IW0079

PACIFICORP
TECHNICAL SERVICES REPORT
RODGER C. FRY

CENTRAL ENGINEERING

ANNUAL SUBSIDENCE MONITORING REPORT
EAST/TRAIL MOUNTAIN PROPERTIES
1998

APRIL 28, 1999

File in:
☐ Confidential
☐ Shelf
☒ Expandable
Refer to Record No 0008 Date 04291999
In C/0150069, 1999 Incoming
For additional information

0008

COPY

ENERGY WEST Mining Co.
PO Box 310
Huntington, Utah 84528

April 29, 1999

ACT/015/009 #6
ACT/015/019 #6
ACT/015/018 #6
ACT/015/019 #6

Utah Coal Regulatory Program
Division of Oil, Gas and Mining
1594 West North Temple, Suite 121 0
Box 145801
Salt Lake City, Utah 84114-5801

Attention: Ms. Pamela Grubaugh-Littig

Re: Submittal of Annual Report for 1998, PacifiCorp, Trail Mountain Mine, ACT/015/009, Cottonwood Mine, ACT/015/019, Deer Creek Mine, ACT/015/018, Des-Bee-Dove, ACT/015/017, Emery County, Utah.

PacifiCorp, by and through its wholly-owned subsidiary, Energy West Mining Company as mine operator, herewith submit the Annual Report for 1998.

Please find enclosed two copies each of all forms and activities of the above mines related to coal mining and reclamation monitoring during the 1998 year, including the Subsidence and Hydrologic reports.

If there are any questions or concerns please call Dennis Oakley at 687-4825.

Sincerely,

Charles A. Semborski
Geology/Environmental Supervisor

cc: Blake Webster
Carl Pollastro
Barbara Adams (File)

I:\PCCOMMON\PCCOMMON\ENVIRONM\PEI

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Date 04-29-99 For additional information

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APR 30 1999
DIV. OF OIL, GAS & MINING

Huntington Office:
(435) 687-9821
Fax (435) 687-2695
Purchasing Fax (435) 687-9092

Deer Creek Mine:
(435) 687-2317
Fax (435) 687-2285

Trail Mountain Mine:
(435) 748-2140
Fax (435) 748-5125

PACIFICORP

SUBSIDENCE MONITORING PROGRAM

ANNUAL REPORT FOR 1998

April, 1999

Submitted to:

United States Department of the Interior
Office of Surface Mining
Minerals Management Service
Utah Division of Oil, Gas and Mining

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L, GAS & MININ

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Spring Map with 5-Year Mine Plan Showing Subsidence

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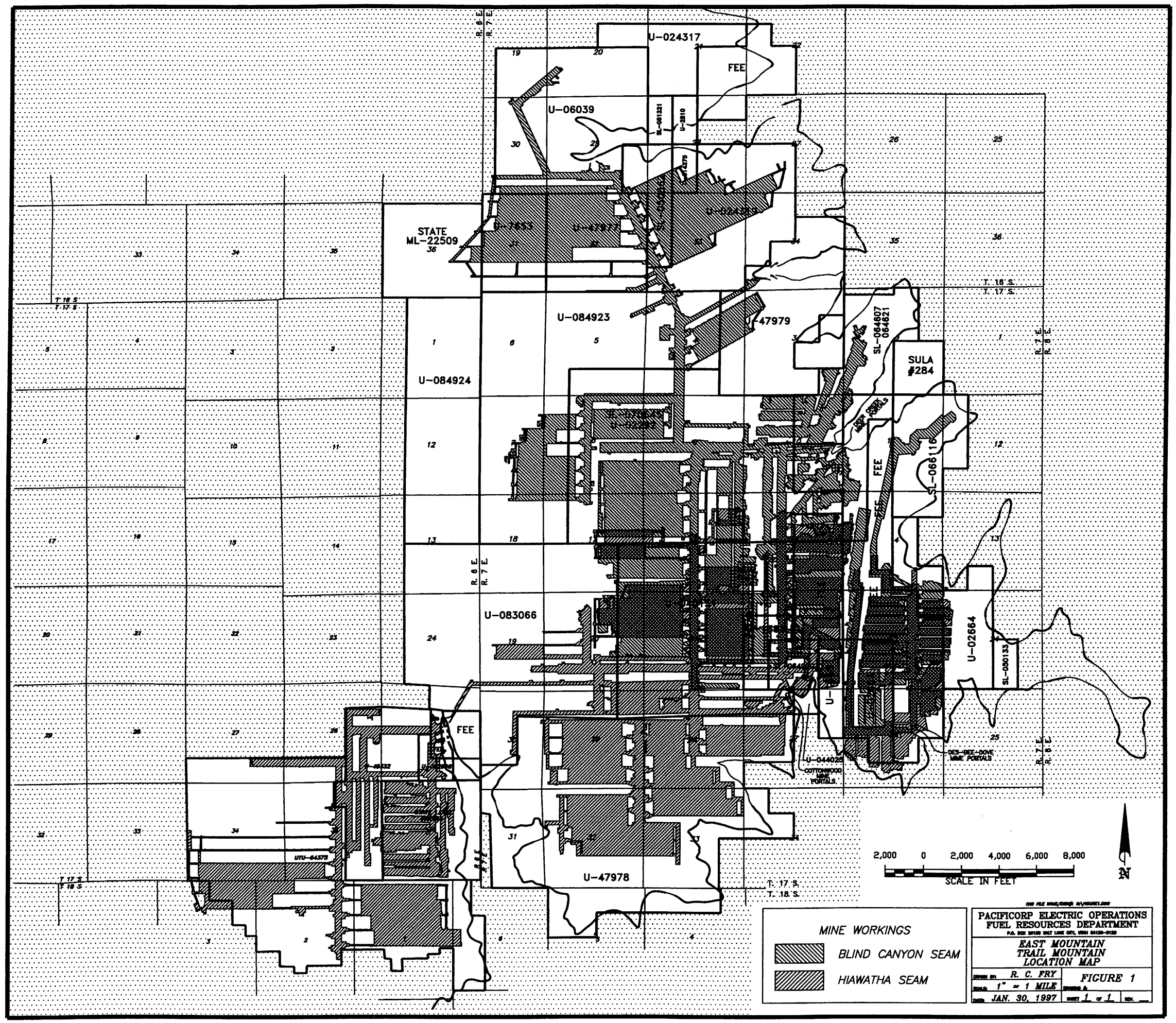
INTRODUCTION

PacifiCorp's East Mountain/Trail Mountain Subsidence Monitoring Study is an ongoing project designed to detect, observe, and report the effects of mining-induced subsidence above the Deer Creek, Wilberg/Cottonwood, Des-Bee-Dove and Trail Mountain Mines (see Figure 1). This, the seventeenth such annual report submitted, covers the period between August 31, 1997 and August 31, 1998.

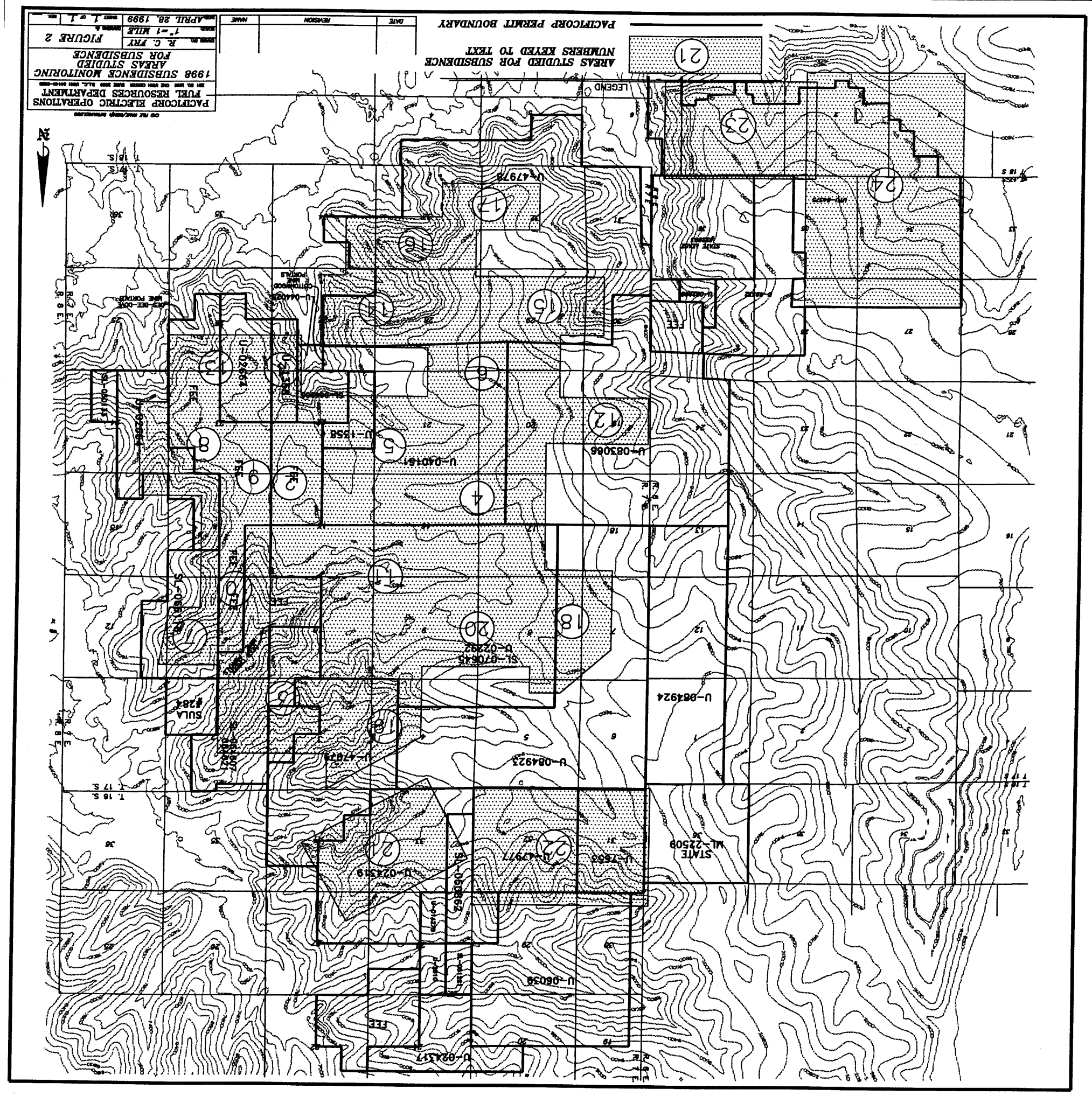
The initial report submitted in 1982 details the monitoring methods used in the study; therefore, they are not discussed in depth here. Briefly, PacifiCorp uses aerial photogrammetric survey methods and annual helicopter reconnaissance flights to monitor subsidence. The aerial photogrammetry work is contracted to a mapping company. Contracts for the work are bid and awarded for a three year period. This is the third contractor that has been involved with the project. Between 1982 and 1987 the work was contracted through Intermountain Aerial Surveys. They established reading points on generally a 200 foot grid but adjusted the location of each point to be on easily reproducible locations. Between 1988 and 1990 the work was contracted to Maps Inc. Because of the type of equipment it was better for them to establish uniform grid points on 200 foot spacing. In 1991 the work was contracted to MapCon Mapping Consultants. The owners of this company were previously employed by Intermountain Aerial Surveys and felt that better results could be obtained by using the original grid established by Intermountain Aerial Surveys. Therefore, they reverted back to the original monitoring grid. A change in the method of reading the aerial photographs may result in some slight changes in


U-024317
FEE
U-06039
STATE
ML-22509
U-084923
U-47979
U-084924
SULA
#284
FEE
SL-066116
U-083066
U-02664
SL-050133
FEE
U-47978
U-044025
COTTONWOOD
MINE
PORTALS
DES-BEE-DOVE
MINE PORTALS
T. 16 S.
T. 17 S.
T. 17 S.
T. 18 S.
R. 6 E
R. 7 E
2,000 0 2,000 4,000 6,000 8,000
SCALE IN FEET
N
MINE WORKINGS
BLIND CANYON SEAM
HIAWATHA SEAM
PACIFICORP ELECTRIC OPERATIONS
FUEL RESOURCES DEPARTMENT
EAST MOUNTAIN
TRAIL MOUNTAIN
LOCATION MAP
DRAWN BY: R. C. FRY
SCALE: 1" = 1 MILE
DATE: JAN. 30, 1997
FIGURE 1
SHEET 1 OF 1

measured subsidence in some areas. Also, it is crucial that accurate paneled control be surveyed and recorded on the photographs to enable close subsidence readings. Between 1987 and 1990, some of the survey control in the more difficult to reach areas were not properly paneled and could not be identified on the photographs. It appears that this diminished the precision of the subsidence reading in some of the areas during those years. Using the aerial photographs derived from a flight conducted on August 29, 1998, elevations were measured at 17,277 different points. These elevations were then compared with the baseline survey elevations measured from the aerial photos collected in 1980, 1986, 1987 and 1994. The difference in elevation is the amount of subsidence that has occurred. A map of all areas of subsidence is included in the appendix to this report. The raw data is included in the appendix of this report on a 3 ½ inch disk in an ASCII file called 98SUB.TXT. The photography completed on August 29, 1999 included color Infra-red and black and white and included all of the areas where longwall or room and pillar extraction has been completed. A helicopter reconnaissance flight May 19, 1998 revealed no new fracturing or visible signs of subsidence in any of the monitored areas. Prior to PacifiCorp's acquisition of the Trail Mountain Mine from ARCO Coal Co., they monitored subsidence using on the ground monumentation. Nowhere did that monitoring identify subsidence greater than a few tenths of feet. Substantial longwall mining has now occurred in the Trail Mountain Mine. As a result, subsidence has been detected and is reported herein.

Location

Figure 2 shows all areas above PacifiCorp's coal mines which have potential for mining-induced subsidence. In 1998, twenty-four areas of subsidence were monitored and are reported herein. In areas where subsidence has been detected, data is shown in the form of contour maps and profiles. Both indicate elevation change from pre-mining elevations. The profile figures present data for all years monitored with the exception of the 1990 data. The computer data files from that year were damaged rendering them unreadable. At this time it is felt that enough data exists from the other years and the task of regenerating that data is not warranted. In many areas of subsidence the angle-of-draw has been calculated and reported; however, in the majority of cases the angle should not be considered the actual final angle-of-draw due to several factors. For example, the zone of subsidence to date may be small and contained within the underlying mined area, suggesting that the subsidence has not yet reached its maximum extent. Also, many mined sections are surrounded by other older workings which influence the calculation. In a few areas where the mined-out workings are surrounded by burned coal, the failure of clinker beds promotes subsidence outside the mined area resulting in an angle-of-draw greater than might be expected.


PACIFICORP ELECTRIC OPERATIONS
FUEL RESOURCES DEPARTMENT
1998 SUBSIDENCE MONITORING
AREAS STUDIED
FOR SUBSIDENCE
R. C. FRY
1"=1 MILE
APRIL 28, 1999
FIGURE 2
AREAS STUDIED FOR SUBSIDENCE
NUMBERS KEYED TO TEXT
PACIFICORP PERMIT BOUNDARY
LEGEND
U-47978
U-083066
U-040161
U-1358
U-02664
U-084924
U-084923
U-47977
U-024319
U-06039
U-024317
SULA #284
STATE ML-22509
FEE

Area 1

Deer Creek 9th East - Wilberg 1st Right

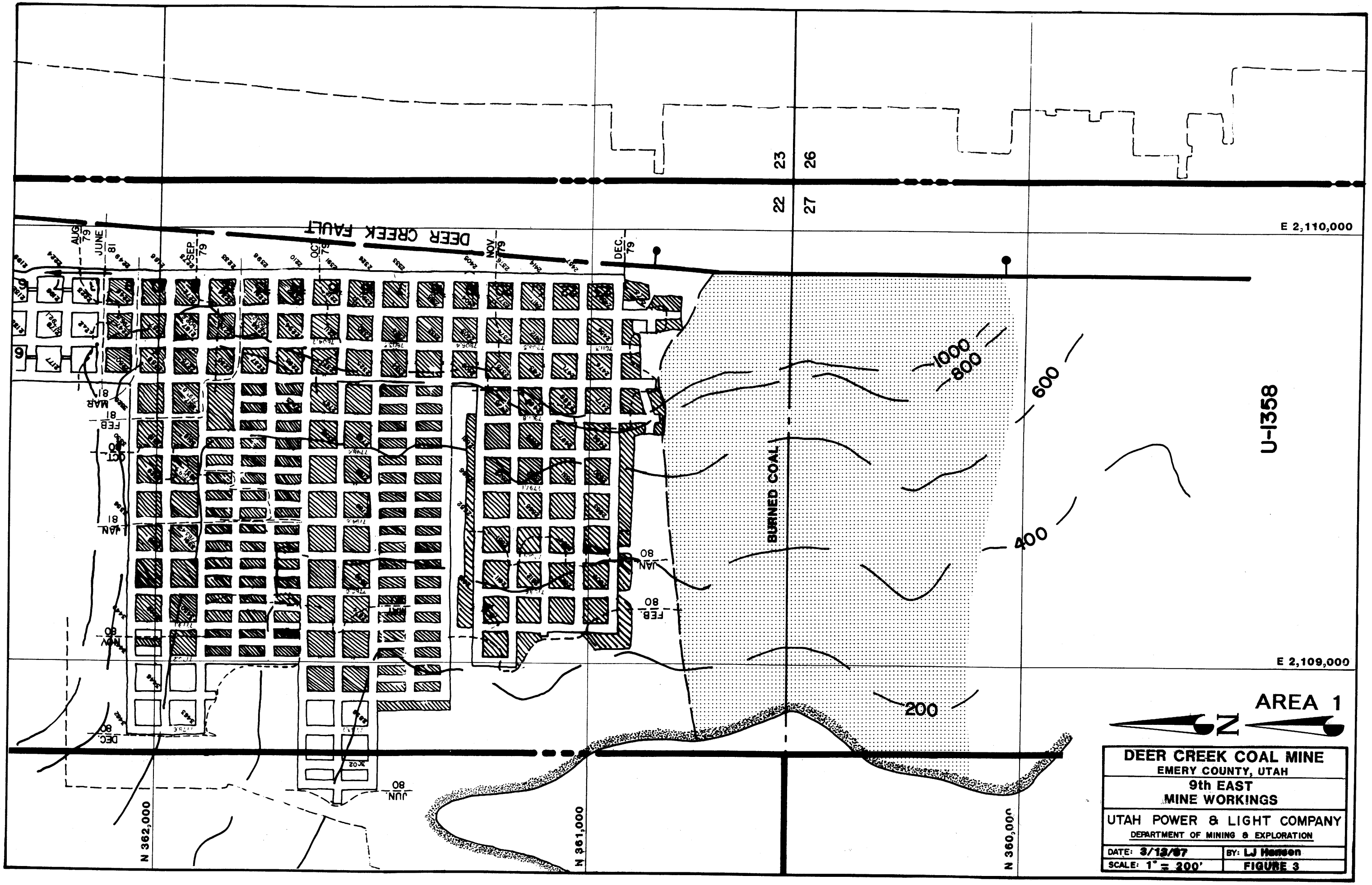
Subsidence in Area 1 was first documented in the 1981 Subsidence Monitoring Report submitted in 1982. The relationship of the subsidence to the underlying Deer Creek and Wilberg mine workings is shown in Figures 3, 4, and 5. Each map covers the same area, Figure 5 being a contour map of subsidence on the surface over the mine workings depicted in the other two figures. The most recent mining in this area occurred in the Wilberg 1st Right section in June 1984.

Figures 6 and 7 are north to south and west to east profiles showing the amount of subsidence in this area during the past fifteen years. The location of each line is shown on Figure 5. The area has seen little change since 1985 and appears to have totally stabilized. Maximum subsidence remains at about twenty-eight (28) feet. A detailed look from a helicopter revealed that the subsidence maximum is located on a steep slope, about 200 feet south of the southernmost mining, where a good-sized rotational slump has occurred. The workings here are also surrounded by burned coal. It is probable that the combination of steep slopes and crushing of clinker beds has allowed subsidence to occur well outside the area of mine workings. An inspection of the area from the ground indicates that many of the open fractures forming the graben-like structure have begun to heal and fill in with soil.

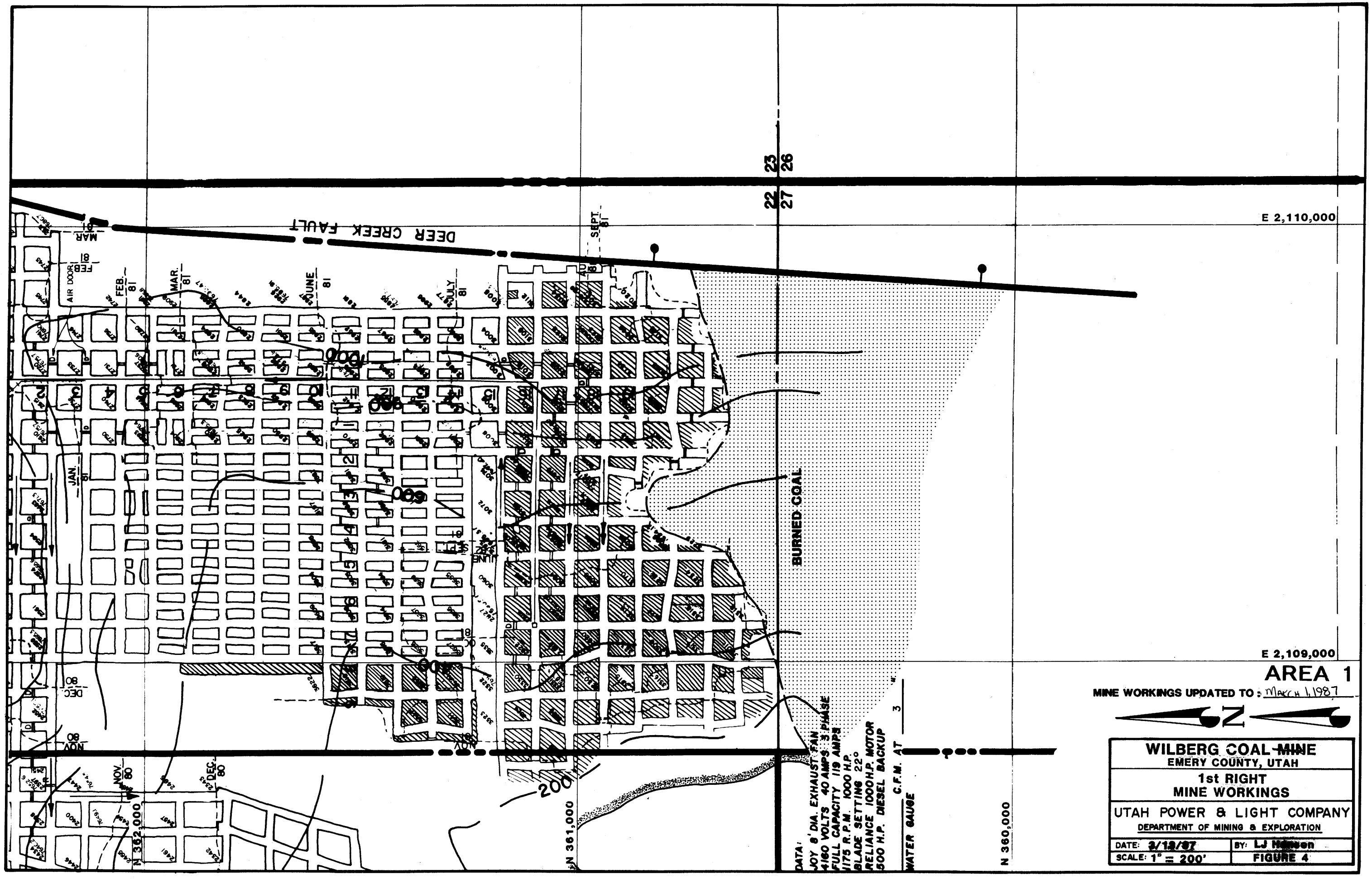
Calculation of the angle-of-draw is complicated because the workings are nearly surrounded by faults, burned coal, and other mine workings. Due to this complexity, angle-of-draw was not determined for Area 1.

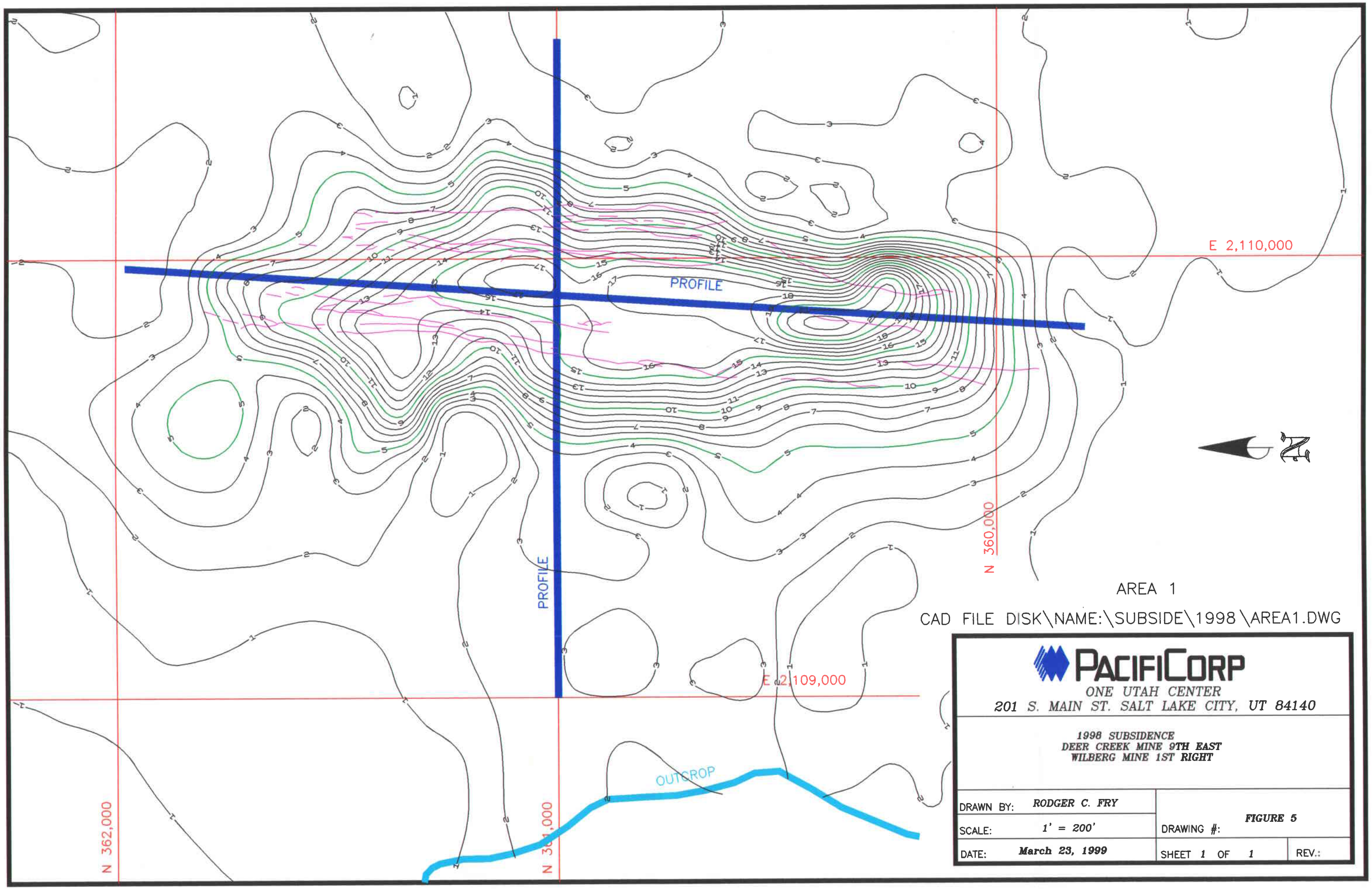
In the summer of 1997, some of the fractures in this area were reclaimed per the U. S. Forest Service recommendations. This reclamation consisted of knocking down the abrupt escarpments and filling in the fractures in accessible areas. The top soil was then evenly distributed and the area re-seeded. This reclamation was completed by September 1, 1997 and encompassed 1.5 acres.

There are no springs, and no hydrologic impacts due to mining have been observed at this location.



DEER CREEK COAL MINE
EMERY COUNTY, UTAH
9th EAST
MINE WORKINGS
UTAH POWER & LIGHT COMPANY
DEPARTMENT OF MINING & EXPLORATION
DATE: 3/13/87 | BY: LJ Hansen
SCALE: 1" = 200' | FIGURE 3


DEER CREEK FAULT
BURNED COAL
E 2,110,000
E 2,109,000
N 362,000
N 361,000
N 360,000
AIR DOOR
MAR. 81
FEB. 81
JAN. 81
DEC. 80
NOV. 80
JUNE 81
JULY 81
SEPT. 81
AUG. 81
DATA:
JOY 8' DIA. EXHAUST FAN
4160 VOLTS 40 AMPS 3 PHASE
FULL CAPACITY 119 AMPS
1175 R.P.M. 1000 H.P.
BLADE SETTING 22°
RELIANCE 1000 H.P. MOTOR
500 H.P. DIESEL BACKUP
C.F.M. AT 3
WATER GAUGE
AREA 1
MINE WORKINGS UPDATED TO: MARCH 1, 1987
N
WILBERG COAL MINE
EMERY COUNTY, UTAH
1st RIGHT
MINE WORKINGS
UTAH POWER & LIGHT COMPANY
DEPARTMENT OF MINING & EXPLORATION
DATE: 3/13/87
BY: LJ Hansen
SCALE: 1" = 200'
FIGURE 4



AREA 1

CAD FILE DISK\NAME:\SUBSIDE\1998\AREA1.DWG

PACIFICORP

ONE UTAH CENTER

201 S. MAIN ST. SALT LAKE CITY, UT 84140

1998 SUBSIDENCE
DEER CREEK MINE 9TH EAST
WILBERG MINE 1ST RIGHT

DRAWN BY:	RODGER C. FRY	DRAWING #:	FIGURE 5
SCALE:	1' = 200'		
DATE:	March 23, 1999	SHEET 1 OF 1	REV.:

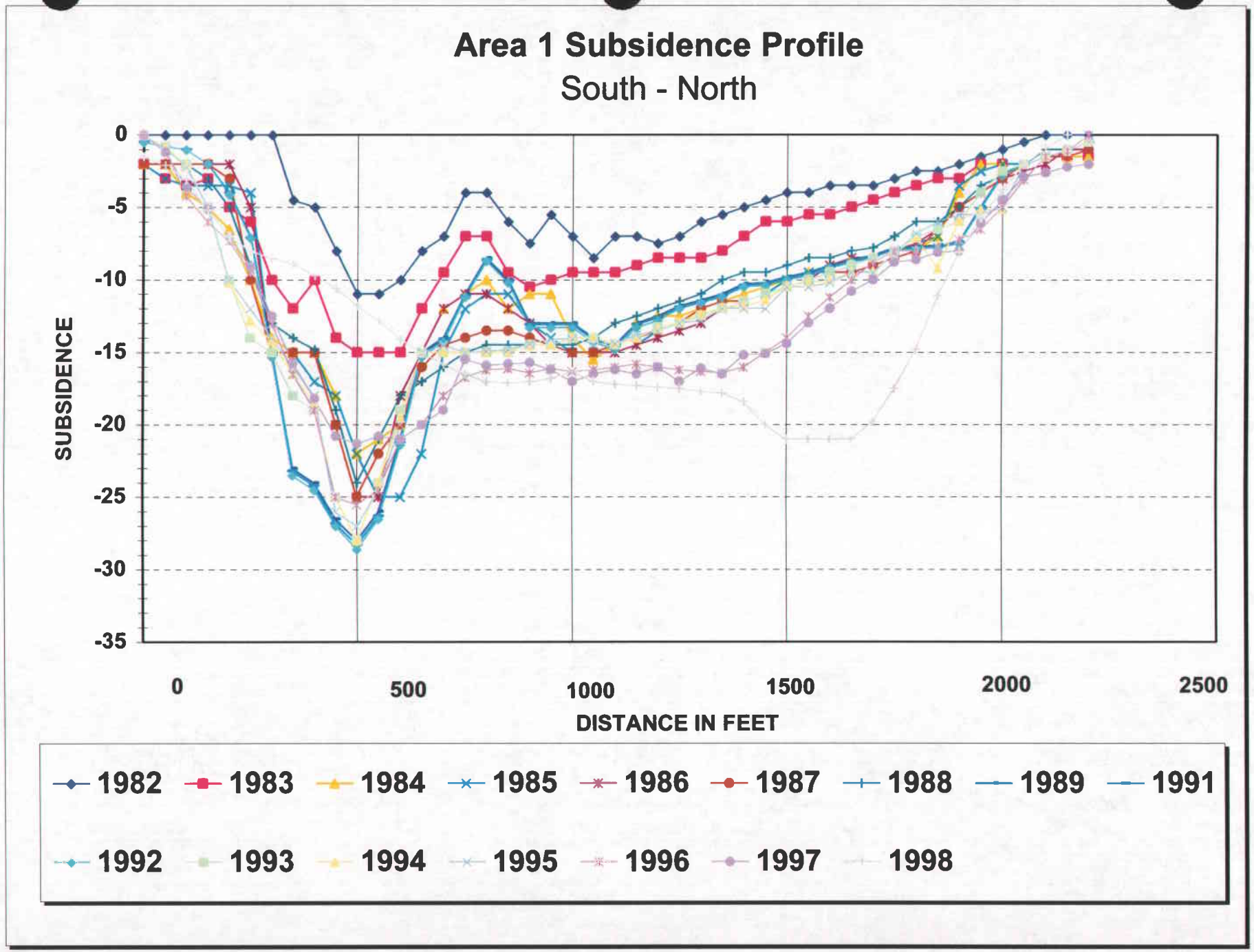

Area 1 Subsidence Profile
South - North
SUBSIDENCE
0
-5
-10
-15
-20
-25
-30
-35
0
500
1000
1500
2000
2500
DISTANCE IN FEET
1982
1983
1984
1985
1986
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 6

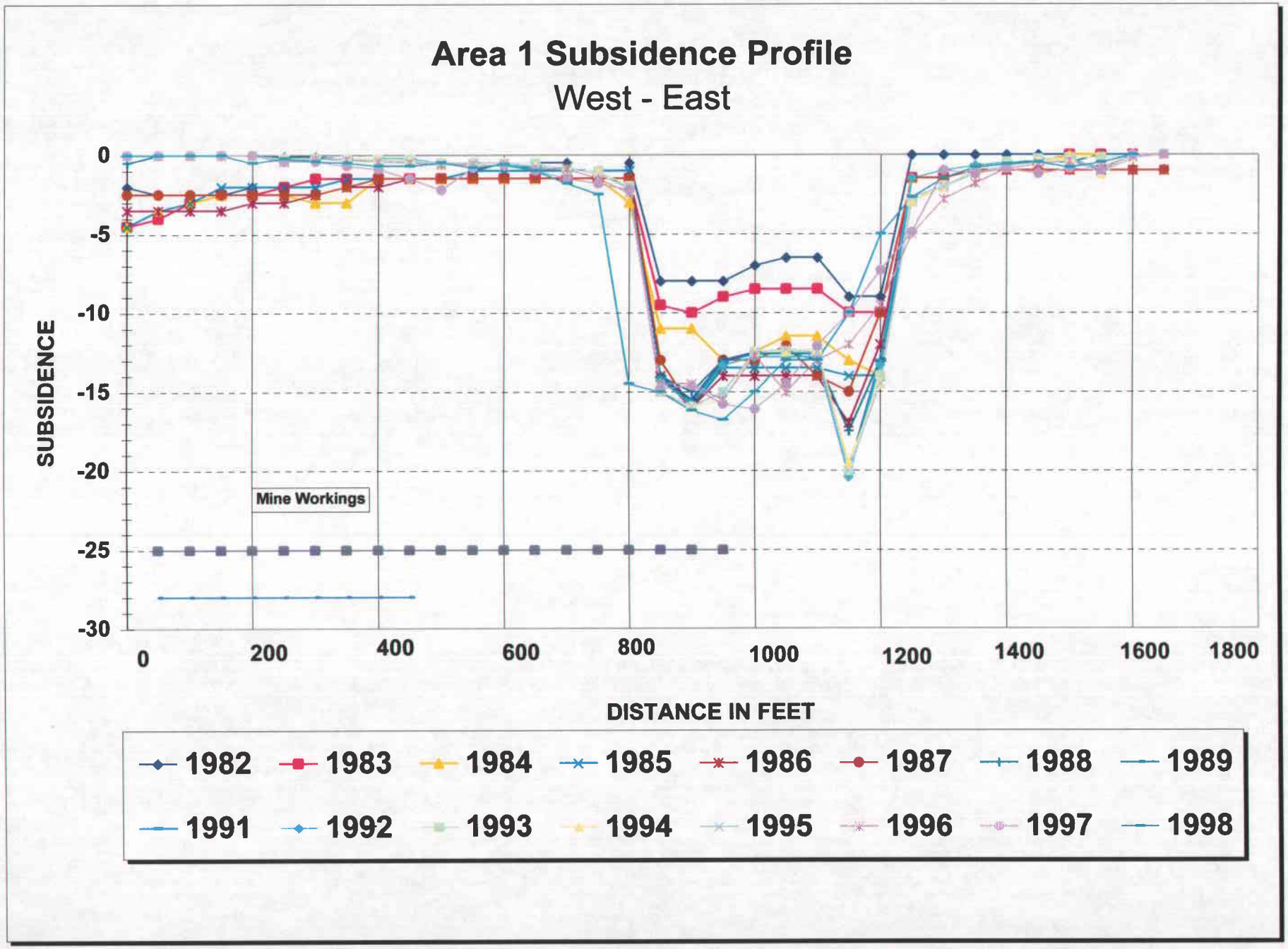

Area 1 Subsidence Profile
West - East
SUBSIDENCE
0
-5
-10
-15
-20
-25
-30
Mine Workings
0
200
400
600
800
1000
1200
1400
1600
1800
DISTANCE IN FEET
1982
1983
1984
1985
1986
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 7

Area 2

Deer Creek 5th, 6th, 7th, and 8th East Longwall Panels

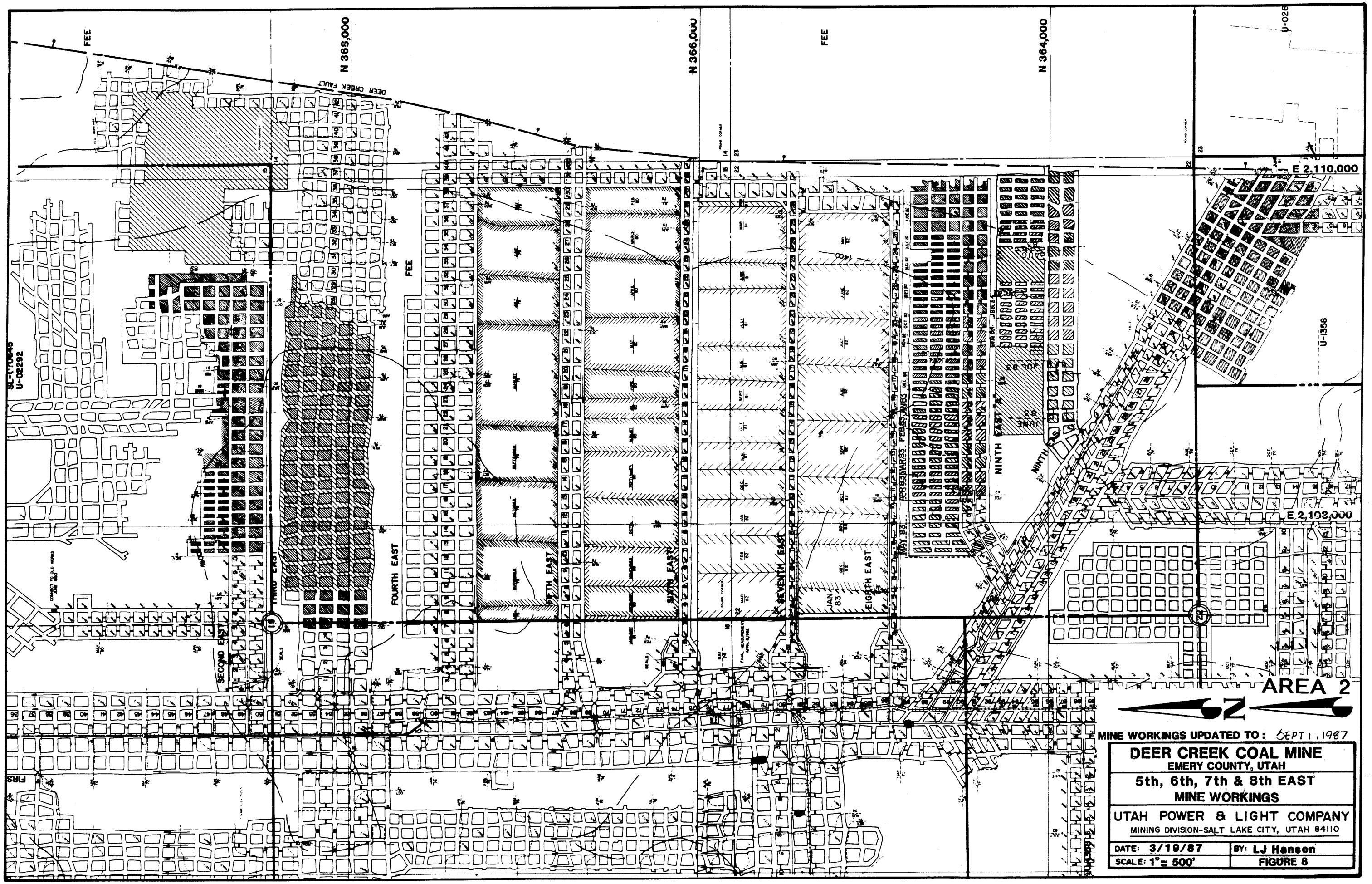
Wilberg 3rd through 13th Right Panels

Mining in the Deer Creek Mine in Area 2 was completed by February 1985 (Figure 8). Coal extraction in the underlying Wilberg Mine 3rd and 4th Right panels was completed between September 1987 and the end of January 1988 (Figure 9).

Maximum subsidence in Area 2 has stabilized at 13 feet in one area above the center of the multiple seam mining area (Figure 10). The subsidence profiles (Figures 11 and 12) indicate that the subsidence has been stable for the past 6 years or more. Neither PacifiCorp nor other contracted personnel have detected any surface fissures or other visible disturbance in the area.

Angle-of-draw has been calculated where possible. On the eastern side of Area 2 the angle is influenced by the Deer Creek Fault and the adjacent Little Dove Mine workings across the fault; thus, no angle was calculated. On other sides it ranges from less than zero to 11 degrees.

No springs have been identified over the subsidence area but two springs, one-fourth to one-third mile to the west, show no effects from mining (see Hydrologic Monitoring Report, 1998).



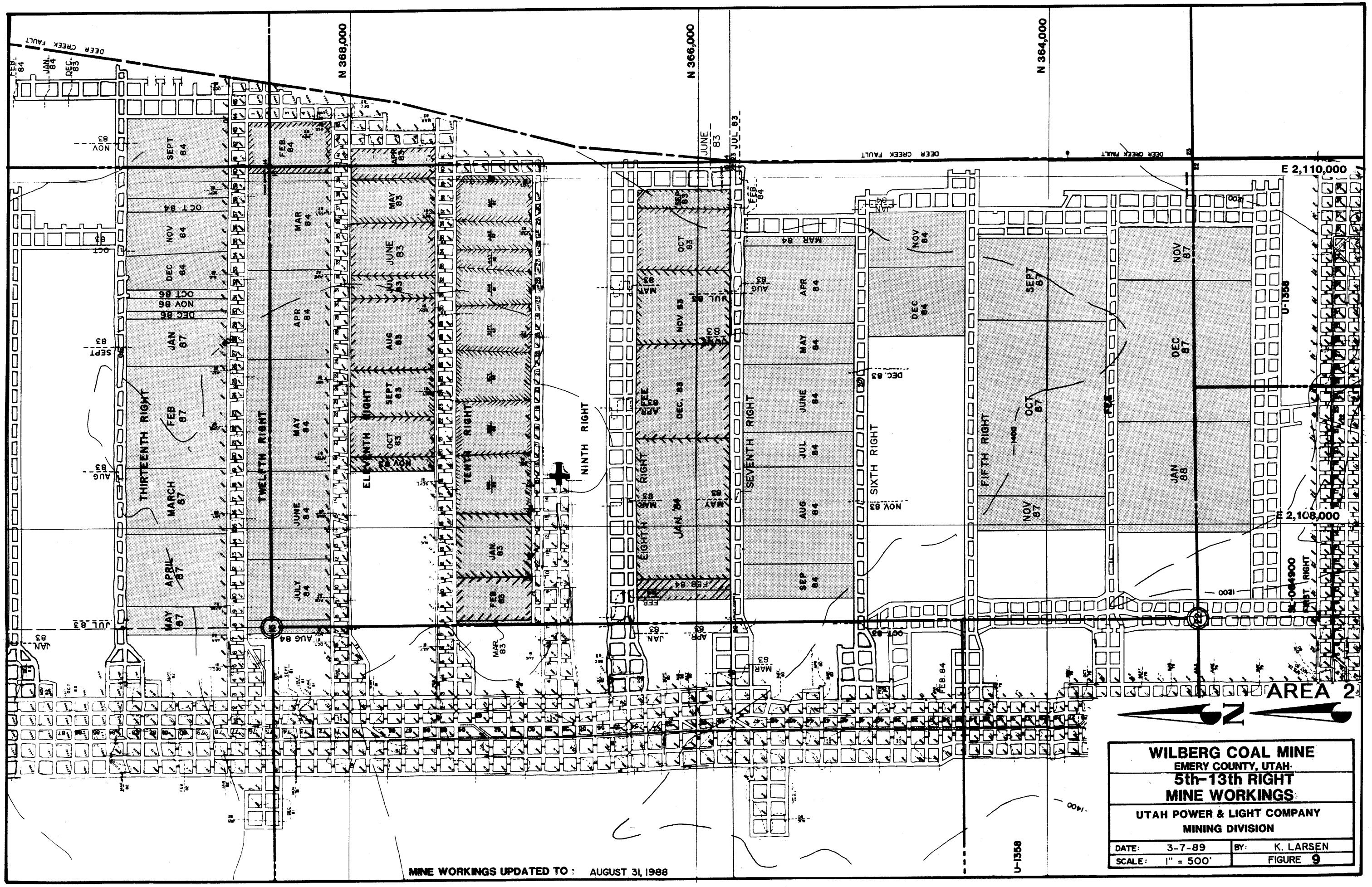
MINE WORKINGS UPDATED TO: SEPT 1, 1987

DEER CREEK COAL MINE
EMERY COUNTY, UTAH

5th, 6th, 7th & 8th EAST
MINE WORKINGS

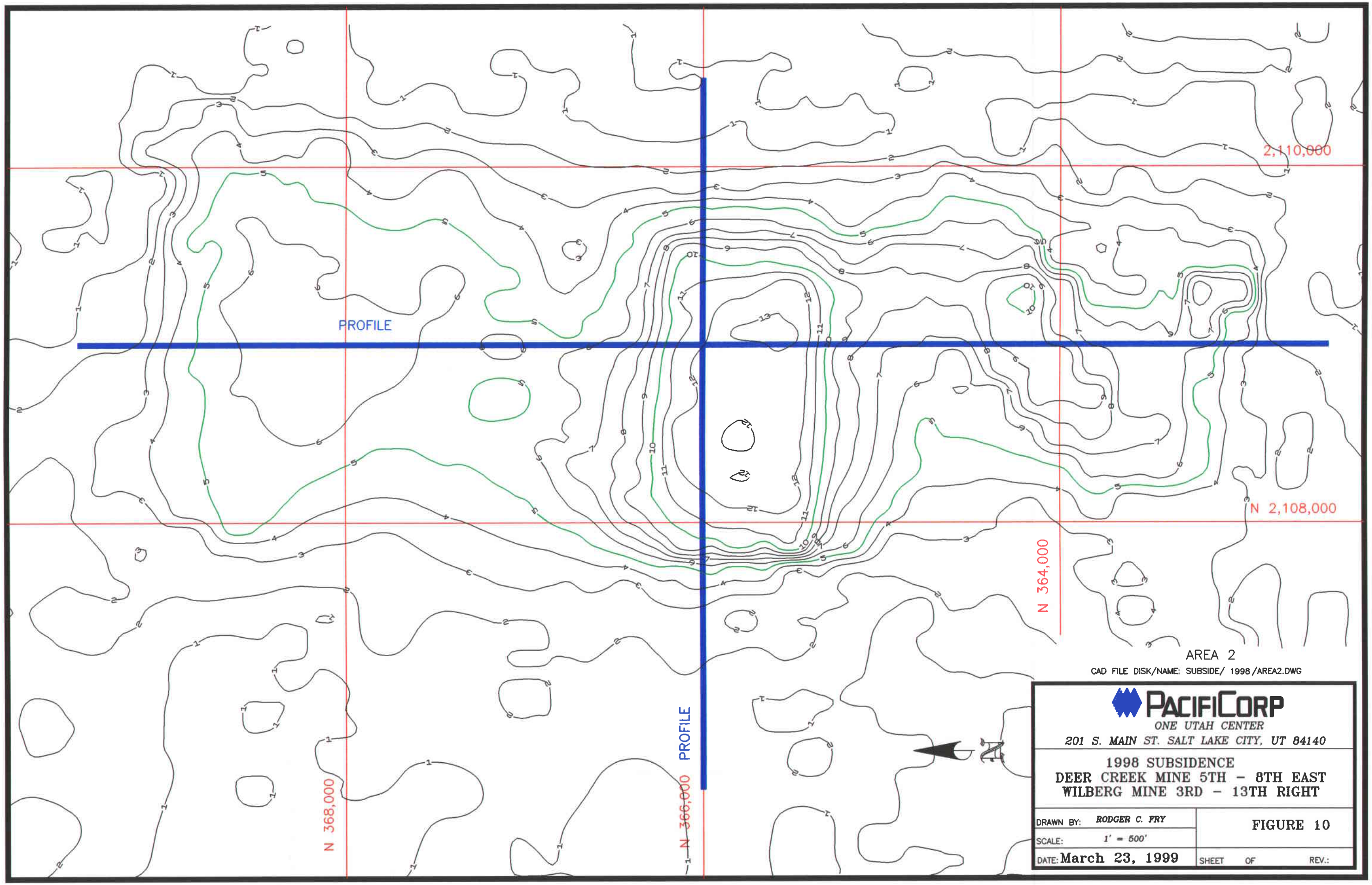
UTAH POWER & LIGHT COMPANY
MINING DIVISION-SALT LAKE CITY, UTAH 84110

DATE: 3/19/87	BY: LJ Hansen
SCALE: 1" = 500'	FIGURE 8



WILBERG COAL MINE
EMERY COUNTY, UTAH
5th-13th RIGHT
MINE WORKINGS
UTAH POWER & LIGHT COMPANY
MINING DIVISION

DATE:	3-7-89	BY:	K. LARSEN
SCALE:	1" = 500'		FIGURE 9


2,110,000
N 2,108,000
N 364,000
N 368,000
N 366,000
PROFILE
PROFILE
AREA 2
CAD FILE DISK/NAME: SUBSIDE/ 1998 /AREA2.DWG
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
1998 SUBSIDENCE
DEER CREEK MINE 5TH - 8TH EAST
WILBERG MINE 3RD - 13TH RIGHT
DRAWN BY: RODGER C. FRY
SCALE: 1' = 500'
DATE: March 23, 1999
FIGURE 10
SHEET OF REV.:

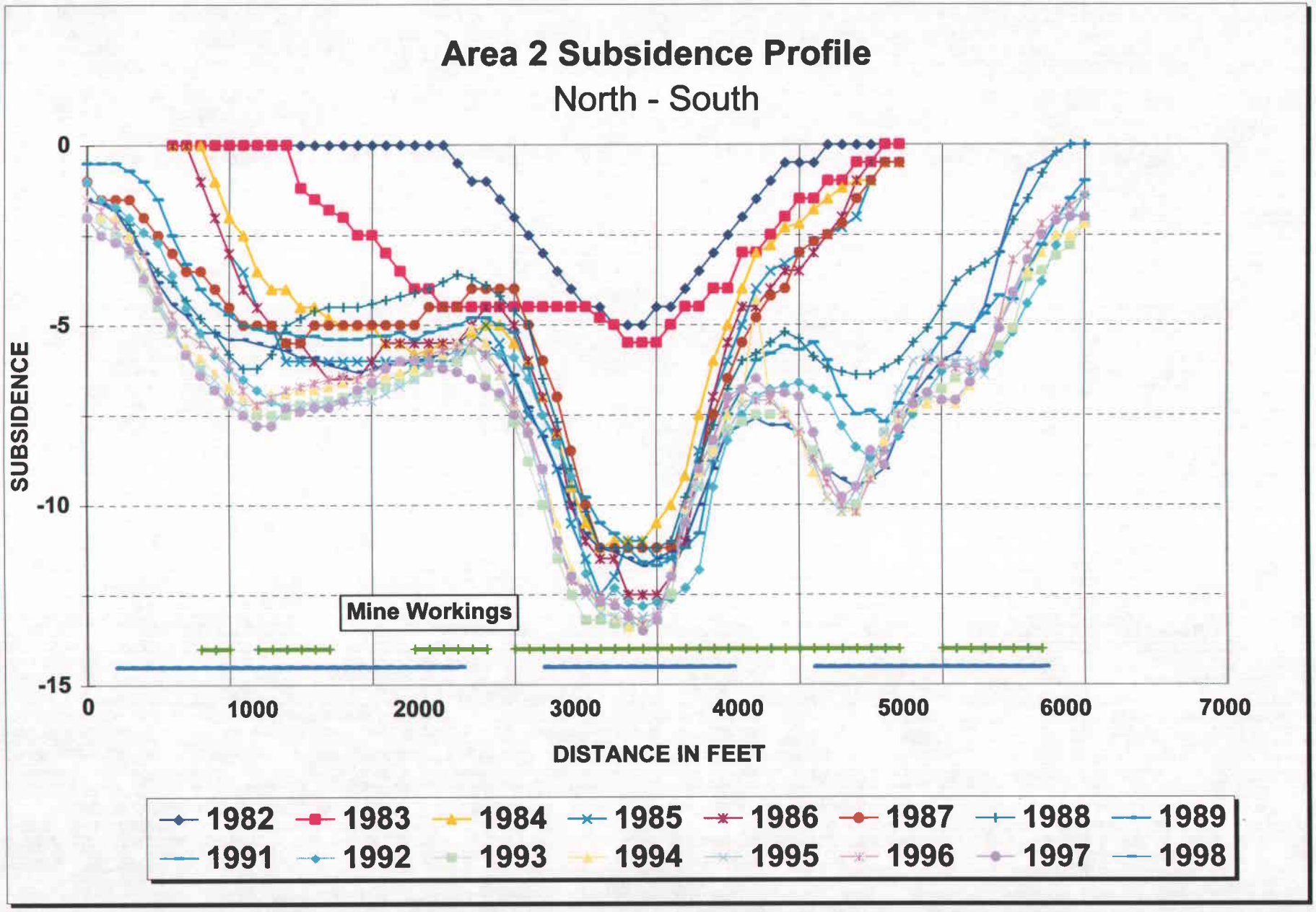

Area 2 Subsidence Profile
North - South
SUBSIDENCE
0
-5
-10
-15
0
1000
2000
3000
4000
5000
6000
7000
DISTANCE IN FEET
Mine Workings
1982
1983
1984
1985
1986
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 11

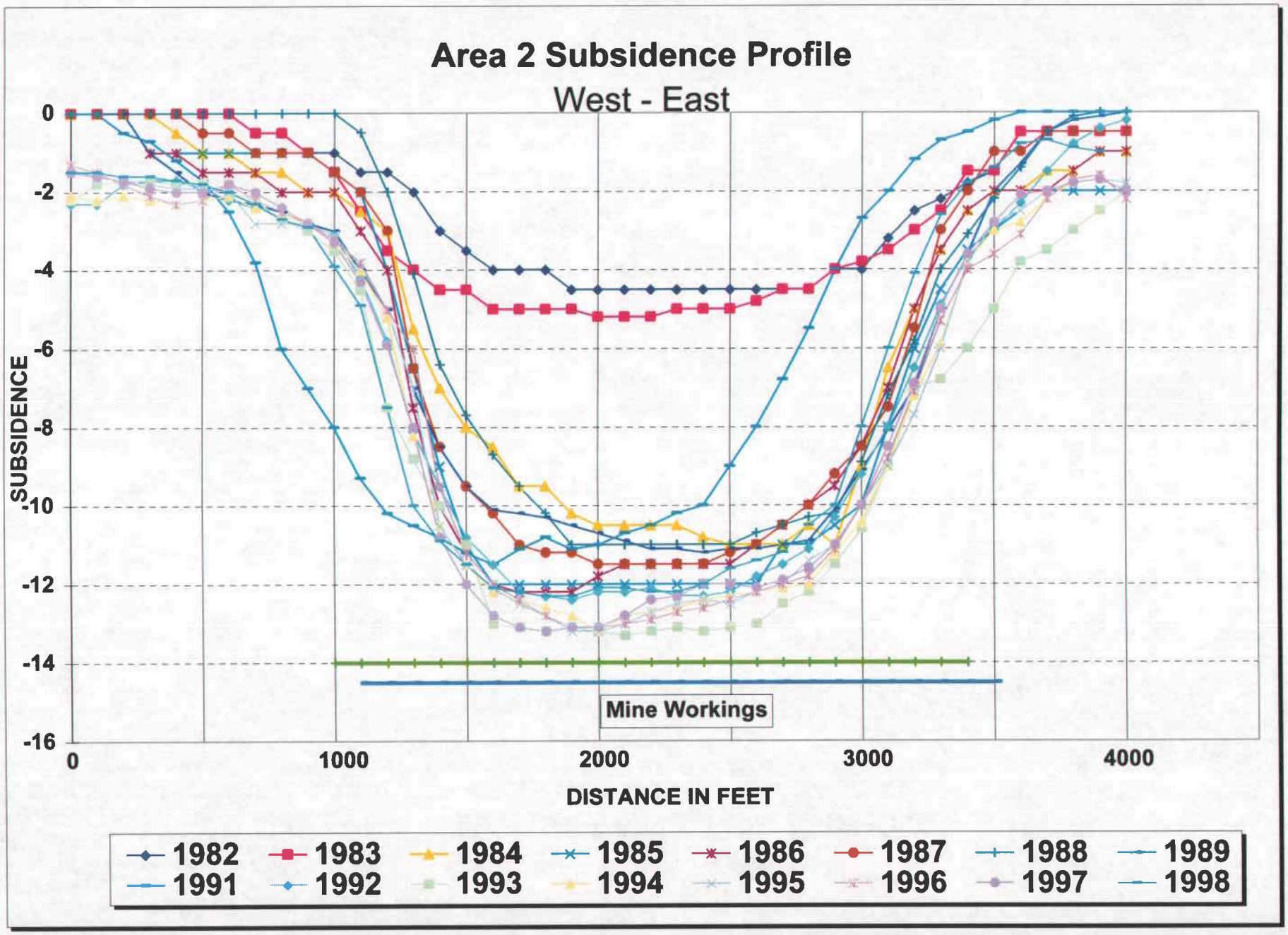

Area 2 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
-10
-12
-14
-16
0
1000
2000
3000
4000
DISTANCE IN FEET
Mine Workings
1982
1983
1984
1985
1986
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 12

Area 3

Deer Creek 1st North Area

Most of the 1st North section of the Deer Creek Mine was abandoned and sealed in 1978 after being mined out. The southern portion is still open and may be used for access to a block of coal which lies to the west. Pillar extraction in the 3rd Left and 1-1/2 North sections was completed early in 1980 (Figure 13).

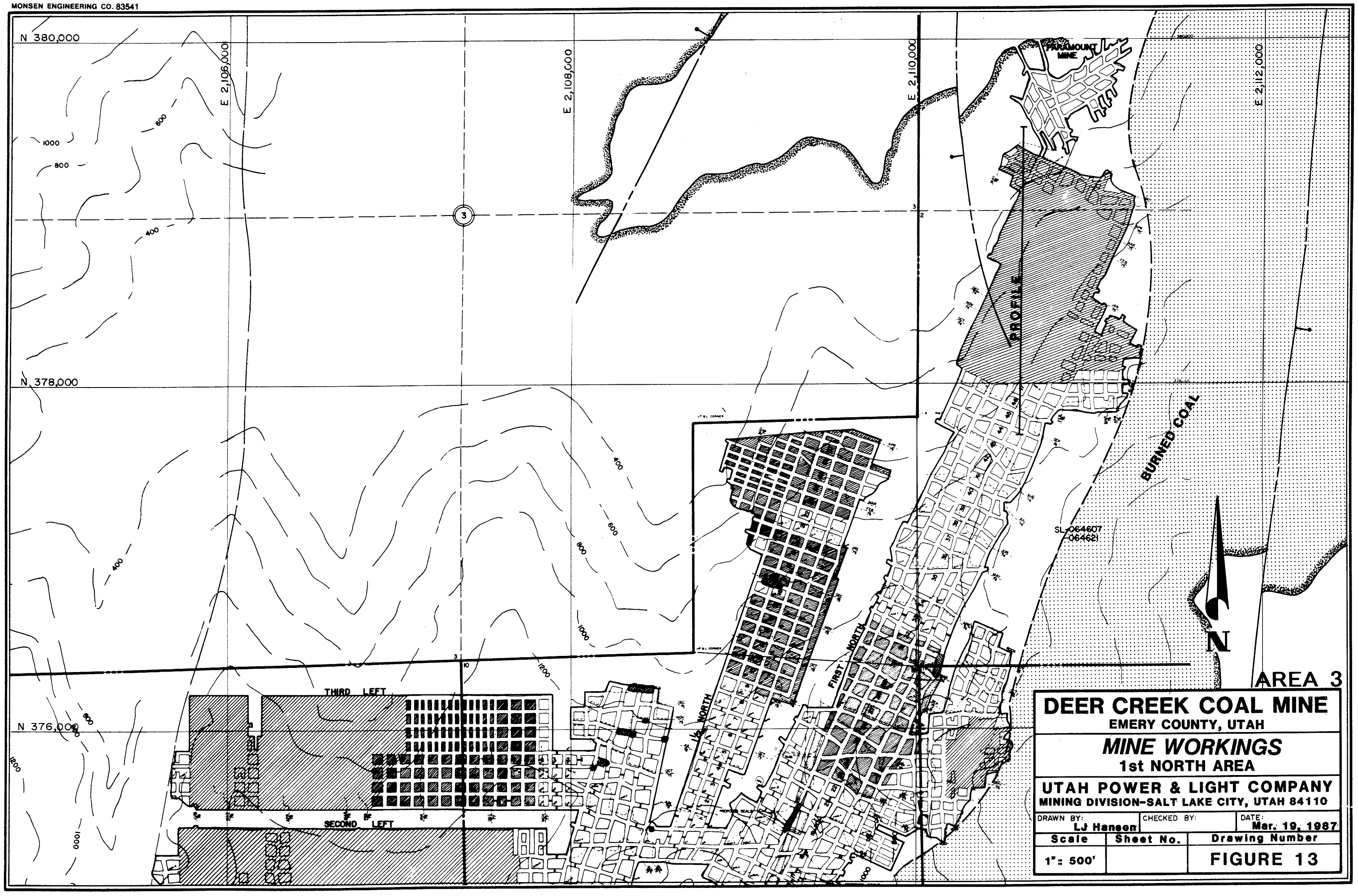
The subsidence above 1st North occurs on a narrow ridge capped by a highly fractured sandstone. The subsidence measured is depicted in Figure 13A. Figure 14 is a profile of total subsidence as it occurred along a line of points above the workings. The subsidence in area 3 has shown no significant change in the past 5 years.

