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Treatment Alternatives for Vehicle Maintenance Pollution Control



US Army Corps of Engineers  
Construction Engineering Research Laboratory

# Analysis of Usage Data for Central Vehicle Wash Facilities at Three Army Installations

by  
Susan J. Bevelheimer

AD-A203 520

The Central Vehicle Wash Facility (CVWF) concept was developed by the U.S. Army Construction Engineering Research Laboratory (USA-CERL) to save washing time, conserve potable water, and reduce pollution from tactical vehicle cleaning operations. CVWFs have been operating successfully at several installations for the past 8 years.

This report presents an analysis of usage data for the CVWFs at Fort Polk, LA, Fort Lewis, WA, and Yakima Firing Center, WA. These wash facilities were sized according to the user's estimates of washing requirements. The comparison between actual usage of these facilities and the design estimates will be helpful in planning and designing new CVWFs.

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## FOREWORD

This work was performed for the Directorate of Engineering and Construction, Headquarters, U. S. Army Corps of Engineers (HQUSACE), under Project 4A162731A896, "Environmental Quality Technology"; Task Area B, "Environmental Design and Construction"; Work Unit 051, "Treatment Alternatives for Vehicle Maintenance Pollution Control." The HQUSACE Technical Monitor was Robert Ross, CEEC-EB.

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# **ANALYSIS OF USAGE DATA FOR CENTRAL VEHICLE WASH FACILITIES AT THREE ARMY INSTALLATIONS**

## **1 INTRODUCTION**

### **Background**

The U.S. Army Construction Engineering Research Laboratory (USA-CERL) developed the concept of a Central Vehicle Wash Facility (CVWF) to allow units to clean their military vehicles quickly and efficiently, while reducing the use of potable water and providing treatment of waste washwater. Based on this facility concept, CVWFs have been constructed at several installations, with some operating since 1980.

CVWFs currently in service were sized according to the users' estimates of washing requirements. An analysis of actual long-term usage data from functional CVWFs would allow a comparison with the design estimates. This information would be helpful in sizing new facilities and determining operational requirements.

### **Objective**

The objective of this work is to analyze actual usage data at selected CVWFs so that lessons learned can be incorporated into future designs.

### **Approach**

Three installations with a total of six CVWFs were selected to provide facility usage data. These data were collected on vehicle count logs that listed the numbers and types of vehicles being cleaned on a daily basis. It was later determined that data from two CVWFs were unusable and could not be included in the analysis. Therefore, this report presents daily, weekly, and monthly usage data as graphs and tables for four CVWFs.

### **Mode of Technology Transfer**

The CVWF technology is already being transferred successfully to the field. The data in this report will be delivered to the U.S. Army Corps of Engineers (USACE) Center-of-Expertise for input in designing future CVWFs.

## 2 RESULTS AND ANALYSIS

Daily vehicle count logs providing numbers and types of vehicles using the CVWFs were obtained from Fort Lewis, Yakima Firing Center, and Fort Polk. Vehicles were classified into six categories: wheeled (light, medium, and heavy), trailers, tracked, engineering, towed guns, and unknown. Appendix A lists major vehicle types and their classifications. It should be noted that in this report, an armored engineer vehicle is classified as a tracked vehicle whereas a mechanical bridge is listed as an engineering vehicle. Many of the graphs show usage by "Tracks" and "All Others." For this analysis, the group "All Others" includes all vehicles except tracked vehicles. Thus, engineering vehicles can be grouped with wheeled vehicles in the data.

### Fort Lewis, WA

There are three CVWFs at Fort Lewis: North Fort, Southeast, and Southwest. They process vehicles belonging to infantry, mechanized infantry, and armored units of the 2nd and 3rd Brigades, 9th Division (Mech); the Washington National Guard; and Army Reserve units. Only the usage data for the North Fort and Southeast CVWFs are presented here; problems with integrity of data from the Southwest facility precluded their use.

#### North Fort Lewis

The CVWF on North Fort Lewis has 10 wash positions to clean vehicles. Logs beginning 27 January 1986 were the earliest records available. Processing times were not available. Generally, the facility is open for 8 hr/day, 5 days/week, although records on the actual hours of operation were not kept. Washing activity on Saturdays and Sundays was a rare occurrence. The facility was usually closed on holidays.

Usage data were supplied for the period 27 January 1986 through 4 December 1987. Between 27 January and 31 December 1986, 8687 vehicles (less than 1 percent tracked vehicles) were processed through the facility. Monthly usage data are presented in Table 1. Twelve weekdays are missing from the logs: 1 May, 19 and 20 May, 5 August, 26 September, the week of 29 September through 3 October, and 18 and 19 December. For the period 5 January 1987 through 4 December 1987, 10,269 vehicles (less than 1 percent tracked vehicles) were washed. Table 2 lists monthly usage data for this period. No data were received for 6 February 1987.

During 1986, washing levels were the highest in May and August. The volume of washing increased through the spring and peaked in May and June, then dropped in July, and peaked again in August and September. The decline in washing activity during July could be attributed to training exercises at Yakima Firing Center. August, followed by September, had the highest level of washing activity for 1987. Overall, relatively light washing activity occurred in November and December. Very little tracked vehicle washing was done at the North Fort facility.

Figures 1 through 22\* are daily usage charts for each month. January 1986 and December 1987 were excluded due to the small number of data. The monthly graphs for 1986 reveal a consistent pattern of use with only small variations. The exception is

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\*Figures appear at the end of text, beginning on p 24.

Table 1

Monthly Usage Data for North Fort Lewis CVWF - 1986

Month	Total	Wheels	Tracks	Days in Use
January (27-31)	140	138	2	5
February	626	620	6	19
March	890	887	3	23
April	851	841	10	24
May	985	976	9	18
June	919	919	0	21
July	591	588	3	22
August	968	964	4	21
September	912	908	4	18
October	764	754	10	20
November	673	671	2	17
December	368	366	2	16
<b>TOTALS</b>	<b>8687</b>	<b>8632</b>	<b>55</b>	<b>224</b>

**Table 2**  
**Monthly Usage Data for North Fort Lewis CVWF - 1987**

Month	Total	Wheels	Tracks	Days in Use
January	834	833	1	19
February	832	831	1	19
March	970	968	2	23
April	846	844	2	22
May	958	951	7	20
June	955	924	31	22
July	980	968	12	23
August	1261	1260	1	21
September	1009	1006	3	21
October	842	842	0	21
November	574	574	0	18
December (1-4)	208	207	1	4
<b>TOTALS</b>	<b>10269</b>	<b>10208</b>	<b>61</b>	<b>233</b>

March 13, when the largest daily vehicle cleaning operation occurred in 1986: 146 vehicles (one tracked vehicle). In 1987, January, August, and September show greater daily fluctuations in use. The largest daily washing activity occurred during these months.

Figures 23 and 24 show the frequency of usage levels at the facility for 1986 and 1987. These charts generally indicate the same pattern for both years. Vehicle cleaning operations occurred at a rate of 26 to 50 vehicles/day 41 percent (1986) and 44 percent (1987) of the time. Washing rates exceeding 100 vehicles per day occurred twice as often (13 days vs. 6 days) in 1987 as in 1986. The facility was designed to process peak washing loads of 130 vehicles during an 8-hr day.<sup>1</sup> This level was exceeded once in 1986 and six

<sup>1</sup> Feasibility Study for POL Pollution Control Facilities at Fort Lewis, Washington (De Leuw, Cather and Co., March 1978).

times in 1987. The highest daily use occurred on 7 August 1987, when 178 wheeled vehicles were washed.

Figures 25 and 26 summarize usage data for the facility by day of the week. Both graphs show that demand for the facility is highest on Thursdays and Fridays. The figures in Appendix B show usage by individual days for all weeks where data were provided.

Figures 27 and 28 show the types and numbers of vehicles using the wash facility by day of the week. Wheeled vehicles were excluded from the figures due to the large number washed. In general, the facility cleaned more engineering vehicles than tracked vehicles. Overall, vehicles other than wheeled types comprised a very small portion of total washing activity at the North Fort CVWF.

#### *Southeast Fort Lewis*

The wash facility at the Southeast site has 15 wheeled vehicle and 7 tracked vehicle wash positions. This facility operates on a 40-hr week with infrequent weekend washing. Records are not kept on the actual hours of operation. The facility is usually closed on holidays.

For the period 21 January 1986 through 4 December 1987, 28,596 vehicles were processed through the facility. Vehicle count logs were not received for 29 September through 3 October 1986. Monthly usage data for 1986 are summarized in Table 3. The largest volume of vehicle cleaning operations occurred in September, followed by May and August. Less than 1 percent of the vehicles were tracked.

Table 4 lists monthly usage data for 5 January 1987 through 4 December 1987. The facility was closed for maintenance during 10 through 13 February. The largest number of vehicles were washed in June and January during 1987.

Daily usage data by month for 1986 and 1987 are graphed in Figures 29 through 50. Again, January 1986 and December 1987 were excluded due to the small number of data. In the spring, use of the facility peaked in the middle of every month. Usage jumped upward every Thursday of August 1987. The graphs for September, November, and December 1986 show substantial increases in daily washing levels.

Figures 51 and 52 present the varied usage frequency for 1986 and 1987. These figures indicate a consistent pattern of vehicle washing operations. Most washing activity occurred at a rate of 50 vehicles/day or less for both years. In 1986, there were 5 days for which washing activity exceeded 150 vehicles/day. During 1987, 9 days had washing activity exceeding 150 vehicles/day. Tracked vehicle cleaning activity always occurred at a daily rate of 25 or fewer vehicles. The facility was sized to process a peak load of 9 tracked and 240+ wheeled vehicles/day.<sup>2</sup> The largest number of vehicles washed in one day was 242 (one tracked), and that occurred once in a 2-year period.

Washing times were not logged at the wash facility. From personal observations (102) over 2 days of washing, the average wash time for wheeled vehicles was estimated at 13 min/vehicle. The vehicles' soiling conditions were light.

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<sup>2</sup>*Basis for Design and Analysis of Design, POL Pollution Control, Fort Lewis, Washington, Phase II (De Leuw, Cather and Co., October 1979).*

**Table 3**  
**Monthly Usage Data for Fort Lewis Southeast CVWF - 1986**

Month	Total	Wheels	Tracks	Days in Use
January (21-31)	446	444	2	9
February	1187	1184	3	20
March	1286	1283	3	22
April	1280	1279	1	15
May	1434	1427	7	22
June	1024	1022	2	21
July	1101	1074	27	23
August	1315	1293	22	21
September	1516	1506	10	19
October	1283	1276	7	20
November	1224	1220	4	19
December	905	903	2	19
<b>TOTALS</b>	<b>14001</b>	<b>13911</b>	<b>90</b>	<b>240</b>

Figures 53 and 54 summarize usage data for the facility by day of the week. The largest number of vehicles were washed on Thursdays. The graphs in Appendix C give usage by individual days for all weeks where data were provided. Graphs for Saturday and Sunday were excluded due to insufficient data.

Figures 55 and 56 graph the types and numbers of vehicles using the wash facility by day of the week. Wheeled vehicle numbers were excluded. These graphs show the diverse types of vehicles using the wash facility. In addition to wheeled vehicles, engineering vehicles and towed howitzers comprised the bulk of vehicles cleaned.

**Yakima Firing Center, WA**

The CVWF at Yakima Firing Center has 10 wheeled and 12 tracked vehicle washing positions. The Firing Center serves as a training area for infantry, mechanized infantry,

**Table 4**  
**Monthly Usage Data for Fort Lewis Southeast CVWF - 1987**

Month	Total	Wheels	Tracks	Days in Use
January	1510	1503	7	19
February	1117	1104	13	15
March	1426	1418	8	24
April	1430	1428	2	23
May	1175	1169	6	20
June	1596	1590	6	26
July	1197	1192	5	26
August	1340	1330	10	21
September	1262	1253	9	23
October	1319	1310	0	21
November	1002	1001	1	18
December (1-4)	221	218	3	4
<b>TOTALS</b>	<b>14595</b>	<b>14516</b>	<b>79</b>	<b>240</b>

and armored units of the 2nd and 3rd Brigades (9th Division, Fort Lewis), the Washington National Guard, and Army and Marine Corps Reserve units. The National Guard maintains a Mobilization and Training Equipment Site (MATES) on the Firing Center which supports tactical vehicles used in training exercises.

Collection of usage data for the wash facility began 13 July 1987. Data on numbers and types of vehicles using the wash facility and processing times were collected daily. Some undercounting at the facility occurred when unscheduled washing took place and on days when the facility was used intensively. The wash facility was closed 20 November 1987 through 11 February 1988 due to cold weather. With the startup of operations on 12 February, additional information was collected on a daily facility operation log. Maintenance tasks performed, weather conditions, and vehicle soiling conditions were noted on the facility log. Also, more accurate processing times were collected than had been

previously. Processing times collected for the period July through November 1987 were found to be inaccurate and could not be used.

The facility was closed 3 through 5 and 7 through 9 March for maintenance. There was no washing activity for the following weekdays: 26 February, 29 February through 2 March, 11 March, 30 March, and 1 April. In addition, there were 9 weekdays for which it could not be determined if the lack of data was due to the contractor's absence or to no activity at the facility.

For 13 July 1987 through 19 November 1987 and 12 February 1988 through 1 May 1988, 590 tracked and 9390 wheeled vehicles were washed. Monthly usage data are summarized in Table 5. The busiest months were October and September. The largest number of tracked vehicles were washed in October and April. Overall, tracked vehicle washing accounted for a small portion (6 percent) of total vehicle washing activity.

Figures 57 through 64 present daily usage for each month. These graphs indicate that facility demand increased toward the end of every month except in August and November. Relatively light usage of the facility occurred in August and it was closed during the third week of November. From 21 through 25 February, 991 wheeled and 16 tracked vehicles were cleaned (1007 total). In general, large washing operations represent brigade-level cleaning.

Figure 65 shows the frequency of usage levels at the facility. Total vehicle cleaning occurred at a rate of 50 or fewer vehicles/day 64 percent of the time. There were 10 days (6 percent) during the period 13 July 1987 through 1 May 1988 when daily washing activity exceeded 200 vehicles. Tracked vehicles were washed at the facility at a daily rate of 25 vehicles or fewer 88 percent of the time.

The most intensive use of the facility occurred on the following days:

<u>Date</u>	<u>Vehicle Count</u>	<u>Rate/hr</u>
23 July	377	37
22 September	248	31
25 September	277	31
26 September	184	50
24 October	390	39
28 October	421	47

For the above dates (except 24 October), washing activity consisted mainly of wheeled vehicle cleaning. On 24 October, 51 tracked vehicles (tanks and armored personnel carriers) were cleaned along with 339 wheeled vehicles. The facility was in continuous use for each of the above days. Although heavy use of the facility occurred in the spring, the hours of operation were usually extended to handle the high washing loads. During the brigade-level washup of 28 and 29 March, the facility was open for 32 (discontinuous) hours to clean 680 vehicles. The facility was designed to accommodate a delete

**Table 5**  
**Monthly Usage Data for Yakima Firing Center CVWF**

<b>Year/Month</b>	<b>Total</b>	<b>Wheels</b>	<b>Tracks</b>	<b>Days in Use</b>
1987 July (13-31)	1068	1041	27	18
August	775	771	4	25
September	1571	1549	22	23
October	2426	2140	286	25
November (5-19)	915	872	43	12
1988 February (12-25)	1334	1318	16	10
March	1167	1105	62	18
April	710	587	123	22
<b>TOTALS</b>	<b>9966</b>	<b>9383</b>	<b>583</b>	<b>153</b>

peak washing volume of 150 tracked and 126 wheeled vehicles/day.<sup>3</sup> There were 20 days (out of 154) in which wheeled vehicle washing levels met or exceeded 126 vehicles/day. Tracked vehicle washing never exceeded a rate of 51 to 75 tracks/day for the period 31 July 1987 through 1 May 1988. Since summer training exercises usually produce high tracked vehicle washing levels, an accurate comparison between design usage rates and actual usage rates for tracked vehicle cleaning cannot be made until data for a complete summer are available.

Vehicle wash times were collected for the period 12 February through 1 May. Based on 907 observations (44 days of data), the average washing time for wheeled vehicles was 21 min. This average time represents washing of individual vehicles; processing times for vehicles with trailers are excluded. Also, processing times collected on days when the facility was used heavily were discarded due to questionable accuracy of these data. Thus, the average wash time reflects light and moderate processing times. It should not be used to determine peak operational efficiency at the site. Based on 128 observations (18 days of data) between 21 February and 1 May, the average washing time for tracked vehicles was 28 min. Again, this number does not reflect typical tracked vehicle processing time due to the absence of data for heavily used days. Also, the

<sup>3</sup>Feasibility Study for POL Pollution Control Facilities at Yakima Firing Center, Washington (De Leuw, Cather and Co., February 1978).

contractor reports the occasional occurrence of "fine-detail" tracked vehicle cleaning where the vehicles are cleaned inside and outside as well as in the engine compartments. This kind of facility use is not associated so much with the soiling conditions of the vehicles as with inspection and maintenance requirements.

Processing times could not be correlated with vehicle soiling conditions due to insufficient data. Vehicle soiling condition data continue to be collected and will be analyzed later.

The graph in Figure 66 shows the distribution of washing activity over the week. Activity peaked on Wednesdays and dropped to the lowest level on Sundays. Tracked vehicle washing increased on Saturdays and Sundays. A detailed view of use by individual days for all the weeks is provided in Appendix D.

Figure 67 displays wash facility usage by vehicle type and day of the week (excluding wheeled vehicles). After wheeled vehicles, trailers and tracked vehicles were the predominant vehicle types using the wash facility. Tracked vehicle washing accounted for the greater part of activity on weekends. Tracked vehicles using the facility were mostly combat tanks (M60s) and armored personnel carriers (M113s and M577s).

#### **Fort Polk, LA**

There are two CVWFs at Fort Polk: North Fort and South Fort. However, this section presents an analysis of usage data for the South Fort CVWF only. There were not enough usage data to analyze for the North Fort wash facility due to a long closure. The facility was closed from 6 February through 23 April in part due to electrical problems at the site. The extent to which closure at one facility impacted use at the other was not determined because historical records were not available for comparison. The vehicle count logs received for the South Fort CVWF included daily hours of operation.

The wash facility cleans tactical vehicles belonging to units of the 5th Infantry Division (Mech). A three-lane bath cleans tracked vehicles and 12 wash positions process wheeled vehicles. One lane of the tank bath has been modified to wash both tracked and wheeled vehicles. The tank bath facility provides a way to remove occasional large quantities of heavy soil from tracked vehicles efficiently.

According to Fort Polk personnel, normal operation hours are 0630 to 1930. However, a review of the logs disclosed that the facility opened earlier and stayed open later if needed by units. It was also opened for weekend washing. Generally, nighttime washing is scheduled for the South Fort facility.

The South Fort CVWF processed 7022 vehicles--5360 wheeled (66 percent) and 1662 (24 percent) tracked vehicles--between December 1987 and May 1988. Monthly usage data are presented in Table 6. The largest number of vehicles were processed in April (1460). This increase is partly due to the large amount of tracked vehicle washing (520). The fewest tracked vehicles (121) were washed in February, although it was the second busiest month overall (1412).

Monthly usage data are charted in Figures 68 through 73. These figures reveal the sporadic, sometimes intensive use of the facility. The high volume of washing activity in February and April resulted from a few days of peak washing loads.

**Table 6**  
**Monthly Usage Data for South Fort Polk CVWF**

<b>Month</b>	<b>Total</b>	<b>Wheels</b>	<b>Tracks</b>	<b>Days in Use</b>
December	997	859	138	9
January	687	487	200	14
February	1412	1291	121	14
March	1308	914	394	22
April	1460	940	520	17
May	1158	869	289	14
<b>TOTALS</b>	<b>7022</b>	<b>5360</b>	<b>1662</b>	<b>90</b>

Figure 74 displays the frequency of the varying ranges of use. Most vehicle cleaning activity occurred at the rate of 50 or fewer vehicles/day. There were 8 days (9 percent) during the 6-month period when daily washing activity exceeded 200 vehicles. Tracked vehicle cleaning was logged at a rate of 25 or fewer vehicles/day for 80 percent of the days. There were 3 days when tracked vehicle cleaning exceeded the rate of 100 vehicles/day: 27 March (102), 26 April (193), and 22 May (131).

The most intensive use of the facility occurred on the following days:

<u>Date</u>	<u>Vehicle Count</u>	<u>Rate/hr</u>
11 February	390	39
28 February	221	31
1 April	249	49
26 April	532	36

In general, very little tracked vehicle washing occurred on these days except for 26 April, when 36 percent of the vehicles were tracked--mainly armored personnel carriers. The design usage rate is to prewash 20 to 24 vehicles (85 percent tracked

vehicles)/hr.<sup>4</sup> Actual use based on 6 months of data shows that the amount of tracked vehicle washing is much lower than the projected use (overall only 24 percent). The estimated annual usage of the facility was 59,274 vehicles/year.<sup>5</sup> For the 6-month period December to May (with one wash facility closed for about 2.5 months), more than 7000 vehicles were washed.

Figure 75 summarizes usage data for the facility by day of the week. The graph indicates an uneven distribution of vehicle cleaning operations over the week. Washing levels peaked on Tuesdays and Fridays. The figures in Appendix E show usage by individual days for all weeks of the 6-month period.

Figure 76 charts the types of vehicles using the South Fort wash facility. Wheeled vehicles were excluded due to the large numbers washed. Other than wheeled, trailers, and tracked vehicles, very few other types of vehicles were washed at the facility. Most tracked vehicle cleaning consisted of M60 tanks, armored personnel carriers (M113s and M577s), cargo carriers (M548s), and improved TOW vehicles (ITVs and M901s).

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<sup>4</sup>*Final Design Analysis: Tank Prewash Facilities, Fort Polk, Louisiana (S.E. Huey Co., 1978).*

<sup>5</sup>*Final Design Analysis: Tank Prewash Facilities, Fort Polk, Louisiana.*

### 3 SUMMARY AND RECOMMENDATIONS

Usage data have been collected and analyzed for four CVWFs: North Fort and Southeast at Fort Lewis, Yakima Firing Center, and South Fort Polk. The data consisted of the numbers and types of vehicles processed, frequency of facility usage, and processing rates when available.

The North Fort Lewis facility operated above its design capacity once in 1986 and six times in 1987. Mainly wheeled vehicles are washed at this facility.

Data for the Southeast CVWF showed that this facility generally operated below its design capacity. Personal observations during site visits revealed an average wash time of 13 min/wheeled vehicle. Wheeled vehicles, engineering vehicles, and towed howitzers are the predominant types washed.

At the Yakima Firing Center CVWF, data showed that wheeled vehicle washing levels are higher and tracked vehicle washing levels much lower than projected in the design analysis. The major vehicle types using the facility are wheeled, tanks, and armored personnel carriers.

Data from the South Fort Polk CVWF indicated very high daily use. The facility is experiencing higher than projected wheeled vehicle washing rates whereas the amount of tracked vehicle washing is much lower than design estimates. Tracked and wheeled vehicles are the primary types using the facility.

It is recommended that CVWF designers consider the results of this analysis in planning and designing future facilities.

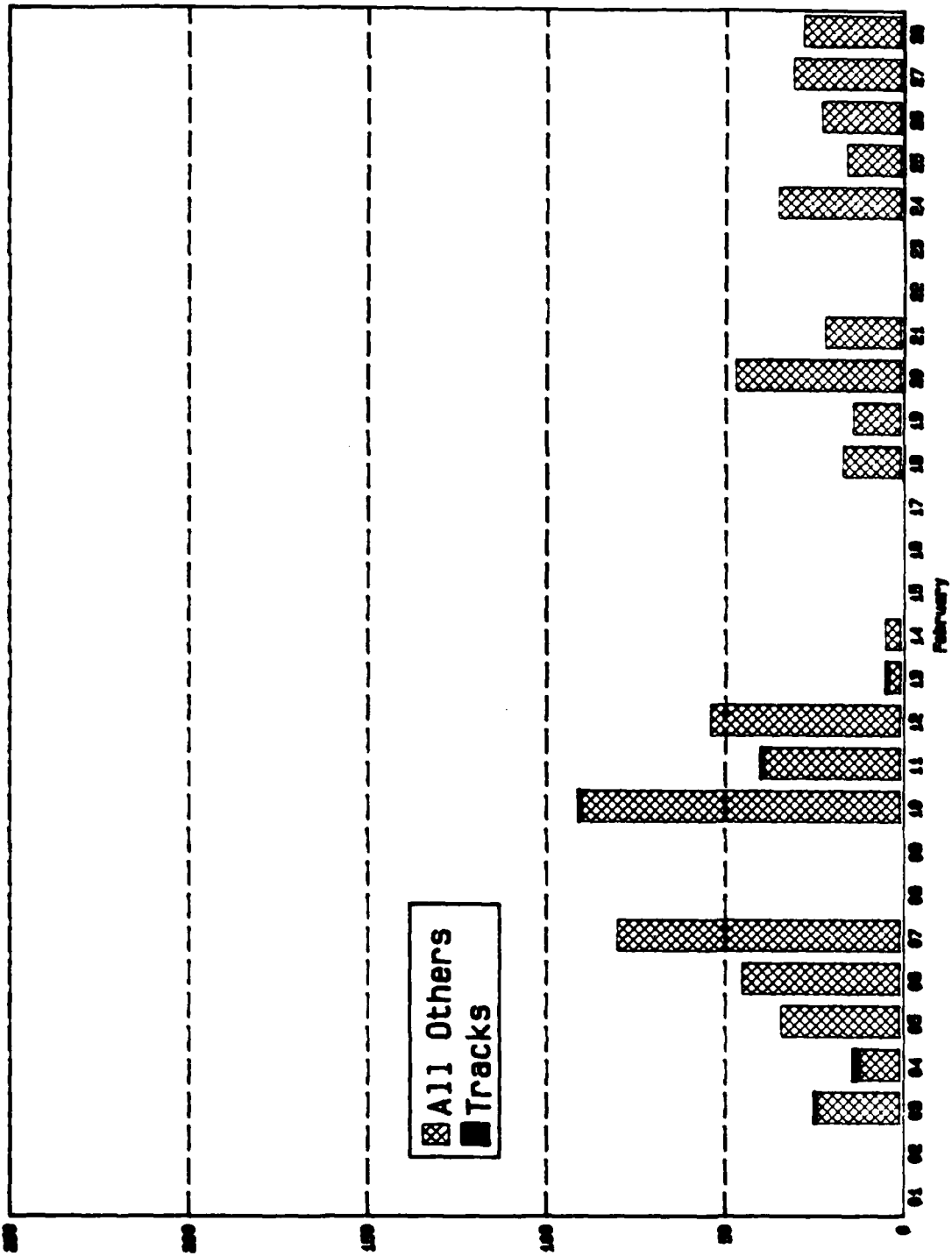


Figure 1. North Fort Lewis CVWF usage by month - February 1986.

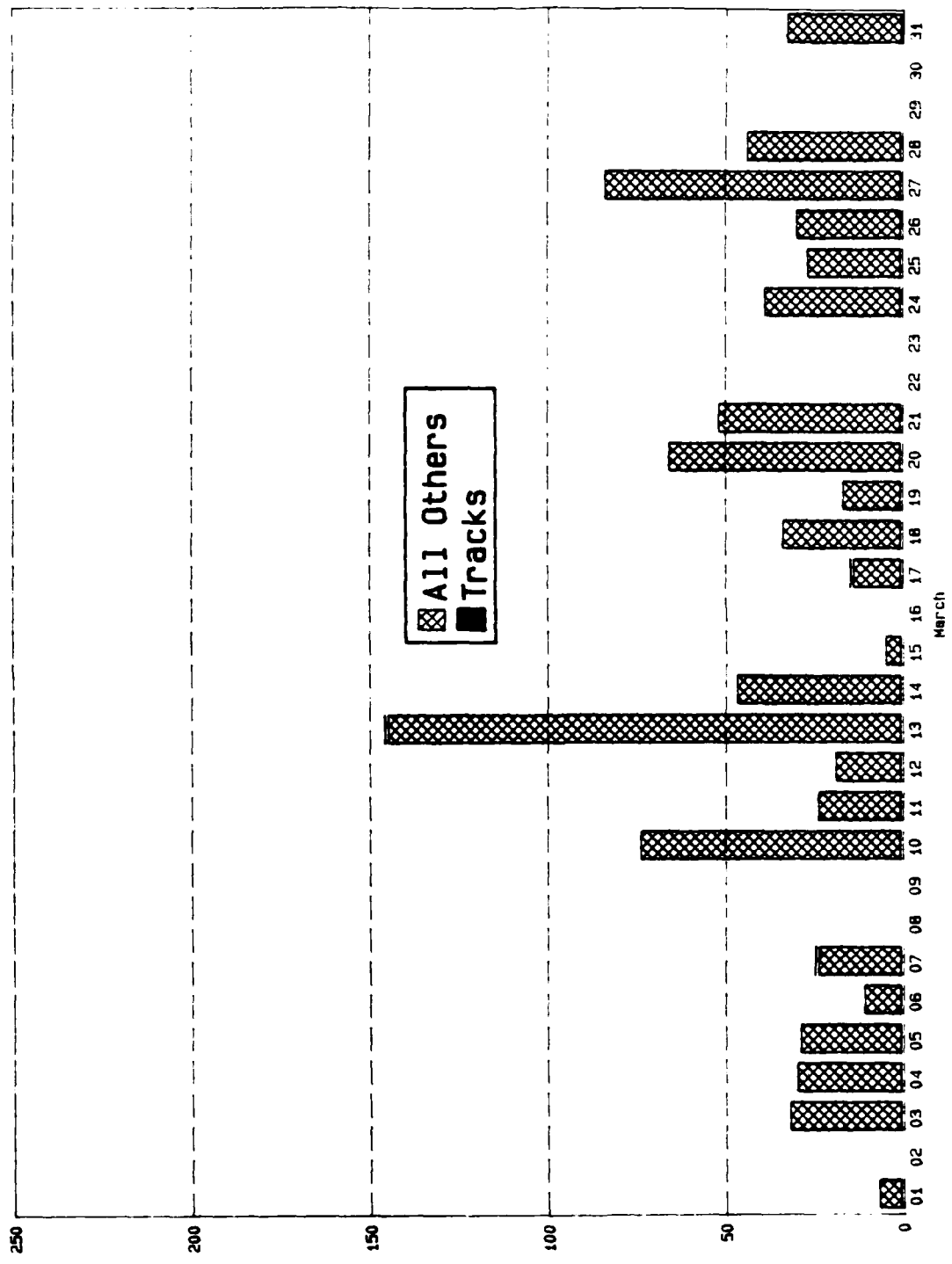


Figure 2. North Fort Lewis CVWF usage by month - March 1986.

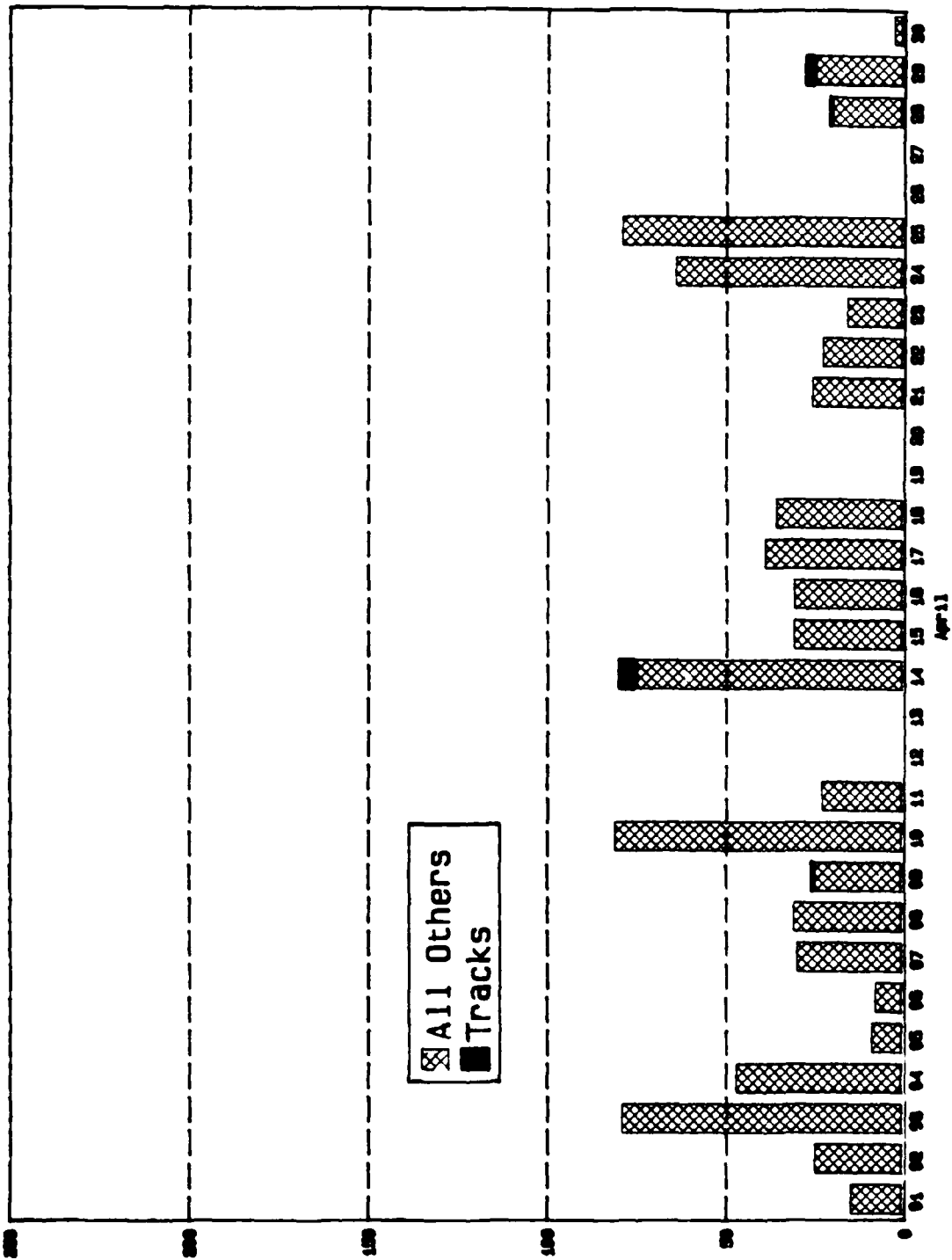


Figure 3. North Fort Lewis CVWF usage by month - April 1986.

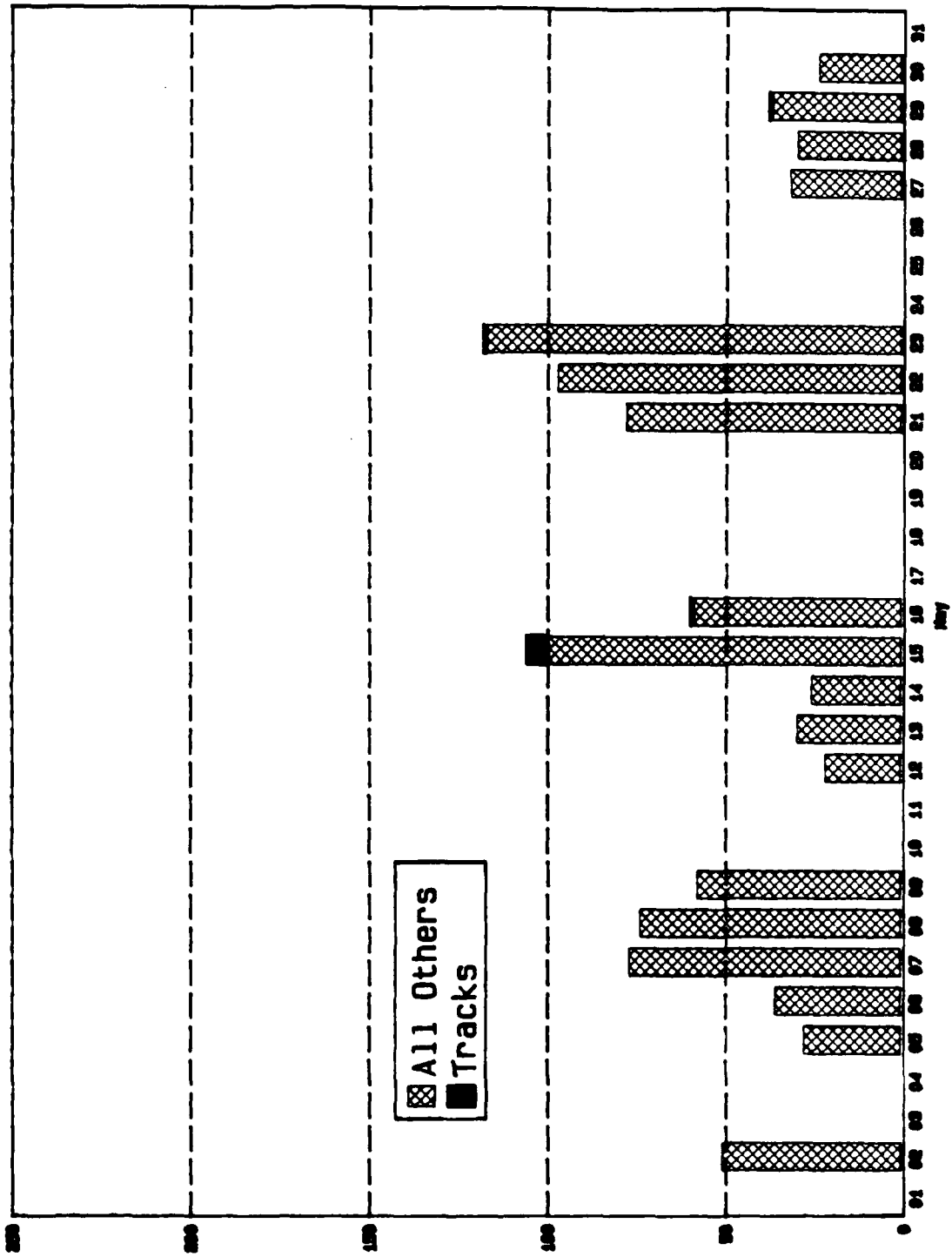


Figure 4. North Fort Lewis CVWF usage by month - May 1986.

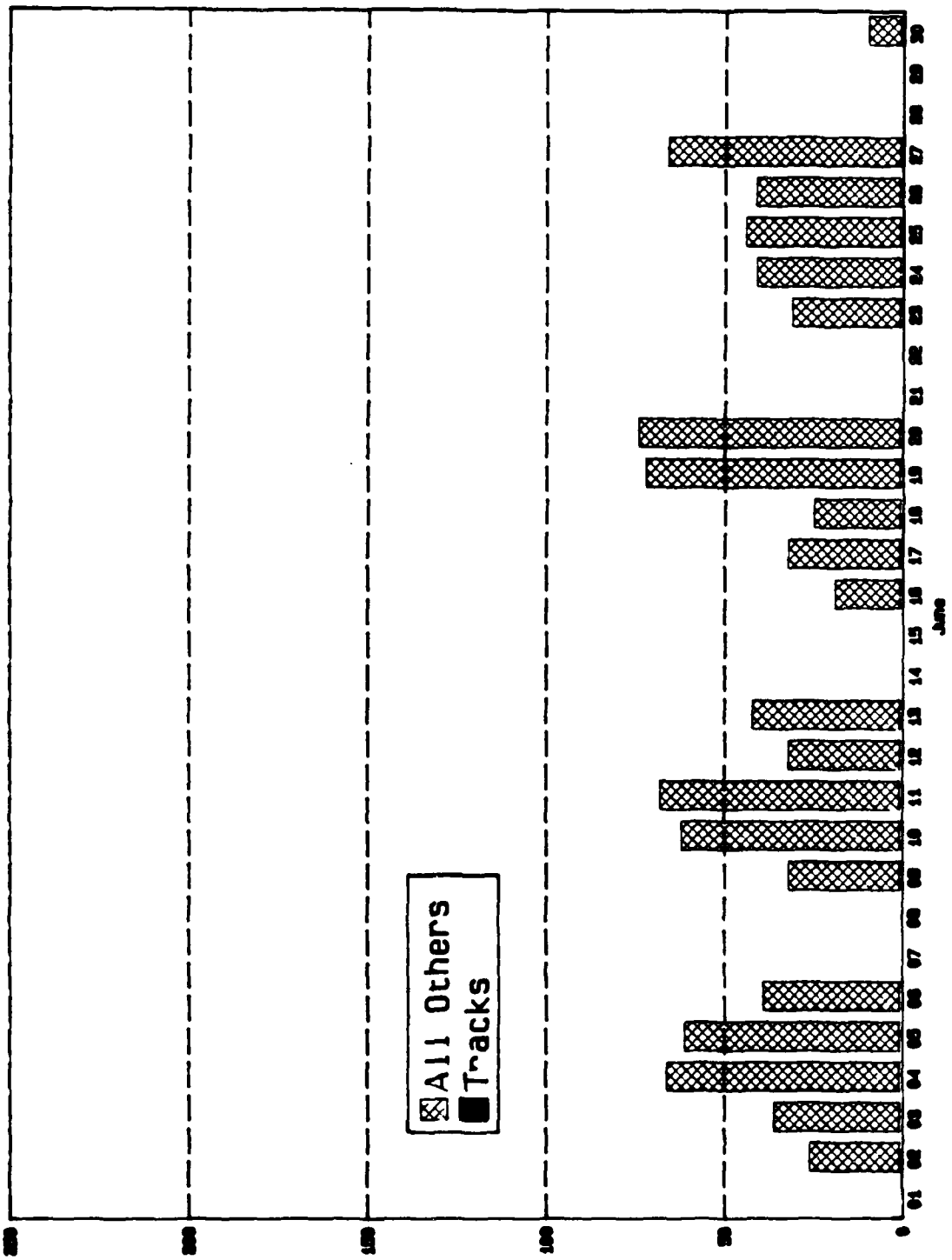


Figure 5. North Fort Lewis CVWF usage by month - June 1986.

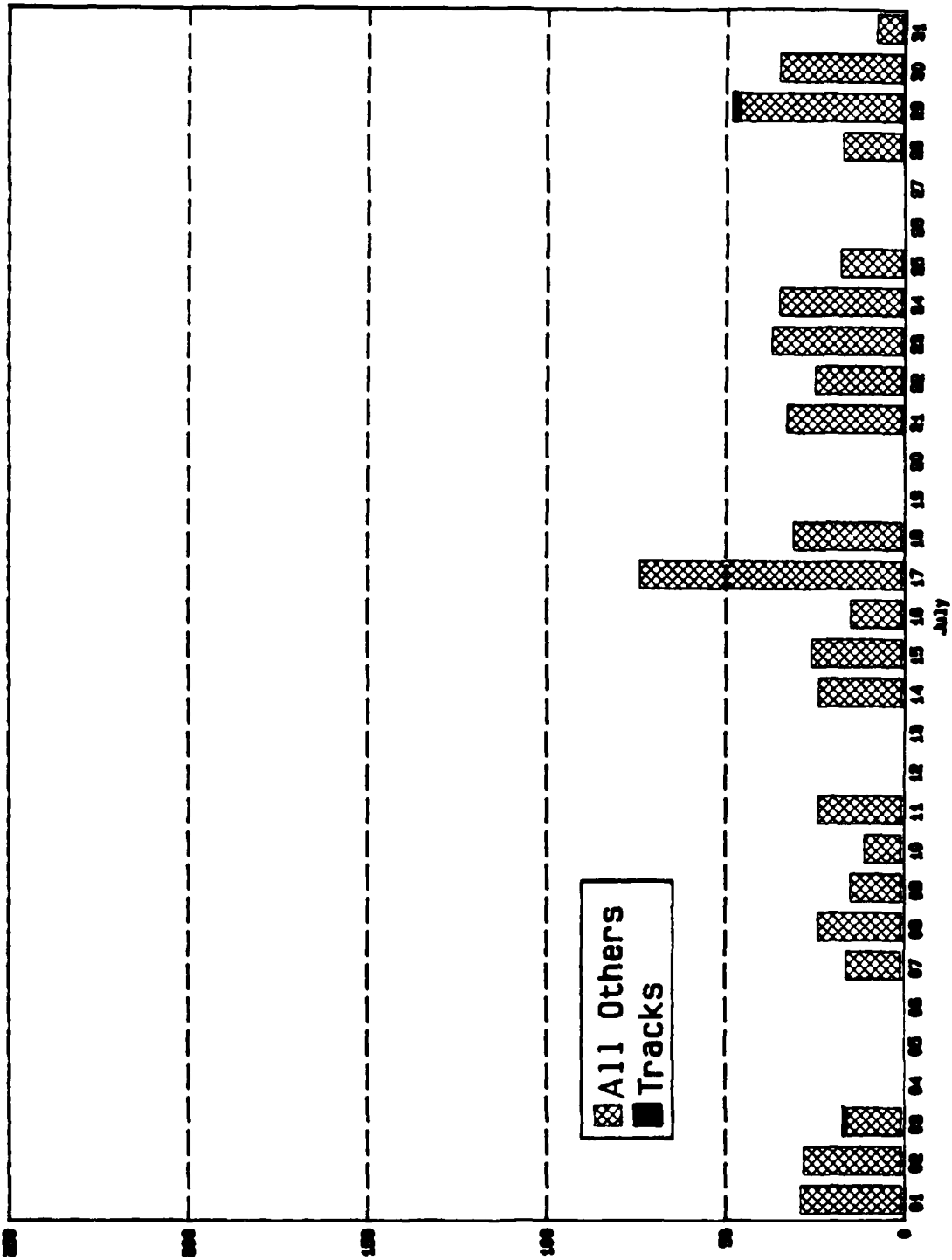


Figure 6. North Fort Lewis CVWF usage by month - July 1986.

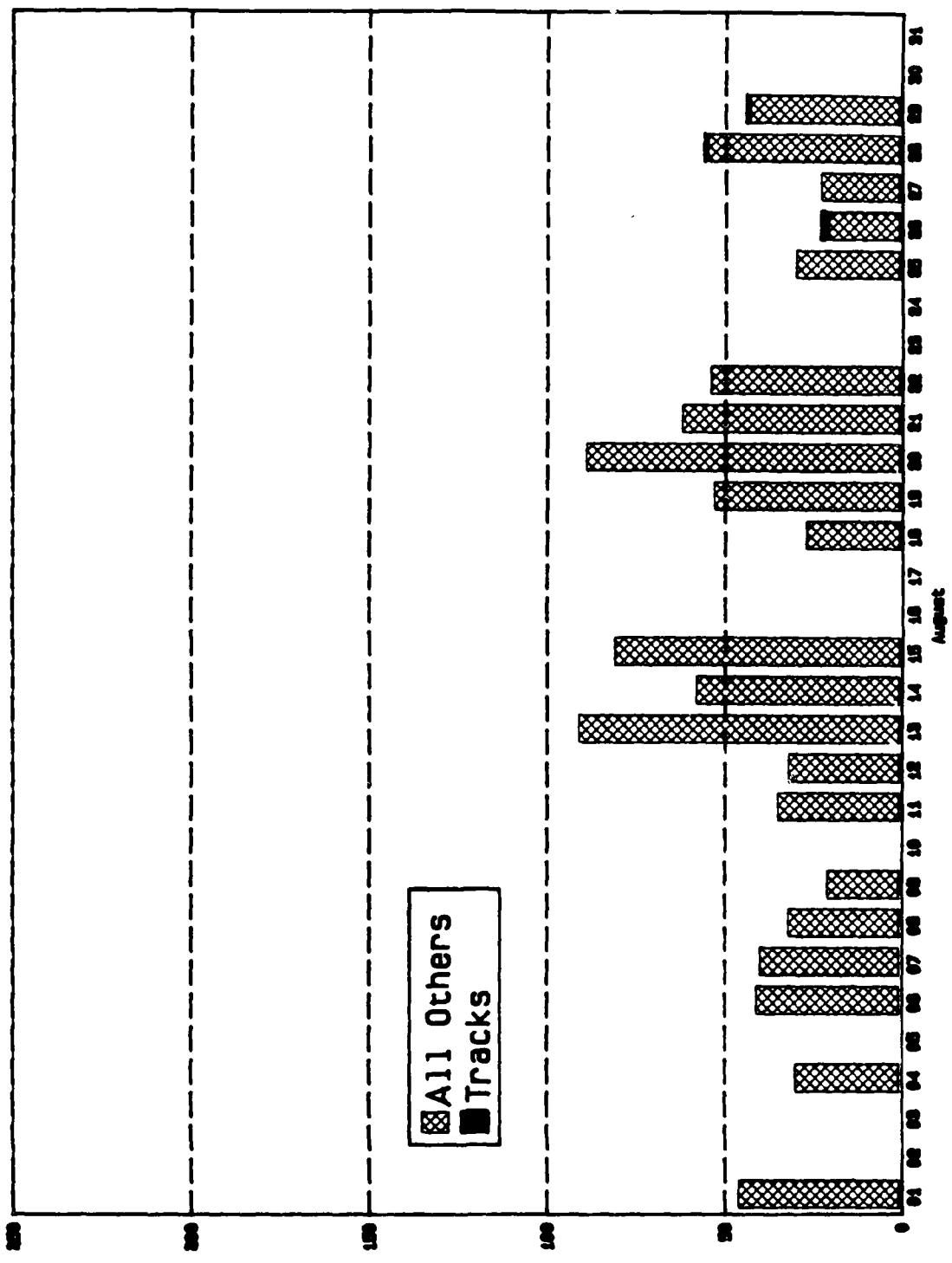


Figure 7. North Fort Lewis CVWF usage by month - August 1986.

