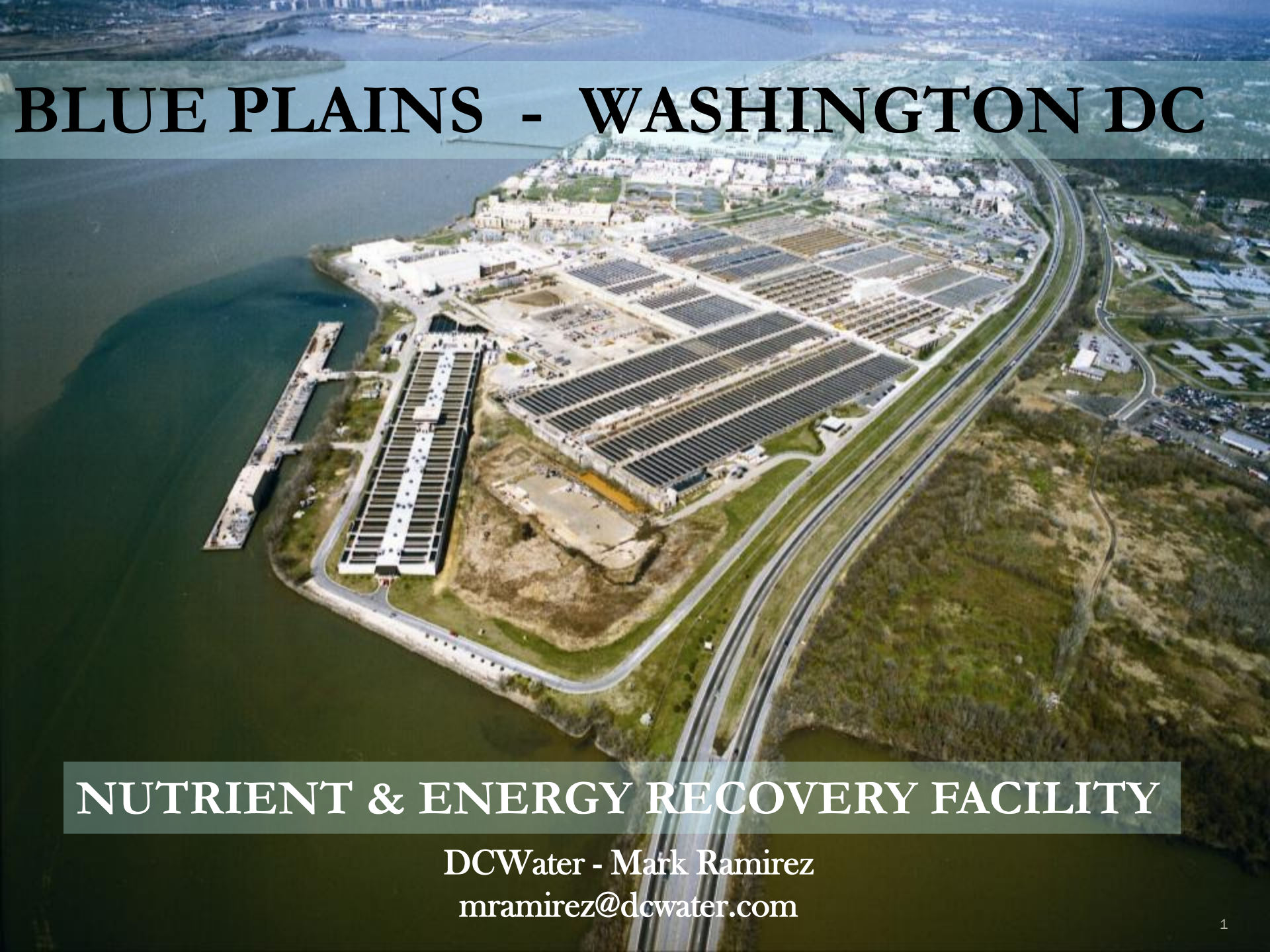


BLUE PLAINS - WASHINGTON DC

NUTRIENT & ENERGY RECOVERY FACILITY

DCWater - Mark Ramirez
mramirez@dcwater.com

Introduction

We have been recognized as a profession that protects the environment and public health. We are now beginning to be recognized as resource stewards, needing to recover and utilize valuable and important resources as well.

WATER RESOURCE RECOVERY FACILITY

OUR VISION

CLEAN WATER –

PROCESSES TO REMOVE ORGANICS & NUTRIENTS FROM THE EXCESS WATER DISTRIBUTED FOR COMMUNITY USE & PRODUCE CLEAN EFFLUENT AND CLEAN RIVERS .

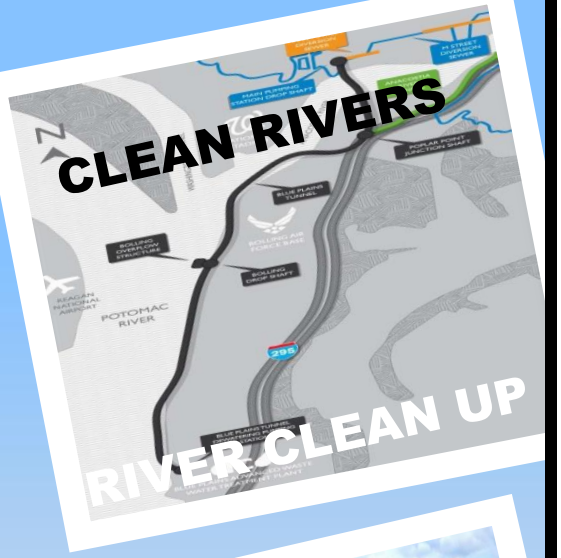
ENERGY–

PROCESSES TO GENERATE ELECTRICITY FOR THE LARGEST USER OF POWER IN WASHINGTON DC. AND REDUCE POWER CONSUMPTION

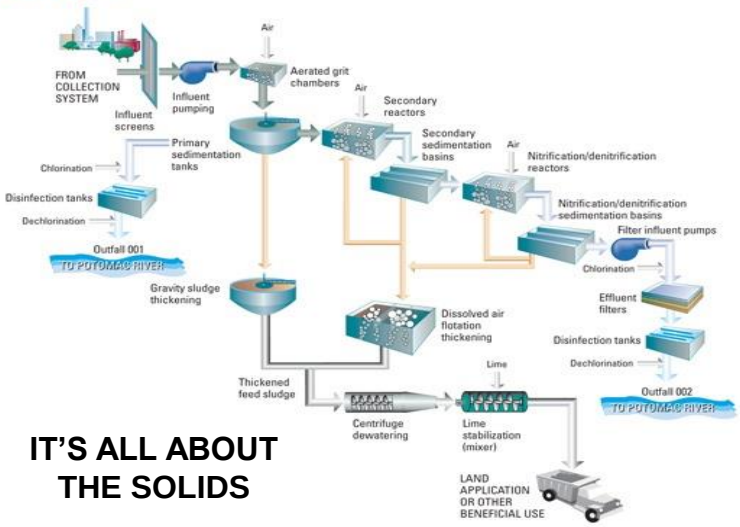
NUTRIENTS –

BENEFITS OF RECYCLING RECOVERED NUTRIENTS & ORGANICS AS A RESOURCE FOR SUSTAINABLE WORLD AGRONOMIC PRODUCTION

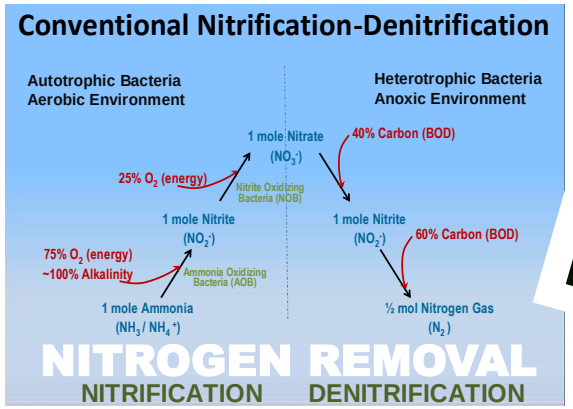
Clean (RIVER) Water



SOLIDS REMOVAL



IT'S ALL ABOUT THE SOLIDS



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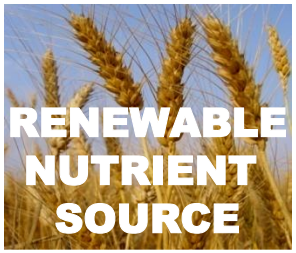
Sustainable Agriculture