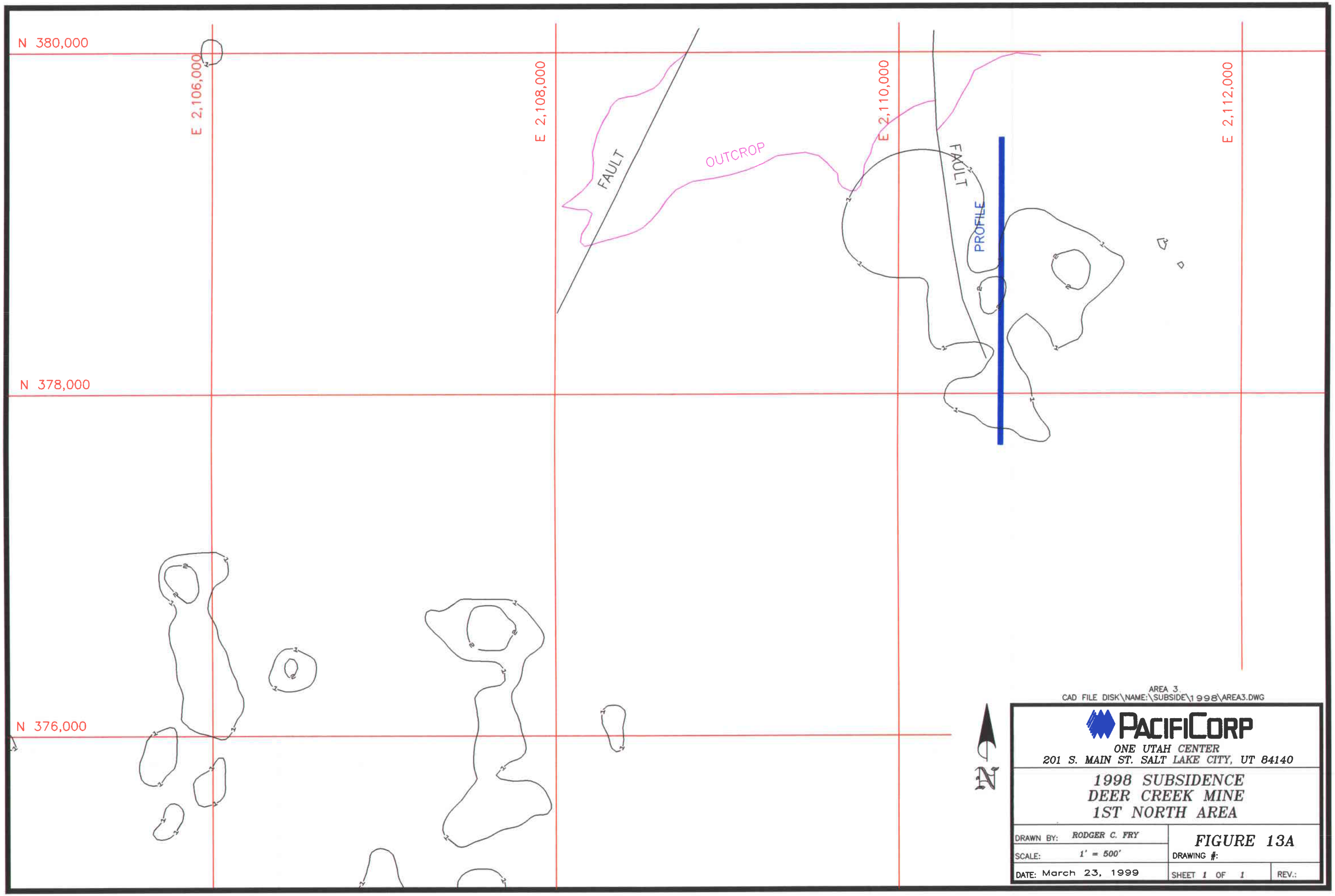
A Helicopter survey in 1998 did not reveal any new surface cracks or new areas of cliff failure.

No angle-of-draw was determined due to the steep slopes, burned coal, and mode of subsidence.

The strata surrounding and above the 1st North workings are generally dry; therefore, mining has not adversely affected the groundwater.

MONSEN ENGINEERING CO. 83541




N 380,000
N 378,000
N 376,000
E 2,106,000
E 2,108,000
E 2,110,000
E 2,112,000
FAULT
OUTCROP
FAULT
PROFILE
N
AREA 3
CAD FILE DISK\NAME:\SUBSIDE\1998\AREA3.DWG
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
1998 SUBSIDENCE
DEER CREEK MINE
1ST NORTH AREA
DRAWN BY: RODGER C. FRY
SCALE: 1' = 500'
DATE: March 23, 1999
FIGURE 13A
DRAWING #:
SHEET 1 OF 1
REV.:

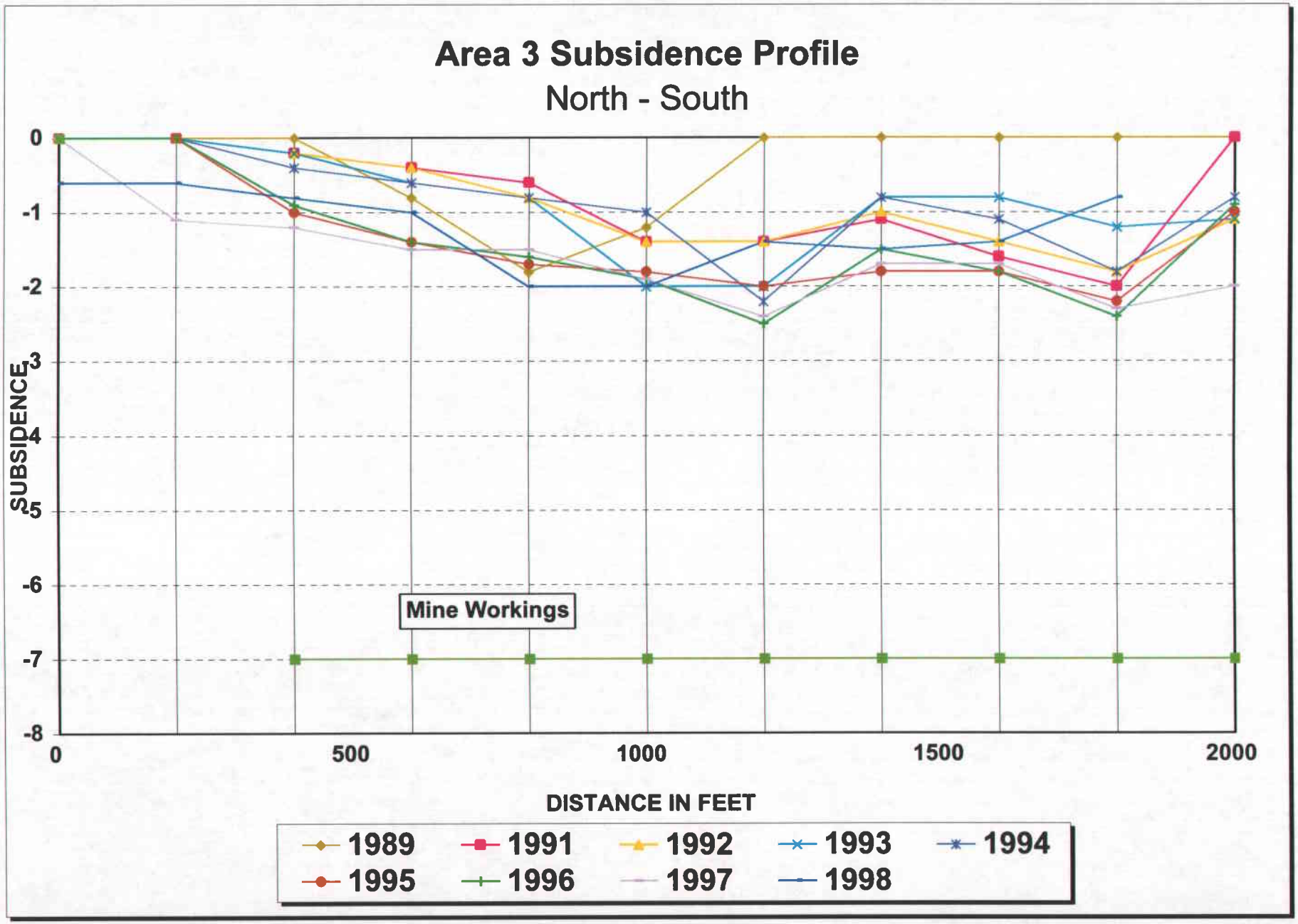

Area 3 Subsidence Profile
North - South
SUBSIDENCE
0
-1
-2
-3
-4
-5
-6
-7
-8
0
500
1000
1500
2000
DISTANCE IN FEET
Mine Workings
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 14

Area 4

Deer Creek 2nd through 17th Right Longwall Panels

Subsidence in Area 4 was detected for the first time in 1984 by photogrammetric methods. Longwall mining commenced in the 2nd Right longwall panels in 1980 and by the end of August 1991 the 2nd through 17th Right panels had been completed (Figure 15). In the Cottonwood mine, Longwall mining began in September of 1992 in the 9th Left Panel off 2nd north and the 8th Left Panel was terminated early because of unacceptable coal quality in February 1993. Mining resumed in this area in the 5th Left Longwall Panel in August of 1994 and continued through August of 1995 when mining was active in the 2nd Left Longwall Panel (Figure 15A).

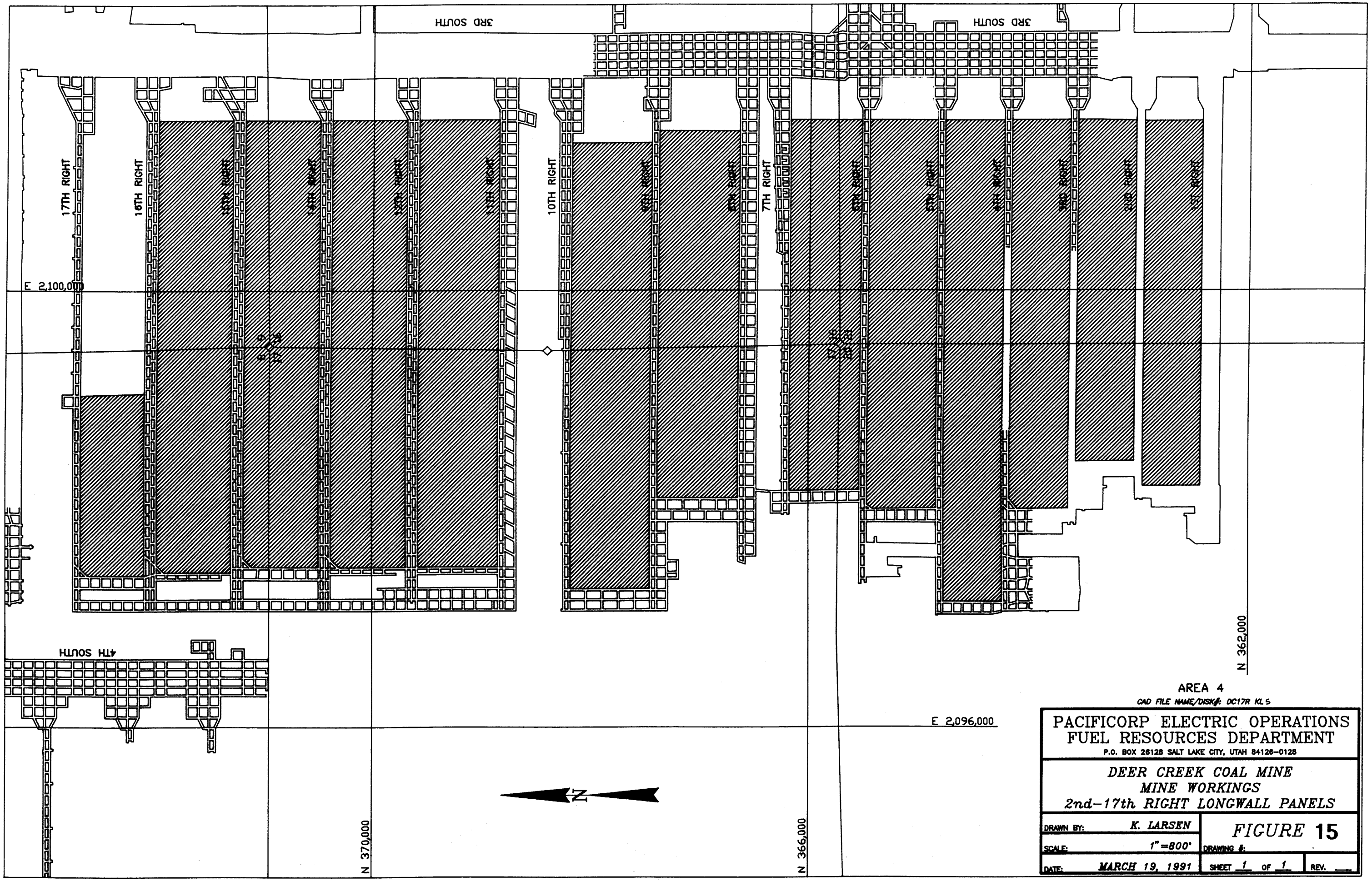
Maximum subsidence increased dramatically between 1994 and 1995 (8) feet to over thirteen (13) feet (Figure 16) due to the mining which occurred in the Hiawatha seam. The subsidence was virtually unchanged between 1995 and 1998 as shown in the profiles, Figures 17 and 18.

Surface fractures were identified in the field in late May of 1995. These fractures were located on Fee surface land and PacifiCorp filled in the fractures with a motor grader and reseeded the area. The location of the fractures are shown on figure 16. The revegetation in these areas is now established and no further fracturing has been identified.

The calculated angle-of-draw of the subsidence ranges from less than zero to 22 degrees. Several springs are located on East Mountain above these longwall panels and the 2nd through 5th Left panels located directly to the east (see Area 5). Fluctuations

in spring flow occur from year to year but seem to be related to variations in precipitation rather than mining. Flows are generally low in dry years and higher in wetter years (see Hydrologic Monitoring Report, 1998 and the Appendices to this report).

The left fork of the Grimes Wash drainage crosses the middle of the subsidence area. Stream monitoring has revealed no changes attributable to mining. This stream has been called Perennial by the US Forest Service, but our data indicates that it is ephemeral.



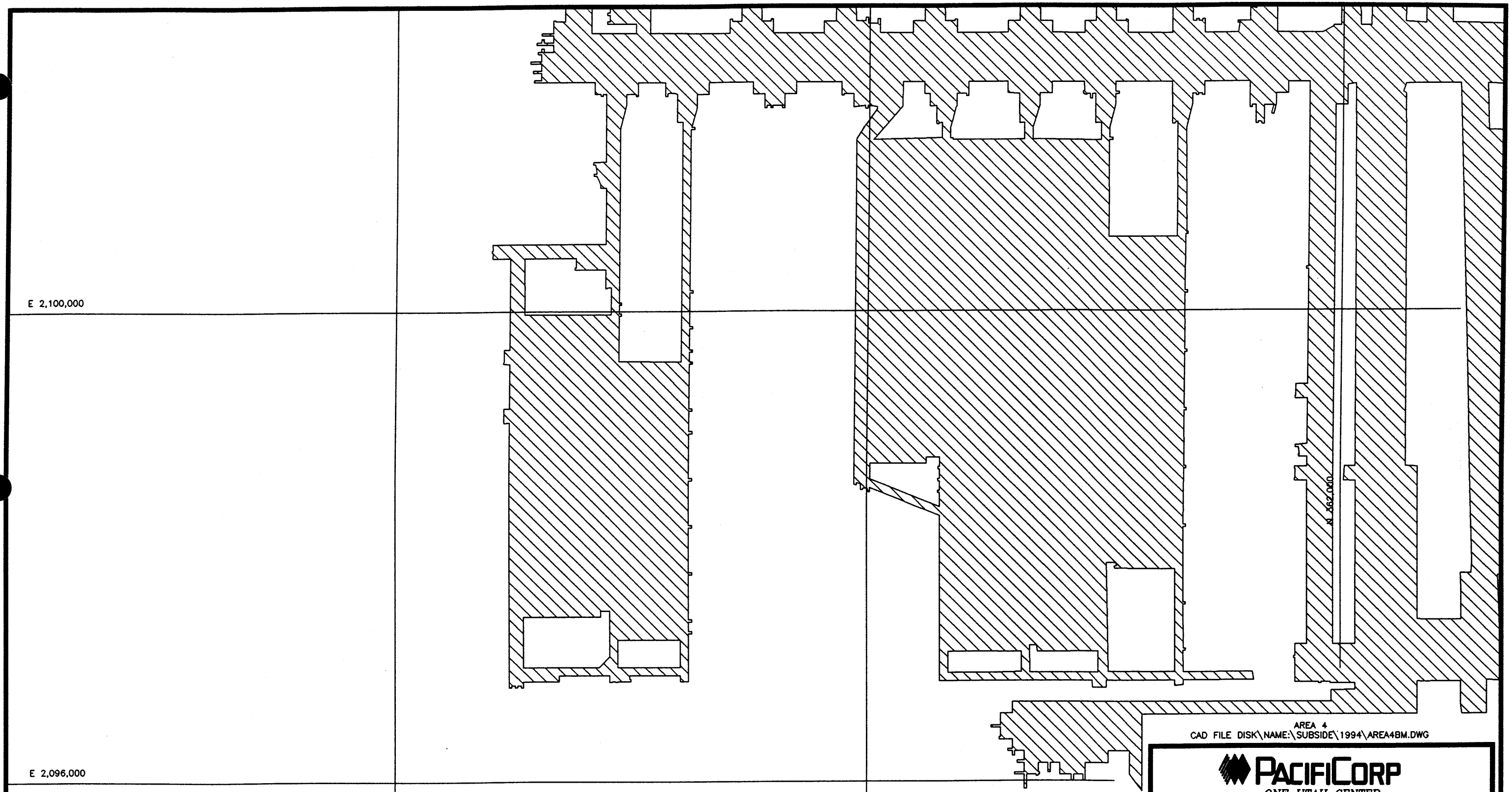
AREA 4

CAD FILE NAME/DISK#: DC17R KL 5

PACIFICORP ELECTRIC OPERATIONS
FUEL RESOURCES DEPARTMENT
P.O. BOX 26128 SALT LAKE CITY, UTAH 84126-0128

DEER CREEK COAL MINE
MINE WORKINGS
2nd-17th RIGHT LONGWALL PANELS

DRAWN BY: K. LARSEN	FIGURE 15	
SCALE: 1"=800'	DRAWING #:	
DATE: MARCH 19, 1991	SHEET 1 OF 1	REV.

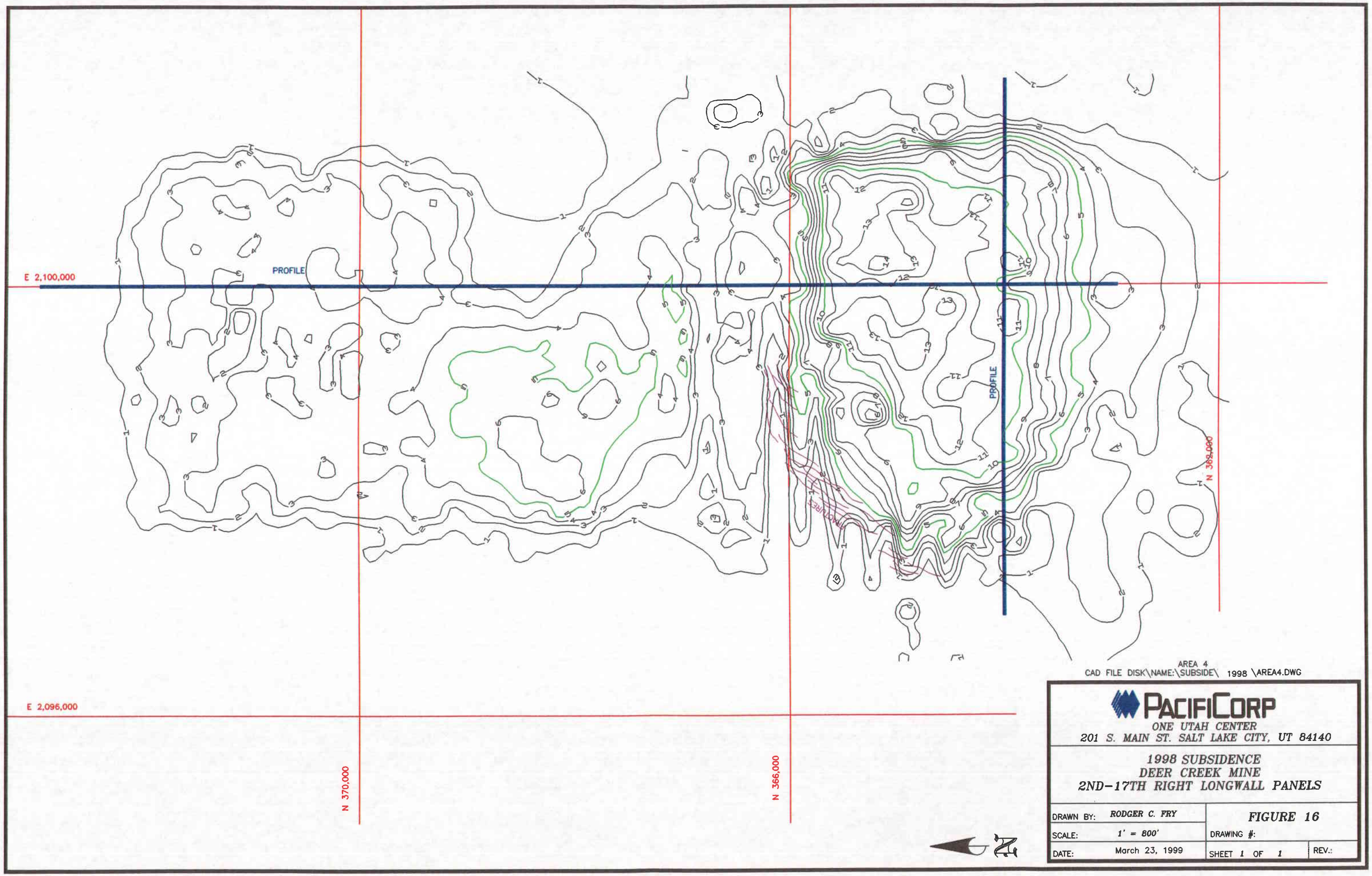


AREA 4
CAD FILE DISK\NAME:\SUBSIDE\1994\AREA4BM.DWG

PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140

COTTONWOOD COAL MINE
MINE WORKINGS
2ND-5TH LEFT & 8TH-9TH LEFT PANELS

DRAWN BY: RODGER C. FRY	FIGURE 15A	
SCALE: 1' = 800'	DRAWING #:	
DATE: MARCH 31,1995	SHEET 1 OF 1	REV.: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E 2,096,000
N 370,000
N 366,000
N 362,000
PROFILE
PROFILE
AREA 4
CAD FILE DISK\NAME:\SUBSIDE\ 1998 \AREA4.DWG
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
1998 SUBSIDENCE
DEER CREEK MINE
2ND-17TH RIGHT LONGWALL PANELS
DRAWN BY: RODGER C. FRY
SCALE: 1' = 800'
DATE: March 23, 1999
FIGURE 16
DRAWING #:
SHEET 1 OF 1
REV.:

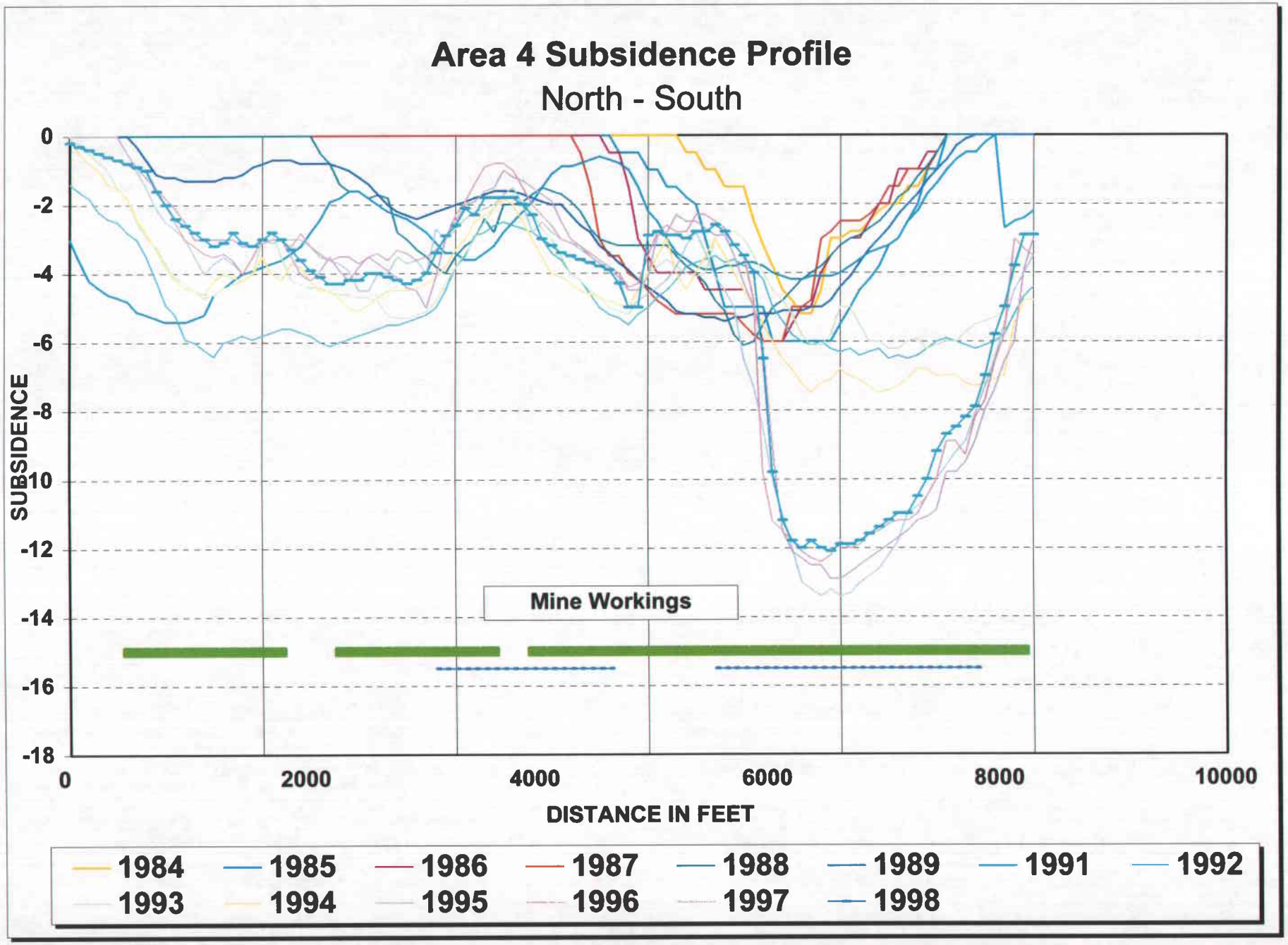

Area 4 Subsidence Profile
North - South
SUBSIDENCE
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
0
2000
4000
6000
8000
10000
DISTANCE IN FEET
Mine Workings
1984
1985
1986
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 17

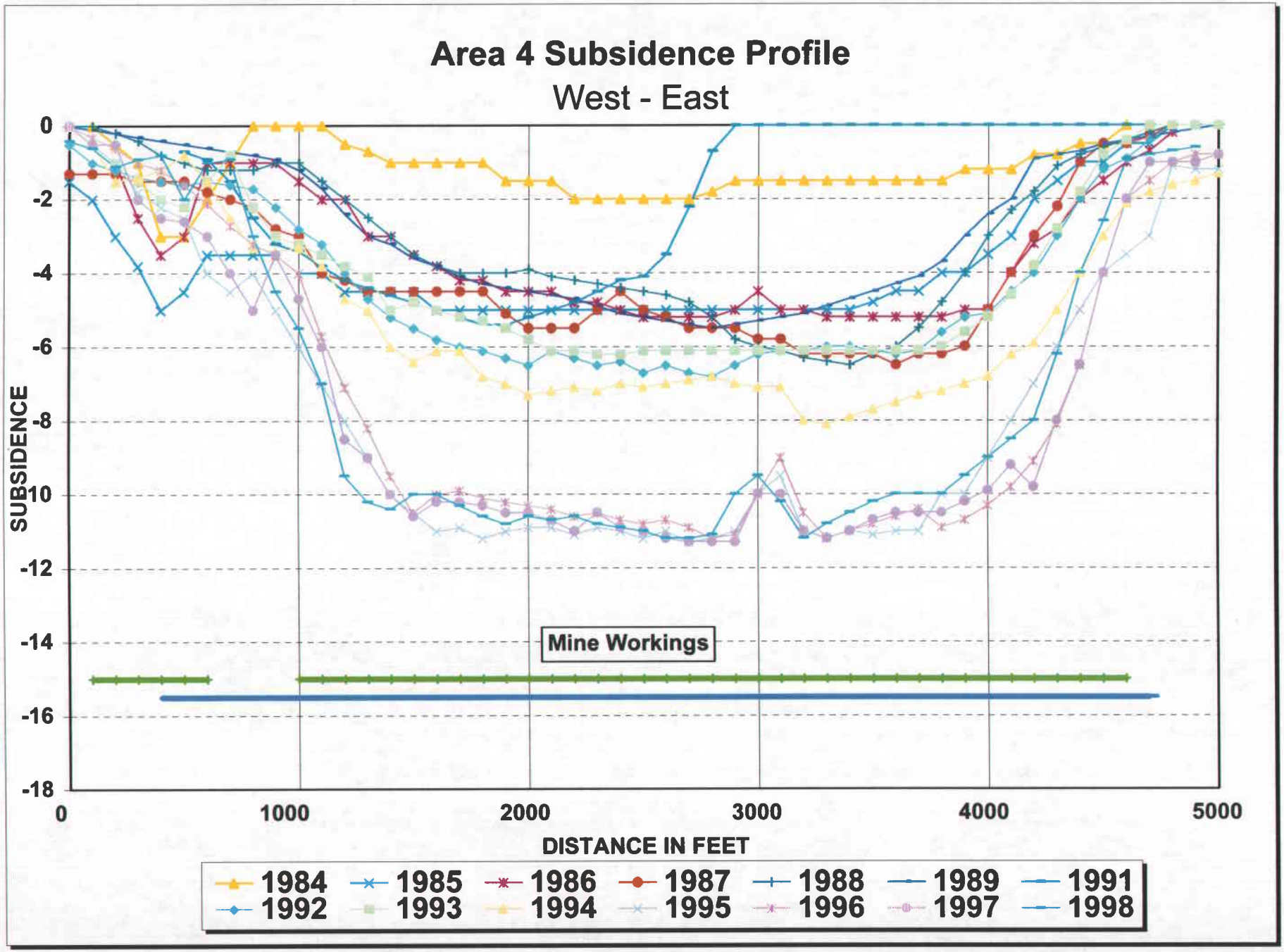

Area 4 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
0
1000
2000
3000
4000
5000
DISTANCE IN FEET
Mine Workings
1984
1985
1986
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 18

Area 5

Deer Creek 2nd through 5th Left Longwall Panels

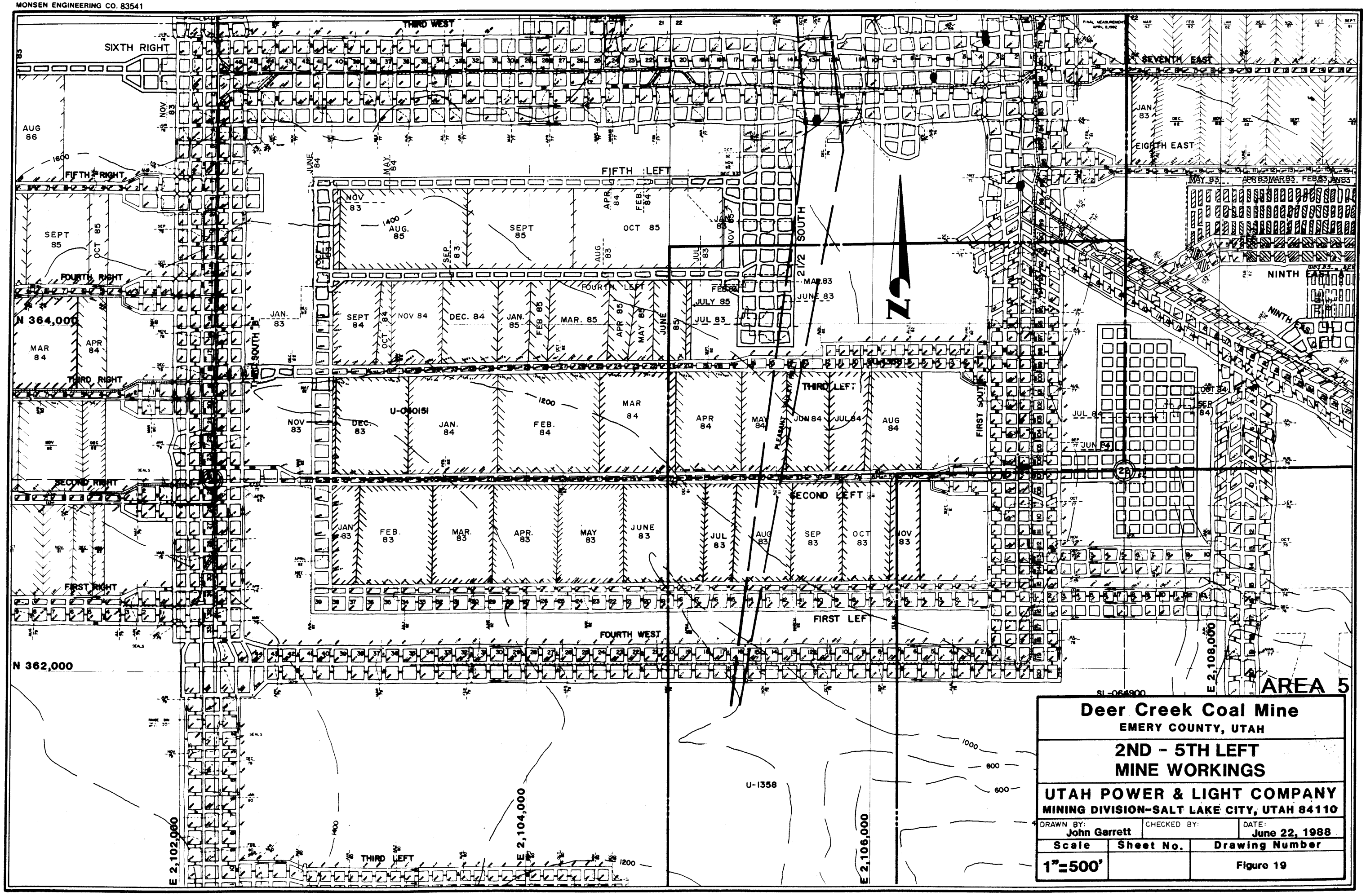
Photogrammetry revealed subsidence in Area 5 for the first time in 1984. Mining of the 2nd Left longwall panel in the Deer Creek Mine began in January 1983, and by October 1985 all four panels had been completed (Figure 19). In the Cottonwood Mine, longwall mining began in the 6th Right Longwall Panel in February 1993 and the last mining was completed in the 1st Right Longwall Panel in August 1994 completing all mining in this area (Figure 19A).

Maximum subsidence over the panels is slightly greater than thirteen (13) feet where both seams have been mined (Figure 20). The maximum subsidence showed a substantial increase between 1993 and 1994 but showed slight change between 1994 and 1998. It is important to point out that the subsidence measurements in 1997 between the 1,500 foot and 2,500 foot marks on the North-South profile show about 1 foot greater subsidence in 1997 than was measured in 1996. This could be due to measuring error or continuing subsidence. Future monitoring should identify which case exists. No surface disturbance has been identified over the panels.

As mentioned in the previous section, none of the springs located above the workings show any adverse effects due to mining.

Measured angle-of-draw is between zero and 13 degrees.

MONSEN ENGINEERING CO. 83541



Deer Creek Coal Mine

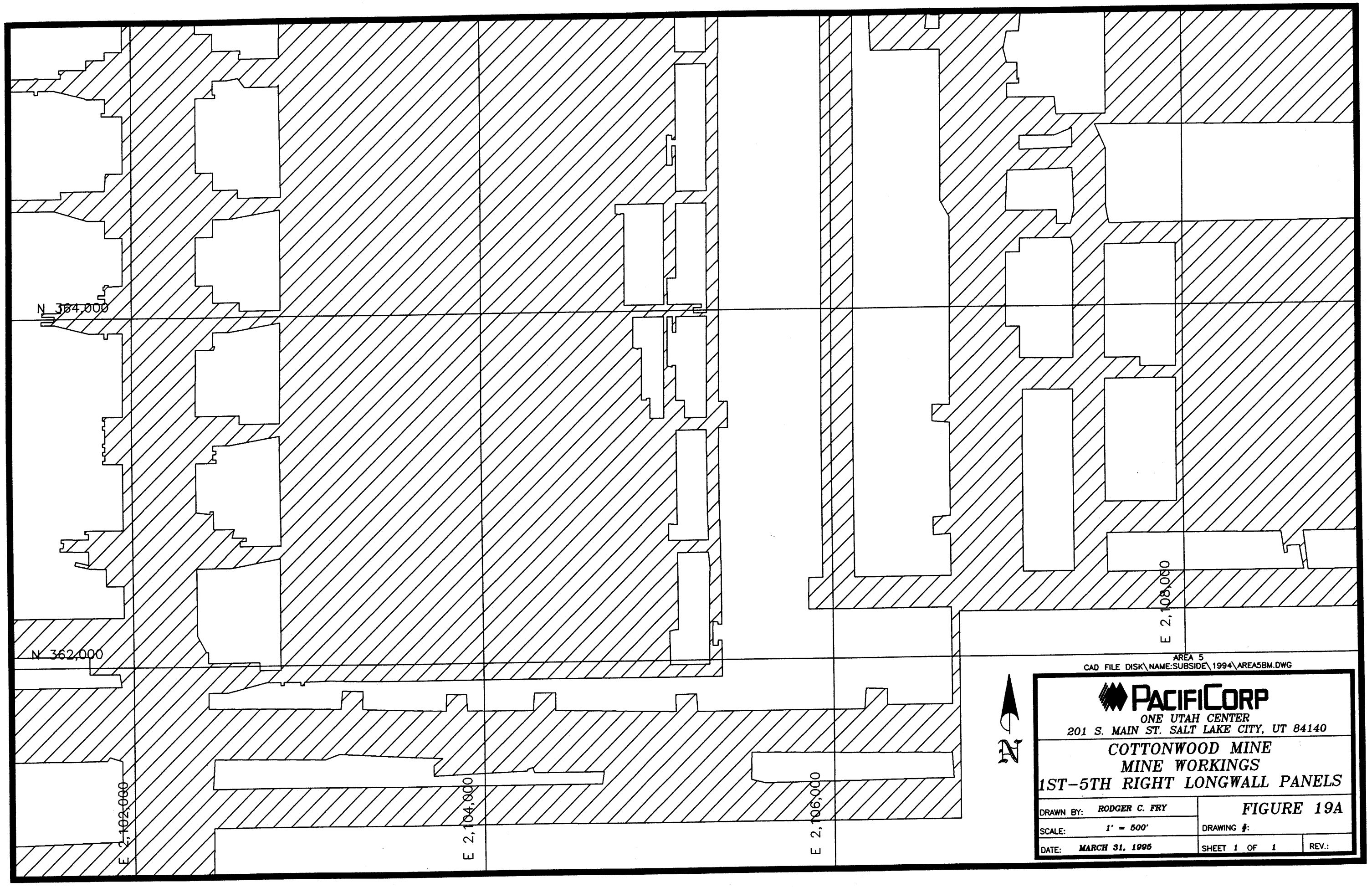
EMERY COUNTY, UTAH

2ND - 5TH LEFT MINE WORKINGS

UTAH POWER & LIGHT COMPANY

MINING DIVISION-SALT LAKE CITY, UTAH 84110

DRAWN BY: John Garrett	CHECKED BY:	DATE: June 22, 1988
Scale	Sheet No.	Drawing Number
1"=500'		Figure 19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N 362,000
E 2,102,000
E 2,104,000
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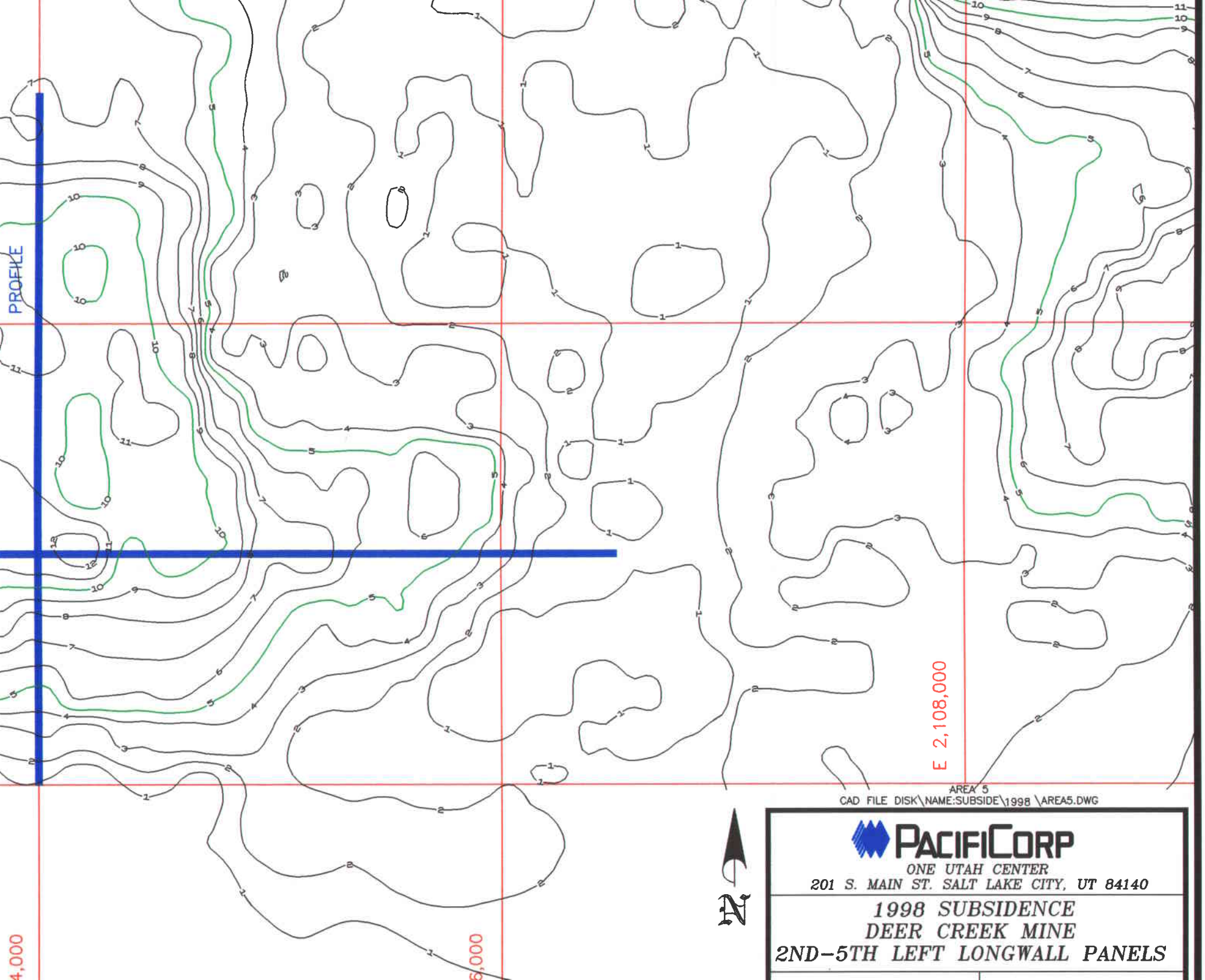
AREA 5
CAD FILE DISK\NAME:SUBSIDE\1994\AREA5BM.DWG
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
COTTONWOOD MINE
MINE WORKINGS
1ST-5TH RIGHT LONGWALL PANELS
DRAWN BY: RODGER C. FRY
SCALE: 1' = 500'
DATE: MARCH 31, 1995
FIGURE 19A
DRAWING #:
SHEET 1 OF 1
REV.:



AREA 5
CAD FILE DISK\NAME:SUBSIDE\1998 \AREA5.DWG

PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140

1998 SUBSIDENCE
DEER CREEK MINE
2ND-5TH LEFT LONGWALL PANELS

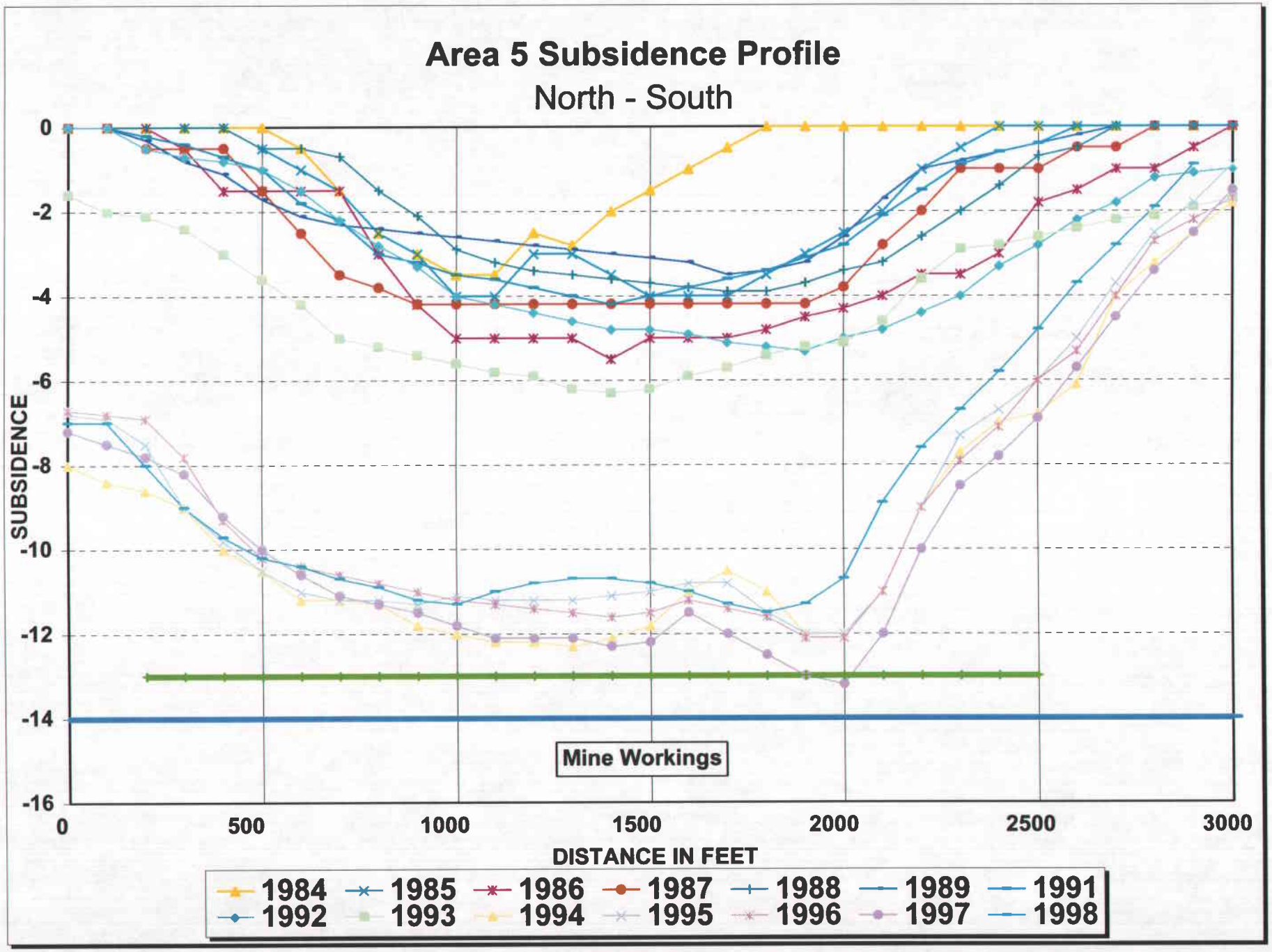

Area 5 Subsidence Profile
North - South
SUBSIDENCE
0
-2
-4
-6
-8
-10
-12
-14
-16
0
500
1000
1500
2000
2500
3000
DISTANCE IN FEET
Mine Workings
1984
1985
1986
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 21

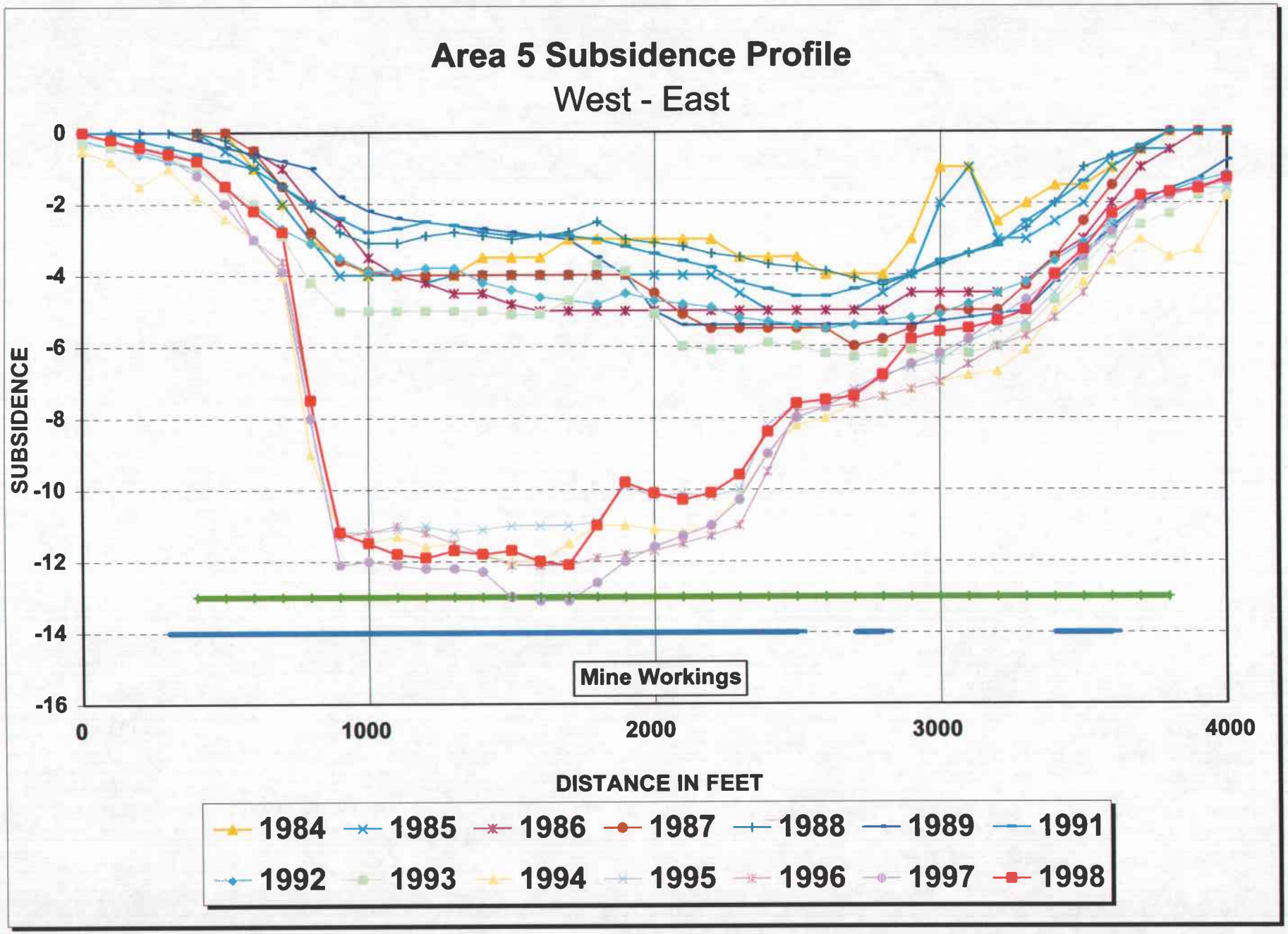

Area 5 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
-10
-12
-14
-16
0
1000
2000
3000
4000
DISTANCE IN FEET
Mine Workings
1984
1985
1986
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 22

Area 6

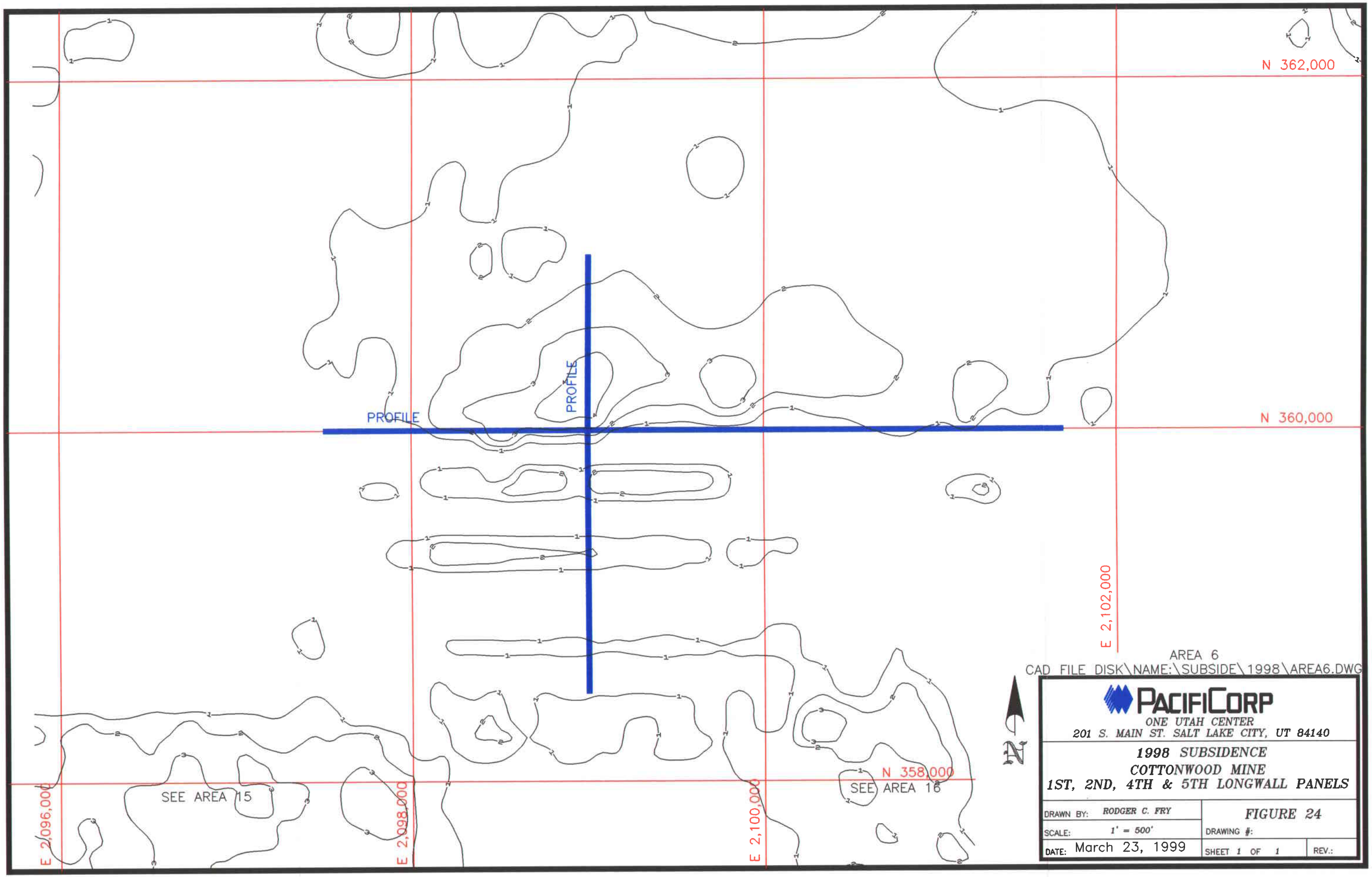
Wilberg 1st and 2nd West Longwall Panels

Mining in the Wilberg 1st and 2nd West longwall panels was completed in June 1983 (Figure 23). This area of subsidence has now reached a maximum of between four and five feet over the Second West Longwall Panel (Figure 24). The subsidence in this area has been stable for the past four years. The subsidence profiles (Figures 25 and 26) show the change in subsidence since 1983.

Calculated angle-of-draw ranges from zero to 15 degrees where not influenced by other workings.

Four springs located just north of the area show no effect from the subsidence (see Hydrologic Monitoring Report, 1998).

FIRST LEFT
N 362,000
MAIN WEST
MAIN WEST
MAIN WEST
FIRST WEST
FIRST EAST
SECOND SOUTH
THIRD SOUTH
SECOND WEST
3RD EAST
N 360,000
SIXTH WEST
4TH EAST
SEVENTH WEST
THIRD WEST
8TH WEST
4TH WEST
E 2,102,000
5TH EAST
AREA 6
CAD FILE NAME/DISK#: DC89SUB KLS
5TH WEST MAINS
N 358,000
8TH WEST
E 2,075,000
E 2,088,000
3RD SOUTH
E 2,100,000
UTAH POWER & LIGHT
MINING DIVISION
P.O. BOX 310, HUNTINGTON, UTAH 84528
COTTONWOOD COAL MINE
MINE WORKINGS
1st, 2nd, 4th & 5th WEST
DRAWN BY: K. LARSEN
SCALE: 1"=500'
DATE: 4-11-90
FIGURE 23
DRAWING #:
SHEET 1 OF 1
REV.


