Appendix D-2

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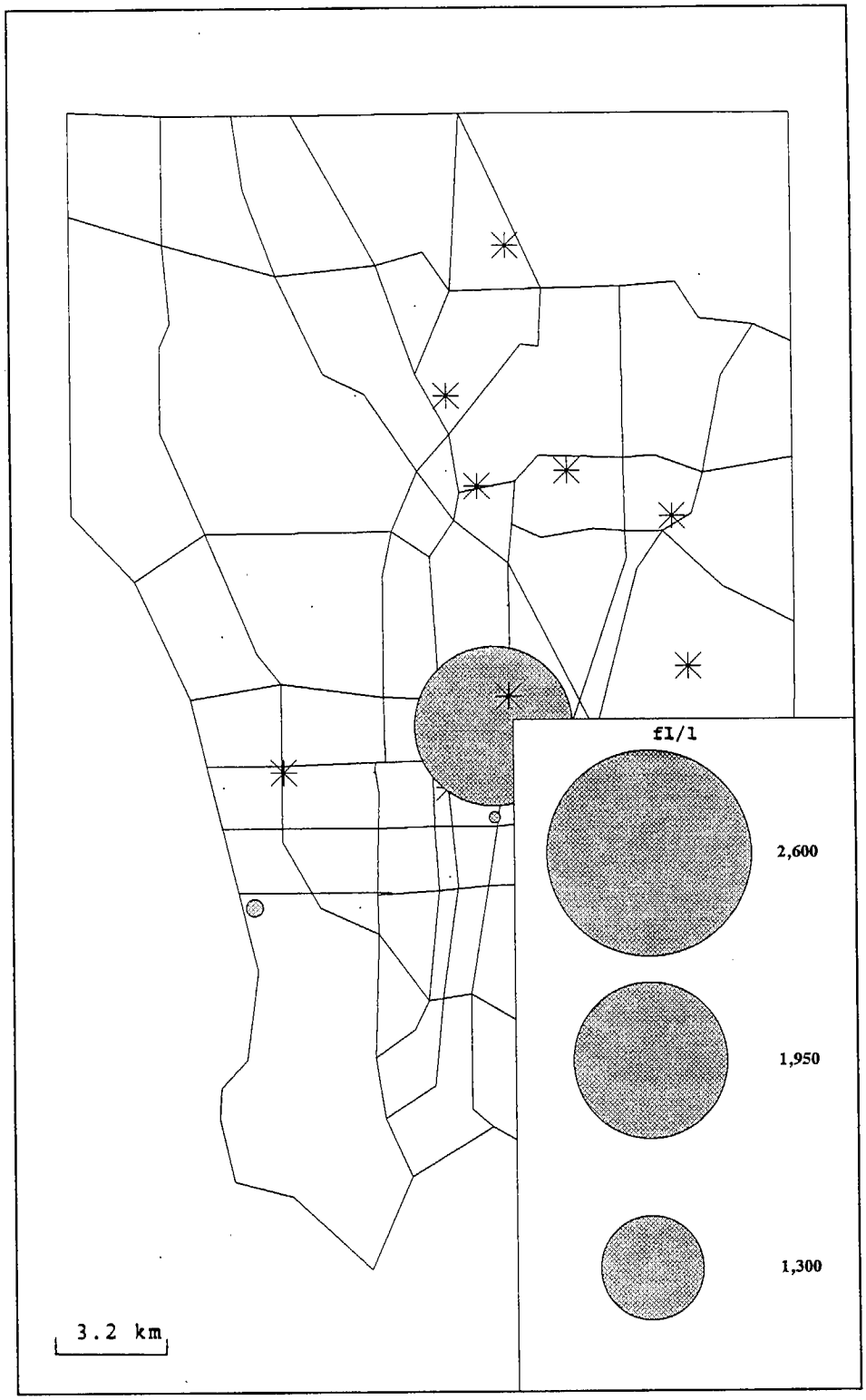

TA 12/19/1989 12:00

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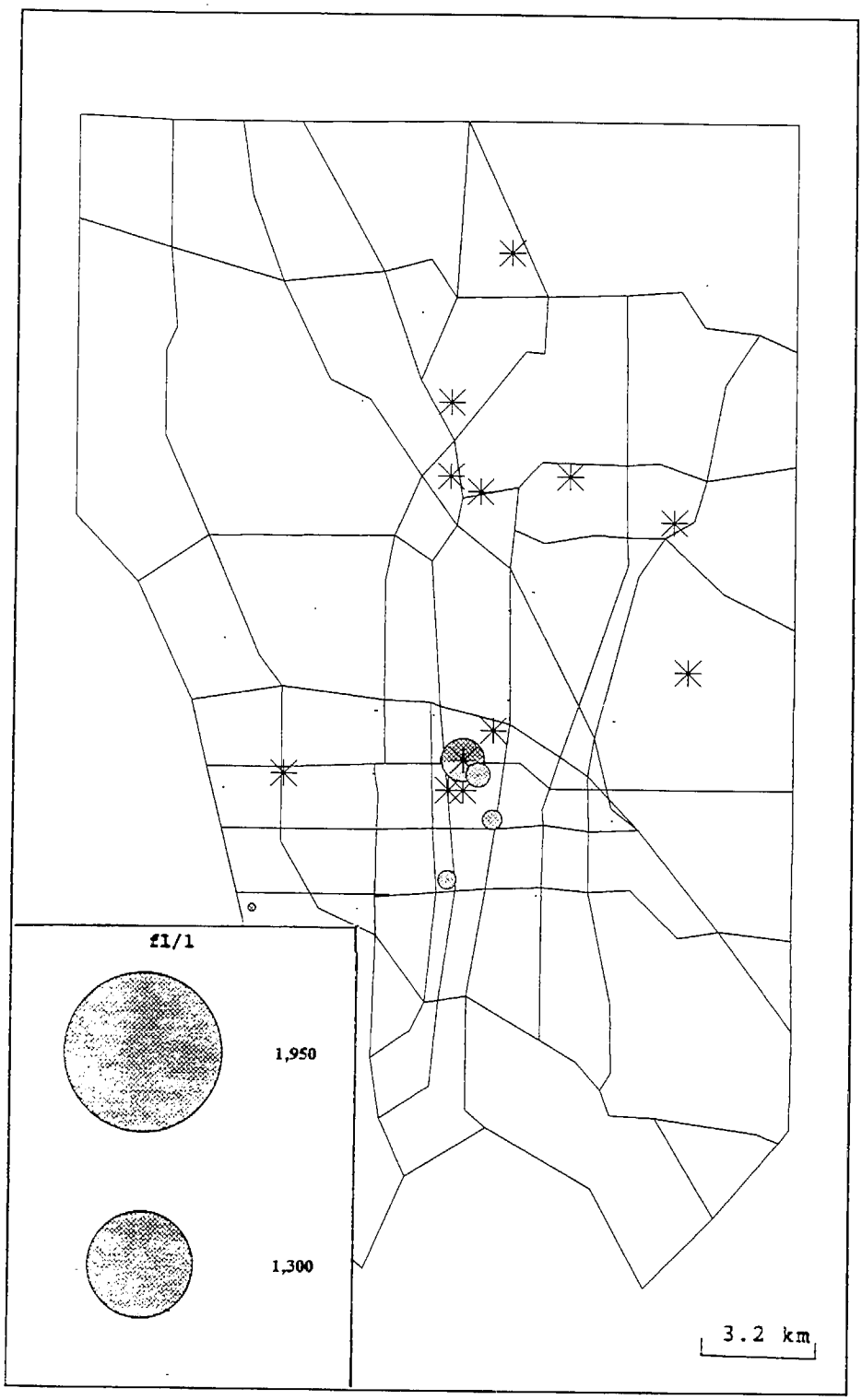

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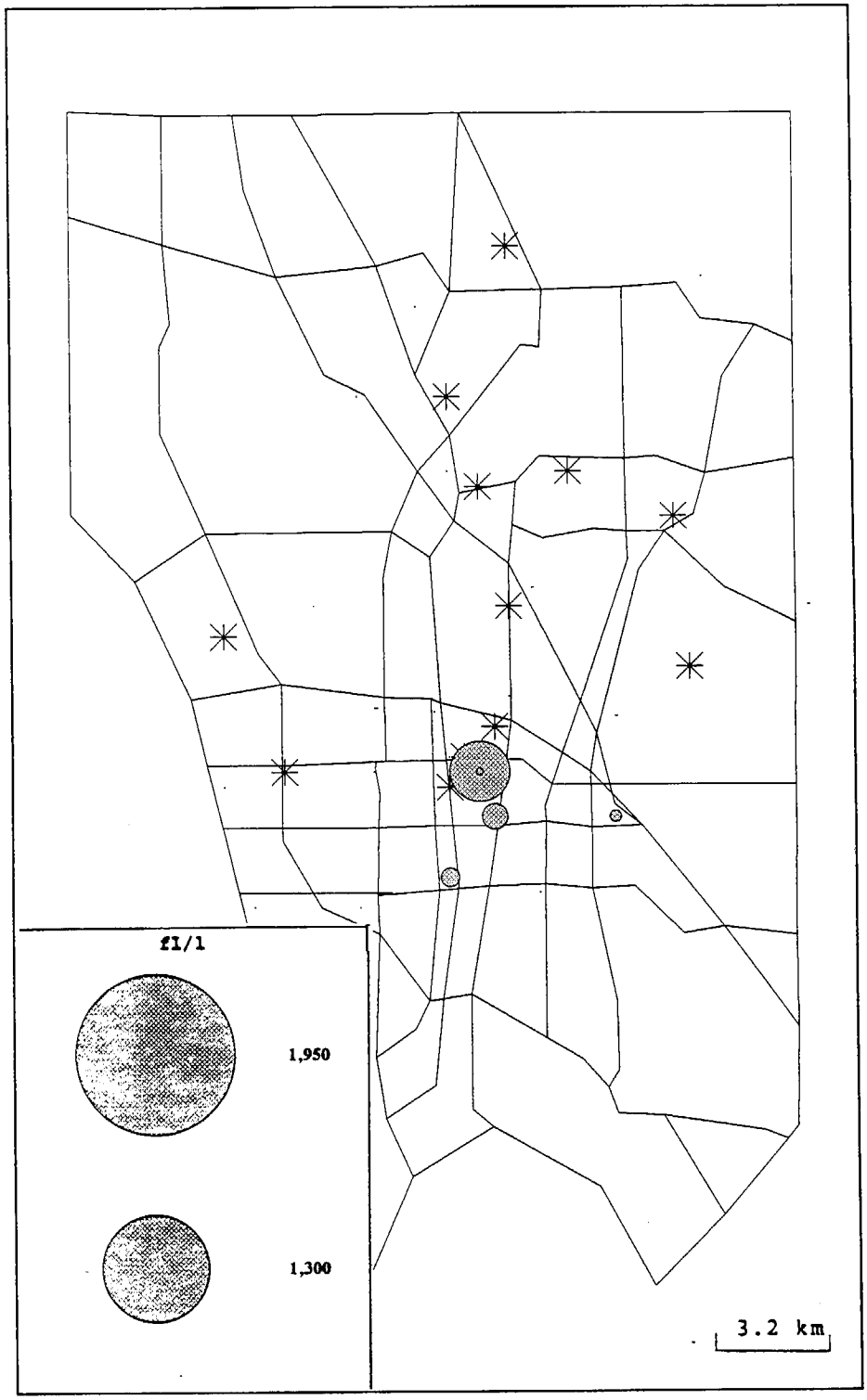

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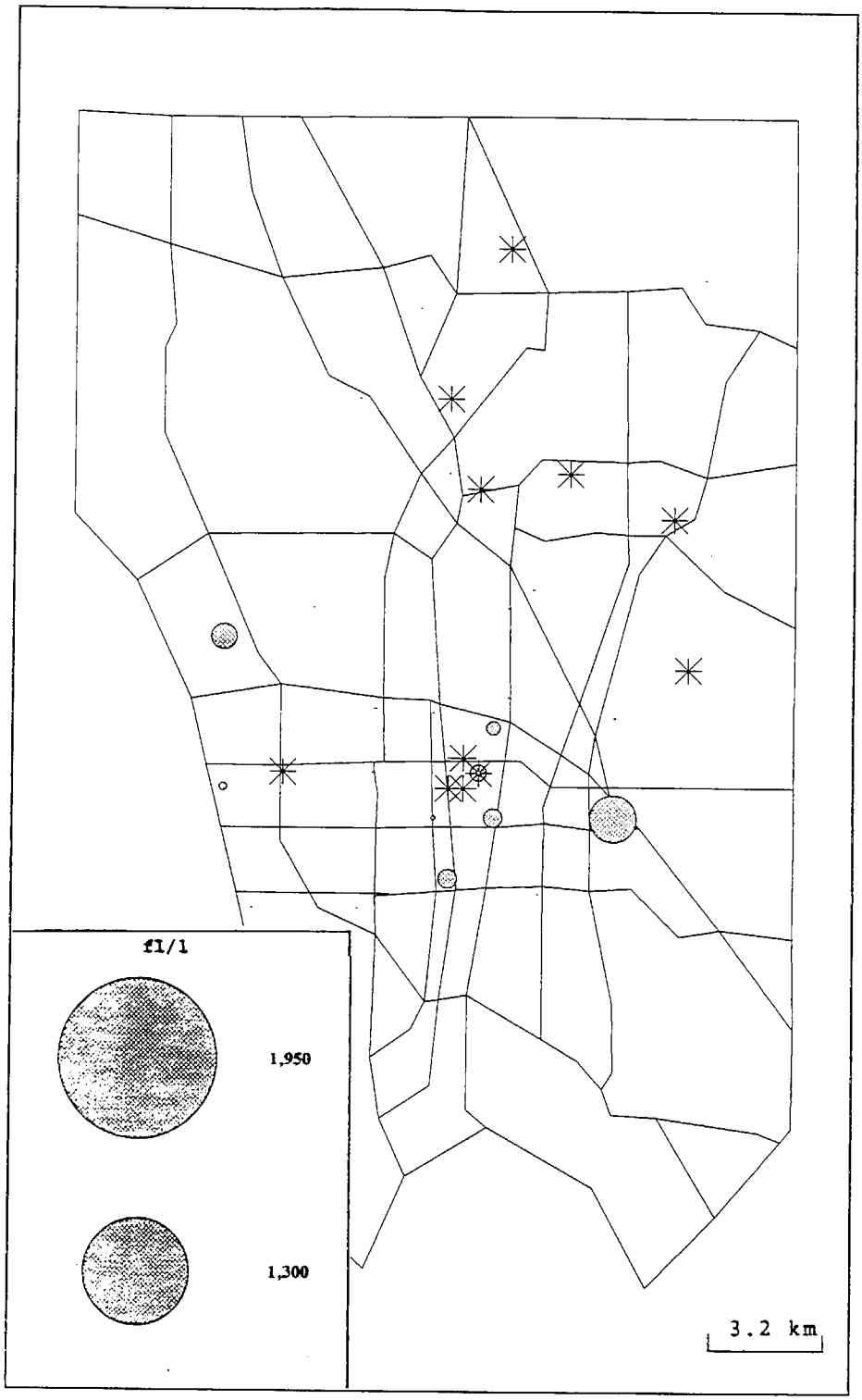

TA 12/19/1989 18:00

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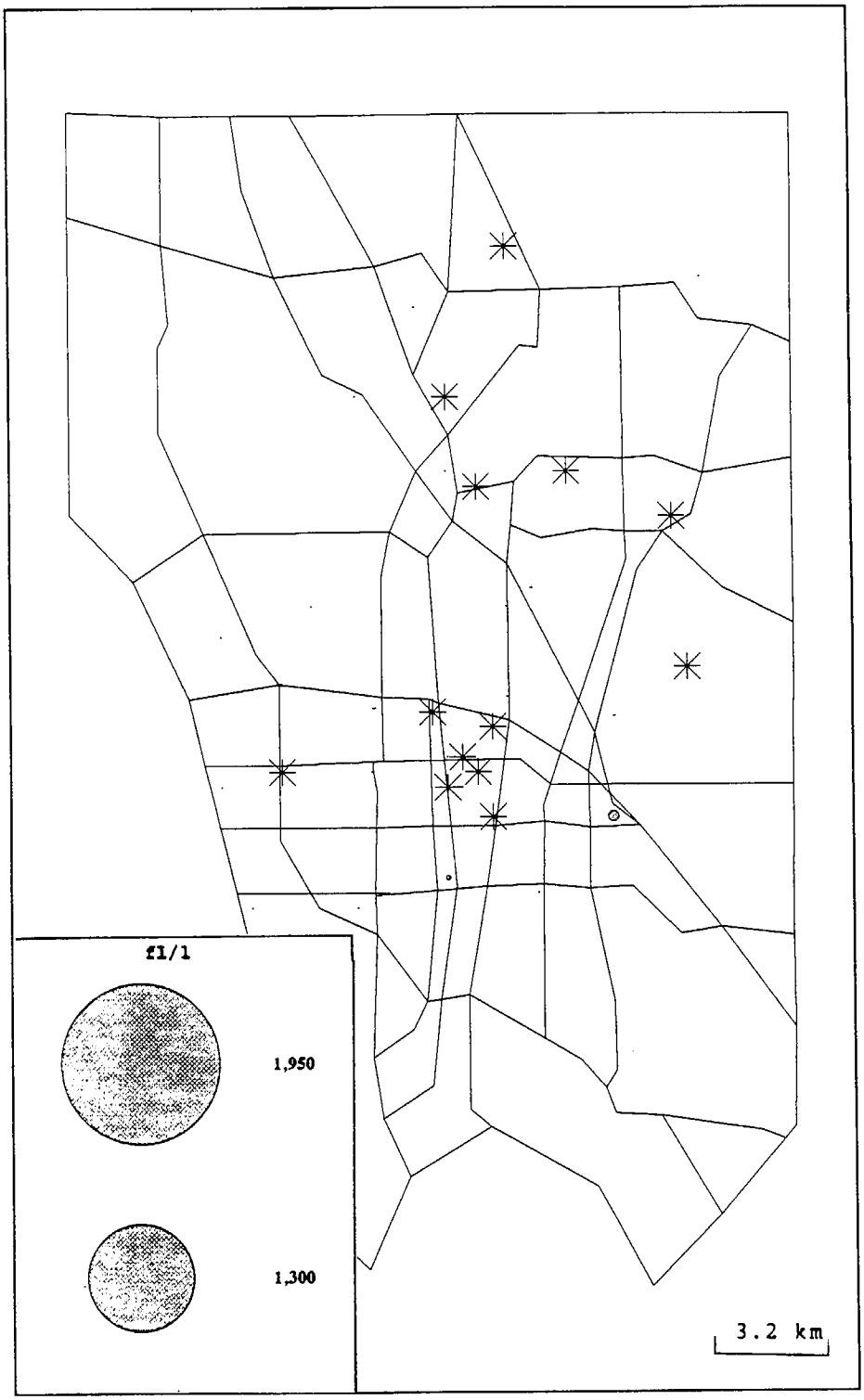

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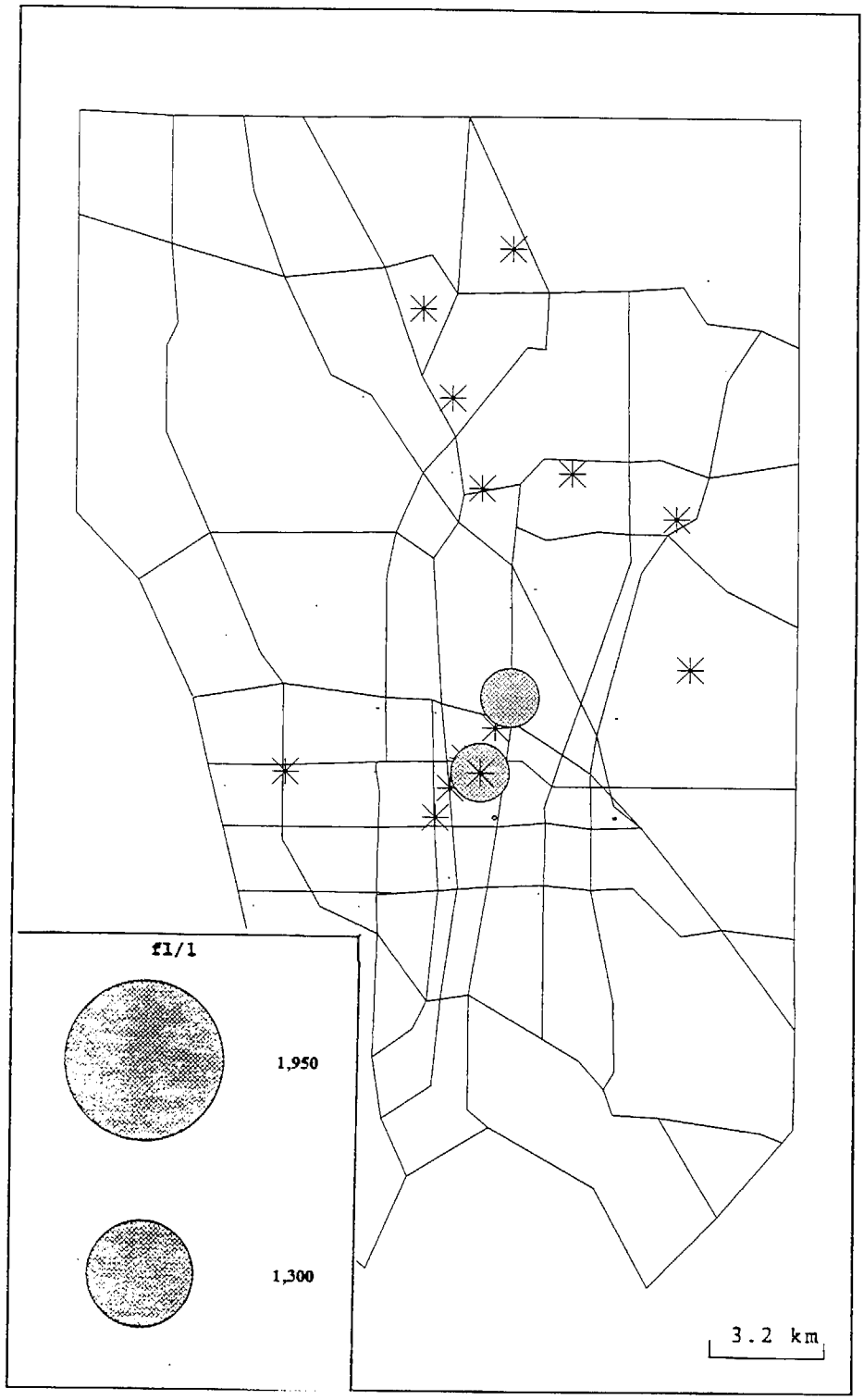

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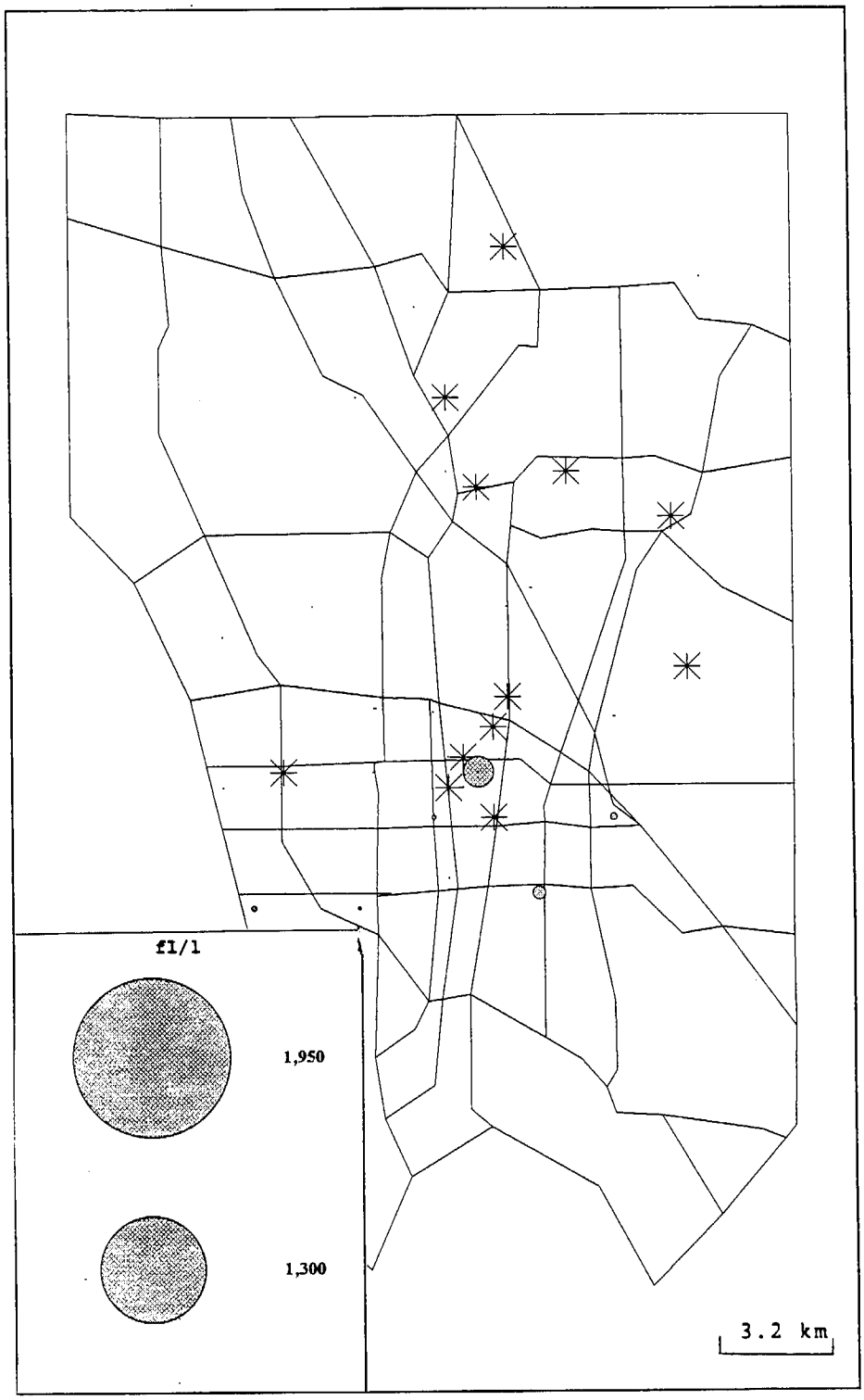

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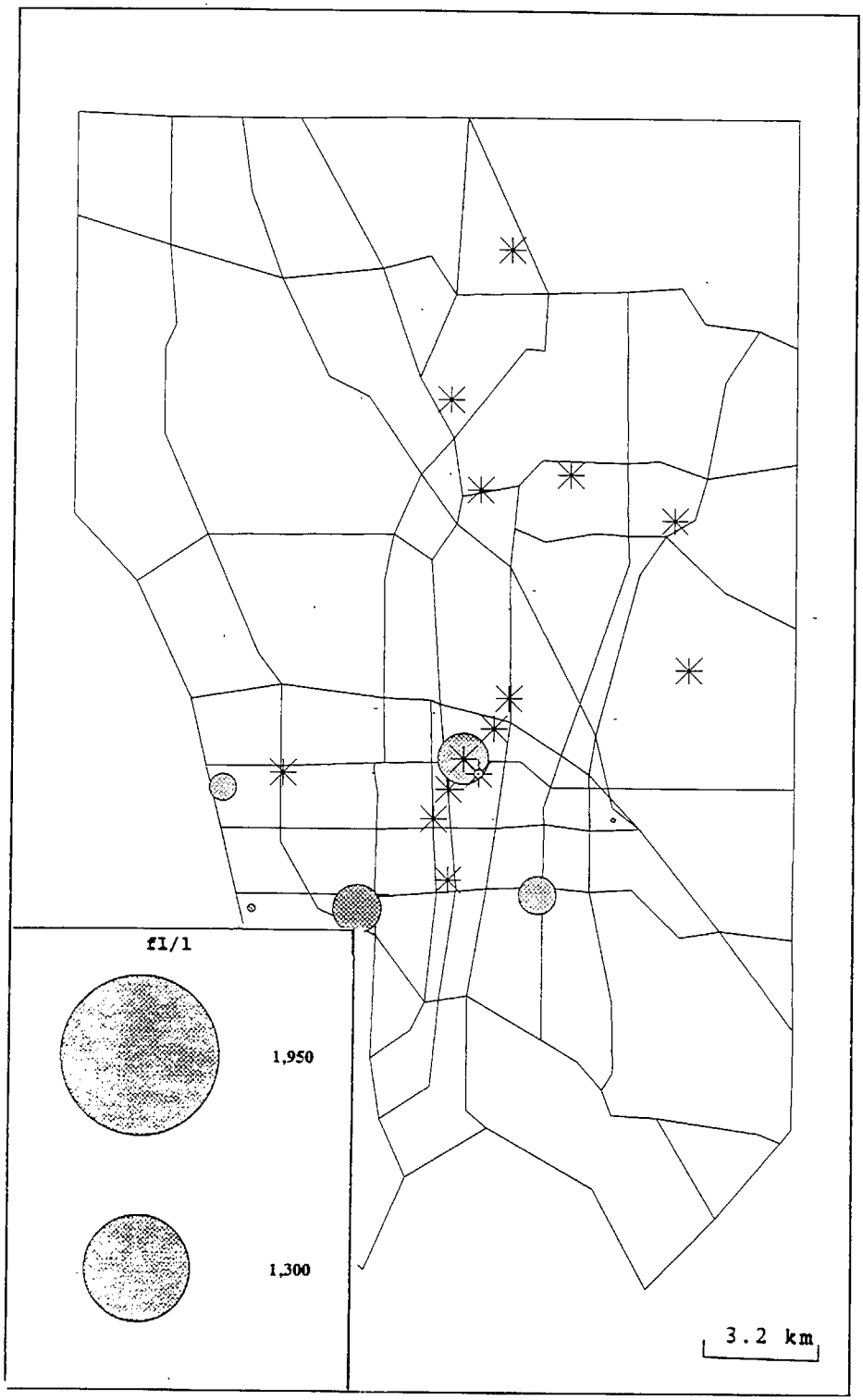

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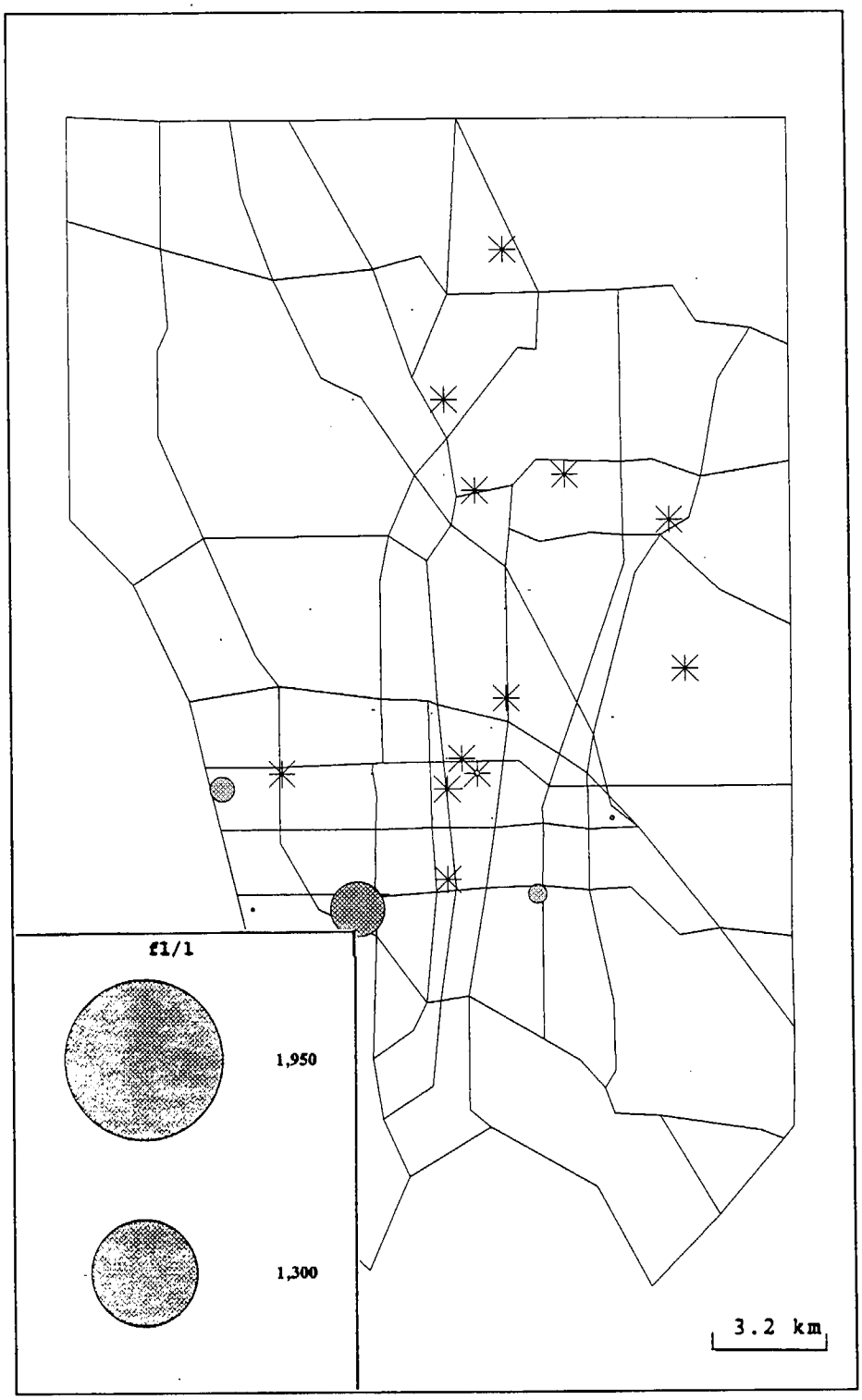

TA 12/20/1989 04:00

Appendix E-2

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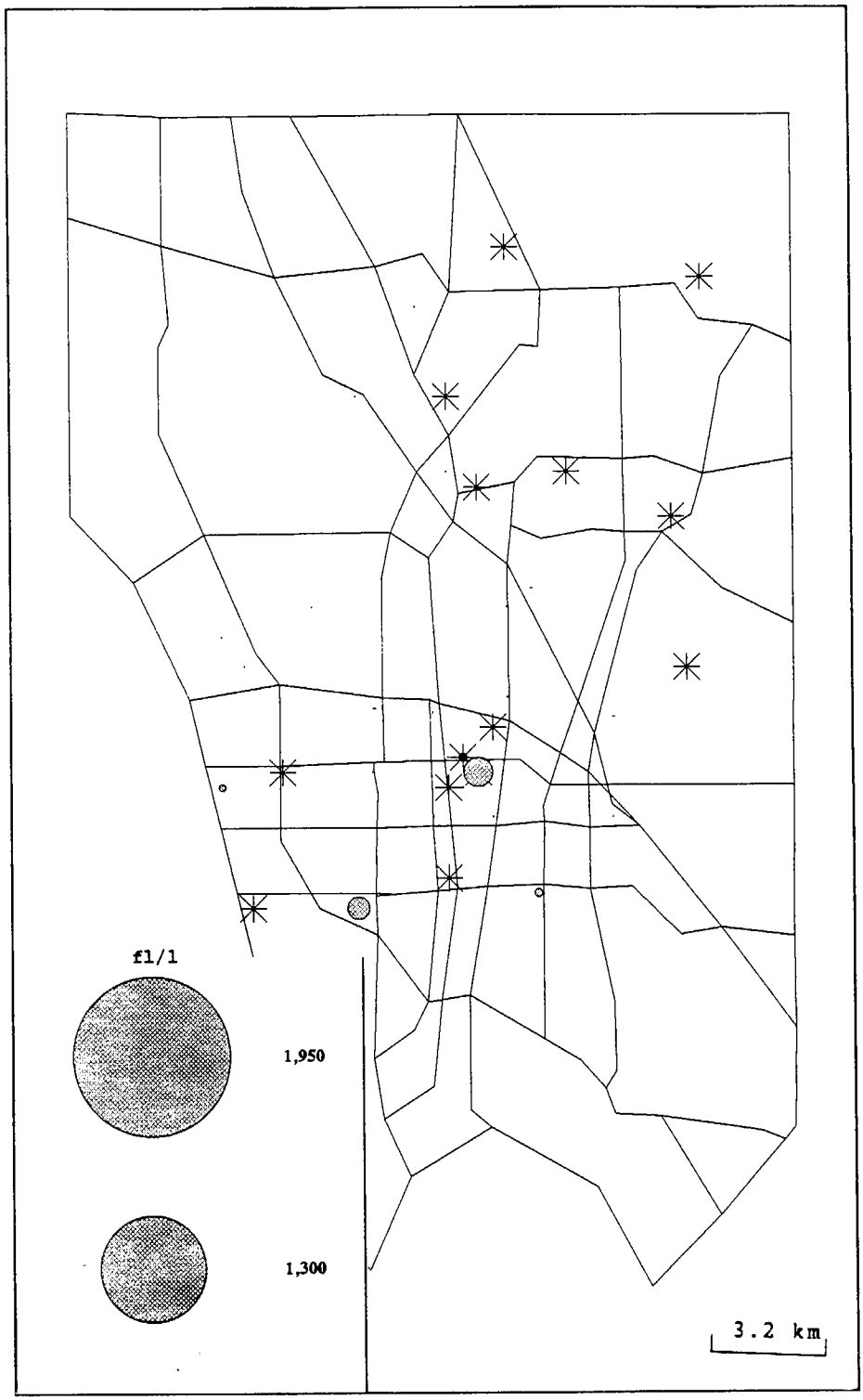

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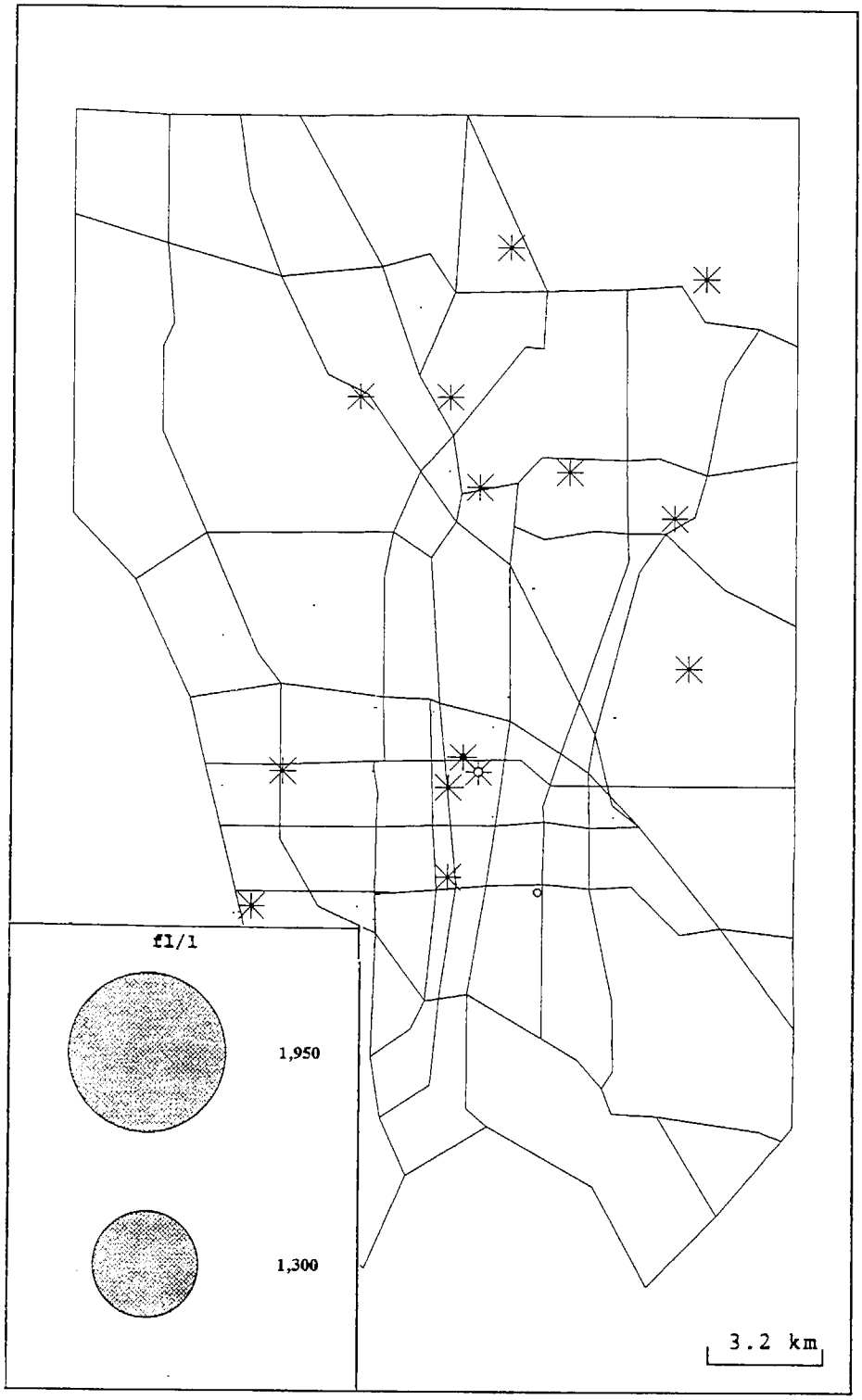

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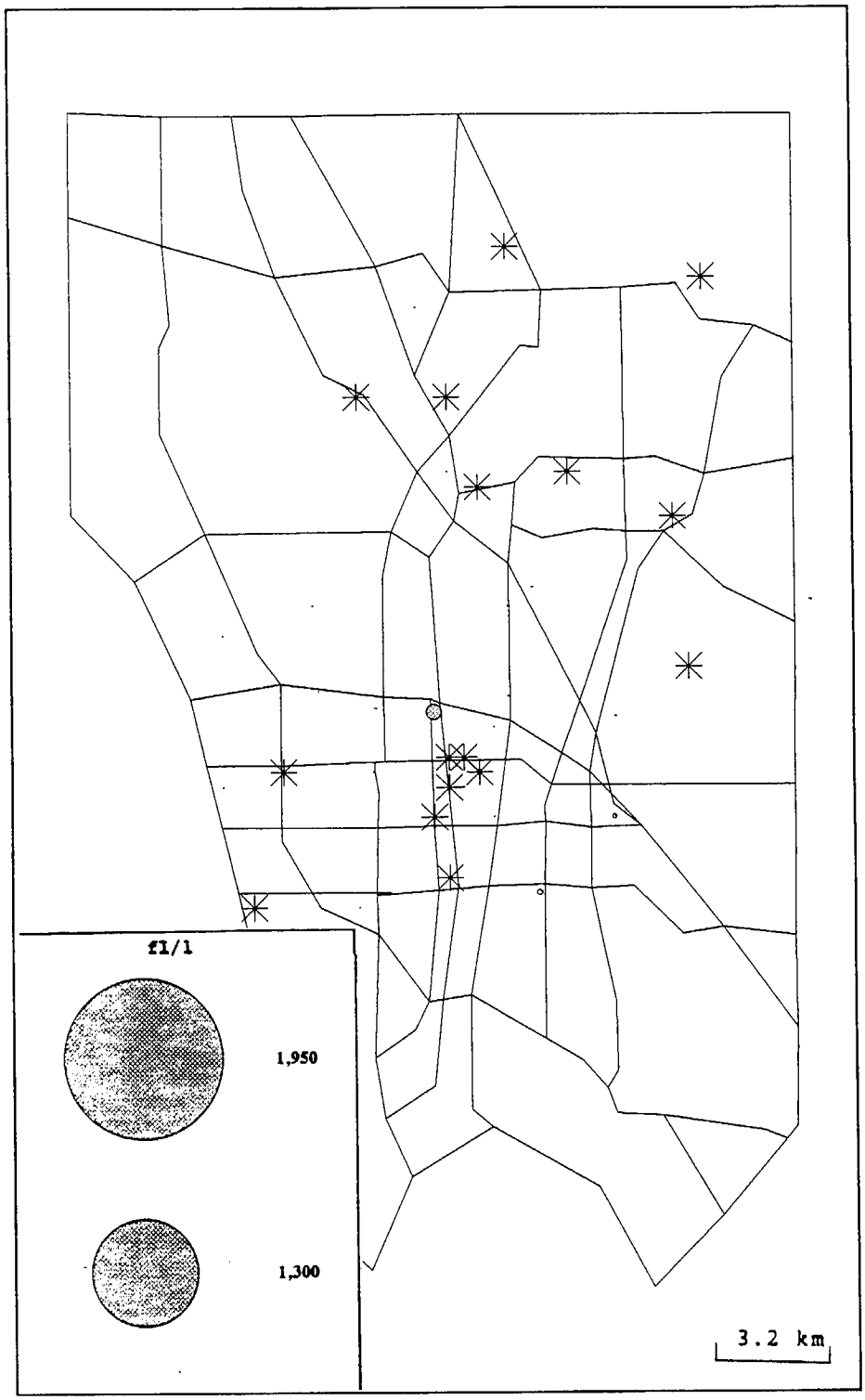

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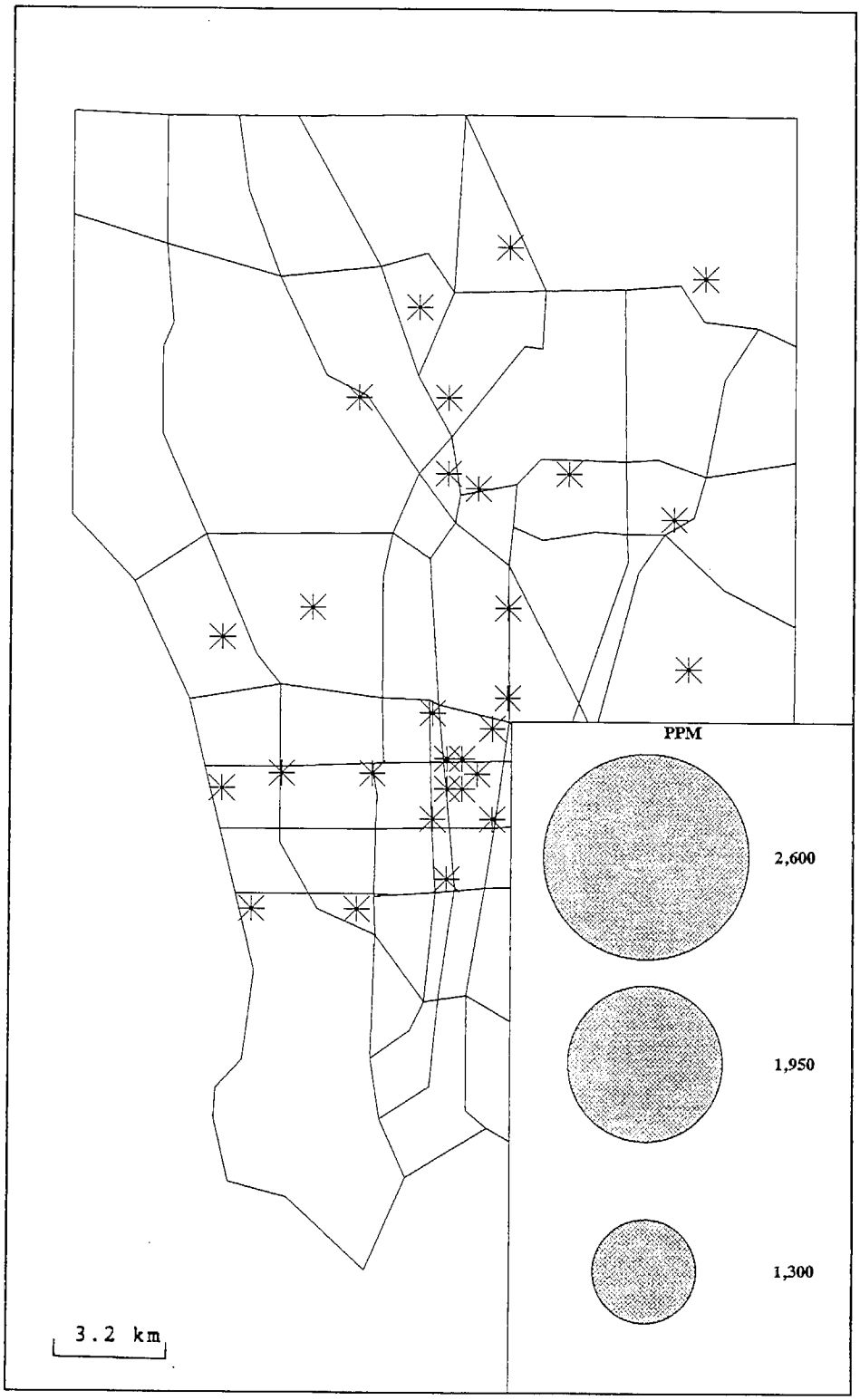

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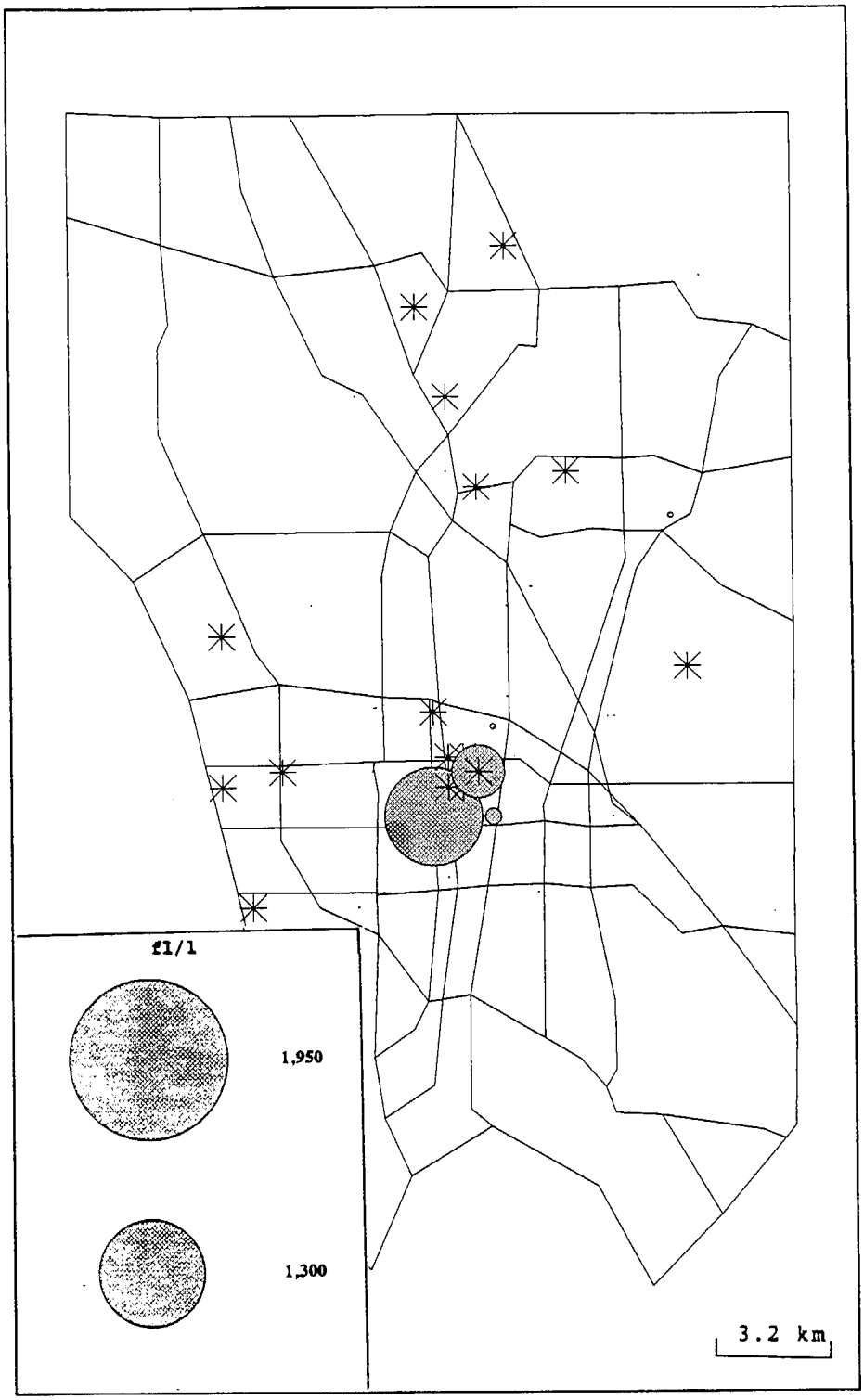

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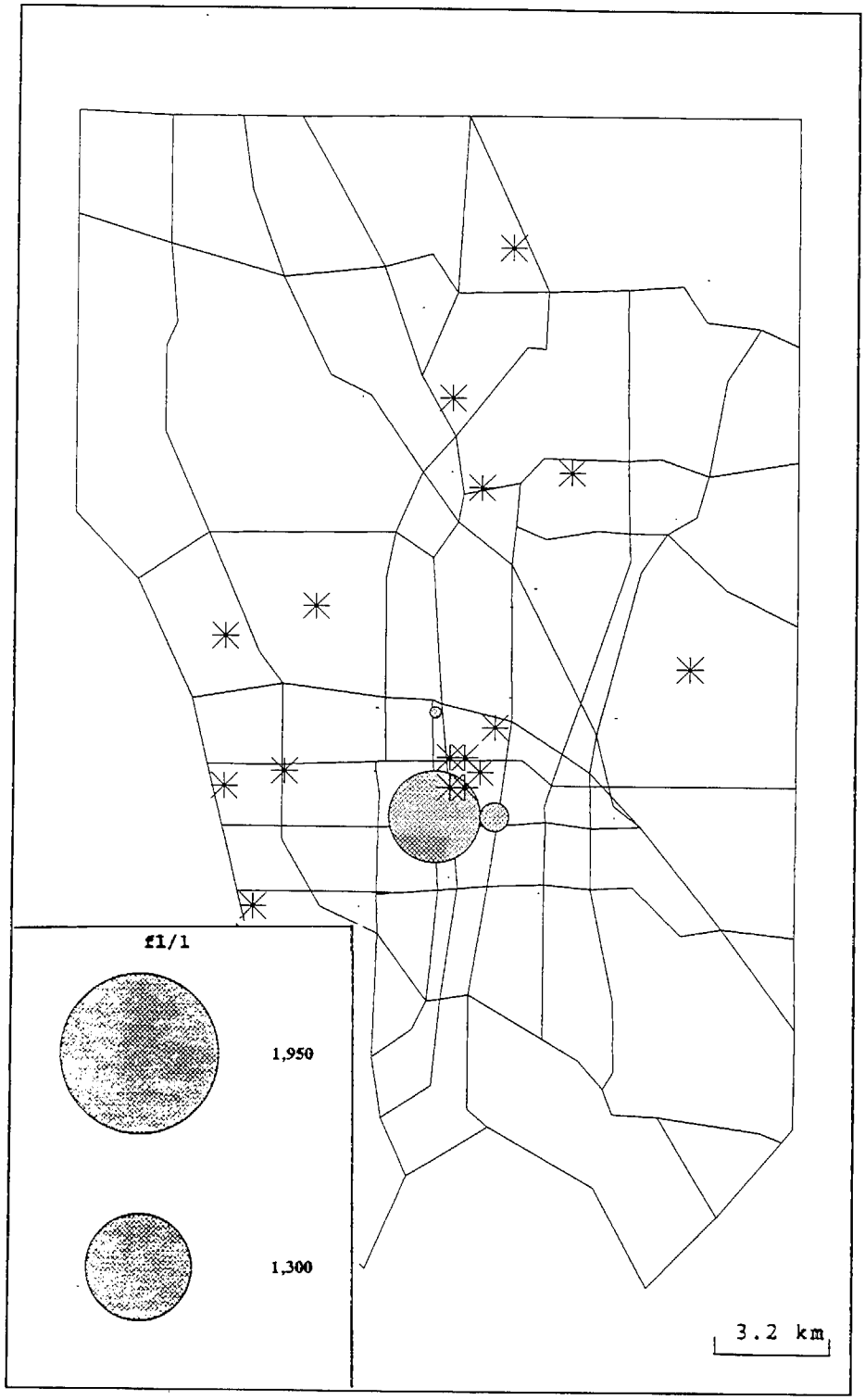

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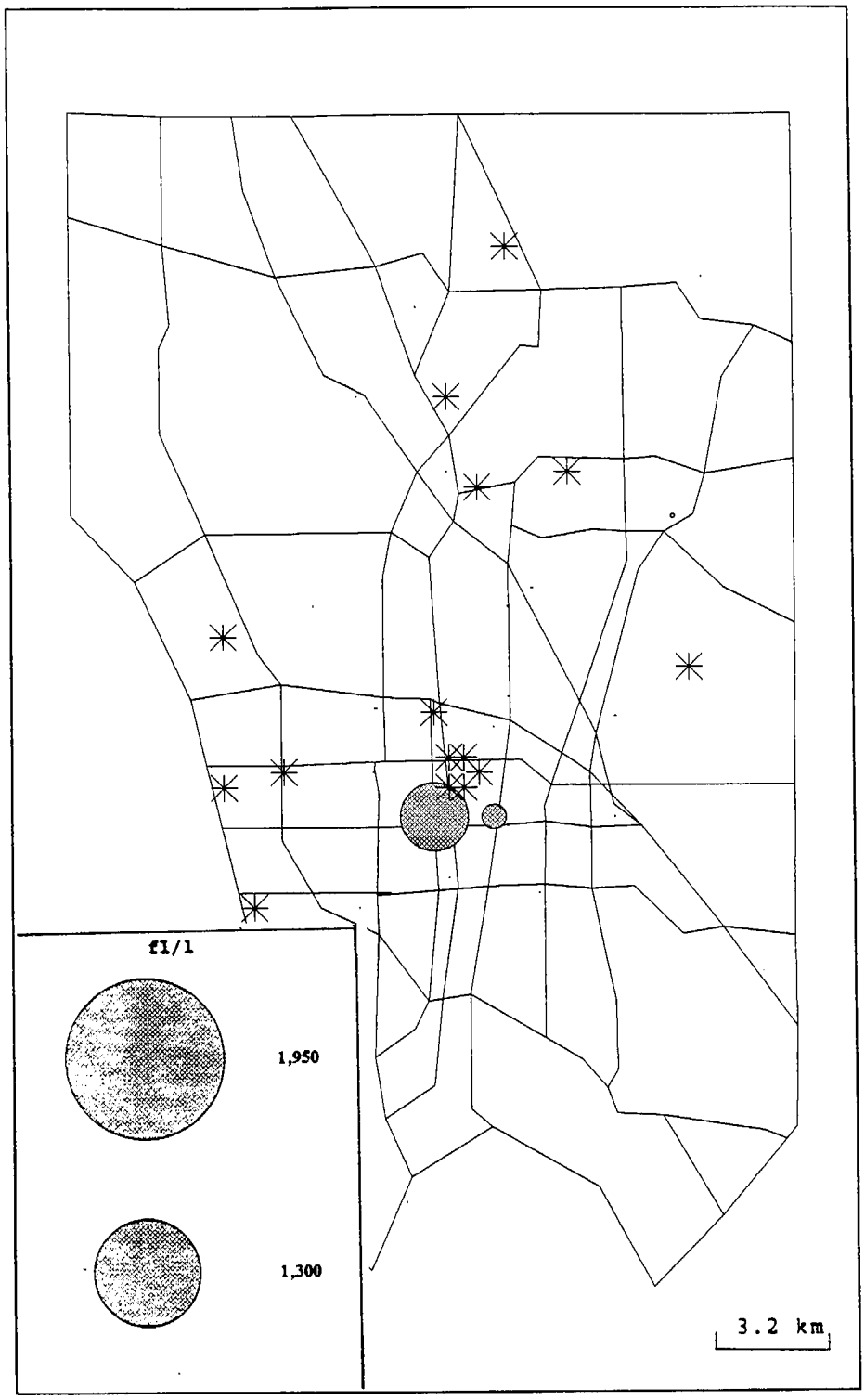

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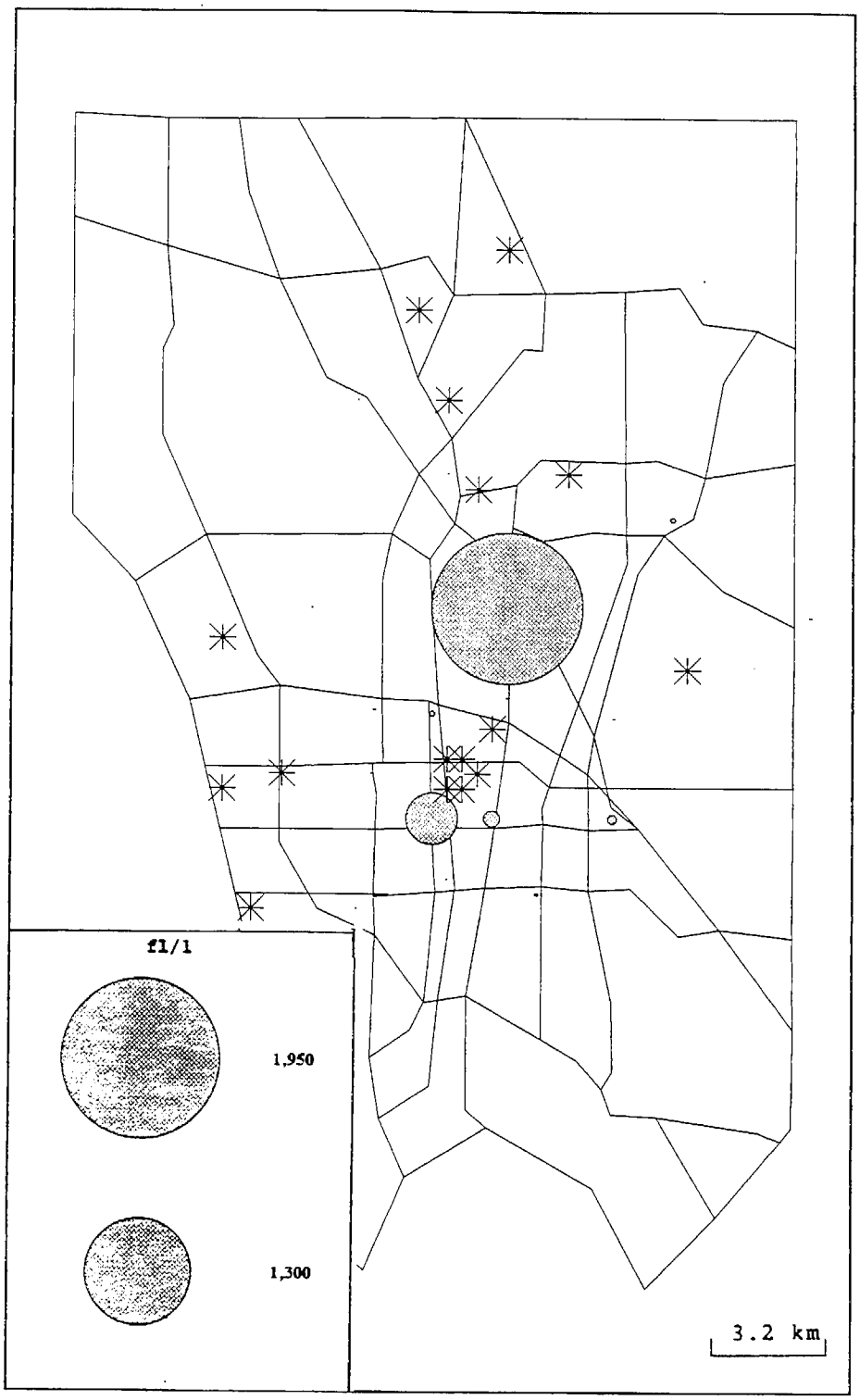

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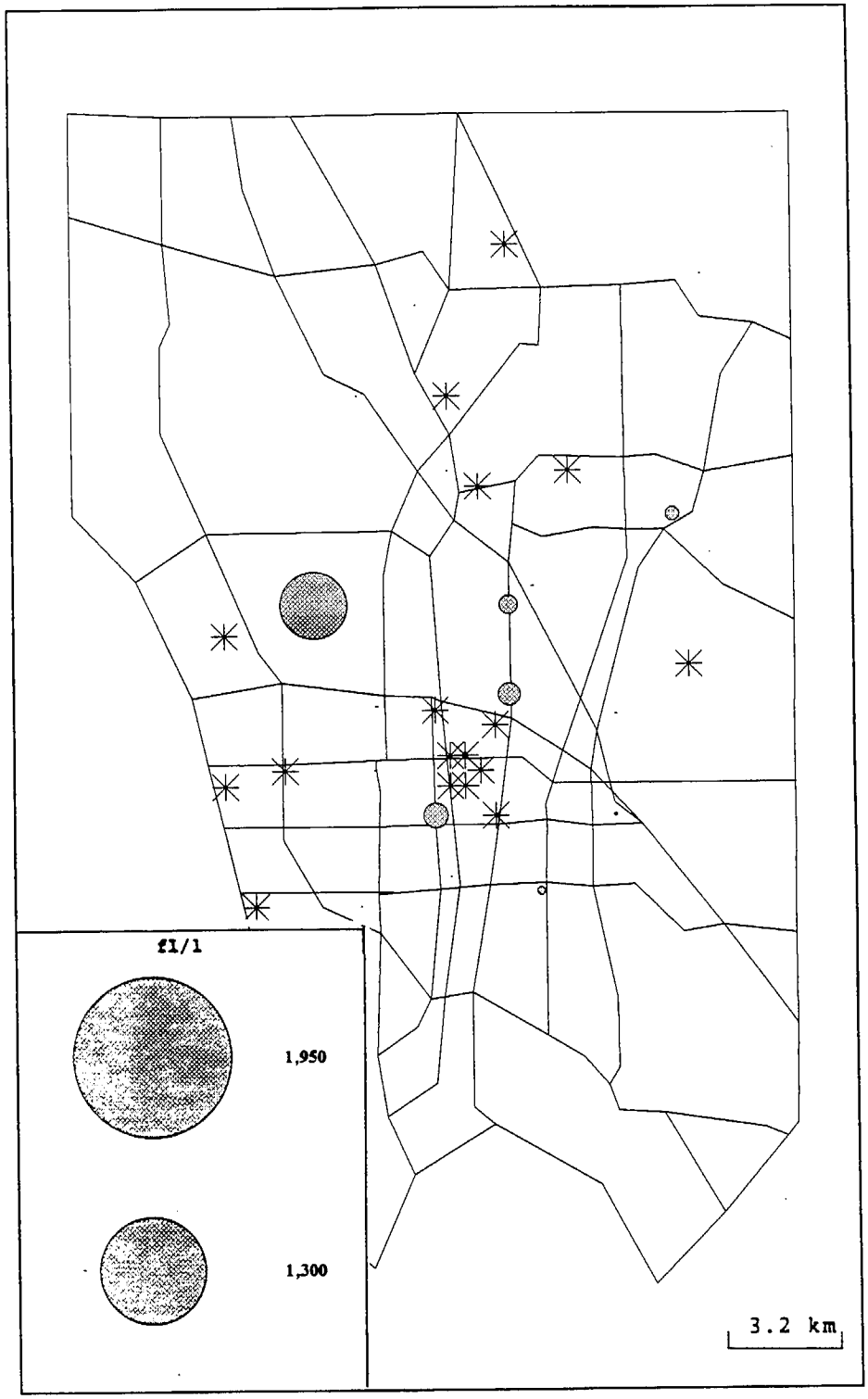

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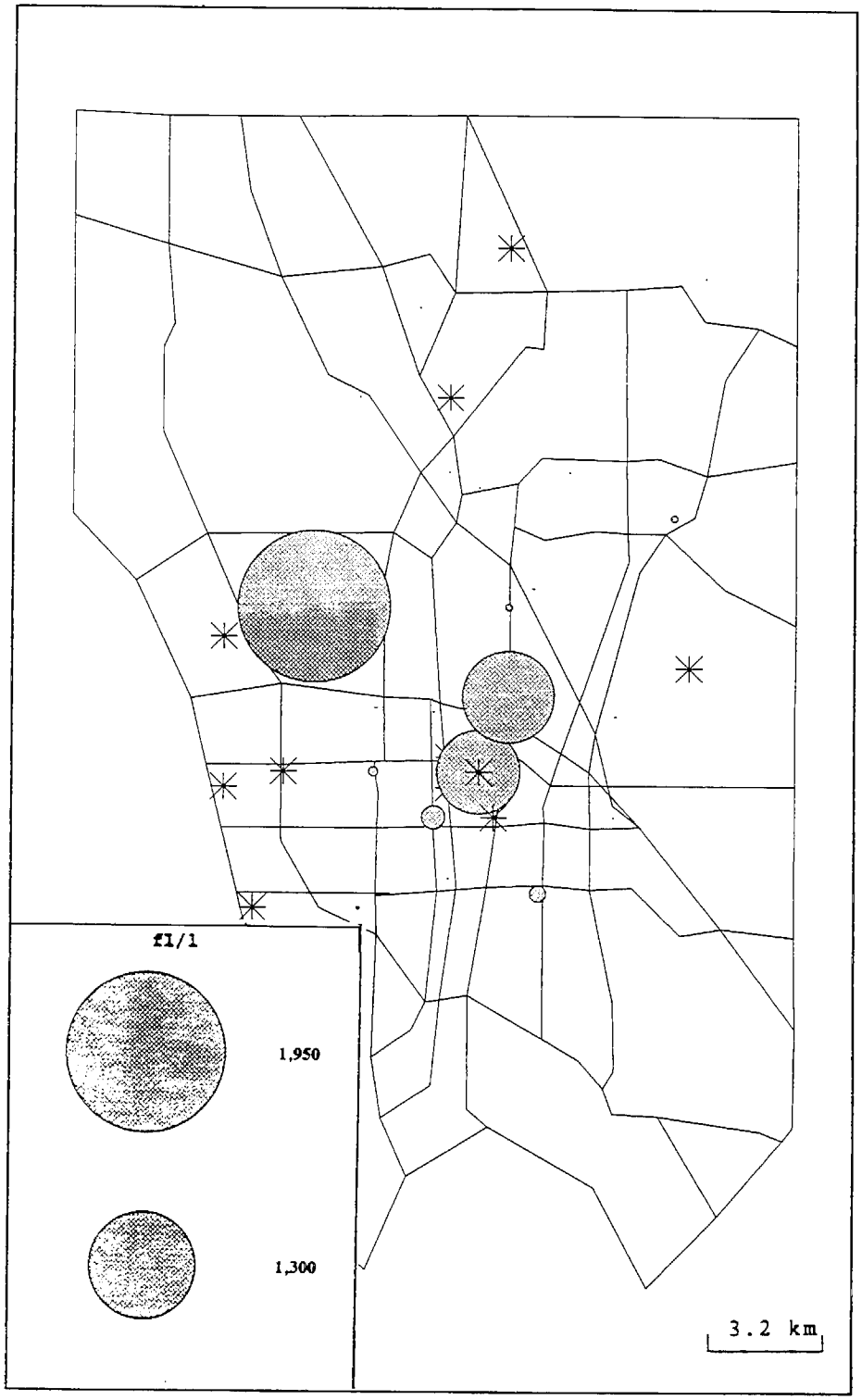

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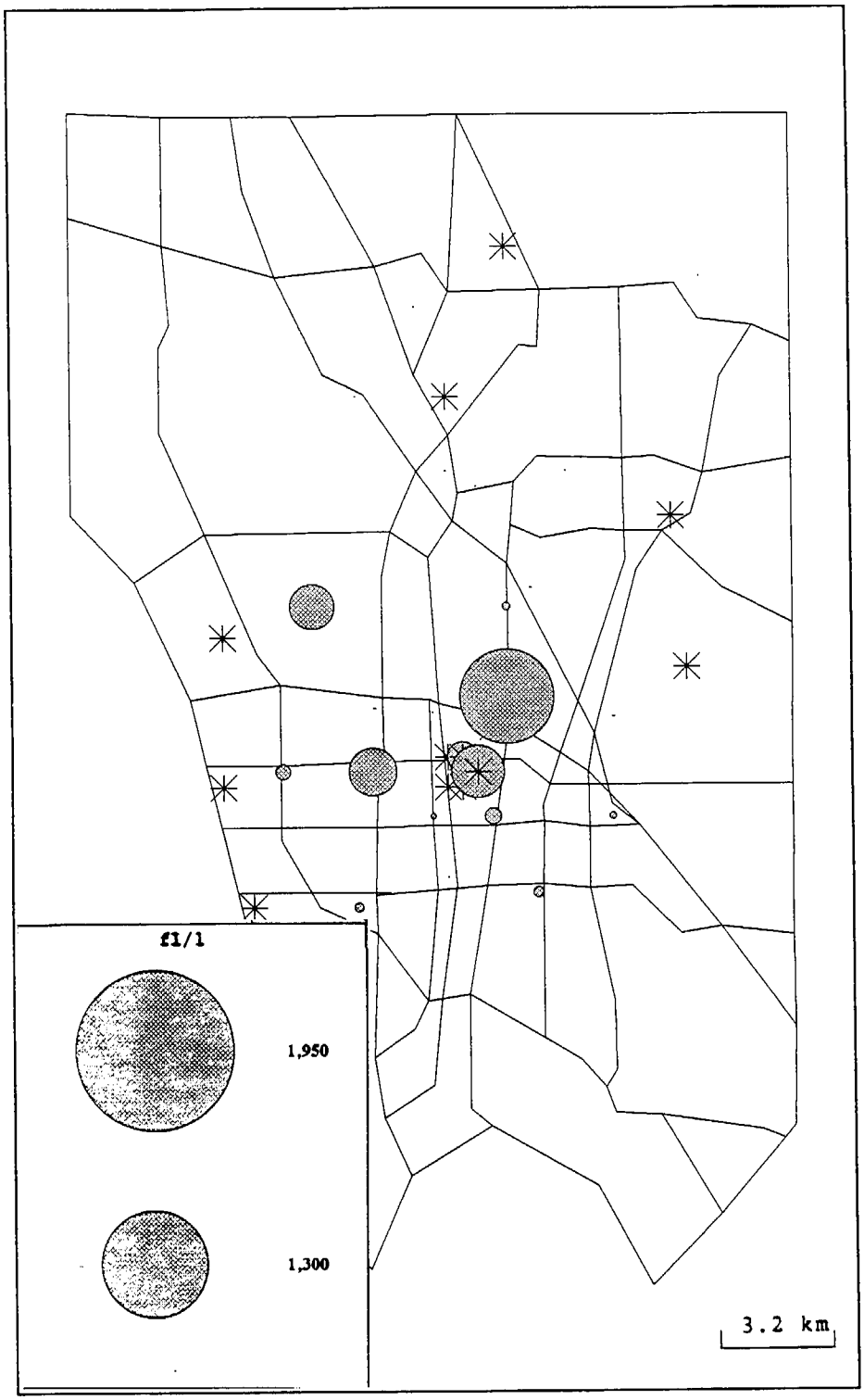

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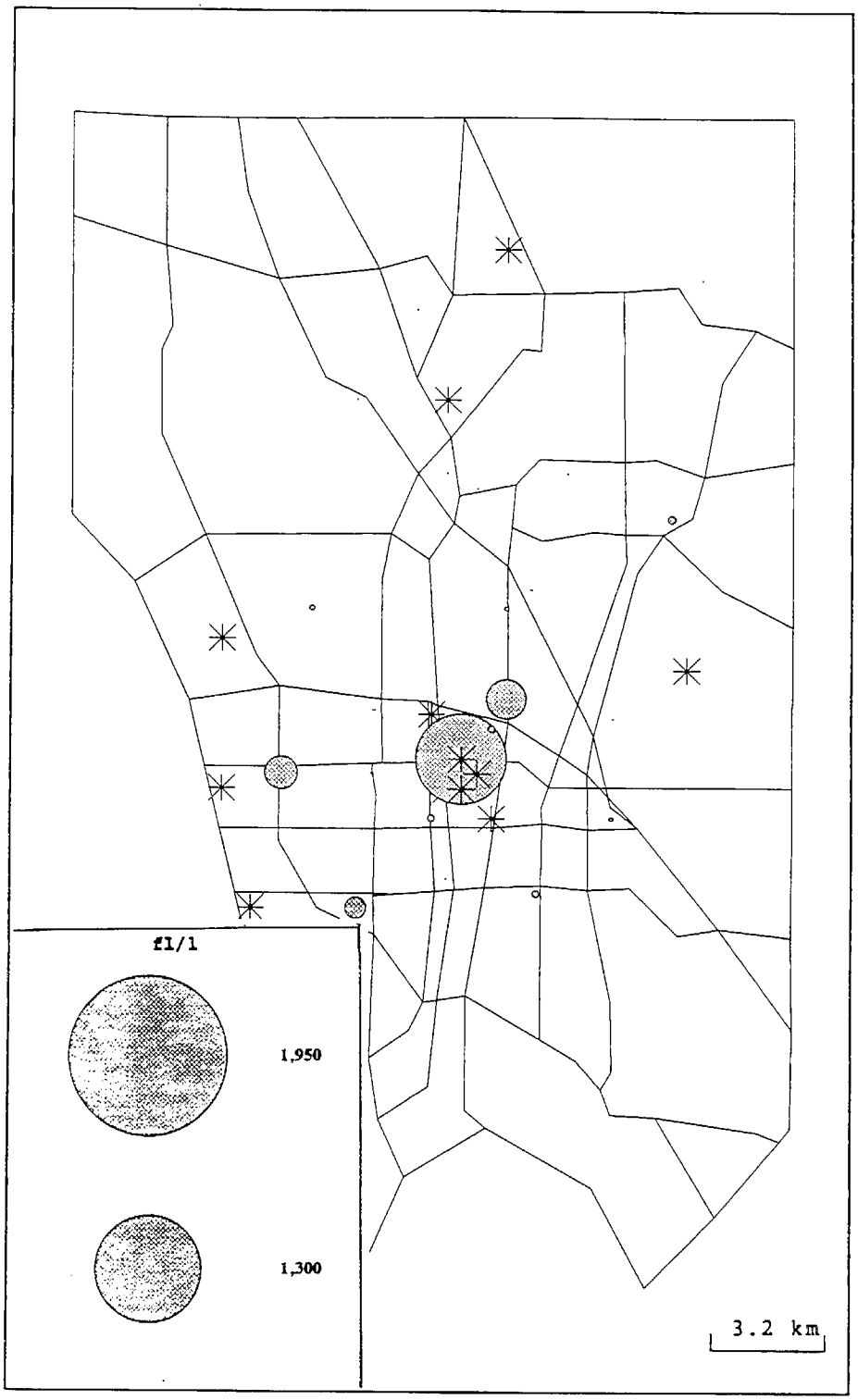

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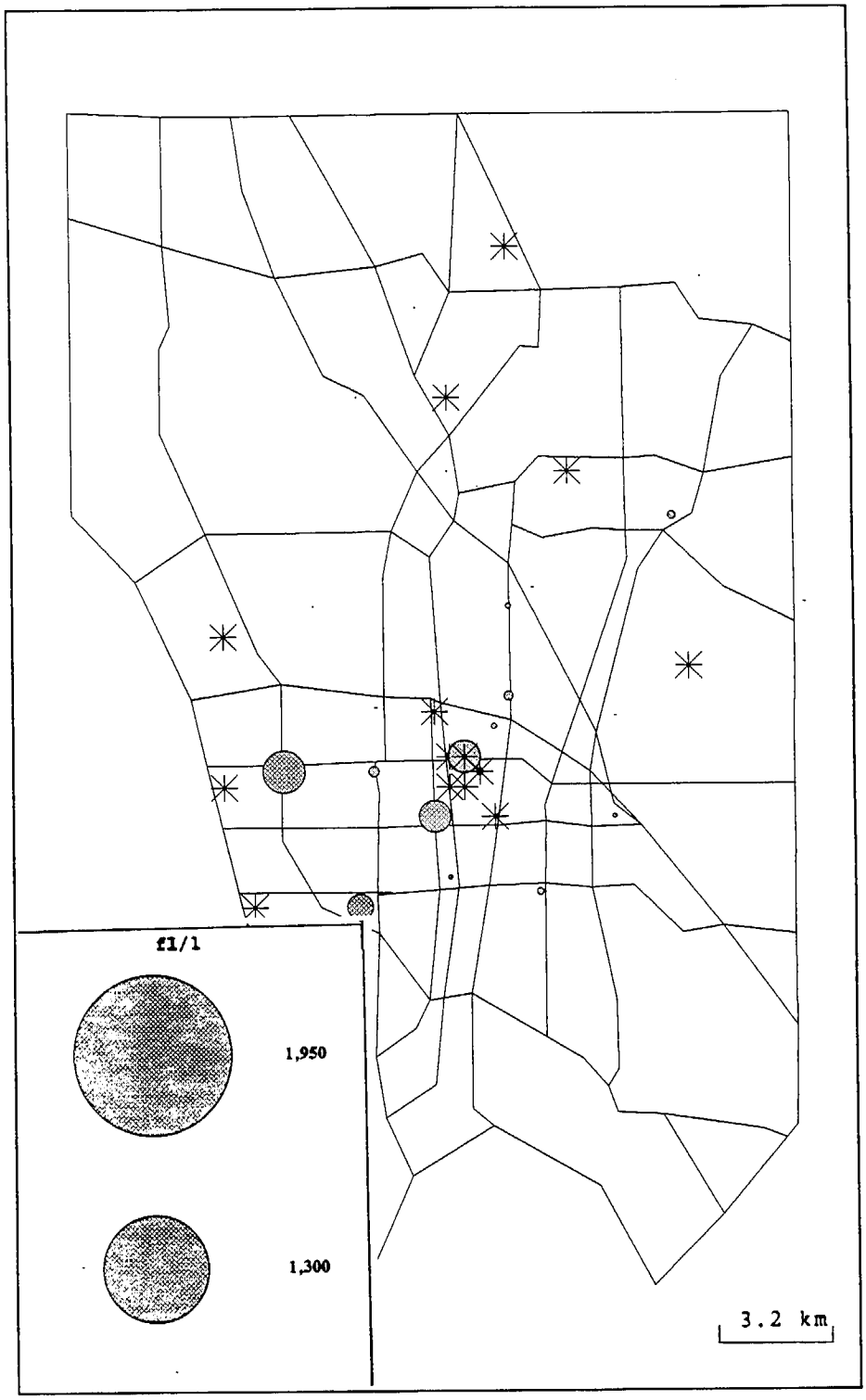

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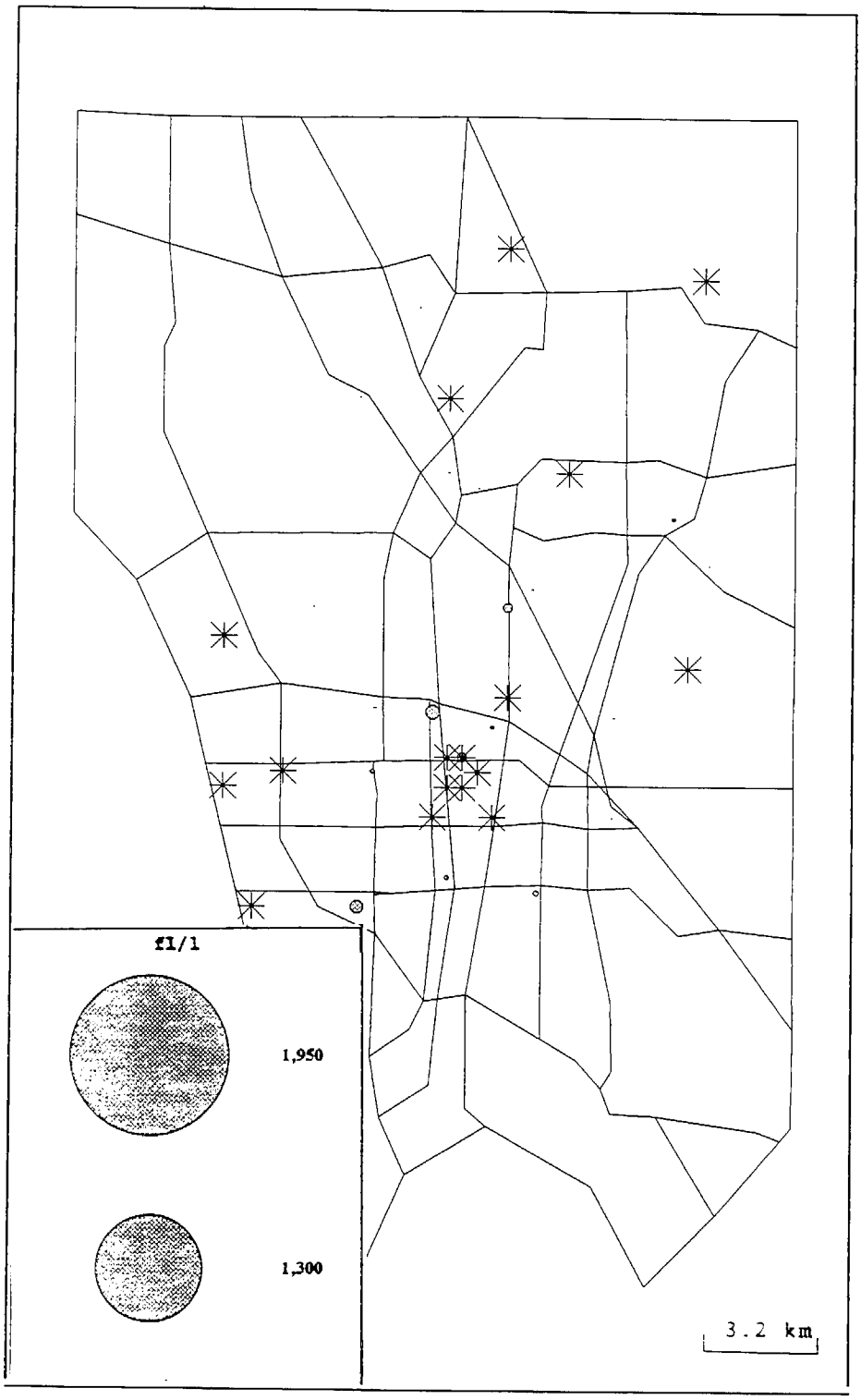

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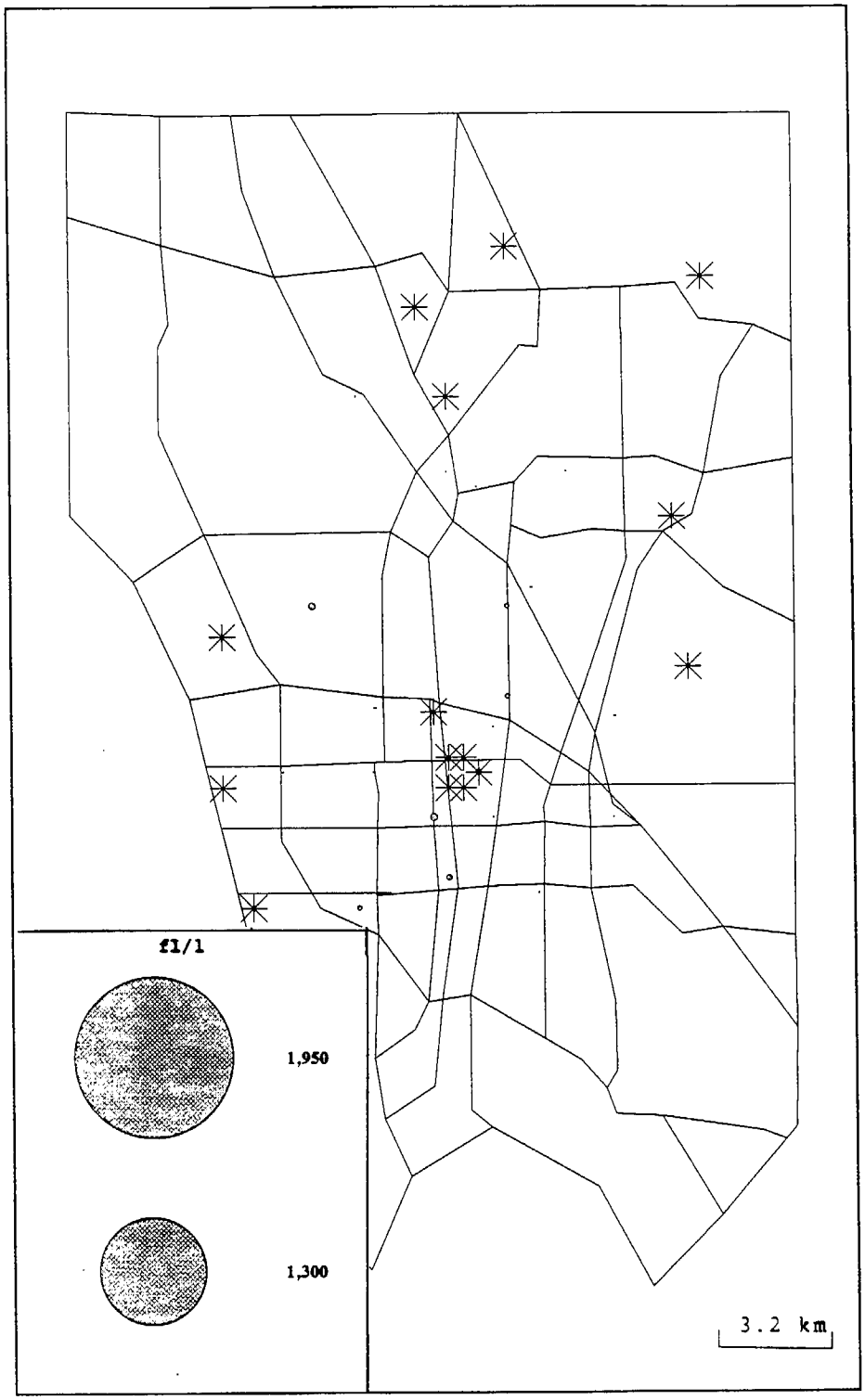

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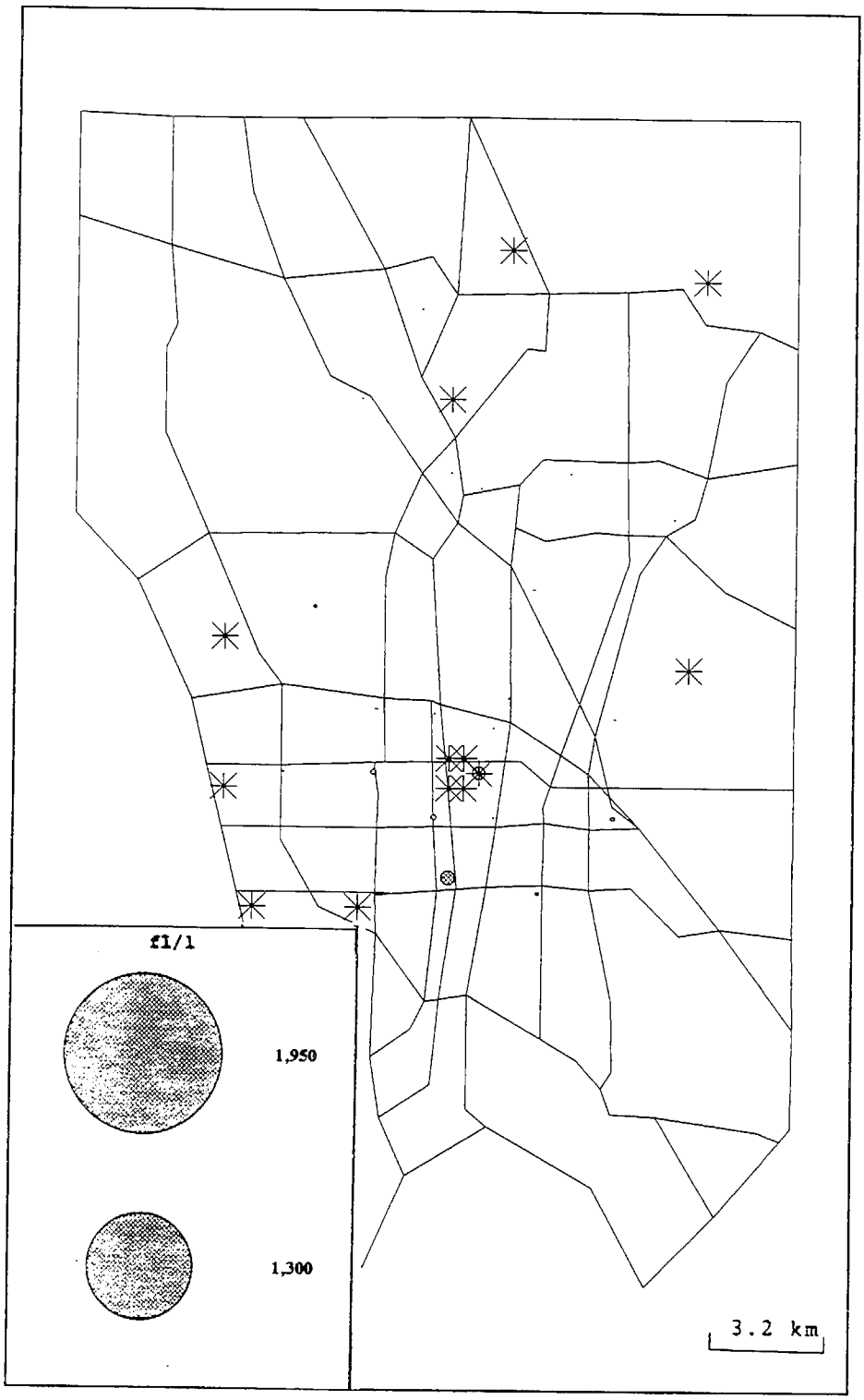

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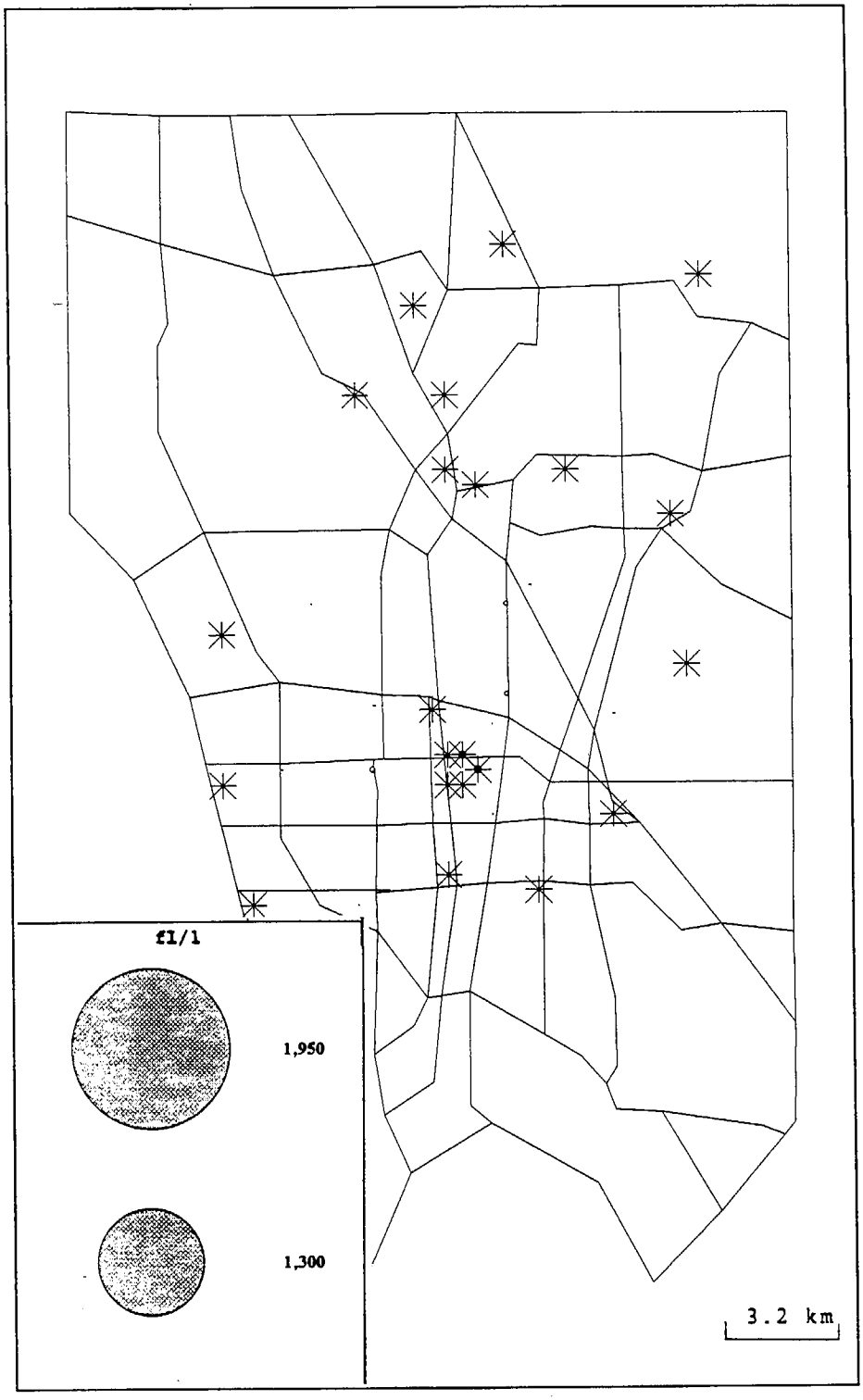

