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ConocoPhillips Gas Hydrate Production Test

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Abstract

This report summarizes Phase I of ConocoPhillips' "Gas Hydrate Production Test" NETL/DOE Project (DOE Award No.: DE-NT0006553). The period covered is Q408 through Q109. The primary accomplishments of this first budget period are the multiple subtasks associated with Site Selection, which culminated with a Site Selection Workshop, held at ConocoPhillips' Houston Complex on April 3, 2009. To maximize the chance of encountering gas hydrates in the field trial wellbore, the work focused on identifying wells that demonstrated gas hydrates when they were drilled and logged. To optimize the location of the trial well, which will "twin" an existing well that encountered hydrates, wireline logs for 117 Alaska North Slope wells were evaluated and locations most favorable for CO2-CH4 exchange field trial have been ranked. The top three candidates each have multiple hydrate-saturated sandstones; the 4th and 5th candidates each have a single hydrate-saturated sandstone.

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Executive Summary

This topical report documents the completion of Phase I of ConocoPhillips' "Gas Hydrate Production Test" NETL/DOE Project (DOE Award No.: DE-NT0006553). The primary accomplishment of Phase I was completion of Task 2: Identification, Evaluation and Selection of Sites for Field Activity. Task 2 was completed via completion of subtasks 2.1 through 2.6. In addition, Task 3: Field Site Ownership Partner Negotiations was initiated during the period covered by this Topical Report. Currently available data has been evaluated for existing license areas on the North Slope of Alaska to identify and rank sites considered to hold merit as potential locations for conducting field testing (Phase 3) of the CO_2/CH_4 exchange methodology for production of natural gas from gas hydrate.

Though nearly 6000 wells are present on Alaska's North Slope, less than 1000 have the minimum wireline log suite required for identification of gas hydrates. Only log data available in the public domain was evaluated for site selection. North Slope gas hydrates occur mostly in conventional sandstone reservoirs of the Sagavanirktok clastic reservoirs, and they can be inferred from the basic gamma-ray, sonic, and resistivity log suite. Historically this zone has been viewed as hazardous to drill, consequently less than one-fifth of the wells have any logs through this interval. Logs from approximately 900 wells were reviewed by ConocoPhillips staff and integrated with in-house ConocoPhillips studies to identify the most promising candidates.

Candidates were divided into three groups based on their location; wells exist either in the ConocoPhillips-operated Kuparuk River Unit (KRU), the BP-operated Prudhoe Bay Unit (PBU), or outside KRU and PBU, in other units or on leased-for-exploration acreage. Each group was ranked, first into three categories of log confidence, then by total thickness of clean and resistive sandstone that has potential to be hydrate-bearing and is more than 200ft below the calculated base of permafrost. Potential hydrate-bearing sandstones less than 200ft below calculated permafrost were not considered when ranking candidates for two reasons. It is estimated that the permafrost calculation has up to 200ft of uncertainty. This depth criterion was used to ensure that clean and resistive sandstones that may be ice-bearing are eliminated from consideration. Additionally, the preference is to perform the field trial at a reservoir temperature close to 4°C (39°F), the temperature at which the laboratory experimentation has been conducted. At a geothermal gradient of 2°F/100ft, 39°F will be encountered approximately 350ft below base of permafrost.

Mudlogs were interpreted for the best field trial candidate locations. Mudlogs graphically represent drill-cuttings circulated out of the hole, correlated with rate-of-penetration and shows of hydrocarbons measured in the mud, gathered while drilling. Mudlog shows have been divided into four qualitative categories, by interpreted strength, to assist in candidate ranking. Gravel roads and pads provided another criterion for ranking: wells on existing gravel pads, serviced by all-season gravel roads, are superior to gravel pads with no roads, which are, in turn, superior to wells with neither; the latter are most often exploratory wells that were drilled during the winter on ice pads serviced by ice roads.

Mapping of the strength of mudlog shows with log confidence and thickness of potential hydrate-bearing sandstones confirms that the highest confidence of encountering significant thicknesses of hydrate-bearing sandstones occur in the western Prudhoe Bay Unit. Comparison of the top candidates from each list (KRU, PBU, other areas) allowed us to identify the top five candidates for exchange field trial location. Four of the top five candidates are in the Prudhoe Bay Unit (W Kup 3-

11-11, L-106, NWE2-01, and Kup St 7-11-12) and one candidate is in the eastern Kuparuk River Unit. Proprietary 3D seismic data was interpreted to evaluate the structural configuration of each of the top five candidates. While each site has unique subsurface and surface issues, the top three PBU candidates each have two or three interpreted hydrate-bearing sandstones; candidates four and five (Kup St 7-11-12 and W Sak 24) contain just one interpreted hydrate-bearing sandstone.

Report Details

Experimental Methods

Subtask 2.1 - Site Identification: One hundred and seventeen potential sites have been identified for the proposed field trial (Phase 3) testing of the CO_2/CH_4 exchange methodology for production of natural gas from gas hydrate. Specific tasks completed during site identification include evaluation of wireline logs (gamma-ray, resistivity, and sonic logs) to identify those wells in which gas hydrate presence can be inferred. Wireline logs have been carefully reviewed between the interpreted base of permafrost (BPF) and the calculated base of the gas hydrate stability zone (BGHSZ). Base of permafrost represents the shallowest inferred gas hydrate occurrences of current interest for CO_2 / CH_4 exchange technology. In this report the term "zone of interest" refers to the interval from BPF to BGHSZ. Gas hydrates in the Prudhoe Bay/Kuparuk River area of the Alaska's North Slope are hosted in the Brookian terrigenous wedge and occur mostly in high porosity, high permeability sandstones of the Sagavanirktok Formation. Site identification methodology utilized has three aspects: interval recognition, criteria determination, and candidate selection.

Interval Recognition: Gas hydrate deposits occur within and below the ice-bearing permafrost on Alaska's North Slope, since the gas hydrate stability zone includes temperatures that are below and above the freezing point of water. In the site selection process, we have elected to pursue only below-permafrost targets for two reasons. First, it is difficult to differentiate ice-bearing sandstones in the permafrost from hydrate-bearing intervals from well log or seismic data. Second, the CO_2/CH_4 exchange experiments have been conducted at 4°C and we desire to perform the initial exchange field trial at similar conditions. This temperature corresponds to a depth approximately 350ft below the base of permafrost. The overall interval reviewed for gas-hydrate bearing sandstone occurrence starts at the base of permafrost and extends downhole to the base of the gas hydrate stability zone (BGHSZ). Though the depth of permafrost has been mapped regionally, it is not a pick that can be made easily in every well. A permafrost-depth calculation was devised based on well coordinates, which in turn reflect regional permafrost contours. Once the depth of permafrost was calculated, we used the publically available "CSMHYD" program to predict the depth of the BGHSZ, based on assumptions of pore water salinity, density of the hydrostatic column, gas composition, and geothermal gradient. For each well in the ConocoPhillips proprietary database, depth of permafrost and depth of BGHZ was calculated and posted on each digital log.

Criteria Determination: The primary dataset for site identification is wireline logs from existing wells. All wells drilled on the North Slope have penetrated the gas hydrate stability zone, though less than one sixth of these wells have been logged between base of permafrost and base of gas hydrate stability zone. Bob Lankston and David Schoderbek, the two primary COP investigators in this phase, met October 17 with Tim Collett, Myung Lee, Warren Agena, and several of their geophysical colleagues at USGS in Denver. The main goal of this meeting was to understand previous gas hydrate work performed by the USGS and to assure accurate calibration of ConocoPhillips site selection well log criteria to existing USGS evaluations (e.g. Collett, 1993). Sandstones with gas hydrate in their pores exhibit high resistivity and high velocity (low transit time), like their ice-bearing counterparts. Collett (1993) summarized sonic and resistivity log criteria to identify gas hydrate-bearing sandstones: resistivity 50X greater than associated water-bearing sandstones and sonic transit time 40 microseconds/ft faster than adjacent wet sandstones. For scoping site identification, we examined numerous North Slope logs, all available in the public domain, and modified the aforementioned criteria into log cutoffs that allowed rapid screening of many well logs. A quick-look interpretation of the available well log data was performed with cutoffs based on the USGS criteria (Table 1). Sandstone with pore-filling gas hydrate is inferred to have gamma ray log response less than 55 API units, sonic transit time less than 140 microseconds/ft, and resistivity greater than 30 ohm-m.

Table 1. Log Interpretation Cutoff Parameters for Hydrate Identification

Measurement	Cutoff Value
Gamma Ray (GR)	< 55 API
Deep Resistivity (Rt)	> 30 Ohm-m
Sonic Slowness (ΔT)	< 140 μsec/ft

Initial log review identified sandstones with variable resistivities, which may reflect variable gas hydrate saturations. A recent publication by Gomez et al (2008) describes the simultaneous calculation of both porosity and gas hydrate saturation. Once the model is appropriately parameterized, only two inputs are required: acoustic impedance (product of velocity and density) and resistivity (normalized by wet-sand resistivity). Research was initiated to determine if the method of Gomez et al (2008) added incrementally to conventional Archie-equation computations of gas hydrate saturation. An example wireline log is shown as Figure 1.

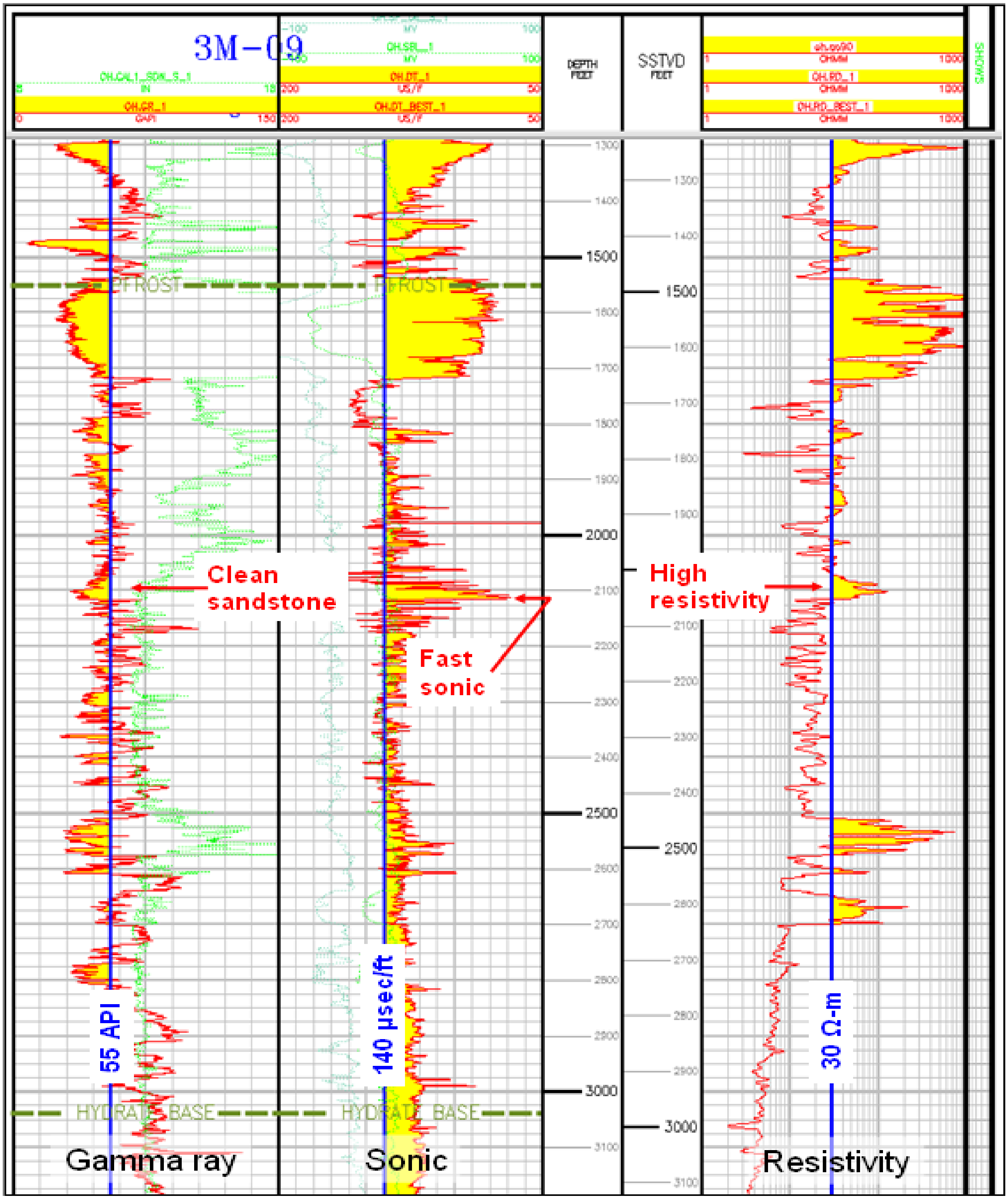

Figure 1: Wireline Log Example

<u>Candidate Selection:</u> Of the 5700 wells present in ConocoPhillips' database, only 900 wells have gamma-ray, sonic, and resistivity logs over the BPF to BGHSZ zone of interest. Not all 900 wells have full coverage of the zone of interest with unambiguous, high-quality logs. Using the log cut-