N 362,000
N 360,000
N 358,000
E 2,096,000
E 2,098,000
E 2,100,000
E 2,102,000
PROFILE
PROFILE
SEE AREA 15
SEE AREA 16
N
AREA 6
CAD FILE DISK\NAME:\SUBSIDE\1998\AREA6.DWG
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
1998 SUBSIDENCE
COTTONWOOD MINE
1ST, 2ND, 4TH & 5TH LONGWALL PANELS
DRAWN BY: RODGER C. FRY
SCALE: 1' = 500'
DATE: March 23, 1999
FIGURE 24
DRAWING #:
SHEET 1 OF 1
REV.:

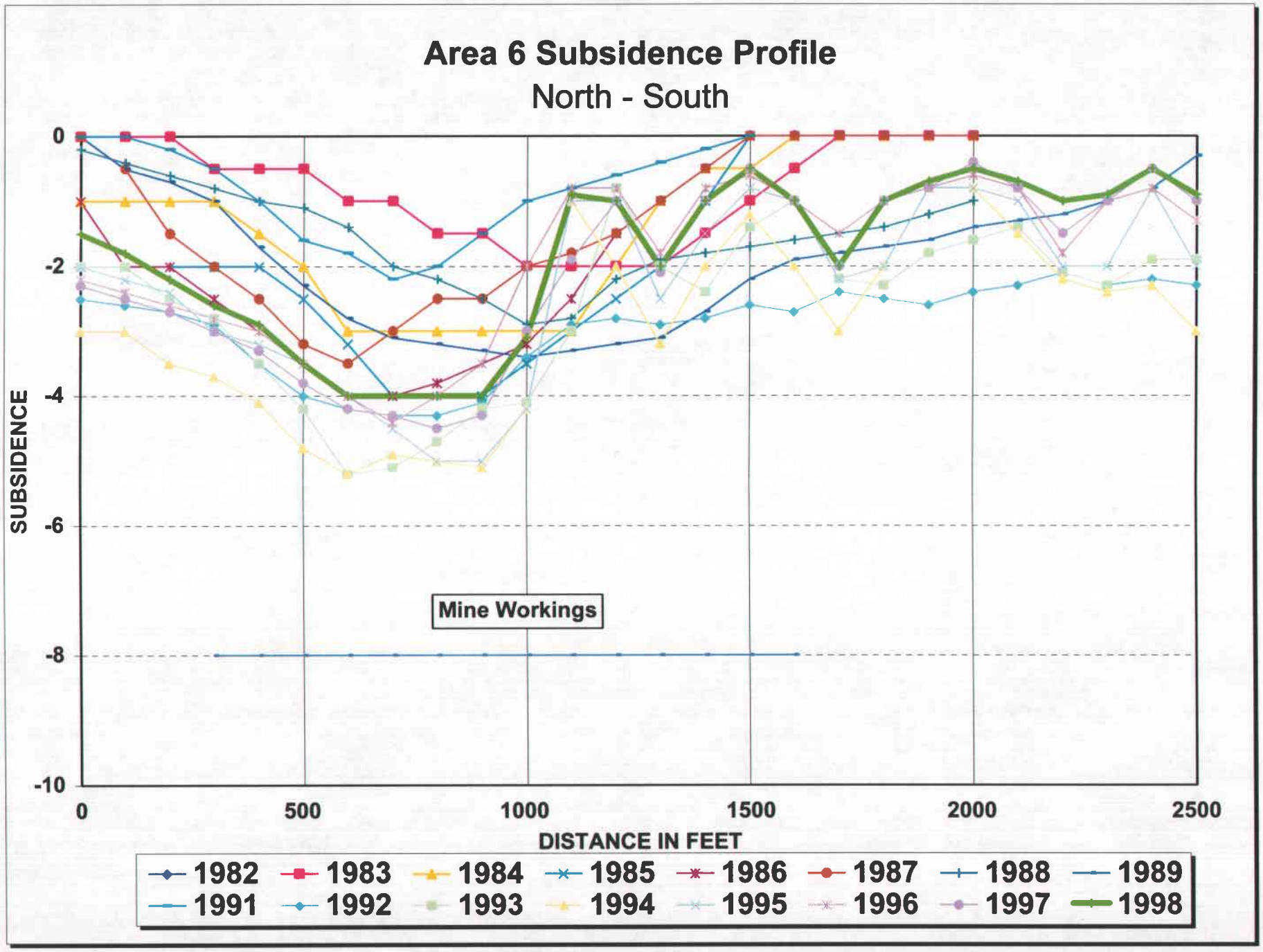

Area 6 Subsidence Profile
North - South
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
500
1000
1500
2000
2500
DISTANCE IN FEET
Mine Workings
1982
1983
1984
1985
1986
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 25

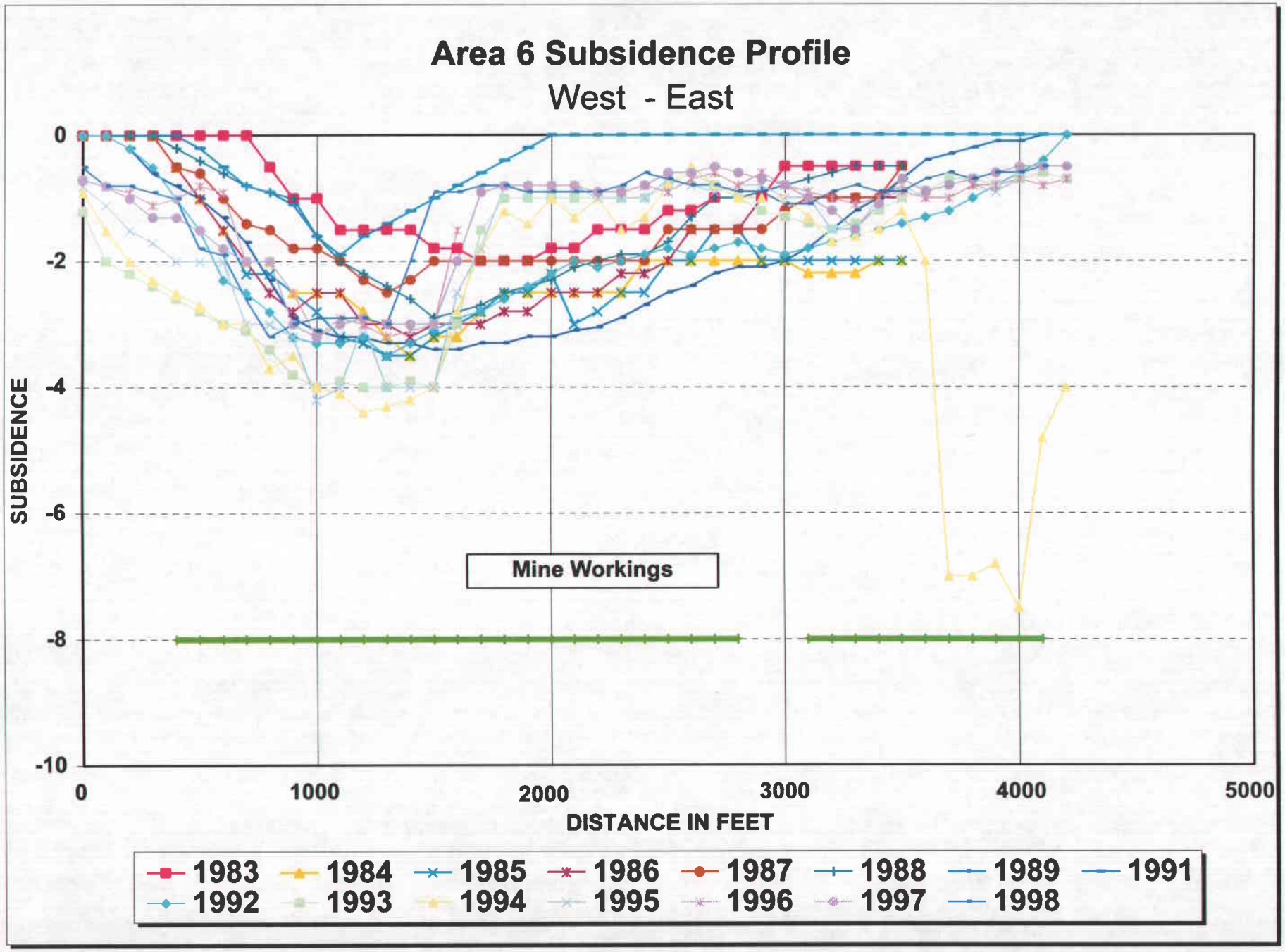

Area 6 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
1000
2000
3000
4000
5000
DISTANCE IN FEET
Mine Workings
1983
1984
1985
1986
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 26

Area 7

Beehive Mine 2nd North off 8th West

Pillar extraction mining in 2nd North was completed in 1983 and, as shown in Figures 27, 28, and 29, little additional subsidence has occurred over the workings since 1984. The workings are surrounded by burned coal.

Maximum subsidence is as much as seven (7) feet. In examining the area by helicopter and aerial photography, it is apparent that much of the elevation change measured was due to cliff failure and mass wasting on the steep slopes above the workings, where the rocks were highly fractured prior to mining. The profile, Figure 29, shows no measurable subsidence since 1991, this area is however, steep and rugged limiting the accuracy of the photogrammetric monitoring. Hence, the fluctuations in the reading are experienced from year to year.

It was not possible to get an accurate angle-of-draw because crushing of the surrounding clinker beds allowed subsidence to occur several thousand feet from the mine workings in some cases.

The subsidence has had no known influence on the hydrology in the area since they lack adequate recharge and are generally dry.

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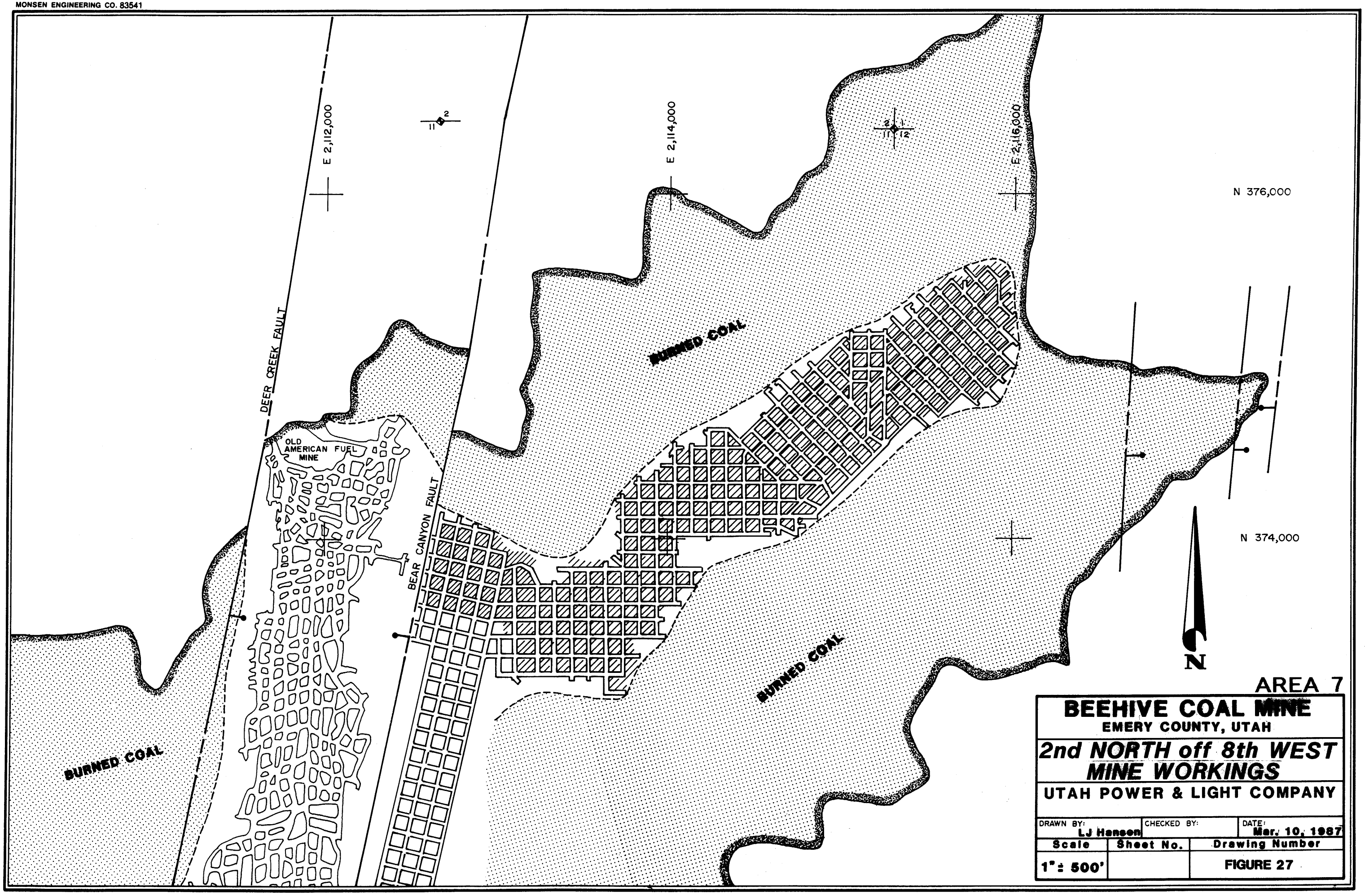

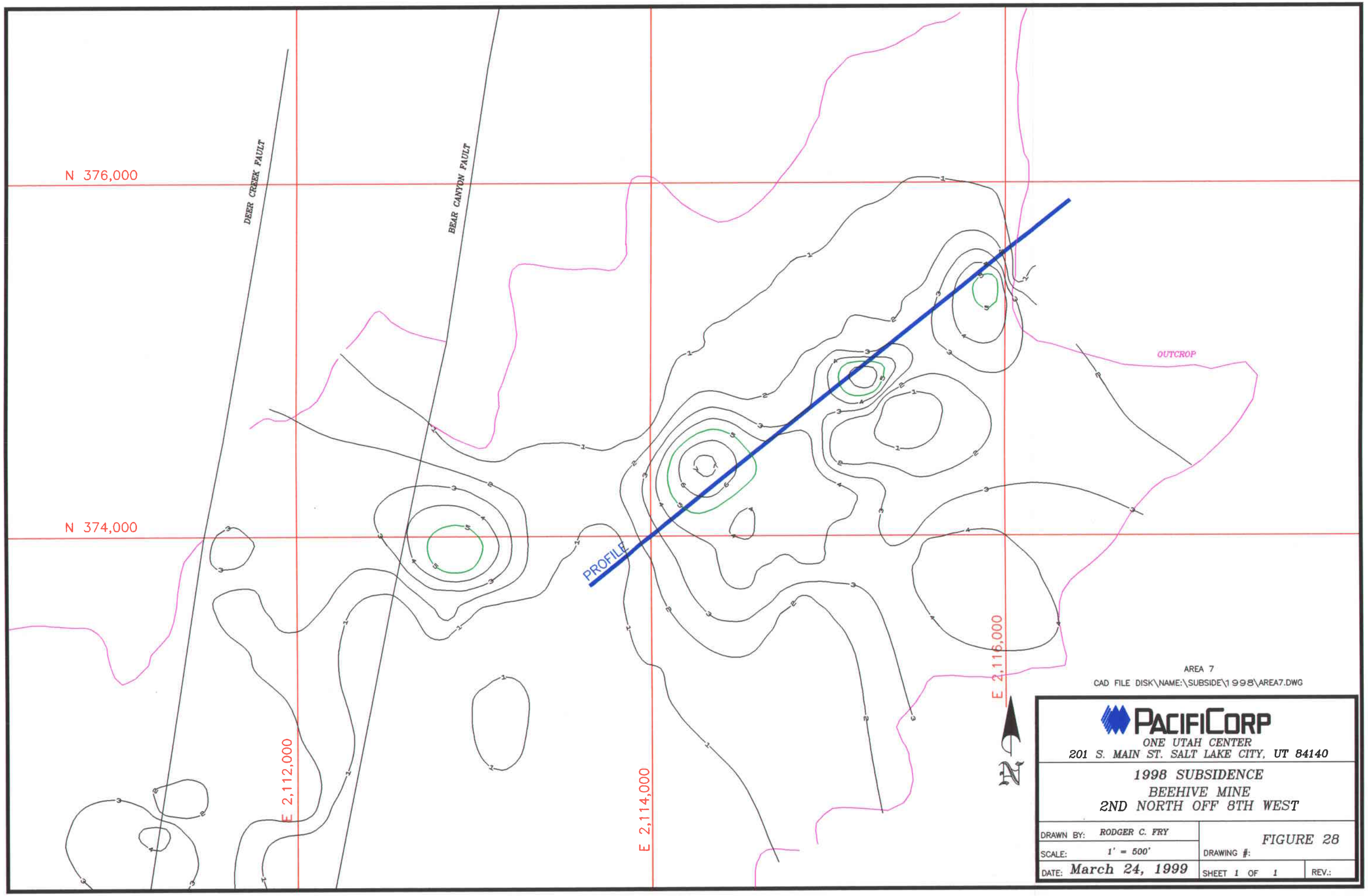
N 376,000
N 374,000
E 2,112,000
E 2,114,000
E 2,116,000
DEER CREEK FAULT
BEAR CANYON FAULT
PROFILE
OUTCROP
N
AREA 7
CAD FILE DISK\NAME:\SUBSIDE\1998\AREA7.DWG
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
1998 SUBSIDENCE
BEEHIVE MINE
2ND NORTH OFF 8TH WEST
DRAWN BY: RODGER C. FRY
SCALE: 1' = 500'
DATE: March 24, 1999
FIGURE 28
DRAWING #:
SHEET 1 OF 1
REV.:

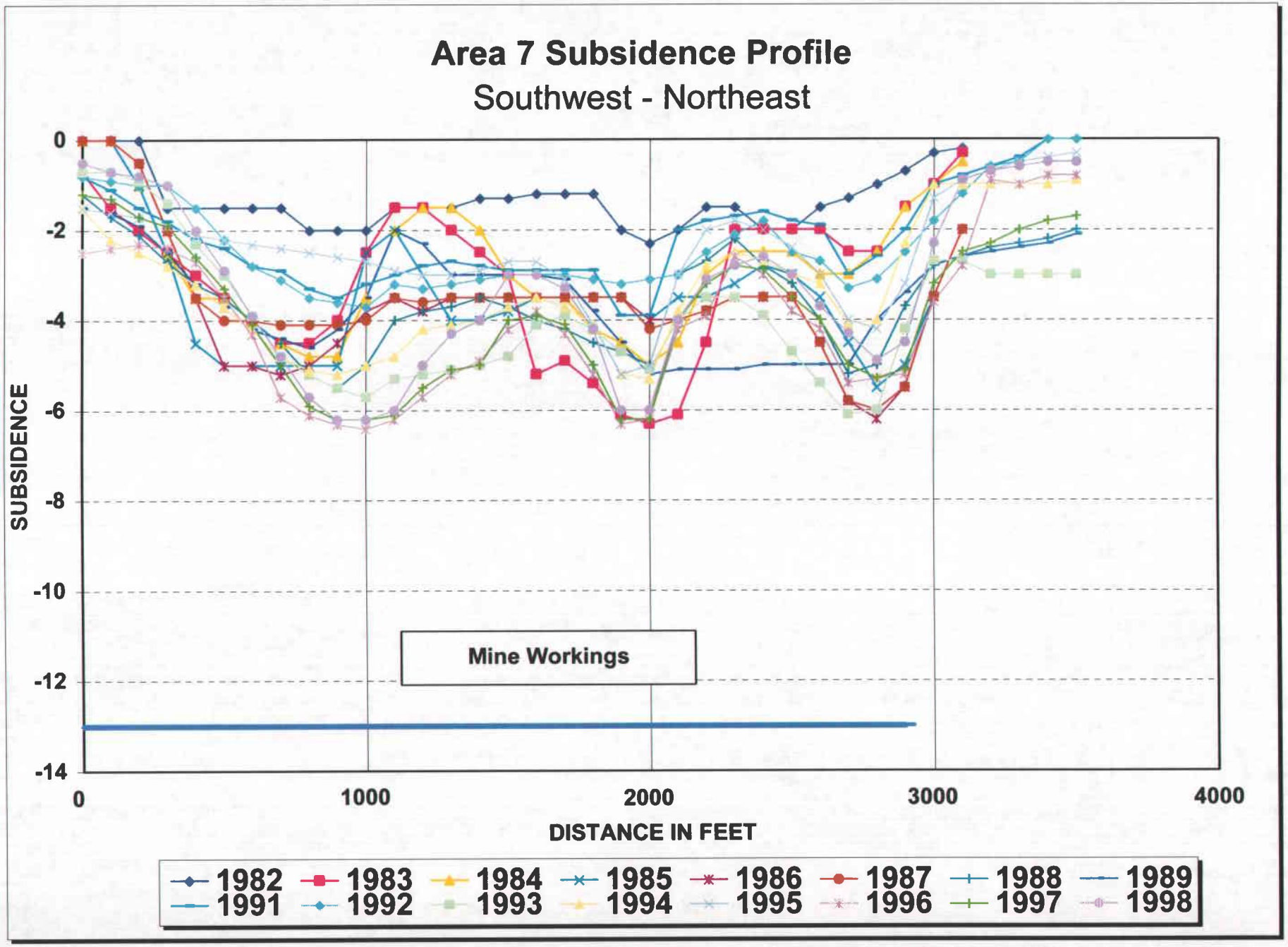
Area 7 Subsidence Profile
Southwest - Northeast
SUBSIDENCE
0
-2
-4
-6
-8
-10
-12
-14
0
1000
2000
3000
4000
DISTANCE IN FEET
Mine Workings
1982
1983
1984
1985
1986
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 29

Area 8

Beehive 3rd Through 8th West and 3rd Through 9th East

Deseret 3rd Through 9th West and 1st Through 5th East

Some of the subsidence in Area 8 may have gone undetected because pillar extraction, and presumably subsidence, in part of the area was completed before the establishment of baseline survey data (Figures 30, 31, and 32). The west to east subsidence profile of the area depicted in Figure 33 indicates that subsidence up to slightly under seven (7) feet has occurred. The profile shows a fair amount of variability. This is due to the rugged terrain in the area. The profile indicates that no detectable change in subsidence has occurred in the past five years. Where not influenced by other workings, the angle-of-draw reached a maximum of 31 degrees on the eastern edge of the area.

The strata in this area is dry and the subsidence that has occurred has had no impact on the hydrology of the area.

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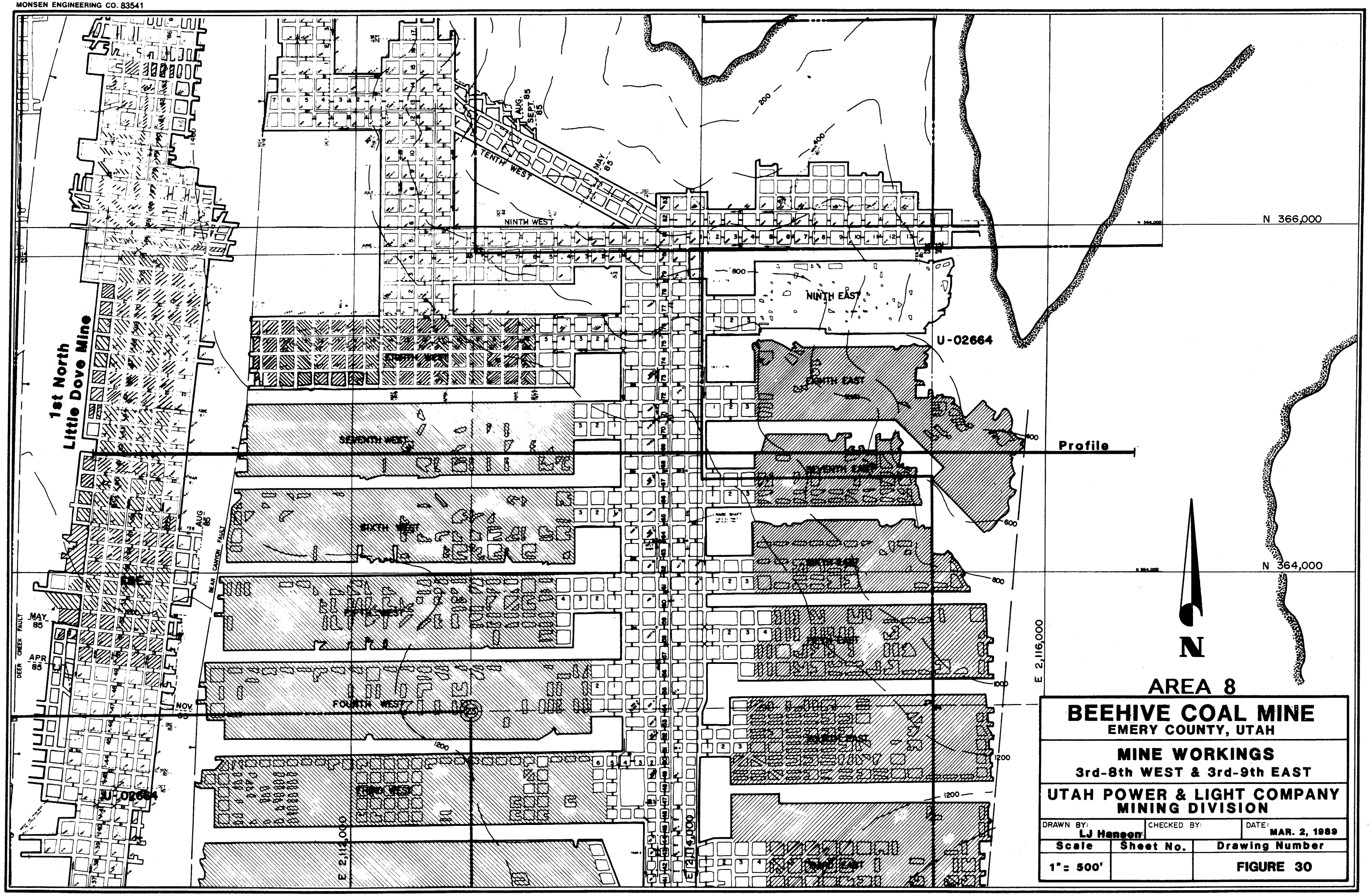


AREA 8

BEEHIVE COAL MINE

EMERY COUNTY, UTAH

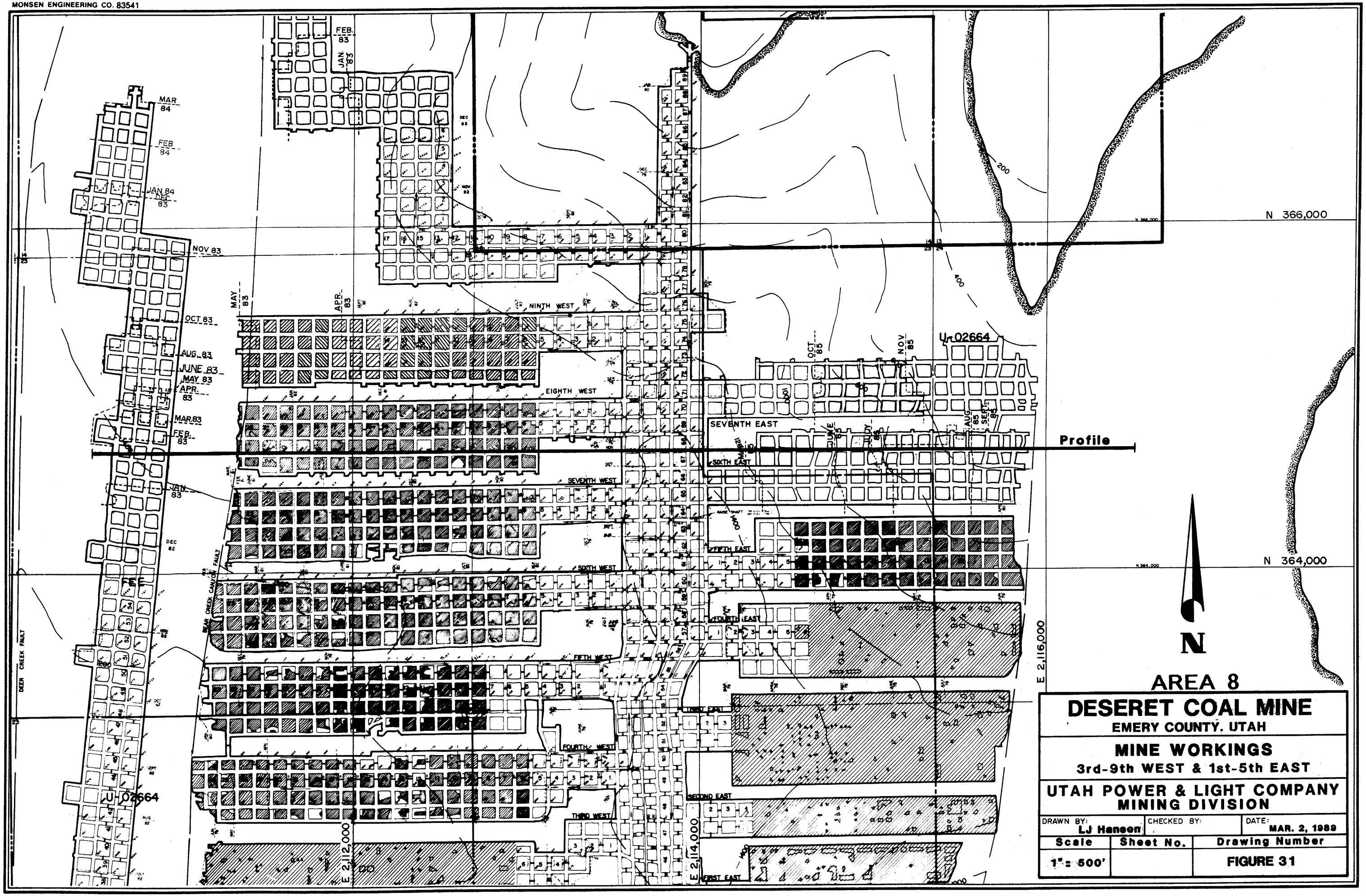
MINE WORKINGS

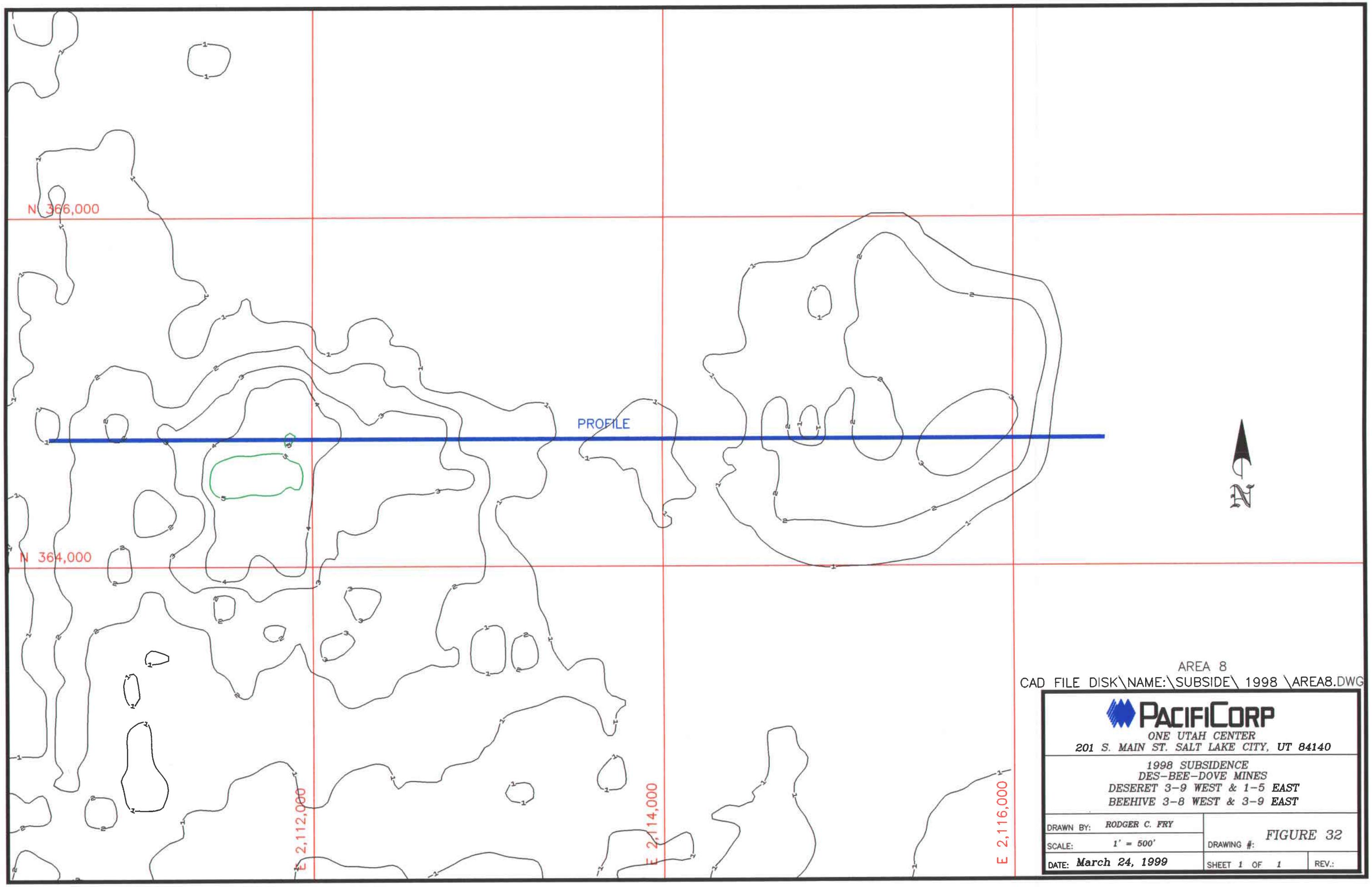
3rd-8th WEST & 3rd-9th EAST

UTAH POWER & LIGHT COMPANY
MINING DIVISION

DRAWN BY: LJ Hansen	CHECKED BY:	DATE: MAR. 2, 1989
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 30

MONSEN ENGINEERING CO. 83541





AREA 8

CAD FILE DISK\NAME:\SUBSIDE\ 1998 \AREA8.DWG

PACIFICORP

ONE UTAH CENTER

201 S. MAIN ST. SALT LAKE CITY, UT 84140

1998 SUBSIDENCE

DES-BEE-DOVE MINES

DESERET 3-9 WEST & 1-5 EAST

BEEHIVE 3-8 WEST & 3-9 EAST

DRAWN BY: RODGER C. FRY	DRAWING #: FIGURE 32	
SCALE: 1' = 500'		
DATE: March 24, 1999	SHEET 1 OF 1	REV.:

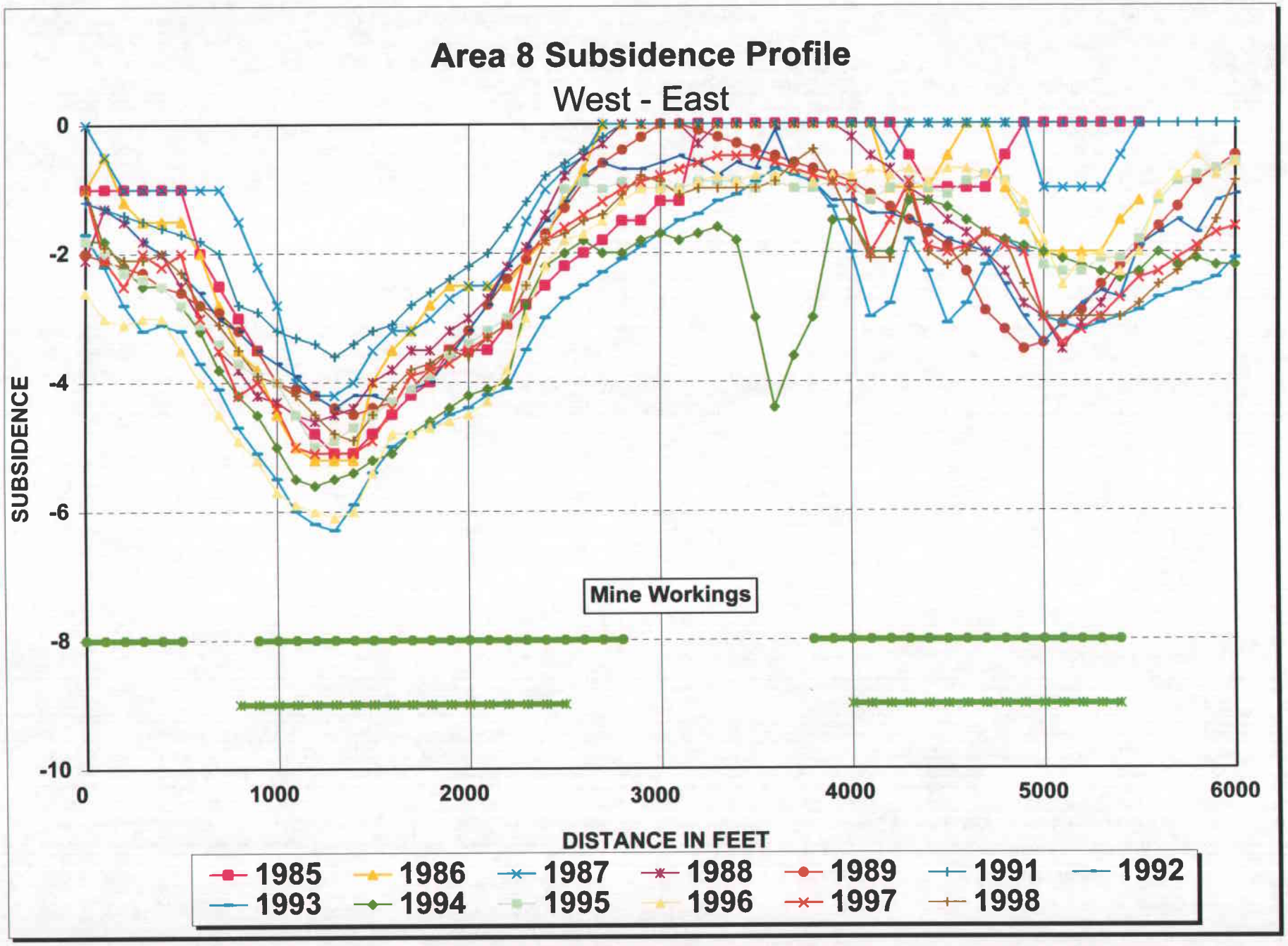

Area 8 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
1000
2000
3000
4000
5000
6000
DISTANCE IN FEET
Mine Workings
1985
1986
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 33

Areas 9 and 10

Little Dove 1st North and the old American Fuel Mine

The 1st North section of the Little Dove Mine and the American Fuel Mine workings are located in a graben formed by the Deer Creek and Bear Creek Canyon faults (see figures for Areas 7 and 8). In August 1982 the Little Dove workings, mining in a northerly direction, intersected the old workings of the American Fuel Mine about 1000 feet south of where available maps indicated they extend. Mining conditions in that area of Little Dove revealed that strata were highly stressed. In some cases pillars were crushed before they could be extracted. At that time pillar extraction mining was begun in 1st North and continued to the south with minor interruptions from 1982 through much of 1987.

To date the maximum observed subsidence over 1st North is about three to four feet, occurring over some of the most recently extracted pillars (see Subsidence Map in Appendix). No other notable subsidence has been detected over the remainder of 1st North.

. Subsidence of over six (6) feet has been measured above the American Fuel Mine workings.

Any angle-of-draw calculation would be affected by both the surrounding mine workings and the faults on either side; therefore, no angle-of-draw was calculated for either the 1st North area of the Little Dove Mine or the old American Fuel Mine.

No fractures are known over the 1st North workings, but some cliff failure and

fractures are probably present over the American Fuel Mine on the cliffs and steep slopes.

Mining has had no known effect on the hydrology of the areas.

Area 11

Deer Creek C and D North Longwall Panels

Cottonwood 11th Right Longwall Panel off 2 ½ North

Cottonwood 6th & 7th Right Longwall Panel off of 2nd North

Longwall mining in the C North panel began in December 1984 and was terminated in April 1986 due to geologic complications. New setup entries were driven further south and mining resumed in September 1986; the panel was completed in March 1987. The D North longwall panel began production in July 1987, but after October 1987 production was limited due to poor coal quality. The panel was terminated in August 1988 at a length of 1750 feet. Pillar extraction mining in A North and A South was completed in June 1983 (Figure 34).

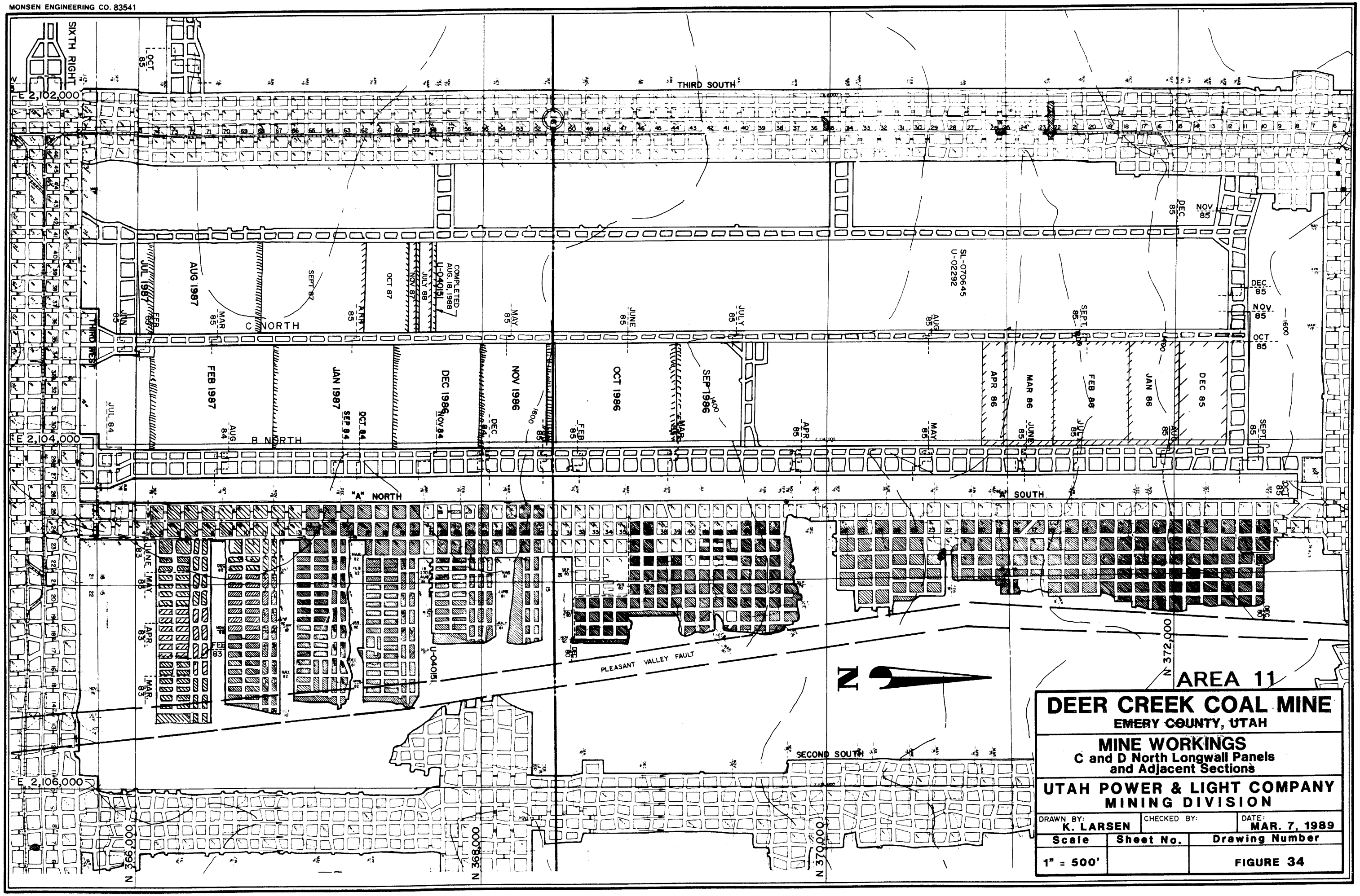
Mining in the 11th Right Panel in the Cottonwood Mine began In July of 1992 and was completed in September 1992 (Figure 35). The 10th Right Panel to the south was developed but couldn't be mined with longwall methods because of thin coal and poor coal quality. Mining began in the 7th Right Panel in February 1993 and by August 1993 mining in the 6th Right Panel had been completed.

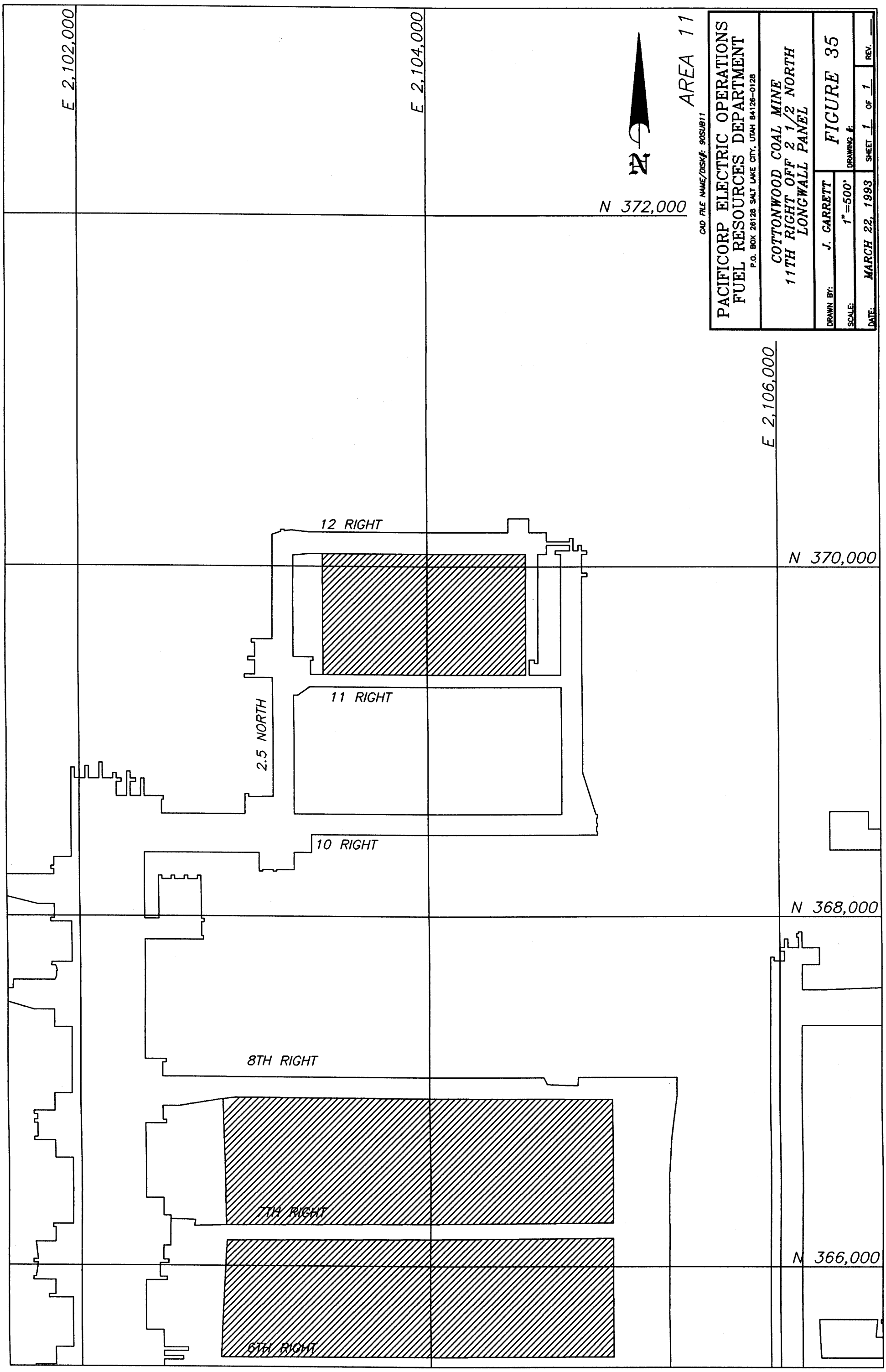
Measurable subsidence to date has exceeded thirteen (13) feet in the area of multiple seam mining above the 6th and 7th Right Longwall Panels in the Cottonwood mine (Figures 36, 37, and 38). The maximum subsidence showed an increase between 1993 and 1994 but has been stable the past five years.

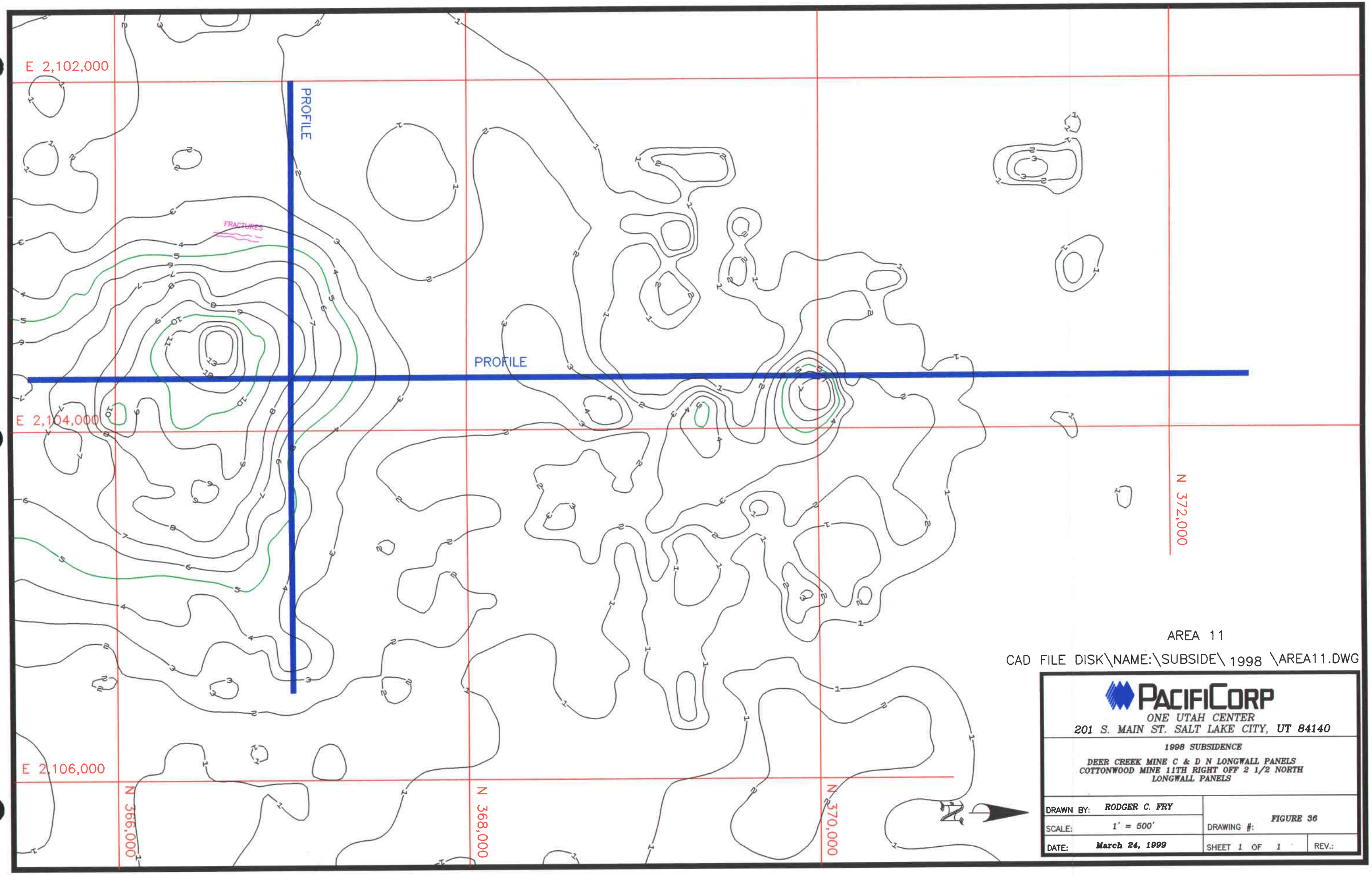
Fractures were discovered at the western end of coal extraction above the 7th Right

Longwall Panel. The fractures were first discovered on June 17, 1993. Mining of the longwall panel was completed on May 12, 1993. An aerial reconnaissance of the area on May 18, 1993 revealed no surface fractures at that time. This places the occurrence of the fractures between May 18, 1993 and June 17, 1993. Burnt Tree Springs is located approximately 800 feet to the southeast of the fractures. Measurements of the spring discharge throughout the summer of 1993 through 1998 indicated that the fracturing has had no effect on the spring. The angle-of-draw measured ranges from less than zero to 28 degrees.

MONSEN ENGINEERING CO. 83541




E 2,102,000
E 2,104,000
E 2,106,000
N 372,000
N 370,000
N 368,000
N 366,000
N
AREA 11
12 RIGHT
11 RIGHT
10 RIGHT
2.5 NORTH
8TH RIGHT
7TH RIGHT
6TH RIGHT
CAD FILE NAME/DISK#: 90SUB11
PACIFICORP ELECTRIC OPERATIONS
FUEL RESOURCES DEPARTMENT
P.O. BOX 26128 SALT LAKE CITY, UTAH 84126-0128
COTTONWOOD COAL MINE
11TH RIGHT OFF 2 1/2 NORTH
LONGWALL PANEL
FIGURE 35
DRAWN BY: J. GARRETT
SCALE: 1"=500'
DATE: MARCH 22, 1993
DRAWING #:
SHEET 1 OF 1
REV.



AREA 11

CAD FILE DISK\NAME:\SUBSIDE\ 1998 \AREA11.DWG

PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140

1998 SUBSIDENCE

DEER CREEK MINE C & D N LONGWALL PANELS
COTTONWOOD MINE 11TH RIGHT OFF 2 1/2 NORTH
LONGWALL PANELS

DRAWN BY:	RODGER C. FRY	DRAWING #:	FIGURE 36
SCALE:	1' = 500'		
DATE:	March 24, 1999	SHEET 1 OF 1	REV.:

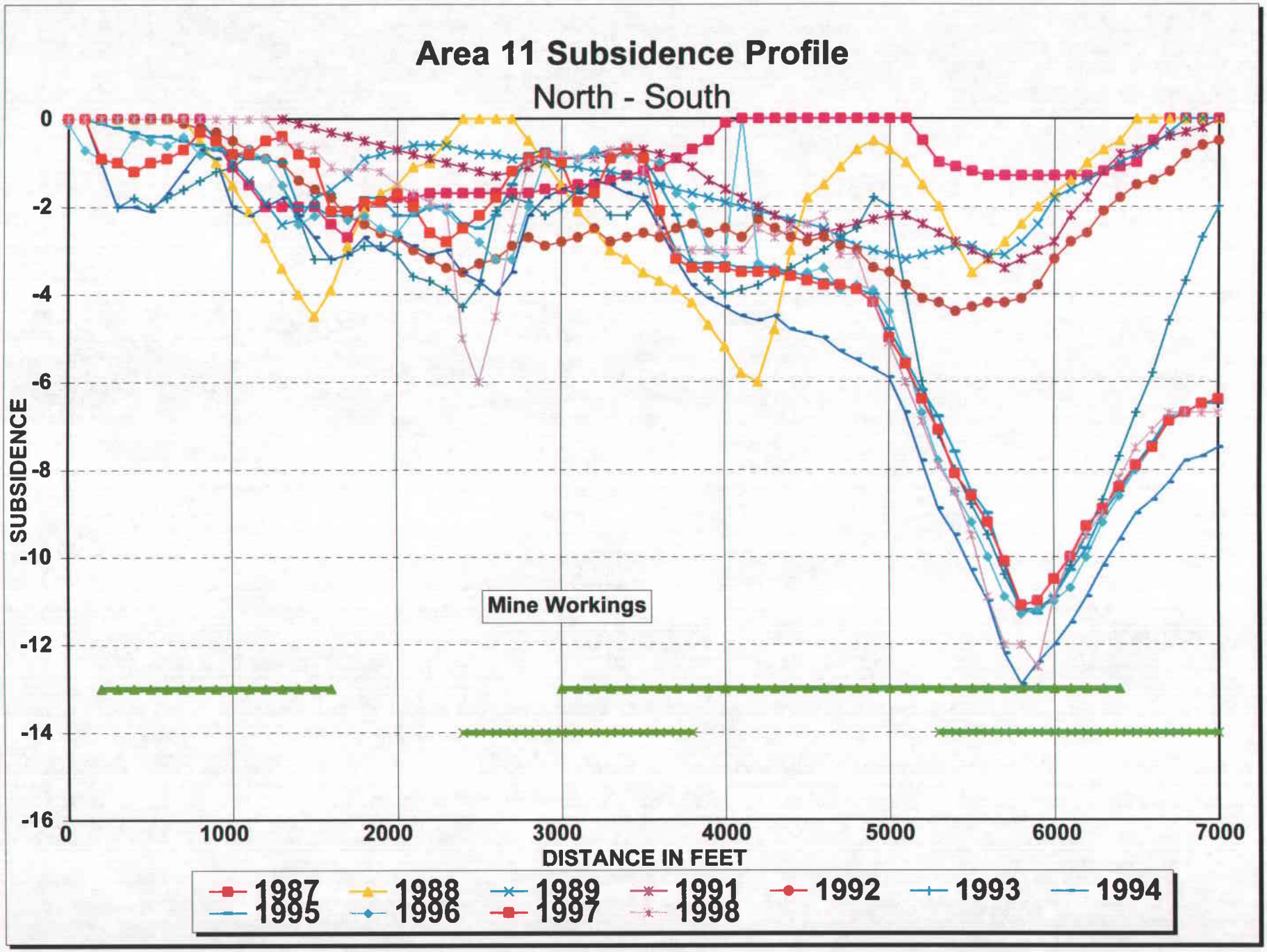

Area 11 Subsidence Profile
North - South
SUBSIDENCE
0
-2
-4
-6
-8
-10
-12
-14
-16
0
1000
2000
3000
4000
5000
6000
7000
DISTANCE IN FEET
Mine Workings
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 37

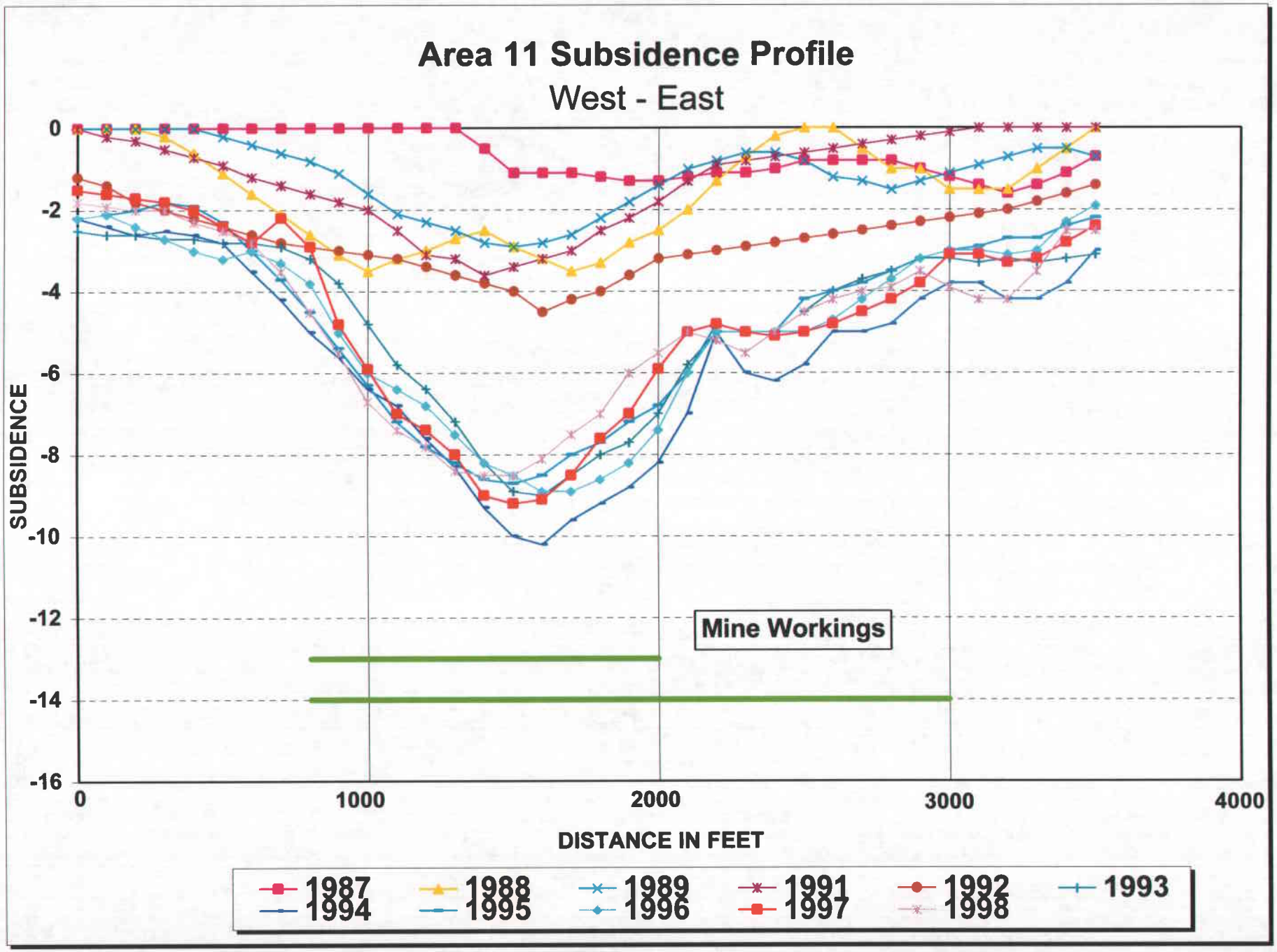

Area 11 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
-10
-12
-14
-16
0
1000
2000
3000
4000
DISTANCE IN FEET
Mine Workings
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 38

Area 12

Wilberg 2nd Left Longwall Panel

The 2nd Left longwall panel is located in the western portion of the Wilberg Mine (Figure 2). A block of coal measuring 2300 feet by 530 feet was extracted during 1981 and 1982. To date no measurable subsidence has occurred and no visible surface disturbance has been observed. Overburden ranges from 1500 to 1900 feet over the panel. It is somewhat surprising that no movement has been detected since subsidence has been observed in other instances where smaller blocks of coal were extracted and overburden was of similar thickness.

One spring is located approximately 800 feet northeast of the extracted workings on the surface. It has not been affected by mining.

Area 13

Des-Bee-Dove Southern Areas

Area 13, covering the southern portions of the Deseret, Beehive, and Little Dove Mines, was first monitored for subsidence in 1986. Some of the sections were mined before baseline survey data were established; therefore, subsidence measured over these sections will likely not represent what actually occurred. The 4th North section in the Little Dove Mine was completed in February 1987 (Figures 39 and 40).

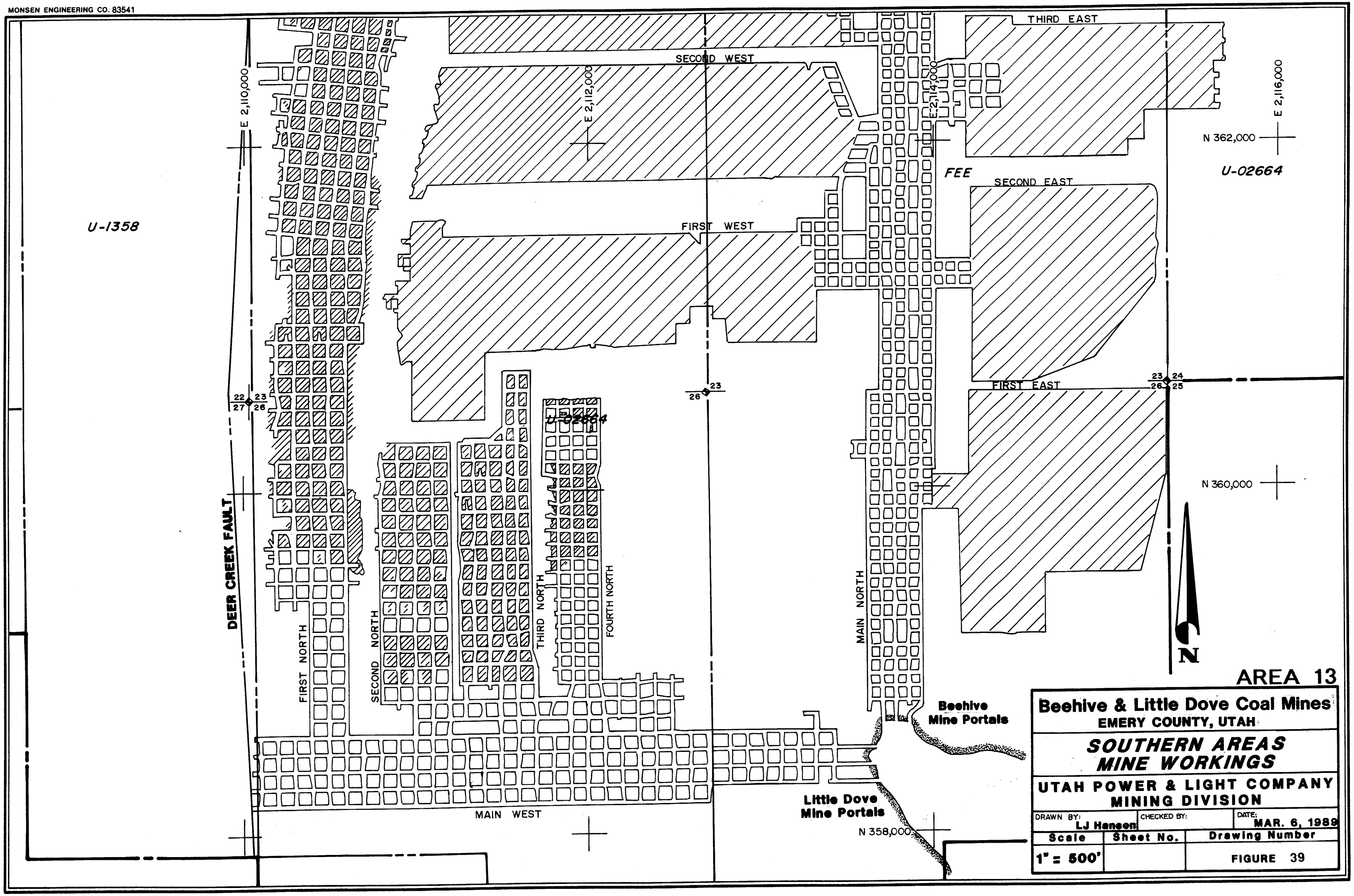
Maximum subsidence over the area as of August 1998 was about three (3) feet over the second and third north sections of the Little Dove Mine (Figures 41, 42, and 43). No change in subsidence has occurred in the past three years.

