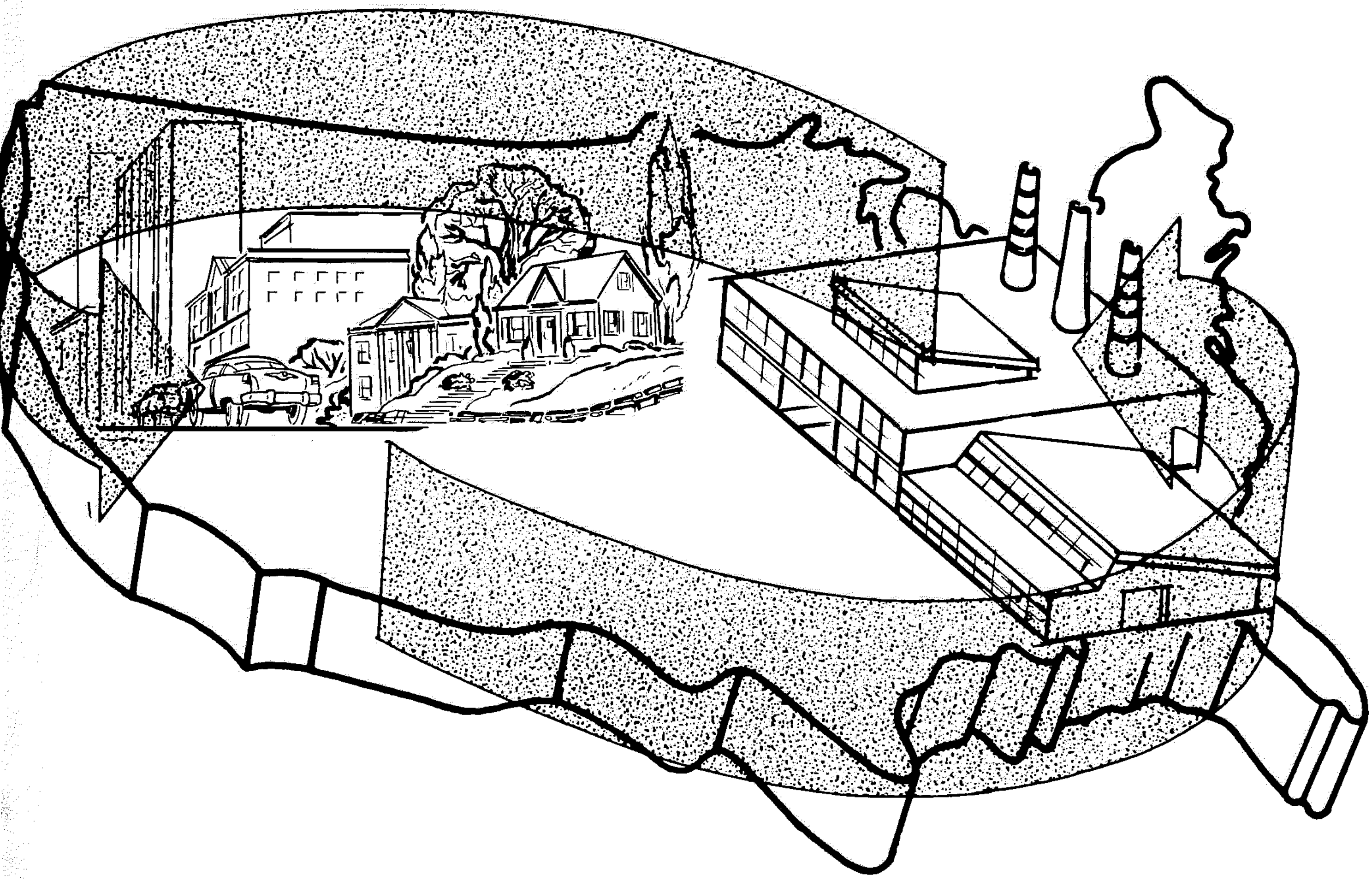
POWELL COUNTY, MONTANA
AIR POLLUTION ABATEMENT ACTIVITY



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Bureau of Disease Prevention and Environmental Control
National Center for Air Pollution Control

July 1967

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PRE-CONFERENCE INVESTIGATIONS

Prepared for Conference Use Only

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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Following the Powell County, Montana, Air Pollution Abatement Conference a comprehensive report including this report; the Conference presentations of the Department of Health, Education, and Welfare; and the recommendations resulting from the Conference, will be prepared and made available for general distribution.

CONTENTS

I. Introduction 1

II. Rocky Mountain Phosphates, Inc. - Process and Emissions 7

General 7

Process Description 7

Air Pollution Emissions 11

Design, Operation, and Maintenance Deficiencies 12

III. Fluoride Emission Control Technology 17

IV. Topography and Climatology of Garrison Area 19

Topography 19

Temperature 19

Precipitation 20

Atmospheric Stability 20

Wind Speed 24

Wind Direction 27

V. Distribution of Fluoride in Garrison Area 33

Fluorides in Grass 33

Fluorides in Evergreen Foliage 37

Fluorides in Water 37

Fluorides in Soil 41

APPENDICES 43

Appendix A Correspondence and Resolutions 43

Appendix B Analytical Methodology for Fluoride 49

REFERENCES 51

POWELL COUNTY, MONTANA
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I. Introduction

By letter of March 8, 1967, the Governor of the State of Montana forwarded to the Secretary of Health, Education, and Welfare a resolution of the Board of Commissioners of Powell County, Montana, requesting the Secretary to call a Conference to deal with the problem of air pollution in the County. In forwarding the resolution, the Governor stated his concurrence in the request. Concurrence was received from the Montana State Health Officer as well. The resolution of the Powell County Board of Commissioners, and a resolution of the Senate of Montana, both recognize the air pollution problem in the Garrison area of the County. Copies of the letters from the Governor and from the State Health Officer to the Secretary of Health, Education, and Welfare, and copies of the Powell County and the Senate resolutions appear in Appendix A.

Powell County, located in west central Montana, has an area of 2,337 square miles and an estimated 1965 population of 7,300. The County seat is Deer Lodge. The more than 200 farms and ranches in the County yield products valued at more than $4,000,000 per year. Livestock production accounts for almost 80 percent of the total value of the County's agricultural products. Powell County is shown in Figure 1.

Garrison is located near the junction of the Clark Fork and the Little Blackfoot Rivers, approximately 45 miles west of Helena, Montana. The town of Garrison is situated in a mountain valley slightly west of the junction of U.S. Highways 10 and 12. The valley floor is approximately 4,400 feet above sea level, and the surrounding mountains rise to elevations of 9,400 feet.

Approximately 200 people live within a half-mile of the junction of U.S. Highways 10 and 12. Garrison contains about 50 permanent homes, as shown in Figure 2, and about 20 mobile units at Lahman's Trailer Court about a half mile south of the junction of the highways.

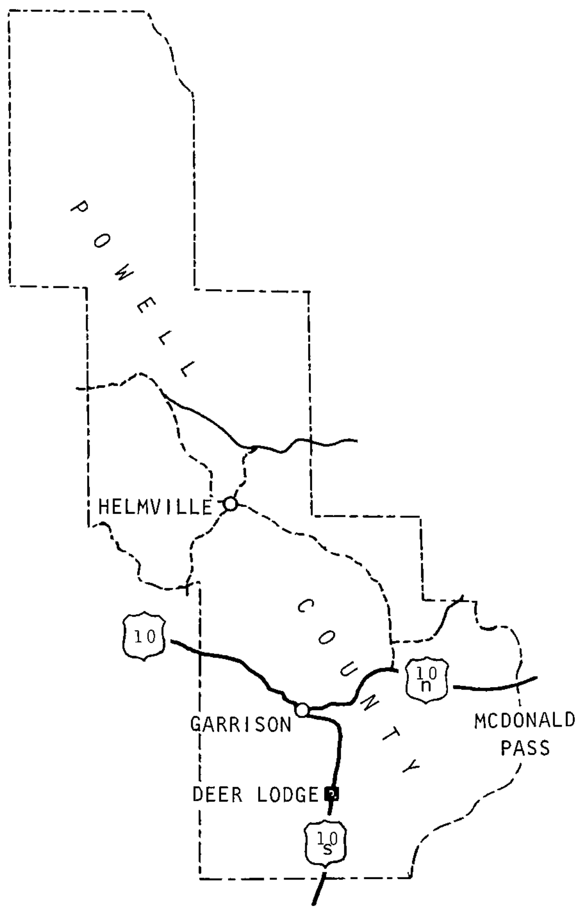


Figure 1. Map of Powell County, Montana.

In 1963 Rocky Mountain Phosphates, Inc., installed a phosphate rock defluorination plant in Garrison and began producing an animal feed supplement in August of 1963. In the early days of its operation the plant had practically no air pollution control devices, and sulfur dioxide, acid mist, and gaseous and particulate fluoride were released directly to the atmosphere. Vegetation damage and glass etching were soon apparent. Montana State authorities received many complaints about these emissions.

Personnel from the Montana Board of Health analyzed grass samples from the vicinity of the plant prior to operation and found fluoride concentrations of less than 10 ppm. Very shortly after the plant began operating, the fluoride content of the grass in the vicinity of the plant increased to over 300 ppm. Between September 1963 and March 1964, classes at the Garrison Public School reportedly

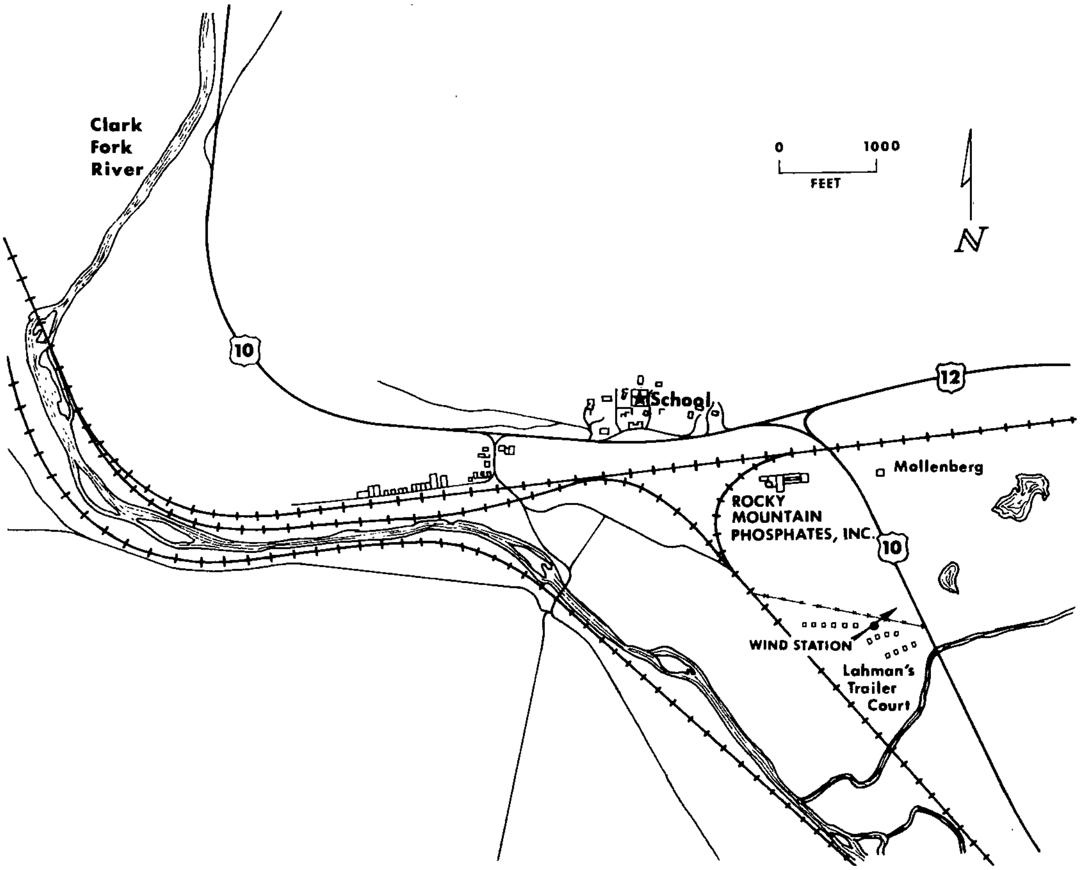


Figure 2. Map of Garrison, Montana.

were interrupted 35 times because of air pollution from the plant. During this time court action was brought against Rocky Mountain Phosphates, Inc., by the citizens of Garrison for alleged nuisance and health effects caused by the emissions. Because of the serious complaints and court actions, technical personnel from the Public Health Service, U.S. Department of Health, Education, and Welfare; the Montana State Board of Health; and private consultants inspected the plant and/or the vegetation in the area. All inspectors agreed that significant quantities of fluoride and/or sulfur dioxide were released during the 1963 and 1964 growing season. Donald F. Adams, Technical Consultant to the Third Judicial District Court, found varying degrees of needle burn of up to 100 percent on pinus ponderosa, depending on the distance and direction from the Rocky Mountain Phosphates, Inc., operation.[1]

During the time of these early complaints and court trials, the company installed spray towers in an attempt to remove the fluorides from the exhaust gases. In August of 1964 personnel from the Public Health Service and the Montana State Board of Health conducted a stack test at the plant. The findings of this stack test indicated conclusively that the collection equipment provided by Rocky Mountain Phosphates, Inc., was ineffective in removing fluorides from the stack gases.[2]

Reports of these studies also testify to the poor maintenance and operating procedures applied by the Company to limit pollution.

