NOAA Technical Memorandum ERL GLERL-53

"PATHFINDER"--A TRAJECTORY PREDICTION SYSTEM FOR THE GREAT LAKES

David J. Schwab
John R. Bennett
Edward W. Lynn

Great Lakes Environmental Research Laboratory
Ann Arbor, Michigan
May 1984

UNITED STATES
DEPARTMENT OF COMMERCE

Malcolm Baldrige,
Secretary

NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION

John V. Byrne,
Administrator

Environmental Research
Laboratories

Vernon E. Derr
Director

NOTICE

Mention of a commercial company or product does not constitute an endorsement by NOAA Environmental Research Laboratories. Use for publicity or advertising purposes of information from this publication concerning proprietary products or the tests of such products is not authorized.

CONTENTS

FIGURES

"PATHFINDER"--A TRAJECTORY PREDICTION SYSTEM FOR THE GREAT LAKES*

David J. Schwab, John R. Bennett, and Edward W. Lynn

This report describes a series of computer programs that can be used interactively to simulate currents and particle trajectories on the Great Lakes. The user of the programs supplies meteorological data and initial particle locations. The programs allow the user to examine predicted currents, particle locations, and particle paths in several different formats.

1. INTRODUCTION

The "PATHFINDER" trajectory prediction system is a series of six FORTRAN interactive computer programs that allow a user to predict the movement of drifting particles in the Great Lakes. These particle trajectories can be used to estimate the motion of spilled oil, a disabled vessel, or imaginary markers used to illustrate the lake's currents. For the purposes of this report, we will refer to any of these types of targets simply as "spills." The system requires the user to specify wind speed and direction at 6-h intervals for 24 h previous to and 24 h following the spill. (There is an option to extend the post-spill prediction up to 672 h in 24-h increments.) Calculation of lake currents for the entire prediction period are based on these winds. The user can then specify up to nine spills by specifying their initial locations and the relative amounts of wind and currents influencing their motion. The tracks of the spills are calculated and the user can examine the results in a variety of formats.

The system wss developed in response to the needs of the National Weather Service (NWS), U.S. Coast Guard, and NOAA personnel for lake current information to aid them in forecasting the movement of hazardous material spills and in search and rescue operations. Currents in the Great Lakes are largely driven by wind, unlike currents on ocean coasts, which are also driven by tides, or currents in channels and estuaries, which are hydraulically driven. Because lake currents are complicated and can change rapidly in response to the wind, it is difficult to describe them in terms of only a few simple patterns. Therefore an automatic system was developed to calculate circulation patterns.

Several oil spill simulation models that could be used on the Great Lakes are available (Simons et *al.*, 1975; Torgrimson, 1983; Hess, 1983), but none has the capability to simulate the time-dependent large-scale circulation of the lakes that can determine the movement of a spill. In 1979 the Great Lakes Environmental Research Laboratory (GLERL) began a project to couple lake circulation prediction with trajectory prediction (Boyd, 1979). The operational spill model developed and tested (Pickett, 1983) in that project has been used

*GLERL Contribution No. 414.

by the Coast Guard and NWS since 1980. Recently, GLERL developed and tested a series of numerical circulation and trajectory prediction models (Schwab *et* at., 1981; Bennett *et al.*, 1983; Schwab, 1983; Bennett et *al.*, 1984) that have the potential to forecast large-scale circulation patterns and the trajectories of drifting particles in the lakes even more accurately than earlier models. This report describes an interactive system that uses these improved methods.

2. SYSTEM OVERVIEW

The "PATHFINDER" system is made up of six computer programs. The first program obtains wind information from the user. The second program numerically models lake circulation. The third program allows the user to examine currents calculated by the circulation model. The fourth program asks for the initial locations of the spills to be tracked. The fifth program uses currents and wind to calculate spill trajectories. The sixth program allows the user to examine the calculated trajectories. The programs are written in VAX FORTRAN 77. The source code for the programs is available upon request to the authors. Although the system consists of six separate programs, the computer runs the consecutive programs automatically so that the transition from one program to the next is invisible to the user.

The first program asks for the name and agency of the user, the start date and time for the run, and the wind direction and speed for the previous 24 h and for up to 672 additional hours (28 days). The date is used only for putting a time tag on wind prompting messages and output displays. The program checks for valid month (l-12). day, year (1900-1999), and hour (O-23). The program prompts for wind direction and wind speed at 6-h intervals for the previous 24 h and the next 24 h. Wind direction is in degrees (0°-360°, 0° = wind from the north) and wind speed is in knots (O-100). If the user wants to interpolate for wind direction and speed, i.e., specify only the -18-h and -6-h values of speed and direction and let the program determine the -12-h values, the "/" (slash) character should be entered instead of direction and speed for the -12-h values. After 48 h of wind data have been entered, the user is given the option of extending the run by another 24 h. The program can accommodate up to 27 extensions. After all the wind data are typed in, a table of wind speed and direction is produced and the user is given the option of changing any erroneous values. Appendix A contains an example of a model run illustrating the wind input phase of the system for a 96-h run.

The second program is the numerical circulation model. The details of the numerical methods used in the program are described in Schwab et *al.* (1981). Some of the assumptions and limitations of the circulation model are discussed in section 4.

The third program allows the user to examine currents calculated by the second program (the numerical circulation model). It can display maps of current speed, current direction, or streamline patterns. (Current vectors are parallel to streamlines.) It can also produce a time series of current speed and direction at a specific point in the lake. For time series data, the program checks whether the specified latitude and longitude are both within the computational grid. If they are not, an error message is printed and the program asks for another location. If the user elects to have maps printed, a list of times for which maps are required may be entered, allowing the user to leave the terminal while the maps print out. For time series data, the currents are interpolated to the exact coordinates requested. The maps for current speed, direction, and streamlines show values at the corners of the grid boxes.

The fourth program asks the user for information about the spills to be tracked. If the user designates a given spill as "leaking," the program introduces one new particle into the lake at the specified position every 3 h for the duration of the run; otherwise a single particle is released at the spill location at time zero. The program checks whether the initial locations are within the computational grid and issues an error message if they are not. The maximum number of spills the program will accept is nine and the maximum total number of particles 1,000.

The fifth program calculates the trajectories of the marker particles according to the percentages of wind and current effect the user specified. The numerical methods used in this program are described in Bennett et *al.* (1983). Some of the limitations of this technique are discussed in section 7.

The final program allows the user to examine the particle trajectories through a square viewing window (or subgrid). The user must specify the latitude and longitude of the center of the subgrid and the size of the subgrid in nautical miles. The program checks whether the center of the subgrid is in a lake grid square and issues an error message if it is not. The user is then given the option to see a depth map of the chosen subgrid. Particle trajectories can be viewed either as a map of the locations of all the drifting particles at a specified time or the track of an individual particle from the time of release to the end of the run. If the user chooses to examine a map of particle locations, he/she can pick which of the spills should be included in the display. The user can also alter the sire and location of the subgrid at any time, allowing "close-ups" of critical areas.

If the user would like to use a different set of initial spill locations with the same winds (and currents). it is possible to restart the system with the fourth program. It is also possible to keep the same spill locations and change the winds (and currents).

