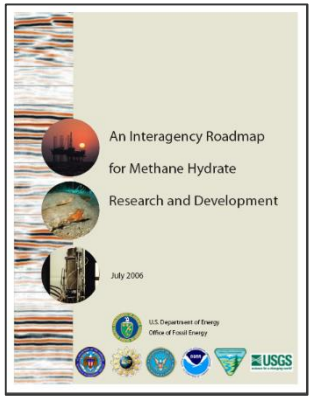
GH Testing in Alaska

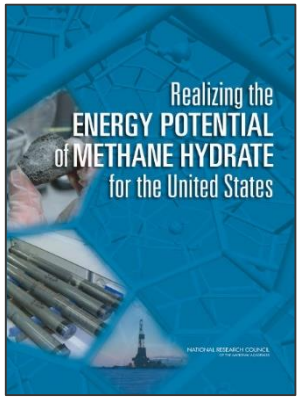
MHFAC Meeting, October 19, 2018

Doe-BPXA-USGS Mt Elbert Test Site, Milne Point Unit, 2007. Photo by R. Boswell

Alaska Testing: A Long-standing Priority

Internal, Interagency, External Oversight, Congressional, Programmatic





The Methane Hydrate Advisory Committee

Advisory Committee to The Secretary of Energy

May 21, 2014

The Honorable Ernest J. Moniz
Secretary of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585

Dear Mr. Secretary:

The Methane Hydrate Advisory Committee (MHAC) is composed of international experts in methane hydrate research from academia and industry. Our charge is to provide you with guidance to sustain and improve the Methane Hydrates R&D Program in the U.S. Recent advancements have identified ways of exploring for and producing from high concentration methane hydrate deposits. Our primary priority must now be to demonstrate, through a long term production test, the technical feasibility of producing methane hydrates.

We recommend the following focused 10-year investment.

1) **Perform a production test on land in the Arctic within 4 years.** The State of Alaska has temporarily set aside unleased onshore state lands just north of the Prudhoe Bay Unit for a potential methane hydrate te… a long term methane hydrate …

Department of Energy
Washington, DC 20585
December 21, 2016

Ms. Janet Weiss
Regional President
BP Exploration (Alaska) Inc.
900 E. Benson Blvd.
Anchorage, Alaska 99508

RE: Gas Hydrate Research and Production Testing on the Alaska North Slope

Dear Ms. Weiss:

I would like to express my appreciation for the sharing of proprietary data that BP Exploration (Alaska) (BPXA) and the other Prudhoe Bay Unit (PBU) working interest owners agreed to this past June. This has allowed the Department of Energy (DOE), U.S. Geological Survey (USGS) and industry partner Japan Oil, Gas, and Metals National Corporation (JOGMEC) to prepare a conceptual draft work plan for gas hydrate production testing within the PBU.

The DOE, USGS, and BPXA have a long history of collaboration in the evaluation of gas hydrate resources in Alaska. An extended-duration scientific production test is warranted to better understand the nature of gas hydrate resources. Toward this end, DOE has entered into separate Memoranda of Understanding with the Alaska DNR and with JOGMEC to evaluate opportunities for conducting such a test. A conceptual draft work plan has been developed which indicates that the optimal place to conduct the desired gas hydrate field testing is most likely within the west end of the Prudhoe Bay Unit. Specifically, we have identified the gravel pad known as the Kuparuk State 7-11-12 pad. We believe this location offers the best potential balance of access to infrastructure and minimized impact on ongoing unit operations. Our plan includes an initial stratigraphic test well (with conventional logging program only), followed, if successful, by a production test well, scientific coring programs, and installation of one or more close-offset monitoring wells.

A long-term production test is necessary to advance the scientific understanding of gas hydrates as they occur in nature so that their resource potential can be fully understood. DOE fully supports this plan and hereby respectfully requests that BPXA (as Operator of the PBU) and the other PBU working interest owners give full consideration to the plan as briefly discussed herein. If you would like to discuss this topic, please feel free to contact me at 202-586-6660.

Sincerely,

Christopher A. Smith
Assistant Secretary
Office of Fossil Energy

STATE OF ALASKA

SARAH PALIN, GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
OFFICE OF THE COMMISSIONER

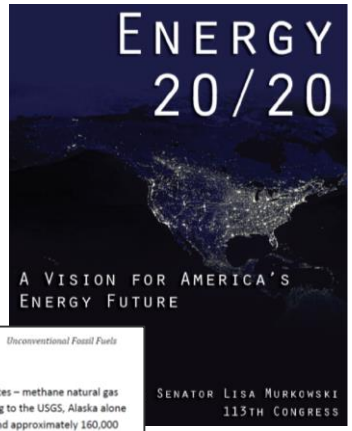
550 WEST 7TH AVENUE, SUITE 1400
ANCHORAGE, ALASKA 99501-3650
PHONE: (907) 269-8431
FAX: (907) 269-8918

January 30, 2009

Dr. Ray Boswell
Manager, Gas Hydrates R&D Programs
U.S. Department of Energy, National Energy Technology Laboratory
3610 Collins Ferry Road
Morgantown, WV 26507

Dear Dr. Boswell:

The State of Alaska Department of Natural Resources would like to confirm our commitment and show our support for the important leadership role the federal government is providing concerning permafrost related gas hydrates research on the North Slope of Alaska. This work, led by the U.S. Department of Energy (DOE) and the U.S. Geological Survey (USGS) in collaboration with numerous universities and industry partners, is some of the most critical energy-related research being undertaken around the globe. If viable development and production scenarios for gas



Producing More — Unconventional Fossil Fuels

METHANE HYDRATES AND OTHER UNCONVENTIONAL GAS RESOURCES

The U.S. contains an estimated 200,000 trillion cubic feet (TCF) of methane hydrates – methane natural gas locked in solid, ice-like structures, underground or under the sea floor.[36] According to the USGS, Alaska alone contains between 560 and 600 trillion cubic feet of methane hydrate onshore[37] and approximately 160,000 TCF offshore.[38] Once safely unlocked, Alaska's methane hydrate resources could power America for nearly 1,000 years at current rates of gas consumption, according to the Alaska Division of Geological and Geophysical Surveys (ADGGS).[39] Important steps we need to take to access these resources include:

- Expedite research on methane hydrate well flows to prove that methane will continue to "flow" to the surface after drilling efforts. Increase funding for environmental reviews of the effects of liberating methane hydrates, the resulting land impacts, and for research already underway by the DOE National Energy Technology Laboratory (NETL).

