WIPP
Subsidence Monument
Leveling Survey
2003

October 2003

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List of Acronyms

DOE	Department of Energy
DOY	Day of year
FGCS	Federal Geodetic Control Subcommittee
M&TE	Measurement and Test Equipment
NGS	National Geodetic Survey
WTS	Washington TRU Solutions
WIPP	Waste Isolation Pilot Plant

References

Classification, Standards of Accuracy, and General Specifications of Geodetic Control Surveys, Federal Geodetic Control Committee (now Federal Geodetic Control Subcommittee), [1975] 1980, Reprint.

FGCS Specifications and Procedures to Incorporate Electronic Digital / Bar-Code Leveling Systems, Federal Geodetic Control Subcommittee, ver. 4.0, dated July 15,1994.

WP 09-ES4001, *Subsidence Survey Data Acquisition and Report,* June 2002

Subsidence Monitoring Software Quality Assurance Plan, July 2002

WIPP Subsidence Monument Leveling Surveys 1986-1997, DOE / WIPP 98-2293, June 1998.

WIPP Subsidence Monument Leveling Surveys 1998, DOE / WIPP 99-2293, October 1998.

WIPP Subsidence Monument Leveling Surveys 1999, DOE / WIPP 00-2293, October 1999.

WIPP Subsidence Monument Leveling Surveys 2000, DOE / WIPP 01-2293, October 2000

WIPP Subsidence Monument Leveling Surveys 2001, DOE / WIPP 02-2293, October 2001

WIPP Subsidence Monument Leveling Surveys 2002, DOE / WIPP 03-2293, October 2002

1. Introduction

Sections 2 through 7 of this report define the result of the 2003 leveling survey through the subsidence monuments at the WIPP site. Approximately 18 miles of leveling was completed through nine vertical control loops. The 2003 survey includes the determination of elevation on each of the 51 existing subsidence monuments and the WIPP baseline survey, and 14 of the National Geodetic Survey's (NGS) vertical control points. The field observations were completed during September of 2003 by personnel from the Washington TRU Solutions (WTS) Surveying Group, Mine Engineering Department. Additional rod persons were provided by the Drafting and Geotechnical Engineering departments.

Digital leveling techniques were utilized to achieve better than Second Order Class II loop closures as outlined by the Federal Geodetic Control Subcommittee (FGCS). Because it is important to perform the subsidence survey in exactly the same manner each year, WIPP procedure (WP 09-ES4001) details each step of the survey. Starting with the 2002 survey this procedure has been used to perform the subsidence survey.

Starting with the survey of the year 2001, Loop 1 and redundant survey connections among the various loops were removed from the survey and report. This resulted in a reduction of fieldwork with no loss of accuracy or precision. The redundant connections caused multiple elevations for the same stations. The differences were so slight that they were not used in elevation adjustments for the loops. The redundancy was used to spot gross errors in the field. After several years of surveying these loops it is evident that no gross errors occur that are not also evident in the loop closures.

Finally, Section 8 contains Table F, which summarizes the elevations for all surveys from 1987 through 2003, inclusive. A detailed listing of the 1986 through 1997 surveys is contained in the report, *WIPP Subsidence Monument Leveling Surveys 1986-1997*, DOE/WIPP 98-2293. A reference to the summary reports for each year after 1997 is listed in the reference section of this document.

2. Equipment

The observations were taken with the WILD NA3003 Electronic Digital Level (WIPP M&TE ID# DM0999) manufactured by Leica, and bar coded leveling staffs. The calibration for the NA3003 is valid from February 11, 2003, through February 11, 2005. The data were recorded electronically on the Leica GRM10 REC-Module, which plugs directly into the instrument. In addition to the electronic record, a written field log was maintained to record information that is not stored in the electronic record.

3. Office Processing

Each day the data were downloaded from the GRM10 REC-Module to the survey group computer. The original raw data files were maintained intact, and further processing was performed on a copy of the original raw data file.

Listing of the data, and the adjustment of the loops, was completed with the DIGILEV software (version 10.94d) from Leica Canada. The results, as summarized below, were extracted from the output of the DIGILEV software. A Software Quality Assurance Plan was written for the computer programs used in reducing the subsidence survey field notes. DIGILEV was tested, verified and validated. The program was deemed acceptable and is now in the WIPP controlled software list.

4. Methodology

The weather conditions during the observations of the 2003 survey were generally mild with moderate temperatures and light to moderate breezes.

The elevations for the 2003 survey are computed from the adjusted observations based on the elevation of the subsidence monument, S-37 (3,423.874 feet). S-37 is the WIPP monument that is furthest from the influence of the underground excavations, and has been held fixed for all of the subsidence leveling surveys since 1993. The condition of the individual monuments was substantially the same as the previous subsidence survey. No points were missing or significantly damaged.

