Workshop Symposium
Northern Research Basins
Objectives and Measurements
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Reports on activities of the United States National Weather Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, in Northern Research Basins:

I. Snowmelt

II. Precipitation

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I. Snowmelt research

A. Objectives, results, and future plans

1. General objectives

Cold regions have been neglected to a large degree throughout the history of hydrology. Most modern hydrologic forecasting techniques are not applicable or have not been applied to areas where snow is a major factor. The majority of procedures currently used in river forecasting in cold regions are empirical and to a large extent subjective. In order to increase the accuracy of river forecasts in cold regions, two things need to be accomplished. First, the basic processes of snow accumulation, snow cover energy exchange, liquid water retention and transmission in snow, soil freezing and thawing, and the retention and transmission of water in cold soils and soils subjected to temperature gradients must be reasonably well understood. Secondly, models which are based on the physical laws governing the basic processes need to be developed for snow accumulation and ablation and for the movement and retention of water in soils.

2. Specific project objectives

a) To develop and test a conceptual model of snow accumulation and ablation process. This model will utilize only data of the type, quantity, and accuracy presently available on an operational basis.

b) To collect the highest possible quality data on the variables affecting energy-exchange across the snow-air interface.

c) To develop and test physcially based techniques for estimating energy-exchange across the snow-air interface. This includes techniques for point and areal applications.

d) To investigate the basic temperature related processes that affect the retention and movement of water in soils.

e) To make improvements, on a continuing basis, to the conceputal model of the snow accumulation and ablation process. These improvements may be based on studies within the Hydrologic Research Laboratory or they may be based on data collected by or studies performed by other hydrologists.

f) To develop a set of guidelines which will estimate forecast accuracy given: 1) the snow cover energy exchange technique, b) the accuracy of point data measurements, 2) data network density, 3) climatic conditions, and 4) physiographic conditions.

g) To develop a conceptual soil-moisture accounting procedure which is applicable to all cold regions. This model must include the modeling of soil freezing and thawing and other temperature dependent soils phenomena which influence the movement and retention of water.

3. Current projects

a) Energy exchange across the snow-air interface at Townline station, Danville, Vermont

The basic objectives of this project are: 1) to measure the variables affecting snow cover energy exchange with the highest possible accuracy, 2) to develop physically based techniques to estimate snow cover energy exchange, and 3) to test the accuracy of the techniques at a point under all possible climatic conditions.

Continuous measurements of meteorological and snow cover variables have been made at Townline station since December 1968. Most of the data have been reduced and checked for accuracy and consistency. A technique has been developed to estimate energy exchange. This technique is based on the combination method (combination of energy balance and aerodynamic equations). The energy exchange technique will soon be tested on the data collected to date.

b) Modeling the snow accumulation and ablation process

The basic objectives of this project are: 1) to develop and test a conceptual model of the snow accumulation and ablation process which utilizes only data presently available on an operational basis, and 2) to develop and test techniques to use a physically based energy exchange estimation technique in the snow model.

A conceptual model which uses air temperature as the sole index to the energy exchange across the snow-air interface has been developed and included in the National Weather Service Forecast System (NWSRFS). The snow model has been tested on western mountain watersheds, a north-central agricultural watershed, and northern New England watersheds.

c) Modeling the freezing and thawing of soil and its effect on infiltration

The basic objectives of this project are: 1) to determine which physical parameters have a significant influence on the freezing, thawing, and infiltration rates of soils, and 2) to fit these parameters into a physical model which will predict the frost depth and type of frost formed.

A model has been developed and programed which estimates the soil moisture profile and the depth and type of frost. Data have been obtained from the Agricultural Research Service station at Coshocton, Ohio, to test the vailidity of the model.

d) Evaluation and development of forecast techniques in subartic areas (Alaska)

The NWS has participated in the establishment and instrumentation of the multi-agency Caribou-Poker Creeks Research Watershed north of Fairbanks. This watershed was established to acquire data on basic climatologic, hydrologic, and environmental relationships for use in model evaluation and development. The NWS has provided a basic data collection system to collect basic hydrological and meteorological information for the watershed.

4. Results

Results from specific projects have been published in the following articles:

Anderson, E. A., and Baker, D. R., "Estimating Incident Terrestrial Radiation Under All Atmospheric Conditions," Water Resources Research, Vol. 3, No. 4, 1967.

Anderson, E. A., "Development and Testing of Snow Pack Energy Balance Equations," Water Resources Research, Vol. 4, No. 1, Feb. 1968.

Anderson, Eric, "Techniques for Predicting Snow Cover Runoff," International Symposia on the Role of Snow and Ice in Hydrology, September 6-13, 1972, Banff, Canada.

Anderson, Eric, "National Weather Service River Forecast System, Snow Accumulation and Ablation Model," NOAA NWS Tech Memo HYDRO 17, U.S. Dept. of Commerce, Silver Spring, Md., Nov. 1973.

