BUTTES GAS & OIL

IRON HILL — POWDERHORN

ENVIRONMENTAL STUDY 1977

December 1978 Western State College of Colorado

Project Director and Editor: Hugo A. Ferchau

Volume I

IRON HILL — POWDERHORN ENVIRONMENTAL STUDY

PREPARED FOR BUTTES GAS & OIL

PREPARED BY: WESTERN STATE COLLEGE OF COLORADO, GUNNISON, COLORADO

Project Director and Editor: Hugo A. Ferchau

Volume I

VOLUME I

Chapter I . . . . . Introduction

Chapter II . . . . . Background and Scope

Chapter III . . . . . Geology and Mining History

Chapter IV . . . . . Current Land Use

Chapter V . . . . . Climate and Air Quality

Chapter VI . . . . . Microclimate and Other Weather Data

CHAPTER I

INTRODUCTION

Prepared by: Hugo A. Ferchau

INTRODUCTION

In December, 1976, a study design (Ferchau, 1976) was generated to provide an environmental inventory of the proposed Buttes Gas and Oil Powderhorn titanium development, enabling the sound presentation of facts to the various state and federal agencies with environmental concern. The document was assembled under the direction of Dr. Hugo A. Ferchau, with able assistance from Dr. William Marlatt (climatology) and Dr. Richard Richards (water quality and wildlife). Mr. Gerry Grandey of Holland and Hart and Mr. Karl Ranous, attorneys, were instrumental in structuring the study design so the legal requirements were properly addressed and communicated.

The study design was submitted for review by the Colorado Air Pollution Control Commission and the Colorado Mined Land Reclamation Board.

Throughout the study, several people made contributions which enabled the maximum gain of information. Mr. Glenn Sammons and Mr. Ed Howard of Powderhorn permitted use of their land for weather station siting. Mrs. Fred Youmans and Miss Bobbie Youmans of Powderhorn contributed to the groups survival by their attitude and service when we were operating under adverse circumstances. The inhabitants of the Cebolla Creek Valley provided a setting which enabled us the opportunity to carry out our work in a pleasant environment. Some of the scientific approach provided the local citizens with moments of entertainment. Mr. James Thompson and Mr. David Watson of Kaiser Engineering (Oakland, California) were always willing and able to provide insights which made the work

easier. Dr. William Berg of Colorado State University and Dr. Robert Pennak of University of Colorado gave valuable assistance in the areas of soils and aquatic biology, respectively. Ruth L. and Robert Willey of the University of Illinois at Chicago Circle gave invaluable assistance to the aquatic biology element of the project. Dr. William Weber of the University of Colorado verified all the plant specimens. Dr. Charles Handley (Smithsonian Institution) provided valuable input on mammal field technique, particularly bats. Harold Burdick and Allen Anderson of the Colorado Division of Wildlife contributed ideas regarding large game analysis. Robert and Larry Norman of Buttes Resources provided assistance which expedited the report preparation. The provision of a cabin by Buttes Gas and Oil enabled us to carry out our work with maximum efficiency.

In addition to providing the needed environmental information for industry, there was the additional objective in providing an educational experience for students who aspire to include the study of the environment in their educational experience. To facilitate the educational endeavor, many individuals contributed their time without compensation: Mr. Jerry Piquette, Vice President for Business Affairs (WSC) and his staff; Mr. Robert Arnold, WSC printing office and his staff; Professor L. Scott McRae, Chairman, Division of Natural Sciences and Mathematics (WSC): Mrs. Pamela French, Divisional Secretary; Colorado State University Mountain Meadow Research Station (directed by Dr. Eugene Siemers); some special thanks should be directed to Mrs. Ann Gery of the Mountain Meadow Research Station who bailed us out of many problems related to chemistry. Mr. Frank Edlin and the staff of the college computer center always provided willing assistance. The Colorado Division of

Wildlife (with special thanks to pilot Gordon Seville) permitted us to join them in the aerial censussing of wildlife in the Powderhorn Valley.

A cadre of graduate students provided the kind of diligence and loyalty to the project without which the project would have failed: James Coressel and Paul Edwards (climate and soils), Robert Haagensen (water quality and aquatic biology), Robert Jennings (vegetation) and Peter Michling (wildlife). Three of these people will make use of this opportunity to generate a graduate degree.

More than 50 undergraduate and graduate students had the opportunity to gain field experience, and in some cases received the necessary background to make the decision to do graduate work in the environmental sciences.

CHAPTER II

BACKGROUND AND SCOPE

Prepared by: Hugo A. Ferchau

BACKGROUND

Buttes is a Delaware corporation qualified to do business in the State of Colorado. Several years ago, Buttes acquired several mining properties in an area commonly referred to as Powderhorn, located in the southeastern part of Gunnison County. Continued exploration and development of this area has outlined a titanium ore body contained within a mass of igneous intrusive rocks. Buttes intends to conduct mining on this property, together with associated crushing and milling operations.

SCOPE

Attached as Exhibit A is a map showing the location of the property owned by Buttes in relation to surrounding towns, roads, and water drainages. Much of the property lies on patented mining claims which were located in the early 1930's. The area has been the subject of repeated mining activity since the 1880's.

Buttes' proposed project will consist of surface mining by the open pit method for titanium ores with on-site milling of raw ore. The resulting ore concentrate will be transported by truck to shipping points on the Denver and Rio Grande Western Railroad. Waste rock from the mining operation will be disposed of on property owned by Buttes. The milling process will consist of primary crushing, autogenous grinding, wet magnetic separation, gravity concentration and electrical separation. Mill waste or tailings will be disposed of on property owned by Buttes. Associated with the milling operation and other mine facilities will be a small steam heating plant. Much of the operational relationship to the existing landscape may be noted in Exhibit B.

It is estimated that the mine may occupy several hundred acres and that its life will be in the order of forty to fifty years. Likewise, the tailings disposal area may occupy several hundred acres with the mill site itself occupying approximately twenty acres.

CHAPTER III

GEOLOGY AND MINING HISTORY

Prepared by: James V. Thompson

Edited by: Hugo A. Ferchau

GEOLOGY OF THE IRON HILL AREA NEAR POWDERHORN, COLORADO

The Iron Hill area contains two major geological formations:

1. The carbonatite of Big Iron and Little Iron Hill which is transected by Deldorado Creek is a dolomitic intrusive formation containing many mineral species other than dolomite. Its unique interest stems from the mineral pyrochlore which is a source of the metal columbium (niobium). Topically Big Iron Hill is the most prominant feature in the area and is plainly visible from the Cebolla Creek Road which parallels Little and Big Iron Hill on the west. The summit of Big Iron Hill is at 9,245 feet.
2. Surrounding the carbonatite is the alkalic stock. This is an intrusive of coarse and fine-grained pyroxenite rocks which surround the carbonatite of Iron Hill on three sides from the northwest around to the southwest. The alkalic stock has been intruded into the surrounding granites and other metamorphic complexes. Because the alkalic stock is relatively soft it has eroded to a lower relief than the surrounding granites or the carbonatite of Big Iron Hill. The alkalic stock is believed to be about 580 million years old. There have been many secondary intrusions, particularly along the northeast contact with the granite. Also, there is evidence that there has been faulting since the initial intrusive activity.

The northwest portion of the alkalic stock in the vicinity of Huntsman's Gulch is covered with a lava cap which is much younger than any other rocks in the vicinity. Drilling through this lava cap has revealed the presence of the alkalic stock and transected the surface upon which the lava was deposited.

The principal mineral of interest commercially in the alkalic stock is perovskite, a calcium titanate mineral. This mineral also contains rare earths and other obscure elements. In addition to perovskite, titaniferous magnetite is abundant, particularly along the contact zone on the northeast. The perovskite-magnetite zone extends four miles north-west and slightly southeast along the contact, passing under the lava cap and emerging in Stone Gulch to the northwest beyond the margin of the lava cap.

Another mineral in great abundance which might have some commercial significance is biotite. This black mica occurs in huge "books" frequently as much as six inches in diameter and it has been a source of past economic interest.

There are many petrographic species in the alkalic stock but the most common is pyroxenite whose principal mineral constituent is augite. In the coarse-grained pyroxenite area along the northeast contact magnetite is the most common, occurring at times in wide segregations of nearly pure perovskite and at other times in wide segregations of mixed magnetite-perovskite. The fine-grained pyroxenite area to the south of the northeast contact is not particularly rich in perovskite or magnetite though neither mineral is totally absent.

The extreme age of the intrusive poses the question as to exactly where in the original column the present surface belongs. Obviously thousands of feet of the alkalic stock have eroded. However, the carbonatite could have been deeply buried and not as much of it has succumbed to erosion forces.

There is a United States Geological Survey map of the Powderhorn Quadrangle (D.C. Hedlund and J.C. Olson, 1975). Part of the south half of the alkalic stock and Big Iron Hill is not shown because it lies in the adjacent Rudolf Hill Quadrangle. This map is an excellent reference. However, Hedlund and Olson (1975) did not have access to all of the drill data in possession of the present owners. Surficially their map is accurate and informative.

THE MINING HISTORY OF POWDERHORN

In the late 1800's prospectors en route to Lake City and the San Juans were attracted to the carbonitate of Big Iron Hill. The reddish-brown color of pyrite and apparent veining encouraged examination.

The "White Earth Mining District" and a "U. S. Mineral Monument" was established as a bearing point for rough claim surveys. Mining districts and mineral monuments were often established before public land survey or before the establishment of political units and have lost some of the legal significance. "White Earth" refers to the white deposits around Cebolla Hot Springs across the valley from Big Iron Hill.

In the process of examining the carbonitate of Big Iron Hill some prospectors noted the weird and beautiful basic intrusive rocks

which surround it. Closer attention was provided to the massive magnetite outcrops in the same area.

During the early 1930's considerable attention was given to the black biotite mica which was assumed to have the capability of being a source of vermiculite. The extensive ore body between Big Iron Hill and Huntsman Mesa was brought to patent and a small plant was built to recover the mica. Because of poor mica exfoliation characteristics, the plant was closed. Its ruins are still evident.

During the late 1930's and after World War II, interest developed in the magnetite-perovskite (calcium titanate) in much the same region which previously provided interest in mica. The ore extends northerly to near Youman's Store, but much of this alkalic stock is under a lava cap.

In the early 1950's Humphreys Gold Mining Company of Denver obtained the leases to the land between Big Iron Hill and Huntsman Mesa and it did considerable research in perovskite recovery and developed a basic concept of recovery. DuPont became interested in the property and was associated with it for ten years. However, they became interested in Big Iron Hill and ignored the perovskite. The shift of interest was precipitated by the observation of pyrochlore (a source of columbium). The pyrochlore proved to be of high quality.

In 1967 Buttes Gas and Oil became aware of the property and has since acquired the entire holding. They were initially interested in the carbonatite (pyrochlore) but because recovery was difficult, world prices were not attractive, and exploration encountered setbacks due to drilling difficulties, they decided to examine the perovskite.

Despite earlier attention devoted to the perovskite, a thorough exploration had not been accomplished. Ultimately, a 1000 feet by three mile zone of rich ore was identified. The deepest hole drilled was 600 feet and the ore was still evident.

PEROVSKITE

Originally (Larson, 1942) perovskite was considered to be found as crystals a few millimeters in size, and often encapsulated by magnetite. This results in considerable difficulty in the extraction process. Most of the conclusions had been drawn from observations of bulldozer cuts or where ore was exposed at the ground surface. The exploration process showed massive (several meters) segregations of the ore. The reason surficial deposition was not readily evident was because perovskite is easily oxidized to leucoxene which is soft and easily erodable.

Perovskite can be recovered from nearly all of the ore by grinding to 35 mesh using wet magnetite separation to remove magnetite, separating by gravity to recover perovskite from augite, and cleaning with dry high tension electrical separation.

REFERENCES

Hedlund, D.C. and J.C. Olson. 1975. Geologic Map of the Powderhorn Quadrangle, U.S.G.S.

Larsen, E.S. 1942. Alkalic Rocks of Iron Hill, Gunnison County, Colorado: U.S. Geological Survey Prof. Paper 197-A. 64 p.

Temple, A.K., and Grogan, R.M. 1965. Carbonatite and related alkalic rocks at Powderhorn, Colorado: Econ. Geol. 60: 672-692.

CHAPTER IV

CURRENT LAND USE

Prepared by: Hugo A. Ferchau

CURRENT LAND USE

Agriculture is one of the most significant elements of the Gunnison County economy. The Cebolla Creek drainage, of which the Powderhorn mineral development is a part, is relatively narrow, and represents a series of eleven family ranches, averaging 1500 acres, extending from Colorado 149 to approximately 20 miles upstream where the road enters the Gunnison National Forest. Most of the ranches have been maintained without disruption in individual families. Although the operations cannot be considered prosperous, the families have enjoyed their particular situation, as evidenced by the family ownership continuity.

The second most influential consideration is tourism. The Youmans Cabins, General Store, and Cebolla Hot Springs provides a focal point for tourism in the valley. Most of the resort clients are individuals who return, and have been visiting the resort for many years. They utilize the hot springs, enjoy the scenics, and fish Cebolla Creek. There are two additional resorts in the valley. The proximity of the relatively newly developed Blue Mesa Reservoir has been considered an advantage. Many people travel along the Cebolla Creek Road to enjoy the scenery and gain access to the Powderhorn Primitive Area, to U.S. Forest Service Campgrounds (Cebolla, Spruce, Deer Lakes, Slumgullion); and to take the scenic ride over Slumgullion Pass to Creede or Lake City. The road along Cebolla Creek is currently unpaved.

The Cebolla Creek drainage is also well hunted. The earlier referred to resorts usually cater to full occupancy during the hunting season. Many other hunters establish hunting camps along the various drainages.

Other economic interests are becoming evident. A new sawmill has been approved by Gunnison County and will utilize a recent federal timber sale. There is an existing sawmill. Various mining sites have been examined for future mining, and there are probably as many rumors regarding development as there are prospectors who anticipate "striking it rich".

Thus far, the utilization of land for housing development is limited. Occasional parcels of land have been sold by the local ranchers to individuals who have constructed a cabin or utilize the land as a place to escape. There is some possibility, considering the parcels of land which are for sale, that development will occur in the near future.

The approximately five square miles which is associated with the Buttes project area is primarily an elevated bowl which lies behind Iron Hill. The land has been actively hunted and extensively grazed. When David Howard sold the land to the DuPont interests, he also gave up much of the grazing interests. DuPont and subsequently Buttes Resources have deeded the grazing rights to the Fred Youman family for one dollar per year. There is a stipulation the lessee may not fence the property. There is no management program established for the area and the cattle, in any numbers, may utilize the range for whatever time period the lessees see fit. Normal practice is for the cattle to go on the site at mid-May, stay on the site until July 1, at which time they move on to BLM land.

They move back down on to the site about September 1 and remain until near mid-October. The number of cattle which appear to use the property is approximately two hundred.

Buttes presently owns patented lode claims, patented placer claims and patented homestead entries comprising a fairly discrete block of land east of the Cebolla Creek Valley. In addition, it has located or acquired location for unpatented lode and placer claims, thereby filling in gaps in its fee land and extending the project area. Approximately 580 acres of the project area, including both patented and unpatented lands, are overlain by a stock raising homestead patent owned by David Howard, a Cebolla Valley rancher, which reserves surface rights to that individual. Surrounding the Project area is a mix of federally owned land, some of which is subject to unpatented mining claims of others, and privately owned land, including patented ranch land in the valley floor and a tract owned by New Jersey Zinc Co. The foregoing land ownership is shown in detail in Exhibit C to this report.

FINAL REPORT

CLIMATE AND AIR QUALITY BASELINE ANALYSIS AND IMPACT EVALUATION FOR THE BUTTES TITANIUM MINING PROPERTY GUNNISON COUNTY, COLORADO

Prepared by

W. Marlatt

J. Saraiva

J. Childs

K. Roselius

T. Priddy

May 1978

MARLATT & ASSOCIATES
3611 Richmond Drive
Fort Collins, Colorado

TABLE OF CONTENTS

	Page
LIST OF FIGURES	iv
LIST OF TABLES	v
INTRODUCTION	1
PART I: CLIMATIC ANALYSIS	2
CLIMATE SETTING	2
BASELINE CLIMATOLOGY	7
METEOROLOGY -- TOPOGRAPHY INTERACTIONS	15
CLIMATOLOGY OF AIRFLOW PATTERNS	15
PART II: ANALYSIS OF AIR QUALITY	27
LEGAL UPDATE	27
Applicable Federal Air Quality Regulations	27
New Source Performance Standards	27
Ambient Air Quality Standards	28
Prevention of Significant Deterioration (PSD)	28
Applicable Colorado Air Quality Standards	30
Emission Standards	30
Ambient Air Quality Standards	31
Mine Environmental Air Standards	31
BACKGROUND AIR QUALITY	31
EMISSIONS INVENTORY	33
MODEL DESCRIPTION	37
MODELING RESULTS	50
UNAVOIDABLE ADVERSE IMPACTS	51
MITIGATION MEASURES	52

TABLE OF CONTENTS
(Continued)

	Page
REFERENCES	53
APPENDIX A: WIND SPEED/DIRECTION FREQUENCY ANALYSIS	
APPENDIX B: WIND DIRECTION/DURATION OF WIND	
APPENDIX C: WIND SPEED .VS. DURATION OF WIND	
APPENDIX D: TIME OF ONSET .VS. DURATION OF PERSISTENT WINDS	
APPENDIX E: STATISTICS OF TEMPERATURE	

LIST OF FIGURES

Figure		Page
1.	Location of Powderhorn Project and Sites of Weather Stations Used in This Report	3
2.	Annual March of Precipitation (and Extremes of Monthly Totals) for Powderhorn, Colorado	5
3.	Computer Generated Windfield Map of Powderhorn Project Area; 1.5 m/s Southeast Background Flow	16
4.	Computer Generated Windfield Map of Powderhorn Project Area; 1.5 m/s Northwest Background Flow	17
5.	Diurnal March of Wind Speed	21
6.	Computer Generated Air Pollution Potential Map of Powderhorn Project Area; Southeast Background Flow . .	25
7.	Computer Generated Air Pollution Potential Map of Powderhorn Project Area; Northwest Background Flow . .	26
8.	Ventilated Valley Diffusion Model	39
9.	Configuration of "Boxes" Used in Air Quality Simulation	43
10.	Access to Mining Operation, Powderhorn Project Area .	48

LIST OF TABLES

Table		Page
1.	Summary of Data Processed From the Three MRI Weather Stations	9
2.	Temperature Summary for Powderhorn Ending 2/1970	10
3.	Temperature Summary for Gunnison Ending 12/1970	11
4.	Summary of Monthly Climatic Data for Gunnison. Last data 12/1972	12
5.	Air Temperature Comparison Between the Long-Term Climatological Station at Gunnison to Those Measured at the Powderhorn Project Site	14
6.	Diurnal Wind Direction Patterns, Powderhorn Project Area	18
7.	Diurnal Wind Speeds, Powderhorn Project Area	19
8.	Analysis of Prevailing Wind Directions	20
9.	Analysis of Persistent Winds > 0 but $\leq$ 7 mph	23
10.	Analysis of Persistent Winds > 10 mph	24
11.	Ambient Air Quality Standards	32
12.	Total Suspended Particulates	34
13.	Employee Traffic Volume Through the Cebolla Valley Area	36
14.	Volumes of "Boxes" Comprising the Cebolla Creek Airshed	42
15.	Exchange Areas Between "Boxes"	44
16.	Road Mileages in Each "Box"	45
17.	Particulate Emission Factors for Vehicular Traffic	46
18.	Particulate Emission Factors for Fugitive Dust Emissions from Unpaved Roads	46
19.	Ambient Particulate Concentrations Estimated for Each "Box" Under "Worst Case" Meteorological Conditions	50

CLIMATE AND AIR QUALITY BASELINE ANALYSIS AND IMPACT EVALUATION FOR THE BUTTES TITANIUM MINING PROPERTY GUNNISON COUNTY, COLORADO

INTRODUCTION

An analysis of the climatic environment, present air quality, potential impacts and possible mitigation measures has been conducted for the Buttes Gas and Oil Company's Powderhorn Project, Gunnison County, Colorado.

The specific objectives of the study plan were:

A. To collect and interpret all presently available weather and air quality data for the study area.

B. To establish and operate for a period of one year, three battery powered weather stations at selected locations (on the ridge at ore pit #2, in the valley near the proposed tailings dam and in the Cebolla Creek Valley near Sammons Ranch), and a Hi-Vol particulate sampler at the Sammons Ranch.

C. To evaluate the data collected in (B) in terms of frequency of wind direction/velocity combinations, time of onset of drainage and upslope winds, etc. and to reduce and compare the measurements of total suspended particulates (TSP) with data collected by the State Department of Health at selected locations in western Colorado.

D. To prepare maps of wind flow patterns (upslope and drainage for the airshed using the WINDS model, and from these, prepare maps of the relative pollution potential over the region.

E. To model the atmospheric carrying capacity of the Beaver Creek--Deldorado Creek--Cebolla Creek airshed.

This report summarizes the results of a one year monitoring program and the modeling of anticipated ambient air quality changes resulting from the proposed activity under limiting dispersion conditions.

Due to computer programming problems resulting in part from a conversion from a CDC 6400 to a CYBER computer, the baseline climatology section of this report is incomplete (although the requirements of the study plan are fulfilled). The climatology section of this report may be revised if necessary as soon as all data are analyzed.

PART I

CLIMATIC ANALYSIS

CLIMATE SETTING

The Powderhorn Project is located in a small sub-basin of the Cebolla Creek airshed about 25 miles southwest of Gunnison, Colorado. The study area comprises a generally circular valley with a dominant ridge (elevation, 8,800 msl) running east-west through the middle, drained on the south by Beaver Creek and on the north by Deldorado Creek. Both creeks are small and the total drainage area is not more than perhaps eight to ten miles squared. The Cebolla Valley which drains to the northwest is generally flat bottomed hay/pasture land with an average elevation at the junction of Beaver and Deldorado Creeks of 8,200 feet. The entire airshed is surrounded by higher ridges averaging 9,500 to 10,500 feet.

Figure 1 is a map of the study area. As can be seen from this map, the topography of the area is quite complex. The local climate is a reflection, therefore, of the interaction between the large scale climatic controls and the topographically controlled small scale controls.

The primary large scale controls of the region include latitude, distance from major bodies of water, position with respect to air mass

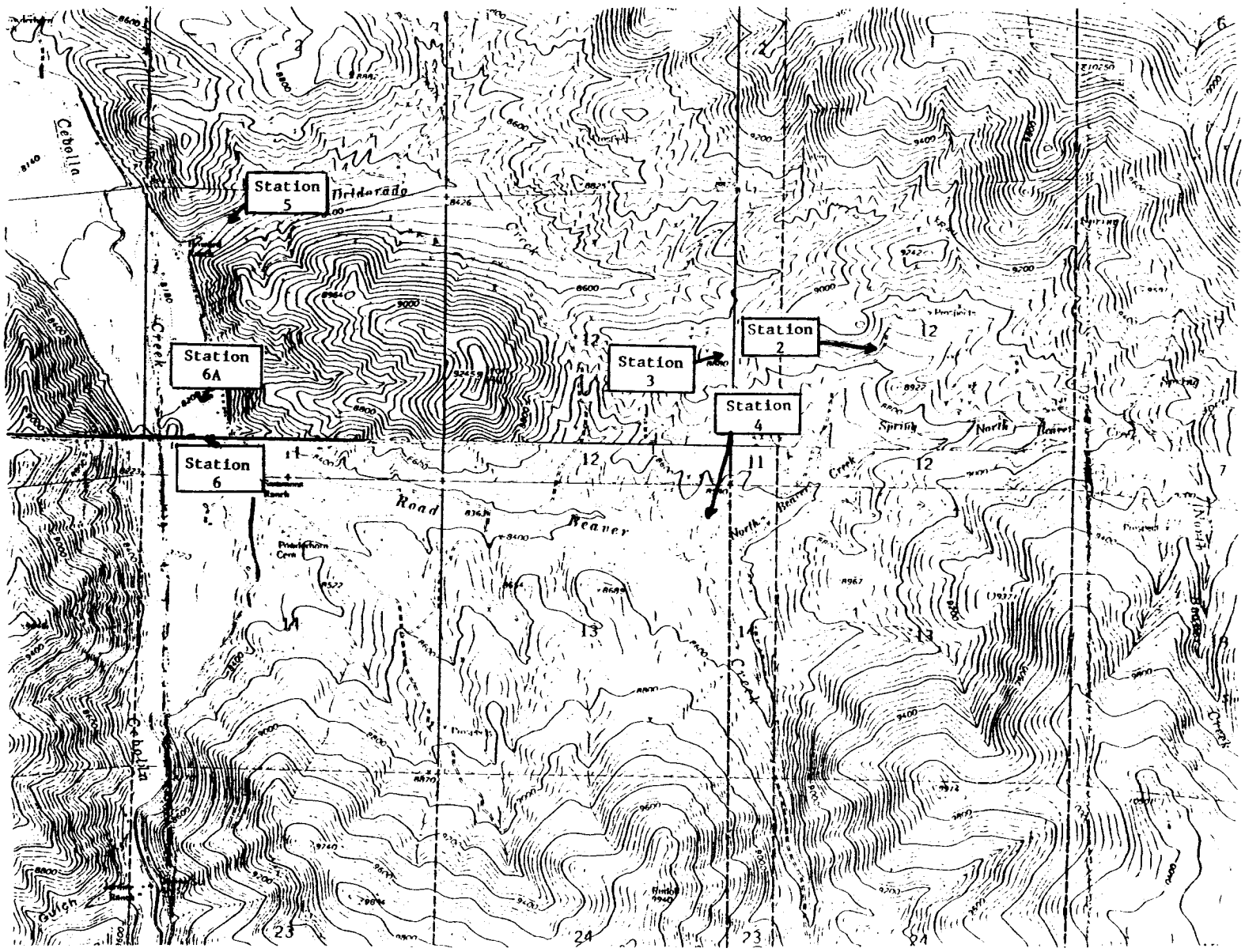

Figure 1. Location of Powderhorn Project and Sites of Weather Stations Used in This Report.

and storm movements and major topographic features. On a smaller scale, the local climate is strongly influenced by elevation, slope, aspect and spatial distribution of the surrounding topography. Thus, we find fairly strong climatic diversity with patterns of conifer and aspen trees, sagebrush and grass reflecting the combined influences of the climatic controls.

Overall, the climate of the region is classified as steppe at lower elevations changing to montane in the higher elevations. Precipitation is strongly influenced by topographic uplifting with large gradients typical of the central Colorado mountains. At the Powderhorn Store several miles northwest of the project area, the average precipitation for a six year period of record ending in 1972 was 11.62 inches with 54 percent occurring between July 1 and October 31. Figure 2 shows the annual march of precipitation at the Powderhorn Store. For comparison, at Gunnison, Colorado the average precipitation over a period of 80 years is 10.59 inches. Gunnison, on the other hand, has 60 days per year with precipitation greater than 0.1 inch while only 40 days are recorded in the Cebolla Valley.

The distance from major sources of moisture is a limiting factor in the amount of winter precipitation received. Since the nearest moisture source is a thousand miles and several mountain ranges to the west, the air arriving from this direction has already lost much of its moisture and even major storms require considerable topographic lifting to produce significant amounts of precipitation. At Powderhorn an average total of 56 inches of snow falls on an average of 88 days of the year between October 1 and April 30.

During the winter months, the predominant air mass over the Rocky Mountains of Colorado is either continental polar or, less often, maritime

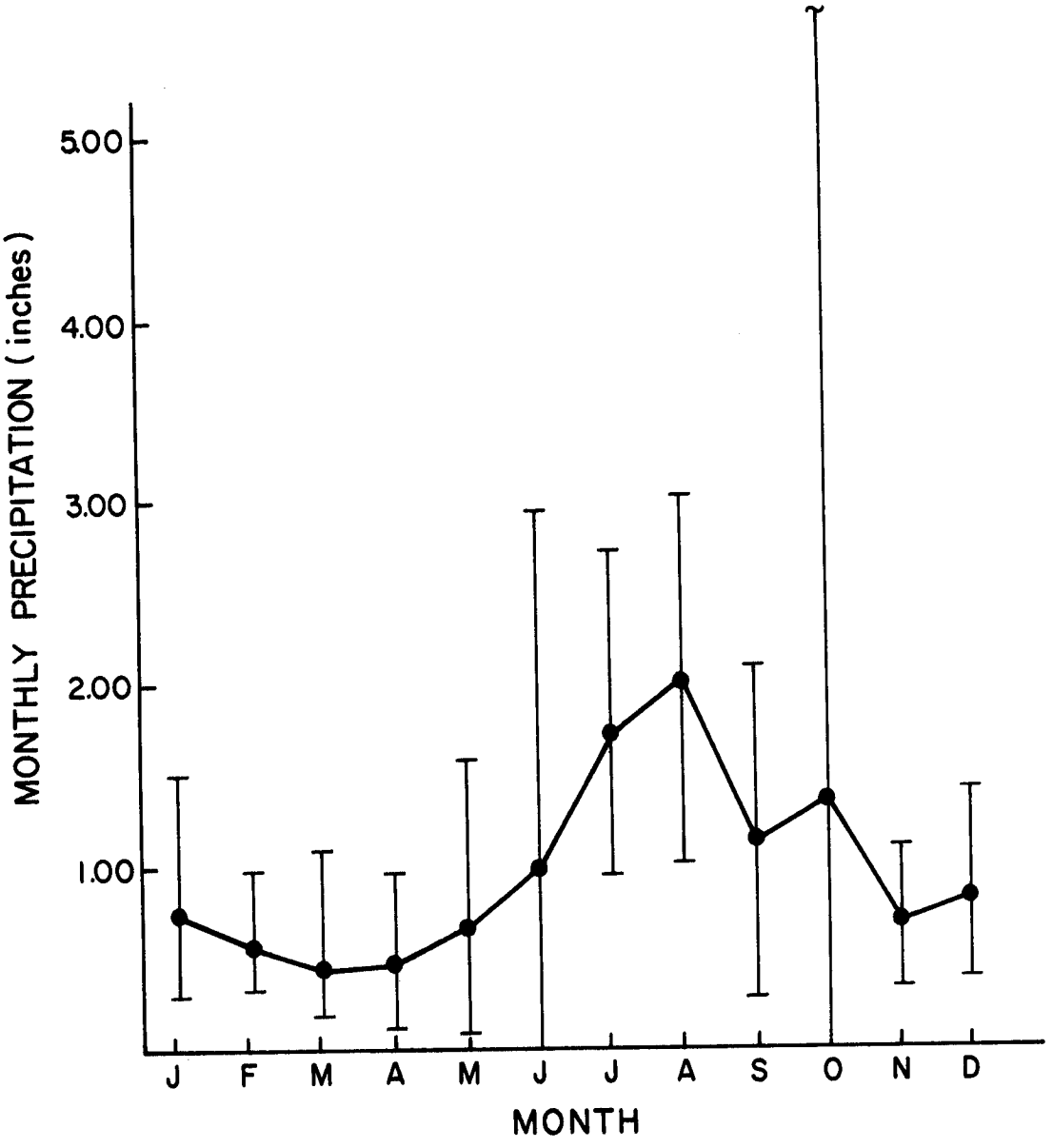

Figure 2. Annual March of Precipitation (and Extremes of Monthly Totals) for Powderhorn, Colorado.

polar resulting in cold, dry air during storm free periods. In the summer the predominant air masses over central Colorado are continental tropic or, less often, maritime polar.

During summer the Cebolla Valley is well south of the storm track. If sufficient moisture is present in the air mass, surface heating and upslope winds may produce afternoon or evening thunderstorms. These storms are often quite localized and are normally not accompanied by hail or violent winds. Of particular interest in this regard in the study area is the influence of Iron Hill on local thunderstorms. While no long-term records are available, observations by local residents indicate that the presence of an ore body of magnetite at this location results in an unusual amount of lightning from thunderstorms passing across the study area.

The local air temperature patterns are also strongly influenced by the microclimate features -- slope, aspect, elevation, soil moisture, vegetation, etc.

For example, the warmest surfaces in midwinter are the lower elevation, unvegetated, steep (approximately 50^{o}) south-facing slopes, while in midsummer the warmest surfaces are those with only 12 to 20^{o} slope. The steepness of the terrain, together with its type and amount of vegetation; its orientation and range of elevation are the major controls of the diurnal wind patterns. During a warm, sunny day, the heating of the sunlit south slope along the side of the Cebolla Valley warms the adjacent air producing upslope flow. At night, radiative cooling of the valley walls and higher terrain cools the adjacent air. This air, becoming more dense than the surrounding air, slides into the lowest portion of the Cebolla Valley. Below the Powderhorn Store area (to the northwest), the valley narrows sharply. As a result the cold air tends to "pool" in the valley resulting

in persistent temperature inversions and minimum nighttime temperatures in winter averaging below $0^{o}F$. Absolute minimum temperatures of -35 to $-45^{o}F$ are experienced nearly every winter in the Cebolla Valley.

BASELINE CLIMATOLOGY

The current guidelines for air pollution modeling released by the U. S. Environmental Protection Agency in October 1977 suggest that, in most places, data on meteorological and air quality parameters are available from existing stations and that these can be extrapolated to the study site. As discussed above, it appears that the measurements of air temperature and precipitation measured at the long-term station at Gunnison can be used only as a gross estimate of the general climatic conditions at the Powderhorn project area.

A one year monitoring program was established to measure wind, temperature and total suspended particulates around the project area. Three battery powered mechanical weather stations (Meteorology Research, Inc.) were placed in operation in November 1976 and were operated through November 1977. (The stations have been continued since that date but data after November 1977 are not included here.) Station 2 is located on the ridge near the crusher site. It is situated at the top of a tall conifer tree to provide information on the larger scale wind patterns in the mining and concentrator plant area. Station 4 is located near the proposed tailing pond dam to obtain diurnal wind flow frequency distribution in the drainage area below the ridge. Station 6 is located in the Cebolla Valley to determine flow characteristics in the main valley of the airshed.

Table 1 summarizes the record of meteorological data collected by the three recording weather stations. Wind and air temperature measurements were reduced at one-half hour intervals and analyzed using the Colorado State University Computer Center.

A National Weather Service climatological station was operated at the Powderhorn Store for a six year period ending in 1972. Tables 2 and 3 provide a comparison of monthly air temperatures at this station with the Gunnison station for the five year period ending in 1970. Table 4 provides data on the long term climate at Gunnison.

Table 5 provides information on the comparison of monthly average air temperatures at the three project monitoring sites with the same time periods at the Gunnison station. From this table, it is seen that Station 2 averaged 4.0°F cooler than Gunnison, Station 4, 3.4°F cooler and Station 6, 2.1°F cooler for the entire monitoring year. The differences are not uniform however, indicating that the use of the long-term Gunnison station data to estimate long-term climatology at the project area could lead to erroneous results.

1977 was an unusual weather period throughout Colorado. Air temperatures were above normal at Gunnison for all months except May, July and August. The months of February, November and December were well above normal with February 8.2°F above the long-term average. The winter of 1976-1977 was also exceptionally snow free. Whether this would indicate an abnormal wind pattern in the Cebolla Valley cannot, of course, be determined. It would, however, provide conditions conducive to high particulate concentrations on days with strong wind.

Totalizing non-directional anemometers were established at Stations 3 and 5 to determine the distribution of wind around Iron Hill and to aid in

Table 1. Summary of Data Processed From the Three MRI Weather Stations. (* indicates partial month's data)

Month	Station 2 (treetop)	Station 4	Station 6
1976 Nov	X		*Chart on 11/6
Dec	X	*Chart on 12/15	X
1977 Jan	X	X	X
Feb	X	X	X
Mar	X	*X	X
Apr			*X
May	*X	*X	X
Jun	*X	*X	*X
Jul	*X	X	*X
Aug	X	X	X
Sep	*X	X	X
Oct	X	*Batteries Failed 10/16	X
Nov	*Chart Off 11/5		*Chart Off 11/12

Missing Data From MRI Weather Stations:

Station 2	Station 4	Station 6
Chart Jammed 12/12-12/15	Instrument Down 3/24-5/18	Chart Ran Out 11/15-11/20
Instrument Down 3/26-5/18	Chart Jammed 6/6-6/11	Instrument Malfunction 4/9-4/16
No Chart Recvd. 6/19-7/23		Chart Ran Out 5/10-5/19
Instrument Malfunction 9/3-9/17		No Chart Recvd. 6/19-7/23

Table 2. Temperature Summary for Powderhorn Ending 2/1970.

SUMMARY OF MONTHLY CLIMATIC DATA FOR POWDERHORN COLORADO LAST DATA 2/1970 SUBSTATION NO. 6651 DIV. 2
PREPARED BY THE COLORADO CLIMATOLOGIST, DEPARTMENT OF ATMOSPHERIC SCIENCE, COLORADO STATE UNIV., FT. COLLINS, CO 80523

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
MONTHLY MEAN MAXIMUM TEMP (F)	AVE.	31.0	34.6	42.7	54.1	65.1	72.0	78.7	76.6	68.9	59.3	46.1	32.2	55.1
	MAX.	37.9	42.2	52.5	58.9	71.4	77.2	82.8	82.5	72.9	65.4	53.0	36.7	
	MIN.	16.0	21.7	38.5	50.3	60.4	64.8	71.7	66.5	64.7	50.2	41.9	21.9	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	5.	6.	6.	72.
MONTHLY MEAN MINIMUM TEMP (F)	AVE.	-8.3	-5.6	4.1	14.8	23.6	29.7	38.5	38.3	29.3	19.3	10.9	-2.3	16.0
	MAX.	-2.4	.3	12.2	18.8	27.5	30.5	41.5	42.5	33.2	21.3	17.2	4.1	
	MIN.	-15.5	-12.8	-4.0	8.7	19.9	28.9	36.2	33.9	24.0	17.4	6.5	-7.8	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	5.	6.	6.	71.
MONTHLY MEAN AVERAGE TEMP (F)	AVE.	11.4	14.6	23.4	34.5	44.4	50.9	58.6	57.5	49.1	39.0	28.5	14.9	35.5
	MAX.	17.8	21.3	32.4	38.9	49.5	53.8	61.0	62.5	52.9	43.1	31.5	20.4	
	MIN.	.3	4.5	17.8	29.8	42.4	47.0	54.0	50.2	45.7	34.7	24.2	7.1	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	5.	6.	6.	71.
DEGREE DAYS (BASE 65F)	AVE.	1658.3	1414.5	1282.5	908.5	632.8	416.7	191.7	229.2	470.2	800.0	1088.2	1547.0	10639.5
	MAX.	2007	1690	1459	1047	698	534	333	452	572	934	1219	1793	
	MIN.	1457	1218	1008	775	474	331	124	78	355	673	1001	1378	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	5.	6.	6.	71.
NO DAYS MAX TEMP GTR OR EQ 90F	AVE.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.2	0.0	0.0	0.0	0.0	.2
	MAX.	0	0	0	0	0	0	0	1	0	0	0	0	
	MIN.	0	0	0	0	0	0	0	0	0	0	0	0	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	72.
NO DAYS MAX TEMP LESS OR EQ 32F	AVE.	16.0	11.2	3.7	.3	0.0	0.0	0.0	0.0	0.0	0.0	1.3	15.6	48.1
	MAX.	31	28	8	1	0	0	0	0	0	0	4	29	
	MIN.	7	2	0	0	0	0	0	0	0	0	0	10	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	5.	71.
NO DAYS MIN TEMP LESS OR EQ 32F	AVE.	31.0	28.2	31.0	30.0	28.7	21.5	3.8	6.5	20.8	29.4	30.0	31.0	291.8
	MAX.	31	29	31	30	30	25	4	17	30	31	30	31	
	MIN.	31	28	31	30	26	18	3	0	10	27	30	31	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	5.	6.	5.	5.	6.	6.	69.
NO DAYS MIN TEMP LESS OR EQ 0 F	AVE.	24.2	19.7	11.5	.5	0.0	0.0	0.0	0.0	0.0	.2	4.2	19.2	79.4
	MAX.	30	27	24	3	0	0	0	0	0	1	8	27	
	MIN.	18	13	3	0	0	0	0	0	0	0	0	11	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	5.	6.	5.	70.
HIGHEST TEMPERATURE (F)	TEMP	55	52	64	74	83	89	88	90	84	78	68	51	
	YEAR AND DAY	197023	197018	196723	196921+	196926	197026	196821+	196909	196906	196708	196605	196602	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	
LOWEST TEMPERATURE (F)	TEMP	-32	-39	-27	-7	6	14	23	24	16	-1	-22	-26	
	YEAR AND DAY	197006+	196901	196605+	197002	196703	196605	196801	196622	196824	196818	196830	196819+	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	

Table 3. Temperature Summary for Gunnison Ending 12/1970.

