Beaufort Sea Play 4: Endicott

Geological Assessment:

Grasp UAI: (AAAAABAE)
Play Area: 757 square miles
Play Water Depth Range: 5 – 65 feet
Play Depth Range: 8,000 – 13,500
Play Exploration Chance: 0.75

Play 4, Endicott, Beaufort Sea OCS Planning Area, 2006 Assessment, Undiscovered Technically-Recoverable Oil & Gas		
Assessment Results as of November 2005		
Resource Commodity (Units)	Resources *		
	F95	Mean	F05
BOE (Mmboe)	46	354	1,076
Total Gas (Tcfg)	0.070	0.524	1.572
Total Liquids (Mmbo)	33	261	796
Free Gas** (Tcfg)	0.038	0.251	0.722
Solution Gas (Tcfg)	0.032	0.273	0.850
Oil (Mmbo)	32	255	780
Condensate (Mmbc)	1	6	16
* Risked, Technically-Recoverable			
** Free Gas Includes Gas Cap and Non-Associated Gas			
F95 = 95% chance that resources will equal or exceed the given quantity			
F05 = 5% chance that resources will equal or exceed the given quantity			
BOE = total hydrocarbon energy, expressed in barrels-of-oil-equivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas			
Mmb = millions of barrels			
Tcf = trillions of cubic feet			

Table 1

Play 4, The Endicott play is estimated to contain 354 Mmbl mean BOE of which 75% is expected to be liquid hydrocarbons. This represents about 2.5% of the Beaufort Sea Province hydrocarbon endowment. The overall assessment results for play 4 are shown in table 1. Table 5 reports the detailed assessment results by commodity for play 4.

Table 3 summarizes the volumetric input data developed for the *GRASP* computer model of Beaufort Sea play 4. Table 4 reports the risk model used for play 4. The location of play 4 is shown in figure 1.

The play includes the sandstone reservoirs of the Mississippian Endicott Group. The depositional environment is a pair of regressive - transgressive sequences consisting of swamp, braided stream, flood plain, and shallow marine environments. Hydrocarbon traps are formed by anticlines, faulted anticlines, fault blocks, and unconformable truncations of Endicott reservoirs at younger unconformities. Four OCS wells testing this play (three Tern Island wells and the Liberty #1 well) resulted in the discovery of the 150 Mmbbl in place Liberty oil field. Two OCS wells, Beechy Pt #1 and #2, unsuccessfully tested prospects in the play. The Endicott field with 582 million barrels of recoverable oil produces from the near-shore (Alaska State waters) extension of this play. The primary risk to this play is the presence of a seal since the seal requires impermeable Brookian rocks above the Lower Cretaceous Unconformity which caps the reservoir sequence.

A maximum of 12 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 4. These pools range in mean conditional (un-risked) recoverable volumes from 1.6 Mmboe (pool rank 12) to 244 Mmboe (pool rank 1). Pool rank

1 ranges in possible conditional recoverable volumes from 23 Mmboe (F95) to 885 Mmboe (F05). Table 2 shows the conditional sizes of the 10 largest pools in play 4.

Play 4, Endicott, Beaufort Sea OCS Planning Area, 2006 Assessment, Conditional BOE Sizes of Ten Largest Pools			
Assessment Results as of November 2005			
Pool Rank	BOE Resources *		
	F95	Mean	F05
1	23	244	885
2	8	72	220
3	3.05	34	97
4	1.23	19	56
5	0.62	12	35
6	0.40	8	24
7	0.29	6	18
8	0.24	4.2	14
9	0.19	3.3	11
10	0.15	2.6	8
* Conditional, Technically-Recoverable, Millions of Barrels Energy-Equivalent (Mmboe), from "PSRK.out" file			
F95 = 95% chance that resources will equal or exceed the given quantity			
F05 = 5% chance that resources will equal or exceed the given quantity			
BOE = total hydrocarbon energy, expressed in barrels-of-oil-equivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas			

Table 2

Table 6 reports statistics for the simulation pools developed in the *GRASP* computer model for play 4. In the computer simulation, a total of 57,568 "simulation pools" were sampled for size. These simulation pools can be grouped according to the USGS size class system in which sizes double with each successive class. Pool size class 10 contains the largest share (9,935, or 17%) of simulation pools (conditional, technically recoverable BOE resources) for play 4.   Pool size class 10 ranges from 16 to 32 Mmboe. The largest pool among the 57,568 simulation pools falls within pool size class 17, which ranges in size from 2,048 to 4,096 Mmboe.