FOOD NUTRIENTS



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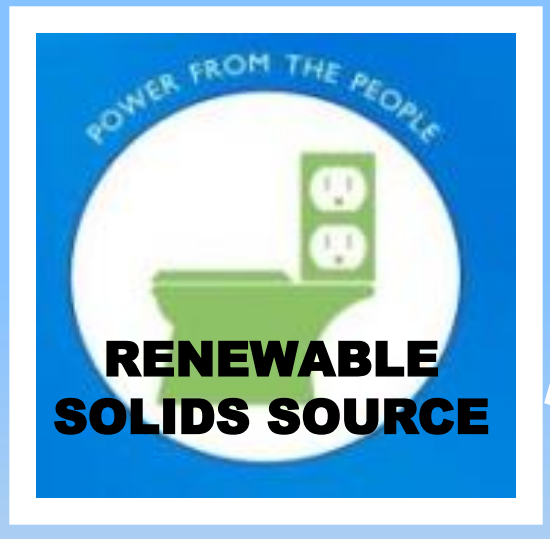
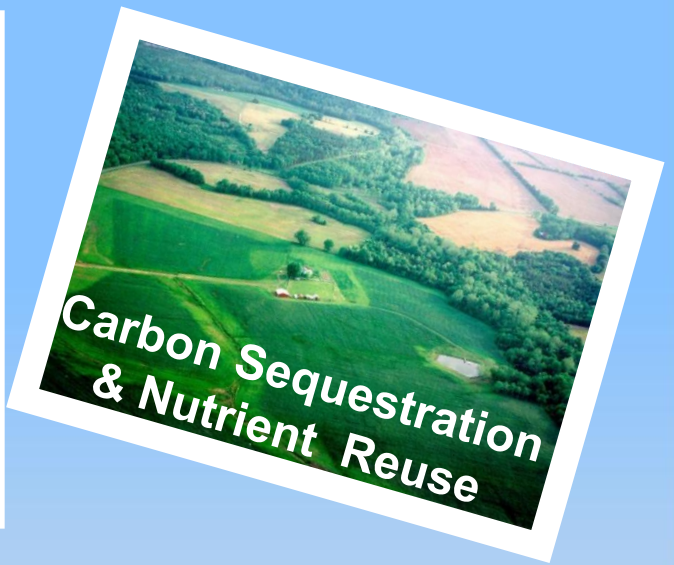
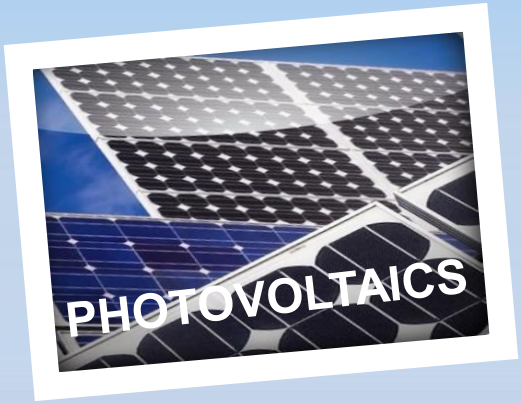
Energy Recovery







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NUTRIENT & ENERGY RECOVERY

1937 ➔ 2015

ENGINEERING NEWS-RECORD

March 25, 1937

Sewage Disposal For the Nation's Capital

Pollution of the Potomac River will be greatly lessened when the 130 m.g.d. primary sewage treatment and sludge digestion plant for the District of Columbia goes into operation this spring.

By Frank A. Marston

Metcalf & Eddy, Consulting Engineers, Boston, Mass.

CONSTRUCTION WORK has been practically completed on the 130 m.g.d. disposal plant that will provide sedimentation for all the sewage in the District of Columbia that is now pouring untreated into the Potomac River. The new plant, to be placed in operation this spring, includes such features as grease separation, sludge digestion and utilization of gas for power generation, and elutriation of sludge prior to dewatering in vacuum filters. The project is costing about $3,600,000 and has been financed with a PWA loan and 30 per cent grant. The design of the plant was predicated on an investigation of the sewage disposal problem of the District of Columbia made in 1933 by a board of sanitary engineers, composed of Harrison P. Eddy, Samuel A. Greeley, and the late John H. Gregory.

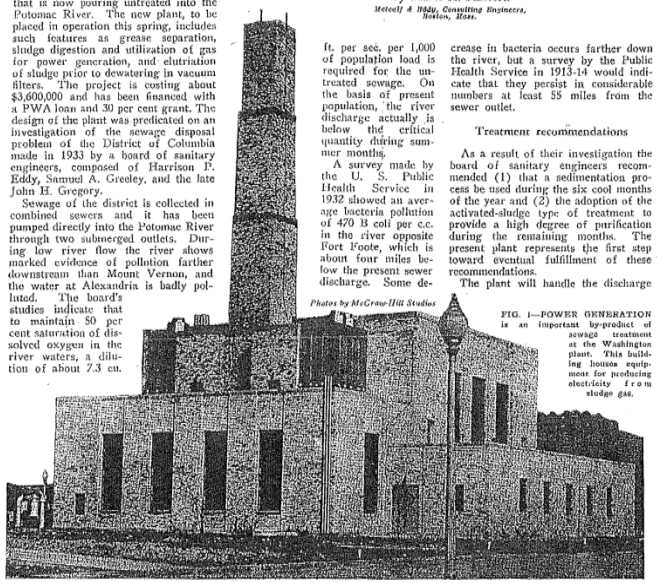
Sewage of the district is collected in combined sewers and it has been pumped directly into the Potomac River through two submerged outlets. During low river flow the river shows marked evidence of pollution farther downstream than Mount Vernon, and the water at Alexandria is badly polluted. The board's studies indicate that to maintain 50 per cent saturation of dissolved oxygen in the river waters, a dilution of about 7.3 cu. ft. per sec. per 1,000 of population load is required for the untreated sewage. On the basis of present population, the river discharge actually is below the critical quantity during summer months.

A survey made by the U. S. Public Health Service in 1932 showed an average bacteria pollution of 470 B coli per c.c. in the river opposite Fort Foote, which is about four miles below the present sewer discharge. Some decrease in bacteria occurs farther down the river, but a survey by the Public Health Service in 1913-14 would indicate that they persist in considerable numbers at least 35 miles from the sewer outlet.

Treatment recommendations

As a result of their investigation the board of sanitary engineers recommended (1) that a sedimentation process be used during the six cool months of the year and (2) the adoption of the activated-sludge type of treatment to provide a high degree of purification during the remaining months. The present plant represents the first step toward eventual fulfillment of these recommendations.

The plant will handle the discharge



Photos by McGraw-Hill Studios

FIG. 1—POWER GENERATION is an important by-product of sewage treatment at the Washington plant. This building houses equipment for producing electricity from sludge gas.

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Original "DISPOSAL" Plant

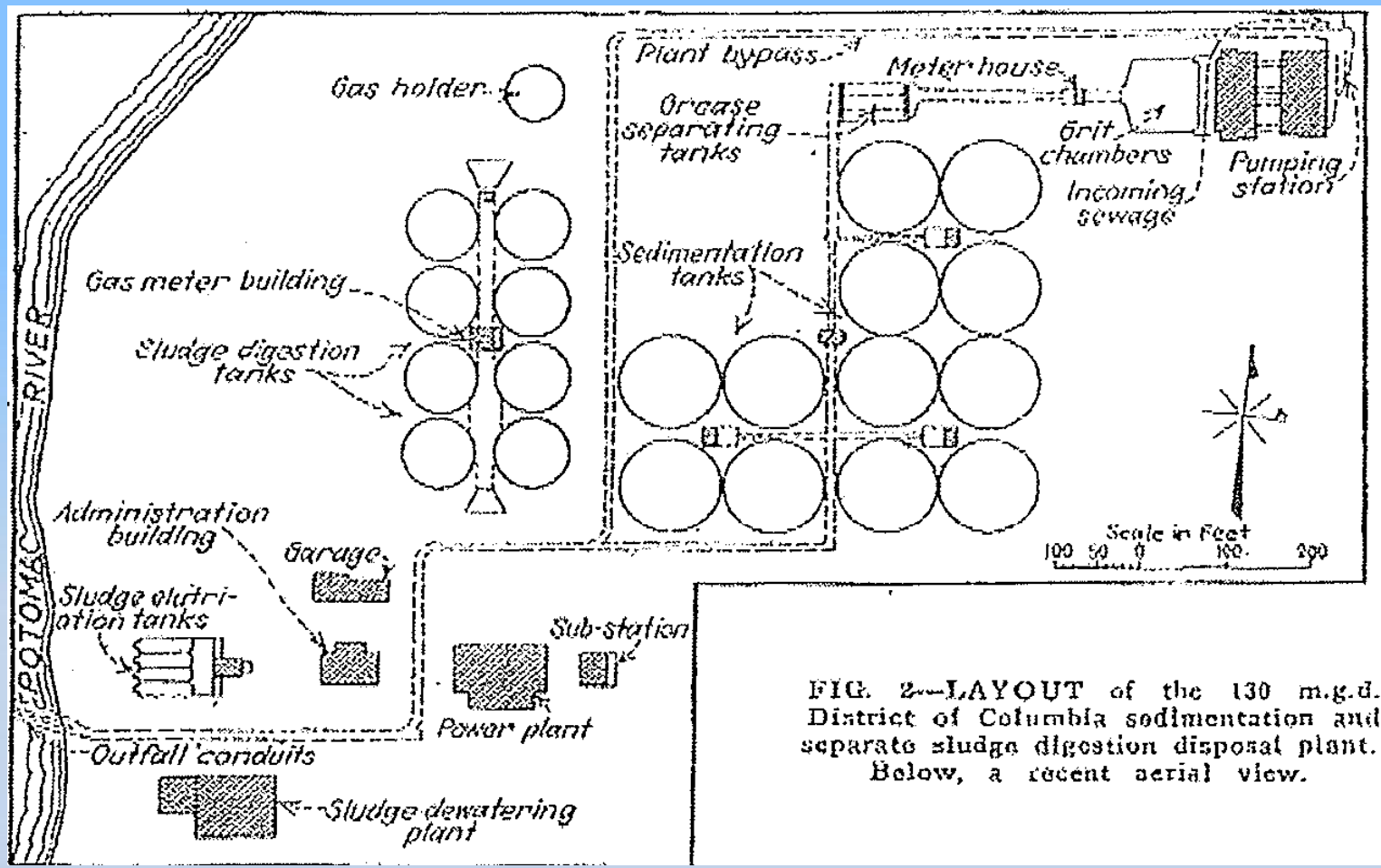

FIG. 2.—LAYOUT of the 130 m.g.d. District of Columbia sedimentation and separate sludge digestion disposal plant. Below, a recent aerial view.