SUMMARY OF MONTHLY CLIMATIC DATA FOR GUNNISION COLORADO LAST DATA 12/1970 SUBSTATION NO. 3662 DIV. 2
PREPARED BY THE COLORADO CLIMATOLOGIST, DEPARTMENT OF ATMOSPHERIC SCIENCE, COLORADO STATE UNIV., FT. COLLINS, CO 80523

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
MONTHLY MEAN MAXIMUM TEMP (F)	AVE.	24.8	29.2	40.3	54.2	65.6	73.0	79.6	77.3	69.8	58.7	44.6	29.3	53.9
	MAX.	30.8	37.6	51.3	57.2	70.0	76.3	82.3	80.3	73.4	65.8	49.2	32.1	
	MIN.	14.3	21.4	32.5	49.6	62.3	69.9	77.4	73.9	65.9	47.3	39.4	24.8	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	72.
MONTHLY MEAN MINIMUM TEMP (F)	AVE.	-7.2	-4.4	8.8	19.6	27.6	34.7	43.8	40.7	31.5	20.4	12.4	-.6	18.9
	MAX.	3.2	5.6	16.8	23.6	31.1	35.9	44.4	43.7	35.3	22.6	17.0	3.0	
	MIN.	-21.5	-15.3	1.3	16.0	24.8	31.0	41.8	37.9	27.7	18.2	9.2	-4.8	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	72.
MONTHLY MEAN AVERAGE TEMP (F)	AVE.	8.8	12.4	24.6	36.9	46.6	53.9	61.7	59.0	50.6	39.5	28.5	14.4	36.4
	MAX.	17.0	21.6	34.1	40.0	50.6	54.8	63.3	62.0	53.1	42.0	30.6	17.6	
	MIN.	-3.6	3.3	16.9	33.0	43.6	52.9	60.3	56.9	48.7	34.6	25.7	10.0	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	72.
DEGREE DAYS (BASE 65F)	AVE.	1738.3	1477.0	1246.0	836.0	563.5	328.0	98.0	180.8	423.3	781.5	1087.7	1564.2	10324.3
	MAX.	2127	1728	1483	953	658	360	141	242	484	935	1171	1701	
	MIN.	1482	1207	953	743	439	300	58	91	349	706	1025	1465	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	72.
NO DAYS MAX TEMP GTR OR EQ 90F	AVE.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	MAX.	0	0	0	0	0	0	0	0	0	0	0	0	
	MIN.	0	0	0	0	0	0	0	0	0	0	0	0	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	72.
NO DAYS MAX TEMP LESS OR EQ 32F	AVE.	23.3	16.2	6.8	.3	0.0	0.0	0.0	0.0	0.0	0.0	2.8	20.7	70.2
	MAX.	31	27	17	1	0	0	0	0	0	0	5	25	
	MIN.	16	5	1	0	0	0	0	0	0	0	1	15	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	72.
NO DAYS MIN TEMP LESS OR EQ 32F	AVE.	30.8	28.2	30.8	29.5	24.5	10.0	.3	3.3	15.8	28.7	30.0	31.0	263.0
	MAX.	31	29	31	30	27	19	2	6	26	30	30	31	
	MIN.	30	28	30	29	19	5	0	0	7	25	30	31	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	72.
NO DAYS MIN TEMP LESS OR EQ 0 F	AVE.	21.7	17.5	7.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	18.5	67.7
	MAX.	31	25	14	0	0	0	0	0	0	0	4	24	
	MIN.	16	11	0	0	0	0	0	0	0	0	0	14	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	72.
HIGHEST TEMPERATURE (F)	TEMP	50	49	64	73	81	88	87	89	80	75	64	50	
	YEAR AND DAY	197023+	197017	196631	196522	196927	197026	196821+	197001+	196704+	196502	196715	196921+	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	
LOWEST TEMPERATURE (F)	TEMP	-37	-34	-27	4	7	22	23	26	17	3	-22	-25	
	YEAR AND DAY	196604	196901	196605	196823	196807	197001+	196801	196824	197026	196730	196530	196931+	
	MONTHS OF RECORD	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	

Table 4. Summary of Monthly Climatic Data for Gunnison, Colorado. Last data 12/1972.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Monthly Mean Maximum Temp (F)	Ave.	25.8	31.2	41.1	56.0	66.6	76.3	80.9	78.7	72.9	62.0	46.0	29.8	55.5
	Max.	38.6	48.5	56.8	63.8	75.0	83.2	85.9	86.5	79.9	71.8	56.1	47.9	
	Min.	12.6	16.9	31.0	46.8	58.4	69.9	70.2	59.7	60.3	47.3	35.1	16.0	
	Months of Record	75.	75.	72.	72.	73.	74.	73.	72.	70.	70.	70.	72.	868.
Monthly Mean Minimum Temp (F)	Ave.	-7.6	-1.9	10.4	22.4	29.0	35.6	42.5	40.8	31.8	21.7	10.4	-2.9	19.2
	Max.	3.9	16.1	22.3	28.2	34.5	41.1	47.1	46.4	41.5	31.7	17.5	8.8	
	Min.	-22.3	-15.3	-3.4	16.0	24.1	28.9	38.3	34.0	26.5	17.3	-3.1	-16.0	
	Months of Record	75.	75.	72.	73.	74.	74.	73.	72.	70.	71.	70.	73.	872.
Monthly Mean Average Temp (F)	Ave.	9.1	14.6	25.8	39.2	47.9	56.0	61.7	59.8	52.4	41.9	28.2	13.4	37.4
	Max.	21.0	31.5	38.0	44.0	53.4	61.8	65.0	63.7	57.2	46.7	35.4	26.2	
	Min.	-3.6	3.2	15.0	33.0	42.3	50.8	57.6	49.7	46.2	34.6	16.0	1.2	
	Months of Record	75.	75.	72.	72.	73.	74.	73.	72.	70.	70.	69.	72.	867.
No Days Max Temp Gtr or Eq $90^{o}F$	Ave.	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.3	0.0	0.0	0.0	0.0	1.2
	Max.	0	0	0	0	0	5	4	5	0	0	0	0	
	Min.	0	0	0	0	0	0	0	0	0	0	0	0	
	Months of Record	24.	24.	24.	24.	24.	24.	24.	23.	23.	23.	24.	24.	285.
No Days Min Temp Less or Eq $32^{o}F$	Ave.	30.9	28.3	30.9	28.8	22.4	8.5	0.6	4.2	18.1	27.5	29.8	31.0	260.9
	Max.	31	29	31	30	28	19	3	12	26	31	30	31	
	Min.	30	28	29	26	17	1	0	0	7	17	29	30	
	Months of Record	25.	25.	25.	25.	25.	25.	25.	23.	24.	24.	25.	25.	296.
No Days Min Temp Less or Eq $0^{o}F$	Ave.	20.7	15.2	6.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	4.5	18.5	65.8
	Max.	31	25	17	1	0	0	0	0	0	0	16	27	
	Min.	11	0	0	0	0	0	0	0	0	0	0	8	
	Months of Record	25.	25.	25.	24.	24.	24.	24.	23.	23.	23.	25.	25.	290.
Highest Temperature (F)	Temp	63	61	75	78	87	99	95	104	91	82	69	62	
	Year and Day	195431	190425	192827	193010	193630	191305	193207	193116	193003	193801	190601	193910	
	Months of Record	75.	75.	72.	72.	73.	74.	73.	72.	70.	70.	70.	72.	
Lowest Temperature (F)	Temp	-45	-43	-29	-10	7	15	23	24	13	-6	-26	-47	
	Year and Day	190622	191601	190302	192004	196807	191901	196801	196225	191223	193225	195227	192425	
	Months of Record	75.	75.	72.	73.	74.	74.	73.	71.	70.	71.	70.	73.	

Table 4. (Continued)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Monthly Precipitation (in)	Ave.	.84	.81	.74	.75	.77	.71	1.53	1.43	.91	.77	.62	.73	10.59
	Max.	3.52	2.61	3.31	3.10	2.72	2.95	4.21	3.61	3.32	4.13	3.60	2.91	
	Min.	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.16	0.00	0.00	0.00	0.00	
	Months of Record	80.	79.	80.	79.	79.	78.	81.	80.	80.	75.	78.	79.	948.
Greatest Daily Precip (in)	Amount	.97	.78	1.50	.79	.95	1.10	1.24	1.21	1.16	1.14	1.25	.80	
	Year and Day	196925	196209	194801	190309	190625	191217	191914	197128	191710	196903	195904	190931	
	Months of Record	55.	54.	53.	53.	55.	53.	56.	54.	54.	55.	53.	51.	
Monthly Snowfall (in)	Ave.	12.7	11.6	7.9	4.5	1.0	0.1	0.0	0.0	0.3	1.8	5.8	10.8	56.4
	Max.	50.2	34.8	26.0	16.0	7.0	5.5	0.0	0.0	7.0	24.0	19.5	29.4	
	Min.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	
	Months of Record	72.	69.	66.	55.	52.	71.	74.	70.	62.	50.	64.	68.	773.
No Days Precip Gtr or Eq 0.1 in	Ave.	5.2	5.3	4.8	4.5	4.1	3.8	7.9	8.3	5.0	3.8	3.4	5.0	61.1
	Max.	16	11	13	11	12	12	18	20	12	13	10	11	
	Min.	1	0	0	0	0	0	1	0	0	0	0	0	
	Months of Record	57.	56.	54.	56.	57.	55.	56.	54.	53.	55.	55.	54.	662.
Number of Days With Hail	Ave.	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.3
	Max.	0	0	0	0	0	1	1	1	1	0	0	1	
	Min.	0	0	0	0	0	0	0	0	0	0	0	0	
	Months of Record	17.	17.	17.	17.	17.	17.	17.	16.	16.	16.	17.	17.	201.
Number of Days With Snow	Ave.	27.4	20.5	11.4	0.4	0.0	0.0	0.0	0.0	0.0	1.1	3.7	23.8	88.3
	Max.	31	29	31	2	0	0	0	0	0	8	9	31	
	Min.	12	1	0	0	0	0	0	0	0	0	0	7	
	Months of Record	9.	10.	10.	8.	10.	10.	10.	10.	10.	10.	10.	10.	117.

Table 5. Air Temperature Comparison Between the Long-Term Climatological Station at Gunnison to Those Measured at the Powderhorn Project Site.

Month	Gunnison °F	Station 2 °F	G-2	Station 4 °F	G-4	Station 6 °F	G-6
1976 November	28.7	23.0	5.7	M	M	22.5	6.2
December	18.4	15.8	2.6	14.5	3.9	15.4	3.0
1977 January	11.8	14.0	-2.2	13.3	-1.5	12.6	-0.8
February	23.3	18.6	4.7	M	M	19.2	4.1
March	26.5	19.6	6.9	19.9	6.6	22.5	4.0
April	40.5	M	M	M	M	37.1	3.4
May	47.2	44.1	3.1	M	M	46.9	0.3
June	57.4	55.8	1.6	57.1	0.3	57.9	0.3
July	60.2	60.8	-0.6	57.5	2.7	61.3	-1.1
August	58.5	51.7	6.8	55.9	2.6	59.9	-1.4
September	55.0	45.2	9.8	49.3	5.7	48.9	6.1
October	43.0	36.1	6.9	36.5	6.5	39.9	3.1
November	31.2	28.9	2.3	M	M	30.2	1.0

evaluating the flow down the Deldorado side of Iron Mountain. Average wind speed was only 3.27 miles per hour for the entire measurement period while at the tailings pile dam site on the Beaver Creek side, it was 6.25 miles per hour.

If it is assumed that drainage winds and upslope winds occurred at essentially the same time periods each day, it is concluded that the Deldorado Creek air drainage is only about half that of Beaver Creek. Whether this is a valid assumption is not known but the low airflow leads one to

conclude at least that the Deldorado Creek drainage is probably not a significant route for pollutants to flow into the Cebolla Valley from the mine area.

METEOROLOGY -- TOPOGRAPHY INTERACTIONS

In order to mathematically quantify the air pollution potential in the Powderhorn project area and the Cebolla airshed, an understanding of the relationship between the local circulation patterns and topography is necessary. The interactions between topography and the lowest atmosphere in the Powderhorn are highly complex and the few point measurements are often insufficient to provide a complete evaluation of the ventilation potential of the valley. A method of calculating the wind pattern in mountainous areas which incorporates the perterbations of the synoptic flow by terrain features, surface temperatures and roughness has been developed by the author and his colleagues (Fosberg, Marlatt and Krupnak, 1976). Computer generated wind maps of the study area are shown in Figures 3 and 4.

CLIMATOLOGY OF AIRFLOW PATTERNS

While these figures are useful in determining the geographical pattern of wind movement in the Cebolla Valley airshed under conditions of generally light background flow, the time of onset of drainage and upslope winds, their frequency and duration are also of importance in determining the air pollution potential. Tables 6 and 7 provide information on the average wind speed/ wind direction at the crusher site, the tailings pile and in the Cebolla Valley.

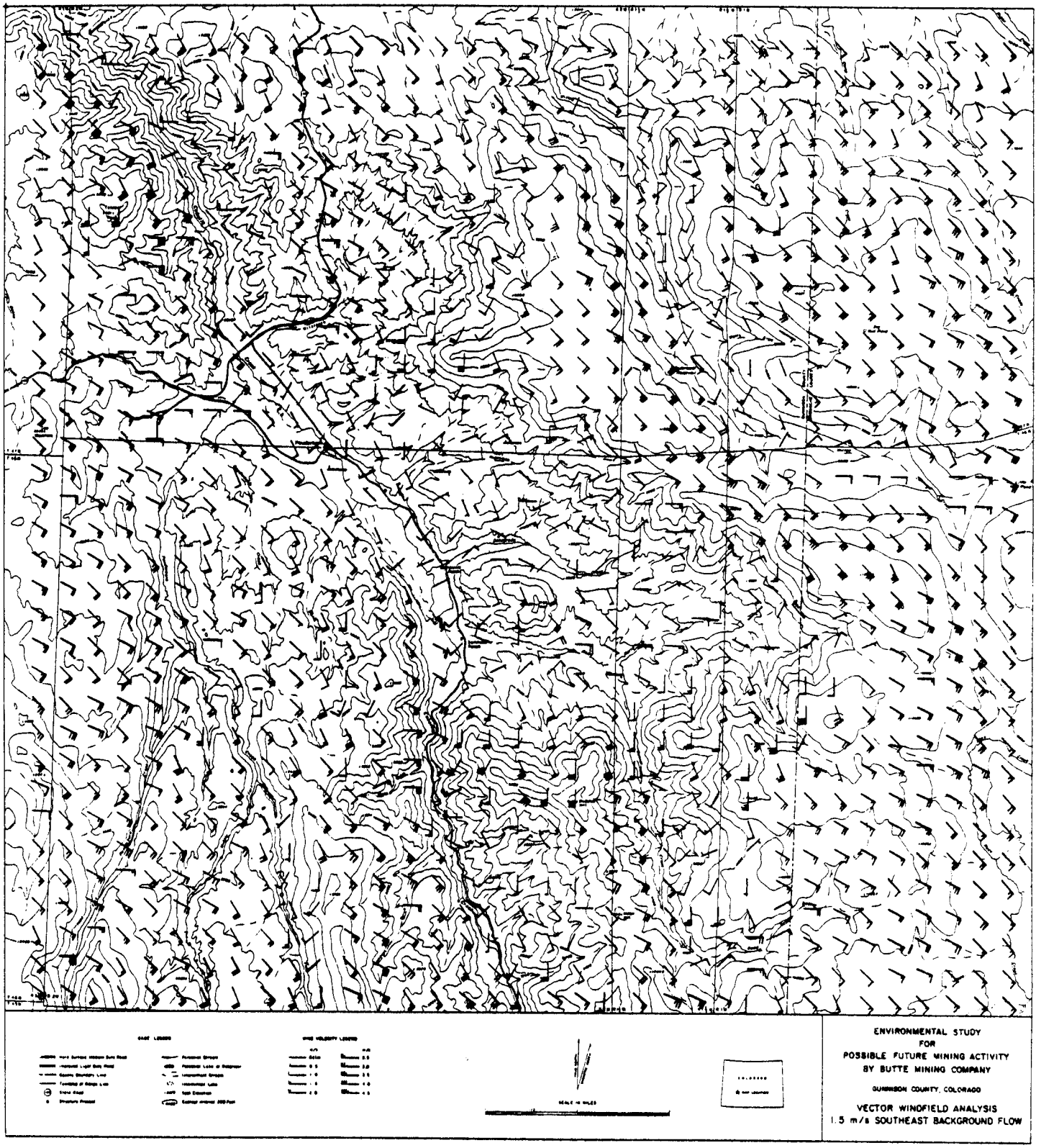

Figure 3. Computer Generated Windfield Map of Powderhorn Project Area; 1.5 m/s Southeast Background Flow.

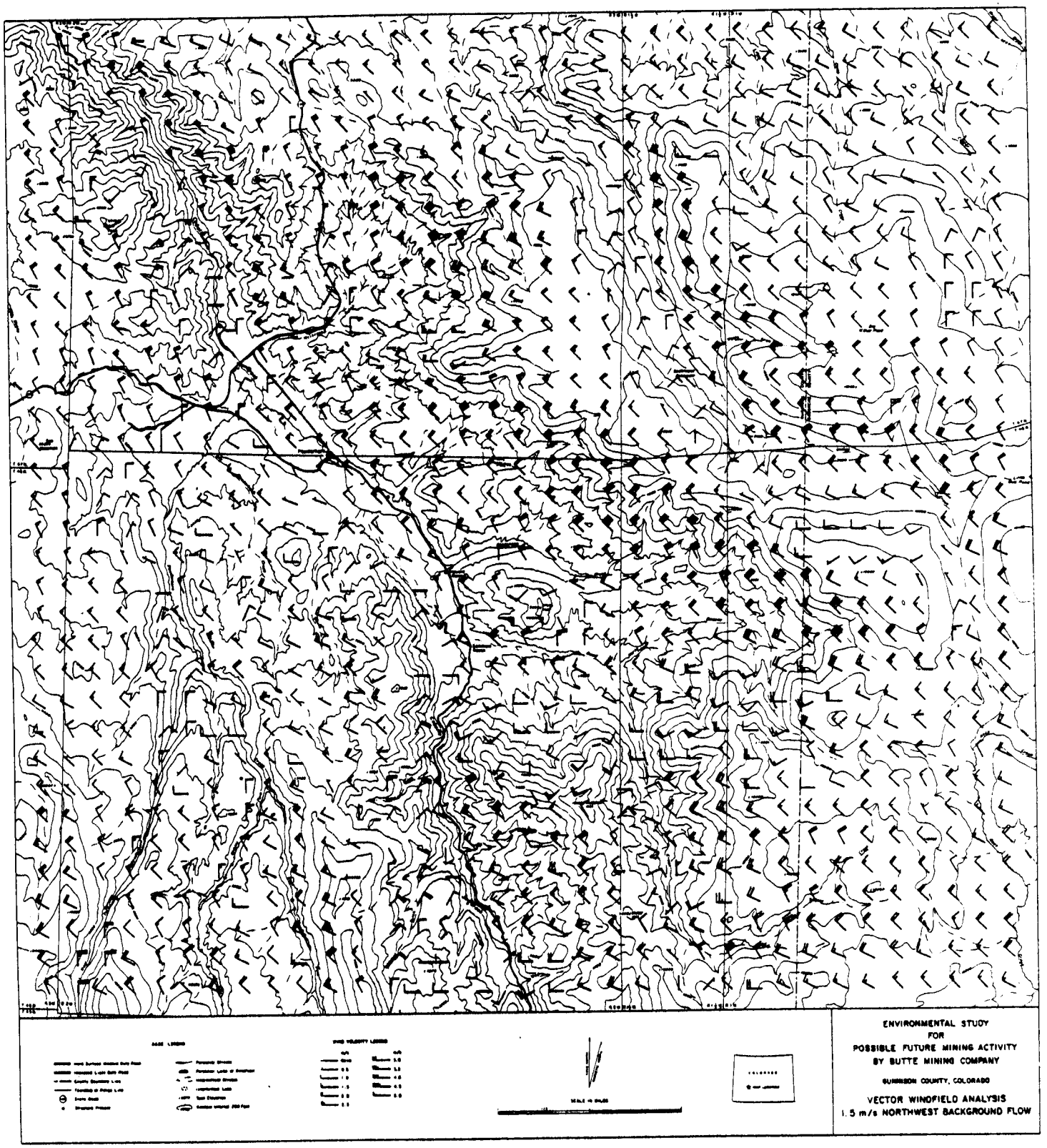

Figure 4. Computer Generated Windfield Map of Powderhorn Project Area; 1.5 m/s Northwest Background Flow.

Table 6. Diurnal Wind Direction Patterns, Powderhorn Project Area.

Month	Station	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
11/76	2	E	E	E	NW	E	SE	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	E	E	E	E	E	NE
	4	NE	NE	NE	NE	NE	NE	NE	SW	SW	SW	W	NW	NW	NW	NW	NW	NW	NE	NE	NE	NE	NE	NE	NE
	6	E	E	NE	NE	NE	NE	E	NW	NW	NW	NW	NW	W	W	W	W	NE	E	E	E	E	E	E	E
12/76	2	E	E	N	N	E	E	SE	N	NW	NW	NW	NW	NW	NW	NW	NW	NW	E	E	E	E	E	E	E
	4	E	NE	E	E	E	E	E	E	SW	SW	SW	W	W	NW	NW	NW	E	E	E	E	E	E	E	NE
	6	E	NE	E	E	E	NE	NE	NW	NW	NW	NW	W	W	W	W	W	NE	NE	E	E	E	E	E	NE
1/77	2	SE	E	E	E	E	E	E	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	E	E	E	E	E
	4	NE	E	E	E	E	E	NE	E	SW	SW	SW	SW	SW	NW	NW	NW	E	E	E	E	E	E	E	NE
	6	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
2/77	2	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	6	SE	E	NE	NE	NE	E	NE	NW	NW	NW	NW	NW	W	W	W	W	W	NE	E	E	E	E	E	NE
3/77	2	SE	E	E	NW	SE	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	SE	SE	E	SE	E
	4	NE	E	NE	NE	NE	E	SW	SW	SW	SW	SW	NW	NW	NW	NW	NW	NW	N	NE	E	E	E	NE	NE
	6	SE	SE	SE	SE	SE	SE	SE	NW	NW	NW	NW	W	W	W	W	W	W	SE	SE	E	E	SE	E	E
4/77	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	6	E	E	NE	NE	NE	NW	NW	NW	NW	W	W	W	W	W	W	W	W	W	SE	E	E	E	E	E
5/77	2	SE	SE	SE	N	SE	N	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	N	NW	NW	E	SE	E	SE	E
	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	6	E	E	E	E	E	SE	NW	NW	W	W	W	W	W	SE	W	W	W	W	W	E	E	E	E	E
6/77	2	SE	E	SE	SE	N	N	N	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	SE	SE	SE	E	E	E
	4	NE	NE	NE	NE	NE	NE	SW	SW	SW	NW	W	NW	NW	NW	W	S	S	S	S	NE	NE	NE	NE	N
	6	E	E	E	E	E	E	NW	NW	NW	W	W	W	SE	W	W	W	W	W	E	E	E	E	E	E
7/77	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	4	NE	NE	NE	NE	NE	NE	SW	SW	SW	SW	NW	NW	W	NW	NW	NW	NW	W	W	NE	NE	NE	NE	N
	6	E	SE	SE	SE	E	SE	SE	NW	NW	NW	W	NW	NW	W	W	W	W	W	E	SE	SE	SE	E	E
8/77	2	E	E	E	E	E	E	E	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	E	E	E	E	E
	4	NE	NE	NE	NE	NE	NE	NE	S	SW	SW	SW	NW	NW	NW	NW	NW	NW	W	W	W	NE	NE	NE	NE
	6	E	E	E	E	E	E	SE	NW	NW	NW	NW	NW	NW	NW	NW	W	W	W	W	E	E	SE	E	E
9/77	2	E	E	E	E	NW	E	E	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	E	E	E	E	E
	4	NE	NE	NE	NE	NE	NE	NE	SW	SW	SW	NW	NW	NW	NW	NW	NW	NW	NW	E	NE	NE	NE	NE	NE
	6	E	E	E	NE	NE	NE	NE	NW	NW	NW	NW	NW	W	W	W	W	W	W	E	E	E	E	E	E
10/77	2	NW	E	N	E	N	N	N	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	E	E	E	E	NE
	4	NE	NE	E	E	E	NE	E	SW	SW	SW	SW	W	NW	NW	NW	NW	NW	NW	E	E	E	E	E	NE
	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 7. Diurnal Wind Speeds, Powderhorn Project Area.

Month	Sta.	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
11/76	2	4.4	4.4	3.6	3.2	2.8	3.0	2.3	2.2	2.8	4.3	6.6	8.8	12.0	13.4	13.7	12.4	7.9	5.5	5.3	5.2	5.9	5.8	5.0	4.7
	4	2.9	3.4	3.0	3.3	2.8	2.9	2.3	2.3	3.7	4.8	5.5	6.6	7.4	9.5	9.6	8.6	5.9	6.7	6.6	5.8	4.3	3.9	3.4	3.6
	6	7.0	6.7	6.4	5.8	5.5	4.7	4.4	4.5	3.9	4.4	6.3	8.4	10.3	11.1	9.1	7.3	5.6	5.9	6.5	6.3	6.3	6.5	6.9	6.9
12/76	2	3.2	2.9	2.9	2.8	2.6	2.5	3.0	2.5	2.7	3.8	5.6	7.6	10.0	12.3	11.7	8.8	6.8	5.5	4.7	5.1	5.3	5.2	5.2	4.0
	4	3.3	3.3	3.3	3.0	2.9	2.8	2.7	3.0	2.8	3.7	5.8	7.9	10.0	10.3	8.8	7.0	6.4	6.3	5.7	5.2	4.7	4.3	4.1	3.6
	6	6.8	6.1	6.5	6.8	6.5	5.2	5.2	5.6	3.8	4.3	6.5	9.1	11.9	10.9	7.7	5.2	5.6	5.3	6.1	6.7	7.6	8.5	7.5	8.1
1/77	2	3.4	3.1	2.9	3.2	2.9	3.0	2.8	2.3	3.2	4.1	6.0	8.8	10.8	11.8	11.4	10.4	7.8	5.8	4.6	4.1	4.1	3.5	3.7	3.2
	4	3.3	2.7	2.7	3.0	3.1	2.8	2.9	2.3	3.2	4.8	6.2	6.9	7.7	8.2	7.5	5.8	5.5	4.7	4.8	4.8	4.4	4.1	3.9	4.3
	6	7.1	6.7	6.4	5.9	6.1	6.5	6.6	5.6	4.1	3.7	4.2	4.7	7.8	7.3	6.0	4.9	4.7	5.3	5.1	5.9	6.9	6.9	7.5	5.0
2/77	2	4.4	4.1	4.2	3.9	4.2	3.9	3.3	3.0	4.1	6.4	8.9	11.2	13.2	14.8	15.1	13.8	10.8	6.8	6.2	6.5	5.9	5.7	5.0	3.0
	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	6	7.5	7.0	7.1	6.5	6.6	6.9	6.9	5.3	4.7	5.2	6.1	8.3	9.1	9.9	10.4	8.0	6.5	5.9	5.5	5.9	6.3	6.6	7.4	7.3
3/77	2	6.4	6.6	6.4	5.6	4.8	5.0	5.5	6.2	8.1	9.4	11.2	12.7	13.9	14.8	15.0	15.0	13.5	9.8	8.0	7.6	7.6	8.3	7.7	5.7
	4	5.3	5.4	4.6	3.9	3.9	3.7	3.9	4.8	7.0	8.2	9.8	10.9	11.8	12.5	11.9	12.1	9.7	7.2	6.4	6.5	6.1	6.5	6.1	4.6
	6	6.7	6.4	6.5	6.1	6.3	6.2	6.1	5.7	7.0	8.9	10.2	10.6	10.1	10.8	11.6	10.9	8.7	6.5	5.5	5.1	5.3	6.2	5.8	6.0
4/77	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	6	5.6	5.3	4.8	4.2	3.9	3.1	3.2	5.2	6.7	7.3	8.5	9.1	8.5	8.7	8.1	9.1	7.6	5.1	6.4	6.0	5.8	5.6	6.2	6.4
5/77	2	5.0	5.3	5.5	4.8	5.5	4.8	6.0	9.4	12.7	14.4	14.9	15.3	16.2	15.7	16.5	16.7	15.4	13.6	10.7	6.1	5.5	6.9	7.6	5.7
	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	6	7.7	7.8	7.3	7.2	6.7	6.6	5.5	7.0	8.4	10.2	10.9	11.2	11.5	11.8	12.0	11.9	11.5	8.8	6.0	5.1	5.9	6.3	7.0	5.8
6/77	2	5.8	5.6	4.6	3.7	3.8	3.4	3.9	4.9	6.9	9.5	11.1	10.8	11.7	12.3	12.9	11.9	12.2	9.3	7.4	7.5	7.3	7.1	6.0	5.4
	4	5.4	5.6	5.7	5.3	4.9	4.0	3.9	4.9	6.5	8.9	11.3	12.0	13.2	13.5	13.1	14.1	12.0	11.0	8.4	6.4	6.1	5.6	4.3	3.9
	6	7.8	7.2	7.5	7.1	6.3	5.9	4.3	3.6	5.4	6.6	7.7	7.4	7.6	7.8	9.1	8.8	7.7	6.0	4.3	4.7	5.1	6.9	8.1	7.6
7/77	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	4	3.5	3.0	2.6	3.0	2.9	2.6	2.9	3.2	4.8	7.3	8.6	10.6	11.4	11.4	10.8	10.1	11.4	8.7	7.2	5.3	5.3	4.4	4.4	3.5
	6	4.7	4.6	5.0	5.0	4.4	3.5	2.8	3.3	3.6	4.4	6.0	7.3	7.0	7.7	7.8	6.9	7.1	4.8	3.7	5.4	5.7	6.0	5.6	5.2
8/77	2	5.9	5.3	4.5	4.7	4.8	4.9	3.4	3.1	3.8	5.9	7.6	8.9	10.8	12.7	13.7	14.1	13.4	12.1	9.8	7.0	6.1	6.9	6.5	6.0
	4	4.1	4.0	3.7	3.2	3.8	3.7	3.6	2.3	3.2	4.2	6.4	7.8	8.6	10.0	11.7	12.0	11.9	11.7	10.1	7.0	6.0	5.8	5.1	4.4
	6	5.8	6.2	5.2	5.3	5.4	4.8	4.6	4.2	4.4	5.2	5.8	6.7	7.6	8.6	9.8	10.0	8.6	7.4	5.2	4.5	5.2	6.1	6.2	6.1
9/77	2	5.3	4.6	5.8	5.9	4.7	5.0	4.8	4.5	6.2	7.3	8.6	11.3	13.3	16.3	15.4	16.4	16.8	14.4	10.0	6.2	6.4	6.4	6.9	6.3
	4	3.9	3.7	5.2	4.0	3.6	3.7	3.3	3.3	4.8	5.5	7.5	9.1	11.2	12.2	10.6	12.6	11.4	9.3	6.5	5.8	5.1	4.9	4.7	4.0
	6	6.3	6.1	5.9	5.6	5.2	4.8	4.4	4.1	4.3	5.3	6.5	6.8	8.3	9.2	9.8	9.4	8.2	5.6	4.8	5.2	6.2	6.8	7.5	7.2
10/77	2	3.7	4.1	3.4	3.5	–	–	–	2.8	4.1	4.9	7.1	9.5	12.1	13.2	13.6	13.5	11.7	7.9	6.1	6.7	7.7	7.0	6.3	5.2
	4	4.1	3.7	4.3	5.0	5.9	4.9	3.8	3.5	4.7	6.1	7.1	8.7	10.8	11.8	12.1	11.9	10.0	6.6	6.6	6.0	5.2	4.6	4.2	3.2
	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

From these tables the strong influence of microclimate, topography and surface heating on the direction and velocity of flow at each station is evidenced. It is of significance to note that no strong seasonal effect is apparent in either wind speed or direction control. From these tables and from Figure 5, it is seen that while the midafternoon upslope wind is strongest at Station 2, the strongest winds at night are in the bottom of the Cebolla Valley. The nighttime drainage flow at Station 6 is quite strong, averaging more than six miles per hour.

Detailed frequency analysis of wind speed and wind direction for the entire period and for each month are provided in Appendix A.

Table 8 summarizes the prevailing wind directions for the three sites. The strong influence of terrain geography is apparent in this analysis.

Table 8. Analysis of Prevailing Wind Direction.

Location	% of Total Hours							
	NW	N	NE	E	SE	S	SW	W
Station 2	6	10	25	6	10	5	17	22
Station 4	7	17	7	4	15	14	20	16
Station 6	3	18	33	8	4	4	20	10

The persistence of wind by speed and direction are of particular importance in the analysis of worst case meteorology for air pollution. Since the total loading of a sampler at any particular receptor point is measured on a 24 hour basis, it becomes important to determine the time that a receptor will remain downwind of an emitting source. The duration of all winds from a given direction, regardless of speed for the entire monitoring period

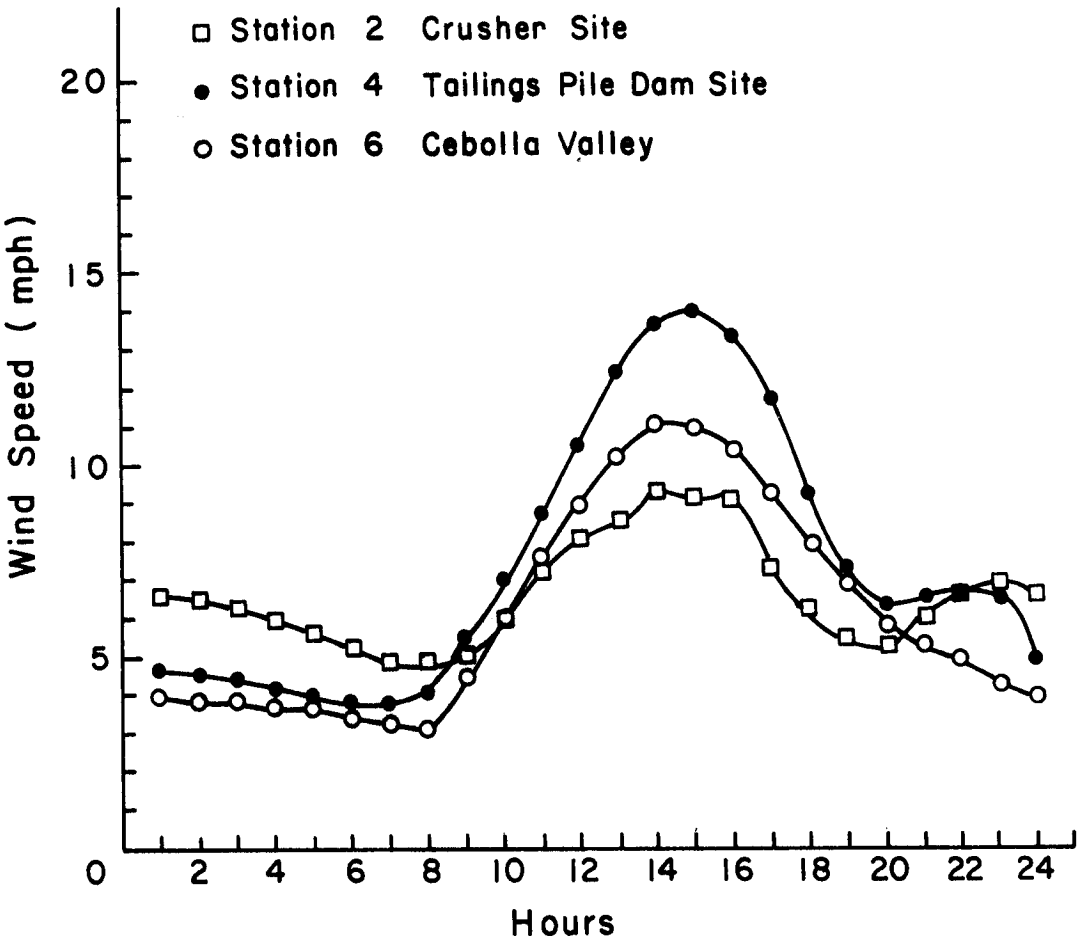

Figure 5. Diurnal March of Wind Speed.

and for each station-month are given in Appendix B. Duration of all wind speeds regardless of direction for the entire monitoring period, regardless of direction are provided in Appendix C.

Anthropogenic, i.e. emitted particulate matter is usually most serious under conditions of light winds while fugitive dust from tailings piles, disturbed soil surfaces, etc. cause most difficulty during periods of persistent strong winds. Tables 9 and 10 summarize the analysis of persistent winds by compass quadrants for wind speeds of less than seven miles per hour and greater than ten miles per hour.

In most analyses of this type, a wind is considered to have persistence of direction if it remains within a 22^{o} sector with only an occasional meander of a few degrees outside of the sector. Since the pollutant of primary concern is fugitive dust and particulate emissions and since topography has such strong influence on wind patterns in the study area, this analysis considered a 90^{o} sector for 24 hours and only a very few times did winds persist from one sector more than 12 hours.

Even for the shorter time periods, Table D1 shows no favored time of day for onset of persistent winds. Results of analyses of the monthly onset times are provided in Appendix D.

From the computer modeled airflow patterns (Figures 3 and 4) areas of high pollution potential, eg. areas of stagnation or convergence where contaminants could accumulate during non-dispersive conditions can be determined. These are shown in Figures 6 and 7.

Table 9. Analysis of Persistent Winds
> 0 but ≤ 7 mph.

	Station		
	2	4	6
SW Quadrant ≥ 24 Hours	0	0	0
< 24 ≥ 18 Hours	0	0	0
< 18 ≥ 12 Hours	0	0	0
< 12 ≥ 6 Hours	1	15	0
SE Quadrant ≥ 24 Hours	0	0	0
< 24 ≥ 18 Hours	0	0	0
< 18 ≥ 12 Hours	2	0	2
< 12 ≥ 6 Hours	36	2	26
NE Quadrant ≥ 24 Hours	0	0	0
< 24 ≥ 18 Hours	0	0	0
< 18 ≥ 12 Hours	0	20	2
< 12 ≥ 6 Hours	6	67	33
NW Quadrant ≥ 24 Hours	0	0	0
< 24 ≥ 18 Hours	0	0	0
< 18 ≥ 12 Hours	1	0	0
< 12 ≥ 6 Hours	38	4	22
E Quadrant ≥ 24 Hours	0	0	0
< 24 ≥ 18 Hours	0	0	0
< 18 ≥ 12 Hours	2	11	8
< 12 ≥ 6 Hours	41	49	70
S Quadrant ≥ 24 Hours	0	0	0
< 24 ≥ 18 Hours	0	0	0
< 18 ≥ 12 Hours	0	0	0
< 12 ≥ 6 Hours	3	0	0
W Quadrant ≥ 24 Hours	0	0	0
< 24 ≥ 18 Hours	0	0	0
< 18 ≥ 12 Hours	0	0	0
< 12 ≥ 6 Hours	9	8	10

Table 10. Analysis of Persistent Winds > 10 mph.

