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TARADCOM

LABORATORY

TECHNICAL REPORT

No. 12391



DIGITAL TERRAIN SIMULATION

October 1978

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by 2nd Lt STEVE CHARLES

14770 ADSCM TR 12391

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RESEARCH AND DEVELOPMENT COMMAND
Warren, Michigan 48090

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ABSTRACT

↙
Road profiles available for digital terrain simulation at TARADCOM are cataloged. The terrain simulation program for the PACER 100/EAI 580 Hybrid computer system is described. The terrain simulation program was developed to better utilize the hybrid computing system when it is required to run several vehicles over known terrains at different speeds for varying lengths of time. The operator can interactively setup the test environment or feed in a prepared paper tape. Terrains are stored on disks and vary from profiles of actual test courses to synthesized forcing functions. Development and operation of the program are described and possible future refinements are explored.
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PREFACE

This report describes digital terrain simulation at TARADCOM. The aim of the simulation is to subject a vehicle to a vibration environment similar to what it might experience in the field. This is accomplished by placing the vehicle on hydraulic actuators which move up or down depending on the electrical voltages applied. Electrical signals are usually supplied by an analog computer. Digital terrain simulation is accomplished using a digital computer to produce voltages in digital-to-analog (D-to-A) components on the analog computer.

Reference 1 describes how several actual terrain profiles were digitized for use as input to vehicle simulation studies. These profiles and others (about 40 in all) were transferred to disk storage for rapid on-line use by the digital computer.

The report describes how these terrain profiles were converted to wheel displacements and how the wheel displacements are applied to a vehicle.

1. CONVERSION OF TERRAINS

The terrain elevations are in feet and were measured at one, three, six, and twelve-inch intervals. Most terrains had 600 or less data points and this was chosen as a practical limit. All elevations are greater than zero and some reach a height of almost eight feet. This presented a problem because the actuators currently available at TARADCOM only have a 12-inch span. It was solved by taking into account the fact that long uphill or downhill trends provide very little input to the vibration response of a vehicle.

The detrending routine is fairly straightforward and is presented in Appendix A. The program takes out long uphill and downhill trends by drawing a line through the slope which has no data point more than six inches away.



Figure 1
TERRAIN ABOVE ZERO

The slope is then moved down to level, with the starting and ending points equal to zero.

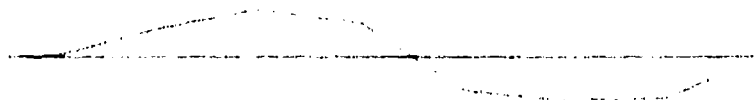


Figure 2
DETRENDED TERRAIN

In this way the relative slopes between data points are preserved while keeping within the physical limits of the actuators. The only discontinuities exist at the pivot points of the detrended segments. The subroutine finds the longest segments in order to minimize the number of discontinuities.

Now that the terrains fit an actuator it is necessary to calculate the motion of a wheel traversing the data points. The wheel trajectory routine described in reference 2 obtains the position of the bottom of a rigid wheel traversing a non-deformable terrain. The resulting wheel trajectories for each terrain were then dumped to paper tape and loaded into separate disk files on a digital/analog hybrid computer.

2. SIMULATION PROGRAM

The program has basically three phases:

1. Terrain Input - Subroutine "INPUT"
2. Bay Setup - Subroutine "BAYS"
3. Terrain Output - Subroutine "RUN"

In the terrain input phase, the operator is asked the names of the files on disks containing terrain data. The first record of the disk file has the number of samples and sample interval in inches followed by records containing the scaled fraction data. In scaled fraction data there are 15 bits of information plus a sign bit. For example:

```
0000000000000000 = 0 volts = 0 feet  
1000000000000000 = -9.999 volts = -.5 feet  
0111111111111111 = 9.999 volts = .5 feet
```

After all terrains have been input, the operator is asked how many bays will be run. The operator must supply the number of axles and their dimensions, which terrains will be traversed, the angle of traversal, the desired speeds, and distances for each bay.

The subroutine BAYS translates these parameters into control variables which are later used by subroutine RUN. To get an idea how this is done, picture a jeep mounted on four actuators. If the wheel signal were applied to all four actuators simultaneously the jeep would have only vertical accelerations being input into it. Now if the back

wheel signals were delayed a small amount of time there would be angular motion between the front and rear of the vehicle (called pitch). When wheels on both sides of a vehicle see duplicate paths the vehicle is said to be traversing a "washboard"-type terrain. Traversing the washboard at an angle causes a time delay from when a wheel on one side of the vehicle hits a point to when a wheel on the other side hits it. This produces a side-to-side motion called roll.

BAYS will translate the speed and angle of attack into relative delays between the wheels of a vehicle. In this way vertical acceleration, pitch, and roll can be produced in a vehicle in the laboratory.

In the output routine, RUN (see figure 1), the data channels are all more-or-less independent. The subroutine scans the channels and subtracts the time since the last scan from each channel timer. If the timer reaches zero, a new data point is output. A channel may change to a new terrain only after a complete run of the current terrain. This is to insure that the output of one terrain is zero before a new terrain is introduced. Channels common to a bay are sequential and the right rear wheel is identified as the LAST to finish the phase. This insures proper interwheel timing for the next phase. There is a two-second pause between phases to allow easy differentiation of terrains.

It should be noted that this setup allows two vehicles to use the same terrain. If one vehicle changes terrains, it should in no way affect another vehicle which might happen to be in the middle of a run.

Once the digital program is running, the hydraulics should then be turned up to whatever level is desired. To shut down, the hydraulic controllers should be brought to zero and the program terminated.

SUBROUTINE TO
OUTPUT TERRAINS

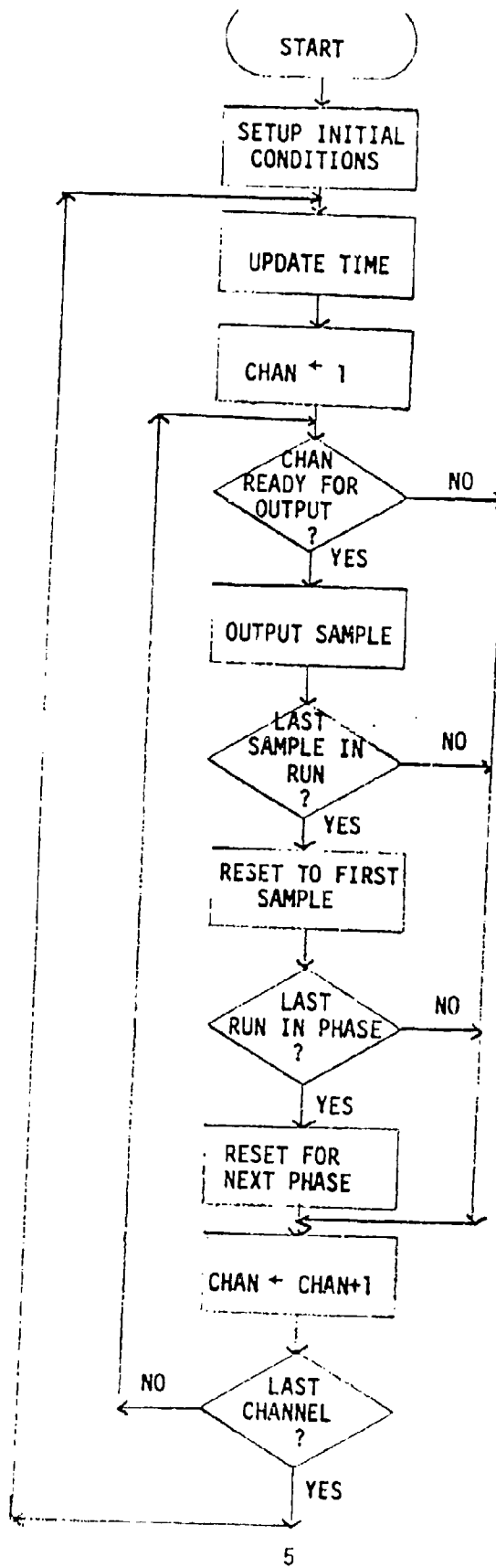


Figure 3

3. FUTURE PROJECTS

a. The system currently has eight channels of analog wheel displacement data. This allows, for example, a three-axle truck and a one-axle water trailer or, say, a four-axle tracked vehicle by itself. If eight more channels were added, there would be greater flexibility in simulation scheduling. Three vehicles in the three bays would be virtually independent of each other and would not have to double up on data channels.

b. Due to the digital nature of the terrain simulation, the output is a staircase function as shown below in Figure 4.



Figure 4

STAIRCASE FUNCTION

This introduces high-frequency noise and is not very realistic. A straightline approximation as in Figure 5 is desired. There are two basic approaches to this problem.



Figure 5

LINEAR INTERPOLATION

1. Construct linear interpolators as shown below.

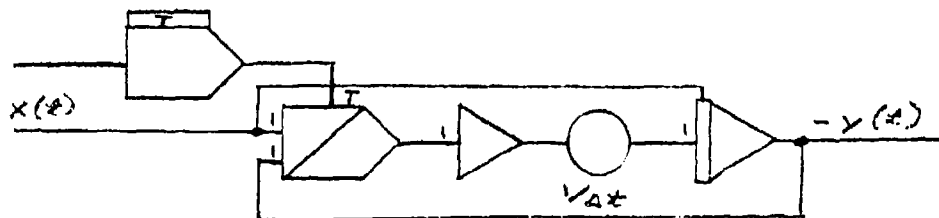


Figure 6

LINEAR INTERPOLATOR

The resources exist to construct only four of these and would necessitate changing the potentiometer settings for a bay each time it changed terrains. The effect of this would be to require all of the bays to run the same terrain at the same speed and for the same distance, which would limit the flexibility of the system.

2. As the number of data points is increased (by decreasing the sample interval) the staircase more closely approximates a straight line. All that is needed is to use Capacitance Limiting to smooth out the small increments.

This approach is currently being pursued but it is limited by the digital computer having only 16K of memory. The addition of 16K would allow a greater number of terrains in a test setup.

c. In a system with a large library of terrains such as this, it soon becomes desirable to modify or combine terrains for special applications. A system for updating or modifying terrains would be a future enhancement.

4. TERRAINS

On the following pages you will find plots of terrain profiles with detrended wheel trajectories below them. The actual wheel displacements are tabulated after each plot.

The RMS value is calculated by the following formula:

$$\text{RMS} = \sqrt{\frac{1}{N} \sum_{i=1}^N (Y_i - \bar{Y})^2}$$

where:

N = Number of terrain samples

\bar{Y} = Average wheel displacement

Y_i = Wheel displacement for sample i

The date on the plot is when the terrain was converted. The date on the tabulation is when the terrain was first stored on disk.

TABLE 1

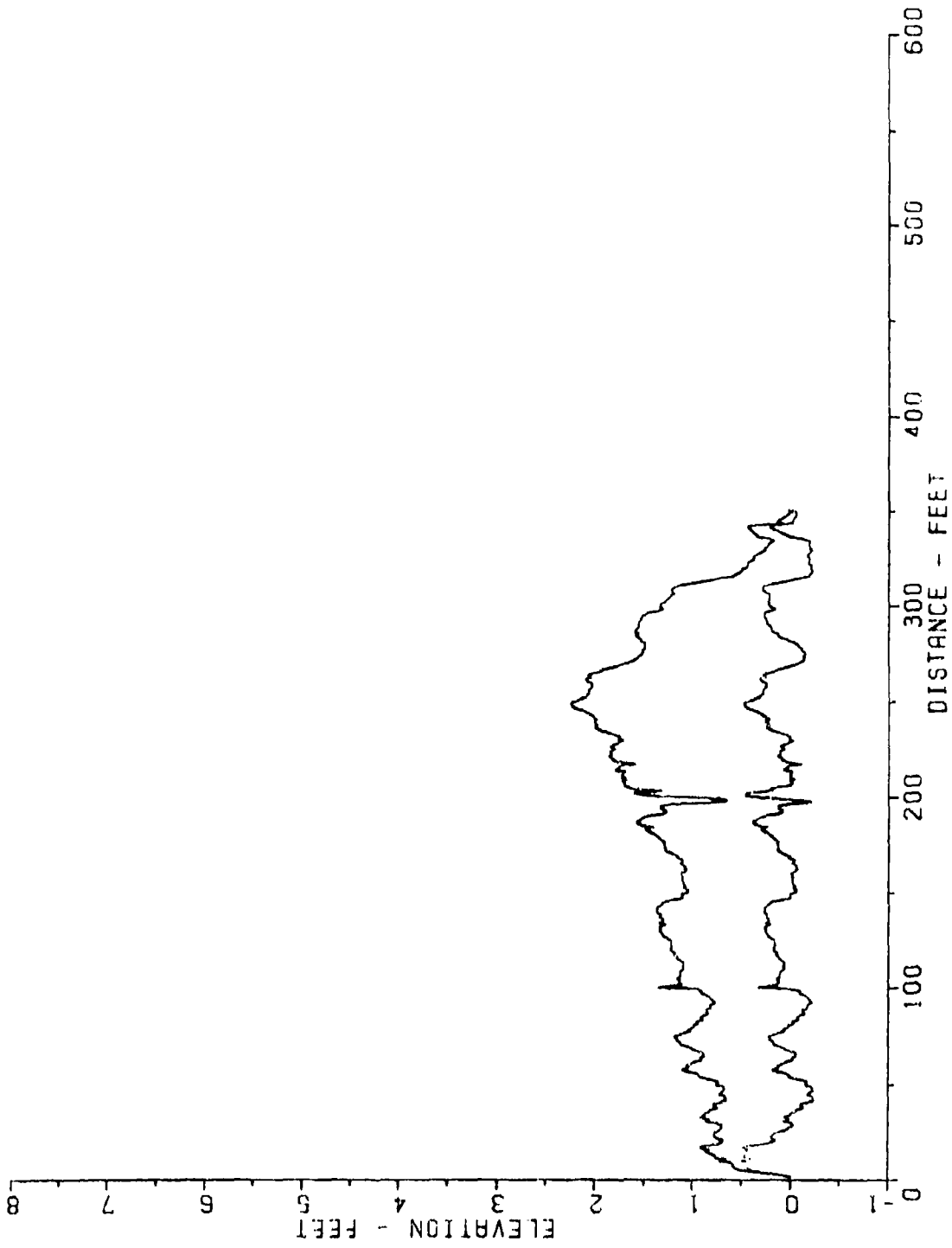
TERRAINS WITH CORRESPONDING FILE NAMES

<u>TERRAIN</u>	<u>FILE NAME</u>
Ft. Knox Mild	RD01
Ft. Knox Rocky	RD02
Synthetic Field	RD03
Ft. Knox Medium	RD04
Synthetic Rock and Log	RD05
APG Perryman III	RD06
APG Belgian Block	RD07
Six-Inch Sine Wave Course	RD08
Three-Inch Spaced Bump	RD09
RMS Equal One	RD10
Modified RMS	RD12
APG Terrain 10	RD13
APG Terrain 9	RD14
APG Terrain 11	RD15
APG Terrain 12	RD16
Houghton Data 3	RD17
Houghton Data 4	RD18
Houghton Data 5	RD19
Houghton Data 6	RD21
Houghton Data 7	RD22

TABLE 1

TERRAINS WITH CORRESPONDING FILE NAMES (CONT'D)

<u>TERRAIN</u>	<u>FILE NAME</u>
TARADCOM Wood Course	RD23
Ft. Knox CTA1	RD24
Ft. Knox CTA2	RD25
Ft. Knox STV1	RD26
Ft. Knox STV9	RD27
Ft. Knox STV4	RD28
APG 30	RD29
APG 29	RD30
APG 34	RD31
APG 35	RD32
APG 37	RD33
APG 32	RD34
APG 36	RD35
APG 34	RD36
APG 31	RD37
APG 29	RD38
Profile 4 APG	RD39
Profile 4 Chrysler	RD40



R001

Figure 7

6/21/78

TABLE 2
R001

FORT KNOX MILD 1964

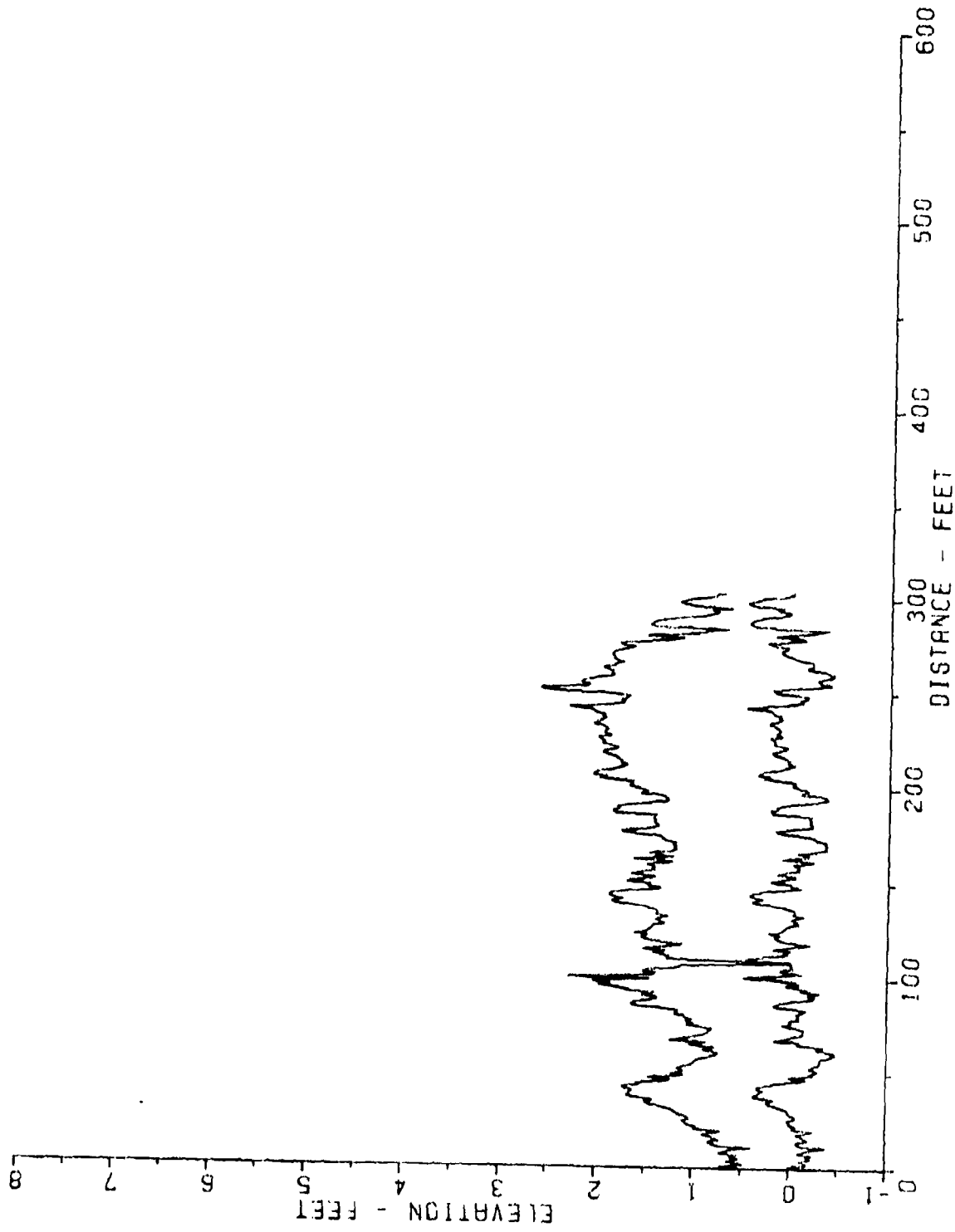
ADDED TO THE DISK ON 1.MAR.77

NUMBER OF POINTS • 351

INTERVAL IN INCHES • 12

POINT	ELEVATIONS IN FEET									
	.00	.01	.10	.23	.40	.44	.42	.39	.41	.49
1	.00	-.01	.10	.23	.40	.44	.42	.39	.41	.49
11	.40	.48	.46	.48	.50	.42	.49	.44	.39	.49
21	.15	.19	.19	.17	.14	.07	.02	-.01	-.04	-.01
31	.07	.01	.07	.00	-.01	-.05	-.07	-.13	-.18	-.18
41	-.19	-.23	-.23	-.23	-.17	-.20	-.23	-.23	-.22	-.18
51	-.17	-.16	-.07	.01	.02	.03	.14	.18	.12	.13
61	.09	.04	-.02	-.01	-.06	-.05	-.03	.02	.06	.10
71	.17	.18	.19	.21	.23	.18	.13	.08	.08	.02
81	.02	-.03	-.02	-.07	-.06	-.09	-.14	-.13	-.12	-.17
91	-.17	-.17	-.22	-.20	-.18	-.16	-.13	-.18	.10	.07
101	.34	.15	.12	.11	.14	.11	.11	.10	.18	.07
111	.06	.08	.06	.06	.10	.12	.13	.16	.14	.18
121	.18	.18	.16	.17	.16	.18	.20	.24	.24	.25
131	.27	.25	.27	.21	.26	.22	.23	.26	.24	.27
141	.27	.28	.27	.23	.20	.21	.08	-.08	.08	.01
151	-.06	-.06	-.02	-.05	-.03	-.02	-.01	-.02	-.02	-.01
161	-.01	-.05	-.07	-.05	-.06	-.01	-.04	-.03	.02	.01
171	.06	.10	.14	.13	.13	.14	.12	.14	.17	.18
181	.21	.24	.28	.31	.24	.34	.39	.39	.35	.31
191	.26	.13	.08	.09	.13	.11	.01	-.22	-.19	.18
201	.47	.45	.45	.18	.29	.11	.01	-.02	.01	-.04
211	.00	.00	-.01	-.02	.07	.03	.03	-.11	.05	.00
221	.09	.13	.10	.12	.09	.07	.19	.06	.01	-.03
231	.01	.00	.06	.10	.19	.22	.24	.22	.24	.26
241	.22	.25	.26	.30	.33	.38	.45	.47	.49	.47
251	.41	.35	.31	.30	.28	.29	.27	.24	.26	.24
261	.30	.32	.26	.29	.25	.17	.13	.07	.08	.07
271	-.10	-.13	-.14	-.12	-.15	-.14	-.11	-.12	-.09	-.07
281	-.04	.02	.03	.09	.13	.14	.19	.20	.20	.21
291	.24	.24	.26	.27	.28	.27	.26	.20	.16	.22
301	.23	.24	.22	.22	.21	.22	.22	.26	.29	.28
311	.27	.21	.10	.02	-.09	-.19	-.19	-.22	-.22	-.21
321	-.22	-.21	-.18	-.19	-.20	-.19	-.17	-.18	-.08	-.22
331	-.20	-.20	-.19	-.20	-.20	-.12	.01	.04	.18	.14
341	.18	.22	.21	-.02	-.02	-.03	-.05	-.05	-.05	-.05
351	.00	-1.00	1.12	.00	-.03	-.43	-.21	.08	-.16	-.33

RMS = 2.135 INCHES



RD02

Figure 8

6/21/78

TABLE 3
R082

FORT KNOX ROCKY 1964

ADDED TO THE DISK ON 1 MAR 77

NUMBER OF POINTS ■ 303

INTERVAL IN INCHES ■ 12

POINT	ELEVATIONS IN FEET									
1	.00	-.19	-.17	-.11	-.23	-.16	-.24	-.19	-.10	-.23
11	-.39	-.15	-.09	-.08	-.20	-.10	-.14	-.08	-.08	-.20
21	-.04	-.08	-.02	-.02	-.01	-.07	-.07	-.01	-.01	-.02
31	.04	.10	.17	.23	.24	.16	.27	.37	.34	.30
41	.27	.33	.34	.19	.16	-.08	-.17	.00	-.25	-.20
51	-.29	-.25	-.20	-.26	-.31	-.32	-.32	-.32	-.41	-.47
61	-.48	-.35	-.28	-.35	-.17	-.08	-.10	.17	.03	-.08
71	-.13	-.15	-.15	-.13	.01	.08	-.02	.00	-.15	-.08
81	-.10	-.07	-.10	-.17	.02	.17	.16	.00	-.09	-.04
91	-.26	-.18	-.30	-.11	-.17	-.08	.04	-.10	.00	.17
101	.48	.17	-.12	.07	.17	-.02	.00	.00	.13	.45
111	.46	.05	.03	.08	-.00	.16	-.00	-.20	-.08	.00
121	.15	.18	.12	.23	.12	.08	.05	.02	-.09	-.07
131	.08	-.07	-.13	-.02	-.04	-.02	.05	.09	.23	.38
141	.40	.29	.36	.43	.40	.29	.02	.11	.00	.02
151	.20	.14	-.05	-.03	.15	.04	.06	-.07	-.00	-.02
161	-.23	-.18	.10	-.17	-.18	-.07	-.25	-.37	-.34	-.37
171	-.34	-.36	-.28	-.23	-.16	.03	.13	.17	-.06	-.22
181	-.21	-.19	-.21	-.18	-.20	-.08	.20	.22	.15	.17
191	.10	-.09	-.31	-.38	-.35	-.26	-.19	-.17	-.15	-.00
201	-.01	-.03	-.03	-.15	.30	.24	.35	.33	.21	.12
211	.05	-.02	.05	.02	.05	.08	.16	.22	.20	.00
221	.05	.13	.20	.18	.20	.23	.11	.17	.15	.12
231	.15	.18	.25	.23	.16	.12	.15	.13	.20	.23
241	.29	.40	.22	-.01	-.10	-.08	-.15	-.15	.03	.10
251	.21	.04	-.27	-.30	-.28	-.26	-.33	-.40	-.43	-.35
261	-.32	-.24	-.14	-.21	-.19	-.20	-.08	-.01	.02	.00
271	.12	.13	.05	.06	.21	.20	.10	-.12	-.09	.10
281	-.10	-.22	-.37	.04	.36	.43	.45	.45	.35	.24
291	.11	.03	.06	.17	.11	.37	.47	.48	.38	.20
301	.00	.00	.00	-1.00	1.12	.00	-.24	.52	.55	.50

RMS ■ 2.914 INCHES

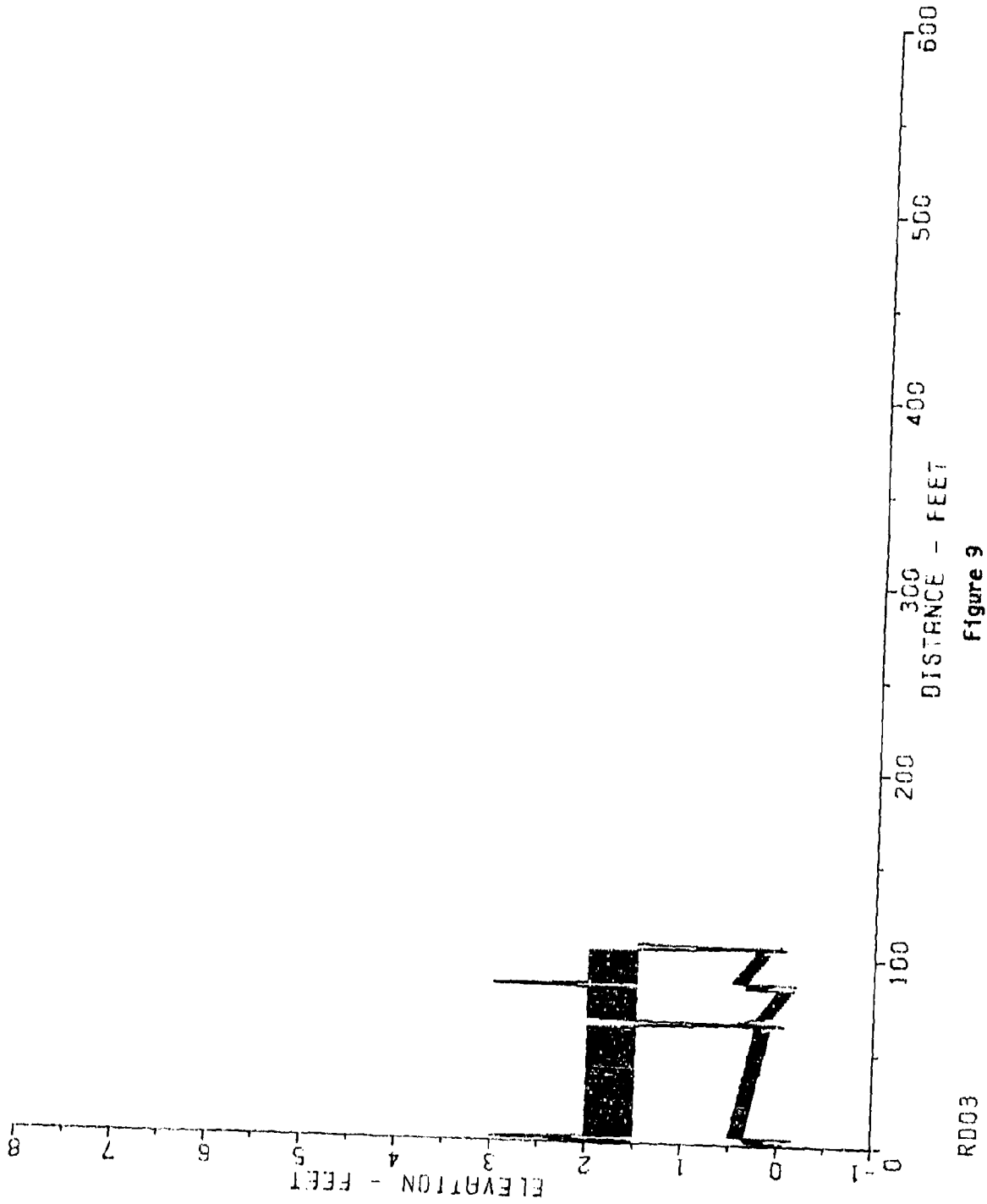


Figure 9

6/21/78

RD03

NUMBER OF POINTS = 428

INTERVAL IN INCHES = 3

POINT	ELEVATIONS IN FEET									
1	.00	-.02	-.07	-.02	.08	.18	.27	.32	.34	.32
11	.27	.17	.03	-.19	-.03	.18	.33	.42	.48	.60
21	.48	.42	.33	.42	.47	.49	.47	.42	.32	.41
31	.47	.48	.47	.41	.32	.41	.46	.48	.46	.41
41	.31	.40	.45	.47	.45	.40	.30	.39	.45	.47
51	.45	.30	.30	.39	.44	.46	.44	.39	.29	.38
61	.43	.45	.43	.38	.28	.37	.43	.45	.43	.37
71	.28	.37	.42	.44	.42	.37	.27	.36	.41	.43
81	.41	.36	.26	.35	.41	.43	.41	.35	.26	.36
91	.40	.40	.40	.35	.25	.34	.40	.41	.40	.34
101	.24	.33	.39	.41	.39	.33	.24	.33	.38	.40
111	.38	.33	.23	.32	.38	.39	.38	.32	.23	.31
121	.37	.39	.37	.31	.22	.31	.36	.38	.36	.31
131	.21	.30	.36	.37	.36	.30	.21	.30	.35	.37
141	.35	.34	.20	.29	.34	.36	.34	.29	.19	.28
151	.34	.35	.34	.28	.19	.28	.33	.38	.33	.28
161	.18	.27	.32	.34	.32	.27	.17	.26	.32	.34
171	.32	.26	.17	.26	.31	.33	.31	.26	.16	.25
181	.34	.32	.32	.25	.18	.24	.30	.32	.38	.24
191	.15	.24	.29	.31	.29	.24	.14	.23	.29	.38
201	.29	.23	.13	.22	.28	.30	.28	.22	.13	.22
211	.27	.29	.27	.22	.12	.21	.27	.26	.27	.21
221	.11	.20	.28	.28	.26	.20	.11	.20	.25	.27
231	.25	.20	.10	.19	.25	.26	.25	.10	.16	.18
241	.24	.26	.24	.18	.09	.18	.23	.25	.23	.18
251	.19	.24	.26	.24	.19	.09	-.01	-.07	.01	.18
261	.19	.27	.36	.41	.43	.41	.36	.33	.34	.33
271	.27	.17	.16	.21	.23	.21	.16	.06	.14	.18
281	.21	.10	.14	.04	.11	.17	.19	.17	.11	.02
291	.09	.14	.16	.14	.00	-.01	.07	.12	.14	.12
301	.07	-.03	.04	.10	.12	.10	.04	-.05	.02	.08
311	.09	.08	.02	-.07	-.00	.05	.07	.05	-.06	-.18
321	-.02	.03	.05	.03	-.02	-.12	-.05	.01	.03	.01
331	-.05	-.14	-.17	-.07	.01	.10	.19	.27	.33	.34
341	.33	.27	.17	.03	-.18	-.03	.18	.32	.42	.47
351	.49	.47	.42	.32	.40	.45	.47	.45	.40	.38
361	.37	.43	.44	.43	.37	.28	.35	.40	.42	.40
371	.35	.25	.32	.38	.40	.38	.32	.23	.30	.36
381	.37	.36	.30	.20	.28	.33	.35	.33	.28	.18
391	.25	.31	.33	.31	.25	.16	.23	.20	.30	.28
401	.23	.13	.20	.26	.28	.26	.20	.11	.18	.24
411	.26	.24	.18	.19	.24	.26	.24	.19	.09	-.01
421	-.07	-.02	.26	.00	.00	.00	.00	.00	-1.00	1.12

RMS = 1.709

INCHES

TABLE 4

RD03

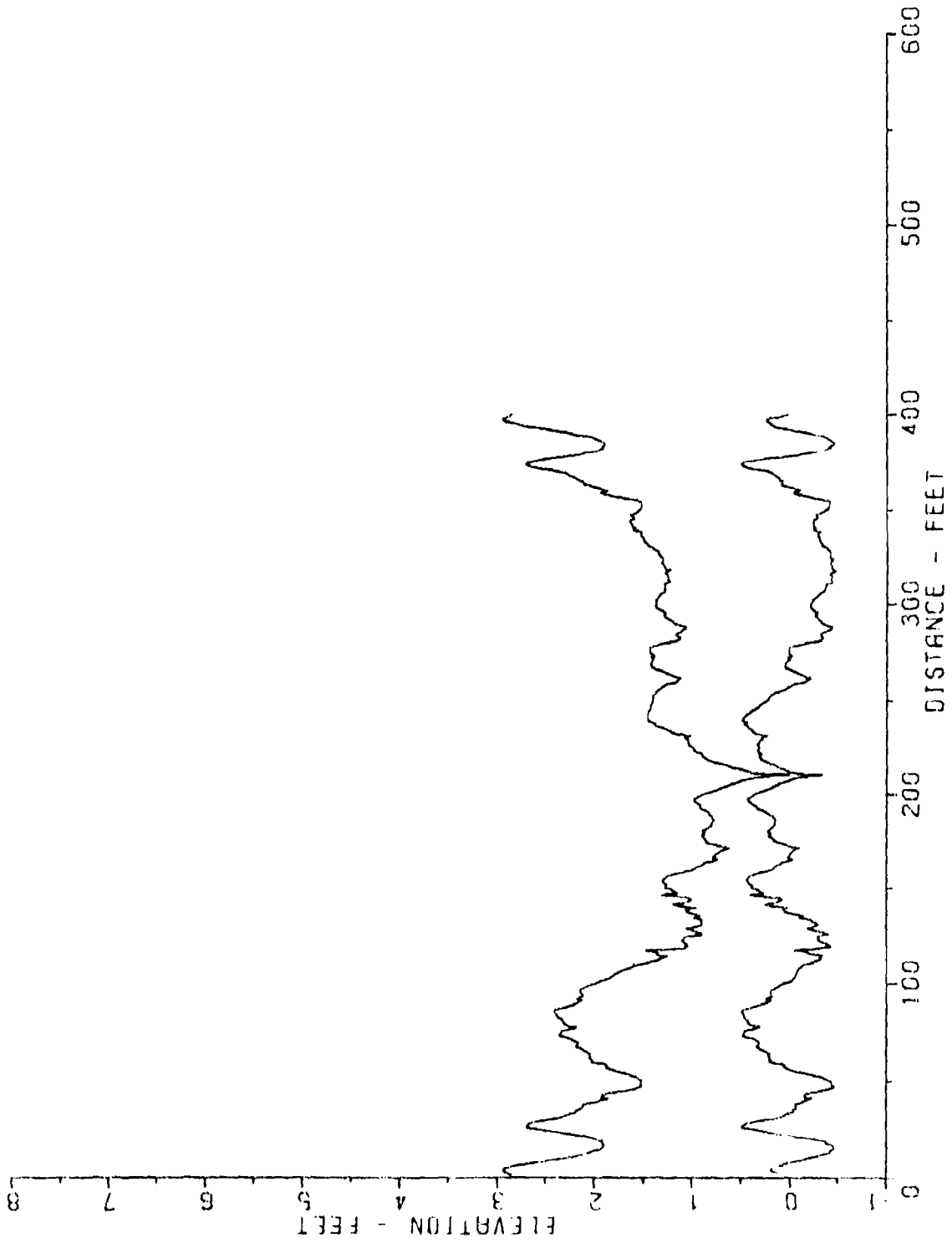


Figure 10

RDC4

6/21/78

TABLE 5
RDS

FORT KNOX MEDIAN 1964

ADDED TO THE DISK ON 1.MAR.77

NUMBER OF POINTS = 400

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.00	.16	.20	.18	.11	.06	-.03	-.12	-.21
11	-.29	-.38	-.41	-.42	-.45	-.46	-.44	-.38	-.36	-.28
21	-.15	.01	.12	.25	.38	.49	.49	.44	.36	.22
31	.12	.05	.00	-.05	-.05	-.08	-.07	-.06	-.14	-.18
41	-.24	-.15	-.18	-.26	-.34	-.43	-.47	-.44	-.43	-.42
51	-.37	-.31	-.24	-.15	-.07	.00	.07	.05	.09	.21
61	.19	.22	.21	.19	.23	.27	.30	.34	.31	.38
71	.34	.38	.46	.49	.46	.46	.35	.38	.39	.42
81	.42	.44	.46	.47	.48	.49	.48	.39	.33	.27
91	.22	.18	.24	.17	.18	.20	.18	.18	.11	.07
101	.08	-.03	-.04	-.09	-.07	-.08	-.08	-.18	-.13	-.15
111	-.21	-.25	-.32	-.31	-.34	-.22	-.18	-.05	-.31	-.43
121	-.39	-.34	-.29	-.29	-.29	-.41	-.38	-.28	-.18	-.25
131	-.29	-.27	-.23	-.20	-.18	-.14	-.03	.08	.07	.02
141	.16	.25	.13	.08	.11	.22	.41	.27	.38	.34
151	.40	.39	.42	.44	.45	.42	.41	.34	.29	.19
161	.16	.15	.09	.08	.01	-.03	.02	-.00	-.01	-.04
171	-.06	-.11	-.00	.26	.14	.17	.18	.21	.21	.20
181	.22	.19	.18	.15	.16	.16	.15	.17	.18	.22
191	.24	.26	.34	.34	.36	.40	.43	.43	.40	.37
201	.33	.29	.24	.18	.14	.09	.05	.01	-.07	-.15
211	-.34	-.08	.00	.06	.12	.16	.21	.23	.20	.30
221	.38	.28	.31	.32	.32	.31	.33	.31	.39	.28
231	.29	.23	.35	.37	.39	.42	.43	.46	.43	.48
241	.47	.45	.43	.40	.38	.34	.32	.38	.27	.24
251	.22	.20	.19	.14	.10	.06	.02	-.03	-.07	-.15
261	-.19	-.22	-.17	-.13	-.08	-.05	.01	.04	.04	.00
271	.02	-.01	.01	-.03	.00	.00	-.01	.00	.05	-.18
281	-.25	-.34	-.36	-.34	-.33	-.38	-.41	-.45	-.48	-.37
291	-.33	-.32	-.30	-.28	-.26	-.30	-.26	-.23	-.21	-.22
301	-.22	-.24	-.23	-.27	-.30	-.32	-.36	-.37	-.37	-.38
311	-.37	-.44	-.43	-.44	-.45	-.42	-.43	-.48	-.44	-.43
321	-.44	-.43	-.45	-.46	-.43	-.43	-.43	-.42	-.39	-.38
331	-.34	-.36	-.33	-.31	-.32	-.30	-.30	-.32	-.25	-.28
341	-.25	-.25	-.24	-.25	-.29	-.29	-.27	-.33	-.37	-.40
351	-.42	-.42	-.42	-.43	-.37	-.27	-.18	-.07	-.08	-.12
361	-.05	.01	.08	.08	.07	.10	.10	.16	.18	.22
371	.38	.41	.47	.49	.48	.33	.18	.02	-.11	-.20
381	-.37	-.43	-.42	-.47	-.47	-.44	-.40	-.36	-.28	-.22
391	-.10	.00	.08	.16	.19	.24	.24	.19	.08	.08

