ALASKA STATE LEGISLATURE
SENATE RESOURCES STANDING COMMITTEE
January 28, 2013
3:29 p.m.

MEMBERS PRESENT

Senator Cathy Giessel, Chair
Senator Fred Dyson, Vice Chair
Senator Peter Micciche
Senator Click Bishop
Senator Lesil McGuire
Senator Anna Fairclough
Senator Hollis French

MEMBERS ABSENT

All members present

COMMITTEE CALENDAR

SENATE BILL NO. 29
"An Act relating to the regulation of wastewater discharge from commercial passenger vessels in state waters; and providing for an effective date."

- MOVED SB 29 OUT OF COMMITTE

PRESENTATION: ALASKA PETROLEUM SYSTEMS BY DNR

- HEARD

PREVIOUS COMMITTEE ACTION

BILL: SB 29
SHORT TITLE: CRUISE SHIP WASTEWATER DISCHARGE PERMITS
SPONSOR(s): RULES BY REQUEST OF THE GOVERNOR

01/18/13	(S)	READ THE FIRST TIME - REFERRALS
01/18/13	(S)	RES, FIN
01/23/13	(S)	RES AT 3:30 PM BUTROVICH 205
01/23/13	(S)	Heard & Held
01/23/13	(S)	MINUTE(RES)
01/25/13	(S)	RES AT 3:30 PM BUTROVICH 205
01/25/13	(S)	Heard & Held
01/25/13	(S)	MINUTE(RES)
01/28/13	(S)	RES AT 3:30 PM BUTROVICH 205

WITNESS REGISTER

LYNN KENT, Deputy Commissioner
Department of Environmental Conservation (DEC)
Anchorage, Alaska
POSITION STATEMENT: Supported SB 29.

BOB SWENSON, State Geologist and Director
Division of Geographic and Geophysical Surveys (DGGS)
Department of Natural Resources (DNR)
Fairbanks, Alaska
POSITION STATEMENT: Presented an overview of petroleum resources focusing on the North Slope.

PAUL DECKER, Sr. Petroleum Geologist and Manager
Resource Evaluation Team
Division of Oil and Gas
Department of Natural Resources (DNR)
Anchorage, Alaska
POSITION STATEMENT: Talked about North Slope production and how reserves are estimated.

ACTION NARRATIVE

3:29:14 PM
CHAIR CATHY GIESSEL called the Senate Resources Standing Committee meeting to order at 3:29 p.m. Present at the call to order were Senators French, Bishop, Dyson, Micciche, McGuire, Fairclough and Chair Giessel.

^#SB29

SB 29-CRUISE SHIP WASTEWATER DISCHARGE PERMITS

3:30:06 PM
CHAIR GIESSEL announced SB 29 to be up for consideration.

3:30:36 PM
LYNN KENT, Deputy Commissioner, Department of Environmental Conservation (DEC), Anchorage, Alaska, said the department supported SB 29. She reported that the large cruise ships had made tremendous improvements to their waste water quality over the years, particularly since they had installed advanced waste water treatment systems. Of the 28 ships that visit Alaska regularly, only 15-18 are permitted in any given year to discharge in Alaska and of those, a subset does not discharge. So they are talking about a small universe of dischargers given

the variety of industries in the state. Those that discharge are meeting all of the water quality standards at the point of discharge except for the four they talked about last time. Other methods of reducing those concentrations were evaluated by the Science Advisory Panel and potential improvements to existing systems were looked at, but no new technologies were found that now or in the future would get them all the way to meeting water quality standards at the point of discharge. So, SB 29 allows the department to treat them as other waste water dischargers and to continue to push for improvements over time.

MS. KENT explained that right now cruise ship permits expire every three years, but now for most permits and under this bill they will expire every five years. She said they do have the ability to push the cruise ships to do better and to look at new technologies as they become available and this bill will allow them to make that progress with them.

3:32:26 PM
SENATOR FRENCH said one public comment caught his attention: section 5 that repeals four statutes; the last one being AS 46.03.464 that sets up the Advisory Panel. Someone asked why they are sunseting it before their final report is issued.

3:33:08 PM
MS. KENT explained that when the panel was set up it was in an advisory capacity to the commissioner on improvements that could be made on waste water treatment in cruise ships; it was this panel that decided to produce a report. The report is preliminary, but they did a thorough review and looked at promising technologies, as well. There is no need to keep them on tab for another couple of years when the department has the authority under AS 46.03.048 to continue to push for improvements and search for new technologies with or without a science advisory panel. She said the department did the first technology conference without one.

