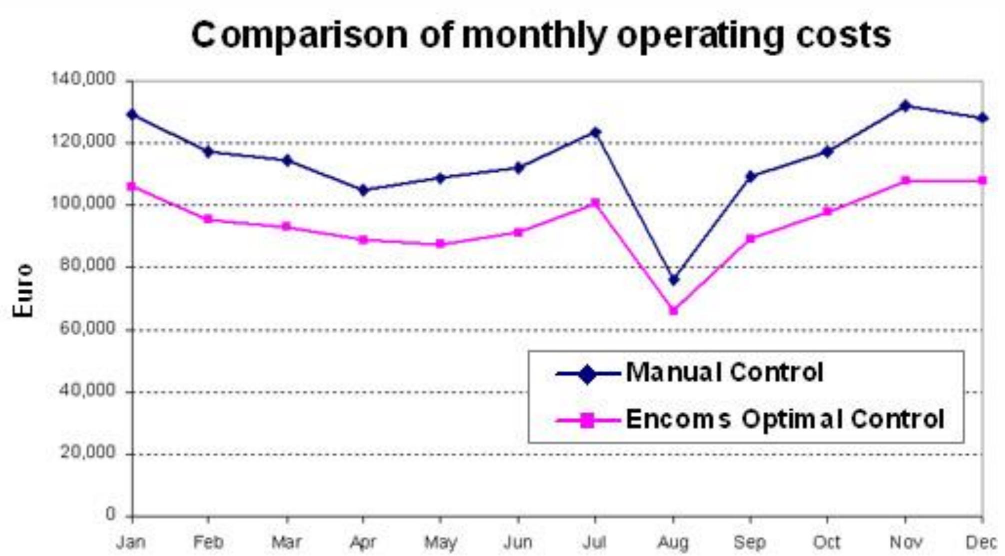
Energy Savings - Plant Compressed Air Systems

- Baseline
  - Compress and dry air used for Pneumatic Primary Sludge Pumps and other controls
  - Maintenance issues with compressor cooling system
    - Required 500,000 gpd of potable (softened water)
    - New close loop heat exchanger with air cooled or reclaim water
- Recommended Action Plan
  - Re-size new air compressor (25% of original) which allows air cooled unit
  - Savings/Benefits: 50% overall power costs, no softened water required, minimal maintenance
  - Allows resizing and possible elimination of air gap tank and associated pumps

Energy Savings (cont)

- System Wide (real time) Energy Optimization Systems

Resulting from groundbreaking advances in combined use of genetic algorithms and artificial neural networks, ENCOMS identifies in realtime the optimal operational control settings that will best meet not only the current demands but also the projected ones along the operating horizon (typically 24 hours) at maximum cost savings, taking account of the electricity rate structure, system operational constraints, and demand projections. The real-time control process operates continually and is updated at periodic intervals by SCADA data and new demand forecasts.



ENCOM: Energy Cost Minimization System

Case Studies - 20% saving

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Evaluate multiple factors to evaluate projects

