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Landfill GCCS Collection Efficiency - What do the Numbers Really Mean?

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ReInvent. ReInvest.

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Operating Metrics

- Since we began collecting landfill gas, owners, operators and regulatory agencies have been searching for appropriate metrics to evaluate the relative performance of landfill gas collection and control systems
- This quest has been driven by a number of factors, primarily regulatory and economic

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Operating Metrics

- Typical Questions:
  1. Is the GCCS doing what it's supposed to do?
  2. Is the GCCS complying with regulatory requirements?
  3. Should I be getting more gas out of my landfill?
  4. Should I be getting better gas out of my landfill?
  5. Do I have an "efficient" GCCS?
- These all lead to the "Big Question"…

Big Question

What's my collection efficiency?

What is “Collection Efficiency”?

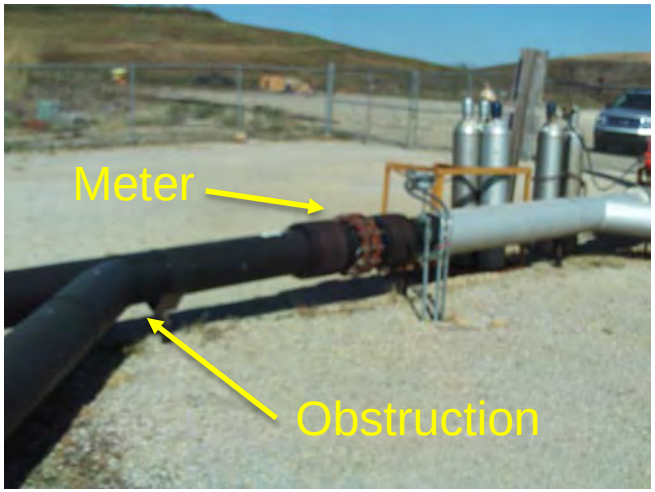
- Efficiency
  - The ability to do something or produce something without wasting materials, time, or energy
  - The quality or degree of being efficient

What is "Collection Efficiency"?

- Collection Efficiency (as applies to GCCS)
  - Traditionally - the rate of gas extraction compared to the rate of gas generation
  - Is that really correct?
- Appears to be a very simple, straightforward approach to evaluating the operations of the GCCS
- USEPA estimates the average CE ~75% (*AP-42, 1998)*
- SWANA estimates the average CE ~91% *(LFG Collection Efficiencies, 2007)*

Potential Errors

- Human error
  - Poor meter installation
    - 18″ SDR 17 HDPE vs 18″ SCH 10 steel (15.88″ ID vs 17.5″ ID)
    - Incorrect orifice plate
    - Bad location
- Poor or infrequent meter calibration
- Errors in monitoring components
  - Good meter: +/- 1% accuracy
  - Assuming:
    - Dry gas
    - No liquids accumulation
    - No particulate fouling



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Potential Errors

- Single meter at flare station
  - Potential physical errors are rather limited
  - Relatively easy to identify and correct
- Multiple meters throughout wellfield
  - Potential for errors increases greatly
  - Using 100 meters on 100 extraction points – potential error at +/- 1% is +/- 100%
  - Should never rely on individual wellhead meters as an aggregate of total flow – *indicators only*!

Potential Errors

- Oxidation
  - Occurs when LFG (i.e. methane) passes through cover soils/organic materials between the anaerobic zone to the atmosphere
  - Acknowledged within the industry but field studies are relatively limited
  - Incorporated into select regulatory models – primarily in California (CALMIN default of 10%)
- CE_{REV} = (Rate of LFG recovery + Rate of oxidation) / Rate of LFG generation
  - 2007 SWANA – Palos Verde CE >99% (including oxidation)

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Potential Errors

- Assuming that your flow meters are accurate, you still need to consider the base calculation – LandGEM
- LandGEM was developed by USEPA based on test data from 40 landfills in 1980's and 1990's

$$Q_{CH4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} kL_0 \frac{M_i}{10} e^{-kt_{i,j}}$$

- Assumes uniform waste characteristics
  - Waste types
  - Moisture
  - Compaction