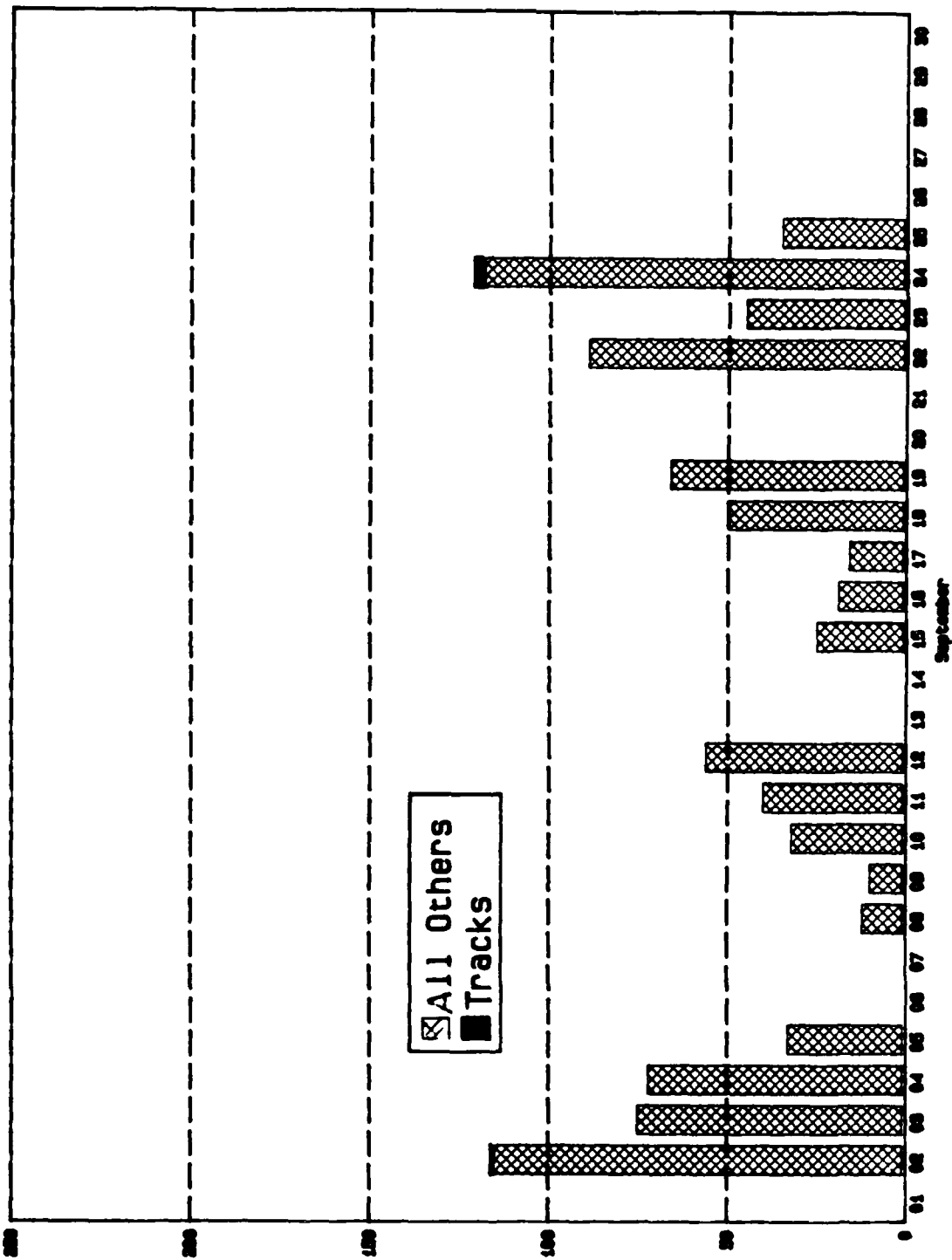


Figure 8. North Fort Lewis CVWF usage by month - September 1986.

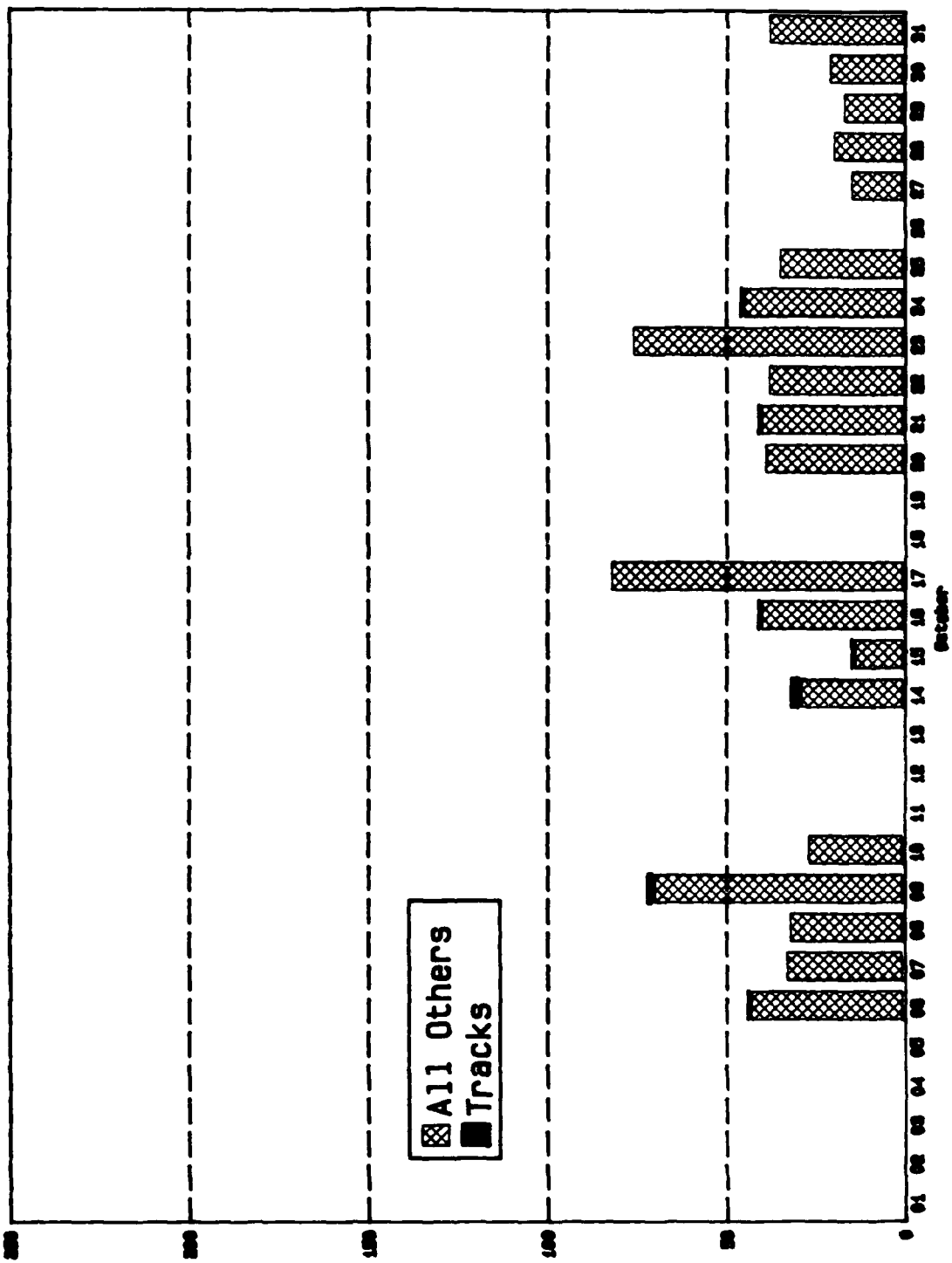


Figure 9. North Fort Lewis CVWF usage by month - October 1986.

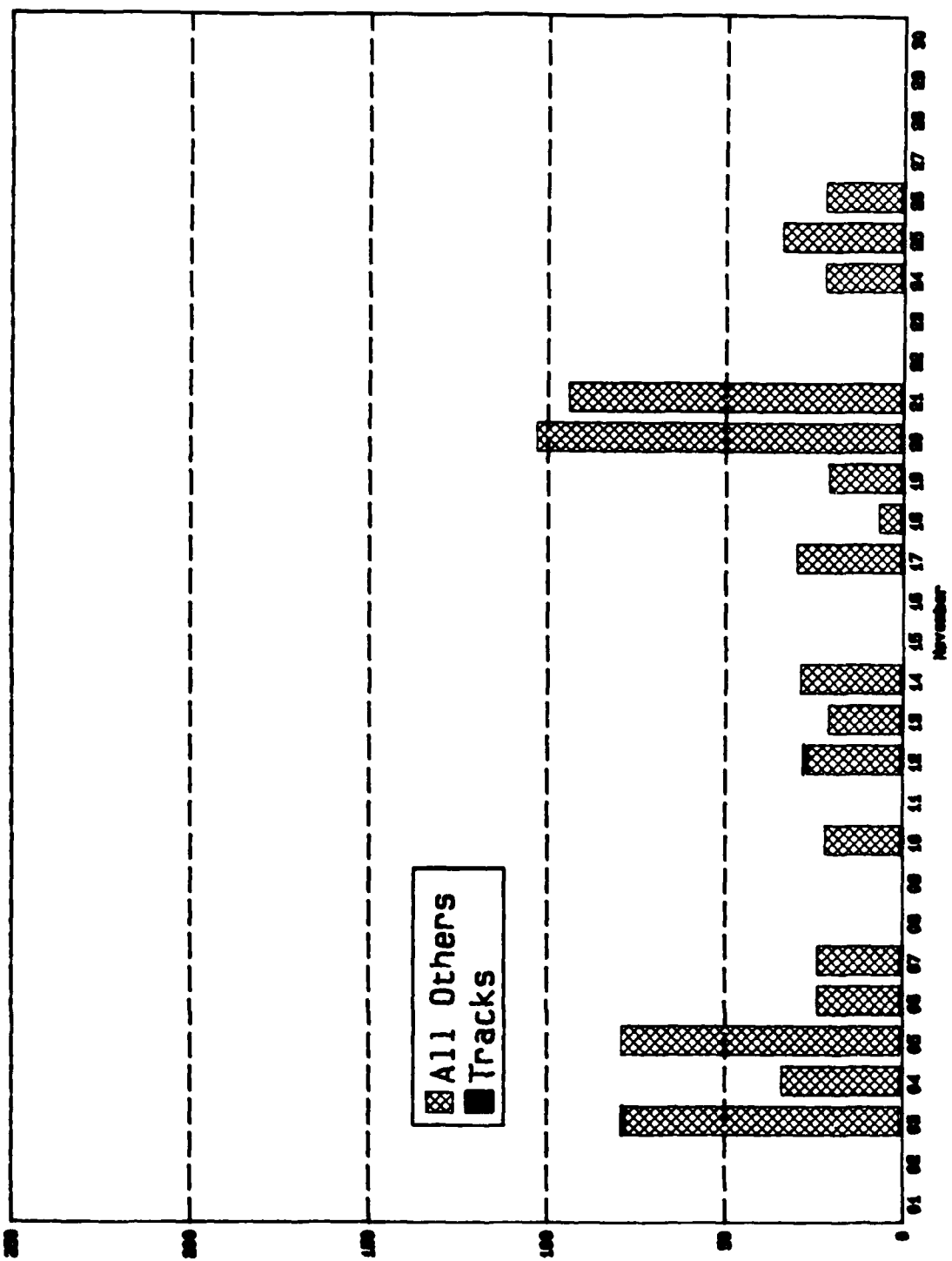


Figure 10. North Fort Lewis CVWF usage by month - November 1986.

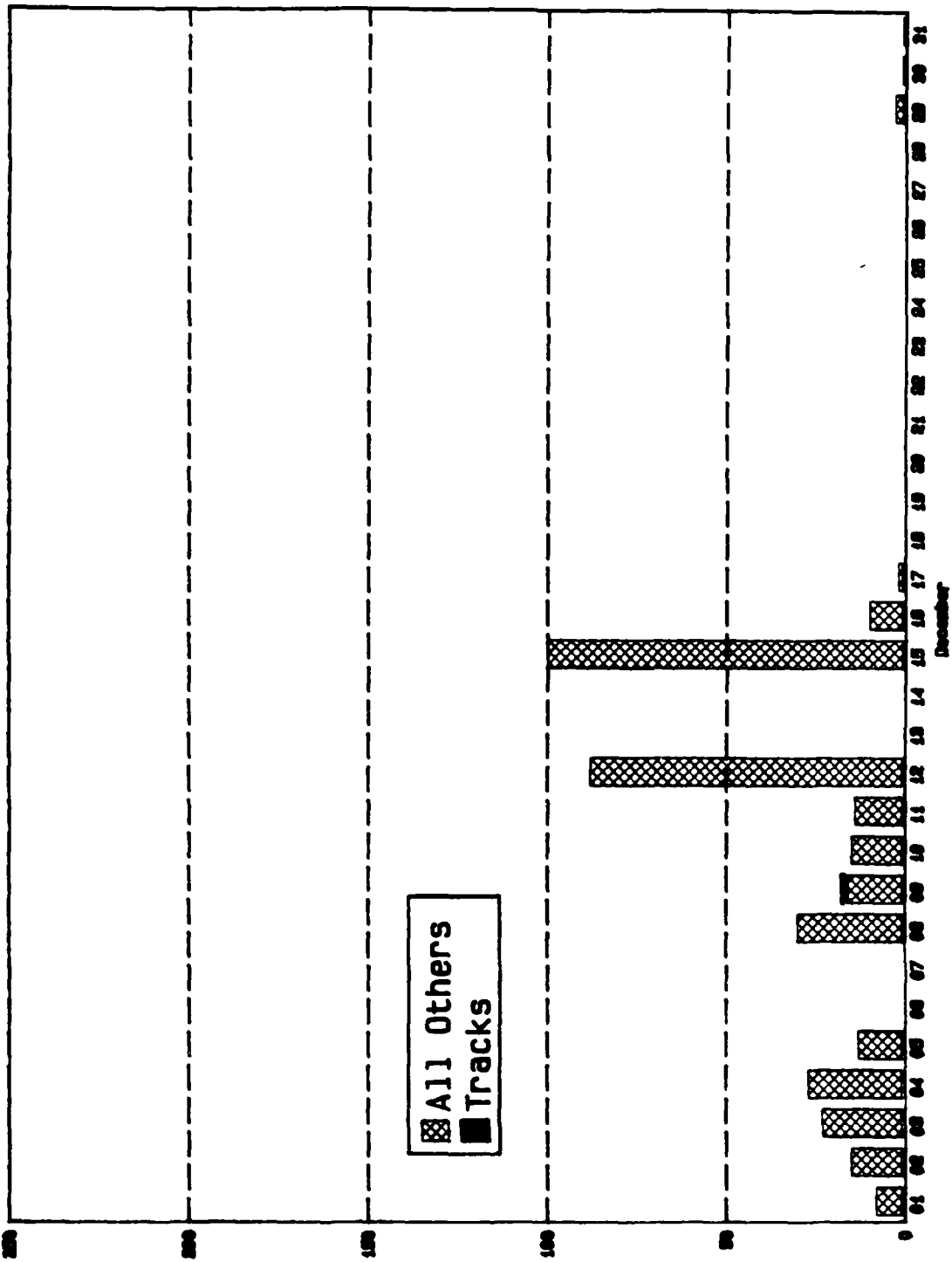


Figure 11. North Fort Lewis CVWF usage by month - December 1986.

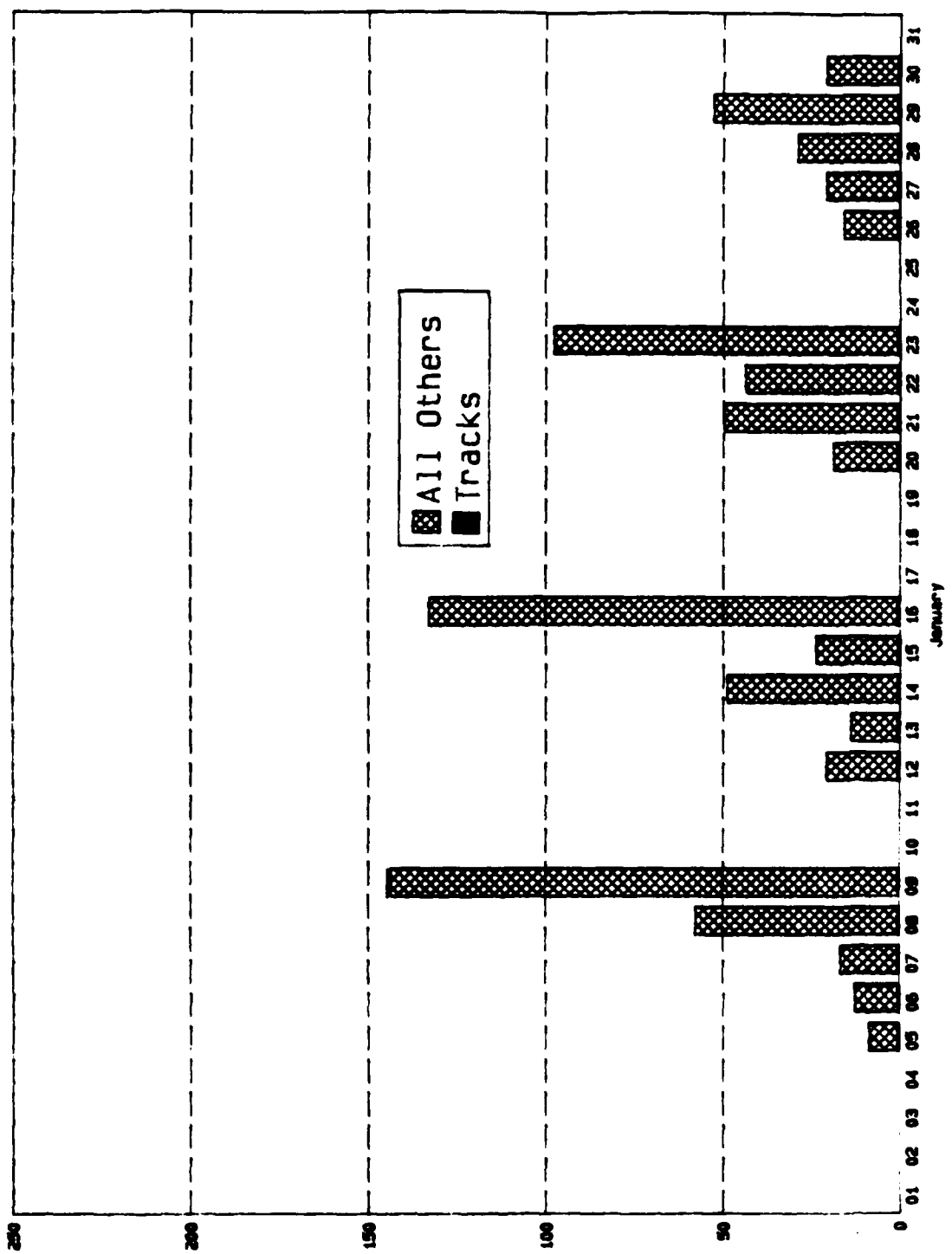


Figure 12. North Fort Lewis CVWP usage by month - January 1987.

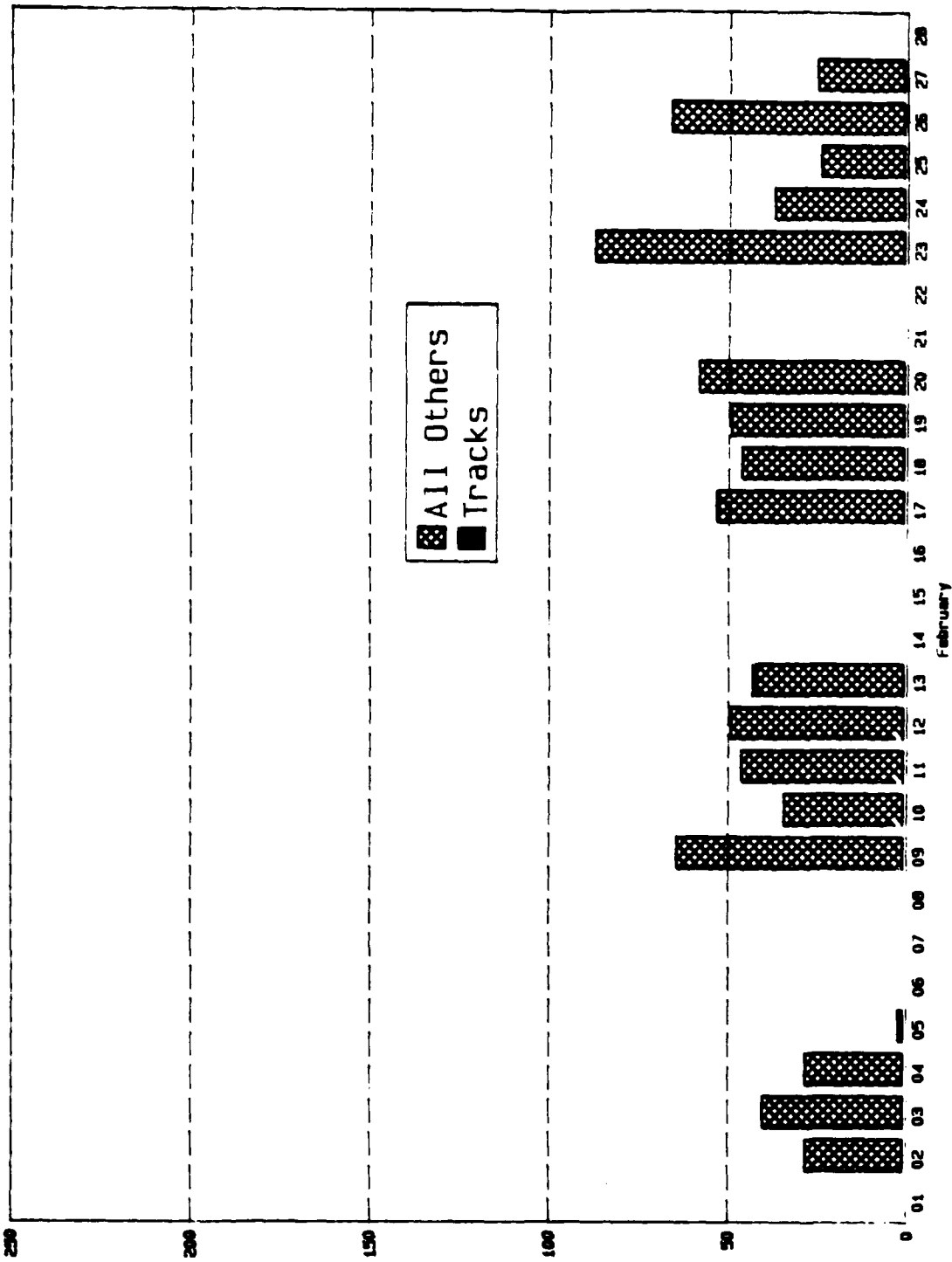


Figure 13. North Fort Lewis CVWF usage by month - February 1987.

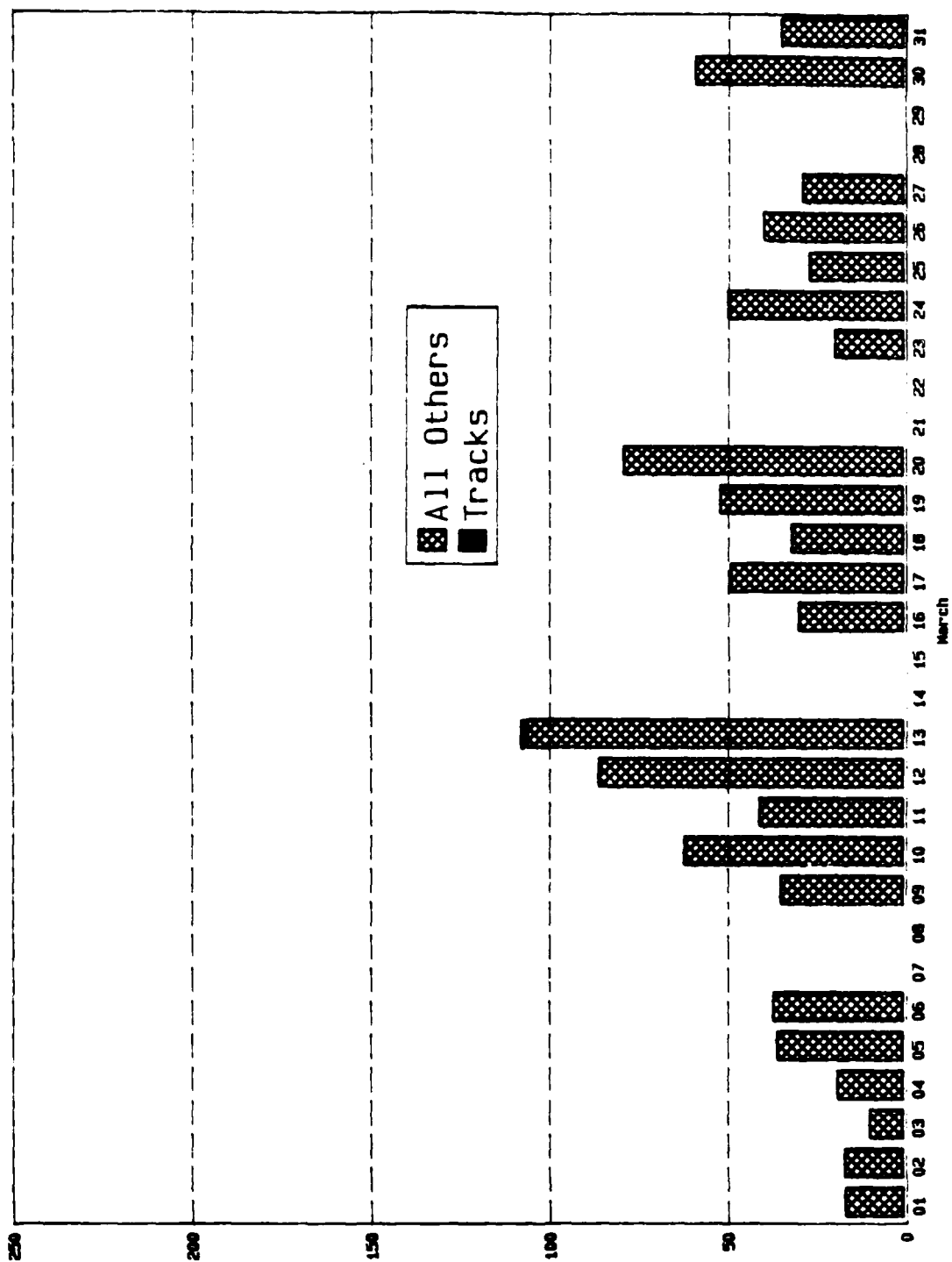


Figure 14. North Fort Lewis CVWF usage by month - March 1987.

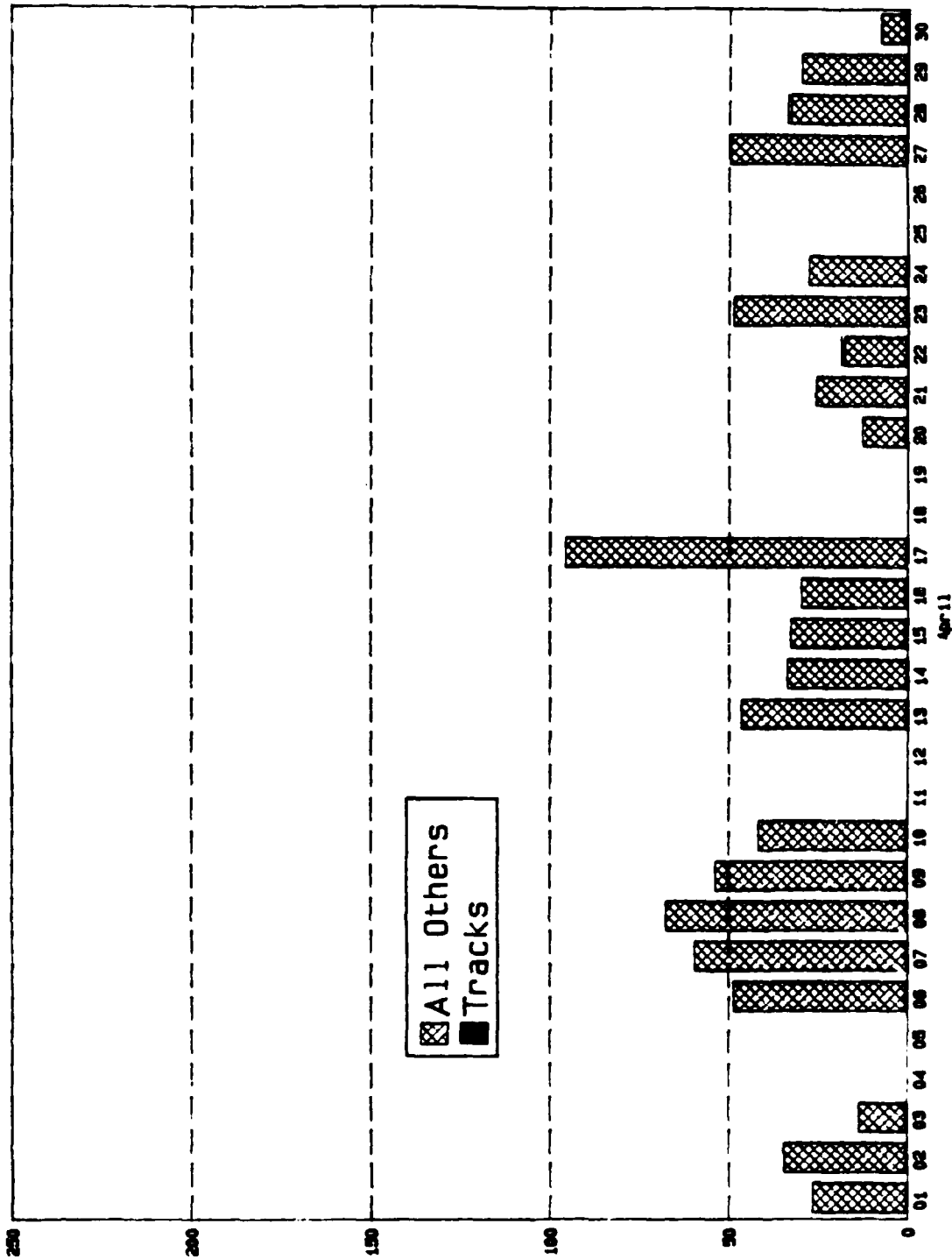


Figure 15. North Fort Lewis CVWF usage by month - April 1987.

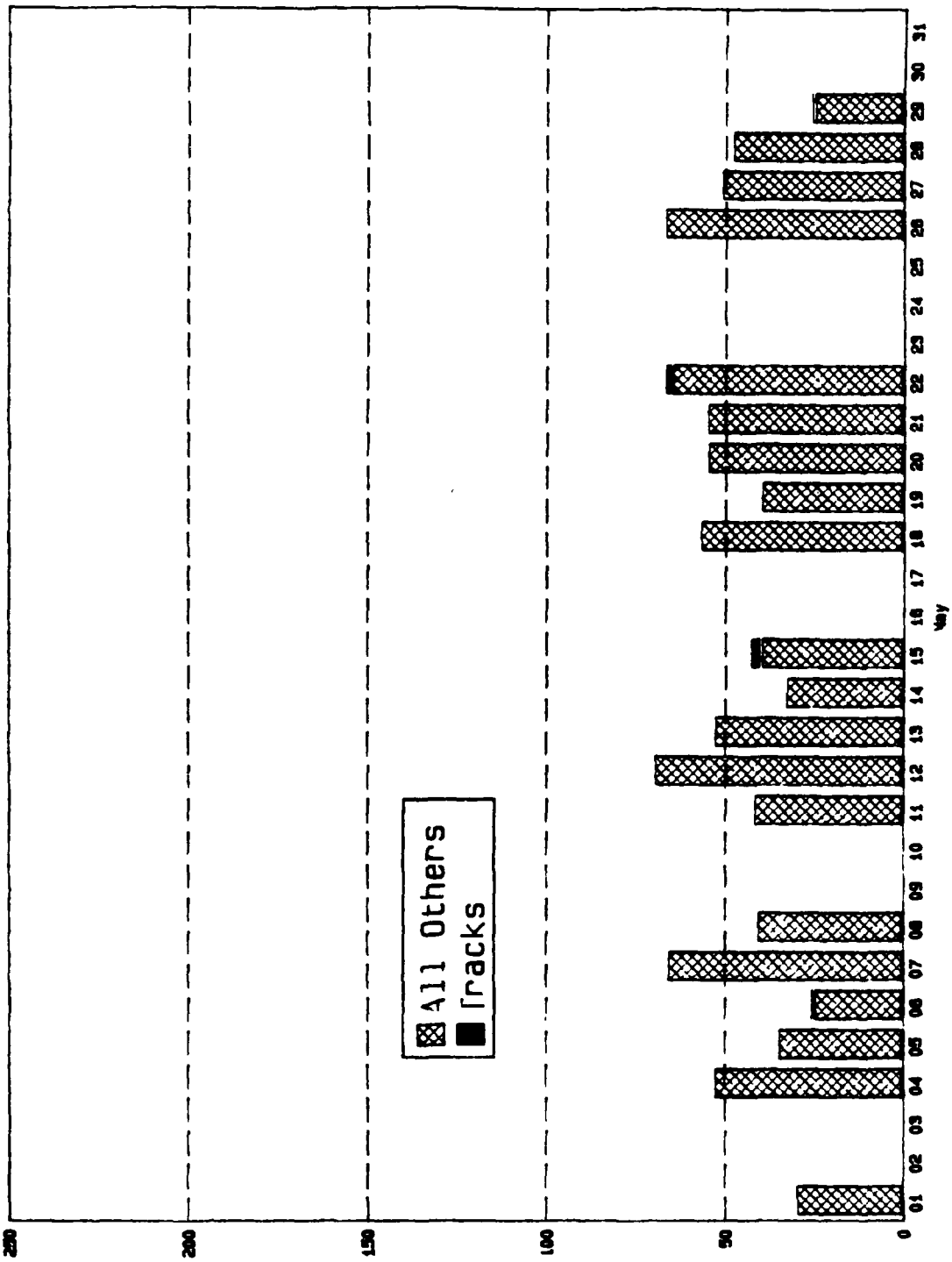


Figure 16. North Fort Lewis CVWF usage by month - May 1987.

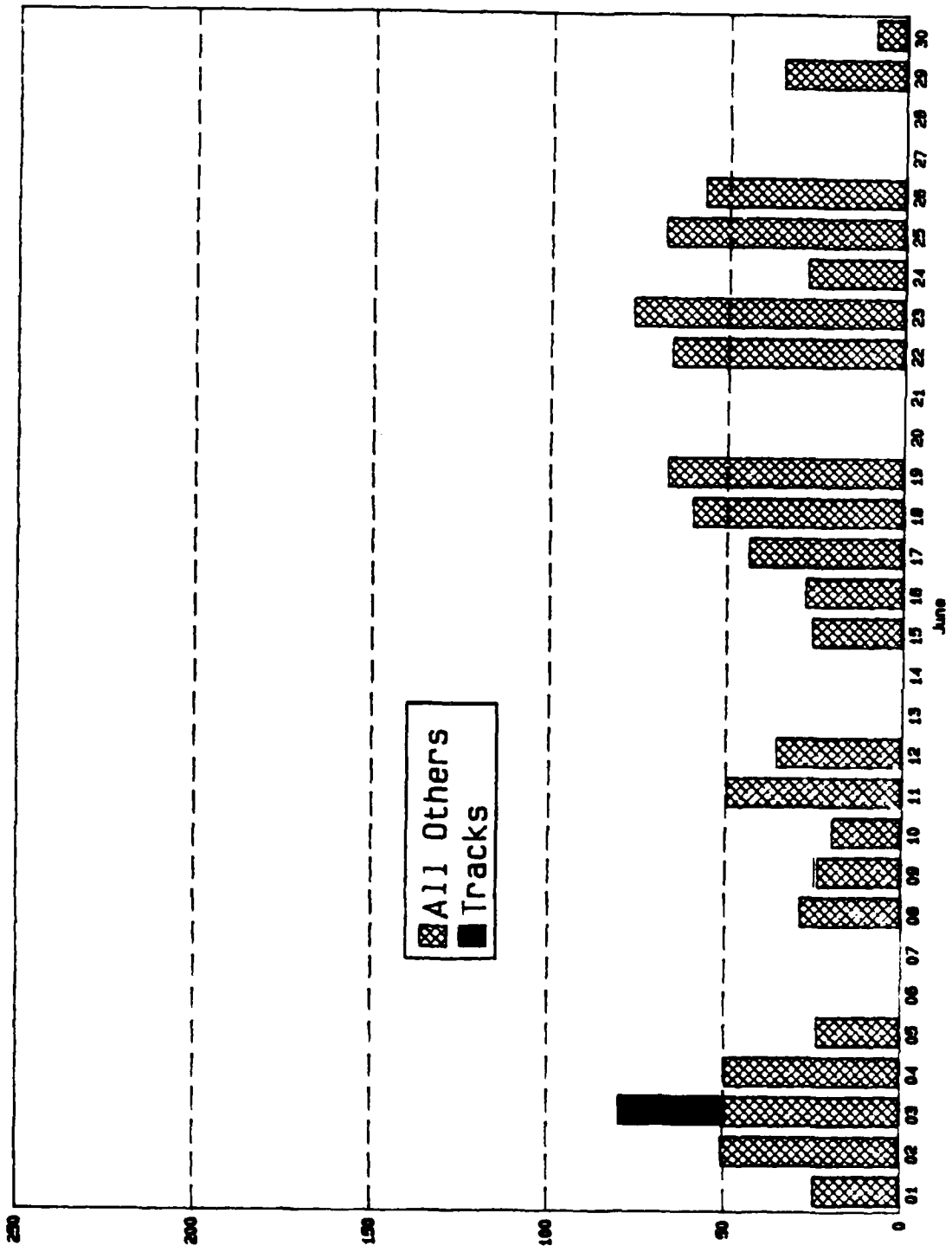


Figure 17. North Fort Lewis CVWF usage by month - June 1987.



Figure 18. North Fort Lewis CVWF usage by month - July 1987.

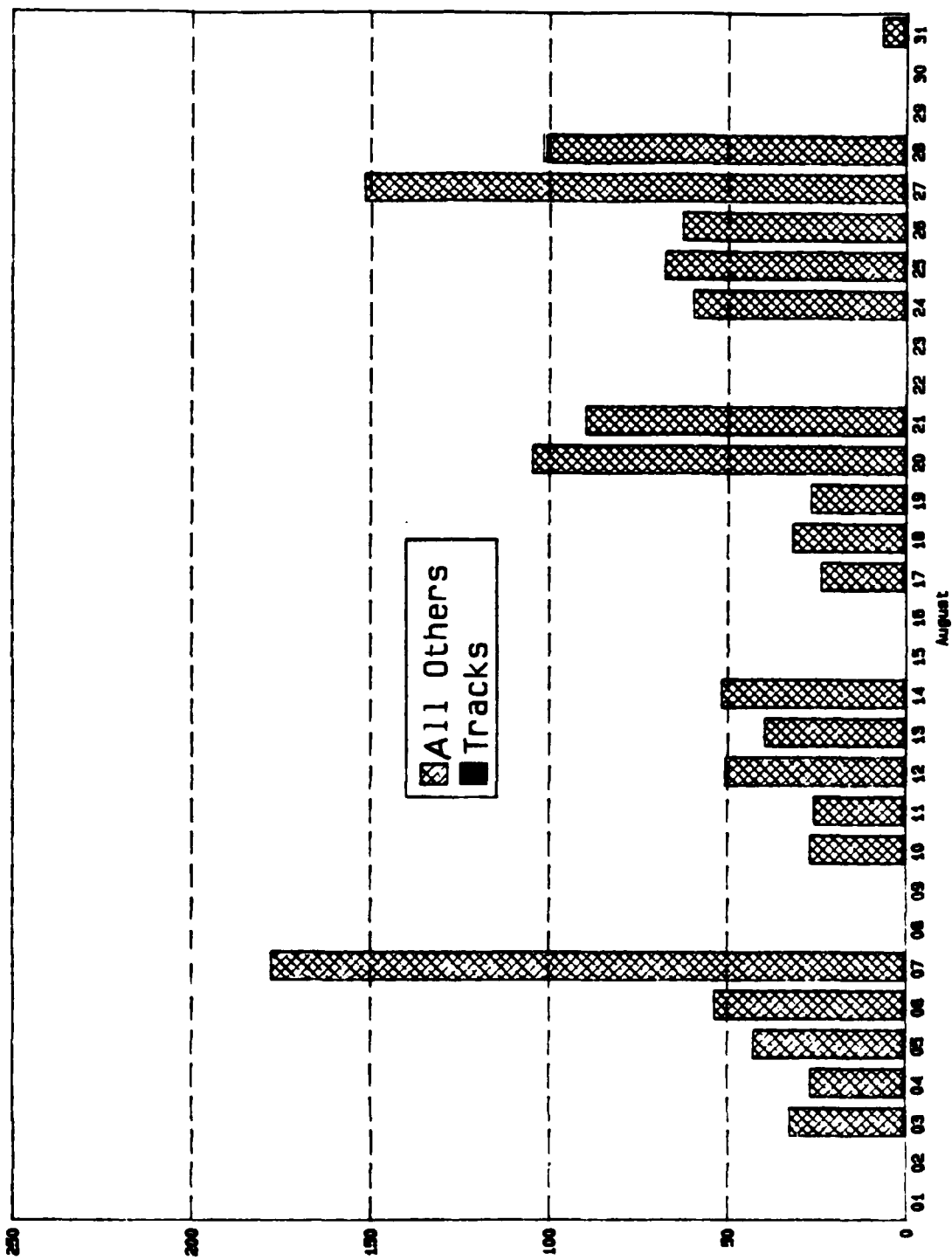


Figure 19. North Fort Lewis CVWF usage by month - August 1987.



Figure 20. North Fort Lewis CVWF usage by month - September 1987.

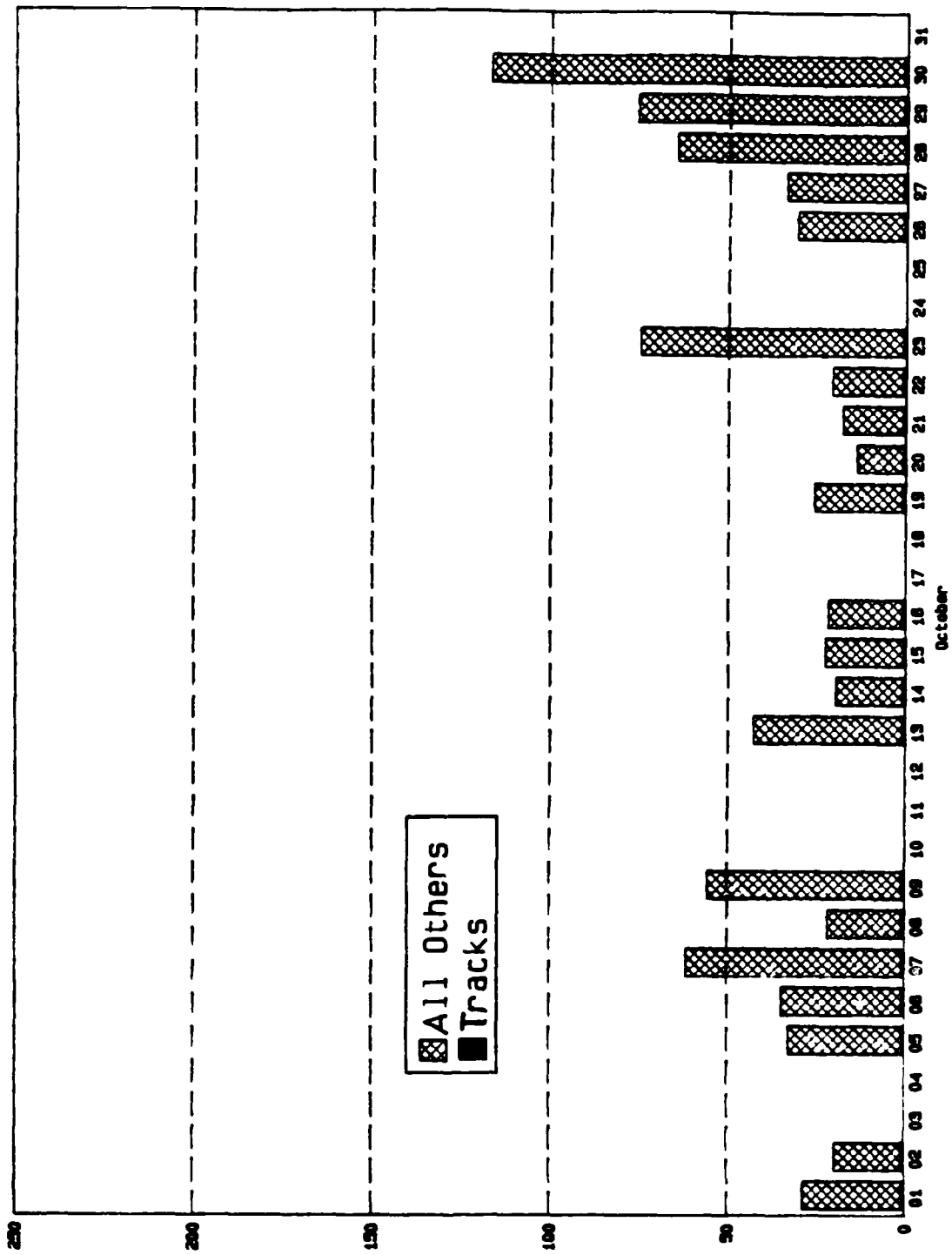


Figure 21. North Fort Lewis CVWF usage by month - October 1987.

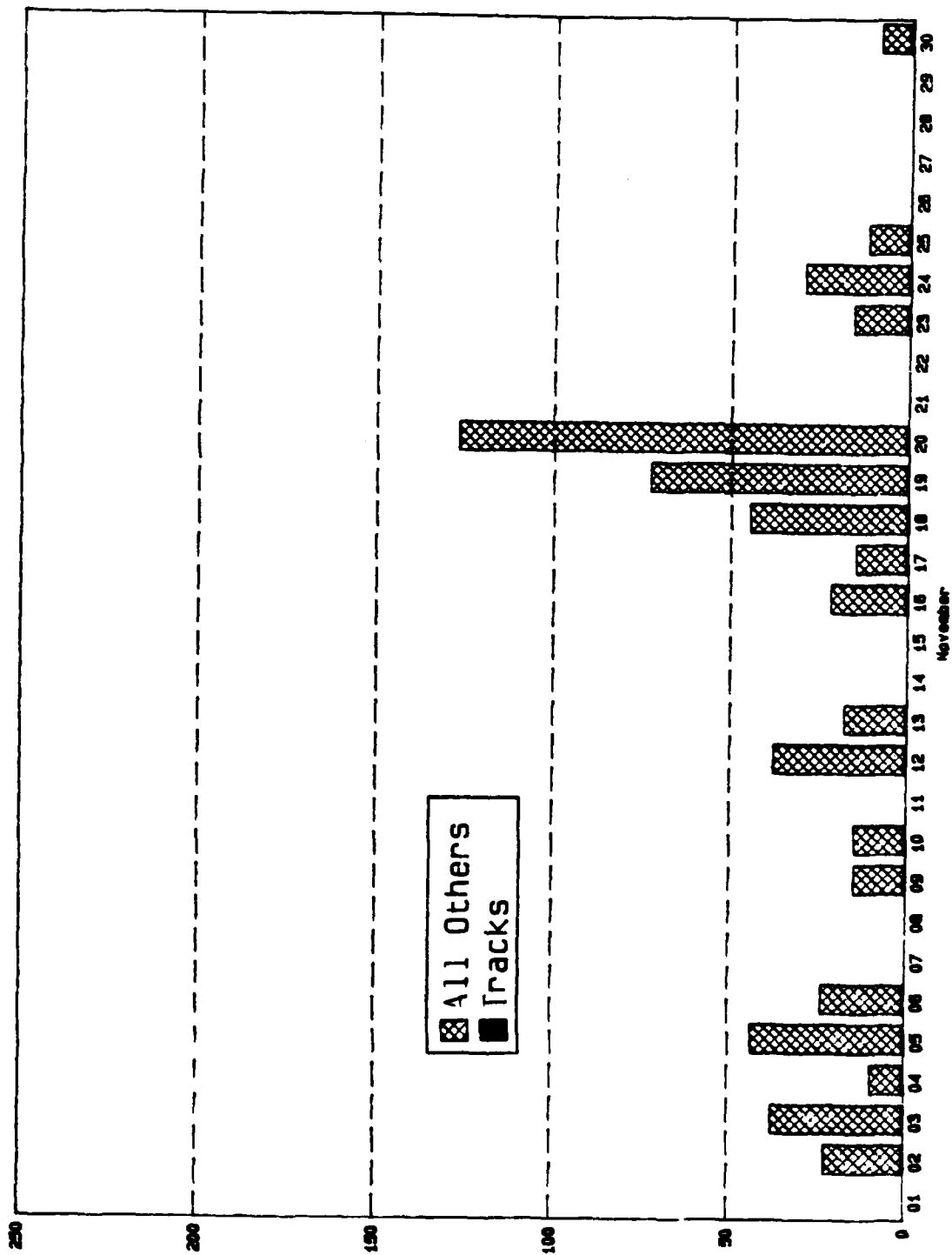


Figure 22. North Fort Lewis CVWF usage by month - November 1987.