Anderson, Eric A., "Conceptual Streamflow Forecasting Model Applied to Northern New England Rivers," Proceedings, 31st Eastern Snow Conference, Feb. 7-8, 1974, Ottawa, Canada.

Peck, E. L., "Effect of Snow Cover on Upward Movement of Soil Moisture," Journal of the Irrigation and Drainage Division, ASCE, Vol. 100, No. IR4, Proc. Paper 10989, Dec. 1974.

5. Future plans for research basin operations

    a) Continue operation of data collection at Danville, Vermont, snowmelt study site to provide information for model evaluation and basin studies.

    b) Continue cooperative operation of Caribou-Poker Creeks Interagency Research Watershed near Fairbanks, Alaska.

B. Hydrometeorological data measurements at the NOAA-ARS Cooperative Snow Research Project for Townline station near Danville, Vermont, U.S.A.

1. Introduction

This outline summary reviews the hydrological and meteorological observations taken at the Townline station, operated by the Office of Hydrology of the National Weather Service, NOAA. Data were collected from December 1958 through April 1969 and from November 1969 to present.

This outline summarizes only the data collected by the NWS; however, additional data on snow cover, precipitation, and streamflow are collected by the Agricultural Research Service (ARS) for the complete watershed. The cooperative data transfer between the ARS and NOAA provides the basis upon which complete hydrological analyses are being made.

2. Station location map

Figures 1 and 2 show the location of Townline station. The station is located within the Sleepers River Reserch Watershed of the ARS, U.S. Dept. of Agriculture, at an elevation of 1812 feet, mean sea level.

3. Data collection

The basic data are observed on either an hourly or daily basis. General meteorological variables (air temperature, dew point, wind, incident radiation, and precipitation) are measured hourly throughout the year. During the period of snow cover, the snow cover, as well as other variables affecting the ablation of the snow cover, is measured. Daily observations are made on each day the observer is at the station. In addition to the basic observations, the observer keeps a daily log, during the winter, on weather conditions, instrumentation checks and failures, and other information that seems pertinent.

4. Measurements of variables

This section discusses briefly each of the variables measured and the techniques that have been developed to insure quality data. It will be noted in this section one of the major features is the use of "back-up" equipment that in essence is a double measurement. This feature in practice is one of the most useful features in insuring quality data. While it is obvious that this feature requires additional investment into the project, the worth of consistent quality data justifies the needs.

The following list of variables are considered to be the basic data requirements necessary for snowmelt research purposes.

a) Air temperature

Primary sensor Yellow Springs Instruments precision thermolinear thermistor mounted in an aspirated radiation shield. Instantaneous values at the end of each hour are recorded on a digital printer.

Secondary sensor is a platinum resistance element in an aspirated radiation shield. Instantaneous values are recorded each 6 minutes on a strip chart recorder.

Back up sensor is a Bematellic strip thermograph in a "cotton region" shelter with a continuous trace. Maximum and minimum liquid in glass thermometers are also located in this shelter and are part of the daily observations.

b) Dew point temperature

Primary sensor, Yellow Springs Instruments precision thermolinear thermistor, is utilized to measure the cavity temperature of a miniature lithium chloride dewcell in an aspirated radiation shield. Instantaneous values at the end of each hour are recorded on a digital printer.

Secondary sensor is a platinum resistance element within a standard lithium chloride dewcell. The cavity temperature of this dewcell is also utilized and it also is located within an aspirated radiation shield. Instantaneous values are recorded every 6 minutes on a strip chart recorder.

Back up sensor is a human hair element of a hydrograph located in a cotton region shelter. Continuous strip charts of relative humidity are maintained for the back-up record. An aspirated psychormeter is also located within this shelter and data are compiled each day for the daily observation record and for calibration of the hydrograph.

c) Wind

Miniature, low threshold (0.75 m.p.h.) three-cup anemometers are utilized at both 1/2 and 1 meter above the ground or snow surface to totalize wind passage. These sensors are utilized as primary measurements and the accumulated wind movement is printed and reset each hour. Values are printed to the nearest 0.1 mile.

NWS F-104 three-cup anemometers are utilized as back-up sensors. Measurements are taken at 1 meter above the ground or snow surface, 6 feet above the ground, and 15 feet above ground. Each anemometer

has a mechanical odometer as well as electrical contacts. The electrical contacts are utilized to count miles and tenths of miles on digital printers which print and reset at the end of each hour.

d) Incident solar radiation

Eppley Laboratory Model 2 precision pyranometers are currently utilized to measure incoming solar radiation. Periodically two sensors are used at the same time for consistency checks against one another and they are periodically calibrated against national standards to insure data quality.

Back-up, or reserve, sensors are Eppley Laboratory 50 junction model A-100 sensors. These older type "bulb" pyranometers have been found to be less accurate; however, as back-up sensors, they serve sufficiently well.

