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DIVISION OF
OIL, GAS & MINING

UTAH POWER & LIGHT COMPANY
SUBSIDENCE MONITORING PROGRAM
ANNUAL REPORT FOR 1988

March 1989

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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APPENDICES

Des-Bee-Dove Mines
Deer Creek Mine
Wilberg/Cottonwood Mine

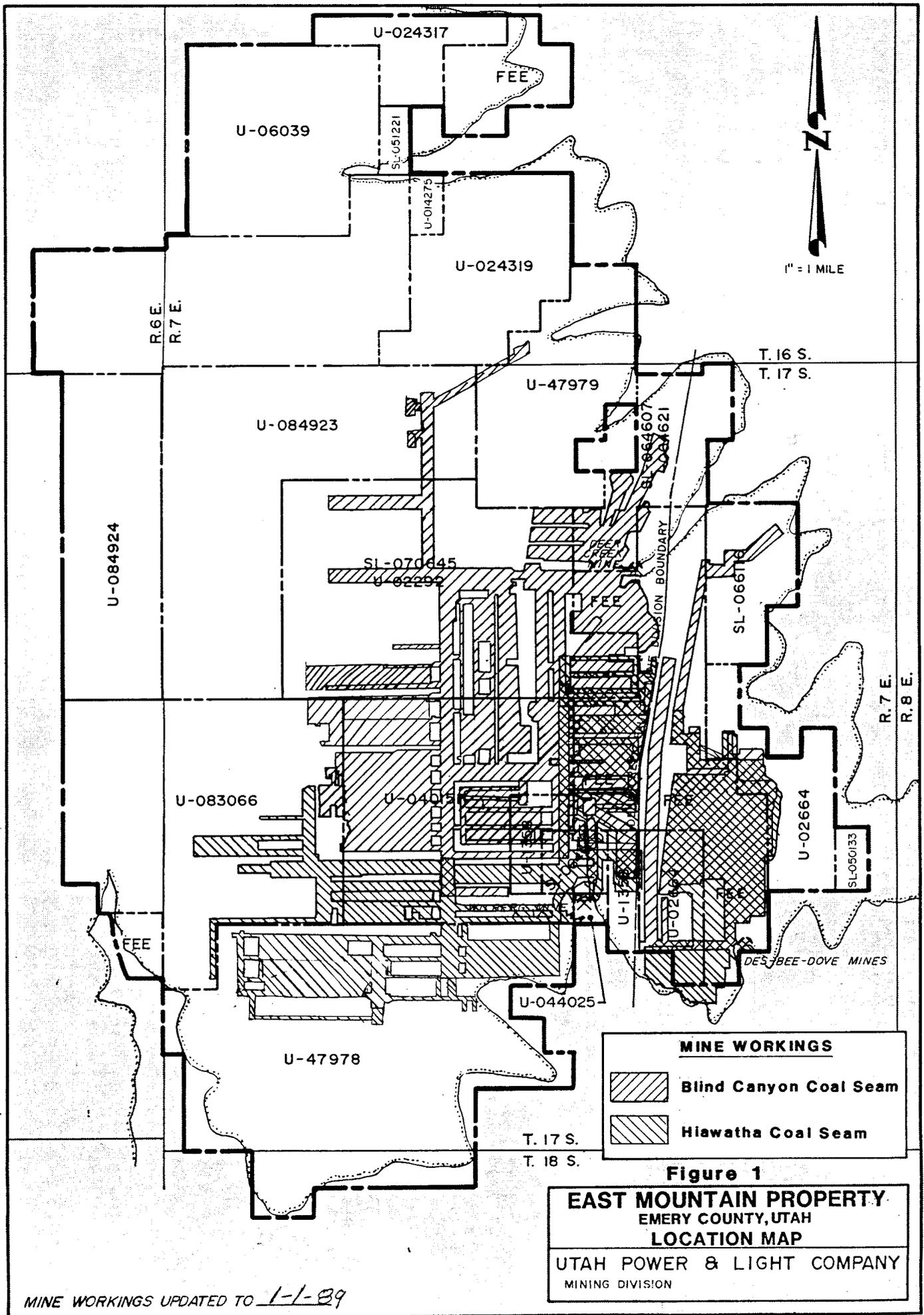
Utah Power & Light Company's (UP&L) East Mountain Subsidence Monitoring Study is an ongoing project designed to detect, observe, and report the effects of mining-induced subsidence above the Deer Creek, Wilberg/Cottonwood, and Des-Bee-Dove Mines (see Figure 1). This, the eighth such annual report submitted, covers the period between August 31, 1987 and August 31, 1988.

The initial report submitted in 1982 details the monitoring methods used in the study; therefore, they are not discussed in depth here. Briefly, UP&L uses aerial photogrammetric survey methods and annual helicopter reconnaissance flights to monitor subsidence. Conventional surveying of monuments above multi-seam longwall mining in the Deer Creek and Wilberg mines performed previously by the U.S. Bureau of Mines and UP&L was done in 1988 for the last time. UP&L has shown that aerial surveys provide a better indication of actual subsidence and has received acceptance from the Division of Oil, Gas and Mining (DOGM) of our request to discontinue the on-the-ground work.

Location

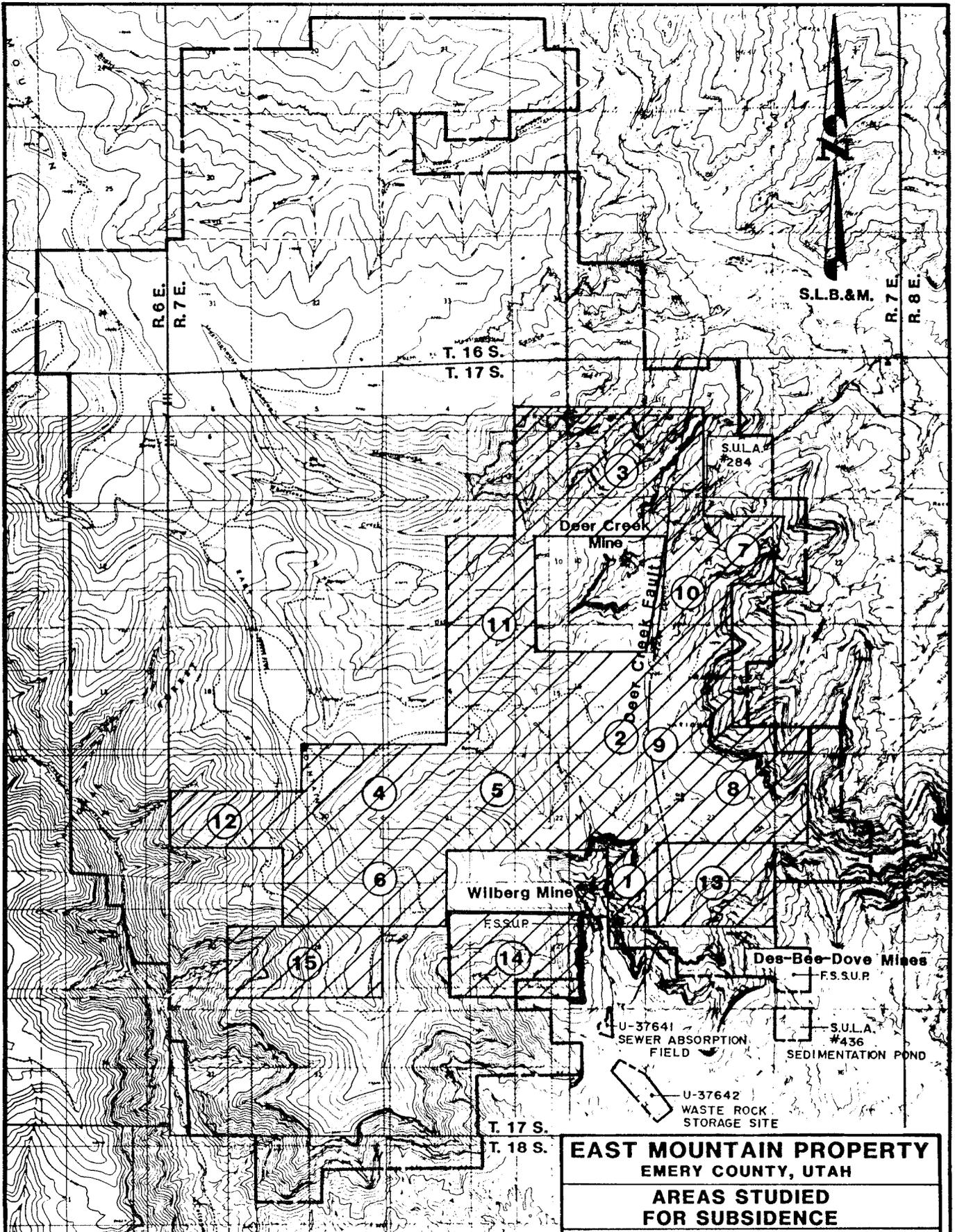
Figure 2 shows all areas above UP&L's coal mines which have potential for mining-induced subsidence. Several helicopter reconnaissance flights during 1988 revealed no new areas of visible surface disturbance. As expected, aerial surveying revealed subsidence over the Cottonwood 9th and 10th West longwall panels.

The 1985, 1986, and 1987 reports stated that in several subsidence areas where mining has ceased, ground movement has



MINE WORKINGS UPDATED TO 1-1-89

Figure 1
EAST MOUNTAIN PROPERTY
 EMERY COUNTY, UTAH
LOCATION MAP
 UTAH POWER & LIGHT COMPANY
 MINING DIVISION



NUMBERS KEYED TO TEXT

 AREAS STUDIED FOR SUBSIDENCE

 U.P.&L.CO. PERMIT BOUNDARY LINE

EAST MOUNTAIN PROPERTY	
EMERY COUNTY, UTAH	
AREAS STUDIED FOR SUBSIDENCE	
UTAH POWER & LIGHT COMPANY	
DEPARTMENT OF MINING & EXPLORATION	
DATE: 2/11/86	BY: LJ GUM
SCALE: 1" = 1 Mile	FIGURE 2

stopped. In those areas, with the concurrence of DOGM, annual subsidence monitoring will be discontinued but periodic checks will be made to assure that any further subsidence does not go undetected. In order to better track ground movement and determine when stability actually occurs, subsidence profiles of each area are included where possible. The profiles show the surface elevation change relative to the pre-mining elevation for each year data is available. It is easy to see from the profiles that in some areas little change has taken place over the past two or three years. If more information is required for such stable areas between periodic monitoring, previous aerial photography is available and can be read. Past reports describe the topographic and geologic settings of each locality and can be consulted if necessary.

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.

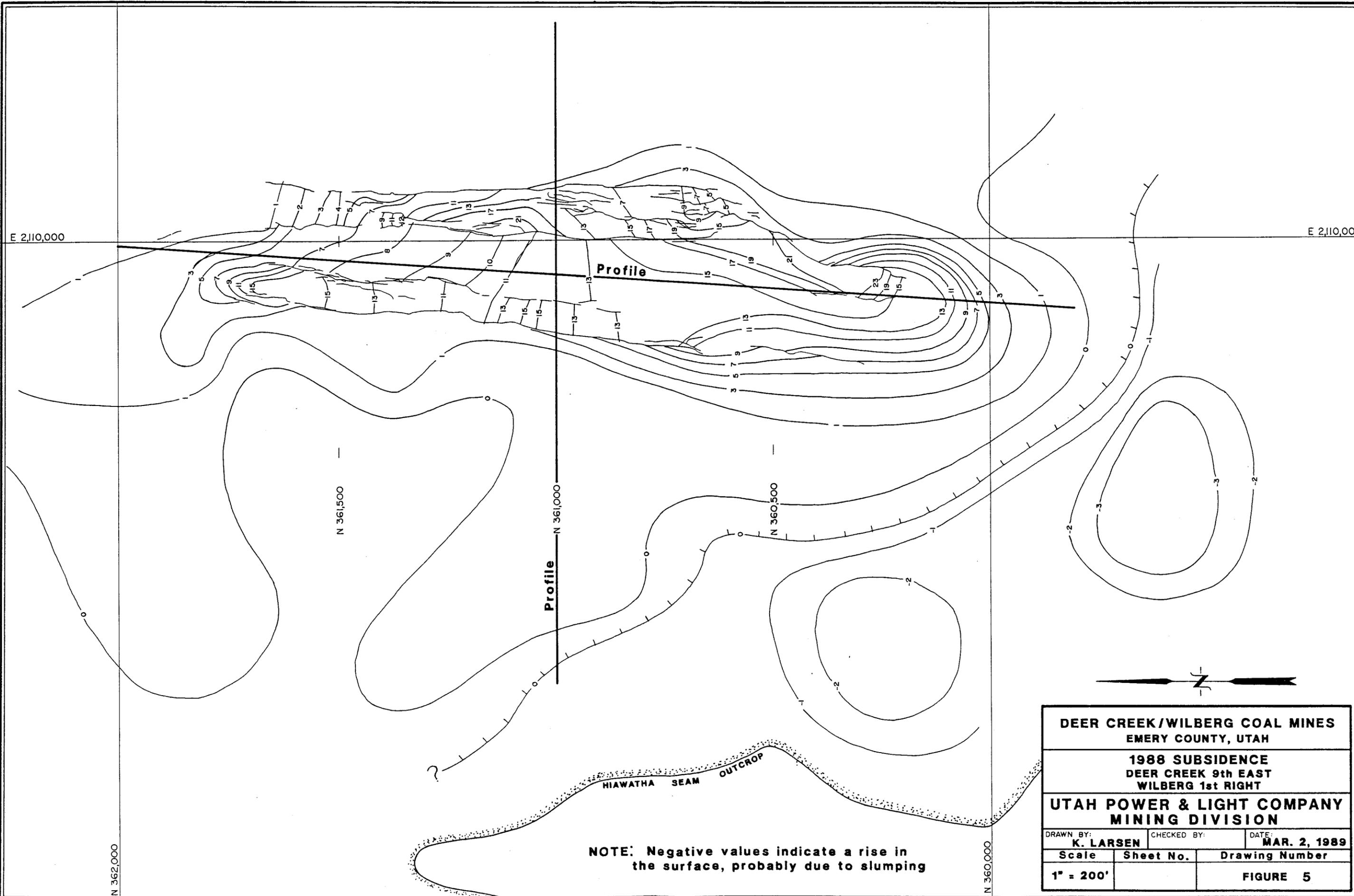
Area 1

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.

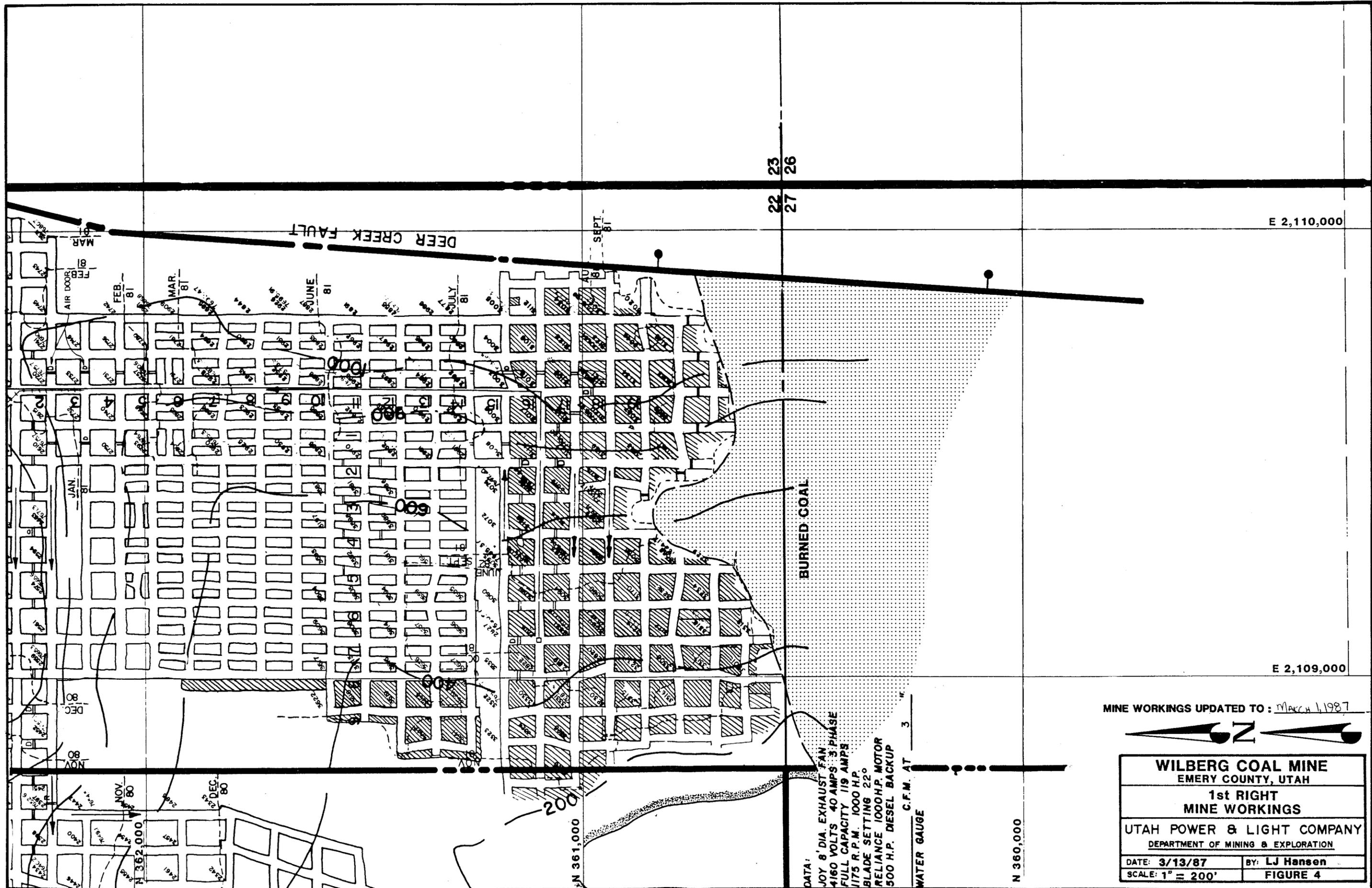
Figures 6 and 7 are north to south and west to east profiles showing the amount of subsidence in this area during the past seven years. The location of each line is shown on Figure 5. The area has seen little change since 1985. Maximum subsidence remains at about twenty-five (25) feet. A detailed look 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 this year for Area 1.



NOTE: Negative values indicate a rise in the surface, probably due to slumping

DEER CREEK/WILBERG COAL MINES EMERY COUNTY, UTAH		
1988 SUBSIDENCE DEER CREEK 9th EAST WILBERG 1st RIGHT		
UTAH POWER & LIGHT COMPANY MINING DIVISION		
DRAWN BY: K. LARSEN	CHECKED BY:	DATE: MAR. 2, 1989
Scale 1" = 200'	Sheet No.	Drawing Number FIGURE 5



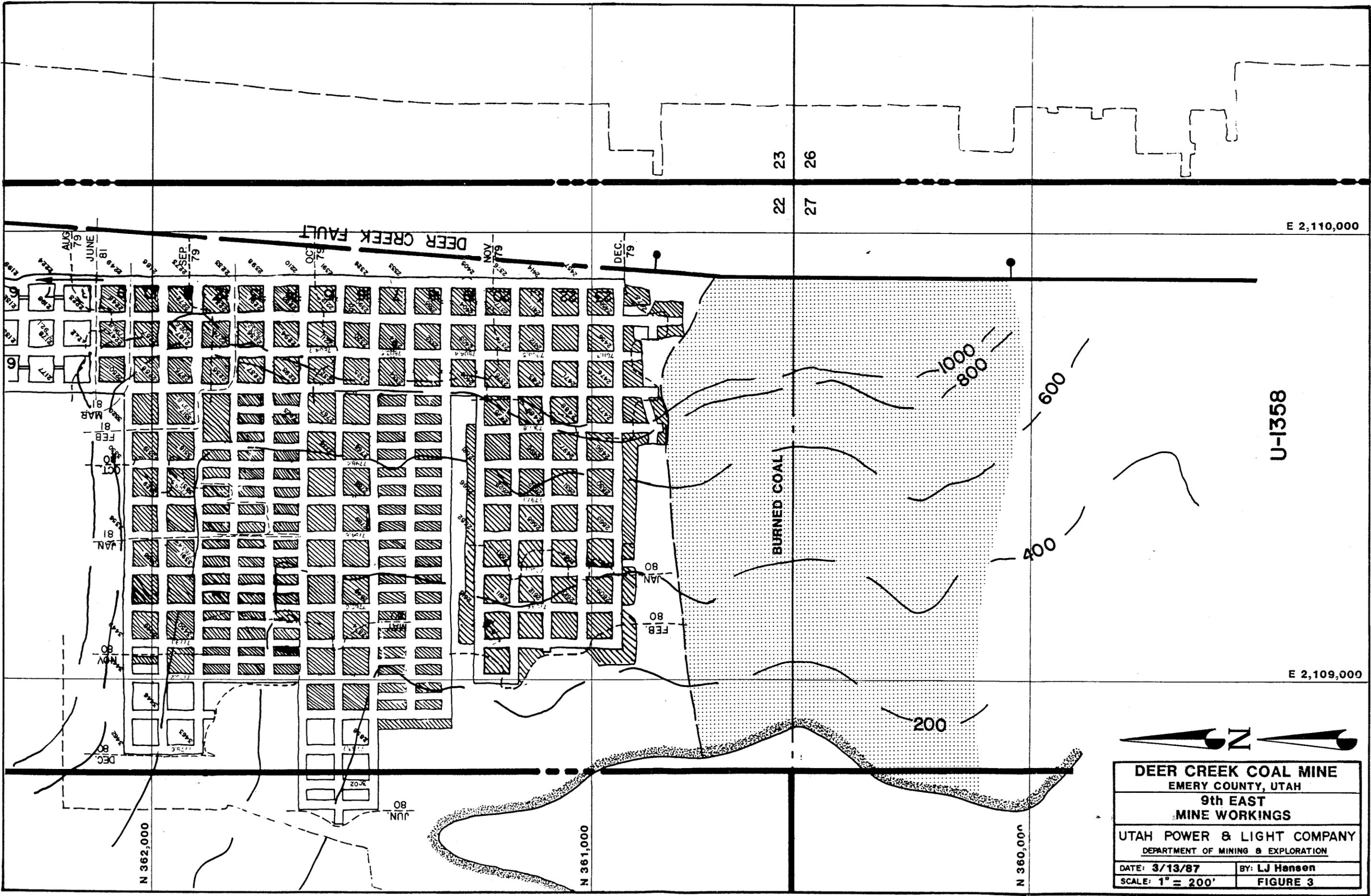
DATA:
 JOY 8' DIA. EXHAUST FAN
 4160 VOLTS 40 AMPS 3 PHASE
 FULL CAPACITY 119 AMPS
 1175 R.P.M. 1000 H.P.
 BLADE SETTING 22°
 RELIANCE 1000H.P. MOTOR
 500 H.P. DIESEL BACKUP