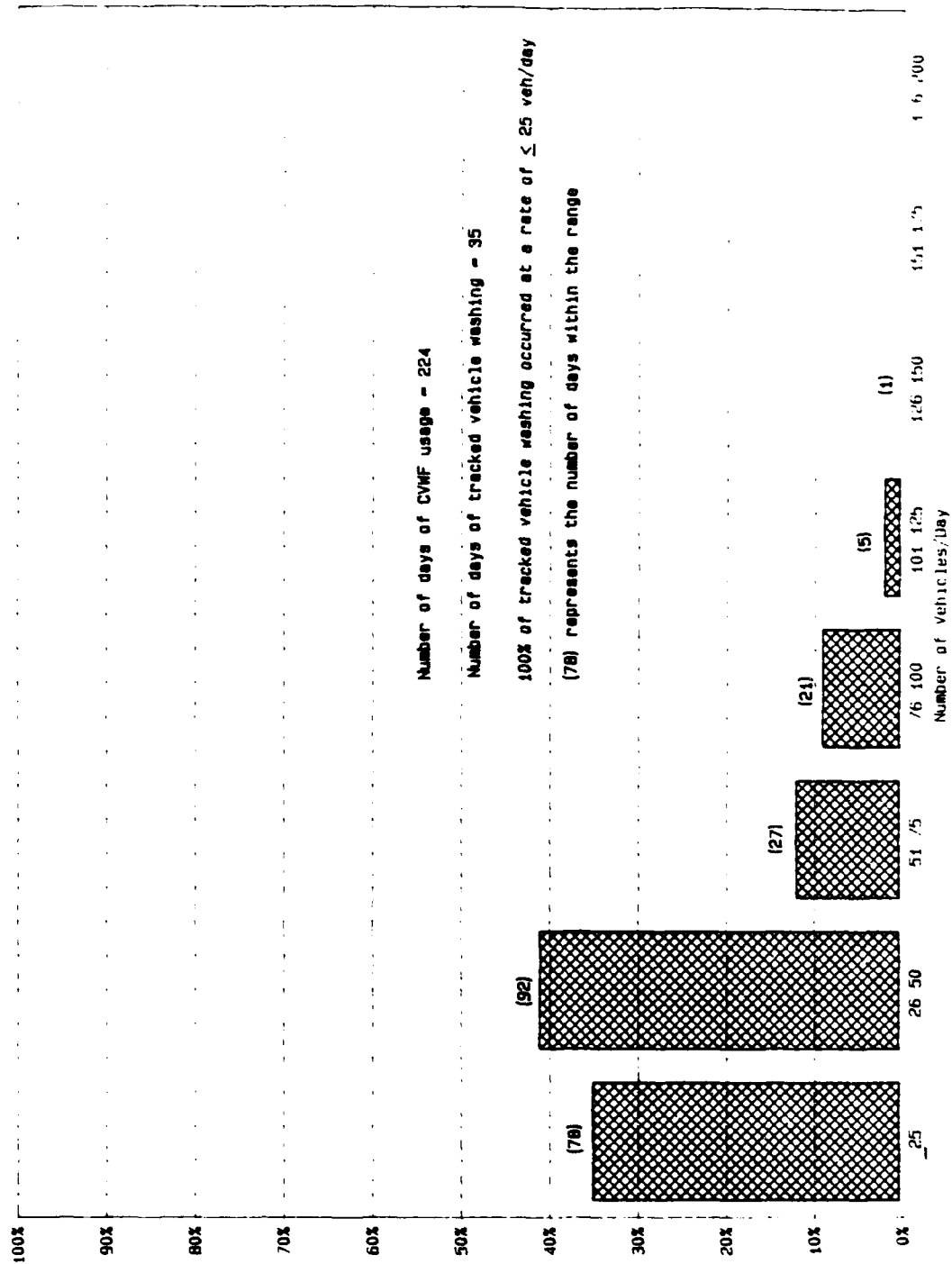


Figure 23. North Fort Lewis CVWF usage level frequency - 27 January 1986 to 31 December 1986.

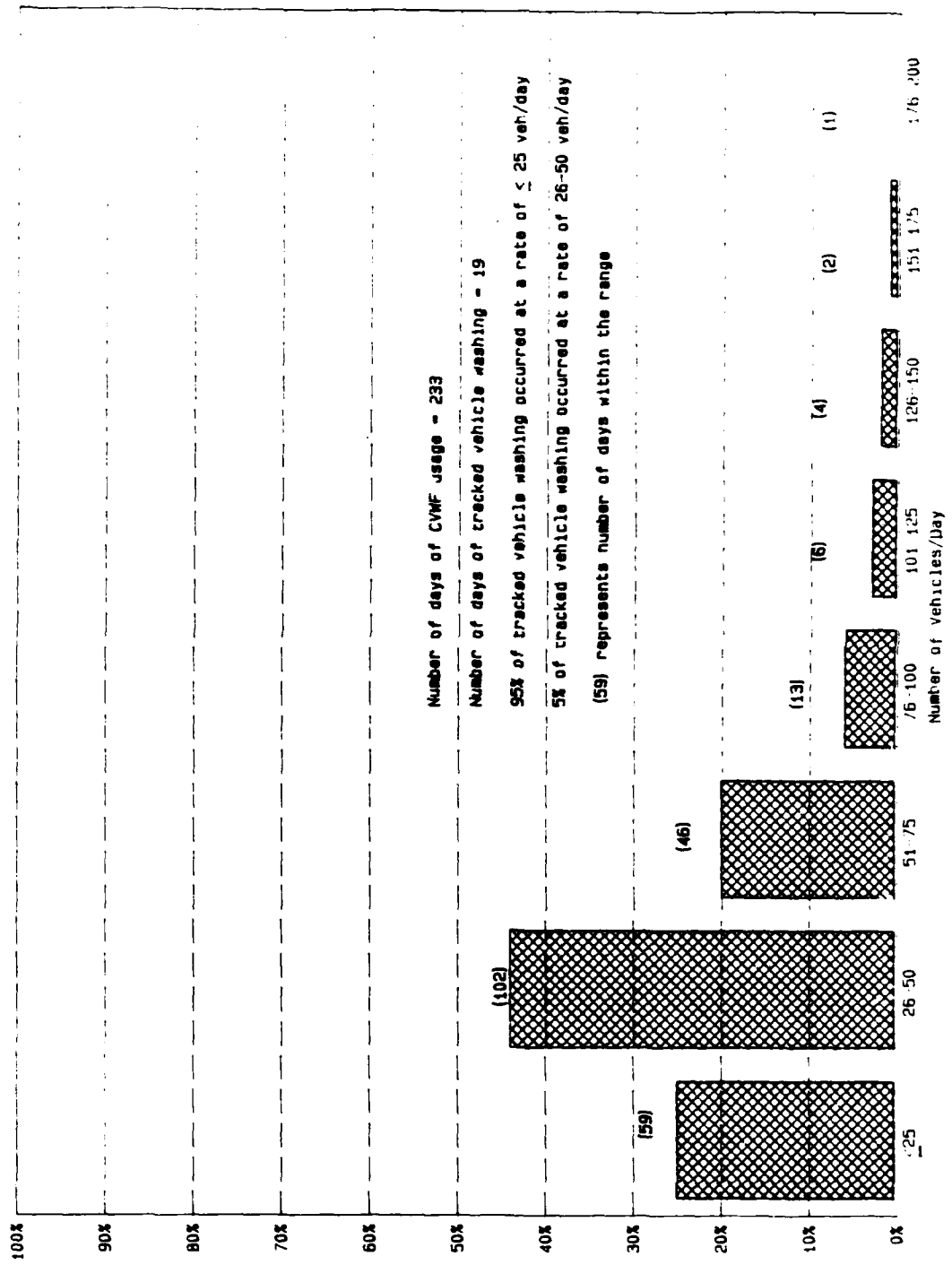


Figure 24. North Fort Lewis CVWF usage level frequency - 5 January 1987 to 4 December 1987.

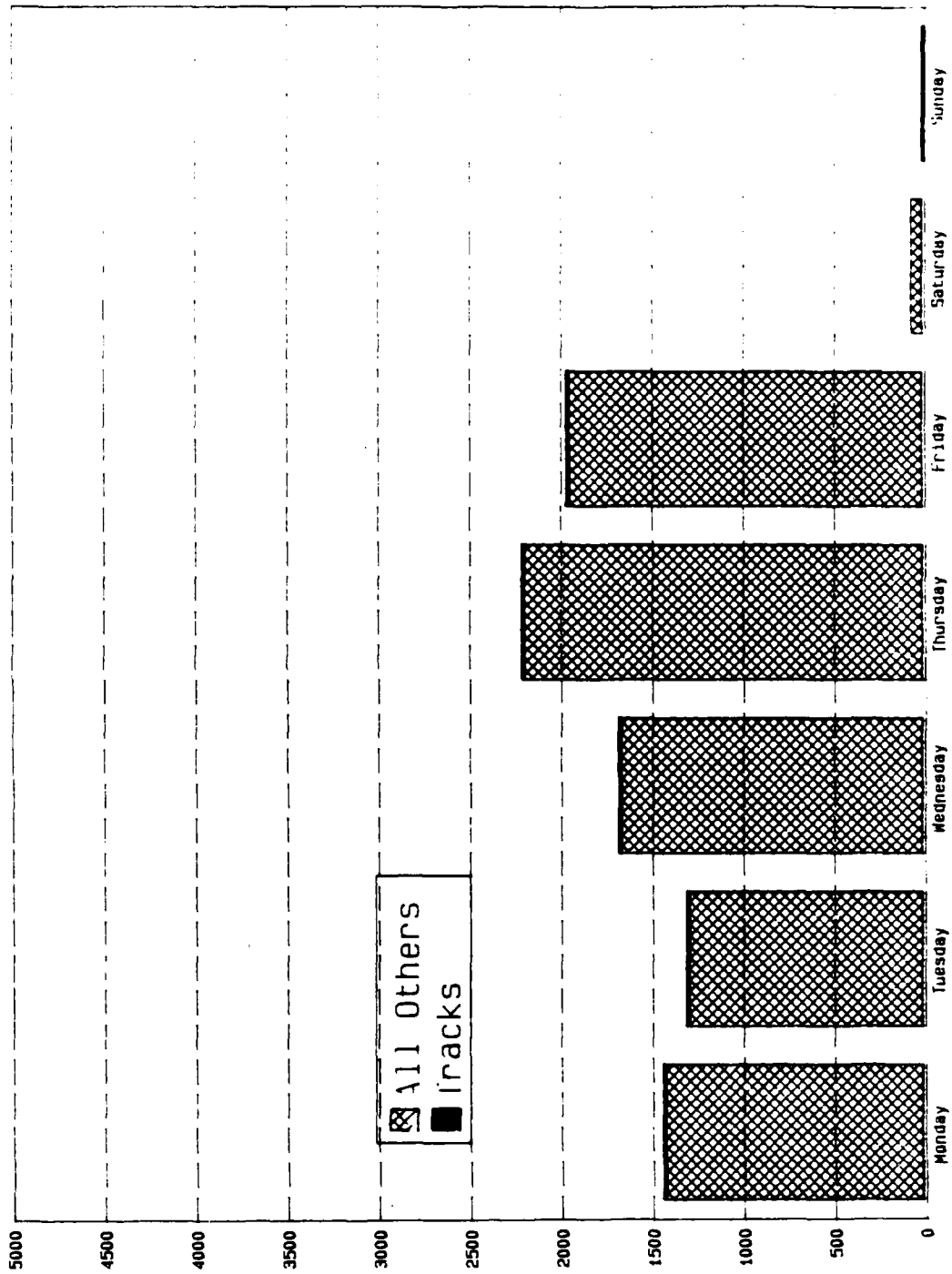


Figure 25. North Fort Lewis CVWR usage by day of the week - 27 January 1986 to 31 December 1986.

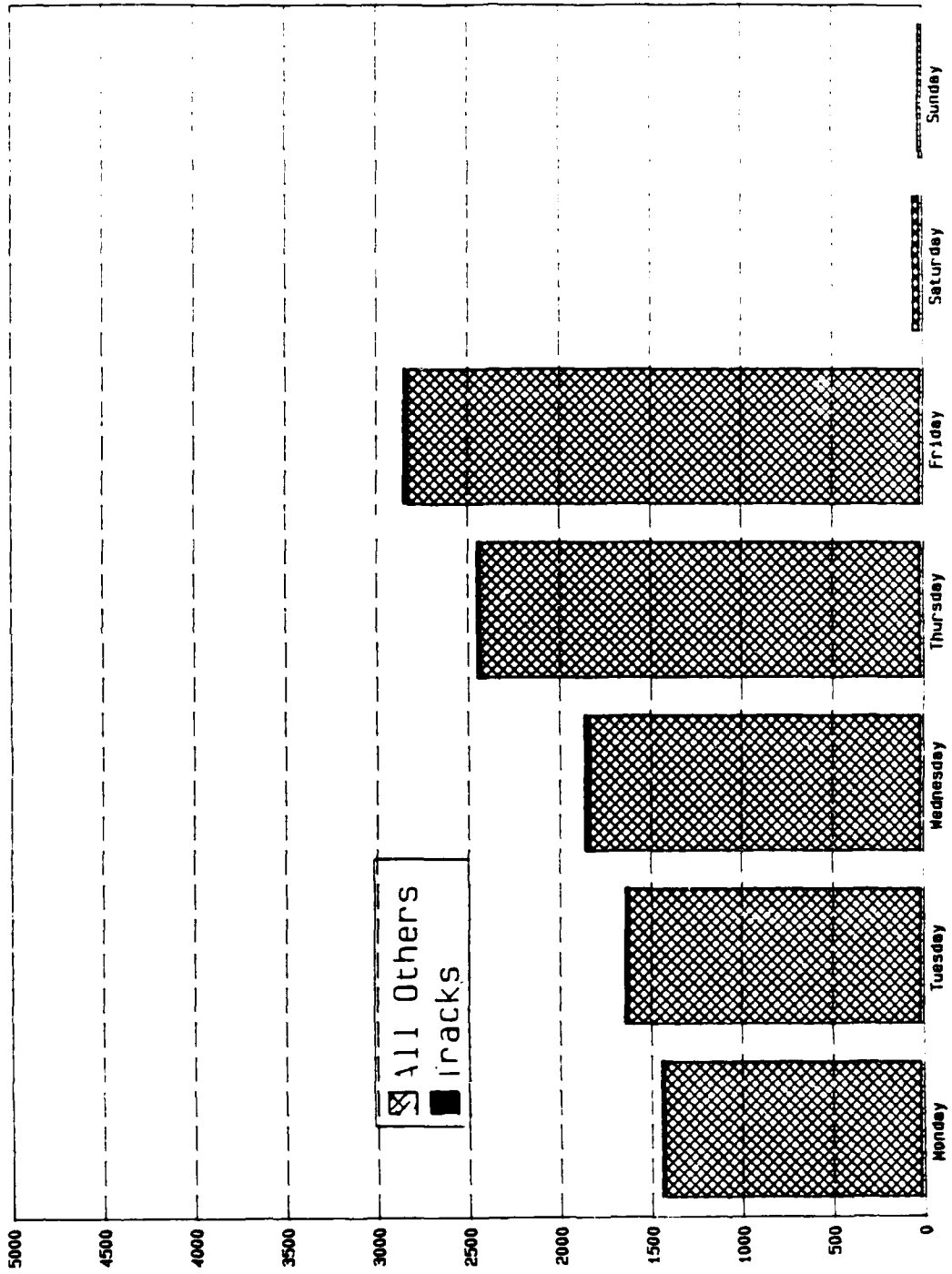


Figure 26. North Fort Lewis CVWF usage by day of the week - 5 January 1987 to 4 December 1987.

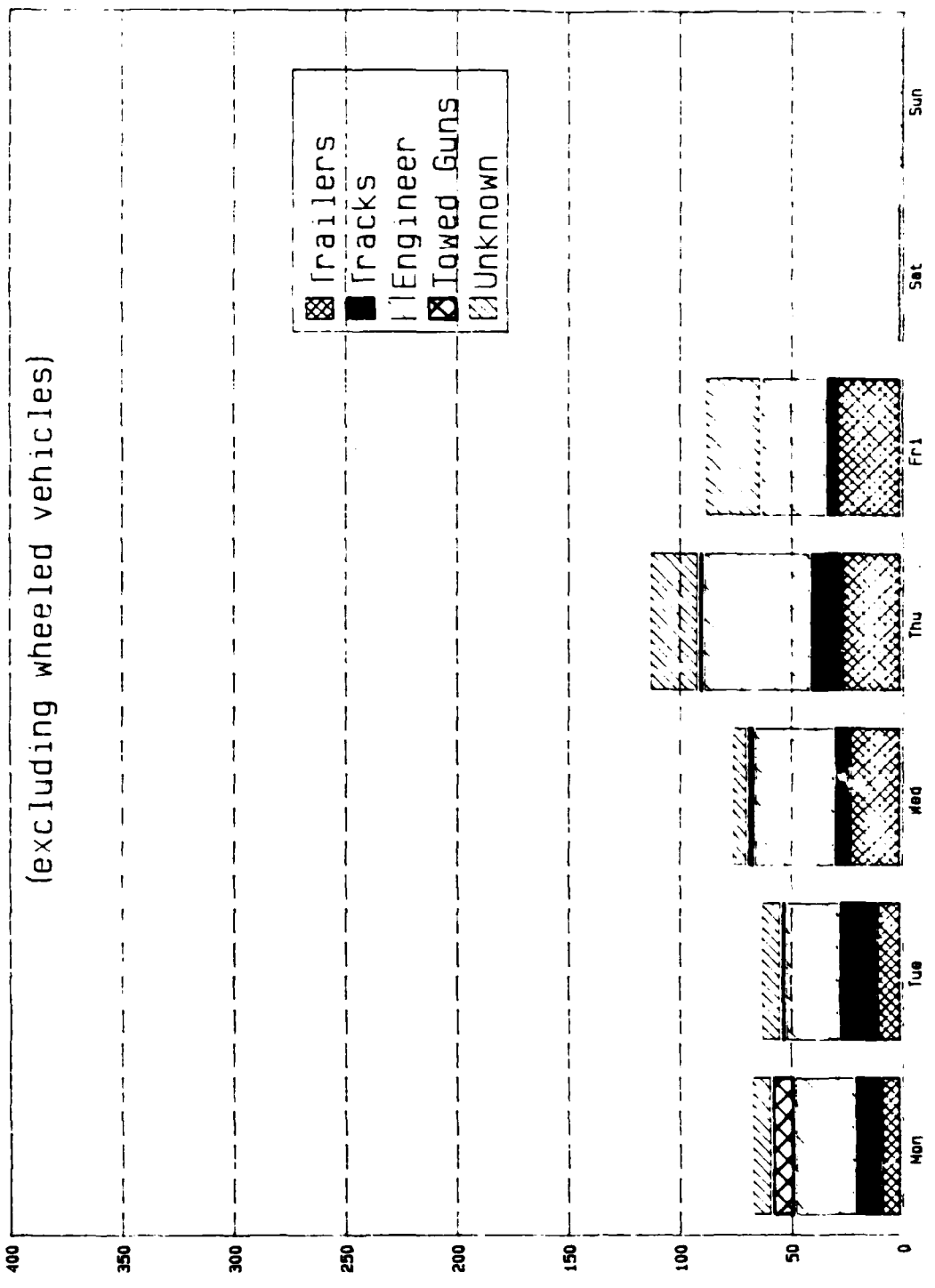


Figure 27. North Fort Lewis CVWP usage by vehicle type - 27 January 1986 to 31 December 1986.

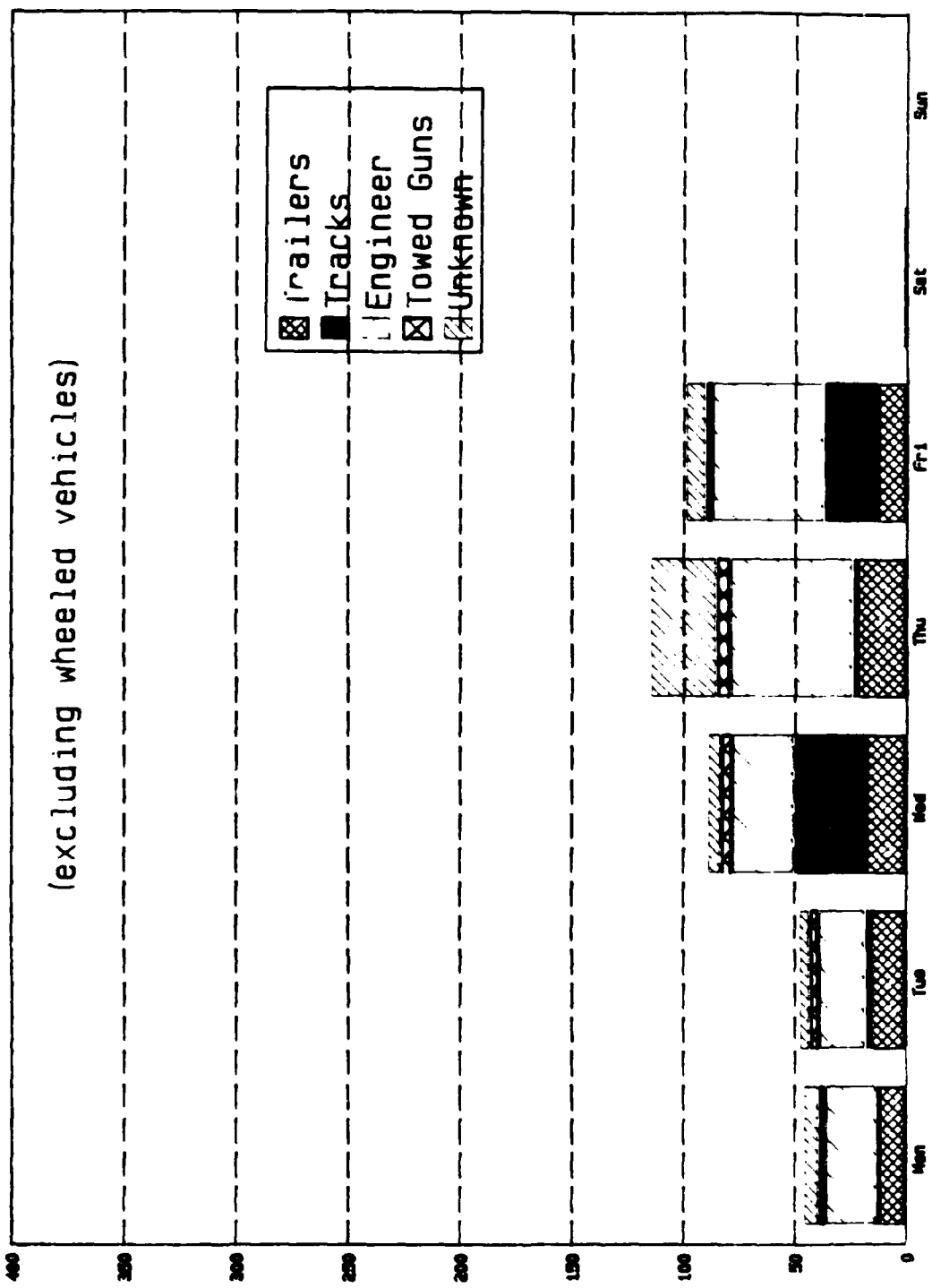


Figure 28. North Fort Lewis CVWF usage by vehicle type - 5 January 1987 to 4 December 1987.

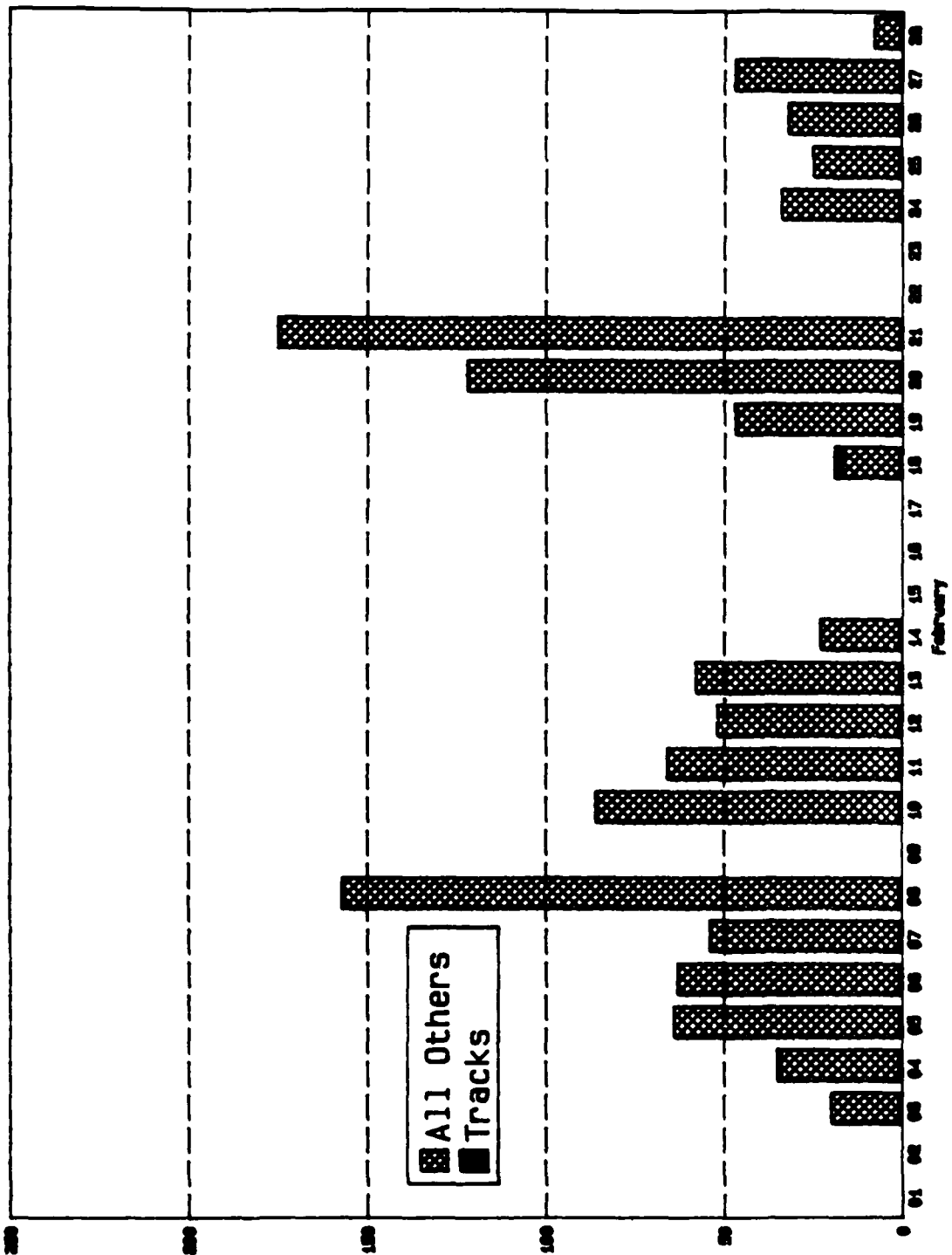


Figure 29. Southeast Fort Lewis CVWF usage by month - February 1986.

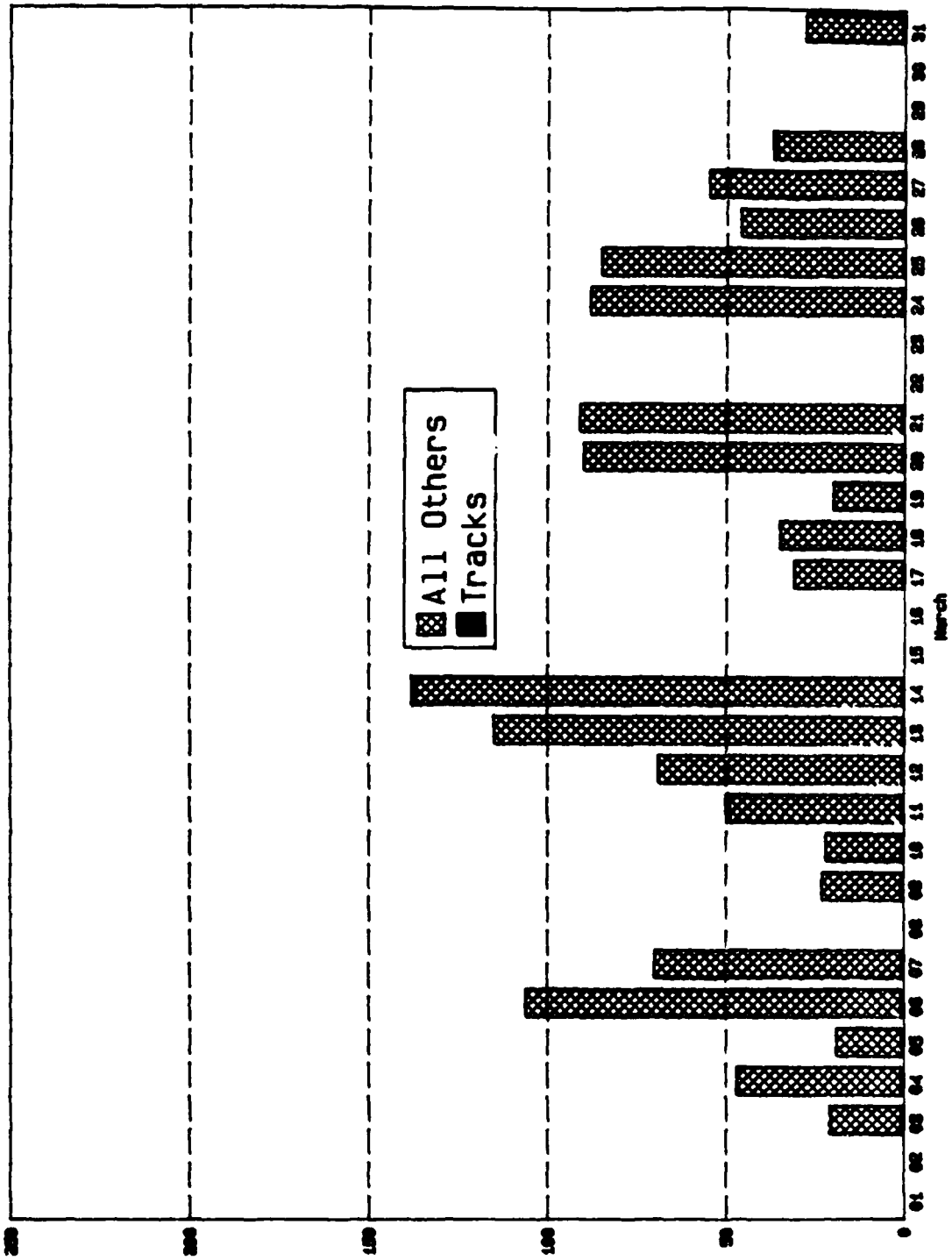


Figure 30. Southeast Fort Lewis CVWF usage by month - March 1986.

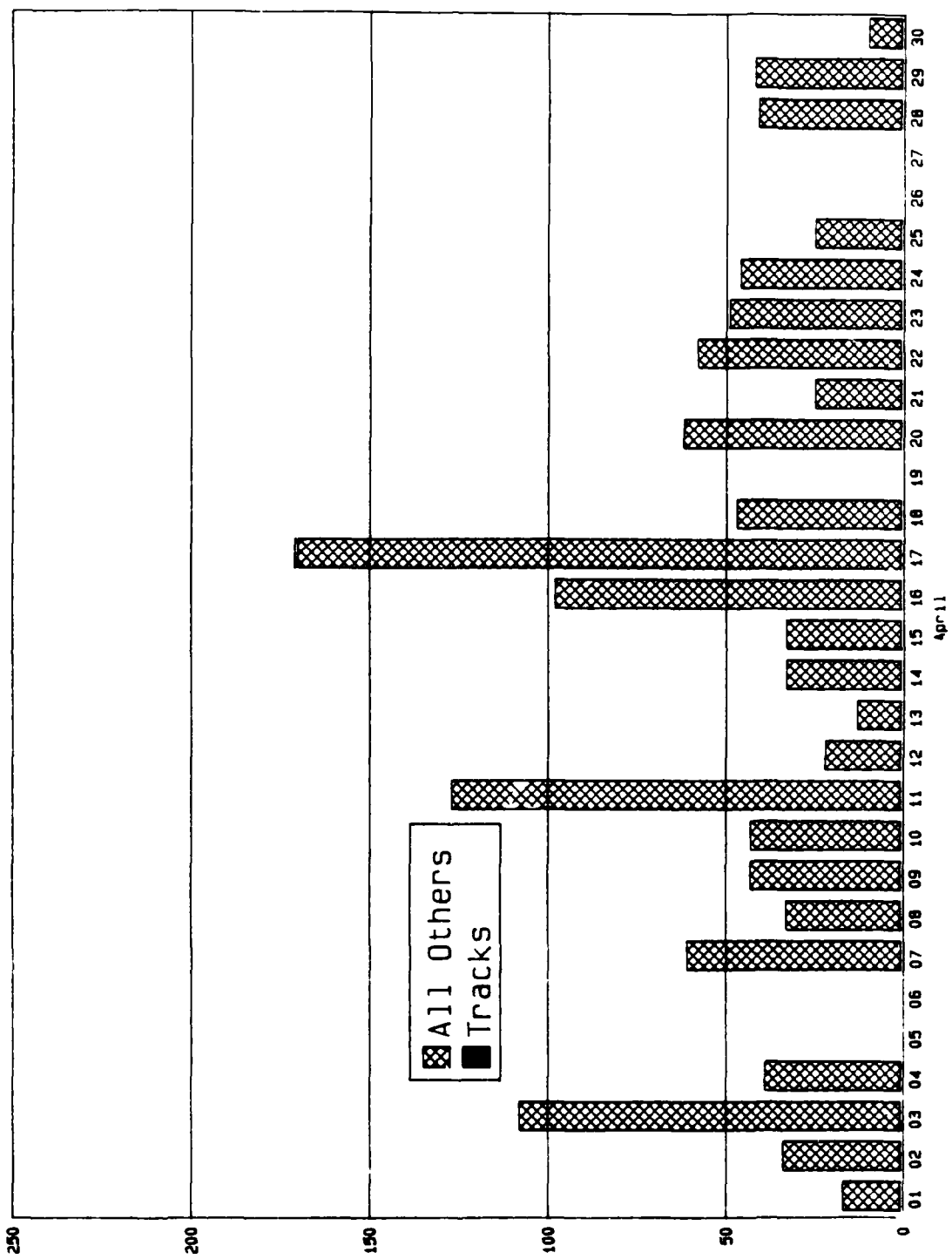


Figure 31. Southeast Fort Lewis CVWF usage by month - April 1986.

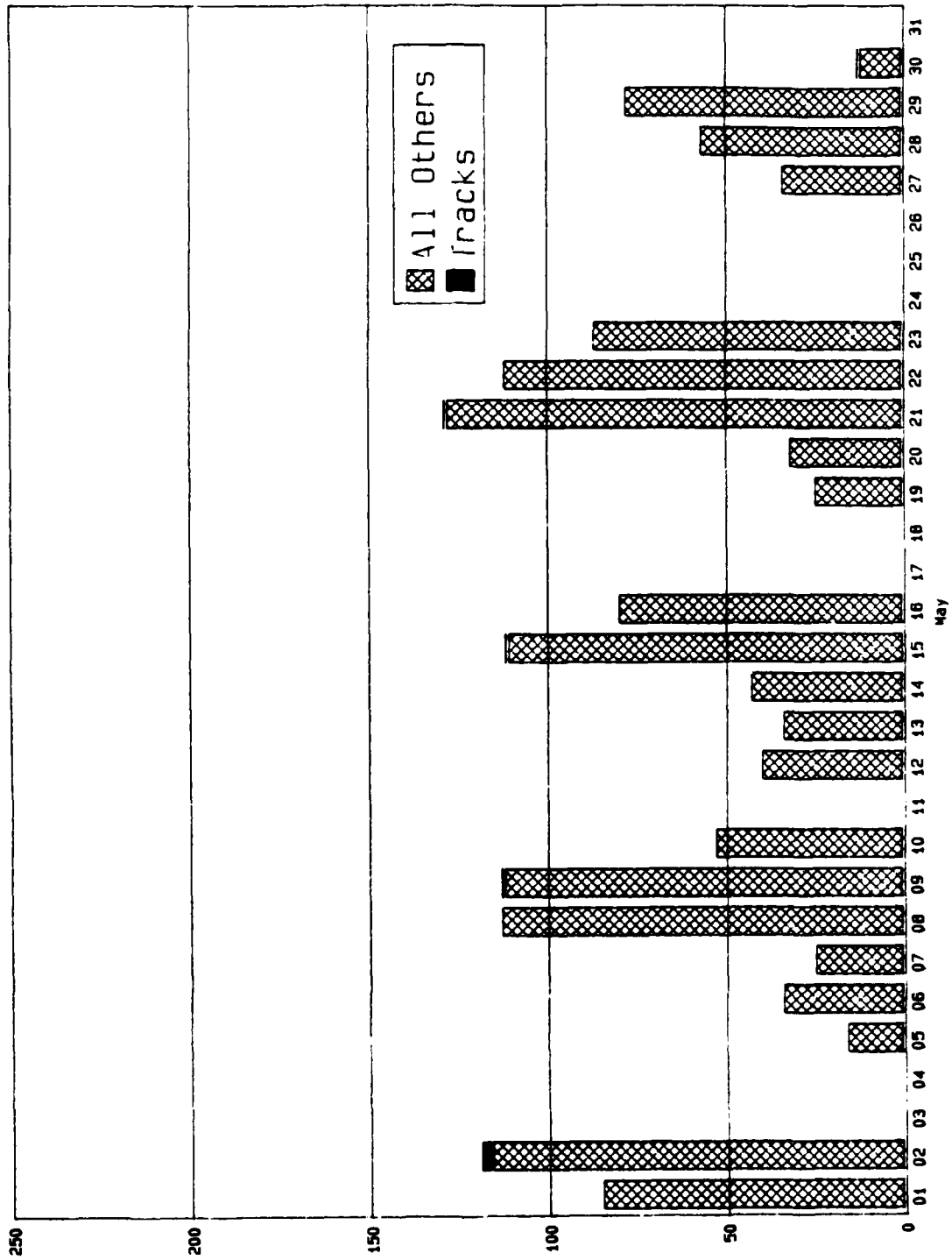


Figure 32. Southeast Fort Lewis CVWF usage by month - May 1986.

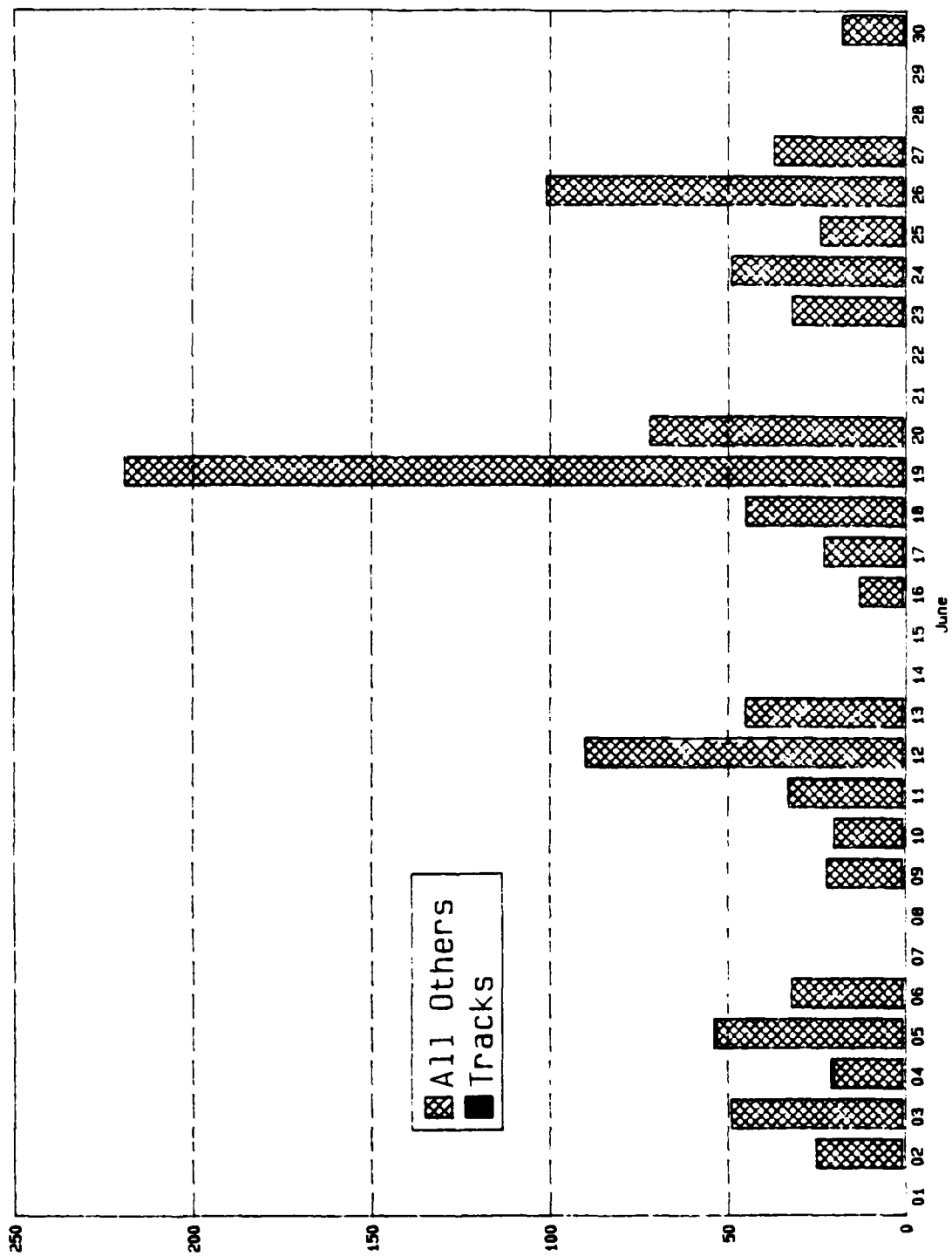


Figure 33. Southeast Fort Lewis CVWF usage by month - June 1986.

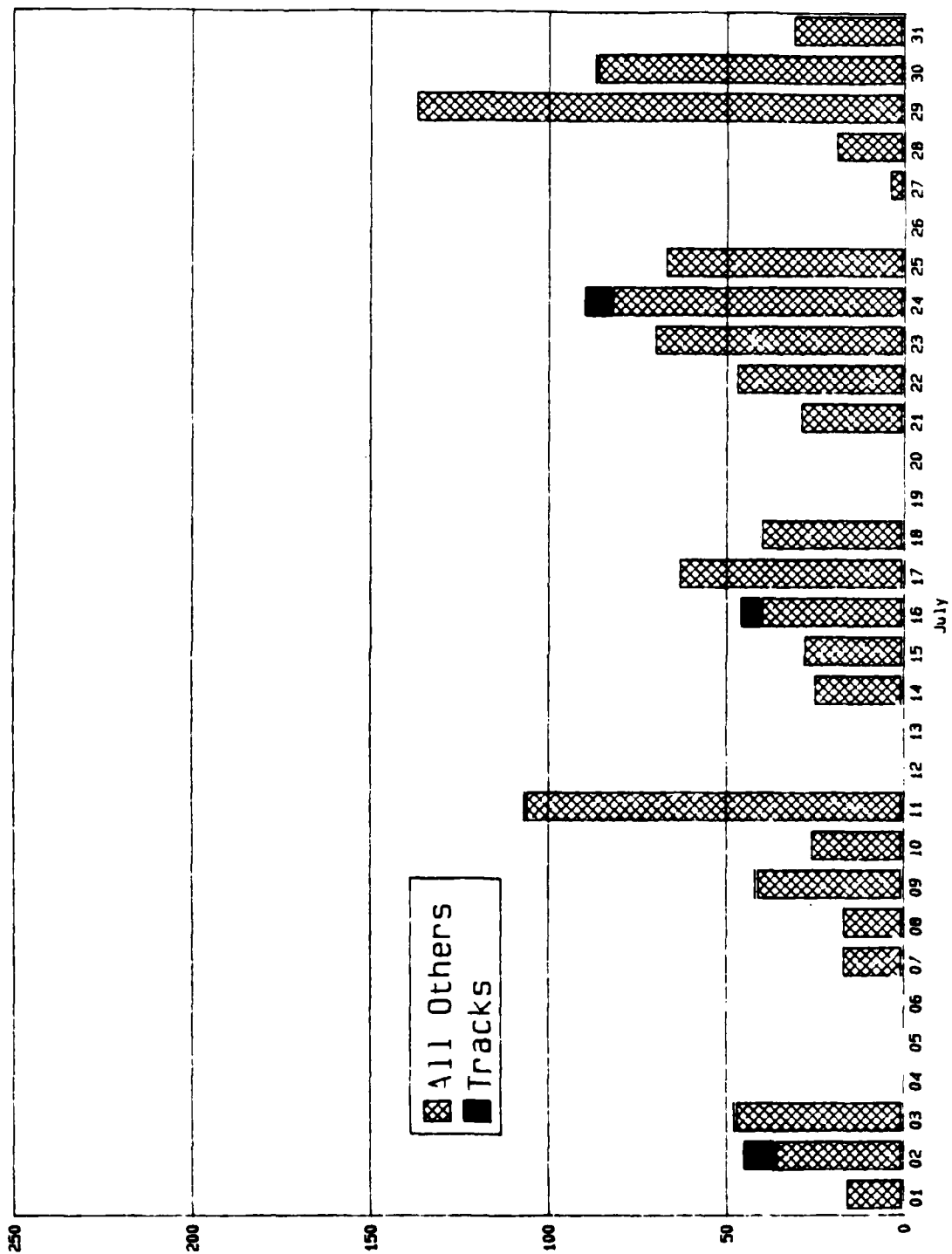


Figure 34. Southeast Fort Lewis CVWF usage by month - July 1986.

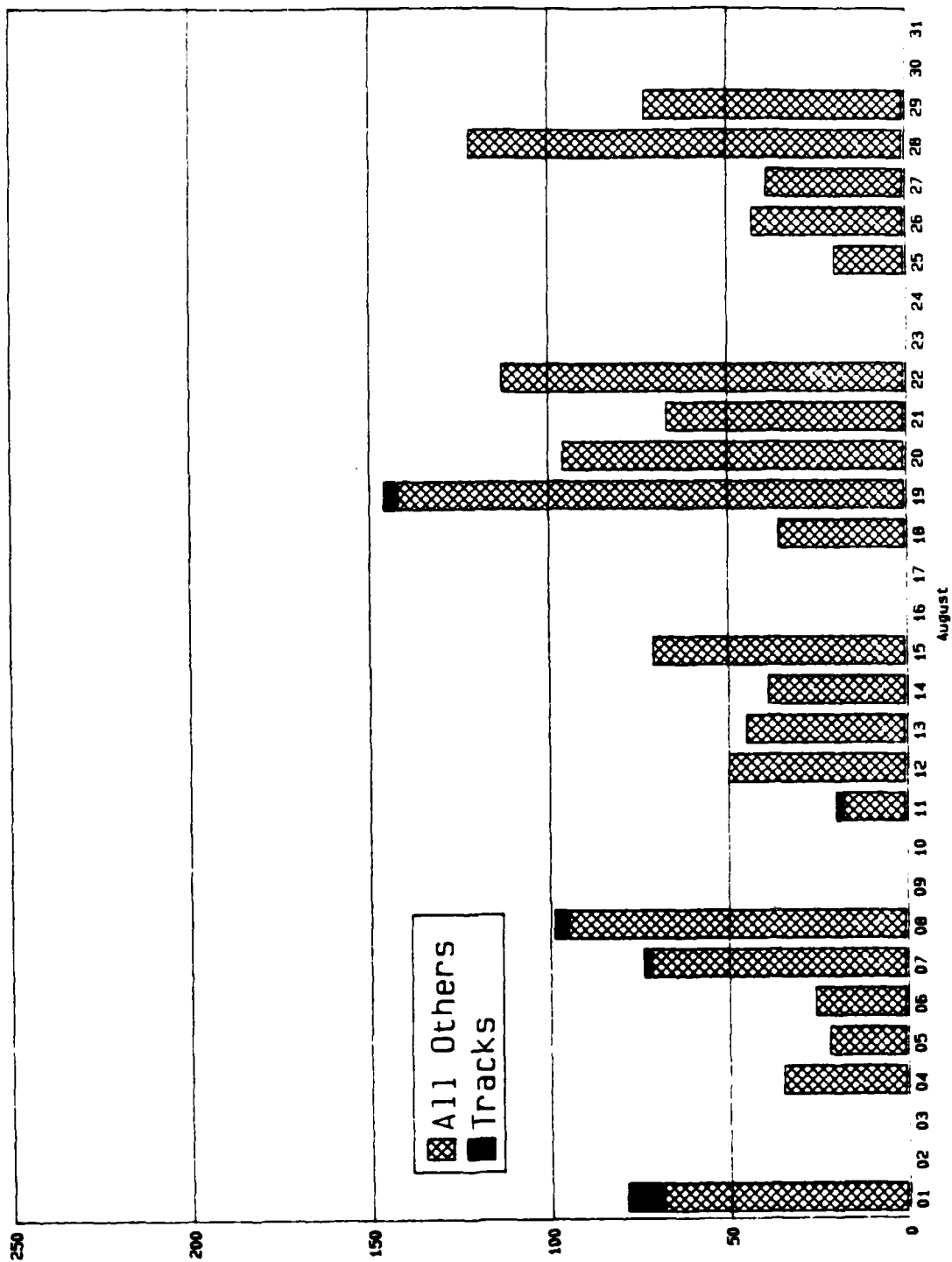


Figure 35. Southeast Fort Lewis CVWF usage by month - August 1986.



Figure 36. Southeast Fort Lewis CVWF usage by month - September 1986.