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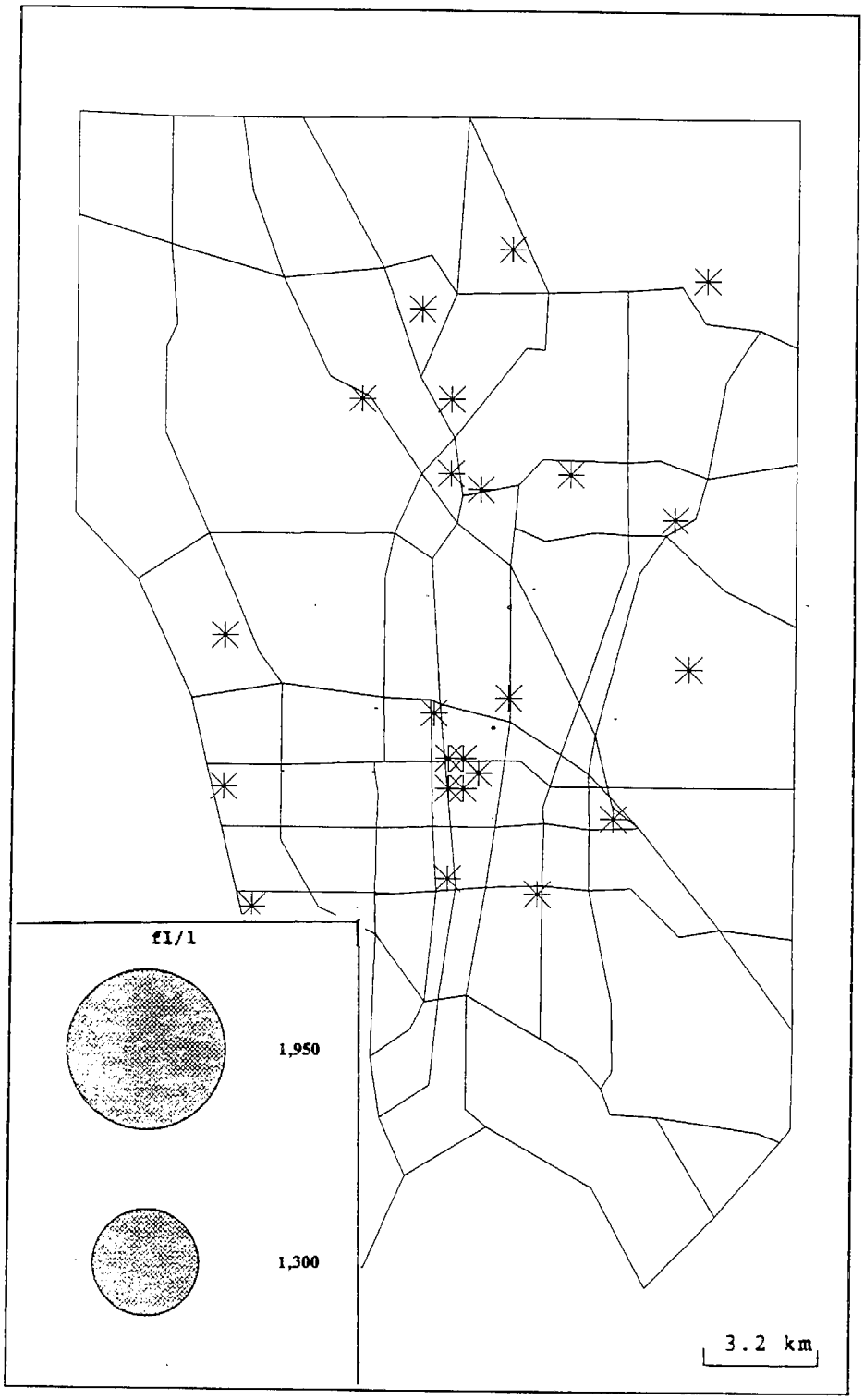

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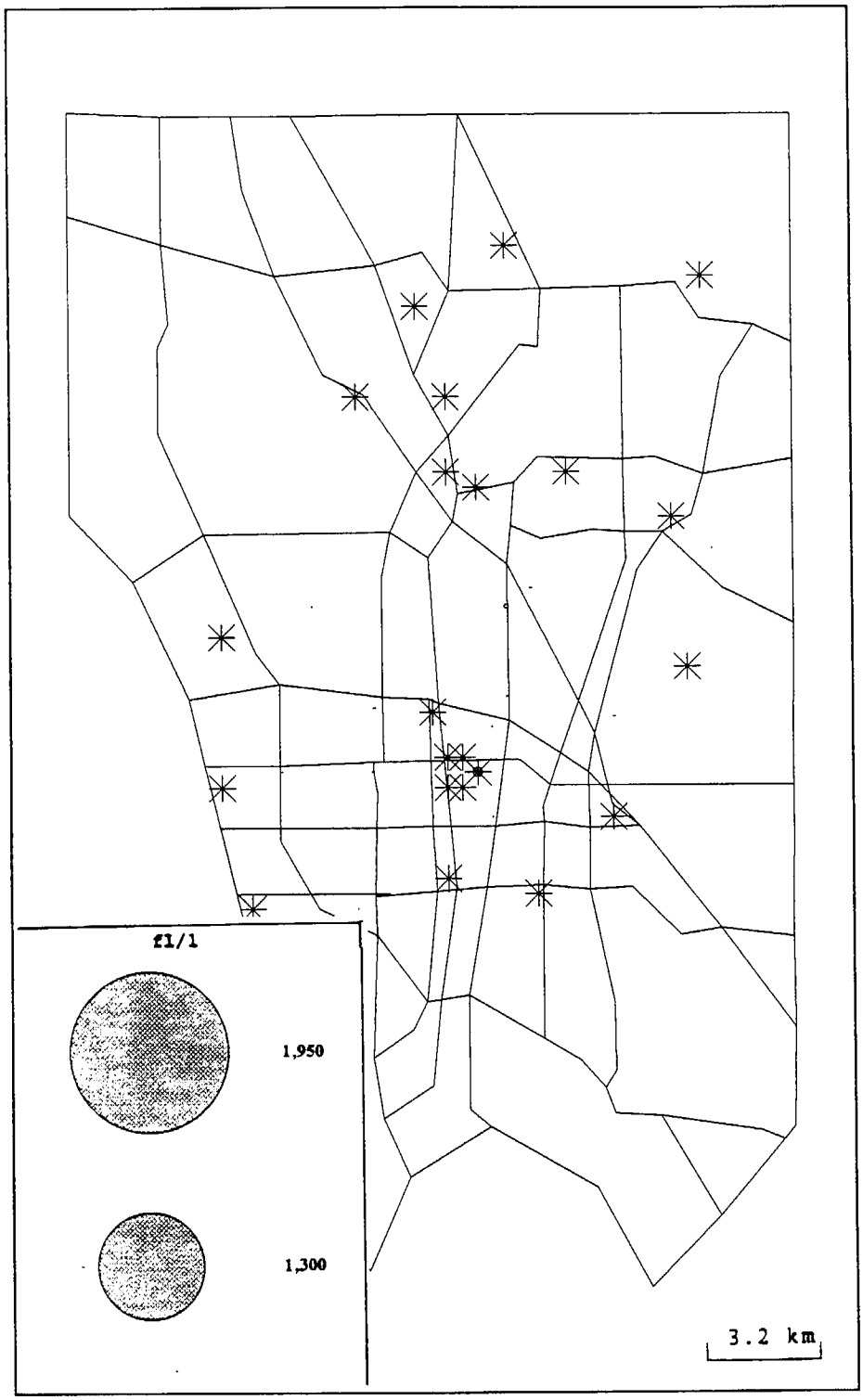

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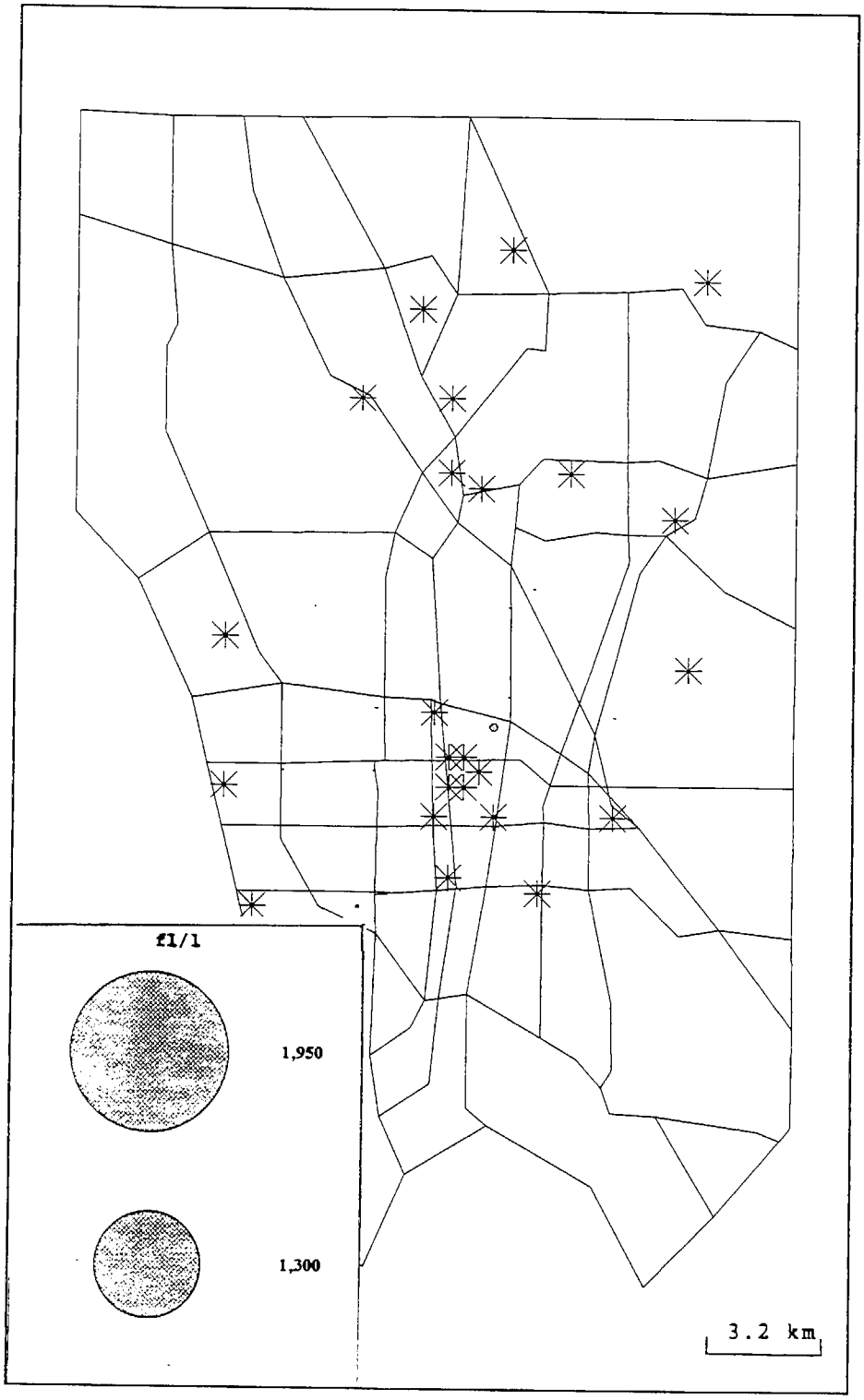

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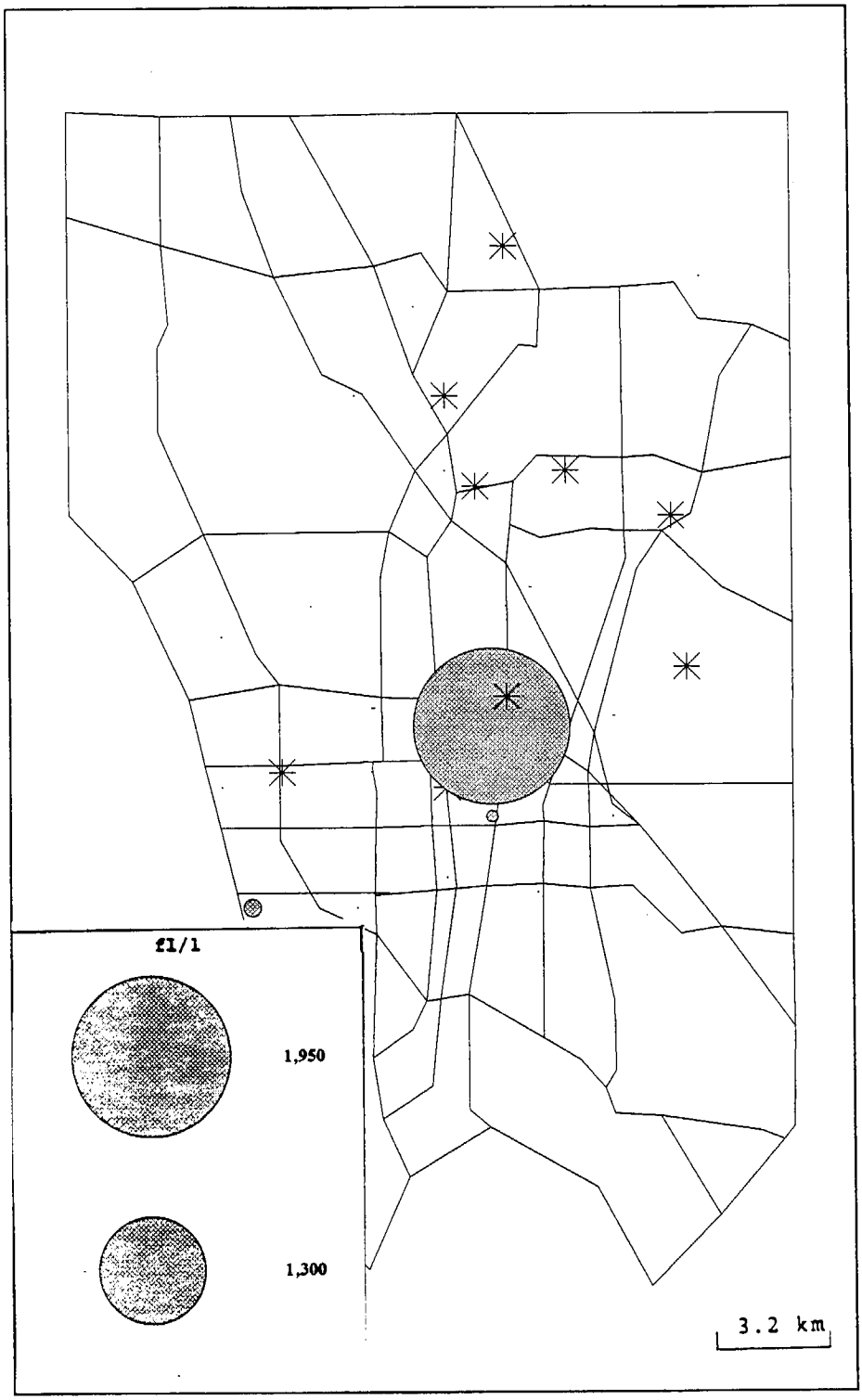

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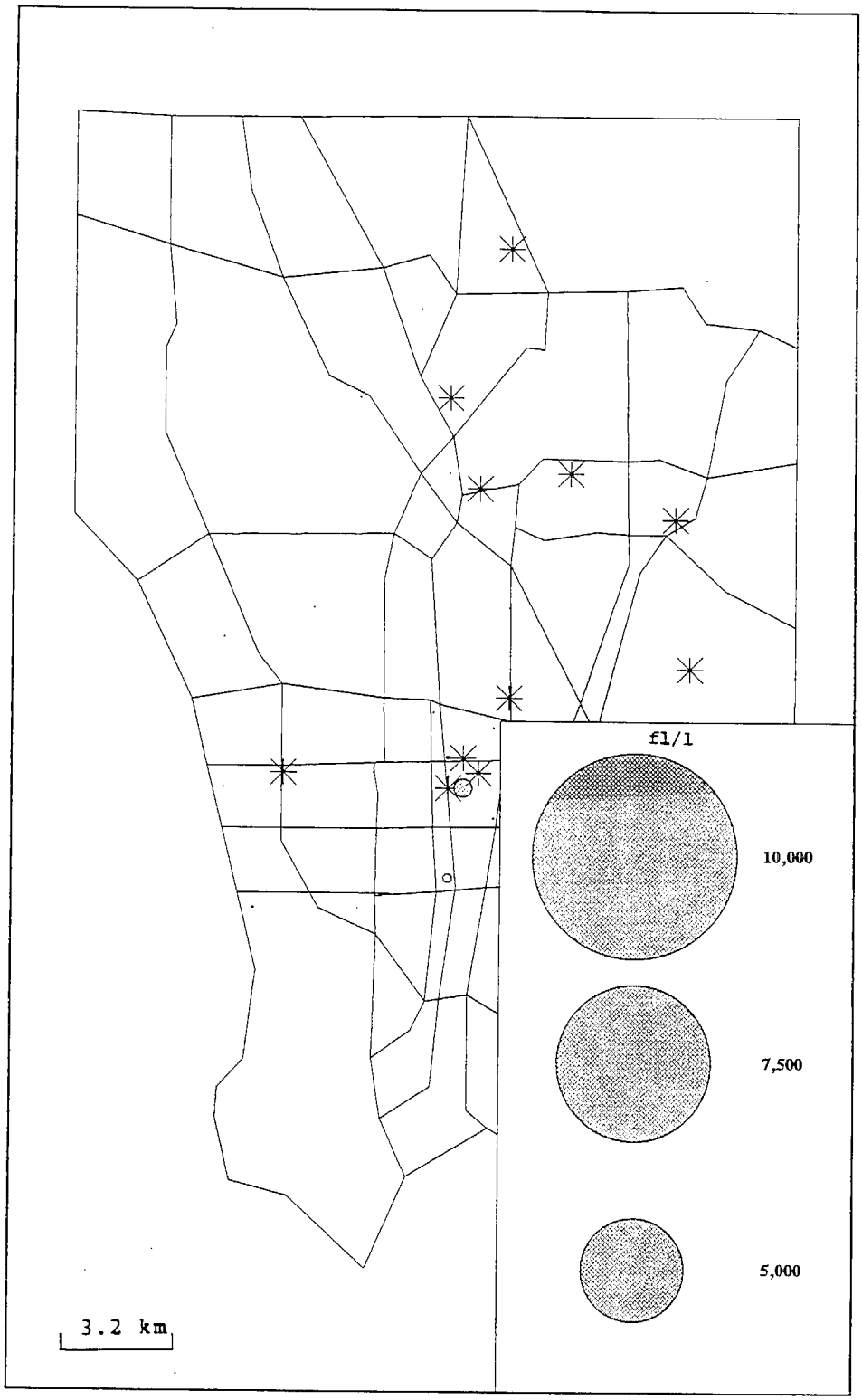

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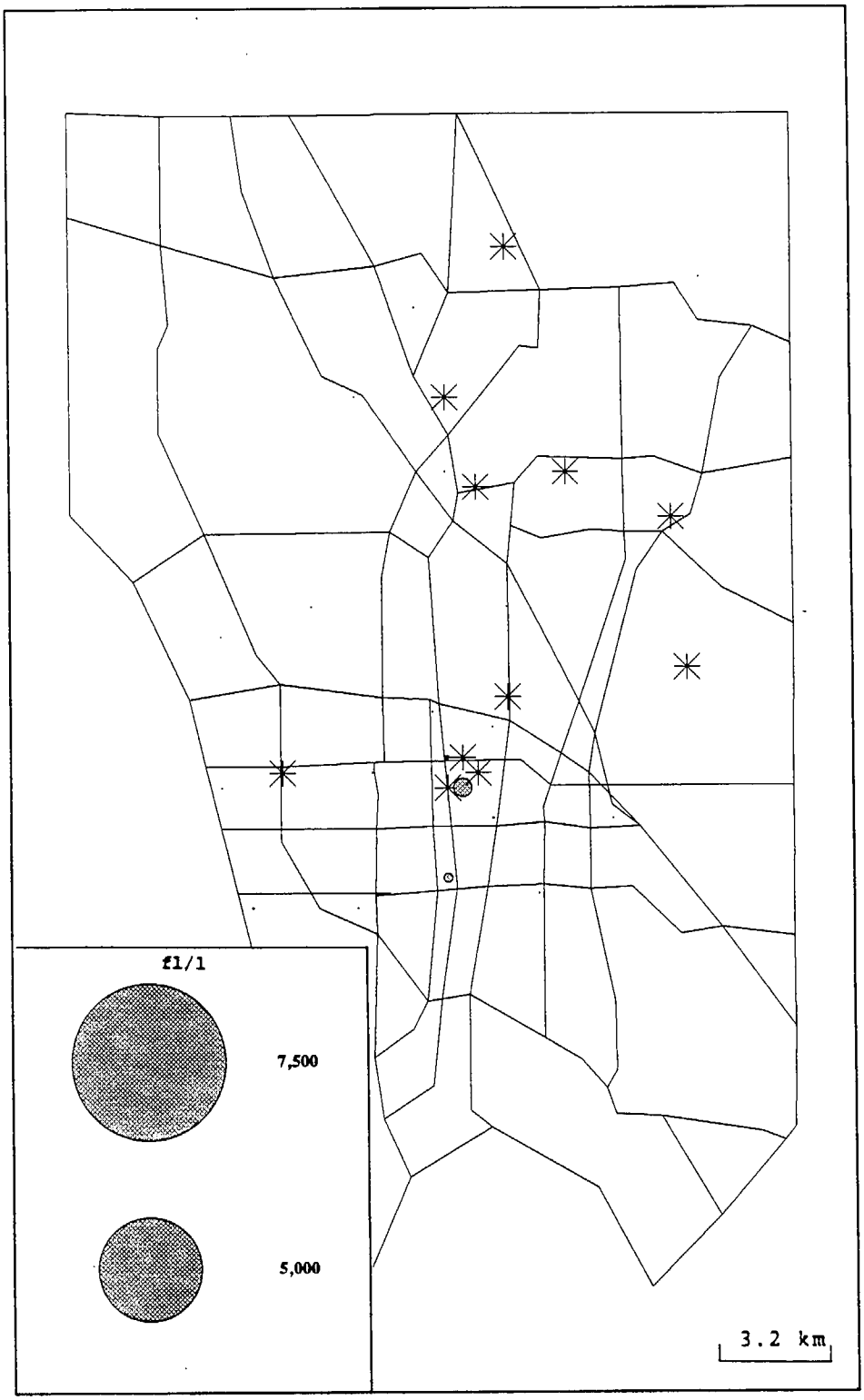

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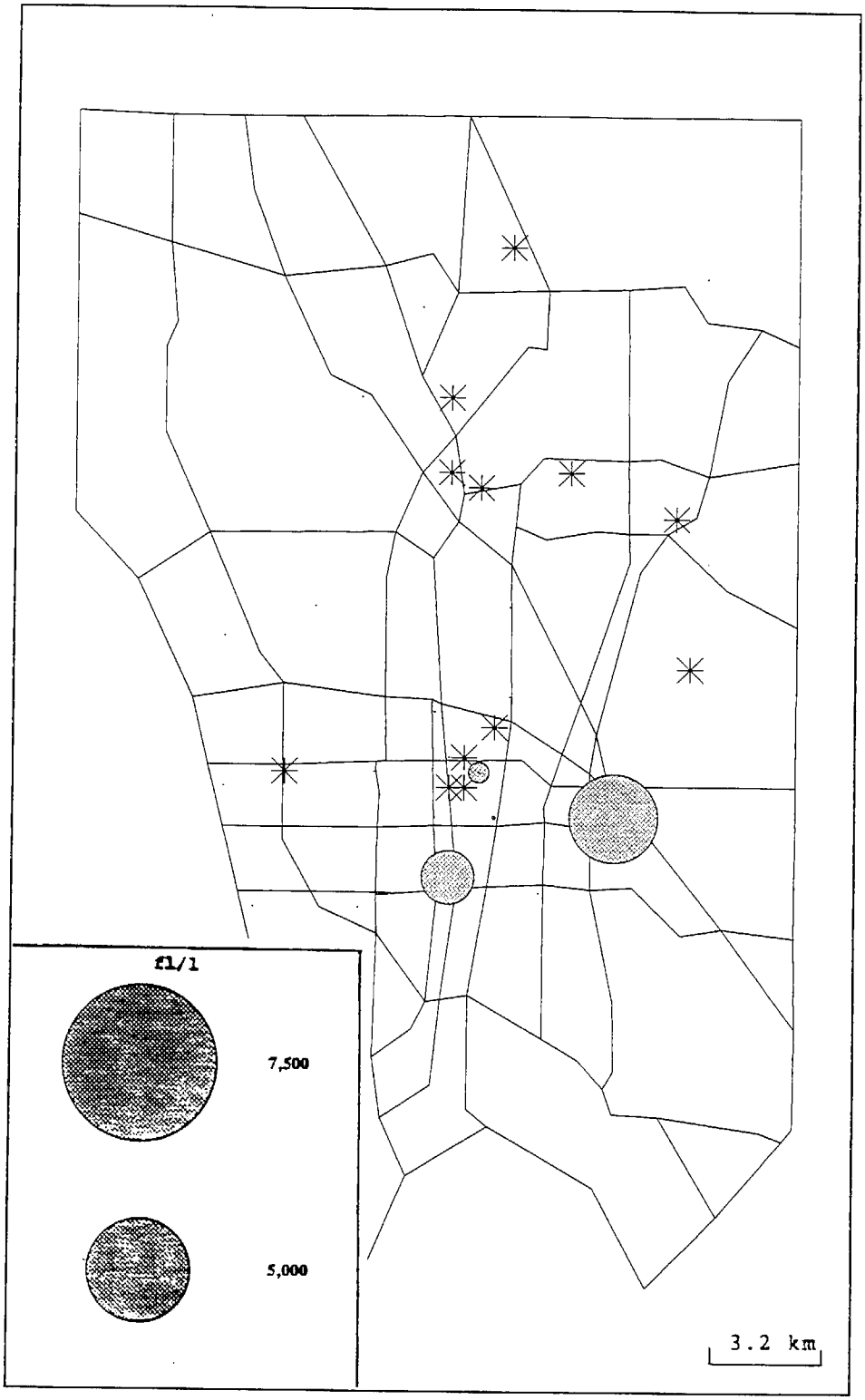

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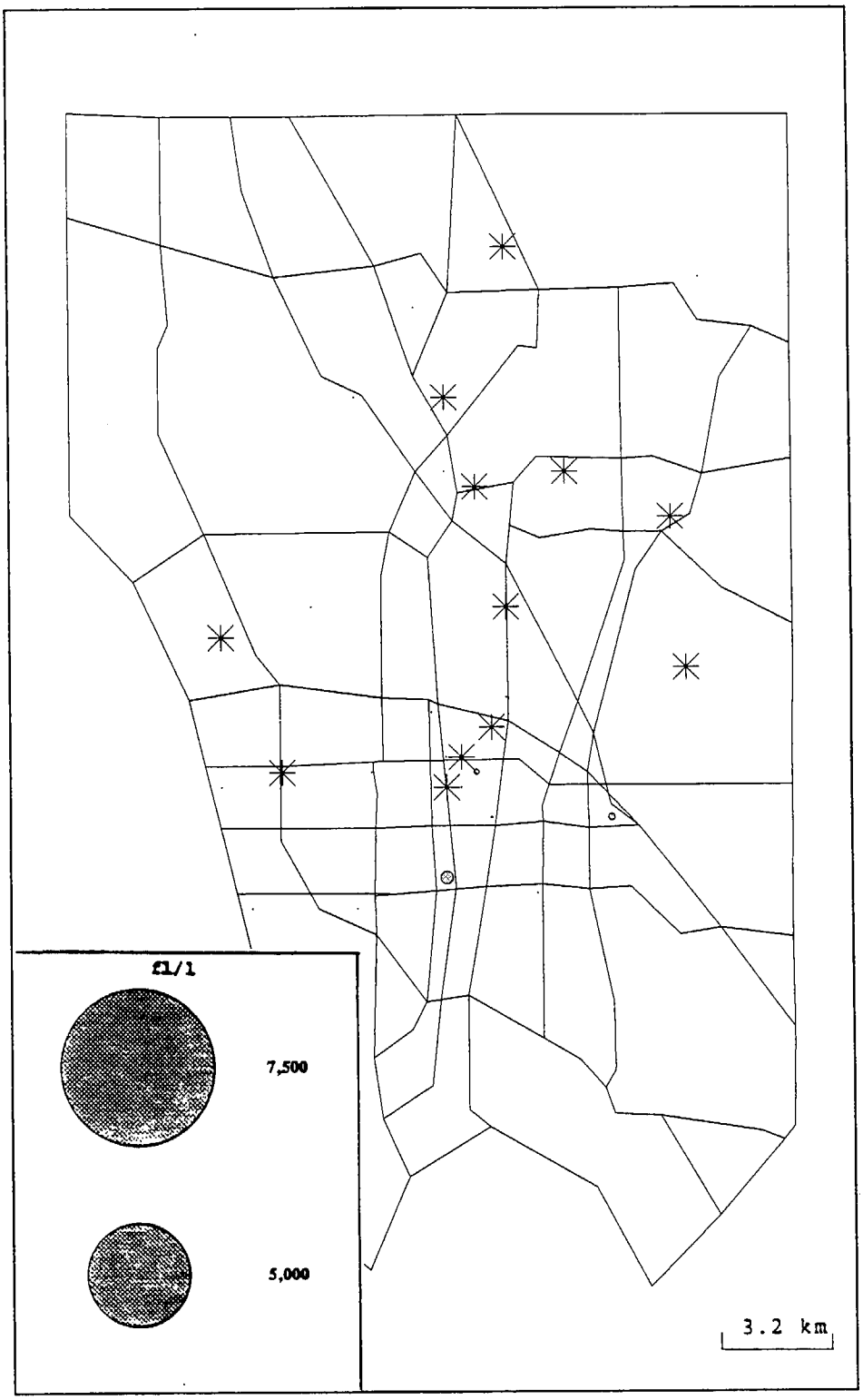

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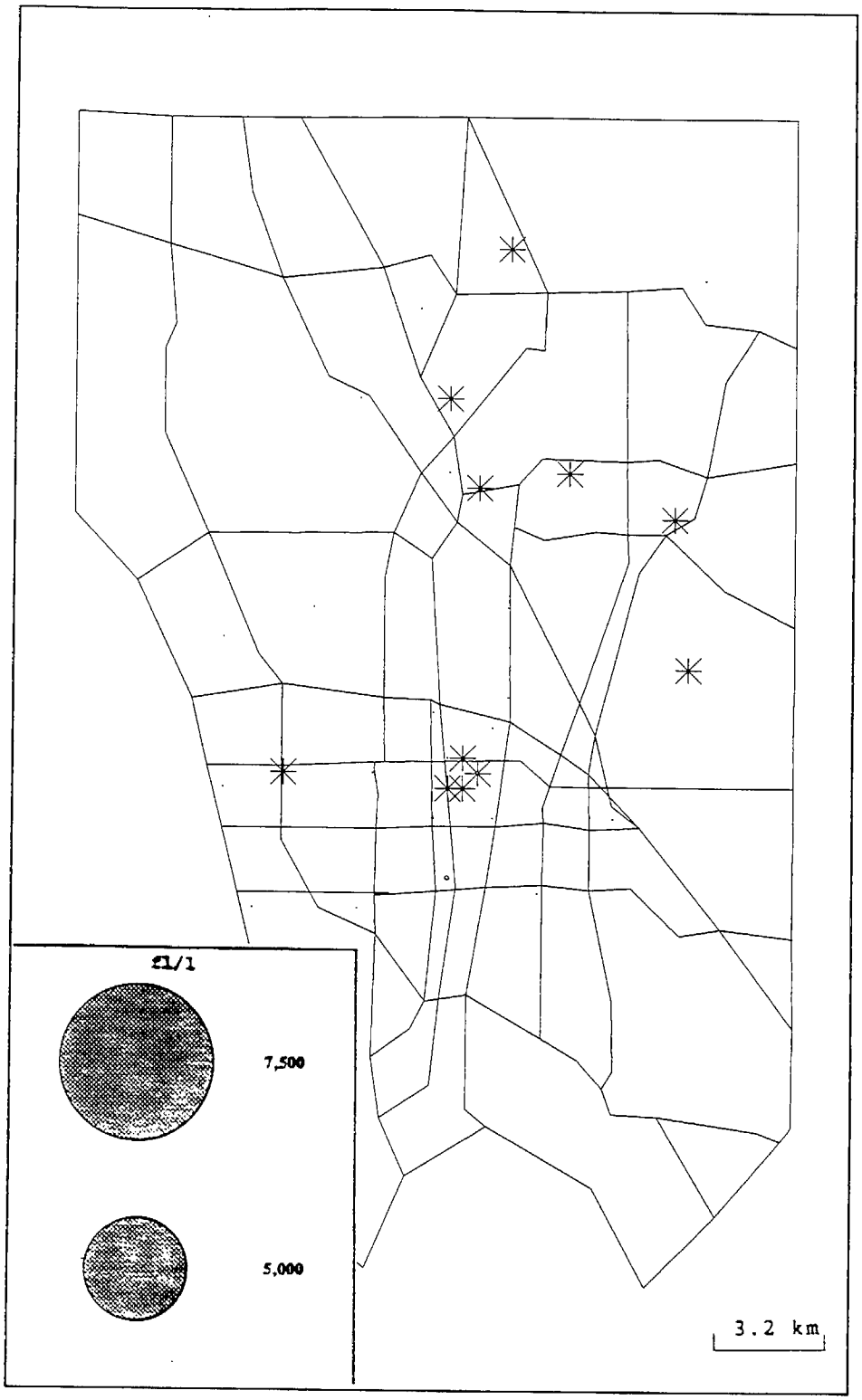

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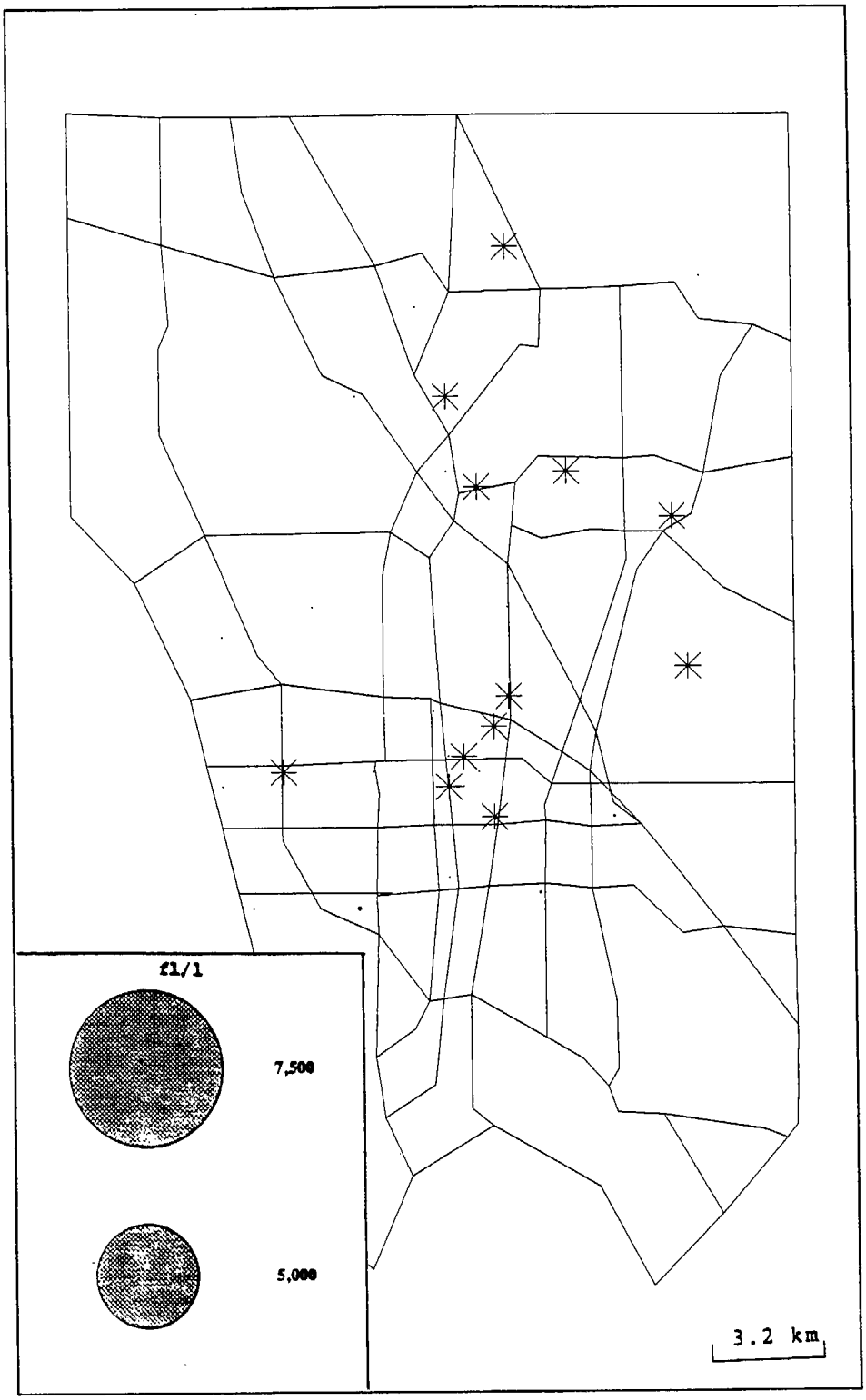

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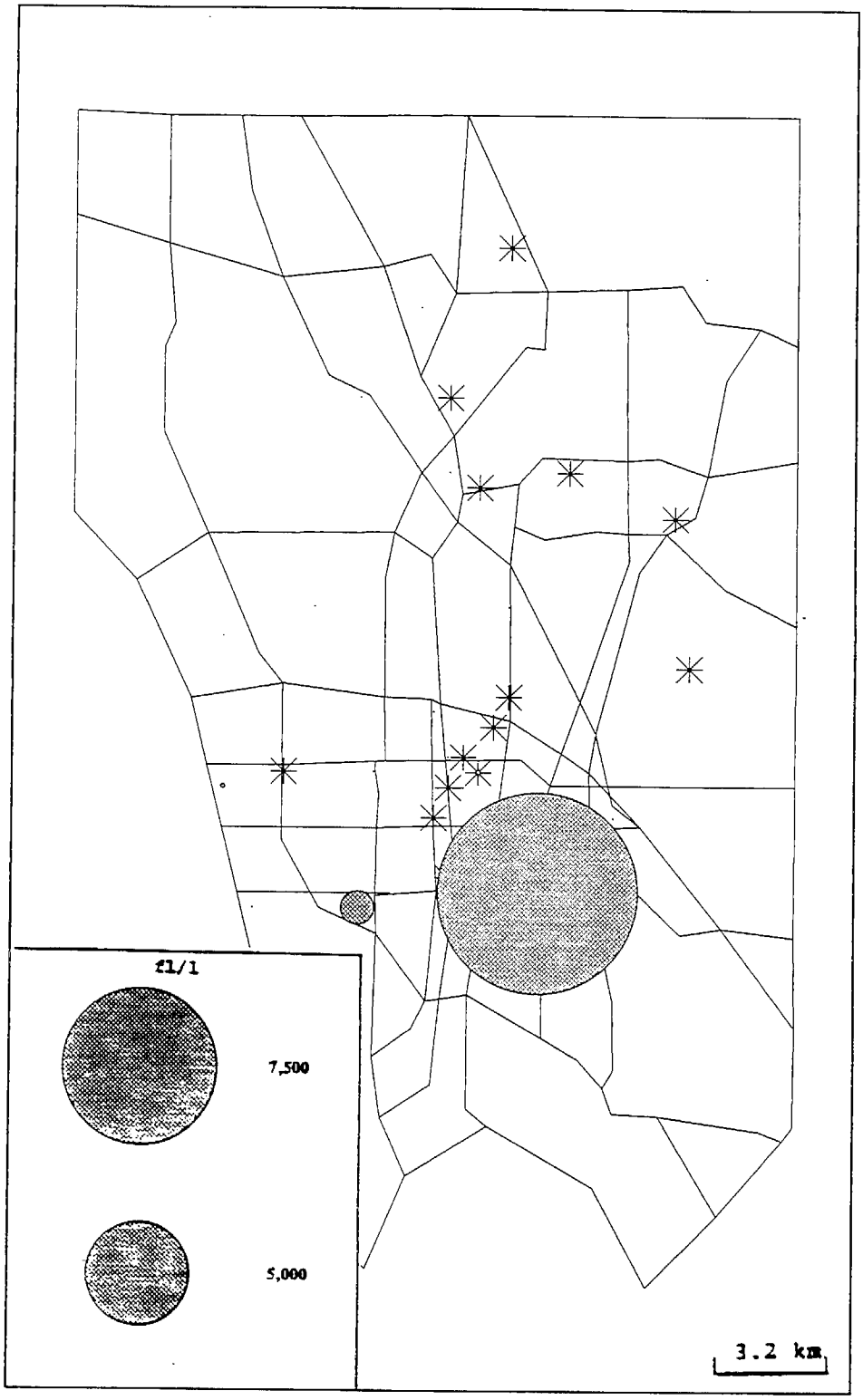

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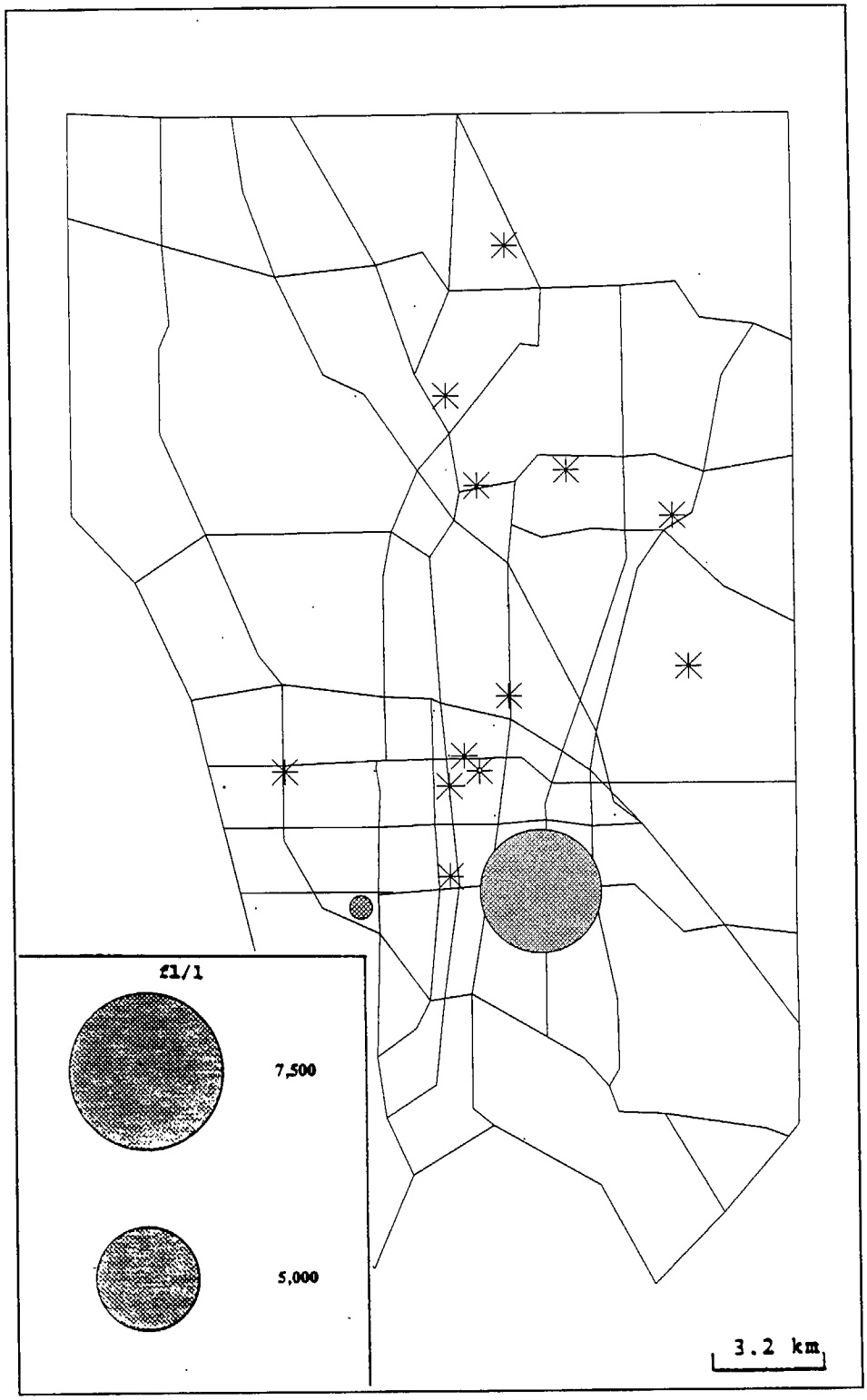

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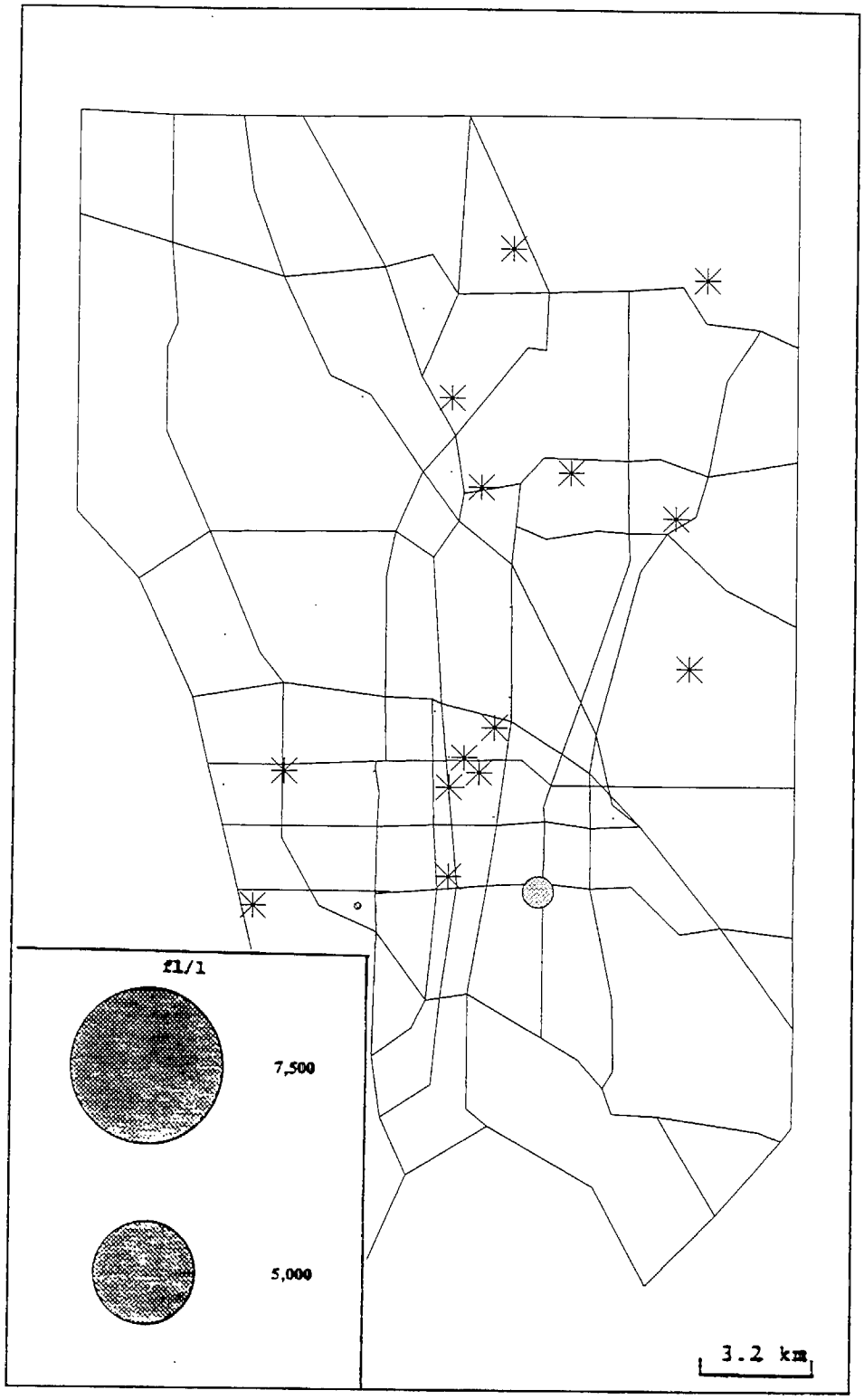

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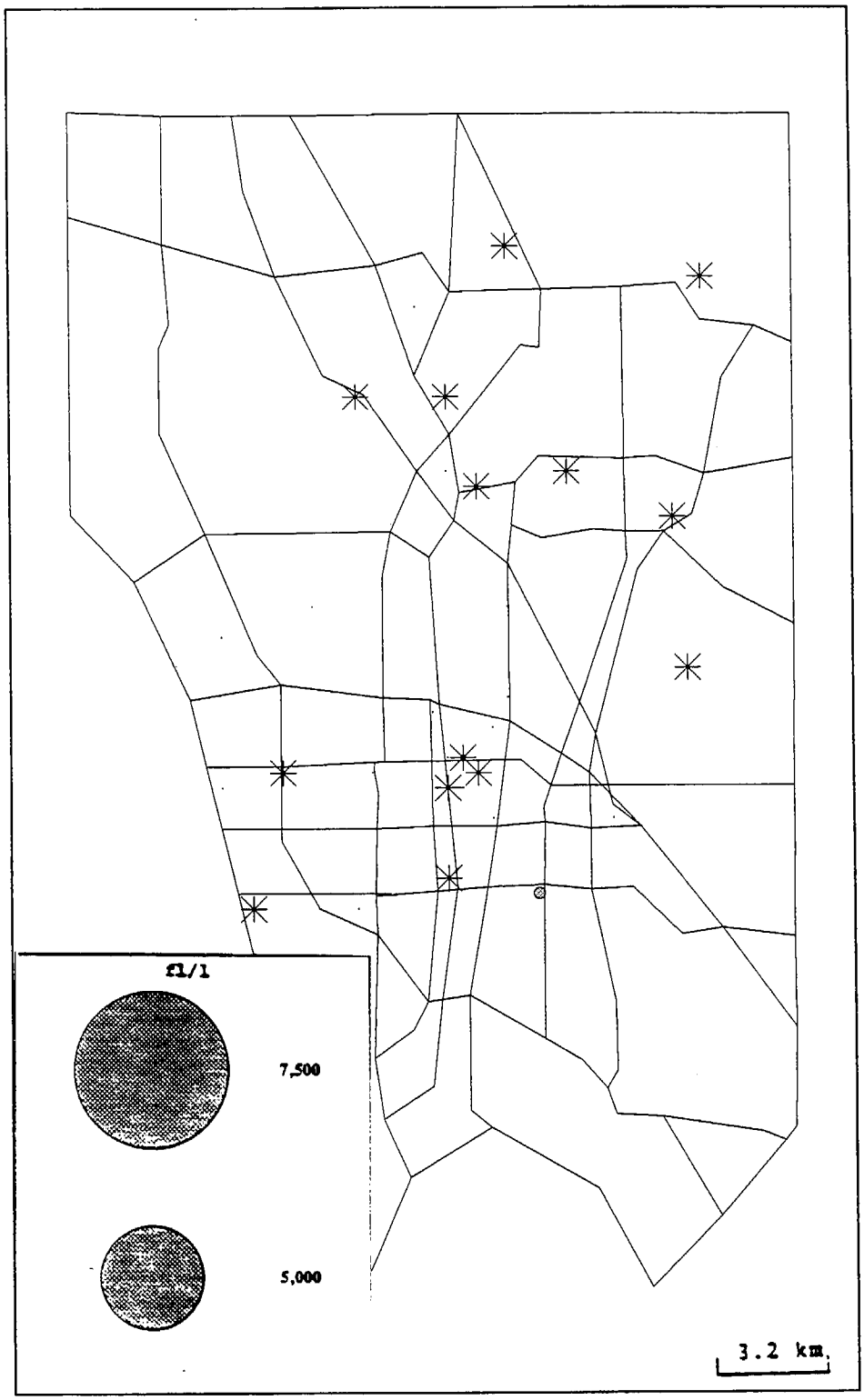

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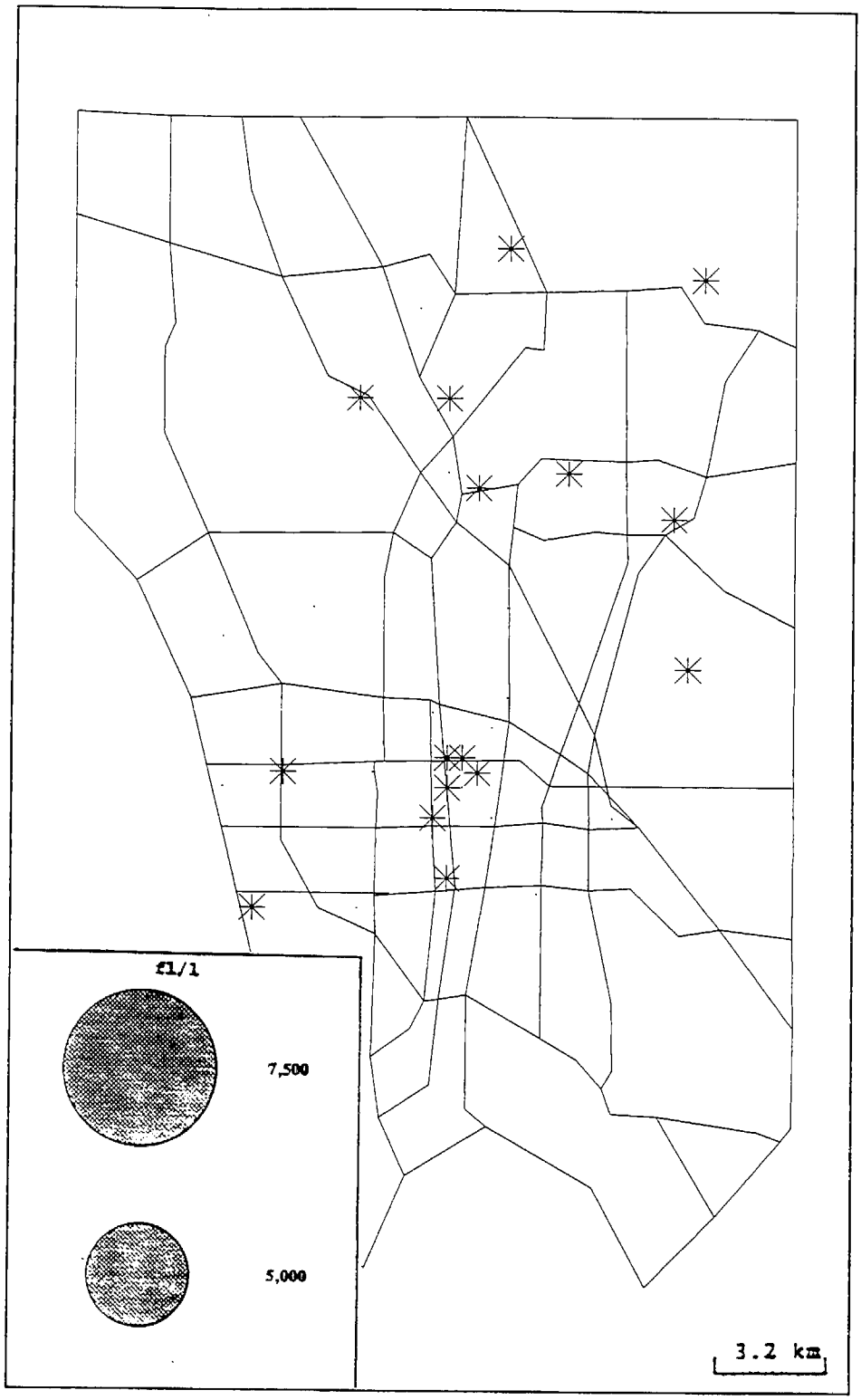

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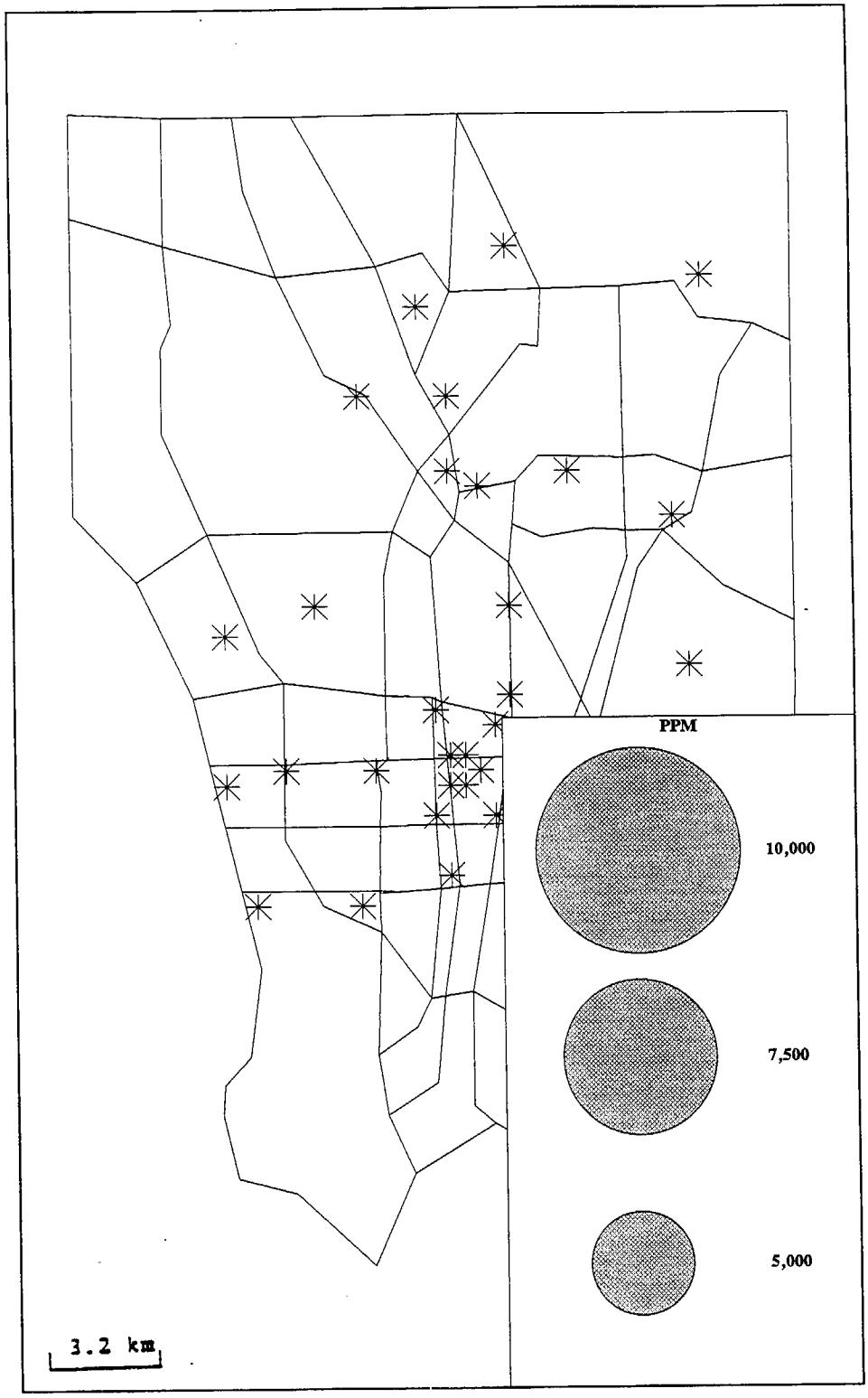

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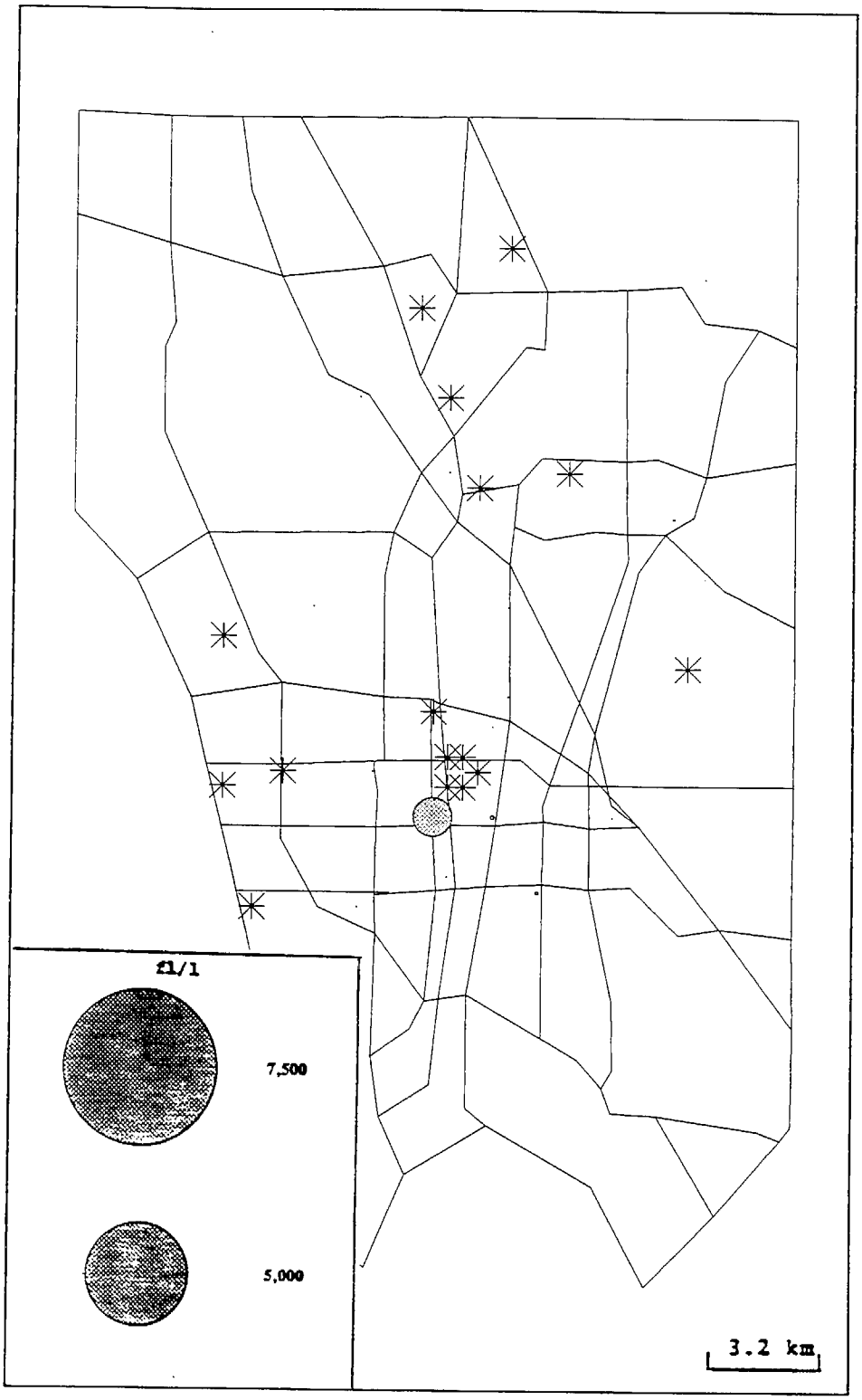

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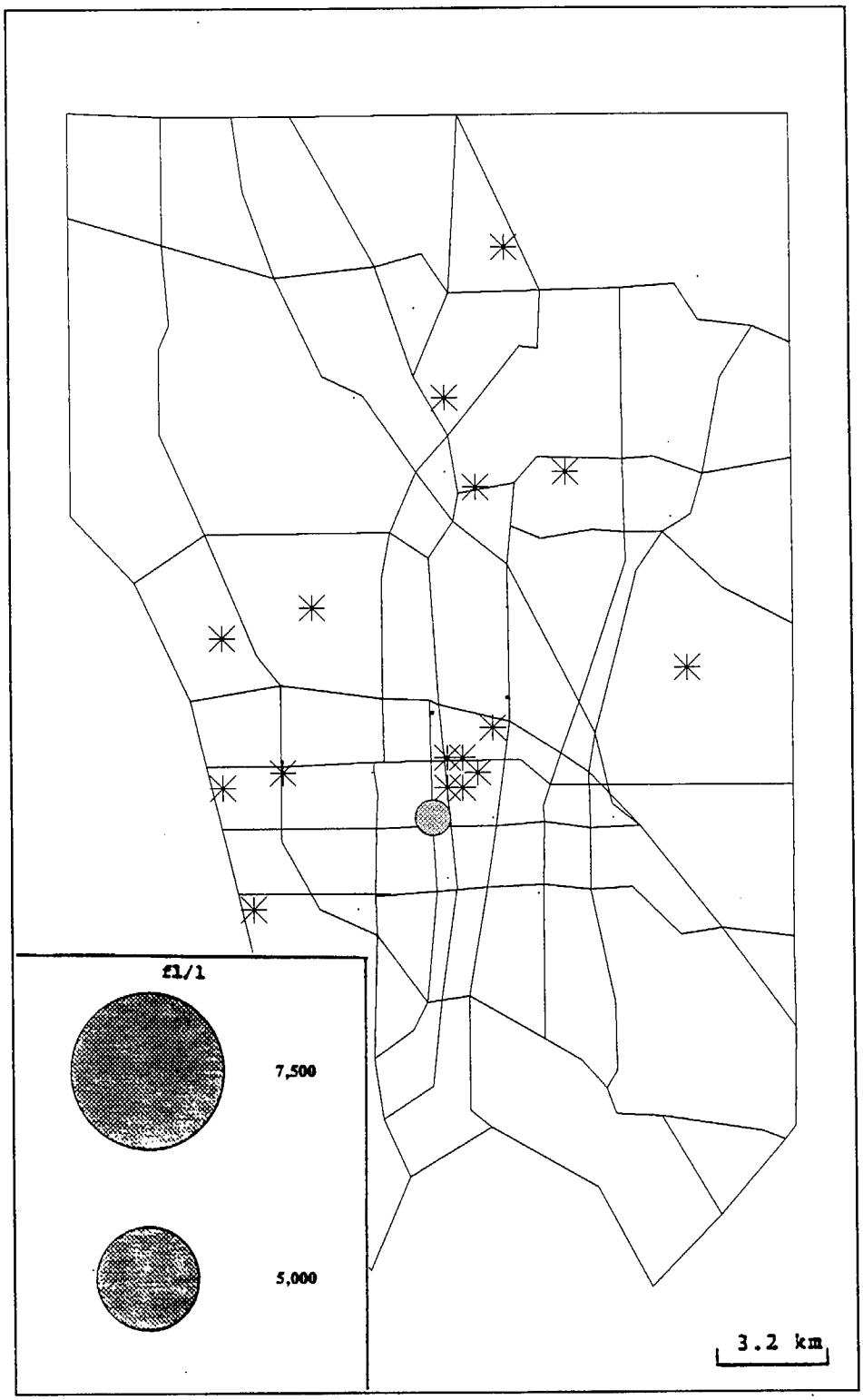

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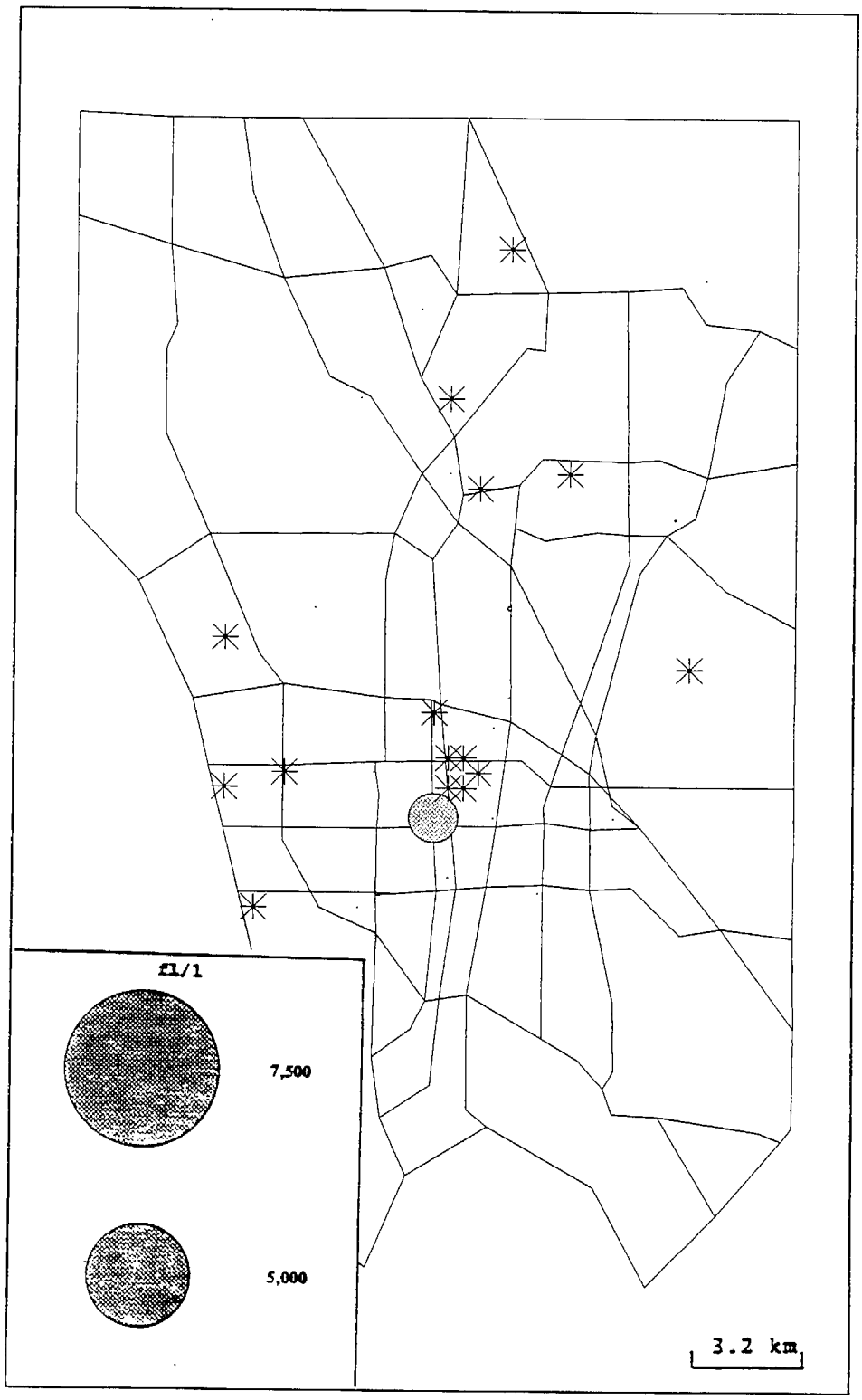

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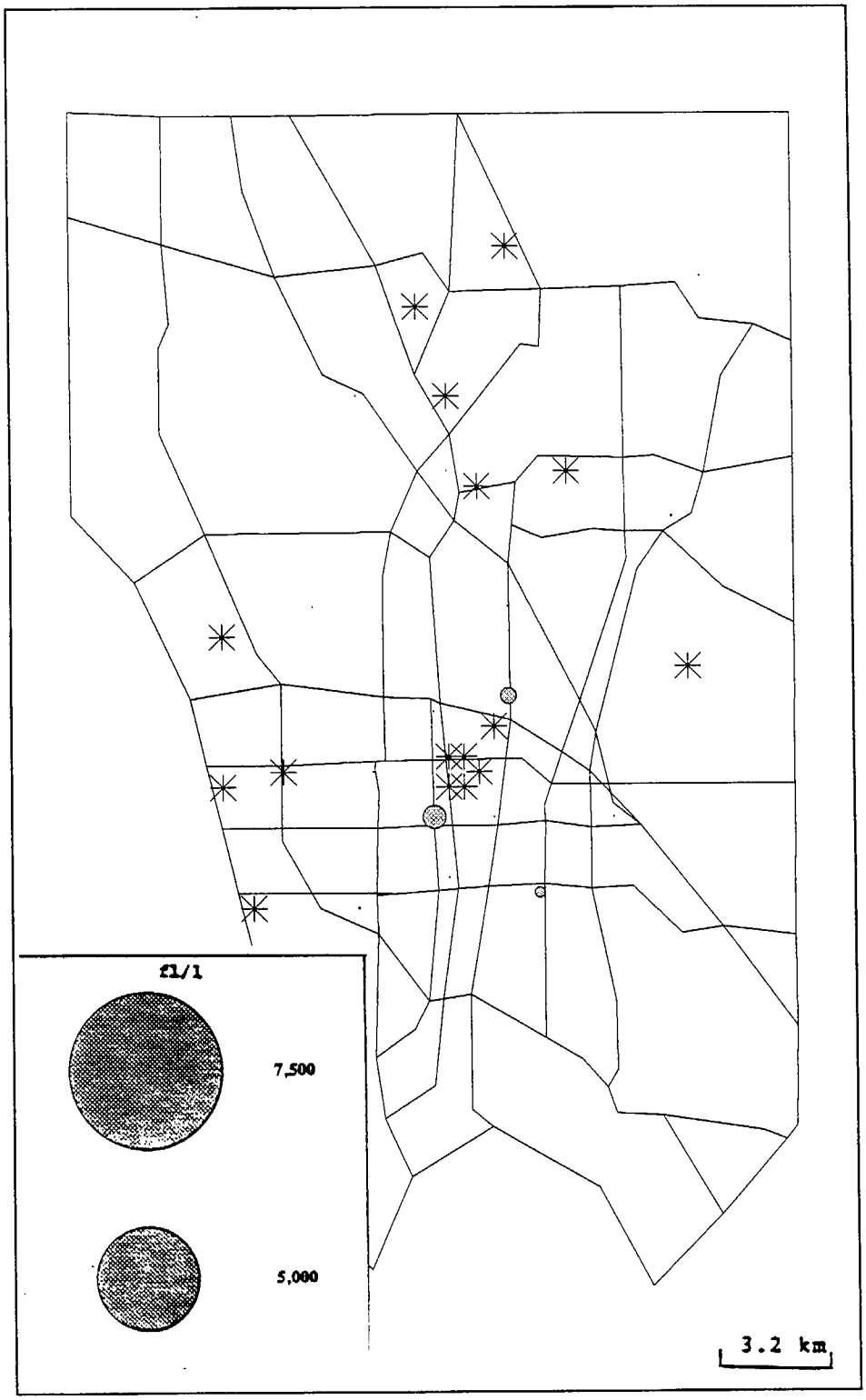

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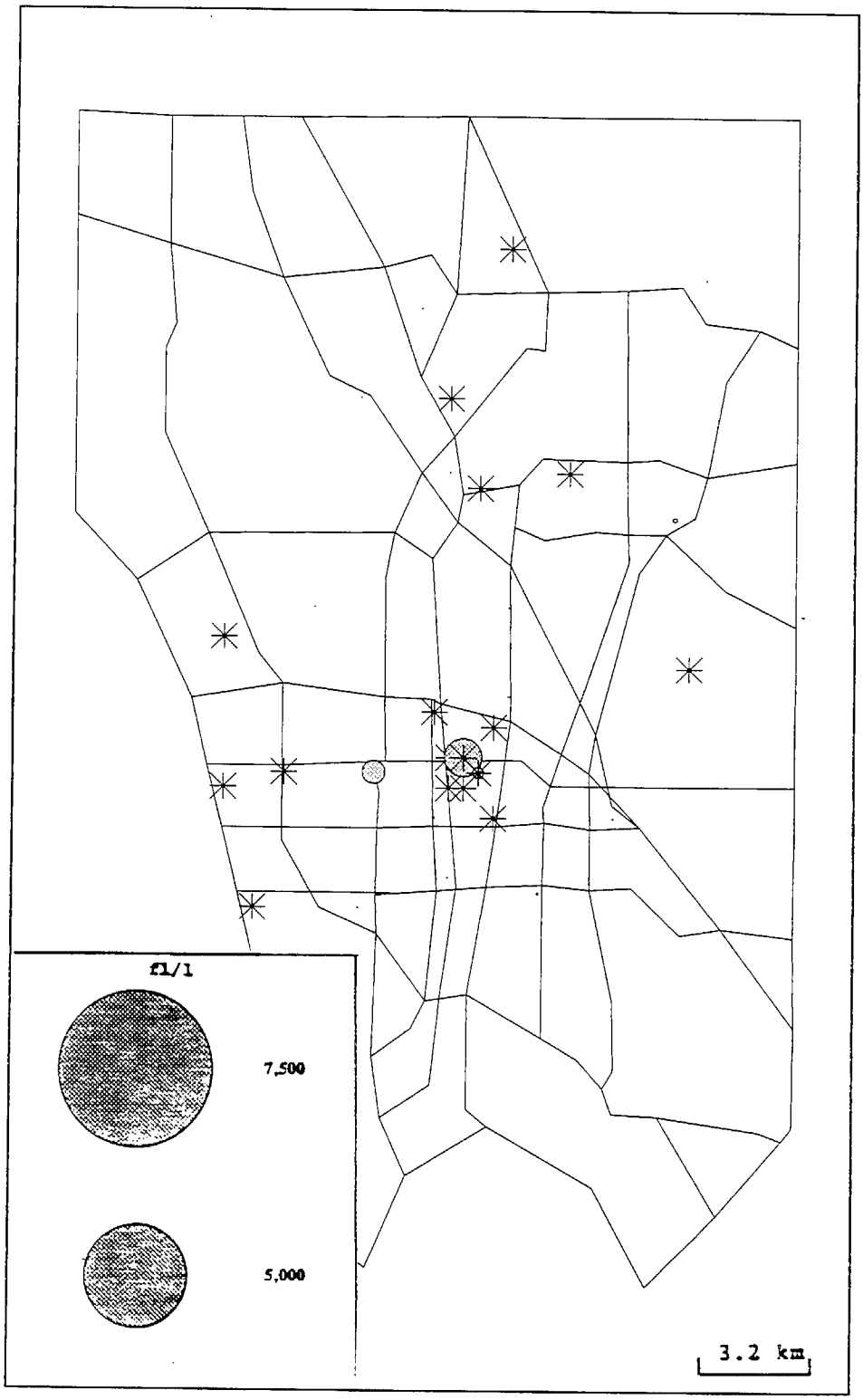

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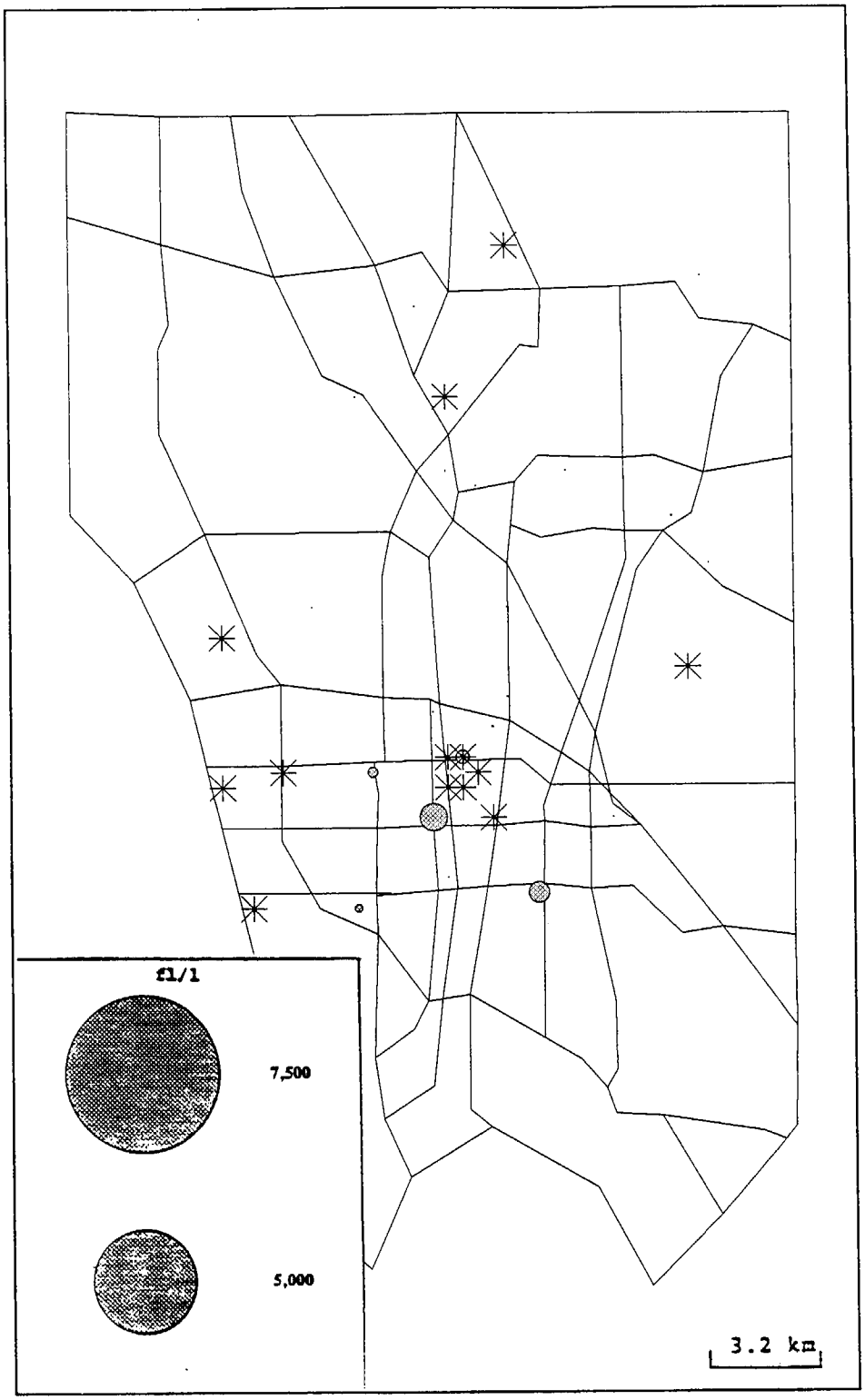

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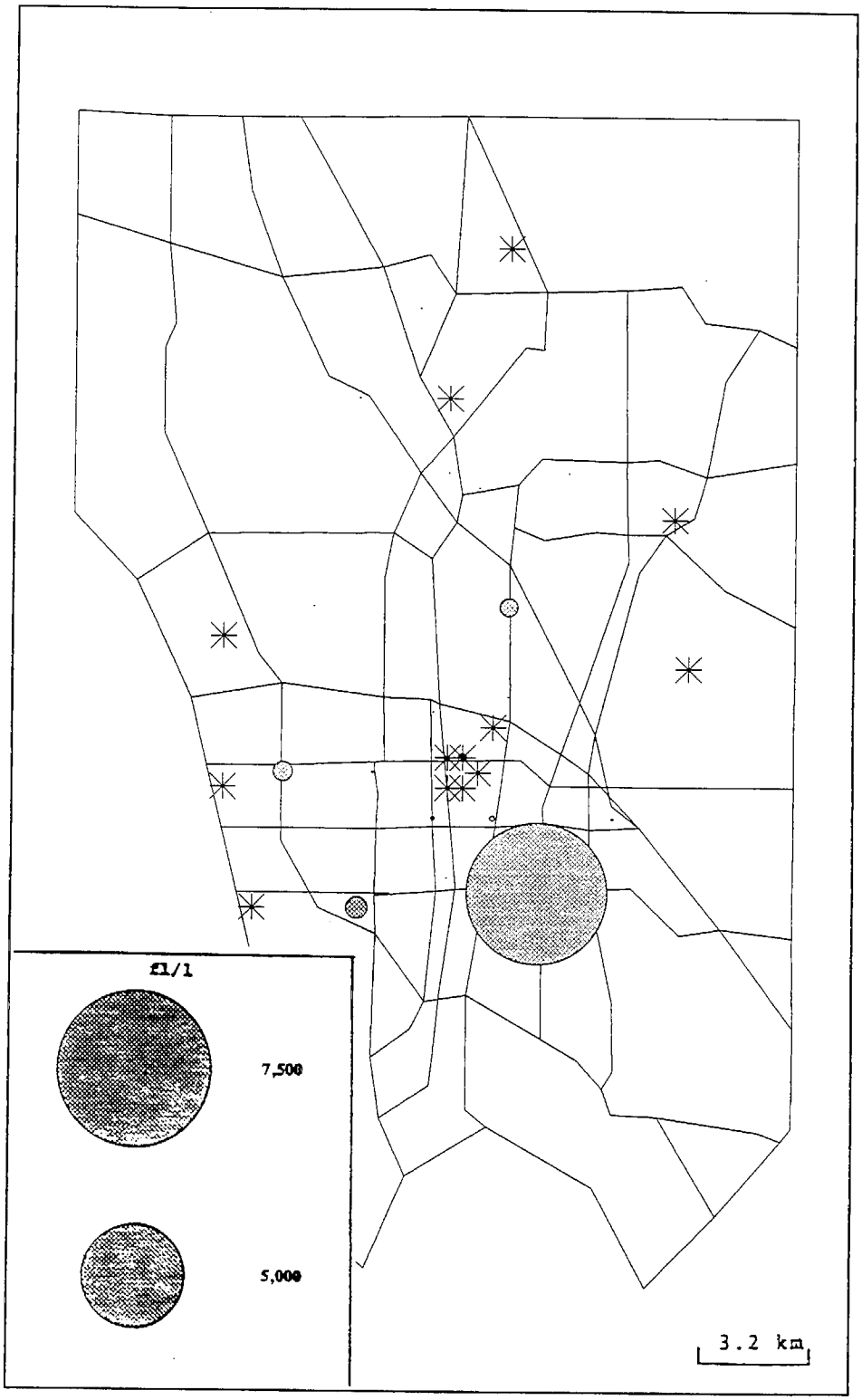

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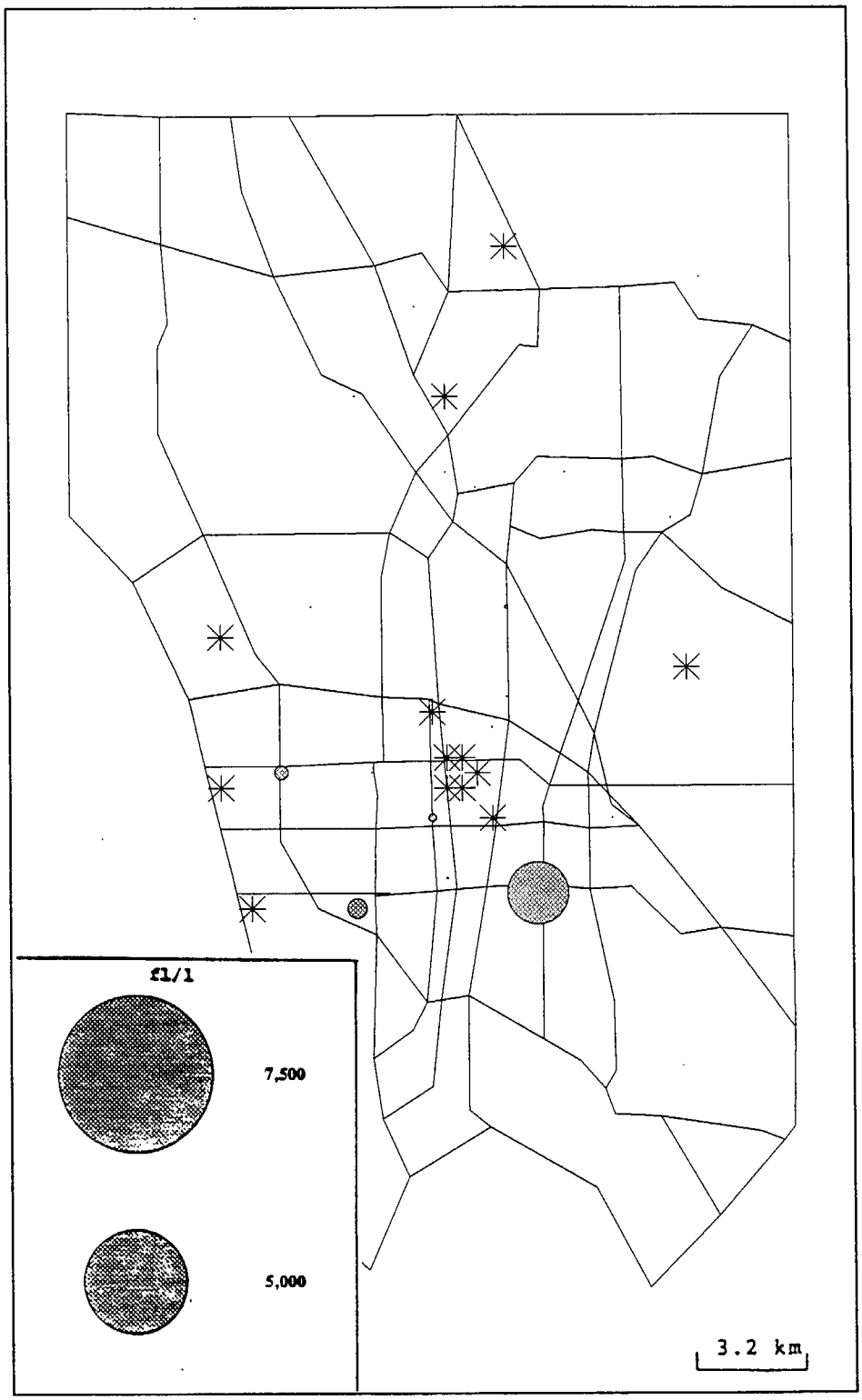

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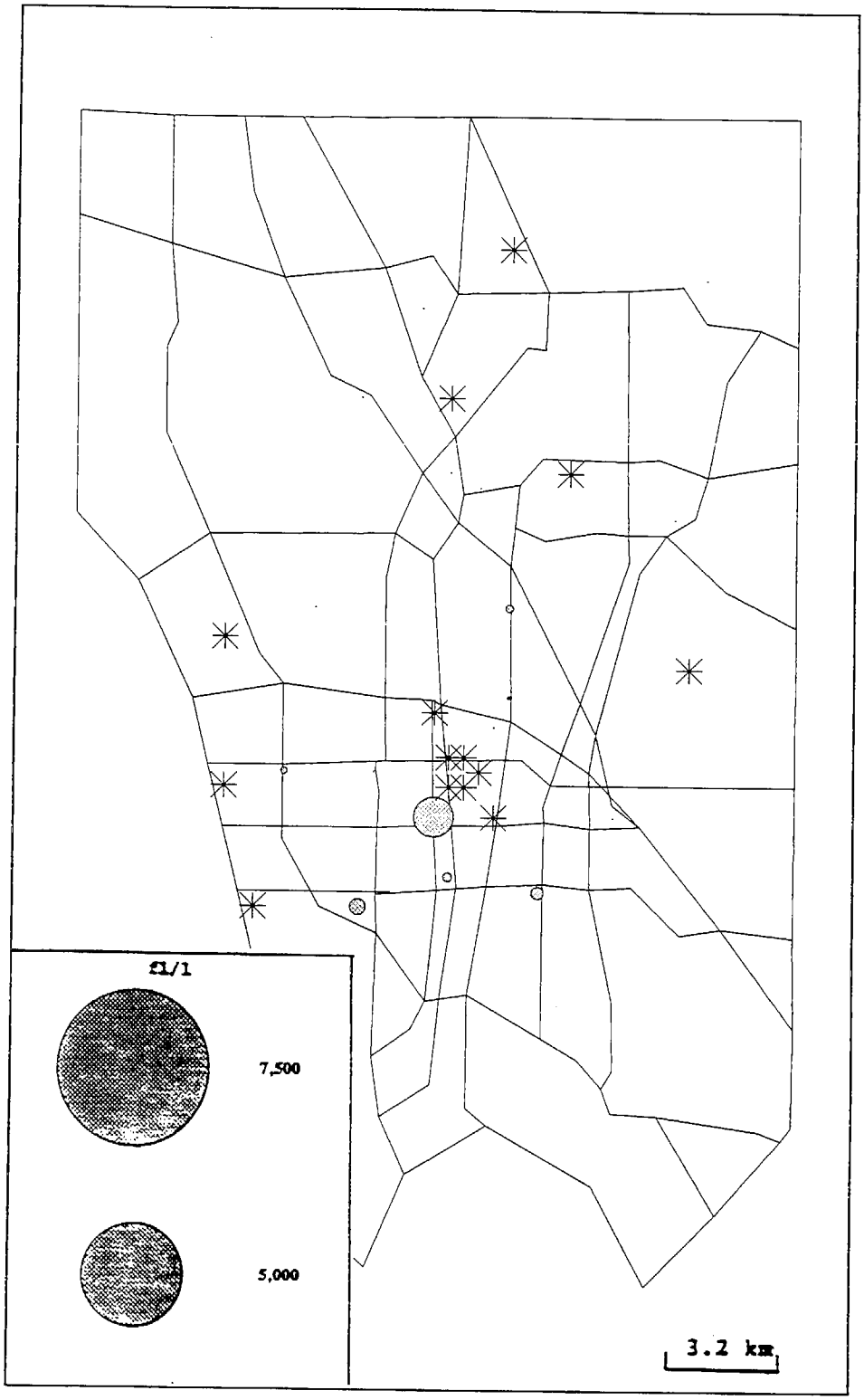

TB 01/09/1990 06:00

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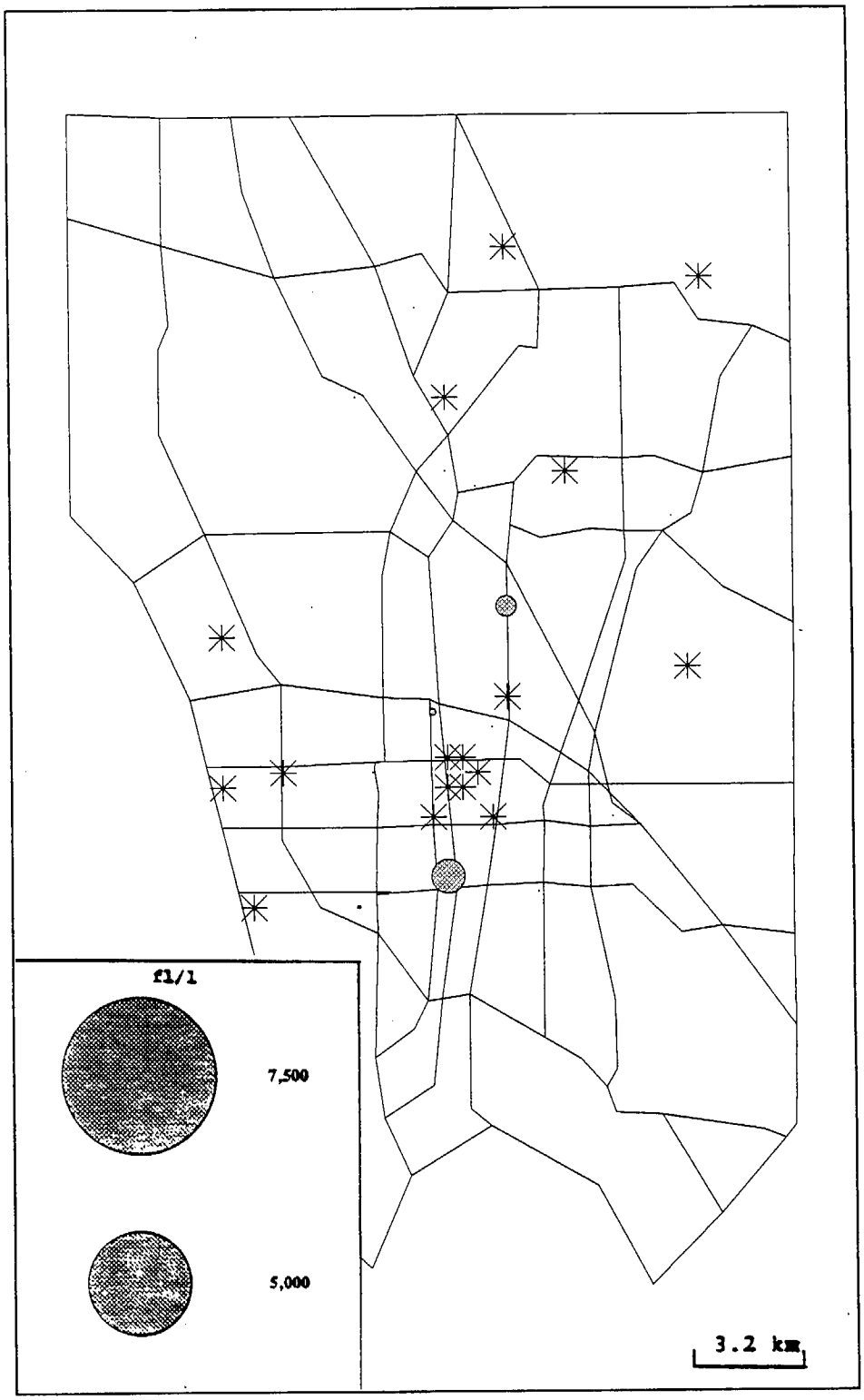

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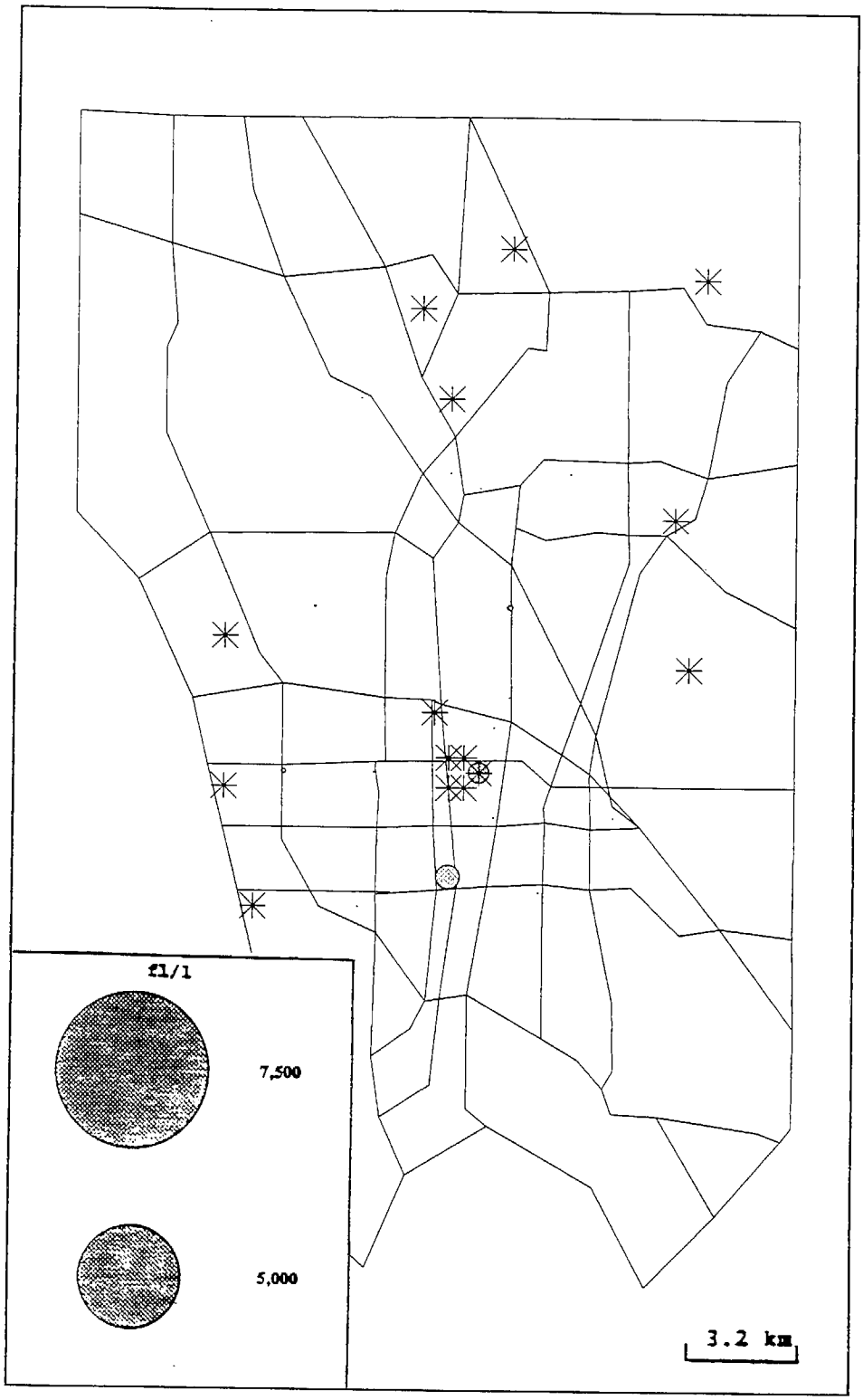

