

UNITED STATES DEPARTMENT OF THE INTERIOR  
BUREAU OF LAND MANAGEMENT

WYOMING STATE OFFICE  
RESERVOIR MANAGEMENT GROUP

Revised Activity and Surface Disturbance Projections for  
the Reasonable Foreseeable Development Scenario for Oil  
and Gas Activities on Bureau Managed Lands in the North  
Dakota Study Area

February 25, 2011

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**REVISED ACTIVITY AND SURFACE  
DISTURBANCE PROJECTIONS FOR THE  
REASONABLE FORESEEABLE DEVELOPMENT  
SCENARIO FOR OIL AND GAS ACTIVITIES ON  
BUREAU MANAGED LANDS IN THE NORTH  
DAKOTA STUDY AREA**

Stratum	Oil
<sup>3</sup> Ratcliff	Gas, Oil
Bakken	Gas, Oil; Source Rock
Three Forks Fm/ <sup>4</sup> Sanish sand	Gas, Oil
<sup>5</sup> Birdbear	Gas, Oil
Dunaway	Gas, Oil; Source Rock

*Image from the North Dakota Study Area stratigraphic chart, Bureau files.*

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BUREAU OF LAND MANAGEMENT

**FINAL**

February 25, 2011

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# **Revised Activity and Surface Disturbance Projections for the Reasonable Foreseeable Development Scenario for Oil and Gas Activities on Bureau Managed Lands in the North Dakota Study Area<sup>1</sup>**

## ***Discussion***

The final report of the Reasonable Foreseeable Development Scenario for Oil and Gas Activities on Bureau Managed Lands in the North Dakota Study Area (Final Report) was submitted to the Montana State Office on October 2, 2009. During the months that followed, new developments in well drilling and completion techniques allowed for operators to effectively target the Three Forks Formation in a manner similar to that employed in the most recent Bakken play (see discussion in final report). Since this Three Forks play was not foreseen to be as productive or as attractive a drilling target as it became, a supplement to the Final Report was made.

## **Methodology<sup>2</sup>**

The first step in determining how to revise the projected activity and disturbance estimates involved a new poll of the operators in the Study Area who were actively drilling the Three Forks Formation. A list of operators was obtained from the North Dakota Field Office. Each operator was contacted by telephone and asked what additional development activity they anticipated during the Planning Period as it related to the Three Forks, and where they anticipated development occurring. A new development potential map was produced based on the original work included in the Final Report and the new information gathered from these operators (Figure S1).

During the course of the operator polling it became apparent that not only would the activity projections need to be revised, but also the method for calculating the associated surface disturbance. In the Final Report we had originally tied surface disturbance to individual wells. Each well had an associated initial and interim disturbance acreage which varied type of well (exploratory, existing, oil, gas, or coalbed gas). However, many of the Three Forks wells anticipated to be drilled by the polled operators are expected to be co-located with new or existing Bakken wells, and/or drilled from multi-well pads. Resultantly, the method for calculating disturbance was revised. Instead of a *per well* disturbance figure, calculations were made *per well pad* (Tables S1 and S2).

Polling of active operators conducted in May, 2010 indicated areas of activity where development is expected to occur with an average of 1.5 wells per well pad. The areas are

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<sup>1</sup> This document is a supplement to the *Reasonable Foreseeable Development Scenario for Oil and Gas Activities on Bureau Managed Lands in the North Dakota Study Area* (Stilwell, et al., 2009).

<sup>2</sup> The reader is encouraged to refer to the Final Report for a detailed discussion of the general methodology used in determining development and surface disturbance projections. Only the deviations from the original method are discussed in this report.

where either the Bakken or Three Forks *new exploratory oil well* development is expected to include some multi-pad drilling for either Three Forks or Bakken oil, as well as areas where existing or new Bakken wells will be co-located with Three Forks wells. It is important to note that 1.5 wells per pad is the anticipated *average*, and that some well pads may have far more than the average (as many as eight according to one operator's estimate), but many more will be single-well pads. These areas are shown on the development potential map (Figure S1) and include lands in both the High and Very High development potential categories.