Memorandum of Understanding
Alaska Department of Natural Resources
and
U.S. Department of Energy, Office of Fossil Energy
Energy Research, Methane Hydrates, and Other Unconventional Resources in Alaska

A Memorandum of Understanding (MOU) between the Alaska Department of Natural Resources (Alaska DNR) and the United States Department of Energy, Office of Fossil Energy, (DOE/FE) regarding energy development and unconventional resource research and demonstration in Alaska's Arctic.

Whereas, Alaska DNR's mission is to responsibly develop Alaska's resources by making them available for maximum use and benefit consistent with the public interest.

Whereas, DOE/FE is responsible for managing the Department of Energy's fossil energy research and development programs and advising the Secretary of Energy on all matters related to our nation's fossil energy resources, including research and demonstration of methane hydrates, viscous oil, and other potential unconventional resources.

Prior Alaska Field Programs

Conducted in Partnership with Industry and Academia

"Mt. Elbert" (2007) with BP Exploration Alaska, Inc

- Safe/efficient scientific field program within industry operations area
- Extensive wireline, core, and pressure test data

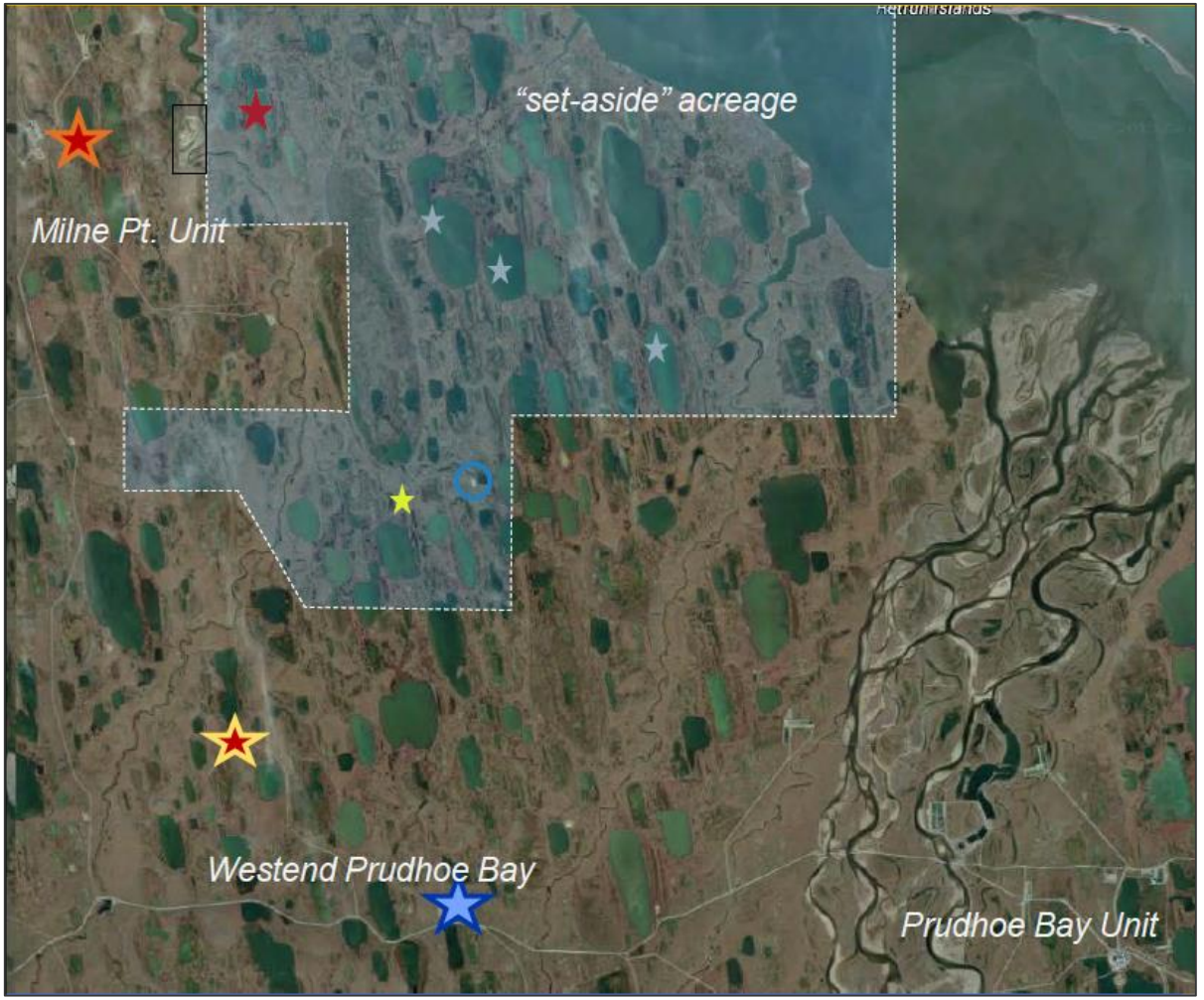
"Iġnik Sikumi" (2011-2012) with ConocoPhillips and JOGMEC

- Short term (days) field test of CO_2 injection
- Mechanical stability achieved through standard engineering controls.
- Demonstration of the issues that attend any well shut-in.
- Flow assurance and wellbore maintenance through chemical intervention
- Confirmation of the superiority of depressurization with respect to production rate.

