



# North Slope Drilling Activity

January, 2011

Compiled by Division of Oil and Gas

# Exploration Drilling

## What drives exploration?

- Economy
- Land availability
- Evolving exploration concepts
- Advances in seismic and drilling technology

## What affects exploration in Alaska?

- Successful exploration (encourages more exploration)
- Available acreage
- Global economics of oil & gas
- Fiscal regime

## Recent explorers on the North Slope:

- |                  |                |
|------------------|----------------|
| • Chevron        | • Pioneer      |
| • ConocoPhillips | • Brooks Range |
| • Anadarko       | • Savant       |
| • FEX            | • Rampart      |
| • ENI            | • UltraStar    |

## Seismic Technology

The revolution of 3D Seismic in the 1990s changed the map by allowing exploration companies to search for more subtle stratigraphic traps than earlier technology allowed. Usually, development of an area expands from the obvious structural traps, leading to better understanding, and to further exploration. Now, exploration on the North Slope has developed past the obvious structural traps.

## 2000 to 2010:

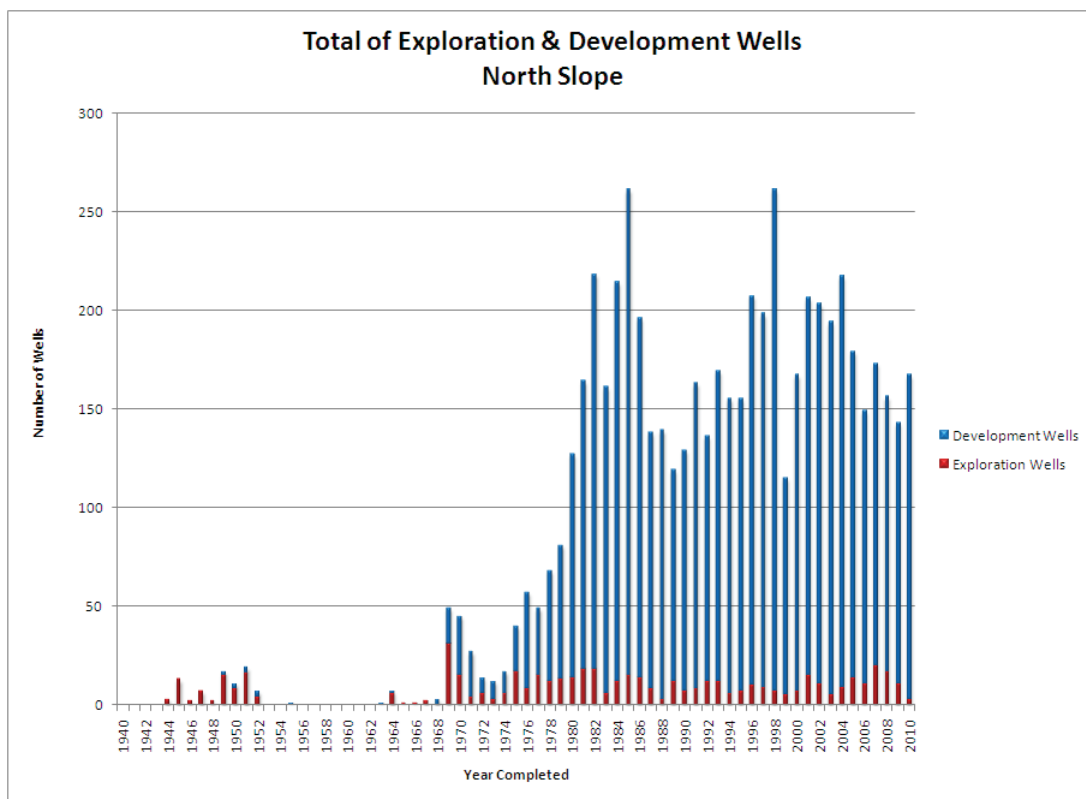
- Primary exploration activity north of the Kuparuk field (Oooguruk and Nikaitchuq fields)
- Also activity in the vicinity of Alpine and its satellites, Fiord, Nanuq, Qannik, and NPR-A.
- ConocoPhillips, in partnerships with Anadarko and Pioneer, has operated more exploration wells in NPR-A than any other company since the renewal of BLM leasing there in 1999. The company drilled 19 NPR-A wells and multiple sidetracks between 2000 and 2009, with most of the drilling and the greatest success concentrated in northeast NPR-A. ConocoPhillips has announced discoveries of multiple hydrocarbon accumulations in Upper Jurassic Alpine-equivalent reservoir sandstones, and has gone on to form and expand the BLM-administered Greater Moose's Tooth unit encompassing those discoveries. In addition, ConocoPhillips also formed the adjacent BLM-administered Bear Tooth Exploration Unit, based on Cretaceous and Jurassic sandstone prospects. ConocoPhillips has also operated exploration wells farther west in NPR-A, including Pu-  
viaq 1 near the Ikpiuk River and Intrepid 2 south of Barrow's Walakpa gas field.
- Other operators operating exploration wells in NPR-A since 2000 include BP (two Trailblazer wells), Total (Caribou 1), Anadarko (Altamura 1 and Wolf Creek 4 wells), and FEX (four Aklaq, Aklaqyaaq, and Ama-  
guq wells). Several of these wells remain confidential pending lease expiration per BLM policy, but clearly the region has been explored for multiple play concepts in the last decade. The Trailblazer leases expired during 2010 and those two wells should be released to the public by February, 2011. FEX is currently in the process of

marketing their NPRA acreage, and have no further plans in NPR-A.

- Foothills oil and gas accumulations originally discovered decades ago were retested by several new wells in 2008 and 2009 in Anadarko’s drilling campaign with partners Petro-Canada and BG. The partnership drilled two wells evaluating the Gubik gas accumulation (Gubik 3 and 4), and one flanking the previously discovered East Umiat gas accumulation and assessing the potential of deeper Brookian strata there (Chandler 1). Anadarko’s Wolf Creek 4 was also drilled in 2009, following the same frontal structural zone of the foothills belt in southeast NPR-A. Anadarko did not drill any wells in 2010 and has no plans for 2011 drilling in the Gubik area, waiting on economic issues such as the availability of a gas pipeline before considering further delineation and development. Renaissance still has permitted drilling locations on its Umiat acreage, but future activity will depend on finding investors and the possibility of development of road access to their Umiat site (west of the Colville River).

- In addition to drilling activity, the last decade has seen significant new seismic acquisition in the foothills belt, including proprietary 3D programs in the vicinity of the Kavik gas accumulation near ANWR, and over the Umiat oil accumulation and Gubik gas accumulation near the Colville River, as well as more regional, high quality 2D surveys on state, federal, and native lands across much of the central foothills belt. DNR has maintained its program of integrated foothills field investigations and subsurface studies throughout the last decade, and is currently focused on the Umiat – Gubik area. These projects focus on clarifying the region’s oil and gas potential and delivering results to a broad audience, including industry and decision makers in state and federal agencies.

## Development drilling



Development drilling reflects a company’s efforts to develop a discovery, satellite, or similar prospect near existing infrastructure.

North Slope development is staying fairly strong, but the graph above shows that it is somewhat cyclic in response to industry-wide conditions: oil prices,

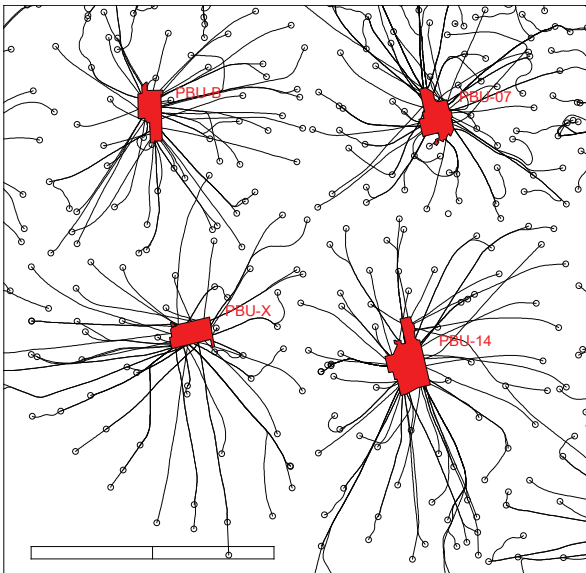
costs, and alternative development opportunities.

