

# **Bicycle™ Process** **...with Reservoir or Aquifer** **Recharge for Drought Control!**

Made possible by the

**OAT™**

**Optimized Anaerobic**  
**Treatment Process**

# Sustainable Drought Control

- 💧 Is achieved by Reservoir Recharge with Reverse Osmosis Permeate Water, and/or
- 💧 Is achieved by Aquifer Recharge with Reverse Osmosis Permeate Water.
  
- 💧 Reverse Osmosis Permeate Water is One of the several Co-Products of the OAT™ (Optimized Anaerobic Treatment) Process.

# Reverse Osmosis Treatment

- 💧 Represents universally accepted technology for potable water treatment.
- 💧 Has been successfully used by Orange County, California since 1975 for aquifer recharge while repelling seawater intrusion (Water Factory 21 Project).

# Water Factory 21

- 💧 Uses Reverse Osmosis treatment after tertiary filtration of its sanitary wastewater.
- 💧 Is now being replaced by a much larger reverse osmosis treatment system.

# Bicycle™ Process

- 💧 Uses Reverse Osmosis treatment of sanitary wastewater coupled with the OAT™ Process.
- 💧 **Requires** additional organic wastes such as municipal solid wastes (MSW), food & green wastes, and animal wastes **for its successful application.**

# Bicycle™ Process

- 💧 Can beneficially recycle 100% of sanitary wastewaters while
- 💧 Eliminating all wastes sent to sanitary landfills thereby
- 💧 Providing 100% sustainable drought relief for the community
- 💧 Made possible by the **OAT™ Process.**

# Zero Wastes to Landfill!

- 💧 All ferrous and non-ferrous metals are sorted out and beneficially recycled.
- 💧 Glass, rubber, leather, plastics, and other residuals are ground and anaerobically digested.
- 💧 All remaining solid organics are also ground and anaerobically digested.

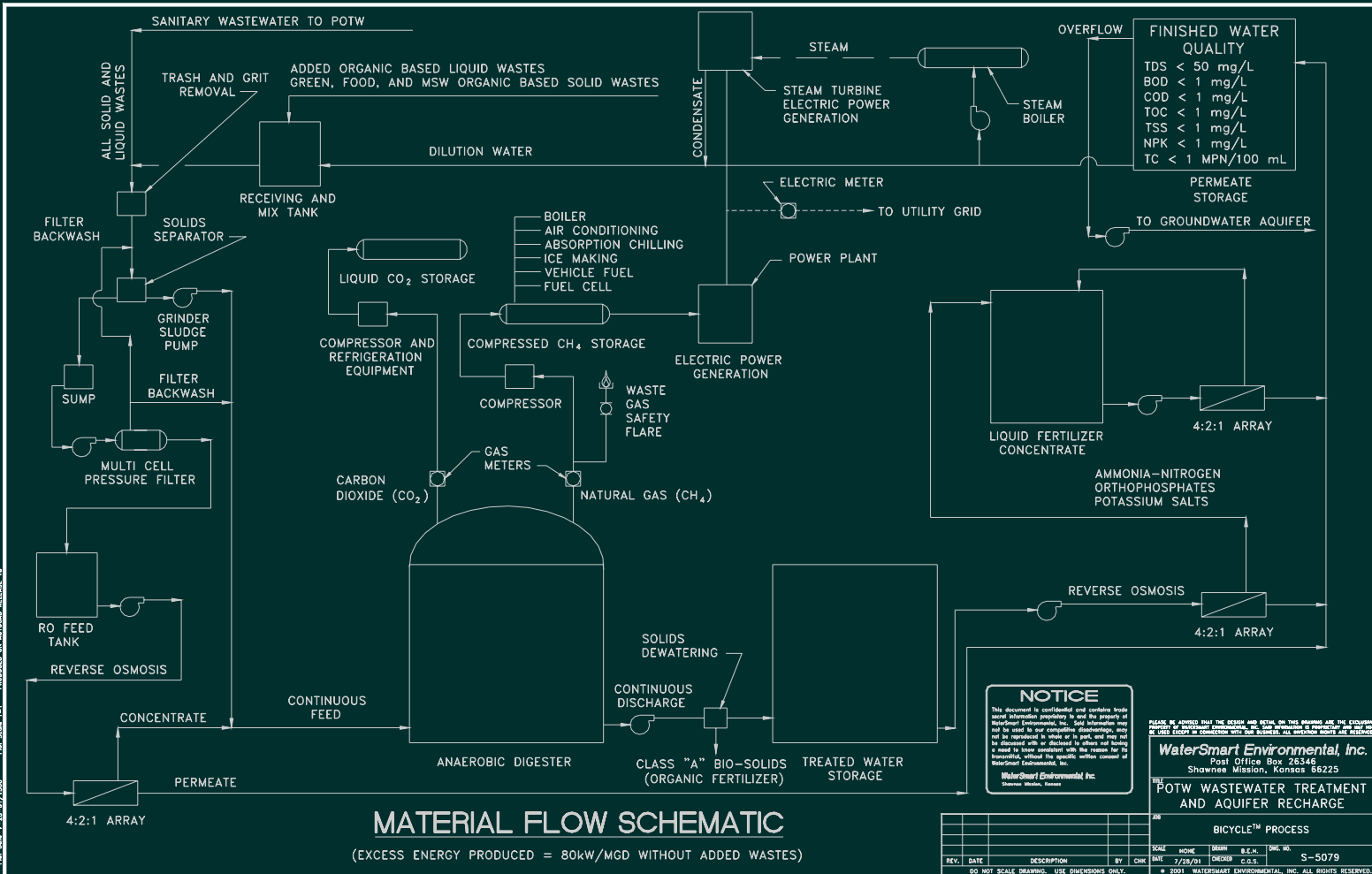
# Digester Co-Products.

