

Linking Proven Technologies to Bioremediate TNT and Metabolites and Facilitate Onsite Reuse of Soil

Scott M. Larew
E.D. Meeks, A.G. Seech

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 Kennedy Jenks



How We Got Here... ...and TNT Got There



SOURCE WWI-Era Manufacturing



RELEASE Process Upsets



TIME Redistribution & Dissolution

Starting With The End In Mind

Monitored Natural Attenuation GW Remedy

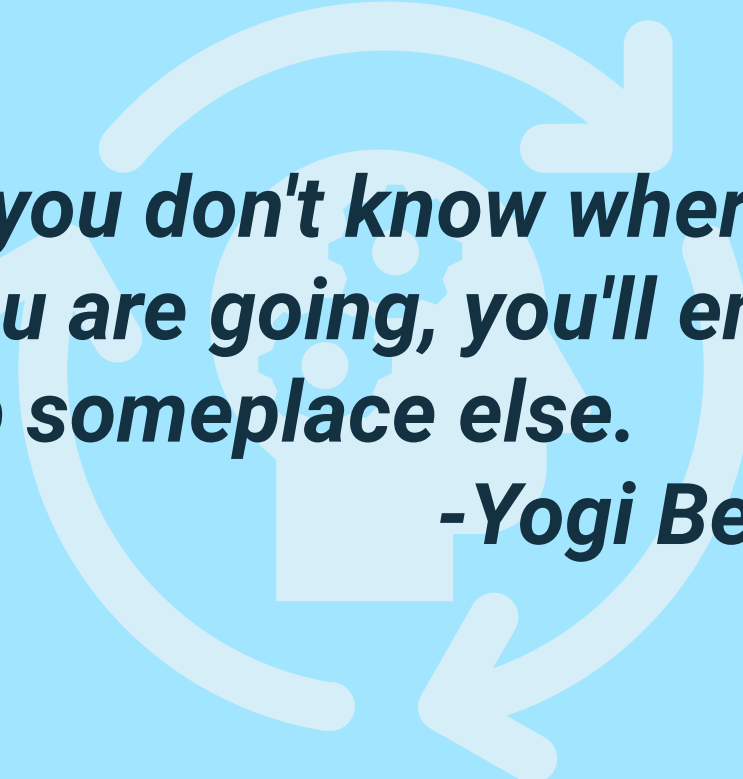
Dissolved Phase Degradation

Soil Source Mass Removal

PILOT STUDY → Biology & Chemistry

CONCEPT DESIGN → Regulatory Approvals

ENGINEERING → Particle Size Reduction