As in previous years, the subsidence survey was divided into nine loops. Each loop generally takes one day to complete. This allows a loop to be completed in one surveying session and results in a lower probability of error.

For visual reference, Figure 1 shows a graphic display of the individual loops, the total survey, and the relationship to the underground excavations.

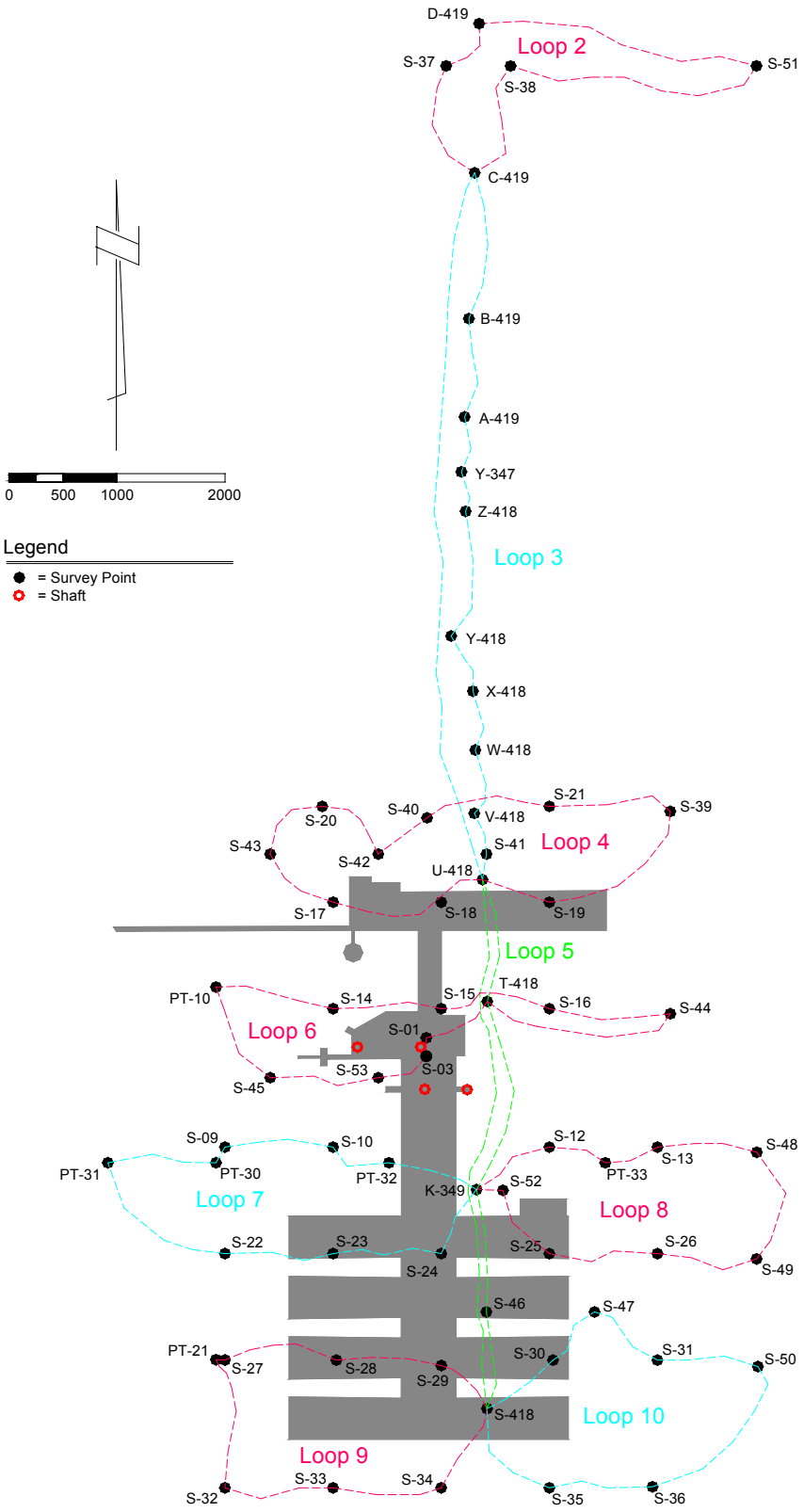

Figure 1. Individual Loops, Total Survey and Underground Excavations

5. General Summary of Results

Table A below describes the nine leveling loops that were measured to obtain the elevations of the subsidence monuments. The table contains the start date of the observations, a loop number, and the points that are contained within the loop.