### **Revised Activity and Surface Disturbance Projections**

Since the revisions to the Final Report only include changes to projected development associated with the Three Forks and Bakken oil plays, the original projections related to gas and coalbed gas activity have remained unchanged. These projections are included on Table S1 and S2. It should be noted, however, that these tables differ from the corresponding tables in the Final Report (Tables 5, 8a and 8b)<sup>345</sup> in that the total number of *well pads* are presented, and not individual wells. For gas and coalbed gas these are considered interchangeable as the average well pad for these types of development is expected to be associated with only one well. Such is not the case for new exploratory oil wells, however.

Included in the original Table 8 from the Final Report were wells projected to be drilled from August 2008 through December 2009. This category was necessary at the time because the Planning Period was to start in January 2010, and the most current drilling data was only available through August 2008 at the time of the initial writing. Since this supplement/revision was prepared after December 2009 and drilling data was available for the August 2008 to December 2009 time period, this category was dropped from the revised table as any wells drilled during that time are now considered historic and not part of future projections. Well data was downloaded from IHS Energy that included wells spud through August, 2010 in order to obtain an accurate account of existing active gas wells and active oil wells for Table S2a (IHS Energy Group, 2010).

Oil wells are the primary category in which revisions to the Final Report were needed. The vast majority of existing active oil wells at the time of the revision were single well pads. No changes were made to this category in the table except to update the actual number based on the new data download mentioned above.

Multi-well pads associated with new exploratory oil development will have slightly larger initial surface disturbance (4.2 acres/pad) than the single well pads (4.0 acres/pad).

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<sup>3</sup> **Table 5.** Estimated oil and gas (excluding coalbed gas) development potential classification acres, number of townships, projected average drilling densities, and percentage of the North Dakota Study Area within each development potential classification type for the period 2010 through 2029.

<sup>4</sup> **Table 8a.** Disturbance Associated With Existing Well Pads and Projected Active Well Pads for the Baseline Scenario (Short-Term Disturbance).

<sup>5</sup> **Table 8b.** Disturbance Associated With Existing Well Pads and Projected Producing Well Pads for the Baseline Scenario (Long-Term Disturbance).

Access road disturbance will remain the same. Based on information provided by the North Dakota Field Office, operator input, current drilling trends, and institutional knowledge, areas of Very High development potential are expected to average 30 *pads* per township. Similarly, areas of High development potential are expected to average 15 *pads* per township (Table S1).

Tables S2a and S2b project short-term and long-term disturbance associated with existing wells and projected drilling activity for 2010 through 2029. The method used to determine the number of new wells drilled during this period has been previously discussed here and in the Final Report. In addition, we assumed that:

- of the existing active wells, eight gas wells and 879 oil wells will be abandoned by December 2029,
- the success rate of new coalbed gas wells will be 90 percent,
- the success rate of new noncoalbed gas wells will be 93 percent as determined by the previous 20 years of drilling history, and
- the success rate for new oil *pads* will average 78 percent for single-well pads, and 88 percent for multi-well pads.

The rationale behind these success rates is discussed in detail in the Final Report with the exception of the rate for new multi-oil well pads.<sup>6</sup> Multi-well pads are expected to have a greater success rate than for single-well pads as only one of the multiple wells need be a productive well for the well pad to remain in the long-term. Based on the assumptions outlined in the Final Report and regional data comparing the success rates of multi-well versus single-well pads, a success rate ten percent greater than that for single-well pads is used. This amounts to 88 percent.