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CLEAN WATER

NUTRIENT RECOVERY FACILITY 2015

Largest Advance Recovery System in the World

Largest user of power in DC

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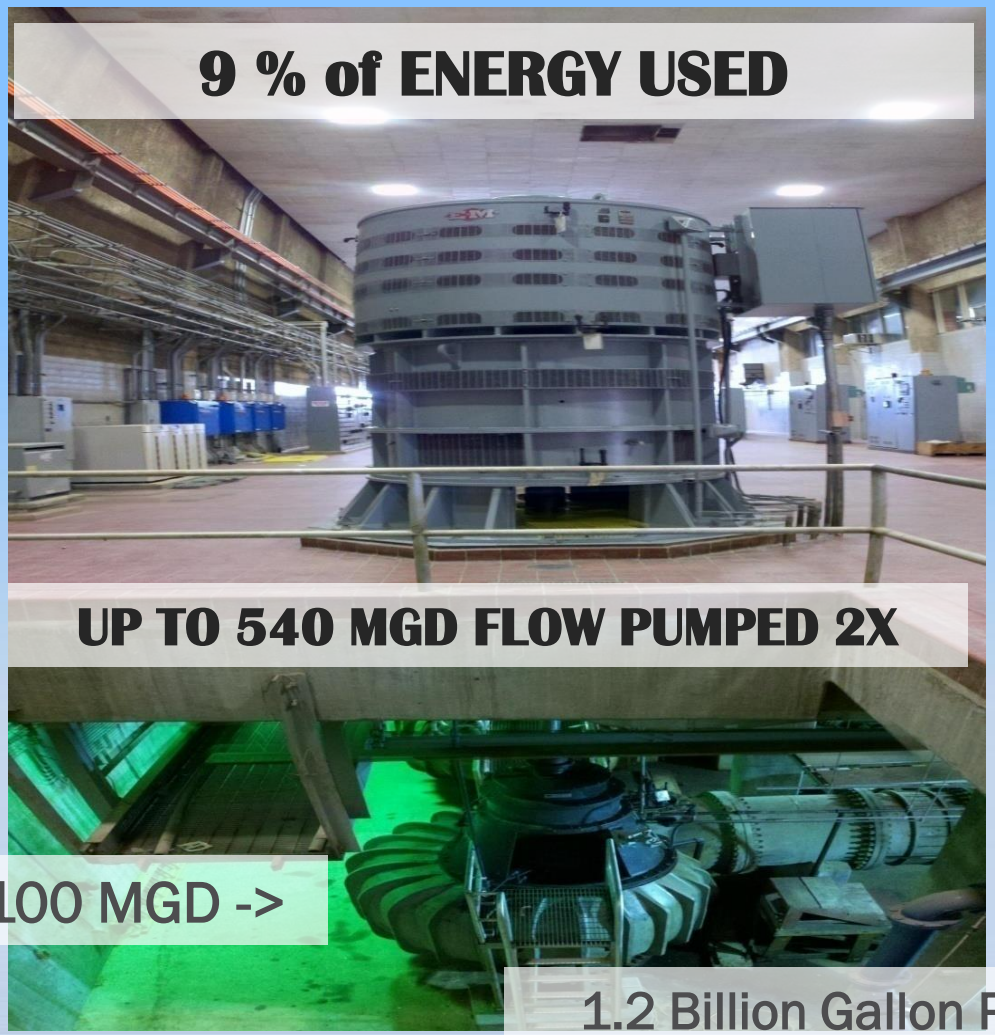
PUMPING – ENERGY CONSUMED



27 Pumps up to 100 MGD ->

1.2 Billion Gallon Per Day Capacity

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36 – PRIMARY CLARIFIERS

4% ENERGY CONSUMPTION - Removal Of Solids by Settling
35% of CBOD – 50% TSS
Ferric Chloride & Anionic Polymer Added

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SECONDARY REACTORS

REMOVE CBOD
By Aerobic Microbial Respiration
Ferric Chloride Added For Phosphorus Removal

6 TWO STAGE CENTRIFICAL COMPRESSION BLOWERS USE 14% OF TOTAL ENERGY CONSUMPTION FOR AERATION

FINE BUBBLE DIFFUESERS LOWERS ENERGY USE
TESTING MIRCOBIAL ELECTROCHEMICAL CELLS TO REDUCE ENERGY CONSUMPTION FOR AERATION

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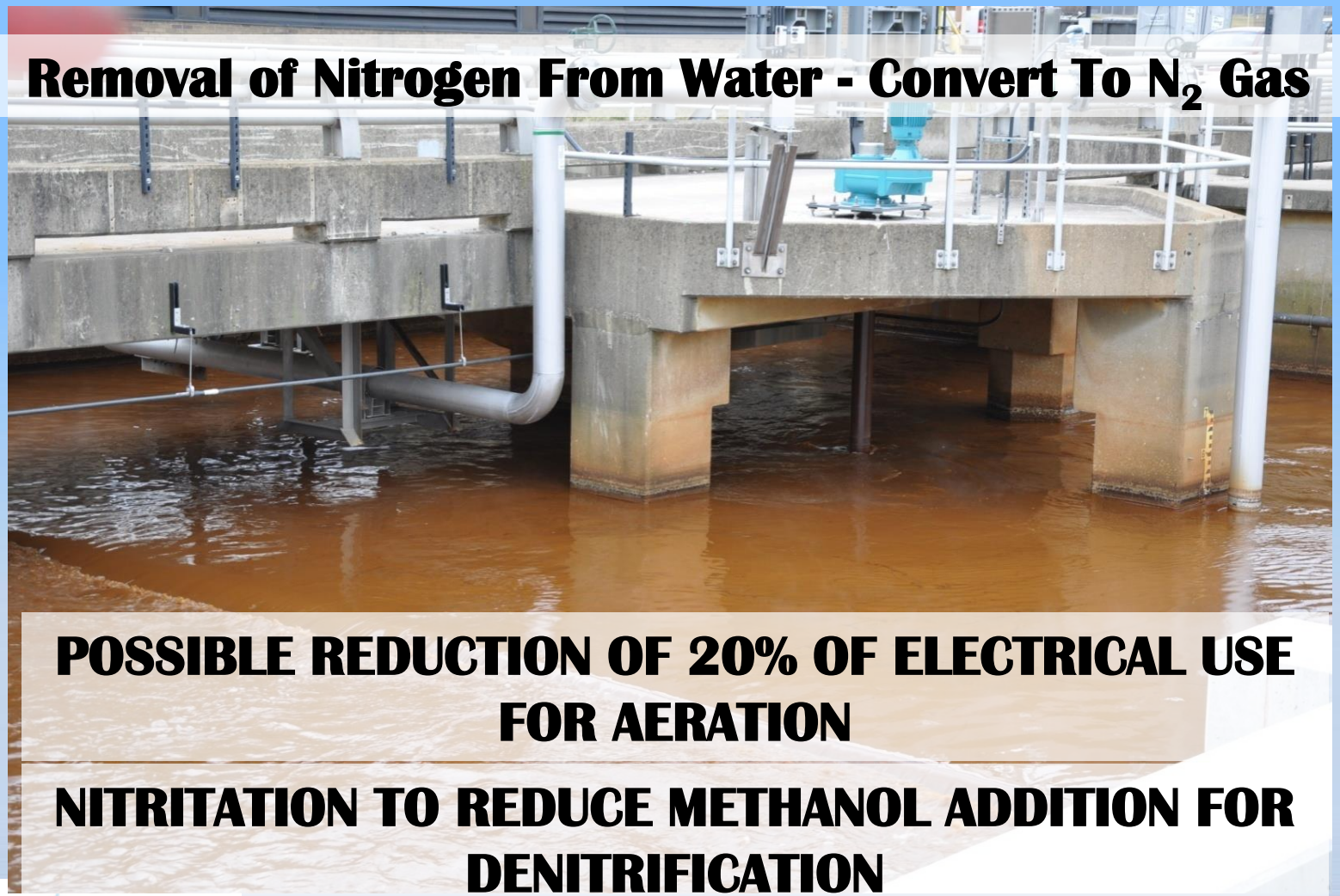
NITRIFICATION / DENITRIFICATION BASINS