SENATOR MICCICHE said he, as a commercial fisherman who demands clean water in a pristine marine environment, would vote to pass SB 29 to the next committee. It was better to allow tertiary treated waste water discharge into mixing zones than rather than to encourage cruise ships to discharge into federal waters or into municipal systems that don't require the same degree of treatment. However, he wanted to encourage the cruise industry to convert away from copper water distribution systems in a timely manner and noted that after hearing from some constituents today he would recommend that SB 29 be amended to

not permit waste water discharges within the boundaries of Alaska critical habitat areas in existence at the time of the passage of this bill.

SENATOR DYSON moved to report SB 29, version \A, from committee with individual recommendations [and attached fiscal note(s)]. There were no objections and it was so ordered.

3:36:06 PM
At ease from 3:36 to 3:38 p.m.

3:38:25 PM
CHAIR GIESSEL revised the motion to include the attached fiscal note to SB 29.
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Presentation: Alaska Petroleum Systems by DNR

SENATOR GIESSEL said they would start their first informational hearings on the topic of Alaska's Petroleum Systems that will prepare them for hearing the oil and gas tax legislation.

3:39:33 PM
BOB SWENSON, State Geologist and Director, Division of Geographic and Geophysical Surveys (DGGS), Department of Natural Resources (DNR), Fairbanks, Alaska, said he would present an overview of Alaska's petroleum resources focusing on the North Slope (the most prolific petroleum system that has resource potential).

3:40:43 PM
He said Alaska has an amazing resource base and is a virtual "candy store of geology," particularly in a number of sedimentary basins, each with their unique geologic histories. The North Slope and Cook Inlet are the two producing basins and the state has a significant amount of data from them - both surface geology and subsurface information in the form of seismic data, well logs and other things. They don't have a crystal ball, so a lot of what they do is interpretation; they look at other basins as analogies, at geology in other areas and all the other data available that could help them figure out the subsurface. If they knew exactly where everything was there really wouldn't be an exploration process.

He said the federal government had gone through all of the basins in Alaska and done resource assessments of their own. He explained that each of these basins has varying amounts of data

available to use in that resource assessment. Both on-shore and off-shore Arctic Alaska has huge "technically recoverable undiscovered" resource potential from their standpoint, but it hasn't had "a bit in the ground." The Interior basins are only partially assessed and there is very little information on them available, but he was focusing primarily on the North Slope resources and using mean estimates.

3:43:32 PM
MR. SWENSON went to slide 3: For any one of the basins there are some key components that must be in place for them to have an active and productive petroleum system.
-Must have highly organic source rock and it has to have gone through a maturity phase (heated under great pressure to crack the organics in a hydrocarbon.
-Must have a migration pathway (for conventional resources) to a reservoir with rock that has spaces between all the sand grains so there is a place for the fluid to reside.
-Must have reservoir-quality rock facies (often sandstones with porosity (spaces) and permeability (pathway between those spaces) so the fluid can move.
-Sealing rock (or cap rock) that stops the migration of that fluid. Because hydrocarbons are lighter than water and the primary fluid in subsurface rock is water, the oil always must move up. Because the seal rock has such low permeability the oil will migrate until it hits it and then it can't migrate vertically any further.
-Must have a trap, which is the configuration of a reservoir to where the sealing facies keeps the oil and/or gas in place. (Later he would talk about the difference between reserves and resource estimates.)

3:45:36 PM
He was recently asked what a "basin" is. So slide 4 would help everyone understand what is meant by geologic sedimentary basin. Generally a basin has a highlands area - mountains or someplace - where rock is being eroded into the rivers, and then the rivers carry that out into an accommodation space. It could be a non-marine basin like the Susitna Basin; as long as it is subsiding and going down, space is being created for the sand or other material being carried by the river system to accumulate over millions of years (like Cook Inlet where the deepest part has five miles of non-marine stratigraphy).

In a marine setting like the North Slope, it still has the highlands from which the sediment is being eroded and it's being carried by the large river systems that will dump tons of

sediment into a marine setting every day. So, if you add that up over millions of years, that's how such thick sequences of rock accumulate over time.

