

RNG from a Different Perspective



System Integration, Engineering, Procurement, Construction, Operations



Tetra Tech

- Leading full-service provider of consulting and engineering services
- Founded in 1966
- \$2.8B in revenue for FY 2017
- 400 offices
- 16,000+ employees worldwide
- \$1B Bonding Capacity



Tetra Tech Design Rankings

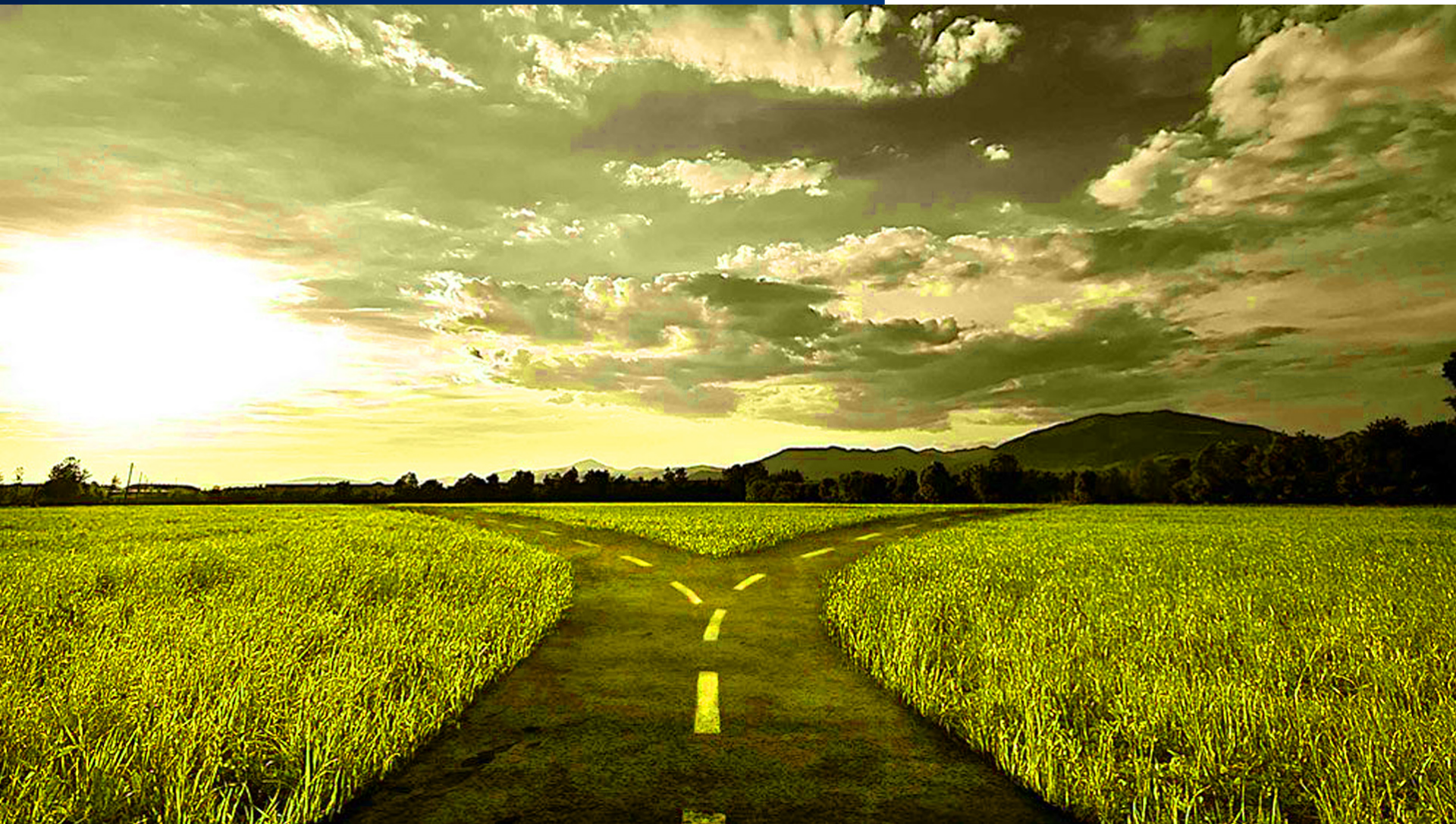
- 1 Pipelines
- 1 Dams & Reservoirs
- 4 Aerospace
- 4 Marine & Port Facilities
- 5 Private Clients
- 6 Federal Clients
- 7 Combined Design and CM/PM
- 10 Data Centers

Why Clients Choose Tetra Tech for RNG?

1. Technical Excellence
2. Uncompromised Quality
3. Market Leading Expertise:
 - More than 300 bioenergy projects
 - More than 90 LFGTE projects
 - More than 25 RNG Projects



RNG from a Different Perspective



Two Ways of Approaching RNG Implementation?