Drilling activity is also affected by the timing of development programs. One year of development drilling will be followed by a year of tie-back and facility installation.

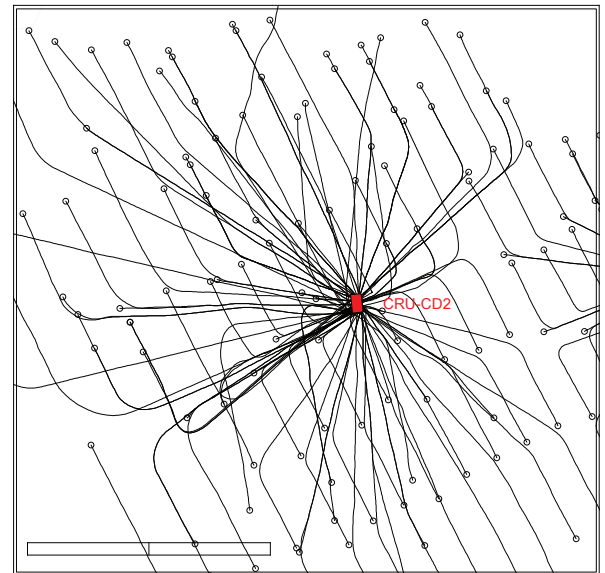
## Drilling technology

Advances in drilling technology have greatly advanced the reach of modern exploration and development wells.

- The Alpine field discovered in 1994 and delineated in the late 1990's was the first North Slope field to be developed exclusively with all horizontal wells, both producers and injectors.
- The use of multi-lateral technology has improved the economics and oil recovery of the West Sak and Schrader Bluff formations (Shallow Sands)
  - Horizontal and multi-lateral drilling technology represents a cost-effective method to develop remaining oil or oil located in isolated but closely stacked sandstones separated by shale.
  - The use of multi-lateral wells helps to keep the numbers up. Each lateral counts as a separate well so comparing activity to a time when laterals were not common may not give an entirely accurate picture. On the other hand, extended-reach horizontal drilling also means that today, the same level of production can be achieved with a fewer number of wells.
  - This means not only that more complicated stratigraphic plays can be developed, but also that any formations can be more efficiently drilled and produced with a smaller number of wells.



Prudhoe Bay



Alpine

Division of Oil and Gas, 4/2/2010

## Well Count and Well Footage Drilled

Year	ALPINE WELLS	footage	KUPARUK WELLS	footage	PRUDHOE WELLS	footage	OTHER WELLS	footage	TOTAL WELLS	TOTAL Footage
1995	4	28,530	28	296,416	91	715,529	32	353,003	155	1,393,478
1996	8	59,329	42	369,416	106	745,710	51	567,516	207	1,741,971
1997	0	0	36	291,517	116	783,954	44	481,358	196	1,556,829
1998	3	28,869	70	518,764	126	783,871	62	518,764	261	1,850,268
1999	14	154,899	28	245,626	62	265,688	11	102,249	115	768,462
2000	25	313,509	45	330,972	79	363,035	18	168,845	167	1,176,361
2001	16	193,504	51	419,323	93	504,328	46	341,622	206	1,458,777
2002	21	261,815	29	224,979	112	654,919	41	327,397	203	1,469,110
2003	18	267,496	35	309,947	87	460,597	53	440,372	193	1,478,412
2004	20	273,111	47	291,536	100	546,319	50	364,245	217	1,475,211
2005	13	200,332	57	342,433	82	451,733	27	288,400	179	1,282,898
2006	17	242,138	52	404,241	68	360,278	12	100,034	149	1,106,691
2007	14	213,618	59	442,638	70	376,267	30	214,250	173	1,246,773
2008	17	209,252	33	163,326	80	424,910	26	169,595	156	967,083
2009	12	209,030	27	130,565	74	362,924	29	250,202	142	952,721
2010	15	204,422	52	231,111	73	357,506	27	247,752	167	1,040,791
<b>total</b>	<b>217</b>	<b>2,859,854</b>	<b>691</b>	<b>5,012,810</b>	<b>1419</b>	<b>8,157,568</b>	<b>559</b>	<b>4,935,604</b>	<b>2886</b>	<b>20,965,836</b>

The well count above includes

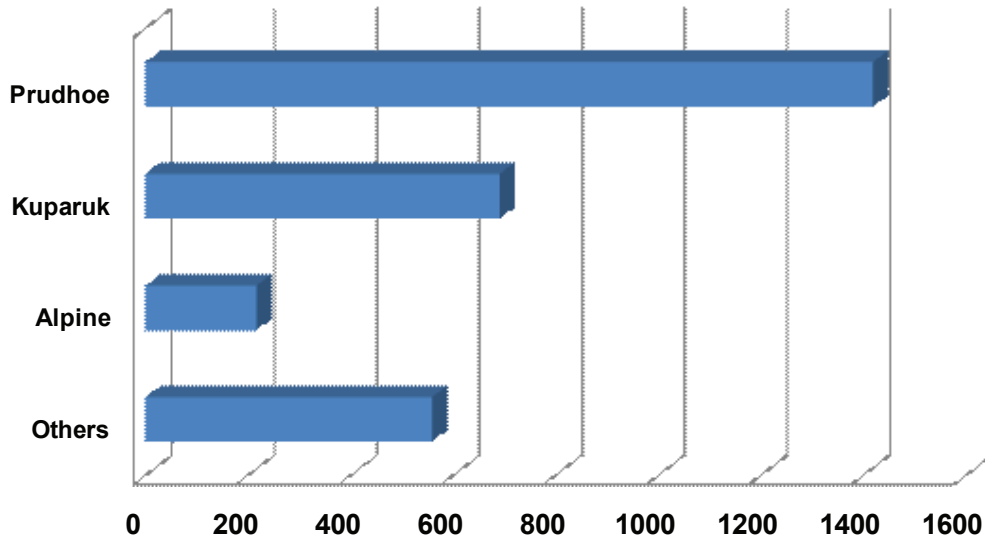
- Grass roots wells
- Side tracts
- Deepening
- Laterals

AREA	# Wells	Footage
Others	559	4,935,604
Alpine	217	2,859,854
Kuparuk	691	5,012,810
Prudhoe	1419	8,157,568
<b>Total</b>	<b>2886</b>	<b>20,965,836</b>