offs described above, these 900 well logs were reviewed and interpreted by ConocoPhillips geoscience staff and the “top hundred” candidates were identified. Many wells on this short list have ambiguous sonic log response due to poor hole conditions and incomplete log overlaps. In addition, we believe partial post-drilling dissociation of gas-hydrate bearing sandstones during subsequent deeper drilling may have occurred before logging to further complicate wireline log responses. Comparison to well lists generated by historical ConocoPhillips’ in-house studies and Collett (1993) identified additional candidates, and the “top hundred” list grew to 117 candidates.

Subtask 2.2 - Identification of Site Ownership Partners: Activities have been conducted to identify lease ownership for potential sites identified under Subtask 2.1. This task includes research and review of ConocoPhillips in-house land records and data from public sources. Lease ownership at the top sites has been identified along with individual company working interest. Division of the 117-well list into three subgroups made this task simpler. Forty-five field trial candidates lie within the Kuparuk River Unit (KRU) and are operated by ConocoPhillips on behalf of the KRU owners. These wells have common working interests throughout. Thirty-one candidates lie within the Prudhoe Bay Unit (PBU); these also have common working interests throughout the unit, which is operated by BP. Forty-one candidates lie outside the Kuparuk River and Prudhoe Bay units. These wells lie within other units (Colville River Unit, Milne Point Unit, Oooguruk Unit) and outside units, on a combination of leased and unleased lands (Figure 2). Each unit has a different operator and working interest owners. Leased lands are leased to a variety of operators. Unleased lands, administered by both federal and state agencies, are also present in the study area. Some leased lands outside unit boundaries are shared via exploratory areas of mutual interest, referred to as AMIs.

Subtask 2.3 – Evaluation of Potential Site Ownership Issues: Potential ownership issues were evaluated for sites identified in Subtask 2.1 for the purpose of contributing to overall site evaluation conducted under Subtask 2.4. This evaluation included consultation with ConocoPhillips commercial advisors who have relevant experience with potential co-owners as well as frequent dealings with the North Slope stakeholder community. Candidate sites in Kuparuk River Unit and Prudhoe Bay Unit are owned jointly by ConocoPhillips, BP, ExxonMobil, and Chevron, though the ownership percentages are different in each unit.

Subtask 2.4 - Site Evaluation: Potential sites have been evaluated (as identified in Subtask 2.1) for use in (Phase 3) testing of the CO_2 / CH_4 exchange methodology for production of natural gas from gas hydrate. Evaluation has been on currently available field data for existing license areas of the Alaska North Slope including, but not limited to, available seismic, well logs, cores, or other relevant data. Very few well logs exhibit the ideal (clean GR, fast transit time, high resistivity) hydrate log response. Mapping of interpreted possible hydrate-bearing “clean and resistive sandstone” is shown in Figure 3. Existing gravel roads and pads are also shown on Figure 3.

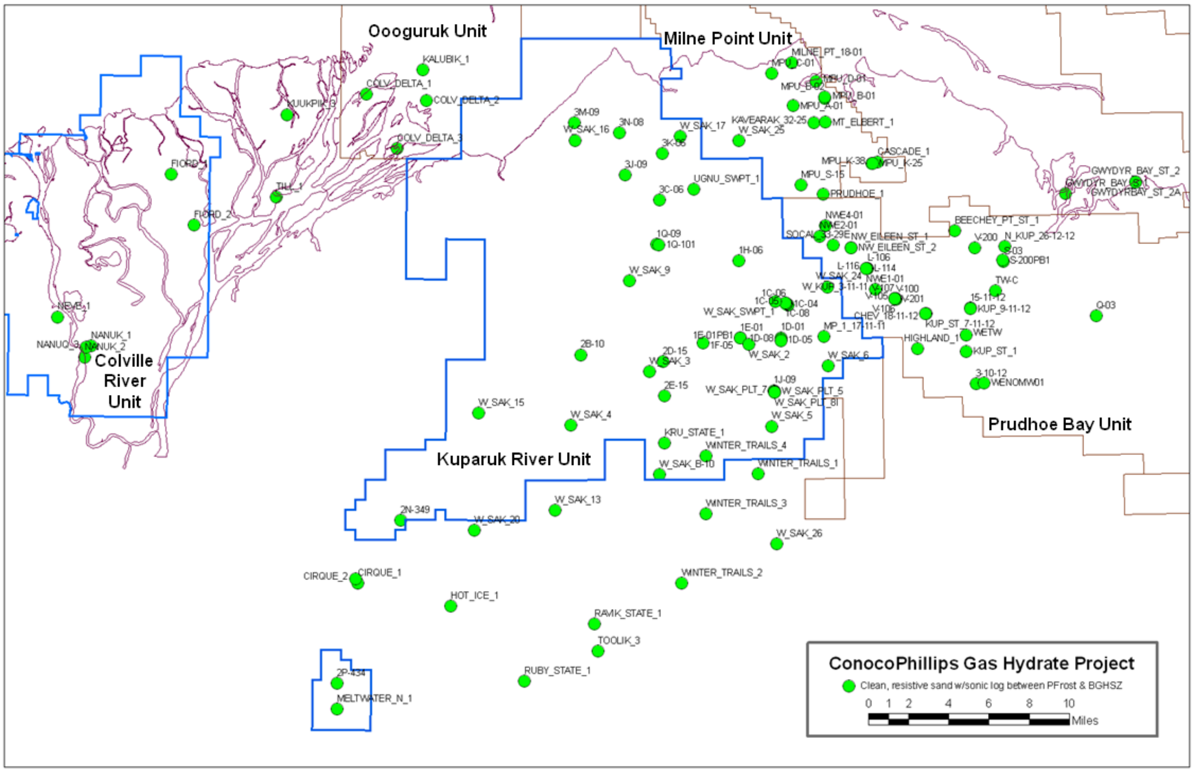

Figure 2: Location of 117 Field Trial Candidates, Kuparuk River Unit and Prudhoe Bay Unit

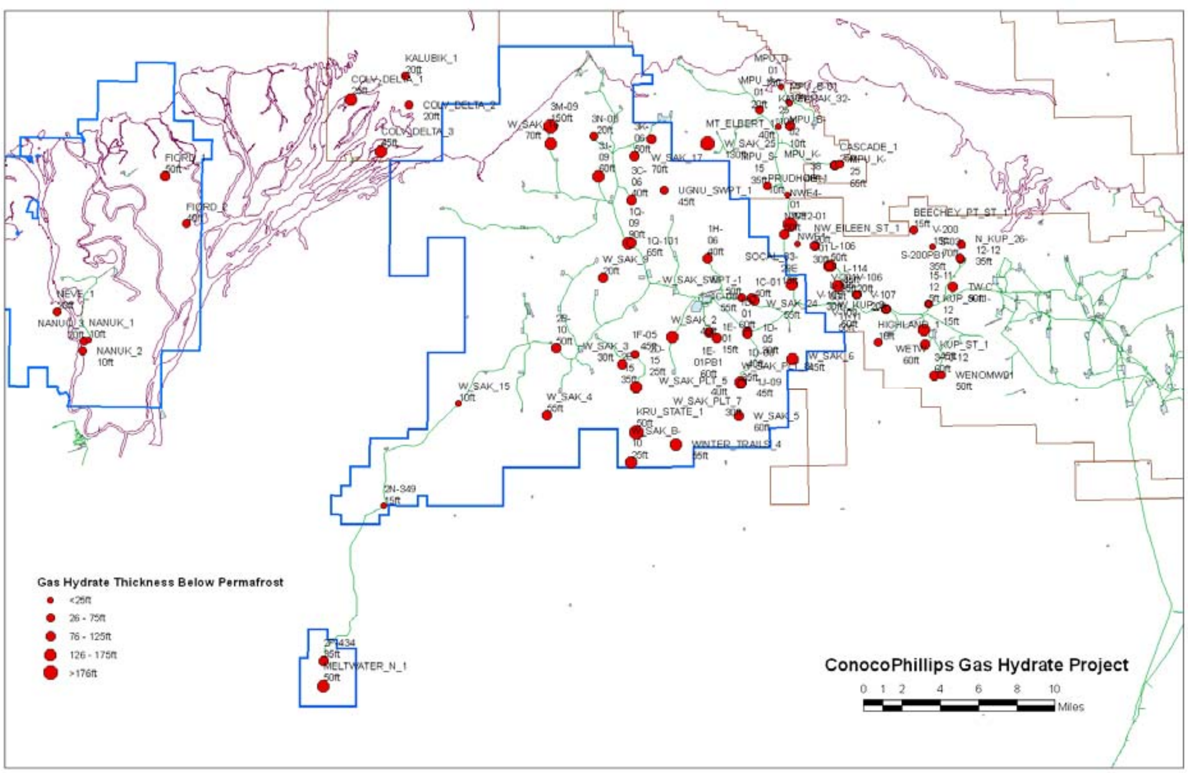

Figure 3: Possible hydrate: Thickness of clean and resistive sandstone between BPF and BGHSZ

Subtask 2.5 - Ranking of Sites: Documentation has been developed ranking potential field sites identified and evaluated under Subtasks 2.1 – 2.2 based on factors including:

- suitability for specific testing of the CO_2 / CH_4 exchange methodology,
- availability of data related to site,
- ownership and access risk,
- physical site accessibility, geologic risk for gas hydrate occurrence,
- depth to target intervals,
- number and thickness of sand intervals below permafrost and above the base of gas hydrate stability zone,
- geologic risk for well design,
- facilities access to power, water, and gas disposal
- number of associated phases in the target interval(s): water, gas, and hydrate.

Geologic risk for well design was addressed with proprietary seismic data for the top five candidates. Candidates close to seismically identified faults, especially where these faults contribute to hydrate trapping, are considered less favorable. Candidates adjacent to seismically inferred hydrate/water contacts are also considered less favorable. Associated phases in the target intervals have been investigated via petrophysical methods. Five different methods exist for calculation of hydrate saturation from wireline logs (Figure 4). It is concluded that hydrate saturation calculations are not accurate enough to allow discrimination among the top candidates, given the highly variable quality of logs present through the zone of interest.