Note: It is important at this point to mention that the collection of data from radiation sensors is dependent upon both the quality of the sensor and the quality of the recorder. The recorders utilized are volt-time integrators to accumulate data hourly for digital printout. The volt-time integrators are separately checked and calibrated for 1 hour every night to insure their precision.

e) Reflected solar radiation

Pyranometers used to measure reflected solar radiation are identical to those used for the measurement of incoming solar radiation.

Extensive tests were performed on one of the Eppley A-100 "bulb" type radiometers and it was found that the inverted calibration factor was 7 percent less than the calibration factor used while the sensor was in the upright position. This has not been experienced with the newer model 2 pyranometers, however.

Recently tests have begun utilizing a filtered solar cell to measure reflected solar radiation from a snow surface. This sensor is shunted in order to linerize the voltage output with radiation and the filter has been added to normalize the wavelength response function since a typical solar cell does not have the same wavelength response as does a typical pyranometer. Further testing is required before any conclusions can be reached.

f) Atmospheric long wave radiation

The Eppley Laboratories Infrared Pyrgeometer is considered to be the primary sensor for the measurement of this variable; however, the KRS-5 dome is not sufficiently protected from weather and will cause the hygroscopic KRS-5 dome itself to oxidize. Once this occurs,

the dome itself tends to heat up and emit radiation causing the instrument to overmeasure. In addition, it is a rather time consuming and detailed task to calibrate the thermopile sensor and adjust the back radiation circuit that is used in conjunction with the sensor output.

Gier and Dunkle type ventilated total hemispherical radiometers have also been utilized to measure this variable; however, they also measure the short wave component which must be subtracted from the output for the determination of the atmospheric long wave radiation. This instrument is affected by wind (especially if blowing perpendicular to the direction of the forced ventilation) and by precipitation that lands on the sensing plate. The forced ventilation does aid in keeping most snow from landing on the plate.

Recently a Swissteco total hemispheric radiation sensor has been installed in hopes some of the problems of both the Gier and Dunkle ventilated flat plate radiometer and Eppley Laboratory pyrgeometer can be eliminated. Our experience with this sensor is limited at this time.

Atmospheric long wave radiation has been estimated by a method suggested by Anderson and Baker (Water Resources Research, Vol. 3, No. 4, 1967). Though this method can have considerable daily scatter, previous tests had shown very little bias. On a monthly basis, estimated radiation was within +1 to -3 percent of observed thus substantiating the previous tests.

g) Snow surface temperature

An infrared thermometer (Barnes Engineering Co. Model IT-3) has been utilized since the beginning of the project to measure snow surface temperature. Originally this variable was recorded on a strip chart recorder; however, when the wind is blowing, there is considerable "painting" of the pen on the chart due to the high sensitivity. This has been corrected by integrating the output and recording the data digitally.

A back-up sensor is a Cooper-Constantan thermocouple placed at or near the snow surface. Two main factors limit the usefulness of these measurements:

1) Radiation causes the thermocouple to heat and thus the measurement is higher than the actual snow surface temperature

2) New snow falling on the sensor covers it and thus it becomes difficult to maintain the sensor at the snow surface.

It is also possible to use the Eppley precision infrared pyrgeometer to estimate snow surface temperature or a ventilated total hemispherical radiometer if they are inverted and facing the snow surface. When using the total hemispherical radiometer, the reflected short wave component must be removed, however.

h) Net radiation

Data have been collected at the Townline station; however, it has been determined that the energy balance components can be more accurately determined if measured independently than if the use of a net radiation were the sole measurement.

i) Precipitation

Data are collected at the snow study site by both a weighing recording precipitation gage and a non-recording precipitation gage. Both gages have free swinging Alter type shields and have been used since the station was established. In addition, special studies have been carried out and these will be described in another portion of this report.

j) Water equivalent of snow

This is determined primarily by the use of snow tubes at Townline station. Most of these measurements have been made with an Adirondack (Green Instrument Co.) snow tube. The Adirondack snow tube has a diameter of 2.655 inches. When the snowcover is either shallow or dry, it is difficult to keep the core in the Adirondack tube and on such occasions a Bowman snow tube has been used instead. The Bowman snow tube is plastic and has a diameter of 1.495 inch.

Snow pillows, 12 feet in diameter, have also been used to determine the water equivalent of snow. Several types of installations have been attempted, including: surface placement; buried under several inches of sand; top surface flush with ground; single bladder pillows; and double bladder pillows (butyl bladder inside with nylon reinforced butyl bladder on the outside). When ice lenses become existent in the snowcover, pillow measurements become erratic. Our experience has shown that snow tube measurements are much better snow pillow measurements.

During the 1971-72 period, heat rings were installed. These rings consist of 5/8-inch O.D. aluminum tubing with heat cord inserted inside. The rings are supported by four guide poles. In their use, the ring is lowered to the snow surface directly above the snow pillow, heat is applied, and the ring is allowed to melt through the snow to the ground. These heat rings melt a narrow slot which separates the snow on the pillow from the surrounding snowcover, thus, breaking any ice lenses which have formed.