The subsidence profiles, figures 42 and 43 show subsidence yearly since 1986. These profiles show that the readings in 1993 and 1994 are somewhat lower than in 1995, 1996, 1997 or in previous years. This is most likely a problem with the aerial triangulation because a comparison of the survey monuments in the area show no subsidence change in that time period.

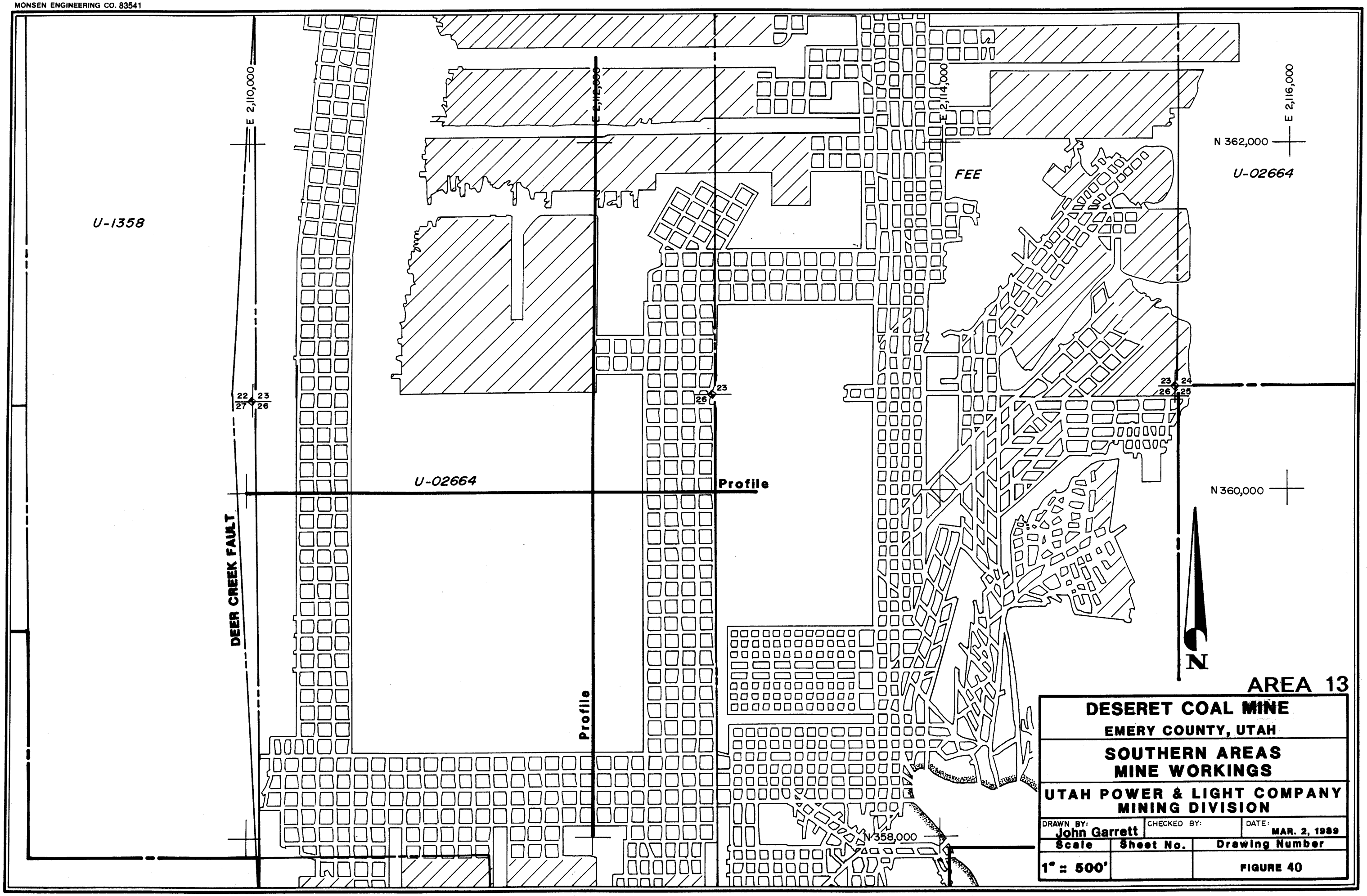
No visible surface disturbance of any kind has been found.

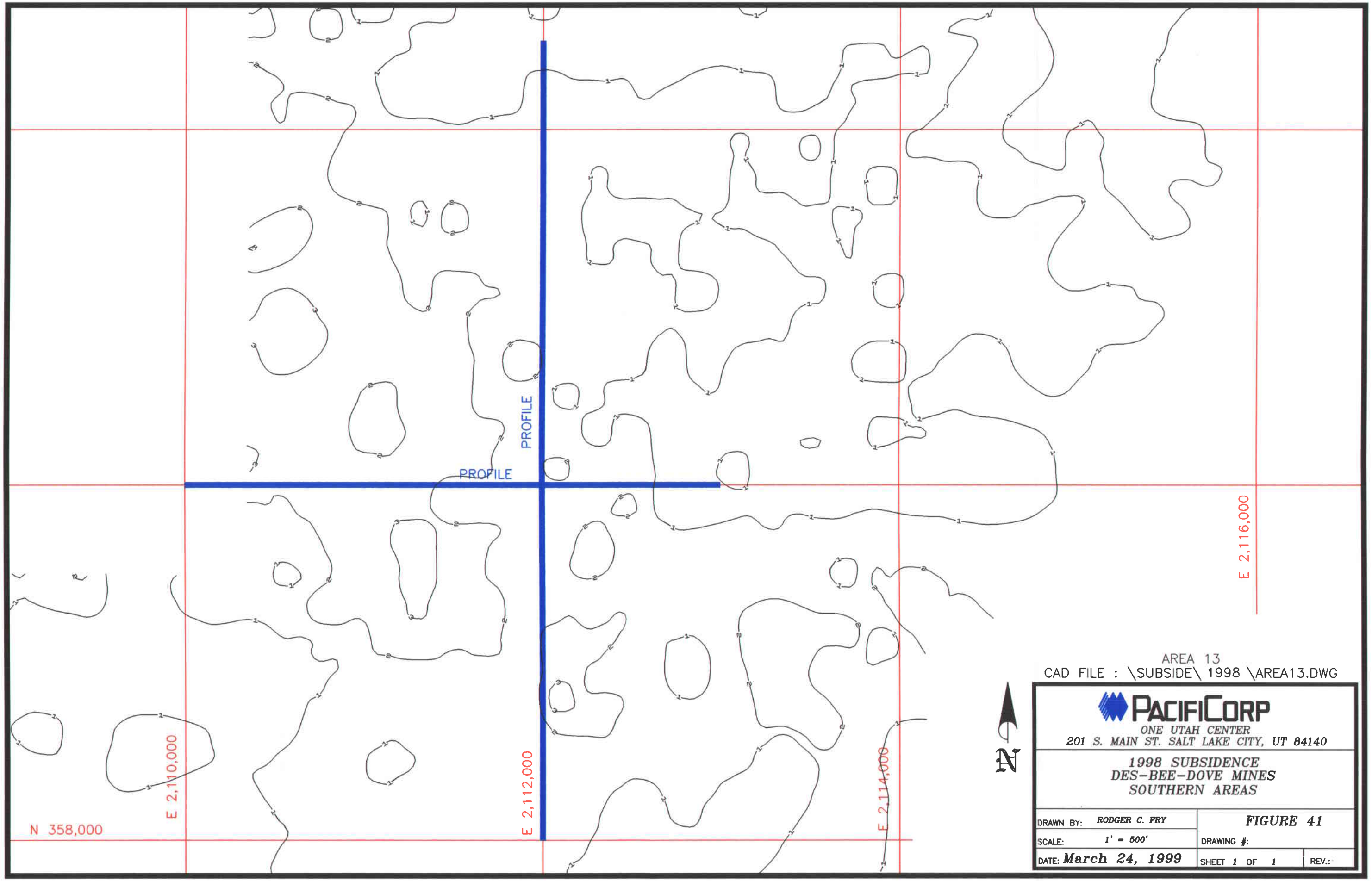
There are no known springs over the workings, and mining is not expected to have any effect on the hydrology of the area.

MONSEN ENGINEERING CO. 83541



MONSEN ENGINEERING CO. 83541

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PROFILE
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E 2,110,000
E 2,112,000
E 2,114,000
E 2,116,000
N
AREA 13
CAD FILE : \SUBSIDE\ 1998 \AREA13.DWG
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
1998 SUBSIDENCE
DES-BEE-DOVE MINES
SOUTHERN AREAS
DRAWN BY: RODGER C. FRY
SCALE: 1' = 500'
DATE: March 24, 1999
FIGURE 41
DRAWING #:
SHEET 1 OF 1
REV.:

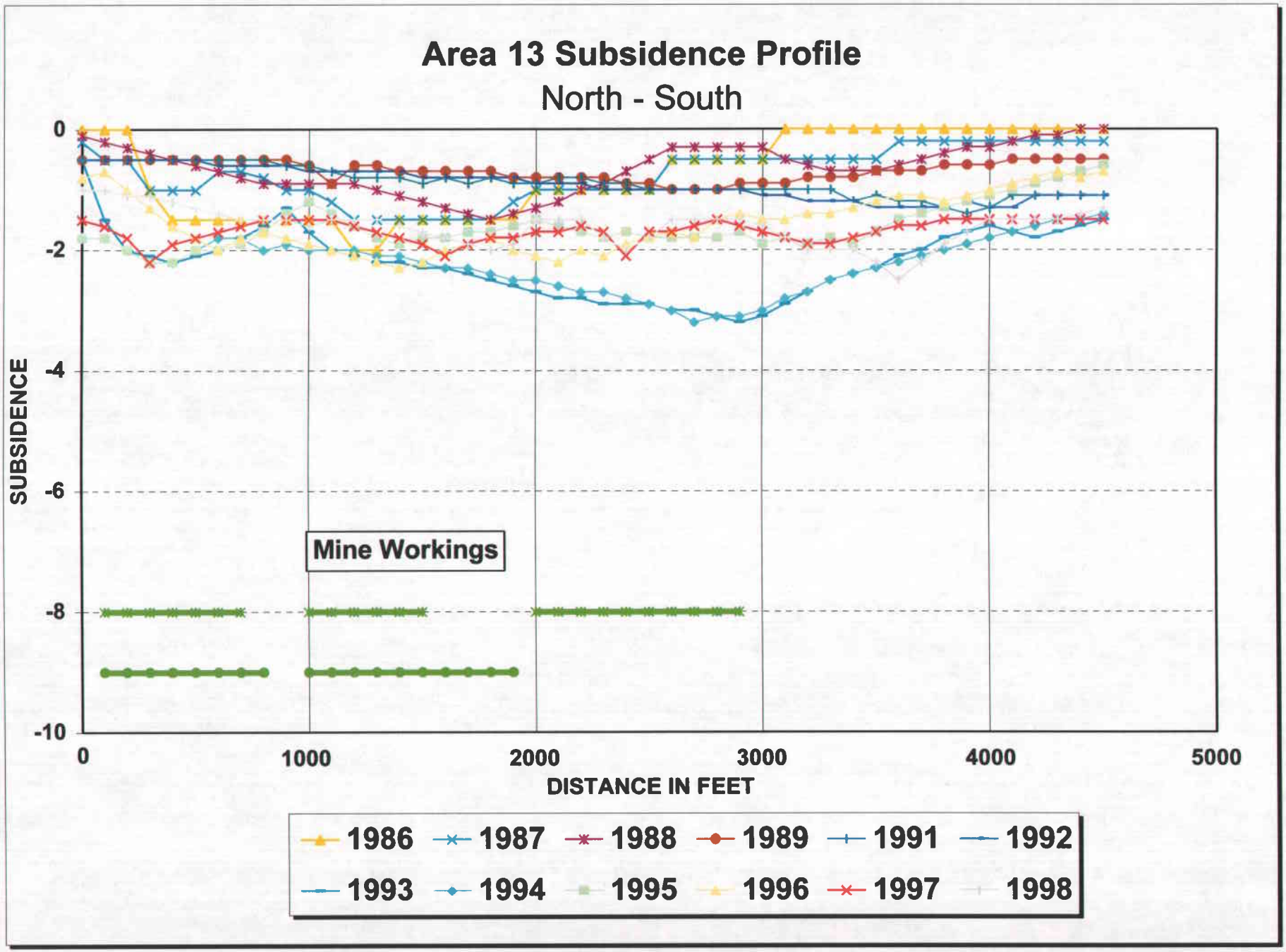

Area 13 Subsidence Profile
North - South
SUBSIDENCE
0
-2
-4
-6
-8
-10
Mine Workings
0
1000
2000
3000
4000
5000
DISTANCE IN FEET
1986
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 42

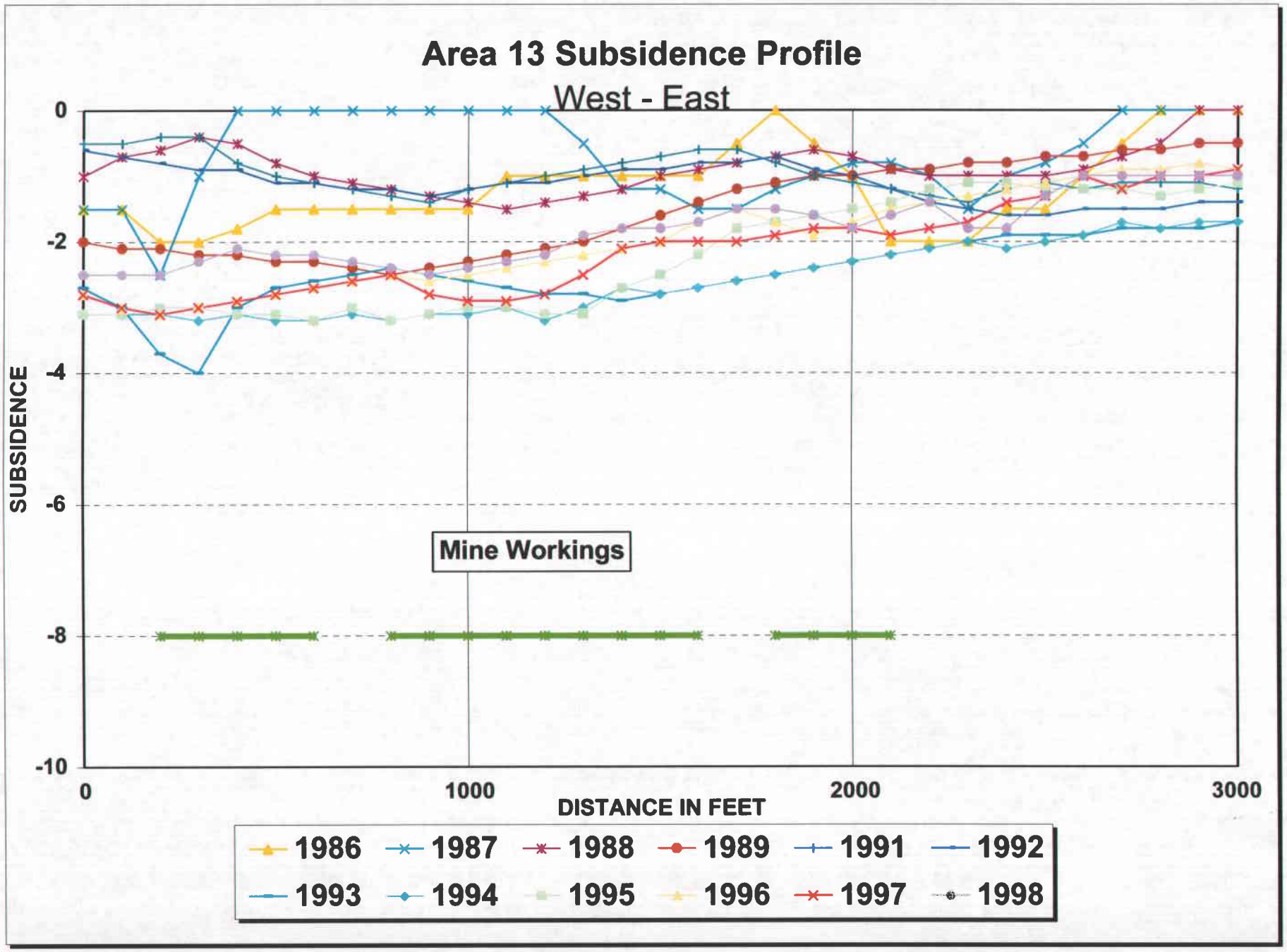

Area 13 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
1000
2000
3000
DISTANCE IN FEET
Mine Workings
1986
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 43

Area 14

Cottonwood 6th and 7th East Longwall Panels

Subsidence in Area 14 was first monitored and detected in 1987. Mining began in the 6th East panel in September 1986 and continued until the panel was completed in March 1987. Mining in the 7th East panel began in April 1987, and the panel was finished in September 1987 (Figure 44).

Topography consists of very steep south facing slopes and cliffs with slopes covered by a few scattered pinon, juniper, mountain brush, and grasses. Overburden ranges from 200 to near 1,400 feet.

The Castlegate Sandstone forms a 200-foot high escarpment along the north side of Newberry Canyon with numerous naturally occurring joints and fractures. Stress caused by removal of coal was transferred to the fractures resulting in brittle failure of the cliff face (spalling) in some places. Talus from the spalling has accumulated on the steep slopes below the cliffs on older natural talus slopes. The newer debris remains mostly above the coal outcrop level and reaches the canyon floor in only one location. Surface cracks have been observed and mapped along the ridge above the cliff. The cracks are discontinuous and extend for approximately 2,000 feet parallel to the northern edge of the 6th East longwall panel. A few cracks are also found directly on top of the Castlegate Sandstone escarpment. Maximum subsidence to date is over seven (7) feet above the western end of the 7th East Longwall Panel and five (5) feet over the eastern end of 6th East along the Pleasant Valley Fault (Figures 45, 46, and 47). Because this area has rugged and steep

terrain, it is the most difficult to achieve consistent results using the photogrammetric monitoring. As can be seen on the subsidence map (Figure 45) and the profiles (Figures 46 and 47) the subsidence appears to vary substantially from one location to another and change up and down in time. This is because the photogrammetric monitoring is difficult in this type of terrain. The "bulls-eyes" of subsidence shown in 1996 are still present in the 1998 data. The aerial reconnaissance on May 19, 1998 showed no visible indication of change in these areas. It should be expected that inaccuracies in the reading will occur in this area because of the rugged terrain. Several survey targets were established in this area on the Castlegate cliff and have been surveyed since their emplacement in 1986. This monitoring shows no changes in the last five years. The data from these monitoring sites are located in the appendix to this report.

The angle-of-draw was not calculated to the west, south and east because of the steep slopes, burned coal, and other workings surrounding the 6th and 7th East panels. The angle of draw on the north side of the 6th East Panel is 25 degrees.

There are no springs in the vicinity of Area 14. The strata are generally dry; thus, mining is expected to have no adverse impact on the hydrology.

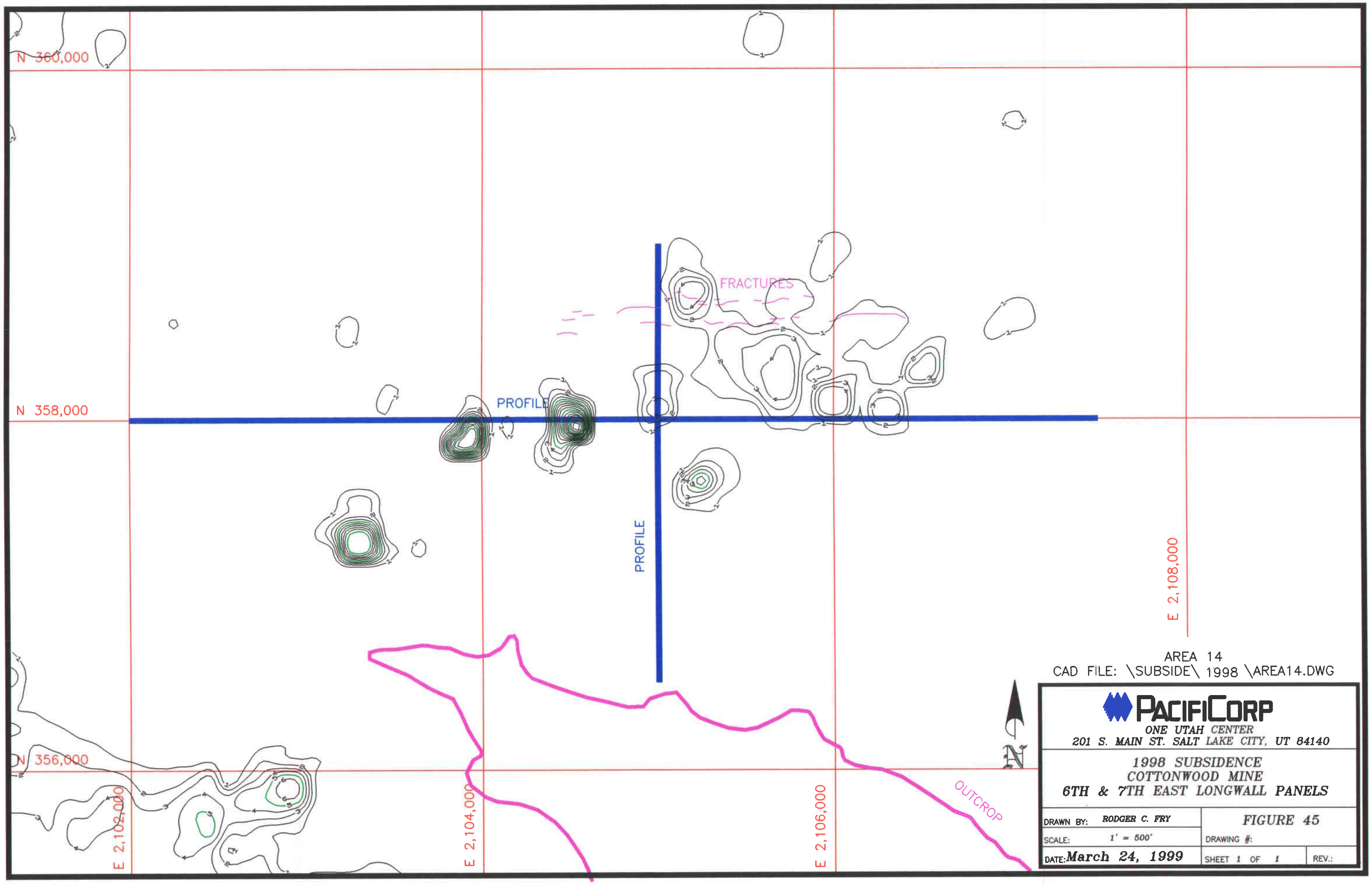
Wildlife in the area includes deer, elk, nesting golden eagles in spring and summer, wintering bald eagles, hares, rabbits, grouse, and other species. Grazing cattle can also be found along the ridge top in the summer months.

The major impacts associated with subsidence and resulting cliff failure, surface cracking, and talus deposition in Area 14 are 1) possible loss of golden eagle nests and/or

nest sites, 2) disruption of grazing and hunting land use, and 3) loss of wildlife habitat.

Prior to longwall mining in the area an eagle monitoring plan was developed and implemented. It went into effect in February 1986 and is an ongoing program. The purpose of the plan is to collect data whereby the impacts of subsidence and cliff spalling upon eagle nesting can be assessed. The report entitled "Assessment of Mining Related Impacts in Newberry Canyon" submitted to the Utah Division of Oil, Gas and Mining discusses all mining related impacts in Area 14 and includes the eagle monitoring plan as an appendix.

2ND WEST
360,000
E 2,102,000
E 2,104,000
E 2,106,000
E 2,108,000
3RD EAST
3RD WEST
4TH WEST
4TH EAST
5TH EAST
2ND SOUTH
5TH WEST MAINS
N 358,000
6TH EAST
7TH EAST
7TH EAST
8TH EAST
N 356,000
9TH EAST
PLEASANT VALLEY FAULT
(NO DISPLACEMENT)
1ST SOUTH
BURNED COAL
N
AREA 14
CAD FILE NAME/DISK#: CW67ELP/KLS
UTAH POWER & LIGHT
MINING DIVISION
P.O. BOX 310, HUNTINGTON, UTAH 84528
COTTONWOOD COAL MINE
MINE WORKINGS
6th & 7th EAST LONGWALL PANELS
DRAWN BY: K. LARSEN
SCALE: 1"=500'
DATE: 4-24-90
FIGURE 44
DRAWING #:
SHEET 1 OF 1
REV.


N 360,000
N 358,000
N 356,000
E 2,102,000
E 2,104,000
E 2,106,000
E 2,108,000
FRACTURES
PROFILE
PROFILE
OUTCROP
N
AREA 14
CAD FILE: \SUBSIDE\ 1998 \AREA14.DWG
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
1998 SUBSIDENCE
COTTONWOOD MINE
6TH & 7TH EAST LONGWALL PANELS
DRAWN BY: RODGER C. FRY
SCALE: 1' = 500'
DATE: March 24, 1999
FIGURE 45
DRAWING #:
SHEET 1 OF 1
REV.:

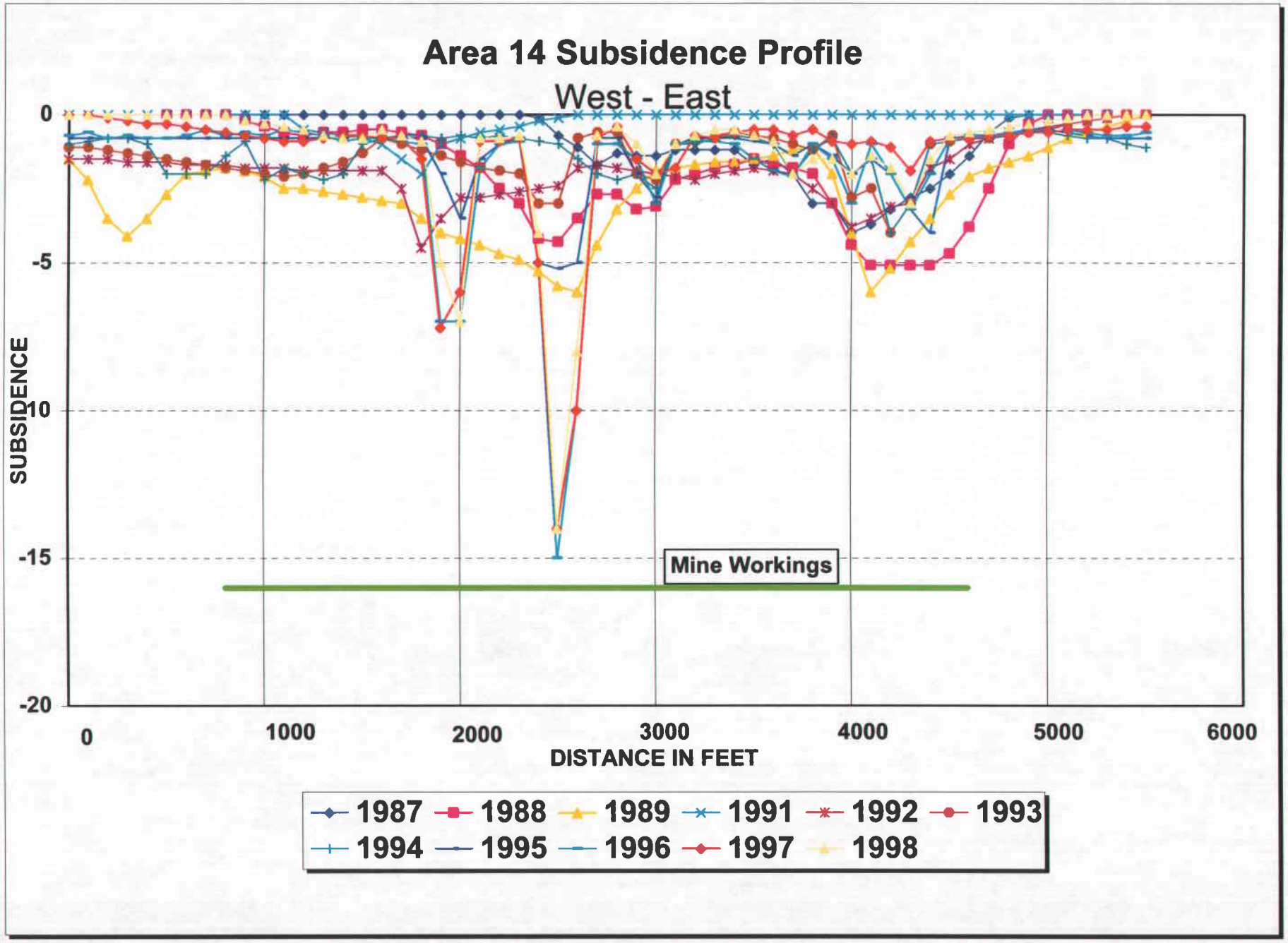

Area 14 Subsidence Profile
West - East
SUBSIDENCE
0
-5
-10
-15
-20
0
1000
2000
3000
4000
5000
6000
DISTANCE IN FEET
Mine Workings
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 46

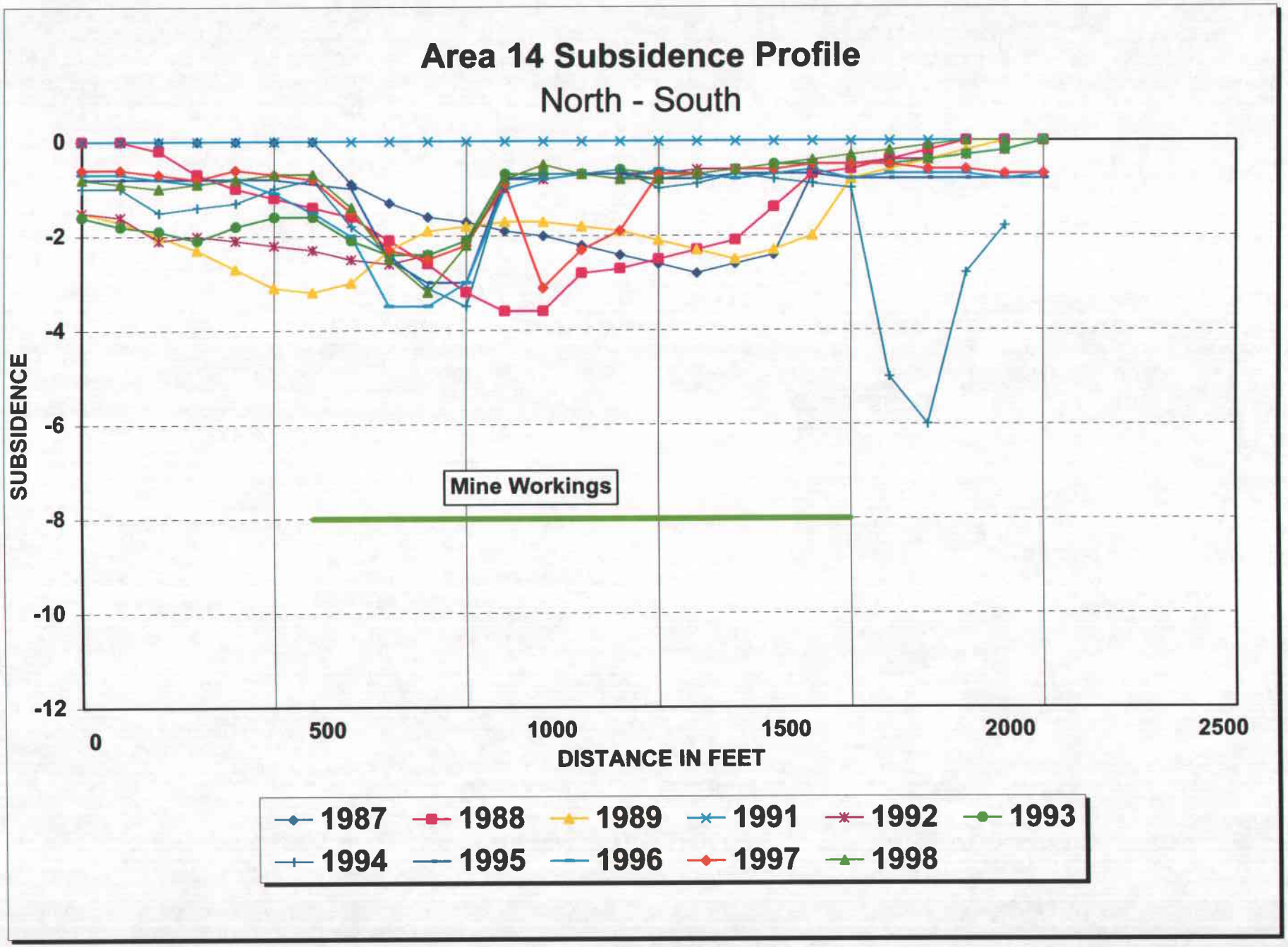

Area 14 Subsidence Profile
North - South
SUBSIDENCE
0
-2
-4
-6
-8
-10
-12
0
500
1000
1500
2000
2500
DISTANCE IN FEET
Mine Workings
1987
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 47

Area 15

Cottonwood 9th and 12th West Longwall Panels

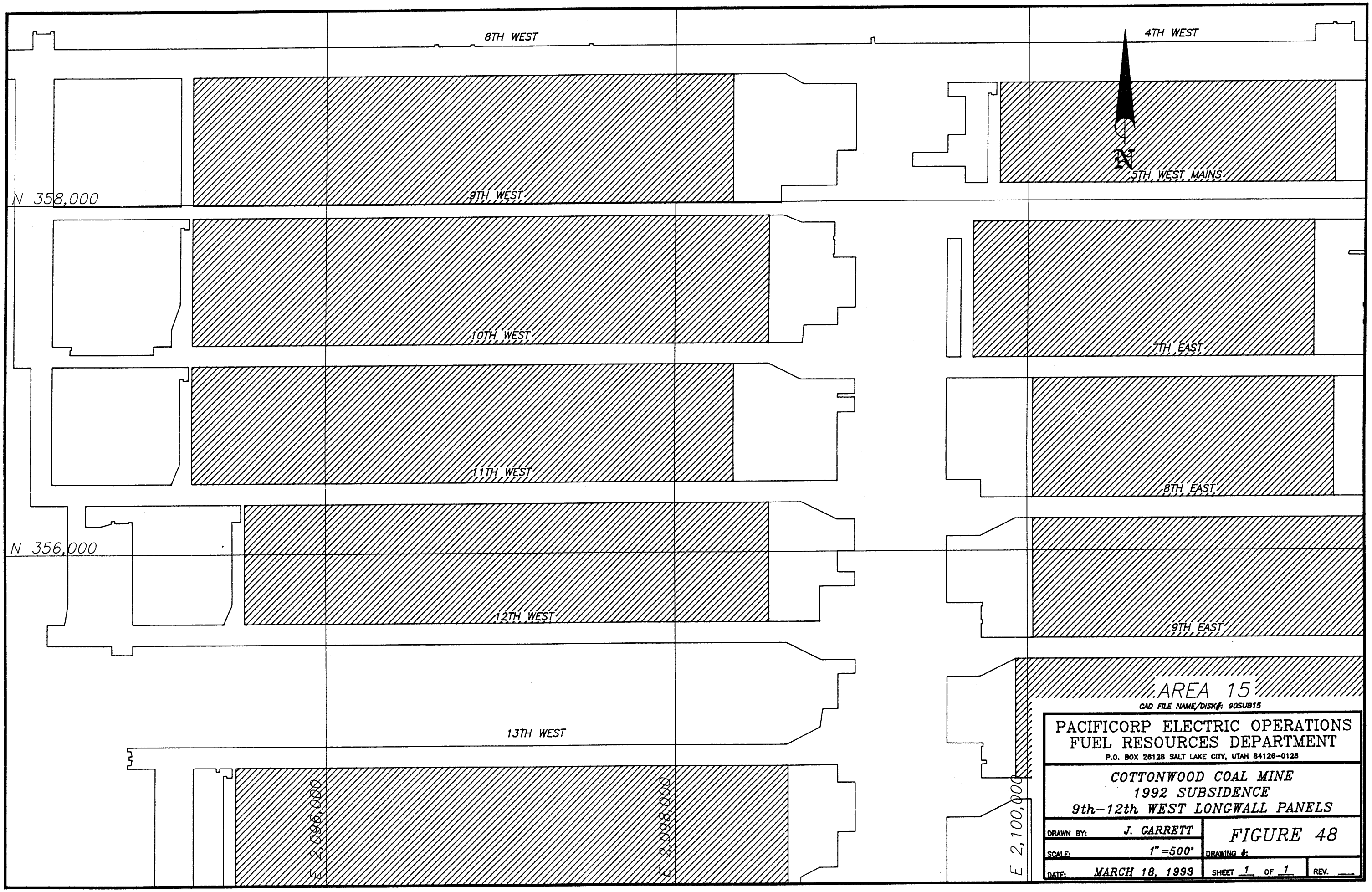
Subsidence in 9th and 10th West was first monitored and detected in 1988 when longwall extraction began there. The 9th through 12th West panels were all completed by fall of 1989 (Figure 48).

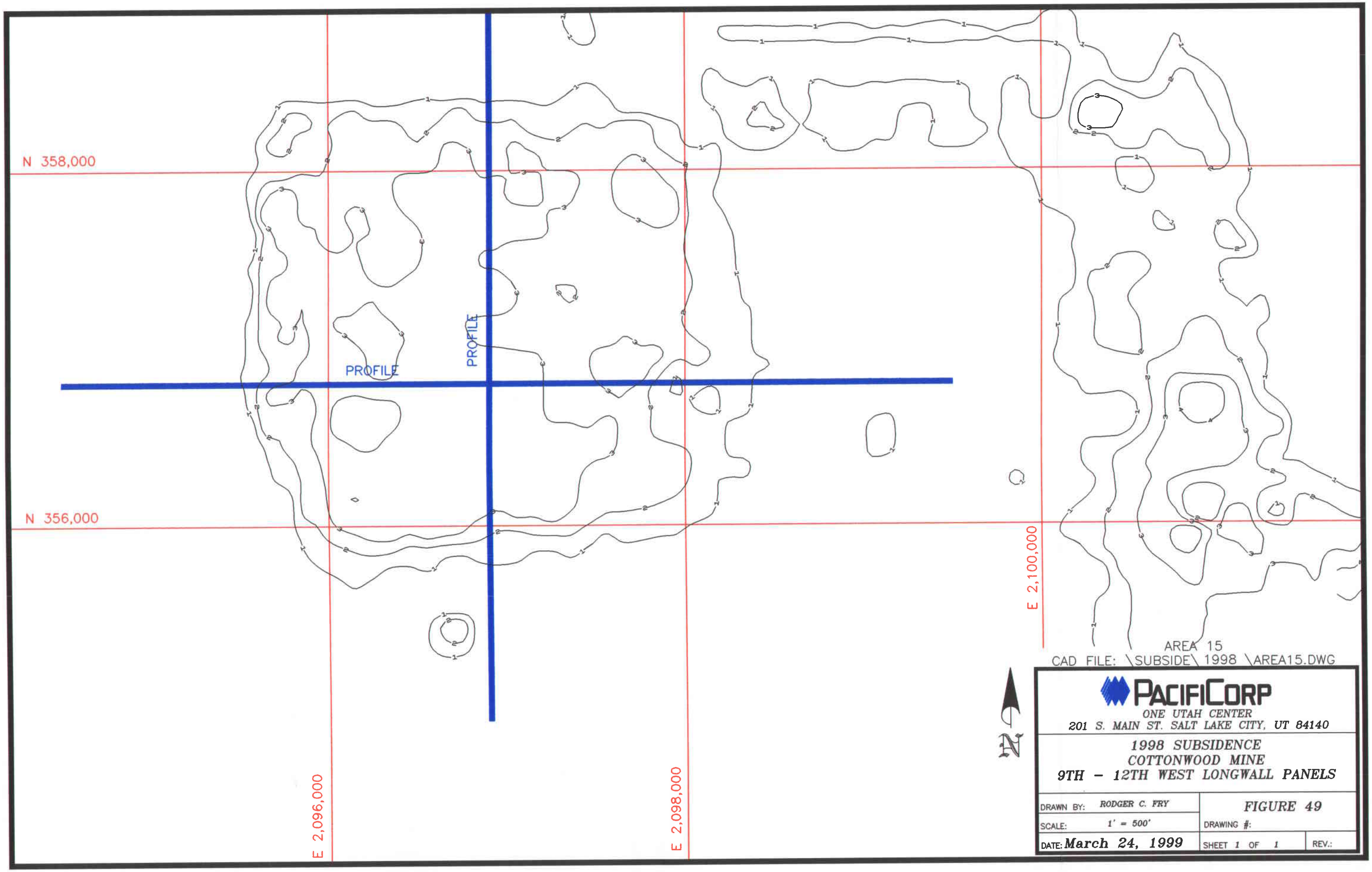
The surface above these panels is comprised mainly of steep to moderate slopes with a small flat area forming the top of East Mountain on the area's eastern edge. Overburden ranges from 800 feet to over 2000 feet.

Maximum measured subsidence in 1998 is slightly over four feet which is similar to that which was measured in 1995 above 11th West (Figures 49, 50, and 51). This area has experienced no additional subsidence in the past seven years.

Calculated angle-of-draw is less than zero on the south and east and reaches 20 degrees on the west.

There are no known springs in the area.


8TH WEST
4TH WEST
N
5TH WEST MAINS
N 358,000
9TH WEST
10TH WEST
7TH EAST
11TH WEST
8TH EAST
N 356,000
12TH WEST
9TH EAST
AREA 15
CAD FILE NAME/DISK#: 90SUB15
13TH WEST
E 2,096,000
E 2,098,000
E 2,100,000
PACIFICORP ELECTRIC OPERATIONS
FUEL RESOURCES DEPARTMENT
P.O. BOX 26128 SALT LAKE CITY, UTAH 84126-0128
COTTONWOOD COAL MINE
1992 SUBSIDENCE
9th-12th WEST LONGWALL PANELS
DRAWN BY: J. GARRETT
SCALE: 1"=500'
DATE: MARCH 18, 1993
FIGURE 48
DRAWING #:
SHEET 1 OF 1
REV.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N 356,000
E 2,096,000
E 2,098,000
E 2,100,000
PROFILE
PROFILE
N
AREA 15
CAD FILE: \SUBSIDE\ 1998 \AREA15.DWG
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
1998 SUBSIDENCE
COTTONWOOD MINE
9TH - 12TH WEST LONGWALL PANELS
DRAWN BY: RODGER C. FRY
SCALE: 1' = 500'
DATE: March 24, 1999
FIGURE 49
DRAWING #:
SHEET 1 OF 1
REV.:

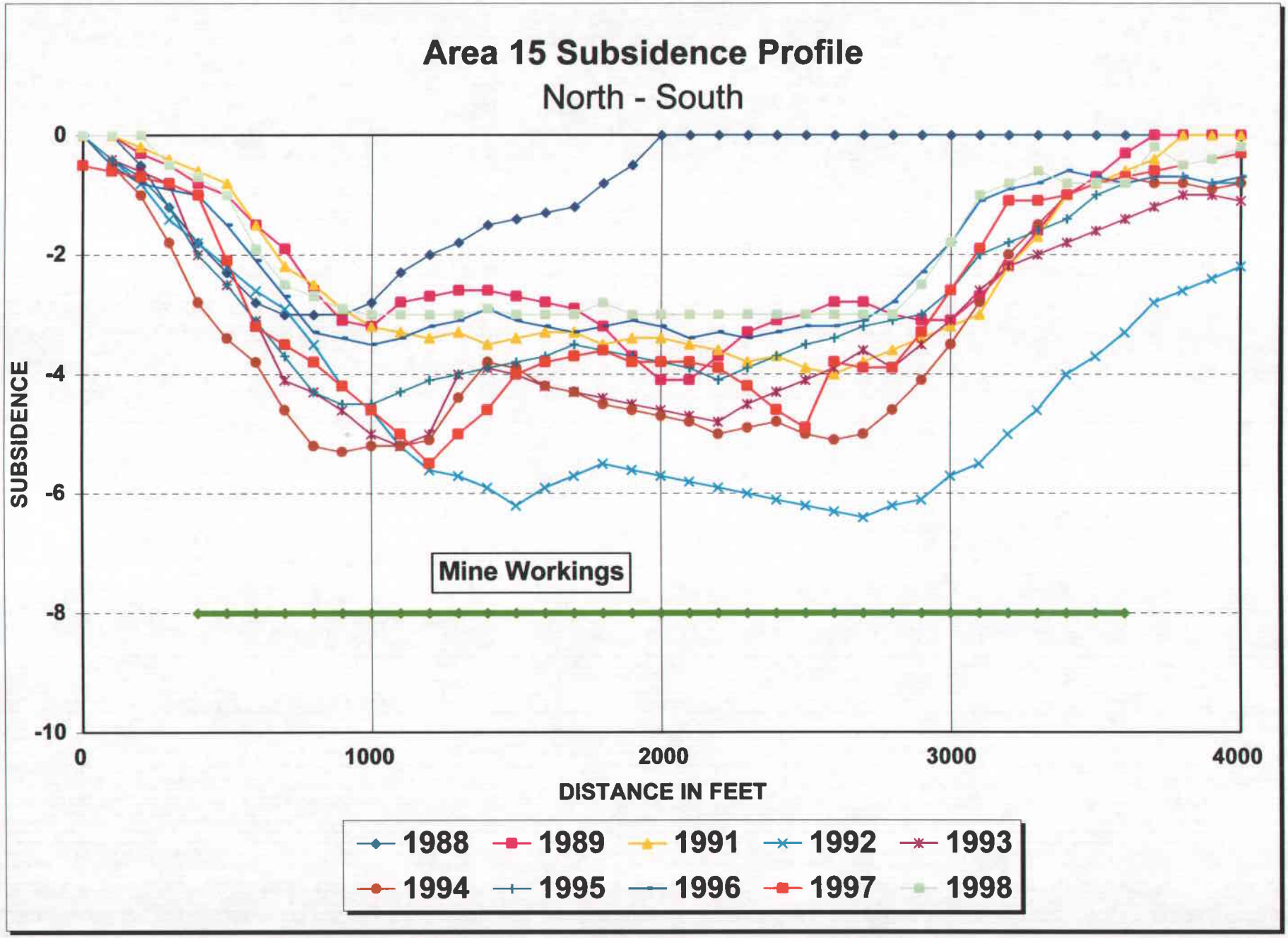

Area 15 Subsidence Profile
North - South
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
1000
2000
3000
4000
DISTANCE IN FEET
Mine Workings
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 50

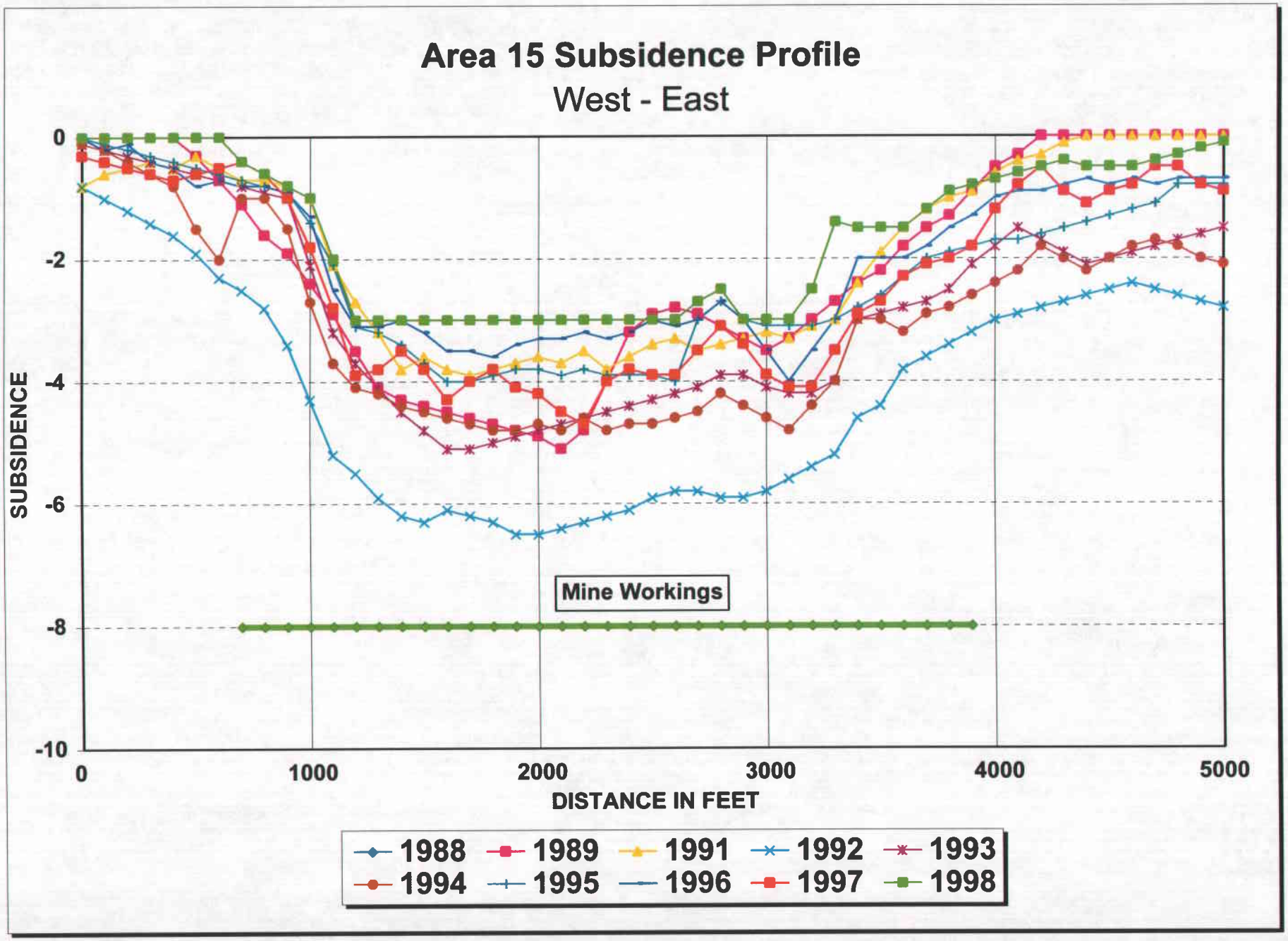

Area 15 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
1000
2000
3000
4000
5000
DISTANCE IN FEET
Mine Workings
1988
1989
1991
1992
1993
1994
1995
1996
1997
1998

Figure 51

Area 16

Cottonwood 8th Through 11th East Longwall Panels

Mining in Area 16 began in the 8th East panel in June of 1989, and ended in the 8th East panel in May, 1992 (Figure 52).

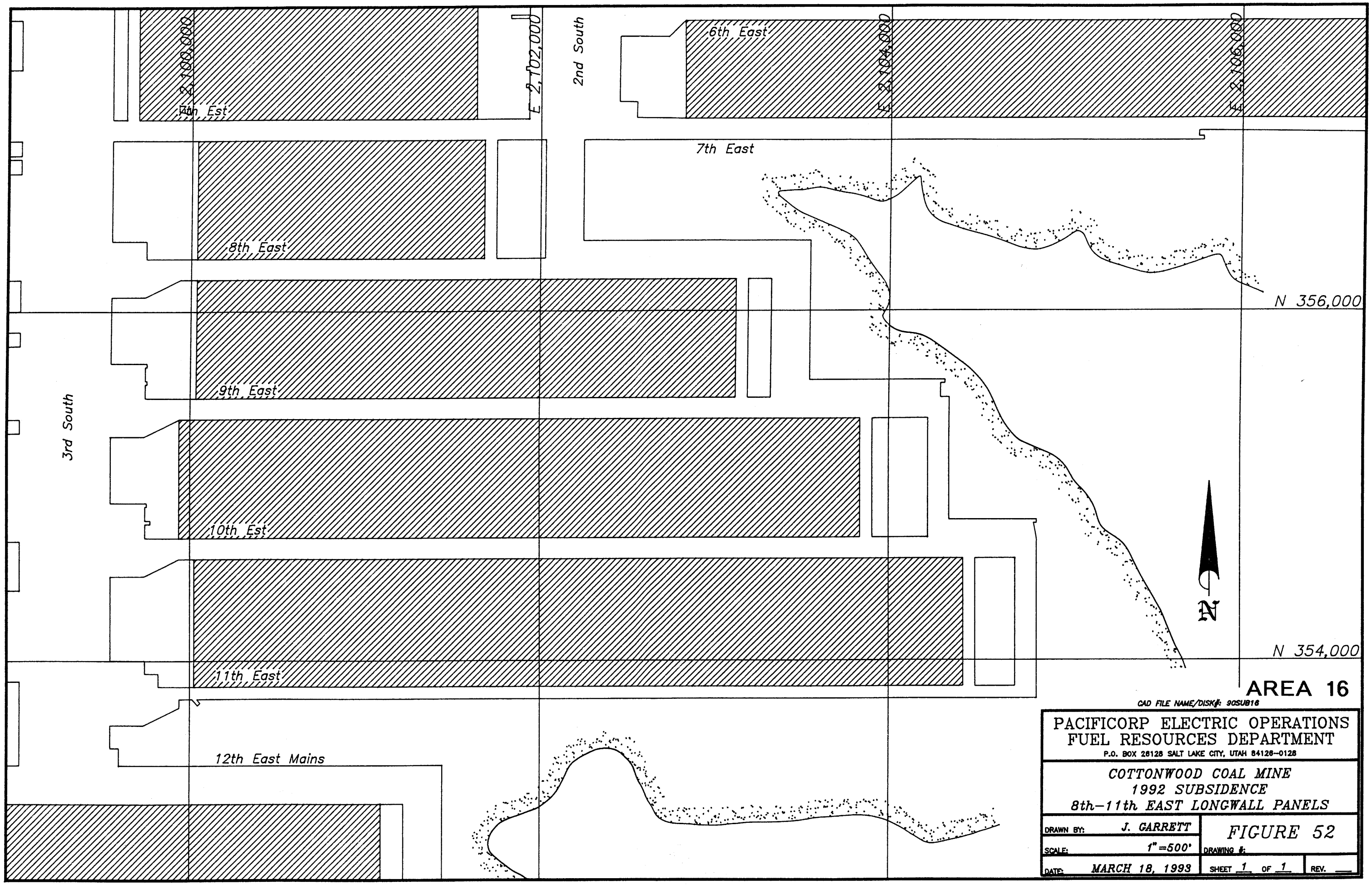
Topography in Area 16 is very similar to that of Area 14 with cliffs and very steep slopes covered by a few scattered pinon, juniper, mountain brush, and grasses. Overburden ranges from near 100 feet near outcrop to about 1800 feet.

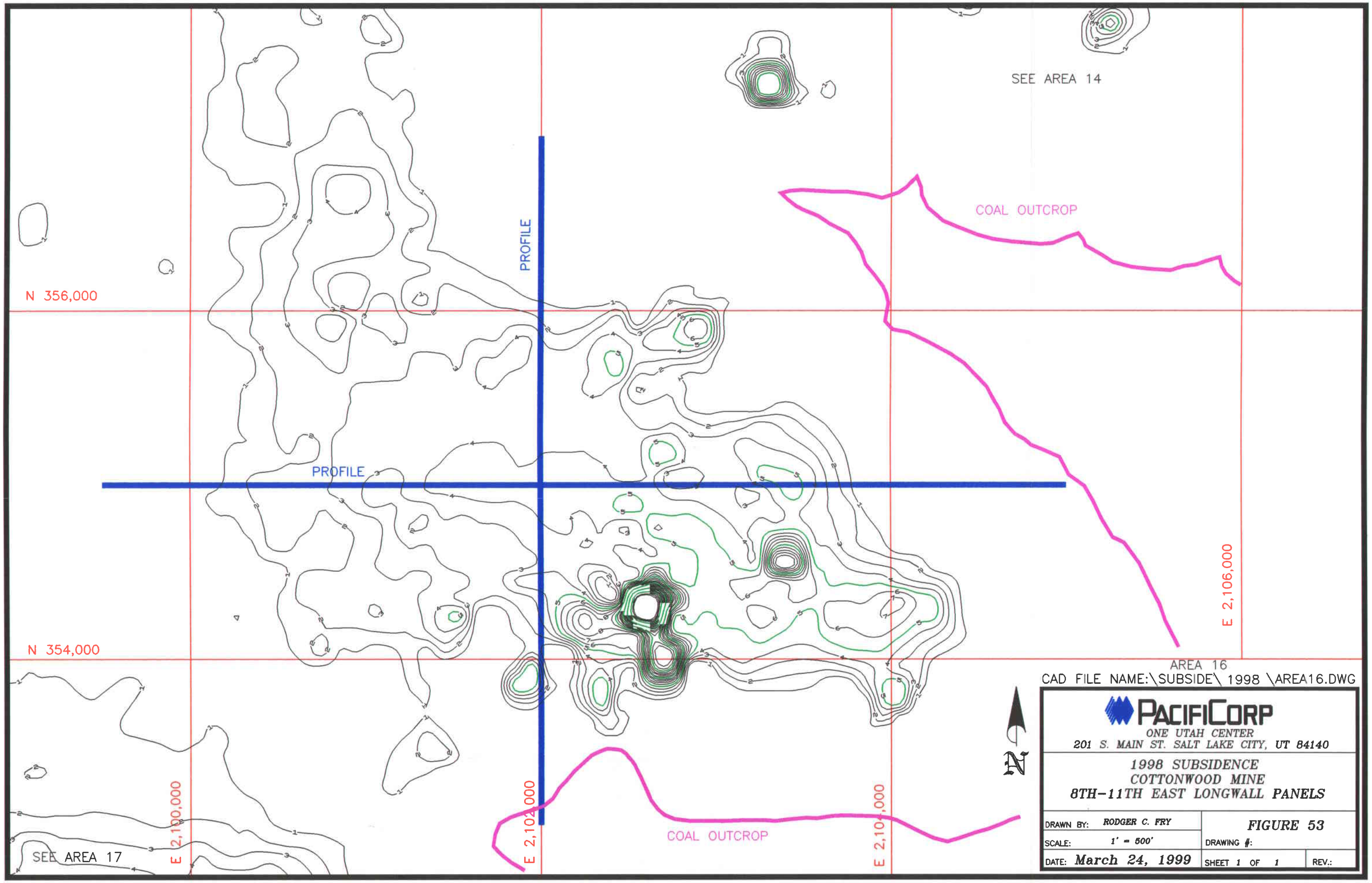
As with Area 14 cliff spalling has occurred in places and the resulting talus has accumulated on the slopes below the cliffs. No surface cracks have been observed to date.

Maximum subsidence observed in 1998 is similar to the 1997 measurement that exceeded five (5) feet and occurs over the 11th East panel where the overburden is less than 600 feet (Figure 53, 54, and 55). Figure 53 shows several "bulls-eyes" in the area of the Castlegate cliff which are in very steep and rugged areas. The photogrammetric method is not reliable in these areas and it is not felt that the areas have subsided to the extent shown on figure 53. This is supported by the fact that subsidence survey targets placed along the cliff in 1986 have shown no movement in recent years (see appendix).

The angle-of-draw was not calculated because the steep slopes and other adjacent workings make accurate measurement difficult.

There are no known springs in the area. Strata on both the surface and in underground mine workings are typically very dry; therefore, mining is not expected to affect the hydrology.


2,100,000
E 2,102,000
2nd South
6th East
E 2,104,000
E 2,106,000
7th Est
7th East
8th East
N 356,000
9th East
3rd South
10th Est
N
N 354,000
11th East
AREA 16
CAD FILE NAME/DISK#: 90SUB16
12th East Mains
PACIFICORP ELECTRIC OPERATIONS
FUEL RESOURCES DEPARTMENT
P.O. BOX 26128 SALT LAKE CITY, UTAH 84126-0128
COTTONWOOD COAL MINE
1992 SUBSIDENCE
8th-11th EAST LONGWALL PANELS
DRAWN BY: J. GARRETT
SCALE: 1"=500'
DATE: MARCH 18, 1993
FIGURE 52
DRAWING #:
SHEET 1 OF 1
REV.