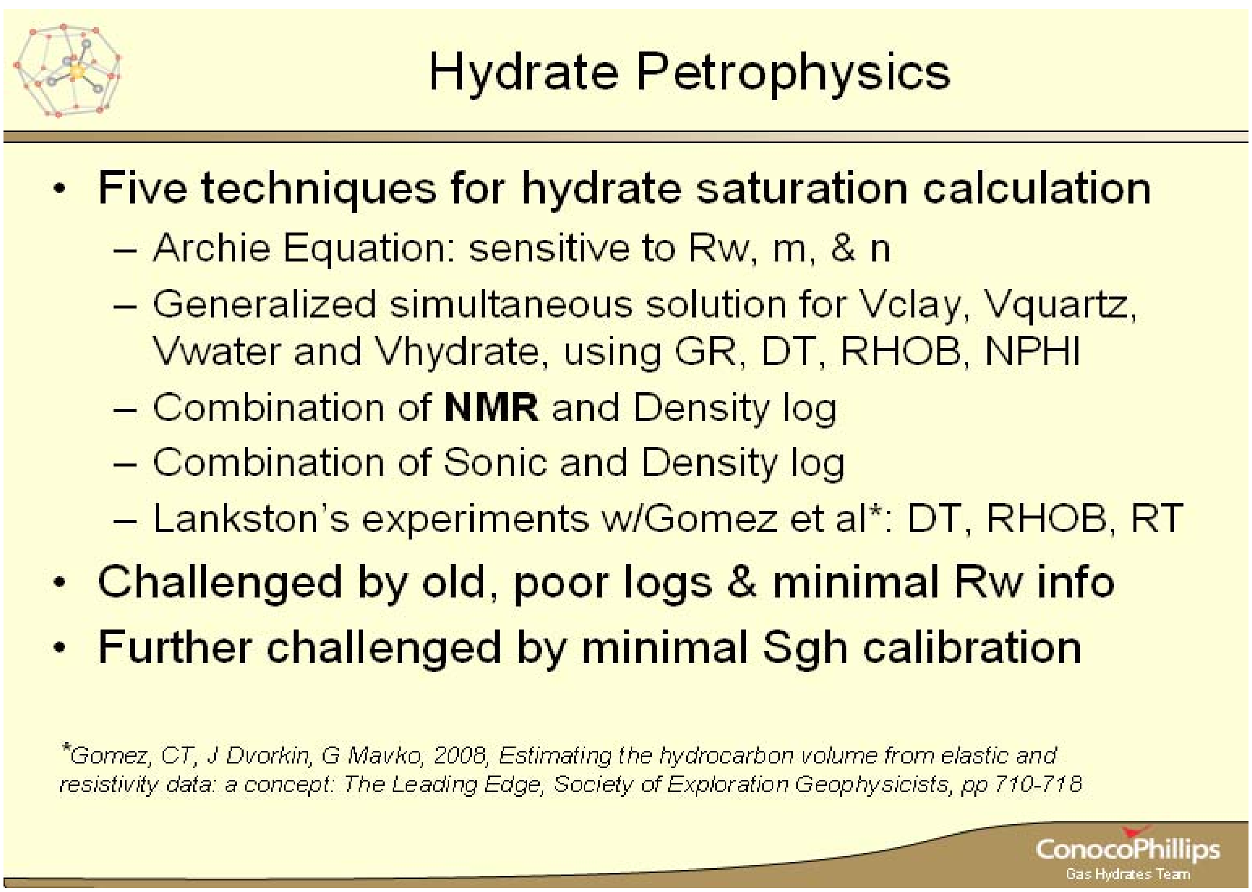

Figure 4: Summary of methods for wireline log-based calculation of gas hydrate saturation

Log confidence and log coverage through the zone of interest has been quantified for 117 field trial candidates. Figure 5 graphically depicts three classes of log confidence. Candidates were further identified as those with existing gravel pads, access by existing gravel roads, and isolated bare tundra locations. In the final ranking matrix, gravel roads and gravel pads each received a "1" for either and a "0" for neither.

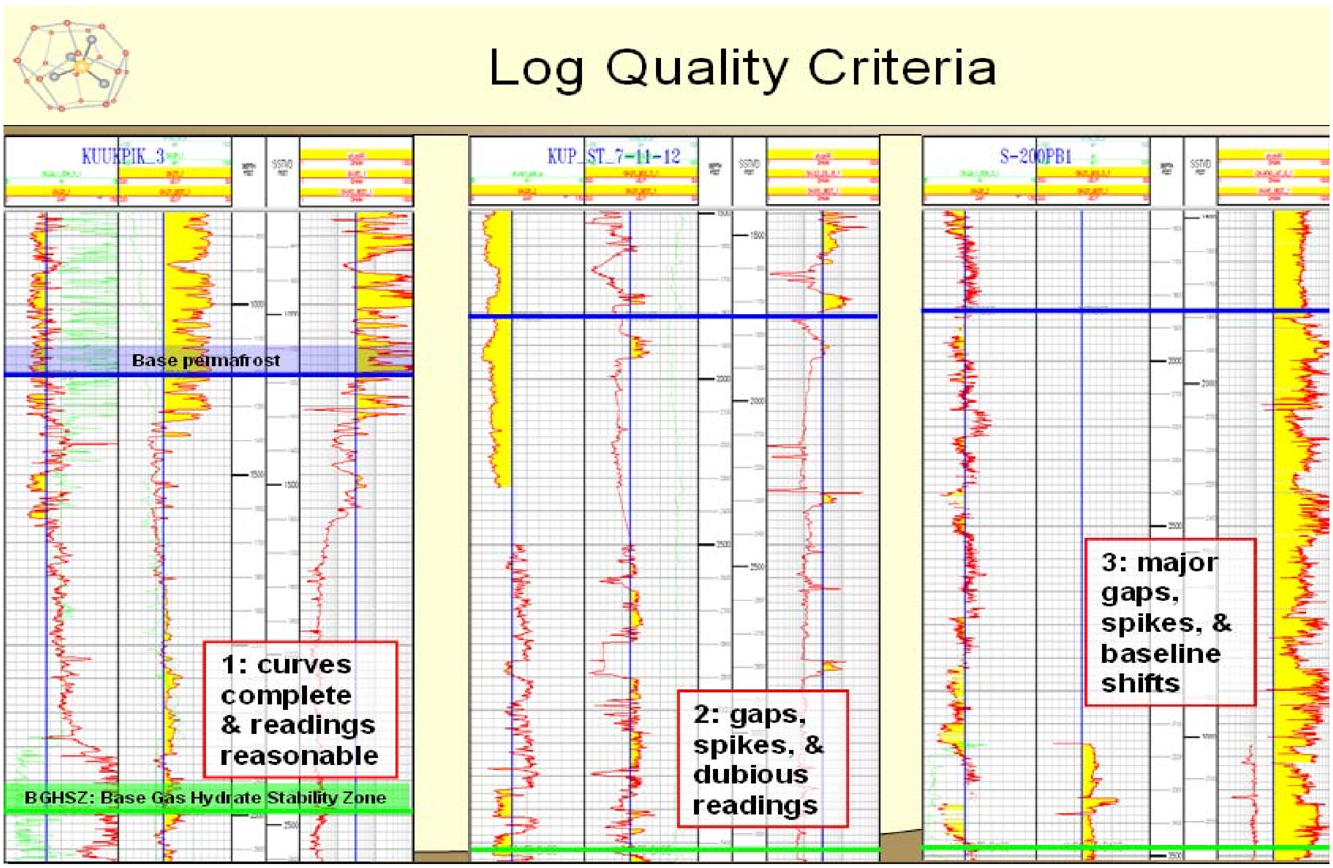

Figure 5: Log Confidence

A mudlog is a compilation of penetration rate, cuttings lithotype, and measurements of hydrocarbon gases in the drilling fluid. Mudlogs are compiled while drilling, usually before any wireline logs are run. Publically available mudlogs were reviewed for forty-one of the top exchange field trial candidate locations. No mudlogs were available in the public domain for the remaining top candidates. We interpreted the strength of gas shows from mudlogs generated while drilling through potential hydrate-bearing sandstones. Interpretation indicates that mudlog shows can be divided by their strength into four categories (Figure 6).

Subtask 2.6 - Site Selection: Recommendations for a field test site (Phase 3) have been developed, and these recommendations presented, with supporting evidence and justification for the selection, to DOE representatives and others mutually agreed upon between ConocoPhillips and DOE at a Site Selection Workshop in Houston on April 3rd. Attendees included NETL/DOE Hydrates Technology Manager Ray Boswell and Rick Baker, NETL/DOE Hydrates Team Lead, Tim Collett

(Hydrates Lead Scientist, USGS), Myung Lee (USGS), and Matt Frye (Gas Hydrate Assessment Lead, MMS). Proprietary seismic data, not available for public release, were also reviewed.

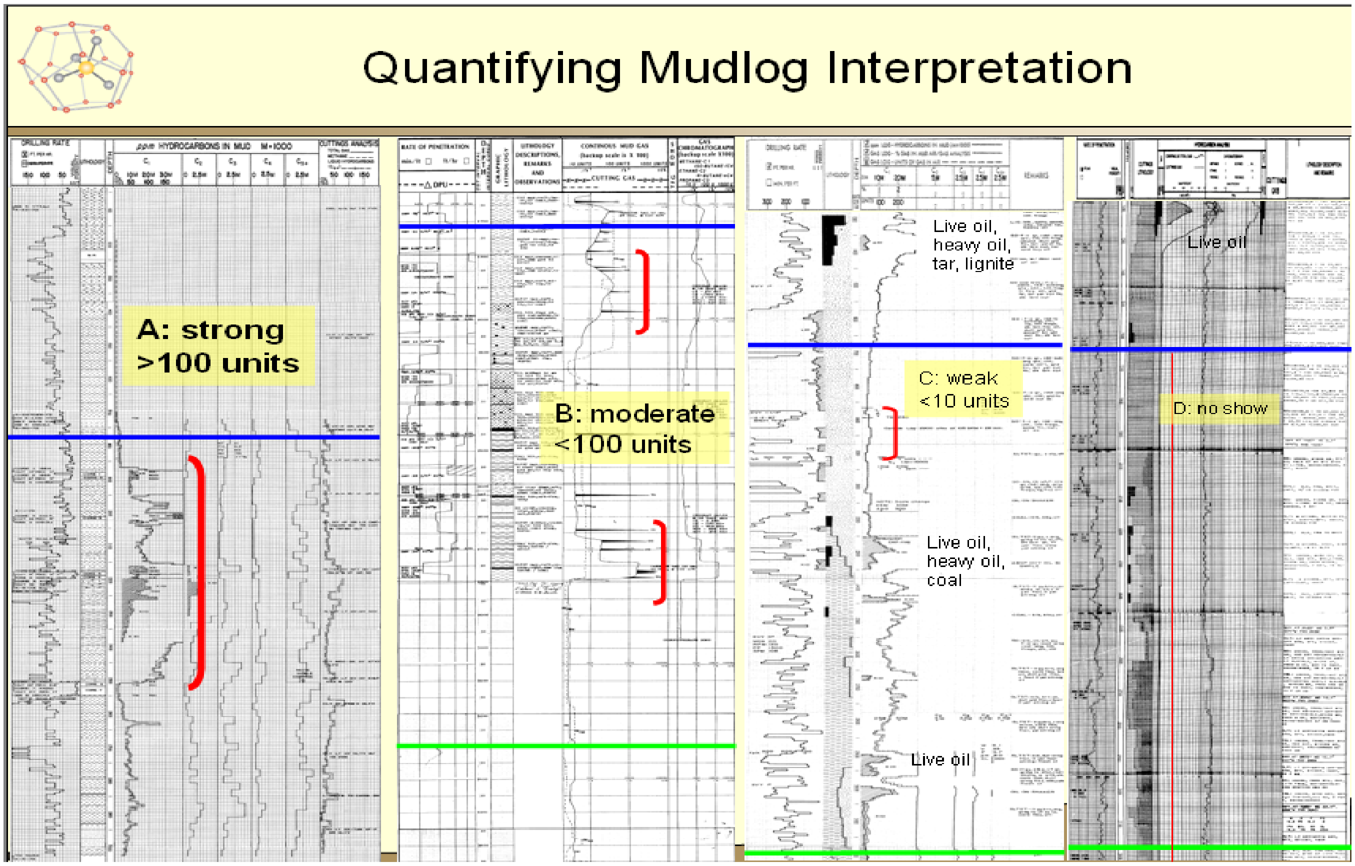

Figure 6: Mudlog categorization

Task 3 - Field Site Ownership Partner Negotiations: Discussions have been initiated with unit and lease co-owners for access to potential field sites selected under Subtask 2.6. DOE has been kept, and will continue to be kept, informed of progress on co-owner discussions through regular project communications.