RMS = 3.437 INCHES

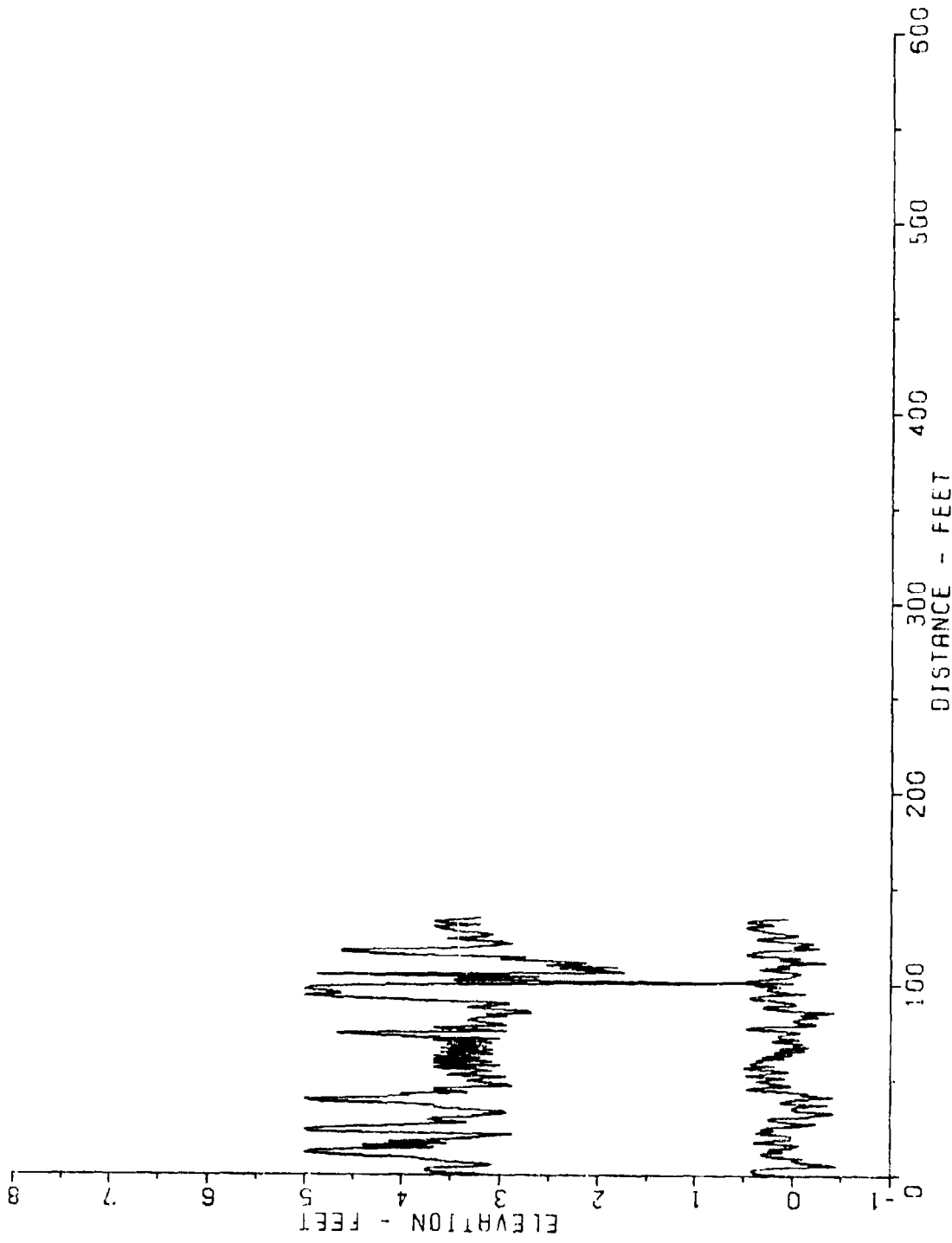


Figure 11

R005

6/21/78

NUMBER OF POINTS = 270

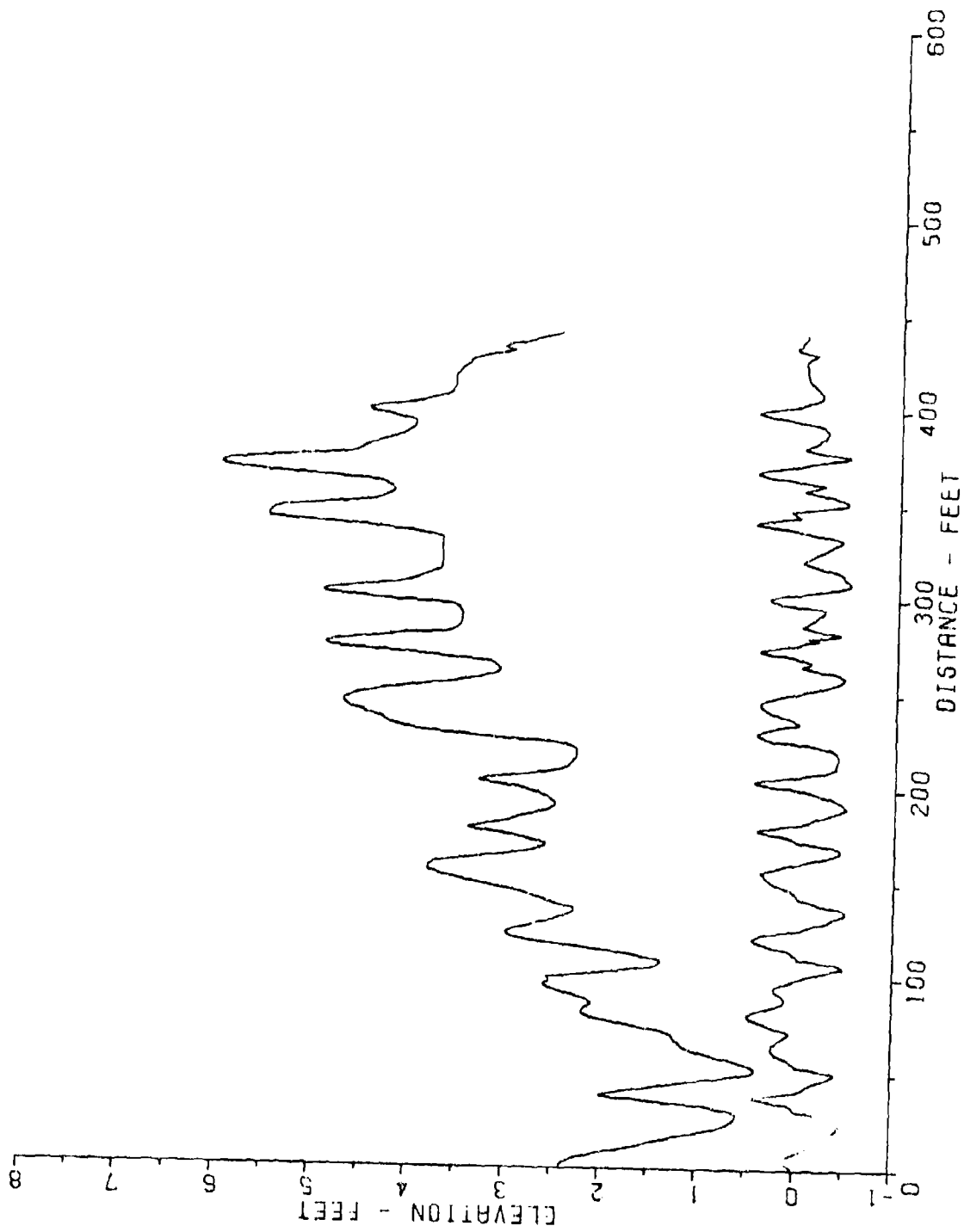
INTERVAL IN INCHES = 6

POINT	ELEVATIONS IN FEET										
1	.13	.33	.40	.41	.43	.39	.33	.24	.08	-.33	
11	-.45	-.36	-.23	-.17	-.02	.00	-.05	-.11	-.02	.10	
21	.27	.29	.33	.25	.09	.16	.25	.18	.05	-.03	
31	.00	-.07	.08	.32	.40	.32	.14	.02	.03	.00	
41	.01	.00	.13	.31	.38	.31	.19	.27	.33	.20	
51	.14	.02	-.13	-.24	-.07	.11	.19	.23	.27	.20	
52	.01	-.17	-.25	-.34	-.43	-.39	-.24	-.07	.00	.00	
71	.01	-.07	-.23	-.36	-.18	.05	.13	.00	.01	.07	
81	-.27	-.42	-.33	-.16	-.08	-.16	-.13	.11	.06	.40	
91	.47	.40	.19	.02	.06	.14	.22	.31	.37	.30	
101	.19	.07	.17	.41	.48	.41	.30	.10	.03	.07	
111	.25	.43	.07	.43	.19	.37	.44	.43	.35	.31	
121	.38	.31	.08	.25	.32	.25	.01	.12	.19	.12	
131	-.12	.04	.13	.00	-.16	-.07	.00	-.07	-.10	.14	
141	.21	.14	-.07	.06	.13	.14	.15	.00	.02	-.07	
151	-.07	.11	.26	.41	.49	.41	.17	-.21	-.23	-.16	
161	-.08	-.04	.00	-.03	-.08	-.15	-.26	-.14	-.07	-.14	
171	-.34	-.42	-.21	-.01	.12	.24	.31	.24	.04	-.04	
181	.00	-.01	.03	.15	.25	.30	.45	.41	.37	.30	
191	.08	-.13	.01	.19	.27	.25	.23	.16	.13	.30	
201	.39	.32	.19	.41	.49	.41	.17	.11	.00	-.00	
211	.40	-.07	-.07	.00	.10	.20	.30	.20	.04	.00	
221	.16	.09	-.14	-.33	-.13	.07	.14	.07	-.07	.07	
231	.24	.40	.48	.42	.40	.33	.13	-.07	-.27	-.07	
241	.00	-.07	-.20	-.19	-.04	.11	.22	.32	.30	.31	
251	.11	-.05	-.06	.04	.14	.24	.30	.33	.07	.44	
261	.49	.42	.20	.27	.36	.43	.40	.40	.25	.00	

RMS = 2.611 INCHES

TABLE 6

RD05



RD06

Figure 12

6/21/78

TABLE 7
SC06

APG HERRYMAN III 1954

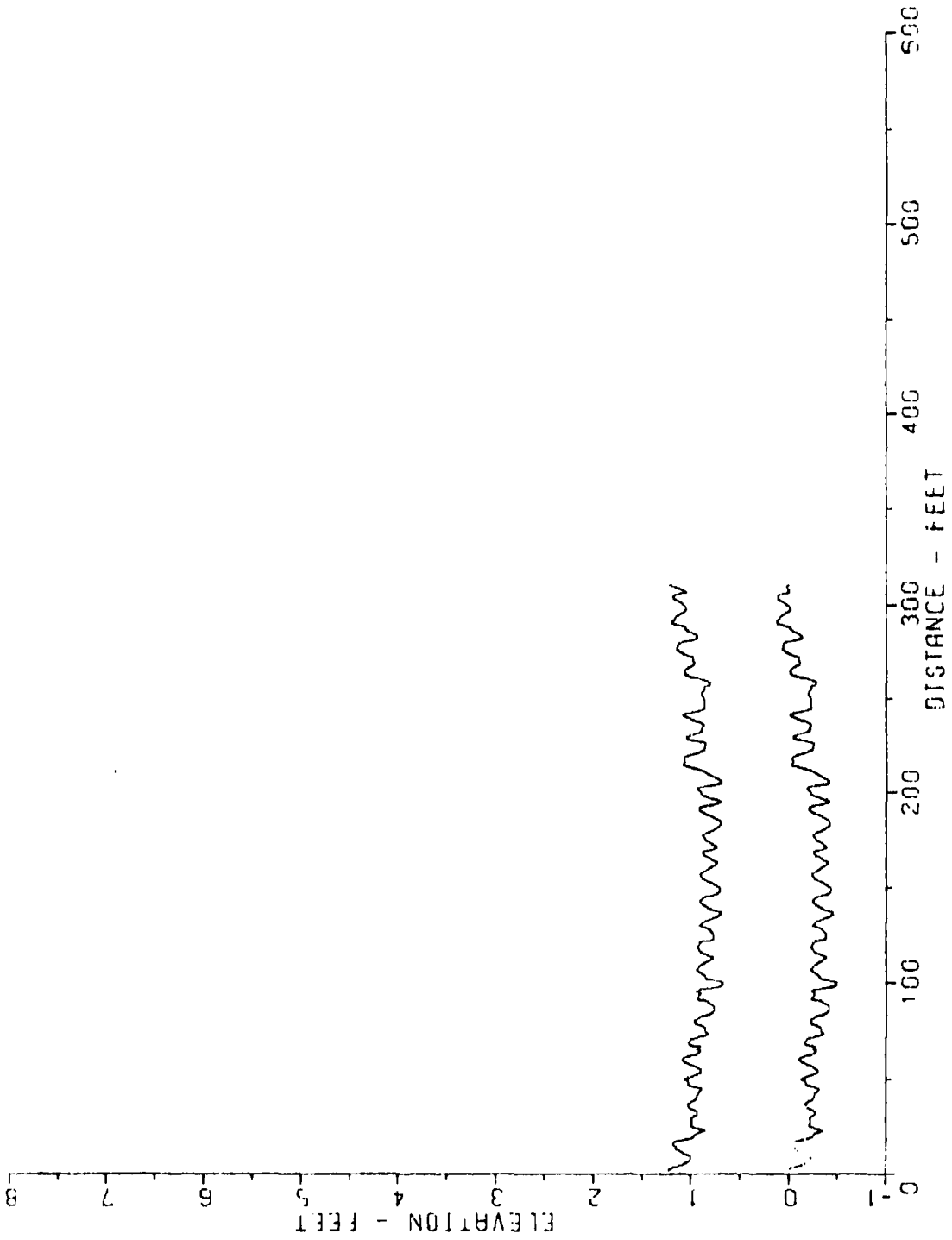
ADDED TO THE DISK ON 1.MAR.77

NUMBER OF POINTS = 440

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.04	.07	.08	.09	.08	.06	.02	-.03	-.08
11	-.13	-.16	-.17	-.20	-.23	-.25	-.29	-.33	-.39	-.42
21	-.45	-.46	-.47	-.46	-.43	-.38	-.34	-.28	-.20	-.18
31	.00	.01	.02	.09	.20	.28	.42	.41	.25	.04
41	-.04	-.08	-.12	-.17	-.20	-.25	-.30	-.36	-.41	-.42
51	-.35	-.25	-.12	.02	.01	.04	.07	.11	.15	.20
61	.21	.23	.24	.23	.23	.18	.18	.15	.12	.08
71	.05	.09	.14	.22	.26	.33	.38	.43	.47	.49
81	.50	.45	.40	.33	.26	.18	.13	.11	.11	.13
91	.14	.16	.19	.22	.23	.21	.16	.07	.03	.00
101	-.07	-.15	-.22	-.31	-.40	-.48	-.45	-.38	-.28	-.14
111	.00	.01	.03	.06	.10	.14	.24	.33	.39	.44
121	.45	.43	.37	.29	.17	.02	-.07	-.14	-.20	-.27
131	-.34	-.39	-.44	-.47	-.49	-.48	-.46	-.35	-.27	-.19
141	-.13	-.08	.00	.09	.02	.04	.08	.13	.18	.22
151	.26	.38	.32	.35	.35	.38	.33	.28	.21	.12
161	.01	-.06	-.13	-.23	-.32	-.39	-.43	-.44	-.42	-.37
171	-.28	-.14	.00	.04	.10	.17	.29	.39	.43	.35
181	.17	.02	-.07	-.13	-.18	-.24	-.31	-.38	-.43	-.47
191	-.49	-.47	-.44	-.40	-.36	-.33	-.27	-.20	-.14	-.06
201	.05	.01	.07	.06	.01	.00	.13	-.04	-.19	-.29
211	-.36	-.38	-.39	-.40	-.39	-.40	-.40	-.39	-.38	-.37
221	-.34	-.30	-.24	-.13	.05	.24	.36	.41	.44	.43
231	.39	.31	.23	.13	.01	.00	.07	.12	.20	.22
241	.31	.35	.38	.40	.41	.41	.36	.30	.23	.13
251	.01	-.07	-.16	-.23	-.31	-.39	-.43	-.45	-.46	-.43
261	-.38	-.30	-.20	-.10	.00	-.10	-.11	-.06	.00	.07
271	.17	.35	.43	.36	.24	.05	.01	-.05	-.18	-.07
281	-.33	-.41	-.32	-.22	-.11	.00	-.04	-.08	-.11	-.14
291	-.17	-.19	-.21	-.24	-.25	-.19	.04	.23	.26	.33
301	.34	.29	.03	-.10	-.25	-.38	-.45	-.49	-.49	-.47
311	-.43	-.42	-.42	-.40	-.35	-.28	-.21	-.14	-.07	.00
321	-.04	-.07	-.11	-.15	-.19	-.22	-.26	-.30	-.34	-.37
331	-.41	-.40	-.33	-.24	-.12	.00	.07	.20	.35	.48
341	.46	.34	.19	.02	.06	.10	.12	-.04	-.18	-.38
351	-.48	-.45	-.41	-.36	-.30	-.21	-.11	.00	.08	.17
361	-.22	-.10	.03	.10	.34	.43	.47	.44	.36	.22
371	.03	.04	.12	.27	.42	.48	.34	-.22	-.11	.00
381	-.04	-.05	-.12	-.16	-.17	-.22	-.22	-.24	-.23	-.22
391	.21	.10	.12	.01	.11	.22	.34	.42	.46	.39
401	.25	.12	.03	-.04	-.10	-.16	-.18	-.18	-.17	-.18
411	-.15	-.12	-.10	-.08	-.05	-.03	-.02	-.01	-.01	-.01
421	-.02	-.01	-.02	-.01	-.00	.00	-.03	-.07	-.11	-.13
431	-.02	.09	.18	.45	.04	.03	.01	-.01	-.01	.00

RCS = 3.155 INCHES



RD07

Figure 13

6/21/78

NUMBER OF POINTS = 311

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.00	-.03	-.09	-.15	-.19	-.21	-.22	-.21	-.17
11	-.12	-.09	-.06	-.05	-.03	-.03	-.04	-.14	-.03	-.24
21	-.26	-.32	-.35	-.26	-.24	-.21	-.22	-.21	-.21	-.23
31	-.26	-.27	-.25	-.21	-.17	-.16	-.16	-.20	-.24	-.26
41	-.26	-.27	-.29	-.31	-.30	-.23	-.17	-.17	-.15	-.12
51	-.14	-.25	-.24	-.24	-.29	-.26	-.22	-.17	-.12	-.10
61	-.11	-.17	-.24	-.28	-.29	-.25	-.27	-.16	-.15	-.17
71	-.18	-.27	-.34	-.36	-.32	-.32	-.32	-.29	-.22	-.21
81	-.22	-.26	-.29	-.35	-.39	-.42	-.42	-.40	-.38	-.35
91	-.32	-.22	-.24	-.26	-.27	-.22	-.29	-.40	-.40	-.58
101	-.45	-.35	-.31	-.30	-.26	-.23	-.21	-.23	-.25	-.28
111	-.30	-.35	-.38	-.39	-.32	-.26	-.24	-.23	-.22	-.24
121	-.26	-.24	-.37	-.38	-.38	-.37	-.36	-.34	-.30	-.23
131	-.26	-.28	-.32	-.38	-.42	-.45	-.45	-.39	-.33	-.29
141	-.26	-.24	-.23	-.25	-.28	-.34	-.41	-.43	-.42	-.42
151	-.39	-.36	-.32	-.28	-.24	-.23	-.22	-.26	-.29	-.32
161	-.35	-.33	-.40	-.37	-.33	-.31	-.26	-.24	-.25	-.33
171	-.39	-.38	-.34	-.31	-.27	-.26	-.24	-.26	-.29	-.33
181	-.37	-.40	-.42	-.42	-.40	-.38	-.34	-.31	-.26	-.22
191	-.20	-.28	-.25	-.34	-.41	-.39	-.32	-.27	-.22	-.21
201	-.20	-.18	-.17	-.30	-.41	-.41	-.39	-.36	-.31	-.28
211	-.24	-.22	-.15	-.08	-.02	-.04	-.04	-.03	-.04	-.00
221	-.14	-.22	-.23	-.23	-.24	-.25	-.22	-.13	-.05	-.04
231	-.08	-.15	-.21	-.21	-.21	-.23	-.22	-.17	-.11	-.07
241	-.03	-.07	-.06	-.15	-.22	-.22	-.22	-.22	-.22	-.22
251	-.21	-.20	-.19	-.21	-.22	-.22	-.22	-.27	-.28	-.25
261	-.10	-.12	-.04	-.01	-.00	-.01	-.04	-.07	-.11	-.11
271	-.09	-.09	-.09	-.04	-.01	-.05	-.07	-.07	-.06	-.07
281	.03	-.08	-.13	-.13	-.11	-.07	-.03	-.01	-.01	-.06
291	.13	.13	.10	.09	.04	.04	-.00	-.02	-.00	-.02
301	.04	.07	.10	.12	.13	.09	-.00	-.00	.02	.02
311	.00	-1.00	1.12	.00	.00	-.55	-.41	-.27	-.13	.00

RES = 1.632 INCHES

TABLE 8

RD07

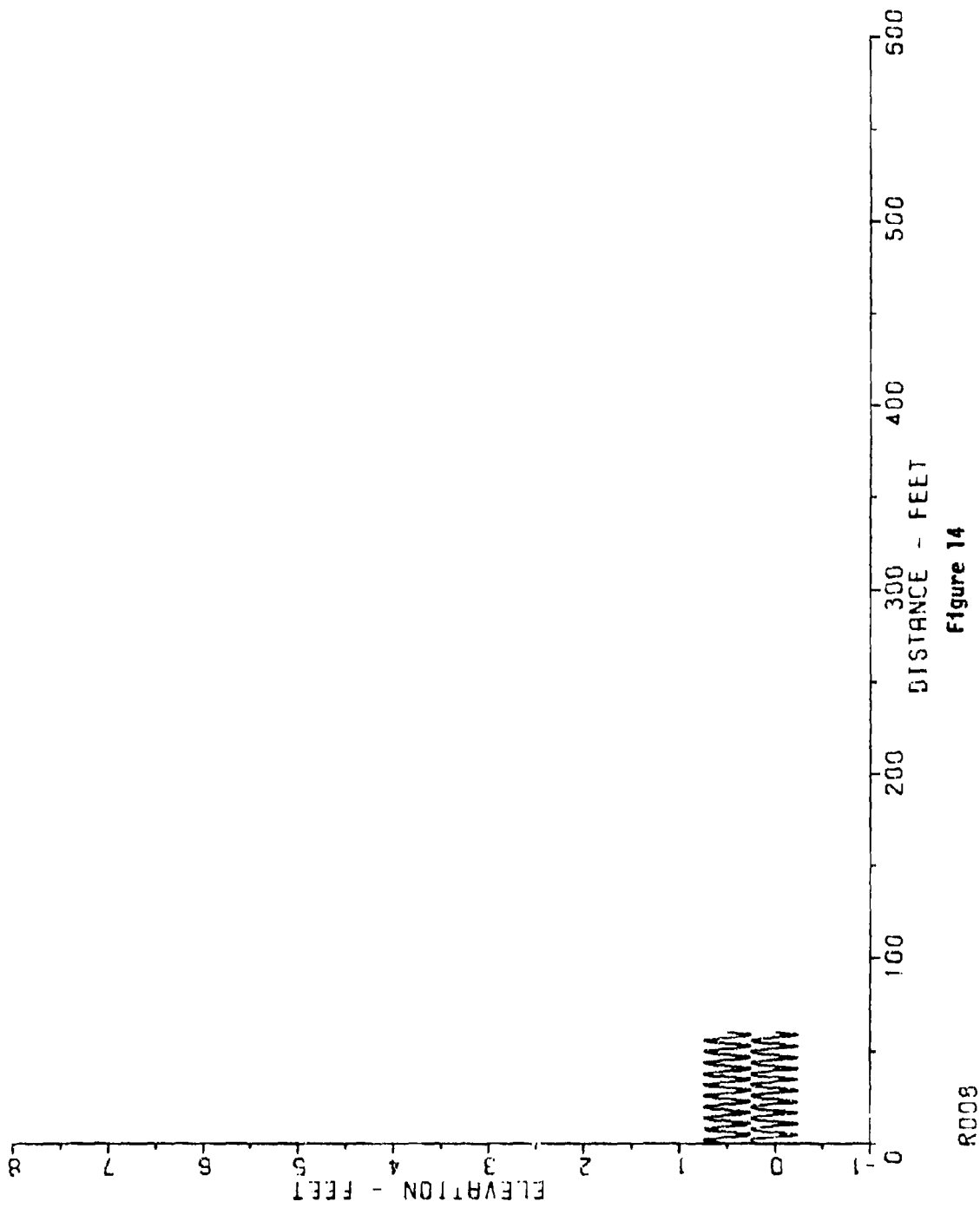


Figure 14

6/21/78

SIX INCH SINE WAVE COURSE 1964 ADDED TO THE DISK ON 3.MAR.77

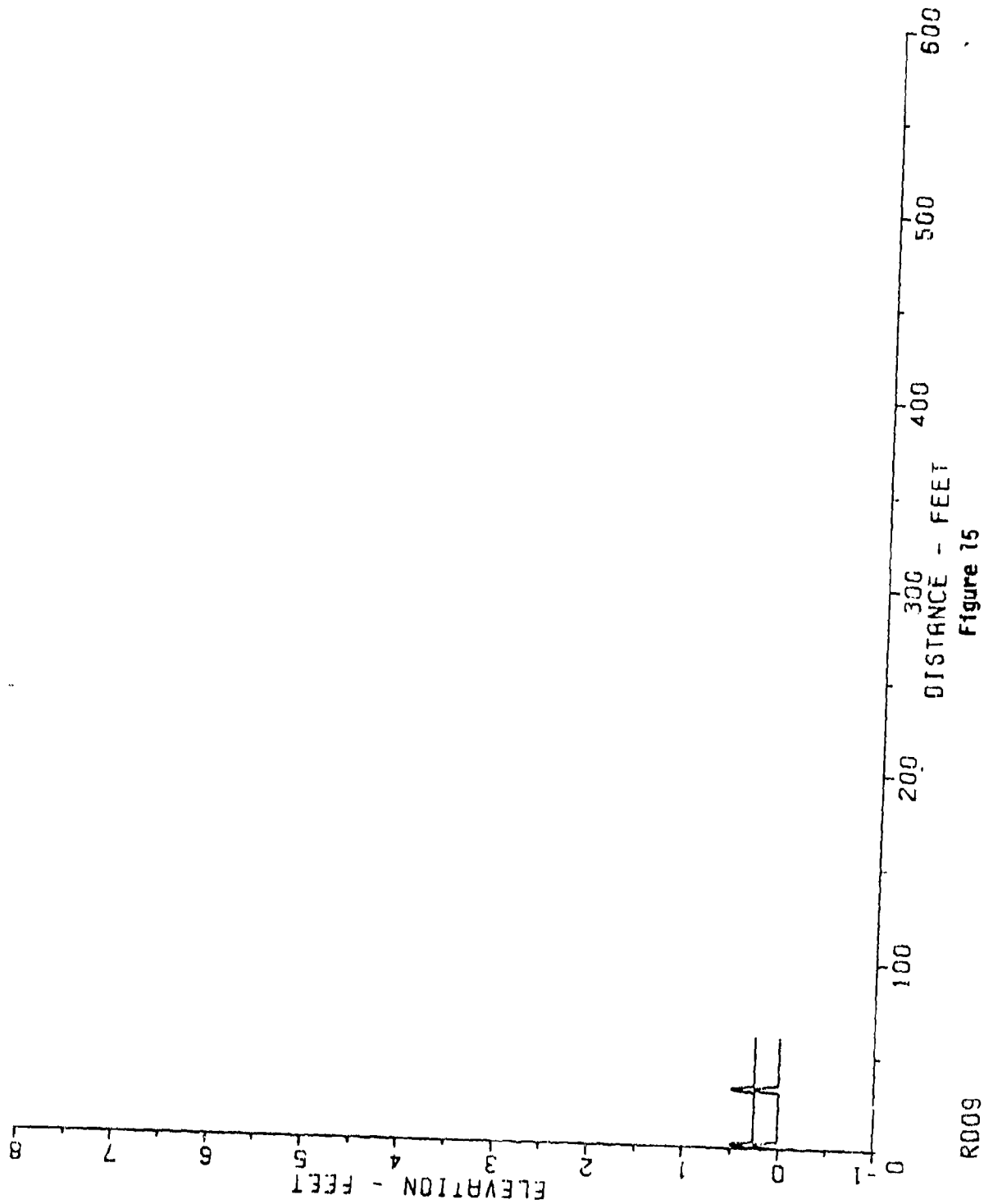
NUMBER OF POINTS = 241

INTERVAL IN INCHES = 3

POINT	ELEVATIONS IN FEET									
1	.06	.11	.16	.20	.23	.24	.25	.24	.23	.20
11	.16	.11	.06	-.01	-.07	-.13	-.20	-.23	-.25	-.23
21	-.20	-.13	-.07	-.01	.06	.11	.16	.20	.23	.24
31	.25	.24	.23	.20	.16	.11	.06	-.01	-.07	-.13
41	-.19	-.23	-.25	-.23	-.20	-.13	-.07	-.01	.06	.11
51	.16	.20	.23	.24	.25	.24	.23	.20	.16	.11
61	.05	-.01	-.07	-.13	-.20	-.23	-.25	-.23	-.20	-.13
71	-.07	-.01	.06	.11	.16	.20	.23	.24	.25	.24
81	.23	.20	.16	.11	.06	-.01	-.07	-.13	-.19	-.23
91	-.25	-.23	-.19	-.13	-.07	-.01	.06	.11	.16	.20
101	.23	.24	.25	.24	.23	.20	.16	.11	.06	-.01
111	-.07	-.13	-.19	-.23	-.25	-.23	-.20	-.13	-.07	-.01
121	.06	.11	.16	.20	.23	.24	.25	.24	.23	.20
131	.16	.11	.05	-.01	-.07	-.13	-.19	-.23	-.25	-.23
141	-.19	-.13	-.07	-.01	.06	.11	.16	.20	.23	.24
151	.25	.24	.23	.20	.16	.11	.06	-.01	-.07	-.13
161	-.20	-.23	-.25	-.23	-.19	-.13	-.07	-.01	.06	.11
171	.16	.20	.23	.24	.25	.24	.23	.20	.16	.11
181	.05	-.01	-.07	-.13	-.19	-.23	-.25	-.23	-.19	-.13
191	-.07	-.01	.06	.11	.16	.20	.23	.24	.25	.24
201	.23	.20	.16	.11	.06	-.01	-.07	-.13	-.19	-.23
211	-.25	-.23	-.20	-.13	-.07	-.01	.06	.11	.16	.20
221	.23	.24	.25	.24	.23	.20	.16	.11	.06	-.01
231	-.07	-.13	-.20	-.23	-.25	-.23	-.20	-.13	-.07	-.01
241	.06	-1.00	1.12	-.24	-.22	-.18	-.13	-.06	.00	.00

RMS = 2.069 INCHES

TABLE 9



R009

Figure 75

6/21/78

THREE INCH SPACED NUMP 1964 ADDED TO THE DISK ON 3. MAR. 77

NUMBER OF POINTS • 241

INTERVAL IN INCHES • 3

POINT	ELEVATIONS IN FEET									
	.07	.12	.17	.20	.23	.24	.25	.24	.23	.22
1	.07	.12	.17	.20	.23	.24	.25	.24	.23	.22
11	.17	.12	.07	.01	.04	.03	.02	.01	.00	.00
21	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
31	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
41	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
51	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
61	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
71	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
81	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
91	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
101	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
111	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
121	.07	.12	.17	.20	.23	.24	.25	.24	.23	.22
131	.17	.12	.07	.01	.04	.03	.02	.01	.00	.00
141	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
151	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
161	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
171	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
181	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
191	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
201	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
211	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
221	.20	.07	.02	.00	.03	.02	.01	.00	.00	.00
231	.00	.04	.09	.02	.09	.08	.07	.06	.05	.04
241	.01	-1.00	1.12	.00	.00	.00	.00	.00	.00	.00