Early in the project a twin probe gamma radiation gage was installed to determine snowcover water equivalent. Several problems were encountered in this early design, making the measurements unreliable. Attempts to correct these failed, due primarily to the fact that a fully qualified person was not available to redesign the equipment. Thus, no further measurements have been made since the first winter with this instrument.

Snowcover water equivalent has also been monitored using natural soil radioactivity as a source and either a small gamma scintillation detector or a Geiger Mueller tube as a detector. The water content of the snowcover attenuates the radiation and thus the rate of natural radiation penetrating the soil is inversely proportional to the water equivalent of the snowcover. This is primarily a research project in hopes that an instrument can be developed for remote field installations.

k) Snow depth

Snow depth measurements are made each day during the snow season by reading four each 2-inch by 2-inch white wood stakes which are permanently installed at each corner of the snow pillow area.

l) Snow density

Snow density and surface properties are observed utilizing USA CRREL sampling equipment. Standard 500-cc snow sample tubes are used during the winter to measure the density of the surface layers of the snowcover. This tube is inserted horizontally into the snow as close to the surface as possible. In addition, the size of the snow crystals is measured by putting a small amount of snow on a piece of metal containing a grid. By observing how the crystals cover the grid squares, the crystal size can be estimated.

m) Snow evaporation and condensation

Plastic pans filled with snow have been used to measure evaporation and condensation of snow during each winter. Readings are only recorded for periods when there has been no precipitation or blowing or drifting snow. Two pans have always been exposed during each measuring period, except during the 1971-72 season when one pan of each of three sizes was exposed.

n) Snowcover and soil temperature

Copper-Constantan thermocouples have been used with a multipoint strip chart recorder to measure both snowcover and soil temperatures. The soil thermocouples are located at the surface and 3, 6, 12, 24, and 36 inches below the surface. Snowcover temperatures are located 6, 12, 24, 36, and 48 inches above the soil surface.

o. Snowmelt

The snowcover water equivalent measurements originally were intended for both the determination of changes in water equivalent on a daily basis and the total water equivalent of the snowcover. Considering the difficulties in recording these values from snow pillows, it was decided to install equipment that would measure only snowmelt. Two of the original snow pillows were removed and plywood disks were installed that are circular in shape and slope uniformly to the center. Drainage pipes were installed to carry the melt water away to a small equipment house where tipping buckets are installed to record the rate of melt.

The two melt lysimeters are situated under the heat rod system described earlier in order that only the snowmelt immediately above them is collected. A digital event recorder collects the data, printing once each hour the total amount of melt.

C. Caribou-Poker Creeks Experimental Watershed near Fairbanks, Alaska

The Caribou-Poker Creeks Experimental Watershed is operated by an interagency agreement with a number of federal and state agencies cooperating in the research of hydrologic phenomena in Alaska.

Due to the remote location of the watershed and the extreme environmental conditions, it is not possible to have a technician present at the field station on a daily basis during the winter months. Therefore, a rather elaborate and unique method was employed to monitor the research data from Fairbanks. This method can be described in a simple form as follows: 1) Data sensors are connected to either a primary or secondary device which either measures an instantaneous or time-averaged value; 2) The data are printed for on-site record (only at the primary station); 3) The data are telemetered via FM radio carrier to a repeater station for transmission to the base station in Fairbanks; 4) Finally, all data are recorded at the base station on a teletype printer, as well as punched on paper tape (for later computer reduction).

In addition to the primary and secondary stations, there are several locations where data are on-site recorded and not monitored. These sensors obviously are of a lower priority in the maintenance program and therefore are only visited periodically.

While all the sensors in the Caribou-Poker Creeks Experimental Watershed are calibrated and checked periodically to insure high quality data and the data are checked through the monitor-radio telemetry system for the same purpose, little back-up equipment has as yet been installed. In due time, this will be done, however, and thus will serve a purpose similar to that done at the Townline station near Danville, Vermont.

Instrumentation and measuring techniques performed in the Caribou-Poker Creeks Experimental Watershed are similar in nature to those in use in Vermont. Consequently, only a list of the stations and variables is presented.

The station number can be coordinated with the map of the Caribou-Poker Creeks Experimental Watershed that follows.

II. Precipitation

A. Objectives, results, and future plans

1. General objectives:

   a) The evaluation and improvement of precipitation measurement techniques;

   b) The evaluation of analytical adjustment techniques for point precipitation measurements;

   c) The improvement of mean areal precipitation (MAP) values through the use of alternate techniques;

   d) The evaluation of the effect of improved point and areal precipitation values on hydrologic models

   e) The evaluation of techniques to measure areal average of water equivalent of snow cover by techniques such as airborne gamma surveys.