Further court action filed by local ranchers in 1965 alleged cattle damage by fluorides emitted by the plant. The court ruled in favor of the plaintiffs in this case and awarded $123,000 in damages.

Complaints against the plant continued, and in a letter dated March 8, 1967 Governor Tim Babcock of Montana concurred in a request by the Powell County Board of Commissioners for the Secretary of Health, Education, and Welfare to initiate a Federal air pollution abatement action under the provisions of Section 105 of the Clean Air Act (42 U.S.C. 1857 et seq.).

The following is a brief chronological record of the plant operation:

(Approximate Dates)	
January 14, 1960	Plant opened in Butte, Montana. Complaints were received by Montana Board of Health almost immediately. One school was interrupted several times, and a nuisance action was filed but no action was taken.
August 1, 1963	Plant began operation in Garrison. Complaints of severe air pollution were made to Montana Board of Health soon after plant began operating.
September 1963 to March 19, 1964	Garrison school interrupted 35 times by gas and smoke.
October 1963	Donald F. Walters, Engineer, Public Health Service inspected the plant with Benjamin F. Wake of the Montana State Board of Health.
October 1963	Court action brought by citizens of Garrison against Rocky Mountain Phosphates, Inc.

February 1964	Hearing before Judge Haswell in Powell County with plant's consulting engineer and R. Smith of Montana School of Mines. Plant's consulting engineer stated 2,000 lb/day of fluoride being emitted.
March 9, 1964	Court action, Mollenberg et al. versus Rocky Mountain Phosphates, Inc., before Judge Haswell in Powell County.
June 12 to 15, 1964	Plant closed by court order; then allowed to open again.
July 27, 1964	Plant ordered closed by State Board of Health as health menace. Plant back in operation within a few days.
August 1964	80-foot section added to lengthen stack. Total stack height increased to 210 feet.
August 17. 1964	Public Health Service and State Board of Health began stack testing at plant. Findings were conclusive that controls were poor to nonexistent.
November 6, 1964	Plant ordered by State Board of Health to cease operations until court order of June 10, 1964, had been complied with. Plant closed for a few days.
November 11, 1964	Affidavit from Plant stating compliance with all court orders. Production resumed.
November 11, 1964	Contempt order issued by State Board of Health. Plant continued to operate.
November 20, 1964	Montana State Board of Health hearing with Rocky Mountain Phosphates representatives.
December 7, 1964	Trial before Judge Jack Green at Deer Lodge, Montana. Suit brought by State Board of Health on contempt charge and charge that Plant was a menace to health. A suit was also brought by Garrison citizens and heard at the same time to abate the Plant as a nuisance. Mrs. Ralph Davis, teacher at Garrison School, was given authority to close plant during 2-week period. Board of Health authorized to close plant if good reason could be given.
March 1965	Plant defluorinating process changed from acid to alkali process.
April 5, 1965	Ruling by Judge Green on December 1964 trial - contempt charges disallowed; health hazard charge disallowed; nuisance charge upheld. Plant shut down for short time by order of Judge Green. Permitted to operate again after few days to allow sampling by Resources Research, Inc.
April 1965	Plant capacity doubled by addition of second kiln.

May 5, 1965	Suit brought by local ranchers to close Plant and to collect damages.
July 1965 to September 1965	Study of emissions at Plant made by Montana State University for Judge W. W. Lessley.
July 1965 to October 1965	Donald F. Adams, Court Consultant, studied ambient air and vegetation in Garrison for Judge Jack Green.
February 1966	First commercial scrubber installed at Rocky Mountain Phosphates, Inc. James T. Tomany, engineer for the vendor, testified that if the vendor's scrubber was operated in accordance with design flow rates, the fluoride removal from the stack gases would be 98 percent and that a total of less than 7 pounds/hour would be emitted when the Plant was producing 70 tons per day.
April 2, 1966	Final trial on ranchers damage action; $123,000 damages awarded. Decision now being appealed to the Montana Supreme Court by Rocky Mountain Phosphates, Inc.
May 11, 1966	Abatement action requested by ranchers denied by Judge Lessley. Decision being appealed to Montana Supreme Court.
Summer 1966	Plant stack collapsed and was replaced by discarded product cooler, 4 feet diameter, 90 feet high.
September 1966	Commercial scrubber severely corroded and removed from service. Replaced by "plant designed" scrubber.
Late 1966	Second scrubber built by Rocky Mountain Phosphates for use on No. 2 kiln.
March 3, 1967	Montana Air Pollution Control Law signed by Governor.
March 8, 1967	Governor Tim Babcock of Montana concurred in the resolution of Powell County Board of Commissioners requesting Federal Abatement Action in Powell County.

II. ROCKY MOUNTAIN PHOSPHATES, INC. - PROCESS AND EMISSIONS

GENERAL

Rocky Mountain Phosphates, Inc., is engaged in defluorinating phosphate rock to make a product suitable for an animal feed supplement. Phospate rock used in this process ordinarily contains from 3.5 to 5 percent fluorine. In the processing of phosphate rock for use as an animal feed, the fluorine content of the defluorinated product must be reduced to at least 0.18 percent.

Two processes, the acid process, and the alkali process, have been used by Rocky Mountain Phosphates, Inc., in removing fluorine from phosphate rock at its Garrison plant.

Originally the acid process was used. This process involved adding phosphoric acid and sulfuric acid to ground rock in a mixing operation. Sulfur oxides, acid mists, and gaseous fluorides are released in this process. The resulting mix, similar to normal superphosphate fertilizer, is passed through a high-temperature, gas-fired kiln, where most of the remaining fluorides are released. This type of process was used by the plant from the beginning of its operation until early in 1965 when the process was changed to the alkali process. The process now used is essentially a modification of the soda-ash process patented by the Smith-Douglas Company of Norfolk, Virginia, under U. S. Patents 2,839,377, dated June 17, 1958; and 2,995,437, dated August 8, 1961.

Only the mixing operation is changed in converting from the acid to the alkali process. Ground phosphate rock, phosphoric acid, and soda ash are mixed to form a relatively dry mixture called "acid rock." Little or no emissions are released in the mixing operation. The resulting "acid rock" is further processed in the fired kiln to release the fluorides in a manner similar to that of the acid process.

PROCESS DESCRIPTION

Figure 3 shows the plant layout, and Figure 4 is a flow diagram of the defluorination process. The mixing operation is performed in a small pug mill. The phosphate rock, soda ash, and phosphoric acid are transferred from storage to small weigh tanks directly above the mixer. These feed materials are charged to the mixer in the proper proportion. Mixing is continued at a steady rate

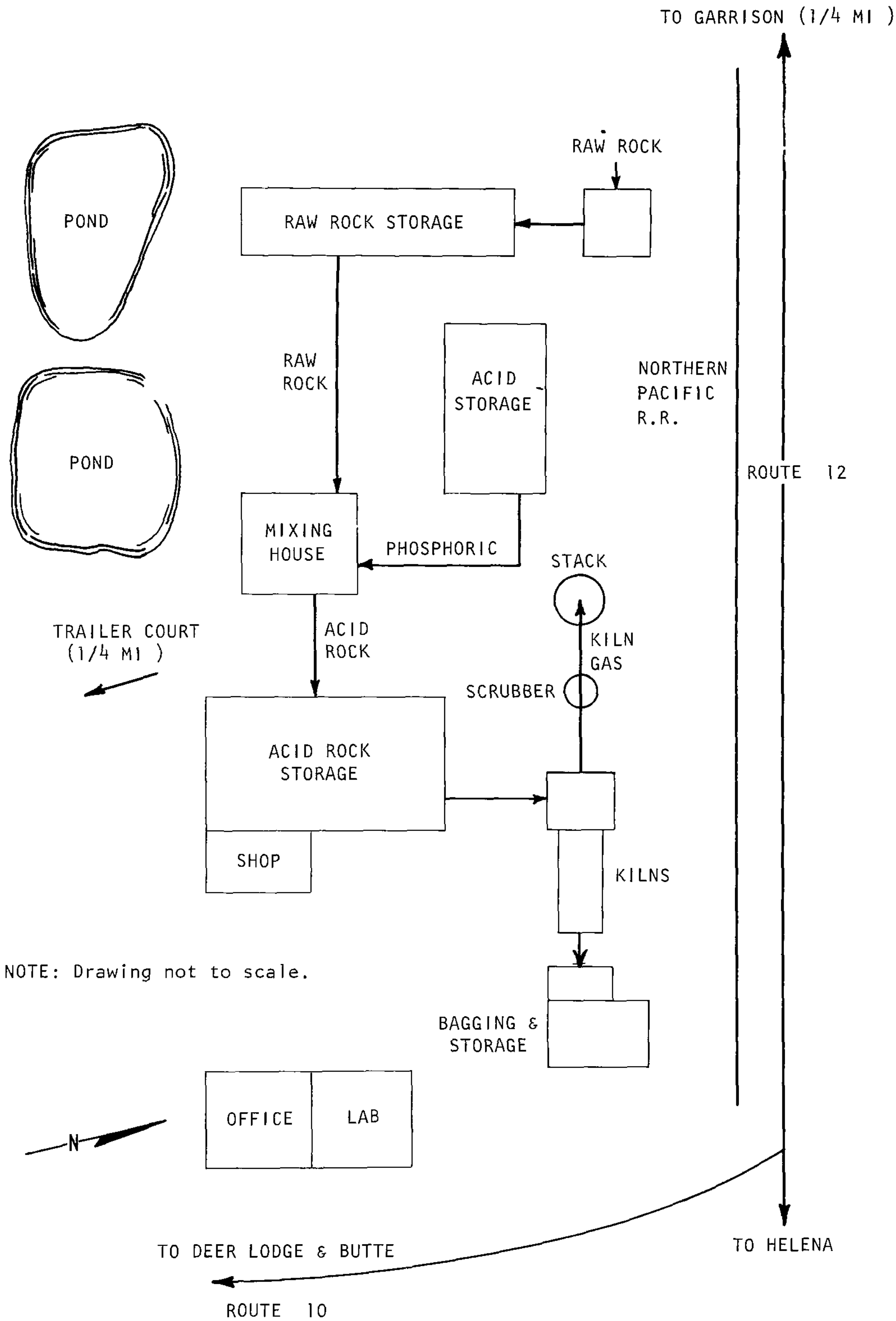


Figure 3. Rocky Mountain Phosphates Inc. plant layout.

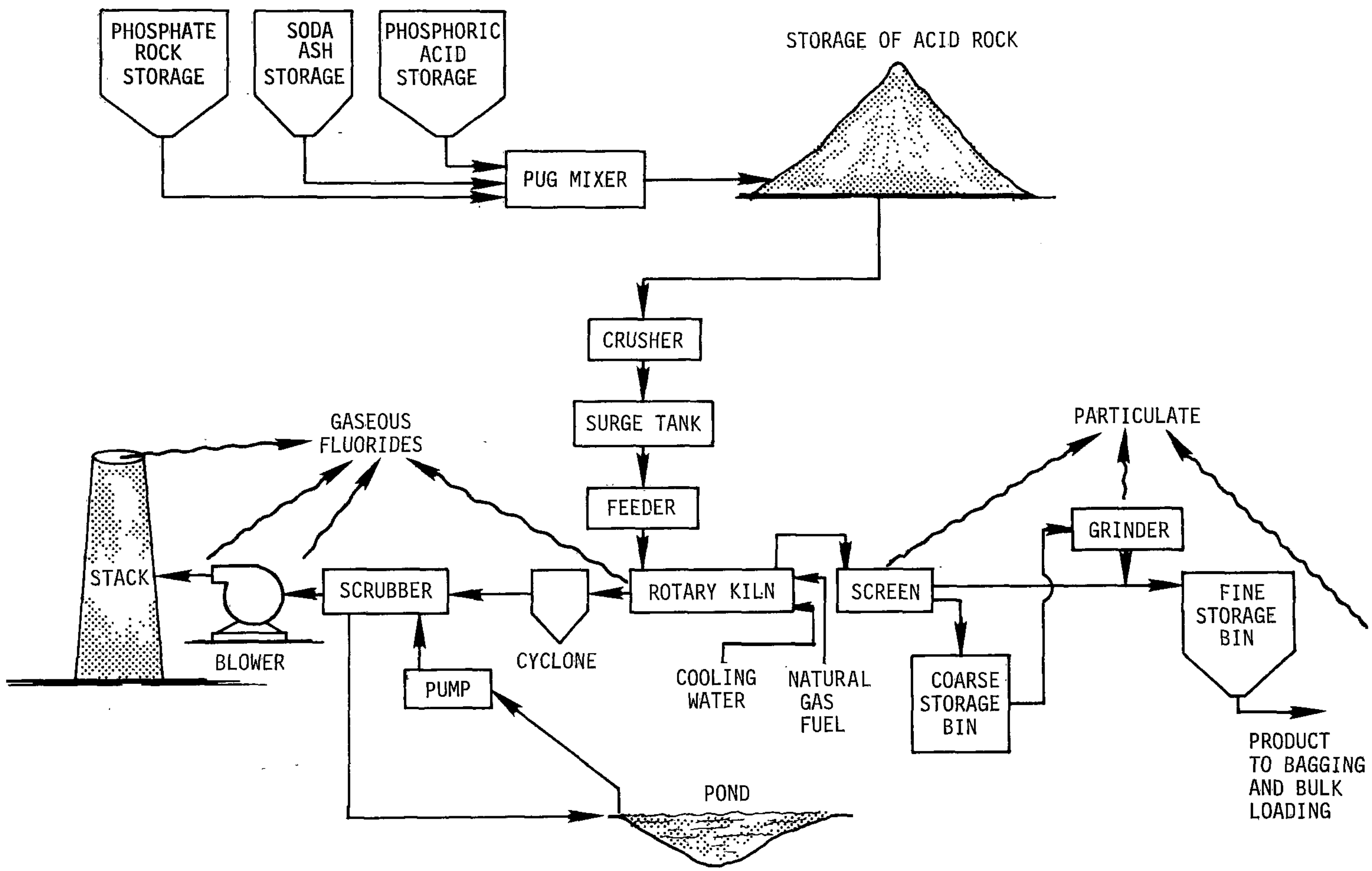


Figure 4. Flow diagram of Rocky Mountain Phosphates, Inc., phosphate rock defluorination plant in Garrison, Montana.

of one 2,400-pound batch about every 5 minutes. Approximate feed rates and fluoride content of the feed material as supplied by Rocky Mountain Phosphates, Inc., are as follows:

Phosphate rock	21,600 lb/hr @ 3.4 - 3.6% fluoride
Soda ash	2,100 lb/hr @ 0.1% fluoride
Phosphoric acid	3,960 lb/hr @ 1.0 - 1.5% fluoride

Because the capacity of the mixing equipment is greater than the capacity of the kilns, the mixing equipment is usually operated on 8-hour shifts at required intervals to maintain sufficient "acid rock" feed material for the kilns.

