1979 A0006174

SPH WINDFIELDS FOR THE NEW ORLEANS, LA. AREA

NATIONAL WEATHER SERVICE

LMVED-WH (OCE 28 Nov 78) 1st Ind
SUBJECT: Standard Project Hurricane (SPH) Wind Fields for the New Orleans, Louisiana, Area

DA, Lower Mississippi Valley Division, Corps of Engineers, Vicksburg, Miss. 39180 6 DEC 78

TO: District Engineer, New Orleans, ATTN: LMNED-HD

Inclosed for your use is a copy of subject study provided by Hydrometeorological Branch, National Weather Service.

FOR THE DIVISION ENGINEER:

1 Incl
nc

R. H. RESTA
Chief, Engineering Division

ED-W

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314

REPLY TO
ATTENTION OF:

DAEN-CWE-HY

28 November 1978

SUBJECT: Standard Project Hurricane (SPH) Wind Fields for the New Orleans, Louisiana, Area

Division Engineer, Lower Mississippi Valley (LMVED)

Inclosed for your retention and use is a copy of a study giving SPH wind fields for the New Orleans area as requested by the New Orleans District. The study was made by the Hydrometeorological Branch, National Weather Service. A copy of the report is being retained in OCE.

FOR THE CHIEF OF ENGINEERS:

1 Incl
as

for Jacob H. Douma
HOMER B. WILLIS
Chief, Engineering Division
Directorate of Civil Works

STANDARD PROJECT HURRICANE WIND FIELDS FOR THE NEW ORLEANS, LA., AREA

Francis P. Ho

Hydrometeorological Branch
Office of Hydrology
NOAA, National Weather Service
Silver Spring, Md.

November 1978

1. Introduction

A letter from the New Orleans District, Corps of Engineers [1] requested that the Hydrometeorological Branch determine Standard Project Hurricane (SPH) wind fields for the New Orleans, La., area. Time and cost estimates were furnished the Office of the Chief, Corps of Engineers, April 12, 1978 [2]. Authorization to conduct the study was received August 24, 1978. **From consideration of topographic and oceanographic factors, the District has selected two critical tracks for the SPH.** They **have also specified through telephone conversations that the slowest forward speed of the hurricane and the largest radius to maximum wind should be used for both sets of wind fields.**

The memorandum from the Hydrometeorological Branch [2] spells out in more detail how the study will be undertaken. It was agreed that the latest SPH criteria [3] would be used as the primary basis for the study. This is presently being edited prior to publication. We henceforth will refer to this soon-to-be-published report as the 1979 SPH.

In brief, the 1979 SPH sets the level or range of values of meteorological parameters important to extreme wind fields. Following after the definition of the SPH "...a steady state hurricane having a severe combination of values of meteorological parameters, that will give high sustained wind speeds that are reasonably characteristic of a specified coastal location" [3] only a few record hurricanes have had values of parameters that exceed the SPH. The 1979 SPH makes use of all noted hurricanes along the gulf and Atlantic coast and pertinent studies to date as well as typhoon data from the western north Pacific as guidance in setting values of the SPH parameters. The 1979 SPH criteria includes probable maximum hurricane criteria. Development of the two criteria simultaneously brought additional insight and control to setting the level of parameters for each. The 1979 SPH sets values of the parameters primarily for the open ocean adjacent to a generalized coastline. Thus, the effects of small bays, estuaries, capes, and coastal indentations are not included in the generalized regional portrayal of SPH parameter values.

Some general procedures are given in the 1979 SPH based on earlier storm data as summarized [4, 5] and recent data and studies for setting reductions to the open water SPH wind field as the storm approaches and encroaches on the shore and moves inland. These procedures are used in the present study along with changes brought about from analysis of observed winds in record storms crossing inland from the Gulf of Mexico in the vicinity of New Orleans.

An additional adjustment to overwater winds is made because of filling of or increase in the storm central pressure after the storm moves inland. The present study uses such adjustments given in the 1979 SPH.

2. Overwater SPH Wind Field in Vicinity of New Orleans

Meteorological parameters needed to construct an overwater SPH wind field and their values or ranges in values from the 1979 SPH for off the coast near New Orleans are listed in table 1. **Figure 1 shows the two tracks of the SPH selected by the New Orleans District.**

Table 1.--Values of Meteorological Parameters for the SPH [3] in the Vicinity of New Orleans.

Parameter	Value or range in values	Selected values
Central pressure (p_o)	27.29 in.	**27.29 in.**
Peripheral pressure (p_w)	29.77 in.	**29.77 in.**
Radius of maximum winds (R)	7 to 29 n.mi.	**29 n.mi.**
Speed of storm motion (T)	4 to 25 kt	**4 kt**
Direction of storm motion (θ)*	120° to 240°	Within allowable limits (see figure 1)∇

*Direction from which the hurricane is coming, measured clockwise from north.

∇The 1979 SPH criteria specifies a steady state hurricane. This assumes a constant track direction. The tracks specified by the New Orleans District are monotonically curved tracks. Such tracks are reasonable for this northern portion of the Gulf coast even though they depart from the 1979 SPH.

The steps used in the 1979 SPH were followed to arrive at the overwater wind field having the specifications of this study. These include applying a standardized wind profile from the storm center outward and adjusting the isotachs of a stationary storm for asymmetry due to the forward motion of the storm.

Figure 2 gives the isotachs for the specified overwater wind field. There is no significant difference in the overwater wind field for the two storm tracks. Figure 3 gives stream lines. The direction of wind at any point is given by a line tangent to the stream line at that point.

3. Adjustment of Overwater Winds for Friction Near and On Shore

The rougher the terrain, the more the over water wind speed will be reduced due to friction as the storm approaches the coast.

In the present study we make use of available wind observations for the more recent severe storms that passed inland near New Orleans in order to make modifications, if any, to the 1979 SPH generalized adjustment factors near and on shore because of the specific terrain features in the New Orleans area.

3.1 Terrain Classification

A first step is to classify terrain in accordance with the degree of roughness. For the New Orleans area we classified as follows: a) Lake surface: self explanatory, b) Lowlands: includes areas with brush-wood, marsh, and swamps as shown on USGS quadrangle maps. Some, but not all of the terrain in this category could be inundated for a particular passage of an SPH storm; c) Land: includes populated areas and ground elevation higher than 15 feet, north of Lake Pontchartrain and inland from the gulf coast east of the Lake, and d) "rough terrain" for the New Orleans metropolitan area. Figure 4 shows the New Orleans region categorized by this system.

Our classification differs somewhat from the generalized scheme used in the 1979 SPH study. There, an "awash" category is used (inundated land during a storm passage). Our "Lowland" category is used here rather than "awash" since the terrain so designated is marshy and surge inundation would not change the frictional effect.

3.2 Wind Data in the New Orleans Area

Available surface wind records observed at stations in the New Orleans area and in the southern portion of the Mississippi River Delta during the passage of hurricane Camille of 1969, hurricane Betsy of September 1965, and the hurricane of September 1947 were compared to determine frictional effects. The winds were first normalized by a) subtracting the wind component due to the storm's forward motion, and b) adjusting to a 30-ft level by using the seventh power law. The fact that the stations would be in a different part of the hurricane wind field at a particular time was taken into account by constructing profiles of speed against the radial distance from the storm center. Stations providing wind data are shown in figure 4.

3.3 Camille 1969

Winds at Southwest Pass (on the end of the Delta) were considered most representative of over water winds. These were compared with an average smooth curve of winds at Boothville and Point Sulphur, considered representative of "lowland." Figure 5 gives the smooth curve of wind speed vs. distance. Curve B (Camille), figure 6, shows the ratio of "over lowland" to "overwater" wind.

Similar plots were made of wind speed vs. distance from storm center for Lake Front Airport, International Airport, Naval Air Station (NAS) and West End. From smooth analysis of Lake Front Airport winds, ratios were computed of winds here to those at Southwest Pass. This was restricted to times with northerly winds such that the ratios are considered representative of "over lake" to "overwater" winds. This set of ratios is shown as curve A (Camille) in figure 6. An average smooth wind speed curve for International Airport, NAS, and West End was determined. Values from this average curve were compared to those for Southwest Pass resulting in ratios of "overland" to "overwater" winds. This set of ratios is shown as curve C (Camille) in figure 6.

3.4 Betsy 1965, and the 1947 Hurricane

There were sufficient data in these storms to compare "overland" winds with "overwater" winds in the same manner as in Camille. The resulting smooth ratio curves are so labeled in figure 6.

3.5 Adopted Frictional Adjustments

Figure 7 shows the adopted curves giving adjustment ratios for the terrain categories in the New Orleans area. Curve A (overlake/overwater) and curve B (over lowland/overwater) are the same as curve A and B of figure 6. Curve C (overland/overwater) is the same as that used for "land" classification in the 1979 SPH. It differs only slightly from curve C (Camille) in figure 6. Curve D of figure 7 gives the frictional adjustments for the New Orleans metropolitan area.

Curve A can be used for adjustment of over-water wind speeds to wind speeds over Lake Pontchartrain and Lake Borgne. Curve B is applicable to lowland areas as defined.

In this study, areas to the north of Lake Pontchartrain and areas inland from the gulf coast to the east of the lake are classified under the same general classification of "land." This is assuming that the terrain is uniform inland. There is no attempt to distinguish the various degrees of roughness over the higher ground in the area. This approximation is permissible for our specific task because of the small effect of overland wind speed on the generation of peak surges on the open coast or on the lake shore.

A comparison of daily average wind speeds at the New Orleans National Weather Service (Weather Bureau), city office, and at the International Airport [6] reveals that the wind speeds at the city office were consistently lower than the speeds at the airport (about 0.6 of the airport speed). During the September 1947 hurricane the winds at the city office were about 50% of those at Huey Long Bridge. Such decreases in winds is the basis for the "rough terrain" friction category of the 1979 SPH. This frictional reduction is curve D of figure 7.

Overwater winds reaching the coast are reduced immediately due to friction. In the present study we have used the frictional reduction factor of 0.95 for awash for the "lowland" surfaces and 0.89 for "land" surfaces. These adjustments are those in the 1979 SPH. Winds going from lowland or land to overwater were adjusted back to overwater winds within 10 miles out to sea from the coast.

3.6 Wind Direction

The wind direction for the overwater wind field, obtained from the stream lines of figure 3, comes from the 1979 SPH. However, when the wind field encroaches on land, the rougher the terrain, the more the wind will blow towards the storm center. We recommend that for over "lowland" and over "land" areas, the angle towards the center be increased by 5 and 10 degrees, respectively. These inflow angle increases are incorporated in the determined wind fields.

4. Adjustment for Filling When the SPH is Overland

The hurricane begins to fill (the central pressure increases) after crossing from sea to land and the wind decreases. In the 1979 SPH criteria, adjustments that vary with region are given for estimating the decrease of the wind speed. The filling rate for hurricanes over the gulf coast is higher than that of hurricanes over the Florida peninsula because a greater portion of the storm's circulation remains overwater in the latter cases. The Mississippi River Delta and its vicinity south of New Orleans also has a peninsular shape. Therefore, we adopt the 1979 SPH filling rate of the Florida peninsula for the western track after it crossed the coast east of Port Sulphur (figure 1). No reduction was applied along the eastern track as it crossed the southern tip of the Delta where the land would be inundated as the hurricane approaches.

5. SPH Wind Fields for New Orleans Areas

The conclusions and discussions of the foregoing sections are the basis for the SPH wind fields of this study.

Figure 8 to 15 show these wind fields for the eastern track when the storm's center is located at the numbered points on the track in figure 1. Figures 16 to 23 show the wind fields for the numbered points shown on the western track of figure 1.

Wind directions are shown by arrow on the maps. Because of the spiraling characteristic of the wind, direction is correct only at the point indicated by the dot on the arrow. To obtain more directions, superimpose figure 3 on the map of concern with the storm centers and lines indicating the storm's forward motion falling on top of each other. The direction is then read from figure 3. Adjustments need to be made when the wind is not overwater (para. 3.6).

Should winds be required for positions between those given, they can be interpolated.

References

1. Letter LMNED-HD, dated March 17, 1978 from New Orleans District, Corps of Engineers, to U.S. Department of Commerce, Hydrometeorological Branch.

2. Memorandum from the Hydrometeorological Branch to Corps of Engineers, dated April 12, 1978, "Request from the New Orleans District for Standard Project Hurricane (SPH) Wind Field Critical to New Orleans, La."

3. Schwerdt, R. W., F. P. Ho and R. Watkins: "Meteorological Criteria for Standard Project Hurricane and Probable Maximum Hurricane Wind Fields, Gulf and East Coasts of the United States." (in preparation)

4. Graham, H. E., and D. E. Nunn, 1959: "Meteorological Considerations Pertinent to Standard Project Hurricane, Atlantic and Gulf Coasts of the United States." National Hurricane Research Project Report No. 33, U.S. Weather Bureau, Department of Commerce, Washington, D.C.