3. WIND INPUT

After the user enters the lake name, his/her name and agency, and the starting date and time for the run, the "PATHFINDER" system asks for values of wind direction and speed at 6-h intervals. If some values are not available, the programs will interpolate between values. Although the program has the capability to incorporate spatially variable wind fields, the operational version uses a uniform wind over the entire lake. This wind should be chosen to be representative of the region of interest.

The program also has the capability to adjust wind measurements for height and stability, but again these features are not used in the operational system. We have assumed that the winds provided by the user are representative overwater winds at 5 m (16 ft) above the water surface under neutral conditions (air temperature equal to water temperature). If the available wind measurements are from a different height above the water, if the winds are overland winds, or if the overlake air temperature is quite different from the water temperature, the wind speed should be adjusted accordingly. That is, measurements from less than 5 m should be increased, measurements from greater than 5 m should be decreased, and overland winds should generally be increased. (See Schwab and Morton, 1984.)

4. THE NUMERICAL CIRCULATION MODEL

When the message "CALCULATING CURRENTS . . . PLEASE STAND BY" is printed, the numerical circulation model is running. The details of the numerical circulation model are fully described in Schwab et *al.* (1981). Some minor modifications to program RLID described in that report have been made to eliminate the printed output from the program and to interface with the other programs in the system. The circulation model is a vertically integrated, two-dimensional model. This means that the calculated currents are vertically averaged over the depth of the water column. In real lakes, the surface current can differ from the vertically averaged current because of wind-induced shear near the surface or temperature stratification. These effects are not included in the RLID model.

It was stated in section 1 that Great Lakes currents are wind driven. Yet sometimes even when the wind is strong, the currents in the shallow nearshore region can also be significantly influenced by incoming waves. Waves approaching the shoreline at an angle tend to set up a shore-parallel current that is stronger for larger angles of approach. These effects are not included in the RLID model either.

Islands are included in the model as grid squares with very shallow water depth because if the islands were treated as land, the boundary condition on the shore of the island would require a more complicated numerical method. This means that sometimes the simulation might say that the currents or wind carries a spill right through the island.

5. CURRENT DISPLAYS

After currents are calculated by the circulation model, the user has the option of examining the forecast currents either as maps of current speed, direction, and streamlines at a given time or as a time series of current speed and direction at a given point. In the maps, current speed, direction, and stream function values at the corners of the grid boxes are displayed as shown in appendix A. The lake grids are described in section 9 and shown in figures 1-6.

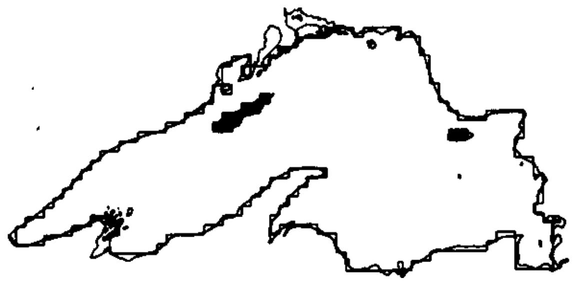

FIGURE I.--Lake Superior 10-km grid.

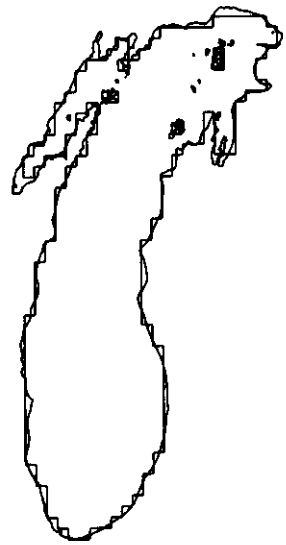

FIGURE 2.--Lake Michigan 10-km grid.

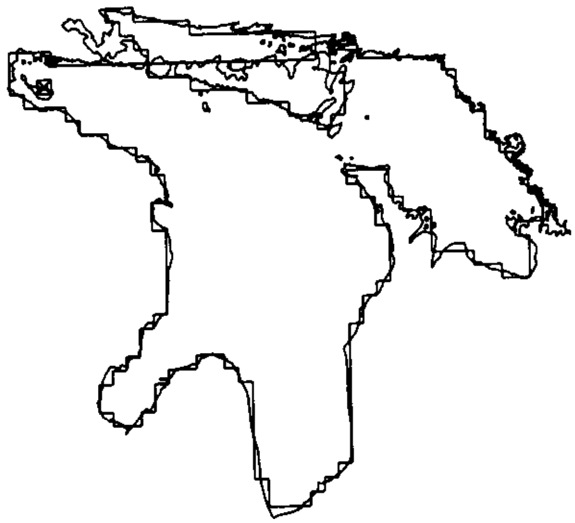

FIGURE 3.--Lake Huron 10-km grid.

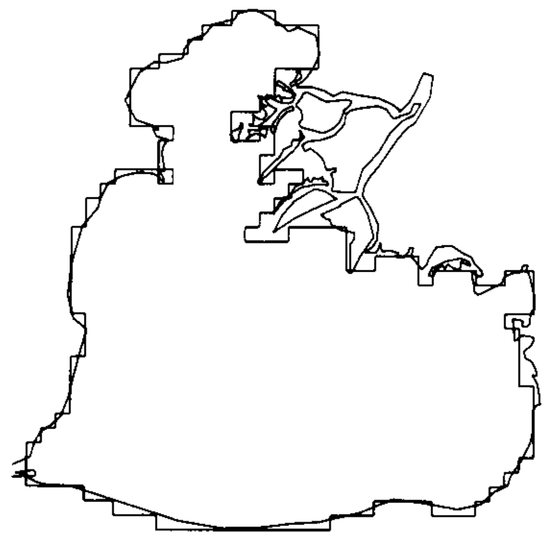

FIGURE 4.--Lake St. Clair 1.2-km grid.

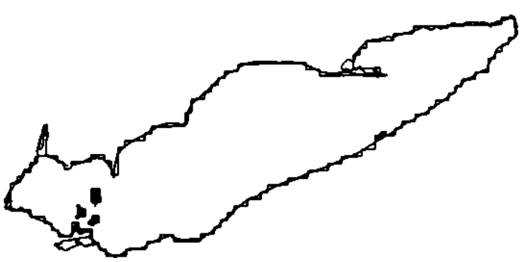

FIGURE S.--Lake Erie 5-km grid.

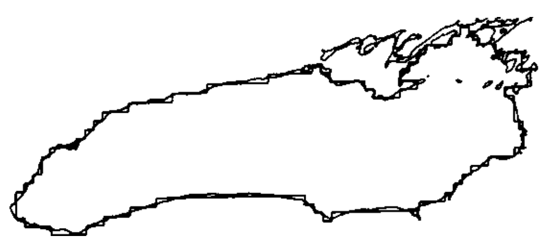

FIGURE 6.--Lake Ontario 5-km grid.

For current speed and direction, the east-west and north-south components of the current vector are calculated from the computed stream function field at the centers of the eastern and northern sides of the grid boxes, respectively. The components are then interpolated to the corners of the grid boxes as described in Bennett *et al.* (1983) for the particle trajectory model. Speed and direction are then calculated from the interpolated components. Note that current direction means the direction the current is coming from (meteorological convention, 0° = from the north).