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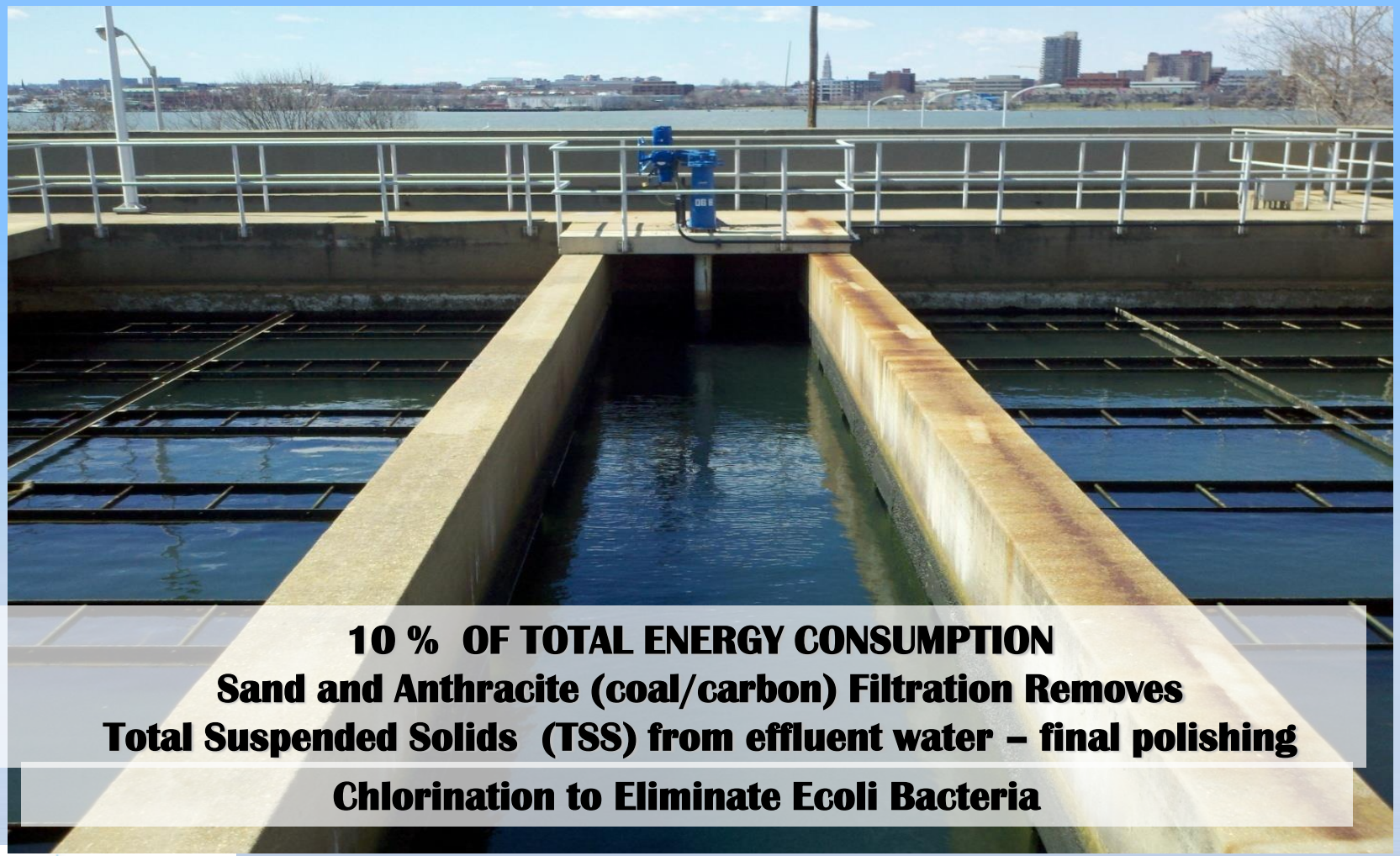
Multimedia Filters



10 % OF TOTAL ENERGY CONSUMPTION

Sand and Anthracite (coal/carbon) Filtration Removes Total Suspended Solids (TSS) from effluent water – final polishing

Chlorination to Eliminate Ecoli Bacteria

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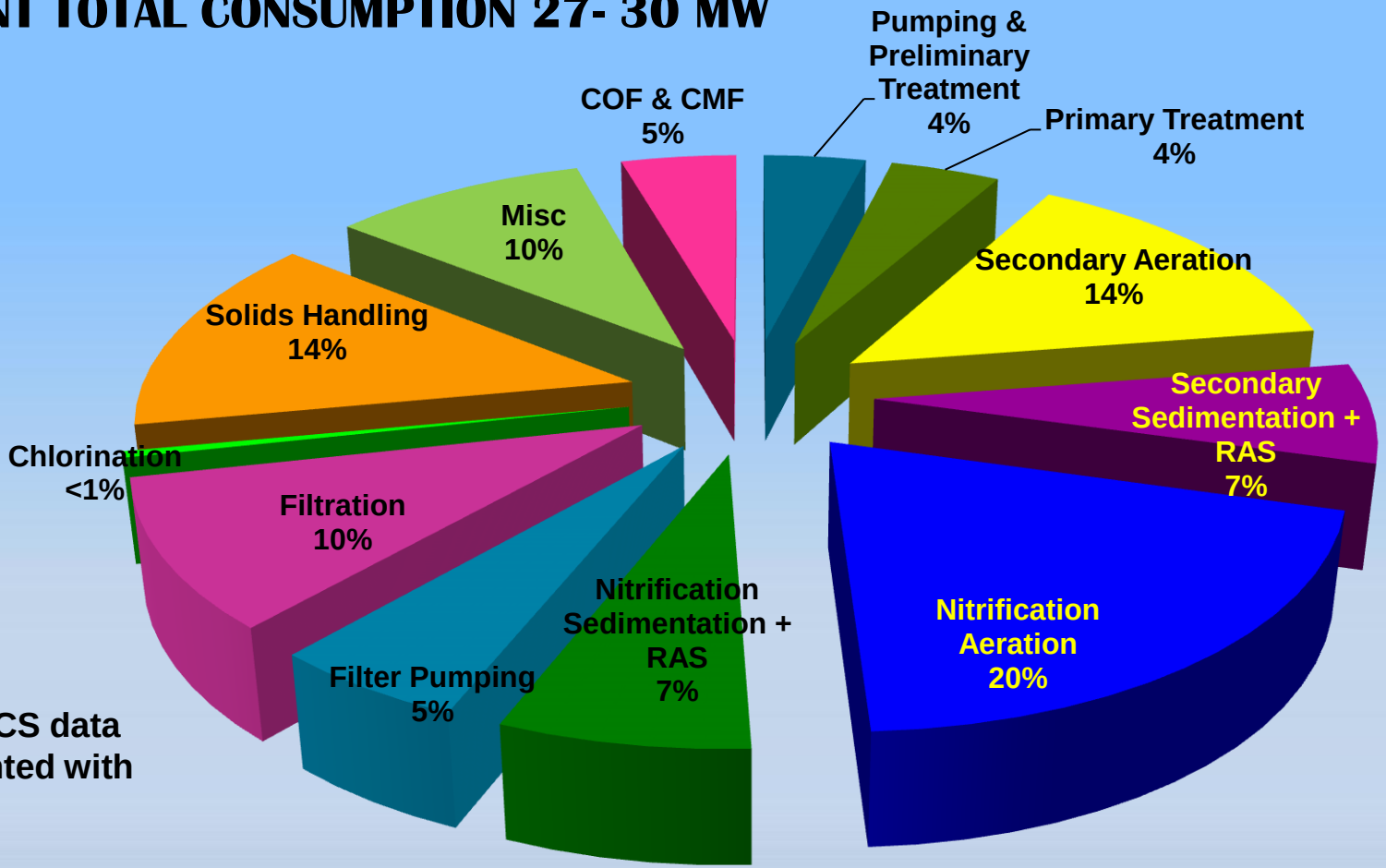
Electricity Consumption at Blue Plains

CURRENT TOTAL CONSUMPTION 27- 30 MW



Source: PCS data supplemented with estimates

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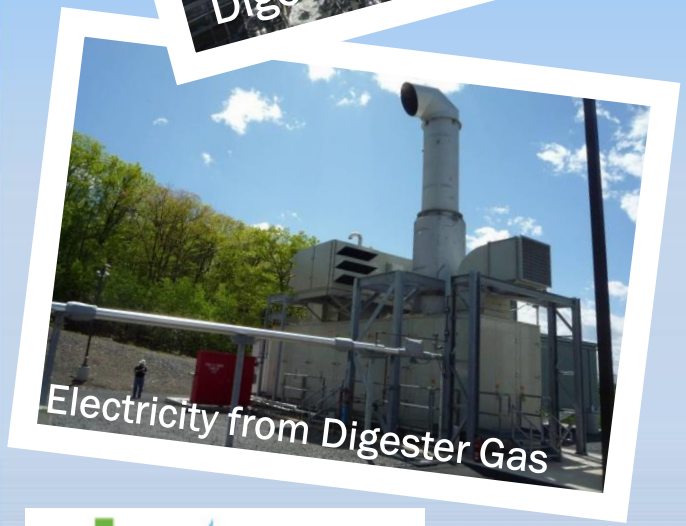
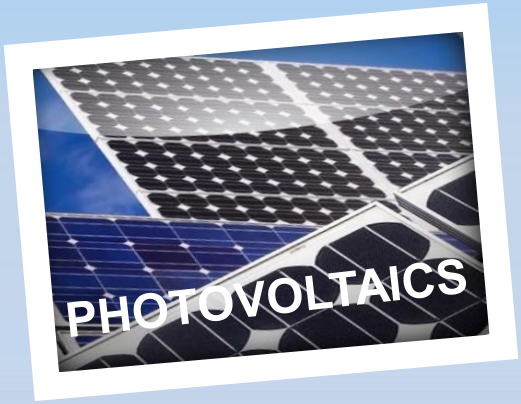
Fast Fact:
Over 1MW of installed lighting capacity at Blue Plains alone!