The acid rock from the mixer is dropped onto a conveyor belt and moved to the storage building. Normal practice is to hold the acid rock in the storage building 1 to 7 days prior to charging it to the kiln. This holding time may vary, depending on product demand.

Acid rock is moved from storage to the calcination equipment by a front bucket loader. The operator charges a load into the process at specified intervals in an attempt to maintain a uniform feed. The feed material is "run of pile" in particle size and must be crushed prior to entering the kilns. Feed rate varies according to the time interval between charges and the weight of acid rock in each load of the loader.

The acid rock is dropped onto a grizzly screen. Large lumps fall to the floor, and lumps less than 3 inches in diameter fall to the charge hopper. From the charge hopper the acid rock is moved by a bucket elevator to a crusher, which reduces the particle size to 3/8 inch and drops the ground rock into a surge tank. A vibrating feeder meters the material to a belt conveyor, which feeds the kilns.

If feed to the belt were continuous, the kilns would be fed at a uniform and continuous rate. Frequent equipment failures make it necessary to estimate kiln feed rate from the frequency and weight of acid rock charges added to the process. The feed is at the cold end of the kiln opposite the burners. Each kiln is about 150 feet long and 8 feet in diameter. Natural gas is used as fuel. The retention time of the material in the kiln is around 6 hours. Temperatures in the kiln range from about 1800°F at the hot end to about 650°F at the charging end.

As the defluorinated rock leaves the hot end of the kiln, it is cooled by a water spray. The spray also supplies the moisture in the kiln essential to fluoride removal. The cooled product is screened to separate large pieces, crushed as required to meet specifications, and discharged into a hopper for storage. The product may be bagged for sale or may be sold in bulk. The product is about 16 mesh in size and contains less than 0.18 percent fluorine. The product trade name is "Feed Phos."

The exhaust gases leave the charge end of the kiln and pass through a water scrubber and a blower, and into a common stack. Separate water scrubbers and blowers are provided for each of the two kilns. The exhaust gas rate for each kiln is between 14,000 and 17,000 scfm. The gases, leaving the kiln at about 650°F, contain water vapor, gaseous fluorides, particulate, and combustion products.

The water for the two scrubbers is supplied from a pond located about 200 yards south of the scrubbers. The water flows from the pond to the base of the scrubbers and returns to the pond in open ditches. Adjacent to the scrubbers, a sump pump forces water in an 8-inch line to an overhead water tank. This tank is kept full at all times, and the overflow from the tank is divided into the two scrubbers. Water rate to the scrubbers is reported to be from 1,000 to 1,500 gallons per minute. The pond is about 80 feet wide, 150 feet long, and 4 feet deep.

AIR POLLUTANT EMISSIONS

Air pollutant emissions from the Rocky Mountain Phosphates, Inc., rock defluorination plant are of two types, particulates and gaseous. Particulate emissions from the crushing, bagging, and handling of both the feed and product result in a fine gray dust, which covers buildings, cars, yards, and other exposed surfaces in the vicinity. These emissions for the most part, consist of relatively large particles, which normally settle near the plant property. Particulate released from handling the feed material contains 3.5 to 5 percent fluorine; particulate from product handling contains no more than the 0.18 percent fluorine permissible in the finished product.

Gaseous pollutants escape from the plant processing equipment and the stack. The reactions involved in the defluorination of phosphate rock and the chemical analysis of the rock itself are quite complex. Typical of the reactions thought to occur in defluorination is the following:

$$(CaF)\ Ca_4\ (PO_4)3 + 7\ H_3PO_4 + 5\ H_2O \longrightarrow 5\ CaH_4\ (PO_4)_2 \cdot H_2O + HF.$$

Silicon tetrafluoride may also be formed at elevated temperature by a number of reactions. It is probable that both hydrogen fluoride and silicon tetrafluoride are formed.

The gaseous phase reaction of water vapor with silicon tetrafluoride under high-temperature conditions has been studied by Lenfesty et al[3], who found that the equilibrium favored the formation of hydrogen fluoride at high temperature. The following reaction is involved:

$$SiF_4\ (g) + 2\ H_2O\ (g) \rightleftharpoons SiO_2\ (s) + 4\ HF\ (g)$$

Semrau[4] reports that no significant amounts of silicon tetrafluoride should exist as such in moist, high-temperature furnace gases, the conditions which exist at the Rocky Mountain Phosphates, Inc., plant.

Plant inspections have revealed that fluoride emissions come from three locations and appear to be about equally divided among these locations. The normal point of discharge is the top of the stack, where the fluoride content of the effluent depends upon the efficiency of the scrubbing equipment. A second emission comes from the many leaks in and around the bottom of the stack and in the piping. These emissions are practically at ground level. Fluoride content here also depends upon the efficiency of the scrubbing system. A third emission source, perhaps the most significant, is leakage at the end of the kiln where the gases are collected for transport to the scrubbing system. This emission, which can be detected visually during nighttime observations, contains completely unscrubbed gases having high concentrations of fluoride. This emission is also practically at ground level.

DESIGN, OPERATION, AND MAINTENANCE DEFICIENCIES

Deficiencies in design and in operation and maintenance practices at the Rocky Mountain Phosphates, Inc., plant have contributed greatly to the emission of fluerides. This condition began when the plant originally started operating without air pollution control equipment and has generally continued to the present time. Evidence of these poor practices have been described in previous reports.[1,2,5] Some examples of poor practices used in the past are the following:

1. By-passing of gas in water spray towers due to improper liquid seals in the tower. This results in inefficient scrubbing.

2. Operating the plant without addition of lime to the scrubbing medium. In a recirculating water scrubbing system the fluoride content of the

scrubbing solution continually increases. Unless lime is added to remove the fluoride from the scrubbing water, the efficiency of the scrubber is reduced. Rocky Mountain Phosphates, Inc., frequently has operated the plant without addition of lime. During a plant inspection on April 12, 1967 no lime was available for addition to the scrubber, but both kilns were being operated.

3. Poor fabrication of piping, which results in direct discharge of pollutants to the atmosphere. A specific example is the copious leakage of fluoride gases at the charge end of the kiln. Some attempt was being made in the Spring of 1967 to correct this situation, but the plant has continued to operate many months with this condition existing. Another example is the poor construction of the gas inlet of the south scrubber. An opening about 4 by 12 inches in this line, adjacent to the scrubber, was noted during the inspection of the plant on April 12, 1967.

4. Poor water distribution in the scrubbers. During the plant inspections of August 1964, one-third of the spray nozzles were completely plugged. The reduced scrubbing capacity results in decreased fluoride collection efficiency. In the inspection of April 1967 no method of water distribution was provided in the scrubbers.

5. Corrosion of piping which results in leakage of gas and scrubbing water, indicates generally poor maintenance. Toxic gas is discharged through these holes at ground level, where there is little chance for atmospheric dispersion. In addition, holes in gas piping reduce the draft on the equipment and affect the collection of toxic gases from the kiln.

6. Lack of spare or standby equipment to insure continuous operation of air pollution control equipment. The south scrubber, purchased from a commercial company, originally consisted of several beds of plastic spheres supported on a grid similar to that depicted in Figure 5. Spray nozzles distributed the scrubbing liquid uniformly over the packed section. Several beds of spheres were provided. The gas to be cleaned entered the scrubber near the bottom and traveled upward through the sphere bed while the scrubbing liquid cascaded down from the spray heads at the top. Under the influence of this counter-current gas and liquid flow, the spheres are forced into violent, random motion, and impinge against each other.

The unit functions in this manner to provide contact surfaces for absorbing gases and also serves as a gas cooler. Several types of scrubbers of this general design are available commercially.

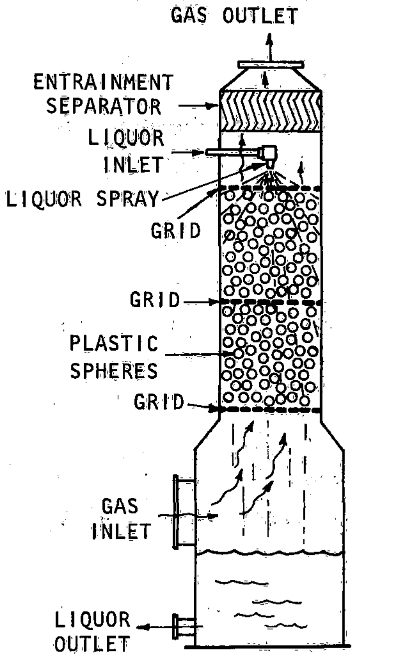


Figure 5. Fluoride scrubber.

Equipment failures at the Garrison plant caused loss of cooling water in the scrubber within a few months after it was installed in 1966. The gases from the kiln at a temperature of about 650°F melted the corrosion-resistant lining and the plastic balls in the scrubber. Because of the low pH of the circulating water, severe corrosion soon resulted and the original scrubber was destroyed within 6 months. In its place the Company has erected two "plant designed" scrubbers of somewhat similar design.

One of these scrubbers is 6 feet in diameter and the second is 8 feet in diameter. The south scrubber still retains the top portion of the commercial scrubber; however the bottom consists of several sections of concrete pipe. Wooden supports and grids support the plastic balls and restrain them from passing out with the exhaust gases. The north scrubber has a steel shell, but its internal parts also are wooden. To operate a scrubber of this type properly consideration must be given to both gas and liquid flow rates. In an oversized scrubber, gas and liquid flow rates are too low for adequate turbulence and efficiency of pollutant gas absorption is reduced. In an undersized scrubber, contact time is limited and inadequate absorption results.

As the result of the scrubber pump failures the wooden lining and support structure in the existing scrubbers were charred by the hot gases. Charred pieces of scrubber internal parts were found lying about the scrubber area. No alternative method is provided at the present to insure water flow to the scrubber.

In order for the scrubber to function properly, the fluoride content of the scrubbing water must be controlled by adding lime to the scrubber water either at the pump or at the pond. The desired result is that calcium fluoride precipitates within the pond and thereby removes fluoride from the recirculating water. Approximately 2 pounds of lime is required for each pound of fluorine absorbed. When the plant was inspected in April 1967, no lime was being added to the scrubber water. In fact, there was no lime available on the plant site. At the time of this inspection both kilns were operating.

Good water distribution in the scrubbers is essential if high collection efficiency is to be achieved. In a commercial scrubber, water sprays are provided to insure good distribution and to prevent channeling. In the scrubber designed by the plant the water is added in the top of the scrubber through an 8-inch pipe. This pipe ends within 12 inches of the scrubber wall and merely dumps the water on the upper grid.

Scrubber water flows from the base of the tower to the pond and back to the pump in open ditches. No method of preventing freeze-up during cold weather operation is provided.

Both scrubbers are severely corroded. The most recently installed scrubber was leaking from at least ten holes in the shell within 6 months of installation.

III. FLUORIDE EMISSION CONTROL TECHNOLOGY

The most effective method for removing fluoride from stack discharge is by the use of liquid scrubbers. Hundreds of scrubbers are operating for this purpose throughout the country. Efficiency of collection depends upon factors such as design features, pressure drop, scrubbing medium, and temperature as well as on proper maintenance and attention to operation.

Corrosion of metallic surfaces and plugging of sprays and packing are serious operating problems that must be considered in the design of equipment. Some method of removing the fluoride from the scrubbing liquid must be provided if a recirculating system is used. Removal of fluoride from discharge gases decreases markedly when the concentration of hydrofluorosilic acid in the recycle solution exceeds 2 percent.[7]

Phosphate rock defluornation plants similar to that of the Rocky Mountain Phosphates, Inc., plant in Garrison are operating in several other locations in the United States. Most of these plants use water scrubbers as air pollution control equipment.