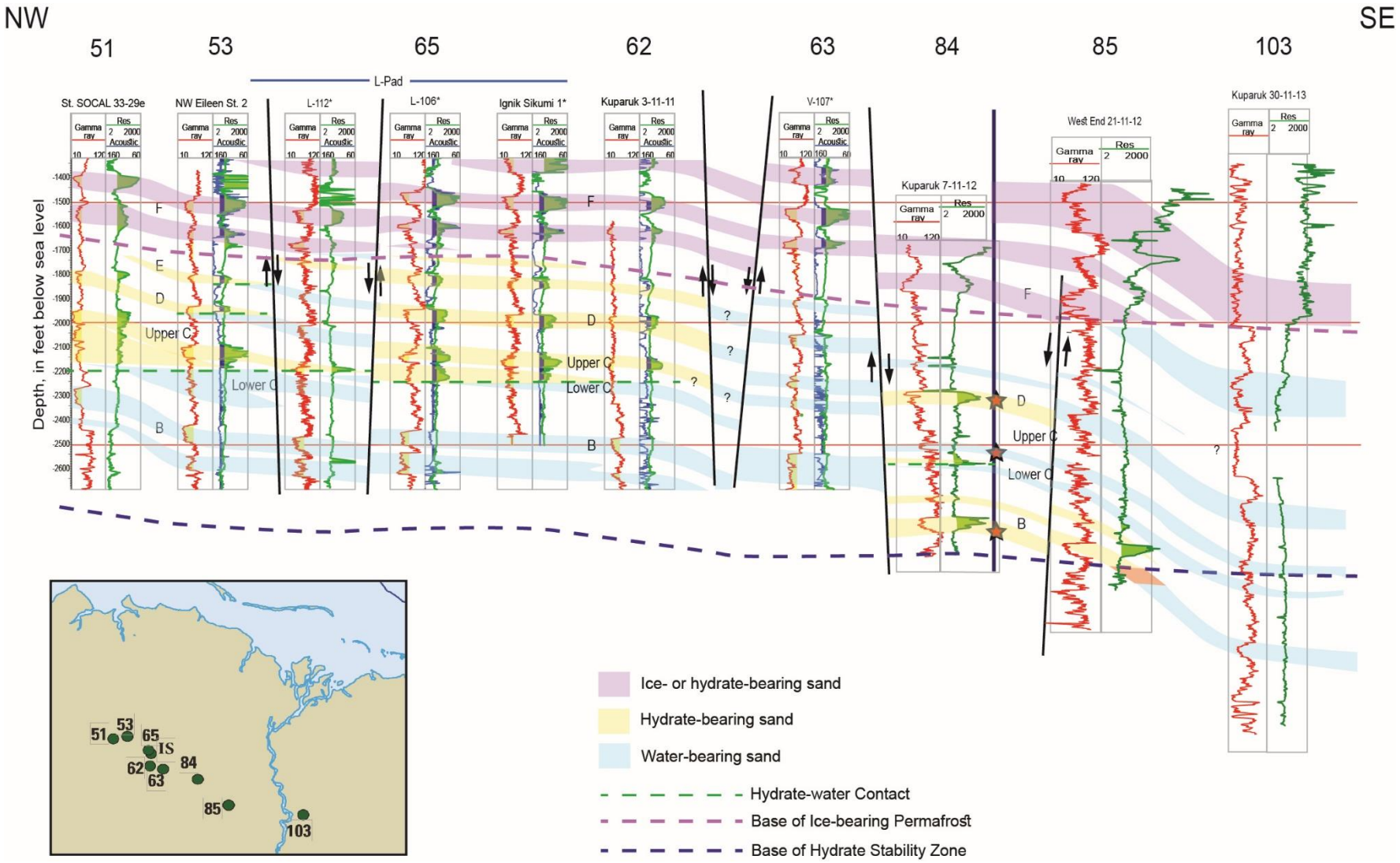
Review of Sites on Unleased Land

Potential Recognized, but….

- **Remote:** High logistics cost (roads, pads)
- **Remote:** High operational risk (lack of infrastructure)
- **Unleased:** Uncertain regulatory environment.
- **Undrilled**: High geologic risk (limited indications of GH and free gas)

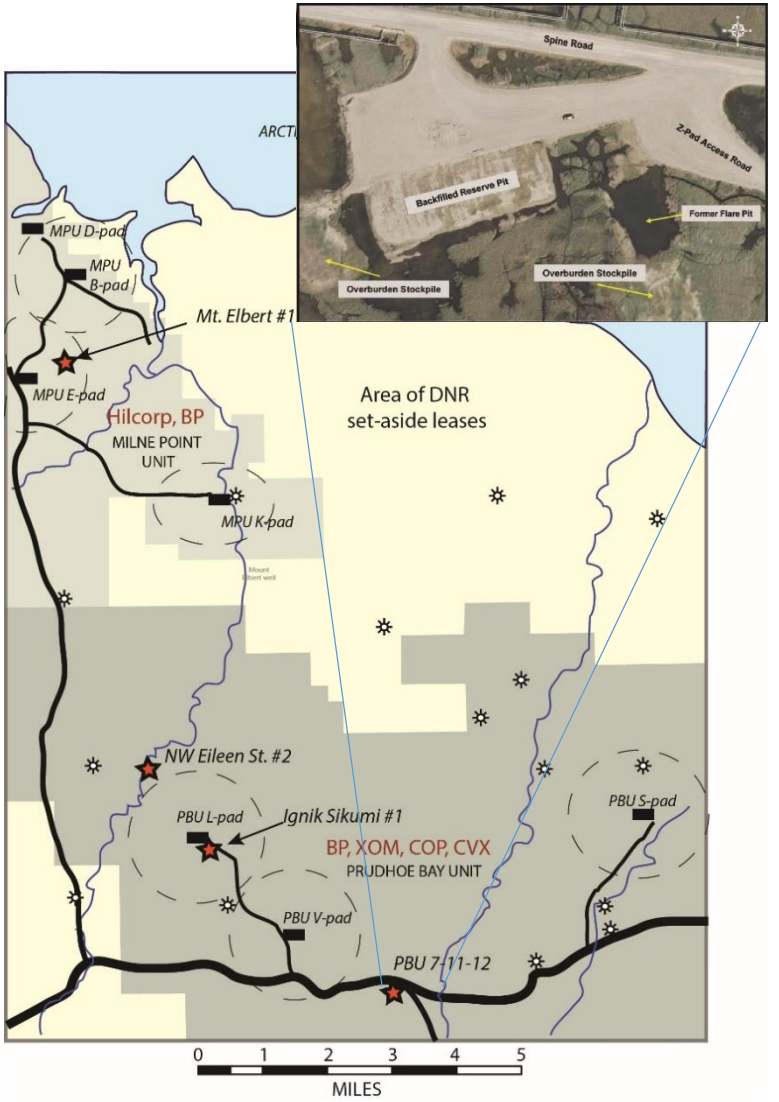


Review of Sites: Westend PBU



Where We Are – Pt 1

- 2013: AK DNR and DOE sign an MoU. DNR sets select leases aside to enable their evaluation.
- Initial evaluation indicated high costs and elevated operational and geological risks for operations outside established infrastructure.
- 2015: AK DNR conducts scoping studies to refine list of greater PBU test site opportunities.
- DNR/DOE re-engage the PBU companies. WIOs approve our review of proprietary data for a site in the Westend PBU.
- 2015: A three-well science plan is drafted featuring a field program designed to maximize science and minimize impact on existing operations.