2. Specific project objectives:

   a) Measurement techniques:

   The basic objectives are to improve point precipitation measurements by investigating improved gage-shield configurations, the importance of site selection, the use of artificial barriers for site improvements, and the adjustment of point precipitation values by analytical techniques.

   b) Areal distribution:

   The basic objective is to provide improved mean basin precipitation estimates for use in a hydrologic model. Of special interest is a detailed study and documentation of the use of the current MAP program. In addition, to investigate the use of meteorological parameters and other pertinent information such as orographic effects to improve MBP estimates.

   c) Remote measurements:

   The measurement of snow cover water equivalent through the use of aerial gamma surveys is intended to improve snowmelt flood forecasts by providing aerial

measurements as opposed to point measurements, reducing expenses while maintaining desired accuracies, and providing a quick response capability. Investigation will continue into utilizing ground gamma measurements for determining snow cover water equivalent. This would extend the water equivalent data base to include remote inaccessible sites and intermediate elevation sites not feasible to be included in regular snow survey networks.

3. Results:

Results from specific projects have been published in the following articles:

Bissell, Vernon C., and Peck, Eugene L., "Monitoring Snow Water Equivalent Using Natural Soil Radioactivity," Vol. 9, No. 4, Water Resources Research, 1973.

Bissell, V. C., and Peck, E. L., "Measurement of Snow at a Remote Site: Natural Radioactivity Technique," Advanced Concepts and Techniques in the Study of Snow and Ice Resources, National Academy of Science, December 2-6, 1973, Monterey, Calif.

Bissell, Vernon C., "Natural Gamma Spectral Peak Method for Snow Measurement from Aircraft," Advanced Concepts and Techniques in the Study of Snow and Ice Resources, National Academy of Science, December 2-6, 1973, Monterey, Calif.

Larson, Lee W., "Approaches to Measuring 'True' Snowfall," Proceedings, Eastern Snow Conference, February 3-4, 1972, Oswego, New York.

Larson, Lee W., "An Application of the Dual-Gage Approach for Calculating 'True' Solid Precipitation," presented at the Fifty-Third Annual Meeting of the American Geophysical Union, April 17-21, 1972, Washington, D.C.

Larson, L. W., and Peck, E. L., "Accuracy of Precipitation Measurements for Hydrologic Modeling," Water Resources Research, Vol. 10, No. 4, August 1974.

Peck, Eugene L., "Review of Methods of Measuring Snow Cover, Snowmelt, and Streamflow Under Winter Conditions," International Symposia on the Role of Snow and Ice in Hydrology, September 6-13, 1972, Banff, Canada.

Peck, Eugene L., "Discussion of Problems in Measuring Precipitation in Mountainous Areas," Distribution of Precipitation in Mountainous Areas, Geilo, Norway, August 1972, Vol. I, WMO/OMM No. 326, Geneva, Switzerland, 1973.

Peck, Eugene L., "Relation of Orographic Winter Precipitation Patterns to Meteorological Parameters," Distribution of Precipitation in Mountainous Areas, Geilo, Norway, August 1972, Vol. II, Technical Papers, WMO/OMM No. 326, Geneva, Switzerland.

Peck, Eugene L., Larson, Lee W., and Wilson, James W., "Lake Ontario Snowfall Observational Network for Calibrating Radar Measurements," Advanced Concepts and Techniques in the Study of Snow and Ice Resources, National Academy of Science, December 2-6, 1973, Monterey, Calif.

Peck, Eugene L., "Snow Measurement Predicament," Water Resources Research, Vol. 8, No. 1, February 1972.

Peck, E. E., and Bissell, V. C., "Aerial Measurement of Snow Water Equivalent by Terrestrial Radiation Survey," Bulletin, International Association of Hydro Sciences, Vol. XVIII, No. 1, March 1973.

4. Future plans

a) The establishment of improved point precipitation measurement facilities in calibrated watersheds to evaluate their effect on hydrologic models.

b) The establishment and/or operation of networks to provide information on improving mean basin precipitation and to relate storm characteristics with physical and meteorological parameters.

c) The investigation of statistical properties of precipitation and precipitation measurements that have an important effect on hydrologic modeling.

d) The evaluation of the entire current concept of point measurements of precipitation, areal estimates of precipitation, and their input to hydrologic models with the thought of perhaps utilizing entirely new concepts to replace the total program.

B. Measurements in northern research basins

1. Instruments used:

   a) Weighing-recording gages, heated tipping bucket gages, overflow gages are being tested in Vermont and Wyoming.

   b) Wyoming shields and improved alter shields are being tested in Wyoming in addition to a WMO gage comparison program.

2. Techniques and accuracy

   Gage accuracy for several configurations have been tested at Vermont, Wyoming, and Utah. Profile techniques utilized at Vermont. Dual-gage techniques are being tested at Vermont and Wyoming.

3. Corrections

   Precipitation correction factors for hydrologic modeling have been investigated by utilizing the National Weather Service River Forecast System.