Location	Activity	Energy Source	Current Annual Cost	Impacts On Operation	Maturity & Reliability	Cost To Implement	Permitting Challenges	Level Of Complexity	Funding Avail.	Net Energy Production	Criteria Air Pollutants	Co2 Emissions	Safety & Health	Return On Invest.	Minimize Biogas Flaring	Total Score
				RANKING and CRITERIA												
Omohundro WTP	Project 1	Electrical	$10,000	1	4	2	5	3	2	2	3	3	4	5	2	36
Omohundro WTP	Project 2	Electrical	$25,000	5	2	3	3	2	3	2	1	1	2	3	0	27
Omohundro WTP	Project 3	Natural Gas	$16,000	2	3	5	1	1	4	2	3	0	2	2	3	28
Omohundro WTP	Project 4	Natural Gas	$65,000	4	4	3	3	3	2	2	5	3	4	2	3	38
KR Harrington WTP	Project 1	Natural Gas	$30,000	1	4	3	2	3	5	5	2	2	1	3	1	32
KR Harrington WTP	Project 2	Electrical	$12,000	4	2	1	2	2	5	2	1	4	3	2	2	30
Biosolids Fac.	Project 1	Electrical	$32,000	4	4	5	5	3	4	4	4	5	3	3	5	49
Biosolids Fac.	Project 2	Electrical	$53,000	3	2	4	2	2	1	1	0	3	3	2	4	27
Biosolids Fac.	Project 3	Natural Gas	$5,000	2	3	2	3	1	1	2	2	2	3	3	4	28
Biosolids Fac.	Project 4	Digester Gas	$0	5	5	4	4	3	5	4	5	5	4	5	5	54
Central WWTP	Project 1	Electrical	$18,000	4	2	2	3	3	4	2	1	2	1	1	2	27
Central WWTP	Project 2	Electrical	$24,000	2	4	3	4	5	2	3	2	1	3	4	5	38
Central WWTP	Project 3	Electrical	$54,000	4	1	2	3	2	3	5	4	4	3	2	3	36
Central WWTP	Project 4	Natural Gas	$8,000	3	4	5	4	3	3	3	3	2	2	3	1	36

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Solids Handling – Operational Changes

- Dewatering polymer optimization
- Continuously evaluate best deal for disposal
- Process Changes (SRT/Digestion)
- Develop benchmarks and closely monitor

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Solids Handling – Capital Improvements

- Replace Solids Process Technology
- Replace Dewatering Equipment
- WERF LCAMER (Life Cycle Assessment Manager for Energy Recovery) tool

LCAMER OUTPUT

	Internal Combustion Engine		Gas Turbine	Micro Turbine	Fuel Cell
	(W/O FOG)	(With FOG)	(With FOG)	(With FOG)	(With FOG)
CAPEX ($) for Cogen (including replacements)	$5.54M	$6.91M	$6.41M	$8.85M	$25.39M
CAPEX ($) for FOG Receiving Facility	0	$4.08M	$4.08M	$4.08M	$4.08M
OMEX ($/yr) for Biogas System & Natural Gas	$562K	$762K	$536K	$572K	$1.32M
OMEX ($/yr) for FOG Receiving Facility	0	$145K	$145K	$145K	$145K
Revenue ($/yr) from Electricty Savings[1]	$870K	$1.17M	$723K	$766K	$1.23M
Revenue ($/yr) from FOG Receipts	0	$850K	$850K	$850K	$850K
Payback Period (years)	18	9.9	11.8	14.4	47.9

(1) - Estimated @ $0.07/KWh

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Chemical Savings - Operational

- Develop benchmarks and closely monitor
- Frequent calibration checks
- Tune Control Loops

Chemical Savings - Capital

- New Disinfection System (i.e UV, onsite hypo generation)
- Improved Chemical Mixing (i.e water champs or statiflo)
- Chemical Feed Modifications
- New Odor Control (ie. Biofilters)