RMS • .7865 INCHES

TABLE 10
RD09

Reproduced From
Best Available Copy

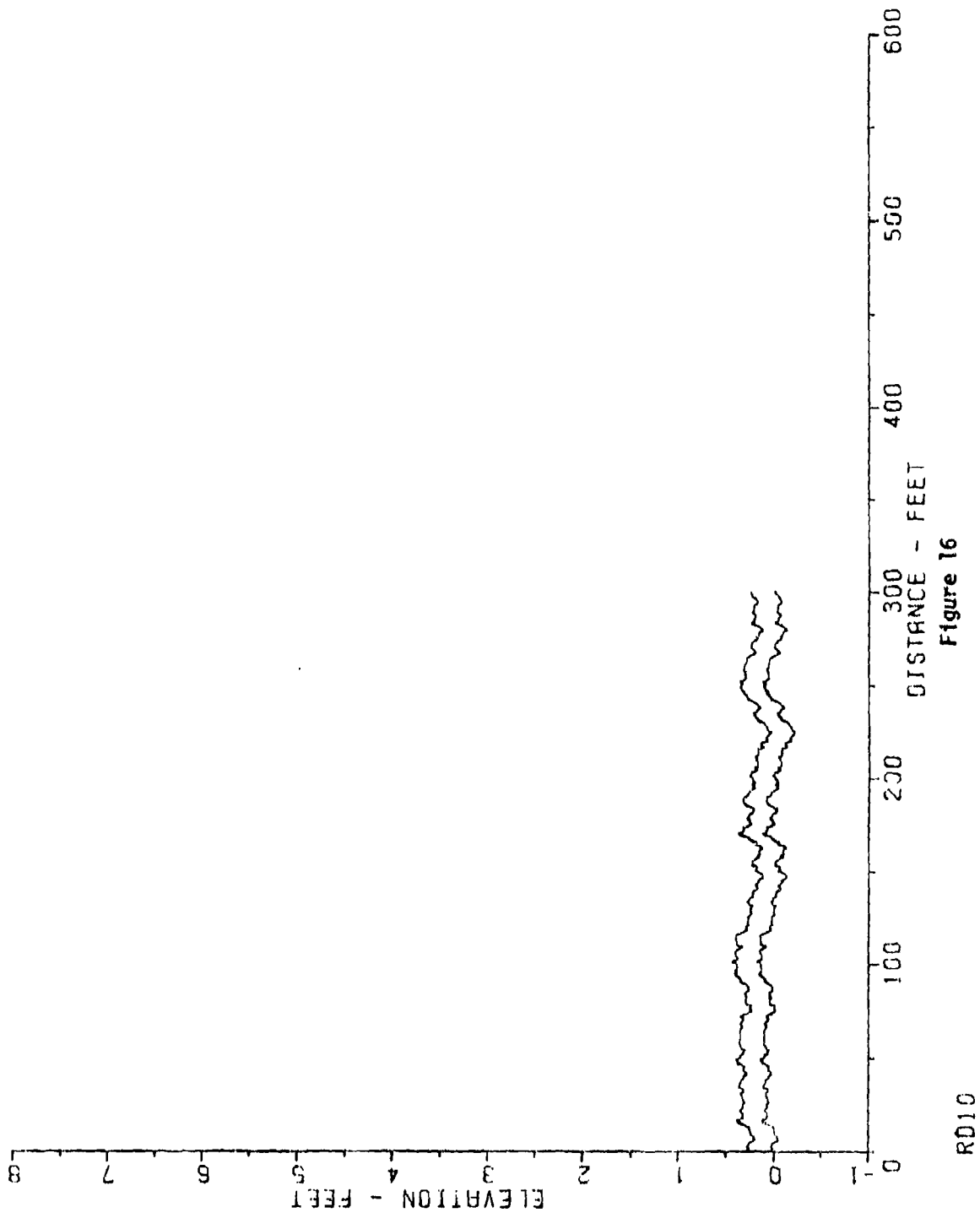


Figure 16

6/21/78

R010

RMS=1

ADDED TO THE DISK ON 11.MAR.77

NUMBER OF POINTS = 300

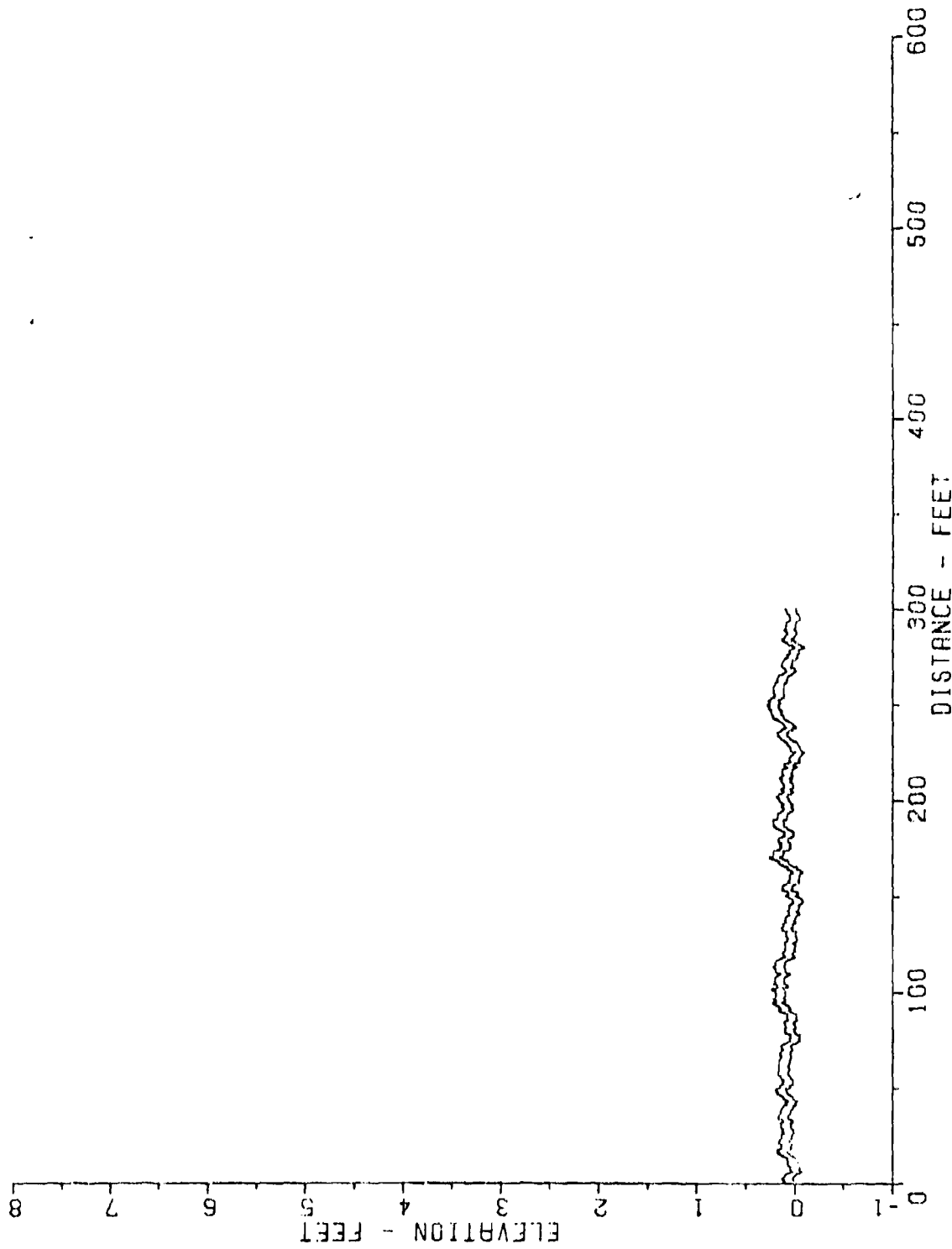
INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.03	.01	.01	-.01	-.00	-.04	-.04	-.01	-.01
11	.00	.00	.01	.05	.09	.12	.12	.06	.08	.07
21	.09	.10	.07	.07	.07	.03	.07	.06	.06	.09
31	.09	.06	.07	.11	.11	.09	.09	.08	.06	.06
41	.03	.03	.06	.06	.05	.08	.12	.13	.14	.09
51	.10	.06	.07	.05	.09	.09	.11	.11	.10	.10
61	.11	.10	.12	.10	.09	.08	.08	.10	.08	.06
71	.06	.09	.06	.02	-.01	.00	-.01	-.02	.04	.05
81	.05	.03	.03	.05	.05	.01	.02	.02	.03	.05
91	.10	.09	.11	.14	.16	.13	.15	.13	.14	.14
101	.15	.18	.12	.13	.15	.15	.15	.13	.11	.08
111	.14	.14	.14	.15	.14	.15	.12	.06	.03	.04
121	.05	.02	.03	.02	.02	.03	.00	-.01	-.01	.06
131	-.01	-.03	.02	.03	.00	.01	-.03	-.02	-.03	-.03
141	-.07	-.07	-.05	-.08	-.09	-.08	-.13	-.13	-.12	-.08
151	-.05	-.07	-.06	-.01	-.02	-.03	-.06	-.09	-.07	-.10
161	-.09	-.10	-.13	-.09	-.05	-.06	-.01	.02	.02	.09
171	.12	.07	.07	.06	.02	-.01	.01	.00	.04	.02
181	.01	-.03	-.04	-.03	.01	.04	.07	.07	.07	.07
191	.03	.02	.01	.00	-.04	-.05	-.02	-.05	-.03	-.02
201	.00	.01	-.01	-.06	-.07	-.04	-.08	-.08	-.07	-.06
211	-.07	-.05	-.09	-.08	-.09	-.08	-.15	-.12	-.11	-.12
221	-.17	-.18	-.19	-.21	-.23	-.19	-.18	-.17	-.16	-.15
231	-.11	-.08	-.06	-.04	-.03	-.07	-.08	-.11	-.09	-.07
241	-.04	-.01	.03	.03	.05	.07	.06	.09	.09	.10
251	.00	.11	.07	.05	.05	.06	.05	.07	.07	.06
261	.06	.04	.04	.04	.02	.00	-.04	-.06	-.04	-.01
271	-.01	-.01	-.03	-.04	-.07	-.07	-.09	-.10	-.10	-.14
281	-.11	-.08	-.05	-.01	-.05	-.04	-.06	-.06	-.03	-.04
291	-.04	-.04	-.04	-.07	-.08	-.07	-.05	-.03	-.02	.00

RMS = .9727 INCHES

TABLE 11

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RD12

Figure 17

6/22/78

RECEIVED RMS APRIL 77

ADDED TO THE LIBRARY ON 11.MAR.77

NUMBER OF POINTS • 300

INTERVAL IN INCHES • 12

POINT	ELEVATIONS IN FEET									
1	.80	.43	.01	.08	-.02	-.07	-.05	-.06	-.03	-.03
11	-.03	-.42	-.02	.02	.05	.08	.08	.23	.04	.03
21	.06	.48	.04	.03	.04	.01	.03	.02	.04	.02
31	.05	.42	.03	.07	.07	.06	.08	.04	.03	.02
41	-.01	.40	-.03	.02	.02	.05	.08	.00	.17	.02
51	.06	.40	.03	.01	.05	.05	.07	.07	.06	.02
61	.07	.47	.06	.06	.05	.04	.04	.06	.24	.02
71	.03	.45	.02	-.02	-.05	-.04	-.05	-.08	.08	.01
81	.01	-.41	.00	.01	.01	-.03	-.01	-.02	-.01	.02
91	.07	.05	.07	.10	.13	.20	.12	.16	.18	.15
101	.11	.14	.08	.09	.12	.11	.11	.10	.28	.05
111	.14	.14	.11	.12	.14	.11	.09	.03	.08	.02
121	.03	.07	.01	.00	.00	.02	-.01	-.02	-.01	.02
131	-.01	-.42	.03	.04	.02	.03	-.21	.01	.02	-.01
141	-.04	-.43	-.01	-.00	-.05	-.03	-.06	-.08	-.07	-.03
151	.08	-.43	-.02	.04	.03	.02	-.01	-.05	-.03	-.05
161	-.04	-.45	-.08	-.05	-.01	-.02	.03	.07	.08	.13
171	.16	.12	.12	.13	.06	.04	.06	.04	.08	.07
181	.06	.01	.01	.01	.06	.09	.12	.12	.12	.12
191	.08	.08	.07	.08	.02	.02	.04	.02	.04	.06
201	.07	.04	.07	.03	.02	.05	.01	.02	.03	.05
211	.03	.06	.02	.04	.03	.05	-.03	.01	.01	-.00
221	-.04	-.05	-.06	-.08	-.10	-.06	-.08	-.04	-.03	-.02
231	.01	.05	.06	.08	.09	.04	.03	-.01	.01	.03
241	.06	.05	.12	.12	.14	.15	.14	.17	.16	.18
251	.15	.18	.14	.11	.11	.12	.11	.12	.12	.11
261	.11	.08	.09	.08	.07	.04	.01	-.01	.00	.04
271	.03	.03	.02	.08	-.03	-.02	-.05	-.08	-.05	-.10
281	-.07	-.03	.08	.04	.00	.00	-.02	-.02	.01	-.01
291	-.01	-.41	-.02	-.05	-.06	-.05	-.04	-.02	-.01	.02

RMS • .6787

INCHES

TABLE 12

Reproduced From
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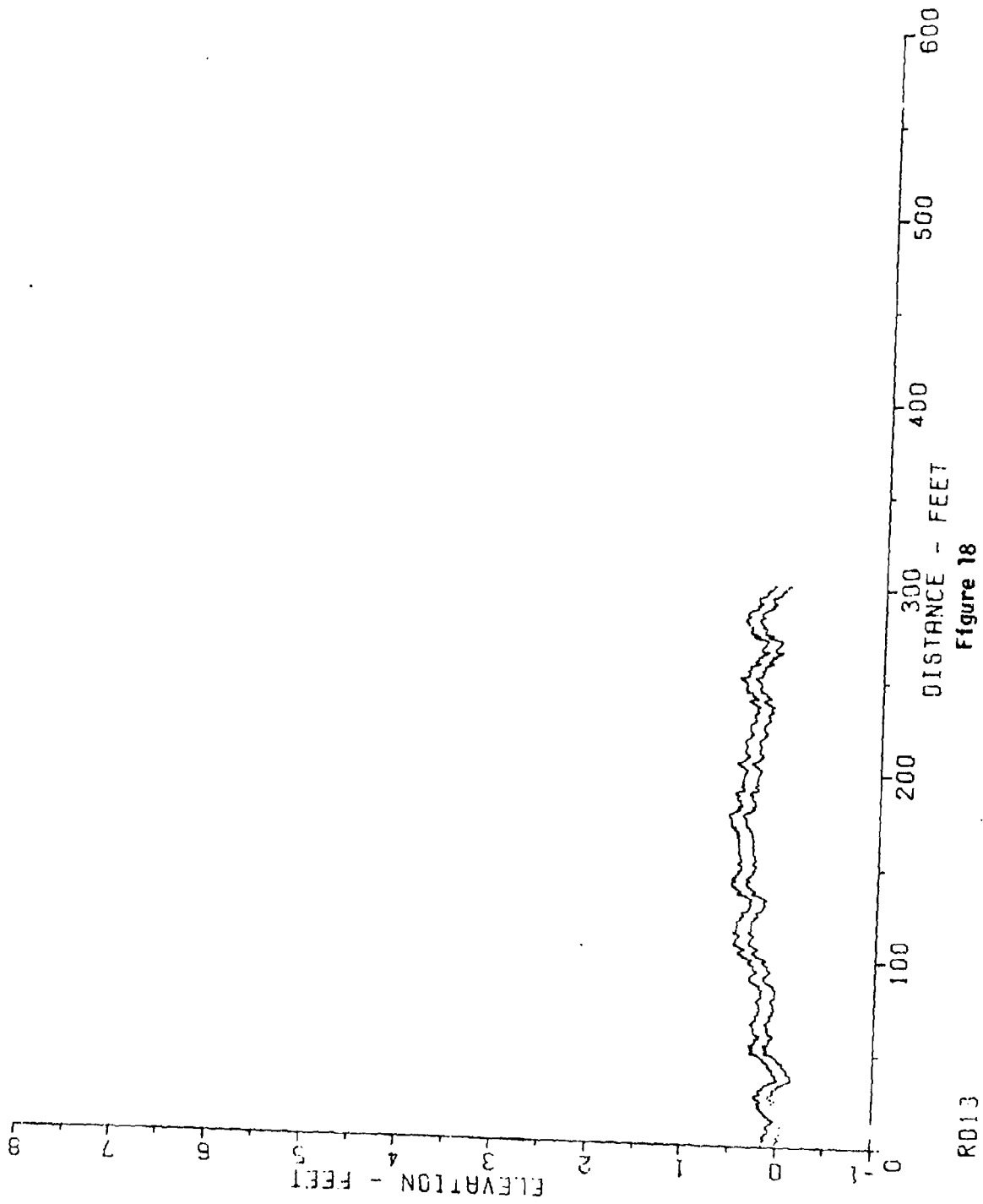


Figure 18

RD13

6/22/78

APR 15 RAIN 12 P.M. = .55

ADDED TO THE DISK ON 11.MAR.77

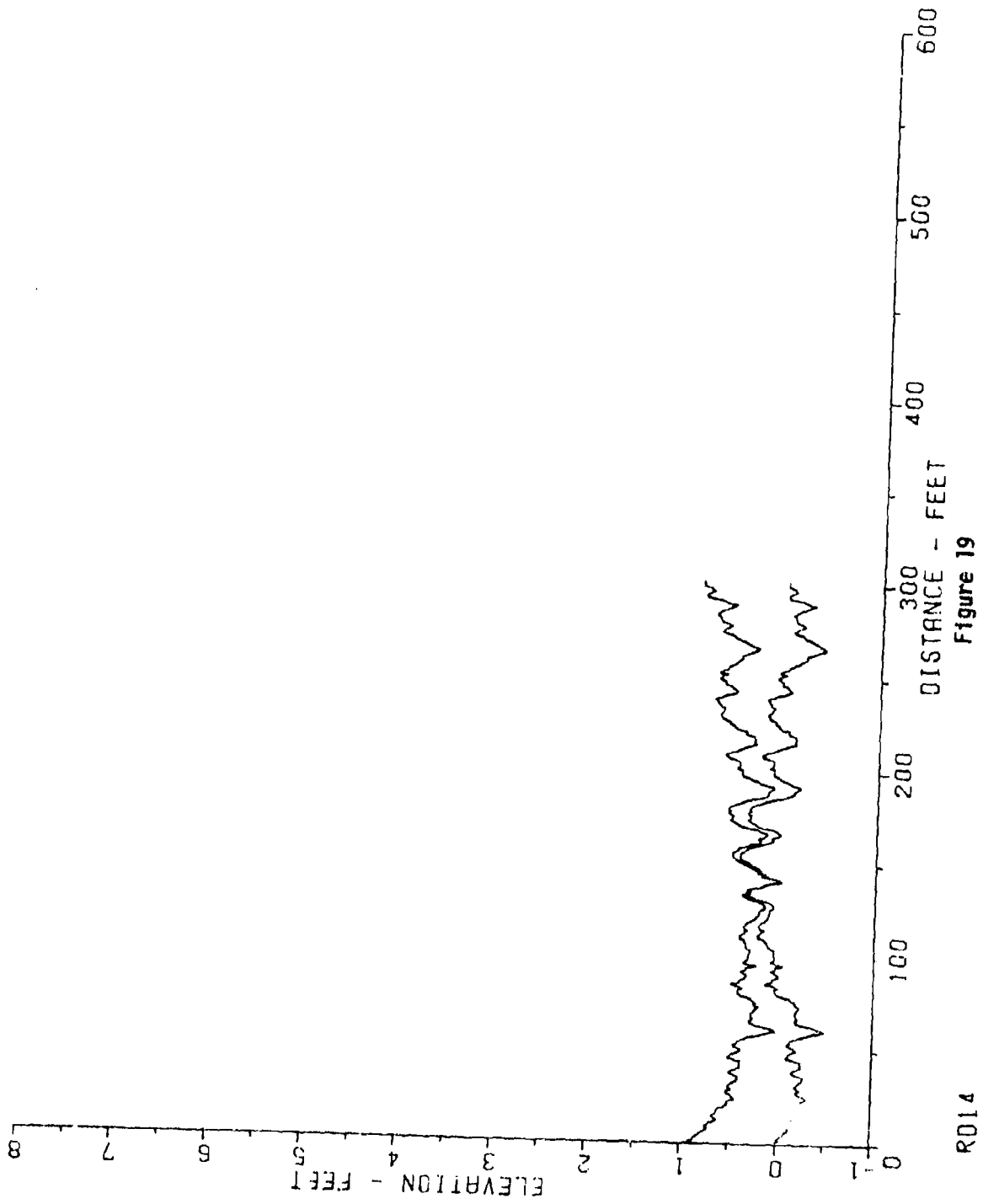
NUMBER OF POINTS = 301

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
	1	2	3	4	5	6	7	8	9	10
1	.07	.08	.02	.03	.01	.03	.04	.07	.06	.05
11	.04	.06	.10	.12	.07	.06	.03	.02	.00	.02
21	.05	.03	.06	.01	.00	.09	.09	.03	.05	.04
31	.02	.01	.02	.07	.13	.15	.12	.13	.00	.10
41	.09	.07	.05	.04	.04	.01	.01	.05	.08	.15
51	.12	.15	.12	.16	.10	.09	.10	.06	.05	.11
61	.12	.13	.11	.13	.12	.15	.10	.09	.10	.11
71	.07	.08	.06	.05	.07	.07	.09	.10	.08	.08
81	.06	.04	.04	.04	.08	.06	.10	.15	.17	.17
91	.17	.15	.12	.10	.14	.15	.13	.17	.19	.15
101	.19	.25	.27	.31	.26	.24	.29	.32	.34	.35
111	.33	.31	.29	.31	.35	.33	.32	.31	.32	.33
121	.32	.29	.29	.25	.26	.28	.21	.20	.19	.18
131	.20	.19	.17	.22	.24	.33	.29	.31	.35	.38
141	.39	.38	.35	.39	.34	.35	.31	.33	.29	.38
151	.29	.33	.30	.29	.31	.30	.32	.32	.32	.32
161	.32	.33	.33	.33	.32	.34	.32	.35	.33	.37
171	.36	.40	.47	.41	.40	.41	.43	.43	.40	.35
181	.32	.34	.30	.32	.32	.35	.35	.33	.37	.34
191	.28	.29	.32	.29	.31	.30	.29	.29	.28	.27
201	.25	.25	.30	.33	.36	.30	.29	.27	.24	.25
211	.29	.20	.27	.26	.27	.20	.29	.27	.24	.23
221	.27	.22	.24	.24	.24	.24	.20	.18	.19	.18
231	.22	.18	.15	.17	.16	.13	.20	.23	.25	.17
241	.20	.22	.23	.28	.30	.30	.28	.28	.30	.31
251	.36	.28	.27	.27	.28	.24	.26	.20	.25	.21
261	.18	.18	.13	.12	.07	.14	.13	.12	.10	.00
271	.07	.12	.22	.17	.26	.26	.24	.25	.28	.20
281	.30	.31	.30	.27	.30	.29	.27	.20	.18	.19
291	.14	.18	.17	.19	.14	.09	.10	.07	.03	.02
301	.00	-1.00	1.12	.00	.00	.00	.00	.00	.00	.00

RMS = 1.594 INCHES

TABLE 13



RD14

Figure 19

6/22/78

RD14

APG TERRAIN & RMS=1.77

ADDED TO THE DISK ON 11.MAR.77

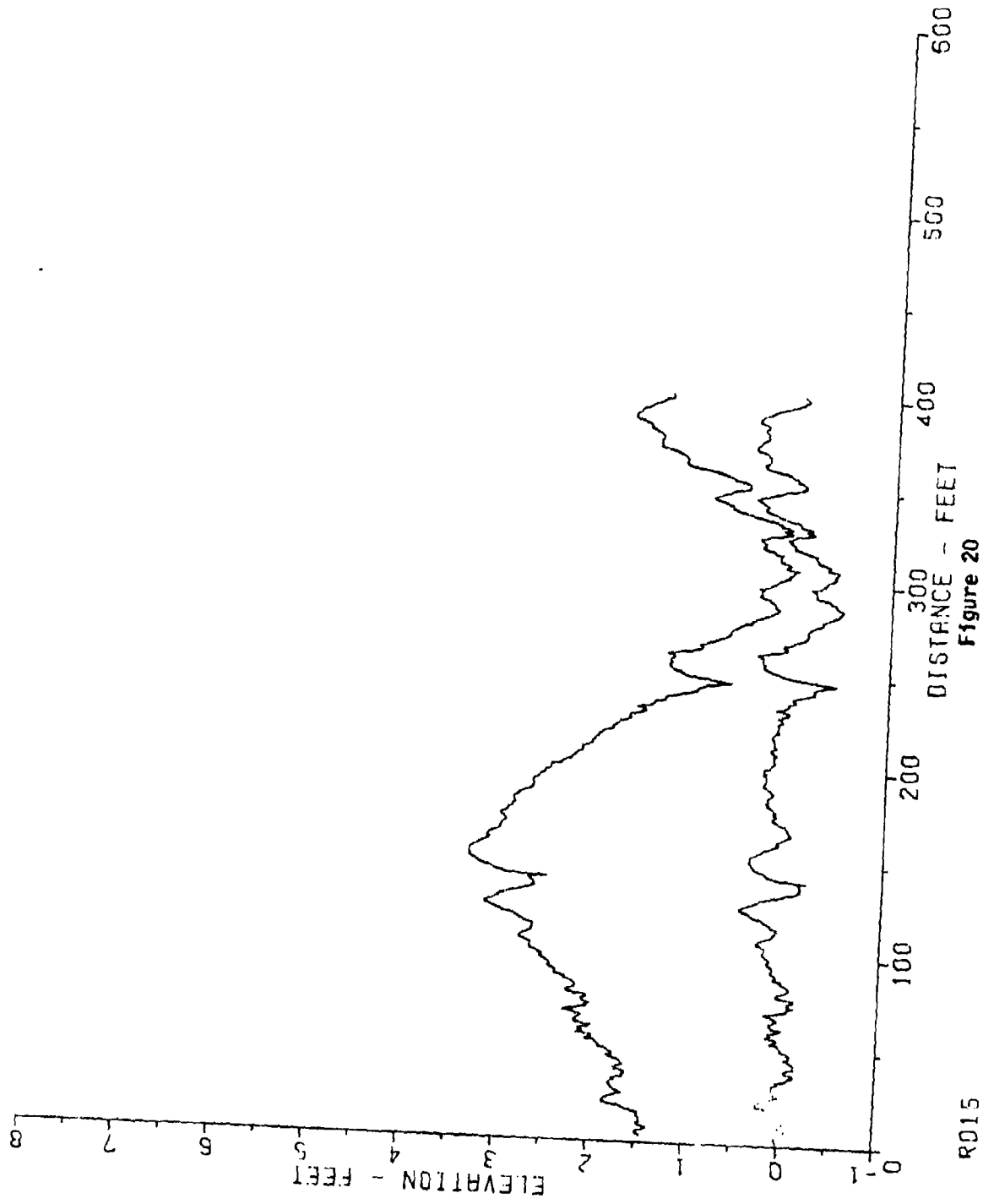
NUMBER OF POINTS * 301

INTERVAL IN INCHES * 12

POINT	ELEVATIONS IN FEET									
1	.00	-.13	-.03	-.05	-.07	-.10	-.13	-.14	-.11	-.14
11	-.15	-.18	-.20	-.16	-.14	-.17	-.18	-.18	-.18	-.24
21	-.28	-.24	-.26	-.31	-.29	-.28	-.21	-.21	-.25	-.28
31	-.20	-.22	-.24	-.27	-.27	-.26	-.22	-.18	-.18	-.21
41	-.26	-.25	-.24	-.25	-.17	-.09	-.18	-.13	-.17	-.28
51	-.16	-.12	-.11	-.14	-.13	-.17	-.22	-.27	-.36	-.44
61	-.49	-.42	-.34	-.26	-.20	-.16	-.21	-.19	-.17	-.18
71	-.19	-.20	-.22	-.22	-.17	-.19	-.14	-.11	-.07	-.01
81	.04	.05	.05	.02	.07	.15	.07	.00	.05	.01
91	.03	.07	.09	.04	.04	-.04	.07	.00	.06	.06
101	.07	.06	.06	.07	.11	.13	.14	.15	.16	.17
111	.23	.24	.22	.21	.17	.22	.24	.21	.20	.17
121	.13	.14	.12	.12	.13	.11	.09	.09	.11	.14
131	.20	.20	.32	.36	.32	.32	.31	.22	.17	.09
141	.01	.03	.11	.19	.18	.22	.22	.26	.29	.33
151	.35	.39	.44	.45	.44	.44	.40	.37	.37	.28
161	.21	.13	.10	.12	.06	.02	.03	.06	.13	.21
171	.28	.30	.34	.36	.34	.32	.37	.37	.34	.36
181	.34	.27	.24	.18	.10	.00	-.08	-.10	-.11	-.14
191	-.17	-.16	-.08	-.06	-.01	.04	.07	.11	.11	.11
201	.11	.16	.12	.12	.11	.14	.17	.22	.24	.18
211	.11	.00	.04	-.04	-.11	-.10	-.12	-.11	-.11	-.04
221	-.04	-.04	.05	.07	.09	.11	.10	.16	.17	.17
231	.18	.15	.13	.12	.16	.17	.18	.18	.20	.13
241	.07	-.00	-.06	-.04	-.01	.00	.04	.04	.06	.10
251	.06	.00	.07	.03	-.03	-.04	-.08	-.13	-.15	-.18
261	-.20	-.21	-.27	-.32	-.38	-.41	-.37	-.33	-.38	-.26
271	-.22	-.18	-.18	-.11	-.07	-.10	-.14	-.18	-.18	-.00
281	-.08	-.08	-.07	-.05	-.09	-.14	-.19	-.24	-.20	-.28
291	-.15	-.04	-.00	-.00	-.03	-.09	-.07	-.06	.00	-.08
301	.00	-1.00	1.12	.00	-.03	.00	.00	.00	.00	.00

RMS * 2.323 INCHES

TABLE 14



6/22/78

APG TERRAIN 11 RMS = 1.32 1974 ADDED TO THE DISK ON 18.APR.77

NUMBER OF POINTS = 421

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.01	.02	.01	.06	.04	-.04	-.09	-.01	-.08
11	-.05	-.05	-.06	-.04	-.06	-.07	-.08	.05	.05	-.15
21	.25	.24	.22	.17	.09	.00	.04	.00	.08	.07
31	.08	.06	.01	.03	-.08	-.10	-.14	-.13	-.05	-.05
41	-.15	-.14	-.15	-.17	-.09	-.04	-.10	-.10	-.06	-.08
51	.01	.01	.02	.03	.11	.03	.06	.17	.11	.14
61	.04	-.01	.11	.13	.13	.09	.04	.07	.11	.10
71	.10	-.04	-.06	-.11	-.05	-.05	-.11	-.11	-.01	.07
81	.04	-.03	-.06	-.06	-.04	-.01	.02	.02	.11	.05
91	.09	.11	.15	.12	.11	.14	.18	.19	.16	.14
101	.20	.23	.24	.22	.20	.23	.26	.30	.27	.23
111	.19	.13	.12	.10	.08	.09	.16	.17	.20	.24
121	.29	.34	.38	.42	.46	.49	.49	.41	.36	.32
131	.27	.19	.10	.01	-.07	-.13	-.12	-.14	-.12	-.10
141	-.19	.06	.15	.23	.24	.20	.33	.35	.38	.30
151	.41	.39	.40	.39	.37	.33	.20	.24	.20	.14
161	.10	.13	.10	.04	.00	-.03	.01	.01	.03	.04
171	.04	.09	.14	.17	.17	.14	.18	.14	.17	.17
181	.20	.24	.26	.23	.24	.24	.16	.18	.20	.22
191	.25	.27	.28	.26	.26	.20	.20	.20	.25	.00
201	.20	.21	.21	.19	.17	.18	.18	.18	.16	.16
211	.22	.21	.15	.16	.18	.19	.19	.21	.19	.15
221	.13	.16	.16	.14	.17	.13	.10	.13	.16	.00
231	.04	.07	.10	.08	.04	.06	-.01	-.00	.02	-.00
241	-.16	-.22	-.22	-.20	-.26	-.34	-.44	-.30	-.20	.01
251	.12	.16	.22	.28	.31	.33	.30	.34	.34	.20
261	.33	.40	.31	.16	.00	.10	.14	.05	.00	-.00
271	-.10	-.12	-.14	-.12	-.13	-.16	-.17	-.22	-.20	-.27
281	-.31	-.36	-.40	-.45	-.48	-.49	-.48	-.44	-.41	-.41
291	-.35	-.33	-.26	-.19	-.20	-.19	-.21	-.14	-.25	-.20
301	-.30	-.31	-.35	-.40	-.38	-.41	-.41	-.43	-.30	-.33
311	-.32	-.28	-.21	-.20	-.19	-.19	-.11	-.00	-.01	.00
321	.05	.05	.09	.13	.08	.05	-.08	-.18	-.05	-.14
331	-.08	-.00	.00	.05	.11	.18	.23	.00	.05	.34
341	.37	.34	.37	.41	.46	.47	.39	.30	.22	.10
351	.02	-.03	-.06	-.04	-.00	.05	.05	.00	.13	.17
361	.20	.33	.40	.41	.37	.34	.33	.34	.36	.37
371	.40	.47	.49	.47	.45	.44	.40	.39	.37	.36
381	.36	.40	.40	.37	.37	.40	.48	.47	.44	.40
391	.36	.31	.27	.20	.14	.06	.00	-.01	-.00	-.03
401	.00	-1.00	1.12	.00	.01	.00	.00	.00	.00	.00

RMS = 2.553 INCHES

TABLE 15

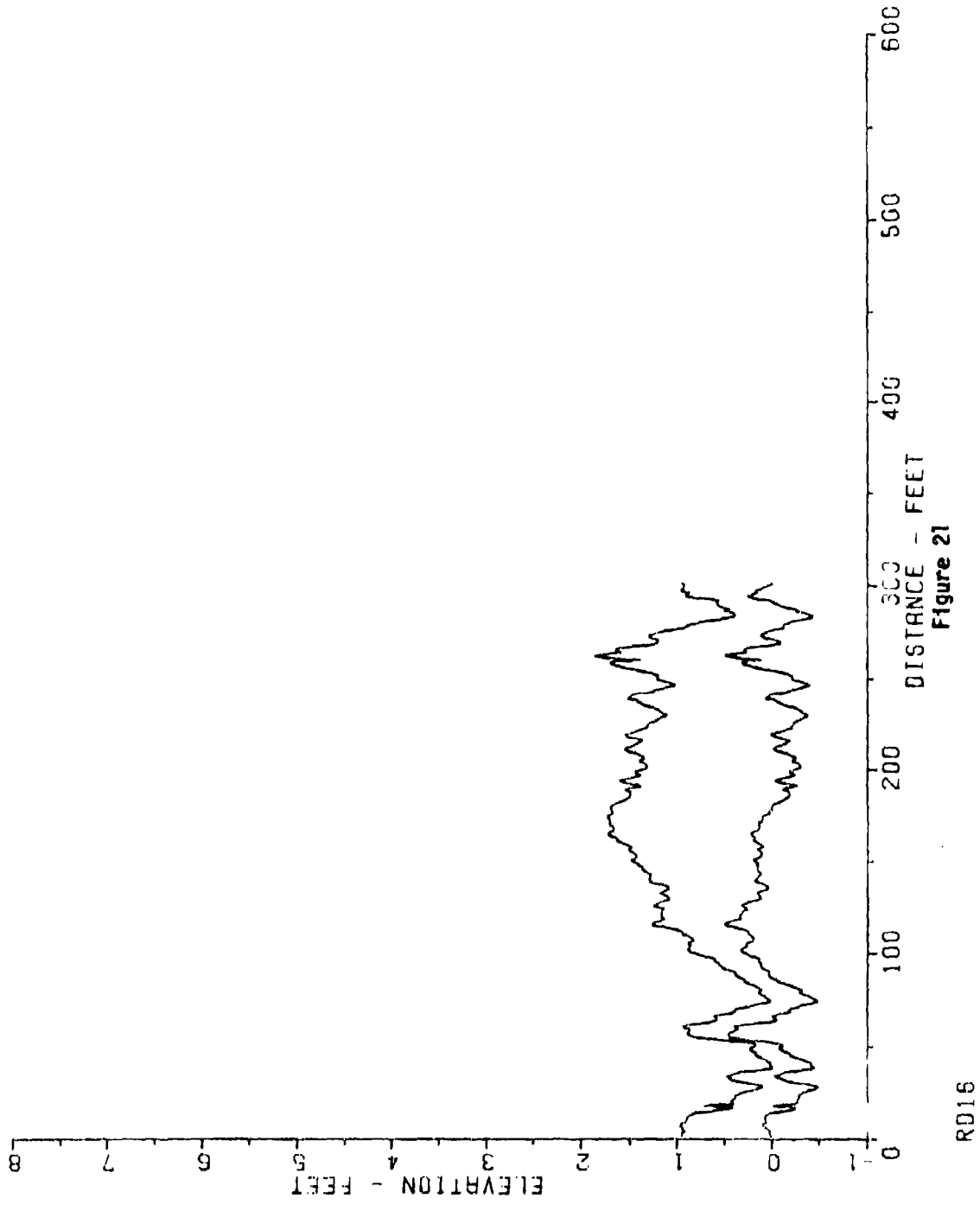


Figure 21

RD16

6/22/78

APG TERRAIN 12 WGSN1.72

ADDED TO THE DISK ON 11.MAR.77

NUMBER OF POINTS = 301

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.04	.01	.04	.01	.04	.07	.10	.09	.06	.07
11	.06	.08	.05	.01	-.10	-.23	-.24	-.01	-.23	-.27
21	-.26	-.24	-.28	-.29	-.33	-.37	-.40	-.40	-.43	-.31
31	-.18	-.11	-.06	-.03	-.11	-.15	-.31	-.44	-.44	-.41
41	-.40	-.34	-.31	-.24	-.10	-.19	-.14	-.09	-.08	-.12
51	-.09	.03	.21	.35	.44	.47	.45	.40	.36	.30
61	.35	.18	.02	-.05	-.03	.00	-.07	-.16	-.19	-.10
71	-.27	-.33	-.43	-.48	-.47	-.41	-.38	-.32	-.29	-.31
81	-.27	-.23	-.18	-.12	-.06	-.05	.00	.04	.03	.03
91	.05	.11	.12	.14	.11	.15	.12	.17	.24	.20
101	.32	.34	.30	.27	.28	.27	.20	.19	.21	.23
111	.25	.25	.30	.36	.44	.50	.48	.39	.34	.34
121	.33	.31	.29	.26	.28	.33	.30	.24	.14	.12
131	.13	.15	.16	.09	.05	.03	.07	.11	.19	.17
141	.16	.13	.12	.13	.16	.15	.14	.17	.15	.18
151	.20	.14	.11	.10	.13	.15	.13	.08	.11	.15
161	.20	.18	.19	.21	.23	.19	.15	.13	.13	.14
171	.13	.10	.10	.09	.09	.03	.01	.00	.00	.00
181	-.02	-.08	-.10	-.15	-.18	-.18	-.18	-.17	-.11	-.16
191	-.26	-.24	-.26	-.03	-.11	-.19	-.24	-.19	-.19	-.20
201	-.30	-.34	-.27	-.21	-.20	-.26	-.23	-.19	-.14	-.07
211	-.02	-.03	-.09	-.15	-.15	-.18	-.10	-.02	-.00	-.06
221	-.12	-.17	-.21	-.22	-.22	-.25	-.30	-.33	-.37	-.38
231	-.33	-.29	-.25	-.23	-.14	-.09	-.05	-.02	.06	.04
241	.01	-.15	-.20	-.27	-.33	-.40	-.37	-.28	-.21	-.21
251	-.01	.15	.11	.01	.09	.21	.20	.31	.38	.11
261	.37	.50	.46	.28	.30	.28	.18	.02	-.10	-.02
271	-.01	.08	.11	.09	.04	-.04	-.12	-.13	-.13	-.20
281	-.29	-.36	-.44	-.43	-.36	-.25	-.26	-.10	-.00	.02
291	-.08	.03	.19	.26	.21	.15	.18	.12	.07	.01
301	.20	-1.00	1.12	.00	.01	-.02	-.02	-.06	-.00	-.03

