U.S. Underground Storage of Natural Gas in 1997: Existing and Proposed

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This special report examines recent and proposed expansions of underground natural gas storage capacity and deliverability in the United States, as of September 1, 1997.

Underground natural gas storage facilities and operations have taken on a higher profile in today's restructured, competitive market. With customers making their own arrangements to ensure supply reliability, they are more conscious of costs involved and are demanding new and more flexible storage services. This has led to increased interest in information about existing storage resources and proposals for development of new storage resources.

In 1993, 1994, and 1995, significant amounts of working gas capacity and deliverability were added to the Nation's inventory of underground natural gas storage assets (Table SR1). The greatest increases occurred in 1993, with more than 103 billion cubic feet (Bcf) of added working gas capacity and almost 4 Bcf per day of added deliverability. Additions in 1994 and 1995 were a little less than half that of 1993, with working gas capacity increases of about 42 and 49 Bcf, respectively, and deliverability increases of about 1.9 and 1.4 Bcf per day.

The development pace slowed substantially in 1996, with only 12 Bcf of added working gas capacity and less than 700 million cubic feet per day of added deliverability. However, the set of storage projects currently planned or under development would boost development activity considerably in the next several years. If all projects currently proposed through the year 2000 are built as planned, working gas additions in 1997 and 1998 would exceed the level in any of the past 3 years. Also, the average additions to deliverability during the next 4 years would be comparable to the average in 1994 and 1995 (Table SR2). Indeed, 1998 would be a standout year, with 147 Bcf of added working gas capacity—43 percent more than the 103 Bcf added in 1993—and 2.7 Bcf per day of added deliverability.

At least 104 storage projects are currently in some stage of consideration or development—31 of these projects represent new facilities and 73 are expansion projects. If all of these projects were implemented, working gas capacity would increase by 10 percent (393 Bcf) from the 1996 level and deliverability by almost 15 percent (11.1 Bcf per day). However, 13 of the 31 proposed new projects have such uncertain futures that their developers are unwilling to specify projected online dates. Taken together, all projects with uncertain online dates account for 34 percent (135 Bcf) of proposed new working gas capacity and 28 percent (3.1 Bcf) of additions to deliverability.

A variety of reasons have been offered for the uncertain status of these projects, including: lack of customer commitments, the need for various approval actions by regulatory agencies, unexpected physical difficulties in developing the facility, and the need to attract investor capital. Certainly, in some cases these obstacles can be overcome, but it remains to be seen which projects will actually be implemented.

In reality, the same can be said of many of the projects that do have projected online dates. Past history has shown that many supposedly viable projects continue to be pushed into the future, go on indefinite "hold," or are canceled outright. Thus, while the industry's current plans for storage development are quite extensive, it is still too early to tell whether the slowdown in storage development during 1996 was only temporary or the beginning of a tapering off of storage development.

Gas Storage Facilities

There are three principal types of underground storage facilities in operation in the United States today:

- Depleted reservoirs in oil and/or gas fields ("depleted fields" for short), which in many instances were at one time producing reservoirs for these hydrocarbons
- Caverns hollowed out in salt "bed" or "dome" formations
- Aquifer reservoirs, which are water-only reservoirs conditioned to hold natural gas.

Table SR1. Additions to Working Gas Capacity and Deliverability, by New and Expansion Projects, 1993-1996

Storage Additions	1993	1994	1995	1996	Total 1993-96
Number of Projects					
New	11	7	6	3	27
Expansion	7	7	7	3	24
Total	18	14	13	6	51
Working Gas Capacity (billion cubic feet)					
New	87.2	20.9	34.4	4.8	147.3
Expansion	16.0	20.9	14.6	7.0	58.5
Total	103.2	41.8	49.0	11.8	205.8
Deliverability (million cubic feet per day)					
New	3,233	986	940	480	5,639
Expansion	564	870	470	200	2,104
Total	3,797	1,856	1,410	680	7,743

Sources: Energy Information Administration (EIA), *The Value of Underground Storage in Today's Natural Gas Industry* (March 1995); and EIAGIS-NG Geographic Information System, Proposed Underground Storage Database, as of September 1, 1997, based on Federal Energy Regulatory Commission filings and information compiled from various industry news sources.

In addition, one gas storage facility is currently operating in a defunct mine. (A second such facility is under consideration as a potential new gas storage facility.) Natural gas is also commonly stored in a liquefied state (as liquefied natural gas, or LNG) in above-ground tanks and used primarily to augment supplies of gas from pipeline and traditional underground storage sources to satisfy the intermittent, localized peak demands on distribution systems. A discussion of LNG developments is beyond the scope of this article; therefore, the tables and figures in the report do not include LNG data.

Underground storage facilities are typically characterized by two measures of capability: (1) working gas capacity, or the total amount of gas that can be withdrawn (or injected) as readily available inventory; and (2) daily deliverability, or withdrawal capability, which is the amount of gas that can be withdrawn in a 24-hour period. Both measures are somewhat variable for any given facility, with deliverability being the more variable of the two. A given reservoir will have a design level of working gas capacity (which, in the case of regulated facilities, is certificated by the Federal Energy Regulatory Commission) that is largely dependent on reservoir pressure. This design level can be physically exceeded by some small percentage for short periods if necessary or desirable.

Deliverability is largely dependent on the amount of gas in a reservoir; it is at its maximum when the storage reservoir is completely full. As stored gas is withdrawn from the reservoir, the capability to maintain deliverability decreases. At low levels of working gas, deliverability can fall to a fraction of its maximum value. For purposes of this article and associated tables, deliverability data represent "maximum deliverability," which is the estimated maximum deliverability rate at the developed maximum operating capacity.

Existing Storage Capacity

At the beginning of 1997, at least 410 underground storage facilities were in operation in the United States (Figure SR1), with almost 3.8 trillion cubic feet (Tcf) of working gas capacity and nearly 75 billion cubic feet (Bcf) per day of deliverability. To put these numbers in perspective, total production and consumption of natural gas in the United States in 1996 were 19.0 and 21.9 Tcf, respectively.[1] About 2.8 Tcf of gas was imported from Canada.[2] At the end of 1996, total pipeline capacity to transport gas between geographic regions within the United States was about 84 Bcf per day.[3] Besides the one mine cavern facility previously mentioned, the 410 operating storage sites consist of 342 depleted fields, representing about 88 percent of U.S. total working gas capacity and 74 percent of total deliverability; 40 aquifer reservoirs, with about 9 percent of working gas capacity and 11 percent of deliverability; and 27 salt cavern

[1]Energy Information Administration, *Natural Gas Monthly* (April 1997), Tables 2 and 3.

[2]Energy Information Administration, *Natural Gas Monthly* (April 1997), Table 5.

[3]Energy Information Administration, "Natural Gas Pipeline and System Expansions," *Natural Gas Monthly* (April 1997), Table SR3.

Table SR2. Proposed Underground Natural Gas Storage, by Planned In-Service Year and Type of Project, 1997-2004

Year / Type	Depleted Gas/Oil Field			Aquifer Storage			Salt Cavern Storage			Total		
	Number of Sites	Working Gas Capacity (Bcf)	Daily Deliver-ability (MMcf/d)	Number of Sites	Working Gas Capacity (Bcf)	Daily Deliver-ability (MMcf/d)	Number of Sites	Working Gas Capacity (Bcf)	Daily Deliver-ability (MMcf/d)	Number of Sites	Working Gas Capacity (Bcf)	Daily Deliver-ability (MMcf/d)
Existing Year-end 1996*	343	3,298	55,171	40	351	8,290	27	116	11,117	410	3,765	74,579
1997												
New	3	33	690	1	1	15	0	0	0	4	34	705
Expansion	18	17	349	0	0	0	4	6	914	22	23	1,263
Total	21	51	1,039	1	1	15	4	6	914	26	57	1,968
1998												
New	6	125	1,940	1	5	40	2	3	395	9	133	2,375
Expansion	17	11	249	0	0	0	3	3	125	20	14	374
Total	23	135	2,189	1	5	40	5	6	520	29	147	2,749
1999												
New	1	6	100	0	0	0	2	3	650	3	10	750
Expansion	15	6	85	1	3	50	3	3	250	19	12	385
Total	16	12	185	1	3	50	5	7	900	22	22	1,135
2000												
New	0	0	0	0	0	0	1	4	400	1	4	400
Expansion	1	3	45	0	0	0	2	8	700	3	11	745
Total	1	3	45	0	0	0	3	12	1,100	4	15	1,145
2001–2004												
New	0	0	0	0	0	0	1	5	500	1	5	500
Expansion	2	6	90	0	0	0	5	6	400	7	13	490
Total	2	6	90	0	0	0	6	12	900	8	18	990
In-Service Year Uncertain												
New	11	114	2,299	0	0	0	2	16	500	13	131	2,799
Expansion	0	0	0	0	0	0	2	4	350	2	5	350
Total	11	114	2,299	0	0	0	4	21	850	15	135	3,149
Total Proposed												
New	21	278	5,029	2	6	55	8	32	2,445	31	316	7,529
Expansion	53	43	819	1	3	50	19	32	2,739	73	77	3,608
Total	74	321	5,848	3	9	105	27	64	5,184	104	393	11,137