- 💧 Methane gas
- 💧 Carbon dioxide gas
- 💧 Organic fertilizer – 30% moisture
- 💧 Liquid fertilizer concentrate
- 💧 Reverse osmosis permeate water

# Combined Cycle Electricity Generation.

- 💧 Methane gas is used to generate electricity with reciprocating engines or gas turbines.
  - 💧 Waste heat from methane gas electric power generation is used to make steam.
  - 💧 Steam is then used in a steam turbine generator to make additional electricity.
- ... Very efficient cogeneration of electricity.

# Total Treatment Design.



Prof. Date: 7-28-01/1000  
 Prof. Scale: 1=1  
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# Each MW of Electricity Generates About

- 💧 1.93 Tons/Day Of Organic Fertilizer @ 30% Moisture
- 💧 3.94 Tons/Day Of Liquid Fertilizer Concentrate @ 10% Total Solids
- 💧 3.81 Tons/Day Of Carbon Dioxide
- 💧 350,000 Gallons/Day Of Reverse Osmosis Permeate Water
- 💧 \$5.71+ Of Carbon Dioxide Credits @ about \$1.50/Ton
- 💧 MSW Produces About 600 kWh/Ton

# Solids (Digestate) Composition.

- 💧 Grit and sand.
- 💧 Insoluble Sulfides of Cadmium, Calcium, Copper, Iron, Lead, Manganese, Trivalent Chromium, and Zinc.
- 💧 Approximately 1-1-1 NPK (Nitrogen, Phosphorus, and Potassium)
- 💧 Qualifies as Class “A” Biosolids in compliance with 40 CFR Part 503
- 💧 Also Qualifies as Organic Fertilizer

# Solids Management.

- 💧 May be sold to the marketplace as an organic fertilizer commodity.
- 💧 May be sold to the marketplace as a soil amendment or conditioner.

# Liquid Streams.

- 💧 Liquid fertilizer concentrate.
- 💧 Reverse osmosis permeate.

# Liquid Fertilizer Concentrate.

- 💧 Contains about 20-10-10 NPK in a 10% water solution.
- 💧 Also contains trace amounts of aluminum, magnesium, and sodium micronutrients.