Defluorinated phosphate rock is manufactured in Florida in one of the largest and best equipped plants in the country. This plant had an air pollution problem in the past, but installation of a three-stage water scrubber has eliminated the problems. Effluent gases from the kilns are cooled by water sprays, scrubbed in two packed spray scrubbers in series for removal of most of the fluoride, and then passed through a milk-of-lime scrubber for removal of the remaining traces of fluoride. Milk-of-lime solution is prepared in separate mixing equipment, and only the overflow solution is added to the milk-of-lime scrubber. Overall efficiency of fluoride removal for this plant is reported by the Florida Board of Health to be greater than 99 percent.[8] This Florida plant has almost ten times the pollution potential of the Rocky Mountain Phosphates, Inc., plant.

IV. TOPOGRAPHY AND CLIMATOLOGY OF GARRISON AREA

TOPOGRAPHY

Garrison, Montana, is located at the fork of a Y-shaped mountain valley system containing the Clark Fork River and the Little Blackfoot River. The town is at the north end of the Deer Lodge Valley, which is approximately 35 miles long and 8 to 10 miles wide, and which extends straight north and south. In the vicinity of Garrison the Clark Fork River, which flows from the south, turns to flow generally west-northwestward so that its valley forms the stem and left arm of the Y. The Clark Fork River valley narrows and is curving in parts just west of Garrison, but the valley straightens and widens further westward. At Drummond, Montana, which is 20 miles west-northwest of Garrison, the valley becomes 15 miles wide; but just west of there, it becomes very narrow and continues so through high mountains for many miles.

The Little Blackfoot River begins near the Continental Divide, 25 miles east of Garrison, and flows generally in an east-to-west direction. Its valley, which forms the right arm of the Y, is relatively narrow where it cuts through the Garnet Range, about 10 miles east of Garrison. In effect, Garrison, at 4,400 feet mean sea level and surrounded by mountains 7,000 to 9,000 feet high, is in a closed-off irregularly shaped, bowl-like valley system.

TEMPERATURE

Air temperature is important with respect to the air pollution problem in Garrison, Montana, primarily because of its effect on the growing season. In the Deer Lodge Valley, frosts and freezes do not have quite the same effects as in the warmer parts of Montana, largely because growers concentrate on crops not susceptible to damage at temperatures as low as 25^{o} F. Crops grown in the area include hay and grasses.

Based on 25 years of data, 1921-1950 (some data incomplete), the average last date in spring for a temperature of 24^{o} F is May 3, and the average first date in fall for this temperature is September 30; consequently, there are 151 days in an average year between 24^{o} F freezes.

PRECIPITATION

Official precipitation records are not available for Garrison, Montana, but 30 years of data are available for Deer Lodge, about 10 miles to the south. Other locations in the general area for which precipitation data are available are Drummond, 19 miles west-northwest and Elliston, 18 miles east. The mean annual precipitation for Deer Lodge is 11 inches; Drummond, 11 inches; and Elliston, 16 inches. The mean annual precipitation for Garrison, Montana, is estimated to be about 12 inches.

Figure 6 shows monthly means, mean number of days with precipitation of 0.10 inch or more, and monthly means of inches of snow and sleet on the ground for Deer Lodge. The pattern of distribution of precipitation throughout the year is similar to those for Drummond, Elliston, and the Garrison area. In Deer Lodge, 7.56 inches, or 71 percent, of the precipitation falls during the growing season (April-September) Normal years, therefore, have enough rainfall for many types of dryland farming and ranching. The winter is relatively dry, with February, the month with the least precipitation having only one-sixth that of June, the wettest month. Snowfall in the surrounding mountains provides enough water for irrigation during most of the summer in many years.

ATMOSPHERIC STABILITY

If in the atmosphere the temperature decrease with elevation is greater than 5.4^{o} F per 1,000 feet, conditions are described as "unstable" and air pollution is readily dispersed. Such a condition generally occurs on sunny days when the ground becomes heated and warms the air above. Wind speeds are low and wind directions, variable on such days.

If the temperature decrease is close to 5.4^{o} F per 1,000 feet, the atmospheric stability is "neutral." When atmospheric conditions are neutral, dispersion potential is relatively good. The meteorological conditions associated with neutral stability are cloudy skies and strong enough winds to cause thorough mixing. Wind directions are more or less steady.

If the temperature decrease with elevation is less than 5.4^{o} F per 1,000 feet, conditions are "stable." As the rate decreases, the dispersion rate for air pollutants also decreases. If the temperature of the atmosphere increases with elevation, dispersion of air pollutants is poor.

The condition in which temperature increases with elevation is called a "temperature inversion." The base of a layer of temperature inversion may be located either at the surface or aloft. Over land, surface-based temperature in-

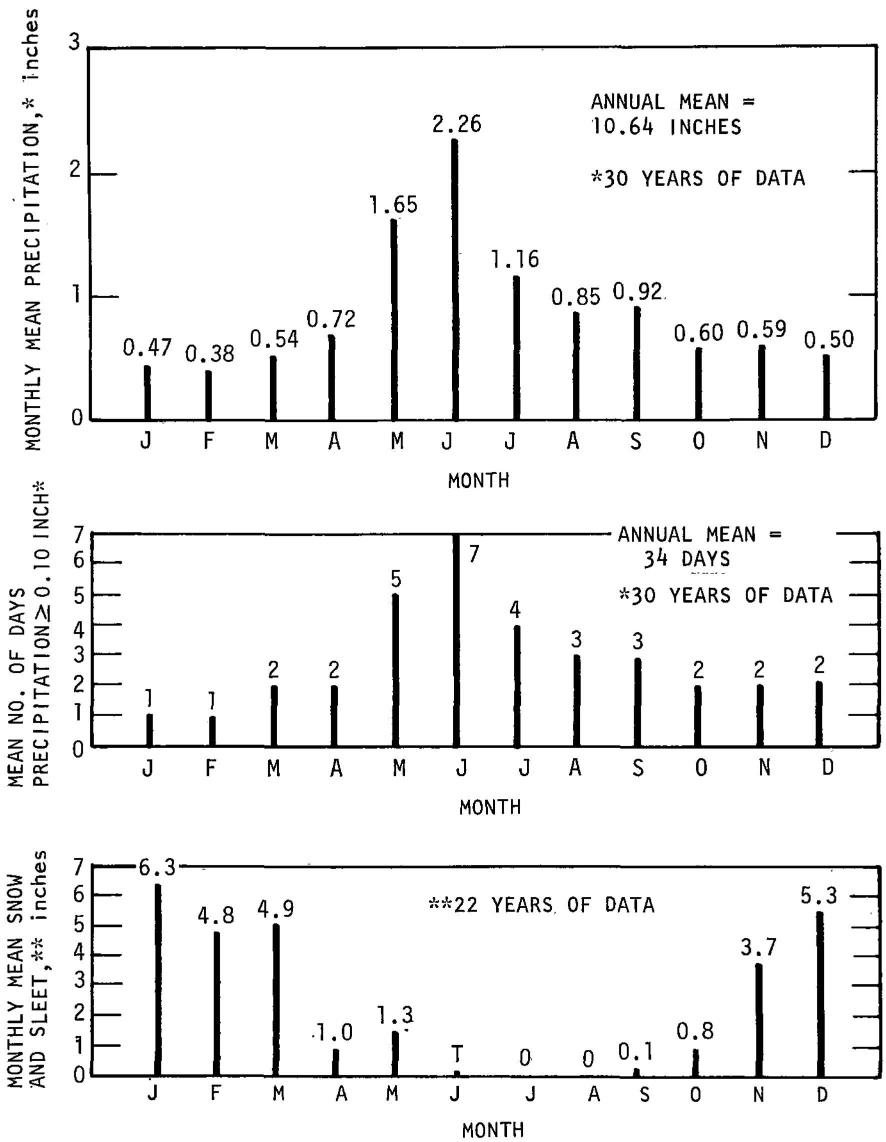


Figure 6. Summary of precipitation records for Deer Lodge, Montana.

versions occur at night under clear or partly cloudy skies with calm or light winds. When the ground cools by radiation, the layer of air above it also cools progressively.

Mountain valleys, such as the one in which Garrison is located, are particularly subject to intense and long-lasting inversion conditions for several reasons. The air in these valleys is usually an insignificant barrier to outgoing heat for several reasons: it is less dense than air at lower altitudes and is generally dry, winter nights are relatively long, surrounding mountains are a barrier to strong winds, and snow cover during the colder months reflects away solar energy and is an excellent radiator of heat at night. Furthermore, cool air in time drains to lower elevations because of its greater density and thereby causes deeper and more intense inversions in a valley than would occur on level ground.

A U.S. Weather Bureau study[9] reports the following inversion frequencies for the general region of the United States in which Garrison is located:

Inversion frequency

Season	Percent of total hours
Winter	45-55
Spring	30
Summer	30-35
Fall	40-50
Annual	40

Protected mountain valleys such as the Deer Lodge Valley have even higher percentages of inversions. In fact, the study indicates that the total of the fall and winter frequencies of inversions for this and some of the other valleys of western Montana is higher than for any other location in the contiguous United States.

The behavior of a plume from a stack during stable, neutral, and unstable conditions is shown in Figure 7. The unstable plume is described as "looping," the neutral plume as "coning," and the stable plume as "fanning." The cross sections of the looping and coning plumes are somewhat circular, whereas the fanning plume is greatly flattened because of restricted vertical motion. Both the unstable and stable plumes, when viewed from above, generally show evidence of meandering motion because of wind direction changes.

A plume from a source at the surface behaves similarly to that from a stack. One difference, however, is that the maximum ground concentrations for pollutants emitted from a stack occur some distance away from the stack, whereas with a ground level source the maximum concentration is at the source and the concentration decreases with increasing distance.

As would be expected, plume behavior is greatly affected by topography, and it follows that ground concentrations of air pollution are also affected. Air is channelled by a valley, especially during stable conditions; and a plume of air pollution is confined by a valley, or will follow valley walls. Effluent from the

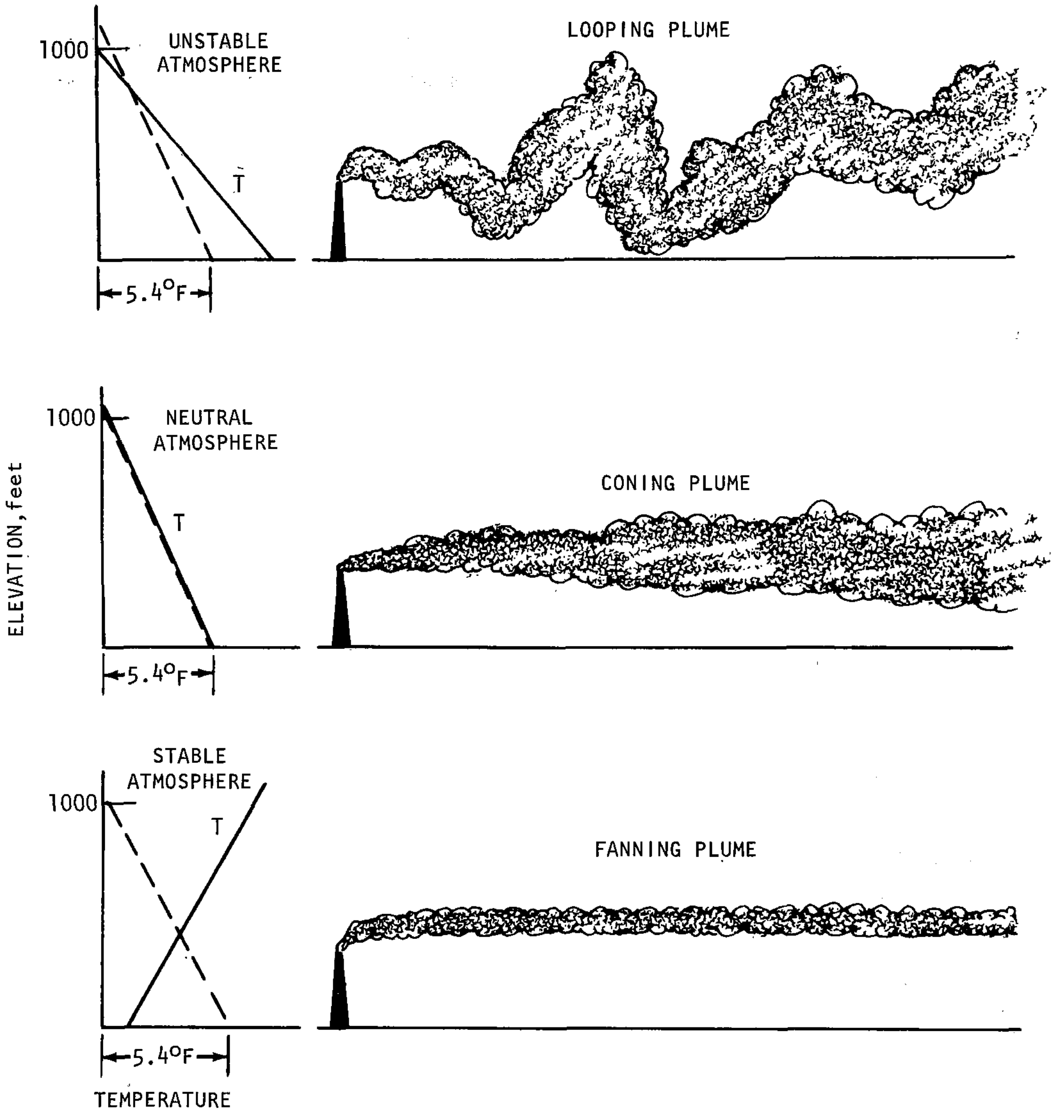


Figure 7. Temperature lapse and plume behavior in unstable, neutral, and stable atmospheric conditions.