SEE AREA 14
COAL OUTCROP
PROFILE
PROFILE
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N 354,000
E 2,100,000
E 2,102,000
E 2,104,000
E 2,106,000
COAL OUTCROP
SEE AREA 17
AREA 16
CAD FILE NAME:\SUBSIDE\ 1998 \AREA16.DWG
N
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
1998 SUBSIDENCE
COTTONWOOD MINE
8TH-11TH EAST LONGWALL PANELS
DRAWN BY: RODGER C. FRY
SCALE: 1' = 500'
DATE: March 24, 1999
FIGURE 53
DRAWING #:
SHEET 1 OF 1
REV.:

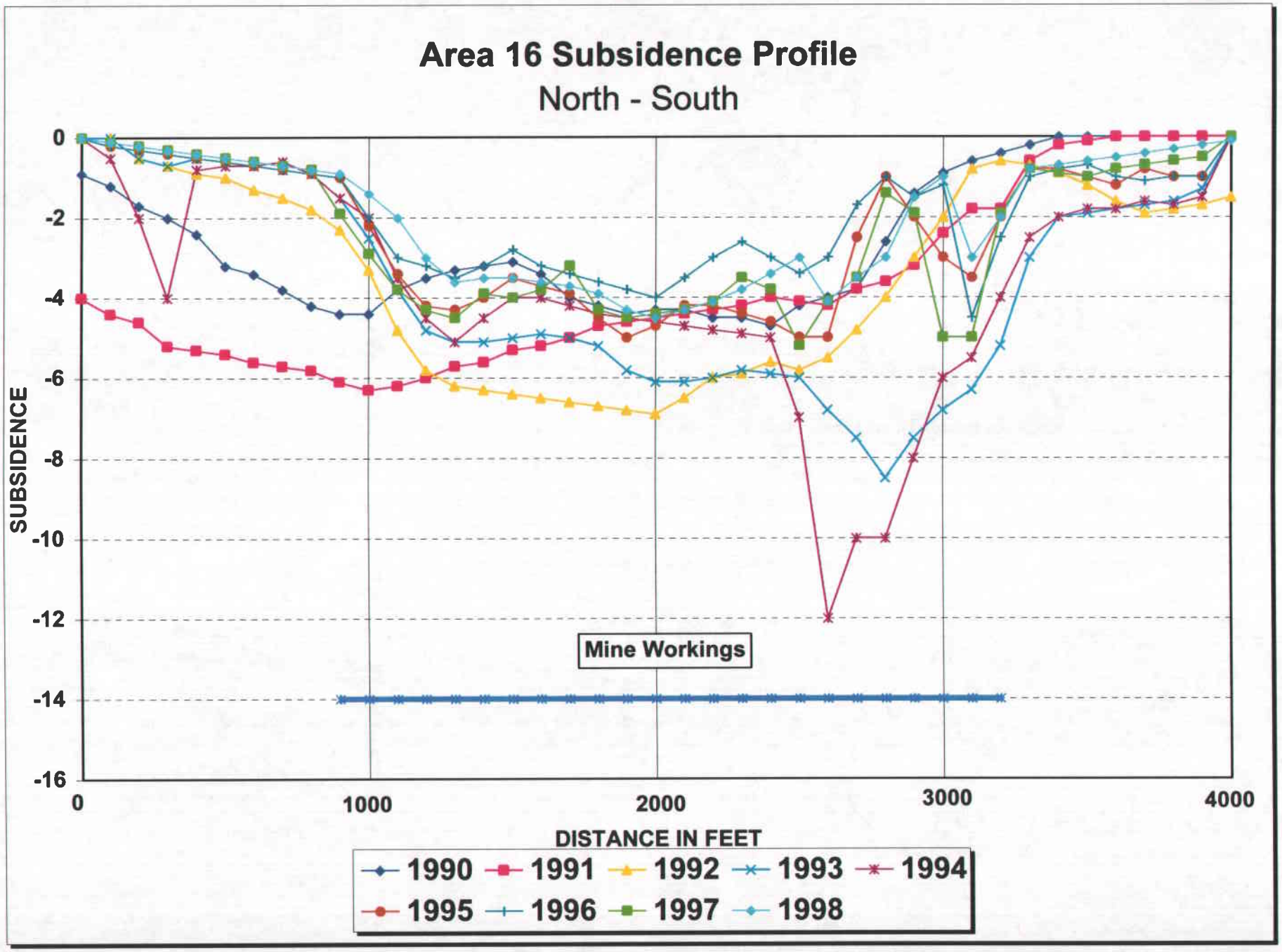

Area 16 Subsidence Profile
North - South
SUBSIDENCE
0
-2
-4
-6
-8
-10
-12
-14
-16
0
1000
2000
3000
4000
DISTANCE IN FEET
Mine Workings
1990
1991
1992
1993
1994
1995
1996
1997
1998

Figure 54

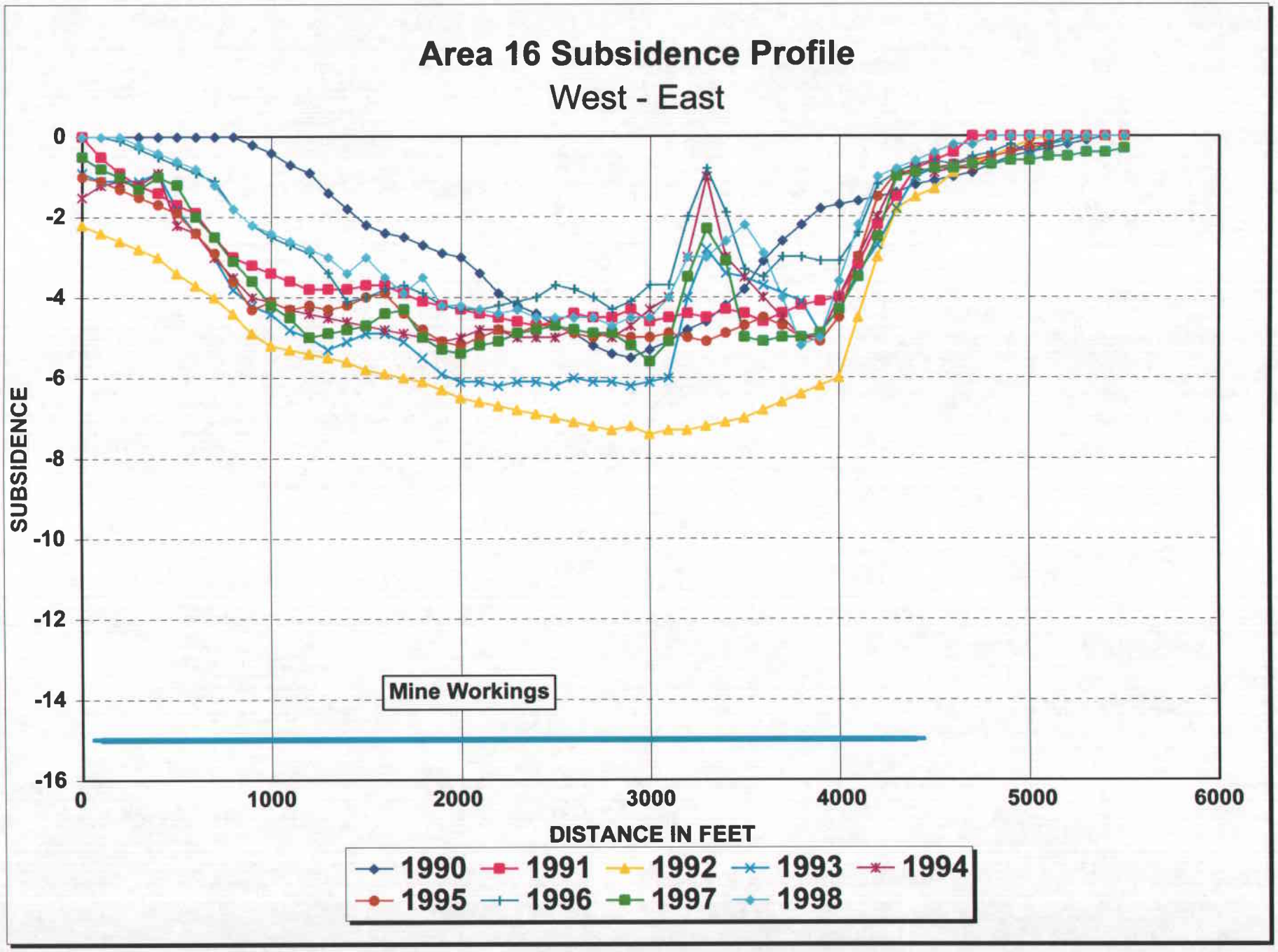

Area 16 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
-10
-12
-14
-16
0
1000
2000
3000
4000
5000
6000
DISTANCE IN FEET
Mine Workings
1990
1991
1992
1993
1994
1995
1996
1997
1998

Figure 55

Area 17

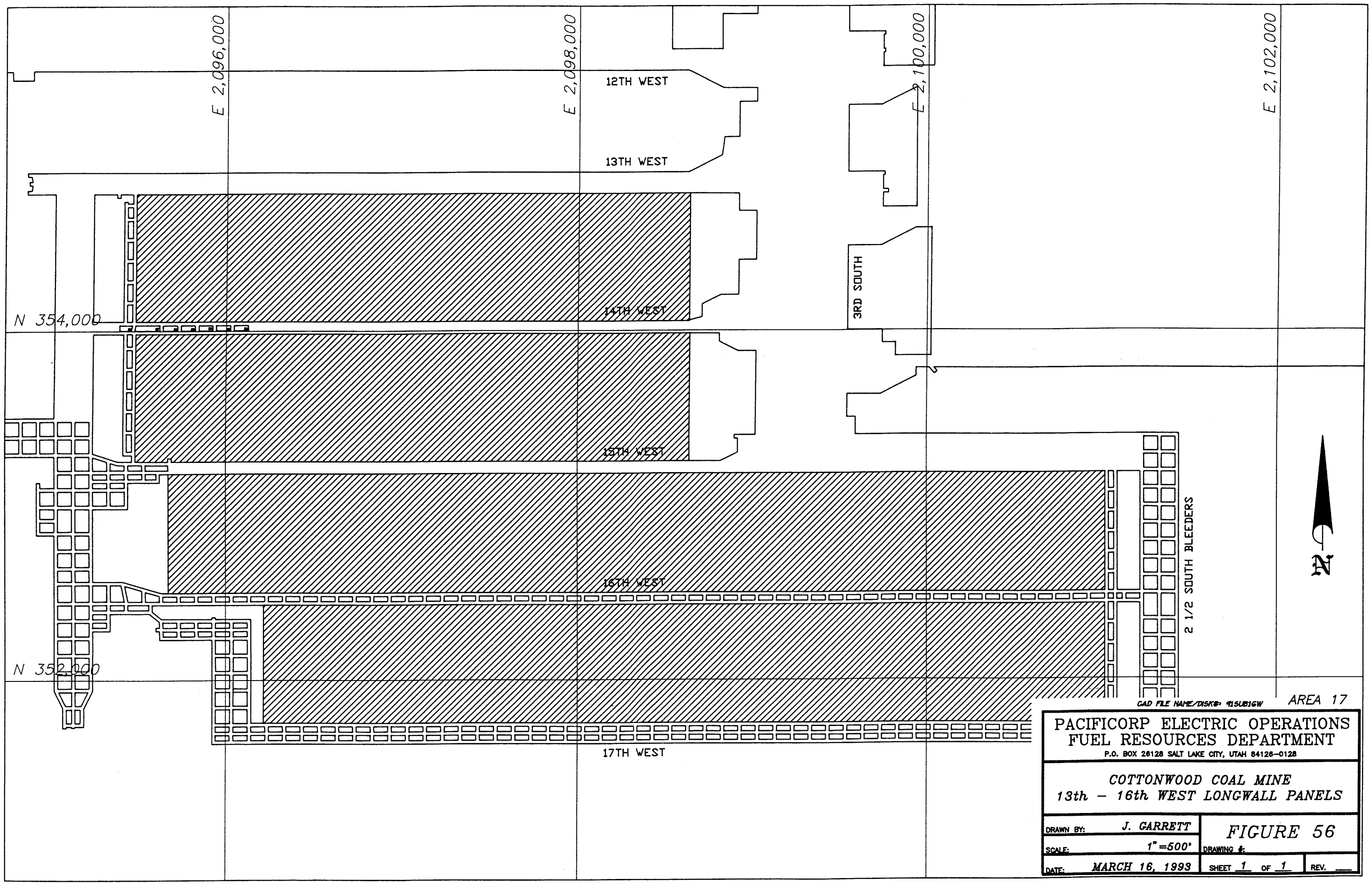
Cottonwood 13th Through 16th West Longwall Panels

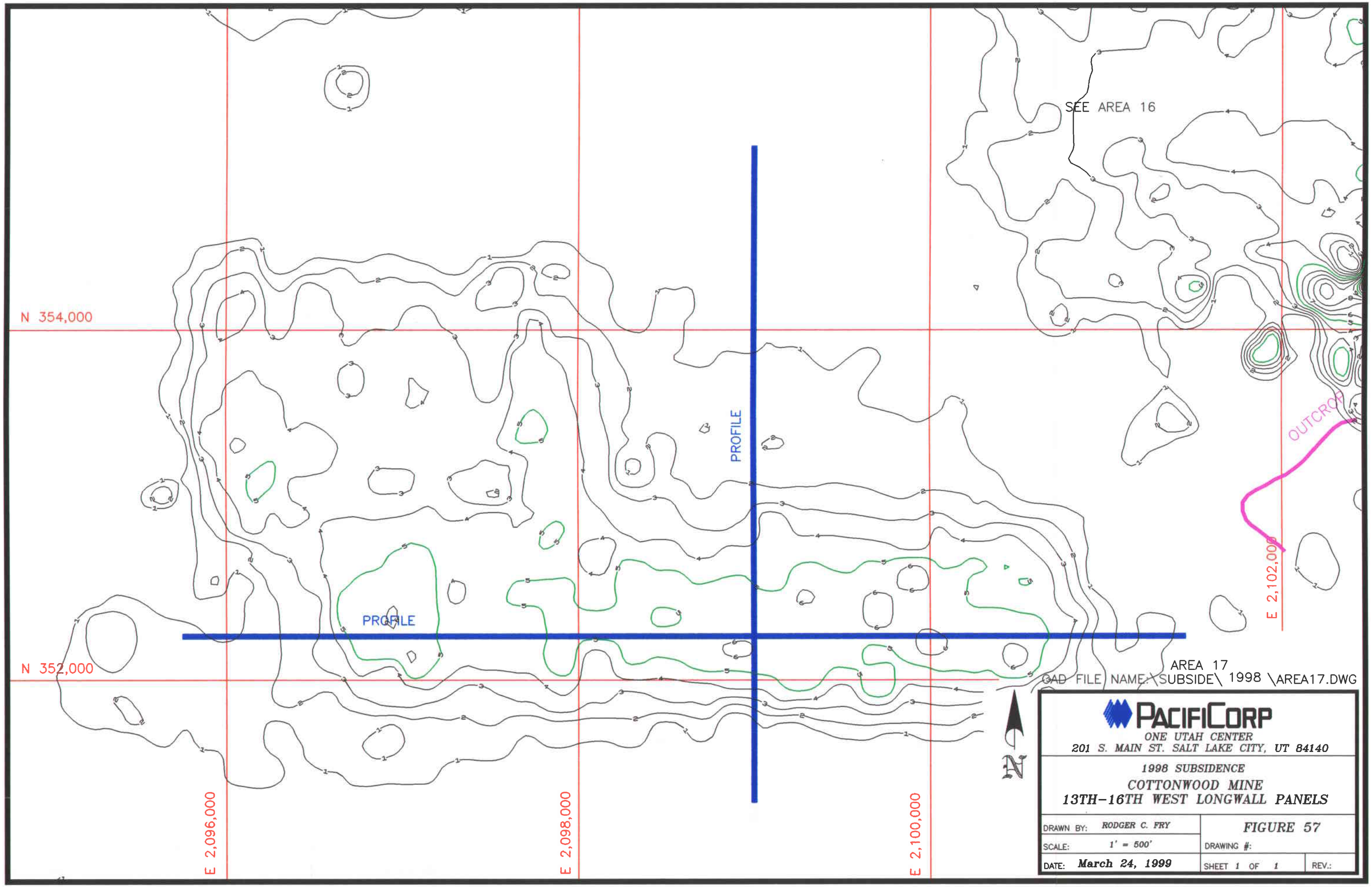
Mining in the 16th West longwall panel began in October 1990 and the panel was completed in March 1991. Mining in the area was finished in March, 1992 with the completion of the 13th West longwall panel (figure 56). The topography over these longwall panels is characterized by steep slopes covered with conifer and aspen trees which extend up from the cliffs which surround the east, south and west sides of the panels. The panels are covered by overburden ranging from 800 feet at both the west and east end of the panels to over 1,800 feet in the center of the panels.

The measured subsidence exceeds six (6) feet in an area above the 16th west panel which is slightly less than measured in 1997. The subsidence zone follows a narrow east-west trending trough centered above the two longer panels and then extends north above the 14th and 13th west longwall panels (figures 57, 58, and 59). No surface fractures have been observed in the area above theses longwall panels. Subsidence in this area has been stable for over six years.

On the south side of the subsidence zone, the angle of draw is less than 10 degrees.

No springs are located above this area and the strata is not saturated. Therefore, it is not likely that this subsidence will have any effect on the hydrology of the area.


E 2,096,000
E 2,098,000
E 2,100,000
E 2,102,000
12TH WEST
13TH WEST
14TH WEST
15TH WEST
16TH WEST
17TH WEST
3RD SOUTH
2 1/2 SOUTH BLEEDERS
N 354,000
N 352,000
N
GAD FILE NAME/DISK#: 41SUB1GW
AREA 17
PACIFICORP ELECTRIC OPERATIONS
FUEL RESOURCES DEPARTMENT
P.O. BOX 26128 SALT LAKE CITY, UTAH 84126-0128
COTTONWOOD COAL MINE
13th – 16th WEST LONGWALL PANELS
DRAWN BY: J. GARRETT
SCALE: 1" =500'
DATE: MARCH 16, 1993
FIGURE 56
DRAWING #:
SHEET 1 OF 1
REV.


SEE AREA 16
N 354,000
N 352,000
PROFILE
PROFILE
OUTCROP
E 2,096,000
E 2,098,000
E 2,100,000
E 2,102,000
N
AREA 17
CAD FILE NAME: \SUBSIDE\ 1998 \AREA17.DWG
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
1998 SUBSIDENCE
COTTONWOOD MINE
13TH-16TH WEST LONGWALL PANELS
DRAWN BY: RODGER C. FRY
SCALE: 1' = 500'
DATE: March 24, 1999
FIGURE 57
DRAWING #:
SHEET 1 OF 1
REV.:

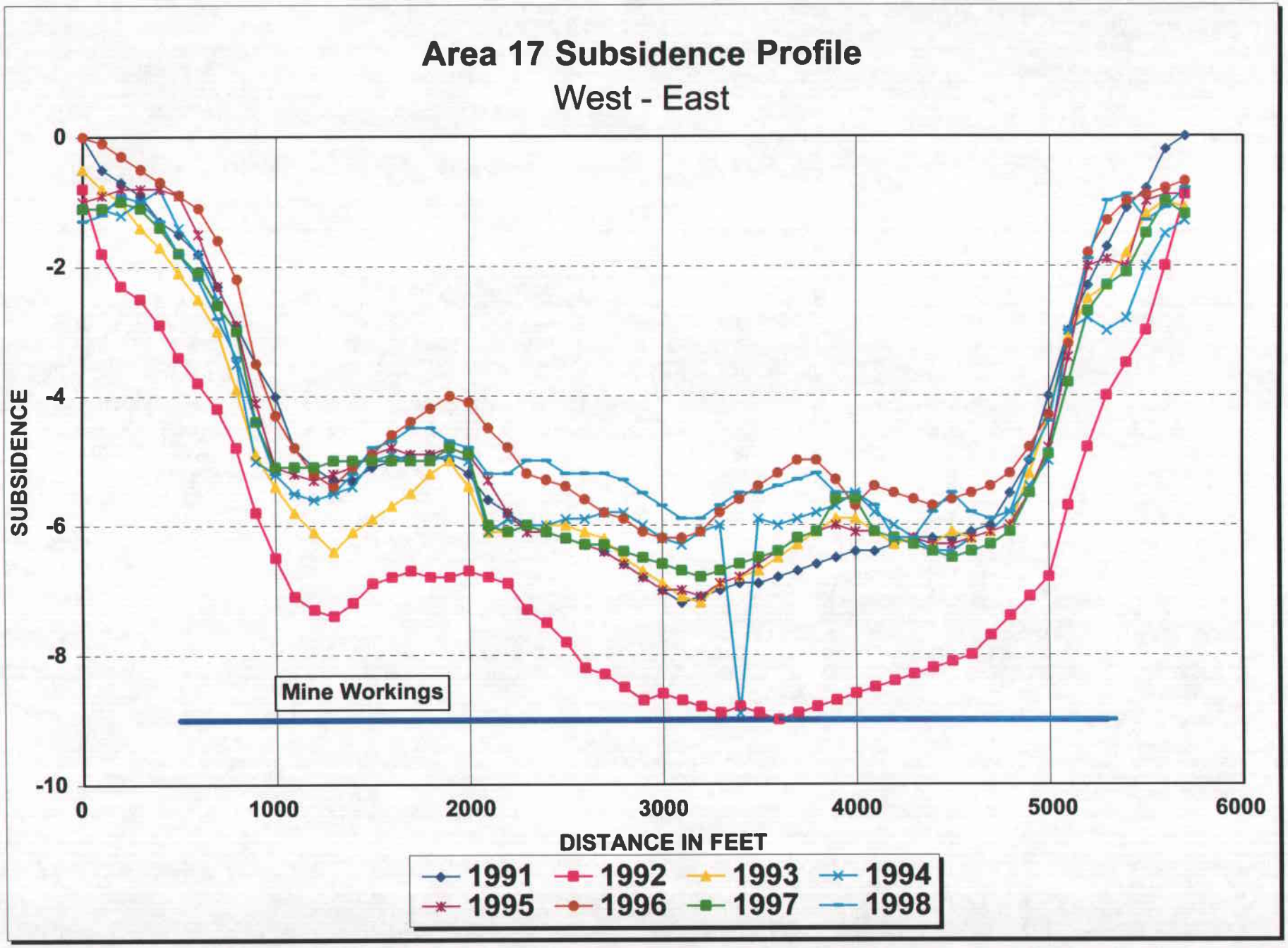

Area 17 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
1000
2000
3000
4000
5000
6000
DISTANCE IN FEET
Mine Workings
1991
1992
1993
1994
1995
1996
1997
1998

Figure 58

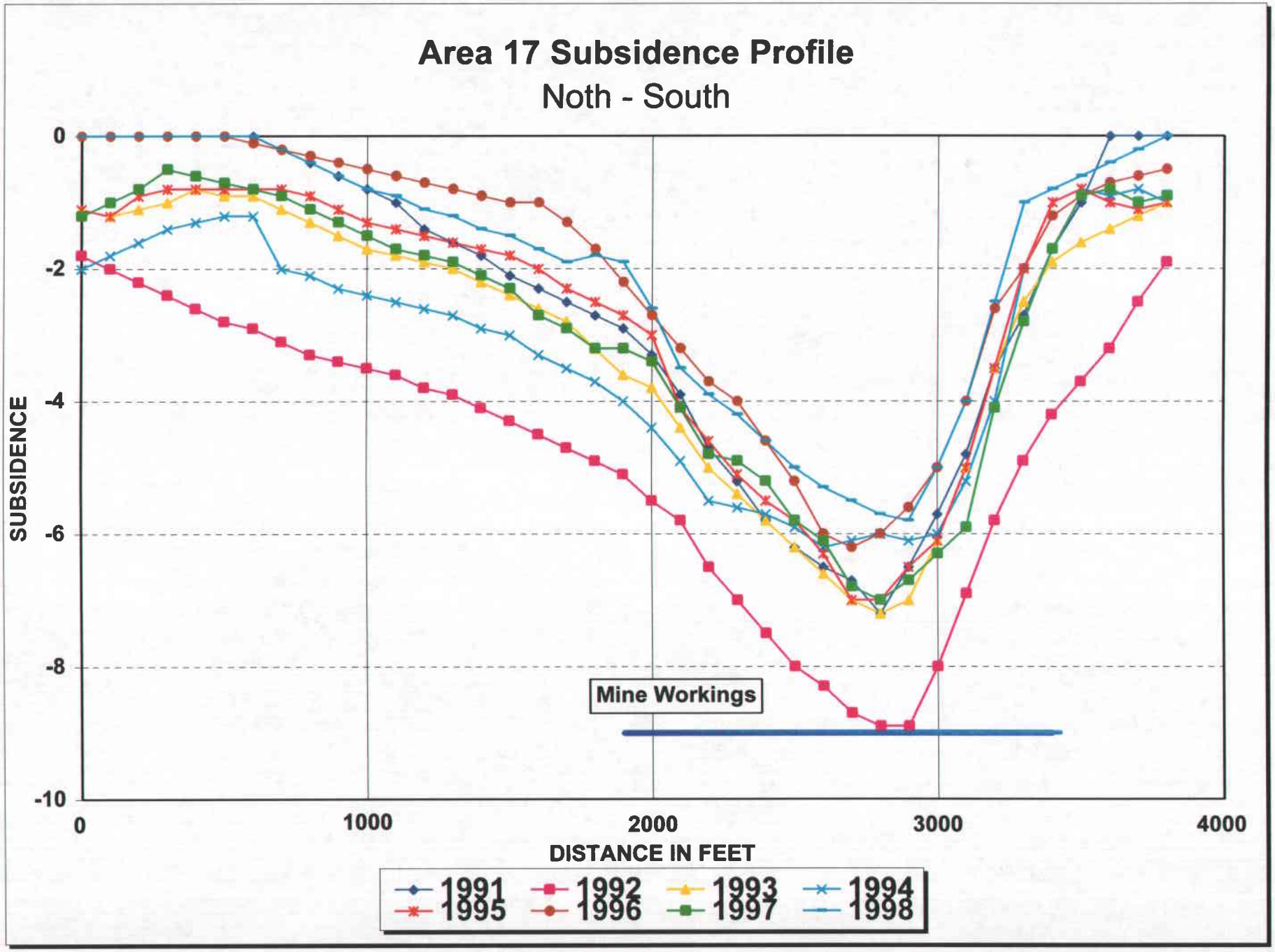

Area 17 Subsidence Profile
Noth - South
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
1000
2000
3000
4000
DISTANCE IN FEET
Mine Workings
1991
1992
1993
1994
1995
1996
1997
1998

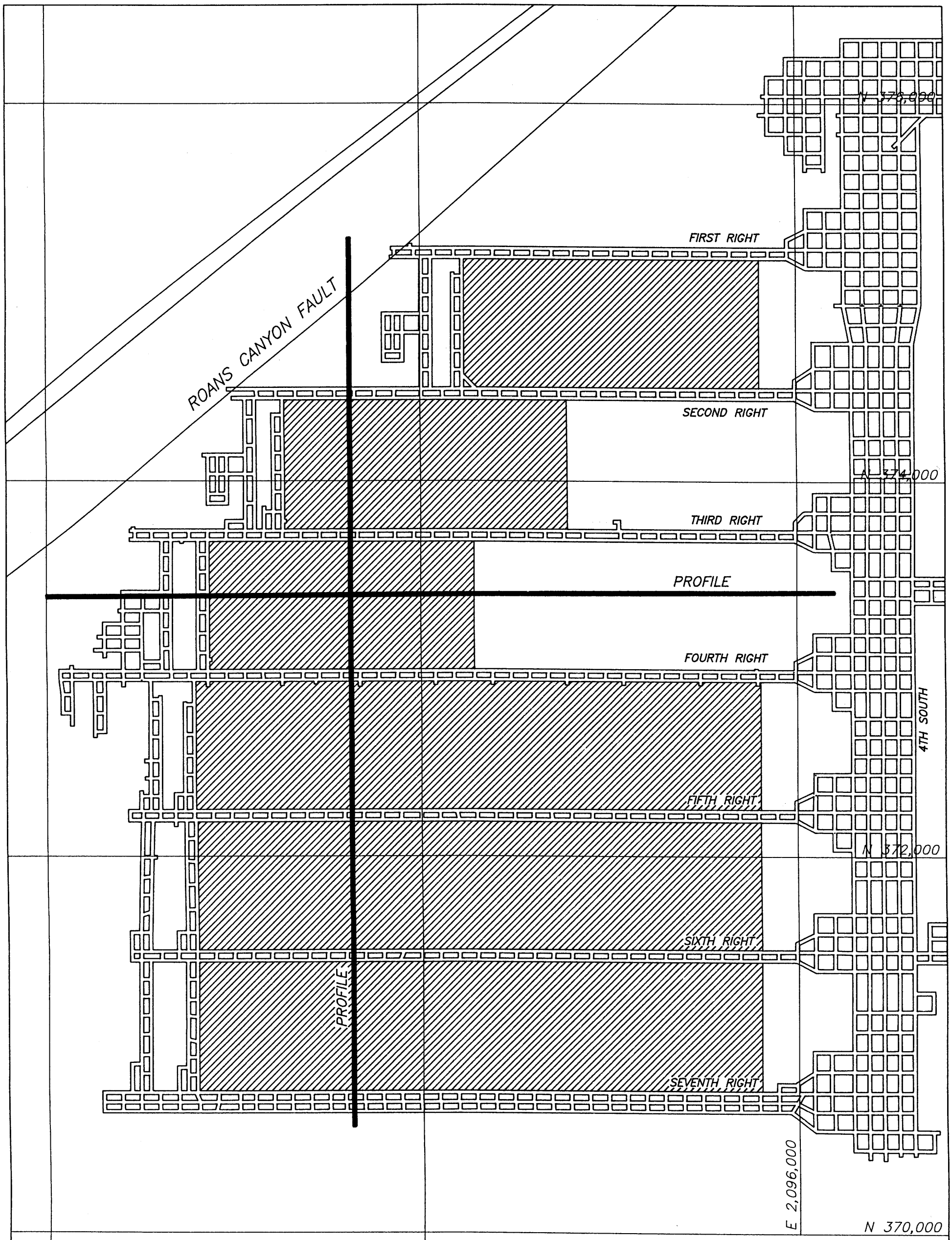
Figure 59

Area 18

Deer Creek Mine 2nd through 7th Right Longwall Panels

Longwall mining in this area was completed in May, 1992 with the extraction of six adjacent longwall panels (figure 60). The 3rd and 4th Right panels were terminated short of the entire panel due to geologic complications. The land surface in the area of these panels contains steep slopes covered by conifer and aspen trees, and sagebrush. The longwall panels have overburden ranging from 1,800 feet on the west end of the panels to 2,000 feet on the east side of the panels.

Subsidence in this area has reached a maximum of nearly seven (7) feet, which is slightly less than measured in 1997 (Figures 61, 62, and 63). The subsidence zone is a broad trough running in a north - south direction. This area is overlain by several springs. Monitoring of these springs has shown no change in the quality or quantity of water discharged from them (see appendix and the 1998 Hydrologic Monitoring report).



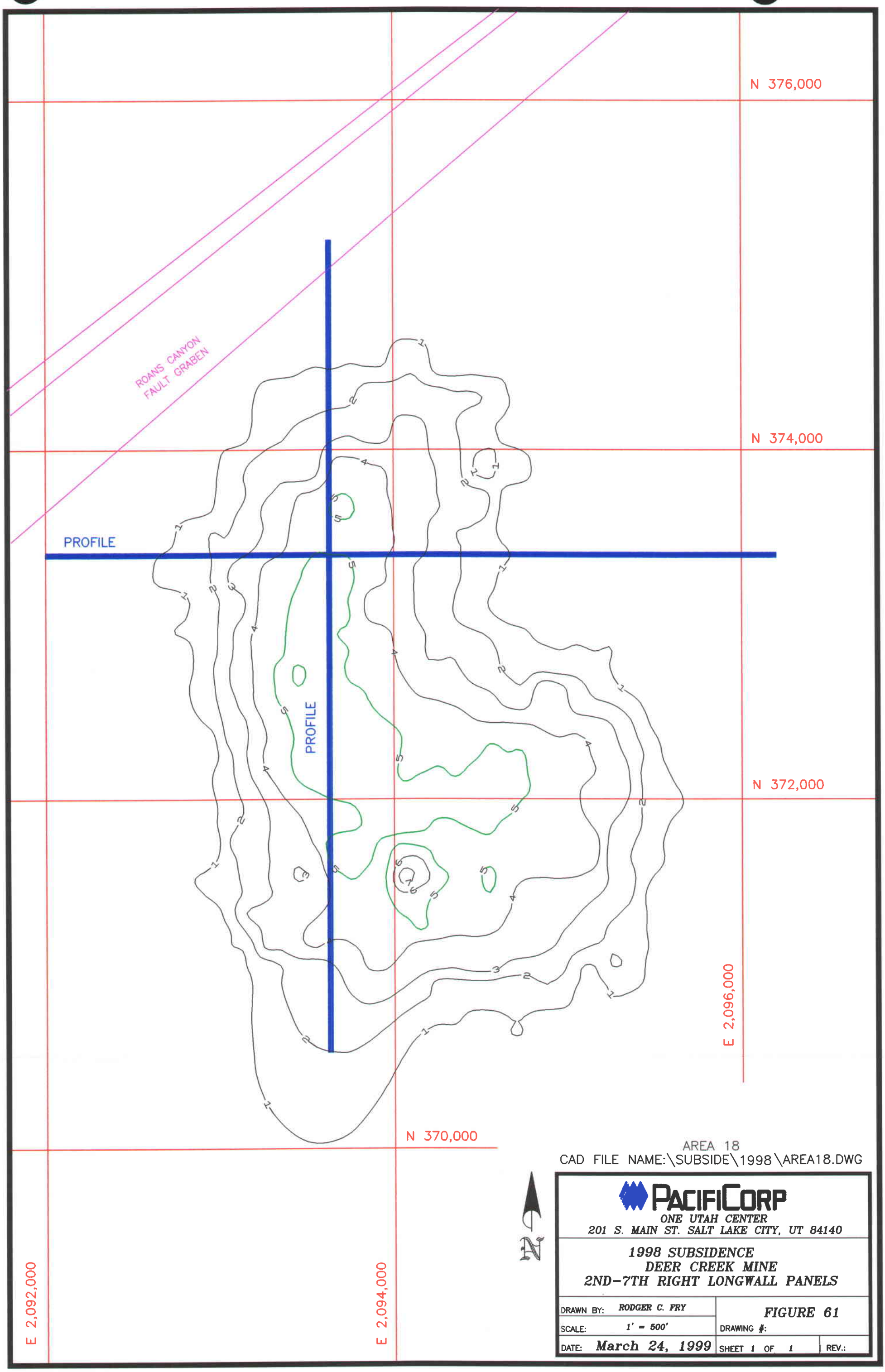
CAD FILE NAME/DISK#: 91SUB7R

AREA 18

PACIFICORP ELECTRIC OPERATIONS
FUEL RESOURCES DEPARTMENT
P.O. BOX 26128 SALT LAKE CITY, UTAH 84126-0128

DEER CREEK MINE
2nd-7th RIGHT LONGWALL PANELS

DRAWN BY: J. GARRETT	FIGURE 60	
SCALE: 1"=500'	DRAWING #:	
DATE: MARCH 16, 1993	SHEET 1 OF 1	REV.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N 374,000
N 372,000
N 370,000
E 2,092,000
E 2,094,000
E 2,096,000
ROANS CANYON
FAULT GRABEN
PROFILE
PROFILE
AREA 18
CAD FILE NAME:\SUBSIDE\1998\AREA18.DWG
N
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
1998 SUBSIDENCE
DEER CREEK MINE
2ND-7TH RIGHT LONGWALL PANELS
DRAWN BY: RODGER C. FRY
SCALE: 1' = 500'
DATE: March 24, 1999
FIGURE 61
DRAWING #:
SHEET 1 OF 1
REV.:

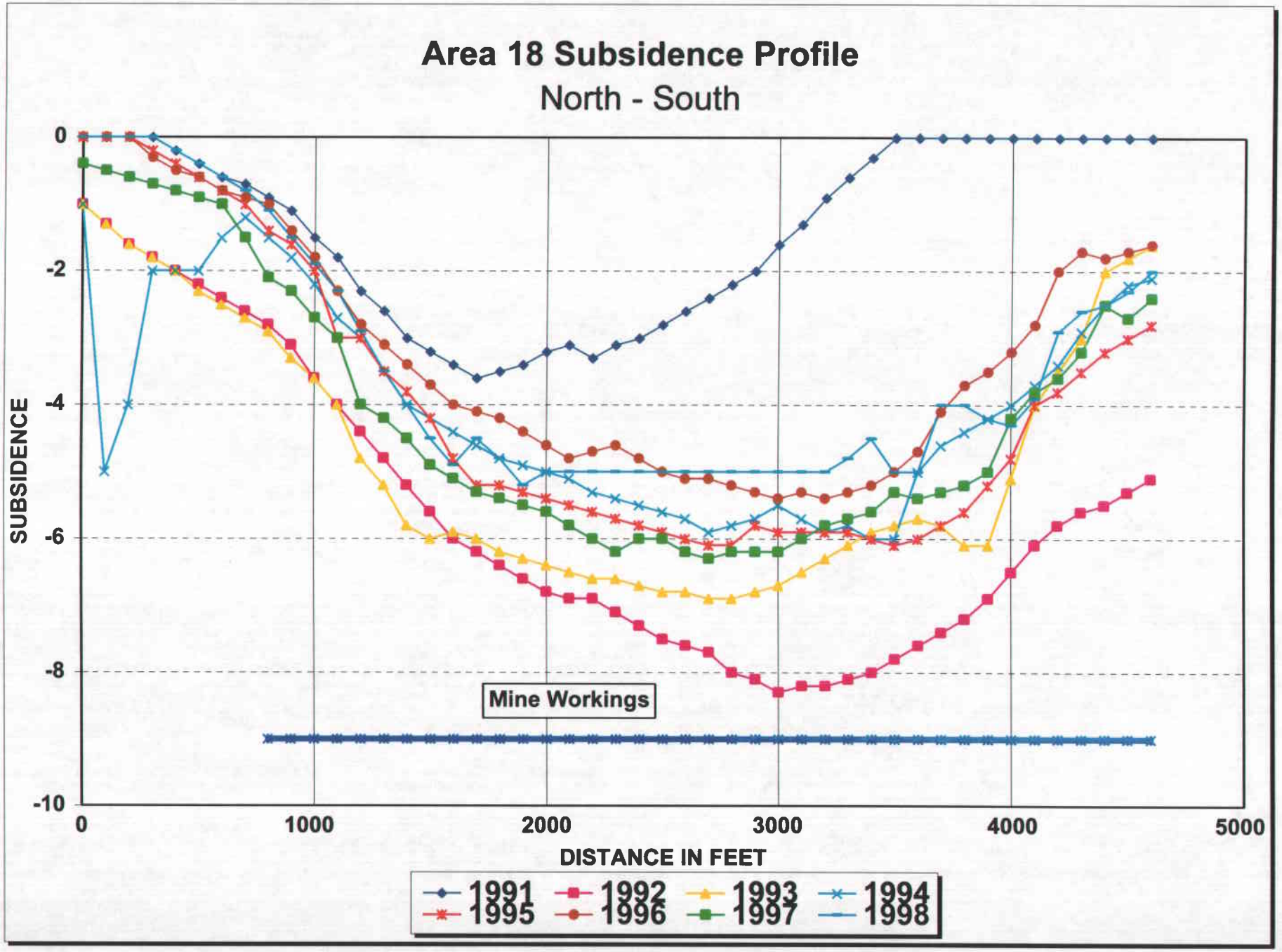

Area 18 Subsidence Profile
North - South
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
1000
2000
3000
4000
5000
DISTANCE IN FEET
Mine Workings
1991
1992
1993
1994
1995
1996
1997
1998

Figure 62

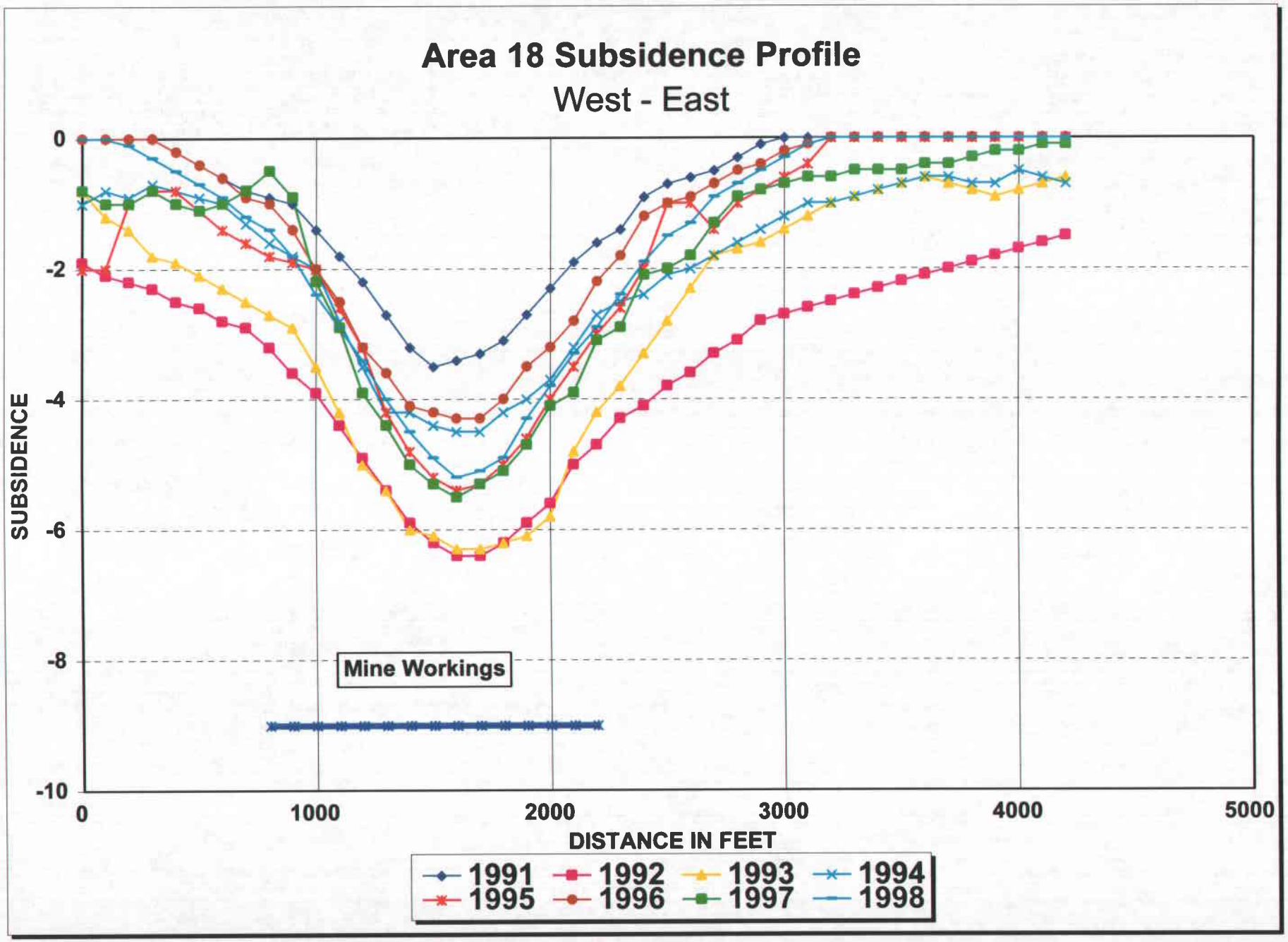

Area 18 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
1000
2000
3000
4000
5000
DISTANCE IN FEET
Mine Workings
1991
1992
1993
1994
1995
1996
1997
1998

Figure 63

Area 19

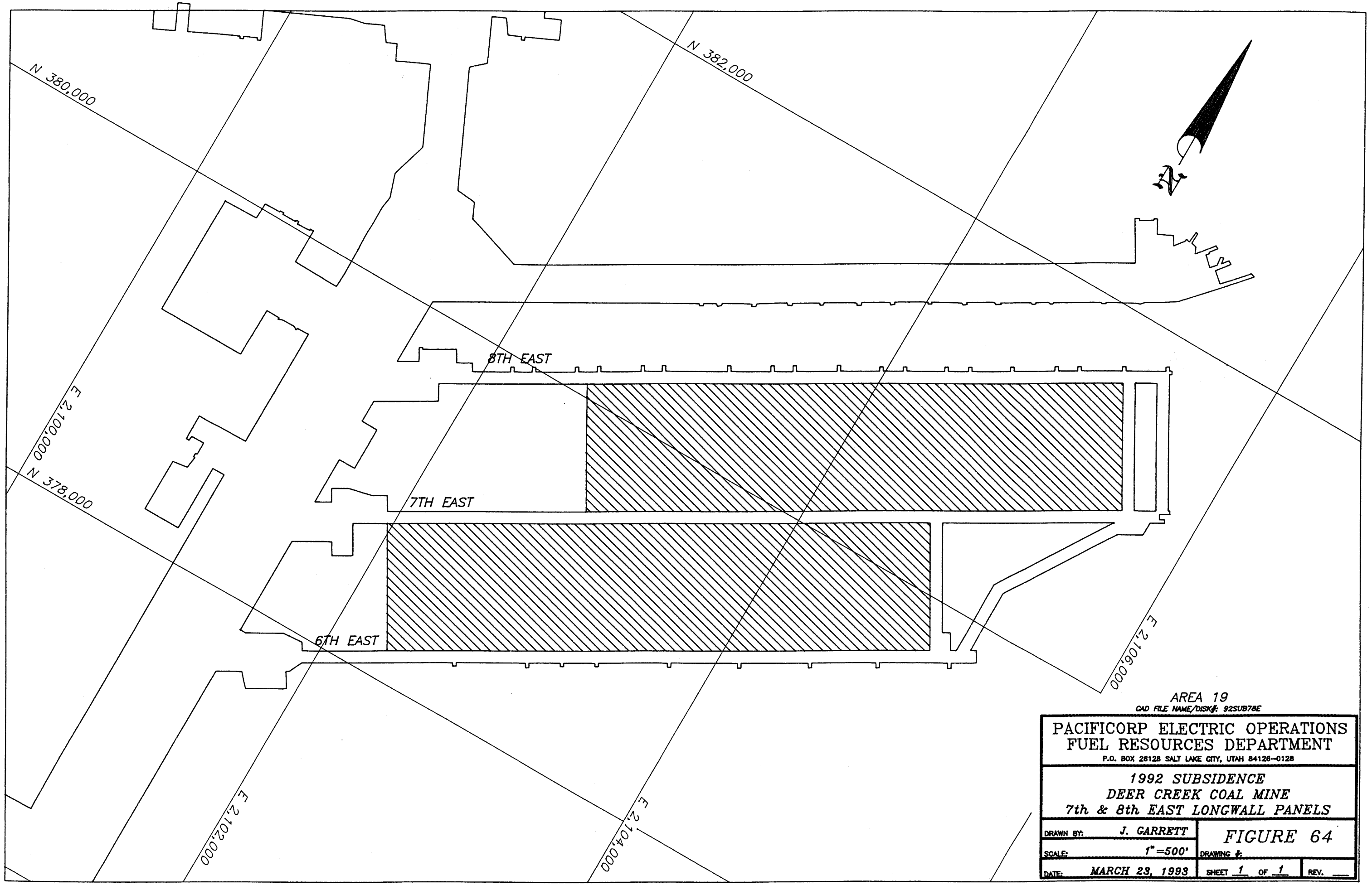
Deer Creek 7th and 8th East Longwall Panels off 3rd North

Mining in the 7th East Longwall Panel began in May, 1992 and by January 1993 mining was completed in the 8th East Longwall Panel (Figure 64).

The land surface above these two panels is very rugged. The longwall panels are located beneath a ridge located between the left and right forks of Meetinghouse Canyon. The area is covered by sagebrush on the south facing slopes and dense stands of spruce trees on the north facing slopes. The overburden in the area of these panels ranges from 400 feet on the north to over 1,800 feet on the south.

Subsidence in this area has increased from slightly over one foot in 1992 to over four feet in 1993 but has been stable between 1993 and 1998 (Figures 65 and 66).

This area is overlain by a few springs. Monitoring of these springs has shown no change in the quality or quantity of water discharged from them (see appendix and the 1998 Hydrologic Monitoring Report).



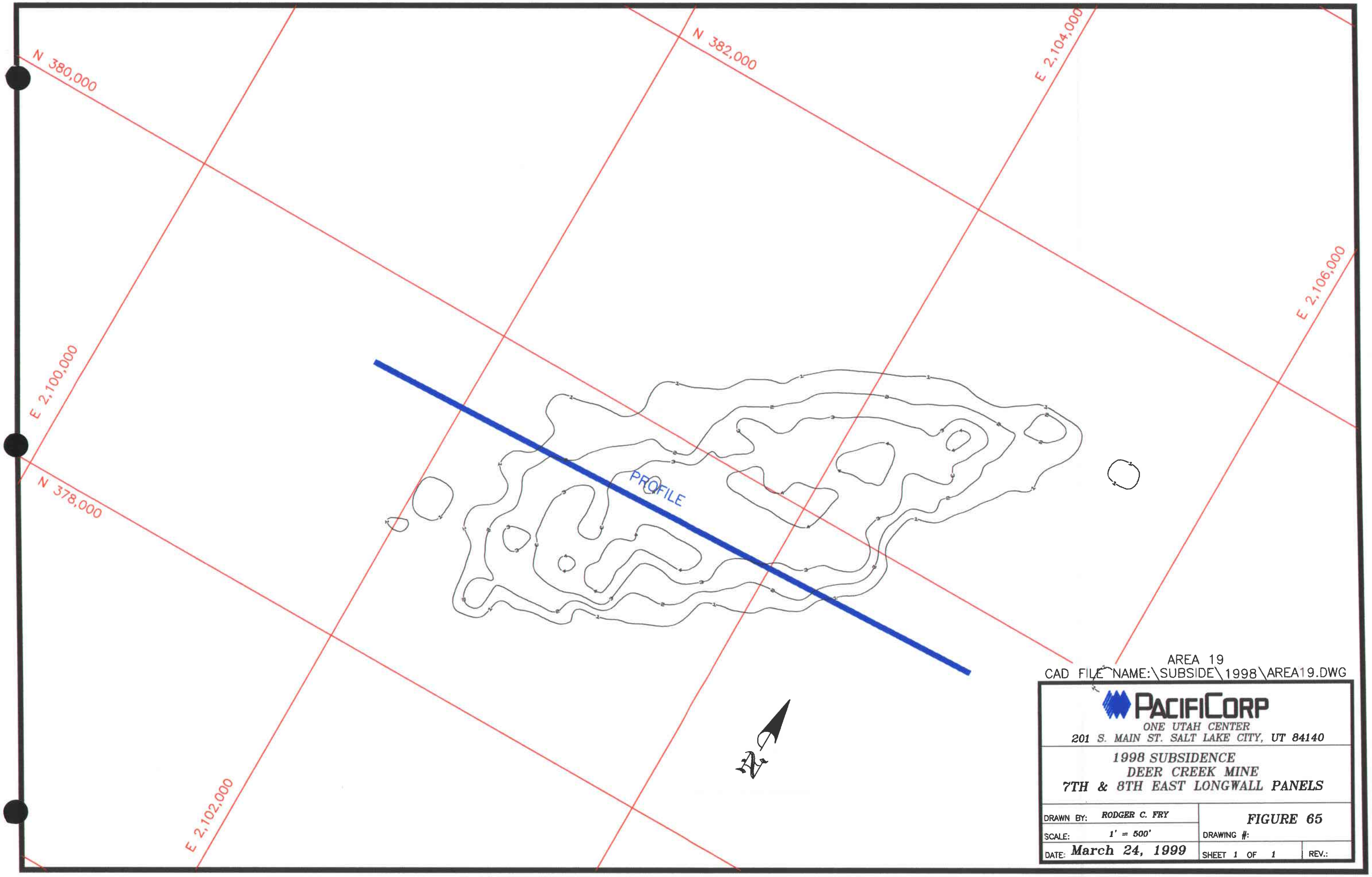
AREA 19

CAD FILE NAME/DISK#: 92SUB78E

PACIFICORP ELECTRIC OPERATIONS
FUEL RESOURCES DEPARTMENT
P.O. BOX 26128 SALT LAKE CITY, UTAH 84126-0128

1992 SUBSIDENCE
DEER CREEK COAL MINE
7th & 8th EAST LONGWALL PANELS

DRAWN BY: J. GARRETT	FIGURE 64	
SCALE: 1"=500'	DRAWING #:	
DATE: MARCH 23, 1993	SHEET 1 OF 1	REV. ___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E 2,106,000
E 2,100,000
N 378,000
E 2,102,000
PROFILE
AREA 19
CAD FILE NAME:\SUBSIDE\1998\AREA19.DWG
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
1998 SUBSIDENCE
DEER CREEK MINE
7TH & 8TH EAST LONGWALL PANELS
DRAWN BY: RODGER C. FRY
SCALE: 1' = 500'
DATE: March 24, 1999
FIGURE 65
DRAWING #:
SHEET 1 OF 1
REV.:

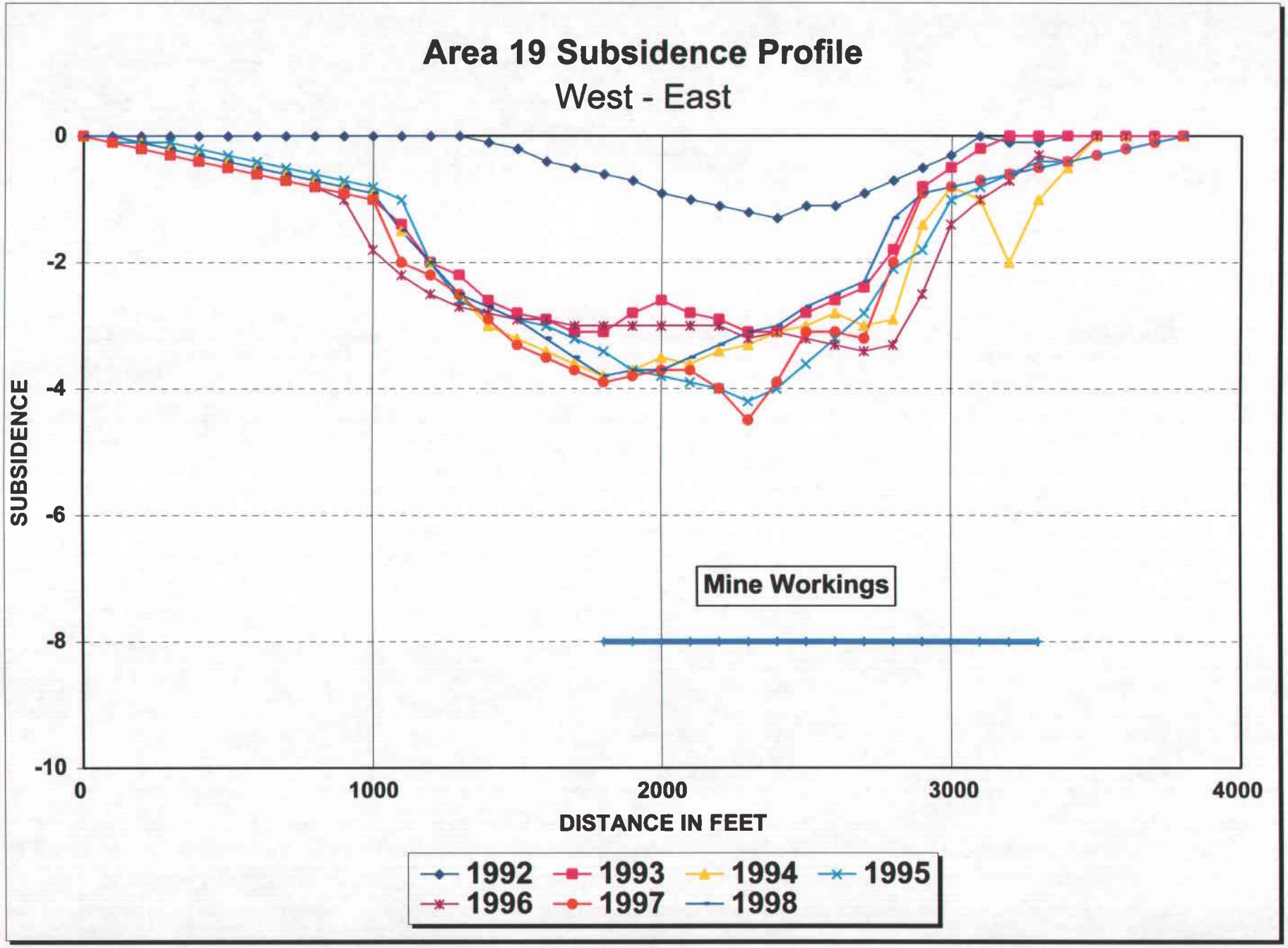

Area 19 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
1000
2000
3000
4000
DISTANCE IN FEET
Mine Workings
1992
1993
1994
1995
1996
1997
1998

Figure 66

Area 20

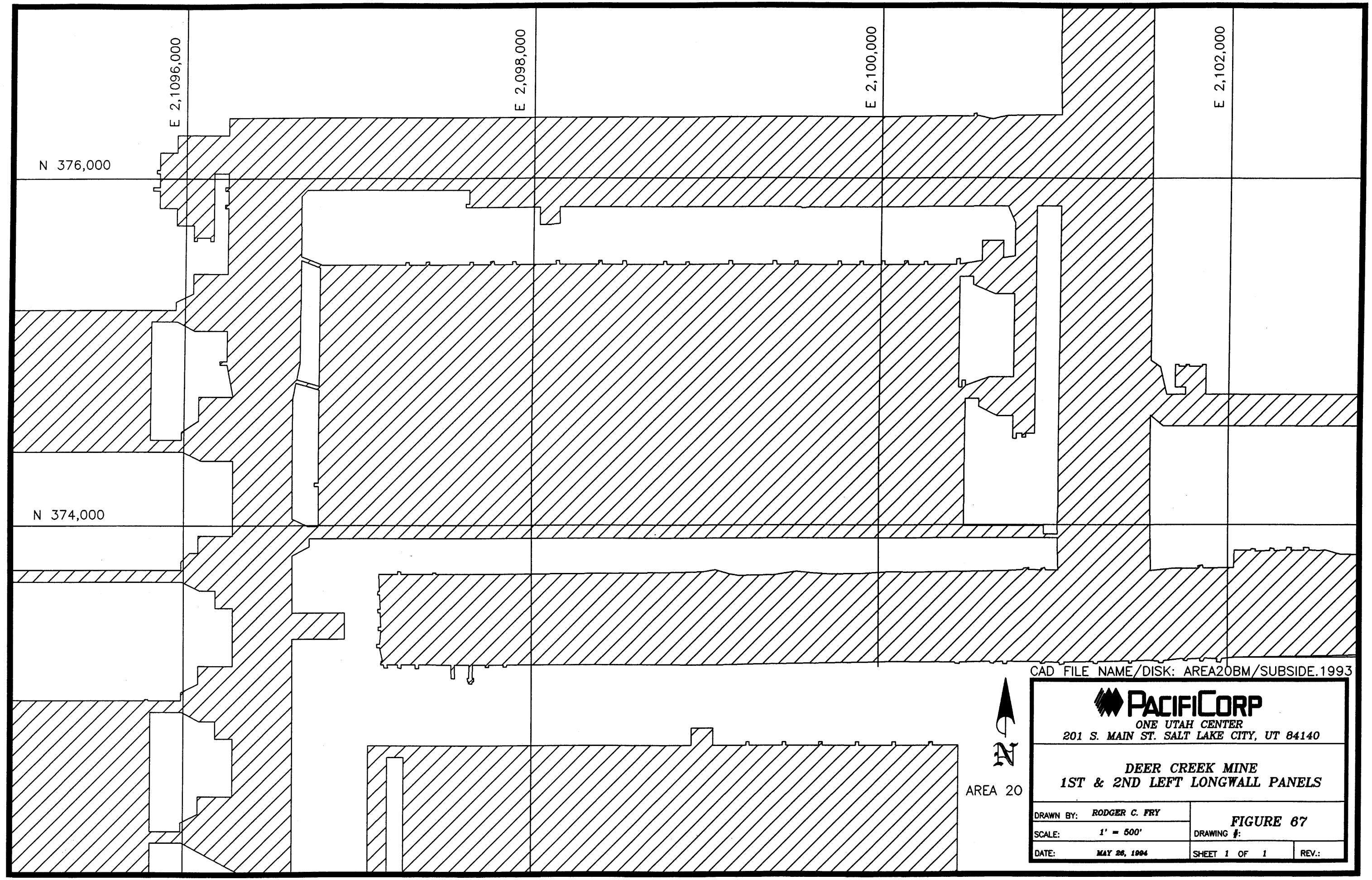
Deer Creek 1st & 2nd Left Longwall Panels off 3 ½ South

Mining in the 2nd Left Longwall Panel began in February 1993 and was completed in June 1993. Mining then started in the 1st Left Longwall Panel in July 1993 and was completed in November of 1993 (Figure 67).

These longwall panels are overlain by moderately steep slopes that are heavily covered with aspen and spruce trees. The overburden above these panels range from 1,400 feet at their east end to over 2,000 feet above their west end.

The monitoring detected a maximum of slightly over four (4) feet of subsidence in 1998 which is similar to that measured in 1997 but less than the maximum of slightly over six (6) feet of subsidence above the 2nd Left Longwall Panel measured in 1996. The 1996 reading showed an increase from the maximum of slightly over four feet that was measured in 1995 and a foot greater than that measured in 1994 which showed a maximum of five feet of subsidence (Figures 68 and 69). It is believed that subsidence in this area is substantially complete. All of the subsidence detected falls within the bounds of the longwall area. Therefore; the angle of draw in this area is considered to be steeper than 10°.