RMS = 2.716 INCHES

TABLE 16

HOUGHTON DATA SEPT 75

ADDED TO THE DISK ON 23 MAR 77

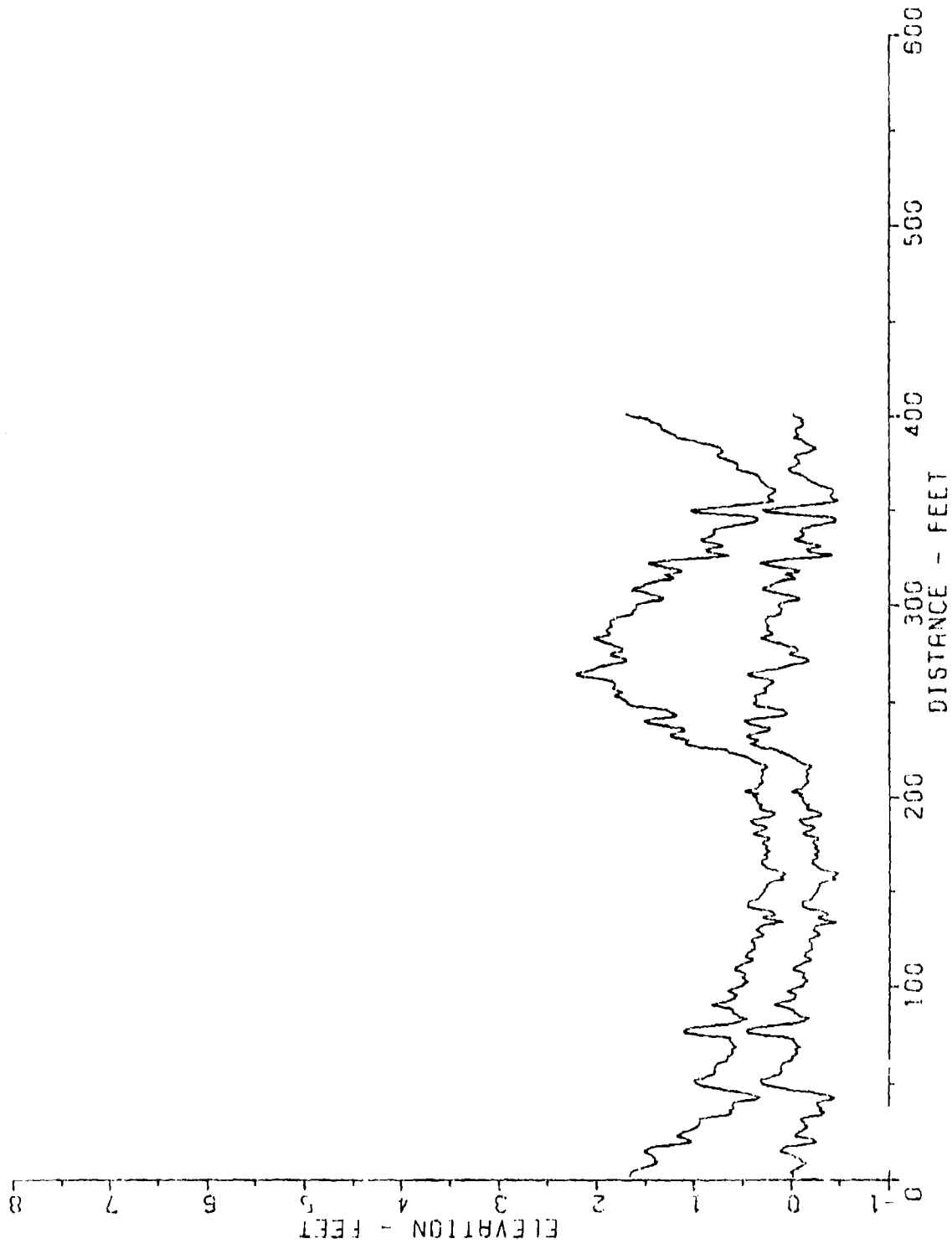
NUMBER OF POINTS = 401

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.01	.12	.20	.23	.20	.14	.08	.07	.04	.00
11	-.09	-.14	-.13	-.14	-.21	-.29	-.38	-.47	-.48	-.48
21	-.34	-.22	-.17	-.15	-.14	-.13	-.14	-.17	-.19	-.17
31	-.14	-.17	-.21	-.25	-.31	-.42	-.48	-.34	-.21	-.18
41	-.20	-.22	-.14	-.29	-.22	.03	.05	.04	-.01	-.04
51	-.06	-.07	-.08	-.09	-.05	-.00	.01	.03	-.02	.01
61	.03	.01	.01	-.01	.01	.08	.08	.08	.13	.14
71	.14	.09	.06	.10	.15	.20	.23	.23	.11	-.02
81	-.08	.04	.13	.19	.27	.27	.25	.23	.16	-.03
91	.01	.02	-.06	-.14	.02	.14	.11	.01	-.15	-.24
101	-.12	.01	.14	.17	.18	.18	.21	.18	.08	-.05
111	-.17	-.14	.11	.26	.36	.43	.36	.20	.03	-.07
121	.01	.22	.38	.37	.23	.06	-.00	.06	.03	-.61
131	.04	.08	.15	.12	.13	.10	.16	.17	.21	.05
141	.28	.24	.17	.19	.16	.11	.12	.11	.06	.04
151	.07	.05	.01	.09	.04	-.01	-.15	-.22	.03	-.08
161	.32	.41	.35	.21	.03	.00	.02	.08	-.06	-.13
171	-.22	-.25	-.29	-.34	-.44	-.49	-.41	-.29	-.20	-.11
181	-.11	-.14	-.24	-.31	-.28	-.26	-.25	-.22	-.08	-.07
191	-.13	-.21	-.24	-.29	-.14	-.02	.02	.08	.08	.05
201	.08	.10	.09	.08	.02	.00	.03	.07	.06	.09
211	.05	-.01	-.01	-.04	-.09	-.14	-.18	-.19	-.15	-.14
221	-.19	-.19	-.12	.02	.12	.16	.19	.18	.18	.01
231	.17	.44	.17	.07	.14	.16	.14	.14	.10	.25
241	.28	.24	.26	.22	.25	.32	.40	.39	.38	.38
251	.23	.19	.12	.17	.20	.38	.36	.48	.49	.43
261	.35	.34	.34	.25	.17	.19	.23	.24	.17	.18
271	.08	.08	.01	.00	.01	.06	.10	.09	.02	.09
281	.01	.06	-.06	-.24	-.30	-.18	-.02	.22	.41	.48
291	.48	.45	.35	.15	-.10	-.27	-.31	-.22	-.15	-.09
301	.00	.14	.26	.35	.38	.29	.27	.13	.09	.11
311	.12	-.05	-.18	-.07	.01	.02	.08	.14	.11	.00
321	-.18	-.31	-.21	-.09	.02	.05	.11	.11	-.00	-.18
331	-.07	-.02	-.10	-.07	.03	.10	.15	.16	.07	-.08
341	-.07	.04	.01	-.03	-.01	.07	.18	.28	.27	.14
351	-.09	-.32	-.45	-.37	-.25	-.18	-.17	-.19	-.18	-.10
361	-.05	-.23	.00	.00	.02	-.04	-.14	-.21	-.14	-.00
371	-.07	-.10	-.16	-.25	-.37	-.43	-.37	-.38	-.21	-.16
381	-.12	-.14	-.20	-.22	-.22	-.12	-.09	-.16	-.16	-.13
391	-.08	-.02	-.05	-.07	-.07	-.10	-.09	-.07	-.18	-.03
401	.00	-1.00	1.12	.00	.12	.00	.00	.00	.00	.00

RMS = 2.341 INCHES

TABLE 17



RD19
Figure 23

6/22/78

HOUGHTON DATA4 SEPT 75

ADDED TO THE DISK ON 23.MAR.77

NUMBER OF POINTS = 401

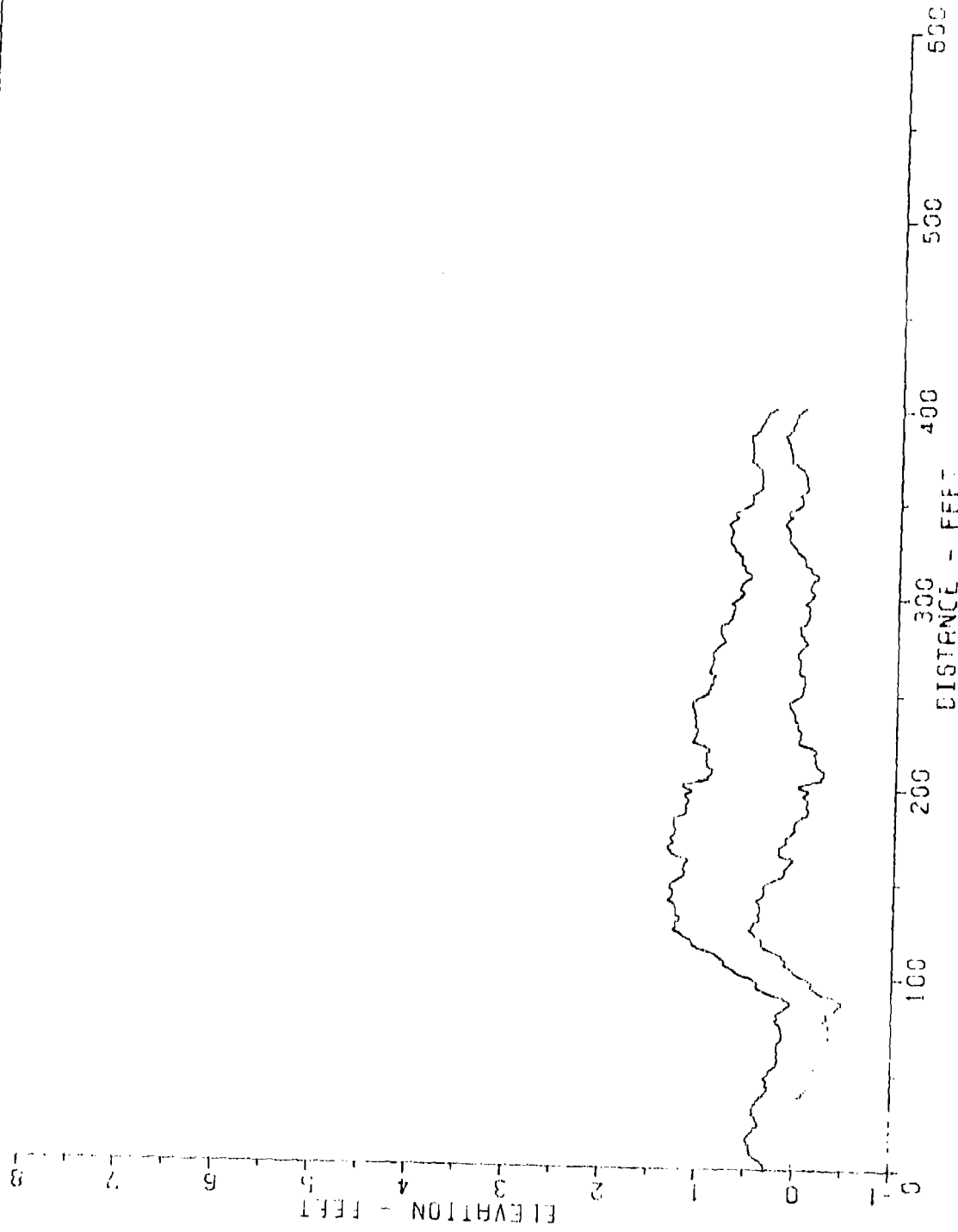
INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.03	.01	.01	.02	.06	.10	.14	.15	.18
11	.08	.04	.01	.08	.12	.09	.08	.04	.18	.06
21	.20	.11	.04	.05	.08	.12	.16	.16	.13	.13
31	.10	.09	.20	.31	.34	.29	.31	.28	.27	.25
41	.32	.02	.45	.35	.25	.11	.01	.12	.25	.31
51	.32	.34	.23	.18	.12	.10	.12	.12	.16	.08
61	.07	.00	.01	.01	.04	.08	.05	.03	.09	.04
71	.05	.21	.03	.04	.27	.41	.46	.48	.39	.21
81	.01	.08	.15	.17	.08	.07	.02	.02	.02	.18
91	.19	.14	.03	.03	.03	.06	.08	.04	.01	.07
101	.12	.12	.16	.13	.10	.17	.13	.08	.02	.01
111	.05	.11	.14	.20	.19	.12	.13	.13	.18	.22
121	.19	.20	.20	.17	.17	.24	.29	.28	.23	.21
131	.24	.26	.31	.46	.40	.26	.28	.36	.37	.31
141	.18	.10	.11	.19	.11	.18	.21	.22	.24	.27
151	.26	.27	.29	.28	.31	.39	.46	.42	.44	.48
161	.43	.33	.26	.24	.21	.22	.21	.27	.26	.22
171	.28	.29	.24	.26	.24	.21	.23	.27	.27	.18
181	.11	.14	.20	.25	.21	.13	.08	.07	.16	.26
191	.31	.31	.21	.16	.15	.18	.13	.11	.11	.11
201	.07	.11	.00	.05	.11	.13	.14	.17	.16	.15
211	.15	.17	.15	.15	.18	.20	.18	.18	.04	.02
221	.00	.02	.06	.11	.15	.32	.37	.43	.39	.33
231	.41	.48	.42	.34	.22	.21	.31	.38	.46	.49
241	.40	.22	.07	.04	.07	.10	.21	.36	.39	.36
251	.36	.37	.40	.34	.26	.27	.29	.24	.21	.19
261	.18	.25	.36	.46	.42	.29	.16	.16	.01	.12
271	.19	.16	.07	.02	.01	.06	.06	.02	.06	.11
281	.18	.25	.32	.25	.19	.21	.25	.24	.22	.28
291	.27	.27	.25	.24	.15	.11	.12	.10	.12	.14
301	.11	.03	.00	.08	.00	.10	.17	.20	.20	.21
311	.20	.14	.08	.04	.00	.07	.03	.09	.02	.13
321	.25	.32	.23	.05	.19	.41	.34	.21	.16	.19
331	.30	.27	.15	.06	.02	.10	.13	.12	.09	.11
341	.16	.24	.34	.44	.46	.44	.26	.02	.24	.38
351	.18	.00	.20	.39	.48	.43	.39	.39	.41	.43
361	.41	.35	.29	.25	.21	.18	.16	.13	.07	.08
371	.03	.04	.01	.06	.08	.08	.05	.02	.05	.12
381	.20	.21	.26	.22	.16	.14	.11	.02	.04	.08
391	.05	.04	.05	.08	.12	.12	.09	.13	.18	.02
401	.00	-1.00	1.12	.00	.03	.00	.00	.00	.00	.00

RMS = 2.570

INCHES

TABLE 18



RD19

Figure 24

5/22/79

HUGHTON DATAS SEPT 75

ADDED TO THE DISK ON 23.MAR.77

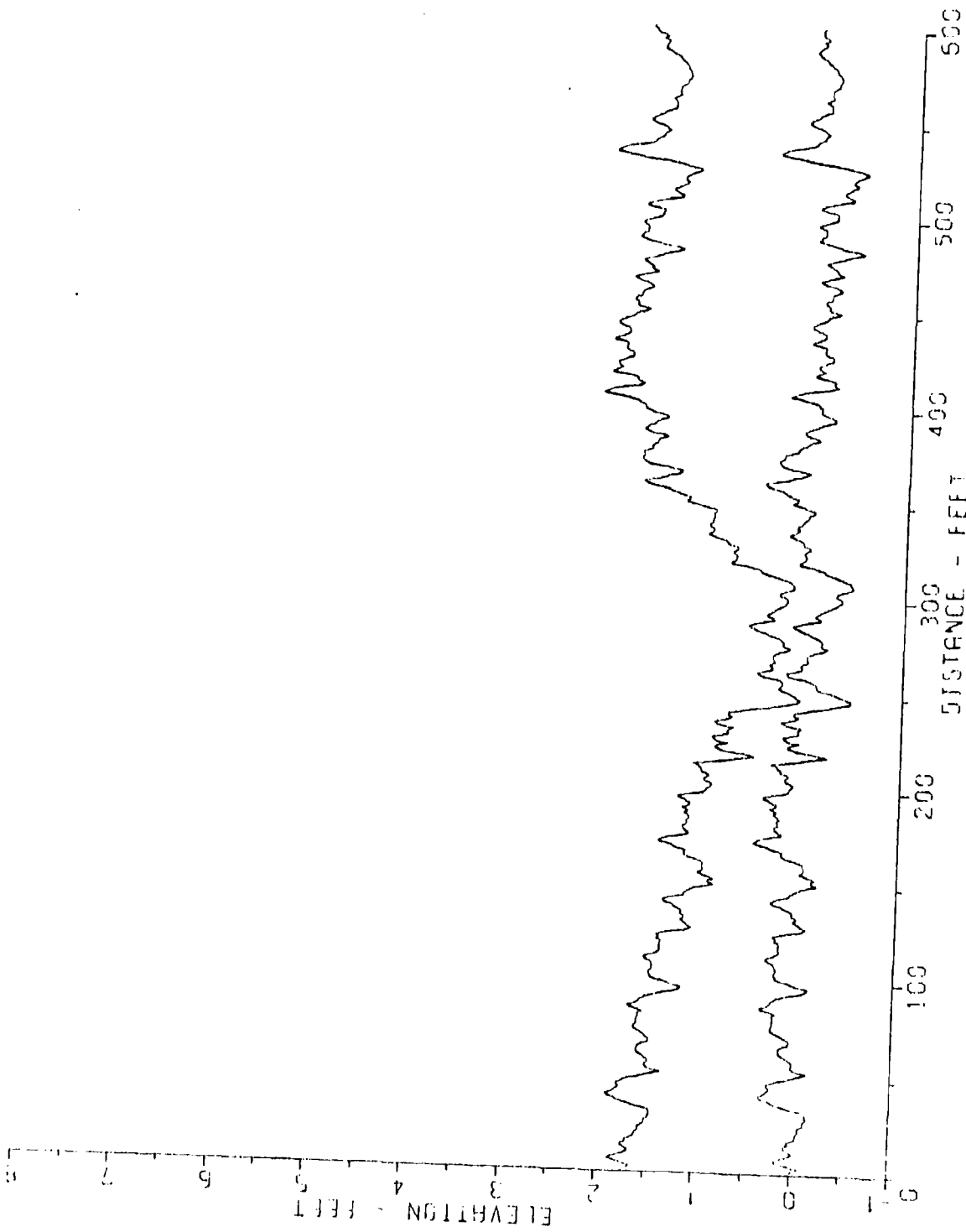
NUMBER OF POINTS = 401

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.02	.01	.01	.03	.05	.00	.10	.13	.13	.14
11	.13	.14	.13	.15	.16	.15	.13	.12	.12	.08
21	.06	.06	.02	.01	.02	.03	.03	.04	.07	.05
31	.06	.05	.03	.03	.00	.00	.03	.04	.08	.10
41	.12	.14	.13	.11	.13	.14	.13	.11	.14	.17
51	.18	.20	.22	.25	.27	.27	.30	.28	.28	.29
61	.30	.29	.28	.29	.30	.30	.33	.35	.36	.35
71	.36	.35	.35	.35	.35	.34	.32	.30	.34	.33
81	.33	.35	.37	.41	.44	.47	.49	.47	.43	.42
91	.34	.29	.23	.26	.16	.15	.17	.17	.13	.09
101	.04	.03	.02	.04	.08	.10	.13	.10	.11	.13
111	.14	.16	.19	.24	.29	.33	.35	.36	.36	.38
121	.39	.42	.44	.47	.50	.46	.47	.44	.44	.48
131	.38	.38	.41	.39	.38	.37	.39	.38	.39	.41
141	.42	.38	.36	.34	.35	.33	.35	.34	.33	.31
151	.27	.22	.17	.14	.12	.13	.14	.11	.10	.08
161	.05	.05	.07	.15	.19	.19	.18	.19	.20	.16
171	.12	.12	.13	.11	.09	.07	.05	.03	.04	.04
181	.14	.03	.02	.06	.04	.00	.11	.10	.11	.08
191	.09	.09	.11	.09	.07	.05	.00	.10	.11	.04
201	.01	.00	.09	.19	.24	.23	.25	.26	.27	.26
211	.22	.19	.18	.18	.18	.17	.17	.15	.15	.19
221	.17	.11	.08	.08	.01	.00	.01	.01	.01	.02
231	.01	.02	.02	.02	.02	.05	.05	.06	.06	.08
241	.08	.09	.11	.09	.12	.08	.07	.03	.00	.02
251	.01	.03	.03	.03	.05	.05	.04	.04	.06	.03
261	.02	.02	.01	.01	.00	.00	.01	.01	.02	.03
271	.04	.01	.01	.01	.03	.06	.07	.05	.03	.02
281	.00	.00	.01	.01	.02	.01	.05	.06	.07	.08
291	.08	.09	.07	.09	.08	.08	.03	.06	.08	.12
301	.10	.14	.12	.08	.09	.09	.10	.11	.13	.16
311	.16	.15	.09	.09	.08	.08	.03	.03	.02	.02
321	.02	.00	.03	.06	.07	.09	.10	.13	.13	.15
331	.15	.14	.13	.15	.14	.16	.18	.19	.18	.16
341	.14	.11	.15	.16	.14	.13	.07	.05	.02	.02
351	.01	.03	.03	.05	.01	.01	.04	.06	.04	.03
361	.03	.02	.02	.02	.01	.00	.00	.01	.04	.07
371	.09	.14	.13	.14	.14	.15	.14	.15	.15	.16
381	.16	.16	.19	.19	.20	.21	.17	.16	.14	.13
391	.12	.12	.10	.10	.09	.09	.08	.08	.05	.04
401	.00	-1.00	1.12	.00	.01	.00	.00	.00	.00	.00

RMS = 2.242 INCHES

TABLE 19



RD21

Figure 25

6/23/79

TABLE 20
R021

HOUGHTON DATA6 SEPT 75

ADDED TO THE DISK ON 20, APR, 77

NUMBER OF POINTS = 600

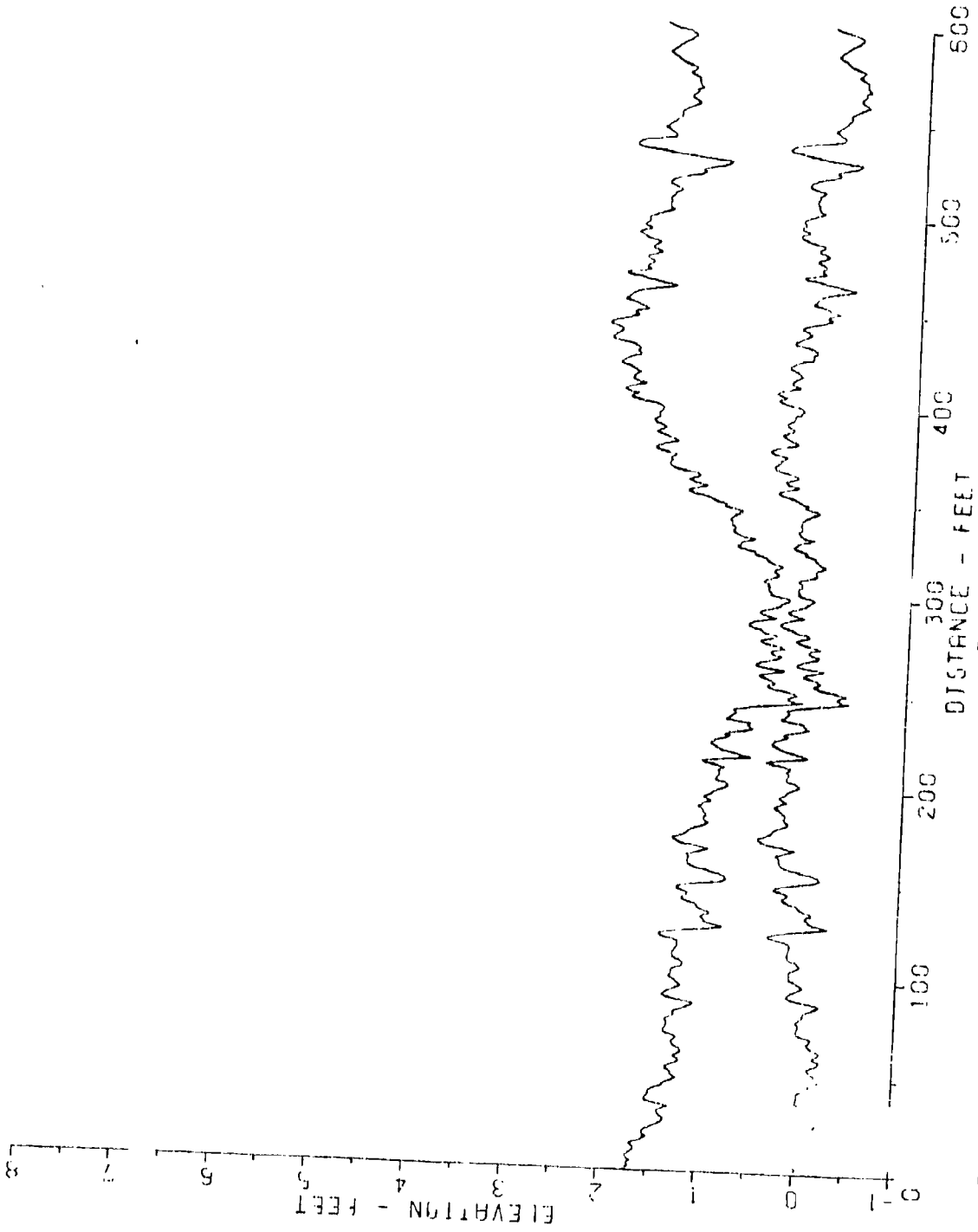
INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	-.03	-.08	-.02	.03	.10	.16	.13	.05	-.00
11	-.02	-.01	.03	.06	.08	.02	.04	-.01	-.05	-.06
21	-.05	-.07	-.08	-.07	-.10	-.12	-.12	-.14	-.16	-.18
31	-.15	-.13	-.14	-.06	.05	.12	.19	.24	.26	.33
41	.35	.30	.27	.24	.24	.26	.26	.21	.17	.08
51	.01	-.10	-.14	-.04	-.00	.02	.01	.00	.02	.05
61	.08	.12	.14	.16	.15	.15	.11	.06	.04	.05
71	.00	.12	.16	.20	.25	.24	.23	.22	.22	.22
81	.22	.23	.23	.19	.26	.35	.37	.20	.25	.25
91	.21	.20	.12	.03	-.07	-.12	-.13	-.03	.03	.10
101	.16	.20	.21	.23	.21	.20	.20	.23	.23	.25
111	.29	.32	.30	.23	.19	.18	.19	.19	.20	.10
121	.20	.24	.21	.25	.21	.09	-.04	-.08	-.03	-.01
131	.02	.05	.02	.02	.06	.07	.07	.11	.16	.19
141	.26	.29	.25	.19	.09	.08	.06	.03	-.01	-.09
151	-.18	-.12	-.12	-.17	-.11	-.04	.00	-.04	-.05	-.03
161	-.03	-.03	.01	.07	.14	.19	.19	.18	.21	.30
171	.34	.41	.48	.45	.42	.30	.19	.20	.25	.27
181	.28	.23	.23	.25	.22	.24	.26	.29	.25	.38
191	.33	.26	.25	.30	.34	.40	.40	.09	.17	.13
201	.13	.11	.09	.12	.17	.18	.18	.14	.16	.23
211	.22	.26	.27	.33	.21	.05	-.09	-.20	-.16	-.03
221	.06	.13	.17	.14	.24	.14	.19	.21	.14	.05
231	.06	.06	.01	.12	.20	.23	.16	.08	.06	.11
241	.10	.01	-.10	-.22	-.30	-.40	-.47	-.47	-.41	-.37
251	-.31	-.24	-.17	-.12	-.11	-.11	-.08	-.04	.01	.11
261	.18	.20	.14	.04	.03	.05	.02	-.02	.01	-.01
271	-.01	-.05	-.10	-.18	-.22	-.15	-.15	-.17	-.16	-.14
281	-.09	-.04	-.01	.03	.09	.13	.15	.07	-.04	-.14
291	-.13	-.08	-.10	-.15	-.18	-.22	-.27	-.31	-.33	-.36
301	-.35	-.32	-.28	-.29	-.35	-.42	-.46	-.46	-.44	-.43
311	-.39	-.33	-.27	-.21	-.17	-.15	-.10	-.08	.10	.10
321	.06	.04	.03	.05	.06	.02	-.01	.08	.06	.07
331	.07	.11	.17	.21	.18	.13	.11	.14	.13	.08
341	.06	.05	.02	.01	.00	-.05	-.05	.02	.07	.15
351	.19	.13	.13	.18	.22	.26	.29	.35	.40	.46
361	.48	.36	.23	.19	.09	.02	.02	.13	.24	.31
371	.33	.34	.34	.29	.26	.28	.20	.16	.15	.10
381	.06	.04	.01	-.08	-.06	.04	.07	.00	.05	.01
391	-.06	-.09	-.15	-.23	-.23	-.18	-.14	-.10	-.08	-.09
401	-.09	-.06	-.04	.02	.09	.17	.24	.18	.10	.02
411	-.17	-.25	-.20	-.20	-.23	-.16	-.06	.00	-.05	-.11
421	-.07	-.05	-.04	-.10	-.13	-.18	-.19	-.17	-.11	-.09
431	-.10	-.11	-.09	-.04	.05	.02	-.05	-.10	-.10	-.18
441	-.07	-.01	.03	.04	.02	-.03	-.09	-.11	-.13	-.21
451	-.25	-.13	-.11	-.13	.11	-.00	-.09	-.14	-.14	-.15
461	-.17	-.23	-.24	-.22	-.17	-.09	-.05	-.02	-.09	-.10
471	-.26	-.24	-.16	-.20	-.14	-.11	-.08	-.12	-.19	-.27
481	-.34	-.42	-.47	-.38	-.25	-.20	-.13	-.06	.00	-.01
491	-.02	-.06	-.06	.06	-.06	-.02	.01	-.02	-.09	-.17
501	-.18	-.16	-.19	-.16	-.07	-.00	-.01	-.07	-.15	-.26

TABLE 20 (Cont'd)

511	-.34	-.34	-.27	-.24	-.24	-.29	-.32	-.36	-.37	-.33
521	-.34	-.37	-.40	-.46	-.48	-.48	-.35	-.27	-.14	-.03
531	.12	.23	.34	.42	.43	.38	.29	.17	.07	.06
541	.04	-.01	-.02	-.04	-.06	-.03	-.01	.03	.08	.12
551	.15	.12	.08	.03	.02	-.03	-.06	-.07	-.07	-.07
561	-.05	-.02	-.07	-.10	-.05	-.05	-.06	-.07	-.11	-.14
571	-.14	-.16	-.17	-.18	-.16	-.15	-.13	-.12	-.10	-.08
581	-.06	-.03	-.02	.00	.03	.05	.07	.09	.06	.03
591	.00	-.01	.03	-.03	-.01	.02	.03	.03	.04	.00

RMS = 2.254 INCHES



R022

Figure 26

9/23/78

TABLE 21

RD22

HEIGHTON DATA7 SEPT 75

ADDED TO THE DISK ON 23.MAR.77

NUMBER OF POINTS ■ 500

INTERVAL IN INCHES ■ 12

POINT	ELEVATIONS IN FEET									
1	.00	-.04	-.03	-.02	-.05	-.00	.02	.02	-.01	-.03
11	-.05	-.05	-.02	.01	-.02	-.08	-.11	-.14	-.10	-.09
21	-.09	-.11	-.14	-.19	-.22	-.25	-.26	-.25	-.21	-.19
31	-.17	-.17	-.22	-.26	-.16	-.07	-.01	-.01	-.02	-.03
41	-.02	-.02	-.05	-.11	-.14	-.16	-.17	-.24	-.27	-.24
51	-.19	-.18	-.16	-.13	-.12	-.15	-.23	-.24	-.23	-.18
61	-.18	-.23	-.24	-.22	-.18	-.14	-.12	-.11	-.14	-.15
71	-.13	-.03	.01	.01	-.01	-.02	-.01	-.08	-.02	-.01
81	-.05	-.06	-.04	-.06	-.12	-.16	-.22	-.21	-.11	-.01
91	.10	.13	.11	.08	.03	-.02	-.05	-.02	-.02	-.06
101	.10	.11	.09	.11	.09	.07	.00	-.01	.01	-.04
111	.00	.13	.14	.14	.12	.13	.11	.11	.11	.13
121	.17	.25	.33	.32	.23	.09	-.10	-.26	-.20	-.12
131	-.08	-.07	-.04	-.07	-.12	-.09	-.01	.02	.04	.07
141	.13	.19	.21	.17	.16	-.16	.23	.29	.28	.21
151	.06	-.12	-.19	-.17	-.16	-.09	.08	.07	.18	.21
161	.25	.25	.26	.25	.20	.20	.22	.15	.06	.16
171	.27	.37	.44	.47	.48	.40	.35	.33	.32	.29
181	.21	.17	.17	.21	.22	.20	.21	.24	.25	.28
191	.31	.28	.28	.19	.24	.26	.24	.20	.19	.16
201	.09	.06	.08	.12	.20	.21	.19	.16	.16	.21
211	.16	.16	.25	.36	.41	.24	-.02	-.08	.10	.10
221	.24	.30	.32	.37	.33	.35	.24	.19	.25	.10
231	.07	-.02	.01	.05	.04	.19	.28	.25	.22	.20
241	.21	.23	.12	-.01	-.19	-.41	-.34	-.29	-.32	-.38
251	-.31	-.22	-.12	-.06	-.04	-.11	-.07	-.05	.01	.07
261	.02	-.12	-.15	.01	.14	.14	.08	.02	-.07	-.09
271	-.02	.02	-.00	-.10	-.04	.05	.11	.16	.13	.02
281	.03	.12	.16	.20	.29	.33	.33	.27	.16	.07
291	.15	.23	.26	.21	.14	.07	.05	.02	-.02	.01
301	.10	.16	.13	.15	.15	.11	.13	.11	.15	.11
311	.03	-.03	-.03	-.02	-.04	-.11	-.12	-.06	-.04	-.01
321	-.01	.02	.09	.07	.14	.20	.22	.17	.16	.06
331	.00	.10	.15	.17	.16	.14	.14	.15	.14	.14
341	.14	.09	.06	.01	-.04	-.03	.07	.11	.08	.15
351	.19	.22	.29	.36	.41	.38	.30	.18	.21	.30
361	.33	.26	.20	.21	.23	.33	.40	.44	.45	.42
371	.38	.39	.36	.31	.37	.45	.49	.47	.42	.31
381	.21	.23	.28	.31	.36	.38	.31	.26	.27	.38
391	.33	.34	.29	.26	.25	.24	.19	.16	.16	.18
401	.23	.30	.38	.43	.49	.34	.41	.46	.41	.33
411	.21	.25	.30	.29	.26	.23	.18	.22	.24	.27
421	.31	.34	.30	.24	.17	.09	.08	.10	.05	.05
431	.07	.10	.20	.28	.28	.23	.19	.16	.10	.13
441	.17	.22	.19	.09	.01	-.06	-.10	-.05	-.16	-.17
451	-.13	-.05	-.02	.05	.11	.08	.08	.05	.02	-.06
461	-.17	-.32	-.34	-.19	-.10	-.01	.07	.18	.22	.07
471	-.01	.03	.02	-.00	-.01	.05	.05	.06	.01	-.04
481	.01	.05	.07	.04	.01	.05	.13	.16	.23	.27
491	.25	.18	.18	.26	.25	.21	.22	.24	.23	.17
501	.12	.05	.02	.08	.08	.09	.08	.11	.11	.08
511	.08	.09	.04	.02	.10	.14	.19	.16	.17	.11

TABLE 21 (Cont'd)

521	.04	-.07	-.13	-.09	-.11	-.20	-.29	-.34	-.34	-.17
531	.01	.12	.21	.31	.39	.49	.36	.29	.20	.03
541	-.14	-.16	-.15	-.10	-.06	-.05	-.09	.12	.14	.16
551	-.18	-.21	-.21	-.28	-.22	-.27	-.30	.35	.39	.37
561	-.33	-.38	-.31	-.34	-.36	-.34	-.40	.35	.37	.38
571	-.35	-.36	-.32	-.29	-.27	-.31	-.33	.31	.31	.31
581	-.17	-.14	-.13	-.08	-.05	-.06	-.10	.15	.15	.15
591	-.21	-.26	-.27	-.30	-.20	-.26	-.22	.13	.10	.10

RMS = 2.344 INCHES

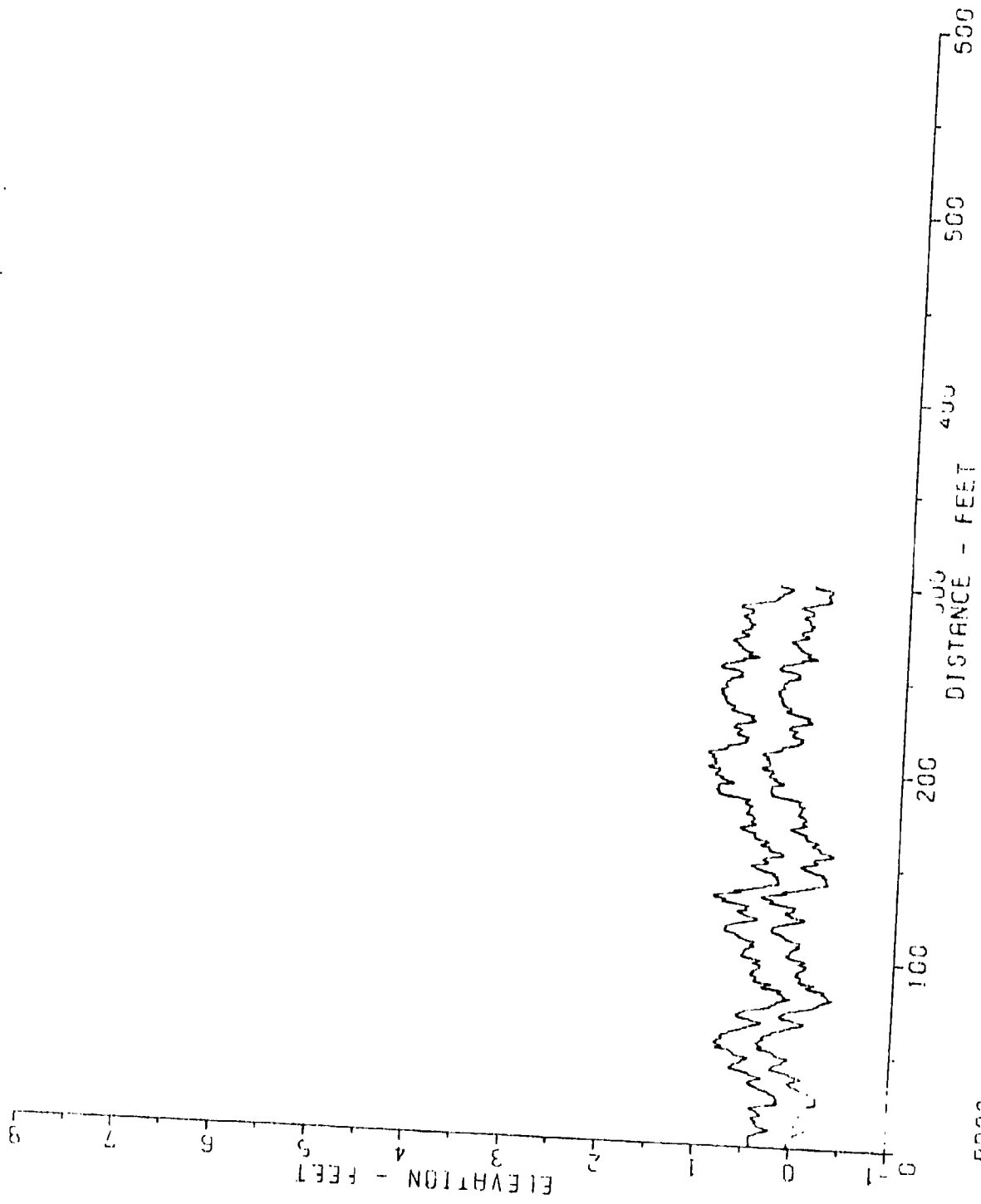


Figure 27

5/23/78

TABLE 22
FD23

TARAPICUM WOOD COURSE

ADDED TO THE DISK ON 23.MAR.77

NUMBER OF POINTS ■ 544

INTERVAL IN INCHES ■ .0

POINT	ELEVATIONS IN FEET									
1	.00	.03	.01	.02	.03	.03	.02	.03	.02	.03
11	.03	.01	.04	.05	.05	.10	.13	.16	.18	.15
21	.10	.07	.05	.04	.03	.04	.05	.05	.03	.01
31	.00	.02	.06	.10	.10	.08	.05	.05	.05	.01
41	.01	.02	.02	.05	.14	.21	.26	.24	.27	.25
51	.27	.26	.25	.25	.24	.24	.26	.17	.16	.15
61	.12	.08	.07	.06	.04	.01	.01	.02	.04	.01
71	.00	.03	.09	.11	.08	.03	.08	.03	.03	.05
81	.11	.16	.20	.24	.22	.21	.19	.19	.15	.15
91	.11	.10	.10	.08	.04	.05	.13	.19	.19	.26
101	.21	.22	.23	.20	.36	.38	.33	.32	.35	.37
111	.37	.30	.36	.35	.32	.31	.33	.32	.31	.28
121	.25	.23	.24	.20	.16	.12	.10	.05	.04	.01
131	.04	.02	.10	.05	.02	.01	.03	.00	.14	.16
141	.10	.15	.12	.11	.08	.06	.01	.05	.11	.16
151	.10	.20	.22	.24	.25	.26	.29	.31	.36	.30
161	.33	.34	.32	.32	.39	.27	.27	.28	.38	.22
171	.14	.10	.11	.14	.10	.18	.09	.03	.01	.04
181	.03	.04	.05	.03	.01	.01	.01	.02	.00	.02
191	.05	.08	.09	.05	.10	.08	.03	.01	.05	.00
201	.07	.02	.04	.09	.11	.12	.10	.08	.07	.05
211	.06	.06	.03	.01	.02	.01	.02	.01	.02	.03
221	.01	.06	.09	.13	.14	.15	.17	.17	.21	.26
231	.27	.27	.28	.27	.26	.27	.26	.22	.16	.12
241	.08	.02	.04	.06	.05	.04	.02	.00	.00	.10
251	.14	.16	.10	.05	.08	.06	.05	.04	.10	.17
261	.25	.31	.29	.27	.28	.30	.37	.40	.37	.03
271	.25	.14	.13	.19	.12	.04	.03	.10	.14	.15
281	.18	.25	.29	.28	.27	.27	.27	.25	.27	.28
291	.22	.22	.24	.23	.18	.14	.10	.05	.04	.20
301	.01	.01	.07	.14	.17	.17	.13	.11	.14	.17
311	.23	.32	.33	.33	.31	.26	.21	.18	.19	.17
321	.10	.16	.11	.09	.13	.10	.10	.13	.05	.05
331	.04	.04	.03	.02	.05	.03	.03	.00	.06	.10
341	.13	.10	.05	.02	.04	.02	.01	.01	.00	.02
351	.02	.02	.01	.00	.02	.06	.04	.03	.03	.02
361	.03	.03	.02	.01	.01	.05	.06	.07	.05	.03
371	.03	.10	.19	.25	.29	.34	.34	.33	.33	.35
381	.36	.34	.34	.34	.35	.35	.31	.23	.21	.25
391	.28	.32	.33	.30	.33	.38	.38	.37	.37	.35
401	.33	.33	.37	.43	.45	.43	.39	.37	.37	.37
411	.39	.37	.38	.38	.42	.42	.39	.40	.44	.45
421	.44	.39	.34	.30	.26	.25	.25	.25	.20	.14
431	.10	.06	.06	.04	.07	.06	.03	.05	.11	.15
441	.16	.15	.14	.13	.11	.10	.15	.10	.10	.15
451	.14	.09	.03	.02	.04	.03	.00	.01	.00	.02
461	.02	.07	.12	.16	.18	.23	.21	.19	.16	.10
471	.22	.24	.26	.26	.27	.27	.28	.29	.27	.25
481	.29	.30	.31	.32	.28	.31	.31	.33	.29	.27
491	.25	.27	.29	.27	.28	.27	.24	.22	.21	.20
501	.15	.10	.13	.12	.10	.09	.12	.16	.22	.20
511	.33	.32	.31	.29	.27	.22	.17	.12	.05	.00