MR. SWENSON said one of the issues is, especially if you are in a marine setting that has high organic productivity, that relatively clean water and lots of organics are being developed (algae and other things like diatoms, a microscopic animal) that as it dies rains down on the surface of the sea floor. If you don't have a lot of sediment coming in with that, the only thing that is actually accumulating on the sea floor are these dead animals. If that goes on for millions of years, you get a relatively thick sequence of organic material. It's possible that the surface geology then may change and you start getting a lot of sediment. If the sediments come in and the water becomes "dirty" as soon as it gets into a low energy environment (like a marine setting) that will rain out of the sea water column and deposit the mud, stones and sandstones. As that continues on through time, the rock that was first deposited will be buried very deeply and increase in temperature and pressure. That is when the hydrocarbons get generated and basins get created. The higher temperatures move the rocks into a cracking phase that creates gas instead of the liquid hydrocarbons.

3:48:44 PM
SENATOR DYSON asked if "thermogenic" is what happens at the higher temperatures at the bottom of the chart.

MR. SWENSON responded that it happens in the entire sequence [vertical]; and explained that there are two types of hydrocarbon system: biogenic and thermogenic. The biogenic methane is organic material decaying manifested by bubbling at the surface; Cook Inlet is about 90 percent biogenic methane coming from the coals. It was actually generated when the sediments were very close to the surface, and as the pressure increased it was dissolved into the water system as well as absorbed onto the coal facies. The biogenic methane actually happens in the first 100-200 ft. of burial. The thermogenic gas phase takes over once that is heated up. It goes through a whole series from the initial phase of liquid hydrocarbons being generated and expelled; if you keep heating it up it moves into a gas phase and you get a gas sleeve.

3:50:17 PM
He said the North Slope is a very large area about the size of Wyoming [slide 5] and the Coleville Basin has had a long history of deposition (being a sedimentary basin). Prior to the opening

of the Arctic Ocean, all the sediments came from the north into a marine basin; and the Barrow Arch is really a rift margin that was created when the Arctic Ocean opened. It is an important part of the depositional and tectonic history of this basin that helps the state have such an active petroleum system.

A lot of organic material from that proto-continent came into this basin; the Shublik formation and other source rocks were deposited during that time. The Brooks Range, developed in the late Cretaceous, closed the basin to the south creating what is called the Foreland Basin. Then the sediment source coming from the north changed and a lot of sediments started coming in from the south from the eroding and developing Brooks Range.

MR. SWENSON said during the entire history we ended up with a number of different stratigraphic packages that were either source rocks, seals or reservoir rocks, but primarily source rocks (the Shublik formation and the Kingak shale (actually derived from the north). Once the sediment source started coming from the south, two additional source rock facies were deposited called the gamma ray zone (GRZ) that is very radioactive and rich and the Hue Shale. Each of those in itself are world-class source rocks and an important part of the petroleum system.

3:53:05 PM
SENATOR FRENCH asked why it took so long for a shale play to develop on the North Slope.

MR. SWENSON said he wouldn't have believed that oil could be produced out of shale 10 years ago. He explained that only a portion of the oil is expelled when it is conventionally produced; oil is always left and the problem has always been the technology to extract it. The fracing and horizontal drilling technology to go into shale or low permeable rocks and frac a permeable pathway to get into a well bore has developed greatly over the last 10 years increasing the possibilities of production. However, a number of considerations go into those decisions: the price of the commodity is one so that you can use the more expensive technology to acquire it and the technology, itself.

3:54:59 PM
SENATOR DYSON went to slide 6 and said one rock column had 40,000 ft. and the right hand side had 3,000 ft. and asked what he was missing.

MR. SWENSON answered the 3,000 ft. represents that the Barrow Arch (rock package) is only 3,000 ft. thick, but going south it gets incredibly thick, up to 40,000 ft.

SENATOR DYSON said when he worked at Prudhoe Bay the wells were averaging 8,000 to 10,000 ft. deep, and asked how he could figure out where those wells were on this picture.

MR. SWENSON answered that "Rock Column" is diagrammatic, so the very thinnest that that package gets in the north is 3,000 ft. When you go to the south, it gets up to 40,000 ft. This tells you the thinnest that rock package gets is around 3,000 ft. But Prudhoe Bay is producing rocks at about 8,000 (Sadlerochit Group).

3:57:08 PM
MR. SWENSON explained that slide 7 depicted how the National Petroleum Reserve, Alaska (NPRA) filled going west to east. Organic rocks were deposited and the Brooks Range started to form; a lot of sediment was entering the basin during that mountain building phase. That filling distributes the sand being eroded off the Brooks Range creating the future reservoir rock. It also buries all the source rocks into the hydrocarbon generation window. The further south you get into the 40,000 ft. range all of that goes into the gas phase. That is why there is so much gas potential in the southern part of the Coleville Basin. Up near the Arch where it hasn't been buried very deeply, it stayed within the oil facies (within the shale oil play that Mr. Decker would talk about).