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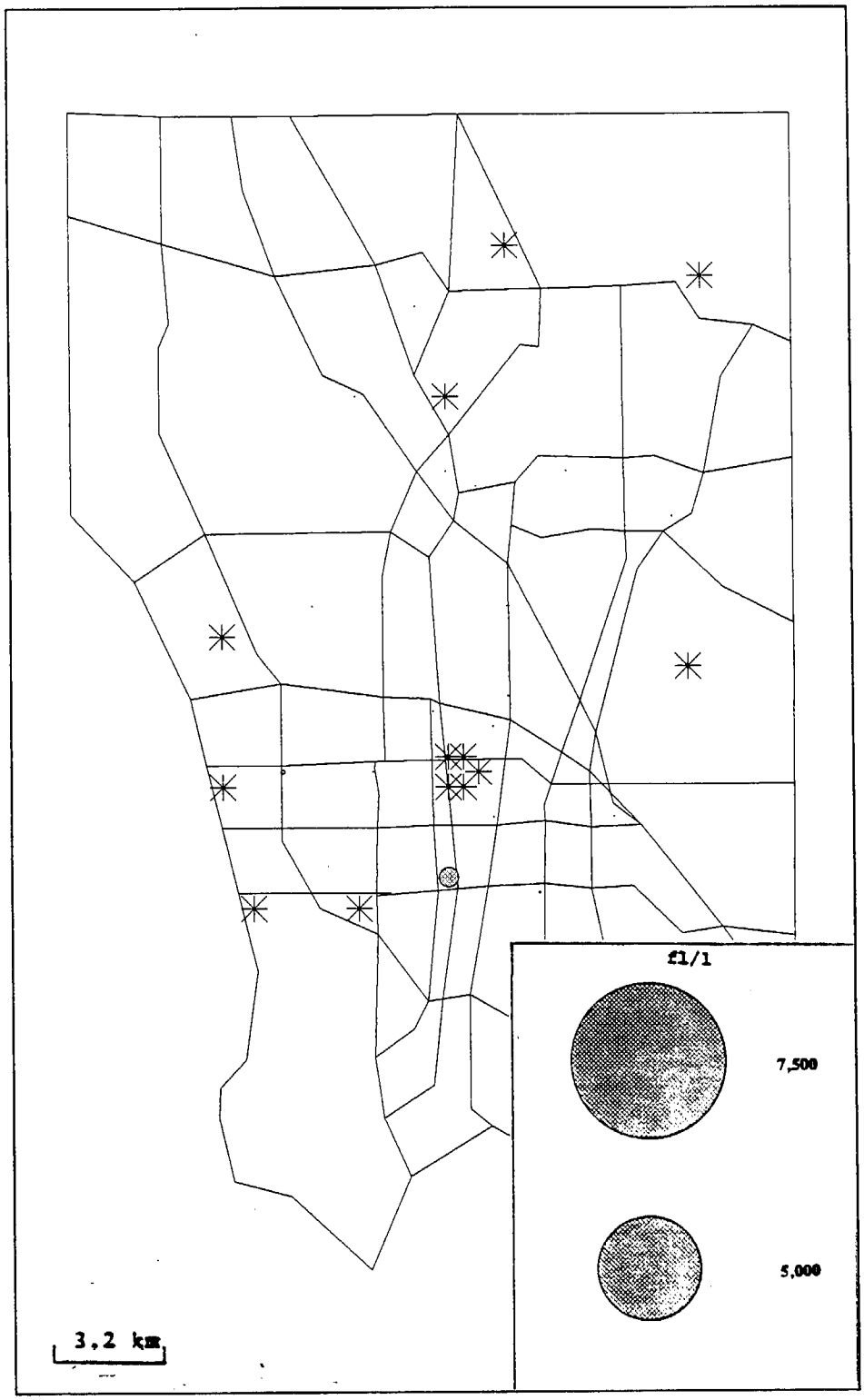

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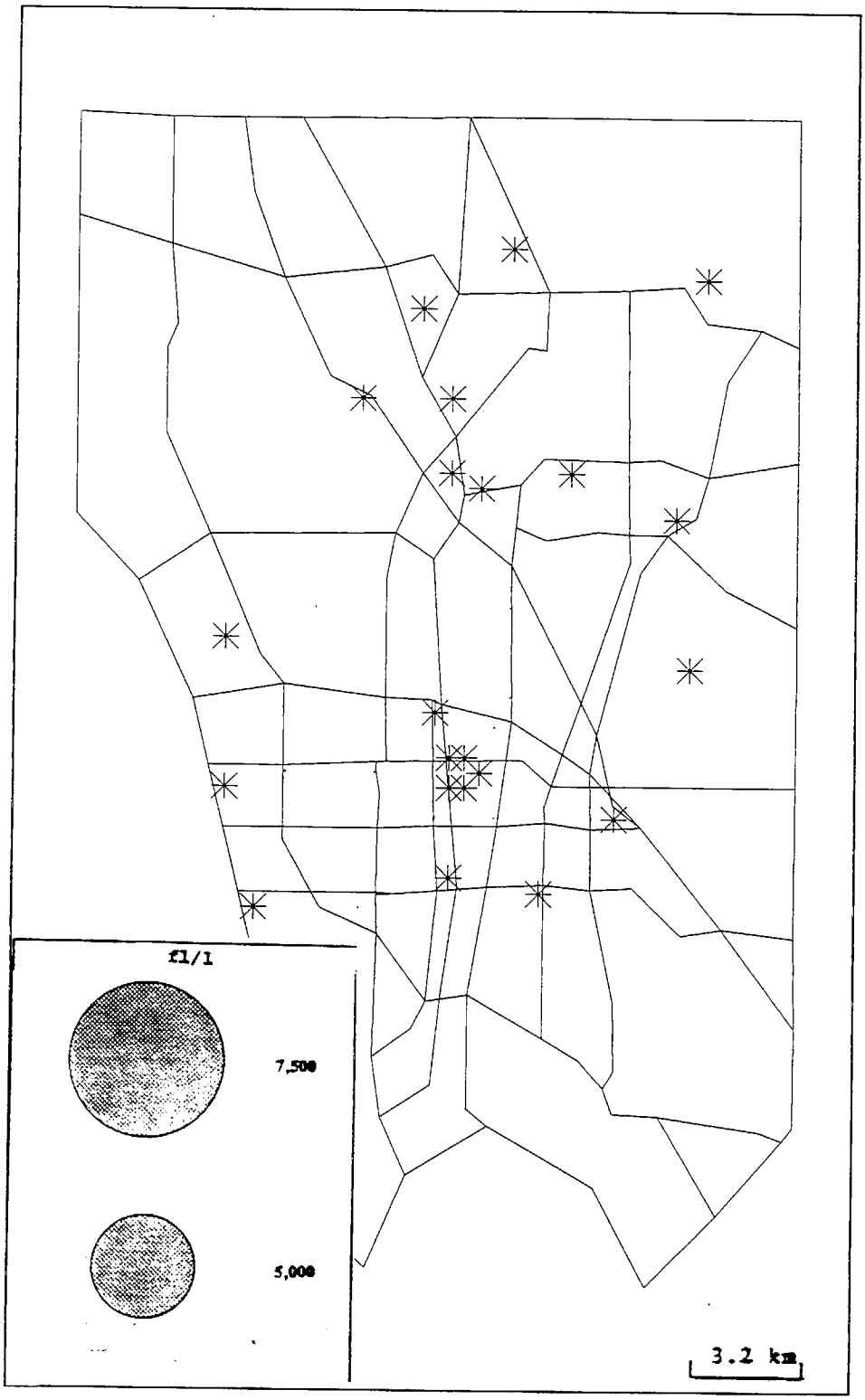

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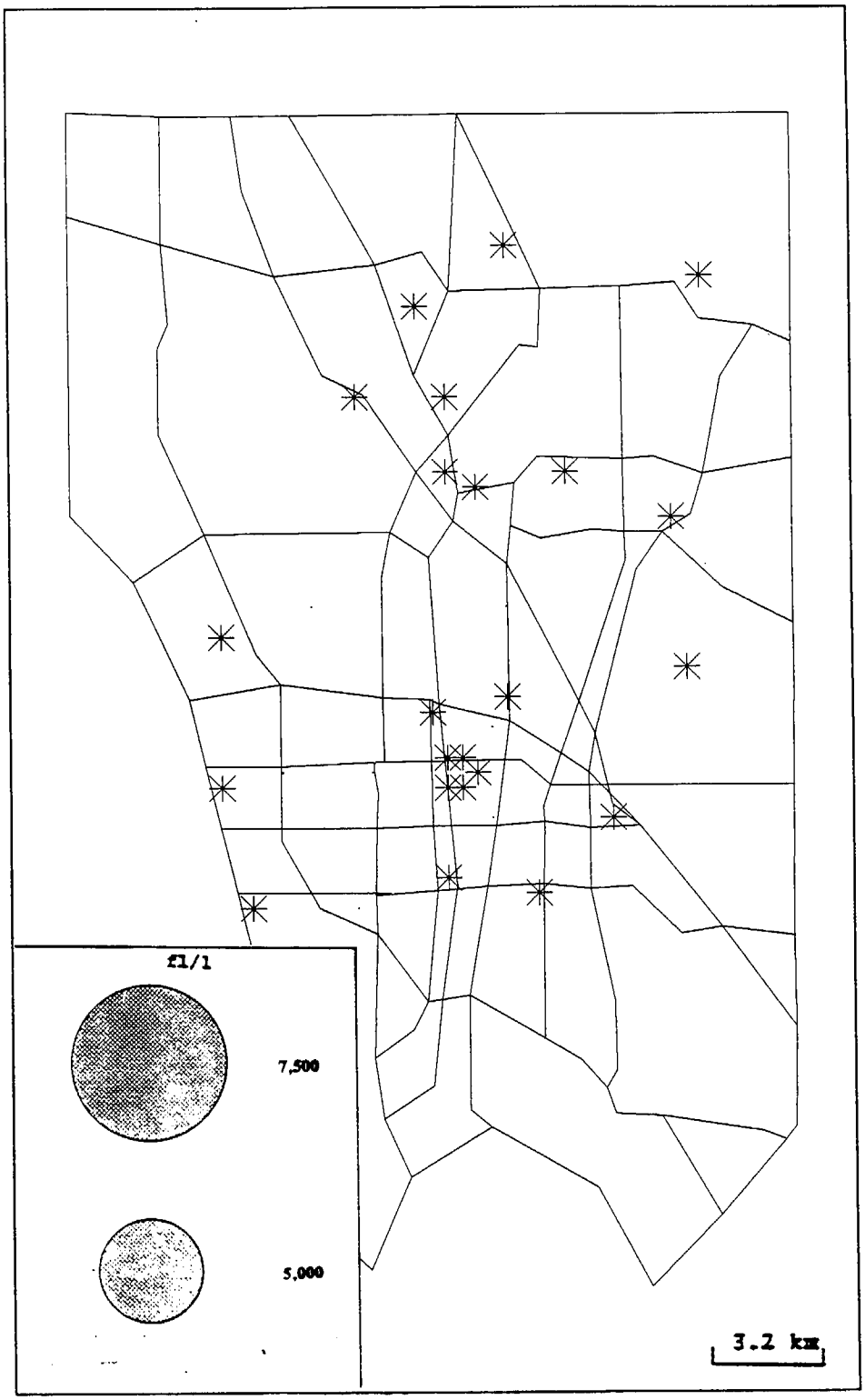

TB 01/09/1990 18:00

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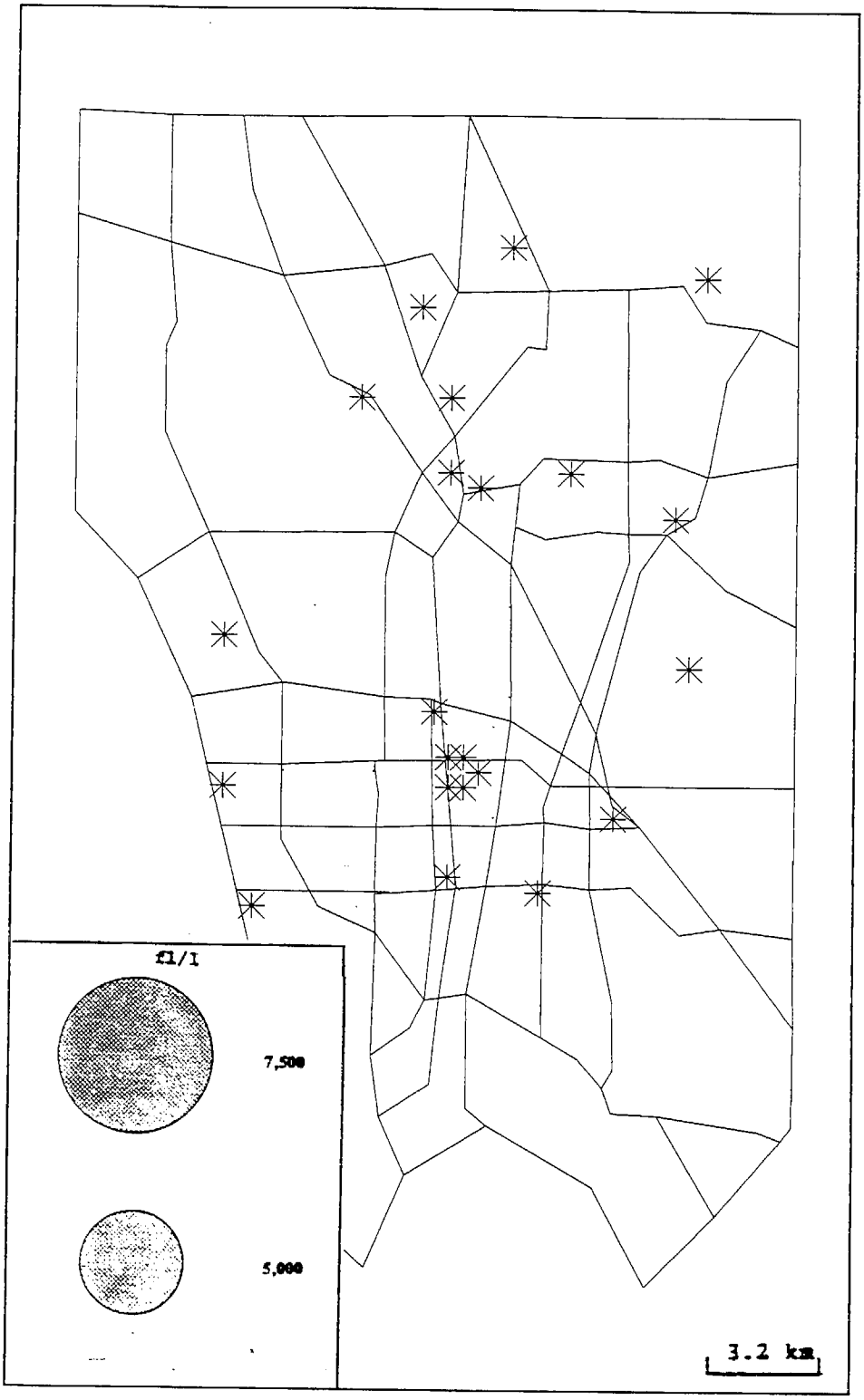

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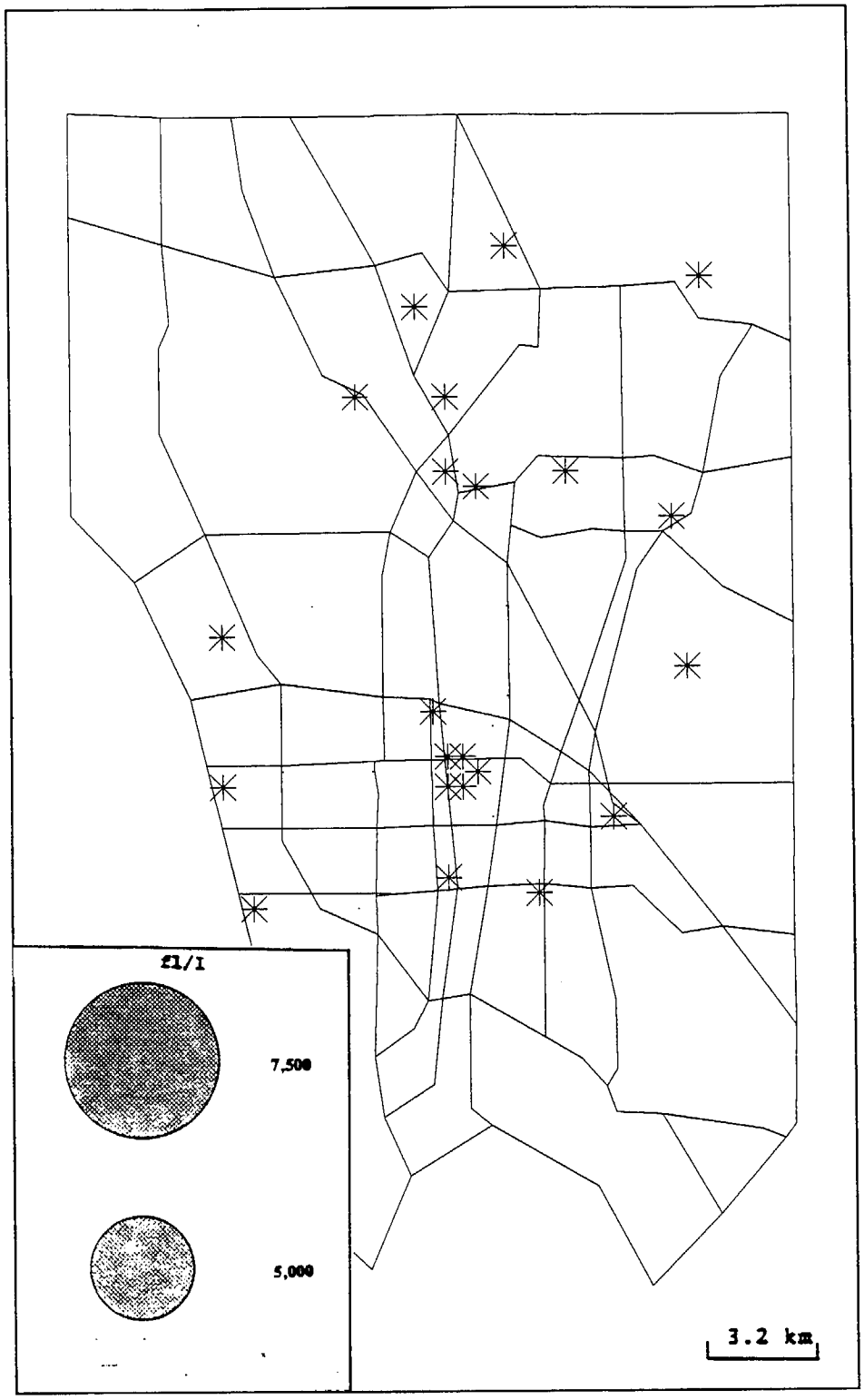

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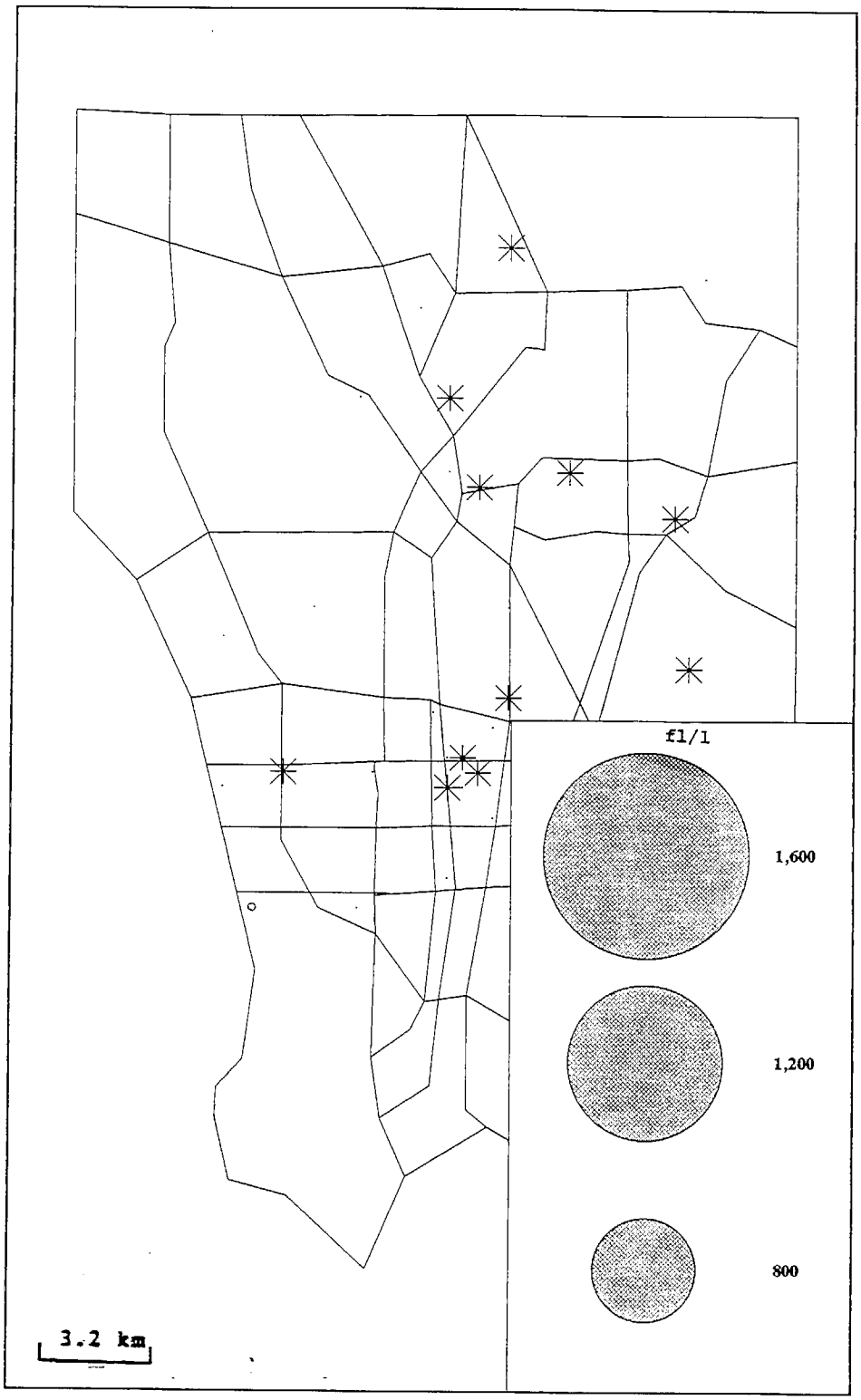

TC 12/19/1989 12:00

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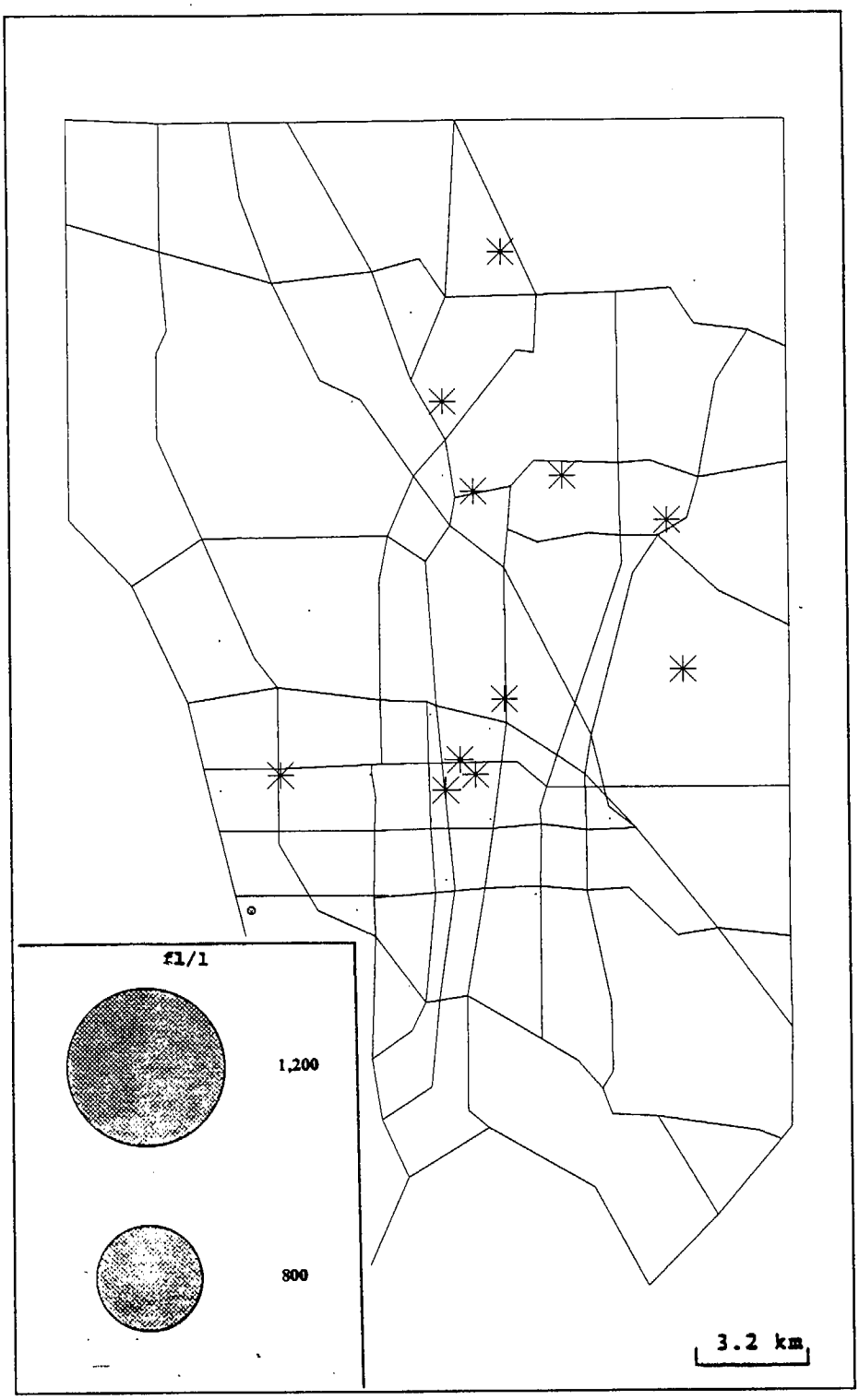

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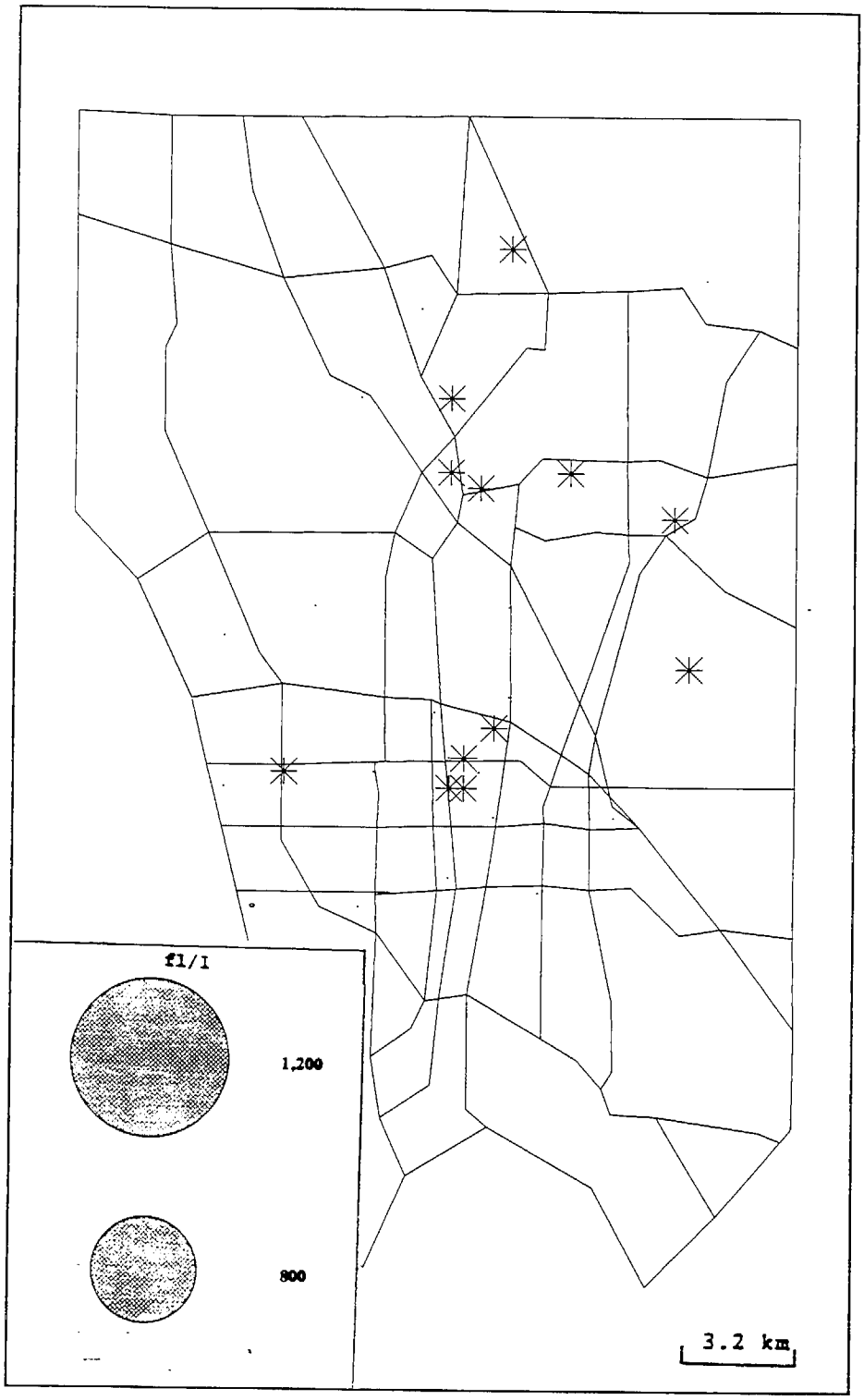

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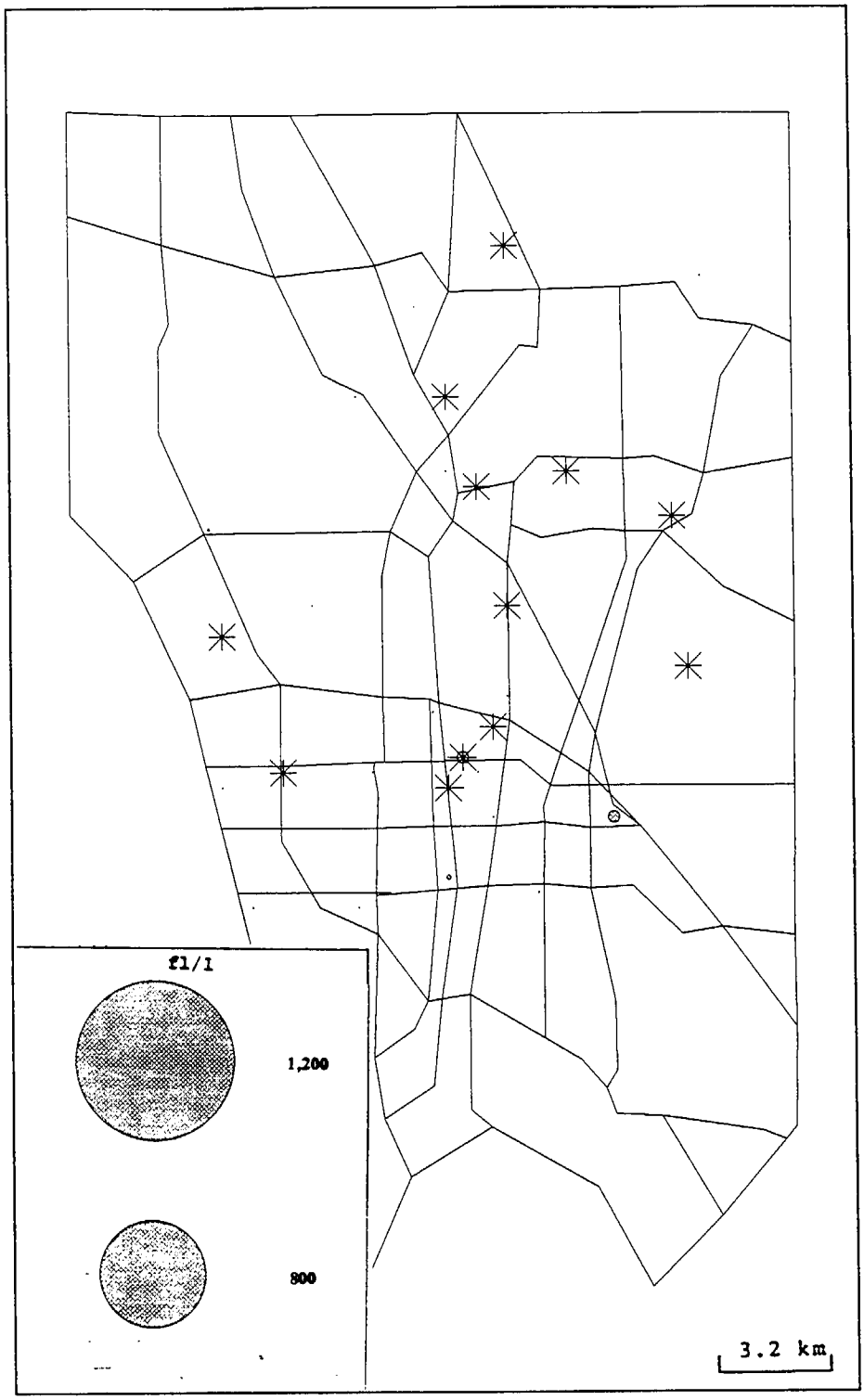

TC 12/19/1989 16:00

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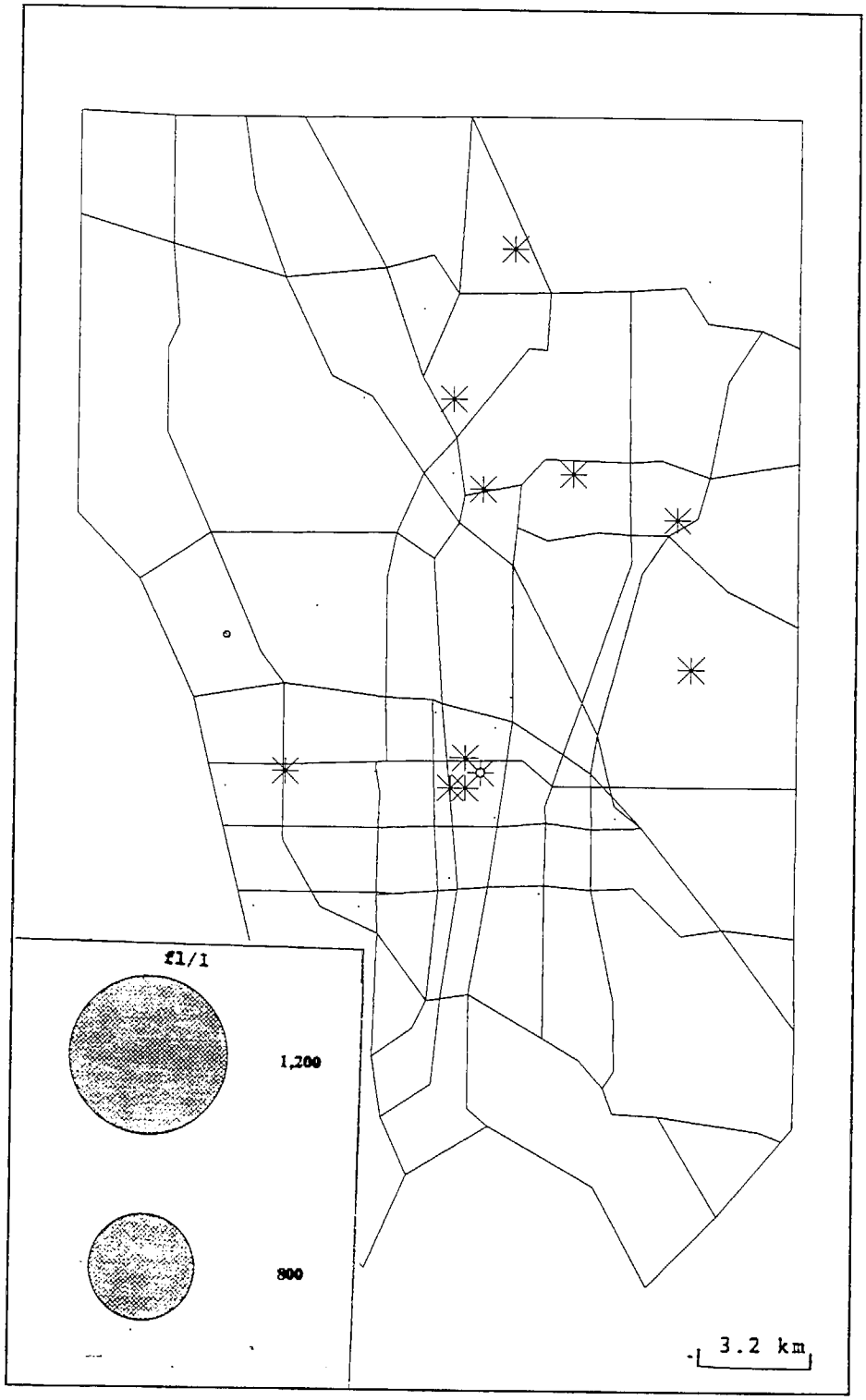

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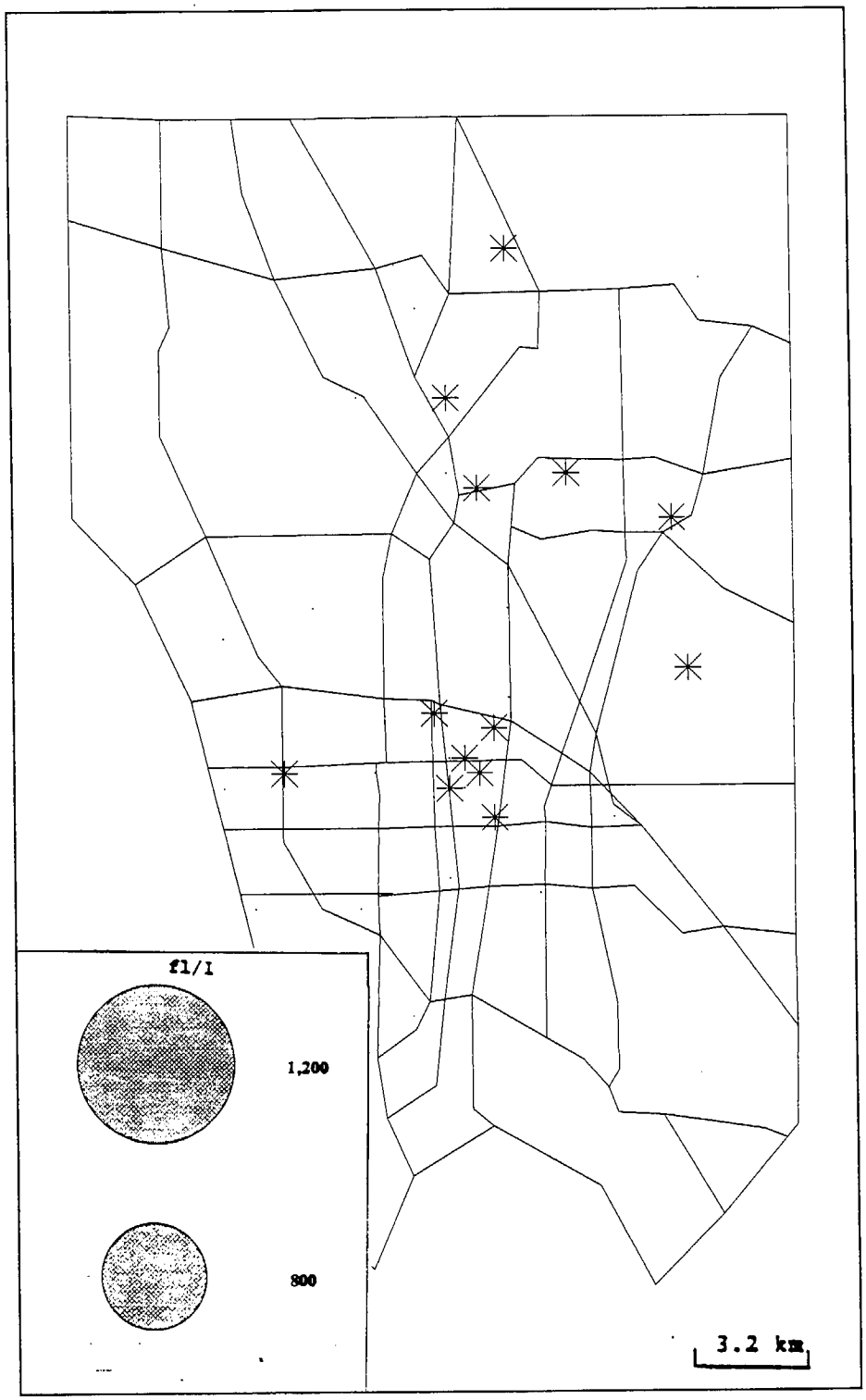

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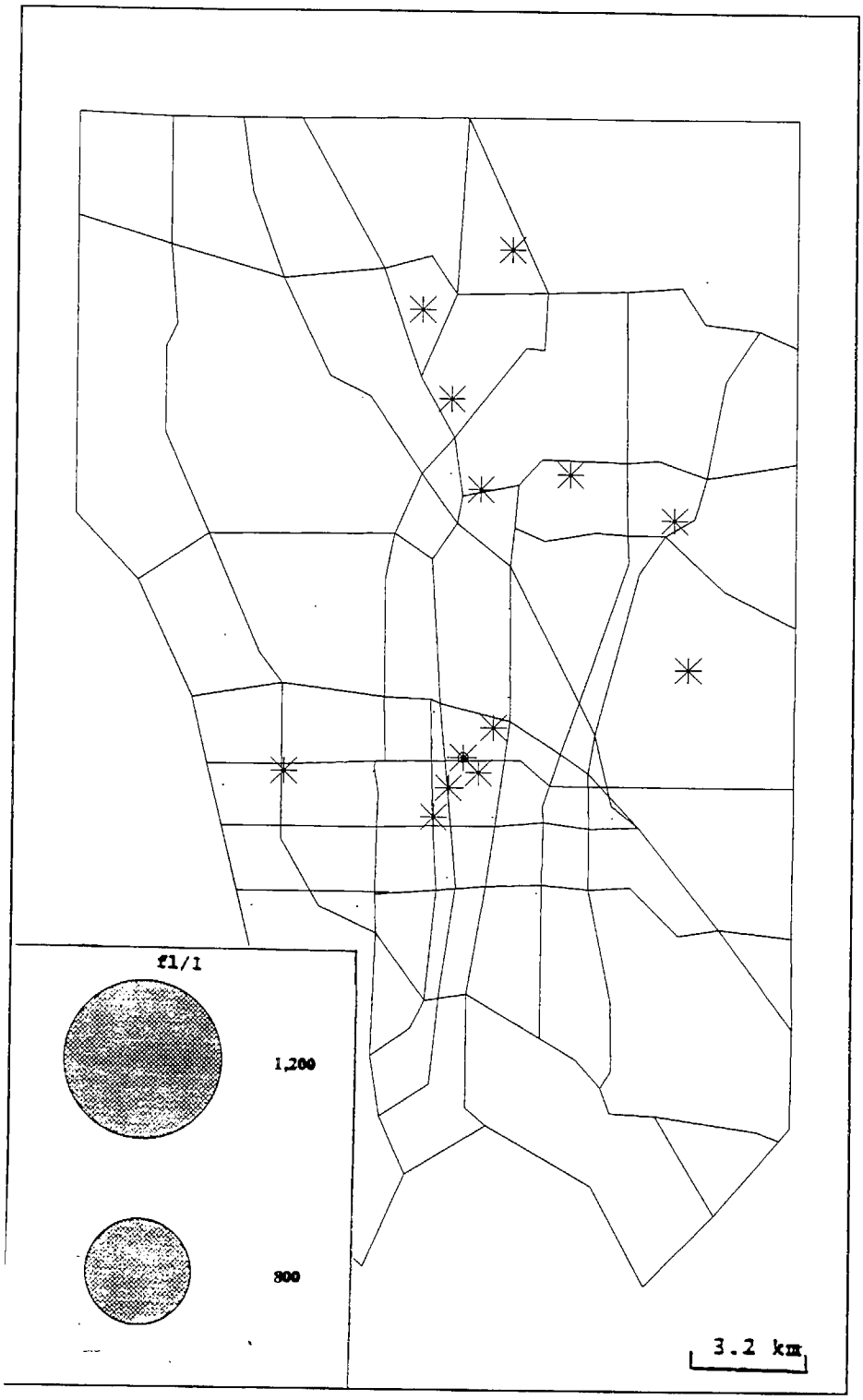

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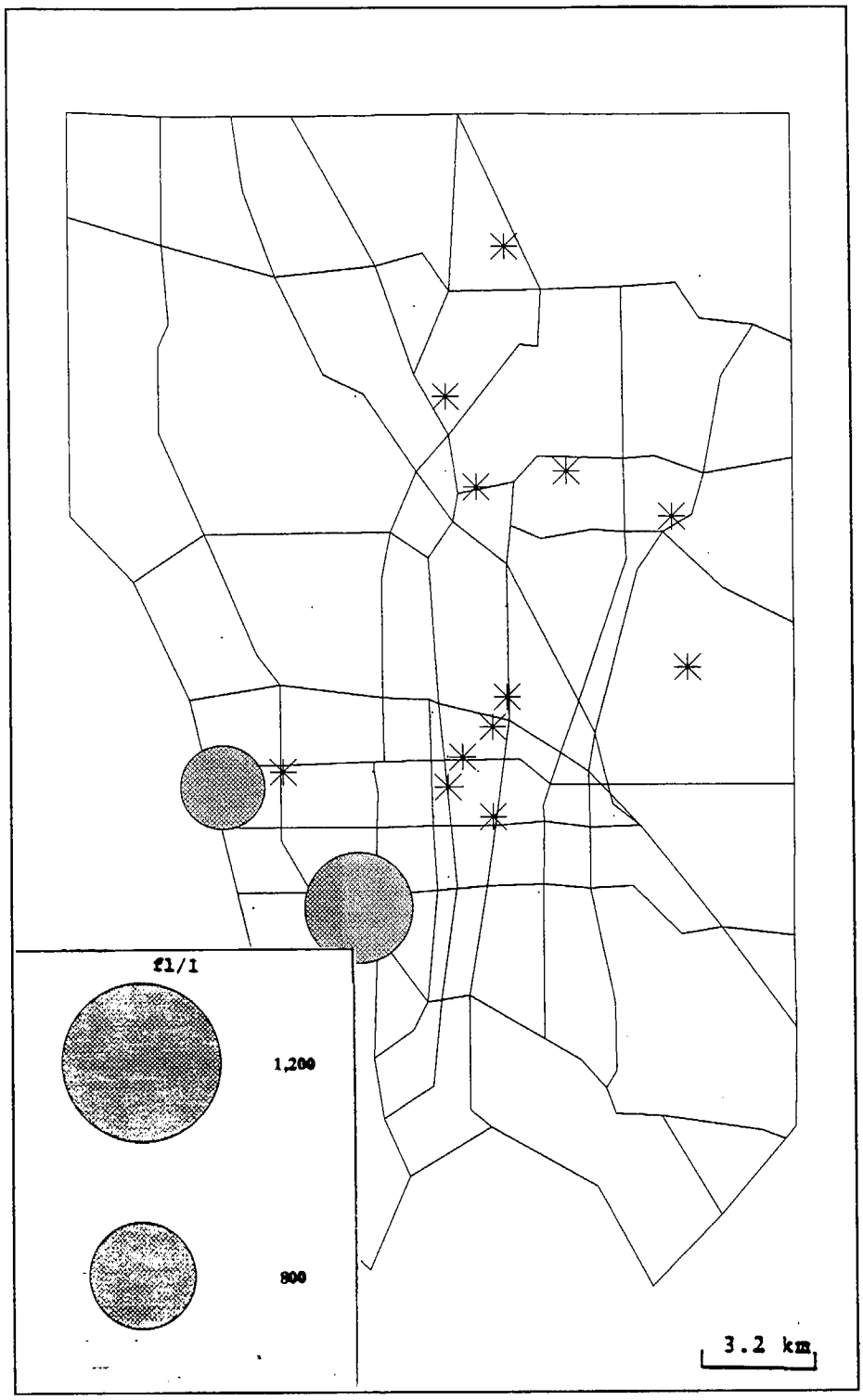

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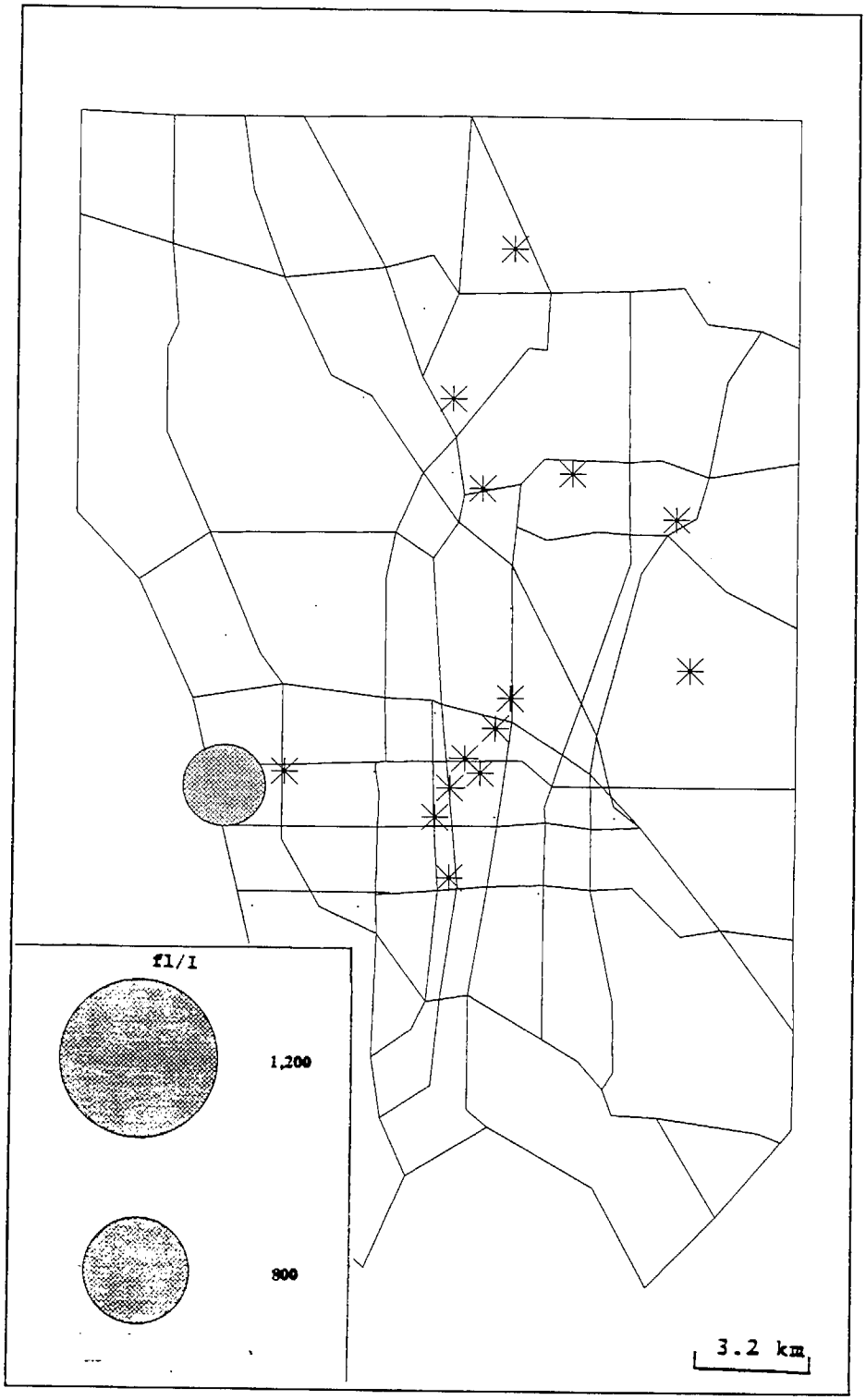

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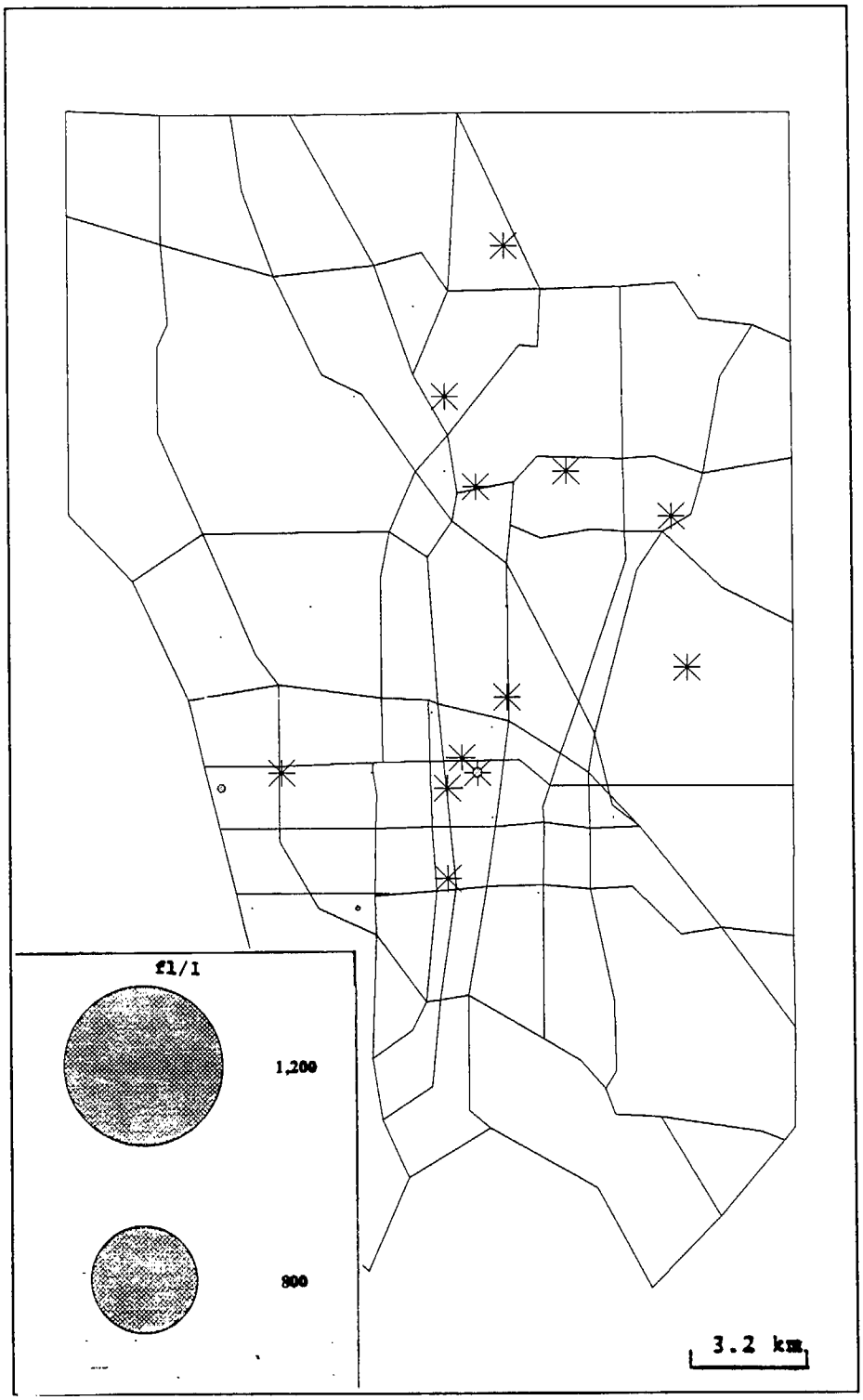

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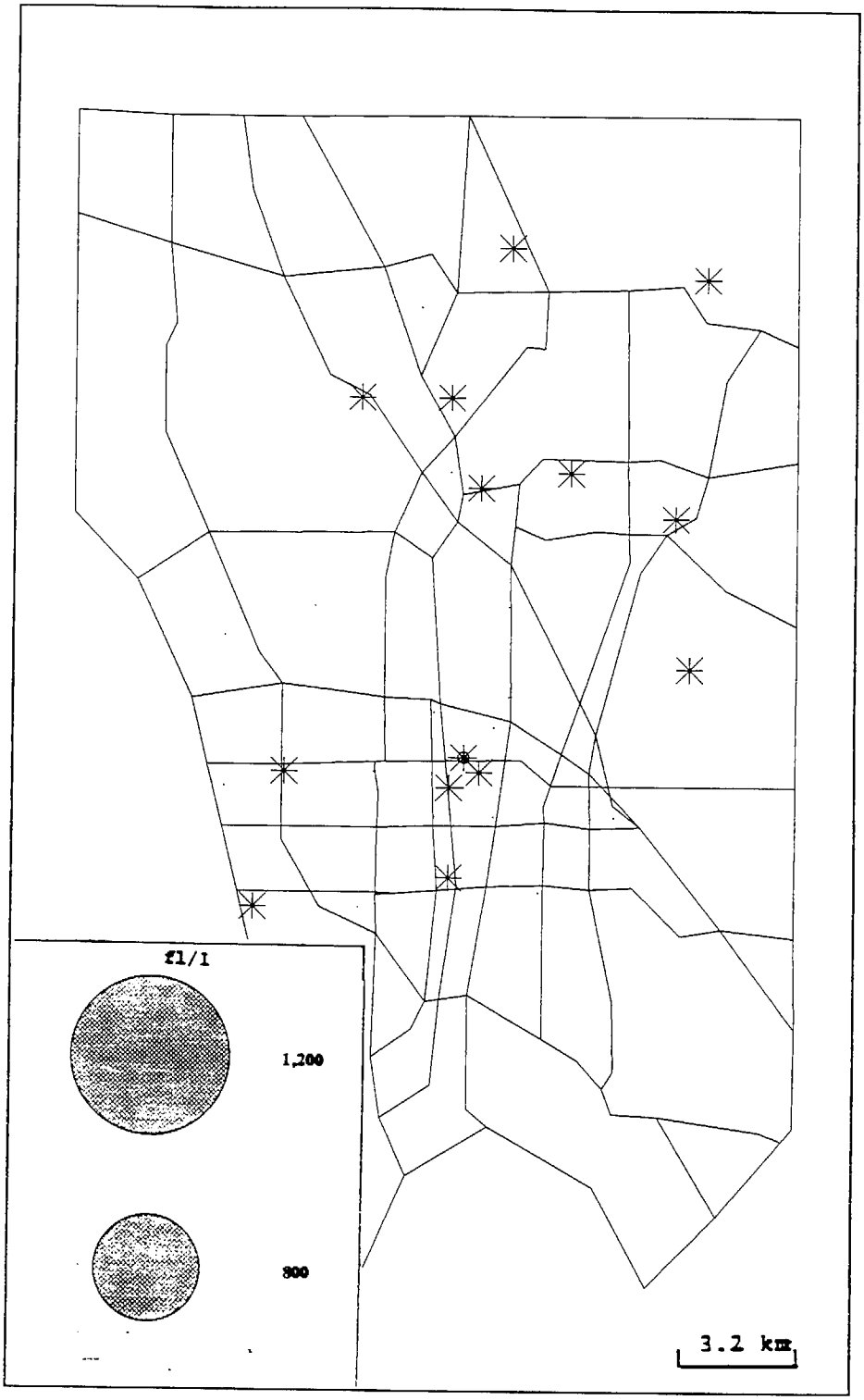

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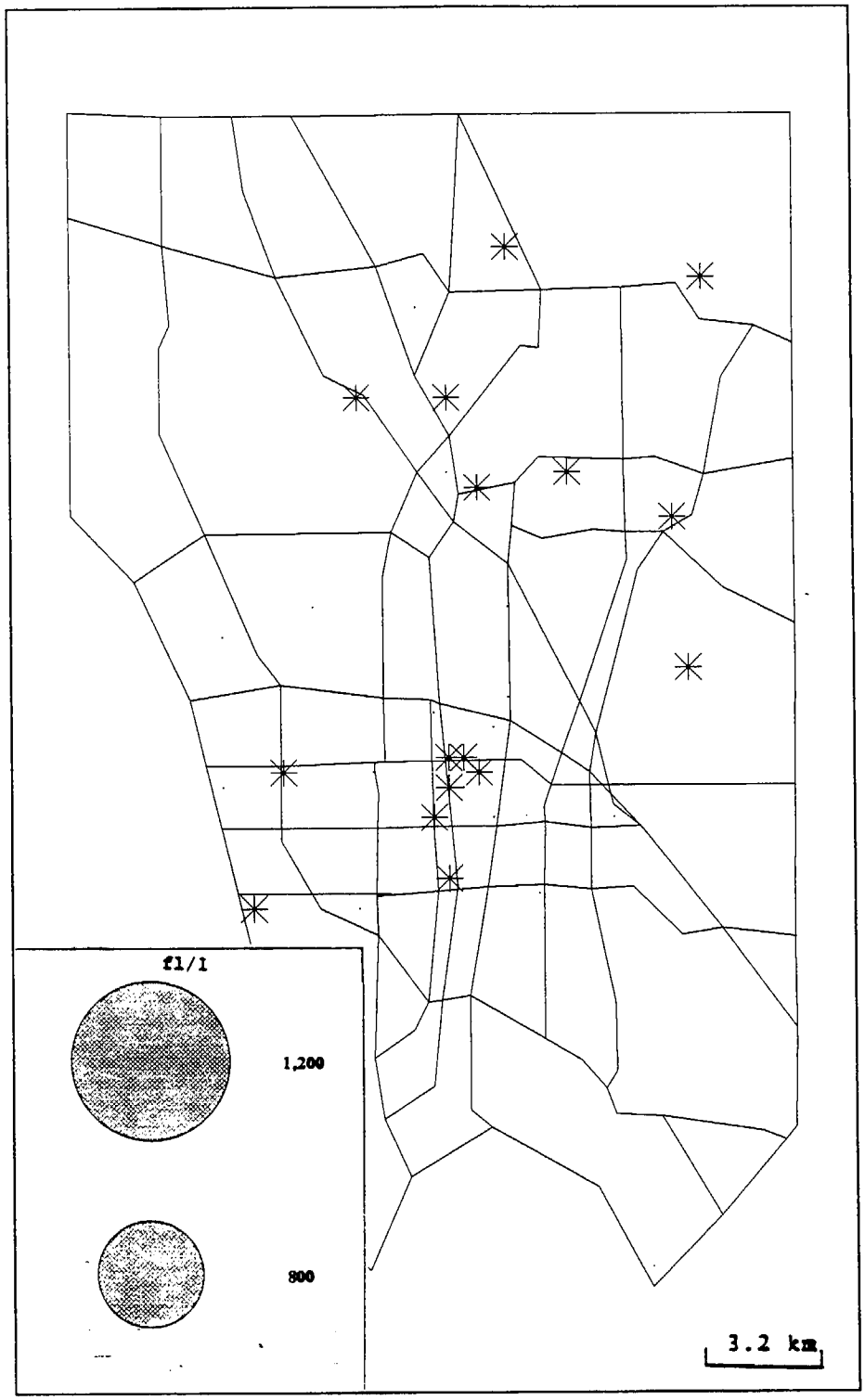

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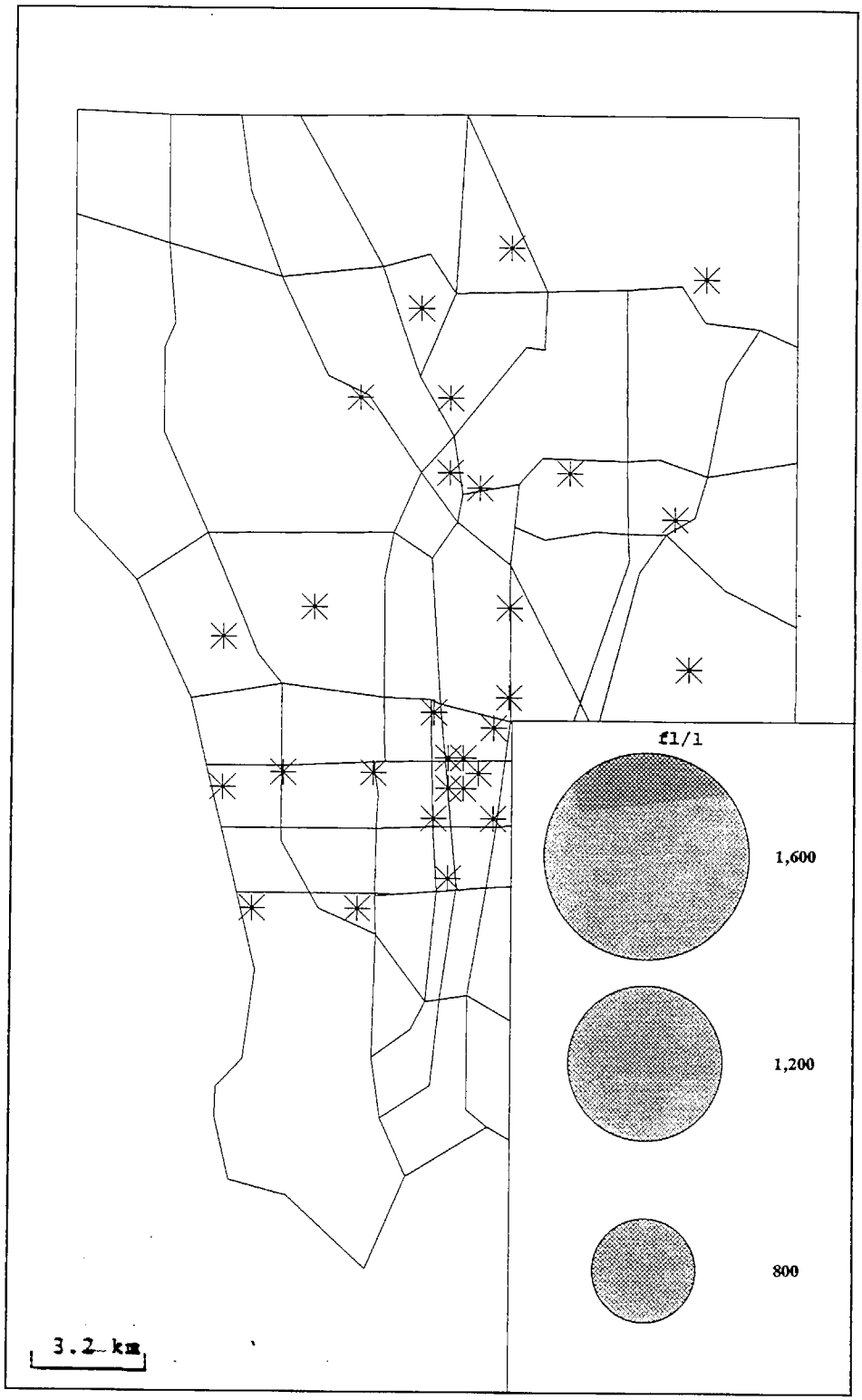

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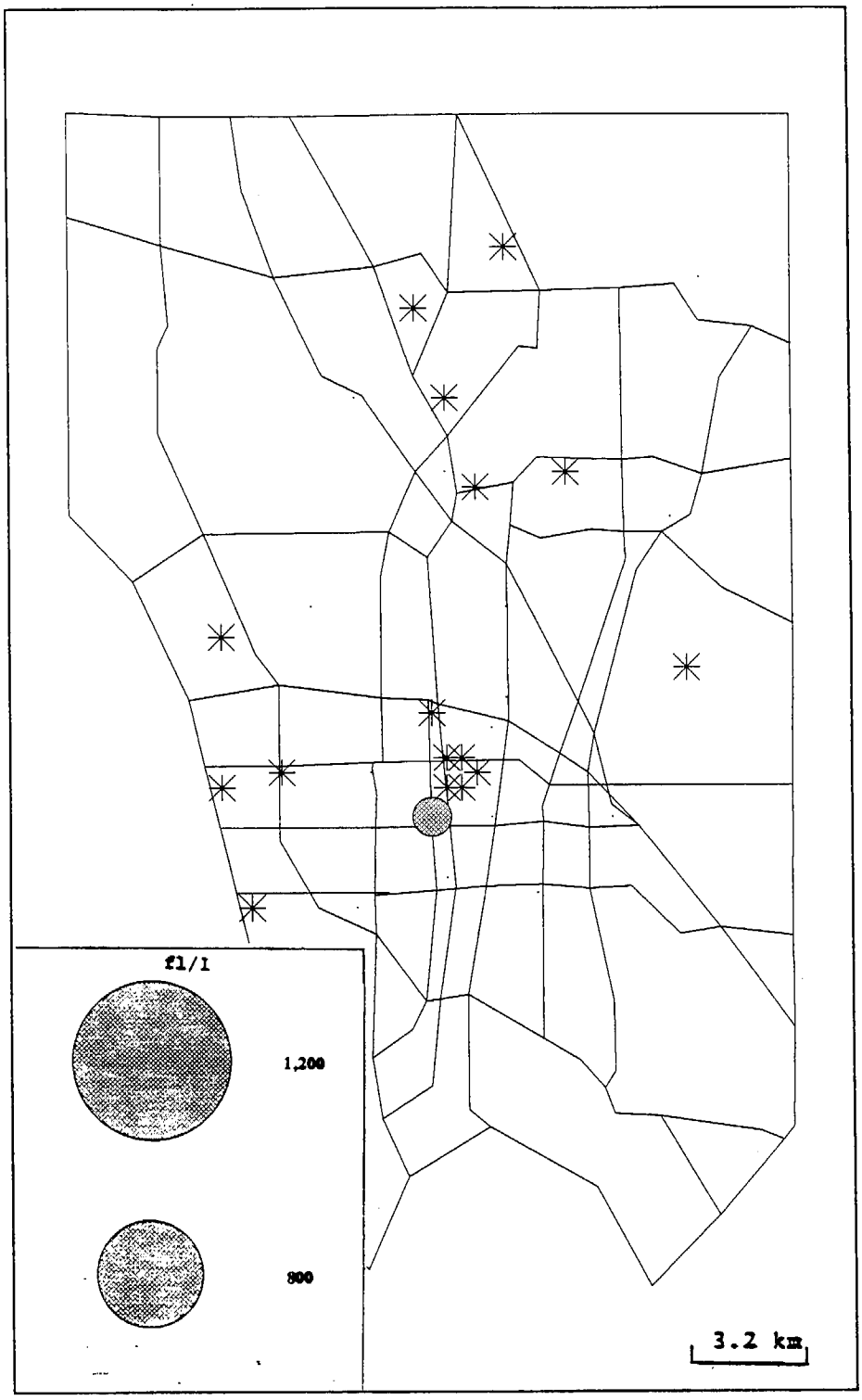

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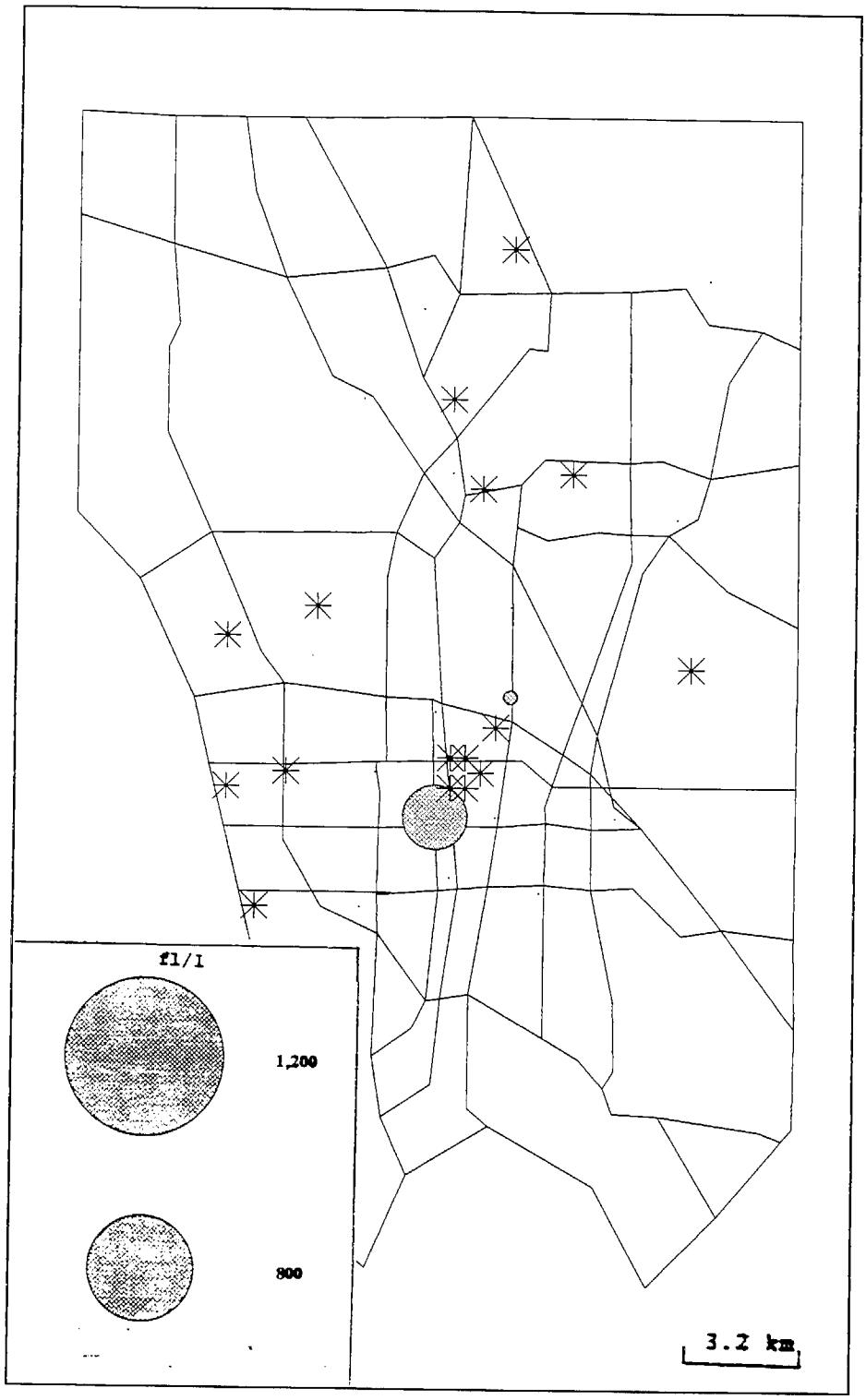

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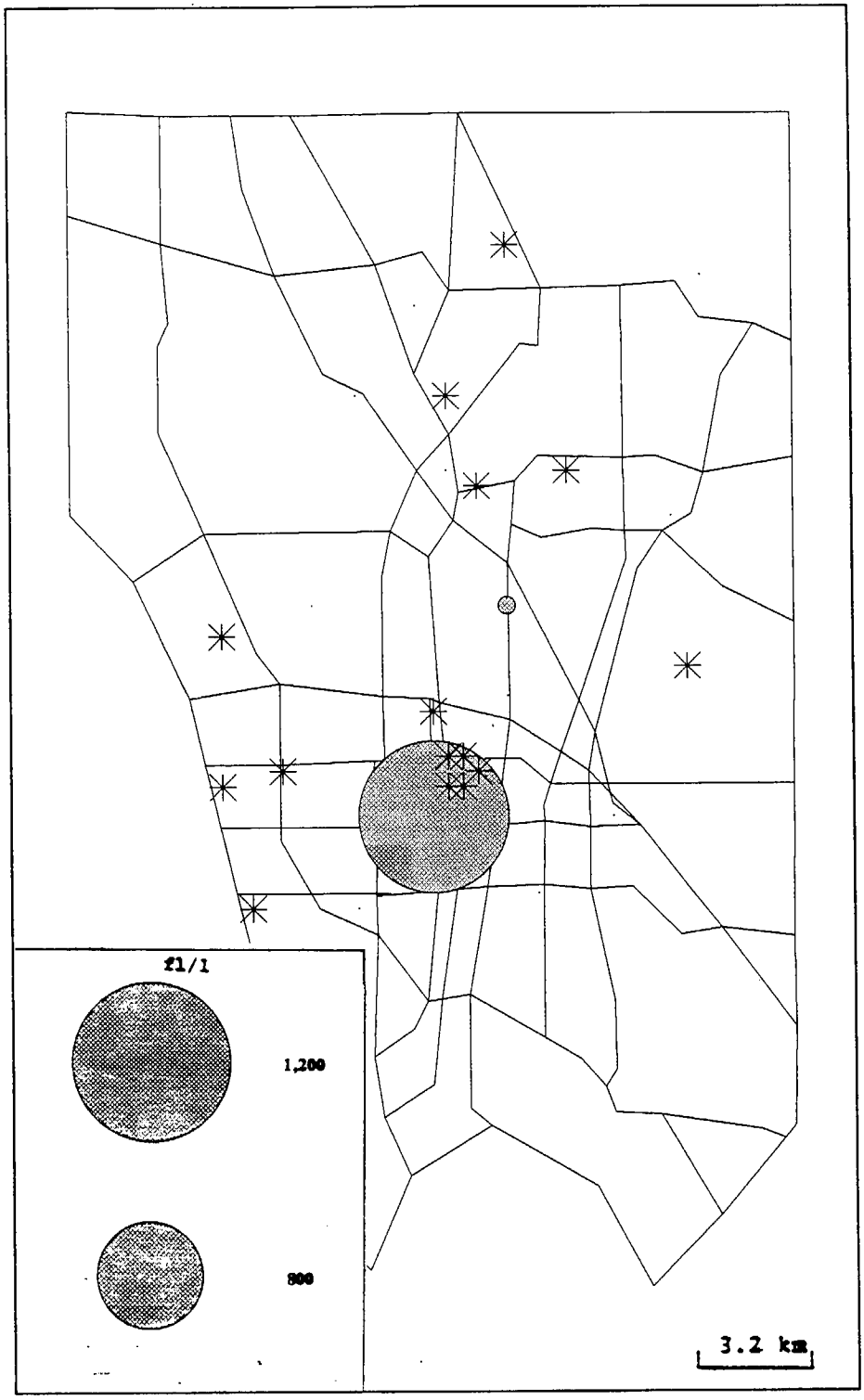

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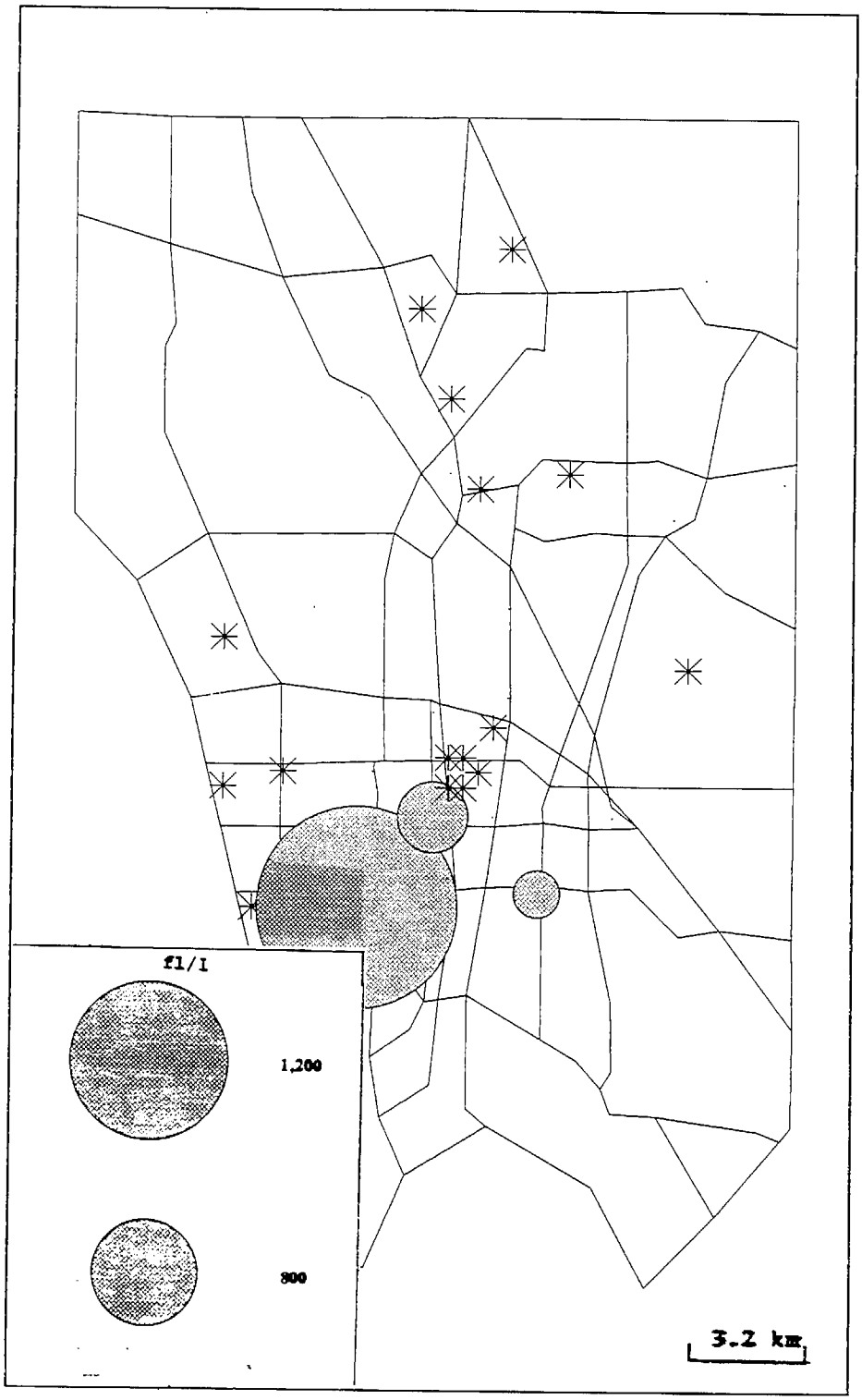

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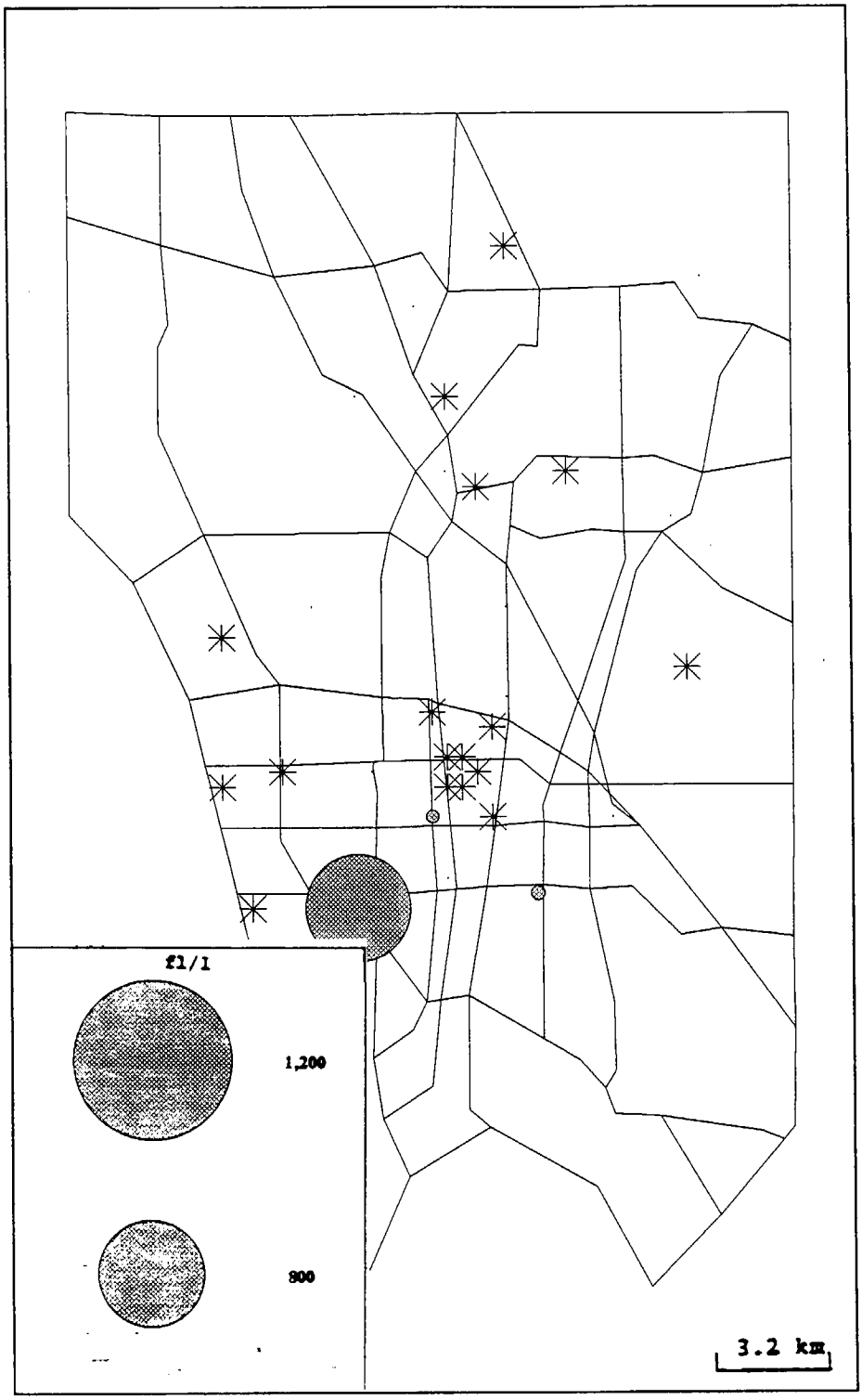

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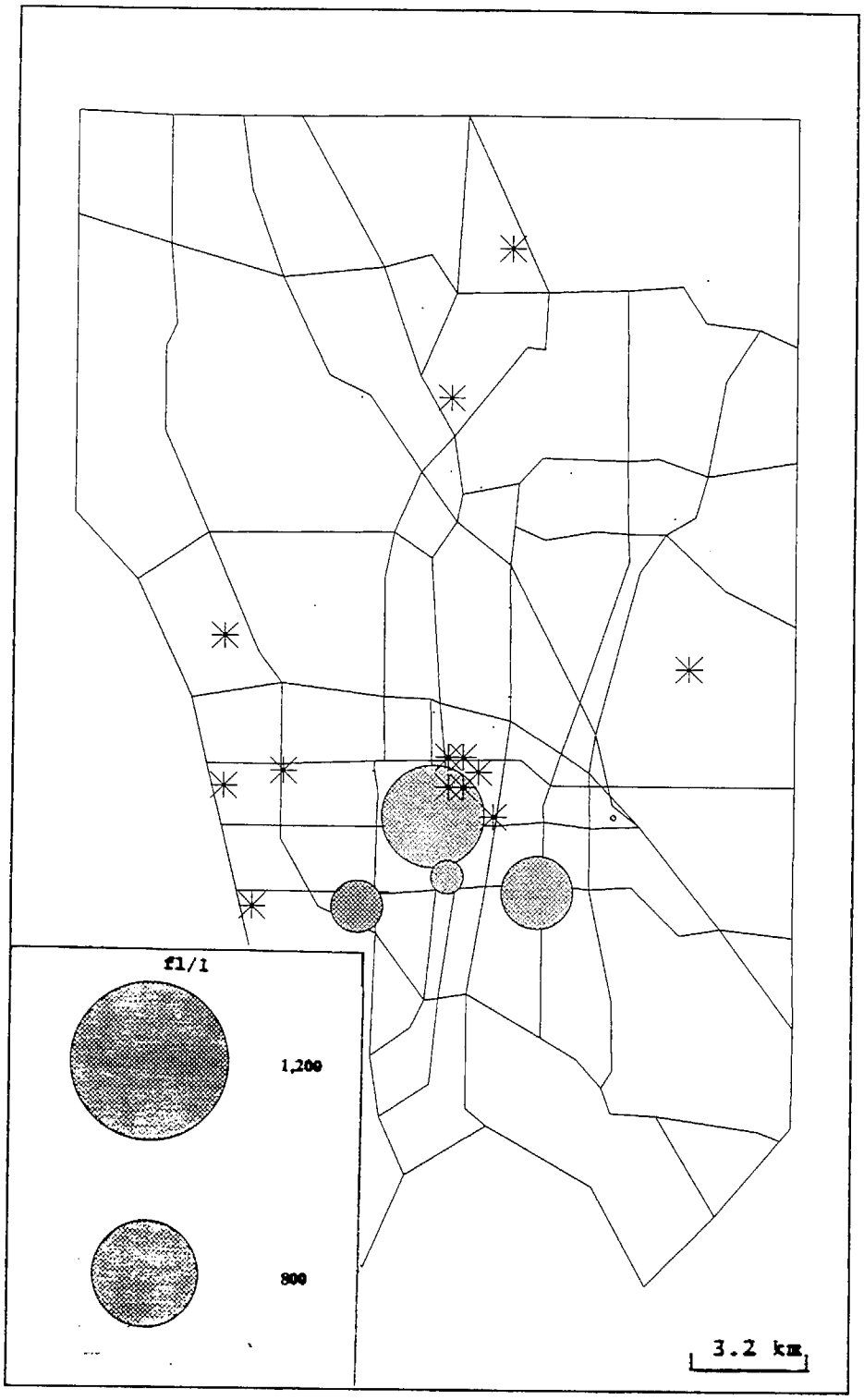

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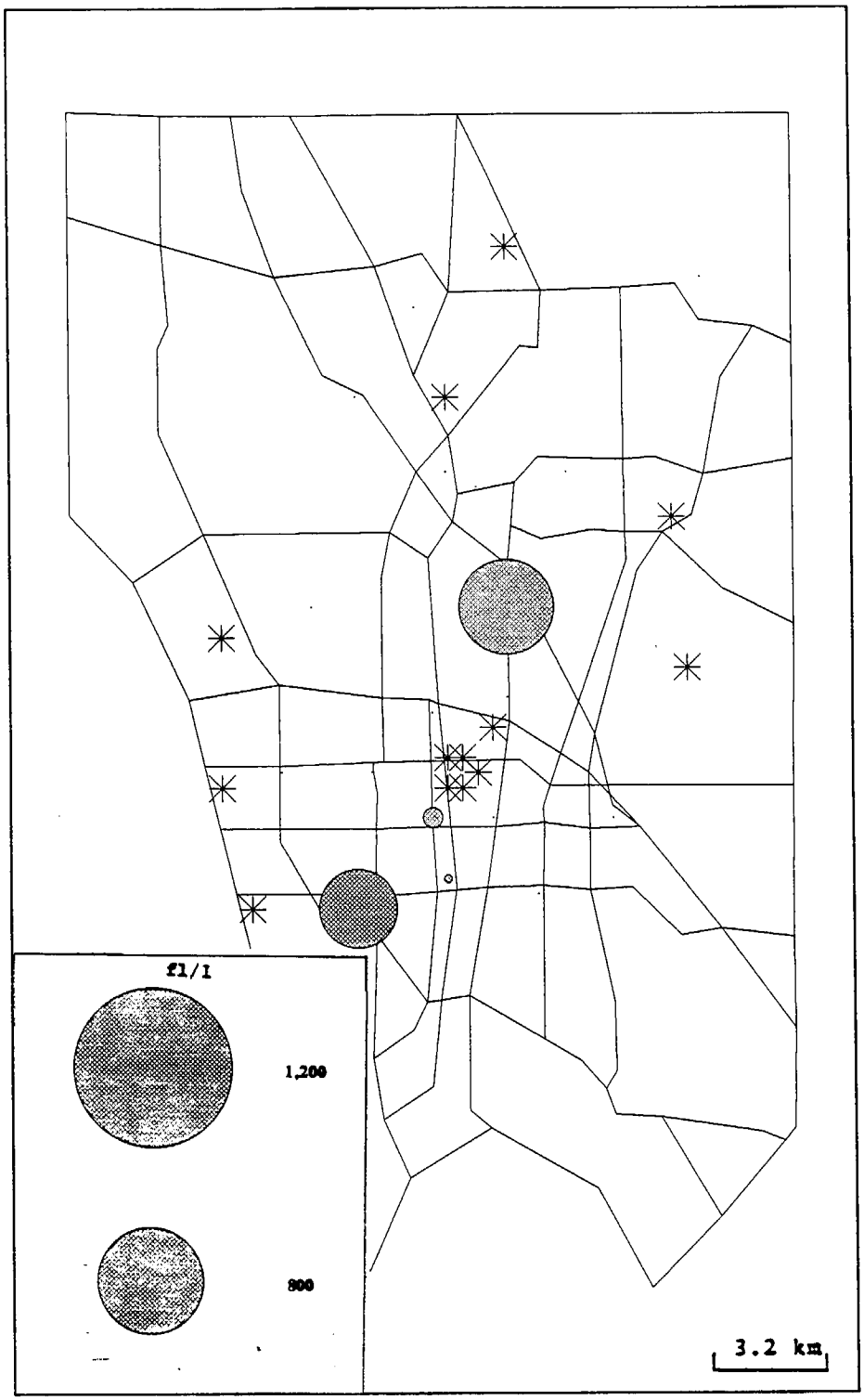

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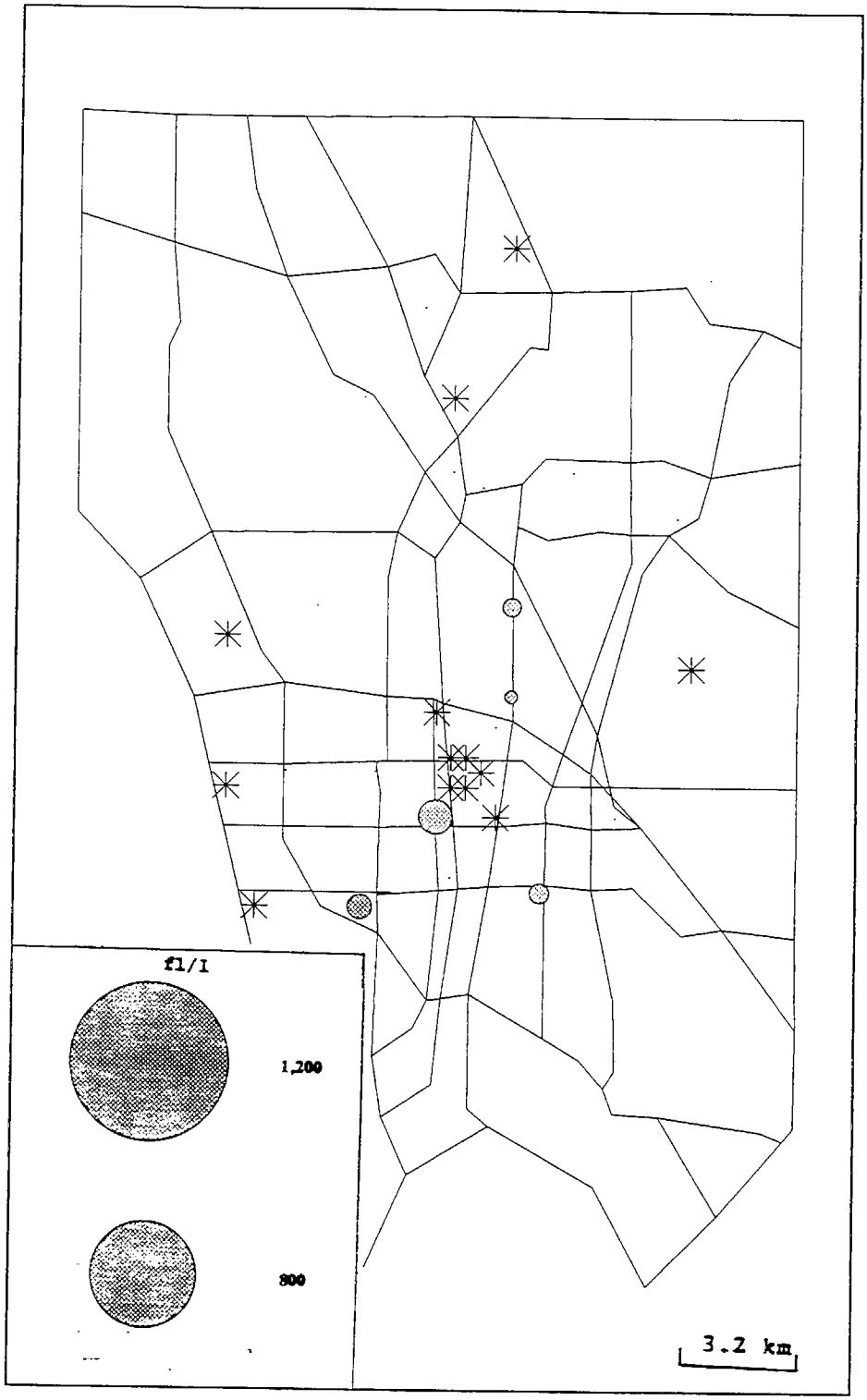

