Stationary Source and Geologic Storage Estimates for Carbon Dioxide by State/Province

APPENDIX C

Prepared for

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Prepared by

DOE Regional Carbon Sequestration Partnerships and the National Carbon Sequestration Database and Geographical Information System

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Stationary Source Emissions Estimates by State/Province for CO_2

The Table ("Identified Stationary CO_2 Sources") displays stationary source data by state/province which were obtained from the RCSPs and compiled by NATCARB. As described on page 17, a total of more than 4,600 stationary sources with total annual emissions exceeding 3,200 million metric tons (3,500 million tons) of CO_2 have been documented by the RCSPs.

Information on the methods used in estimating stationary source emissions can be found in the "CO_2 Stationary Source Emission Estimation Methodologies Summary" in Appendix A. Emissions data specific to each RCSP can be found within each RCSP's section of this document.

States with the greatest stationary source emissions include Texas, Indiana, Florida, Ohio, Pennsylvania, Illinois, New York, Kentucky, California, and West Virginia. The 332 stationary sources identified in Texas are estimated to emit 365 million metric tons/year (402 million tons/year) of CO_2. The 82 stationary sources identified in Indiana are estimated to emit 164 million metric tons/year (181 million tons/year). The 108 stationary sources identified in Florida are estimated to emit 143 million metric tons/year (157 million tons/year).

Identified Stationary CO_2 Sources

State/Province	CO_2 Emissions Million Metric Ton/Year	Number of Sources
Alabama	79.6	59
Alaska	6.0	20
Alberta	95.5	101
Arizona	59.5	24
Arkansas	34.5	30
British Columbia	3.4	6
California	103.7	159
Colorado	46.7	56
Connecticut	9.7	63
Delaware	6.2	16
District of Columbia	0.2	5
Florida	142.7	108
Georgia	89.9	64
Hawaii	8.3	40
Idaho	2.5	16
Illinois	121.1	150
Indiana	164.1	82
Iowa	50.3	178
Kansas	43.9	102
Kentucky	106.8	50
Louisiana	98.7	129
Maine	5.3	106
Manitoba	1.7	9
Maryland	38.1	22
Massachusetts	24.6	137
Michigan	95.7	54
Minnesota	65.6	168
Mississippi	33.8	48
Missouri	89.8	217
Montana	45.5	71
Nebraska	30.6	94
Nevada	26.9	19
New Hampshire	8.3	66
New Jersey	15.4	103
New Mexico	31.7	32
New York	111.4	412
North Carolina	76.8	55
North Dakota	41.6	58
Ohio	139.1	53
Oklahoma	51.6	45
Ontario	3.3	2
Oregon	12.6	14
Pennsylvania	131.0	74
Rhode Island	2.2	18
Saskatchewan	19.0	18
South Carolina	40.3	48
South Dakota	18.0	38
Tennessee	65.6	29
Texas	364.8	332
Utah	39.1	27
Vermont	0.4	73
Virginia	46.4	56
Washington	25.4	21
West Virginia	102.1	30
Wisconsin	81.6	580
Wyoming	53.7	87
TOTAL	3,212	4,674

Total CO_2 Storage Resource Estimates by State/Province

The Table ("Total CO_2 Storage Resource") displays the total CO_2 resource estimates by state/province which were obtained from the RCSPs and compiled by NATCARB. The total CO_2 resource is the sum of oil and gas reservoir, unmineable coal seam, and deep saline formation CO_2 resource estimates. The current total CO_2 storage resource identified by the RCSPs is approximately 3,600 to 12,900 billion metric tons (3,900 to 14,200 billion tons).

Information on the methods used in estimating CO_2 storage resource can be found in the "Methodology for Development of Geologic Storage Estimates for Carbon Dioxide" in Appendix B. It is important to note that the data in the table is a high-level overview and is not intended as a substitute for site-specific assessment and testing. Individual projects will require development of detailed geologic models and simulation of CO_2 injection to estimate site-specific storage potential.