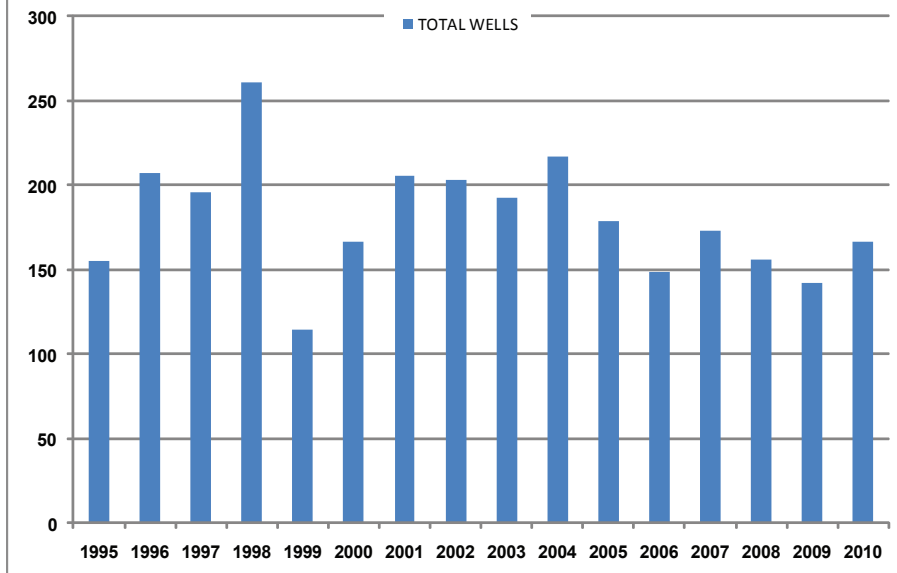
It does not count

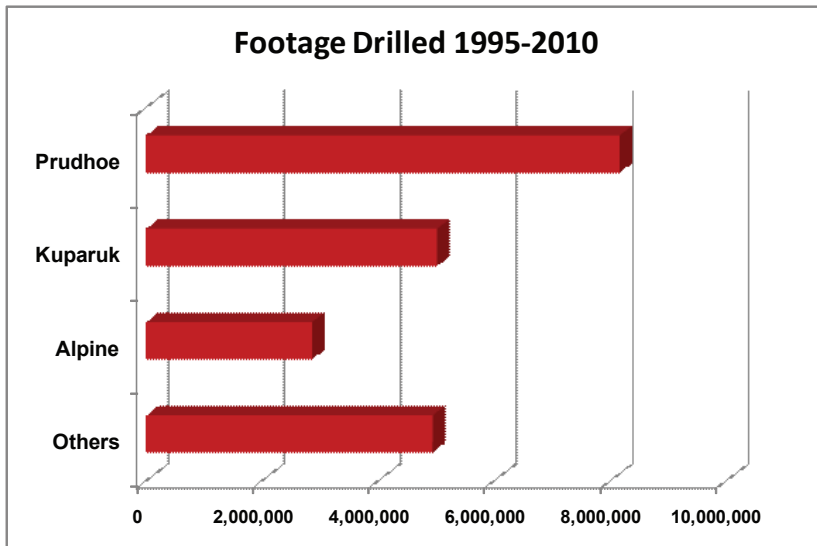
- Pilot holes
- Each leg of a multilateral (no systematic repeatable way to count)
- Mechanical sidetracks (where an explorer has a mechanical problem and has to sidetrack to get to their objective. At Oooguruk 3, Pioneer had many (6 or more) sidetracks in one straight hole.
- Where there are multiple bottom holes, targeted sidetracks are counted as separate wells. In an exploration well, the first target might be a straight hole, and the well might then be sidetracked to a new bottom hole a mile away.

### # Wells Drilled 1995-2010



### Total NS Wells 1995-2010





The number of wells, as well as the footage, drilled in any particular year is affected by a number of factors.

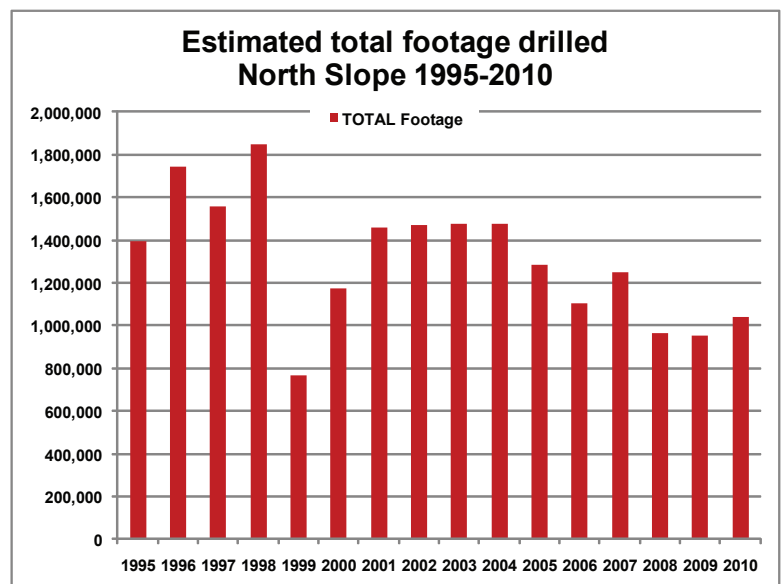
#### **Stage of development:**

In the early years of developing a new field, infrastructure needs to be put in place (drill pads, well housing, flowlines, etc.) and the initial wells drilled are from the surface. This means that in the early years of development, well footage drilled will be higher, as the developer hits the targeted horizon.

As development progresses, these “grassroot wells” are opened to sidetracking to either maximize production from the well, or to target non-connected pools. The sidetracked wells, going out laterally from a starting point in an initial grassroot well already drilled down, usually are shorter in length. Sidetracked wells are also less costly, given that they benefit from already existing infrastructure.

#### **Drilling development:**

Not only can today’s wells drain a larger area from a smaller “footprint” – today’s wells are also more efficient than wells drilled in the infancy of Prudhoe Bay.

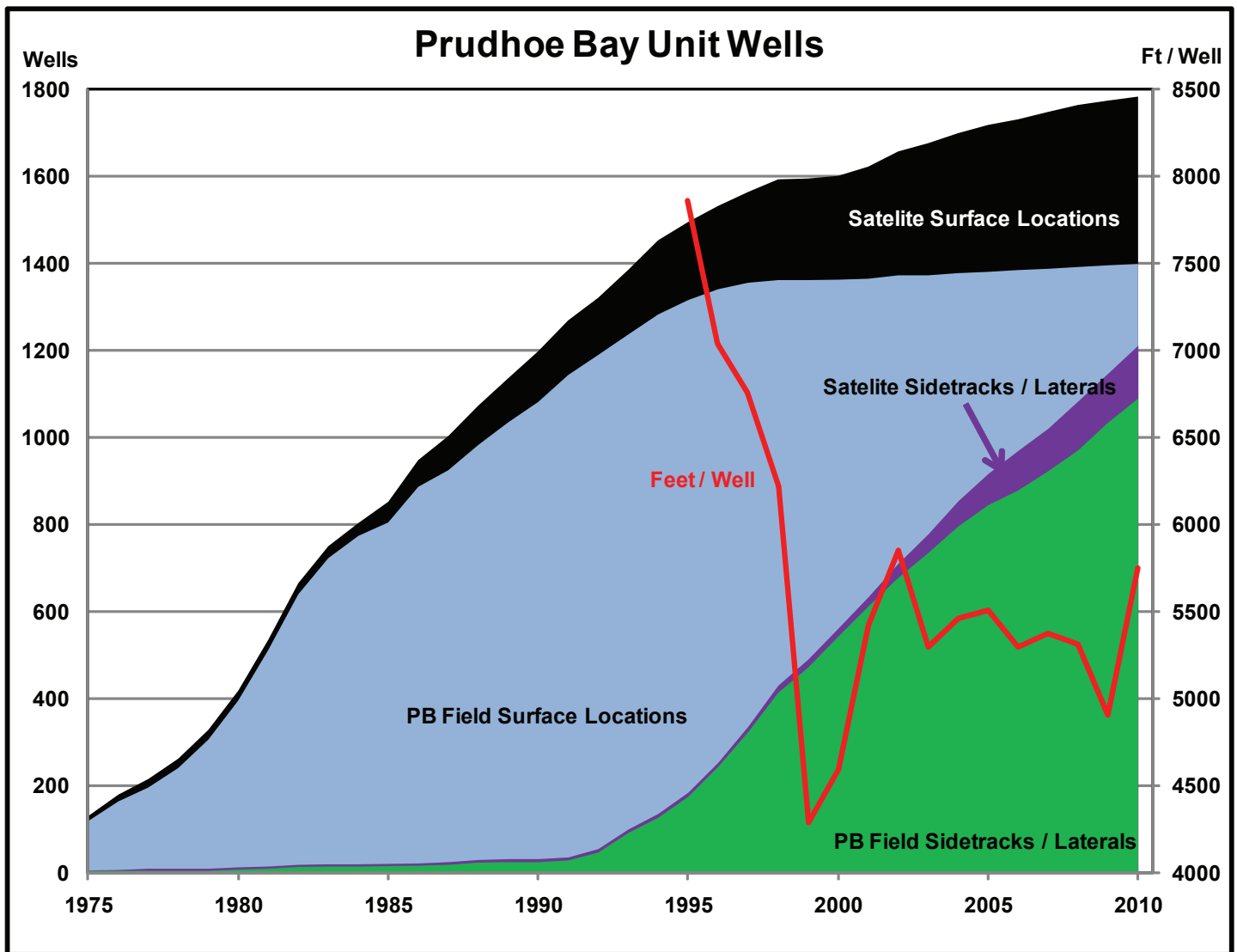


#### **Equipment availability:**

When a drill rig is available, you will see several wells drilled in a field in the same year. A period of drilling is then followed by well-completion and other preparation for production, which means it is normal for a period of drilling to be followed by a period of no drilling – it’s all part of the development cycle.

