Example Project Walk Through

BCarbon

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Disclaimers and Considerations

- This document is for example purposes only and should only be used as a reference.. It is an informational and educational reference guide to the “BCarbon Methane Capture and Reclamation Protocol Version 1.1” (the Protocol). The definitions, equations, acronyms, procedures, and processes presented in this document adhere to the Protocol and are not necessarily those of ALL Consulting.
- Calculations were performed based on input data for the subject well, results may not be the same for all wells.
- This document does not contain all the required Data and Information for successful project submission. Moreover, it is provided for example purposes.
- The gas reserves and projected values used in this report are estimates and should not be construed as exact quantities.

Methane Emissions Calculations Process Flow

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Decline_Curve_Model (DCM)

Identify 36–48-month period of stable production near the end of the life of the well. The model calculates several outputs including the ADR and LPE values.

Decline_Curve_Model

Generate Annual Decline Rate (ADR) and Last Production (LPE)

Leak_Rate_ Model

Use DCM outputs and other well info to calculate gross emission reductions

Leak_Rate_Model (LRM)

Populate the Well information Sections. The DCM Output and methane concentration will also be needed for the LRM. The model will output the 20-year total well emissions in CO2e

Project Emissions and Uncertainty

Calculate the project emissions required to properly plug the well and reclamate the location. Include a 5% uncertainty Factor

Project Emissions &Uncertainty

Determine the emissions required to complete the well and site work.

Net Emission Reductions

Calculate the Well's total net emissions

Net Emissions Reductions

Using the Total Well Emissions, Project Emissions and Uncertainty, calculate the Net Emission Reductions for the well. *Repeat this process for every well in the project*.

Acronyms and Definitions

- **Net Emission Reductions** - The total emissions reductions of the project, which must include the project emissions and uncertainty.
- **Decline_Curve _Model (DCM)**- An excel-based set of calculations used to project future gas volumes from actual, historical production.
  - **Annualized Decline Rate (ADR)**- The decline rate upon which a well's production is declining over time. The ADR can be no less than 3% and no more than 30% per BCarbon Protocol.
  - **Last Production Estimate (LPE or ELP)**- The calculated final production rate (in mcfd) of the historic production. This is the initial rate upon which the forecast begins.
- **Leak_Rate_Model (LRM)**- An excel-based model that accounts for factors like future well production, the risk of a well leaking, and gas composition to predict a 20-year emission footprint of a well.
- **CO2e**- The number of metric tons of CO2 emissions with the same global warming potential as one metric ton of another greenhouse gas.
- **Global Warming Potential (GWP)**- A measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide (CO2).
- **Total Project Emissions (TPE or PE)**- Emissions from the work required to plug the well and reclamate the site.

Example Well #1 History

- Drilled and Completed in 2007
- Central Texas
- 4800’ vertical well
- Originally produced from a deeper formation
- Barnett formation was the active zone when the well was shut-in (ie. abandoned) by the operator
- Actively leaking near the wellhead prior to P&A
- Shut-in January 2016
- Plugged EOY 2022

Decline_Curve_Model

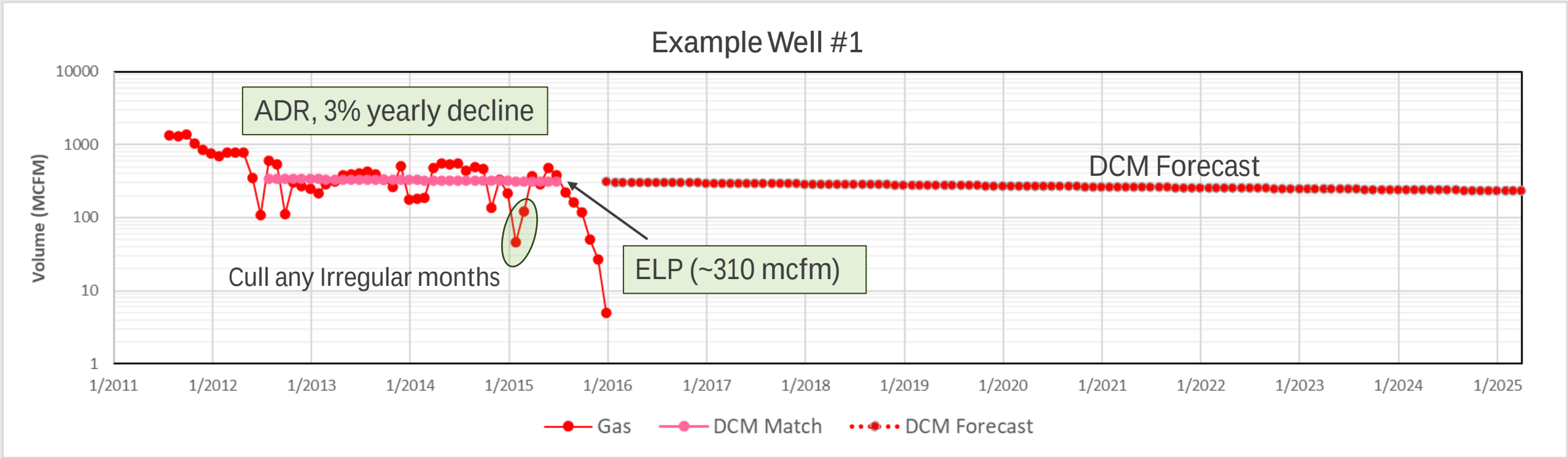
Input the identified ~48 months of production into the spreadsheet.