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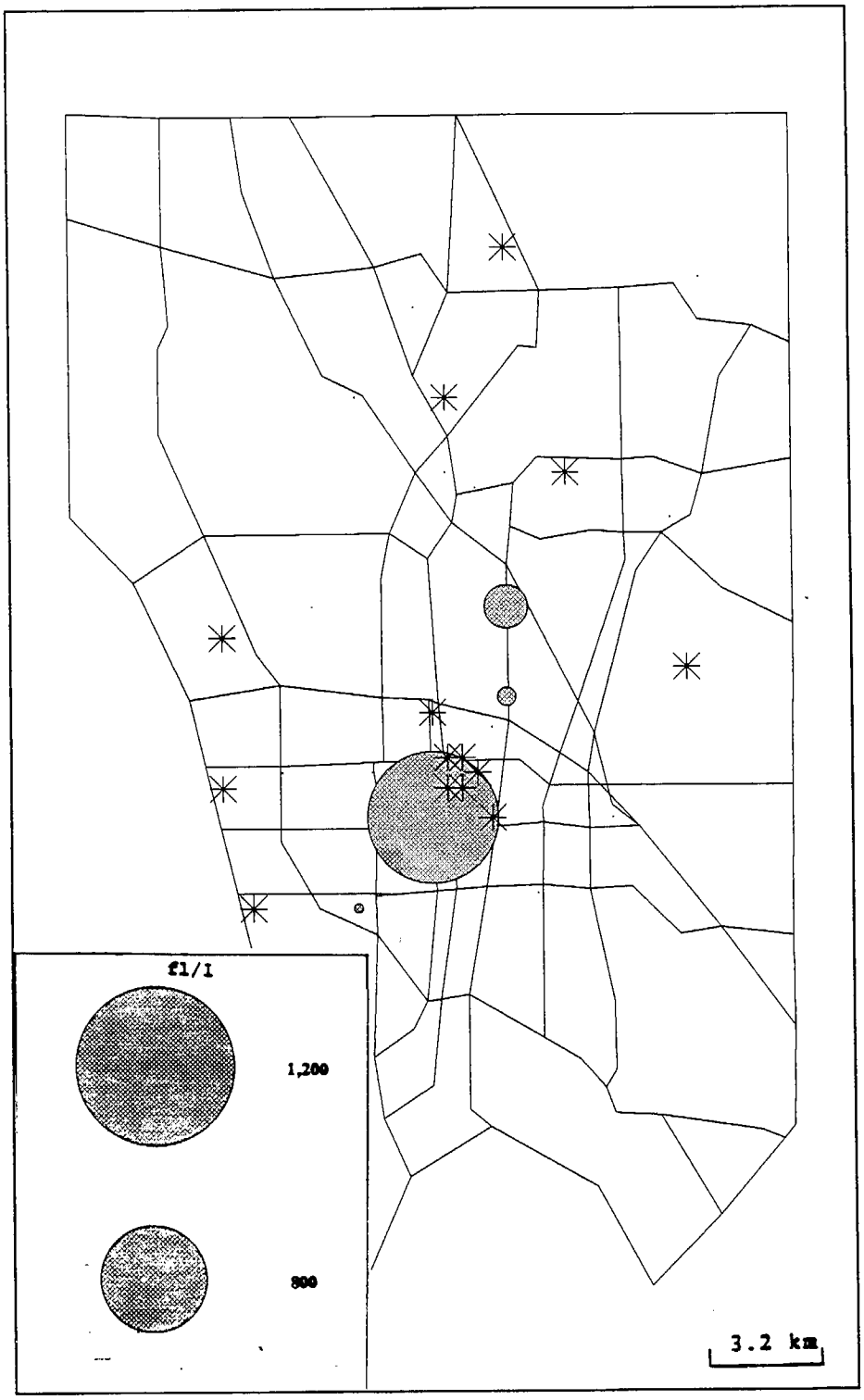

TC 01/09/1990 06:00

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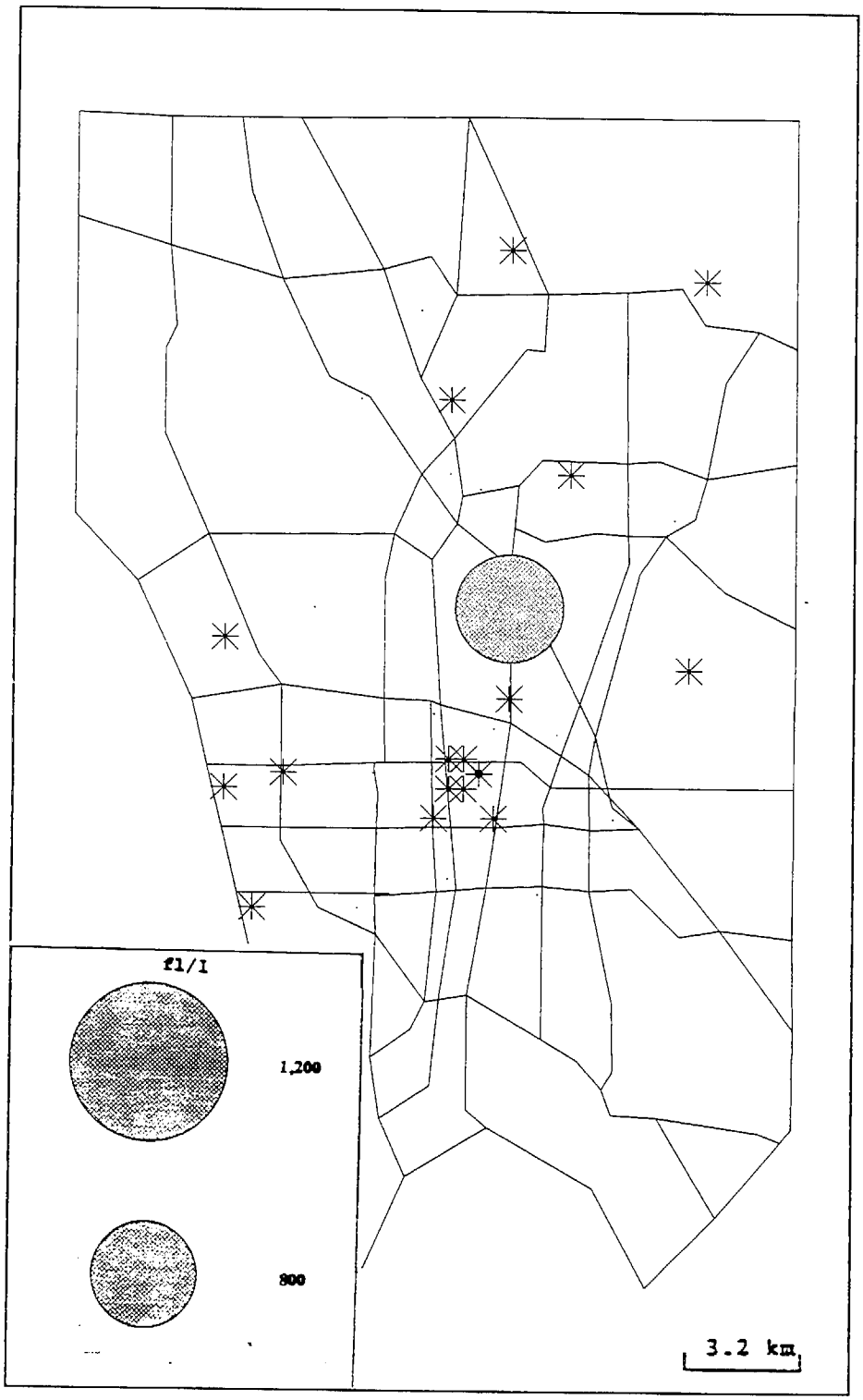

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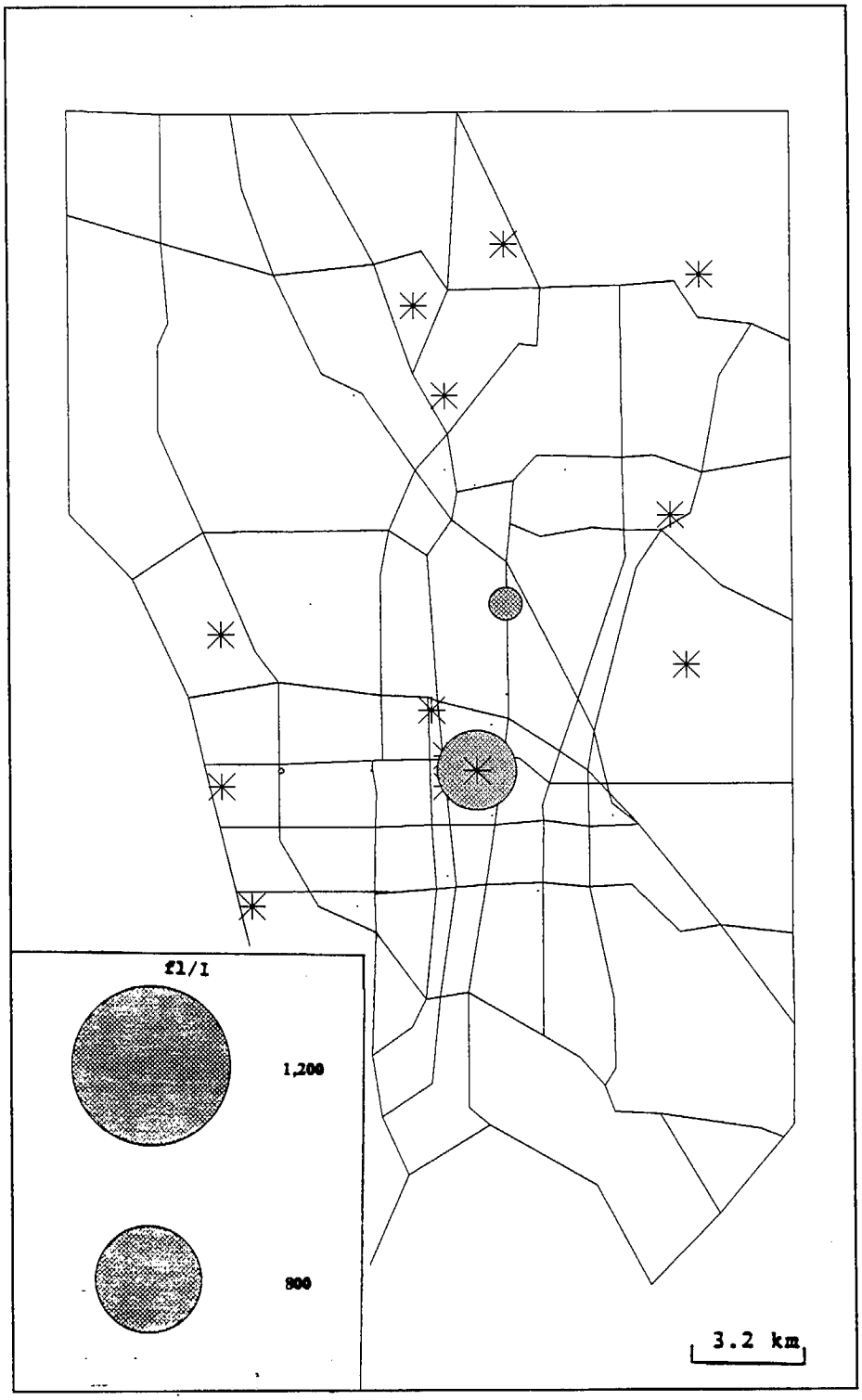

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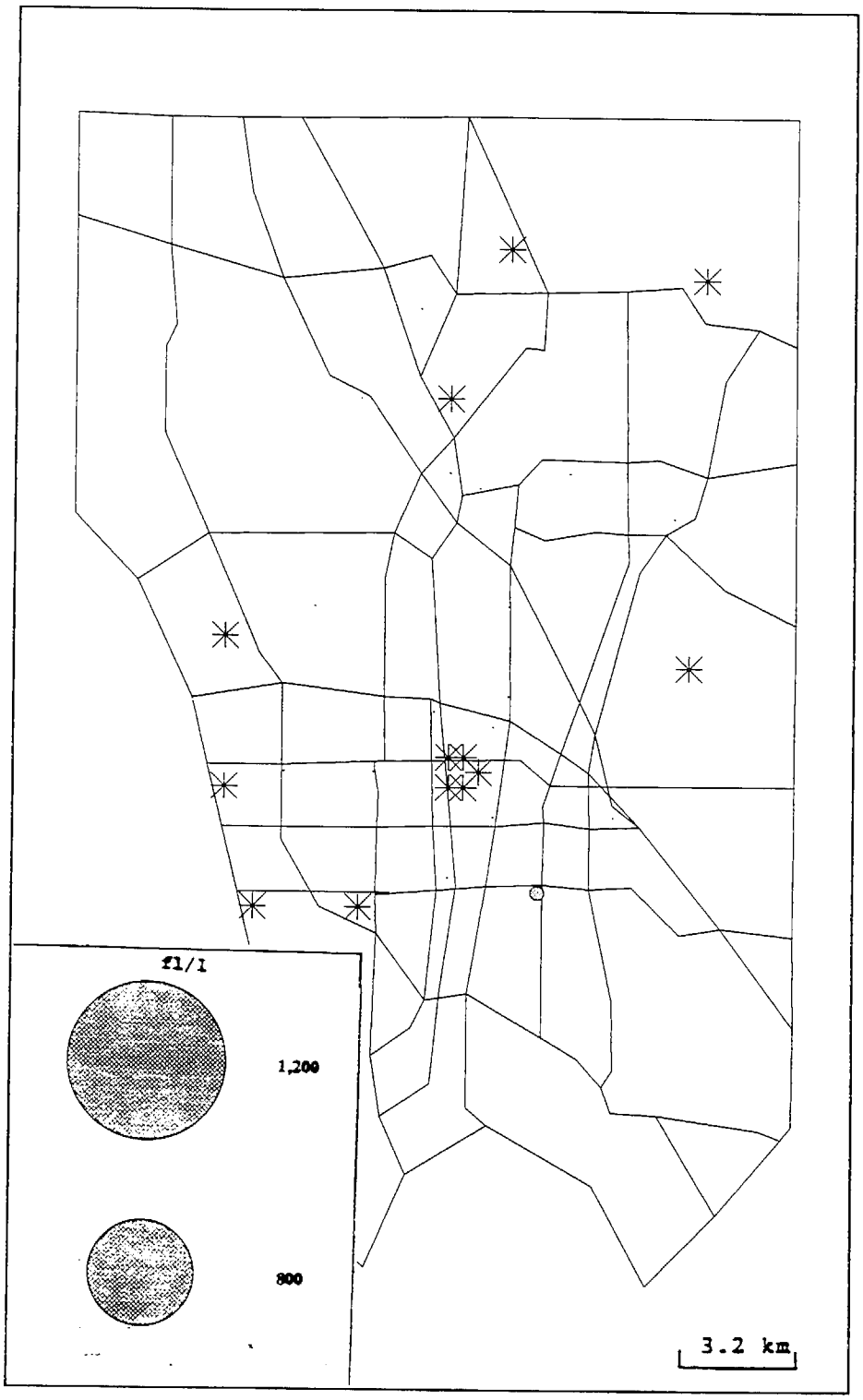

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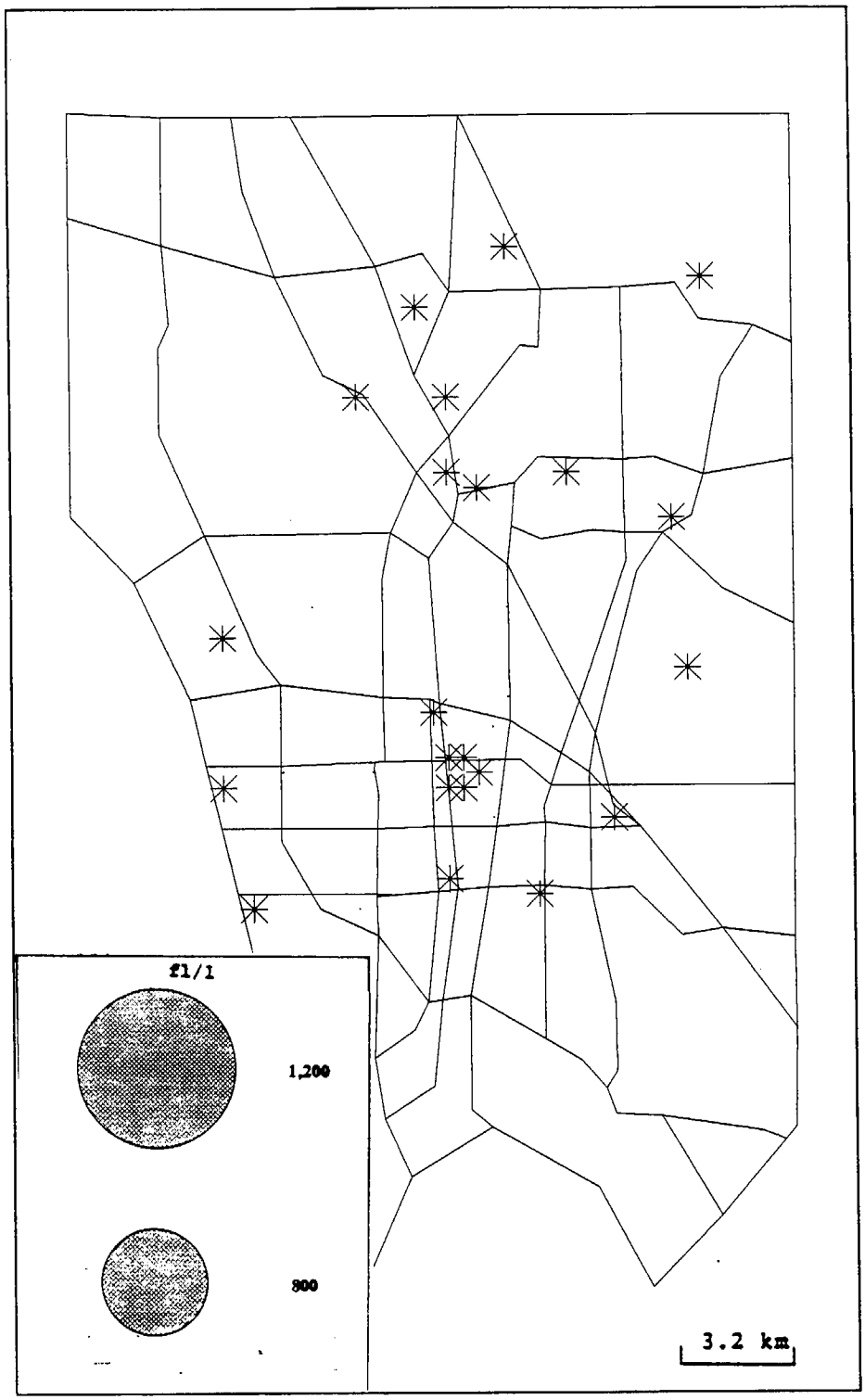

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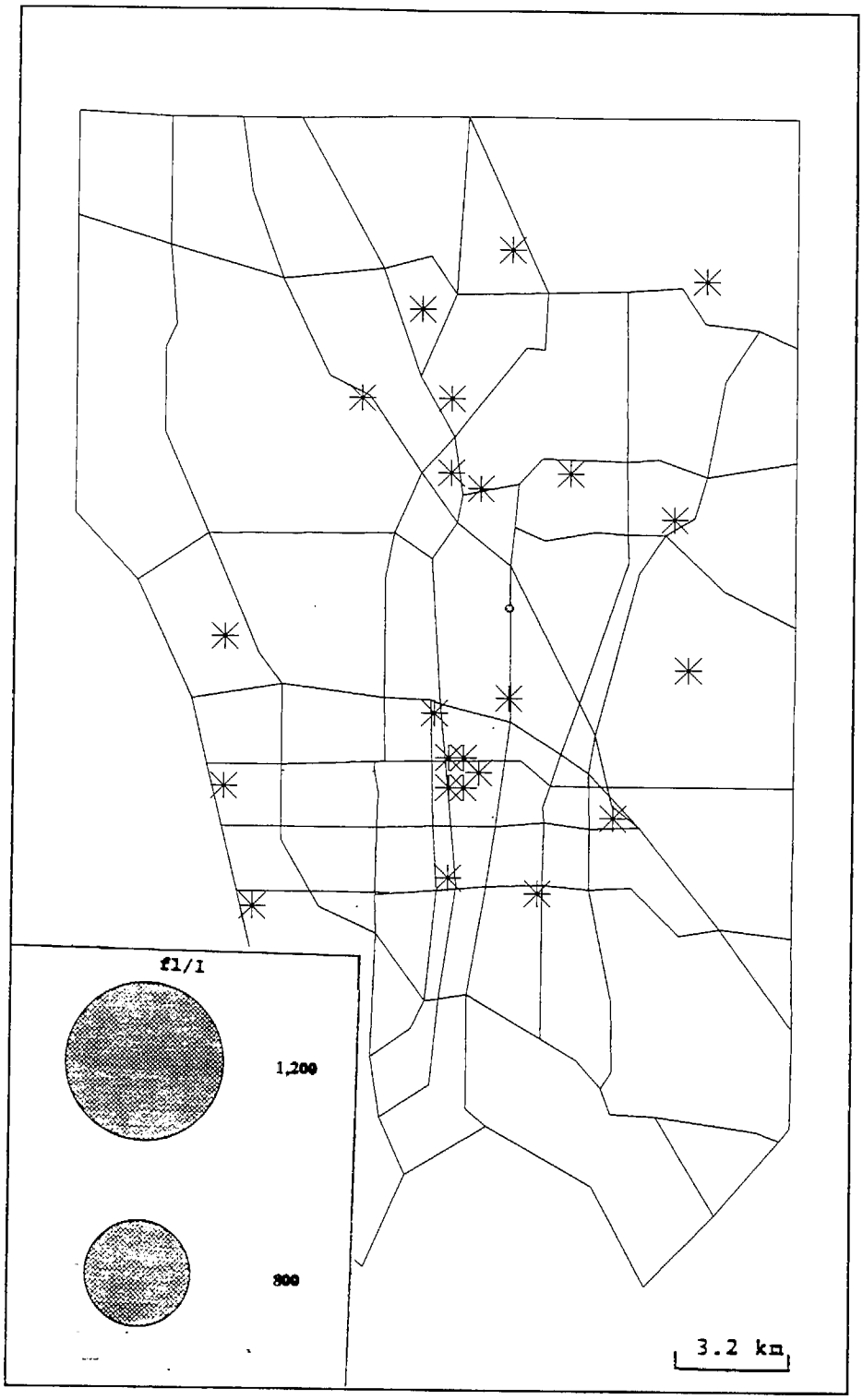

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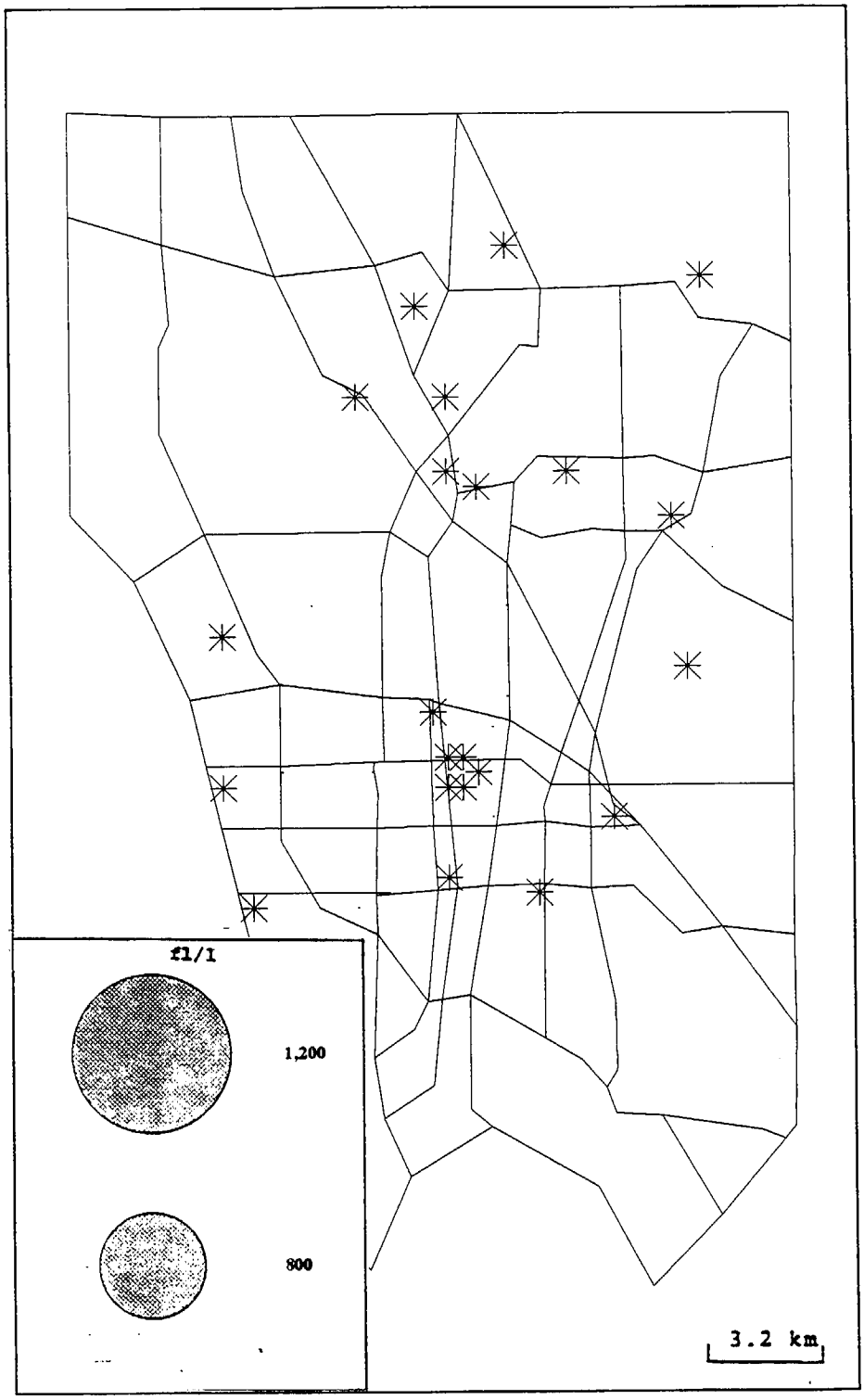

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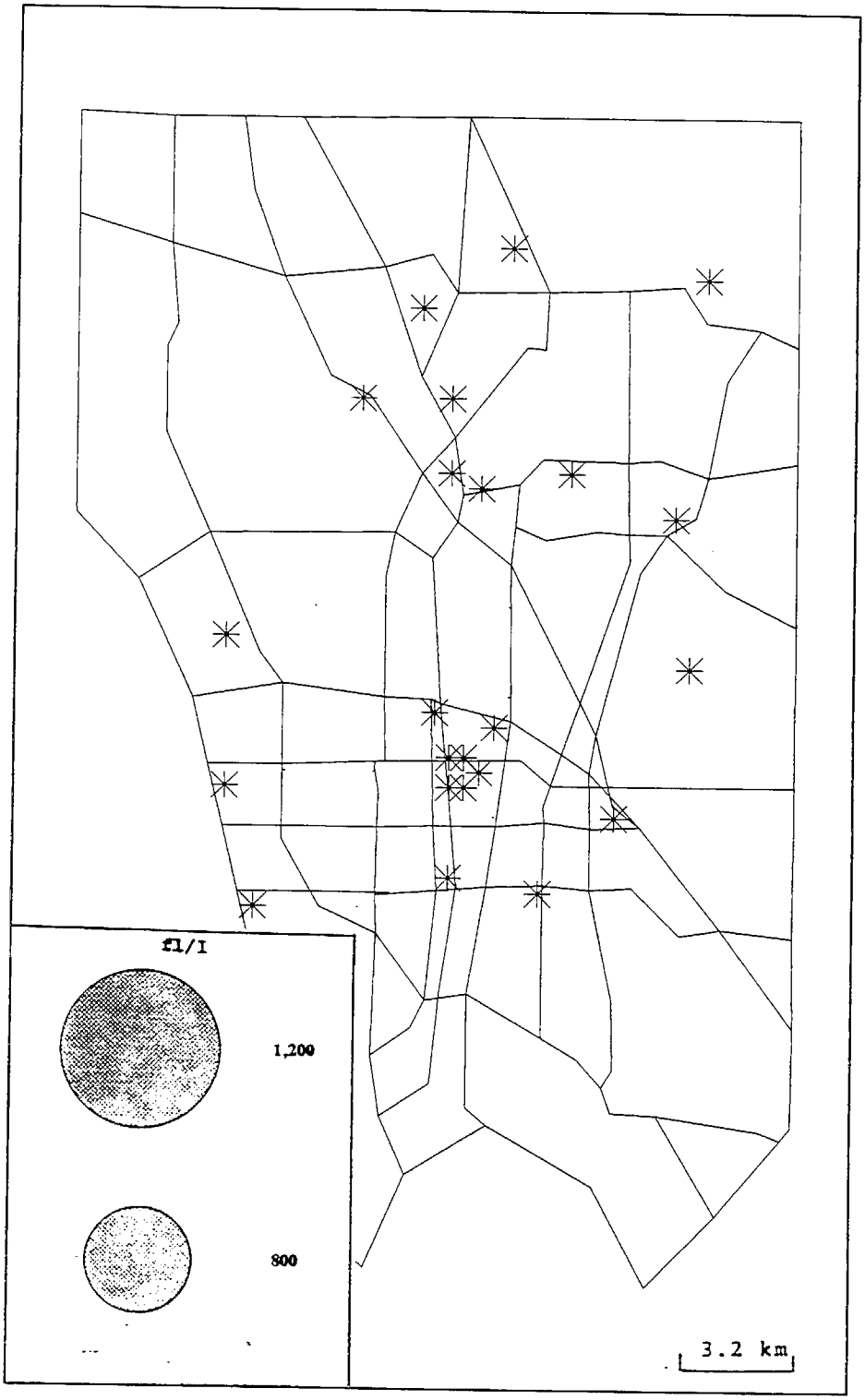

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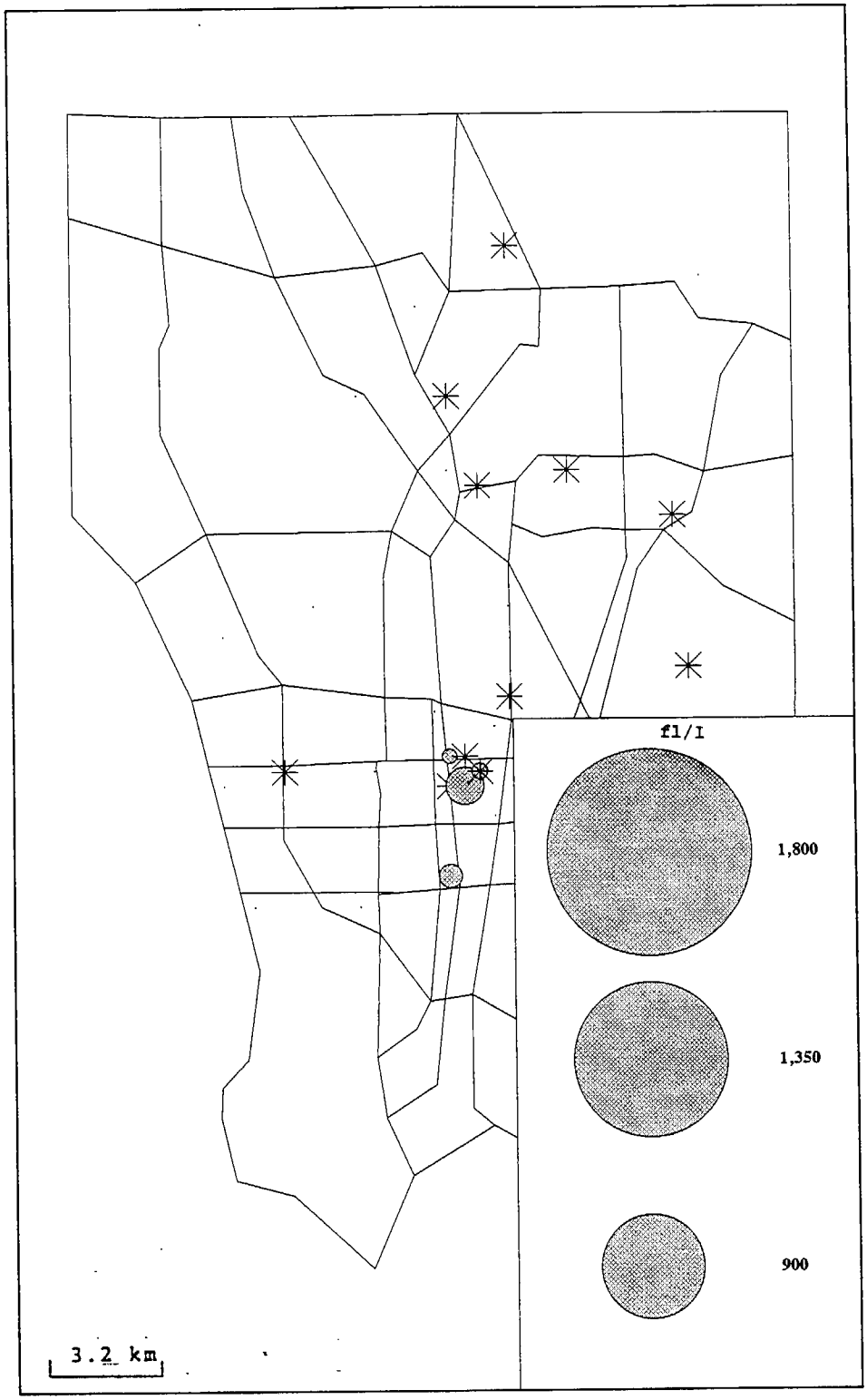

TD 12/19/1989 12:00

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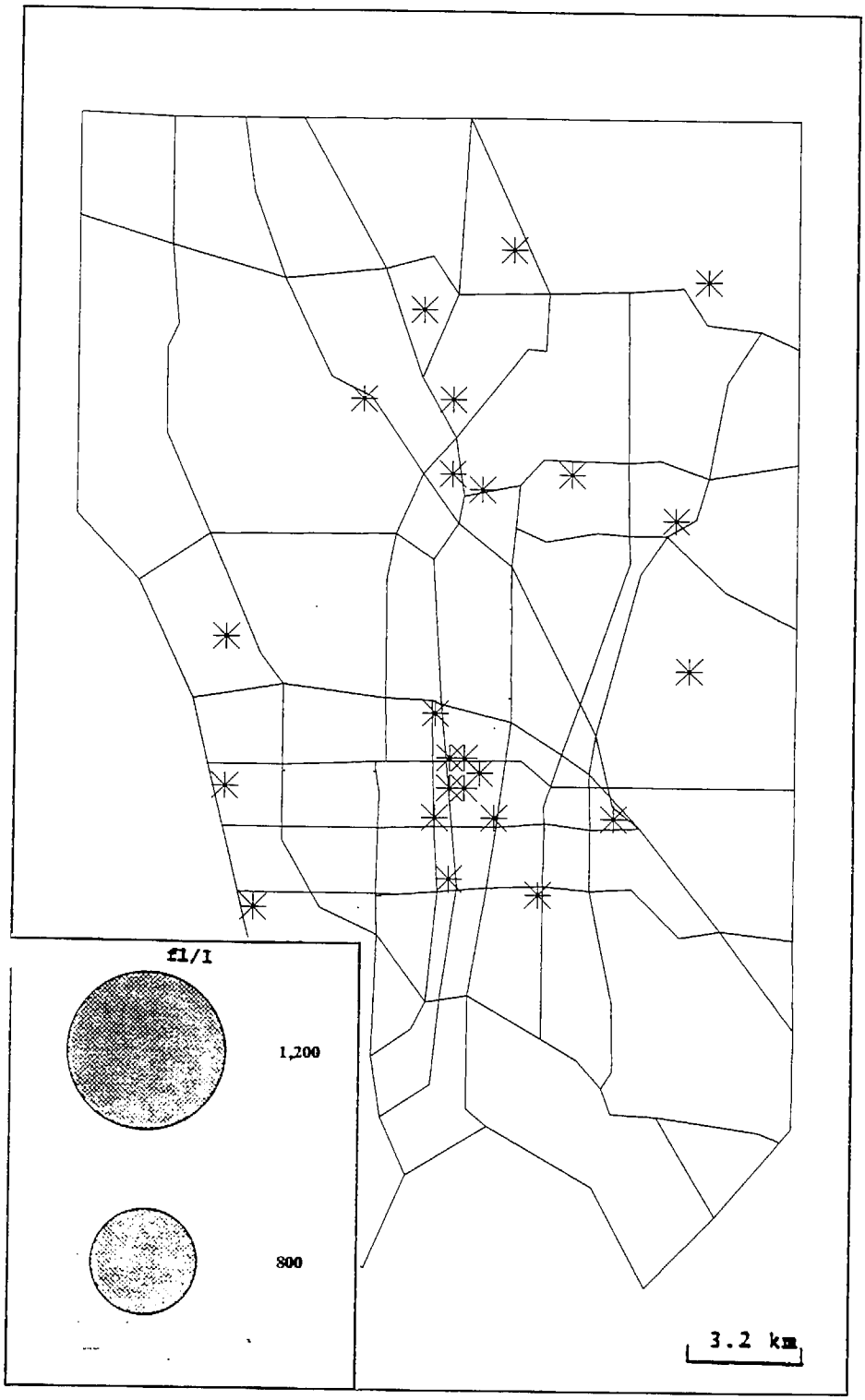

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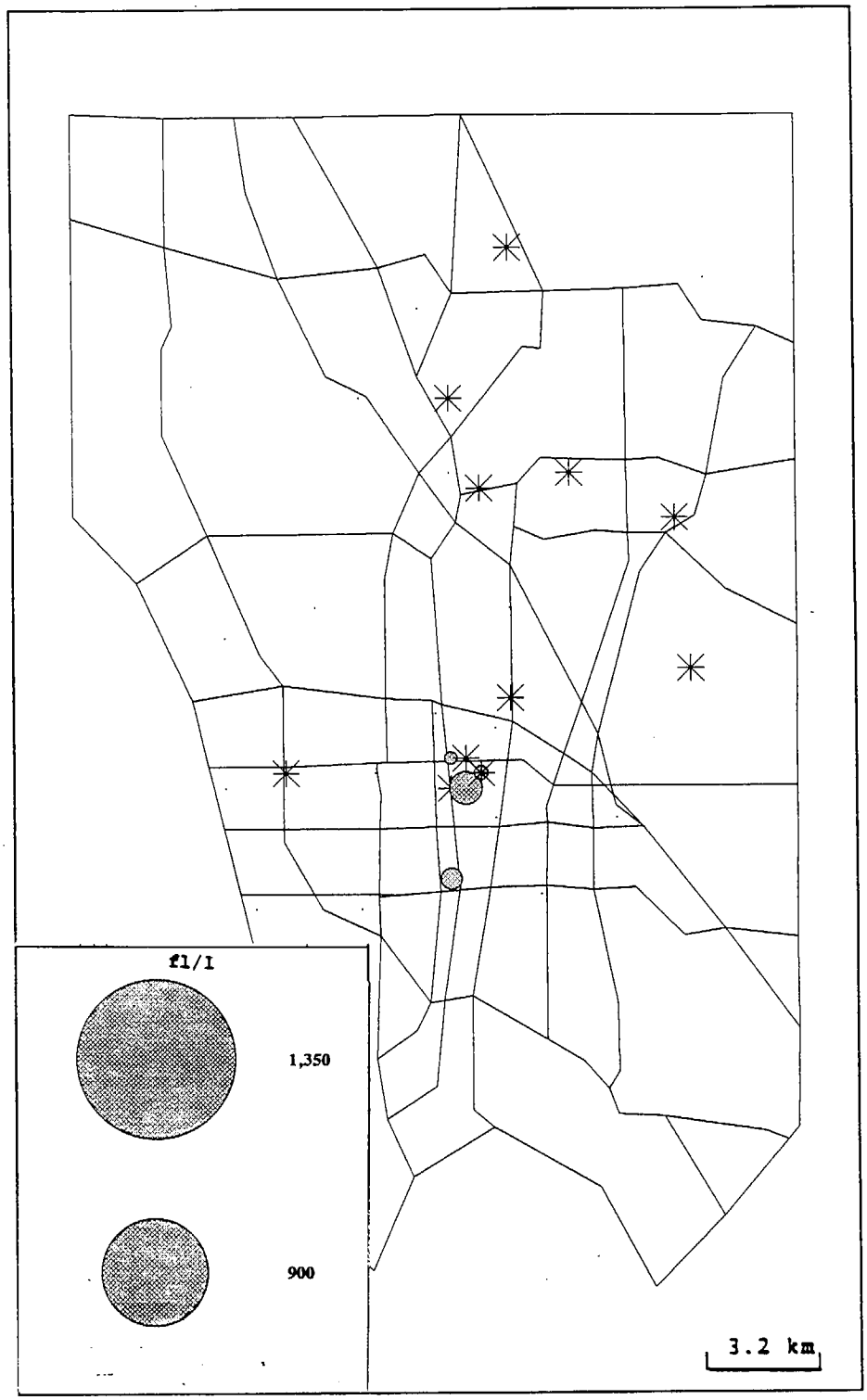

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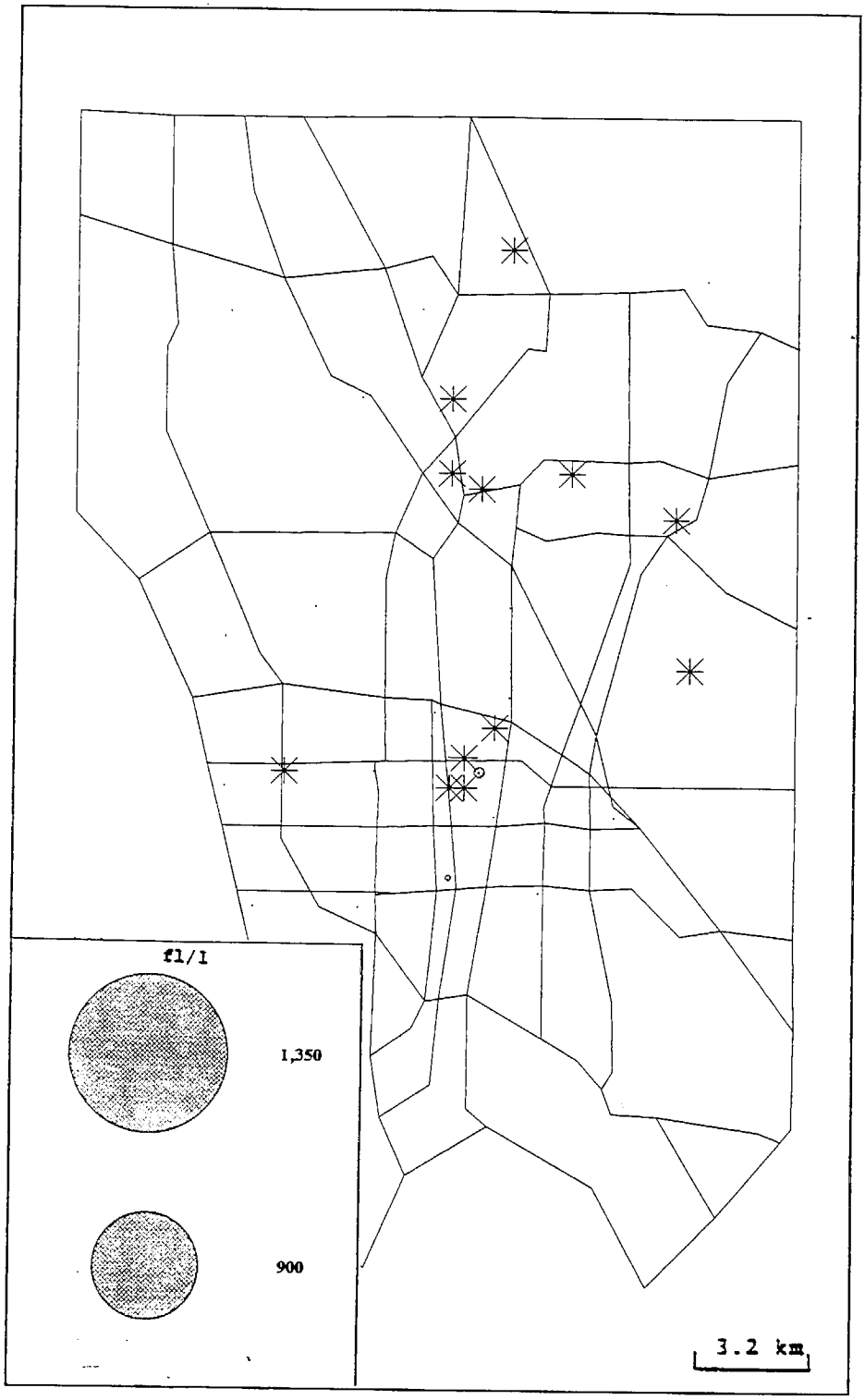

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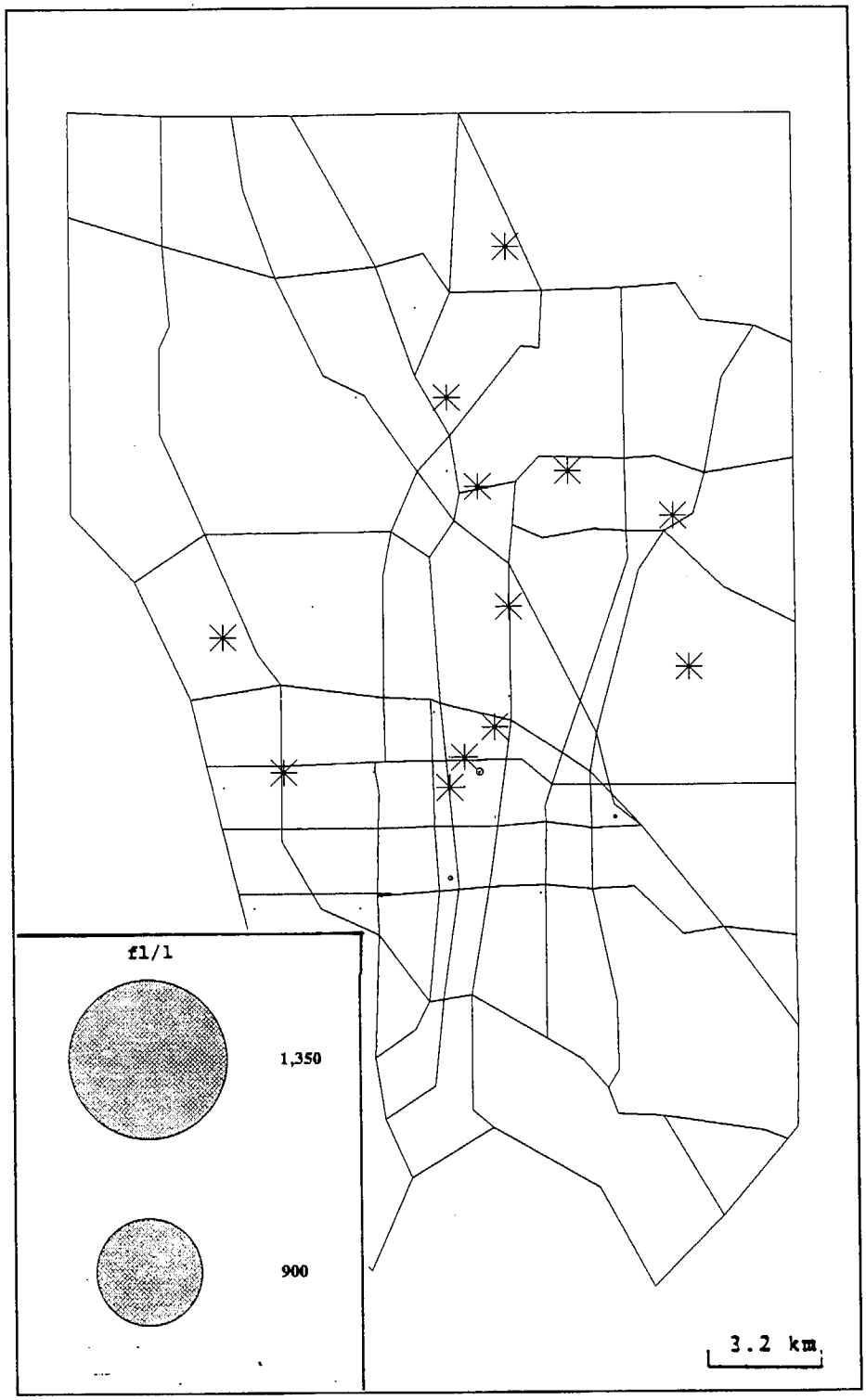

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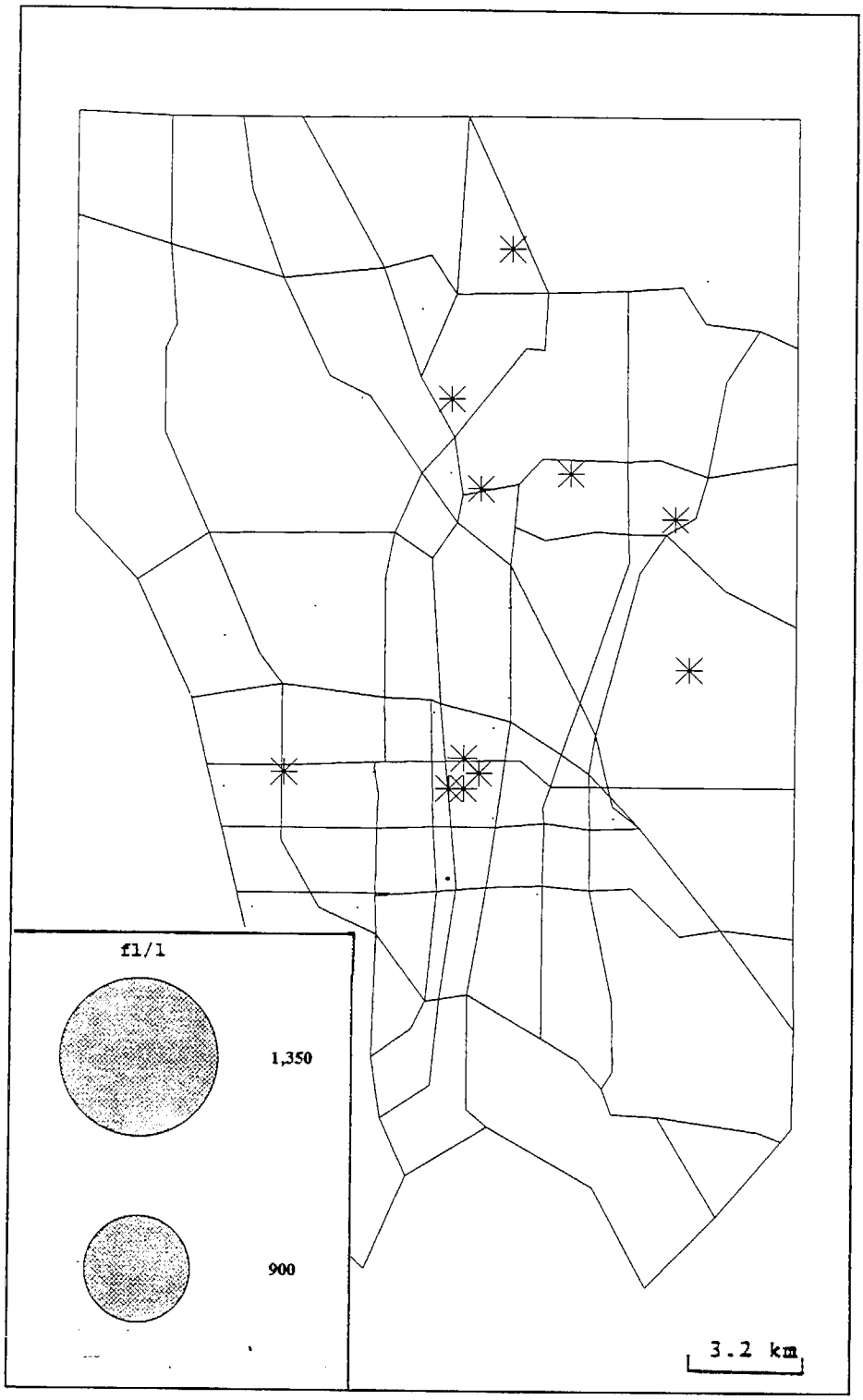

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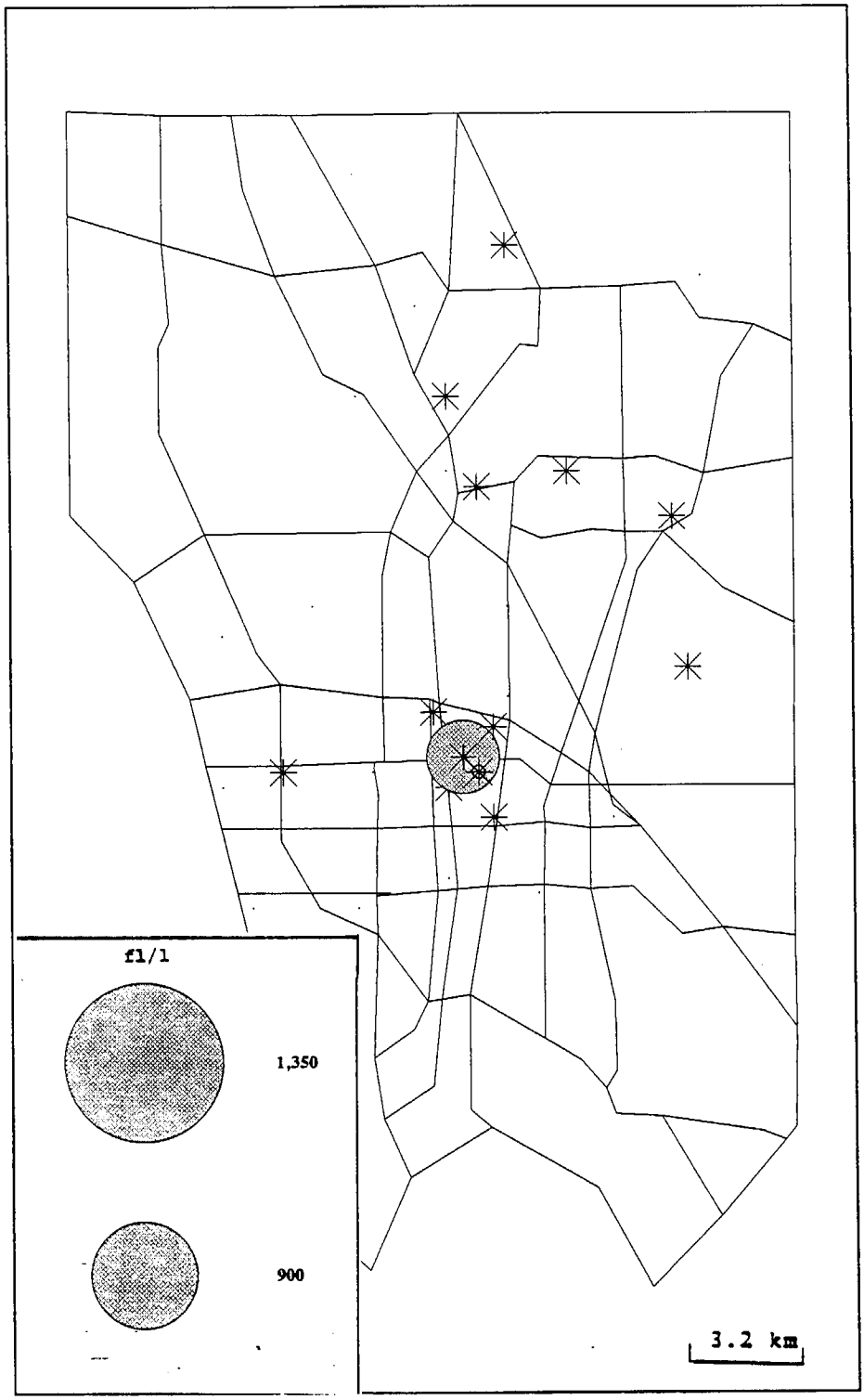

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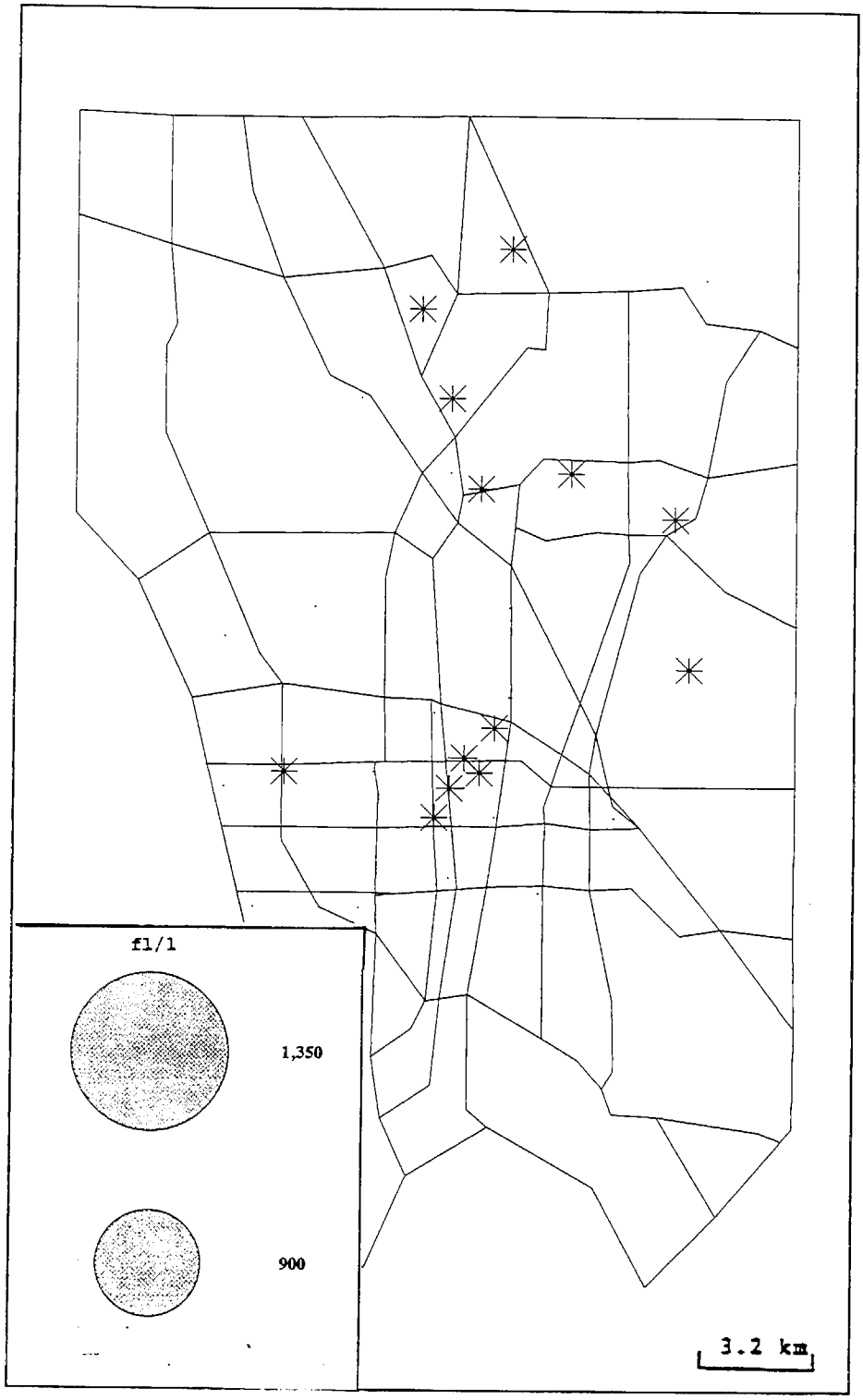

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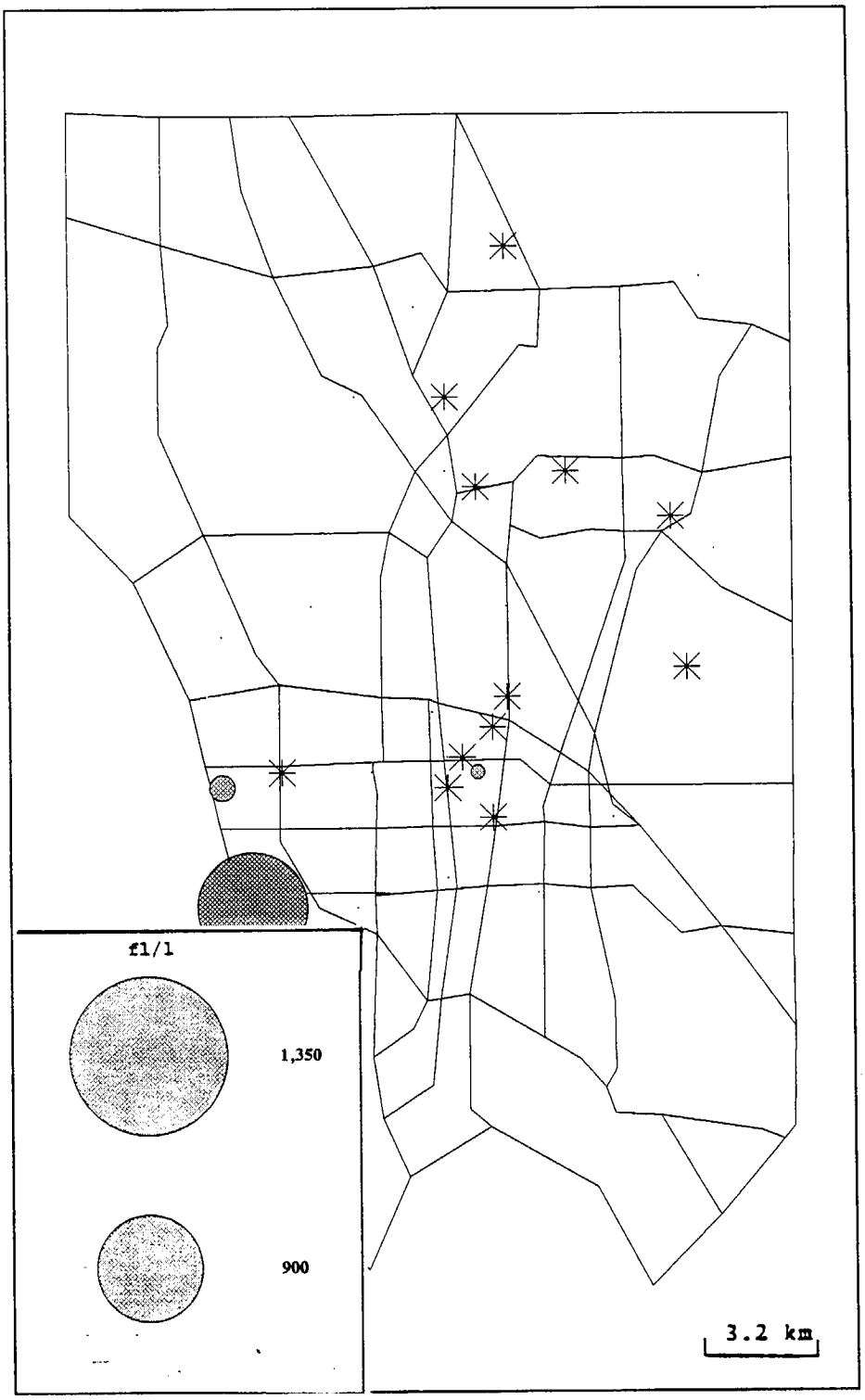

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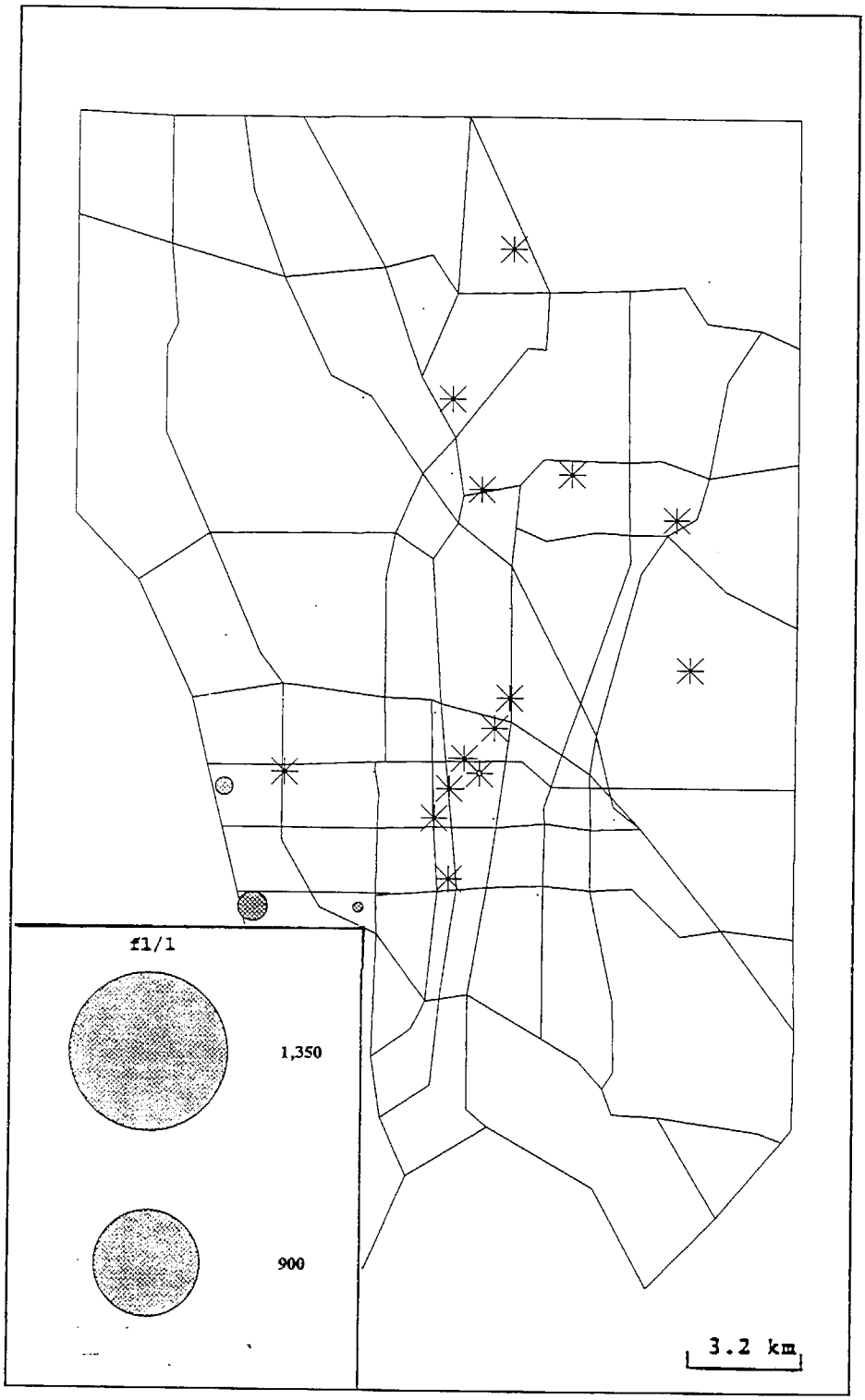

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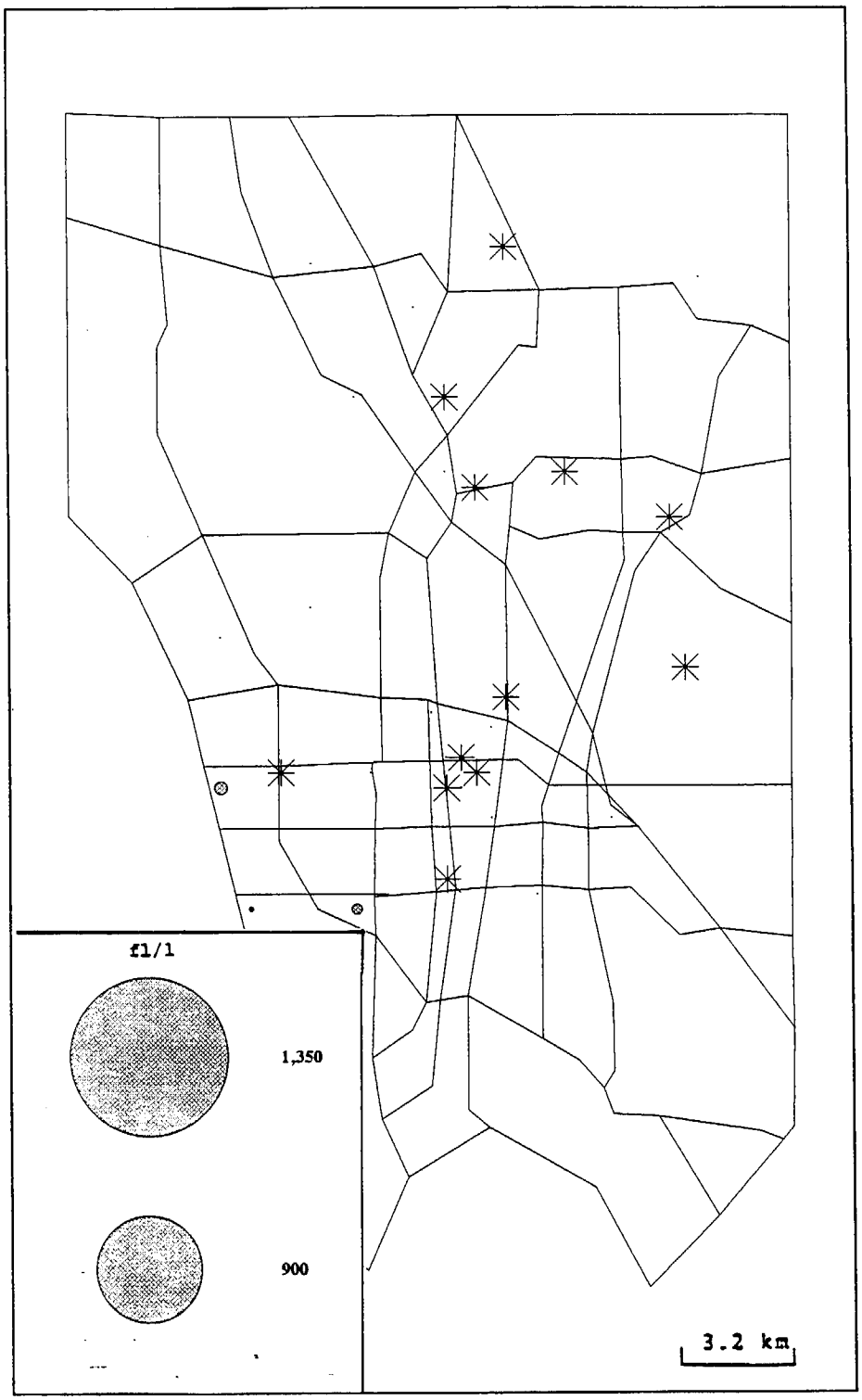

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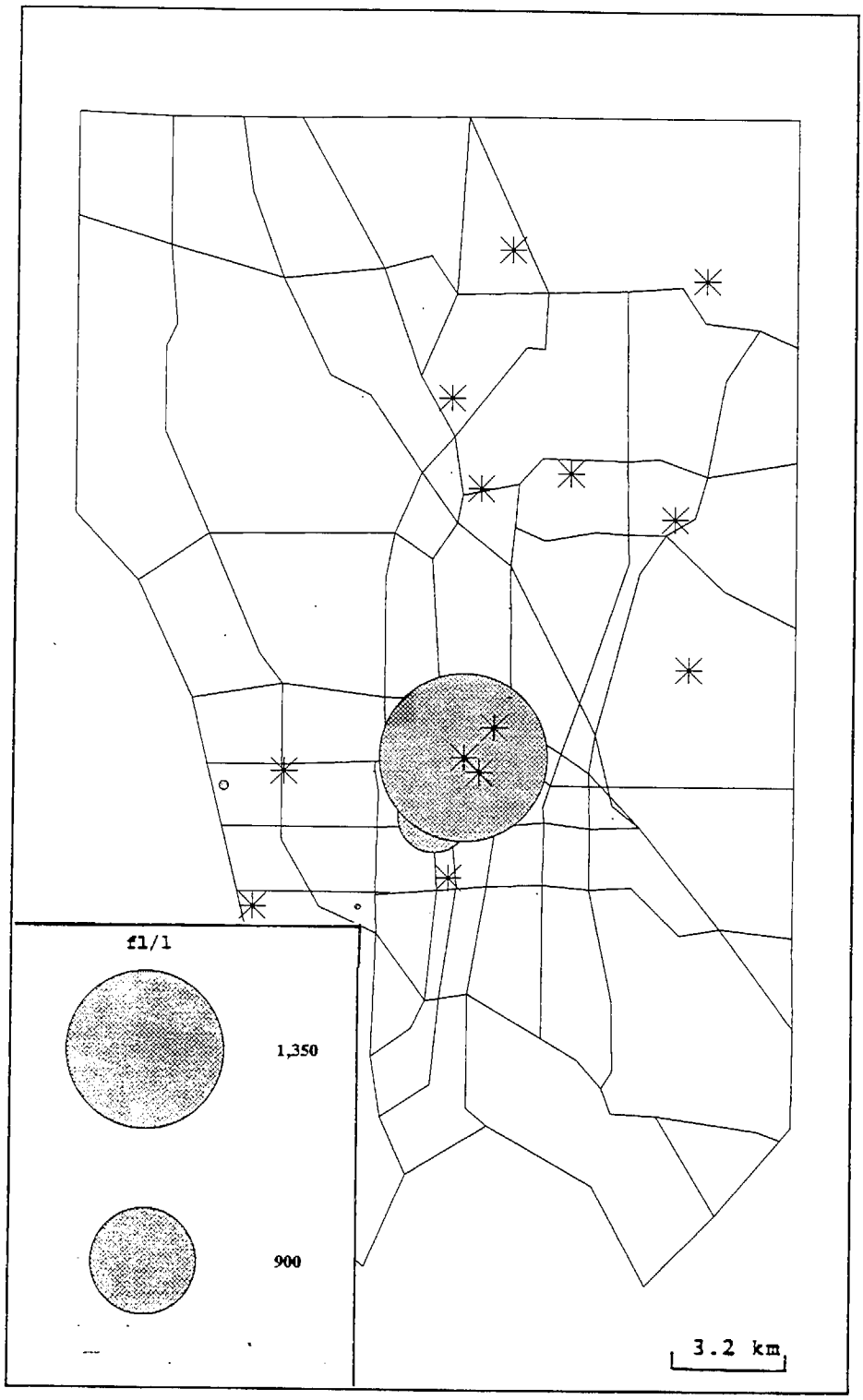

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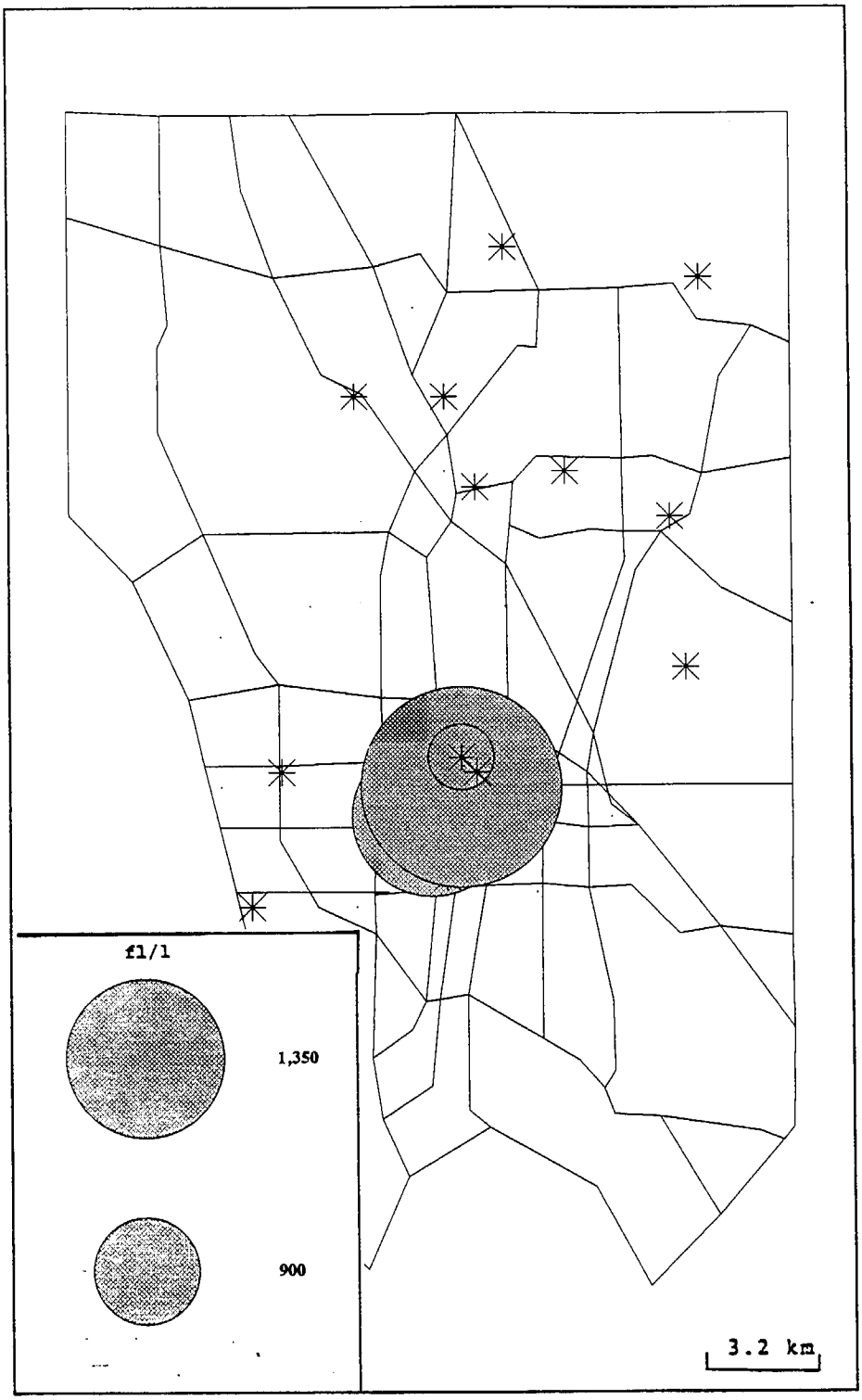

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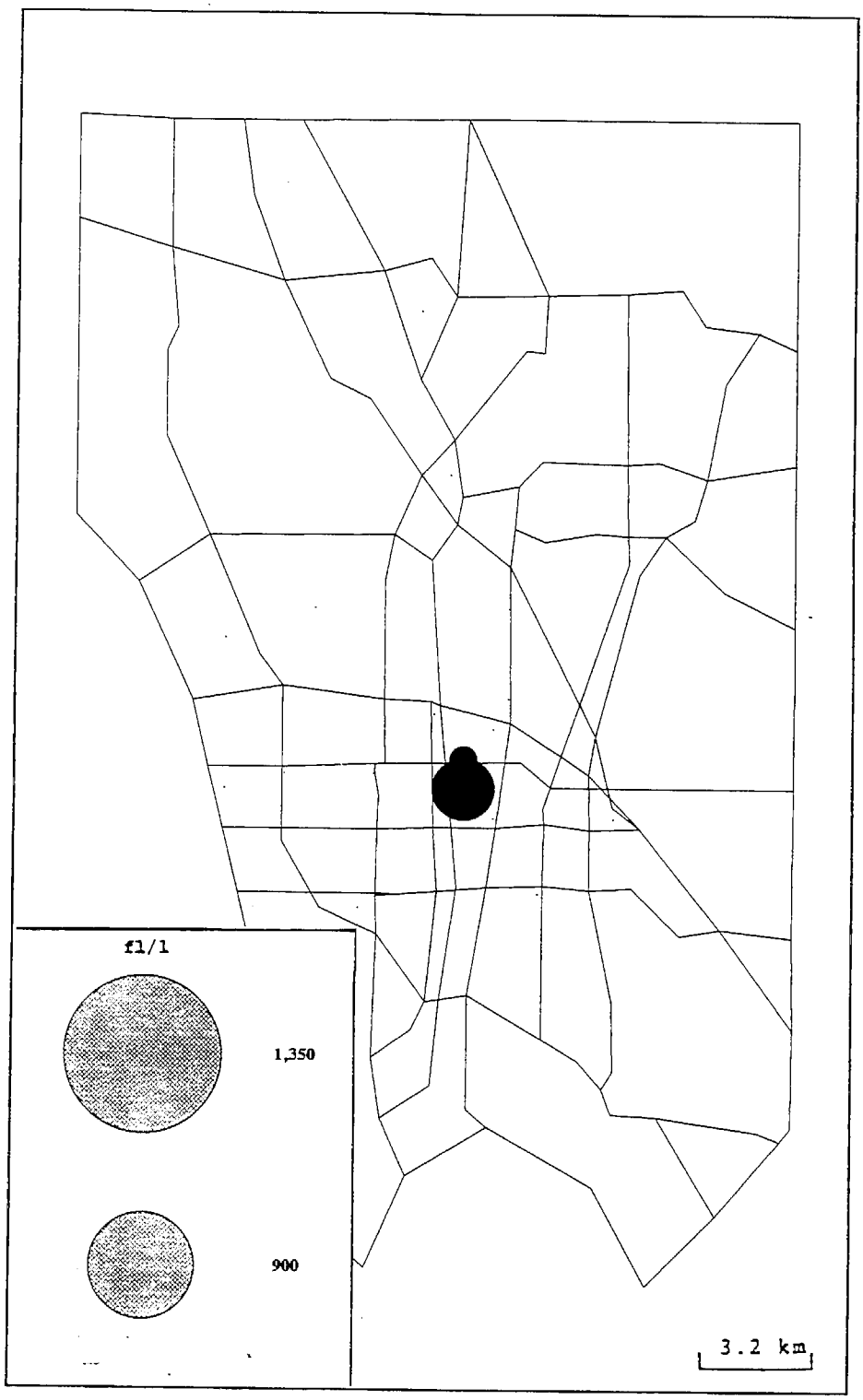

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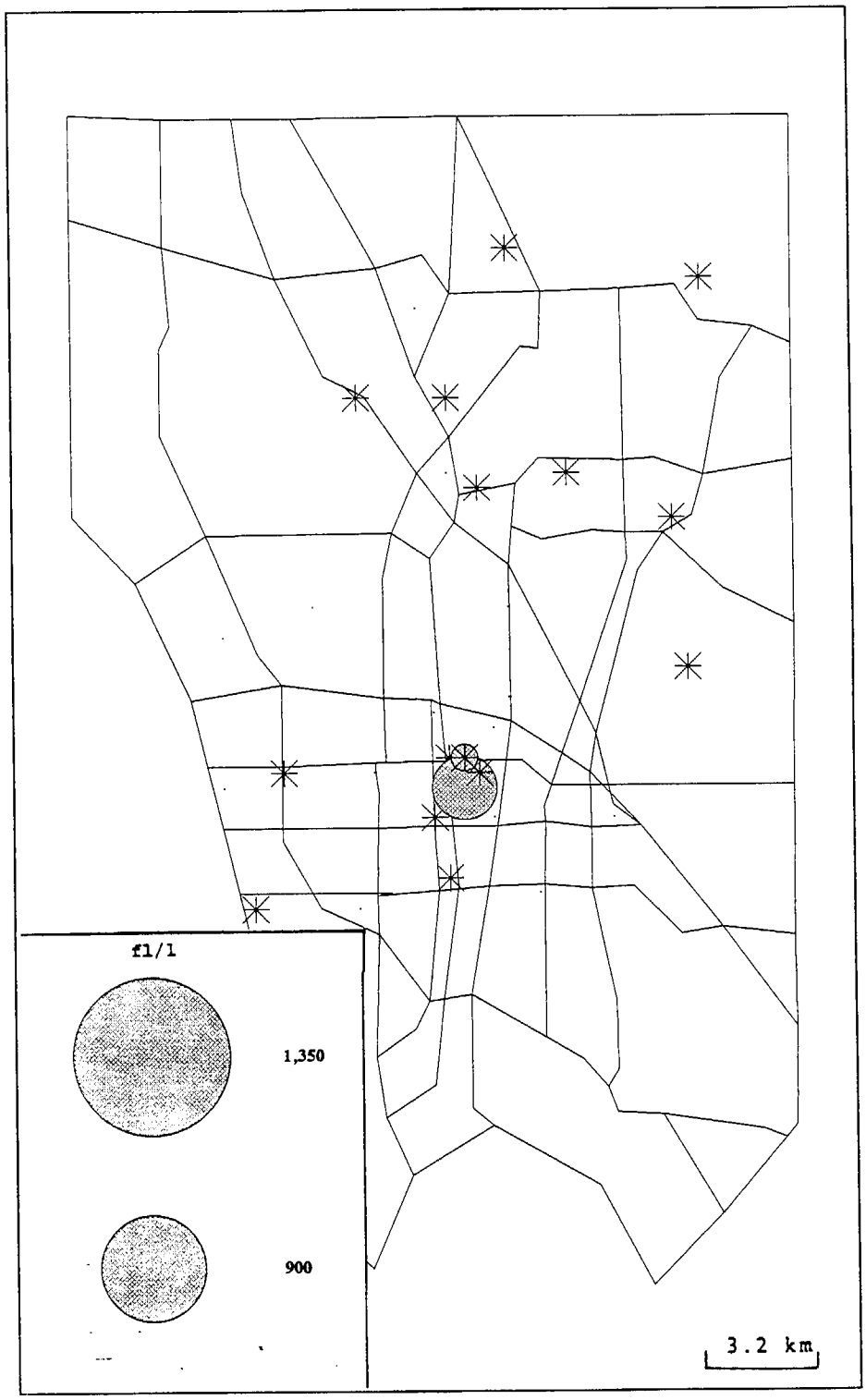

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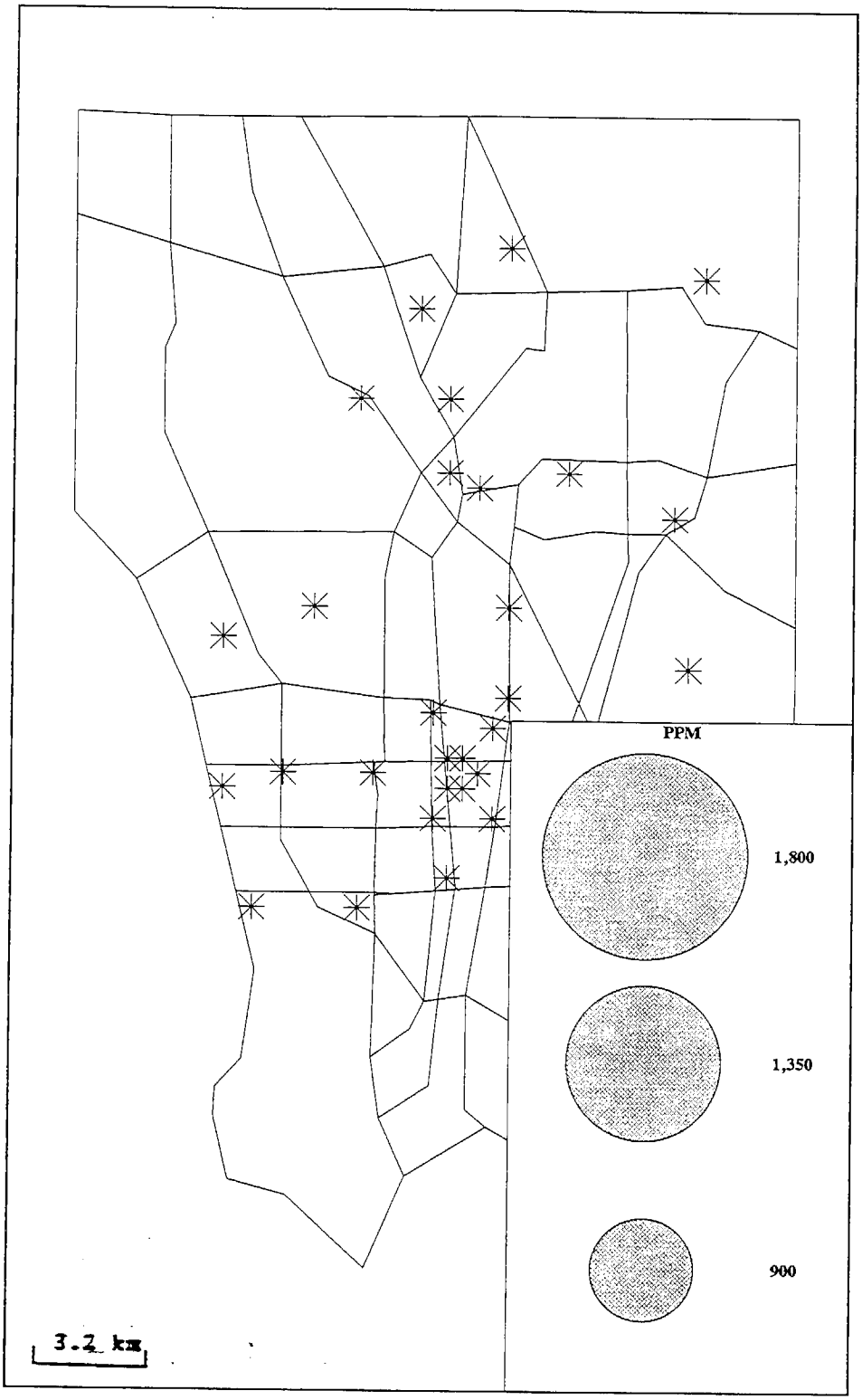

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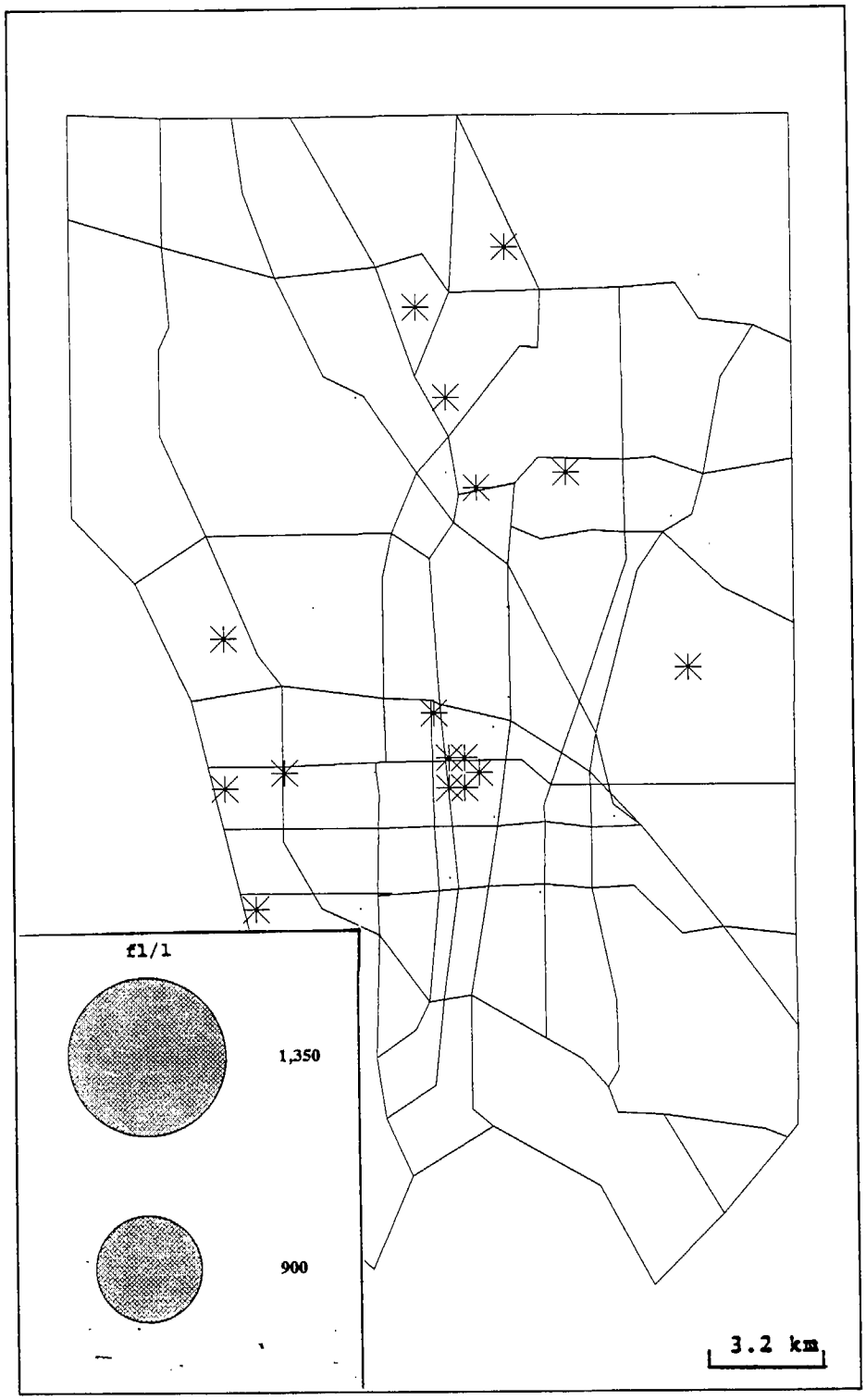

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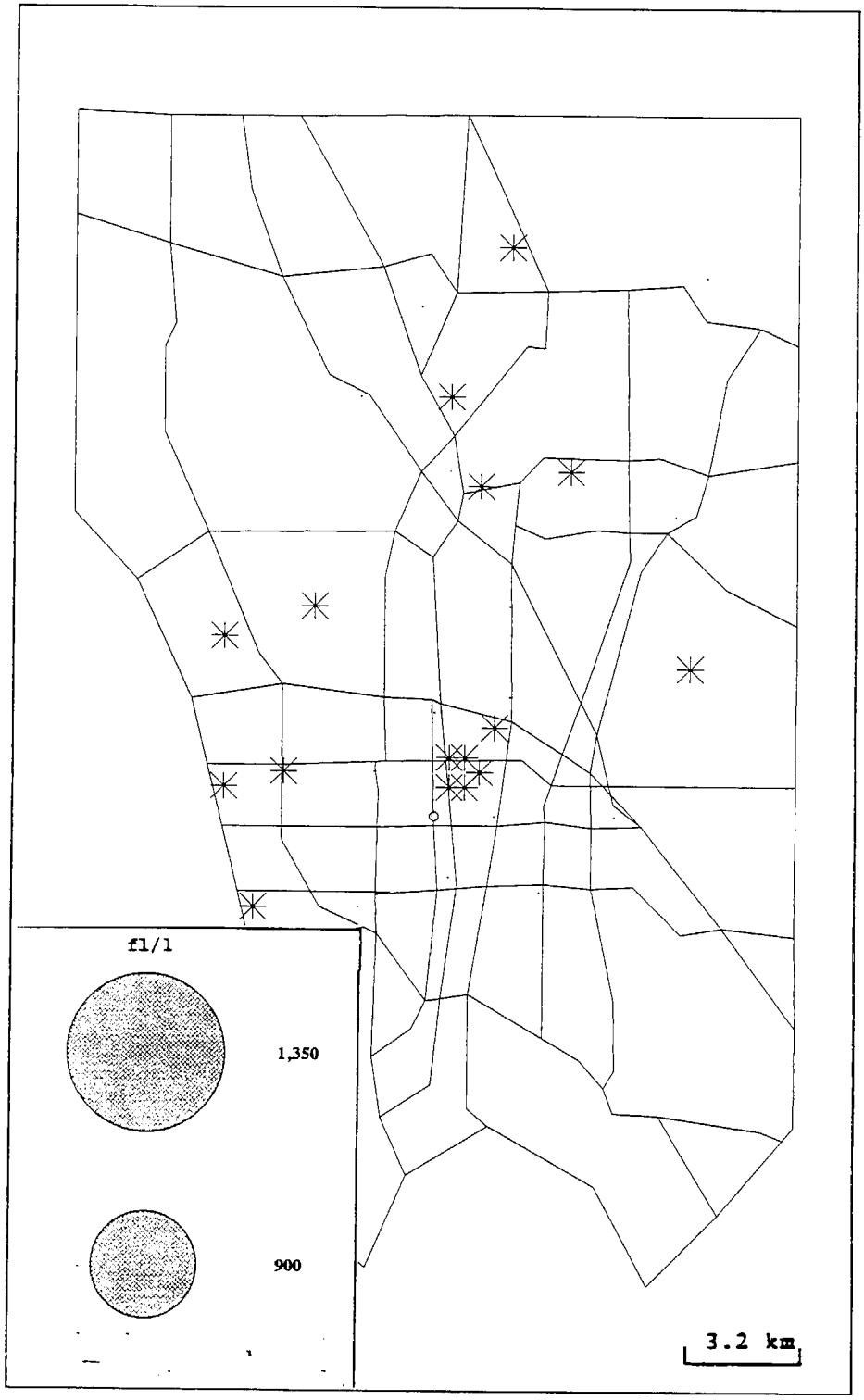

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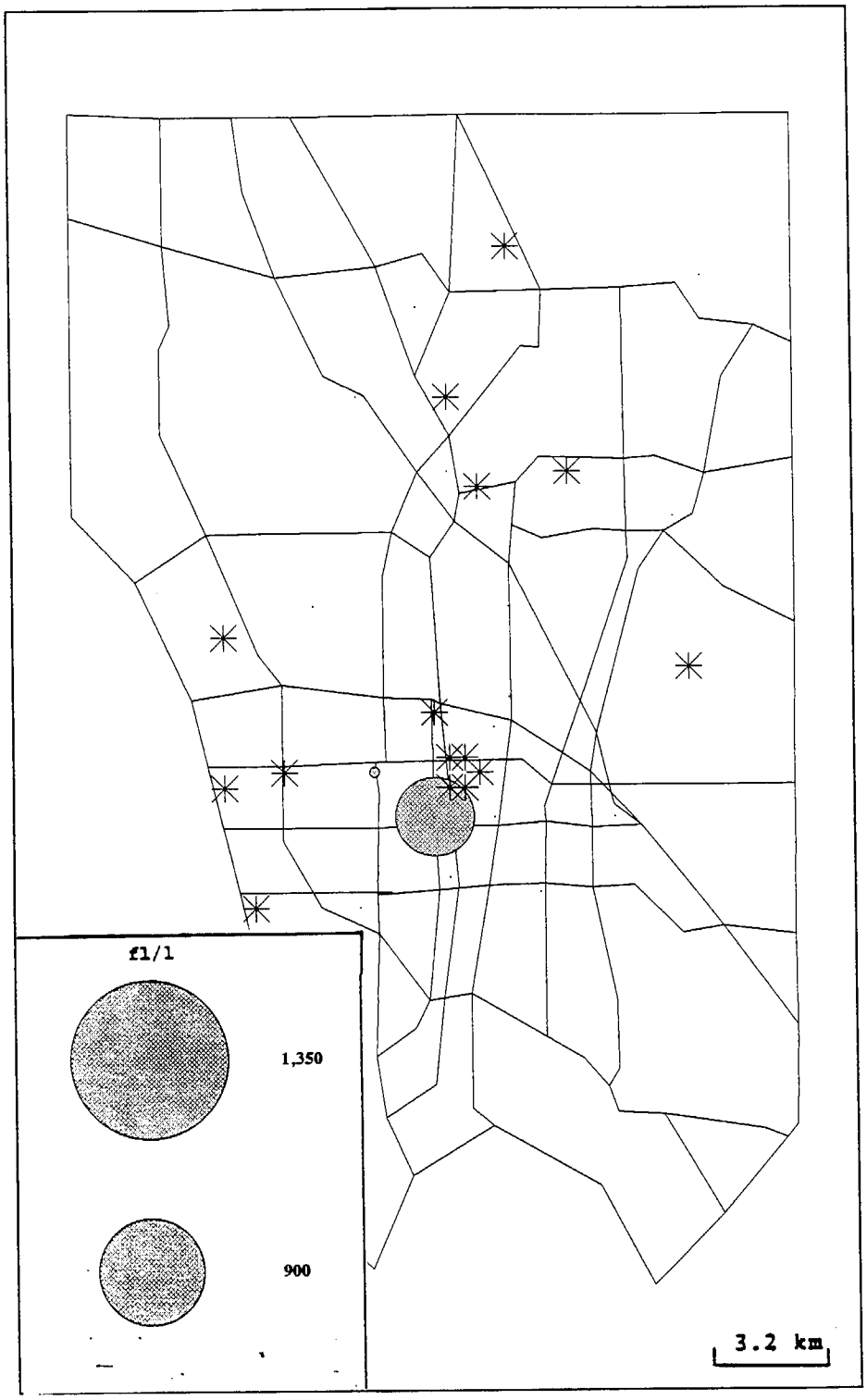