GRASP Play Data Form (Minerals Management Service-Alaska Regional Office)

Basin: Beaufort
Play Number: 04
Play UAI Number: AAAAABAE

Assessor: Johnson/Scherr
Play Name: Endicott

Date: 10/7/2005

Play Area: mi^2 (million acres)	757 (484.4)	**Play Depth Range:** feet	8000 10400 13500	
Reservoir Thermal Maturity: % Ro		**Expected Oil Gravity:** $^{\circ}$ API	25	
		Play Water Depth Range: feet	5 35 65	

POOLS Module (Volumes of Pools, Acre-Feet)

Fractile	F100	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Prospect Area (acres)-Model Input	100	800		2000	4000		8000			20000		40000	50000
Prospect Area (acres)-Model Output													
Fill Fraction (Fraction of Area Filled)	0.1		0.14	0.29	0.5		0.76			0.95		0.99	1
Productive Area of Pool (acres)	11	250	393	830	1915	4239.225/7169.512	4377	6705	9097	13450			48980
Pay Thickness (feet)	1	5	10	25	55	59.91/40.890	88	107	117	135	155		170

MPRO Module (Numbers of Pools)

Play Level Chance	1	**Prospect Level Chance**	0.75	**Exploration Chance**	0.75	

Risk Model	Play Chance	Petroleum System Factors	Prospect Chance
		adequate seal	0.75

Fractile	F99	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	4.00	4.70	5.10	5.95	7.00	7.68/1.72	8.20	9.00	9.40	10.30	11.30	11.90	12.00
Numbers of Pools in Play	2	3	4	5	6	5.76/1.76	7	8	8	9	10	10	12

Minimum Number of Pools	0	**Mean Number of Pools**	5.76	**Maximum Number of Pools**	12	

POOLS/PSRK/PSUM Modules (Play Resources)

Fractile	F100	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Oil Recovery Factor (bbl/acre-foot)	34.404	93.601	111.536	149.495	207	233.204/121.884	286.625	341.319	384.173	457.782	557.628	636.018	1245
Gas Recovery Factor (Mcfg/acre-foot)	107	285	338	451	621	696.623/356.606	855	1015	1140	1354	1643	1870	3600
Gas Oil Ratio (Sol'n Gas)(cf/bbl)	90	170	230	390	720	1075.25/1034.163	1350	1900	2300	3200	4700		6000
Condensate Yield ((bbl/Mmcfg)	0.458	3.206	4.508	7.967	15	22.190/21.054	28.241	39.659	49.911	70.179			102.9896

Pool Size Distribution Statistics from *POOLS* (1,000 BOE):	μ (mu)= 9.77009488 σ^2 (sigma squared)= 2.87888523	**Random Number Generator Seed=** 98399

BOE Conversion Factor (cf/bbl)	5620	**Probability Any Pool Contains Both Oil and Free Gas (Gas Cap)**	1
Probability Any Pool is 100% Oil	0	**Fraction of Pool Volume Gas-Bearing in Oil Pools with Gas Cap**	0.25
Probability Any Pool is 100% Gas	0		

Table 3. Input data for Beaufort Sea play 4, 2006 assessment.

Risk Analysis Form - 2006 National Assessment

Assessment Province:	Beaufort	Play Number, Name:	04, Endicott
Assessor(s):	Johnson/Scherr	Play UAI:	AAAAABAE
Date:	19-Oct-05		

For each component, a *quantitative* probability of success (i.e., between zero and one, where zero indicates no confidence and one indicates absolute certainty) based on consideration of the *qualitative* assessment of **ALL** elements within the component was assigned. This is the assessment of the probability that the minimum geologic parameter assumptions have been met or exceeded.