API	WellName	ProducingMonth	GasProd_MCF	ProducingDays
42417xxxxx	Example Well #1	8/1/2011	1335	31
42417xxxxx	Example Well #1	9/1/2011	1314	30
42417xxxxx	Example Well #1	10/1/2011	1392	31
42417xxxxx	Example Well #1	11/1/2011	1041	30
42417xxxxx	Example Well #1	12/1/2011	842	31
42417xxxxx	Example Well #1	1/1/2012	754	31
42417xxxxx	Example Well #1	2/1/2012	696	29
42417xxxxx	Example Well #1	3/1/2012	771	31

Output parameters

						mcfd
A	B	EADR	ADR	Z	FLP	ELP
0.00005396	2.5251	-1.951%	-3.0%	-3.0%	11.108	10.28

Identify ADR and ELP Output Parameters



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Leak_Rate_Model

Populate the LRM **Well Details** and **Volume Projection** sections. If necessary, run the Excel iterative tool "Goal Seek" in the **Leak Rate Projections** section.

Well Details for Example Well #1

-Yellow Cells are mandatory Inputs

Well Details	
Sour / non-sour?	non-sour
Bradenhead valve present?	yes
Sustained casing pressure?	no
Methane detected?	yes
Large leak probability	0.1
Year drilled	2007
Year shut-in	2016
Plugging year	2022
Probability leaking at shut-in	0.02900

LPE and ADR go here

Volume Projection from DCA	
Last rate, mcfpd	10.3
Exponential decline rate, %pa	3%
Volume window, years	30
Volume, mcf	74,222
Methane concentration, %	72%

Leak Rate Projections for Example Well #1

Leak Rate Projections		
"Large" leak factor	0.50	
Initial "large" leak rate, mcfpd	5.14	
"Large" leak decline rate, %pa		0.98%
"Large" leak time, years	50	
"Large" leak volume, mcf		74,222
difference	0	
"Restricted" leak factor	0.20	
Initial "restricted" leak rate, mcfpd	1.03	
Decline rate, %pa		0.00%
"Restricted" leak time, years	100	
"Restricted" leak volume, mcf		37,520
difference	36,702	

Manually input decline rate since it was less than 0

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Leak_Rate_Model Output

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GHG Emissions			
CH4 density, lb/cu. ft. at standard conditions	0.0418	60 F	14.5 psia
ton, lb	2,204	metric ton	
GWP20 (lb CO2/lb CH4)	84.00		

	CH4, mcf	CH4, tons	CO2 equiv, tons
Volume leaked pre-plugging	1,875	36	2,987
Volume leaked 20 years post plugging	**7,200**	**136.55**	**11470**

- The Volume leaked after 20 years post plugging, also known as the *Baseline Emissions (BE),* are the total projected leak volumes for a well over 20 years.
- Pre-Plugging Volumes are the volumes leaked between shut-in and plugging.
- *Example Well #1 is projected to leak about 7,200 mcf of methane or ~11,470 Metric Tons of CO2e over the next 20 years!*

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Project Emissions

- **Materials emissions** from concrete used for plugging
- **Fuel for equipment and materials** transport to project site
- **Fuel for rig** operation during plugging activity
- **Methane vented** during baseline measurement
- Project Developers shall use the current version of the U.S. Environmental Protection Agency's Emission Factors Hub (GHG Emission Factors Hub | US EPA) to determine the correct factors to use for their equipment. For diesel fuel, use No. 2 Fuel Oil