5. National Weather Service, 1972: "Revised Standard Project Hurricane Criteria for the Atlantic and Gulf Coasts of the United States." Memorandum HUR 7-120, U.S. Department of Commerce, NOAA, Silver Spring, Md. (unpublished).

6. Graham, H. E., and G. N. Hudson, 1962: "Surface Winds Near the Center of Hurricanes and Other Cyclones." National Hurricane Research Project Report No. 39, U.S. Weather Bureau, Department of Commerce, Washington, D. C.

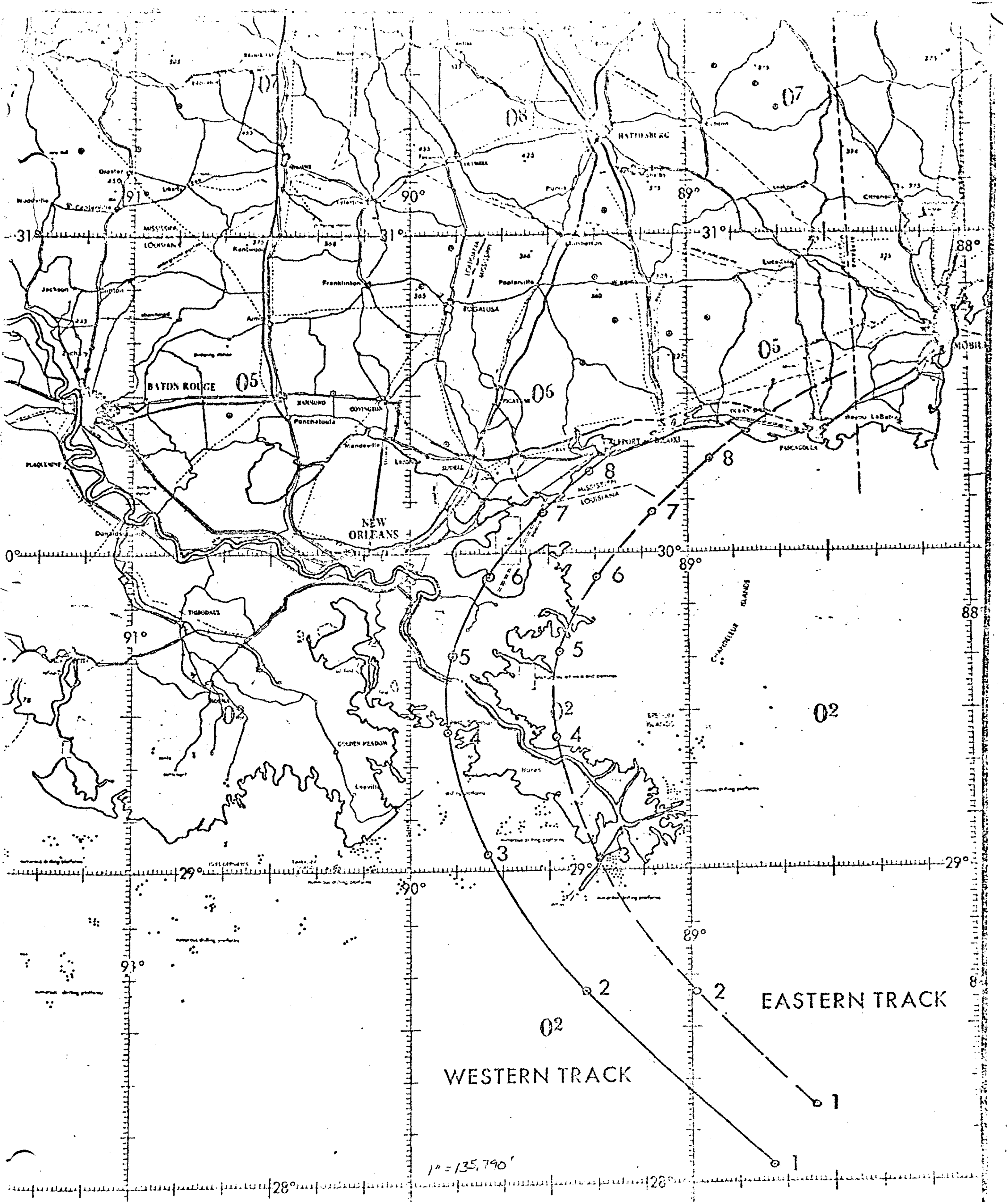


Figure 1.--Designated storm tracks. Numbers on tracks designate positions for which wind fields are given.

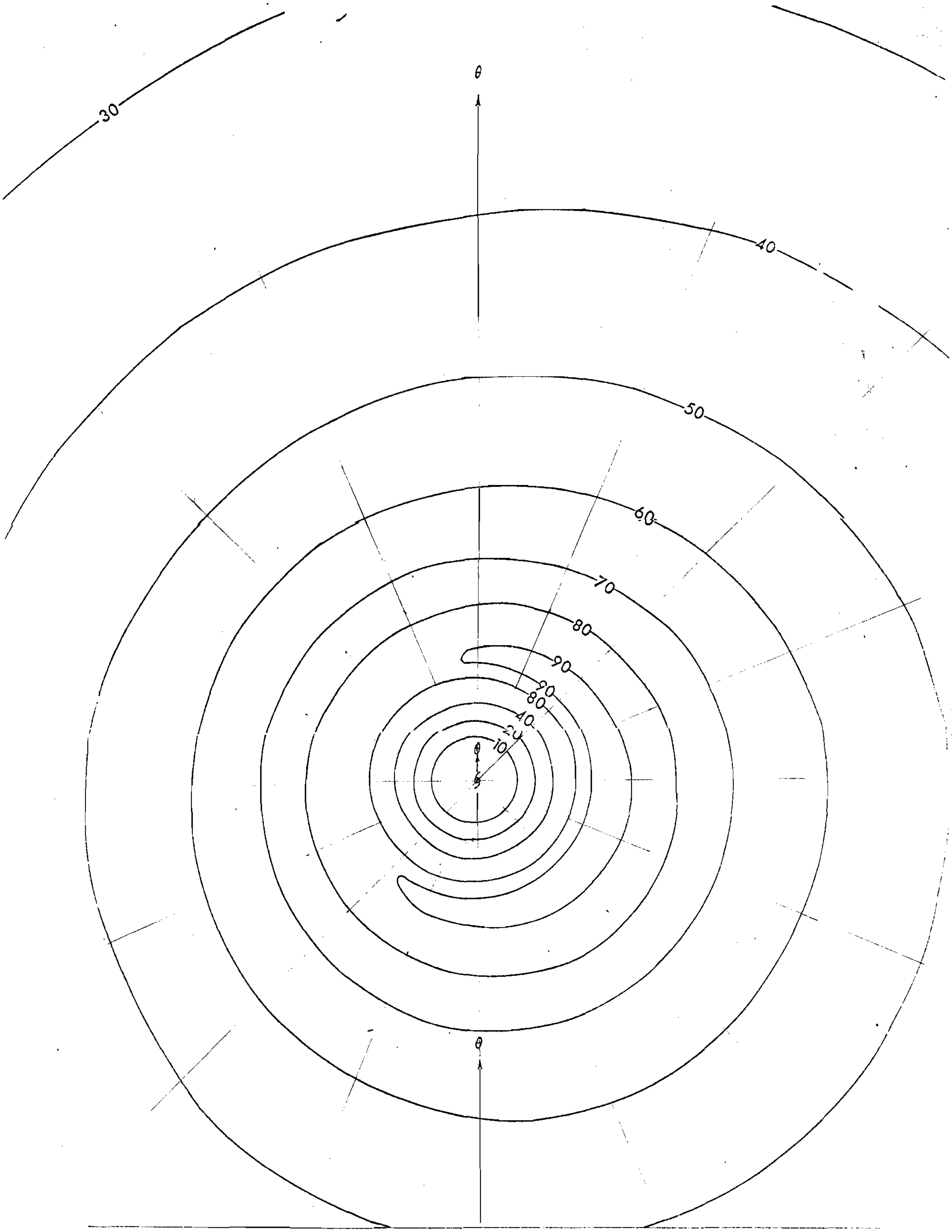


Figure 2.--Overwater SPH wind field isotachs (kts). Arrow indicates direction of storm motion (θ). Same scale as figure 1.

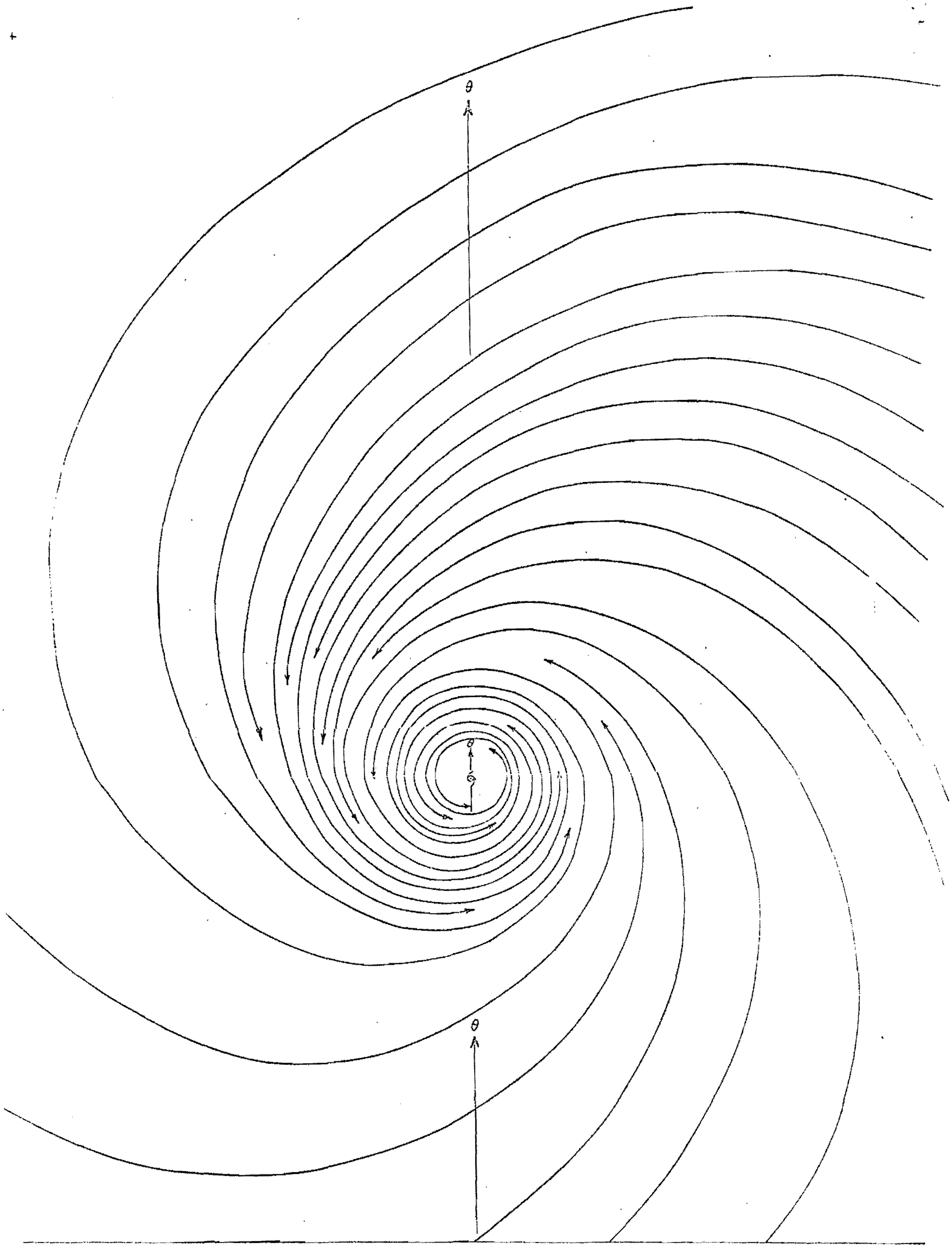
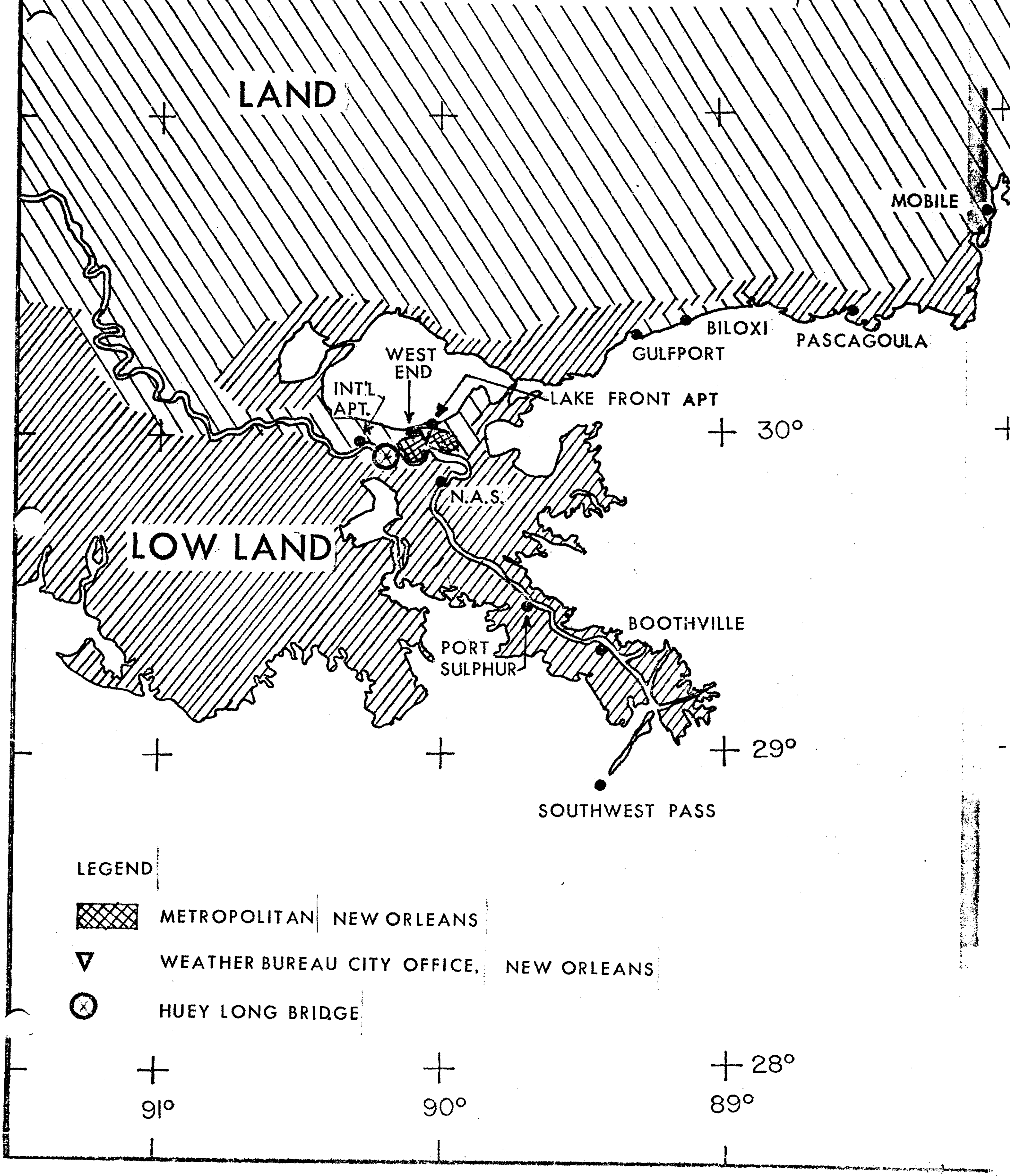