		Play Chance Factors	Averge Conditional Prospect Chance[1]
1. Hydrocarbon Fill component (1a * 1b * 1c)	**1**	*1.0000*	*1.0000*
a. Presence of a Quality, Effective, Mature Source Rock			
Probability of efficient source rock in terms of the existence of sufficient volume of mature source rock of adequate quality located in the drainage area of the reservoirs.	1a	1.00	1.00
b. Effective Expulsion and Migration			
Probability of effective expulsion and migration of hydrocarbons from the source rock to the reservoirs.	1b	1.00	1.00
c. Preservation			
Probability of effective retention of hydrocarbons in the prospects after accumulation.	1c	1.00	1.00
2. Reservoir component (2a * 2b)	**2**	*1.0000*	*1.0000*
a. Presence of reservoir facies			
Probability of presence of reservoir facies with a minimum net thickness and net/gross ratio (as specified in the resource assessment).	2a	1.00	1.00
b. Reservoir quality			
Probability of effectiveness of the reservoir, with respect to minimum effective porosity, and permeability (as specified in the resource assessment).	2b	1.00	1.00
3. Trap component (3a * 3b)	**3**	*1.0000*	*0.7500*
a. Presence of trap			
Probability of presence of the trap with a minimum rock volume (as specified in the resource assessment).	3a	1.00	1.00
b. Effective seal mechanism			
Probability of effective seal mechanism for the trap.	3b	1.00	0.75

Overall Play Chance (Marginal Probability of hydrocarbons, MPhc)	**1.0000**	
(1 * 2 * 3) *Product of All Subjective Play Chance Factors*		

Average Conditional Prospect Chance[1]		**0.7500**
(1 * 2 * 3) *Product of All Subjective Conditional Prospect Chance Factors*		
[1] **Assumes that the Play exists (where all play chance factors = 1.0)**		
Must be consistent with play chance and prospect distribution -- See discussion on Page 3 of Guide		

Exploration Chance	**0.7500**
(*Product of Overall Play Chance and Average Conditional Prospect Chance*)	

Comments: *See guidance document for explanation of the Risk Analysis Form*

Table 4. Risk model for Beaufort Sea play 4, 2006 assessment.

GRASP - Geologic and Economic Resource Assessment Model - PSUM Module Results
Minerals Management Service - Alaska OCS Region
GRASP Model Version: 8.29.2005)
Computes the Geologic Resource Potential of the Play

Play UAI: AAAAABAE			**Play No.**		**4**	
World	Level	-	World	Level	Resources	
Country	Level	-	UNITED	STATES	OF	AMERICA
Region	Level	-	MMS	-	ALASKA	REGION
Basin	Level	-	**BEAUFORT**	**SHELF**		
Play	**Level**	**-**	**Play**		**4 -**	**Endicott Play**
Geologist	Peter	Johnson				
Remarks	Play	4	2005	Assessment		
Run Date & Time:	Date	19-Sep-05	Time	13:47:36		

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	354,250	367,650
Oil (Mbo)	255,400	269,950
Condensate (Mbc)	5,538	8,215
Free (Gas Cap & Nonassociated) Gas (Mmcfg)	251,110	266,240
Solution Gas (Mmcfg)	273,300	399,790

10000 (Number of Trials in Sample)
0.9996 (MPhc [Probability] of First Occurrence of Non-Zero Resource)
Windowing Feature: used

Empirical Probability Distributions of the Products

Greater Than Percentage	BOE (Mboe)	Oil (Mbo)	Condensate (Mbc)	Free (Gas Cap & Nonassociated) Gas (Mmcfg)	Solution Gas (Mmcfg)
100	0	0	0	0	0
99.99	0	0	0	0	0
99	17,401	12,224	358	15,311	11,770
95	45,589	32,288	821	38,390	31,750
90	69,395	49,403	1,247	57,619	47,730
85	88,287	62,901	1,490	74,514	59,786
80	107,900	77,181	1,892	84,584	77,448
75	127,060	89,208	2,358	107,710	91,760
70	147,050	104,280	2,617	109,910	115,770
65	166,970	121,150	2,889	132,280	109,030
60	188,580	138,160	3,196	140,560	124,850
55	210,680	149,820	3,847	164,030	156,350
50	236,900	171,710	4,059	184,210	159,360
45	265,040	189,680	4,748	206,060	190,740
40	298,740	217,230	4,541	217,730	214,850
35	338,570	242,200	5,195	252,470	259,930
30	385,180	278,330	5,513	269,210	300,260
25	440,230	317,500	7,090	318,510	331,380
20	516,540	368,840	7,507	360,810	427,080
15	620,270	452,740	10,924	442,080	438,050
10	778,590	555,250	11,874	563,670	624,780
8	863,910	618,630	14,137	648,080	650,930
6	987,160	696,960	14,282	728,380	822,230
5	1,076,000	780,240	16,076	722,460	849,630
4	1,186,700	877,390	21,468	839,680	778,120
2	1,508,600	1,098,600	23,942	989,660	1,179,800
1	1,852,100	1,356,800	24,704	1,049,800	1,595,200
0.1	2,952,100	2,230,100	13,291	1,135,700	2,847,000
0.01	3,591,900	2,007,000	26,237	919,730	7,840,200
0.001	3,785,400	2,626,900	31,817	1,311,700	5,019,800

Table 5. Assessment results by commodity for Beaufort Sea play 4, 2006 assessment.