Top Down?

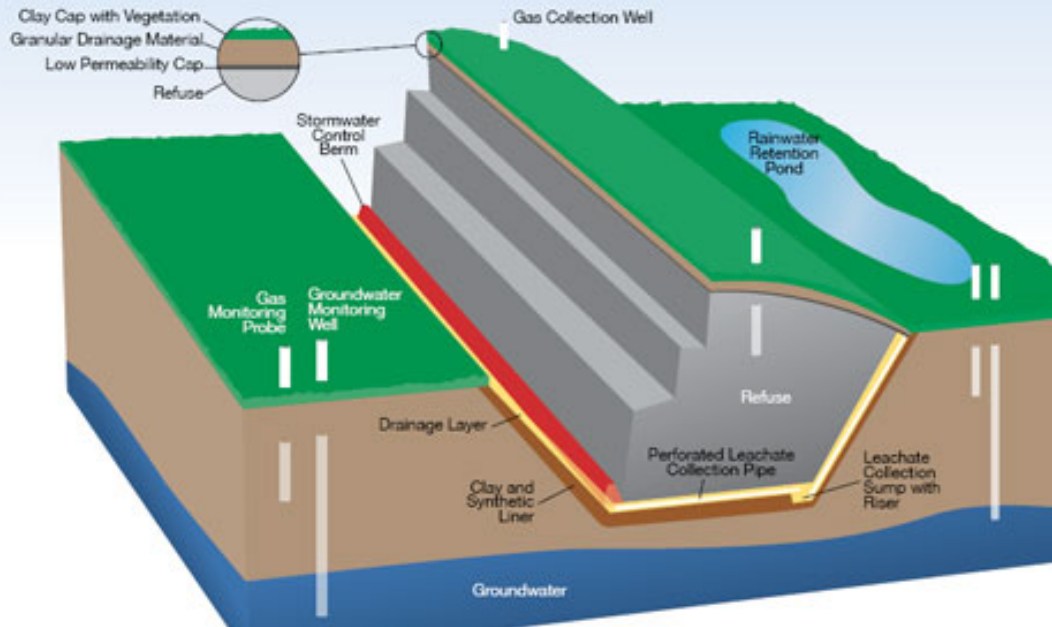
OR



Bottom Up?

What skillset does one need on an RNG Project?

Modern Landfills Require Complex Engineering



A “Bottom Up” Approach



What Skillsets are Required for Successful RNG Implementation?

Civil Engineering
 Vendor Contacts
 Mechanical Eng.
 Safety Expertise
 Maintenance
 Electrical Eng.
 Startup
 Instrumentation
 Plant
 Management
Financial & Econ Analysis
 Process Engineering
 Operations
 System Integration
 Procurement
 Controls
 Construction Management
 Troubleshooting

Whoa?!?



©daniel tolson

Start with a “Top Down” Approach!

- Natural gas processing
- Refineries
- Industrial gas processing
- Syngas processing
- LNG



Start with a “Top Down” Approach!



Start with a “Top Down” Approach!



The Gold Rush!

A NEW AND MAGNIFICENT CLIPPER FOR SAN FRANCISCO.

MERCHANTS' EXPRESS LINE OF CLIPPER SHIPS!

Loading none but First-Class Vessels and Regularly Dispatching the greatest number.

THE SPLENDID NEW OUT-AND-OUT CLIPPER SHIP



CALIFORNIA

HENRY BARBER, Commander, AT PIER 13 EAST RIVER.

This elegant Clipper Ship was built expressly for this trade by Samuel Hall, Esq., of East Boston, the builder of the celebrated Clippers "SURPRISE," "GAMECOCK," "JOHN GILPIN," and others. **She will fully equal them in speed!** Unusually prompt dispatch and a very quick trip may be relied upon. Engagements should be completed at once.

Agents in San Francisco,
Messrs. DE WITT KITTLE & CO.

RANDOLPH M. COOLEY, 88 Wall Street, Tontine Building.

How do you want to approach it?

To win – work smarter, not harder



[Coach Geline Cabrera - WordPress.com](http://CoachGelineCabrera.wordpress.com)

Is RNG the 21st Century Gold Rush?



How do you want to approach it?



Tony Beets (aka 'The Viking')



Elon Musk

This?