The current streamline map shows normalized values of the transport stream function at grid box corners. The values are normalized by the maximum absolute value of transport stream function. These maps are useful for getting a picture of the lakewide circulation pattern since currents are everywhere parallel to contour lines of the stream function, with the current flowing in the direction that puts higher values of stream function on the right. In the sample run shown in appendix A, contour lines have been drawn on the stream function map to indicate the circulation pattern. The contour lines are similar to isobars on a barometric pressure map. On the stream function map in appendix A, contours have been drawn for stream function values -50, 0, and 50.

6. INITIAL SPILL INFORMATION

After the user specifies the initial latitude and longitude of each spill, the program asks whether the spill is leaking or not. For most applications, an all-at-once spill (not leaking) is the best choice since it simplifies the displays of forecast spill locations considerably. If a leaking spill is chosen, a particle is released from the initial spill location every 3 h and tracked for the duration of the run. The sample run in appendix A illustrates a leaking spill in spill number 8.

The program then asks if the user wants to use standard wind and current effects (wind = 2 percent, current = 100 percent). If the answer is "no," the program asks the user to specify values for wind and current effect. The particle velocity is then the sum of the wind effect times the wind velocity plus the current effect times the current velocity. Since the circulation model only gives the vertically averaged current, some of the difference between surface current and vertically averaged current is empirically accounted for in the default factors of 2-percent wind effect and 100-percent current effect. For objects with a large windage (such as ships adrift), a higher wind effect should be specified. The current effect should generally be left at 100 percent.

7. THE TRAJECTORY MODEL

The trajectory model uses currents from the numerical lake circulation model and the winds specified by the user to predict the movement of spills in the lakes. When the message "CALCULATING TRAJECTORIES . . . PLEASE STAND BY" is printed, the trajectory model is running. The details of the numerical method and the computer program are given in Bennett *et al.* (1983). A few minor modifications have been made to the computer program **PARTIC** described in that report to make it compatible with the "PATHFINDER" system. The main assumptions about physical processes in the model are that

(1) The particles move with the vertically averaged current (optionally multiplied by a specified factor) plus some user-supplied fraction of the wind.

(2) When the particles are driven by currents alone (zero wind effect), they do not cross the shore boundary.

(3) When the particles are driven onshore by wind, they stay there.

(4) Within the large model time step (3 h for the "PATHFINDER" *system),* the current and wind stay constant (at their values at the middle of the time step).

The particle trajectory program is very versatile; its applications are potentially much broader than the "PATHFINDER" system. For other applications, the reader is encouraged to read Bennett *et al. (1983).*

8. TRAJECTORY DISPLAYS

The trajectory display program allows the user to view the results of the trajectory forecasts through a square window (or **subgrid**) that can be moved and changed in size at any time. The user is first asked to specify the latitude and longitude of the **subgrid** center. The center must be located in the lake. (See figs. l-6.) The user can then change the size of the **subgrid** from the default value of 60-by-60 nautical miles if necessary. The **subgrid** is divided by the computer into a 30-by-30 array of square cells; the cell size for a 60-nautical-mile **subgrid** is thus 2 nautical miles by 2 nautical miles. When locations of the spills are displayed, the program only shows which cell they are in. Therefore a large **subgrid** covers more area, but is not as precise in locating spills since particles are only located to the nearest grid cell.

After the user has decided on the center and size of the **subgrid,** he/she can examine a depth map of the **subgrid** area. In the map, the difference between the maximum and minimum depths in the **subgrid** is divided into five equal parts and the symbols O-4 are used to represent a depth in one of these five categories. One symbol is printed for each of the 30-by-30 array of cells in the **subgrid.** Land is indicated by an **"="** symbol.

The program then prints a menu of options for examining particle trajectory forecasts in the **subgrid.** The user can look at either the locations of specified spills at a given time or the track of a specified spill as a function of time. If the spill location option is chosen, the user is asked to enter the identifying numbers of the spills to be plotted (l-9) and then a list of times. *One* map will be printed for each specified time. If the initial location of one of the spills falls within the **subgrid** *area,* it is indicated on the map by a letter (A-Z). If more than one spill and/or initial location falls within the *same* **subgrid** cell, another letter (A-Z) is used and an entry is made in the list at the top of the map explaining the meaning of that letter. For instance, if the list looks like

A = ORIGIN OF SPILL 1

B = **A,1,**

The initial location of spill 1 and its current position both fall in the cell on the **subgrid** containing the letter B on the map. The sample run in appendix A contains several examples of multiple overlapping spill locations and origins.

For individual spill tracks, the position of the spill is plotted every 3 h from the time of release to the end of the run. The positions are indicated by the numbers O-9. If *more* than **10** positions are to be plotted, the numbers repeat. See appendix A for a sample plot of an individual spill track.

In both the spill location and spill track maps, land cells and islands are indicated by an **"="** symbol. If a spill has hit land, the spill number (I-9) for spill location plots or position number (O-9) for spill track plots is replaced by a letter (A-Z) and the letter is set off with an asterisk **("*")** in the list at the top of the map.

9. COMPUTATIONAL GRIDS

The computational grids used by the model for Lakes Superior, Michigan, Huron, St. Clair, Erie, and Ontario are shown in figures 1-6. The upper lakes (Superior, Michigan, and Huron) have **10-km** grids; the lower lakes (Erie and Ontario) have S-km grids; and Lake St. Clair has a 1.2-k" grid. Islands are indicated by grid squares with an **"X"** in them. As mentioned above, the islands are represented as grid squares with very shallow depths. The figures show the relation between the computational grid boundary and the actual shoreline of the lake. The user should be aware of the difference between the two shorelines because all calculations in the "PATHFINDER" system are based on the computational grid. If a spill hits the boundary of the grid, it is considered beached, even though it may not have reached the actual shoreline. **When** the spill locations are examined in program **DSPLAY,** the computational grid boundaries are used to determine which parts of the **subgrid** are land and which parts are water. The grid sires for the various lakes were chosen as an acceptable compromise between realistic resolution of the shoreline and computational speed. Higher resolution grids can be accommodated for special applications or on a more powerful computer system.

10. REFERENCES

Bennett, J. R., Clites, A. H., and Schwab, D. J. (1983): A two-dimensional lake circulation modeling system: Programs to compute particle trajectories and the motion of dissolved substances, NOAA Tech. Memo. ERL GLERL-46, National Technical Information Service, Springfield, Va. 22161. 51 pp.

Bennett, J. R., Clites, A. H., and Campbell, J. E. (1984): Accuracy of trajectory calculations in a finite difference lake circulation. *J. Comp. Phys.* (*In* review).

Boyd, J. D. (1979): A surface spill model for the Great Lakes, GLERL Open File Rept., Great Lakes Environmental Research Laboratory, Ann Arbor, Mich. 48 pp.

Hess, K. W. (1983): Simulation of spilled oil behavior in bays and coastal waters, NOAA Techniques Development Laboratory Computer Program NWS CP 83-2, Techniques Development Laboratory, Silver Springs, Md. 21 pp.

Pickett, R. L. (1983): Great Lakes spill model, GLERL Open File Rept., Great Lakes Environmental Research Laboratory, Ann Arbor, Mich. 25 pp.