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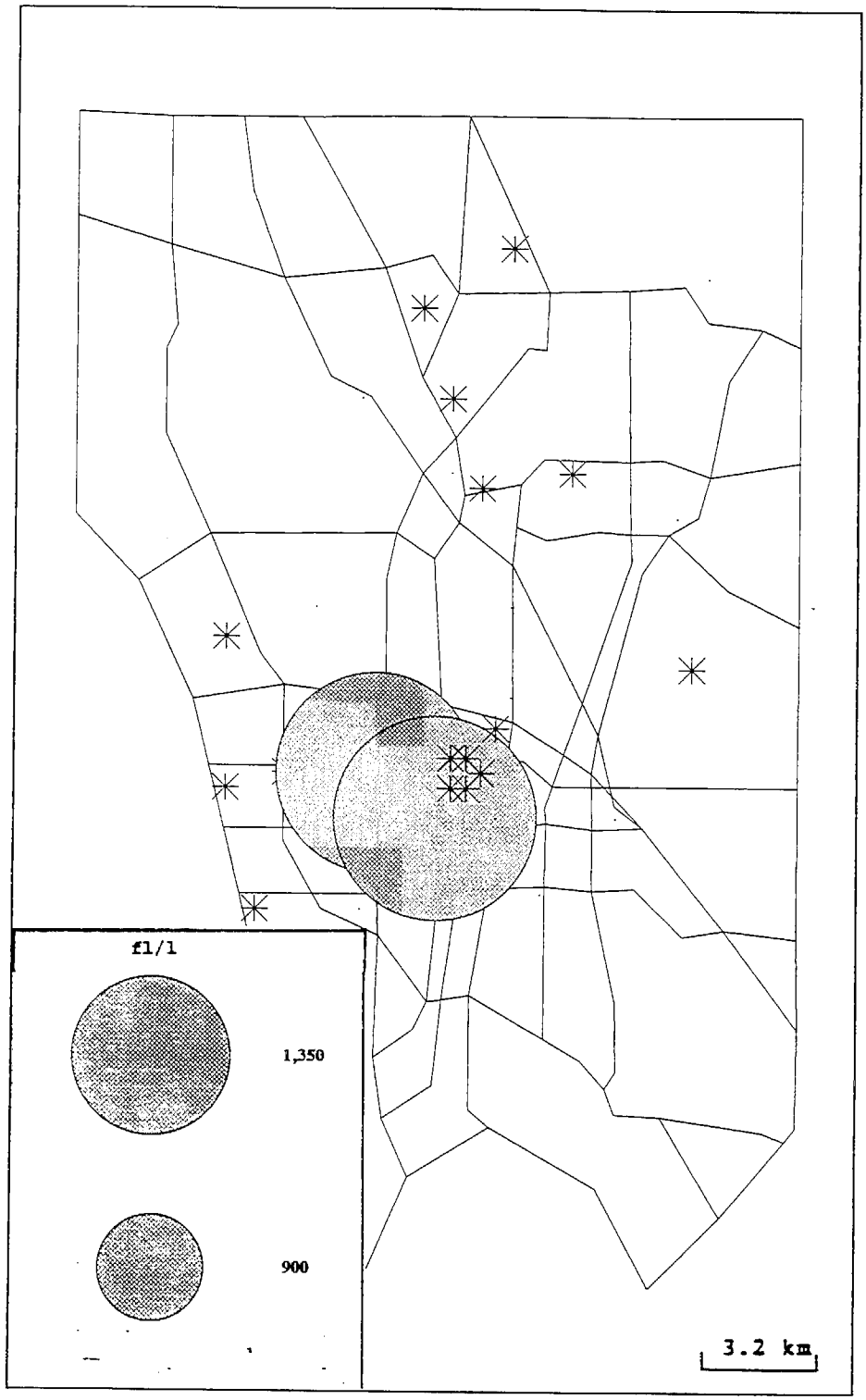

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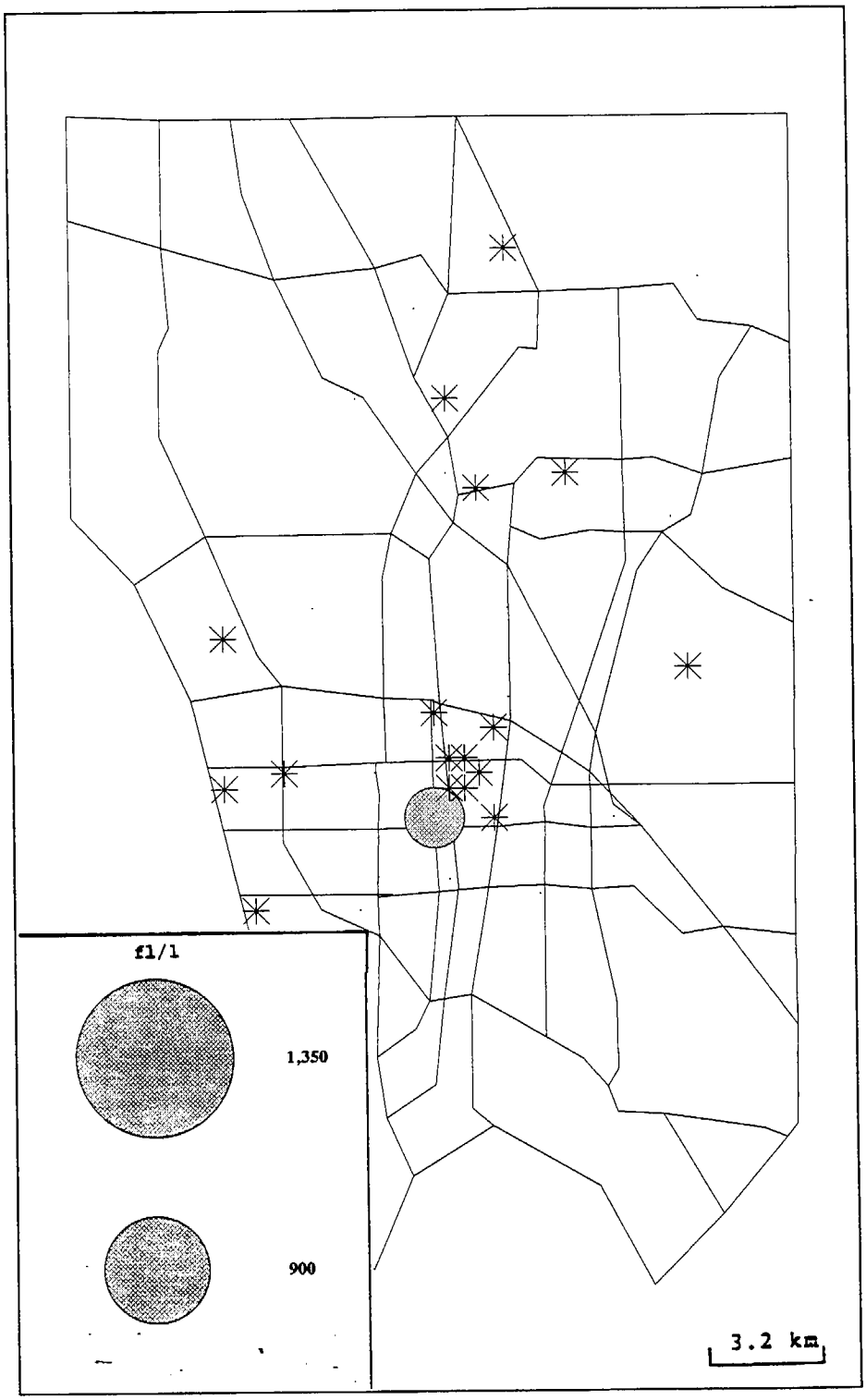

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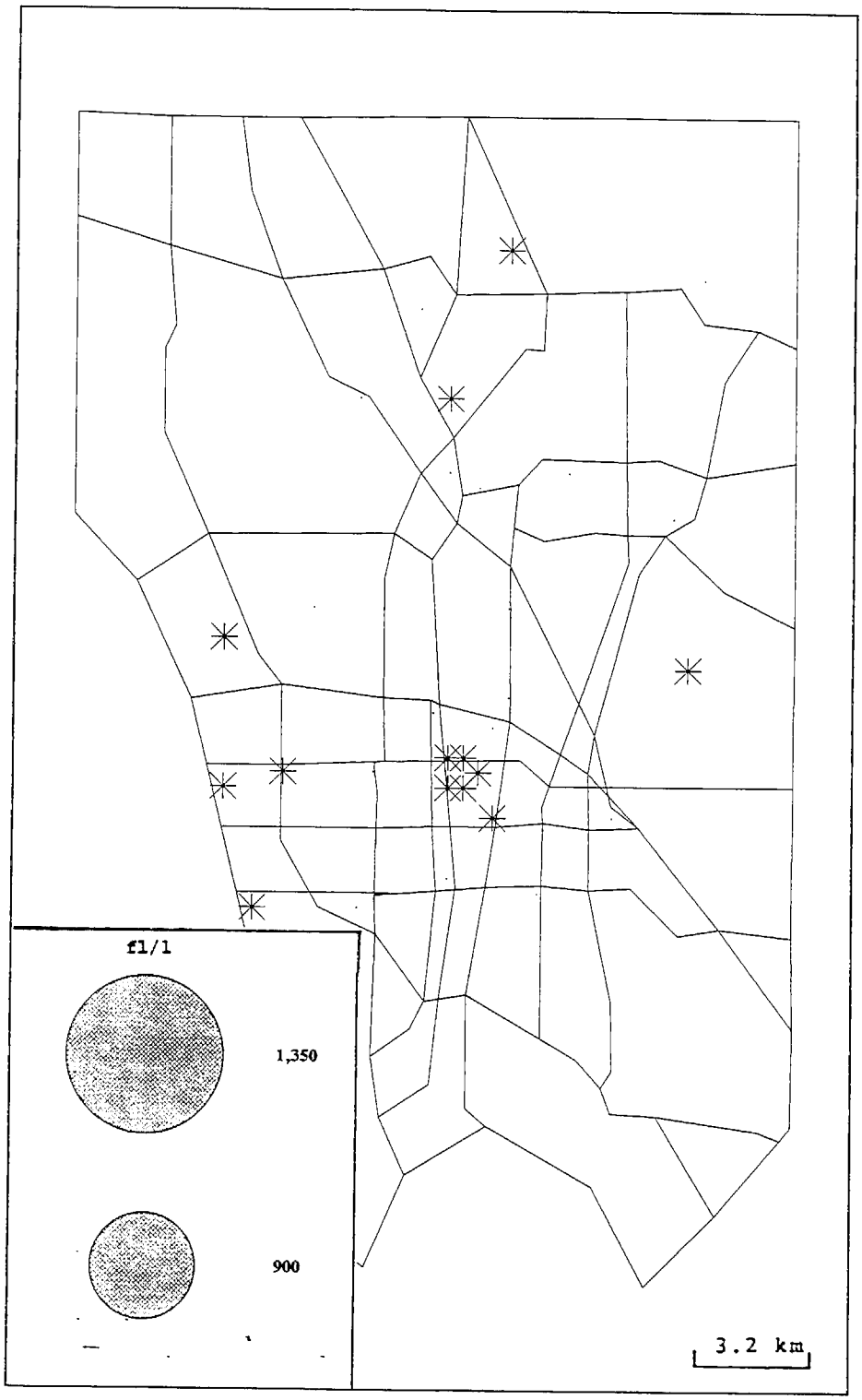

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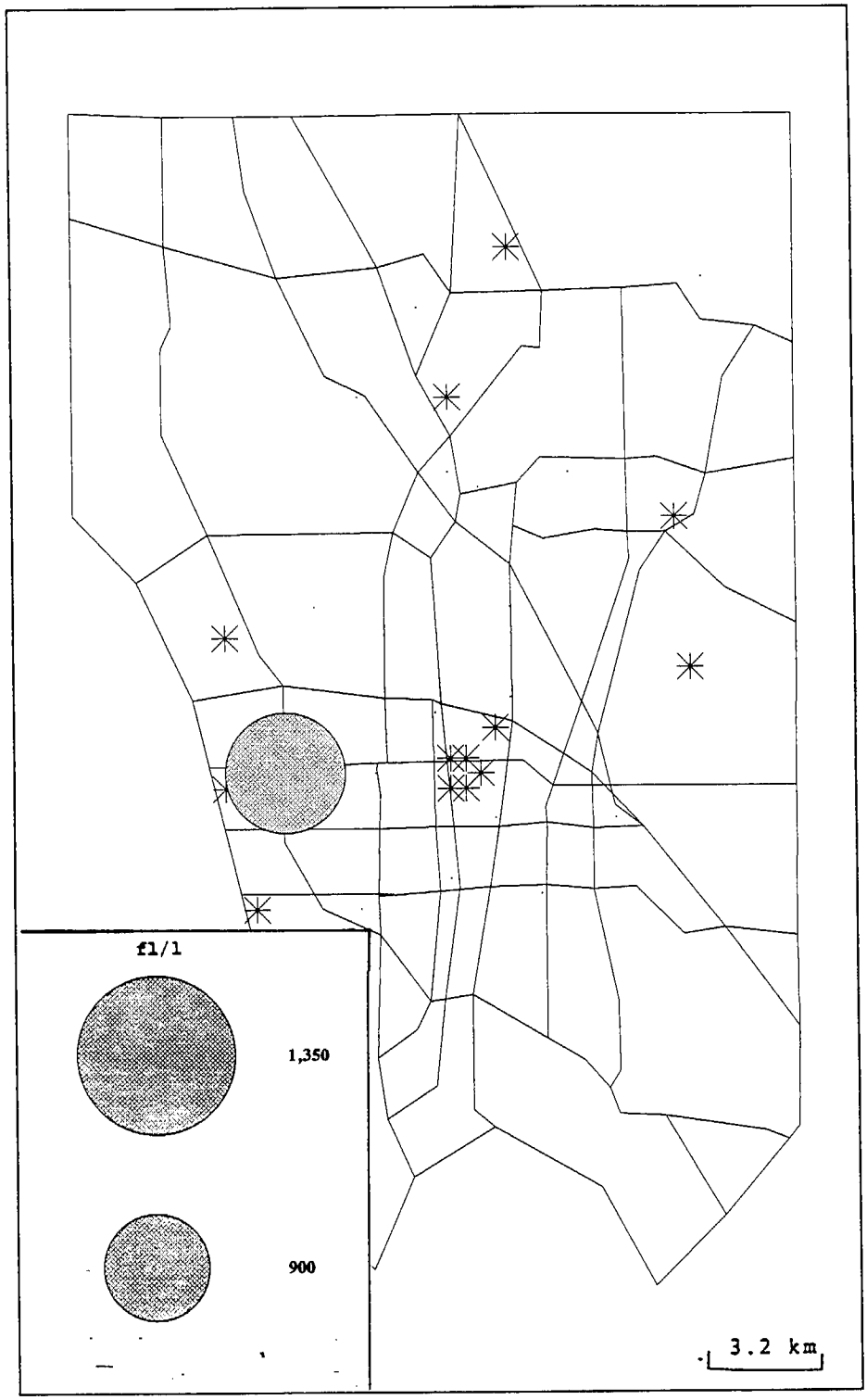

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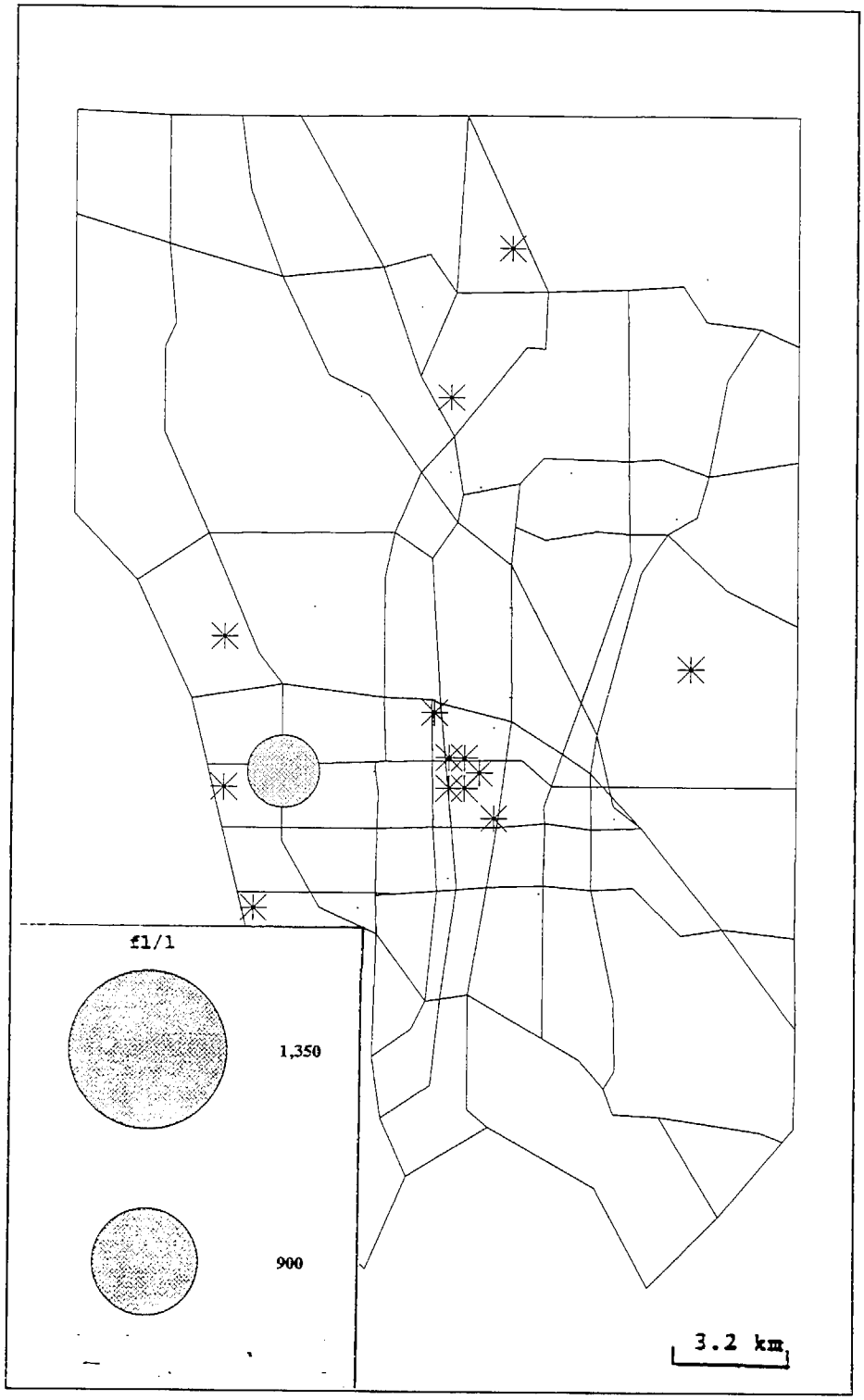

TD 01/09/1990 04:00

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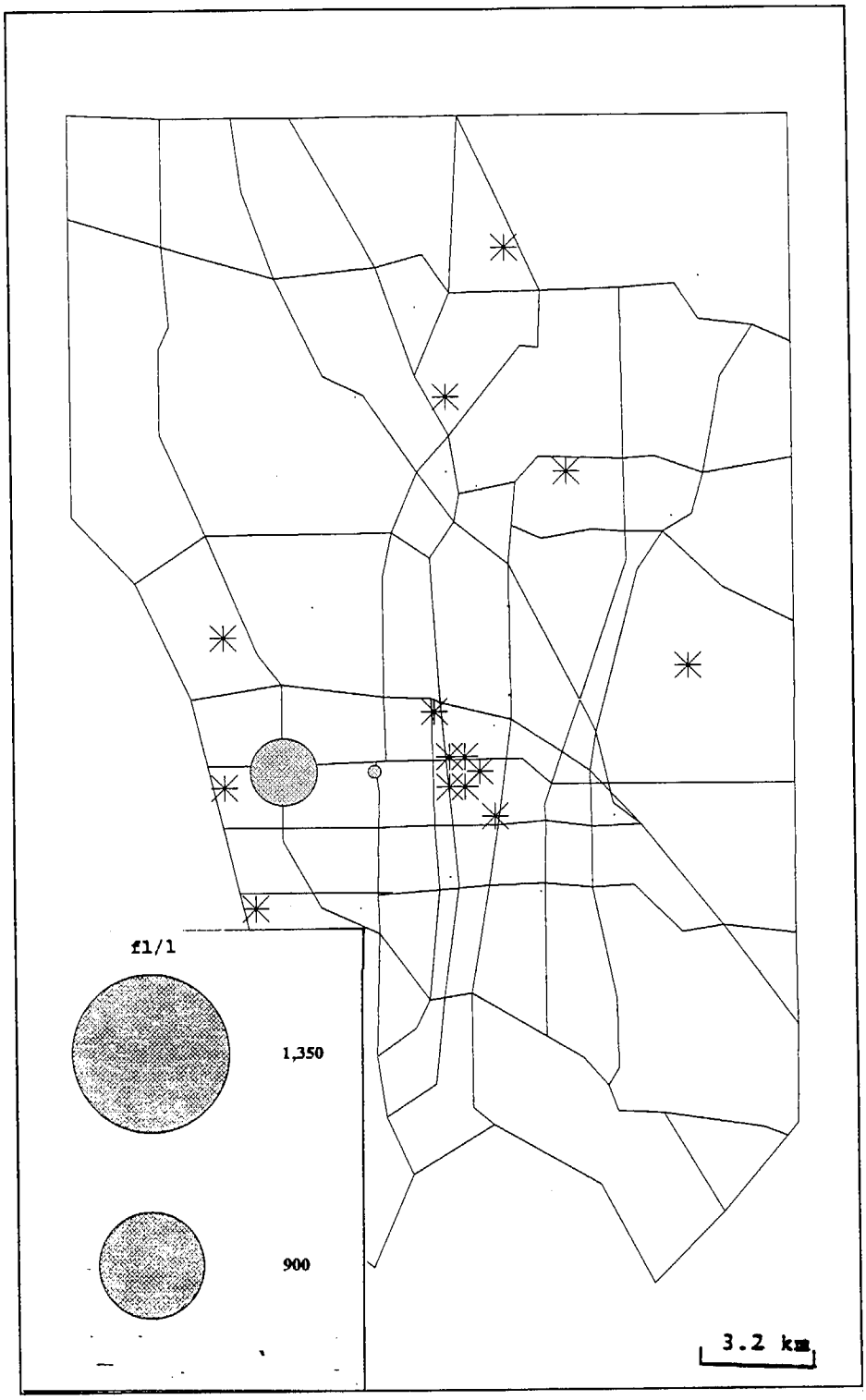
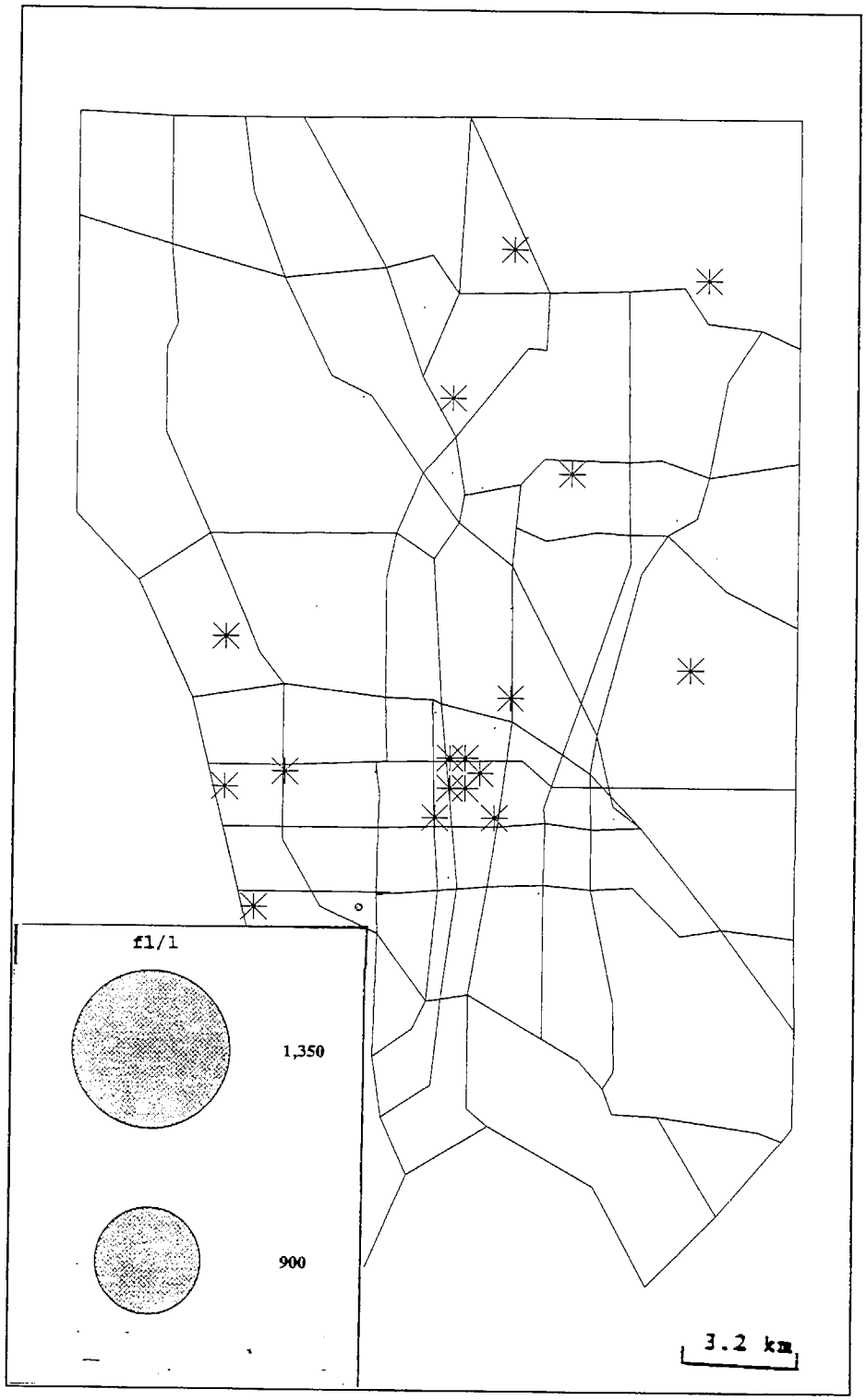


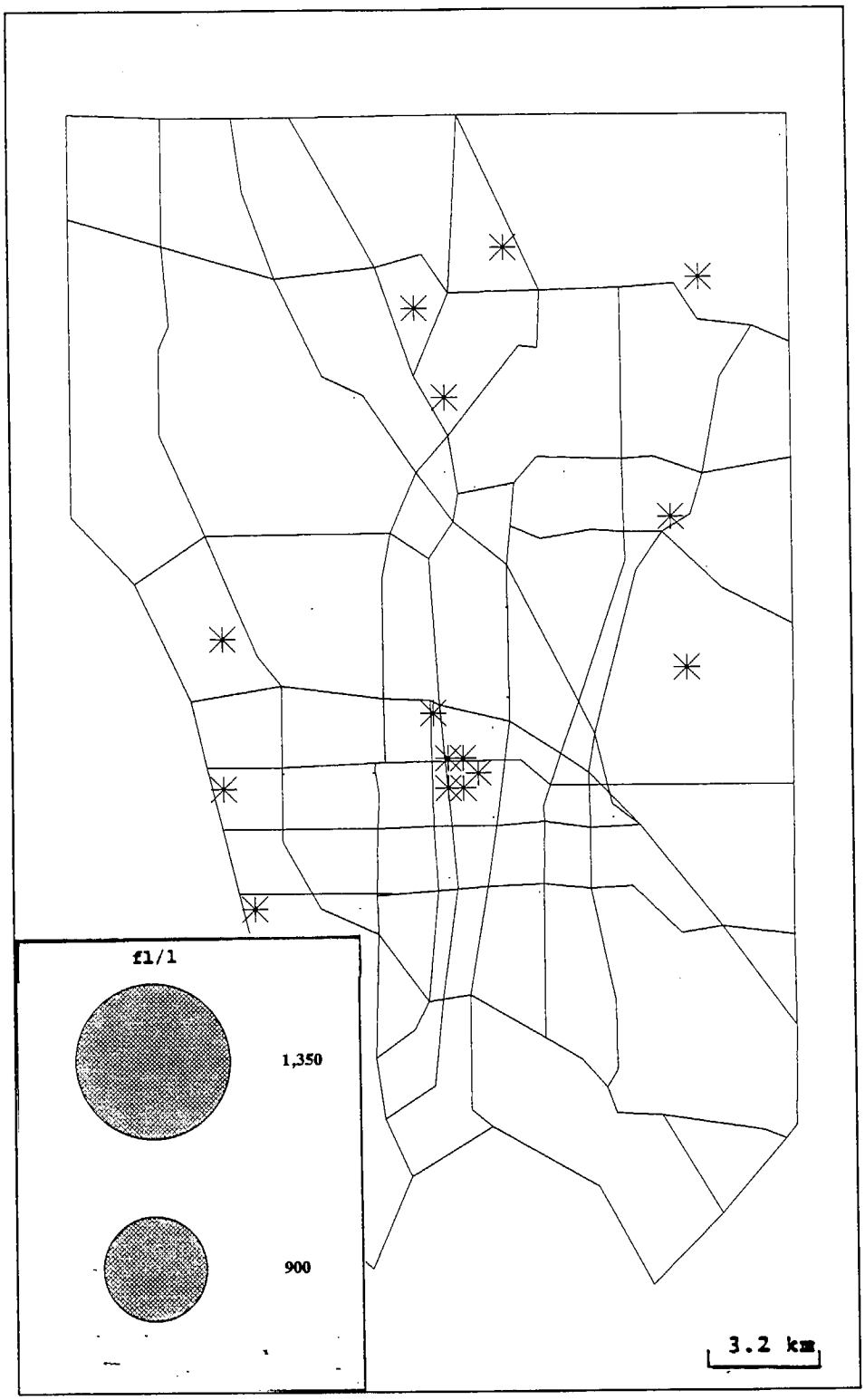
TD 01/09/1990 06:00

Tracer PTCH



TD 01/09/1990 08:00

Tracer PTCH



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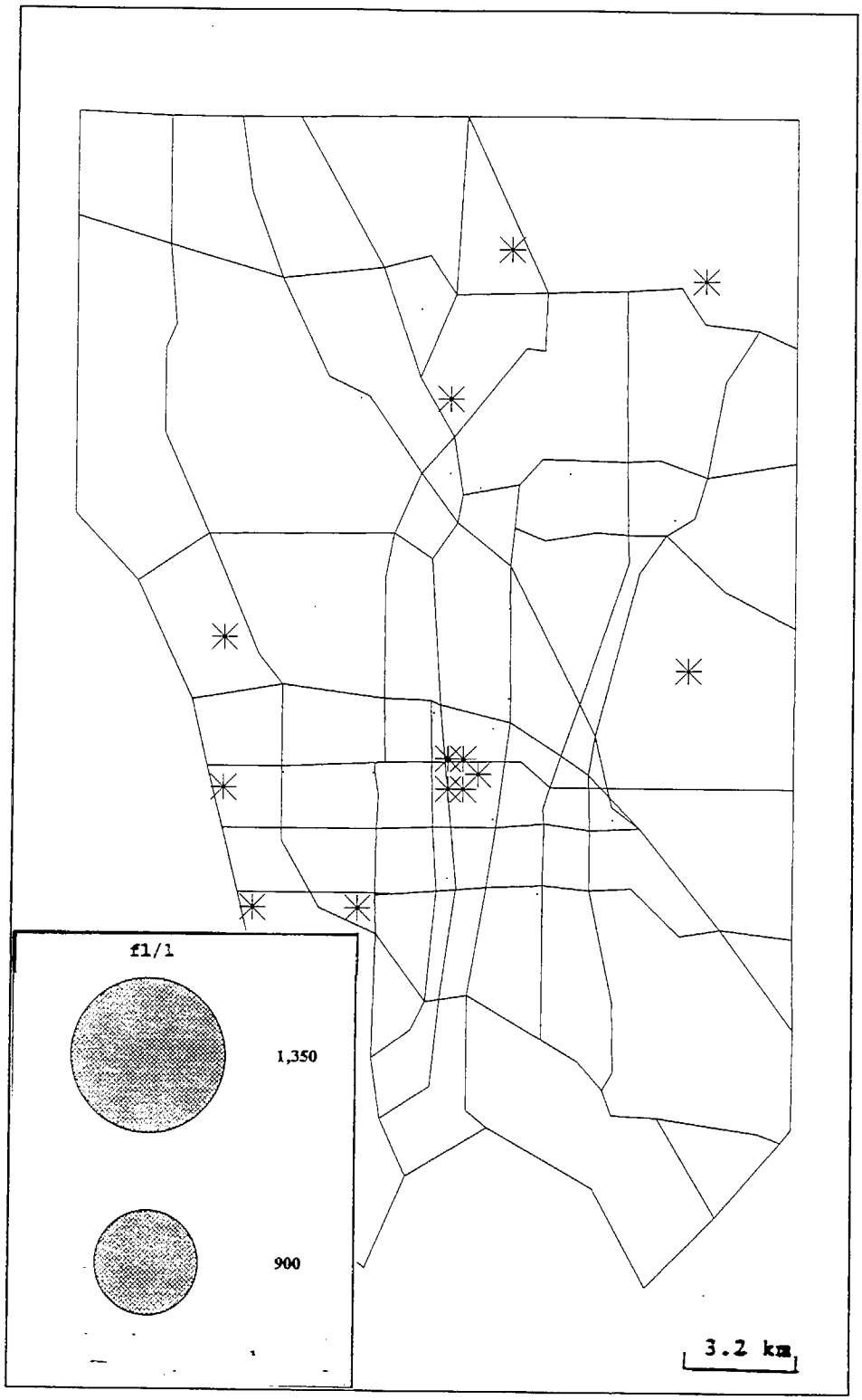

TD 01/09/1990 12:00

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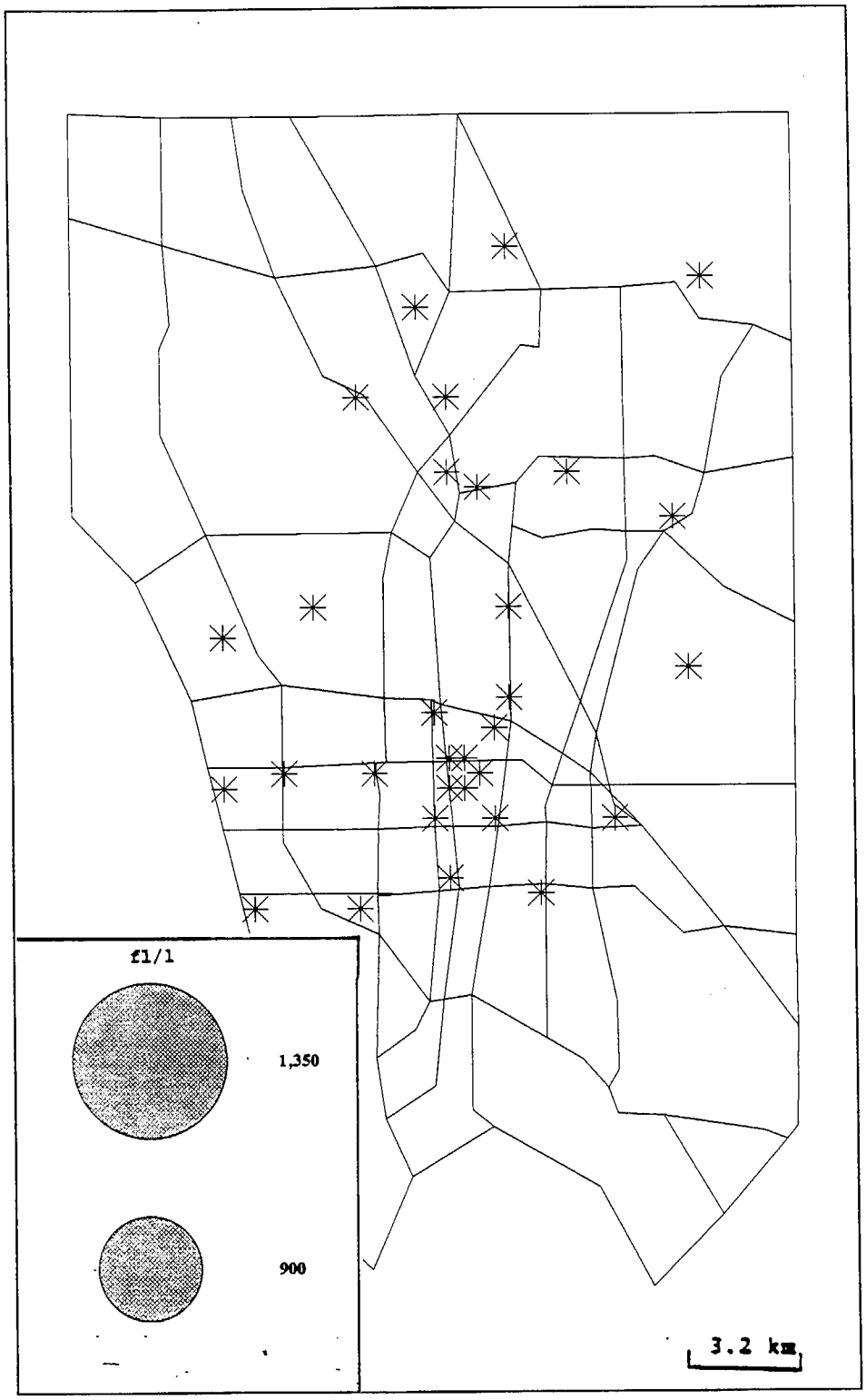

TD 01/09/1990 14:00

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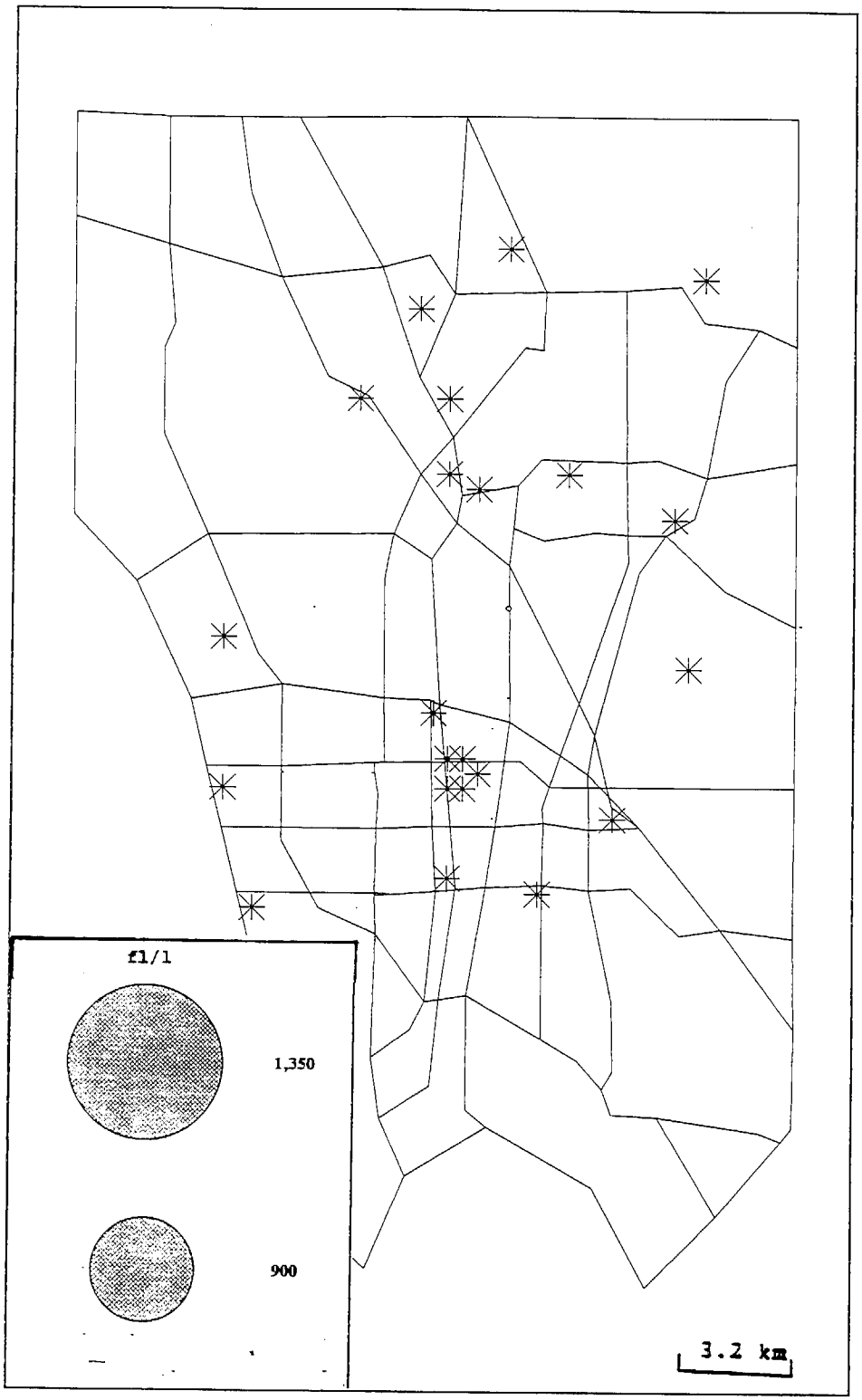

TD 01/09/1990 16:00

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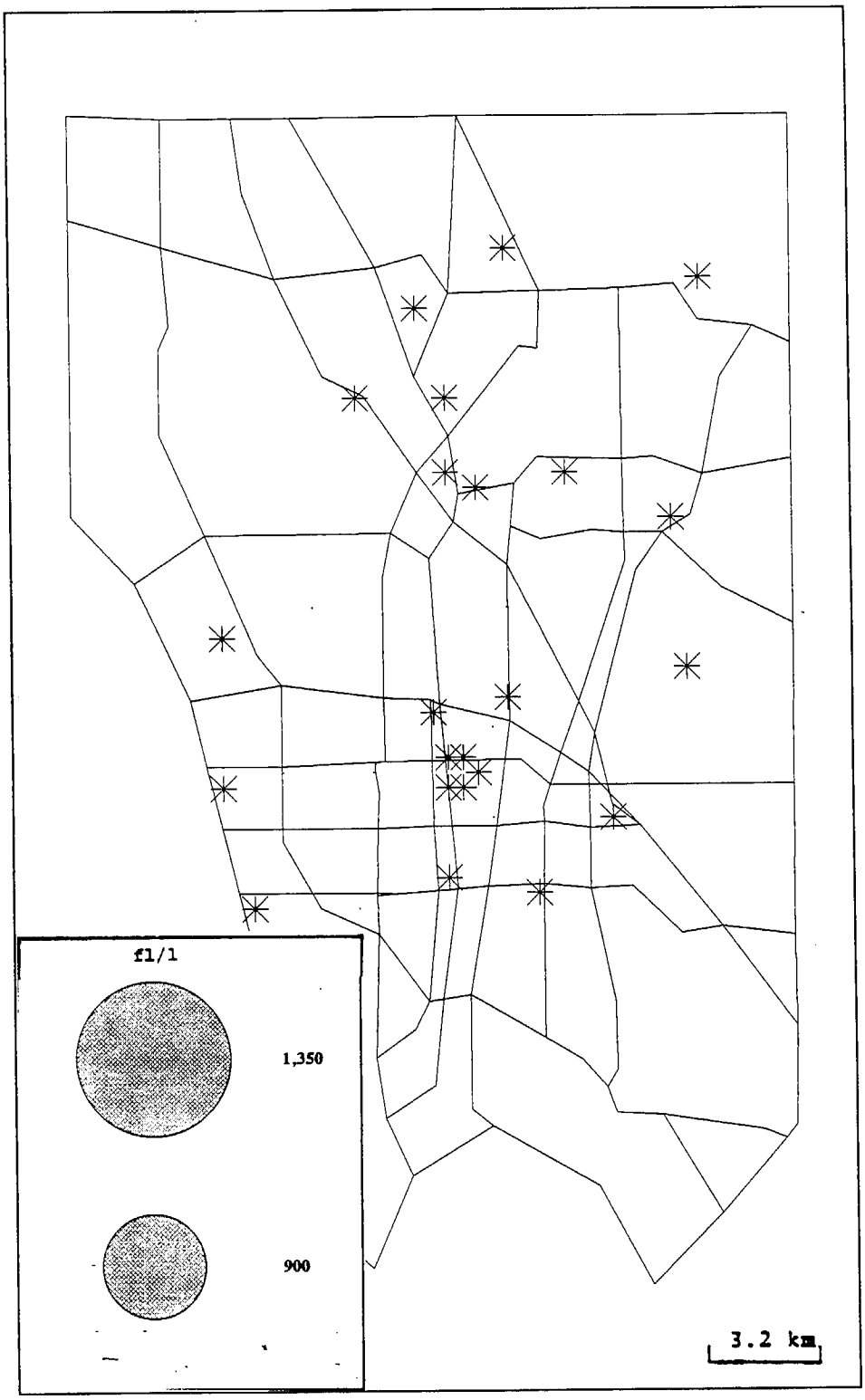

TD 01/09/1990 18:00

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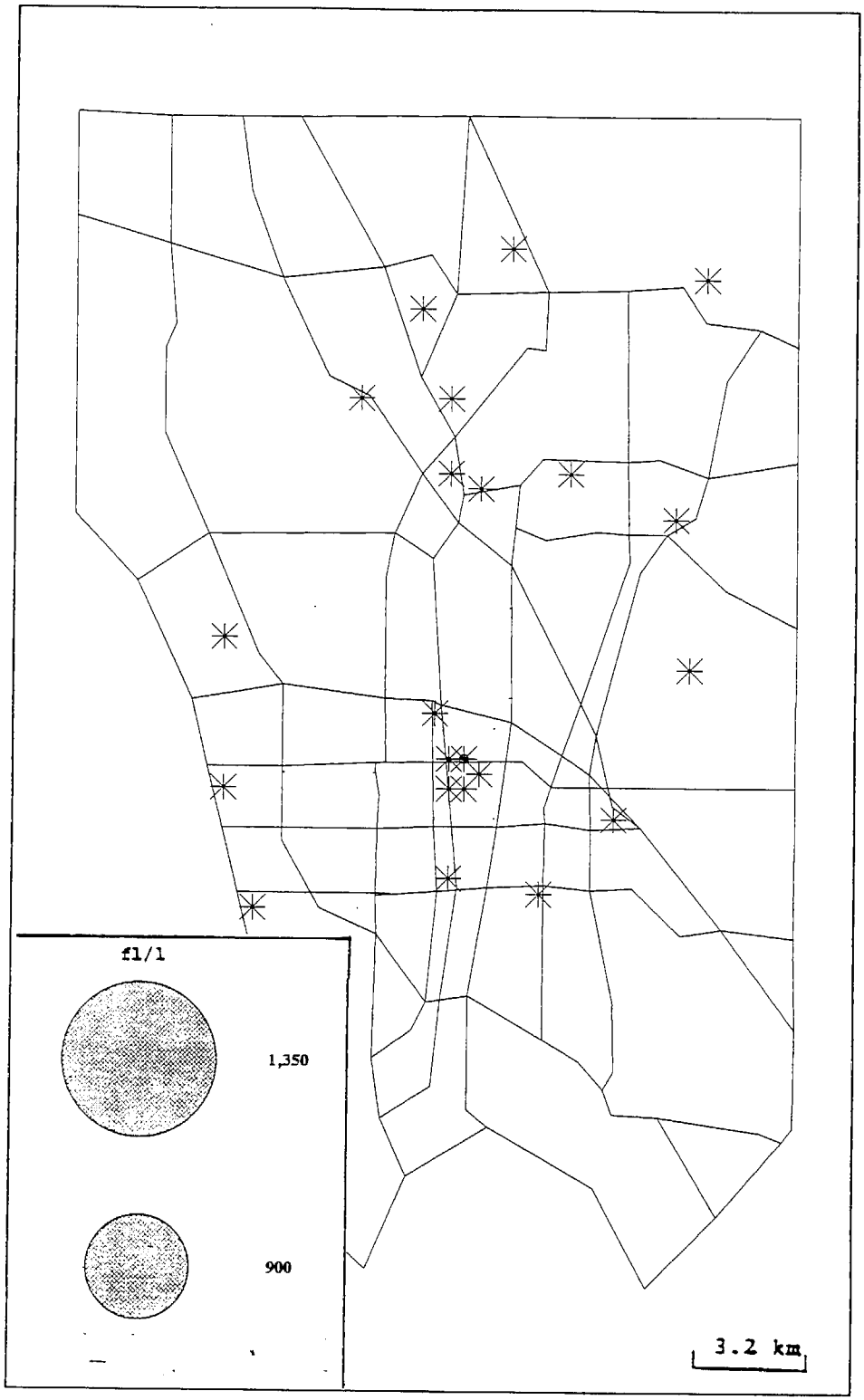

TD 01/09/1990 20:00

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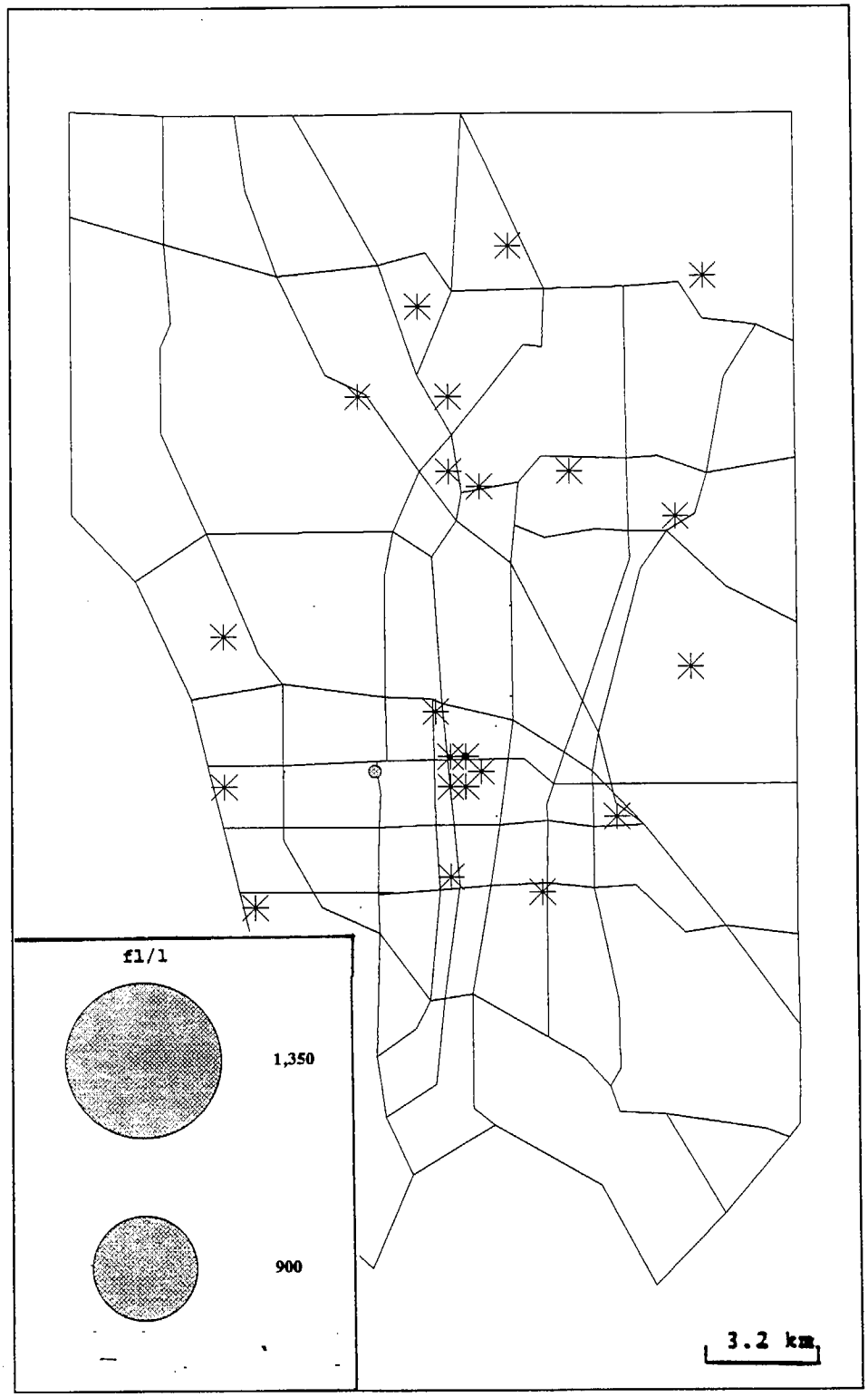
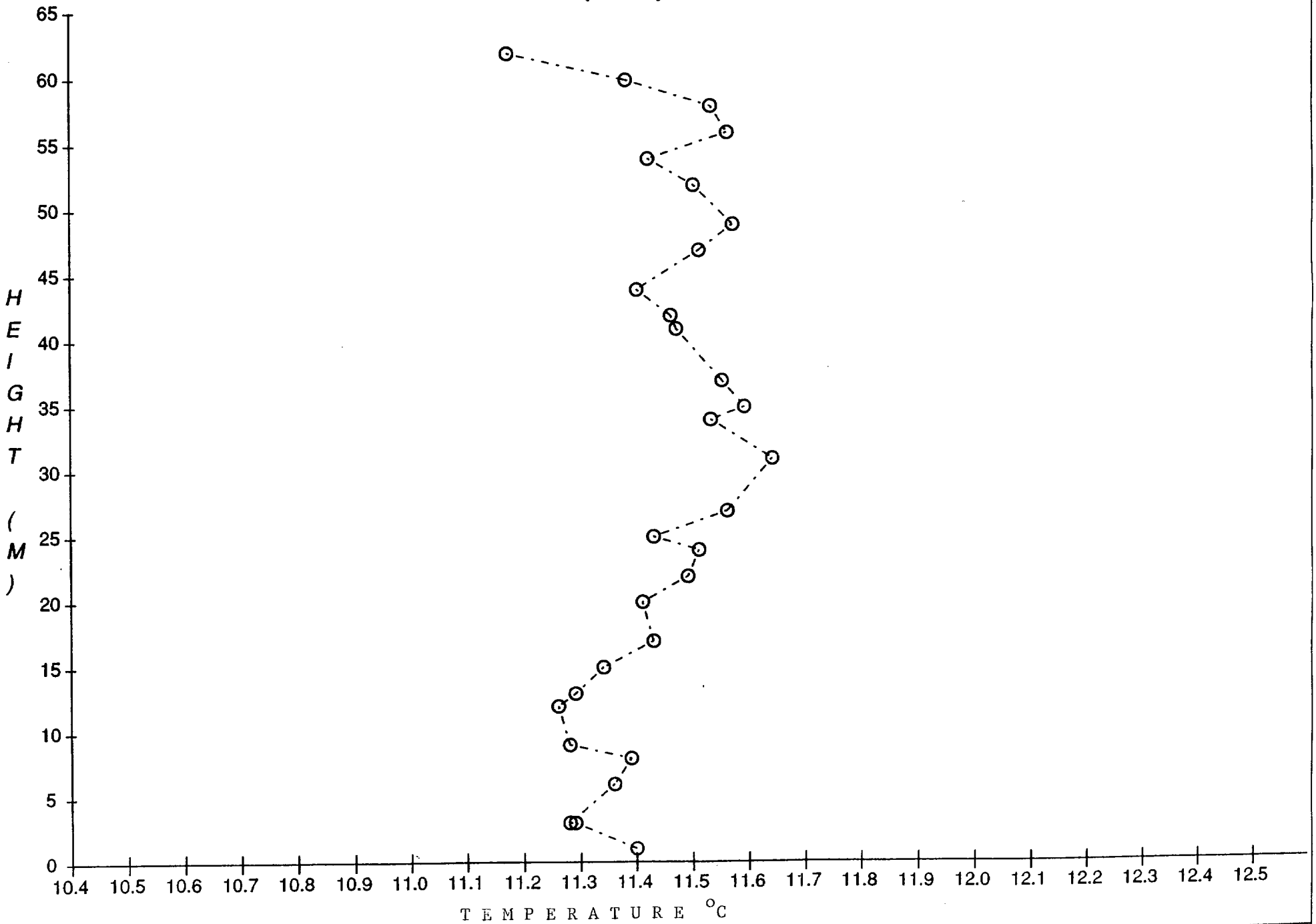


TD 01/09/1990 22:00

Appendix E-1

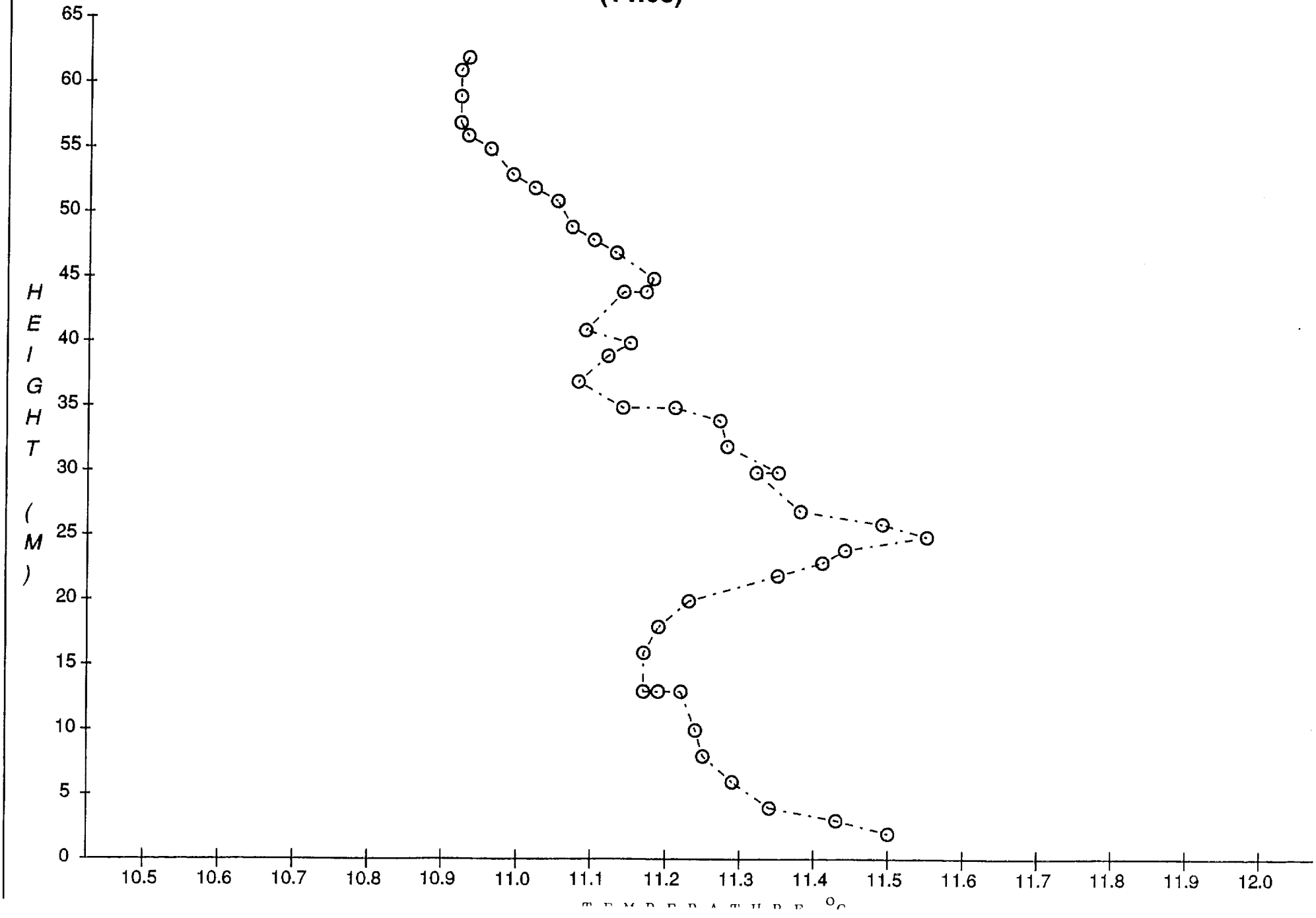
LYNWOOD STATION (December 19, 1989)

(13:34)



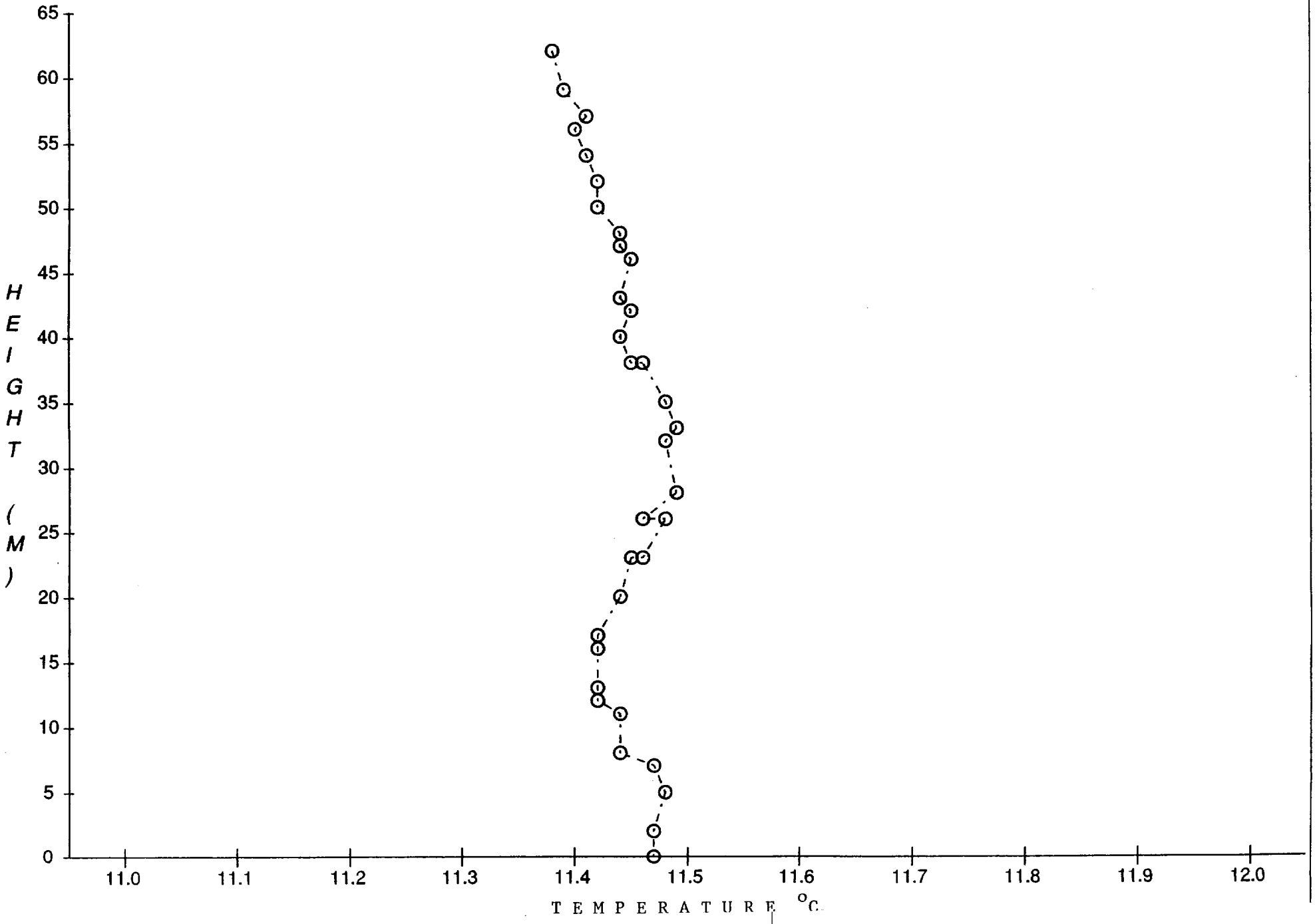
LYNWOOD STATION (December 19, 1990)

(14:03)



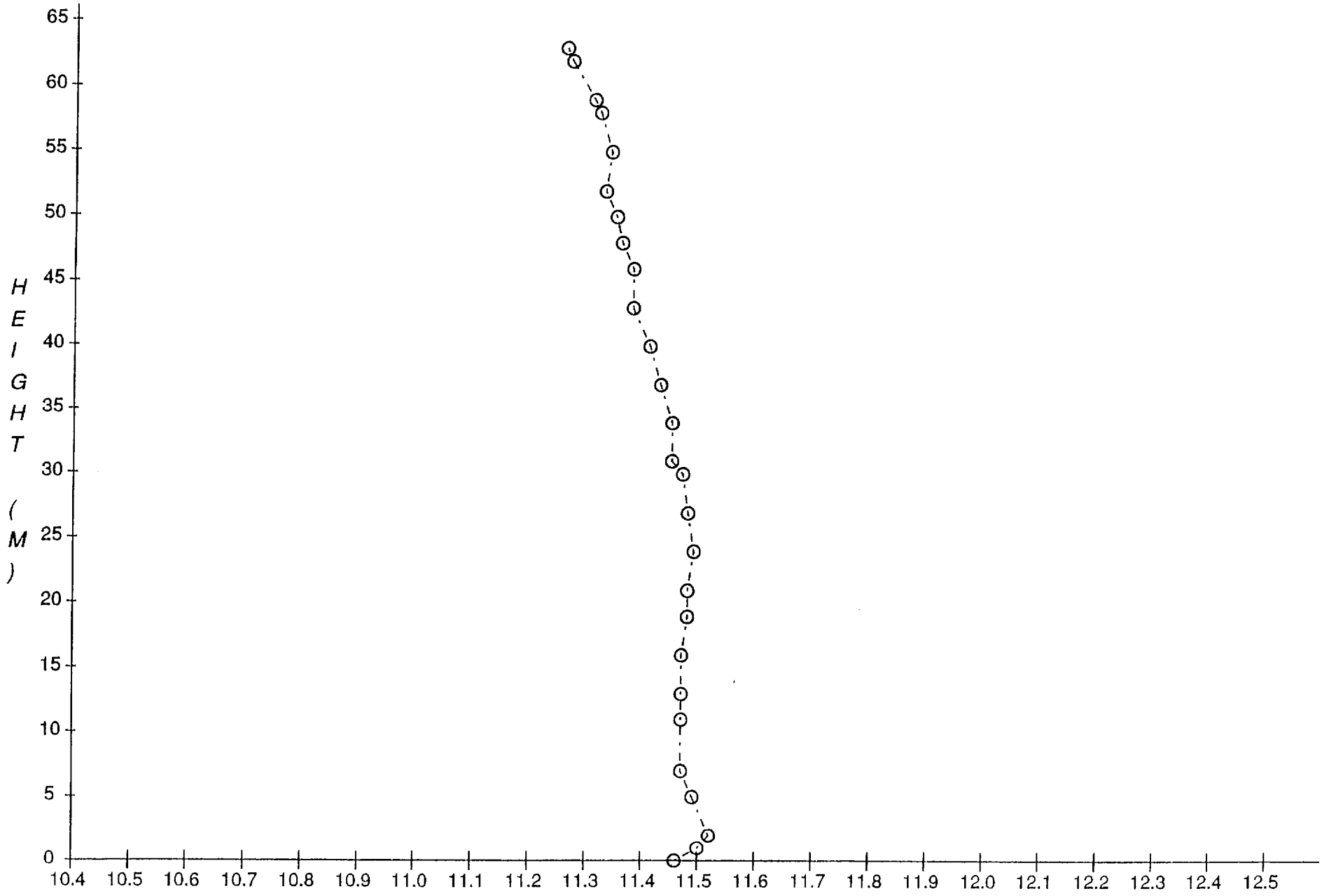
LYNWOOD STATION (December 19, 1989)

(17:31)



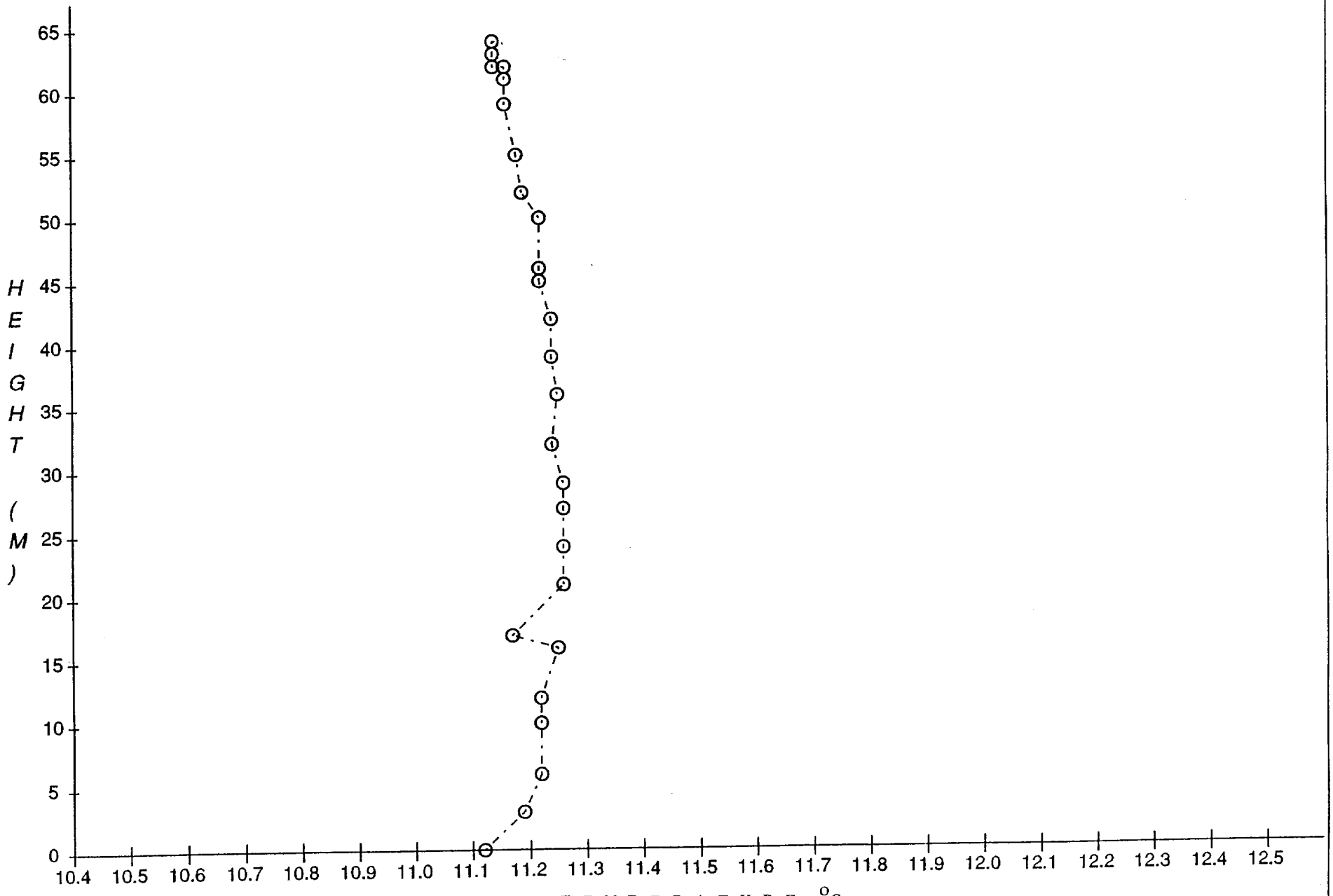
LYNWOOD STATION (December 19, 1989)

(18:31)



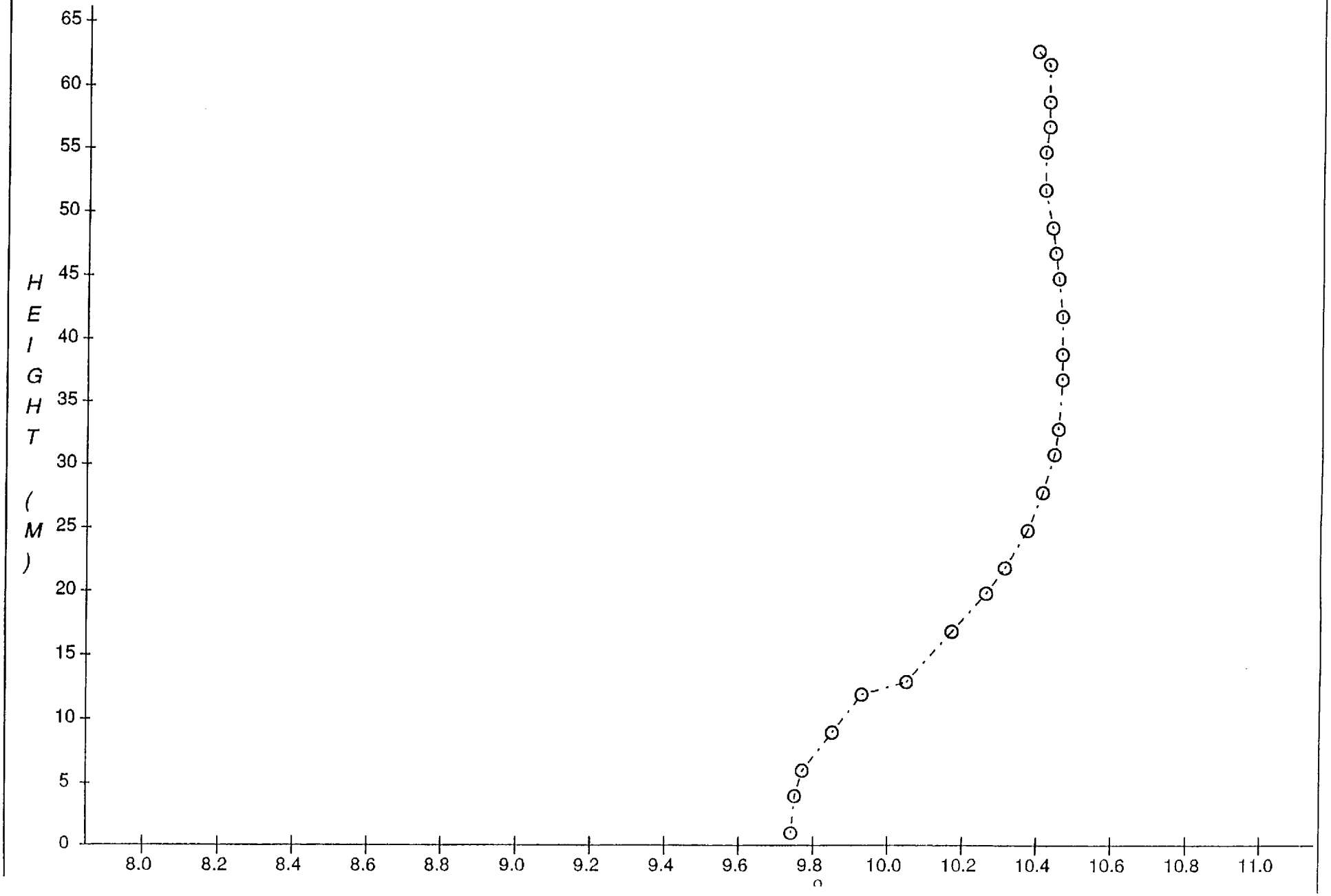
LYNWOOD STATION (December 19, 1989)

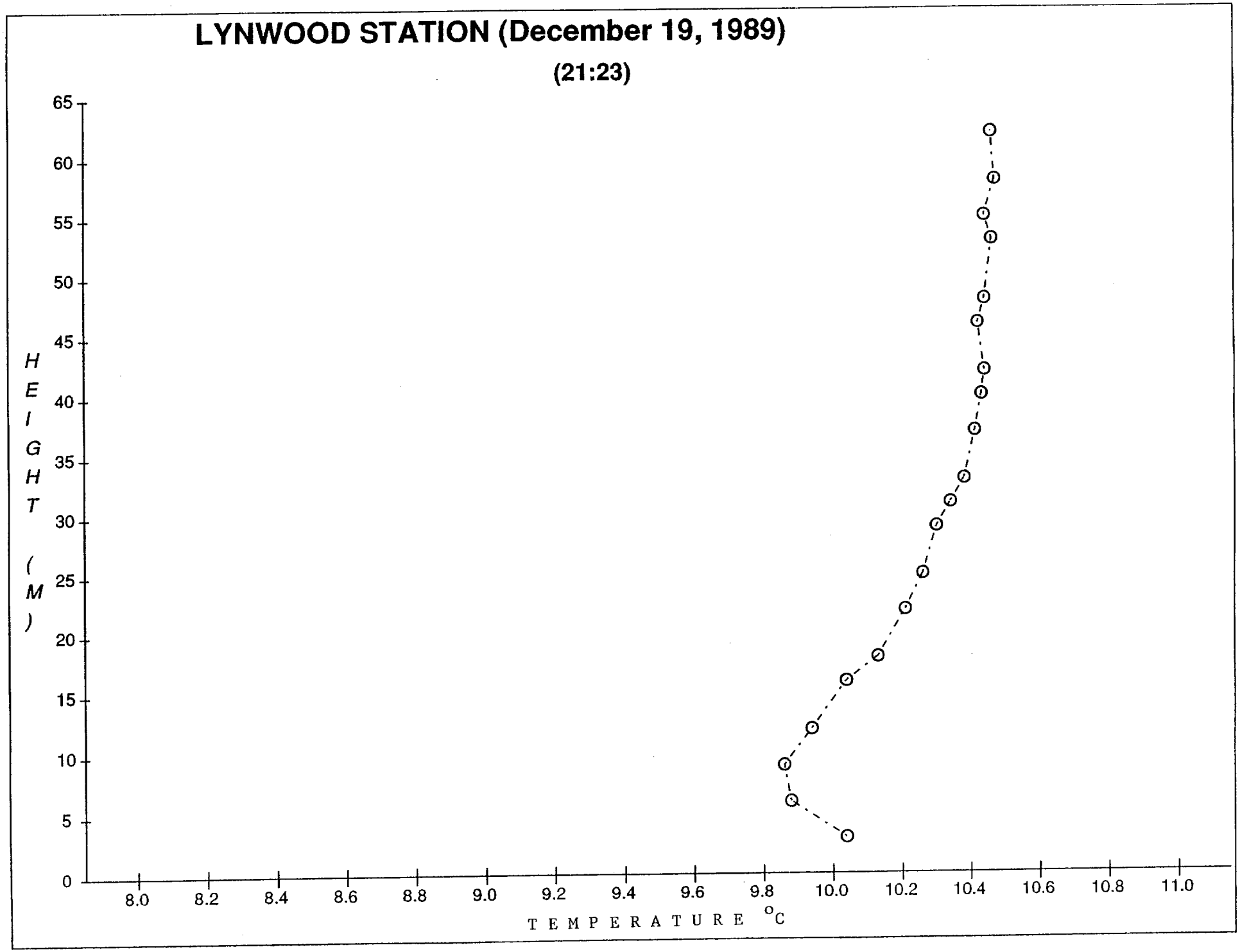
(19:02)



LYNWOOD STATION (December 19, 1989)

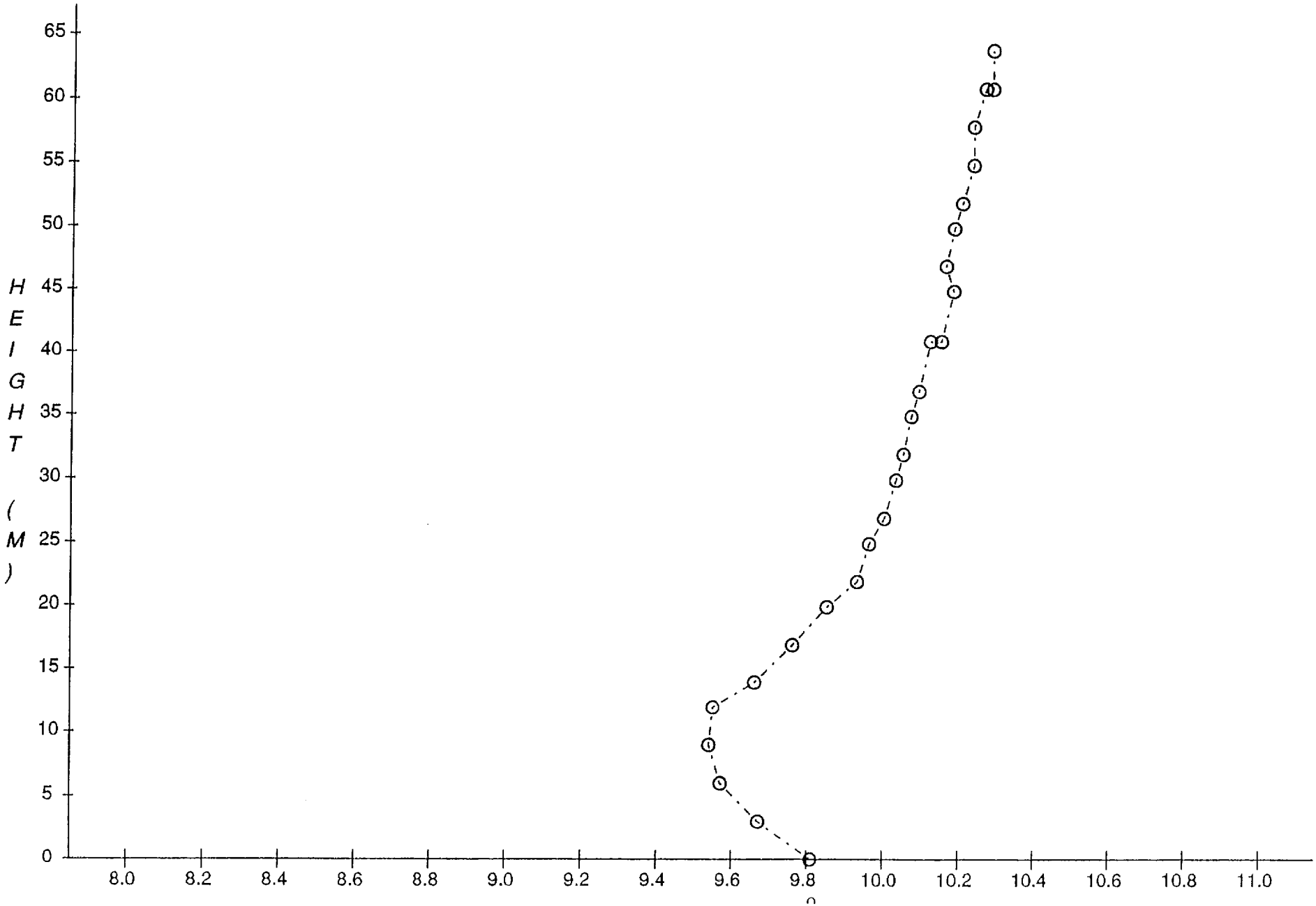
(20:30)




LYNWOOD STATION (December 19, 1989)
(21:23)
HEIGHT (M)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
8.0
8.2
8.4
8.6
8.8
9.0
9.2
9.4
9.6
9.8
10.0
10.2
10.4
10.6
10.8
11.0
TEMPERATURE °C

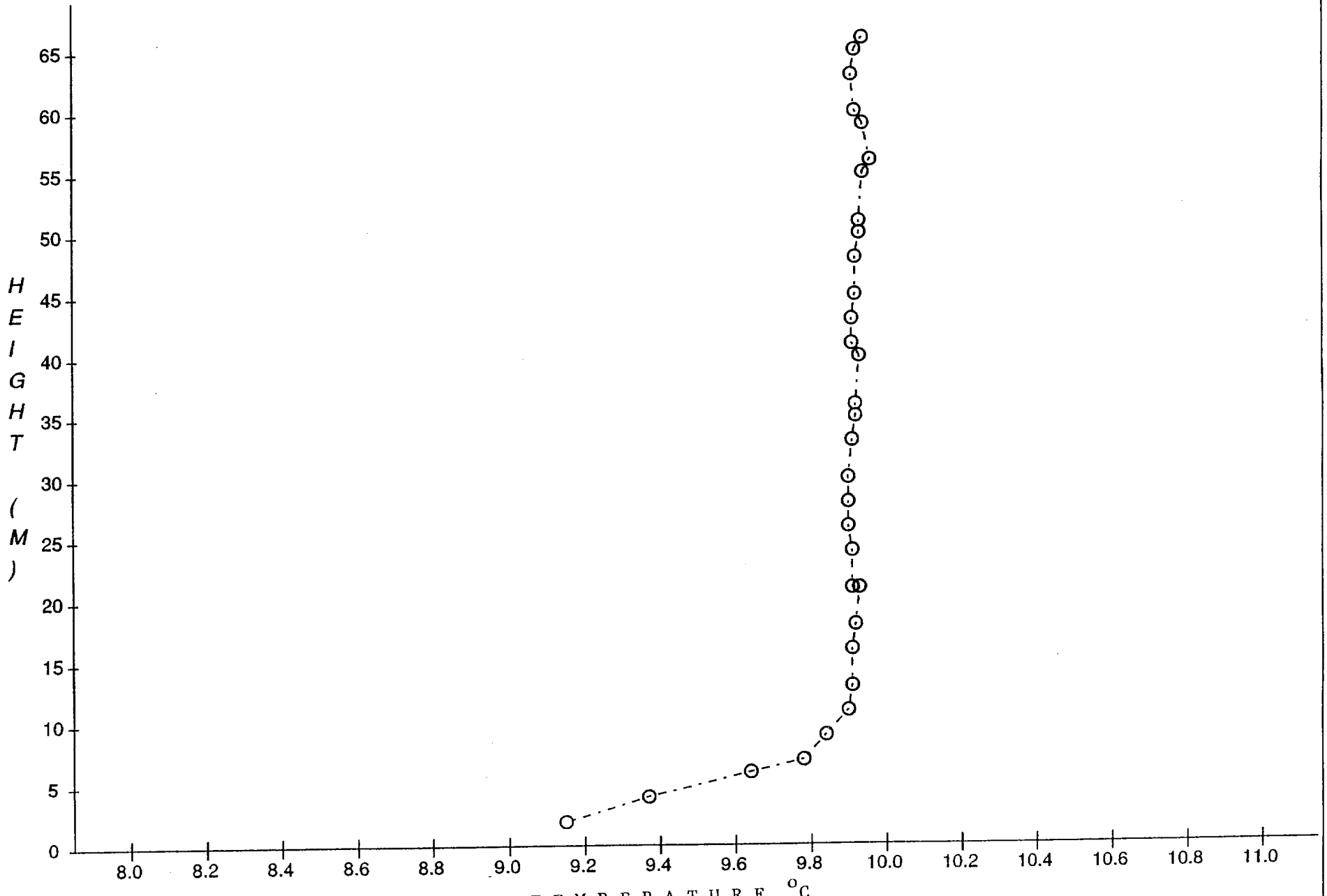
LYNWOOD STATION (December 19, 1989)

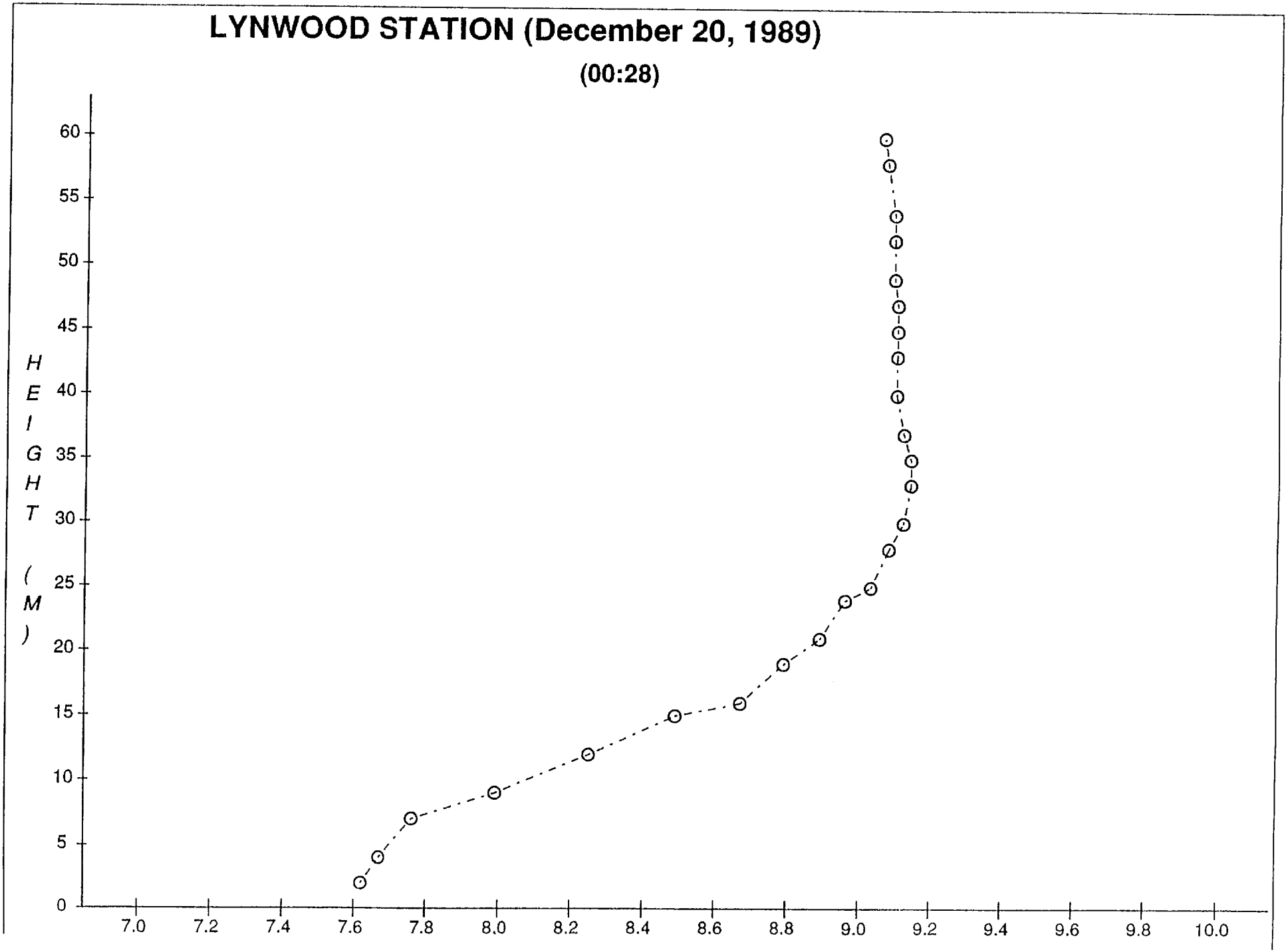
(22:02)



LYNWOOD STATION (December 19, 1989)

(23:06)




LYNWOOD STATION (December 20, 1989)
(00:28)
HEIGHT (M)
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10
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35
40
45
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55
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7.0
7.2
7.4
7.6
7.8
8.0
8.2
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9.0
9.2
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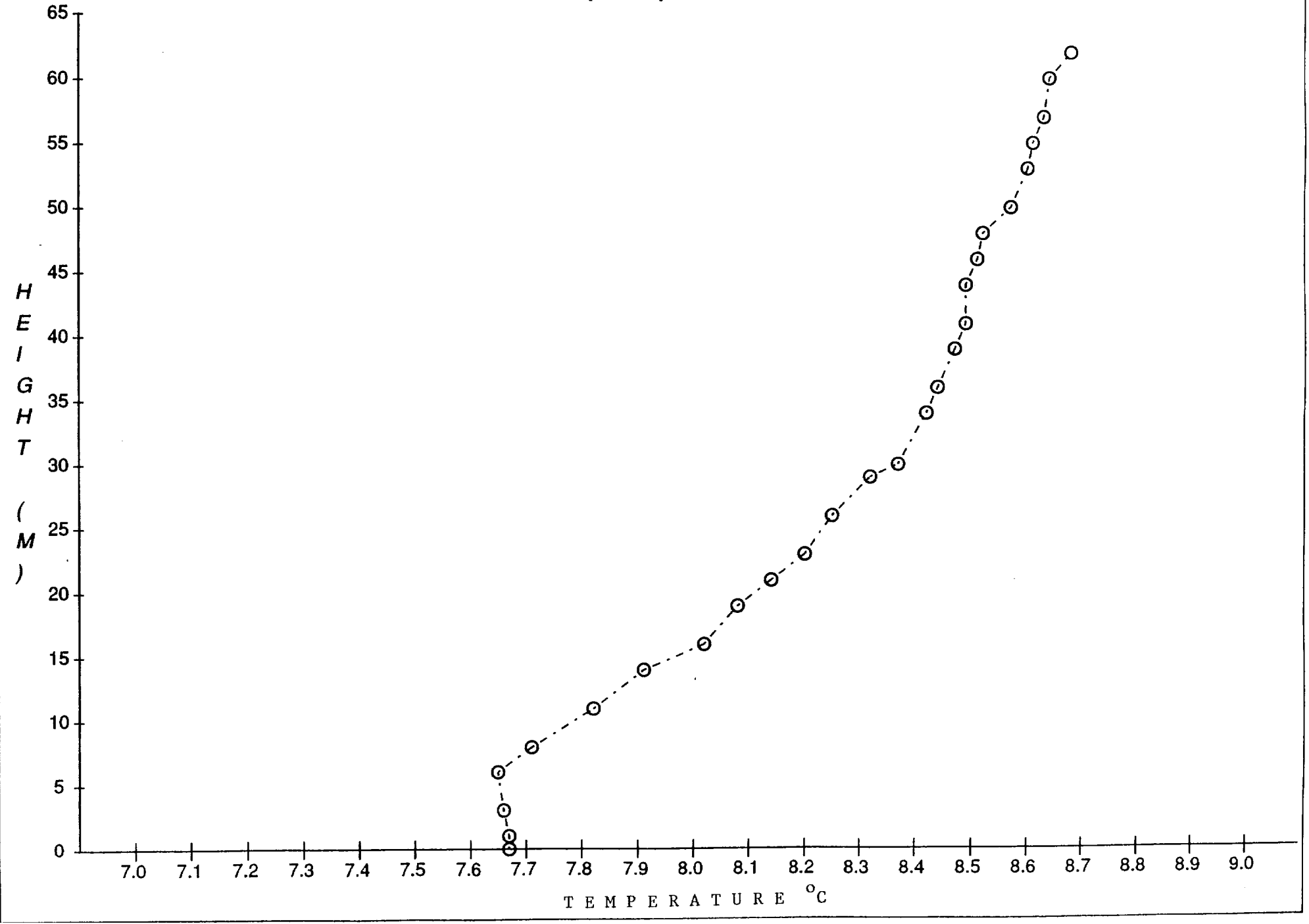
9.6
9.8
10.0

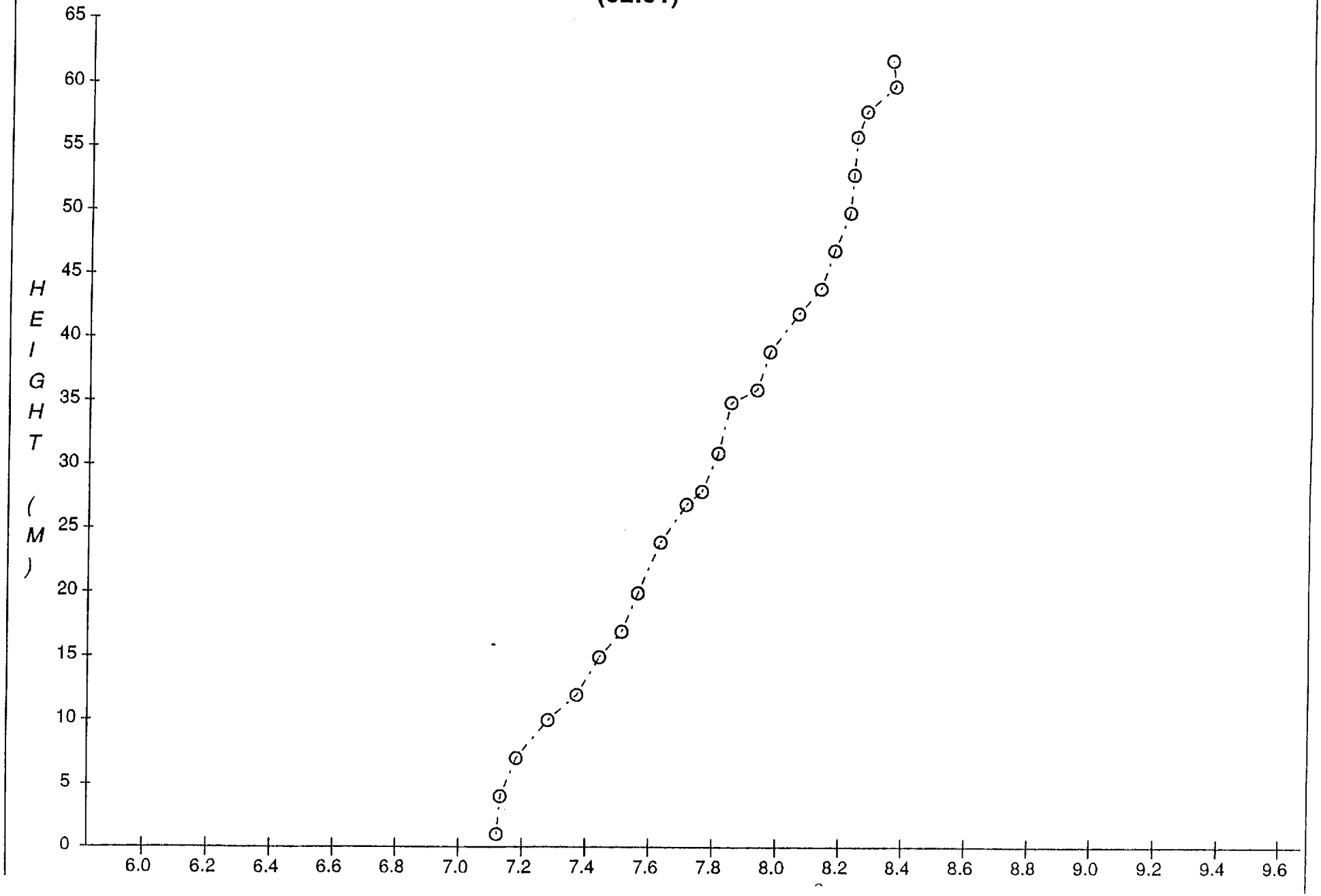
LYNWOOD STATION (December 20, 1989)