Figure 3.--Stream lines of wind directions for the designated overwater SPH. Arrow indicates direction of storm motion (θ).

Figure 4.--Classification of terrain in New Orleans area.



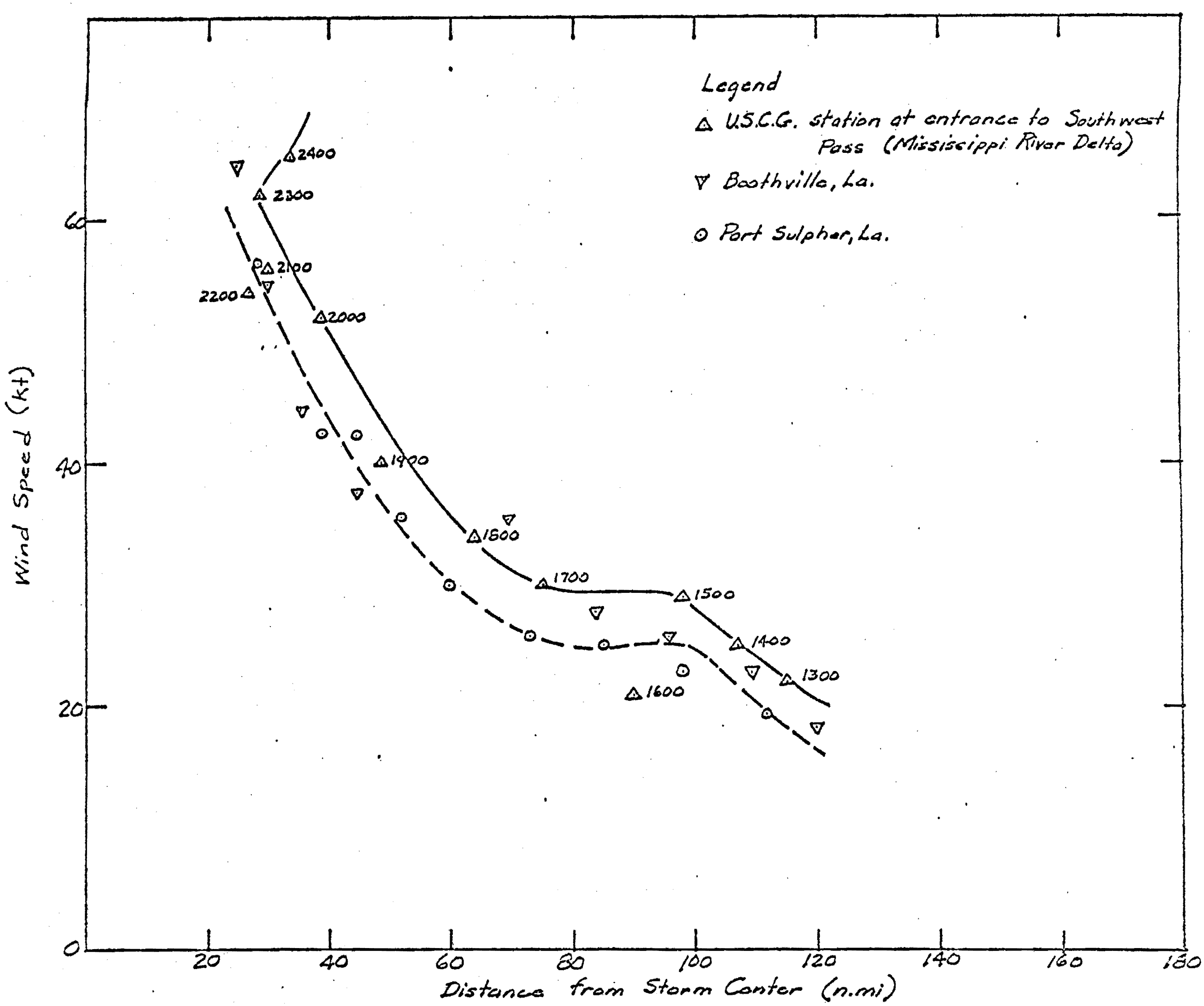


Figure 5.--Observed and analyzed wind speed for Camille, 1969.

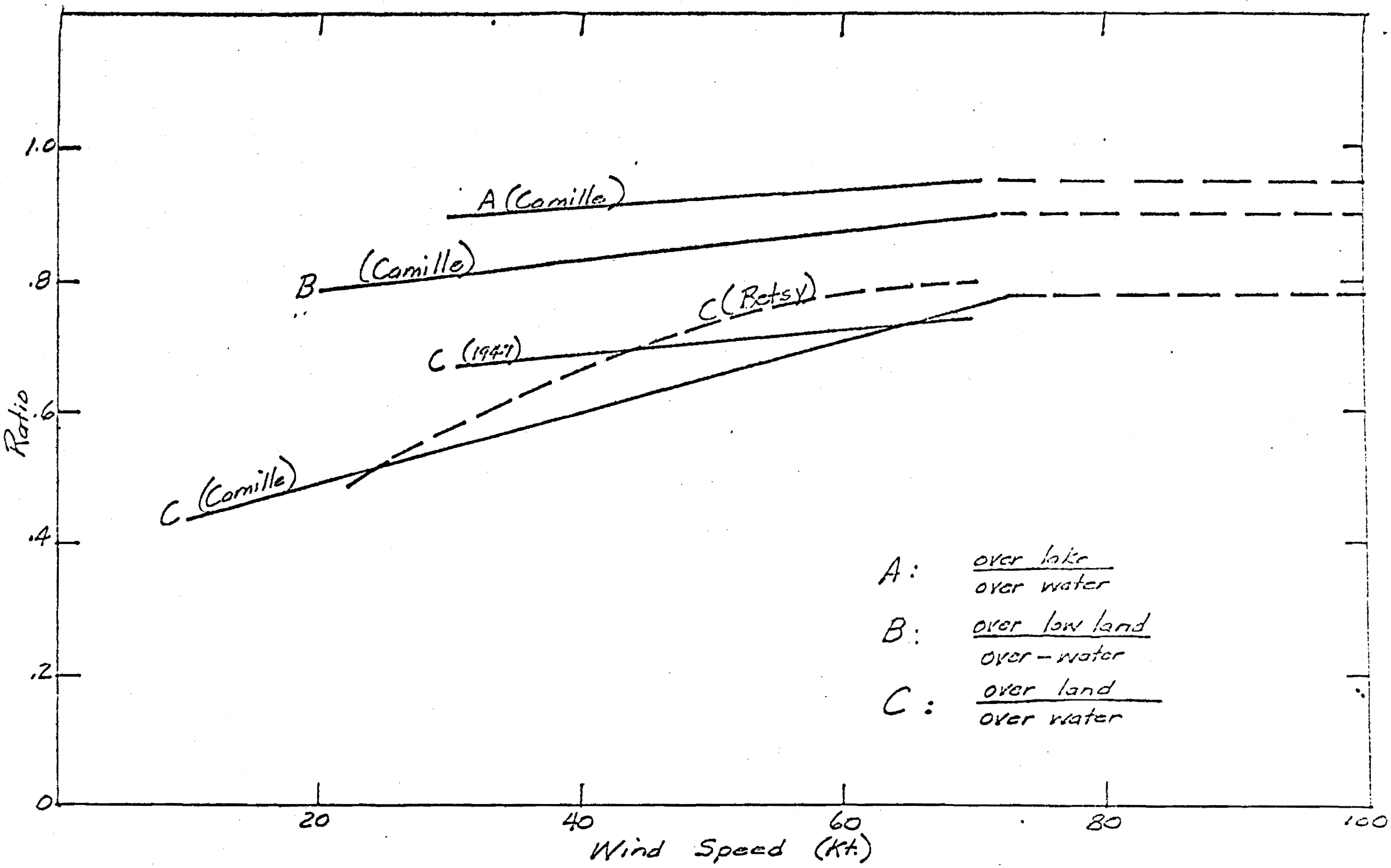


Figure 6.--Smoothed ratios of wind speeds for Camille (1969), Betsy (1965) and 1947 hurricane.