***If you don't know where
you are going, you'll end
up someplace else.***
-Yogi Berra

Pilot Study – Proof of Concept

<https://youtu.be/3v1sU9sfEKY>

STUDY TRIALS

- 3 Controls
- 2 Wood Mulch
- 6 Soil Amendment



STUDY VARIABLES

- Amendment
- Dosage
- Turnover

STUDY PERIOD

- 12 Wk. Active Management
- 2 Yr. Passive Monitoring



Pilot Study Takeaways



EFFECTIVENESS:
Commercial Soil Amendment

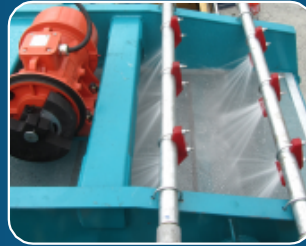
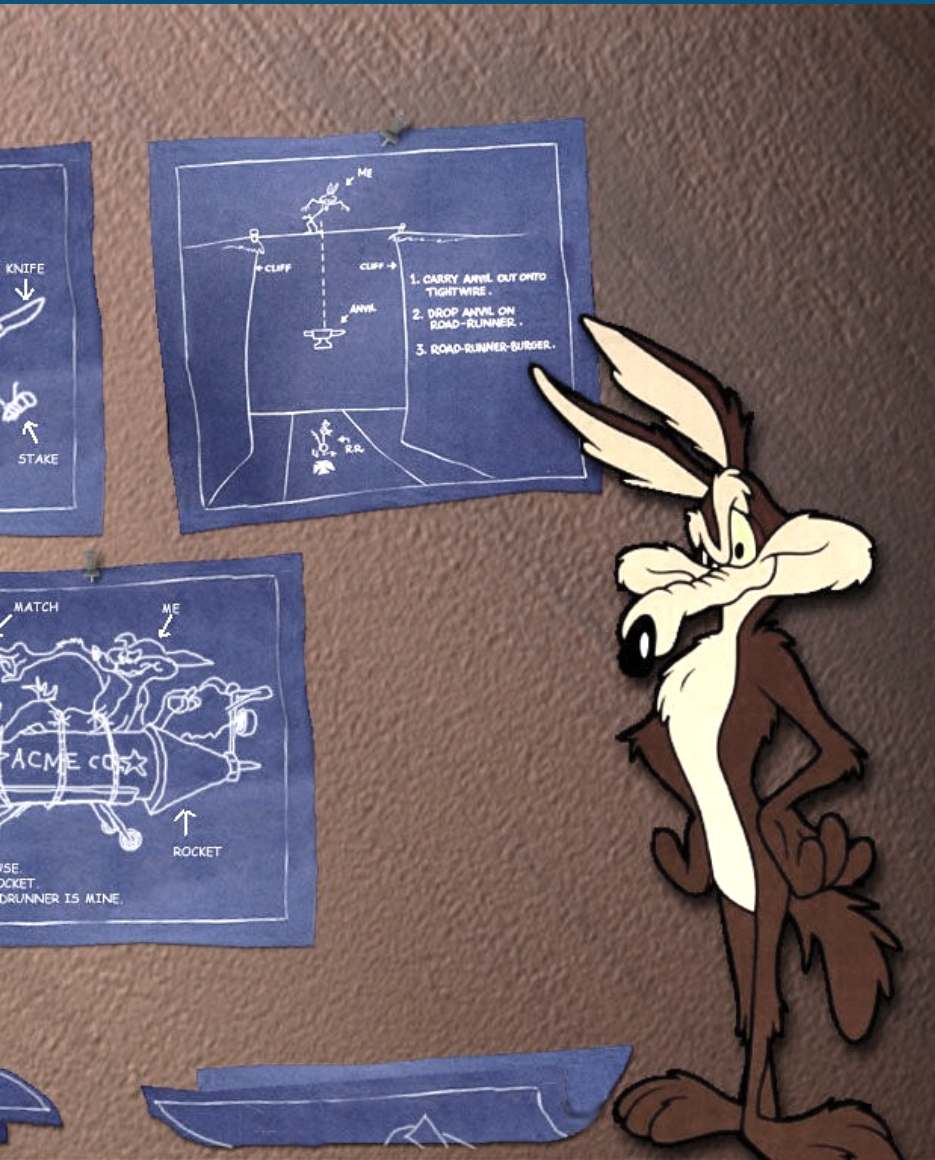


EFFICIENCY:
Single Field Season & Dosing Regime



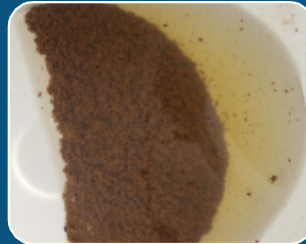
ENGINEERING:
Soil Preparation & Blending