Table S2a shows our projection of new exploratory and development well pads (6,765 pads with 727 of those managed by the Bureau) that could be constructed in the Study Area from 2010-2029. The number of associated wells would be 8,460 total new exploratory and development wells with 921 managed by the Bureau. There are an additional 6,971 existing active wells/pads (211 gas and 6,760 oil) (IHS Energy Group, 2010). Of those existing wells/pads, 972 total wells (121 gas, and 851 oil wells) are Bureau managed. Table S2a also calculates associated acres of total surface disturbance (short-term disturbance) directly associated with all new and existing well pads. Approximately 66,806 acres of new and existing short-term surface disturbance (7,945 acres of disturbance on Bureau managed lands) could occur if all 6,765 projected wells are drilled.

Table S2b calculates new producing well pads remaining active after all new exploratory and development wells are drilled and all dry holes are abandoned and reclaimed (5,711 total new well pads with 602 of those pads on Bureau managed lands). There are an additional 6,084 existing well pads (857 on Bureau managed lands) that will remain active after some formerly existing producing wells cease to be productive and are

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<sup>6</sup> In the Final Report, the success rate for new exploratory oil *wells* is presented as 78 percent. Since single-well pads were assumed in the Final Report, this success rate was used in the revision for new exploratory single-oil well pads.

abandoned. Table S2b also calculates unreclaimed associated acres of total surface disturbance (long-term disturbance) directly associated with all remaining well pads. Approximately 17,405 acres of new unreclaimed surface disturbance (1,945 acres of unreclaimed Bureau managed lands) could remain in the long-term. Total unreclaimed long-term surface disturbance (for all well types) would be 36,631 acres, with 4,499 of those acres on Bureau managed lands.

### **Estimated Future Oil and Gas Production**

As indicated above, we projected 8,460 wells (not including coalbed gas wells) would be drilled within the analysis period of 2010 through 2029. A table projecting wells spud by year, for the 2010 through 2029 period, was calculated along with a confidence interval of values (Table S3). These values were determined by using a GNU Octave program that was written to statistically analyze the available historical drilling and production data constrained by oil and gas futures prices and projected drilling activities (8,460 new wells in 20 years) to generate the values in Table S3. Although Table S3 projects a range of new wells that could be drilled each year, the mean value projected should be considered the most likely scenario for new drilling in any one year and cumulatively for the 20-year period. Yearly drilling projections are provided for analysis purposes only. The likelihood that the mean well projection in any given year will match actual activity is low. As stated earlier, we expect that if coalbed gas drilling does occur that activity will only come about toward the end of the 20-year assessment period and drilling will be in groups of 16 to 25 wells.

Table S4 is our forecast of hydrocarbon production for 20 years beyond 2009. Both gas and oil production will increase during the period. The cumulative values listed are just for the 2010 through 2029 projection period and ignore historical production. Of the 64,743,748 barrels of forecasted cumulative oil production, about 7,575,019 barrels are projected to come from Bureau managed oil and gas minerals. Of the 1,740,974,343,000 cubic feet of forecasted cumulative gas production, about 480,508,918,668 cubic feet are projected to come from Bureau managed oil and gas minerals.

As with the Final Report, coalbed gas production was not assessed. If any coalbed gas production does come online during the 20-year assessment period it will only be a minor part of the total hydrocarbon production between 2010 and 2029.

## ***References***

IHS Energy Group, 2010, Rocky Mountain US Well Data: Network License for PI/Dwights PLUS Version 1.7.

Stilwell, D.E., Elser, A.M., and Davis-Lawrence, S.W., 2009, Reasonable Foreseeable Development Scenario for Oil and Gas Activities on Bureau Managed Lands in the North Dakota Study Area: U.S. Department of the Interior, Bureau of Land Management, Wyoming State Office. Available for download from [http://www.blm.gov/mt/st/en/fo/north\\_dakota\\_field/rmp/RFD.html](http://www.blm.gov/mt/st/en/fo/north_dakota_field/rmp/RFD.html)

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**Table S1.** Estimated oil and gas (excluding coalbed gas) development potential classification acres, number of townships, projected average drilling densities, and percentage of the North Dakota Study Area within each development potential classification type for the period 2010 through 2029.

**Table S2a.** Disturbance Associated With Existing Well Pads and Projected Active Well Pads for the Baseline Scenario (Short-Term Disturbance).