Results and discussions

Sites have been divided into three groups based on location: Kuparuk River Unit, Prudhoe Bay Unit, and other areas (Figures 7-9). Within each ranking matrix, locations have been sorted first by log confidence, then by thickness of interpreted hydrate-bearing sandstone. The thickest candidates in log confidence categories are shaded yellow. The calculated permafrost depth is believed to have approximately 200ft of uncertainty, so possible gas hydrate within 200ft of the permafrost base pick has been excluded from this tabulation. Ranking matrices also include gravel road and pad scores, calculated temperature at best hydrate-bearing sandstone, mudlog "scores," and the final ranking of the top candidates. Only twenty-four of the forty-one candidates evaluated in the "other areas" category are shown on Figure 9. The other seventeen were drilled on lands deemed "exploratory & confidential" by ConocoPhillips staff. Log confidence and possible hydrate thickness are combined on the map labeled Figure 10. Well symbols are colored by log confidence and symbol size is proportional to possible hydrate-bearing sandstone thickness. Isolated large (thick), red (high confidence) and yellow (intermediate confidence) symbols are present in several areas, but the western Prudhoe Bay Unit and eastern Kuparuk River Unit contain the greatest concentration of favorable candidates for exchange field trial.

UNIT	Access gravel pad	Access road	mudlog have or none	mudlog score & comments	FINAL RANKING	Well	DAS comments	depth below calc'd PF [feet]	total [ft]	thickest [ft]	LOG CONF score	Confidence: Calculated Permafrost base GH <200ft below PF	% <200ft below PF	GH >200ft below PF	Wireline logs GR %	GR quality	Sonic %	Sonic quality	Resistivity %	Resistivity quality	Est'mtd (at 2F/100ft) temp at "blue" GH
KRU	1	1	1	B	2	**3M-09**	1490 (150ft) PF pick? 1730 (35ft); 1795 (20ft); 1850 (40ft); **2020 (30ft)** ~~2450 (60ft); 2590 (40ft thn-bdd)~~ HO	0	275	150	1	150	55	125	100	1	100	1	100	1	43F
KRU	0	0	1	C		**WINTER_TRAILS_4**	**1530 (55ft + 2x50ft)** ?dt	0	155	55	1	105	68	50	100	1	100	1	100	1	36F
KRU	1	1				3J-09	1595 (25ft); **1680** (60ft); 1780 (4x10ft); ~~2440 (60ft)~~ HEAVY OIL	70	125	60	1	85	68	40	100	1	100	1	100	1	35F
KRU	0	0				KRU_STATE_1	**1505 (50ft + 30ft + 6x20ft)**; 2550 (10ft) PF pick?	10	200	50	1	160	80	40	100	1	100	1	100	1	37F
KRU	1	1				2E-15	**1525 (5x10ft + 2x20ft + 35ft)** +	5	125	35	1	90	72	35	100	1	100	1	100	1	36F
KRU	1	1			3	2D-15	1505 (3x15ft); **1660 (25ft)**	0!!	70	25	1	55	100	15	100	1	100	1	100	1	35F
KRU	1	1	1	B		**KRU C-5 (1C-05)**	**2715 (5ft)**	1080	5	5	1	0	0	5	35	1	35	1	35	1	54F
KRU	1	1				2N-349	**1305 (15ft)**	100	15	15	1	15	100	0	65	1	65	2	100	1	34F
KRU	1	1				3N-08	**1545 (3x20ft)**; ~~2690 (80ft)~~ HEAVY OIL	10	60	20	1	60	100	0	100	1	100	1	100	1	35F
KRU	1	1	1	D		**W_SAK_16**	1550 (55ft); 1715 (35ft); **1880 (70ft)**; ~~2375 (100ft + 25ft)~~ ?dt HO	60	160	70	2	55	34	105	100	2	100	1	100	1	40F
KRU	1	1	1	A	1	**W_SAK_24**	1685 (45ft); **1935 (55ft)**; 2175 (40ft); 2505 (10ft) PF pick?	20	150	55	2	45	30	105	100	1	100	1	100	1	42F
KRU	1	1	none[1]	B	4	**1J-09 (RWL fave)**	1550 (35ft); 1745 (35ft); **1845 (45ft)**; 2020 (25ft)	350	140	45	2	35	25	105	100	1	100	1	100	1	41F
KRU	1	1	1	C	8	**KRU F-5 (1F-05)**	1650 (45ft); **1750 (90ft ALMOST makes Rt cutoff)** no dt	100	135	45	2	45	33	90	95	1	50	1	100	1	34F
KRU	1	0	1	B		**W_SAK_6**	1735 (40ft); 1995 (45ft); **2325 (40ft)** ?dt	70	125	45	2	40	32	85	100	1	100	1	100	1	45F
KRU	1	0	1	C		**W_SAK_4**	1445 (2x20ft); 1615 (25ft); **1735 (55ft)** ?dt	80	110	55	2	40	36	70	90	1	90	1	90	1	39F
KRU	1	1	digital[2]	B	5	**1Q-101**	1510 (25ft); **1695** (65ft but thn-bdd)	140	90	65	2	25	28	65	85	1	85	1	95	1	36F
KRU	1	1	none[3]			KRU 1D-1 (1D-01)	1750 (30ft); **2030 (60ft)** ?dt	160	90	60	2	30	33	60	100	1	10	1	100	1	38F
KRU	1	1	none			KRU 1E-1 (1E-01PB1)	1580 (40ft); **1860 (60ft thin-bedded)** ?dt	0!!	100	60	2	40	40	60	100	1	100	1	100	1	37F
KRU	1	1	1	D		**W_SAK_SWPT_1**	**1855 (50ft)**; 2410 (10ft)	230	60	50	2	0	0	60	95	1	95	1	95	1	36F
KRU	1	1	none[3]	C	9	**KRU 1D-5 (ID-05)**	1755 (30ft); **2030 (2x25ft)** ?dt	180	80	30	2	30	38	50	100	1	85	1	100	1	41F
KRU	1	0	1	C		**UGNU_SWPT_1**	1640 (20ft); **2955 (45ft)** ?GR	20	65	45	2	20	31	45	100	2	100	1	100	1	60F
KRU	1	1	none[1]			W_SAK_PLT_5	1745 (20ft); **1845 (40ft)** no dt	145	60	40	2	20	33	40	100	1	0		100	1	37F
KRU	1	0	1	C		**W_SAK_2**	1715 (45ft); **2000 (4x10ft)** ?dt	90	85	45	2	45	53	40	100	1	100	1	100	1	40F
KRU	1	1			6	3C-06	1485 (15ft); 1505 (25ft); **1825 (40ft no dt)**	30	80	40	2	40	50	40	100	1	70	2	100	1	39F
KRU	1	1	1	C	10	**1H-06**	1680 (40ft); 1900 (10ft); **3120 (30ft w/H20 below: AT calc'd BGHSZ)**	75	80	40	2	40	50	40	100	1	70	1	100	1	38F
KRU	1	1	none			3K-06	1710 (50ft); **2000 (40ft)**; ~~2940 (45ft fining updward)~~ ?dt HEAVY OIL	150	90	50	2	50	56	40	100	1	100	1	100	1	41F
KRU	1	1	none[4]	B	7	**KRU C-1 (1C-01)**	1660 (40ft); **1920 (40ft)** ?dt	30!!	80	40	2	40	50	40	100	1	100	1	100	1	38F
KRU	1	1	1			W_SAK_PLT_8I (J-pad)	1745 (20ft); **1850 (35ft)**; ? DT	130	55	35	2	20	36	35	100	1	100	1	100	1	37F
KRU	1	1	none[4]			1C-08	1645 (55ft); **1905 (35ft)** ?dt	10	90	55	2	55	69	35	100	1	100	1	100	1	38
KRU	1	0				W_SAK_B-10	**1465 (2x25ft + 8x10ft)** ?dt	50	130	25	2	95	73	35	100	1	100	1	100	1	37F
KRU	1	0				W_SAK_9	**1545 (3x20ft + 3x10ft)** no dt	60	90	20	2	60	100	30	100	1	55	2	100	1	36F
KRU	1	1	none[1]			W_SAK_PLT_7	1750 (25ft); **1855 (30ft)** NO DT	150	55	30	2	25	45	30	100	1	0		100	1	37F
KRU	1	1				1Q-09	1540 (90ft); **1740** (3x15ft) ?dt	10	135	90	2	105	78	30	100	1	100	1	100	1	36F
KRU	1	1	1	C		**KRU 1D-8 (1D-08)**	1730 (40ft); 2015 (10ft); **2035 (20ft)** ?dt	110	70	40	2	40	57	30	100	1	100	1	100	1	40F
KRU	1	0				W_SAK_5	1790 (60ft); **1855 (30ft)** ?dt	170	90	60	2	60	67	30	100	1	100	1	100	1	36F
KRU	1	1				2B-10	1525 (35ft); 1570 (20ft); **1615**	90	105	50	2	75	71	30	100	1	100	1	100	1	36F
KRU	1	1				W_SAK_17	1600 (70ft); **1950 (25ft)**; ~~3070 (90ft at GHSZ)~~ probably HEAVY OIL	10	95	70	2	70	74	25	100	1	100	1	100	1	39F
KRU	1	0				W_SAK_3	1540 (30ft & 20ft); 1620 (15ft); **2510 (20ft)** ?dt	30	85	30	2	65	81	20	100	1	100	1	100	1	52F
KRU	1	1				W_SAK_15	**1510 (10ft)**	220	10	10	2	0	0	10	100	1	100	1	100	1	36F
KRU	1	1				2P-434	1035 (25ft); 1115 (15ft); **1215 (35ft)** no dt	25	75	35	2	75	100	0	100	1	0		95	1	36F
KRU	1	1				KRU 1E-1 (1E-01)	**2560 (15ft)** incomplete logsuite	980	15	15	3	0	0	15	30	2	30	1	30	1	52F
KRU	0	0				MELTWATER_N_1	1000 (30ft); 1055 (45ft no GR); **1930 (50ft)**	20	125	50	3	75	60	50	30	1	30	2	100	2	51F
KRU	1	1	none[4]			KRU C-4 (1C-04)	none		0	0				0	25	1	25	1	25	1	
KRU	1	1	none[4]			KRU C-6 (1C-06)	none (almost no log)							0	2		2		2		
KRU	1	1				MP_1_17-11-11	none		0	0				0	25	1	25	1	25	1	
	1: yes, 0: no		[1]digits 1J-14, see W_SAK_PLT_8I																		
			[2]see 1Q-16 & 1Q_09			has PUBLIC mudlog															
			[3]see 1D-08 & 1D-04																		
			[4]see 1C-05																		
				A: STRONG muglog show																	
				B: fair mudlog show																	
				C: weak mudlog show																	
				D: no mudlog show																	