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Variability in methane yield rates

- USEPA defaults are 100 m^3 CH_4/Mg (L_0) and 0.04/yr (k)
- 2010 study (De La Cruz and Barlaz), along with other studies, demonstrate variations:

Refuse Type	L_0 (m^3/Mg)	k (yr^{-1})
office paper	217	3.1
grass	144	31
newspaper	74	3.5
food	301	15
corrugated containers	152	2.1

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Operating Metrics

- Back to the original Questions:
  1. Is the GCCS doing what it's supposed to do?
  2. Is the GCCS complying with regulatory requirements?
  3. Should I be getting more gas out of my landfill?
  4. Should I be getting better gas out of my landfill?
  5. Do I have an "efficient" GCCS?

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1. Is the GCCS doing what it's supposed to do?

- Control LFG within the waste mass
  - Subsurface methane concentrations less than 5% v/v at the facility boundary and less than 1.25% v/v within an occupied structure
  - Limit surface methane emissions to <500 ppmv above background
  - Minimize off-site nuisance odors
- If your system is doing these things, it is operating effectively
- Approaching 100% efficiency? Getting pretty close!

2. Is the GCCS complying with regulatory requirements?

- Items we just reviewed…plus
  - Vacuum applied to all collectors
  - Oxygen <5% v/v or Nitrogen <20%v/v
  - Temperature <55^{0}C (131^{0}F)
  - Any applicable variances (NSPS/EG)
- If your system is successfully operating within these parameters, it is complying with regulatory requirements

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3. Should I be getting more gas out of my landfill?

- From monitoring data (Items 1 and 2)
  - Do I have vacuum on all of my collectors?
  - Do I have flow from all of my collectors?
  - Do I have subsurface migration?
  - Do I have surface emissions above permissible limits?
  - Do I have off-site odors?

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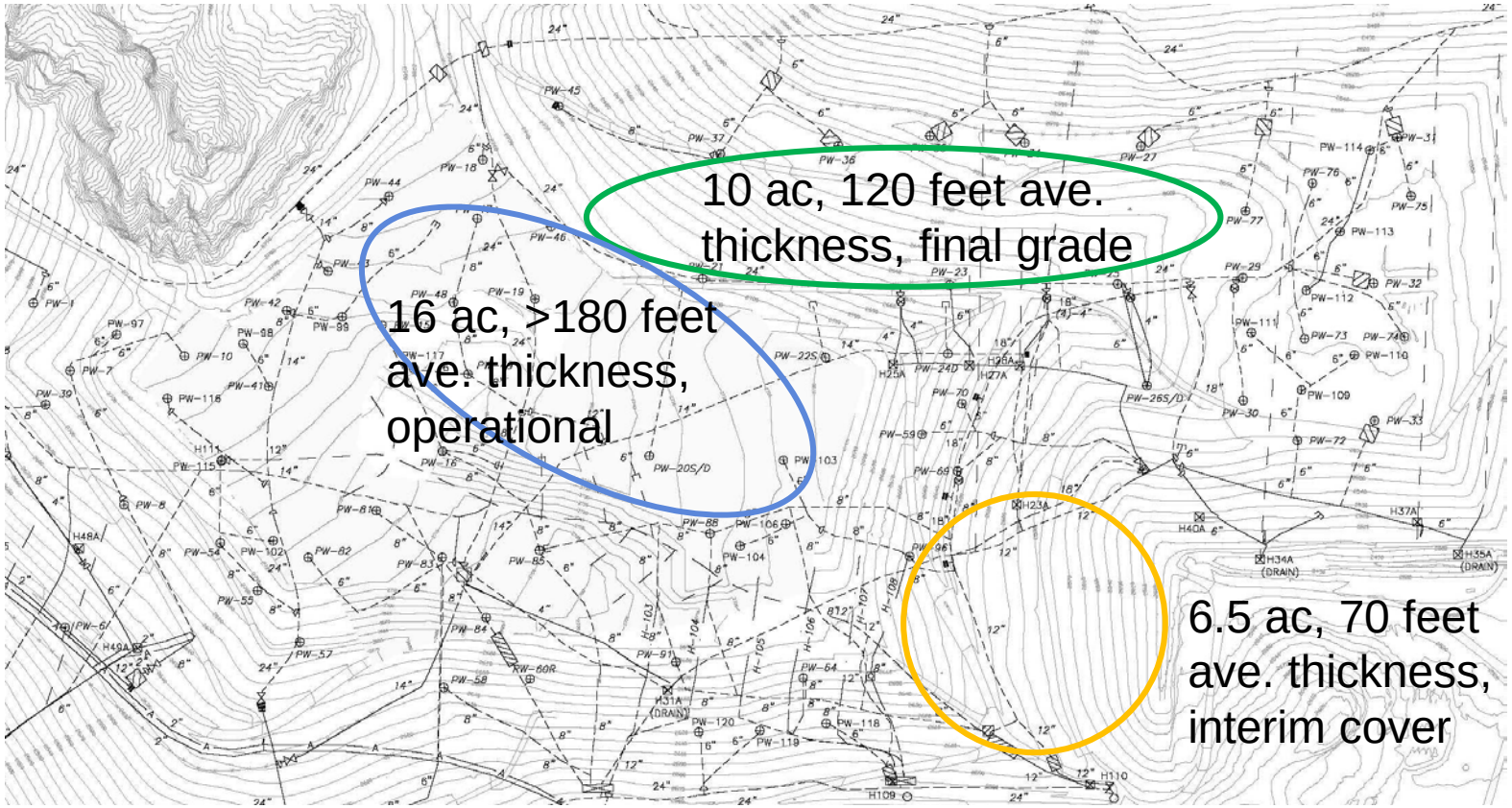
3. Should I be getting more gas out of my landfill?