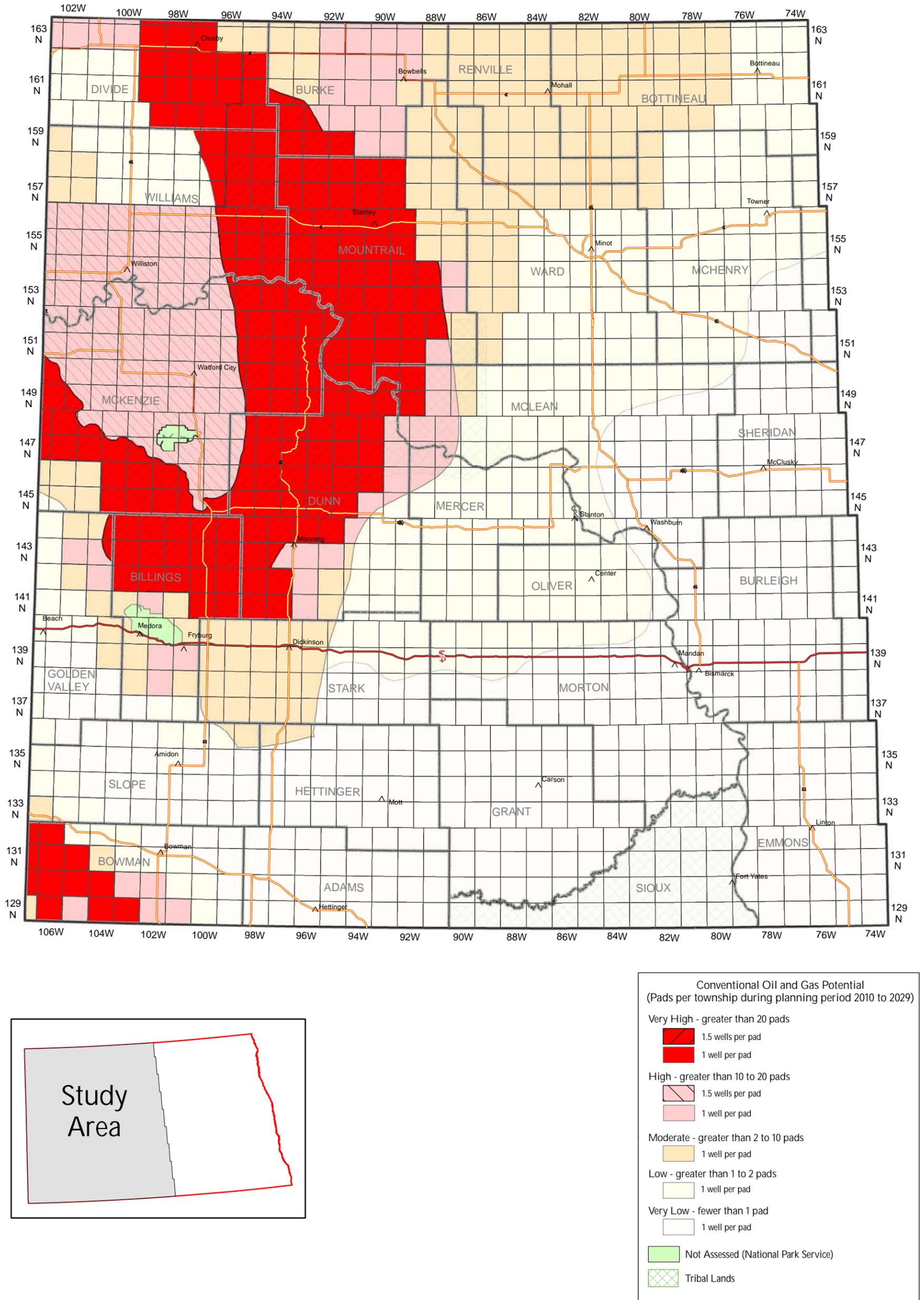
**Table S2b.** Disturbance Associated With Existing Well Pads and Projected Producing Well Pads for the Baseline Scenario (Long-Term Disturbance).