Schwab, D. J. (1983): Numerical simulation of low-frequency current fluctuations in Lake Michigan. *J. Phys. Oceanogr.* 13:2213-2224.

Schwab, D. J., Bennett, J. R., and Jessup, A. T. (1981): A two-dimensional lake circulation modeling system, NOAA Tech. Memo. ERL GLERL-38, National Technical Information Service, Springfield, Va. 22161. 79 pp.

Schwab, D. J., and Morton, J. A. (1984): Estimation of overlake wind speed from overland wind speed: A comparison of three methods. *J. Great Lakes Res.* 10:68-72.

Simons, T. J., Beal, G. S., Beal, K., El-Shaarawi, A. H., and Murty, T. S. (1975): Operational model for predicting the movement of oil in Canadian navigable waters, Manuscript Rept. Series, No. 37, Marine Sciences Directorate, Dept. of the Environment, Ottawa, Ont., Canada. 30 pp.

Torgrimson, G. M. (1983): A comprehensive model for oil spill simulation. In *Proceedings of the* 1983 Oil Spill Conference, pp. 423-420. American Petroleum Institute, Washington, D.C.

Appendix A.--ANNOTATED SAMPLE OF THE TRAJECTORY PREDICTION SYSTEM

APPENDIX A - ANNOTATED SAMPLE OF THE TRAJECTORY PREDICTION SYSTEM

This appendix contains a sample run of the 'PATHFINDER' trajectory prediction system on the GLERL computer. User responses in the sample below are underlined but in an actual run they are not. All user responses end with a carriage return. Numbers on the right side of the page refer to footnotes below.

```
                                                                    Footnotes
GREAT LAKES ENVIRONMENTRL RESEARCH LABORATORY VAX 11/780              (1)

Username: SPILL                                                       (2)

  GREAT LAKES ENVIRONMENTRL RESEARCH LABORATORY
     PATHFINDER TRRJECTORY PREDICTION SYSTEM
                REVISION 2.0 3/84
  IN CASE OF A SPILL OR SEARCH AND RESCUE OPERATION
  CALL FTS 378-2069 OR COMMERCIAL 313-668-2069

  TO BACKSPACE, USE THE KEY OR COMBINATION OF KEYS ON YOUR TERMINAL THAT
  GENERRTES AN ASCII RUBOUT CODE. TO RBORT THE RUN, USE THE CTRL-Y COMBINATION.

ENTER LAKE NAME: MICHIGAN                                             (3)
PLEASE ENTER YOUR NAME AND RGENCY (E.G. RODSTEIN/NOAA)
RODSTEIN/NOAA                                                         (4)
DO YOU WANT DETAILED INSTRUCTIONS ABOUT HOW TO
USE THIS PROGRAM ?   (INPUT Y...OR...N)
NO
INPUT STARTING DATE FIND TIME AS MONTH, DAY,YEAR, HOUR (0-23).
THIS WILL BE HOUR 0 (ZERO) (E.G. 7,28,1983,14)
3.27.1902.2                                                           (5)
INPUT WINDS (DIRECTION,SPEED) IN DEGREES RND KNOTS (E.G. 270,10)
TYPE '/' FOR LINEAR INTERPOLATION
INPUT WIND FIT -24 HOURS  3/26/1982  2:00
130,10                                                                (6)
INPUT WIND AT -18 HOURS  3/26/1982  8:00
130,12
INPUT WIND FIT -12 HOURS  3/26/1982 14:00
125,12
INPUT WIND FIT  -6 HOURS  3/26/1982 20:00
100,14
INPUT WIND FIT   0 HOURS  3/27/1982  2:00
90,23
INPUT WIND FIT   6 HOURS  3/27/1982  8:00
90,19
INPUT WIND AT   12 HOURS  3/27/1982 14:00
90,14
INPUT WIND FIT  18 HOURS  3/27/1982 20:00
60,10
INPUT WIND FIT  24 HOURS  3/28/1982  2:00
10,17
IS A FORECRST LONGER THRN 24 HOURS DESIRED?
(INPUT Y...OR...N)
YES                                                                   (7)
FORECRST WILL BE EXTENDED TO 48 HOURS
```

INPUT WIND AT 30 HOURS 3/28/1982 8:00
360,23
INPUT WIND AT 36 HOURS 3/28/1982 14:00
360,21
INPUT WIND AT 42 HOURS 3/28/1982 20:00
350,21
INPUT WIND FIT 48 HOURS 3/29/1982 2:00
10,16
IS A FORECRST LONGER THAN 48 HOURS DESIRED?
(INPUT Y...OR...N) Footnotes
YES (8)
FORECRST WILL BE EXTENDED TO 72 HOURS
INPUT WIND FIT 54 HOURS 3/29/1982 8:00
30,14
INPUT WIND AT 60 HOURS 3/29/1982 14100
80,8
INPUT WIND AT 66 HOURS 3/29/1982 20:00
70,6
INPUT WIND AT 72 HOURS 3/30/1982 2:00
90,10
IS A FORECAST LONGER THAN 72 HOURS DESIRED?
(INPUT Y...OR...N)
YES (9)
FORECAST WILL BE EXTENDED TO 96 HOURS
INPUT WIND FIT 78 HOURS 3/30/1982 8:00
140,14
INPUT WIND AT 84 HOURS 3/30/1982 14:00
140,14
INPUT WIND AT 90 HOURS 3/30/1982 20:00
135,10
INPUT WIND FIT 96 HOURS 3/31/1982 2:00
110,8
IS A FORECAST LONGER THAN 96 HOURS DESIRED?
(INPUT Y...OR...N)
NO (10)

HOUR	DATE	TIME	WIND DIR.	WIND SPEED
-24	3/26/1982	2:00	130	10.0
-18	3/26/1982	8:00	130	12.0
-12	3/26/1982	14:00	125	12.0
-6	3/26/1982	20:00	100	14.0
0	3/27/ 1902	2:00	90	23.0
6	3/27/1982	8:00	90	19.0
12	3/27/1982	14:00	90	14.0
18	3/27/1982	20:00	60	10.0
24	3/28/1982	2:00	10	17.0
30	3/28/1982	8:00	360	23.0
36	3/28/ 1902	14:00	360	21.0
42	3/28/1982	20:00	350	21.0
48	3/29/ 1902	2:00	10	16.0
54	3/29/1982	8:00	30	14.0
60	3/29/1982	14:00	80	6.0
66	3/29/1982	20:00	70	6.0
72	3/30/1982	2:00	90	10.0
78	3/30/1982	8:00	140	14.0
a4	3/30/1982	14:00	140	14.0
90	3/30/ 1982	20:00	135	10.0
96	3/31/1982	2:00	110	a. 0

IS WIND DATA O.K.? (INPUT Y...OR...N) | Footnotes

YES (11)

CALCULATING CURRENTS...PLEASE STAND BY (12)

DO YOU WANT TO SEE ANY CURRENTS?