MR. SWENSON said they do a lot of surface work, looking at all the different reservoir facies. Slide 8 showed the Colville Basin stratigraphy; he explained that they try to understand where the facies are and what type of system they were deposited in, and tie that to the subsurface with well and seismic data, to put together how these sediment facies are distributed. This is how they understand where the reservoirs facies might be.

4:00:00 PM
During the mountain building phase, all the deformation moved out into the Coleville Basin; that is where the big folds are - like Umiat.

4:00:25 PM
SENATOR BISHOP asked if a geologist could at least in theory tell from the way the rock lays which direction a reservoir might be.

MR. SWENSON answered that they actually have a "dip meter" and that is one of the pieces of information they look at when doing surface geology or well logs. They look at the angle the rock is laying assuming it was laid flat when it was first put down and that helps to understand the geometries (the trap phase) and to prospectively put together what an individual trap may look like. All of the data goes together into what is called a basin history; keeping that updated is a never-ending process.

He explained that they put a certain geometry, a certain type of geology and geologic history together in what is called a series of "play types," which means possible location for the accumulation of hydrocarbon. The North Slope has literally thousands of those types of configurations. One of the big questions in any basin is if it works and if everything happened at the right time. The wonderful thing about the North Slope is that they have tested many of these plays and have found them to be proven geologic plays and those can be used to extrapolate to areas that are unexplored and under-explored to say that play type works.

4:03:15 PM
Once that is put together, the United States Geological Survey (USGS) uses it along with other data on the basin to do a probabilistic analysis. They do a Monte Carlo on all that information and put out the figure of occurrences that may or may not be and come up with an amount of accumulations they think are in the basin. Then they "risk it" by going through a play risk and an individual prospect risk. Then they come up with a distribution of the reserves in place and take the amount of oil one may get out of it (there is always a lot more oil you don't ever get out) and they come up with a technically recoverable number. As part of that process they end up with a distribution of field sizes (just for state land).

4:06:28 PM
The USGS compare models that are generated in basins with those that don't have that much exploration to make sure they are in the same ball park. There are many smaller fields, but the USGS had only one undiscovered field that is greater than 250 million barrels. You don't even see the Prudhoes and Kuparuks and barely see the Alpines in the distribution. So, it's relatively conservative.

MR. SWENSON said it's important to note that the Prudhoe Bays in the world are "one in a million" in terms of accumulations.

4:07:18 PM
SENATOR FRENCH said he couldn't see Prudhoe Bay on the North Slope on the graph and asked why.

MR. SWENSON answered if this would have been done prior to drilling Prudhoe Bay they wouldn't have seen it either; this is a probabilistic determination, so the chance of running into it is very small. He said this field size distribution was just on state lands and the distribution of field sizes would be different in other areas like the Beaufort and Chukchi Seas, ANWR and NPRA, because there is more area and different geology. But the chance of running into another field the size of Prudhoe Bay on state lands is close to zero.

SENATOR FRENCH asked, for context, how big Alpine is.

MR. SWENSON answered that Alpine is about 635 million barrels. All of this information goes into what is reported as their resource assessments for technically recoverable conventional oil and gas.

4:08:54 PM
How do these resource assessment fit in a global sense? Mr. Swenson explained that back in 2008, the USGS did an assessment of all the circum-Arctic basins and put Alaska into that context. Their assessment indicated that Alaska actually has the highest potential of any of the basins. However, some of the basins they assessed didn't have much information, some of them none. So they some large assumptions were necessary and that resulted in Alaska being 27 percent of their circum-Arctic assessment values. The same thing goes for natural gas.

4:10:26 PM
The next chart [15] incorporated all oil not just circum-polar; they put in all the major petroleum systems on the planet and made comparisons associated with that: the former Soviet Union, the Middle East, Asia-Pacific, Europe and North America (Alaska is included in North America).

The dark green color indicated how much oil had been produced to date. The lighter green color is the remaining reserves (P-1 reserves); the cross hatching represented reserves growth from continued delineation of plays. Finally, if you put Alaska's undiscovered technically recoverable 40 billion barrels (bbo) that has been reported by the USGS, slide 15 showed what it would look like in comparison to other fields in North America.