We can see this in looking at graphic representations of the number of wells drilled over the lifespan of a field, as well as the average footage of wells drilled over the same time period.

The following graphs also show the difference in types of wells, number of wells, and footage drilled, comparing older fields (Prudhoe Bay and Kuparuk) with a newer developing field (Colville River).



This graph shows a cumulative plot.

The light blue shows the Prudhoe Bay Unit grassroots wells; a total of about 1,400, drilled in the past 15 years. There is a significant stock of wells in the IPA. New wells require surface facilities (flowlines, well housing, new gravel pads, etc.)

The black shows the satellite grassroots wells. These continue to grow -- there are approximately 400 drilled to date.

Green is Prudhoe Bay IPA sidetracks -- about 1,000 to date, and growing. The last several years' Plans Of

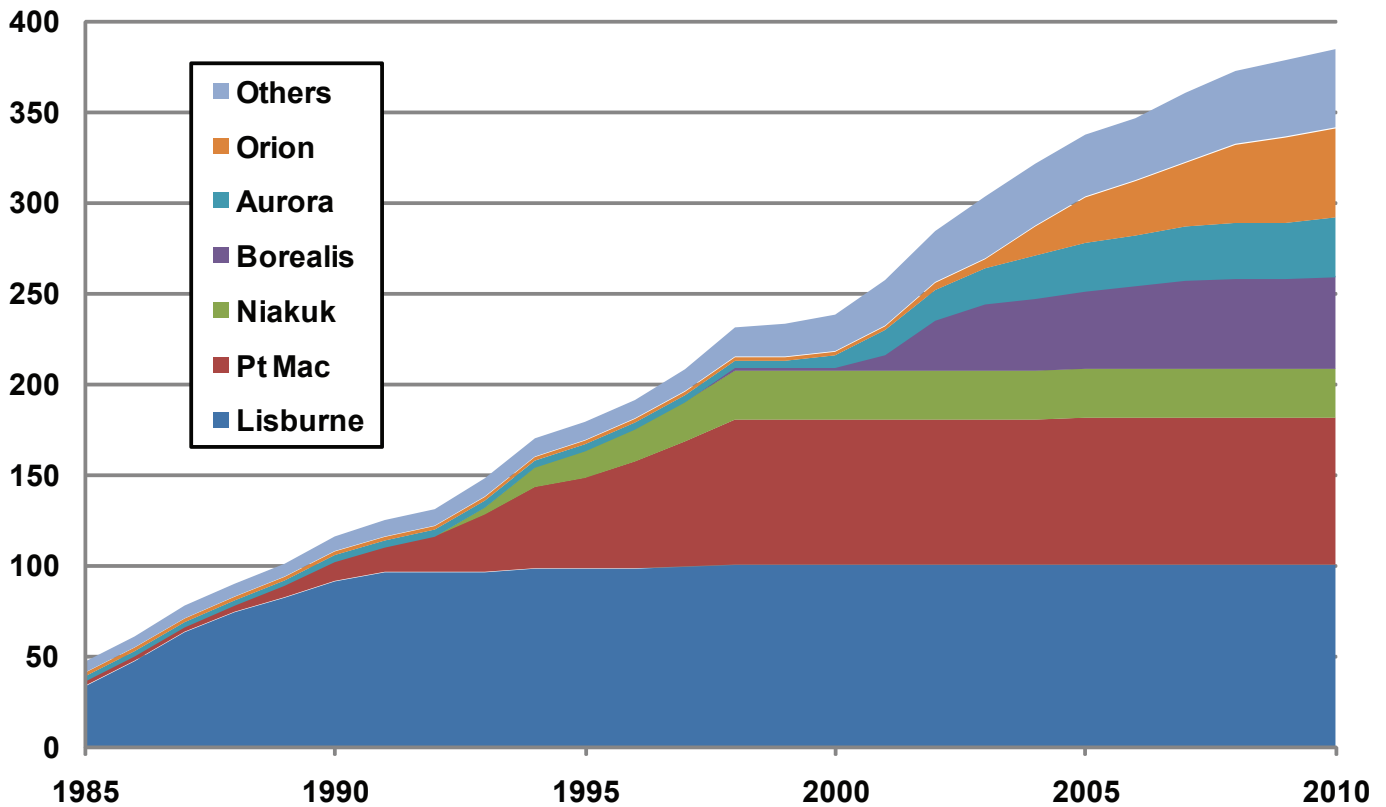
Development (POD) talk about waiting for suitable wellbores to sidetrack to target a particular accumulation. 10/14ths of the IPA wells have been sidetracked. Sidetracks require no surface facilities.

Purple shows satellite sidetracks -- 100 to date, and growing.

The red line shows the number of feet per well drilled (scale on the right side of the graph). As sidetracks increase, there is a significant drop in feet per well.



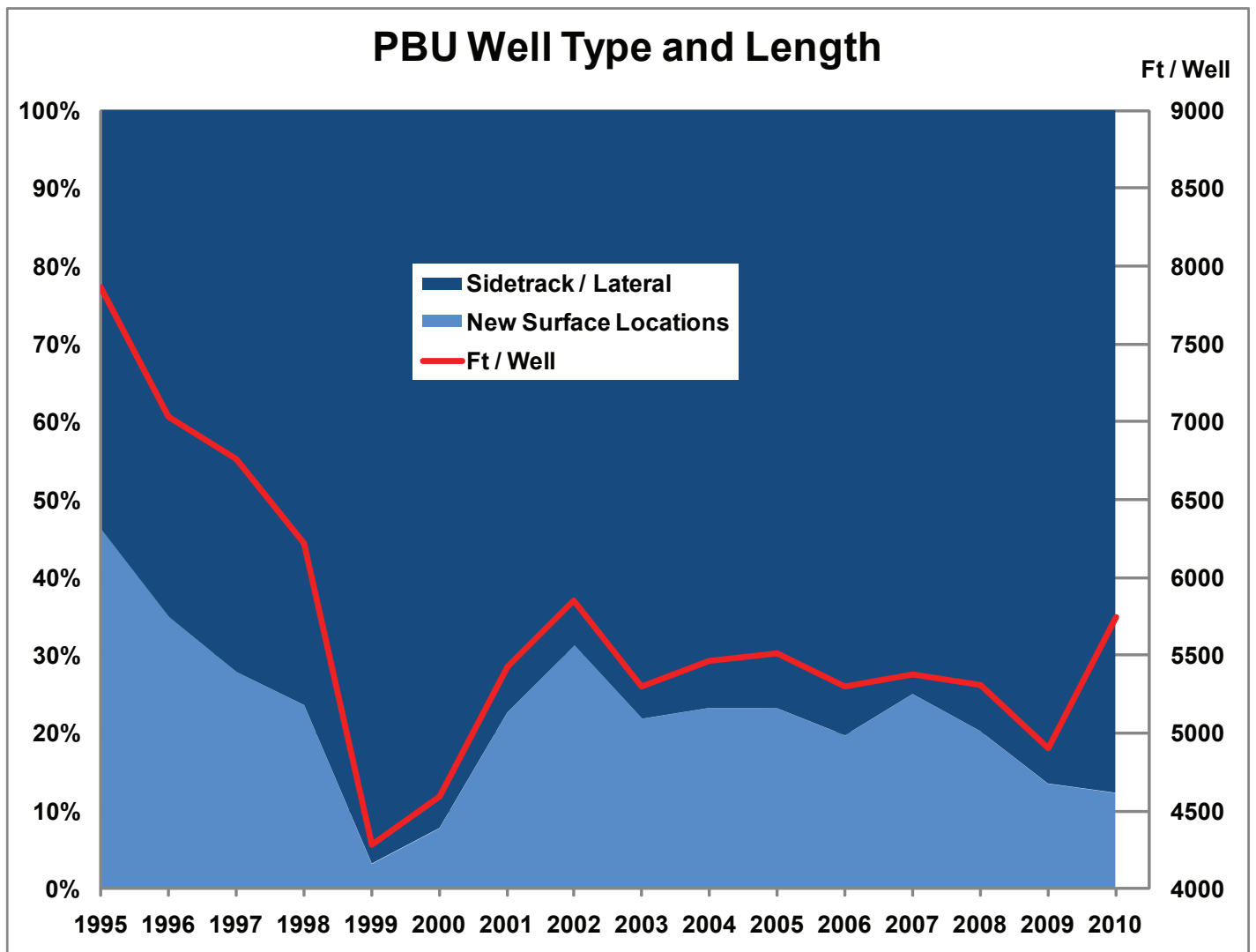
## PBU Satellite Surface Locations



This graph expands the black wedge from the previous slide, showing only new wells. Notable here is that development of satellites start and finish. Looking, for example, at Pt. MacIntyre or Lisburne, there has been no new wells drilled in many years. This has

nothing to do with the financial regime or even oil prices, but is attributable to the fact that the wells have been drilled and the project completed.