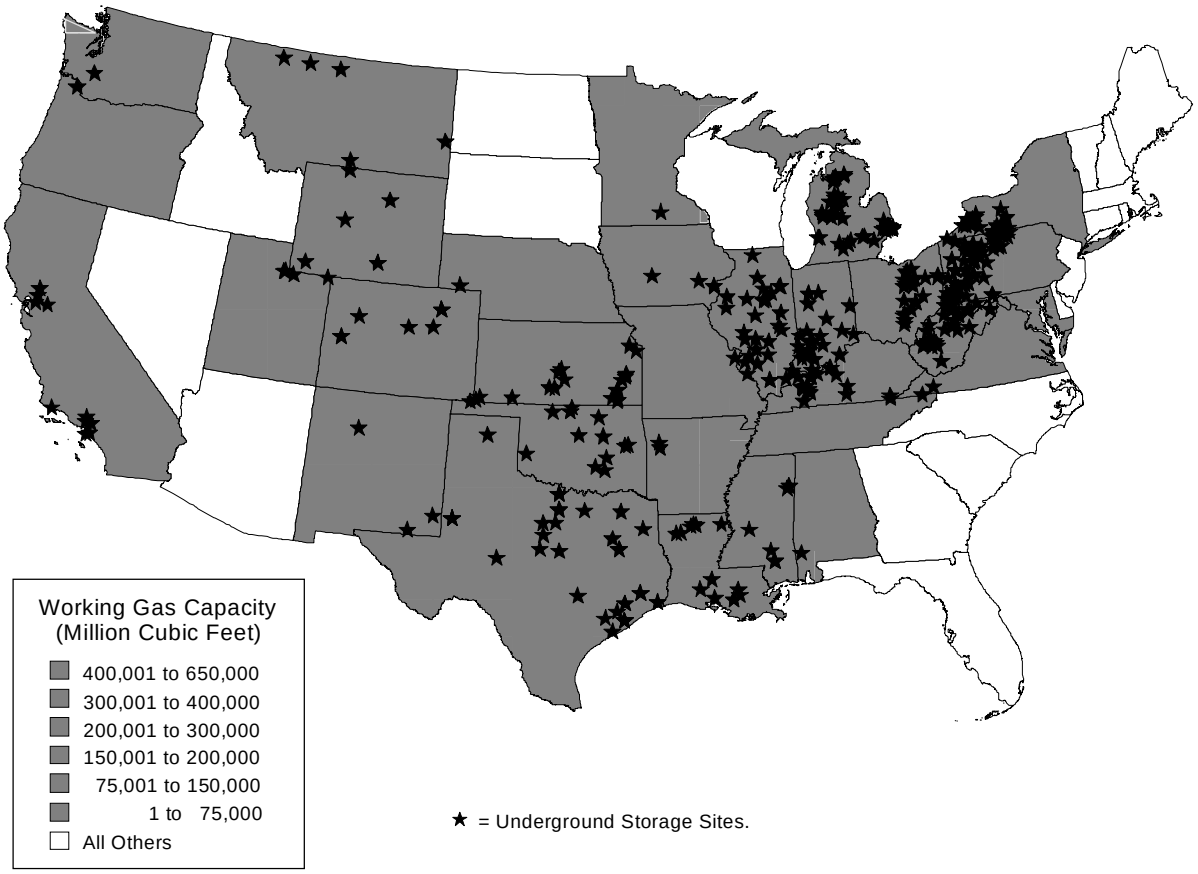
*The year-end 1996 data include revisions to both working gas capacity and deliverability for a significant number of the storage facilities responding to Form EIA-191, "Monthly Underground Gas Storage Report." Thus, year-end 1996 capacities cannot be derived by adding 1996 storage additions to previously published 1995 capacities.

Bcf = Billion cubic feet. MMcf/d = Million cubic feet per day.

Notes: "Salt Cavern Storage" includes one proposed mine cavern facility in New York. Totals may not equal sum of components because of independent rounding.

Source: Energy Information Administration (EIA). **Year-end 1996:** EIAGIS-NG Geographic Information System, Underground Storage Database, as of September 1, 1997, compiled from Form EIA-191, "Monthly Underground Gas Storage Report" and various industry sources. **1997-2004 and In-Service Year Uncertain:** EIAGIS-NG Geographic Information System, Proposed Underground Storage Database, as of September 1, 1997, based on Federal Energy Regulatory Commission filings and information compiled from various industry sources.

Figure SR1. Locations of U.S. Underground Storage Sites and Working Gas Capacity by State, 1996



Source: Energy Information Administration. EIAGIS-NG Geographic Information System, Natural Gas Underground Storage Database, compiled from Form EIA-191 "Monthly Underground Gas Storage Report" and various industry sources.

facilities, with only 3 percent of working gas capacity but nearly 15 percent of total deliverability.

These storage facilities are distributed among 30 States and all six regions of the continental United States (Tables SR3 and SR4). The State of Michigan, with 47 storage facilities, ranks first both in terms of working gas capacity and deliverability, followed closely by Texas in both measures, with 35 storage sites. Pennsylvania has the greatest number of storage sites with 60, and ranks third in both working gas capacity and deliverability. Eleven States (Alabama, Arkansas, Maryland, Minnesota, Missouri, Nebraska, New Mexico, Oregon, Tennessee, Virginia, and Washington) have three or fewer storage facilities. Eighteen States in the continental United States have no reported storage facilities.

Regionally,[4] the Midwest ranks first both in terms of working gas capacity and deliverability, with 30 percent of the Nation's working gas capacity and 32 percent of its deliverability (Figure SR2). The Southwest Region ranks second, with 26 percent of working gas capacity and 28 percent of deliverability. The Southwest, which has fewer than half the number of storage facilities as the Midwest, includes the storage-rich States of Texas, Louisiana, and Oklahoma as well as the majority of the Nation's salt cavern facilities. The Northeast Region, with significant storage assets in Pennsylvania and West Virginia and to a lesser extent in New York, ranks third, with 18 percent of working gas capacity and 16 percent of deliverability.

[4]Figure SR3 shows the States included in each of the six regions used in this analysis.

Table SR3. Summary of Existing Underground Natural Gas Storage, by State and Type of Reservoir, January 1997

State	Depleted Gas/Oil Field			Aquifer Storage			Salt Cavern Storage			Total		
	Number of Sites	Working Gas Capacity (Bcf)	Daily Deliver-ability (MMcf/d)	Number of Sites	Working Gas Capacity (Bcf)	Daily Deliver-ability (MMcf/d)	Number of Sites	Working Gas Capacity (Bcf)	Daily Deliver-ability (MMcf/d)	Number of Sites	Working Gas Capacity (Bcf)	Daily Deliver-ability (MMcf/d)
Alabama	0	0	0	0	0	0	1	2	260	1	2	260
Arkansas	3	20	239	0	0	0	0	0	0	3	20	239
California	10	222	6,470	0	0	0	0	0	0	10	222	6,470
Colorado	9	52	1,112	0	0	0	0	0	0	9	52	1,112
Iowa	0	0	0	4	74	1,000	0	0	0	4	74	1,000
Illinois	12	47	792	17	200	5,642	0	0	0	29	247	6,435
Indiana	18	19	362	10	22	394	0	0	0	28	41	757
Kansas	18	107	2,249	0	0	0	1	2	160	19	109	2,409
Kentucky	22	107	1,657	2	6	67	0	0	0	24	113	1,725
Louisiana	8	273	4,049	0	0	0	5	17	1,804	13	290	5,853
Maryland	1	15	306	0	0	0	0	0	0	1	15	306
Michigan	45	632	11,886	0	0	0	2	2	78	47	634	11,964
Minnesota	0	0	0	1	2	60	0	0	0	1	2	60
Missouri	0	0	0	1	10	350	0	0	0	1	10	350
Mississippi	4	36	1,050	0	0	0	3	20	2,170	7	56	3,220
Montana	5	208	283	0	0	0	0	0	0	5	208	283
Nebraska	1	8	101	0	0	0	0	0	0	1	8	101
New Mexico	2	64	304	1	8	10	0	0	0	3	72	314
New York	21	82	1,014	0	0	0	1	0	80	22	83	1,094
Ohio	23	206	4,782	0	0	0	0	0	0	23	206	4,782
Oklahoma	13	157	2,742	0	0	0	0	0	0	13	157	2,742
Oregon	1	7	100	0	0	0	0	0	0	1	7	100
Pennsylvania	60	378	7,022	0	0	0	0	0	0	60	378	7,022
Tennessee	1	1	15	0	0	0	0	0	0	1	1	15
Texas	22	373	4,826	0	0	0	13	70	6,525	35	443	11,351
Utah	2	51	390	2	9	130	0	0	0	4	60	520
Virginia	1	1	15	0	0	0	1	0	40	2	1	55
Washington	0	0	0	1	15	550	0	0	0	1	15	550
West Virginia	36	192	3,223	0	0	0	0	0	0	36	192	3,223
Wyoming	5	41	146	1	4	85	0	0	0	6	45	261
Total	**343**	**3,299**	**55,171**	**40**	**351**	**8,290**	**27**	**116**	**11,117**	**410**	**3,765**	**74,579**

Bcf = Billion cubic feet. MMcf/day = Million cubic feet per day.

Note: "Depleted Gas/Oil Field" data include one storage cavern facility classified as "other." Totals may not equal sum of components because of independent rounding.

Source: Energy Information Administration (EIA), EIAGIS-NG Geographic Information System, Underground Natural Gas Storage Database as of September 1, 1997, compiled from Form EIA-191, "Monthly Underground Gas Storage Report" and various industry sources.