Critical Engineering Design Objectives



SOIL PREPARATION

- TNT to $<2\text{mm}$
- Clean Aggregate



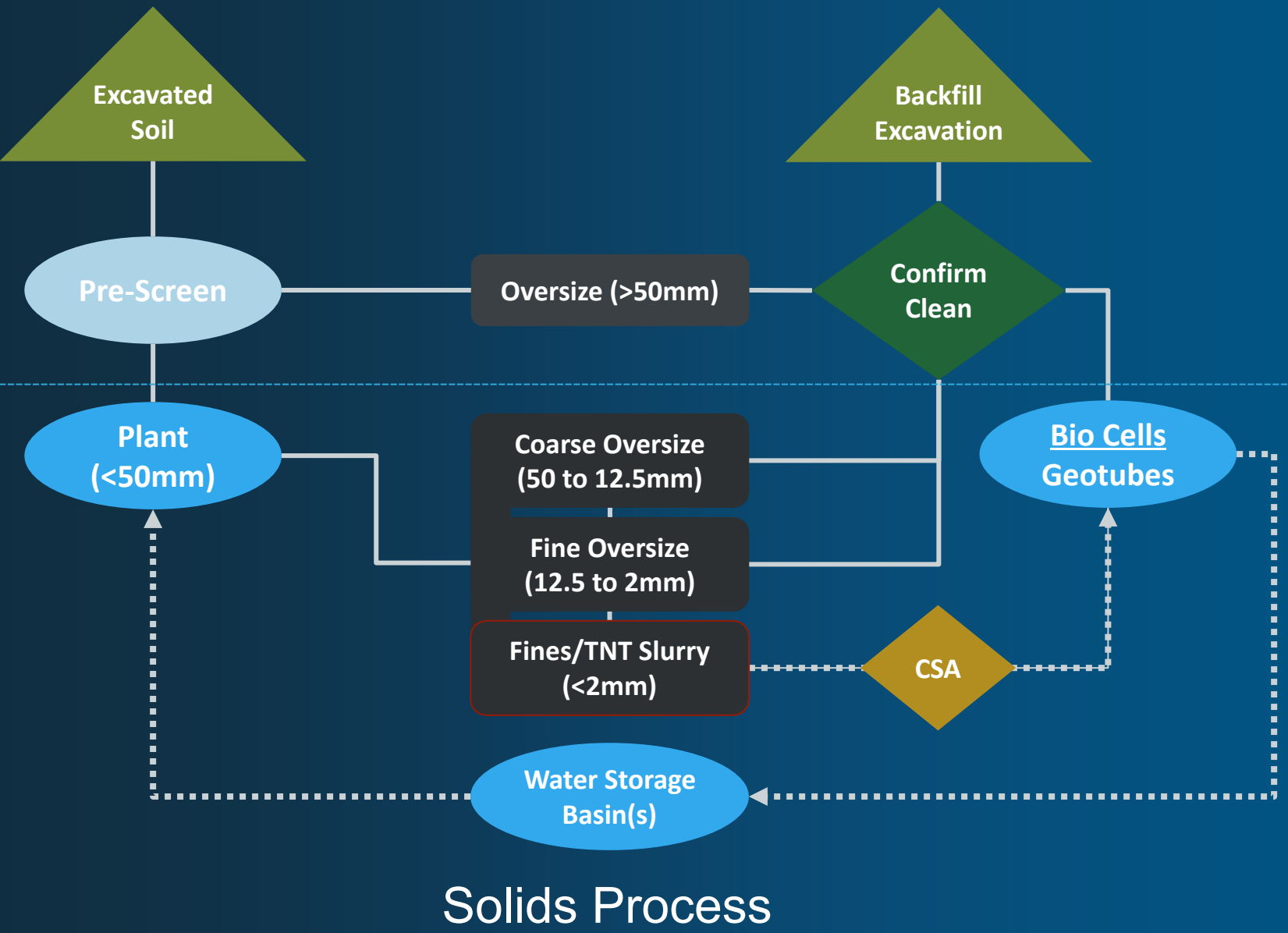
BIOSLURRY MANAGEMENT

- Homogenization & Solids Settling
- Moisture & Temperature

	Apr	May	June	July	Aug
2	7.13	5.47	5.96	2.88	0.99
7	2.31	4.55	2.20	0.85	10.69
8	4.83	3.96	1.82	6.71	6.01
1	4.50	10.38	4.50	0.81	4.73
9	5.21	4.59	2.86	6.82	8.73
2	3.89	5.41	3.12	0.22	4.25
6	2.19	3.91	2.42	6.57	3.07
4	2.49	1.33	7.10	2.75	2.86
0	4.76	5.51	4.67	5.14	2.22
7	2.21	5.04	8.26	5.01	4.82
4	2.80	5.54	3.38	3.63	3.85
5	0.85	5.75	4.64	3.18	13.29
9	3.16	3.64	2.70	4.37	3.51
	3.21	4.67	7.93	5.72	7.01