The cumulative production has been 16 to 18 billion barrels. The same thing goes for gas. The Arctic Alaska gas resources on slide 16 were relative small in comparison to all the other undiscovered resources in North America. The one real point of this graph is that there are lots of areas for investment. These companies have many, many areas with development potential and reserves addition potential as well as undiscovered wild cat resource exploration potential.

4:12:09 PM
The large the range of the numbers on slide 19 meant they don't have as much information for other areas as they do on state lands because the distribution is so wide. Slide 20 presented petroleum reserves and resource definitions. "Plays" are on the bottom, above it is "leads" and "prospects." At the prospect level is when a geologist and engineers will present that prospect to management and say that is something they are putting forth to put in the portfolio of prospects. If it is drilled and they find oil, it moves into the contingent resources; whether or not its economic to develop it has to be worked out. As move up that column you have an increased probability of going to commerciality. Each prospect goes through this process.

SENATOR MICCICHE asked what "PIIP" meant.

MR. SWENSON replied "Petroleum Initially in Place;" in other words all the oil there regardless of how much is recovered.

Slide 21 was a cartoon of how to go from the geology to development. If the geology is wrong, you will never get to development; if any one of the links is not in place you will never get to development; the whole chain has to be there. The next phase is having surface access and capital. Once the prospects are identified, then the industry has to compete for that capital not only externally to the company but internally as well, especially international companies that are looking globally. Competing for that internal cash to actually get to a drilling phase is incredibly important. Every knows the regulatory phase is important, and then there's the next phase: exploration.

4:15:43 PM
If you're in wildcat areas in that exploration phase, you have a 10-20 percent chance of success. Discovering hydrocarbon in one or two of ten wells is considering successful exploration. Finally, you move into the development phase.

SENATOR BISHOP said it's expensive to do business on the North Slope compared to any other provinces south of the 63rd parallel; he had seen a drilling ratio of almost 2:1.

MR. SWENSON said that was an important point and it's just wonderful to have the geology that we do, because we wouldn't be able to compete if we didn't.

4:16:57 PM
PAUL DECKER, Sr. Petroleum Geologist and Manager of the Resource Evaluation Team, Division of Oil and Gas, Department of Natural Resources (DNR), Anchorage, Alaska, started with what production looks like on the North Slope to date saying he would then talk about how future reserves are estimated. Then he would go from the most certain reserves that are actively producing down to the least certain things that aren't actually called reserves but resources.

The first chart (slide 23) was an oil production history graph that showed the Prudhoe Bay unit quickly ramping up in 1977 with over 1.5 million barrels of oil per day through 1988; that had been going down ever since. When Kuparuk River, Milne Point and Endicott came on line, those four together peaked out at over 2 million barrels of oil per day, but the long slide had begun. In about 1999 a number of things happened: one, critical facilities sharing agreements (for some of the discovered resources that had been waiting for some way to get into facilities) were finally reached in the Prudhoe Bay/Kuparuk area. Markedly in about the year 2000 Alpine and Northstar started up and flattened out the decline for two or three years. Colville, North Star, Oooguruk and Nikaitchuq came on in the later years and they were in the over 100 - 600 million barrel ranges. They, too, helped stem the decline but not for very long. So, it's important to do what can be done on the "big dog" at Prudhoe Bay, which decline dictates the overall picture pretty strongly.

SENATOR MICCICHE asked if Prudhoe Bay production from 1978 through about 1992 or 1993 was fairly normal for a field of that size.

MR. DECKER answered yes; it is representative of the three phases in any field if you plot it by itself; you have a sharp ramp-up initially, a plateau and then a drop off.

SENATOR MICCICHE said he was referencing the steady decline after 1993.

MR. DECKER agreed that by then the decline was clearly well under way. He reminded them that often decline curves are plotted on a logarithmic scale, but he didn't do that on this slide so it looks like a concave-up decline.

4:22:05 PM
SENATOR DYSON said Kuparuk was the second largest oil field in all of North America and the graph showed the magnitude of Prudhoe Bay, which is world class. He said the governor was talking about getting back to 1 million barrels a day, but he was not optimistic about doing that just based on these fields, and asked when water flood and other kinds of enhanced oil recovery (EOR) was started.

MR. DECKER answered that he didn't know the details of all the Prudhoe Bay enhanced recovery projects, but it was clearly well under way in 1988 when he started working there. The distinct flattening in 2006/07 was because of an operator began the gas cap water injection project (EOR) to maintain pressure in the reservoir and very successfully slowed the decline.