Plant Flow Rate (MGD)	Daily Hypochlorite Usage (gallons)	Daily Bisulfite Usage (gallons)	Hypochlorite Cost Per Day	Bisulfite Cost Per Day	Seasonal Chemical Costs	UV Power Requirement (kW)	UV Cost Per Day	UV Lamp Replacement	Seasonal UV Costs		Annual Savings w/ UV
60	1785	231	$ 1,153	$ 298	$ 333,737	138.4	$ 199.30	$ 130,000	$ 175,838		$ 157,899
70	2083	269	$ 1,345	$ 347	$ 389,360	161.5	$ 232.51	$ 130,000	$ 183,478		$ 205,882
80	2380	307	$ 1,538	$ 397	$ 444,983	184.5	$ 265.73	$ 130,000	$ 191,117		$ 253,865
90	2678	346	$ 1,730	$ 447	$ 500,605	207.6	$ 298.94	$ 130,000	$ 198,757		$ 301,848
100	2975	384	$ 1,922	$ 496	$ 556,228	230.7	$ 332.16	$ 130,000	$ 206,397		$ 349,831
110	3273	423	$ 2,114	$ 546	$ 611,851	253.7	$ 365.38	$ 130,000	$ 214,036		$ 397,815
120	3570	461	$ 2,306	$ 596	$ 667,474	276.8	$ 398.59	$ 130,000	$ 221,676		$ 445,798
130	3868	499	$ 2,499	$ 645	$ 723,097	299.9	$ 431.81	$ 130,000	$ 229,316		$ 493,781
140	4165	538	$ 2,691	$ 695	$ 778,719	322.9	$ 465.02	$ 130,000	$ 236,956		$ 541,764
150	4463	576	$ 2,883	$ 745	$ 834,342	346.0	$ 498.24	$ 130,000	$ 244,595		$ 589,747
	Assumptions										
	Cost per kW Hour (average cost)					$ 0.06					
	Cost per Gallon Hypo (historical)					$ 0.65					
	Cost per Gallon Bisulfite (estimated)					$ 1.29					
	Annual Disinfection Season (days)					230					
	Bisulfite dose per 1 mg/l Cl Residual					1.46					
	Max UV Lamp Replacment Cost (estimated from Trojan Quote)					$ 130,000					
	UV Power consumption kW/MGD treated					$ 2.31					
	Hypochlorite feed rate, mg/l (historical)					4.5					

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Process Changes

Consider Holistic Effects of Any Process Changes

Variables:

- Units in service
- Processes In Service
- MCRT/SRT
- Solids Processing Objectives

Example

NSU - Configuration	Available	Current	Alt. No. 4
Aeration Basins	2.0	2.0	1.0
Aerobic Digesters	4	4	4

NSU - Process		Current	Alt. No. 4	Range	Typical
Cake Solids, % -		15.5	15.9	15-23	18
Polymer Use, lbs/ton -		20.0	20.0	8-20	10
Run Time, hrs/d -		8.0	8.0		

NSU - Performance	Actual	Current	Alt. No. 4	Range	Typical
SRT, days =		26.0	9.8	10-30	15
HDT wo/RAS, hrs. =		43.9	18.9	8-36	12
Clarifier Slds Loading, Lbs/D/SF =		15.3	19.7	5-24	12
Belt Press Hydraulic Loading, gpd/U =		98848	112892	57k-115K	
Belt Press Solids Loading, lbs/d/U =		7672	9483	4.8k-9.6k	
Solids Produced lbs/day	3222.0	3260.7	4702.1		
Solids Produced cy/day =	12.6	12.8	17.9		

NSU - Costs	Actual		Alt. No. 4	Savings
CHEMICALS	$ 15,431		$ 22,009	**$ (6,578)**
CONTRACT HAULING COSTS	$ 161,280		$ 228,750	**$ (67,470)**
ELECTRICITY	$ 401,047		$ 323,261	**$ 77,786**
Total	$ 577,758		$ 574,020	**$ 3,738**

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Evaluate Best Case and Worst Case Scenarios

Current Strategy

- One Large Oxidation Ditch
- Three Aerobic Digesters

Alternative No. 3

- One Small Oxidation Ditch
- Two Aerobic Digesters

	Current	No. 3 Best Case	Savings
CHEMICALS	$ 9,843	$ 7,209	$ 2,635
CONTRACT HAULING COSTS	$ 103,893	$ 101,740	$ 2,153
ELECTRICITY	$ 207,815	$ 125,924	$ 81,891
Total	$ 321,551	$ 234,873	$ 86,679