Consensus Production Test Concept

The Site:

- Geologically well-characterized (complimented as needed by project strat/sci test wells)
- Hydraulic isolation (away from sources of free gas or water)
- Sufficient reservoir temperature (at least 5C) and intrinsic reservoir quality
- Multiple reservoir zones – operational risk mitigation and expanded science options
- Well location that allows continual operations of 6 mo (minimum); optimally18-24 mo.
- Location that minimizes interference with ongoing operations
- Non-disruptive gas/water handling
- Minimal complexity – avoid use of unproven technologies

7-11-12 site meets these criteria: Ongoing G&G review to confirm

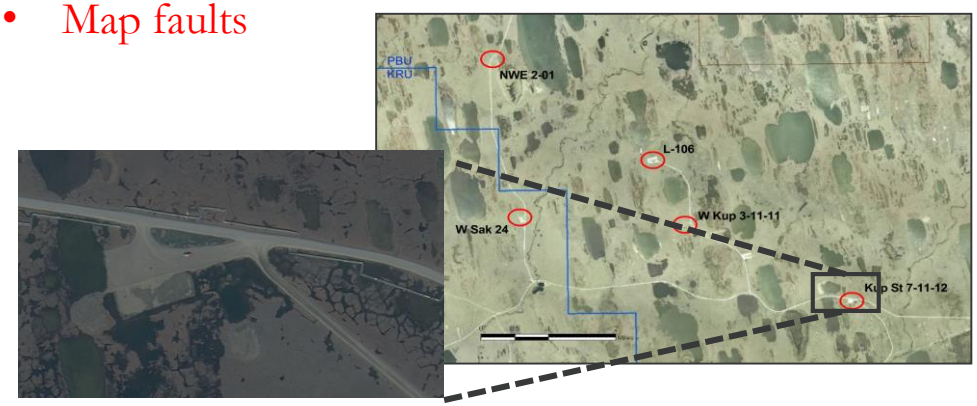
The Test:

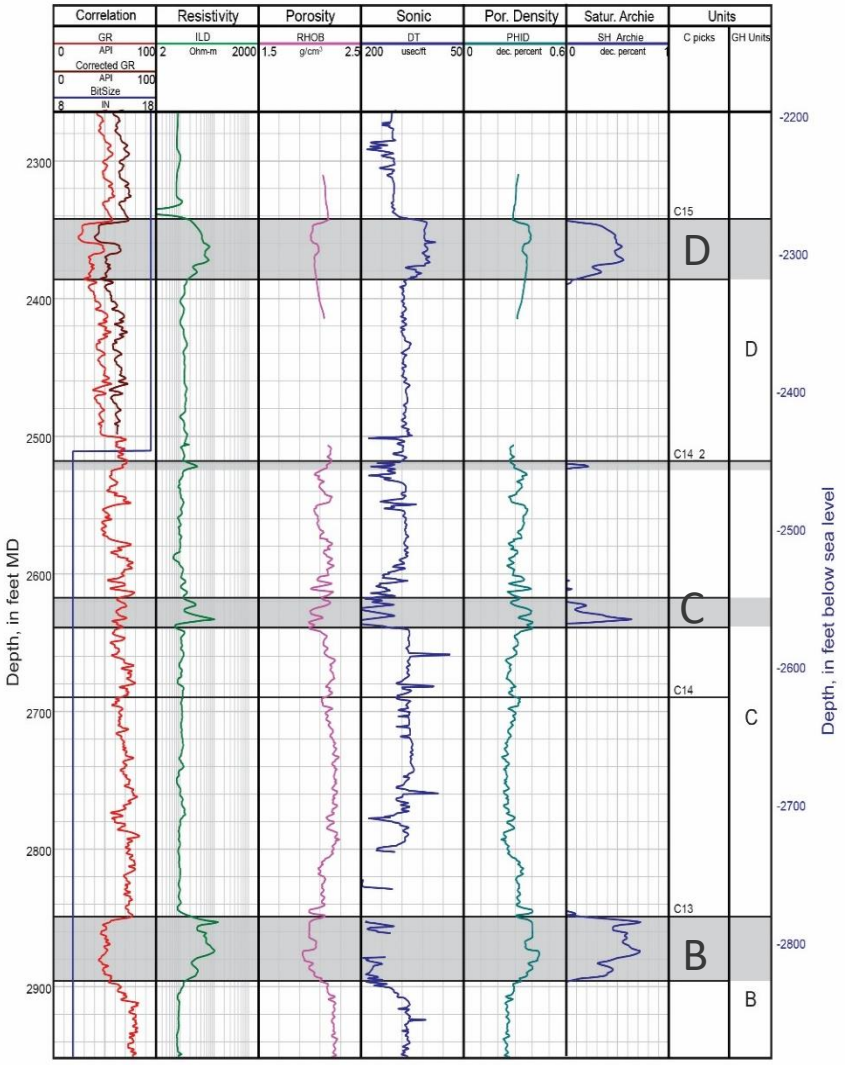
- Focus on depressurization
- Focus on Science not Rate Demonstration (Scale to commercial applications)
- Flow assurance - ability to maintain wellbore during likely interruptions
- Sand control
- Robust downhole equipment; Minimize risks; Use proven oilfield tech where possible.
- P/T monitoring and DTS; offset monitoring wells
- Progressive well stimulation available – thermal, mechanical, chemical
- Operational plan flexibility – ability to "listen to" and respond appropriately to reservoir

Kuparuk 7-11-12 Well Site (PBU)

Confirmed GH in D sand. Limited GH in C sand. Uncertain GH in B sand.