Energy Recovery





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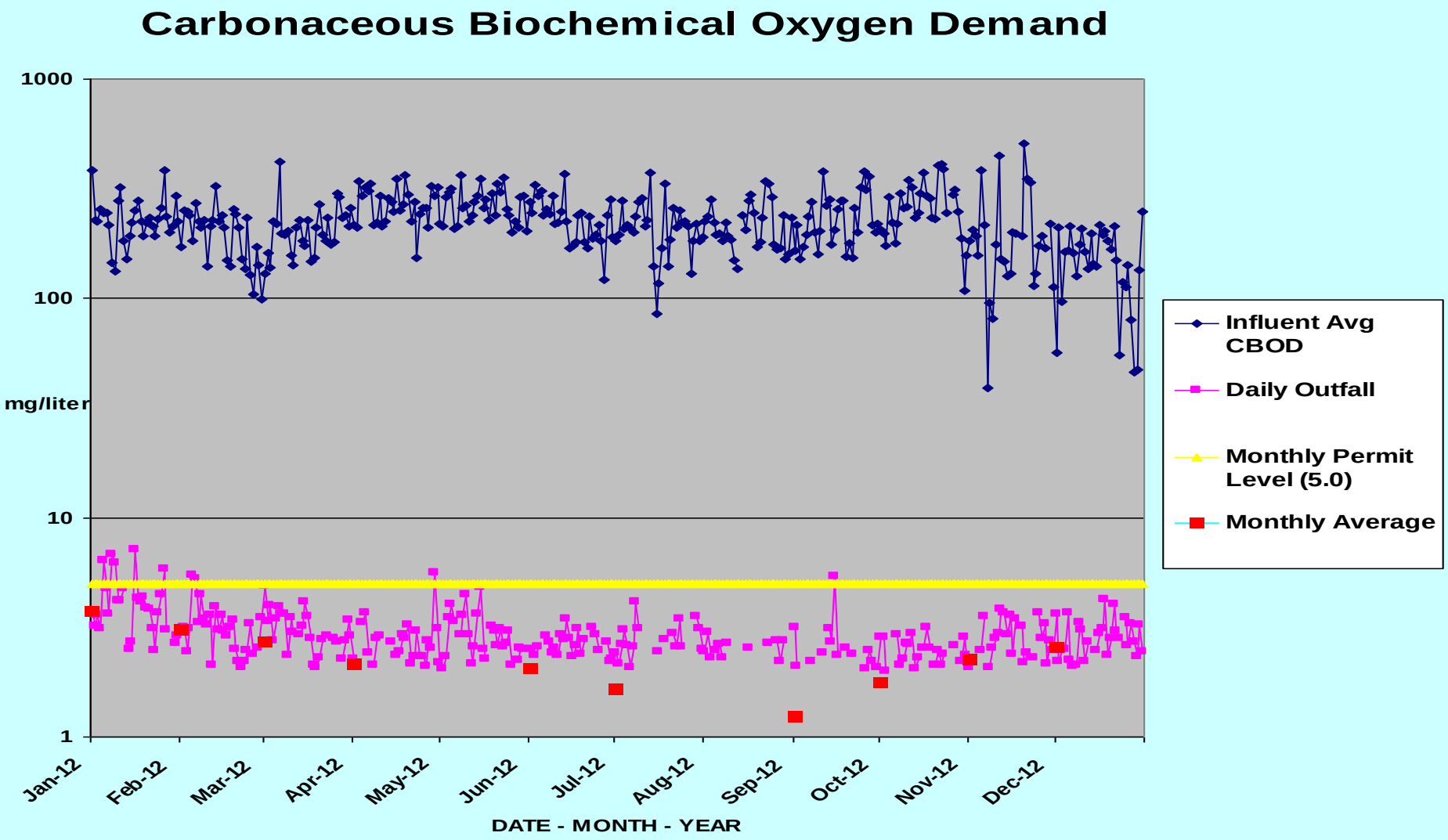
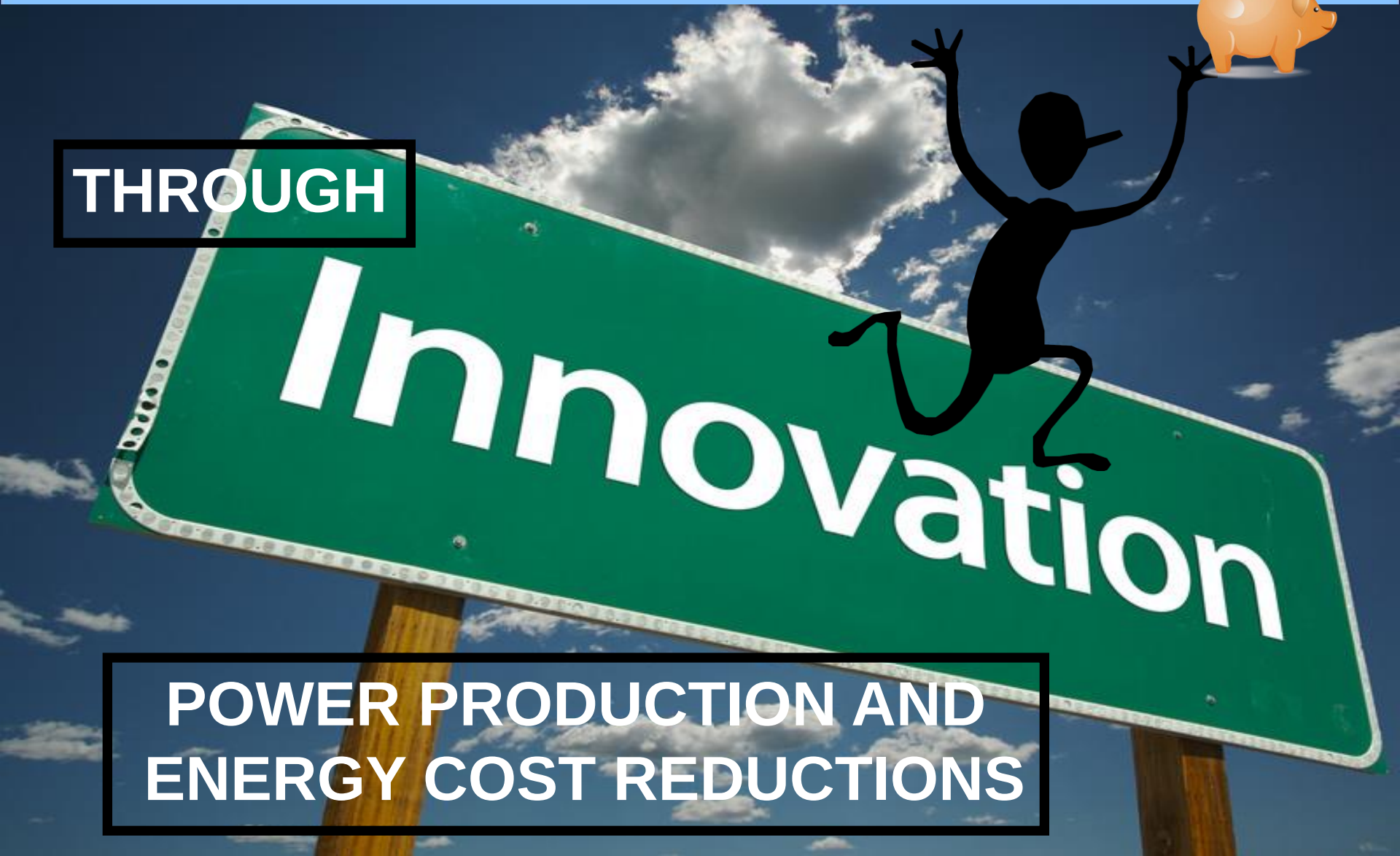
TOTAL CBOD REMOVAL



Zero Net Energy Facility



ENERGY REDUCTION & RECOVERY

- BLUE PLAINS - LARGEST D.C. ELECTRICAL USER
- GOAL TO NET ZERO –$ 1.1 – $1.4 MILLION MONTHLY ELECTRIC BILL REDUCTION (Strass, Austria Facility is NET ZERO ENERGY)
- DIGESTION = %40 REDUCTION IN FUEL COSTS - NUTRIENT DISTRIBUTION TO FARM LAND
- DIGESTION = GAS TURBINES - 8 TO 13 MW OF POWER
- "UTILIZE CARBON"- REDUCE DEPENDENCE ON FOSSIL FUELS
- SUSTAINABLE ENERGY SOURCES
- UTILIZE MULTIPLE RENEWABLE FORMS OF ENERGY

LOW HANGING FRUIT

- Thermal Hydrolysis - over 15 Years
- Digestion – Methane Production
- Combined Heat and Power – CHP
- Recuperative Turbines
- Photovoltaic's
- Annamox
- CoDigestion
- Thermal Heat Recovery
- Hydrogen Production ? Proven – Pilot Ready ?

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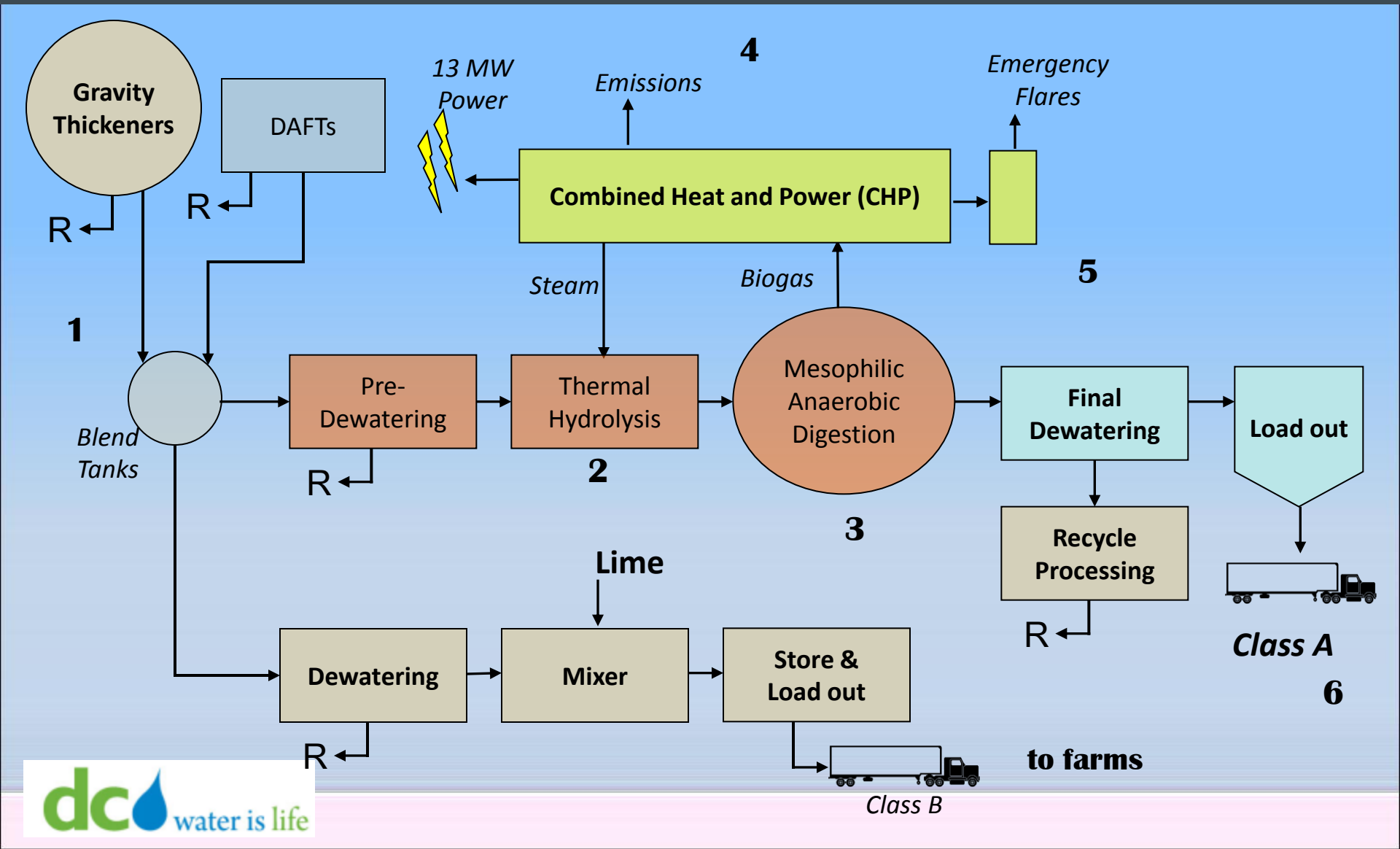
INNOVATION For GAS Production