WATER BUDGET & BALANCE

- Operations vs. Stormwater
- Active vs. Passive Seasons



Pre-Screen Oversize

- Dry sorted, no TNT
- *Reuse as backfill*

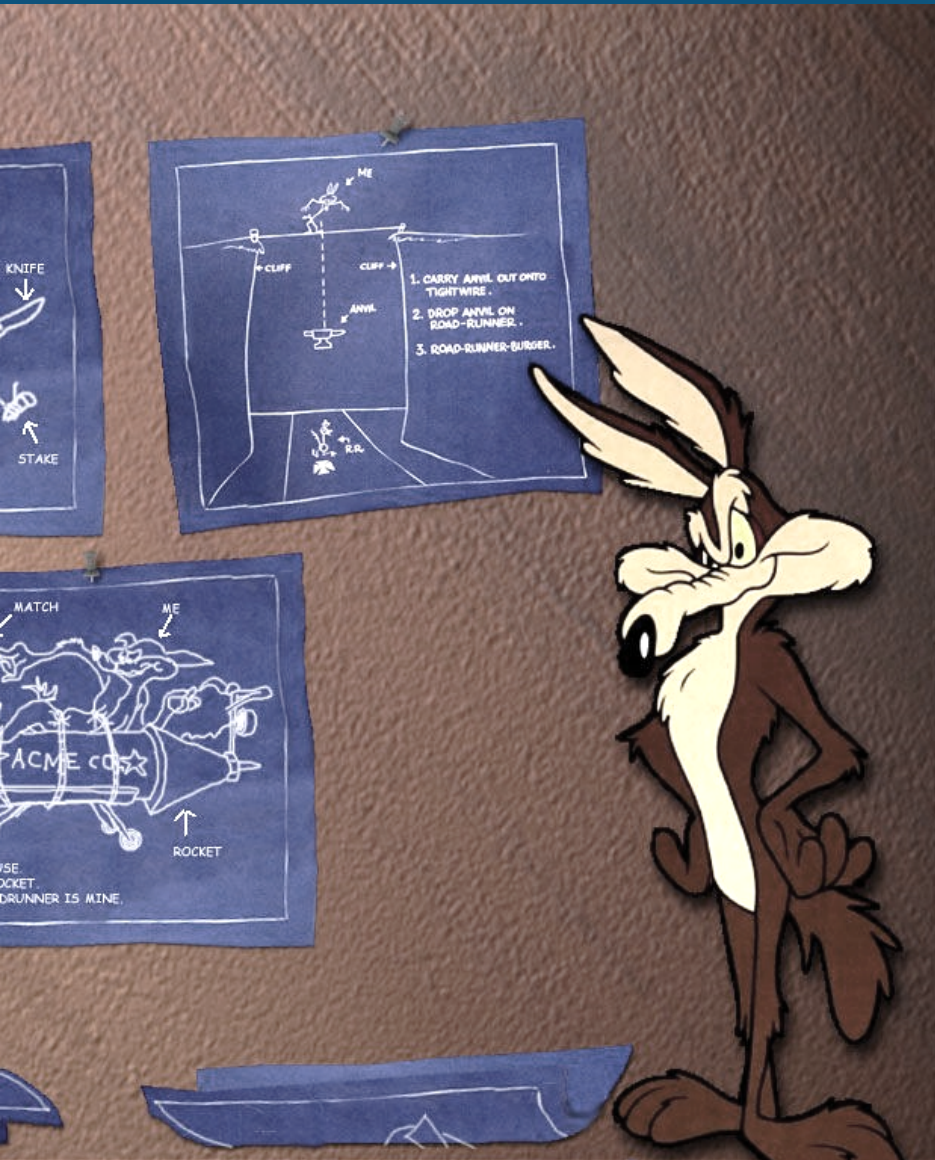
Wet Screen Oversize

- Washed clean, no TNT
- *Reuse as backfill*

Fines/TNT Slurry

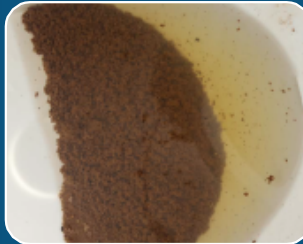
- Amend with CSA
- Degradation in geotubes
- *Reuse as backfill*
- In-situ degradation

Critical Engineering Design Objectives



SOIL PREPARATION

- TNT to <2mm
- Clean Aggregate



BIOSLURRY MANAGEMENT

- Homogenization & Solids Settling
- Moisture & Temperature

	Apr	May	June	July	Aug
2	7.13	5.47	5.36	2.88	0.99
7	2.31	4.55	2.20	0.85	10.69
8	4.83	3.96	1.82	6.71	6.01
1	4.50	10.38	4.50	0.81	4.73
9	5.21	4.59	2.86	6.82	8.73
12	3.89	5.41	3.12	6.22	4.25
6	2.19	3.91	2.42	6.57	3.07
4	2.49	1.33	7.10	2.75	2.86
0	4.76	5.51	4.67	5.14	2.22
7	2.21	5.04	8.26	5.01	4.82
4	2.80	5.54	3.38	3.63	3.85
3	0.85	5.75	4.64	3.18	13.29
9	3.16	3.64	2.70	4.37	3.51
	3.21	4.67	7.93	5.72	7.01