- Two exploration wells from pad: One log suite
- D-sand low geologic risk
- C-sand: limited charge.
- B-sand: HC-charge but poor log quality
- Drilling-disturbed at time of logging
- B-sand is predicted to occur 100'+ above BGHS
- Slight well deviation: BHL away from old boreholes
- Assess potential for nearby free-gas or water
- Map faults

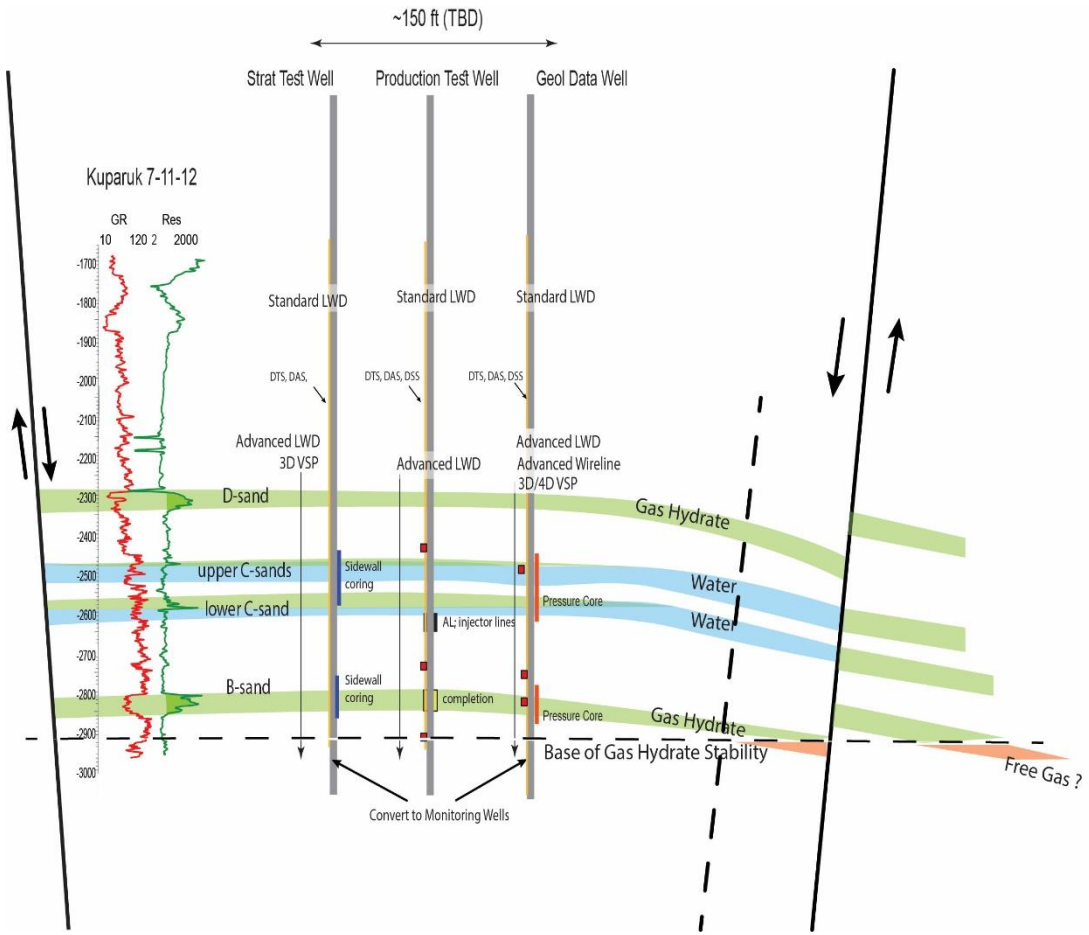




Seismic Data Review (2016 and 2018)

PRA-JOGMEC-USGS-NETL: Enabled by AK DNR and PBU WIOs

- Preferred BHLs identified.
- Geologic risk in B-sand reduced but not eliminated.
- Prospectivity of D-unit confirmed.
- Three-Well/Two Phase Program developed
- Phase 1: Conduct stratigraphic test → complete as monitoring well
- Phase 2: Establish facilities; drill and instrument science well; drill, complete and conduct test in production test well.



Where we are – Pt 2

Assessing project feasibility

- 2017: The companies indicate the most likely path forward is a 3rd Party Operator conducting a Standalone Test. Now working to develop a costed/risked site-specific science plan. UPDATE: PBU is assessing viability of BP operation of initial Stratigraphic Test Well only as part of the CY2019 PBU rig mobilization activities. Pad has been determined to be suitable (in size) for planned activities.

- Log/Core/Monitoring data acquisition (science) plans are well advanced. Drilling and Facilities plans under review. UPDATE: Add'l G&G review refined reservoir target locations. Technical viability of "Standalone" operation confirmed. Initial cost estimates generated.

- Testing plan (base plan and contingencies) is in development between DOE, JOGMEC, and USGS.

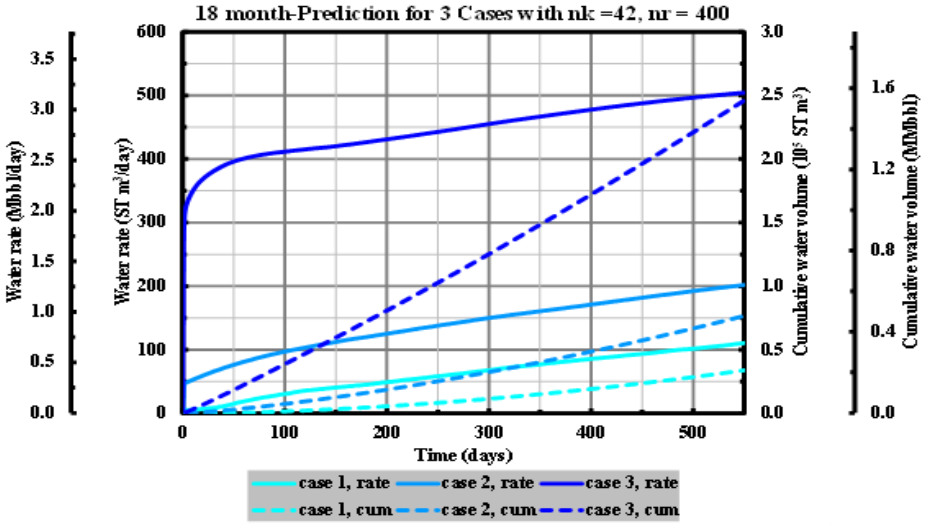
Figure 7: Operations Stage 5 (2020-21 or 22): Operate 3-well Program, Test Facility & Well Intervention