(ENTER Y...OR...N) (13)

YES

ENTER C IF YOU WANT TO SEE CURRENT SPEED MAP

ENTER D IF YOU WANT TO SEE CURRENT DIRECTION MAP

ENTER E IF YOU WANT TO SEE CURRENT STREAMLINE MAP

ENTER T IF YOU WANT TO SEE A TIMESERIES OF CURRENT SPEED, RND DIRECTION AT A GIVEN LOCATION

ENTER Q IF NO MORE CURRENTS ARE DESIRED

C (14)

ENTER THE TIME(S) IN HOURS (0-96) AFTER THE START TIME 3/27/1982 2:00 AT WHICH YOU WANT TO SEE CURRENT SPEED MAP

YOU MAY MAKE UP TO 25 ENTRIES, ONE ENTRY PER LINE

END THE LIST WITH -1

96

-1

CURRENT SPEEDS IN TENTHS OF KNOTS AT 96 HOURS 3/31/1982 2:00

```
*****************************************************************************
*****************************************************************************
*************************************************************  1  1  0  1  1  1***
**********************************************  2  2  1  1  1  1  1  0  0  0  0  0
*********************************  0  0***  2  2  1  1  1  1  1  1  0  1  0  0  0
******************************  0  0  0  1  1  0  0  1  1  1  1  2  1  1  0  0  0
***********************  1  1  1  1  0  1  0  1  1  1  2  3  2  1  1  0  0  0***
********************  1  1  1  1  1  0  0  1  1  1  1  2  1  2  1  0  0  0******
********************  1  0  0  0  1  1  1  1  0  1  1  0  1  0  0  0  0  0  0***
*****************  0  0  0  0  1  1  1  1  0  1  1  0  0  1  0  0  0  0  0  0***
**************  1  0  0  0  0  0  0  0  1  0  1  1  0  0  0  0  0  0  0**********
**************  1  0  1  0  1  1  0  1  0  0  1  1  1  0  0  1  1  1************
**************  1  0  1***  1  1  1  1  1  0  1  3  3  0  0  1  1  1************
****it***  0  0  0  1  1  0  0  1  0  0  1  1  1  1  0  0  0  0  0************
******  0  0  0  0***  0  1  0  0  0  1  1  1  1  0  0  0  1  0  0************
***  0  0  0  0  0  0  0  0  0  0  0  1  1  1  0  0******  1  1  1************
***  0  0  0***  0  0  1  0  0  0  1  1  0  1  0******************************
***  0  0******  0  1  0  0  0  0  0  0  0  0  0******************************
************  1  0  0  0  0  0  0  0  0  0  0*********************************
************  1  1  0  0  0  0  0  0  0  0  0*********************************
************  0  0  0  0  0  0  0  0  0  0  0*********************************
************  1  0  0  0  1  1  0  1  0  0  0*********************************
************  1  0  0  0  1  0  1  1  0  0************************************
*********  0  0  0  0  0  1  1  1  1  0  0************************************
*********  0  1  1  1  1  1  1  1  0  1***************************************
******  1  1  1  1  0  1  0  1  0  0  0***************************************
******  1  1  0  1  1  1  0  0  1  0  1***************************************
******  2  1  1  1  1  1  0  0  0  0  1***************************************
******  2  0  1  0  0  0  0  0  0  0  1***************************************
******  0  1  0  1  1  1  1  0  0  0  1***************************************
***  0  0  0  1  1  0  1  1  0  0  0  1***************************************
***  0  0  0  0  0  1  1  1  0  0  0  1  2************************************
***  0  0  0  0  0  1  1  1  1  0  0  1  2************************************
***  0  0  0  0  0  1  1  1  1  1  0  0  1  2*********************************
***  0  0  0  0  1  1  1  0  0  1  1  0  1  2*********************************
***  1  0  0  0  1  1  1  0  0  1  1  0  0  1*********************************
***  1  0  0  0  0  1  1  0  0  1  1  1  1  1*********************************
***  2  1  1  0  1  1  1  1  0  1  1  1  1  1*********************************
***  1  0  0  1  1  1  1  1  1  1  1  1  1  1*********************************
***  1  0  1  1  1  1  1  1  1  1  2  1  1  1*********************************
***  1  1  1  1  1  0  1  1  1  1  2  1  1  1*********************************
***  2  2  1  1  0  0  1  1  1  1  1  1  1  1*********************************
***  2  1  1  1  1  0  1  1  0  1  1  1  1  1*********************************
***  2  1  1  1  1  0  1  1  0  0  0  0  0  1*********************************
***  2  2  1  1  1  0  1  1  0  0  1  1  0************************************
******  2  1  1  1  0  1  1  0  1  1  0  0************************************
******  2  2  1  1  1  1  1  1  1  0  0***************************************
*********  1  2  2  1  1  1  1  1  1  0***************************************
*********  2  2  2  2  1  1  1  2  1******************************************
*********  2  2  2  2  2  2  2  2*********************************************
************  2  2  2  2  2  2************************************************
***************  1  1  1*****************************************************
```

ENTER C IF YOU WANT TO SEE CURRENT SPEED MAP
ENTER D IF YW WNT TO SEE CURRENT DIRECTION MAP
ENTER E IF YW WANT TO SEE CURRENT STREAMLINE MAP
ENTER T IF YW WANT TO SEE A TIMESERIES OF CURRENT SPEED,
RND DIRECTION FIT A GIVEN LOCATION
ENTER Q IF NO MORE CURRENTS ARE DESIRED
D
ENTER THE TIME(S) IN HOURS(0-96) AFTER THE START TIME
3/27/1982 2:00 AT WHICH YW WANT TO SEE CURRENT DIRECTION MAP
YW MAY MAKE UP TO 25 ENTRIES, ONE ENTRY PER LINE
END THE LIST WITH -1
96
-1

Footnotes
(15)