Basin: BEAUFORT SHELF
Play 04 - Endicott Play
UAI Key: AAAAABAE

Model Simulation "Pools" Reported by "Fieldsize.out" *GRASP* Module

	Classification and Size			Pool Count Statistics				Pool Types Count			Mixed Pool Range		Oil Pool Range		Gas Pool Range		Total Pool Range			Pool Resource Statistics (MMBOE)			
Class	Min (MMBOE)	Max (MMBOE)	Pool Count	Percentage	Trial Average	Trials w/Pool Avg		Mixed Pool	Oil Pool	Gas Pool	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Total Resource	Average Resource
1	0.0312	0.0625	79	0.137229	0.0079	0.007902		79	0	0	1	1	0	0	0	0	1	1		0.031643	0.062367	3.697193	46.799909
2	0.0625	0.125	180	0.312674	0.018	0.018005		180	0	0	1	2	0	0	0	0	1	2		0.062685	0.124613	17.227526	95.708475
3	0.125	0.25	367	0.637507	0.0367	0.036711		367	0	0	1	2	0	0	0	0	1	2		0.125628	0.249536	69.160233	188.447505
4	0.25	0.5	877	1.523416	0.0877	0.087726		877	0	0	1	3	0	0	0	0	1	3		0.250063	0.499507	327.276426	373.177230
5	0.5	1	1645	2.85749	0.1645	0.164549		1645	0	0	1	3	0	0	0	0	1	3		0.500059	0.999490	1228.477000	746.794581
6	1	2	2898	5.034047	0.2898	0.289887		2898	0	0	1	4	0	0	0	0	1	4		1.000152	1.999135	4312.425000	1.488070
7	2	4	4631	8.044399	0.4631	0.463239		4631	0	0	1	4	0	0	0	0	1	4		2.000990	3.999710	13754.510000	2.970095
8	4	8	6846	11.892023	0.6846	0.684805		6846	0	0	1	5	0	0	0	0	1	5		4.000474	7.999452	40385.015000	5.899067
9	8	16	8847	15.367912	0.8847	0.884965		8847	0	0	1	6	0	0	0	0	1	6		8.000602	15.998774	102971.803000	11.639177
10	16	32	9935	17.257851	0.9935	0.993798		9935	0	0	1	6	0	0	0	0	1	6		16.000058	31.996222	228614.631000	23.011034
11	32	64	8756	15.209839	0.8756	0.875863		8756	0	0	1	6	0	0	0	0	1	6		32.001356	63.989197	397744.978000	45.425419
12	64	128	6226	10.815036	0.6226	0.622787		6226	0	0	1	5	0	0	0	0	1	5		64.010032	127.994017	560883.918000	90.087364
13	128	256	3478	6.041551	0.3478	0.347904		3478	0	0	1	4	0	0	0	0	1	4		128.013226	255.844182	617279.470000	177.481155
14	256	512	1645	2.85749	0.1645	0.164549		1645	0	0	1	3	0	0	0	0	1	3		256.066056	511.966615	578064.725000	351.407135
15	512	1024	827	1.436562	0.0827	0.082725		827	0	0	1	3	0	0	0	0	1	3		512.171930	1021.343000	578027.825000	698.945374
16	1024	2048	263	0.456851	0.0263	0.026308		263	0	0	1	2	0	0	0	0	1	2		1027.292000	2001.917000	352753.110000	1.341267
17	2048	4096	26	0.045164	0.0026	0.002601		26	0	0	1	1	0	0	0	0	1	1		2057.434000	3515.309000	66049.555000	2.540367
18	4096	8192	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
19	8192	16384	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
20	16384	32768	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
21	32768	65536	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
22	65536	131072	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
23	131072	262144	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
24	262144	524288	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
25	524288	1048576	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
Not Classified			42	0.072957	0.0042	0.004201	Below Class	42	0	0									Below Class	0.006074	0.030420	0.894736	21.303242
	Totals		57568	99.999992	5.7568	5.758528	Above Class	0	0	0									Above Class	0.000000	0.000000	0.000000	0.000000

Min and Max refer to numbers of pools of the relevant size class that occur within any single trial in the simulation.