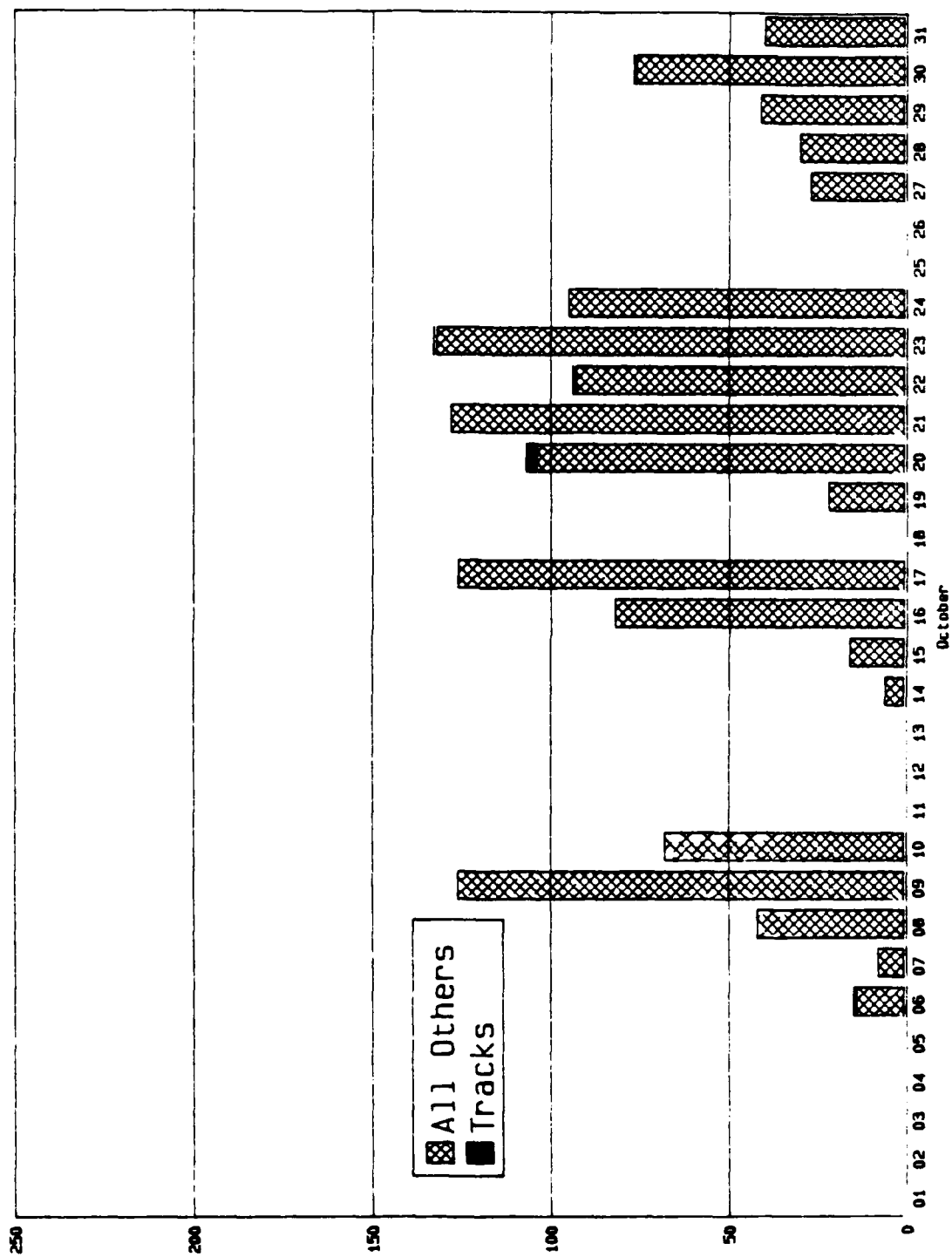


Figure 37. Southeast Fort Lewis CVWF usage by month - October 1986.

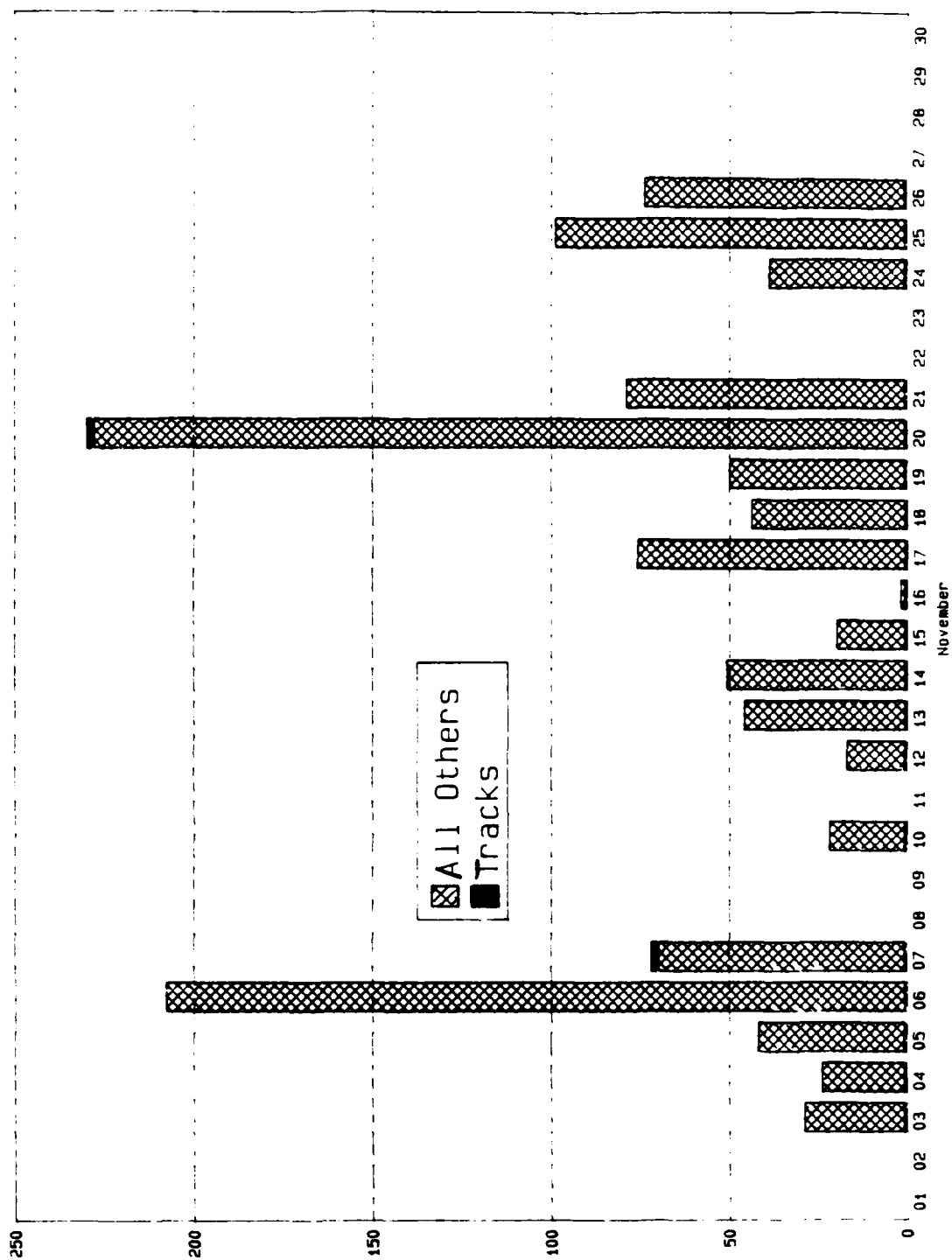


Figure 38. Southeast Fort Lewis CVWF usage by month - November 1986.

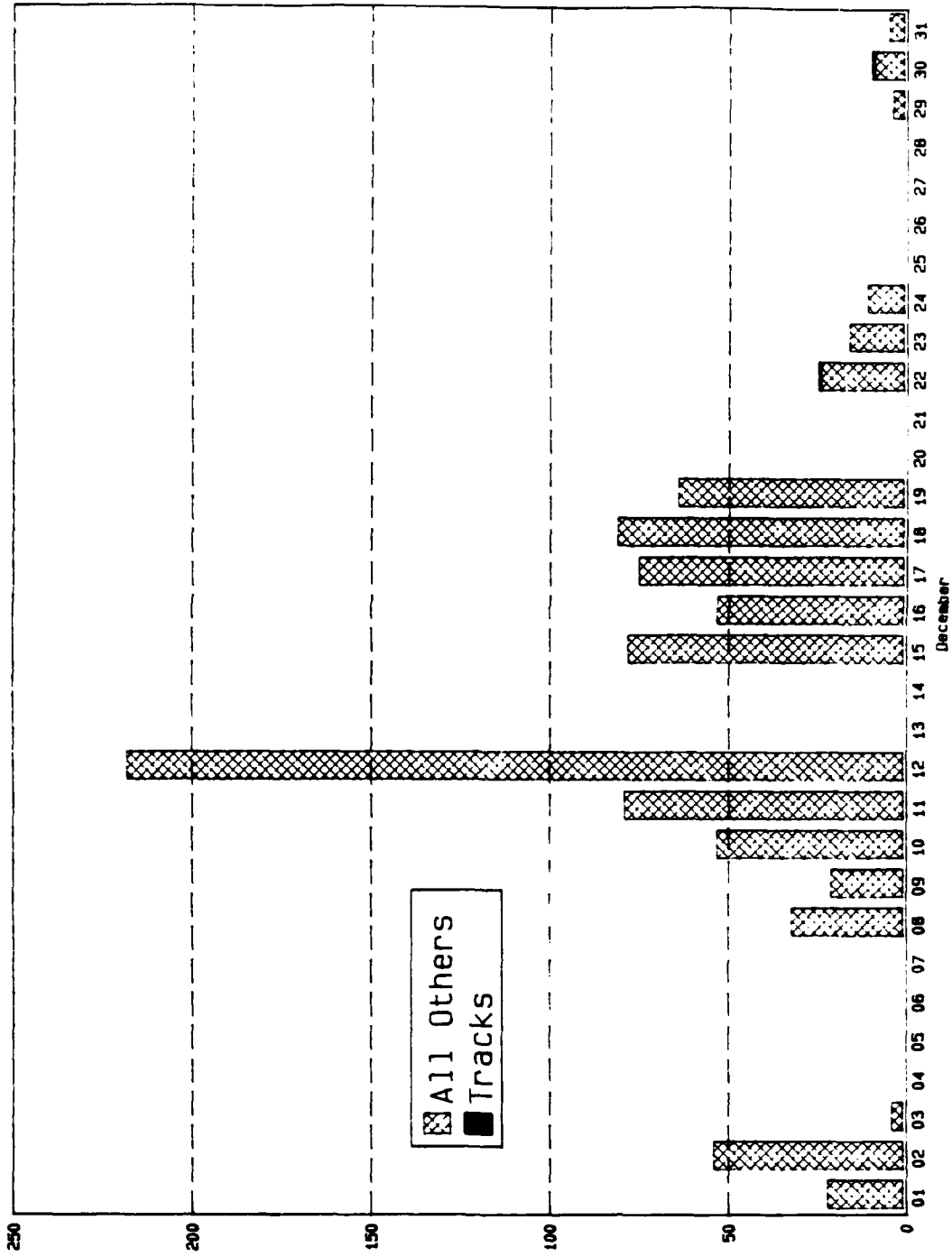


Figure 39. Southeast Fort Lewis CVWF usage by month - December 1986.

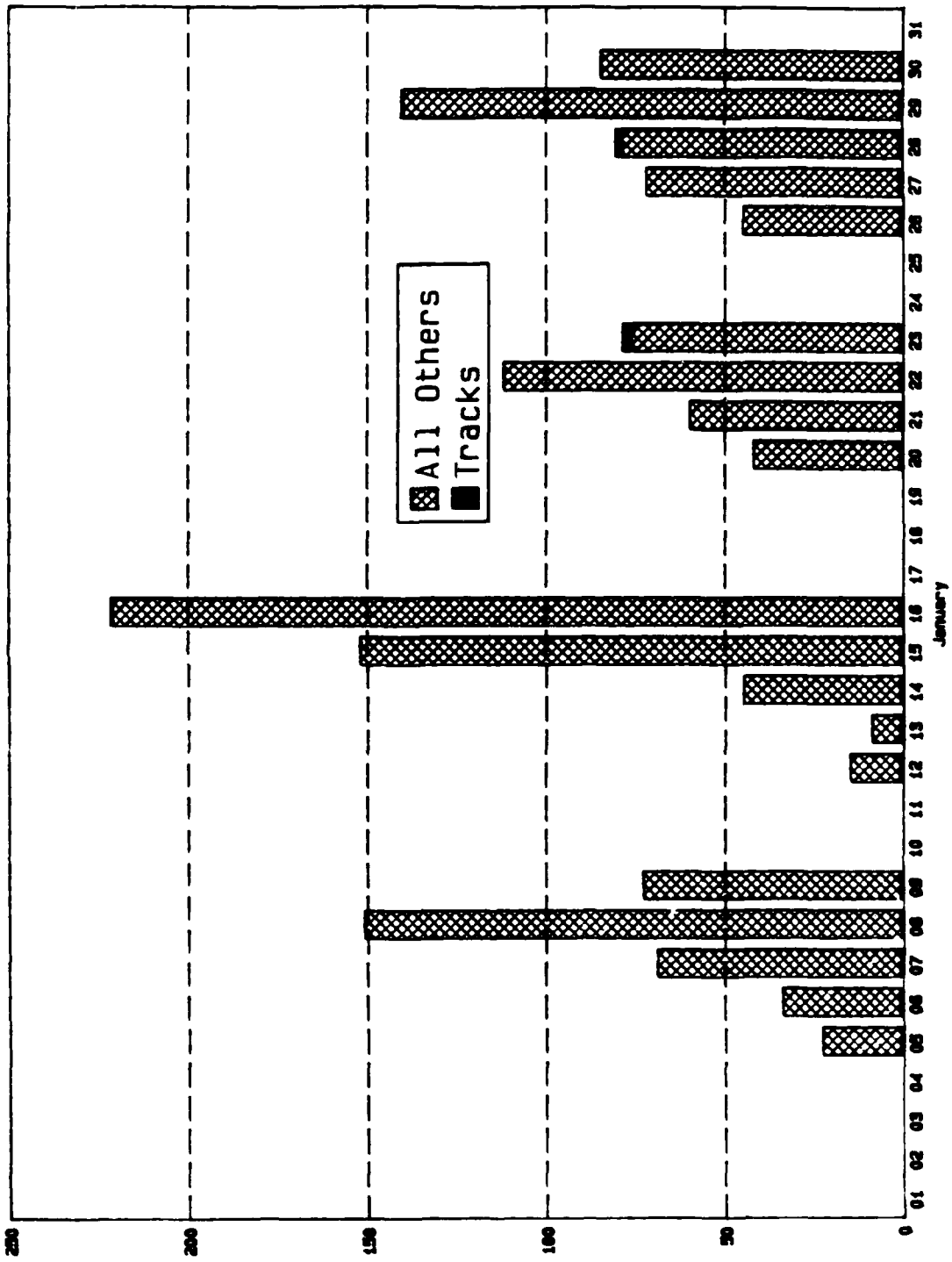


Figure 40. Southeast Fort Lewis CVWF usage by month - January 1987.



Figure 41. Southeast Fort Lewis CVWF usage by month - February 1987.

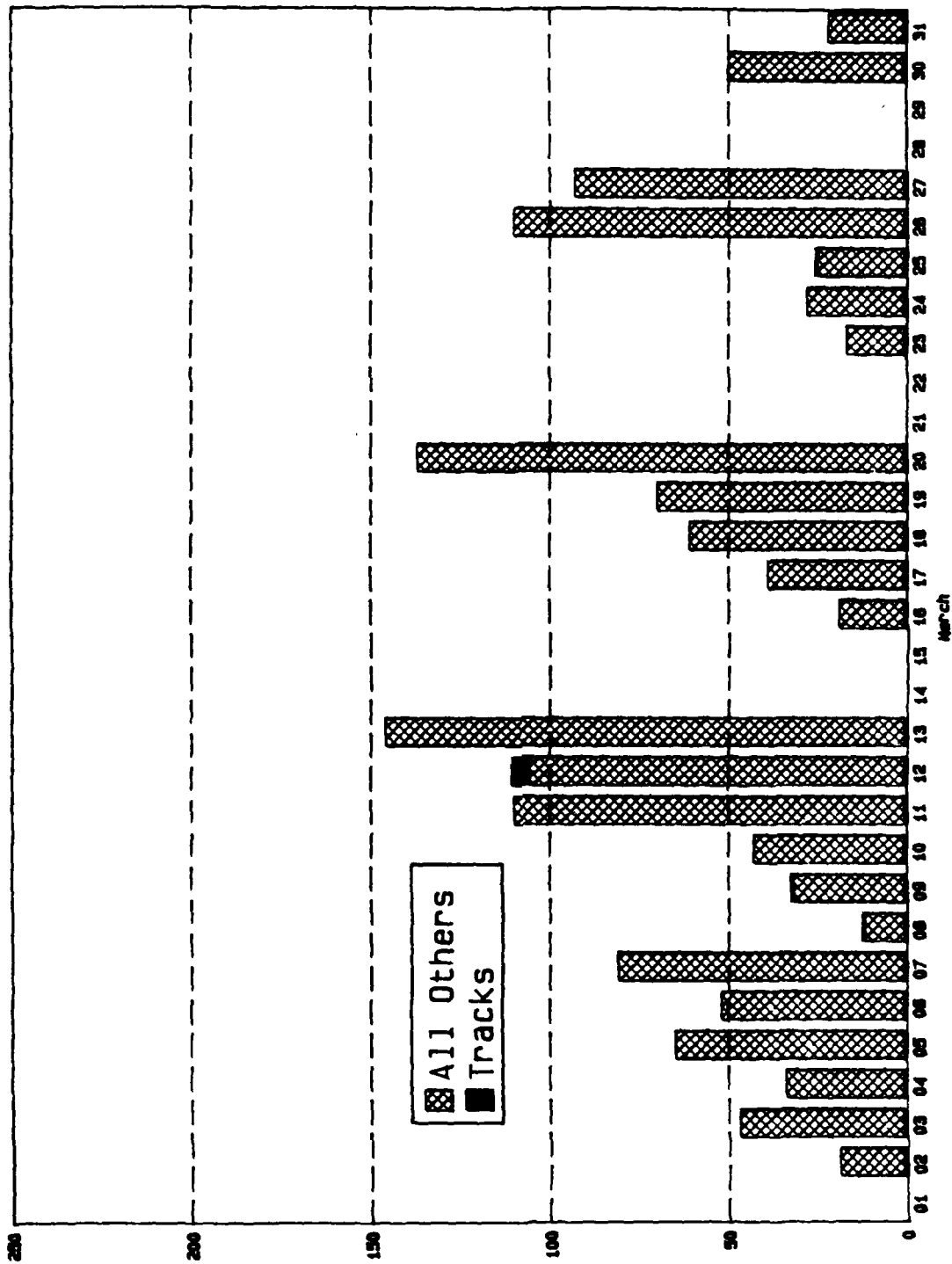


Figure 42. Southeast Fort Lewis CVWF usage by month - March 1987.

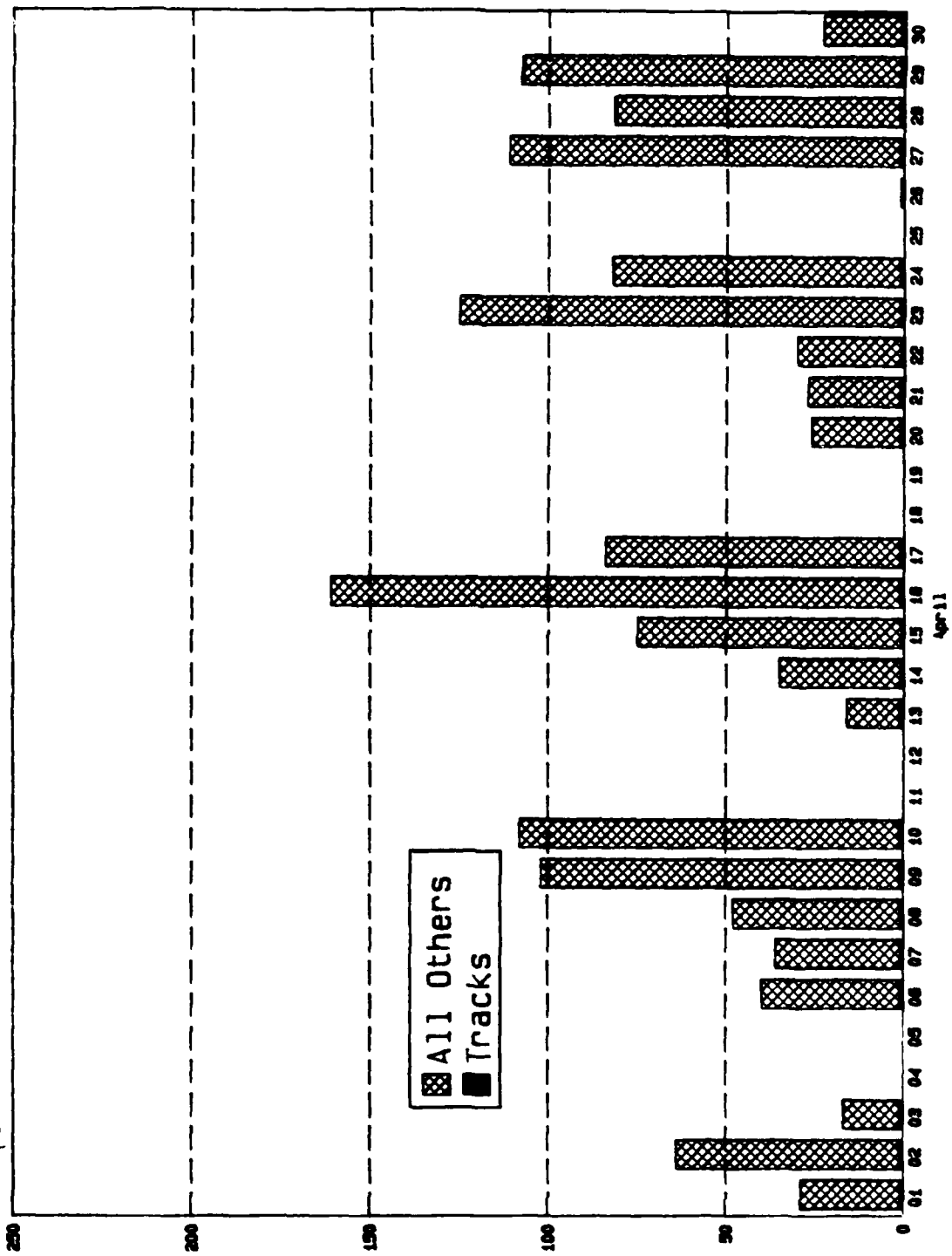


Figure 43. Southeast Fort Lew's CVWF usage by month - April 1987.

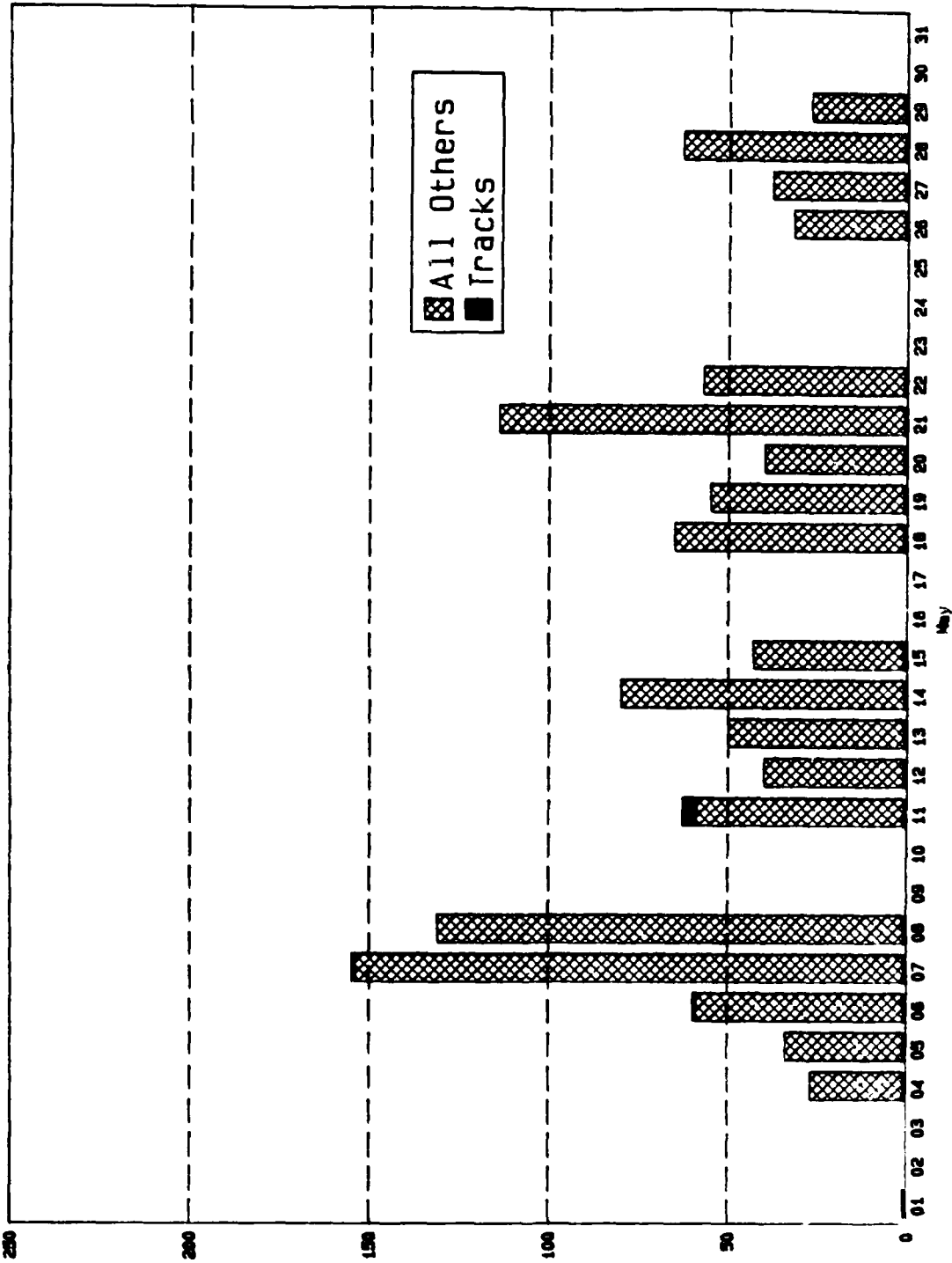


Figure 44. Southeast Fort Lewis CVWF usage by month - May 1987.

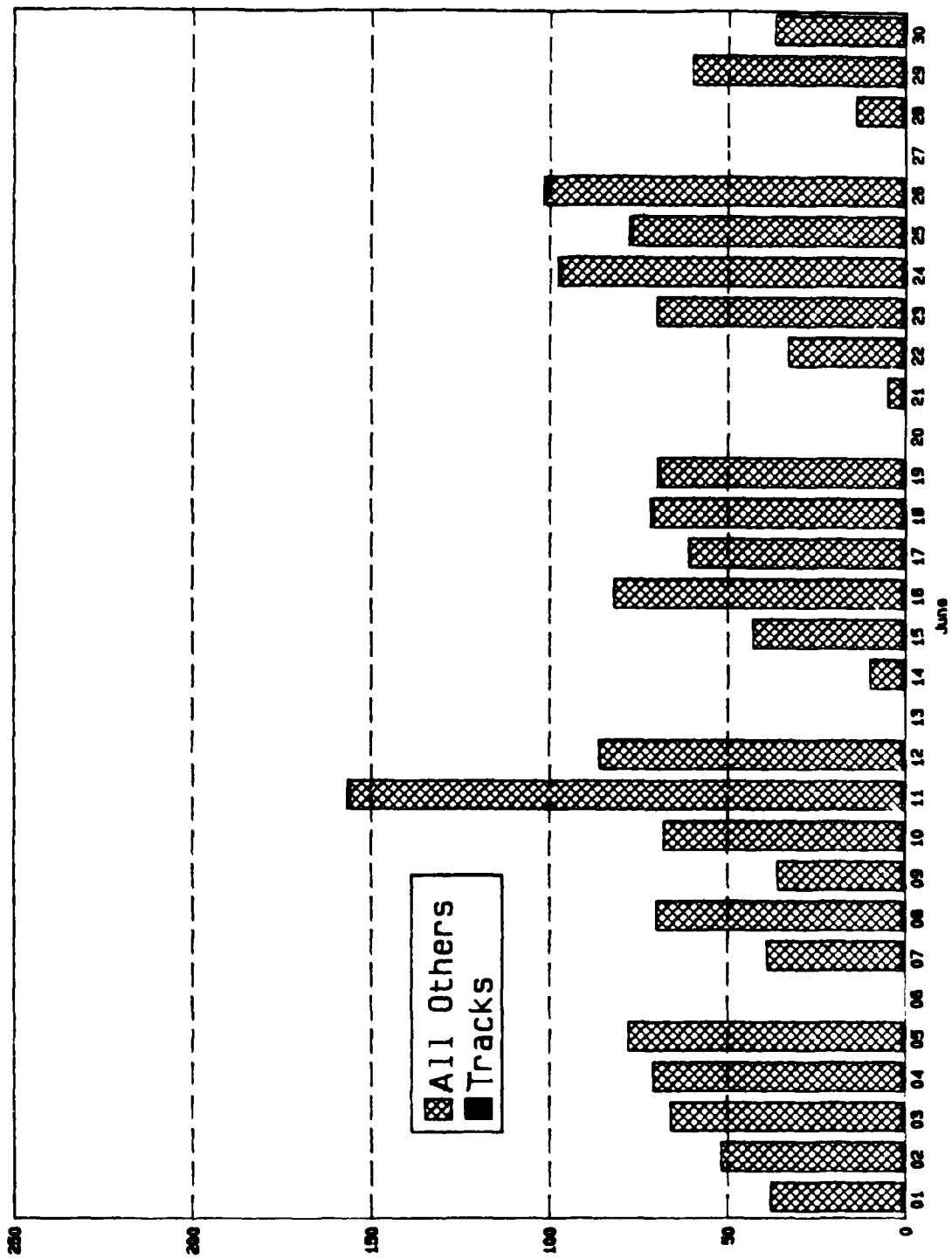


Figure 45. Southeast Fort Lewis CVWF usage by month - June 1987.

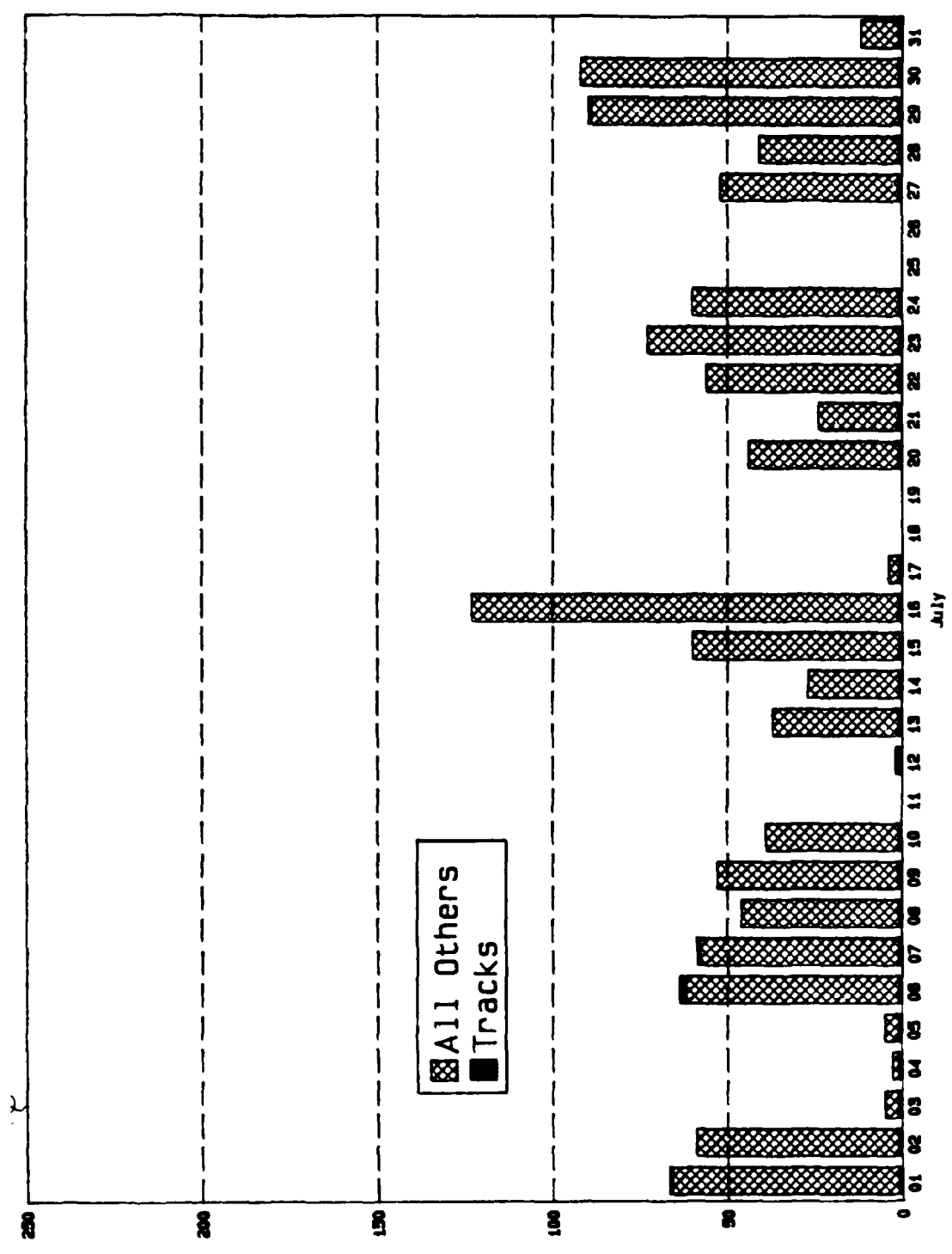


Figure 46. Southeast Fort Lewis CVWF usage by month - July 1987.

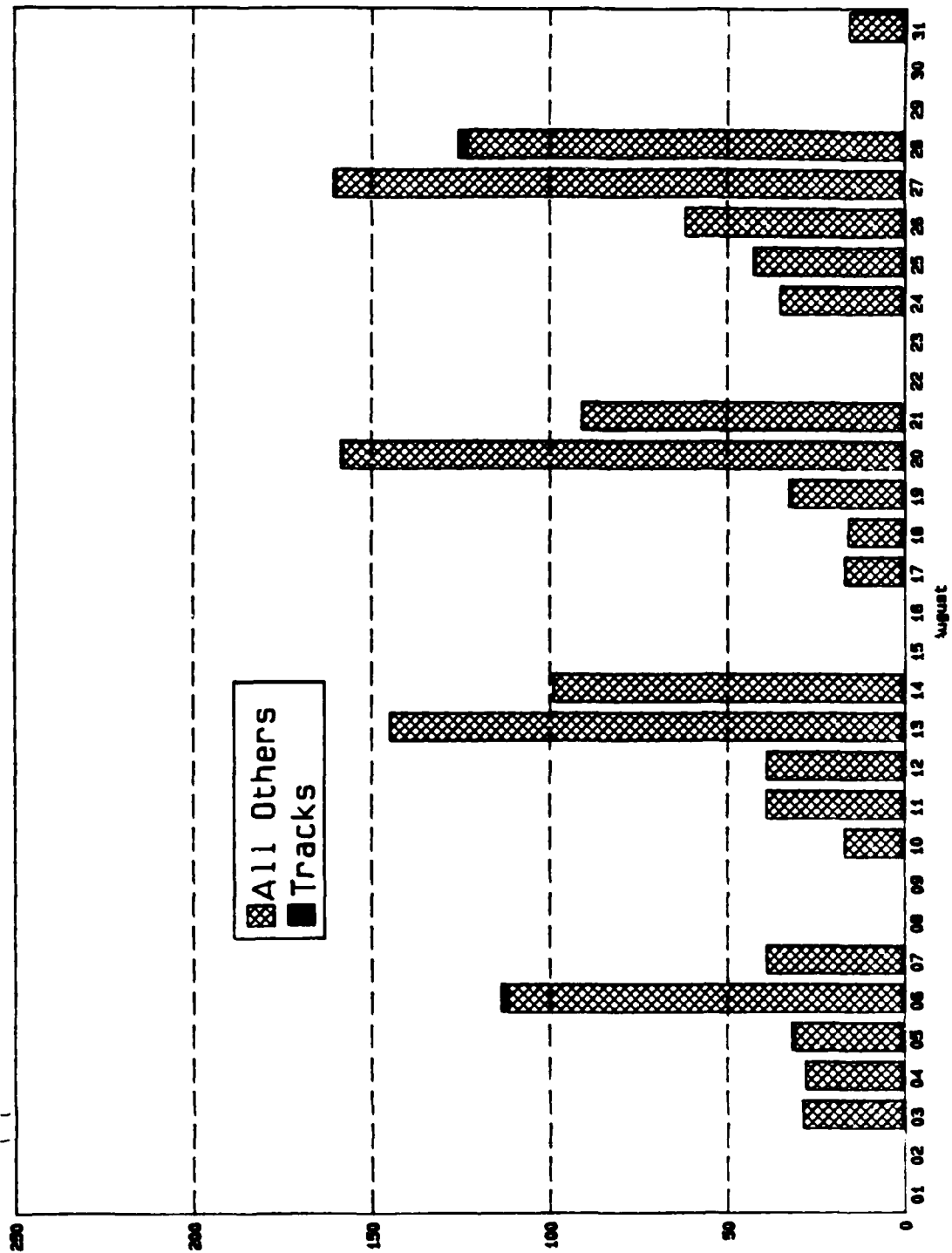


Figure 47. Southeast Fort Lewis CVWF usage by month - August 1987.

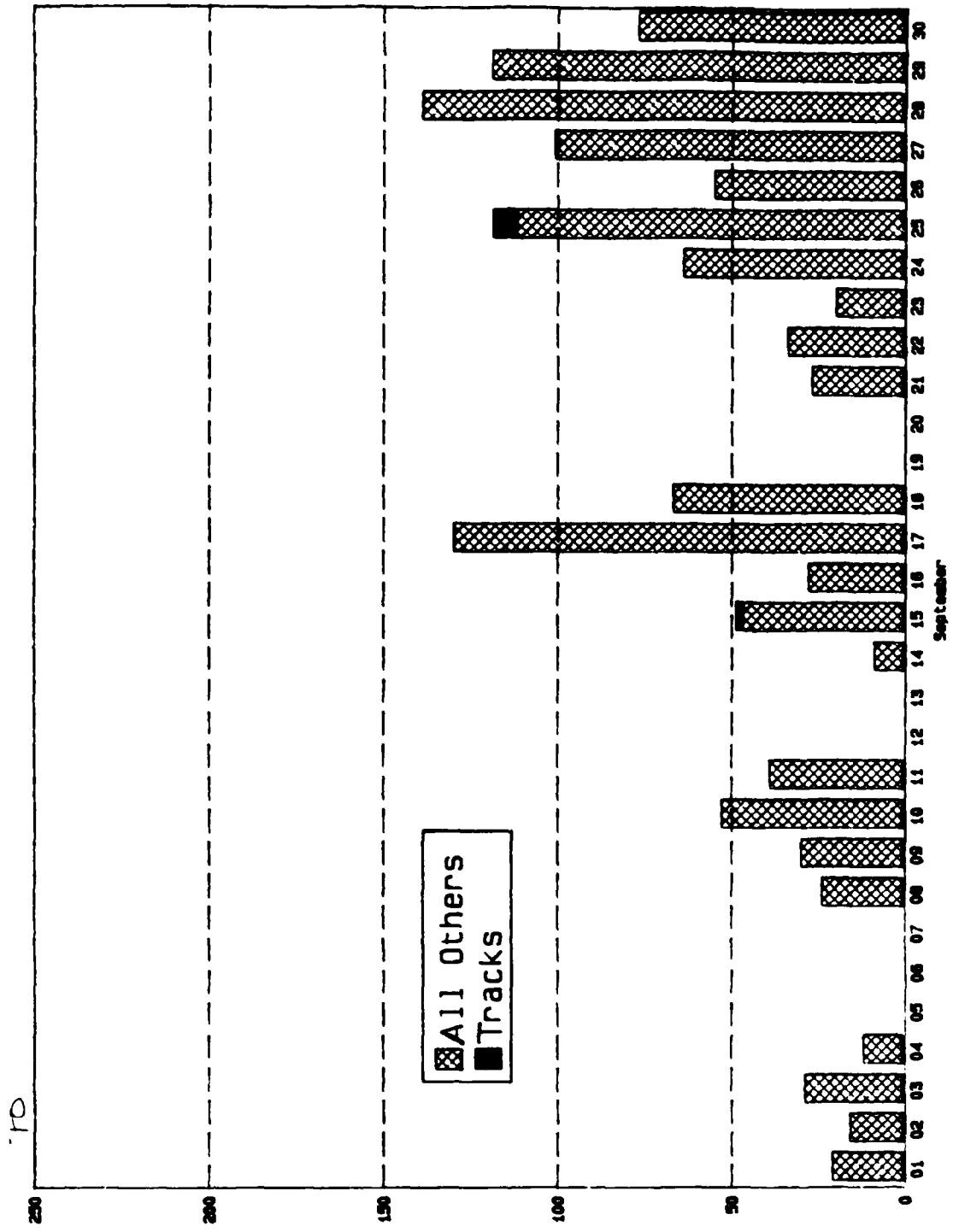


Figure 48. Southeast Fort Lewis CVWF usage by month - September 1987.

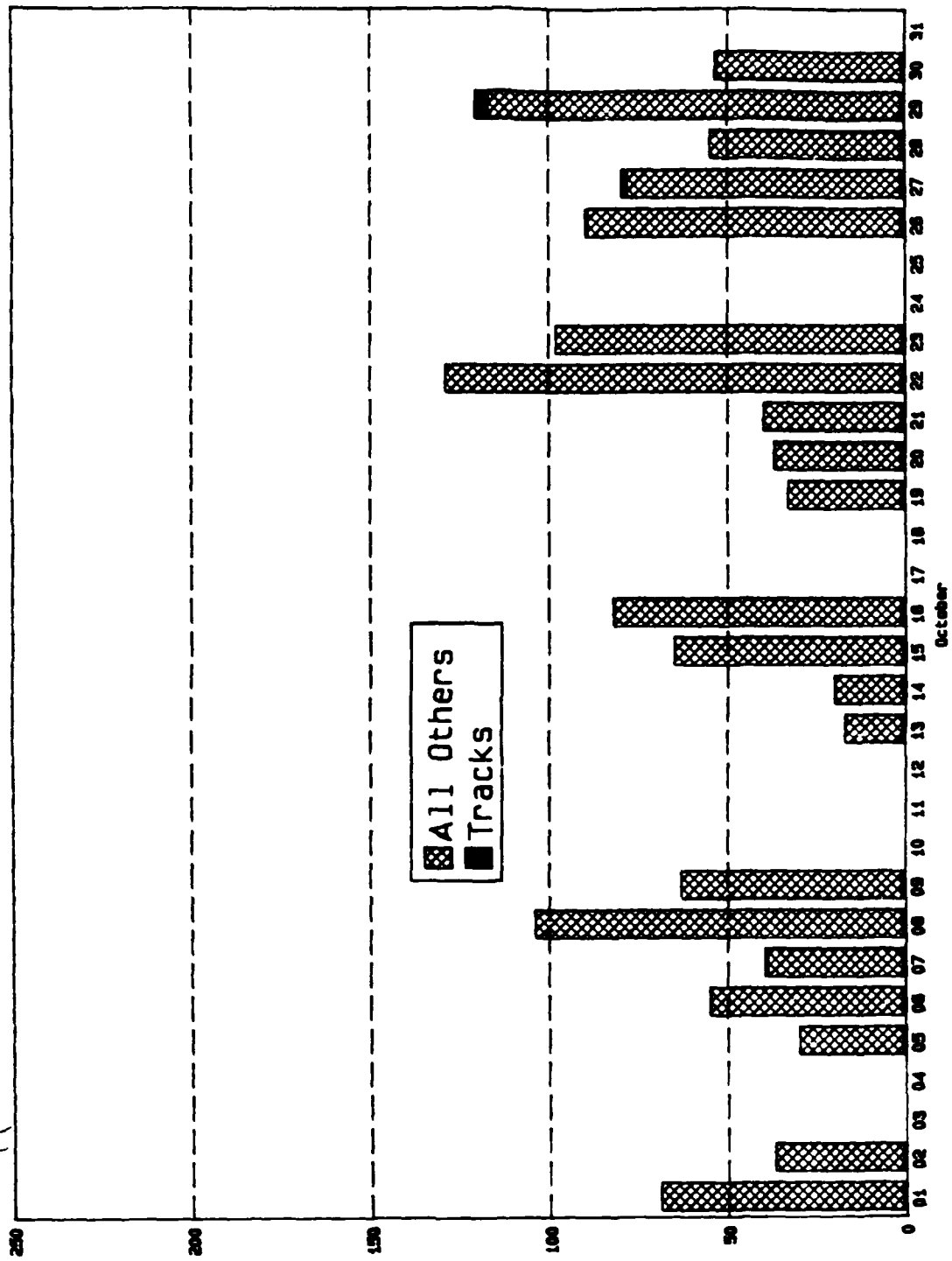


Figure 49. Southeast Fort Lewis CVWF usage by month - October 1987.

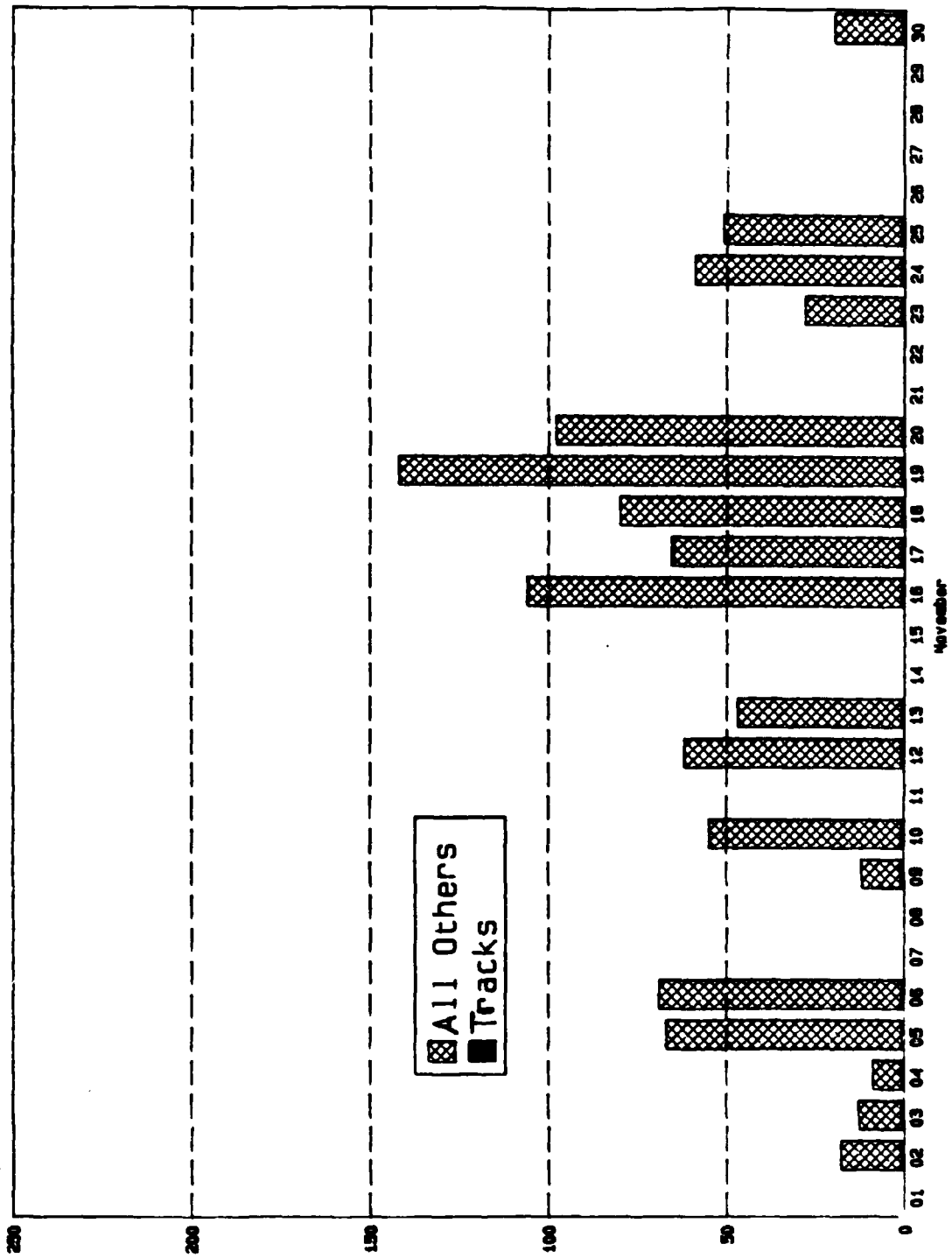


Figure 50. Southeast Fort Lewis CVWF usage by month - November 1987.