CURRENT DIRECTIONS IN TENS OF DEGREES AT 96 HOURS 3/31/1982 2:00

```
******************************************************************************
******************************************************************************
*********************************************************  5  7  8  8 12 13***
******************************************  5  7  9 10 10  7  7  9  8 17 13 32
******************************  0  0***  5  5  4  8 10 10 11 12 12 18 19 36 36
***************************  0  0  0  5  5  2 27  4 11 23 20 12 17 18 16  4  4
*********************  6  7  9  9  4  5 20 25 34  2 19 24 33  3 21 20 22 22***
******************  5  5  6 11 13 18 22 23 26 35 32 22 26 32 29 19 28 28******
******************  1  1 34 27 17 22 22 22 34 36 29 20 11 31 32 16 19 32  0***
***************  0 26 28 26 26 22 19 20 17  4  3 34  7 12 10  3 31  4  0  0***
************  4  4  0  2 26 25 23 19 15  9  5  8 33 33 19 10 34 28  4*********
************ 33 27 25  0 20 22 26 27 11  6  3 14 18 32 21 12  8  4************
************ 22 29 33*** 17 17 19 26 32 35 35 19 16  3  5  8  9 10************
*********  0  9  3  3 22 19 25 17 16 35  2  1 27 16 18  8  9 27 25************
******  0  0  0  0*** 20 19 22 24 12  3  5 16 22 23 22  5  7 13  1************
***  0  0  0  0  0 22 20 23 13 22  5  3  6 20 20  6*** '*  3 10  6************
***  0  0  0*** 21 21 24 22 18 13  4  2 23 20 22******************************
***  0  0****** 19 18 20  2  9  8  5 13 25 17 21******************************
************ 21 20 25 11  9  6  7  8 13 17 18*********************************
************ 18 18 28  2  8  6  7 12 15 22 22*********************************
************ 35 21 14 33  3  5  9 15 20 19 34*********************************
************ 20 21  9  2  2  4 12 19 20  6  2*********************************
************ 18 16  5  2  1  0 20 21 18 18************************************
********* 22 15 28 30 32 34 28 23 19 16 21************************************
********* 23 19 22 30 34 33 25 26 18 18***************************************
****** 20 21 22 15  5  1 33 22 31 35 19***************************************
****** 19 19 21  7  7  6  6 13  8 13 17***************************************
****** 19 20  8  6  7  7  9 13 13 19 19***************************************
****** 18 18  6  5 33 32 21 18 18 18 18***************************************
****** 11  2  3 21 27 29 29 23 20 17 17***************************************
***  3 21 34 28 19 20 34 33 26 22 17 17***************************************
*** 35 18  5 30 14 10  7  5 11 14 17 16 16************************************
*** 25 31  5 33  5  6  7  8 12 14 24 15 17************************************
*** 21 26 35 34 36  2  4  7 13 15 18 14 16 15*********************************
*** 19 24 35 34 33 35  1  4 15 16 15 25 15 16*********************************
*** 19 21 35 31 31 33 35  1 18 17 16  2 12 17*********************************
*** 18 19  1 18 28 33 34 35 16 15 13 11 18 18*********************************
*** 17 16  3 20 24 32 33 35  9 12 14 16 18 19*********************************
*** 16  9 35 21 23 31 34 35  5 13 16 18 18 18*********************************
*** 17 16 23 21 22 31 34 34 34 19 18 19 19 19*********************************
*** 20 20 21 20 21 32 34 34 32 25 21 19 19 19*********************************
*** 19 19 19 18 17  1 35 34 31 26 24 20 19 20*********************************
*** 18 18 17 16 14  6  0 36 31 25 26 23 20 21*********************************
*** 16 16 17 15 14  9  1  0  0 20 20 24 20 21*********************************
*** 15 16 16 15 15 12  1 36 35 20 21 19 20************************************
****** 15 15 15 16 16 36 35 30 21 23 22 22************************************
****** 14 15 16 17 16 36 34 29 25 20 23***************************************
********* 17 17 16 14  3 35 30  2  4 21***************************************
********* 15 16 15 12  7  3  4  5  4******************************************
********* 14 14 13 10  8  5  5  5*********************************************
************ 14 13  9  7  6  5************************************************
*************** 13  9  5******************************************************
```

ENTER C IF YOU WANT TO GEE CURRENT SPED MAP
ENTER D IF YOU WANT TO SEE CURRENT DIRECTION MAP
ENTER E IF YW WANT TO SEE CURRENT STREAMLINE MAP
ENTER T IF YW WANT TO SEE A TIMESERIES OF CURRENT SPEED,
AND DIRECTION FIT A GIVEN LOCATION
ENTER Q IF NO MORE CURRENTS ARE DESIRED
E

Footnotes
(16)

ENTER THE TIME(S) IN HOURS (0- 96) AFTER THE START TIME
3/27/1982 2100 AT WHICH YOU WANT TO SEE CURRENT STREAMLINE MAP
YW MAY MAKE UP TO 25 ENTRIES, ONE ENTRY PER LINE
END THE LIST WITH -1
96
-1

STREAM FUNCTION AS A PERCENT OF MAXIMUM ABSOLUTE VRLUE 0.2063E+06 M**3/SEC
AT 9 6 H O U R S 3/31/1982 2:00

```
*****************************************************************************
*****************************************************************************
***************************************************************  0  0  0  0  0  0***
************************************************  0   0   0   0   0   0-2-1-2-2  0  0
************+++*+***+**********  0  0***  0  0 -8 -9-11 -6 -7 -5 -4 -3 -1  0  0
**************************** 0  0  0  0  0 -9 -2-14-20-13 -9 -7 -5 -2  0  0  0
*********************  0  0  0  0  0  0 -8  8  5-25-24  0 -6-12 -4 -4  0  0***
****************** 0 0 -3 -3  0  0 -3  8 34 14-24-12 18  1-10  1  1  0******
****************** 0 -3 -4 -7 -3  1  6 41 50 19 -1  6 12 11  4 -3  4  0  0***
**************** 0  0  0 -1  1  0  9 26 48 39 15  6 -3 -2  8  2  0  0  0  0***
************  0  0  0  0  0  1  2  4 19 37 17  1  7-10 -6  8  0  0  0*********
************  0 -3  0  0  0  6  4 13  1 18 -8-25 14  3  0  0  4  0************
************  0  3  0***  0  8 22 63 23 19-11-30  7  2  0  0 -1  0************
*********  0  0  0  0  0  0  3  8 70 40 24 -1-15 -4 -1  0  0 -1  0************
******  0  0  0  0***  0  5 32 12 48 29 13-11  0  0  0  0  0  5  0************
***  0  0  0  0  0  0  0  6  9 32 41 12-17-10  0  0******  0  0  0************
***  0  0  0***  0  0  1  la  10 34 24 -8-28 -3  0******************************
*** 0  0******  0  0 25 15 10 16  2 -9 -1  0  0******************************
************  0  0  0  5 11  2 -4-12-10 -9  0********************************
************  0  3 14 -6 -1-12-23-23-13 -3  0********************************
************  0 -1  7  1-10-30-41-33-21  1  0********************************
************  0  5 10 14-20-63-62-35  3  0  0********************************
************ 0  a -1 -8-34-71-79-22 -6  0**********************************
*********  0  0  2 -6-10-34-59-45  1  0  0**********************************
*******ii 0 1 29 24 10-21-28 -1-11  0***********************************
******  0  0  4 26 31 13-12 -3 24 -4  0***********************************
******  0  5 25 16 11  0 10 -  5  8 -8  0**********************************
******  0  5  8 -8-17-22- 27-24 -9 -7  0**********************************
******  0 12-23-23-29-37- 42-32-15 -  5  0*********************************
******  0  1-48-14 -5-13-26-24-11 -6  0***********************************
***  0  0  4-83 -3 12  8 10-16 -7 -7  0***********************************
***  0  0 17-11 -5  1 -1-12-17 -6 -8  0  0*********************************
***  0  0 -3 -9-12-16-23-30-31-13 -9 -8  0*********************************
***  0  2 -1 -7-14-25-41-51-49-26  3 -9  0  0*******************************
***  0  3  0 -5-12-26-45-60-60-39-10-15 -7  0*******************************
***  0  4  0 -2 -4-18-44-63-63-43-10  9 -8  0*******************************
***  0  5  0 -2  6 -6-39-62-61-45-24-14-11  0*******************************
***  0  6 -2 -2 15 11-25-58-68-61-42-23 -7  0*******************************
***  0  3 -6  3 28 31 -6-57-91-88-59-28 -9  0*******************************
***  0  2  1 20 46 49 15-43-96***-65-25 -7  0*******************************
***  0  2  7 34 58 61 33-22-74-83-58-23 -7  0*******************************
***  0  6 19 41 62 66 43 -4-42-46-37-1a -4  0*******************************
***  0  6 12 32 52 60 43  8-23-20-15-12 -3  0*******************************
***  0  61525 41 52 39  1- 21-14 -6 -1  0  0*******************************
***  0  0  9 17 31 45 35  0-23-14-10 -2  0*********************************
******  0  6 14 25 42 34  2-19 -9  0  0  0*********************************
******  0  0  8 22 41 36  9 -6 -1  0  0************************************
*********  0  5 19 36 35 15  7  7  0  0************************************
*********  0  4 14 25 26 13 10  0  0***************************************
*********  0  0  6 13 10  7  0  0****************************************
************  0  0  4  0  0  0*****************************************
***************  0  0  0*********************************************
```