	Station		
	2	4	6
SW Quadrant ≥ 24 Hours	0	0	0
< 24 ≥ 18 Hours	0	0	0
< 18 ≥ 12 Hours	1	0	0
< 12 ≥ 6 Hours	7	4	0
SE Quadrant ≥ 24 Hours	0	0	0
< 24 ≥ 18 Hours	0	0	0
< 18 ≥ 12 Hours	0	0	0
< 12 ≥ 6 Hours	2	0	2
NE Quadrant ≥ 24 Hours	0	0	0
< 24 ≥ 18 Hours	0	0	0
< 18 ≥ 12 Hours	0	0	0
< 12 ≥ 6 Hours	0	0	0
NW Quadrant ≥ 24 Hours	0	0	0
< 24 ≥ 18 Hours	1	0	1
< 18 ≥ 12 Hours	4	1	0
< 12 ≥ 6 Hours	34	19	24
E Quadrant ≥ 24 Hours	0	0	0
< 24 ≥ 18 Hours	0	0	0
< 18 ≥ 12 Hours	0	0	0
< 12 ≥ 6 Hours	1	0	1
S Quadrant ≥ 24 Hours	0	0	0
< 24 ≥ 18 Hours	0	0	0
< 18 ≥ 12 Hours	0	0	0
< 12 ≥ 6 Hours	4	3	0
W Quadrant ≥ 24 Hours	0	0	0
< 24 ≥ 18 Hours	0	0	1
< 18 ≥ 12 Hours	0	0	0
< 12 ≥ 6 Hours	8	7	25

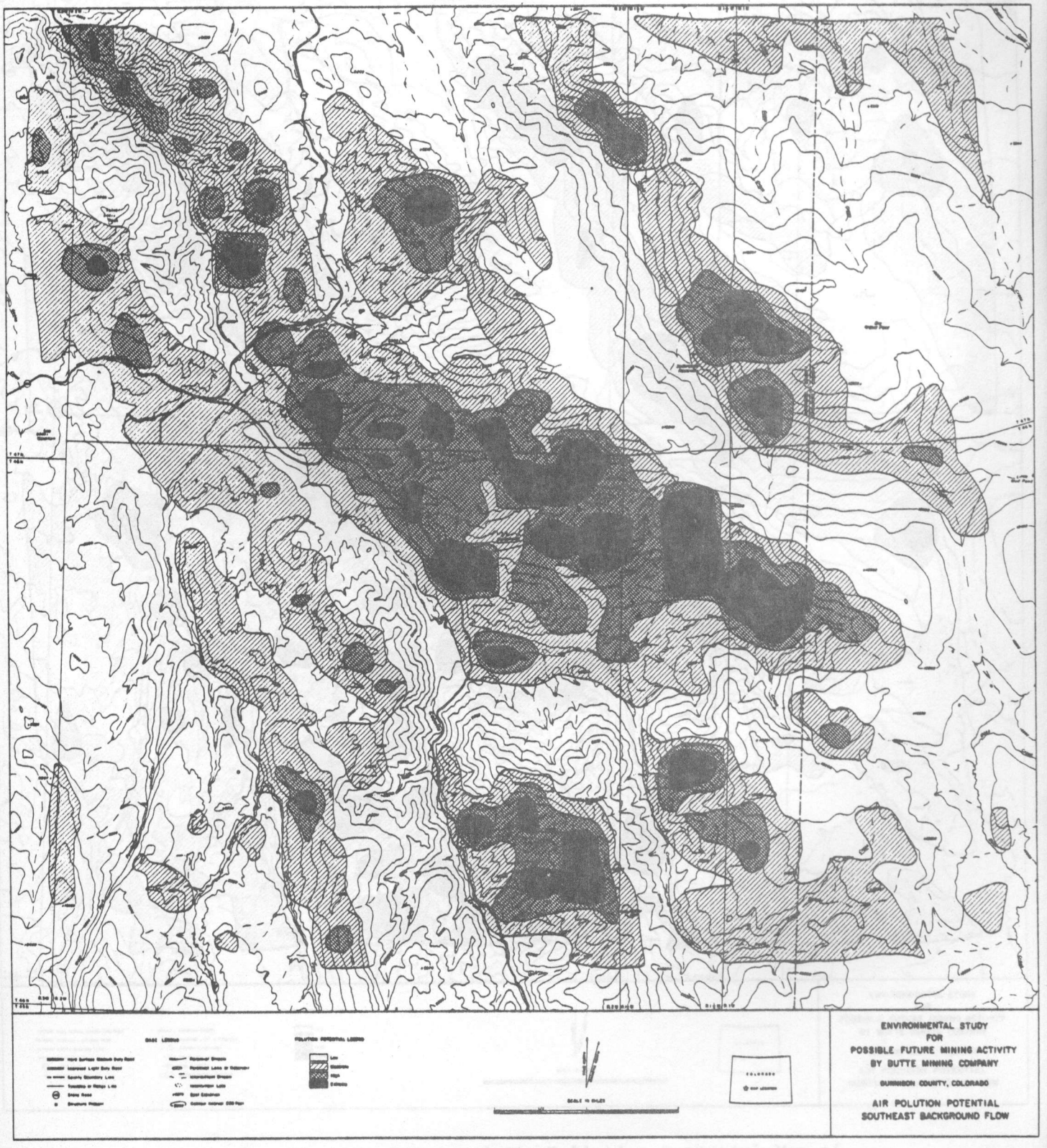

Figure 6. Computer Generated Air Pollution Potential Map of Powderhorn Project Area; Southeast Background Flow.

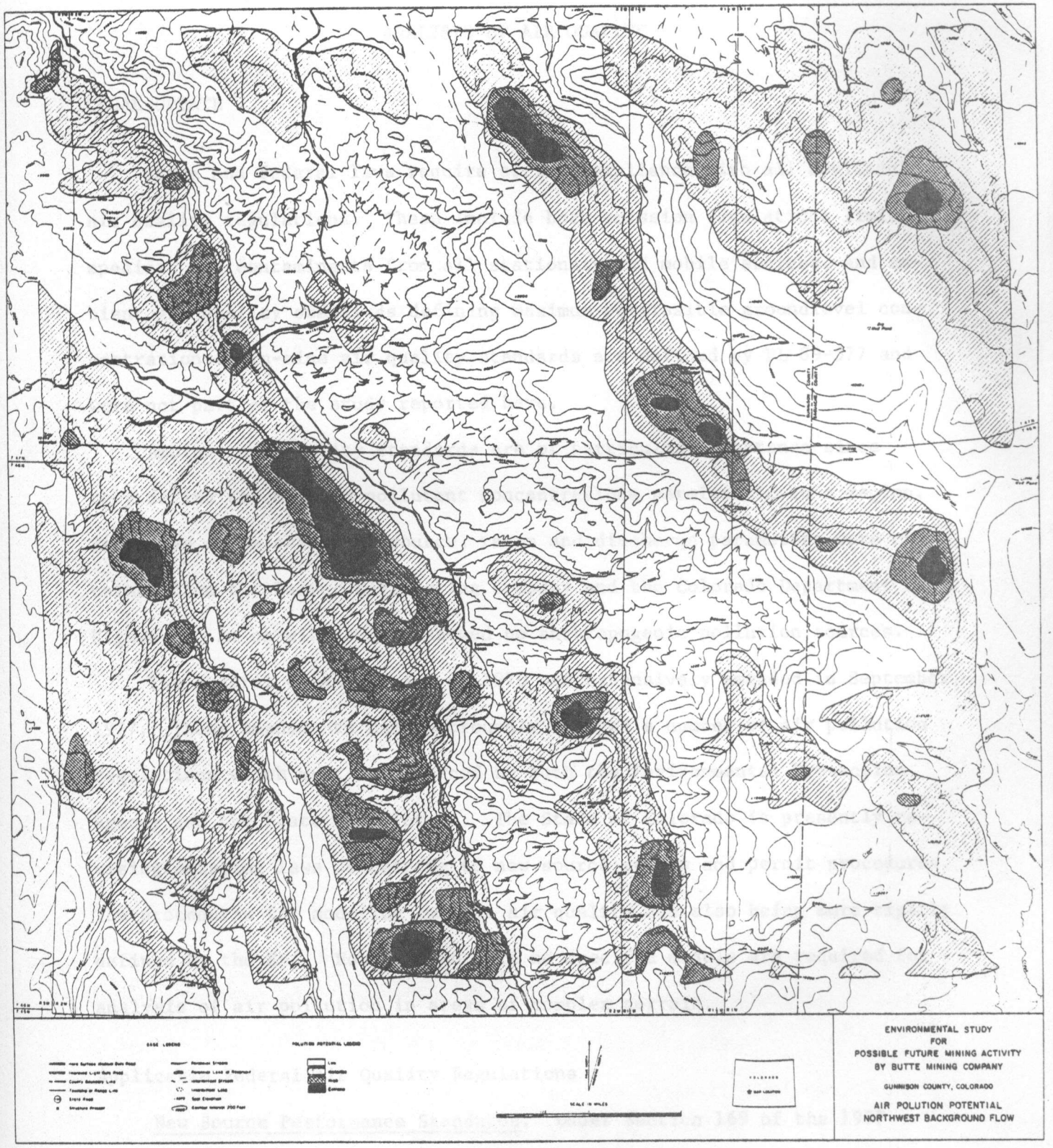

Figure 7. Computer Generated Air Pollution Potential Map of Powderhorn Project Area; Northwest Background Flow.

PART II

ANALYSIS OF AIR QUALITY

LEGAL UPDATE

State and federal laws require strict compliance with all applicable air quality regulations. These include both emission regulations limiting specific air contaminants from all stationary and mobile sources, and ambient air quality standards defining maximum permissible groundlevel concentrations. In-mine air quality standards are defined by PL 89-577 and were not part of the study reported here.

Ambient air quality standards are of particular importance since they define the maximum pollutant concentrations permissible in a region. Estimates of emissions by source, rates and discharge parameters were obtained from the Kaiser Engineering Company and the Colorado Department of Highways. An on-site survey showed no anthropogenic pollution sources.

The Federal Clean Air Act of 1970 was extensively amended in September, 1977. These amendments have profoundly changed a number of air pollution regulations which must be enforced by both the Environmental Protection Agency and the State of Colorado. The State of Colorado is presently revising existing laws pertaining to new source review and permit procedures. The procedures for modeling ambient air quality are also being more tightly defined by the EPA. However, to date no specific models are required for analysis of air pollution in areas of complex terrain.

Applicable Federal Air Quality Regulations

New Source Performance Standards. Under Section 169 of the 1977 Clean Air Act Amendments, the Powderhorn mine and plant is included under "other major sources." By this designation, a number of specific

procedures including use of "best available control technology" and modeling to determine compliance with ambient and PSD standards (see below), analysis of pollution from secondary growth and monitoring are required to assure continued compliance. Since at the time of this analysis, it was believed that the local population would not be increased appreciably, no off-site secondary impact analysis was deemed necessary.

Ambient Air Quality Standards. As required by the Clean Air Act of 1970 as amended in 1977, primary standards have been established which are intended to protect human health and secondary standards for protection of public welfare. These standards, based on both long-term and short-term exposure, are enforced for sulfur dioxide, nitrogen dioxide, carbon monoxide, photochemical oxidants, non-methane hydrocarbons and suspended particulates.

Prevention of Significant Deterioration (PSD). The Clean Air Act Amendments of 1977 allow only a specified "increment" of additional particulate matter or sulfur oxides in areas currently meeting the National Ambient Air Quality Standards, the so-called "attainment areas." The amendments also require the states to designate all areas into attainment and non-attainment areas. Colorado has not completed this designation at the time of this report. Even though seven of the 14 state operated particulate samplers in Air Quality Control Region 7 showed violations of the federal standards, the background air quality in the Cebolla Valley airshed is probably as clean as it is anywhere in Colorado and it is not anticipated that this condition will change appreciably in the foreseeable future, with or without the Buttes Company mine activity.

The Cebolla Valley is currently in an area classified by the EPA as Class II for PSD. The PSD Class II standards are:

	Maximum Allowable Increment ($\mu g/m^3$)
Particulate Matter	
Annual Average	19
24 Hour Maximum*	37
Sulfur Dioxide	
Annual Arithmetic Mean	21
24 Hour Maximum*	91
3 Hour Maximum*	512

*Not to be exceeded more than once per year.

The Powderhorn Wilderness area (supervised by the BLM) located about ten miles southwest of the project area, is the nearest Class I area. This area is not listed as a Class I region by the State of Colorado at this time (Air Pollution Control Commission, Colorado Department of Health, 1977). The PSD standards for Class I regions are:

	Maximum Allowable Increment ($\mu g/m^3$)
Particulate Matter	
Annual Average	5
24 Hour Maximum*	10
Sulfure Dioxide	
Annual Arithmetic Mean	2
24 Hour Maximum*	5
3 Hour Maximum*	10

*Not to be exceeded more than once per year.

PSD standards for hydrocarbons, carbon monoxide, photochemical oxidants and nitrogen oxides are not yet promulgated, however, these must be established within the next two years. No significant emission sources for any of the gaseous pollutants are identified for the Powderhorn project.

Applicable Colorado Air Quality Standards

Air quality standards are established by the Colorado Air Pollution Control Commission (APCC) and are administered by the Air Pollution Control Division (APCD) of the Colorado Department of Health. A number of current statues which may affect the Powderhorn mine operation are presently under review.

Emission Standards. Regulation #1: Regulation #1 of the APCC sets emission standards for opacity, fugitive dust, particulates and sulfur oxides. Opacity of emissions is limited to 20 percent. Specific procedures for minimizing fugitive dust are included.

Regulation #3: Regulation #3 requires that an "air contaminant emission notice" describing each anticipated emission source be filed prior to the release of any air contaminant. Obtaining an "emission permit" prior to construction and/or operation of an air contamination source is also required from the APCD. In order for the permit to be granted, the APCD must ascertain that applicable regulations will not be violated and that applicable ambient air quality standards will not be exceeded more than once per year even under "worst meteorological conditions." In the case of an air pollution alert, "halt and curtailment" procedures to be followed are defined by Regulation #3.

Regulation #8: Colorado's Regulation #8 controls emission levels for approximately 500 "chemical substances and physical agents," including those covered by the Federal "National Emission Standards for Hazardous Pollutants." Whether this regulation would apply to the Powderhorn mine and plant operation depends upon the trace elements in the ore and waste and the cleaning process used.

Ambient Air Quality Standards. The State of Colorado has adopted specific ambient air quality standards for suspended particulate matter and sulfur dioxide. These standards are more stringent than those promulgated by the federal government.

The applicable air quality standards set by both the federal government and the State of Colorado are given in Table 11.

Mine Environmental Air Standards. The air quality standards requirements are part of the Mine Environment and Safety Act and are probably better knwon to the Buttes Gas and Oil Company's mining engineering staff than to these authors. It is assumed that all regulations pertinent to air quality within the mine can and will be met.

BACKGROUND AIR QUALITY

The study area is in a very rural area of the state where the only human activities are ranching and recreation. No measurements of either gaseous pollutants nor particulate matter had been made in the area prior to the monitoring program established for the Powderhorn project. Since no emission sources of significance of any of the gaseous pollutants exist in the region, no monitoring program was established. It may be assumed that these are all at or below average global background.

Data from measurements of the total suspended particulates are available from Gunnison, Montrose and Crested Butte. None of these locations could be considered representative of the Cebolla Valley airshed. After consultation with the staff of the Colorado Air Pollution Division, one high volume particulate sampler was established at the Sammons Ranch in the Cebolla Valley just west of Iron Hill (Station 6A, Figure 1). This

Table 11. Ambient Air Quality Standards

Air Quality Standards

Pollutant	Type of Standard	Time Interval	Effective Year	Concentration µg/m³	Concentration PPM
Carbon Monoxide	Federal	1 hour	1977	10,000	35
		8 hour	1977	10,000	9
Hydrocarbons (non-methane)	Federal	3 hour (6-9 a.m. only)	(See Ozone)	160	0.24
Nitrogen Dioxide	Federal	1 year (arith.)	(undetermined)	100	0.05
Ozone (Oxidants)	Federal	1 hour	1977	160	0.08
Sulfur Dioxide**	Federal Primary	24 hour	1975	365	0.14
		1 yr. (arith.)	1975	80	0.03
	Secondary	3 hour	1975	1,300	0.5
Particulates	Federal Primary	24 hour	1975	260	--
		1 yr. (geo.)	1975	75	--
	Secondary	24 hour	1975	150	--
		1 yr. (geo.)	1975	60*	--
	State Non-Designated Areas	24 hour	1970	150	--
		1 yr. (arith.)	1970	45	--
	Designated	24 hour	1973	200	--
			1976	180	--
			1980	150	--
		1 yr. (arith.)	1973	70	--
			1976	55	--
			1980	45	--

* Federal guideline only

**SULFUR DIOXIDE (SO_2) AMBIENT AIR STANDARDS FOR THE STATE OF COLORADO

A. The actual concentration of sulfur dioxide at any receptor site (no greater than five meters above ground level) in the State of Colorado shall not exceed a three-hour maximum of 700 micrograms per cubic meter ($\mu g/m^3$) more than once in any twelve-month period.

B. The following ambient standards for sulfur dioxide are expressed as allowable amounts of increase in ambient concentration (increments) over an established baseline. All concentrations are expressed in micrograms per actual cubic meter under local conditions of temperature and pressure:

	Category I (incremental)	Category II (incremental)	Category III (incremental)
Annual Arithmetic Mean	2	10	15
24-Hour Maximum	5	50	100
3-Hour Maximum	25	300	700

1. The 24-hour and 3-hour standards are not to be exceeded at any receptor site more than once in any twelve-month period.

2. The "baseline" for these incremental standards is defined as that concentration of sulfur dioxide either measured or estimated by the Division to exist on the effective date of this amended regulation.

site was selected to represent the general airshed and it was agreed that a second station would be established at the crusher site when electrical power becomes available.

Table 12 provides a comparison of particulate measurements made at the Cebolla site with Gunnison, Montrose and Crested Butte.

In the study of Northwest Colorado for Coal Development (U.S. Bureau of Land Management) an annual arithmetic average concentration of 20 $\mu g/m^3$ was assumed to be characteristic of rural areas. This is the same as the annual arithmetic average measured at the Powderhorn project site. The highest single day concentration of 135 $\mu g/m^3$ was measured on March 22. The reason for this high value, nearly twice as high as the next highest, is not obvious. Wind speeds were not unusual on that date. Even so, this was below the state and federal 24 hour concentration standards.

EMISSIONS INVENTORY

The only sources of particulate matter pollution within the Cebolla Valley airshed at present include emissions and fugitive dust due to vehicular traffic along State Road 149, emissions from residential heating from the few ranch homes and fugitive dust from naturally exposed soil surfaces during periods of high winds.

The most recent monitoring study of daily vehicular traffic on State Road 149 (gravel) was conducted in 1976. At that time, the average daily traffic count was 290 vehicles. The expected rate of growth is three percent per year (Colorado Department of Highways, 1977). Applying this factor to the 1976 count, the daily traffic on State Road 149 predicted for 1996 is 520 vehicles (without the Powderhorn project).

Table 12. Total Suspended Particulates.

Date			Powderhorn	Gunnison	Montrose	Crested Butte
1976	December	4	14	109	114	-
		8	11	82	-	-
		12	18	58	70	159
		16	34	91	116	255
		20	2	-	106	262
		24	14	64	73	152
		28	15	80	98	130
1977	January	1	1	-	31	52
		5	3	-	54	59
		9	3	-	26	32
		13	5	-	59	87
		17	20	-	48	-
		21	11	-	102	120
		25	-	-	95	56
		29	5	-	87	58
	February	2	-	-	-	61
		6	4	-	-	-
		10	13	-	-	92
		14	13	-	78	65
		18	6	-	-	-
		22	35	-	-	-
		26	3	-	-	32
	March	2	11	-	-	-
		6	8	-	57	-
		10	87	-	143	74
		14	65	-	165	89
		18	9	-	68	35
		22	135*	-	62	-
		26	18	-	65	-
		30	22*	-	74	-
	April	3	6*	-	49	-
		7	-	-	73	72
		11	51	-	55	34
		15	26	-	77	32
		19	21	-	53	60
		23	18	-	51	-
		27	31*	-	71	66
	May	1	-	-	73	55
		5	-	61	152	107
		9	-	-	108	78
		13	46*	29	78	23
		17	48	89	151	96
		21	14	40	56	67
		25	16	38	114	55
		29	25*	45	45	81

Table 12. Continued

Date			Powderhorn	Gunnison	Montrose	Crested Butte
1977	June	2	17	62	-	118
		6	15*	-	-	57
		10	21	-	-	80
		14	21*	-	92	110
		18	-	58	89	151
		22	40	49	82	115
		26	21	46	38	39
		30	-	56	81	113
	July	4	12	30	-	47
		8	28	15	78	76
		12	10	-	80	104
		16	15	-	41	45
		20	7	-	41	29
		24	-	19	23	31
		28	-	28	56	173
	August	1	-	32	65	159
		5	13*	38	84	-
		9	20	30	65	-
		13	15	43	70	-
		17	14	-	-	31
		21	-	19	50	33
		25	-	28	50	78
		29	11*	36	49	167
	September	2	18*	36	76	165
		6	-	-	54	171
		10	-	40	56	163
		14	1*	30	55	120
		18	11*	29	39	112
		22	22*	-	109	146
		26	6*	34	-	95
		30	-	75	111	84
	October	4	8*	43	55	53
		8	-	37	44	71
		12	8	48	-	142
		16	14	53	59	-
		20	23*	70	59	-
		24	17*	-	68	-
		28	31*	101	75	166
	November	1	10	54	48	84
		5	-	60	73	46
		9	55	51	73	71
		13	41*	74	69	146
		17	17*	64	92	77
		21	7*	49	-	35
		25	8*	47	69	35
		29	-	73	55	75
	December	3	2	41	75	23
	Average		20	53	74	83

Both particulate emissions and fugitive dust may be expected to increase when the mine and processing plant become operational. The proposed mining activity is scheduled to operate with three daily work periods with shift change times anticipated to be at 7:00 a.m., 3:00 p.m. and 11:00 p.m. The three shifts will be manned with 100, 60 and 40 workers, respectively. A company bus system will bring employees from Gunnison, however it is estimated that ten percent of the workers for each shift will drive their own cars or pickup trucks. The EPA classified cars as Light Duty Vehicles (LDV) and pickup trucks as Light Duty Trucks (LDT) (EPA, 1977). The proposed bus will be a 36 seat vehicle and is classified as a Heavy Duty Vehicle (HDV). The traffic volume over paved roads expected for transportation of the workers at shift change times is shown in Table 13.

Table 13. Employee Traffic Volume Through the Cebolla Valley Area.

Period	Shift	LDV & LDT	HDV
11:30 - 12:30 a.m.	1	10	3
6:30 - 7:30 a.m.	2	14	4
2:30 - 3:30 p.m.	3	16	5

The proposed project will utilize 25 ton diesel trucks (heavy duty diesel - HDD) to transport ore concentrate from the process plant at the rate of one truck per hour in each direction, seven days per week. Large off-highway trucks of 120 ton capacity will operate over a 0.53 mile long gravel road hauling raw ore to the primary crusher. These trucks will travel at approximately 30 mph, delivering 600 tons per hour to the

crusher, five days per week during two of the shifts. There will be no mining during shift three. This gravel road will also be used by some service vehicles, mainly light duty trucks at an average speed of 40 to 50 miles per hour. During a normal working day, this gravel road will be used, then by ten-120 ton heavy duty vehicles per hour and eight light duty vehicles per day during the 7:00 a.m. to 11:00 p.m. period.

Sources of particulate matter emissions directly associated with the proposed mining operation will include the crushing and drying facilities and the tailings pile. The only dry processes involved are those of the drying plant and the electrostatic concentrator. All feed to these facilities will be plus 200 mesh. It is anticipated that cyclones and wet scrubbers will be adequate to control emissions. Consequently, most particulate matter emitted from the mining operation will be fugitive dust from disturbed or exposed soil surfaces. The tailings pile is expected to remain wet indefinitely, although the effect of surface skin drying along the pile has been included in the modeling calculations.

MODEL DESCRIPTION

Groundlevel concentrations of pollutants may be estimated through the use of mathematical air quality diffusion models which provide the capability to interface the dispersive characteristics of the boundary layer of the atmosphere with the quantities of contaminant material introduced into the air.

Air quality diffusion models may generally be classified into three categories. A statistical approach to diffusion forms the basis of the Gaussian plume model (Turner, 1969), the gradient theory of diffusion provides the basis of a second technique (Shaw and Munn, 1971) and an assumption of instantaneous, uniform mixing within a constrained region

offers the basis for a third set of models (Marlatt, Holben and Renne, 1973). The first two categories of models are not readily applicable to the situation encountered in the study area. The Gaussian plume model is limited to flat or gently rolling terrain. A version of the Gaussian plume model, the EPA Valley Terrain Model, can be used when a source is located in a valley area with a high terrain feature downwind. Both the Gaussian plume and the Valley terrain models must assume that the streamlines of the wind carrying the pollutant do not change direction. Since the measurements from Stations 2, 4 and 6, plus the computer generated windfield patterns show strong terrain control of the boundary layer wind, these models cannot be applied to the Powderhorn area. The gradient theory technique is of limited usefulness in any analysis for remote areas due to lack of input diffusivity data. The elementary mixing model, however, is particularly suited for use in the complex terrain situations. This model is a mathematical expression for computing the average concentration of a pollutant within a given volume of air over a short time period. A modification of the Ventilated Valley Diffusion Model (Marlatt, Holben and Renne, 1973) incorporating multiple volumes or "boxes" is used in this analysis.

In the Ventilated Valley Diffusion Model, the airshed is represented by a geometric shape or "box" of equivalent volume, such as the parallelepiped shown in Figure 8 and a mass balance expression is written. The volume of air considered is that of the appropriate airshed, horizontally constrained by the valley walls and vertically limited by a temperature inversion at a given height above the valley floor. Temperature inversions are formed when cold air "pools" in the bottom of the valleys in mountainous regions. Although no measurements are available, such cold air pools are believed to be common in the Cebolla Valley. The height, frequency

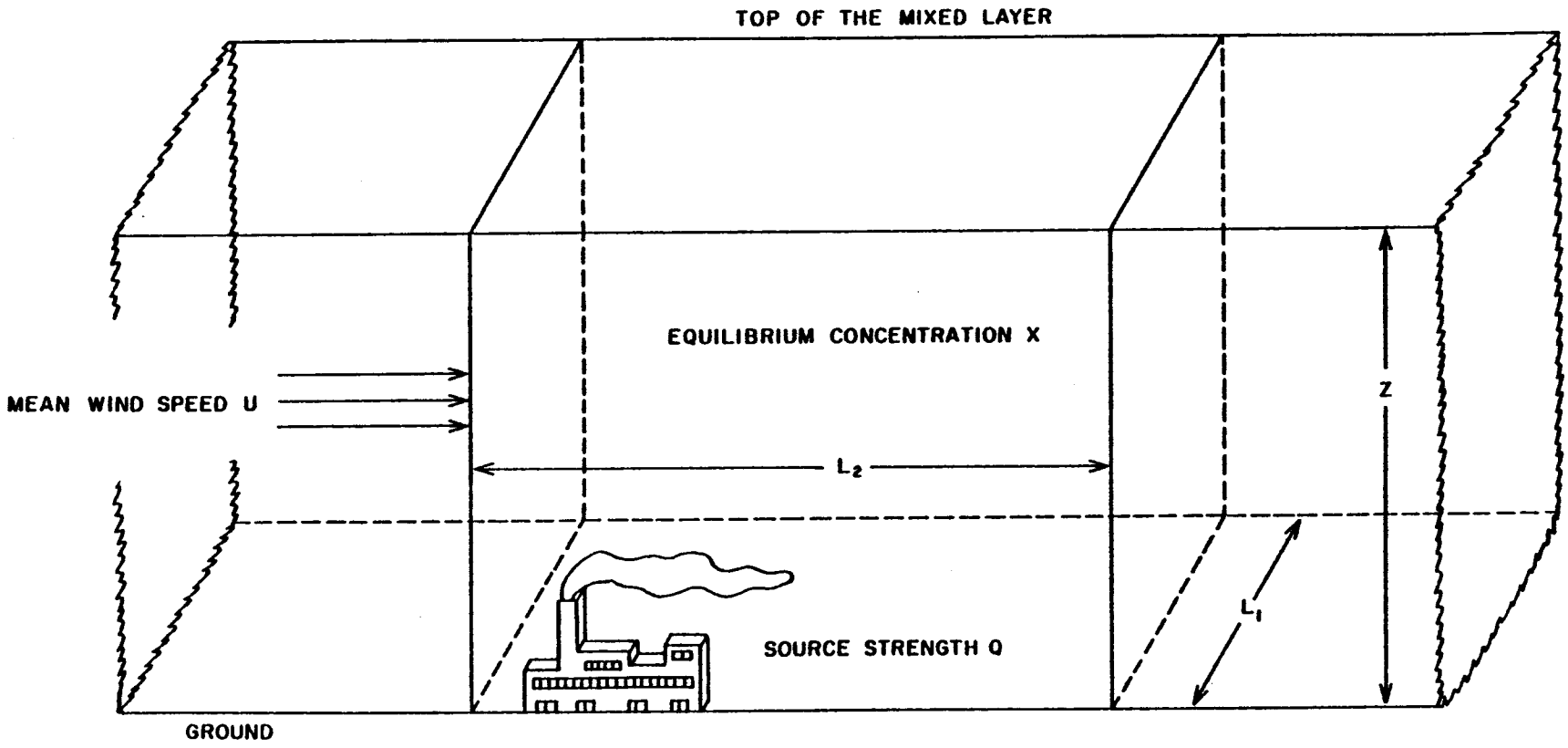

Figure 8. Ventilated Valley Diffusion Model.
(After Marlatt, Renne, and Holben, 1973)

and duration of temperature inversions and mixing depths require intensive (and expensive) measurement programs. The low emission rates anticipated from the proposed mining activity did not justify such a program. Based on previous experiences in mountain valleys in central Colorado, worst meteorological conditions was defined as an inpenetrable inversion at 120 meters above the valley floor in each box. The inversion was assumed to persist at this height for the entire analysis period.

The following assumptions are basic to the models' derivation:

(1) The source emission rate(s), q (mass per unit time), of any pollutant introduced into the airshed is constant during any functional period of time.

(2) There is instantaneous, perfect mixing within the constrained airshed so that the concentration, χ (mass per unit volume), of any pollutant is uniform throughout the airshed volume at any point in time.

(3) The meteorological state remains constant during each computational period.

(4) The total mass of pollutants is conserved-reactivity and deposition of the pollutants are ignored.

(5) The throughflow remains constant in direction and speed throughout each computational period.

The mass balance equation equates the time rate of change of pollutants in the box to the rate of emissions introduced into the "box". Mathematically stated that is:

$$\frac{dm}{dt} = \{q + Vr\chi_{BND}\} - Vr(\frac{m}{v})$$

where: m = the mass of pollutant material in the "box"

v = the volume of the "box"

q = the emission rate of pollutant material from sources located within the "box"

χ_{BND} = the concentration of pollutant at the upwind boundary of the "box"

Vr = the ventilation rate (ventilating area ($L_1 Z$) times the mean throughflow speed ($\bar{u}$).

$\frac{m}{v}$ = the contaminant concentration within the "box", often expressed by the equivalent symbol, χ.

The general solution of the model is:

$$\chi = \{\frac{q + \chi_{BND} Vr}{Vr}\} \{1-e^{\frac{-Vr}{v}t}\} + \chi_{BGD} e^{\frac{-Vr}{v}t}$$

where: χ = equilibrium concentration of the pollutant ($\frac{\text{mass}}{\text{unit volume}}$)

χ_{BND} = concentration of the pollutant at the volume's upwind boundary ($\frac{\text{mass}}{\text{unit volume}}$)

χ_{BGD} = concentration of the pollutant within the volume at t=0. That is, the volume's background concentration ($\frac{\text{mass}}{\text{unit volume}}$)

Vr = the ventilation rate = $\bar{u} L_1 Z$ (where $\bar{u}$ is the mean wind speed, L_1 is the crosswind length of the volume and Z is the mixing depth) ($\frac{\text{volume}}{\text{unit time}}$)

q = emission rate of pollutant from sources located within the airshed volume ($\frac{\text{mass}}{\text{unit time}}$)

t = elapsed time

v = volume of the box

e = base of Naperian logorithms.

The model therefore requires values for the following input parameters: inversion height (Z), ventilation rate ($\bar{u}L_1Z$), volume of the "boxes" (v), background pollutant concentration level (χ_{BGD}), the pollutant concentration level at the upwind boundary of each "box" (χ_{BND}), and the emission rate (q) of pollutant from contributing sources. For purposes of analysis, the study area was fragmented into the 11 "boxes" shown in Figure 9. Volumes of the "boxes", defined by the bottom and sides of the Cebolla, Powderhorn, Deldorado and Beaver Creek Valleys and a 120 meter mixing height, were determined with the aid of U.S.G.S. topographic maps (7.5 minute series). The following table (Table 14) summarizes the volumes of the 11 "boxes" and Table 15 presents the exchange areas of each "box".

Table 14. Volumes of "Boxes" Comprising the Cebolla Creek Airshed. Units are cubic kilometers.

Box	Volume (km^3)
1	.07
2	.37
3	.67
4	.20
5	.62
6	.70
7	1.00
8	.82
9	.78
10	.32
11	.08

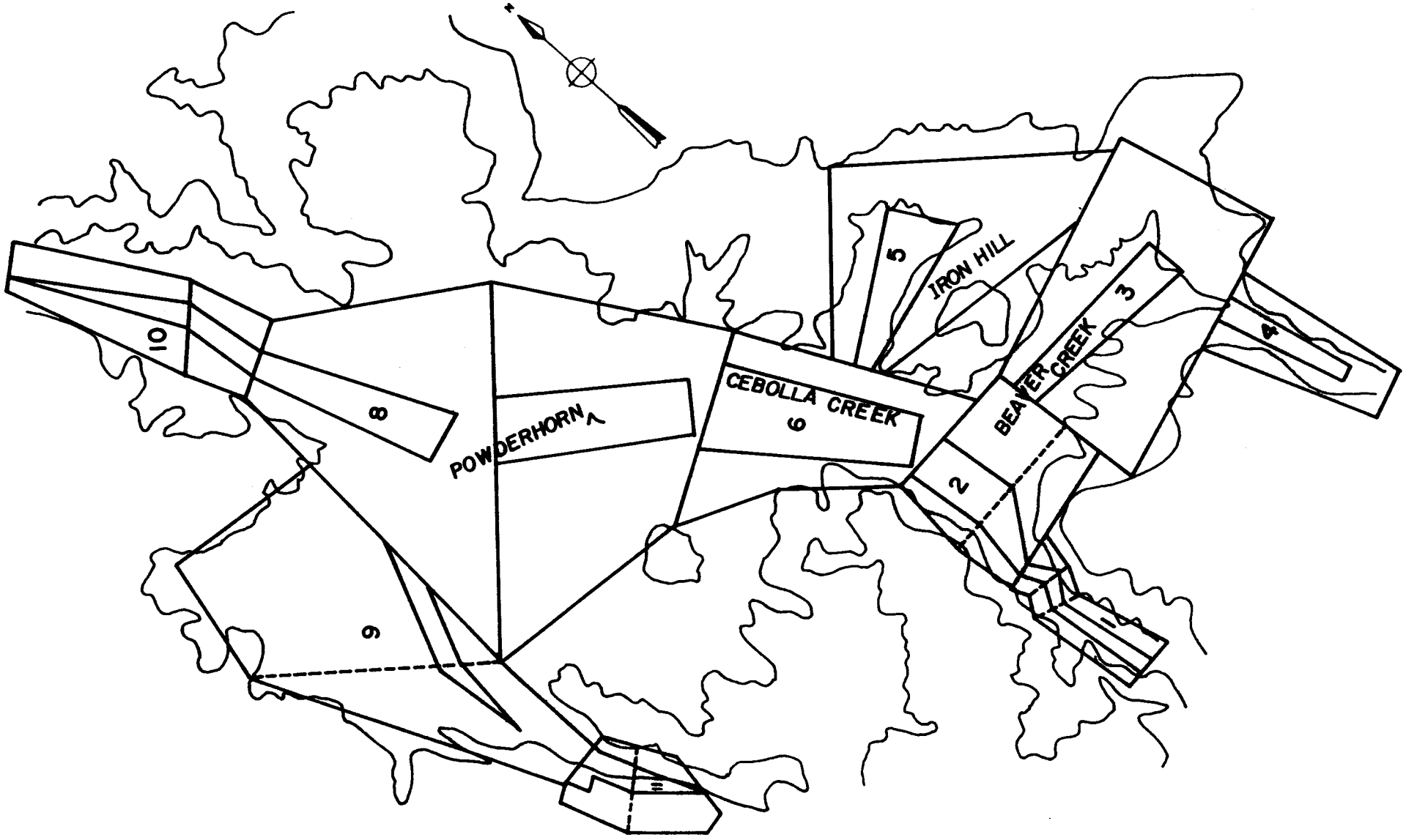

Figure 9. Configuration of "Boxes" Used in Air Quality Simulation.

Table 15. Exchange Areas Between "Boxes". Units are squared kilometers.

Boxes	Exchange Area (km^2)
1,2	.52
2,3	1.19
2,6	1.11
3,4	.67
3,5	.09
5,6	.46
6,7	1.87
7,8	2.86
8,9	2.14
8,10	.71
9,11	.15
1,00	.45
10,00	.45
11,00	.09

The particulate concentration at the upwind boundary of each "box" (χ_{BND}) is the concentration within the "box" immediately upwind of each respective "box" at the end of each computational period. Boxes 1, 4, 10 and 11 contain no emission sources. Box 4 acts as a reservoir where pollutants accumulate during the upvalley flow and are then advected into box 3 when the wind direction is downvalley.

Air entering box 10 during the downvalley condition is assumed to be uncontaminated. Similarly, the flow into boxes 1 and 11 during the downvalley phase is assumed to be clean air.

Although long-term observations of the mean wind velocity through the ascribed mixing depth in the study area are not available, sufficient meteorological data was collected during the monitoring period to postulate the behavior of the regional windfield under "worst case" conditions.

For purposes of analysis, a wind speed of 1.5 m/sec through the area was used to simulate the "worst case" situation.

To estimate the vehicular contribution to the suspended particulate matter emissions in each "box", the length of the roads in each "box" were determined with the aid of U.S.G.S. topographic maps (7.5 minute series). These are shown in Table 16.

Table 16. Road Mileages in Each "Box".

Box	Road Type	Road Length (miles)	Route
2	paved	.55	
3	paved	1.19	to the office
3	paved	1.66	to the piles
5	unpaved	.53	from mine to crusher
6	paved	1.63	
7	paved	1.94	
8	paved	1.55	Highway 149
8	paved	1.44	heading to the mine from Montrose
8	paved	1.00	heading to the mine from mobile homes
9	paved	1.28	Highway 149

Emission factors for particulate emissions from vehicular traffic due to exhaust and tire wear are shown in Table 17. For this analysis, the generation of fugitive dust due to the movement of vehicles over the paved roads was regarded as negligible.

Vehicular contributions to particulate emissions may be estimated by the following formula:

$$Q = EF \cdot VFR \cdot M \cdot CF$$

where Q = the vehicular emission strength (grams per second)

EF = the pollutant emission factor (grams per vehicle-mile)

VFR = the vehicle flow rate (vehicles per time step)

M = the miles traveled (miles)

CF = a conversion factor, seconds per time step ($seconds^{-1}$).

Table 17, Particulate Emission Factors for Vehicular Traffic. Units are grams per vehicle-mile (EPA AP-42, 1976).

Vehicle Type	Emission Factor (g/v-mi)
National Average	.58
Light Duty Vehicle	.54
Light Duty Truck	.54
Heavy Duty Vehicle	1.10
Heavy Duty Diesel	1.90

The pollutant emissions factors used are those presented in Table 18 and the miles traveled in each box are indicated in Table 16. The vehicle flow rate for each time period and box was determined from the traffic data presented previously.

Table 18. Particulate Emission Factors for Fugitive Dust Emissions from Unpaved Roads. Units are grams per vehicle-mile.

Speed (miles/hour)	Emission Factor (g/v-mi)
30	3.60
40	4.79
50	6.00

Since the access route to the crusher from the mining site will be surfaced with gravel, the passage of vehicles over this route will be a significant source of particulates (Figure 10). The amount of dust emitted from an uncontrolled gravel road per vehicle-mile of travel may be estimated (± 20 percent) using the following empirical expression (EPA AP-42, 1976):

$$EF = .6(.81s)\left(\frac{S}{30}\right)\left(\frac{365-W}{365}\right)$$

where: EF = the TSP emission factor for unpaved roads (grams per vehicle-mile)

s = the silt content of the road surface material (percent)

S = the average vehicle speed (miles per hour)

W = the mean annual number of days with .01 inches or more of rainfall

.6 = a factor incorporated into the expression to account for and report only those particles smaller than 30 μm in diameter, which constitute the emissions that may remain indefinitely suspended.

As the silt content of gravel roads averages about 12 percent (EPA AP-42, 1976) and the mean annual number of days with .01 inches or more of rainfall in the area is 120 (EPA AP-42, 1976), the emission factor (EF) for gravel roads under different speeds in the study area is shown in Table 18.