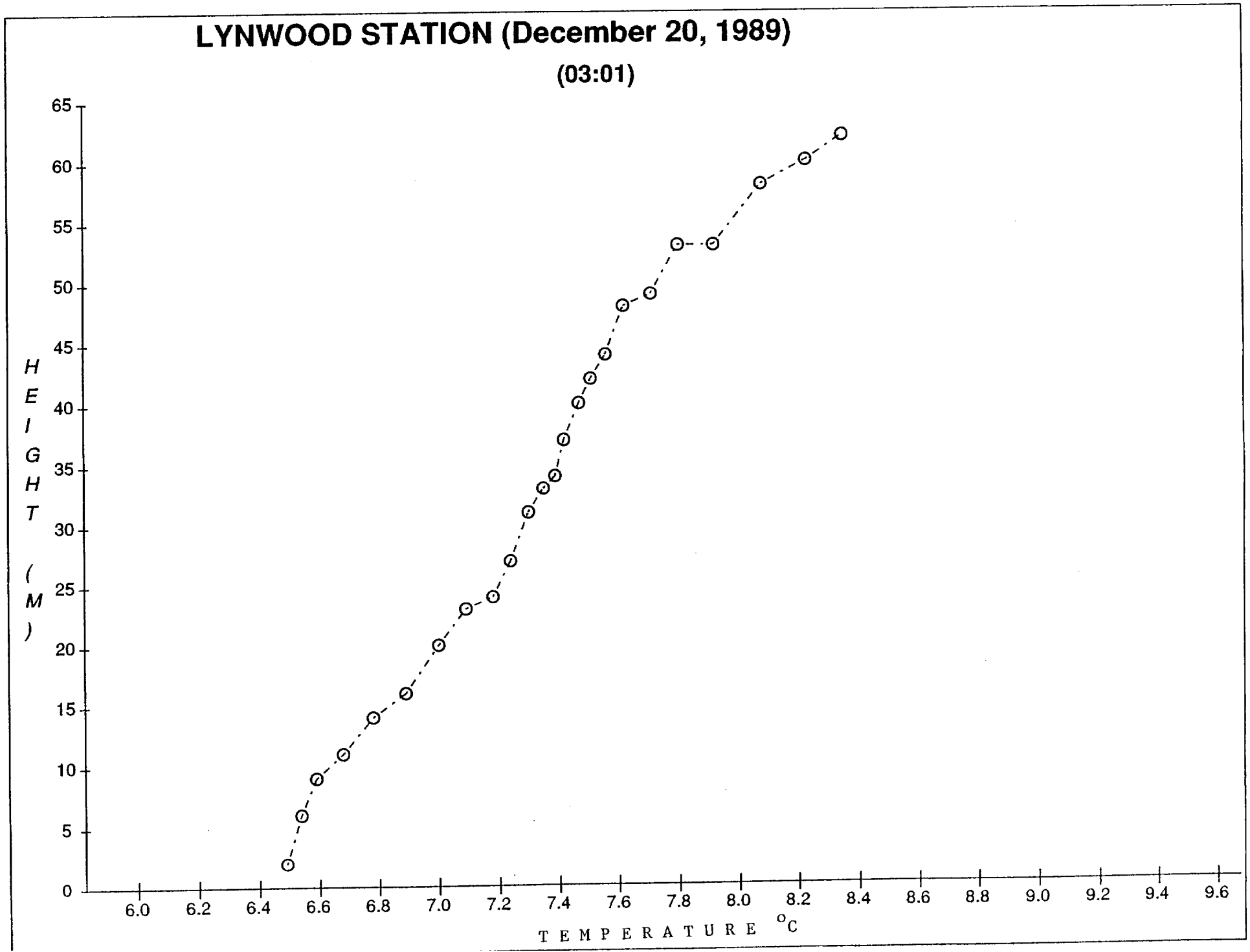
(01:00)



LYNWOOD STATION (December 20, 1989)

(02:01)




LYNWOOD STATION (December 20, 1989)
(03:01)
HEIGHT (M)
65
60
55
50
45
40
35
30
25
20
15
10
5
0
6.0
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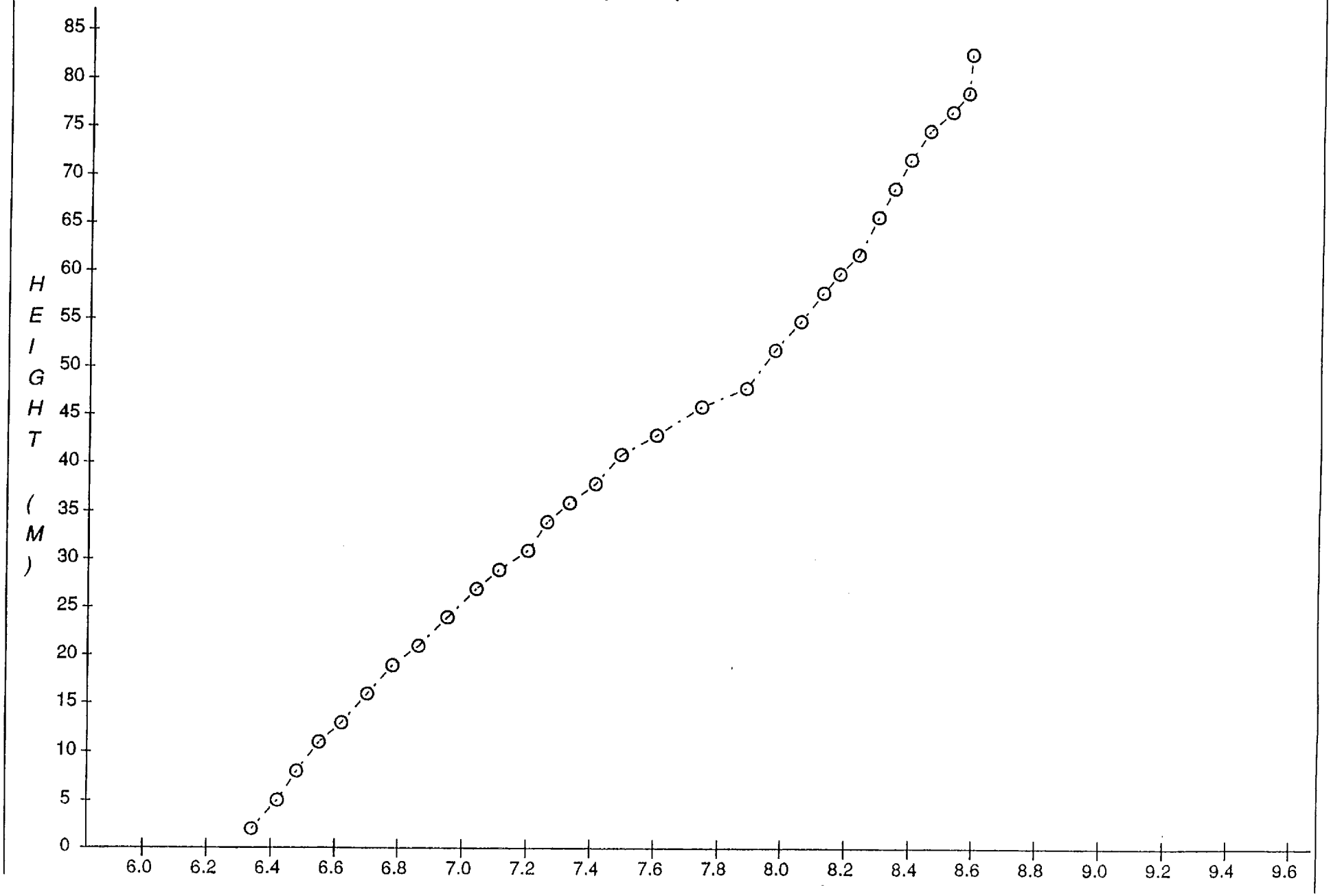
9.4
9.6
TEMPERATURE °C

LYNWOOD STATION (December 20, 1989)

(04:05)



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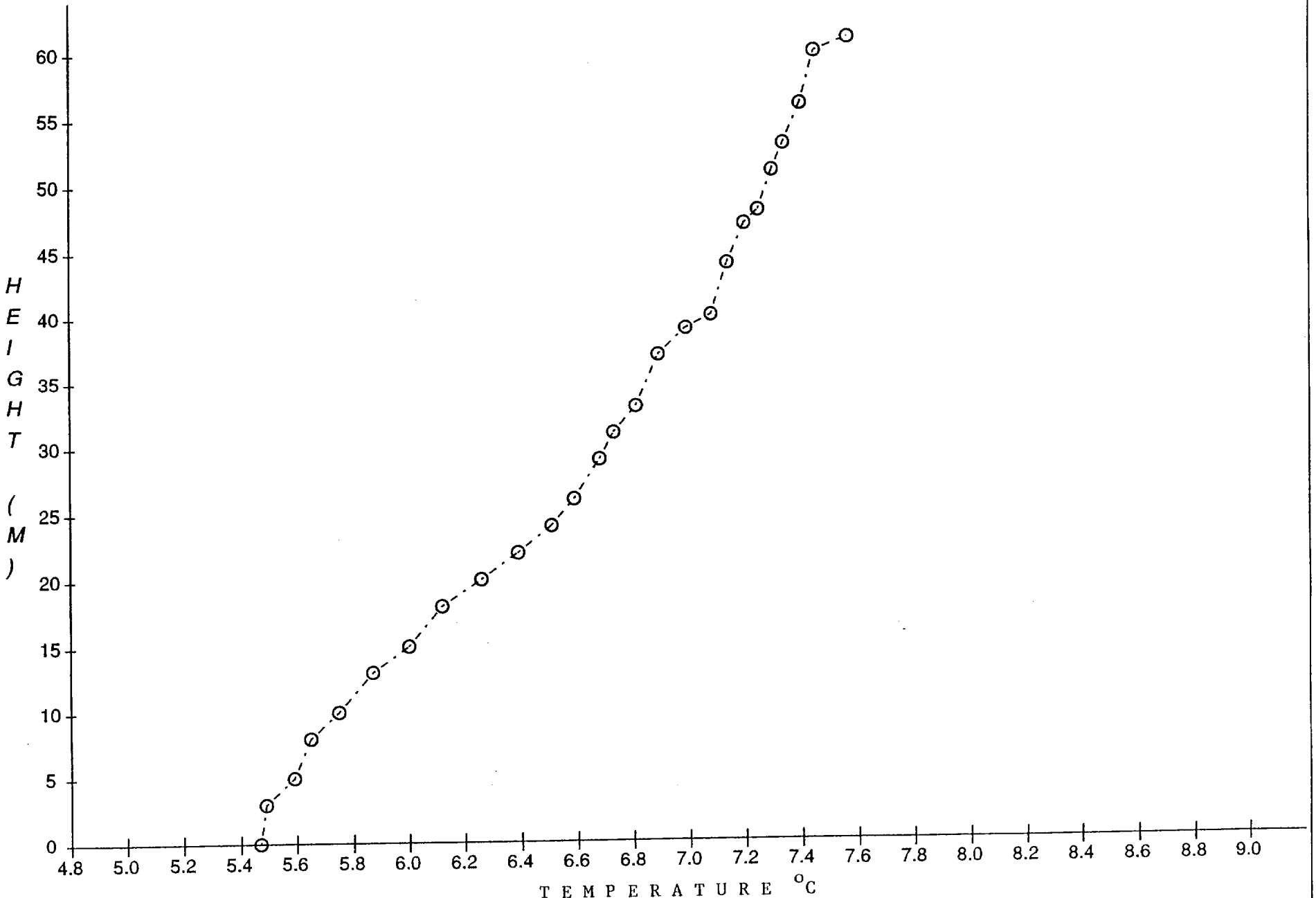
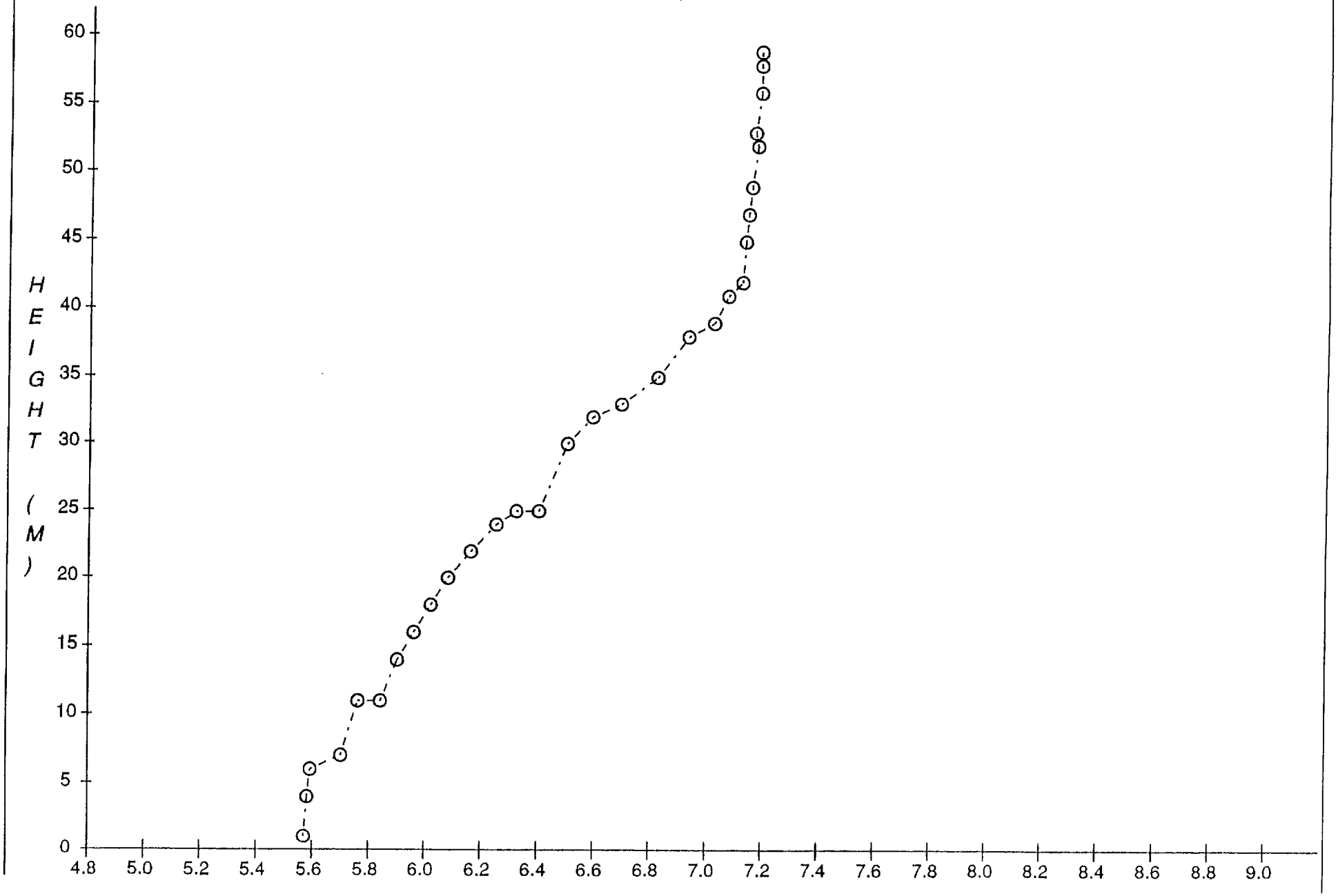
(05:01)



LYNWOOD STATION (December 20, 1989)

(06:02)



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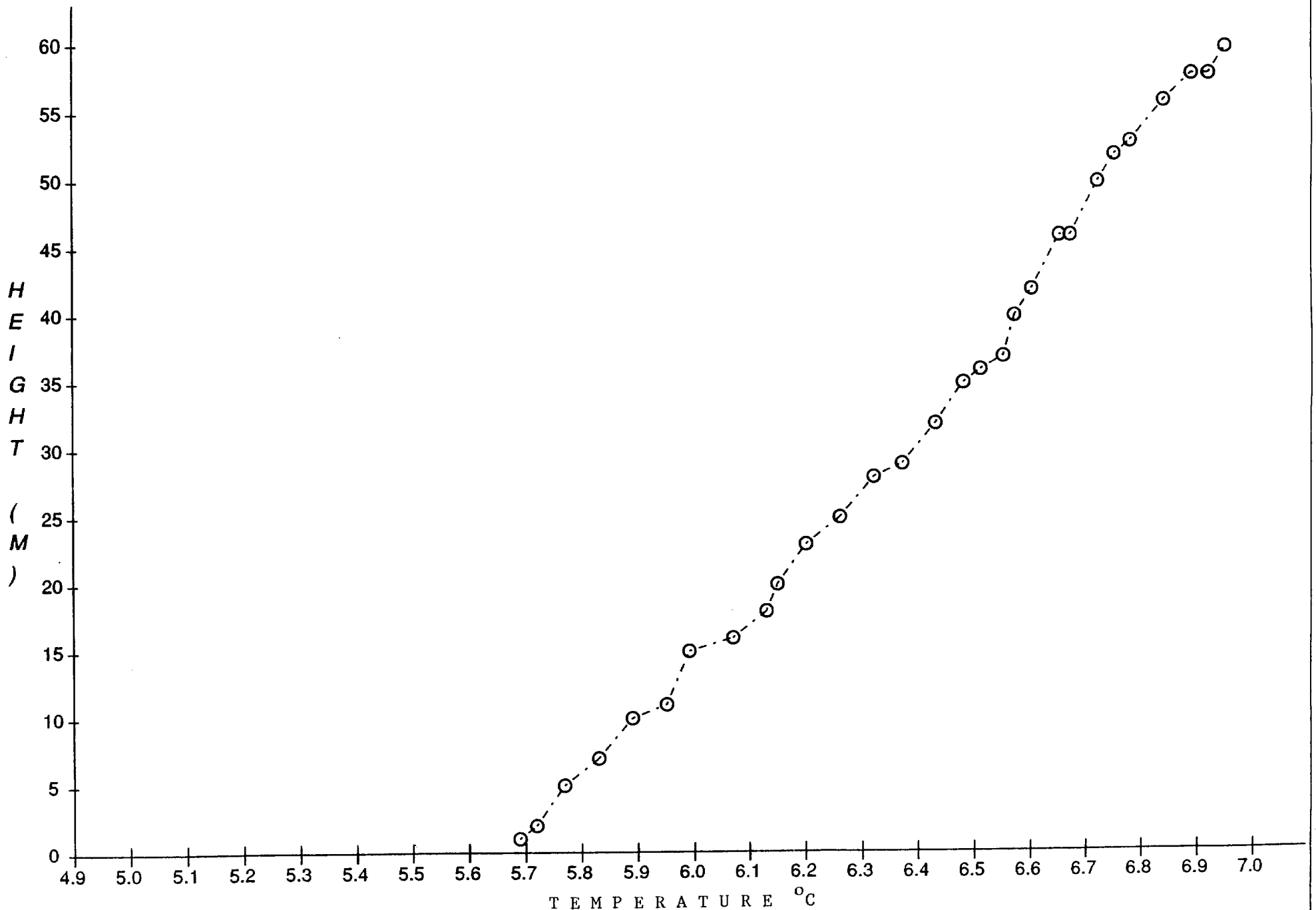
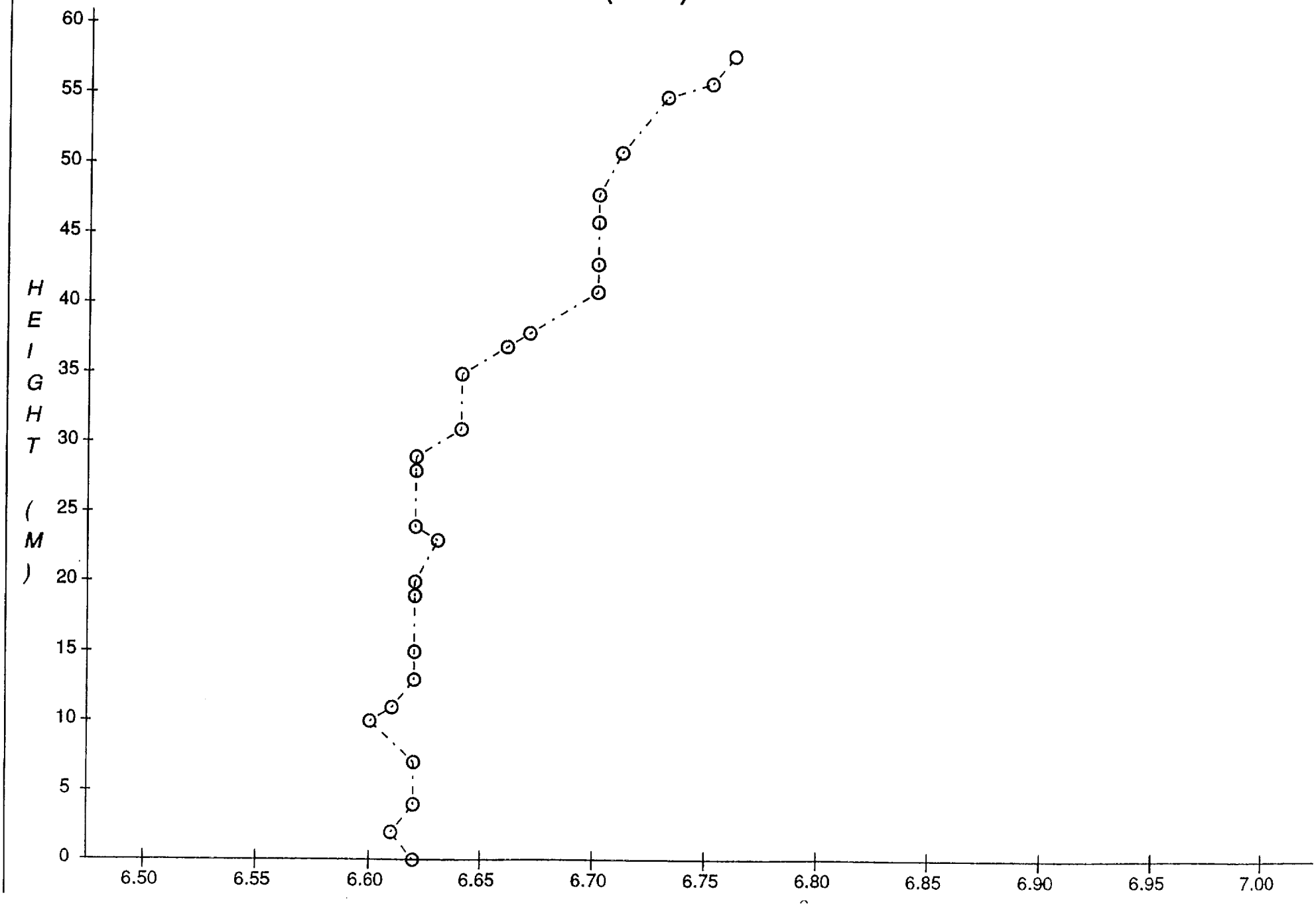
(07:02)



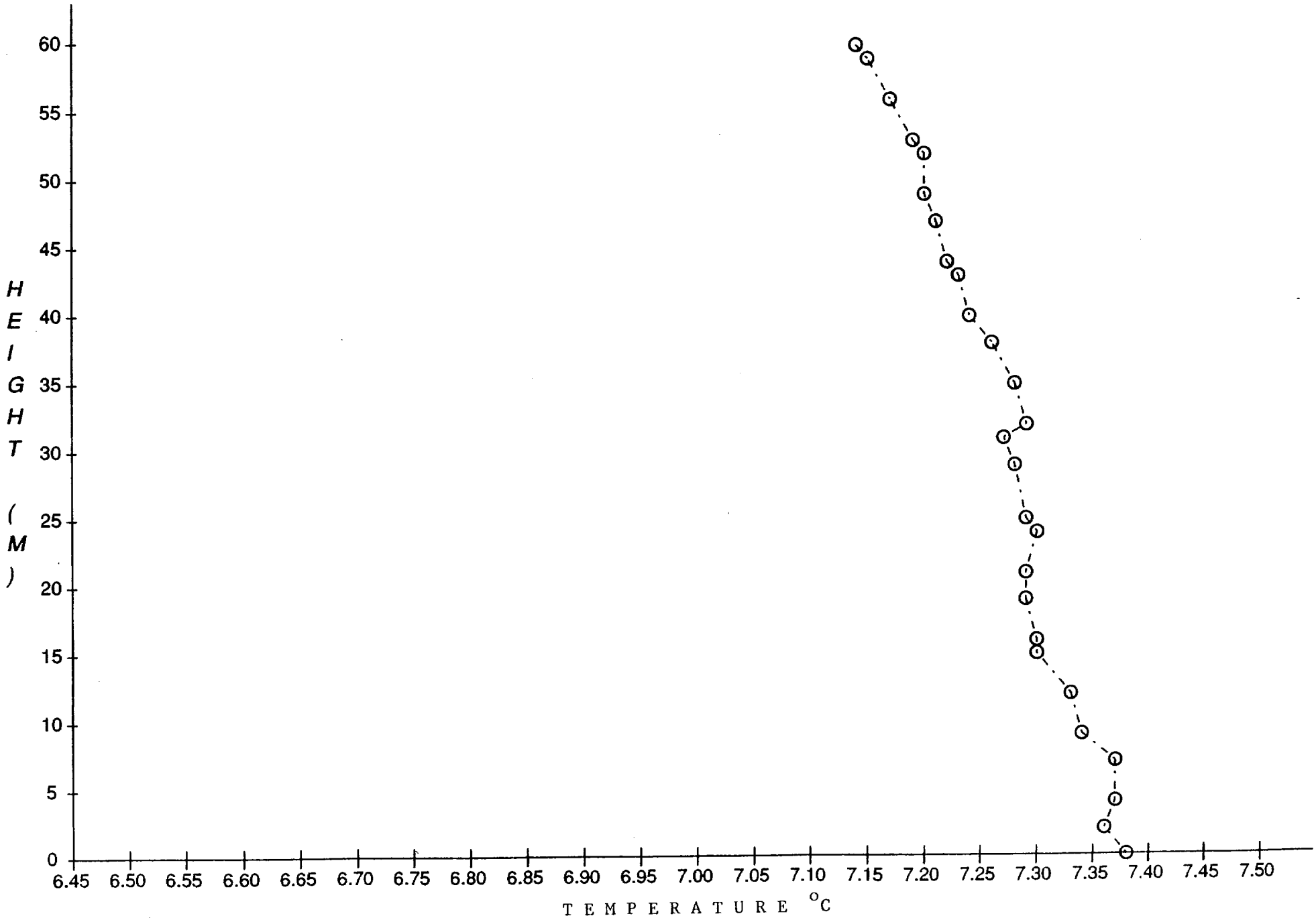
LYNWOOD STATION (December 20, 1989)

(08:01)



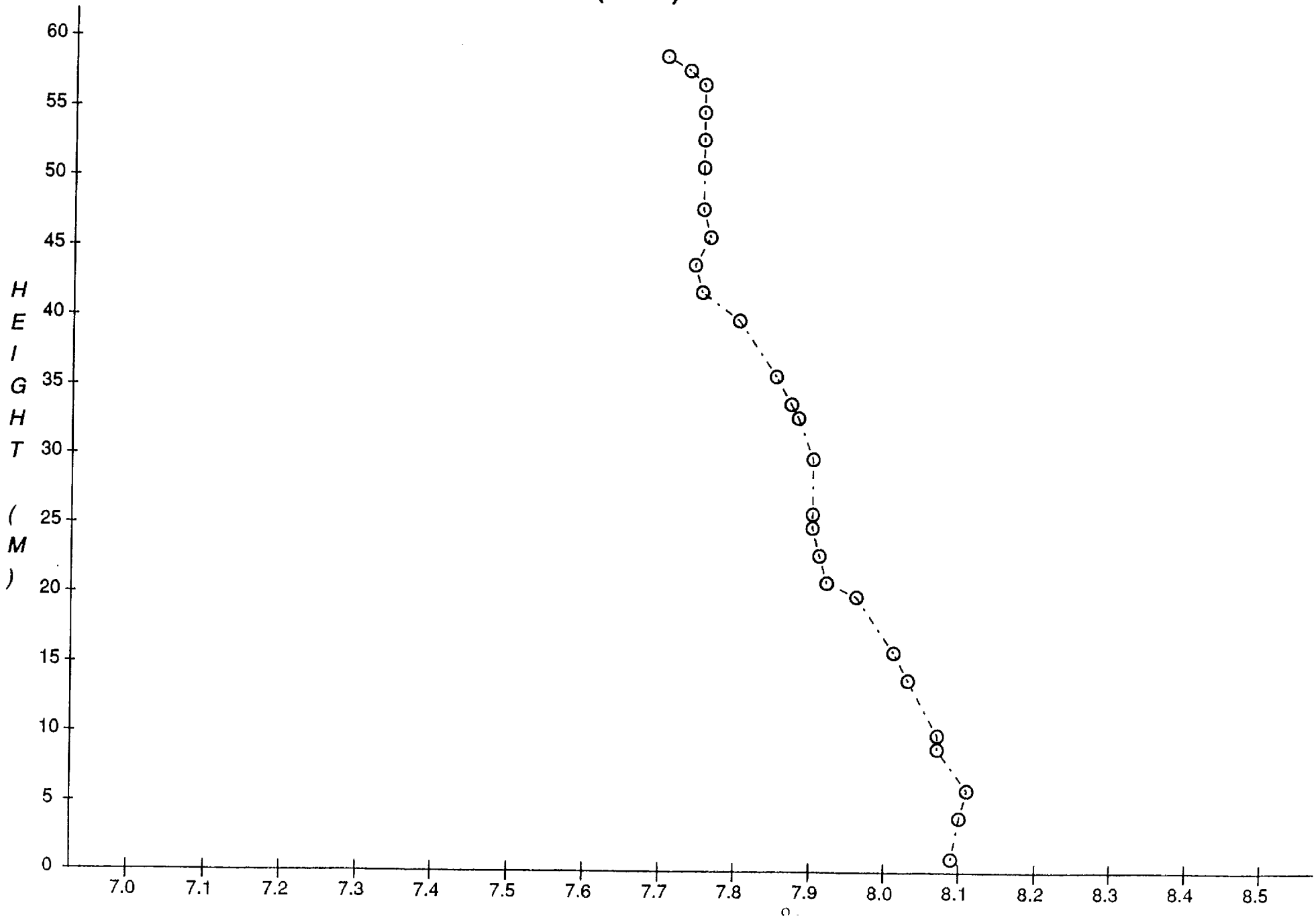
LYNWOOD STATION (December 20, 1989)

(08:33)



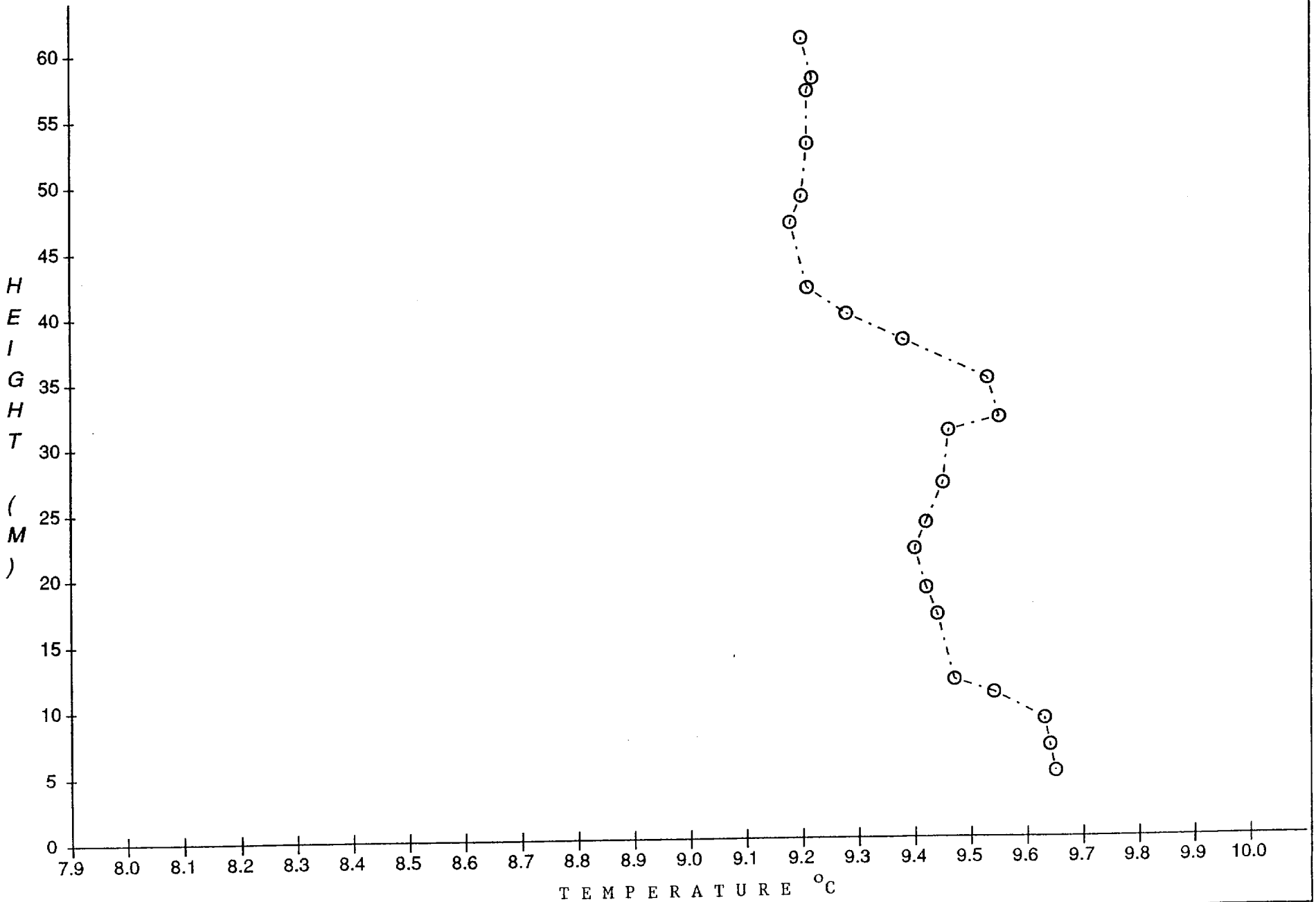
LYNWOOD STATION (December 20, 1989)

(09:03)



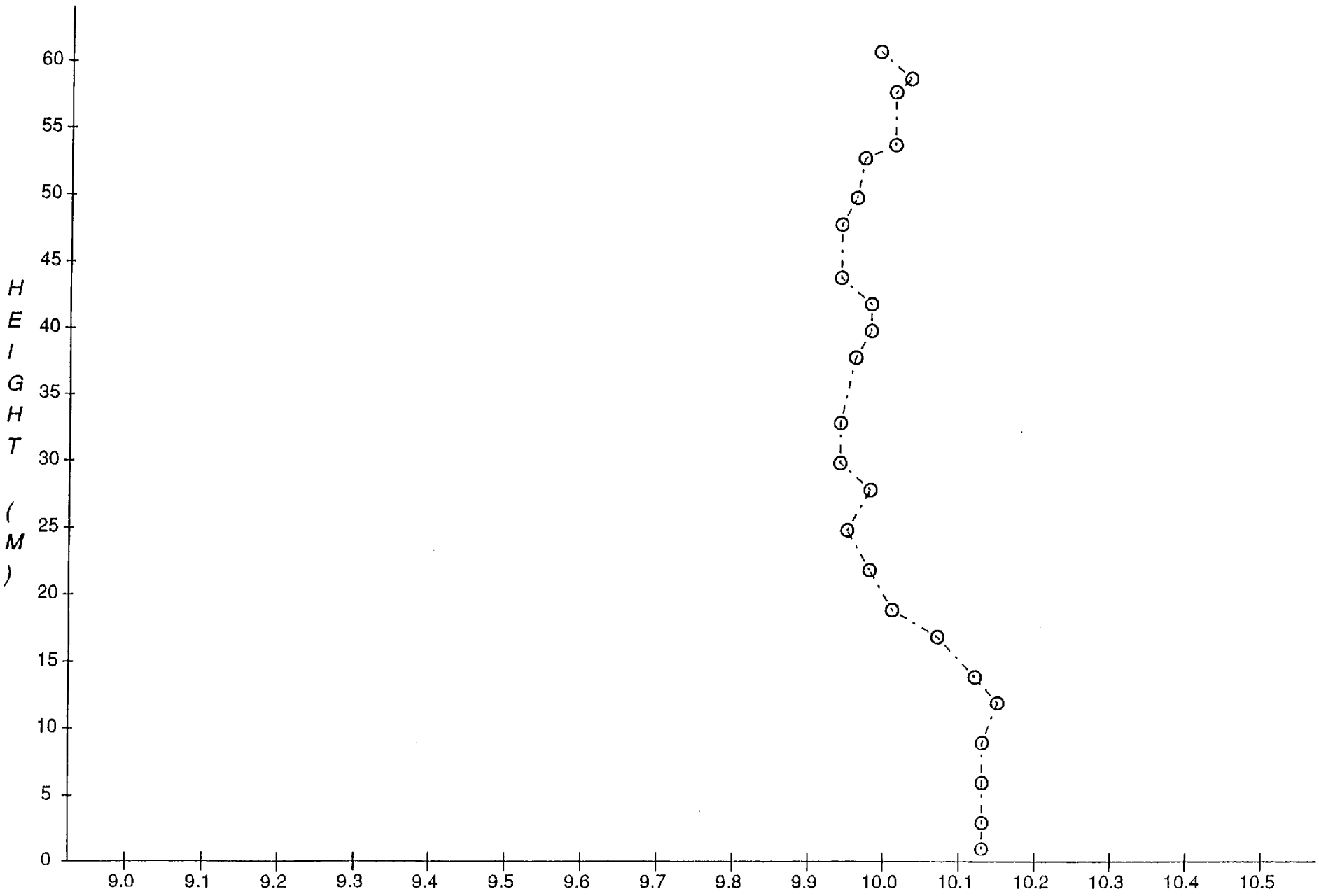
LYNWOOD STATION (December 20, 1989)

(10:37)



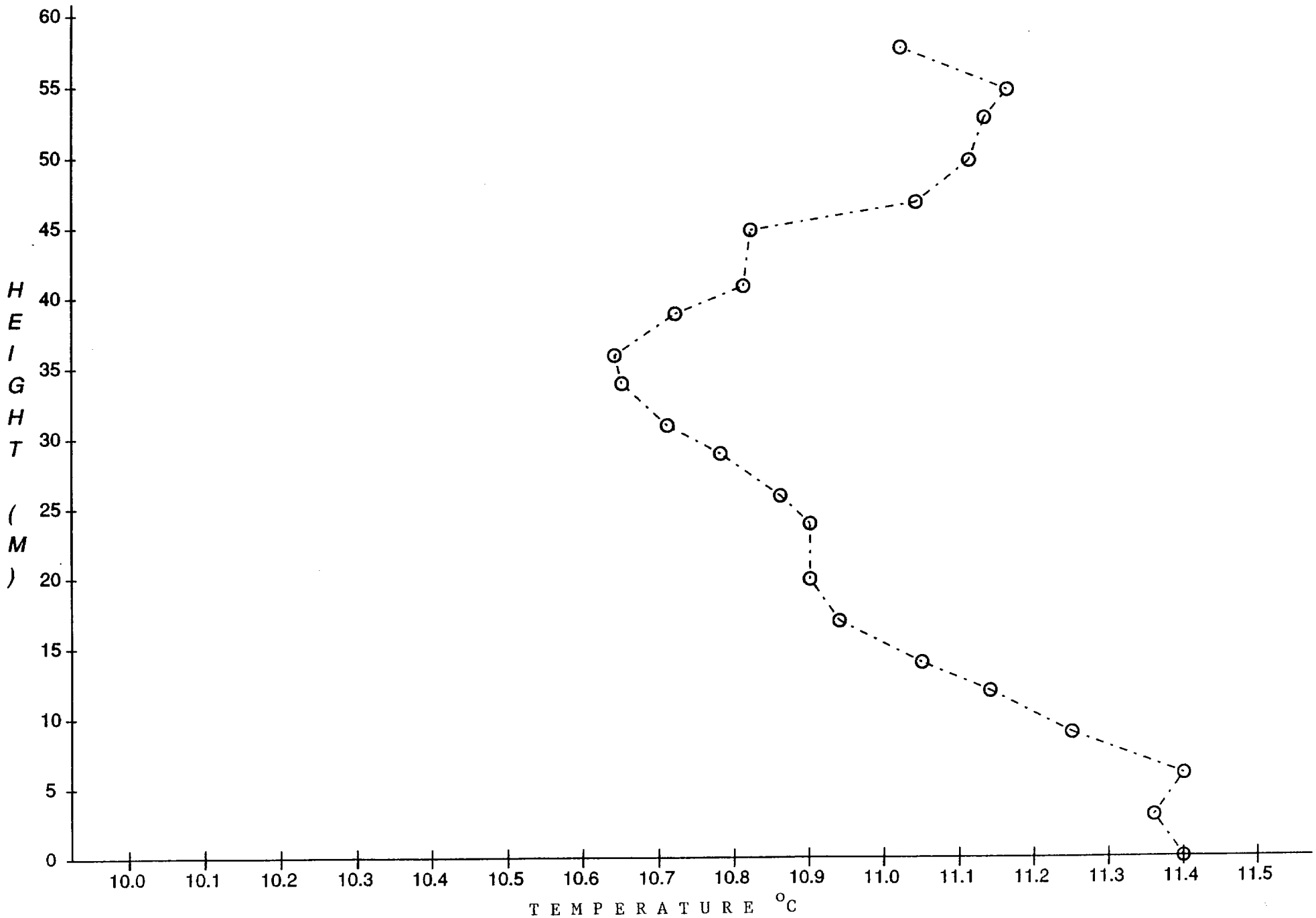
LYNWOOD STATION (December 20, 1989)

(11:02)



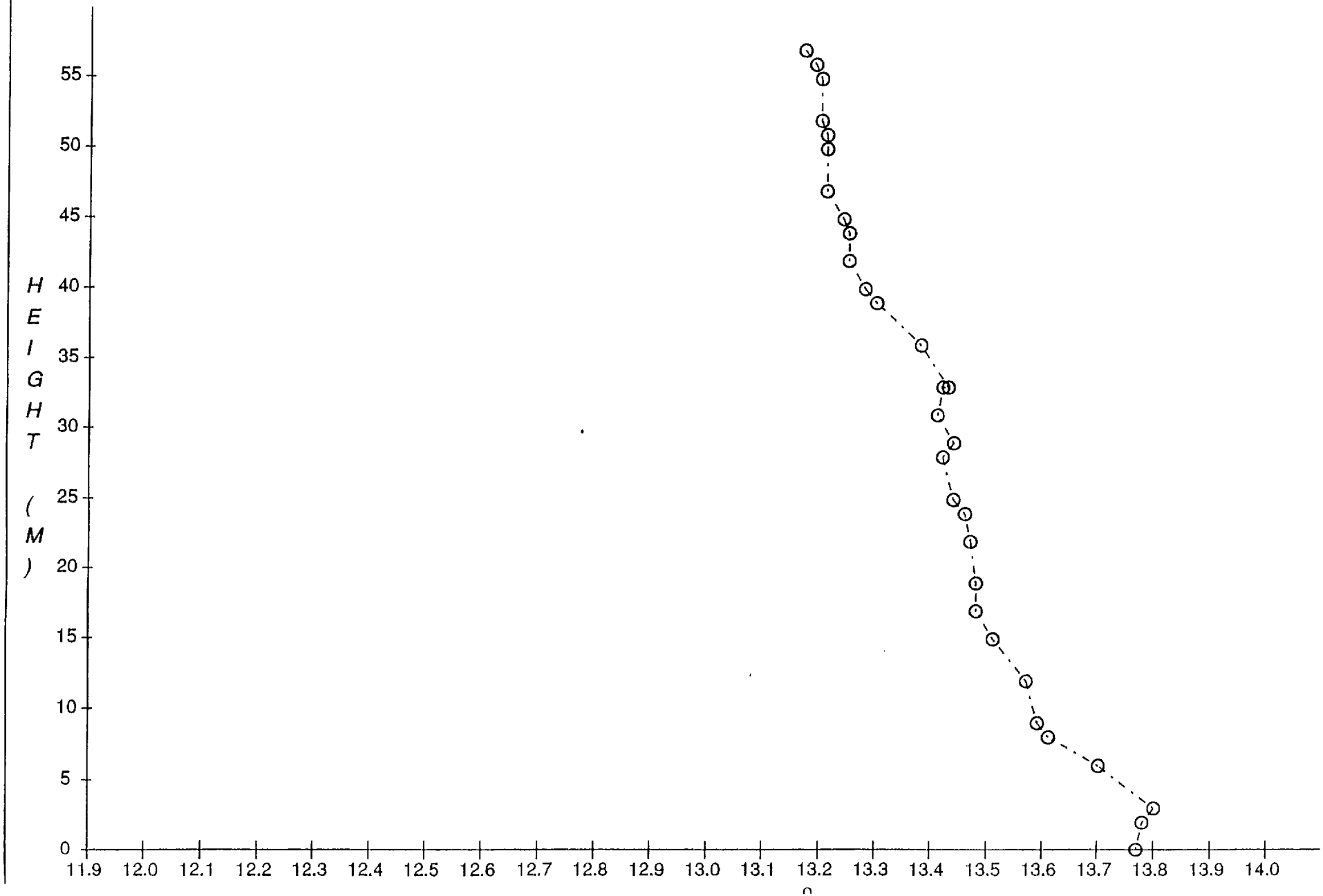
LYNWOOD STATION (December 20, 1989)

(12:01)



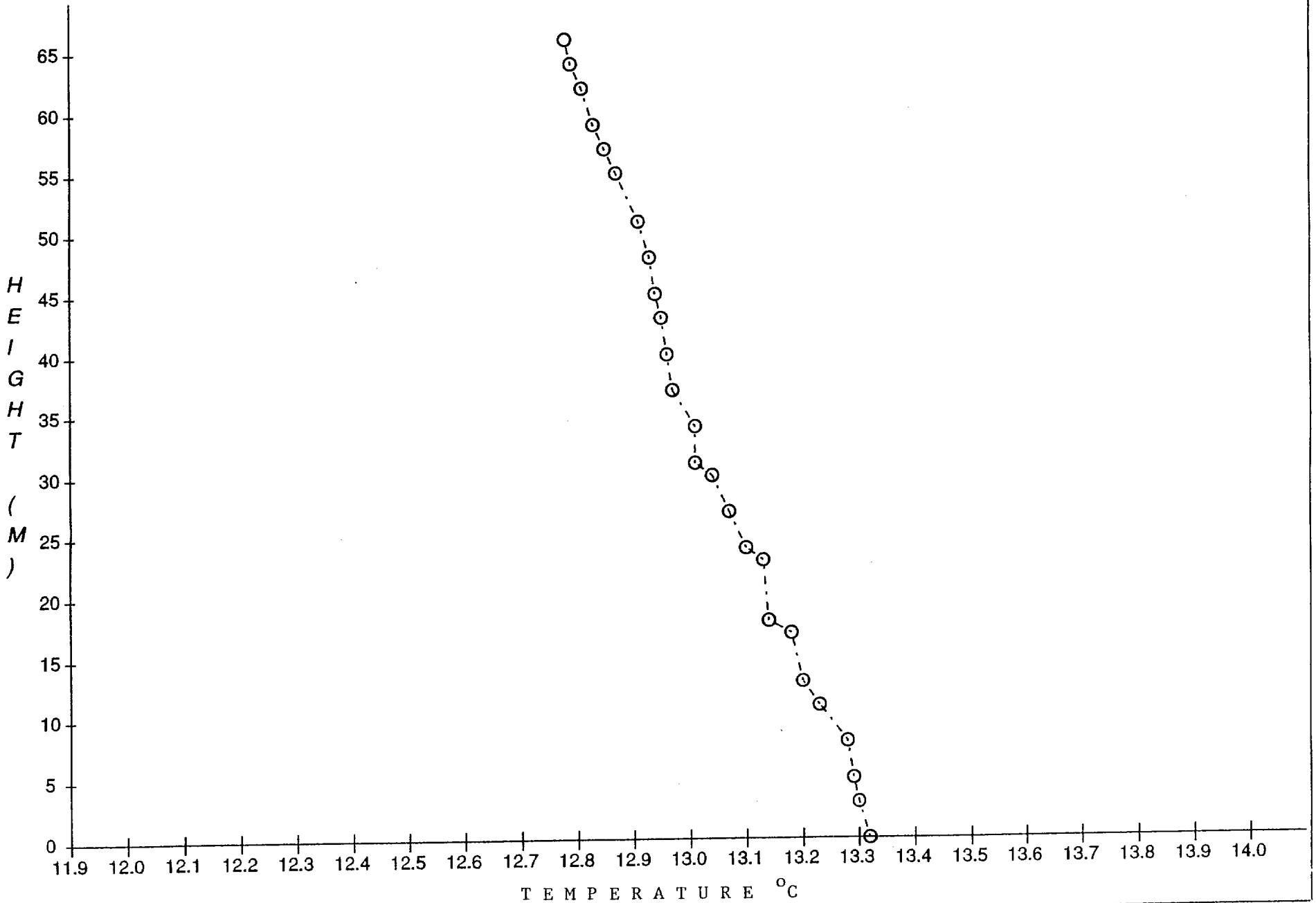
LYNWOOD STATION (January 8, 1990)

(16:06)



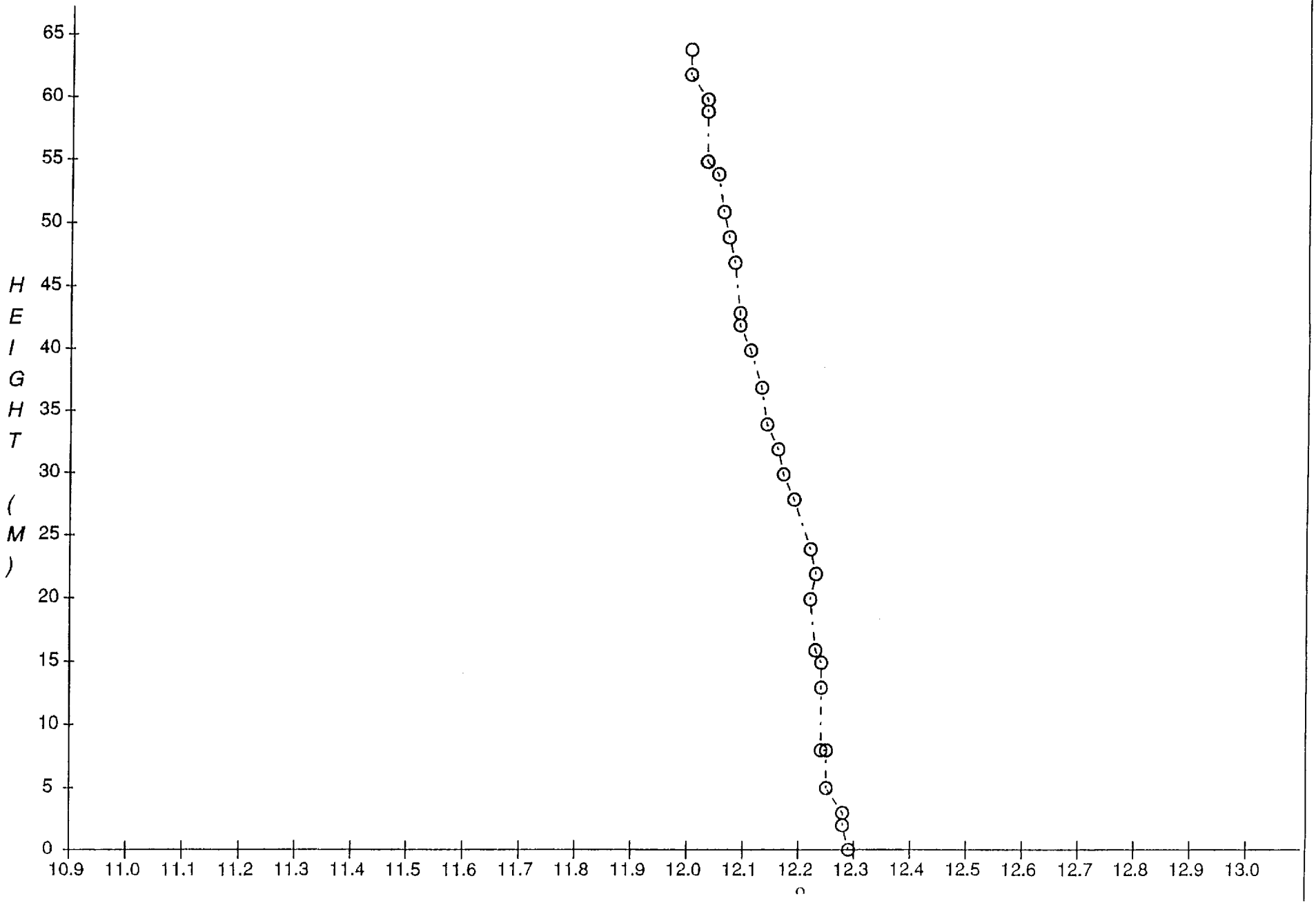
LYNWOOD STATION (January 8, 1990)

(17:03)



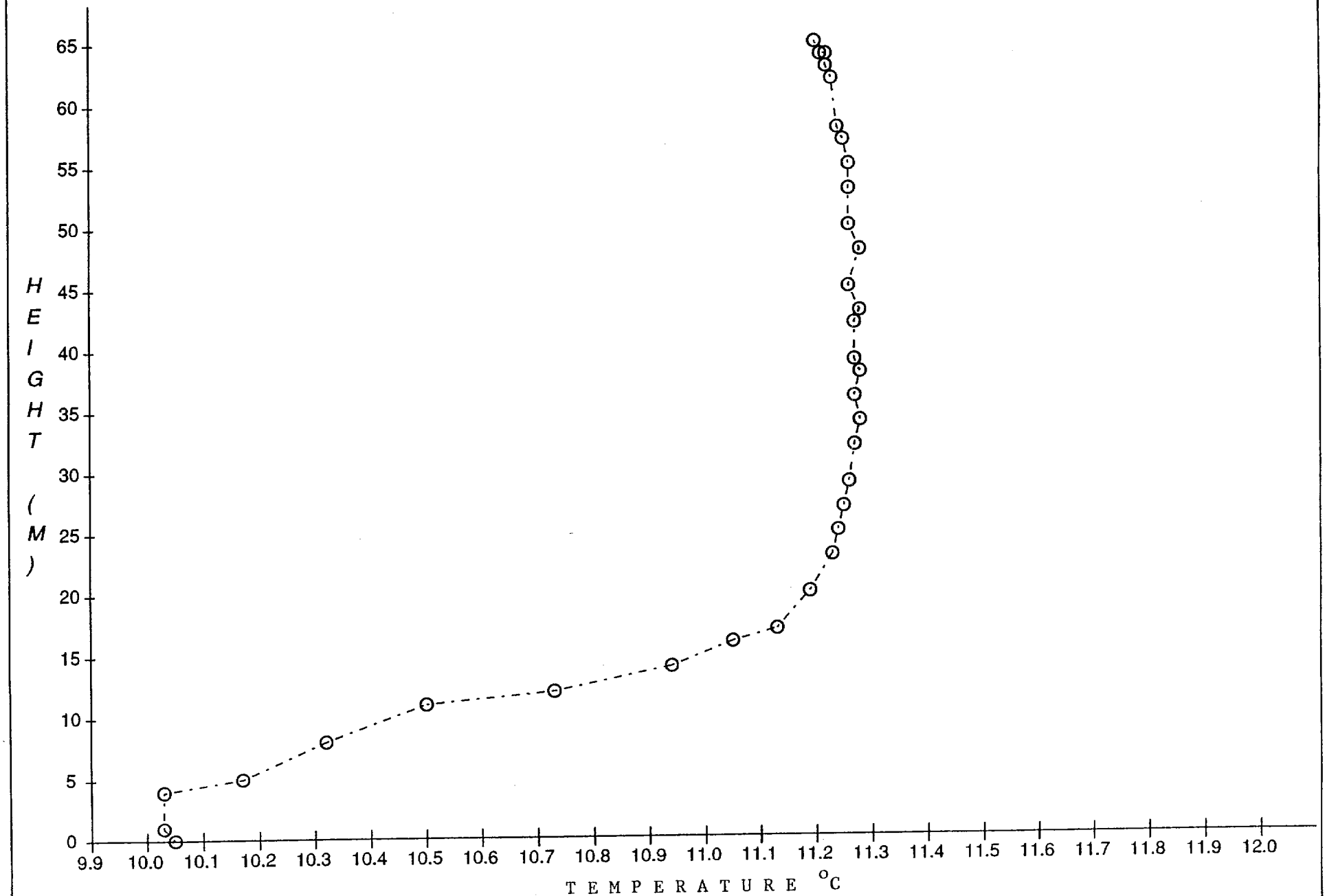
LYNWOOD STATION (January 8, 1990)

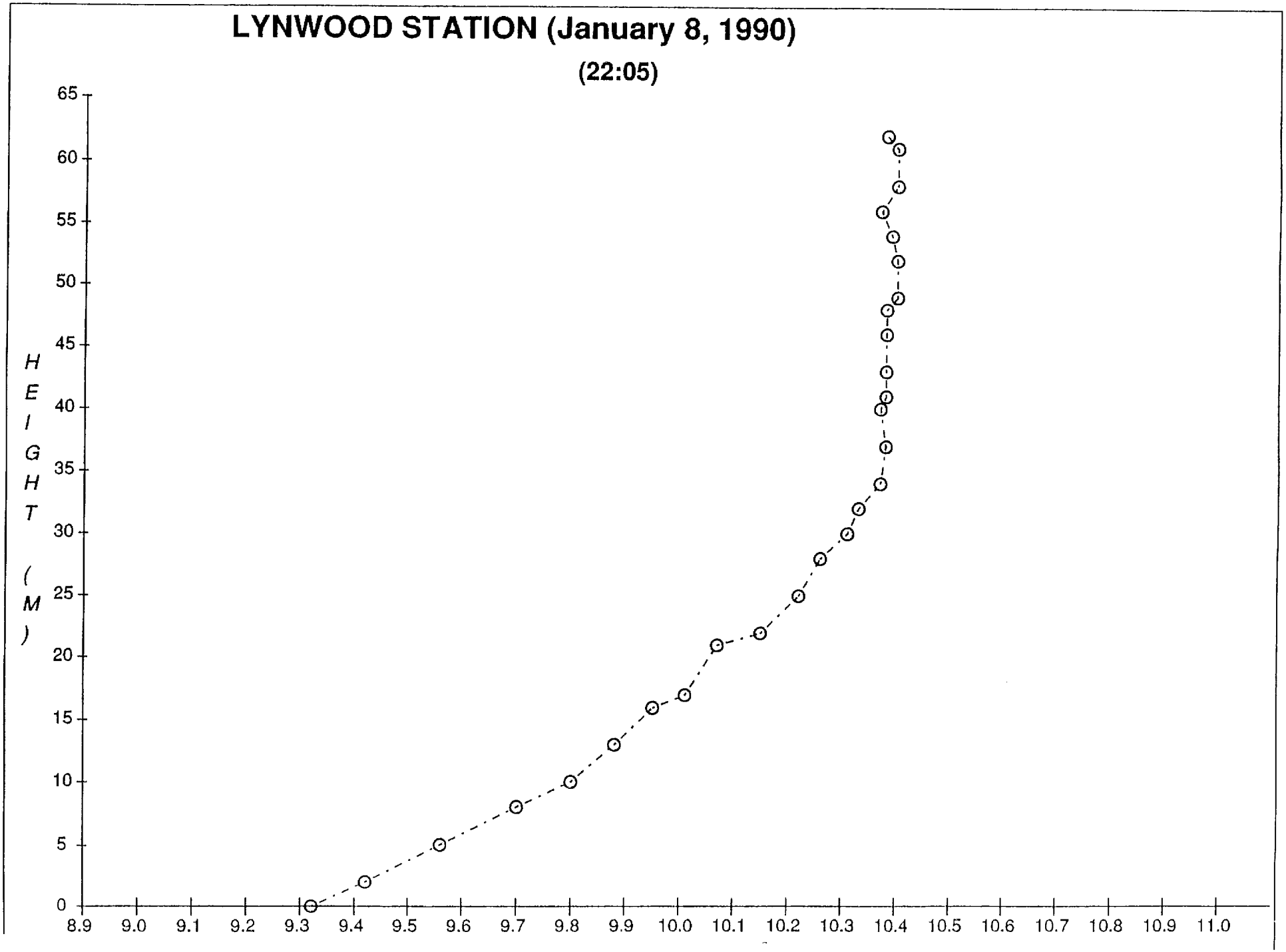
(18:01)



LYNWOOD STATION (January 8, 1990)

(20:05)




LYNWOOD STATION (January 8, 1990)
(22:05)
HEIGHT (M)
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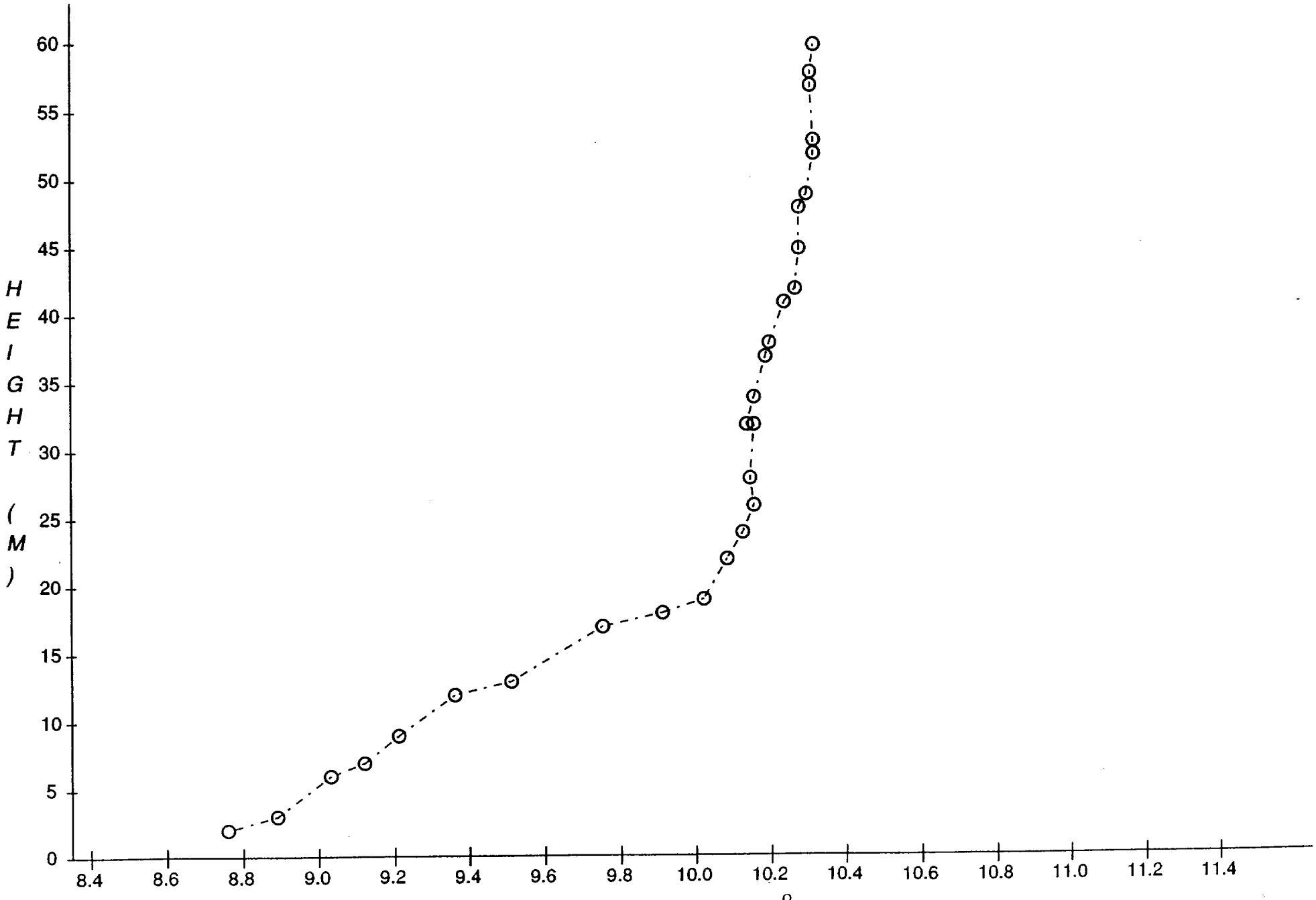
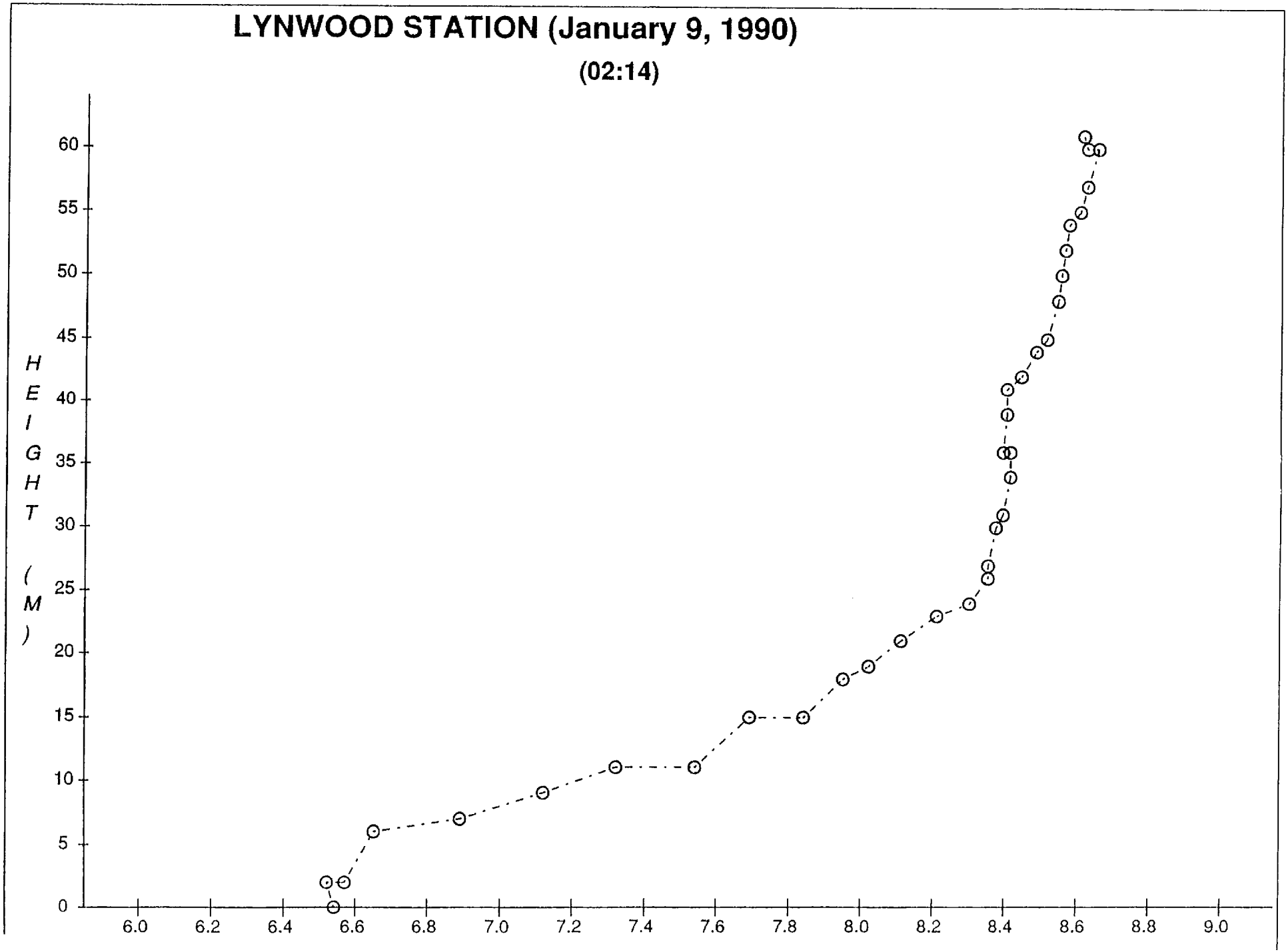
LYNWOOD STATION (January 9, 1990)

(00:07)




LYNWOOD STATION (January 9, 1990)
(02:14)
HEIGHT (M)
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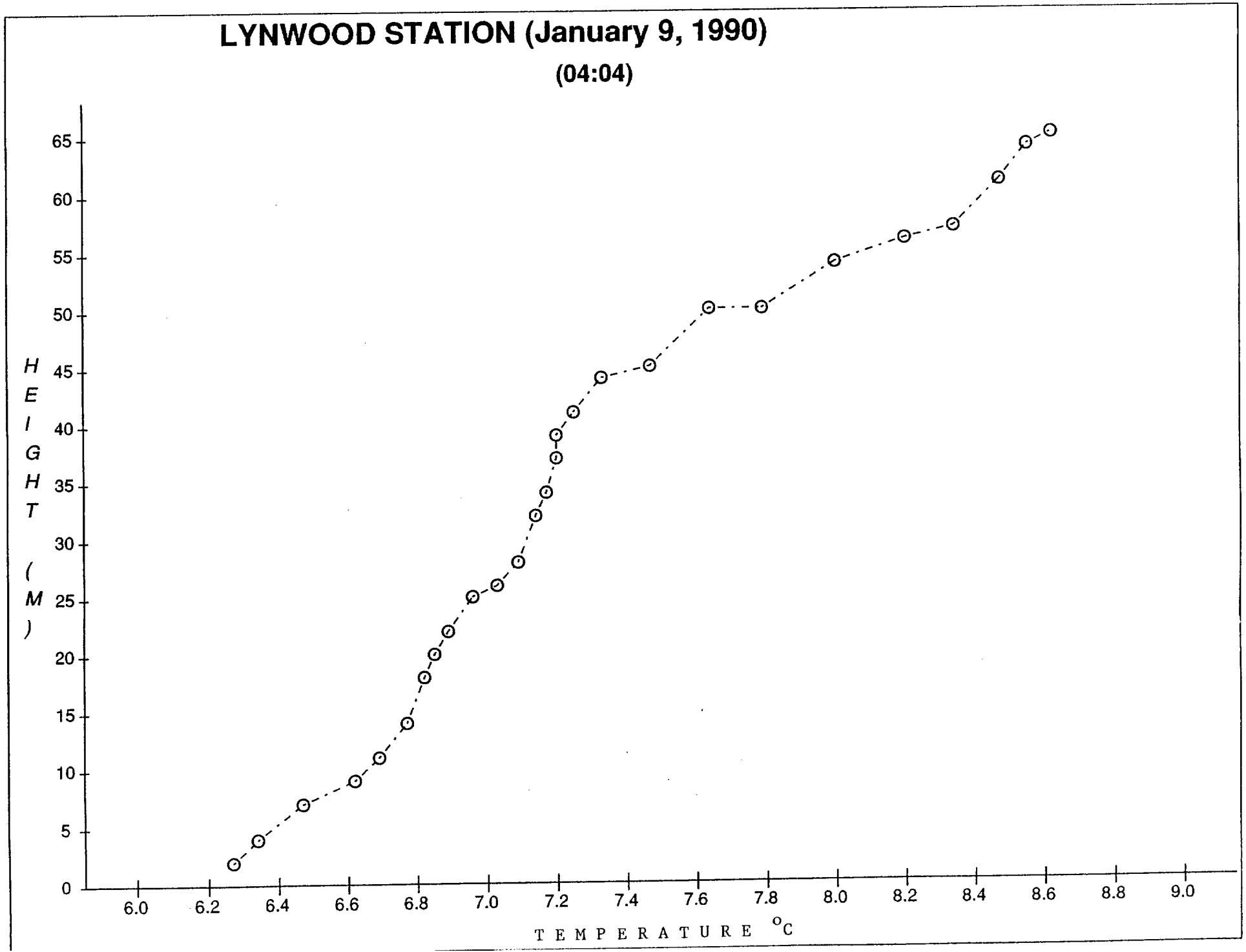
9.0


LYNWOOD STATION (January 9, 1990)
(04:04)
HEIGHT (M)
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8.6
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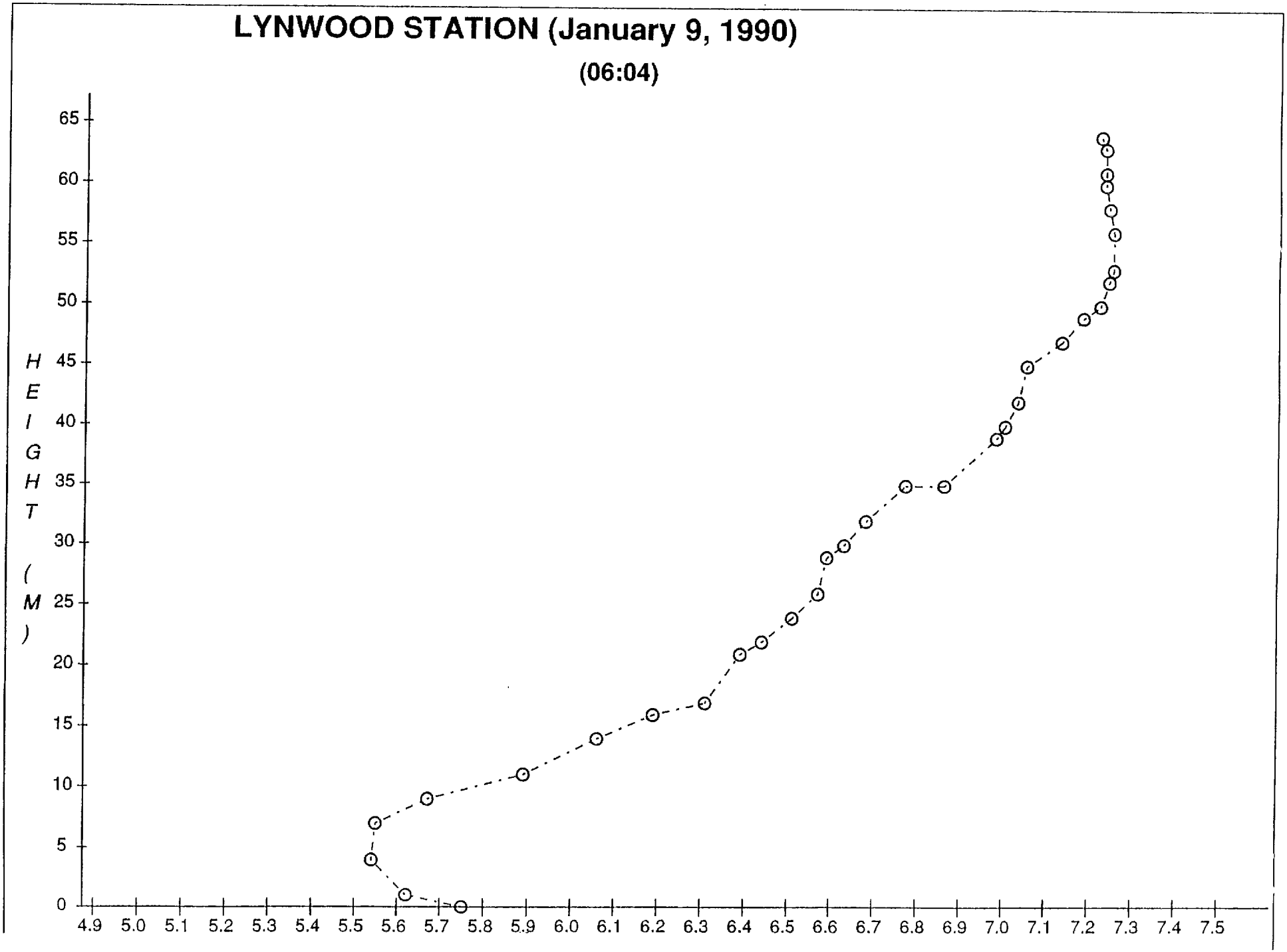
9.0
TEMPERATURE °C


LYNWOOD STATION (January 9, 1990)
(06:04)
HEIGHT (M)
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50
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60
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4.9
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5.6
5.7
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6.1
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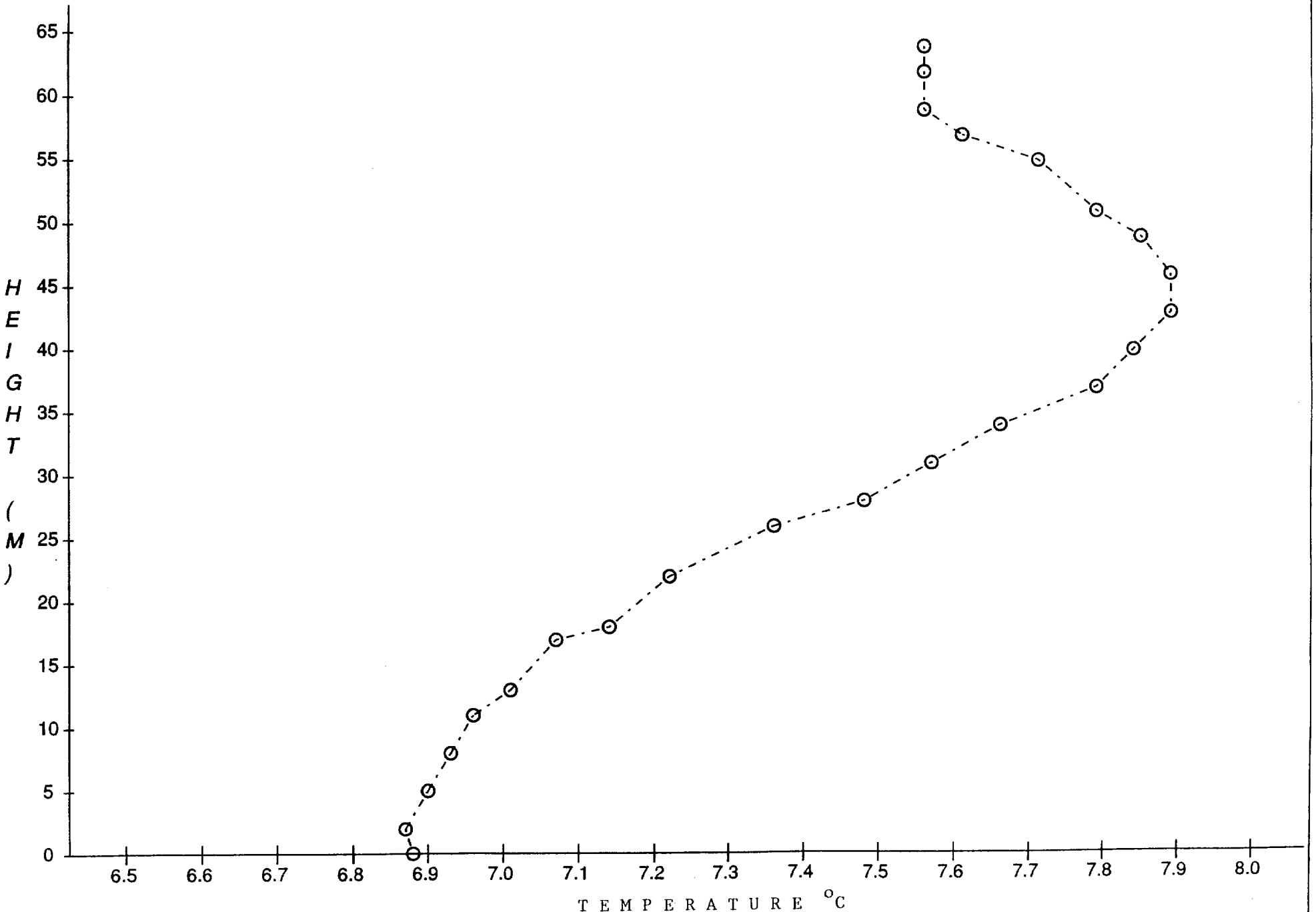
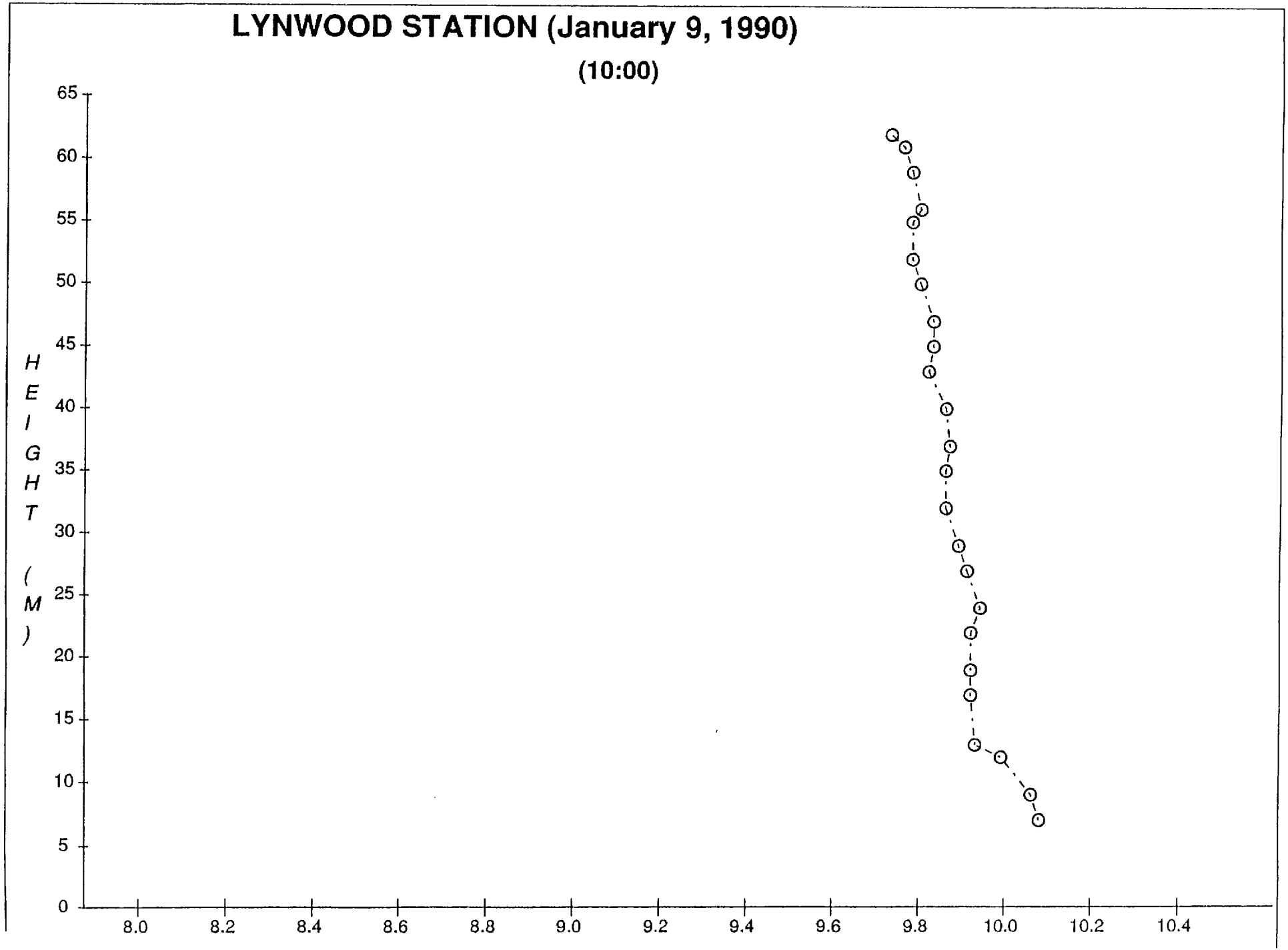
7.4
7.5

LYNWOOD STATION (January 9, 1990)

(08:08)




LYNWOOD STATION (January 9, 1990)
(10:00)
HEIGHT (M)
65
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55
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45
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35
30
25
20
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8.0
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8.6
8.8
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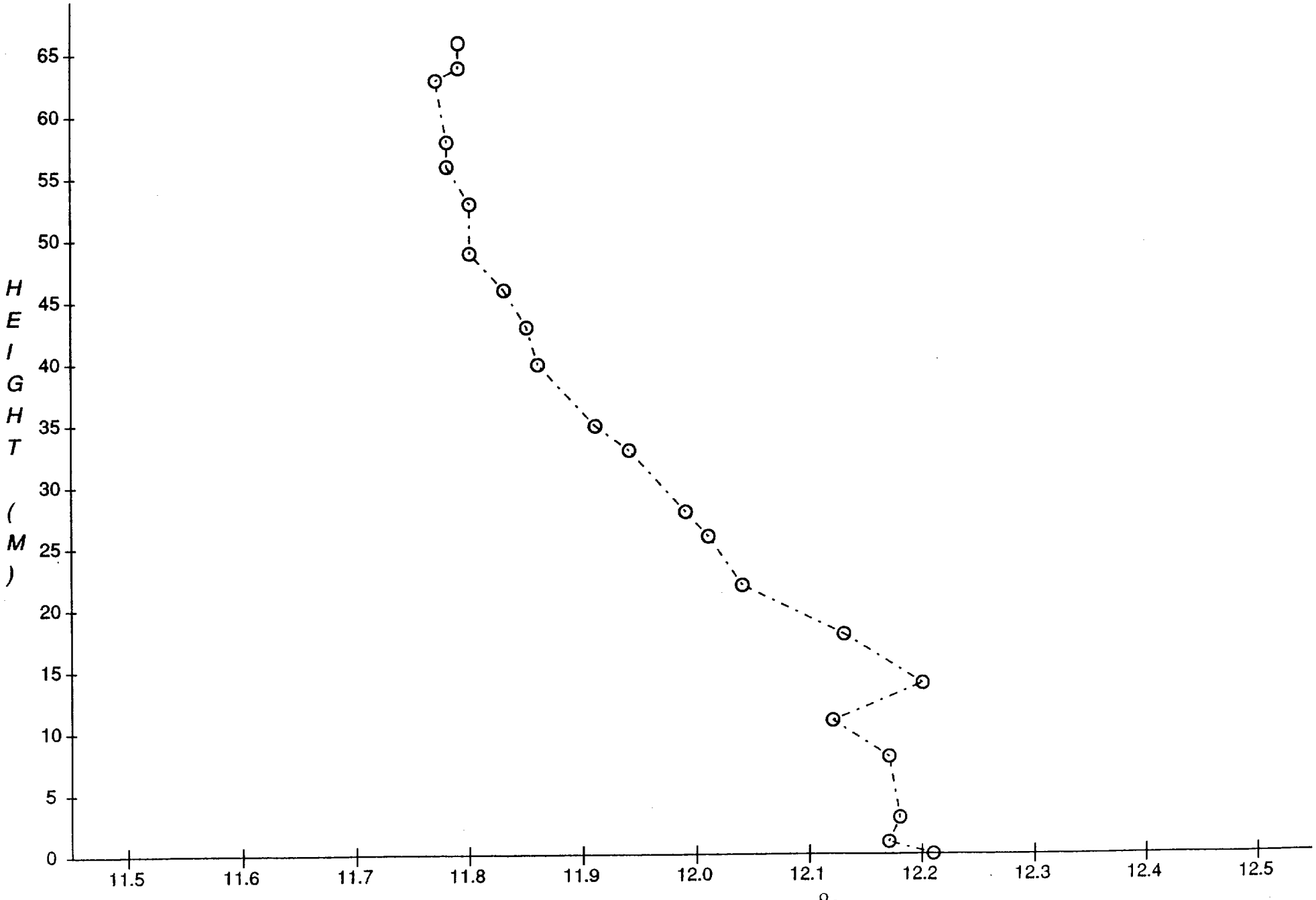
9.8
10.0
10.2
10.4

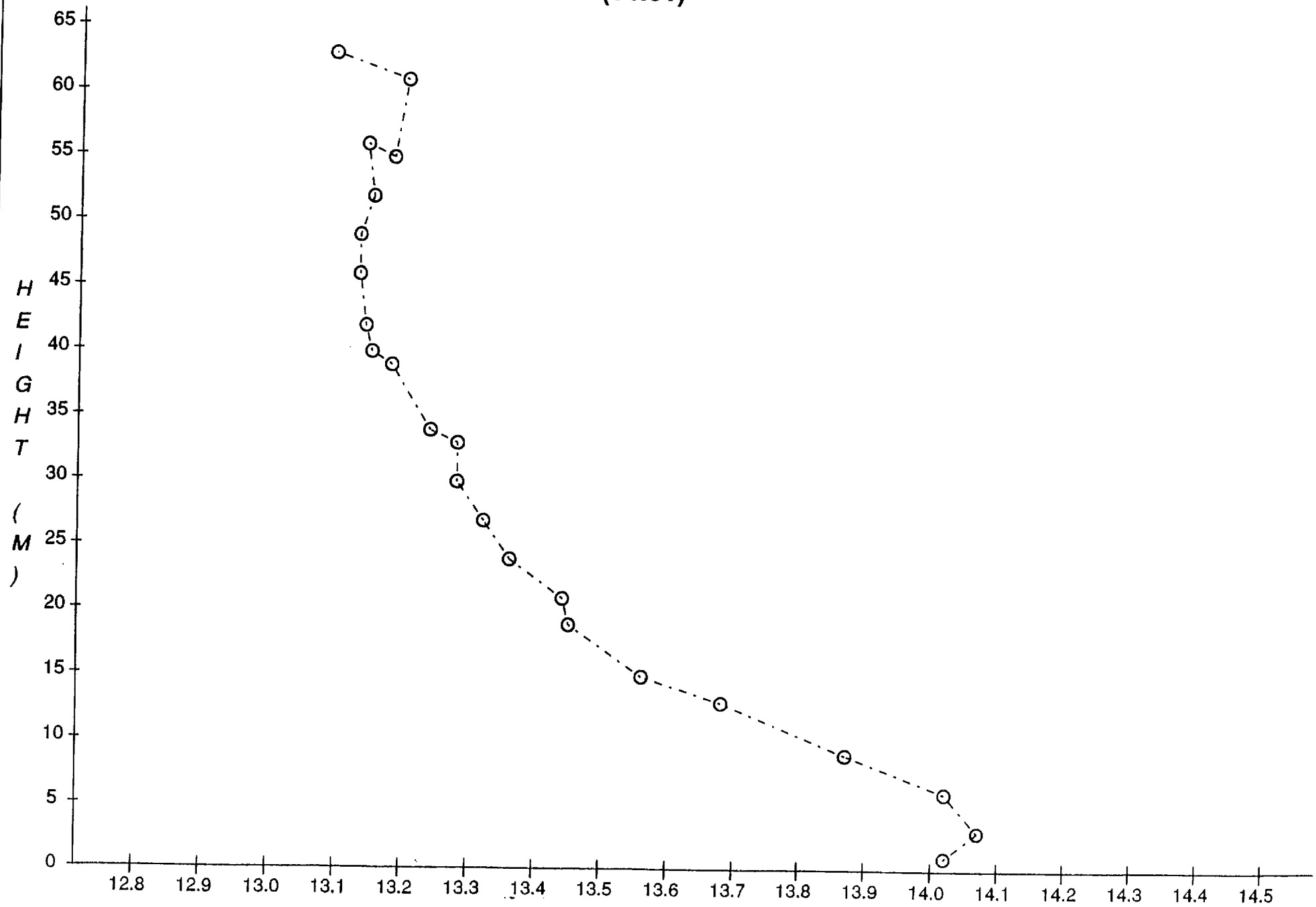
LYNWOOD STATION (January 9, 1990)

(12:05)



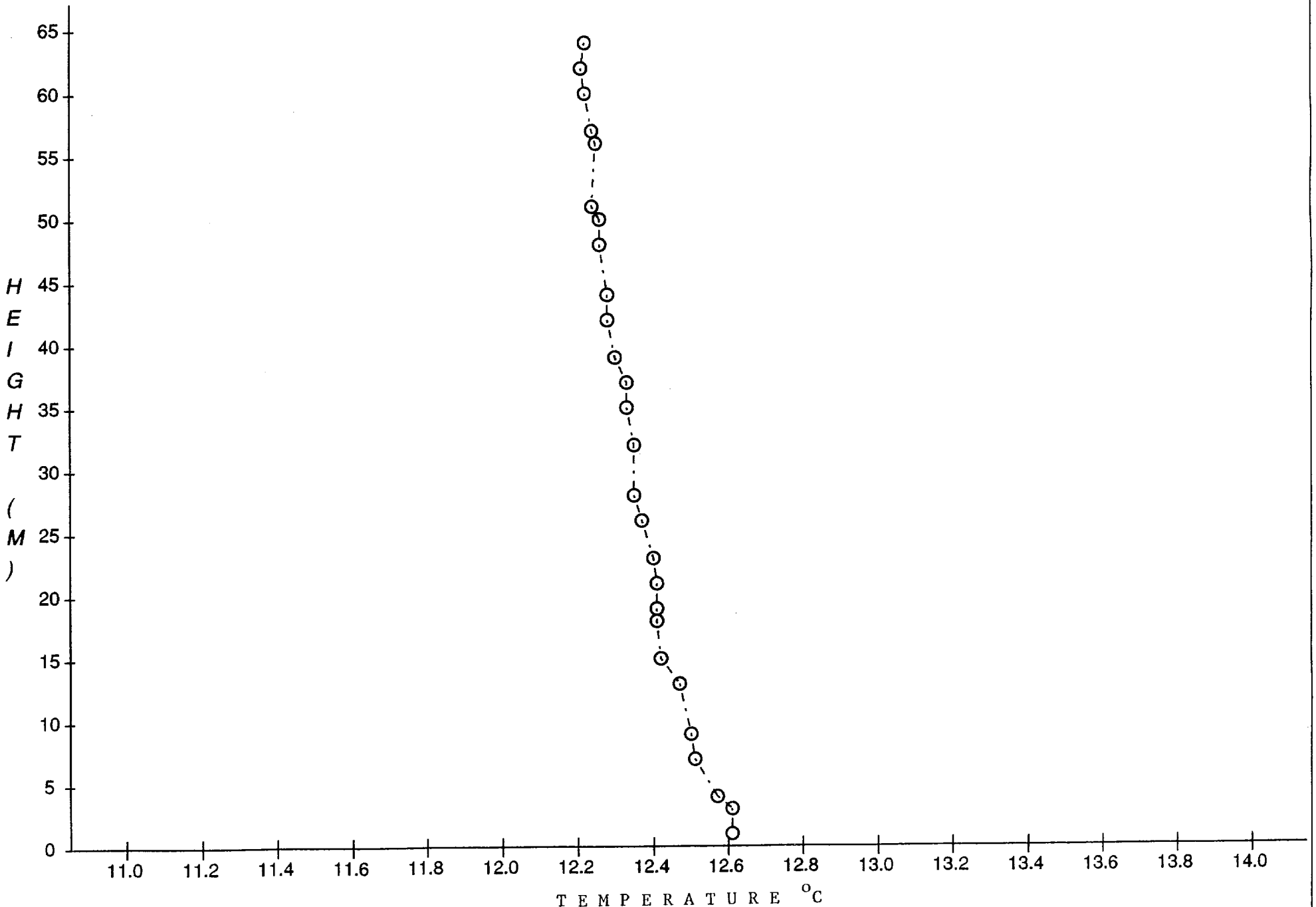
LYNWOOD STATION (January 9, 1990)

(14:01)



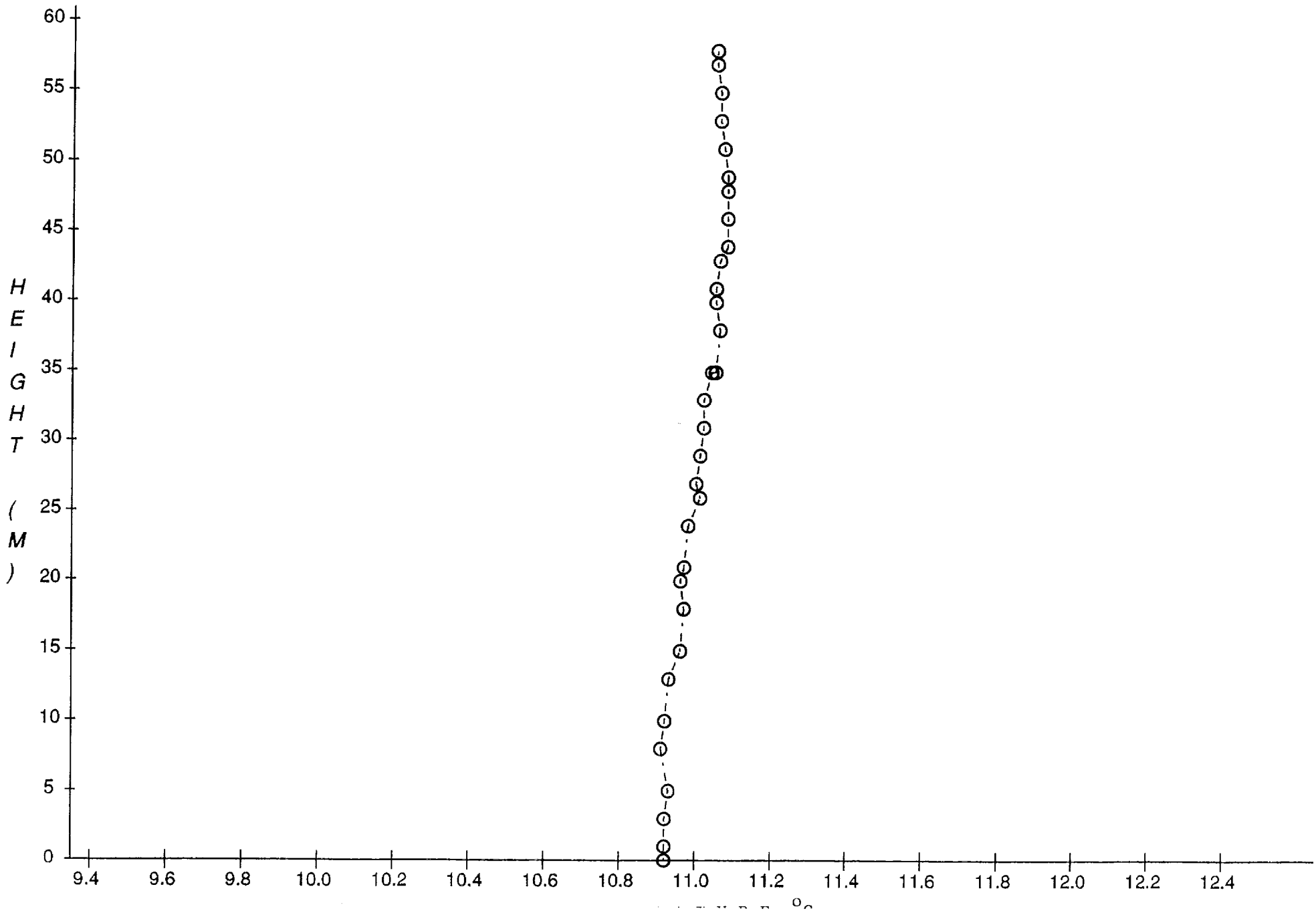
LYNWOOD STATION (January 9, 1990)

(16:03)