C.F.M. AT
 WATER GAUGE

MINE WORKINGS UPDATED TO: *March 1, 1987*



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



E 2,110,000

E 2,109,000

U-1358



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

AREA 1 SUBSIDENCE PROFILE

South - North

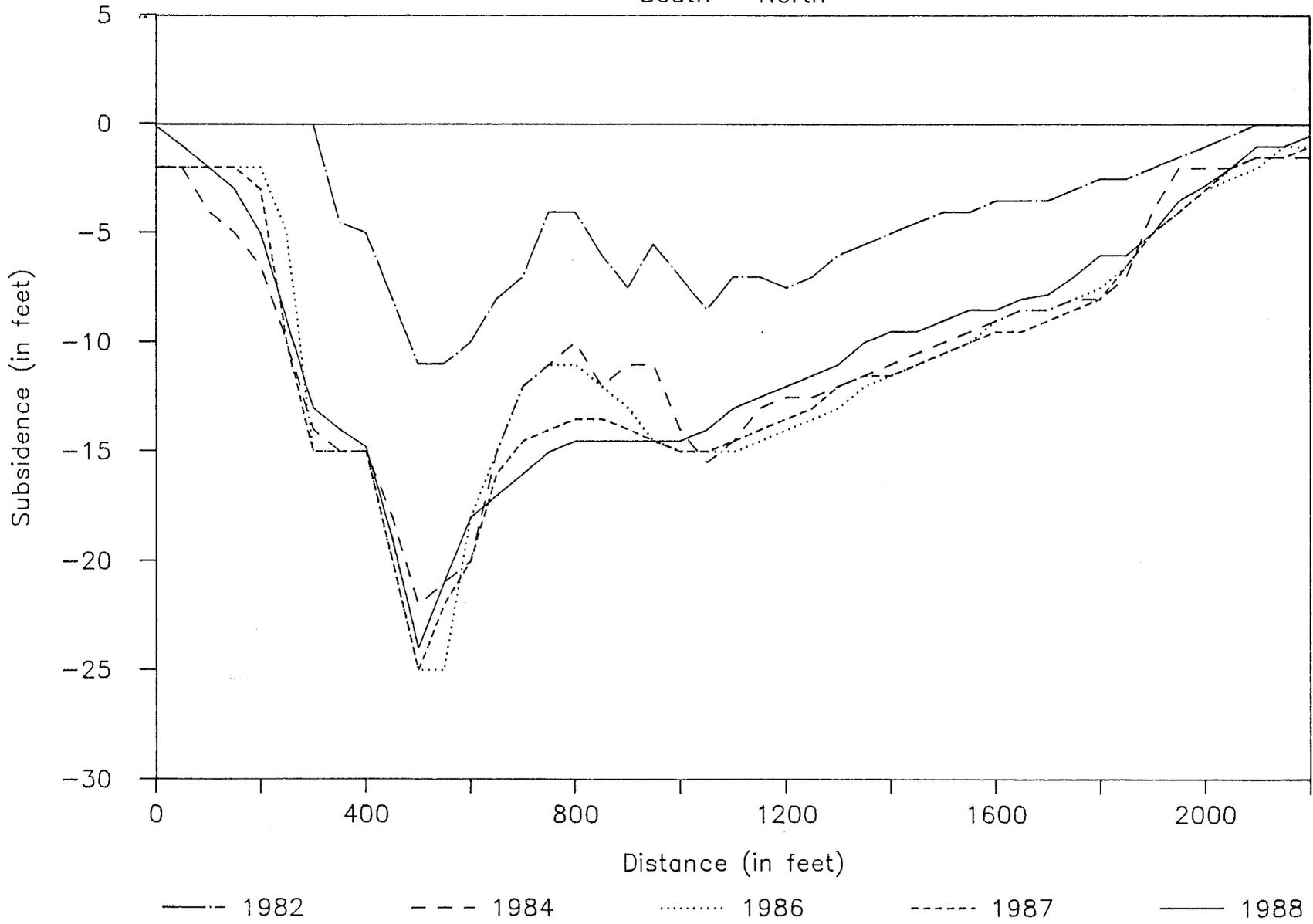


FIGURE 6

AREA 1 SUBSIDENCE PROFILE

West - East

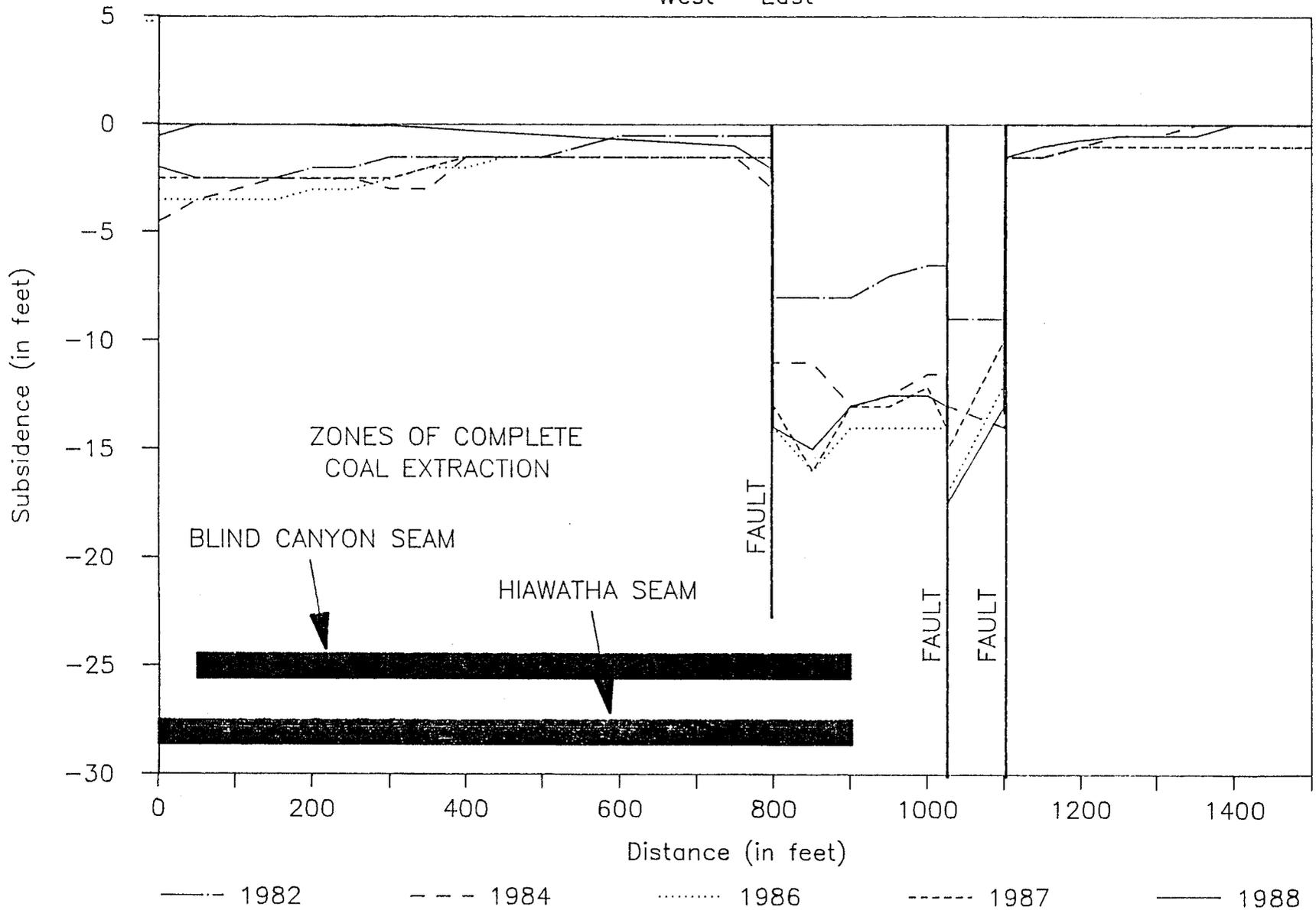


FIGURE 7

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

Area 2

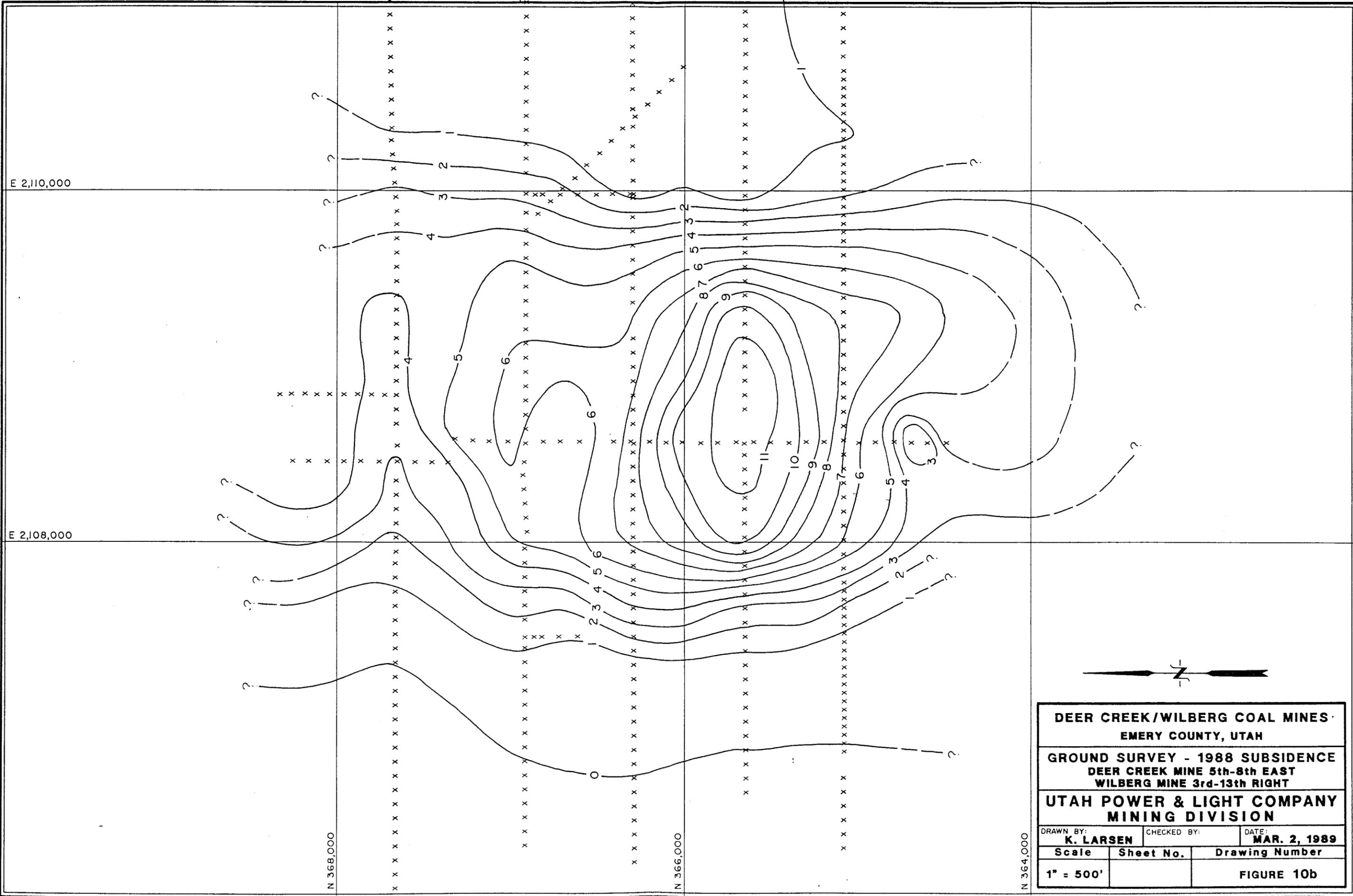
Deer Creek 5th, 6th, 7th, and 8th East Longwall Panels

Wilberg 3rd through 7th and 10th through 13th Right Panels

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

In 1988 the area was surveyed by both photogrammetric methods and conventional on-the-ground methods. As usual the two methods show very close correlation but the photogrammetry gives more detail due to tighter grid spacing of the measurement points. UP&L has received permission to stop conventional surveying and use photogrammetry only. Maximum subsidence in Area 2 remains at just under twelve (12) feet and occurs over the Deer Creek 6th East and the Wilberg 6th and 7th Right longwall panels (Figure 10). The subsidence profiles (Figures 11 and 12) indicate that ground movement over much of the area has stabilized, but the subsidence trough continues to elongate over the most recently mined panels. Neither UP&L 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; it ranges from near vertical to 12 degrees. On other sides it ranges from less than zero to 36 degrees.



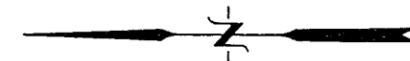
E 2,110,000

E 2,108,000

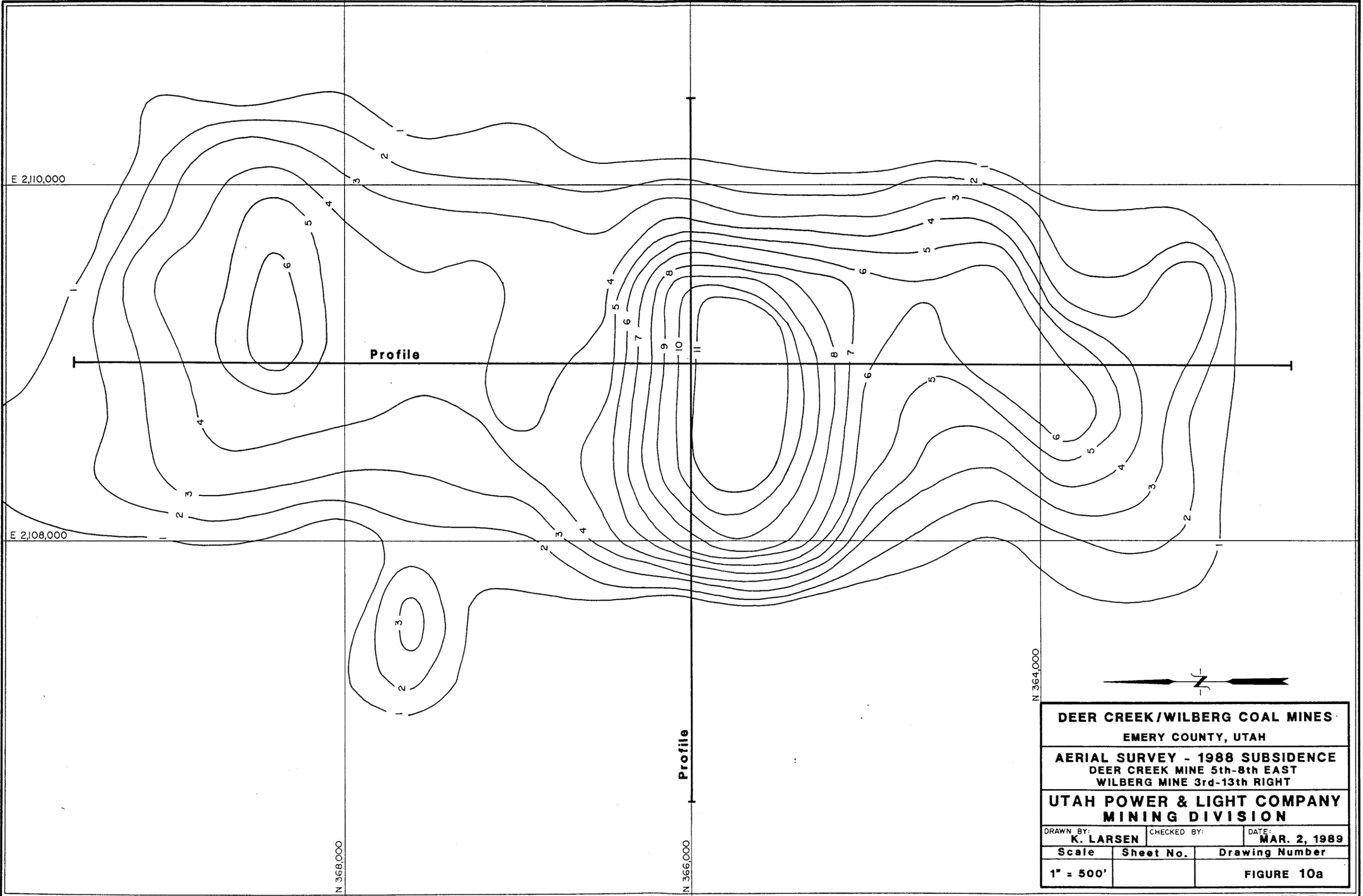
N 368,000

N 366,000

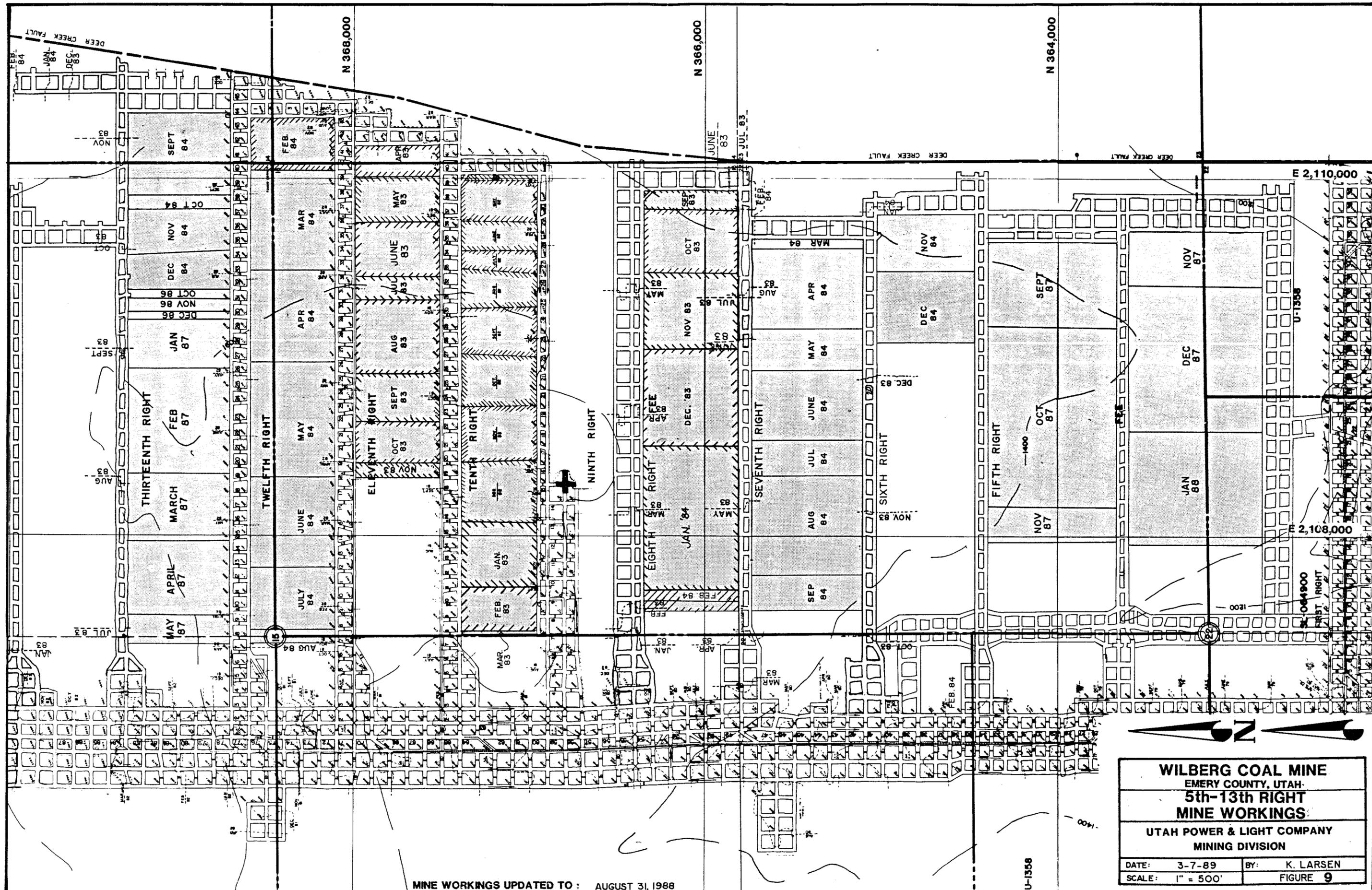
N 364,000



DEER CREEK/WILBERG COAL MINES		
EMERY COUNTY, UTAH		
GROUND SURVEY - 1988 SUBSIDENCE		
DEER CREEK MINE 5th-8th EAST		
WILBERG MINE 3rd-13th RIGHT		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION		
DRAWN BY: K. LARSEN	CHECKED BY:	DATE: MAR. 2, 1989
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 10b

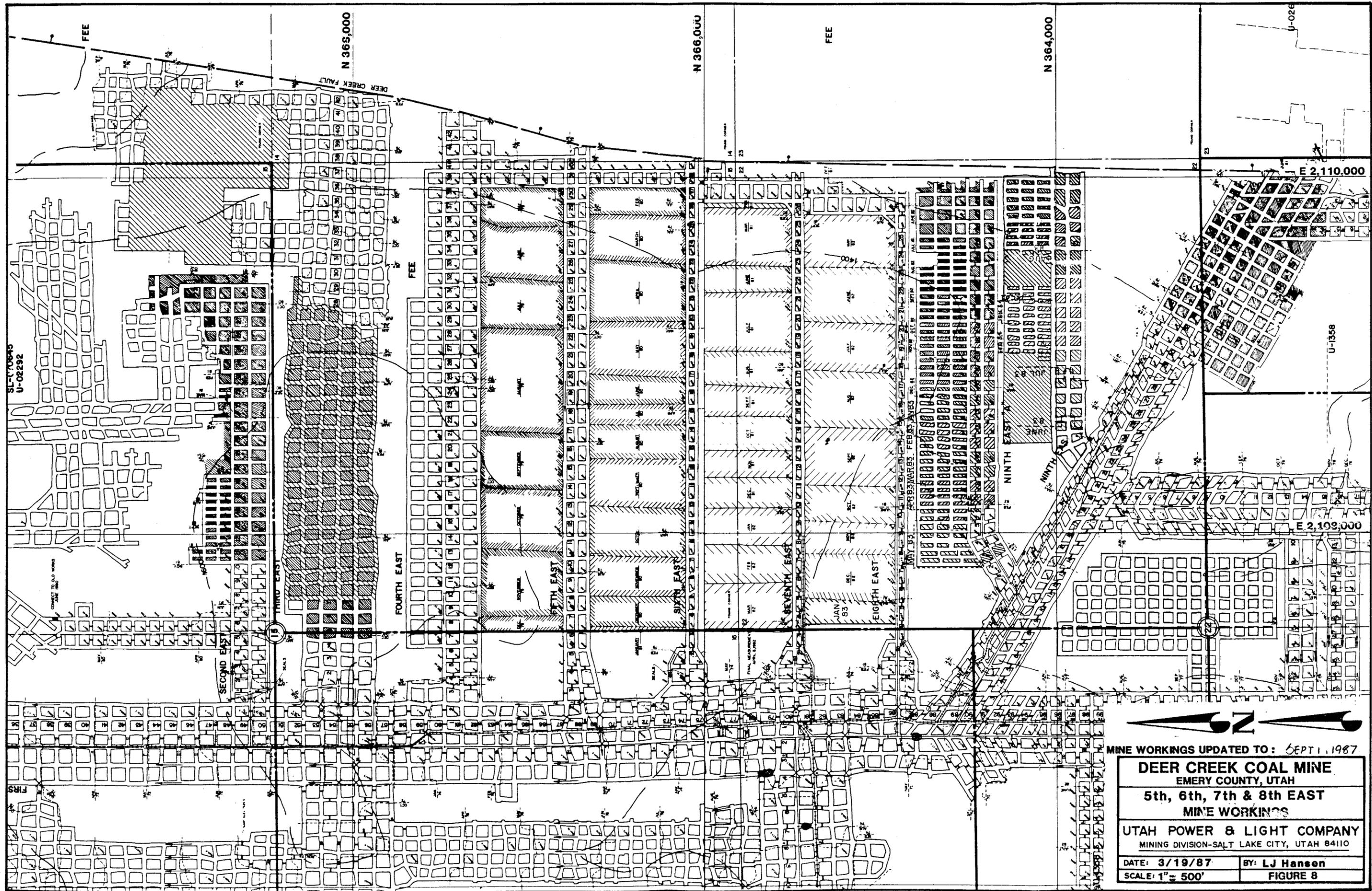


DEER CREEK/WILBERG COAL MINES		
EMERY COUNTY, UTAH		
AERIAL SURVEY - 1988 SUBSIDENCE		
DEER CREEK MINE 5th-8th EAST		
WILBERG MINE 3rd-13th RIGHT		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION		
DRAWN BY: K. LARSEN	CHECKED BY:	DATE: MAR. 2, 1989
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 10a



MINE WORKINGS UPDATED TO : AUGUST 31, 1988

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



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
SCALE: 1" = 500'

BY: LJ Hansen
FIGURE 8

AREA 2 SUBSIDENCE PROFILE

North - South

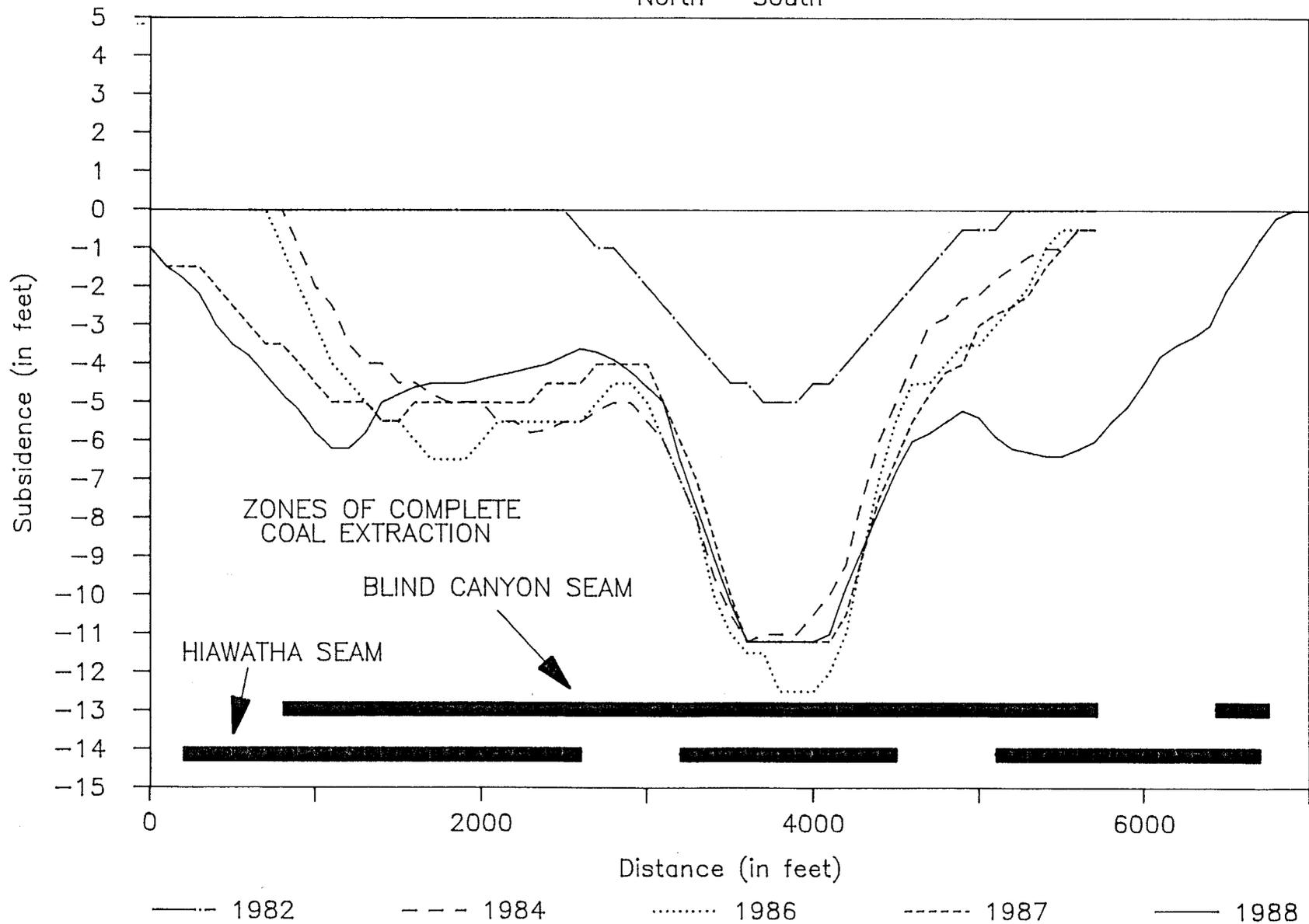


FIGURE 11

AREA 2 SUBSIDENCE PROFILE

West - East

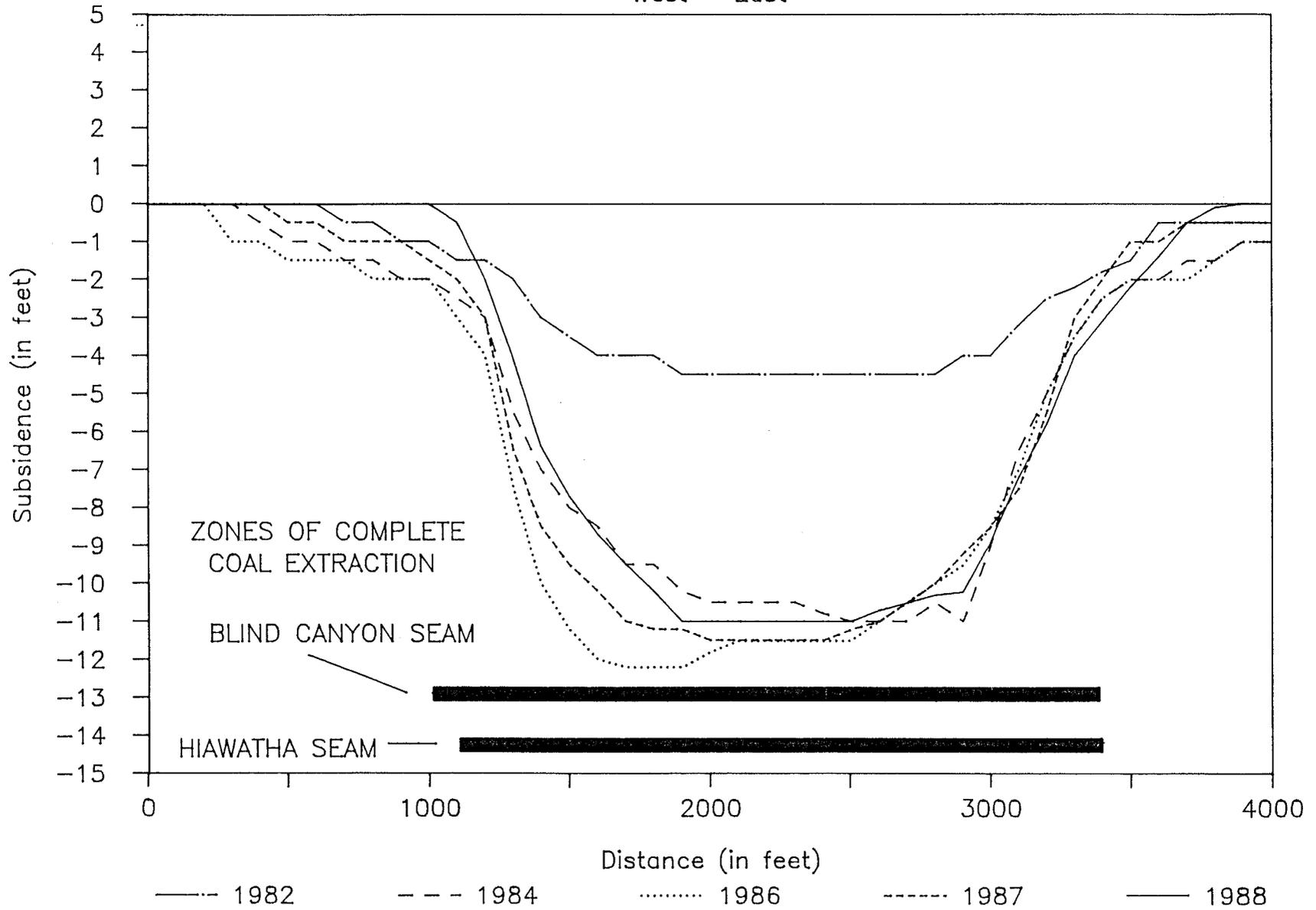


FIGURE 12

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, 1988).