- Are there areas of the waste mass that need collectors?



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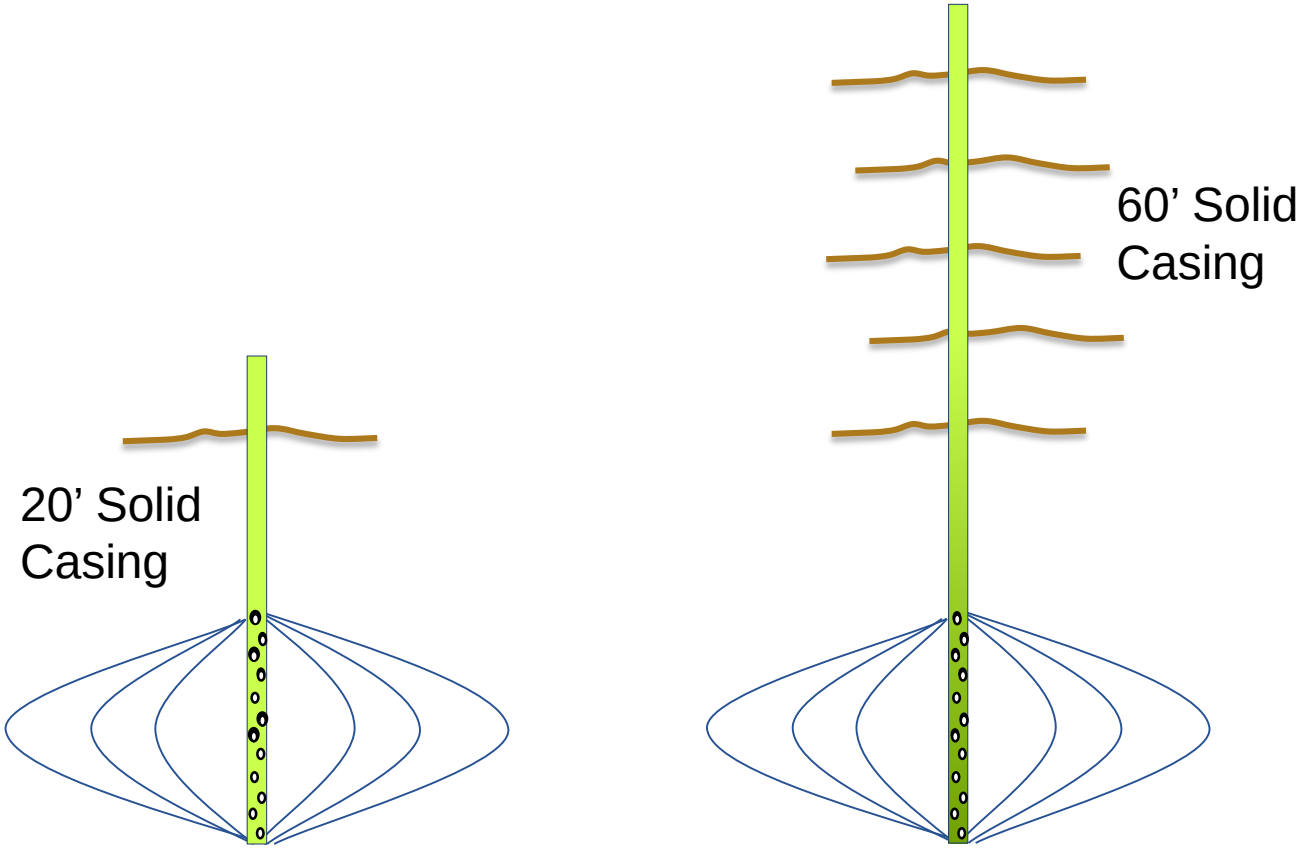
3. Should I be getting more gas out of my landfill?