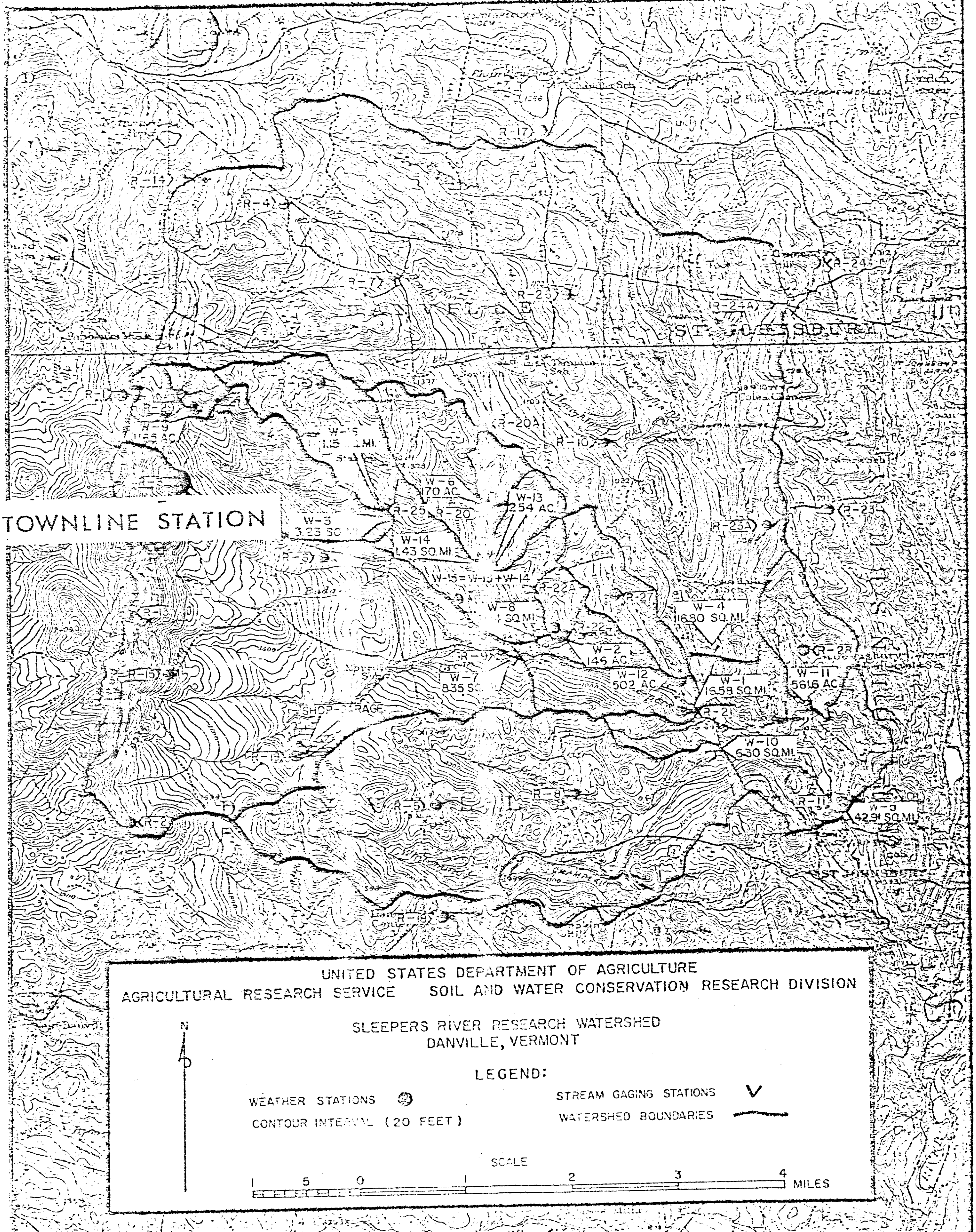
TOWNLINE STATION
UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE SOIL AND WATER CONSERVATION RESEARCH DIVISION
SLEEPERS RIVER RESEARCH WATERSHED
DANVILLE, VERMONT
LEGEND:
WEATHER STATIONS
CONTOUR INTERVAL (20 FEET)
STREAM GAGING STATIONS
WATERSHED BOUNDARIES
SCALE
MILES
N
R-17
R-14
R-4
R-7
R-24A
R-20A
R-10
W-9
W-6
170 AC.
W-13
254 AC.
R-25
R-20
W-3
W-14
1.43 SQ.MI.
W-15=W-13+W-14
R-22A
R-27
W-4
116.50 SQ.MI.
W-8
R-22
W-2
146 AC.
W-12
502 AC.
W-1
W-11
561.6 AC.
W-7
SHOP-GARAGE
R-21
W-10
6.30 SQ.MI.
R-8
R-11
W-5
42.91 SQ.MI.