Total CO_2 Storage Resource*

State/Province	Million Metric Tons		Million Tons	
	Low Estimate	High Estimate	Low Estimate	High Estimate
Alabama	31,260	117,765	34,458	129,813
Alaska	84,000	84,000	92,594	92,594
Alberta	87,625	87,625	96,590	96,590
Arizona	254	810	280	893
Arkansas	11,929	41,778	13,150	46,052
British Columbia	749	749	826	826
California	83,567	311,194	92,117	343,032
Colorado	36,312	125,781	40,028	138,650
Connecticut	11	46	13	51
Delaware	1	5	1	5
District of Columbia	14	57	16	63
Florida	43,828	170,078	48,313	187,479
Georgia	3,313	13,252	3,652	14,608
Hawaii	0	0	0	0
Idaho	0	0	0	0
Illinois	20,693	78,226	22,810	86,229
Indiana	13,440	53,313	14,815	58,768
Iowa	3	10	3	11
Kansas	4,326	12,232	4,769	13,484
Kentucky	7,175	27,583	7,909	30,405
Louisiana	420,944	1,633,040	464,011	1,800,116
Maine	0	0	0	0
Manitoba	618	618	681	681
Maryland	1,315	5,266	1,450	5,804
Massachusetts	6	25	7	27
Michigan	20,651	81,487	22,764	89,824
Minnesota	0	0	0	0
Mississippi	118,744	454,150	130,893	500,614
Missouri	152	606	167	669

State/Province	Million Metric Tons		Million Tons	
	Low Estimate	High Estimate	Low Estimate	High Estimate
Montana	266,962	990,386	294,275	1,091,712
Nebraska	13,434	13,524	14,808	14,908
Nevada	0	0	0	0
New Hampshire	0	0	0	0
New Jersey	49	198	54	218
New Mexico	40,510	137,301	44,654	151,348
New York	2,969	10,869	3,273	11,981
North Carolina	3,679	14,714	4,055	16,220
North Dakota	30,478	35,498	33,597	39,130
Ohio	10,790	32,336	11,894	35,644
Oklahoma	11,165	14,033	12,307	15,469
Ontario	1	3	1	3
Oregon	16,727	66,909	18,438	73,754
Pennsylvania	8,247	24,263	9,091	26,746
Rhode Island	0	0	0	0
Saskatchewan	29,666	29,666	32,701	32,701
South Carolina	1,373	5,491	1,513	6,053
South Dakota	28,210	65,219	31,096	71,892
Tennessee	1,249	4,998	1,376	5,509
Texas	599,899	2,207,530	661,275	2,433,382
Utah	34,005	130,519	37,484	143,873
Vermont	0	0	0	0
Virginia	496	1,161	547	1,280
Washington	93,045	363,779	102,564	400,997
West Virginia	4,873	14,994	5,372	16,528
Wisconsin	0	0	0	0
Wyoming	217,820	784,329	240,105	864,574
Offshore	1,184,928	4,686,453	1,306,158	5,165,924
TOTAL	3,591,506	12,933,868	3,958,953	14,257,132

* States/Provinces with a "zero" value represent estimates of minimal CO_2 storage resource.

CO_2 Storage Resource Estimates for Oil and Gas Reservoirs by State/Province

The Table ("CO_2 Storage Resource Estimates for Oil and Gas Reservoirs") displays oil and gas reservoir CO_2 resource estimates by state/province. As described on page 18, the RCSPs have documented the location of 138 billion metric tons (152 billion tons) of CO_2 storage potential in oil and gas reservoirs distributed over 27 states and 3 provinces. In the Table, states/provinces with a "zero" value represent estimates of minimal oil and gas reservoir CO_2 storage resource while states/provinces with a blank represent areas that have not yet been assessed by the RCSPs. Carbon dioxide storage resource data for oil and gas reservoirs specific to each RCSP can be found within each RCSP's section of this document. Additional details can be obtained from the NATCARB website (http://www.natcarb.org/).