Table SR4. Summary of Existing Underground Natural Gas Storage, by Region and Type of Reservoir and Operator, January 1997

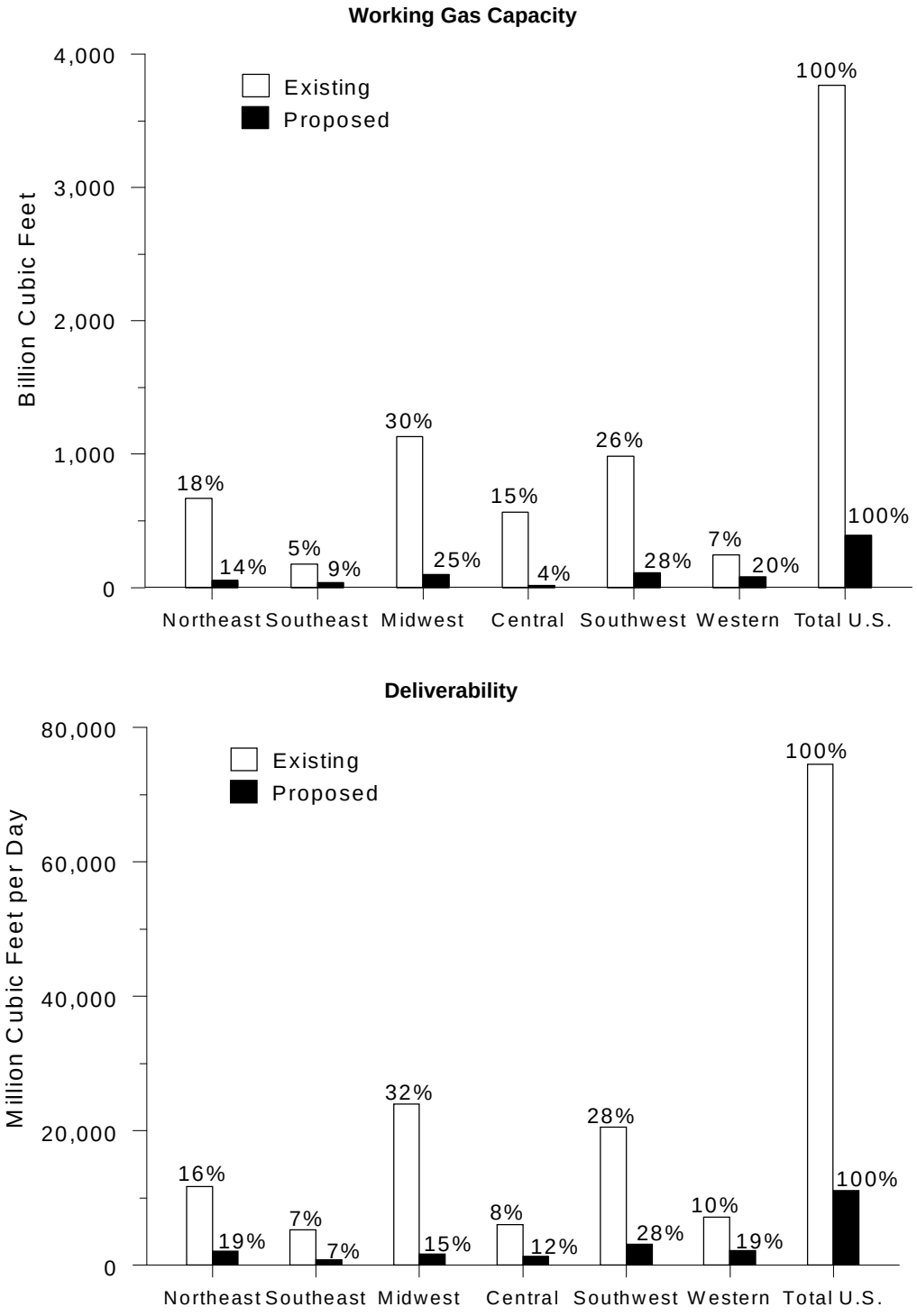
Region/ Operator	Depleted Gas/Oil Field			Aquifer Storage			Salt Cavern Storage			Total		
	Number of Sites	Working Gas Capacity (Bcf)	Daily Deliver-ability (MMcf/d)	Number of Sites	Working Gas Capacity (Bcf)	Daily Deliver-ability (MMcf/d)	Number of Sites	Working Gas Capacity (Bcf)	Daily Deliver-ability (MMcf/d)	Number of Sites	Working Gas Capacity (Bcf)	Daily Deliver-ability (MMcf/d)
Northeast												
Interstate	93	627	10,967	0	0	0	1	0	40	94	630	11,007
Intrastate	0	0	0	0	0	0	0	0	0	0	0	0
LDC	23	29	500	0	0	0	1	1	80	24	28	580
Independent	3	12	114	0	0	0	0	0	0	3	12	114
Total	119	669	11,581	0	0	0	2	1	120	121	670	11,701
Southeast												
Interstate	7	114	2,164	0	0	0	1	15	1,500	8	129	3,664
Intrastate	0	0	0	0	0	0	0	0	0	0	0	0
LDC	17	27	520	2	6	67	1	2	260	20	34	848
Independent	3	4	38	0	0	0	2	6	670	5	10	708
Total	27	145	2,722	2	6	67	4	23	2,430	33	173	5,220
Midwest												
Interstate	35	385	6,658	6	33	1,383	0	0	0	41	418	8,041
Intrastate	0	0	0	0	0	0	0	0	0	0	0	0
LDC	55	399	9,594	22	192	4,714	2	2	78	79	595	14,387
Independent	8	120	1,571	0	0	0	0	0	0	8	120	1,571
Total	98	903	17,824	28	225	6,097	2	2	78	128	1,133	24,000
Central												
Interstate	21	380	3,726	7	88	1,215	0	0	0	28	466	4,941
Intrastate	0	0	0	0	0	0	0	0	0	0	0	0
LDC	17	83	534	1	10	350	0	0	0	18	90	884
Independent	2	4	51	0	0	0	1	2	160	3	6	211
Total	40	467	4,312	8	97	1,565	1	2	160	49	562	6,037
Southwest												
Interstate	15	466	6,693	0	0	0	3	20	1,250	18	486	7,943
Intrastate	12	156	2,736	0	0	0	2	13	1,080	14	169	3,816
LDC	14	118	1,350	1	8	10	4	22	1,414	19	146	2,775
Independent	7	145	1,380	0	0	0	9	34	4,585	16	180	5,965
Total	48	886	12,160	1	8	10	18	88	8,329	67	981	20,500
Western												
Interstate	0	0	0	0	0	0	0	0	0	0	0	0
Intrastate	0	0	0	0	0	0	0	0	0	0	0	0
LDC	10	222	6,565	1	15	550	0	0	0	11	239	7,115
Independent	1	7	5	0	0	0	0	0	0	1	7	5
Total	11	229	6,570	1	15	550	0	0	0	12	246	7,120
United States												
Interstate	171	1,971	30,209	13	120	2,598	5	35	2,790	189	2,129	35,597
Intrastate	12	156	2,736	0	0	0	2	12	1,080	14	169	3,816
LDC	136	880	19,065	27	231	5,692	8	26	1,832	171	1,132	26,590
Independent	24	291	3,159	0	0	0	12	41	5,415	36	335	8,574
Total	343	3,299	55,171	40	351	8,290	27	116	11,117	410	3,765	74,579

Bcf = Billion cubic feet. MMcf/d = Million cubic feet per day. LDC = Local distribution company.

Notes: "Depleted Gas/Oil Field" data include one storage cavern facility classified as "other." Totals may not equal sum of components because of independent rounding. Figure SR3 shows regional boundaries.

Source: Energy Information Administration (EIA), EIAGIS-NG Geographic Information System, Underground Natural Gas Storage Database, as of September 1, 1997, compiled from Form EIA-191, "Monthly Underground Gas Storage Report" and various industry sources.

Figure SR2. Existing and Projected Additions to Working Gas Capacity and Deliverability, by Region



Notes: Proposed capacity includes all proposed storage projects, including projects with unknown online dates. Figure SR3 shows regional boundaries. Totals may not equal sum of components because of independent rounding.

Sources: Energy Information Administration (EIA). **Existing Capacity:** EIAGIS-NG Geographic Information System, Underground Storage Database, as of September 1, 1997, compiled from Form EIA-191, "Monthly Underground Gas Storage Report," and various industry sources. **Proposed Capacity:** EIAGIS-NG Geographic Information System, Proposed Underground Storage Database, as of September 1,1997, based on Federal Energy Regulatory Commission filings and information compiled from various industry sources.

1996 Additions to Storage Assets

Of the 14 projects that at this time last year were slated to come on line in 1996,[5] only 6 projects were actually implemented in 1996 (Figure SR3). Three were new storage facilities, and three were expansions to existing facilities. Of the new facilities, all were salt cavern storage, one each in Louisiana, New York, and Virginia. Collectively, these facilities added 4.8 Bcf of working gas capacity and 480 million cubic feet (MMcf) per day of deliverability. Expansions were completed at two different salt cavern facilities in Texas, while 600 MMcf of working gas capacity was added at a depleted reservoir facility in Pennsylvania. Taken together, these expansion projects added about 7 Bcf of working gas capacity and 200 MMcf per day of deliverability.

The results for 1996 were notable in that very little storage capacity was added. In total, new facilities and expansions to existing facilities during 1996 added only about 12 Bcf of working gas capacity and 680 MMcf per day of storage deliverability. In the previous 2 years, average additions to working gas capacity, at about 45 Bcf, were almost four times greater, while additions to deliverability, at more than 1,600 MMcf per day, were over twice as large.