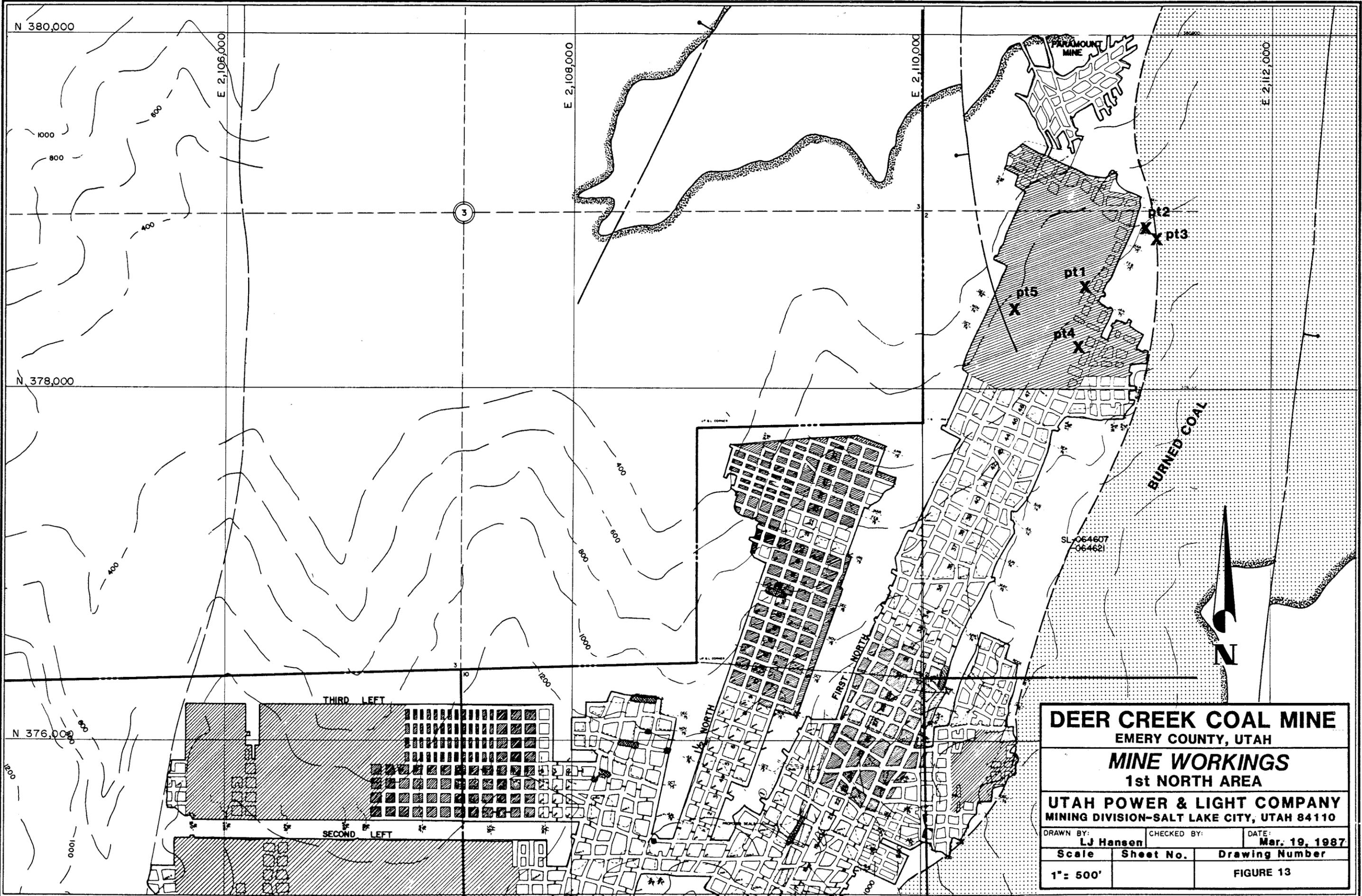
Area 3

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 greatest subsidence measured over these points was over seven (7) feet. The large change at that point may be due to a localized cliff or ledge failure since it appears so anomalous.

It appears that in the 1st North area the ground has not stabilized. The subsidence above 1st North occurs on a narrow ridge capped by a highly fractured sandstone, and a review of the subsidence data indicates that, due to the mode of subsidence, elevation change cannot be depicted accurately with a contour map. Figure 14 is a graph of subsidence as it occurred at several points above the 1st North workings. Elevations are not consistent from year to year at a given point. One explanation is that the magnitude of the subsidence is on the order of the precision of the measurements. Keeping this in mind, all but point 2 showed subsidence in 1988. The large change at point 3 appears anomalous and may be due to a localized cliff or ledge failure.

Several helicopter surveys in 1988 revealed no new surface cracks or areas of cliff failure; however, selected points in Area 3 will continue to be monitored until the area's stability can be better assessed.



DEER CREEK COAL MINE		
EMERY COUNTY, UTAH		
MINE WORKINGS		
1st NORTH AREA		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION-SALT LAKE CITY, UTAH 84110		
DRAWN BY:	CHECKED BY:	DATE:
LJ Hansen		Mar. 19, 1987
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 13

DEER CREEK 1st NORTH
Subsidence at Selected Points

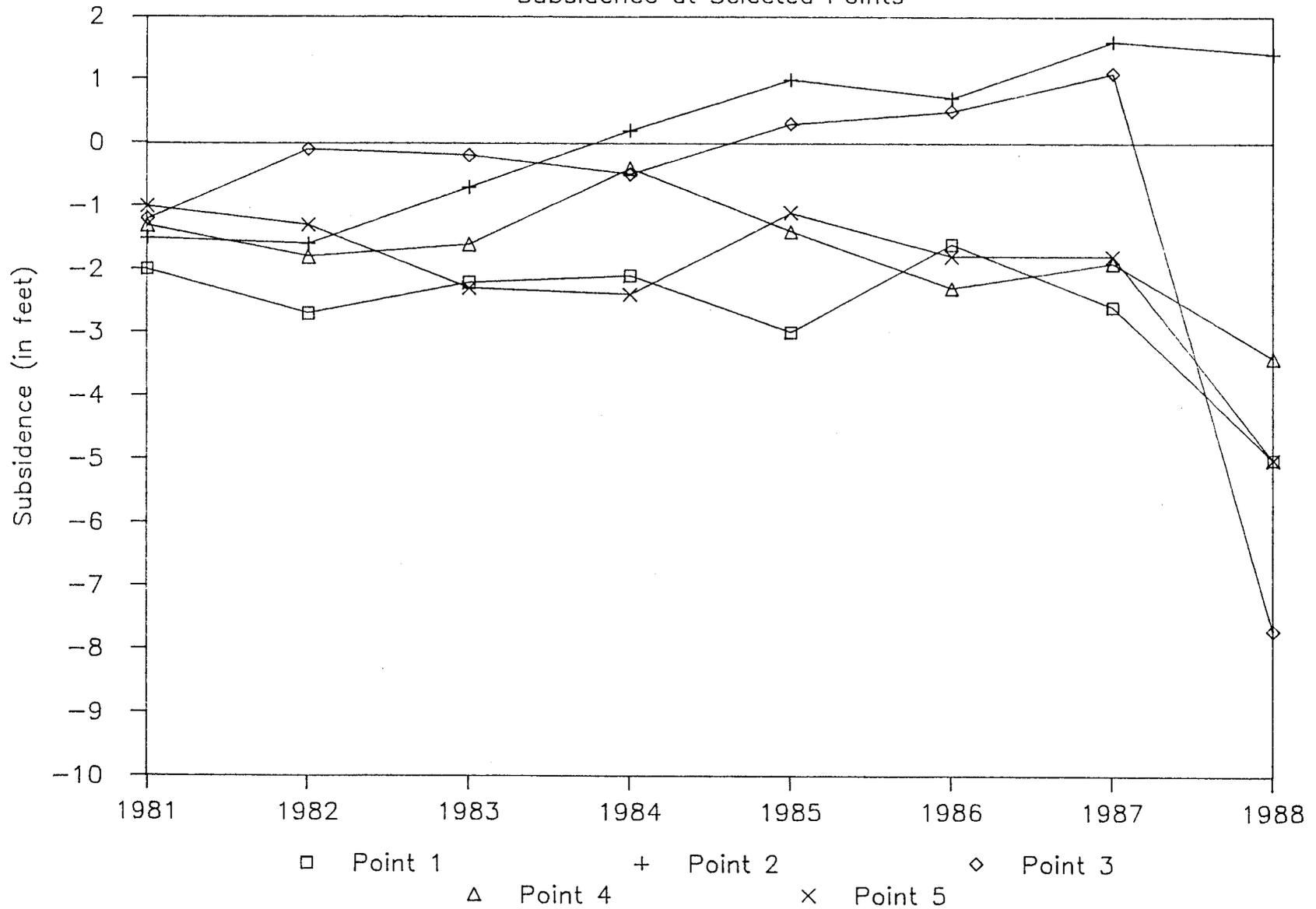


FIGURE 14

Calculated angle-of-draw ranges from vertical to 40 degrees; but the measurements are influenced by burned coal, steep slopes, and fracturing, all of which have complicated the subsidence process.

The strata in the area are dry because they lack adequate recharge; therefore, the subsidence will not affect the hydrology.

Area 4

Deer Creek 2nd through 10th 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 panel in 1980 and, by the end of August 1988, the 2nd through 7th Right panels, the 9th Right panel, and 4400 feet of the 10th Right panel had been fully completed (Figure 15).

For the third successive year the maximum subsidence is just under seven (7) feet over the 3rd and 4th Right longwall panels (Figure 16), indicating that the maximum subsidence may have been reached for this area. The subsidence trough continues to extend northward over the most recent 9th and 10th Right longwall panels (see Subsidence Profiles, Figures 17 and 18). The calculated angle-of-draw of the subsidence ranges from less than zero to 18 degrees.

Several springs are located on East Mountain above the 2nd through 7th Right 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.

The left fork of the Grimes Wash drainage crosses the middle of the subsidence area. Stream monitoring has revealed no changes attributable to mining.

E 2,102,000

E 2,100,000

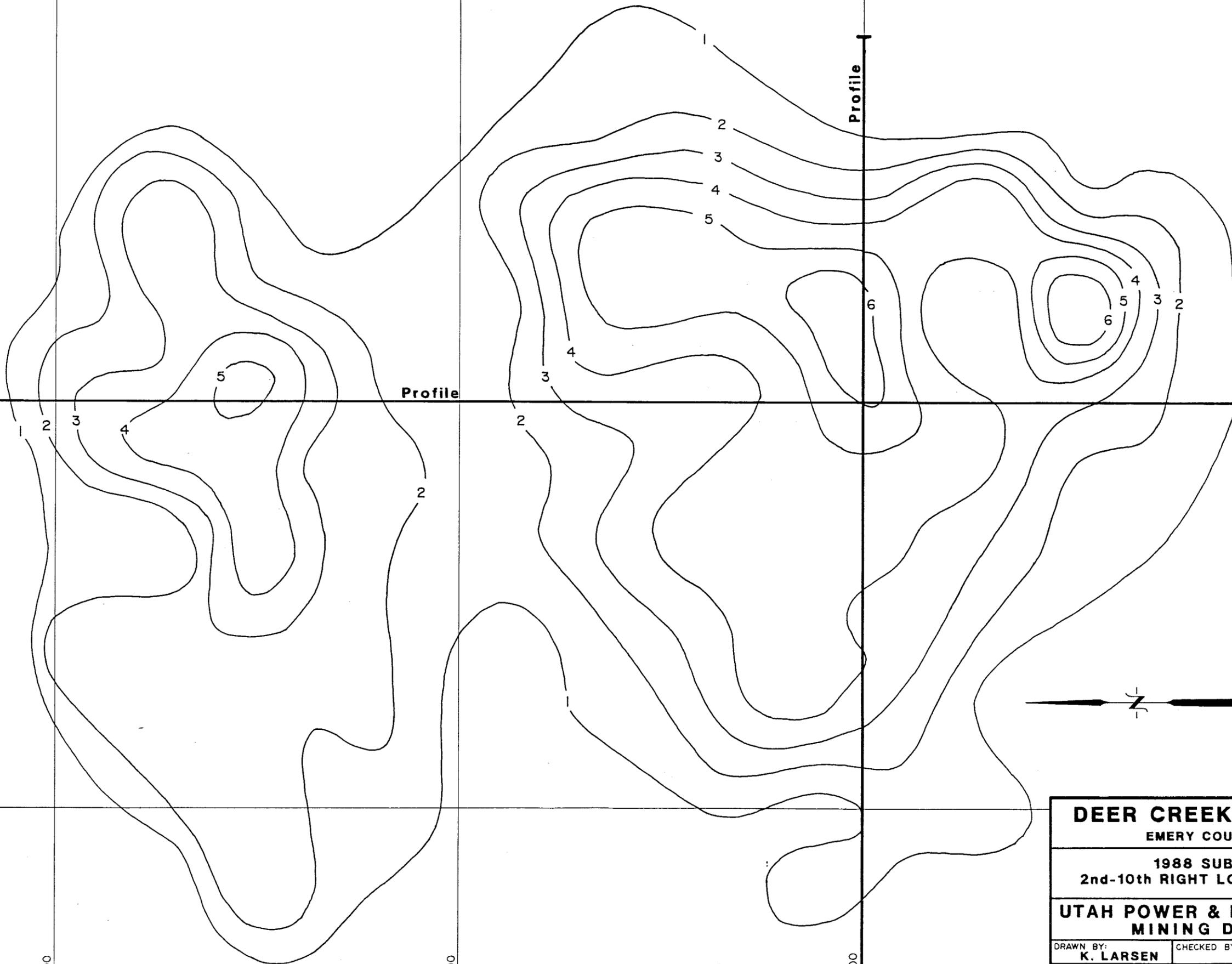
E 2,098,000

N 368,000

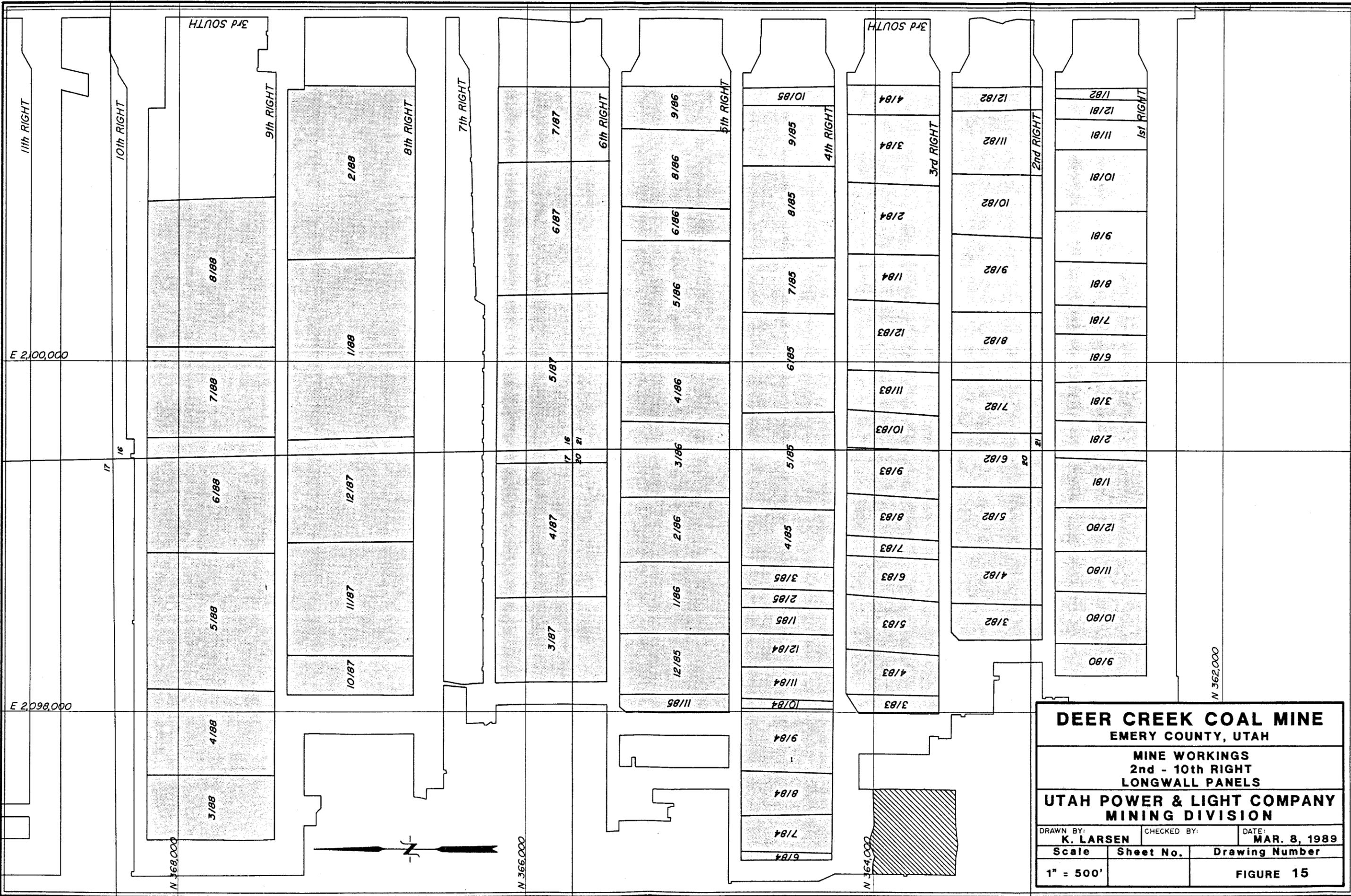
N 366,000

N 364,000

N 362,000



DEER CREEK COAL MINE		
EMERY COUNTY, UTAH		
1988 SUBSIDENCE		
2nd-10th RIGHT LONGWALL PANELS		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION		
DRAWN BY: K. LARSEN	CHECKED BY:	DATE: MAR. 9, 1989
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 16



DEER CREEK COAL MINE		
EMERY COUNTY, UTAH		
MINE WORKINGS 2nd - 10th RIGHT LONGWALL PANELS		
UTAH POWER & LIGHT COMPANY MINING DIVISION		
DRAWN BY: K. LARSEN	CHECKED BY:	DATE: MAR. 8, 1989
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 15

AREA 4 SUBSIDENCE PROFILE

North - South

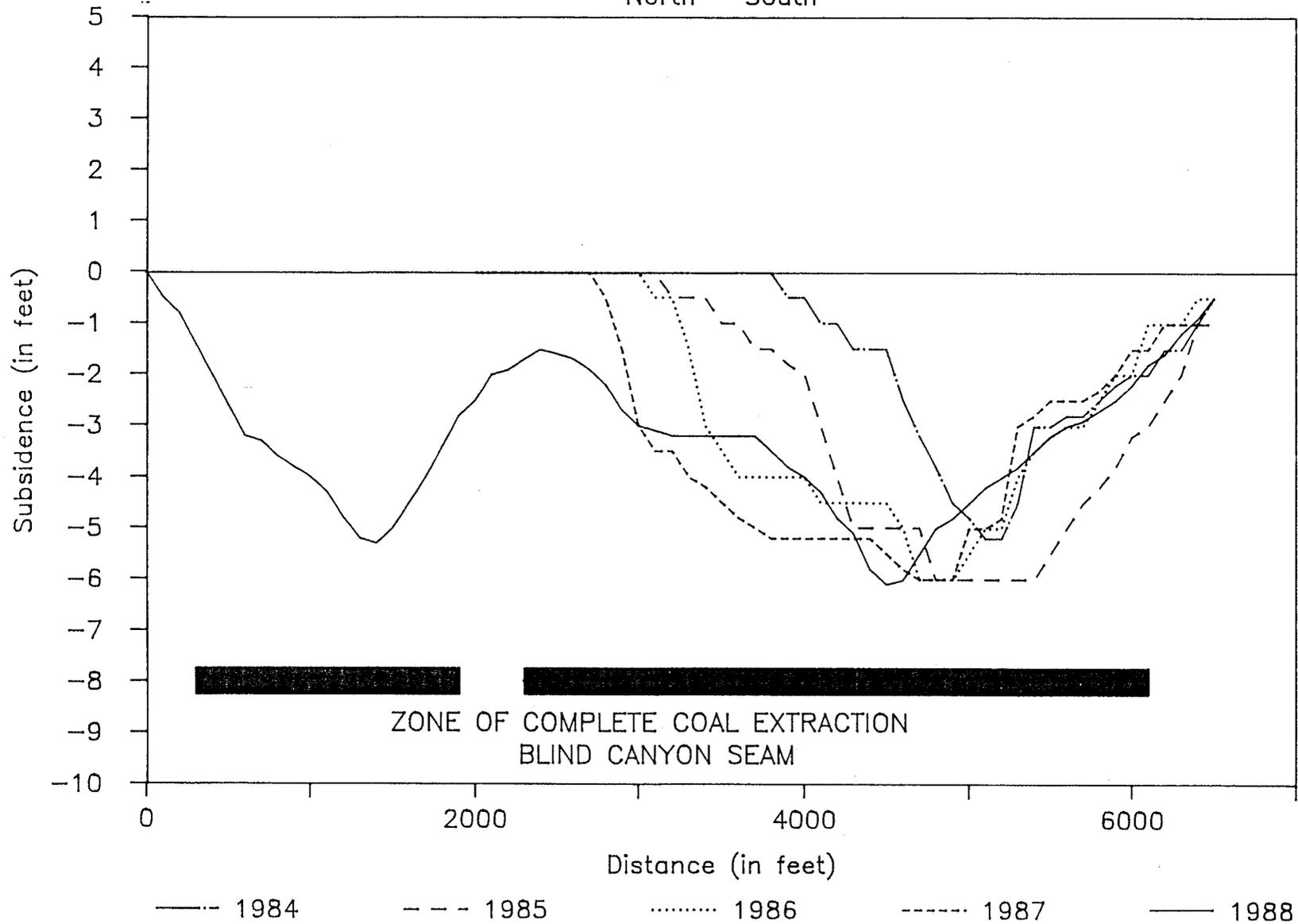


FIGURE 17

AREA 4 SUBSIDENCE PROFILE

West - East

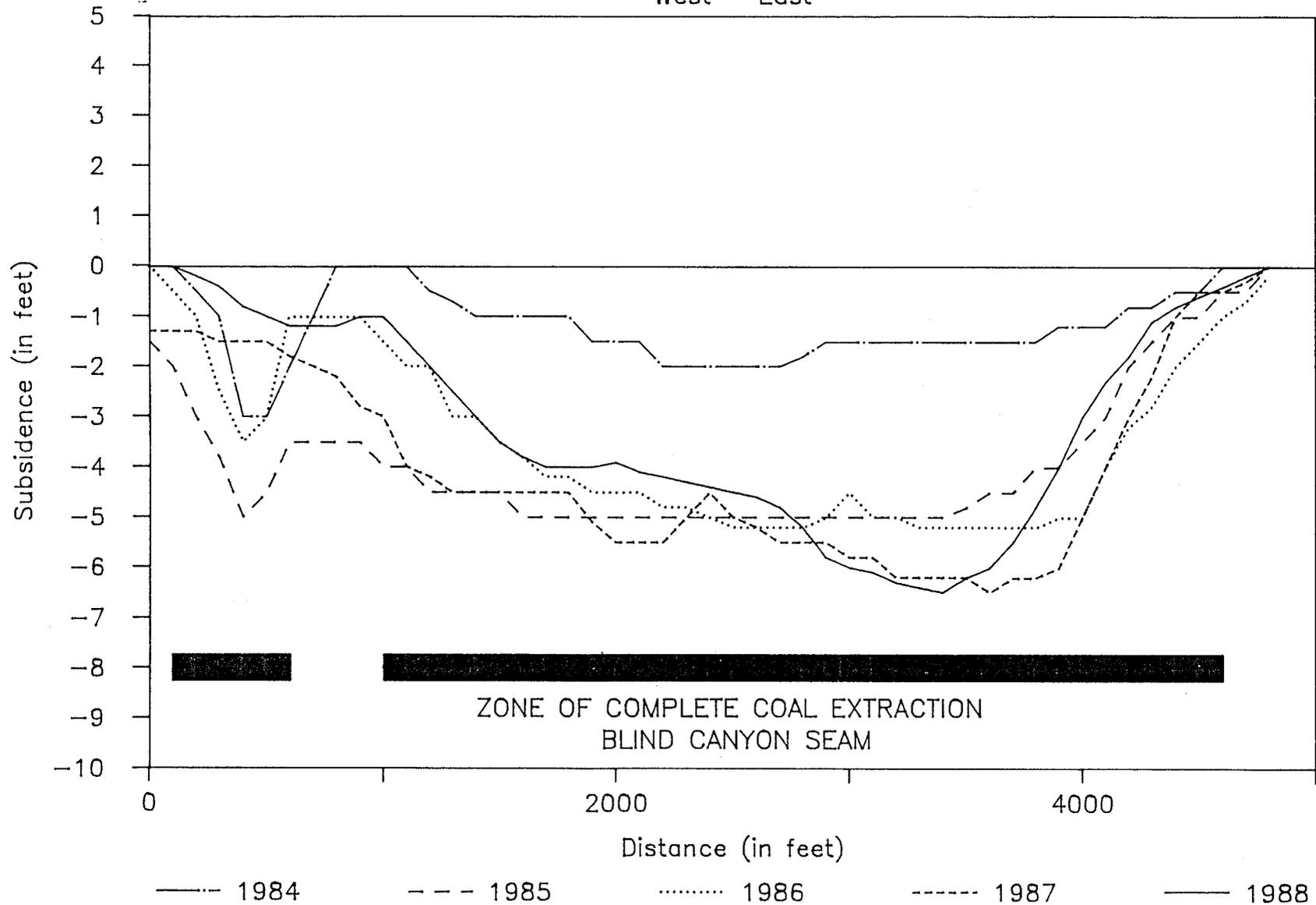


FIGURE 18

Area 5

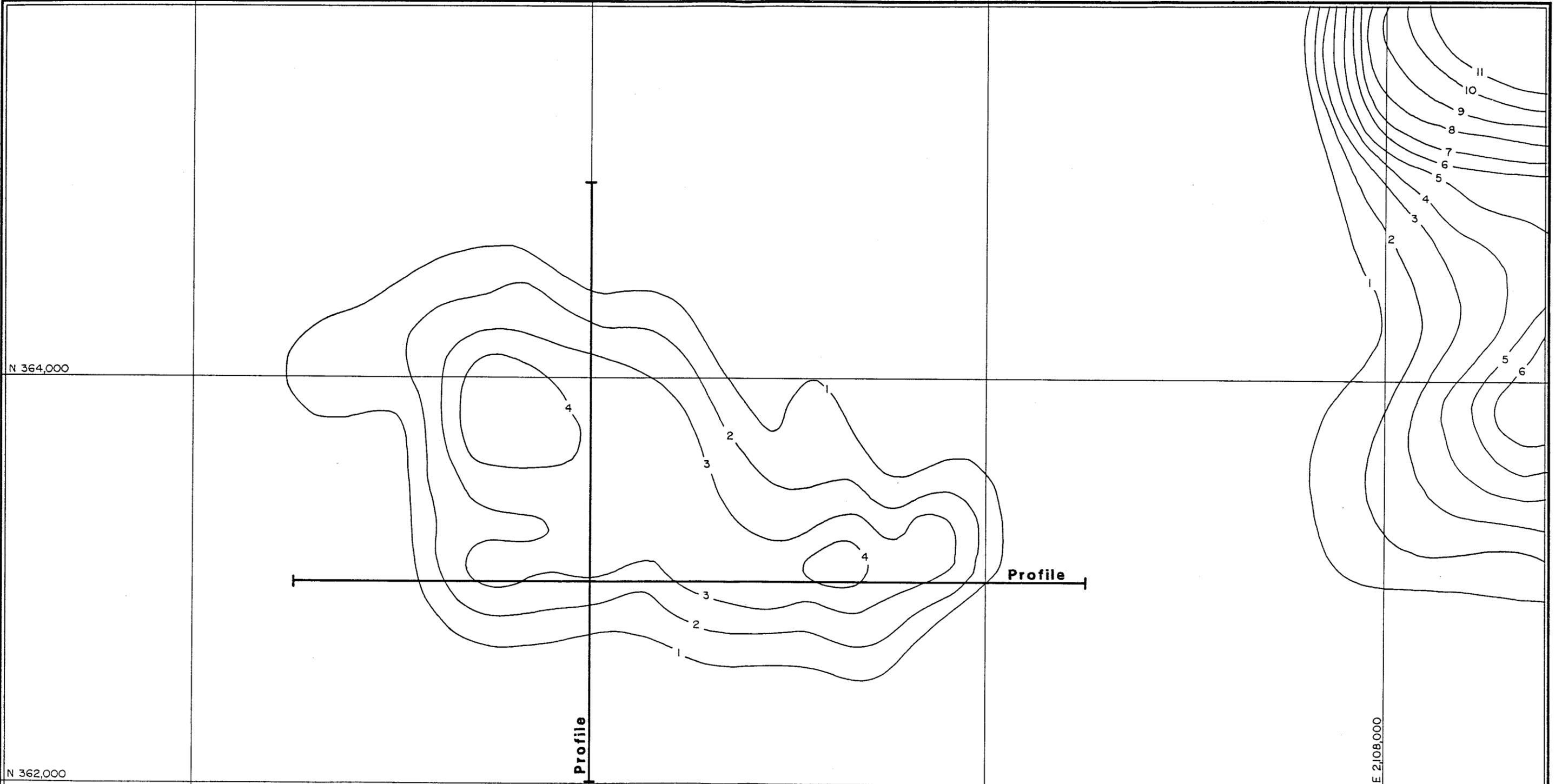
Deer Creek 2nd through 5th Left Longwall Panels

Photogrammetry revealed subsidence in Area 5 for the first time in 1984. Mining of the 2nd Left longwall panel began in January 1983, and by October 1985 all four panels had been completed (Figure 19).