Areas with the greatest oil and gas reservoir storage potential identified include Texas, offshore, Oklahoma, Alberta, New Mexico, California, and Louisiana. These CO_2 storage resources are significant, with an estimated 130 years of storage available in Texas oil and gas reservoirs at Texas's current emission rate. Oklahoma's oil and gas reservoirs are estimated to have CO_2 resource for 194 years worth of emissions from the state.

It is important to note that the data in the table is a high-level overview and is not intended as a substitute for site-specific assessment and testing. Individual projects will require development of detailed geologic models and simulation of CO_2 injection to estimate site-specific storage potential.

CO_2 Storage Resource Estimates for Oil & Gas Reservoirs by State*

State/Province	Million Metric Tons	Million Tons
Alabama	427	471
Alaska		
Alberta	9,328	10,282
Arizona	70	77
Arkansas	313	345
British Columbia		
California	7,692	8,479
Colorado	1,723	1,899
Connecticut	0	0
Delaware	0	0
District of Columbia	0	0
Florida	197	217
Georgia	0	0
Hawaii	0	0
Idaho	0	0
Illinois	338	373
Indiana	68	75
Iowa	0	0
Kansas	1,624	1,791
Kentucky	104	114
Louisiana	6,990	7,705
Maine	0	0
Manitoba	618	681
Maryland	0	0
Massachusetts	0	0
Michigan	457	504
Minnesota	0	0
Mississippi	699	771
Missouri		

State/Province	Million Metric Tons	Million Tons
Montana	1,262	1,391
Nebraska	23	26
Nevada		
New Hampshire	0	0
New Jersey	0	0
New Mexico	8,246	9,090
New York	240	264
North Carolina		
North Dakota	4,589	5,059
Ohio	3,481	3,838
Oklahoma	10,012	11,036
Ontario		
Oregon		
Pennsylvania	2,759	3,041
Rhode Island	0	0
Saskatchewan	6,245	6,884
South Carolina	0	0
South Dakota	232	255
Tennessee		
Texas	47,761	52,648
Utah	1,410	1,544
Vermont	0	0
Virginia	81	89
Washington	0	0
West Virginia	1,353	1,492
Wisconsin	0	0
Wyoming	2,100	2,315
Offshore	17,628	19,432
TOTAL	138,070	152,198

* States/Provinces with a "zero" value represent estimates of minimal oil and gas reservoir CO_2 storage resource while states/provinces with a blank represent areas that have not yet be assessed by the RCSPs.

CO_2 Storage Resource Estimates for Unmineable Coal Seams by State/Province

The Table ("CO_2 Storage Resource Estimates for Unmineable Coal Seams") displays unmineable coal seam storage resource estimates by state/province. As described on page 19, the RCSPs have documented the location of 157 to 178 billion metric tons (173 to 196 billion tons) of CO_2 geologic storage potential in unmineable coal seams distributed over 24 states and 3 provinces. In the Table, states/provinces with a zero represent estimates of minimal unmineable coal seam CO_2 storage resource while states/provinces with a blank represent areas that have not yet be assessed by the RCSPs. Unmineable coal seam CO_2 storage resource data specific to each RCSP can be found within each RCSP's section of this document. Additional details can be obtained from the NATCARB website (http://www.natcarb.org/).

Areas with the greatest unmineable coal seam CO_2 storage resource identified include Alaska, Wyoming, Texas, Louisiana, Mississippi, Alberta, Washington, Alabama, and Arkansas. These CO_2 storage resources are significant, with an estimated 14,000 years of CO_2 storage resource available in Alaska unmineable coal seams for Alaska's current emission rate. Wyoming's unmineable coal seams alone are estimated to have storage resource for 350 to 356 years worth of emissions from the state.

It is important to note that the data in the table is a high-level overview and is not intended as a substitute for site-specific assessment and testing. Individual projects will require development of detailed geologic models and simulation of CO_2 injection to estimate site-specific storage potential.