The low level of storage expansion in 1996 reflects decisions made as far back as 1992 and earlier, just as the natural gas marketplace was undergoing major restructuring.[6] Uncertainty about the needs of this new market probably kept the number of proposed projects to a minimum. In addition, as market conditions changed so did some project plans. For example, of the 12 projects on the books as of the third quarter of 1994 that were slated for completion by the close of 1996, 6 were eventually postponed or canceled.

Another factor that influenced future planning during the period was that a large amount of underground storage capacity was already in service and service interruptions resulting from inadequate supply backup were infrequent. In addition, between 1989 and 1993, storage utilization per storage field increased significantly compared with the previous 5-year period, while since 1990 the average level of working gas maintained in inventory during the heating season declined. The changing business environment was permitting a greater degree of inventory management and an improvement in operational efficiency.[7]

As the form and function of the new natural gas marketing environment evolved over the past several years, storage developers shifted from emphasizing new-site installation to expanding and enhancing existing underground storage facilities. The new market appears to be signaling that, at least in the near future, the greatest increase in demand for storage service will be at locations already linked to the national pipeline network and that these sites will need to be upgraded. For example, the number of proposed expansion projects slated for development during the period 1997 through 2004 far exceeds the number of proposed new sites (Table SR2). Most of these expansions involve enhancements to daily deliverability at depleted field reservoirs, most of which are operated by interstate pipeline companies. Second, 13 of the 15 proposed projects with uncertain inservice dates are new-site developments, indicating that the marketplace has yet to provide a clear indication regarding the economic feasibility of, or need for, creating these new storage facilities.

Planned Additions to Storage

As previously noted, there are at least 104 storage projects in some stage of consideration or development, including 31 new facilities and 73 expansion projects (Table SR2). Completion of these projects would increase working gas capacity by 10 percent (393 Bcf) from the 1996 level and deliverability by about 15 percent (11.1 Bcf per day). However, past experience has shown that only some proportion of proposed projects are actually implemented; a smaller proportion still are implemented according to their original schedules. For example, of the 14 projects that last year at this time were scheduled for implementation in 1996, 6 were completed (see the previous section), 4 were rescheduled, 3 were canceled, and 1 was put on hold.

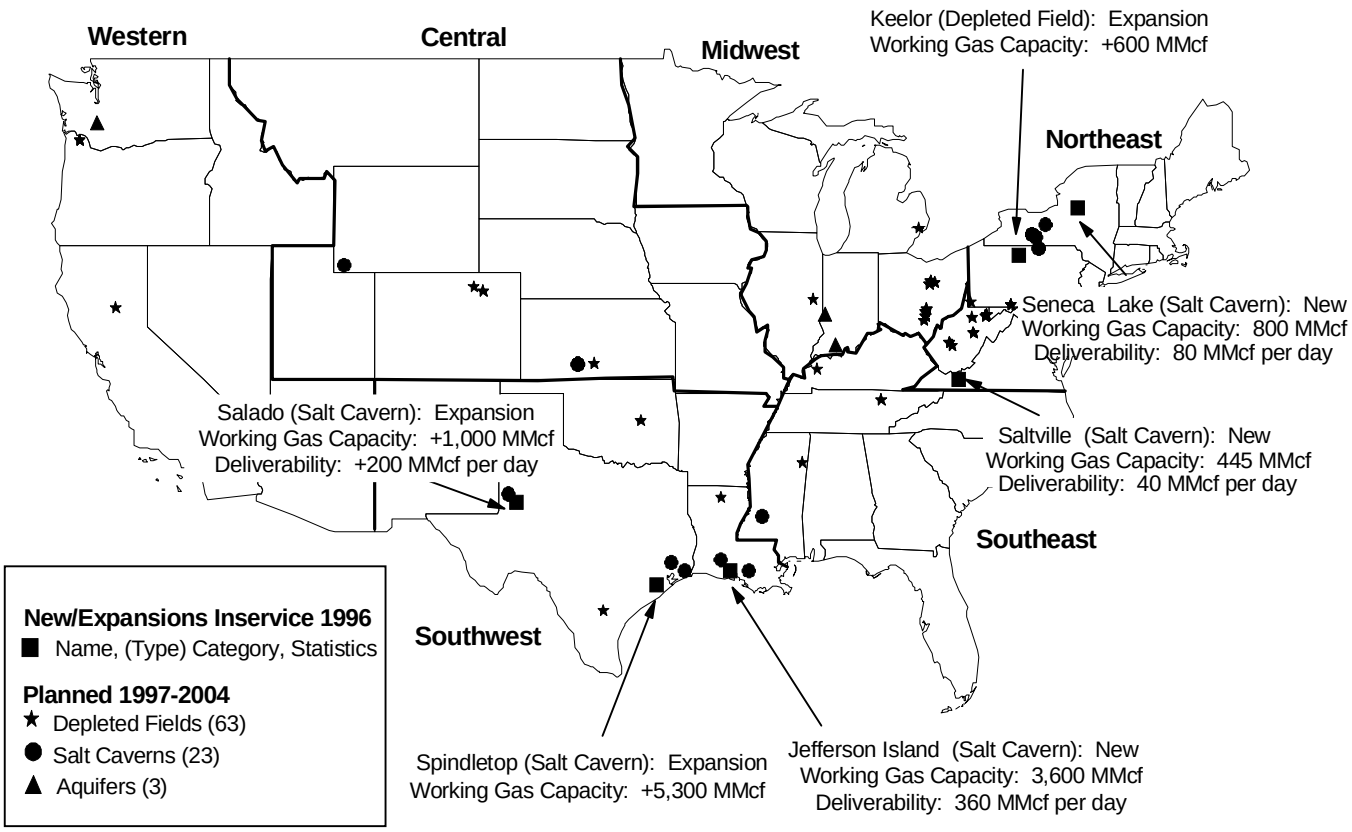
Also as noted earlier, 13 of the 31 proposed new projects are sufficiently uncertain as to their chances for implementation that their respective developers are unwilling to schedule projected operational dates. On the

[5]The Energy Information Administration publication, *Natural Gas 1996: Issues and Trends*, DOE/EIA-0560(96) (Washington, DC, December 1996), reported that 15 projects were scheduled for completion during 1996 (Appendix F, Table F2). However, it was discovered that 2 of these projects had come on line before 1996 and 1 scheduled project had not been listed, yielding 14 projects scheduled for 1996.

[6]Open access to interstate underground natural gas storage was formalized with the issuance of Order 636 by the Federal Energy Regulatory Commission in 1992.

[7]See Energy Information Administration, *The Value of Underground Storage in Today's Natural Gas Industry*, DOE/EIA-0591 (Washington, DC, March 1995).

Figure SR3. Locations of New/Expanded Storage Facilities Online in 1996, and Planned Additions, 1997-2004



MMcf = Million cubic feet.

Notes: Includes expansions to existing facilities, proposed new facilities, and proposed expansions to new facilities. Does not include projects with unknown online dates. In many cases, planned facilities and/or expansions are at the same location or in very close proximity, in which case facility symbols will overlay one another on the map.

Source: Energy Information Administration (EIA), EIAGIS-NG Geographic Information System, Proposed Underground Natural Gas Storage Database, as of September 1, 1997.

other hand, only 2 of the 73 expansion projects are in this same uncertain status. However, taken together, these uncertain projects represent about 34 percent of all currently planned new working gas capacity and 28 percent of new deliverability. Some of these projects seem certain to be implemented eventually but some will probably never be developed.

Planned Additions by Region and Type of Facility

The supply-rich Southwest Region is slated to have the largest increases in both working gas capacity, at 109 Bcf, and deliverability, at 3,150 MMcf per day (Table SR5). These additions are about 28 percent of total proposed U.S. additions for both capability measures and would increase the Southwest's existing working gas capacity by about 11 percent and its deliverability by about 15 percent. Both the Midwest, with its high concentration of natural gas end users, and somewhat surprisingly, the Western Region, are slated for significant working gas capacity increases totaling 100 and 79 Bcf, respectively. In addition, the Western Region has the second largest projected deliverability increase, at 2,130 MMcf per day.

The Western Region data are dominated by four California projects, which have somewhat uncertain futures (see "Notable Storage Developments"). The element of surprise relating to the size of proposed storage additions in the West reflects the sense that, at least in California, there is currently a surplus of pipeline capacity into the State, which makes additional storage facilities less needed. The Northeast, Midwest, and Central regions all are scheduled to have significant

Table SR5. Summary of Proposed Underground Natural Gas Storage, by Region and Type of Reservoir and Operator, 1997–2004