# Reverse Osmosis Permeate Water.

- 💧 Total dissolved solids < 50 mg/L
- 💧 Total coliform count < 1MPN/100 mL
- 💧 BOD < 1 mg/L
- 💧 COD < 1 mg/L
- 💧 TOC < 1 mg/L
- 💧 TSS < 1 mg/L
- 💧 NPK < 5 mg/L

# Liquids Management.

- 💧 Liquid fertilizer concentrate may be sold to the marketplace as a commodity.
- 💧 Reverse osmosis permeate water may be used for boiler water make-up, reservoir recharge, aquifer recharge, and/or irrigation.

# Other Co-Products.

- 💧 Methane gas.
- 💧 Carbon dioxide gas.

# Co-Product Methane Gas.

- 💧 Is compressed, dried, and stored at 300 psig for site use and for the generation of electricity.
- 💧 Compressed methane may also be sold as CNG (compressed natural gas).
- 💧 Generated electricity may be used at site as well as sold to utility grid.

# Co-Product Carbon Dioxide Gas.

- 💧 Is compressed, dried, purified, liquefied, and sold to the marketplace as a commodity.
- 💧 Meets food and medical grade specifications quality.

# Co-Product Management.

- 💧 No release of methane gas to the environment.
- 💧 No release of carbon dioxide gas to the environment.
- 💧 Zero gas releases accomplish a 500%+ reduction in greenhouse gas effect.

# Odor Control.

- 💧 MSW receiving and sorting building is kept under negative pressure thereby preventing odor release to the environment.
- 💧 Air quality within receiving and sorting building is continuously recycled and purified by vapor phase activated carbon treatment.

# The OAT™ Process.

Is the *only* process that combines:

- 💧 Two-phase Anaerobic Digestion
- 💧 Thermophilic Bacteria
- 💧 Staged Phase Treatment
- 💧 Fixed Growth Media
- 💧 Flow Recirculation
- 💧 pH and Temperature Control
- 💧 Essential Nutrient Addition

# Bacteria Can Produce Fuel From Liquid & Solid Wastes.

- 💧 Solid waste landfills biologically generate methane gas (called *biogas*) as clear evidence of the ability of bacteria to produce fuel.
- 💧 Biogas is a mixture of carbon dioxide and methane gas. It has a heating value of about 25,000 kJ per cubic meter.
- 💧 Biogas may be used as a primary fuel or to generate electricity.

# Wastewater Treatment Plants Use Bacteria.

- 💧 Almost all wastewater treatment plants use bacteria to treat the water.
- 💧 Aerobic plants use aeration. They *consume* about 8,000 kJ per kg COD (Chemical Oxygen Demand) removed.
- 💧 WaterSmart's OAT™ anaerobic plant *generates* about 22,000 kJ/kg COD for an energy improvement of about 30,000 kJ/kg COD.

# Wastes That Can Be Converted Into Methane.

- 💧 Municipal Wastewater
- 💧 Landfill Leachate
- 💧 Chemical Manufacturing
- 💧 Pulp & Paper Mills
- 💧 Sugar Mills
- 💧 Palm Oil Mills
- 💧 Breweries & Distilleries
- 💧 Fish & Food Processing
- 💧 Agricultural Solid Wastes
- 💧 Cardboard & Sawdust
- 💧 Ethanol Plants
- 💧 Rubber Plantations

# ...More Eligible Wastes.

- 💧 Animal Feed Lot Wastes
- 💧 Dairy & Cheese Production
- 💧 Fruit & Vegetable Canning
- 💧 Pharmaceutical Wastes
- 💧 Rendering Plants
- 💧 Textile Manufacturing
- 💧 Municipal & Industrial Digester Sludge
- 💧 Municipal Solid Wastes

# A Renewable And Alternative Energy Source.

- 💧 These many wastes are generated each and every day in the normal course of living.
- 💧 The routine treatment or disposal of wastes is tremendously *expensive*.
- 💧 The OAT™ process, however, makes their conversion into methane gas and other co-products *profitable*, an extremely pleasant surprise.
- 💧 This was made possible by managing wastes as a valuable resource rather than a burden on society.

# Excess Energy Produced.

- 💧 The OAT process uses some of the methane it generates to heat the wastewater being treated.
- 💧 The excess methane can be sold, used to operate equipment, or generate electricity.
- 💧 The excess **green power** electricity can be used by the treatment plant, sold to the local electric utility, or even to a distant business or city through the Internet.