CO_2 Storage Resource Estimates for Unmineable Coal Seams*

State/Province	Million Metric Tons		Million Tons	
	Low Estimate	High Estimate	Low Estimate	High Estimate
Alabama	2,333	3,308	2,572	3,646
Alaska	84,000	84,000	92,594	92,594
Alberta	3,197	3,197	3,524	3,524
Arizona	0	0	0	0
Arkansas	2,000	3,001	2,205	3,308
British Columbia				
California				
Colorado	489	858	540	946
Connecticut	0	0	0	0
Delaware	0	0	0	0
District of Columbia	0	0	0	0
Florida	1,795	2,534	1,978	2,793
Georgia	0	0	0	0
Hawaii				
Idaho	0	0	0	0
Illinois	1,371	1,953	1,511	2,153
Indiana	172	245	190	271
Iowa	3	10	3	11
Kansas	2	8	2	9
Kentucky	276	385	304	424
Louisiana	11,554	16,448	12,736	18,131
Maine	0	0	0	0
Manitoba	0	0	0	0
Maryland	5	5	6	6
Massachusetts				
Michigan				
Minnesota	0	0	0	0
Mississippi	7,289	10,424	8,034	11,491
Missouri	3	12	3	13
Montana	293	293	322	322
Nebraska	0	1	0	1
Nevada	0	0	0	0
New Hampshire	0	0	0	0
New Jersey	0	0	0	0
New Mexico	78	310	86	342
New York	129	129	142	142
North Carolina				
North Dakota	599	599	660	660
Ohio	192	192	212	212
Oklahoma	4	10	4	11
Ontario	0	0	0	0
Oregon				
Pennsylvania	198	198	219	219
Rhode Island	0	0	0	0
Saskatchewan				
South Carolina	0	0	0	0
South Dakota				
Tennessee	1	1	1	1
Texas	18,538	26,469	20,435	29,177
Utah	30	120	33	132
Vermont	0	0	0	0
Virginia	279	730	307	805
Washington	2,800	2,800	3,086	3,086
West Virginia	177	177	195	195
Wisconsin	0	0	0	0
Wyoming	18,788	19,109	20,710	21,064
Offshore	0	0	0	0
TOTAL	156,595	177,526	172,616	195,689

* States/Provinces with a "zero" value represent estimates of minimal unmineable coal seam CO_2 storage resource while states/provinces with a blank represent areas that have not yet be assessed by the RCSPs.

Deep Saline Formation Storage Resource Estimates by State/Province

The table displays deep saline formation storage resource estimates by state/province. As described on page 20, the RCSPs have documented the location of deep saline formations with an estimated storage potential from 3,300 to more than 12,200 billion metric tons (from 3,600 to more than 13,500 billion tons). In the table, states/provinces with a zero represent estimates of deep saline formation storage resource while states/provinces with a blank represent areas that have not yet be assessed by the RCSPs. Deep saline formation storage resource data specific to each RCSP can be found within each RCSP's section of this document. Additional details can be obtained from the NATCARB website (http://www.natcarb.org/).

Areas with the greatest deep saline formation storage resource identified include offshore, Texas, Louisiana, Montana, Wyoming, Mississippi, Washington, California, Alberta, and Florida. These storage resources are significant, with an estimated 1,466 to 5,860 years of storage resource available in Texas deep saline formations for Texas's current emission rate.

It is important to note that the data in the table is a high-level overview and is not intended as a substitute for site-specific assessment and testing. Individual projects will require development of detailed geologic models and simulation of CO_2 injection to estimate site-specific storage potential.

CO_2 Storage Resource Estimates for Deep Saline Formations*

State/ Province	Million Metric Tons		Million Tons	
	Low Estimate	High Estimate	Low Estimate	High Estimate
Alabama	28,500	114,030	31,416	125,696
Alaska				
Alberta	75,100	75,100	82,783	82,783
Arizona	184	740	203	816
Arkansas	9,616	38,465	10,600	42,400
British Columbia	749	749	826	826
California	75,875	303,502	83,638	334,553
Colorado	34,100	123,200	37,589	135,805
Connecticut	11	46	13	51
Delaware	1	5	1	5
District of Columbia	14	57	16	63
Florida	41,837	167,348	46,118	184,469
Georgia	3,313	13,252	3,652	14,608
Hawaii				
Idaho				
Illinois	18,984	75.935	20,926	83,704
Indiana	13,200	53.000	14,550	58,422
Iowa				
Kansas	2,700	10,600	2,976	11,684
Kentucky	6,796	27,094	7,491	29,866
Louisiana	402,401	1,609,602	443,570	1,774,280
Maine				
Manitoba				
Maryland	1,309	5,260	1,443	5,798
Massachusetts	6	25	7	27
Michigan	20,194	81,030	22,260	89,320
Minnesota				
Mississippi	110,757	443,026	122,088	488,352
Missouri	149	595	164	655