4:24:15 PM
Slide 24 was a graph of cumulative oil production by unit starting at zero in 1977 going up to the current 16 billion barrels (13 billion barrels of which came from the Prudhoe Bay unit).

MR. DECKER explained that the department turned first to the federal government for the estimates of in-place proved reserves. That is because the Energy Information Administration (EIA) collects information through a questionnaire from both publicly traded and privately held companies every year. The Division of Oil and Gas does not receive reserves data typically on fields; however, they receive seismic and well data and from that they can calculate the state's reserves from production data. So, this slide represents what they have told the federal government, but the drawback is that it is two years out of date even though it was published just a few months ago. In 2010 Alaska-wide proved reserves were about 3.3 billion barrels, almost all of on the North Slope.

4:26:43 PM
He said the division is in the process of trying to make its own estimates from decline curve analysis and he noted that depending on where points in the production history they considered were the rate of decline into the future can be

interpreted very differently (by 1 percent either way). Three annual decline rates varied from 5.17 percent per year to 7.43 percent per year. Just evaluating those two different decline rates resulted in a range of reserves estimates from 2.05 billion barrels to 3.24 billion barrels.

He explained when you are making reserve estimates you can't run the fields all the way down to zero, because they will not continue to be produced below a certain threshold and the threshold rate they chose to truncate everything at was Judge Gleason's estimate of the TAPS low flow rate of 100,000 barrels/day. So, they made the assumption that when TAPS reaches 100,000 barrels a day the fields will shut in and anything gotten out of them to that point will be remaining reserve that we have today. So, if you think back, the 3.24 billion barrel upside number is very close to what the EIA's number would give you if you accounted for the 400 million additional barrels produced after 2010.

SENATOR FAIRCLOUGH said the Judge's analysis was an assumption not a proven fact and she personally didn't believe it was accurate.

MR. DECKER said they had to pick something for their analysis, because reserves have to be truncated at some stage. He explained that varying the decline rates from 5.17 percent to 7.43 percent, both of which are justified from the data, result in a range of 1.19 billion barrels of impact on the estimates. The through-put estimate was varied plus or minus 30 percent (not being sure it was a wide enough range of analysis to look at), but even varying it from an extremely low flow rate of 70,000 barrels to 130,000 barrels a day at a higher low flow threshold varied reserves estimates only by 300 to 400 million barrels a day. So, less sensitivity was attached to the low flow estimate to see if anything can be done to flatten it compared to the decline rate.

He said the decline rates don't account for projects under evaluation or things that may or may not happen into the future; they are simply based on the existing well stock and the decline from the current production.

4:31:08 PM
He showed a forecast (slide 27) based on a decline rate that was calculated from the present back to 1988 when the field peaked out. If you fit a log linear decline to that for an exponential fit to all those data points, then you end up with the most

optimistic lowest decline rate of 5.9 percent. Again - just taking the assumption of the 100,000 barrels a day throughput - you would reach that throughput in the year 2045. So, basically, all the area between present day and 2045 sums up to the existing reserves right now of 3.24 billion barrels.

A forecast based on the decline rate based on the data since 2002 (looking at the steepened part of the graph and not the plateau that happened between 1999 and 2002) to present resulted in an annual decline of about 6.4 percent and the 100,000 barrels a day low flow limit would be hit in 2038 with a reserves rate of 2.41 billion barrels.

Finally, a forecast based on just the last three years of decline with all the maintenance schedules and everything else that goes into that aging facility presents the least optimistic decline of over 7.4 percent per year reaching the 100,000 low flow rate in 2034 ending up with 2.05 billion barrels of reserves. He summarized that he wanted to show them the process of the analysis and the importance of incorporating uncertainty into it just like with undiscovered resources.

SENATOR MICCICHE said the chart seems to show the decline rate decreasing as the flow rates decrease and asked if he carried the 5.19 percent decline through to 2045.

MR. DECKER answered that slide was plotted on a linear vertical axis and explained that part of the reason they typically show things on the logarithmic scale (as with the three decline cases), is that you end up with a log linear fit, which is manifested by a consistent percentage decline year on year.

SENATOR MICCICHE asked if it's easier to slow the decline on a percentage basis in a 400,000 barrel a day field than it is in a 1 million barrel a day field.