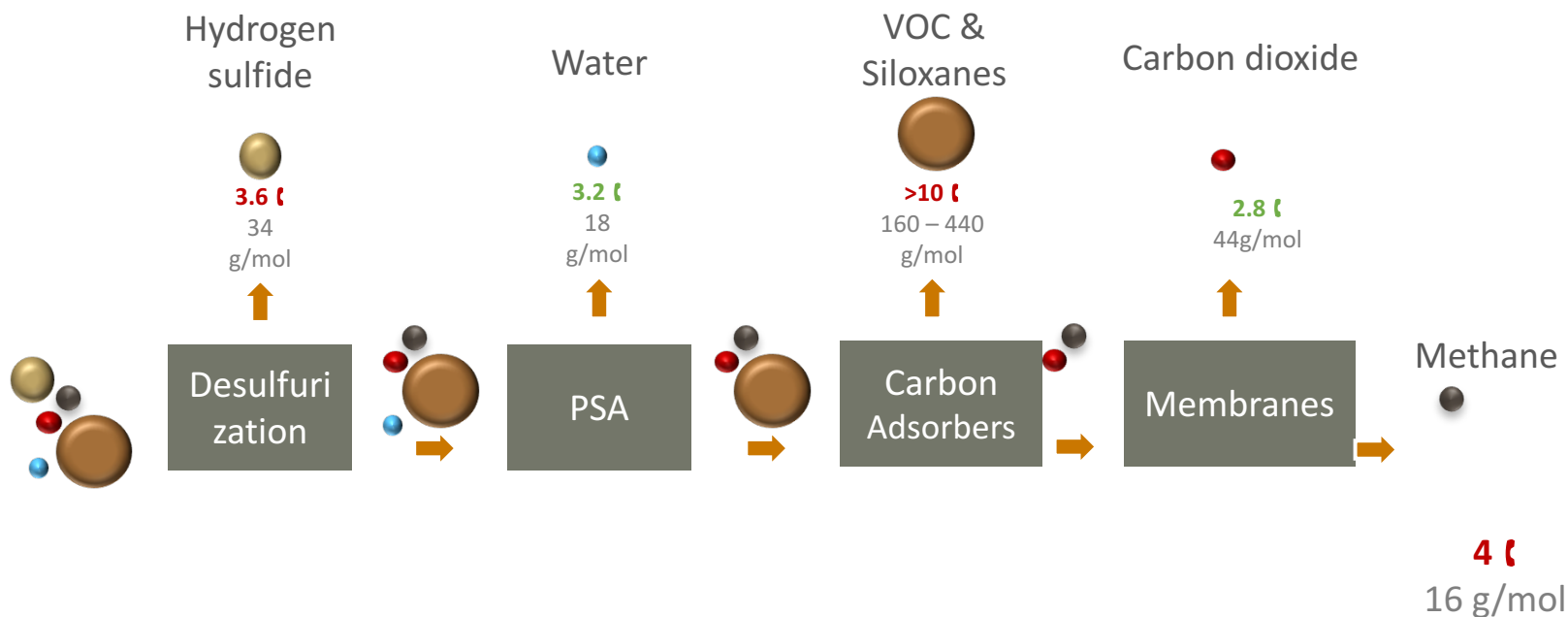
Tony Beets (aka 'The Viking') has set his mind on a 75 year old dredge this season. Quite popular in the old days, can Tony still resurrect this piece of machinery?

Or this?



No problem I got this....

“We picked our equipment!”