State/ Province	Million Metric Tons		Million Tons	
	Low Estimate	High Estimate	Low Estimate	High Estimate
Montana	265,407	988,831	292,561	1,089,998
Nebraska	13,410	13,500	14,782	14,881
Nevada				
New Hampshire				
New Jersey	49	198	54	218
New Mexico	32,186	128,744	35,479	141,916
New York	2,600	10,500	2,866	11,574
North Carolina	3,679	14,714	4,055	16,220
North Dakota	25,290	30,310	27,877	33,411
Ohio	7,117	28,663	7,845	31,595
Oklahoma	1,149	4,011	1,267	4,421
Ontario	1	3	1	3
Oregon	16,727	66,909	18,438	73,754
Pennsylvania	5,290	21,306	5,831	23,486
Rhode Island				
Saskatchewan	23,420	23,420	25,817	25,817
South Carolina	1,373	5,491	1,513	6,053
South Dakota	27,979	64,987	30,841	71,636
Tennessee	1,248	4,997	1,376	5,508
Texas	533,600	2,133,300	588,193	2,351,558
Utah	32,565	128,990	35,897	142,187
Vermont				
Virginia	137	350	151	386
Washington	90,245	360,979	99,478	397,911
West Virginia	3,343	13,463	3,685	14,840
Wisconsin				
Wyoming	196,932	763,120	217,080	841,195
Offshore	1,167,300	4,668,825	1,286,726	5,146,493
TOTAL	3,296,843	12,618,271	3,634,143	13,909,246

* States/Provinces with a "zero" value represent estimates of minimal deep saline formation CO_2 storage resource while states/provinces with a blank represent areas that have not yet be assessed by the RCSPs.

CO_2 Stationary Source Emissions and CO_2 Storage Resource Estimates Summary by State/Province

This table is a compilation of all data provided in this Appendix. State/Provinces with the "zero" represents estimates of the minimal CO_2 storage resource while States/Provinces with a blank represent areas that have not yet been accessed by the RCSPs.

CO_2 Emissions			Oil and Gas Reservoir Storage Resource	Unmineable Coal Seams Storage Resource		Deep Saline Formation Storage Resource		Total Storage Resource	
				Million Metric Tons		Million Metric Tons		Million Metric Tons	
State/ Province	Million Metric Ton/ Year	No. Sources	Million Metric Tons	Low Estimate	High Estimate	Low Estimate	High Estimate	Low Estimate	High Estimate
Alabama	79.6	59	427	2,333	3,308	28,500	114,030	31,260	117,765
Alaska	6.0	20		84,000	84,000			84,000	84,000
Alberta	95.5	101	9,328	3,197	3,197	75,100	75,100	87,625	87,625
Arizona	59.5	24	70	0	0	184	740	254	810
Arkansas	34.5	30	313	2,000	3,001	9,616	38,465	11,929	41,778
British Columbia	3.4	6				749	749	749	749
California	103.7	159	7,692			75,875	303,502	83,567	311,194
Colorado	46.7	56	1,723	489	858	34,100	123,200	36,312	125,781
Connecticut	9.7	63	0	0	0	11	46	11	46
Delaware	6.2	16	0	0	0	1	5	1	5
District of Columbia	0.2	5	0	0	0	14	57	14	57
Florida	142.7	108	197	1,795	2,534	41,837	167,348	43,828	170,078
Georgia	89.9	64	0	0	0	3,313	13,252	3,313	13,252
Hawaii	8.3	40	0					0	0
Idaho	2.5	16	0	0	0			0	0
Illinois	121.1	150	338	1,371	1,953	18,984	75.935	20,693	78,226
Indiana	164.1	82	68	172	245	13,200	53	13,440	53,313
Iowa	50.3	178	0	3	10			3	10
Kansas	43.9	102	1,624	2	8	2,700	10,600	4,326	12,232
Kentucky	106.8	50	104	276	385	6,796	27,094	7,175	27,583
Louisiana	98.7	129	6,990	11,554	16,448	402,401	1,609,602	420,944	1,633,040
Maine	5.3	106	0	0	0			0	0
Manitoba	1.7	9	618	0	0			618	618
Maryland	38.1	22	0	5	5	1,309	5,260	1,315	5,266
Massachusetts	24.6	137	0			6	25	6	25
Michigan	95.7	54	457			20,194	81,030	20,651	81,487
Minnesota	65.6	168	0	0	0			0	0
Mississippi	33.8	48	699	7,289	10,424	110,757	443,026	118,744	454,150