ENTER C IF YOU WANT TO SEE CURRENT SPEED MAP
ENTER D IF YOU WANT TO SEE CURRENT DIRECTION MAP
ENTER E IF YOU WANT TO SEE CURRENT STREAMLINE MAP
ENTER T IF YOU WANT TO SEE A TIMESERIES OF CURRENT SPEED,
AND DIRECTION FIT A GIVEN LOCATION
ENTER Q IF NO MORE CURRENTS ARE DESIRED

Footnotes
(17)

T
INPUT LRTITUDE OF POINT FIT WHICH YOU WWT TO SEE TINE SERIES
IN DEG,MIN,SEC (E. G. 44,06,00)
OR IN DECIMAL DEGREES (E.G. 44.1,0,0)
42,47,0
INPUT LONGITUDE OF POINT FIT WHICH YOU WANT TO GEE TIME SERIES
IN DEG, MIN, SEC (E.G. 84, la, 30)
OR IN DECIMAL DEGREES (E.G. 84.35,0,0)
87,23,49
ORIGIN OF TIME SERIES LOCATION
LATITUDE 42 DEG 47.0 MIN
LONGITUDE 87 DEG 23.0 MIN

HOUR	DATE	TIME	CURRENT SPEED(KNOTS)	CURRENT DIR.(DEG)
0	3/27/1982	2:00	0.0	332.
3	3/27/1982	5:00	0.0	337.
6	3/27/1982	8:00	0.0	343.
9	3/27/1982	11:00	0.0	348.
12	3/27/1982	14:00	0.0	352.
15	3/27/1982	17:00	0.0	355.
la	3/27/1982	20:00	0.0	358.
21	3/27/1982	23:00	0.0	4.
24	3/28/1982	2:00	0.0	20.
27	3/28/1982	5:00	0.0	63.
30	3/28/1982	8:00	0.0	100.
33	3/28/1982	11:00	0.0	112.
36	3/28/1982	14:00	0.1	117.
39	3/28/1982	17:00	0.1	121.
42	3/28/1982	20:00	0.1	125.
45	3/28/1982	23:00	0.1	129.
48	3/29/1982	2:00	0.1	132.
51	3/29/1982	5:00	0.1	137.
54	3/29/1982	8:00	0.1	142.
57	3/29/1982	11:00	0.1	148.
60	3/29/1982	14:00	0.1	154.
63	3/29/1982	17:00	0.1	161.
66	3/29/1982	20:00	0.1	168.
69	3/29/1982	23:00	0.1	176.
72	3/30/1982	2:00	0.1	183.
75	3/30/1982	5:00	0.1	189.
78	3/30/1982	8:00	0.1	196.
al	3/30/1982	11:00	0.1	203.
a4	3/30/1982	14:00	0.1	210.
87	3/30/1982	17:00	0.1	217.
90	3/30/1982	20:00	0.1	223.
93	3/30/1982	23:00	0.1	229.
96	3/31/1982	2:00	0.1	235.

```
ENTER C IF YOU WANT TO SEE CURRENT SPEED MAP
ENTER D IF YOU WANT TO GEE CURRENT DIRECTION MAP
ENTER E IF YOU WANT TO SEE CURRENT STREAMLINE MRP
ENTER T IF YOU WANT TO GEE A TIMESERIES OF CURRENT SPEED,
 RND DIRECTION FIT A GIVEN LOCATION
ENTER Q IF NO MORE CURRENTS ARE DESIRED                    Footnotes
a                                                              (18)
INPUT LRTITUDE OF SPILL # 1
  IN     DEG, MIN, SEC     (E.G. 44,06,00)
  OR IN  DECIMAL DEGREES (E.G. 44.1,0,0)
42,47,0
INPUT LONGITUDE OF SPILL # 1
  IN     DEG, MIN, SEC     (E.G. 84,18,30)
  OR IN  DECIMAL DEGREES (E.G. 84.35,0,0)
87.23.49
ORIGIN OF SPILL NUMBER 1
LATITUDE   42 DEG 47.0 MIN
LONGITUDE 87 DEG 23.8 MIN
IS SPILL # 1 LEAKING? (ENTER NO FOR ALL-AT-ONCE SPILL)
(ENTER Y...OR...N)
NO                                                             (19)
DO YOU WRNT TO USE STANDARD WIND FIND CURRENT EFFECTS
ON THIS SPILL (SPILL # 1)?
THEY FIRE... WIND= 2X, CURRENT=100%
(ENTER Y...OR...N)
YES
-----------------      ----------------------

ORIGIN OF SPILL # 1
LATITUDE   42 DEG 47.0 MIN
LONGITUDE 87 DEG 23.8 MIN
WIND EFFECT=   2.0% CURRENT EFFECT= 100.0%
APPROXIMATE WATER DEPTH IS 334 FEET
THIS SPILL IS ALL-AT-ONCE
            ------------------------

ANY MORE SPILL ORIGINS FOR THIS RUN?
(ENTER Y... OR... N)
YES
INPUT LATITUDE OF SPILL # 2
  IN     DEG, MIN, SEC     (E. G. 44,06,00)
  OR IN  DECIMAL DEGREES (E.G. 44.1,0,0)
42.47.0
INPUT LONGITUDE OF SPILL # 2
  IN     DEG, MIN, SEC     (E.G. 84,18,30)
  OR IN DECIMAL DEGREES (E.G. 84.35,0,0)
87.24.49                                                       (20)
ORIGIN OF SPILL NUMBER 2
LFITITUDE   42 DEG 47.0 MIN
LONGITUDE 87 DEG 24.8 MIN
IS SPILL # 2 LEAKING? (ENTER NO FOR ALL-AT-ONCE SPILL)
(ENTER Y...OR...N)
NO
DO YW WANT TO USE STANDARD WIND FIND CURRENT EFFECTS
ON THIS SPILL (SPILL # 2)?
THEY FIRE... WIND= 2%, CURRENT=100%
(ENTER Y...OR...N)
YES
```

ORIGIN OF SPILL # 2
LATITUDE 42 DEG 47.0 MIN
LONGITUDE 87 DEG 24.8 MIN
WIND EFFECT= 2.0% CURRENT EFFECT= 100.0%
RPPROXIMRTE WRTER DEPTH IS 334 FEET
THIS SPILL IS ALL-AT-ONCE