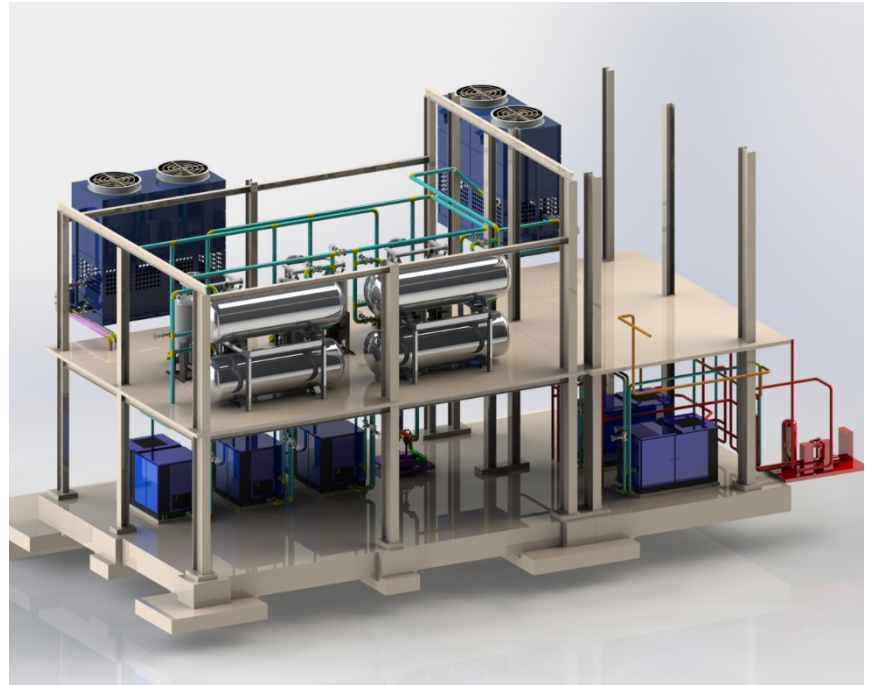
Process Engineering & Integration

- Processes simulation – steady state and dynamic model
- Optimization of processes (Six sigma, KPI)
- Trouble shooting Services (Kepner-Tregoe)
- Energy efficiency
- Heat and mass balance
- Heat transfer calculations
- Performance specifications for equipment and packages
- Process Hazard Analysis (HAZID, HAZOP, What-If, LOPA)
- Process Safety Management as per OSHA
- Technical assistance
 - Training Manuals
 - VPO
 - Start-up



Integration & Safety

- Hydraulic analysis and calculations (i.e. Pipe Flow, Hysys, SynerGEE)
- Analysis and equipment specifications
- 3D modeling, isometrics
- Pipe stress analysis
- Transient analysis
- Standards: ASME, API, NFPA

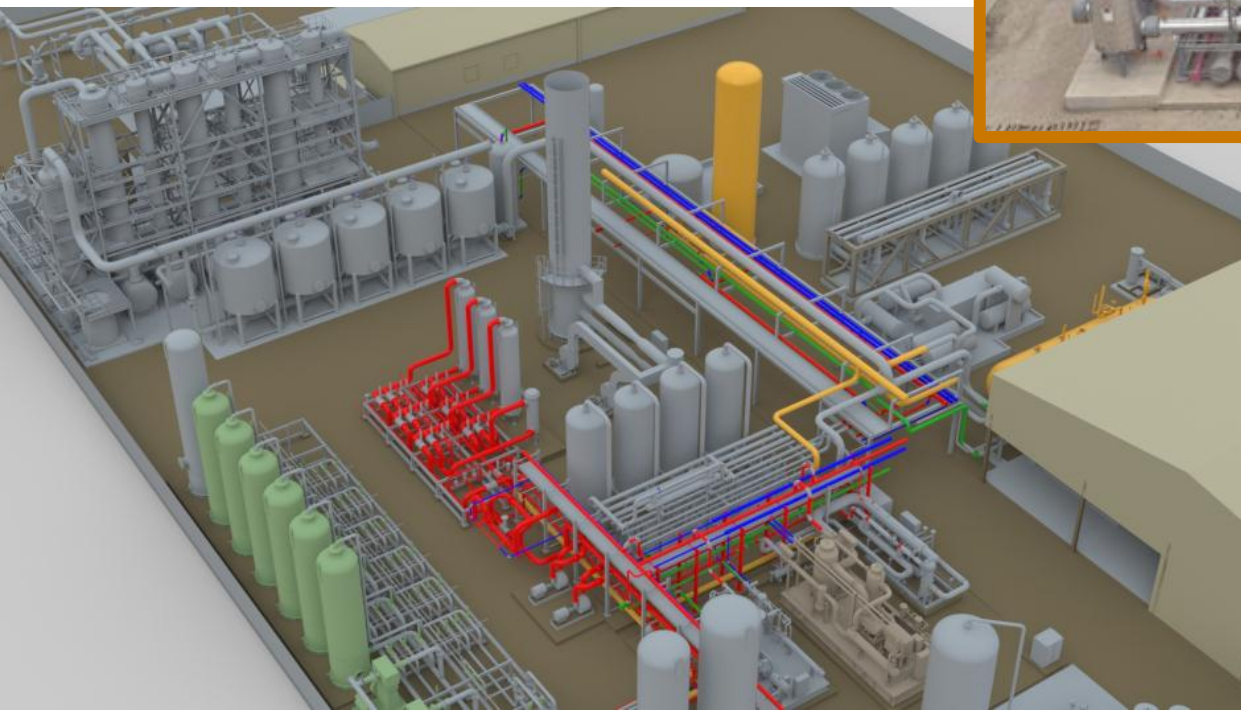


This?



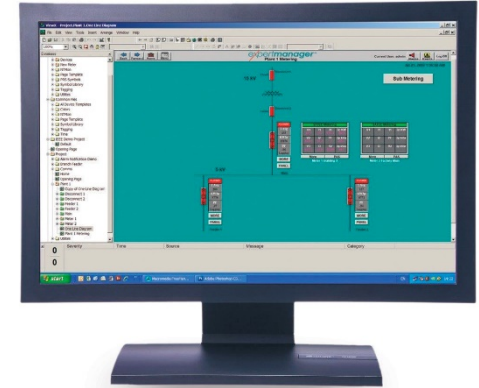
Tony Beets (aka 'The Viking') has set his mind on a 75 year old dredge this season. Quite popular in the old days, can Tony still resurrect this piece of machinery?