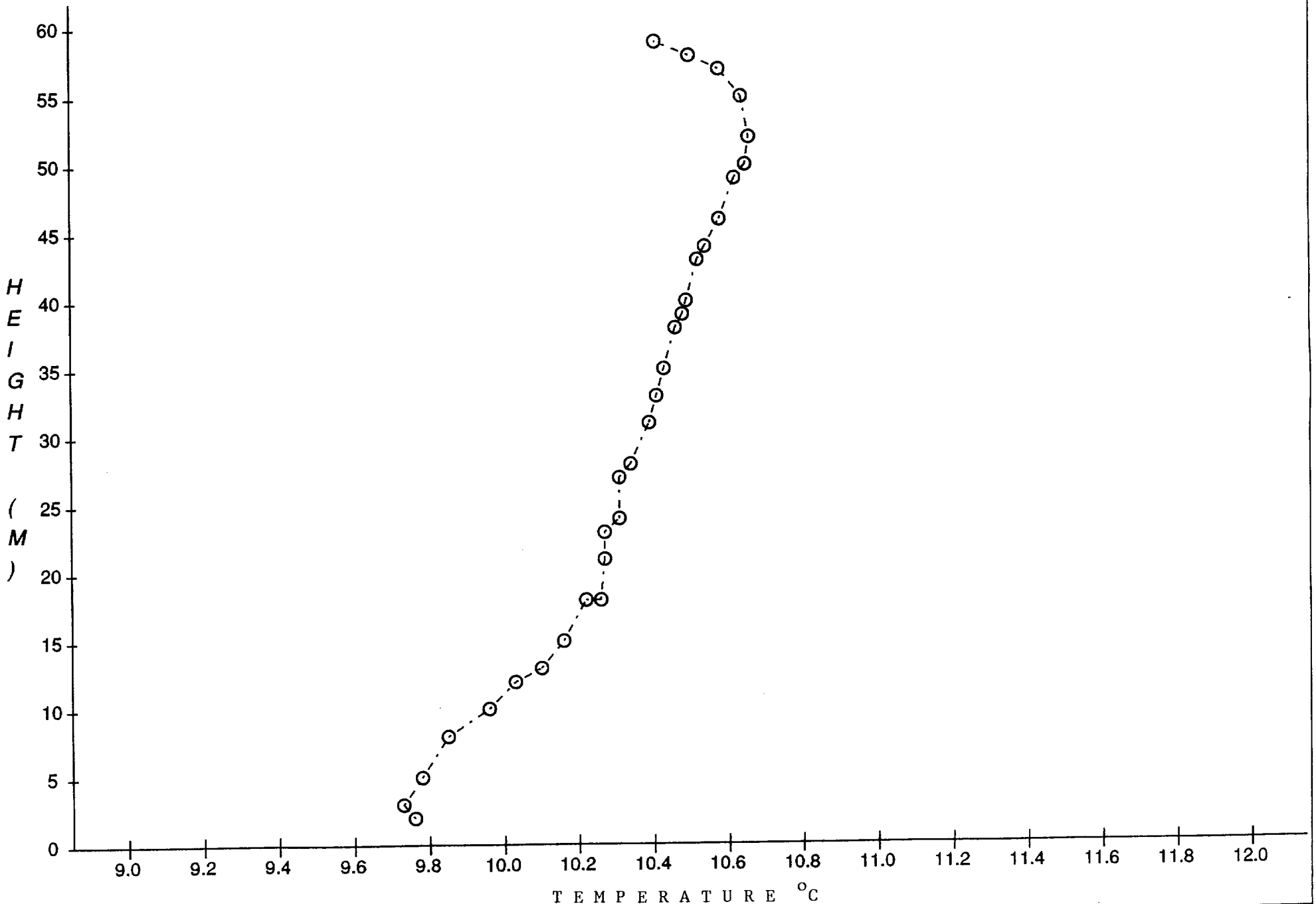
LYNWOOD STATION (January 9, 1990)

(18:02)



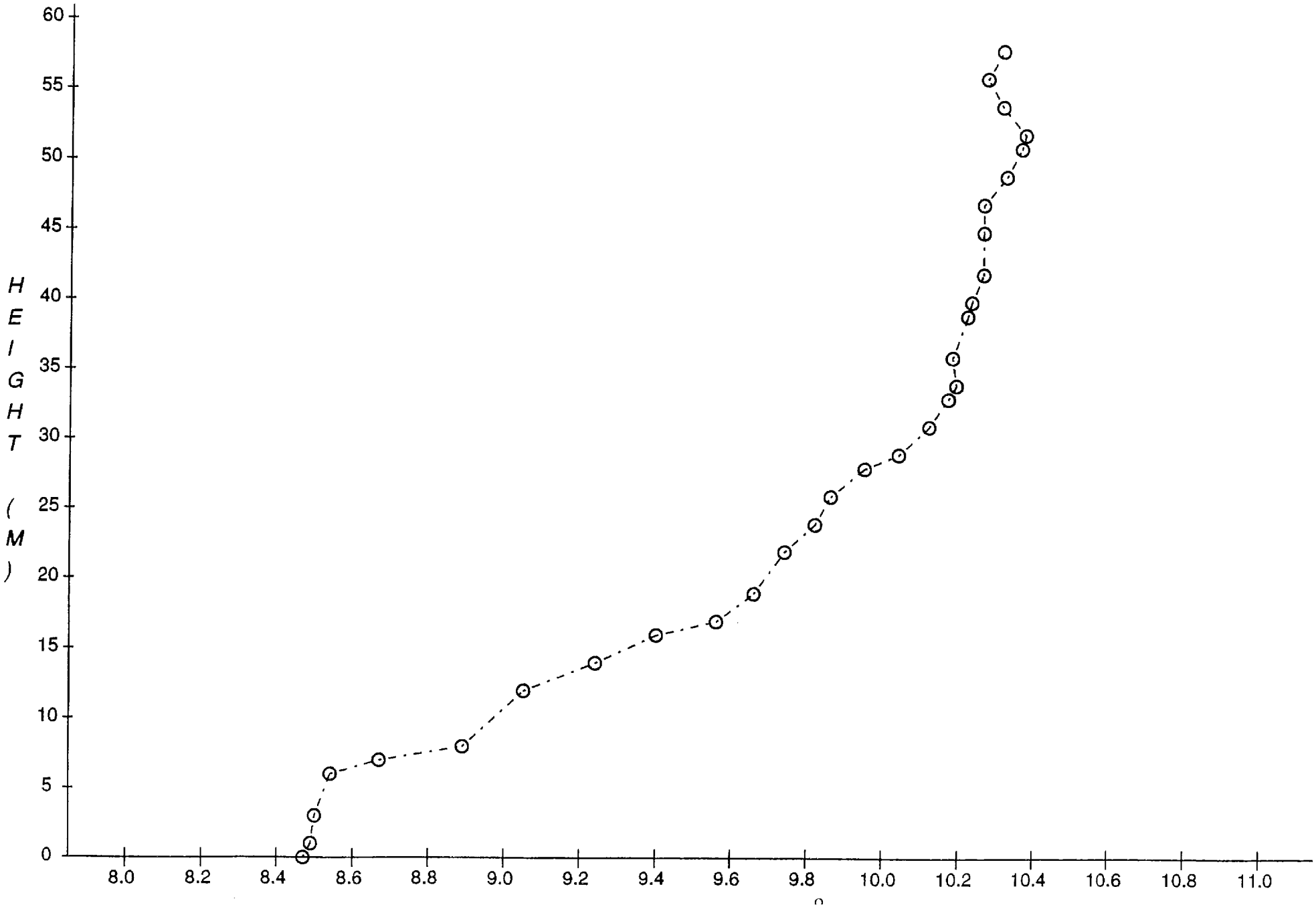
LYNWOOD STATION (January 9, 1990)

(20:02)



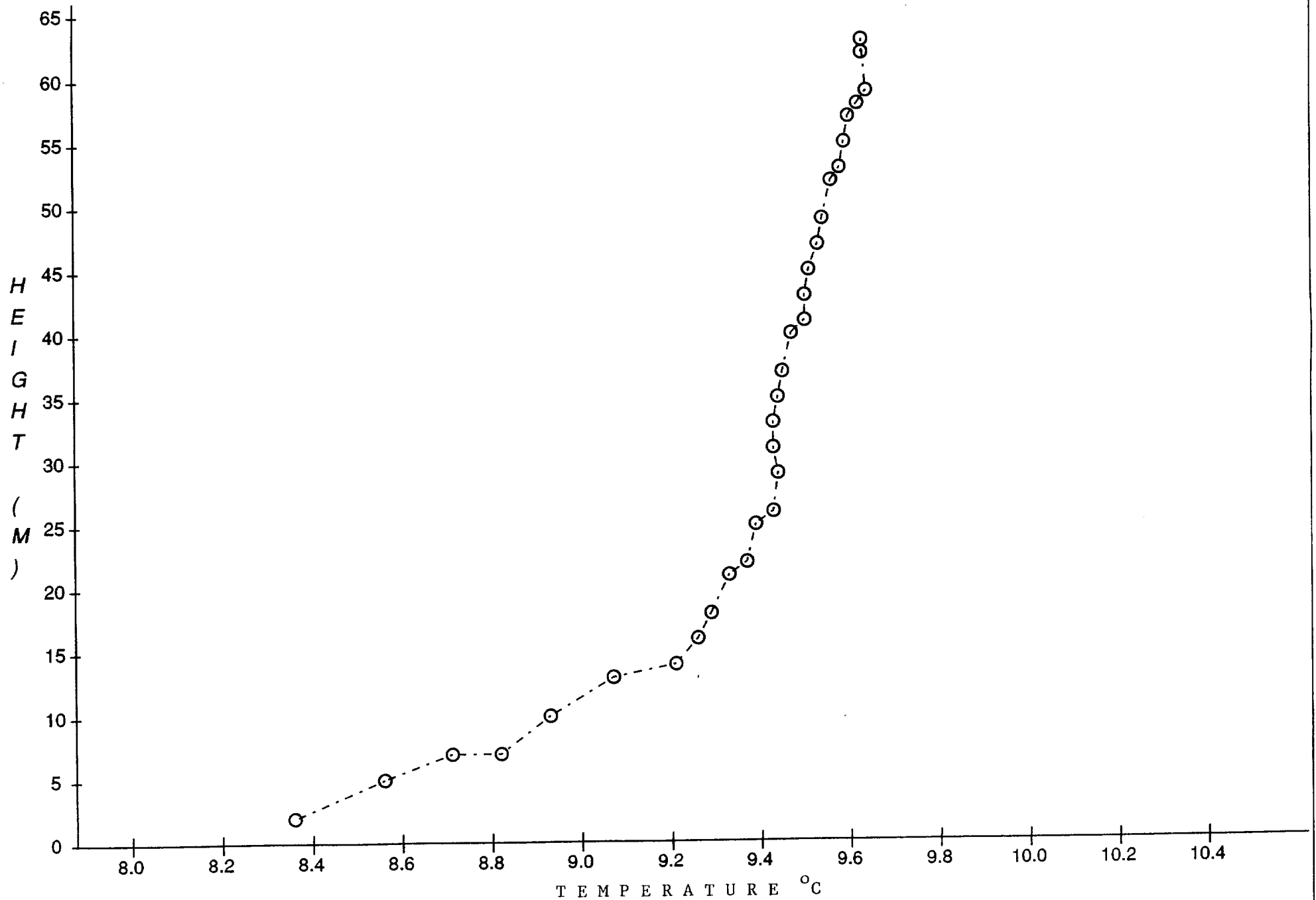
LYNWOOD STATION (January 9, 1990)

(22:01)



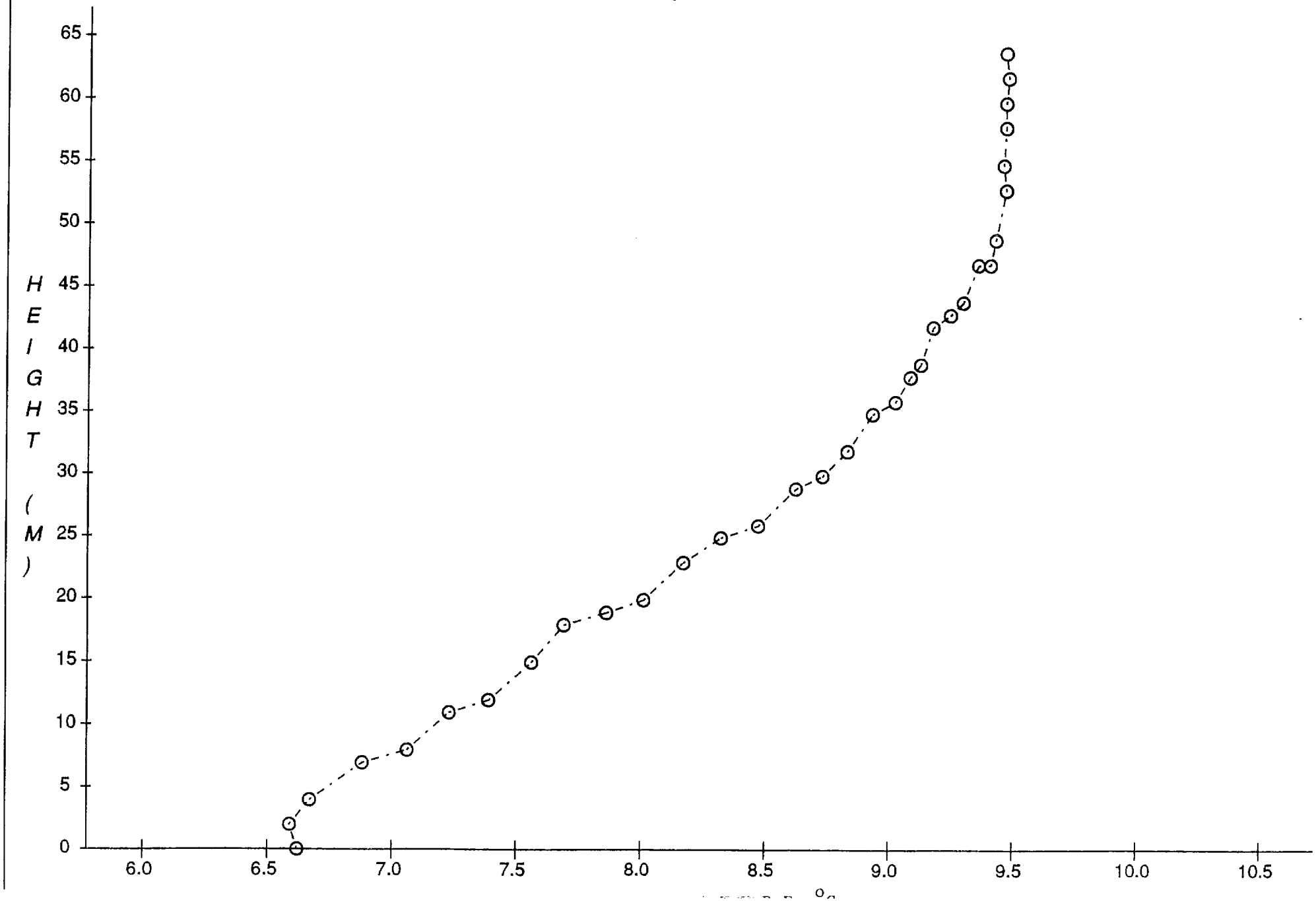
LYNWOOD STATION (January 10, 1990)

(00:07)



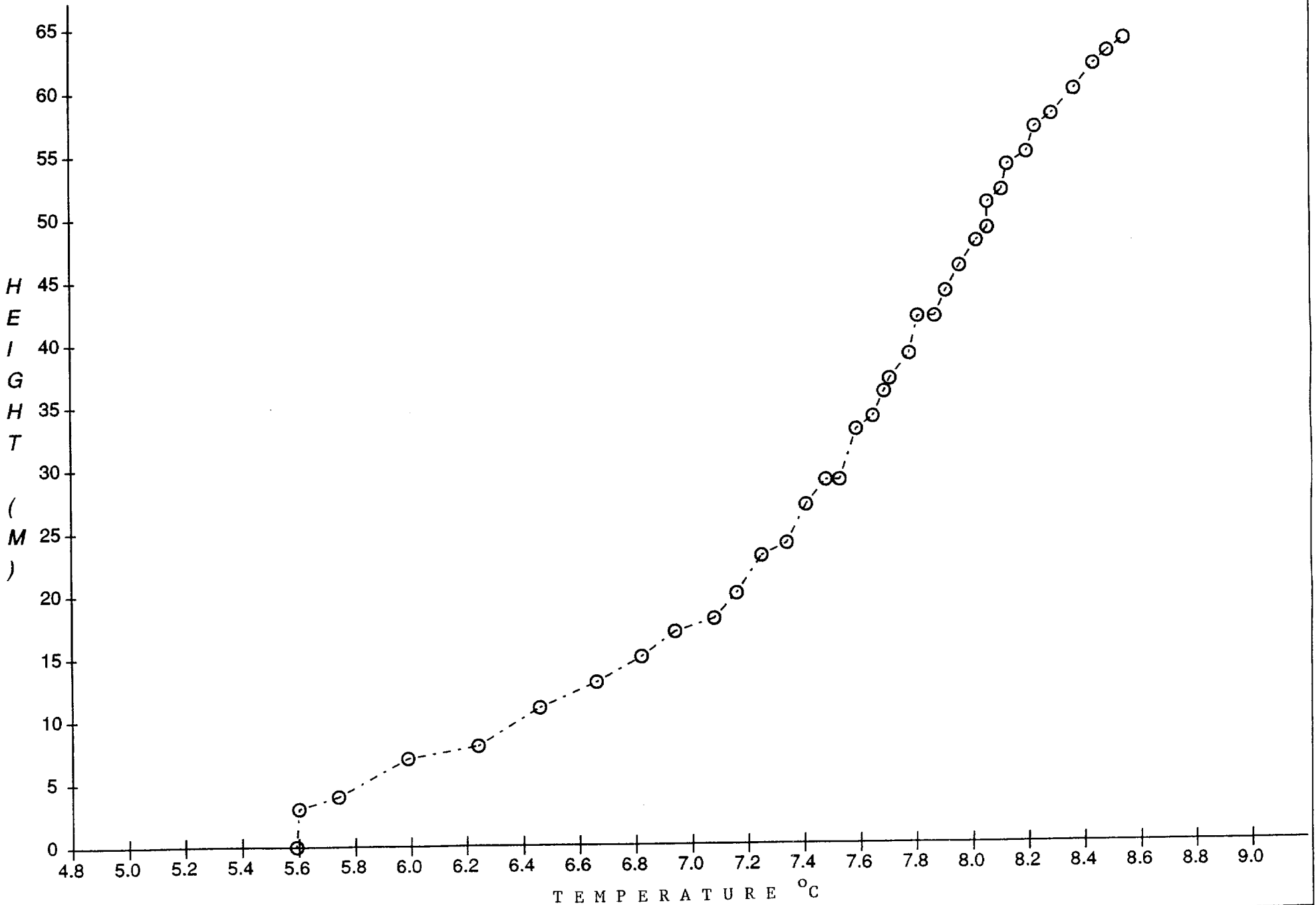
LYNWOOD STATION (January 10, 1990)

(02:02)

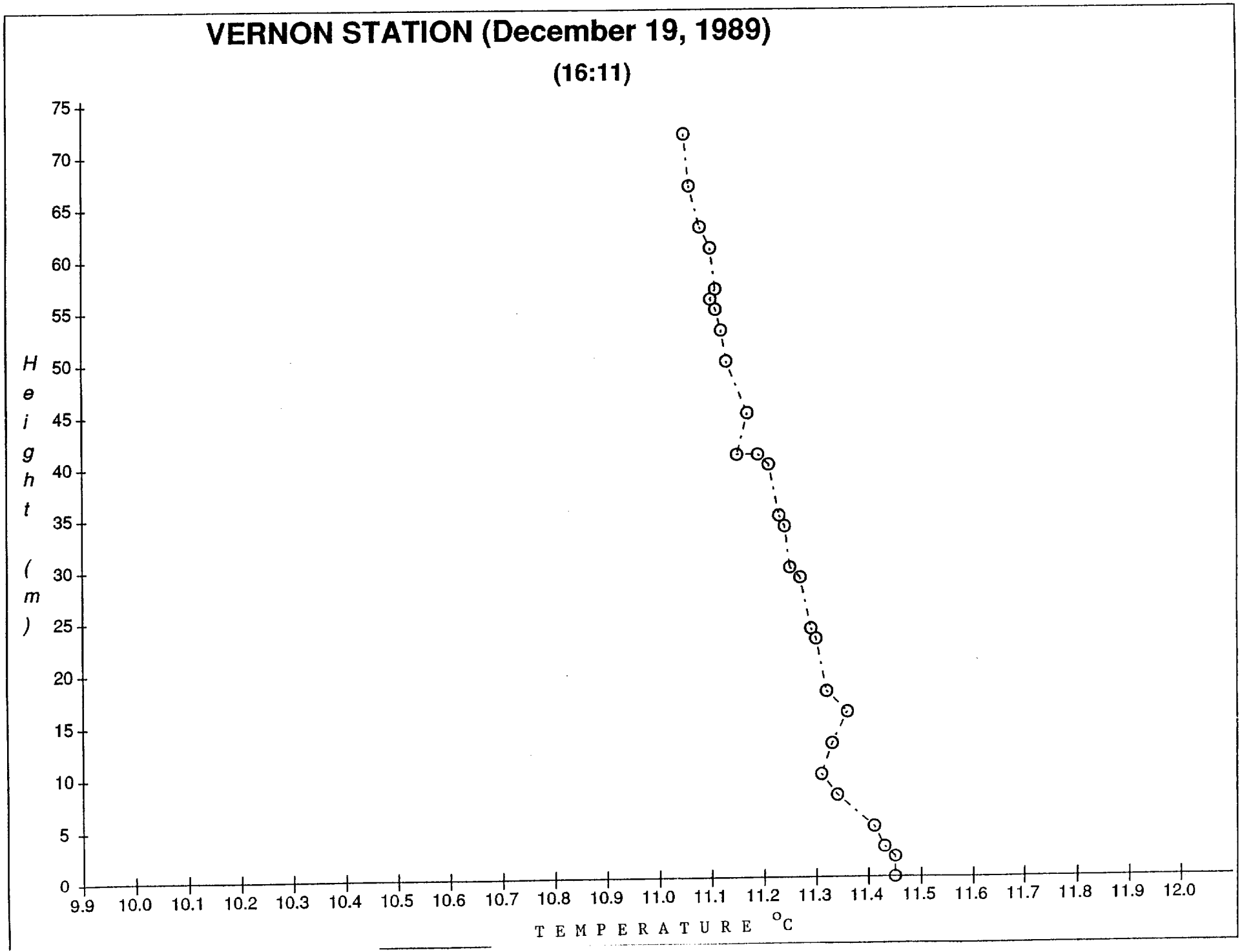


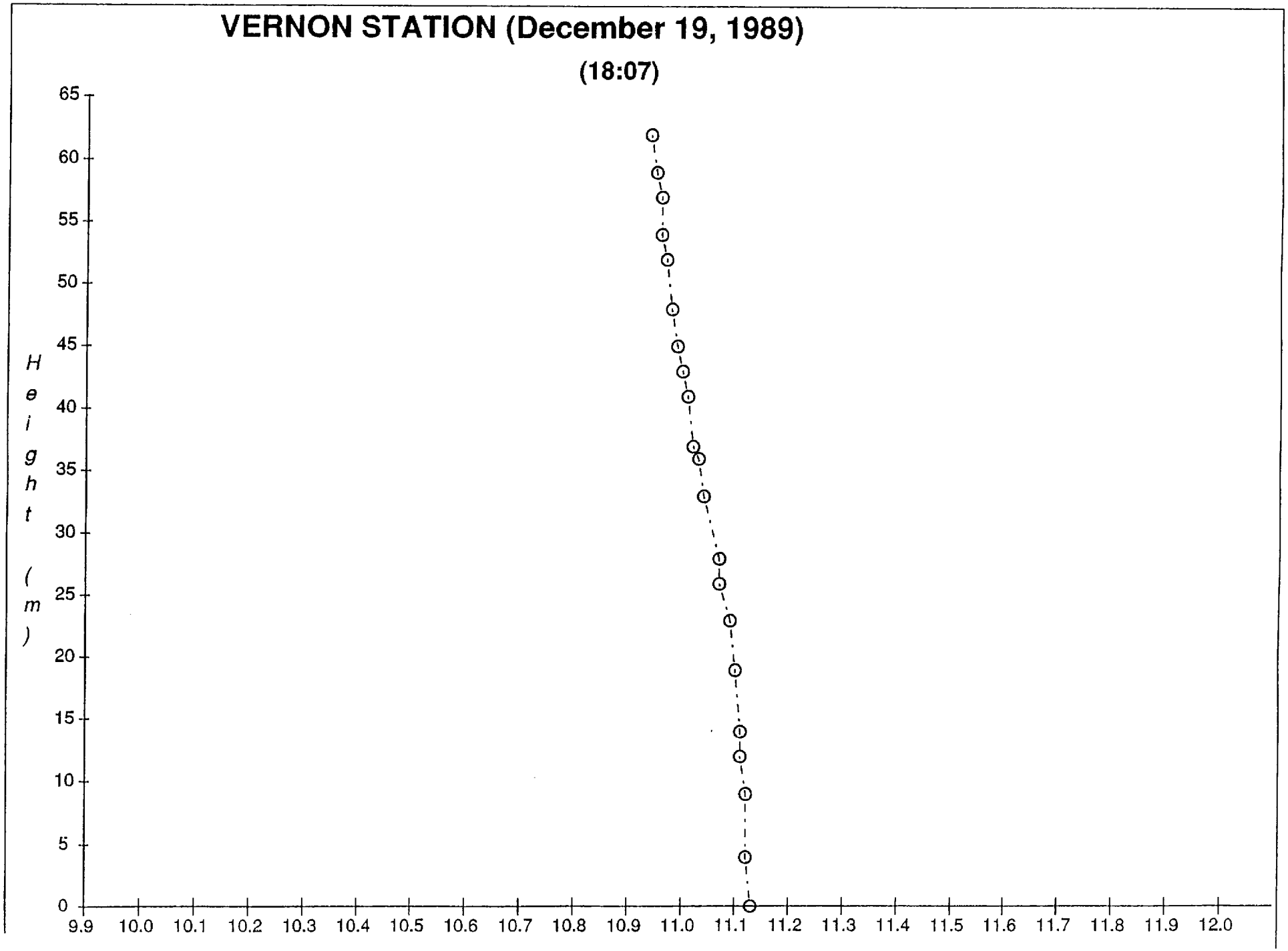
LYNWOOD STATION (January 10, 1990)

(04:01)



Appendix E-2


VERNON STATION (December 19, 1989)
(16:11)
Height (m)
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
9.9
10.0
10.1
10.2
10.3
10.4
10.5
10.6
10.7
10.8
10.9
11.0
11.1
11.2
11.3
11.4
11.5
11.6
11.7
11.8
11.9
12.0
TEMPERATURE °C


VERNON STATION (December 19, 1989)
(18:07)
Height (m)
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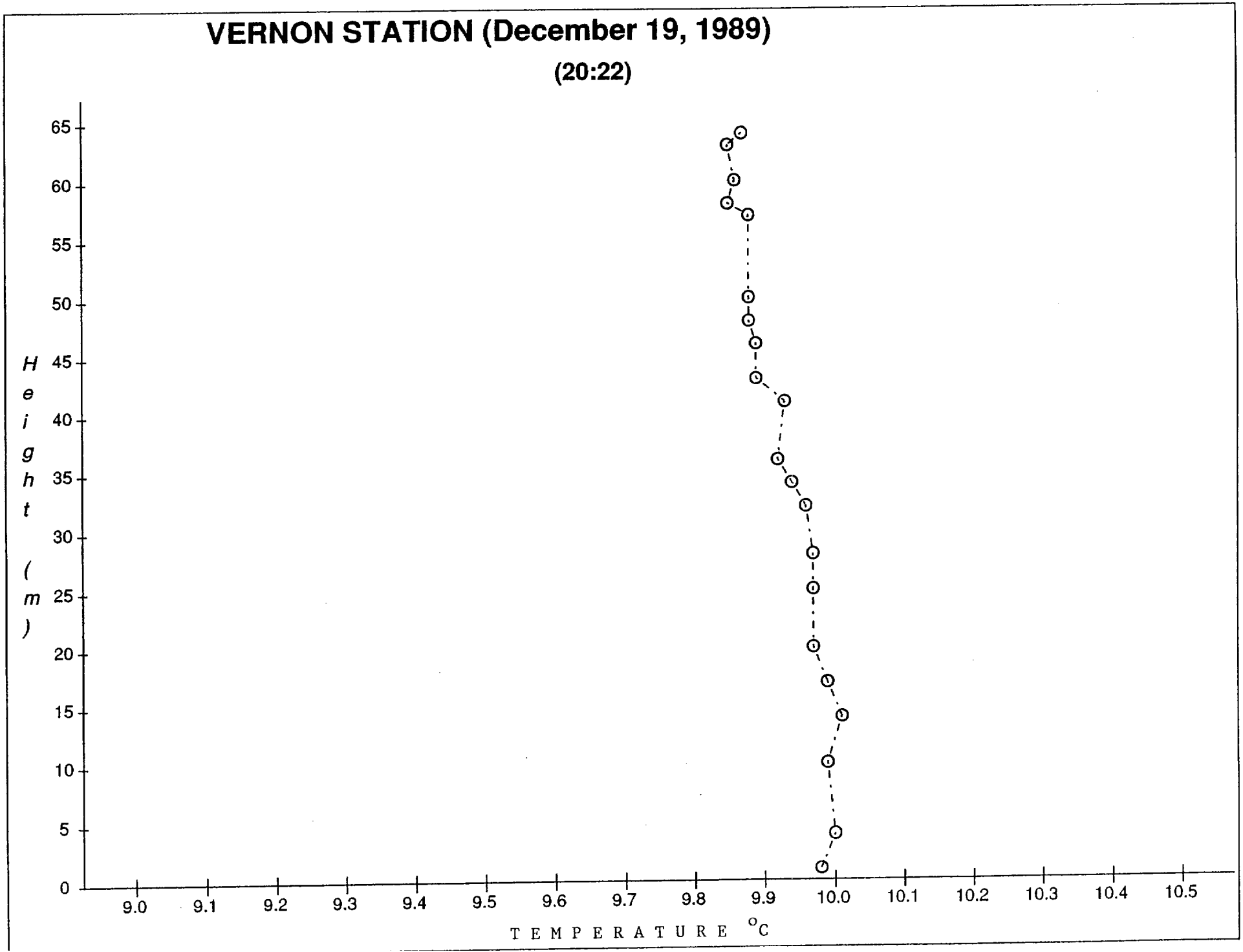
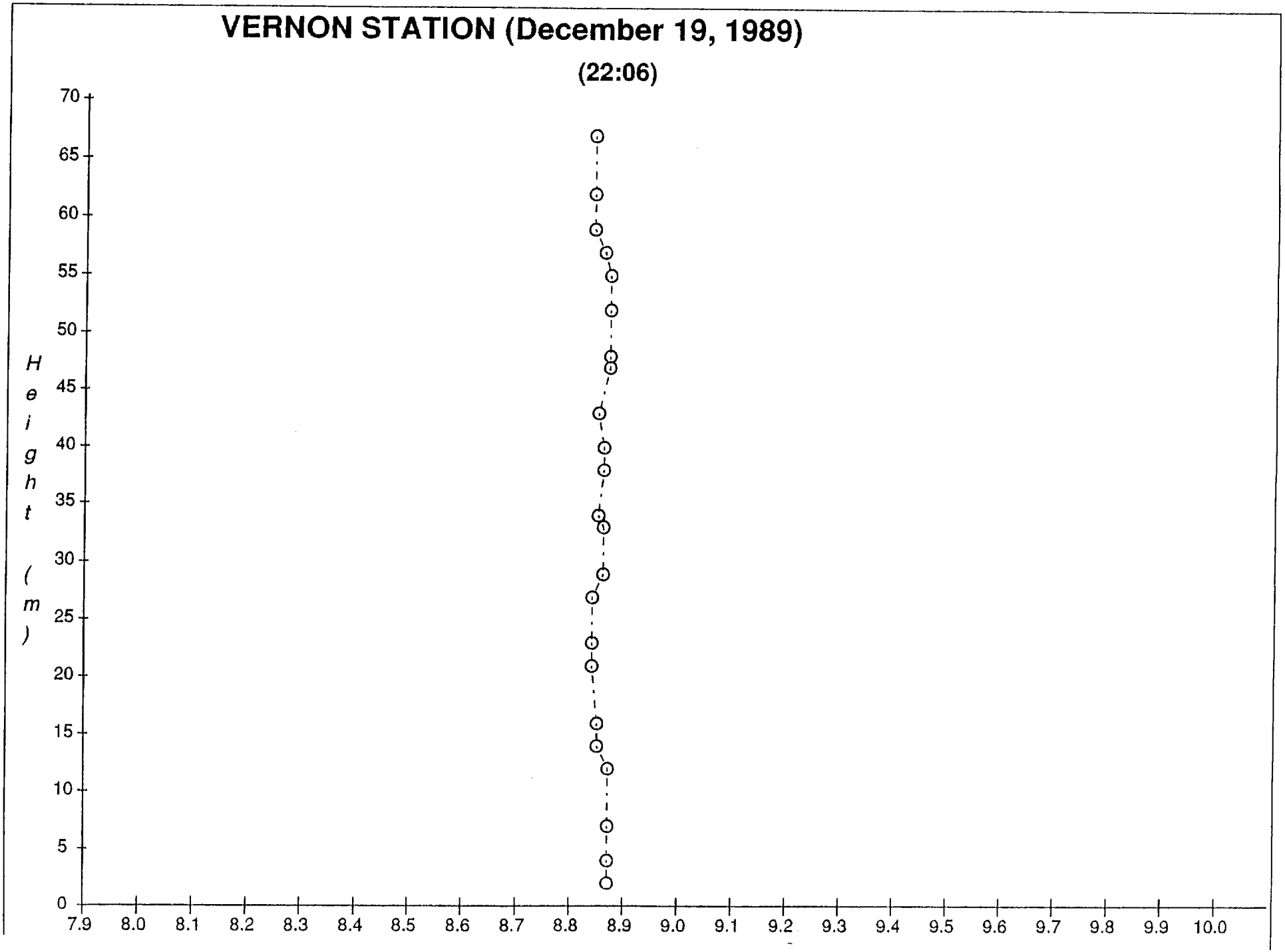
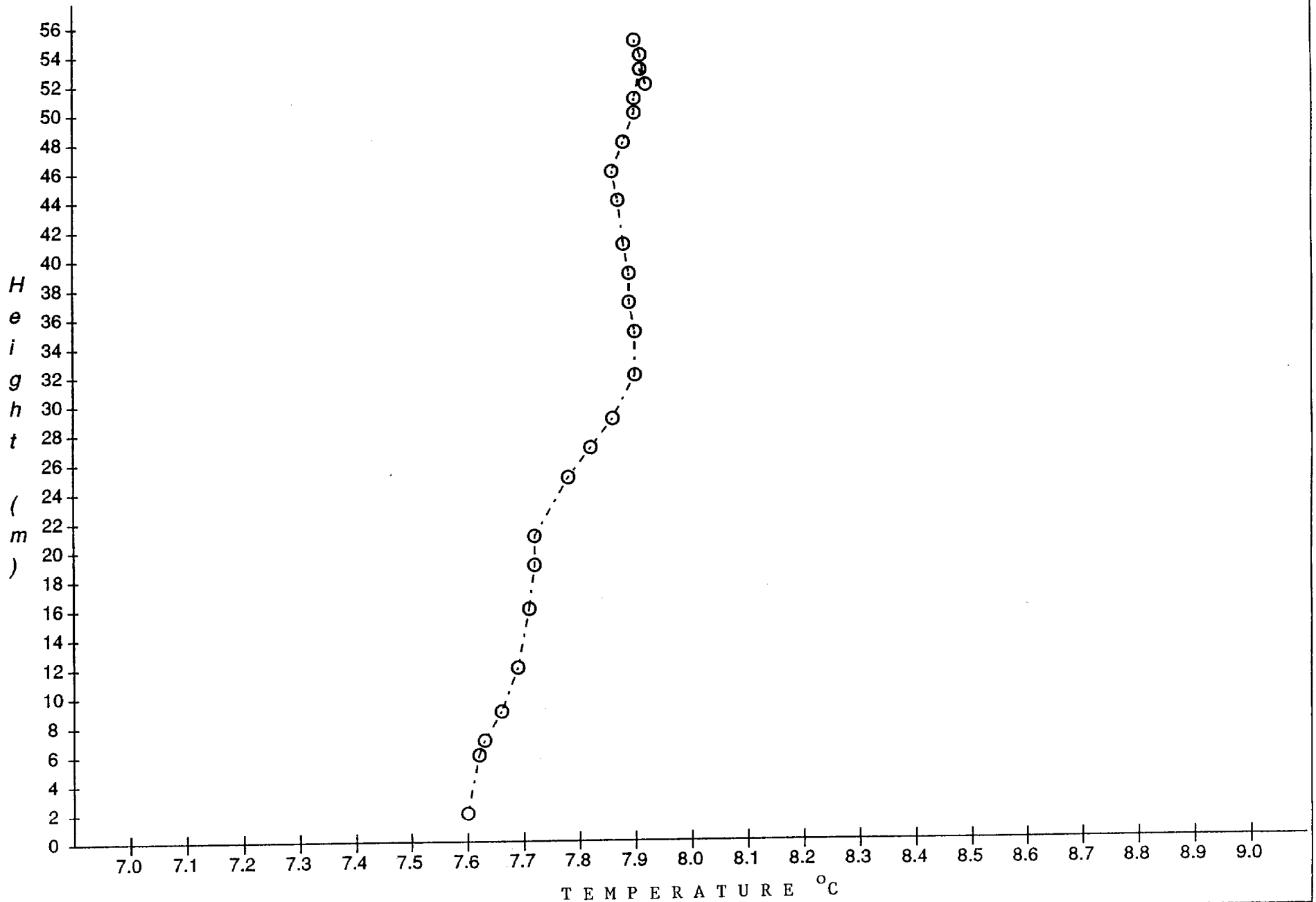
60
55
50
45
40
35
30
25
20
15
10
5
0
9.9
10.0
10.1
10.2
10.3
10.4
10.5
10.6
10.7
10.8
10.9
11.0
11.1
11.2
11.3
11.4
11.5
11.6
11.7
11.8
11.9
12.0


VERNON STATION (December 19, 1989)
(20:22)
Height (m)
65
60
55
50
45
40
35
30
25
20
15
10
5
0
9.0
9.1
9.2
9.3
9.4
9.5
9.6
9.7
9.8
9.9
10.0
10.1
10.2
10.3
10.4
10.5
TEMPERATURE °C


VERNON STATION (December 19, 1989)
(22:06)
Height (m)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
7.9
8.0
8.1
8.2
8.3
8.4
8.5
8.6
8.7
8.8
8.9
9.0
9.1
9.2
9.3
9.4
9.5
9.6
9.7
9.8
9.9
10.0

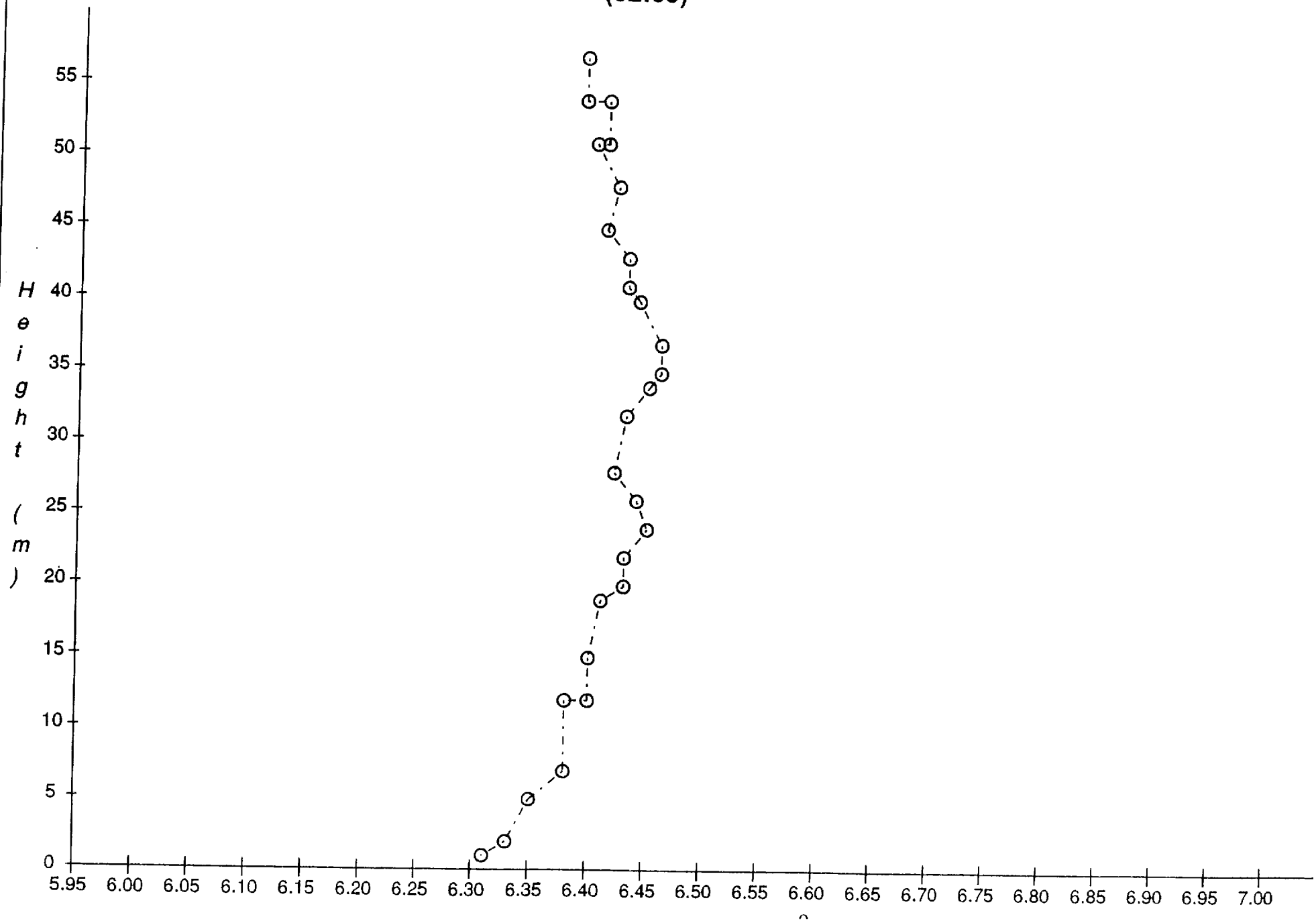
VERNON STATION (December 20, 1989)

(00:09)



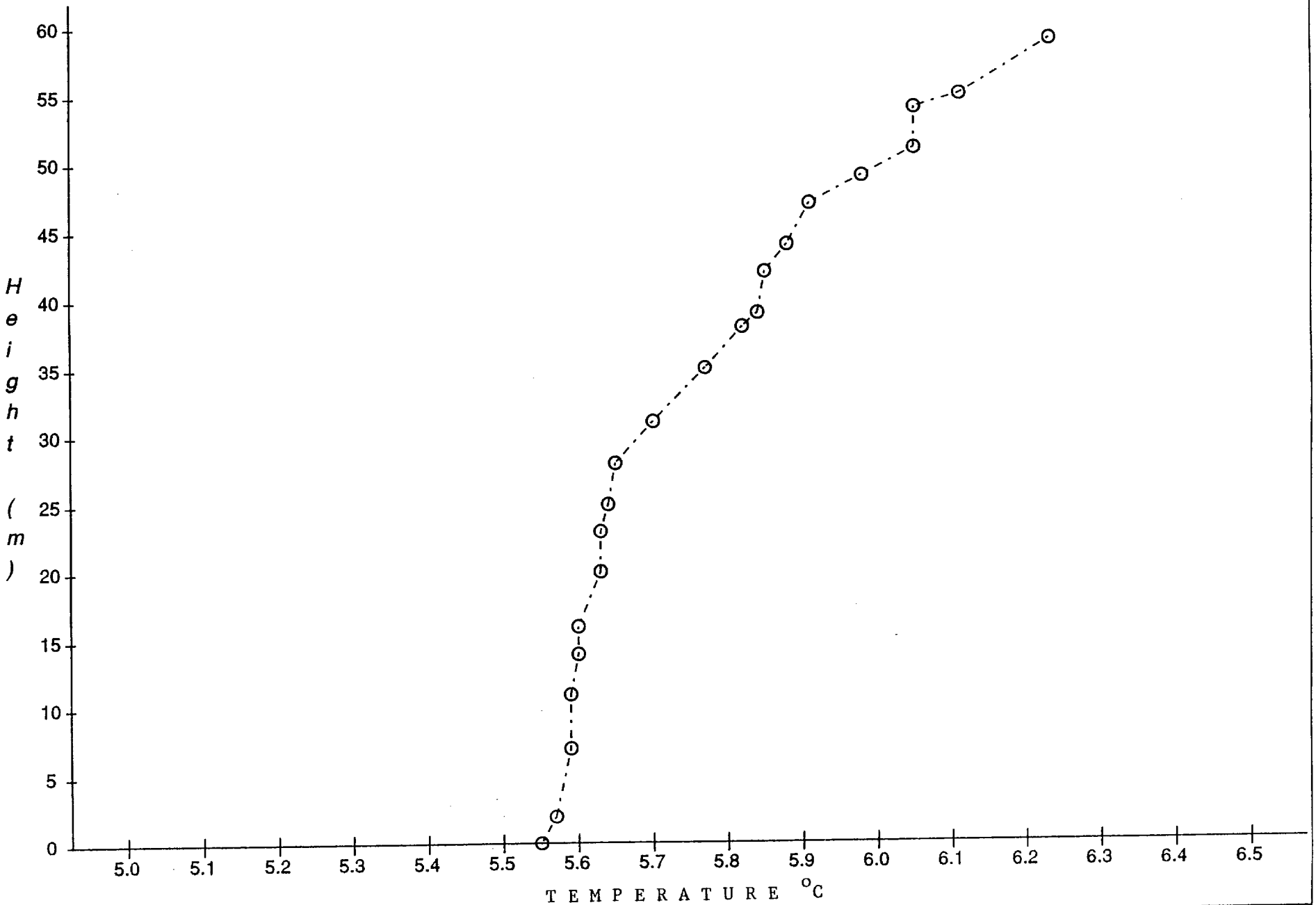
VERNON STATION (December 20, 1989)

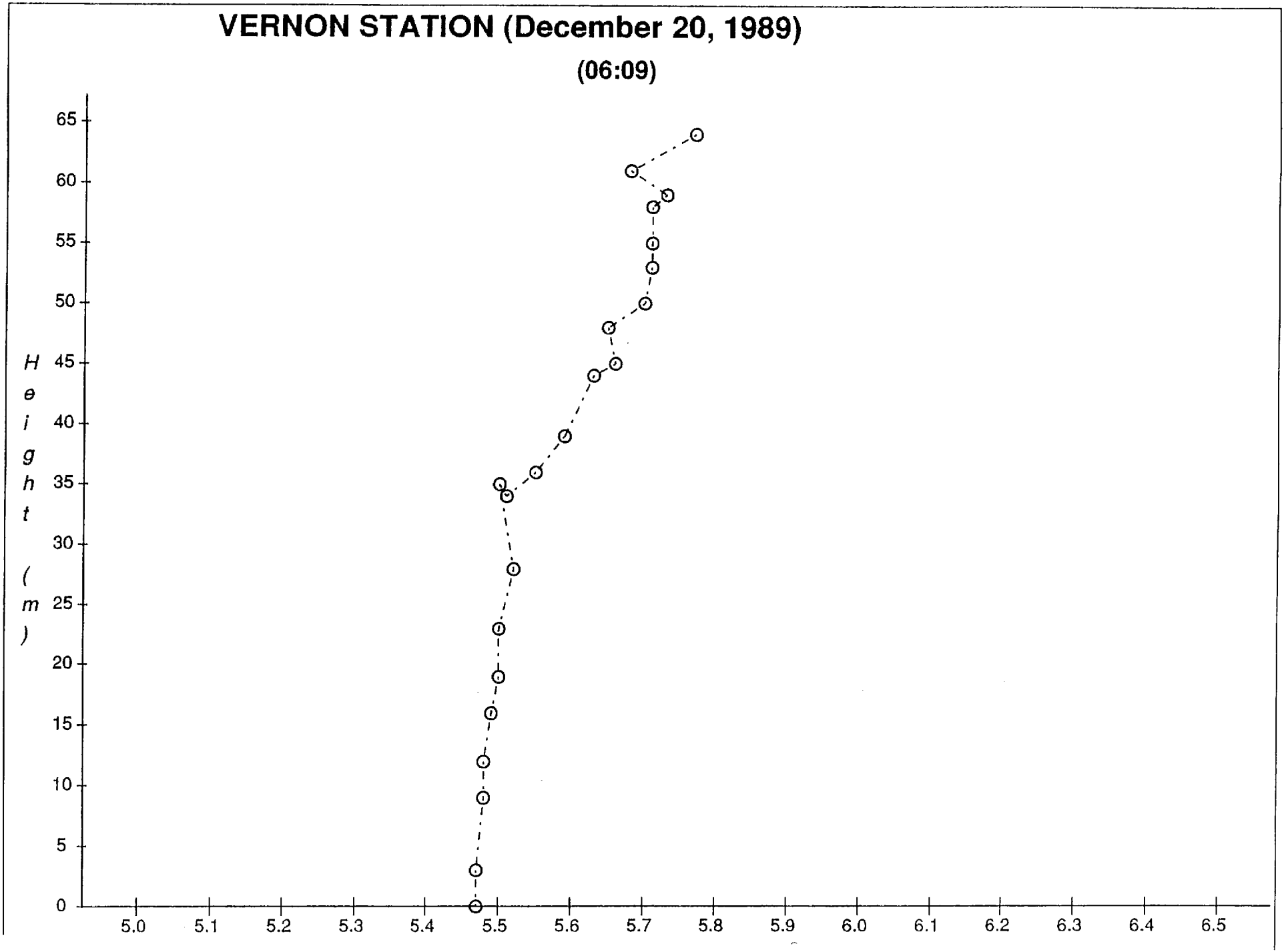
(02:09)



VERNON STATION (December 20, 1989)

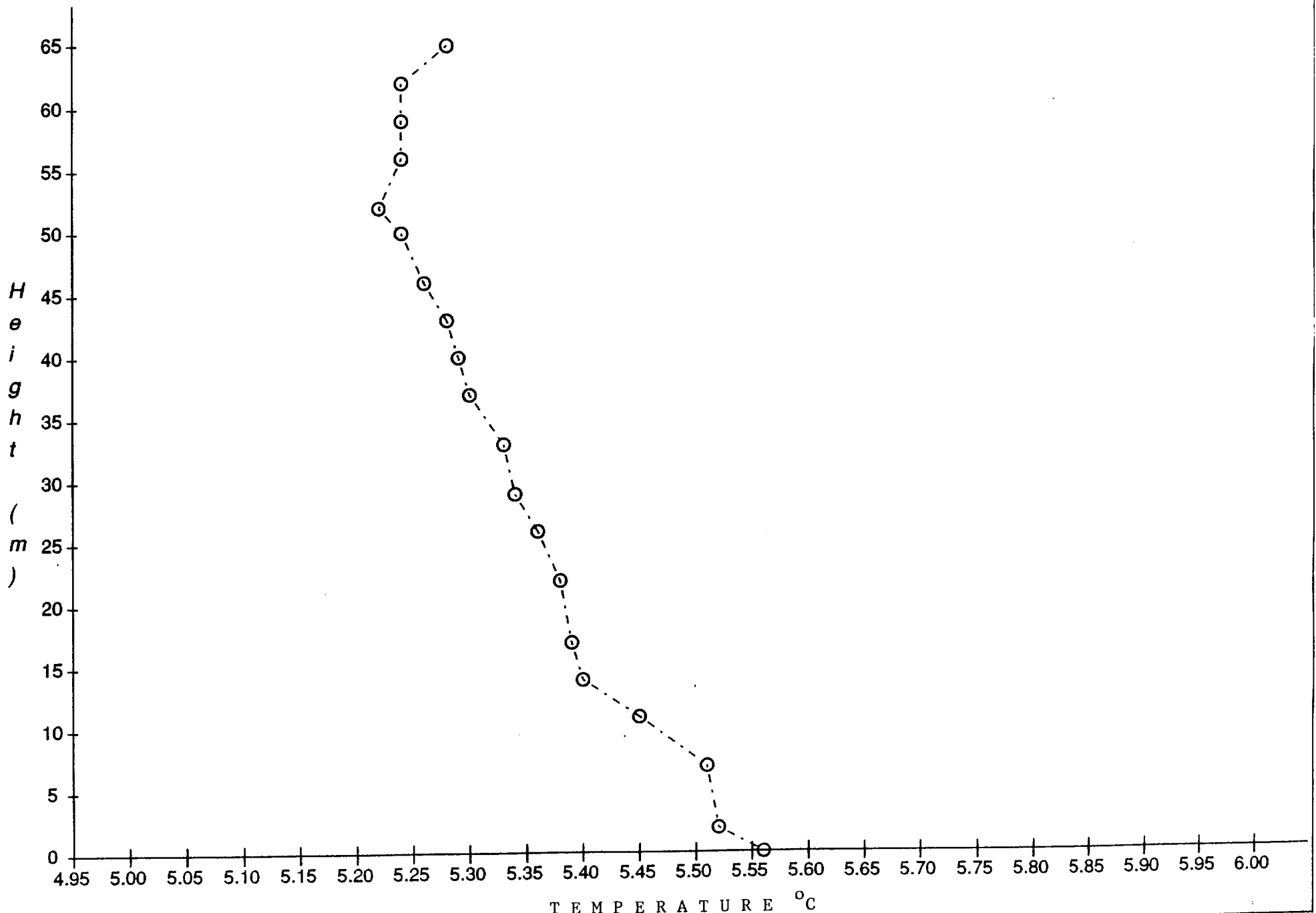
(04:10)

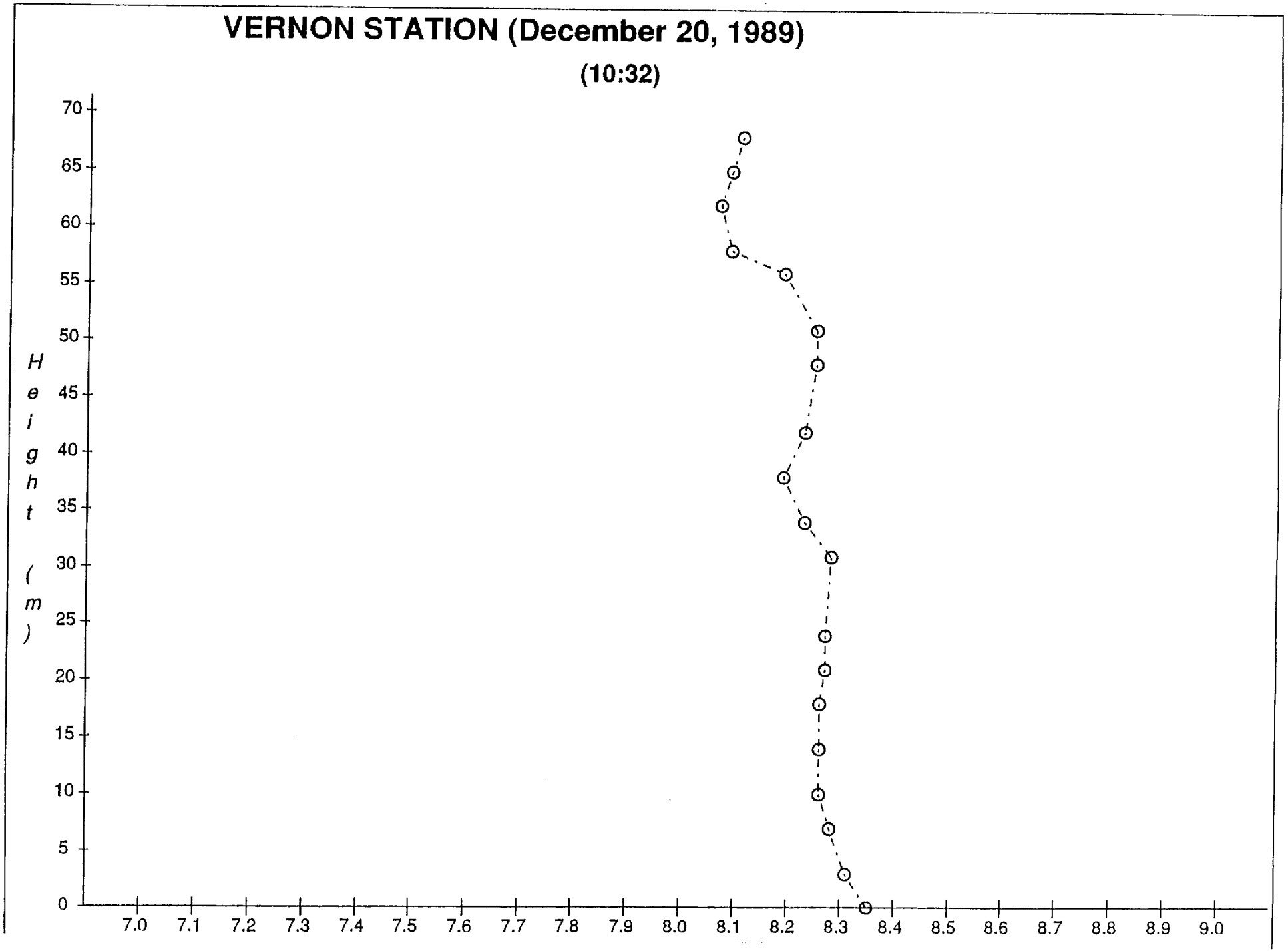



VERNON STATION (December 20, 1989)
(06:09)
Height (m)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
5.0
5.1
5.2
5.3
5.4
5.5
5.6
5.7
5.8
5.9
6.0
6.1
6.2
6.3
6.4
6.5

VERNON STATION (December 20, 1989)

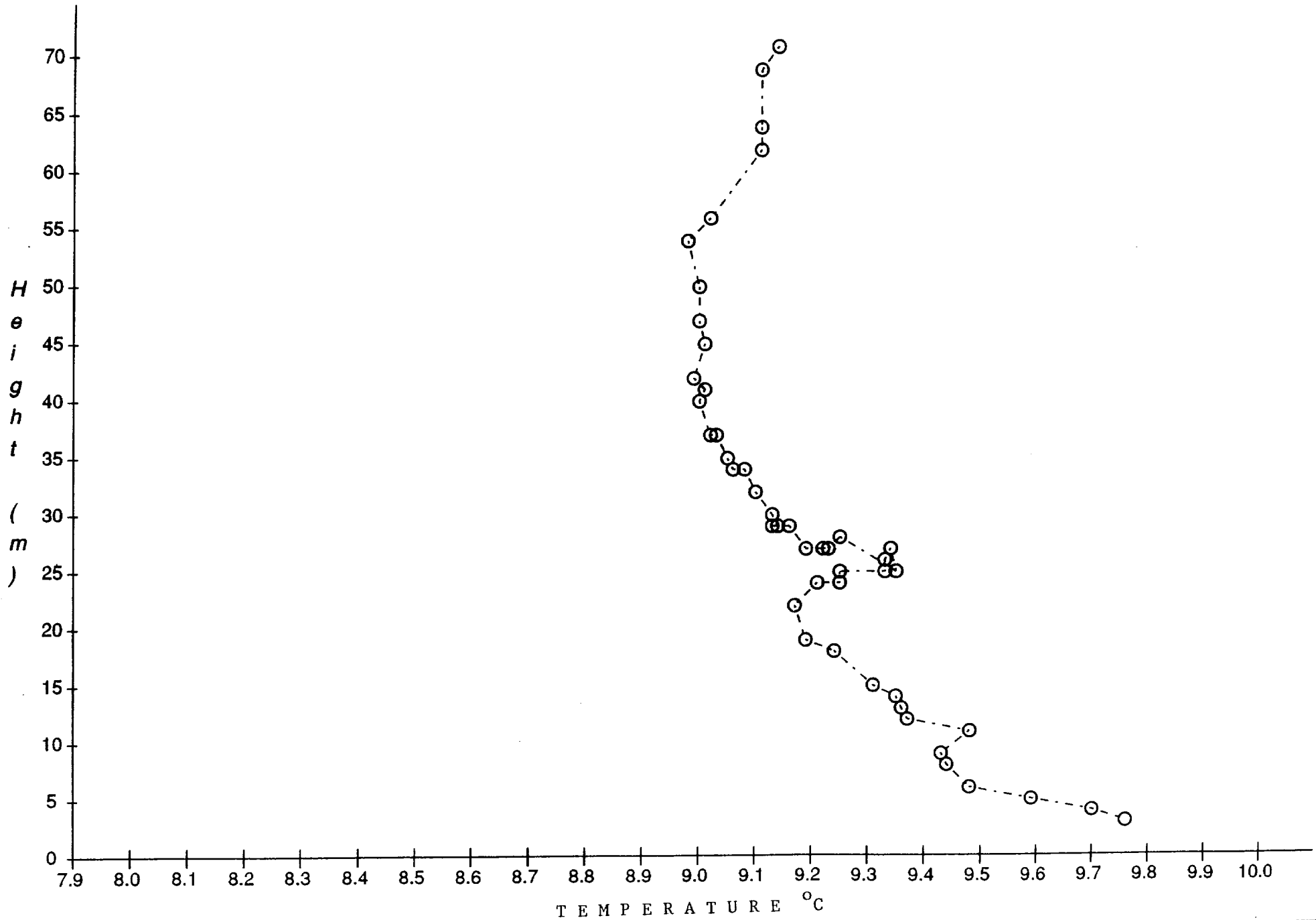
(08:02)

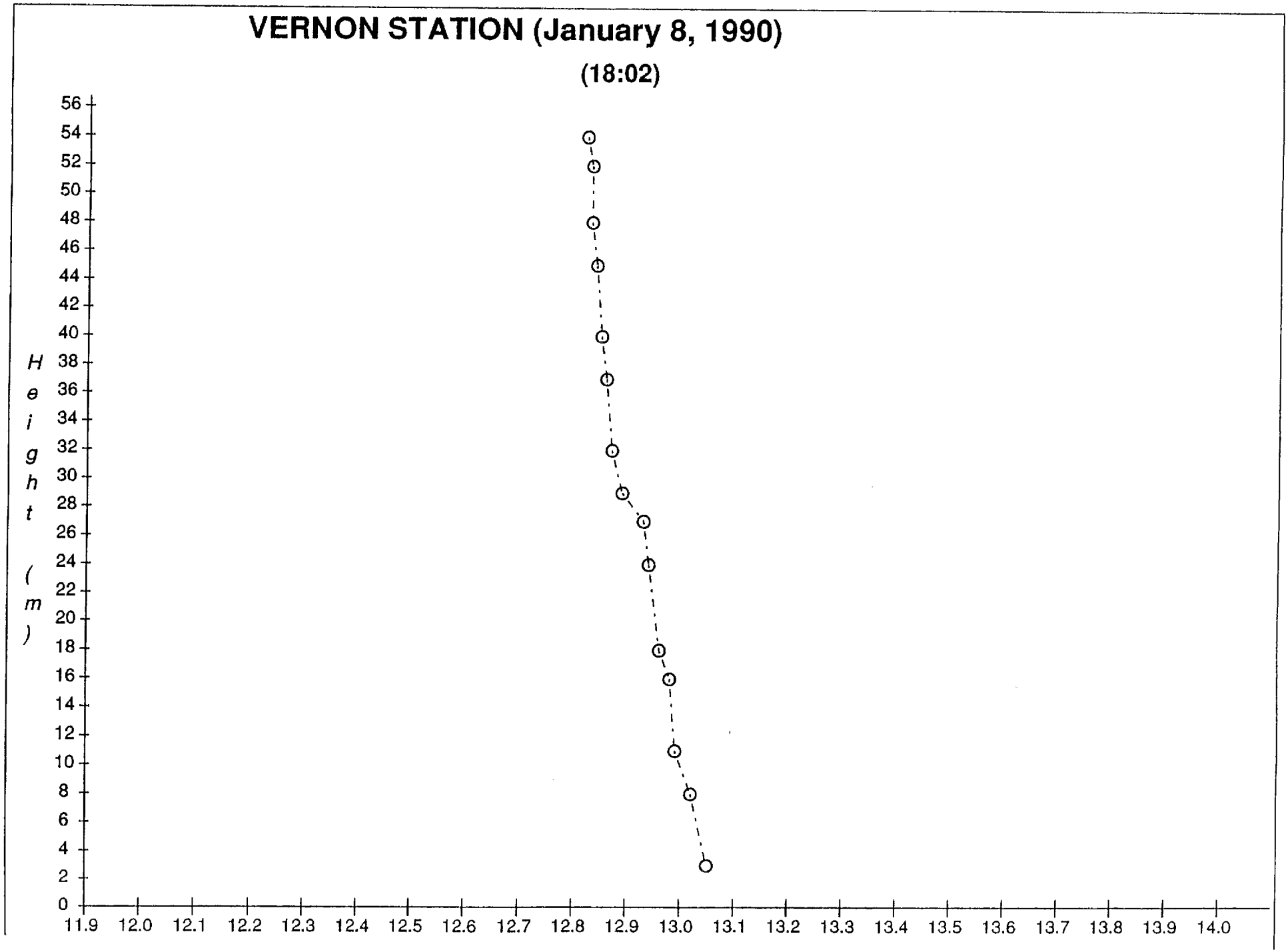



VERNON STATION (December 20, 1989)
(10:32)
Height (m)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
7.0
7.1
7.2
7.3
7.4
7.5
7.6
7.7
7.8
7.9
8.0
8.1
8.2
8.3
8.4
8.5
8.6
8.7
8.8
8.9
9.0

VERNON STATION (December 20, 1989)

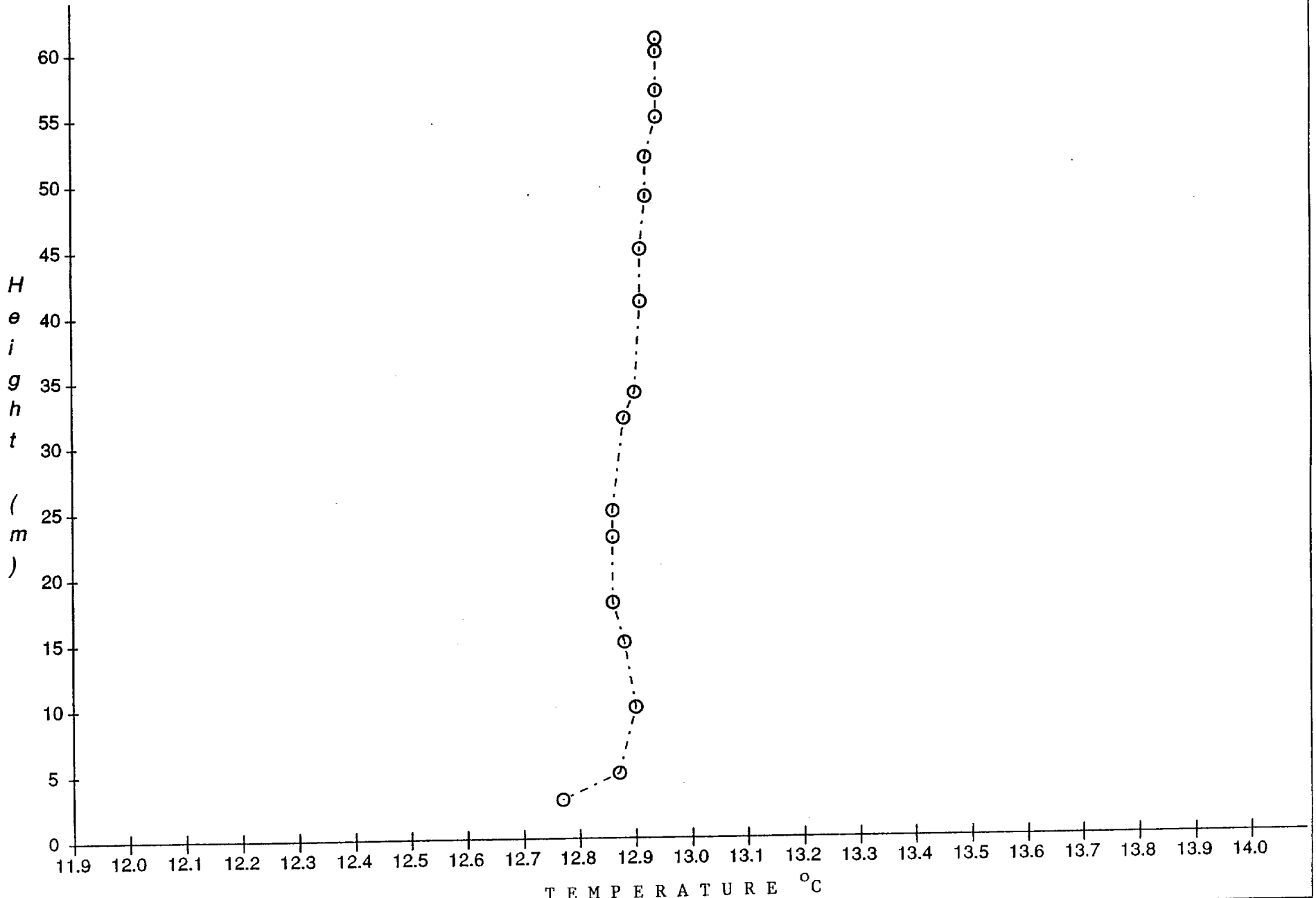
(12:01)

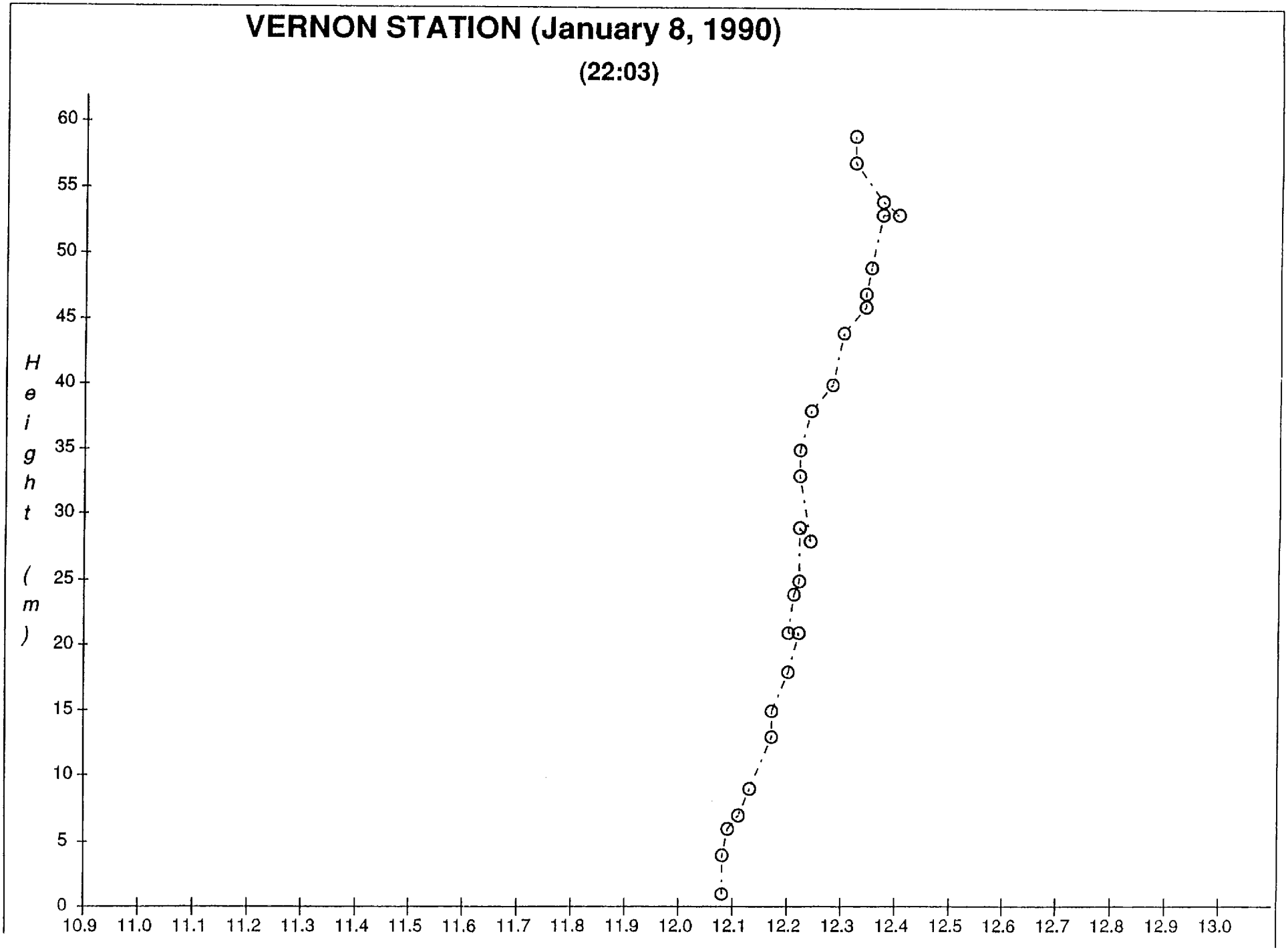



VERNON STATION (January 8, 1990)
(18:02)
Height (m)
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
11.9
12.0
12.1
12.2
12.3
12.4
12.5
12.6
12.7
12.8
12.9
13.0
13.1
13.2
13.3
13.4
13.5
13.6
13.7
13.8
13.9
14.0

VERNON STATION (January 8, 1990)

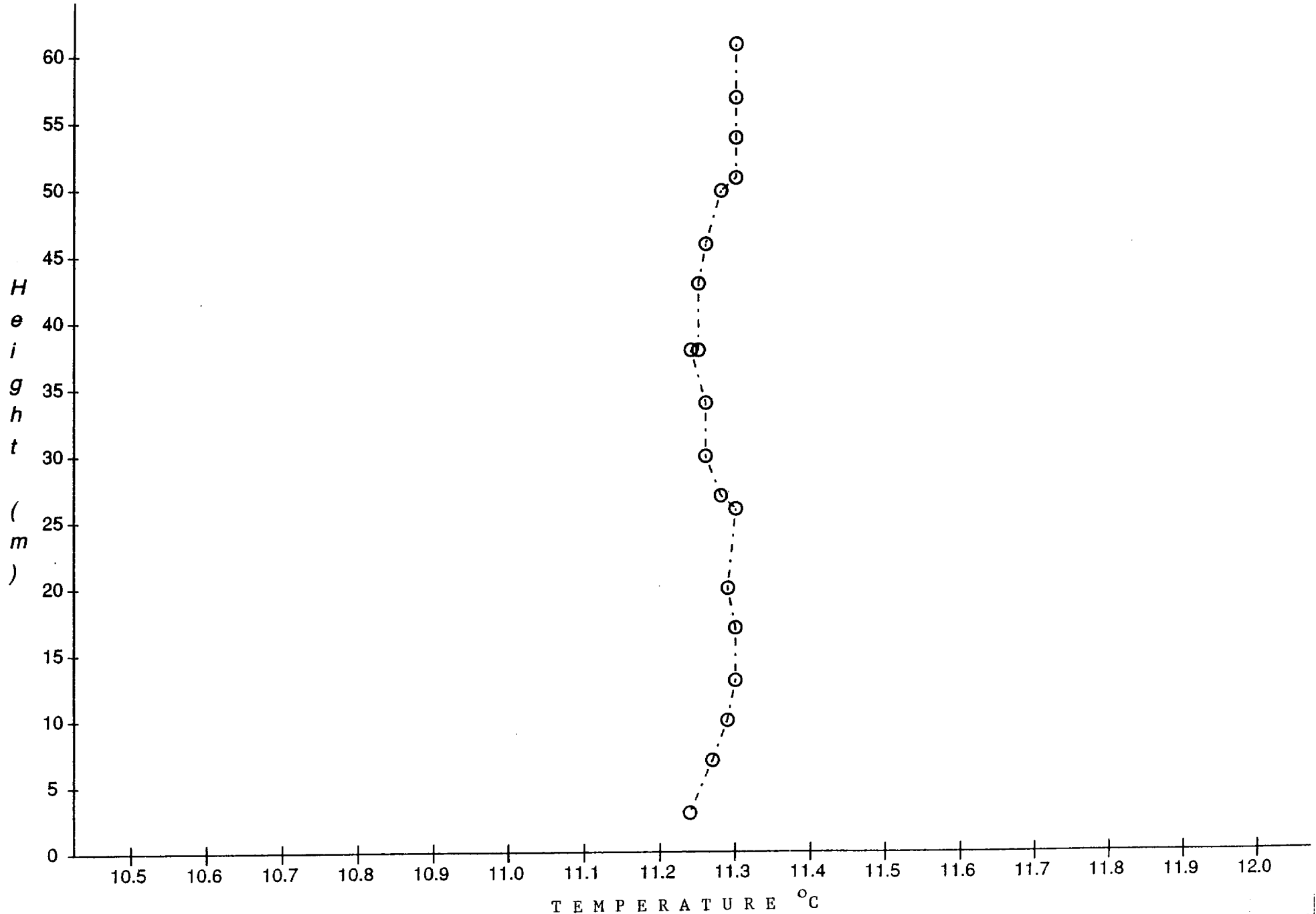
(20:04)

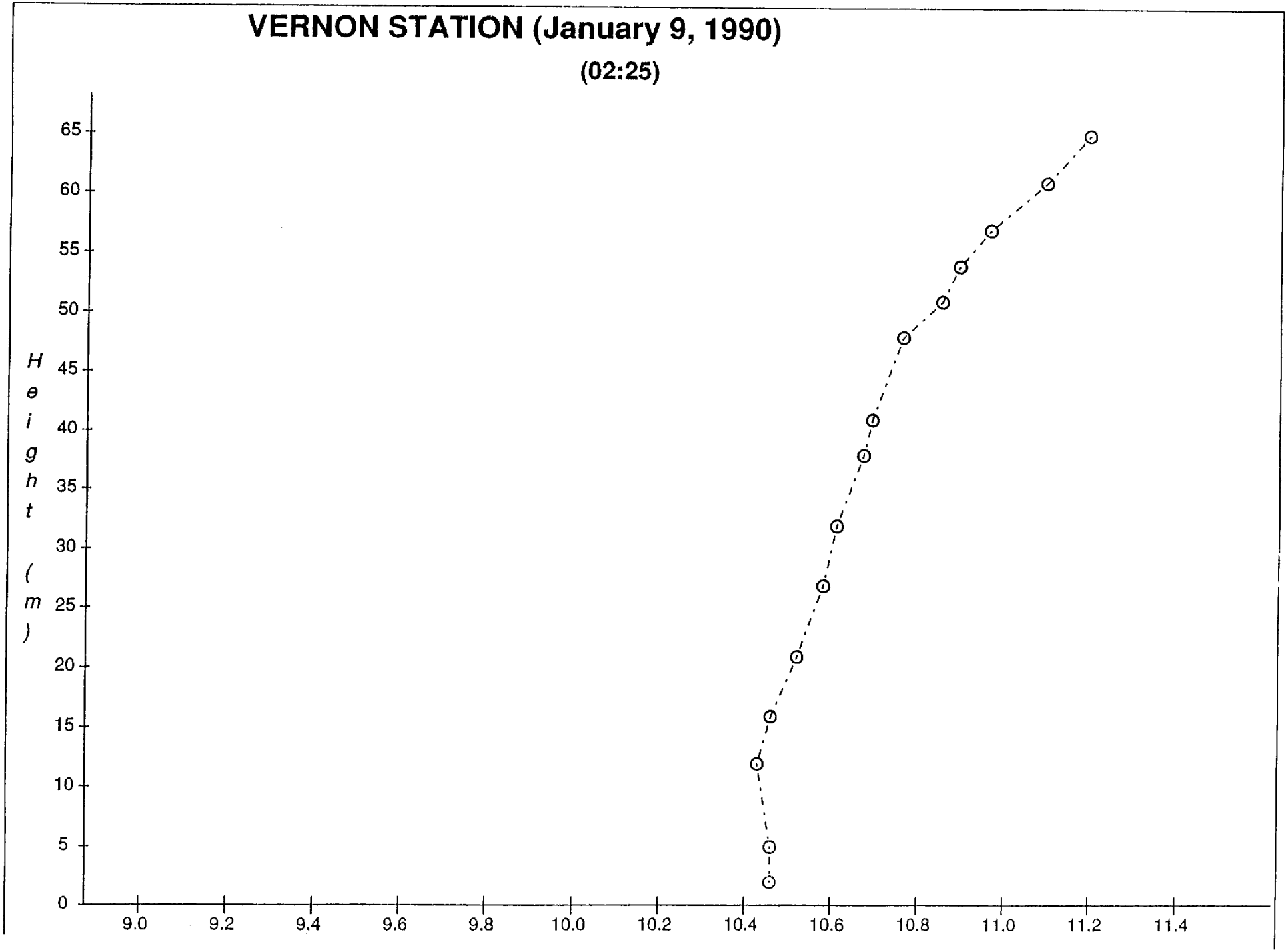


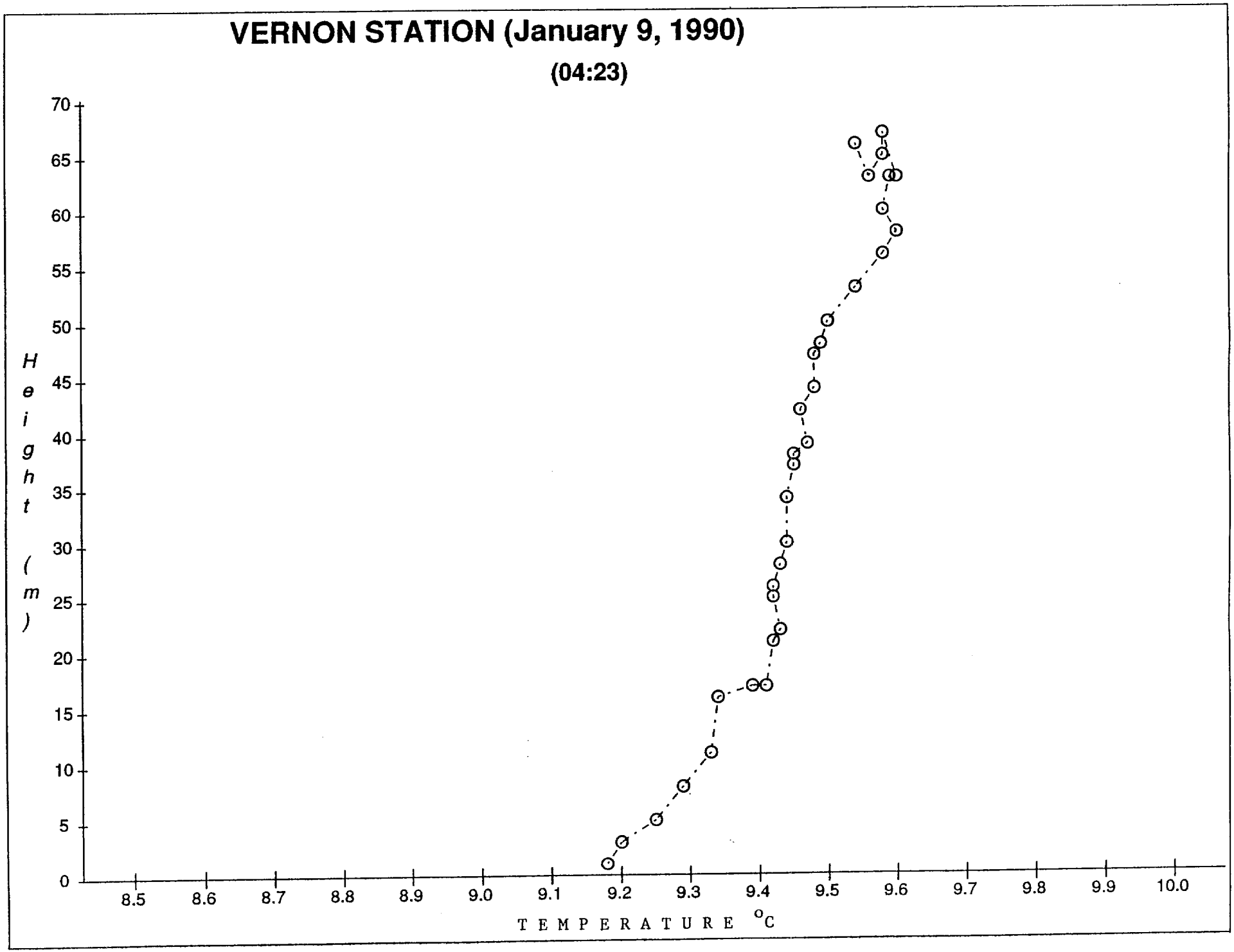

VERNON STATION (January 8, 1990)
(22:03)
Height (m)
0
5
10
15
20
25
30
35
40
45
50
55
60
10.9
11.0
11.1
11.2
11.3
11.4
11.5
11.6
11.7
11.8
11.9
12.0
12.1
12.2
12.3
12.4
12.5
12.6
12.7
12.8
12.9
13.0

VERNON STATION (January 9, 1990)

(00:01)




VERNON STATION (January 9, 1990)
(02:25)
Height (m)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
9.0
9.2
9.4
9.6
9.8
10.0
10.2
10.4
10.6
10.8
11.0
11.2
11.4


VERNON STATION (January 9, 1990)
(04:23)
Height (m)
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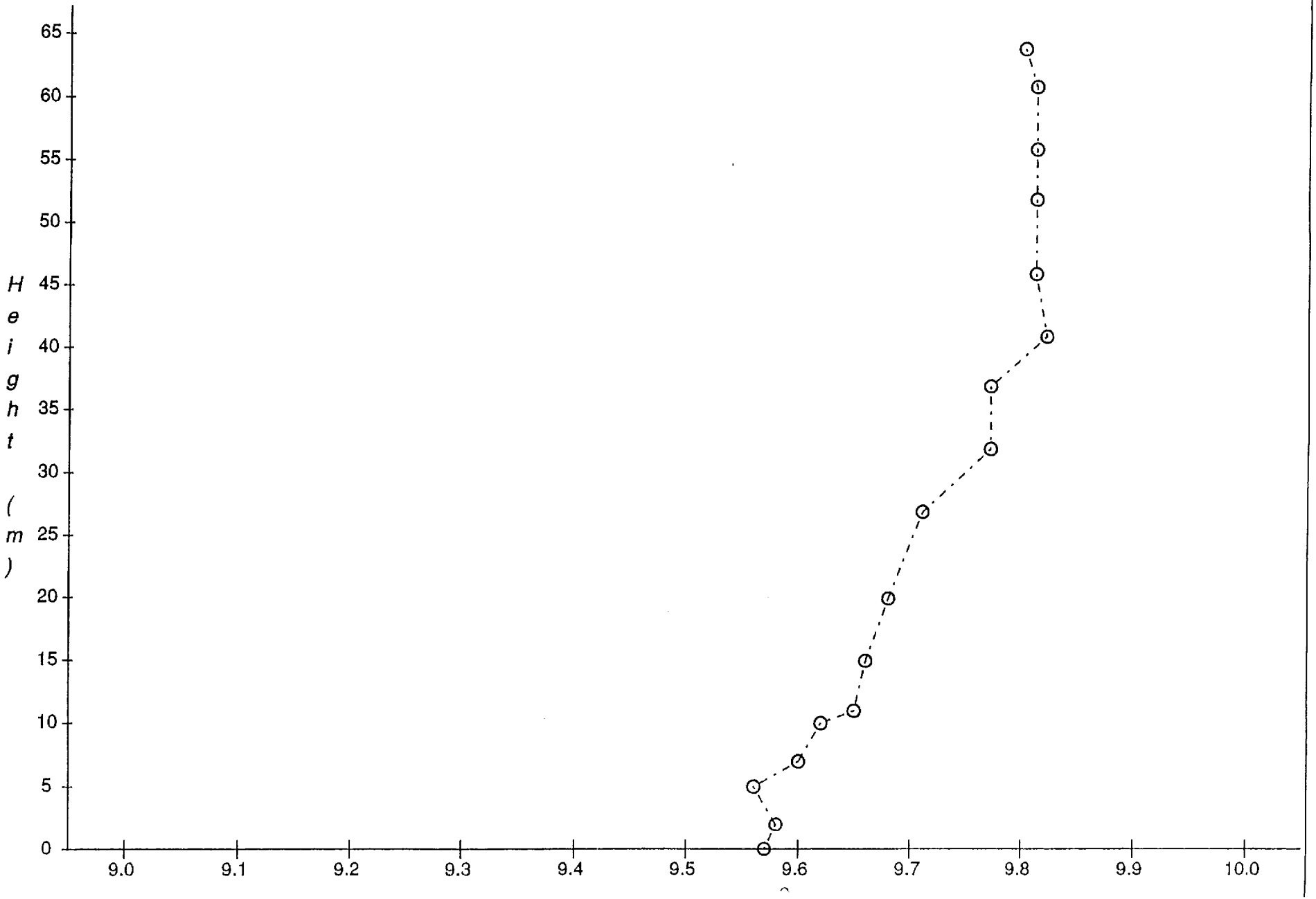
65
60
55
50
45
40
35
30
25
20
15
10
5
0
8.5
8.6
8.7
8.8
8.9
9.0
9.1
9.2
9.3
9.4
9.5
9.6
9.7
9.8
9.9
10.0
TEMPERATURE °C

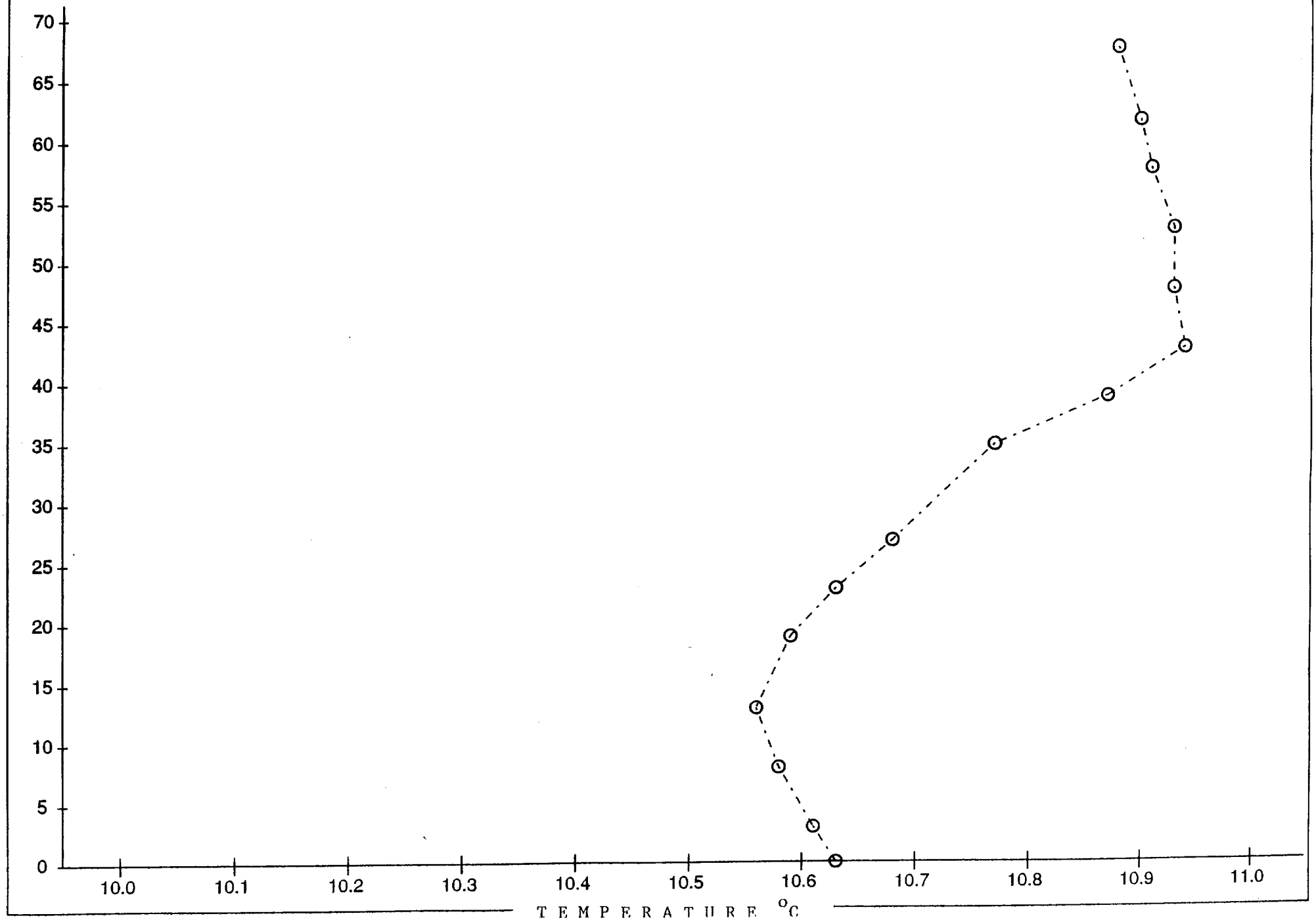
VERNON STATION (January 9, 1990)

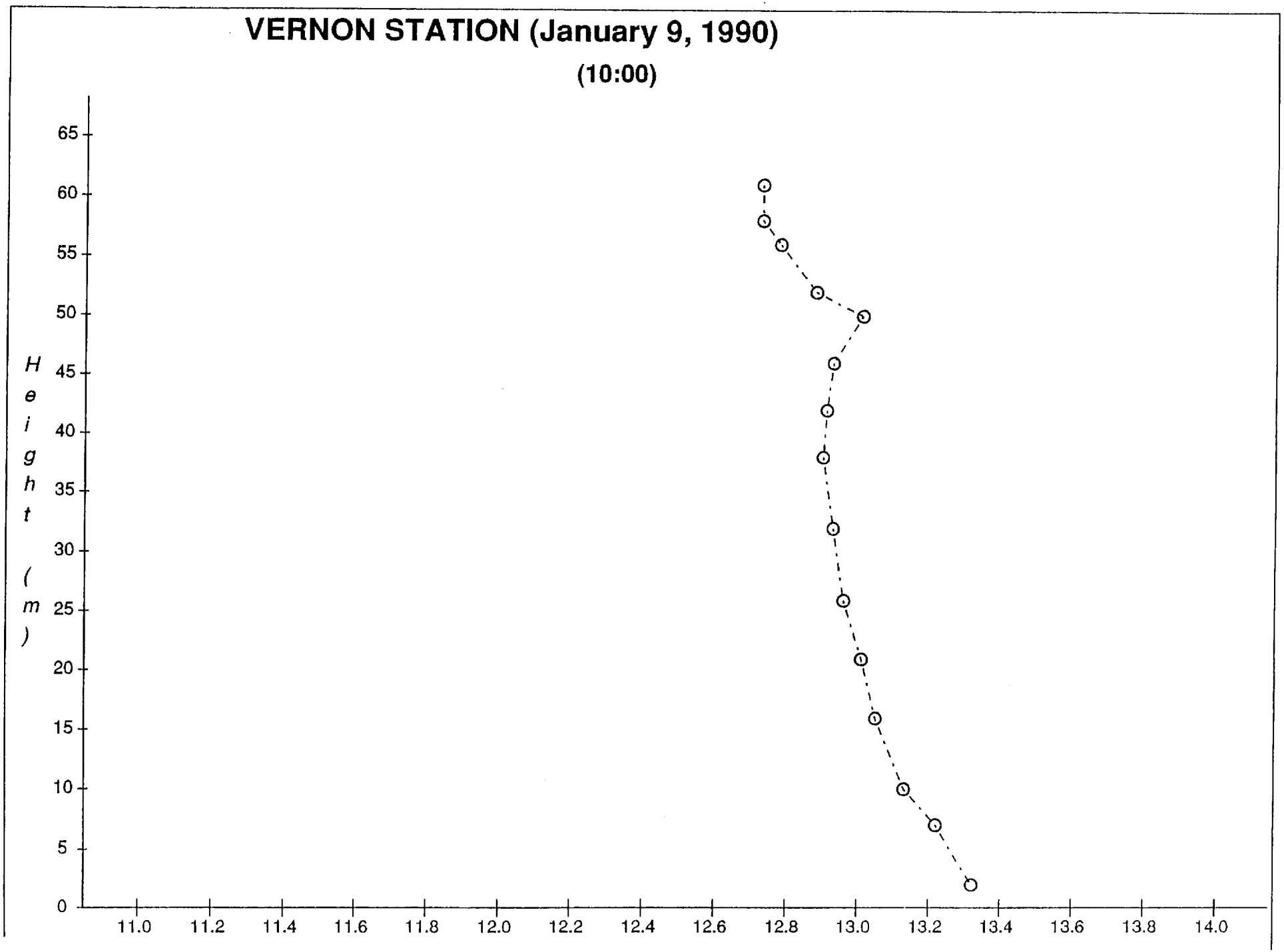
(06:22)



VERNON STATION (January 9, 1990)

(08:00)