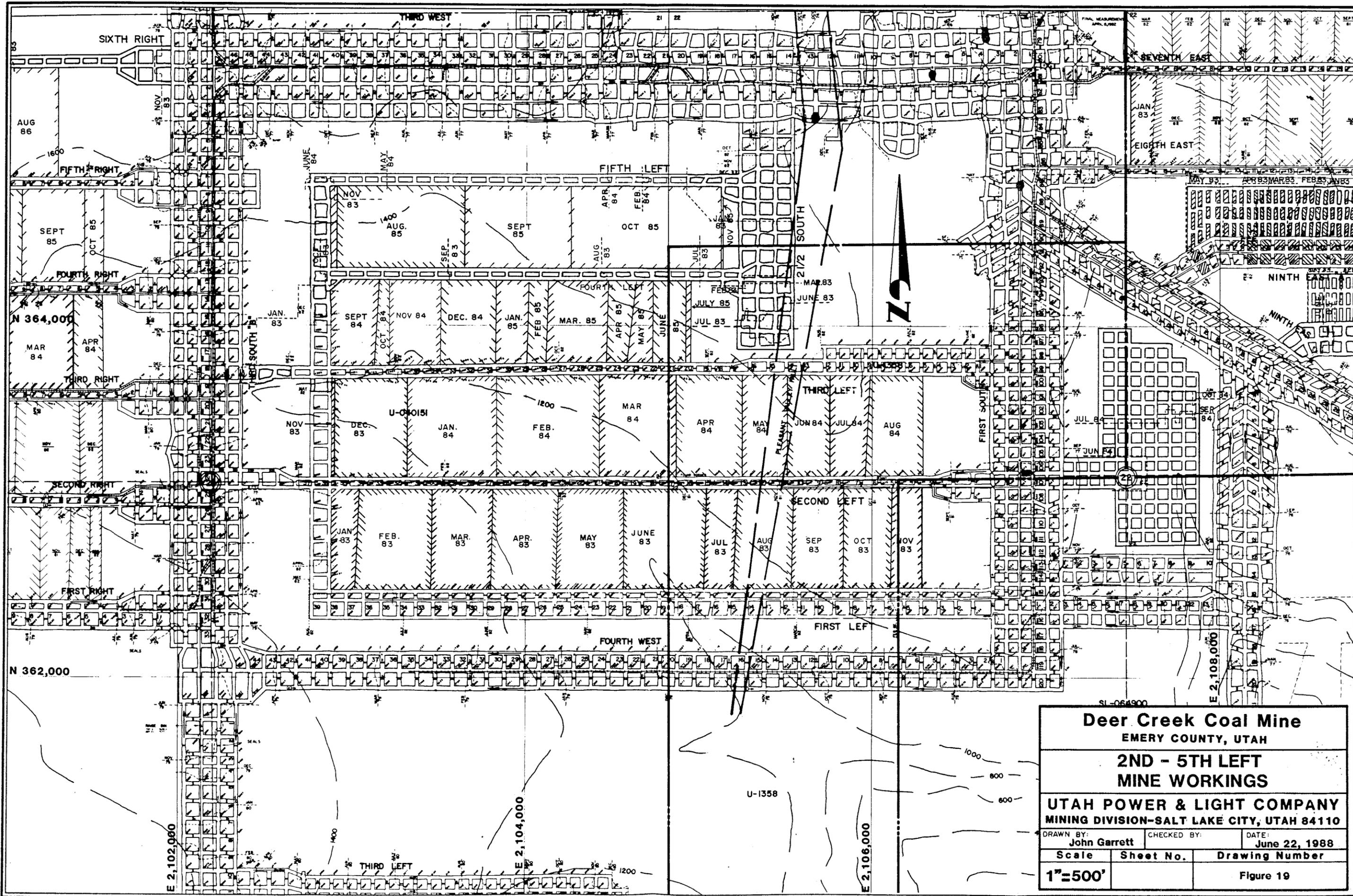
For the third consecutive year the maximum subsidence over the panels is about five (5) feet and occurs over the 3rd and 4th Left longwall panels (Figure 20). Little change has occurred in the area since 1986 (Figures 21 and 22). Since subsidence appears to have stabilized, with DOGM approval readings of subsidence will no longer be performed annually; but the area will be photographed yearly and readings can be made of the photos if deemed necessary. 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 ranged from less than zero to 16 degrees.



DEER CREEK COAL MINE		
EMERY COUNTY, UTAH		
1988 SUBSIDENCE		
2nd-5th LEFT		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION		
<small>DRAWN BY:</small> K. LARSEN	<small>CHECKED BY:</small>	<small>DATE:</small> MAR. 2, 1989
<small>Scale</small>	<small>Sheet No.</small>	<small>Drawing Number</small>
1" = 500'		FIGURE 20



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

AREA 5 SUBSIDENCE PROFILE

North - South

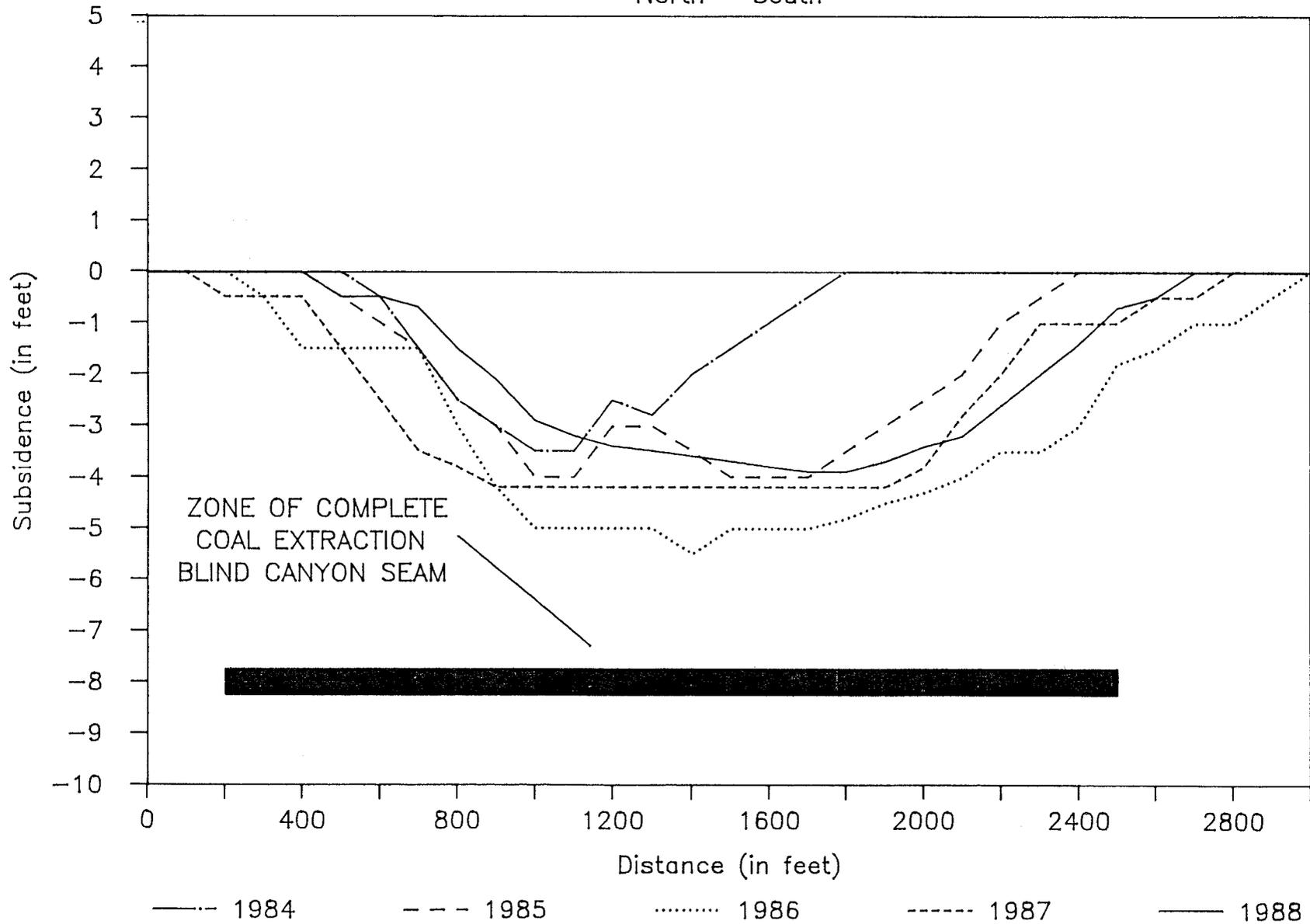


FIGURE 21

AREA 5 SUBSIDENCE PROFILE

West - East

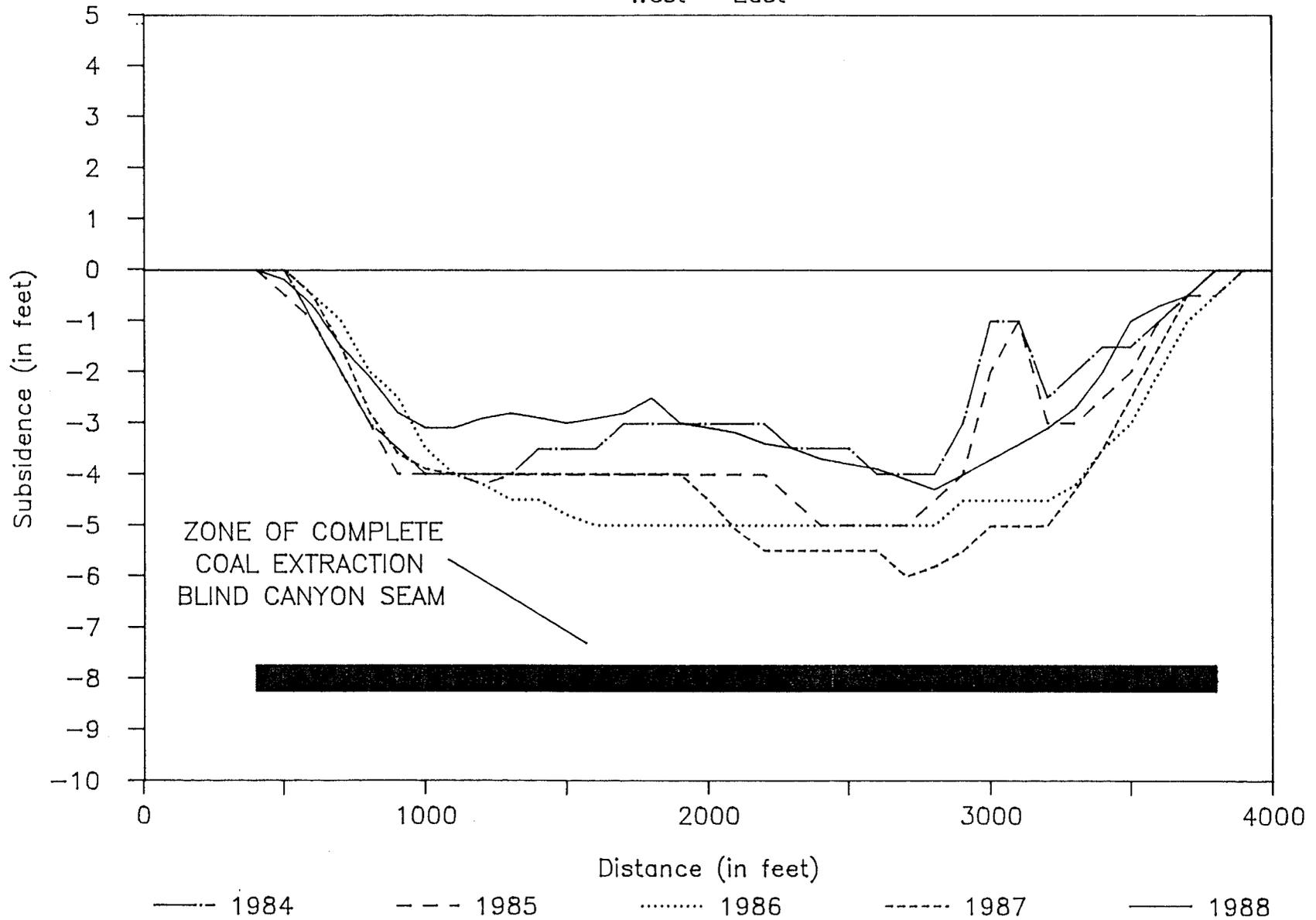


FIGURE 22

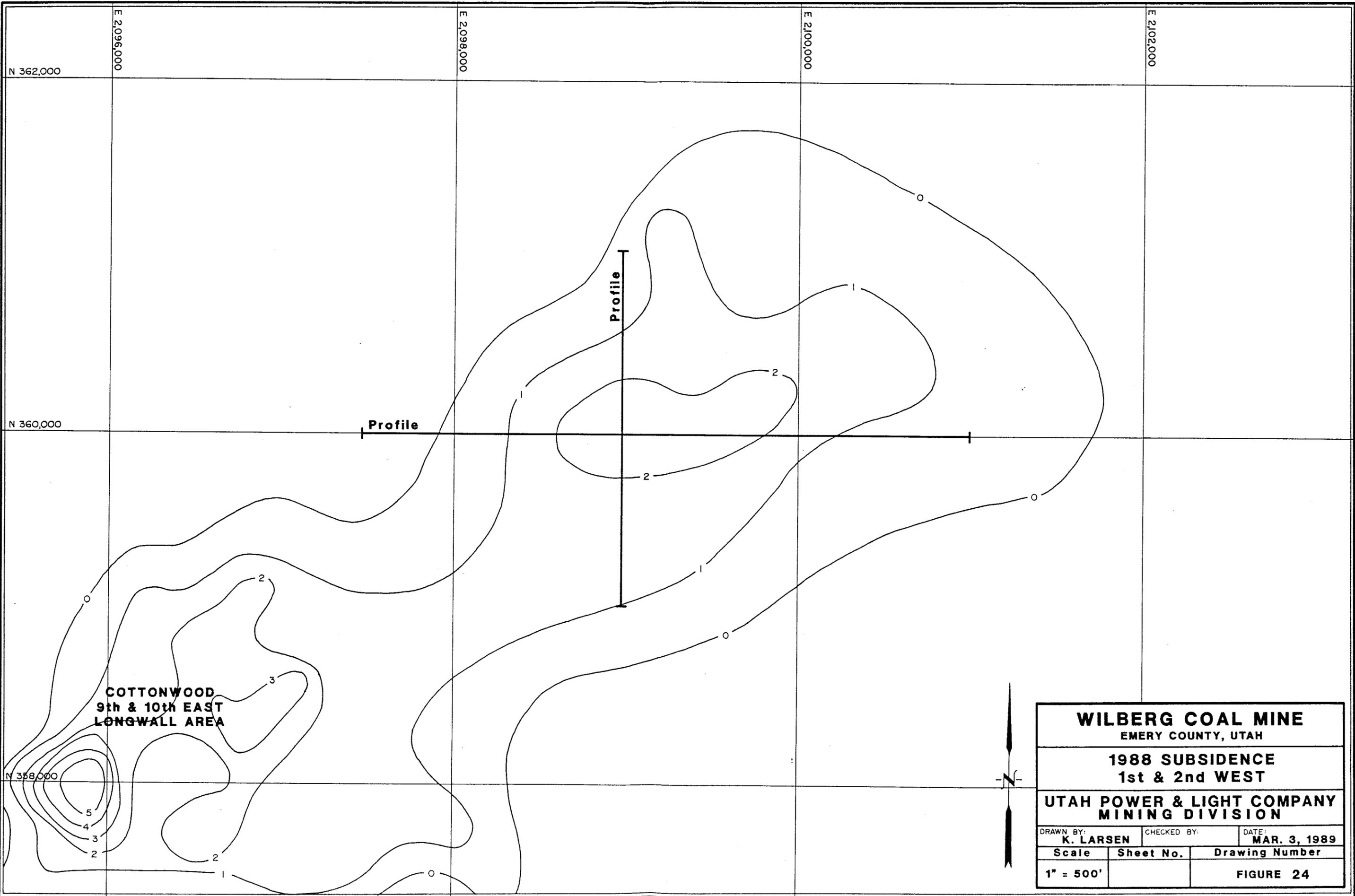
Area 6

Wilberg 1st and 2nd West Longwall Panels

Mining in the Wilberg 1st and 2nd West longwall panels was completed in June 1983, and subsidence continued into the 1984 monitoring period (Figure 23). Since late 1984 no significant additional movement has been detected and the area appears to have stabilized with approximately three (3) feet of subsidence (Figure 24). Upon approval, Area 6 will no longer be monitored annually, but aerial photos will be available to measure subsidence for any year when readings were not made. The subsidence profiles (Figures 25 and 26) show some irregularity from year to year, but the variation is within the margin of error in the photogrammetric method (± 0.7 feet).

Calculated angle-of-draw ranges from zero to 29 degrees. The subsidence trough formed over these workings has elongated to the southwest to merge with the trough forming over the 9th and 10th West panels in the Cottonwood Mine (see Area 15).

Four springs located just north of the area show no effect from the subsidence (see Hydrologic Monitoring Report, 1988).



COTTONWOOD
9th & 10th EAST
LONGWALL AREA

WILBERG COAL MINE
EMERY COUNTY, UTAH

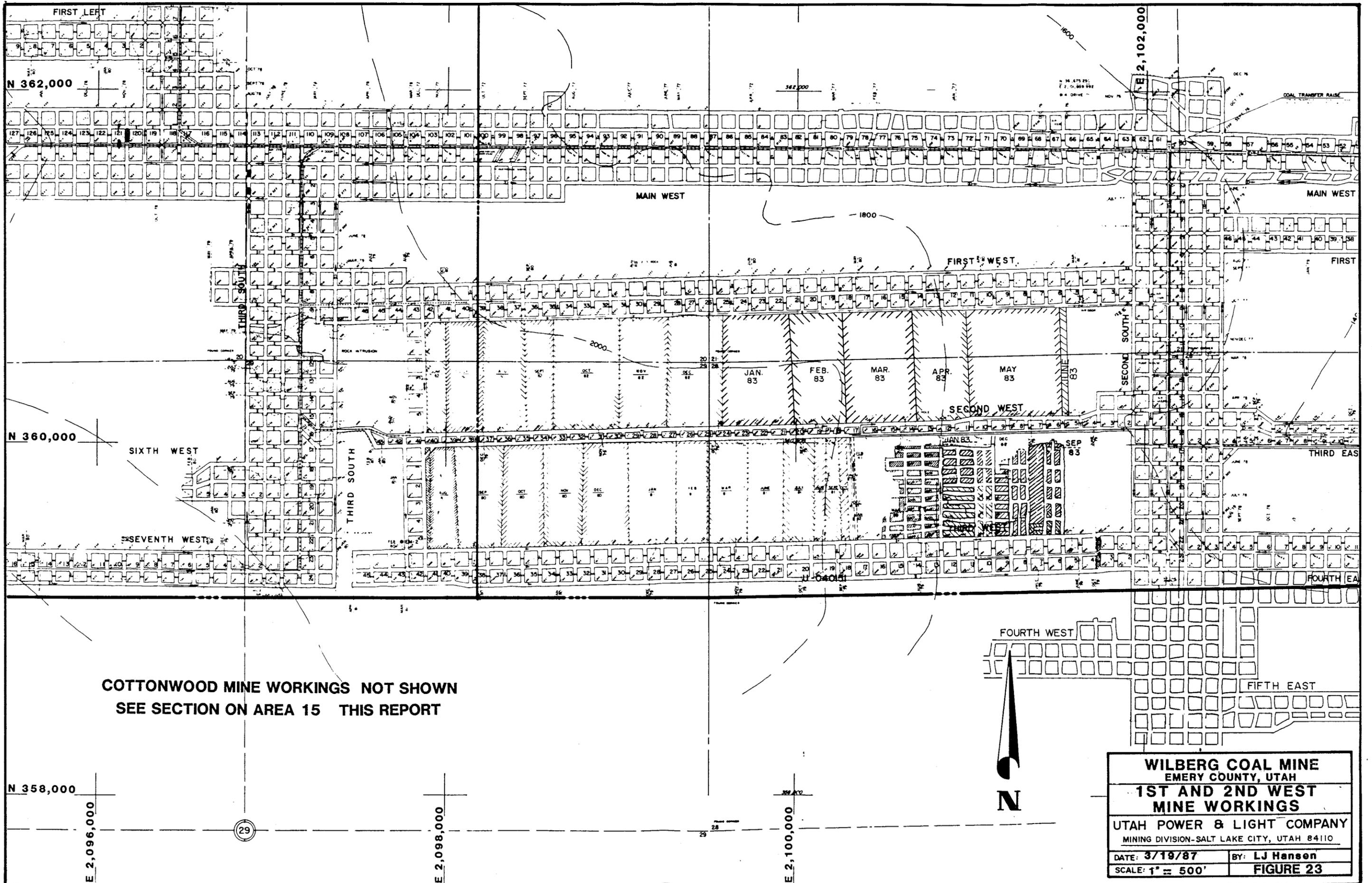
1988 SUBSIDENCE
1st & 2nd WEST

UTAH POWER & LIGHT COMPANY
MINING DIVISION

DRAWN BY: K. LARSEN CHECKED BY: DATE: MAR. 3, 1989

Scale Sheet No. Drawing Number

1" = 500' FIGURE 24



WILBERG COAL MINE EMERY COUNTY, UTAH	
1ST AND 2ND WEST MINE WORKINGS	
UTAH POWER & LIGHT COMPANY MINING DIVISION-SALT LAKE CITY, UTAH 84110	
DATE: 3/19/87	BY: LJ Hansen
SCALE: 1" = 500'	FIGURE 23