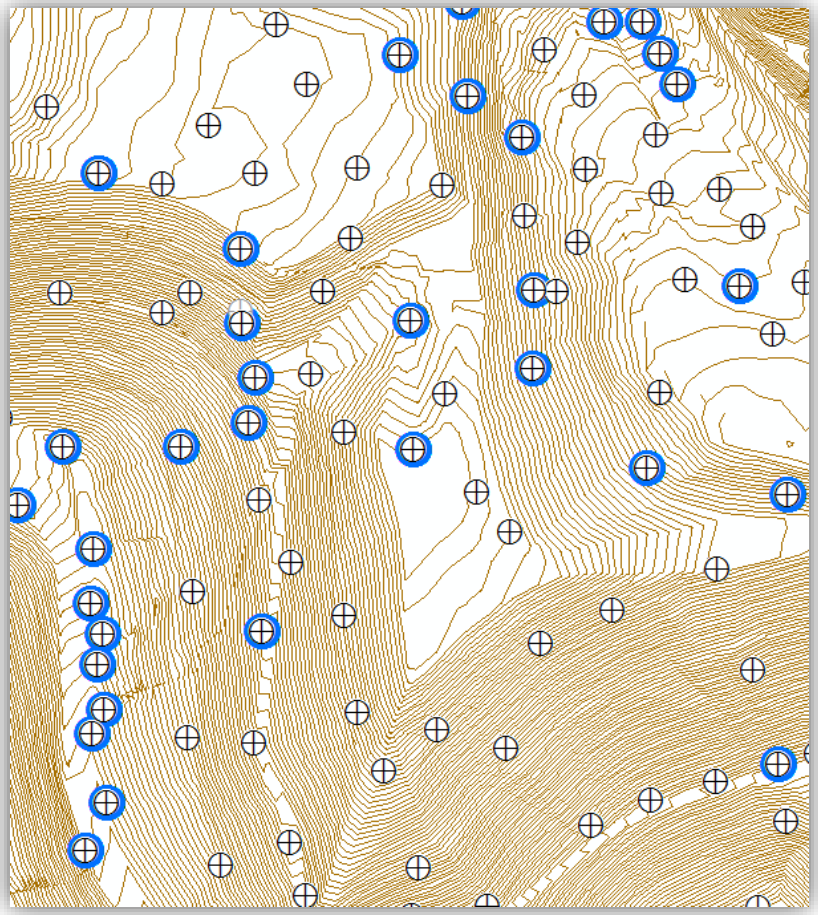
- How much solid casing do I have?