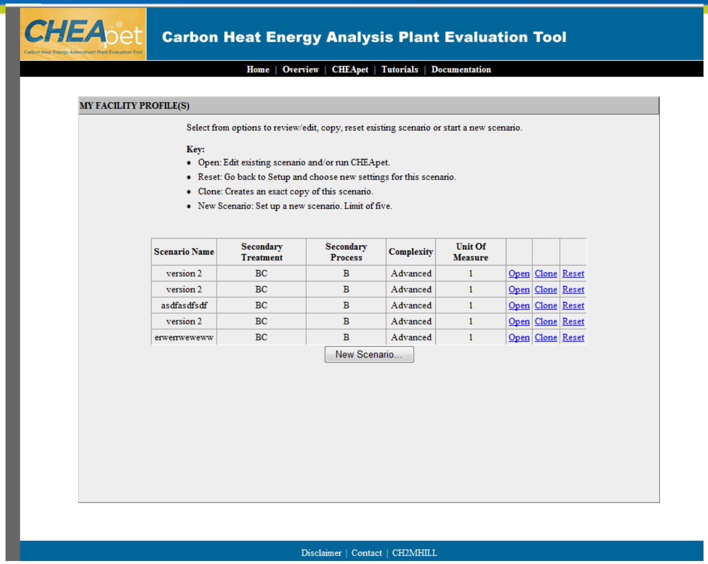
	Current	Worst Case	Savings
CHEMICALS	$ 9,843	$ 9,536	$ 308
CONTRACT HAULING COSTS	$ 103,893	$ 121,128	$(17,235)
ELECTRICITY	$ 207,815	$ 127,437	$ 80,378
Total	$ 321,551	$ 258,101	$ 63,450

Consider Holistic Operational Affects

- Based on analysis Alternative No. 4 shows the lowest overall operating cost. However, the analysis shows that using only one small oxidation ditch will not provide the horse-power requirements to meet oxygen demands. Therefore this alternative is not viable.
- Alternative No. 3 is the lowest cost viable option and meets all design criteria.
- Increased process control and monitoring will be critical to success (higher frequency of testing, added testing locations, effective wasting program).
- Monitoring of all cost related factors such as quantities, dosages, and unit cost of chemicals and biosolids disposal.
- A control procedure for operating with only two aerobic digesters must be develop and staff trained on how it should be implemented.
- Due to increase sludge production the belt press will have to be operated daily for 8 hours.

WERF CHEApet Tool basics

- Provides mass, energy and thermal balances as well as carbon footprint (GHG emissions)
- Tool Platform - Static whole wastewater & STP plant simulator
- Tool Delivery - Online (internet) tool hosted by WERF
  - MS Excel™ Based
- It will be available to WERF subscribers
  - You can download your inputs and outputs but not the tool



CHEApet
Carbon Heat Energy Assessment Plant Evaluation Tool
Carbon Heat Energy Analysis Plant Evaluation Tool

Home | Overview | CHEApet | Tutorials | Documentation

MY FACILITY PROFILE(S)

Select from options to review/edit, copy, reset existing scenario or start a new scenario.

Key:
- Open: Edit existing scenario and/or run CHEApet.
- Reset: Go back to Setup and choose new settings for this scenario.
- Clone: Creates an exact copy of this scenario.
- New Scenario: Set up a new scenario. Limit of five.

Scenario Name	Secondary Treatment	Secondary Process	Complexity	Unit Of Measure			
version 2	BC	B	Advanced	1	Open	Clone	Reset
version 2	BC	B	Advanced	1	Open	Clone	Reset
asdfasdfsdf	BC	B	Advanced	1	Open	Clone	Reset
version 2	BC	B	Advanced	1	Open	Clone	Reset
erwerrwewewww	BC	B	Advanced	1	Open	Clone	Reset

New Scenario...