WATER BUDGET & BALANCE

- Operations vs. Stormwater
- Active vs. Passive Seasons

Fines & TNT (<2mm)

+ CSA → 20% Slurry

Homogeneous Blend

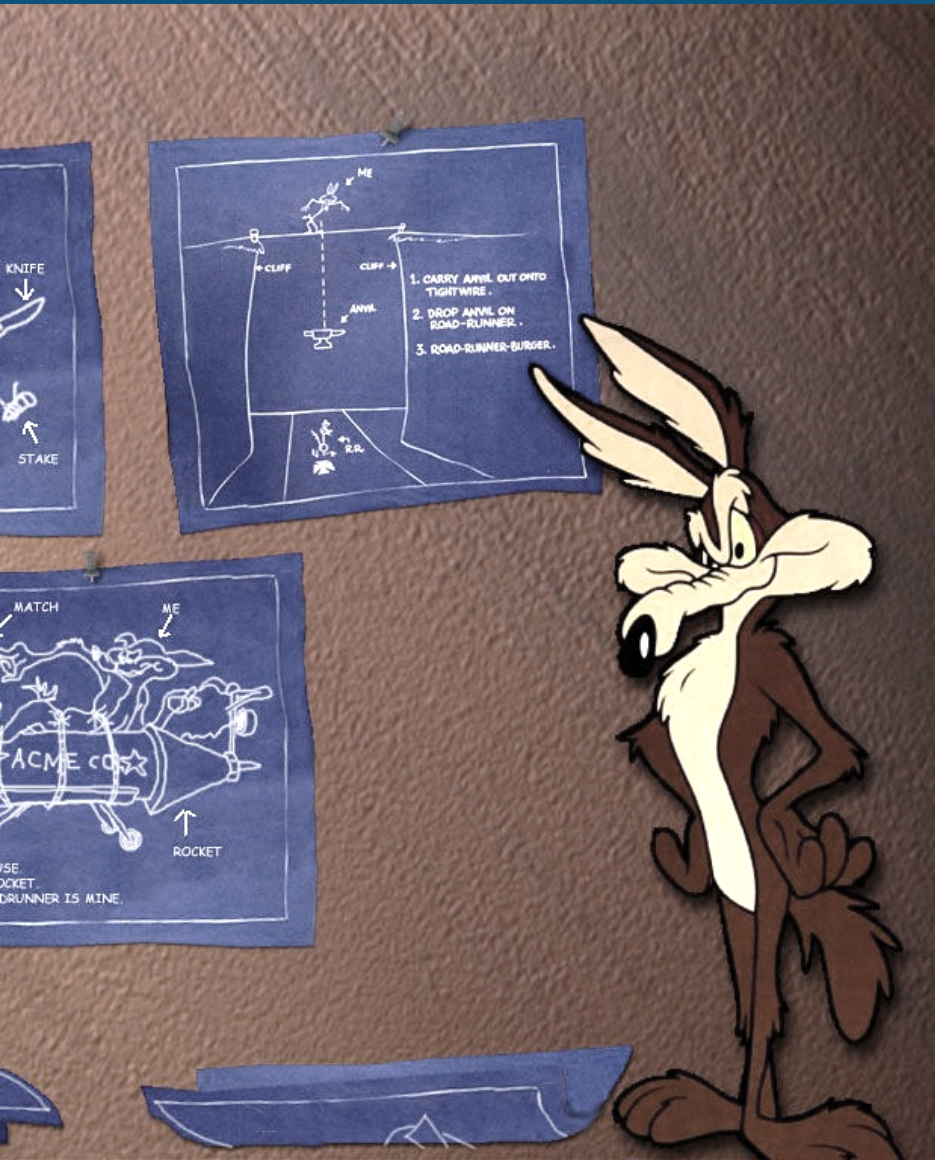


Single Dose → Use of Geotubes



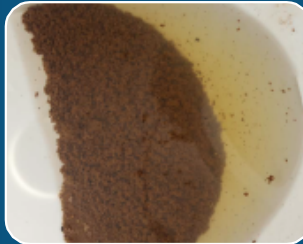
Geotubes → Optimized Conditions

Critical Engineering Design Objectives



SOIL PREPARATION

- TNT to <2mm
- Clean Aggregate



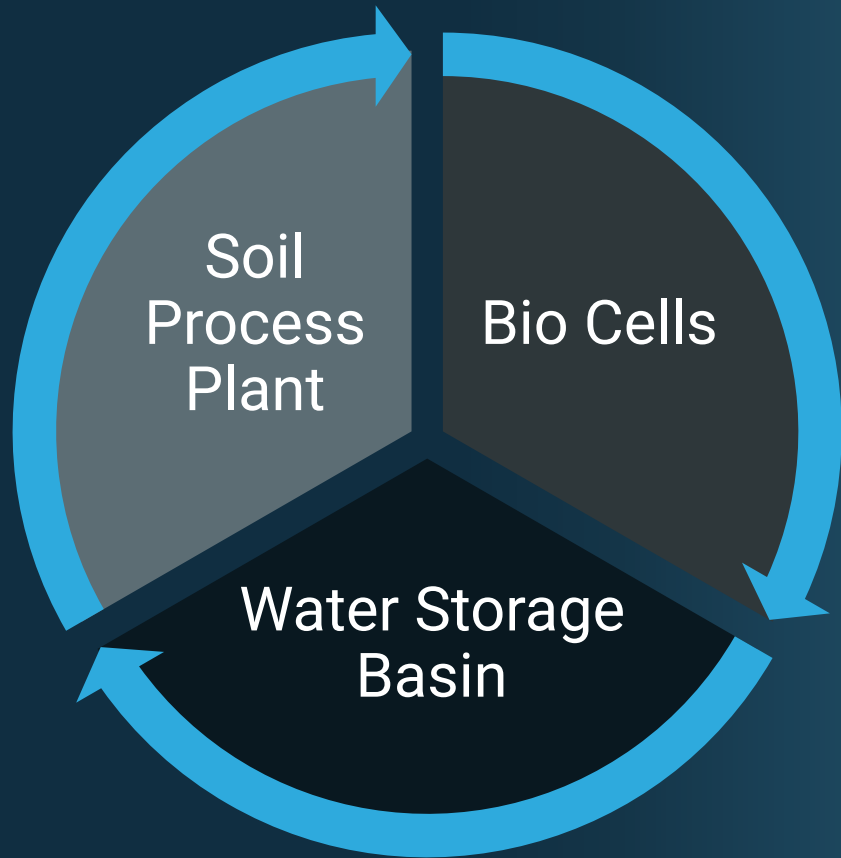
BIOSLURRY MANAGEMENT

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3	0.85	5.75	4.64	3.18	13.29
9	3.16	3.64	2.70	4.37	3.51
	3.21	4.67	7.93	5.72	7.01

WATER BUDGET & BALANCE

- Operations vs. Stormwater
- Active vs. Passive Seasons



Balanced Water Cycle

- Closed Loop (1.6M gal)
- Makeup Water Sources
- Seasonal Run-on/Run-off
- In-situ Irrigation

- **Wet Screening**
- **Attritioning**
- **Biofeed Slurrying**
- **Polymer Blending**

- **Biofeed Dewatering**
- **Soil Moisture Mgmt**

- **Inflows/Outflows**
- **Recirculation**
- **Degradation**
- **Irrigation**





We Promised Data...