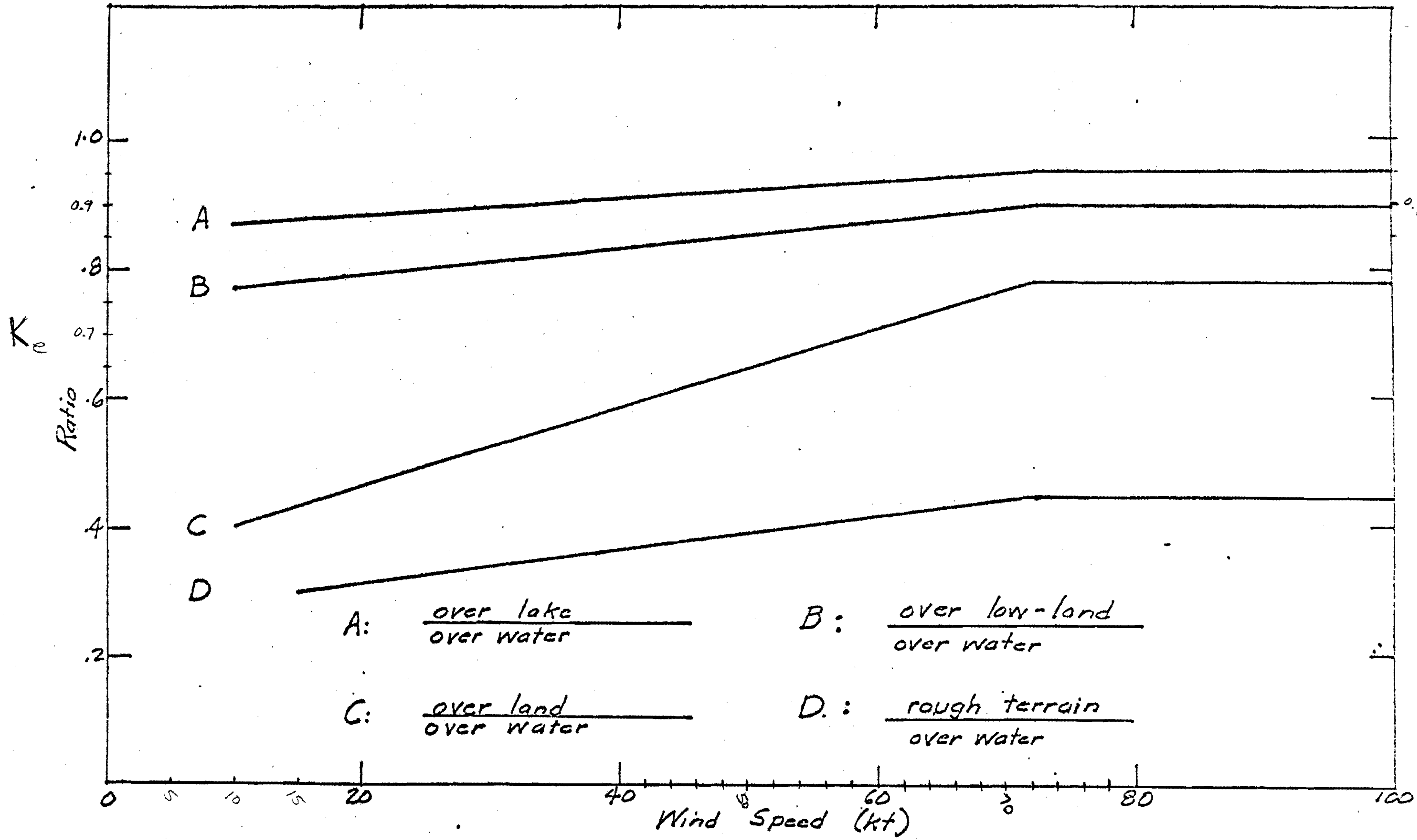


Figure 7.--Adopted wind speed ratios.

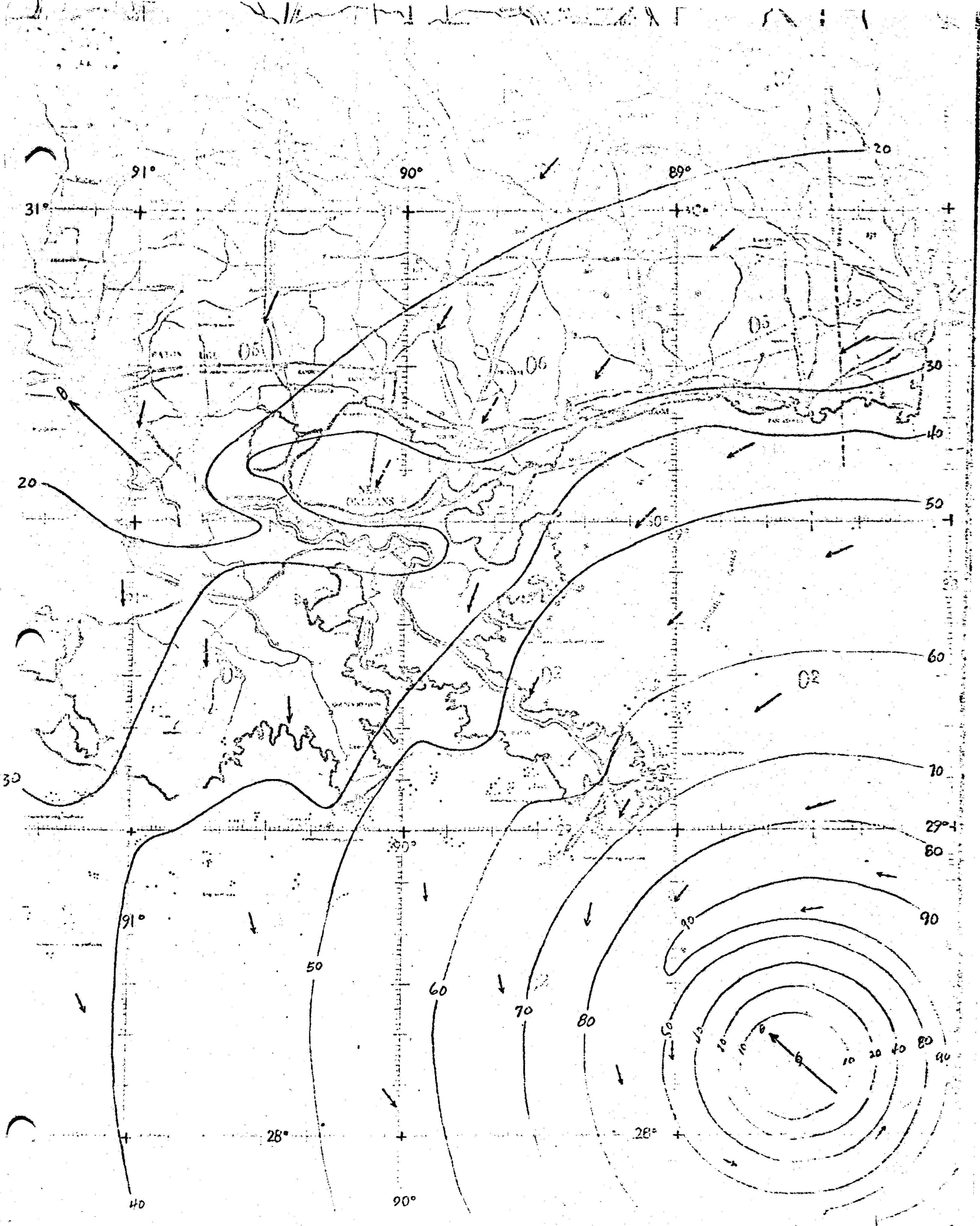


Figure 8.--SPH wind field for the eastern track; centered at location 1 (fig. 1).

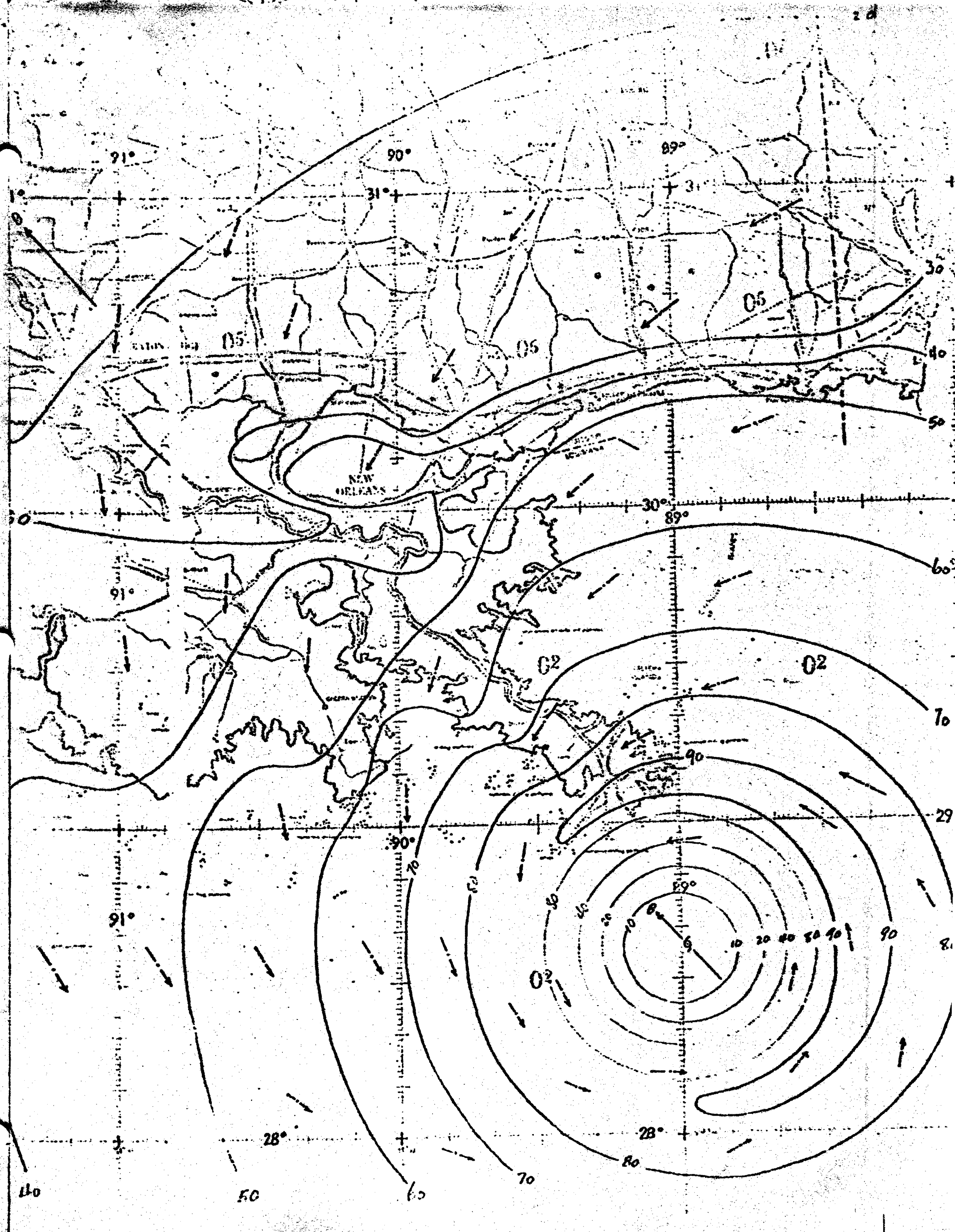


Figure 9.—SPH wind field for the eastern track, centered at location 2 (fig. 1).

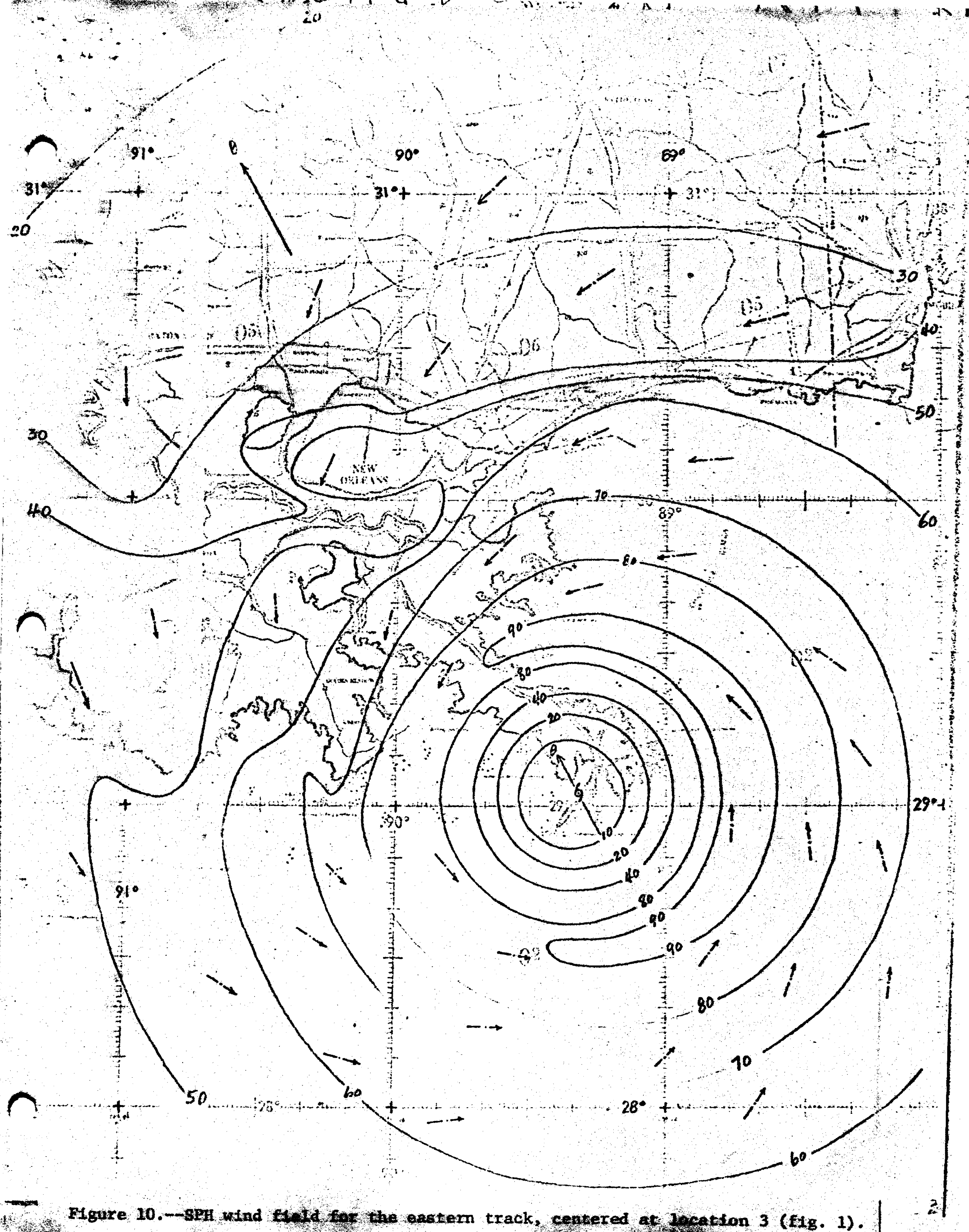


Figure 10.--SPH wind field for the eastern track, centered at location 3 (fig. 1).