Region/ Operator	Depleted Gas/Oil Field			Aquifer Storage			Salt Cavern Storage			Total		
	Number of Sites	Working Gas Capacity (Bcf)	Daily Deliver-ability (MMcf/d)	Number of Sites	Working Gas Capacity (Bcf)	Daily Deliver-ability (MMcf/d)	Number of Sites	Working Gas Capacity (Bcf)	Daily Deliver-ability (MMcf/d)	Number of Sites	Working Gas Capacity (Bcf)	Daily Deliver-ability (MMcf/d)
Northeast												
Interstate	23	15	250	0	0	0	7	8	870	30	22	1,120
Intrastate	2	19	134	0	0	0	0	0	0	2	19	134
LDC	0	0	0	0	0	0	1	1	64	1	1	64
Independent	1	5	70	0	0	0	3	7	700	4	11	770
Total	26	39	454	0	0	0	11	16	1,634	37	54	2,088
Southeast												
Interstate	1	6	100	0	0	0	0	0	0	1	6	100
Intrastate	0	0	0	0	0	0	0	0	0	0	0	0
LDC	0	0	0	0	0	0	0	0	0	0	0	0
Independent	6	26	270	0	0	0	1	4	400	7	30	670
Total	7	32	370	0	0	0	1	4	400	8	36	770
Midwest												
Interstate	22	14	189	0	0	0	0	0	0	22	14	189
Intrastate	0	0	0	0	0	0	0	0	0	0	0	0
LDC	1	17	200	0	0	0	0	0	0	1	17	200
Independent	3	48	885	2	6	15	1	15	350	5	69	1,290
Total	26	79	1,274	2	6	15	1	15	350	28	100	1,679
Central												
Interstate	3	2	200	0	0	0	1	5	500	4	6	700
Intrastate	0	0	0	0	0	0	0	0	0	0	0	0
LDC	0	0	0	0	0	0	0	0	0	0	0	0
Independent	1	4	120	0	0	0	4	6	500	5	9	620
Total	4	5	320	0	0	0	5	11	1,000	9	15	1,320
Southwest												
Interstate	0	0	0	0	0	0	1	7	600	1	7	600
Intrastate	0	0	0	0	0	0	1	3	350	1	3	350
LDC	0	0	0	0	0	0	1	4	150	1	4	150
Independent	3	90	1,350	0	0	0	6	6	700	9	95	2,050
Total	3	90	1,350	0	0	0	9	20	1,800	12	109	3,150
Western												
Interstate	0	0	0	0	0	0	0	0	0	0	0	0
Intrastate	0	0	0	0	0	0	0	0	0	0	0	0
LDC	4	12	180	1	3	50	0	0	0	5	15	230
Independent	4	64	1,900	0	0	0	0	0	0	4	64	1,900
Total	8	76	2,080	1	3	50	0	0	0	9	79	2,130
United States												
Interstate	49	36	739	0	0	0	9	19	1,970	58	55	2,709
Intrastate	2	19	134	0	0	0	1	3	350	3	22	484
LDC	5	29	380	1	3	50	2	4	214	8	36	644
Independent	18	237	4,595	2	6	55	15	37	2,650	35	279	7,300
Total	74	321	5,848	3	9	105	27	64	5,184	104	393	11,137

Bcf = Billion cubic feet. MMcf/d = Million cubic feet per day. LDC = Local distribution company.

Notes: "Salt Cavern Storage" includes one proposed mine cavern facility in New York. Totals may not equal sum of components because of independent rounding. Figure SR3 shows regional boundaries.

Source: Energy Information Administration (EIA), EIAGIS-NG Geographic Information System, Proposed Underground Natural Gas Storage Database, as of September 1, 1997, based on Federal Energy Regulatory Commission filings and information compiled from various industry sources.

deliverability additions, amounting to 2,088 MMcf, 1,679 MMcf, and 1,320 MMcf per day, respectively.

Depleted field reservoirs and salt cavern facilities dominate planned storage additions. There are currently only three aquifer projects proposed (two new, one expansion). Aquifer reservoirs are generally much more difficult and expensive to develop and operate, and are usually only developed in areas where the other reservoir types do not exist.[8] Depleted field additions to working gas capacity represent about 82 percent of total additions, while salt cavern projects account for about 16 percent. However, increases to deliverability are more nearly even: 53 percent from depleted fields and 46 percent from salt caverns. Capacity additions from depleted fields are concentrated in the Western, Southwest, and Midwest regions.

Quite surprisingly, the largest number of salt cavern projects is planned for the Northeast, where natural gas is generally stored in depleted gas/oil fields. Of the 27 planned salt projects, 11 are in the Northeast, representing 32 percent of planned additions to deliverability. Significant salt cavern development is also planned for the Southwest Region, with 9 projects and over 30 percent of both working gas capacity and deliverability additions. The Southwest has numerous pipeline connections in place and large areas with suitable salt cavern geology.

Notable Storage Developments

Several noteworthy developments are underway in the storage industry that are likely to affect how much storage capacity will actually be added in the next few years. For example, the public utility commission in California recently approved the first-ever storage project by an independent storage operator, which has implications for future storage development in the State. Another example is the interest in developing salt cavern storage facilities in the Northeast where most storage sites are generally in depleted fields. It is also interesting to note that one company, Columbia Gas Transmission, accounts for 23 percent of all proposed expansions to working gas capacity.

[8]See Energy Information Administration, *The Value of Underground Storage in Today's Natural Gas Industry*, DOE/EIA-0591 (March 1995), Appendix A, "Underground Natural Gas Storage Operations."

California

In California, the door may finally be open for independent storage development projects to proceed. Four storage development applications (Table SR6) have been on hold for a number of years, waiting for the California Public Utilities Commission (CPUC) to decide whether or not to allow independent developers into the storage service market. Currently the market is dominated by the two giant utility companies in the State: Pacific Gas and Electric Company and Southern California Gas Company. Between them, these two local distribution companies own and operate nearly 100 percent of all storage assets and capacity. However, in late June, the CPUC unanimously approved an application for construction of the Wild Goose storage facility by a subsidiary of the large Canadian Alberta Energy Company.

The Wild Goose Gas Storage Company projects a fall 1998 startup date for the facility, which will be developed in a depleted gas reservoir in the north central part of the State. If developed as planned, Wild Goose would become the fifth largest (out of 11) storage facility in California. It will be interesting to see what will happen to the other three California projects proposed by independent operators. The Ten Section project, with a planned working gas capacity of 40 Bcf, would be the third largest storage field in California and would increase the State's total working gas capacity by 18 percent.

Salt Cavern Developments in the Northeast

Three salt cavern projects and a depleted field facility are in various stages of development near the border of northern Pennsylvania and southwestern New York, and all within a circle with about a 25-mile radius. A fourth salt cavern facility, Seneca Lake, to the northeast in Seneca County, New York, came on line last year and is tentatively slated for expansion during 1997. Two of the salt cavern projects—Avoca in New York and Tioga in Pennsylvania—have struggled with the problem of disposing of the brine formed in the construction process. The third salt cavern project—Bath Petroleum Salt Caverns—involved a leasing arrangement between CNG Transmission and Bath Petroleum that was rejected by the Federal Energy Regulatory Commission (FERC) because of jurisdictional issues.

Table SR6. Proposed Natural Gas Storage Projects Planned for Service, 1997-2004

Project Name/State	Status	Expansion of Existing Facility? (X=Yes)	Developer/Owner/Operator	County	Projected Year in Service	Reservoir Type
CALIFORNIA						
LODI	HOLD		NORTHERN CA. GAS STORAGE	SAN JOAQUIN	UNKNOWN	DEPL FLD
PUTAH SINK	HOLD		EAGLE ENERGY/NAHAMA NAT GAS	SACRAMENTO	UNKNOWN	DEPL FLD
TEN SECTION	HOLD		MCFARLAND ENERGY	KERN	UNKNOWN	DEPL FLD
WILD GOOSE	IN DEVELOP		WILD GOOSE GAS STORAGE	BUTTE	1998	DEPL FLD
COLORADO						
RUSH CREEK	PLAN/PROP		PICEANCE NATURAL GAS, INC	WELD	1998	DEPL FLD
YOUNG	IN DEVELOP	X	CIG	MORGAN	1997	DEPL FLD
YOUNG	IN DEVELOP	X	CIG	MORGAN	1998	DEPL FLD
ILLINOIS						
COOKS MILL	PLAN/PROP	X	NAT GAS P L CO OF AMERICA	DOUGLAS	1997	DEPL FLD
INDIANA						
BLACKHAWK	IN DEVELOP		PROGAS STORAGE AND MARKETING	VIGO	1998	AQUIFER
EAST STENDAL	IN DEVELOP		PROGAS STORAGE AND MARKETING	DUBOIS	1997	AQUIFER
RICHLAND CITY	HOLD		ROBINSON ENGINEERING	SPENCER	UNKNOWN	DEPL FLD
KANSAS						
CUNNINGHAM	IN DEVELOP	X	NORTHERN NATURAL GAS CO	PRATT	1997	DEPL FLD
KIOWA PHASE 1	PLAN/PROP		HNG STORAGE	KIOWA	1998	SALT CAV
KIOWA PHASE 2	PLAN/PROP	X	HNG STORAGE	KIOWA	1998	SALT CAV
KIOWA PHASE 3	PLAN/PROP	X	HNG STORAGE	KIOWA	1999	SALT CAV
KIOWA PHASE 4	PLAN/PROP	X	HNG STORAGE	KIOWA	1999	SALT CAV
KENTUCKY						
ELK CREEK	HOLD		HAR-KEN	SPENCER	UNKNOWN	DEPL FLD
LISMAN	IN DEVELOP		PROGAS STORAGE AND MARKETING	WEBSTER	1997	DEPL FLD
SOUTH ST. CHARLES	HOLD		HAR-KEN	HOPKINS	UNKNOWN	DEPL FLD
ST. CHARLES	HOLD		HAR-KEN	HOPKINS	UNKNOWN	DEPL FLD
LOUISIANA						
EGAN (CAVERN #2)	IN DEVELOP	X	EGAN HUB PARTNERS, LP	ACADIA	1997	SALT CAV
NAPOLEONVILLE PHASE 2	IN DEVELOP	X	ENRON STORAGE	ASSUMPTION	2000	SALT CAV
SOUTH DOWNSVILLE	IN DEVELOP		OUACHITA RIVER GAS STORAGE CO.	UNION	1998	DEPL FLD

Table SR6. Proposed Natural Gas Storage Projects Planned for Service, 1997-2004 (Continued)