Growth here comes from new projects being added -- such as Borealis, Aurora, and Orion.



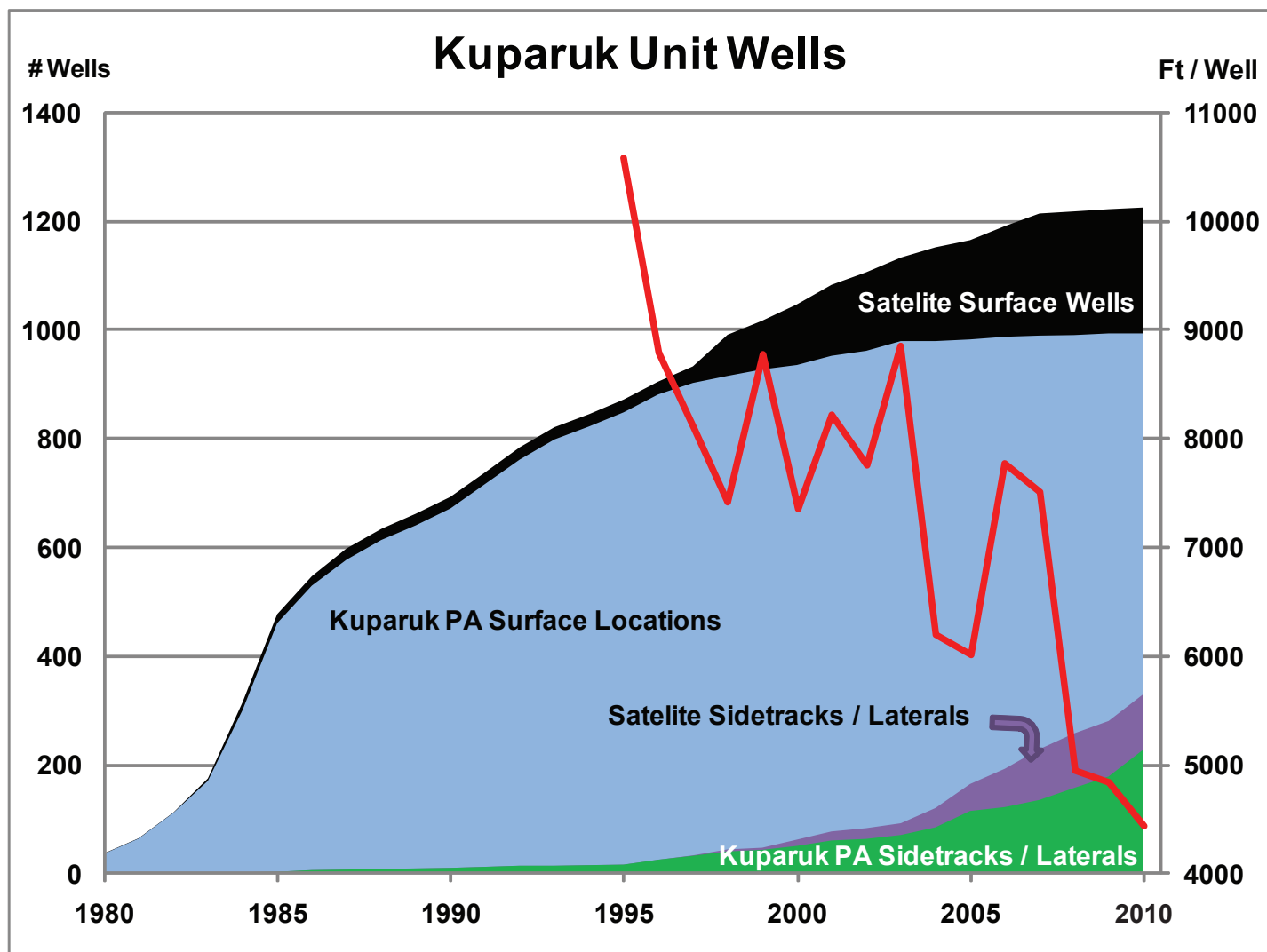
The above graph shows grassroots wells (light blue) as percentage of total wells (dark blue is side-tracks).

In the mid-1990s, about half of the wells in the Prudhoe Bay Unit were grassroots wells, with an average length of 8,000 feet.

Today, only 15 percent of the wells in the Prudhoe Bay Unit are grassroots wells. The average length of a

well is 5,000 feet.

This does not point to diminished drilling, but *different drilling*. Sidetracking existing downholes means lower cost (no new facilities, no new gravel pads). Together with greater efficiency in drilling technology this all means lower associated cost for the developer).



This cumulative plot can be compared to the cumulative plot for Prudhoe Bay on page 8.

The light blue shows Kuparuk Participating Unit grassroots wells -- approximately 1,000 drilled, only about 100 of them drilled in the past 15 years.

As in the case of Prudhoe Bay, the Kuparuk River Unit has a significant stock of wells.

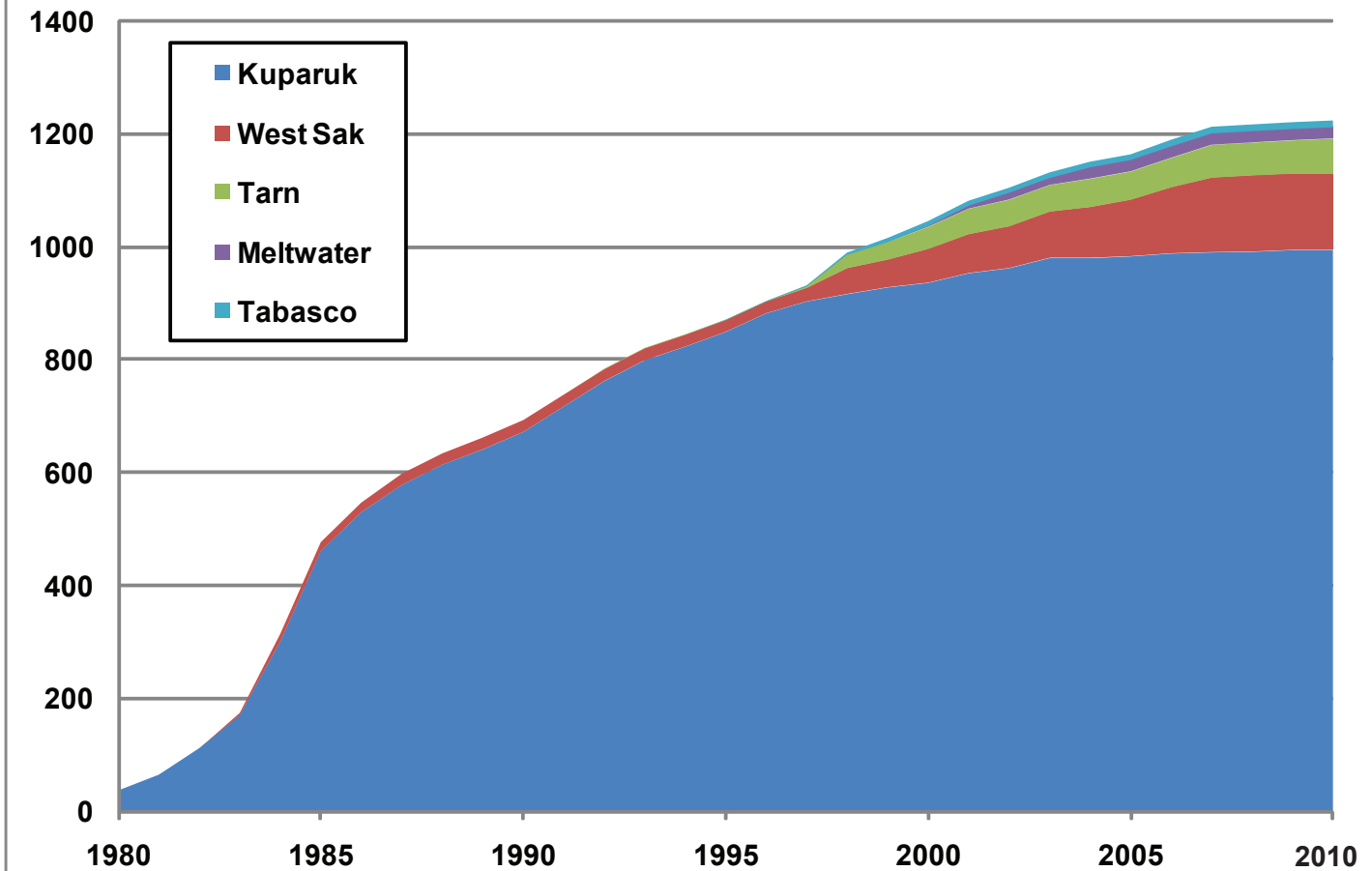
Black shows satellite grassroots wells -- a category that continues to grow, with about 200 wells to date.