# Positive Return On Investment.

- 💧 When one generates a profit from the treatment of wastes, a *positive return on investment* (ROI) always results.
- 💧 Rather than a burden on society, wastes may now be viewed as an **asset**--an incredible reversal of common perception.
- 💧 Wastewater treatment plants of the patented OAT™ Process design pay for themselves!

# Energy Costs.

- 💧 Wastewater treatment is very expensive, particularly because of energy costs which increase at 3-5% every year.
- 💧 A typical biological wastewater treatment plant uses about 8,000 kJ per kg COD (Chemical Oxygen Demand) removed.
- 💧 WaterSmart's OAT™ process can produce up to 22,000 kJ/kg COD removed, for an *energy improvement* of about 30,000 kJ per kg COD.

# Capital Equipment Costs.

- 💧 Are also very expensive, on the order of US\$2,000+ for every kg of COD treatment capacity.
- 💧 If ammonia, nitrate, phosphorus, or heavy metal removals are required, the associated costs are much higher.
- 💧 WaterSmart's OAT™ Anaerobic Treatment Plant costs about half as much as other anaerobic systems treating the same amount of COD or Volatile Solids.

# Environmentally Friendly And Sensible.

- 💧 Korea's Sudokwon Landfill, the world's largest, has the motto: *"Don't Waste Wastes."*
- 💧 We share that view and believe wastes should be converted into something useful, like fuel or electricity, if it can be done so safely and economically.
- 💧 In so doing, waste volumes are greatly reduced to better manage the environment on a sustainable basis.

# Odors?

## Absolutely None!

- 💧 All treatment is carried out in closed vessels.
- 💧 Hydrogen Sulfide is removed from produced biogas.
- 💧 All gasses are captured and used or recycled. None escape.

# Environmental Damage? Absolutely None!

- 💧 No emissions to atmosphere.
- 💧 Heavy metals removed as insoluble sulfides.
- 💧 Organic constituents are converted into methane gas.
- 💧 All nutrients are captured and recycled.

# Beneficial Co-Products

In addition to **methane gas**, the OAT™ Process also generates other useful and profitable co-products.

- 💧 Carbon Dioxide Gas
- 💧 Organic Fertilizer
- 💧 Liquid Fertilizer Concentrate
- 💧 Reverse Osmosis Permeate Water

# Greenhouse Gasses

- 💧 A methane powered generator or gas turbine will discharge EPA permissible amounts of carbon dioxide when producing electricity.
- 💧 If a fuel cell is used to make electricity, no carbon dioxide is discharged.
- 💧 No methane is ever discharged to the environment.