These longwall panels are overlain by several springs. Monitoring of the springs revealed no impacts due to the subsidence.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E 2,098,000
E 2,100,000
E 2,102,000
N 376,000
N 374,000
AREA 20
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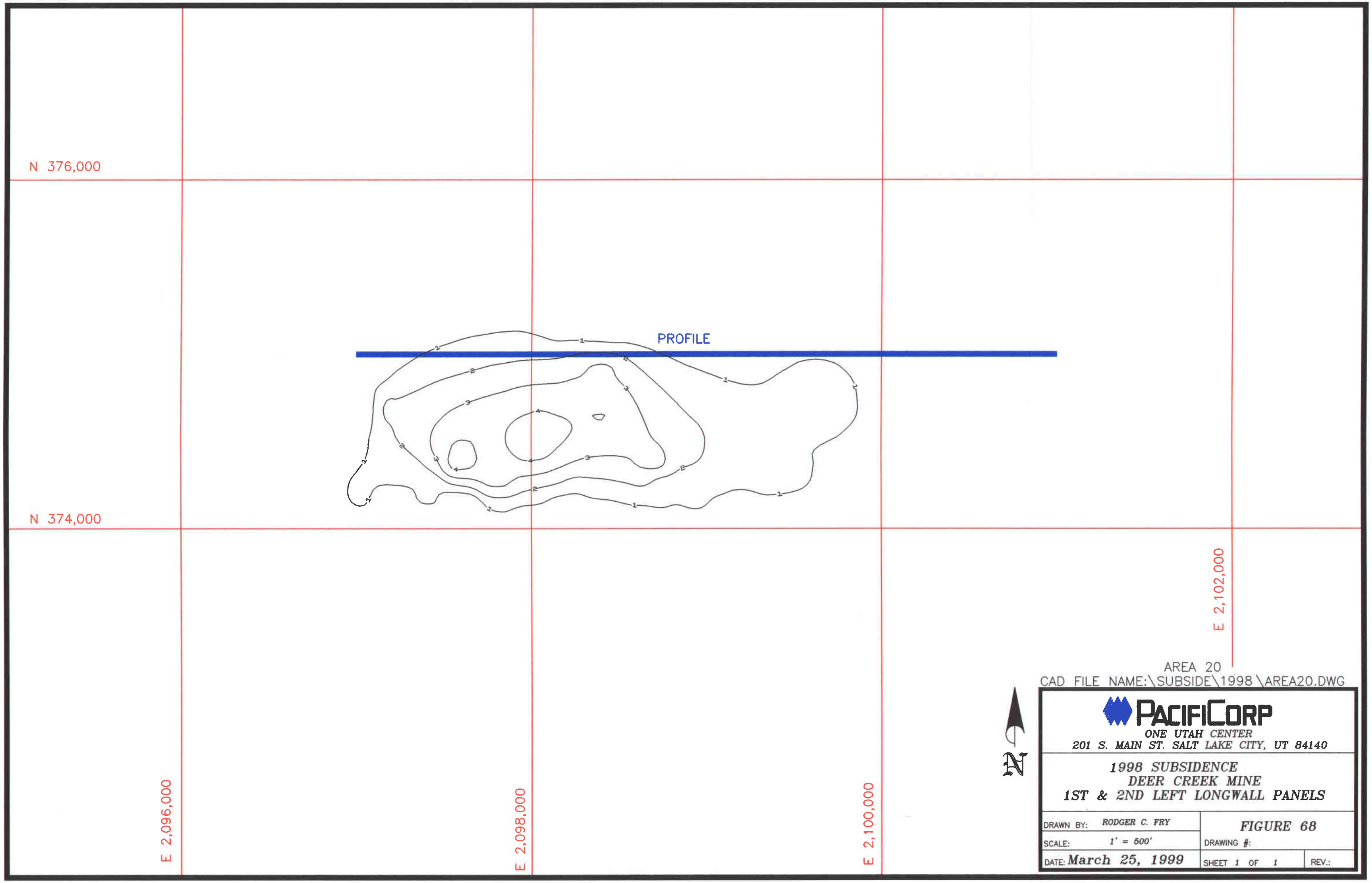
CAD FILE NAME/DISK: AREA20BM/SUBSIDE.1993
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
DEER CREEK MINE
1ST & 2ND LEFT LONGWALL PANELS
DRAWN BY: RODGER C. FRY
SCALE: 1' = 500'
DATE: MAY 26, 1994
FIGURE 67
DRAWING #:
SHEET 1 OF 1
REV.: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N 374,000
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E 2,098,000
E 2,100,000
E 2,102,000
PROFILE
AREA 20
CAD FILE NAME:\SUBSIDE\1998\AREA20.DWG
N
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
1998 SUBSIDENCE
DEER CREEK MINE
1ST & 2ND LEFT LONGWALL PANELS
DRAWN BY: RODGER C. FRY
SCALE: 1' = 500'
DATE: March 25, 1999
FIGURE 68
DRAWING #:
SHEET 1 OF 1
REV.:

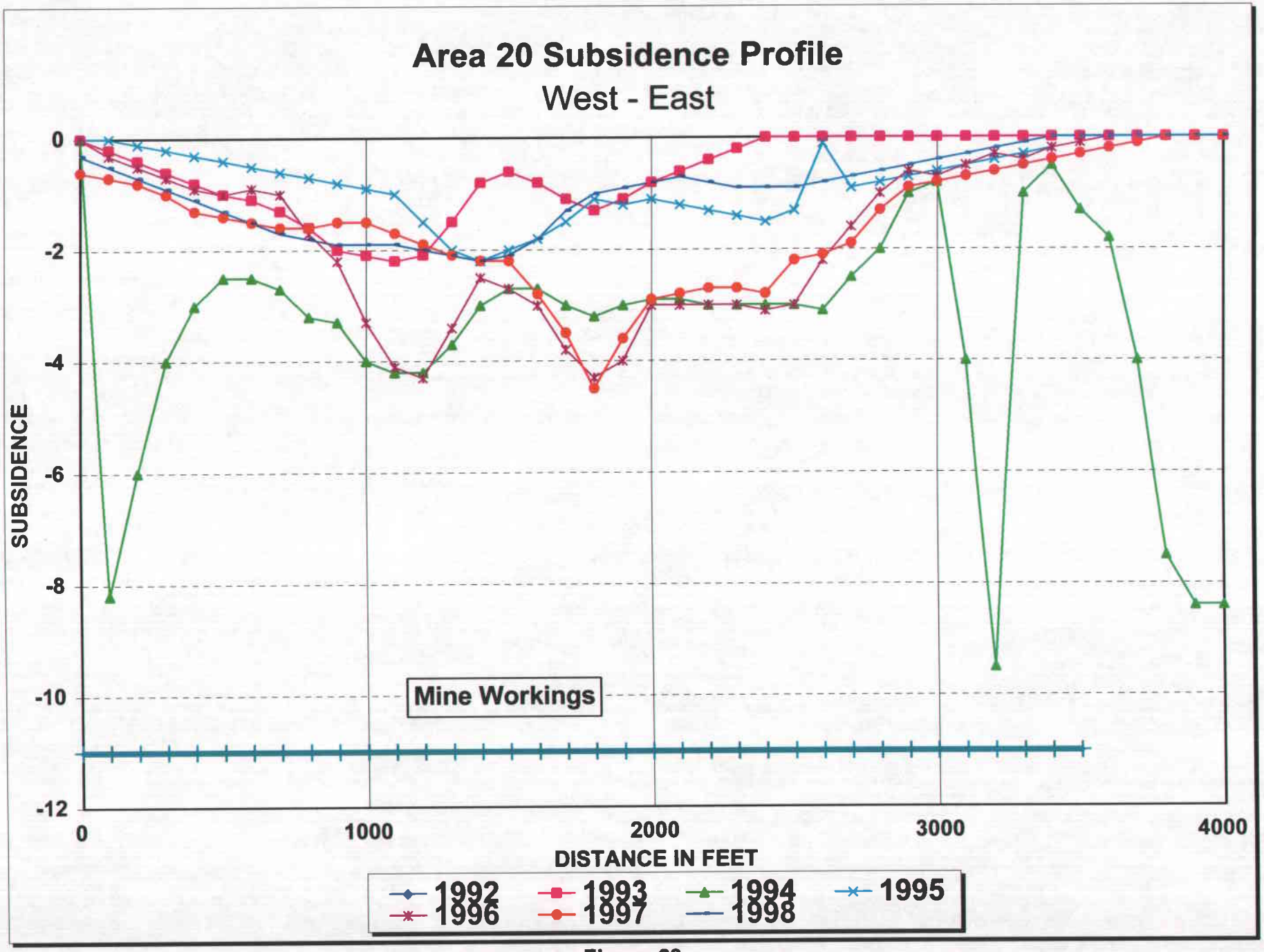

Area 20 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
-10
-12
0
1000
2000
3000
4000
DISTANCE IN FEET
Mine Workings
1992
1993
1994
1995
1996
1997
1998

Figure 69

Area 21

Deer Creek Mine 2nd East Through 7th East Longwall Panels

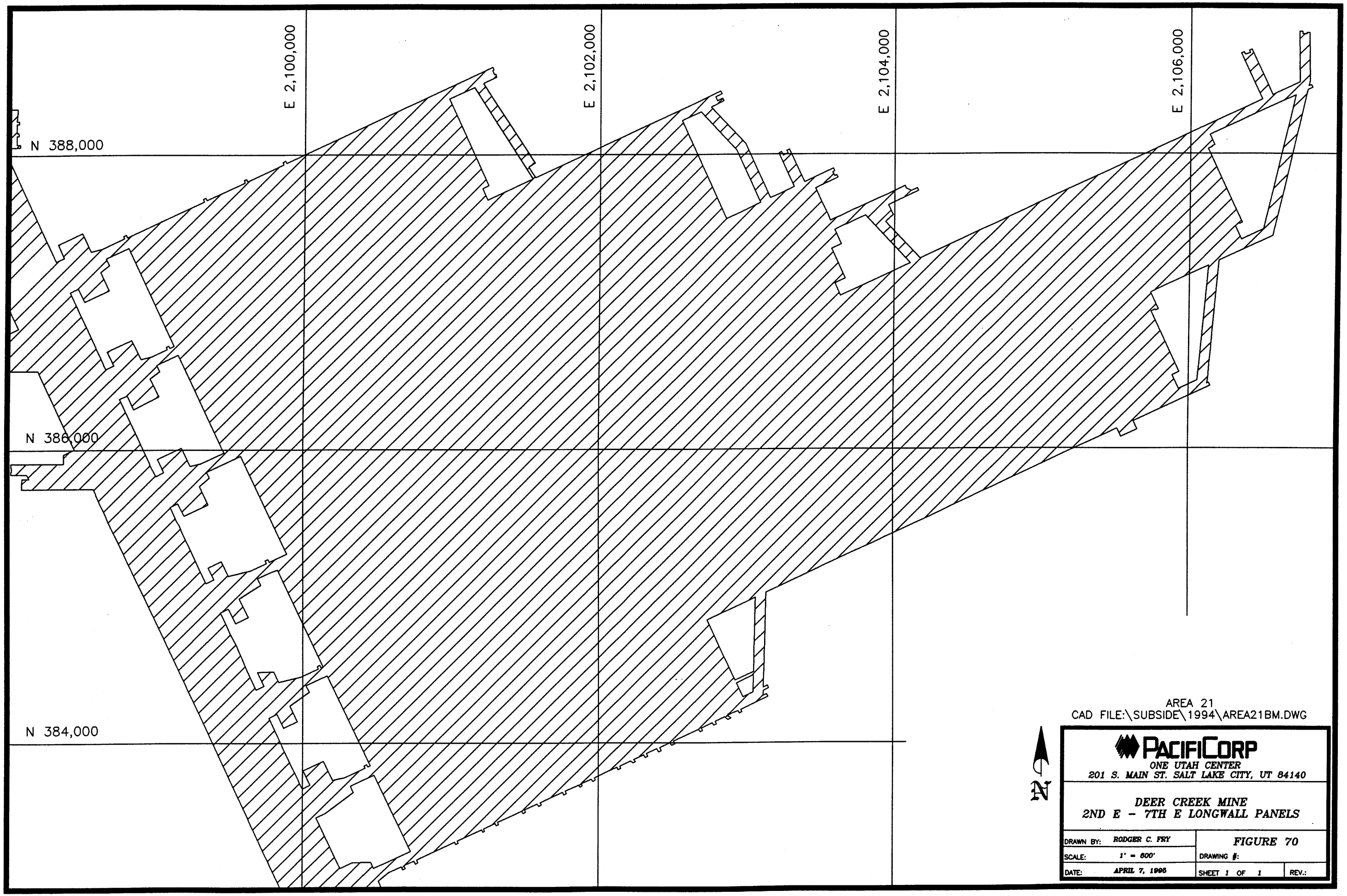
Mining in the 2nd East Longwall panel began in November of 1993 and by the End of August 1995 longwall mining had removed all of the 2nd through 5th East Longwall Panels and the eastern 1,100 feet of the 6th East Longwall Panel (Figure 70). Mining in this area, including the remainder of the 6th East and all of the 7th East Longwall Panels, was completed in January 1996.

The topography in this area is fairly rugged. A ridge along the south side of Rilda Canyon is located through the center of the area. The slopes leading down from this ridge to Rilda Canyon on the north are heavily vegetated with conifer trees. Overburden in this area ranges from less than 200 feet in the north to greater than 1,800 feet beneath the ridge top.

Subsidence detected in 1994 had reached a maximum of over four (4) feet above the 2nd East Longwall Panel (Figures 71, 72 and 73). Subsidence over the 3rd East longwall panel was not detected because this panel is longer than the 2nd East panel and subsidence doesn't usually occur until two panel widths have been mined. In 1995, subsidence had progressed to where most of the areas underlain by the 2nd through 6th East Longwall Panels had subsided between 5 and 6 feet. In 1996, the maximum subsidence that was measured had not increased from that measured in 1995 but an increase in subsidence was noted on the north end of figure 72 and on the western end of figure 73. This is in the area of the 6th and 7th East Longwall Panels that were the last to be extracted. The 1998

monitoring indicated that subsidence has increased to slightly over eight (8) feet over the Second and Third East longwall panels in this area. In 1996, this area showed a maximum subsidence of six (6) feet. During the helicopter reconnaissance in 1995, several fractures were identified and several areas were noted where boulders had rolled from the Castlgate cliff. These are shown on figure 71. The area of subsidence is completely contained within the mining area; Therefore, the angle of draw is near vertical.

Several springs are located above these longwall panel. However, hydrologic monitoring has not detected any change to the spring flow that is attributable to mining (see 1998 Hydrologic Monitoring Report).

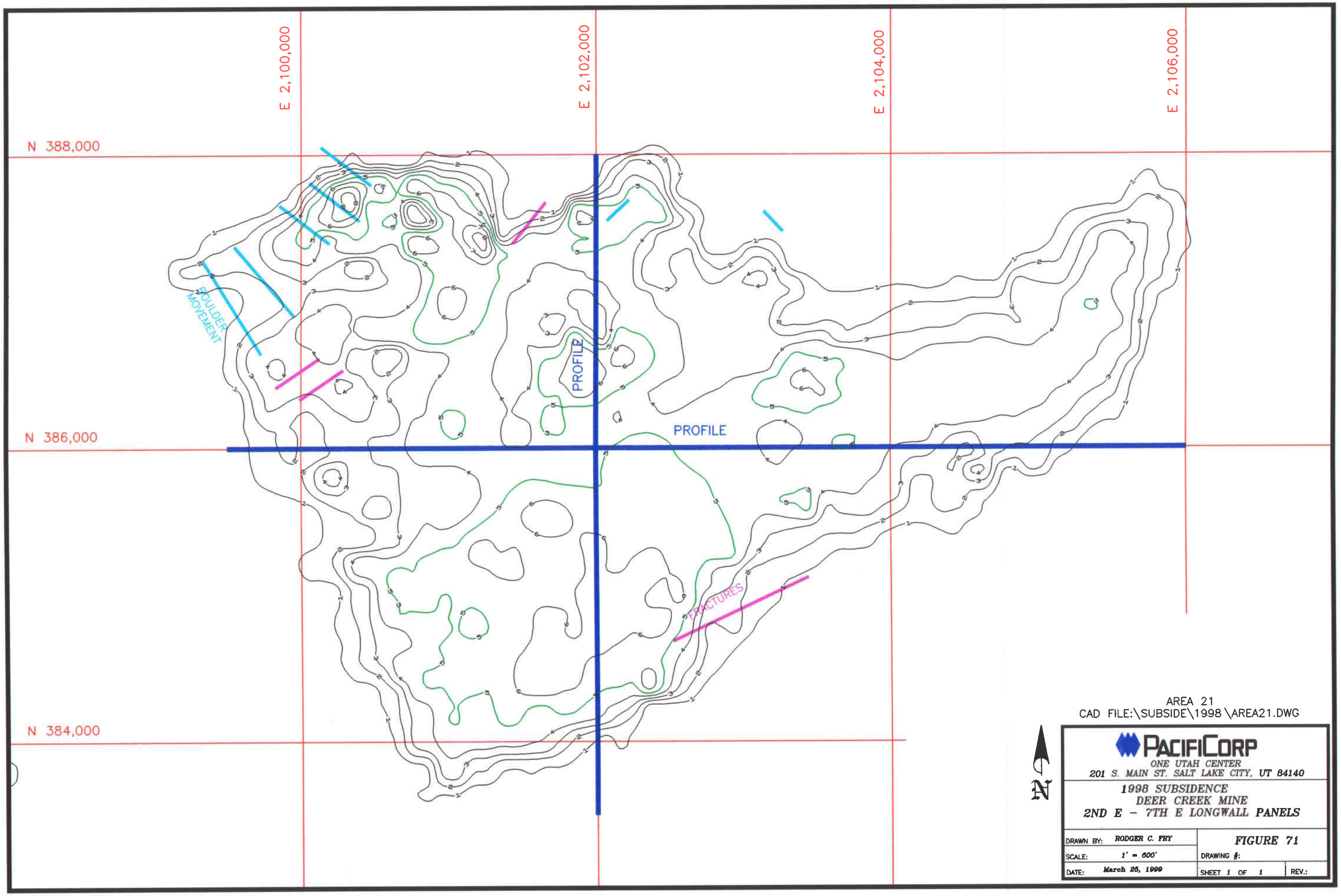


AREA 21
CAD FILE:\SUBSIDE\1994\AREA21BM.DWG

PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140

DEER CREEK MINE
2ND E - 7TH E LONGWALL PANELS

DRAWN BY:	RODGER C. FRY	FIGURE 70	
SCALE:	1" = 800'	DRAWING #:	
DATE:	APRIL 7, 1995	SHEET 1 OF 1	REV.:


E 2,100,000
E 2,102,000
E 2,104,000
E 2,106,000
N 388,000
N 386,000
N 384,000
BOULDER MOVEMENT
PROFILE
PROFILE
FRACTURES
N
AREA 21
CAD FILE:\SUBSIDE\1998\AREA21.DWG
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
1998 SUBSIDENCE
DEER CREEK MINE
2ND E - 7TH E LONGWALL PANELS
DRAWN BY: RODGER C. FRY
SCALE: 1" = 600'
DATE: March 25, 1999
FIGURE 71
DRAWING #:
SHEET 1 OF 1
REV.:

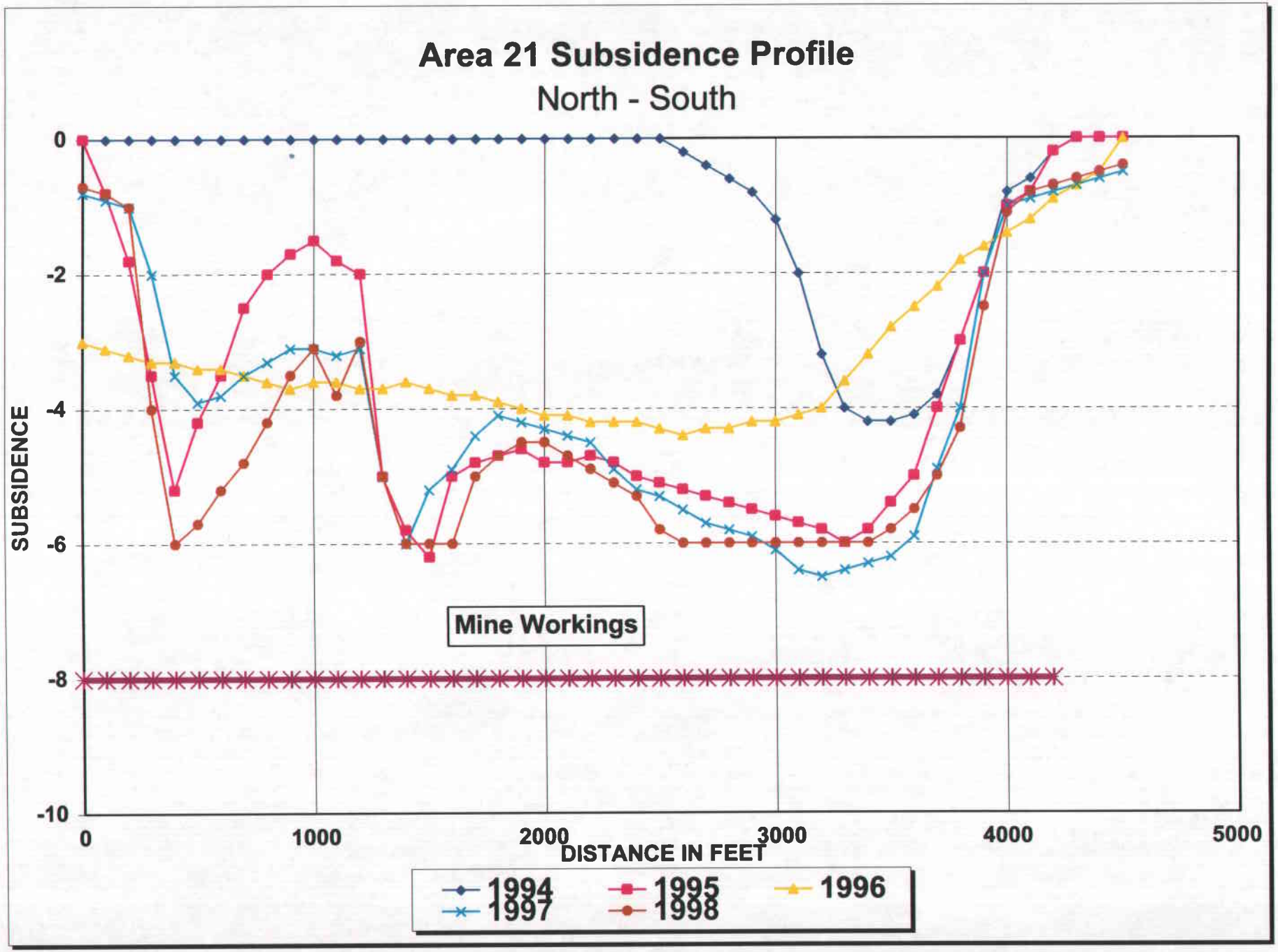

Area 21 Subsidence Profile
North - South
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
1000
2000
3000
4000
5000
DISTANCE IN FEET
Mine Workings
1994
1995
1996
1997
1998

Figure 72

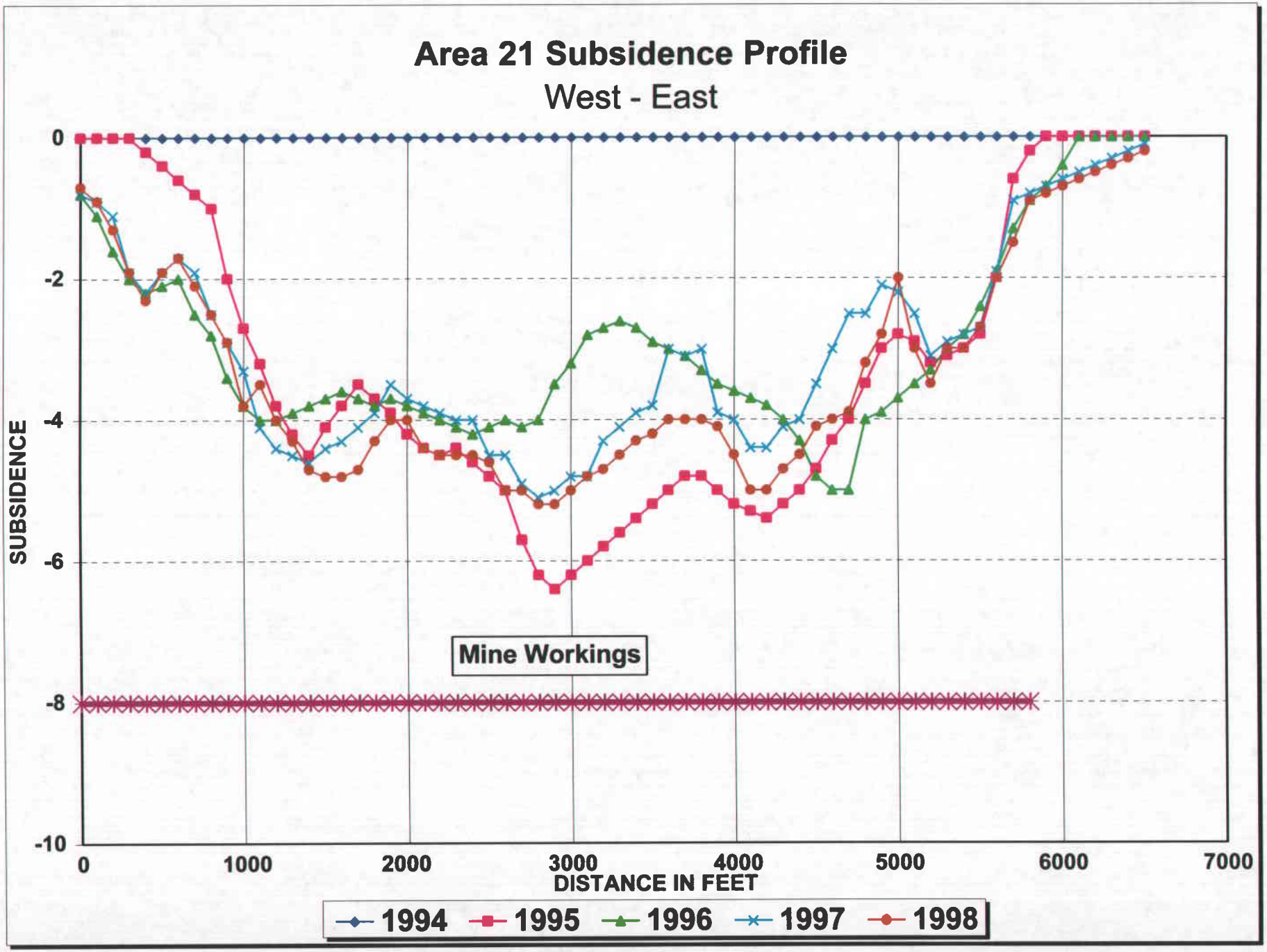

Area 21 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
1000
2000
3000
4000
5000
6000
7000
DISTANCE IN FEET
Mine Workings
1994
1995
1996
1997
1998

Figure 73

Area 22

Deer Creek Mine 2nd through 8th West Longwall Panels off 3rd North

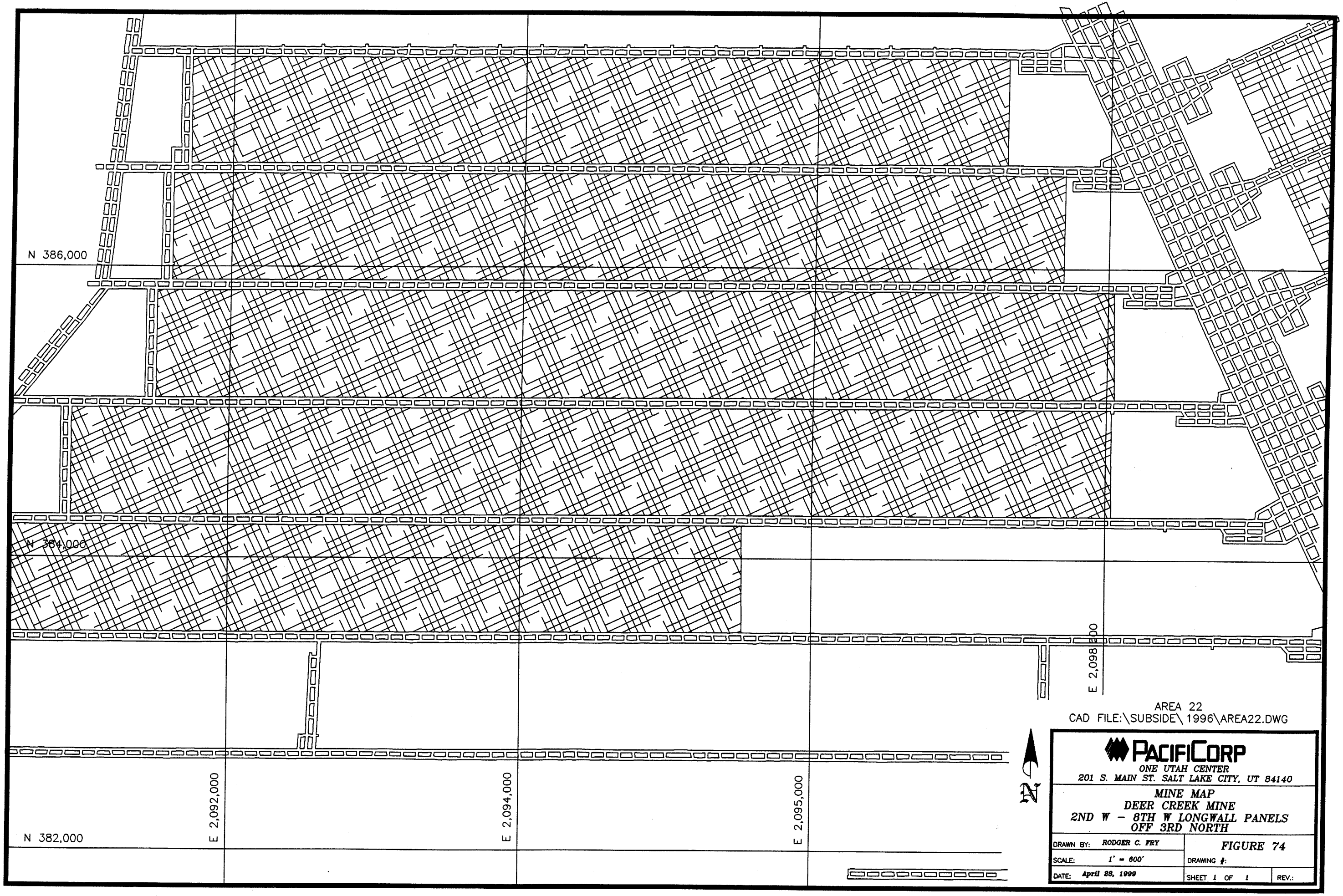
Longwall Mining began in the 8th West Longwall Panel in February 1996 and the entire panel was mined by July 1996. Mining then moved to the 7th West Longwall Panel in July 1996 was completed in January 1997. Mining then started in the 6th west panel in January 1997 and this panel was completed in July 1997. Mining in the 5th west panel began in July 1997 and was completed in February 1998. Mining in the 4th west panel began in March 1998 and by August 31, 1998, the western 5,300 feet of the panel had been extracted (see figure 74). Mining in this area will remain active for the next year. This area is located on the southern side of Rilda Canyon in an area where the terrain is very rugged. Several north-south side tributaries to Rilda Canyon are located in the area and form a series of canyons and steep ridges along the flanks of Rilda Canyon. Elevations range from 8,000 feet at the coal outcrop to 9,900 feet along the ridge tops. The area is heavily vegetated with spruce trees, aspen trees at the higher elevations and pinion-junipers at the lower elevations.

Several springs are located in the area and have been catalogued and are being monitored (see 1998 Annual Hydrologic Monitoring Report).

The subsidence monitoring showed an increase in subsidence in 1998 over that which was measured in 1997. Above the western end of the 7th west panel the subsidence has reached a maximum of eight (8) feet but in that area remains unchanged in 1998. And in a small area on the eastern end of the eighth west panel the subsidence has reached as

much as ten (10) feet in a small area. The topography in this area is fairly rugged which limits the resolution of the photogrammetric monitoring (see figures 75, 76 and 77). The subsidence trough continued to expand to the south in 1998 as mining progressed in that direction. Subsidence now has reached up to six (6) feet over a small portion of the western end of the 6th west panel. It should be expected that as more panels to the south are mined the area of subsidence will broaden.

The subsidence that has occurred to date has had no effect on the springs or groundwater in the area (see 1998 Hydrologic Monitoring Report).

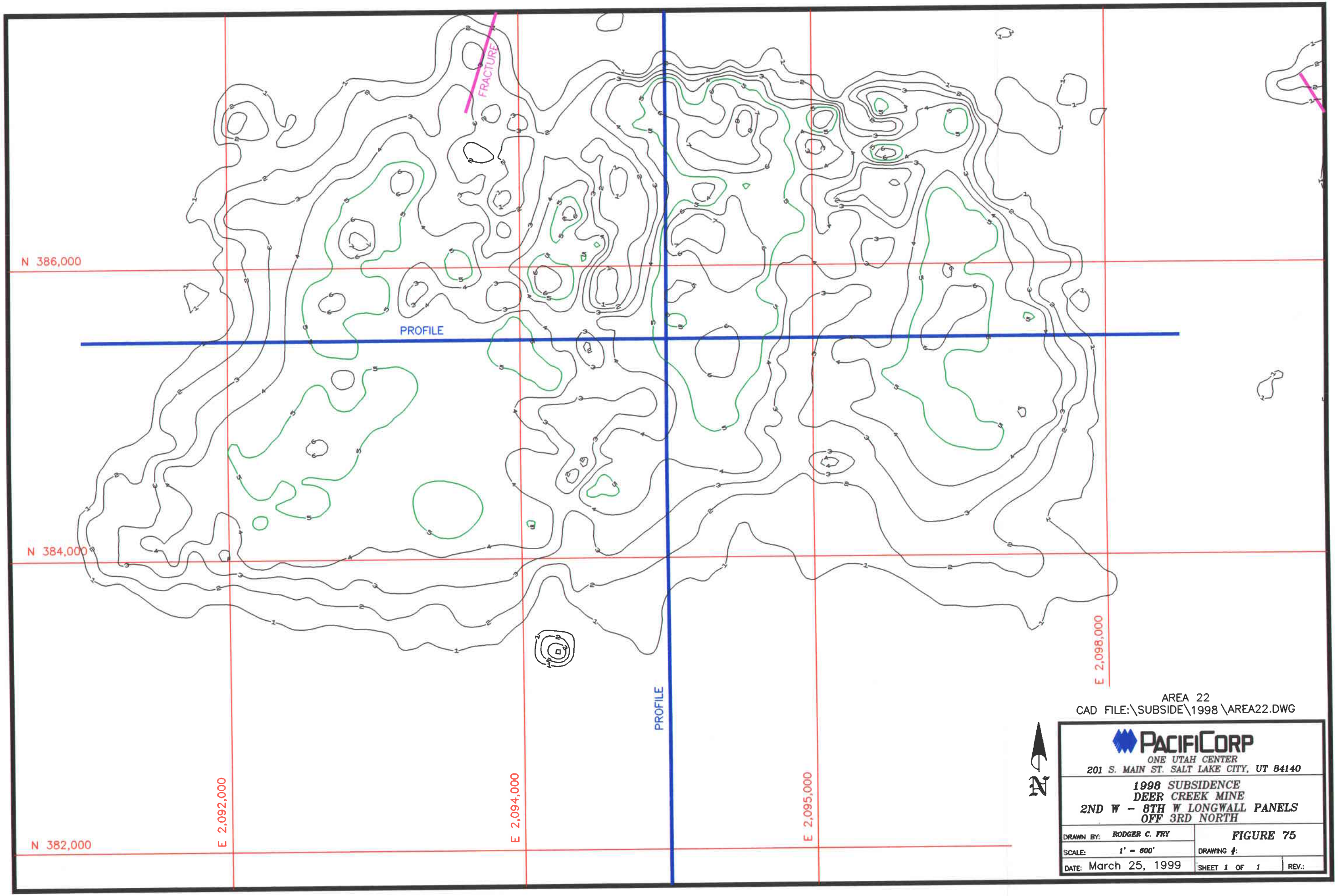


AREA 22
CAD FILE:\SUBSIDE\1996\AREA22.DWG

PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140

MINE MAP
DEER CREEK MINE
2ND W – 8TH W LONGWALL PANELS
OFF 3RD NORTH

DRAWN BY: RODGER C. FRY	FIGURE 74	
SCALE: 1' = 600'	DRAWING #:	
DATE: April 28, 1999	SHEET 1 OF 1	REV.:


FRACTURE
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PROFILE
N 384,000
PROFILE
N 382,000
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E 2,094,000
E 2,095,000
E 2,098,000
N
AREA 22
CAD FILE:\SUBSIDE\1998 \AREA22.DWG
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
1998 SUBSIDENCE
DEER CREEK MINE
2ND W - 8TH W LONGWALL PANELS
OFF 3RD NORTH
DRAWN BY: RODGER C. FRY
SCALE: 1' = 600'
DATE: March 25, 1999
FIGURE 75
DRAWING #:
SHEET 1 OF 1
REV.:

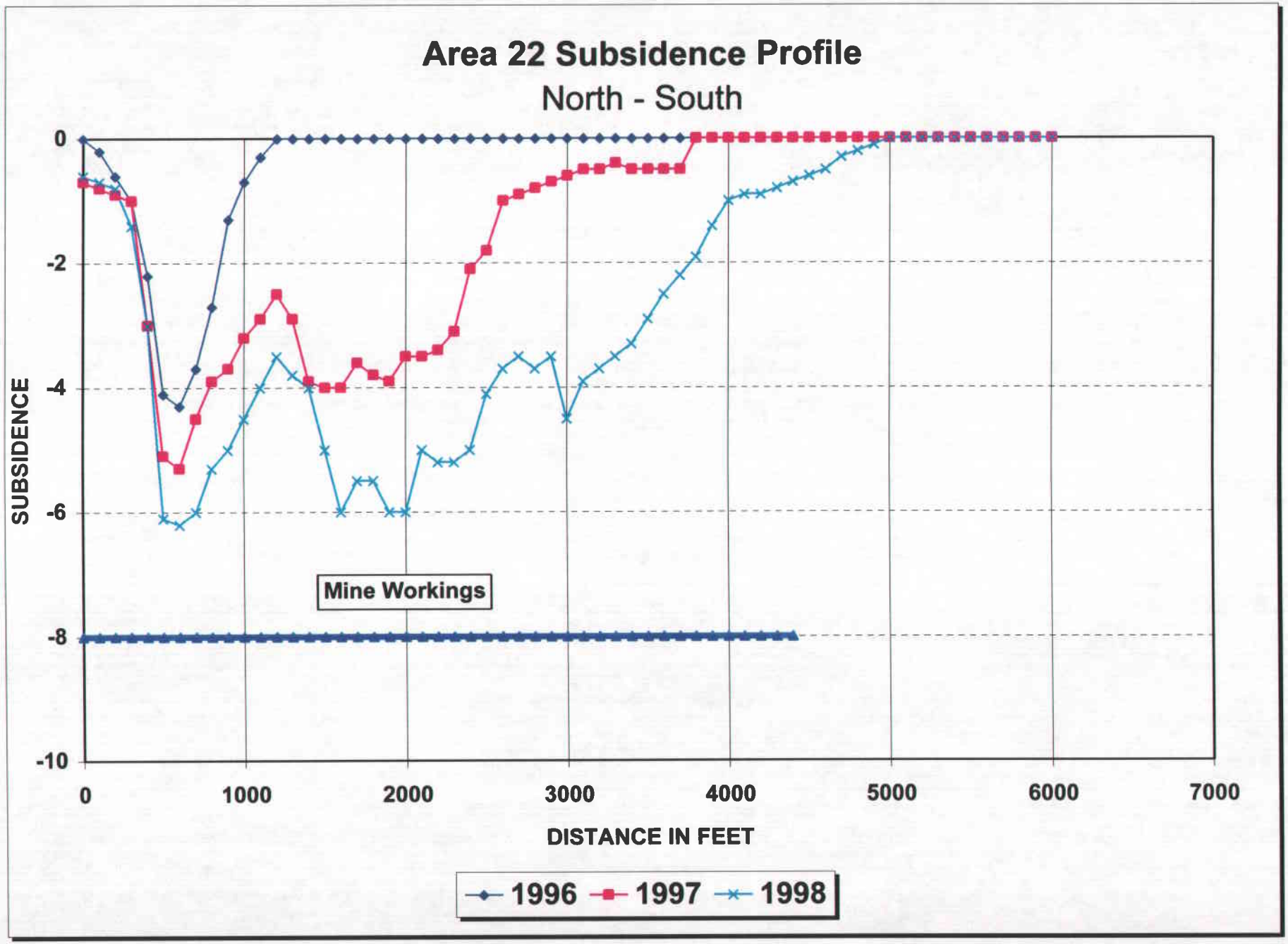

Area 22 Subsidence Profile
North - South
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
1000
2000
3000
4000
5000
6000
7000
DISTANCE IN FEET
Mine Workings
1996
1997
1998

Figure 76

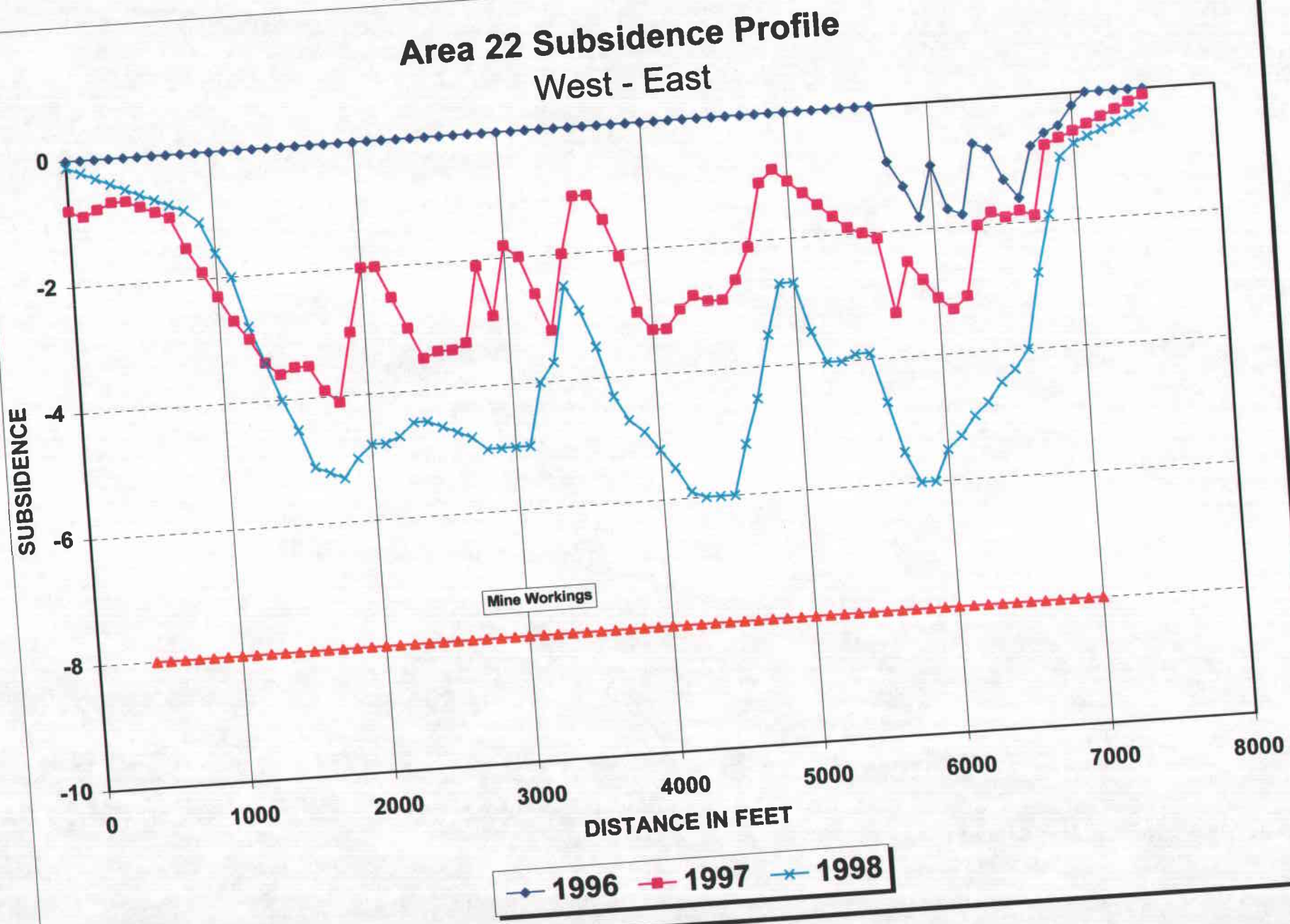

Area 22 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
1000
2000
3000
4000
5000
6000
7000
8000
DISTANCE IN FEET
Mine Workings
1996
1997
1998

Figure 77

Area 23

Trail Mountain Mine 2nd through 5th East Longwall Panels off 5th Left

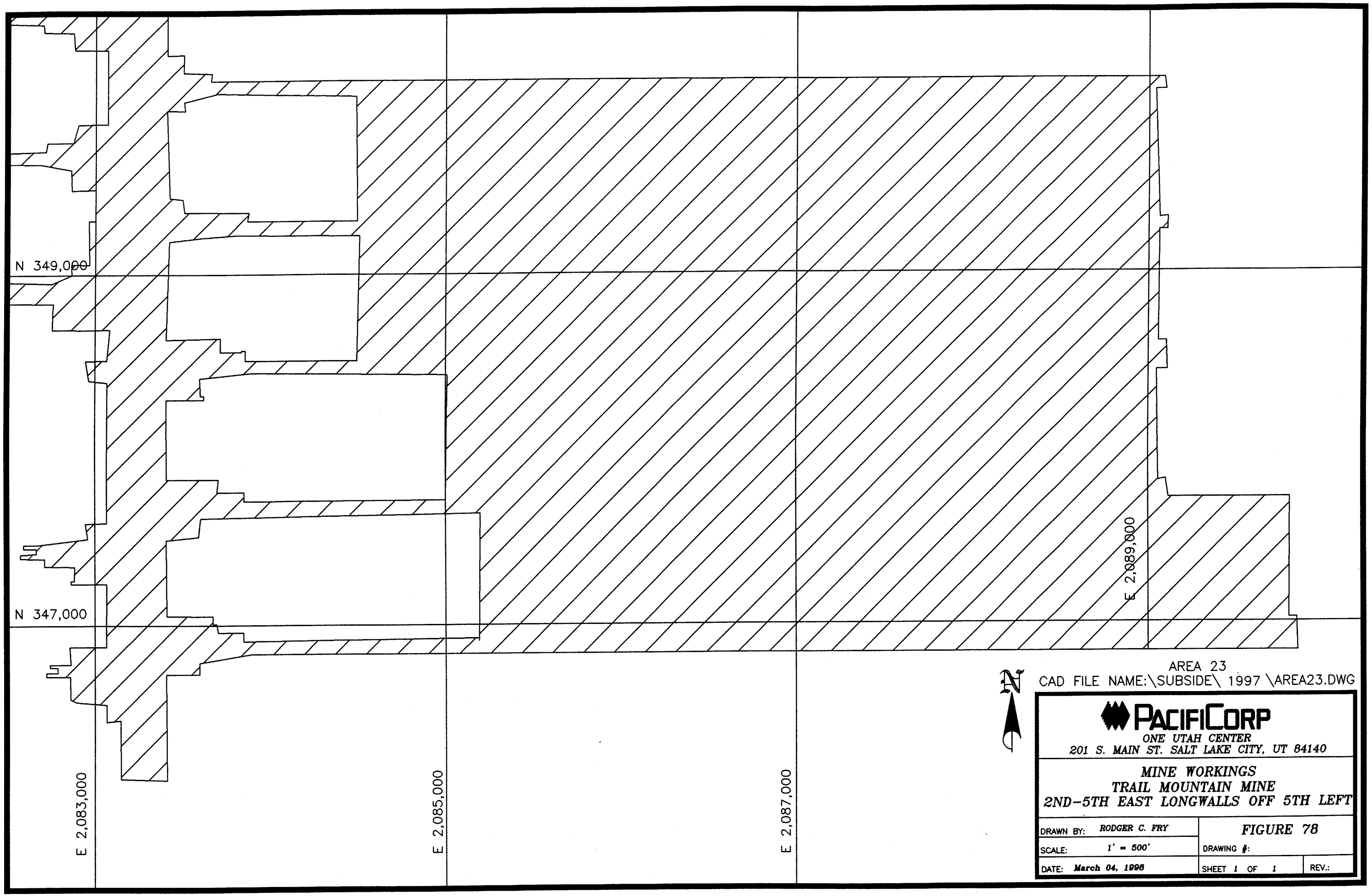
Mining in the 2nd East Longwall Panel began in October 1995 and mining continued until February 1996. In this panel only the eastern 2,600 feet was mined because the western 2,000 feet was not minable due to high ash content in the coal. Mining Began in the 3rd East Panel in February and was completed in June 1996. Mining began in the 4th East panel starting in June 1996 and was completed in October 1996. Mining then began in the 5th East panel which was completed in March 1997 (see figure 78). All of the longwall mining conducted to date has extracted an average thickness of 8 feet of coal. Mining in this area is now complete.

This area generally contains gentle south-facing slopes that project down to a steep escarpment along the south and east end of the area. Elevations in the area range from 8,750 feet to less than 6,700 feet along the coal outcrop in Straight Canyon. The land is sparsely vegetated with grasses and brush with some dense patches of ponderosa pine at the higher elevations and pinion-juniper trees in the steeper slopes above and below the escarpment.

The subsidence monitoring has detected up to eight (8) feet of subsidence that has occurred. This maximum subsidence is located over the east end of the 4th East longwall panels (see figures 79, 80 & 81). Most of the undermined area has subsided between five (5) and seven (7) feet. One point at the extreme east side of the 5th East panel shows

subsidence up to over 22 feet. This is in an area of steep terrain and may be reading inaccuracies or a large boulder may have moved causing the change in readings between 1996 and 1997 but no additional change was noted in the past year. No angle of draw calculations have been made because subsidence in this area is not yet complete.

No surface fractures or visual evidence of subsidence has been observed. One spring is located in the area but as of yet has not been subsided. No change in spring discharge has been identified due to the mining activities (see 1998 Annual Hydrologic Monitoring Report).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E 2,085,000
E 2,087,000
E 2,089,000
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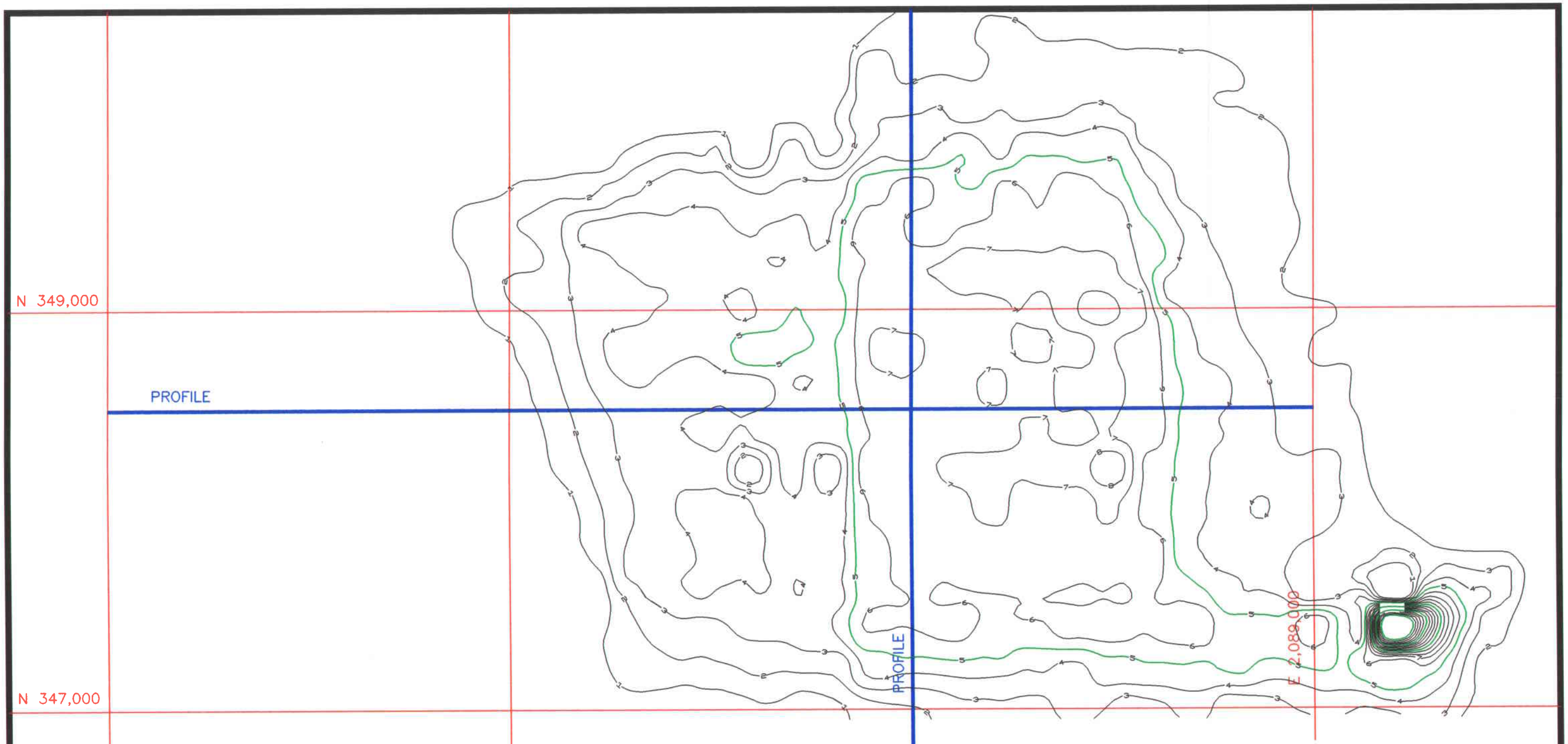
AREA 23
CAD FILE NAME:\SUBSIDE\ 1997 \AREA23.DWG
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
MINE WORKINGS
TRAIL MOUNTAIN MINE
2ND-5TH EAST LONGWALLS OFF 5TH LEFT
DRAWN BY: RODGER C. FRY
SCALE: 1' = 500'
DATE: March 04, 1998
FIGURE 78
DRAWING #:
SHEET 1 OF 1
REV.:



AREA 23
CAD FILE NAME:\SUBSIDE\ 1998 \AREA23.DWG

N

PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140

1998 SUBSIDENCE
TRAIL MOUNTAIN MINE
2ND-5TH EAST LONGWALLS OFF 5TH LEFT

DRAWN BY: RODGER C. FRY	FIGURE 79	
SCALE: 1' = 500'	DRAWING #:	
DATE: March 25, 1999	SHEET 1 OF 1	REV.:

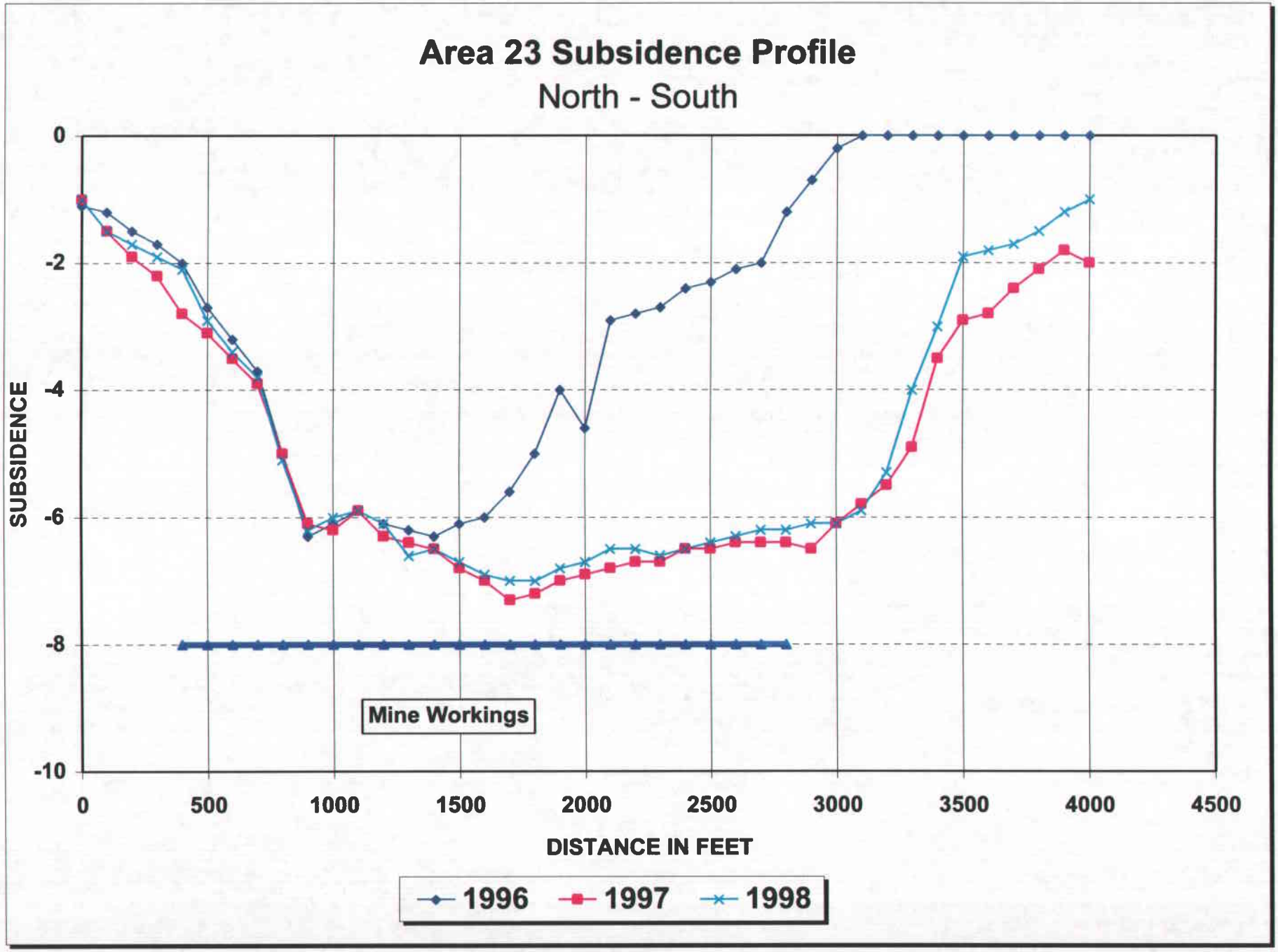

Area 23 Subsidence Profile
North - South
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
500
1000
1500
2000
2500
3000
3500
4000
4500
DISTANCE IN FEET
Mine Workings
1996
1997
1998

Figure 80

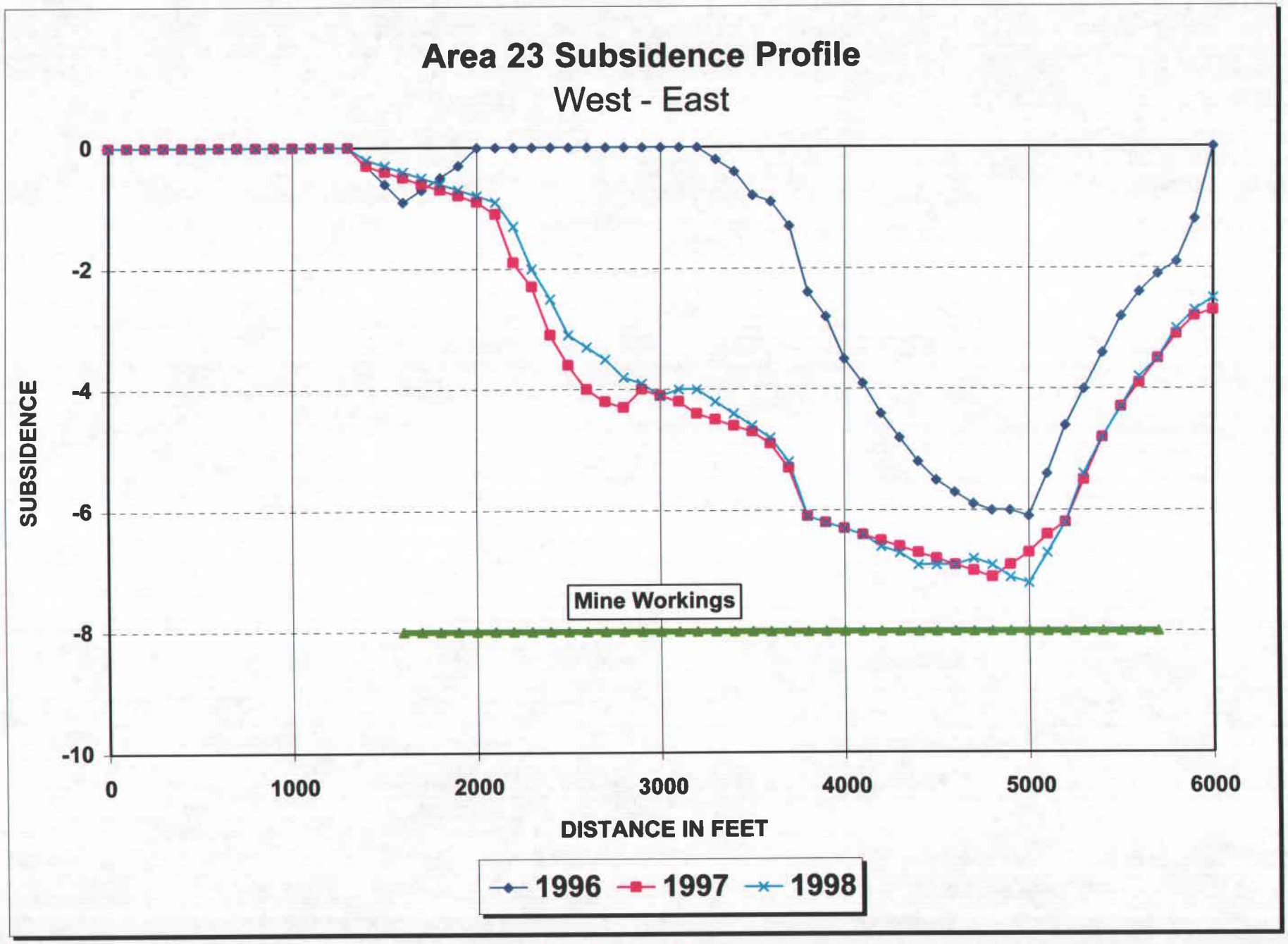

Area 23 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
-10
0
1000
2000
3000
4000
5000
6000
DISTANCE IN FEET
Mine Workings
1996
1997
1998

Figure 81

AREA 24

TRAIL MOUNTAIN MINE 1ST-10TH RIGHT OFF 5TH LEFT

Mining in the 9th Right panel began in March 1997 and was completed at the end of August 1997. In 1998, the western 4,800 feet of the 8th Right panel had been extracted leaving the remaining 1,600 feet unmined due to inferior coal quality. Mining then moved into the 7th Right panel and by the end of August, 1998, all of this panel had been extracted. The mining was completed to an average mining height of nine (9) feet.

The topography within this mining area is quite variable. Elevations range from less than 7,000 feet in Straight Canyon on the southwest side of the area, where the topography is very rugged, to over 8,800 feet in the northeast portion of the area where the land is gently sloping to the south. The lower elevation areas are heavily vegetated with pinion and juniper trees interspersed with grasses. The higher elevations have stands of spruce and aspen trees separated by areas of sage brush and grasses.

The overburden above the coal seam in this area ranges from less than 1,400 feet in the southwest corner of the area to over 2,200 feet in the northeast corner of the area.