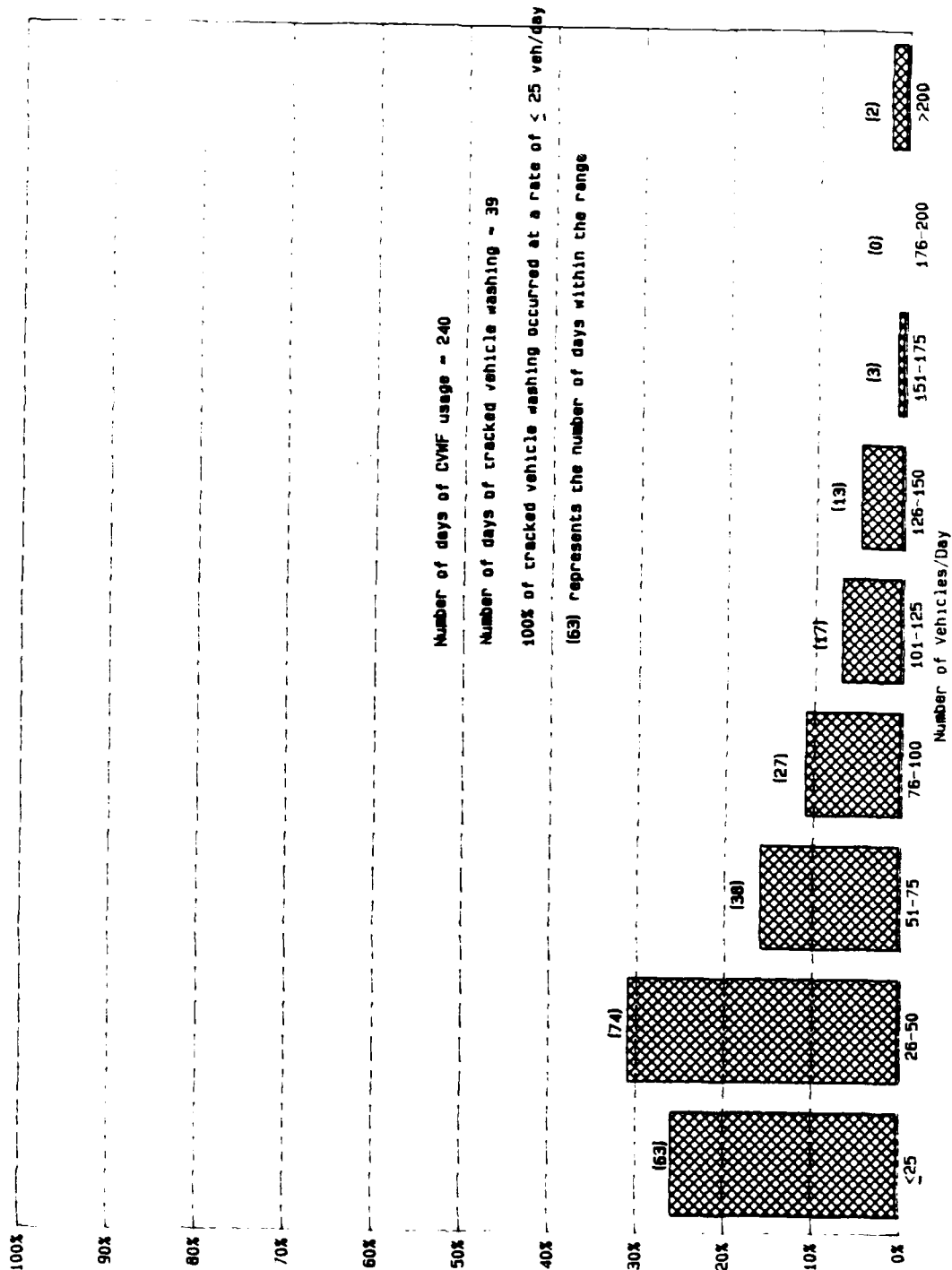


Figure 51. Southeast Fort Lewis CVWF usage level frequency - 21 January to 31 December 1986.

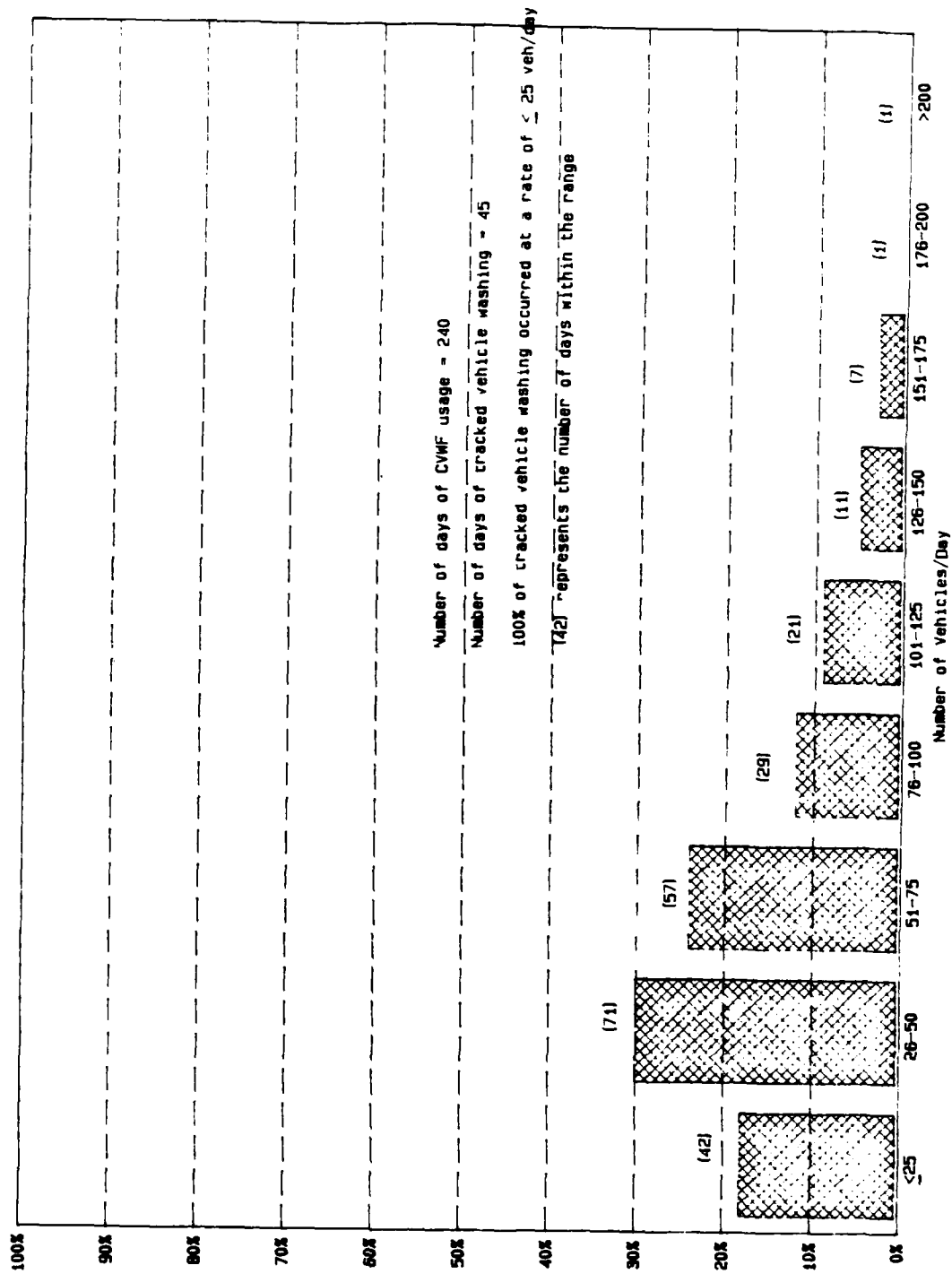


Figure 52. Southeast Port Lewis CVWF usage level frequency - 5 January to 4 December 1987.

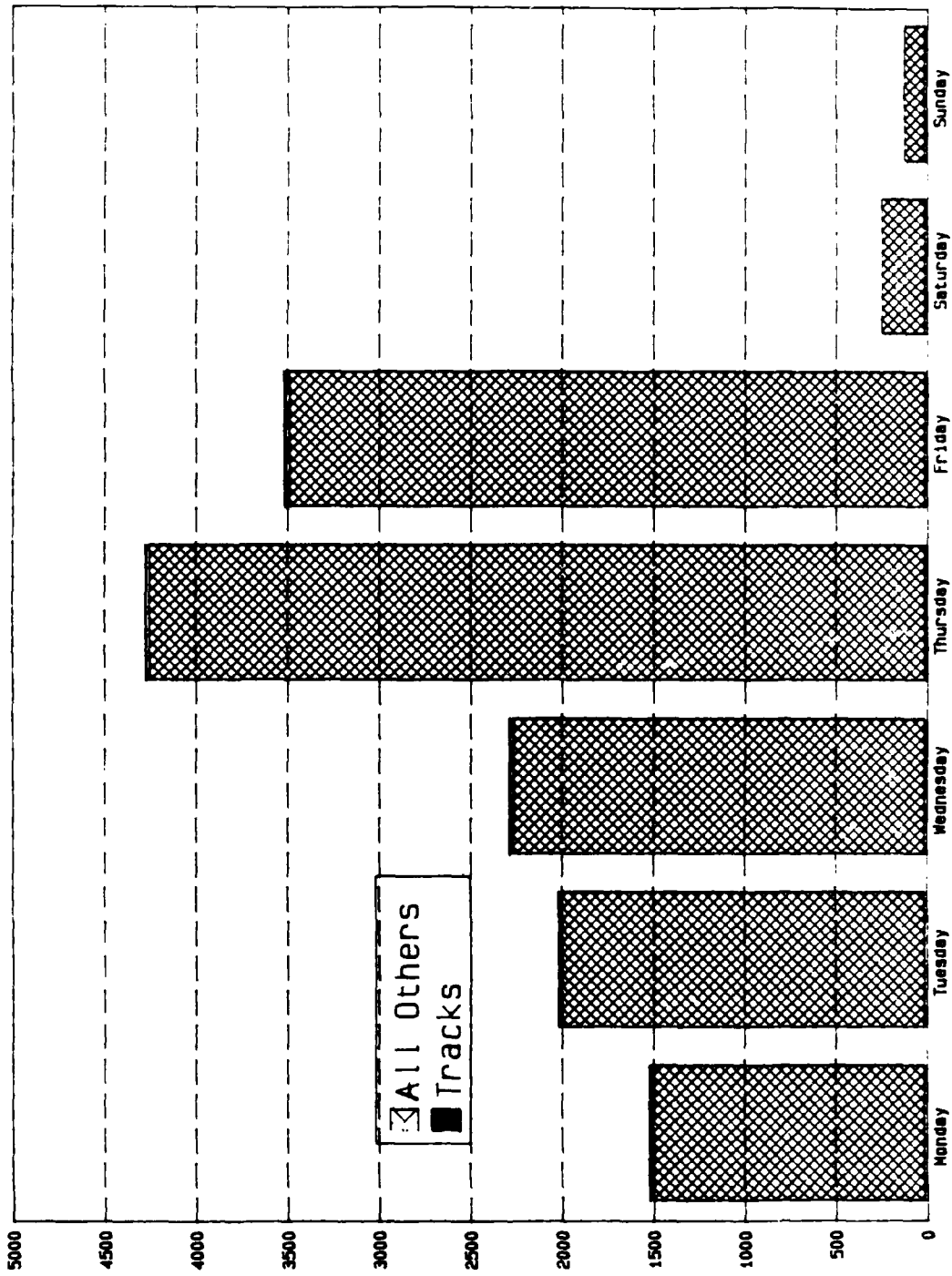


Figure 53. Southeast Fort Lewis CVWF usage by day of the week - 21 January to 31 December 1986.

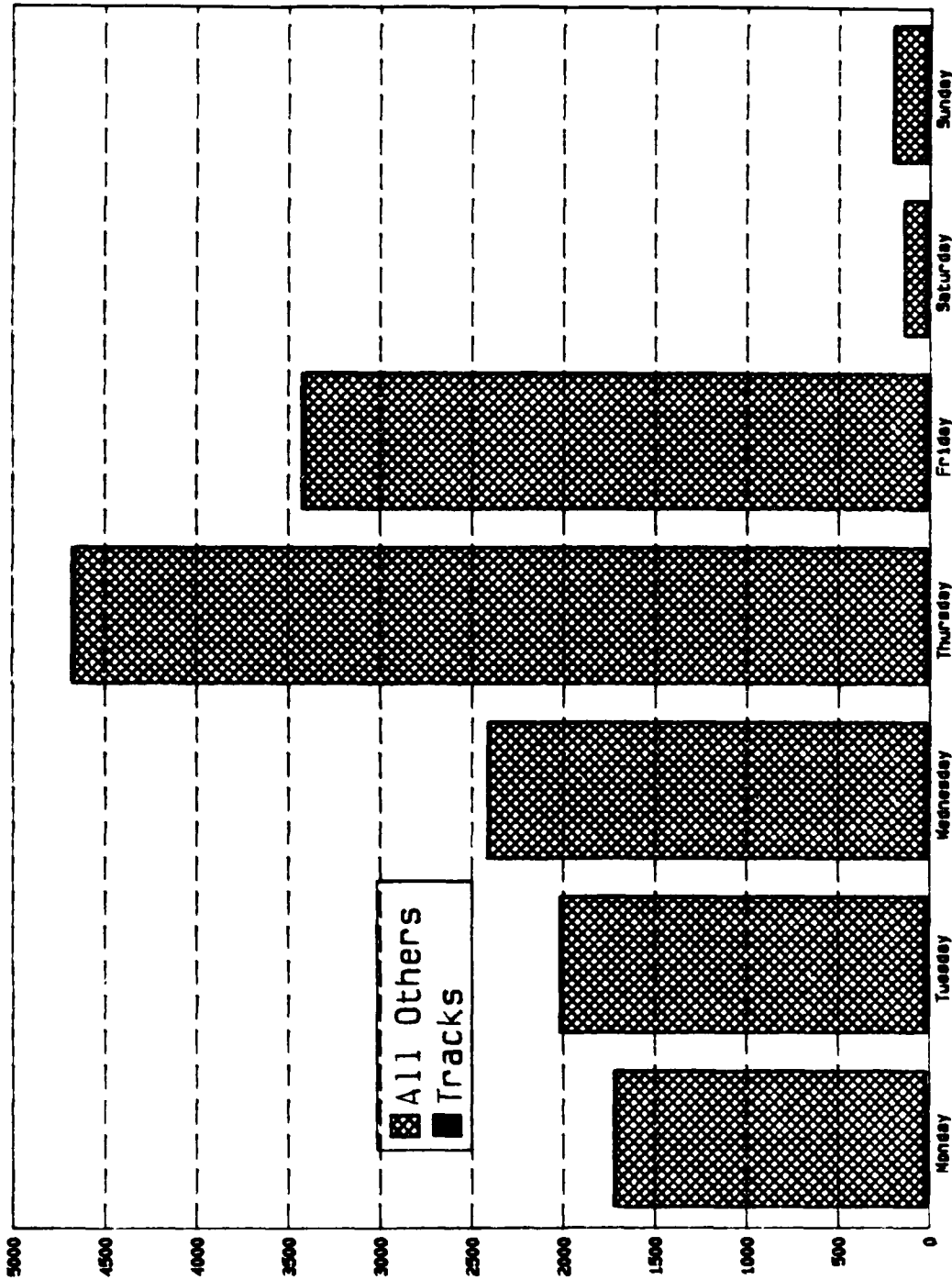


Figure 54. Southeast Fort Lewis CVWF usage by day of the week - 5 January to 4 December 1987.

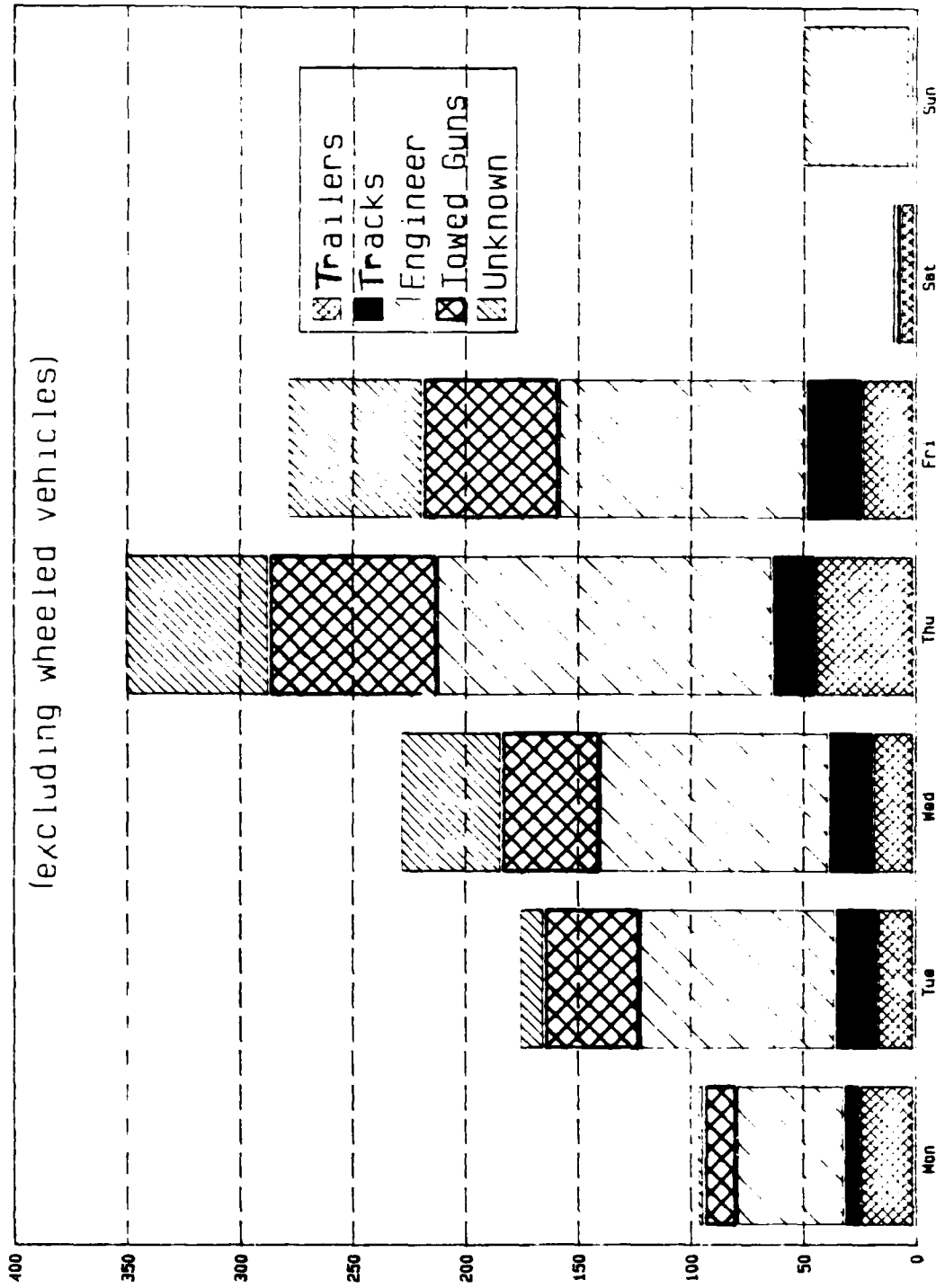


Figure 55. Southeast Fort Lewis CVWF usage by vehicle type - 21 January to 31 December 1986.

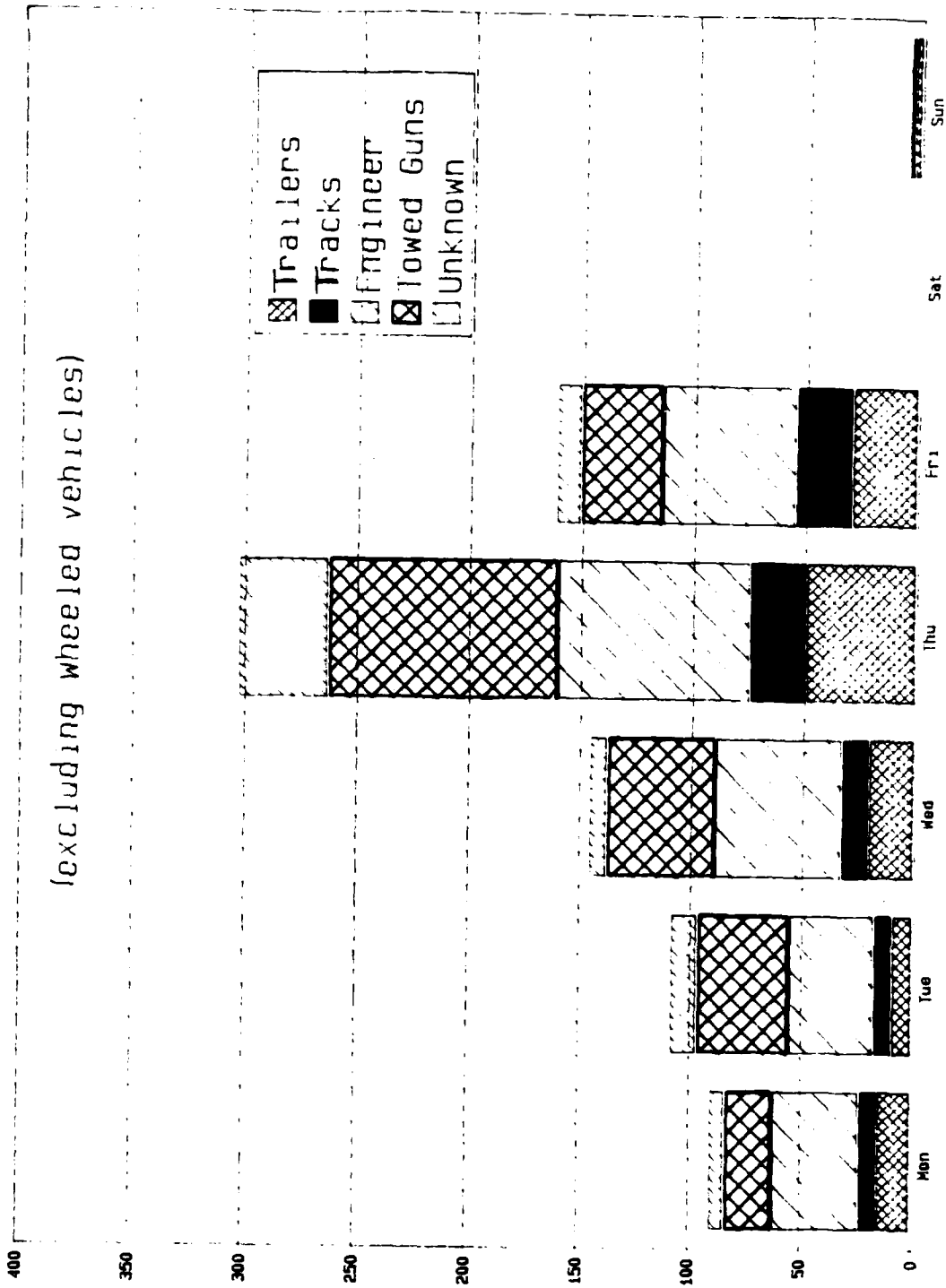


Figure 56. Southeast Fort Lewis CVWF usage by vehicle type - 5 January to 4 December 1987.

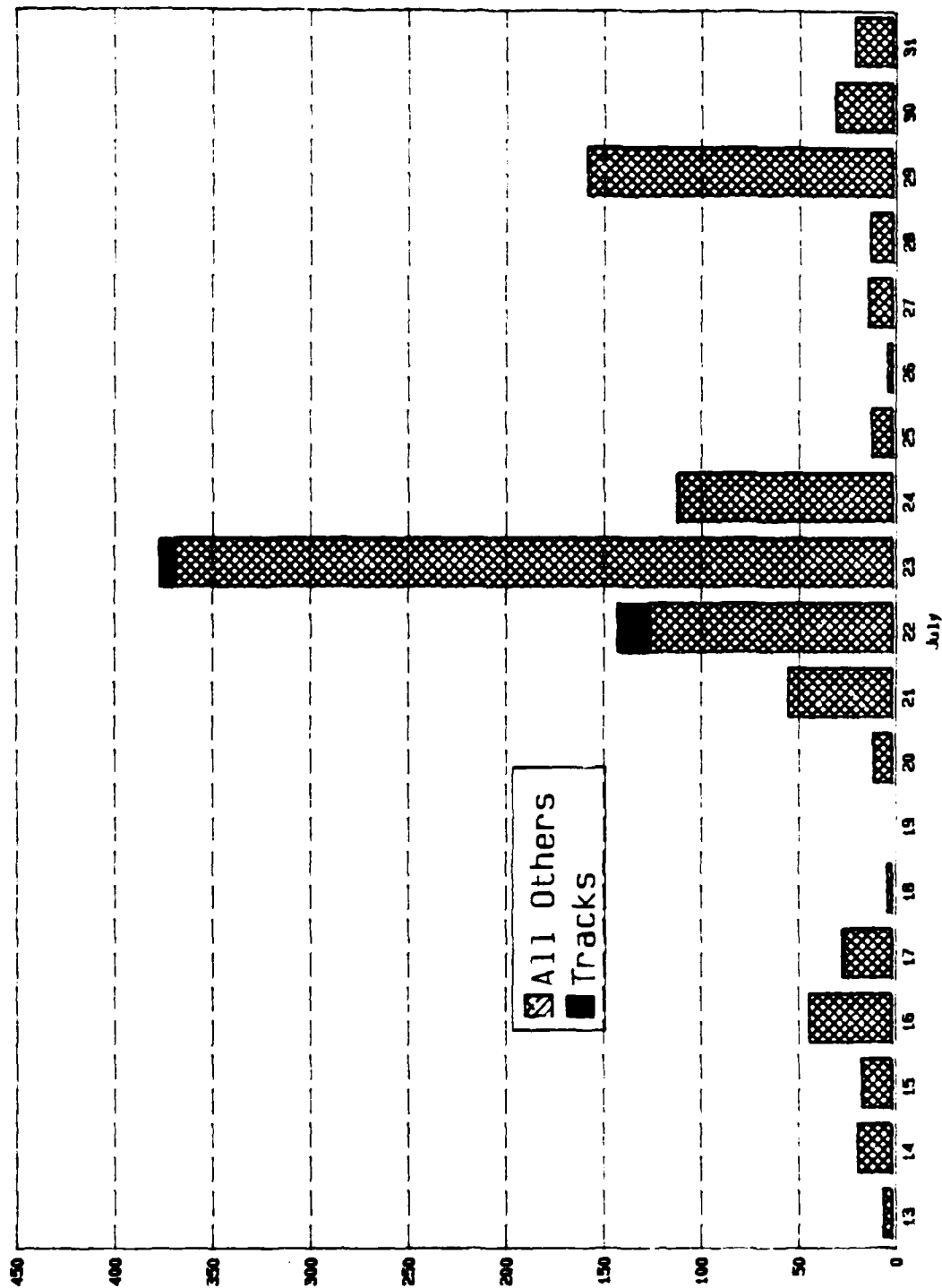


Figure 57. Yakima Firing Center CVWF usage by month - July 1987.

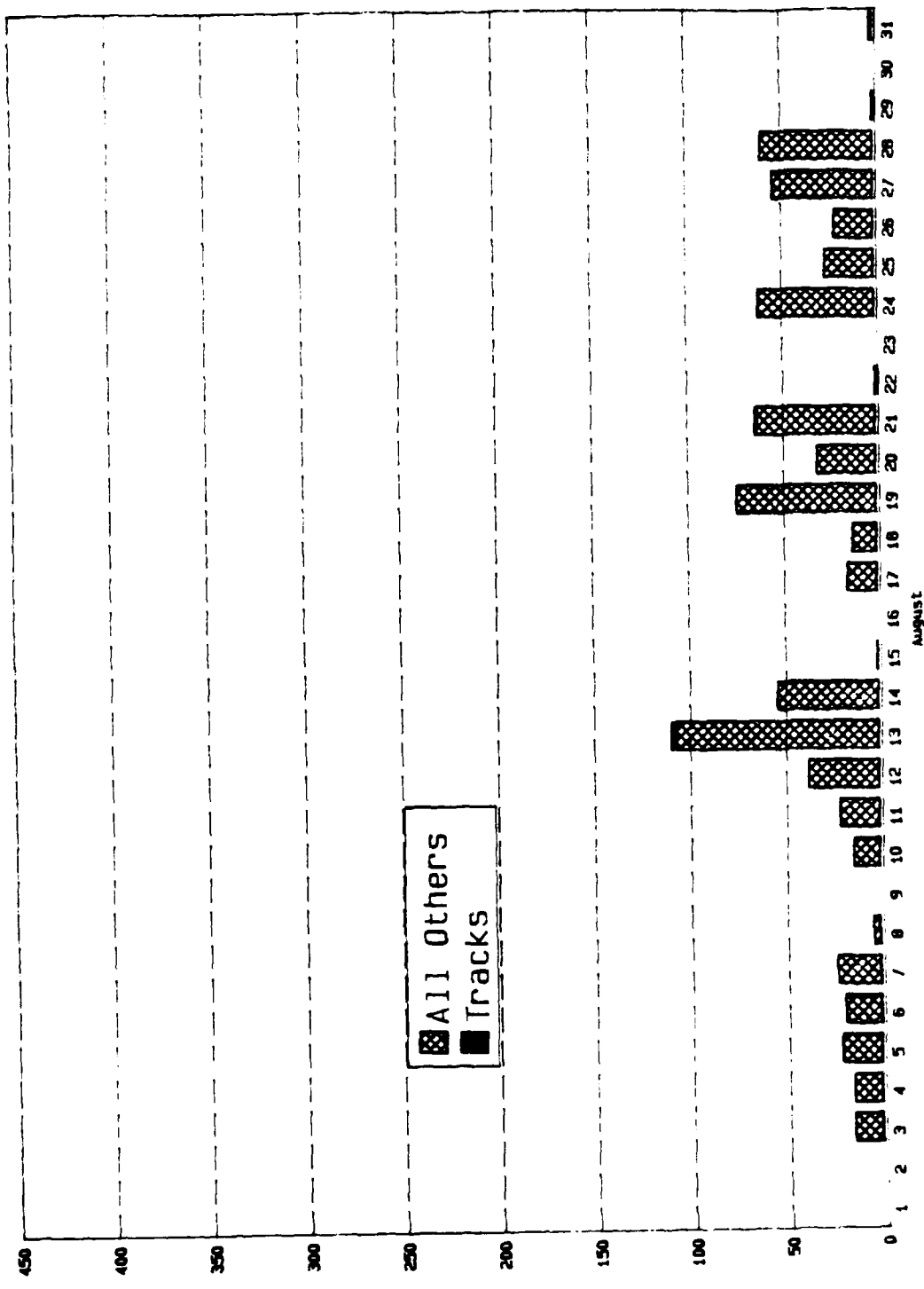


Figure 58. Yakima Firing Center CVWF usage by month - August 1987.

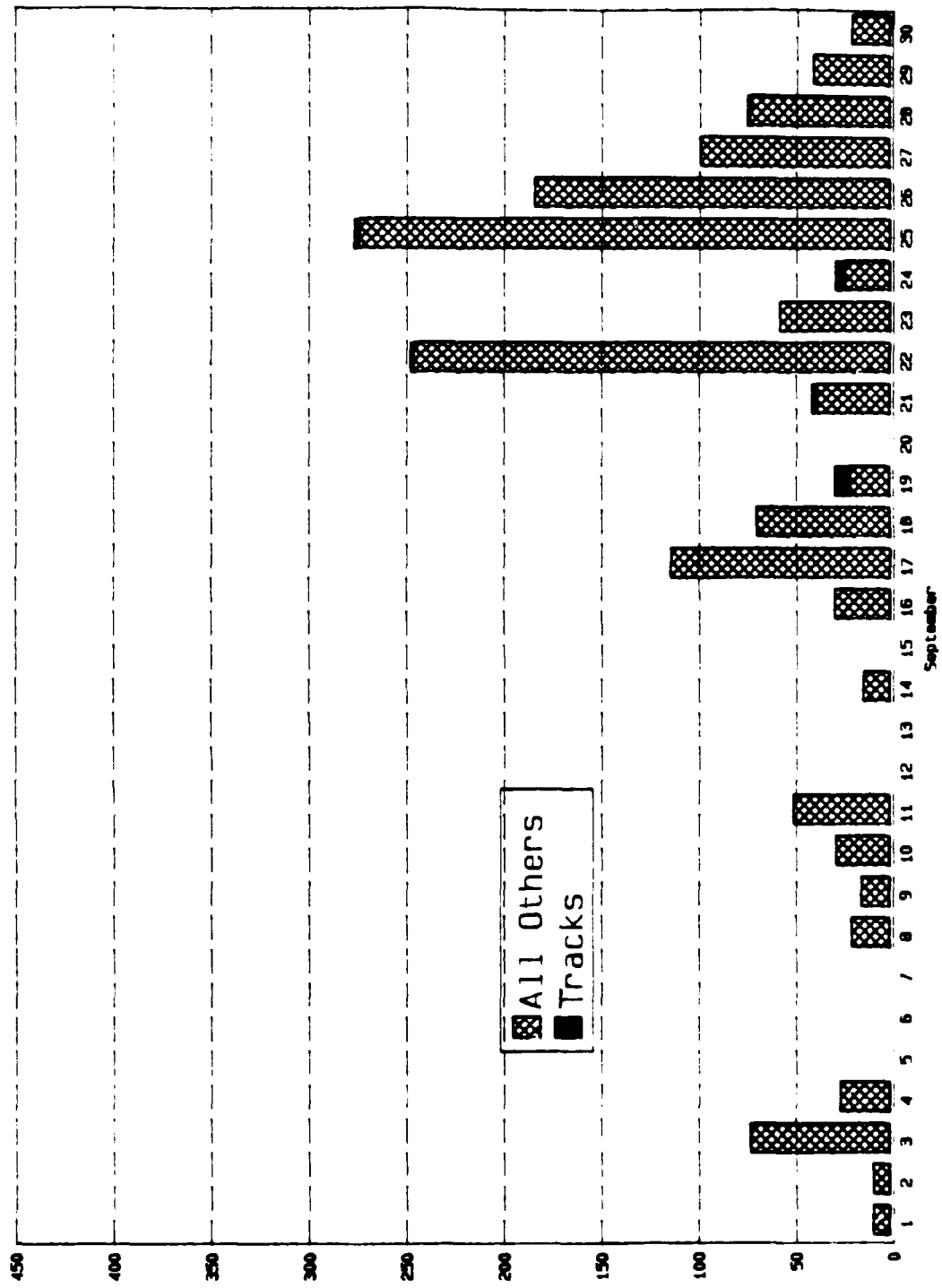


Figure 59. Yakima Firing Center CVWF usage by month - September 1987.

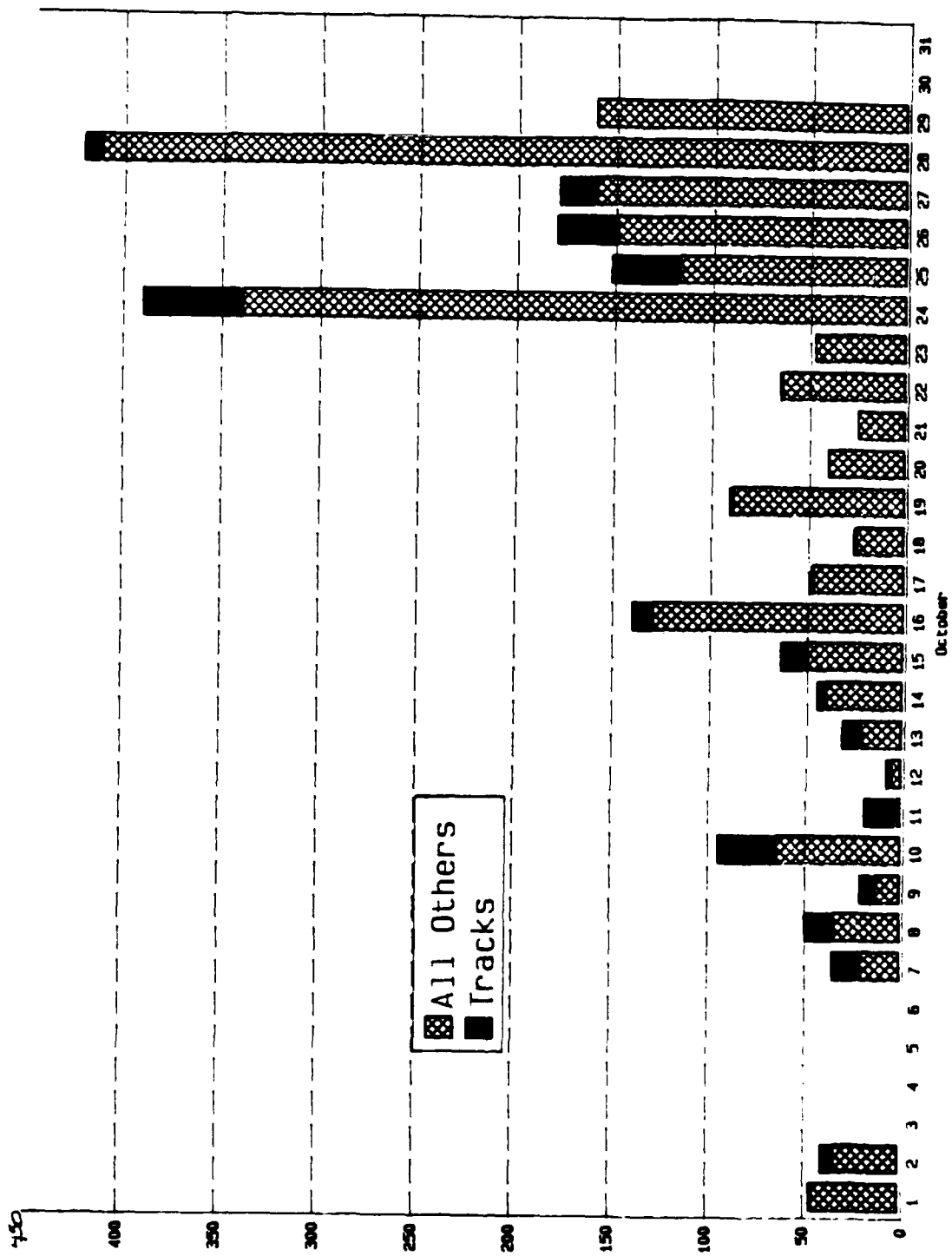


Figure 60. Yakima Firing Center CVWF usage by month - October 1987.



Figure 61. Yakima Firing Center CVWF usage - 1 to 19 November 1987.

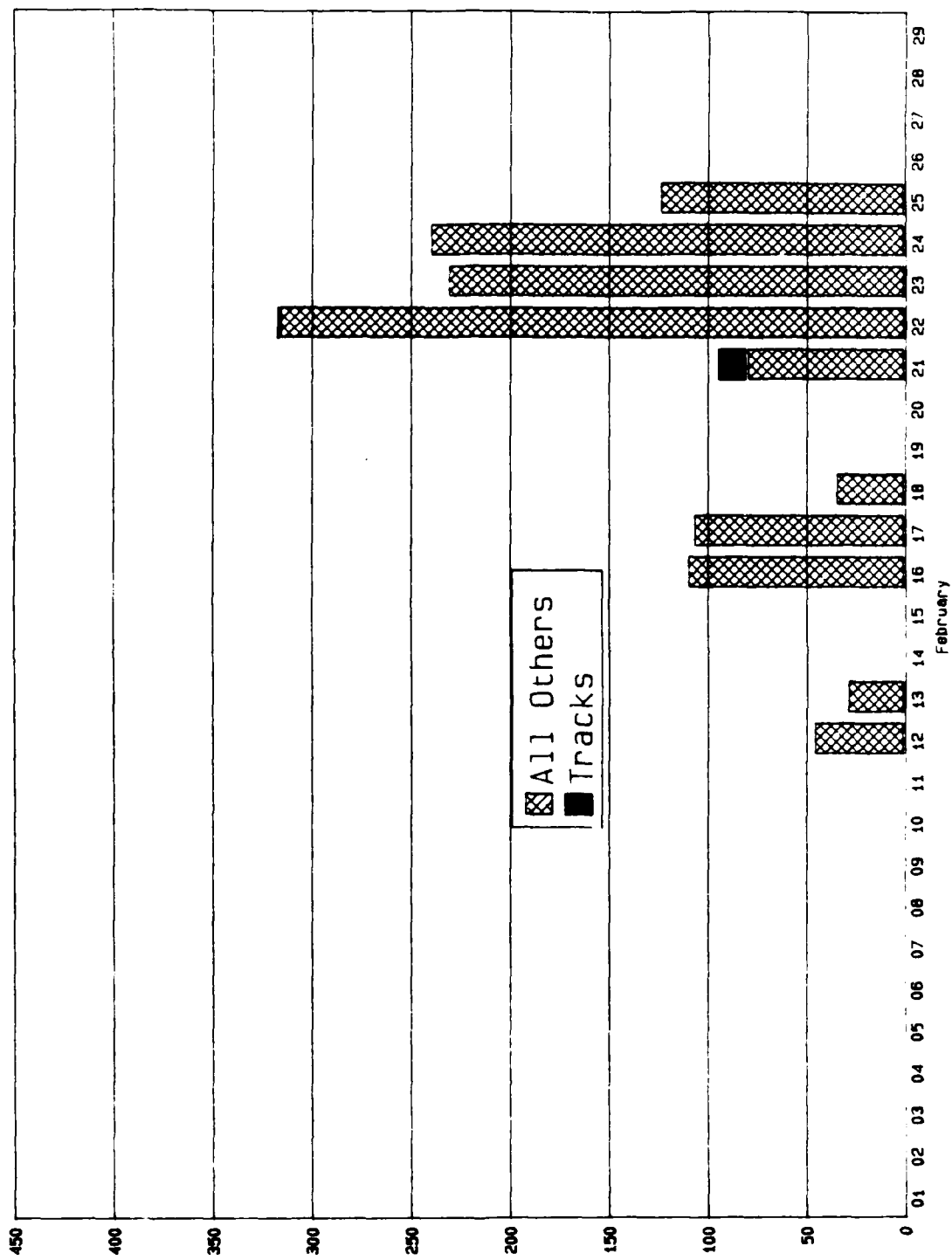


Figure 62. Yakima Firing Center CVWF usage - 12 to 29 February 1988.

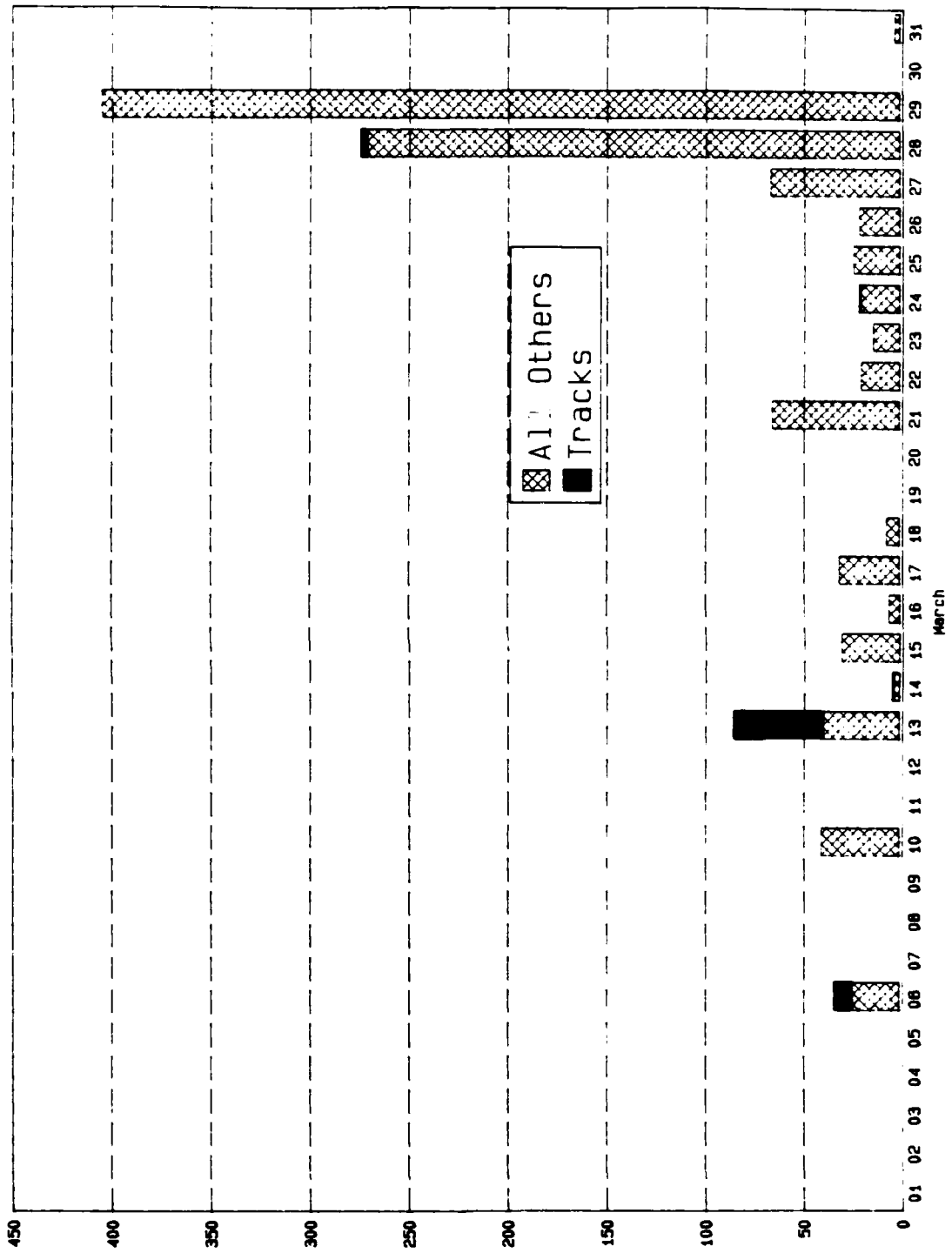


Figure 63. Yakima Firing Center CVWF usage by month - March 1988.



Figure 64. Yakima Firing Center CVWP usage by month - April 1988.

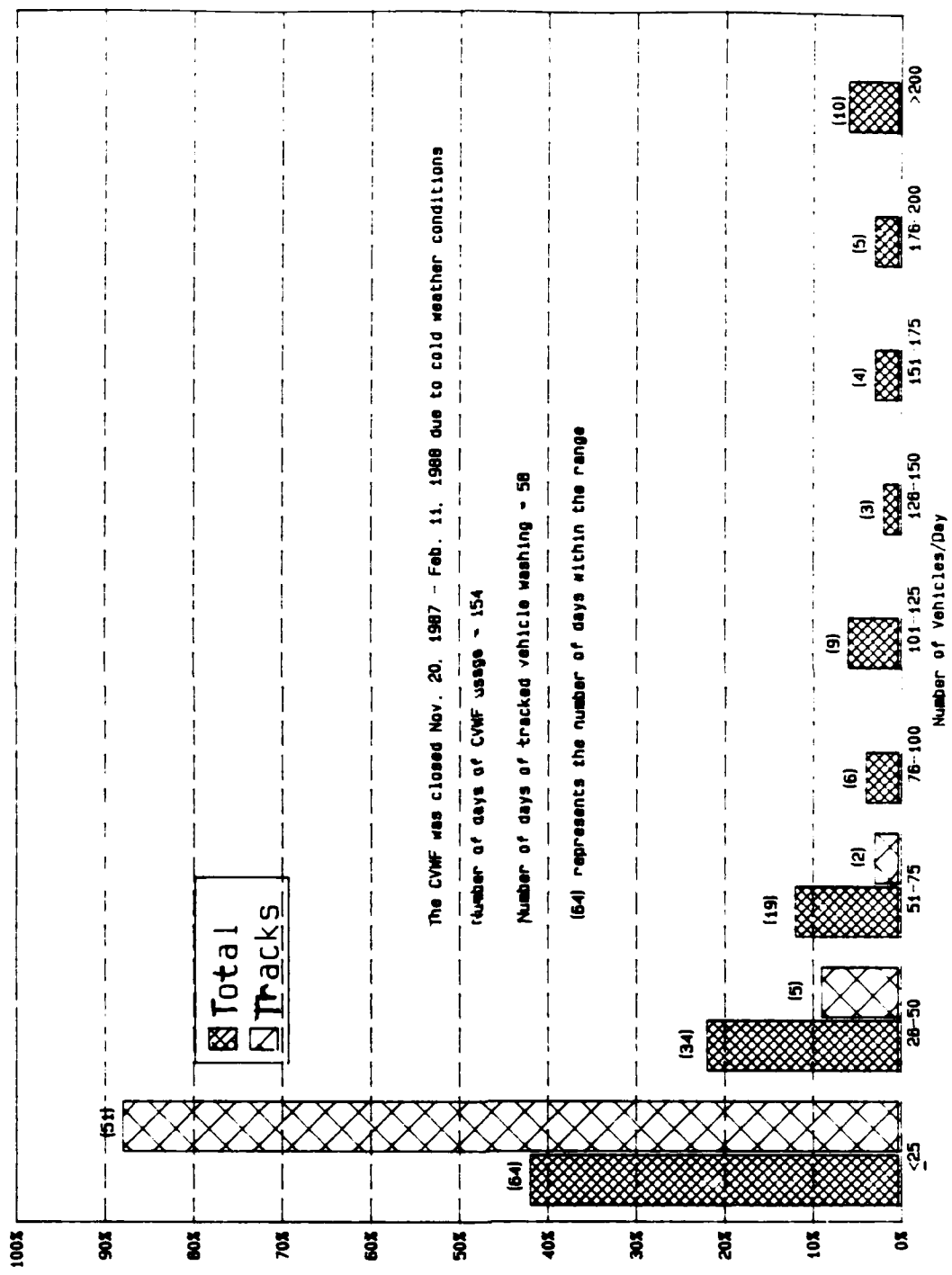


Figure 65. Yakima Firing Center CVWF usage level frequency - 13 July 1987 to 1 May 1988.