**Table S3.** Annual projection of North Dakota Study Area Wells drilled from 2010 to 2029 and their associated confidence interval.

**Table S4.** Forecast of North Dakota Study Area annual and cumulative oil and gas production for 2010 through 2029.

Figure S1.

Oil and gas (excluding coalbed gas) development potential and projected pad densities and associated wells within the North Dakota Study Area for 2010 through 2029



0 25 50 Miles  
1:1,419,517

**Table S1.** Estimated oil and gas (excluding coalbed gas) development potential classification acres, number of townships, projected average drilling densities, and percentage of the North Dakota Study Area within each development potential classification type for the period 2010 through 2029.

<b>Development Potential</b>	<b>Acres</b>	<b>Area (townships)</b>	<b>Average pads per township</b>	<b>% of Study Area</b>
Very High (1.5 wells/pad)	3,469,258	150.58	30.00	13.68
Very High (1 well/pad)	622,928	27.04	30.00	2.46
High (1.5 wells/pad)	1,564,674	67.91	15.00	6.17
High (1 well/pad)	1,195,994	51.91	15.00	4.72
Moderate	3,581,305	155.44	6.00	14.12
Low	5,865,171	254.56	1.50	23.13
Very Low	9,059,101	393.19	0.05	35.72
None	0	0.00	0.00	0.00

**Table S2a. Disturbance Associated With Existing Well Pads and Projected Active Well Pads for the Baseline Scenario (Short-Term Disturbance)**

Well Pads/Wells					Acres of Surface Disturbance			
Type	Total Pads	Total Wells	BLM Managed Pads	BLM Managed Wells	Access Roads	Well Pad	Total	BLM Managed
New Exploratory and Development Coalbed Gas (2010-2029)	150	150	7	7	0.6	0.50	165	8
New Exploratory and Development Gas (2010-2029)	315	315	34	34	0.6	0.50	347	40
New Exploratory and Development Oil (1.5 wells/pad) (2010-2029)	3,691	5,537	402	602	2.9	4.20	26,206	2,945
New Exploratory and Development Oil (1.0 wells/pad) (2010-2029)	2,609	2,609	284	284	2.9	4.00	18,002	2,023
<b>Total New Exploratory and Development Well Pads/Wells</b>	<b>6,765</b>	<b>8,611</b>	<b>727</b>	<b>927</b>			<b>44,720</b>	<b>5,017</b>
Existing Active Gas (as of August 2010)	211	211	121	121	0.3	0.25	116	71
Existing Active Oil (as of August 2010)	6,760	6,760	851	851	1.5	1.75	21,970	2,857
<b>Total Existing and Projected Well Pads/Wells</b>	<b>6,971</b>	<b>6,971</b>	<b>972</b>	<b>972</b>			<b>22,086</b>	<b>2,928</b>
<b>Total Well Pads/Wells</b>	<b>13,736</b>	<b>15,582</b>	<b>1,699</b>	<b>1,899</b>	<b>Total Short-Term Disturbance</b>		<b>66,806</b>	<b>7,945</b>

**Table S2b. Disturbance Associated With Existing Well Pads and Projected Producing Well Pads for the Baseline Scenario (Long-Term Disturbance)**