# Noise...

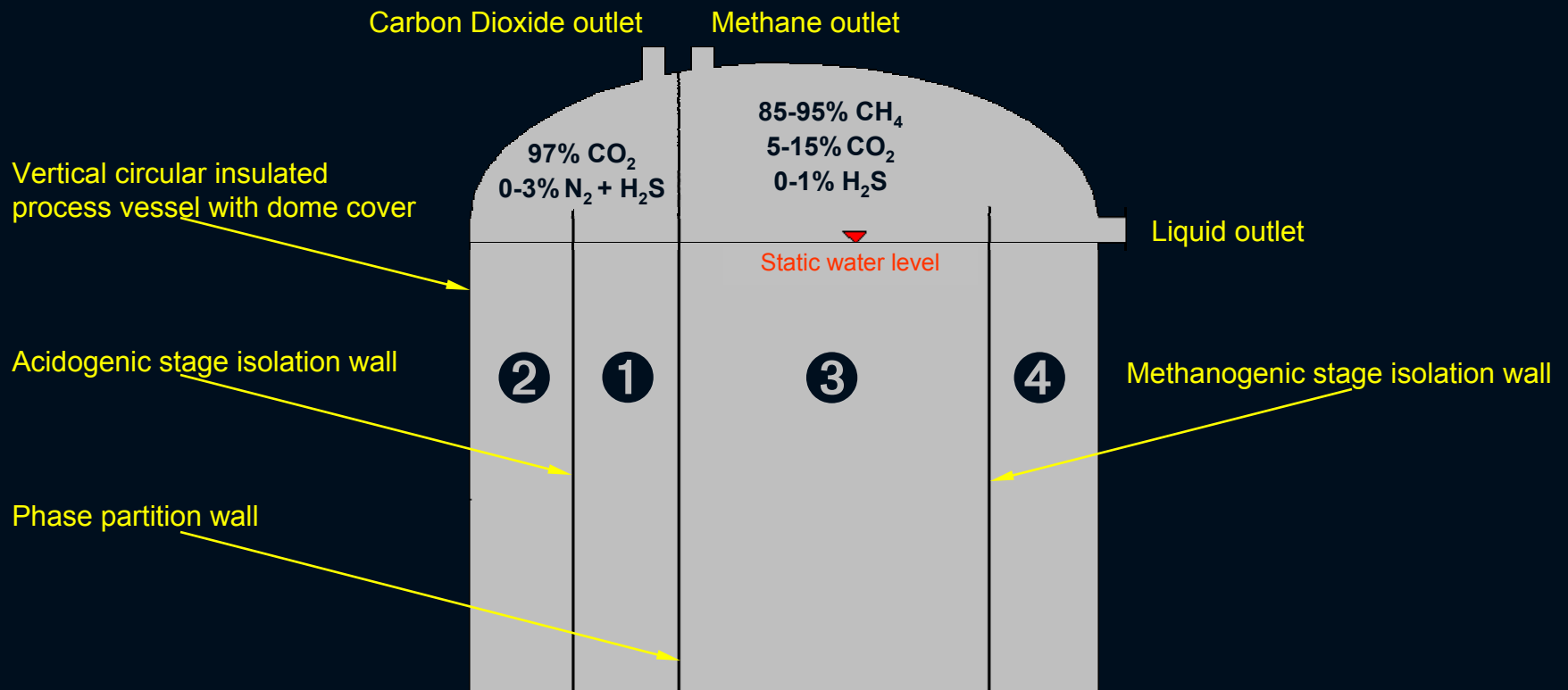
## Practically none!

- 💧 The loudest component is a biogas powered generator or turbine -- similar to a truck engine.
- 💧 Noise producing equipment can easily be enclosed for sound attenuation.

# Sludge

- 💧 0.01 pounds of solids produced for every pound of BOD removed—about 25% that of competitive anaerobic treatment plants!
- 💧 OAT™ process sludge qualifies as **Class “A” Biosolids** that can be sold as fully certified organic fertilizer or soil amendment.

# Single Vessel Design.



- ① 1st stage acidogenic digester
- ② 2nd stage acidogenic digester

- ③ 1st stage methanogenic digester
- ④ 2nd stage methanogenic digester

# Headworks.

- 💧 Trash and grit removal.
- 💧 Grind or comminute the raw wastewater.
- 💧 No primary treatment required.
- 💧 Biosolids may be ground and added.
- 💧 Organic solid wastes may also be added.
- 💧 Liquid organic wastes may also be added.
- 💧 Green wastes may also be added.
- 💧 Food wastes may also be added.

# Sophisticated Design But Easy To Operate.

- 💧 Automatic controls simplify routine plant operations.
- 💧 Close process control translates into a high degree of treatment efficiency.
- 💧 Minimal plant operator skill required.

# OAT Upgrades Available.

- Existing anaerobic digesters may usually be upgraded to the OAT process thus saving project site construction and piping costs.
- A complete upgrade to the OAT process can increase the digester organic loading capacity by a factor of 10.
- Beneficial use or sale of the produced methane gas, generated electricity, Class A biosolids, reverse osmosis permeate water, and carbon dioxide gas makes the upgrade a positive ROI.

# Summary.

- 💧 Wastes can be beneficially converted into fuel or electricity.
- 💧 An efficient anaerobic treatment process results in a positive return on investment.
- 💧 The OAT™ process is the **most efficient** anaerobic treatment available worldwide.
- 💧 OAT™ plants are smaller, less expensive, do not smell, and generate a profit.
- 💧 Reverse Osmosis permeate water can be used for reservoir or aquifer recharge and other purposes.

# For Project Feasibility Studies and Proposals

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