Figure 7: Ranking matrix for Kuparuk River Unit with top four candidates highlighted

Access		mudlog		FINAL RANKING	Well	DAS comments	depth below calc'd PF			LOG CONF	Confidence: Calculated Permafrost base			Wireline logs						Est'mtd (at 2F/100ft)
gravel pad	road	have or none	score & comments				[feet]	total [ft]	thickest [ft]	score	GH <200ft below PF	% <200ft below PF	GH >200ft below PF	GR %	GR quality	Sonic %	Sonic quality	Resistivity %	Resistivity quality	temp at "blue" GH
1	1	1	A	1	**W_KUP_3-11-11**	1835 (40ft); 1980 (50ft); **2155(45ft)**	120	135	50	1	40	30	95	100	2	100	1	100	1	42F
1	0	1	A		**NW_EILEEN_ST_2**	1815 (30ft); 1940 (20ft); **2100 (70ft)**	100	120	70	1	30	25	90	100	1	100	1	100	1	40F
1	1	1	C		**WETW**	1770 (40ft); 2925 (35ft); **1910 (60ft ALMOST)** ?dt	60	135	60	1	75	56	60	100	1	100	1	100	1	57F
1	1	1	D		**TW-C**	1810 (40ft); **2200 (50ft)** ?dt	40	90	50	1	40	44	50	100	1	100	1	100	1	40F
1	1	none			V-107	2690 (15ft); **2880 (20ft)** ?dt	985	35	20	1	0	0	35	100	1	100	1	100	1	51F
1	1				3-10-12	1745 (50ft); **1840** (60ft w/H2O below)	0	110	60	1	110	100	0	100	1	100	1	100	1	34F
1	1				Q-03	1815 (60ft) PF pick?	5	60	60	1	60	100	0	100	1	100	1	100	1	32F
1	1				S-03	**1795 (70ft thn-bdd)**; ~~2560 (35ft)~~ ?dt CSG PT	20	70	70	1	70	100	0	100	1	100	1	100	1	33F
0	1	none			NEW4-01 (I-PAD)	1600 (40ft); 1820 (15ft); **1980 (70ft)**; 2075 (35ft); 2610 (30ft) ?dt	0	180	70	2	40	22	140	100	1	100	1	100	1	40F
1	1	none[1]	A	2	**L-106**	1815 (30ft); 1955 (50ft); 2140 (30ft); **2200 (45ft)** no dt (but TSC has it??)	130	155	50	2	30	19	125	100	1	60	1	100	1	43F
1	1	none[1]			L-116	**2415 (80ft);** 2735 (45ft); incomplete lgs, ?DT	730	125	80	2	0	0	125	60	1	60	1	50	1	46F
1	1	none[2]			V-100	2570 (50ft no dt Rt); 2895 (20ft)	850	70	50	2	0	0	70	50	1	40	1	40	2	52F
1	0	none			HIGHLAND_1	**2305 (10ft)** + seven other thin zones	360	60	10	2	0	0	60	100	1	100	1	100	1	43F
1	1	none[2]			V-105	2780 (25ft); **2845 (30ft)**; incomplete logs	1075	55	30	2	0	0	55	35	1	29	1	30	1	56F
1	0	1	A		**NW_EILEEN_ST_1**	2140 (15ft); **2160 (20ft)** + two 10ft sands shallower	410	55	20	2	0	0	55	80	1	80	2	80	1	42F
~~1~~ 0	~~1~~ 0	1	A	3 (200ft off road)	**NWE2-01**	1715 (25ft); 1875 (15ft); **1955 (50ft)** NO DT	35	90	50	2	40	44	50	100	1	50	2	100	1	38F
1	1	1	A	4	**KUP_ST_7-11-12**	1830 (25ft); 2280 (25ft); **2790 (25ft)**	70	75	25	2	25	33	50	90	2	90	2	100	1	53F
1	1	none[1]			L-114	**2715 (45ft)** ?dt (off depth)	1020	45	45	2	0	0	45	65	1	45	1	45	1	52F
0	0	1	A		**BEECHY_PT_ST_1**	**2595 (15ft)**; 2760 (10ft); 2785 (10ft w/water beneath); 3285 (10ft) ?dt	810	45	15	2	0	0	45	55	1	55	1	55	1	48F
1	1	1	A	5	**CHEV_18-11-12**	**2785 (40ft)** ?dt	1040	40	40	2	0	0	40	50	1	50	2	50	1	53F
1	1	none[2]			V-106	**2615 (20ft)**; 2670 (10ft); thick uphole SS	960	30	20	2	0	0	30	30	1	20	2	20	1	51F
1	1	1	A	6	**NWE1-01 (L-pad)**	1670 (15ft); 1745 (15ft); **2175 (30ft)** NO DT	35	60	30	2	30	50	30	100	1	0		100	1	43F
1	1	1 (no gas curve)			KUP_ST_1	1770 (25ft); 1870 (45ft); **2890 (30ft)** ?dt	5	90	45	2	60	67	30	95	2	95	2	85	1	54F
1	1				KUP_9-11-12	2855 (10ft); **3290 (15ft)**	1100	25	15	2	0	0	25	50	1	50	2	100	1	62F
0	0	none[2]			PBU SHB V-200 (V-200)	**2205 (15ft)**	430	15	15	2	0	0	15	100	1	15	2	100	1	40F
1	0				SOCAL_33-29E	**2620 (15FT)** INCOMPLETE LOGS	860	15	15	2	0	0	15	100	2	50	1	30	1	50F
1	1	none[2]			V-201	1665 (25ft no GR/dt); **2680 (10ft)**	10	35	25	2	25	71	10	30	1	20	1	100	1	53F
1	1				15-11-12	**2865 (5ft) i**ncomplete logs	1060	5	5	2	0	0	5	80	1	80	2	80	1	54F
1	0				N_KUP_26-12-12	**1830 (35ft)** ?dt	30	35	35	2	35	100	0	100	1	100	1	100	1	33F
1	0				WENOMW01	**1775 (50ft)** ++ POOR LOGS	15!!	50	50	2	50	100	0	100	2	100	2	100	2	33F
1	1				PBU SB-01 (S-200PB1)	**3145 (35ft)** POOR LOGS	1375	35	35	3	0	0	35	100	1	20	2	100	2	59F
1: yes, 0: no		[1]see L-101 & NWE1-01																		
		[2]NOTHING on V-pad			**has mudlog**															
			A: STRONG muglog show																	
			B: fair mudlog show																	
			C: weak mudlog show																	
			D: no mudlog show																	

Figure 8: Ranking matrix for Prudhoe Bay Unit with top four candidates highlighted

UNIT	COP WI	Access		mudlog		Well	DAS comments	depth below calc'd PF			LOG CONF	Confidence: Calculated Permafrost base			Wireline logs						Est'mtd (at 2F/100ft)
		gravel		have or	score &			[feet]				GH <200ft	% <200ft	GH >200ft	GR		Sonic		Resistivity		temp at
		pad	road	none	comments				total [ft]	thickest [ft]	score	below PF	below PF	below PF	%	quality	%	quality	%	quality	"blue" GH
MPU	**0% MPU**	0	0	pdf	A	**MT_ELBERT_1**	1875 (10ft); 1915 (10ft); 2020 (40ft); **2140 (40ft over water)** PF pick?	100	100	40	1	20	20	**80**	100	1	100	1	100	1	40F
OU	**0% OU**	0	0	none		COLV_DELTA_3	1335 (30ft); 1380 (20ft); 1460 (30ft); **1585 (45ft)** PF pick?	20	125	45	1	80	64	**45**	100	1	100	1	100	1	37F
OU	**0% OU**	0	0	1	C	**COLV_DELTA_1**	**1290** (2x25ft + 2x20ft + 4x10ft) PF pick?	10	130	25	1	110	85	**20**	90	1	100	1	100	1	36F
CRU		0	0			FIORD_2	**1030 (40ft)** plus many 5-10ft stringers	10	40	40	1	40	100	0	100	1	100	1	100	1	33F
MPU		1	1			MPU_C-01	none		0	0	1			0	100	1	100	2	100	2	
MPU		1	1			MPU_S-15	**1790 (35ft)** ?dt	140	35	35	1	35	100	0	100	1	100	1	100	1	35F
MPU	**0% MPU**	1	1	none		MPU_K-25	2245 (10ft); **2645 (65ft)**; 2850 (10ft); 2870 (10ft); 3045 (25ft); ?dt	520	115	65	2	0	0	115	100	1	0		100	1	51F
MPU	**0% MPU**	1	0	1	B	**W_SAK_25**	1630 (130ft); **1915 (65ft)**; 2090 (25ft) PF pick?	0	220	130	2	130	59	90	100	1	100	1	100	1	38F
MPU		1	1	none		MPU_K-38	2230 (20ft); **2725 (40ft) w/H2O below?**; 3045 (10ft) no dt	520	70	40	2	0	0	70	100	1	0		100	1	52F
MPU		0	0			CASCADE_1	2870 (10ft); 2990 (10ft); **3080 (25ft)** ?dt incomplete logsuite	1140	45	25	2	0	0	45	30	1	30	2	30	1	59F
CRU	**CRU 78%**	1	1	1	C	**NANUQ_3**	990 (10ft); 1010 (15ft); 1155 (15ft); **1315 (20ft)**	20	60	20	2	20	33	40	100	1	0		100	1	42F
CRU		0	0			NEVE_1	840 (20ft); 1020 (2x10ft); **1090 (10ft)** no dt, just below Rt cutoff: THIN GHSZ	30	50	20	2	20	40	30	100	1	0		100	1	38F
MPU		1	1			PRUDHOE_1	2700 (10ft); **2715 (10ft)** SKINNY: INCOMPLETE LOGS	1020	20	10	2	0	0	20	50	1	50	1	50	1	53F
MPU		1	1			MPU_A-01	1905 (20ft); **1995 (2x10ft)** WHOPPER in PF	220	40	20	2	20	50	20	100	1	10	2	100	1	38F
MPU		1	1			MPU_D-01	**2015 (2x10ft)** ?dt	290	20	10	2	0	0	20	100	1	100	1	100	1	38F
MPU		1	1			MPU_B-02	1900 (10ft); **2100 (10ft w/water underneath)**	190	20	10	2	10	50	10	100	1	100	1	100	2	39F
CRU		0	0			NANUK_2	970 (10ft); 985 (10ft); 1000 (10ft); **1115 (10ft)** NO dt	70	40	10	2	30	75	10	100	1	10	1	100	1	37F
MPU		1	1			MPU_B-01	**1900 (10ft)**	190	10	10	2	10	100	0	100	1	100	2	100	1	36F
CRU		0	0			FIORD_1	1100 (50ft); 1060 (20ft); **1185 (20ft)** plus 2x10ft	65	110	50	2	110	100	0	90	2	0		90	1	34F
OU		0	0			COLV_DELTA_2	1365 (20ft); **1400 (20ft)** PF pick?	10	40	20	2	40	100	0	100	1	100	1	100	1	33F
OU		0	0			KALUBIK_1	1365 (20ft); **1400 (20ft thn-bdd)**	10	40	20	2	40	100	0	75	1	75	1	100	1	33F
CRU		0	1			NANUK_1	995 (10ft); **1095 (10ft)** QUESTIONABLE: no GR of dt; thin GHSZ	120	20	10	3	10	50	10	10	1	10	1	100	1	34F
MPU		1	1			KAVEARAK_32-25	**2160 (10ft)** only Rt	445	10	10	3	0	0	10	50	2	50	1	100	1	41F
MPU		0	0			MILNE_PT_18-01	none		0	0				0	80	1	100	2	100	1	
MPU: Milne Point Unit																					
OU: Ooguruk Unit						**has mudlog**															
CRU: Colville River Unit																					
		1: yes, 0: no			A: STRONG muglog show																
					B: fair mudlog show																
					C: weak mudlog show																
					D: no mudlog show																