Potentially, the major sources of particulate pollution from the mining plant are the dryers. It is anticipated that cycone's and wet scrubbers will be adequate to control particulate emissions from the

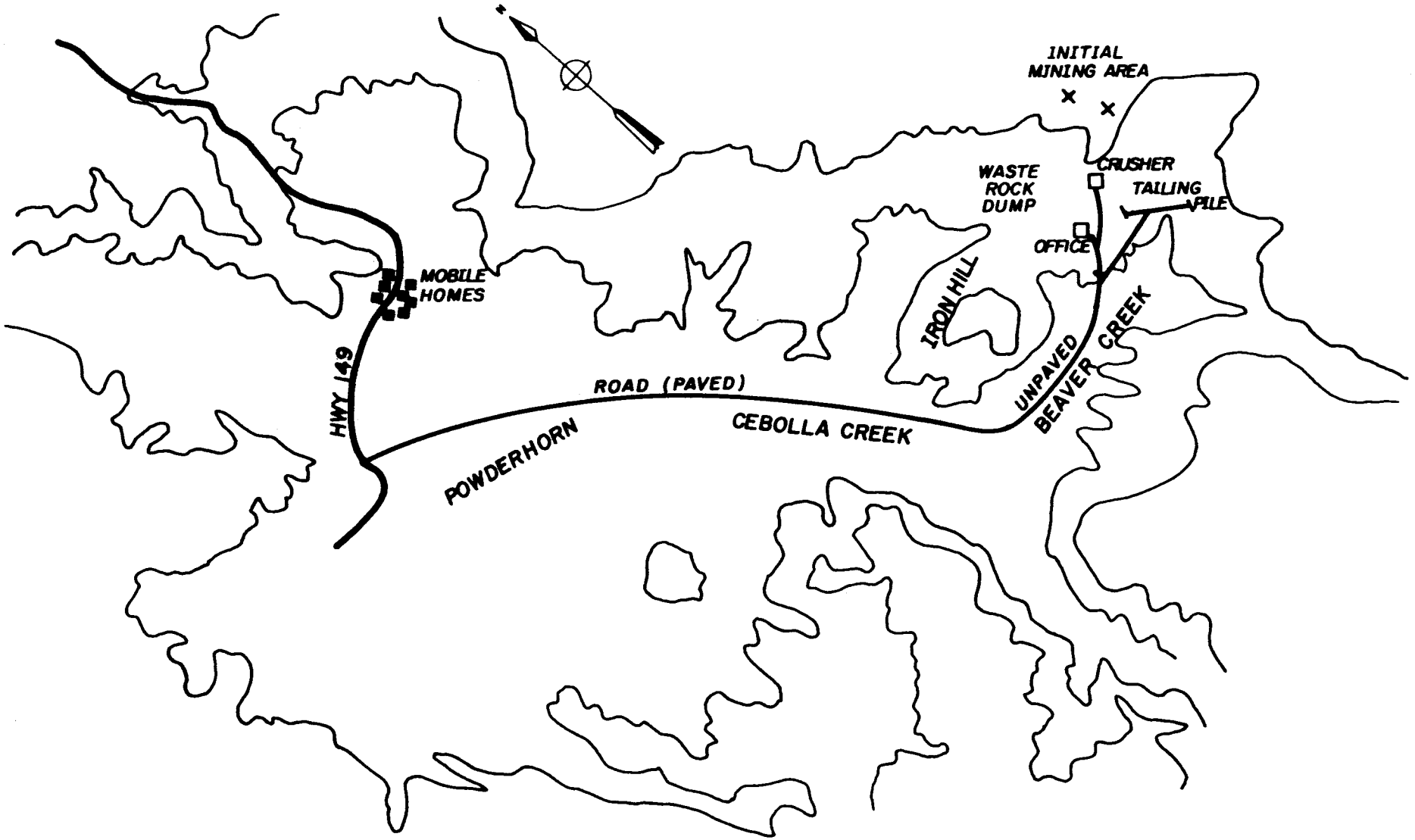

Figure 10. Access to Mining Operation, Powderhorn Project Area.

proposed drying plant. One other significant source of particulate emissions associated with the mining plant itself will be from the activity of crushing. An estimate of the amount of particulate that might be generated from this process may be obtained from data published by the U. S. Environmental Protection Agency on rock and crushed stone products processing (EPA AP-42, 1976). The estimated emission factor for uncontrolled emissions from the crushing of rock is 907 grams TSP per ton of ore processed. If it is assumed that 50 to 60 percent of this particulate matter will settle out in the plant, approximately 450 grams TSP per ton of ore processed will be released to the atmosphere, since no dust collection system is anticipated for the crushing facility.

The maintenance of outdoor storage or tailings piles may also be a significant source of dust. Particulate emissions from such piles may be caused by several distinct types of surface disturbances:

(1) The loading of processed ore onto the pile

(2) Equipment traffic over the storage area

(3) Disturbance by wind circulation

(4) The loading out of material from the pile.

The tailings pile will stay wet indefinitely but those tailings above the water level in the pond may undergo some surface skin drying. Assuming a 90 percent efficiency of dust suppression, an emission factor of 104 grams TSP per ton of ore processed has been used to estimate fugitive dust emissions from the tailings pile (EPA AP-42, 1976).

MODELING RESULTS

A 24 hour "worst case" simulation was run using the meteorological assumptions and emission estimates described in the previous sections. Table 19 shows ambient particulate concentrations reached in the simulation -- the 24 hour average concentration for each "box".

Table 19. Ambient Particulate Concentrations Estimated for Each "Box" Under "Worst Case" Meteorological Conditions. Units are micrograms per cubic meter.

Box Number	24 Hour Average ($\mu g/m^3$)
1	11.3
2	12.3
3	18.4
4	14.5
5	11.5
6	11.4
7	11.1
8	11.0
9	11.0
10	11.0
11	11.0

The results indicate that all areas of the Cebolla Creek airshed should be well within both federal and Colorado short-term air quality standards, even under "worst case" meteorological conditions. The 24 hour average concentrations are low enough that even a doubling of production levels by the proposed operation should result in particulate

concentrations well within the acceptable range. Mine contributions to particulate matter in the atmosphere, when added to the measured background particulate levels of less than 20 $\mu g/m^3$ should again be well within acceptable limits.

No attempt was made to "calibrate" the model used by adjusting the inversion height, wind speed, box dimensions, etc. to predict the concentration of a pollutant simultaneous to a measurement period. While total suspended particulates were monitored, the total lack of any sources in the region (with the exception of the one lightly traveled road) precluded a calibration effort. Whether the selection of 120 meters temperature inversions "lid" is realistic for this valley is not known but is believed to be a realistic, although very conservative, estimate.

No attempt was made to calculate the amount of particulate matter that was removed from the air by gravity or impingement. In a recent report (EPA, 1978), recommendations were made for calculating the removal of fugitive dust particulates through a fallout function. If this correction had been used, the values in Table 19 would have been reduced by perhaps 40 percent in the sub-airshed boxes next to the mine area and 60 percent in the valley in the area of the Powderhorn store.

UNAVOIDABLE ADVERSE IMPACTS

Air quality in the Cebolla Valley airshed is pristine at the present time; any development in the area would, of course, degrade this to some extent. And, although emission controls, cyclones, baghouses, scrubbers, etc. will be installed as necessary to assure that projected emission levels are below federal and state standards, and vehicular emissions are minimized

by busing the workers, adverse environmental effects can never be avoided entirely. Under certain conditions, the emission of fine particles and conversion of sulfur and nitrogen oxides in vehicular exhaust to aerosols may cause a small visibility reduction that cannot be mitigated.

Coal burned in the plant contains small amounts of trace elements and radionuclides, some of which would be released to the atmosphere during the operating lifetime of the mine. Although emission levels and groundlevel concentration of these will be extremely low, the pathways of many of the trace elements through the ecosystem are not yet well defined.

MITIGATION MEASURES

As discussed earlier, the primary air quality impact from the proposed action would be fugitive dust from the mining and processing and from vehicular traffic on unpaved roads. Fugitive dust from roads can be controlled by watering or, if necessary, by paving. A major mitigating measure for the control of fugitive dust is the reclamation of all disturbed surfaces. Reclamation includes grading, revegetation and other landscaping.

An air quality moinitoring program for total suspended particulates should be established at the mining/processing plant as soon as electrical power becomes available. At that time, it is recommended that dichotomous sizing heads be placed on both the particulate samplers to determine the relative proportion of large and small particles. The particulate monitoring program should be continued throughout the operation period. Data from the two locations should be used to determine the success of abatement programs.

REFERENCES

Air Pollution Control Commission. 1977. Report to the Public. An Annual Progress Report of the Colorado State Air Pollution Control Program. Colorado Department of Health, Denver, Colorado.

Colorado Department of Highways. 1977. Traffic Investigations Section, Personal Communication.

Fosberg, M. A., W. E. Marlatt and L. Krupnak. 1976. Estimating Airflow Patterns Over Complex Terrain. U.S.D.A. Forest Service, Research Paper RM-162. Rocky Mountain Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, Ft. Collins, Co.

Marlatt, W. E., B. Holben and D. A. Renne. 1973. Climatic Inventory and Related Environmental Impact of the Beaver Creek Development. Report Prepared for Rocky Mountain Seminar on the Environment.

Shaw, R. W. and R. E. Munn. 1971. Air Pollution Meteorology, p. 53-96, in McCormac, B. M., "Introduction to the Scientific Study of Atmospheric Pollution." D. Reidel Publishing Company, Dordrecht, Holland.

Turner, D. 1969. Workbook of Dispersion Estimates. U. S. Public Health Service, Department of Health, Education and Welfare. PHS Publication No. 99-AP-26, 84 pp.

U. S. Environmental Protection Agency. 1973. Guide for Compiling a Comprehensive Emission Inventory (Revised). Monitoring and Data Analysis Division. Publication No. APTD-1135. Office of Air and Water Programs, Office of Air Quality Planning and Standards, Research Triangle Park, NC.

U. S. Environmental Protection Agency. 1976. Compilation of Air Pollutant Emission Factors. Second Edition. Office of Air and Waste Management, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

U. S. Environmental Protection Agency. 1978. Survey of Fugitive Dust from Coal Mines. Report Prepared for Region 8, Denver, Colorado by PEDCO, EPA 908/1-78-003.

APPENDIX

A

WIND SPEED/DIRECTION FREQUENCY ANALYSIS

TABLE A1

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	92	251	93	50	21	6	11	0	2	0	526	5.4
NNE	9	100	50	29	24	30	19	1	0	3	265	2.7
NE	4	58	14	3	5	5	0	1	0	0	90	.9
ENE	20	150	97	5	4	14	2	0	0	3	295	3.0
E	30	289	529	205	42	5	4	1	2	2	1109	11.5
ESE	26	264	579	251	102	46	11	1	4	6	1290	13.3
SE	10	73	61	16	19	7	7	0	0	0	193	2.0
SSE	12	74	89	34	32	16	2	0	0	1	260	2.7
S	11	77	82	59	113	76	62	1	4	1	486	5.0
SSW	8	62	41	17	40	22	12	0	0	0	202	2.1
SW	4	22	16	9	21	13	3	0	1	6	95	1.0
WSW	14	44	34	17	24	19	11	3	1	0	167	1.7
W	18	97	79	22	40	9	6	1	1	7	280	2.9
WNW	36	270	356	219	231	123	78	9	1	1	1324	13.7
NW	34	268	223	176	345	202	180	17	0	7	1452	15.0
NNW	62	359	221	176	432	264	130	1	2	2	1649	17.0
TOTALS	390	2458	2564	1288	1495	857	538	36	18	39	9683	
%	4.0	25.4	26.5	13.3	15.4	8.9	5.6	.4	.2	.4		100.0

TABLE A1 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	4	68	48	25	25	2	0	0	0	0	172	2.8
NNE	11	121	69	9	7	1	0	0	0	0	218	3.6
NE	7	148	251	43	1	1	1	0	0	0	452	7.4
ENE	14	375	680	165	4	4	0	0	0	0	1242	20.3
E	16	86	159	27	3	4	1	0	1	0	297	4.9
ESE	9	19	14	14	14	11	3	0	0	0	84	1.4
SE	0	5	5	9	3	2	0	0	0	0	24	.4
SSE	6	16	32	38	46	21	4	0	0	0	163	2.7
S	13	41	37	55	93	42	7	0	0	0	288	4.7
SSW	13	109	71	29	55	11	4	0	0	0	292	4.8
SW	16	129	134	19	17	8	2	0	0	0	325	5.3
WSW	23	153	210	69	73	27	19	0	0	0	574	9.4
W	8	40	100	80	78	31	10	0	0	0	347	5.7
WNW	8	40	80	154	245	100	16	0	0	0	643	10.5
NW	4	42	58	92	187	99	36	0	0	0	518	8.5
NNW	4	71	75	106	141	58	10	0	0	0	465	7.6
TOTALS	156	1463	2023	934	992	422	113	0	1	0	6104	
%	2.6	24.0	33.1	15.3	16.3	6.9	1.9	0.0	.0	0.0		100.0

TABLE A1 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	45	58	27	4	1	0	0	0	0	0	135	1.1
NNE	2	37	38	11	11	3	8	16	0	5	131	1.1
NE	11	115	253	20	1	0	0	0	0	0	400	3.3
ENE	26	283	774	276	12	0	4	7	2	0	1384	11.6
E	23	201	615	722	132	6	0	0	0	0	1699	14.2
ESE	20	156	669	667	418	8	9	25	3	16	1991	16.7
SE	11	64	256	224	273	20	1	0	0	0	849	7.1
SSE	21	47	135	119	91	6	0	0	0	0	419	3.5
S	15	21	25	19	15	23	10	0	6	2	136	1.1
SSW	9	16	10	1	3	1	1	0	0	0	41	.3
SW	3	16	5	0	1	2	3	3	0	7	40	.3
WSW	9	25	65	42	15	0	0	1	2	0	159	1.3
W	26	94	260	260	239	142	27	0	2	9	1059	8.9
WNW	28	224	565	447	771	231	43	0	0	0	2309	19.3
NW	9	171	443	157	81	11	2	1	0	0	875	7.3
NNW	3	94	166	29	15	2	5	0	1	0	315	2.6
TOTALS	261	1622	4306	2998	2079	455	113	53	16	39	11942	
%	2.2	13.6	36.1	25.1	17.4	3.8	.9	.4	.1	.3		100.0

TABLE A2

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 NOVEMBER 1976

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	4	30	10	4	1	0	0	0	0	0	49	4.1
NNE	1	20	5	0	0	0	0	0	0	0	26	2.2
NE	0	5	1	0	0	0	0	0	0	0	6	.5
ENE	2	26	17	0	0	0	0	0	0	0	45	3.8
E	9	54	71	26	1	0	0	0	0	0	161	13.6
ESE	9	36	78	23	12	11	3	0	0	0	172	14.5
SE	2	12	7	0	0	0	0	0	0	0	21	1.8
SSE	2	15	1	0	0	0	0	0	0	0	18	1.5
S	3	12	1	0	0	0	0	0	0	0	16	1.4
SSW	1	8	2	0	0	0	0	0	0	0	11	.9
SW	2	4	2	3	3	0	0	0	0	0	14	1.2
WSW	4	11	3	0	3	2	0	0	0	0	23	1.9
W	8	15	7	2	0	0	0	0	0	0	32	2.7
WNW	11	46	51	27	21	17	8	0	0	0	181	15.3
NW	4	45	25	22	45	32	17	4	0	0	194	16.4
NNW	9	43	26	27	65	32	14	0	0	0	216	18.2
TOTALS	71	382	307	134	151	94	42	4	0	0	1185	
%	6.0	32.2	25.9	11.3	12.7	7.9	3.5	.3	0.0	0.0		100.0

TABLE A2 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 NOVEMBER 1976

WIND SPEED MPH

DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	2	0	0	0	0	0	0	0	0	2	.2
NNE	0	1	9	0	0	0	0	0	0	0	10	1.2
NE	0	13	36	2	0	0	0	0	0	0	51	6.3
ENE	0	12	67	40	2	0	0	0	0	0	121	14.8
E	0	12	67	101	28	0	0	0	0	0	208	25.5
ESE	1	2	24	22	14	0	0	0	0	0	63	7.7
SE	0	1	10	1	1	0	0	0	0	0	13	1.5
SSE	0	2	5	5	0	0	0	0	0	0	12	1.5
S	1	2	1	0	0	0	0	0	0	0	4	.5
SSW	0	0	0	0	0	0	0	0	0	0	0	0.0
SW	0	0	0	0	0	0	0	0	0	0	0	0.0
WSW	4	0	3	0	0	0	0	0	0	0	7	.9
W	2	12	11	14	17	13	4	0	0	0	73	8.9
WNW	1	27	49	37	56	19	4	0	0	0	193	23.7
NW	0	11	24	10	2	3	0	0	0	0	50	6.1
NNW	0	2	7	0	0	0	0	0	0	0	9	1.1
TOTALS	9	99	313	232	120	35	8	0	0	0	816	
%	1.1	12.1	38.4	28.4	14.7	4.3	1.0	0.0	0.0	0.0		100.0

TABLE A3

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 DECEMBER 1976

WIND SPEED MPH

DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	2	26	10	0	1	0	0	0	0	0	39	3.9
NNE	2	15	6	1	0	0	0	0	0	0	24	2.4
NE	2	5	1	0	0	0	0	0	0	0	8	.8
ENE	3	18	6	0	0	0	0	0	0	0	27	2.7
E	3	46	76	20	3	0	0	0	0	0	148	14.9
ESE	2	31	94	32	0	0	0	0	0	0	159	16.1
SE	0	15	6	0	0	0	0	0	0	0	21	2.1
SSE	2	7	5	0	0	0	0	0	0	0	14	1.4
S	2	6	5	0	0	0	0	0	0	0	13	1.3
SSW	1	11	7	0	0	0	0	0	0	0	19	1.9
SW	0	3	1	0	0	0	0	0	0	0	4	.4
WSW	0	12	3	0	0	0	0	0	0	0	15	1.5
W	0	23	18	2	0	0	0	0	0	0	43	4.3
WNW	1	44	53	20	17	6	1	0	0	0	142	14.3
NW	5	29	11	13	30	17	25	4	0	0	134	13.5
NNW	5	39	34	23	42	25	12	0	0	0	180	18.2
TOTALS	30	330	336	111	93	48	38	4	0	0	990	
%	3.0	33.3	33.9	11.2	9.4	4.8	3.8	.4	0.0	0.0		100.0

TABLE A3 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 DECEMBER 1976

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	9	1	0	0	0	0	0	0	0	10	1.7
NNE	0	10	3	0	0	0	0	0	0	0	13	2.2
NE	0	12	6	0	0	0	0	0	0	0	18	3.0
ENE	2	56	97	35	2	0	0	0	0	0	192	32.2
E	1	16	51	8	0	0	0	0	0	0	76	12.7
ESE	0	2	2	0	0	0	0	0	0	0	4	.7
SE	0	0	0	0	0	0	0	0	0	0	0	0.0
SSE	0	1	0	0	0	0	0	0	0	0	1	.2
S	0	3	0	0	0	0	0	0	0	0	3	.5
SSW	0	4	5	0	0	0	0	0	0	0	9	1.5
SW	1	18	15	1	0	0	0	0	0	0	35	5.9
WSW	1	33	49	6	3	0	0	0	0	0	92	15.4
W	0	6	5	6	5	1	0	0	0	0	23	3.9
WNW	0	1	2	8	11	4	0	0	0	0	26	4.4
NW	0	2	8	5	18	14	2	0	0	0	49	8.2
NNW	0	5	8	13	14	4	2	0	0	0	46	7.7
TOTALS	5	178	252	82	53	23	4	0	0	0	597	
%	.8	29.8	42.2	13.7	8.9	3.9	.7	0.0	0.0	0.0		100.0

TABLE A3 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 DECEMBER 1976

WIND SPEED MPH

[illegible]	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
[illegible]	0	0	2	0	0	0	0	0	0	0	2	.5
[illegible]E	0	2	0	0	0	0	0	0	0	0	2	.5
[illegible]	0	4	26	3	0	0	0	0	0	0	33	7.4
[illegible]E	0	3	42	7	0	0	0	0	0	0	52	11.7
E	0	6	38	44	9	0	0	0	0	0	97	21.9
ESE	0	3	13	24	19	0	0	0	0	0	59	13.3
SE	0	1	8	11	8	0	0	0	0	0	28	6.3
SSE	0	1	1	0	0	0	0	0	0	0	2	.5
S	1	0	0	0	0	0	0	0	0	0	1	.2
SSW	0	0	0	0	0	0	0	0	0	0	0	0.0
SW	0	0	0	0	0	0	0	0	0	0	0	0.0
WSW	0	1	1	2	0	0	0	0	0	0	4	.9
W	0	3	16	3	5	6	0	0	0	0	33	7.4
WNW	1	7	20	7	31	11	7	0	0	0	84	19.0
NW	0	10	27	3	1	0	0	0	0	0	41	9.3
NNW	1	1	3	0	0	0	0	0	0	0	5	1.1
TOTALS	3	42	197	104	73	17	7	0	0	0	443	
%	.7	9.5	44.5	23.5	16.5	3.8	1.6	0.0	0.0	0.0		100.0

TABLE A4

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 JANUARY 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	4	17	8	2	1	0	1	0	0	0	33	3.9
NNE	0	6	2	0	0	0	0	0	0	0	8	1.0
NE	0	14	0	0	0	0	0	0	0	0	14	1.7
ENE	2	7	0	0	0	0	0	0	0	0	9	1.1
E	5	28	31	6	0	0	0	0	0	0	70	8.4
ESE	3	49	69	18	0	0	0	0	0	0	139	16.6
SE	5	18	2	0	0	0	0	0	0	0	25	3.0
SSE	3	12	3	0	0	0	0	0	0	0	18	2.1
S	2	17	3	1	0	0	0	0	0	0	23	2.7
SSW	1	9	2	0	0	0	0	0	0	0	12	1.4
SW	1	5	5	0	0	0	0	0	0	0	11	1.3
WSW	0	8	6	0	0	0	0	0	0	0	14	1.7
W	1	13	8	1	0	0	0	0	0	0	23	2.7
WNW	3	40	41	18	6	1	0	0	0	0	109	13.0
NW	4	43	27	20	29	16	13	4	0	0	156	18.6
NNW	3	27	22	21	52	38	11	0	0	0	174	20.8
TOTALS	37	313	229	87	88	55	25	4	0	0	838	
%	4.4	37.4	27.3	10.4	10.5	6.6	3.0	.5	0.0	0.0		100.0

TABLE A4 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 JANUARY 1977

WIND SPEED MPH

DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	1	13	4	4	4	0	0	0	0	0	26	3.7
NNE	3	11	2	0	0	0	0	0	0	0	16	2.3
NE	2	9	3	0	0	0	0	0	0	0	14	2.0
ENE	2	59	111	35	0	0	0	0	0	0	207	29.1
E	2	27	40	7	0	0	0	0	0	0	76	10.7
ESE	0	2	1	0	0	0	0	0	0	0	3	.4
SE	0	0	0	0	0	0	0	0	0	0	0	0.0
SSE	0	0	0	0	0	0	0	0	0	0	0	0.0
S	0	0	0	0	0	0	0	0	0	0	0	0.0
SSW	1	13	4	0	0	0	0	0	0	0	18	2.5
SW	5	29	43	6	0	0	0	0	0	0	83	11.7
WSW	6	32	36	3	0	0	0	0	0	0	77	10.8
W	5	7	18	8	0	0	0	0	0	0	38	5.3
WNW	2	8	5	17	8	1	0	0	0	0	41	5.8
NW	0	6	5	16	20	12	7	0	0	0	66	9.3
NNW	0	6	9	13	15	2	1	0	0	0	46	6.5
TOTALS	29	222	281	109	47	15	8	0	0	0	711	
%	4.1	31.2	39.5	15.3	6.6	2.1	1.1	0.0	0.0	0.0		100.0

TABLE A4 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 JANUARY 1977

WIND SPEED MPH

DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	44	46	17	2	0	0	0	0	0	0	109	9.4
NNE	0	3	4	3	6	3	8	16	0	5	48	4.1
NE	0	6	36	4	0	0	0	0	0	0	46	3.9
ENE	4	17	68	32	0	0	4	7	1	0	133	11.4
E	3	13	46	70	16	5	0	0	0	0	153	13.1
ESE	1	11	20	37	41	6	9	25	3.	16	169	14.5
SE	1	7	8	21	38	1	1	0	0	0	77	6.6
SSE	8	0	1	2	1	0	0	0	0	0	12	1.0
S	2	2	5	9	15	23	10	0	6	2	74	6.4
SSW	4	2	0	0	0	1	0	0	0	0	7	.6
SW	0	2	0	0	1	2	3	3	0	7	18	1.5
WSW	1	7	9	24	9	0	0	0	2	0	52	4.5
W	3	12	8	5	4	7	2	0	2	9	52	4.5
WNW	6	27	34	20	29	14	1	0	0	0	131	11.2
NW	3	9	22	12	4	0	0	1	0	0	51	4.4
NNW	1	5	8	8	4	1	5	0	1	0	33	2.8
TOTALS	81	169	286	249	168	63	43	52	15	39	1165	
%	7.0	14.5	24.5	21.4	14.4	5.4	3.7	4.5	1.3	3.3		100.0

TABLE A5

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 FEBRUARY 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	59	100	10	2	1	1	6	0	2	0	181	24.6
NNE	1	4	4	4	7	14	2	1	0	3	40	5.4
NE	0	1	1	1	0	0	0	1	0	0	4	.5
ENE	0	14	5	1	1	12	1	0	0	3	37	5.0
E	1	14	21	4	4	2	1	1	2	2	52	7.1
ESE	0	15	29	22	22	11	1	1	4	6	111	15.1
SE	0	4	1	2	2	2	0	0	0	0	11	1.5
SSE	0	2	0	0	0	3	0	0	0	1	6	.8
S	0	2	0	10	10	0	0	1	4	1	28	3.8
SSW	0	3	2	0	1	0	2	0	0	0	8	1.1
SW	0	1	0	1	1	0	0	0	1	6	10	1.4
WSW	1	2	5	2	0	0	2	3	1	0	16	2.2
W	2	2	0	1	1	1	0	1	1	7	16	2.2
WNW	1	15	28	14	13	1	1	1	1	1	76	10.3
NW	0	26	13	7	5	0	0	0	0	7	58	7.9
NNW	2	23	12	8	25	6	2	1	2	2	83	11.3
TOTALS	67	228	131	79	93	53	18	11	18	39	737	
%	9.1	30.9	17.8	10.7	12.6	7.2	2.4	1.5	2.4	5.3		100.0

TABLE A5 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 FEBRUARY 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	5	4	0	0	0	0	0	0	0	9	.9
NNE	0	2	4	0	0	0	0	0	0	0	6	.6
NE	2	9	25	2	0	0	0	0	0	0	38	3.9
ENE	2	17	107	22	0	0	0	0	0	0	148	15.3
E	0	7	61	61	15	0	0	0	0	0	144	14.9
ESE	0	5	24	44	53	0	0	0	0	0	126	13.0
SE	3	3	3	9	7	1	0	0	0	0	26	2.7
SSE	2	1	5	4	12	1	0	0	0	0	25	2.6
S	2	2	1	0	0	0	0	0	0	0	5	.5
SSW	1	1	1	0	1	0	0	0	0	0	4	.4
SW	1	1	0	0	0	0	0	0	0	0	2	.2
WSW	3	0	3	1	1	0	0	0	0	0	8	.8
W	6	11	28	32	26	30	9	0	0	0	142	14.7
WNW	4	22	74	18	55	29	3	0	0	0	205	21.2
NW	2	11	31	8	9	0	0	0	0	0	61	6.3
NNW	0	8	9	1	2	0	0	0	0	0	20	2.1
TOTALS	28	105	380	202	181	61	12	0	0	0	969	
%	2.9	10.8	39.2	20.8	18.7	6.3	1.2	0.0	0.0	0.0		100.0

TABLE A6

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 MARCH 1977

WIND SPEED MPH

DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	7	13	3	4	2	0	0	0	0	0	29	2.6
NNE	0	13	7	2	0	0	0	0	0	0	22	2.0
NE	1	6	1	0	0	0	0	0	0	0	8	.7
ENE	3	20	12	0	0	0	0	0	0	0	35	3.1
E	4	27	26	1	1	0	0	0	0	0	59	5.3
ESE	3	29	55	15	6	3	1	0	0	0	112	10.0
SE	0	8	6	5	7	0	0	0	0	0	26	2.3
SSE	0	5	14	10	12	7	0	0	0	0	48	4.3
S	0	6	12	14	35	41	17	0	0	0	125	11.2
SSW	2	9	16	4	10	7	0	0	0	0	48	4.3
SW	0	1	5	3	7	9	2	0	0	0	27	2.4
WSW	1	4	7	4	3	4	4	0	0	0	27	2.4
W	0	8	8	4	10	0	2	0	0	0	32	2.9
WNW	1	17	28	16	14	6	17	0	0	0	99	8.9
NW	2	26	18	17	55	35	40	0	0	0	193	17.3
NNW	10	39	25	23	54	44	30	0	0	0	225	20.2
TOTALS	34	231	243	122	216	156	113	0	0	0	1115	
%	3.0	20.7	21.8	10.9	19.4	14.0	10.1	0.0	0.0	0.0		100.0

TABLE A6 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 MARCH 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	1	9	10	6	3	0	0	0	0	0	29	3.0
NNE	4	13	11	2	1	0	0	0	0	0	31	3.2
NE	2	11	0	0	0	0	0	0	0	0	13	1.4
ENE	1	61	107	14	0	0	0	0	0	0	183	19.1
E	8	12	17	3	0	0	0	0	0	0	40	4.2
ESE	3	3	1	1	0	0	0	0	0	0	8	.8
SE	0	1	2	2	0	0	0	0	0	0	5	.5
SSE	4	1	6	3	5	1	0	0	0	0	20	2.1
S	4	4	9	10	33	18	2	0	0	0	80	8.4
SSW	1	13	15	5	28	5	0	0	0	0	67	7.0
SW	5	30	24	3	4	3	0	0	0	0	69	7.2
WSW	3	18	20	6	10	6	5	0	0	0	68	7.1
W	0	4	16	14	7	8	6	0	0	0	55	5.7
WNW	3	0	14	18	16	10	2	0	0	0	63	6.6
NW	1	5	8	15	41	29	6	0	0	0	105	11.0
NNW	2	8	12	17	52	29	1	0	0	0	121	12.6
TOTALS	42	193	272	119	200	109	22	0	0	0	957	
%	4.4	20.2	28.4	12.4	20.9	11.4	2.3	0.0	0.0	0.0		100.0

TABLE A6 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 MARCH 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	1	1	0	0	0	0	0	0	0	0	2	.1
NNE	0	3	1	0	0	0	0	0	0	0	4	.3
NE	0	12	18	0	0	0	0	0	0	0	30	2.2
ENE	4	37	58	14	0	0	0	0	0	0	113	8.3
E	4	32	59	44	5	0	0	0	0	0	144	10.6
ESE	1	31	91	65	56	1	0	0	0	0	245	18.0
SE	1	10	39	38	57	2	0	0	0	0	147	10.8
SSE	1	9	23	12	21	0	0	0	0	0	66	4.8
S	2	3	0	1	0	0	0	0	0	0	6	.4
SSW	0	0	0	0	0	0	0	0	0	0	0	0.0
SW	0	0	1	0	0	0	0	0	0	0	1	.1
WSW	0	4	14	0	0	0	0	0	0	0	18	1.3
W	8	16	23	40	55	28	5	0	0	0	175	12.9
WNW	3	21	55	40	114	57	7	0	0	0	297	21.8
NW	1	12	37	22	20	3	2	0	0	0	97	7.1
NNW	0	5	8	1	1	1	0	0	0	0	16	1.2
TOTALS	26	196	427	277	329	92	14	0	0	0	1361	
%	1.9	14.4	31.4	20.4	24.2	6.8	1.0	0.0	0.0	0.0		100.0

TABLE A7

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 APRIL 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	2	0	0	0	0	0	0	0	0	2	.2
NNE	0	5	3	2	1	0	0	0	0	0	11	1.1
NE	2	16	30	4	1	0	0	0	0	0	53	5.5
ENE	3	29	57	26	1	0	0	0	0	0	116	12.1
E	2	26	45	58	6	0	0	0	0	0	137	14.2
ESE	4	14	58	32	18	0	0	0	0	0	126	13.1
SE	1	5	17	13	13	0	0	0	0	0	49	5.1
SSE	2	2	6	12	5	0	0	0	0	0	27	2.9
S	2	2	2	2	0	0	0	0	0	0	8	.9
SSW	0	1	1	0	1	0	0	0	0	0	3	.3
SW	0	3	2	0	0	0	0	0	0	0	5	.5
WSW	0	3	5	1	3	0	0	0	0	0	12	1.2
W	1	8	33	44	43	21	2	0	0	0	152	15.9
WNW	4	28	45	29	42	4	0	0	0	0	152	15.8
NW	2	10	47	14	10	2	0	0	0	0	85	8.9
NNW	1	5	12	3	3	0	0	0	0	0	24	2.5
TOTALS	24	159	363	240	147	27	2	0	0	0	962	
%	2.5	16.5	37.7	24.9	15.3	2.8	.2	0.0	0.0	0.0		100.0

TABLE A8

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 MAY 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	5	2	6	5	3	1	0	0	0	22	4.0
NNE	0	4	2	3	0	0	0	0	0	0	9	1.6
NE	0	2	0	0	0	0	0	0	0	0	2	.4
ENE	3	5	2	0	0	0	0	0	0	0	10	1.8
E	0	7	15	0	1	0	0	0	0	0	23	4.2
ESE	1	16	42	23	9	0	0	0	0	0	91	16.6
SE	0	4	12	4	3	1	0	0	0	0	24	4.4
SSE	0	6	11	3	1	0	0	0	0	0	21	3.8
S	1	3	2	1	7	7	21	0	0	0	42	7.7
SSW	0	2	2	0	15	10	10	0	0	0	39	7.1
SW	0	1	0	0	4	0	1	0	0	0	6	1.1
WSW	0	0	2	2	7	5	1	0	0	0	17	3.1
W	0	3	1	2	4	2	3	0	0	0	15	2.7
WNW	0	2	1	3	6	2	0	0	0	0	14	2.6
NW	1	4	13	11	16	12	9	2	0	0	68	12.4
NNW	0	21	11	14	42	29	28	0	0	0	145	26.5
TOTALS	6	85	118	72	120	71	74	2	0	0	548	
%	1.1	15.5	21.5	13.1	21.9	13.0	13.5	.4	0.0	0.0		100.0

TABLE A8 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 MAY 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	0	0	1	0	0	0	0	0	0	1	.1
NNE	0	3	6	5	4	0	0	0	0	0	18	1.9
NE	0	3	10	0	0	0	0	0	0	0	13	1.3
ENE	0	21	48	18	3	0	0	0	0	0	90	9.3
E	1	20	39	52	12	0	0	0	0	0	124	12.8
ESE	0	6	59	74	76	1	0	0	0	0	216	22.4
SE	0	2	18	35	88	13	0	0	0	0	156	16.1
SSE	0	1	11	9	12	1	0	0	0	0	34	3.5
S	0	0	4	1	0	0	0	0	0	0	5	.5
SSW	0	3	1	1	0	0	1	0	0	0	6	.6
SW	0	0	0	0	0	0	0	0	0	0	0	0.0
WSW	0	1	2	2	0	0	0	0	0	0	5	.5
W	0	2	11	11	18	21	5	0	0	0	68	7.0
WNW	0	12	27	35	67	39	2	0	0	0	182	18.8
NW	0	7	19	12	5	0	0	0	0	0	43	4.5
NNW	0	2	2	1	0	0	0	0	0	0	5	.5
TOTALS	1	83	257	257	285	75	8	0	0	0	966	
%	.1	8.6	26.6	26.6	29.5	7.8	.8	0.0	0.0	0.0		100.0

TABLE A9

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 JUNE 1977

WIND SPEED MPH

DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	4	17	7	8	3	1	3	0	0	0	43	5.7
NNE	0	7	3	2	2	1	0	0	0	0	15	2.0
NE	0	6	4	0	3	1	0	0	0	0	14	1.9
ENE	2	13	3	0	2	0	0	0	0	0	20	2.6
E	0	9	22	6	2	0	3	0	0	0	42	5.5
ESE	3	16	60	48	28	8	2	0	0	0	165	21.8
SE	1	5	10	2	4	4	7	0	0	0	33	4.4
SSE	0	7	7	7	3	0	0	0	0	0	24	3.2
S	1	4	8	7	11	6	2	0	0	0	39	5.2
SSW	1	10	1	9	12	1	0	0	0	0	34	4.5
SW	1	1	1	2	5	1	0	0	0	0	11	1.5
WSW	0	1	2	2	5	0	0	0	0	0	10	1.3
W	2	3	6	1	5	0	0	0	0	0	17	2.2
WNW	0	3	4	7	3	4	1	0	0	0	22	2.9
NW	1	5	21	15	18	7	2	0	0	0	69	9.1
NNW	8	46	32	19	43	37	13	0	0	0	198	26.2
TOTALS	24	153	191	135	149	71	33	0	0	0	756	
%	3.2	20.2	25.3	17.9	19.7	9.4	4.4	0.0	0.0	0.0		100.0

TABLE A9 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 JUNE 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	2	2	3	3	1	0	0	0	0	11	2.3
NNE	0	5	13	3	4	1	0	0	0	0	26	5.4
NE	1	10	34	10	1	0	0	0	0	0	56	11.6
ENE	0	13	42	5	1	0	0	0	0	0	61	12.6
E	0	2	5	1	1	3	0	0	0	0	12	2.5
ESE	0	0	1	2	0	6	2	0	0	0	11	2.3
SE	0	0	0	1	2	0	0	0	0	0	3	.6
SSE	0	1	5	12	8	8	3	0	0	0	37	7.7
S	1	1	5	7	23	9	1	0	0	0	47	9.7
SSW	2	4	3	1	5	1	0	0	0	0	16	3.3
SW	0	9	8	0	4	1	1	0	0	0	23	4.8
WSW	2	2	6	11	10	10	8	0	0	0	49	10.1
W	0	2	6	5	10	2	0	0	0	0	25	5.2
WNW	0	3	5	13	24	6	0	0	0	0	51	10.6
NW	0	2	2	5	17	6	0	0	0	0	32	6.6
NNW	0	3	7	8	3	2	0	0	0	0	23	4.8
TOTALS	6	59	144	87	116	56	15	0	0	0	483	
%	1.2	12.2	29.8	18.0	24.0	11.6	3.1	0.0	0.0	0.0		100.0

TABLE A9 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 JUNE 1977

WIND SPEED MPH

DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	0	0	1	1	0	0	0	0	0	2	.2
NNE	0	0	1	0	0	0	0	0	0	0	1	.1
NE	0	2	10	4	0	0	0	0	0	0	16	2.0
ENE	0	9	32	36	4	0	0	0	0	0	81	10.0
E	4	15	45	76	13	0	0	0	0	0	153	18.9
ESE	1	7	58	52	21	0	0	0	0	0	139	17.2
SE	0	2	26	23	17	2	0	0	0	0	70	8.7
SSE	0	4	7	11	7	1	0	0	0	0	30	3.7
S	0	2	5	2	0	0	0	0	0	0	9	1.1
SSW	1	2	3	0	0	0	0	0	0	0	6	.7
SW	0	2	2	0	0	0	0	0	0	0	4	.5
WSW	1	1	3	0	0	0	0	0	0	0	5	.6
W	1	4	12	12	15	1	0	0	0	0	45	5.6
WNW	2	23	47	50	50	6	0	0	0	0	178	22.0
NW	0	8	42	9	3	0	0	0	0	0	62	7.7
NNW	0	3	3	1	1	0	0	0	0	0	8	1.0
TOTALS	10	84	296	277	132	10	0	0	0	0	809	
%	1.2	10.4	36.6	34.2	16.3	1.2	0.0	0.0	0.0	0.0		100.0

TABLE A10

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 JULY 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	2	4	5	1	0	0	0	0	0	12	19.0
NNE	1	2	4	1	3	3	5	0	0	0	19	30.2
NE	0	1	0	1	0	1	0	0	0	0	3	4.8
ENE	0	1	0	0	0	0	0	0	0	0	1	1.6
E	0	0	2	0	0	0	0	0	0	0	2	3.2
ESE	0	0	2	6	0	0	0	0	0	0	8	12.7
SE	0	0	0	0	0	0	0	0	0	0	0	0.0
SSE	0	0	0	0	0	0	0	0	0	0	0	0.0
S	0	0	0	0	0	0	0	0	0	0	0	0.0
SSW	0	0	0	0	0	0	0	0	0	0	0	0.0
SW	0	0	0	0	0	0	0	0	0	0	0	0.0
WSW	0	0	0	0	0	0	0	0	0	0	0	0.0
W	0	0	0	0	0	0	0	0	0	0	0	0.0
WNW	0	0	1	0	0	0	0	0	0	0	1	1.6
NW	0	1	0	0	1	2	2	0	0	0	6	9.5
NNW	0	2	1	1	3	2	2	0	0	0	11	17.5
TOTALS	1	9	14	14	8	8	9	0	0	0	63	
%	1.6	14.3	22.2	22.2	12.7	12.7	14.3	0.0	0.0	0.0		100.0