Table A. Description of 2003 Leveling Loops

Start Date (DOY)	Loop	Points
September 03, 2003 (246)	2	D-419, S-37, C-419, S-38, S-51, D-419
Sept. 4 & 8, 2003 (247 & 251)	3	C-419, B-419, A-419, Y-347, Z-418, Y-418, X-418, W-418, V-418, S-41, U-418, C-419
September 9,2003 (252)	4	U-418, S-18, S-17, S-43, S-20, S-42, S-40, S-21, S-39, S-19, U-418
September 11, 2003 (254)	5	U-418, T-418, K-349, S-46, S-418, U-418
September 29, 2003 (272)	6	T-418, S-01, S-03, S-53, S-45, PT-10, S-14, S-15, S-16, S-44, T-418
September 24, 2003 (267)	7	K-349, S-24, S-23, S-22, PT-31, PT-30, S-09, S-10, PT-32, K-349
September 23, 2003 (266)	8	K-349, S-52, S-25, S-26, S-49, S-48, S-13, PT-33, S-12, K-349
September 18, 2003 (261)	9	S-418, S-34, S-33, S-32, PT-21, S-27, S-28, S-29, S-418
September 16, 2003 (259)	10	S-418, S-35, S-36, S-50, S-31, S-47, S-30, S-418

Table B summarizes the results of the leveling loops in terms of vertical closure and accuracy. The requirement for Second Order Class II loop closure accuracy was achieved in all cases.

Table B. Summary of Distance and Accuracy for 2003 Leveling Loops

Loop	Cumulative Distance (ft.)	Vertical Closure (ft.)	Accuracy (ft.√mile)	Allowable Accuracy (ft.√mile)
2	8,186.32	0.0015	0.001	0.041
3	13,695.78	0.0070	0.004	0.053
4	8,872.62	-0.0306	0.024	0.043
5	11,928.40	0.0031	0.002	0.050
6	9,995.20	0.0076	0.006	0.045
7	8,540.21	0.0003	0.000	0.042
8	6,995.07	-0.0034	0.003	0.038
9	7,458.34	-0.0008	0.001	0.039
10	6,957.40	-0.0069	0.006	0.038

5.1 Accuracy Summary by Loop

Table C shows a detailed summary of the observations in the leveling loops for the 2003 survey. All results are shown in feet. The information in the table for each loop includes:

Between each benchmark in the loop:

- The distance leveled between benchmarks along the loop.
- The number of instrument setups between each of the benchmarks.
- The difference in elevation from each benchmark to the next.

For each loop as a whole:

- The cumulative, or total, distance of each loop.
- The vertical closure of the loop.
- The accuracy of leveling.
- Allowable accuracy for each loop.

The accuracy of the leveling is given in terms of feet times the square root of the length of the loop in miles. The actual accuracy of leveling is computed in the DIGILEV software, and is based on the actual vertical closure of the loop. The maximum allowable accuracy is based on the allowable accuracy of a loop as stated in the FGCS specification for digital leveling. The FGCS specification for Second Order Class II loop closure permits a maximum of 8mm$\sqrt{}$Km (8mm times the square root of the length of the loop in Km). This converts to 0.033ft.$\sqrt{}$mile (0.033 feet times the square root of the length of the loop in miles) when stated in English System. All values indicated in this summary are expressed in feet.

Inspection of the following tables shows that in every case the actual accuracy is well below the maximum allowable accuracy for each loop. The column in each table that is labeled “Difference” is the vertical difference from one point to the next. It is important to note that the vertical difference figures have been rounded, and a slight difference may exist in the vertical closure figure from the algebraic sum of the column.

Table C. Detailed Loop Measurements

Loop 2

From	To	Distance	Setups	Difference
D-419	S-37	520	4	0.618
S-37	C-419	1,179	6	13.791
C-419	S-38	1,389	8	-7.905
S-38	S-51	2,330	14	7.971
S-51	D-419	2,768	18	-14.475
Cumulative Distance:		8,187		
Vertical Closure:				0.001
Accuracy of Leveling:				0.001
Allowable Accuracy:				0.041

Loop 3

From	To	Distance	Setups	Difference
C-419	B-419	1,420	8	12.191
B-419	A-419	963	6	4.896
A-419	Y-347	540	4	0.560
Y-347	Z-418	379	2	5.800
Z-418	Y-418	1,198	6	4.013
Y-418	X-418	565	4	-9.118
X-418	W-418	580	4	-6.699
W-418	V-418	602	4	-12.808
V-418	S-41	403	4	-5.608
S-41	U-418	244	2	-4.627
U-418	C-419	6,801	38	11.400
Cumulative Distance:		13,695		
Vertical Closure:				0.007
Accuracy of Leveling:				0.001
Allowable Accuracy:				0.053