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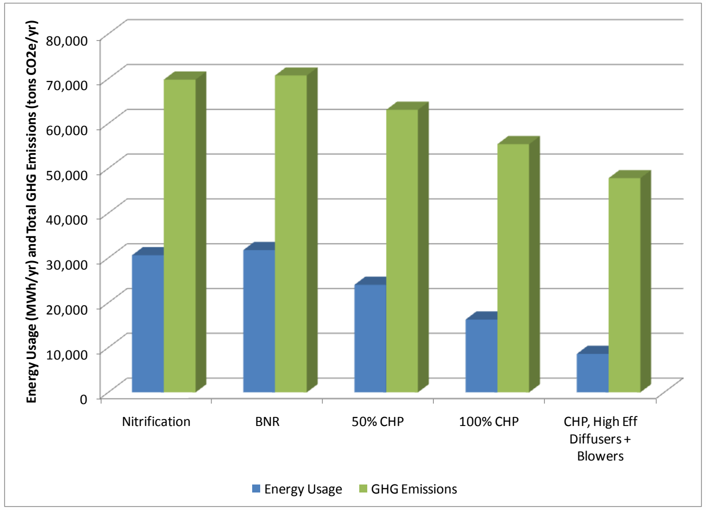

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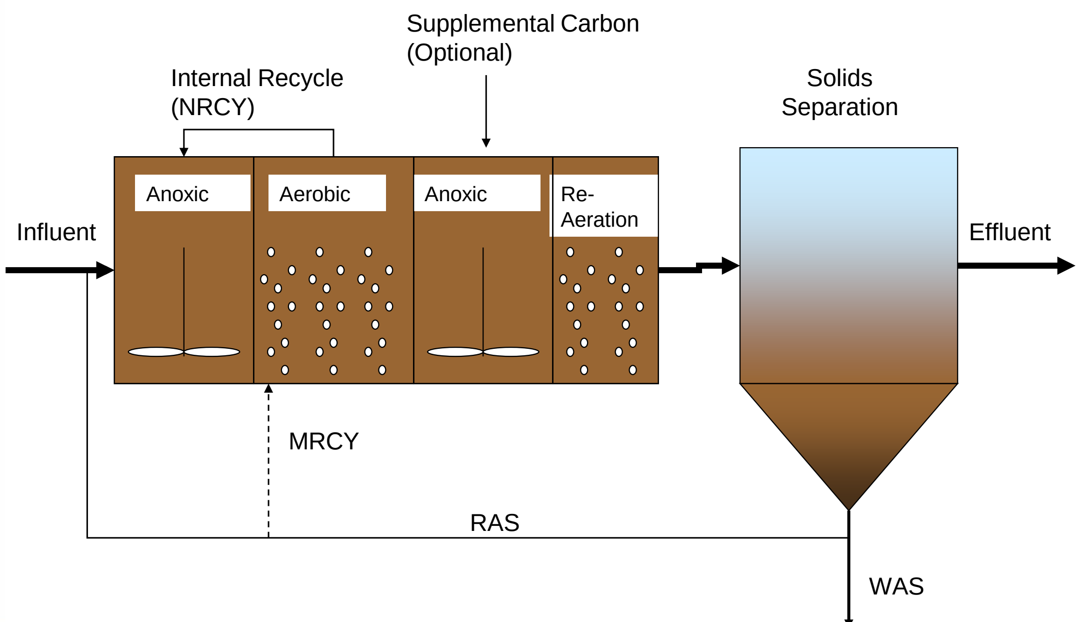
WERF CHEApet - Unit Processes