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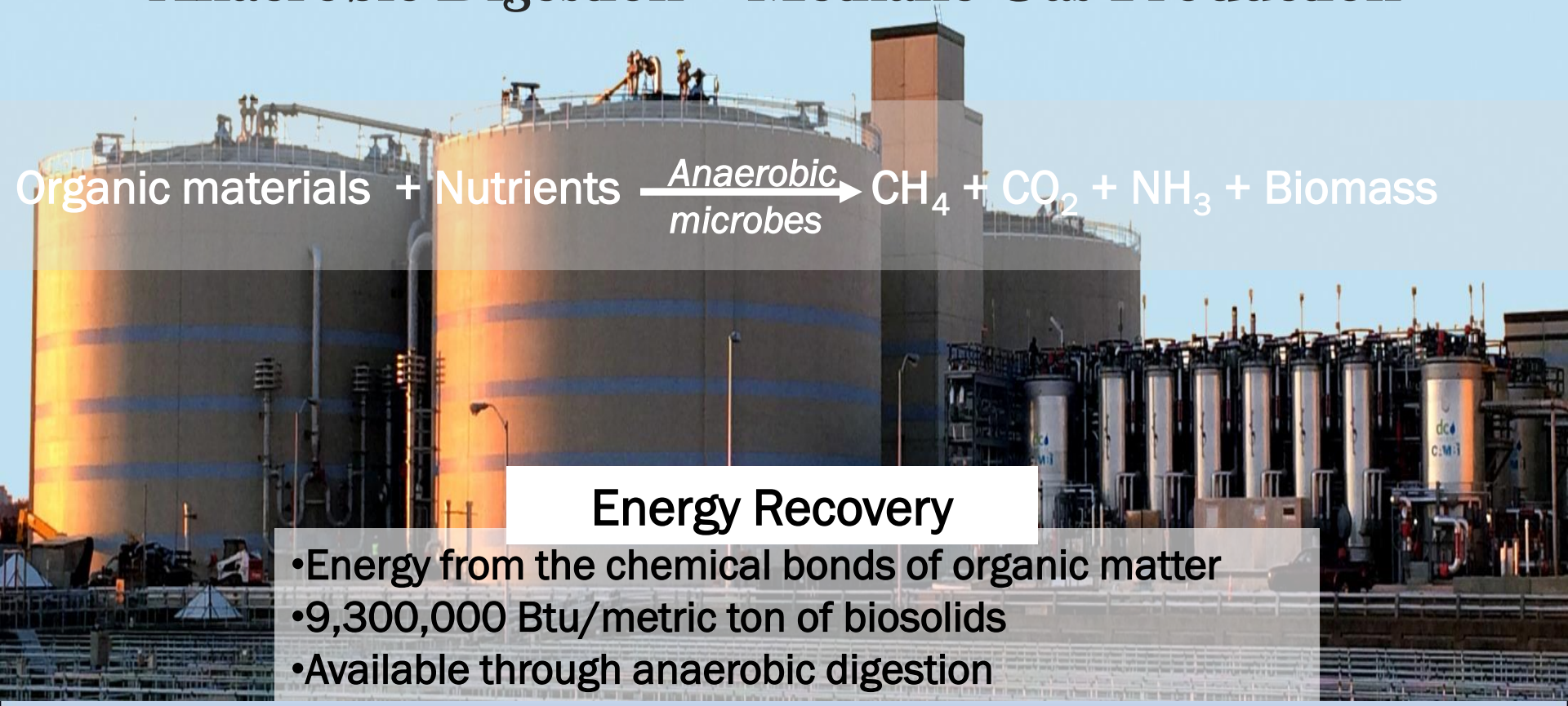
Digesters Gas Recovery

Anaerobic Digestion = Methane Gas Production



Organic materials + Nutrients $\xrightarrow[\text{microbes}]{\text{Anaerobic}}$ $CH_4 + CO_2 + NH_3 + \text{Biomass}$

Energy Recovery

- Energy from the chemical bonds of organic matter
- 9,300,000 Btu/metric ton of biosolids
- Available through anaerobic digestion

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RECUPERATIVE GAS TURBINES

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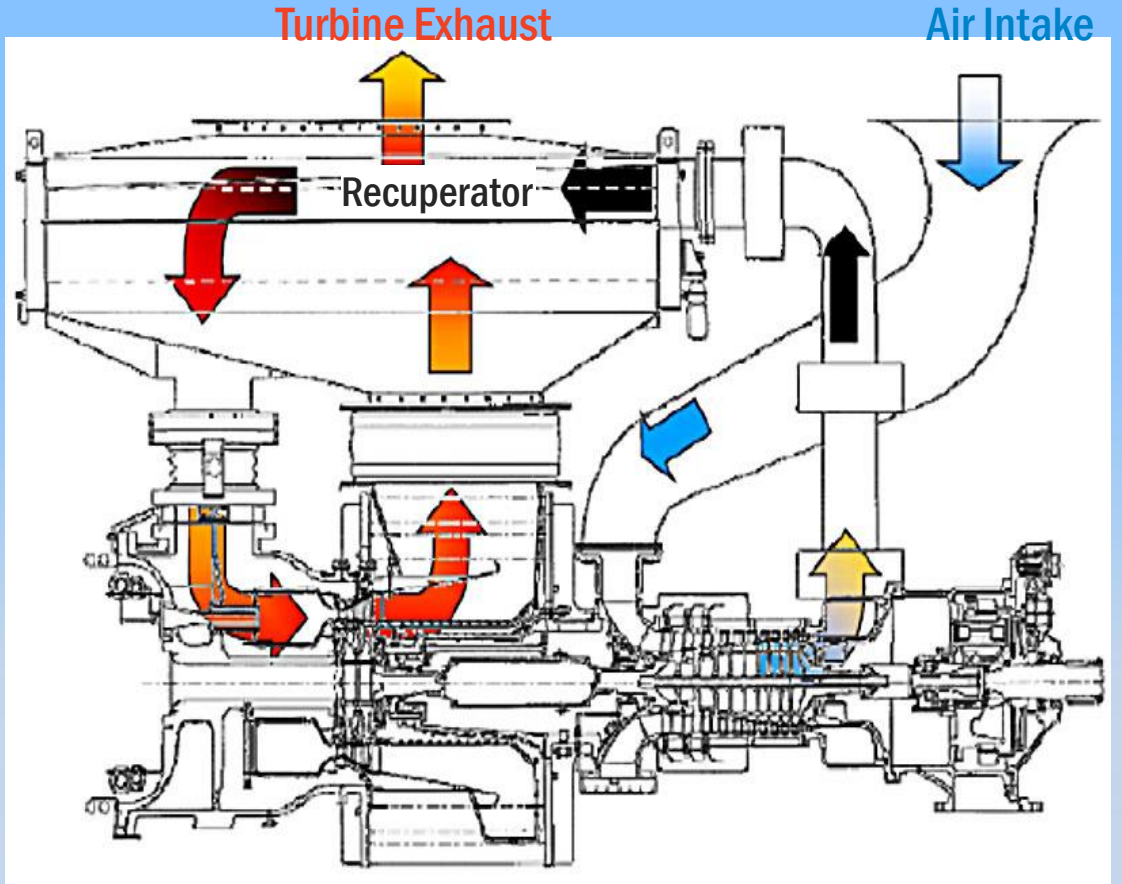
Gas Turbine Technology Overview

- Gas to air recuperative which increases efficiency and reduces air emissions
- Exhaust can be used to generate process steam
- No pre- or post-combustion emission controls required to meet CA BACT (LAER)



Combustor | Turbine | Compressor | Gearbox

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ENERGY FROM THE DIGESTER GAS