TABLE A10 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 JULY 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	5	3	1	0	0	0	0	0	0	9	2.0
NNE	3	13	7	1	1	0	0	0	0	0	25	5.4
NE	0	16	35	9	0	0	0	0	0	0	60	13.0
ENE	2	14	20	5	0	2	0	0	0	0	43	9.3
E	1	4	1	0	2	1	0	0	0	0	9	2.0
ESE	3	3	4	5	6	0	1	0	0	0	22	4.8
SE	0	0	0	3	0	1	0	0	0	0	4	.9
SSE	1	1	4	8	7	1	0	0	0	0	22	4.8
S	2	1	5	2	7	0	0	0	0	0	17	3.7
SSW	3	10	5	2	1	1	1	0	0	0	23	5.0
SW	2	6	4	0	3	0	0	0	0	0	15	3.3
WSW	0	14	15	8	12	0	0	0	0	0	49	10.6
W	0	3	8	4	7	3	0	0	0	0	25	5.4
WNW	0	7	6	18	31	14	1	0	0	0	77	16.7
NW	1	5	2	3	12	5	0	0	0	0	28	6.1
NNW	1	14	2	7	5	4	0	0	0	0	33	7.2
TOTALS	19	116	121	76	94	32	3	0	0	0	461	
%	4.1	25.2	26.2	16.5	20.4	6.9	.7	0.0	0.0	0.0		100.0

TABLE A10 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 JULY 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	0	1	0	0	0	0	0	0	0	1	.3
NNE	0	0	0	0	0	0	0	0	0	0	0	0.0
NE	0	1	1	0	0	0	0	0	0	0	2	.5
ENE	0	9	14	3	0	0	0	0	0	0	26	7.1
E	2	9	12	13	1	0	0	0	0	0	37	10.1
ESE	3	16	43	16	6	0	0	0	0	0	84	22.9
SE	0	6	18	2	2	1	0	0	0	0	29	7.9
SSE	1	5	13	8	3	0	0	0	0	0	30	8.2
S	0	0	1	0	0	0	0	0	0	0	1	.3
SSW	3	0	0	0	0	0	0	0	0	0	3	.8
SW	1	1	0	0	0	0	0	0	0	0	2	.5
WSW	0	1	2	0	0	0	0	0	0	0	3	.8
W	2	5	12	7	2	0	0	0	0	0	28	7.6
WNW	1	10	23	21	24	1	0	0	0	0	80	21.8
NW	0	8	11	0	0	0	0	0	0	0	19	5.2
NNW	0	9	11	2	0	0	0	0	0	0	22	6.0
TOTALS	13	80	162	72	38	2	0	0	0	0	367	
%	3.5	21.8	44.1	19.6	10.4	.5	0.0	0.0	0.0	0.0		100.0

TABLE A11

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 AUGUST 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	4	9	22	16	5	1	0	0	0	0	57	4.2
NNE	4	16	13	12	12	12	12	0	0	0	81	6.0
NE	1	12	5	1	2	1	0	0	0	0	22	1.6
ENE	3	13	12	3	1	2	1	0	0	0	35	2.6
E	6	43	96	31	11	3	0	0	0	0	190	14.1
ESE	0	39	87	39	24	13	4	0	0	0	206	15.3
SE	2	5	10	1	2	0	0	0	0	0	20	1.5
SSE	2	12	12	8	7	4	0	0	0	0	45	3.3
S	1	10	21	9	30	9	10	0	0	0	90	6.7
SSW	2	5	4	2	0	1	0	0	0	0	14	1.0
SW	0	2	2	0	1	2	0	0	0	0	7	.5
WSW	2	3	4	2	2	2	0	0	0	0	15	1.1
W	2	8	6	2	3	1	1	0	0	0	23	1.7
WNW	5	30	38	40	41	33	12	0	0	0	199	14.8
NW	4	22	30	18	40	23	24	0	0	0	161	12.0
NNW	2	34	27	17	57	31	11	0	0	0	179	13.3
TOTALS	40	263	389	201	238	138	75	0	0	0	1344	
%	3.0	19.6	28.9	15.0	17.7	10.3	5.6	0.0	0.0	0.0		100.0

TABLE A11 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 AUGUST 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	11	7	3	4	0	0	0	0	0	25	2.2
NNE	1	36	17	3	0	0	0	0	0	0	57	4.9
NE	1	42	122	18	0	1	1	0	0	0	185	15.9
ENE	2	35	55	12	1	2	0	0	0	0	107	9.2
E	1	7	6	3	0	0	1	0	0	0	18	1.5
ESE	1	2	1	4	5	5	0	0	0	0	18	1.5
SE	0	2	2	1	1	1	0	0	0	0	7	.6
SSE	1	8	15	10	18	10	1	0	0	0	63	5.4
S	2	16	10	22	13	7	2	0	0	0	72	6.2
SSW	3	28	24	5	2	0	1	0	0	0	63	5.4
SW	3	13	16	6	4	3	1	0	0	0	46	4.0
WSW	5	18	34	12	27	8	1	0	0	0	105	9.0
W	2	9	15	18	29	8	0	0	0	0	81	7.0
WNW	2	12	19	35	84	38	1	0	0	0	191	16.4
NW	0	9	7	13	29	7	1	0	0	0	66	5.7
NNW	1	13	18	13	12	1	0	0	0	0	58	5.0
TOTALS	25	261	368	178	229	91	10	0	0	0	1162	
%	2.2	22.5	31.7	15.3	19.7	7.8	.9	0.0	0.0	0.0		100.0

TABLE A11 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 AUGUST 1977

WIND SPEED MPH

DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	0	1	0	0	0	0	0	0	0	1	.1
NNE	2	2	0	0	0	0	0	0	0	0	4	.3
NE	1	4	5	1	0	0	0	0	0	0	11	.8
ENE	2	50	62	10	0	0	0	0	0	0	124	9.4
E	1	20	80	51	8	1	0	0	0	0	161	12.2
ESE	3	27	88	93	23	0	0	0	0	0	234	17.7
SE	1	11	47	33	13	0	0	0	0	0	105	8.0
SSE	2	14	44	44	20	3	0	0	0	0	127	9.6
S	2	3	3	2	0	0	0	0	0	0	10	.8
SSW	0	2	2	0	0	0	0	0	0	0	4	.3
SW	0	2	0	0	0	0	0	0	0	0	2	.2
WSW	0	2	2	1	0	0	0	0	0	0	5	.4
W	3	7	22	13	16	0	0	0	0	0	61	4.6
WNW	0	16	58	73	117	8	0	0	0	0	272	20.6
NW	0	23	61	27	9	1	0	0	0	0	121	9.2
NNW	0	28	38	8	3	0	0	0	0	0	77	5.8
TOTALS	17	211	513	356	209	13	0	0	0	0	1319	
%	1.3	16.0	38.9	27.0	15.8	1.0	0.0	0.0	0.0	0.0		100.0

TABLE A12

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 SEPTEMBER 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	2	8	5	1	1	0	0	0	0	0	17	2.4
NNE	0	1	1	1	0	0	0	0	0	0	3	.4
NE	0	0	0	0	0	1	0	0	0	0	1	.1
ENE	1	6	5	0	0	0	0	0	0	0	12	1.7
E	0	13	43	37	9	0	0	0	0	0	102	14.4
ESE	0	11	36	14	1	0	0	0	0	0	62	8.8
SE	0	2	3	0	0	0	0	0	0	0	5	.7
SSE	0	4	17	5	3	0	2	0	0	0	31	4.4
S	1	5	19	12	16	7	10	0	0	0	70	9.9
SSW	0	2	2	1	0	2	0	0	0	0	7	1.0
SW	0	1	0	0	0	1	0	0	0	0	2	.3
WSW	1	0	0	1	2	6	3	0	0	0	13	1.8
W	0	4	1	1	3	2	0	0	0	0	11	1.6
WNW	2	19	25	17	34	16	11	8	0	0	132	18.6
NW	2	16	19	18	35	27	26	3	0	0	146	20.6
NNW	3	28	17	10	18	13	5	0	0	0	94	13.3
TOTALS	12	120	193	118	122	75	57	11	0	0	708	
%	1.7	16.9	27.3	16.7	17.2	10.6	8.1	1.6	0.0	0.0		100.0

TABLE A12 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 SEPTEMBER 1977

WIND SPEED MPH

DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	1	2	7	2	6	1	0	0	0	0	19	2.0
NNE	0	8	7	0	1	0	0	0	0	0	16	1.7
NE	1	25	45	6	0	0	0	0	0	0	77	8.3
ENE	4	75	110	21	0	0	0	0	0	0	210	22.6
E	1	10	16	2	0	0	0	0	1	0	30	3.2
ESE	0	3	3	2	3	0	0	0	0	0	11	1.2
SE	0	2	1	2	0	0	0	0	0	0	5	.5
SSE	0	4	2	5	8	1	0	0	0	0	20	2.2
S	2	13	4	10	15	7	2	0	0	0	53	5.7
SSW	2	22	10	15	14	3	1	0	0	0	67	7.2
SW	0	13	12	1	2	1	0	0	0	0	29	3.1
WSW	5	19	23	16	10	3	5	0	0	0	81	8.7
W	1	4	16	14	14	8	3	0	0	0	60	6.5
WNW	0	7	8	15	31	20	7	0	0	0	88	9.5
NW	0	9	18	16	25	14	12	0	0	0	94	10.1
NNW	0	14	5	20	18	11	1	0	0	0	69	7.4
TOTALS	17	230	287	147	147	69	31	0	1	0	929	
%	1.8	24.8	30.9	15.8	15.8	7.4	3.3	0.0	.1	0.0		100.0

TABLE A12 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 SEPTEMBER 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	0	0	0	0	0	0	0	0	0	0	0.0
NNE	0	4	0	1	0	0	0	0	0	0	5	.5
NE	4	18	7	0	0	0	0	0	0	0	29	3.1
ENE	3	31	53	16	0	0	0	0	1	0	104	11.1
E	4	13	55	33	4	0	0	0	0	0	109	11.6
ESE	4	22	90	65	33	0	0	0	0	0	214	22.8
SE	1	9	29	20	10	0	0	0	0	0	69	7.4
SSE	4	2	9	5	4	0	0	0	0	0	24	2.6
S	0	1	1	1	0	0	0	0	0	0	3	.3
SSW	0	3	1	0	1	0	0	0	0	0	5	.5
SW	1	2	0	0	0	0	0	0	0	0	3	.3
WSW	0	3	5	0	1	0	0	0	0	0	9	1.0
W	0	6	21	17	10	6	0	0	0	0	60	6.4
WNW	4	9	47	43	68	24	10	0	0	0	205	21.9
NW	0	16	39	18	6	0	0	0	0	0	79	8.4
NNW	0	2	16	1	0	0	0	0	0	0	19	2.0
TOTALS	25	141	373	220	137	30	10	0	1	0	937	
%	2.7	15.0	39.8	23.5	14.6	3.2	1.1	0.0	.1	0.0		100.0

TABLE A13

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 OCTOBER 1977

WIND SPEED MPH

DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	6	24	12	2	0	0	0	0	0	0	44	3.6
NNE	0	11	3	3	0	0	0	0	0	0	17	1.4
NE	0	5	1	0	0	1	0	0	0	0	7	.6
ENE	1	25	26	1	0	0	0	0	0	0	53	4.4
E	2	43	102	71	7	0	0	0	0	0	225	18.6
ESE	5	19	21	7	0	0	0	0	0	0	52	4.3
SE	0	0	1	0	1	0	0	0	0	0	2	.2
SSE	2	4	14	0	0	1	0	0	0	0	21	1.7
S	0	11	7	5	4	6	2	0	0	0	35	2.9
SSW	0	3	1	1	2	1	0	0	0	0	8	.7
SW	0	1	0	0	0	0	0	0	0	0	1	.1
WSW	3	3	2	1	0	0	1	0	0	0	10	.8
W	2	14	17	6	12	3	0	0	0	0	54	4.5
WNW	11	39	78	49	72	37	27	0	0	0	313	25.8
NW	10	48	39	31	66	25	22	0	0	0	241	19.9
NNW	16	48	12	13	31	7	2	0	0	0	129	10.6
TOTALS	58	298	336	190	195	81	54	0	0	0	1212	
%	4.8	24.6	27.7	15.7	16.1	6.7	4.5	0.0	0.0	0.0		100.0

TABLE A13 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 OCTOBER 1977

WIND SPEED MPH

DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	11	11	6	5	0	0	0	0	0	33	5.4
NNE	0	17	4	0	0	0	0	0	0	0	21	3.4
NE	0	13	2	0	0	0	0	0	0	0	15	2.4
ENE	1	43	104	29	0	0	0	0	0	0	177	28.8
E	2	6	19	3	0	0	0	0	0	0	30	4.9
ESE	1	4	1	0	0	0	0	0	0	0	6	1.0
SE	0	0	0	0	0	0	0	0	0	0	0	0.0
SSE	0	0	0	0	0	0	0	0	0	0	0	0.0
S	2	3	4	4	2	1	0	0	0	0	16	2.6
SSW	0	10	4	1	5	1	1	0	0	0	22	3.6
SW	0	9	9	2	0	0	0	0	0	0	20	3.3
WSW	1	13	23	5	1	0	0	0	0	0	43	7.0
W	0	5	11	9	6	1	1	0	0	0	33	5.4
WNW	0	1	10	22	28	7	5	0	0	0	73	11.9
NW	2	3	6	13	22	12	8	0	0	0	66	10.7
NNW	0	6	12	13	19	5	5	0	0	0	60	9.8
TOTALS	9	144	220	107	88	27	20	0	0	0	615	
%	1.5	23.4	35.8	17.4	14.3	4.4	3.3	0.0	0.0	0.0		100.0

TABLE A13 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 OCTOBER 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	1	2	0	0	0	0	0	0	0	3	.2
NNE	0	10	10	0	0	0	0	0	0	0	20	1.5
NE	1	12	48	0	0	0	0	0	0	0	61	4.5
ENE	5	28	145	49	1	0	0	0	0	0	228	16.8
E	0	20	53	108	15	0	0	0	0	0	196	14.5
ESE	2	9	66	106	40	0	0	0	0	0	223	16.4
SE	2	4	16	5	7	0	0	0	0	0	34	2.5
SSE	1	4	1	1	1	0	0	0	0	0	8	.6
S	2	2	0	0	0	0	0	0	0	0	4	.3
SSW	0	2	0	0	0	0	0	0	0	0	2	.1
SW	0	2	0	0	0	0	0	0	0	0	2	.1
WSW	0	1	12	11	1	0	0	1	0	0	26	1.9
W	0	6	53	56	16	1	0	0	0	0	132	9.7
WNW	1	14	69	52	79	14	9	0	0	0	238	17.6
NW	0	33	68	11	5	0	0	0	0	0	117	8.5
NNW	0	18	41	2	1	0	0	0	0	0	62	4.6
TOTALS	14	166	584	401	166	15	9	1	0	0	1356	
%	1.0	12.2	43.1	29.6	12.2	1.1	.7	.1	0.0	0.0		100.0

TABLE A14

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 NOVEMBER 1977

WIND SPEED MPH

DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	0	0	0	0	0	0	0	0	0	0	0.0
NNE	0	1	0	0	0	0	0	0	0	0	1	.5
NE	0	1	0	0	0	0	0	0	0	0	1	.5
ENE	0	2	9	0	0	0	0	0	0	0	11	5.8
E	0	5	24	5	3	0	0	0	0	0	37	19.6
ESE	0	3	6	4	0	0	0	0	0	0	13	6.9
SE	0	0	3	2	0	0	0	0	0	0	5	2.6
SSE	1	0	5	1	6	1	0	0	0	0	14	7.4
S	0	1	4	0	0	0	0	0	0	0	5	2.6
SSW	0	0	2	0	0	0	0	0	0	0	2	1.1
SW	0	2	0	0	0	0	0	0	0	0	2	1.1
WSW	2	0	0	3	2	0	0	0	0	0	7	3.7
W	1	4	7	0	2	0	0	0	0	0	14	7.4
WNW	1	15	8	8	4	0	0	0	0	0	36	19.0
NW	1	3	7	4	5	6	0	0	0	0	26	13.8
NNW	4	9	2	0	0	0	0	0	0	0	15	7.9
TOTALS	10	46	77	27	22	7	0	0	0	0	189	
%	5.3	24.3	40.7	14.3	11.6	3.7	0.0	0.0	0.0	0.0		100.0

TABLE A14 (continued)

WIND SPEED / DIRECTION FREQUENCY ANALYSIS
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 NOVEMBER 1977

	WIND SPEED MPH											
DIR	0.0- 1.9	2.0- 3.9	4.0- 6.9	7.0- 9.9	10.0-14.9	15.0-19.9	20.0-29.9	30.0-44.9	45.0-59.9	60.0-	TOTALS	%
N	0	1	0	0	0	0	0	0	0	0	1	.2
NNE	0	2	0	0	0	0	0	0	0	0	2	.4
NE	1	15	2	0	0	0	0	0	0	0	18	3.8
ENE	3	20	22	3	1	0	0	0	0	0	49	10.3
E	2	8	15	11	0	0	0	0	0	0	36	7.6
ESE	0	3	35	37	18	0	0	0	0	0	93	19.6
SE	1	3	17	13	12	0	0	0	0	0	46	9.7
SSE	0	2	9	6	5	0	0	0	0	0	22	4.6
S	1	2	2	1	0	0	0	0	0	0	6	1.3
SSW	0	0	1	0	0	0	0	0	0	0	1	.2
SW	0	1	0	0	0	0	0	0	0	0	1	.2
WSW	0	1	4	0	0	0	0	0	0	0	5	1.1
W	0	2	10	6	12	8	0	0	0	0	38	8.0
WNW	1	8	17	22	39	5	0	0	0	0	92	19.4
NW	1	13	15	11	7	2	0	0	0	0	49	10.3
NNW	0	6	8	1	0	0	0	0	0	0	15	3.2
TOTALS	10	87	157	111	94	15	0	0	0	0	474	
%	2.1	18.4	33.1	23.4	19.8	3.2	0.0	0.0	0.0	0.0		100.0

APPENDIX

B

WIND DIRECTION/DURATION OF WIND

TABLE B1

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	158	68	26	20	16	3	4	3	2	57	357	9.9
NE	559	157	60	43	15	9	7	2	31	9	892	24.7
E	118	52	17	10	7	2	0	0	0	6	212	5.9
SE	188	64	42	13	7	2	4	6	43	7	376	10.4
S	96	33	11	3	5	1	6	0	0	8	163	4.5
SW	328	142	51	22	14	14	9	8	29	5	622	17.2
W	382	173	87	40	24	9	6	8	47	9	785	21.8
NW	90	24	31	12	12	3	2	12	3	11	200	5.5
TOTALS	1919	713	325	163	100	43	38	39	155	112	3607	
%	53.2	19.8	9.0	4.5	2.8	1.2	1.1	1.1	4.3	3.1		100.0

TABLE B1 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4

	DURATION IN HOURS											
DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	220	80	28	17	14	1	1	0	1	0	362	17.2
NE	77	35	17	8	3	5	1	0	0	0	146	6.9
E	50	14	5	3	1	0	1	0	0	0	74	3.5
SE	190	72	26	14	4	4	2	2	3	3	320	15.2
S	205	55	15	11	4	3	6	0	3	2	304	14.4
SW	253	103	35	14	9	7	1	0	0	0	422	20.0
W	192	71	32	19	8	2	1	0	1	1	327	15.5
NW	76	38	15	11	5	3	2	1	0	0	151	7.2
TOTALS	1263	468	173	97	48	25	15	3	8	6	2106	
%	60.0	22.2	8.2	4.6	2.3	1.2	.7	.1	.4	.3		100.0

TABLE B1 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6

	DURATION IN HOURS											
DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	309	156	75	58	28	13	5	4	1	4	653	17.9
NE	638	325	114	59	18	7	6	2	37	1	1207	33.2
E	145	77	28	15	4	1	3	2	2	0	277	7.6
SE	40	22	51	14	4	2	0	8	14	3	158	4.3
S	45	60	21	11	0	2	2	1	0	0	142	3.9
SW	330	207	106	44	16	7	5	9	4	2	730	20.1
W	156	116	40	16	11	10	2	3	4	3	361	9.9
NW	31	20	27	4	3	1	2	10	10	2	110	3.0
TOTALS	1694	983	462	221	84	43	25	39	72	15	3638	
%	46.6	27.0	12.7	6.1	2.3	1.2	.7	1.1	2.0	.4		100.0

TABLE B2

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 NOVEMBER 1976

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	19	7	5	3	2	0	1	0	0	0	37	9.7
NE	73	23	8	2	1	2	1	0	0	0	110	28.8
E	14	7	3	1	1	0	0	0	0	0	26	6.8
SE	12	9	2	0	0	0	0	0	0	0	23	6.0
S	9	5	2	0	1	0	0	0	0	0	17	4.5
SW	42	17	10	3	0	2	1	0	0	0	75	19.6
W	30	16	9	5	3	1	0	0	2	1	67	17.5
NW	18	5	2	1	1	0	0	0	0	0	27	7.1
TOTALS	217	89	41	15	9	5	3	0	2	1	382	
%	56.8	23.3	10.7	3.9	2.4	1.3	.8	0.0	.5	.3		100.0

TABLE B2 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 NOVEMBER 1976

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	20	11	7	7	3	3	0	0	0	0	51	26.0
NE	37	16	8	1	0	1	0	0	0	0	63	32.1
E	5	2	1	0	0	0	1	0	0	0	9	4.6
SE	1	0	0	0	1	0	0	0	0	0	2	1.0
S	1	2	2	0	0	1	0	0	0	0	6	3.1
SW	13	19	5	4	1	0	0	0	0	1	43	21.9
W	7	3	1	1	2	2	0	0	0	0	16	8.2
NW	3	1	1	0	1	0	0	0	0	0	6	3.1
TOTALS	87	54	25	13	8	7	1	0	0	1	196	
%	44.4	27.6	12.8	6.6	4.1	3.6	.5	0.0	0.0	.5		100.0

TABLE B3

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 DECEMBER 1976

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	17	10	3	3	0	0	1	0	0	0	34	9.3
NE	73	22	9	3	2	0	0	0	0	0	109	29.9
E	9	3	1	3	0	0	0	0	0	0	16	4.4
SE	21	3	4	1	0	0	0	0	0	1	30	8.2
S	9	1	3	0	1	0	0	0	0	0	14	3.8
SW	47	19	5	1	3	1	3	1	0	0	80	21.9
W	33	15	11	1	2	1	0	0	1	0	64	17.5
NW	11	2	3	2	0	0	0	0	0	0	18	4.9
TOTALS	220	75	39	14	8	2	4	1	1	1	365	
%	60.3	20.5	10.7	3.8	2.2	.5	1.1	.3	.3	.3		100.0

TABLE B3 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 DECEMBER 1976

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	22	10	3	2	4	1	0	0	0	0	42	28.4
NE	2	1	1	1	0	1	0	0	0	0	6	4.1
E	0	1	0	0	0	0	0	0	0	0	1	.7
SE	3	3	2	1	0	1	0	1	0	0	11	7.4
S	10	7	3	2	0	0	2	0	0	1	25	16.9
SW	6	9	4	1	2	0	0	0	0	0	22	14.9
W	18	4	2	1	2	0	0	0	0	0	27	18.2
NW	2	4	4	3	0	0	0	1	0	0	14	9.5
TOTALS	63	39	19	11	8	3	2	2	0	1	148	
%	42.6	26.4	12.8	7.4	5.4	2.0	1.4	1.4	0.0	.7		100.0

TABLE B3 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 DECEMBER 1976

	DURATION IN HOURS											
DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	12	12	2	2	1	1	0	0	0	1	31	25.8
NE	24	13	7	4	0	0	0	0	0	0	48	40.0
E	0	0	1	0	0	0	0	0	0	0	1	.8
SE	0	0	1	0	0	0	0	0	0	0	1	.8
S	3	1	2	0	0	0	0	0	0	0	6	5.0
SW	7	7	3	1	1	0	0	0	0	0	19	15.8
W	5	4	2	0	0	1	0	0	0	0	12	10.0
NW	1	0	1	0	0	0	0	0	0	0	2	1.7
TOTALS	52	37	19	7	2	2	0	0	0	1	120	
%	43.3	30.8	15.8	5.8	1.7	1.7	0.0	0.0	0.0	.8		100.0

TABLE B4

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 JANUARY 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	13	5	3	3	2	1	0	0	0	0	27	9.0
NE	40	20	6	5	1	0	1	0	0	1	74	24.7
E	13	6	0	1	1	0	0	0	0	0	21	7.0
SE	15	6	5	0	0	0	0	0	0	0	26	8.7
S	12	0	1	1	0	0	0	0	0	0	14	4.7
SW	32	12	6	4	0	0	2	1	0	0	57	19.1
W	28	24	7	2	2	0	1	0	0	0	64	21.4
NW	9	4	2	1	0	0	0	0	0	0	16	5.4
TOTALS	162	77	30	17	6	1	4	1	0	1	299	
%	54.2	25.8	10.0	5.7	2.0	.3	1.3	.3	0.0	.3		100.0

TABLE B4 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 JANUARY 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	20	15	5	2	2	0	0	0	0	0	44	23.2
NE	7	4	4	1	0	1	1	0	0	0	18	9.5
E	0	0	0	0	0	0	0	0	0	0	0	0.0
SE	7	3	3	0	1	0	0	0	0	1	15	7.9
S	16	9	4	3	1	2	2	0	2	0	39	20.5
SW	14	8	6	4	0	2	0	0	0	0	34	17.9
W	12	4	5	2	1	1	1	0	0	1	27	14.2
NW	8	0	1	2	1	1	0	0	0	0	13	6.8
TOTALS	84	43	28	14	6	7	4	0	2	2	190	
%	44.2	22.6	14.7	7.4	3.2	3.7	2.1	0.0	1.1	1.1		100.0

TABLE B4 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 JANUARY 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	24	16	15	10	3	2	0	0	0	3	73	13.2
NE	44	34	10	30	2	0	0	0	36	1	157	28.5
E	10	21	2	2	0	0	0	0	0	0	35	6.4
SE	1	2	39	13	0	0	0	8	13	3	79	14.3
S	3	35	5	1	0	1	1	1	0	0	47	8.5
SW	16	17	8	4	3	0	0	8	4	0	60	10.9
W	4	19	5	4	0	2	0	1	3	0	38	6.9
NW	6	8	21	4	0	1	0	10	10	2	62	11.3
TOTALS	108	152	105	68	8	6	1	28	66	9	551	
%	19.6	27.6	19.1	12.3	1.5	1.1	.2	5.1	12.0	1.6		100.0

TABLE B5

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 FEBRUARY 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	10	5	4	5	9	0	0	3	1	57	94	16.7
NE	21	8	5	23	7	5	2	0	30	7	108	19.1
E	4	4	0	3	3	2	0	0	0	6	22	3.9
SE	4	1	12	7	2	2	2	6	43	6	85	15.1
S	1	7	1	1	3	1	5	0	0	8	27	4.8
SW	14	4	2	2	1	5	0	4	29	4	65	11.5
W	9	8	17	7	1	1	3	5	43	7	101	17.9
NW	6	5	14	5	9	1	0	11	2	9	62	11.0
TOTALS	69	42	55	53	35	17	12	29	148	104	564	
%	12.2	7.4	9.8	9.4	6.2	3.0	2.1	5.1	26.2	18.4		100.0

TABLE B5 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 FEBRUARY 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	26	19	8	3	2	0	1	0	0	0	59	21.7
NE	49	23	7	2	2	0	2	0	0	0	85	31.3
E	6	2	1	1	1	0	0	0	0	0	11	4.0
SE	2	3	1	0	0	0	0	0	0	0	6	2.2
S	2	3	2	3	0	0	0	0	0	0	10	3.7
SW	29	21	9	5	1	1	1	0	0	0	67	24.6
W	11	7	6	1	2	0	0	0	0	1	28	10.3
NW	2	2	1	0	1	0	0	0	0	0	6	2.2
TOTALS	127	80	35	15	9	1	4	0	0	1	272	
%	46.7	29.4	12.9	5.5	3.3	.4	1.5	0.0	0.0	.4		100.0

TABLE B6

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 MARCH 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	22	12	2	1	0	0	0	0	0	0	37	9.9
NE	67	9	1	2	1	0	2	0	0	1	83	22.1
E	15	6	2	0	1	0	0	0	0	0	24	6.4
SE	38	12	5	0	1	0	0	0	0	0	56	14.9
S	23	6	0	0	0	0	1	0	0	0	30	8.0
SW	33	15	5	0	1	3	2	0	0	1	60	16.0
W	39	22	8	2	1	0	0	0	0	0	72	19.1
NW	10	0	1	0	0	0	0	0	1	2	14	3.7
TOTALS	247	82	24	5	5	3	5	0	1	4	376	
%	65.7	21.8	6.4	1.3	1.3	.8	1.3	0.0	.3	1.1		100.0

TABLE B6 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 MARCH 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	35	9	2	1	2	0	0	0	1	0	50	16.3
NE	15	5	2	1	1	1	0	0	0	0	25	8.2
E	8	1	1	0	0	0	0	0	0	0	10	3.3
SE	31	15	6	5	0	2	0	0	1	0	60	19.6
S	24	9	3	1	1	0	1	0	0	0	39	12.7
SW	31	15	3	2	3	1	0	0	0	0	55	18.0
W	34	5	3	4	2	1	0	0	0	0	49	16.0
NW	11	3	0	2	1	1	0	0	0	0	18	5.9
TOTALS	189	62	20	16	10	6	1	0	2	0	306	
%	61.8	20.3	6.5	5.2	3.3	2.0	.3	0.0	.7	0.0		100.0

TABLE B6 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 MARCH 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	38	9	4	5	1	0	1	1	0	0	59	16.0
NE	83	36	12	4	1	3	0	0	0	0	139	37.8
E	17	7	9	3	1	0	0	0	1	0	38	10.3
SE	2	1	0	0	1	1	0	0	0	0	5	1.4
S	4	3	3	1	0	0	0	0	0	0	11	3.0
SW	44	22	10	7	3	1	0	0	0	1	88	23.9
W	12	6	0	4	0	1	0	0	1	2	26	7.1
NW	2	0	0	0	0	0	0	0	0	0	2	.5
TOTALS	202	84	38	24	7	6	1	1	2	3	368	
%	54.9	22.8	10.3	6.5	1.9	1.6	.3	.3	.5	.8		100.0

TABLE B7

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 APRIL 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	29	12	4	5	2	1	0	0	0	0	53	17.7
NE	48	24	12	2	0	0	0	0	0	0	86	28.8
E	16	2	0	0	0	0	0	2	0	0	20	6.7
SE	6	2	3	0	0	0	0	0	0	0	11	3.7
S	10	3	1	0	0	0	0	0	0	0	14	4.7
SW	39	19	14	4	1	1	1	0	0	0	79	26.4
W	10	12	5	2	0	0	0	1	0	0	30	10.0
NW	2	4	0	0	0	0	0	0	0	0	6	2.0
TOTALS	160	78	39	13	3	2	1	3	0	0	299	
%	53.5	26.1	13.0	4.3	1.0	.7	.3	1.0	0.0	0.0		100.0

TABLE B8

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 MAY 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	5	2	1	0	0	0	0	0	0	0	8	4.8
NE	21	12	3	0	0	0	1	1	0	0	38	22.8
E	4	3	3	0	0	0	0	0	0	0	10	6.0
SE	17	7	2	0	1	0	1	0	0	0	28	16.8
S	10	3	1	0	0	0	0	0	0	0	14	8.4
SW	15	3	0	1	1	0	0	0	0	0	20	12.0
W	24	11	3	3	0	2	0	0	0	0	43	25.7
NW	1	1	1	1	0	0	1	1	0	0	6	3.6
TOTALS	97	42	14	5	2	2	3	2	0	0	167	
%	58.1	25.1	8.4	3.0	1.2	1.2	1.8	1.2	0.0	0.0		100.0

TABLE B9

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 JUNE 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	15	6	1	0	0	0	0	0	1	0	23	7.9
NE	58	9	6	2	1	0	0	0	0	0	76	26.2
E	19	4	3	0	0	0	0	0	0	0	26	9.0
SE	26	5	1	1	1	0	0	0	0	0	34	11.7
S	11	3	0	0	0	0	0	0	0	0	14	4.8
SW	13	11	1	1	0	0	0	1	0	0	27	9.3
W	46	20	6	2	2	1	0	0	0	0	77	26.6
NW	8	1	1	1	1	1	0	0	0	0	13	4.5
TOTALS	196	59	19	7	5	2	0	1	1	0	290	
%	67.6	20.3	6.6	2.4	1.7	.7	0.0	.3	.3	0.0		100.0

TABLE B9 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 JUNE 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	19	10	5	1	0	0	0	1	0	0	36	14.6
NE	45	33	8	2	1	1	0	1	0	0	91	36.8
E	11	8	2	3	0	0	0	0	0	0	24	9.7
SE	6	4	2	0	0	0	0	0	0	0	12	4.9
S	4	0	0	2	0	0	1	0	0	0	7	2.8
SW	27	13	5	4	1	0	0	0	0	0	50	20.2
W	14	7	1	0	1	2	0	0	0	0	25	10.1
NW	1	1	0	0	0	0	0	0	0	0	2	.8
TOTALS	127	76	23	12	3	3	1	2	0	0	247	
%	51.4	30.8	9.3	4.9	1.2	1.2	.4	.8	0.0	0.0		100.0

TABLE B10

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 JULY 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	0	0	1	0	0	0	0	0	0	0	1	3.4
NE	10	0	0	0	0	0	0	0	0	0	10	34.5
E	0	0	0	0	0	0	0	0	0	0	0	0.0
SE	0	0	0	0	0	0	0	0	0	0	0	0.0
S	0	0	0	0	0	0	0	0	0	0	0	0.0
SW	2	0	0	0	0	0	0	0	0	0	2	6.9
W	15	0	0	0	0	0	0	0	0	1	16	55.2
NW	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	27	0	1	0	0	0	0	0	0	1	29	
%	93.1	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	3.4		100.0

TABLE B10 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 JULY 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	20	8	2	1	0	0	0	0	0	0	31	13.7
NE	18	5	1	0	1	0	0	0	0	0	25	11.0
E	9	1	2	0	0	0	0	0	0	0	12	5.3
SE	28	6	2	1	0	0	0	0	0	0	37	16.3
S	28	3	0	1	0	0	0	0	0	0	32	14.1
SW	35	9	4	0	0	0	0	0	0	0	48	21.1
W	19	8	2	0	1	0	0	0	1	0	31	13.7
NW	7	4	0	0	0	0	0	0	0	0	11	4.8
TOTALS	164	44	13	3	2	0	0	0	1	0	227	
%	72.2	19.4	5.7	1.3	.9	0.0	0.0	0.0	.4	0.0		100.0

TABLE B10 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 JULY 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	4	7	0	0	1	0	1	0	0	0	13	10.1
NE	27	15	5	0	2	0	0	0	0	0	49	38.0
E	12	6	1	0	0	0	0	0	0	0	19	14.7
SE	2	1	0	0	0	0	0	0	0	0	3	2.3
S	2	0	0	1	0	0	0	0	0	0	3	2.3
SW	14	9	4	0	0	0	0	0	0	0	27	20.9
W	10	3	1	1	0	0	0	0	0	0	15	11.5
NW	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	71	41	11	2	3	0	1	0	0	0	129	
%	55.0	31.8	8.5	1.6	2.3	0.0	.8	0.0	0.0	0.0		100.0

TABLE B11

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 AUGUST 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	18	9	0	3	0	0	0	0	0	0	30	6.0
NE	122	22	8	3	1	2	0	0	0	0	158	31.9
E	21	9	3	0	0	0	0	0	0	0	33	6.5
SE	33	6	2	1	1	0	0	0	0	0	43	8.7
S	10	2	3	0	0	0	0	0	0	0	15	3.0
SW	56	21	6	3	3	0	0	0	0	0	89	17.9
W	77	17	9	6	4	1	1	1	0	0	116	23.3
NW	8	3	1	1	0	0	0	0	0	0	13	2.6
TOTALS	345	89	32	17	9	3	1	1	0	0	497	
%	69.4	17.9	6.4	3.4	1.8	.6	.2	.2	0.0	0.0		100.0

TABLE B11 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 AUGUST 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	39	12	4	3	1	0	0	0	0	0	59	12.6
NE	13	8	2	0	0	2	0	0	0	0	25	5.3
E	14	9	1	0	1	0	0	0	0	0	25	5.3
SE	61	16	6	2	1	1	0	0	1	1	89	18.9
S	52	11	2	2	0	1	0	0	0	0	68	14.5
SW	77	23	6	1	1	1	0	0	0	0	109	23.2
W	37	16	7	3	2	0	0	0	0	0	65	13.8
NW	16	5	2	3	2	1	1	0	0	0	30	6.4
TOTALS	309	100	30	14	8	6	1	0	1	1	470	
%	65.7	21.3	6.4	3.0	1.7	1.3	.2	0.0	.2	.2		100.0

TABLE B11 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 AUGUST 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	34	12	8	7	0	1	0	1	0	0	63	14.7
NE	95	41	13	2	0	0	0	0	0	0	151	35.1
E	34	12	4	4	0	0	1	0	0	0	55	12.8
SE	7	3	0	0	1	0	0	0	0	0	11	2.6
S	1	3	1	0	0	0	0	0	0	0	5	1.2
SW	39	22	12	5	2	1	1	0	0	0	82	19.1
W	27	21	8	1	2	2	2	0	0	0	63	14.7
NW	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	237	114	46	19	5	4	4	1	0	0	430	
%	55.1	26.5	10.7	4.4	1.2	.9	.9	.2	0.0	0.0		100.0

TABLE B12

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 SEPTEMBER 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	5	3	2	0	1	0	0	0	0	0	11	5.5
NE	19	9	4	2	0	0	0	1	0	0	35	17.6
E	8	4	1	1	1	0	0	0	0	0	15	7.5
SE	11	9	3	2	0	0	0	0	0	0	25	12.6
S	5	0	0	0	0	0	0	0	0	0	5	2.5
SW	22	14	6	0	0	2	0	0	0	0	44	22.1
W	25	12	5	6	5	1	0	2	1	0	57	28.6
NW	4	2	0	0	1	0	0	0	0	0	7	3.5
TOTALS	99	53	21	11	8	3	0	3	1	0	199	
%	49.7	26.6	10.6	5.5	4.0	1.5	0.0	1.5	.5	0.0		100.0

TABLE B12 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 SEPTEMBER 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	34	11	4	6	0	0	0	0	0	0	55	15.9
NE	10	7	6	1	0	0	0	0	0	0	24	6.9
E	12	1	0	1	0	0	0	0	0	0	14	4.0
SE	31	17	6	2	1	0	1	1	0	0	59	17.0
S	34	8	1	1	2	0	1	0	1	0	48	13.8
SW	47	16	5	2	2	1	0	0	0	0	73	21.0
W	33	17	6	4	0	0	0	0	0	0	60	17.2
NW	5	7	2	0	1	0	0	0	0	0	15	4.3
TOTALS	206	84	30	17	6	1	2	1	1	0	348	
%	59.2	24.1	8.6	4.9	1.7	.3	.6	.3	.3	0.0		100.0

TABLE B12 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 SEPTEMBER 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	18	15	7	3	3	2	0	0	0	0	48	18.8
NE	40	24	14	2	2	2	0	0	1	0	85	33.3
E	6	5	1	1	0	0	0	0	0	0	13	5.1
SE	3	1	1	1	0	0	0	0	1	0	7	2.7
S	5	3	1	0	0	0	0	0	0	0	9	3.5
SW	24	13	8	5	1	1	0	0	0	0	52	20.4
W	17	9	5	1	0	0	0	0	0	0	32	12.5
NW	5	1	2	0	1	0	0	0	0	0	9	3.5
TOTALS	118	71	39	13	7	5	0	0	2	0	255	
%	46.3	27.8	15.3	5.1	2.7	2.0	0.0	0.0	.8	0.0		100.0

TABLE B13

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 OCTOBER 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	31	4	3	2	1	2	2	0	0	0	45	12.1
NE	46	20	8	1	1	0	0	0	1	0	77	20.6
E	8	4	1	0	0	0	0	0	0	0	13	3.5
SE	9	5	4	1	1	0	1	0	0	0	21	5.5
S	5	3	0	1	0	0	0	0	0	0	9	2.4
SW	44	23	8	5	5	1	1	0	0	0	87	23.3
W	50	26	11	5	4	1	1	0	0	0	98	26.3
NW	15	2	5	0	0	1	0	0	0	0	23	6.2
TOTALS	208	87	40	15	12	5	5	0	1	0	373	
%	55.8	23.3	10.7	4.0	3.2	1.3	1.3	0.0	.3	0.0		100.0