Project Emission Calculations

Plugging Record for Example Well #1

CEMENTING TO PLUG AND ABANDON DATA: CIBP	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7	PLUG #8
*19. Cementing Date 12/29/22	12/30/22	12/30/22						
20. Size of Hole or Pipe in which Plug Placed (inches) 4½	4½	8 5/8						
21. Depth to Bottom of Tubing or Drill Pipe (ft.) 4175	1600	600						
*22. Sacks of Cement Used (each plug) 2	20	60						
*23. Slurry Volume Pumped (cu. ft.) 2.5	23.6	70.8						
*24. Calculated Top of Plug (ft.) 4155	1350							
25. Measured Top of Plug (if tagged) (ft.)		0						
*26. Slurry Wt. # / Gal. 15.6	15.6	15.6						
*27. Type Cement C	A	A						

Cement Volumes

28. CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT.# / FT.	PUT IN WELL (ft.)	LEFT IN WELL (ft.)	HOLE SIZE (In.)
8 5/8		181	181	12¼
4½		15166	15166	7 7/8
4½		4762a	4766	7 7/8

29. Was any non-drillable material (other than casing) left in this well? ☐ Yes ☑ No

29a. If answer to above is "Yes" state depth to top of "junk" left in hole and briefly describe non-drillable material. (Use reverse side of form if more space is needed.)

30. LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS

FROM 4236 TO 4208 FROM TO

FROM TO FROM TO

FROM TO FROM TO

Emissions from Cement

Plug #	Slurry Vol ft3	Density ppg	Total lbs	Conversion lbs CO2/lbs	Total Emissions	
					lbs	MT (CO2e)
1	2.5	15.6	292	0.9	263	0.1
2	23.6	15.6	2754	0.9	2479	1.1
3	70.8	15.6	8263	0.9	7436	3.4
10% Excess	9.69	15.6	1131	0.9	1018	0.5
Total	**106.59**		**12439**		**11195**	**5.1**

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Project Emission Calculations (Part 2)

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Fuel for Travel

Vehicle Description	Type	Total Miles	Est MPG	Fuel Used gal	CO2 Conv kg/gal	Total Emissions lbs	Total Emissions MT (CO2e)
Operator	Light Truck	200	12	16.67	8.78	146	0.146
Rig Operator	Truck	120	8	15.00	10.21	153	0.153
Rig Travel	Truck	120	5	24.00	10.21	245	0.245
Plugger	Light Truck	120	12	10.00	8.78	88	0.088
Cementer	Truck	120	5	24.00	10.21	245	0.245
Misc.	Truck	150	8	18.75	10.21	191	0.191
Total		**830**		**108.42**		**1069**	**1.069**

Fuel Used for Rig and Other Large Equipment

Vehicle Descript	Fuel Used gal	CO2 Conv kg/gal	Total Emissions kg CO2	Total Emissions MT (CO2e)
Rig	100	10.21	1021	**1.021**
Backhoe	18	10.21	184	**0.184**
Cementer	75	10.21	766	**0.766**
Total	**193**		**1971**	**1.971**

Methane vented during baseline emission

WH Gas (mcf)	% of CH4	CH4 (mcf)	Total Emissions MT (CO2e)
1	85%	0.85	**1.35**

Description	Emissions (MT CO2e)
Cement	5.1
Travel to and From Site	1.1
Rig and Equipment	2.0
CH4 while Testing	1.4
TOTAL Project Emissions	**9.5 MT CO2e**

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Example Well Total Emission Reductions

Net Emissions Reductions = (BE– PE) * Uncertainty

- BE or Baseline Emissions calculated from the Leak_Rate Model are 11, 470 MT CO2e.
- PE or Project Emissions to plug and abandon the well and reclamate the surface location are 10 MT CO2e.
- Uncertainty is 5%.