Or This?



Understanding your Investment & Protecting it !

I am investing in a \$ **XX** Million dollar plant
 What is my O&M Cost?
 What is my lifecycle cost?
 How do I know? Make Decisions?

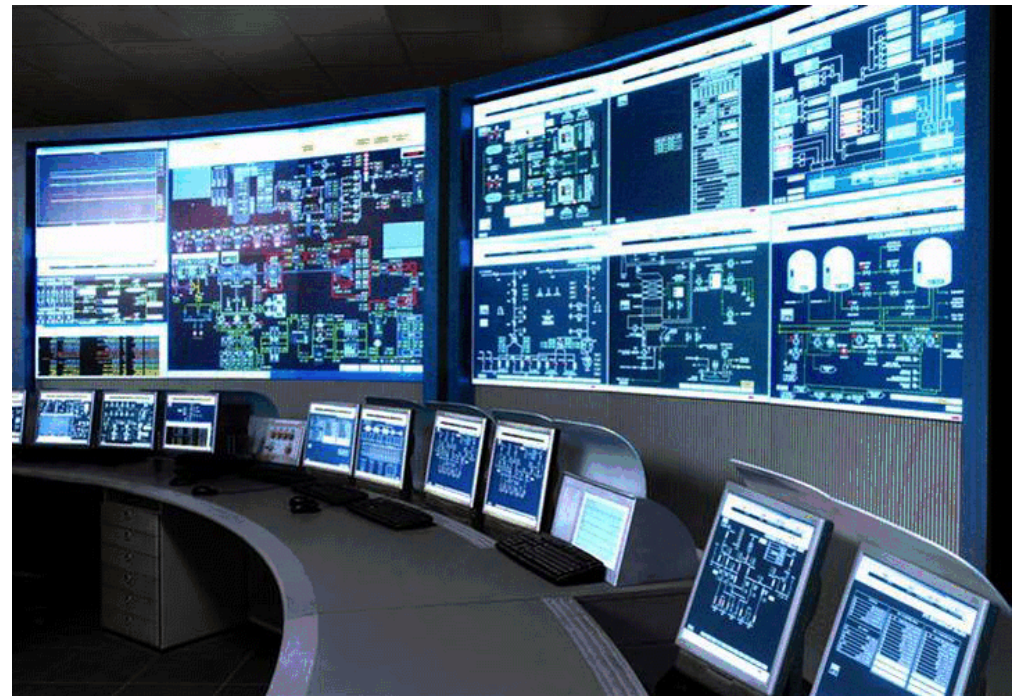


I am projecting a \$ **XX** thousand per day revenue



Automation/System Controls

- Control strategy and operations specifications
- Configuration and programming (PLC, DCS, SIS, HMI)
- Data acquisition and information systems
- Process optimization
- Industrial network and fiber optic
- Pre-commissioning and loop checking
- Commissioning



So, In the 21st Century Gold Rush...



You decide?



There are two
ways to do
something.
The right way,
and again.

 THE INCREMENTAL LIFE.com

Tetra Tech RNG Team!

- ✓ **Technical Excellence**
- ✓ **Full service integration**
- ✓ **Expertise**
- ✓ **Uncompromised Quality**

Thank You!

Keith Henn

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Backup Slides

Full Range of Services – In House

- Financial Analysis
- Planning/due diligence
- Development support
- Permitting
- Systems integration
- (Unbiased) equipment selection
- Full engineering & design
- Procurement
- Construction Management
- Start-up
- Troubleshooting
- O & M



Safety

- Goal of zero incidents/believe that it is obtainable
- Ownership of safety at all levels of the organization
- Integration of safety into all aspects of operations
- Health and Safety Management System focused on continual review and improvement
- On-going focus on hazard assessment