The subsidence monitoring showed an increase in subsidence in 1998 from that measured the previous year. The maximum subsidence over the 9th Right panel was slightly over 2 feet in 1997 but was measured at over 5 feet in 1998. It is expected that the subsidence will continue to increase slightly and progress to the north as mining advances in that direction. The maximum subsidence detected was just over 2 feet (see figures 83, 84 and 85). The subsidence that has occurred has not had any effect on the current land

use or on the hydrology of the area (see 1998 Annual Hydrologic Monitoring Report).

356,000 N
354,000 N
352,000 N
350,000 N
348,000 N
346,000 N
2,082,000 E
2,080,000 E
2,078,000 E
2,076,000 E
\SUBSIDE\ AREA 24 1998 \AREA24BM.DWG
PACIFICORP
ONE UTAH CENTER
201 S. MAIN ST. SALT LAKE CITY, UT 84140
MINE WORKINGS
TRAIL MOUNTAIN MINE
1ST RIGHT–10TH RIGHT
OFF 5TH LEFT
DRAWN BY: RODGER C. FRY
SCALE: 1' = 800'
DATE: APRIL 28, 1999
FIGURE 83
DRAWING #:
SHEET 1 OF 1
REV.:

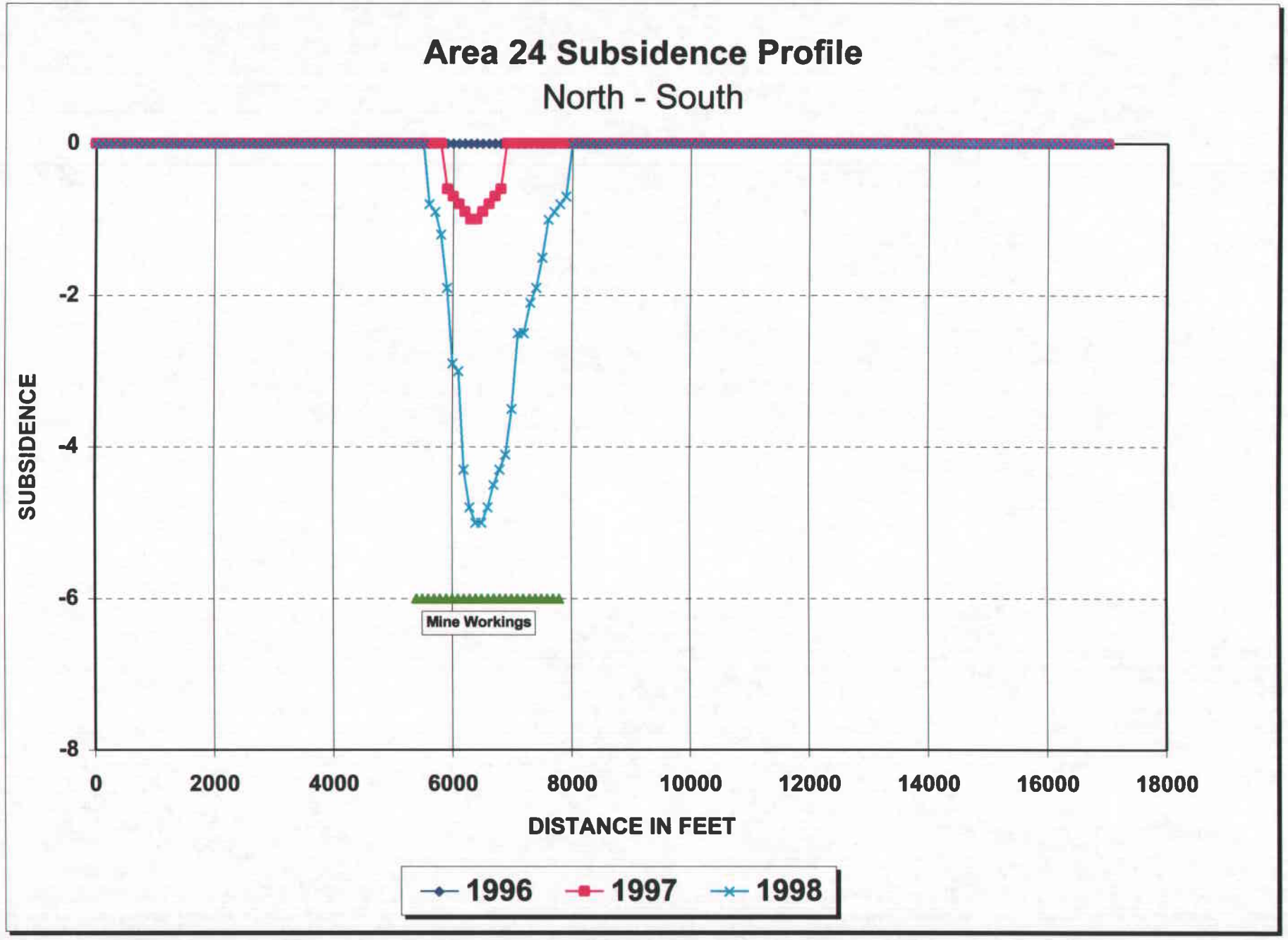

Area 24 Subsidence Profile
North - South
SUBSIDENCE
0
-2
-4
-6
-8
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
DISTANCE IN FEET
Mine Workings
1996
1997
1998

Figure 84

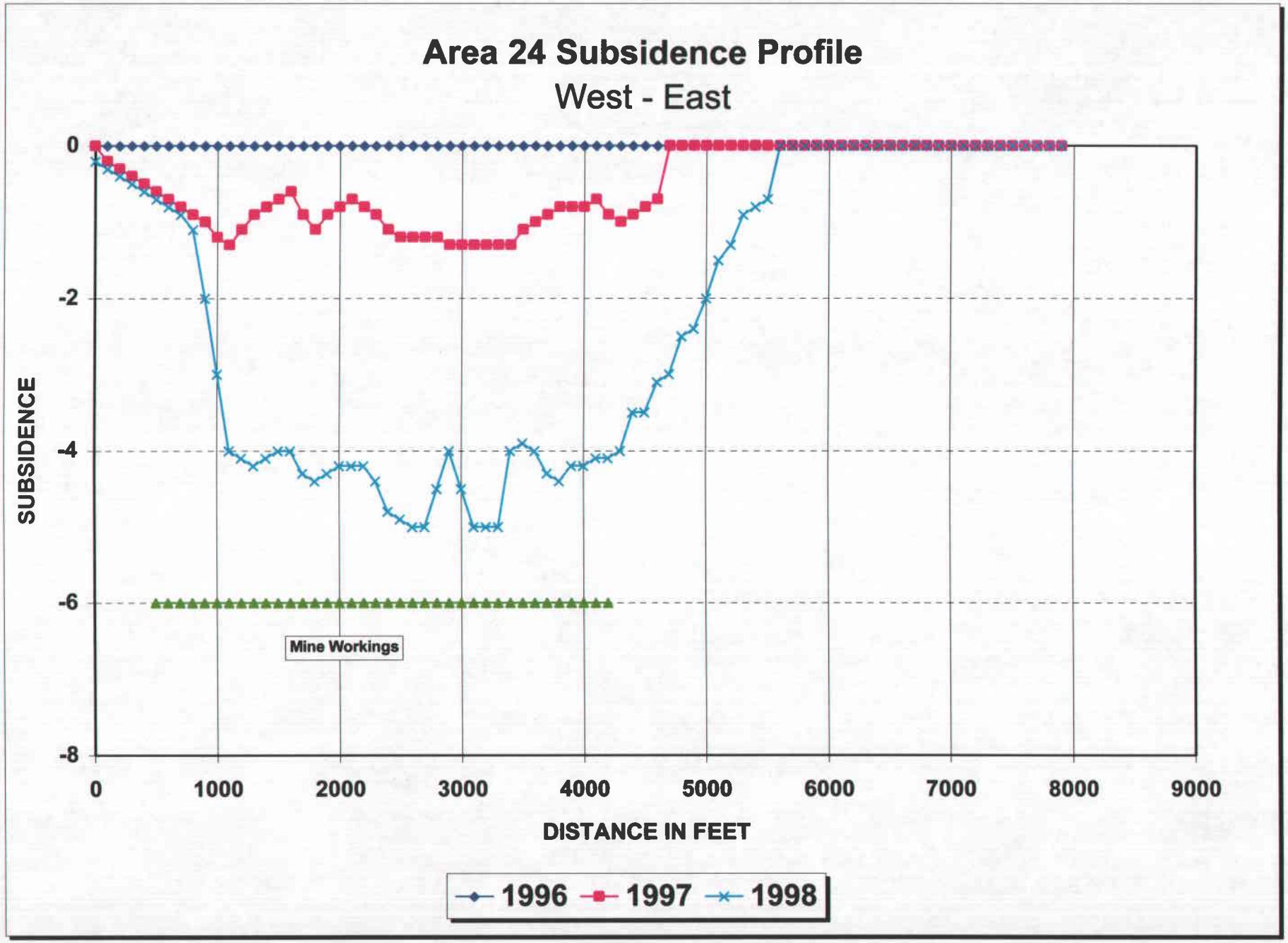

Area 24 Subsidence Profile
West - East
SUBSIDENCE
0
-2
-4
-6
-8
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
DISTANCE IN FEET
Mine Workings
1996
1997
1998

Figure 85

Predicted Maximum Subsidence

A comparison between observed and predicted maximum subsidence for the various areas on PacifiCorp's property has been made using a method developed by the British National Coal Board (NCB). The NCB method utilizes graphs compiled from numerous field observations and takes into consideration the length and width of the mined-out area, thickness of coal extracted, and depth of cover. The method is claimed to be correct to ±10% in the majority of cases, assuming certain limiting conditions are met. The table below compares predicted maximum subsidence with observed subsidence for areas on East Mountain.

Area	Subsidence (feet)		
	Predicted Maximum	Observed	% of Predicted
1* DC 9E/W 1R	15.2	28.0	184
2 DC 5-8E/W, 3-13R	13.8	13.1	95
3 DC 1N Area 7.7	7.7	5.5	71
4 DC 2-17R	13.6	13.5	99
5 DC 2-5L	13.5	12.5	93
6 W 1-2W	5.0	4.5	90
7 Bee 2N off 8W	6.6	7.4	112
8 Bee/Des E&W Sections	6.8	4.8	104

Area	Subsidence (feet)		
	Predicted Maximum	Observed	% of Predicted
9 Little Dove 1N	4.3	3.5	81
10 Old American Fuel Mine	7.0	6.1	87
11 DC C&D N	13.7	13.2	96
12 W 2L	1.5	0.0	0
13 Des-Bee-Dove Southern Areas	2.0	1.8	90
14 Cottonwood 6-7E	7.6	4.7	62
15 Cottonwood 9-12W	7.2	5.0	69
16 Cottonwood 8-11E	7.4	4.5	61
17 Cottonwood 16-15 W	8.1	7.2	89
18 Deer Creek 2nd-7th R	7.7	7.2	94
19 Deer Creek 7th & 8th E	7.9	4.5	57
20 Deer Creek 1st & 2nd L	7.8	6.1	79
21 Deer Creek 2nd- 7th E	7.5	7.5	100
22 Deer Creek 2nd-8th W	7.5	8.1	108
23 Trail Mountain 2nd -5th E	7.8	8.1	104
24 Trail Mountain 1st - 10th Right	7.5	5.4	72

* This area does not fit the NCB prediction model.

In most areas subsidence is less than the maximum predicted by the NCB model. The observed subsidence shown here represents the actual maximum subsidence for the particular geologic conditions -- probably the case in some areas since subsidence appears

to have ceased in several areas where the NCB predicted maxima were not reached. In areas showing greater than expected subsidence, chain pillars or barriers between sections are probably crushing so that strata above the working caves as it would if a wider zone had been mined.

Mitigation of Surface Effects

Prior to mining in an area, we notify the land owner that mining will be in progress beneath his property. The land owners within our permit boundary are as follows:

Karl A. Seely, Inc.

LDS Church

US Forest Service

US Bureau of Land Management

Elk Springs Property Users Assn.

Kent Barton

We will continue to notify those owners prior to undermining their properties.

Over most areas where subsidence has been observed on East Mountain, present land use has not been affected in any way. Areas 2, 5, 6, 8, 9, 10, 12, 13, 15, 16, 17, 18, 19, 20, 23 and 24 are good examples of subsidence without visible surface disturbance or adverse hydrologic effects. In such areas no mitigation is necessary.

In a few areas, such as Areas 1, 3, 4, 7, 10, 11, 14, 21 and 22, surface fractures have been detected. In order to protect livestock PacifiCorp has erected a fence around Area 1 where fractures are of sufficient magnitude to pose a threat to wandering cattle. In the regions where the fractures could be reclaimed they have been filled in with heavy equipment and the escarpments have been evenly contoured and reseeded. In Area 4, the small tension

fractures that formed were reclaimed by filling in the fractures using a motor-grader and reseeding the area. In Area 14, where cracks have also been observed, these were filled in by hand in 1998 and reseeded. The U.S. Forest Service accepted this mitigation as being sufficient and complete.

In Areas 3, 7, 10, 11, 21 and 22 where only minor fracturing has occurred on remote ridges and/or where land use has not been affected, more damage would be done by gaining access to and repairing or fencing fractures than can be justified; therefore, mitigation is counterproductive in those areas and is not planned.

Summary

As of August 1998 PacifiCorp has identified twenty-four (24) areas of mining-induced subsidence on the East Mountain/Trail Mountain property. Terrain in the subsidence areas ranges from relatively flat mountain tops with thick overburden of up to 2,200 feet to steep slopes and cliffs with overburden of less than 200 feet. The most noticeable subsidence effects occur in the steep cliff areas and where mining next to burned coal appears to have caused crushing of the clinker beds. Most of the fractures observed over mined areas have occurred under these conditions, especially where the Castlegate Sandstone (or similar lithologic unit) crops out or is near the surface. The sandstones yield to stress by brittle deformation (fracturing).

In areas where overburden is thicker and other, more clay-rich formations crop out, longwall and room-and-pillar mining methods have allowed the multiple seam mining of large quantities of coal without apparent impact on the environment because the overburden yields through plastic deformation. Areas such as the Beehive-Deseret east and west room-and-pillar sections (Areas 8 and 13) and the Deer Creek 4th through 8th East-Wilberg 3rd through 13th Right longwall panels (Area 2) have demonstrated that subsidence can occur over a broad area with no visible or hydrologic effects. In excess of eighty percent (80%) of the East Mountain property has conditions similar to those areas; therefore, the mining methods being utilized are well suited to the geologic conditions, allowing subsidence to occur without impacting the hydrology or present land use of the area.

An effort was made again this year to predict maximum possible subsidence for the various areas where subsidence has been detected. The prediction was then compared with observed subsidence for each area. It appears that the actual subsidence occurring on East Mountain/Trail mountain is slightly less than that predicted by the NCB model.

Professional Certification of Subsidence Data

I, Rodger C. Fry being a Certified Professional Geologist, with significant experience in subsidence monitoring, certify that the subsidence data contained in this document was collected under my direction, and the attached subsidence materials were prepared by me using industry-accepted methods. I further certify that the interpretations contained herein are an accurate representation of the subsidence that has occurred.

Dated this 29th day of April, 1999.

Rodger C. Fry

Rodger C. Fry

No. 6603

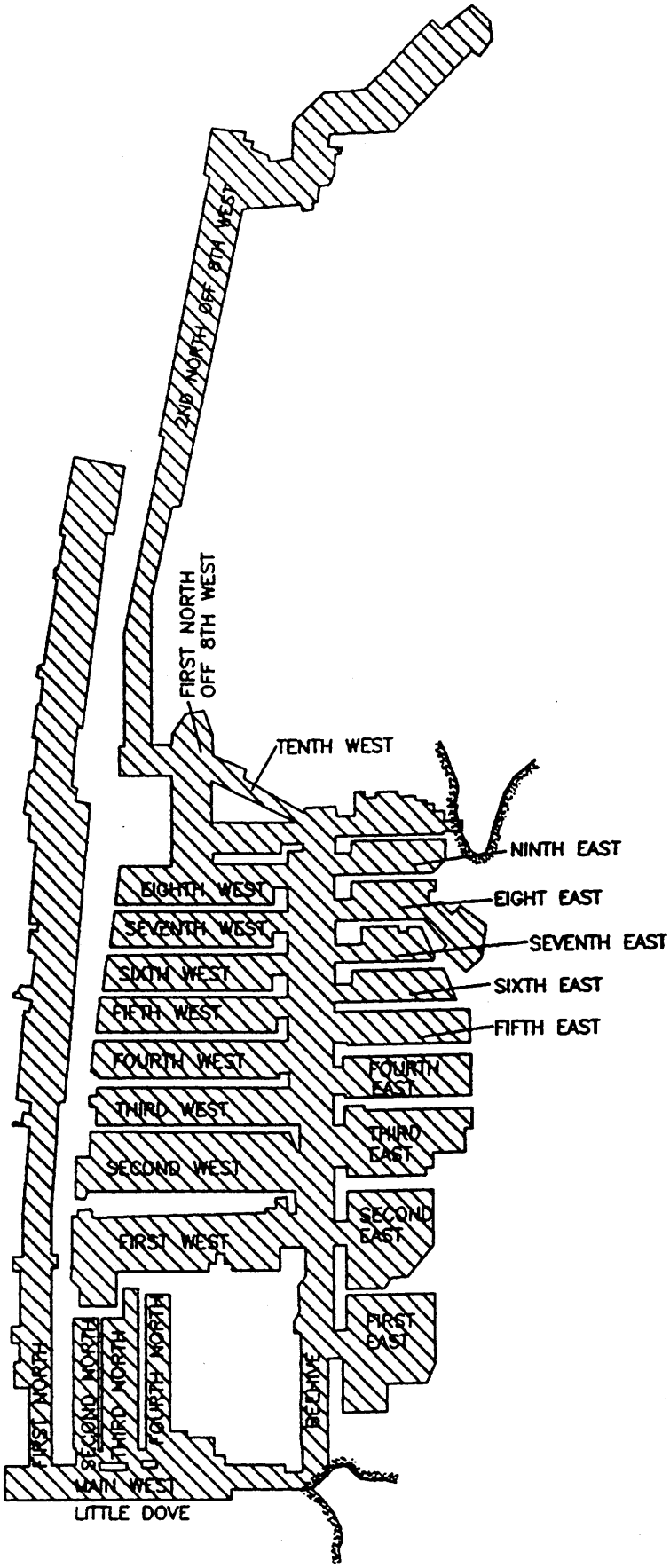
AMERICAN INSTITUTE OF PROFESSIONAL GEOLOGISTS
CERTIFICATE NUMBER
6603
AIPG
RODGER C. FRY
CERTIFIED PROFESSIONAL GEOLOGIST

APPENDICES

SUBSIDENCE MAP

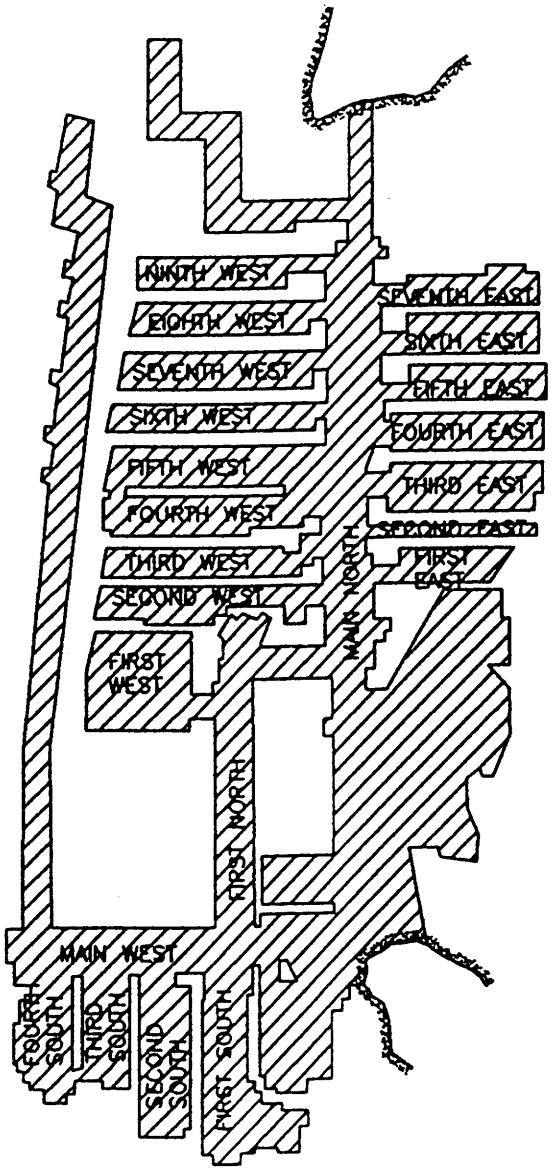
RAW DATA

Des-Bee-Dove Mines



BEEHIVE & LITTLE DOVE COAL MINES

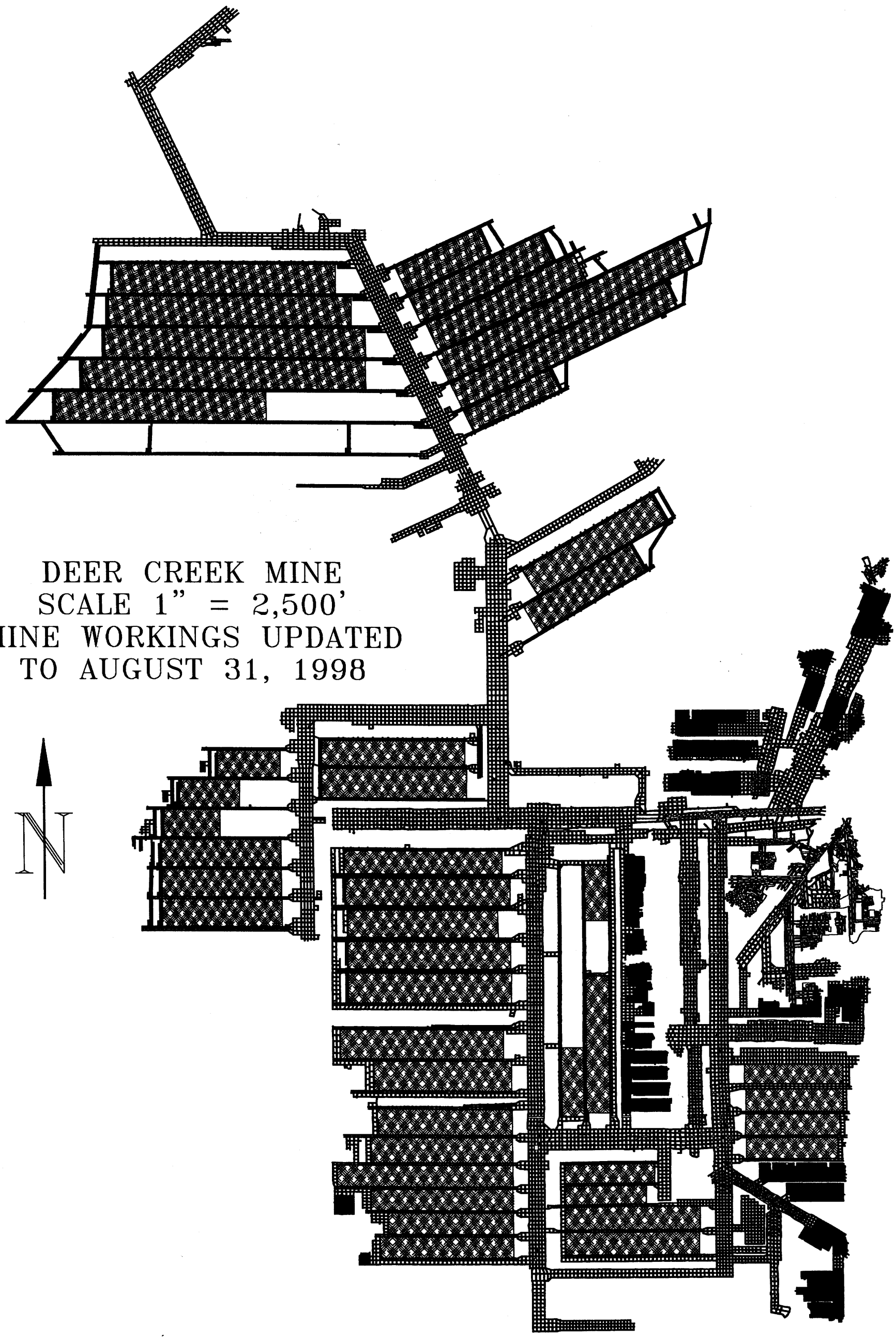
SCALE: 1" = 2,000'



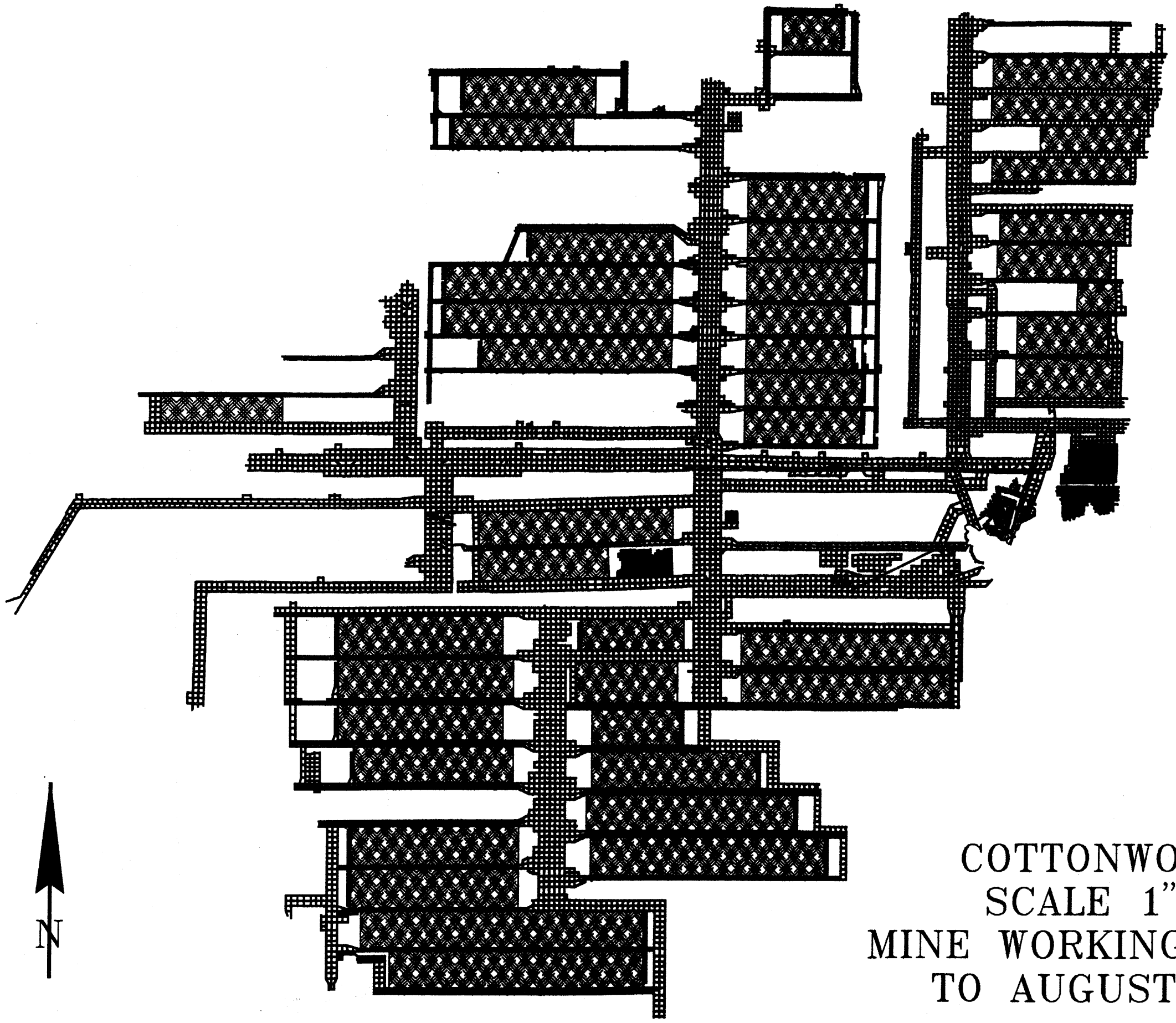
DESERET COAL MINE

SCALE: 1" = 2,000'