AREA 6 SUBSIDENCE PROFILE

North - South

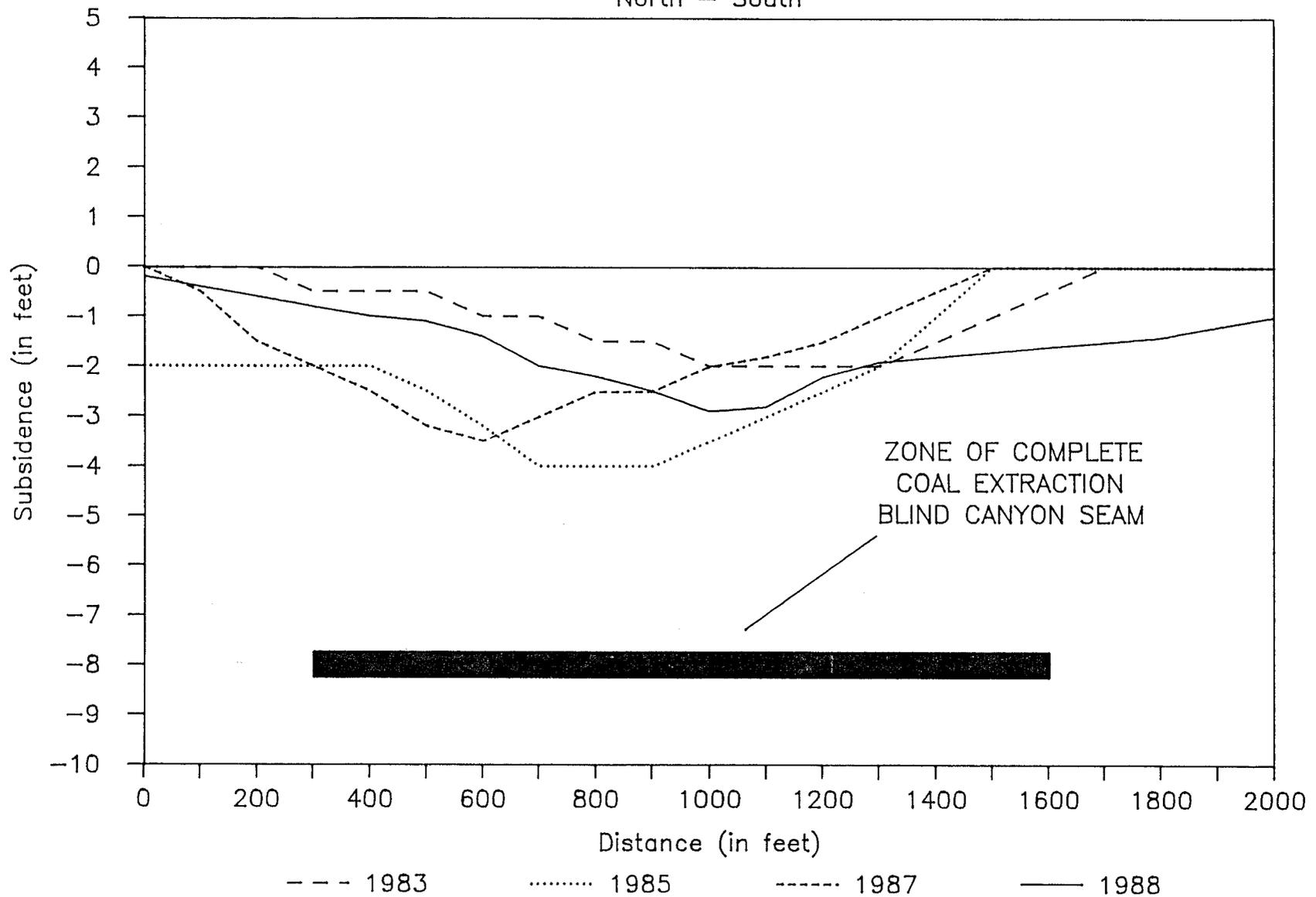


FIGURE 25

AREA 6 SUBSIDENCE PROFILE

West - East

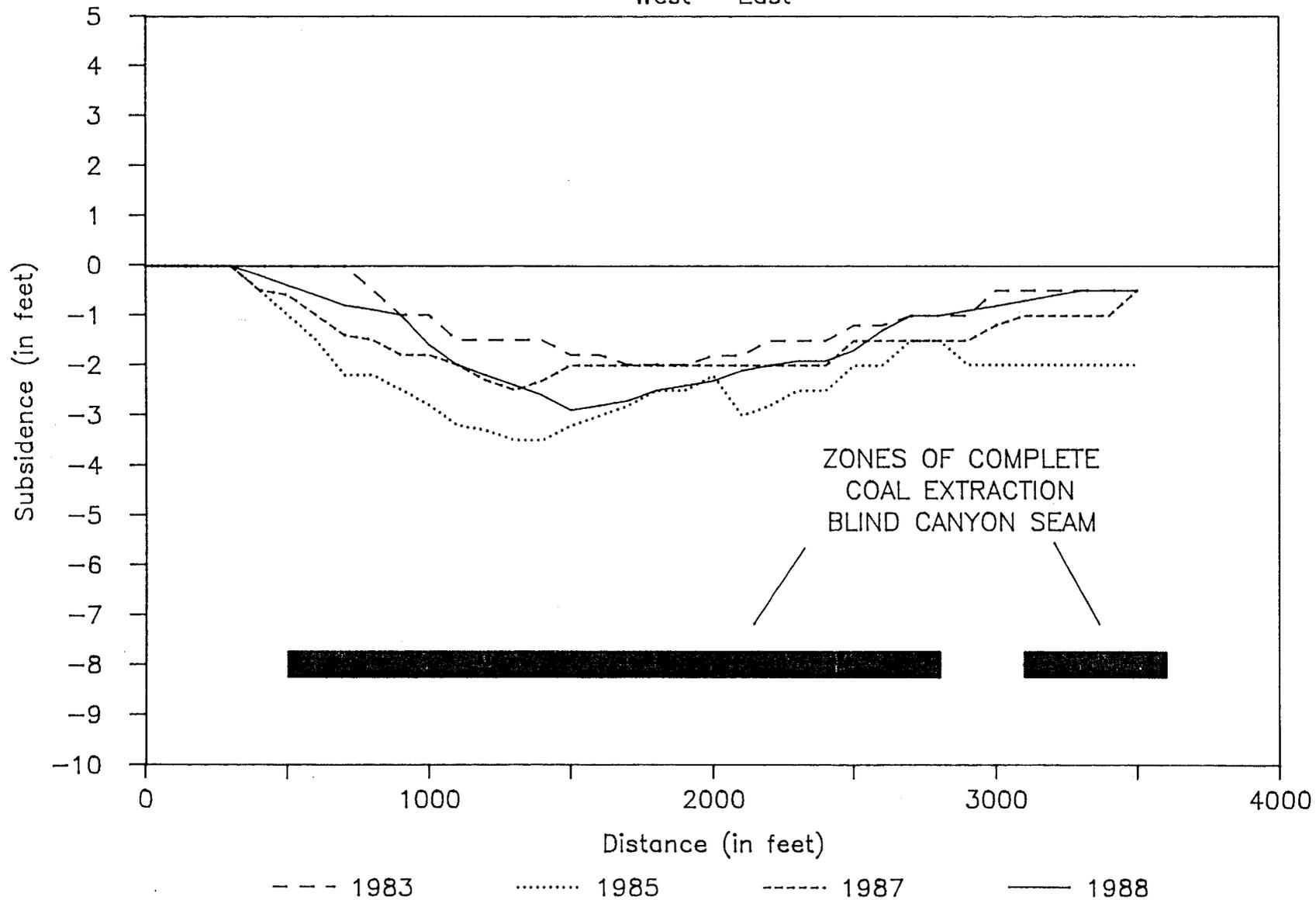
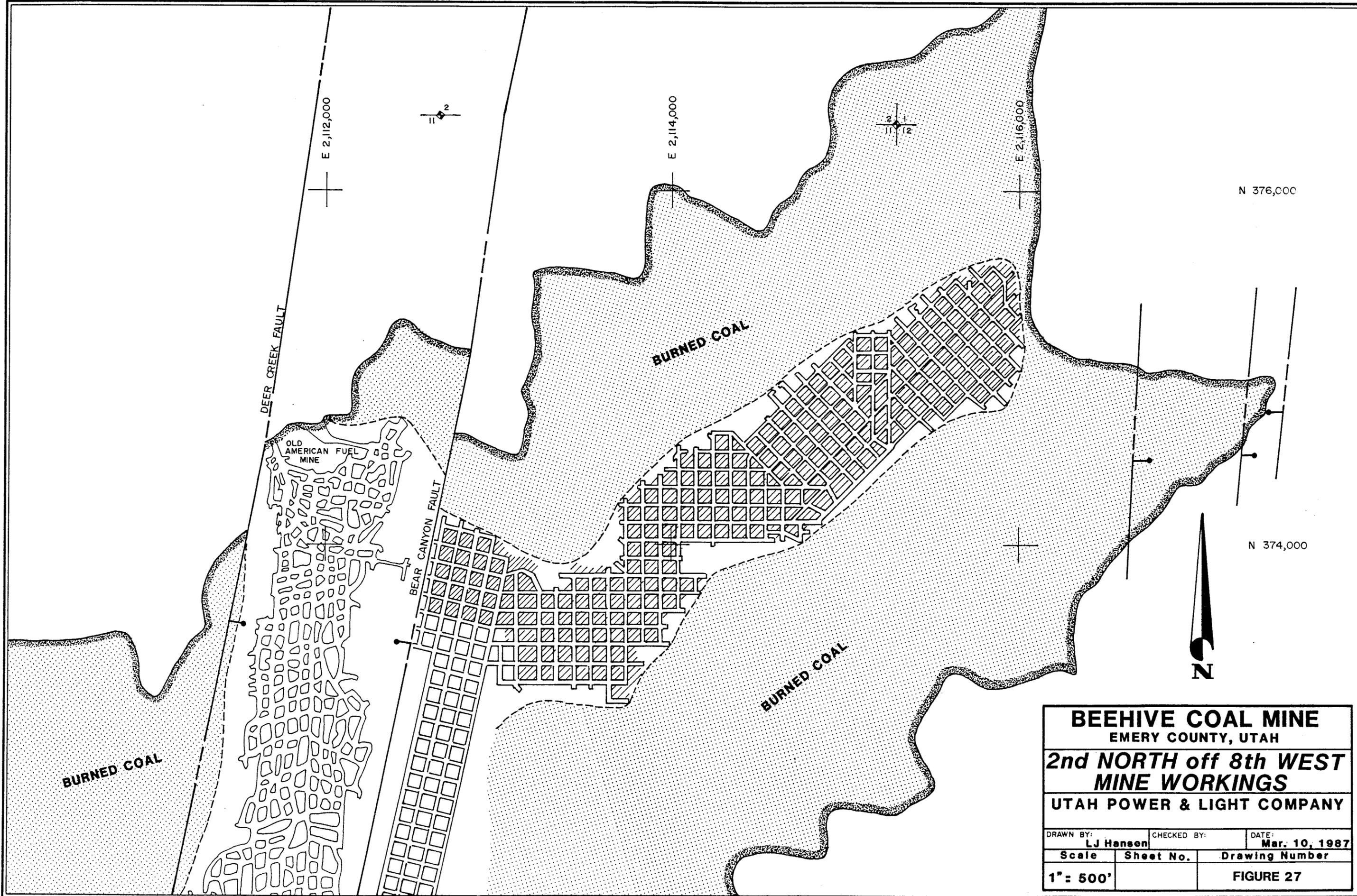


FIGURE 26

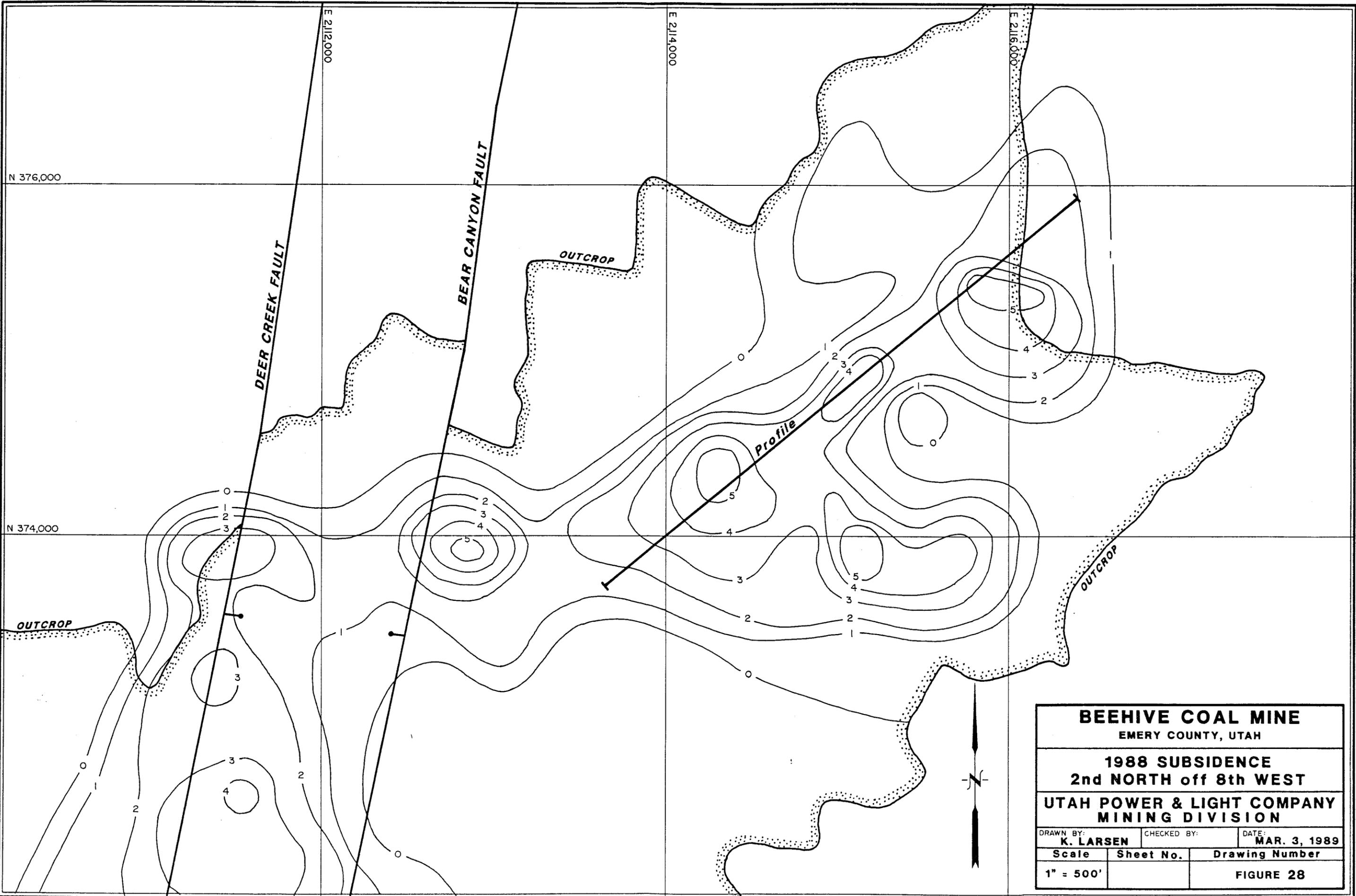
Area 7

Beehive Mine 2nd North off 8th West

Pillar extraction mining in 2nd North was completed in 1983 and, as shown in Figures 28 and 29, little additional subsidence has occurred over the workings since 1984. Subsidence remains at about six (6) feet and, owing to this stability, we also wish to discontinue annual monitoring of this area. For a more complete discussion of subsidence in Area 7, consult the 1986 or a previous report.



BEEHIVE COAL MINE		
EMERY COUNTY, UTAH		
2nd NORTH off 8th WEST		
MINE WORKINGS		
UTAH POWER & LIGHT COMPANY		
DRAWN BY: LJ Hansen	CHECKED BY:	DATE: Mar. 10, 1987
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 27



BEEHIVE COAL MINE		
EMERY COUNTY, UTAH		
1988 SUBSIDENCE		
2nd NORTH off 8th WEST		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION		
DRAWN BY: K. LARSEN	CHECKED BY:	DATE: MAR. 3, 1989
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 28

AREA 7 SUBSIDENCE PROFILE

Southwest - Northeast

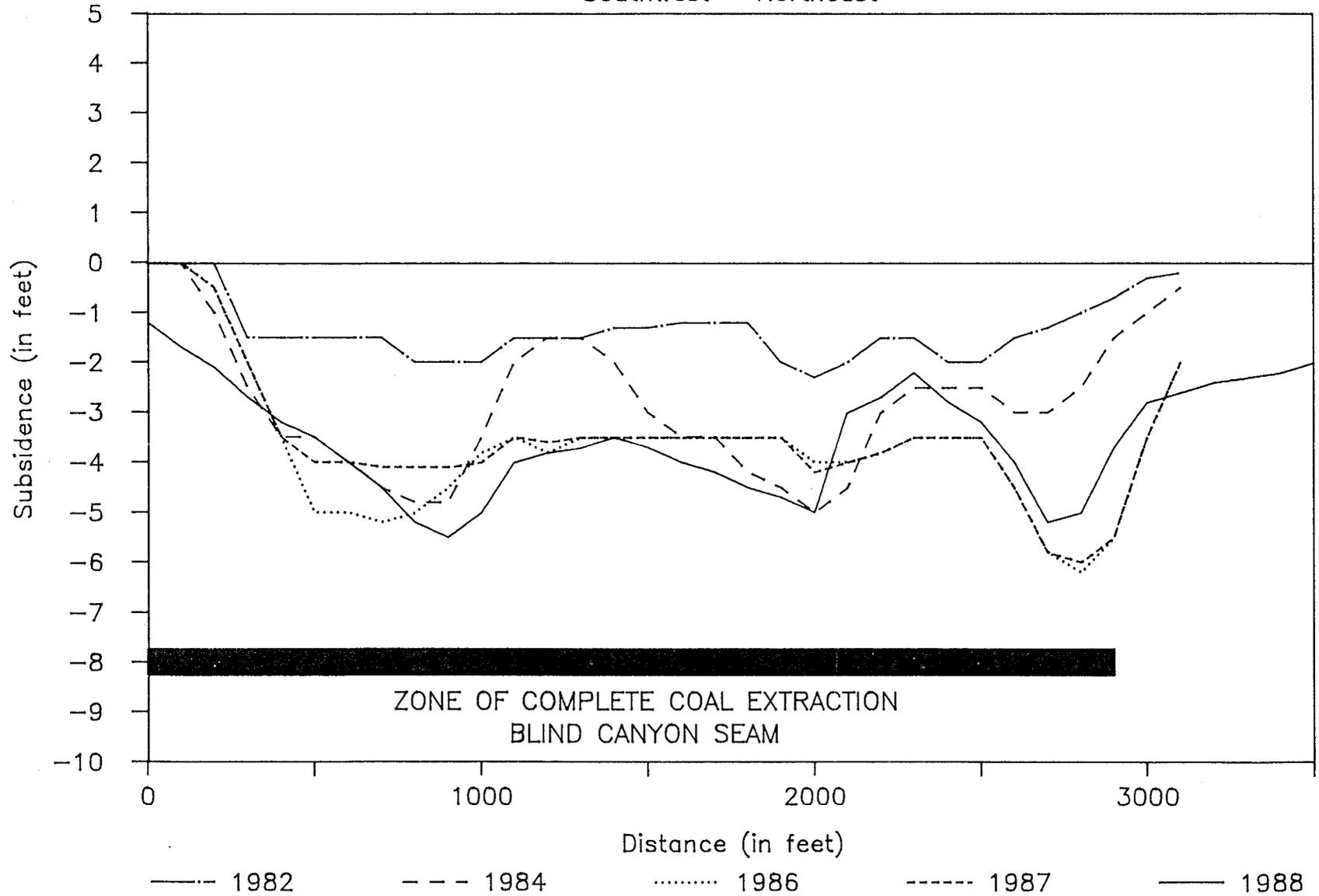


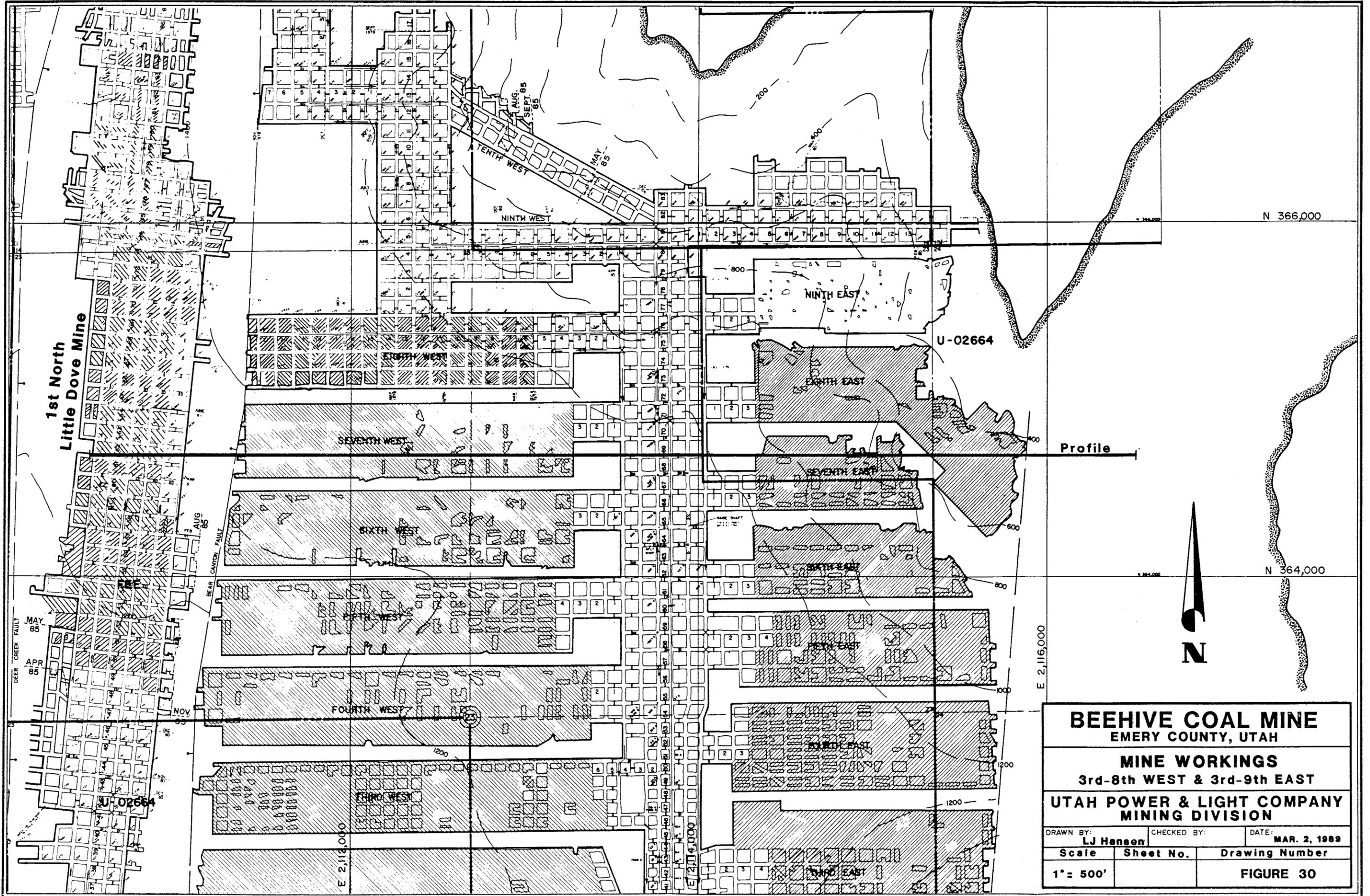
FIGURE 29

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 and 31). The west to east subsidence profile of the area depicted in Figure 32 indicates it had reached a stable state, at near 4.5 feet of subsidence, by 1986. With DOGM approval, annual monitoring will no longer be performed in the area, but aerial photographs will continue to be taken and periodic checks of the photos will be made. The 1986 Subsidence Monitoring Report gives the most recent detailed discussion of ground movement in Area 8.



1st North Little Dove Mine

U-02664

DEER CREEK FAULT
MAY 85
APR 85

BEAR CANYON FAULT
AUG 85

TENTH WEST
MAY 85
AUG 85
SEPT 85

Profile

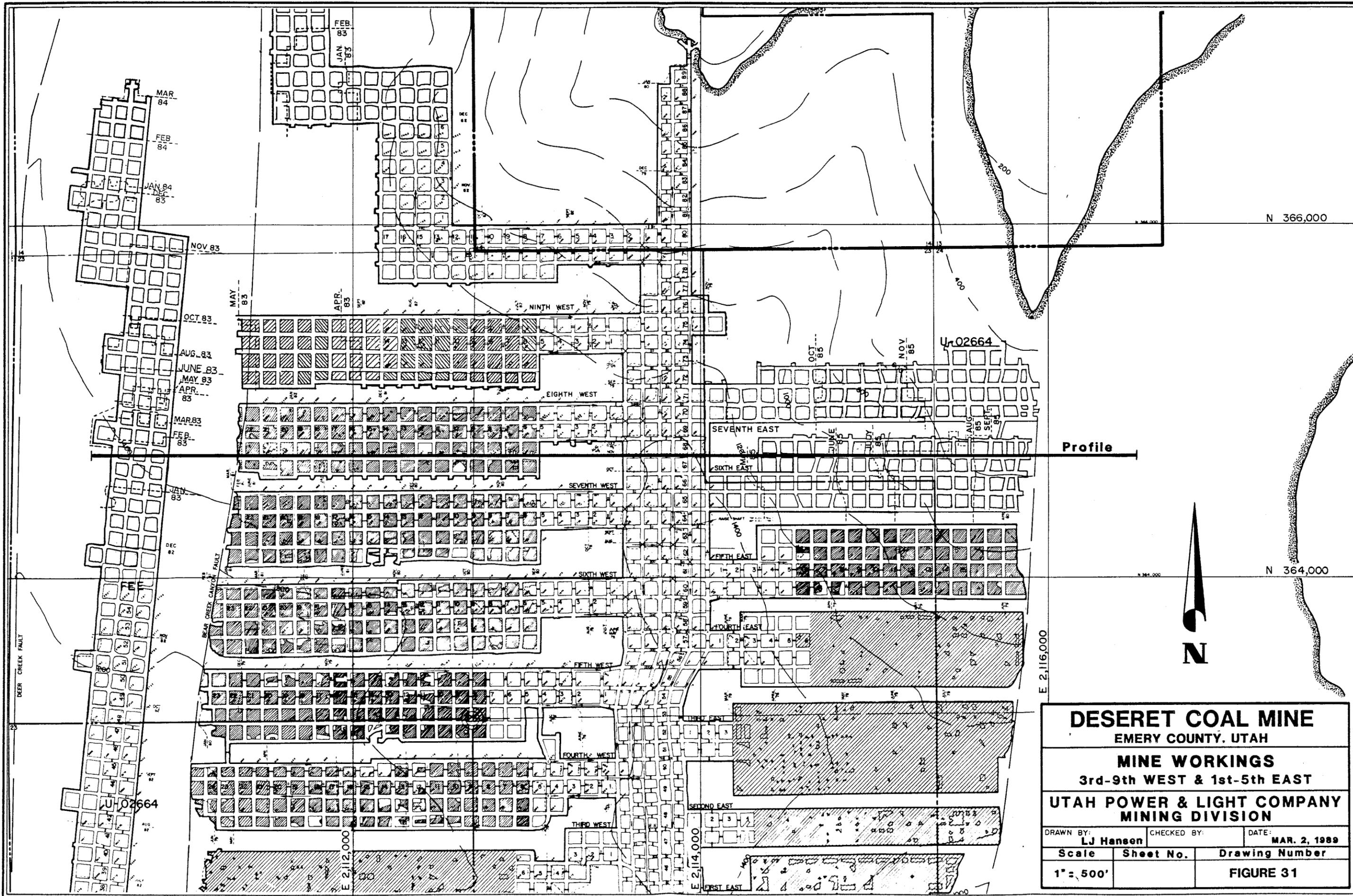


E 2,116,000

N 366,000

N 364,000

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 1" = 500'	Sheet No.	Drawing Number FIGURE 30



DESERET COAL MINE
EMERY COUNTY, UTAH

MINE WORKINGS
3rd-9th WEST & 1st-5th EAST

UTAH POWER & LIGHT COMPANY
MINING DIVISION

DRAWN BY: LJ Hanson	CHECKED BY:	DATE: MAR. 2, 1989
Scale 1" = 500'	Sheet No.	Drawing Number FIGURE 31