Figure 9: Ranking matrix for non-exploratory "Other areas" with top candidate highlighted

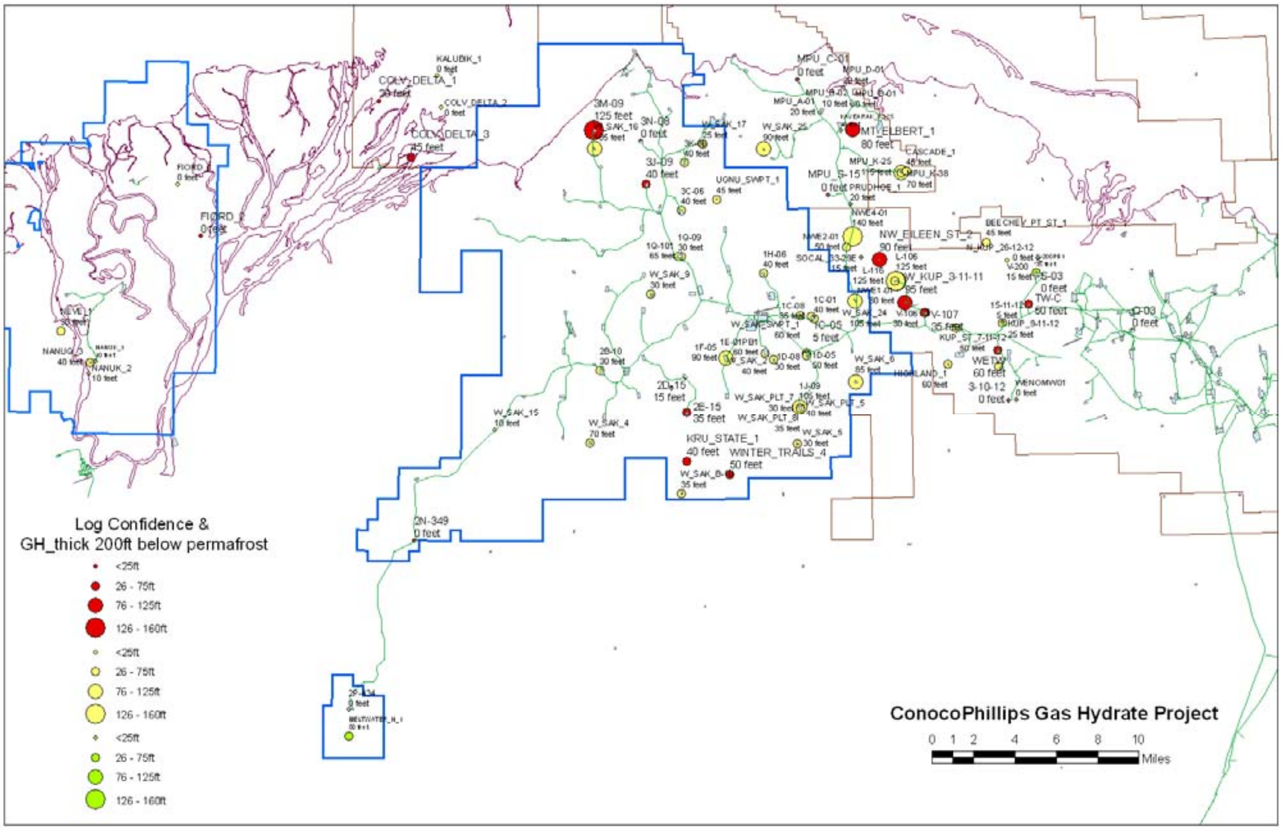

Figure 10: Log confidence and possible gas hydrate thickness

When log confidence and possible hydrate thickness are combined with mudlog show quality (see Figure 11), the western Prudhoe Bay Unit and eastern Kuparuk River Unit are even more favorable.

***Conclusions*:**

Figure 12 summarizes the Site Selection process graphically and shows the top nine candidates (top four in PBU, top four in KRU, and top "other areas" candidate.) Proprietary seismic data has been reviewed for the top candidates in the western Prudhoe/eastern Kuparuk area. The best four Prudhoe Bay Unit candidates (W Kup 3-11-11, L-106, NWE2-01, and Kup St 7-11-12) have high confidence of gas hydrate occurrence, integrating both subsurface and seismic evidence. Only the top Kuparuk River Unit candidate (W Sak 24) has confidence as high as Kup St 7-11-12, which has lower confidence than the other three PBU candidates. Each of the top three PBU candidates (W Kup 3-11-11, L-106, and NWE2-01) has two to three interpreted gas-hydrate saturated sandstones. Kup St 7-11-12 and W Sak 24 each have a single possible hydrate-bearing sandstone target.

Concurrence with these conclusions was reached between COP and DOE/NETL staff, as well as external (USGS and MMS) attendees, at the April 3rd Site Selection workshop. The five top sites have acceptable CO2-CH4 exchange field trial parameters. Selection of a single site for fieldtrial requires additional seismic "due diligence." Fluid substitution and amplitude-versus-offset (AVO) modeling is underway and prospect-scale seismic mapping is ongoing. Proprietary seismic data cannot and will not be disclosed to non-owners without permission of co-owners. The top five locations (summarized in Figures 13-17) have unique surface conditions and lease ownership.

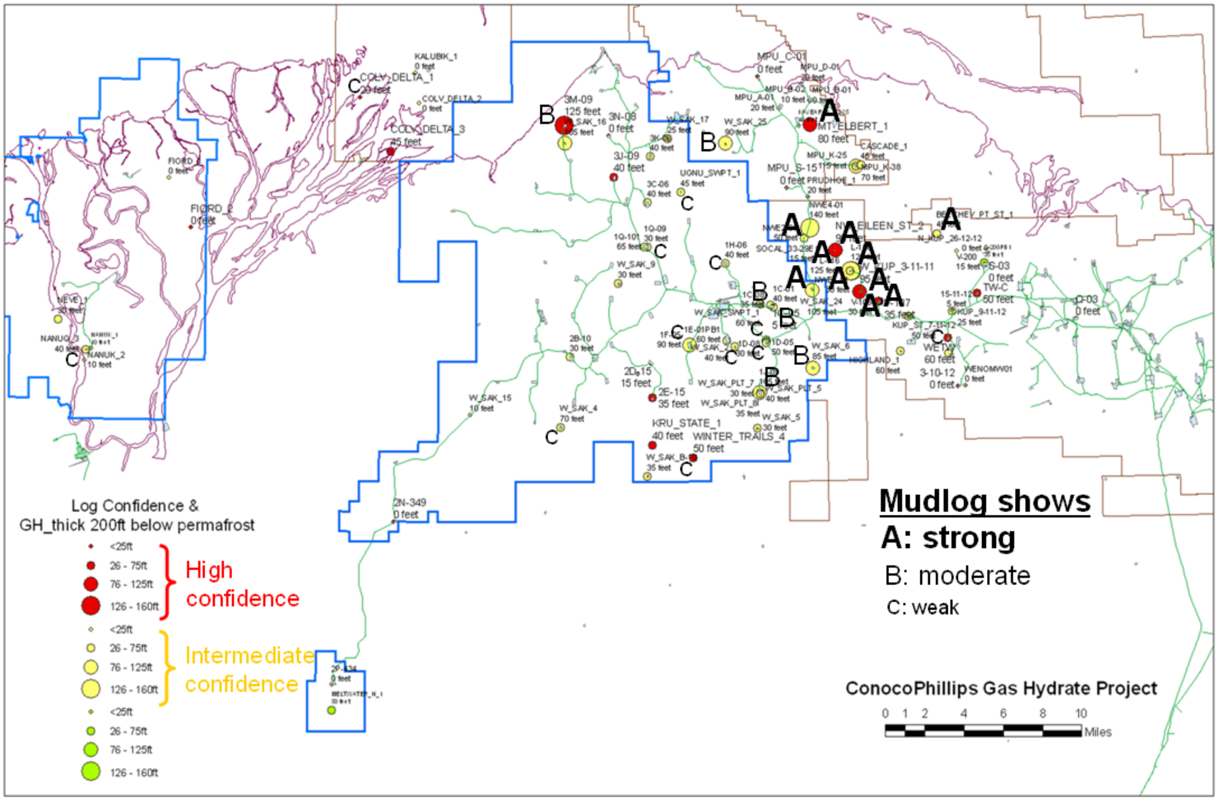

Figure 11: Log confidence, possible gas hydrate thickness, and mudlog show quality