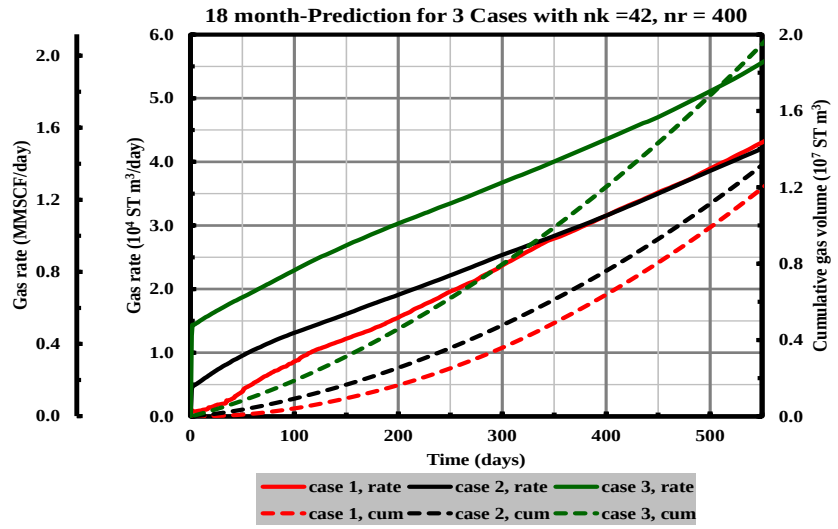
Figure 8: Operations Stage 6 (2021 or 22): Perform Optional Rig Work Over of PTW

Reservoir Modeling (Update)

NETL, JOGMEC, and USGS collaborative effort

- Working to compare and reconcile modeling results
- Divergent results obtained…
- Multiple scenarios to accommodate data uncertainties
- Range of rates for gas and water need to be developed to guide facilities planning
- Modeling also supporting well test alignment and spacing





Program Objectives

Robust, Proven, State-of-art Equipment for Well Sampling, Completion, and Monitoring

Science

Full characterization of GH systems

- Sidewall pressure coring (STW)
- Whole core pressure coring (GDW)
- Full suite LWD and wireline logs (all wells)

Controlled perturbation – comprehensive observation of response → over extended time frames & multiple zones (?)

- Fiber-optic Strain, Acoustic, and Temperature Monitoring
- Pressure monitoring (cables and/or gauges)
- Monitoring inside (PTW) and outside (PTW, STW, GDW) casing
- VSP via DAS

Technology

Identification of emergent production challenges (heat flow, permeability, geomechanics)

- Sand control/completion/stimulation/shut-in
- Artificial Lift; Hydraulic isolation

Improved evaluation of productivity and potential

- Numerical simulation (needed validation/calibration datasets)

Examples of tools under consideration

Stratigraphic Test Well

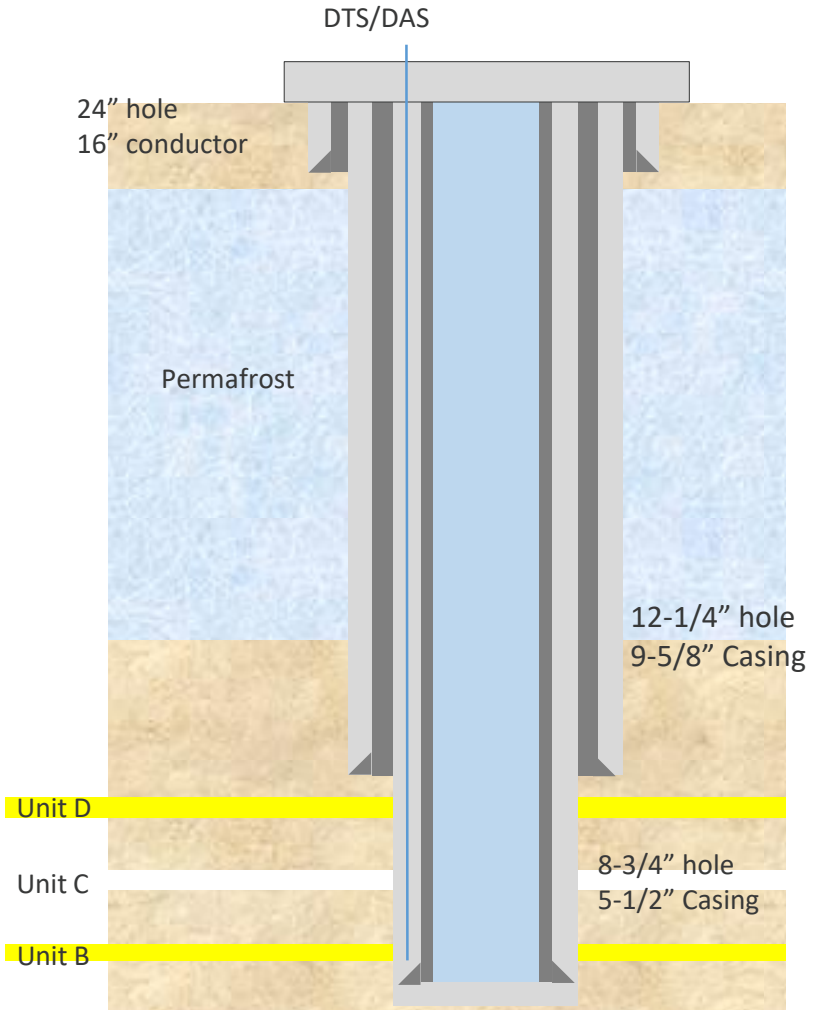
Simplest design desired. Expected Cost $10 to $15 million

Purpose

- Confirm state of GH at site
- Allow selection of test zone and finalization of science well and production well completion design
- Goal is fully saturated GH in B sand
- Fall-back is fully-saturated D sand: D sand test may require change in design.

Design

- Slightly deviated, potential S-shape
- Drill to above D-sand with LWD: Set Surface casing
- Drill with Chilled Oil-based Mud with LWD to TD
- LWD: Wireline Log as backup
- Sample: 3 or 4 Sidewall p-coring runs dedicated to specific reservoir and seal intervals. Grain size focus to support Test Well completion design
- 5 1/2" casing cemented to TD with DTS/DAS



Strat Test Well Success Criteria

Points for Discussion


Nordic Calista #3

<u>GOAL</u>: is the site viable for the desired science?

<u>Related question</u>: is there another site better suited?