Rocky Mountain Phosphates, Inc., stack moves up and down the Clark Fork River Valley or up the valley of the Little Blackfoot River, following the turns in the valley. It also spreads out over the ridges that project into the valleys. It follows errosion channels up and down ridge slopes and tops the ridges at low points. Consequently, exposed locations on slopes facing the source receive relatively high concentrations, as do draws on both sides of the slope where air is channelled. Because of the "valley effect" high ground concentrations can occur at a greater distance downwind from the source than would occur in flat terrain.

WIND SPEED

The Montana State Board of Health operated a wind recording system on the roof of the County Courthouse in Deer Lodge from November 1965 through June 1966. Calm or very light winds, with wind speeds ranging from 0 to 7 miles per hour, were observed 70 percent or more of the time in all months except December (65 percent) and June (58 percent). In February, the month with most light winds, speeds of 0 to 7 miles per hour were observed 91 percent of the time.[10]

A Public Health Service wind recording system installed on the north edge of Lahman's trailer court began to record data in mid-May of 1967. The light-weight design of the wind vane and anemometer cups makes it possible to record wind conditions when speeds are as low as 1 mile per hour. The wind sensors are located on top of a telephone pole, approximately 20 feet above the ground.

Without a longer period of observational records from Garrison, monthly wind conditions throughout the year and annual average conditions must be estimated from observations made at the Drummond airport, 20 miles west-northwest down the Clark Fork River Valley. At the present time wind observations are made at Drummond only during the hours of 0500 to 1700, but summarized data are available for 24 hours daily for the years 1951-1954. Although the topography at Garrison and the Drummond airport are different, a comparison of the limited amount of Garrison data with Drummond observations shows that wind conditions are similar. The average wind speed at Drummond for the month of June 1967 during the hours of the day the station operates was 4.4 miles per hour. The average wind speed for the same hours at Garrison was 4.6 miles per hour, an insignificant difference.

As is shown by the graph of average monthly wind speeds for Drummond, Figure 8, there is a seasonal variation of wind speed in the Garrison area. At Drummond October, November, and December have the lowest wind speeds. The average monthly speed for these months is about 6 miles per hour. Highest monthly averages occur from January through July, when wind speeds average about 8 miles per hour.

The greatest number of periods of calm occur in Drummond during the late fall and early winter. A calm is reported in about 12 percent of all observations during the months of November and December. Fewest calms occur during the warmer months of the year, April through September, when calms occur only 5 to 6 percent of the time (Figure 9). Annually, wind speeds in the range of 0 to 7 miles per hour occurred 52 percent of the time.

The limited amount of wind speed data available for Garrison, Montana, indicates that average wind speeds are relatively very low, as would be expected

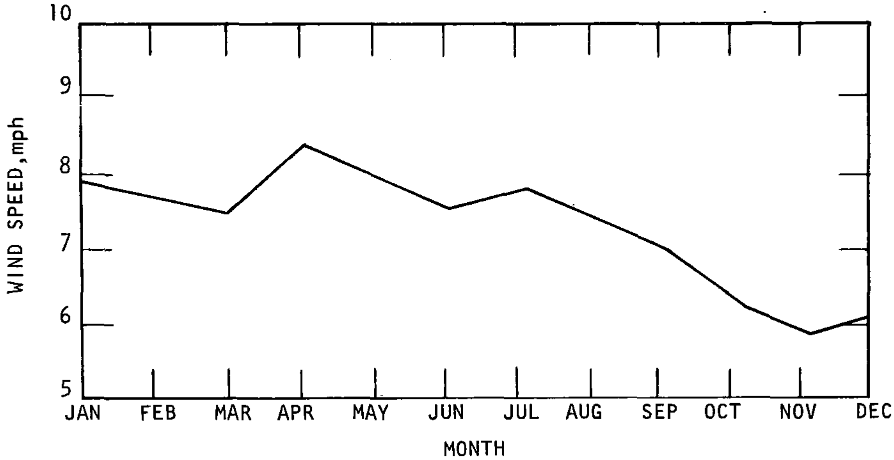


Figure 8. Average monthly wind speeds in Drummond, Montana - U. S. Weather Bureau data from 1951 through 1954.

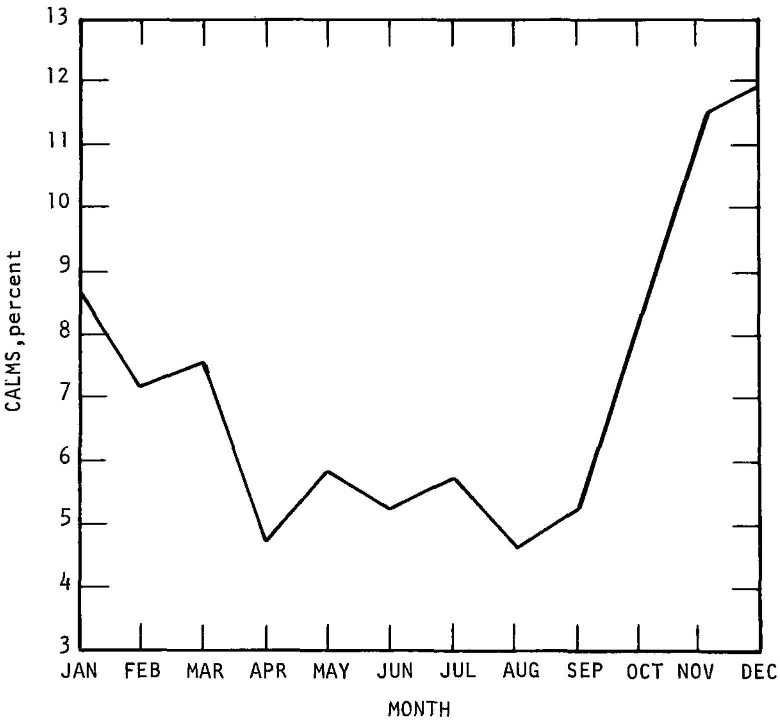


Figure 9 Percent of calms each month during 1951 through 1954 in Drummond, Montana - U. S. Weather Bureau data.

from its sheltered location. The average speed for the month of June 1967 was only 3.8 miles per hour.

For comparison, the average June wind speed for Washington, D. C., is 9 miles per hour; Los Angeles, California, 8 miles per hour; and St. Louis, Missouri, 8 miles per hour.

In Garrison during June, the highest hourly average speed of 7 mph occurred at 3 p.m., whereas the wind speeds during the hours 10 p.m. to 6 a.m. average 2 miles per hour or less (Figure 10). Examination of the wind record showed that true periods of calm when no air movement was detected are rare in Garrison. Wind speeds of at least 1 or 2 mph occur most of the time. During the hours of darkness, when calms are most likely to occur, cold drainage off the slopes causes some movement of air.

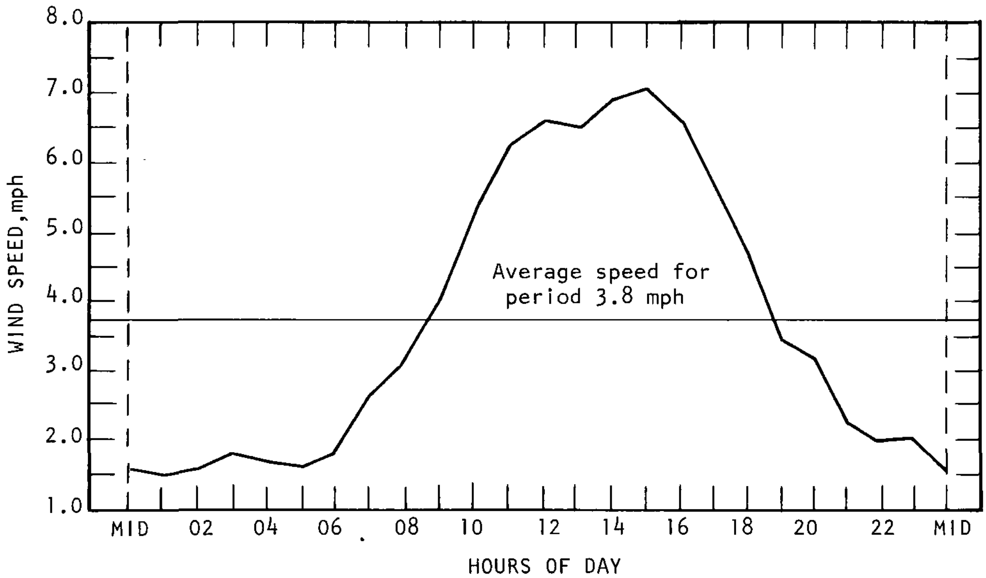


Figure 10. Average hourly wind speed for June 1967 in Garrison, Montana.

Wind speed is very significant in air pollution considerations. With respect to a continuous point source, such as emissions from a stack, ground level concentrations are inversely proportional to wind speed, i.e., low wind speeds produce high concentrations. Also, in the Garrison valley area, where air pollution can be confined by surrounding hill and mountain sides, low wind speeds are associated with atmospheric processes that permit air pollution to accumulate in the vicinity of a continuous source and remain in the general vicinity of it for many hours.

WIND DIRECTION

Topography greatly influences wind direction in the Garrison area. It also is a factor at Deer Lodge, where wind records were obtained by the Montana State Board of Health in May 1966, and at Drummond, the nearest station making official wind observations. The limited data for Deer Lodge confirmed the north-south channelling of air by the north-south orientation of the Clark Fork River Valley in the vicinity of this city. Few westerly and hardly any easterly winds were observed. The sheltering effect of the mountains is shown by the fact that 21 percent of the winds were classified as light and variable.

Wind direction data for the Drummond, Montana, airport are available for all hours of the day for the period July 1950 through December 1954; these data have been summarized by the U.S. Weather Bureau. At the present time, however, meteorological observations, including hourly wind direction readings of an instrument by a Federal Aviation Administration observer, are made daily only for the hours 0500 through 1700.

The annual wind rose for Drummond (Figure 11) gives the percent frequency of occurrence of wind directions and speeds for each direction and the percentage of calm. The relative high frequency of winds from the west through northwest shows the effect of the prevailing westerlies of this latitude. Cold air also drains off the nearby hill sides from a westerly direction. The higher frequency of southwest and northeast winds are indicative of the effect of the Flint Creek Valley and a pass through the Garnet Range in a general northeasterly direction from Drummond. Because of the manner in which large-scale meteorological features affect this region, a large percentage of easterly winds would not be expected. Further, airflow from east to west is inhibited by the high mountains west of Drummond and the narrow, winding nature of the Clark Fork River Valley to the west.

Figure 12 shows wind roses for the 4 months of the year representative of the four seasons. There do not appear to be important seasonal differences in direction, as is often the case at weather stations in other geographical regions.

Because wind data for June 1967 are available for Garrison, the wind roses shown in Figure 13 were prepared for both Drummond and Garrison. Only the hours between 0500 and 1700, inclusive, were used. These correspond to the part of the day when the Drummond Station is operating. Both of these wind roses show wind frequencies of 20 percent from a northwesterly direction, a pattern similar to that seen in the annual wind rose for Drummond. The Garrison wind rose shows a much greater frequency of winds from the east (13%) than Drummond (1%). Air draining from the mountain slopes west of the Continental Divide and down the Little Black-

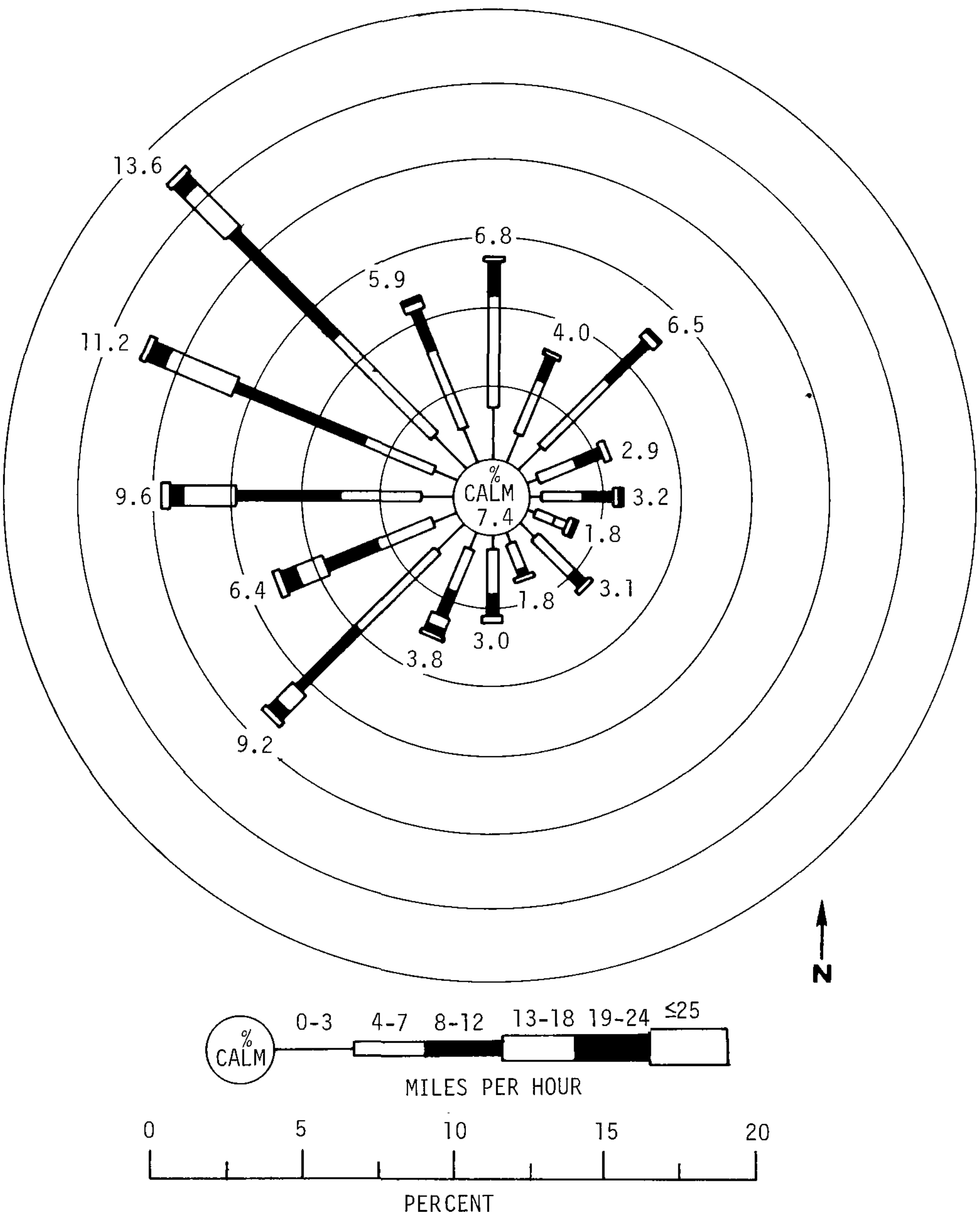


Figure 11. Drummond, Montana, annual wind rose based on data from July 1950 through December 1954 - U. S. Weather Bureau record.