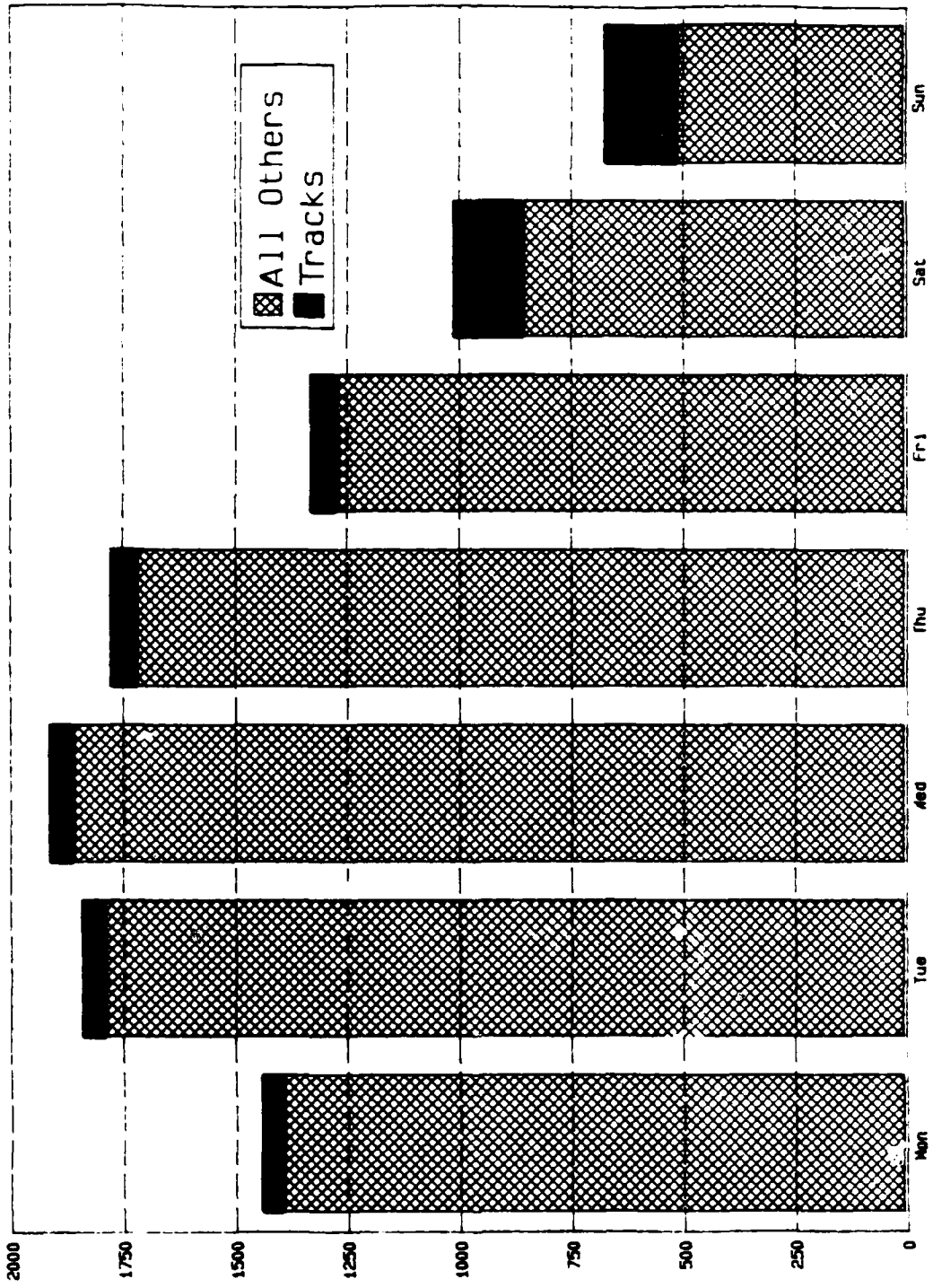


Figure 66. Yakima Firing Center CVWF usage by day of the week - 13 July 1987 to 1 May 1988.

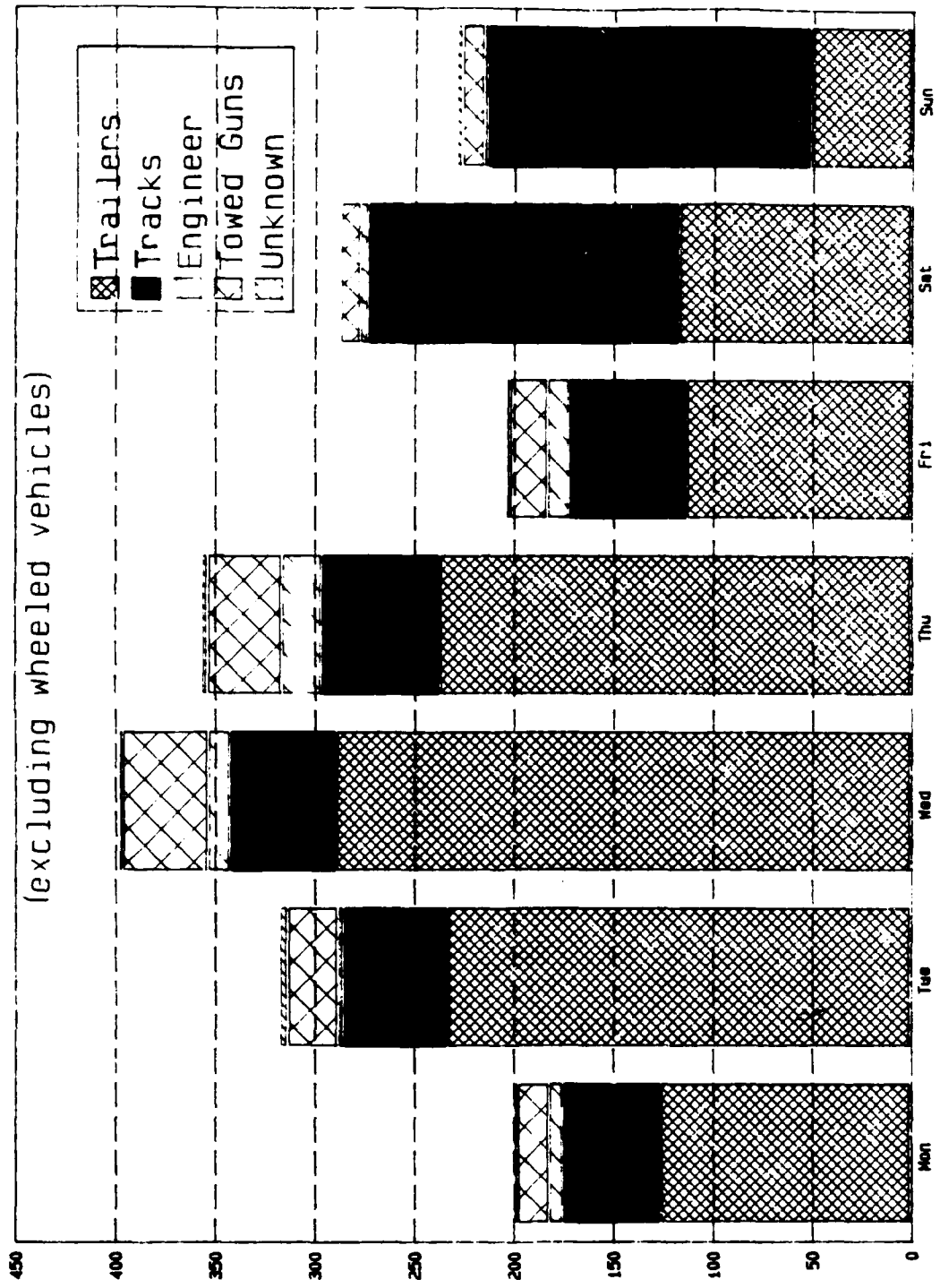


Figure 67. Yakima Firing Center CVWF usage by vehicle type - 13 July 1987 to 1 May 1988.

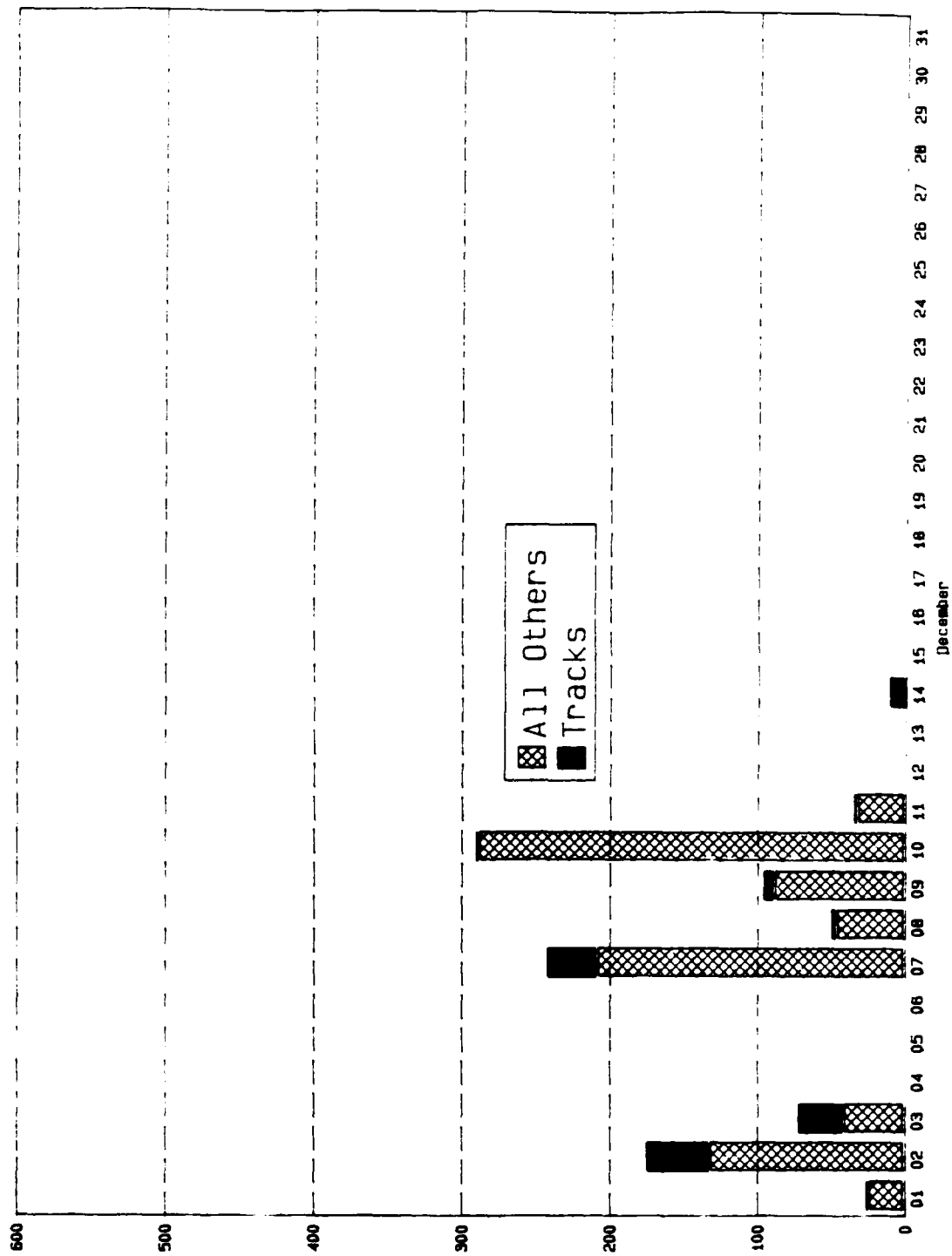


Figure 68. South Fort Polk CVWP usage by month - December 1987.

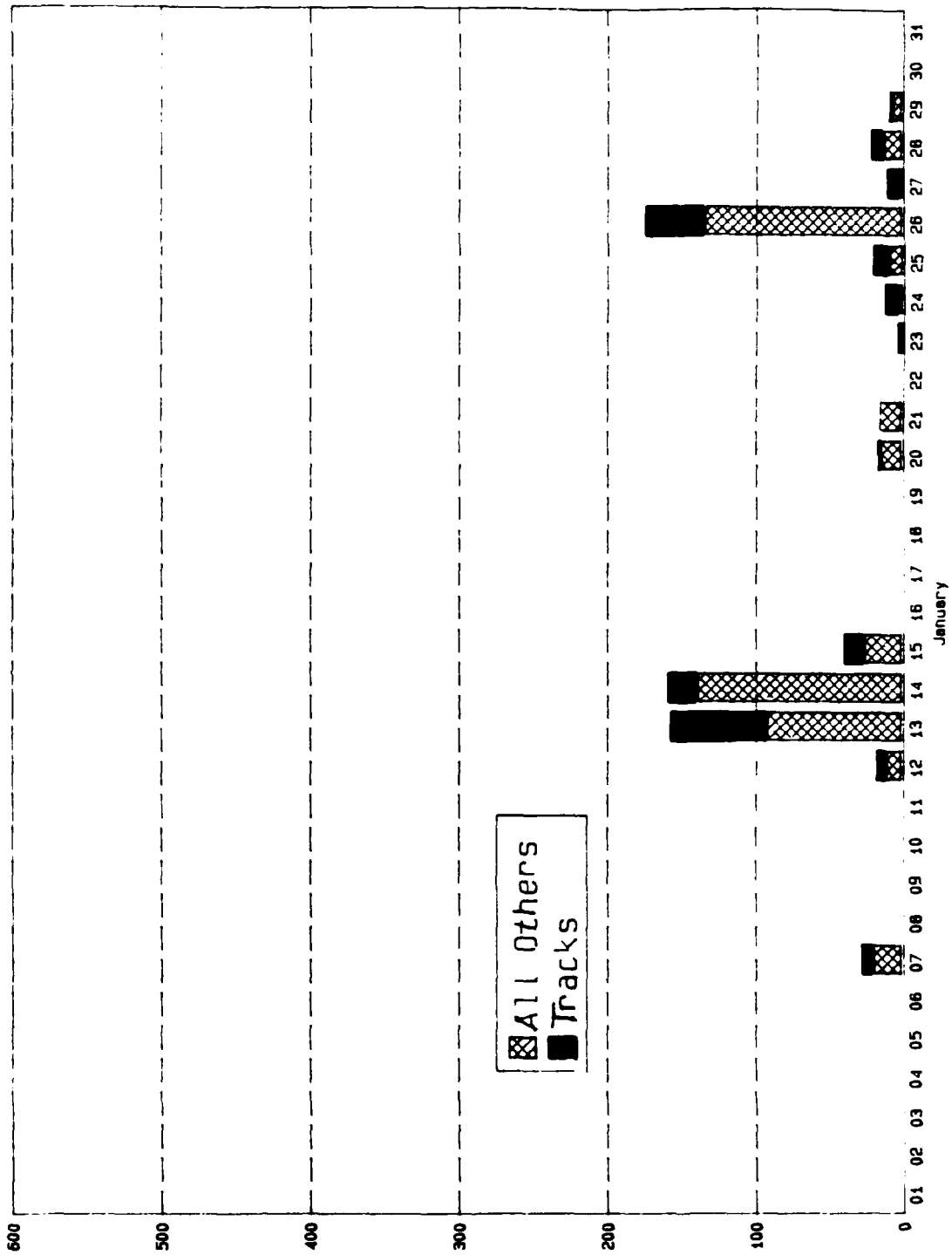


Figure 69. South Fort Polk CVWF usage by month - January 1988.

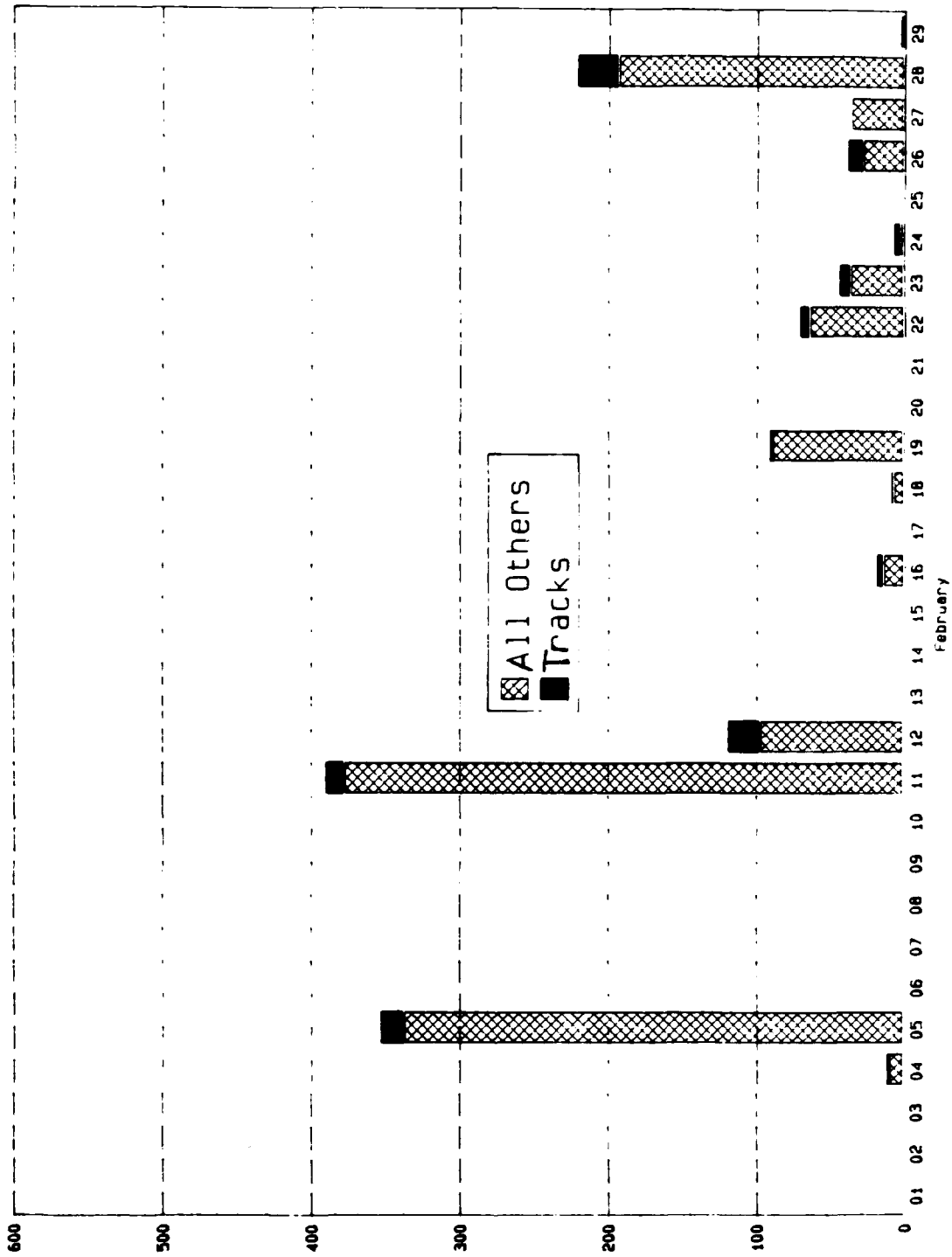


Figure 70. South Fort Polk CVWF usage by month - February 1988.

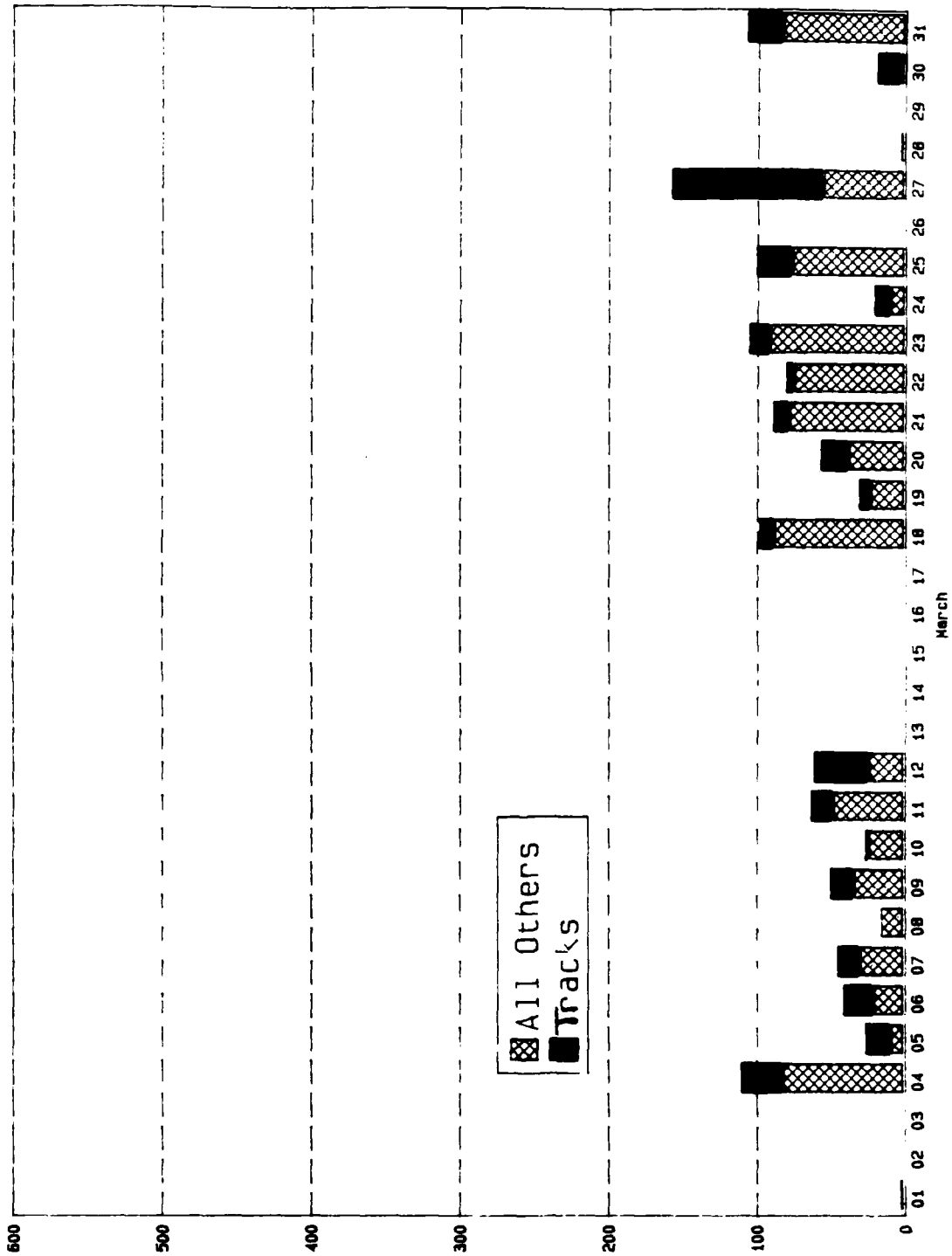


Figure 71. South Fort Polk CVWF usage by month - March 1988.

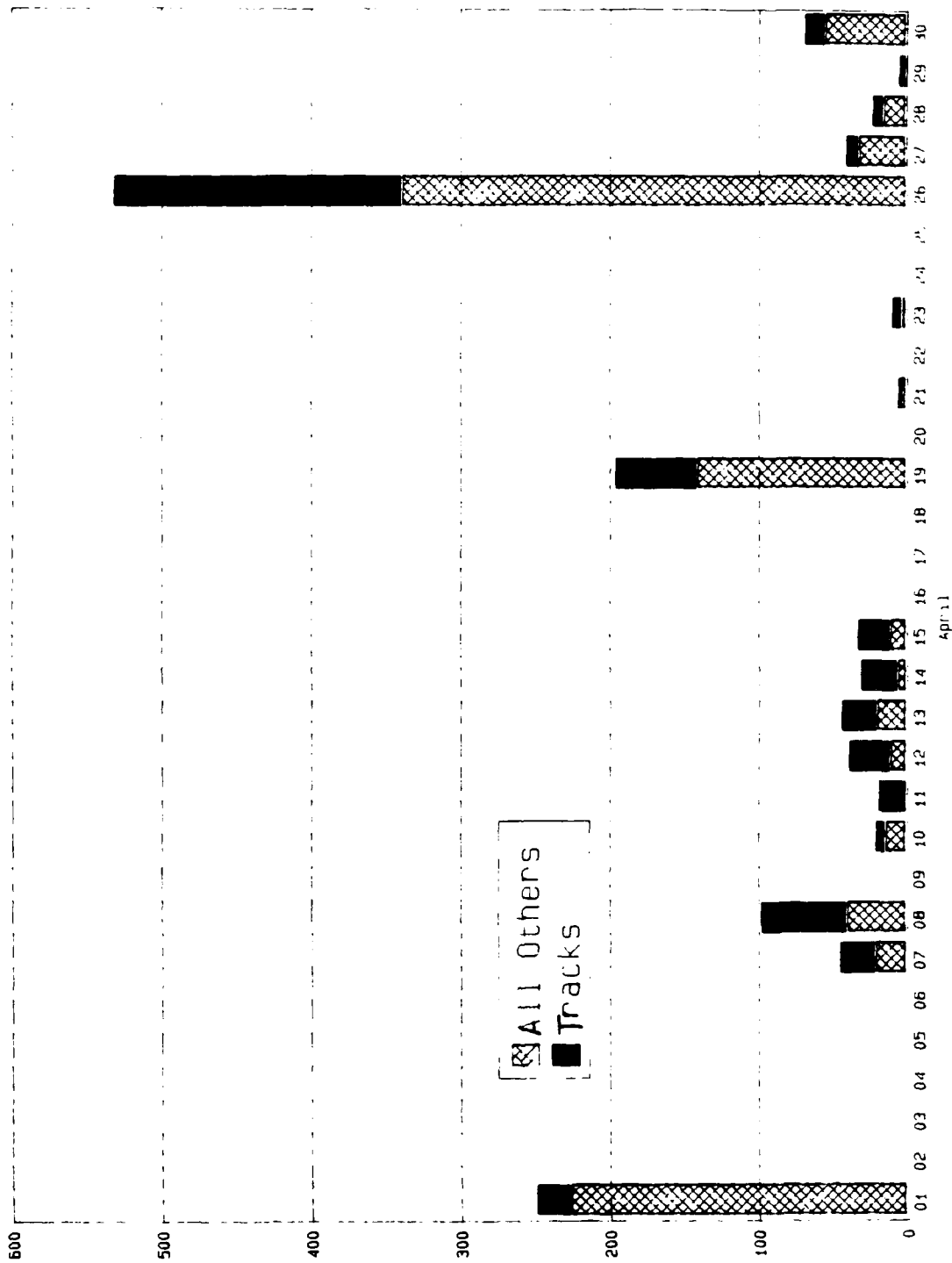


Figure 72. South Fort Polk CVWF usage by month - April 1988.

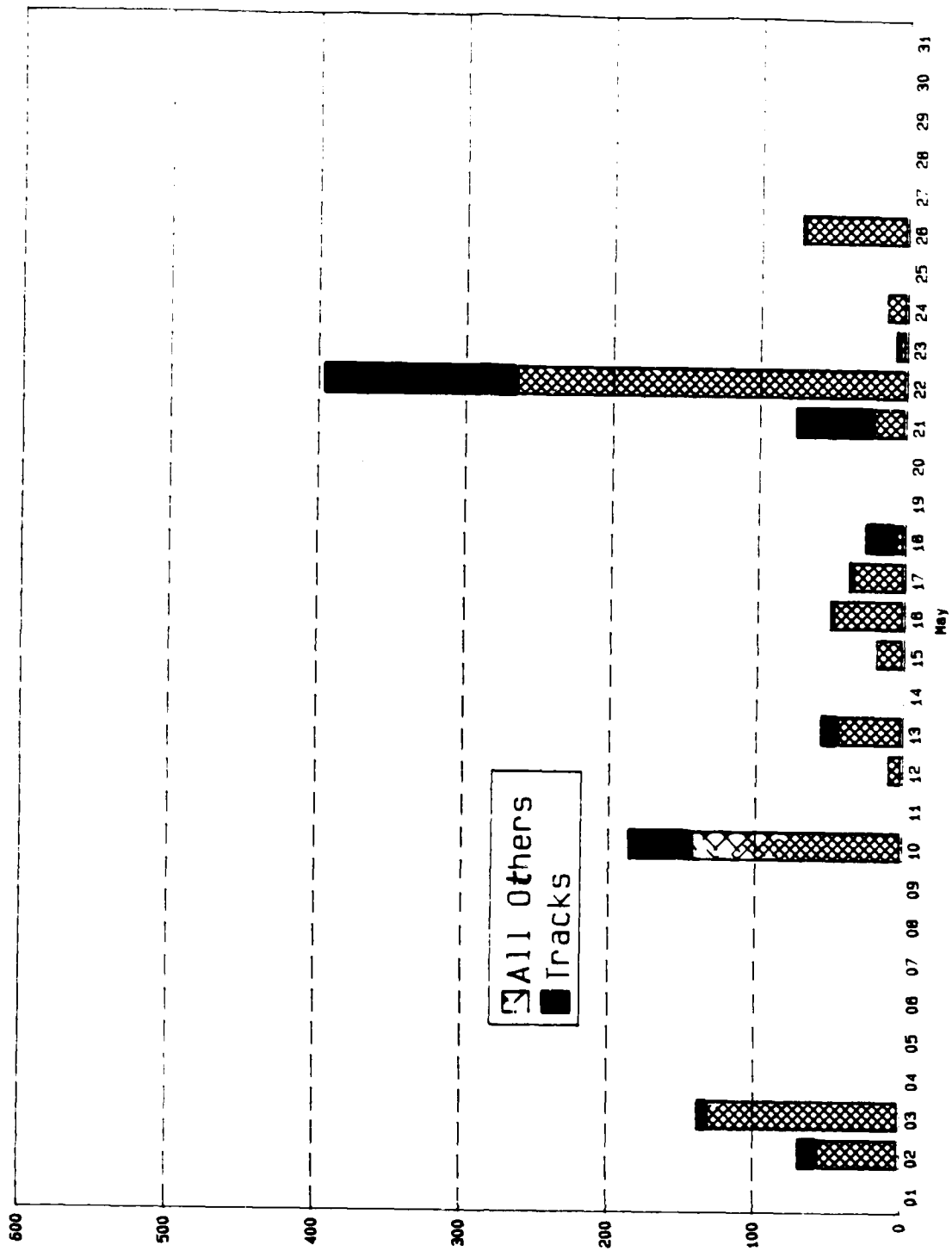


Figure 73. South Fort Polk CVWF usage by month - May 1988.

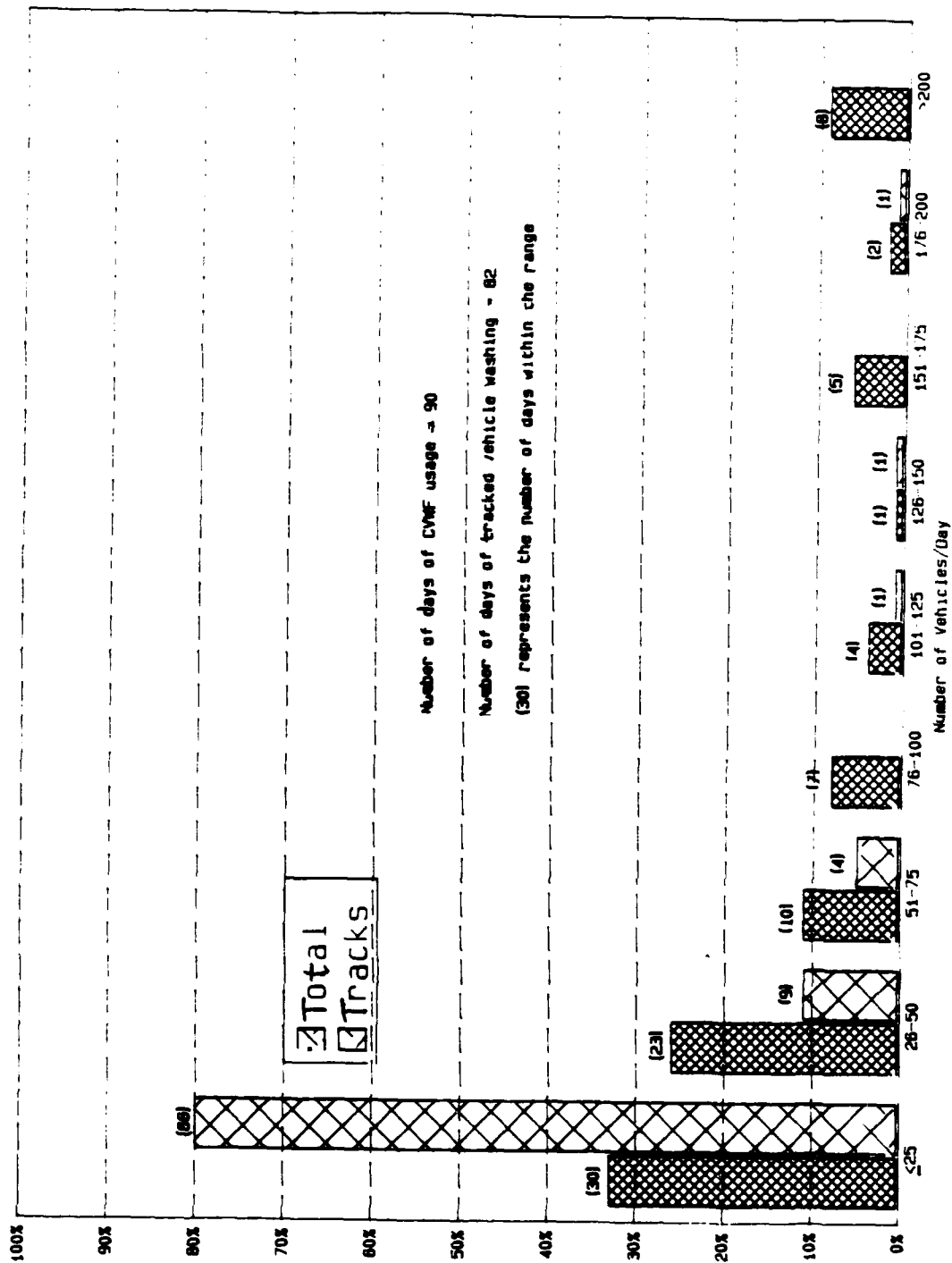


Figure 74. South Fort Polk CVWF usage level frequency - 1 December 1987 to 31 May 1988.

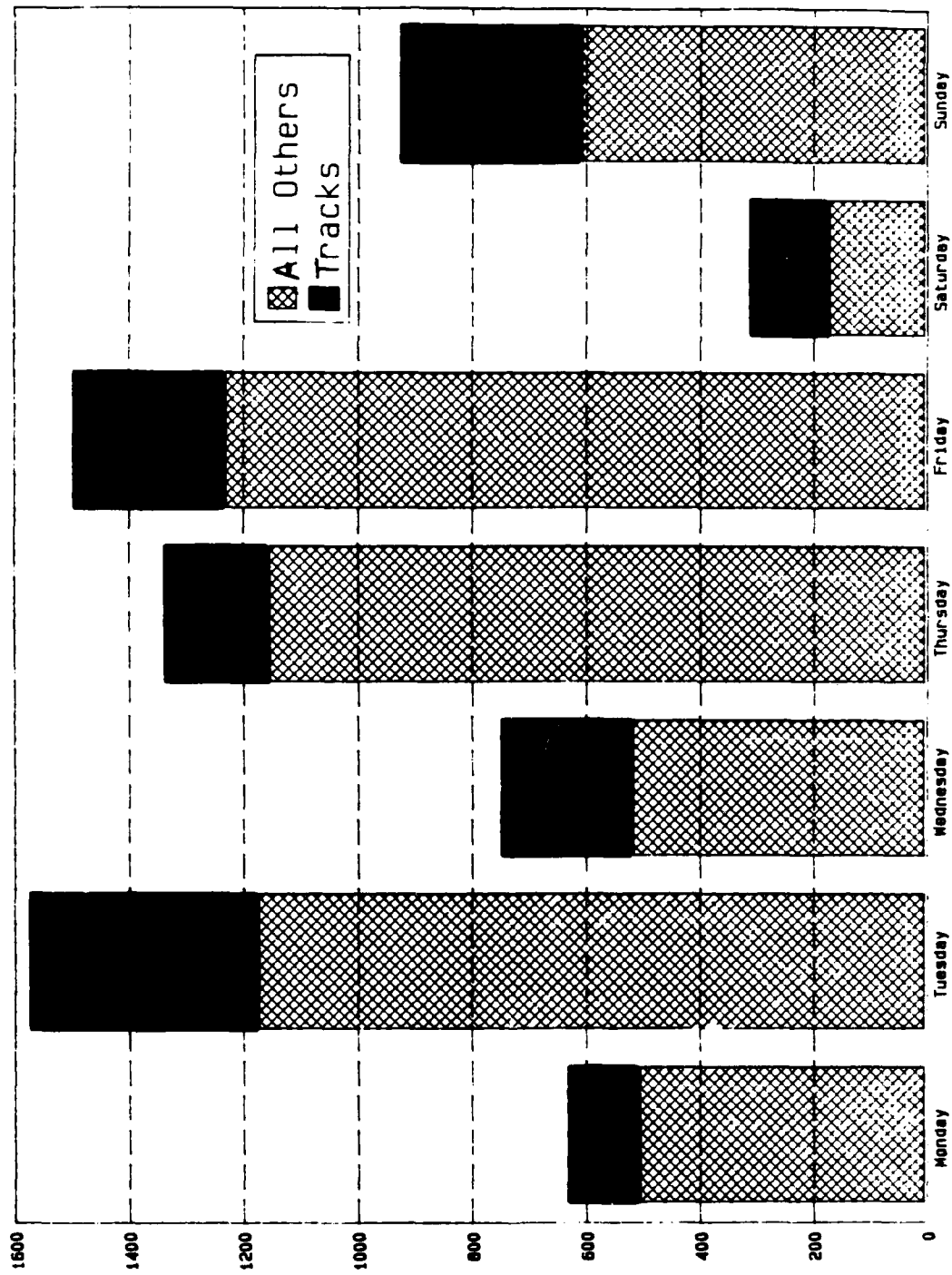


Figure 75. South Fort Polk CVWF usage by day of the week - 1 December 1987 to 31 May 1988.

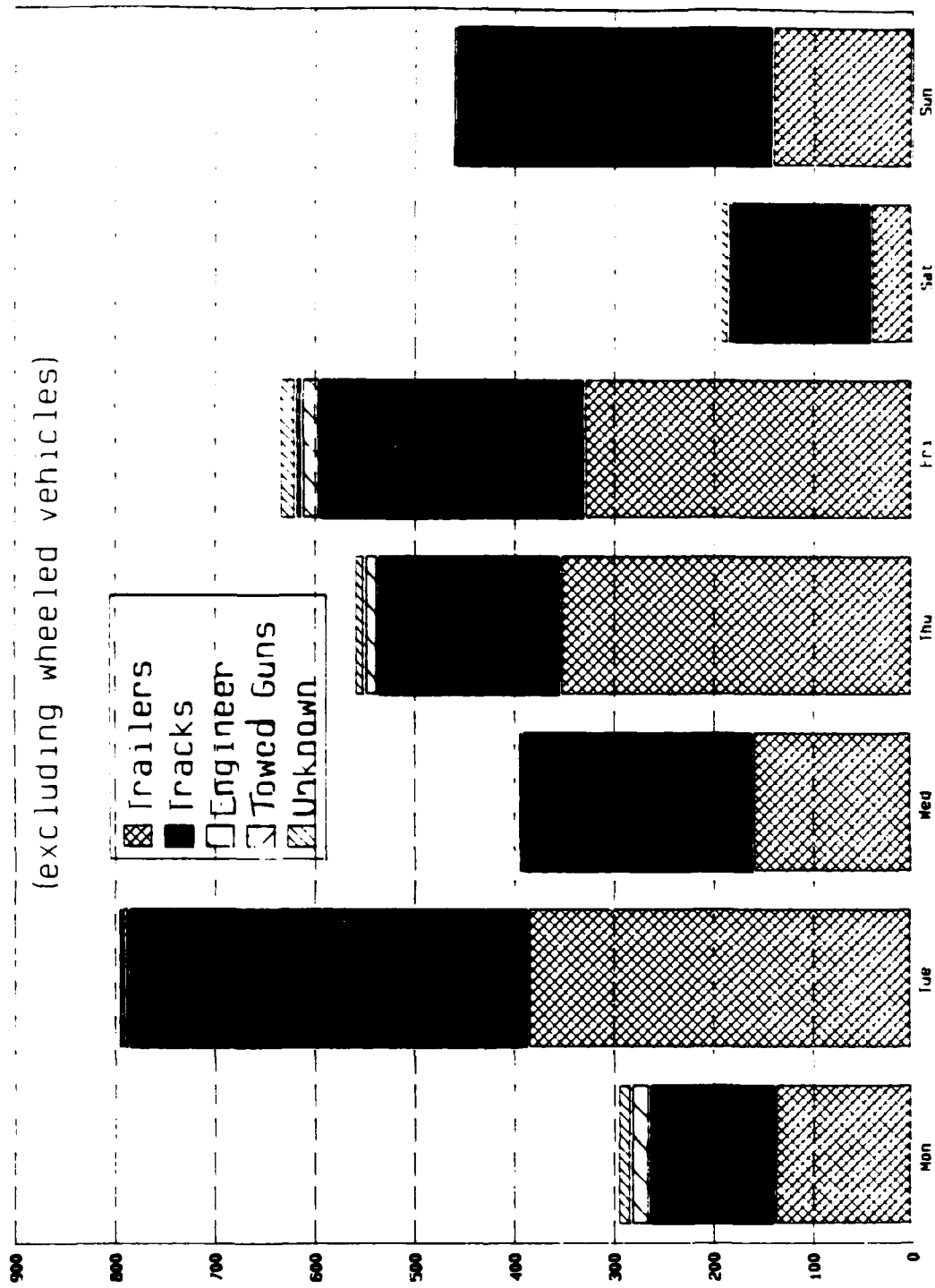


Figure 76. South Fort Polk CVWF usage by vehicle type - 1 December 1987 to 31 May 1988.

**APPENDIX A:**

**VEHICLE CATEGORIES**

**Wheeled Vehicles:**

- All trucks under 20 ton
- Fast attack vehicle (FAV)
- Light, medium, and heavy recovery vehicles
- Tank/heavy equipment transporters (HET)

**Trailers:**

- Light, medium, and heavy trailers
- Water/fuel tank trailers

**Tracked Vehicles:**

- Armored recovery vehicles
- Armored engineer vehicles
- Self-propelled anti-aircraft guns/surface-to-air missile systems
- Prime movers/cargo carriers
- Tanks
- APCs
- Fighting vehicle systems
- Self-propelled howitzers

**Engineering Vehicles:**

- Mechanical bridges
- Construction equipment

**APPENDIX B:**  
**NORTH FORT LEWIS CVWF USAGE BY DAY OF THE WEEK**

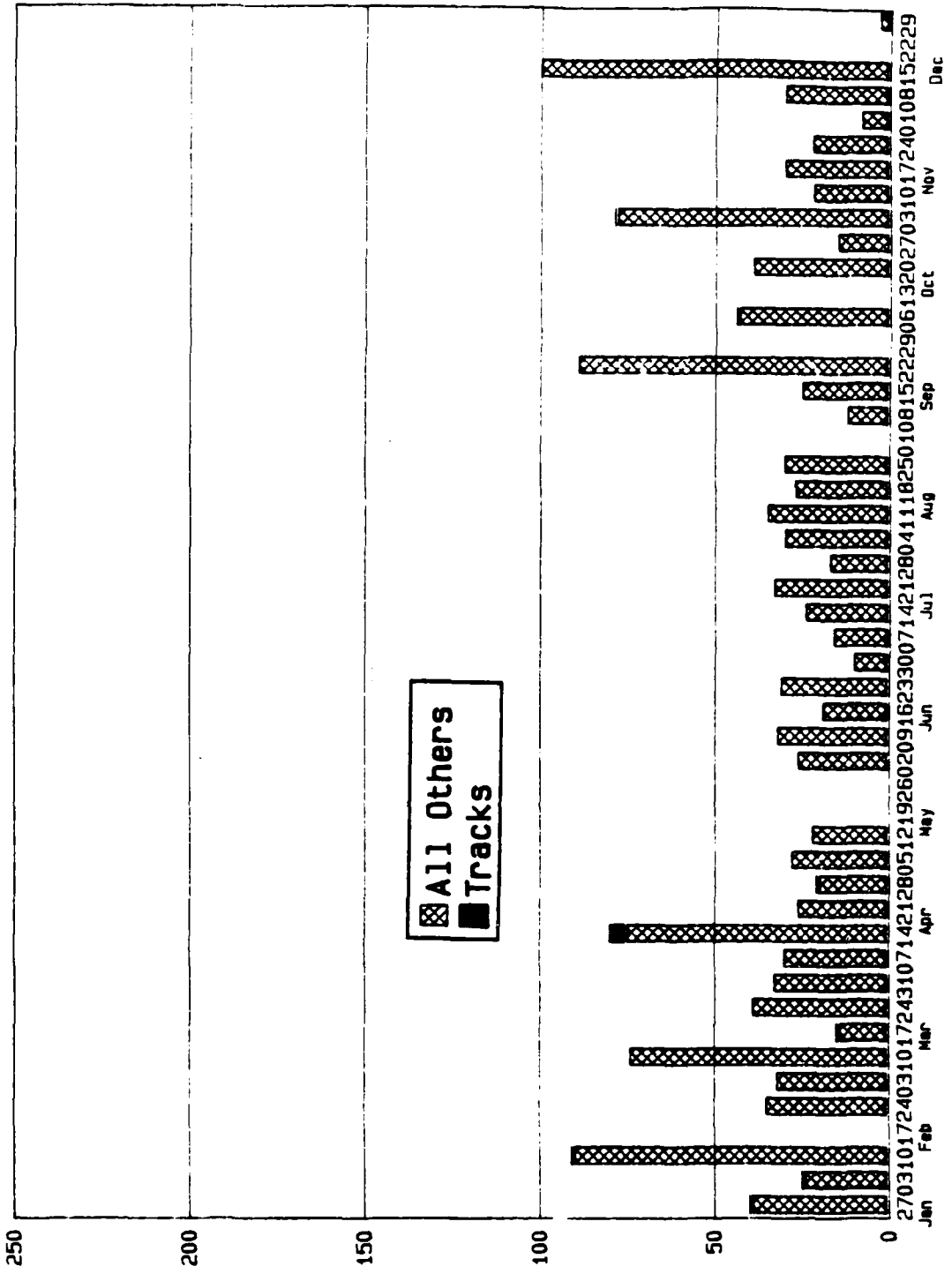


Figure B1. North Fort Lewis CVWF usage by Mondays - 27 January to 29 December 1986.

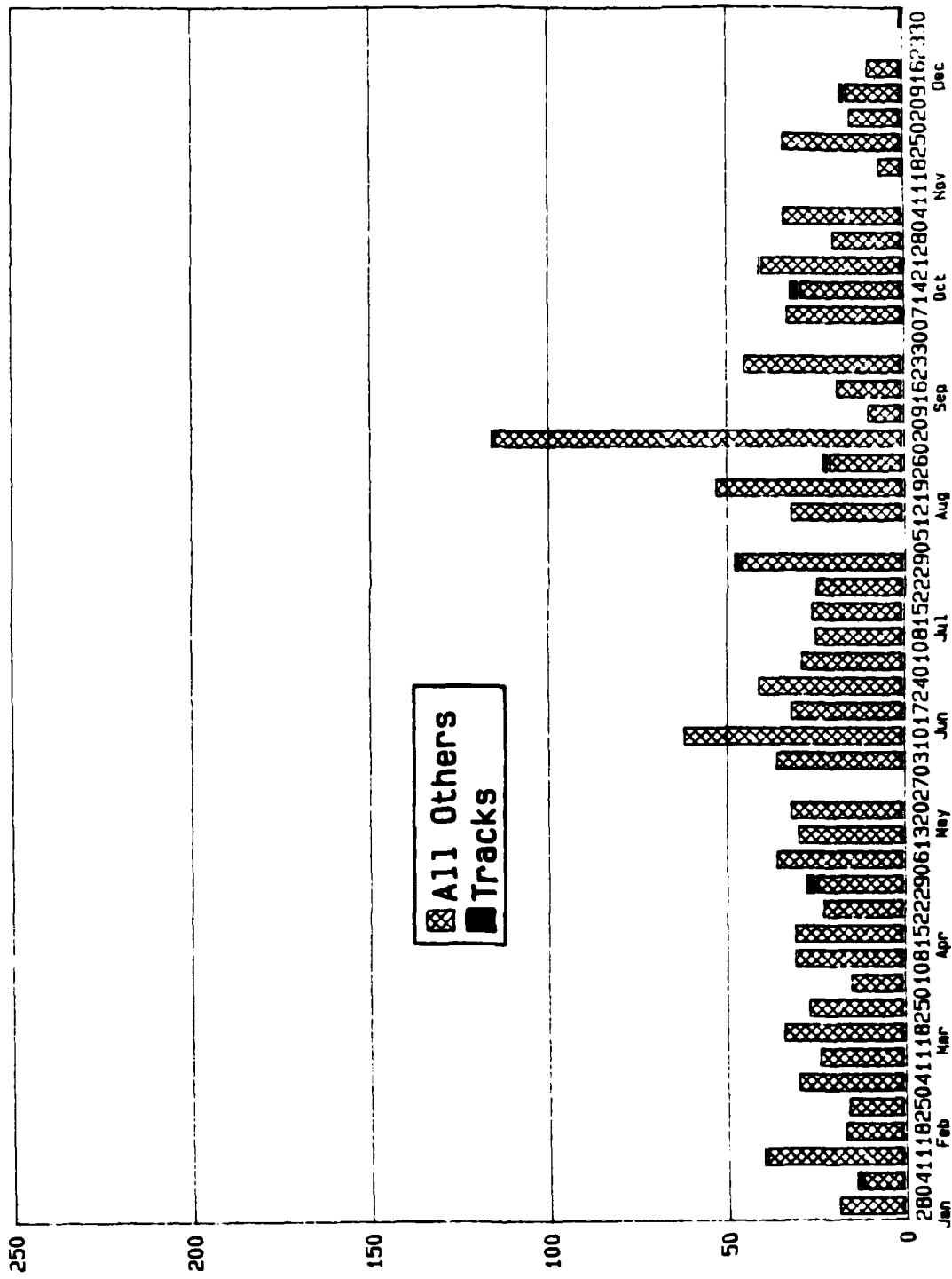


Figure B2. North Fort Lewis CVWF usage by Tuesdays - 28 January to 30 December 1986.



Figure B3. North Fort Lewis CVWF usage by Wednesdays - 29 January to 31 December 1986.