Total Emissions Reductions of 10,887 metric tonnes of CO2e

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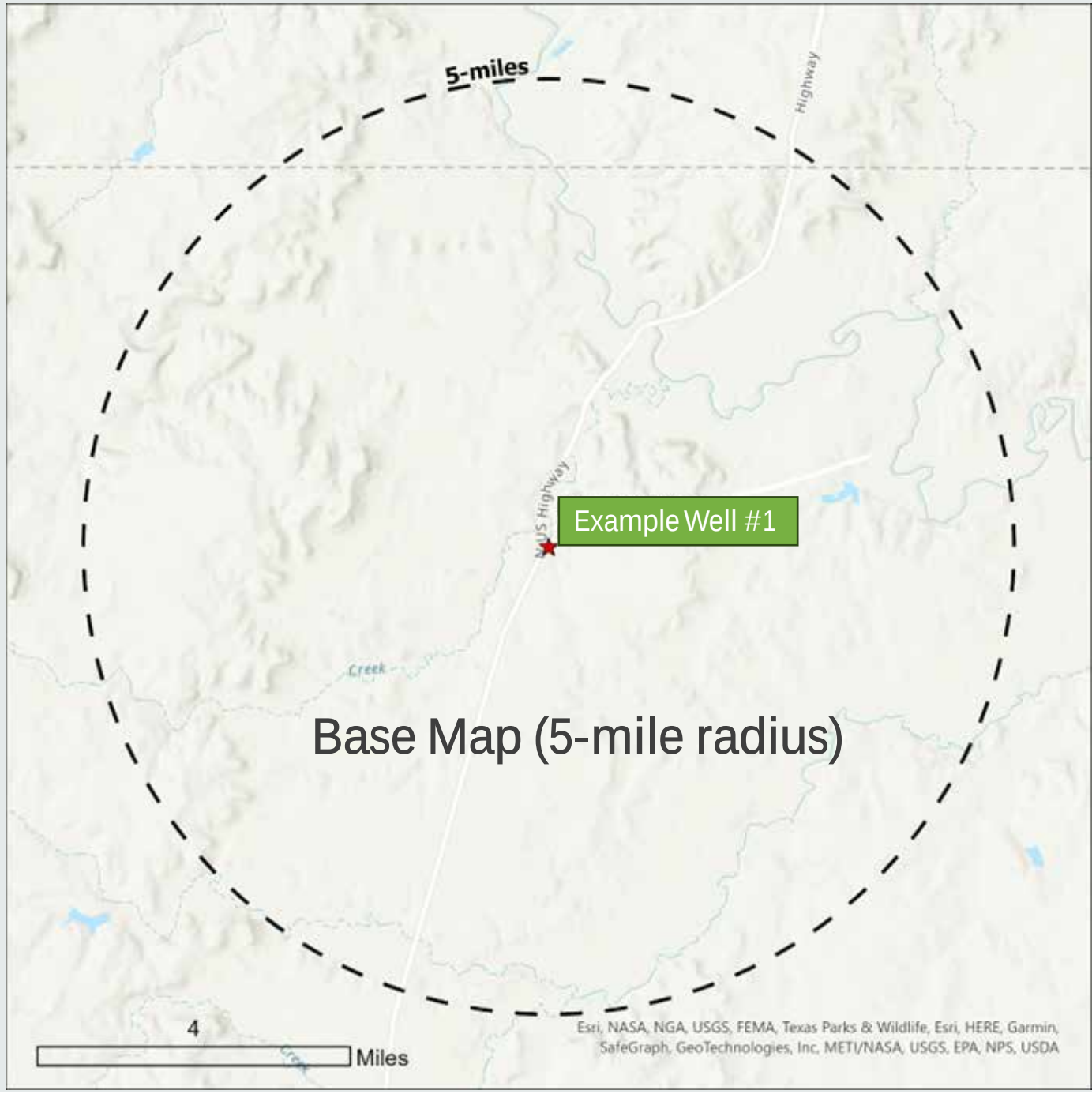
Demographic Details

Start with Base Map and add criteria:

- Aquifers
- Water Wells
- Sensitive Receptors and Environmental Justice Data (Example on Next Slide)
- Endangered Species
- Agricultural Land and Soil Analysis
- Land Reclamation
- Waters of the United States



Demographic Example – Environmental Justice

- Example County Census Tract (to the North) falls within the 5-mile radius for the Example Well #1
- Example County is designated as "disadvantaged" because it exceeds two of the Categories of Burden thresholds classified by the Climate and Economic Justice Screening Tool.
  - Climate Change Disadvantaged – it is at or above the 90th percentile for expected building loss rate AND at or above the 65th percentile for low income
  - Health Burden Disadvantaged - it is at or above the 90th percentile for heart disease AND at or above the 65th percentile for low income