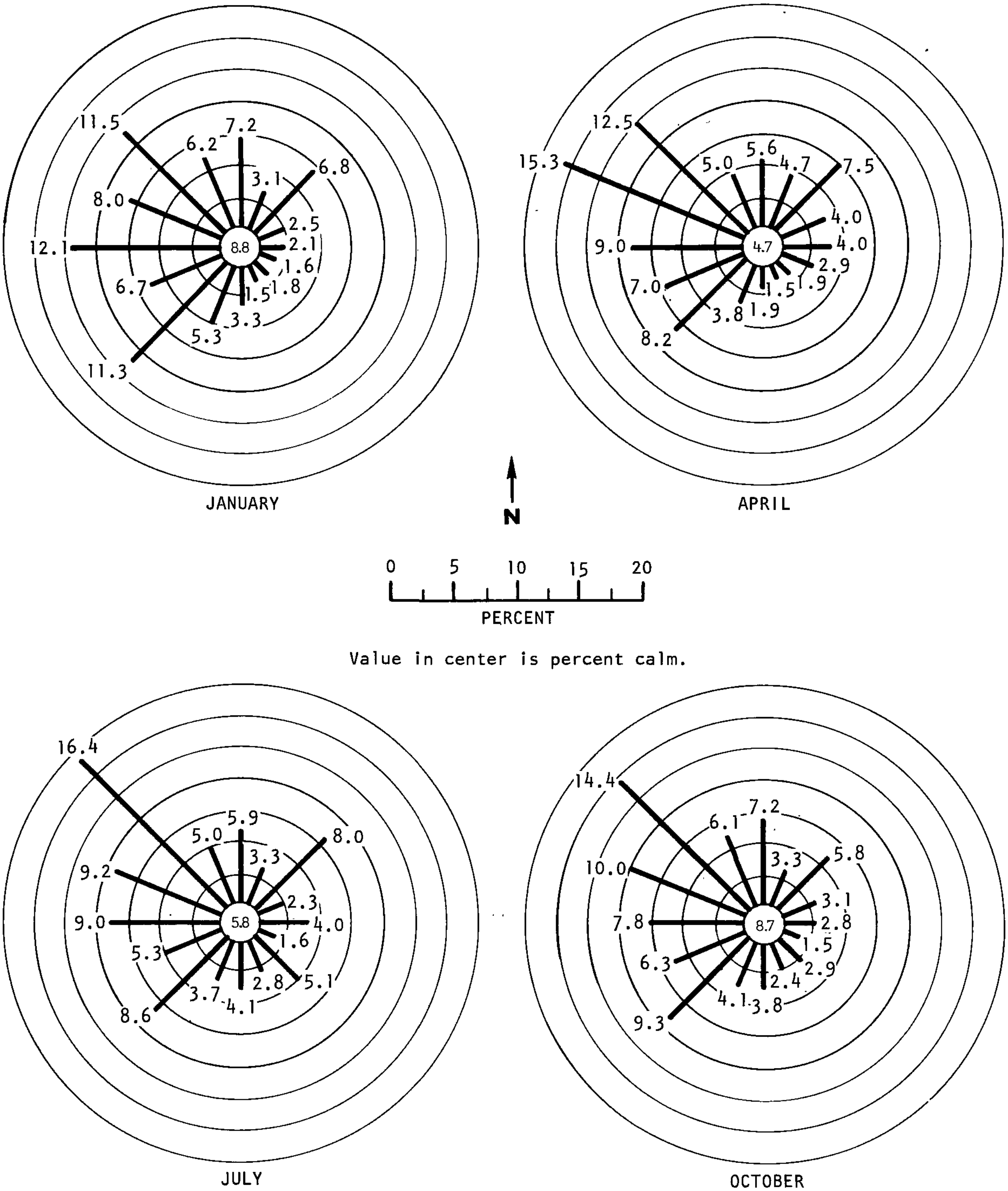


Figure 12. Wind roses for January, April, July, and October from 1950 through 1954 for Drummond, Montana - U. S. Weather Bureau data.

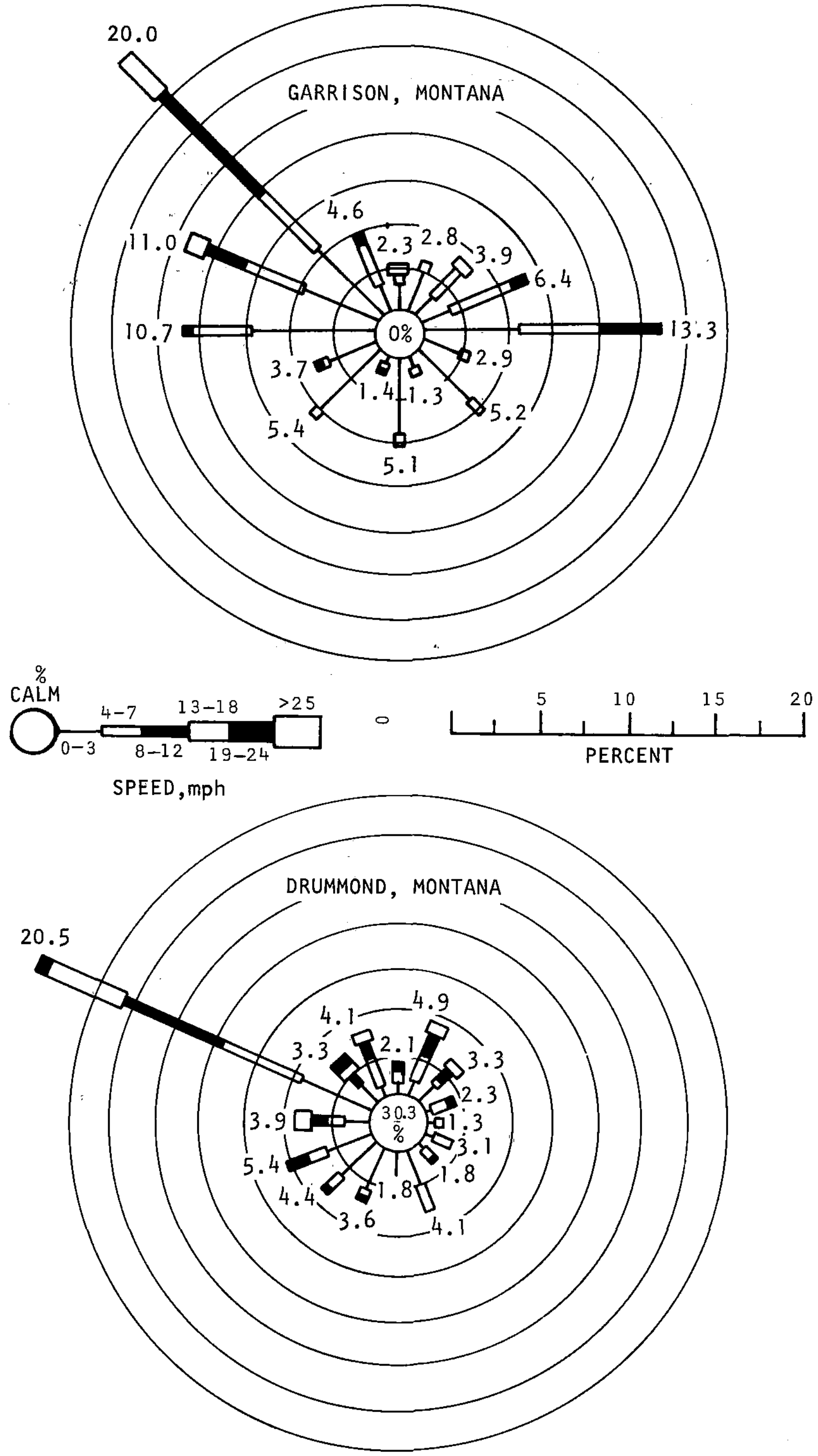


Figure 13. June 1967 wind roses for Garrison and Drummond, Montana.

foot River Valley produces an east wind at Garrison. This air combines with drainage from the Deer Lodge Valley to produce as east southeasterly wind down the valley of the Clark Fork River from Garrison.

The Drummond wind rose shows 30 percent calm, whereas the Garrison rose rose shows none. The apparent high frequency of calms at Drummond is caused by the type of wind equipment in operation there. It is designed for routine aviation purposes and is less responsive to both speed and direction than the wind system in use at Garrison. A wind direction is not recorded unless a speed other than zero is also observed. Also, the wind is observed only for 1 minute each hour, when there may be no wind; whereas at Garrison the wind is recorded continuously and any wind during the hour is considered in the hourly average values used for constructing the wind rose. A large percent, if not all, of the calms for Drummond represent low average hourly wind speeds of perhaps 1 or 2 miles per hour; and the frequency of occurrence of various wind directions is actually greater than shown in the wind roses.

An examination of the wind records at Garrison showed that the wind vane was in a large eddy with slow wind speeds for intervals during many of the nights when drainage flow was being established. At such times the wind vane would turn slowly around, through 360 degrees or more, with the period of turning covering an hour or two. Eighty such periods occurred during June. During some periods the rotation was clockwise and during others it was counter-clockwise. At the end of the period of vane rotation, wind direction was often southeasterly.

Wind direction is important in air pollution problems because it determines the direction of transport of pollutants from the source. Wind direction frequencies indicate the percent of the time a particular receptor is downwind. Calms, light variable winds, or an eddy condition such as has been observed at Garrison can result in relatively high concentrations distributed nearby and around the source, and relatively great exposures or dosages near it.

V. DISTRIBUTION OF FLUORIDE IN GARRISON AREA

FLUORIDES IN GRASS

Vegetation absorbs hydrogen fluoride when the gas is present in the ambient atmosphere. The accumulation of fluoride in vegetation can be determined by chemical analysis.

Specimens of grass from several locations in the Garrison area were collected during 1963, 1965, 1966, and 1967 and analyzed for fluoride content by the Montana State Board of Health. Locations from which these specimens were taken are identified as follows on the area map, Figure 14:

Station	Map location
Garrison North	2
Garrison East	27
Garrison South	39
Garrison West	7
Garrison West Meadow	50
Jens	16
Deer Lodge	42

The concentrations of fluoride in the specimens taken from these locations and the dates upon which the specimens were collected are listed in Table 1. The earliest specimens from the Garrison North and Garrison East stations were taken on June 17, 1963, before operation of the Rocky Mountain Phosphates, Inc., plant began. The results are consistent with fluoride content of such specimens from locations where there is no substantial source of atmospheric fluoride.

Data for an interval of about 2 years following the beginning of operation of the Rocky Mountain Phosphates, Inc., plant in Garrison are available for the Garrison North, Garrison East, and Garrison West stations (map locations 2, 27, and 7). The month-by-month concentrations of fluoride in grass specimens from these locations exhibit a consistent pattern. Concentrations increase rapidly during the late autumn to very high values during the late winter, decrease during the spring, and remain relatively lower than winter values during the summer.