TABLE 22 (Cont'd)

521	.09	.03	-.07	-.01	.04	.02	.02	.00	.05	.00
531	.08	.11	.11	.12	.13	.15	.15	.15	.17	.21
541	.21	.17	.12	.07	.04	.04	.06	.11	.10	.11
551	.09	.05	.01	.00	.02	.02	-.01	-.02	.02	.04
561	.04	.03	.04	.05	.03	.10	.08	.00	.03	.01
571	.00	-.01	-.01	.03	.00	.12	.11	.10	.05	.01
581	-.05	-.10	-.15	-.10	-.10	-.10	-.10	-.10	-.10	-.10
591	-.10	-.10	-.10	-.10	-.20	-.10	-.10	-.07	-.01	.00

RMS = 2.174 INCHES
 END JOB DAVE

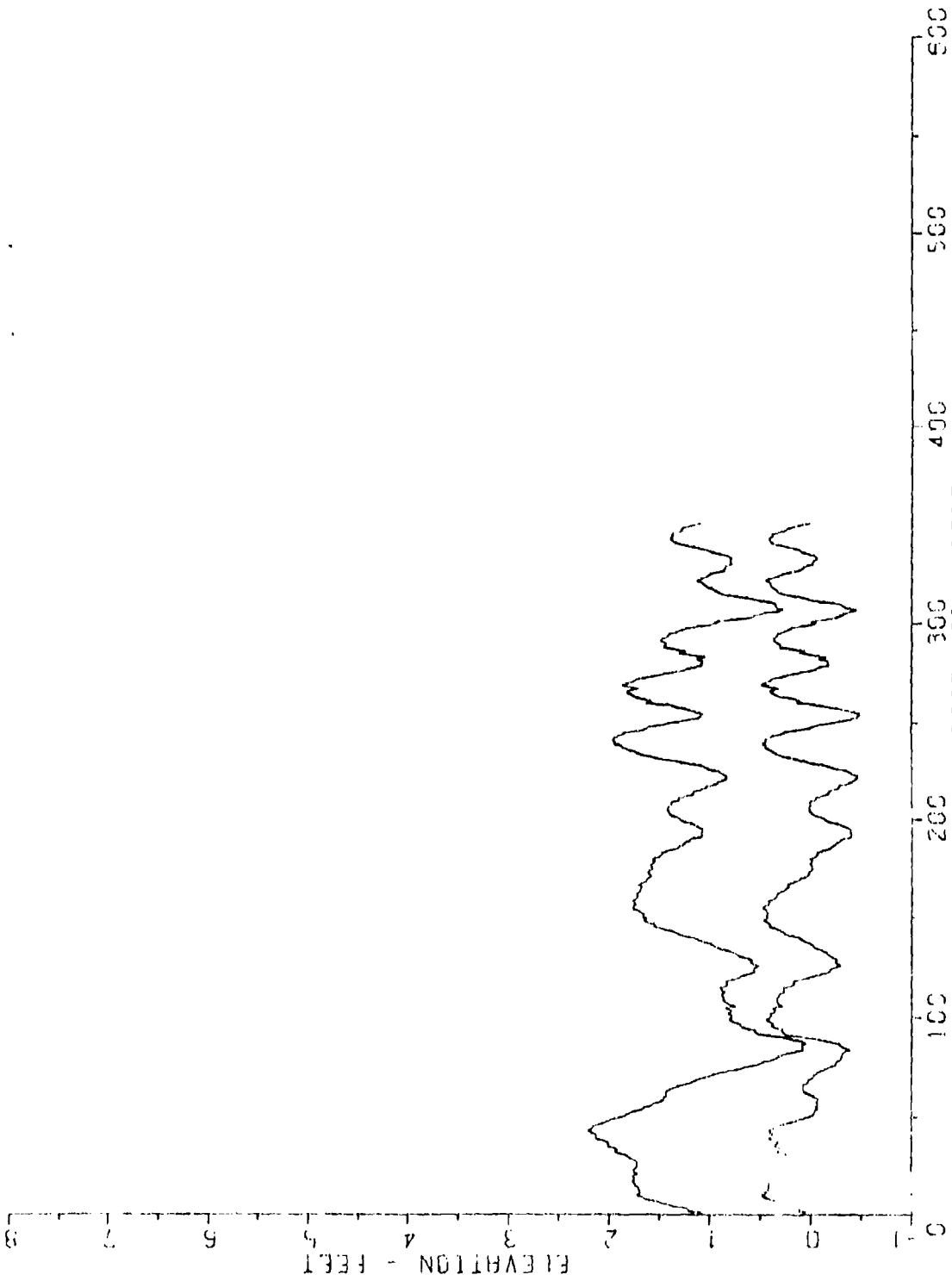


Figure 28

RD24

6/23/73

F05T FNOX CYA1 MAY 76

ADDED TO THE DISK ON 24.MAR.77

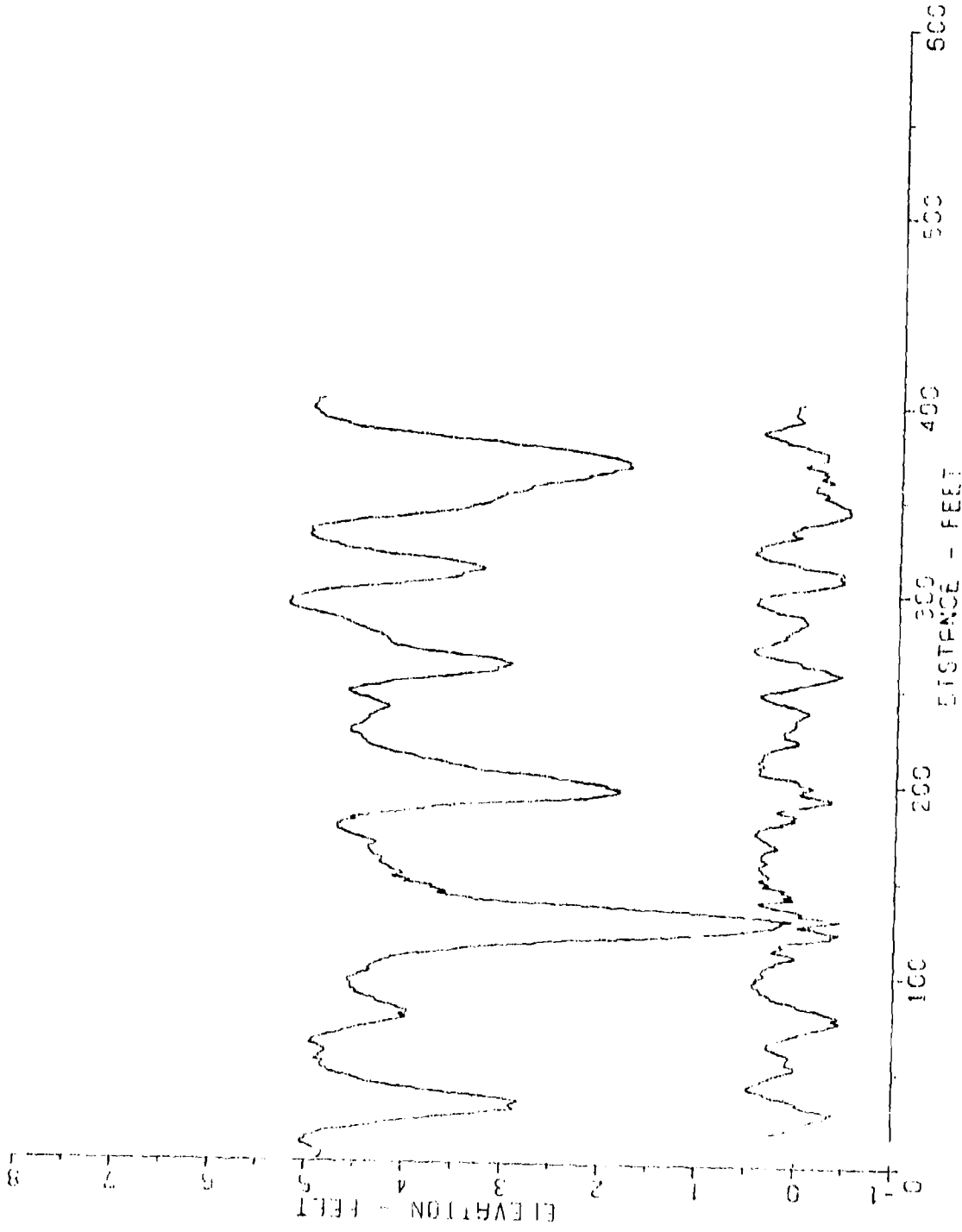
NUMBER OF POINTS ■ 361

INTERVAL IN INCHES ■ 12

POINT	ELEVATIONS IN FEET									
1	.01	.11	.10	.15	.24	.30	.33	.42	.46	.40
11	.48	.42	.42	.41	.42	.42	.42	.38	.37	.38
21	.30	.32	.31	.26	.25	.22	.21	.22	.24	.25
31	.25	.34	.30	.31	.36	.34	.33	.36	.42	.39
41	.37	.41	.42	.37	.35	.27	.21	.14	.06	.08
51	-.02	-.04	-.04	-.07	-.04	-.08	-.05	-.08	-.06	-.03
61	-.01	.05	.07	.08	.08	.08	.03	.03	.02	-.01
71	-.03	-.06	-.11	-.14	-.18	-.25	-.25	-.27	-.30	-.30
81	-.31	-.32	-.34	-.39	-.34	-.29	-.29	-.20	-.08	.02
91	.15	.26	.29	.29	.35	.39	.37	.40	.45	.41
101	.38	.41	.36	.35	.39	.28	.33	.34	.34	.32
111	.32	.31	.26	.28	.27	.20	.16	.17	.12	.03
121	-.04	-.10	-.19	-.21	-.25	-.30	-.28	-.24	-.27	-.24
131	-.19	-.16	-.15	-.10	-.04	-.02	.01	.05	.11	.12
141	.18	.26	.27	.32	.38	.42	.40	.44	.48	.43
151	.45	.42	.45	.45	.49	.47	.42	.43	.41	.38
161	.34	.34	.29	.26	.24	.21	.23	.16	.11	.11
171	.04	.02	.03	.00	-.02	-.01	.01	-.01	-.02	.02
181	-.05	-.07	-.06	-.11	-.20	-.21	-.25	-.26	-.30	-.32
191	-.39	-.40	-.39	-.30	-.39	-.34	-.38	-.25	-.17	-.13
201	-.10	-.04	-.01	.01	.03	.02	.01	.01	.00	.00
211	-.05	-.07	-.17	-.18	-.25	-.28	-.28	-.34	-.39	-.44
221	-.46	-.46	-.43	-.38	-.34	-.24	-.28	-.12	.01	.05
231	.15	.23	.31	.36	.39	.43	.46	.45	.48	.46
241	.46	.42	.37	.30	.25	.10	.01	-.02	-.15	-.23
251	-.34	-.46	-.47	-.49	-.44	-.36	-.24	-.15	-.03	.18
261	.12	.20	.36	.35	.40	.41	.31	.40	.50	.46
271	.40	.38	.28	.21	.11	-.02	-.06	-.11	-.16	-.17
281	-.16	-.08	-.16	-.06	.12	.06	.18	.31	.38	.31
291	.37	.37	.35	.33	.33	.26	.20	.18	.03	-.05
301	-.01	-.13	-.25	-.29	-.33	-.43	-.45	-.37	-.31	-.27
311	-.15	.00	.08	.19	.29	.32	.34	.37	.40	.41
321	.42	.46	.39	.32	.28	.26	.11	.08	.05	.02
331	-.02	-.03	-.07	-.04	-.01	.09	.13	.17	.26	.23
341	.39	.41	.42	.37	.36	.35	.25	.23	.17	.09
351	.01	-1.00	1.12	.00	.11	.00	.00	.00	.00	.00

RMS ■ 3.171 INCHES

TABLE 23



5025

Figure 29

6/26/79

FORM PROJ CTAP MAY 1976

ADDED TO THE DISK ON 18 APR 77

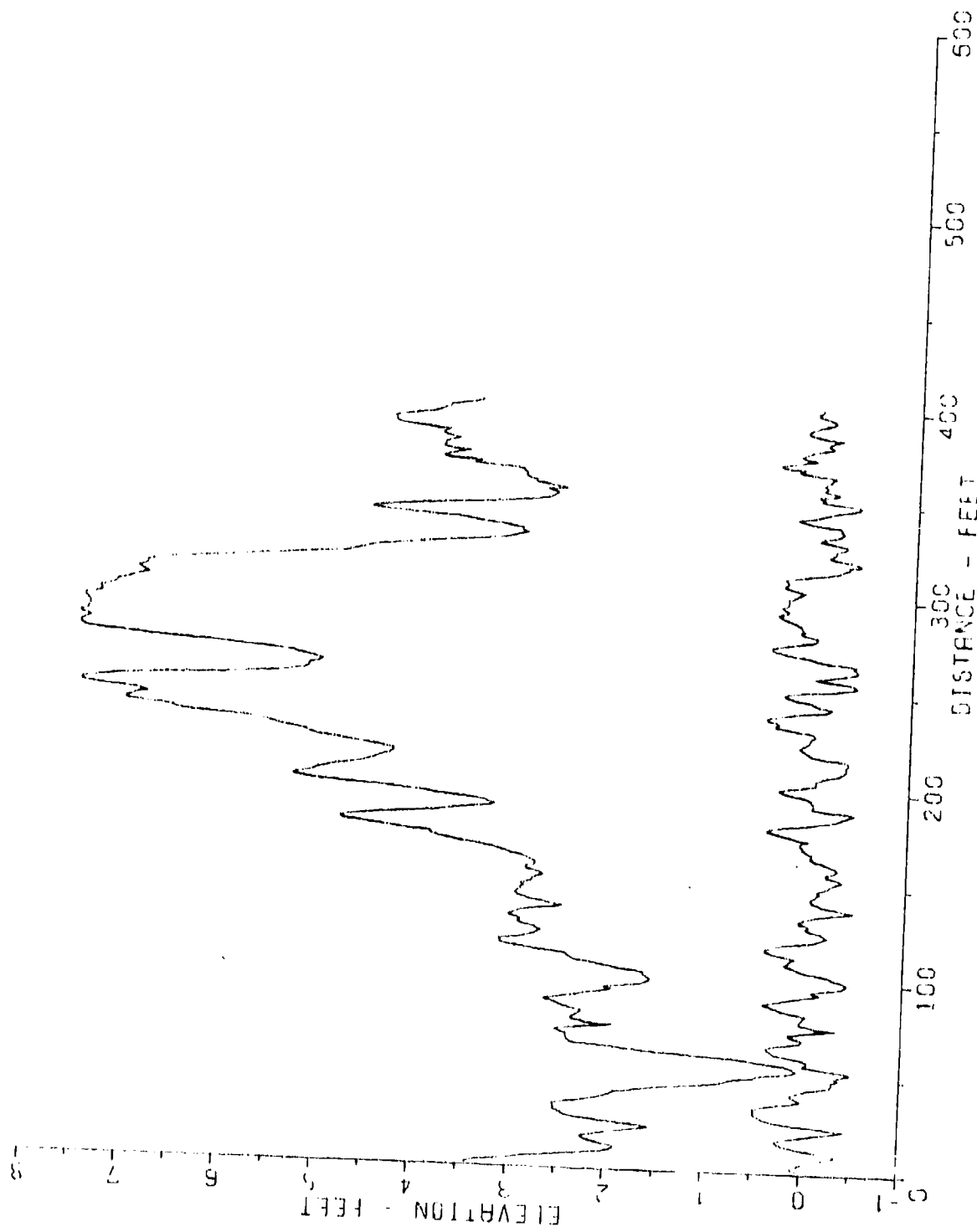
NUMBER OF POINTS ■ 481

INTERVAL IN INCHES ■ 12

POINT	ELEVATIONS IN FEET									
1	.46	-.43	-.41	.42	.45	.11	.20	.20	.38	.44
11	.48	-.46	-.50	.48	.48	.43	.33	.22	.14	.03
21	.40	-.43	-.07	-.14	-.21	-.31	-.34	-.35	-.40	-.24
31	-.13	-.05	.00	-.04	.07	.10	.23	.31	.31	.20
41	.48	.40	.46	.42	.38	.32	.27	.27	.17	.17
51	.41	.40	-.40	.10	.08	.00	.08	.06	.00	.13
61	.18	.23	.30	.30	.20	.22	.18	.12	.05	-.02
71	-.43	-.10	-.23	-.30	-.36	-.45	-.44	-.37	-.43	-.41
81	-.33	-.27	-.21	-.08	-.01	.00	.08	.10	.27	.08
91	.31	.37	.39	.39	.44	.46	.45	.39	.42	.34
101	.32	.37	.36	.34	.31	.28	.21	.21	.14	.02
111	.03	.08	.18	.26	.21	.14	.18	.15	-.01	-.20
121	-.35	-.54	-.44	-.31	-.22	-.17	.00	-.14	-.25	-.44
131	-.30	-.13	.00	-.05	.01	.13	.24	.34	.21	.05
141	.04	.16	.05	.10	.16	.12	.21	.37	.20	.35
151	.41	.20	.20	.32	.37	.37	.40	.40	.36	.41
161	.35	.38	.38	.37	.36	.33	.27	.28	.23	.20
171	.32	.35	.39	.43	.45	.43	.41	.36	.29	.17
181	.18	.13	.07	.02	.08	.14	.22	.13	.02	-.10
191	-.10	-.33	-.33	-.20	-.12	.00	-.04	-.04	-.15	-.00
201	.00	.41	.08	.16	.32	.42	.40	.40	.43	.36
211	.30	.44	.38	.38	.38	.37	.34	.30	.26	.17
221	.40	.41	.41	.06	.16	.15	.16	.14	.10	.06
231	.45	.44	.46	.45	-.00	-.02	-.05	-.10	-.00	.00
241	.46	.12	.19	.28	.34	.41	.41	.36	.29	.16
251	.46	.40	-.47	-.18	-.26	-.31	-.30	.42	.33	.26
261	-.25	-.16	.00	.01	.06	.17	.24	.37	.46	.48
271	.40	.45	.38	.32	.26	.23	.14	.17	.13	.11
281	.08	.03	.01	-.01	-.07	-.08	-.04	-.02	.01	.13
291	.25	.32	.36	.42	.48	.45	.43	.44	.38	.26
301	.21	.04	-.06	-.19	-.30	-.36	-.43	-.43	-.38	-.30
311	-.43	-.41	-.27	-.14	.00	.05	.11	.24	.34	.41
321	.45	.50	.49	.42	.44	.44	.37	.30	.22	.00
331	.41	.49	.12	.11	.07	.02	-.01	-.14	-.25	-.31
341	-.39	-.44	-.49	-.49	-.46	-.45	-.46	-.39	-.35	-.31
351	-.27	-.20	-.26	-.23	-.19	-.11	-.13	-.13	-.21	-.30
361	-.28	-.17	-.22	-.25	-.19	-.23	-.18	-.07	.00	.07
371	-.14	-.23	-.22	-.23	-.24	-.21	-.14	-.06	-.02	.00
381	.19	.20	.25	.33	.40	.44	.37	.28	.24	.18
391	.12	.41	.44	.45	.19	.10	.00	.07	.07	.08
401	.01	-1.00	1.12	.00	-.03	.00	.00	.00	.00	.00

RMS ■ 3.088 INCHES

TABLE 24



RC25

Figure 30

5/23/78

FORT KNOX STATION MAY 1976

ADDED TO THE DISK ON 18 APR 77

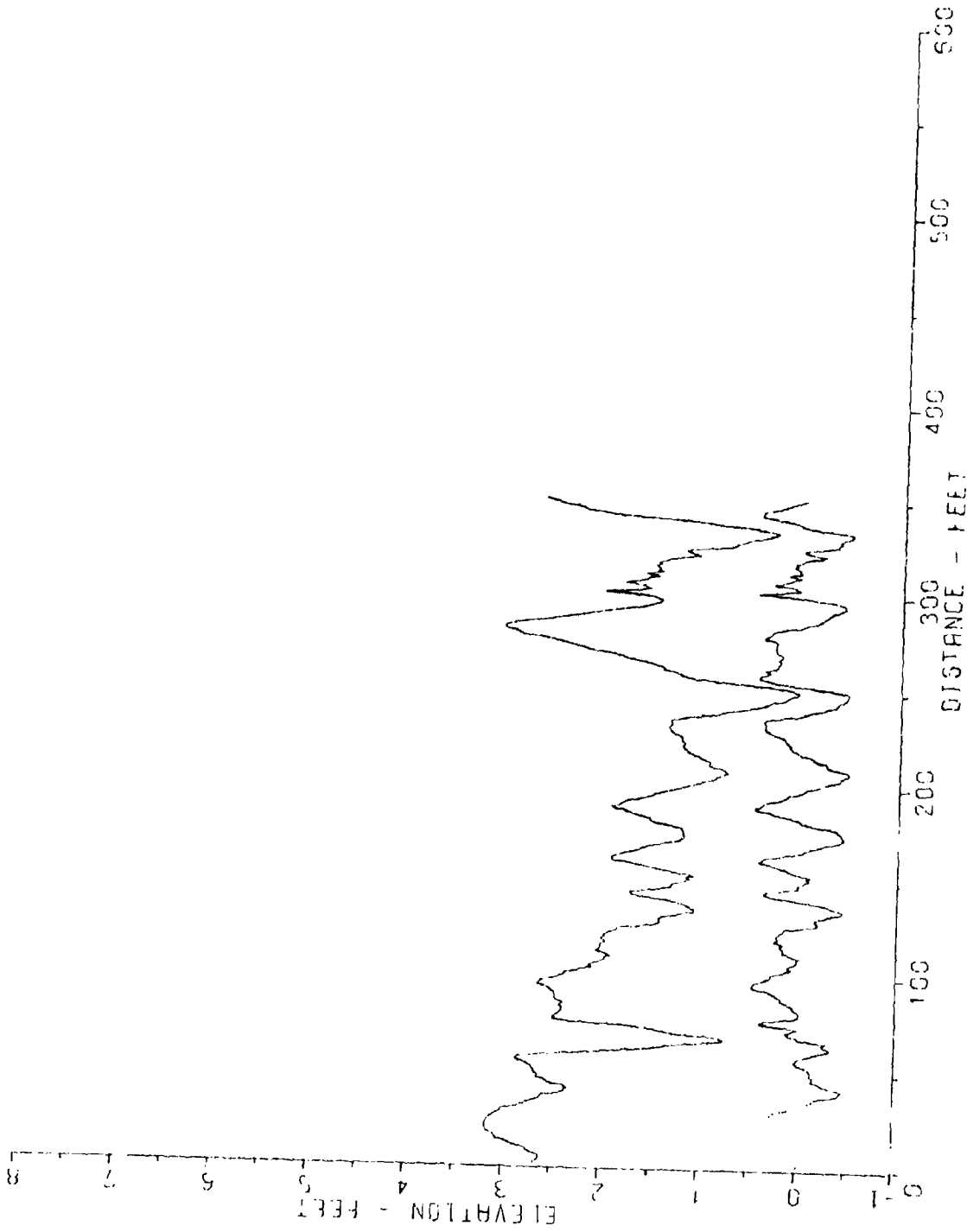
NUMBER OF POINTS = 401

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.12	.04	.07	.00	-.06	-.16	-.25	-.36	-.37
11	-.30	-.16	.01	.10	.19	.25	.26	.18	.07	-.03
21	-.18	-.35	-.44	-.28	-.06	.13	.29	.39	.41	.46
31	.49	.48	.49	.49	.39	.23	.11	.01	.04	.06
41	.12	.24	.03	-.05	-.18	-.30	-.32	-.32	-.31	-.35
51	-.33	-.42	-.49	-.43	-.30	-.16	.00	-.04	.05	.01
61	.07	.19	.29	.33	.37	.39	.33	.19	.02	.01
71	.02	.10	.16	.06	-.11	-.34	-.11	-.04	.05	.04
81	.02	.01	-.02	.03	.15	.24	.20	.36	.43	.36
91	.24	.15	.02	-.11	-.16	-.06	-.10	-.35	-.41	-.43
101	-.40	-.34	-.28	-.25	-.14	.01	.08	.12	.16	.22
111	.18	.15	.11	.18	.28	.36	.43	.43	.36	.32
121	.08	-.06	-.13	-.18	-.22	-.16	-.14	-.03	.02	-.00
131	.01	.02	.10	.02	-.03	-.14	-.34	-.47	-.34	-.26
141	-.15	-.10	-.04	-.02	-.05	-.08	-.08	-.13	-.00	-.17
151	-.22	-.23	-.29	-.34	-.31	-.25	-.18	-.18	.27	.24
161	-.27	-.25	-.19	-.13	-.05	.00	.02	.03	.03	.06
171	.08	.07	.10	.08	.01	.13	.20	.29	.38	.46
181	.41	.26	.05	-.06	-.19	-.27	-.33	-.40	-.40	-.35
191	-.16	.00	-.02	-.03	-.00	.01	.03	.11	.10	.20
201	.34	.27	.06	-.05	-.05	-.04	-.00	-.13	.25	.30
211	-.34	-.35	-.34	-.36	-.37	-.36	-.30	-.15	.00	.06
221	.08	.11	.14	.11	.06	.04	.02	.02	-.02	-.01
231	.02	.18	.32	.42	.35	.38	.47	.49	.40	.25
241	.07	-.12	-.19	-.19	-.04	.02	.03	.19	.26	.31
251	.25	.07	-.19	-.37	-.44	-.39	-.32	-.16	.00	.11
261	-.27	-.40	-.44	-.42	-.38	-.43	-.29	-.12	.01	.09
271	.21	.32	.41	.46	.45	.33	.19	.03	-.01	.05
281	.05	.13	.16	.12	.16	.16	.19	.23	.20	.32
291	.37	.40	.30	.29	.33	.37	.31	.29	.30	.36
301	.25	.20	.17	.12	.21	.27	.34	.32	.30	.33
311	.33	.19	.03	-.09	-.21	-.27	-.32	-.30	.45	.49
321	-.30	-.18	-.10	-.14	-.17	-.17	-.23	-.25	-.20	-.10
331	-.10	.00	-.06	-.18	-.22	-.25	-.21	-.23	-.16	.02
341	.13	.21	.23	.04	-.03	-.08	-.19	-.31	-.40	-.44
351	-.31	-.15	.00	-.04	.02	-.17	-.17	-.07	-.02	-.07
361	-.02	-.05	-.10	-.11	-.14	-.06	.09	.24	.18	.40
371	.42	.34	.20	.05	.16	.22	.16	.13	.04	.00
381	-.12	-.07	-.07	-.12	-.21	-.07	.07	.16	.16	.12
391	.11	.01	-.09	-.12	-.11	-.07	-.02	.00	.06	.01
401	.00	-1.00	1.12	.00	.04	.00	.00	.00	.00	.02

RMS = 2.822 INCHES

TABLE 25



RS27

Figure 31

6/23/78

FORT KAOX STAG MAY 76

ADDED TO THE DISK ON 24.MAR.77

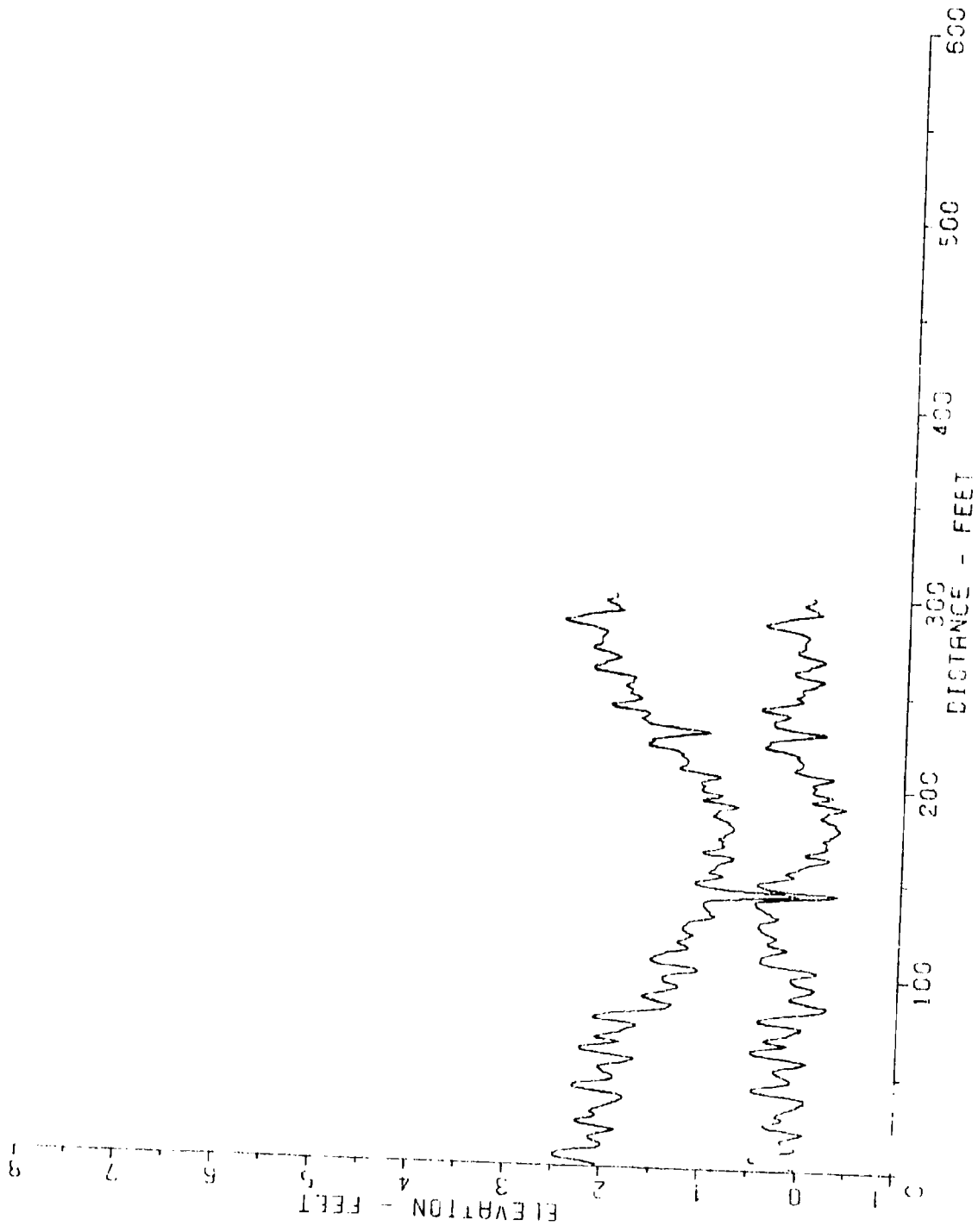
NUMBER OF POINTS = 351

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	-.02	-.03	-.05	-.08	-.09	-.07	.00	.03	.06
11	.11	.17	.23	.29	.34	.36	.37	.39	.42	.43
21	.44	.43	.41	.41	.39	.37	.33	.31	.28	.25
31	.20	.09	-.00	-.03	-.09	-.17	-.19	-.21	-.34	-.44
41	-.45	-.47	-.41	-.31	-.25	-.22	-.16	-.18	-.16	-.13
51	-.15	-.13	-.12	-.08	-.04	.01	.04	.06	-.01	-.12
61	-.16	-.23	-.34	-.34	-.26	-.25	-.29	-.18	.00	.02
71	-.10	.12	.06	-.00	.08	.09	.30	.35	.21	.03
81	-.01	-.01	.01	.01	.06	.05	.09	.15	.10	.10
91	.22	.23	.29	.33	.41	.48	.47	.46	.38	.32
101	.29	.29	.23	.14	.08	.12	.09	.04	.02	.03
111	-.00	.18	.14	.18	.16	.18	.20	.17	.20	.26
121	.22	.24	.22	.20	.17	.16	.02	-.15	-.20	-.17
131	-.14	-.19	-.27	-.32	-.43	-.43	-.36	.31	.24	.14
141	-.01	.13	.25	.36	.38	.28	.15	.02	.03	.01
151	-.05	-.10	-.06	-.11	.01	.06	.13	.18	.22	.20
161	.38	.44	.40	.34	.23	.10	.01	-.06	-.11	-.17
171	-.24	-.32	-.40	-.43	-.41	-.41	-.39	-.36	-.35	-.28
181	-.15	-.13	.02	.04	.13	.19	.28	.35	.44	.40
191	.42	.39	.35	.28	.20	.14	.14	.04	-.05	-.08
201	-.14	-.20	-.26	-.33	-.37	-.39	-.43	-.49	-.46	-.43
211	-.36	-.25	-.24	-.24	-.17	-.11	-.08	-.01	.05	.07
221	.12	.14	.12	.16	.19	.19	.22	.26	.32	.36
231	.38	.39	.38	.40	.41	.38	.30	.19	.03	-.05
241	-.12	-.21	-.26	-.33	-.35	-.36	-.43	-.44	-.45	-.46
251	-.43	-.31	-.18	.01	.14	.31	.40	.46	.47	.39
261	.36	.40	.30	.28	.28	.24	.25	.28	.24	.24
271	.25	.30	.31	.30	.30	.30	.29	.35	.42	.36
281	.34	.34	.29	.19	.03	-.02	-.10	-.15	-.19	-.22
291	-.23	-.24	-.32	-.38	-.40	-.47	-.37	-.29	-.14	.01
301	.23	.49	.28	.07	.11	.16	.33	.25	.15	.11
311	.05	.18	.24	.08	.07	.14	.08	.13	.07	.00
321	-.13	-.19	-.27	.03	.03	-.19	-.32	-.31	-.36	-.33
331	-.39	-.45	-.47	-.46	-.33	-.15	.00	.07	.00	.17
341	.28	.30	.47	.46	.46	.35	.28	.23	.16	.00
351	.01	-1.00	1.12	.00	-.02	-.35	-.34	-.13	-.04	-.16

MM = 3.135 INCHES

TABLE 26



RD28

Figure 32

5/23/78

RI2H

FURT N GX STVA MAY 76

ADDED TO THE DISK ON 24, MAR. 77

NUMBER OF POINTS ■ 301

INTERVAL IN INCHES ■ 12

POINT	ELEVATIONS IN FEET									
1	.40	.44	.21	.35	.47	.48	.46	.42	.28	.08
11	.40	.41	.03	.12	.15	.17	.11	.08	-.04	-.08
21	.42	.16	.31	.34	.30	.19	.14	.17	.21	.10
31	.18	.10	.04	.01	-.04	-.08	-.08	-.08	.04	.22
41	.37	.47	.47	.39	.26	.12	.07	.09	.14	.18
51	.21	.25	.25	.18	.07	-.03	-.10	-.03	.16	.33
61	.46	.50	.49	.35	.19	.12	.26	.37	.33	.23
71	.13	.08	.04	-.02	-.02	.15	.33	.44	.43	.34
81	.22	.04	-.14	-.24	-.27	-.26	-.14	-.04	.07	.18
91	.08	.02	-.05	-.12	-.15	-.11	.01	.07	.19	.12
101	.09	-.02	-.15	-.16	-.07	.11	.29	.40	.43	.41
111	.42	.37	.33	.23	.15	.18	.26	.34	.36	.29
121	.26	.26	.33	.39	.43	.43	.45	.44	.43	.35
131	.26	.25	.32	.33	.39	.42	.46	.49	.50	.45
141	.37	.11	-.28	-.35	-.09	.21	.38	.43	.49	.48
151	.36	.22	.11	.11	.20	.15	.09	.06	.01	-.04
161	-.13	-.21	-.25	-.16	-.01	.00	-.11	-.19	-.24	-.21
171	-.22	-.23	-.17	-.25	-.24	-.30	-.33	-.35	-.36	-.33
181	-.31	-.31	-.25	-.20	-.14	-.18	-.21	-.23	-.31	-.42
191	-.37	-.23	-.06	-.06	-.21	-.27	-.28	-.09	-.08	-.09
201	-.11	-.07	-.07	-.14	-.24	-.28	-.19	-.05	.08	.14
211	.11	.06	.04	.03	.06	.09	.11	.08	.14	.03
221	.33	.43	.43	.38	.39	.33	.16	-.08	-.19	-.13
231	.03	.20	.33	.35	.35	.35	.29	.22	.19	.24
241	.36	.44	.49	.39	.24	.13	.06	.09	.14	.09
251	.04	.08	.08	.01	-.07	-.08	-.14	-.14	-.02	.05
261	.16	.17	.12	.01	-.00	-.06	-.12	-.18	-.12	-.03
271	.04	.14	.14	.09	.05	.07	.06	.06	.05	.02
281	.03	.07	.14	.19	.35	.47	.48	.36	.29	.22
291	.06	-.11	-.07	-.06	-.02	.04	.08	.03	-.03	-.03
301	.00	-1.00	1.12	.00	.07	.33	.66	.51	.31	.22