Success

- GH confirmed in B-Sand and D-Sand (or just D-Sand).
- S_{gh} is at minimum 50%
- Sands are minimum 15' in thickness.
- GH in either sand hydraulically isolated from gas/water
- Either sand in suitable structural condition (coherent fault block)

Mitigation

- STW indecisive → run back-up wireline
- B-sand determined to contain a water leg → redesign for D-sand
- B-sand determined to contain free gas → redesign for D-sand
- Neither B or D sands suitable → **reassess test site locations**

Geo-Data Well

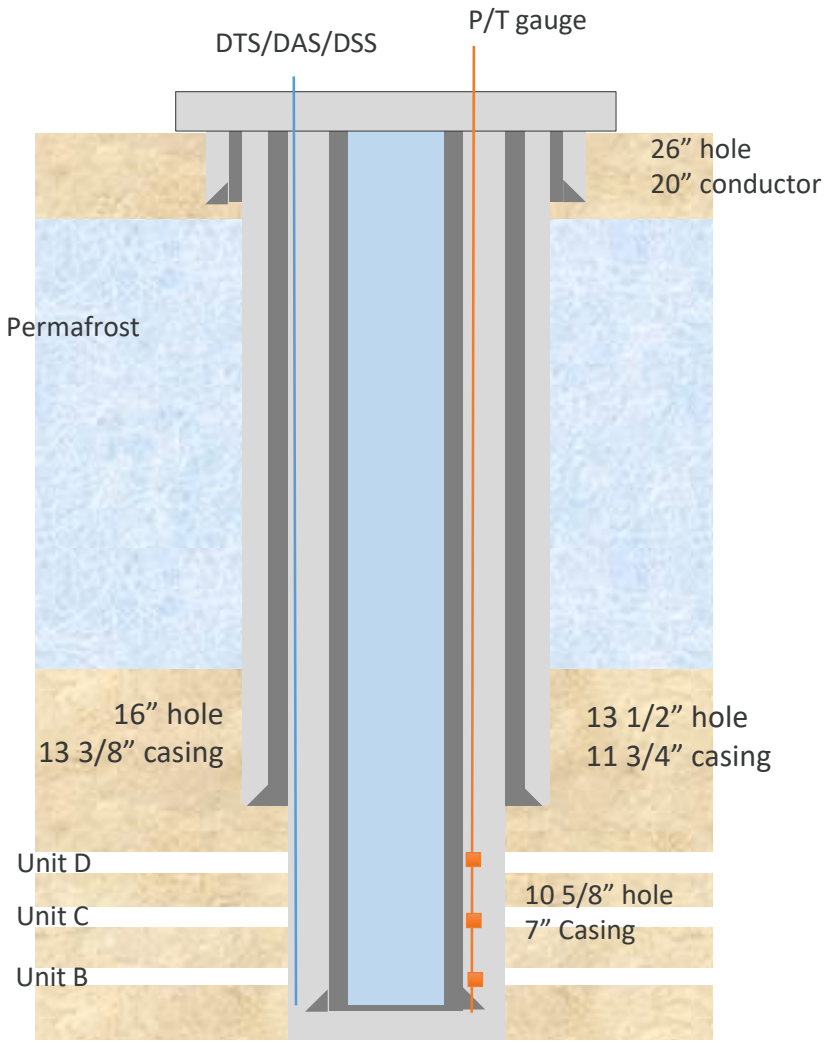
Offset from Stratigraphic well approximately 80 m

Purpose

- Acquire all geologic / engineering / petrophysical data needed to characterize the test reservoir and effectively interpret test results

Design

- Similar to Strat Test well but likely with bigger tubulars to enable deployment of pressure corer
- Acquire conventional core below surface casing with deployment of pressure core in reservoirs and seals
- DTS/DAS/DSS outside casing: 3 P/T gauges per zone
- Most reliable PC device will be utilized



Production Test Well

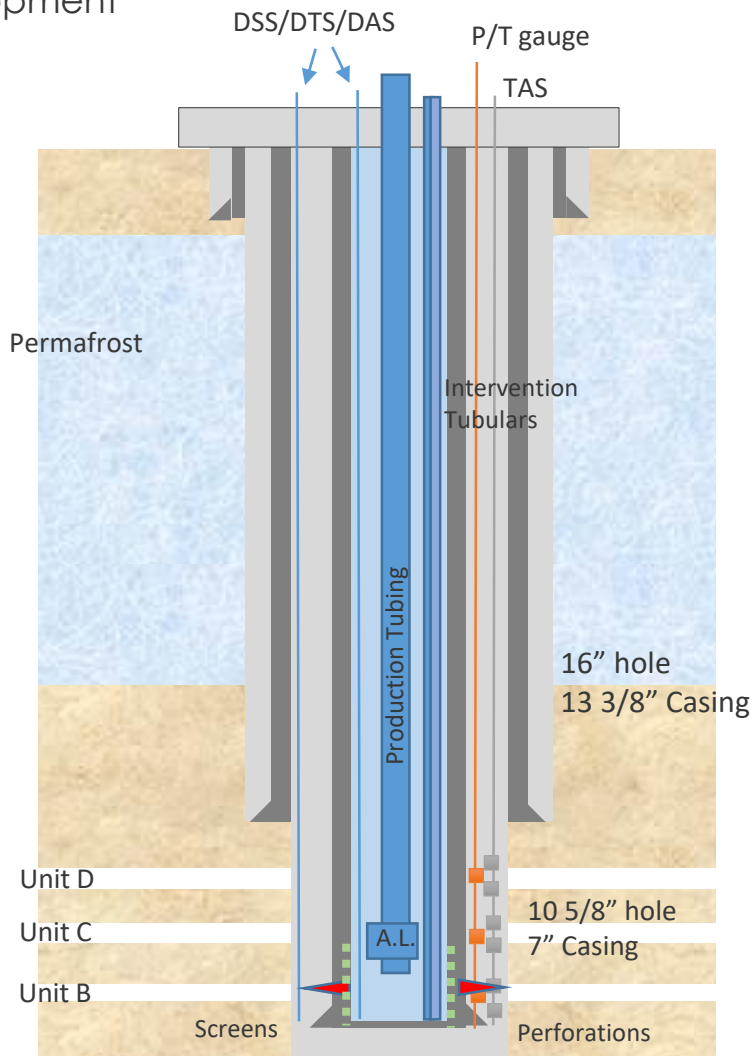
Located between two monitoring wells: design in development

Purpose

- Completed for Production and Monitoring over extended period: artificial lift
- Surface Facilities for Measurement of Gas, Water Sediment Volumes and Analysis of Samples
- Well intervention pre-positioned
- Sand Control completion

Design

- Similar drilling design
- Tubulars set for most effective artificial lift and to accommodate ESP etc.
- Cased and Perforated; but other completions designs may be selected
- Perforation delayed 2 mo. to allow reservoir and monitoring well T equilibration