FIGURE 1

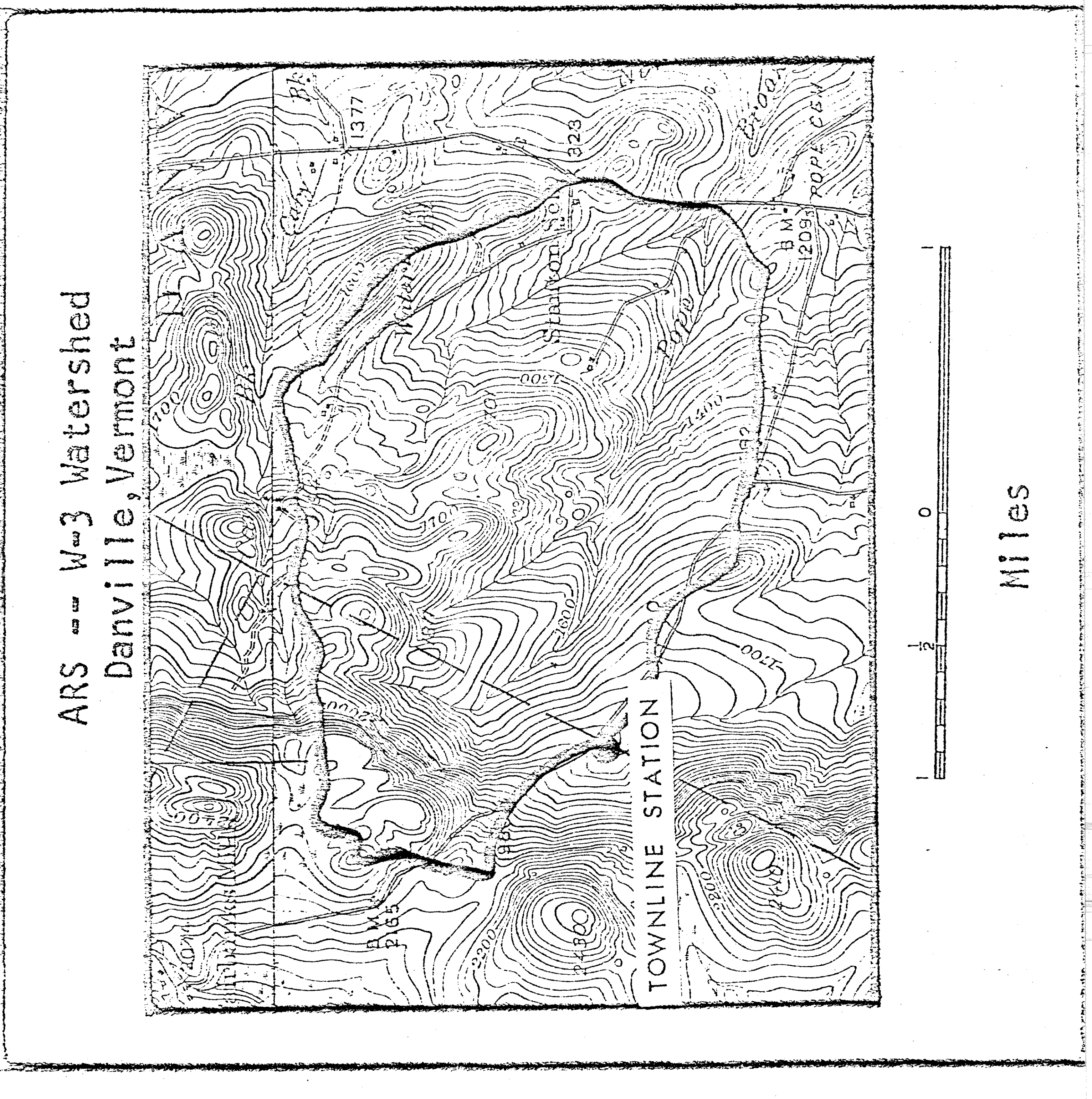

FIGURE 2

CARIBOU-POKER CREEKS EXPERIMENTAL WATERSHED INSTRUMENTATION

<u>Station</u>

1 Monitor Lab data logger (telemetered)--PRIMARY
- Wind speed (3 elevations)
- Air temperature (3 elevations)
- Dew point
- Solar radiation (incoming & reflected)
- *Streamflow (pending)

Other systems
- Precipitation--tipping bucket, heated
- Precipitation--non-recording
- Wind speed and direction (Aerovane)
- Water temperature
- Solar radiation (incoming)
- Soil temperature
  - thermister (Datel system)
  - thermocouple (strip chart system)
- Water quality on both Caribou and Poker Creeks

2 DARDC (telemetered)--SECONDARY
- Fischer/Porter precipitation
- *Air temperature (pending)

3 DARDC (telemetered)--SECONDARY
- Fischer/Porter precipitation
- *Air temperature (pending)

4 DARDC (telemetered)--SECONDARY [REPEATER]
- Wind only system
- *Air temperature

Long-term precipitation (Leopold-Stevens A-35)
- Air temperature

5 *DARDC (telemetered)--SECONDARY
- *Fischer/Porter precipitation
- *Air temperature

6 12-inch weighing precipitation

Snow pillow

Stream gage (U.S.G.S.)

MRI mechanical weather station
- Wind speed
- Wind direction
- Air temperature

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*Anticipated summer 1975.