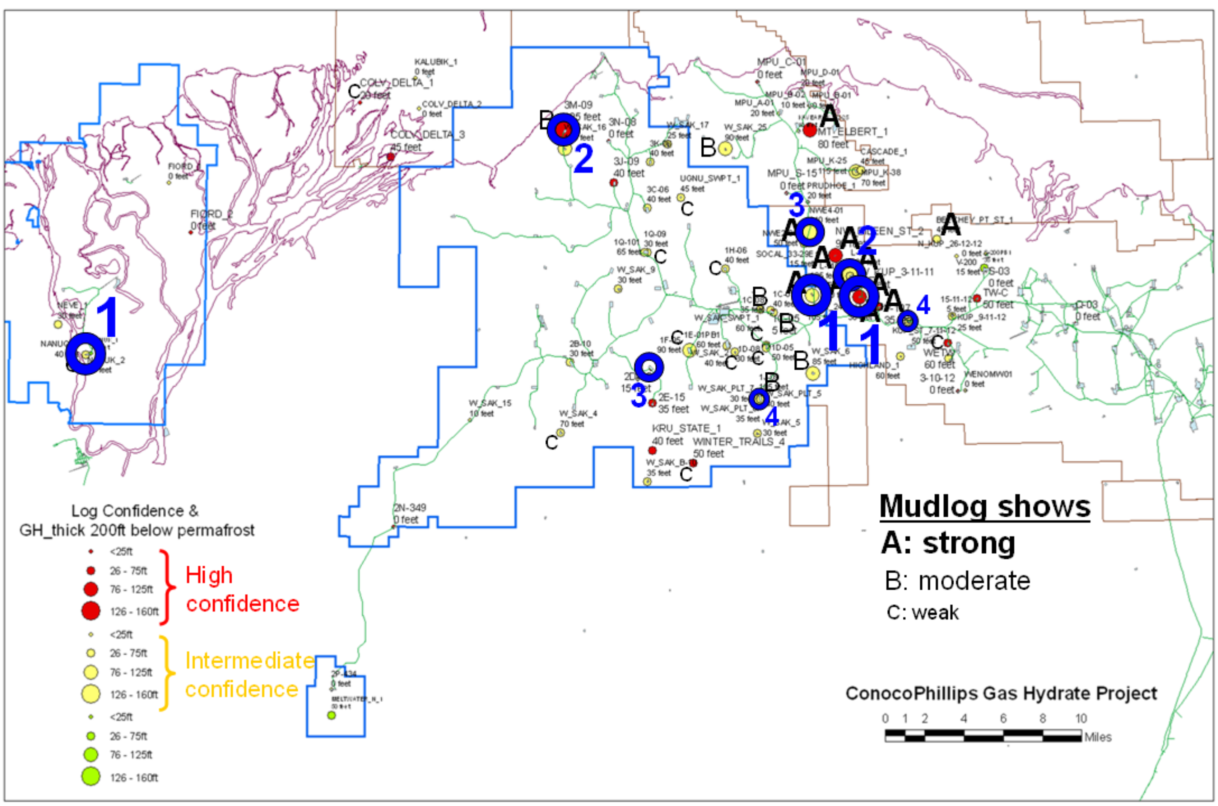

Figure 12: Top Nine Candidate Locations for Exchange Field trial

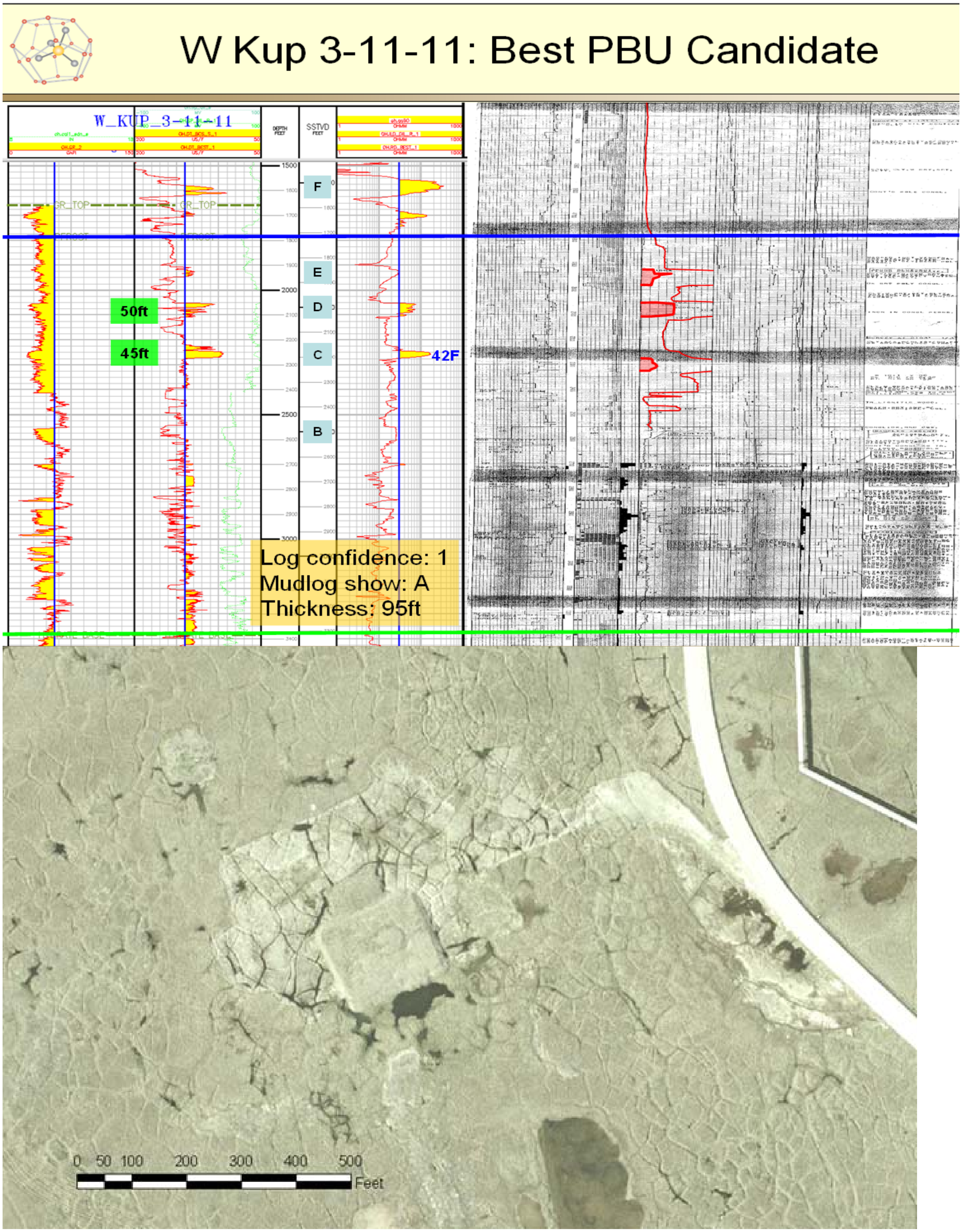

Figure 13: W Kup 3-11-11 wireline logs, mudlog, and aerial photograph

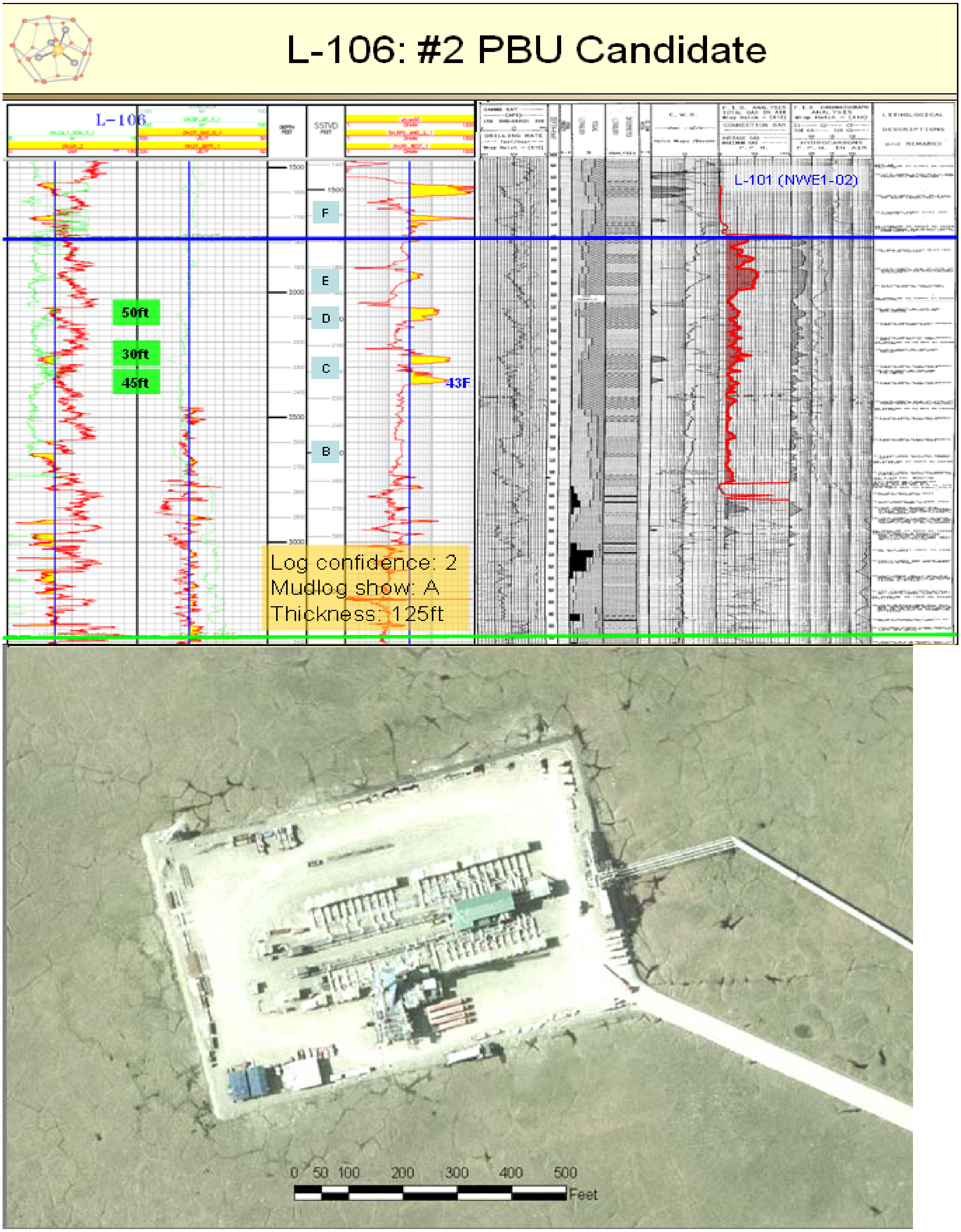

Figure 14: L-106 wireline logs, mudlog, and aerial photograph

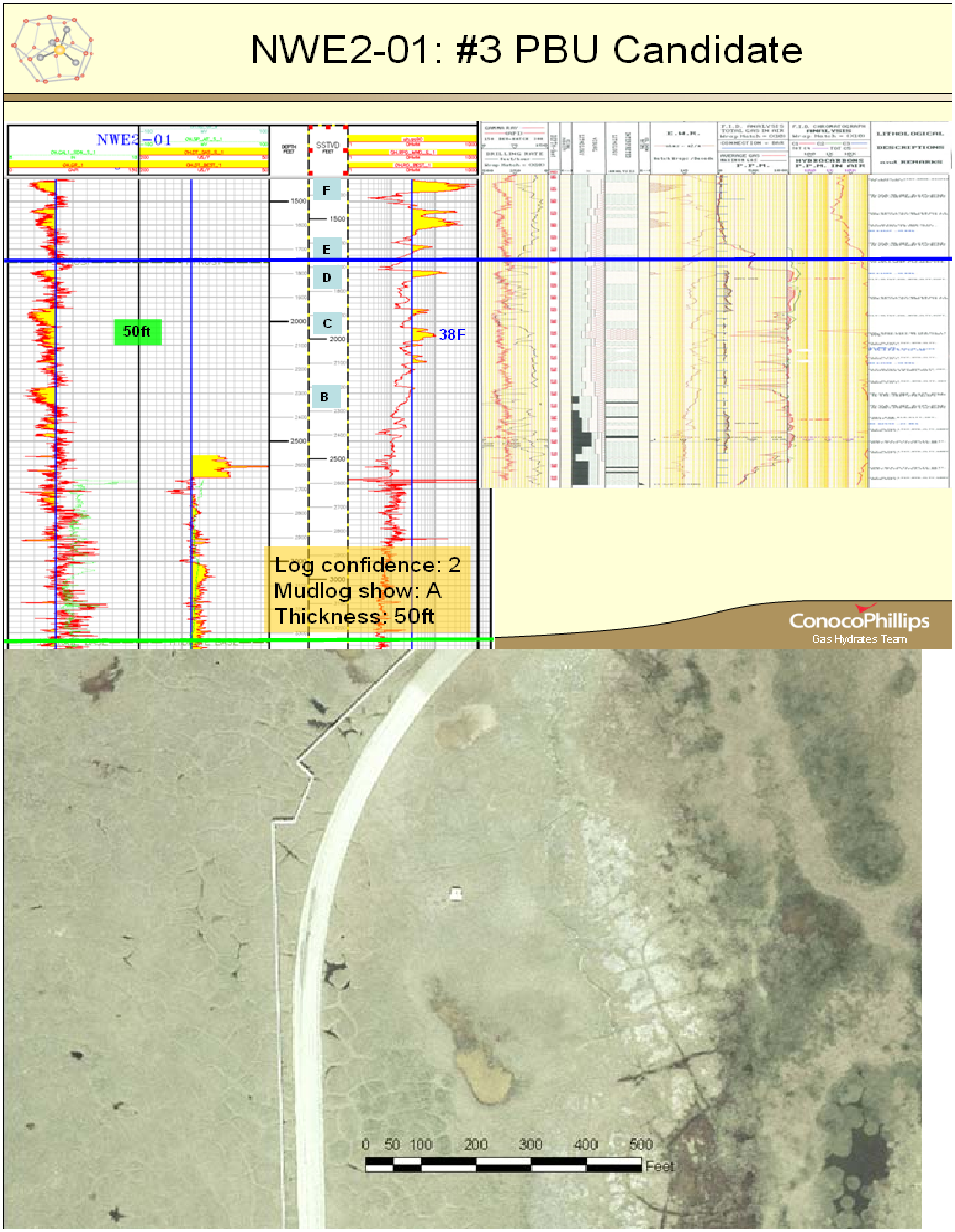

Figure 15: NWE2-01 wireline logs, mudlog, and aerial photograph

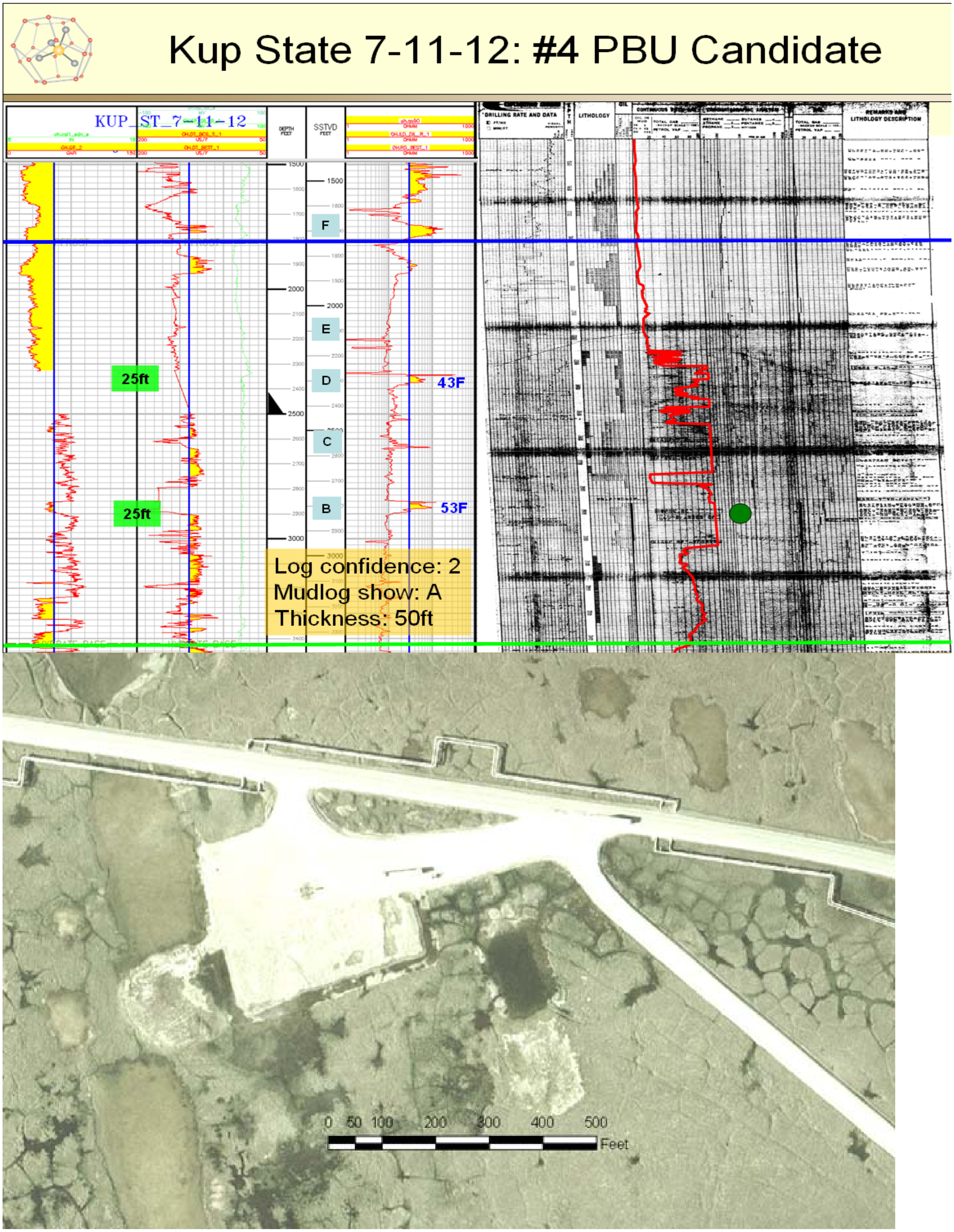

Figure 16: Kup St 7-11-12 wireline logs, mudlog, and aerial photograph

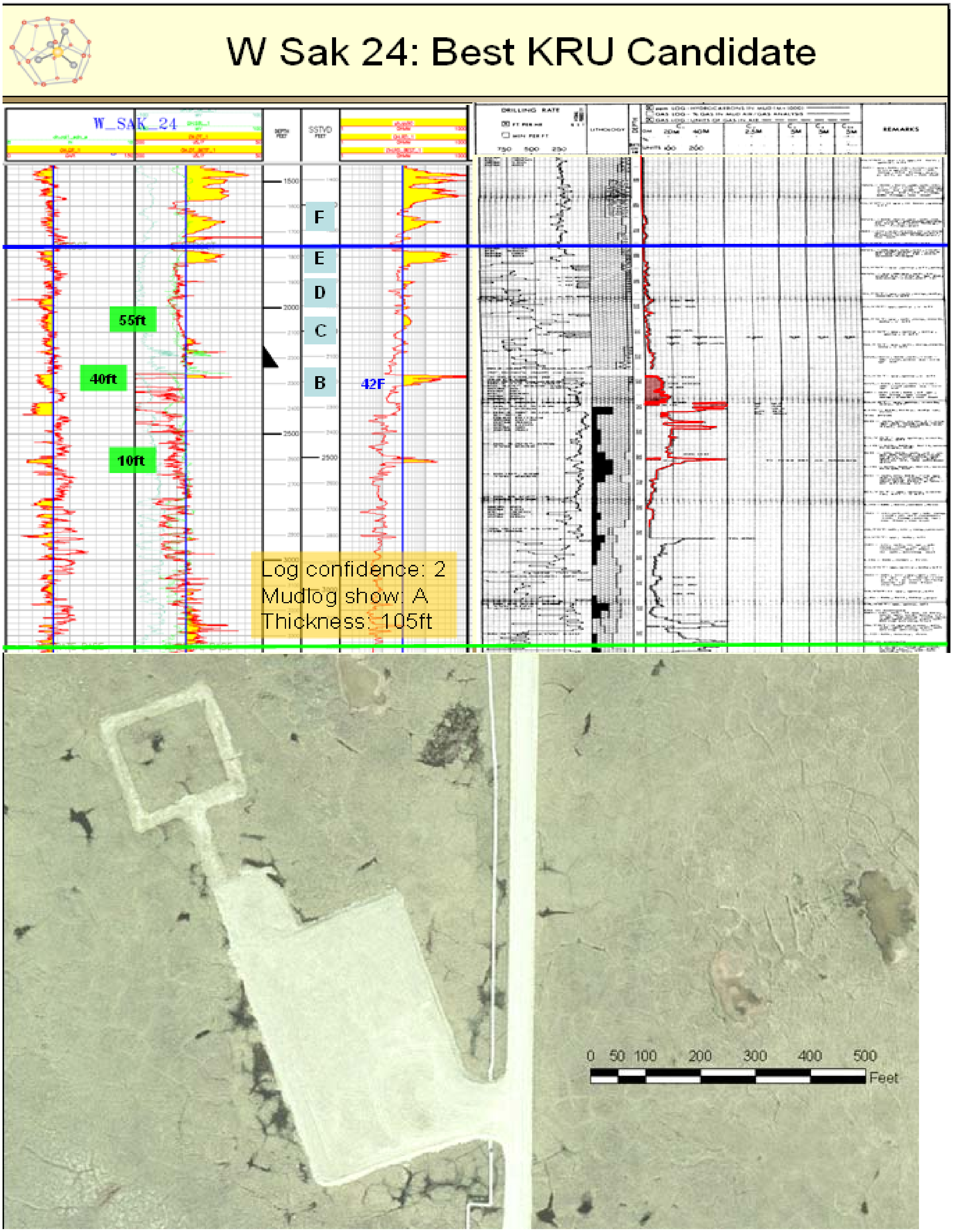

Figure 17: W Sak 24 wireline logs, mudlog, and aerial photograph

Cost Status

Expenses incurred during this six-month Phase 1 of the project were below the Baseline Cost Plan as shown in Exhibit 4. There were no Federal expenses forecast in the Baseline Cost Plan and no Federal expenses were incurred. The Non-Federal Incurred Cost was below Baseline Cost Plan due to fewer hours required by ConocoPhillips' Alaska Business Unit and Technology personnel in this early stage of the project.

Exhibit 4 - Cost Plan/Status

COST PLAN/STATUS									
Project Phase ==>	Phase 1, Site Ident.		Phase 2, Field Test Planning			Phase 3, Field Test			
Baseline Reporting Quarter ==>	Q408	Q109	Q209	Q309	Q409	Q110	Q210	Q310	Q410
BASELINE COST PLAN									
Federal Share	0	0	60000	1450000	0	8315000	1300000	630000	0
Non-Federal Share	325100	499172	390875	333875	170699	361135	353410	348523	151351
Total Planned	325100	499172	450875	1783875	170699	8676135	1653410	978523	151351