TABLE B13 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 OCTOBER 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	19	11	5	0	2	0	0	0	0	0	37	20.3
NE	4	3	0	2	1	0	0	0	0	0	10	5.5
E	1	0	0	0	0	0	0	0	0	0	1	.5
SE	10	6	0	0	0	0	1	0	1	1	19	10.4
S	13	3	0	1	0	1	0	0	0	0	18	9.9
SW	17	7	7	2	0	1	0	0	0	0	34	18.7
W	21	11	3	3	0	0	0	0	0	0	38	20.9
NW	13	7	3	1	0	0	1	0	0	0	25	13.7
TOTALS	98	48	18	9	3	2	2	0	1	1	182	
%	53.8	26.4	9.9	4.9	1.6	1.1	1.1	0.0	.5	.5		100.0

TABLE B13 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 OCTOBER 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	50	18	8	11	8	1	0	0	0	0	96	25.1
NE	65	34	4	5	3	0	1	0	0	0	112	29.2
E	7	4	0	0	0	1	0	0	0	0	12	3.1
SE	1	0	3	0	0	1	0	0	0	0	5	1.3
S	6	2	4	1	0	0	0	0	0	0	13	3.4
SW	41	28	20	3	0	0	1	0	0	0	93	24.3
W	23	14	2	1	2	0	0	0	0	0	42	11.0
NW	5	3	1	0	0	0	1	0	0	0	10	2.6
TOTALS	198	103	42	21	13	3	3	0	0	0	383	
%	51.7	26.9	11.0	5.5	3.4	.8	.8	0.0	0.0	0.0		100.0

TABLE B14

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 NOVEMBER 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	2	5	1	0	1	0	0	0	0	0	9	14.8
NE	11	2	2	0	0	0	0	0	0	0	15	24.6
E	3	2	0	1	0	0	0	0	0	0	6	9.8
SE	2	1	2	0	0	0	0	0	0	0	5	8.2
S	1	2	0	0	0	0	0	0	0	0	3	4.9
SW	7	3	2	2	0	0	0	0	0	0	14	23.0
W	4	3	0	1	0	0	0	0	0	0	8	13.1
NW	1	0	0	0	0	0	0	0	0	0	1	1.6
TOTALS	31	18	7	4	1	0	0	0	0	0	61	
%	50.8	29.5	11.5	6.6	1.6	0.0	0.0	0.0	0.0	0.0		100.0

TABLE B14 (continued)

WIND DIRECTION / DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 NOVEMBER 1977

DURATION IN HOURS

DIR	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
N	20	5	2	1	2	0	0	0	0	0	30	20.4
NE	23	13	5	3	1	0	1	0	0	0	46	31.3
E	6	4	3	0	0	0	0	0	0	0	13	8.8
SE	4	1	1	0	0	0	0	0	0	0	6	4.1
S	3	2	0	1	0	0	0	0	0	0	6	4.1
SW	13	7	3	1	0	1	0	1	0	0	26	17.7
W	9	6	3	0	1	0	0	1	0	0	20	13.6
NW	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	78	38	17	6	4	1	1	2	0	0	147	
%	53.1	25.9	11.6	4.1	2.7	.7	.7	1.4	0.0	0.0		100.0

APPENDIX

C

WIND SPEED .VS. DURATION OF WIND

TABLE C1

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2

	DURATION IN HOURS											
SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	161	52	22	10	3	0	0	1	0	0	249	6.3
< 4.0	985	294	110	48	33	16	9	1	2	1	1499	38.0
< 7.0	698	220	81	43	14	8	8	4	2	3	1081	27.4
<10.0	262	72	30	7	7	0	2	3	1	0	384	9.7
<15.0	244	77	30	8	12	2	3	1	1	0	378	9.6
<30.0	244	64	22	8	5	1	4	0	2	2	352	8.9
<60.0	1	0	1	0	0	0	0	0	0	0	2	.1
>60.0	0	0	0	0	0	1	0	0	0	0	1	.0
TOTALS	2595	779	296	124	74	28	26	10	8	6	3946	
%	65.8	19.7	7.5	3.1	1.9	.7	.7	.3	.2	.2		100.0

TABLE C1 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4

	DURATION IN HOURS											
SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	57	21	5	6	7	5	2	0	0	1	104	4.7
< 4.0	358	152	67	41	22	16	6	2	7	4	675	30.6
< 7.0	398	145	66	27	11	3	5	1	0	1	657	29.8
<10.0	217	77	21	9	8	1	2	0	0	0	335	15.2
<15.0	207	65	19	11	3	3	0	0	0	0	308	14.0
<30.0	84	22	14	4	0	0	0	0	1	0	125	5.7
<60.0	0	0	0	1	0	0	0	0	0	0	1	.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	1321	482	192	99	51	28	15	3	8	6	2205	
%	59.9	21.9	8.7	4.5	2.3	1.3	.7	.1	.4	.3		100.0

TABLE C1 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6

	DURATION IN HOURS											
SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	101	34	17	6	3	3	1	0	0	0	165	4.4
< 4.0	457	232	77	31	16	6	7	3	2	2	833	22.2
< 7.0	890	362	155	68	36	24	10	7	2	3	1557	41.5
<10.0	406	217	76	32	13	6	2	1	1	2	756	20.2
<15.0	192	109	51	29	7	3	3	2	1	1	398	10.6
<30.0	14	10	10	3	3	1	0	0	0	0	41	1.1
<60.0	1	0	0	0	0	0	0	0	0	0	1	.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	2061	964	386	169	78	43	23	13	6	8	3751	
%	54.9	25.7	10.3	4.5	2.1	1.1	.6	.3	.2	.2		100.0

TABLE C2

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 NOVEMBER 1976

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	25	11	7	2	0	0	0	0	0	0	45	11.4
< 4.0	127	48	12	6	5	2	0	0	0	0	200	50.6
< 7.0	59	22	10	7	1	2	3	0	1	1	106	26.8
<10.0	9	5	3	0	1	0	0	0	0	0	18	4.6
<15.0	4	2	4	1	3	1	0	0	0	0	15	3.8
<30.0	2	3	5	0	0	0	0	0	1	0	11	2.8
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	226	91	41	16	10	5	3	0	2	1	395	
%	57.2	23.0	10.4	4.1	2.5	1.3	.8	0.0	.5	.3		100.0

TABLE C2 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 NOVEMBER 1976

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	1	2	2	0	1	0	0	0	0	0	6	3.0
< 4.0	18	14	7	0	1	0	1	0	0	1	42	21.2
< 7.0	48	22	7	6	3	6	0	0	0	0	92	46.5
<10.0	15	11	7	4	0	1	0	0	0	0	38	19.2
<15.0	5	5	1	3	1	0	0	0	0	0	15	7.6
<30.0	1	0	1	1	1	1	0	0	0	0	5	2.5
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	88	54	25	14	7	8	1	0	0	1	198	
%	44.4	27.3	12.6	7.1	3.5	4.0	.5	0.0	0.0	.5		100.0

TABLE C3

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 DECEMBER 1976

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	16	3	0	1	0	0	0	0	0	0	20	5.2
< 4.0	125	38	14	12	6	2	3	0	0	1	201	52.5
< 7.0	74	32	20	2	0	0	0	1	0	0	129	33.7
<10.0	8	1	2	0	1	0	0	0	0	0	12	3.1
<15.0	7	5	2	1	1	0	0	0	1	0	17	4.4
<30.0	2	1	0	0	0	0	1	0	0	0	4	1.0
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	232	80	38	16	8	2	4	1	1	1	383	
%	60.6	20.9	9.9	4.2	2.1	.5	1.0	.3	.3	.3		100.0

TABLE C3 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 DECEMBER 1976

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	0	1	1	0	0	0	0	0	0	0	2	1.3
< 4.0	25	14	9	9	4	3	2	1	1	1	69	45.1
< 7.0	26	13	8	2	3	0	0	0	0	0	52	34.0
<10.0	8	4	1	1	3	0	0	0	0	0	17	11.1
<15.0	3	4	1	0	0	0	0	0	0	0	8	5.2
<30.0	4	1	0	0	0	0	0	0	0	0	5	3.3
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	66	37	20	12	10	3	2	1	1	1	153	
%	43.1	24.2	13.1	7.8	6.5	2.0	1.3	.7	.7	.7		100.0

TABLE C3 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 DECEMBER 1976

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	0	0	1	0	0	0	0	0	0	0	1	.8
< 4.0	13	8	2	2	0	0	0	0	0	0	25	20.7
< 7.0	27	21	8	2	2	2	0	0	0	0	62	51.2
<10.0	6	5	4	2	0	0	0	0	0	1	18	14.9
<15.0	5	4	3	2	0	0	0	0	0	0	14	11.6
<30.0	1	0	0	0	0	0	0	0	0	0	1	.8
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	52	38	18	8	2	2	0	0	0	1	121	
%	43.0	31.4	14.9	6.6	1.7	1.7	0.0	0.0	0.0	.8		100.0

TABLE C4

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 JANUARY 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	11	5	3	2	0	0	0	0	0	0	21	6.9
< 4.0	91	45	19	9	6	1	2	0	0	0	173	56.5
< 7.0	47	14	6	6	0	0	2	1	0	1	77	25.2
<10.0	9	4	2	0	0	0	0	0	0	0	15	4.9
<15.0	5	3	2	1	0	0	0	0	0	0	11	3.6
<30.0	2	7	0	0	0	0	0	0	0	0	9	2.9
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	165	78	32	18	6	1	4	1	0	1	306	
%	53.9	25.5	10.5	5.9	2.0	.3	1.3	.3	0.0	.3		100.0

TABLE C4 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 JANUARY 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	3	2	2	0	1	3	1	0	0	0	12	5.0
< 4.0	42	23	8	5	3	5	0	0	2	1	89	44.7
< 7.0	30	12	12	4	1	0	3	0	0	1	63	31.7
<10.0	11	7	5	2	0	0	0	0	0	0	25	12.6
<15.0	4	1	1	1	1	0	0	0	0	0	8	4.0
<30.0	1	0	0	1	0	0	0	0	0	0	2	1.0
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	91	45	28	13	6	8	4	0	2	2	199	
%	45.7	22.6	14.1	6.5	3.0	4.0	2.0	0.0	1.0	1.0		100.0

TABLE C4 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 JANUARY 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	40	11	3	2	0	0	0	0	0	0	56	9.3
< 4.0	99	31	1	3	1	0	0	0	0	1	136	22.6
< 7.0	125	35	7	5	2	4	1	0	0	0	179	29.8
<10.0	101	24	9	0	1	0	0	0	0	1	136	22.6
<15.0	67	19	3	1	0	0	0	0	0	0	90	15.0
<30.0	1	1	2	0	0	0	0	0	0	0	4	.7
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	433	121	25	11	4	4	1	0	0	2	601	
%	72.0	20.1	4.2	1.8	.7	.7	.2	0.0	0.0	.3		100.0

TABLE C5

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 FEBRUARY 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	43	2	2	1	2	0	0	0	0	0	50	7.5
< 4.0	202	31	12	4	2	2	0	0	0	0	253	38.1
< 7.0	107	19	6	1	1	0	1	0	0	0	135	20.3
<10.0	45	8	0	1	1	0	0	0	0	0	55	8.3
<15.0	52	11	2	1	0	0	0	0	0	0	66	9.9
<30.0	87	14	2	1	0	0	0	0	0	0	104	15.7
<60.0	0	0	1	0	0	0	0	0	0	0	1	.2
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	536	85	25	9	6	2	1	0	0	0	664	
%	80.7	12.8	3.8	1.4	.9	.3	.2	0.0	0.0	0.0		100.0

TABLE C5 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 FEBRUARY 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	10	1	3	1	1	0	0	0	0	0	16	5.7
< 4.0	24	13	3	5	1	1	1	0	0	0	48	17.0
< 7.0	66	30	21	4	5	0	1	0	0	0	127	45.0
<10.0	21	22	4	4	1	0	0	0	0	0	52	18.4
<15.0	13	13	3	1	1	0	2	0	0	1	34	12.1
<30.0	2	1	2	0	0	0	0	0	0	0	5	1.8
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	136	80	36	15	9	1	4	0	0	1	282	
%	48.2	28.4	12.8	5.3	3.2	.4	1.4	0.0	0.0	.4		100.0

TABLE C6

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 MARCH 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	12	5	3	0	0	0	0	0	0	0	20	5.1
< 4.0	100	23	6	0	1	1	0	0	1	0	132	33.8
< 7.0	81	25	5	3	1	2	1	0	0	1	119	30.5
<10.0	22	9	3	0	1	0	1	0	0	0	36	9.2
<15.0	23	9	3	1	1	0	2	0	0	0	39	10.0
<30.0	20	16	4	1	1	0	1	0	0	1	44	11.3
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	258	87	24	5	5	3	5	0	1	2	390	
%	66.2	22.3	6.2	1.3	1.3	.8	1.3	0.0	.3	.5		100.0

TABLE C6 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 MARCH 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	18	6	1	2	1	2	0	0	0	0	30	9.3
< 4.0	54	16	5	4	4	1	1	0	1	0	86	26.6
< 7.0	58	21	8	4	3	1	1	0	0	0	96	29.7
<10.0	23	9	2	2	1	0	0	0	0	0	37	11.5
<15.0	31	6	7	3	1	2	0	0	0	0	50	15.5
<30.0	18	5	0	0	0	0	0	0	1	0	24	7.4
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	202	63	23	15	10	6	2	0	2	0	323	
%	62.5	19.5	7.1	4.6	3.1	1.9	.6	0.0	.6	0.0		100.0

TABLE C6 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 MARCH 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	9	5	1	0	0	1	0	0	0	0	16	4.3
< 4.0	60	24	7	5	0	1	0	0	1	0	98	26.2
< 7.0	87	28	11	9	3	2	1	1	0	3	145	38.8
<10.0	27	11	8	3	2	0	0	0	1	0	52	13.9
<15.0	19	14	10	6	1	2	0	0	0	0	52	13.9
<30.0	4	4	1	1	1	0	0	0	0	0	11	2.9
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	206	86	38	24	7	6	1	1	2	3	374	
%	55.1	23.0	10.2	6.4	1.9	1.6	.3	.3	.5	.8		100.0

TABLE C7

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 APRIL 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	4	3	2	0	0	0	0	0	0	0	9	3.0
< 4.0	37	19	17	2	1	1	0	1	0	0	78	25.7
< 7.0	76	31	12	6	0	1	1	1	0	0	128	42.1
<10.0	33	13	7	4	2	0	0	0	0	0	59	19.4
<15.0	13	11	3	1	0	0	0	1	0	0	29	9.5
<30.0	0	0	1	0	0	0	0	0	0	0	1	.3
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	163	77	42	13	3	2	1	3	0	0	304	
%	53.6	25.3	13.8	4.3	1.0	.7	.3	1.0	0.0	0.0		100.0

TABLE C8

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 MAY 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	1	2	0	0	0	0	0	0	0	0	3	1.8
< 4.0	24	15	4	4	1	0	1	0	0	0	49	29.8
< 7.0	24	12	4	0	0	1	0	1	0	0	42	24.7
<10.0	12	6	1	0	0	0	0	1	1	0	21	12.4
<15.0	24	5	2	0	2	0	0	0	0	0	33	19.4
<30.0	14	3	3	0	0	1	1	0	0	0	22	12.9
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	99	43	14	4	3	2	2	2	1	0	170	
%	58.2	25.3	8.2	2.4	1.8	1.2	1.2	1.2	.6	0.0		100.0

TABLE C8 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 MAY 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	0	0	0	0	0	0	0	0	0	0	0	0.0
< 4.0	20	7	1	1	4	0	2	0	0	0	35	13.9
< 7.0	63	18	11	3	2	2	3	3	1	0	106	42.1
<10.0	30	21	6	1	1	0	0	0	0	0	59	23.4
<15.0	22	12	2	3	3	0	1	0	1	0	44	17.5
<30.0	3	2	2	0	1	0	0	0	0	0	8	3.2
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	138	60	22	8	11	2	6	3	2	0	252	
%	54.8	23.8	8.7	3.2	4.4	.8	2.4	1.2	.8	0.0		100.0

TABLE C9

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 JUNE 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	8	3	0	0	0	0	0	0	0	0	11	3.7
< 4.0	54	20	6	2	1	0	1	0	0	0	84	28.0
< 7.0	46	19	6	1	4	0	0	0	1	0	77	25.7
<10.0	39	6	2	1	0	0	0	1	0	0	49	16.3
<15.0	36	13	3	1	0	1	0	0	0	0	54	18.0
<30.0	18	3	2	1	1	0	0	0	0	0	25	9.3
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	201	64	19	6	6	1	1	1	1	0	300	
%	67.0	21.3	6.3	2.0	2.0	.3	.3	.3	.3	0.0		100.0

TABLE C9 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 JUNE 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	4	1	0	0	0	0	0	0	0	0	5	2.6
< 4.0	14	8	1	3	1	1	1	0	0	0	29	15.3
< 7.0	35	12	2	3	1	0	1	0	0	0	54	28.6
<10.0	26	7	3	1	0	0	1	0	0	0	38	20.1
<15.0	33	6	1	2	0	0	0	0	0	0	42	22.2
<30.0	12	5	1	3	0	0	0	0	0	0	21	11.1
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	124	39	8	12	2	1	3	0	0	0	189	
%	65.6	20.6	4.2	6.3	1.1	.5	1.6	0.0	0.0	0.0		100.0

TABLE C9 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 JUNE 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	3	1	0	0	0	0	1	0	0	0	5	2.0
< 4.0	23	12	3	0	1	0	0	0	0	0	39	15.8
< 7.0	54	33	12	4	1	3	0	2	0	0	109	44.1
<10.0	33	26	7	4	0	0	0	0	0	0	70	28.3
<15.0	13	4	2	4	1	0	0	0	0	0	24	9.7
<30.0	0	0	0	0	0	0	0	0	0	0	0	0.0
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	126	76	24	12	3	3	1	2	0	0	247	
%	51.0	30.8	9.7	4.9	1.2	1.2	.4	.8	0.0	0.0		100.0

TABLE C10

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 JULY 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	1	0	0	0	0	0	0	0	0	0	1	1.7
< 4.0	5	0	1	0	0	0	0	0	0	0	6	10.3
< 7.0	12	0	0	0	0	0	0	0	0	0	12	20.7
<10.0	14	0	0	0	0	0	0	0	0	0	14	24.1
<15.0	8	0	0	0	0	0	0	0	0	0	8	13.8
<30.0	16	0	0	0	0	0	0	0	0	1	17	29.3
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	56	0	1	0	0	0	0	0	0	1	58	
%	96.6	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	1.7		100.0

TABLE C10 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 JULY 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	11	2	0	0	1	0	0	0	0	0	14	5.9
< 4.0	43	18	6	2	1	1	0	0	0	0	71	30.1
< 7.0	39	11	4	1	0	0	0	0	0	0	55	23.3
<10.0	31	3	3	0	0	0	0	0	0	0	37	15.7
<15.0	33	9	1	0	0	0	0	0	0	0	43	18.2
<30.0	11	2	3	0	0	0	0	0	0	0	16	6.8
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	168	45	17	3	2	1	0	0	0	0	236	
%	71.2	19.1	7.2	1.3	.8	.4	0.0	0.0	0.0	0.0		100.0

TABLE C10 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 JULY 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	8	2	0	0	0	0	0	0	0	0	10	7.7
< 4.0	20	16	3	0	2	0	0	0	0	0	41	31.5
< 7.0	32	16	5	1	1	0	1	0	0	0	56	43.1
<10.0	9	7	0	1	0	0	0	0	0	0	17	13.1
<15.0	3	0	3	0	0	0	0	0	0	0	6	4.6
<30.0	0	0	0	0	0	0	0	0	0	0	0	0.0
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	72	41	11	2	3	0	1	0	0	0	130	
%	55.4	31.5	8.5	1.5	2.3	0.0	.8	0.0	0.0	0.0		100.0

TABLE C11

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 AUGUST 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	17	7	3	1	0	0	0	0	0	0	28	4.5
< 4.0	119	25	11	3	3	2	0	0	0	0	163	25.3
< 7.0	144	25	7	5	4	1	0	0	0	0	186	30.0
<10.0	64	15	5	3	1	0	1	0	0	0	89	14.4
<15.0	57	12	7	2	0	0	0	1	0	0	79	12.8
<30.0	62	7	1	3	1	0	0	0	0	0	74	12.0
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	463	91	34	17	9	3	1	1	0	0	619	
%	74.8	14.7	5.5	2.7	1.5	.5	.2	.2	0.0	0.0		100.0

TABLE C11 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 AUGUST 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	12	3	0	2	1	1	0	0	0	0	19	3.9
< 4.0	71	28	16	7	3	2	1	1	1	1	131	26.8
< 7.0	103	29	9	2	1	2	0	0	0	0	146	29.9
<10.0	53	26	1	0	3	1	0	0	0	0	84	17.2
<15.0	57	18	3	2	1	0	0	0	0	0	81	16.6
<30.0	18	6	3	0	0	0	0	0	0	0	27	5.5
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	314	110	32	13	9	6	1	1	1	1	488	
%	64.3	22.5	6.6	2.7	1.8	1.2	.2	.2	.2	.2		100.0

TABLE C11 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 AUGUST 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	11	3	0	1	0	0	0	0	0	0	15	3.5
< 4.0	50	36	10	2	2	1	3	1	0	0	105	24.2
< 7.0	104	39	15	9	2	1	1	0	0	0	171	39.4
<10.0	60	26	11	2	1	2	0	0	0	0	102	23.5
<15.0	15	10	10	5	0	0	0	0	0	0	40	9.2
<30.0	1	0	0	0	0	0	0	0	0	0	1	.2
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	241	114	46	19	5	4	4	1	0	0	434	
%	55.5	26.3	10.6	4.4	1.2	.9	.9	.2	0.0	0.0		100.0

TABLE C12

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 SEPTEMBER 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	5	4	2	0	0	0	0	1	0	0	12	5.9
< 4.0	26	12	4	4	4	3	0	0	0	0	53	26.1
< 7.0	34	18	7	6	0	0	0	1	0	0	66	32.5
<10.0	12	5	4	1	1	0	0	1	0	0	24	11.8
<15.0	10	6	2	0	3	0	0	0	0	0	21	10.3
<30.0	14	8	3	0	0	0	0	0	1	0	26	12.8
<60.0	1	0	0	0	0	0	0	0	0	0	1	.5
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	102	53	22	11	8	3	0	3	1	0	203	
%	50.2	26.1	10.8	5.4	3.9	1.5	0.0	1.5	.5	0.0		100.0

TABLE C12 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 SEPTEMBER 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	5	2	1	2	1	0	1	0	0	0	12	3.3
< 4.0	57	28	11	6	3	2	1	0	1	0	109	30.3
< 7.0	55	24	14	7	1	0	0	0	0	0	101	28.1
<10.0	52	10	2	1	0	0	0	0	0	0	65	18.1
<15.0	30	14	2	2	0	0	0	0	0	0	48	13.3
<30.0	17	2	5	0	0	0	0	0	0	0	24	5.7
<60.0	0	0	0	1	0	0	0	0	0	0	1	.3
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	216	80	35	19	5	2	2	0	1	0	360	
%	60.0	22.2	9.7	5.3	1.4	.6	.6	0.0	.3	0.0		100.0

TABLE C12 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 SEPTEMBER 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	8	3	2	1	0	0	0	0	0	0	14	5.4
< 4.0	28	23	7	4	0	2	0	0	1	0	65	25.2
< 7.0	57	28	16	7	5	2	0	0	1	0	116	45.0
<10.0	16	14	7	1	1	1	0	0	0	0	40	15.5
<15.0	6	6	5	2	0	1	0	0	0	0	20	7.8
<30.0	1	1	1	0	0	0	0	0	0	0	3	1.2
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	116	75	38	15	6	6	0	0	2	0	258	
%	45.0	29.1	14.7	5.8	2.3	2.3	0.0	0.0	.8	0.0		100.0

TABLE C13

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 OCTOBER 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	18	9	2	3	1	0	0	0	0	0	33	8.5
< 4.0	99	33	17	4	4	3	2	0	1	0	163	41.8
< 7.0	59	25	10	7	2	2	1	0	0	0	106	27.2
<10.0	23	11	6	1	1	0	0	0	0	0	42	10.8
<15.0	16	8	3	0	2	0	1	0	0	0	30	7.7
<30.0	7	3	1	2	2	0	1	0	0	0	16	4.1
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	222	89	39	17	12	5	5	0	1	0	390	
%	56.9	22.8	10.0	4.4	3.1	1.3	1.3	0.0	.3	0.0		100.0

TABLE C13 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 4 OCTOBER 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	1	3	0	0	1	0	0	0	0	0	5	2.6
< 4.0	41	13	6	5	1	1	0	0	1	1	69	35.1
< 7.0	34	15	8	1	1	0	0	1	0	0	60	31.4
<10.0	10	9	3	2	1	0	1	0	0	0	26	13.6
<15.0	15	6	3	1	0	1	0	0	0	0	26	13.6
<30.0	3	0	2	0	0	0	0	0	0	0	5	2.6
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	104	46	22	9	4	2	1	1	1	1	191	
%	54.5	24.1	11.5	4.7	2.1	1.0	.5	.5	.5	.5		100.0

TABLE C13 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 OCTOBER 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	5	0	1	1	0	2	0	0	0	0	9	2.3
< 4.0	37	16	10	6	3	0	0	1	0	0	73	18.3
< 7.0	114	52	24	8	7	0	1	0	0	0	206	51.8
<10.0	45	31	5	5	3	1	1	0	0	0	91	22.9
<15.0	7	5	3	1	0	0	0	0	0	0	16	4.0
<30.0	0	1	0	1	0	0	0	0	0	0	2	.5
<60.0	1	0	0	0	0	0	0	0	0	0	1	.3
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	209	105	43	22	13	3	2	1	0	0	398	
%	52.5	26.4	10.8	5.5	3.3	.8	.5	.3	0.0	0.0		100.0

TABLE C14

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 2 NOVEMBER 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	3	1	0	0	0	0	0	0	0	0	4	6.5
< 4.0	13	3	4	0	0	0	0	0	0	0	20	32.3
< 7.0	12	9	1	4	1	0	0	0	0	0	27	43.5
<10.0	3	2	2	0	0	0	0	0	0	0	7	11.3
<15.0	1	3	0	0	0	0	0	0	0	0	4	6.5
<30.0	0	0	0	0	0	0	0	0	0	0	0	0.0
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	32	18	7	4	1	0	0	0	0	0	62	
%	51.6	29.0	11.3	6.5	1.6	0.0	0.0	0.0	0.0	0.0		100.0

TABLE C14 (continued)

WIND SPEED .VS. DURATION OF WIND
DATA RECORDED IS NUMBER OF OCCURRENCES OR OBSERVATIONS (1/2 HOUR INTERVALS)

POWDERHORN STATION 6 NOVEMBER 1977

DURATION IN HOURS

SPEED	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
< 2.0	3	2	2	0	1	0	0	0	0	0	8	5.3
< 4.0	28	13	6	1	0	0	0	0	0	0	48	32.0
< 7.0	37	11	6	4	2	0	0	0	0	0	60	40.0
<10.0	9	6	2	1	1	1	1	1	0	0	22	14.7
<15.0	4	6	1	0	0	0	0	1	0	0	12	8.0
<30.0	0	0	0	0	0	0	0	0	0	0	0	0.0
<60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
>60.0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTALS	81	38	17	6	4	1	1	2	0	0	150	
%	54.0	25.3	11.3	4.0	2.7	.7	.7	1.3	0.0	0.0		100.0

APPENDIX

D

TIME OF ONSET .VS. DURATION OF PERSISTENT WINDS

TABLE D1

TIME OF ONSET ,VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 2

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	359	64	32	16	7	5	0	1	1	0	485	6.0
2:30- 4:00	258	74	19	9	4	2	2	0	0	1	369	9.3
4:30- 6:00	208	62	23	14	5	5	0	0	1	0	318	8.0
6:30- 8:00	220	82	27	8	7	2	1	0	0	0	347	8.7
8:30-10:00	220	73	21	11	12	2	2	1	0	1	343	8.6
10:30-12:00	205	80	20	3	2	0	3	0	0	1	314	7.9
12:30-14:00	171	65	18	11	4	1	4	0	0	0	274	6.9
14:30-16:00	145	36	27	5	4	1	0	0	1	1	220	5.5
16:30-18:00	176	52	31	17	11	2	4	0	2	1	296	7.5
18:30-20:00	241	61	25	14	15	6	7	4	3	1	377	9.5
20:30-22:00	211	72	18	7	2	2	3	1	0	0	316	8.0
22:30-24:00	202	57	35	9	1	0	0	3	0	0	307	7.7

TABLE D1 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 4

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	99	30	17	14	7	4	1	0	0	0	172	3.7
2:30- 4:00	67	34	11	5	2	3	4	0	0	0	126	5.7
4:30- 6:00	70	33	11	6	5	4	1	0	1	0	131	5.9
6:30- 8:00	87	39	13	9	9	4	2	2	1	0	166	7.5
8:30-10:00	169	47	11	15	2	8	5	1	4	6	268	12.1
10:30-12:00	139	53	15	1	1	0	1	0	1	0	211	9.6
12:30-14:00	171	49	23	10	2	0	0	0	0	0	255	11.6
14:30-16:00	138	44	13	5	3	0	0	0	0	0	203	9.2
16:30-18:00	130	41	24	13	3	1	0	0	0	0	212	9.6
18:30-20:00	93	46	16	6	8	1	1	0	1	0	172	7.8
20:30-22:00	92	37	18	8	4	1	0	0	0	0	160	7.2
22:30-24:00	67	29	21	7	6	1	0	0	0	0	131	5.9

TABLE D1 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 6

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	170	75	41	19	9	3	1	1	1	2	322	4.3
2:30- 4:00	170	76	39	12	10	0	0	0	0	1	308	8.2
4:30- 6:00	178	75	29	18	10	3	3	0	0	3	319	8.5
6:30- 8:00	223	94	32	15	7	5	4	1	0	0	381	10.1
8:30-10:00	208	96	30	12	6	4	0	0	1	1	358	9.5
10:30-12:00	140	75	41	8	2	0	1	1	0	0	268	7.1
12:30-14:00	136	71	41	26	2	0	0	0	0	0	275	7.4
14:30-16:00	105	72	30	8	6	4	1	0	1	0	227	6.0
16:30-18:00	148	79	26	19	7	8	0	1	0	0	288	7.7
18:30-20:00	219	81	28	19	16	13	9	1	1	0	387	10.3
20:30-22:00	209	98	18	5	1	3	2	6	2	1	345	9.2
22:30-24:00	157	72	32	8	2	0	2	2	0	0	275	7.3

TABLE D2

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 2 NOVEMBER 1976

DURATION IN HOURS

TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	31	11	1	2	1	1	0	0	0	0	47	6.1
2:30- 4:00	27	10	1	0	0	0	0	0	0	0	38	9.6
4:30- 6:00	19	9	5	3	1	1	0	0	1	0	39	9.9
6:30- 8:00	32	12	3	0	0	0	0	0	0	0	47	11.9
8:30-10:00	27	13	1	1	0	0	0	0	0	0	42	10.6
10:30-12:00	20	5	2	1	1	0	0	0	0	0	29	7.3
12:30-14:00	4	5	5	1	0	1	1	0	0	0	17	4.3
14:30-16:00	2	1	5	0	1	0	0	0	0	0	9	2.3
16:30-18:00	5	5	5	4	2	0	0	0	1	1	23	5.8
18:30-20:00	24	7	1	1	4	2	1	0	0	0	40	10.1
20:30-22:00	9	9	5	1	0	0	1	0	0	0	25	6.3
22:30-24:00	26	4	7	2	0	0	0	0	0	0	39	9.9

TABLE D2 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 6 NOVEMBER 1976

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	5	2	3	2	2	2	0	0	0	0	16	5.6
2:30- 4:00	9	4	4	1	0	0	0	0	0	0	18	9.1
4:30- 6:00	9	5	1	1	0	1	0	0	0	0	17	8.6
6:30- 8:00	14	6	3	1	2	0	0	0	0	0	25	13.1
8:30-10:00	4	8	0	1	0	1	0	0	0	1	15	7.6
10:30-12:00	7	5	1	0	0	0	0	0	0	0	13	6.6
12:30-14:00	5	4	4	1	0	0	0	0	0	0	14	7.1
14:30-16:00	4	3	0	1	1	1	0	0	0	0	10	5.1
16:30-18:00	8	4	3	4	2	2	0	0	0	0	23	11.6
18:30-20:00	14	5	2	0	0	1	0	0	0	0	22	11.1
20:30-22:00	5	5	1	0	0	0	0	0	0	0	11	5.6
22:30-24:00	4	3	3	2	0	0	1	0	0	0	13	6.6

TABLE D3

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 2 DECEMBER 1976

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	18	11	2	4	1	0	0	0	1	0	37	5.0
2:30- 4:00	25	7	4	0	0	0	0	0	0	0	35	9.4
4:30- 6:00	14	6	1	2	0	0	0	0	0	0	23	6.0
6:30- 8:00	23	6	6	1	0	0	0	0	0	0	36	9.4
8:30-10:00	27	5	2	1	2	1	1	0	0	1	40	10.4
10:30-12:00	26	11	1	1	1	0	1	0	0	0	41	10.7
12:30-14:00	12	9	0	2	0	0	1	0	0	0	24	6.3
14:30-16:00	17	3	6	0	1	0	0	0	0	0	27	7.0
16:30-18:00	16	5	6	0	1	0	0	0	0	0	28	7.3
18:30-20:00	22	5	4	1	2	1	1	0	0	0	35	9.4
20:30-22:00	13	8	2	1	0	0	0	0	0	0	24	6.3
22:30-24:00	19	4	4	3	0	0	0	1	0	0	31	8.1

TABLE D3 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 4 DECEMBER 1976

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	6	2	0	1	2	1	0	0	0	0	12	3.3
2:30- 4:00	4	3	1	0	0	0	0	0	0	0	8	5.2
4:30- 6:00	2	1	3	1	0	0	0	0	1	0	8	5.2
6:30- 8:00	0	1	0	1	0	0	0	0	0	0	2	1.3
8:30-10:00	8	5	2	4	0	2	2	1	0	1	25	16.3
10:30-12:00	5	4	3	0	0	0	0	0	0	0	12	7.8
12:30-14:00	8	5	2	1	0	0	0	0	0	0	16	10.5
14:30-16:00	8	6	1	0	2	0	0	0	0	0	17	11.1
16:30-18:00	8	3	2	1	3	0	0	0	0	0	17	11.1
18:30-20:00	3	1	4	0	1	0	0	0	0	0	9	5.9
20:30-22:00	8	2	2	3	0	0	0	0	0	0	15	9.8
22:30-24:00	6	4	0	0	2	0	0	0	0	0	12	7.8

TABLE D3 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 6 DECEMBER 1976

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	6	2	1	1	1	0	0	0	0	1	12	5.8
2:30- 4:00	5	2	1	0	0	0	0	0	0	0	8	6.6
4:30- 6:00	2	3	2	1	0	0	0	0	0	0	8	6.6
6:30- 8:00	6	6	2	2	0	0	0	0	0	0	16	13.2
8:30-10:00	5	4	1	0	0	0	0	0	0	0	10	8.3
10:30-12:00	1	3	3	0	0	0	0	0	0	0	7	5.8
12:30-14:00	4	2	1	0	1	0	0	0	0	0	8	6.6
14:30-16:00	3	2	3	1	0	0	0	0	0	0	9	7.4
16:30-18:00	8	4	1	0	0	1	0	0	0	0	14	11.6
18:30-20:00	5	3	1	0	0	1	0	0	0	0	10	8.3
20:30-22:00	6	4	1	0	0	0	0	0	0	0	11	9.1
22:30-24:00	1	3	1	3	0	0	0	0	0	0	8	6.6

TABLE D4

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 2 JANUARY 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	12	5	3	3	1	1	0	0	0	0	25	3.9
2:30- 4:00	15	9	4	0	0	0	1	0	0	0	29	9.5
4:30- 6:00	17	6	1	0	0	0	0	0	0	0	24	7.8
6:30- 8:00	14	8	3	1	1	0	1	0	0	0	28	9.2
8:30-10:00	17	7	3	2	2	0	1	0	0	0	32	10.5
10:30-12:00	19	8	3	0	0	0	0	0	0	0	30	9.8
12:30-14:00	12	8	3	0	0	0	0	0	0	0	23	7.5
14:30-16:00	4	4	1	1	0	0	0	0	0	0	10	3.3
16:30-18:00	9	4	3	6	0	0	0	0	0	0	22	7.2
18:30-20:00	20	5	2	5	1	0	1	0	0	1	35	11.4
20:30-22:00	17	6	3	0	0	0	0	0	0	0	26	8.5
22:30-24:00	9	8	3	0	1	0	0	1	0	0	22	7.2

TABLE D4 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 4 JANUARY 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	9	5	1	1	0	2	0	0	0	0	18	4.5
2:30- 4:00	5	3	1	0	0	1	1	0	0	0	11	5.5
4:30- 6:00	7	4	0	0	0	0	0	0	0	0	11	5.5
6:30- 8:00	4	2	1	0	0	1	0	0	0	0	8	4.0
8:30-10:00	8	3	2	2	1	4	1	0	2	2	25	12.6
10:30-12:00	6	5	3	0	1	0	1	0	0	0	15	8.0
12:30-14:00	14	4	3	4	0	0	0	0	0	0	25	12.6
14:30-16:00	7	4	4	2	1	0	0	0	0	0	18	9.0
16:30-18:00	15	6	7	1	0	0	0	0	0	0	29	14.6
18:30-20:00	3	4	1	0	0	0	1	0	0	0	9	4.5
20:30-22:00	8	2	3	1	1	0	0	0	0	0	15	7.5
22:30-24:00	5	3	2	2	2	0	0	0	0	0	14	7.0

TABLE D4 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 6 JANUARY 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	35	8	2	0	0	0	1	0	0	0	46	3.8
2:30- 4:00	37	8	2	0	0	0	0	0	0	1	48	7.9
4:30- 6:00	47	8	1	5	1	0	0	0	0	1	63	10.4
6:30- 8:00	36	10	1	0	0	1	0	0	0	0	48	7.9
8:30-10:00	38	8	6	1	1	0	0	0	0	0	54	8.9
10:30-12:00	32	11	1	1	0	0	0	0	0	0	45	7.5
12:30-14:00	24	12	3	2	0	0	0	0	0	0	41	6.8
14:30-16:00	20	13	5	0	1	0	0	0	0	0	39	6.5
16:30-18:00	33	14	0	1	0	2	0	0	0	0	50	8.3
18:30-20:00	44	9	0	1	1	0	0	0	0	0	55	9.1
20:30-22:00	42	12	1	0	0	1	0	0	0	0	56	9.3
22:30-24:00	48	8	3	0	0	0	0	0	0	0	59	9.8

TABLE D5

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 2 FEBRUARY 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	67	7	2	0	1	1	0	0	0	0	78	5.4
2:30- 4:00	46	10	1	0	0	0	0	0	0	0	57	8.3
4:30- 6:00	46	9	2	0	1	0	0	0	0	0	58	8.5
6:30- 8:00	51	6	2	2	0	0	0	0	0	0	61	8.9
8:30-10:00	53	7	3	1	2	0	0	0	0	0	66	9.6
10:30-12:00	49	6	1	0	0	0	0	0	0	0	56	8.2
12:30-14:00	39	8	1	1	0	0	0	0	0	0	49	7.1
14:30-16:00	38	5	2	1	0	0	0	0	0	0	46	6.7
16:30-18:00	46	5	3	1	2	1	0	0	0	0	58	8.5
18:30-20:00	36	10	3	0	0	0	1	0	0	0	50	7.3
20:30-22:00	37	9	1	1	0	0	0	0	0	0	48	7.0
22:30-24:00	50	3	4	2	0	0	0	0	0	0	59	8.6