Loop 4

From	To	Distance	Setups	Difference
U-418	S-18	483	4	-1.416
S-18	S-17	1,111	6	-2.419
S-17	S-43	795	4	1.375
S-43	S-20	734	4	10.545
S-20	S-42	716	4	-6.114
S-42	S-40	576	4	6.189
S-40	S-21	1,207	8	7.514
S-21	S-39	1,143	8	-3.809
S-39	S-19	1,429	12	-12.012
S-19	U-418	677	6	0.147
Cumulative Distance:		8,871		
Vertical Closure:				-0.031
Accuracy of Leveling:				0.024
Allowable Accuracy:				0.043

Loop 5

From	To	Distance	Setups	Difference
U-418	T-418	1,223	8	-9.372
T-418	K-349	2,656	14	-12.755
K-349	S-46	1,166	6	-4.347
S-46	S-418	949	6	1.895
S-418	U-418	5,935	30	24.579
Cumulative Distance:		11,929		
Vertical Closure:				0.003
Accuracy of Leveling:				0.002
Allowable Accuracy:				0.050

Loop 6

From	To	Distance	Setups	Difference
T-418	S-01	796	4	-7.309
S-01	S-03	188	2	-0.812
S-03	S-53	544	4	-0.081
S-53	S-45	1,200	8	-8.260
S-45	PT-10	1,208	6	7.255
PT-10	S-14	1,131	6	3.665
S-14	S-15	1,006	6	1.801
S-15	S-16	1,027	6	8.127
S-16	S-44	1,167	8	6.812
S-44	T-418	1,729	12	-11.198
Cumulative Distance:		9,996		
Vertical Closure:				0.008
Accuracy of Leveling:				0.006
Allowable Accuracy:				0.045

Loop 7

From	To	Distance	Setups	Difference
K-349	S-24	944	6	-2.126
S-24	S-23	1,024	6	-6.162
S-23	S-22	1,056	6	-8.122
S-22	PT-31	1,446	8	-2.674
PT-31	PT-30	1,123	8	7.712
PT-30	S-09	177	2	1.241
S-09	S-10	1,234	8	8.366
S-10	PT-32	552	4	1.862
PT-32	K-349	985	8	-0.097
Cumulative Distance:		8,541		
Vertical Closure:				0.000
Accuracy of Leveling:				0.000
Allowable Accuracy:				0.042

Loop 8

From	To	Distance	Setups	Difference
K-349	S-52	249	2	3.370
S-52	S-25	907	6	0.333
S-25	S-26	1,030	6	12.032
S-26	S-49	928	6	12.738
S-49	S-48	1,013	6	0.685
S-48	S-13	935	6	-10.988
S-13	PT-33	510	4	-2.451
PT-33	S-12	550	4	-8.229
S-12	K-349	874	6	-7.490
Cumulative Distance:		6,996		
Vertical Closure:				-0.003
Accuracy of Leveling:				0.003
Allowable Accuracy:				0.038

Table C continued on next page…

Table C. Detailed Loop Measurements (continued)

Loop 9				
From	**To**	**Distance**	**Setups**	**Difference**
S-418	S-34	1,068	6	-9.628
S-34	S-33	1,069	6	-13.041
S-33	S-32	1,077	6	-5.583
S-32	PT-21	1,280	8	10.440
PT-21	S-27	168	2	3.360
S-27	S-28	1,038	6	6.078
S-28	S-29	977	6	6.705
S-29	S-418	781	6	1.669
Cumulative Distance:		7,458		
Vertical Closure:				-0.001
Accuracy of Leveling:				0.001
Allowable Accuracy:				0.039

Loop 10				
From	**To**	**Distance**	**Setups**	**Difference**
S-418	S-35	1,355	8	-1.174
S-35	S-36	985	6	9.035
S-36	S-50	1,506	8	16.310
S-50	S-31	961	6	-13.604
S-31	S-47	744	4	-3.105
S-47	S-30	598	4	-5.196
S-30	S-418	809	6	-2.266
Cumulative Distance:		6,958		
Vertical Closure:				-0.007
Accuracy of Leveling:				0.006
Allowable Accuracy:				0.039

6. Adjusted Level Loops

Table D is a summary of the adjusted elevations for the nine loops measured in 2003. They have been extracted from the output of the DIGILEV software. These are adjusted elevations within each loop. These final adjusted elevations also appear in Table E

Table D. Adjusted Elevations by Loop

Loop 2	
D-419	3423.256
S-37	3423.874
C-419	3437.665
S-38	3429.760
S-51	3437.731
D-419	3423.256