Project Name/State	FERC Docket	Project Count	Capacity (billion cubic feet)			Capacity (MMcf per day)		Total Cost (Thousand $)
			Base Gas	Working Gas	Total	Withdrawal	Injection	
CALIFORNIA								
LODI			6.000	6.000	12.000	500	300	$25,000
PUTAH SINK			2.133	4.000	6.133	600	180	$40,000
TEN SECTION			25.000	40.000	65.000	600	250	$55,000
WILD GOOSE			4.000	14.000	18.000	200	80	$90,000
		4	37.133	64.000	101.133	1,900	810	$210,000
COLORADO								
RUSH CREEK			1.200	3.500	4.700	120	100	NA
YOUNG	CP93-541		0.000	1.200	1.200	50	0	NA
YOUNG	CP93-541		0.000	0.300	0.300	30	40	NA
		3	1.200	5.000	6.200	200	140	NA
ILLINOIS								
COOKS MILL	CP97-107		0.000	0.000	0.000	70	0	NA
		1	0.000	0.000	0.000	70	0	NA
INDIANA								
BLACKHAWK			5.000	5.000	10.000	40	0	$6,000
EAST STENDAL			0.150	0.500	0.650	15	15	$1,000
RICHLAND CITY			0.250	0.750	1.000	40	20	$3,500
		3	5.400	6.250	11.650	95	35	$10,500
KANSAS								
CUNNINGHAM	CP77-193		0.000	0.000	0.000	120	50	$14,000
KIOWA PHASE 1			0.450	1.400	1.850	125	63	$12,500
KIOWA PHASE 2			0.450	1.400	1.850	125	63	$12,500
KIOWA PHASE 3			0.450	1.400	1.850	125	63	$12,500
KIOWA PHASE 4			0.450	1.400	1.850	125	63	$12,500
		5	1.800	5.600	7.400	620	300	$64,000
KENTUCKY								
ELK CREEK			6.500	6.500	13.000	50	33	$14,000
LISMAN			0.500	2.500	3.000	50	50	$6,000
SOUTH ST. CHARLES			2.000	1.000	3.000	10	4	$3,300
ST. CHARLES			14.750	14.750	29.500	120	80	$51,000
		4	23.750	24.750	48.500	230	167	$74,300
LOUISIANA								
EGAN (CAVERN #2)	CP96-199		0.500	2.000	2.500	500	135	NA
NAPOLEONVILLE PHASE 2			3.500	7.000	10.500	600	300	$33,750
SOUTH DOWNSVILLE	CP94-038		14.000	27.000	41.000	550	250	$80,000
		3	18.000	36.000	54.000	1650	685	NA

Table SR6. Proposed Natural Gas Storage Projects Planned for Service, 1997-2004 (Continued)

Project Name/State	Status	Expansion of Existing Facility? (X=Yes)	Developer/Owner/Operator	County	Projected Year in Service	Reservoir Type
MICHIGAN						
GRANDS LACS	HOLD		CMS GAS TRANS/MARKET HUB PARTNERS	ST CLAIR	UNKNOWN	SALT CAV
KALKASKA 30	HOLD		CMS GAS TRANSMISSION	KALKASKA	UNKNOWN	DEPL FLD
WASHINGTON 10	IN DEVELOP		MCN INVESTMENT CORP	MACOMB	1998	DEPL FLD
MISSISSIPPI						
ABERDEEN	PLAN/PROP		ANR STORAGE CO	MONROE	1999	DEPL FLD
MS-1	PLAN/PROP		MS-1 DISTRIBUTION & STORAGE	COPIAH	2000	SALT CAV
NEW YORK						
AVOCA CAVERN 1	PLAN/PROP		AVOCA NATURAL GAS STORAGE	STEUBEN	1999	SALT CAV
AVOCA CAVERN 2	PLAN/PROP	X	AVOCA NATURAL GAS STORAGE	STEUBEN	2000	SALT CAV
AVOCA CAVERN 3	PLAN/PROP	X	AVOCA NATURAL GAS STORAGE	STEUBEN	2001	SALT CAV
AVOCA CAVERN 4	PLAN/PROP	X	AVOCA NATURAL GAS STORAGE	STEUBEN	2002	SALT CAV
AVOCA CAVERN 5	PLAN/PROP	X	AVOCA NATURAL GAS STORAGE	STEUBEN	2003	SALT CAV
AVOCA CAVERN 6	PLAN/PROP	X	AVOCA NATURAL GAS STORAGE	STEUBEN	2004	SALT CAV
BALMAT	FEASIBILITY		ZINC CORPORATION OF AMERICA	ST LAWRENCE	UNKNOWN	MINE CAV
BATH PETROLEUM SALT CAVERNS	PLAN/PROP		CNG TRANSMISSION CORP	STEUBEN	1998	SALT CAV
LAUREL FIELDS-LIMESTONE	HOLD		NATIONAL FUEL GAS SUPPLY	CATTARAUGUS	UNKNOWN	DEPL FLD
SENECA LAKE PHASE 2	PLAN/PROP	X	NEW YORK STATE ELECTRIC & GAS	SENECA	1997	SALT CAV
THOMAS CORNERS	IN DEVELOP		STEUBEN GAS STORAGE	STEUBEN	1998	DEPL FLD
OHIO						
BENTON-REWORK 97	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	HOCKING	1997	DEPL FLD
BENTON-REWORK 98	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	HOCKING	1998	DEPL FLD
BENTON-REWORK 99	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	HOCKING	1999	DEPL FLD
CRAWFORD-EXPANSION 97	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	FAIRFIELD	1997	DEPL FLD
CRAWFORD-EXPANSION 98	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	FAIRFIELD	1998	DEPL FLD
CRAWFORD-EXPANSION 99	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	FAIRFIELD	1999	DEPL FLD
HACKNEY	PLAN/PROP		HACKNEY PARTNERS	MORGAN	UNKNOWN	DEPL FLD
LAUREL-REWORK 97	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	HOCKING	1997	DEPL FLD
LAUREL-REWORK 98	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	HOCKING	1998	DEPL FLD
LAUREL-REWORK 99	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	HOCKING	1999	DEPL FLD
LUCAS-REWORK 97	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	ASHLAND	1997	DEPL FLD
LUCAS-REWORK 98	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	ASHLAND	1998	DEPL FLD
LUCAS-REWORK 99	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	ASHLAND	1999	DEPL FLD
MCARTHUR-REWORK 97	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	VINTON	1997	DEPL FLD
MCARTHUR-REWORK 98	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	VINTON	1998	DEPL FLD
MCARTHUR-REWORK 99	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	VINTON	1999	DEPL FLD
PAVONIA-REWORK 97	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	ASHLAND	1997	DEPL FLD
PAVONIA-REWORK 98	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	ASHLAND	1998	DEPL FLD
PAVONIA-REWORK 99	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	ASHLAND	1999	DEPL FLD
WEAVER-REWORK 97	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	RICHLAND	1997	DEPL FLD
WEAVER-REWORK 98	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	RICHLAND	1998	DEPL FLD
WEAVER-REWORK 99	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	RICHLAND	1999	DEPL FLD

Table SR6. Proposed Natural Gas Storage Projects Planned for Service, 1997-2004 (Continued)

Project Name/State	FERC Docket	Project Count	Capacity (billion cubic feet)			Capacity (MMcf per day)		Total Cost (Thousand $)
			Base Gas	Working Gas	Total	Withdrawal	Injection	
MICHIGAN								
GRANDS LACS			5.000	15.000	20.000	350	150	$100,000
KALKASKA 30			4.250	17.000	21.250	200	100	$50,000
WASHINGTON 10			8.000	42.000	50.000	800	250	$100,000
		3	17.250	74.000	91.250	1,350	500	$250,000
MISSISSIPPI								
ABERDEEN			6.000	6.000	12.000	100	40	NA
MS-1	CP92-586		1.300	4.000	5.300	400	200	$50,000
		2	7.300	10.000	17.300	500	240	NA
NEW YORK								
AVOCA CAVERN 1	CP94-161		0.340	1.000	1.340	100	50	$166,000
AVOCA CAVERN 2	CP94-161		0.340	1.000	1.340	100	50	$19,000
AVOCA CAVERN 3	CP94-161		0.340	1.000	1.340	100	50	$15,000
AVOCA CAVERN 4	CP94-161		0.340	1.000	1.340	100	50	$15,000
AVOCA CAVERN 5	CP94-161		0.340	1.000	1.340	100	50	$15,000
AVOCA CAVERN 6	CP94-161		0.340	1.000	1.340	100	50	$15,000
BALMAT			0.000	1.500	1.500	150	75	NA
BATH PETROLEUM SALT CAVERNS	CP96-492		0.730	1.770	2.500	270	89	NA
LAUREL FIELDS-LIMESTONE	CP90-2086		10.500	7.000	17.500	0	0	$48,600
SENECA LAKE PHASE 3			0.000	0.650	0.650	64	32	NA
THOMAS CORNERS	CP96-35		2.400	5.300	7.700	70	38	$28,000
		11	15.670	22.220	37.890	1,154	534	NA
OHIO								
BENTON-REWORK 97	CP-96-213		-0.002	0.002	0.000	-2	0	—
BENTON-REWORK 98	CP-96-213		-0.696	0.696	0.000	5	0	$7,922
BENTON-REWORK 99	CP-96-213		-0.098	0.098	0.000	1	0	—
CRAWFORD-EXPANSION 97	CP-96-213		1.590	3.630	5.220	0	0	$5,286
CRAWFORD-EXPANSION 98	CP-96-213		0.740	2.800	3.540	23	0	$3,180
CRAWFORD-EXPANSION 99	CP-96-213		-0.800	2.240	1.440	21	0	$4,043
HACKNEY			1.500	5.000	6.500	45	28	$11,851
LAUREL-REWORK 97	CP-96-213		-0.052	0.052	0.000	1	0	$710
LAUREL-REWORK 98	CP-96-213		-0.100	0.100	0.000	32	0	$708
LAUREL-REWORK 99	CP-96-213		-0.098	0.098	0.000	12	0	—
LUCAS-REWORK 97	CP-96-213		-0.207	0.207	0.000	1	0	$380
LUCAS-REWORK 98	CP-96-213		-0.002	0.002	0.000	6	0	$558
LUCAS-REWORK 99	CP-96-213		-0.195	0.195	0.000	-6	0	$378
MCARTHUR-REWORK 97	CP-96-213		-0.200	0.200	0.000	8	0	$710
MCARTHUR-REWORK 98	CP-96-213		-0.000	0.000	0.000	0	0	—
MCARTHUR-REWORK 99	CP-96-213		-0.098	0.098	0.000	-2	0	$242
PAVONIA-REWORK 97	CP-96-213		-0.405	0.405	0.000	20	0	$630
PAVONIA-REWORK 98	CP-96-213		-0.995	0.995	0.000	6	0	$1,101
PAVONIA-REWORK 99	CP-96-213		-0.890	0.890	0.000	-25	0	$484
WEAVER-REWORK 97	CP-96-213		-0.751	0.751	0.000	1	0	$710
WEAVER-REWORK 98	CP-96-213		-0.200	0.200	0.000	11	0	$661
WEAVER-REWORK 99	CP-96-213		-0.146	0.146	0.000	6	0	$533
		22	-2.106	18.806	16.700	165	28	$40,087