RMS = 2.645 INCHES

TABLE 27

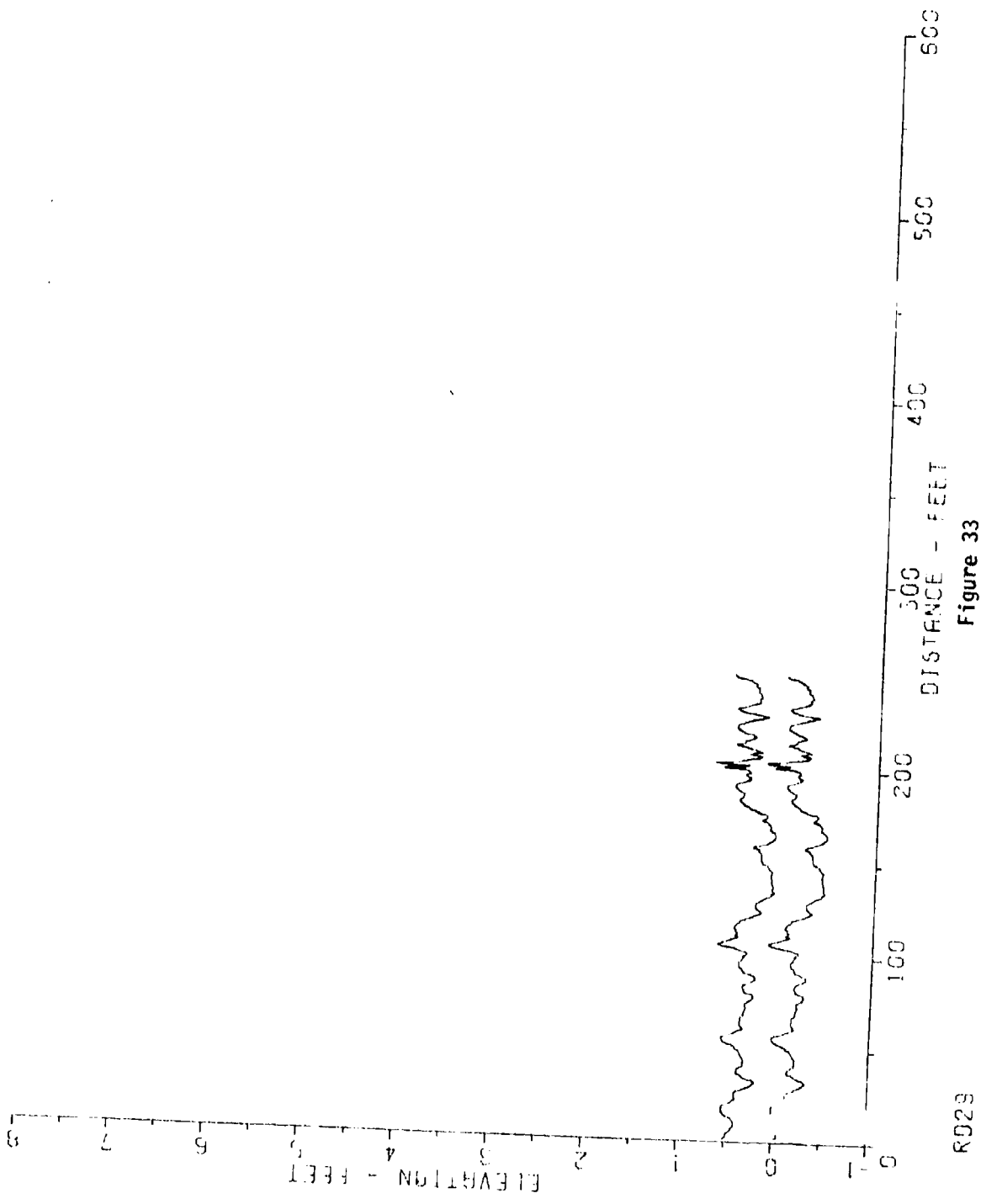


Figure 33

6/23/78

1973 12 NOV 77

ADDED TO THE DISK ON 24.MAR.77

NUMBER OF POINTS = 251

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	-.03	-.06	-.05	-.08	-.10	-.10	-.13	-.14	-.14
11	-.13	-.11	-.09	-.04	-.02	.00	.00	.00	.01	.02
21	-.09	-.11	-.15	-.13	-.14	-.12	-.15	-.22	-.25	-.30
31	-.31	-.34	-.31	-.25	-.22	-.19	-.14	-.15	-.15	-.17
41	-.22	-.22	-.21	-.22	-.20	-.19	-.18	-.17	-.16	-.12
51	-.12	-.07	-.03	.01	.02	.03	.01	.05	.11	.15
61	-.20	-.18	-.17	-.16	-.18	-.17	-.17	-.20	-.20	-.21
71	-.21	-.22	-.22	-.21	-.22	-.25	-.28	-.29	-.29	-.27
81	-.20	-.20	-.18	-.19	-.19	-.23	-.28	-.31	-.31	-.29
91	-.24	-.18	-.18	-.17	-.14	-.14	-.13	-.16	-.17	-.19
101	-.18	-.23	-.21	-.14	-.06	.05	.10	.05	-.00	-.07
111	-.12	-.08	-.11	-.09	-.10	-.07	-.09	-.10	-.13	-.15
121	-.20	-.25	-.30	-.36	-.32	-.30	-.29	-.28	-.29	-.31
131	-.35	-.38	-.45	-.46	-.48	-.46	-.46	-.47	-.45	-.45
141	-.45	-.45	-.44	-.44	-.45	-.46	-.43	-.42	-.40	-.38
151	-.34	-.33	-.34	-.33	-.33	-.32	-.30	-.30	-.24	-.20
161	-.37	-.42	-.45	-.48	-.46	-.48	-.47	-.44	-.42	-.43
171	-.42	-.40	-.36	-.33	-.36	-.39	-.36	-.29	-.24	-.19
181	-.18	-.13	-.12	-.09	-.09	-.12	-.14	-.15	-.10	-.07
191	-.04	-.04	-.06	-.11	-.18	-.20	-.17	-.14	-.10	-.17
201	-.09	.06	.07	.18	.01	-.16	-.27	-.29	-.18	-.30
211	-.24	-.15	-.13	-.04	-.12	-.14	-.20	-.24	-.20	-.12
221	-.10	-.05	-.04	-.05	-.08	-.11	-.20	-.31	-.37	-.24
231	-.15	-.07	-.04	-.11	-.19	-.26	-.27	-.26	-.30	-.28
241	-.27	-.25	-.24	-.26	-.22	-.23	-.20	-.15	-.11	-.02
251	.00	-1.00	1.12	.00	-.04	-.17	-.20	-.27	-.04	.13

SSS = 1.582 INCHES

TABLE 28

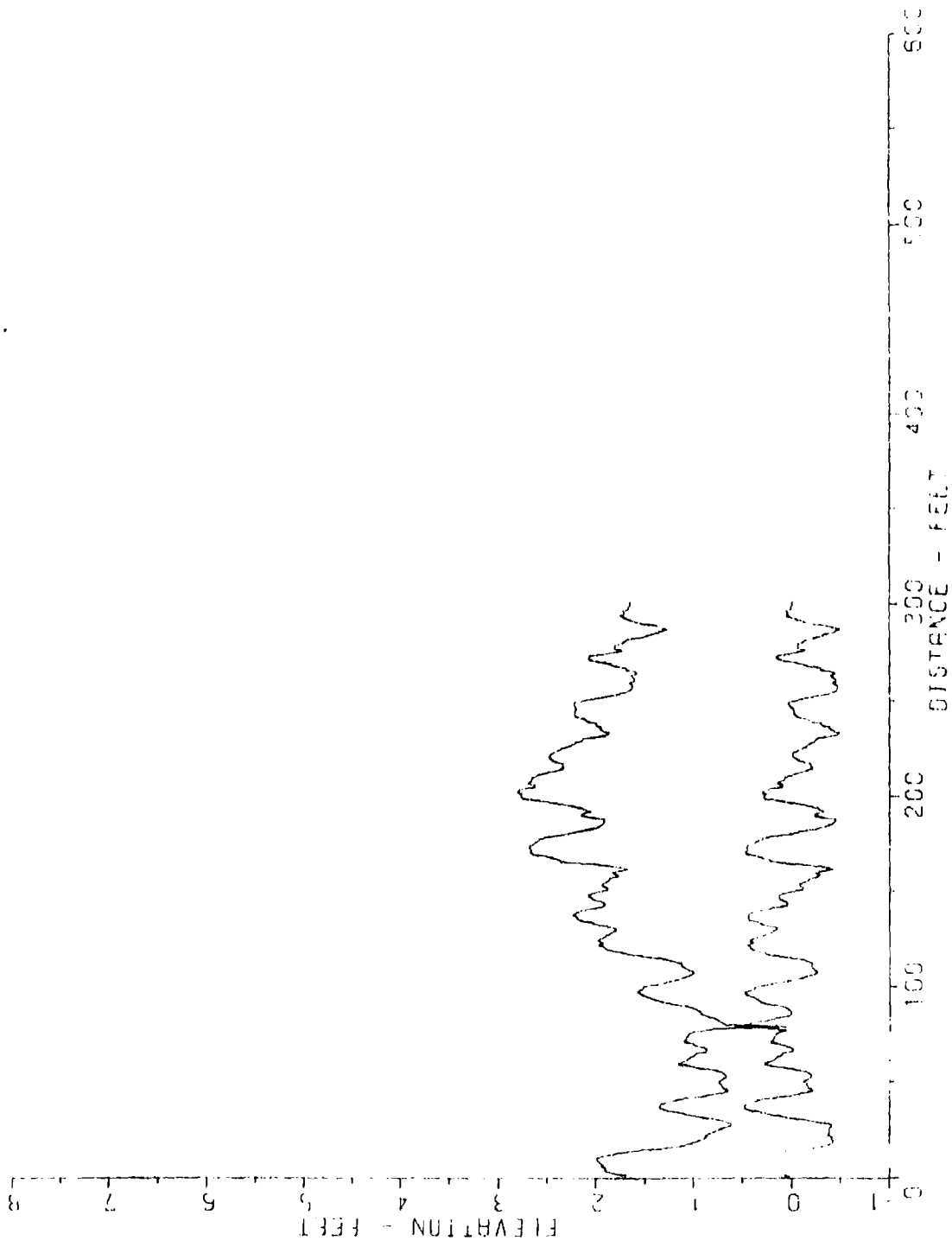


Figure 34

R530

6/23/78

APR 27 11 NOV 76

ADDED TO THE DISK ON 24 MAR 77

NUMBER OF POINTS = 361

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.01	.13	.21	.27	.27	.31	.30	.34	.38	.38
11	.34	.27	.16	.02	-.15	-.31	-.40	-.41	-.44	-.41
21	-.42	-.37	-.36	-.38	-.39	-.39	-.41	-.37	-.26	-.13
31	.11	.13	.24	.29	.44	.48	.49	.47	.42	.34
41	.26	.13	-.03	-.17	-.22	-.21	-.16	-.15	-.13	-.12
51	-.17	-.24	-.21	-.18	-.16	-.06	.03	.15	.28	.25
61	.19	.17	.13	.49	.09	-.01	-.02	.01	.08	.14
71	.21	.19	.19	.16	.15	.10	.25	.24	.20	.40
81	.36	.28	.18	.09	.01	.01	.60	.03	.27	.11
91	.23	.31	.35	.38	.41	.47	.48	.44	.35	.35
101	.25	.12	.25	-.07	-.16	-.21	-.27	-.27	-.23	-.21
111	-.20	-.22	-.18	-.14	-.03	.11	.23	.29	.37	.42
121	.43	.47	.39	.34	.30	.33	.30	.24	.18	.14
131	.16	.23	.31	.36	.44	.45	.45	.46	.48	.33
141	.22	.19	.24	.24	.08	.12	.13	.14	.09	.01
151	-.10	-.11	-.08	-.08	-.14	-.18	-.18	-.26	-.29	-.28
161	-.33	-.41	-.32	-.16	.04	.23	.22	.31	.39	.47
171	.48	.46	.47	.46	.42	.38	.33	.31	.21	.10
181	-.23	-.13	-.24	-.34	-.39	-.42	-.44	-.44	-.32	-.23
191	-.24	-.30	-.28	-.27	-.18	-.06	.03	.15	.28	.20
201	.26	.31	.27	.22	.16	.09	.15	.10	.07	.68
211	.01	-.04	-.11	-.18	-.22	-.20	-.20	-.12	-.08	-.01
221	-.01	-.01	-.03	-.07	-.11	-.15	-.18	-.21	-.25	-.27
231	-.35	-.46	-.40	-.43	-.37	-.37	-.31	-.38	-.21	-.17
241	-.60	-.14	-.02	-.01	-.02	-.00	.02	.04	.04	-.32
251	-.12	-.24	-.34	-.41	-.45	-.47	-.47	-.45	-.41	-.44
261	-.44	-.46	-.39	-.44	-.38	-.30	-.27	-.16	-.09	.00
271	.12	.16	.14	.05	-.07	-.14	-.06	-.06	-.05	-.11
281	-.13	-.20	-.30	-.33	-.40	-.46	-.49	-.39	-.30	-.18
291	-.05	-.01	.02	.07	.04	.07	.00	.01	-.00	-.00
301	.00	-1.00	1.12	.00	.13	.33	.66	.51	.31	.22

RES = 3.215 INCHES

TABLE 29

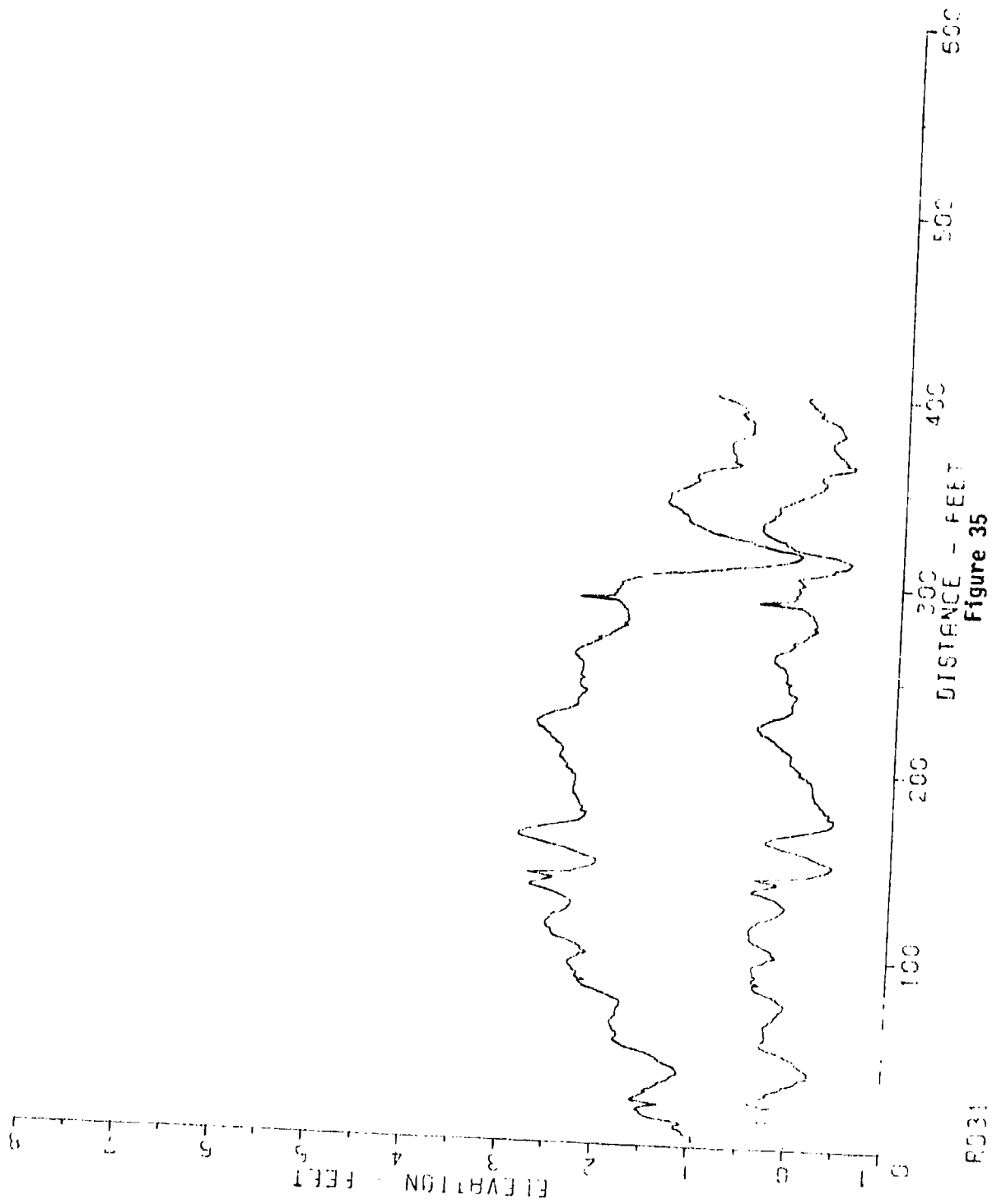


Figure 35

RS31

5/23/79

AP-34 11 NOV 76

ALIGNED TO THE DISK ON 24 MAR 77

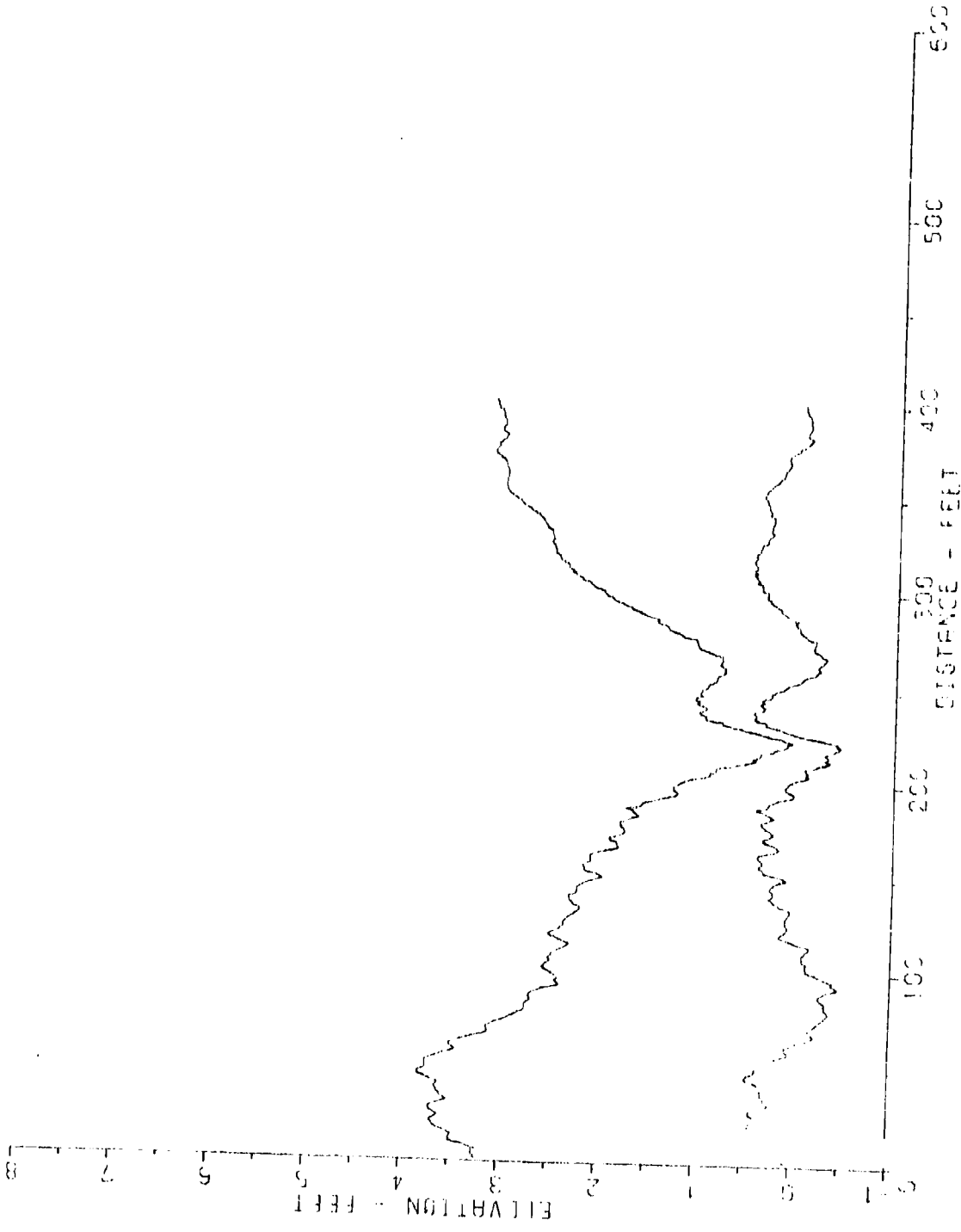
NUMBER OF POINTS * 401

INTERVAL IN INCHES * 12

POINT	ELEVATIONS IN FEET									
1	.00	-.01	-.07	-.06	-.08	-.08	.00	-.01	.03	.07
11	.05	-.03	.03	.15	.27	.33	.36	.36	.39	.38
21	.28	.14	.27	.40	.35	.30	.24	.19	.22	.17
31	.11	.05	.02	-.03	-.10	-.12	-.15	-.22	-.22	-.25
41	-.21	-.19	-.15	-.11	-.09	-.07	-.06	-.02	.03	.07
51	.15	.03	.24	.28	.30	.27	.24	.24	.23	.25
61	.26	.25	.26	.26	.25	.21	.20	.16	.15	.14
71	.12	.11	.08	.08	.05	.05	.07	.12	.14	.18
81	.23	.27	.33	.37	.39	.40	.31	.41	.39	.38
91	.37	.40	.40	.41	.41	.40	.37	.32	.27	.25
101	.16	.17	.21	.24	.23	.26	.31	.36	.41	.44
111	.45	.44	.44	.45	.46	.46	.44	.41	.38	.36
121	.34	.25	.19	.16	.14	.11	.09	.03	.10	.12
131	.16	.24	.23	.20	.34	.45	.41	.36	.27	.18
141	.18	.35	.41	.12	-.12	-.19	-.26	-.32	-.36	-.39
151	-.39	-.34	-.28	-.24	-.19	-.13	-.10	-.02	.05	.14
161	.22	.28	.32	.30	.25	.18	.12	.01	-.09	-.17
171	-.27	-.33	-.38	-.38	-.38	-.39	-.32	-.33	-.33	-.29
181	-.27	-.26	-.24	-.22	-.21	-.18	-.17	-.17	-.15	-.18
191	-.15	-.15	-.16	-.14	-.14	-.14	-.09	-.09	-.04	-.01
201	-.03	.01	.03	.06	.09	.09	.10	.08	.08	.09
211	.11	.13	.17	.19	.22	.25	.27	.31	.33	.38
221	.41	.42	.44	.45	.42	.39	.36	.31	.28	.20
231	.16	.12	.09	.00	.10	.10	.09	.08	.07	.05
241	.04	.07	.12	.13	.14	.14	.15	.10	.16	.16
251	.16	.15	.16	.16	.18	.18	.20	.24	.27	.30
261	.31	.29	.29	.27	.21	.17	.13	.11	.08	.12
271	.03	-.01	-.03	-.04	-.08	-.12	-.14	-.19	-.13	-.14
281	-.11	-.13	-.10	-.10	-.09	-.04	-.03	.00	.04	.02
291	.08	.02	.11	.08	.14	.07	.08	.05	.06	.04
301	.00	.04	.06	.09	.07	-.09	-.20	-.29	-.28	-.42
311	-.44	-.45	-.48	-.44	-.37	-.28	-.16	.00	.06	.15
321	.18	.23	.23	.31	.36	.39	.43	.46	.49	.48
331	.47	.48	.46	.42	.39	.35	.36	.32	.30	.31
341	.31	.31	.26	.20	.16	.12	.06	.00	-.03	-.05
351	-.14	-.14	-.15	-.17	-.17	-.13	-.11	-.12	-.15	-.20
361	-.28	-.38	-.46	-.47	-.37	-.39	-.36	-.36	-.32	-.29
371	-.26	-.25	-.24	-.21	-.22	-.21	-.20	-.27	-.31	-.35
381	-.35	-.33	-.31	-.30	-.30	-.29	-.25	-.20	-.14	-.11
391	-.07	-.11	-.09	-.06	-.03	.00	.00	.02	.06	.06
401	.00	-1.00	1.02	.00	-.01	.00	.00	.00	.00	.00

RMS * 2.853 INCHES

TABLE 30



PC32

Figure 36

5/23/79

APR 35 11 NOV 74

ADDED TO THE DISK ON 24 MAR 77

NUMBER OF POINTS = 461

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.00	.04	.07	.06	.05	.01	.00	.15	.23
11	.27	.26	.25	.23	.26	.28	.35	.39	.41	.42
21	.43	.41	.37	.33	.37	.38	.41	.42	.39	.34
31	.28	.21	.24	.27	.28	.30	.30	.31	.31	.29
41	.27	.31	.37	.42	.47	.46	.45	.38	.36	.37
51	.07	.06	.04	.09	.24	.17	.07	.03	.03	.07
61	.07	.05	.06	-.05	-.12	-.18	-.23	-.23	-.20	-.17
71	-.17	-.16	-.22	-.25	-.28	-.30	-.33	-.35	-.37	-.37
81	-.36	-.33	-.33	-.32	-.34	-.30	-.28	-.26	-.28	-.31
91	-.35	-.40	-.46	-.43	-.38	-.40	-.37	-.32	-.26	-.21
101	-.18	-.12	-.12	-.12	-.14	-.12	-.07	-.10	-.08	-.08
111	-.10	-.10	-.15	-.15	-.13	-.07	.00	.07	.13	.16
121	.14	.10	.08	.07	.07	.09	.10	.09	.10	.08
131	.06	.05	.04	.06	.09	.16	.19	.22	.25	.20
141	.23	.22	.23	.23	.27	.25	.23	.21	.16	.08
151	.12	.14	.28	.33	.35	.38	.38	.35	.34	.37
161	.30	.30	.38	.31	.22	.16	.19	.22	.24	.31
171	.35	.32	.27	.26	.25	.28	.32	.33	.36	.37
181	.31	.27	.23	.26	.32	.34	.43	.31	.30	.26
191	.24	.19	.12	.03	.02	.06	.10	.12	.12	.09
201	.08	.07	.00	-.08	-.12	-.08	-.12	-.09	-.07	-.17
211	-.22	-.23	-.34	-.28	-.32	-.30	-.28	-.35	-.39	-.44
221	-.44	-.39	-.41	-.31	-.21	-.10	.01	.08	.15	.18
231	.25	.30	.33	.41	.46	.43	.44	.47	.44	.36
241	.34	.35	.40	.34	.30	.35	.27	.28	.24	.23
251	.15	.12	.09	.02	-.02	.04	-.07	.12	.19	-.19
261	-.02	-.22	-.19	-.22	-.26	-.27	-.29	-.26	-.22	-.20
271	-.15	-.14	-.15	-.16	-.17	-.17	-.09	-.06	-.06	-.01
281	.01	.03	.01	.04	.06	.02	.06	.11	.15	.16
291	.21	.20	.23	.26	.29	.31	.31	.35	.36	.33
301	.35	.40	.40	.40	.41	.46	.43	.46	.47	.40
311	.45	.40	.46	.46	.48	.49	.49	.47	.47	.48
321	.46	.44	.44	.42	.42	.41	.36	.36	.35	.34
331	.31	.37	.33	.32	.31	.31	.30	.30	.30	.29
341	.31	.34	.32	.34	.36	.36	.36	.37	.38	.39
351	.40	.40	.39	.34	.37	.35	.32	.30	.27	.25
361	.23	.21	.20	.19	.19	.17	.16	.15	.14	.15
371	.16	.16	.15	.12	.09	.05	.05	.00	-.01	-.05
381	-.06	-.09	-.07	-.03	-.03	-.03	-.06	-.06	-.07	-.06
391	-.05	-.06	-.06	-.05	-.04	-.02	-.02	-.00	-.02	-.00
401	.00	-.00	1.12	.00	.05	.00	.00	.00	.00	.00

RMS = 2.940 INCHES

TABLE 31

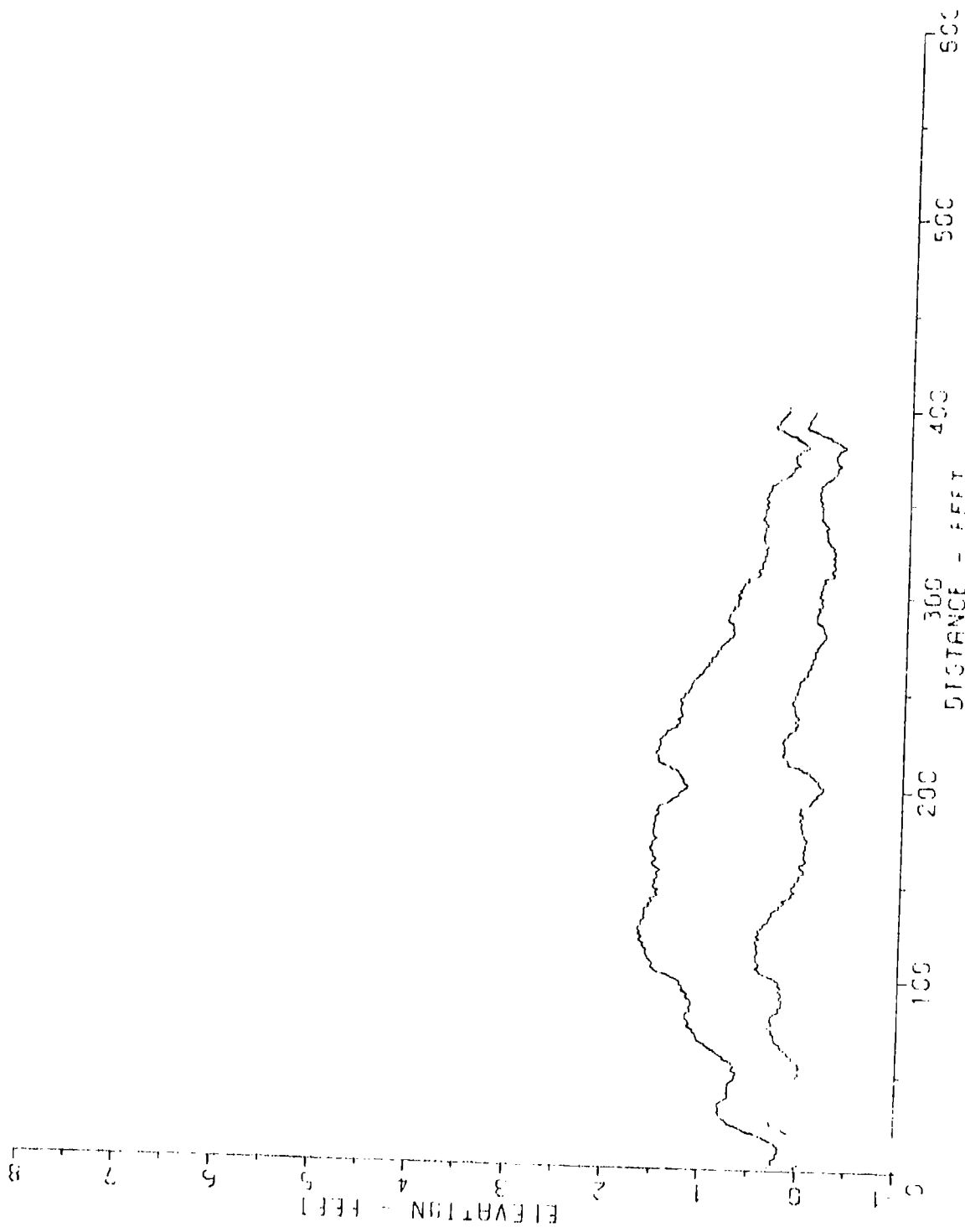


Figure 37

FD33

5/23/78

APR 37 13 NOV 76

ADDED TO THE DISK ON 24 MAR 77

NUMBER OF POINTS = 401

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	.12	.03	.04	.03	.06	.11	.11	.13	.15
11	.15	.17	.15	.13	.12	.08	.04	.01	.04	.14
21	.15	.17	.21	.27	.28	.28	.31	.32	.33	.33
31	.30	.26	.30	.30	.26	.22	.20	.16	.16	.16
41	.14	.12	.13	.11	.11	.08	.04	.02	.02	.01
51	.01	.02	.01	.02	.00	.01	.03	.08	.06	.08
61	.11	.12	.15	.19	.20	.20	.24	.26	.26	.26
71	.26	.28	.28	.29	.32	.28	.28	.30	.30	.29
81	.28	.26	.22	.22	.22	.19	.18	.19	.18	.21
91	.21	.16	.20	.23	.21	.20	.23	.22	.23	.24
101	.29	.33	.38	.43	.44	.46	.44	.43	.44	.46
111	.45	.46	.47	.45	.44	.45	.46	.44	.46	.48
121	.45	.43	.47	.43	.44	.45	.43	.40	.40	.38
131	.34	.34	.34	.31	.31	.31	.29	.24	.25	.19
141	.18	.22	.17	.11	.12	.11	.06	.12	.12	.09
151	.08	.09	.04	.04	.04	.02	.01	.01	.02	.04
161	.04	.00	.02	.00	.00	.01	.01	.01	.00	.01
171	.01	.01	.03	.04	.01	.01	.01	.02	.02	.02
181	.04	.02	.02	.04	.04	.01	.02	.05	.03	.05
191	.03	.04	.07	.07	.10	.13	.12	.14	.16	.19
201	.19	.15	.13	.14	.11	.09	.07	.04	.02	.04
211	.06	.11	.18	.19	.19	.21	.23	.24	.21	.23
221	.22	.22	.23	.24	.22	.22	.19	.19	.18	.14
231	.10	.12	.08	.09	.12	.08	.08	.11	.12	.12
241	.13	.13	.12	.14	.16	.14	.12	.14	.09	.11
251	.09	.09	.08	.08	.08	.07	.05	.04	.01	.01
261	.01	.01	.03	.02	.04	.04	.03	.06	.07	.07
271	.06	.09	.08	.10	.11	.14	.14	.18	.17	.18
281	.16	.15	.16	.15	.13	.08	.07	.07	.08	.07
291	.09	.09	.11	.08	.12	.13	.10	.11	.13	.09
301	.10	.13	.09	.11	.12	.12	.13	.16	.14	.17
311	.24	.25	.22	.22	.25	.24	.23	.23	.24	.25
321	.22	.25	.24	.23	.22	.24	.22	.19	.18	.16
331	.17	.16	.16	.16	.16	.14	.17	.16	.13	.12
341	.09	.10	.11	.09	.10	.08	.11	.10	.08	.10
351	.09	.05	.07	.07	.06	.07	.08	.08	.07	.11
361	.13	.14	.20	.20	.23	.23	.25	.24	.27	.30
371	.25	.24	.23	.22	.22	.25	.26	.26	.33	.31
381	.28	.25	.23	.17	.16	.09	.04	.01	.04	.09
391	.08	.05	.06	.04	.03	.01	.01	.01	.00	.01
401	.00	-1.00	1.12	.02	.02	.00	.00	.00	.00	.00