Loop 3	
C-419	3437.665
B-419	3449.856
A-419	3454.752
Y-347	3455.312
Z-418	3461.112
Y-418	3465.125
X-418	3456.007
W-418	3449.308
V-418	3436.500
S-41	3430.892
U-418	3426.264
C-419	3437.665

Loop 4	
U-418	3426.264
S-18	3424.849
S-17	3422.430
S-43	3423.805
S-20	3434.350
S-42	3428.236
S-40	3434.425
S-21	3441.939
S-39	3438.130
S-19	3426.117
U-418	3426.264

Loop 5	
U-418	3426.264
T-418	3416.892
K-349	3404.137
S-46	3399.790
S-418	3401.685
U-418	3426.264

Loop 6	
T-418	3416.892
S-01	3409.583
S-03	3408.771
S-53	3408.690
S-45	3400.430
PT-10	3407.685
S-14	3411.351
S-15	3413.152
S-16	3421.279
S-44	3428.090
T-418	3416.892

Loop 7	
K-349	3404.137
S-24	3402.012
S-23	3395.850
S-22	3387.728
PT-31	3385.054
PT-30	3392.766
S-09	3394.007
S-10	3402.372
PT-32	3404.234
K-349	3404.137

Loop 8	
K-349	3404.137
S-52	3407.507
S-25	3407.840
S-26	3419.871
S-49	3432.610
S-48	3433.294
S-13	3422.307
PT-33	3419.856
S-12	3411.627
K-349	3404.137

Loop 9	
S-418	3401.685
S-34	3392.057
S-33	3379.016
S-32	3373.433
PT-21	3383.874
S-27	3387.233
S-28	3393.311
S-29	3400.016
S-418	3401.685

Loop 10	
S-418	3401.685
S-35	3400.511
S-36	3409.546
S-50	3425.857
S-31	3412.252
S-47	3409.147
S-30	3403.951
S-418	3401.685

7. Adjusted Elevations (2003)

Table E shows the adjusted elevations for the subsidence monuments and the NGS points contained within the 2003 survey. These elevations are normalized to the monument, S-37. All elevations are shown in feet, and are within the WIPP local coordinate system.

Table E. 2003 Adjusted Elevations

Point	Elevation (ft.)	Point	Elevation (ft.)
S-01	3,409.583	S-42	3,428.236
S-03	3,408.771	S-43	3,423.805
S-09	3,394.007	S-44	3,428.090
S-10	3,402.372	S-45	3,400.430
S-12	3,411.627	S-46	3,399.790
S-13	3,422.307	S-47	3,409.147
S-14	3,411.351	S-48	3,433.294
S-15	3,413.152	S-49	3,432.610
S-16	3,421.279	S-50	3,425.857
S-17	3,422.430	S-51	3,437.731
S-18	3,424.849	S-52	3,407.507
S-19	3,426.117	S-53	3,408.690
S-20	3,434.350		
S-21	3,441.939	PT-10	3,407.685
S-22	3,387.728	PT-21	3,383.874
S-23	3,395.850	PT-31	3,385.054
S-24	3,402.012	PT-32	3,404.234
S-25	3,407.840	PT-33	3,419.856
S-26	3,419.871		
S-27	3,387.233	S-418	3,401.685
S-28	3,393.311	T-418	3,416.892
S-29	3,400.016	U-418	3,426.264
S-30	3,403.951	V-418	3,436.500
S-31	3,412.252	W-418	3,449.308
S-32	3,373.433	X-418	3,456.007
S-33	3,379.016	Y-347	3,455.312
S-34	3,392.057	Y-418	3,465.125
S-35	3,400.511	Z-418	3,461.112
S-36	3,409.546	A-419	3,454.752
S-37	3,423.874	B-419	3,449.856
S-38	3,429.760	C-419	3,437.665
S-39	3,438.130	D-419	3,423.256
S-40	3,434.425	K-349	3,404.137
S-41	3,430.892		

8. Comparison of Elevations*

Table F compares the elevations from all of the subsidence leveling surveys from 1987 through 2003. All elevations are shown in feet.