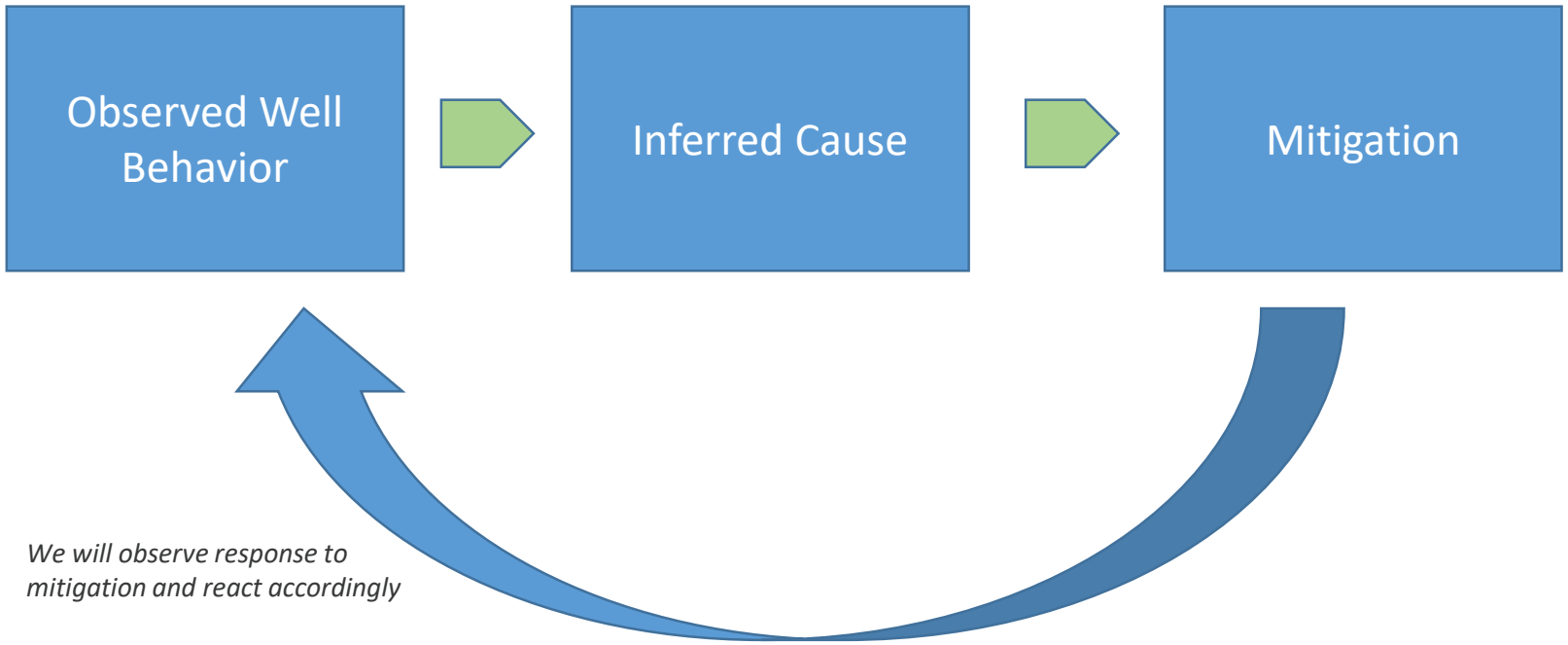


Intervention Plan

We need to emplace the monitoring systems that will allow us to observe reservoir response
&
We need to anticipate the range of possible responses

We will need to work together in real time at the site to infer causes of problematic well behaviors and to select mitigation measure

We need to have emplaced on the pad the systems that are feasible for the site



We will observe response to mitigation and react accordingly

Project Structure

3rd Party and Standalone

Stratigraphic Test Well

- Currently assessing commercial and logistical viability of operation by BPXA as part of pre-CY2019 PBU drilling program
- Fully Funded by DOE: Funds available given expected cost.
- Consensus reached on BHL, Data Acquisition plan, Long-lead items…
- JOGMEC leading effort to install monitoring systems

Production Testing Phase (PTW & GDW): "3rd Party"

- Assessing options for obtaining drilling service providers
- Operatorship will be transferred to a 3rd Party (not a PBU partner) as soon as feasible upon completion of STW.
- Pursuing agreements re framework for co-managing the effort with DOE's partners in Japan

… and "Standalone"

- Operations must not impact PBU operations: self-contained gas handling and disposal system
- Operations will benefit from existing gravel pad, roads, emergency facilities, solids and liquids disposal facilities, etc…

Nominal "Project" Structure

To achieve long-term gas hydrate test in partnership with PBU partners

NETL-JOGMEC MoU

NETL-PRA Contract

JOGMEC-NETL CRADA

NETL + Japan Operator Agreements

Various NL FWPs; AIST etc…

Phase A: Plan Definitization

- Detail the costs and logistics for the plan.
- Resolve project operator/liabilities…
- Submit plan for PBU approvals

Now being pursued in parallel

Phase B: Stratigraphic Test well

- Confirm occurrence of viable test reservoirs and collect any data essential for planning further wells.

Phase C: Reservoir Testing

- Establish monitoring systems (surface, instrumented monitoring wells)
- Drill Geodata well, Test well, Conduct test.
- Site Abandonment (full compliance with all regulations)

Phase D: Data Evaluation

- Studies of log, core, monitoring, and production test data to be conducted by JOGMEC, NETL, and other collaborating organizations as selected and funded by NETL and JOGMEC.

Summary

Ongoing effort to conduct Long-term Gas Hydrate Production Test

- **Alaska North Slope is a "natural laboratory" to assess GH production technology**
  - long-term testing remains the #1 priority in global gas hydrate science.
  - the only feasible spot world-wide to attempt long-term testing (GH onshore with infrastructure).

- **A collaborative effort to develop a Project is ongoing**
  - partners are JOGMEC, State of Alaska, USGS, and Petrotechnical Resources, Alaska.
  - initial focus evaluated acreage outside PBU set-aside by the state. The sites are not promising.
  - DNR and DOE/FE re-engaged with Industry in 2015 to seeking access to PBU sites.
  - BP now providing technical expertise to assess field program viability within the Unit
  - BP now evaluating the potential to operate the first phase of the program – a stratigraphic test.

- **Key Challenges**
  - Logistics/contracting for a Stratigraphic Test this coming November.
  - Successful operation of Stratigraphic Test Well
  - Finalizing agreements with project co-funders JOGMEC
  - Logistics/contracting for a 3rd party to operate production testing phase on our behalf.
  - Finalizing well testing base and contingency plans.

Thank You

ray.boswell@netl.doe.gov