Cumulative Baseline Cost	325100	824272	1275147	3059022	3229721	11905856	13559266	14537789	14689140
ACTUAL INCURRED COSTS									
Federal Share	0	0							
Non-Federal Share	121012	186099							
Total Incurred Cost	121012	186099							
Cumulative Incurred Cost	121012	307111							
VARIANCE									
Federal Share	0	0							
Non-Federal Share	-204088	-313073							
Total Variance	-204088	-313073							
Cumulative Variance	-204088	-517161							

Milestone Status

The Milestone Status Report is attached as Exhibit 5. The first milestone, Field Trial Site Selected was completed on April 3rd at the Site Selection Workshop. Work has begun on the next three milestones, Partner Negotiations, Identifying Synergies with the DOE/BP Project, and Well Test Design.

Exhibit 5 – Milestone Status Report

MILESTONE STATUS REPORT

#	Task/Subtask Description	Planned Start Date	Planned End Date	Actual Start Date	Actual End Date	Comments
	Field trial site selected	1-Oct-08	31-Mar-09	1-Oct-08	3-Apr-09	Top sites identified
	Partner negotiations completed	15-Feb-09	31-Mar-09	17-Mar-09		Ongoing
	Synergies with DOE-BP project identified	1-Mar-09	31-Mar-09	30-Mar-09		Ongoing
	Well test designed and planned	1-Apr-09	30-Sep-09	10-Mar-09		Work started in March
	Well and reservoir performance predicted	1-Jul-09	31-Dec-09			
	Field testing completed	1-Jan-10	31-Dec-10			
	Injection and production monitoring completed	1-Apr-10	30-Apr-10			
	Well abandonment complete	1-May-10	31-Dec-10			

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