Table F. Comparison of Elevations 1987-2003

	S-01	S-02	S-03	S-09	S-10	S-11	S-12	S-13	S-14
1987	3,409.738	3,408.219	3,408.914	3,394.056	3,402.466	3,406.437	3,411.790	3,422.428	3,411.500
1989	3,409.719	3,411.907	3,408.900	3,394.046	3,402.459	3,406.408	3,411.739	3,422.413	3,411.483
1992	3,409.695	3,411.904	3,408.875	3,394.053	3,402.440	3,406.372	3,411.727	3,422.412	3,411.439
1993	3,409.616	(1) (2)	3,408.797	3,393.969	3,402.365	(3)	3,411.630	3,422.324	3,411.382
1994	3,409.626		3,408.806	3,393.988	3,402.374		3,411.653	3,422.348	3,411.372
1995	3,409.613		3,408.795	3,393.986	3,402.373		3,411.650	3,422.345	3,411.376
1996	3,409.615		3,408.795	3,393.994	3,402.373		3,411.645	3,422.340	3,411.369
1997	3,409.610		3,408.793	3,394.002	3,402.379		3,411.656	3,422.349	3,411.368
1998	3,409.617		3,408.802	3,394.011	3,402.388		3,411.653	3,422.352	3,411.374
1999	3,409.613		3,408.798	3,394.004	3,402.385		3,411.650	3,422.358	3,411.365
2000	3,409.607		3,408.792	3,394.003	3,402.381		3,411.644	3,422.352	3,411.364
2001	3,409.599		3,408.786	3,394.006	3402.378		3,411.636	3,422.350	3,411.361
2002	3,409.595		3,408.783	3,394.012	3,402.381		3,411.637	3,422.354	3,411.357
2003	3,409.583		3,408.771	3,394.007	3,402.372		3,411.627	3,422.307	3,411.351

Note: (1) The subsidence monument, S-02 was relocated in 1989.
(2) The subsidence monument, S-02, no longer exists after the 1992 survey.
(3) The subsidence monument, S-11, no longer exists after the 1992 survey.

	S-15	S-16	S-17	S-18	S-19	S-20	S-21	S-22	S-23
1987	3,413.291	3,421.378	3,422.519	3,425.010	3,426.235	3,434.464	3,442.030	3,387.786	3,395.914
1989	3,413.291	3,421.341	3,422.482	3,424.974	3,426.217	3,434.452	3,442.005	3,387.795	3,395.970
1992	3,413.263	3,421.331	3,422.469	3,424.964	3,426.223	3,434.364	3,441.956	3,387.788	3,396.028
1993	3,413.185	3,421.256	3,422.404	3,424.859	3,426.136	3,434.332	3,441.919	3,387.701	3,395.853
1994	3,413.188	3,421.261	3,422.402	3,424.852	3,426.134	3,434.339	3,441.932	3,387.732	3,395.886
1995	3,413.189	3,421.261	3,422.418	3,424.864	3,426.143	3,434.342	3,441.936	3,387.727	3,395.877
1996	3,413.182	3,421.263	3,422.419	3,424.860	3,426.138	3,434.345	3,441.935	3,387.727	3,395.885
1997	3,413.178	3,421.268	3,422.431	3,424.864	3,426.141	3,434.346	3,441.937	3,387.738	3,395.889
1998	3,413.184	3,421.271	3,422.436	3,424.869	3,426.150	3,434.355	3,441.946	3,387.744	3,395.887
1999	3,413.177	3,421.275	3,422.435	3,424.865	3,426.152	3,434.362	3,441.959	3,387.729	3,395.873
2000	3,413.172	3,421.278	3,422.440	3,424.864	3,426.140	3,434.362	3,441.956	3,387.727	3,395.861
2001	3,413.167	3,421.277	3,422.434	3,424.858	3,426.138	3,434.363	3,441.956	3,387.728	3,395.857
2002	3,413.159	3,421.275	3,422.434	3,424.855	3,426.132	3,434.361	3,441.950	3,387.731	3,395.857
2003	3,413.152	3,421.279	3,422.430	3,424.849	3,426.117	3,434.350	3,441.939	3,387.728	3,395.850

	S-24	S-25	S-26	S-27	S-28	S-29	S-30	S-31	S-32
1987	3,402.201	3,408.036	3,420.010	3,387.280	3,393.414	3,400.111	3,404.082	3,412.315	3,373.513
1989	3,402.167	3,408.005	3,419.978	3,387.287	3,393.400	3,400.098	3,404.064	3,412.302	3,373.498
1992	3,402.159	3,407.974	3,419.948	3,387.310	3,393.421	3,400.113	3,404.073	3,412.303	3,373.533
1993	3,402.042	3,407.870	3,419.854	3,387.181	3,393.287	3,400.008	3,403.958	3,412.206	3,373.396
1994	3,402.072	3,407.907	3,419.883	3,387.225	3,393.312	3,400.038	3,403.984	3,412.234	3,373.427
1995	3,402.062	3,407.895	3,419.871	3,387.216	3,393.309	3,400.031	3,403.978	3,412.230	3,373.425
1996	3,402.074	3,407.897	3,419.875	3,387.213	3,393.316	3,400.037	3,403.979	3,412.221	3,373.411
1997	3,402.077	3,407.897	3,419.883	3,387.229	3,393.330	3,400.050	3,403.994	3,412.248	3,373.438
1998	3,402.076	3,407.902	3,419.883	3,387.248	3,393.338	3,400.059	3,403.998	3,412.248	3,373.452
1999	3,402.067	3,407.898	3,419.886	3,387.229	3,393.322	3,400.053	3,403.990	3,412.252	3,373.429
2000	3,402.051	3,407.876	3,419.871	3,387.226	3,393.316	3,400.045	3,403.980	3,412.252	3,373.428
2001	3,402.035	3,407.862	3,419.872	3,387.231	3,393.318	3,400.040	3,403.972	3,412.255	3,373.431
2002	3,402.029	3,407.858	3,419.877	3,387.231	3,393.316	3,400.034	3,403.968	3,412.258	3,373.433
2003	3,402.012	3,407.840	3,419.871	3,387.233	3,393.311	3,400.016	3,403.951	3,412.252	3,373.433