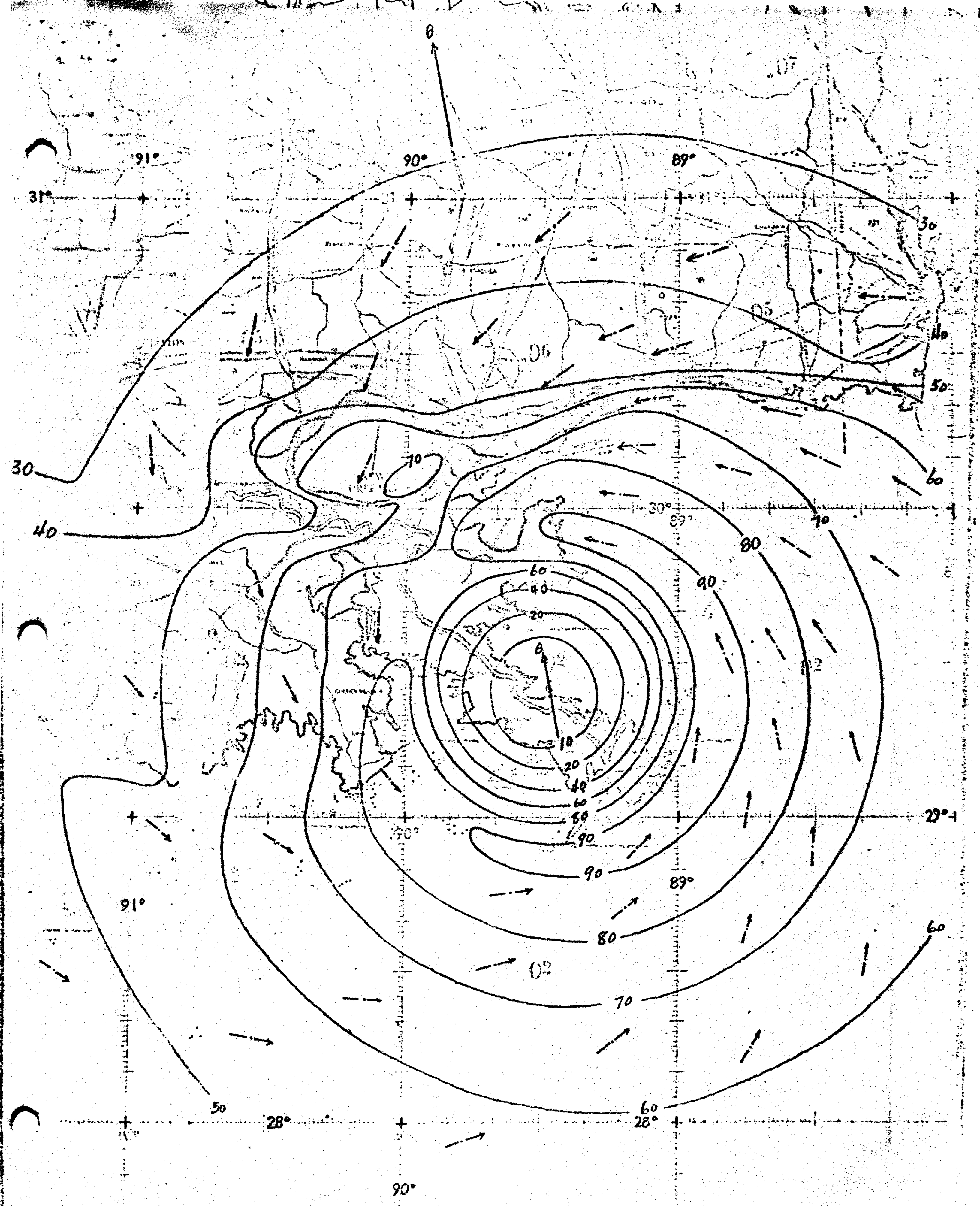


Figure 11.--SPH wind field for the eastern track; centered at location 4 (fig. 1).

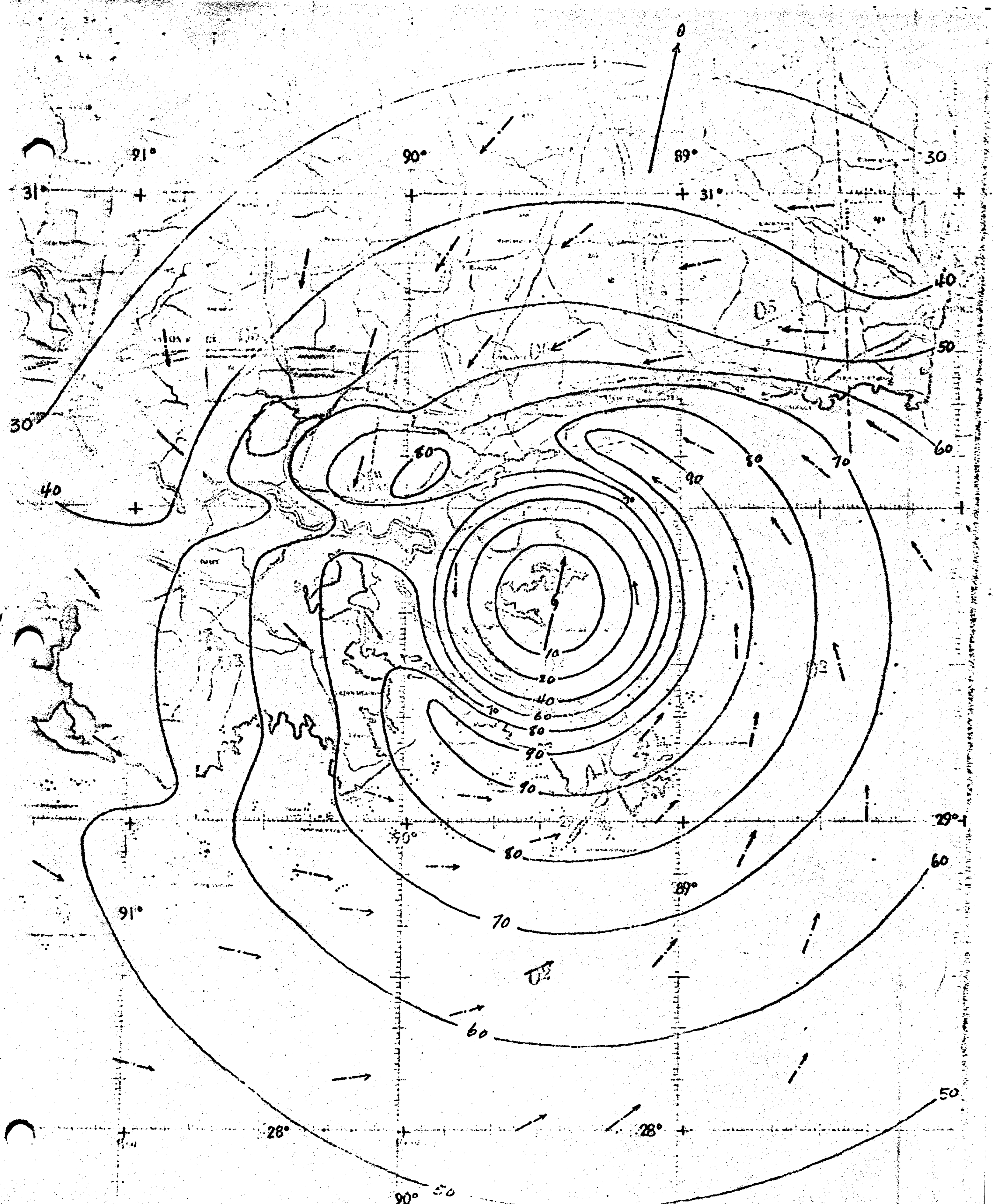


Figure 12.--SPH wind field for the eastern track; centered at location 5 (fig. 1).

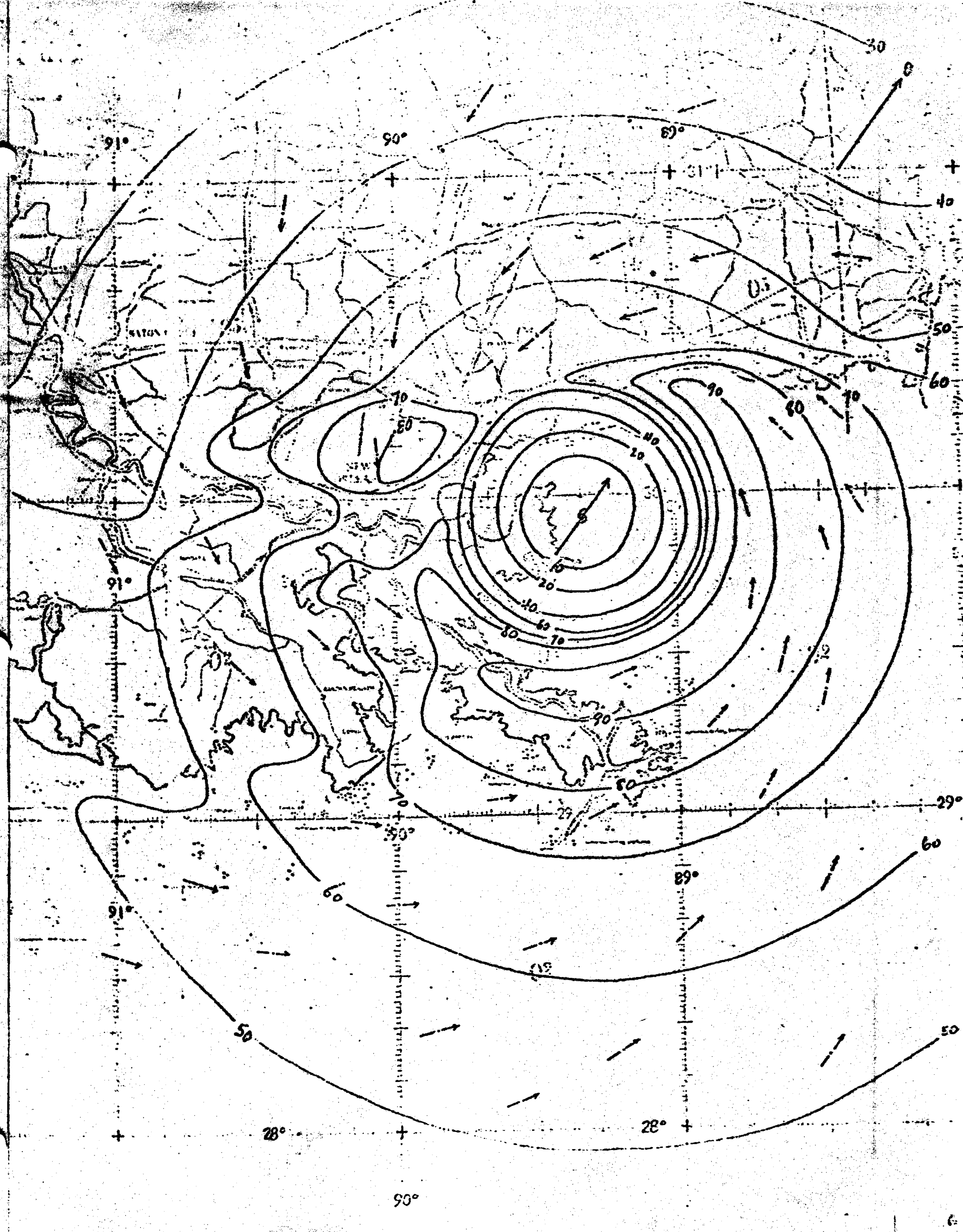


Figure 13.—SPH wind field for eastern track, centered at location 6 (fig. 1).