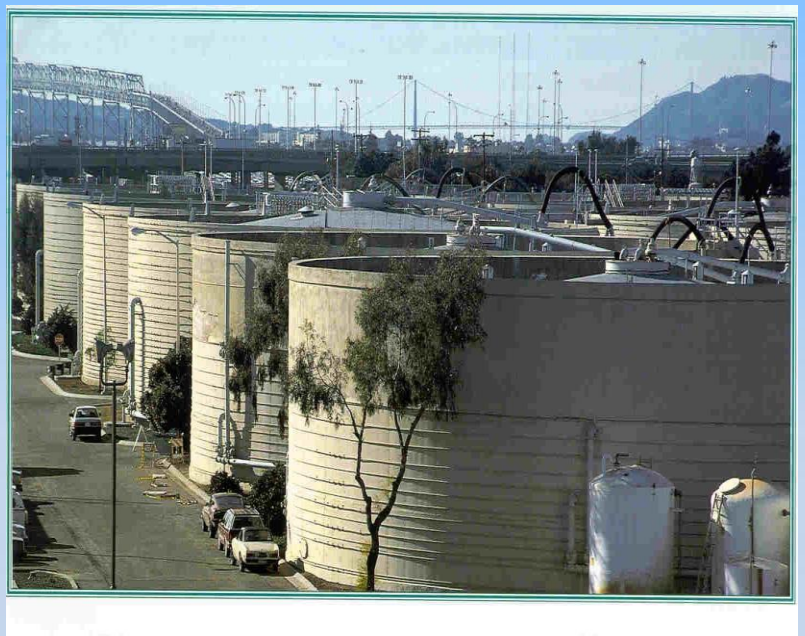
- Digester Gas (methane) collected is fed to a Combined Heat and Power (CHP) system.
- 3 Gas turbines, burn Digester Gas & generate electricity (up to 13 MW, enough to power 8000 homes).
- Heat generated by the turbine is stripped off with a Heart Recovery Steam Generator (HRSG) unit.
- The turbine generates enough excess heat to bring the TH and Digestion process up to temperature.

Energy Production from Co-Digestion Toward Energy Neutrality

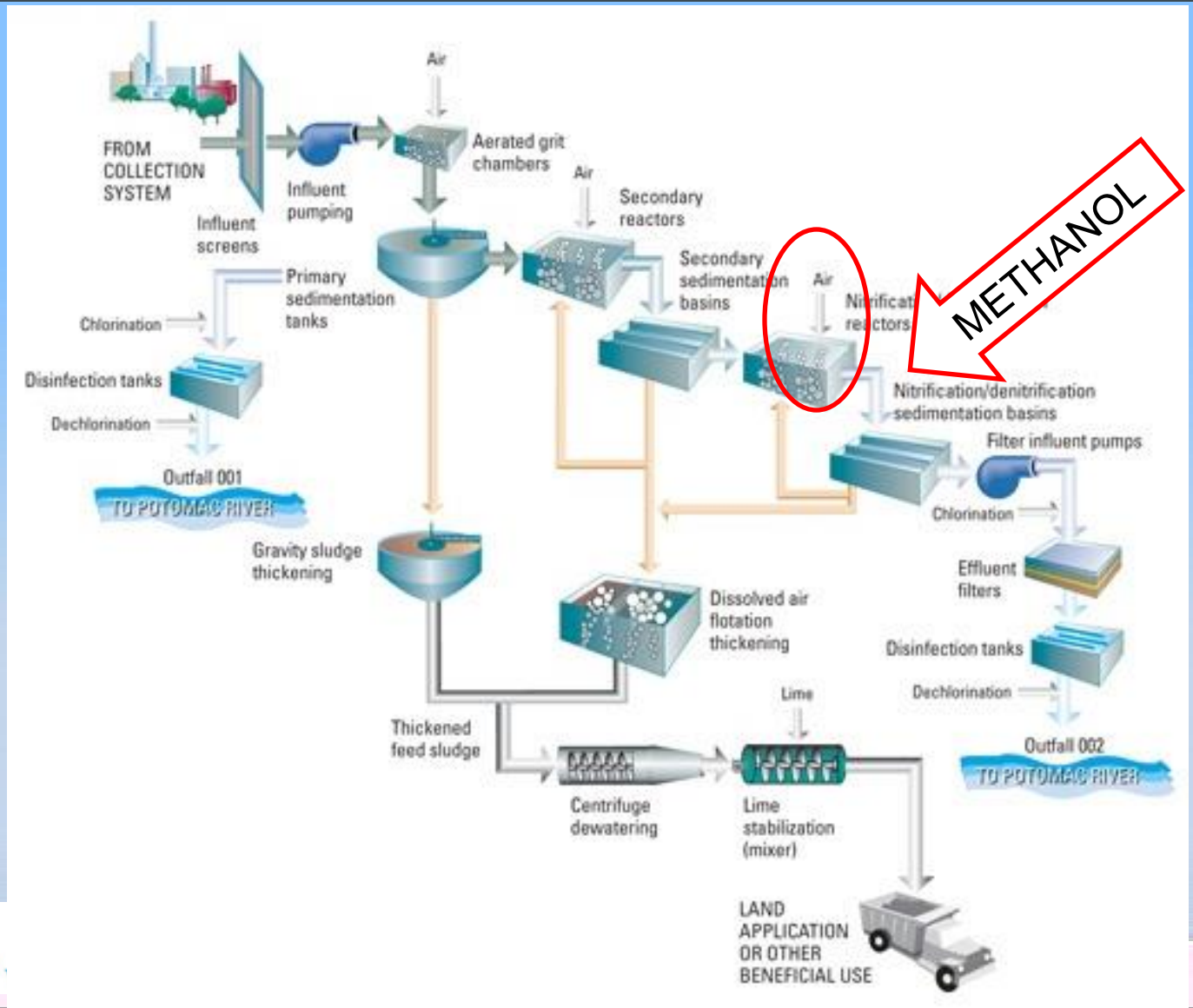
East Bay MUD (Calif) now sells power to the Grid, with a new 4.6 MW gas turbine on-line, it is the 1st water/ww utility in the US to produce more power than it uses

Having excess digester capacity available,

EBMUD has operated like a business to allow fats, greases, and various food and beverage wastes to be trucked in and co-digested at the plant.



Energy Efficient Bacteria : Annamox



Deammonification (simplified)

Partial Nitritation-Anammox = "Deammonification"

Autotrophic
Aerobic Environment

Heterotrophic
Anoxic Environment

1 mol Nitrate
(NO_3^-)

40% Carbon

REDUCTION OF METHANOL ADDED

Nitrite Oxidizers
(e.g. Nitrobacter)

25% O_2

1 mol Nitrite
(NO_2^-)

1 mol Nitrite
(NO_2^-)

60% Carbon

Autotrophic
Anaerobic
Environment

~~75%~~ O_2
37%

Ammonia Oxidizers
(e.g. Nitrosomonas)

1 mol Ammonia
(NH_3/ NH_4^+)

½ mol Nitrogen Gas
(N_2)
+ a little bit of nitrate (NO_3^-)

- 63% reduction in Oxygen demand
- Almost 100% reduction in Carbon demand
- 80% reduction in Biomass production
- Reduced CO_2 emissions (4.7 - 0.7 ton CO_2/ton N)

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ANAMMOX: "Anaerobic" Ammonia Oxidation

PHOTOVOLTAICS

PLANNING FUTURE POWER SOURCE - UP TO 11 MW

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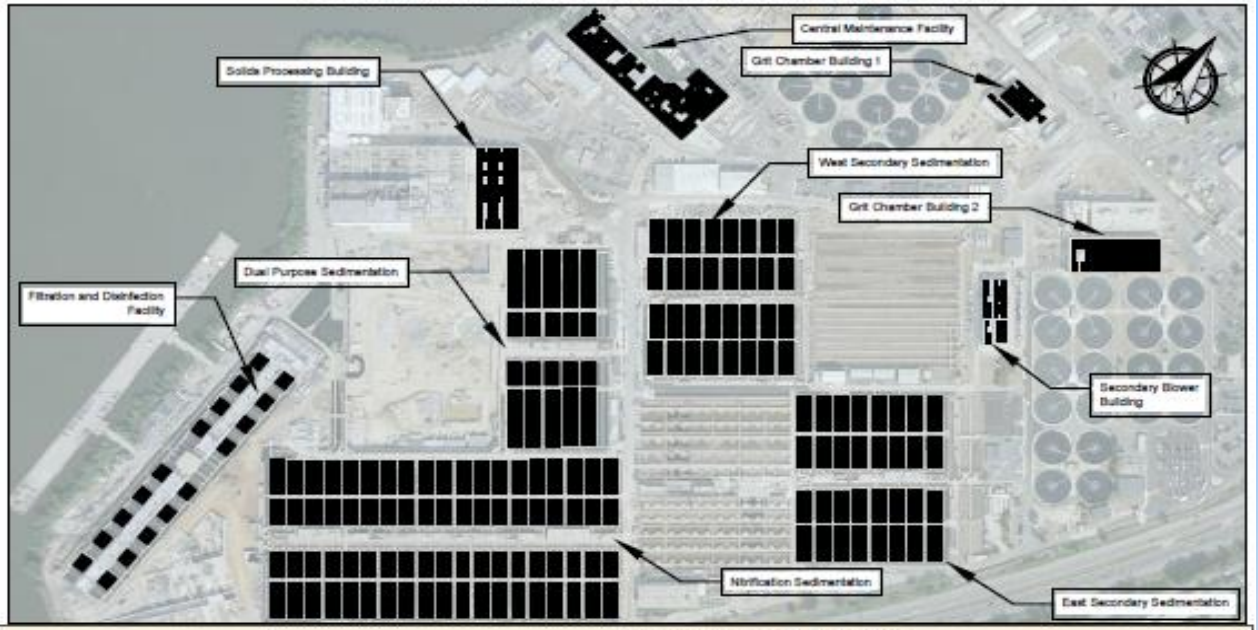
Array Locations for Blue Plains