TABLE D5 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 6 FEBRUARY 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	13	5	5	1	1	0	0	0	0	0	25	4.3
2:30- 4:00	13	8	2	2	0	0	0	0	0	0	25	8.9
4:30- 6:00	19	1	2	1	1	0	1	0	0	1	26	9.2
6:30- 8:00	9	10	4	0	1	0	1	0	0	0	25	8.9
8:30-10:00	16	8	3	1	0	1	0	0	0	0	29	10.3
10:30-12:00	11	5	3	1	0	0	1	0	0	0	21	7.4
12:30-14:00	7	5	4	4	0	0	0	0	0	0	20	7.1
14:30-16:00	4	3	2	0	0	0	0	0	0	0	9	3.2
16:30-18:00	8	6	4	4	4	0	0	0	0	0	26	9.2
18:30-20:00	18	10	2	0	2	0	1	0	0	0	33	11.7
20:30-22:00	12	10	3	0	0	0	0	0	0	0	25	8.9
22:30-24:00	6	9	2	1	0	0	0	0	0	0	18	6.4

TABLE D6

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 2 MARCH 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	25	6	4	0	0	1	0	0	0	0	35	5.4
2:30- 4:00	24	7	1	1	1	0	0	0	0	1	35	9.0
4:30- 6:00	27	8	3	0	0	1	0	0	0	0	39	10.1
6:30- 8:00	22	13	2	0	0	0	0	0	0	0	37	9.5
8:30-10:00	17	6	2	0	1	0	0	0	0	0	26	6.7
10:30-12:00	15	7	2	0	0	0	1	0	0	1	26	6.7
12:30-14:00	16	9	2	1	0	0	0	0	0	0	28	7.2
14:30-16:00	17	3	0	1	0	0	0	0	0	0	21	5.4
16:30-18:00	16	9	2	0	2	0	2	0	0	0	31	8.0
18:30-20:00	25	6	3	1	1	0	1	0	1	0	38	9.8
20:30-22:00	30	4	0	0	0	1	1	0	0	0	36	9.3
22:30-24:00	23	8	3	1	0	0	0	0	0	0	35	9.0

TABLE D6 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 4 MARCH 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	18	2	1	0	1	1	0	0	0	0	23	2
2:30- 4:00	13	6	2	1	1	0	1	0	0	0	24	7
4:30- 6:00	16	7	0	2	2	0	0	0	0	0	27	8
6:30- 8:00	30	9	3	1	0	2	0	0	0	0	45	13
8:30-10:00	22	3	0	0	0	0	1	0	0	0	26	8
10:30-12:00	7	5	3	1	0	0	0	0	1	0	17	5
12:30-14:00	23	3	1	5	2	0	0	0	0	0	34	10
14:30-16:00	21	5	2	1	0	0	0	0	0	0	29	9
16:30-18:00	15	6	3	1	0	0	0	0	0	0	25	7
18:30-20:00	13	7	2	1	3	1	0	0	1	0	28	8
20:30-22:00	10	7	2	0	0	0	0	0	0	0	19	5
22:30-24:00	14	3	4	2	2	1	0	0	0	0	26	8

TABLE D6 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 6 MARCH 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	26	6	5	3	1	0	0	0	0	1	42	6.4
2:30- 4:00	25	7	2	2	0	0	0	0	0	0	36	9.6
4:30- 6:00	18	10	2	0	1	0	0	0	0	1	32	8.6
6:30- 8:00	22	6	5	2	0	1	0	1	0	0	37	9.9
8:30-10:00	16	6	4	1	0	1	0	0	1	0	29	7.8
10:30-12:00	6	7	2	1	2	0	0	0	0	0	18	4.8
12:30-14:00	8	6	4	4	0	0	0	0	0	0	22	5.9
14:30-16:00	7	9	2	2	2	2	0	0	0	0	24	6.4
16:30-18:00	11	7	2	3	0	0	0	0	0	0	23	6.1
18:30-20:00	23	5	7	4	0	2	1	0	1	0	43	11.5
20:30-22:00	25	8	1	1	1	0	0	0	0	1	37	9.9
22:30-24:00	19	9	2	1	0	0	0	0	0	0	31	8.3

TABLE D7

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 6 APRIL 1977

DURATION IN HOURS

TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	13	6	6	1	0	0	0	0	0	0	26	4.3
2:30- 4:00	7	7	4	4	1	0	0	0	0	0	23	7.6
4:30- 6:00	8	2	7	0	0	0	0	0	0	0	17	5.6
6:30- 8:00	12	9	4	4	0	0	0	0	0	0	29	9.5
8:30-10:00	14	12	2	0	0	0	0	0	0	0	28	9.2
10:30-12:00	20	5	6	2	0	0	0	0	0	0	33	10.9
12:30-14:00	13	3	2	0	0	0	0	0	0	0	18	5.9
14:30-16:00	14	6	4	1	0	0	0	0	0	0	25	8.2
16:30-18:00	11	8	3	0	1	1	0	1	0	0	25	8.2
18:30-20:00	23	8	0	1	1	1	1	0	0	0	35	11.5
20:30-22:00	14	9	3	0	0	0	0	0	0	0	26	8.6
22:30-24:00	13	2	2	0	0	0	0	2	0	0	19	6.3

TABLE D8

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 2 MAY 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	7	3	4	0	0	0	0	0	0	0	14	5.3
2:30- 4:00	8	5	1	1	0	0	0	0	0	0	15	8.8
4:30- 6:00	7	4	0	0	0	0	0	0	0	0	11	6.5
6:30- 8:00	8	5	1	2	1	1	0	0	0	0	18	10.6
8:30-10:00	7	4	0	0	0	0	0	0	0	0	11	6.5
10:30-12:00	12	2	1	0	0	0	0	0	0	0	15	8.8
12:30-14:00	7	1	0	0	1	0	1	0	0	0	10	5.9
14:30-16:00	9	2	3	0	0	1	0	0	0	0	15	8.8
16:30-18:00	10	3	0	0	0	0	0	0	0	0	13	7.6
18:30-20:00	9	3	1	1	0	0	0	2	1	0	17	10.0
20:30-22:00	12	6	0	0	1	0	1	0	0	0	20	11.8
22:30-24:00	3	5	3	0	0	0	0	0	0	0	11	6.5

TABLE D8 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 6 MAY 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	22	5	2	0	2	0	0	1	0	0	32	3.6
2:30- 4:00	11	5	5	0	1	0	0	0	0	0	22	8.7
4:30- 6:00	14	7	1	2	2	0	0	0	0	0	26	10.3
6:30- 8:00	21	6	0	2	1	1	0	0	0	0	31	12.3
8:30-10:00	22	6	1	0	0	0	0	0	0	0	29	11.5
10:30-12:00	5	7	0	0	0	0	0	0	0	0	12	4.8
12:30-14:00	5	2	2	1	0	0	0	0	0	0	10	4.0
14:30-16:00	2	3	2	1	2	0	1	0	1	0	12	4.8
16:30-18:00	3	2	1	1	0	0	0	0	0	0	7	2.8
18:30-20:00	8	3	4	1	2	0	3	0	0	0	21	8.3
20:30-22:00	16	5	2	0	0	1	1	2	1	0	28	11.1
22:30-24:00	9	9	2	0	1	0	1	0	0	0	22	8.7

TABLE D9

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 2 JUNE 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	12	5	4	1	0	0	0	0	0	0	22	3.3
2:30- 4:00	17	3	4	1	1	0	1	0	0	0	27	9.0
4:30- 6:00	23	7	1	0	0	0	0	0	0	0	31	10.3
6:30- 8:00	12	8	0	0	1	0	0	0	0	0	21	7.0
8:30-10:00	9	7	2	1	2	0	0	0	0	0	21	7.0
10:30-12:00	12	9	1	1	0	0	0	0	0	0	23	7.7
12:30-14:00	20	4	1	0	2	0	0	0	0	0	27	9.0
14:30-16:00	15	3	2	0	0	0	0	0	0	0	20	6.7
16:30-18:00	23	6	1	1	0	0	0	0	0	0	31	10.3
18:30-20:00	25	3	1	1	0	1	0	1	1	0	33	11.0
20:30-22:00	22	3	1	0	0	0	0	0	0	0	26	8.7
22:30-24:00	11	6	1	0	0	0	0	0	0	0	18	6.0

TABLE D9 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 4 JUNE 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	7	3	0	2	0	0	1	0	0	0	13	3.2
2:30- 4:00	11	0	0	1	0	1	1	0	0	0	14	7.4
4:30- 6:00	6	1	0	0	1	0	1	0	0	0	9	4.8
6:30- 8:00	6	4	1	3	0	0	0	0	0	0	14	7.4
8:30-10:00	13	6	0	2	0	0	0	0	0	0	21	11.1
10:30-12:00	10	7	2	0	0	0	0	0	0	0	19	10.1
12:30-14:00	18	4	1	0	0	0	0	0	0	0	23	12.2
14:30-16:00	18	2	0	2	0	0	0	0	0	0	22	11.6
16:30-18:00	14	2	0	1	0	0	0	0	0	0	17	9.0
18:30-20:00	12	4	2	0	1	0	0	0	0	0	19	10.1
20:30-22:00	5	3	0	1	0	0	0	0	0	0	9	4.8
22:30-24:00	4	3	2	0	0	0	0	0	0	0	9	4.8

TABLE D9 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 6 JUNE 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	6	10	2	0	0	0	0	0	0	0	18	4.5
2:30- 4:00	8	6	2	1	1	0	0	0	0	0	18	7.3
4:30- 6:00	7	5	5	2	0	0	0	0	0	0	19	7.7
6:30- 8:00	14	10	2	0	0	2	0	0	0	0	28	11.3
8:30-10:00	13	5	2	1	0	0	0	0	0	0	21	8.5
10:30-12:00	8	3	3	0	0	0	0	0	0	0	14	5.7
12:30-14:00	13	7	0	4	1	0	0	0	0	0	25	10.1
14:30-16:00	4	8	2	1	0	0	0	0	0	0	15	6.1
16:30-18:00	17	3	1	2	0	0	0	0	0	0	23	9.3
18:30-20:00	12	6	1	0	1	1	1	0	0	0	22	8.9
20:30-22:00	12	9	0	1	0	0	0	2	0	0	24	9.7
22:30-24:00	12	4	4	0	0	0	0	0	0	0	20	8.1

TABLE D10

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 2 JULY 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	23	0	0	0	0	0	0	0	0	0	23	25.9
2:30- 4:00	8	0	0	0	0	0	0	0	0	0	8	13.8
4:30- 6:00	0	0	1	0	0	0	0	0	0	0	1	1.7
6:30- 8:00	2	0	0	0	0	0	0	0	0	0	2	3.4
8:30-10:00	2	0	0	0	0	0	0	0	0	0	2	3.4
10:30-12:00	2	0	0	0	0	0	0	0	0	0	2	3.4
12:30-14:00	2	0	0	0	0	0	0	0	0	0	2	3.4
14:30-16:00	2	0	0	0	0	0	0	0	0	1	3	5.2
16:30-18:00	4	0	0	0	0	0	0	0	0	0	4	6.9
18:30-20:00	3	0	0	0	0	0	0	0	0	0	3	5.2
20:30-22:00	4	0	0	0	0	0	0	0	0	0	4	6.9
22:30-24:00	4	0	0	0	0	0	0	0	0	0	4	6.9

TABLE D10 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 4 JULY 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	6	5	1	1	1	0	0	0	0	0	14	3.4
2:30- 4:00	4	6	1	0	0	0	0	0	0	0	11	4.6
4:30- 6:00	11	3	1	0	1	1	0	0	0	0	17	7.2
6:30- 8:00	14	4	2	0	0	0	0	0	0	0	20	8.4
8:30-10:00	20	4	1	1	0	0	0	0	0	0	26	11.0
10:30-12:00	20	2	1	0	0	0	0	0	0	0	23	9.7
12:30-14:00	19	4	2	0	0	0	0	0	0	0	25	10.5
14:30-16:00	20	3	1	0	0	0	0	0	0	0	24	10.1
16:30-18:00	19	4	1	1	0	0	0	0	0	0	25	10.5
18:30-20:00	14	5	3	0	0	0	0	0	0	0	22	9.3
20:30-22:00	17	1	1	0	0	0	0	0	0	0	19	8.0
22:30-24:00	5	4	2	0	0	0	0	0	0	0	11	4.6

TABLE D10 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 6 JULY 1977

DURATION IN HOURS

TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	5	3	2	0	0	0	0	0	0	0	10	3.1
2:30- 4:00	6	4	1	0	0	0	0	0	0	0	11	8.5
4:30- 6:00	3	5	0	0	1	0	0	0	0	0	9	6.9
6:30- 8:00	14	3	1	0	0	0	0	0	0	0	18	13.8
8:30-10:00	6	5	0	0	0	0	0	0	0	0	11	8.5
10:30-12:00	4	2	0	1	0	0	0	0	0	0	7	5.4
12:30-14:00	6	1	4	0	0	0	0	0	0	0	11	8.5
14:30-16:00	6	2	1	0	0	0	0	0	0	0	9	6.9
16:30-18:00	4	4	0	1	0	0	0	0	0	0	9	6.9
18:30-20:00	7	4	1	0	2	0	1	0	0	0	15	11.5
20:30-22:00	7	3	0	0	0	0	0	0	0	0	10	7.7
22:30-24:00	4	5	1	0	0	0	0	0	0	0	10	7.7

TABLE D11

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 2 AUGUST 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	134	4	7	2	0	0	0	0	0	0	147	11.6
2:30- 4:00	48	7	0	2	1	1	0	0	0	0	59	9.5
4:30- 6:00	24	6	3	2	2	0	0	0	0	0	37	6.0
6:30- 8:00	23	8	3	1	1	1	0	0	0	0	37	6.0
8:30-10:00	32	8	3	0	2	0	0	0	0	0	45	7.3
10:30-12:00	23	9	4	0	0	0	1	0	0	0	37	6.0
12:30-14:00	35	7	2	3	0	0	0	0	0	0	47	7.6
14:30-16:00	27	8	2	2	0	0	0	0	0	0	39	6.3
16:30-18:00	27	7	2	2	1	0	0	0	0	0	39	6.3
18:30-20:00	28	11	5	1	1	0	0	1	0	0	47	7.6
20:30-22:00	31	9	2	1	1	1	0	0	0	0	45	7.3
22:30-24:00	31	7	1	1	0	0	0	0	0	0	40	6.5

TABLE D11 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 4 AUGUST 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	17	5	9	4	0	0	0	0	0	0	35	3.7
2:30- 4:00	12	5	4	0	1	0	0	0	0	0	22	4.5
4:30- 6:00	11	7	2	1	1	2	0	0	0	0	24	4.9
6:30- 8:00	12	6	1	1	3	0	1	1	0	0	25	5.1
8:30-10:00	44	11	4	2	1	3	0	0	1	1	67	13.7
10:30-12:00	47	9	1	0	0	0	0	0	0	0	57	11.7
12:30-14:00	48	13	5	0	0	0	0	0	0	0	66	13.5
14:30-16:00	33	11	2	0	0	0	0	0	0	0	45	9.4
16:30-18:00	27	15	1	2	0	0	0	0	0	0	45	9.2
18:30-20:00	26	9	0	0	0	0	0	0	0	0	35	7.2
20:30-22:00	26	14	2	2	3	1	0	0	0	0	48	9.8
22:30-24:00	11	5	1	1	0	0	0	0	0	0	18	3.7

TABLE D11 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 6 AUGUST 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	21	8	4	0	0	1	0	0	0	0	34	3.5
2:30- 4:00	15	8	7	1	0	0	0	0	0	0	31	7.1
4:30- 6:00	20	7	4	2	0	0	1	0	0	0	34	7.8
6:30- 8:00	20	13	4	1	2	0	3	0	0	0	43	9.9
8:30-10:00	17	13	1	1	1	0	0	0	0	0	33	7.6
10:30-12:00	17	11	10	2	0	0	0	0	0	0	40	9.2
12:30-14:00	14	13	2	2	0	0	0	0	0	0	31	7.1
14:30-16:00	21	9	3	1	0	0	0	0	0	0	34	7.8
16:30-18:00	20	8	1	2	0	0	0	0	0	0	31	7.1
18:30-20:00	28	5	4	4	2	3	0	1	0	0	47	10.8
20:30-22:00	28	12	0	3	0	0	0	0	0	0	43	9.9
22:30-24:00	20	7	6	0	0	0	0	0	0	0	33	7.6

TABLE D12

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 2 SEPTEMBER 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	6	3	2	1	0	0	0	0	0	0	12	2.0
2:30- 4:00	7	2	0	2	1	0	0	0	0	0	12	5.9
4:30- 6:00	6	1	2	5	0	2	0	0	0	0	16	7.9
6:30- 8:00	10	6	1	0	1	0	0	0	0	0	18	8.9
8:30-10:00	7	5	2	0	1	1	0	1	0	0	17	8.4
10:30-12:00	12	8	3	0	0	0	0	0	0	0	23	11.3
12:30-14:00	12	6	2	0	0	0	0	0	0	0	20	9.9
14:30-16:00	8	3	1	0	1	0	0	0	1	0	14	6.9
16:30-18:00	6	4	2	0	2	0	0	0	0	0	14	6.9
18:30-20:00	10	4	4	1	2	0	0	0	0	0	21	10.3
20:30-22:00	12	8	1	2	0	0	0	1	0	0	24	11.8
22:30-24:00	6	3	2	0	0	0	0	1	0	0	12	5.9

TABLE D12 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 4 SEPTEMBER 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	16	3	2	3	1	0	0	0	0	0	25	3.6
2:30- 4:00	13	6	1	3	0	1	0	0	0	0	24	6.6
4:30- 6:00	9	5	3	1	0	1	0	0	0	0	19	5.3
6:30- 8:00	9	9	4	2	3	0	1	0	1	0	29	8.0
8:30-10:00	31	10	2	2	0	0	1	0	0	0	46	12.7
10:30-12:00	29	9	2	0	0	0	0	0	0	0	40	11.1
12:30-14:00	25	10	3	0	0	0	0	0	0	0	38	10.5
14:30-16:00	22	6	3	0	0	0	0	0	0	0	31	8.6
16:30-18:00	27	2	4	3	0	0	0	0	0	0	35	10.0
18:30-20:00	14	11	2	4	1	0	0	0	0	0	32	8.9
20:30-22:00	16	3	5	1	0	0	0	0	0	0	25	6.9
22:30-24:00	5	6	5	0	0	0	0	0	0	0	16	4.4

TABLE D12 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 6 SEPTEMBER 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	5	8	4	2	0	0	0	0	1	0	20	5.0
2:30- 4:00	10	5	6	0	2	0	0	0	0	0	23	8.9
4:30- 6:00	4	11	4	1	0	0	0	0	0	0	20	7.8
6:30- 8:00	18	4	2	2	1	0	0	0	0	0	27	10.5
8:30-10:00	21	7	4	3	0	0	0	0	0	0	35	13.6
10:30-12:00	8	5	4	0	0	0	0	0	0	0	17	6.6
12:30-14:00	9	6	4	3	0	0	0	0	0	0	22	8.5
14:30-16:00	4	4	2	0	0	1	0	0	0	0	11	4.3
16:30-18:00	4	7	0	1	0	1	0	0	0	0	13	5.0
18:30-20:00	6	4	4	3	2	3	0	0	0	0	22	8.5
20:30-22:00	19	7	2	0	0	1	0	0	1	0	30	11.6
22:30-24:00	8	7	2	0	1	0	0	0	0	0	18	7.0

TABLE D13

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 2 OCTOBER 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	21	7	2	3	3	0	0	0	0	0	36	3.3
2:30- 4:00	26	13	4	0	0	1	0	0	0	0	44	11.3
4:30- 6:00	21	5	3	2	1	1	0	0	0	0	33	8.5
6:30- 8:00	21	8	6	1	2	0	0	0	0	0	38	9.7
8:30-10:00	22	10	2	3	0	0	0	0	0	0	37	9.5
10:30-12:00	11	13	1	0	0	0	0	0	0	0	25	6.4
12:30-14:00	9	6	1	2	1	0	1	0	0	0	20	5.1
14:30-16:00	5	4	5	0	1	0	0	0	0	0	15	3.8
16:30-18:00	12	3	5	3	1	1	2	0	1	0	28	7.2
18:30-20:00	35	6	1	2	3	2	2	0	0	0	51	13.1
20:30-22:00	21	8	2	1	0	0	0	0	0	0	32	8.2
22:30-24:00	18	6	7	0	0	0	0	0	0	0	31	7.9

TABLE D13 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 4 OCTOBER 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	16	3	1	2	0	0	0	0	0	0	22	4.7
2:30- 4:00	4	3	1	0	0	0	1	0	0	0	9	4.7
4:30- 6:00	6	5	1	1	0	0	0	0	0	0	13	6.8
6:30- 8:00	8	3	0	1	2	1	0	1	0	0	15	8.4
8:30-10:00	19	5	0	2	0	0	0	0	1	1	29	14.7
10:30-12:00	13	8	0	0	0	0	0	0	0	0	21	11.0
12:30-14:00	10	4	5	0	0	0	0	0	0	0	19	9.9
14:30-16:00	6	5	0	0	0	0	0	0	0	0	11	5.8
16:30-18:00	4	1	5	1	0	1	0	0	0	0	12	6.3
18:30-20:00	6	5	2	1	2	0	0	0	0	0	15	8.4
20:30-22:00	2	4	2	0	0	0	0	0	0	0	8	4.2
22:30-24:00	10	0	5	1	0	0	0	0	0	0	16	8.4

TABLE D13 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 6 OCTOBER 1977

DURATION IN HOURS

TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	12	5	3	8	2	0	0	0	0	0	30	3.8
2:30- 4:00	18	9	4	1	4	0	0	0	0	0	36	9.0
4:30- 6:00	15	10	1	0	2	1	1	0	0	0	30	7.5
6:30- 8:00	28	8	4	1	0	0	0	0	0	0	41	10.3
8:30-10:00	27	10	2	3	2	1	0	0	0	0	45	11.3
10:30-12:00	10	9	7	0	0	0	0	0	0	0	26	6.5
12:30-14:00	24	7	7	4	0	0	0	0	0	0	42	10.6
14:30-16:00	12	7	4	0	0	0	0	0	0	0	23	5.8
16:30-18:00	12	9	8	0	0	1	0	0	0	0	30	7.5
18:30-20:00	27	15	1	5	3	0	1	0	0	0	52	13.1
20:30-22:00	20	10	1	0	0	0	0	1	0	0	32	8.0
22:30-24:00	4	6	1	0	0	0	0	0	0	0	11	2.8

TABLE A14

TIME OF ONSET .VS. DURATION OF PERSISTENT WINDS
DATA RECORDED IS NUMBER OF OCCURENCES OR OBSERVATIONS (2 hour intervals)

POWDERHORN STATION 2 NOVEMBER 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	3	3	0	0	0	0	0	0	0	0	6	4.8
2:30- 4:00	7	1	0	1	0	0	0	0	0	0	9	14.5
4:30- 6:00	4	1	1	0	0	0	0	0	0	0	6	9.7
6:30- 8:00	2	2	0	0	0	0	0	0	0	0	4	6.5
8:30-10:00	0	1	1	2	0	0	0	0	0	0	4	6.5
10:30-12:00	3	1	1	0	0	0	0	0	0	0	5	8.1
12:30-14:00	2	2	1	1	0	0	0	0	0	0	6	9.7
14:30-16:00	1	0	0	0	0	0	0	0	0	0	1	1.6
16:30-18:00	2	1	2	0	0	0	0	0	0	0	5	8.1
18:30-20:00	4	1	0	0	1	0	0	0	0	0	6	9.7
20:30-22:00	3	2	1	0	0	0	0	0	0	0	6	9.7
22:30-24:00	1	3	0	0	0	0	0	0	0	0	4	6.5

TABLE D14 (continued)

TIME OF ONSET .VS. DURATION OF PERSISTANT WINDS
DATA RECORDED IS NUMBER OF OCCURANCES OR OBSERVATIONS (2 HOUR INTERVALS)

POWDERHORN STATION 6 NOVEMBER 1977

	DURATION IN HOURS											
TIME	0.0- 1.4	1.5- 2.9	3.0- 4.4	4.5- 5.9	6.0- 7.4	7.5- 8.9	9.0-10.4	10.5-11.9	12.0-13.4	13.5-	TOTALS	%
0:30- 2:00	2	6	2	1	0	0	0	0	0	0	11	4.7
2:30- 4:00	6	3	0	0	1	0	0	0	0	0	10	6.7
4:30- 6:00	11	2	0	3	1	0	0	0	0	0	17	11.3
6:30- 8:00	9	3	0	0	0	0	0	0	0	0	12	8.0
8:30-10:00	9	4	4	0	2	0	0	0	0	0	19	12.7
10:30-12:00	11	2	1	0	0	0	0	1	0	0	15	10.0
12:30-14:00	5	3	2	1	0	0	0	0	0	0	11	7.3
14:30-16:00	5	3	0	0	0	0	0	0	0	0	8	5.3
16:30-18:00	9	3	2	0	0	0	0	0	0	0	14	9.3
18:30-20:00	3	5	1	0	0	1	0	0	0	0	10	6.7
20:30-22:00	3	4	3	0	0	0	1	1	0	0	12	8.0
22:30-24:00	8	0	2	1	0	0	0	0	0	0	11	7.3

APPENDIX

E

STATISTICS OF TEMPERATURE

TABLE E1

STATISTICS OF TEMPERATURE
POWDERHORN STATION 2

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	*****	32.0	*****
60.0	518.0	0.0	163.0
70.0	116.5	-10.0	14.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E1 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 4

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	*****	32.0	*****
60.0	673.0	0.0	130.0
70.0	263.0	-10.0	11.5
80.0	1.5	-20.0	0.0
90.0	1.5	-30.0	0.0
100.0	1.5	-40.0	0.0

TABLE E1 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 6

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	*****	32.0	*****
60.0	*****	0.0	296.0
70.0	417.0	-10.0	67.5
80.0	39.0	-20.0	4.0
90.0	.5	-30.0	0.0
100.0	.5	-40.0	0.0

TABLE E2

STATISTICS OF TEMPERATURE

POWDERHORN STATION 2 NOVEMBER 1976

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	3.0	32.0	540.5
60.0	0.0	0.0	48.5
70.0	0.0	-10.0	12.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E2 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 6 NOVEMBER 1976

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	24.5	32.0	331.5
60.0	0.0	0.0	46.0
70.0	0.0	-10.0	13.5
80.0	0.0	-20.0	4.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E3

STATISTICS OF TEMPERATURE

POWDERHORN STATION 2 DECEMBER 1976

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	0.0	32.0	648.5
60.0	0.0	0.0	20.0
70.0	0.0	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E3 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 4 DECEMBER 1976

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	0.0	32.0	369.5
60.0	0.0	0.0	25.0
70.0	0.0	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E3 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 6 DECEMBER 1976

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	0.0	32.0	225.5
60.0	0.0	0.0	29.0
70.0	0.0	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E4

STATISTICS OF TEMPERATURE

POWDERHORN STATION 2 JANUARY 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	0.0	32.0	544.5
60.0	0.0	0.0	59.0
70.0	0.0	-10.0	2.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E4 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 4 JANUARY 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	0.0	32.0	470.0
60.0	0.0	0.0	84.5
70.0	0.0	-10.0	11.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E4 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 6 JANUARY 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	.5	32.0	671.0
60.0	0.0	0.0	158.0
70.0	0.0	-10.0	44.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E5

STATISTICS OF TEMPERATURE

POWDERHORN STATION 2 FEBRUARY 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	0.0	32.0	600.0
60.0	0.0	0.0	19.0
70.0	0.0	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E5 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 6 FEBRUARY 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	8.5	32.0	447.5
60.0	.5	0.0	39.0
70.0	.5	-10.0	9.5
80.0	.5	-20.0	0.0
90.0	.5	-30.0	0.0
100.0	.5	-40.0	0.0

TABLE E6

STATISTICS OF TEMPERATURE

POWDERHORN STATION 2 MARCH 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	0.0	32.0	526.0
60.0	0.0	0.0	16.5
70.0	0.0	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E6 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 4 MARCH 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	.5	32.0	464.0
60.0	0.0	0.0	20.5
70.0	0.0	-10.0	.5
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E6 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 6 MARCH 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	19.5	32.0	580.0
60.0	.5	0.0	22.0
70.0	0.0	-10.0	.5
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E7

STATISTICS OF TEMPERATURE

POWDERHORN STATION 6 APRIL 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	130.0	32.0	241.5
60.0	39.0	0.0	.5
70.0	.5	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E8

STATISTICS OF TEMPERATURE

POWDERHORN STATION 2 MAY 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	96.5	32.0	46.5
60.0	30.0	0.0	0.0
70.0	0.0	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E8 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 6 MAY 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	231.5	32.0	77.0
60.0	115.5	0.0	0.0
70.0	21.5	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E9

STATISTICS OF TEMPERATURE

POWDERHORN STATION 2 JUNE 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	286.0	32.0	0.0
60.0	172.5	0.0	0.0
70.0	59.0	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E9 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 4 JUNE 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	215.0	32.0	0.0
60.0	131.5	0.0	0.0
70.0	53.5	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E9 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 6 JUNE 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	317.5	32.0	2.5
60.0	207.0	0.0	0.0
70.0	115.0	-10.0	0.0
80.0	9.5	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E10

STATISTICS OF TEMPERATURE

POWDERHORN STATION 2 JULY 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	74.5	32.0	103.5
60.0	39.5	0.0	0.0
70.0	10.0	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E10 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 4 JULY 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	209.0	32.0	.5
60.0	117.5	0.0	0.0
70.0	64.5	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E10 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 6 JULY 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	177.5	32.0	0.0
60.0	99.0	0.0	0.0
70.0	60.5	-10.0	0.0
80.0	4.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E11

STATISTICS OF TEMPERATURE

POWDERHORN STATION 2 AUGUST 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	514.0	32.0	66.0
60.0	249.0	0.0	0.0
70.0	47.5	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E11 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 4 AUGUST 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	510.5	32.0	7.5
60.0	285.5	0.0	0.0
70.0	104.0	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E11 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 6 AUGUST 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	583.5	32.0	4.0
60.0	355.0	0.0	0.0
70.0	200.0	-10.0	0.0
80.0	25.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E12

STATISTICS OF TEMPERATURE

POWDERHORN STATION 2 SEPTEMBER 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	142.5	32.0	42.5
60.0	27.0	0.0	0.0
70.0	0.0	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E12 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 6 SEPTEMBER 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	250.0	32.0	47.5
60.0	122.0	0.0	0.0
70.0	19.0	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E12 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 4 SEPTEMBER 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	262.5	32.0	47.5
60.0	129.0	0.0	0.0
70.0	40.5	-10.0	0.0
80.0	1.0	-20.0	0.0
90.0	1.0	-30.0	0.0
100.0	1.0	-40.0	0.0

TABLE E13

STATISTICS OF TEMPERATURE

POWDERHORN STATION 2 OCTOBER 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	86.0	32.0	297.0
60.0	0.0	0.0	0.0
70.0	0.0	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E13 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 4 OCTOBER 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	60.0	32.0	145.5
60.0	9.0	0.0	0.0
70.0	0.0	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E13 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 6 OCTOBER 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	194.0	32.0	260.0
60.0	80.5	0.0	0.0
70.0	0.0	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E14

STATISTICS OF TEMPERATURE

POWDERHORN STATION 2 NOVEMBER 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	3.5	32.0	59.5
60.0	0.0	0.0	0.0
70.0	0.0	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

TABLE E14 (continued)

STATISTICS OF TEMPERATURE

POWDERHORN STATION 6 NOVEMBER 1977

STATISTICS	HOURS GREATER THAN OR EQUAL	STATISTIC	HOURS LESS THAN OR EQUAL
50.0	22.0	32.0	159.5
60.0	2.0	0.0	1.5
70.0	0.0	-10.0	0.0
80.0	0.0	-20.0	0.0
90.0	0.0	-30.0	0.0
100.0	0.0	-40.0	0.0

CHAPTER VI

MICROCLIMATE AND OTHER WEATHER DATA

Prepared by: Hugo A. Ferchau

TABLE OF CONTENTS

LIST OF TABLES ii

LIST OF FIGURES iii

INTRODUCTION 1

PRECIPITATION 10

TEMPERATURE 16

WIND 16

REFERENCES 23

LIST OF TABLES

SNOW COURSE DATA FROM COCHETOPA PASS, LAKE CITY AND DELDORADO CREEK (Big Iron Hill) 15

LIST OF FIGURES

Fig. 6-1. Colorado climate zones 2

Fig. 6-2. Station 1. On the southern flank of Huntsman Mesa, east of Station 2. Used to determine baseline inversions 3

Fig. 6-3. Station 2. MRI unit at forty feet atop a Douglas Fir tree. Proposed crusher site 4

Fig. 6-4. Station 2. Fenced shelter and precipitation gauge . 6

Fig. 6-5. Station 4. MRI and fenced shelter. Proposed location of tailings dam 7

Fig. 6-6. Station 5 on Deldorado Creek between Big Iron Hill and Little Iron Hill 8

Fig. 6-7. Station 6A. Cebolla Creek Valley on Ed Howard Ranch. Hi-Vol particulate sampler 8

Fig. 6-8. Powderhorn Store. A local landmark behind which Fred Youman operated a weather station in the 1960's and where Station 8 is currently located . . 9

Fig. 6-9. Precipitation. Monthly 1977 totals for Stations 2, 4, 5, 8 and Gunnison 11

Fig. 6-10. Weekly (Weeks 1-26) precipitation (1977) for Stations 2, 4, 5, 8, and Gunnison. 12

Fig. 6-11. Weekly (Weeks 27-52) precipitation (1977) for Stations 2, 4, 5, 8, and Gunnison. 13

Fig. 6-12. Weekly temperature maxima and minima for Stations 1, 2, 3, 4 for Weeks 1-26, 1977 17

Fig. 6-13. Weekly temperature maxima and minima for Stations 1, 2, 3, 4 for Weeks 27-52, 1977 18

Fig. 6-14. Weekly temperature maxima and minima for Stations 5, 8 and Gunnison for Weeks 1-26, 1977 . . 19

Fig. 6-15. Weekly temperature maxima and minima for Stations 5, 8 and Gunnison for Weeks 27-52, 1977 . . 20

Fig. 6-16. Weekly average windspeeds for Stations 3, 4, 8 for 1977 21

MICROCLIMATE AND OTHER WEATHER DATA

Introduction

It is well recognized that climate may be evaluated on a broad regional base (macroclimate) or on a highly localized base (microclimate). In that sense, Figure 6-1 diagrams the macroclimatic patterns for Colorado (in which Powderhorn is in Zone 7 - Southern Mountains), and appropriate generalizations may be made. By the same token, microclimate information provides an awareness of the circumstances which must be met when revegetation, reclamation, or a specific piece of engineering must be considered.

The original study design (Ferchau, 1976) was assembled to provide two sets of information: (1) Air quality and regional climate (macroclimate) to provide a base to which the significance of a proposed titanium industry might be related and (2) Microclimate, an insight to how various sites for reclamation might differ. Chapter V by Marlatt responds to the questions associated with air quality and macroclimate.

The location of the weather stations used to generate the information are shown in Exhibit B and Figure 5-1. The stations were equipped variously. Station 1 (Fig. 6-2) was a weather shelter housing a hygrothermograph and a maximum-minimum registering thermometer; Station 2, at the proposed crusher site, included an MRI unit at the top of a forty-foot Douglas Fir (Fig. 6-3) and a fenced shelter with a hygrothermograph, maximum-minimum recording

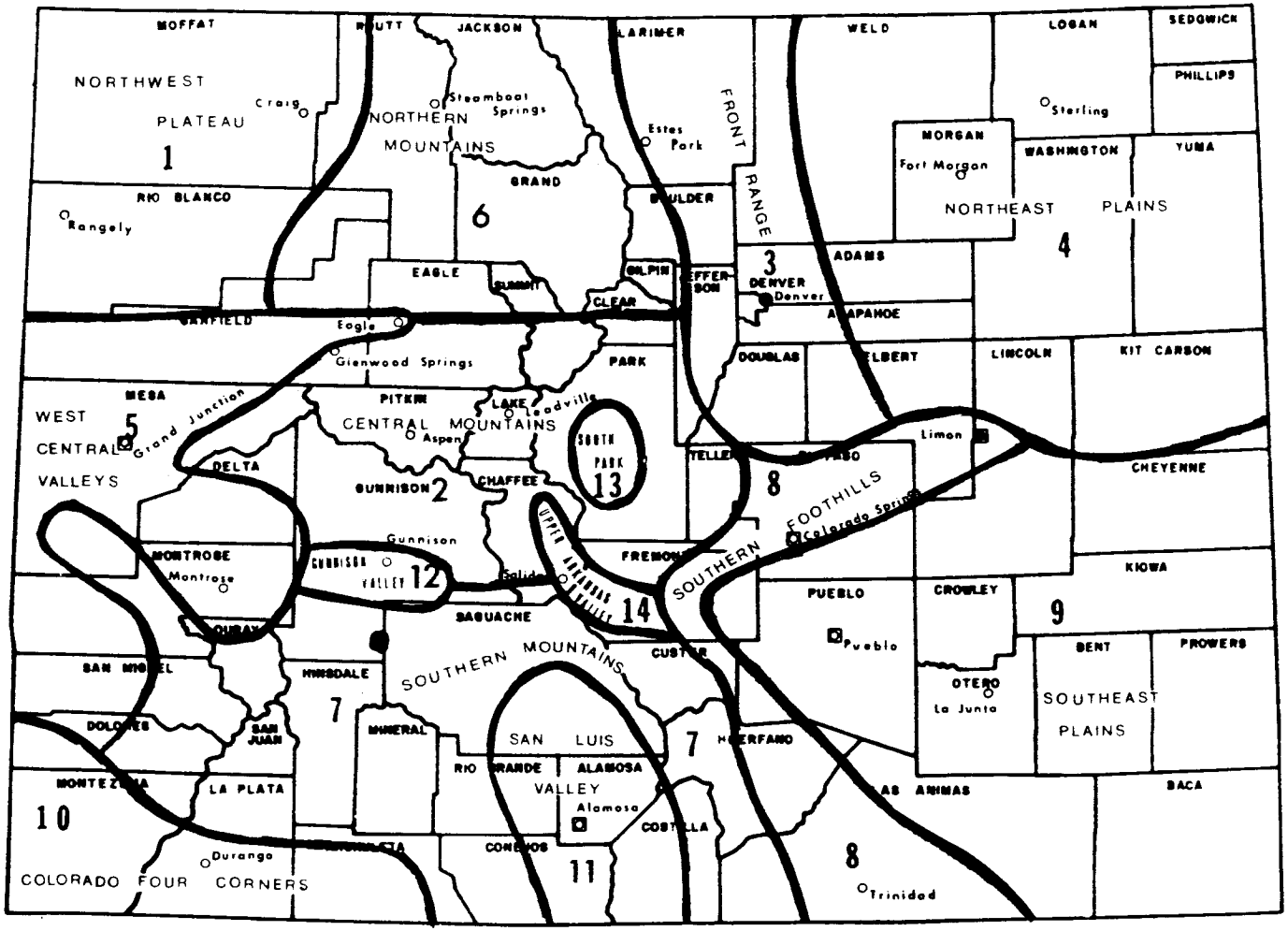

Fig. 6-1. Colorado climate zones. Large dot identifies location of Powderhorn Project. (Adapted from U.S. Weather Bureau Map)

Fig. 6-2. Station 1. On the southern flank of Huntsman Mesa, east of Station 2. Used to determine baseline inversions.

Fig. 6-3. Station 2. MRI unit at forty feet atop a Douglas Fir tree. Proposed crusher site.

thermometer, and a continuously recording precipitation gauge (Fig. 6-4). Station 3, at the proposed mill site, consisted of a fenced shelter with hygrothermograph, a maximum-minimum registering thermometer, and a totalizing anemometer; Station 4, at the proposed tailings dam included an MRI (Fig. 6-5) and a fenced shelter, and was equipped as Station 4. Station 5, on Deldorado Creek (Fig. 6-6) was a fenced shelter with hygrothermograph, maximum-minimum recording thermometer, totalizing precipitation gauge, and a totalizing anamometer. Station 6 was a fenced MRI unit located approximately 150 feet west of the Glen Sammons residence. Station 6A was the fenced Hi-Vol particulate sampler (Fig. 6-7) located one-quarter mile north of Station 6 on a fence line which originally was the boundary between the Dave Howard and Ed Howard ranches. The sampler, located about 200 feet west of the Cebolla Creek Road, utilized an electrical outlet to provide current to heat a cattle watering trough. Station 8 was located behind the Powderhorn Store (Fig. 6-8). It represented the re-establishment of a weather station operated by Fred Youmans during the 1960's, and presented an opportunity to make comparisons between present and past. The station consisted of a totalizing anemometer, recording radiometer, totalizing precipitation gauge, a hygrothermograph, and a maximum-minimum registering thermometer. A microbarograph was maintained in one of the Youman's cabins. Ultimately, a comparison will be made between the Gunnison and Powderhorn weather patterns and it will be reported in a separate paper. A snow survey course was established on the north side of Big Iron Hill, in cooperation with the local office of the U.S. Soil Conservation Service.