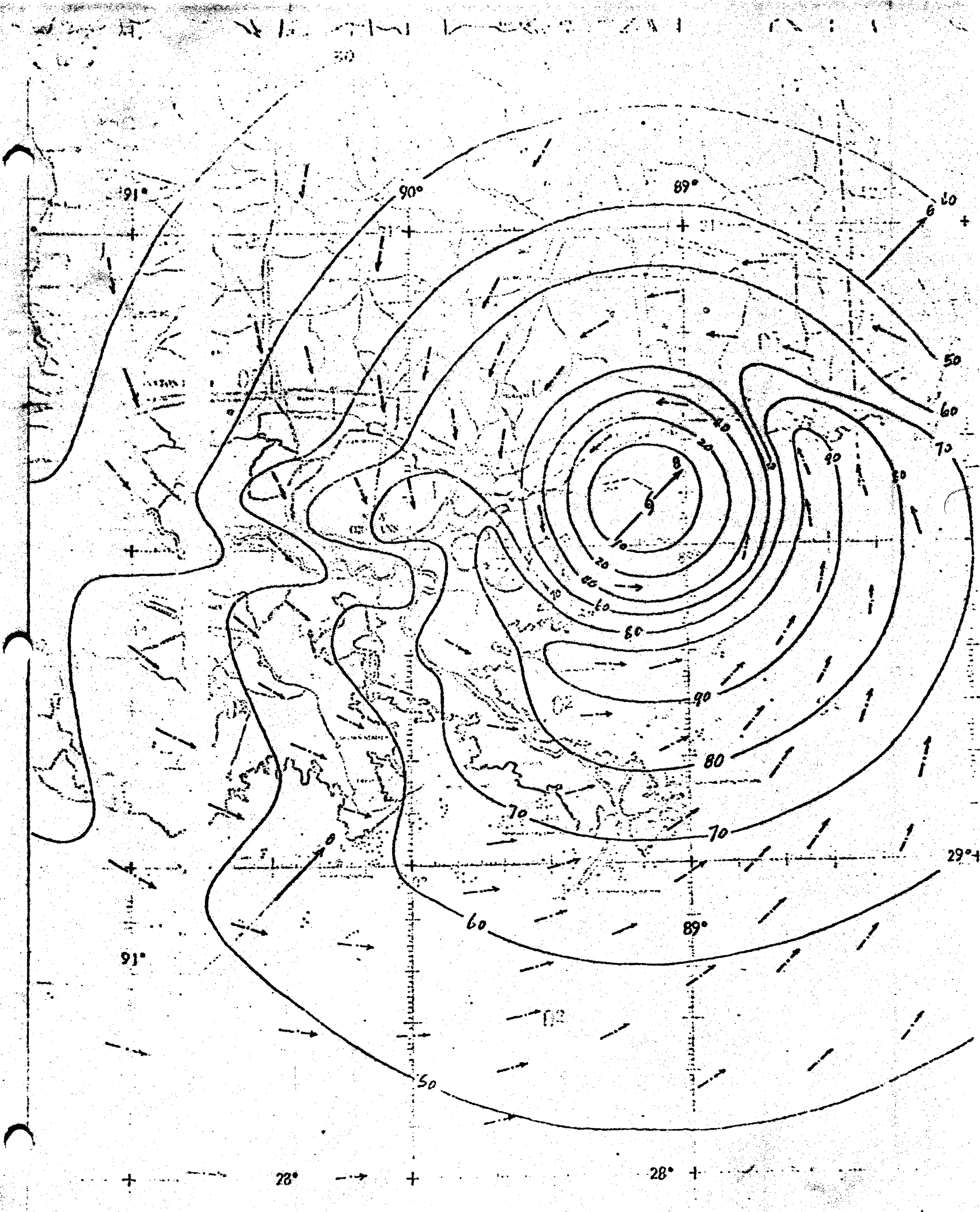


Figure 14.—SPH wind field for the eastern track, centered at location 7 (fig. 1).

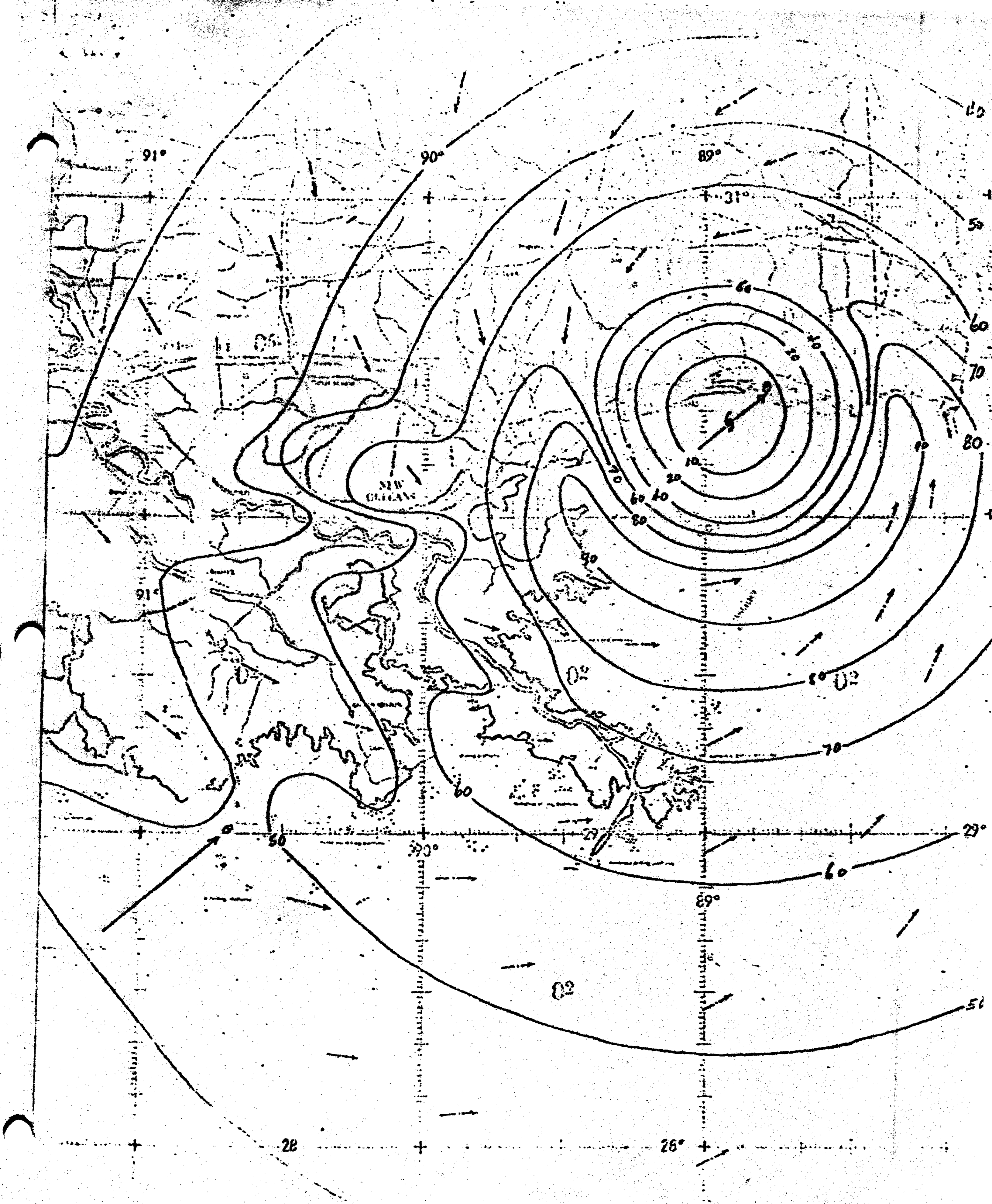


Figure 15.—SPH wind field for the eastern track, centered at location 8 (fig. 1).

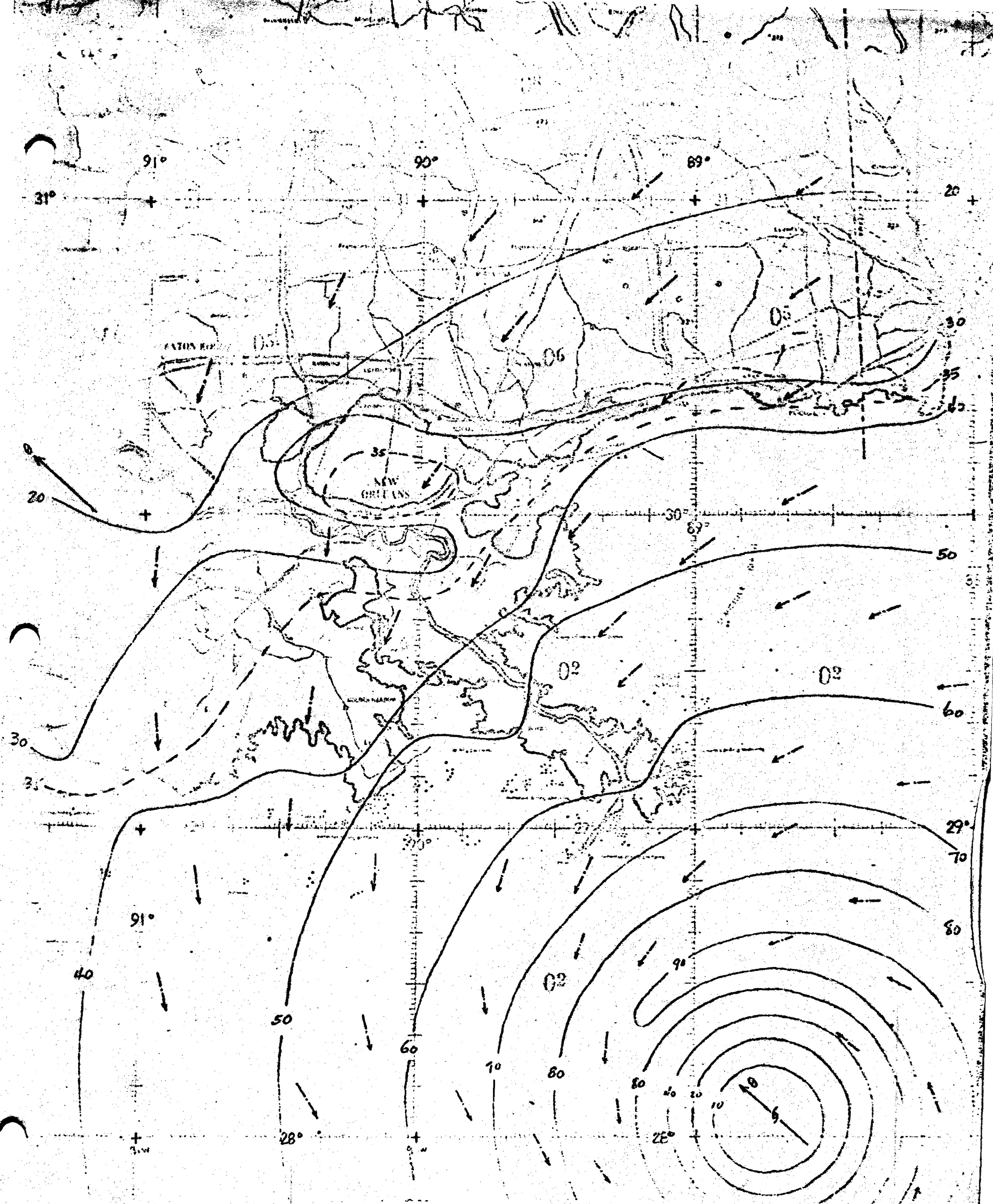


Figure 16.—SPH wind field for the western track; centered at location 1 (fig. 1).