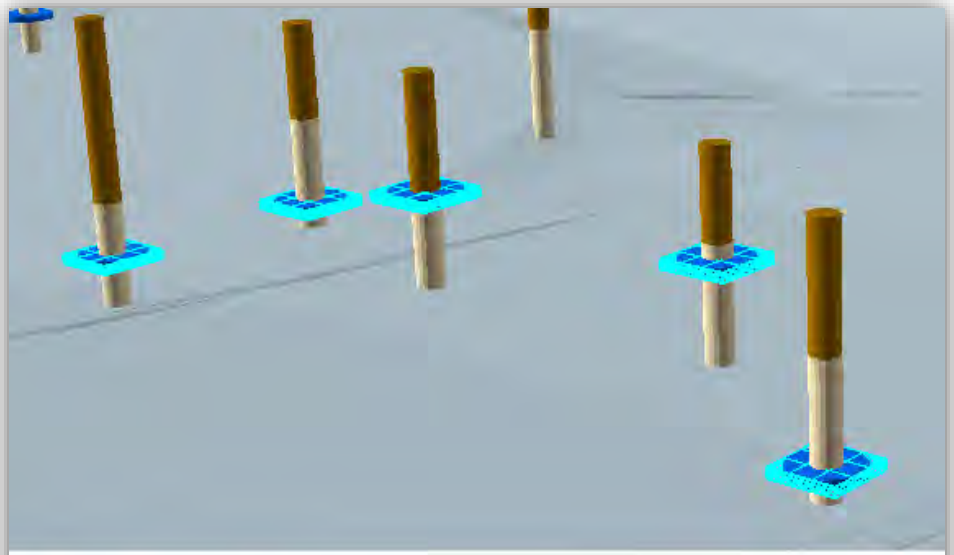


3. Should I be getting more gas out of my landfill?

- Are there liquid impacts on my collectors?
  - LFG collectors are “holes” in the waste mass
  - Highest areas of porosity
  - As liquid levels rise – available perforations are reduced
  - Potential limitations to LFG extraction
  - Need to investigate and track liquid levels to determine potential impact

2D/3D Liquid Levels





Time

G_NUM	HAS_LIQUID	LIQ_ELEV_FT	CASING_TOP	CASING_BOT	DATE_
4131639	1	1594	1607.9	1583.9	201401
4131642	1	1589	1611.3	1584.3	201401
31648.46	1	1621	1622.63	1602.63	201401
4131657	1	1610	1630	1606	201401
4131659	1	1616	1621	1597	201401

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Liquid Levels Over Time

3. Should I be getting more gas out of my landfill?

- Are my collectors damaged?
  - Are they pinched or crushed?
  - Are they filled with sediment or sludge?
- Are my headers distributing vacuum adequately throughout the wellfield?
- Are the headers sized correctly?