MR. DECKER said it's hard for a 400 million-barrel field to make the same kind of dent on the North Slope over all when the Big Kahuna is Prudhoe Bay.

MR. SWENSON added that taking it out of that context and talking about a 10 million barrel field versus a 1 billion barrel field, the decline rate depends on the number of straws in it. So, stopping the decline rate is going to depend on how much work-over and EOR is done. In a huge field, that means an incredible investment - many wells doing all kinds of different things -

and not so much for a smaller field, which may be just drilling one or two wells.

4:36:35 PM
SENATOR FAIRCLOUGH asked if he did an over-laid the qualified capital credits on the decline curve to see what investments were being made and as well as what taxing regimes were in place to see if those had influenced the decline in his three scenarios. She wondered if they were doing a disservice by continually being reflective to 1988 and not honing in on 10 or 5 years to look at how "to move those knobs."

MR. DECKER said the division's analysis had not incorporated those or other variables. It is a complex issue that they hadn't finished at this point.

4:38:10 PM
SENATOR FAIRCLOUGH asked to look at whether the tax structure motivated change on the decline curve or whether qualified capital expenditures had either stayed the curve or overall investment.

CHAIR GIESSEL said those were great questions that PFC could probably answer in the upcoming weeks.

4:39:37 PM
SENATOR FRENCH said he would bring it up after the meeting, but he wanted to know the committee's process for getting questions on the oil bills answered by experts.

MR. DECKER said slide 9 was about reserves growth by reservoir, a concept that was portrayed for the North Slope by pools or participating areas (PA), not at the unit scale.

CHAIR GIESSEL asked him what "PA" meant.

MR. DECKER said a "PA" is the way they manage the land and the thickness of the subsurface that is actually contributing to production in any given pool. Further, he explained that the idea of reserves growth is not that Mother Nature is actually refilling our container, but that more information is available about the fields identifying more oil with a higher level of certainty. The more drilling there is the more can be proved definitively and therefore be booked with the SEC. So, the estimates for any given reservoir or pool typically increase over time as new development investments are made. Slide 30 shows that for a few years after discovery they assigned

something like 7 billion barrels to Prudhoe Bay, but that became 9.6 billion barrels by the time they started the field and then over time it has grown to over 13 billion barrels (just in the main IPA Triassic reservoir). The same can be said of almost every other field on the chart, Kuparuk, for instance. It doesn't always happen; for instance, the Lisburne Field initial held high hopes, but when it began producing, they realized it was not as simple as they had hoped and the reserves were revised downward. But for the most part, the more wells the more investment the more oil you are aware of and can book as reserves.

4:42:37 PM
Slide 10 broke down the estimated total resource by viscous and heavy oil. The first category was the largest; the total in-place viscous and heavy oil on the North Slope (all the reservoirs, all the formations and units) ranged from 24 to 37 billion barrels. Using a reasonable average recovery efficiency of 15 percent, 3.6 to 5.6 billion barrels (viscous and heavy oil) might get recovered. The estimated ultimate recovery (EUR) for the six areas under active development was 1.1 billion barrels (from old division data).

4:44:04 PM
SENATOR FRENCH said 10 years ago they wouldn't have guessed that shale would explode and asked if anything was on the horizon that would give him a glimmer of hope that there is some similar technological advancement coming for heavy oil.

MR. DECKER replied that BP has some pilot projects; their S Pad Ugnu pilot at Milne Point, for instance, and he had received some very encouraging information about that work, but he wasn't in a position to judge their economic benefit.

4:45:15 PM
Slide 11 presented a detailed breakdown on where the viscous and heavy oil reservoirs are; the six active developments are in four different units.

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Slide 12 indicated there was 35 tcf/ of discovered gas on the North Slope, but he was avoiding calling them "reserves," because of the uncertainty of their being produced (for lack of transportation infrastructure). But for most practical purposes, they are secure in the knowledge that there is about 35 tcf of gas in the existing fields (25 tcf at Prudhoe Bay, 8 tcf between Pt. Thomson and some of the NPRA discoveries and 1.8 tcf

scattered between nine other fields). However, he pointed out that the EIA website had a very different number of 8.9 tcf of "proved reserves" which is what the companies were reporting to them.

MR. DECKER said quite a few discoveries had been made on the North Slope since the 1940s, but some have not been put onto sustained production. Slide 13 showed a 2005 USGS list of undeveloped discoveries organized by geologic sequence. Some were going more towards active development and he remarked that in 2005 a lot of projects were on the shelf waiting for things like oil prices to rise, a gas pipeline and an oil pipeline infrastructure to spread.