Green shows Kuparuk PA sidetracks and laterals, also approximately 200 drilled to date, and growing. About 20 percent of the Kuparuk Participating Area wells have been sidetracked.

Purple shows the satellite sidetracks; 100 to date and growing.

As in the case of Prudhoe Bay, we can see how the average footage per well drops significantly as percentage of sidetracks increases.

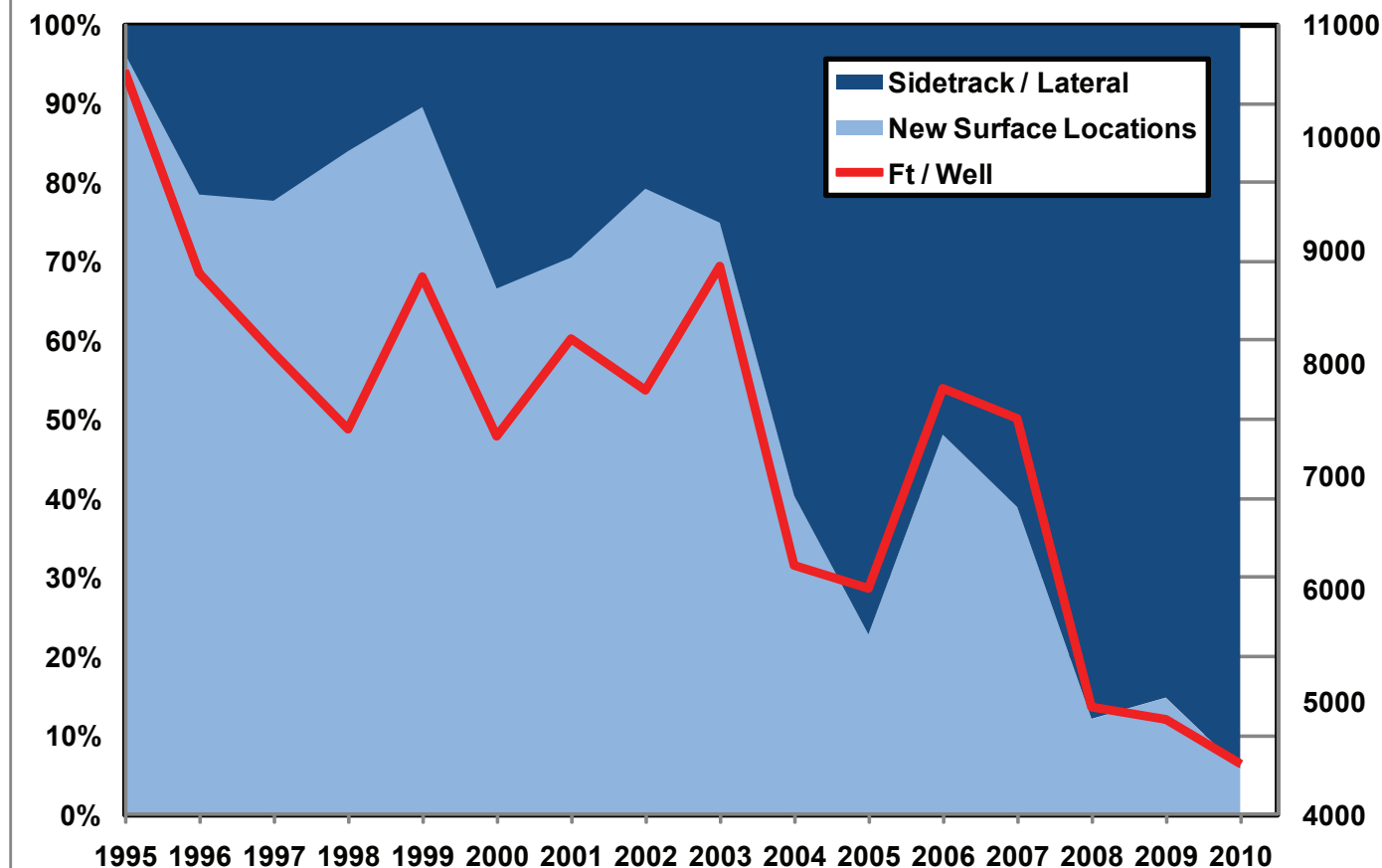
## KRU Surface Locations



This graph expands the black wedge from the previous slide, showing only new wells. As in the case of Prudhoe Bay, we can see how the development of satellites start and finish as wells have been drilled and the project completed.

Growth here comes from new projects being added .

## KRU Well Type and Length



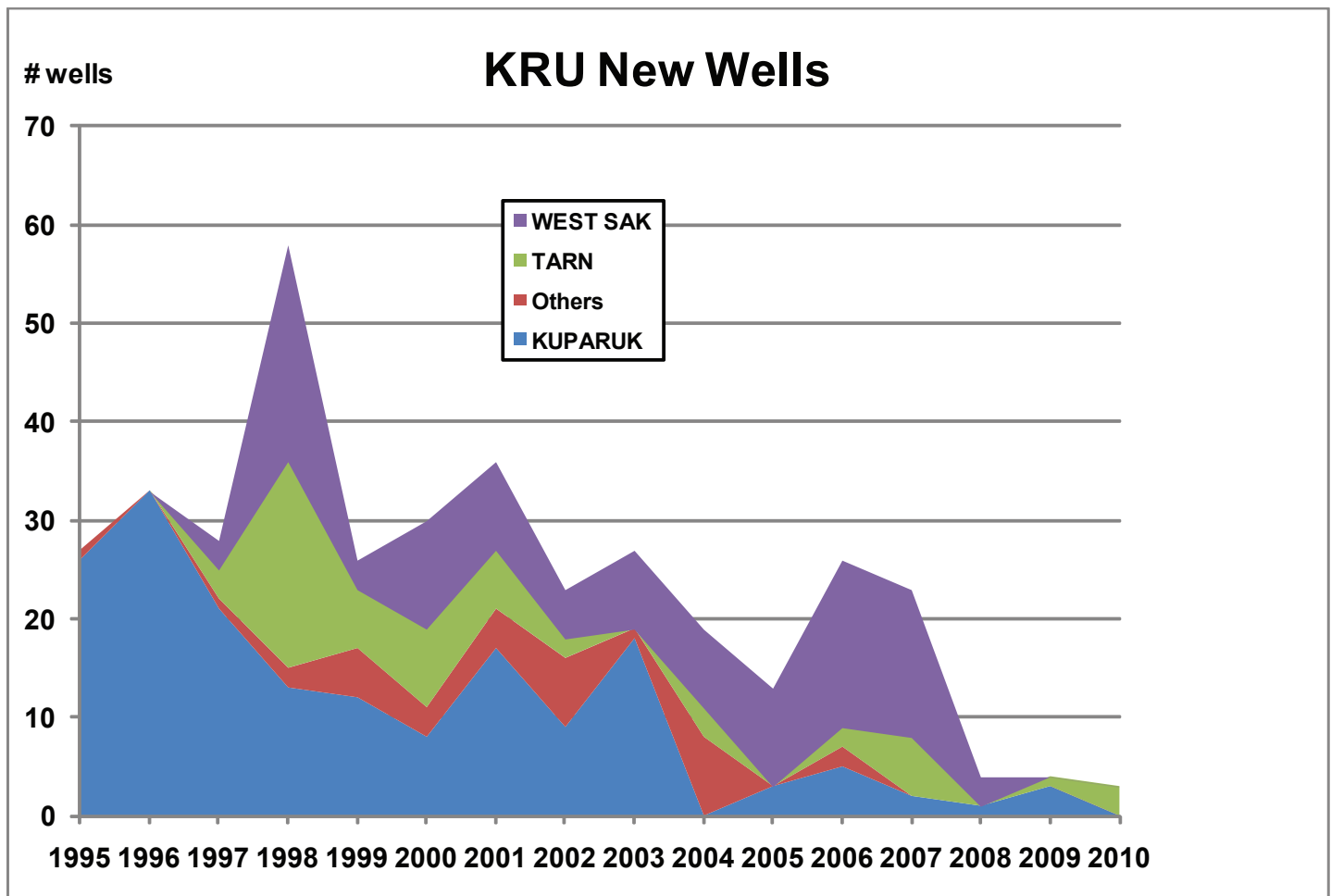
The above graph shows grassroots wells (light blue) as percentage of total wells (dark blue is sidetracks).