VERNON STATION (January 9, 1990)
(10:00)
Height (m)
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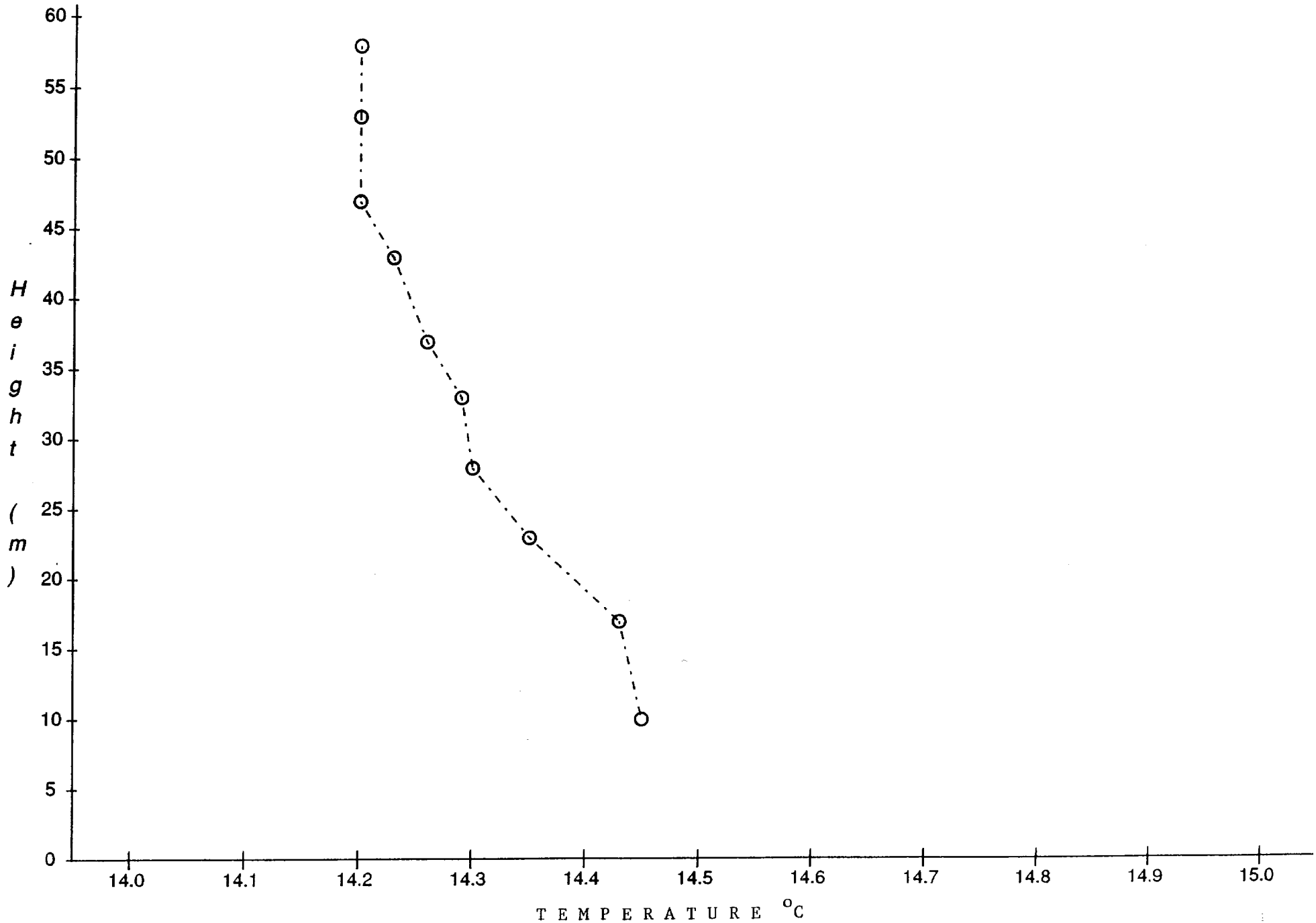
60
55
50
45
40
35
30
25
20
15
10
5
0
11.0
11.2
11.4
11.6
11.8
12.0
12.2
12.4
12.6
12.8
13.0
13.2
13.4
13.6
13.8
14.0

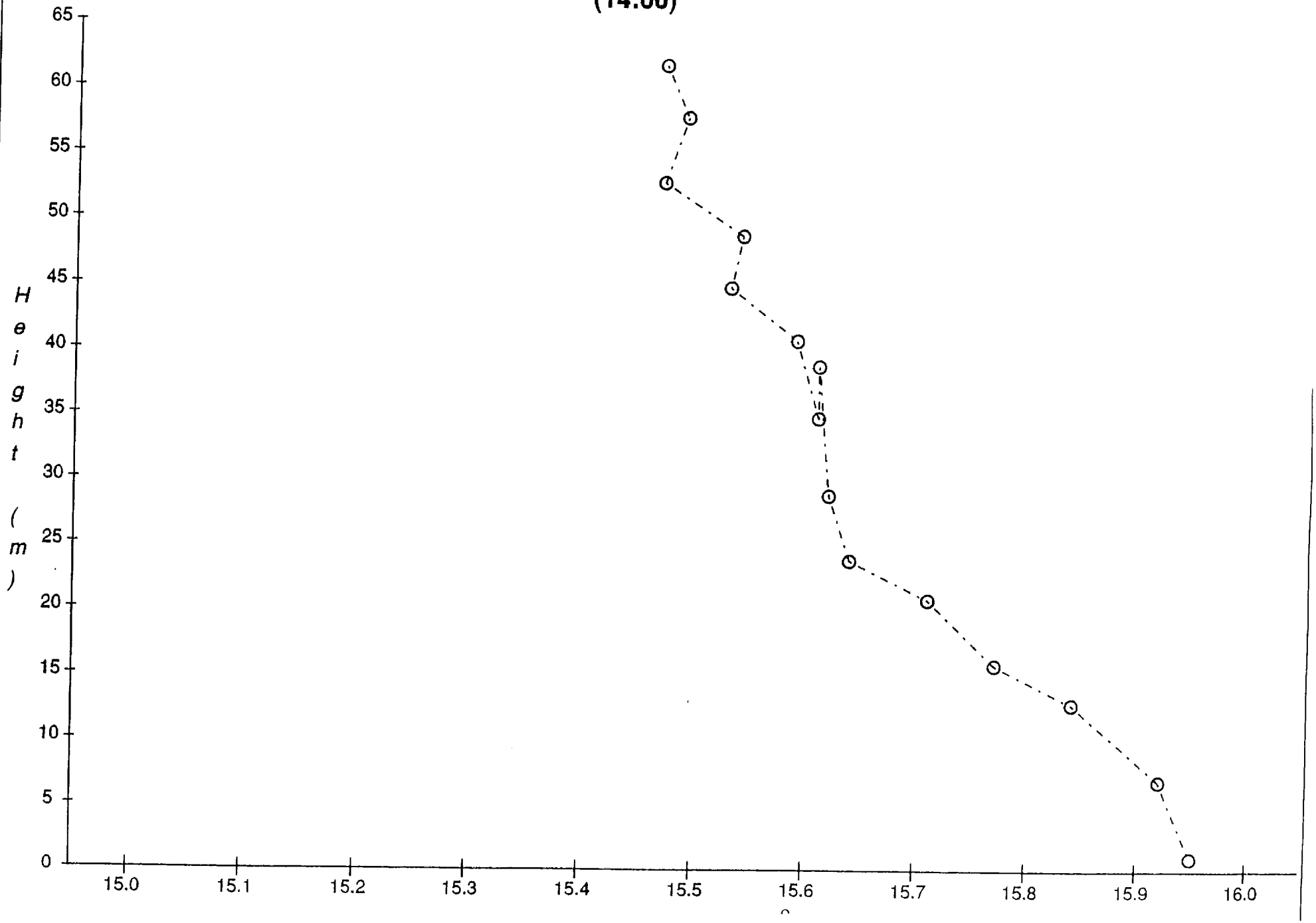
VERNON STATION (January 9, 1990)

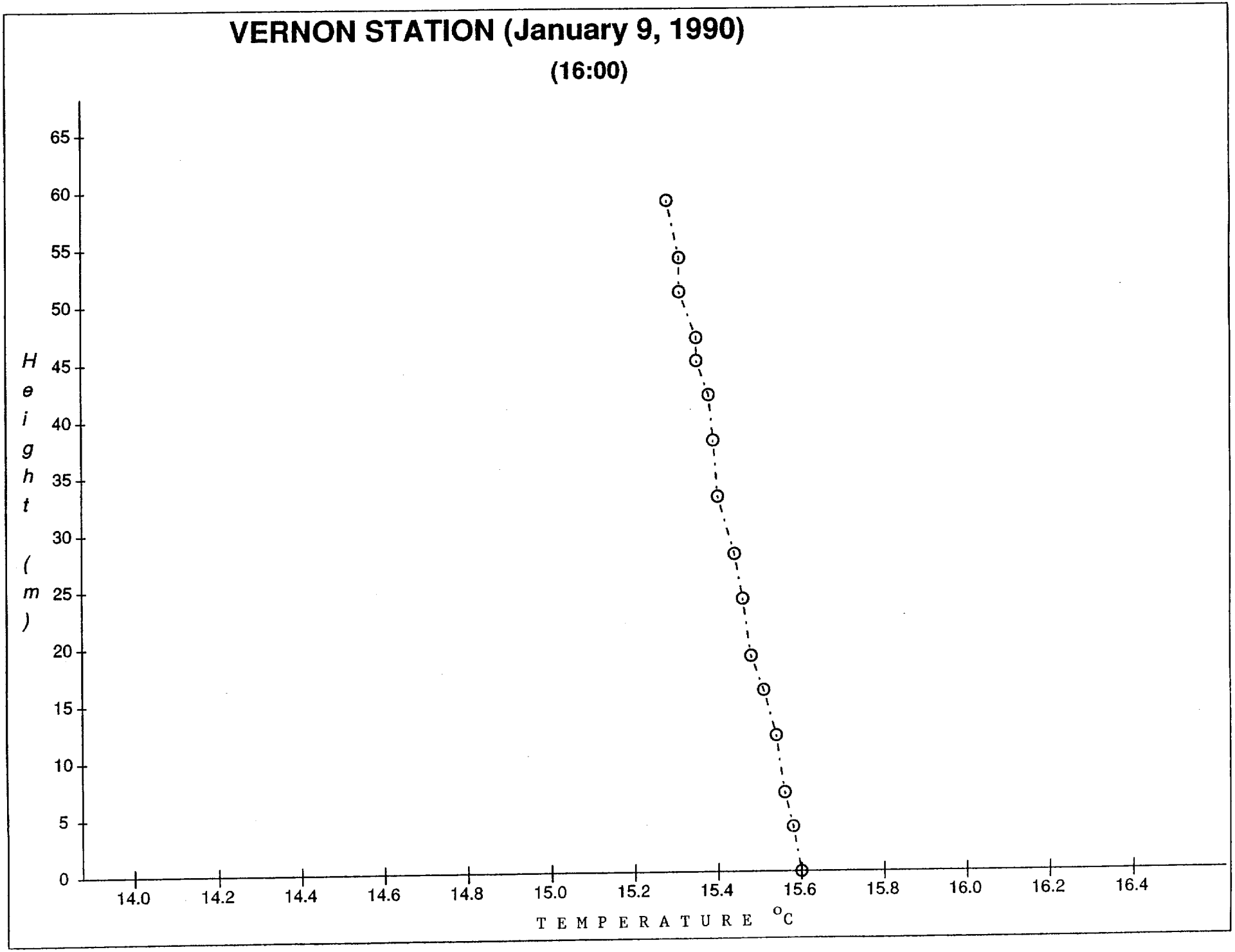
(12:00)

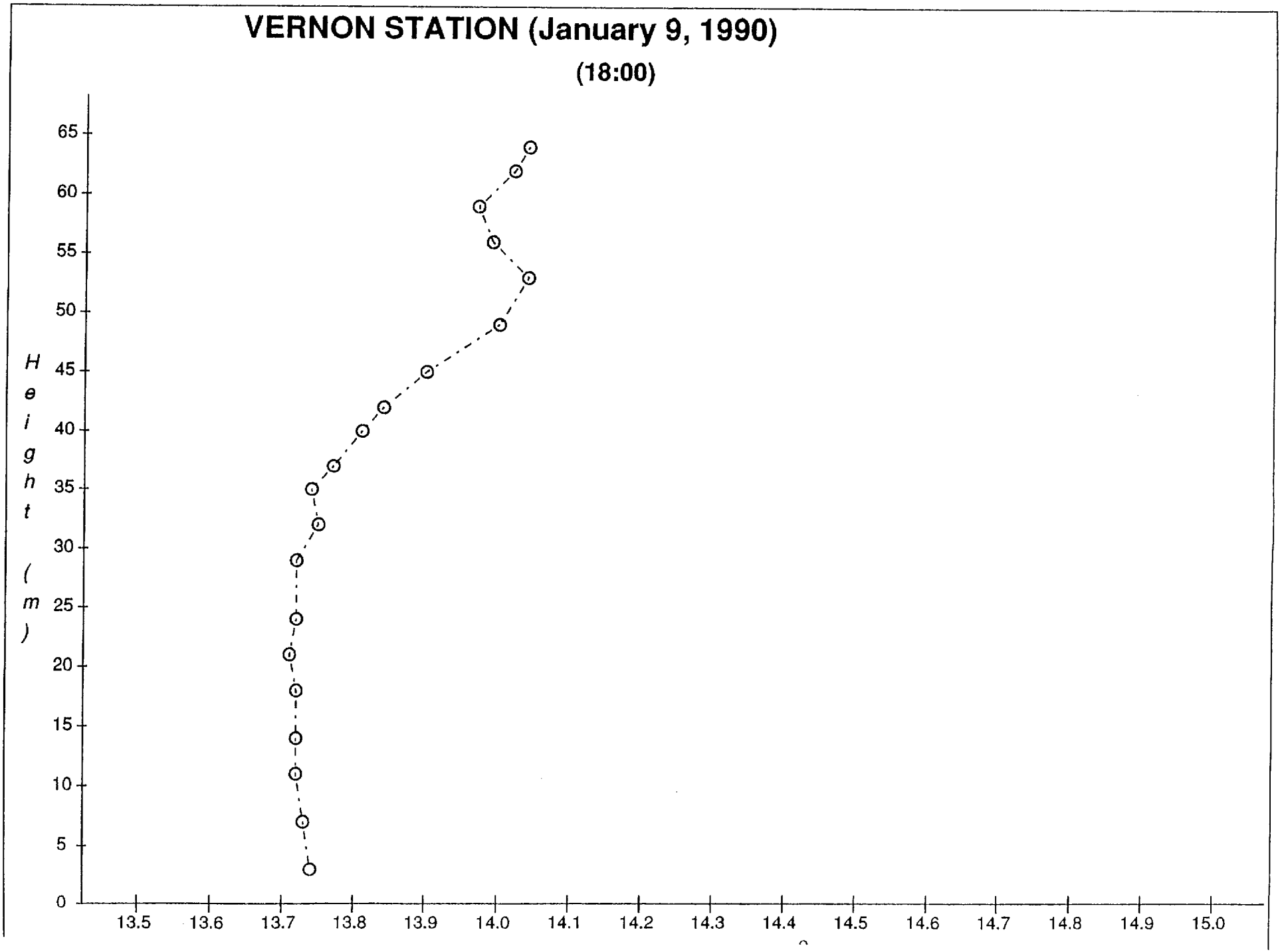


VERNON STATION (January 9, 1990)

(14:00)




VERNON STATION (January 9, 1990)
(16:00)
Height (m)
65
60
55
50
45
40
35
30
25
20
15
10
5
0
14.0
14.2
14.4
14.6
14.8
15.0
15.2
15.4
15.6
15.8
16.0
16.2
16.4
TEMPERATURE °C


VERNON STATION (January 9, 1990)
(18:00)
Height (m)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
13.5
13.6
13.7
13.8
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14.4
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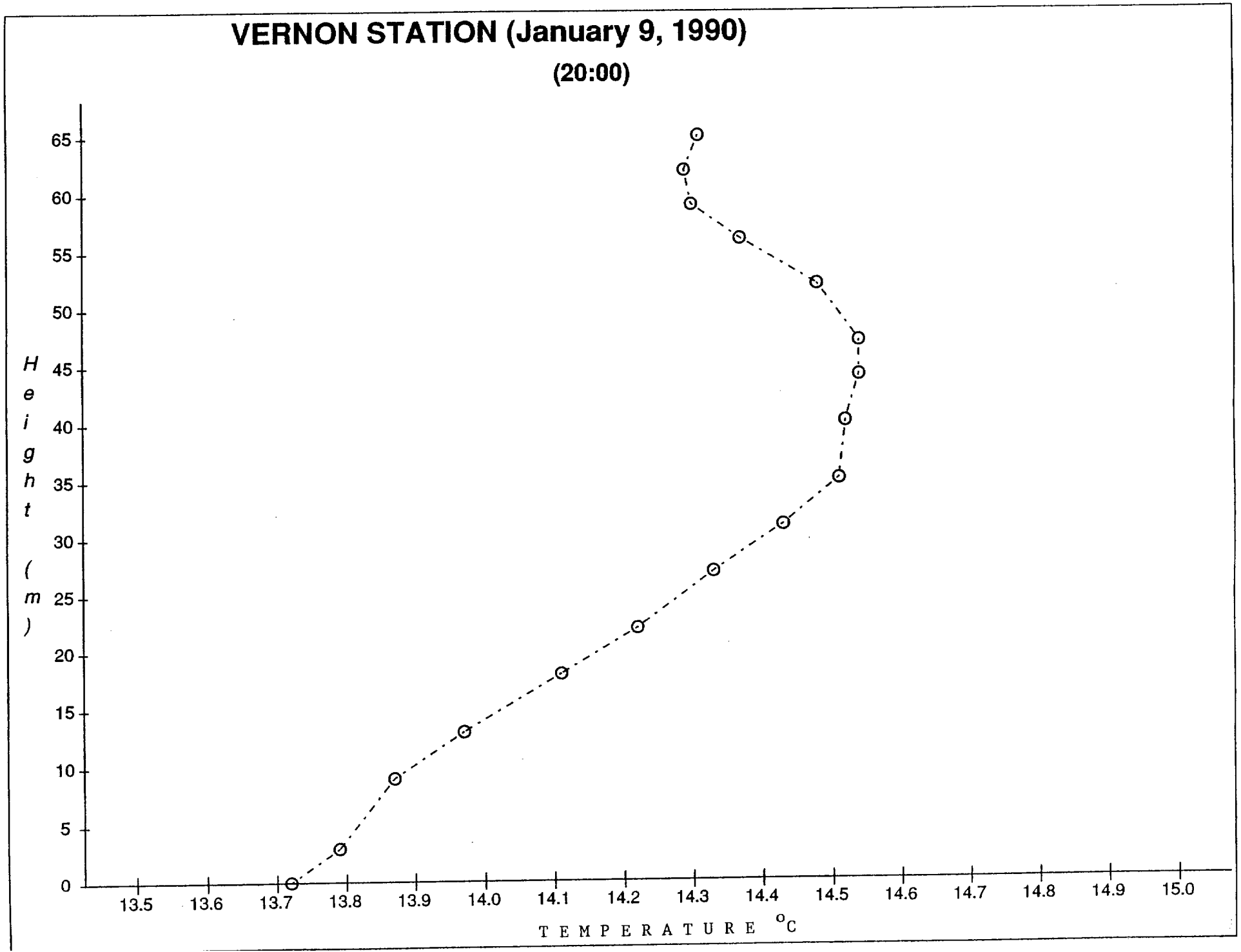
14.6
14.7
14.8
14.9
15.0


VERNON STATION (January 9, 1990)
(20:00)
Height (m)
0
5
10
15
20
25
30
35
40
45
50
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60
65
13.5
13.6
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13.8
13.9
14.0
14.1
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14.3
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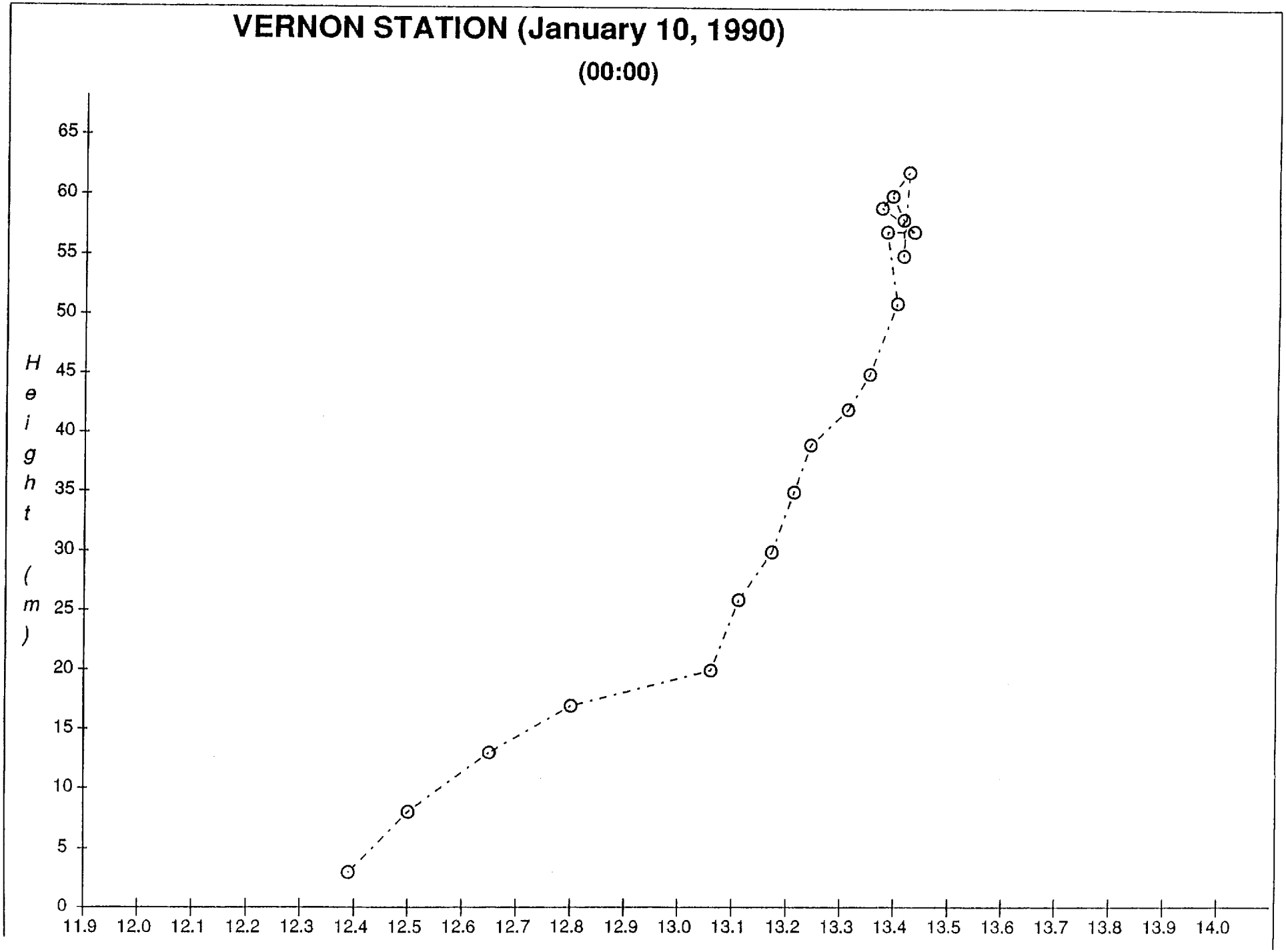
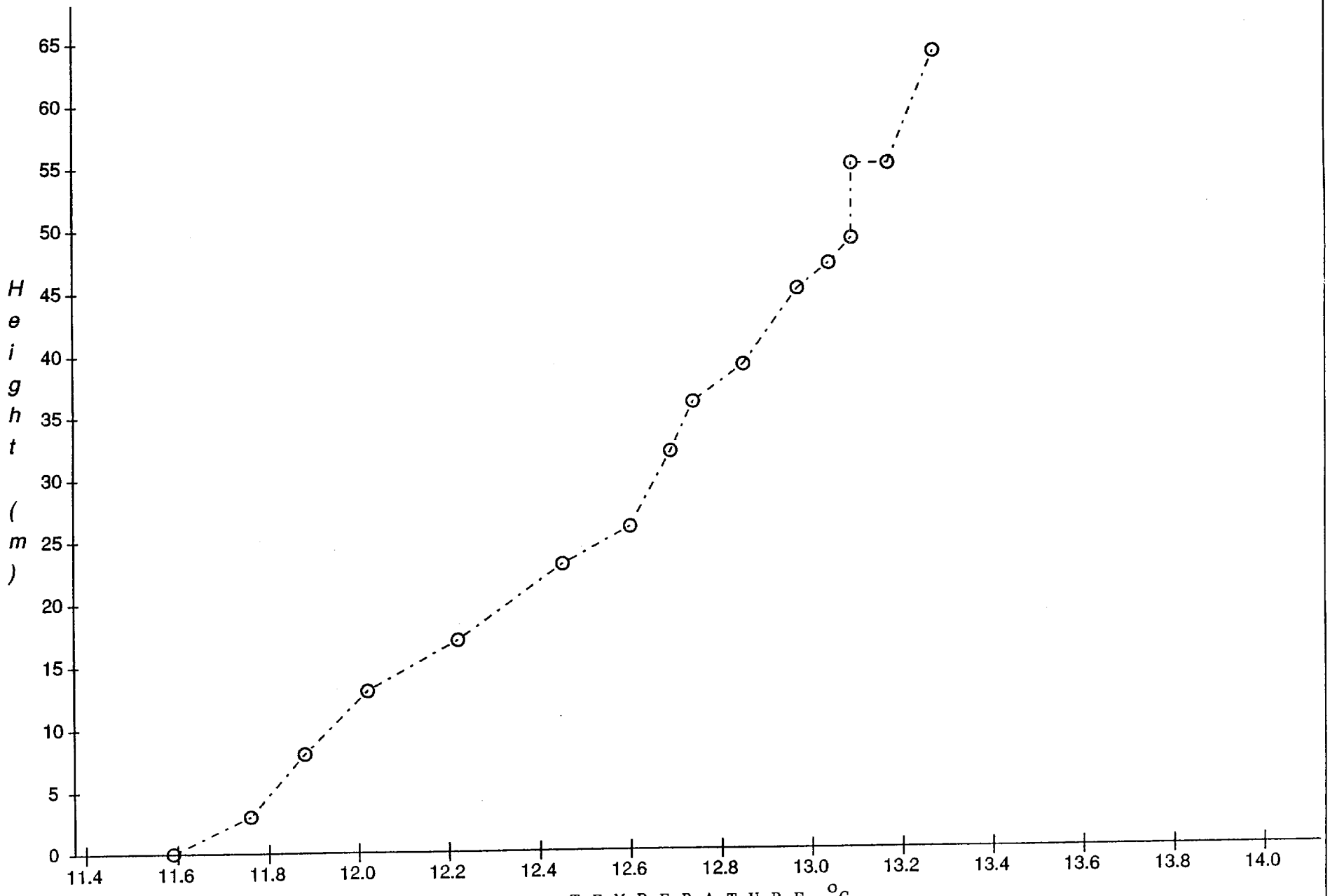
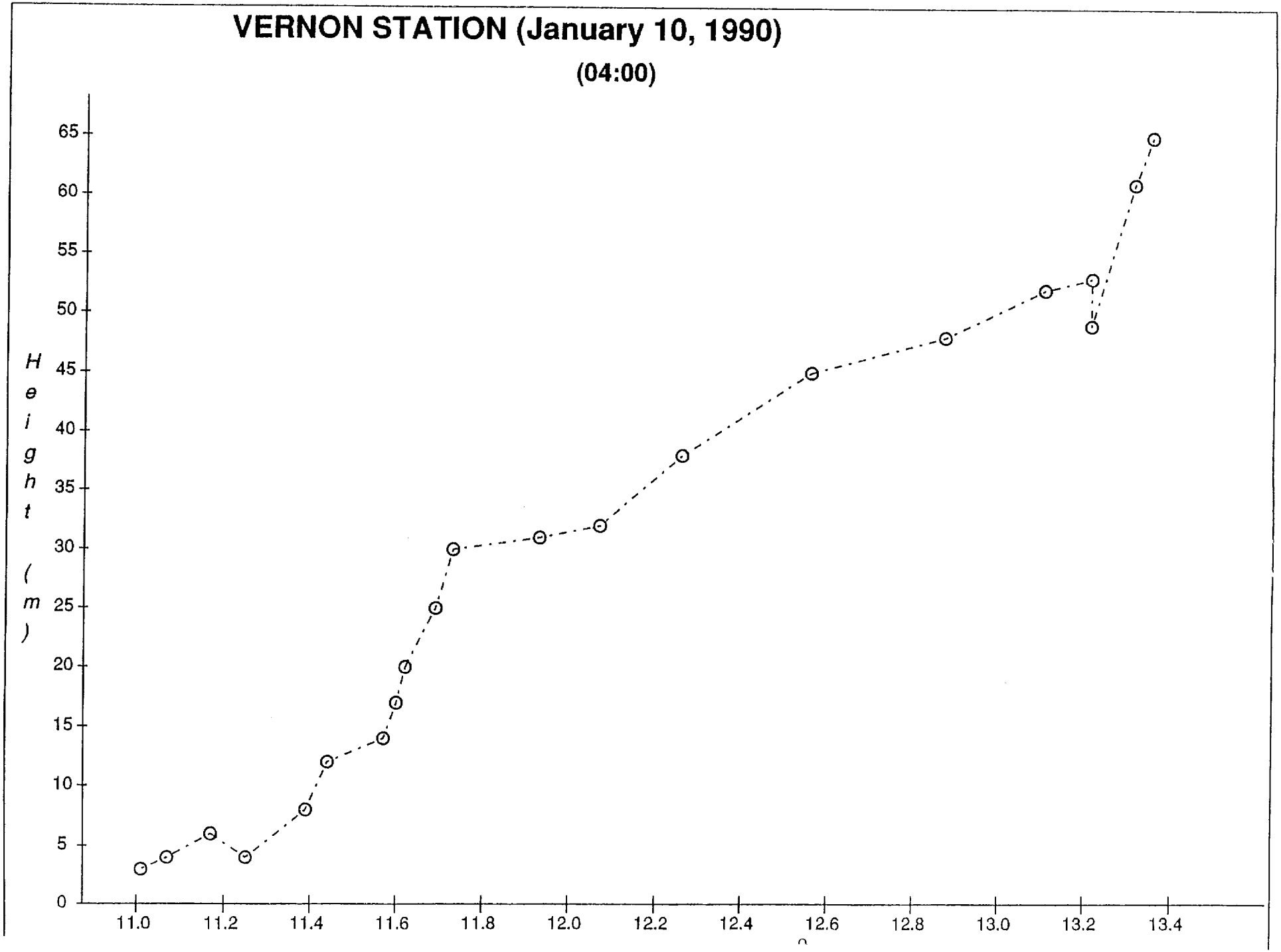
14.5
14.6
14.7
14.8
14.9
15.0
TEMPERATURE °C


VERNON STATION (January 10, 1990)
(00:00)
Height (m)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
11.9
12.0
12.1
12.2
12.3
12.4
12.5
12.6
12.7
12.8
12.9
13.0
13.1
13.2
13.3
13.4
13.5
13.6
13.7
13.8
13.9
14.0

VERNON STATION (January 10, 1990)

(02:00)




VERNON STATION (January 10, 1990)
(04:00)
Height (m)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
11.0
11.2
11.4
11.6
11.8
12.0
12.2
12.4
12.6
12.8
13.0
13.2
13.4

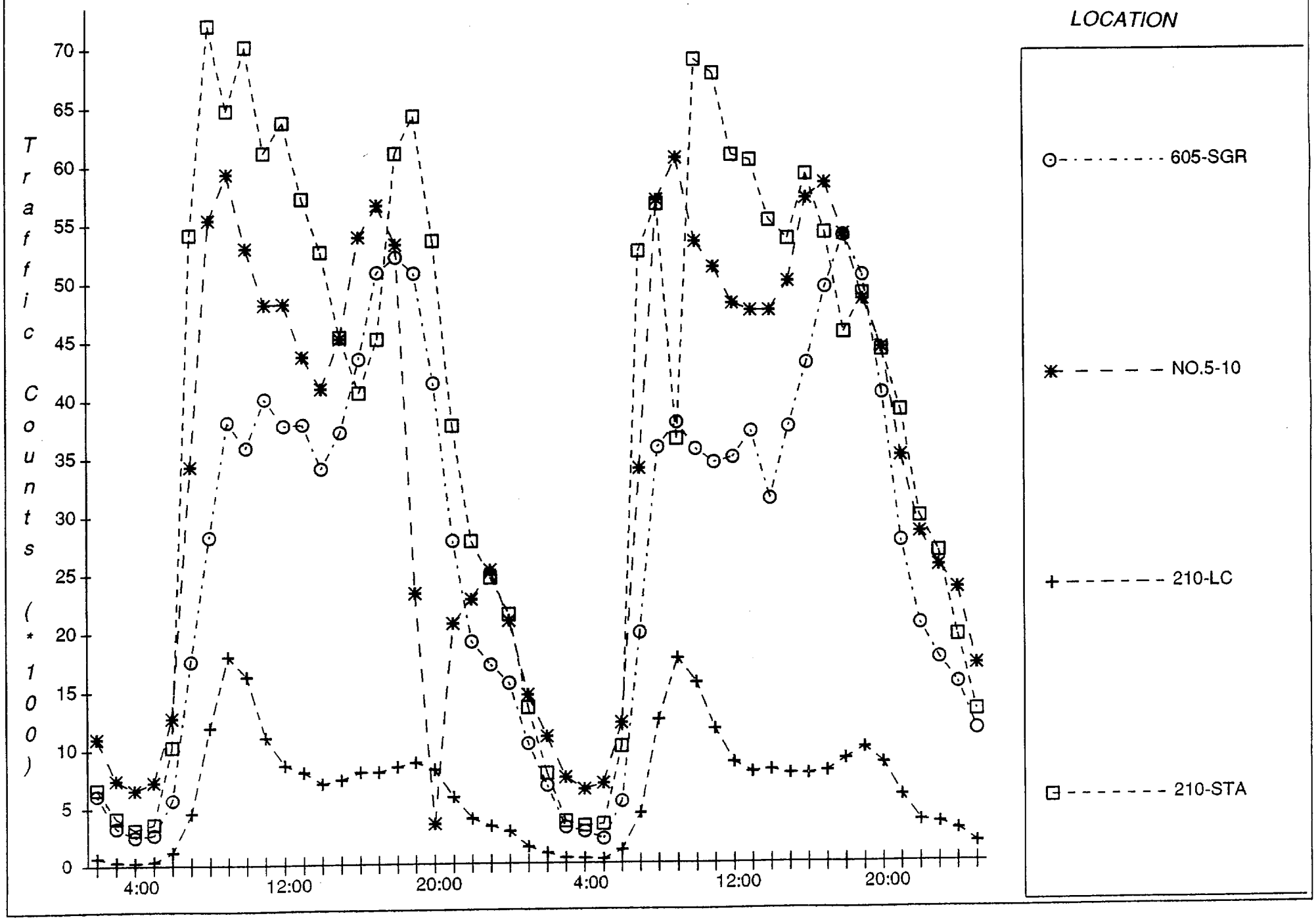
Appendix F

CO CONCENTRATIONS AND TRAFFIC COUNTS

Appendix F-1

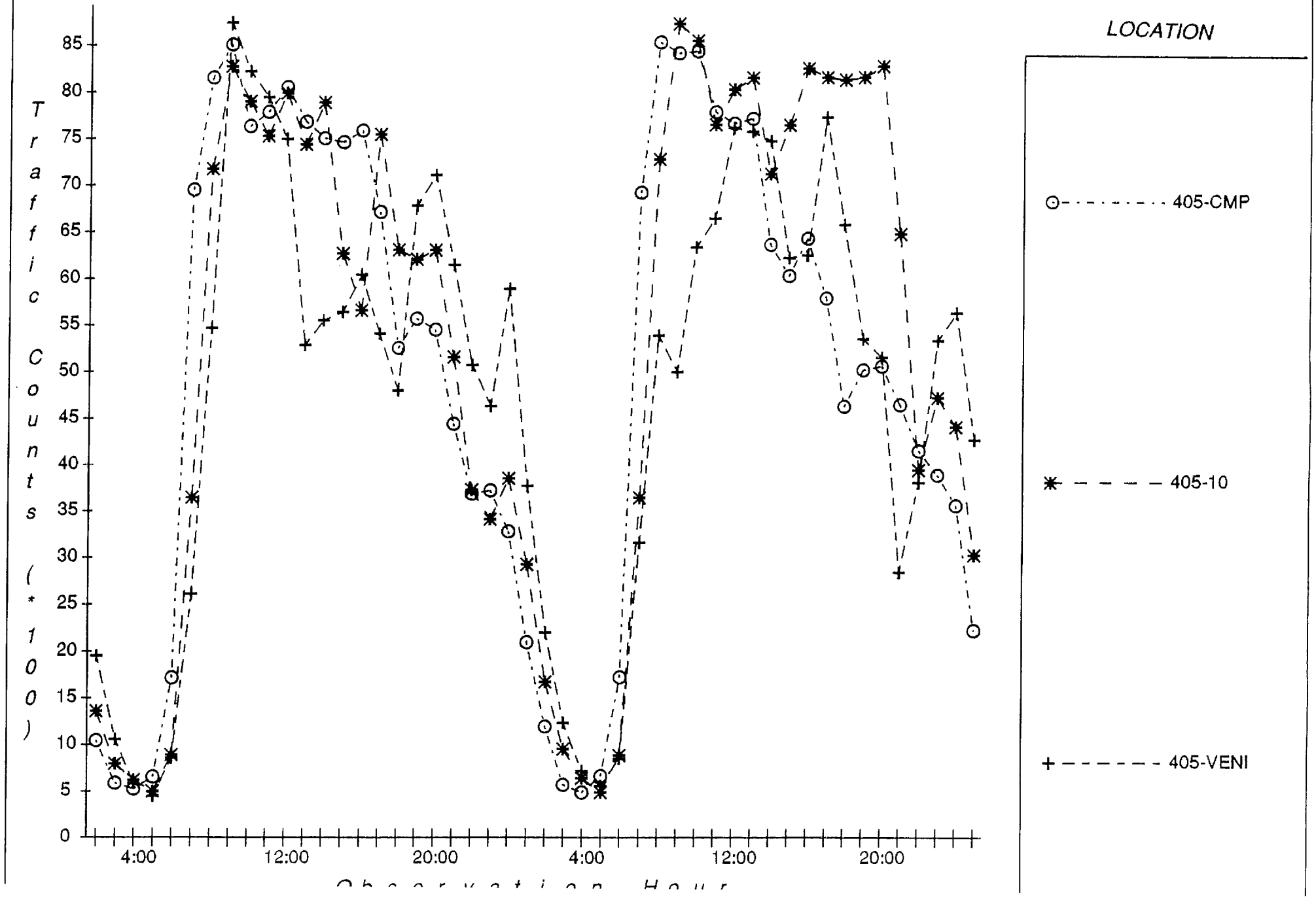
Freeway Traffic Counts

Dec. 19-20, 1989



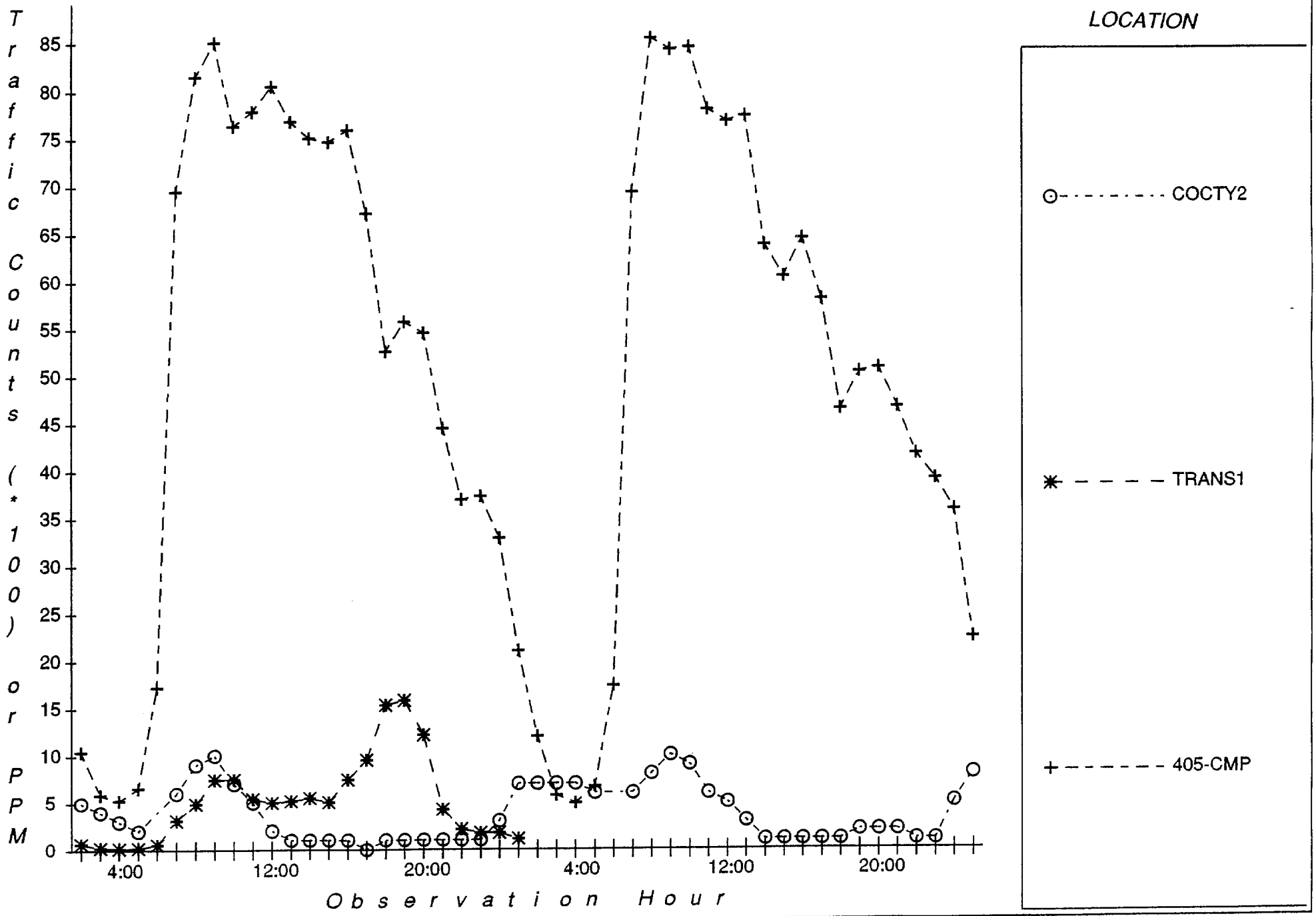
Freeway Traffic Counts

Dec. 19-20, 1989



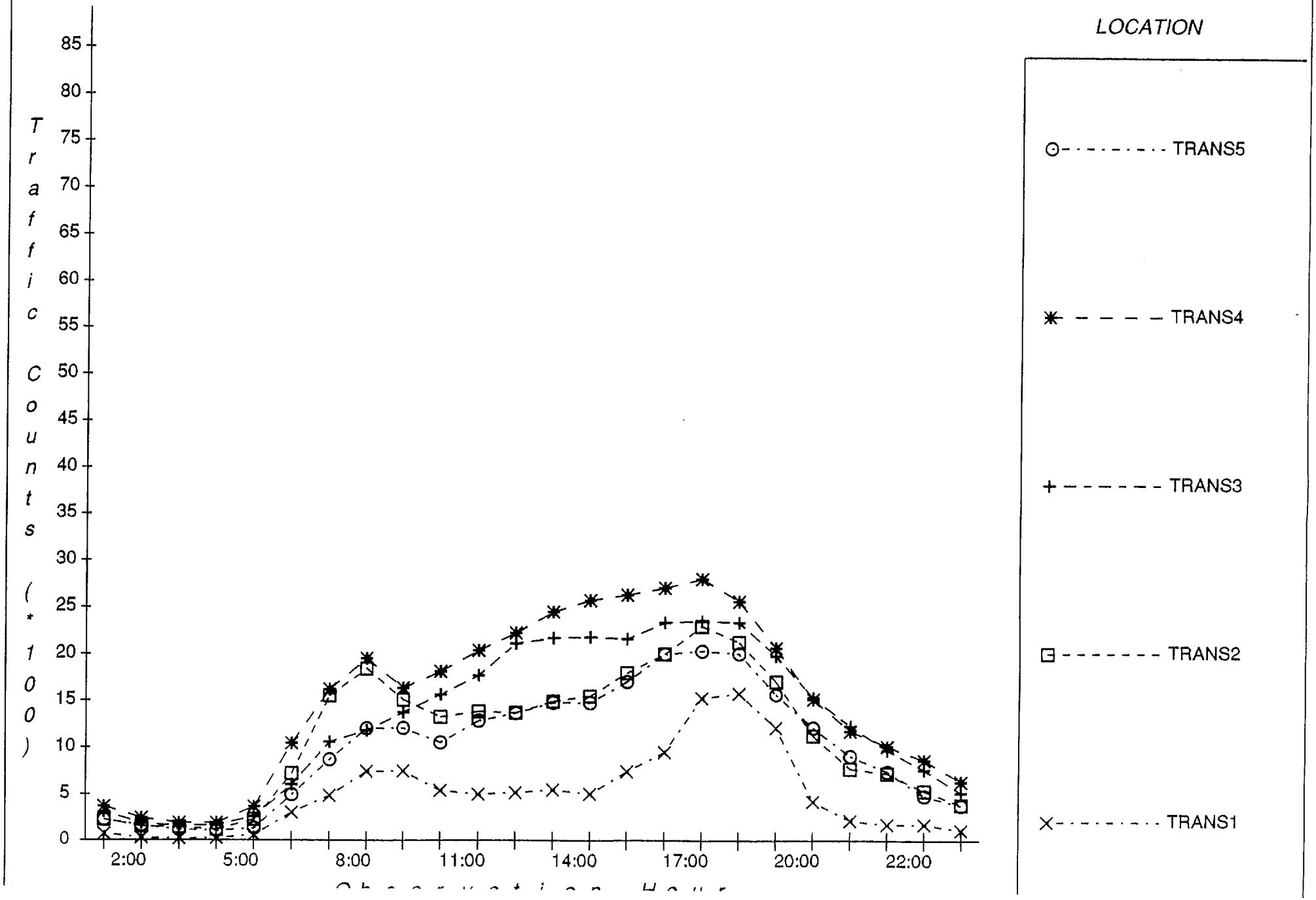
CO and Traffic Study (Episode 2)

Dec. 19-20, 1989



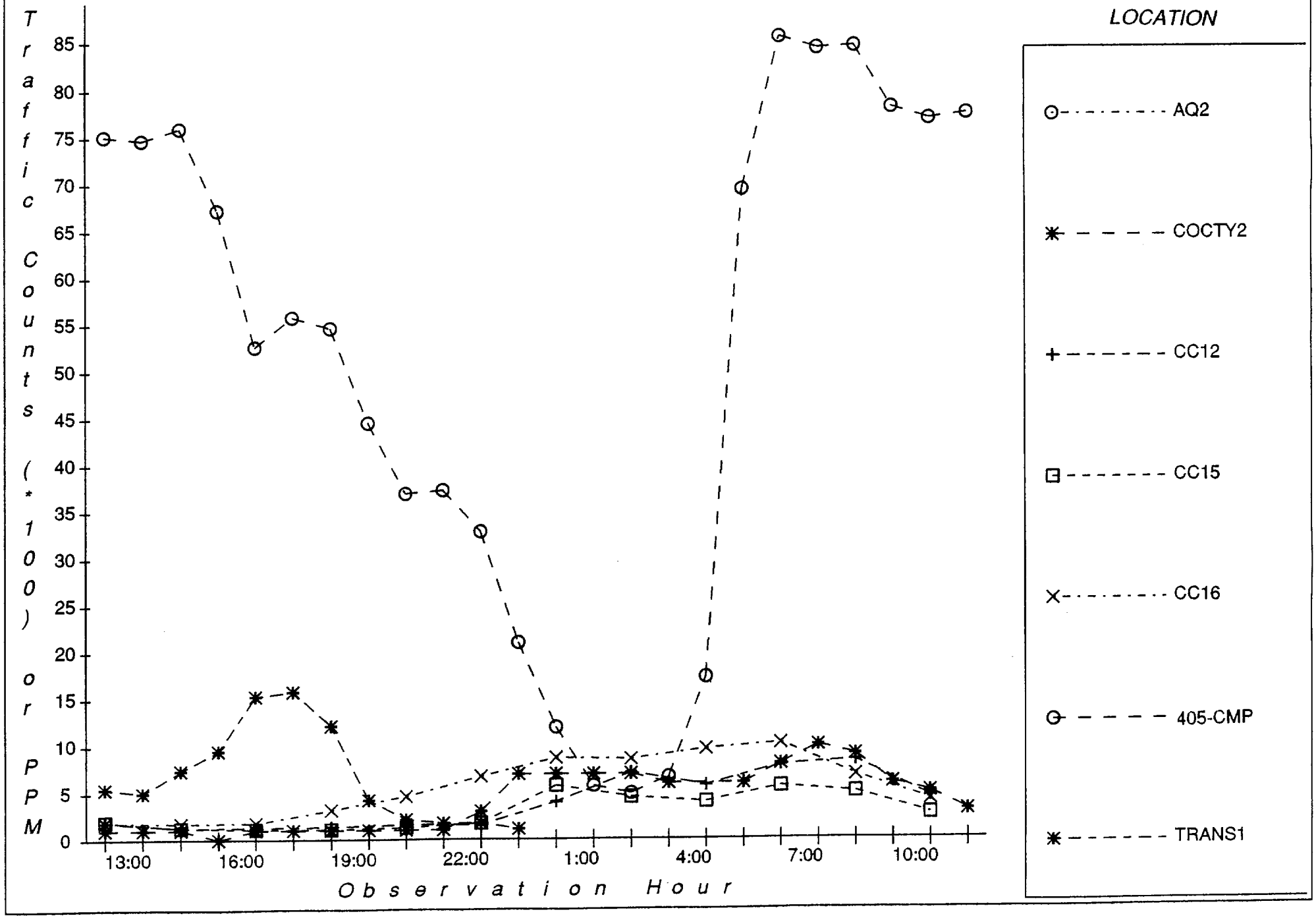
Lynwood Traffic Counts

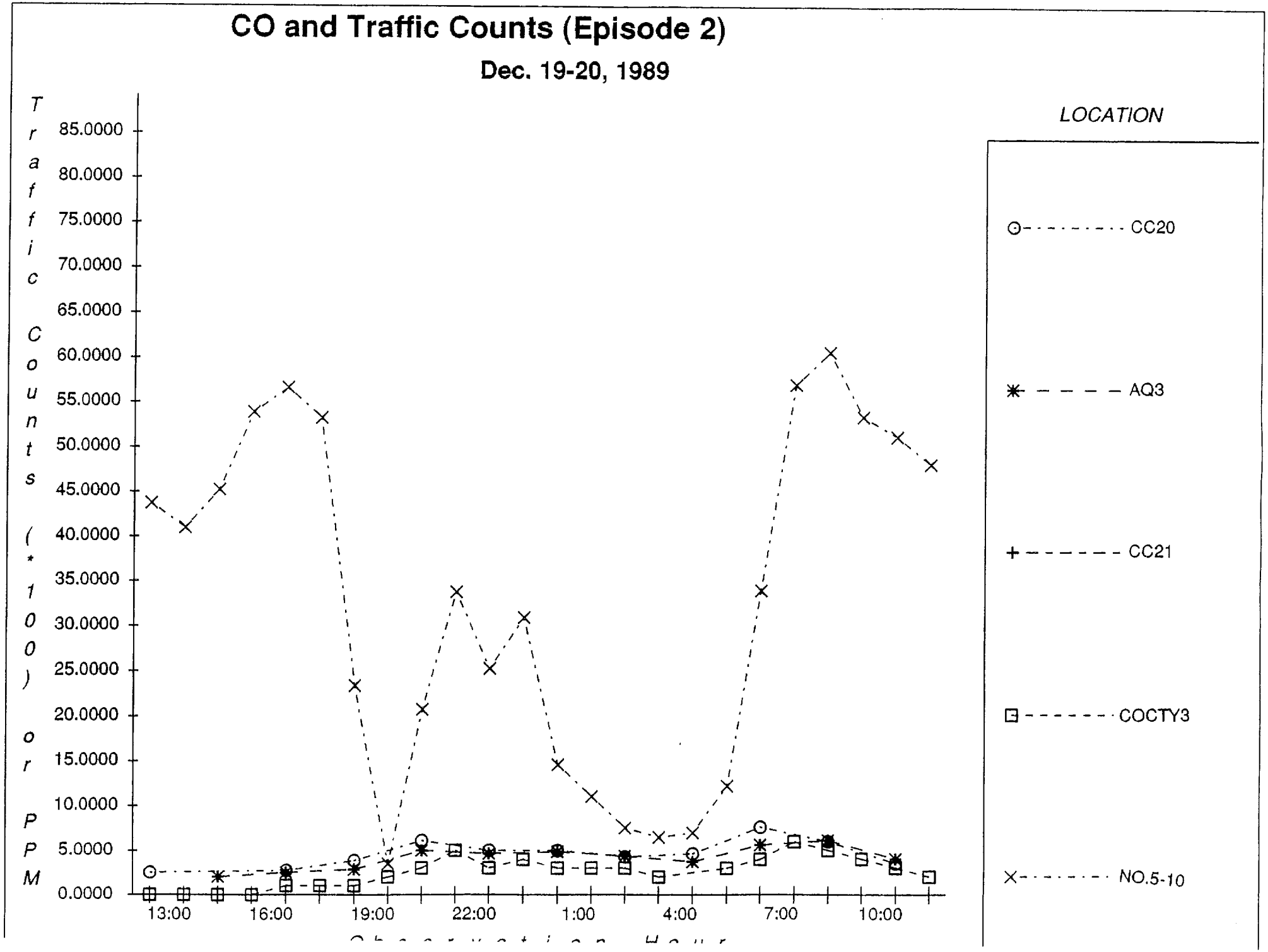
Dec. 19-20, 1989



CO and Traffic Study (Episode 2)

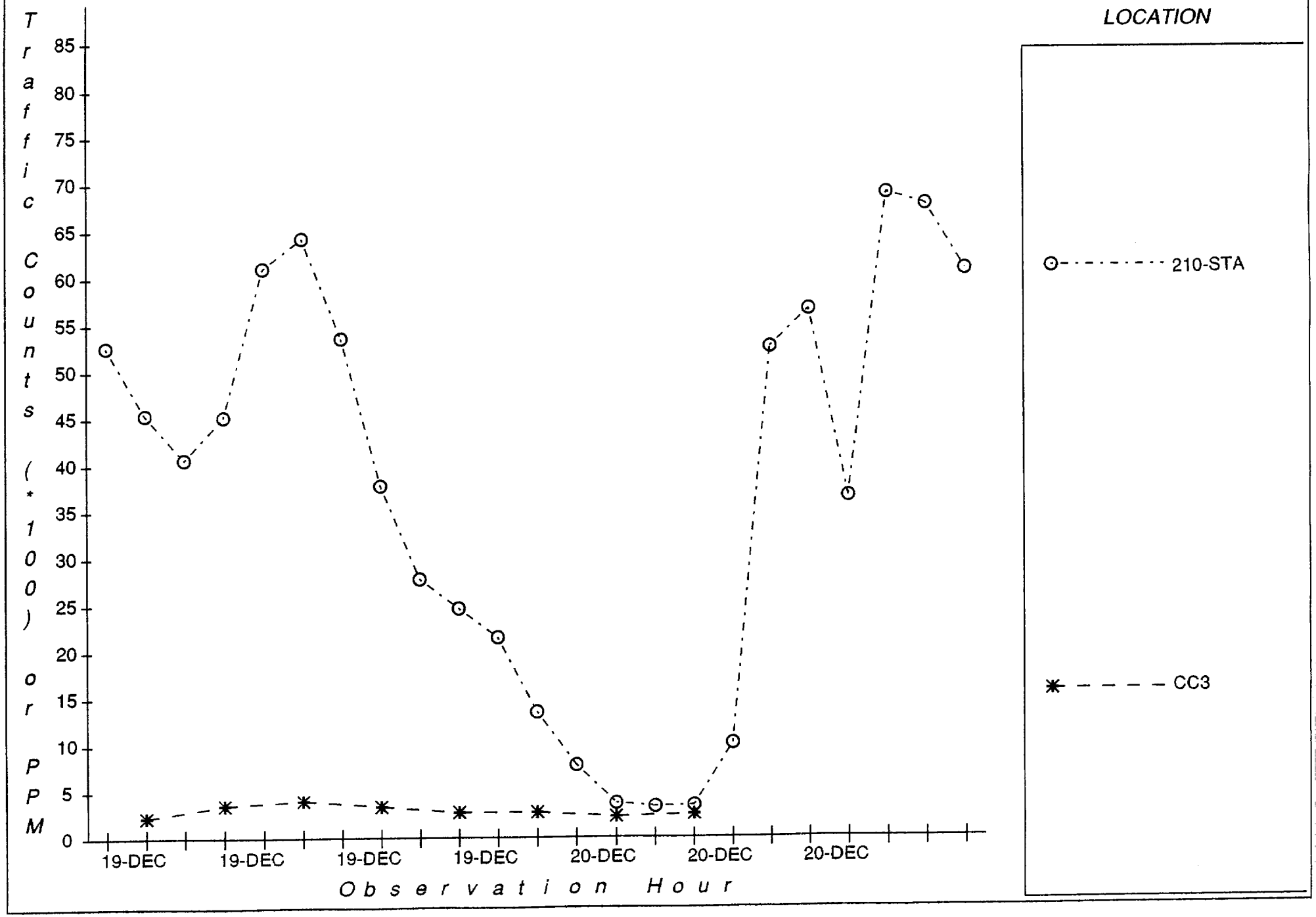
Dec. 19-20, 1989




CO and Traffic Counts (Episode 2)
Dec. 19-20, 1989
Traffic Counts (*100) or PPM
85.0000
80.0000
75.0000
70.0000
65.0000
60.0000
55.0000
50.0000
45.0000
40.0000
35.0000
30.0000
25.0000
20.0000
15.0000
10.0000
5.0000
0.0000
13:00
16:00
19:00
22:00
1:00
4:00
7:00
10:00
LOCATION
CC20
AQ3
CC21
COCTY3
NO.5-10

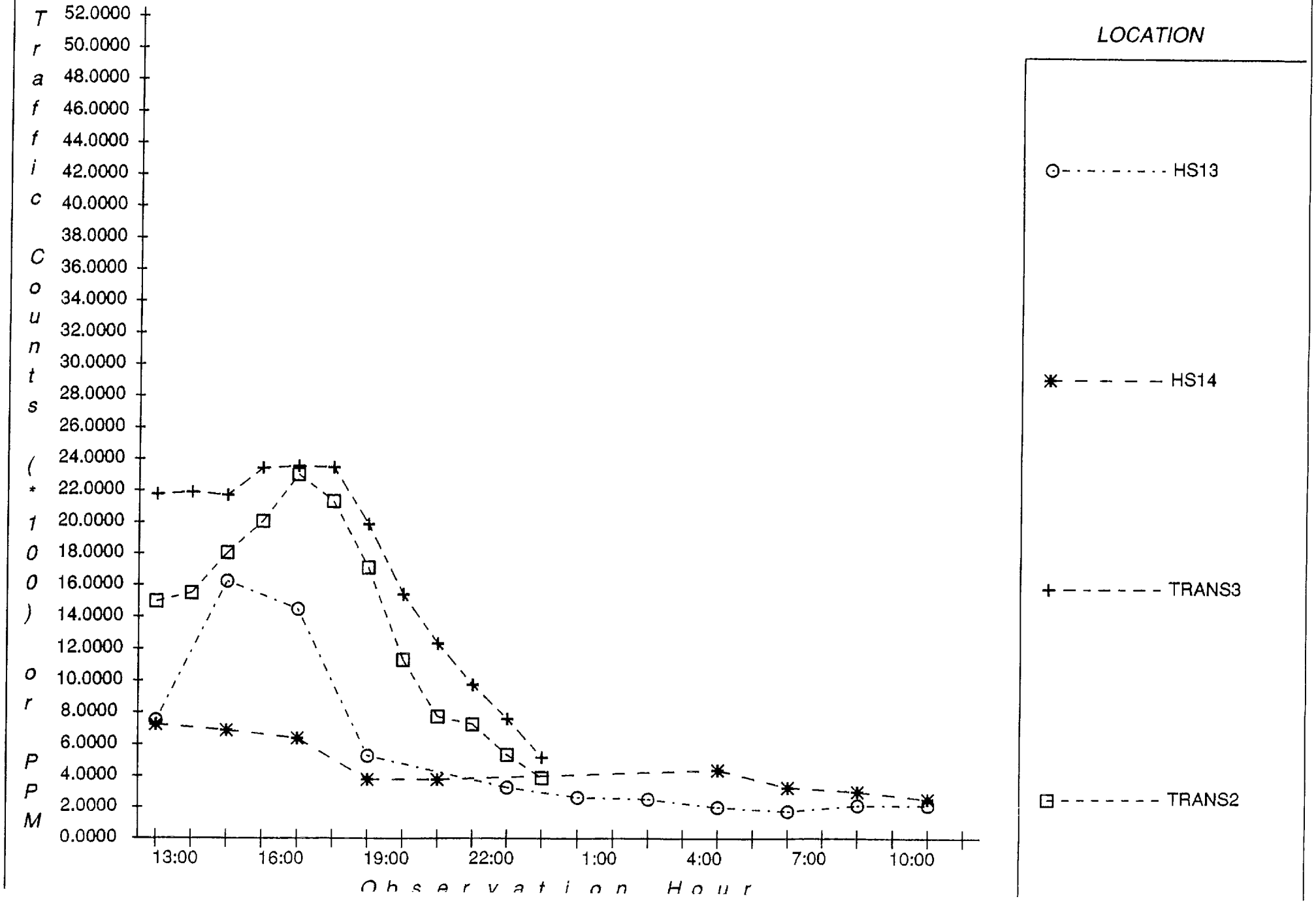
CO and Traffic Counts (Episode 2)

Dec. 19-20, 1989



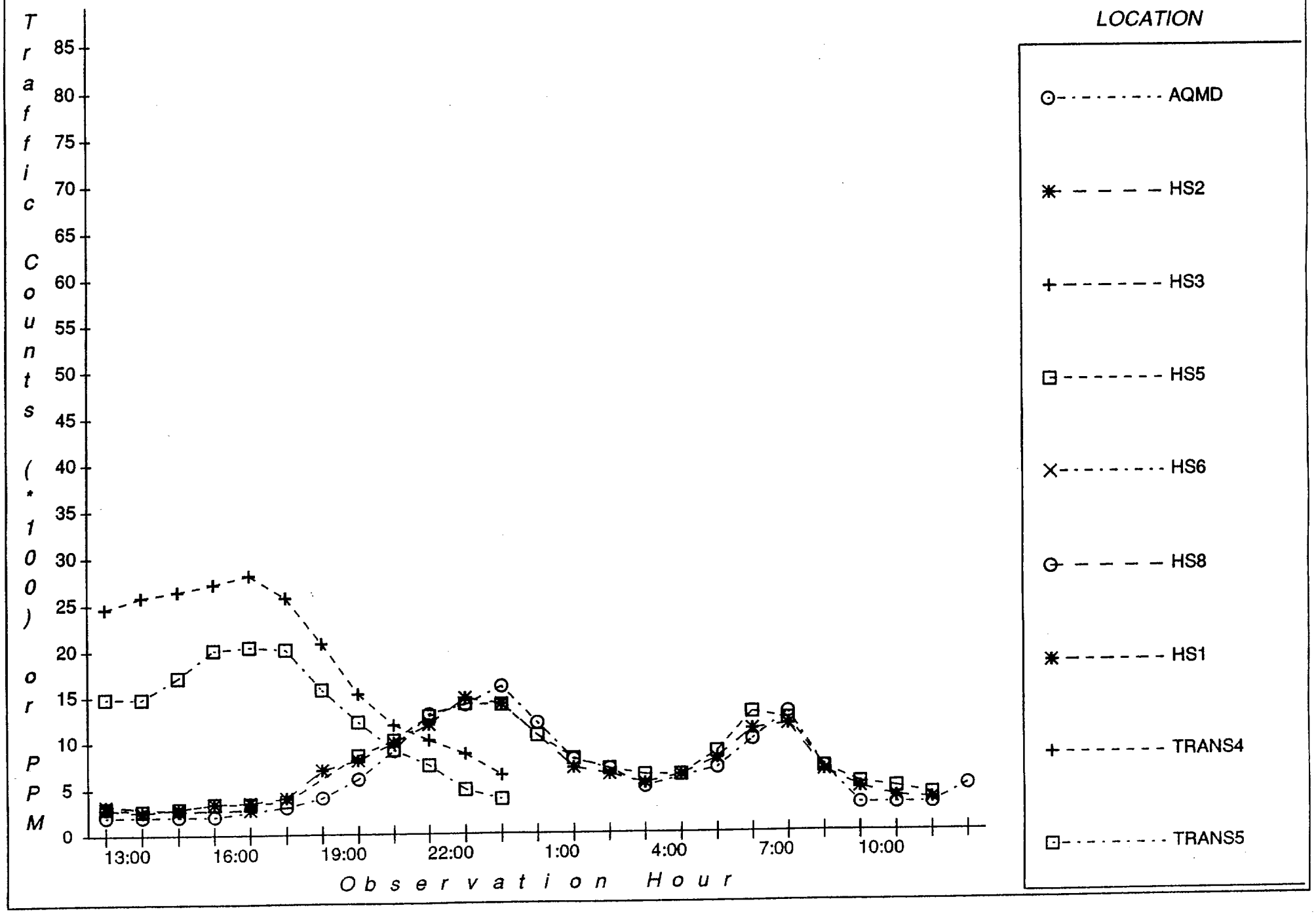
Lynwood CO and Traffic Study Counts

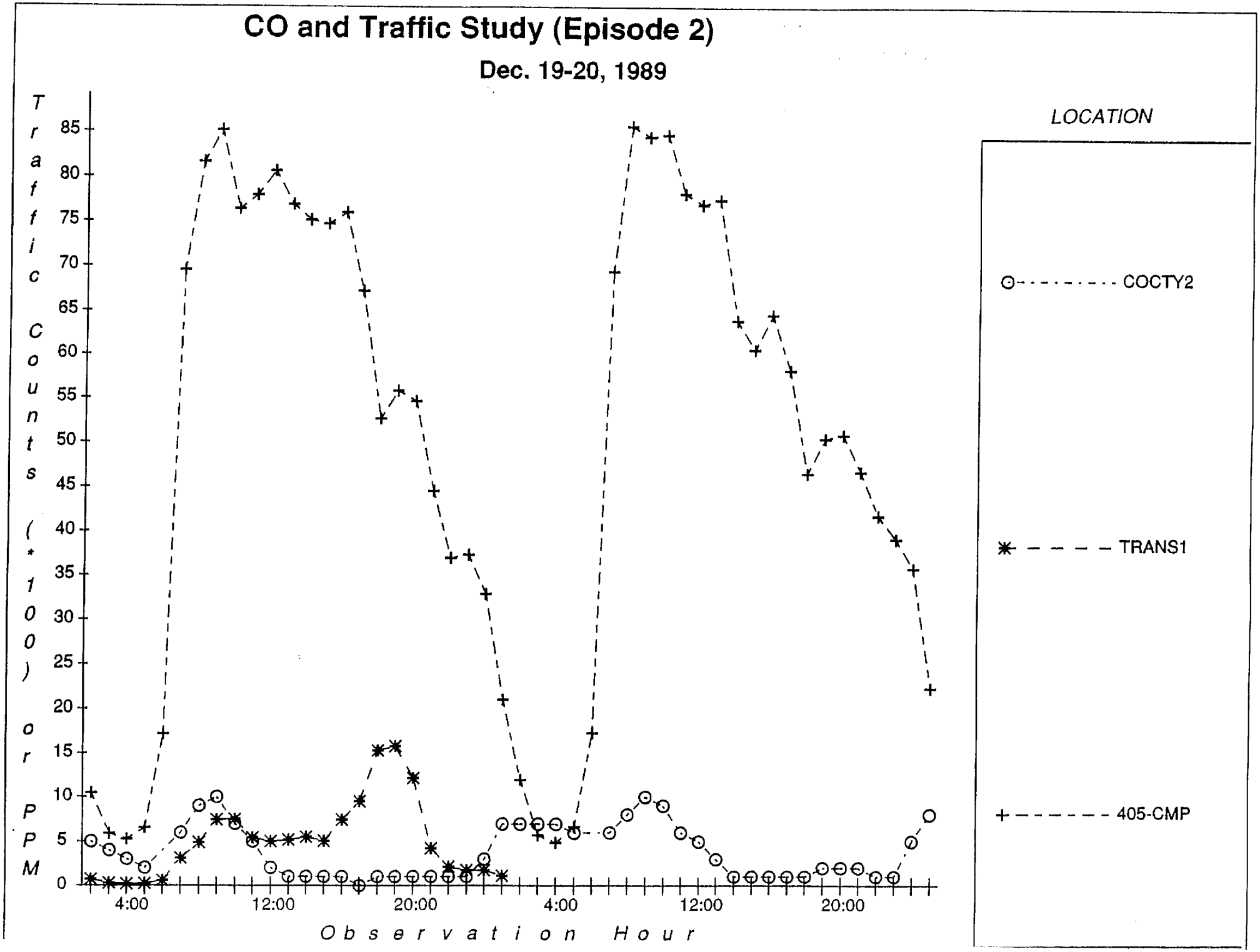
Dec. 19-20, 1989



Lynwood CO and Traffic Counts (Episode 2)

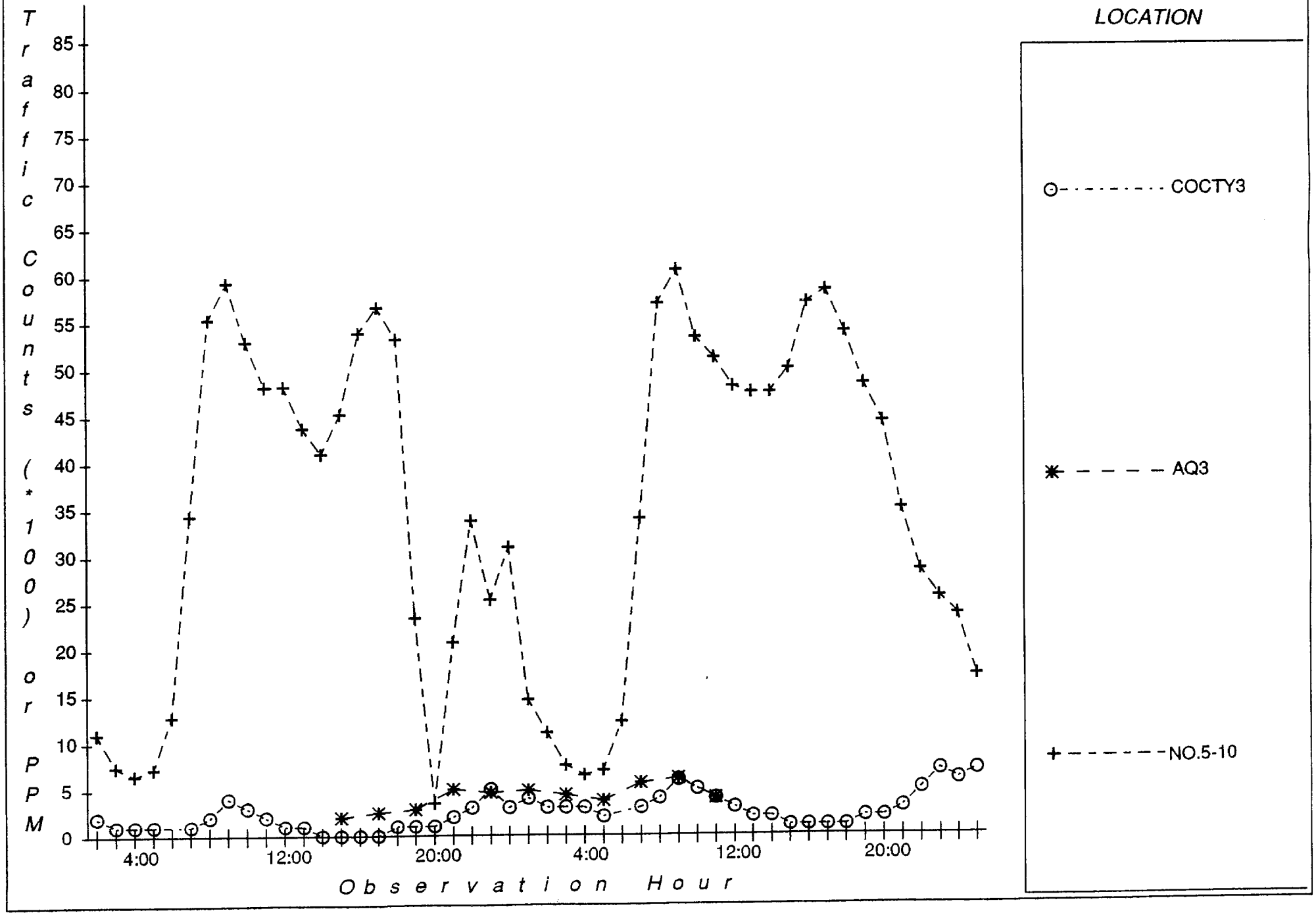
Dec. 19-20, 1989




CO and Traffic Study (Episode 2)
Dec. 19-20, 1989
Traffic Counts (*100) or PPM
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
4:00
12:00
20:00
4:00
12:00
20:00
Observation Hour
LOCATION
COCTY2
TRANS1
405-CMP

CO and Traffic Counts (Episode 2)

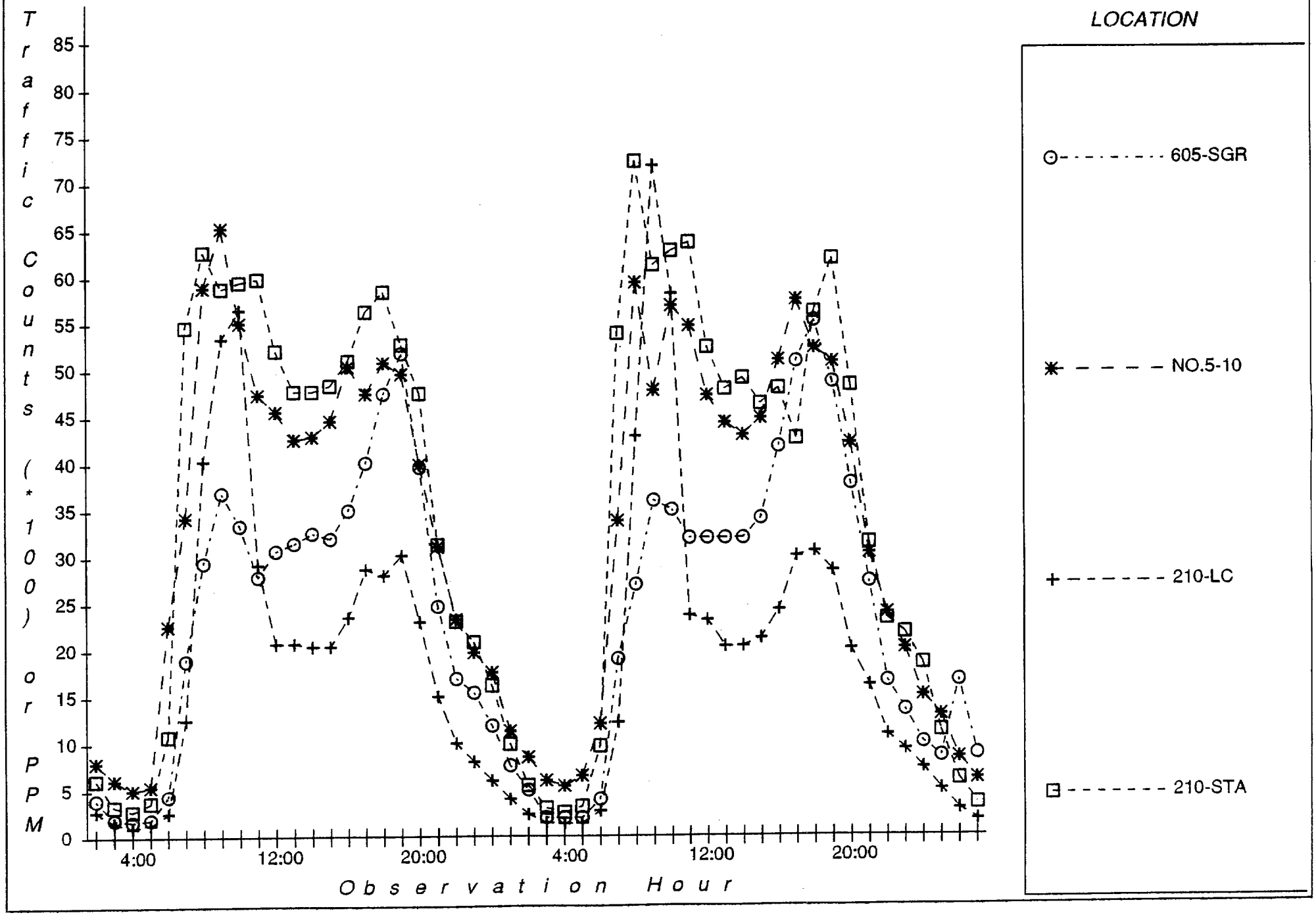
Dec. 19-20, 1989

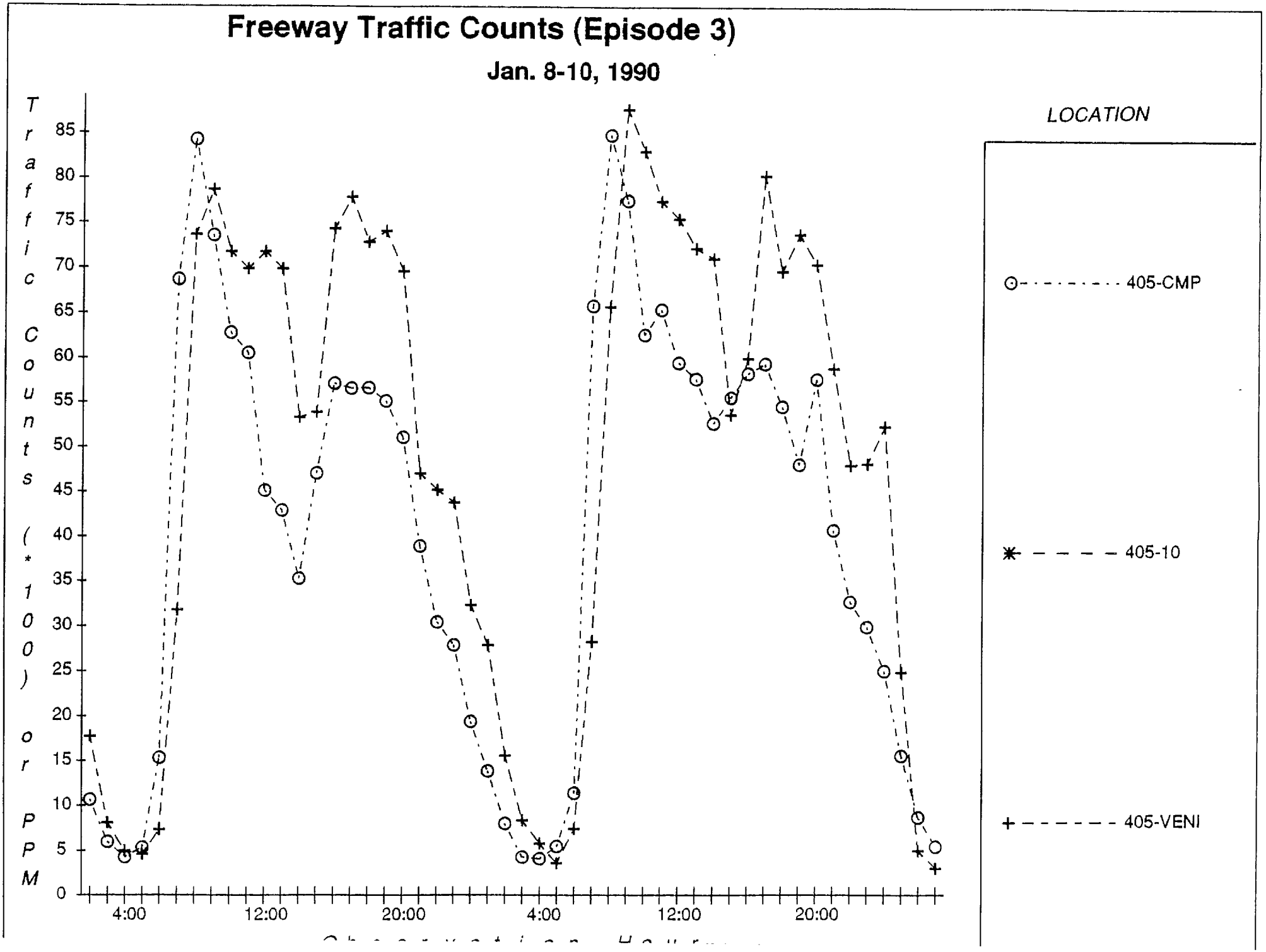


Appendix F-2

Freeway Traffic Counts (Episode 3)

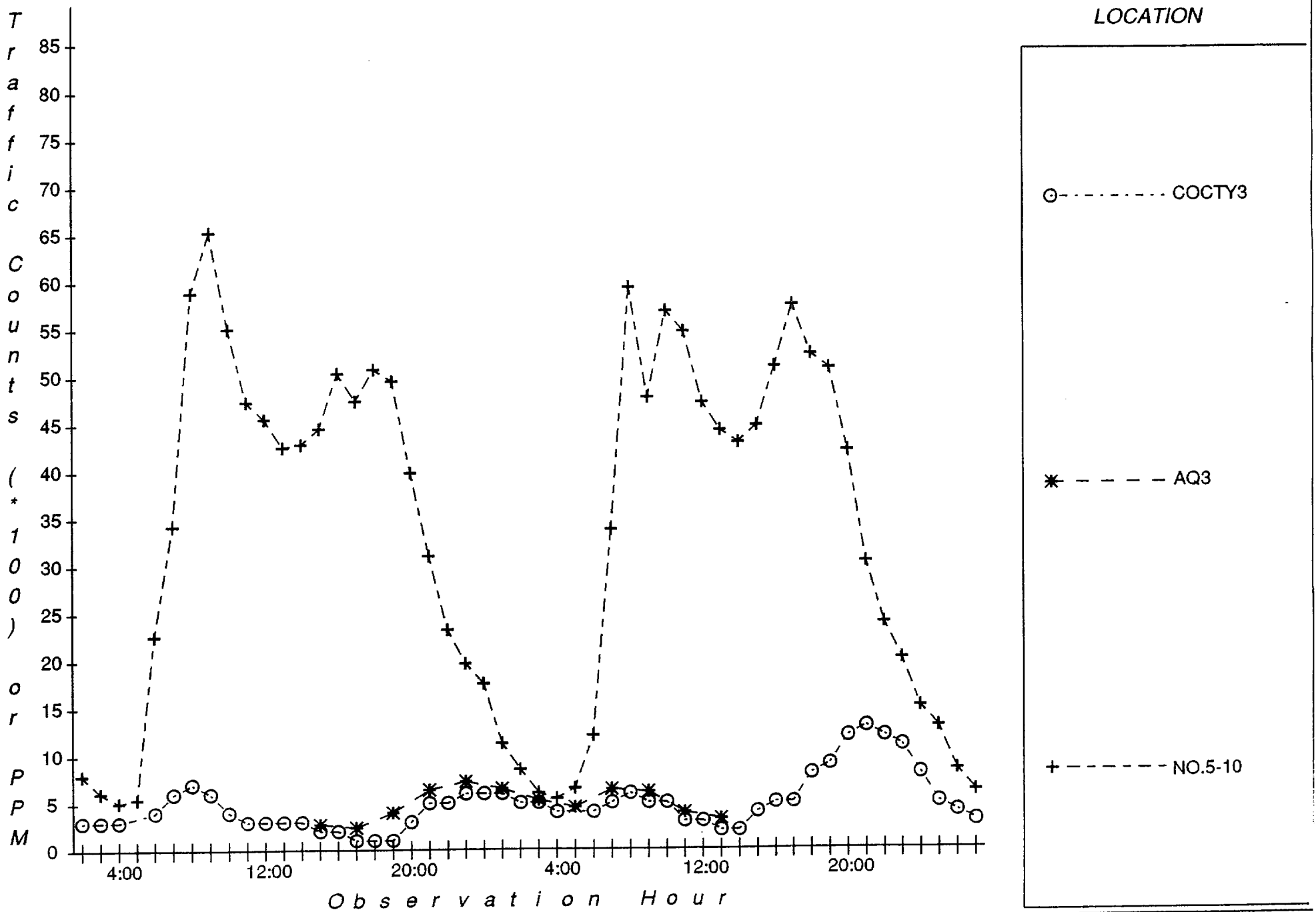
Jan. 8-10, 1990




Freeway Traffic Counts (Episode 3)
Jan. 8-10, 1990
Traffic Counts (*100) or PPM
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
4:00
12:00
20:00
4:00
12:00
20:00
LOCATION
405-CMP
405-10
405-VENI

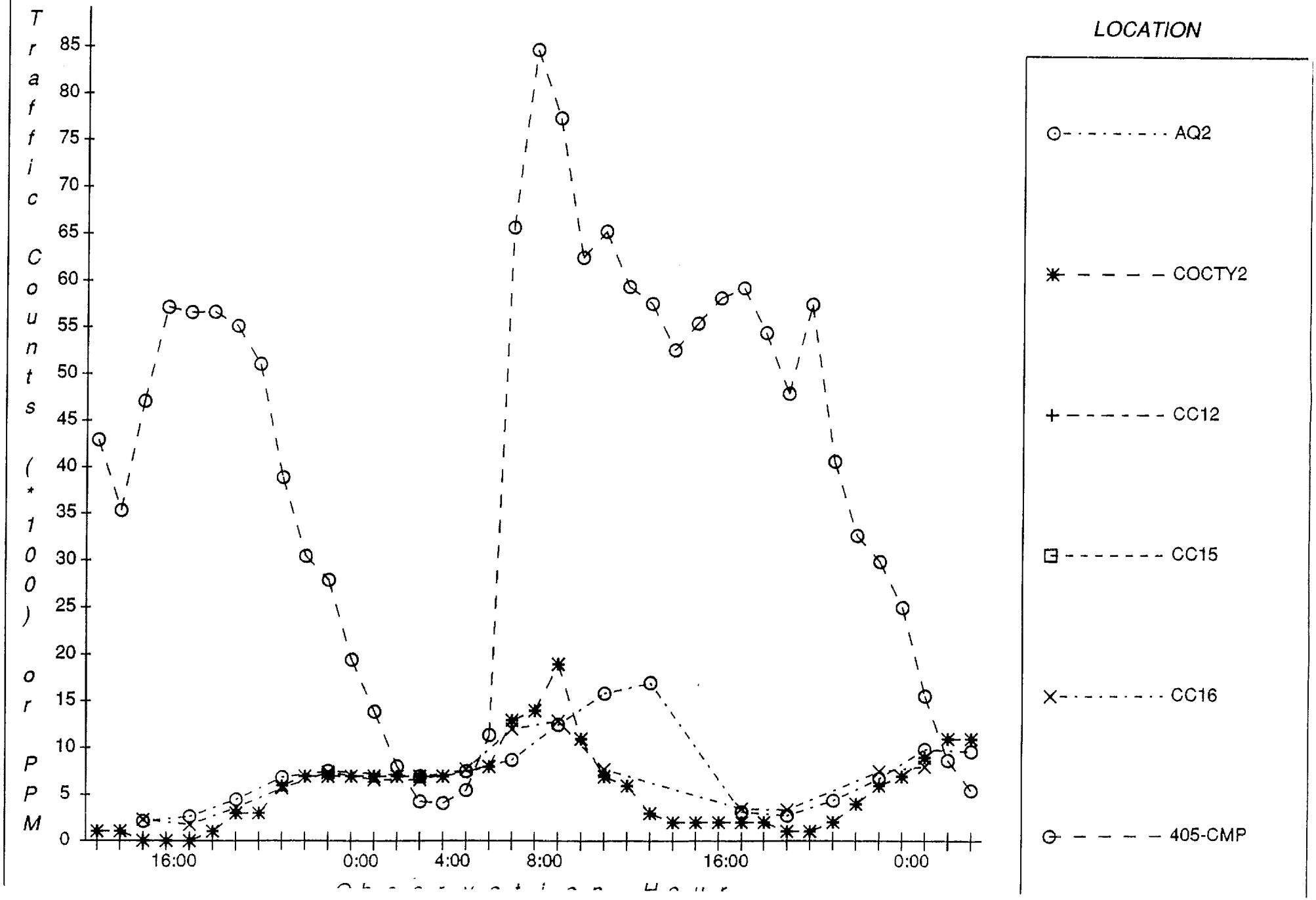
CO and Traffic Counts (Episode 3)

Jan. 8-10, 1990



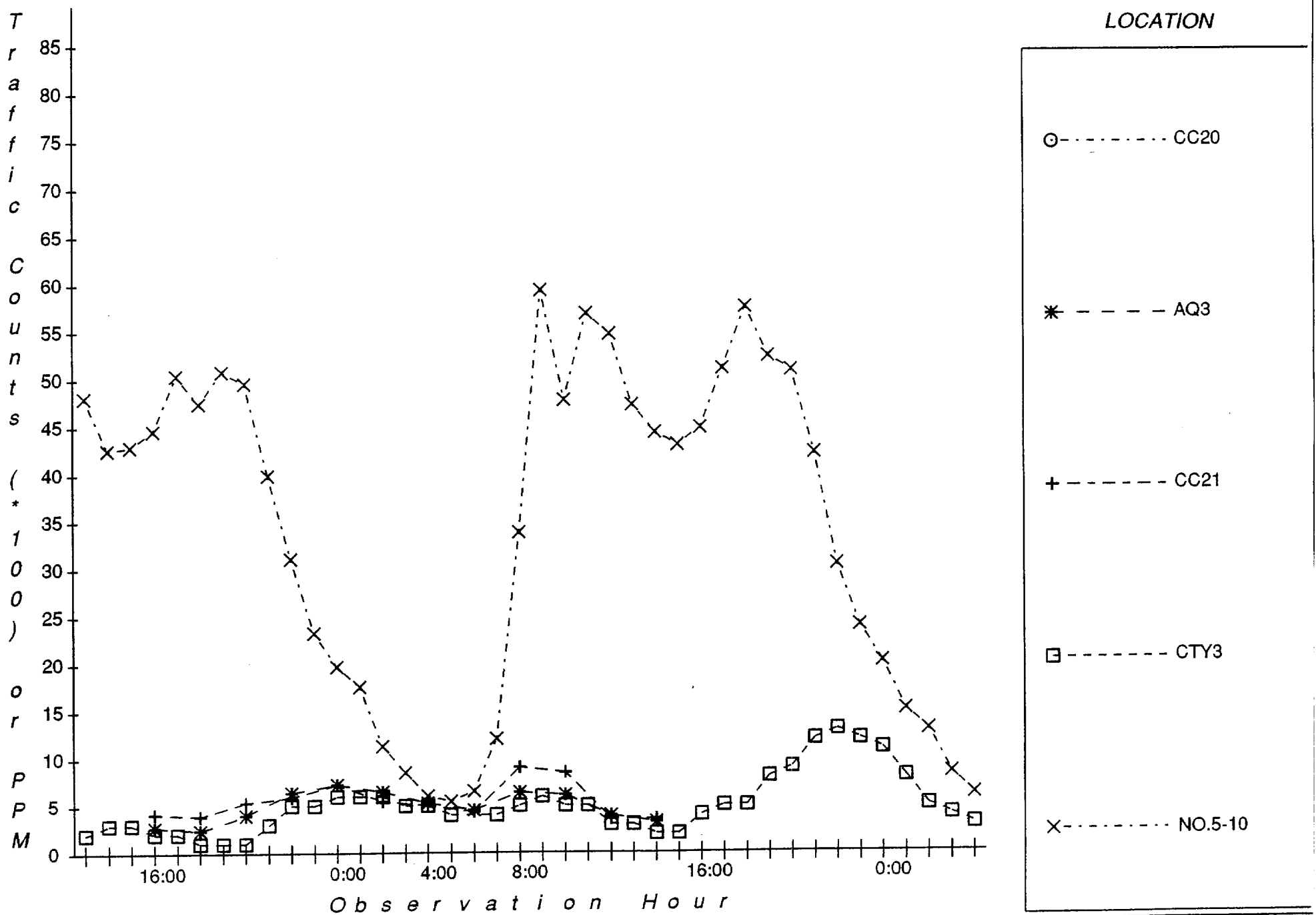
CO and Traffic Counts (Episode 3)

Jan. 8-10, 1990



CO and Traffic Counts (Episode 3)

Jan. 8-10, 1990



Appendix G

CO REMOTE SENSING SUMMARY

ON ROAD CO REMOTE SENSING IN THE LOS ANGELES BASIN

Donald H. Stedman, Gary A. Bishop
James E. Peterson and Paul L. Guenther

University of Denver
Chemistry Department
Denver, CO 80208

DRAFT report to the California Air Resources Board,
under Contract Number A932-189

EXECUTIVE SUMMARY

The University of Denver remote sensor for motor vehicle carbon monoxide emissions was used for eleven days in the Los Angeles Basin in December 1989. The remote sensor measures the CO/CO_2 ratio, from which the %CO is calculated. The results have been validated by both EPA and CARB blind comparisons. The calculated %CO is analogous to that which would have been measured had the vehicle been equipped with a tailpipe probe. The mass emissions in grams CO per gallon of gasoline used can also be derived. Eight of the days monitored normal urban street driving, three monitored freeway ramps. Over 27,000 valid CO emission measurements were made. When the videotapes had been read and returned to California authorities for matching the license plates, the total number of vehicles both measured and matched with the license plate data base was over 16,000. Because off the poor contrast of older California license plates and the sun angles, more plates were readable when the front of the vehicles were imaged. With this arrangement the significant number of vehicles without front plates could not be identified. The license plate matched fleet was about 0.2 %CO cleaner (one year on average newer) than the total fleet. This probably arises because older vehicles have older style plates which are both intrinsically harder to read (lower contrast), and often in poorer condition.

Overall more than 50 percent of the CO was emitted by eleven percent of the vehicles with %CO equal to or greater than 4.98 (gross polluters). New vehicles were so clean (gross polluters were less than 1% for the 1989 and 90 model years) that their emissions were almost negligible. If the whole fleet could maintain the new fleet emissions then the total on-road pollution would decrease more than fivefold. Despite the fact that the new fleet are on average clean, the dirtiest 20% of the one year old fleet was dirtier than the cleanest 20% of any model year regardless of age. Most of the deterioration in carbon monoxide air quality came from emissions of the dirtiest 20% of the vehicles with model years between 1976 and 1988. The percent of gross polluters rises from 4% for 83-90 model year vehicles through 17% for the 75-80 model year vehicles to 30% of the 1974 and older fleet.

There were differences in average CO emissions between the sites measured, and between different days at the same sites. To aid in understanding this phenomenon, all remote sensing data available at the University of Denver from a variety of U.S. cities with altitudes lower than 7,000 feet were analyzed in terms of hourly average CO emissions compared to hourly average fleet age. From this analysis, a linear model was developed which demonstrated that almost all of the observed differences could be accounted for by differences in average age irrespective of I/M program type. Smaller, load induced average emission increases between an uphill but slow cruise-mode freeway off-ramp and a flat but high speed acceleration on-ramp were discernible after the age differences had been eliminated. The linear model predicts average %CO for all fleets measured in the USA to better than 0.5 %CO with a knowledge of only the average age.

Over 50 vehicles out of a fleet off 360 vehicles registered as diesels show emissions greater than 1 %CO. Of these 50, 45 1975-84 General Motors vehicles appear to have had their engines switched to gasoline without informing the appropriate authorities. This dishonesty may arise because diesel vehicles do not have to participate in the California Smog Check program.

An analysis of the data indicates that a <u>conservative upper limit</u> of 15.4% of the measured CO emissions arises from vehicles in either a cold start or an off-cycle acceleration mode. Forty-three percent of the fleet of 77 vehicles measured four or more times were always in the clean (<1 %CO) category. These emit 4% of the total CO from all 77 vehicles. One quarter of the fleet of 77 showed emissions consistently between one and 4.98 percent CO. These vehicles emitted 18% of the CO. An additional 25% of the fleet were over the 4.98 %CO cut point at least twice. These vehicles emitted 70% of the

emissions. Only a small fraction (5 vehicles, 7% of the fleet of 77 vehicles jumped into the high category only once. These results imply that an inspection and maintenance program incorporating remote sensing, which targets gross polluters with multiple violations, has the potential to identify a significant fraction of the CO emissions while inconveniencing only a small fraction of the vehicle owners. Our analysis concludes that on-road remote sensing as a component of an I/M program, although possibly at a disadvantage relative to fixed site test programs in terms of vehicle emissions variability, has the overwhelming advantages of being representative of the on-road emissions of the vehicle in question, being an emissions test which is almost impossible to circumvent, and incorporates a "fairness factor" such that the more a vehicle is driven, the more frequently it will be tested.

Appendix H

ISOTOPE DATA SUMMARY

Final Report

to

AIR QUALITY MANAGEMENT DISTRICT
9150 Flair Drive
El Monte, California 91731

Contract No. 90101

for

SOURCE CHARACTERIZATION OF ATMOSPHERIC CARBON MONOXIDE IN LOS ANGELES BY CARBON ISOTOPE MEASUREMENTS

November 1990

Prepared by

GLOBAL GEOCHEMISTRY CORPORATION
6919 Eton Avenue
Canoga Park, California 91303-2194

Telephone: 818-992-4103

FAX: 818-992-8940

EXECUTIVE SUMMARY

During three events of high atmospheric carbon monoxide content, in the winter of 1989/1990, Global Geochemistry Corporation participated in a program sponsored by the California Air Resources Board and the South Coast Air Quality Management District. The main objective of the GGC effort was to determine the percentage of modern carbon in the atmospheric carbon monoxide and determine the origin of the CO through ^{13}C and ^{14}C isotopic analyses.

To determine the percent of modern carbon in atmospheric CO samples, air was passed through special apparatus designed by D. Levaggi and Associates, Bay Area Air Quality Management District, which converted atmospheric CO to carbon dioxide. The amount of ^{14}C radioactive isotope in the CO_2 was measured at Lawrence Livermore National Laboratory using an accelerator mass spectrometer against known standards of modern and "dead" carbon. Because radioactive ^{14}C disintegrates with a half life of 5730 years, ^{14}C formed in the atmosphere by cosmic radiation and incorporated into living plants and animals, 60,000 years. When ^{14}C can no longer be accurately detected in carbon by the instrumentation used, it is considered "dead". The measured amount of ^{14}C in the sample is used to calculate the percent modern carbon.

The results of the study show that the percentage of modern carbon in the carbon monoxide is inversely proportional to the CO content of the atmosphere, with a correlation coefficient >0.90. This means that high CO levels are dominated by fossil fuel sources, rather than modern sources, such as wood burning. For the three events measured, the content of recent carbon in CO varied from 7.6 to 32.4%. A constant amount of about 0.75 ppm recent carbon was present in all samples measured. It has been reported in the literature that there is a northern hemisphere modern carbon content of CO amounting to 0.2 ppm. Hence, an excess above background of modern carbon in CO (0.55 ppm) is present in the Los Angeles atmosphere.

Once it was confirmed by ^{14}C measurement that the dominant CO source is fossil fuel, an attempt was made to determine the identify of the fuel using $^{13}C/^{12}C$ stable isotope ratios of the atmospheric CO. The magnitude of this ratio, expressed as a $\delta^{13}C$ value, can be used to determine the source of carbon compounds in nature, as shown in Figure 1. The mean $\delta^{13}C$ value measured for atmospheric CO in Los Angeles was -29.3^{o}/oo, which is isotopically depleted in ^{13}C relative to a limited number of stable isotope ratios on CO in vehicle emissions and natural gas combustion. Based on the comparison of stable isotope ratios of atmospheric CO and CO in source emissions, neither vehicle exhaust or natural gas combustion products give a good match. The contractor concluded that the identify of any major source is presently inconclusive. Further studies are required to determine the source by monitoring emissions from automobiles, space heaters and refineries.

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