AREA 8 SUBSIDENCE PROFILE

West - East

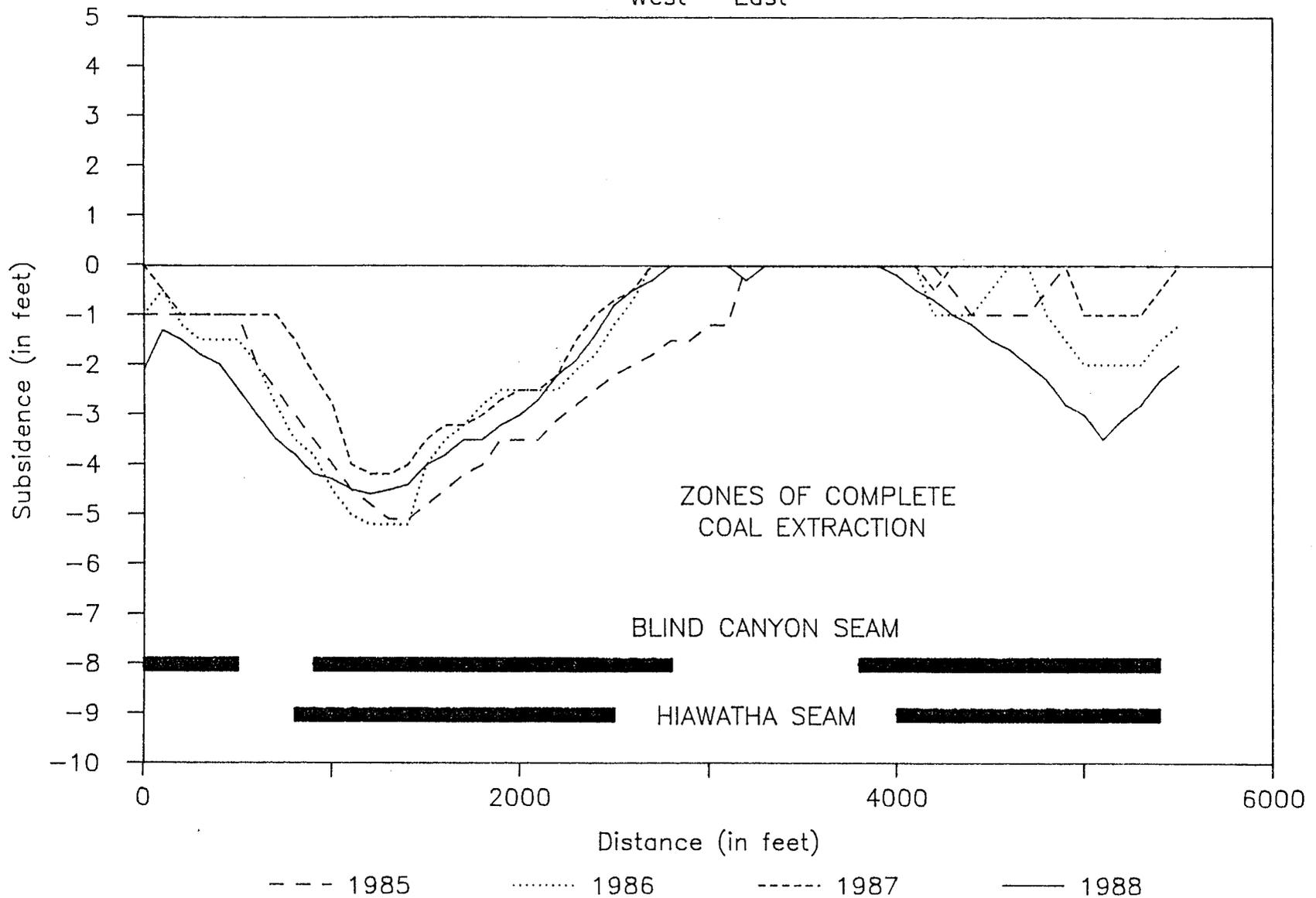


FIGURE 32

Area 9

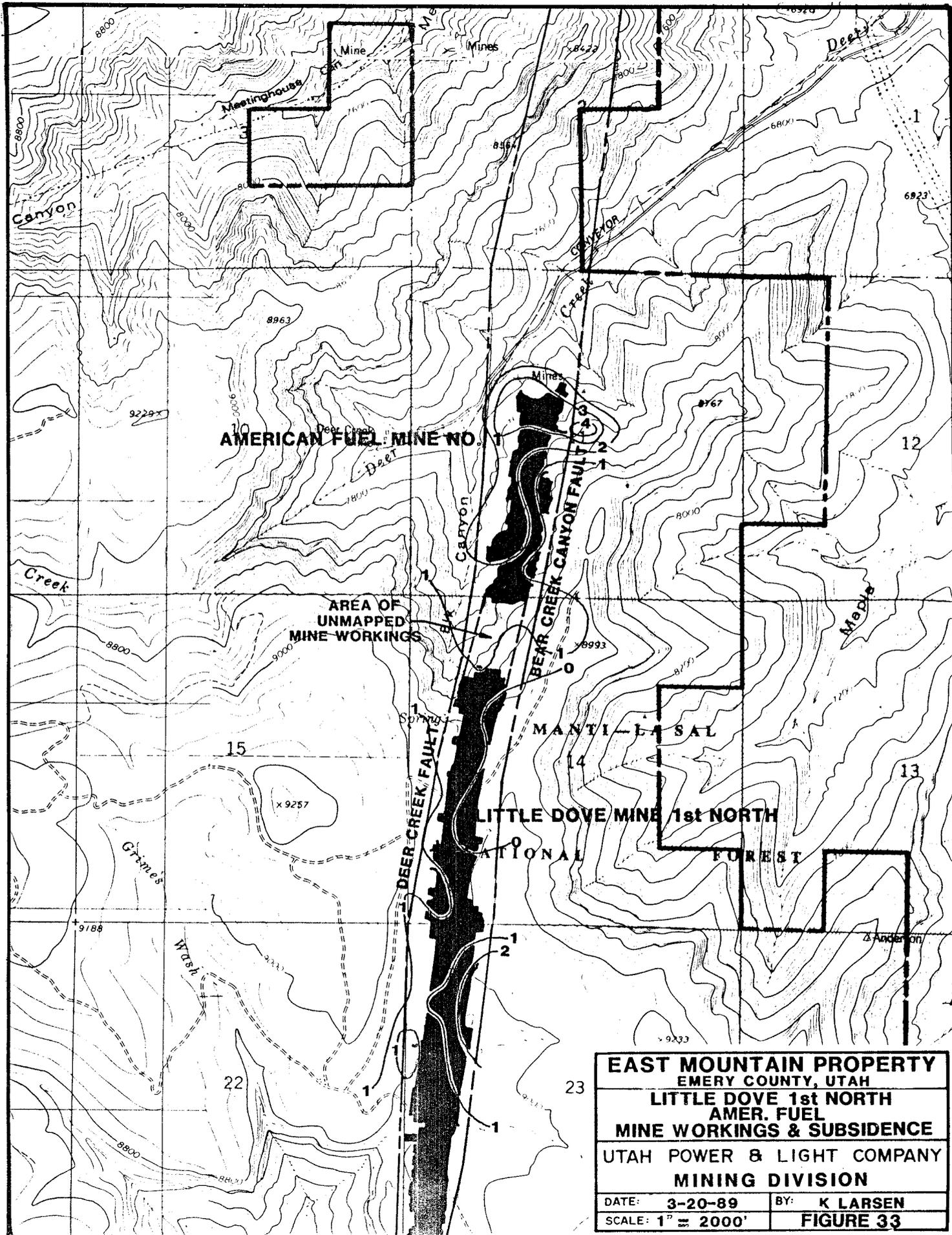
Little Dove 1st North

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 (Figure 33). 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 two (2) feet, occurring over some of the most recently extracted pillars (Figure 33). The northern portions of the 1st North workings and subsidence are included in Area 8, which appears to have stabilized.

Any angle-of-draw calculation would be affected by both the surrounding mine workings of other mines and by the faults on either side; therefore, no angle-of-draw has been calculated for the 1st North area of the Little Dove Mine.

No fractures, slumps, or other effects have been seen over the workings. Mining has had no known effect on the hydrology of the area.



AMERICAN FUEL MINE NO. 1

AREA OF UNMAPPED MINE WORKINGS

MANTI-LASAL

LITTLE DOVE MINE 1st NORTH

NATIONAL FOREST

EAST MOUNTAIN PROPERTY	
EMERY COUNTY, UTAH	
LITTLE DOVE 1st NORTH	
AMER. FUEL	
MINE WORKINGS & SUBSIDENCE	
UTAH POWER & LIGHT COMPANY	
MINING DIVISION	
DATE: 3-20-89	BY: K LARSEN
SCALE: 1" = 2000'	FIGURE 33

Area 10

Old American Fuel Mine

The old American Fuel Mine workings are also located in the graben formed by the Deer Creek and Bear Creek Canyon faults just north of the Little Dove 1st North section (Figures 33 and 28). The latest mining in the American Fuel Mine terminated in 1986. Maximum subsidence remains at about four (4) feet. Since no significant subsidence has taken place in this area over the past three years, we wish, with DOGM approval, to discontinue annual monitoring. The 1986 Subsidence Monitoring Report contains the latest detail concerning the area.

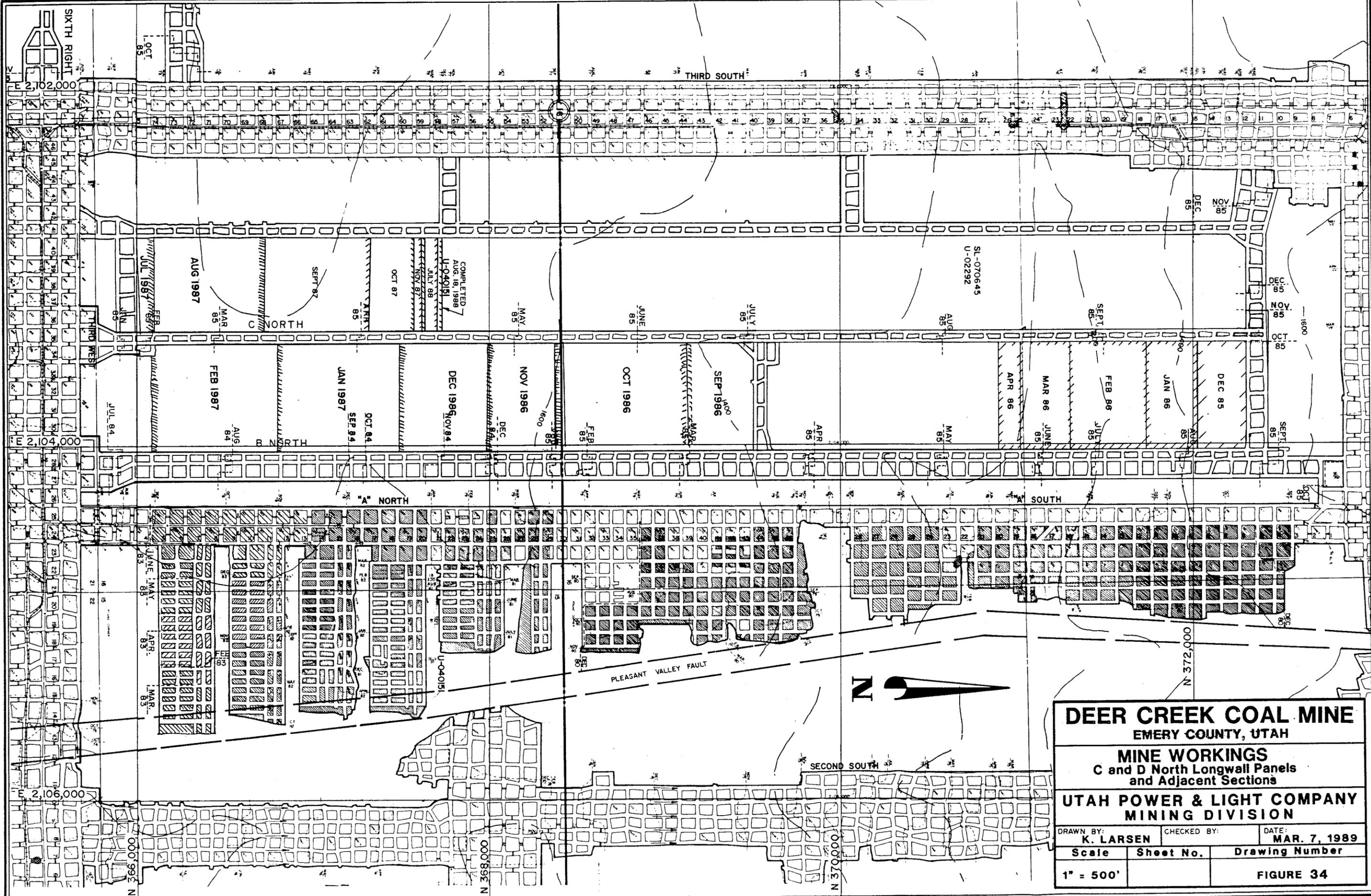
Area 11

Deer Creek C and D North Longwall Panels and Adjacent Sections

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). Measurable subsidence to date has reached six (6) feet over C North and a little more than four (4) feet over the room-and-pillar sections (Figures 35, 36, and 37).

No fractures or disturbance of the surface of the area has been observed. The angle-of-draw measured ranges from less than zero to 28 degrees.

Three springs are located a few hundred feet to the west of the workings, but none falls within the area of measured subsidence. They have shown no effect due to mining (see Hydrologic Monitoring Report, 1988).

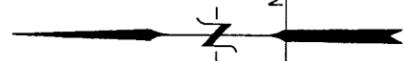
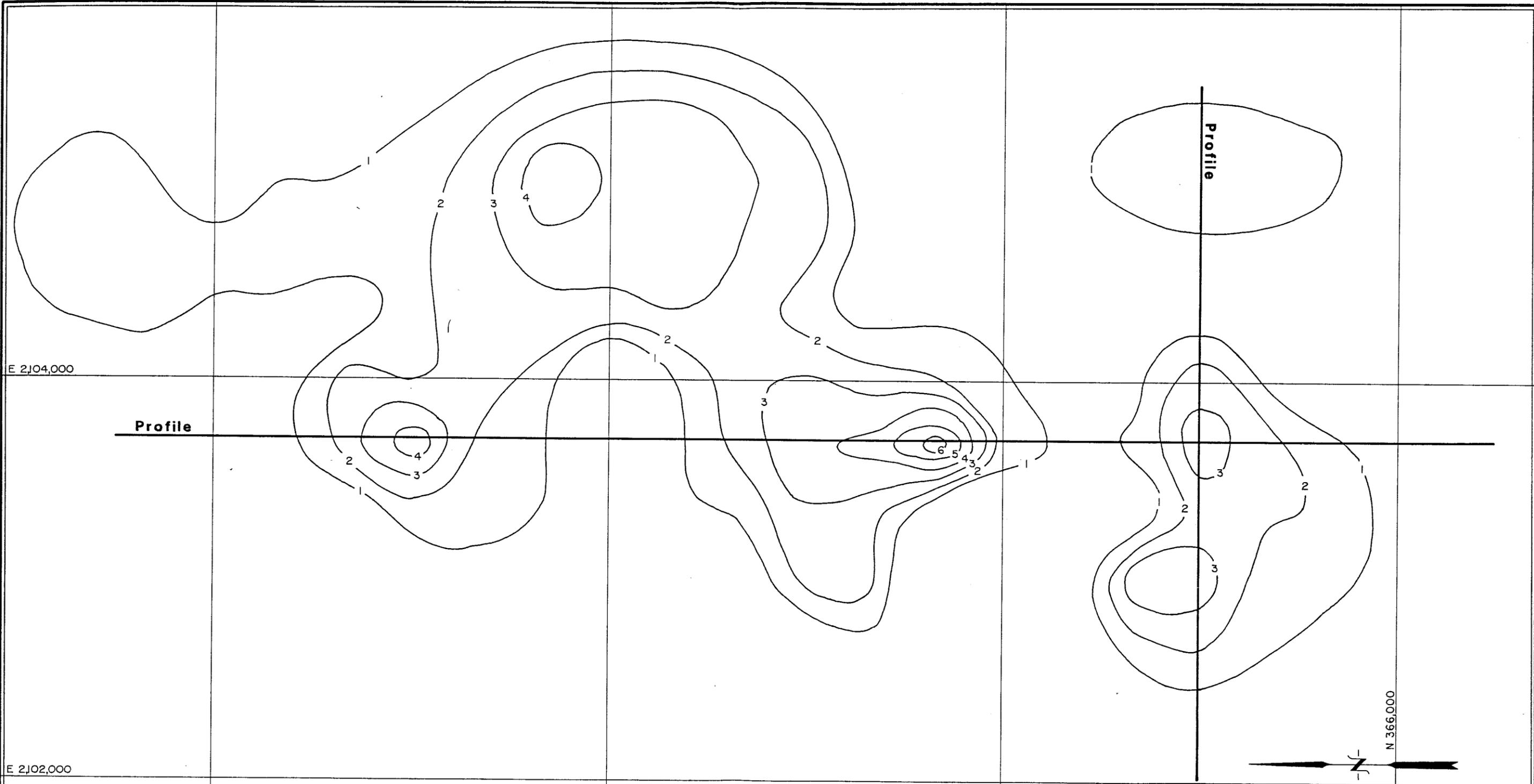


DEER CREEK COAL MINE
 EMERY COUNTY, UTAH

MINE WORKINGS
 C and D North Longwall Panels
 and Adjacent Sections

UTAH POWER & LIGHT COMPANY
 MINING DIVISION

DRAWN BY: K. LARSEN	CHECKED BY:	DATE: MAR. 7, 1989
Scale 1" = 500'	Sheet No.	Drawing Number FIGURE 34



DEER CREEK COAL MINE		
EMERY COUNTY, UTAH		
1988 SUBSIDENCE		
C & D NORTH LONGWALL PANELS		
AND ADJACENT SECTIONS		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION		
DRAWN BY: K. LARSEN	CHECKED BY:	DATE: MAR. 3, 1989
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 35

N 372,000

N 370,000

N 368,000

N 366,000

E 2104,000

E 2102,000

AREA 11 SUBSIDENCE PROFILE

North - South

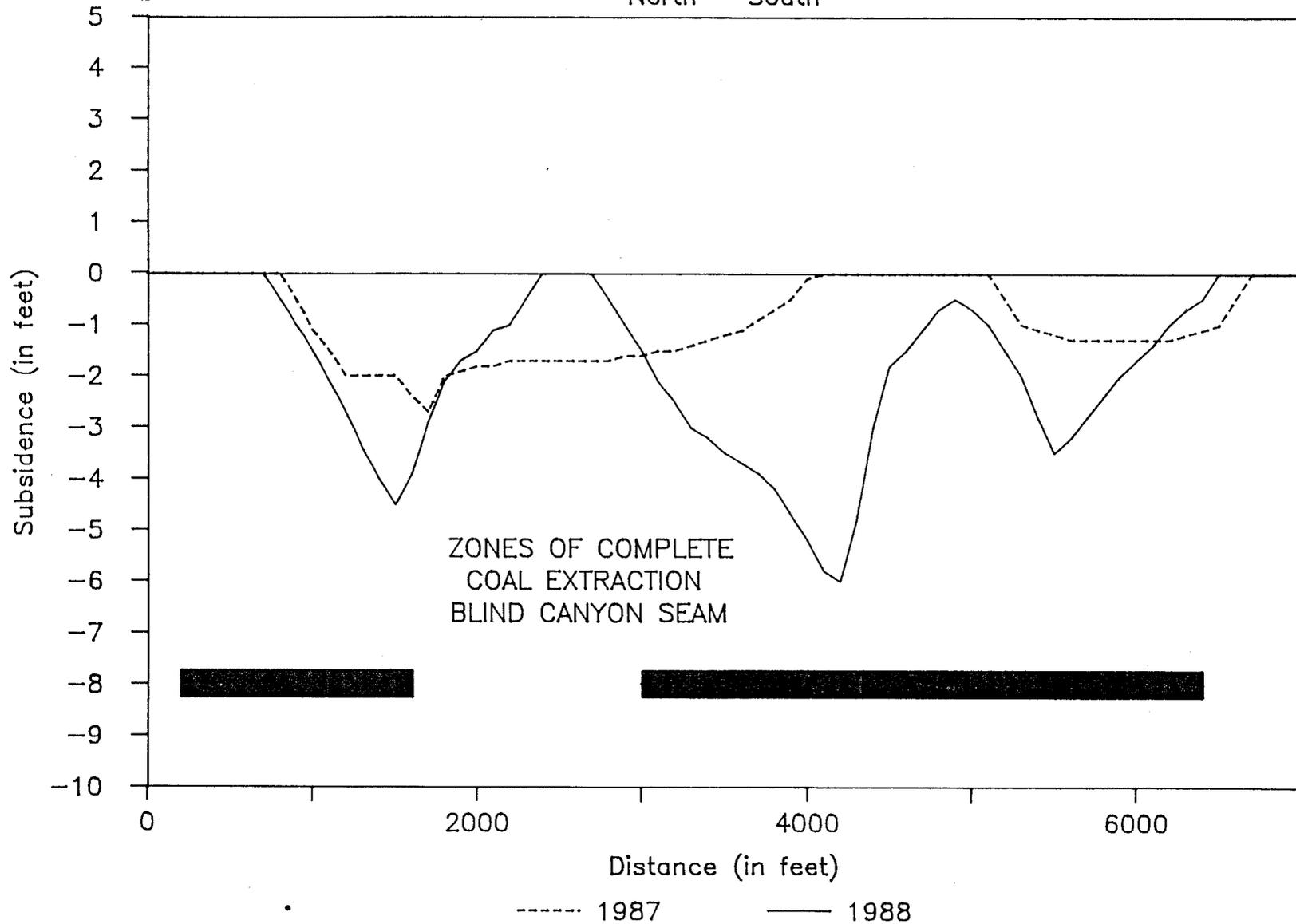


FIGURE 36

AREA 11 SUBSIDENCE PROFILE

West - East

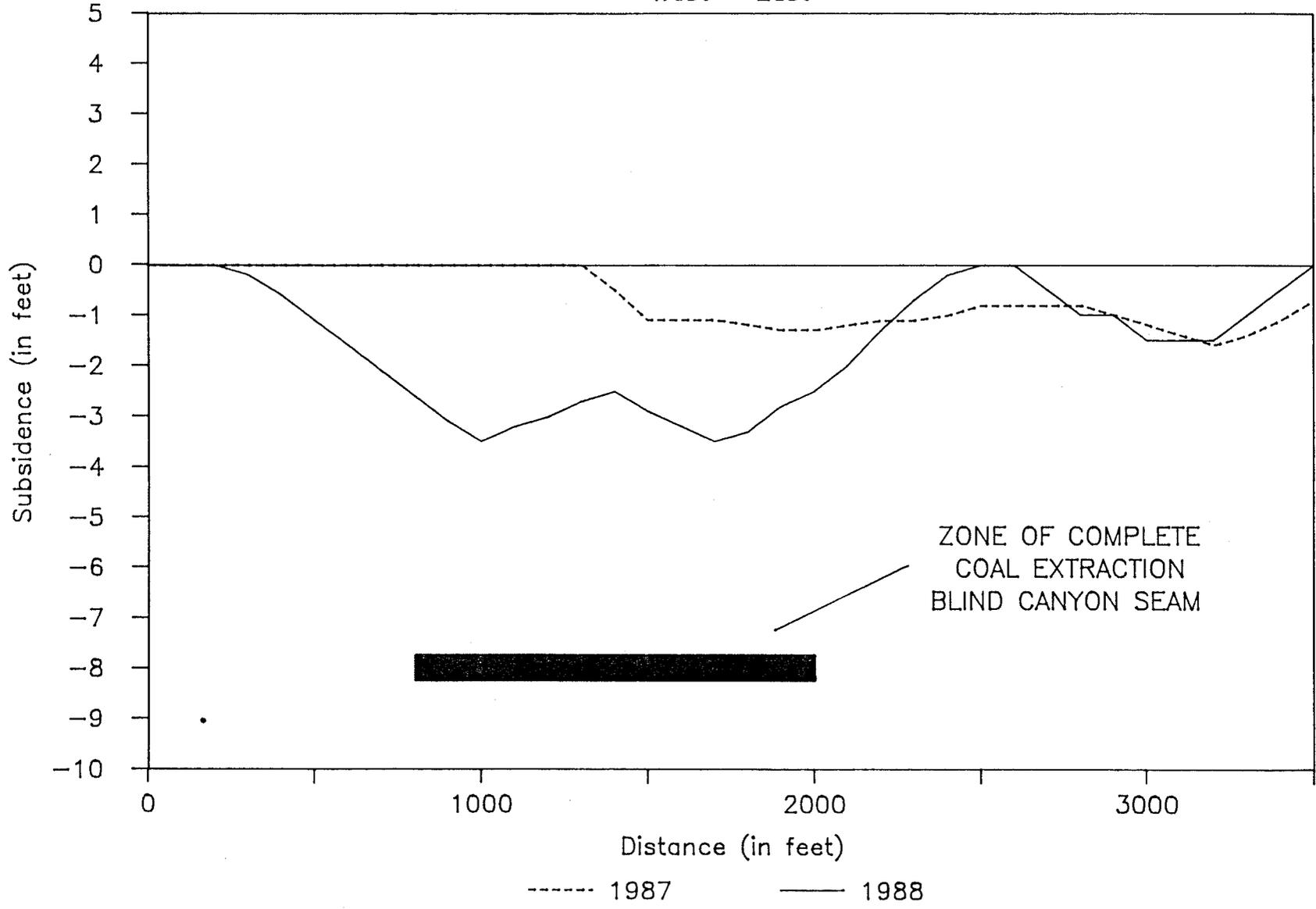


FIGURE 37

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. The area will continue to be monitored periodically, but not annually, upon approval from DOGM.

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

Area 13

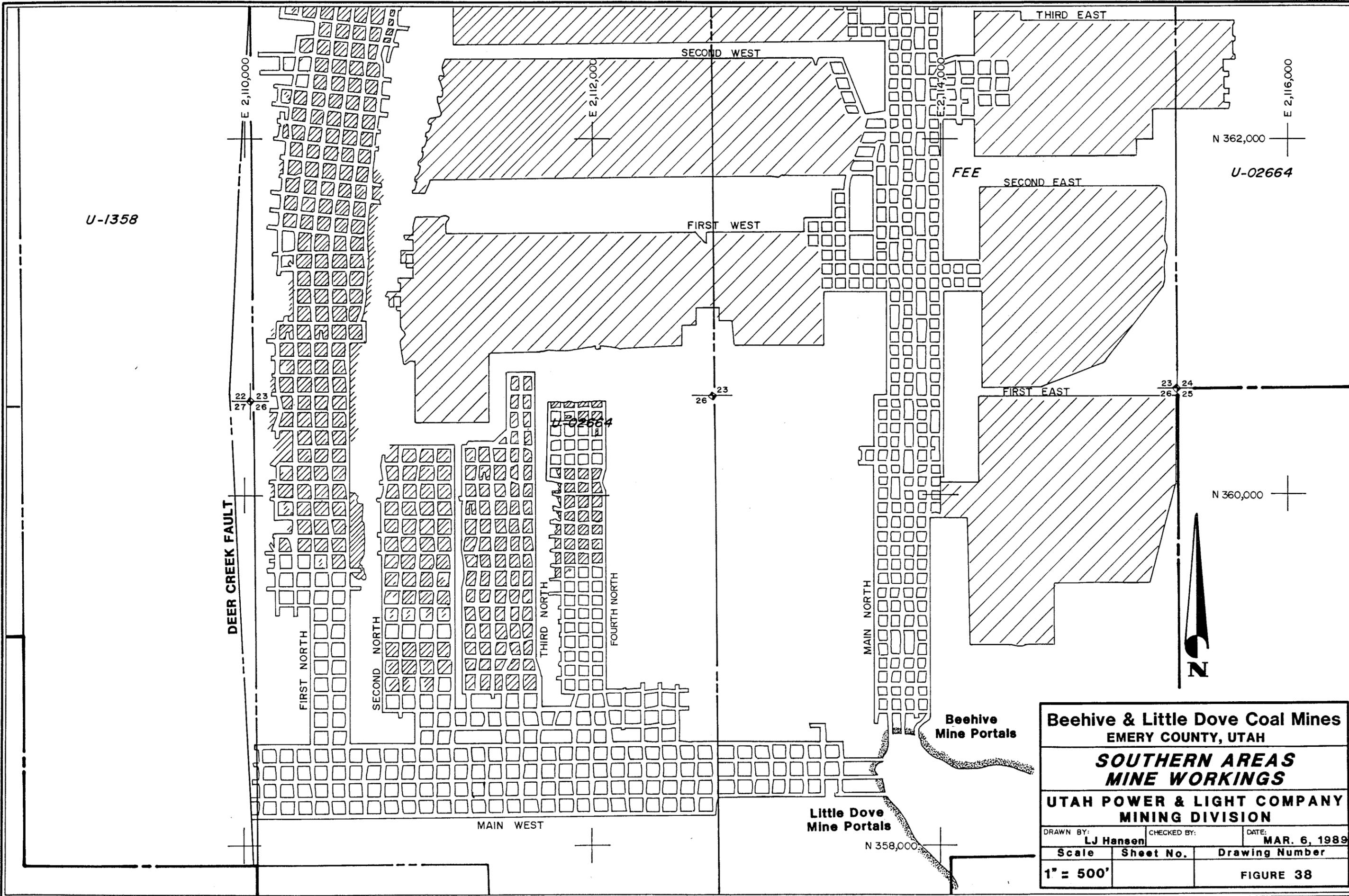
Des-Bee-Dove Southern Area

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 38 and 39).