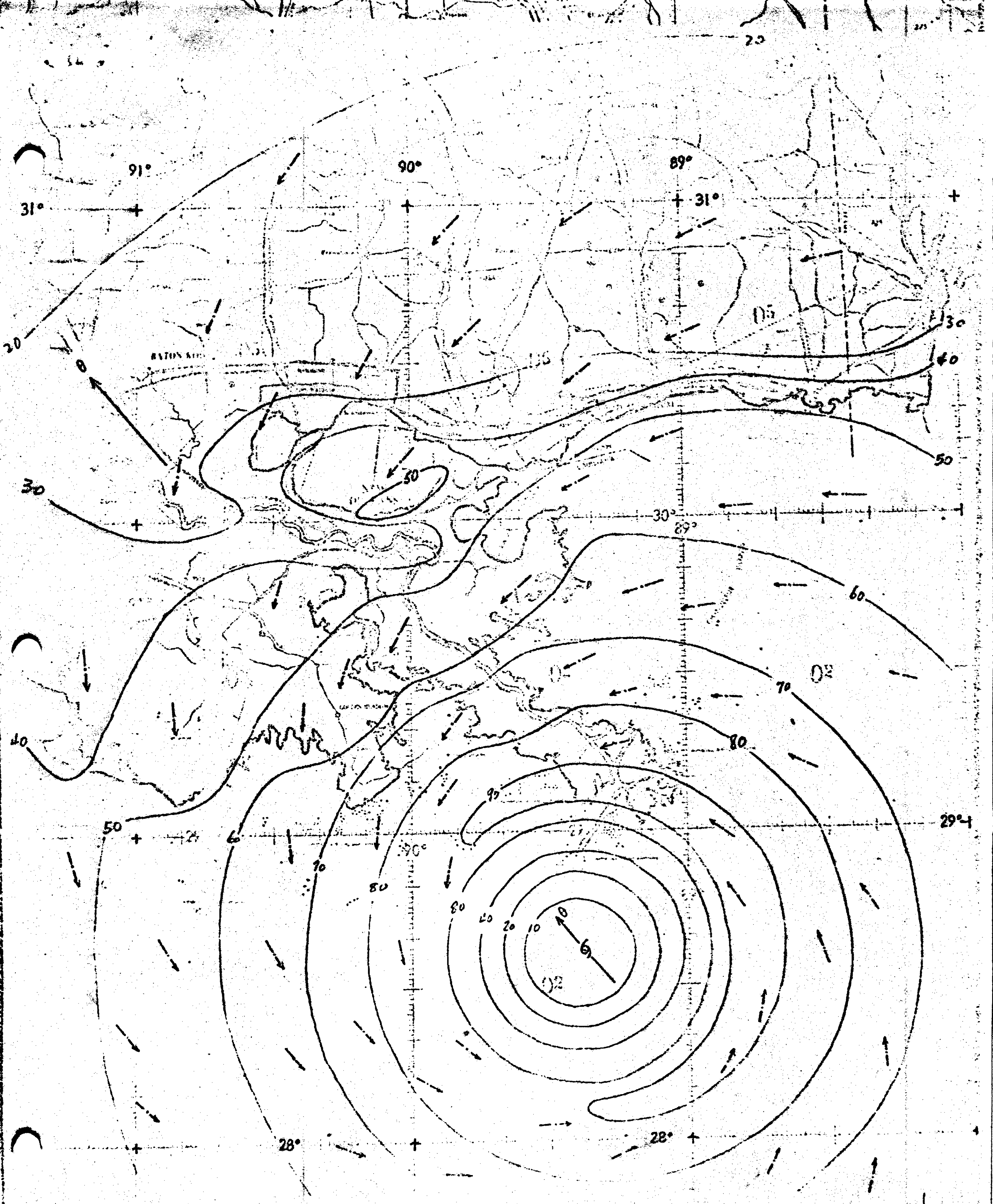


Figure 17.--SPH wind field for the western track; centered at location 2 (fig. 1).

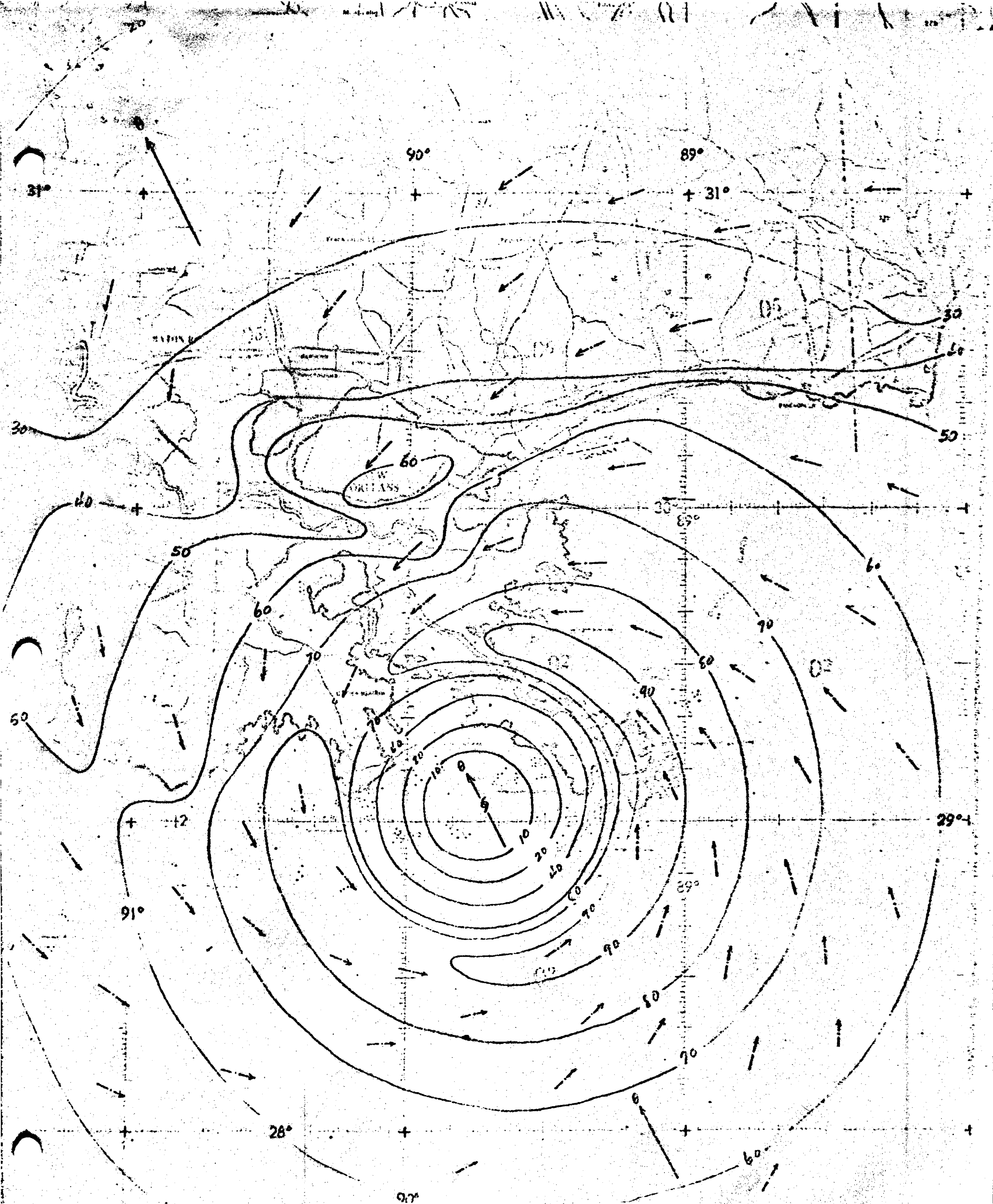


Figure 18.—SPH wind field for the western track; centered at location 3 (fig. 1).

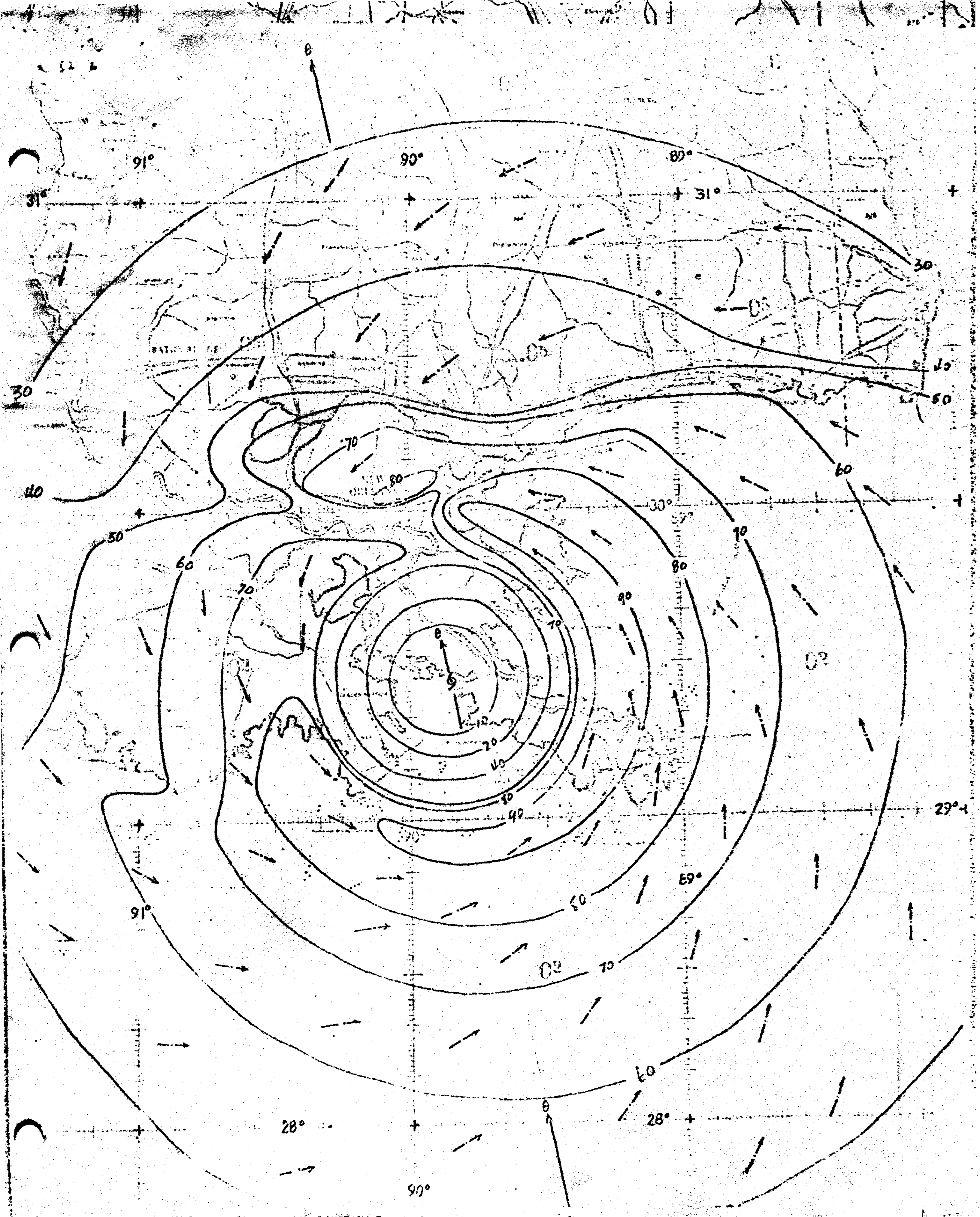


Figure 19.--SPH wind field for the western track; centered at location 4 (fig. 1).

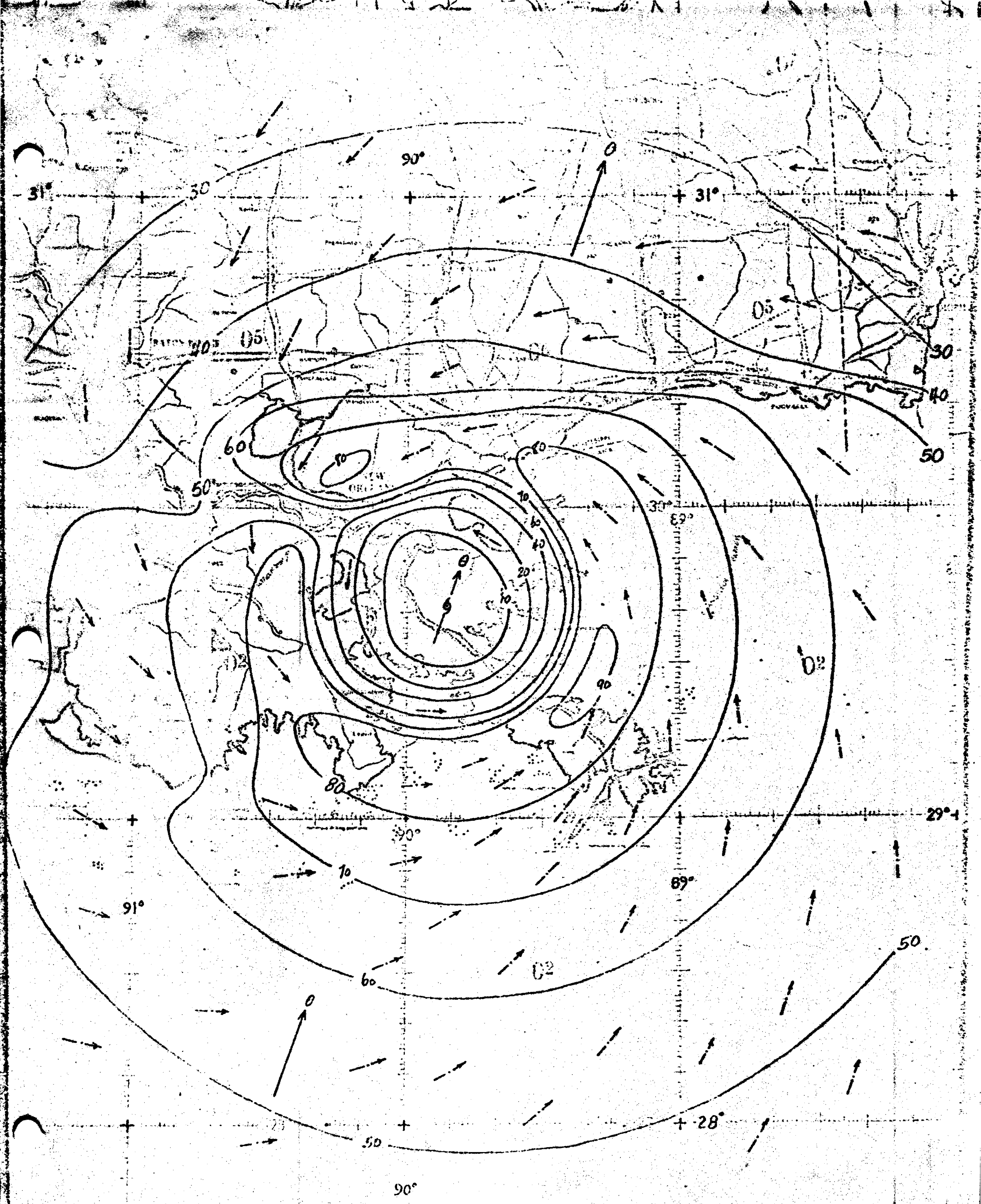


Figure 20.--SPH wind field for the western track; centered at location 5 (fig. 1).