Min and Max refer to aggregate resources of the relevant size class that occur within any single trial in the simulation.

Number of Pools not Classified: 42
Number of Pools below Class 1: 42
Number of Trials with Pools: 9997

Table 6. Statistics for simulation pools created in computer sampling run for Beaufort Sea play 4, 2006 assessment.
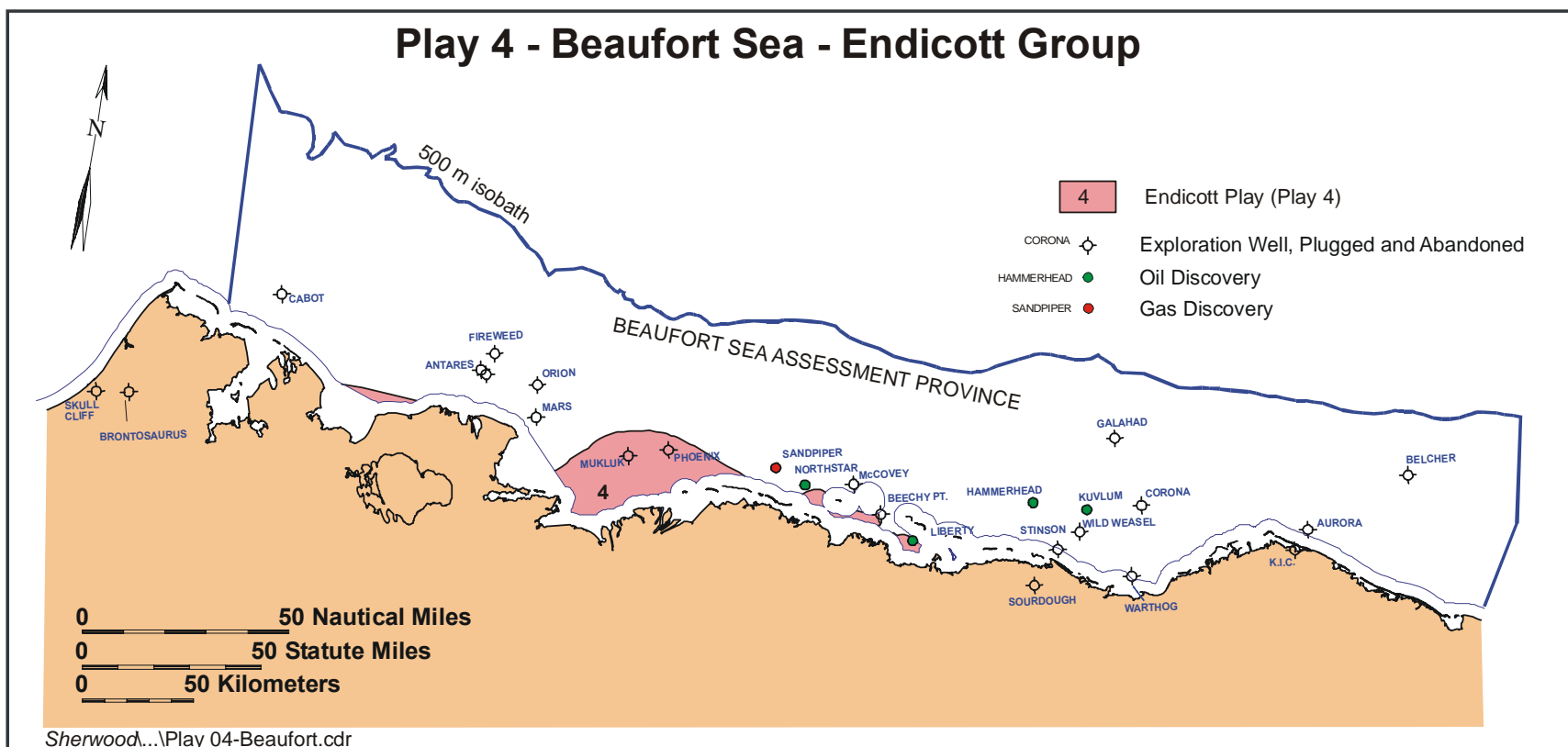
Figure 1. Map location of Beaufort Sea play 4, 2006 assessment.