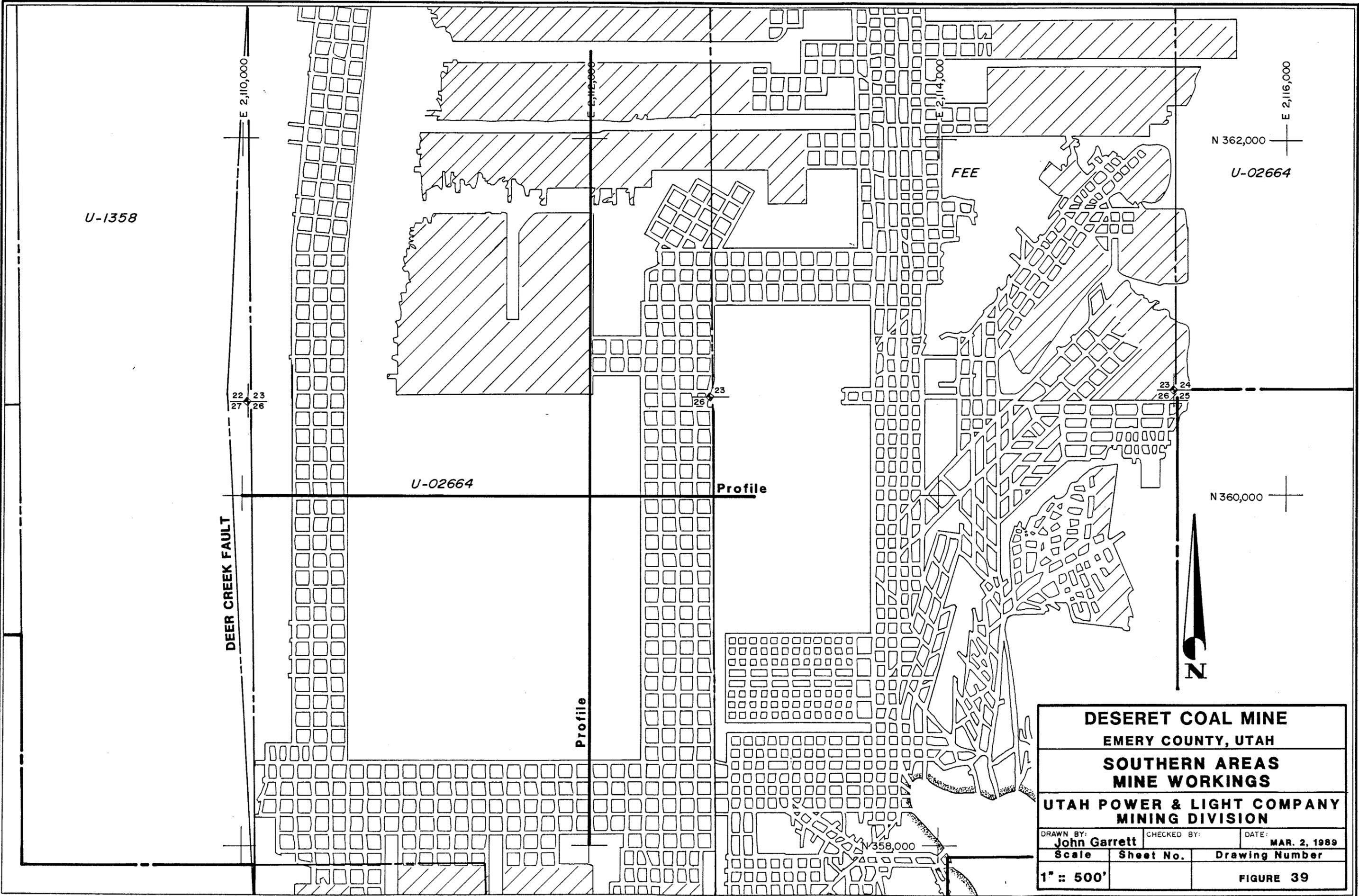
Maximum subsidence over the area as of August 1988 was about two (2) feet (Figures 40 and 41).

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.



Beehive & Little Dove Coal Mines		
EMERY COUNTY, UTAH		
SOUTHERN AREAS		
MINE WORKINGS		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION		
DRAWN BY:	CHECKED BY:	DATE:
LJ Hansen		MAR. 6, 1989
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 38



DESERET COAL MINE		
EMERY COUNTY, UTAH		
SOUTHERN AREAS		
MINE WORKINGS		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION		
DRAWN BY: John Garrett	CHECKED BY:	DATE: MAR. 2, 1989
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 39

AREA 13 SUBSIDENCE PROFILE

North - South

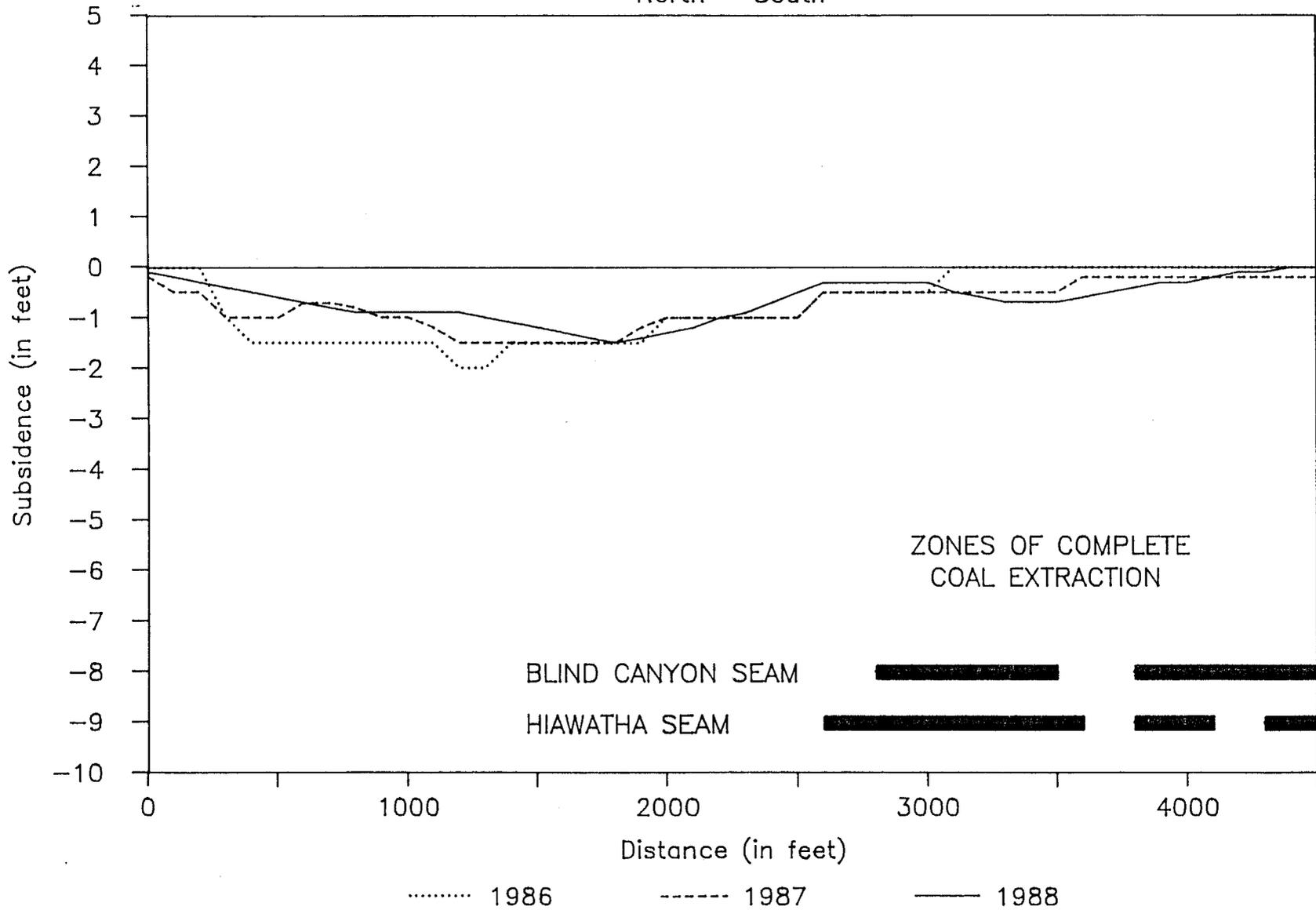


FIGURE 40

AREA 13 SUBSIDENCE PROFILE

West - East

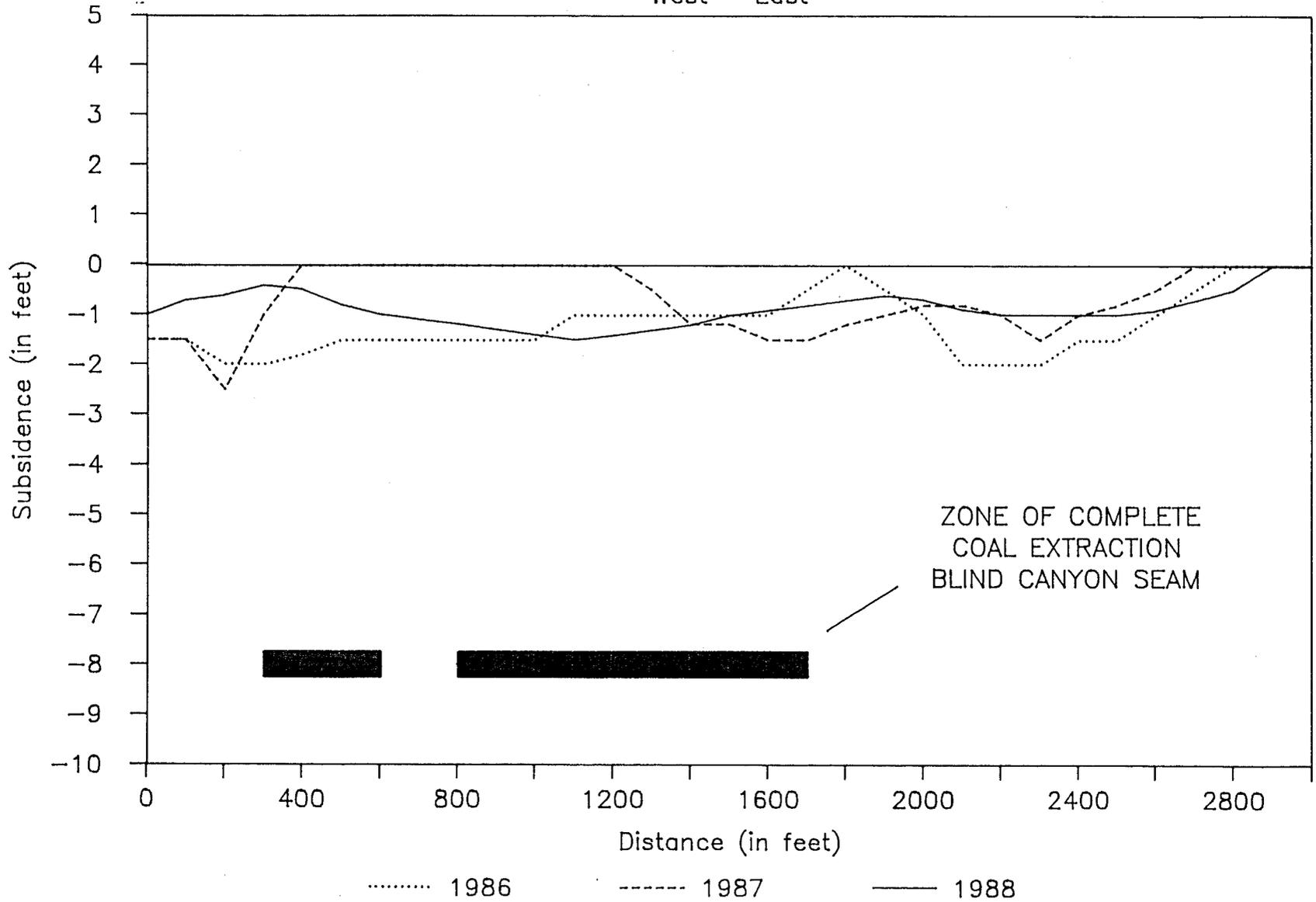


FIGURE 41

Area 14

Cottonwood 6th and 7th East Longwall Panels

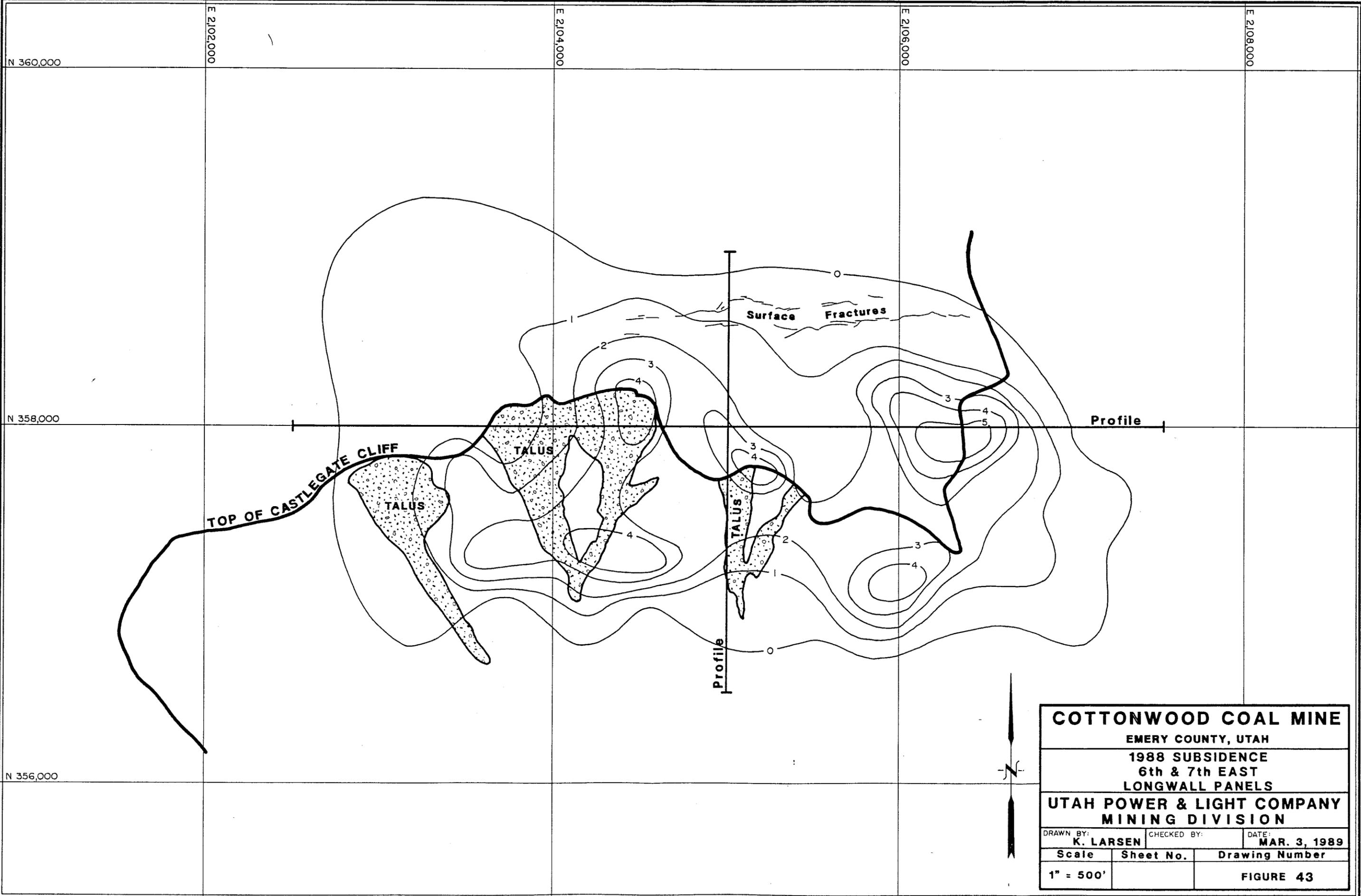
Subsidence in Area 14 was first monitored and detected in 1987. Mining began in the 6th East panel in September 1986 and continued until the panel was completed in March 1987. Mining in the 7th East panel began in April 1987, and the panel was finished in September 1987 (Figure 42).

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 near 1400 feet to 200 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 2000 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 five (5) feet, occurring over the eastern end of the 6th East panel (Figure 43).

Calculated angle-of-draw ranges from less than zero to 29 degrees.



COTTONWOOD COAL MINE		
EMERY COUNTY, UTAH		
1988 SUBSIDENCE		
6th & 7th EAST		
LONGWALL PANELS		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION		
DRAWN BY: K. LARSEN	CHECKED BY:	DATE: MAR. 3, 1989
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 43

AREA 14 SUBSIDENCE PROFILE

North - South

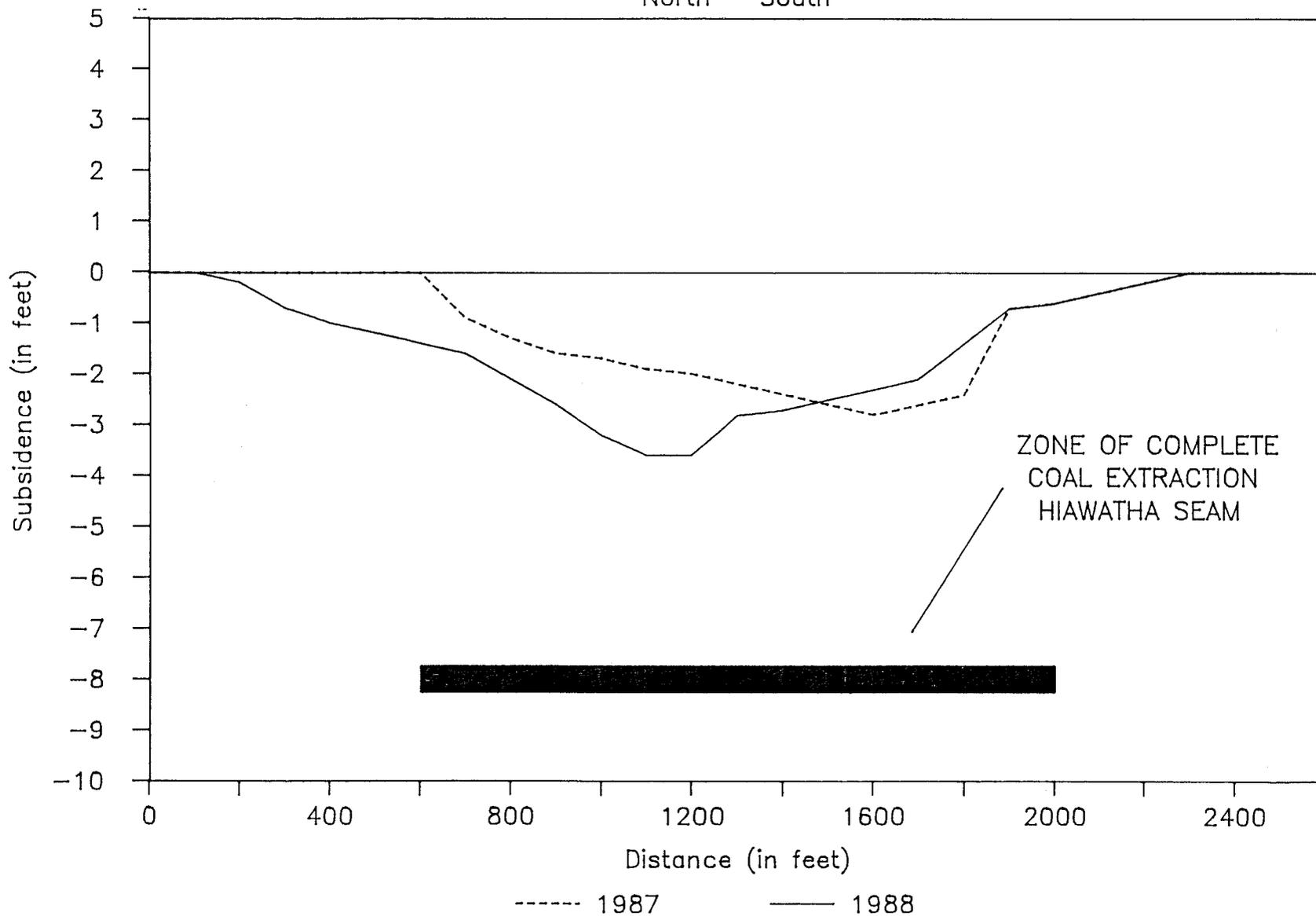


FIGURE 44

AREA 14 SUBSIDENCE PROFILE

West - East

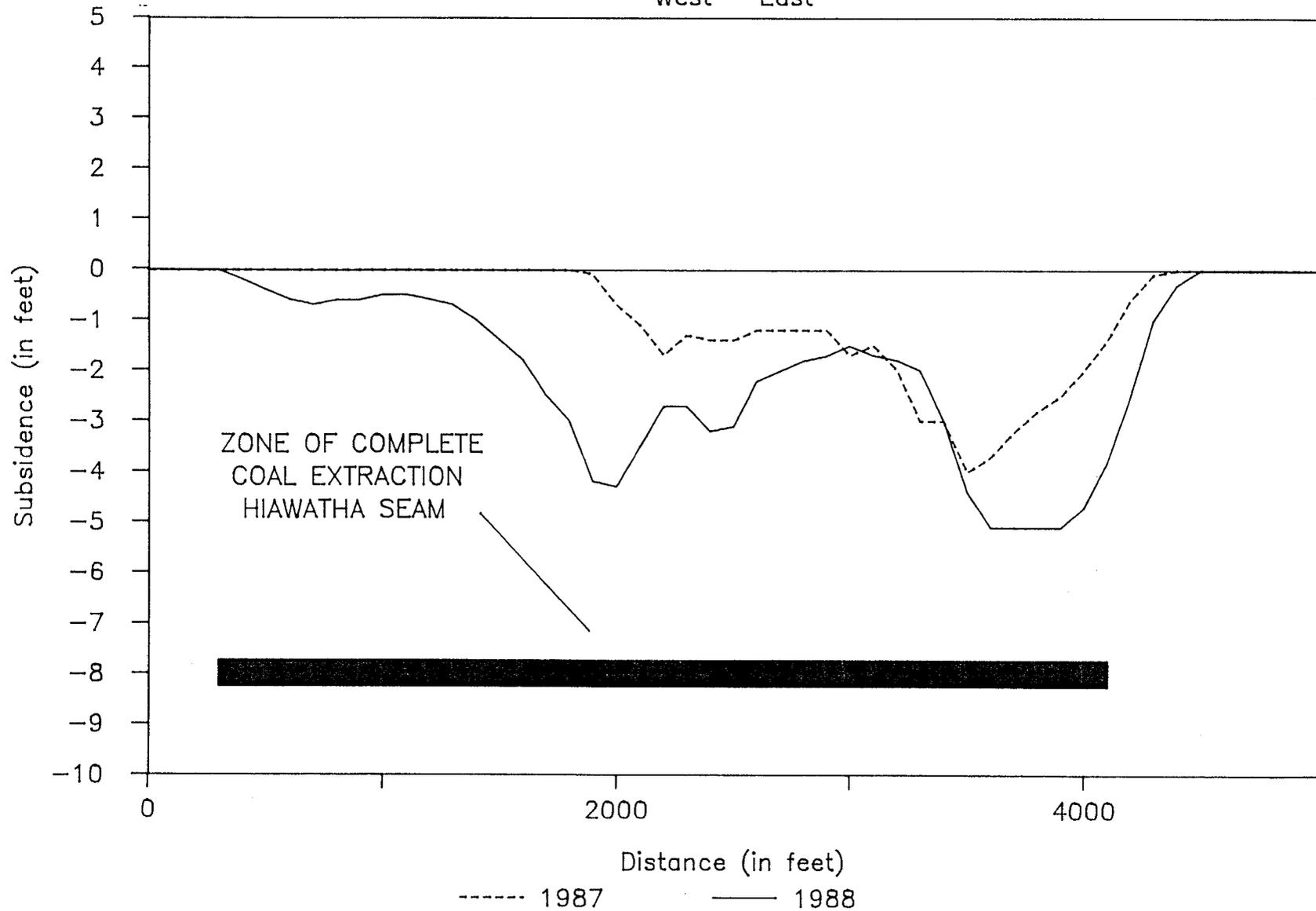


FIGURE 45

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.

Mitigation of effects due to mining may be required in Area 14. A detailed assessment is given in the Newberry Canyon report. Briefly, mitigation may include 1) backfilling, recontouring, and revegetating surface cracks, where accessible; 2) creating artificial eagle nesting sites; and 3) improvement of habitat for existing species or developing habitat for another desirable species.

In all likelihood most of the mitigation measures will be unnecessary. UP&L will continue to monitor subsidence to assess the significance of related impacts.

Area 15

Cottonwood 9th and 10th West Longwall Panels

Subsidence in 9th and 10th West was first monitored and detected in 1988 since longwall extraction there began during this monitoring period. Between February and August 1988 the entire 9th West panel and 2530 feet of the 10th West panel were extracted (Figure 46).

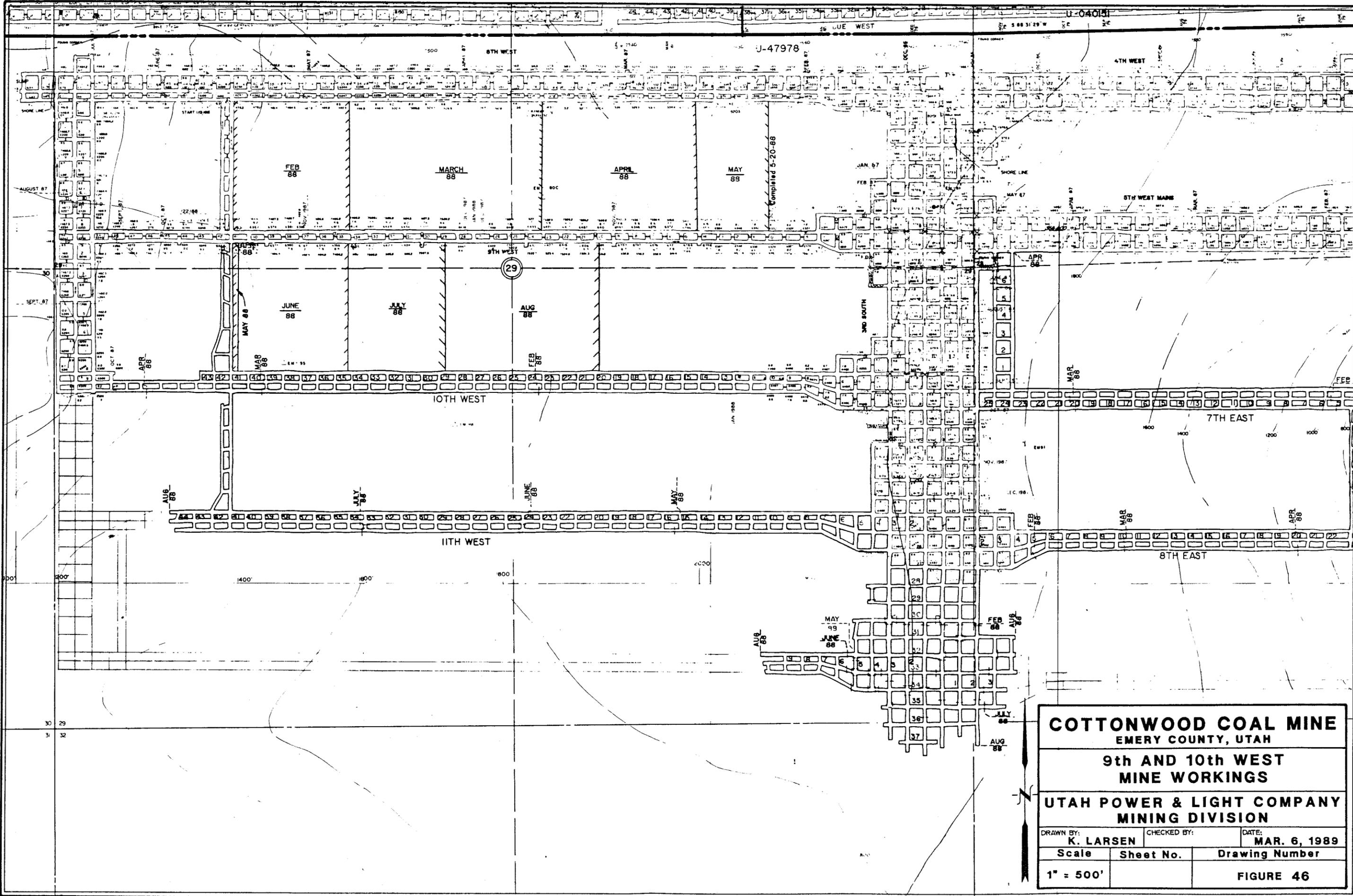
The surface above these panels is comprised mainly of steep to moderate slopes with a small flat area forming the top of East Mountain on the area's eastern edge. Overburden ranges from 1200 feet to over 2000 feet, increasing eastward.