Table SR6. Proposed Natural Gas Storage Projects Planned for Service, 1997-2004 (Continued)

Project Name/State	Status	Expansion of Existing Facility? (X=Yes)	Developer/Owner/Operator	County	Projected Year in Service	Reservoir Type
OKLAHOMA						
OKFUSKEE	IN DEVELOP		UNIGAS CORP	OKFUSKEE	1997	DEPL FLD
OREGON						
MIST EXP PHASE 1 (CALVIN	IN DEVELOP	X	NORTHWEST NATURAL GAS CO	COLUMBIA	1998	DEPL FLD
CREEK)						
MIST EXP PHASE 2	PLAN/PROP	X	NORTHWEST NATURAL GAS CO	COLUMBIA	2000	DEPL FLD
MIST EXP PHASE 3	PLAN/PROP	X	NORTHWEST NATURAL GAS CO	COLUMBIA	2002	DEPL FLD
MIST EXP PHASE 4	PLAN/PROP	X	NORTHWEST NATURAL GAS CO	COLUMBIA	2004	DEPL FLD
PENNSYLVANIA						
ARTEMAS A-REWORK 97	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	BEDFORD	1997	DEPL FLD
ARTEMAS A-REWORK 98	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	BEDFORD	1998	DEPL FLD
ARTEMAS A-REWORK 99	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	BEDFORD	1999	DEPL FLD
ARTEMAS B-REWORK 97	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	BEDFORD	1997	DEPL FLD
ARTEMAS B-REWORK 98	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	BEDFORD	1998	DEPL FLD
ARTEMAS B-REWORK 99	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	BEDFORD	1999	DEPL FLD
HUNTERS CAVE EXPANSION #2	PLAN/PROP	X	EQUITRANS	GREENE	1999	DEPL FLD
LAUREL FIELDS-CALLEN RUN	HOLD		NATIONAL FUEL GAS SUPPLY	JEFFERSON	UNKNOWN	DEPL FLD
TIOGA (CAVERN #1)	HOLD		TIOGA GAS STORAGE	TIOGA	1999	SALT CAV
TIOGA (CAVERN #2)	HOLD	X	TIOGA GAS STORAGE	TIOGA	2001	SALT CAV
TENNESSEE						
WOLF CREEK	IN DEVELOP		WHITEHALL AND DEATS, LTD	MORGAN	1997	DEPL FLD
WOLF CREEK EXPANSION	IN DEVELOP	X	WHITEHALL AND DEATS, LTD	MORGAN	1998	DEPL FLD
TEXAS						
ATKINSON GAS STORAGE	PLAN/PROP		ATGS, LLC	LIVE OAK	1998	DEPL FLD
BETHEL PHASE 3	HOLD	X	LONE STAR GAS	ANDERSON	UNKNOWN	SALT CAV
NORTH DAYTON EXPANSION	IN DEVELOP	X	HNG STORAGE	LIBERTY	1998	SALT CAV
SALADO (CAV #1 EXP)	IN DEVELOP	X	AMERICAN GAS STORAGE	GAINES	1997	SALT CAV
SALADO (CAV #2 EXP)	IN DEVELOP	X	AMERICAN GAS STORAGE LP	GAINES	1998	SALT CAV
SALADO (CAV #3 EXP)	IN DEVELOP	X	AMERICAN GAS STORAGE LP	GAINES	1999	SALT CAV
SALADO (CAV #4)	HOLD	X	AMERICAN GAS STORAGE LP	GAINES	UNKNOWN	SALT CAV
SPINDLETOP CENTANA CAV #3	IN DEVELOP	X	CENTANA INTRASTATE PIPELINE CO	JEFFERSON	1997	SALT CAV
WASHINGTON						
JACKSON PRAIRIE ZONE 9 EXPANSION	IN DEVELOP	X	WASHINGTON NAT GAS	LEWIS	1999	AQUIFER

Table SR6. Proposed Natural Gas Storage Projects Planned for Service, 1997-2004 (Continued)

Project Name/State	FERC Docket	Project Count	Capacity (billion cubic feet)			Capacity (MMcf per day)		Total Cost (Thousand $)
			Base Gas	Working Gas	Total	Withdrawal	Injection	
OKLAHOMA								
OKFUSKEE			15.000	30.000	45.000	600	600	$87,000
		1	15.000	30.000	45.000	600	600	$87,000
OREGON								
MIST EXP PHASE 1 (CALVIN			2.000	3.000	5.000	45	40	NA
CREEK)								
MIST EXP PHASE 2			2.000	3.000	5.000	45	40	NA
MIST EXP PHASE 3			2.000	3.000	5.000	45	40	NA
MIST EXP PHASE 4			2.000	3.000	5.000	45	40	NA
		4	8.000	12.000	20.000	180	160	NA
PENNSYLVANIA								
ARTEMAS A-REWORK 97	CP-96-213		-0.201	0.201	0.000	22	0	$178
ARTEMAS A-REWORK 98	CP-96-213		-0.398	0.398	0.000	11	0	$5,953
ARTEMAS A-REWORK 99	CP-96-213		-0.098	0.098	0.000	44	0	$15,541
ARTEMAS B-REWORK 97	CP-96-213		-0.100	0.100	0.000	-1	0	—
ARTEMAS B-REWORK 98	CP-96-213		-0.149	0.149	0.000	10	0	$811
ARTEMAS B-REWORK 99	CP-96-213		-0.049	0.049	0.000	0	0	$2,670
HUNTERS CAVE EXPANSION #2			0.000	1.200	1.200	0	0	NA
LAUREL FIELDS-CALLEN RUN	CP90-2086		11.400	12.100	23.500	134	98	$100,000
TIOGA (CAVERN #1)	CP96-53		0.700	2.500	3.200	550	250	$100,000
TIOGA (CAVERN #2)	CP96-53		0.700	2.500	3.200	0	0	$30,000
		10	11.805	19.295	31.100	769	348	NA
TENNESSEE								
WOLF CREEK			0.400	0.800	1.200	40	30	$4,600
WOLF CREEK EXPANSION			0.000	0.800	0.800	0	0	NA
		2	0.400	1.600	2.000	40	30	NA
TEXAS								
ATKINSON GAS STORAGE			7.000	33.000	40.000	200	200	$23,000
BETHEL PHASE 3			1.500	3.500	5.000	150	25	$29,000
NORTH DAYTON EXPANSION			0.000	2.000	2.000	0	0	NA
SALADO (CAV #1 EXP)			0.000	0.300	0.300	0	0	NA
SALADO (CAV #2 EXP)			0.000	0.300	0.300	0	0	NA
SALADO (CAV #3 EXP)			0.000	0.300	0.300	0	0	NA
SALADO (CAV #4)			0.500	1.000	1.500	200	150	$4,200
SPINDLETOP CENTANA CAV #3			1.300	3.100	4.400	350	0	NA
		8	10.300	43.500	53.800	900	375	NA
WASHINGTON								
JACKSON PRAIRIE ZONE 9 EXPANSION			0.000	3.000	3.000	50	0	NA
		1	0.000	3.000	3.000	50	0	NA

Table SR6. Proposed Natural Gas Storage Projects Planned for Service, 1997-2004 (Continued)