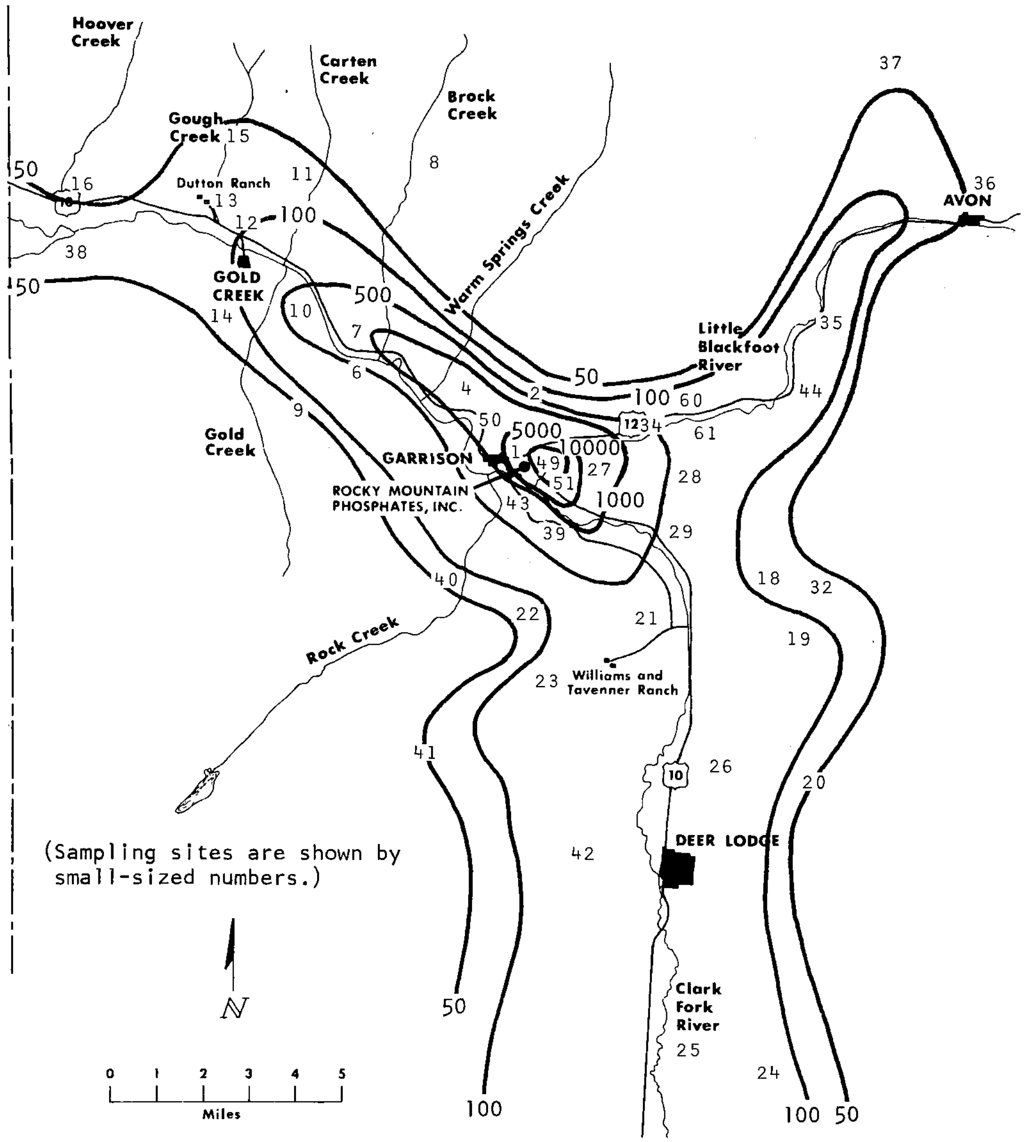


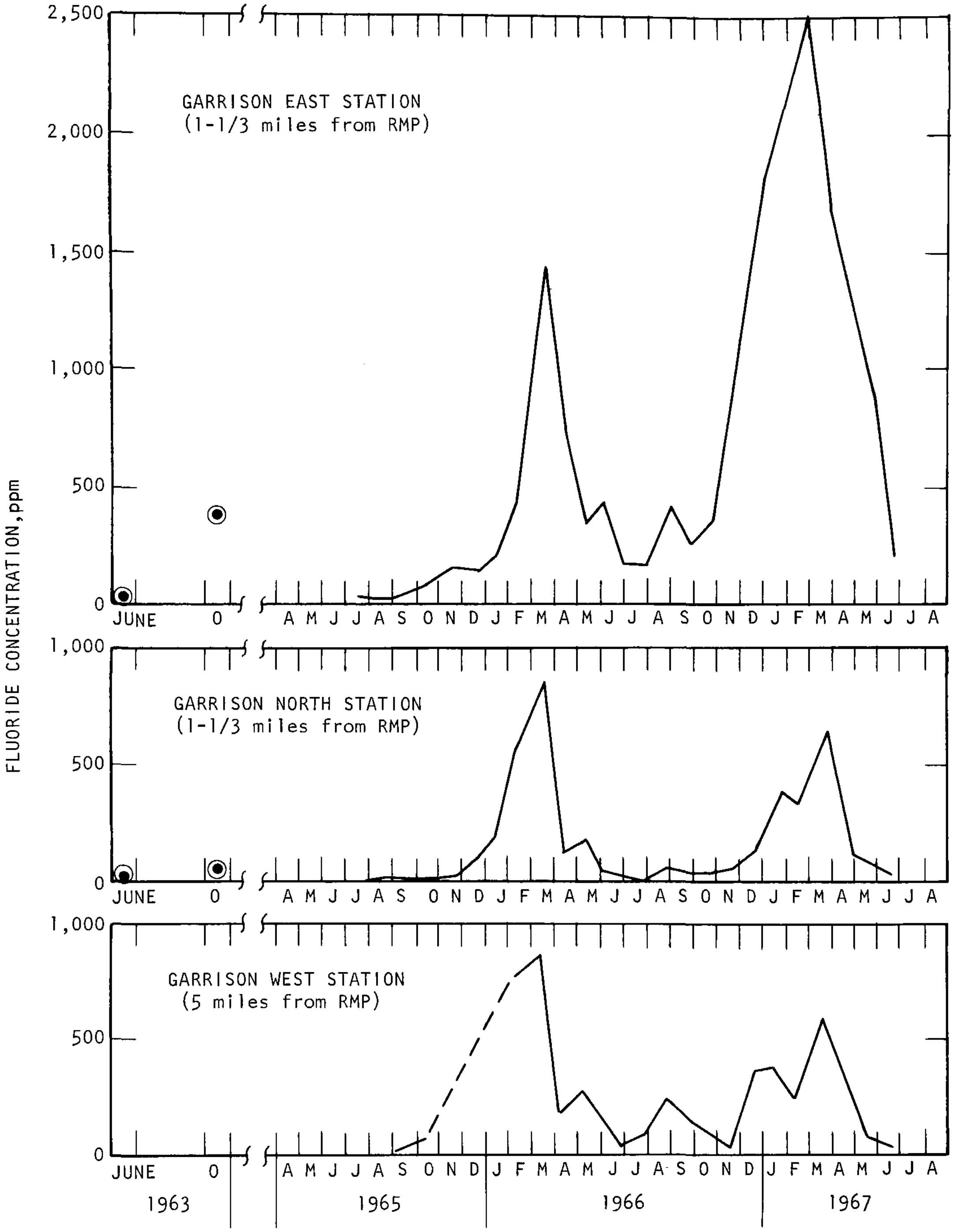
Figure 14. Sampling sites and fluoride concentrations (ppm) for grass specimens collected in Garrison area on April 15, 16, and 17, 1967.

This pattern is consistent with the growing season for grass and, in general, with the seasonal fluctuations in production rate for the Rocky Mountain Phosphates, Inc., plant. During time of rapid grass growth the concentration of fluoride is lower than during periods when growth is static, even though fluoride exposure continues. Further reason for the observed pattern is the greater production rate for the Rocky Mountain Phosphates, Inc., plant reported for the winter season than for the summer. Seasonal fluctuations of fluoride content in grass from the three locations are depicted in Figure 15.

Table 1. CONCENTRATION OF FLUORIDES IN GRASS SAMPLES IN GARRISON, MONTANA, AREA[a] (ppm)

Date of Collection	Garrison North Station	Garrison East Station	Garrison South Station	Garrison West Station	Garrison West Meadow	Jens	Deer Lodge
6/17/63	2	8					
10/16/63	55	320					
4/19/65	79	47					
7/15/65	7	15					
8/11/65	10	11		2			
8/31/65	-	17		10			
10/15/65	8	77		53			
11/17/65	20	148					
12/17/65	92	132					
1/12/66	170	220					
2/9/66	564	416		767			
3/15/66	860	1450		870			
4/11-12/66	130	750		175			
5/9/66	193	340		273			
6/2/66	45	434					
6/30/66	14	159		30			
7/28/66	8	154		75			
8/29/66	52	412		235			13
9/26/66	28	246		151			8
10/26/66	33	355	78	95	161	67	0
11/23/66	63	1000	231	26	316	14	0
12/21/66	141	1750	484	362	590	83	
1/20/67	380	-	695	380			14
2/16/67	327	-	450	230	340	200	70
2/24/67	-	2530					
3/21/67	660	1750	97	598	106	198	25
4/25/67	121	1283	531	393	380	51	61
5/23/67	74	880	176	68	68	22	17
6/23/67	28	182		10	28	9	2

[a] Samples collected and analyzed by Montana State Board of Health.



Fluoride concentrations in grass specimens from Garrison area, 1965-1967.

The concentrations of fluoride found in grass specimens from the Deer Lodge and Jens stations (map locations 16 and 42) are generally lower than those from the other stations. The Jens and Deer Lodge stations are located farther from the Rocky Mountain Phosphates, Inc., plant than are the other stations.

Some 50 grass specimens were collected in the Garrison area April 15 to 17, 1967, by personnel of the Public Health Service and the Montana State Board of Health. Thirty-five of the Powell County specimens, selected to give good geographic distribution, were analyzed for fluoride content in Public Health Service laboratories. Analytic methods and sample handling procedures used in the Public Health Service laboratories for the vegetation specimens, and other samples examined for fluoride, are referenced or described in Appendix B.

Locations and fluoride concentrations for the April specimens are listed in Table 2. Results of the analyses and the topographic features of the area were used to estimate the locations of isopleths of fluoride concentration in grass for mid-April 1967 in the Garrison area. The locations from which grass specimens were collected and the estimated isopleths of fluoride concentrations are shown in Figure 14.

Grass specimens from two of the locations listed in Table 2 were washed gently with water, and the washed grass and washings were then analyzed for fluoride. The technique, while not precise, yields information on the relative amounts of fluoride materials readily removed from the surfaces of the specimens. Results of these examinations are shown in Table 3. Some 5 to 10 percent of the fluoride was removed by gentle washing of these specimens.

FLUORIDES IN EVERGREEN FOLIAGE

Specimens of evergreen foliage were collected in the Garrison area April 15-17, 1967 and analyzed for fluoride content in laboratories of the Public Health Service. Two-inch long portions from the tips of the needles were analyzed. The type of tree, its location, and the concentration of fluoride in its foliage are listed in Table 4.

FLUORIDES IN WATER

Water samples were collected in three locations in the Garrison area in January 1965 and analyzed for fluoride content by the Montana State Board of Health. Locations from which these samples were obtained and results of the analyses are shown in Table 5. Locations, identified by letter, are shown in Figure 16.

Table 2. FLUORIDE CONCENTRATIONS IN GRASS SPECIMENS COLLECTED APRIL 15-17, 1967, BY PUBLIC HEALTH SERVICE

Station	Location	Fluoride, ppm
1	1/2 mi north of RMP[a]	8,400
2	1-1/2 mi north of RMP	200
4	2 mi NW of RMP	1,600
6	4 mi WNW of RMP	250
7	4-1/2 mi NW of RMP	800
9	5 mi west of RMP	50
10	6 mi WNW of RMP	700
11	8 mi NE of RMP	60
12	8 mi NW of RMP	80
13	8 mi NW of RMP	70
14	7 mi NW of RMP	80
15	9 mi NW of RMP	55
18	5 mi ESE of RMP	70
19	7 mi SE of RMP	260
20	9 mi SE of RMP	70
21	4 mi SE of RMP	290
22	3 mi south of RMP	80
23	5 mi SSE of RMP	180
24	15 mi SSE of RMP	165
25	13 mi SSE of RMP	300
26	8 mi SE of RMP	300
27	1-1/2 mi east of RMP	1,500
29	3 mi ESE of RMP	240
34	2-1/2 mi ESE of RMP	430
35	7 mi ENE of RMP	240
36	11 mi ENE of RMP	40
37	12 mi NE of RMP	25
38	11 mi WNW of RMP	60
39	2 mi SSE of RMP	970
40	3 mi SSW of RMP	95
41	7 mi SW of RMP	50
43	1-1/4 mi south of RMP	710
49	1500 ft SE of RMP	11,000
50	1 mi NW of RMP	2,400
51	1/2 mi ESE of RMP	12,600

[a]Rocky Mountain Phosphates, Inc.

Table 3. FLUORIDE CONTENT OF WASHED GRASS SPECIMENS AND OF WATER WASHINGS

Station	Parts Per Million Fluoride		
	Unwashed Grass	Washed Grass	Washings[a]
49	11,000	9,400	940
51	13,000	10,000	820

[a]As ppm of grass sample.