SOLAR PHOTOVOLTAIC FEASIBILITY PROJECT
DISTRICT OF COLUMBIA WATER AND SEWER AUTHORITY
BLUE PLAINS ADVANCED WASTEWATER TREATMENT PLANT



	PV SOLAR ARRAY SYSTEM DATA TABLE :									
Location	Sheet No.	Total Module	Module Nameplate (W)	MW Capacity (DC)	Azimuth (Degree)	Tilt (degrees)	Inverter Mfg. or Approved Equivalent	Inverter Capacity in MW (AC)	Inverter Qty.	Annual Energy Output (MWh)
East Secondary Sedimentation	PV-1.1	8,832	270	2.38	217	10	ADVANCED ENERGY	2	2	2,976
West Secondary Sedimentation	PV-1.2	8,576	270	2.32	217	10	ADVANCED ENERGY	2	2	2,888
Dual Purpose Sedimentation	PV-1.3	6,720	270	1.81	217	10	ADVANCED ENERGY	1.5	2	2,264
Nitrification Sedimentation	PV-1.4	18,544	270	5.01	217	10	ADVANCED ENERGY	4.5	5	6,245
Filtration and Disinfection Facility	PV-1.5	1,944	270	0.52	166	10	ADVANCED ENERGY	0.5	1	661
Solids Processing Building	PV-1.6	1,001	270	0.27	217	10	ADVANCED ENERGY	0.250	1	323
Grit Chamber Building 1	PV-1.7	395	270	0.11	171	10	ADVANCED ENERGY	0.100	1	128
Grit Chamber Building 2	PV-1.8	915	270	0.25	217	10	ADVANCED ENERGY	0.200	2	292
Central Maintenance Facility	PV-1.9	1,915	270	0.52	171	10	ADVANCED ENERGY	0.500	1	653
Secondary Blower Building	PV-1.10	292	270	0.08	217	10	ADVANCED ENERGY	0.075	1	94
Totals		49,134		13.27				11.625	18	16,524

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Nutrient Rebate Research Projects

$2/wt rebated through biosolids contracts. DC Water is obligated to spend it on research

Virginia Tech

- Class A Blended Soil Products
- Cambi Class A Agricultural Certification

University of Maryland + USDA

- Thermal Hydrolysis of Trace Organics
- Odor Modeling and Prevention
- Cambi Class A Pathogen Certification
- Degradation Triclosan, Triclocarban

University of Maryland + NRL

- Microbial Electrochemical Cells

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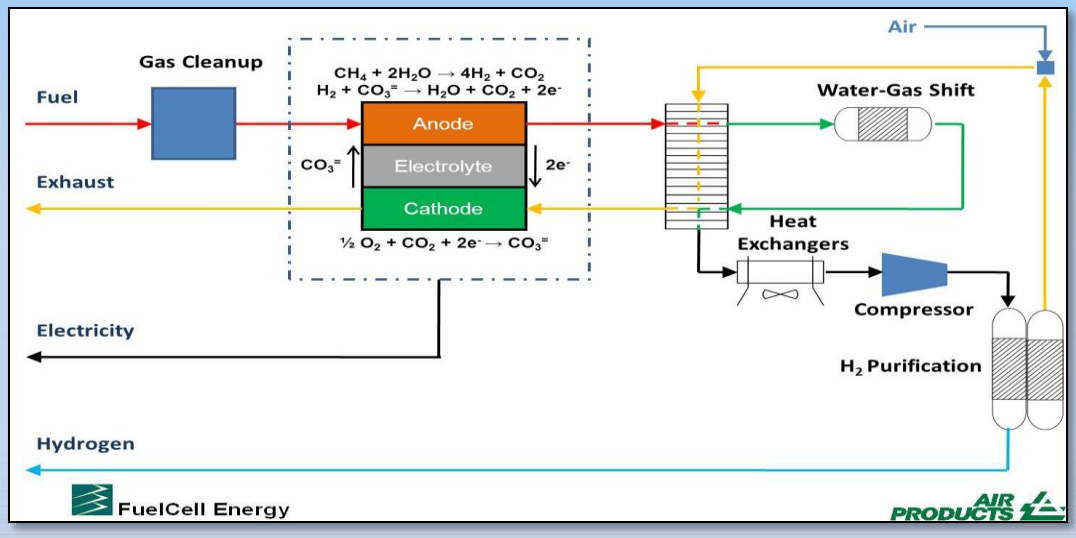
MICROBIAL ELECTROCHEMICAL CELLS

- **RESEARCH BY U of MD, NAVAL RESEARCH LABORATORY & DCWATER**

- **EVALUATEING SEDIMENT/BENTHIC MICROBIAL CELLS -**
  - **Generating Power from Organic Matter Oxidizing**
  - **Future work to Evaluate N Removal & H_2 generation**



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The VISION for Microbial Reactors & Hydrogen Generation

Only 25% of the Carbonaceous Volatile Solids are Now Utilized By Digestion

Expending Energy to Reduce Carbon / Volatile Solids - Energy Capture

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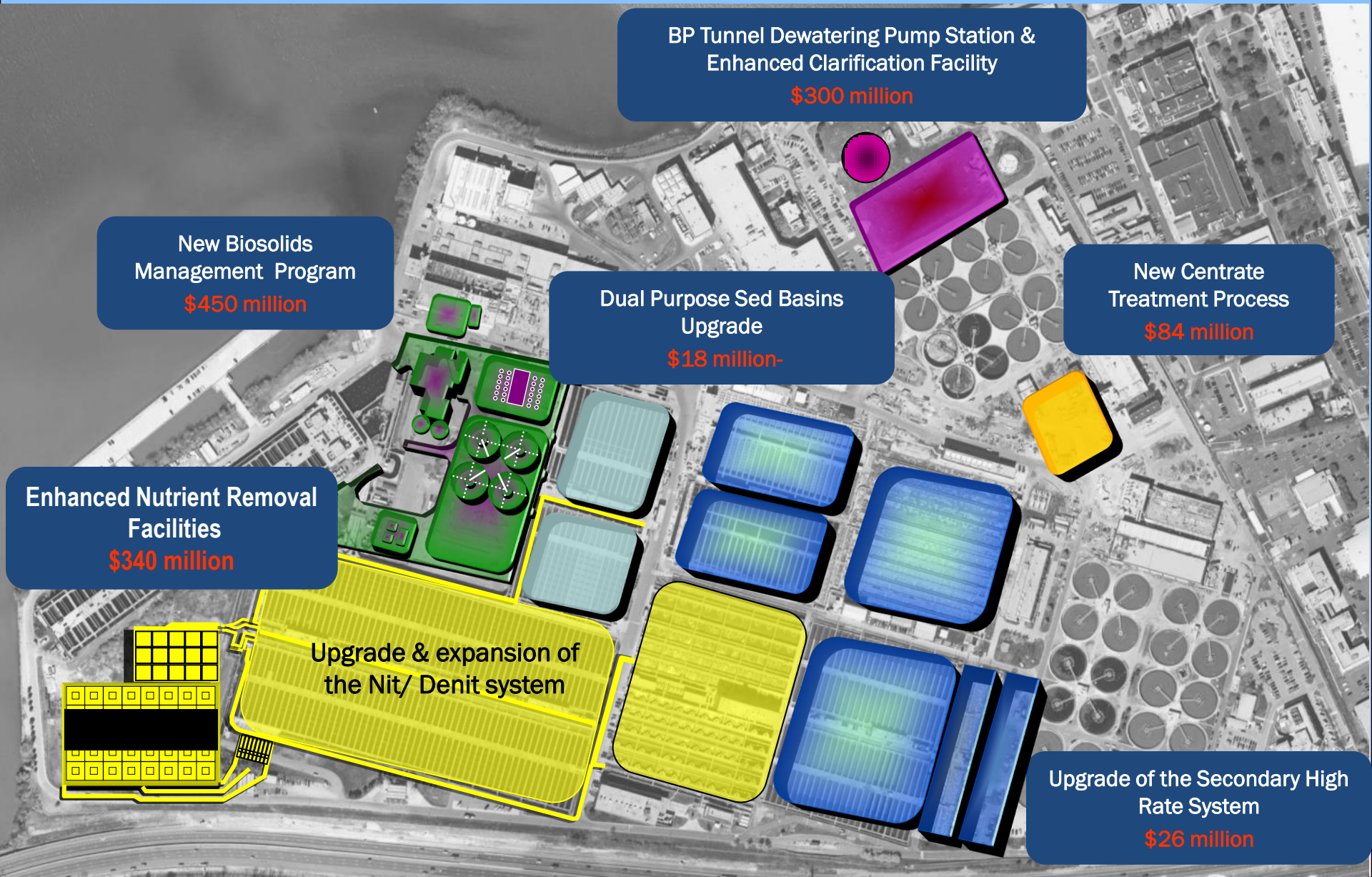
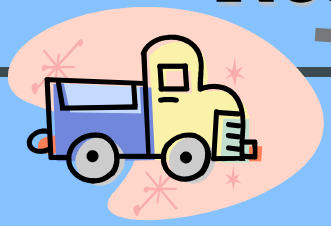
Capital Improvement Projects Underway

INNOVATION



Sustainable Food Nutrients & Energy Resources



Agricultural Products Transported to City

Products / Nutrients

Nutrient Consumption

Animal Consumption of Grain, Hay and Pasture

Recycling of:
Phosphorus
Nitrogen
Organic Matter
Zinc and other micronutrients

Power

Urban Nutrients Flows to Treatment Facility

Nutrient Removal & Power Facility

Crops Fertilized

Nutrients / Biosolids Transported to Land Application

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WASTES

Resources Out of Place