Biological Treatment Options

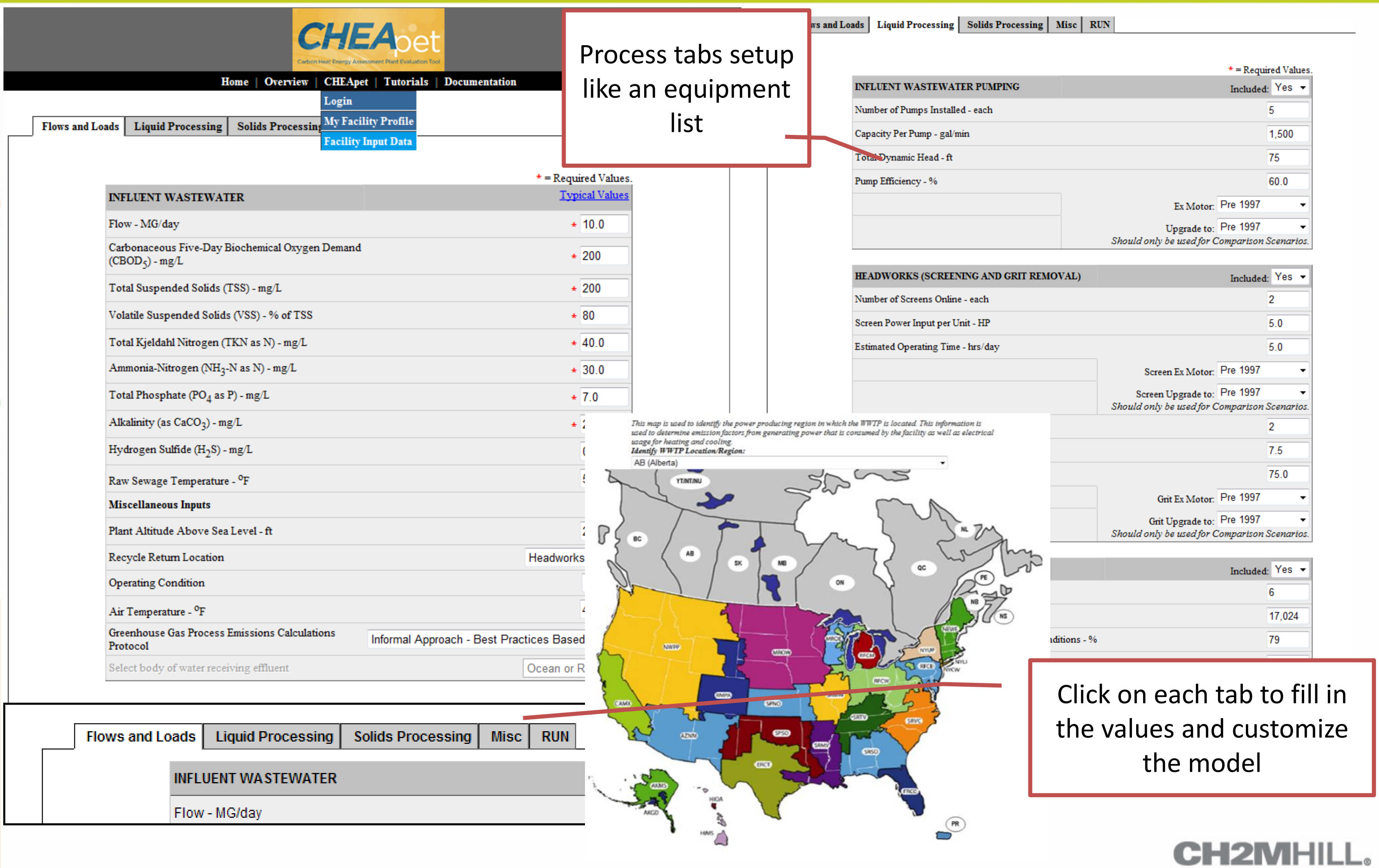
8 Processes with either MBR or Secondary Clarifier

- Nitrification
- MLE
- 4 Stage Bardenpho
- Anaerobic- Aerobic (A/O)
- Anoxic-Anaerobic-Aerobic (A2/O)
- University Cape Town (UCT)
- 5 Stage Bardenpho
- Johannesburg

- Carbon Footprint/Greenhouse Gas Options
  - Local Government Operations Protocol (LGOP)
  - Australian Approach
  - "Informal" Approach



CHEApet Facility Data Input



Summary

- Utilize WERF and network with other utilities to identify opportunities to optimize your plants
- Work with power company to understand your bill and idenitify ways to reduce costs
- When making changes, evaluate risks and look for unintended consequences
- Work with chemical suppliers to find more cost effective ways to solve the problem
- Develop benchmarks and monitor process data
- Develop Business Case Evaluation Process to prioritize capital projects based on payback and noneconomic benefits
- Many financing options available – but understand benefits and risks

O&MBG GENERAL SERVICES

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