Tetra Tech Services



Water

Coastal and Marine Resources Management

Drinking Water

Groundwater

Wastewater Treatment

Water and Agriculture

Water Resources

Wet Weather Infrastructure/CSOs

Environment

Air Quality

Emergency Management and Community Resilience

Environmental Compliance

Environmental Management

Remediation

Waste Management

Infrastructure

Airports and Aviation

Buildings

Industrial

Communications

Dams and Levees

Ports, Harbors, and Waterfront

Transportation

Resource Management

Industrial

Mining and Minerals

Oil and Gas

Energy

RNG/Biogas

Conventional Generation

Energy Efficiency

Hydropower

Nuclear

Solar

Transmission and Distribution

Utilities and Market Analytics

Wind

International Development

Democracy and Governance

Environment and Natural Resources

Land Tenure and Property Rights

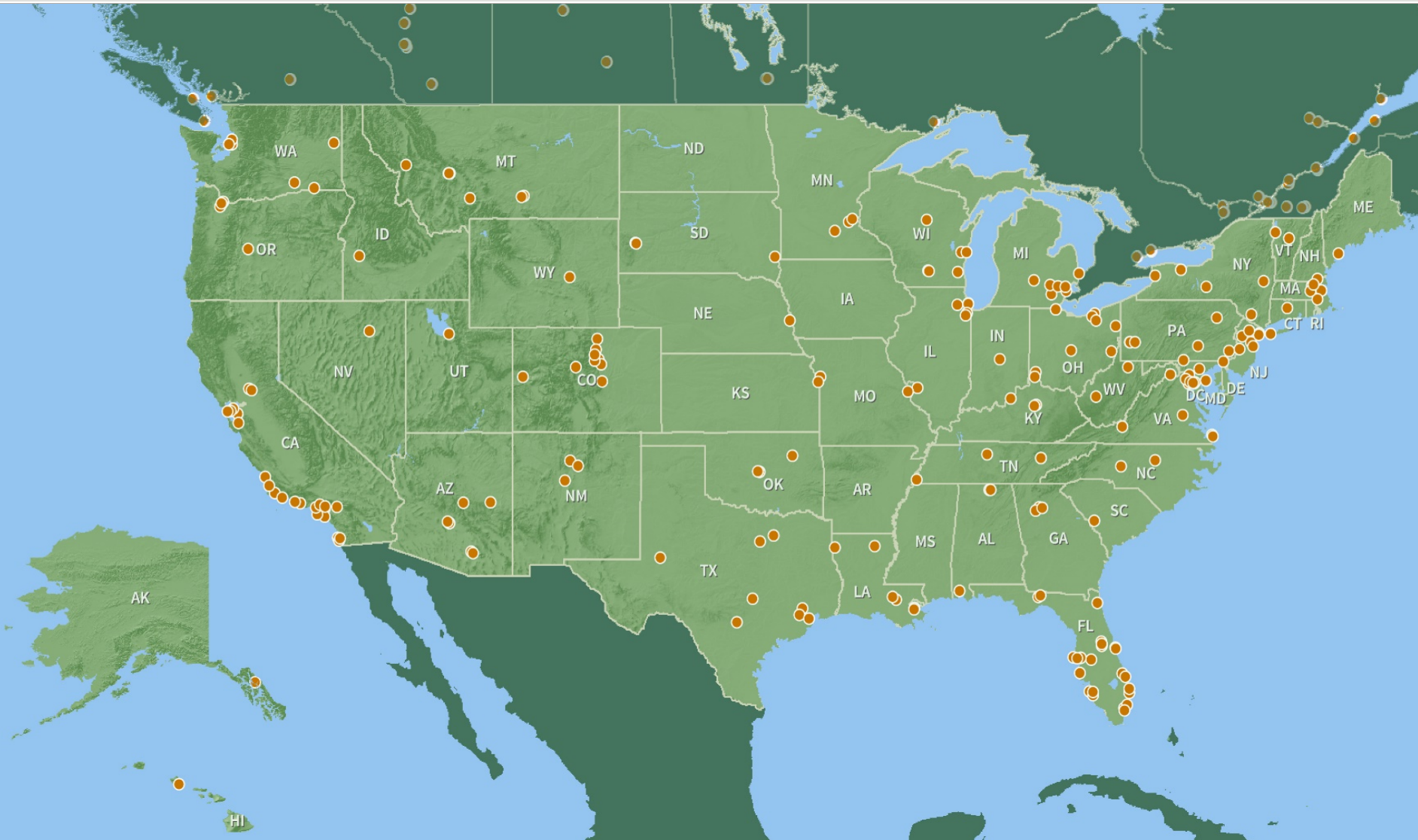
Monitoring and Evaluation

Rule of Law

Security and Stabilization

Water Resources and Infrastructure

Tetra Tech Locations

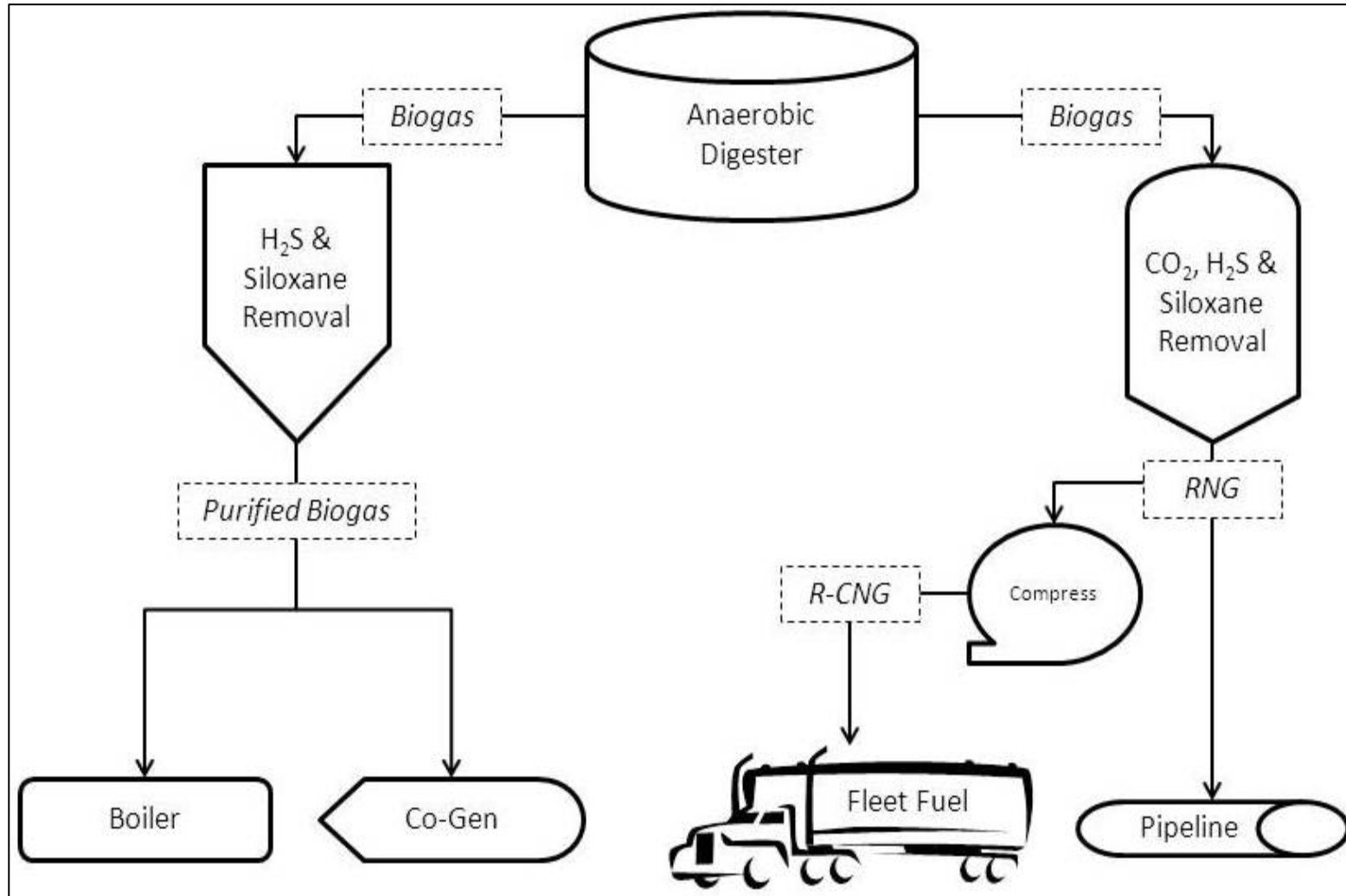


Partnership with Our Customers

LFGTE/RNG experts with 30+ years of experience working with WM:

- **Design**
- **Permitting**
- **Construction**
- **Operations**
- **Financial Planning**

Biogas Utilization



Tetra Tech - Biomethane to the Grid



1250 scfm

Bio-catalyzed scrubber > H₂S polish > PSA > Cooling/Compression > grid injection

MMSD LFG Pipeline, Milwaukee, WI

Veolia Environmental Services

Relevant Project Activities

- Pipeline design services
- 6000 scfm LFG conditioning design
- Operations and safety logic
- Regulatory compliance
- NFPA 56 (PS) purging activities
- Ongoing troubleshooting and operational assistance