Table 4. FLUORIDE CONTENT OF EVERGREEN FOLIAGE COLLECTED IN APRIL 1967[a]

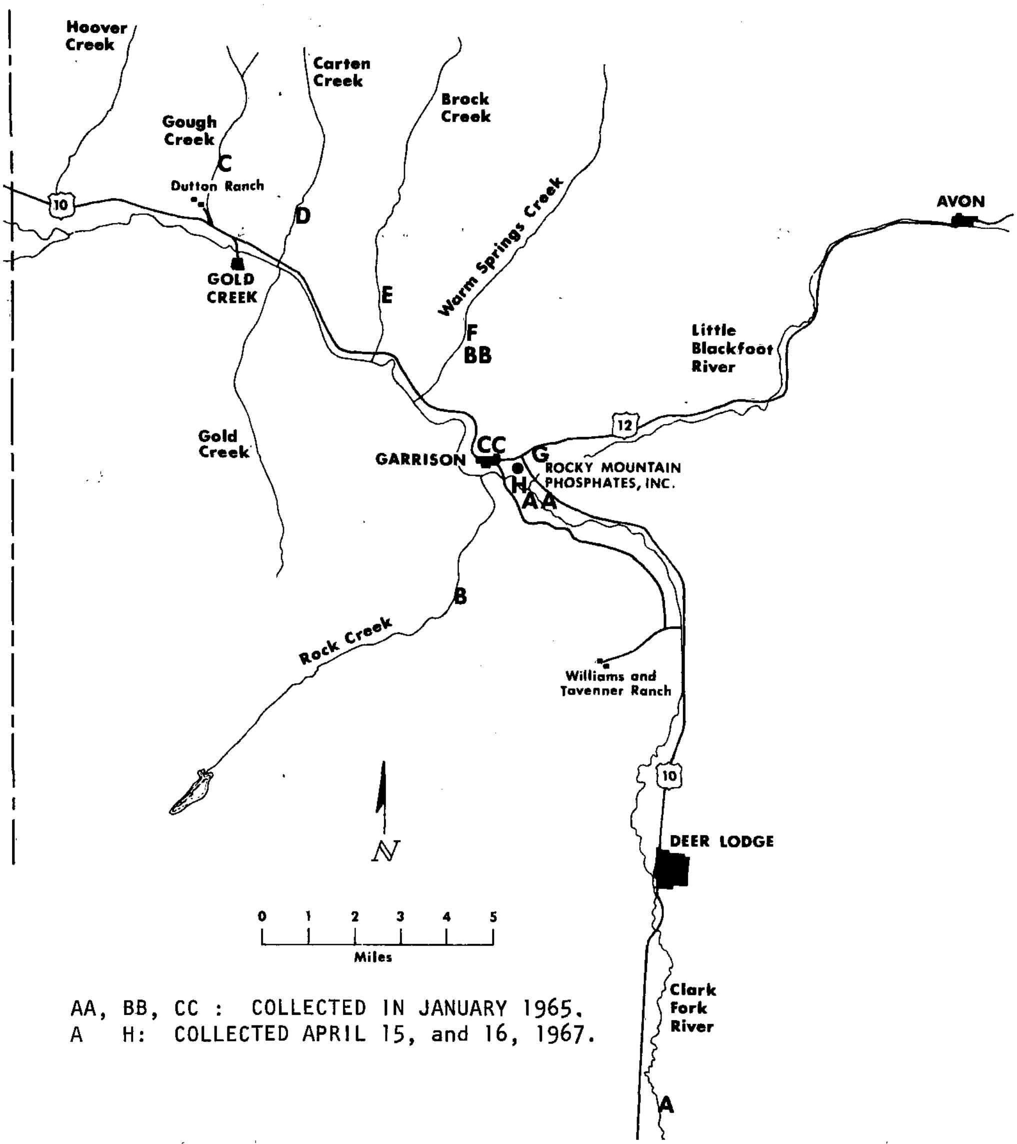
Type of evergreen	Location	Fluoride, ppm
Fir	1 mi east of Garrison	760
Juniper	5 mi WNW of Garrison (Clark Fork Valley)	80
Ponderosa Pine	8 mi WNW of Garrison (Clark Fork Valley)	50
Ponderosa Pine	8 mi WNW of Garrison (Clark Fork Valley)	60
Ponderosa Pine	25 mi east of Garrison (West Side of MacDonald Pass)	40
Ponderosa Pine	25 mi NNW of Garrison (Helmville)	10
Ponderosa Pine	12 mi WNW of Garrison (Jens)	30

[a]Specimens collected and analyzed by Public Health Service personnel.

Table 5. FLUORIDE CONTENT OF WATER SAMPLES COLLECTED ON JANUARY 8, 1965, MONTANA STATE BOARD OF HEALTH

Location	Fluoride, ppm
AA - Lahman's House 12-foot dug well	0.2
BB - Warm Springs Creek William Knope Ranch	1.4
CC - Welsh's Truck Stop	0.2

Samples of surface waters in the Garrison area were collected on April 15 and 16, 1967, and analyzed for fluoride content in Public Health Service laboratories. Locations from which these samples were obtained and results of the analyses are shown in Table 6. Locations are shown in Figure 16.



AA, BB, CC : COLLECTED IN JANUARY 1965.
A H: COLLECTED APRIL 15, and 16, 1967.

Figure 16. Water sample collection locations in Garrison area.

Table 6. FLUORIDE CONTENT OF WATER - APRIL 15-16, 1967, PUBLIC HEALTH SERVICE ANALYSIS

Location	Fluoride, ppm
A - Clark Fork River south of Deer Lodge	0.8
B - Rock Creek, Tavenner Ranch	0.5
C - Pond, Dutton Ranch	0.6
D - Carter Creek, 1 mi from Clark Fork River	0.4
E - Brock Creek, 1 mi from Clark Fork River	0.8
F - Warm Springs Creek, Knope Ranch	1.0
G - Pond, Mollenberg Ranch	0.7
H - Little Blackfoot River, Lahman's Trailer Court	0.5

FLUORIDES IN SOIL

Samples of soil were collected on May 23, 1967, and analyzed for fluoride by the Montana State Board of Health. These samples, with locations of the sampling stations the same as identified in Figure 14, yielded the following results:

Sampling Station	Map Location	Fluoride, ppm
Garrison East	27	230
Garrison West	7	280
Garrison South	39	300

At the end of June 1967, topsoil and subsoil samples were taken from two of these stations, and analyzed for fluoride content and for water-soluble fluoride in laboratories of the Public Health Service. Results of these analyses are given in Table 7.

Table 7. ANALYSIS OF SOIL SAMPLES FOR WATER-SOLUBLE AND TOTAL FLUORIDE CONTENT

		Fluoride, ppm	
Sampling station	Sample type	Water soluble	Total
Garrison East	Topsoil	60	160
Garrison East	Subsoil	60	160
Garrison West	Topsoil	50	140
Garrison West	Subsoil	60	180

APPENDICES

APPENDIX A. CORRESPONDENCE AND RESOLUTIONS

a. Letter from Governor T. Babcock to Secretary J. Gardner

b. Letter from Dr. J. S. Anderson to Secretary J. Gardner

c. Resolution of Powell County Board of Commissioners

d. Resolution of Senate of Montana

State of Montana
Office of The Governor
Helena

March 8, 1967

Mr. John Gardner
Secretary of Health, Education, and Welfare
Washington, D.C.

Dear Secretary Gardner:

I am forwarding herewith a resolution of the Board of County Commissioners of Powell County, Montana, together with my concurrence to initiate an abatement proceeding by the National Center for Air Pollution Control under Section 105 of the Clean Air Act.

This matter has been discussed with representatives of the abatement control division of the center, and I was at one point advised that they might conceivably be far enough along with several interstate abatement proceedings then pending to give attention to our problem sometime this month.

Sincerely yours,

Tim Babcock
GOVERNOR

cc: Mr. S. Smith Griswold
Dept. of Health, Education, and Welfare
Washington, D.C.

Mr. Newman Raymond, Chairman
Powell County Commissioners
Deer Lodge, Montana

State of Montana
State Board of Health
Helena, Montana

<u>AIR MAIL</u>

March 21, 1967

Mr. John Gardner, Secretary
Health, Education, and Welfare
Washington, D.C.

Dear Secretary Gardner:

I concur with the resolution of the Board of County Commissioners of Powell County, Montana, forwarded to you by Governor Tim Babcock on March 8, 1967, in his request to you for initiating abatement proceedings at Garrison, Montana, under the federal Clean Air Act.

This department will cooperate with you to the fullest extent possible. It is my hope that action can be initiated with a minimum of delay.

Sincerely yours,

John S. Anderson, M.D.
Executive Officer

JSA/acw

cc: Mr. Griswold, National Center for Air Pollution Control
Governor Tim Babcock, Capitol Building, Helena, Montana
Mr. Newman Raymond, Chairman, Powell County Commissioners
Deer Lodge, Montana

RESOLUTION OF THE BOARD OF COMMISSIONERS OF POWELL COUNTY, STATE OF MONTANA, REQUESTING THE SECRETARY OF HEALTH, EDUCATION AND WELFARE TO CALL A CONFERENCE TO DEAL WITH THE PROBLEM OF AIR POLLUTION IN POWELL COUNTY.

WHEREAS, residents of the Garrison area of Powell County, Montana, have petitioned the Board of Commissioners for Powell County, to request the United States Secretary of Health, Education and Welfare to call a conference to deal with the problem of air pollution in Powell County, Montana; and

WHEREAS, the Board of Commissioners of Powell County is strongly desirous of initiating an effective program leading to the prevention and control of air pollution in this county,

NOW THEREFORE BE IT RESOLVED BY THE BOARD OF COMMISSIONERS OF POWELL COUNTY, STATE OF MONTANA, that the United States Secretary of Health, Education and Welfare is respectfully requested to call a conference, pursuant to the provisions of Public Law 88-206 as amended by Public Law 89-272, to deal with said pollution. On condition that Powell County bear no part of any expenses or costs incurred.

Originally signed by:

Newman Raymond

Sandy O. Reierson

R.M. Bauman

BOARD OF COMMISSIONERS FOR POWELL COUNTY

I concur in the above request.

TIM M. BABCOCK
Governor of the State of Montana

SENATE

JOINT RESOLUTION NO. 1

INTRODUCED BY FLYNN, McKEON

A RESOLUTION OF THE SENATE OF MONTANA URGING THE GOVERNOR TO REQUEST THE SECRETARY OF HEALTH, EDUCATION, AND WELFARE TO CALL A CONFERENCE ON AIR POLLUTION IN THE VICINITY OF GARRISON, MONTANA.

WHEREAS, the people, the animals, and the plant life in the vicinity of Garrison have suffered, are suffering, and will continue to suffer from the demonstrated effects of air pollution which endangers their health and welfare; and

WHEREAS, the federal Clean Air Act makes provision for the Secretary of Health, Education, and Welfare to call a conference if such air pollution exists whenever requested by the Governor of any State.

NOW, THEREFORE, BE IT RESOLVED BY THE SENATE OF THE STATE OF MONTANA:

That the Governor is urged to request the Secretary of Health, Education, and Welfare to call a conference, as provided in the Clean Air Act.

BE IT FURTHER RESOLVED, that the Secretary be requested to direct such conference to consider, among such other matters as the Secretary may deem appropriate, the occurrence of air pollution in the vicinity of Garrison, the adequacy of measures taken toward abatement of the pollution, and the nature of the delays, if any, being encountered in abating the pollution.

APPENDIX B. ANALYTICAL METHODOLOGY FOR FLUORIDE

Various types of materials collected in the vicinity of Garrison, Montana, were analyzed for fluoride content. The sample treatment for each type was necessarily different; however, the measurement technique was the same for all samples except the water samples. Water samples were analyzed for fluoride with an Orion fluoride selective electrode. All other samples were analyzed by the Willard and Winter* distillation followed by the SPADNS** colorimetric procedure.

Vegetation Specimens

Vegetation samples were analyzed for total fluoride on a dry basis. Some samples were analyzed for water-insoluble particulate fluoride deposited on the surface, and these or other samples were analyzed for water-soluble fluoride in the deposited material.

Total Fluoride - Vegetation is blended with calcium oxide and a small amount of water. The mixture is dried at 70^{o} to 80^{o} C, ignited at 600^{o} C for 2 hours, and fused with sodium hydroxide at 600^{o} C for 10 minutes. This melt is dissolved in water and neutralized with perchloric acid. The solution is then analyzed for fluoride by the combined Willard and Winter distillation and SPADNS colorimetric method.

Water-Soluble and -Insoluble Particulate Fluoride in Vegetation Samples - Total fluoride content of vegetation samples can include fluorides incorporated into the vegetation and particulate fluorides deposited upon the vegetation. To estimate the amount not contained within the vegetation, selected vegetation samples were washed gently with water. These washings were collected and separated according to water-soluble and water-insoluble portions.

The insoluble portion was treated and analyzed in the same way as were the vegetation samples. The soluble portion was distilled directly by the method of Willard and Winter and measured by the SPADNS method.

Soil Samples

Soil samples were analyzed for both total fluorides and for water-soluble fluorides.

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Total Fluoride - The sample was dried at 75^{o} C and passed through a 100-mesh sieve to remove small stones and vegetation. The dry sample was blended with calcium oxide, ignited at 600^{o} C for 2 hours, and fused with sodium hydroxide at 600^{o} C for 10 minutes. The melt was dissolved in water and neutralized with perchloric acid. This solution was analyzed by the SPADNS method after perchloric acid distillation.

Water-Soluble Fluoride - The dried sample of soil was blended with water and filtered. The filtrate was analyzed by the SPADNS method after distillation from perchloric acid.

Water Samples

The fluoride content of water was measured instrumentally by means of an Orion fluoride selective electrode.

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