- **Schedule**

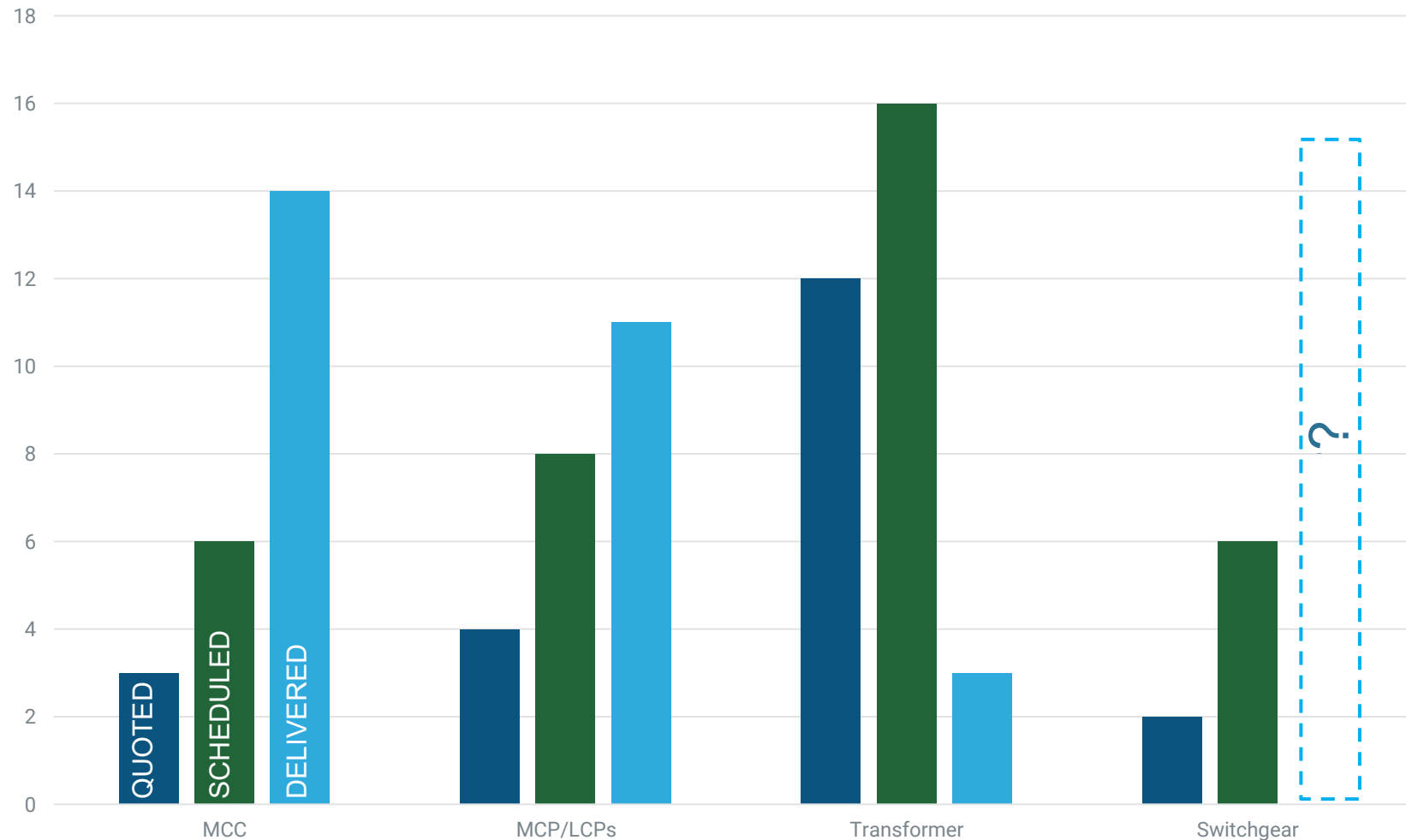
- Delayed 18+ months
- Wet Test & Commission Fall 2023
- Year 1 Soil Processing April 2024

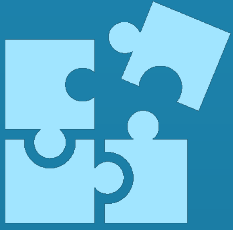
- **Lessons Learned**

- During a pandemic...
 - ...schedule 2x as long
 - ...budget 2x as much

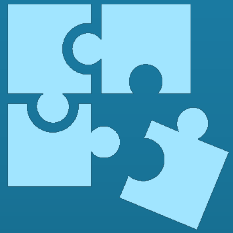
- **See you at Bioremediation Symposium 2025**

Electrical Component Supply Chain Delays

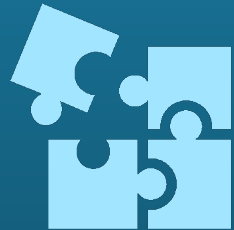




Follow Nature's Lead



Bring The Regulators Along For The Ride



Just Keep Solving

We are continually faced by great opportunities brilliantly disguised as insoluble problems.

– Lee Iacocca



Scott Larew
Principal Scientist

609.285.2626
scottlarew@kennedyjenks.com