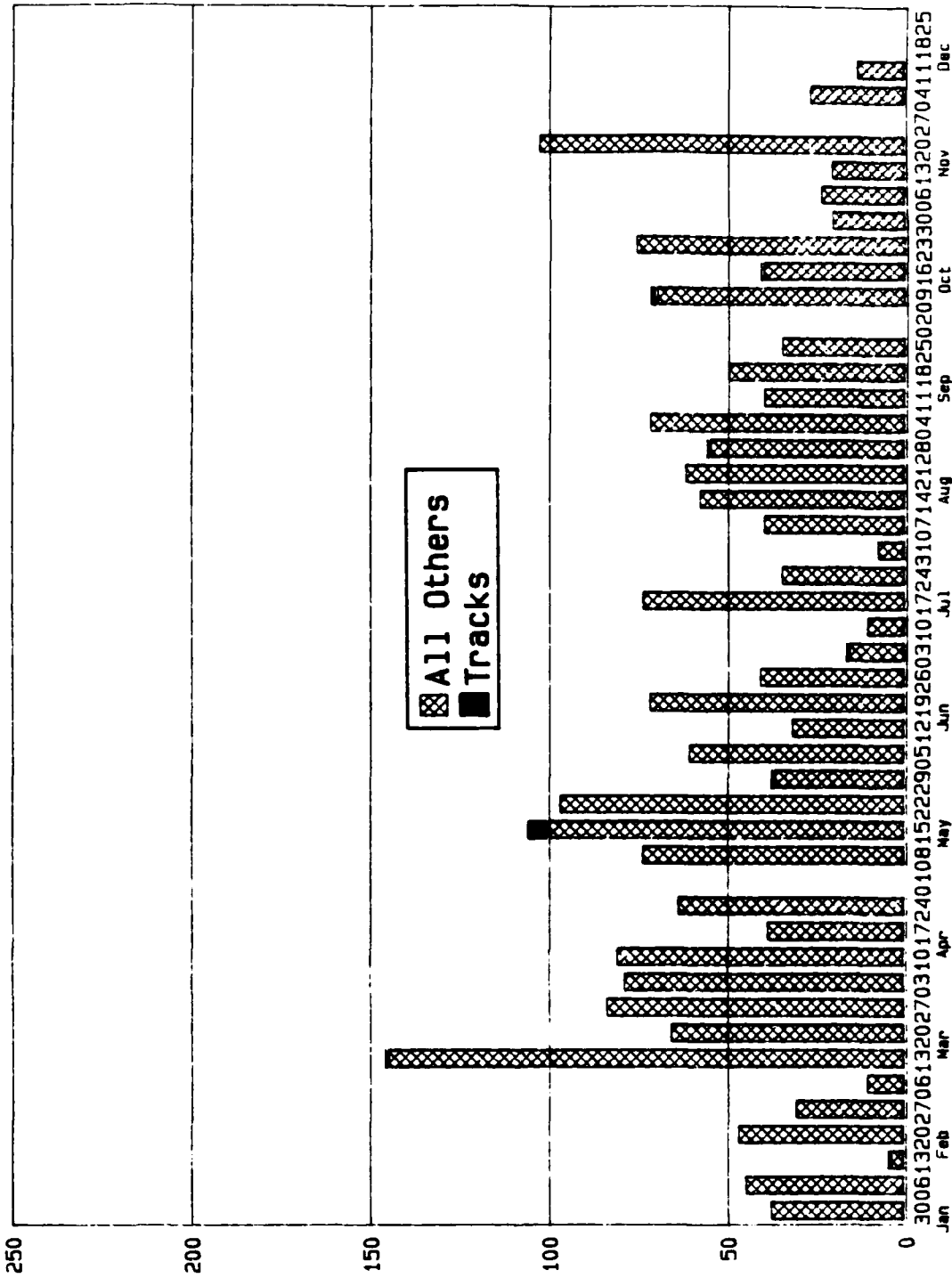


Figure B4. North Fort Lewis CVWP usage by Thursdays - 30 January to 25 December 1986.

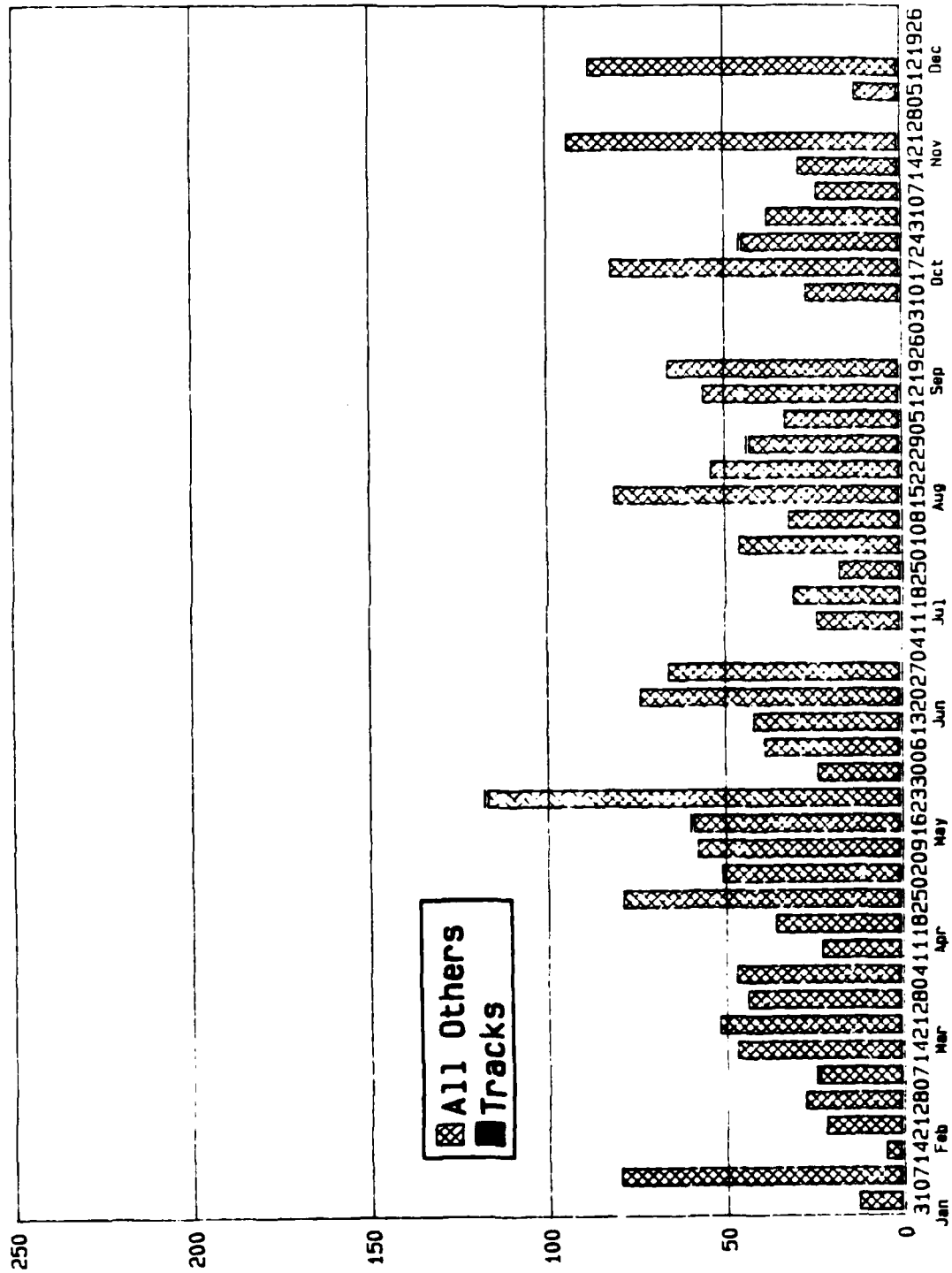


Figure B5. North Fort Lewis CVWF usage by Fridays 31 January to 26 December 1986.



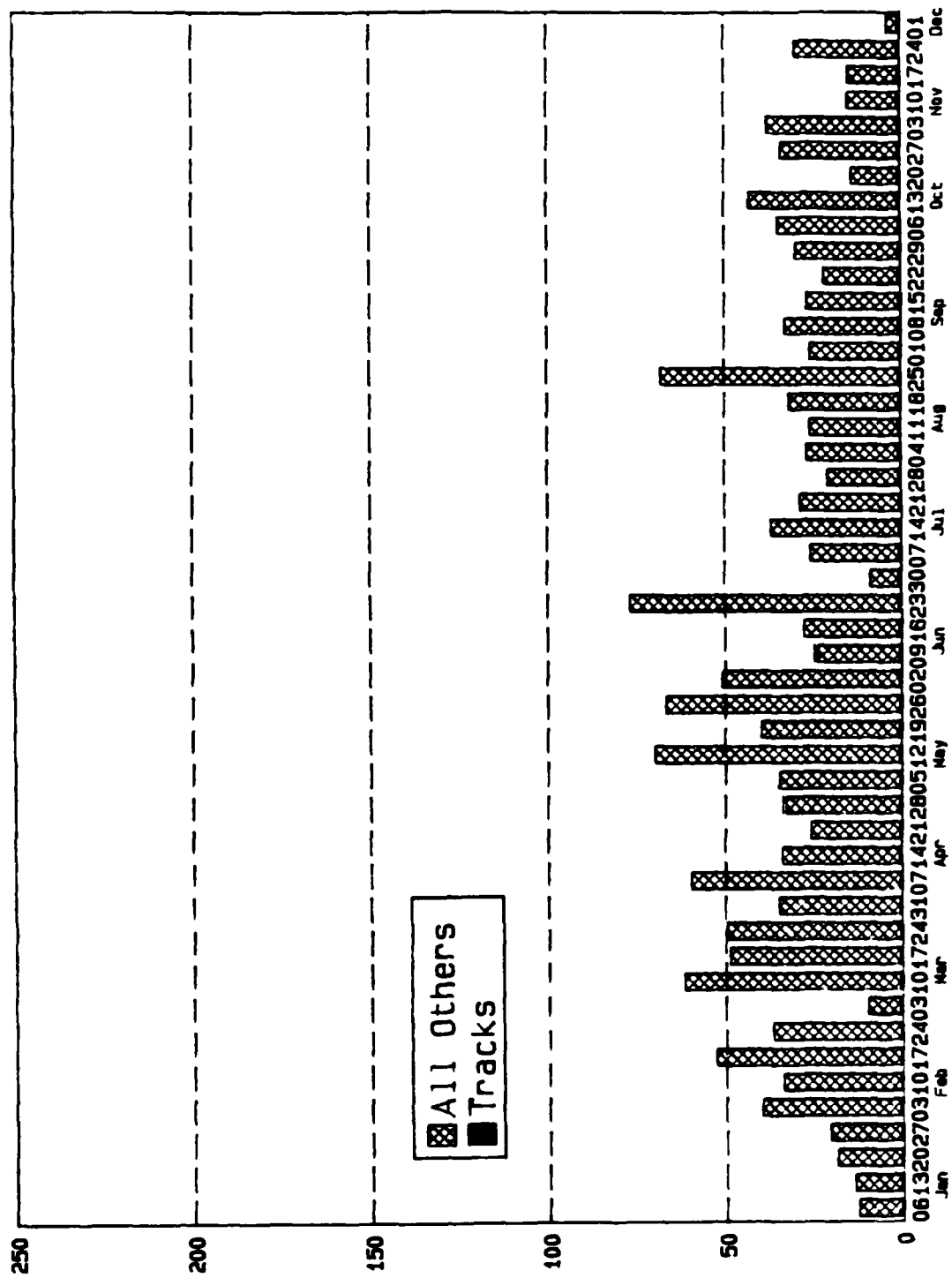
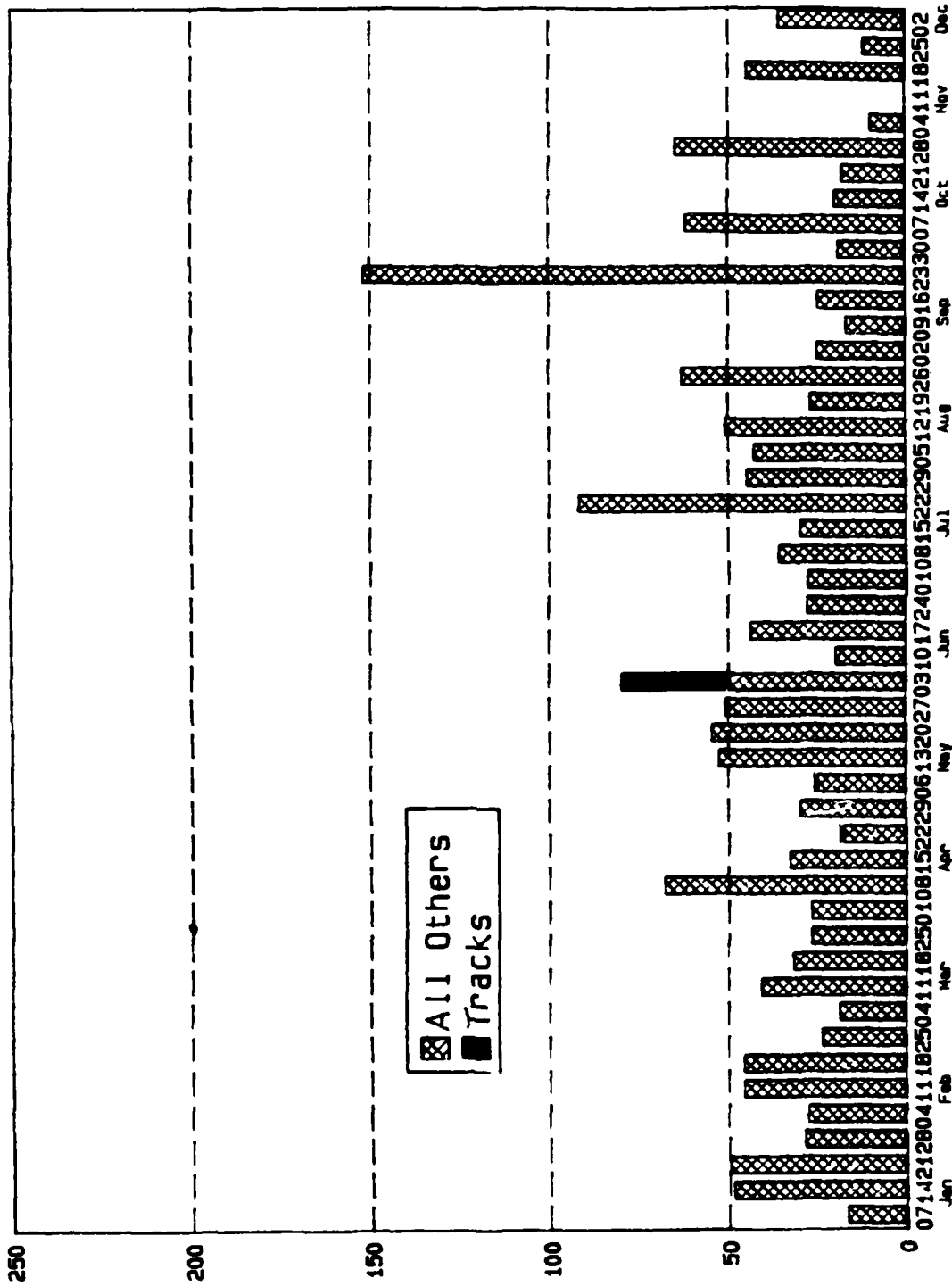


Figure B7. North Fort Lewis CVWF usage by Tuesdays - 6 January to 1 December 1987.



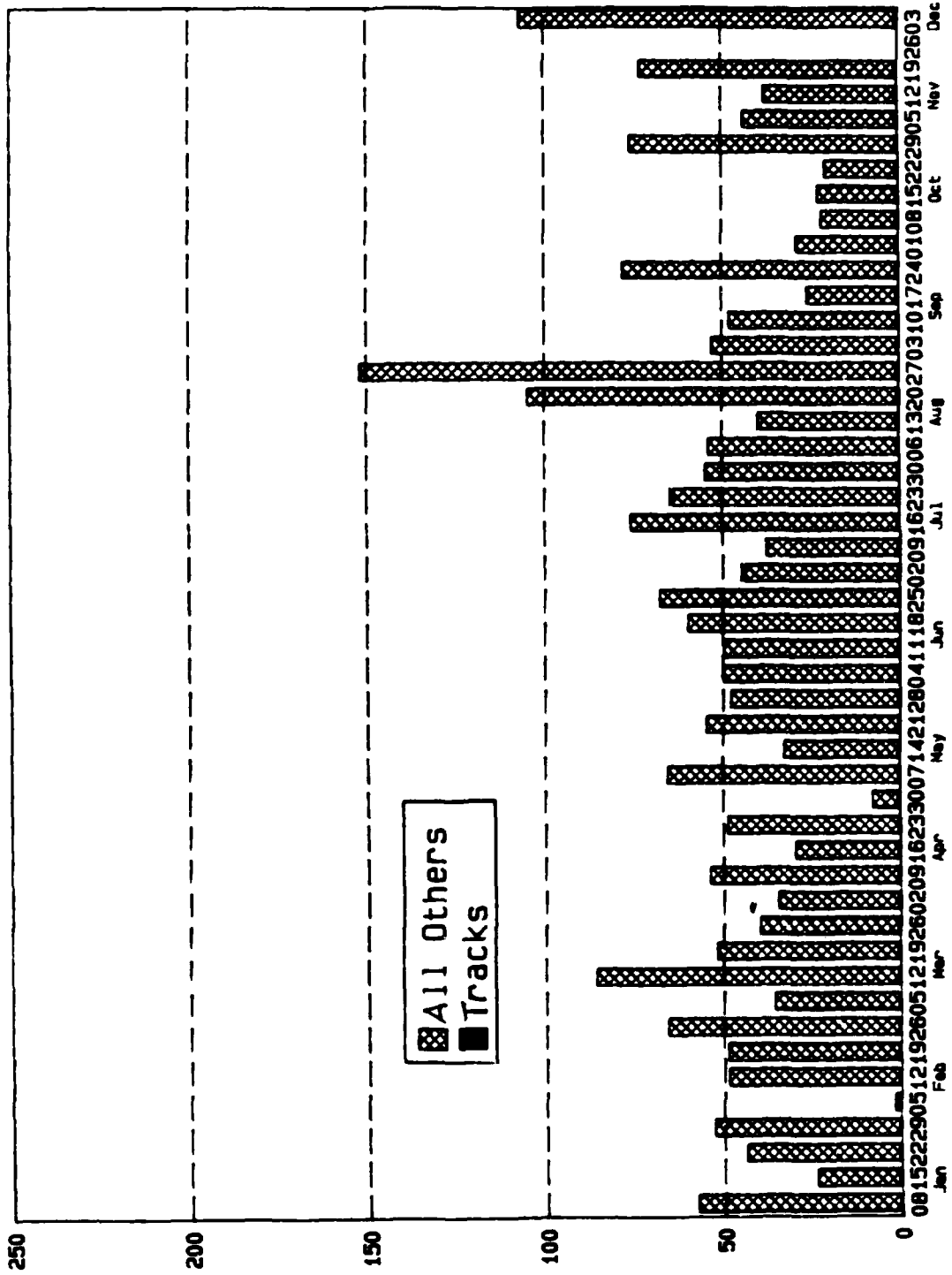


Figure B9. North Fort Lewis CVWF usage by Thursdays - 8 January to 3 December 1987.

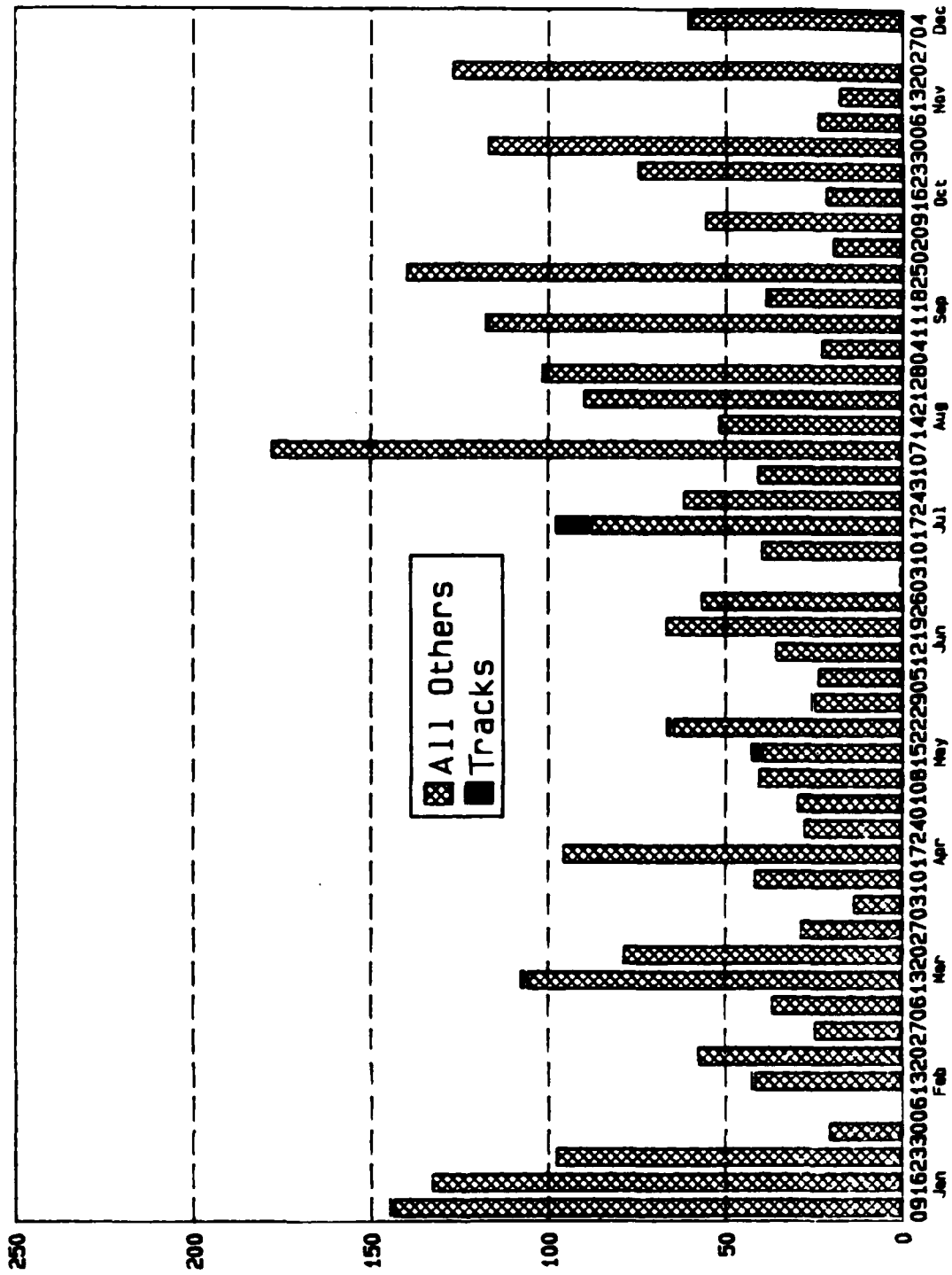


Figure B10. North Fort Lewis CVWF usage by Fridays - 9 January to 4 December 1987.

**APPENDIX C:**  
**SOUTHEAST FORT LEWIS CVWF USAGE BY DAY OF THE WEEK**

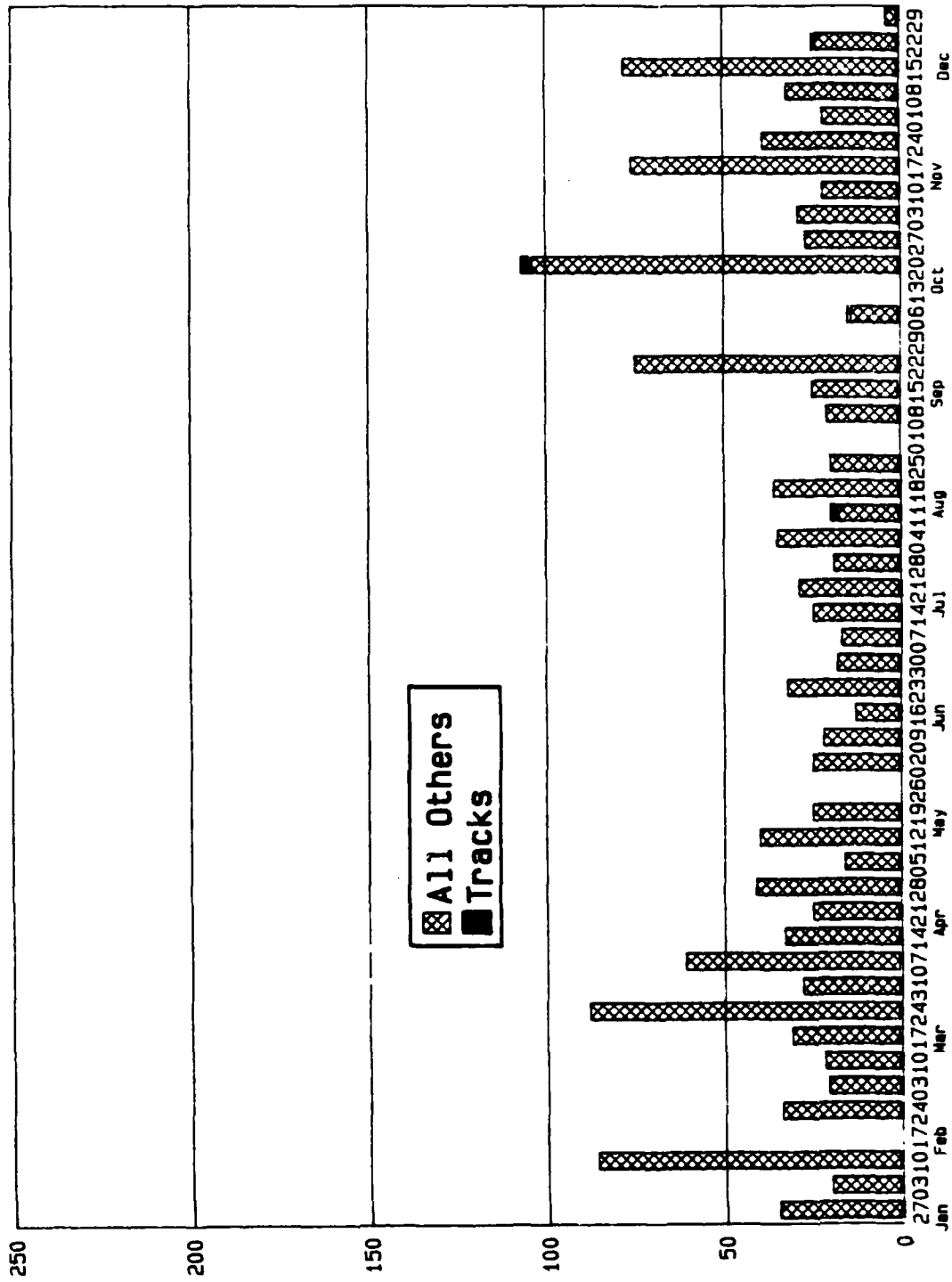


Figure C1. Southeast Fort Lewis CVWF usage by Mondays - 27 January to 30 December 1986.

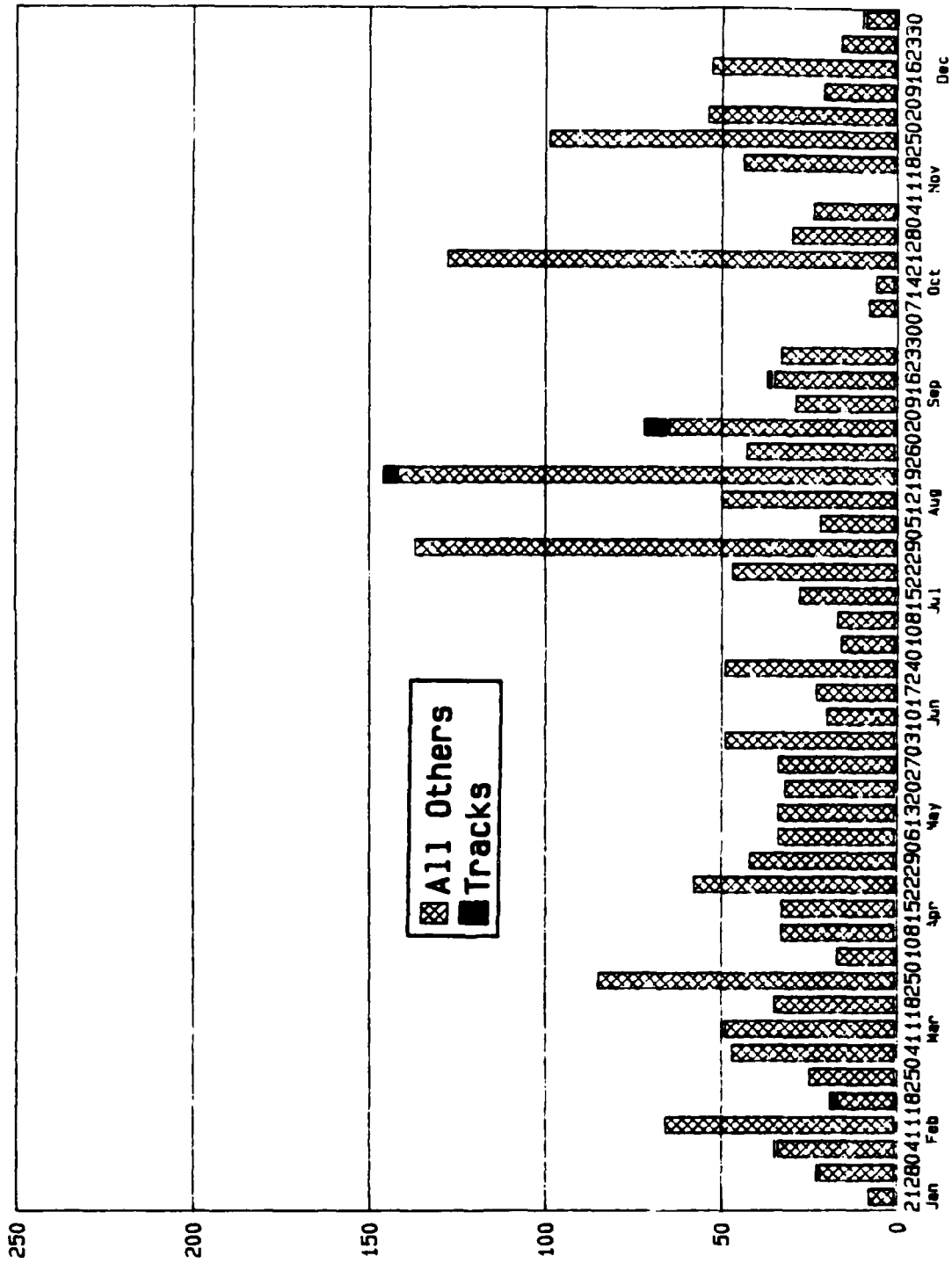


Figure C2. Southeast Fort Lewis CVWP usage by Tuesdays - 21 January to 30 December 1986.

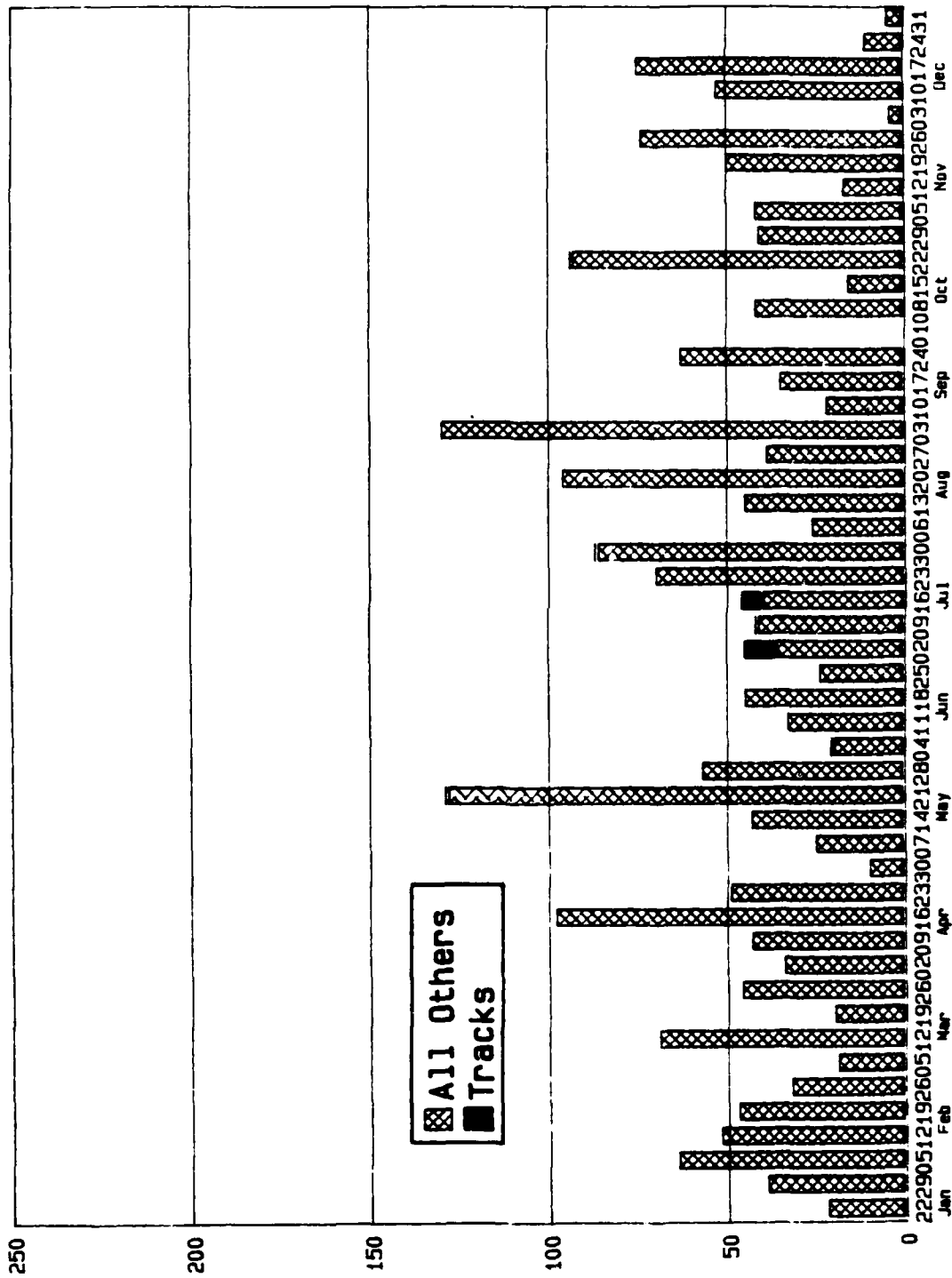


Figure C3. Southeast Fort Lewis CVWP usage by Wednesdays - 22 January to 31 December 1986.



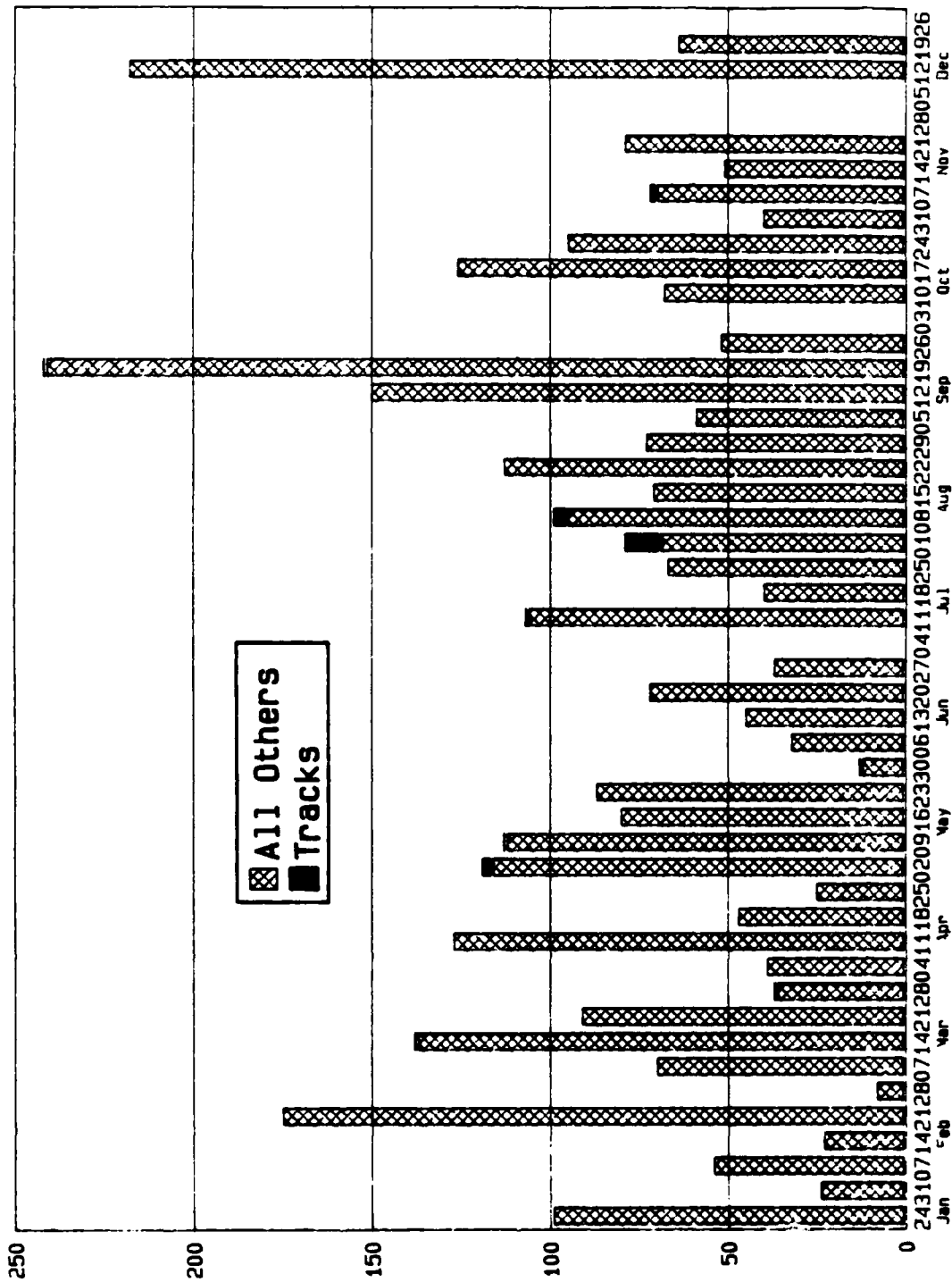


Figure C5. Southeast Fort Lewis CVWF usage by Fridays - 24 January to 26 December 1986.

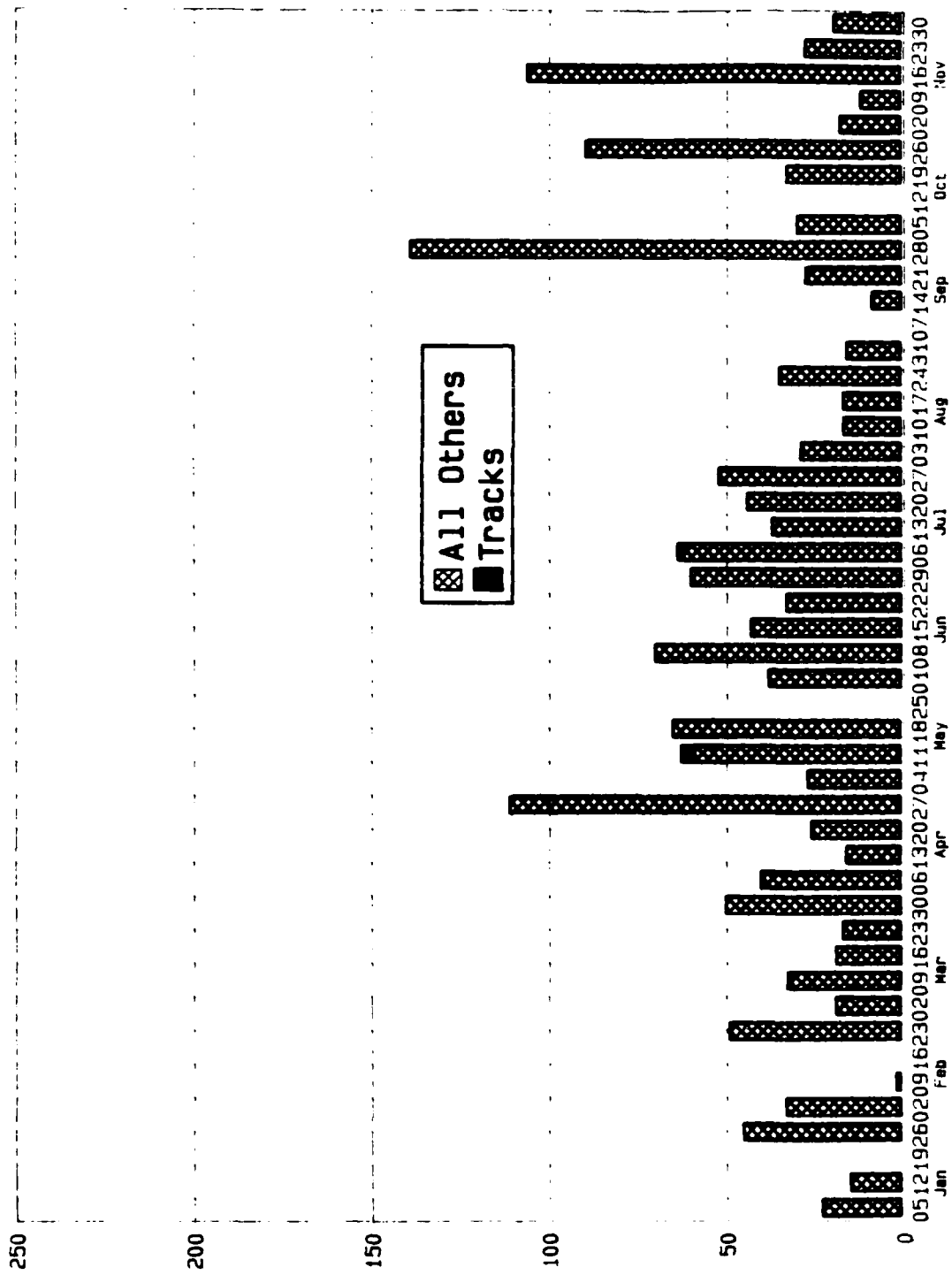


Figure C6. Southeast Fort Lewis CVWP usage by Mondays - 5 January to 30 November 1987.







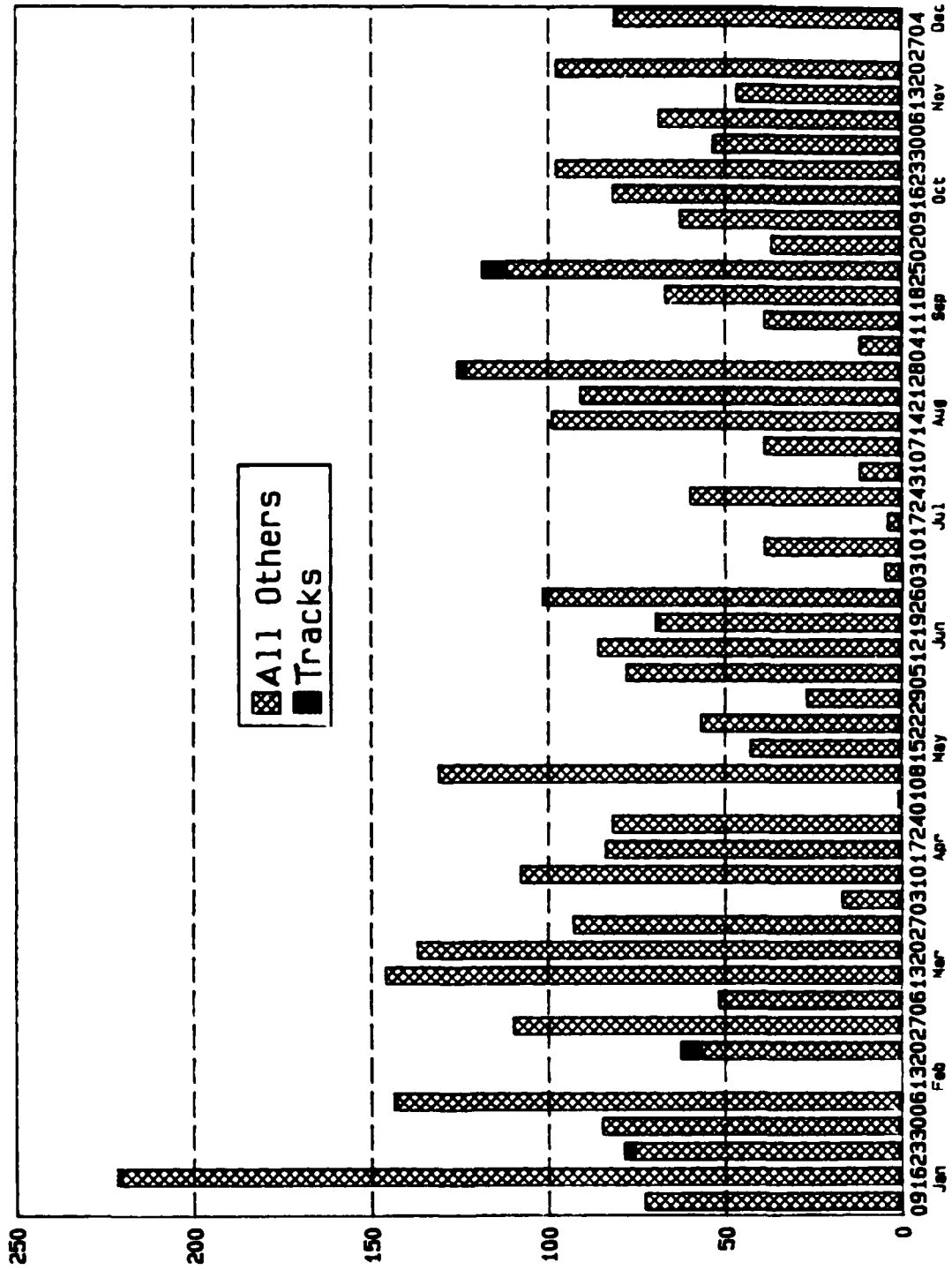


Figure C10. Southeast Fort Lewis CVWF usage by Fridays - 9 January to 4 December 1987.

**APPENDIX D:**  
**YAKIMA FIRING CENTER CVWF USAGE BY DAY OF THE WEEK**

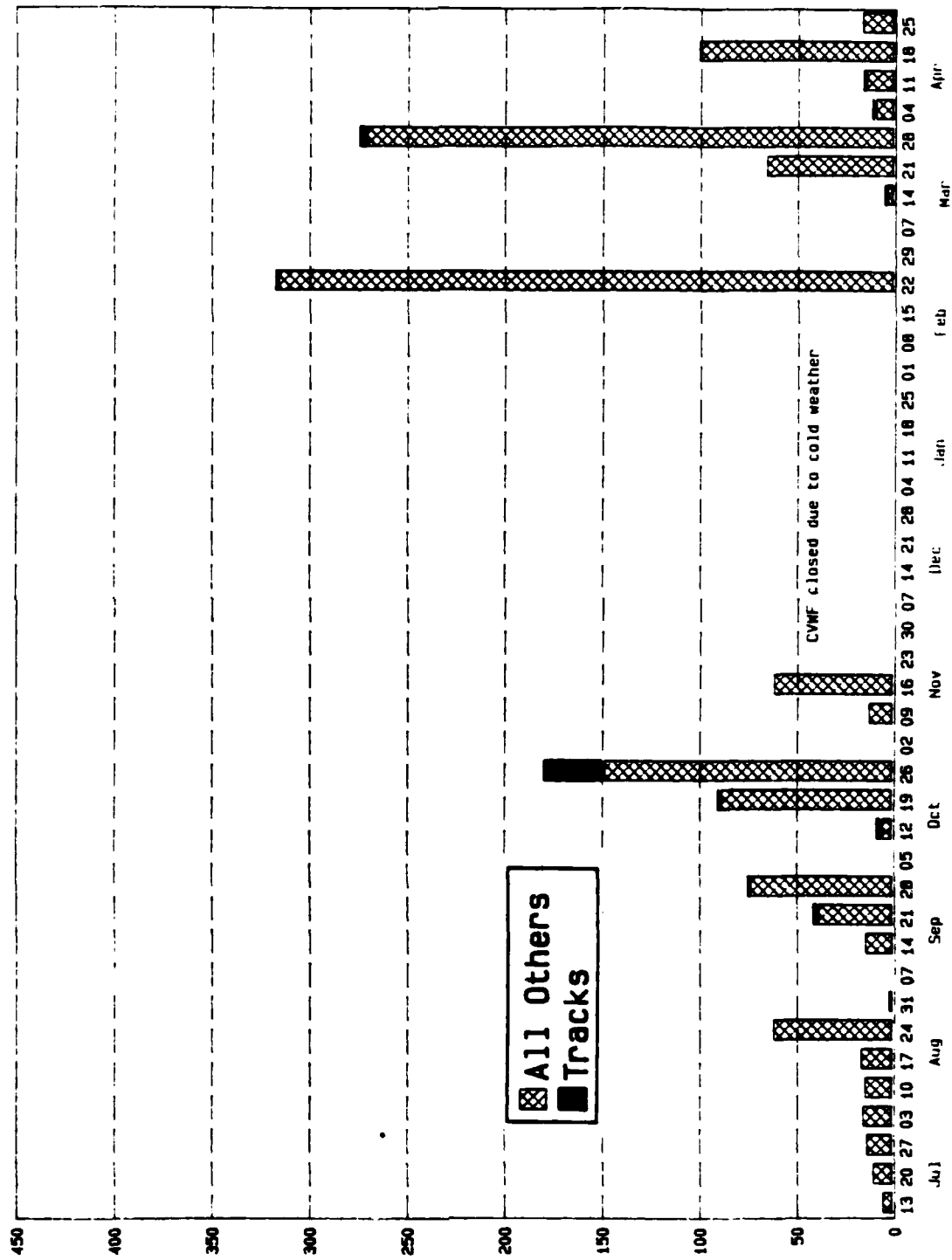


Figure D1. Yakima Firing Center CVWF usage by Mondays - 13 July 1987 to 25 April 1988.