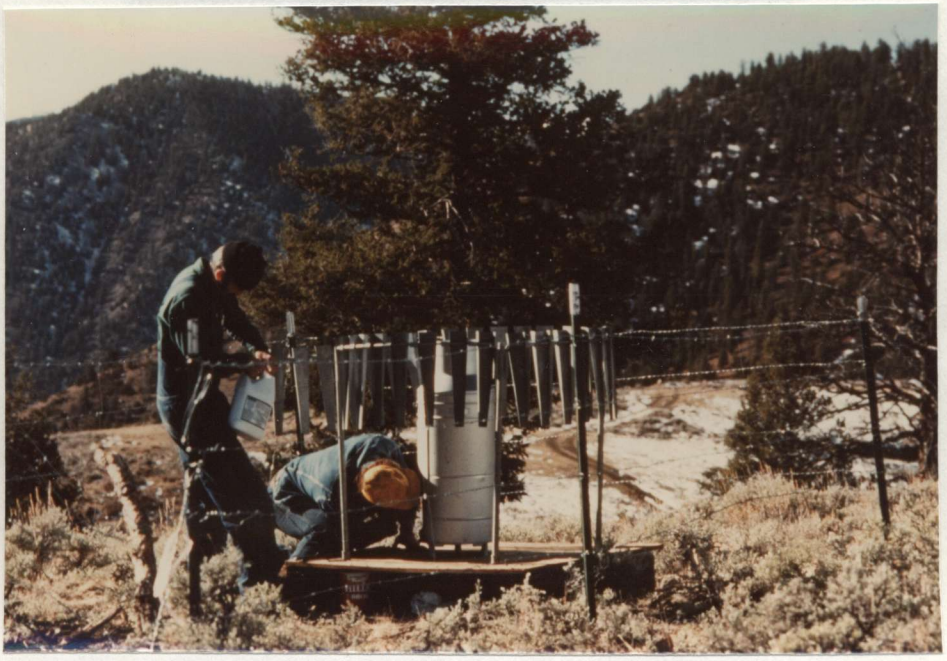

Fig. 6-4. Station 2. Fenced shelter and precipitation gauge.

Fig. 6-5. Station 4. MRI and fenced shelter. Proposed location of tailings dam.

Fig. 6-6. Station 5 on Deldorado Creek between Big Iron Hill and Little Iron Hill.

Fig. 6-7. Station 6A. Cebolla Creek Valley on Ed Howard Ranch. Hi-Vol particulate sampler.

Fig. 6-8. Powderhorn Store. A local landmark behind which Fred Youman operated a weather station in the 1960's and where Station 8 is currently located.

As stated earlier, the use of weather data originally was intended to have macroclimatic and microclimatic implications. As the study developed, it became apparent the primary use of the 1977 data was to support the development of an air quality model (Chapter V) which we felt was the most urgent in view of the various federal and state requirements for gaining permits. Only a limited amount of microclimatic data will be provided in this report. There will be a substantial reorganization of the climatic data for 1977, along with the 1978 data and it will appear in the 1978 report and in the thesis of Paul Edwards. All 1977 data has been removed from the original charts, stored on computer cards and is on file at Western State College (Room 5) and is available for scrutiny by anyone authorized by Buttes Gas and Oil.

Precipitation

Belfort totalizing precipitation gauges were used to record moisture. Wind shields were used for air stabilization. Charts were changed weekly. Anti-freeze was used in the winter to keep the incoming precipitation in a liquid state. The first recorded snow fell on November 20, 1976 and the last snow fell on May 10, 1977.

Figure 6-9 provides a comparison of rainfall and snowfall monthly totals for Stations 2, 4, 5, 8, and Gunnison. A further breakdown to illustrate the nature of individual storms and variations on a daily basis will be accomplished in the 1978 report when much more emphasis will be placed on microclimate. Figures 6-10 and 6-11 are samples of the future treatment. In reality, it is that detail

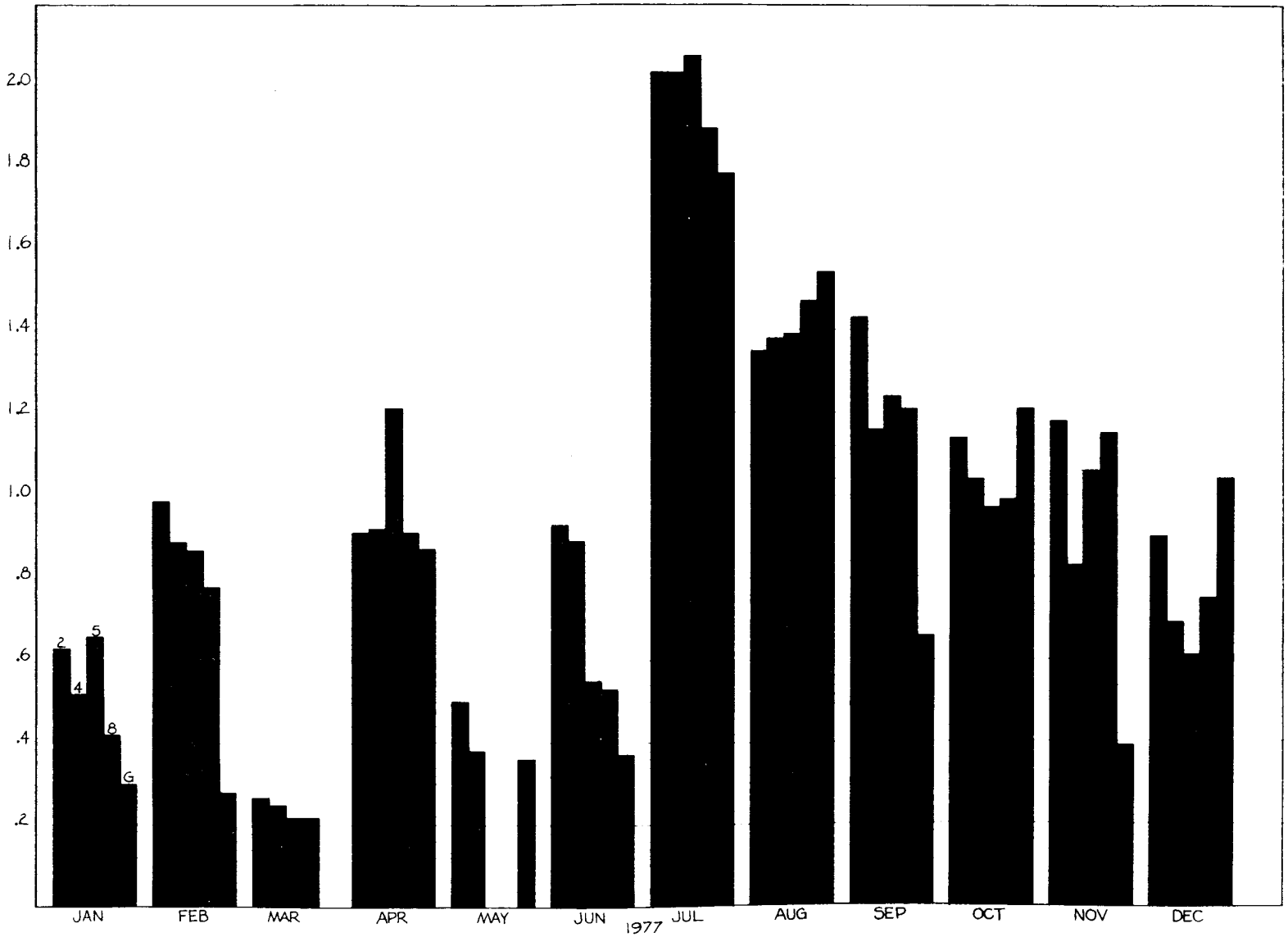

Fig. 6-9. Bar graphs to illustrate total monthly (1977) precipitation for Stations 2, 4, 5, 8 and Gunnison (left to right).

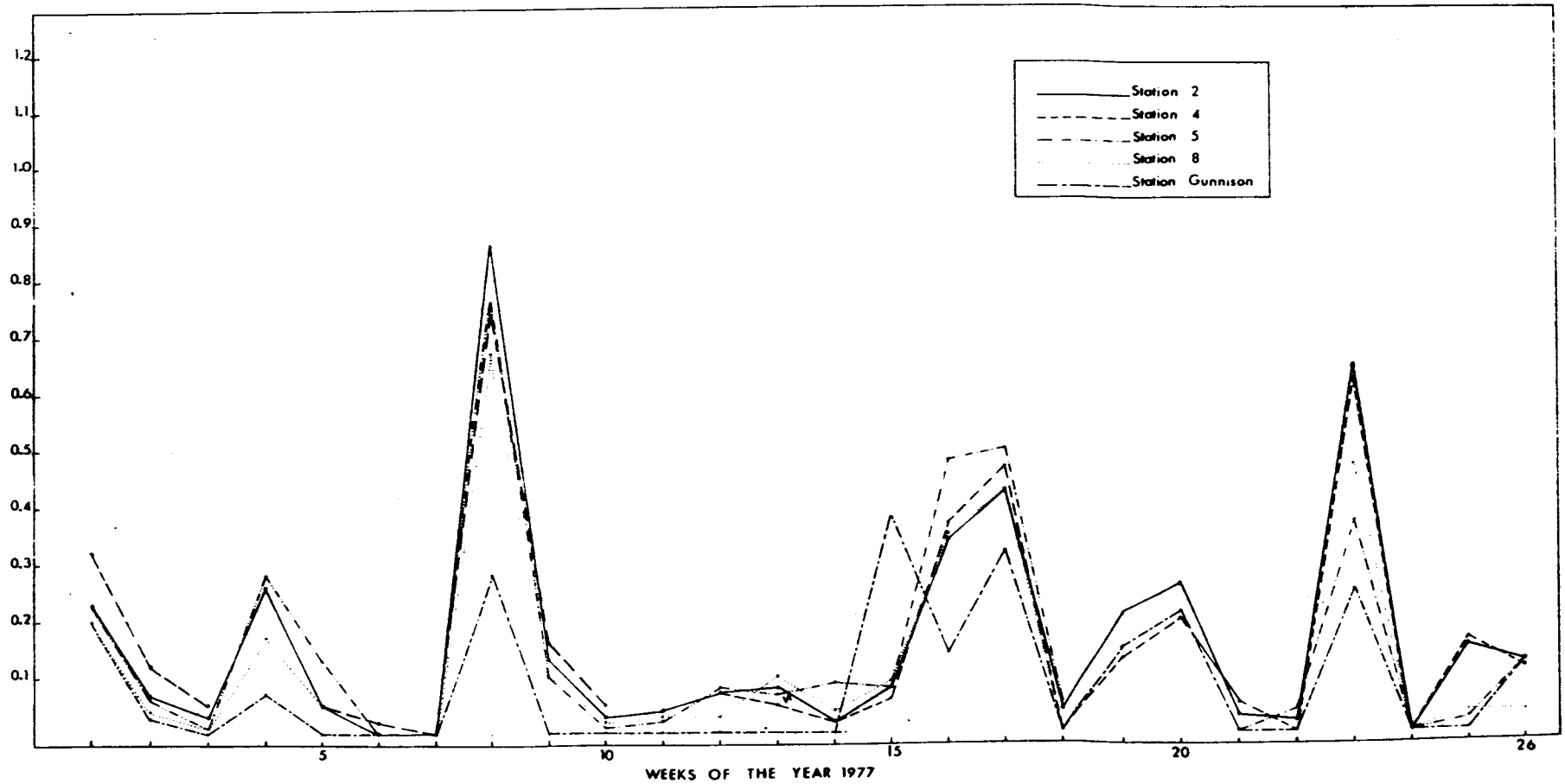

Fig. 6-10. Weekly (Weeks 1-26) precipitation (1977) for Stations 2, 4, 5, 8, and Gunnison.

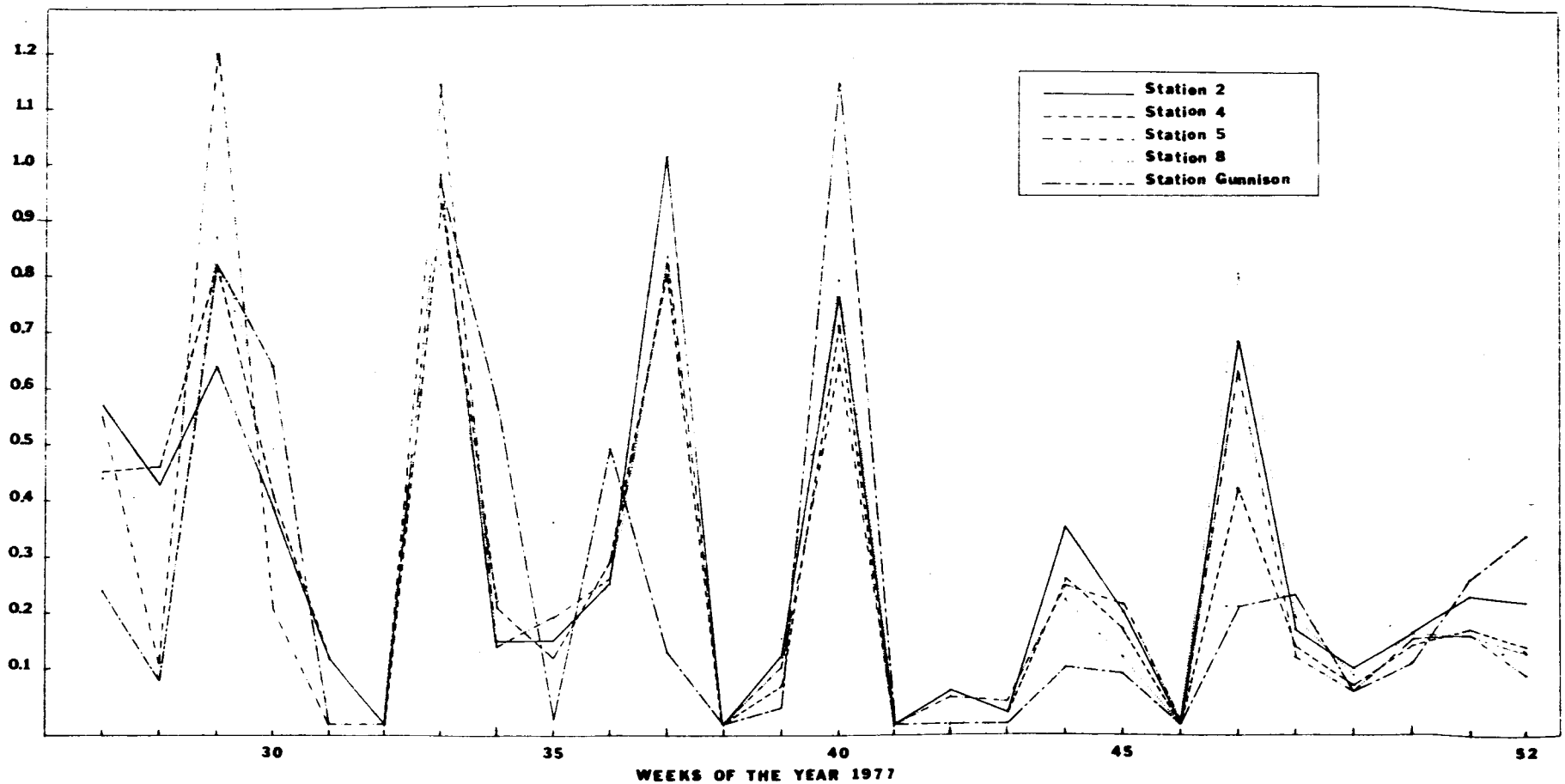

Fig. 6-11. Weekly (Weeks 27-52) precipitation (1977) for Stations 2, 4, 5, 8, and Gunnison.

which contributes most to the knowledge of the plant growth requirements.

If the monthly totals are taken from Figure 6-9, the results are:

Station 2 (Proposed Crusher Site)	12.26 inches
Station 4 (Proposed Tailing Dam)	10.98 inches
Station 5 (Deldorado Creek)	11.21 inches
Station 8 (Powderhorn Store)	10.68 inches
Gunnison	8.80 inches

It is evident the use of Gunnison precipitation data does not provide an accurate means of projecting Powderhorn patterns.

When considering January to May snowfall (in terms of total water), the results are:

Station 2 (Proposed Crusher Site)	2.80 inches
Station 4 (Proposed Tailing Dam)	2.58 inches
Station 5 (Deldorado Creek)	2.96 inches
Station 8 (Powderhorn Store)	2.33 inches
Gunnison	1.45 inches

The Soil Conservation Service helped establish a snow course on the north side of Big Iron Hill. The data was incorporated with the data from Lake City and Cochetopa Pass snow courses for comparison purposes (Table 6-1). The 1976-1977 winter was such a drought, the comparisons also permitted extrapolations to consider more normal winters. These are also shown in Table 6-1.

Summer precipitation (May - August), which is most contributory to sustained plant growth is as follows:

Station 2 (Proposed Crusher Site)	4.81 inches
Station 4 (Proposed Tailing Dam)	4.68 inches
Station 5 (Deldorado Creek)	4.87 inches
Station 8 (Powderhorn Store)	4.25 inches
Gunnison	4.05 inches

No attempt is made at this time to determine how significant the differences are. However, in all cases, the typical regional pattern

TABLE 6-1

SNOW COURSE DATA
FROM COCHETOPA PASS, LAKE CITY AND DELDORADO CREEK
(Big Iron Hill)

Cochetopa Pass 10,000 feet

Rio Grande National Forest Sec. 12, T455, R3E, on old road through lodgepole timber - Drainage Sausage Creek maps 3 & 6.

	February 1		March 1		April 1	
	snow depth	water	snow depth	water	snow depth	water
1949-1977 average	19.1	3.8	22.7	4.8	24.4	5.7
1977	6.3	1.5	8.1	1.6	9.3	2.2
1977 % of average	33%	39%	36%	33%	38%	39%

Lake City 10,300 feet

Gunnison National Forest - 3 miles west of Slumgullion Pass Sec. 13, T43N, R4W, in open area with widely scattered timber - Drainage Lake Fort of Gunnison River.

	February 1		March 1		April 1	
	snow depth	water	snow depth	water	snow depth	water
1948-1977 average	25.5	5.6	29.2	7.0	29.9	7.8
1977	8.3	.9	9.3	1.3	8.8	2.1
1977 % of average	33%	16%	32%	19%	29%	27%

Deldorado Creek 9,000 feet

Powderhorn Project Sec. 12 - north side of Iron Hill - On old road through Douglas Fir Forest.

	February 1		March 1		April 1	
	snow depth	water	snow depth	water	snow depth	water
Deldorado Creek 1977	8.2	.7	14.5	1.5	11.7	1.1
Projected Avg. (1) from % Cochetopa	24.8	1.8	40.3	4.5	30.8	2.8
Projected Avg. (1) from Lake City	24.8	4.4	45.3	7.9	40.3	4.1
Projected Avg. from both data sets	24.8	3.1	42.8	6.2	35.5	3.4

(1) Averages projected from percent decrease in the amount of snowfall for Cochetopa Pass and Lake City.

is noted; the summer local storms contribute more to the total precipitation than the winter frontal storms.

Temperature

Temperatures were recorded a variety of ways. The MRI units noted temperature, and were used by Marlatt in Chapter V for much of the conclusions he drew. Hygrothermographs and Taylor Sixes maximum and minimum recording thermometers were used in shelters and were the primary source of the information presented in this chapter. Multiple lead thermographs were also used, but data from them will not be offered until the 1978 report.

Figures 6-12 - 6-15 illustrate the weekly maximum and minimum temperatures for Stations 1, 2, 3, 4, 5, 8, and Gunnison. The overall patterns are the same, which reflects the regional similarity. Station 8 and Gunnison portray their valley bottom and inversion prone nature. Station 1 indicates a position above the cold layer basin by having high night temperatures and low day temperatures.

Evaluations of temperature durations will be made in the 1978 report. These data will help in determining conditions which control revegetation.

Wind

Wind was recorded using the MRI units and using totalizing anemometers. The MRI data was the primary source of reference for Marlatt's Chapter V. The totalizing anemometers were more indicative of microclimatic concerns for vegetation and the data is illustrated in Figure 6-16. It clearly reflects the amount of wind which is

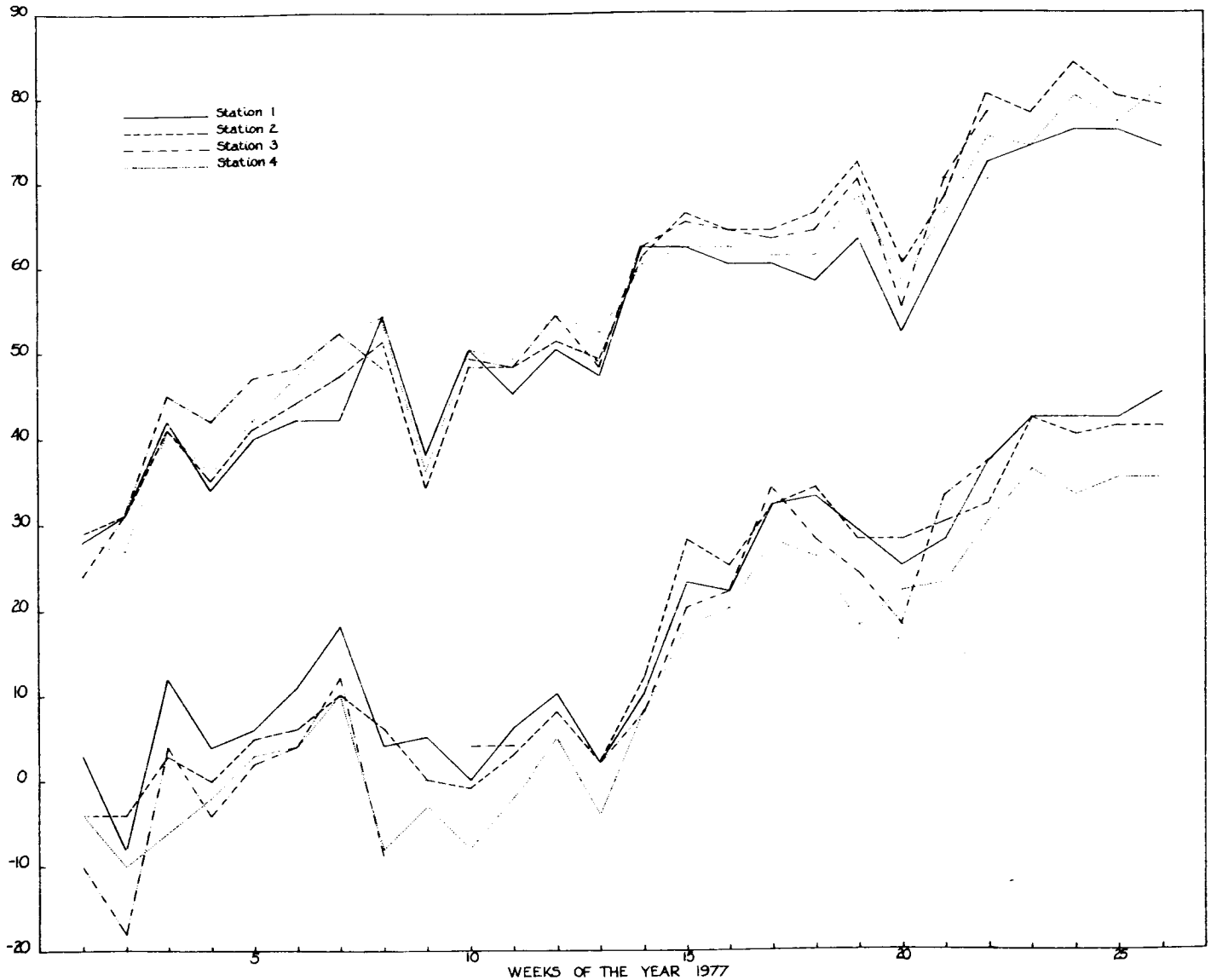

Fig. 6-12. Weekly temperature maxima and minima for Stations 1, 2, 3, 4 for Weeks 1-26, 1977.

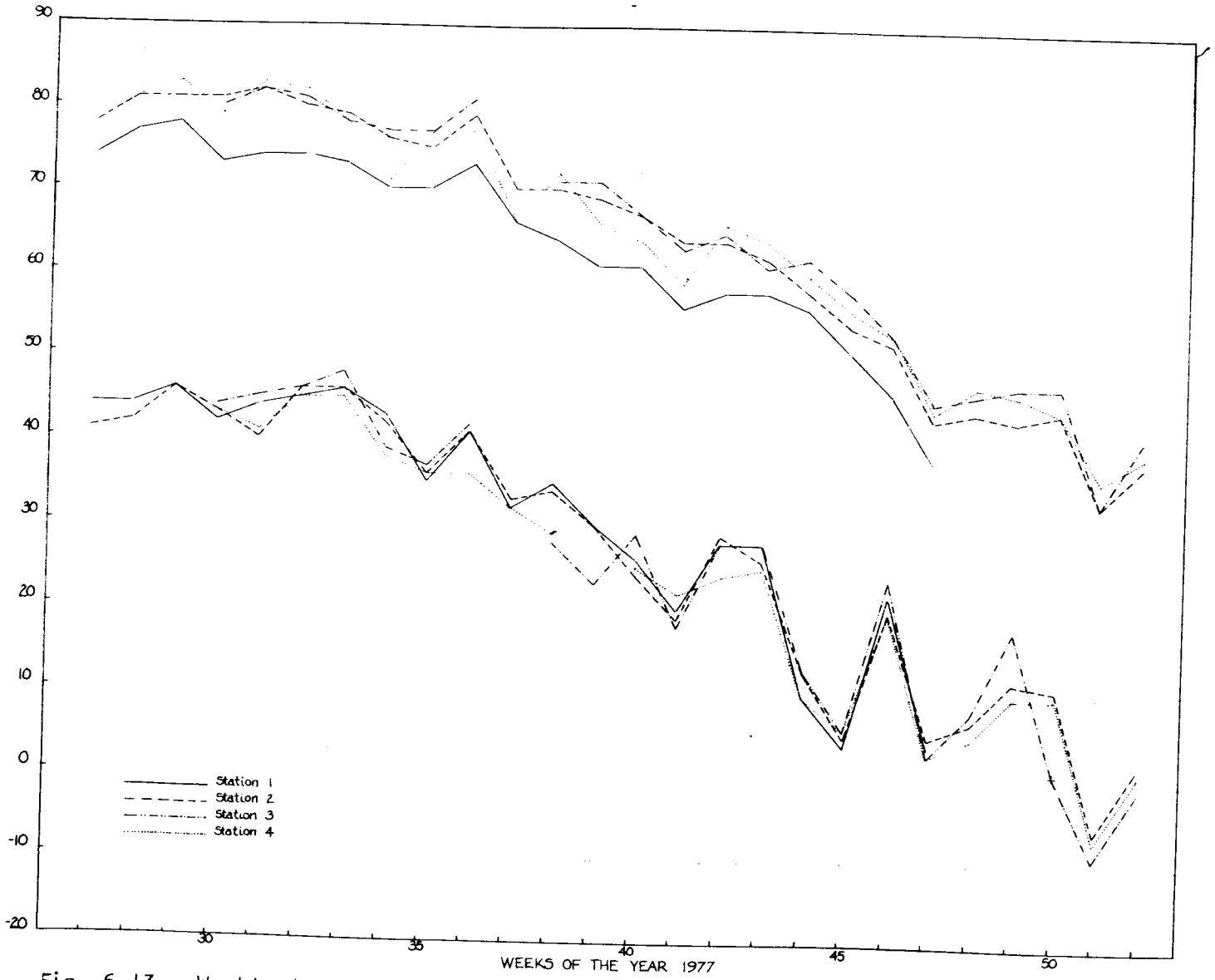

Fig. 6-13. Weekly temperature maxima and minima for Stations 1, 2, 3, 4 for Weeks 27-52, 1977.

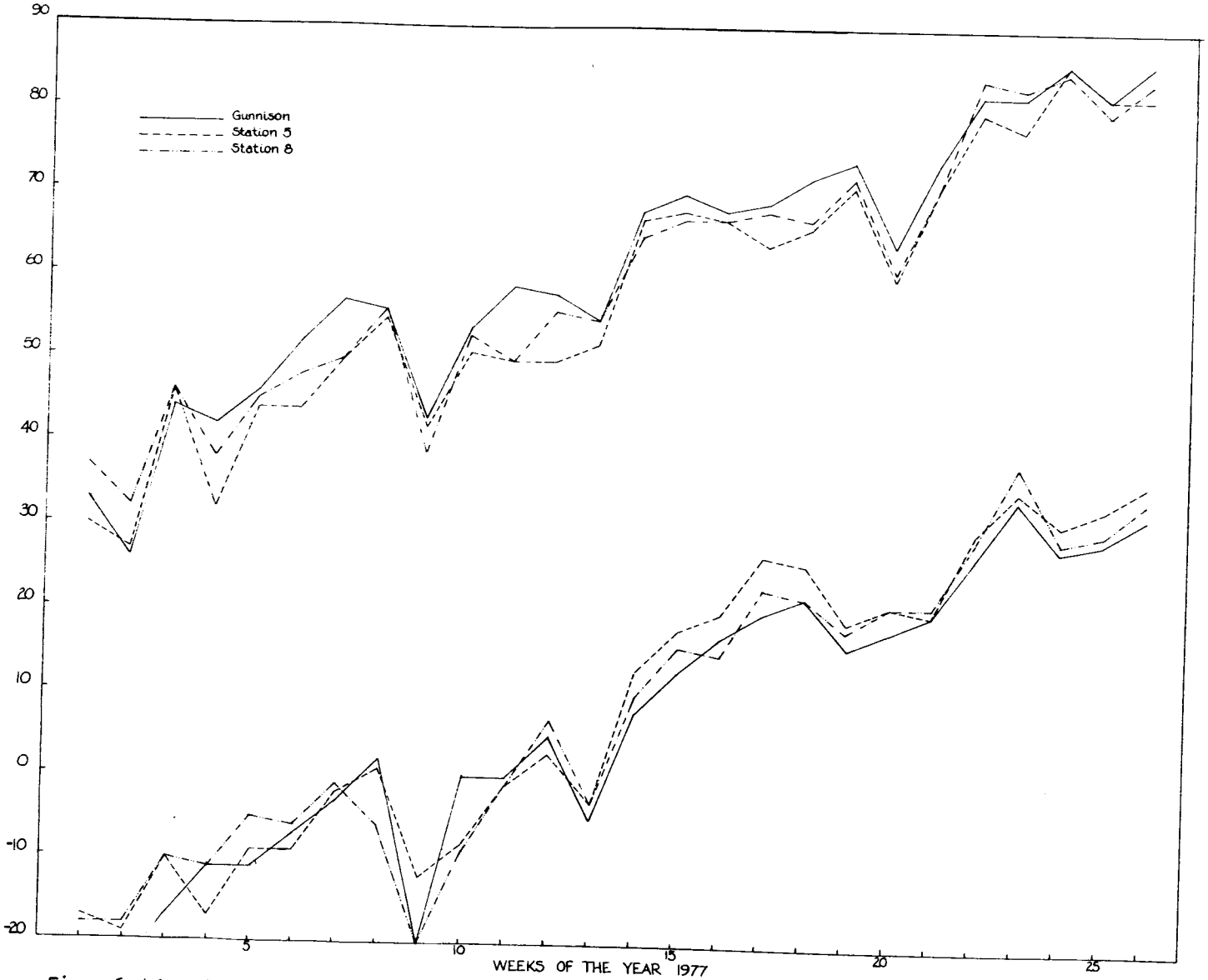

Fig. 6-14. Weekly temperature maxima and minima for Stations 5, 8, and Gunnison for Weeks 1-26, 1977.

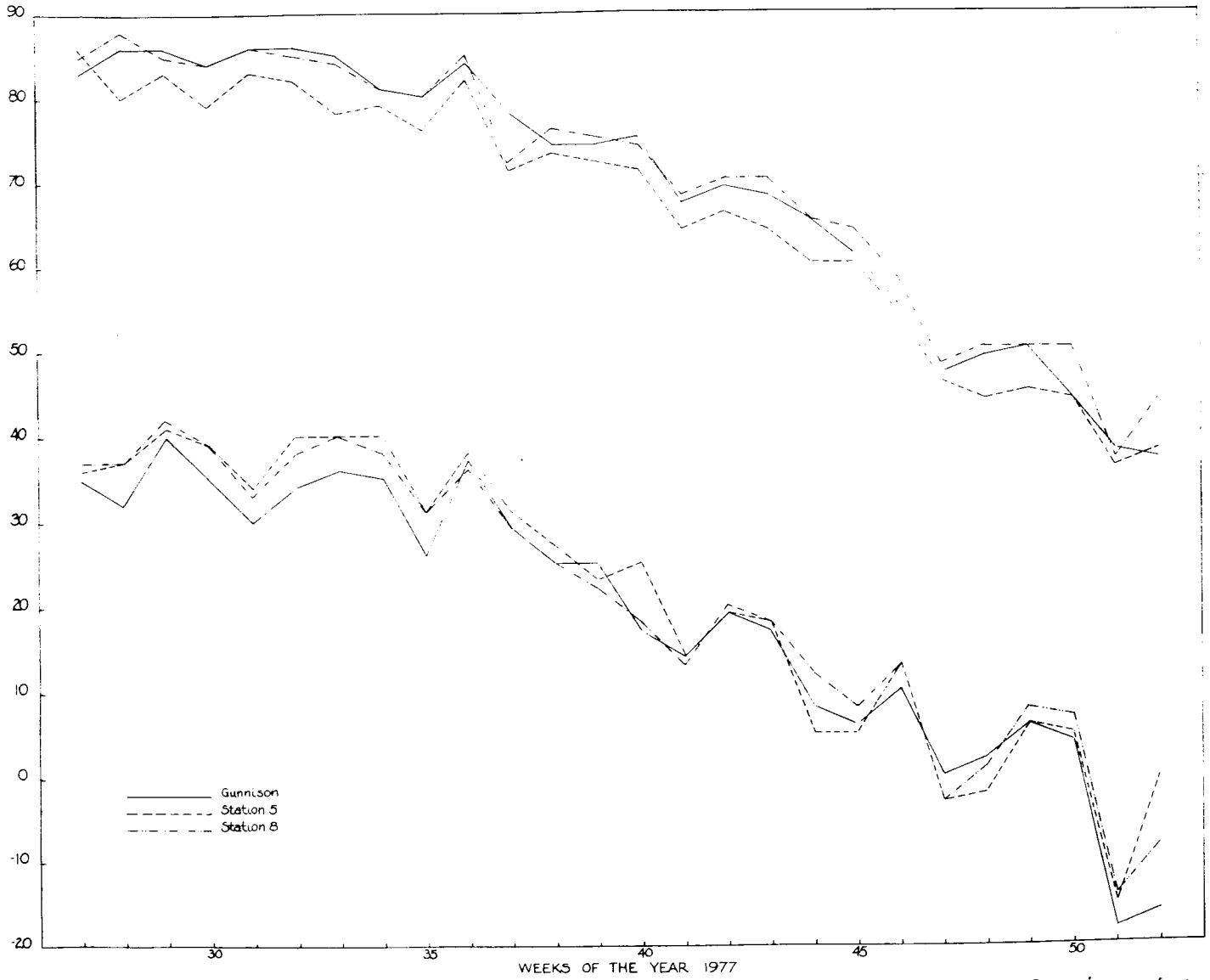

Fig. 6-15. Weekly temperature maxima and minima for Stations 5, 8, and Gunnison for Weeks 27-52, 1977.

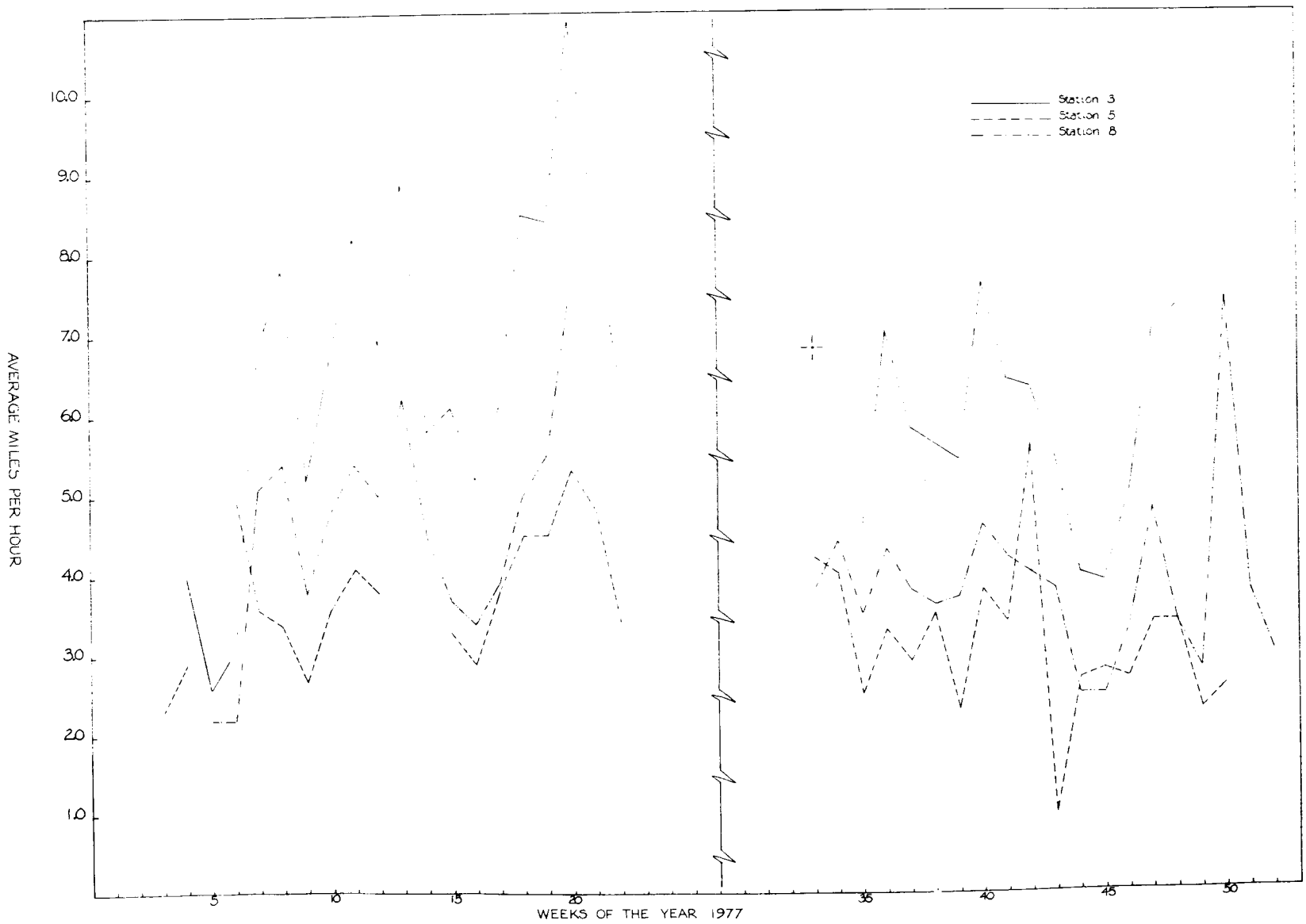

Fig. 6-16. Weekly average wind speeds for Stations 3, 5, 8 for 1977.

associated with the proposed mill site (Station 3), and some of the stress which will be experienced by the plants used for revegetation at the mill site and at the overburden deposit area north of the proposed mill site. Daily patterns and periods of wind duration will be elaborated in the 1978 report.

REFERENCES

Chang, J.H. 1968. Climate and Agriculture. Aldine Publ. Co., Chicago. 304 p.

Daubenmire, R.F. 1974. Plants and Environment, 3rd ed. John Wiley & Sons, New York. 422 p.

Etherington, J.R. 1975. Environment and Plant Ecology. John Wiley & Sons, New York. 345 p.

Geiger, R. 1965. The Climate Near the Ground, 4th ed. Harvard Univ. Press, Cambridge, Mass. 611 p.

Lee, R. 1978. Forest Microclimatology. Columbia Univ, Press, New York. 276 p.

Munn, R.E. 1970. Biometerological Methods. Academic Press, New York. 336 p.

Rosenberg, N.J. 1974. Microclimate: the biological environment. John Wiley & Sons, New York. 315 p.

Yoshino, M.M. 1975. Climate in a Small Area. Univ. of Tokyo Press, Tokyo. 549 p.