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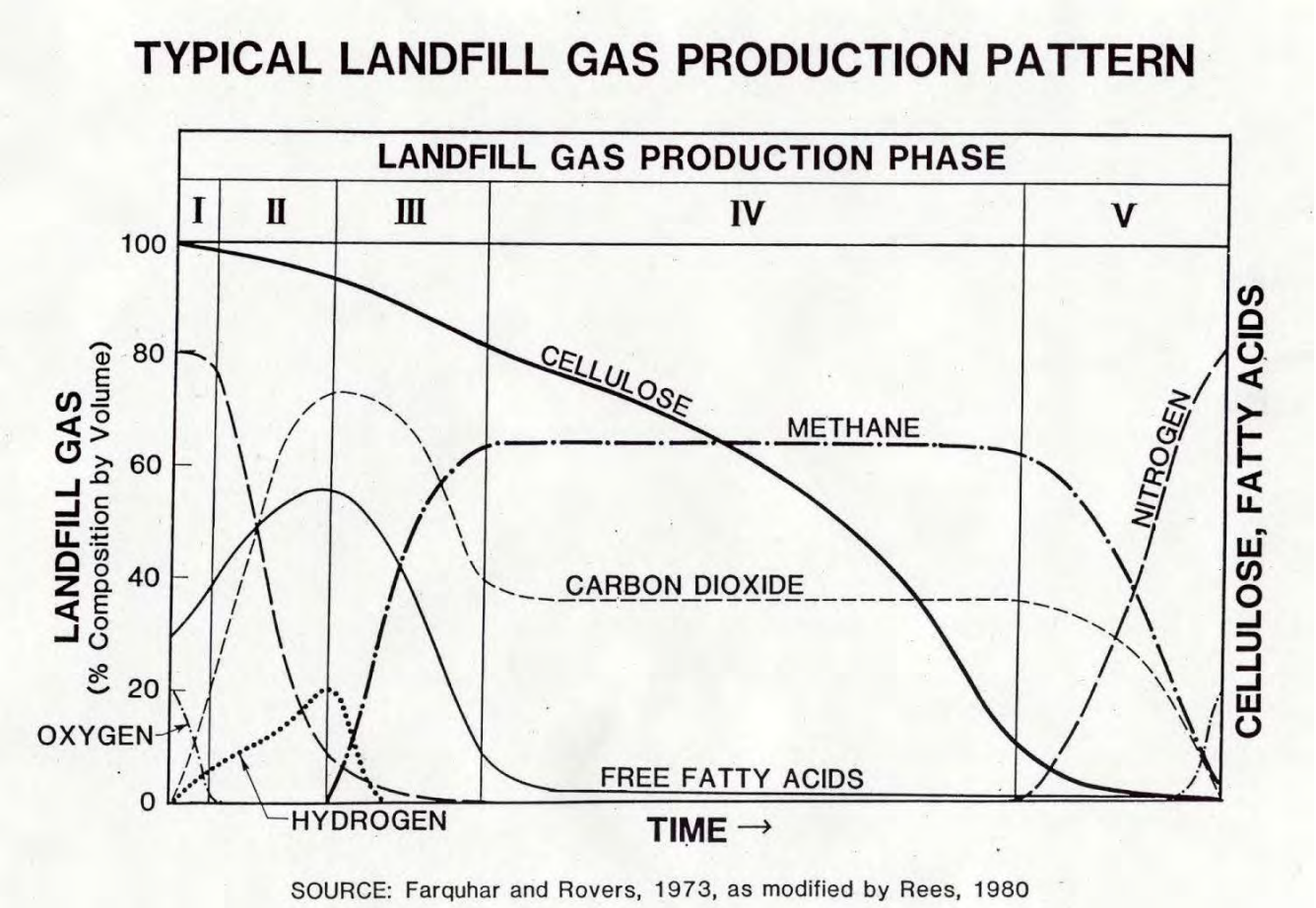
4. Should I be getting better gas out of my landfill?

- How old is the waste mass?



4. Should I be getting better gas out of my landfill?

- What kind of waste am I pulling from?
  - MSW
  - C&D
  - Pulp & Paper Mill or other Industrial Waste
  - Sludge – POTW, industrial, dredgings, solidification
- Do you have other contaminants to deal with?
  - Hydrogen sulfide, Siloxanes, etc.
  - May require additional treatment
  - Segregation of gas extraction