RES = 2.292 INCHES

TABLE 32

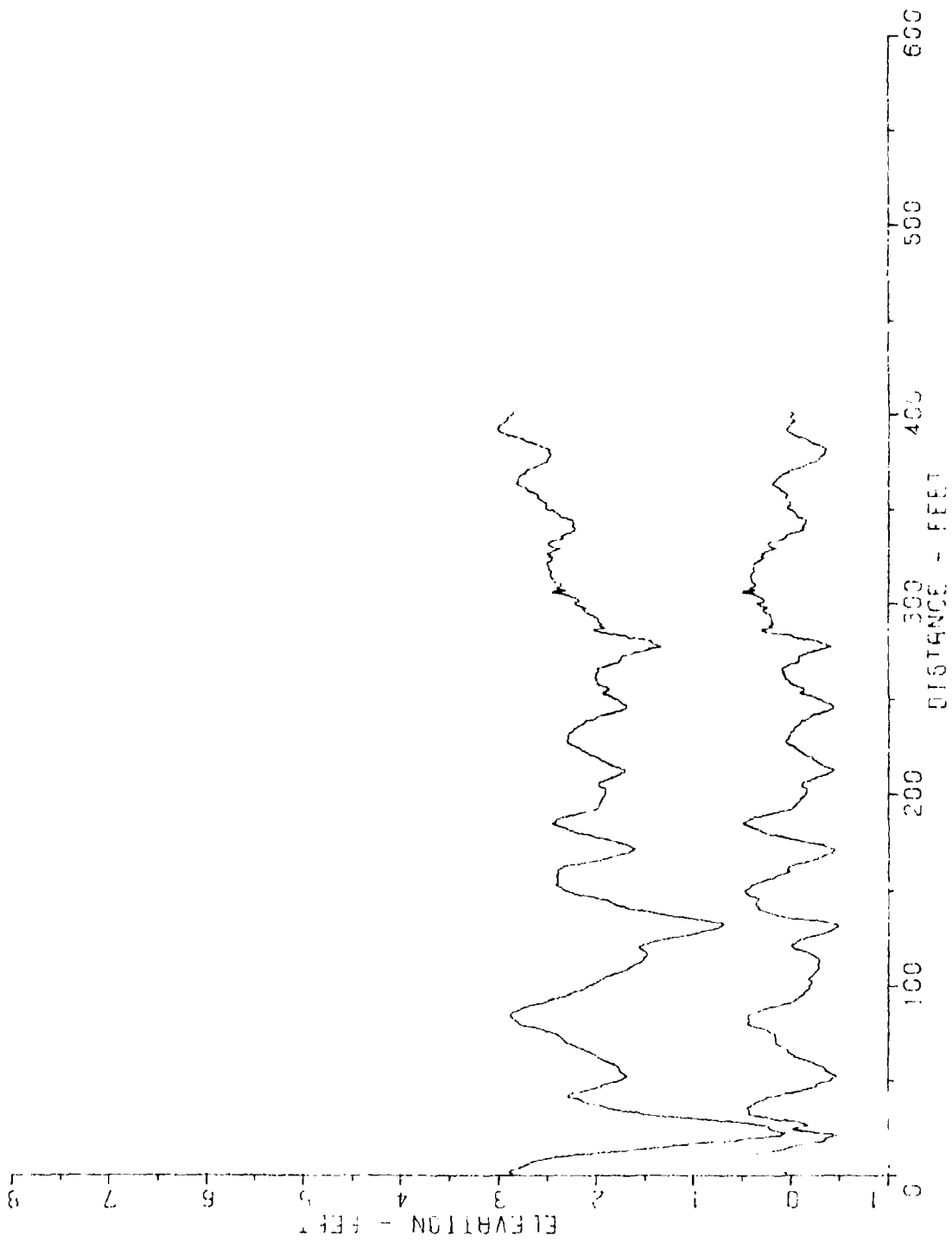


Figure 38

RD34

5/23/79

DE-32 15 NOV 75

ADDED TO THE DISK ON 24.MAR.77

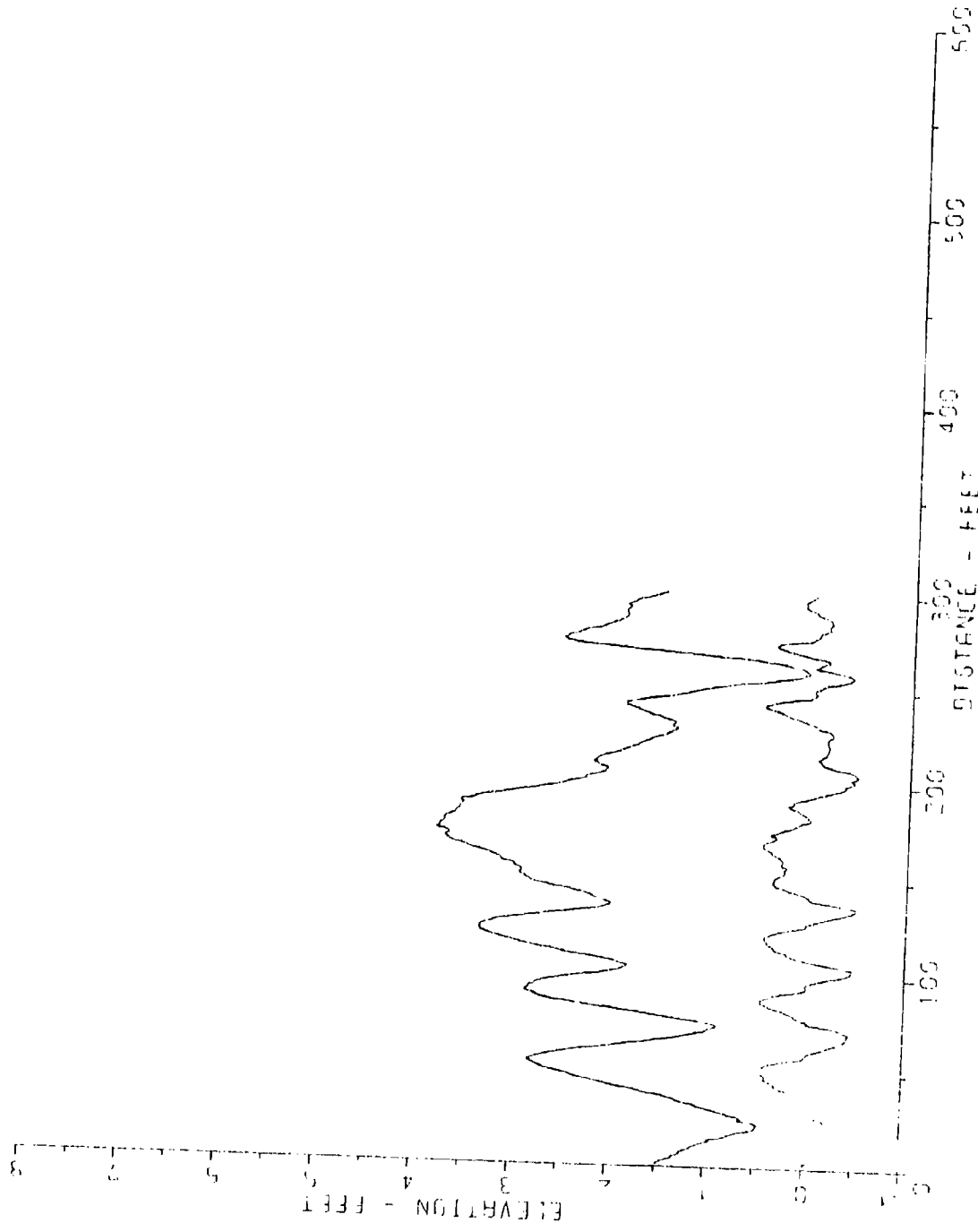
NUMBER OF POINTS * 471

INTERVAL IN INCHES * 12

POINT	ELEVATIONS IN FEET									
1	.12	.15	.20	.26	.31	.37	.44	.48	.50	.49
11	.40	.31	.18	.22	.41	.11	.17	.35	.35	.39
21	.45	.38	.19	.20	.40	.18	.13	.07	.10	.24
31	.32	.44	.43	.44	.47	.41	.38	.36	.32	.25
41	.25	.15	.22	.10	.14	.22	.27	.27	.38	.42
51	.43	.40	.44	.39	.36	.35	.32	.30	.24	.18
61	.14	.10	.03	.04	.13	.04	.07	.09	.12	.15
71	.16	.20	.16	.10	.17	.24	.26	.31	.38	.40
81	.43	.45	.44	.44	.43	.34	.32	.26	.20	.11
91	.41	.13	.26	.29	.11	.15	.16	.18	.21	.19
101	.21	.22	.21	.19	.21	.23	.26	.27	.29	.29
111	.28	.20	.30	.29	.26	.25	.21	.16	.10	.03
121	.41	.32	.45	.12	.15	.20	.28	.35	.41	.44
131	.49	.49	.46	.31	.14	.02	.15	.16	.23	.33
141	.33	.35	.36	.35	.33	.33	.37	.43	.46	.48
151	.45	.41	.41	.34	.28	.24	.17	.12	.05	.00
161	.43	.12	.20	.26	.16	.24	.30	.33	.36	.43
171	.43	.27	.37	.41	.21	.11	.01	.09	.16	.23
181	.31	.37	.41	.44	.50	.45	.43	.37	.29	.20
191	.12	.21	.24	.25	.27	.29	.11	.12	.15	.16
201	.17	.17	.17	.12	.12	.14	.18	.24	.29	.35
211	.40	.44	.44	.39	.33	.29	.26	.23	.21	.17
221	.13	.11	.27	.24	.22	.23	.25	.25	.22	.23
231	.44	.22	.23	.23	.26	.26	.10	.11	.17	.21
241	.22	.22	.35	.41	.44	.43	.40	.34	.31	.26
251	.22	.16	.10	.14	.14	.10	.02	.01	.03	.03
261	.46	.45	.38	.26	.29	.20	.23	.20	.20	.09
271	.49	.40	.15	.19	.27	.34	.42	.36	.32	.28
281	.17	.23	.21	.13	.25	.30	.19	.22	.17	.20
291	.20	.20	.21	.22	.25	.28	.29	.24	.30	.34
301	.27	.28	.30	.34	.40	.50	.30	.43	.37	.35
311	.40	.41	.42	.42	.41	.39	.37	.39	.38	.38
321	.37	.35	.30	.27	.30	.28	.31	.22	.15	.21
331	.23	.23	.19	.28	.24	.25	.21	.27	.13	.14
341	.12	.15	.15	.16	.12	.06	.06	.05	.02	.03
351	.44	.41	.27	.22	.24	.25	.23	.25	.27	.11
361	.12	.15	.19	.17	.15	.14	.12	.08	.02	.02
371	.24	.10	.16	.21	.26	.28	.31	.34	.35	.34
381	.37	.34	.31	.28	.21	.18	.14	.07	.02	.01
391	.24	.25	.21	.20	.21	.24	.23	.20	.21	.23
401	.42	1.00	1.12	.40	.15	.20	.20	.20	.20	.20

RMS * 3.087 INCHES

TABLE 33



FD35

Figure 39

5/27/73

AD 36 16 NOV 76

ADDED TO THE DISK ON 24 MAR 77

NUMBER OF POINTS = 301

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.00	-.02	-.03	-.05	-.09	-.07	-.11	-.09	-.12	-.14
11	-.13	-.15	-.18	-.23	-.17	-.29	-.33	-.34	-.38	-.46
21	-.49	-.47	-.46	-.34	-.21	-.20	-.12	.00	.00	.01
31	.01	.05	.04	.05	.07	.06	.06	.08	.12	.15
41	.20	.25	.30	.30	.32	.39	.41	.40	.42	.44
51	.46	.44	.42	.42	.36	.26	.14	.01	.00	-.03
61	-.74	-.12	-.17	-.21	-.31	-.33	-.35	-.41	-.43	-.42
71	-.45	-.40	-.34	-.31	-.16	.00	-.02	.05	.09	.12
81	.17	.21	.25	.31	.38	.42	.46	.47	.43	.37
91	.34	.25	.12	.01	.00	.02	.00	-.05	-.13	-.21
101	-.33	-.42	-.44	-.46	-.46	-.37	-.25	.12	.00	.00
111	.14	.22	.23	.31	.34	.35	.37	.41	.42	.44
121	.45	.43	.30	.31	.25	.15	.02	.02	-.03	-.08
131	-.16	-.24	-.31	-.42	-.46	-.48	-.47	-.38	-.24	-.10
141	.00	.01	.02	.08	.15	.23	.28	.34	.37	.37
151	.35	.36	.31	.27	.25	.27	.23	.24	.30	.28
161	.28	.00	.31	.36	.39	.40	.42	.48	.48	.47
171	.45	.38	.34	.35	.40	.33	.28	.22	.16	.13
181	.00	.01	-.04	.03	.05	.09	.12	.14	.21	.24
191	.18	.18	.12	.04	-.03	-.09	-.16	-.23	-.30	-.36
201	-.34	-.39	-.43	-.40	-.42	-.48	-.45	-.43	-.36	-.26
211	-.18	-.11	-.10	-.08	-.05	-.09	-.14	-.13	-.16	-.16
221	-.16	-.15	-.14	-.15	-.15	-.16	-.20	-.19	-.17	-.15
231	-.05	-.04	.00	.04	.12	.17	.25	.29	.33	.37
241	.45	.40	.48	.44	.33	.19	.03	.00	-.03	-.00
251	-.02	-.07	-.08	-.13	-.25	-.33	-.38	-.40	-.37	-.33
261	-.21	-.10	.00	-.05	-.05	-.14	-.13	-.06	.06	.16
271	.23	.31	.39	.40	.35	.22	.04	.01	-.03	-.04
281	-.04	-.11	-.14	-.13	-.14	-.17	-.15	-.14	-.10	-.05
291	-.11	.01	.04	.11	.11	.10	.11	.07	.04	.01
301	.00	-1.00	1.50	.00	-.02	.00	.00	.00	.00	.00

RMS = 3.163 INCHES

TABLE 34

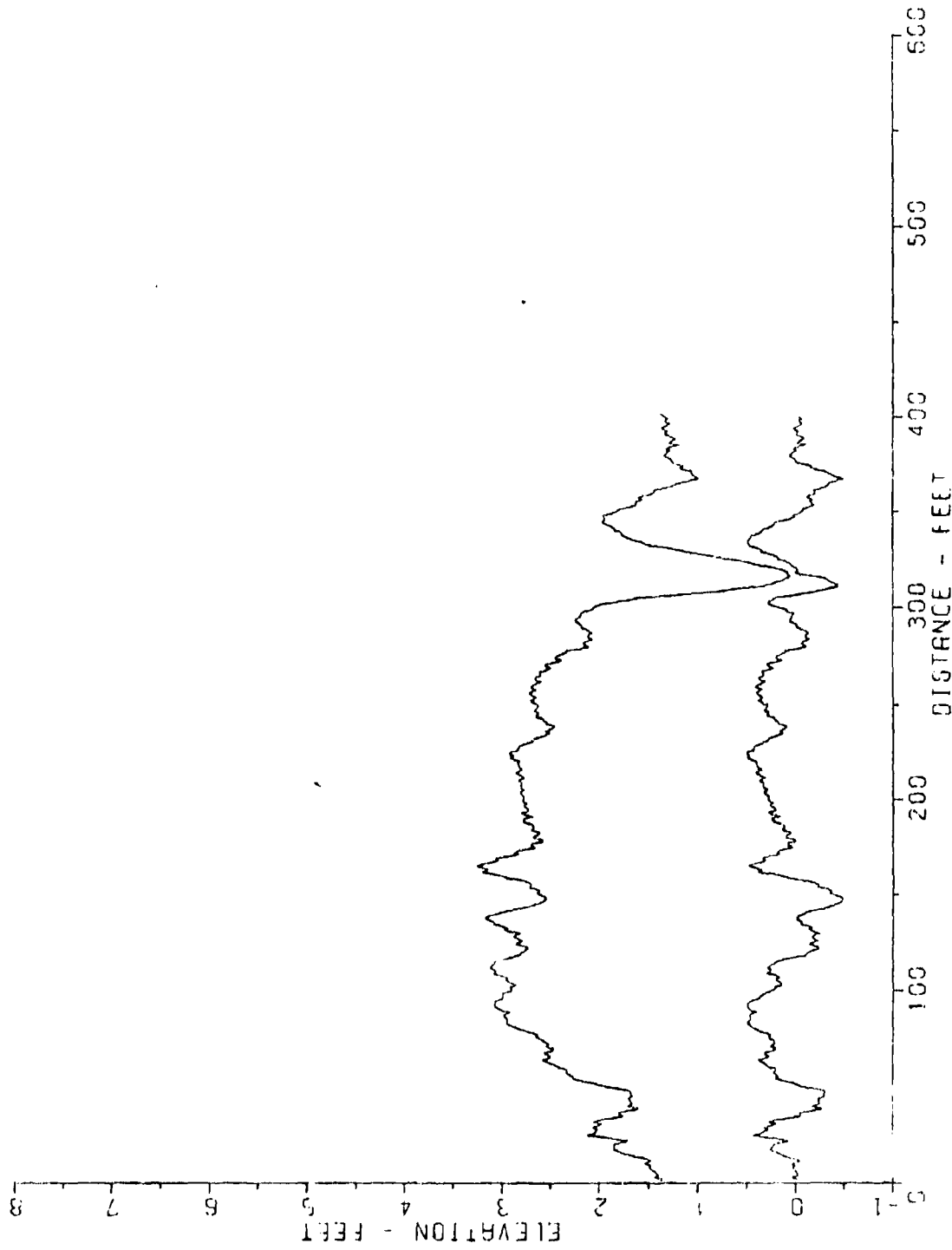


Figure 40

RD35

6/27/79

APR 16 NOV 76

ADDED TO THE DISK ON 24 MAR 77

NUMBER OF POINTS ■ 401

INTERVAL IN INCHES ■ 12

POINT	ELEVATIONS IN FEET									
1	.00	-.13	.03	-.02	-.01	-.01	.01	.02	-.01	.04
11	-.02	-.05	.01	.12	.15	.20	.23	.25	.23	.22
21	.18	.07	.16	.30	.43	.34	.31	.26	.31	.25
31	.20	.27	.17	.07	-.05	-.04	-.05	-.21	-.27	-.18
41	-.23	-.24	-.24	-.25	-.30	-.29	-.30	-.30	-.21	-.11
51	-.02	.03	.12	.20	.18	.20	.23	.21	.20	.27
61	.29	.32	.34	.37	.29	.27	.31	.30	.21	.26
71	.25	.21	.23	.23	.26	.26	.26	.20	.35	.41
81	.44	.46	.49	.48	.45	.46	.47	.45	.39	.46
91	.49	.49	.49	.47	.44	.37	.35	.34	.31	.23
101	.21	.22	.15	.15	.19	.20	.17	.22	.29	.26
111	.25	.26	.26	.22	.19	.17	.08	-.04	-.12	-.14
121	-.19	-.24	-.23	-.14	-.16	-.22	-.20	-.17	-.28	-.25
131	-.18	-.13	-.17	-.12	-.05	-.06	-.02	.00	-.03	-.10
141	-.12	-.19	-.29	-.37	-.41	-.46	-.48	-.40	-.46	-.41
151	-.35	-.37	-.32	-.23	-.23	-.20	-.14	-.02	.00	.14
161	.28	.37	.34	.40	.47	.44	.36	.31	.34	.30
171	.16	.19	.17	.10	.02	.07	.07	-.01	.01	.09
181	.09	.04	.25	.13	.11	.12	.14	.23	.24	.23
191	.15	.24	.27	.20	.21	.26	.25	.23	.27	.27
201	.27	.25	.30	.32	.28	.32	.33	.32	.34	.32
211	.34	.30	.30	.40	.38	.34	.30	.30	.40	.36
221	.44	.48	.46	.50	.49	.43	.42	.41	.38	.32
231	.28	.28	.21	.17	.13	.16	.13	.08	.09	.17
241	.18	.21	.22	.29	.26	.27	.32	.30	.28	.29
251	.34	.37	.35	.32	.37	.39	.36	.33	.39	.39
261	.34	.31	.36	.37	.32	.32	.34	.28	.23	.28
271	.20	.18	.13	.20	.18	.13	.10	.10	-.02	-.12
281	-.08	-.07	-.11	-.15	-.10	-.11	-.14	-.19	-.06	-.02
291	-.01	.02	.05	.06	.03	.02	.01	.06	.10	.17
301	.24	.28	.27	.22	.21	.06	-.05	-.18	-.28	-.30
311	-.43	-.44	-.37	-.34	-.29	-.21	-.08	.00	-.02	-.02
321	.02	.04	.07	.12	.19	.18	.24	.38	.36	.35
331	.39	.46	.48	.48	.47	.45	.45	.40	.34	.33
341	.27	.24	.22	.20	.13	.06	.00	.01	-.05	-.08
351	-.08	-.14	-.24	-.18	-.15	-.18	-.12	-.14	-.20	-.21
361	-.18	-.26	-.32	-.34	-.34	-.42	-.49	-.42	-.37	-.34
371	-.00	-.20	-.15	-.16	-.07	.00	.00	.01	.07	.02
381	.02	.02	.02	-.03	-.11	-.02	-.06	.10	.07	.02
391	-.01	-.04	-.00	.02	.04	.08	.04	.05	.05	.05
401	.00	-.20	1.00	.00	.03	.00	.00	.00	.00	.00

RMS ■ 2.051 INCHES

TABLE 35

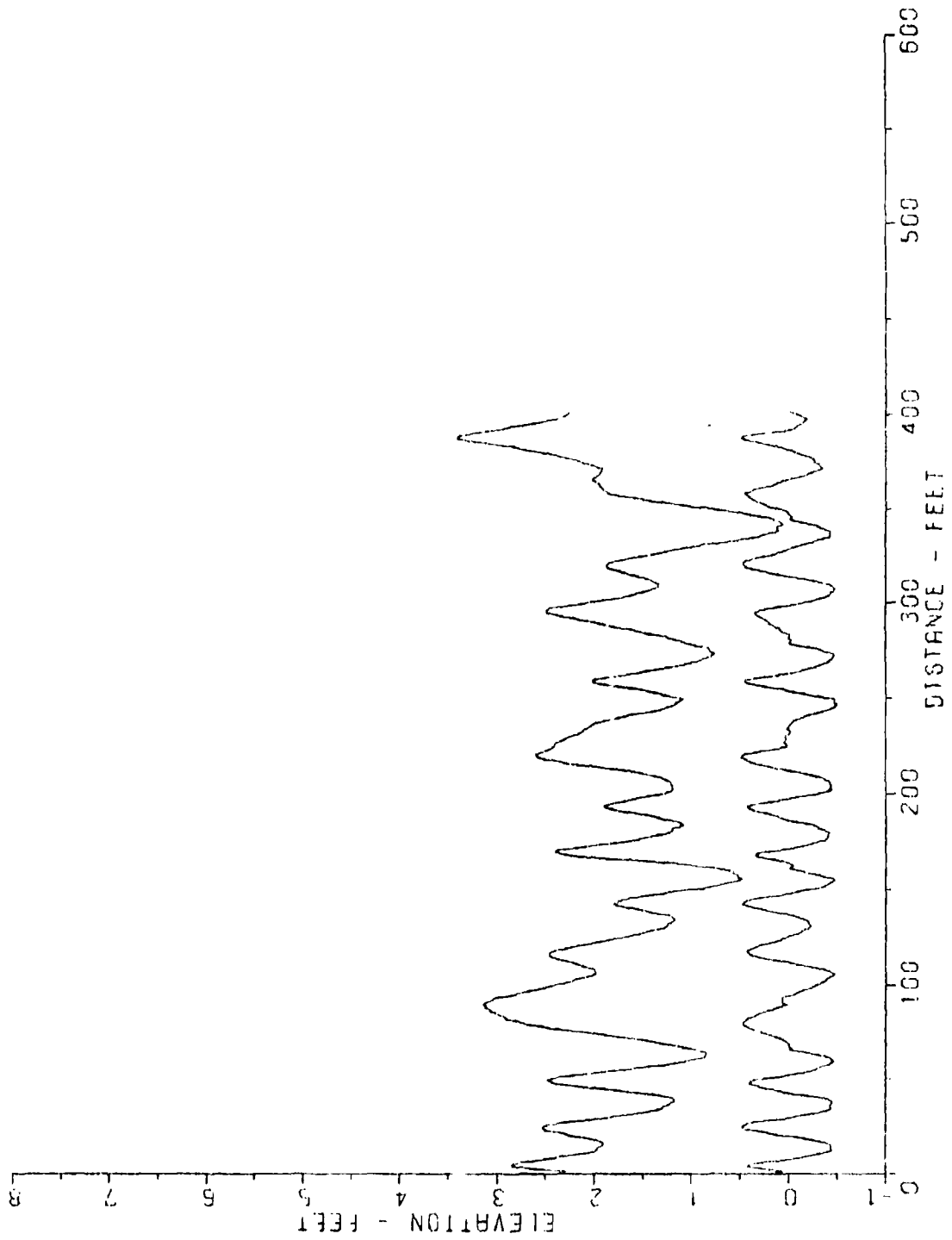


Figure 41

RD37

6/27/78

APR 30 16 NOV 70

ADDED TO THE DISK ON 24 MAR 77

NUMBER OF POINTS = 401

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.92	.19	.35	.43	.39	.23	.04	-.10	-.19	-.27
11	-.39	-.45	-.44	-.44	-.43	-.39	-.29	-.21	-.09	-.06
21	.19	.39	.43	.48	.48	.42	.33	.16	-.01	-.18
31	-.20	-.33	-.42	-.45	-.42	-.45	-.45	-.45	-.41	-.33
41	-.16	.02	.28	.16	.28	.34	.41	.39	.36	.23
51	.04	-.06	-.15	-.23	-.25	-.33	-.40	-.44	-.47	-.44
61	-.43	-.47	-.28	-.16	.00	-.04	.00	.00	.02	.05
71	.06	.12	.19	.24	.30	.37	.41	.45	.48	.46
81	.43	.42	.35	.32	.27	.23	.15	.10	.01	.06
91	.06	.05	.06	-.01	-.07	-.10	-.16	-.22	-.25	-.29
101	-.34	-.39	-.38	-.43	-.47	-.48	-.42	-.35	-.28	-.15
111	-.09	.02	.15	.25	.34	.39	.42	.44	.39	.33
121	.28	.20	.13	.07	.02	-.04	-.10	-.13	-.16	-.21
131	-.23	-.21	-.20	-.19	-.15	-.08	.01	.09	.19	.29
141	.39	.46	.48	.43	.35	.28	.14	.01	-.10	-.18
151	-.31	-.38	-.42	-.45	-.49	-.46	-.37	-.30	-.21	-.14
161	.00	-.04	-.05	.01	.08	.15	.27	.36	.32	.21
171	.04	-.04	-.15	-.25	-.28	-.38	-.40	-.40	-.41	-.43
181	-.38	-.39	-.30	-.25	-.12	.00	.07	.11	.17	.24
191	.32	.39	.44	.39	.29	.14	.01	-.09	-.18	-.39
201	-.41	-.44	-.42	-.44	-.43	-.42	-.39	-.35	-.28	-.18
211	-.11	.01	.13	.21	.30	.39	.45	.48	.49	.44
221	.34	.22	.12	.01	.03	.05	.03	.03	.03	.00
231	-.01	-.02	.01	-.00	-.02	-.02	-.04	-.08	-.12	-.17
241	-.23	-.33	-.39	-.43	-.48	-.49	-.46	-.47	-.46	-.32
251	-.20	-.12	.00	.07	.18	.30	.42	.45	.44	.34
261	.18	.02	-.06	-.13	-.22	-.28	-.34	-.37	-.42	-.45
271	-.46	-.47	-.45	-.36	-.31	-.26	-.12	.00	.01	.04
281	.01	-.01	-.00	.06	.09	.08	.14	.17	.20	.21
291	.25	.28	.33	.35	.34	.29	.19	.03	-.09	-.16
301	-.24	-.34	-.39	-.42	-.43	-.46	-.48	-.45	-.44	-.30
311	-.31	-.21	-.10	.01	.13	.22	.29	.40	.45	.47
321	.47	.45	.38	.30	.21	.12	.05	.00	-.04	-.09
331	-.16	-.25	-.29	-.36	-.44	-.48	-.43	-.44	-.36	-.28
341	-.29	-.27	-.11	.00	.04	.02	.01	.00	.05	.12
351	.27	.24	.30	.35	.38	.41	.43	.46	.39	.34
361	.26	.19	.12	.07	.00	-.05	-.12	-.19	-.25	-.30
371	-.36	-.33	-.32	-.27	-.27	-.26	-.21	-.17	-.10	-.04
381	.02	.08	.14	.24	.34	.42	.49	.45	.34	.19
391	.02	-.00	-.09	-.17	-.15	-.16	-.20	-.15	-.13	-.08
401	.00	-1.00	1.00	.00	.17	.00	.00	.00	.00	.00

RMS = 3.439 INCHES

TABLE 36

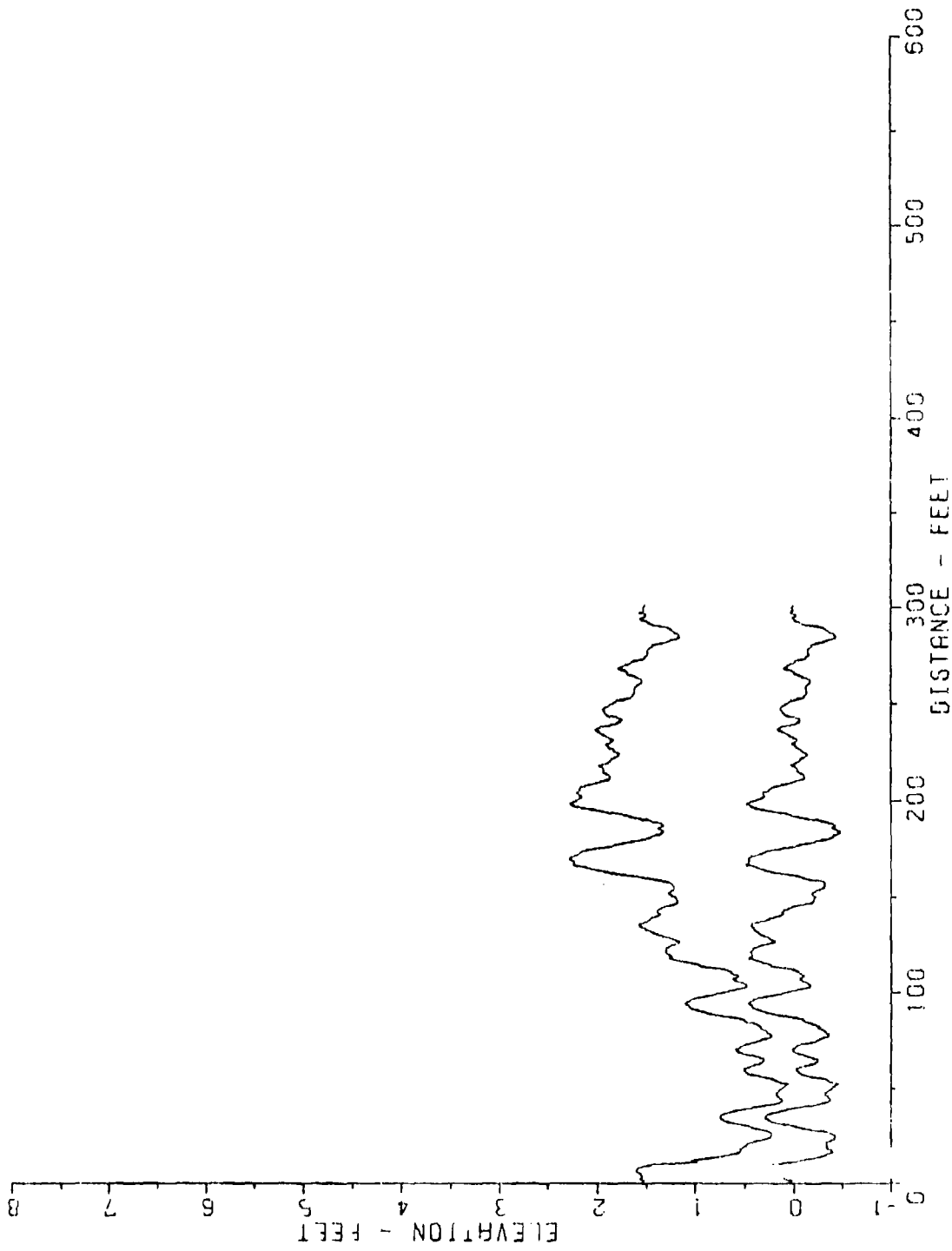


Figure 42

RD33

5/27/78

AP629 16 ADV 70

ADDED TO THE DISK ON 24.MAR.77

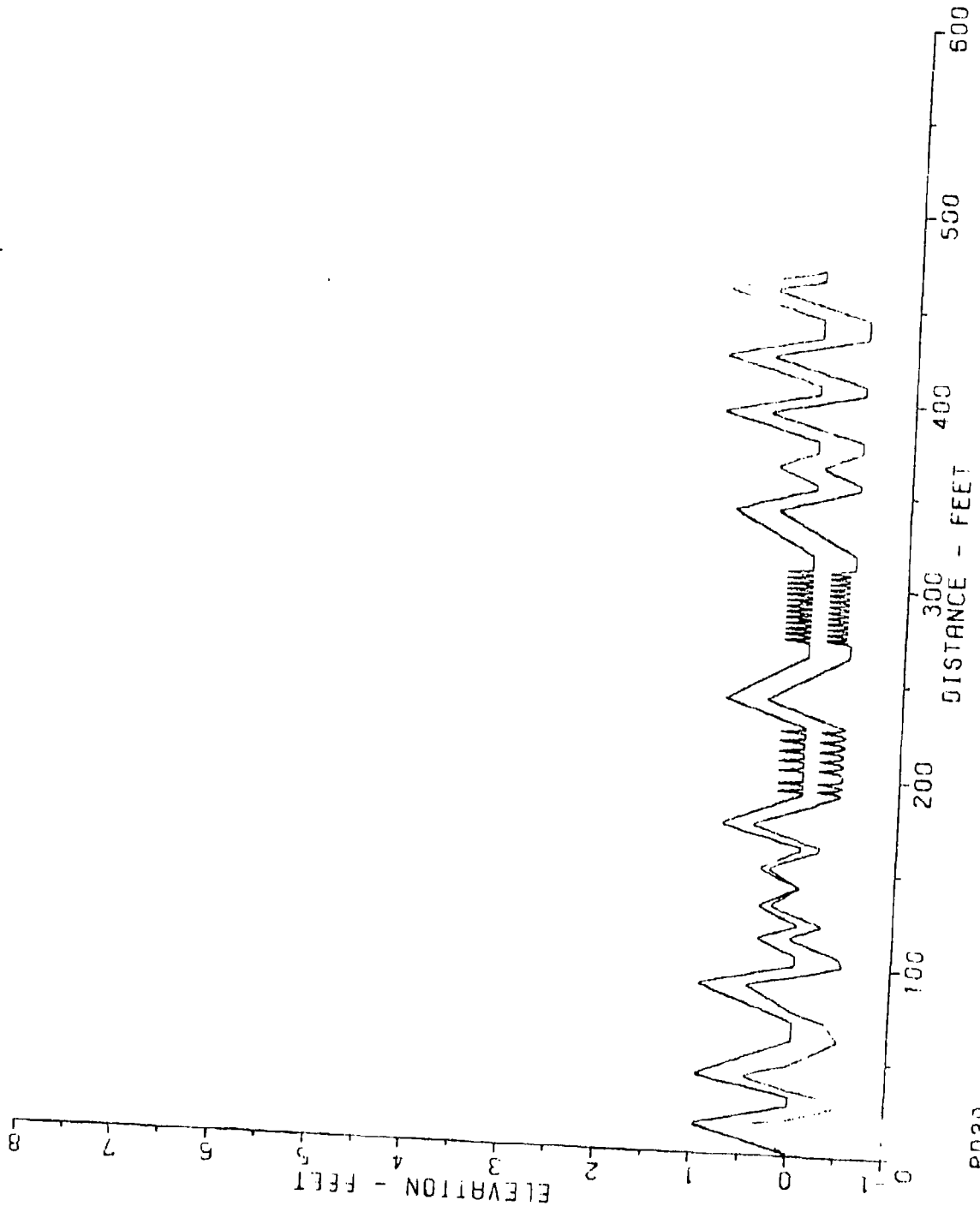
NUMBER OF POINTS = 321

INTERVAL IN INCHES = 12

POINT	ELEVATIONS IN FEET									
1	.01	.11	.11	.16	.21	.28	.31	.32	.28	.24
11	-.03	-.08	-.19	-.32	-.34	-.44	-.39	-.33	-.38	-.33
21	-.32	-.38	-.41	-.44	-.42	-.38	-.29	-.17	-.08	-.01
31	.12	.22	.26	.29	.28	.26	.18	.12	.04	-.02
41	-.22	-.33	-.38	-.37	-.35	-.33	-.32	-.35	-.38	-.48
51	-.43	-.46	-.38	-.33	-.29	-.17	-.09	-.05	-.03	-.03
61	-.49	-.16	-.22	-.25	-.25	-.20	-.12	-.05	.01	.02
71	-.02	-.04	-.09	-.19	-.21	-.32	-.37	-.37	-.32	-.31
81	-.26	-.27	.23	-.19	-.11	-.10	-.01	.14	.24	.26
91	.37	.43	.44	.46	.45	.40	.36	.28	.17	.08
101	-.01	-.09	-.18	-.19	-.15	-.10	-.06	-.11	-.12	-.05
111	-.05	.01	.13	.22	.25	.32	.40	.46	.42	.42
121	.44	.42	.41	.35	.31	.22	.18	.23	.25	.36
131	.36	.39	.40	.40	.43	.42	.33	.27	.23	.15
141	.18	.12	.12	.05	-.01	-.09	-.18	-.21	-.21	-.23
151	-.20	-.19	-.23	-.26	-.32	-.31	-.33	-.30	-.22	-.19
161	-.02	.10	.19	.30	.36	.41	.49	.46	.45	.47
171	.43	.37	.29	.25	.17	.02	-.09	-.14	-.25	-.33
181	-.44	-.42	-.48	-.48	-.43	-.39	-.44	-.38	-.28	-.22
191	-.12	.00	.06	.16	.27	.41	.46	.49	.44	.35
201	.31	.28	.32	.30	.25	.23	.20	.11	.01	-.08
211	-.11	-.12	-.11	-.06	-.04	-.03	-.01	.03	.03	.00
221	-.08	-.12	-.14	-.15	-.08	-.07	-.02	-.01	.02	.04
231	-.05	.04	.04	.07	.12	.16	.13	.10	.06	.06
241	-.06	-.06	.01	.05	.11	.13	.14	.12	.08	.06
251	.02	-.05	-.11	-.13	-.14	-.14	-.13	-.13	-.14	-.16
261	-.18	-.17	-.15	-.08	-.09	-.01	.03	.10	.06	.02
271	-.02	-.03	-.14	-.13	-.17	-.15	-.15	-.16	-.10	-.12
281	-.27	-.32	-.37	-.44	-.43	-.41	-.36	-.34	-.20	-.22
291	-.11	-.07	-.01	.01	-.03	-.03	.04	-.02	.02	.00
301	.00	1.00	1.00	.00	.10	-.02	-.05	-.01	-.08	-.05