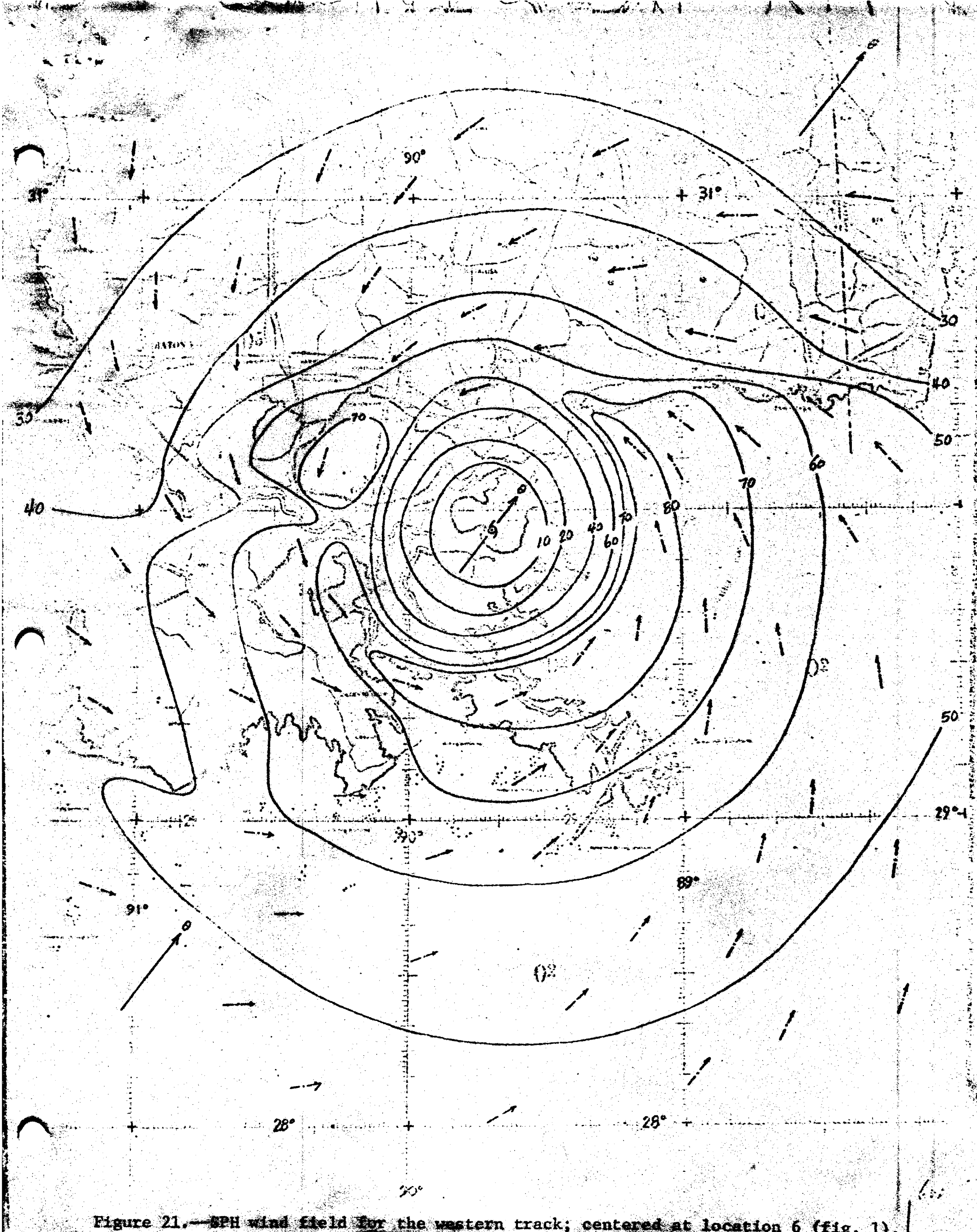


Figure 21.—SPH wind field for the western track; centered at location 6 (fig. 1).

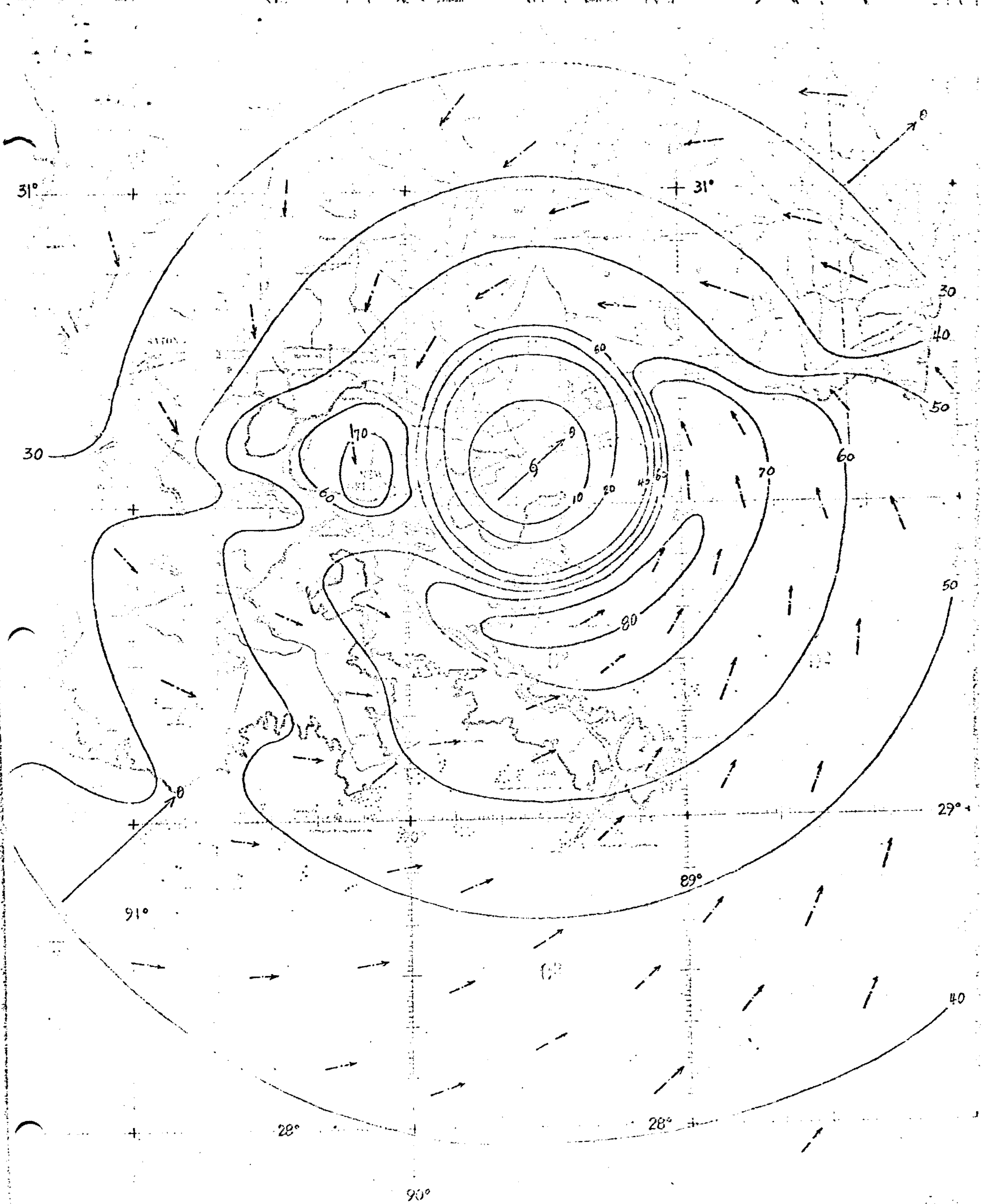


Figure 22.--SPH wind field for the western track; centered at location 7 (fig. 1).

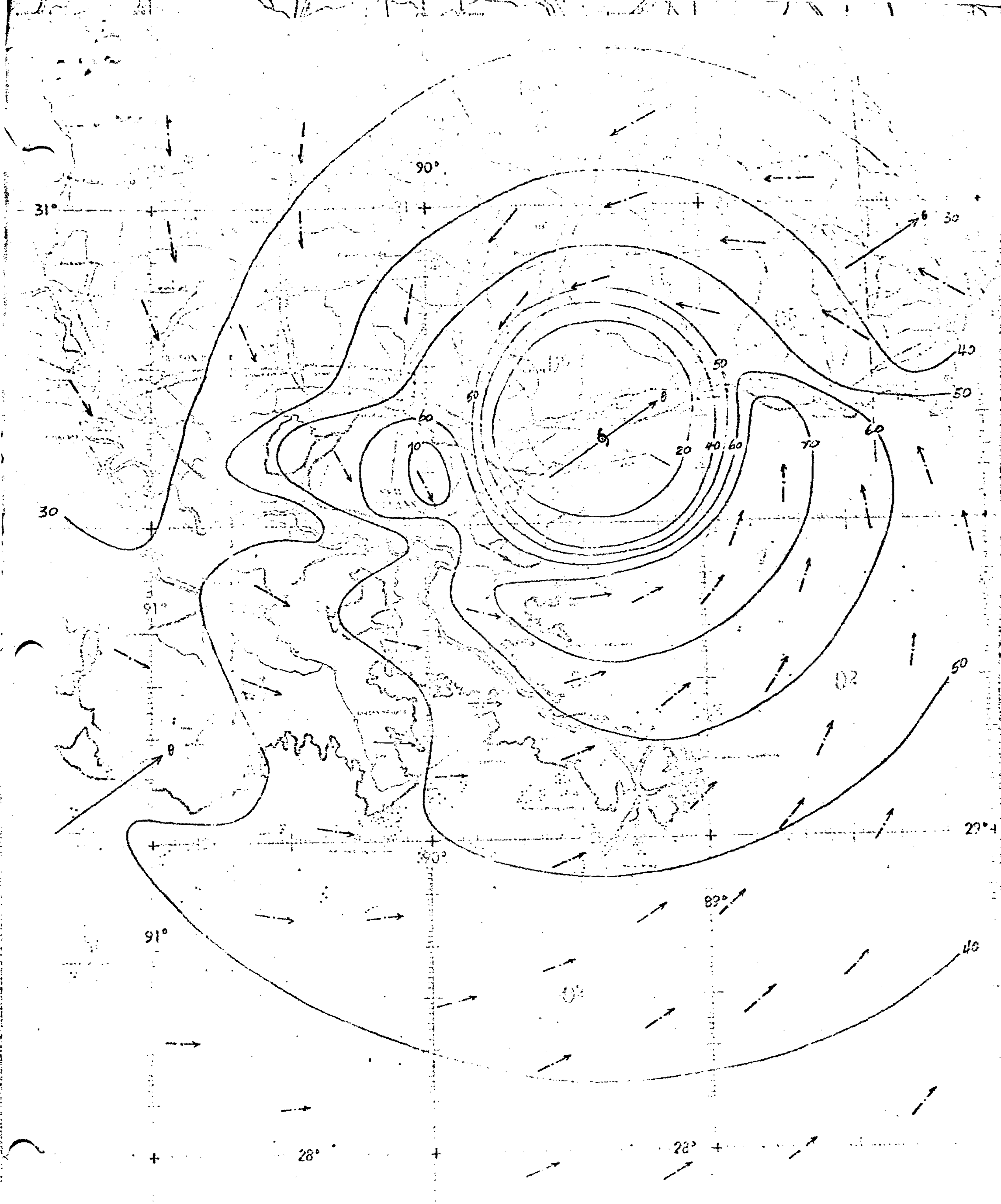


Figure 23.--SPH wind field for the western track; centered at location 8 (fig. 1).