Well Pads/Wells					Acres of Surface Disturbance			
Type	Total Pads	Total Wells	BLM Managed Pads	BLM Managed Wells	Access Roads	Well Pad	Total	BLM Managed
New Producing Coalbed Gas (2010-2029)	135	135	6	6	0.3	0.25	74	4
New Producing Gas (2010-2029)	293	293	21	21	0.3	0.25	161	12
New Producing Oil ( 1.5 wells/pad) (2010-2029)	3,248	4,872	353	530	1.5	1.75	10,556	1,186
New Producing Oil (1.0 wells/pad) (2010-2029)	2,035	2,035	221	221	1.5	1.75	6,614	743
<b>Total New Producing Well Pads/Wells</b>	<b>5,711</b>	<b>7,335</b>	<b>602</b>	<b>778</b>			<b>17,405</b>	<b>1,945</b>
Existing Active Gas (as of August 2010) <sup>1</sup>	203	203	116	116	0.3	0.25	111	68
Existing Active Oil (as of August 2010) <sup>1</sup>	5,881	5,881	740	740	1.5	1.75	19,114	2,486
<b>Total Existing and Projected Well Pads/Wells</b>	<b>6,084</b>	<b>6,084</b>	<b>857</b>	<b>857</b>			<b>19,225</b>	<b>2,554</b>
<b>Total Well Pads/Wells</b>	<b>11,795</b>	<b>13,419</b>	<b>1,458</b>	<b>1,635</b>	<b>Total Long-Term Disturbance</b>		<b>36,631</b>	<b>4,499</b>

<sup>1</sup>Minus projected abandonments during August 2010-December 2029 period.

Table S3: Annual projection of North Dakota Study Area Wells drilled from 2010 to 2029 and their associated confidence interval.

**BASED ON 8,460 WELLS**

<b>YEAR</b>	<b>LOW</b>	<b>MEAN</b>	<b>HIGH</b>
<b>2010</b>	636	730	911
<b>2011</b>	507	571	696
<b>2012</b>	247	320	456
<b>2013</b>	86	173	341
<b>2014</b>	287	373	539
<b>2015</b>	334	413	566
<b>2016</b>	35	120	282
<b>2017</b>	429	491	608
<b>2018</b>	146	229	390
<b>2019</b>	209	294	457
<b>2020</b>	470	559	732
<b>2021</b>	76	157	313
<b>2022</b>	234	328	508
<b>2023</b>	365	452	621
<b>2024</b>	239	326	494
<b>2025</b>	510	611	810
<b>2026</b>	870	961	1,144
<b>2027</b>	435	517	678
<b>2028</b>	314	421	627
<b>2029</b>	311	414	620
<b>Total</b>	<b>6,740</b>	<b>8,460</b>	<b>11,793</b>

Table S4: Forecast of North Dakota Study Area annual and cumulative oil and gas production for 2010 through 2029.

**BASED ON 8,460 WELLS**

<b>YEAR</b>	<b>ANNUAL OIL(bbls)</b>	<b>CUM OIL (bbls)</b>	<b>ANNUAL GAS(mcf)</b>	<b>CUM GAS (mcf)</b>
2010	51,936,770	51,936,770	80,667,706	80,667,706
2011	52,661,468	104,598,238	82,906,807	163,574,512
2012	53,377,120	157,975,358	79,329,016	242,903,528
2013	52,441,000	210,416,358	81,919,767	324,823,295
2014	54,889,219	265,305,577	85,148,165	409,971,460
2015	56,314,876	321,620,453	84,868,270	494,839,730
2016	54,063,805	375,684,259	83,419,791	578,259,521
2017	56,489,859	432,174,118	86,321,419	664,580,940
2018	57,007,889	489,182,007	86,893,375	751,474,315
2019	58,260,262	547,442,269	87,516,299	838,990,613
2020	57,746,297	605,188,566	88,265,154	927,255,767
2021	58,611,845	663,800,411	90,235,880	1,017,491,646
2022	59,788,330	723,588,741	88,307,988	1,105,799,634
2023	59,999,859	783,588,600	88,881,716	1,194,681,350
2024	61,592,215	845,180,816	87,693,623	1,282,374,973
2025	62,391,793	907,572,609	92,062,699	1,374,437,672
2026	61,532,245	969,104,853	88,416,705	1,462,854,378
2027	62,883,936	1,031,988,789	88,995,794	1,551,850,172
2028	62,660,576	1,094,649,365	96,092,795	1,647,942,967
2029	64,743,748	11,593,926,725	93,031,376	1,740,974,343