RPS = 3.025 INCHES

TABLE 37



RO39

Figure 43

5/27/78

TABLE 38
R039

PROFILE 4 APR

ADDED TO THE DISK ON 24.MAR.77

NUMBER OF POINTS * 469

INTERVAL IN INCHES * 12

POINT	ELEVATIONS IN FEET									
1	.89	.83	.77	.70	.63	.55	.47	.22	.25	.29
11	.32	.35	.38	.42	.45	.39	.28	.14	.01	-.07
21	-.14	-.21	-.27	-.35	-.41	-.49	-.47	-.44	-.42	-.39
31	-.35	-.23	-.11	.02	.07	.14	.20	.27	.34	.41
41	.47	.44	.30	.31	.24	.16	.08	.01	-.03	-.08
51	-.11	-.15	-.19	-.22	-.26	-.29	-.33	-.37	-.41	-.44
61	-.48	-.46	-.44	-.44	-.42	-.41	-.39	-.38	-.36	-.35
71	-.33	-.28	-.22	-.13	-.06	.00	.03	.07	.10	.14
81	.17	.20	.25	.28	.31	.35	.38	.42	.45	.48
91	.45	.35	.23	.13	.01	-.07	-.16	-.24	-.33	-.41
101	-.49	-.49	-.47	-.46	-.45	-.44	-.38	-.32	-.27	-.21
111	-.16	-.14	-.04	.01	.06	.06	.01	-.03	-.09	-.14
121	-.20	-.25	-.24	-.18	-.12	-.07	-.01	.04	.10	.16
131	.21	.25	.27	.24	.22	.18	.15	.12	.08	.05
141	.02	-.01	.00	.03	.07	.10	.14	.17	.20	.24
151	.27	.30	.29	.24	.20	.14	.09	.04	-.02	-.07
161	-.13	-.18	-.20	-.20	-.14	-.08	-.01	.05	.11	.17
171	.24	.30	.36	.40	.40	.40	.43	.37	.31	.25
181	.19	.13	.06	.00	-.05	-.10	-.15	-.20	-.25	-.30
191	-.35	-.40	-.35	-.15	-.35	-.40	-.35	-.15	-.55	-.41
201	-.41	-.41	-.41	-.35	-.15	-.35	-.41	-.41	-.35	-.15
211	-.36	-.41	-.41	-.36	-.16	-.36	-.41	-.41	-.36	-.16
221	-.36	-.41	-.41	-.36	-.16	-.36	-.41	-.36	-.20	-.03
231	-.17	-.11	-.05	.01	.07	.13	.18	.23	.29	.35
241	.41	.34	.34	.30	.27	.23	.20	.16	.12	.06
251	.05	.01	-.02	-.06	-.09	-.13	-.17	-.20	-.24	-.28
261	-.32	-.36	-.39	-.43	-.43	-.43	-.43	-.43	-.43	-.43
271	-.43	-.39	-.18	-.38	-.38	-.18	-.38	-.38	-.38	-.38
281	-.38	-.18	-.38	-.38	-.18	-.38	-.38	-.18	-.38	-.38
291	-.19	-.38	-.38	-.19	-.38	-.38	-.19	-.39	-.39	-.19
301	-.39	-.39	-.19	-.39	-.39	-.19	-.39	-.39	-.19	-.39
311	-.44	-.44	-.44	-.44	-.45	-.45	-.45	-.44	-.41	-.38
321	-.34	-.31	-.27	-.23	-.20	-.16	-.12	-.09	-.05	-.02
331	.02	.06	.09	.13	.17	.20	.24	.27	.31	.35
341	.38	.31	.24	.18	.11	.04	-.03	-.10	-.17	-.24
351	-.31	-.38	-.45	-.46	-.46	-.46	-.41	-.36	-.31	-.26
361	-.21	-.17	-.12	-.07	-.07	-.12	-.17	-.21	-.26	-.31
371	-.36	-.41	-.46	-.47	-.47	-.47	-.47	-.47	-.46	-.39
381	-.32	-.25	-.19	-.12	-.06	.01	.06	.15	.22	.29
391	.36	.43	.50	.44	.39	.30	.20	.10	.01	-.08
401	-.18	-.28	-.37	-.47	-.48	-.48	-.48	-.48	-.47	-.40
411	-.33	-.25	-.20	-.14	-.07	.00	.07	.14	.21	.28
421	.35	.42	.49	.47	.39	.29	.20	.10	.01	-.08
431	.18	.25	.37	.47	.48	.48	.48	.48	.48	.48
441	.48	.48	.48	.48	-.41	-.34	-.27	-.20	-.14	-.07
451	.00	.07	.14	.21	.28	.35	.42	.49	.47	.40
461	.29	.20	.10	.01	-.08	.00	-.00	.00	.00	-1.00

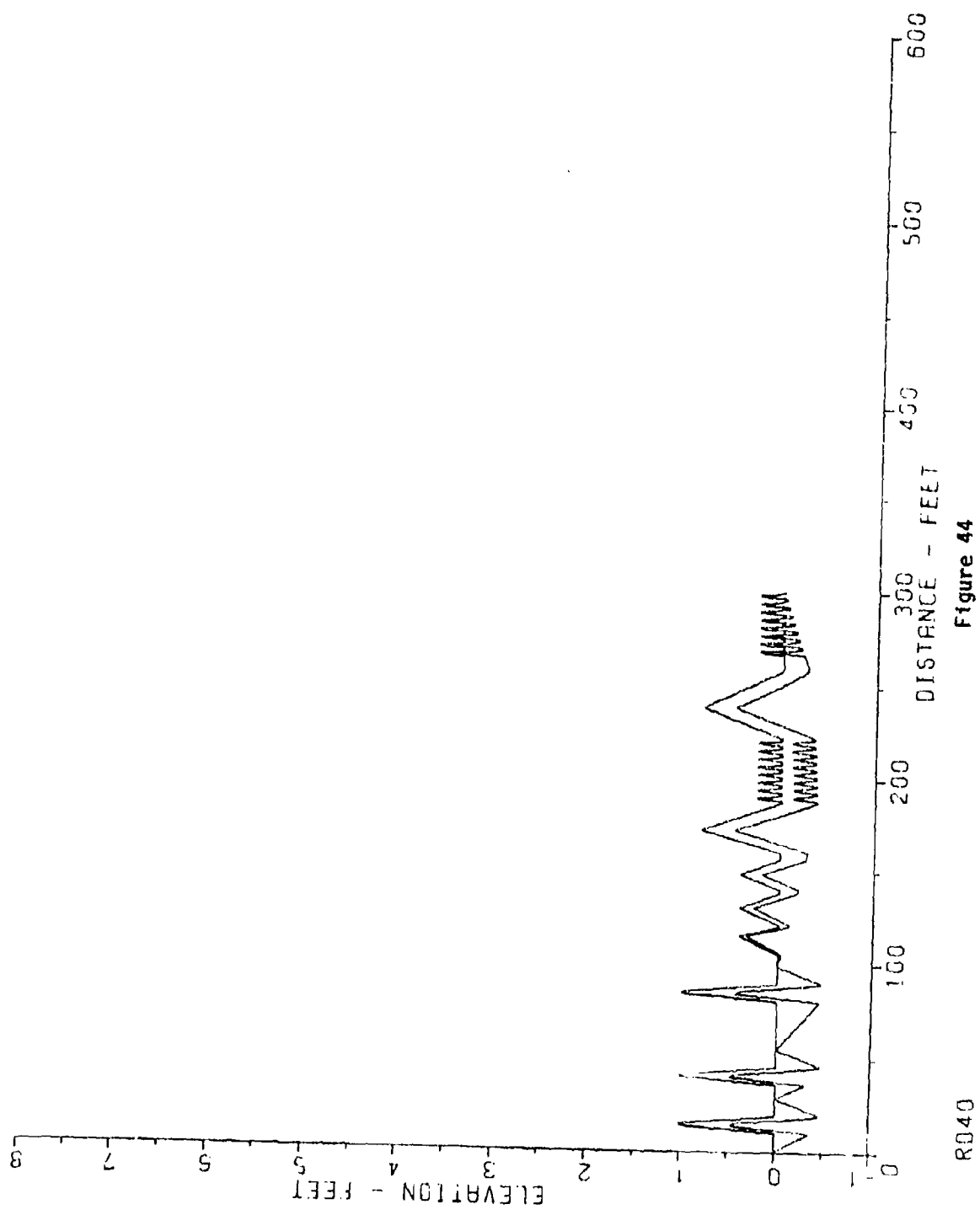


Figure 44

5/27/78

TABLE 39 (Cont'd)

541	-.17	-.17	-.21	-.23	-.24	-.26	-.28	-.27	-.27	-.27
521	-.26	-.26	-.26	-.25	-.25	-.25	-.24	-.24	-.24	-.23
531	-.23	-.23	-.22	-.21	-.19	-.01	.04	.01	.00	-.19
541	-.29	-.19	.13	-.00	.07	.07	.06	.12	.17	-.17
551	-.15	-.04	.05	.14	.05	-.03	-.13	-.14	-.14	-.07
561	.05	.12	.13	.06	-.06	-.11	-.11	-.00	.02	.10
571	.15	.11	.03	-.06	-.08	-.08	-.02	.11	.18	.18
581	.11	-.05	-.06	-.05	-.04	.07	.16	.21	.16	.06
591	-.02	-.03	-.22	.04	.17	.24	.24	.17	.05	.00

RMS = 2.685 INCHES

REFERENCES

1. S. Heal and C. Cicillini, "Micro Terrain Profiles", ATAC report No. AD485664L, 1964
2. F. Hoogterp, "Digital/Analog Vehicle Ride Simulation", TACOM report No. 11705, 1972
3. "Moving-Head Disc Operating System", Hewlett-Packard Company 2116-91779, 1971
4. "Applications Programming Manual", PACER 100 Digital Computing System, EAI Associates Inc., 1976
5. "Moving-Head Disc Software System Manual", PACER 100 Digital Computing System, EAI Associates Inc., 1976

APPENDIX A

COMPUTER PROGRAMS

COMPUTER PROGRAMS

- I. DETR - Detrends terrain and performs wheel trajectory calculations (see section I and Appendix C).

This program reads in a terrain from the disk, graphs it, takes out long uphill and downhill trends (subroutine DETRZ), digitally rolls a wheel over it (subroutine TRAJ) and then graphs the resulting trajectory of the bottom of the wheel. The wheel trajectory can then be listed on the line printer and punched out to paper tape.

DETR is only a control program which handles input, calls the subroutines and provides output.

- II. DETRZ - Detrends a terrain so that it starts and ends at zero and stays within a specified limit.

The subroutine is supplied four parameters.

Y - Real array of terrain data

N - Number of data points

DELTA - Distance between data points

DISP - Maximum distance a data point can be above or below zero

Using the equation for a line

$$Y_i = m X_i + b$$

and the distance of a point (X_j, Y_j) from a line

$$D = \frac{|Y_j - (m X_j + b)|}{\sqrt{1 + m^2}}$$

the subroutine uses Y_i as one of the endpoints of a line and scans the terrain for another endpoint so that D will be less than $DISP$. Once this line is found, the new terrain elevations are calculated as being the distances from this line. The subroutine then uses the second endpoint as a starting endpoint and scans the rest of the terrain for another line. The entire terrain is detrended in this way and the subroutine exits.

III. TRAJ - Translates terrain displacements into wheel trajectories.

This subroutine is taken directly from reference 2. If a rigid tire is rolled over a non-deformable terrain, the bottom of the tire may not meet all of the data points.

The subroutine calculates the height of the bottom of the tire over each of the terrain data points. A tire of 42" diameter was used for all terrains to obtain maximum smoothing. For a discussion of the mathematics involved, see reference 2.

IV. LOAD - Loads a paper tape containing wheel displacements to a disk (see Appendix C).

The program expects the tape to have the five character name of the file as the first record, followed by the number of data points and sample interval in inches in a 215 format as the second record. The data points then follow, ten to a record in a 1055 format. The program creates a disk file for each terrain.

V. SAMP - Sets up and runs a digital terrain simulation (see section 2 and Appendix C).

SAMP is structured as a control program which calls the three subroutines INPUT, BAYS and RUN. Communication of the control variables is accomplished through the two FORTRAN Common's; DATA and PARAM.

COMMON DATA

BEGIN (8) Contains the starting locations of up to eight terrains in the array SAMPLE.

SAMPLE (7500) Contains up to 7500 terrain data points.

COMMON PARAM

- TERRA (8,8) TERRA_{I,J} is the terrain number for CHANNEL_I during PHASE_J.
- SPACE (8,8) The time between data points in milliseconds.
- NRUN (8,8) The number of times the terrain will be traversed.
- DELAY (8,8) The number of milliseconds to wait before outputting the first data point.
- NPHASE (8) NPHASE_I is the number of terrains Channel I will cyclicly execute.
- LAST (8) LAST_I = .TRUE. if I is the last channel for a bay.
- INIT (8) If LAST_I is true then INIT_I will be the first channel for that bay.

```

0001 *TN,L
0002 C
0003 C THIS PROGRAM READS A TERRAIN FROM THE DISK.
0004 C THE FIRST 15 WORDS ARE A DESCRIPTION OF THE TERRAIN.
0005 C WORD 16 IS THE NUMBER OF POINTS IN THE TERRAIN. THE
0006 C REMAINING PORTION OF THE FILE CONTAINS FLOATING POINT
0007 C VARIABLES. THE FIRST OF THESE IS THE POINT SPACING IN INCHES.
0008 C THE REMAINDER OF THE FILE CONTAINS THE ELEVATIONS IN FEET
0009 C OF THE TERRAIN.
0010 C
0011 C THE TERRAIN IS THEN OUTPUT TO PAPER TAPE FOR INPUT TO PAGER 100.
0012 C
0013 PROGRAM DETR
0014 INTEGER TITLE(20)
0015 REAL X(600),Y(600)
0016 DIMENSION A(600),NA(1240),NAF(3)
0017 EQUIVALENCE (A,NA),(Y,A(14)),(TITLE,NA),(N,NA(21))
0018 CALL LPL0T(2)
0019 2 CONTINUE
0020 *WRITE(1,12)
0021 14 FORMAT("ENTER TERRAIN FILE NAME")
0022 READ(1,20) NAF
0023 20 FORMAT(2A2,A1)
0024 CALL ERASE
0025 CALL EXEC(14,1028,NA,128,NAF,0)
0026 DELTA=A(12) / 12.
0027 IF (N.GT. 600) N=600
0028 DO 35 I=1,N
0029 X(I)=J * DELTA
0030 35 CONTINUE
0031 ITEM=(2*N)+26-128
0032 CALL EXEC(14,1028,NA(129),ITER,NAF,1)
0033 CALL LPL0T(1,0.,-1.,12.18,600.,0.)
0034 CALL SYMB(0.,-1.,15,NAF,0.,5)
0035 CALL LPL0T(0,X,Y,N,1,0.,0.)
0036 CALL DETRZ(Y,N,DELTA,.5)
0037 CALL TRAJ(N,IFIX(A(12)),Y,42.)
0038 CALL LPL0T(0,X,Y,N,1,0.,0.)
0039 READ(1,20) NOYES
0040 IF (NOYES.NE. 2HYES) GO TO 2
0041 *WRITE(6,30) NAF,TITLE,N,A(12),(NS,(Y(NS+I-1),I=1,10),NS=1,N,10)
0042 30 FORMAT(1H1,25X,2A2,A1,/,1HA,1BAB," ADDED TO THE DISK ON ",0A8,/)
0043 $"NUMBER OF POINTS = ",I4,/,
0044 $"INTERVAL IN INCHES = ",I4,/,
0045 $"2 POINTS",20X," ELEVATIONS IN FEET ",
0046 $ /,I5,1PF6,2))
0047 SUM=0.
0048 SUM2=0.
0049 DO 35 I=1,N
0050 SUM=SUM + Y(I)
0051 SUM2=SUM2 + Y(I)**2
0052 Y(I)=2 * Y(I)
0053 35 CONTINUE
0054 RMS=SQRT((SUM2 - SUM**2/N)/N) * 12.
0055 *WRITE(6,30) RMS
0056 30 FORMAT("RMS = ",G10.4," INCHES")
0057 CALL EXEC(3,1004B)
0058 *WRITE(4,47) NAF,N,A(12),(Y(1),I=1,N)
0059 40 FORMAT(2A2,A1,/,2I5,6P(/,1PF5,3))
0060 GO TO 2

```

```

0001 FYNAL
0002 SUBROUTINE DETRZ(Y,N,DELTA,DISP)
0003 C
0004 C   DETRZ IS SUCH THAT:
0005 C       (1) STARTING AND ENDING POINTS EQUAL ZERO
0006 C       (2) MAXIMUM POINT < DISP
0007 C       (3) MINIMUM POINT > DISP
0008 C
0009 REAL Y(1),DELTA,DISP,P,X,B
0010 INTEGER N,START,I,DISP,J
0011 C
0012 START=1
0013 10 CONTINUE
0014 C   SCAN UNTIL A LINE IS FOUND THAT 'FITS' THE DATA
0015 B=Y(START)
0016 DO 30 J=START+2,-1
0017 M=(Y(J)-Y(START)) / ((J-START)*DELTA)
0018 FACT=1. / SQRT(1. + M**2)
0019 DO 20 J=START+1,I-1
0020 X=(J-START)*DELTA
0021 D=ABS(Y(J)-(P*X+B)) * FACT
0022 IF (D .GE. DISP) GO TO 30
0023 20 CONTINUE
0024 C   FOUND ONE
0025 GO TO 40
0026 30 CONTINUE
0027 C   NOW HAVE LONGEST LINE POSSIBLE
0028 40 CONTINUE
0029 M=(Y(I)-Y(START)) / ((I-START)*DELTA)
0030 FACT=1. / SQRT(1. + M**2)
0031 DO 50 J=START,I-1
0032 Y(J)=Y(J) - (M*(J-START)*DELTA + B) * FACT
0033 50 CONTINUE
0034 START=I
0035 IF (START .LT. N-1) GO TO 10
0036 Y(N)=Y.
0037 IF (START .LT. N) Y(N-1)=0.
0038 RETURN
0039 END
0040 END
**** LIST END ****

```

FORTRAN COMPILER REV. LEV. J00

```

      INTGER FILE(3),INT,NUM,REC(10)
      INTGER TAPE,PLAT,NAME,WRIT,CLOS,DISK
      SCALED FRACTION REC(10)
      EQUIVALENCE (INT,REC(1)),(NUM,REC(10))
      DATA TAPE/4/, PLAT/22/, NAME/23/, WRIT/16/, CLOS/15/, DISK/'21'/
      CALL QMOND(PLAT,DISK,1)
10  CONTINUE
      READ(TAPE,20) FILE,NUM,INT
20  FORMAT(2A2,A1,/,2I5)
      TYPE 20, FILE,NUM,INT
      CALL QMOND(NAME,DISK,FILE,3,(0))
      CALL QMOND(WRIT,DISK,INT,NUM)
      JEND=NUM / 10
      DO 40 J=1,JEND
          READ(TAPE,30) REC
30  FORMAT(10S5)
          CALL QMOND(WRIT,DISK,REC(1),REC(10))
40  CONTINUE
      IEND=NUM - JEND*10
      IF (IEND .EQ. 0) GO TO 50
C   GET LAST RECORD
      READ(TAPE,30) (REC(I),I=1,IEND)
      CALL QMOND(WRIT,DISK,REC(1),REC(10))
50  CONTINUE
      CALL QMOND(CLOS,DISK)
      GO TO 10
      END

```

PROGRAM SIZE = 1270

CONSTANT TABLE

```

257  $5      OCT I 1
260  $17     OCT I 3
261  $62     OCT I 12
262  $214    OCT I 0

```

PROGRAM ALLOCATION

NAME	ADR	NAME	ADR	NAME	ADR	NAME	ADR
V I JUMM	267	V I CLOS	6	V I DISK	7	A I FILE	10
V I I	266	V I IEND	265	V I INT	13	V I J	184
V I JEND	263	V I NAME	4	V I NUM	24	V I PLAT	5
A S REC	25	A I REC1	13	V I TAPE	2	V I WRIT	16

STATEMENT NUMBER LOCATIONS

```

44  .12      65  .20      152  .30      163  .40      251  .88

```

EXTERNAL REFERENCES

98


```

    INTEGER KEY,NCHAN,NUM(N),INIT(N)
    LOGICAL TERM
    REAL INT(N)
    COMMON /PARAM/ TERRA,SPACE,NRUN,DELAY,NPHASE,LAST,INIT
    INTEGER TERRA(N,N),SPACE(N,N),NRUN(N,N),DELAY(N,N),NPHASE(N)
    LOGICAL LAST(N)
    DATA KEY/2/
C--INITIALIZE ANALOG CONSOLE
    CALL QSHYIN(IERR,500)
    CALL QSSP(IERR)
    CALL QSCLR(IERR)
    TYPE 7
    7 FORMAT(80HENTER LOGICAL UNIT FOR INPUT',/,
      8 80HKEYBOARD = 2',/,
      9 80HHSPT READER = 4',/)
    ACCEPT 10, KEY
    10 FORMAT(I1)
    TERM=KEY .EQ. 2
    CALL INPUT(TERM,KEY,INT,NUM)
    TYPE 20
    20 FORMAT(80HTERRAIN INPUT COMPLETE',/)
    CALL RAYS(TERM,KEY,NCHAN,INT,NUM)
    TYPE 30
    30 FORMAT(80HRAY SETUP COMPLETE',/)
    WRITE(120,40)
    40 FORMAT(80HIRAY PHASE TERRAIN SPACE RUNS CHANNEL DELAY')
    ISTART=1
    K=1
    50 CONTINUE
    DO 60 I=ISTART,N
      IF (LAST(I)) GO TO 70
    60 CONTINUE
    TYPE 61
    61 FORMAT(80HERROR 61')
    CALL EXIT
    70 CONTINUE
    NP=NPHASE(I)
    DO 81 J=1,NP
      WRITE(120,80) X,J,TERRA(J,I),SPACE(J,I),NRUN(J,I),
        (L,DELAY(J,L),L=ISTART,I)
    80 FORMAT(2X,I1,4X,I1,6X,I1,4X,I5,1X,I4,4X,I1,4X,I5,
      7(1,3X,I1,4X,I5))
    81 CONTINUE
    IF (Y .EQ. NCHAN) GO TO 90
    ISTART=I + 1
    K=K + 1
    GO TO 50
    90 CONTINUE
    CALL QSOP(IERR)
    CALL QSRUN(IERR)
    CALL -RUN(NCHAN,NUM)
    END

```

FORTRAN COMPILER REV. LFV. J80

```

SUBROUTINE INPUT(TERM,KEY,INT,NUM)
C--READS IN TERRAIN DATA
LOGICAL TERM
INTEGER KEY,NUM(8)
REAL INT(8)
SCALED FRACTION SAMPLE(5120)
INTEGER BEGIN(8),START
INTEGER NTERRA,NAME(3),NPLAT,PLAT,POST,READ,DISK,REC1(10)
EQUIVALENCE (INT1,REC1(1)),(NUM1,REC1(10))
COMMON /DATA/ BEGIN,SAMPLE
DATA START/1/
DATA PLAT/22/, POSI/21/, READ/17/, DISK/121/
IF (TERM) TYPE 9
9 FORMAT(8#ENTER NUMBER OF TERRAINS:1,/)
READ(KEY,10) NTERRA
10 FORMAT(I1)
CALL QMOND(PLAT,DISK,1)
DO 40 I=1,NTERRA
IF (TERM) TYPE 19, I
19 FORMAT(8#ENTER FILE NAME FOR TERRAIN NUMBER:1,12,/)
READ(KEY,20) NAME
20 FORMAT(3A2)
CALL QMOND(POSI,DISK,NAME)
CALL QMOND(READ,DISK,INT1,NUM1)
INT(I)=FLOAT(INT1)/12./5280.
NUM(I)=NUM1
BEGIN(I)=START
DO 30 J=1,NUM1,10
CALL QMOND(READ,DISK,SAMPLE(START),SAMPLE(START+9))
START=START + 10
30 CONTINUE
40 CONTINUE
RETURN
END

```

PROGRAM SIZE = 1332

CONSTANT TABLE

```

317  $5      OCT I 1
320  $214    OCT J 12
321  $322    OCT R 60000
322          OCT 4
323  $327    OCT R 51200
324          OCT 15

```

PROGRAM ALLOCATION

NAME	ADR	NAME	ADR	100	NAME	ADR	NAME	ADR
V I .01000	327	V I .01010	331	V I DISK	10	V I I	100	
A P INT	2	V I INT1	14	V I J	330	V I KEY	100	

```

SUBROUTINE BAYS(TERM,KEY,NCHAN,INT,NUM)
C--SETS UP A MAXIMUM OF FOUR BAYS
COMMON /PARAM/ TERRA,SPACE,NRUN,DELAY,NPHASE,LAST,INIT
LOGICAL TERM
INTEGER KEY,NCHAN,NUM(8),INIT(8)
INTEGER I,J,K,N,NAXLES,TNUM,NTERRA,RUNS
REAL L(8),L1,D,ANGLE,MPH,MILES,PI,V,WAIT
INTEGER TERRA(8,8),SPACE(8,8),NRUN(8,8),DELAY(8,8),NPHASE(8)
LOGICAL LAST(8)
REAL INT(8)
DATA PI/3.14159/, INTART/1/
TAN(T)=STI(T) / COS(T)
OPP(H,A)=SQRT(H**2 - A**2)
ACOSP(A,H)=ATAN2(OPP(H,A),A)
10 FORMAT(11)
IF (TERM) TYPE 20
20  FORMAT(80CENTER NUMBER OF BAYS:1,/)
  READ(KEY,10) NBAYS
  DO 130 K=1,NBAYS
    IF (TERM) TYPE 30, K
30  FORMAT(80CENTER NUMBER OF AXLES FOR BAY:1,2,1H1,/)
    READ(KEY,10) NAXLES
    NCHAN=ISTART + 2*NAXLES - 1
    DO 40 N=1,NAXLES
      IF (TERM) TYPE 40, N
40  FORMAT(80CENTER DISTANCE(FY) FOR AXLE:1,2,1H1,/)
    READ(KEY,50) D
50  FORMAT(85,2)
    L(N)=D / 5280.
60  CONTINUE
    L1=L(1)
    L(1)=0.
    IF (TERM) TYPE 70, K
70  FORMAT(80CENTER NUMBER OF PHASES FOR BAY:1,2,1H1,/)
    READ(KEY,10) NTERRA
    DO 120 J=1,NTERRA
      IF (TERM) TYPE 80
80  FORMAT(80CENTER TERRAIN,ANGLE(DEGREES),MPH,MILES:1,/)
    READ(KEY,90) TNUM,ANGLE,MPH,MILES
90  FORMAT(11,1X,3E6,2)
    THETA=ANGLE * PI/180.
    DEL1 * TAN(THETA)
    V=MPH/3600. / 1000.
    WAIT=ATNT(INT(TNUM) / (V*COS(THETA)) + .5)
    RUNS=IFIX(MILES/(V*WAIT) / FLOAT(NUM(TNUM))) + .5)
    DO 100 I=ISTART,NCHAN
      TERRA(J,I)=TNUM
      SPACE(J,I)=IFIX(WAIT)
      NRUN(J,I)=RUNS
      NPHASE(I)=NTERRA
      LAST(I)=.FALSE.
100  CONTINUE
    LAST(NCHAN)=.TRUE.
    INT(NCHAN)=ISTART

```

```

I=I*START
DO 110 N=1,NAXLES
    DELAY(J,I)=IFIX(L(N)/V + .5) + 2000
    DELAY(J,I+1)=IFIX((L(N)+D)/V + .5) + 2000
    I=I + 2
110 CONTINUE
    THETA=ACOS2(INT(TNUM),V*WAIT)
    ANGLE=THETA * 180./PI
    D=INT(TNUM) / COS(THETA)
    MPH=D / (WAIT/1200./3600.)
    MILES=FLOAT(RUNS)*FLOAT(NUM(TNUM))*D
111    TYPE 111, X, J, ANGLE, MPH, MILES
    FORMAT(A0H,COMPTEO FOR BAY',I2,0H, PHASE',I2,/,
           F6.2,0H DEGREES ,F6.2,0H MPH ,F6.2,0H MILES)
120 CONTINUE
    I*START=NCHAN + J
130 CONTINUE
    RETURN
    END
    
```

PROGRAM SIZE = 11526

CONSTANT TABLE

1431	\$5	OCT I 1
1432	\$12	OCT I 2
1433	\$144	OCT I 10
1434	\$543	OCT R 51200
1435		OCT 15
1435	\$554	OCT R 0
1437		OCT 200
1440	\$613	OCT R 55000
1441		OCT 10
1442	\$600	OCT R 70200
1443		OCT 14
1444	\$625	OCT R 76400
1445		OCT 12
1446	\$637	OCT R 40000
1447		OCT 0
1450	\$720	OCT L 0
1451	\$727	OCT L 100000
1452	\$721	OCT I 3720

PROGRAM ALLOCATION

NAME	ADR	NAME	ADR	NAME	ADR	NAME	ADR
V I .U1003	1512	V I .U1213	1523	V R .U2000	1581	V R .U2001	1583
V R .U2002	1507	V R .U2003	1524	V R .U2011	1605	V R .U2013	1510
V R .U2023	1517	V R .U2033	1521	V R ANGLE	1467	V R D	1488
V I I	1453	A R INT	3	V I I*START	7	V I J	1484
V I K	1455	V I KEY	1	A R L	10	V R L1	1493
V R MILES	1473	V R MPH	1471	V I N	1458	V I NAXLES	1487
V T NBAYS	1531	V I NCHAN	2	V I NTERRA	1461	A I NUM	1484
V R PI	5	V Y RUNS	1462 102	V L TERM	0	V R THETA	1493

```

SUBROUTINE RUN(NCHAN,NUM)
INTEGER NCHAN,NUM(8),INIT(8)
SCALED FRACTION SAMPLE(5128)
INTEGER BEGIN(8)
INTEGER TERRA(8,8),SPACE(8,8),NRUN(8,8),DELAY(8,8),NPHASE(8)
LOGICAL LAST(8)
INTEGER NTERRA,START,NOW,OLD
INTEGER PHASE(8),TIME(8),INDEX(8),NSEC(8),FIRST(8),STOP(8),
*   PNUM(8)
COMMON /PARAM/ TERRA,SPACE,NRUN,DELAY,NPHASE,LAST,INIT
COMMON /DATA/ BEGIN,SAMPLE
DATA START/1000/, PHASE/8*1/
DO 65 I=1,NCHAN
  NTERRA=TERRA(1,I)
  NSEC(I)=SPACE(1,I)
  L=BEGIN(NTERRA)
  INDEX(I)=L
  FIRST(I)=L
  STOP(I)=L + NUM(NTERRA)
  PNUM(I)=NRUN(1,I)
  TIME(I)=DELAY(1,I)
65 CONTINUE
CALL QWTIME(START,IERR)
C--MAIN LOOP
70 CONTINUE
  CALL QWTIME(NOW,IERR)
  OLD=START-NOW
  CALL QWTIME(START,IERR)
C--SCAN CHANNELS
  DO 72 J=1,NCHAN
    TIME(J)=TIME(I) - OLD
    IF (TIME(J) .GT. 0) GO TO 80
C--OUTPUT DISPLACEMENT
    J=INDEX(I)
    CALL QWJDAS(SAMPLE(J),I=1,IERR)
    J=J+1
    TIME(I)=NSEC(I)
    IF (J .NE. STOP(I)) GO TO 75
C--FINISHED RUN
    RNUM(I)=PNUM(I)-1
    IF (RNUM(I) .GT. 0) GO TO 74
C--FINISHED PHASE
    J=PHASE(I)+1
    IF (J .GT. NPHASE(I)) J=1
    NTERRA=TERRA(J,I)
    NSEC(I)=SPACE(J,I)
    L=BEGIN(NTERRA)
    FIRST(I)=L
    STOP(I)=L + NUM(NTERRA)
    RNUM(I)=NRUN(J,I)
    PHASE(I)=J
    IF (.NOT. LAST(I)) GO TO 75
C--RAY HAS FINISHED PHASE
    KI=INIT(I)

```

PAGE 2 C--OUTPUTS DIGITAL TERRAINS

```

DO 72 K=KI,T
  TIME(K)=DELAY(J,K)
72 CONTINUE
  GO TO 74
C--GET FOR LONG WAIT
73 CONTINUE
  TIME(I)=30000
74 CONTINUE
  J=FIRST(I)
75 CONTINUE
  INDEX(I)=J
80 CONTINUE
  GO TO 70
END

```

PROGRAM SIZE = 11153

CONSTANT TABLE

```

1134 $5      OCT I 1
1135 $50     OCT J 10
1136 $454   OCT T 0
1137 $531   OCT I 72460

```

PROGRAM ALLOCATION

NAME	ADR	NAME	ADR	NAME	ADR	NAME	ADR
V I .U1000	1144	V I .U1010	1145	A I FIRST	43	V I I	1143
V I TERR	1147	A I INDEFY	23	V I J	1150	V I K	1152
V I KI	1151	V I L	1146	V I NCHAN	0	V I NOW	1141
A I NSFC	33	V I NTERRA	1140	A I NIJ	1	V I OLD	1142
A I PHASE	3	A I RNUM	63	V I START	2	A I STOP	33

COMMON ALLOCATION

/PARAM /ALLOCATION LENGTH = 1430

NAME	ADR	NAME	ADR	NAME	ADR	NAME	ADR
A I TERRA	0	A I SPACE	100	A I NRUN	280	A I DELAY	300
A I NPHASE	400	A L LAST	410	A I INIT	420		

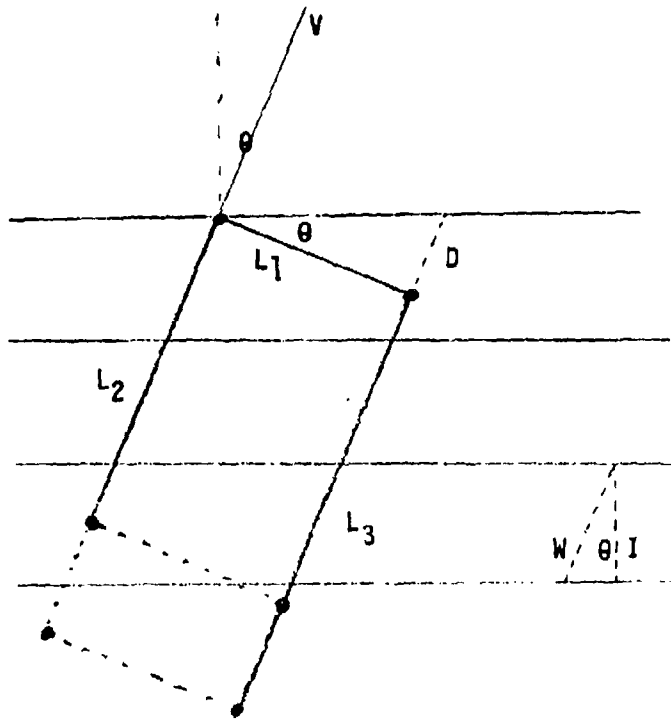
/DATA /ALLOCATION LENGTH = 112010

NAME	ADR	NAME	ADR	NAME	ADR	NAME	ADR
A I BEGIN	0	A S SAMPLE	10				

STATEMENT NUMBER LOCATIONS

APPENDIX B
VEHICLE GEOMETRY

TRUCK CROSSING
WASHBOARD



$$\tan \theta = \frac{D}{L_1} \rightarrow D = L_1 \tan \theta$$

$$\cos \theta = \frac{I}{W} \rightarrow W = I / \cos \theta$$

$$T_W = \frac{W}{V} \rightarrow T_W = \frac{I}{V \cos \theta}$$

AND:

$$T_{L1} = 0, \quad T_{R1} = \frac{D}{V}$$

$$T_{L2} = \frac{L_2}{V}, \quad T_{R2} = \frac{L_2 + D}{V}$$

$$T_{L3} = \frac{L_3}{V}, \quad T_{R3} = \frac{L_3 + D}{V}$$

- θ - Angle of traversal in degrees ($0^\circ \leq \theta < 90^\circ$)
- V - Velocity in miles per millisecond
- I - Sample interval in miles
- T_W - Time between samples in milliseconds
- T_{SN} - Initial delays in milliseconds

APPENDIX C
OPERATING PROCEDURES

OPERATING PROCEDURES

I. Hewlett-Packard 2116B

- A. DETR - Performs detrending and wheel trajectory calculations (see section 3 and Appendix A)
 - 1. The program first asks for parameters necessary for graphing. When the title is asked for, the user should supply blanks (the file name is used as the title).
 - 2. After plotting the terrain profile, the program performs the necessary calculations and plots the resulting wheel displacements.
 - 3. By entering YES after the wheel trajectory is plotted, a listing and paper tape of the wheel profile are produced.

II. PACER 100

- A. LOAD - Loads paper tapes to disk.
 - 1. The program continuously loads paper tape without operator intervention.
 - 2. The computer should be halted at the end of the tape.
- B. SAMP - Runs digital simulation (see section 2 and Appendix A)
 - 1. The EAI 580 should be in digital mode. The program will initiate POT-SET and Logic CLEAR. Hydraulics should be running but with inputs at zero.
 - 2. In the terrain input phase enter the one to six character name of each file.
 - 3. The distance for the first axle is its width. The distances for the following axles are the number of feet from the first axle.

4. The format for TERRAIN, ANGLE, MPH, MILES is (I1, IX, 3E6.2). Free field input may be used if all commas and decimal points are supplied (see example).
5. The computer will go to OPERATE and logic RUN when the bay setup is complete. The hydraulics should be brought slowly in to verify proper operation.
6. To terminate, shut down hydraulics and then HALT computer.

#L,SAMP2,21
 SAMP2 CI P1
 LD
 #G,1000

ENTER LOGICAL UNIT FOR INPUT:

KEYBOARD = 2
 HSPT READER = 4
 2

ENTER NUMBER OF TERRAINS:

3
 ENTER FILE NAME FOR TERRAIN NUMBER: 1
 RD05
 RD05 DA P1

ENTER FILE NAME FOR TERRAIN NUMBER: 2

RD06
 RD06 DA P1

ENTER FILE NAME FOR TERRAIN NUMBER: 3

RD07
 RD07 DA P1

TERRAIN INPUT COMPLETE

ENTER NUMBER OF BAYS:

1
 ENTER NUMBER OF AXLES FOR BAY 1:

3
 ENTER DISTANCE(FT) FOR AXLE 1:

7.,
 ENTER DISTANCE(FT) FOR AXLE 2:

13.,
 ENTER DISTANCE(FT) FOR AXLE 3:

17.5,
 ENTER NUMBER OF PHASES FOR BAY 1:

3
 ENTER TERRAIN,ANGLE(DEGREES),MPH,MILES,:

3,45.,10.,.25
 COMPUTED FOR BAY 1, PHASE 1
 44.75 DEGREES 10.00 MPH .25 MILES
 ENTER TERRAIN, ANGLE(DEGREES),MPH,MILES,:

2,45.,20.,.25
 COMPUTED FOR BAY 1, PHASE 2
 44.75 DEGREES 20.00 MPH .23 MILES

ENTER TERRAIN,ANGLE(DEGREES),MPH,MILES,:

1,45.,30.,.25
 COMPUTED FOR BAY 1, PHASE 3
 44.75 DEGREES 30.00 MPH .25 MILES

BAY SETUP COMPLETE

RAY	PHASE	TERRAIN	SPACE	RUNS	CHANNEL	DELAY
1	1	2	66	3	1	2220
					2	2477
					3	2486
					4	3364
					5	3193
					6	2670
1	2	2	48	2	1	2000
					2	2270
					3	2443
					4	2682
					5	2507
					6	2835
1	1	1	10	7	1	2700
					2	2150
					3	2205
					4	2455
					5	2300
					6	2557

SAMPLE OF COMPUTER PRINTOUT

SPACE: Milliseconds between data-points

RUNS: Number of times terrain is traversed

DELAY: Initial delay in milliseconds

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1. REPORT NUMBER 12391	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) DIGITAL TERRAIN SIMULATION		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) 2nd Lt Steve Charles		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS USATARADCOM ✓ Warren, MI 48090		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Comp Sim & Test Meth, DRDTA-RRS Warren, MI 48090		12. REPORT DATE October 1978
		13. NUMBER OF PAGES 121
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release, distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Analog/Digital Computers Simulation Terrains		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Road profiles available for digital terrain simulation at TARADCOM are cataloged. The terrain simulation program for the PACER 100/EAI 580 Hybrid computer system is described. The terrain simulation program was developed to better utilize the hybrid computing system when it is required to run several vehicles over known terrains at different speeds for varying lengths of time. The operator can interactively setup the test environment or feed in a prepared paper tape. Terrains are stored on disks and vary from profiles of actual test courses to synthesized forcing functions. Development and operation of the program are described and possible future refinements are explored.		