In the mid-1990s, about 95 percent of the wells in the Kuparuk River Unit were grassroots wells, with an average length of over 10,000 feet.

Today, only 15 percent of the wells in the Unit are grassroots wells. The average length of a well is 5,000 feet.

This does not point to diminished drilling, but *different drilling*. Sidetracking existing downholes means lower cost (no new facilities, no new gravel pads). Together with greater efficiency in drilling technology this all means lower associated cost for the developer).

As in the case of Prudhoe Bay, we can see the correspondence between sidetrack percentage and feet per well.

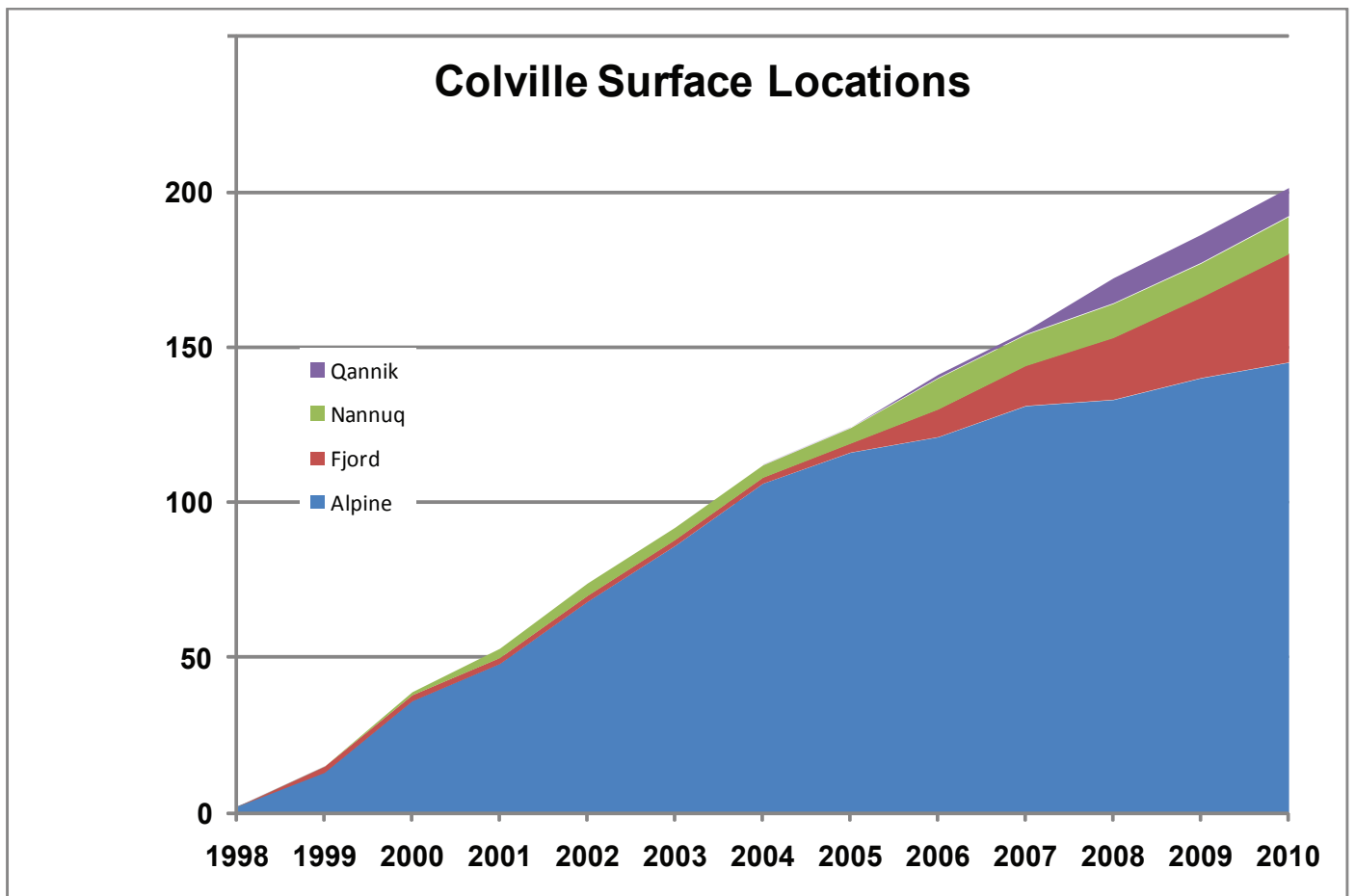


Approximately 5 new wells have been drilled per year in the Kuparuk River Participating Area since 2004. As is the case in Prudhoe Bay, most grassroots drilling has happened in the satellites.

Most satellite development has been in West Sak during this time period. West Sak reservoirs are also produced from the newly formed NEWS (North East West Sak) Participating Area (formed in 2009). Due to budget constraints, ConocoPhillips is not planning any new wells for 2009-2010.