A second list with many of the same fields was from a 2007 U.S. Department of Energy (DOE) consultant study (slide 13). It came up with some estimates for many of their unproduced volumes. This is where the department does outreach to help new players to the state to realize that some opportunities are out there that may be becoming "low hanging fruit."

SENATOR FRENCH remarked that he saw some nice sized fields and asked who leased Kuvlum that was discovered in 1993 and had 400 million barrels of oil.

MR. DECKER replied that ARCO discovered Kuvlum in the Eastern Beaufort not far from the Hammerhead discovery that Shell has renamed [Sevulic]; it is offshore east of Prudhoe Bay where Shell was actively using its Kulluk rig to drill a top hole in the federal Outer Continental Shelf (OCS).

4:49:36 PM
Continuing down the ladder of things from the most certain reserves to the least certain they get to the USGS Circum-Arctic Resource Appraisal (slides 14&15) that ranks Alaska very prominently in undiscovered resource for both oil and gas.

He recapped that the North Slope has world class source rocks; three of which were alluded to in Mr. Swenson's talk. The Shublik formation is the oldest, the Kingak formation is Jurassic age and occurs just above the Shublik, then the Hue and GRZ are a combined cretaceous to tertiary-age source rock, the youngest; all three are very rich and contribute nearly all of the known oil that is currently in Alaska's big reservoirs.

What's interesting, Mr. Decker said, is that no one has previously gone after the oil that was left behind in the source

rocks and that a significant fraction of the oil never migrates out of the source where it was created. That is the idea behind this kind of play. It's already been noted how successful this has been in North Dakota and south Texas; shale gas has been very prolific in quite a few basins in the Lower 48 and elsewhere. The question has been asked why it has been so long in coming on the North Slope and the answer is that the cost of doing business in Alaska is higher than the cost of anything similar down in the Lower 48, and the shale plays are very cost sensitive. It is not known whether this is going to be commercially viable or not, but they are very pleased that the first company that has tried it, Great Bear Petroleum, has gotten a couple of their wells down. They have not yet drilled the laterals they would need or put those on high pressure fracture stimulation to see what kind of flow rates they would be able to get out, but they are at least beginning their analysis of the rocks they have collected from their first wells.

SENATOR FRENCH asked for some background on what "assessed resources" means.

MR. DECKER replied those are ranges of estimated technically recoverable oil (not necessarily economic) made by the USGS. He mentioned that in some basins one gets the impression that anywhere in the basin will be highly prolific and productive. The North Slope Basin is about the size of Montana and Great Bear picked up a half million acres (the maximum) of it in the state's lease sale a couple of years ago. They chose pretty strategically, because their land is just south of the Prudhoe Bay/Kuparuk petroleum complex, but north of the Foot Hills. Great Bear was pretty open about having consulted the USGS's estimates of things like thermal maturity and source rock richness as part of their research.

He explained that the first overlay going west to east represented where the Shublik formation (the source rock) is at thermal maturity for oil. Another shading indicated where the Shublik formation has the proper ratio of hydrogen to carbon (a high hydrogen index) to generate a nice light oil. Another green highlights the proper thermal maturity window allowing one to see how Great Bear's acreage is nicely squeezed into an area that is rich and at the proper thermal maturity for an oil play, at least according to the data that was available.

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MR. DECKER said that methane hydrates are the most speculative resource and a vast quantity of it is locked up in association with the permafrost where it's basically at the right pressure and temperature for the gas to stabilize inside a crystalline lattice of ice. It can cram 360 fold the density of energy content compared to free gas. There is about 590 tcf/gas in place on-shore on the North Slope, but the extraction remains entirely experimental and the recovery factor is still very unknown. But it is something to keep on their radar screen, but not something they expect to see commercialized very soon.

SENATOR MICCICHE asked where the methane hydrate resources were concentrated.

MR. DECKER replied in this case the 590 tcf were located throughout the entire North Slope, but they had been well delineated through drilling in the Prudhoe Bay/Kuparuk/Tarn region just west of Prudhoe Bay and mostly on state lands. It also occurs in the submarine environment many places in the world. But the best to try to make that resource productive is somewhere in the permafrost where it is concentrated.

4:59:06 PM
Chair Giessel thanked the gentlemen for their testimony and finding no further business to come before the committee, adjourned the Senate Resources Committee meeting at 4:59 p.m.