CO_2 Emissions			Oil and Gas Reservoir Storage Resource	Unmineable Coal Seams Storage Resource		Deep Saline Formation Storage Resource		Total Storage Resource	
				Million Metric Tons		Million Metric Tons		Million Metric Tons	
State/ Province	Million Metric Ton/ Year	No. Sources	Million Metric Tons	Low Estimate	High Estimate	Low Estimate	High Estimate	Low Estimate	High Estimate
Missouri	89.8	217		3	12	149	595	152	606
Montana	45.5	71	1,262	293	293	265,407	988,831	266,962	990,386
Nebraska	30.6	94	23	0	1	13,410	13,500	13,434	13,524
Nevada	26.9	19		0	0			0	0
New Hampshire	8.3	66	0	0	0			0	0
New Jersey	15.4	103	0	0	0	49	198	49	198
New Mexico	31.7	32	8,246	78	310	32,186	128,744	40,510	137,301
New York	111.4	412	240	129	129	2,600	10,500	2,969	10,869
North Carolina	76.8	55				3,679	14,714	3,679	14,714
North Dakota	41.6	58	4,589	599	599	25,290	30,310	30,478	35,498
Ohio	139.1	53	3,481	192	192	7,117	28,663	10,790	32,336
Oklahoma	51.6	45	10,012	4	10	1,149	4,011	11,165	14,033
Ontario	3.3	2		0	0	1	3	1	3
Oregon	12.6	14				16,727	66,909	16,727	66,909
Pennsylvania	131.0	74	2,759	198	198	5,290	21,306	8,247	24,263
Rhode Island	2.2	18	0	0	0			0	0
Saskatchewan	19.0	18	6,245			23,420	23,420	29,666	29,666
South Carolina	40.3	48	0	0	0	1,373	5,491	1,373	5,491
South Dakota	18.0	38	232			27,979	64,987	28,210	65,219
Tennessee	65.6	29		1	1	1,248	4,997	1,249	4,998
Texas	364.8	332	47,761	18,538	26,469	533,600	2,133,300	599,899	2,207,530
Utah	39.1	27	1,410	30	120	32,565	128,990	34,005	130,519
Vermont	0.4	73	0	0	0			0	0
Virginia	46.4	56	81	279	730	137	350	496	1,161
Washington	25.4	21	0	2,800	2,800	90,245	360,979	93,045	363,779
West Virginia	102.1	30	1,353	177	177	3,343	13,463	4,873	14,994
Wisconsin	81.6	580	0	0	0			0	0
Wyoming	53.7	87	2,100	18,788	19,109	196,932	763,120	217,820	784,329
Offshore	Not Applicable	Not Applicable	17,628	0	0	1,167,300	4,668,825	1,184,928	4,686,453
TOTAL	3,212	4,674	138,070	156,595	177,526	3,296,843	12,618,271	3,591,506	12,933,868

If you have any questions, comments, or would like more information about DOE's Carbon Sequestration Program, please contact the following persons:

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