7 MRI mechanical weather station
- Wind speed
- Wind direction
- Air temperature

Non-recording precipitation

8 12-inch weighing precipitation

9 Long-term precipitation (Leopold-Stevens A-35)
- Air temperature

10 *Data logger (cassette tape, pending)
- 12-inch weighing precipitation
- Air temperature
- Water temperature (2 streams)
- Soil temperature
- *Dew point (pending)
- *Streamflow (2 streams, pending)
- *Wind direction (pending)

11 Long-term precipitation (Leopold-Stevens A-35)
- Air temperature

12 12-inch weighing precipitation (cassette tape, pending)

13 DARDC (telemetered)--SECONDARY
- Fischer/Porter precipitation
- *Air temperature

14 Long-term precipitation (Leopold-Stevens A-35)
- Air temperature

15 Streamflow (U.S.G.S.)

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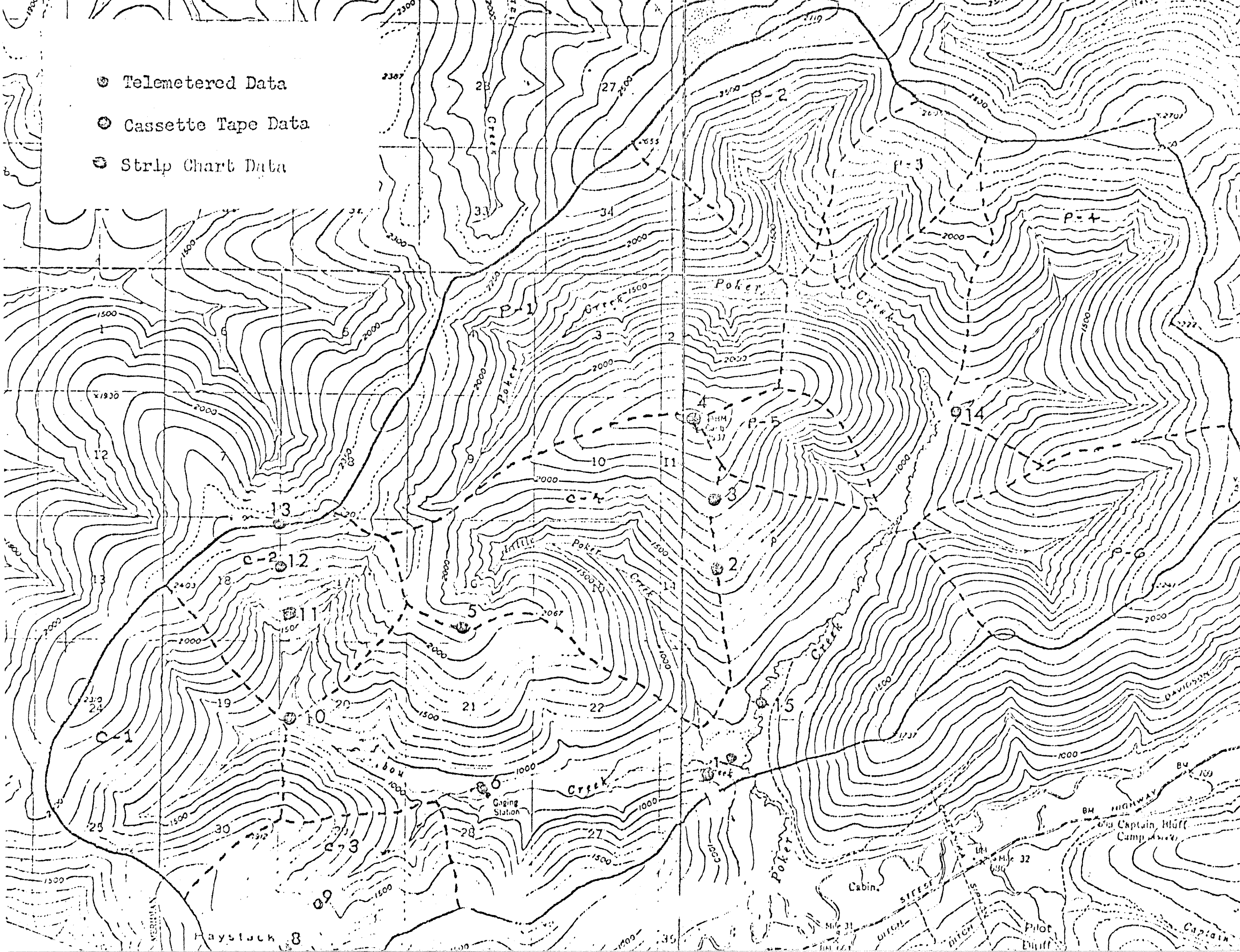
*Anticipated summer 1975.


Telemetered Data
Cassette Tape Data
Strip Chart Data
P-1
P-2
P-3
P-4
P-5
P-6
C-1
C-2
C-3
C-4
Poker Creek
Little Poker Creek
Caribou Creek
Gaging Station
Haystack
Cabin
Steese Highway
Captain Bluff
Pilot Bluff
Mile 32
Mile 31
Davidson Ditch