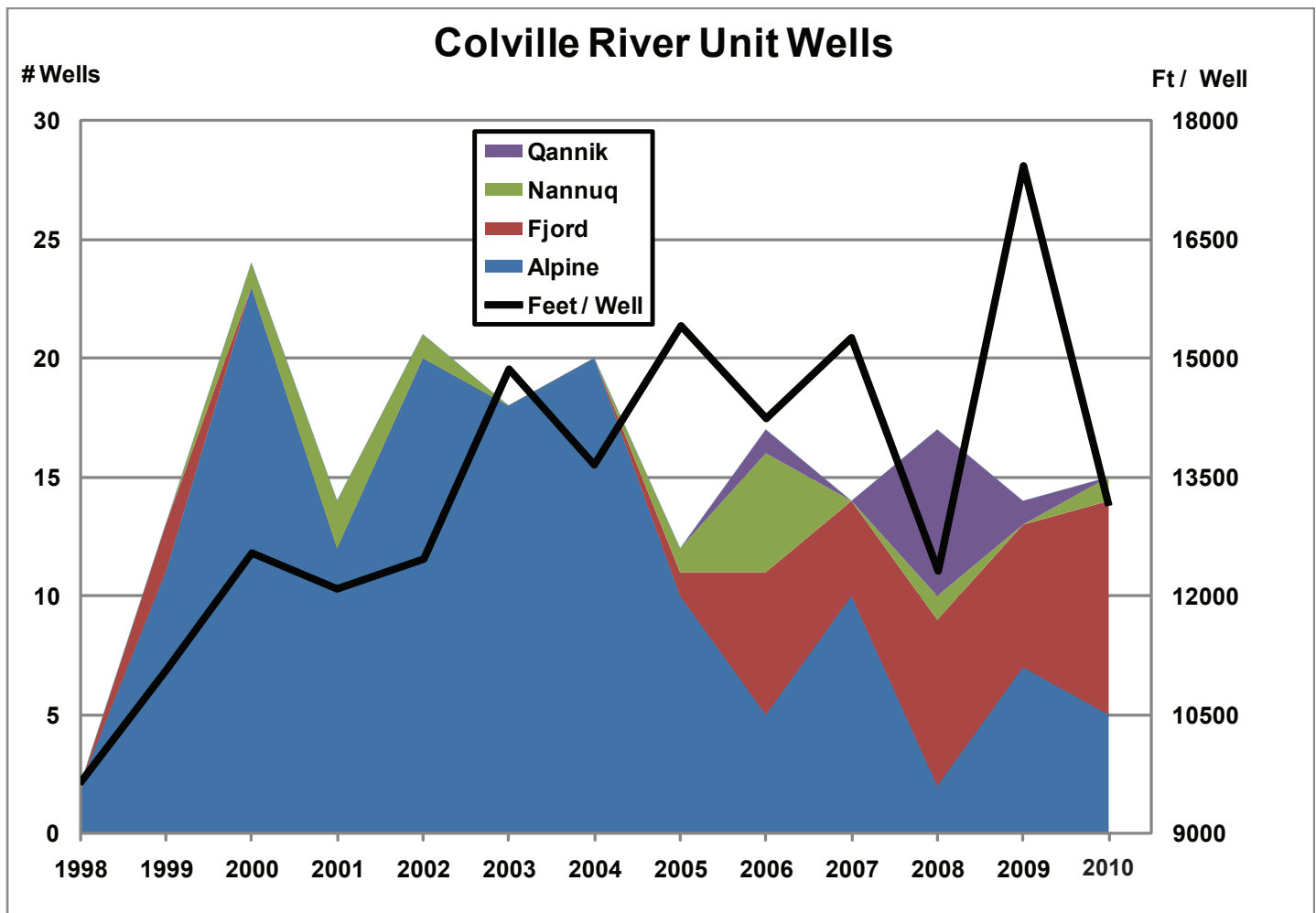
Tarn PA is planning for three new wells within the 2009-2011 timeframe.

Future development in the Kuparuk River Unit will include horizontal, multilateral and coiled tubing drilling to access incremental reserves at reduced cost.



The Colville River Unit graphs show another part of the story -- how development of a field looks at an earlier stage, in comparison to the older fields at Prudhoe Bay and Kuparuk.

The cumulative plot shows a consistent growth in wells drilled, and also how the main area is developed before satellites are added.



Here, again, we can see how Alpine was developed first, and how most development in the past few years are for satellites. Alpine is developed, and needs new pads to the west, which will not happen without a bridge.

The black line shows feet per well increasing over time. The decline in 2008 is due to development of satellites.

Compared to Prudhoe Bay and Kuparuk, we see fewer sidetracked wells. This is due to the stage of the development (Colville River Unit being newer).

Without the bridge, we can expect fewer wells in the future, although some development to the east is possible.



## 2000 - 2009

- Ongoing drilling in the Prudhoe, Kuparuk, and Milne Point fields.
- Northstar came on line late in the year 2000.
- Schrader Bluff development of S-pad at Milne Point and the Polaris satellite at Prudhoe also came online during the same time frame. Continued Ivishak drilling within Prudhoe Bay,
- 2004 drilling activity reflects extensive drilling in the Orion and Polaris satellites in Prudhoe Bay
- West Sak development drilling in Kuparuk, and

- Extensive drilling in the Colville River Unit (CRU).

Drilling in all these areas continue today as companies use new technology to extract more oil out of the reservoirs, as illustrated by the below graph and table.

### Drilling Activity 2000 - 2009

- 1,284 total number of wells drilled (Count includes lateral, sidetrack, and pilot hole wells)
  - 80 Exploration Wells
  - 1,204 Development Wells
- There are two categories for development wells:
  - wells = horizontal, laterals, pilot holes, and conventional (straight & deviated)
  - plugbacks

#### Prudhoe Bay Unit

- Initial Participating Areas (Ivishak)
  - 323 wells
  - 58 plugbacks
- Aurora Participating Area (Kuparuk formation)
  - 11 wells
  - 6 plugbacks
- Borealis Participating Area (Kuparuk formation)
  - 17 wells
  - 12 plugbacks
- Lisburne Participating Area
  - 9 wells
  - 1 plugback
- Niakuk Participating Area (Kuparuk formation)
  - 4 wells
  - 3 plugbacks
- Orion Participating Area (Schrader Bluff formation)
  - 75 wells (included in this total are 32 lateral wells)
  - 22 plugbacks
- Polaris Participating Area

(Schrader Bluff formation)

- 16 wells (included in this total are 5 lateral wells)
- 1 plugback
- Put River Pool (Kuparuk age equivalent)
  - 1 well
  - 1 plugback
- Raven Participating Area (Sag River formation)
  - 2 wells
- Ugnu wells
  - 6 water disposal wells
- Pt McIntyre Participating Area
  - 11 wells
  - 8 plugbacks

#### Milne Point Unit

- 5 exploration wells
- 2 disposal wells
- Kuparuk Participating Area
  - 17 wells
  - 4 plugbacks
- Schrader Bluff Participating Area
  - 42 wells (included in this total are 16 lateral wells)
  - 9 plugbacks
- Ugnu wells
  - 4 wells

#### Endicott Unit

- 1 well in the Sag River formation
- 8 wells Kekiktuk

#### NPR-A

- 14 Exploration wells (Conoco)
- 8 exploration wells (FEX)

#### Colville River Unit

- 1 exploration well (Char)

- Alpine Participating Area
  - 33 wells drilled
  - 12 plugback wells
  - 8 lateral Wells
- Fiord Kuparuk
  - 7 wells drilled
  - 5 plugbacks
  - 1 lateral
- Fiord Nechelik
  - 11 wells
  - 2 lateral wells
- Nanuq Kuparuk
  - 9 wells
  - 2 plugbacks
  - 3 laterals
- Nanuq Nanuq
  - 7 wells
  - 1 plugback
- Qannik
  - 9 wells
- Nechelik Tract Operation
  - 1 well in 2009

#### **Kuparuk River Unit**

- 1 exploration well south of KRU (Antigua in 2006 – Kuparuk target)
- Kuparuk Participating Area
  - 144 wells
  - 26 plugbacks
- Meltwater PA
  - 9 wells
- Tabasco PA
  - 2 wells
  - 3 plugbacks
- Tarn PA
  - 17 wells
  - 1 plugback
- West Sak PA
  - 7 wells labeled exploration (of which 2 are plugbacks)
  - 123 wells (included in total are 72 lateral wells)
  - 75 plugbacks
- ENI drilled south of KRU
  - 3 exploration wells

#### **Northstar Field**

- 13 wells
- 4 sidetracks

#### **Oooguruk Field**

- 1 exploration well in the Torok formation
- 1 disposal well
- 4 Kuparuk wells
- 7 Nuiqsut wells

#### **Nikaichuq field**

- 17 exploration wells (of which 7 are plugbacks)

#### **Badami Unit**

- 2 exploration wells (Kupcake and Red Wolf B1-38 Kekiktuk well)
- Reentering B1-18 Badami development well

#### **Beechey Point**

- 5 exploration wells

#### **Outside established Units**

- West of Kuparuk River Unit
  - 1 exploration well (Cronus)
  - 3 exploration wells (Tofkat)
- South of Kuparuk River Unit
  - White Hills, 5 exploration wells
  - 1 hydrates testing well (Hot Ice)
- North of Prudhoe Bay Unit
  - 4 exploration wells (Sag River, North Shore)
- South of Prudhoe Bay Unit
  - 2 exploration wells (Jacob's Ladder)
  - 1 exploration well (Hailstorm)
- Foothills Area
  - 7 exploration wells

#### **Red Dog Mine**

- 6 wells to supply gas to Red Dog mine

#### **US Government DOI**

##### **Coal Bed Methane Exploration Program**

- 8 in Wainwright
- 1 in Franklin Bluffs