Deer Creek Mine


DEER CREEK MINE
SCALE 1" = 2,500'
MINE WORKINGS UPDATED
TO AUGUST 31, 1998
N

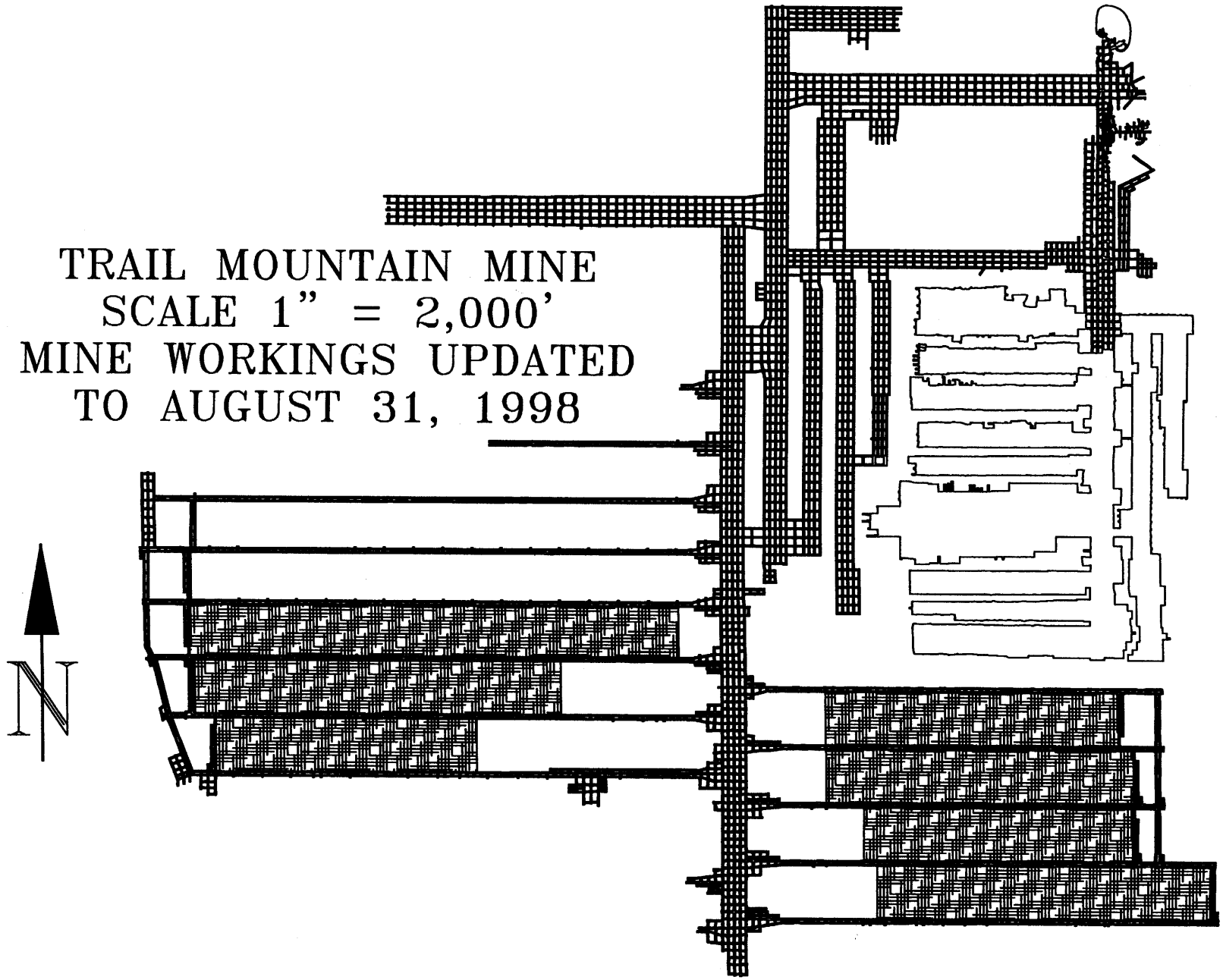
Wilberg/Cottonwood Mine



COTTONWOOD MINE
SCALE 1"=2,000'
MINE WORKINGS UPDATED
TO AUGUST 31, 1996

Trail Mountain Mine

TRAIL MOUNTAIN MINE
SCALE 1" = 2,000'
MINE WORKINGS UPDATED
TO AUGUST 31, 1998



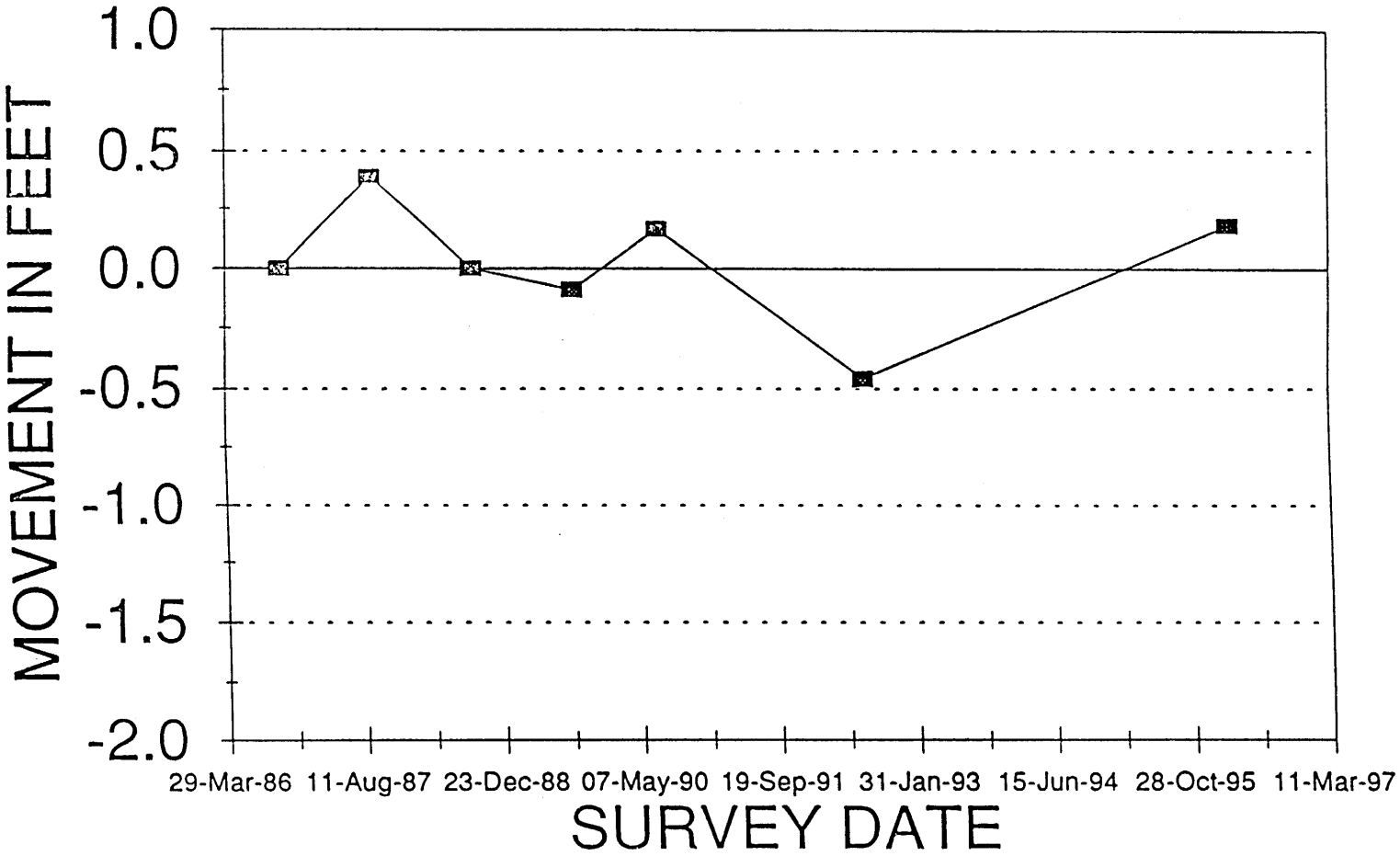
Spring Map with 5-Year Mine Plan

Showing Subsidence

Cliff Stability Survey Targets

NEWBERRY CANYON

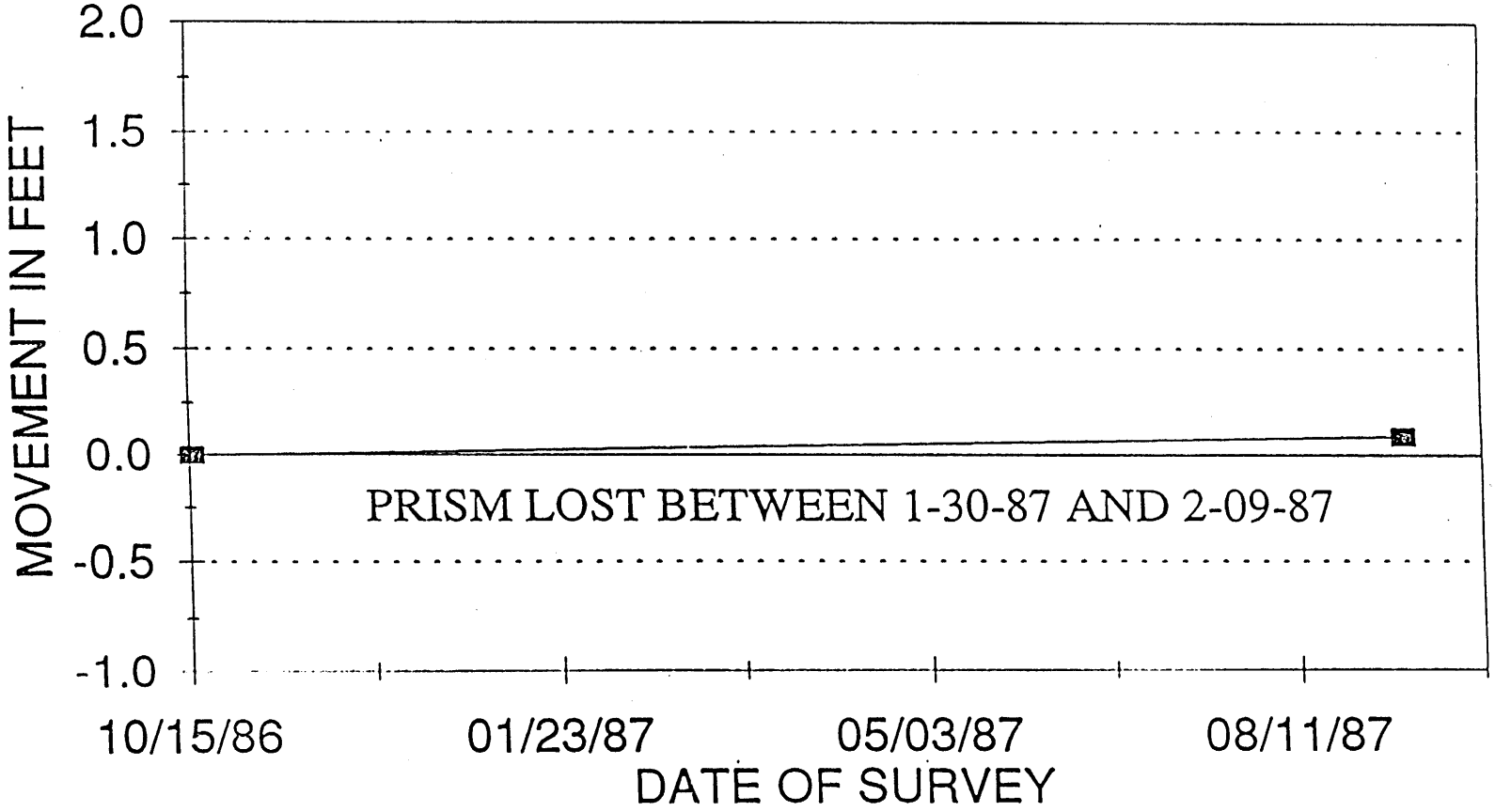
PR-1



REVISED 6/4/96

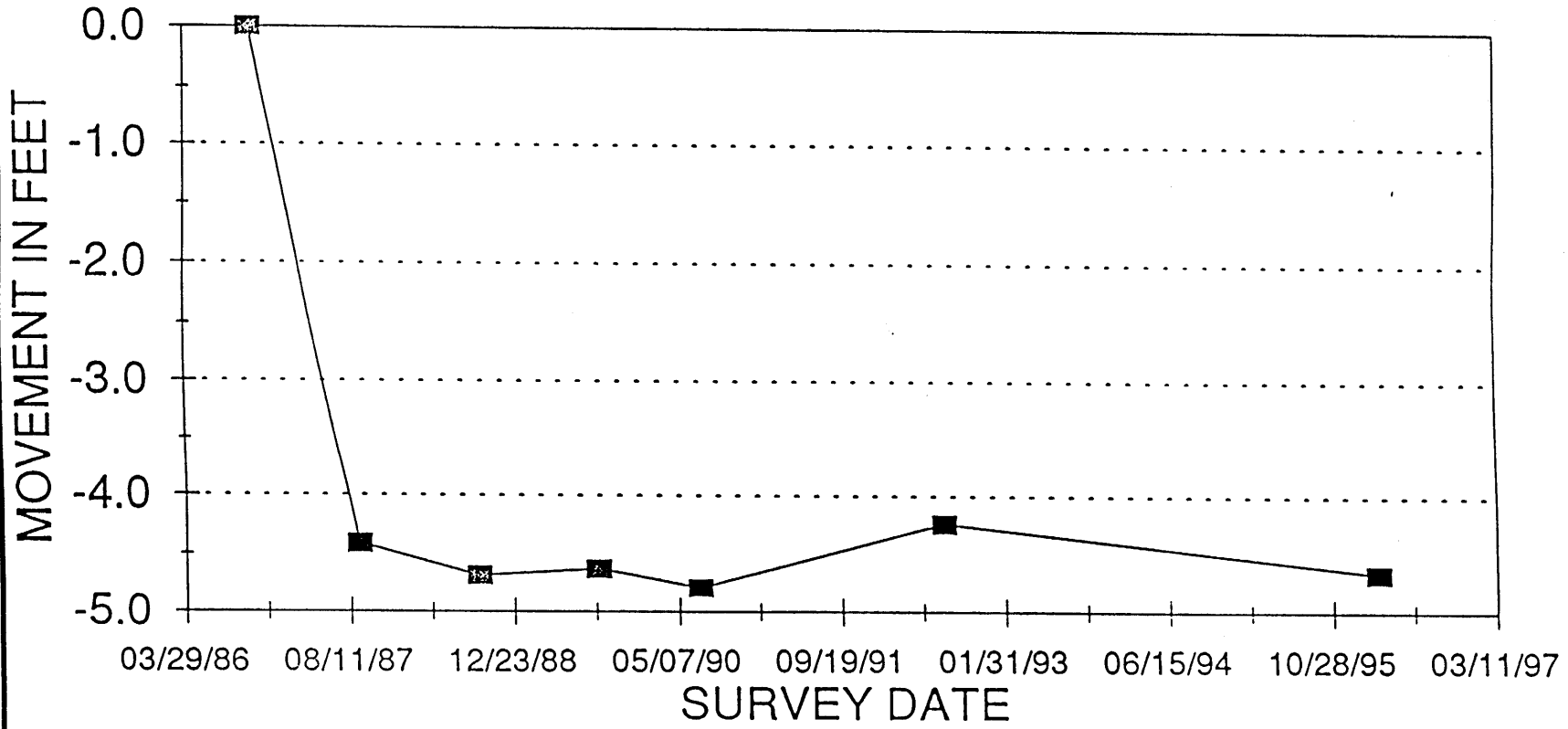
NEWBERRY CANYON

PR-2

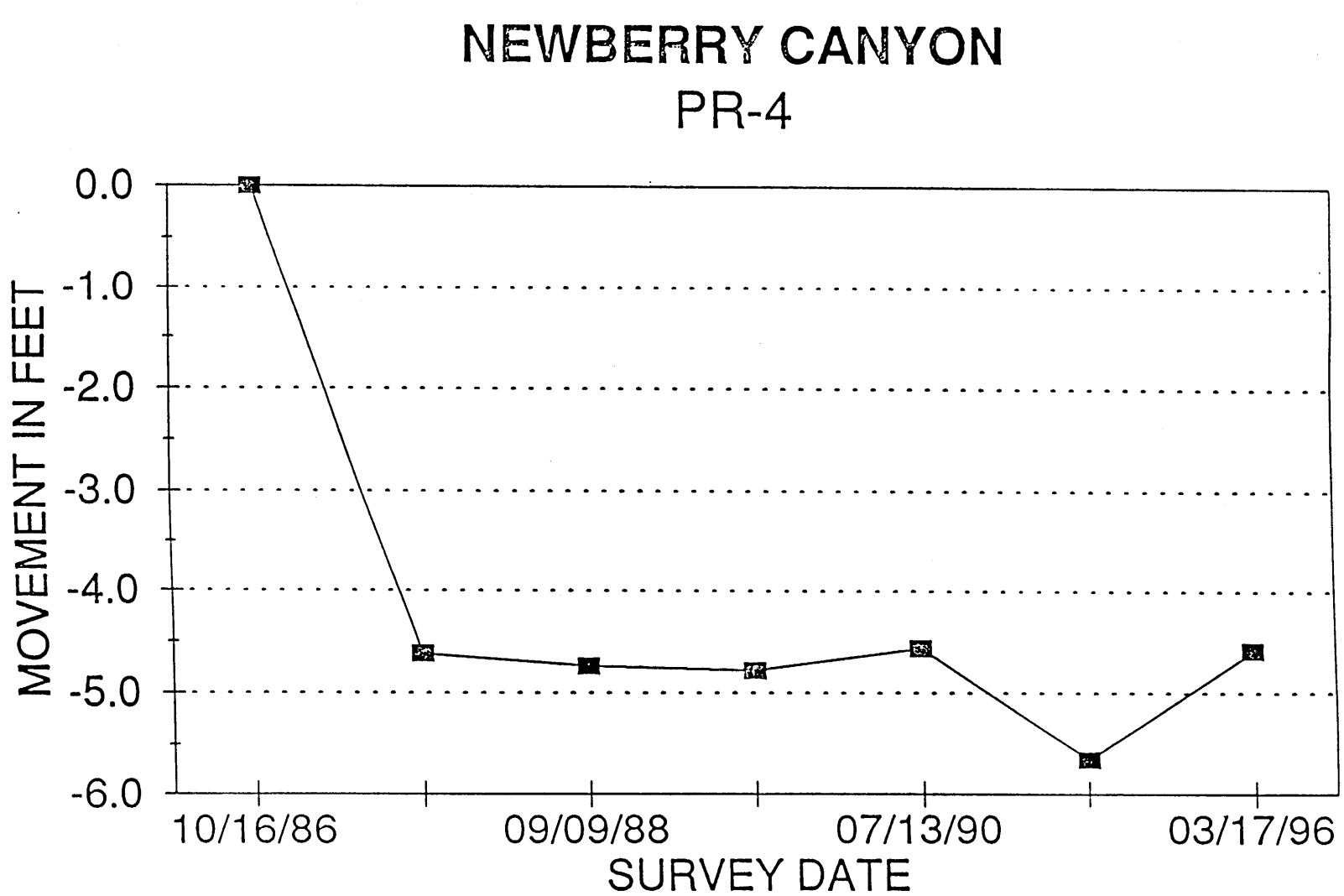


REVISED 6/4/96

NEWBERRY CANYON
PR-3



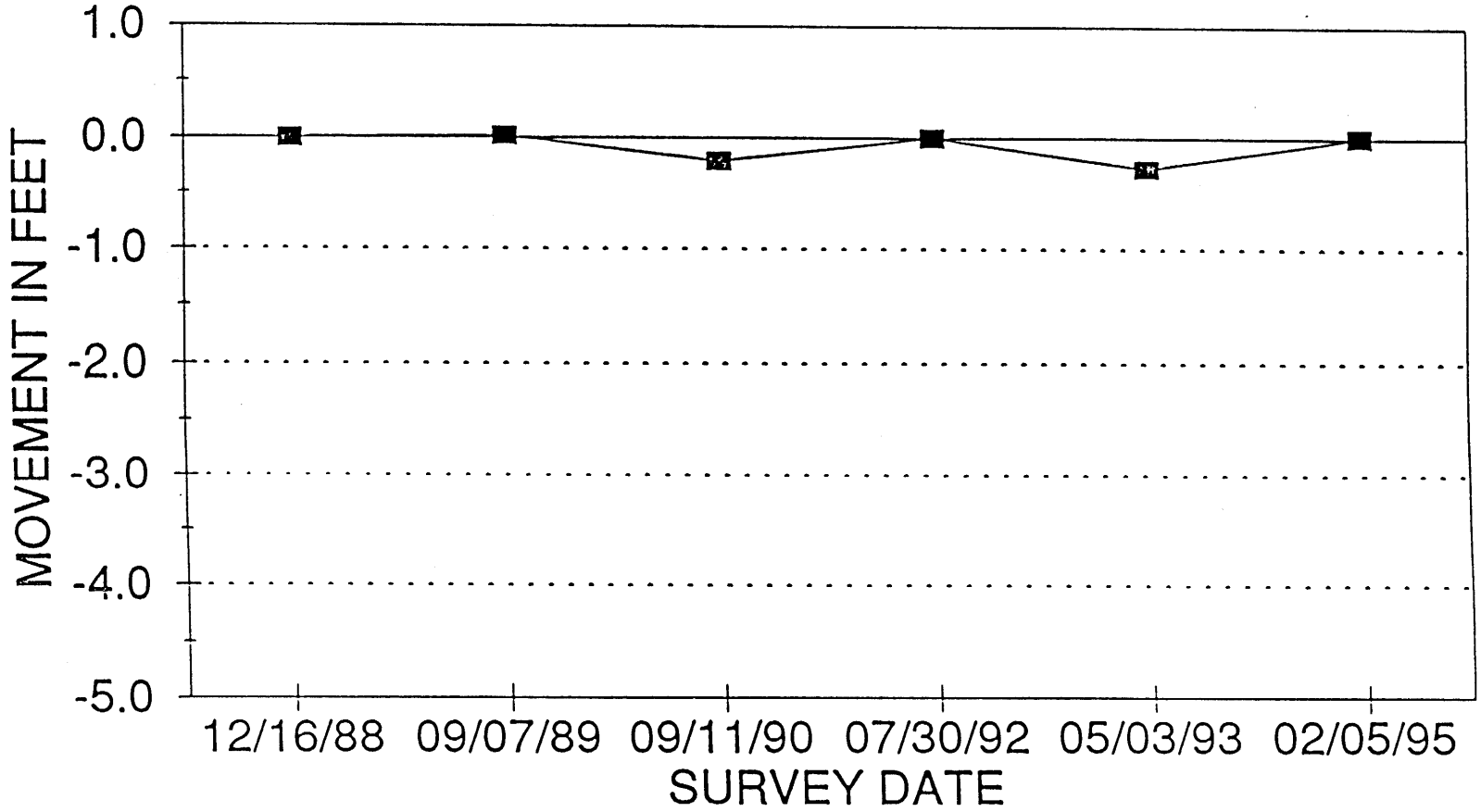
REVISED 6/4/96



REVISED 6/4/96

NEWBERRY CANYON

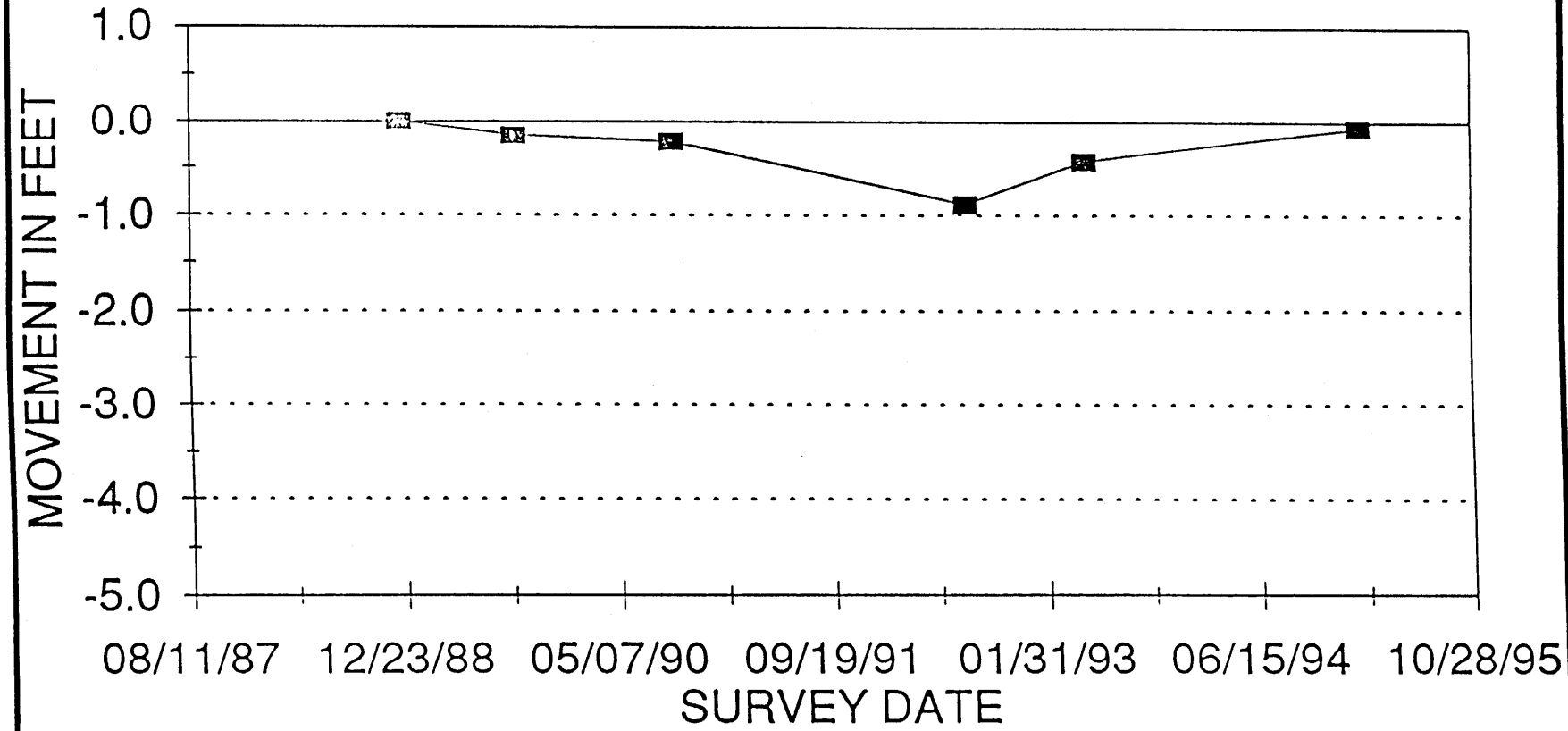
PR-5



REVISED 6/4/96

NEWBERRY CANYON

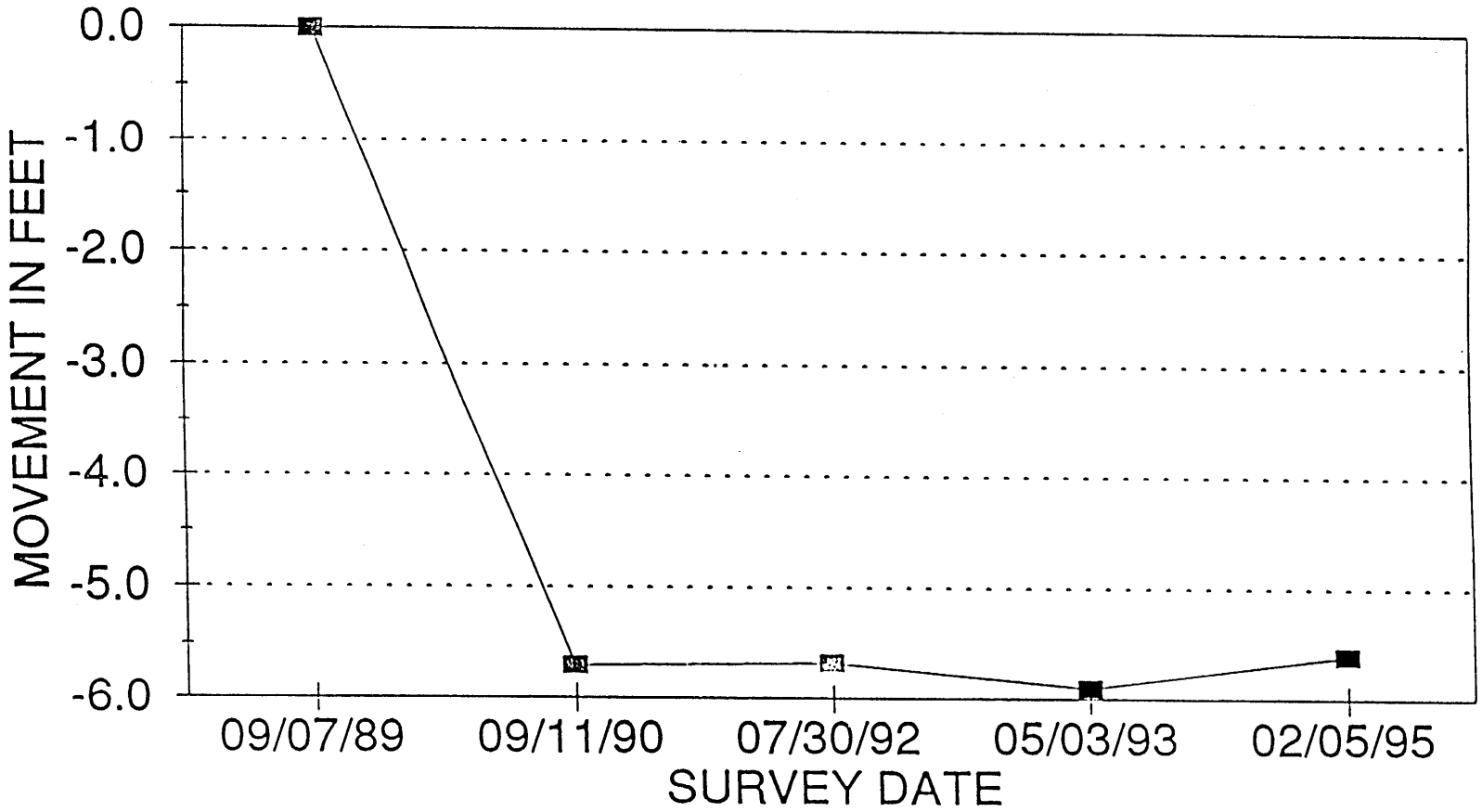
PR-6



REVISED 6/4/96

NEWBERRY CANYON

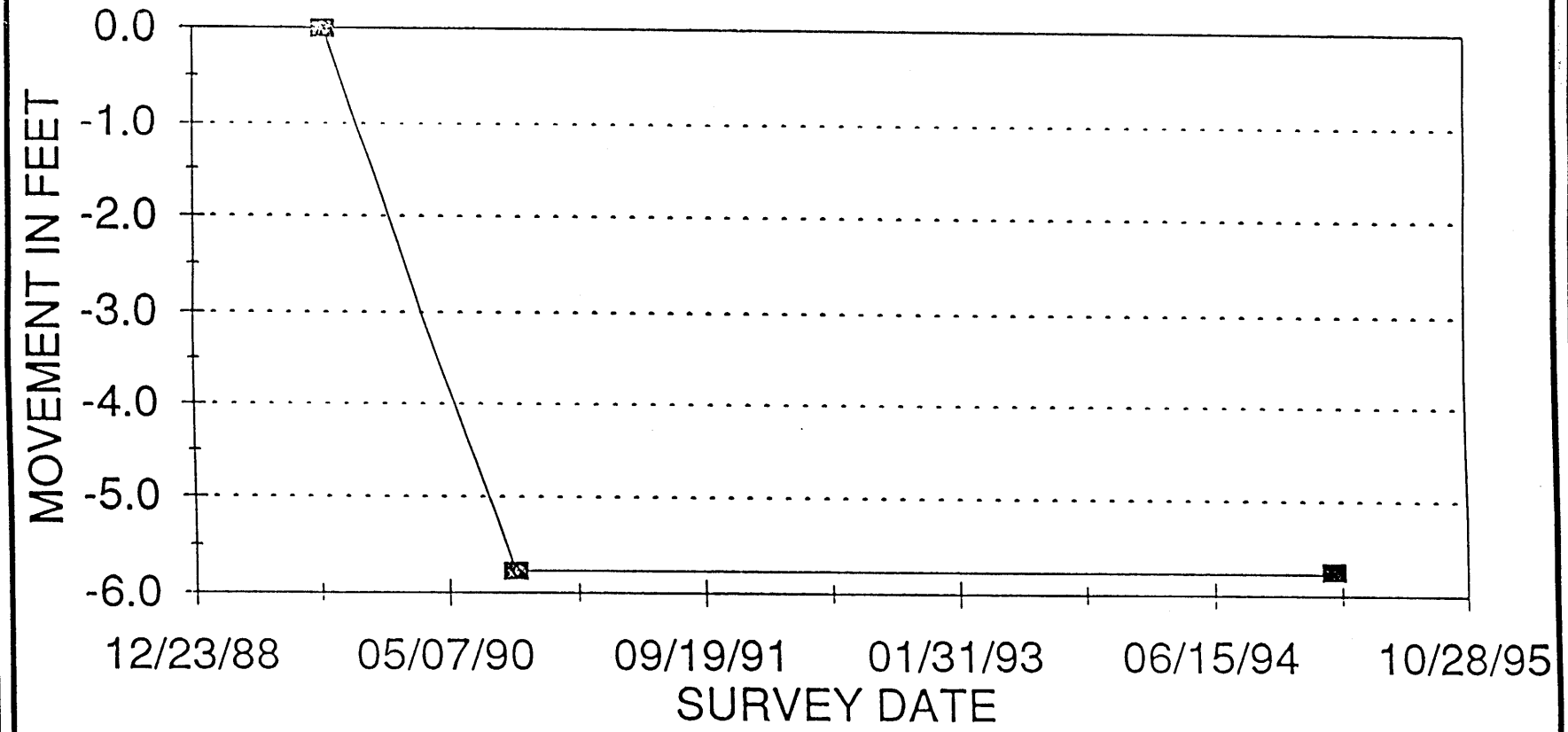
PR-7



REVISED 6/4/96

NEWBERRY CANYON

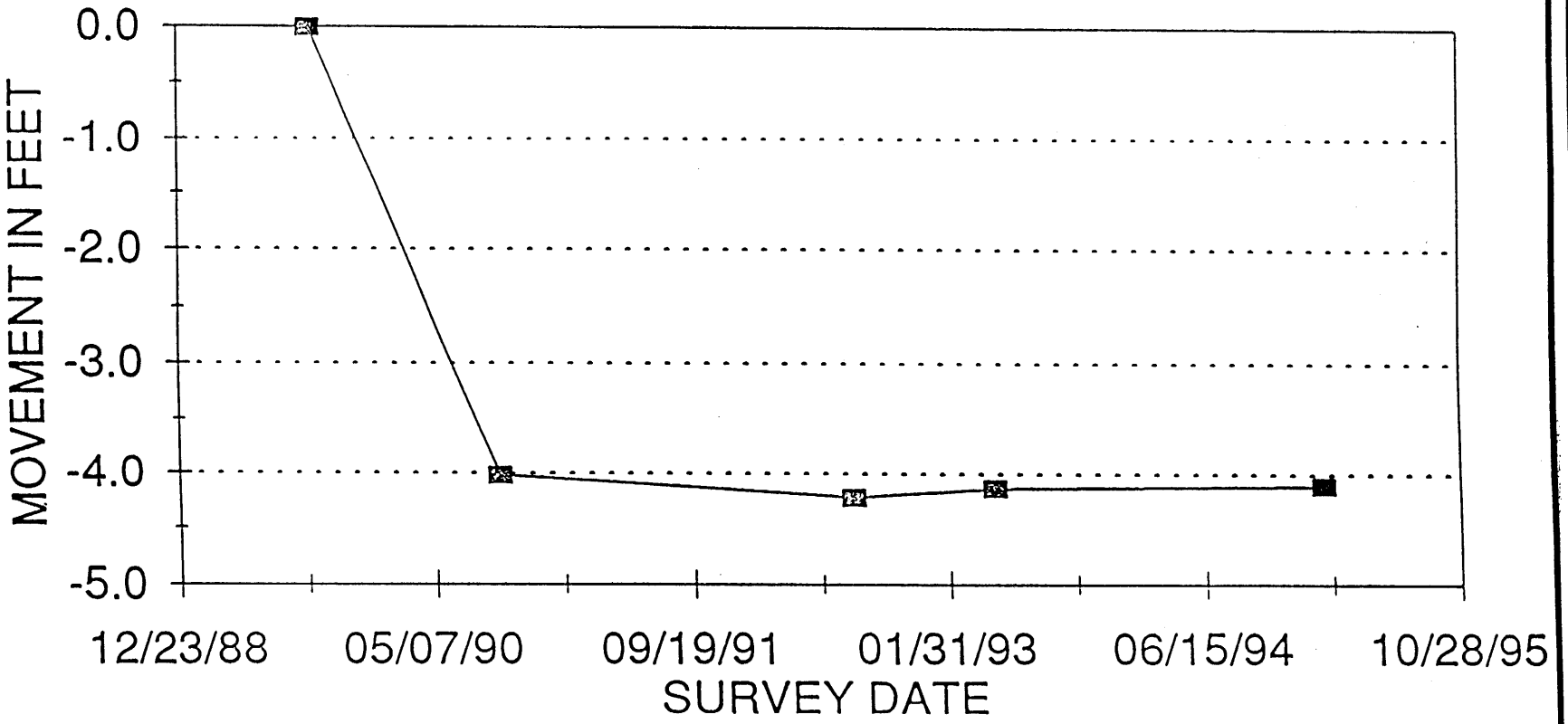
PR-8



REVISED 6/4/96

NEWBERRY CANYON

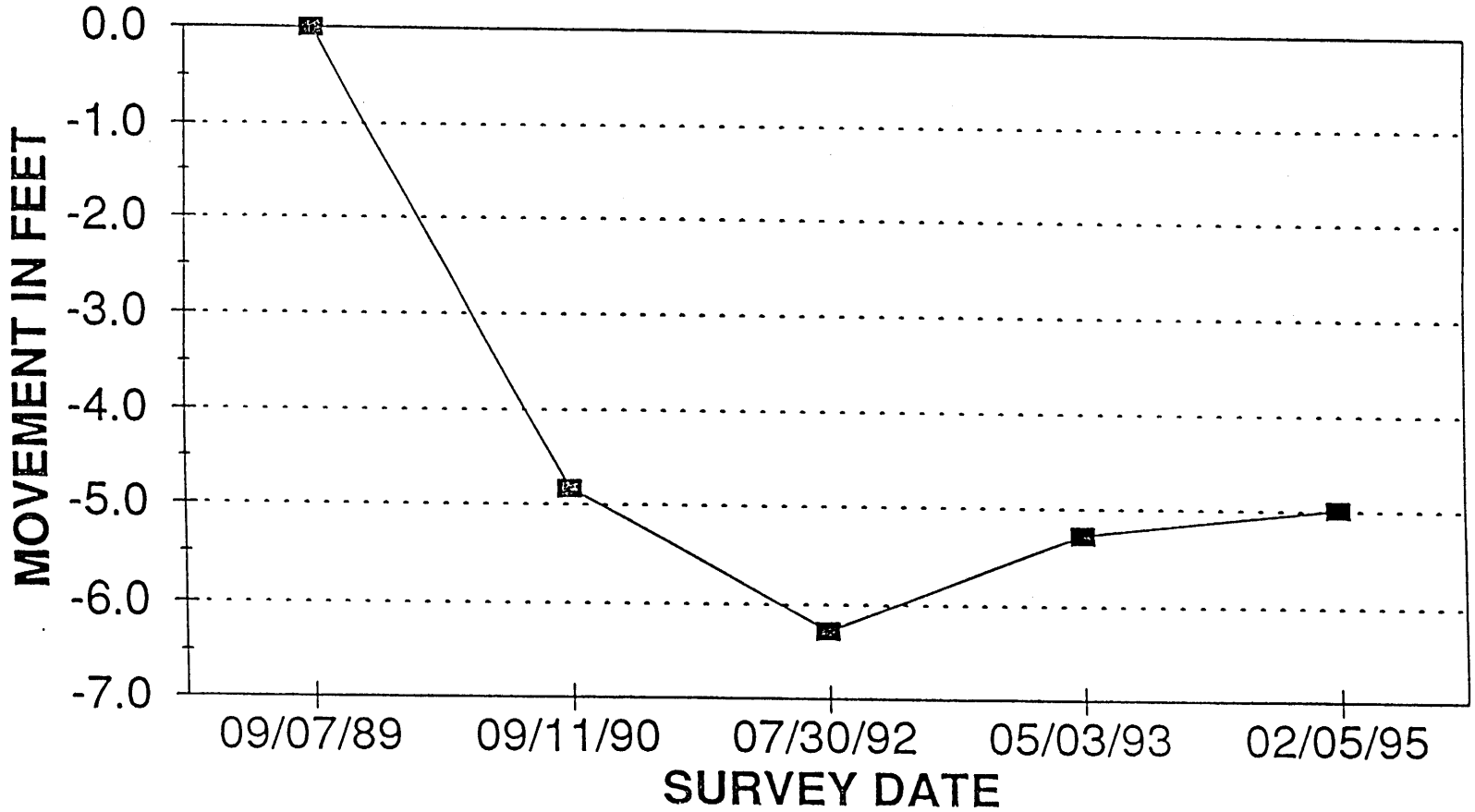
PR-9



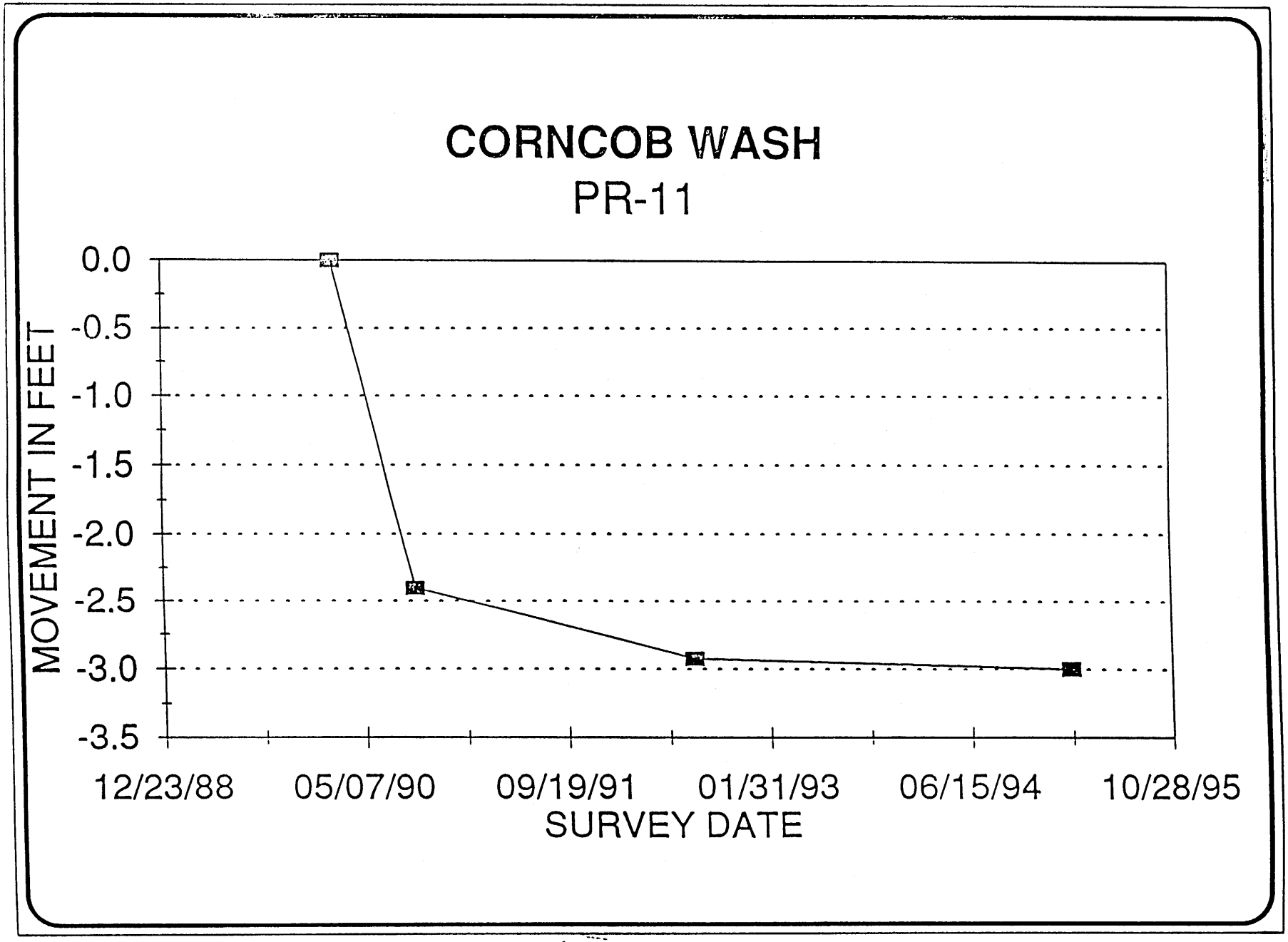
REVISED 6/4/96

NEWBERRY CANYON

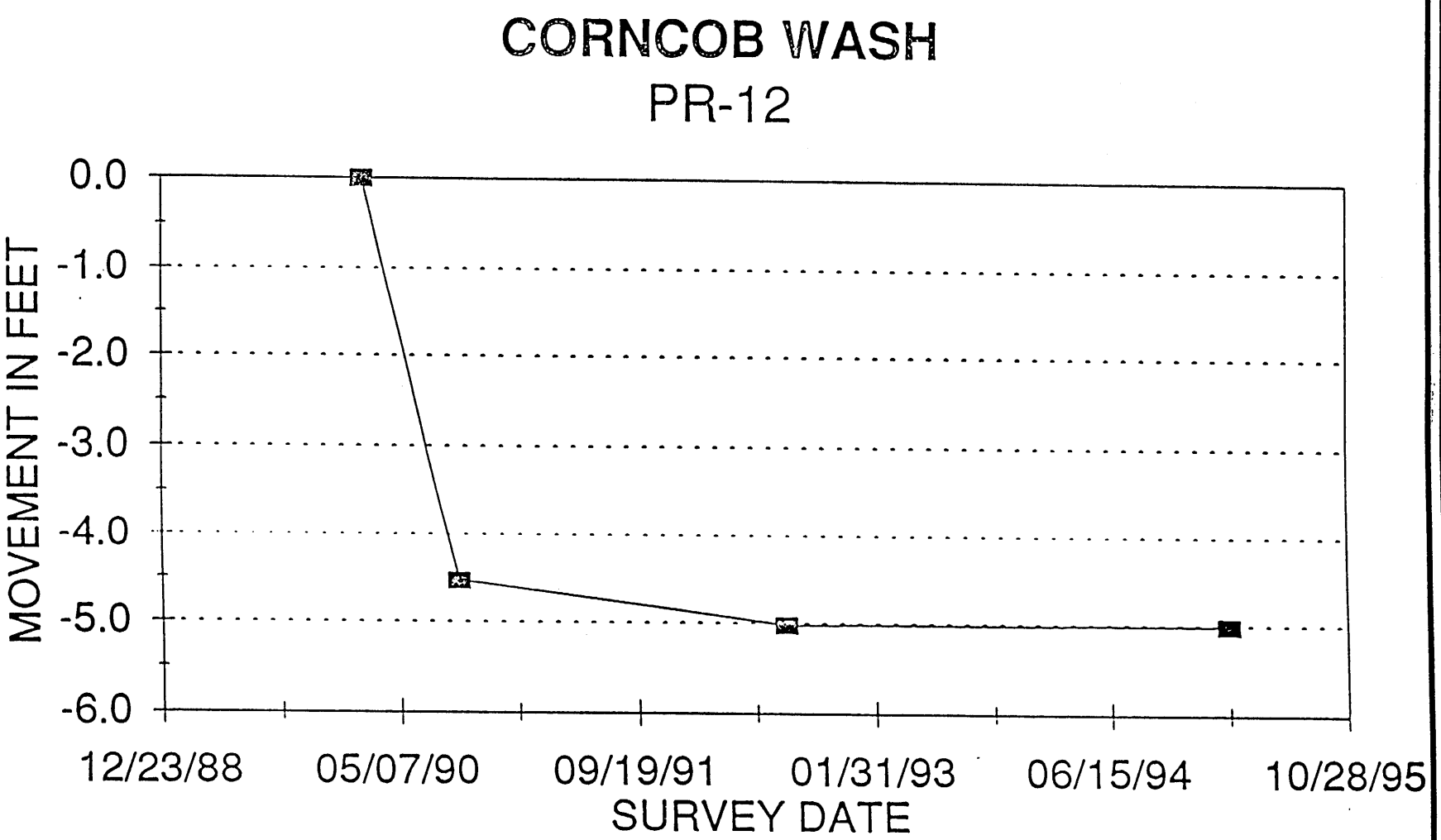
PR-10



REVISED 6/4/96



REVISED 6/4/96



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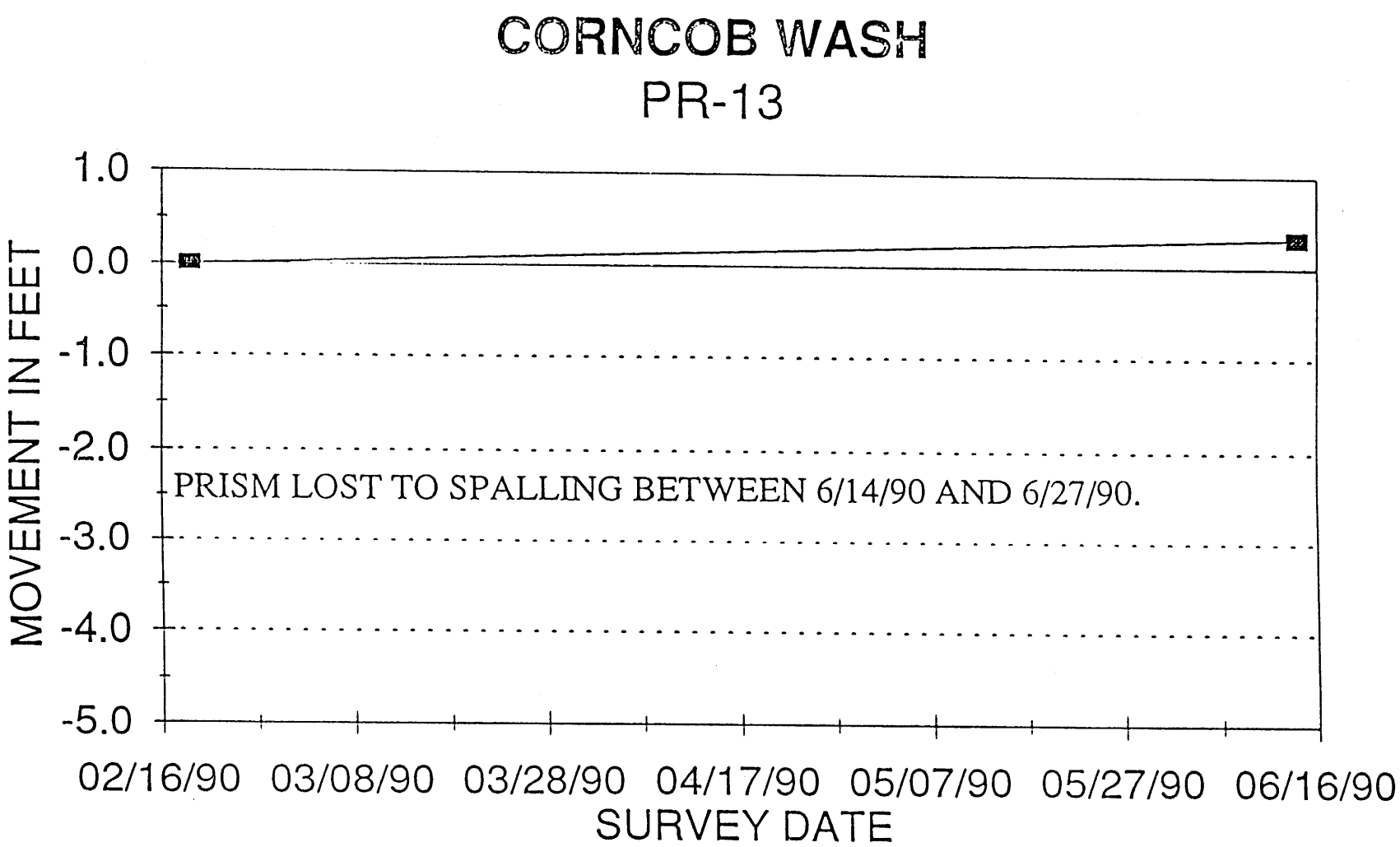
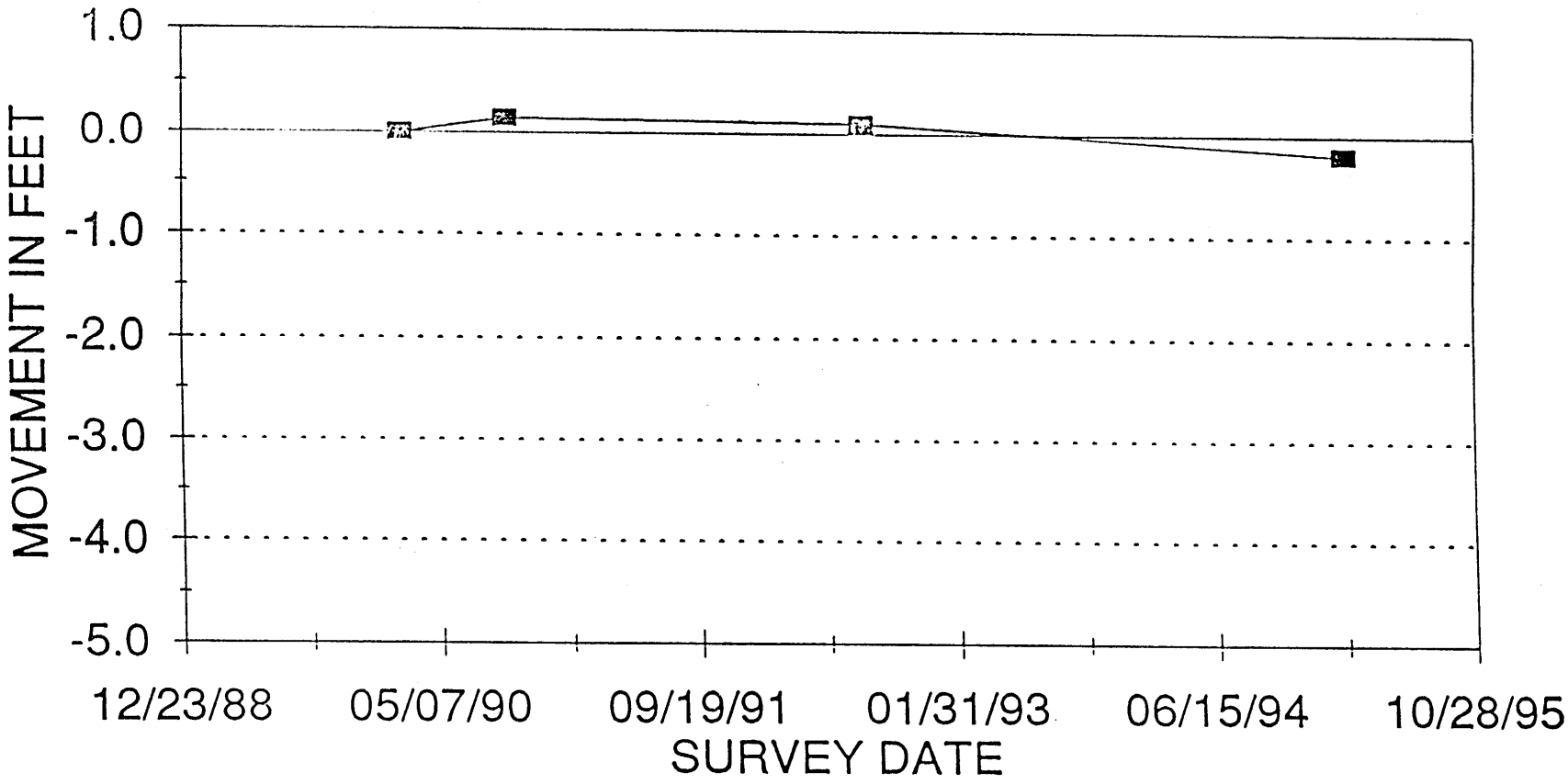


REVISED 6/4/96

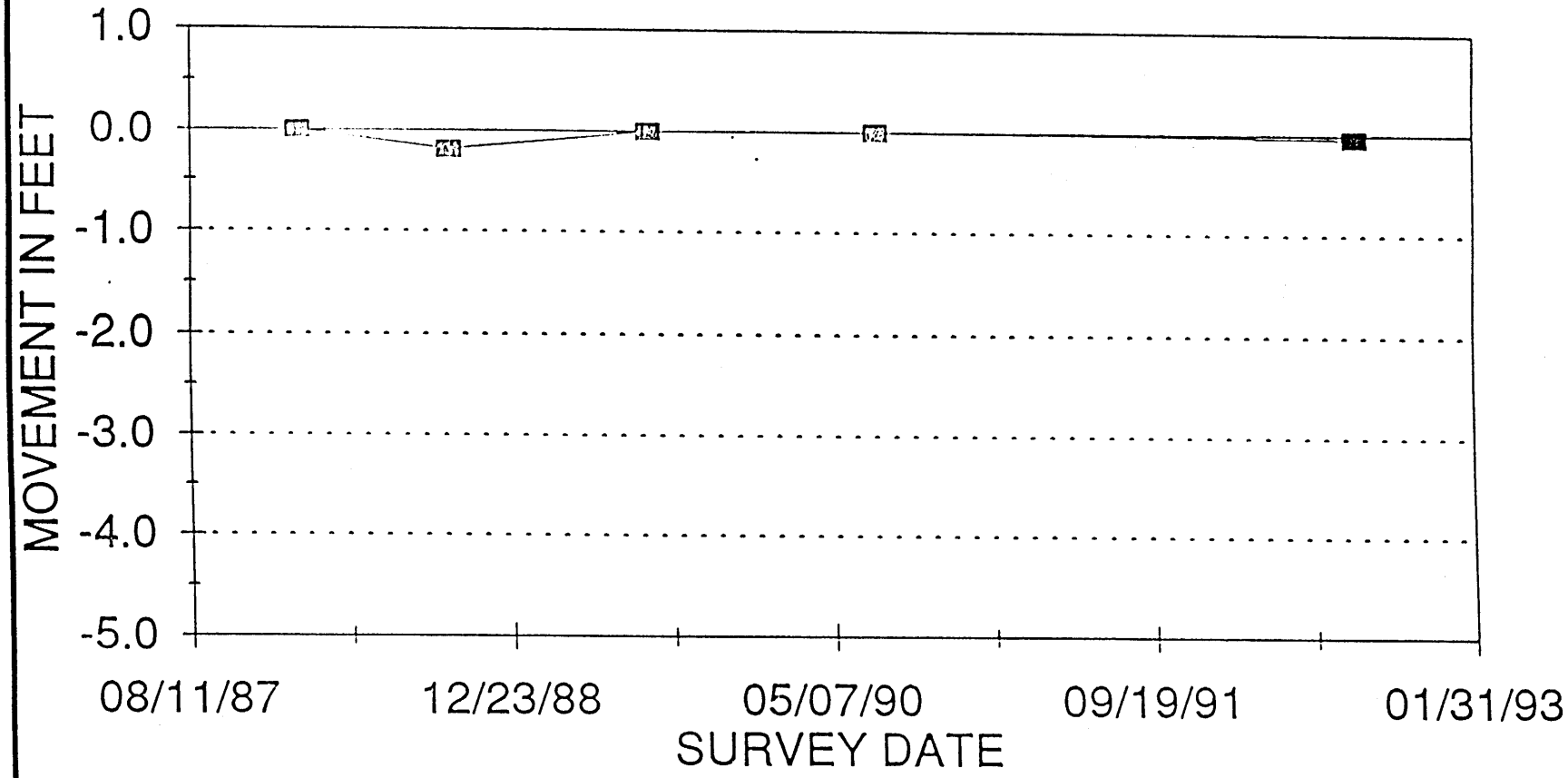
CORNCOB WASH

PR-14



REVISED 6/4/96

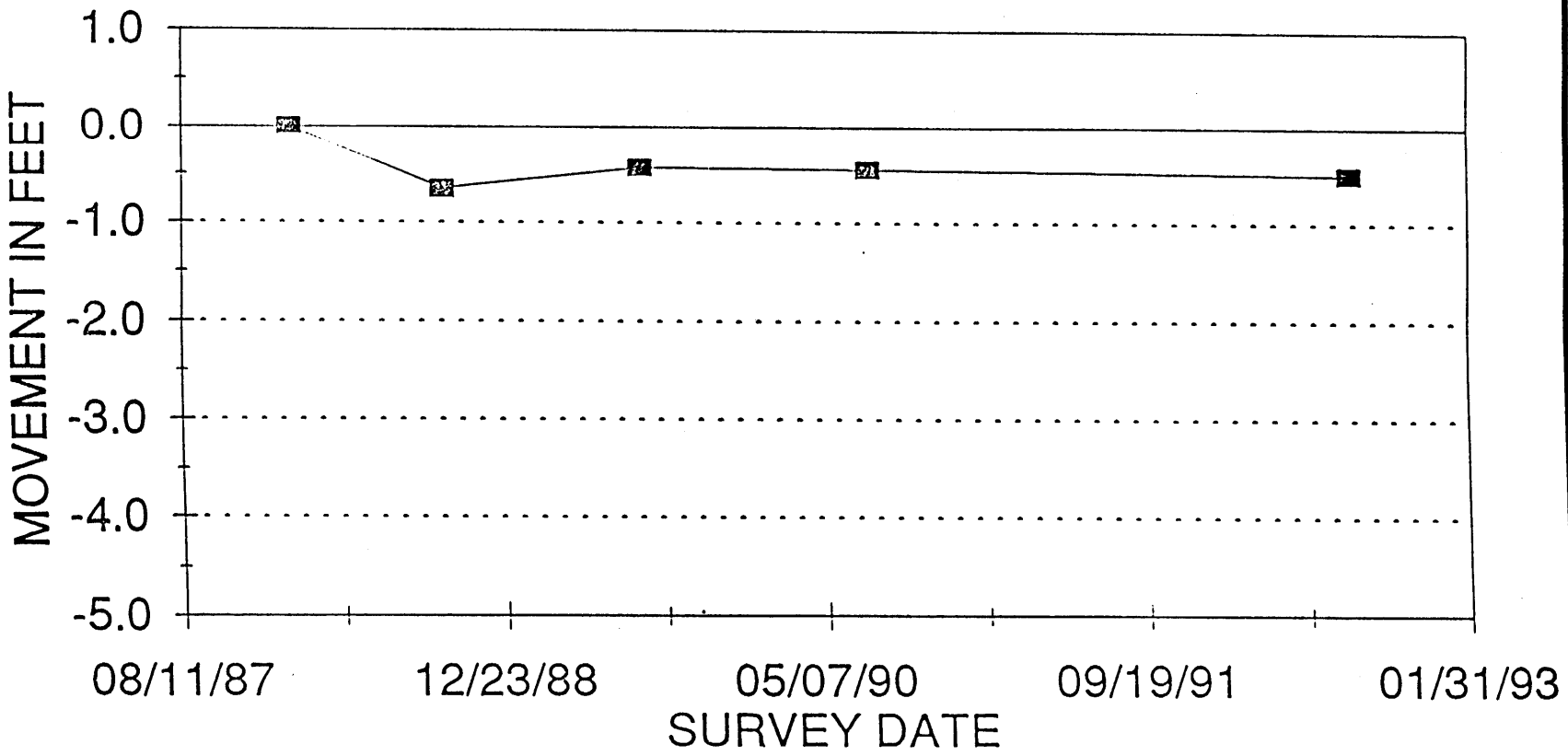
MILLER CANYON
PR-1



REVISED 6/4/96

MILLER CANYON

PR-2



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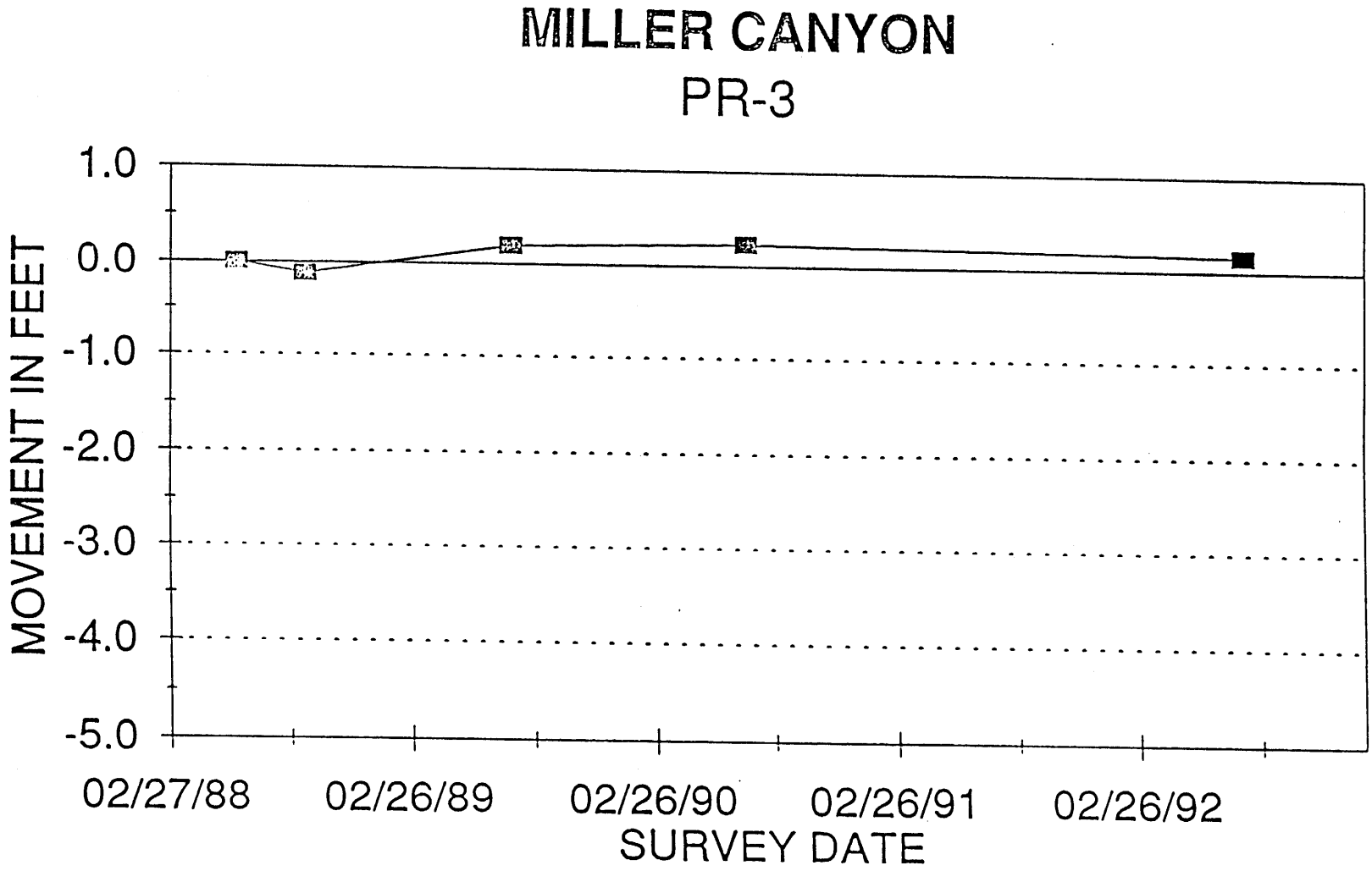

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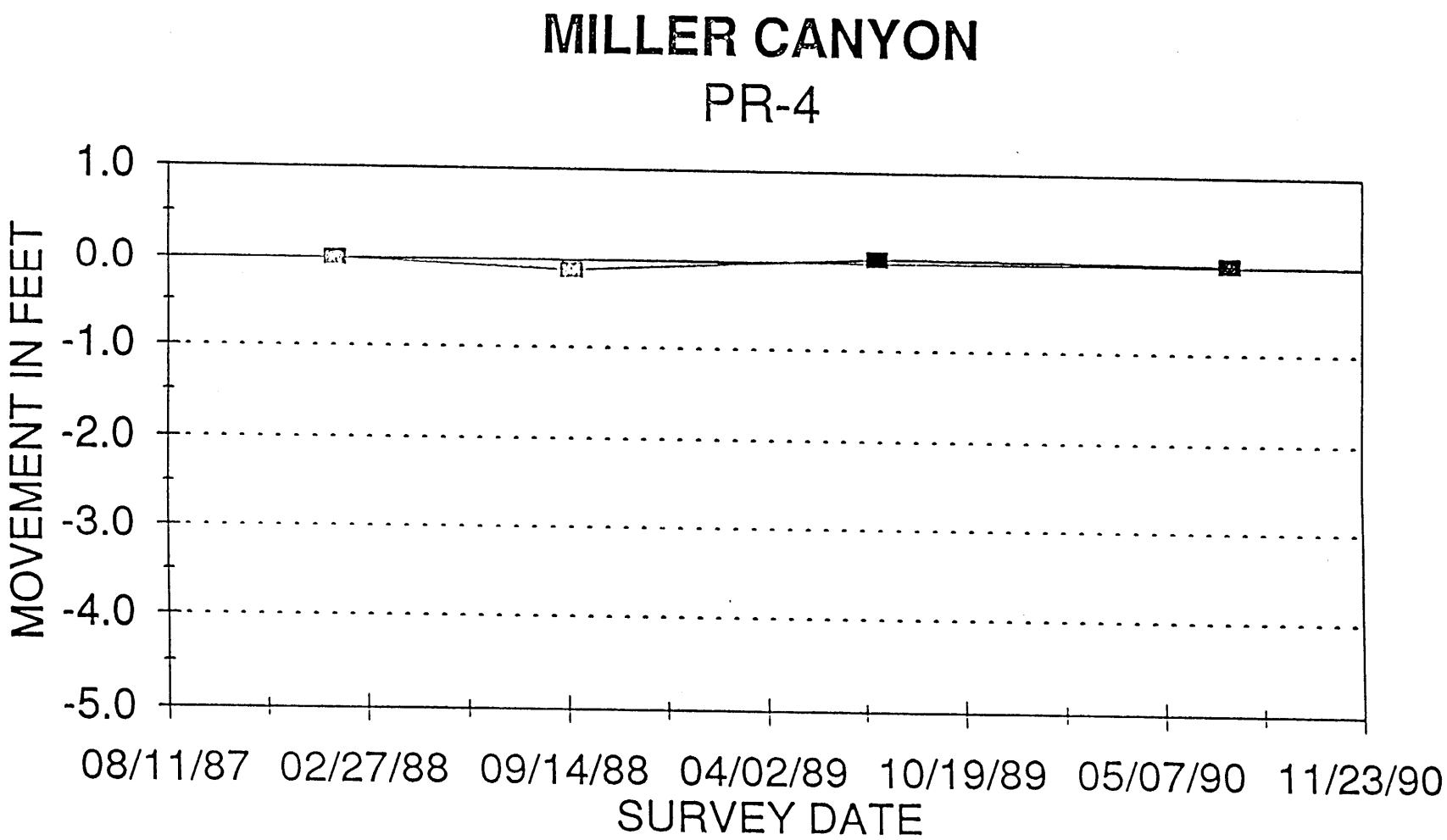

REVISED 6/4/96

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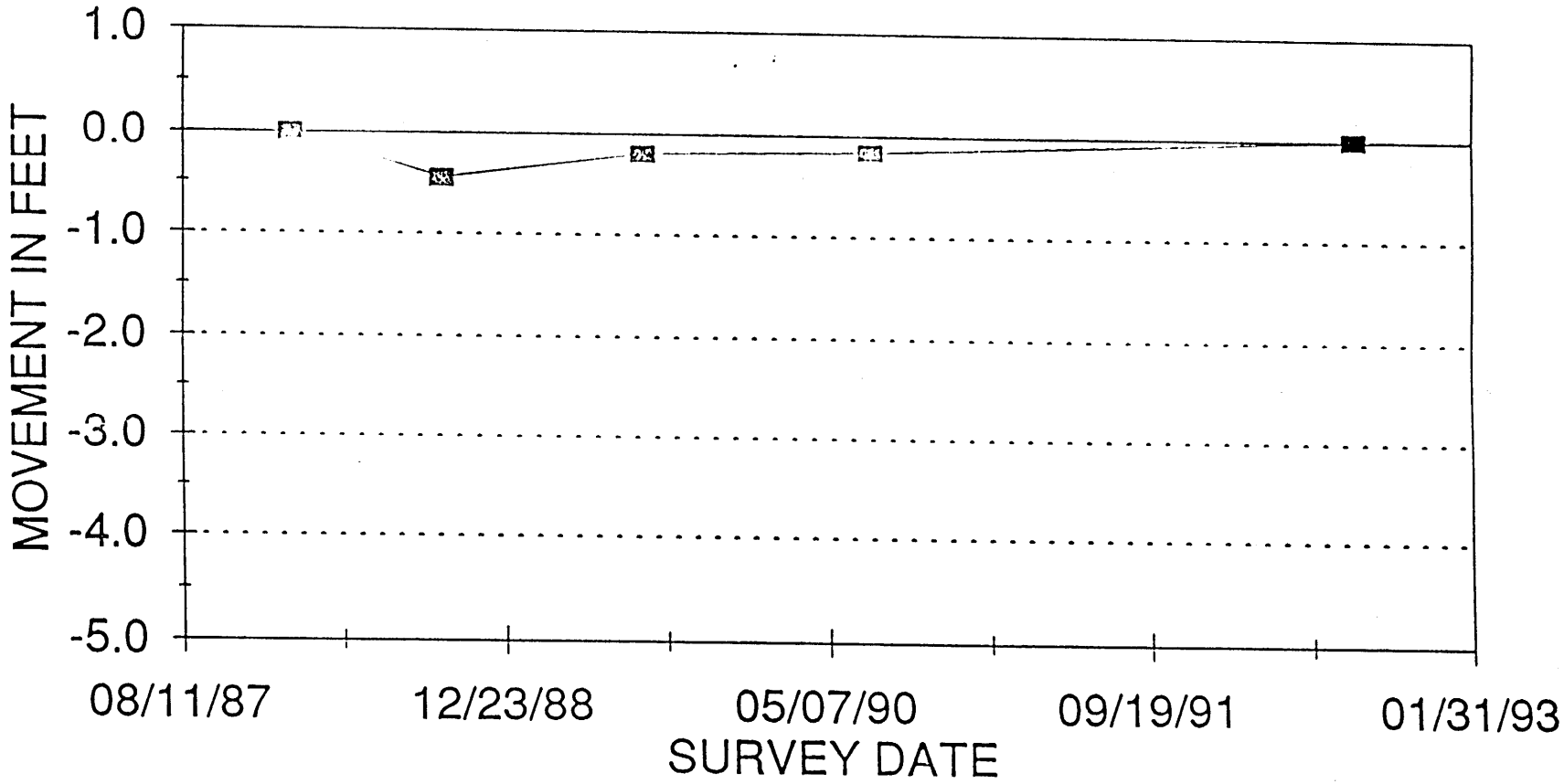

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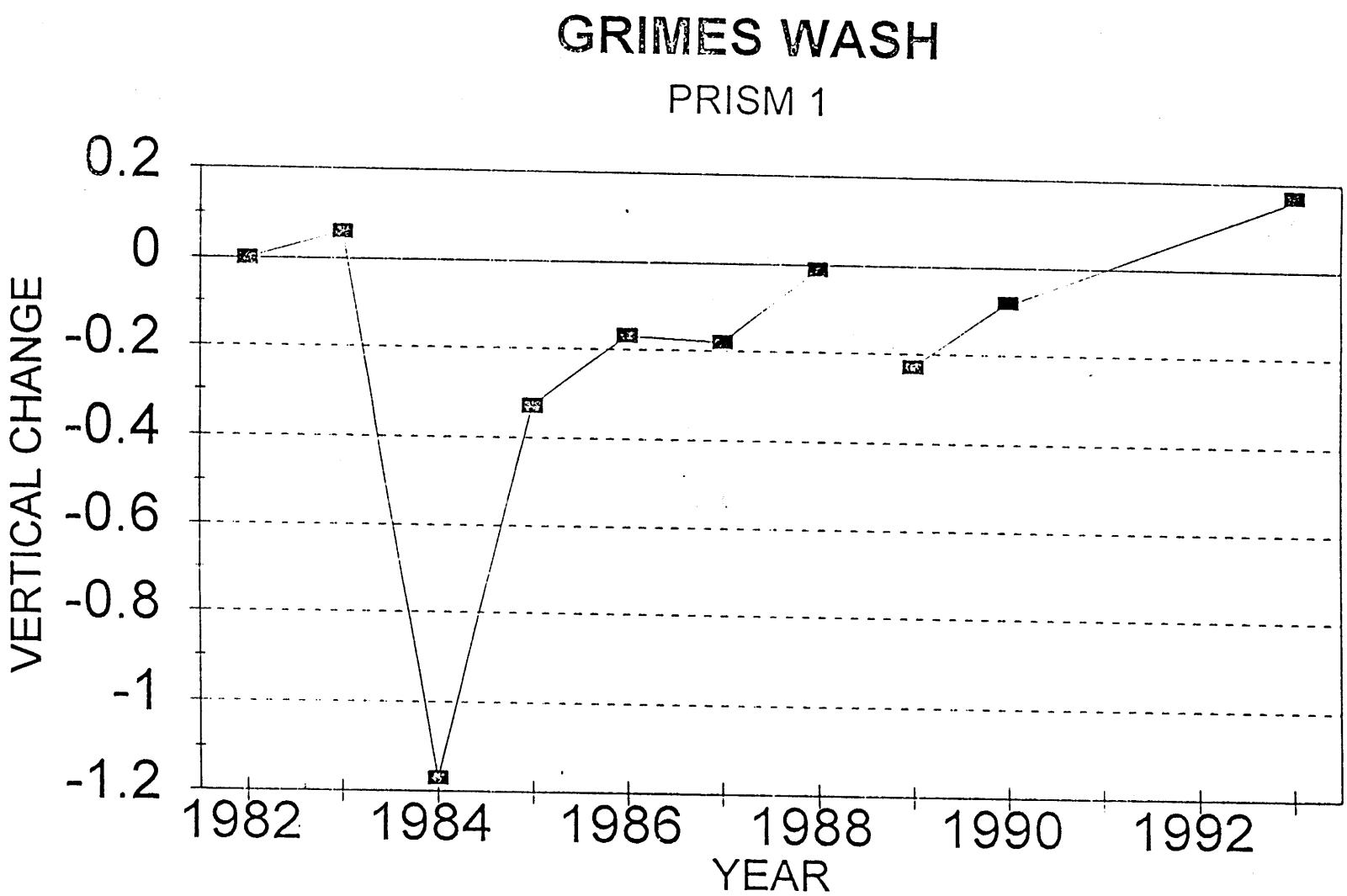
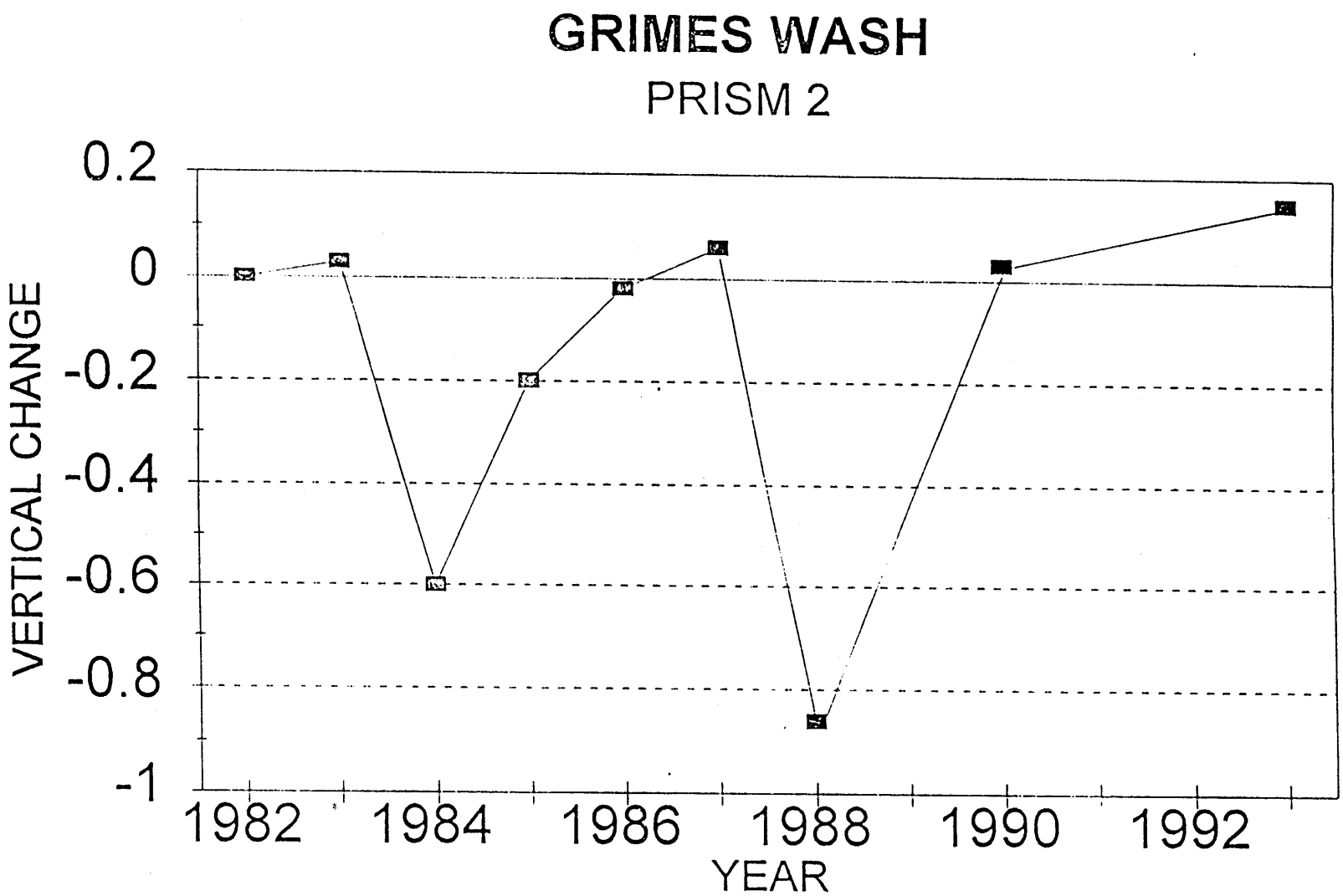
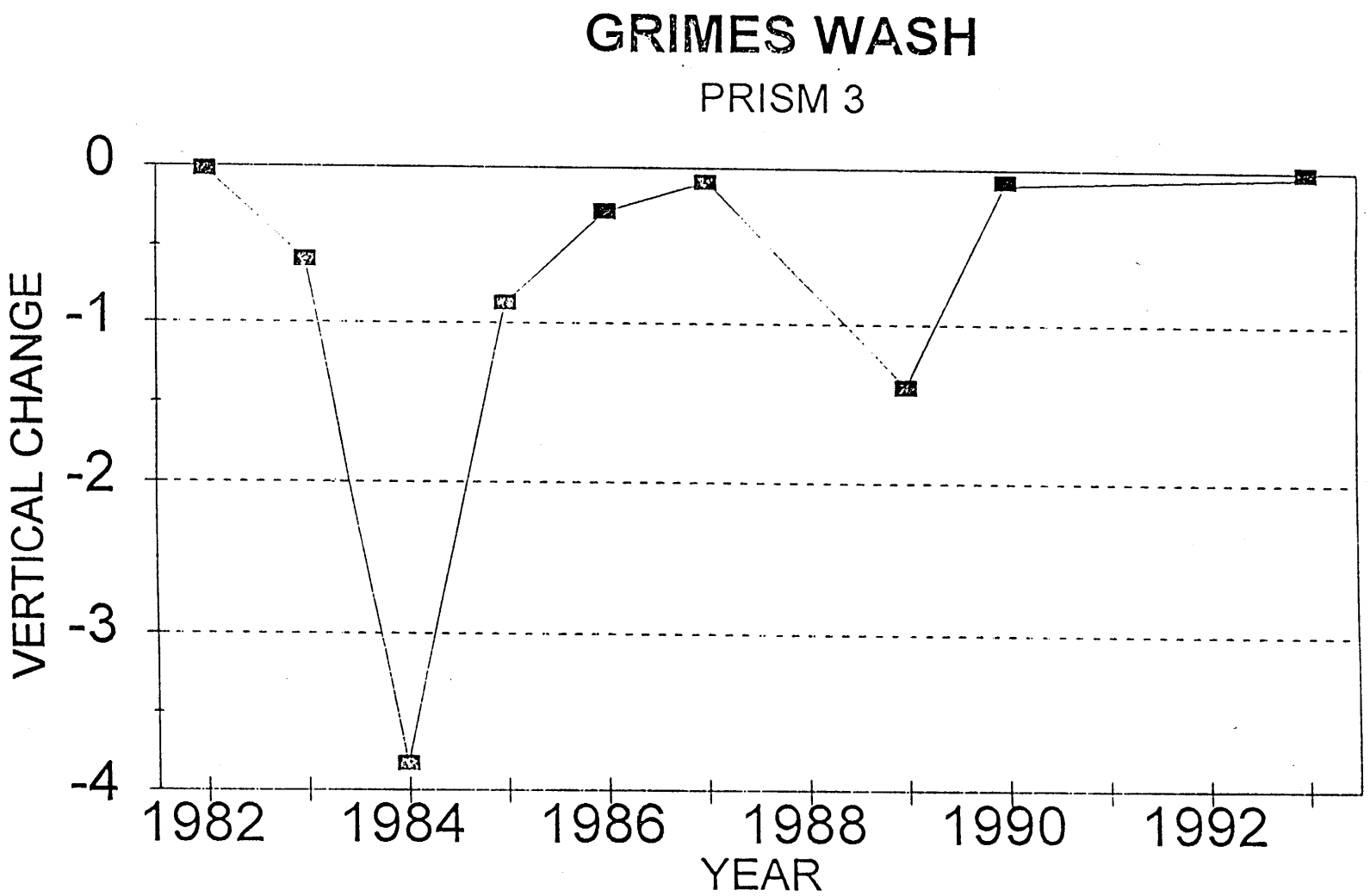

GRIMES WASH
PRISM 1
VERTICAL CHANGE
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
1982
1984
1986
1988
1990
1992
YEAR

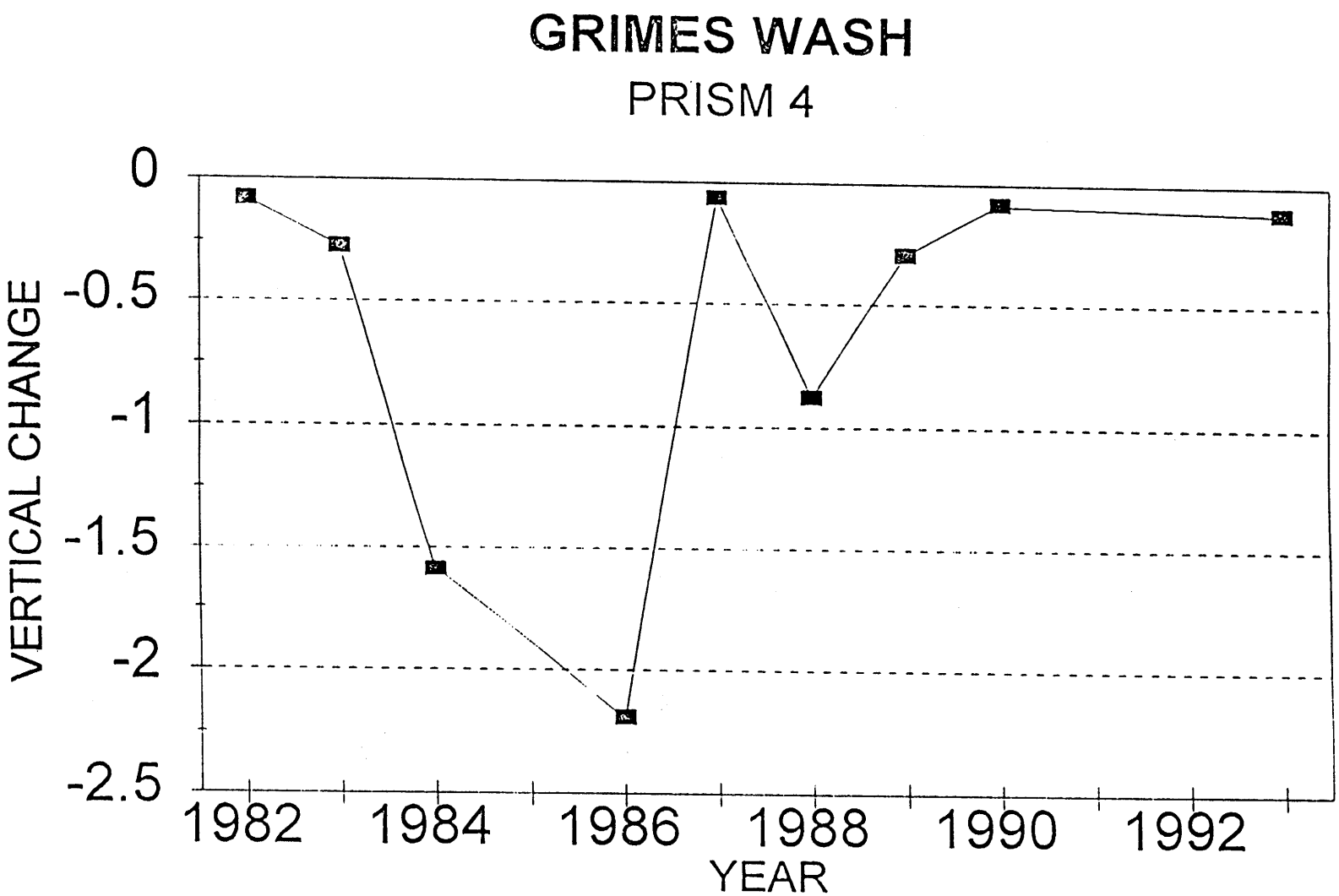
ADDED 6/4/96


GRIMES WASH
PRISM 2
VERTICAL CHANGE
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
1982
1984
1986
1988
1990
1992
YEAR

ADDED 6/4/96


GRIMES WASH
PRISM 3
VERTICAL CHANGE
0
-1
-2
-3
-4
1982
1984
1986
1988
1990
1992
YEAR

ADDED 6/4/96


GRIMES WASH
PRISM 4
VERTICAL CHANGE
0
-0.5
-1
-1.5
-2
-2.5
1982
1984
1986
1988
1990
1992
YEAR

ADDED 6/4/96

NEWBERRY CANYON PRISMS

		ELEV.	CHANGE
PR-1			
BASE	10/16/86	8661.51	0.00
	09/09/87	8661.90	0.39
	09/09/88	8661.51	0.00
	09/09/89	8661.42	-0.09
	07/13/90	8661.68	0.17
	07/31/92	8661.05	-0.46
	03/17/96	8661.69	0.18
PR-2			
BASE	16-Oct-86	8661.20	0.00
	09-Sep-87	8661.29	0.09
PRISM LOST DUE TO SPALLING BETWEEN 1-30-87 AND 2-09-87			
PR-3			
BASE	10/16/86	8884.18	0.00
	09/09/87	8879.77	-4.41
	09/09/88	8879.50	-4.68
	09/09/89	8879.55	-4.63
	07/13/90	8879.39	-4.79
	07/31/92	8879.95	-4.23
	03/17/96	8879.52	-4.66
PR-4			
BASE	10/16/86	8679.50	0.00
	09/09/87	8674.88	-4.62
	09/09/88	8674.76	-4.74
	09/09/89	8674.72	-4.78
	07/13/90	8674.94	-4.57
	07/31/92	8673.84	-5.66
	03/17/96	8674.91	-4.59
PR-5			
BASE	12/16/88	8682.62	0.00
	09/07/89	8682.63	0.01
	09/11/90	8682.41	-0.21
	07/30/92	8682.62	0.00
	05/03/93	8682.34	-0.28
	02/05/95	8682.63	0.01
PR-6			
BASE	12/16/88	8636.87	0.00
	09/07/89	8636.72	-0.15
	09/11/90	8636.65	-0.22
	07/30/92	8635.98	-0.89
	05/03/93	8636.44	-0.43
	02/05/95	8636.81	-0.06
PR-7			
BASE	09/07/89	8649.78	0.00
	09/11/90	8644.08	-5.70

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	07/30/92	8644.11	-5.67
	05/03/93	8643.88	-5.90
	02/05/95	8644.18	-5.60
PR-8			
BASE	09/10/89	8653.62	0.00
	09/11/90	8647.85	-5.76
	07/30/92	NO DATA COLLECTED	
	05/03/93	NO DATA COLLECTED	
	02/05/95	8647.88	-5.74
PR-9			
BASE	09/07/89	8666.49	0.00
	09/11/90	8662.47	-4.01
	07/30/92	8662.27	-4.22
	05/03/93	8662.36	-4.13
	02/05/95	8662.38	-4.11
PR-10			
BASE	09/07/89	8670.71	0.00
	09/11/90	8665.87	-4.84
	07/30/92	8664.43	-6.27
	05/03/93	8665.43	-5.28
	02/05/95	8665.72	-4.98
CORN COB WASH			
PR-11			
BASE	02/19/90	8708.98	0.00
	09/11/90	8706.58	-2.40
	07/30/92	8706.05	-2.93
	02/19/95	8705.98	-3.00
PR-12			
BASE	02/19/90	8698.60	0.00
	09/11/90	8694.06	-4.53
	07/30/92	8693.57	-5.02
	02/19/95	8693.59	-5.01
PR-13			
BASE	02/19/90	8654.05	0.00
	06/14/90	8654.38	0.32
	PRISM LOST TO SPALLING BETWEEN 6/14/90 AND 6/27/90		
PR-14			
BASE	02/19/90	8730.70	0.00
	09/11/90	8730.84	0.14
	07/30/92	8730.80	0.10
	02/19/95	8730.51	-0.19
ER CANYON PRISMS			
PR-1			
BASE	01/27/88	8536.54	0.00

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	09/19/88	8536.35	-0.19
	07/24/89	8536.54	-0.00
	07/13/90	8536.54	-0.01
	07/31/92	8536.51	-0.04
PR-2			
BASE	01/27/88	8832.17	0.00
	09/19/88	8831.52	-0.65
	07/24/89	8831.74	-0.43
	07/13/90	8831.72	-0.45
	07/31/92	8831.68	-0.49
PR-3			
BASE	06/08/88	8426.19	0.00
	09/19/88	8426.07	-0.12
	07/24/89	8426.39	0.20
	07/13/90	8426.43	0.24
	07/31/92	8426.35	0.16
PR-4			
BASE	01/27/88	8781.43	0.00
	09/19/88	8781.31	-0.12
	07/24/89	8781.48	0.05
	07/13/90	8781.45	0.02
	07/31/92	NO DATA COLLECTED	
PR-5			
BASE	01/27/88	8481.41	0.00
	09/19/88	8480.95	-0.46
	07/24/89	8481.21	-0.20
	07/31/92	8481.41	0.00

ADDED 6/4/96

GRIMES WASH PRISMS

LEASE U-1358 CHANGE FROM BASE ELEVATION

YEAR	PR-1	PR-2	PR-3	PR-4
1982	0.00	0.00	-0.02	-0.08
1983	0.06	0.03	-0.59	-0.27
1984	-1.17	-0.60	-3.83	-1.59
1985	-0.33	-0.20	-0.87	
1986	-0.17	-0.02	-0.28	-2.19
1987	-0.18	0.06	-0.09	-0.06
1988	-0.01	-0.86		-0.88
1989	-0.23		-1.40	-0.29
1990	-0.08	0.03	-0.08	-0.08
1991	NO DATA COLLECTED			
1992	NO DATA COLLECTED			
1993	0.17	0.15	-0.01	-0.11
1994	NO DATA COLLECTED			
1995	NO DATA COLLECTED			

ADDED 6/4/96