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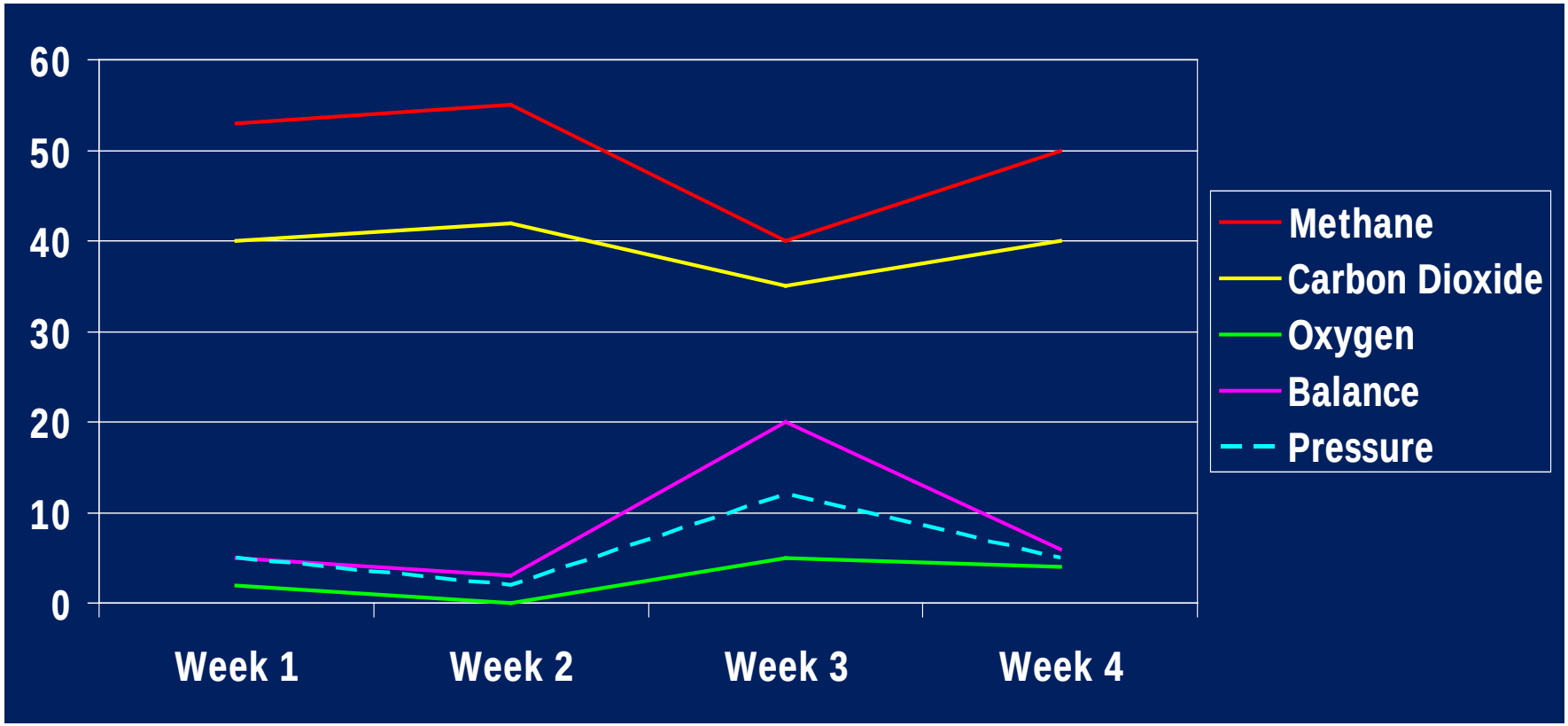
4. Should I be getting better gas out of my landfill?

- Am I over-pulling my wells?



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5. Do I have an "efficient" GCCS?

- How do you answer items 1-4?
  1. Is the GCCS doing what it's supposed to do?
  2. Is the GCCS complying with regulatory requirements?
  3. Should I be getting more gas out of my landfill?
  4. Should I be getting better gas out of my landfill?
- If gas isn't coming out of the cover or being detected in probes, it's either being oxidized or collected by the GCCS

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So what does it all mean?

- Tough to measure overall operations with a single "collection efficiency" metric
- Truly understanding your GCCS is time-intensive – it is a constantly evolving system
- There are a lot of moving parts
- Use appropriate database tools to manage and analyze the data

Operational Locations

Office Locations

Arizona
- Phoenix, AZ
- Tucson, AZ

California
- Dublin, CA
- San Diego, CA

Florida
- Ft. Lauderdale, FL
- Jacksonville, FL

Illinois
- Bolingbrook, IL
- Springfield, IL

Kansas
- Kansas City, KS

Kentucky
- Lexington, KY

Massachusetts
- Reading, MA

Michigan
- Farmington Hills, MI
- Grand Rapids, MI

Missouri
- St. Louis, MO

New Jersey
- East Brunswick, NJ

New York
- Greenwich, NY
- Middletown, NY
- Rochester, NY

Ohio
- Cincinnati, OH
- Logan, OH

Oregon
- Portland, OR

Pennsylvania
- Pittsburgh, PA

Washington
- Spokane, WA

Wisconsin
- Plymouth, WI
- Madison, WI

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