Sauk Trails Hills
Canton Township, MI



McCommas Bluff
Dallas, TX



Holly Frontier
Salt Lake City, UT



Persigo WWTP
Grand Junction, CO



Seabreeze Landfill
Angleton, TX

Full Range of Technologies

Water Scrubbing Technology



Membrane Technology



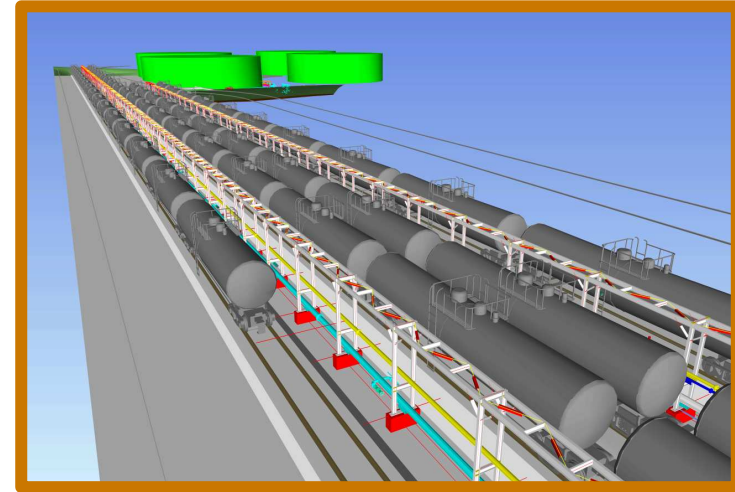
Amine System



PSA System

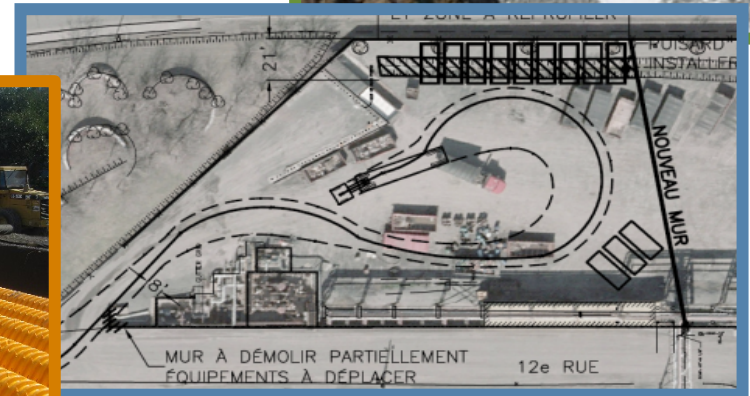
Comprehensive Design Services

- Process
- Mechanical
- Electrical
- Instrumentation
- Environmental
- Civil/Structural
- Landfill Engineering
- Project Management
- Construction Management
- Health and Safety
- Commissioning and Start-Up
- Operations assistance



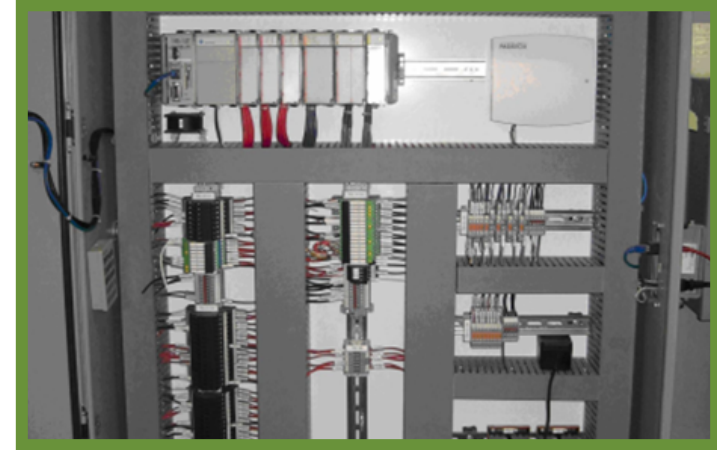
Engineering Services – Civil/Structural

- Site layout
- 3D modeling
- Road, access road study, parking infrastructures design
- Storm and sanitary sewer
- Temporary facilities for construction (fencing, traffic deviation, laydown area, trailer park)



Engineering Services - Instrumentation

- P & ID
- Instrument specification (datasheet)
- Control valve sizing
- Process analyzer
- Flow element selection and analysis
- Distributed control system (DCS)
- Programmable logic controller (PLC)
- Safety instrumented system (SIS)
- Supervisory control and data acquisition (SCADA)
- SIL verification / calculation



Engineering Services - Electrical

Utility Interface and Distribution

- Electric substation
- Switchgear, MCC
- Power generation
- Utility interconnect
- Heat tracing, lighting, heating & services
- 480V, 4160V, 15KV



Electrical Studies and Calculations

- Hazardous area classification study
- Lighting study per area
- Power flow study and electrical load calculations
- Voltage plan motor starting analysis
- Short-circuit and protection coordination
- Grounding and voltage drop calculation
- Arc flash analysis including training session
- Electrical harmonics analysis

Engineering Services - Structural

- Foundation and structural steel analysis/design
 - Finite element
 - Dynamic analysis (SAP 2000)
- Structures capacity verification
- 3D modeling for concrete/structural steel
- Foundations (equipment, tanks, buildings, pipe-racks)
- Structural steel frames (buildings, pipe-racks, platforms)
- Lifting and transportation studies
- Structures inspection



Holly Frontier Salt Lake City, UT



Relevant Project Activities

- Engineering and design all process piping electrical, instrumentation, and structural components for a 4 inch collection header the Installation of two new reciprocating compressors to direct propane vapors to existing Flash Tank #62-95-0020

Construction Services

- Safety
- Constructability review
- Construction management
- Documentation
- QA/QC
- Commissioning and turnovers