Table F continued on next page…

Table F. Comparison of Elevations 1987-2003 (continued)

	S-33	S-34	S-35	S-36	S-37	S-38	S-39	S-40	S-41
1987	3,379.093	3,392.128	3,400.597	3,409.583					
1989	3,379.073	3,392.137	3,400.583	3,409.584	3,423.888	3,429.736			
1992	3,379.090	3,392.138	3,400.591	3,409.605	3,423.874		3,438.146	3,434.469	3,430.931
1993	3,378.975	3,392.026	3,400.478	3,409.504	3,423.874	3,429.736	3,438.110	3,434.430	3,430.888
1994	3,379.006	3,392.042	3,400.490	3,409.518	3,423.874	3,429.740	3,438.115	3,434.425	3,430.888
1995	3,379.009	3,392.042	3,400.495	3,409.520	3,423.874	3,429.739	3,438.124	3,434.437	3,430.899
1996	3,378.992	3,392.028	3,400.483	3,409.501	3,423.874	3,429.744	3,438.118	3,434.436	3,430.891
1997	3,379.019	3,392.057	3,400.516	3,409.533	3,423.874	3,429.745	3,438.127	3,434.444	3,430.894
1998	3,379.028	3,392.066	3,400.516	3,409.539	3,423.874	3,429.750	3,438.134	3,434.442	3,430.901
1999	3,379.011	3,392.056	3,400.507	3,409.539	3,423.874	3,429.751	3,438.149	3,434.445	3,430.900
2000	3,379.012	3,392.053	3,400.505	3,409.541	3,423.874	3,429.754	3,438.145	3,434.445	3,430.902
2001	3,379.014	3,392.057	3,400.509	3,409.546	3,423.874	3,429.756	3,438.145	3,434.436	3,430.898
2002	3,379.017	3,392.060	3,400.513	3,409.550	3,423.874	3,429.757	3,438142	3,434.437	3,430.897
2003	3,379.016	3.392.057	3,400.511	3,409.546	3,423.874	3,429.760	3,438.130	3,434.425	3,430.892

	S-42	S-43	S-44	S-45	S-46	S-47	S-48	S-49	S-50
1987									
1989									
1992	3,428.279	3,423.849	3,428.146	3,400.501	3,399.946	3,409.236	3,433.308	3,432.635	3,425.868
1993	3,428.230	3,423.813	3,428.070	3,400.406	3,399.837	3,409.133	3,433.238	3,432.572	3,425.809
1994	3,428.228	3,423.820	3,428.066	3,400.419	3,399.865	3,409.163	3,433.264	3,432.596	3,425.830
1995	3,428.238	3,423.826	3,428.071	3,400.424	3,399.856	3,409.158	3,433.258	3,432.588	3,425.830
1996	3,428.238	3,423.823	3,428.078	3,400.423	3,399.856	3,409.157	3,433.256	3,432.585	3,425.816
1997	3,428.249	3,423.815	3,428.084	3,400.428	3,399.877	3,409.181	3,433.274	3,432.600	3,425.846
1998	3,428.252	3,423.822	3,428.086	3,400.440	3,399.876	3,409.178	3,433.276	3,432.598	3,425.838
1999	3,428.255	3,423.825	3,428.091	3,400.435	3,399.866	3,409.176	3,433.289	3,432.611	3,425.851
2000	3,428.254	3,423.820	3,428.095	3,400.434	3,399.842	3,409.168	3,433.288	3,432.606	3,425.854
2001	3,428.247	3,423.818	3,428.094	3,400.433	3,399.824	3,409.163	3,433.290	3,432.606	3,425.858
2002	3,428.246	3,423.815	3,428.097	3,400.435	3,399.818	3,409.160	3,433.297	3,432.613	3,425.863
2003	3,428.236	3,423.805	3,428.090	3,400.430	3,399.790	3,409.147	3,433.294	4,432.610	3,425.857