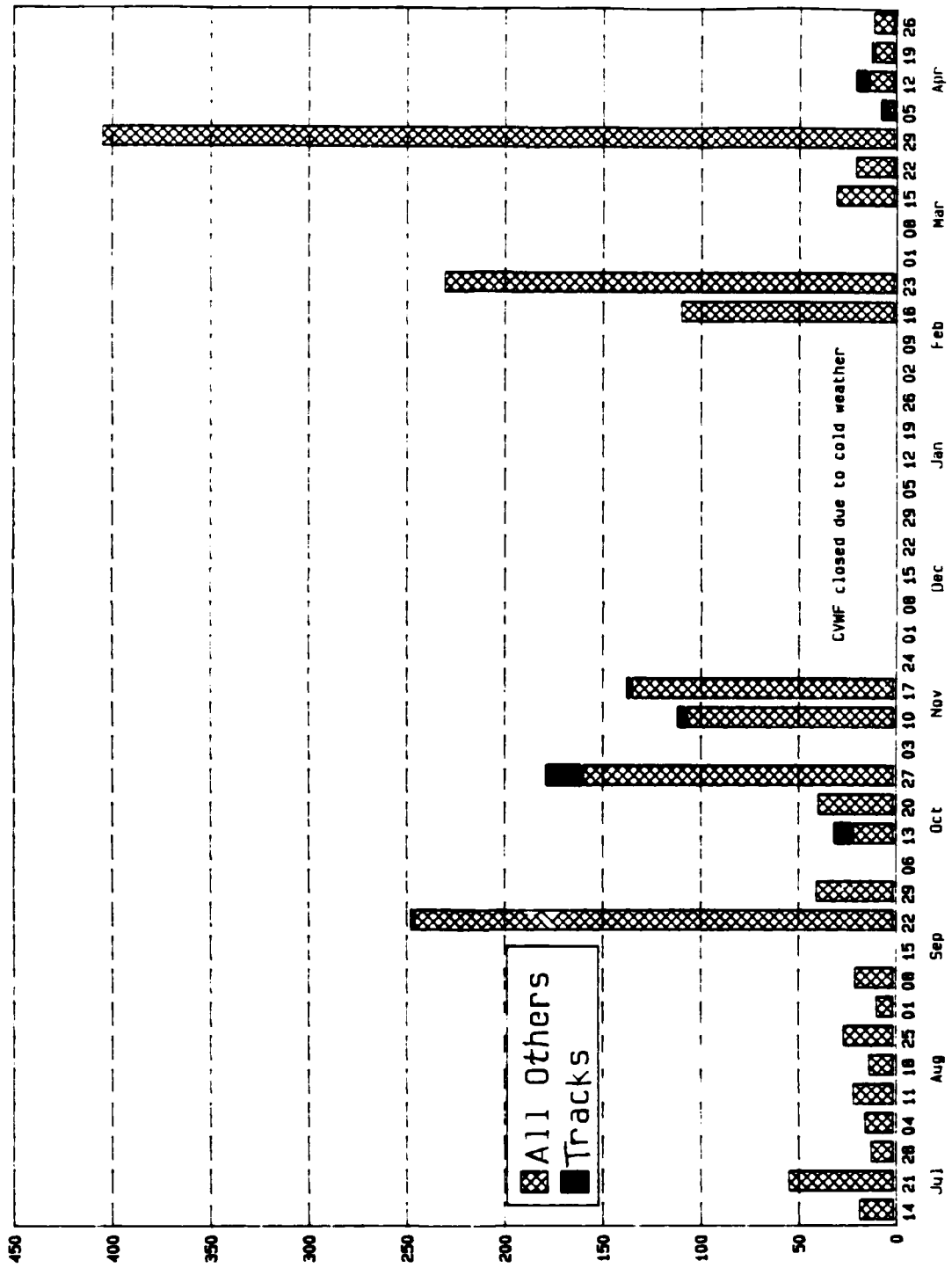


Figure D2. Yakima Firing Center CVWF usage by Tuesdays - 14 July 1987 to 26 April 1988.

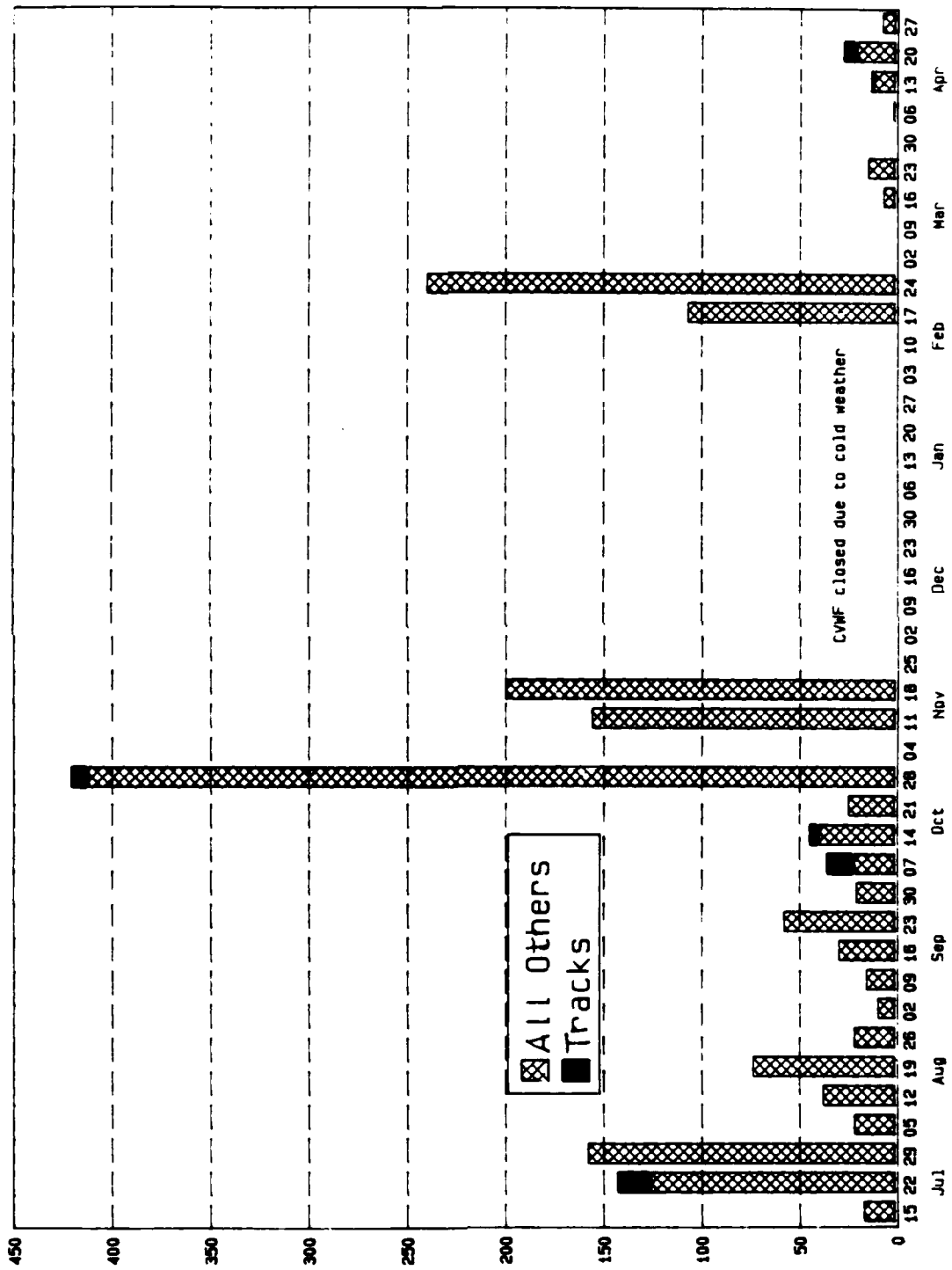


Figure D3. Yakima Firing Center CVWF usage by Wednesdays - 15 July 1987 to 27 April 1988.

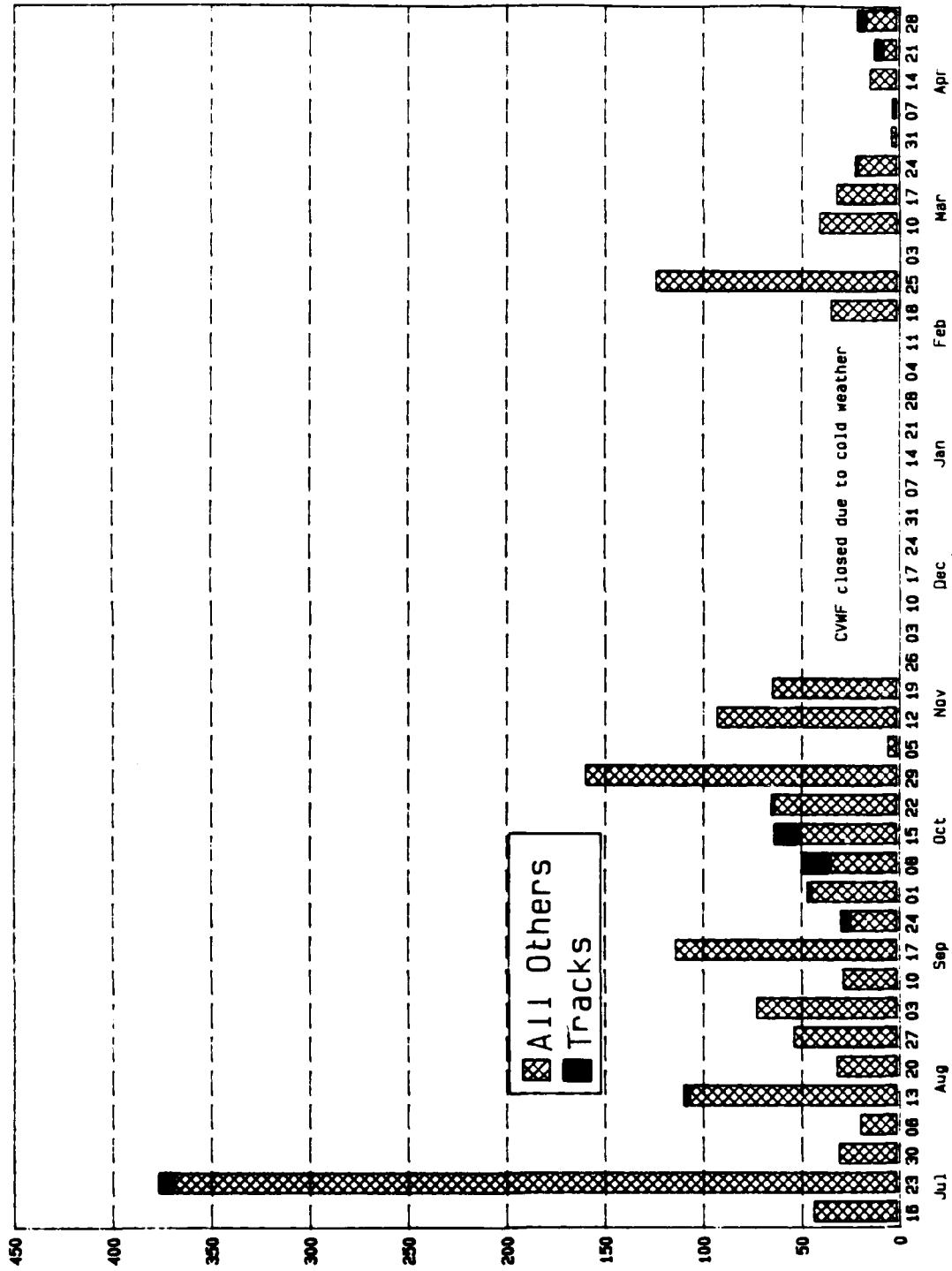


Figure D4. Yakima Firing Center CVWF usage by Thursdays - 16 July 1987 to 28 April 1988.

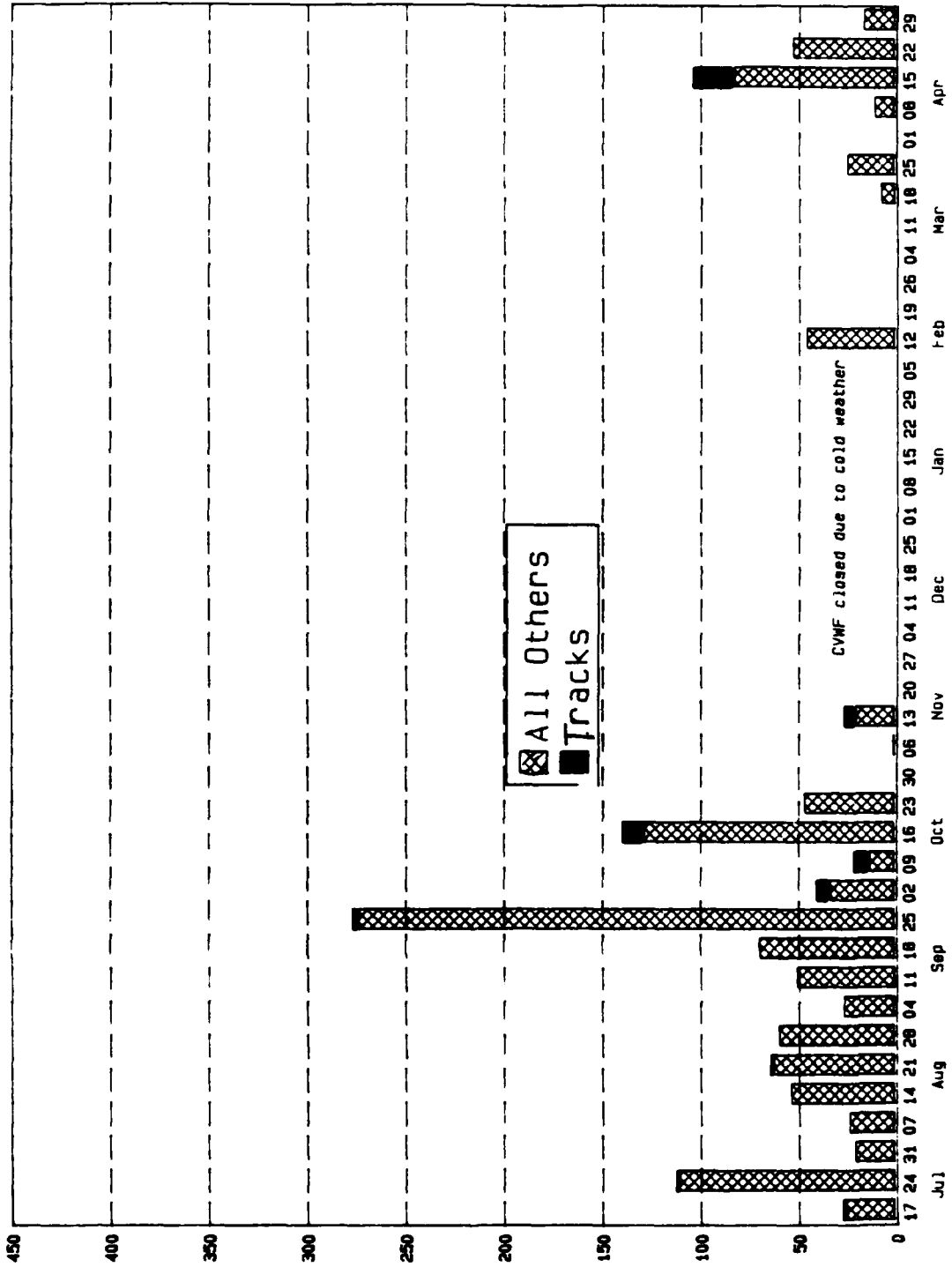


Figure D5. Yakima Firing Center CVWF usage by Fridays - 17 July 1987 to 29 April 1988.

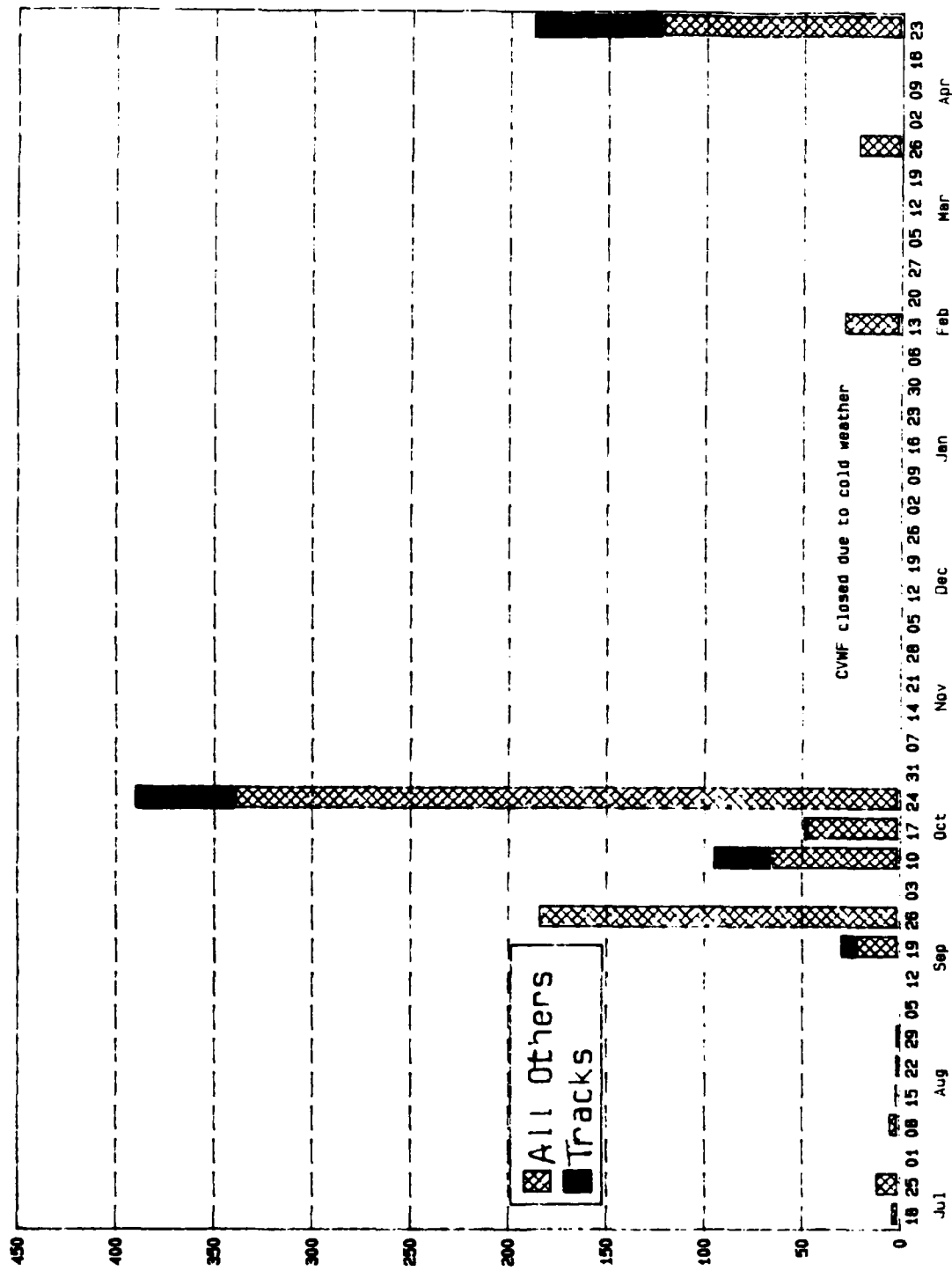
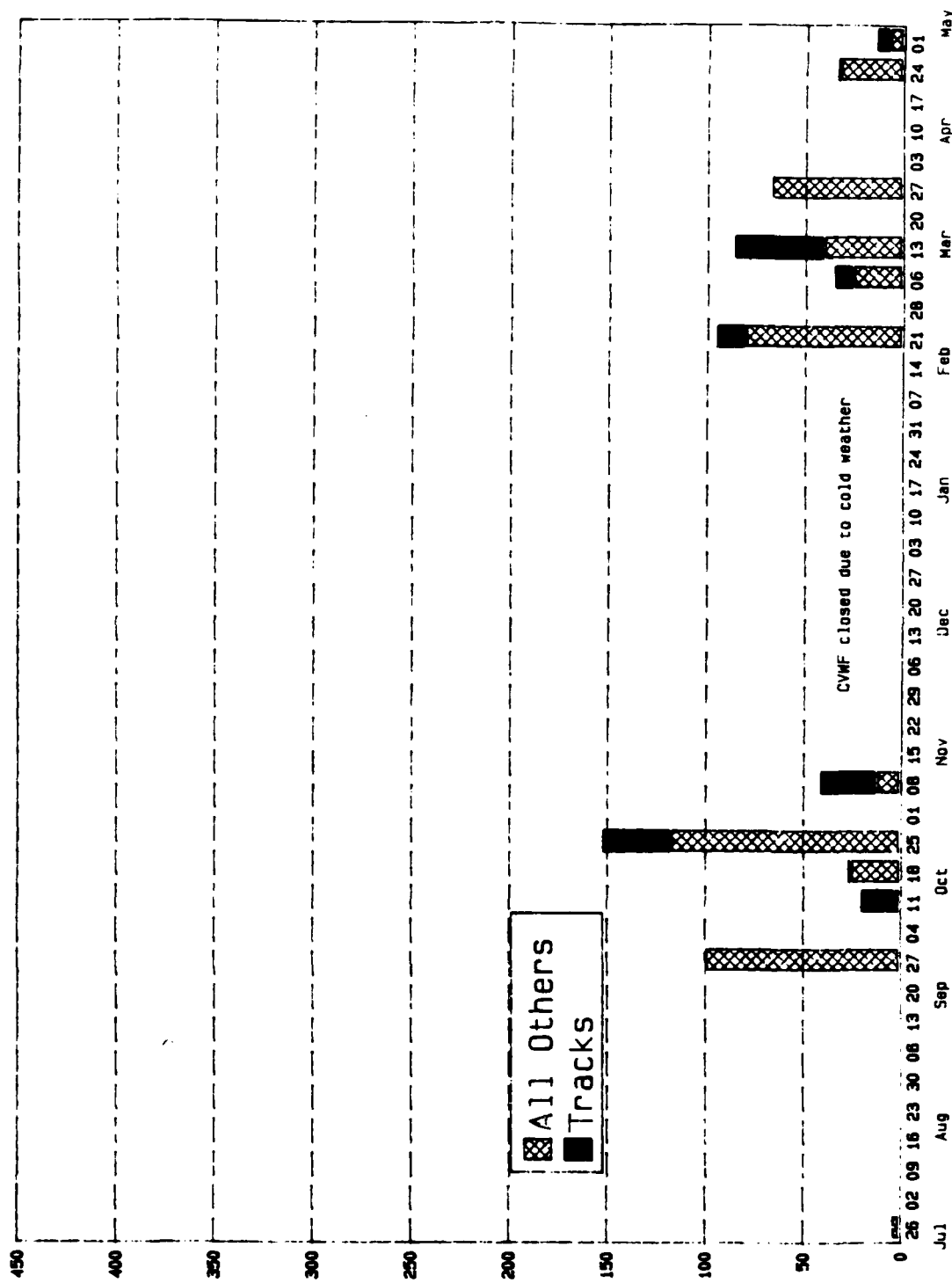


Figure D6. Yakima Firing Center CVWF usage by Saturdays - 18 July 1987 to 23 April 1988.



**APPENDIX E:**  
**SOUTH FORT POLK CVWF USAGE BY DAY OF THE WEEK**

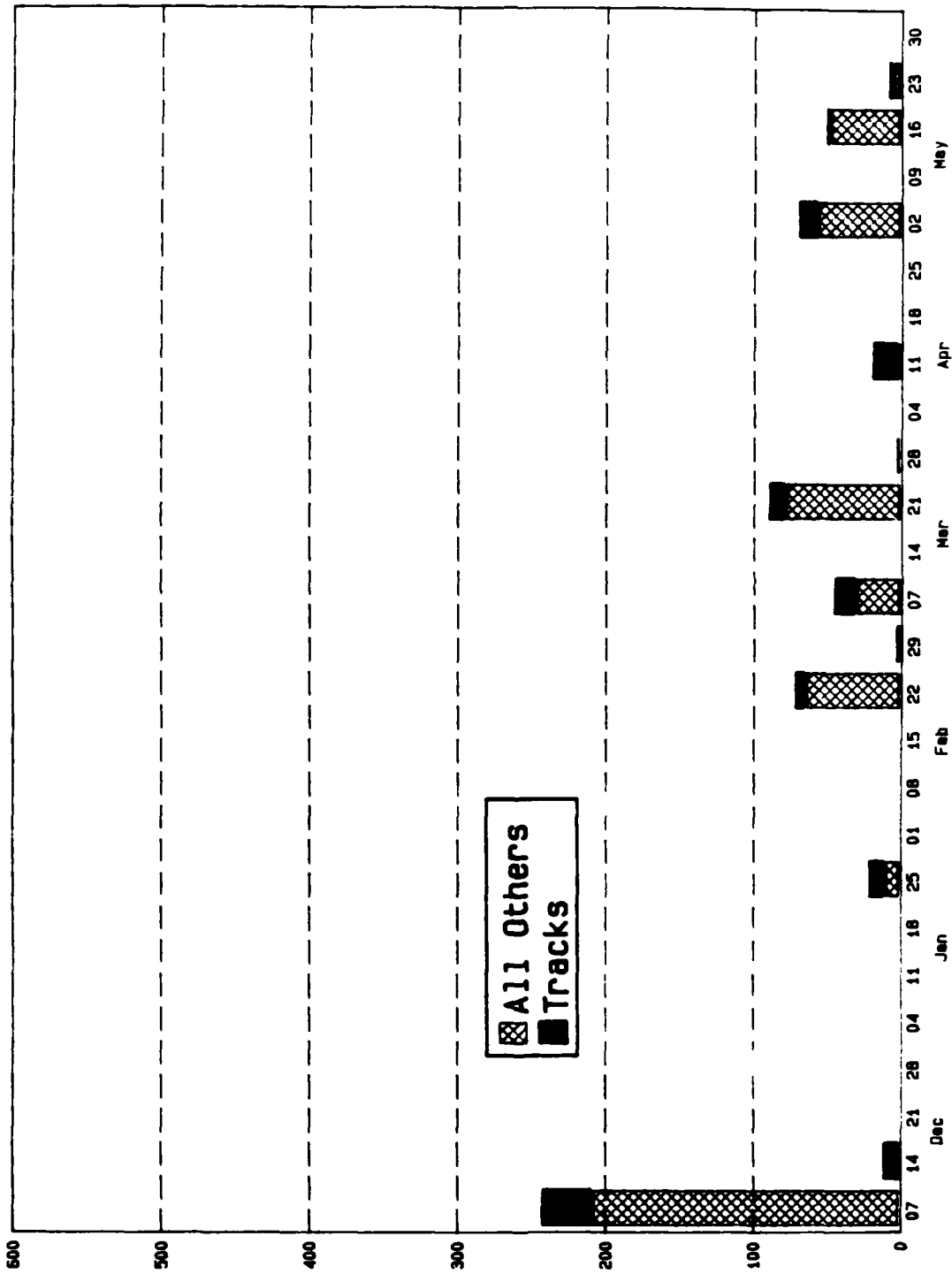


Figure E1. South Fort Polk CVWP usage by Mondays - 7 December 1987 to 30 May 1988.

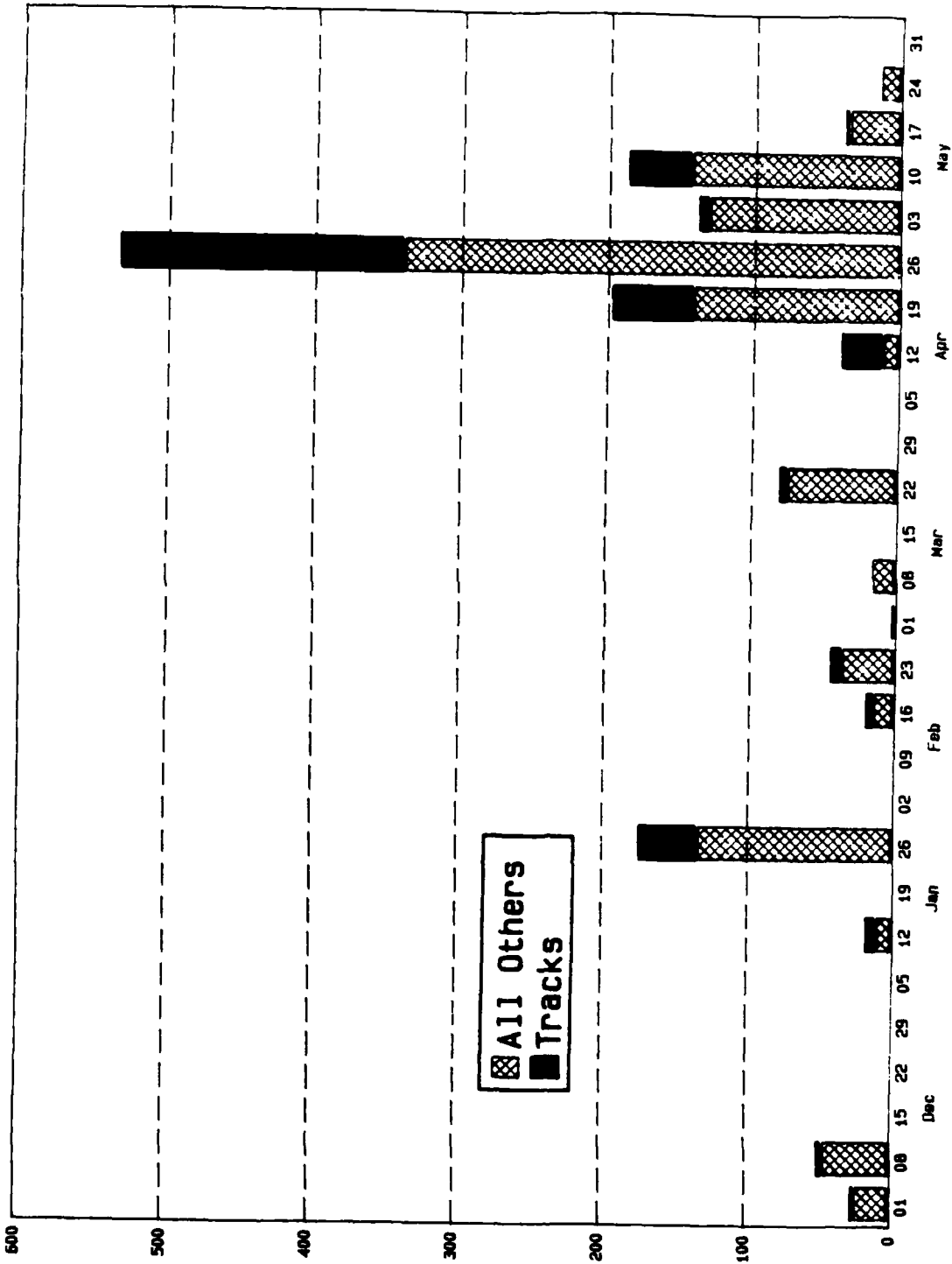


Figure E2. South Fort Polk CVWF usage by Tuesdays - 1 December 1987 to 31 May 1988.

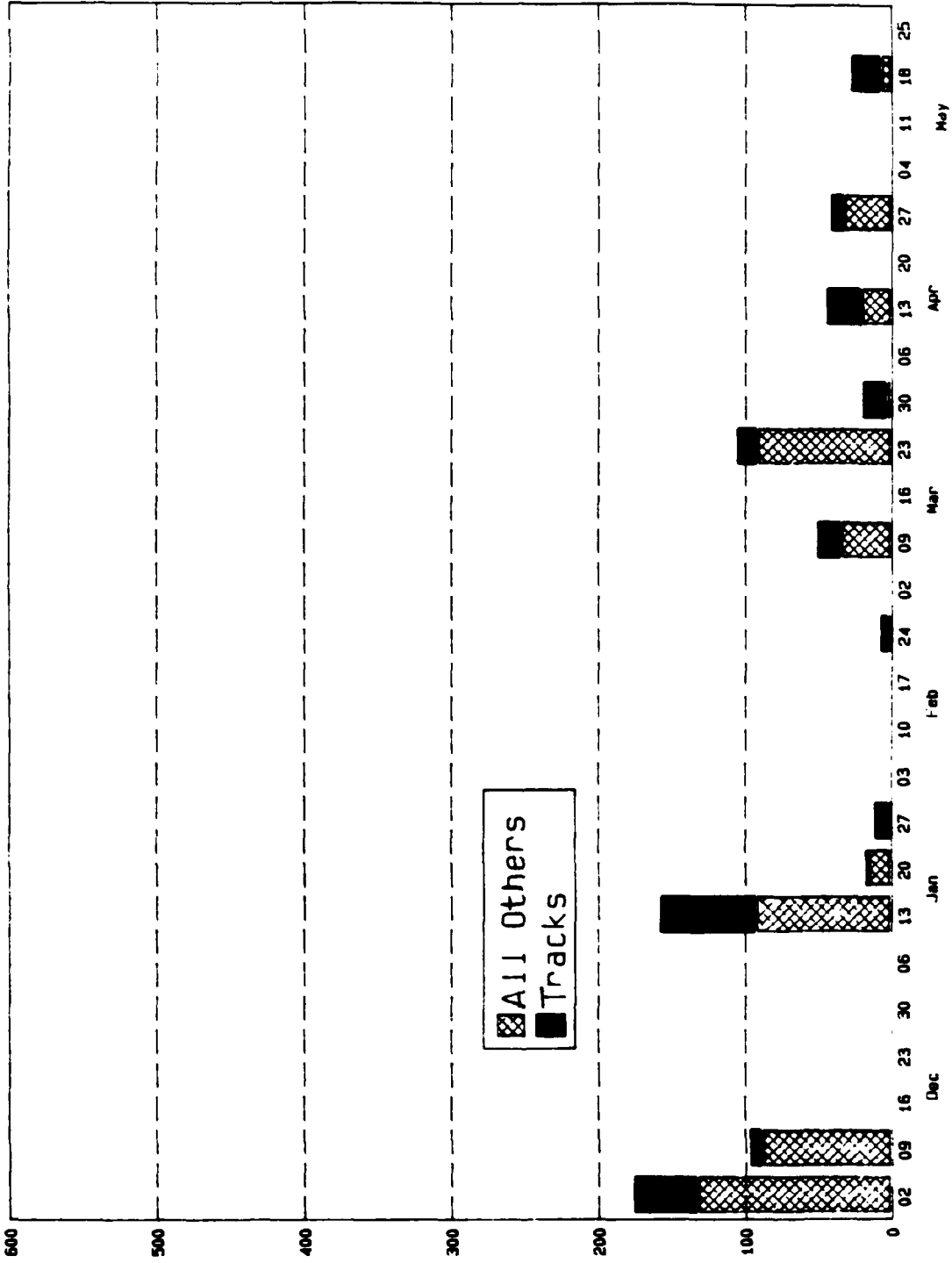


Figure E3. South Fort Polk CVWP usage by Wednesdays - 2 December 1987 to 25 May 1988.

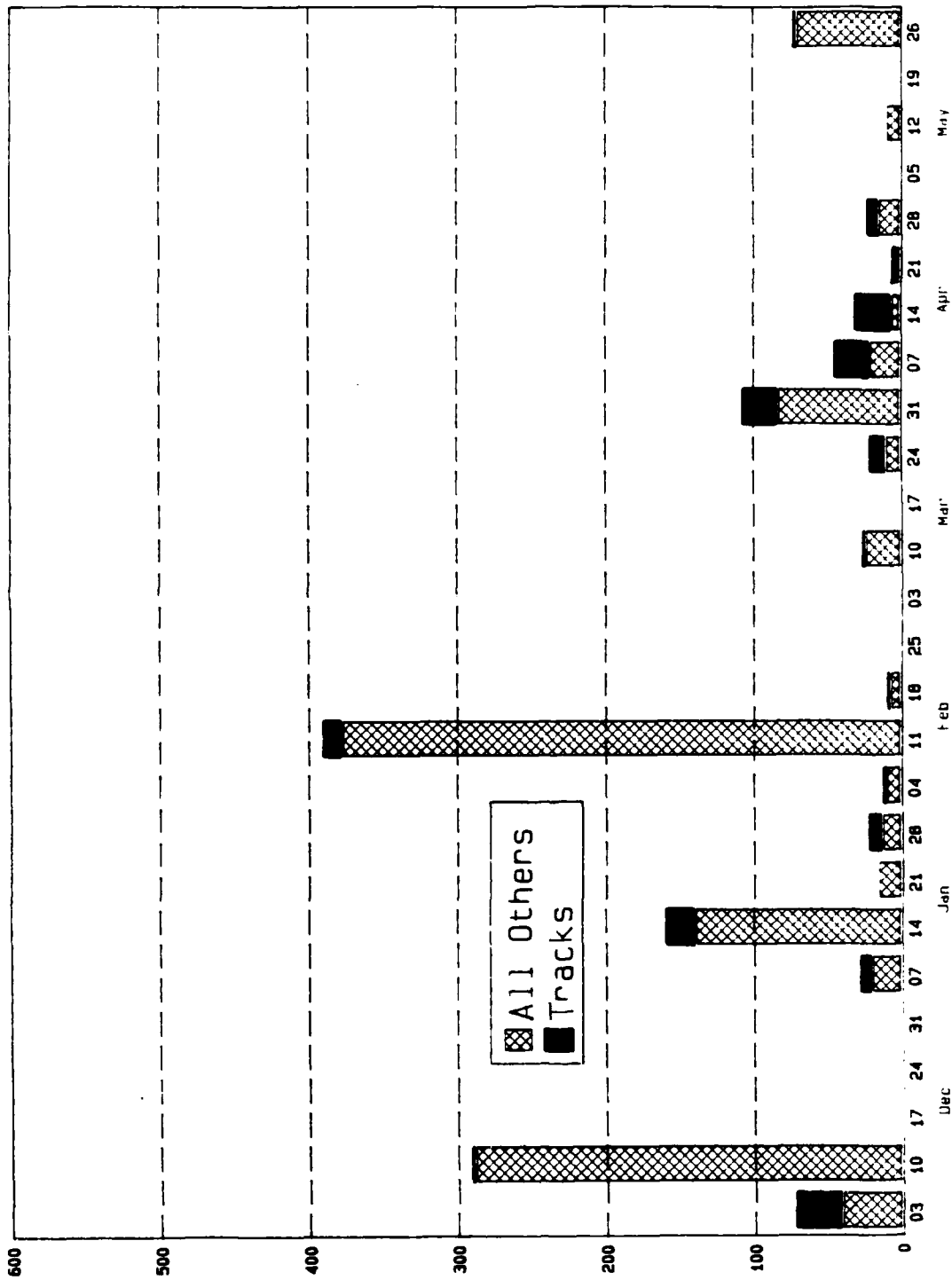


Figure E4. South Kort Polk CVWF usage by Thursdays - 3 December 1987 to 26 May 1988.

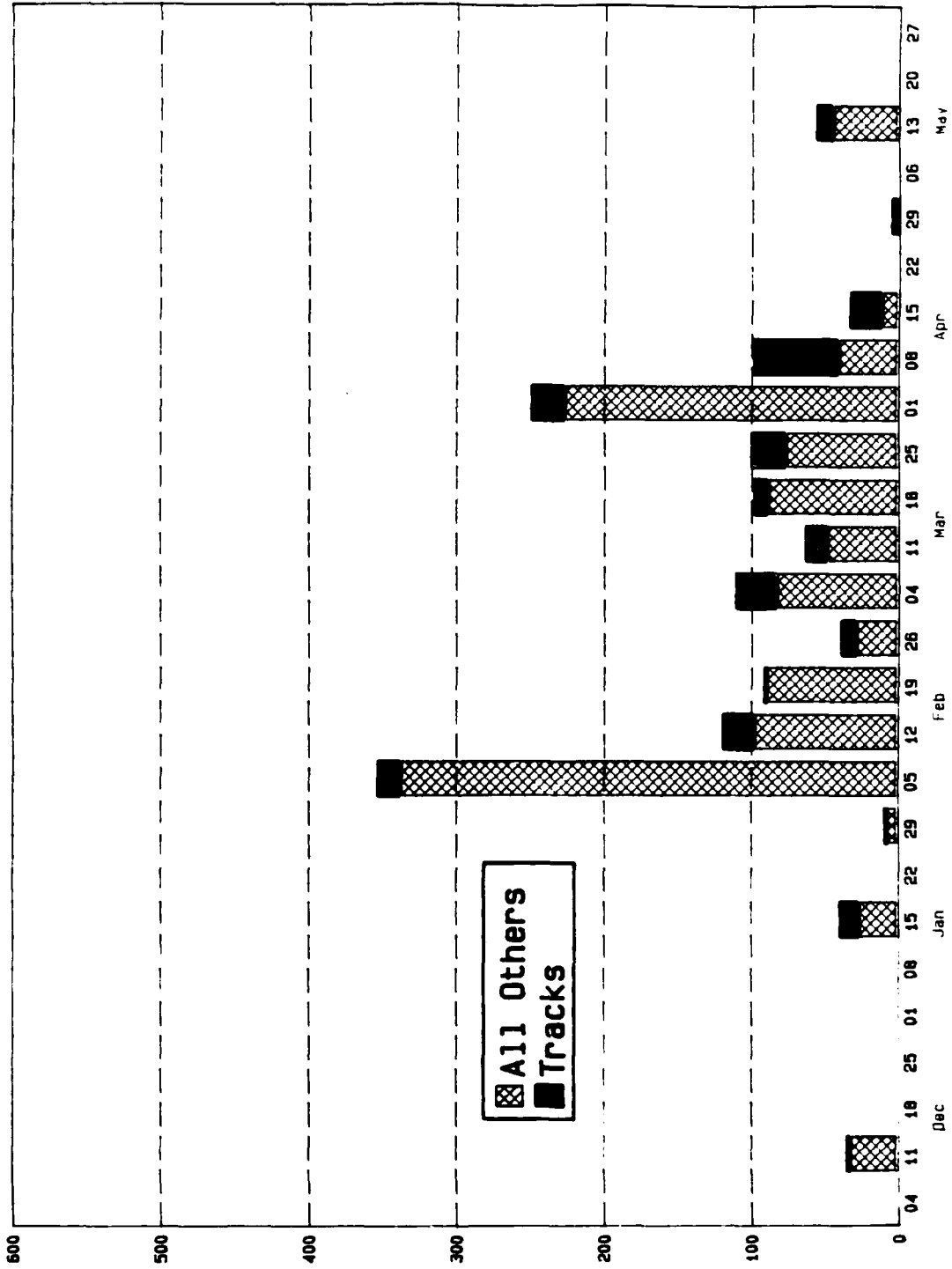


Figure E5. South Fort Polk CVWF usage by Fridays - 4 December 1987 to 27 May 1988.

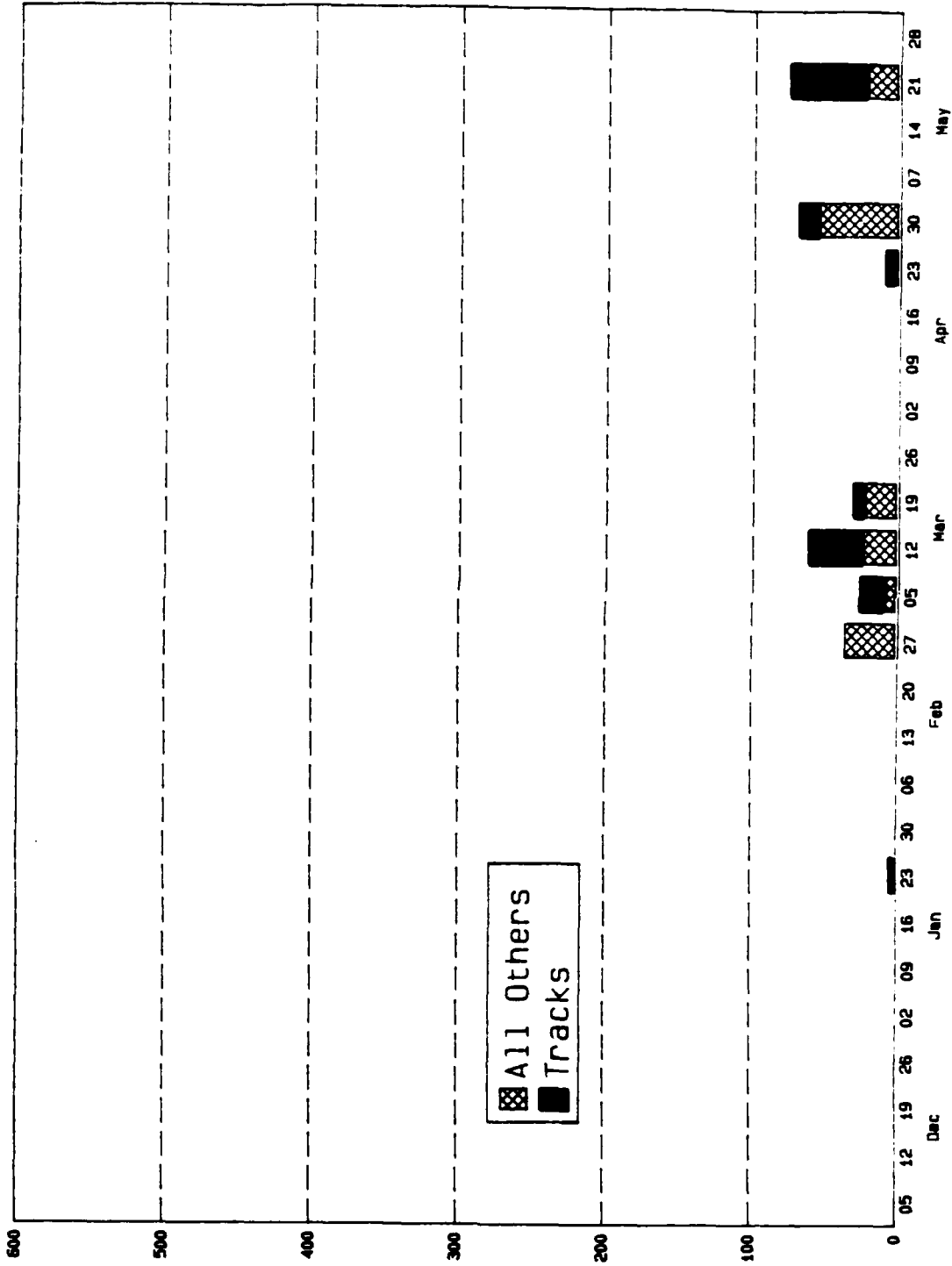


Figure E6. South Fort Polk CVWF usage by Saturdays - 5 December 1987 to 28 May 1988.

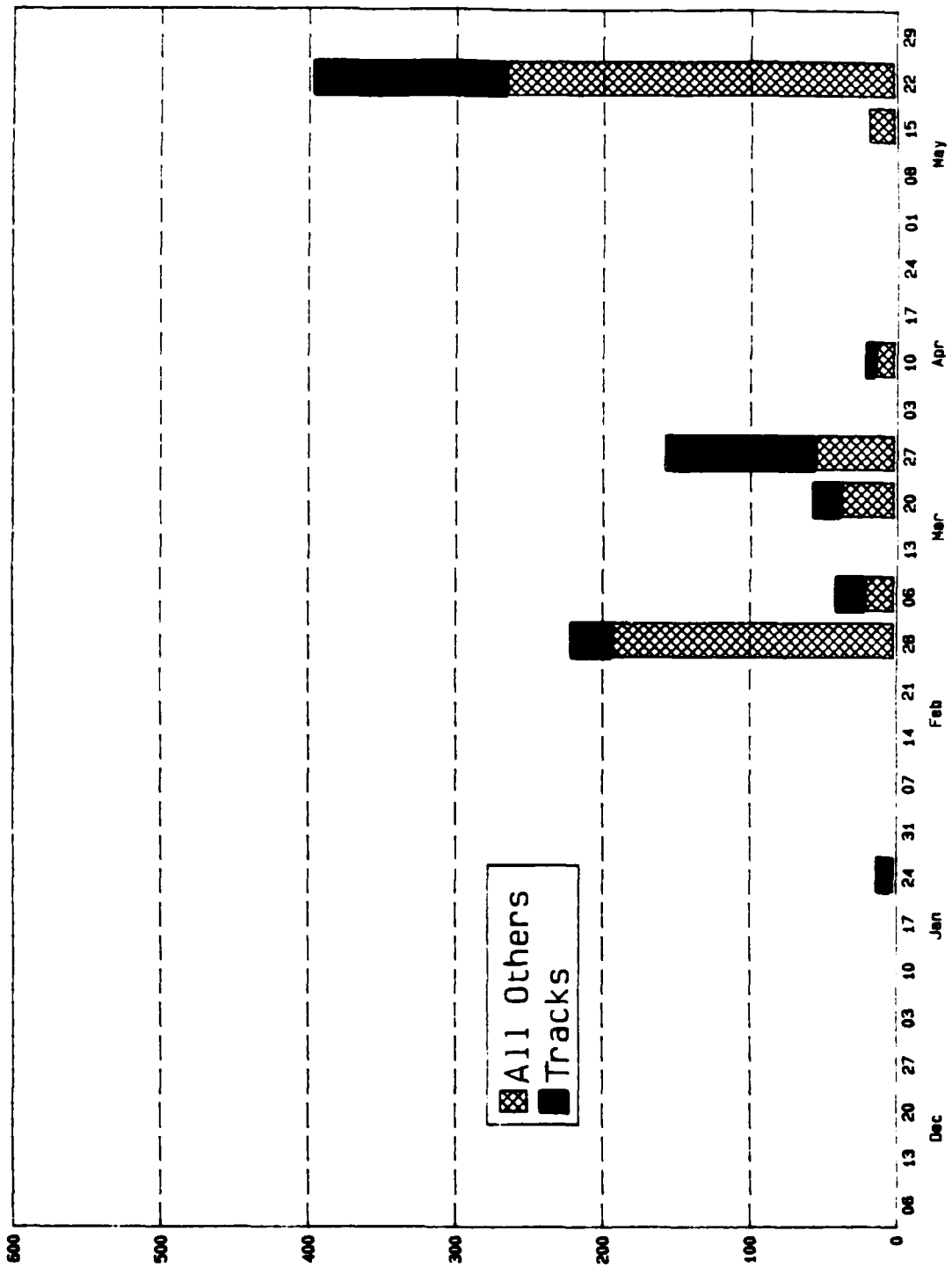


Figure E7. South Fort Polk CVWF usage by Sundays - 6 December 1987 to 29 May 1988.

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