Due to a stipulation by the U.S. Forest Service, both panels were shortened on their western ends to prevent possible failure of portions of the Castlegate Sandstone escarpment in Miller Canyon.

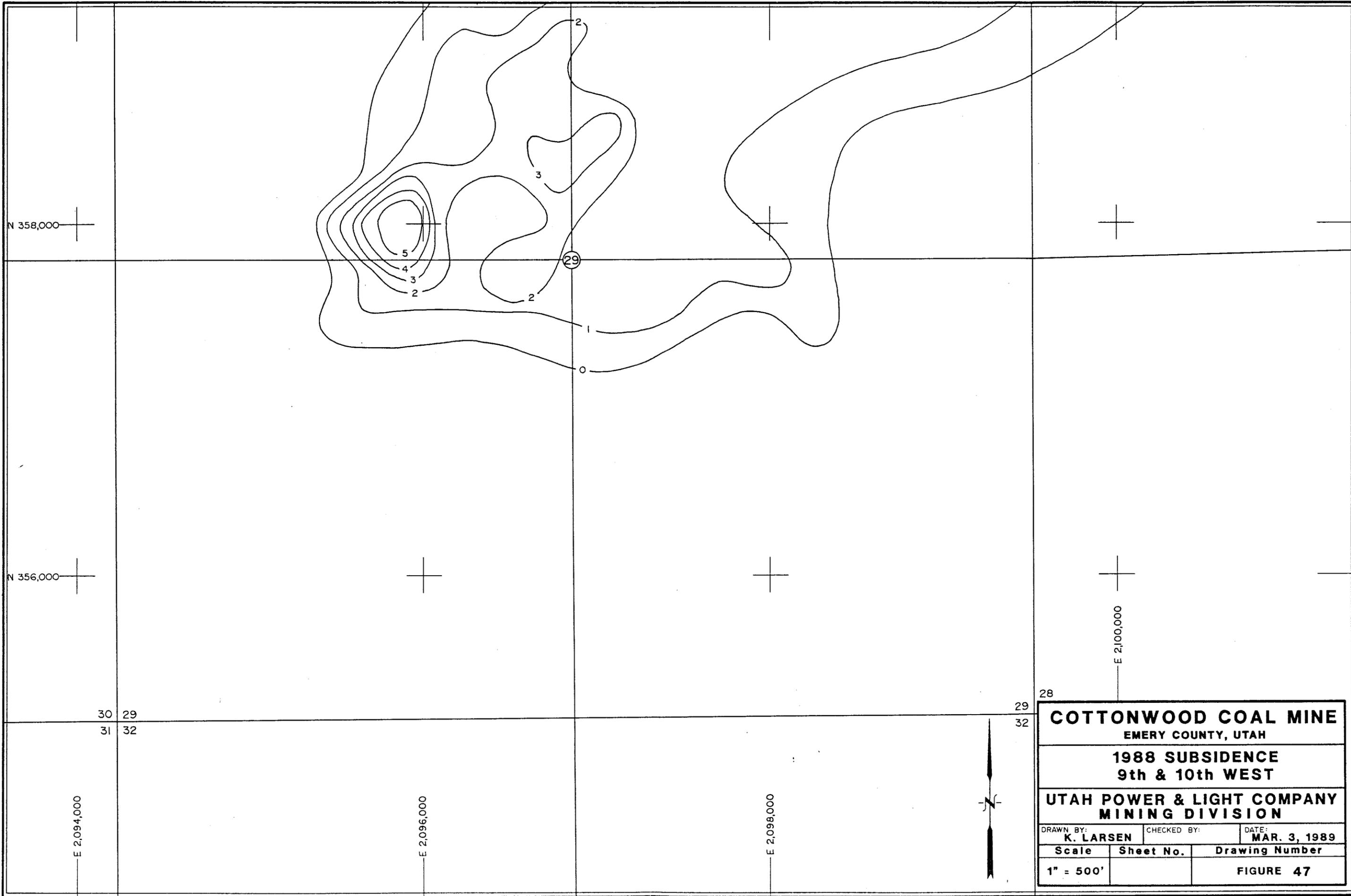
Maximum measured subsidence to date is over five (5) feet above the western ends of the panels (Figure 47).

Calculated angle-of-draw is less than zero on west, south, and east, and reaches 25 degrees on the north where older workings may be causing subsidence to the north of the 9th West panel.

There are no known springs in the area.



COTTONWOOD COAL MINE		
EMERY COUNTY, UTAH		
9th AND 10th WEST		
MINE WORKINGS		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION		
DRAWN BY:	CHECKED BY:	DATE:
K. LARSEN		MAR. 6, 1989
Scale	Sheet No.	Drawing Number
1" = 500'		FIGURE 46



COTTONWOOD COAL MINE		
EMERY COUNTY, UTAH		
1988 SUBSIDENCE		
9th & 10th WEST		
UTAH POWER & LIGHT COMPANY		
MINING DIVISION		
<small>DRAWN BY:</small> K. LARSEN	<small>CHECKED BY:</small>	<small>DATE:</small> MAR. 3, 1989
<small>Scale</small>	<small>Sheet No.</small>	<small>Drawing Number</small>
1" = 500'		FIGURE 47

AREA 15 SUBSIDENCE PROFILE

North - South

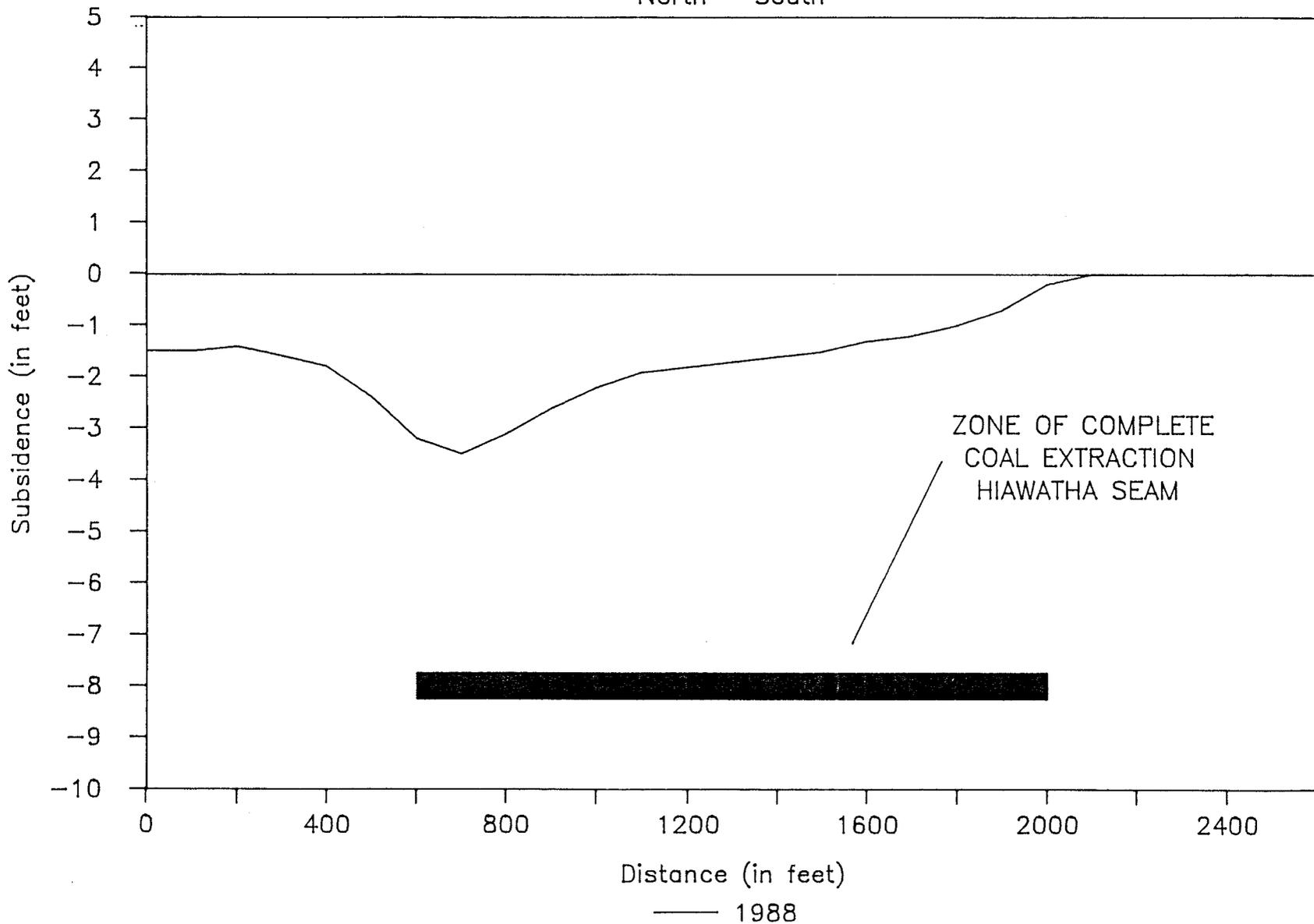


FIGURE 48

AREA 15 SUBSIDENCE PROFILE

West - East

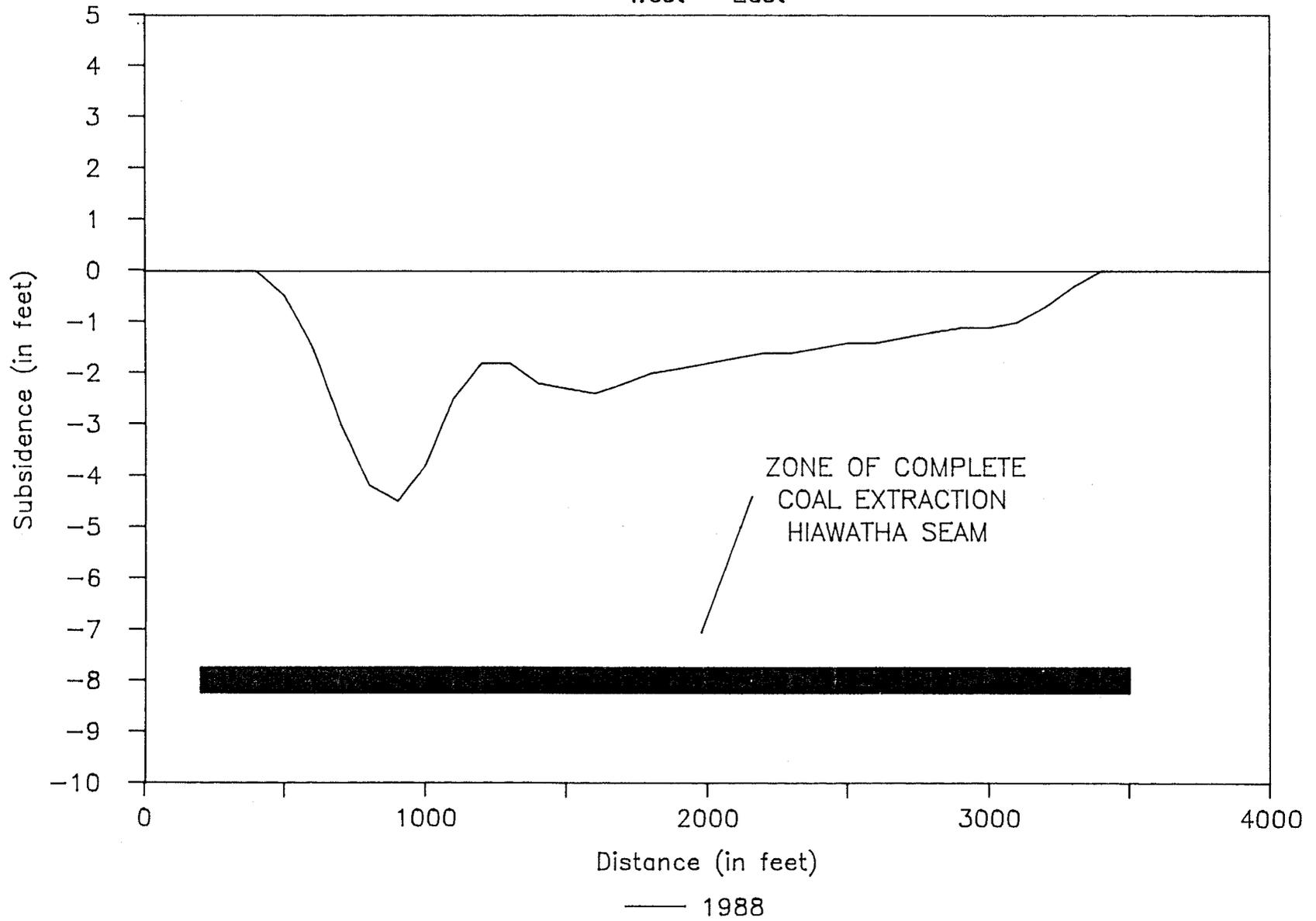


FIGURE 49

Predicted Maximum Subsidence

A comparison between observed and predicted maximum subsidence for the various areas on UP&L'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 $\pm 10\%$ 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.

<u>Area</u>	<u>Subsidence (feet)</u>		
	<u>Predicted Maximum</u>	<u>Observed</u>	<u>% of Predicted</u>
*1 DC 9E/W 1R	8.9	25.0	281
2 DC 5-8E/W, 5-13R	14.4	11.6	81
3 DC 1N Area	5.4	7.0	130
4 DC 2-7R	8.6	6.9	80
5 DC 2-5L	7.7	5.0	65
6 W 1-2W	5.3	3.0	57
7 Bee 2N off 8W	9.9	6.0	61
8 Bee/Des E&W Sections	6.3	4.5	71
9 LD 1N	4.6	2.0	44
10 Old American Fuel Mine	7.3	4.0	55
11 DC A N&S and CN Longwall	6.2	4.4	71
12 W 2L	1.8	0	0
13 Des-Bee-Dove Southern Areas	2.4	2.2	92
14 Cottonwood 6-7E	7.2	5.5	76
15 Cottonwood 9-10W	7.2	5.5	76

* This area does not fit the NCB prediction model.

In all areas except one subsidence is less than the maximum predicted by the NCB model, possibly due to the fact that in some areas mining occurred very recently and subsidence has not yet reached its maximum. It could also be that 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. Figure 50 shows the relationship between predicted and observed subsidence. From the slope of the regressions line ($A = .80$) the average observed subsidence is eighty percent (80%) of the NCB predicted maximum. (Area 1 excluded from graph data.)

Area 1 (DC 9th East - Wilberg 1st Right) is the one anomalous area; it does not fit the special conditions necessary for prediction by the NCB method. The mine workings are surrounded by burned coal and bounded on the east by the Deer Creek Fault. As mentioned before, crushing of clinker beds and movement along the fault have added another complication to the subsidence. The maximum subsidence in the area occurs on a steep slope below a cliff, where slumping has occurred. The twenty-five (25) feet measured here must be due in part to mass wasting on the steep slope.

PREDICTED vs OBSERVED SUBSIDENCE

East Mountain Property

1988

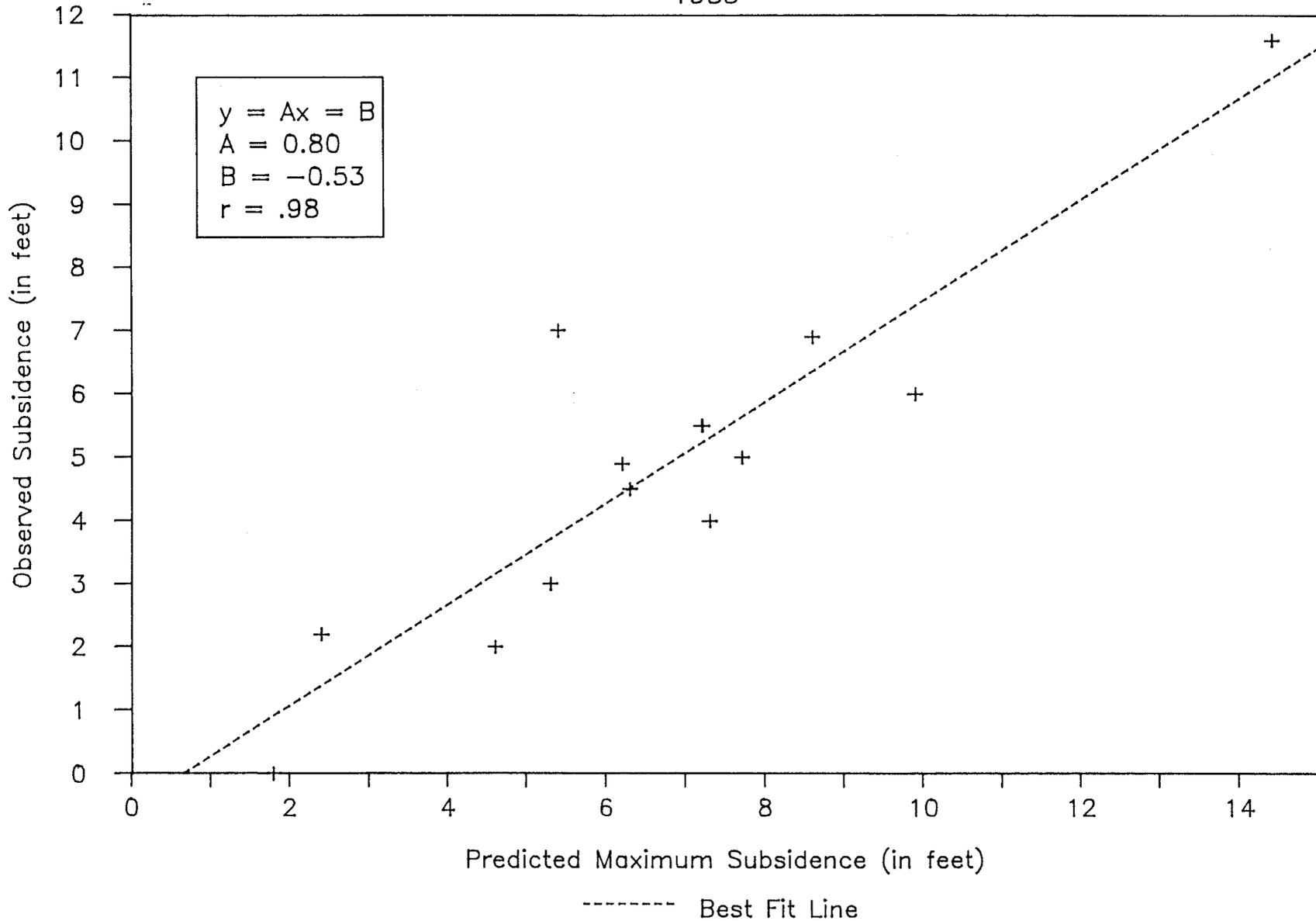


FIGURE 50

Mitigation of Surface Effects

Over most areas where subsidence has been observed on East Mountain, present land use has not been affected in any way. Areas 2, 4, 5, 6, 9, 11, 13, and 15 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, 7, 10, and 14, surface fractures have been detected. In order to protect livestock UP&L has erected a fence around Area 1 where fractures are of sufficient magnitude to pose a threat to wandering cattle. In Area 14, where cracks have also been observed, the U.S. Forest Service has determined that no fencing or other measures are needed unless "significant change" occurs in the area. The agency has recommended that no reclamation be undertaken in Areas 1 or 14 at this time; UP&L will reclaim the areas when and if it is deemed necessary.

As mentioned in the section of this report detailing Area 14, in order to mitigate the effects of subsidence there UP&L may be required to use other means which may include replacing possible lost eagle nesting sites, filling and recontouring surface cracks, and replacing or improving wildlife habitat. Again, whether or not UP&L is required to perform any of this work will depend on the assessment of the regulating state and federal agencies.

In Areas 3, 7, and 10, 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.

Summary

As of August 1988 UP&L has identified fifteen (15) areas of mining-induced subsidence on the East Mountain property. Terrain in the subsidence areas ranges from relatively flat mountain tops with thick overburden of up to 2,100 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). The remaining fractures which have been discovered are reactivated surface traces of the Bear Creek Canyon or Deer Creek faults.

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

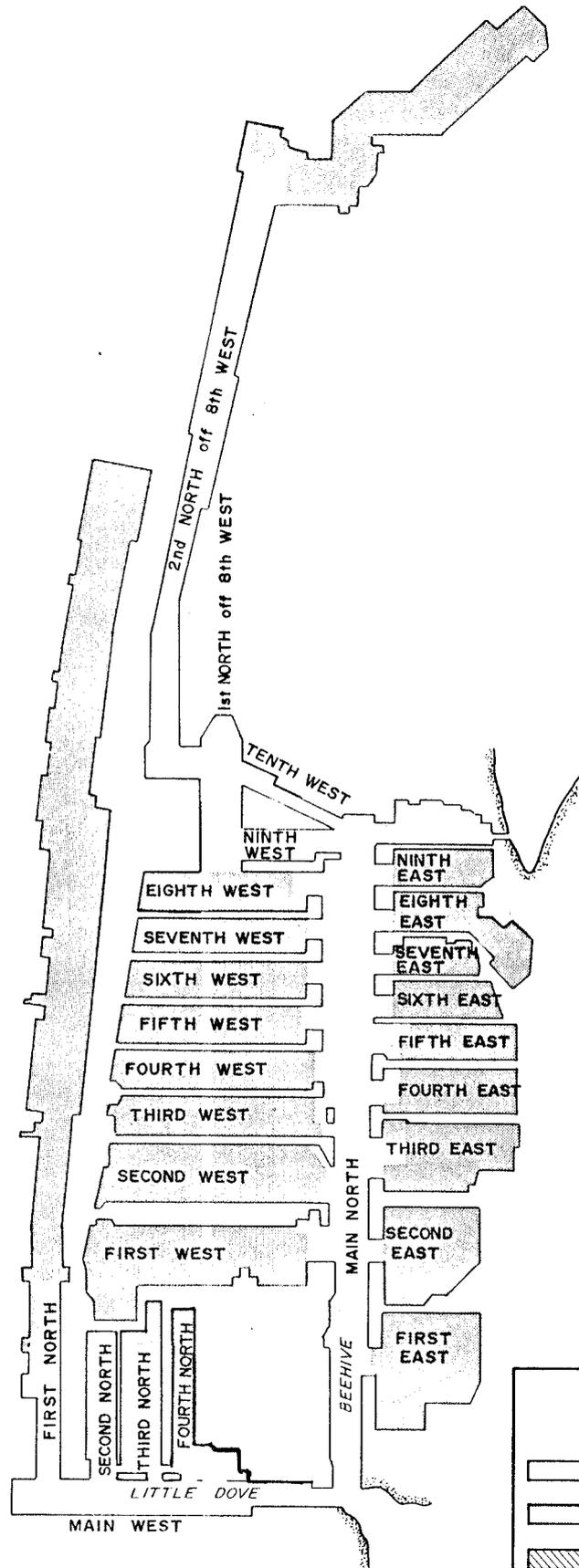
conditions, allowing subsidence to occur without impacting the hydrology or present land use of the area.

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 is slightly less than that predicted by the NCB model.

Because of the data presented herein it is UP&L's opinion that annual monitoring in Areas 5, 6, 7, 8, 10, and 12 is not necessary due to their demonstrated stability. UP&L will file a separate request with the Utah State Division of Oil, Gas and Mining for the suspension of annual monitoring in those areas. Aerial photographs will continue to be taken and, if necessary, they can be read later for elevation changes due to subsidence.

APPENDICES

Des-Bee-Dove Mines



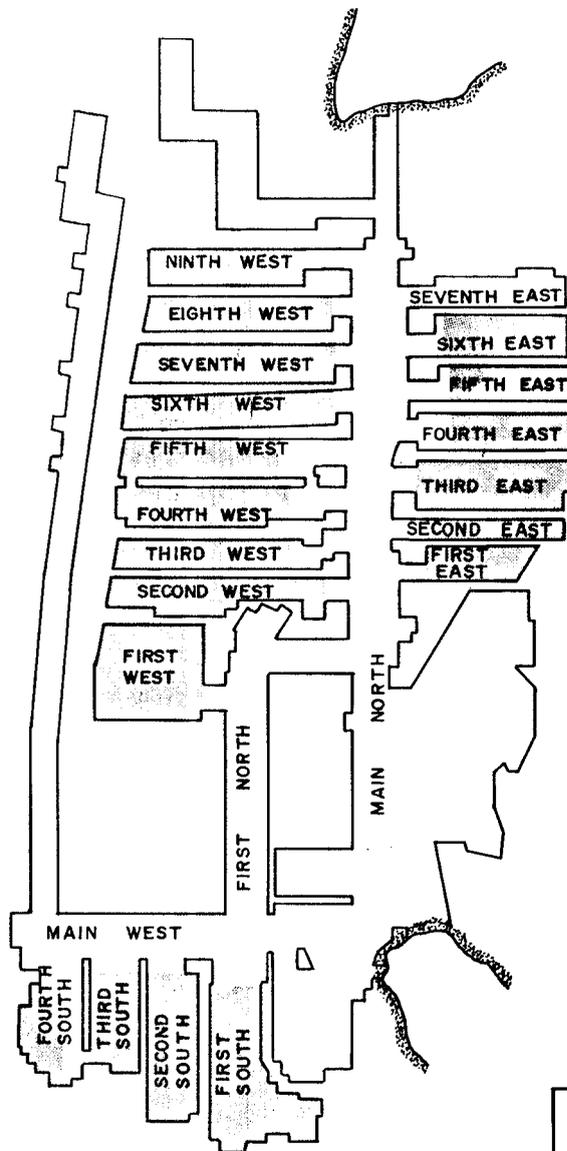
LEGEND

	MINE WORKINGS
	MINING COMPLETED
	ACTIVE MINING AREA

BEEHIVE & LITTLE DOVE COAL MINES

SCALE: 1" = 2000'

UPDATED TO: 5/30/86



LEGEND

	MINE WORKINGS
	MINING COMPLETED
	ACTIVE MINING AREA

MINE WORKINGS UPDATED TO 9/1/86

DESERET COAL MINE

SCALE: 1" = 2000'

Deer Creek Mine

DEER CREEK COAL MINE

SCALE: 1" = 2000'



ROCK ROOMS
THIRD NORTH SUMP

FIRST WEST MAINS

THIRD NORTH

MAIN WEST

LEGEND

- MINE WORKINGS
- MINING COMPLETED
- ACTIVE MINING AREA

MINE WORKINGS UPDATED TO 11/189

11TH RIGHT

TENTH RIGHT

NINTH RIGHT

EIGHT RIGHT

SEVENTH RIGHT

SIXTH RIGHT

FIFTH RIGHT

FOURTH RIGHT

THIRD RIGHT

SECOND RIGHT

FIRST RIGHT

THIRD SOUTH

C NORTH

B NORTH

A NORTH

SECOND SOUTH

FIRST SOUTH

SECOND EAST

THIRD EAST

FOURTH EAST

FIFTH EAST

SIXTH EAST

SEVENTH EAST

EIGHT EAST

NINTH EAST "A"

TENTH EAST

FIFTH LEFT

FOURTH LEFT

THIRD LEFT

SECOND LEFT

FIRST LEFT

FOURTH WEST

THIRD LEFT

1 1/2 NORTH
FIRST NORTH

THIRD LEFT

SECOND LEFT

FIRST LEFT

Wilberg/Cottonwood Mine

COTTONWOOD/WILBERG MINES

SCALE: 1" = 2000'



LEGEND

-  MINE WORKINGS
-  MINING COMPLETED
-  ACTIVE MINING AREA