Project Name/State	Status	Expansion of Existing Facility? (X=Yes)	Developer/Owner/Operator	County	Projected Year in Service	Reservoir Type
WEST VIRGINIA						
COCO A-REWORK 97	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	KANAWHA	1997	DEPL FLD
COCO A-REWORK 98	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	KANAWHA	1998	DEPL FLD
COCO A-REWORK 99	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	KANAWHA	1999	DEPL FLD
COCO C-REWORK 97	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	KANAWHA	1997	DEPL FLD
COCO C-REWORK 98	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	KANAWHA	1998	DEPL FLD
COCO C-REWORK 99	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	KANAWHA	1999	DEPL FLD
GLADY-REWORK 97	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	UPSHUR	1997	DEPL FLD
GLADY-REWORK 98	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	UPSHUR	1998	DEPL FLD
GLADY-REWORK 99	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	UPSHUR	1999	DEPL FLD
LOST-CREEK MODIFICATION	IN DEVELOP	X	CNG TRANS CORP	HARRISON	1997	DEPL FLD
TERRA ALTA -REWORK 97	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	PRESTON	1997	DEPL FLD
TERRA ALTA -REWORK 98	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	PRESTON	1998	DEPL FLD
TERRA ALTA -REWORK 99	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	PRESTON	1999	DEPL FLD
TERRA ALTA SOUTH-REWORK 97	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	PRESTON	1997	DEPL FLD
TERRA ALTA SOUTH-REWORK 98	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	PRESTON	1998	DEPL FLD
TERRA ALTA SOUTH-REWORK 99	IN DEVELOP	X	COLUMBIA GAS TRANS CORP	PRESTON	1999	DEPL FLD
WYOMING						
SOUTHWEST WYOMING	PLAN/PROP		QUESTAR PIPELINE	UINTA	2002	SALT CAV
U.S. TOTAL						

Table SR6. Proposed Natural Gas Storage Projects Planned for Service, 1997-2004 (Continued)

Project Name/State	FERC Docket	Project Count	Capacity (billion cubic feet)			Capacity (MMcf per day)		Total Cost (Thousand $)
			Base Gas	Working Gas	Total	Withdrawal	Injection	
WEST VIRGINIA								
COCO A-REWORK 97	CP-96-213		-0.404	0.404	0.000	11	0	$6,790
COCO A-REWORK 98	CP-96-213		-0.250	0.250	0.000	0	0	$2,707
COCO A-REWORK 99	CP-96-213		-0.245	0.245	0.000	5	0	$4,585
COCO C-REWORK 97	CP-96-213		-0.002	0.002	0.000	-1	0	—
COCO C-REWORK 98	CP-96-213		-0.398	0.398	0.000	49	0	$15,582
COCO C-REWORK 99	CP-96-213		-0.198	0.198	0.000	28	0	$4,232
GLADY-REWORK 97	CP-96-213		-0.798	0.798	0.000	20	0	$3,734
GLADY-REWORK 98	CP-96-213		-0.497	0.497	0.000	2	0	$3,253
GLADY-REWORK 99	CP-96-213		-0.296	0.296	0.000	3	0	$2,209
LOST-CREEK MODIFICATION			-9.100	9.100	0.000	0	0	NA
TERRA ALTA -REWORK 97	CP-96-213		-0.202	0.202	0.000	23	0	$2,875
TERRA ALTA -REWORK 98	CP-96-213		-0.001	0.001	0.000	15	0	$754
TERRA ALTA -REWORK 99	CP-96-213		-0.197	0.197	0.000	-3	0	—
TERRA ALTA SOUTH-REWORK 97	CP-96-213		-0.001	0.001	0.000	7	0	$89
TERRA ALTA SOUTH-REWORK 98	CP-96-213		-0.050	0.050	0.000	4	0	$1,063
TERRA ALTA SOUTH-REWORK 99	CP-96-213		-0.049	0.049	0.000	0	0	—
		16	-12.687	12.687	0.000	165	0	NA
WYOMING								
SOUTHWEST WYOMING			2.000	5.000	7.000	500	300	NA
		1	2.000	5.000	7.000	500	300	NA
U.S. TOTAL		104	160.220	393.710	553.920	11137	5211	NA

Bcf = Billion cubic feet. Mmcf = Million cubic feet per day. NA = Not available.

Notes: Totals may not equal sum of components because of independent rounding. Projected capacities for Columbia Gas Trans Corp MCARTHUR-REWORK 98 project are less than the level of precision in the table. These capacities are: Base Gas: -400 Mcf, Working Gas: +400 Mcf, and Withdrawal: +0.l MMcf per day.

Source: Energy Information Administration (EIA), EIAGIS-NG Geographic System, Proposed Underground Storage Database, as of September 1, 1997, based on Federal Energy Regulatory Commission filings and information compiled from various industry news sources.

The Avoca project, being developed by a partnership of Natural Gas Clearinghouse, Equitable Resources, and U.S. Generating Company (a Bechtel and Pacific Gas and Electric Company joint venture), has been discontinued, at least for the time being, because of a brine disposal problem. The project plan called for brine disposal in special, 2-mile-deep disposal wells, which, when drilled and tested during the summer of 1996, turned out not to have the requisite permeability. Development on the project, which had reached a fairly advanced stage in terms of surface facilities and equipment, came to a virtual halt as several alternatives were debated. The alternative selected was to construct a special pipeline to ship the brine some 45 miles away to commercial salt processors near Watkins Glen, New York. Avoca filed for certification from FERC in February 1997 to construct the brine pipeline, but by June, the partnership had requested that FERC temporarily suspend processing of its application.

The long delay associated with the brine-disposal problem has been costly. It has led to disputes with some contractors and suppliers and has also resulted in a general reevaluation of the project among the partners. While some involved with the project are optimistic that it will eventually be implemented, particularly because customer commitment remains strong, it is very possible that the partnership could be restructured with different ownership interests. The projected online dates for this project are representative of a "best-case" scenario in terms of overcoming the current problems; there is also a chance (although small, according to Avoca personnel) that the project could be canceled.

By contrast, developers of the Tioga salt cavern facility, in Tioga, Pennsylvania, have come up with a seemingly successful brine disposal method. Market Hub Partners, the managing general partner of NE Hub Partners, LP, which is developing Tioga, has made arrangements to dispose of the brine by shipping it to a new brine processing plant to be built nearby by United Salt Northeast, a subsidiary of United Salt. The new plant is expected to employ 100 people and produce 750,000 tons of salt each year.[9] The other advantage for Tioga is that, by disposing of the brine in this way, it largely avoids having to deal with the environmental protection considerations inherent in other methods. Indeed, the Environmental Protection Agency has already granted its clearance for construction to NE Hub Partners. Still to be obtained are construction certificates from the Public Utility Commission of Pennsylvania and from the FERC.

CNG Transmission Corporation's plans for the third salt cavern facility in this area involve leasing storage space in salt caverns, some existing and some to be constructed, from the owner of the caverns, Bath Petroleum. Although the plan may be implemented eventually, it has been put on hold because of jurisdictional problems. Bath Petroleum currently has seven salt caverns, which it has been using since 1983 to store liquid hydrocarbons. In 1991, it developed plans to construct five more. Leaching activities have begun on two of these. In 1996, CNG and Bath entered into a lease agreement in which Bath agreed to provide CNG with natural gas storage capacity from its existing non-jurisdictional liquid hydrocarbon storage caverns by late 1997 and from the new caverns by 1999.

In May of last year, CNG filed an application with FERC requesting authority for a variety of activities comprising its Seasonal Service Expansion project, the heart of which involved the leasing, conversion, and operation of the Bath salt caverns for gas storage. However, FERC rejected CNG's contention that Bath Petroleum's activities in preparing existing nonjurisdictional caverns for gas storage for use in interstate commerce, and constructing new caverns with a potential for nonjurisdictional use, were not subject to FERC regulation. In its order denying CNG a rehearing of the matter, issued in June 1997, FERC reiterated that CNG must obtain a certificate of public convenience and necessity, under section 7(c) of the Natural Gas Act, to construct and operate the storage facilities.

Columbia's Major Expansion Project

The 73 storage expansion projects are dominated by the 42 projects attributed to Columbia Gas Transmission Corporation. Columbia has embarked on a comprehensive effort to upgrade and expand its services, called the "Market Expansion Project," which among other things involves expanding working gas capacity and deliverability at 14 of its 44 storage facilities in Ohio, Pennsylvania, and West Virginia. Through a variety of physical and operational improvements, and over the course of 1997, 1998, and 1999, Columbia aims to add approximately 18.4 Bcf of working gas capacity and almost 370 MMcf per day of additional deliverability from these 14 facilities.

The Market Expansion Project represents 42 percent of proposed working gas capacity in depleted field expansion projects in all years and 23 percent of working gas capacity in all expansion projects in all years. It also represents 45 percent of projected deliverability from depleted field expansion projects in all years and 10 percent of projected deliverability from all expansion projects in all years. The project's lower proportion of

[9]Pasha Publications, Inc., *Gas Daily's Gas Storage Report*, Vol. 7, No. 3 (Arlington, VA, March 1997), p. 10.

total projected deliverability expansions reflects the fact that there are a number of planned expansions to salt cavern projects that include sizeable deliverability additions. In fact, three of the proposed expansions to existing salt cavern facilities would each add deliverability nearly equal to, or in one case almost twice that of, the entire increase from the Market Expansion Project.

Summary

Storage has become a more valuable and higher-profile service in today's natural gas market. Nearly 206 billion cubic feet of working gas capacity was added to the Nation's storage stocks between the end of 1992 and the start of 1997, an increase of 6 percent. Of even greater significance, deliverability from storage increased by almost 8 billion cubic feet per day (12 percent), with particular emphasis placed on development of high-deliverability, salt cavern storage facilities. Many market center operators and marketers offer high-deliverability storage services to support short-term gas loans, gas balancing, and peaking services.

Substantial additions are also planned for completion during the next few years, with independent storage operators developing the most capacity. Of the 104 projects on the drawing board as of September 1, 1997, independents account for more than 70 percent of proposed working gas capacity and two-thirds of additional deliverability. Of course, some of these projects have uncertain futures, but if all 104 are actually completed, working gas capacity will increase by 10 percent from the 1996 level and deliverability by nearly 15 percent.