	S-51	S-52	S-53	S-54	PT-10	PT-21	PT-30	PT-31	PT-32
1987									
1989									
1992	3,437.765	3,407.611	3,408.775	3,411.085	3,407.722		3,392.914	3,385.117	3,404.370
1993	3,437.746	3,407.523	3,408.670	(4)	3,407.664	3,383.821	3,392.823	3,385.027	3,404.296
1994	3,437.749	3,407.542	3,408.709		3,407.672	3,383.868	3,392.843	3,385.051	3,404.311
1995	3,437.746	3,407.542	3,408.702		3,407.671	3,383.862	3,392.844	3,385.050	3,404.322
1996	3,437.729	3,407.536	3,408.704		3,407.669	3,383.858	3,392.852	3,385.053	3,404.312
1997	3,437.725	3,407.544	3,408.702		3,407.675	3,383.874	3,392.857	3,385.063	3,404.321
1998	3,437.724	3,407.549	3,408.714		3,407.687	3,383.887	(5)	3,385.067	3,404.322
1999	3,437.729	3,407.544	3,408.709		3,407.689	3,383.868		3,385.053	3,404.315
2000	3,437.729	3,407.531	3,408.704		3,407.685	3,383.868		3,385.053	3,404.306
2001	3,437.731	3,407.522	3,408.701		3,407.687	3,383.874		3,385.053	3,404.259
2002	3,437.733	3,407.521	3,408.700		3,407.688	3,383.871		3,385.057	3,404.250
2003	3,437.731	3,407.507	3,408.690		3,407.685	3,383.874		3.385.054	3,404.234

Note: (4) The subsidence monument, S-54, no longer exists after the 1992 survey.
(5) The monument, PT-30, has been physically disturbed and was removed from the 1998 survey.

Table F continued on next page…

Table F. Comparison of Elevations 1987-2003 (continued)

	PT-33	S-418	T-418	U-418	V-418	W-418	X-418	Y-347	Y-418
1987									
1989									
1992	3,419.939								
1993	3,419.853								
1994	3,419.884								
1995	3,419.869								
1996	3,419.865	3,401.696	3,416.902	3,426.267	3,436.481	3,449.276	3,455.969	3,455.274	3,465.080
1997	3,419.873	3,401.708	3,416.906	3,426.272	3,436.487	3,449.282	3,455.976	3,455.281	3,465.091
1998	3,419.879	3,401.715	3,416.915	3,426.279	3,436.497	3,449.292	3,455.987	3,455.291	3,465.101
1999	3,419.880	3,401.707	3,416.913	3,426.275	3,436.500	3,449.304	3,456.000	3,455.304	3,465.117
2000	3,419.872	3,401.702	3,416.911	3,426.273	3,436.502	3,449.307	3,456.005	3,455.309	3,465.123
2001	3,419.866	3,401.702	3,416.905	3,426.270	3,436.502	3,449.310	3,456.007	3,455.312	3,465.125
2002	3,419.868	3,401.701	3,416.901	3,426.269	3,436.502	3,449.311	3,456.009	3,455.314	3,465.126
2003	3,419.856	3,401.685	3,416.892	3.426.264	3,436.500	3,449.308	3,456.007	3,455.312	3,465.125

	Z-418	A-419	B-419	C-419	D-419	K-349			
1987									
1989									
1992									
1993									
1994									
1995									
1996	3,461.073	3,454.714	3,449.825	3,437.633	3,423.234	3,404.152			
1997	3,461.082	3,454.720	3,449.829	3,437.642	3,423.238	3,404.162			
1998	3,461.091	3,454.730	3,449.835	3,437.648	3,423.242	3,404.173			
1999	3,461.105	3,454.744	3,449.848	3,437.657	3,423.247	3,404.169			
2000	3,461.109	3,454.749	3,449.853	3,437.660	3,423.250	3,404.157			
2001	3,461.111	3,454.752	3,449.856	3,437.663	3,423.254	3404.152			
2002	3,461.113	3,454.754	3,449.857	3,437.665	3,423.256	3404.150			
2003	3,461.112	3,454.752	3,449.856	3,437.665	3,423.256	3,404.137			

[*] The 1986 elevations that appear in all reports prior to the 2001 report are from a report filed by Jerry Williams (3/89), Geoscience Dept. Those elevations were, in turn, taken from the 1987 data, rounded to two decimal places and referenced as 1986. When this was discovered it was decided to remove the 1986 information from all subsequent reports.