ANY MORE SPILL ORIGINS FOR THIS RUN?
(ENTER Y...OR...N)
YES
INPUT LATITUDE OF SPILL # 3
IN DEG, MIN, SEC (E.G. 44,06,00)
OR IN DECIMRL DEGREES (E.G.44.1,0,0)
42.48.0
INPUT LONGITUDE OF SPILL # 3
IN DEG, MIN, SEC (E.G. 84, la, 30)
OR IN DECIMAL DEGREES (E.G. 84.35.0.0)
87.23.49
ORIGIN OF SPILL NUMBER 3
LRTITUDE 42 DEG 48.0 MIN
LONGITUDE 87 DEG 23.0 MIN
IS SPILL # 3 LEAKING? (ENTER NO FOR RLL-FIT-ONCE SPILL)
(ENTER Y...OR...N)
NO
DO YOU WANT TO USE STANDARD WIND AND CURRENT EFFECTS
ON THIS SPILL (SPILL # 3)?
THEY RRE.. . WIND= 2%, CURRENT=100%
(ENTER Y...OR...N)
YES

ORIGIN OF SPILL # 3
LATITUDE 42 DEG 48.0 MIN
LONGITUDE a7 DEG 23.8 MIN
WIND EFFECT= 2.0% CURRENT EFFECT= 100.0%
APPROXIMATE WATER DEPTH IS 324 FEET
THIS SPILL IS ALL-AT-ONCE

ANY MORE SPILL ORIGINS FOR THIS RUN?
(ENTER Y...OR...N)
YES
INPUT LATITUDE OF SPILL # 4
IN DEG, MIN, SEC (E. G. 44,06,00)
OR IN DECIMRL DEGREES (E.G. 44.1,0,0)
42.47.0
INPUT LONGITUDE OF SPILL # 4
IN DEG, MIN, SEC (E. G. 84,18, 30)
OR IN DECIMAL DEGREES (E. G. 84.35.0.0)
07.22.49
ORIGIN OF SPILL NUMBER 4
LATITUDE 42 DEG 47.0 MIN
LONGITUDE a7 DEG 22.0 MIN
IS SPILL # 4 LEAKING? (ENTER NO FOR ALL-AT-ONCE SPILL)
(ENTER Y...OR...N)
NO

```
DO YOU WRNT TO USE STANDARD WIND FIND CURRENT EFFECTS
ON THIS SPILL (SPILL #4)?
THEY ARE... WIND= 2%, CURRENT=100%
(ENTER Y.. . OR.. . N)
YES
-----------------------------------------
ORIGIN OF SPILL # 4
LATITUDE    42 DEG 47.0 MIN
LONGITUDE 87 DEG 22.8 MIN
WIND EFFECT=    2.0% CURRENT EFFECT= 100.0%
APPROXIMATE WATER DEPTH IS 334 FEET
THIS SPILL IS ALL-AT-ONCE
-----------------------------------------
ANY MORE SPILL ORIGINS FOR THIS RUN?
(ENTER Y.. . OR.. . N)
YES
INPUT LATITUDE OF SPILL #5
  IN      DEG, MIN, SEC      (E.G. 44,06,00)
  OR IN DECIMAL DEGREES (E.G. 44. 1,0,0)
42.46.0
INPUT LONGITUDE OF SPILL # 5
  IN      DEG, MIN, SEC      (E. G. 84,18,30)
  OR IN DECIMAL DEGREES (E.G.84.35,0,0)
87.23.49
ORIGIN OF SPILL NUMBER 5
LATITUDE    42 DEG 46.0 MIN
LONGITUDE 87 DEG 23.8 MIN
IS SPILL # 5 LERKING? (ENTER NO FOR ALL-AT-ONCE SPILL)
(ENTER Y.. . OR.. . N)
NO
DO YOU WRNT TO USE STANDARD WIND AND CURRENT EFFECTS
ON THIS SPILL (SPILL #5)?
THEY FIRE.. . WIND= 2%, CURRENT=100%
(ENTER Y...OR...N)
YES
-----------------------------------------
ORIGIN OF SPILL # 5
LATITUDE    42 DEG 46.0 MIN
LONGITUDE 87 DEG 23.6 MIN
WIND EFFECT=    2.0% CURRENT EFFECT= 100.0%
APPROXIMATE WRTER DEPTH IS 334 FEET
THIS SPILL IS ALL-AT-ONCE
-----------------------------------------
ANY MORE SPILL ORIGINS FOR THIS RUN?
(ENTER Y.. . OR.. . N)
YES
INPUT LATITUDE OF SPILL # 6
  IN      DEG, MIN, SEC      (E. G. 44,06,00)
  OR IN DECIMAL DEGREES (E.G. 44.1,0,0)
42.47.0
INPUT LONGITUDE OF SPILL 8 6
  IN      DEG, MIN, SEC      (E.G. 84, 18,30)
  OR IN DECIMAL DEGREES (E.G. 84.35,0,0)
87,23,49
```

ORIGIN OF SPILL NUMBER 6
LATITUDE 42 DEG 47.0 MIN
LONGITUDE 87 DEG 23.8 MIN
IS SPILL # 6 LERKING? (ENTER NO FOR ALL-AT-ONCE SPILL)
(ENTER Y.. . OR.. . N)
NO
DO YOU WRNT TO USE STANDARD WIND AND CURRENT EFFECTS
ON THIS SPILL (SPILL #6)?
THEY RRE.. . WIND = 2%, CURRENT=100%
(ENTER Y.. . OR.. . N)
NO

Footnotes
(21)

ENTER WIND EFFECT PERCENT (E.G. 2.0 MEANS TWO PERCENT)
0
ENTER CURRENT EFFECT IN PERCENT (E.G. 100 MEANS A HUNDRED PERCENT)
100

ORIGIN OF SPILL # 6
LATITUDE 42 DEG 47.0 MIN
LONGITUDE 87 DEG 23.8 MIN
WIND EFFECT= 0.0% CURRENT EFFECT= 100.0%
APPROXIMATE WATER DEPTH IS 334 FEET
THIS SPILL IS ALL-AT-ONCE

RNY MORE SPILL ORIGINS FOR THIS RUN?
(ENTER Y.. . OR.. . N)
YES
INPUT LRTITUDE OF SPILL # 7
IN DEG, MIN, SEC (E. G. 44,06,00)
OR IN DECIMAL DEGREES (E.G.44.1,0,0)
42,47,0
INPUT LONGITUDE OF SPILL # 7
IN DEG, MIN, SEC (E.G. 84,18,30)
OR IN DECIMAL DEGREES (E.G. 84.35,0,0)
87.23.49
ORIGIN OF SPILL NUMBER 7
LATITUDE 42 DEG 47.0 MIN
LONGITUDE 87 DEG 23.8 MIN
IS SPILL # 7 LEAKING? (ENTER NO FOR ALL-AT-ONCE SPILL)
(ENTER Y.. . OR.. . N)
NO
DO YOU WANT TO USE STANDARD WIND AND CURRENT EFFECTS
ON THIS SPILL (SPILL #7)?
THEY ARE... WIND= 2X, CURRENT=100%
(ENTER Y.. . OR.. . N)
NO (22)
ENTER WIND EFFECT PERCENT (E.G. 2.0 MEANS TWO PERCENT)
2
ENTER CURRENT EFFECT IN PERCENT (E.G. 100 MEANS A HUNDRED PERCENT)
0

ORIGIN OF SPILL # 7
LATITUDE 42 DEG 47.0 MIN
LONGITUDE 87 DEG 23.8 MIN
WIND EFFECT= 2.0% CURRENT EFFECT= 0.0%
APPROXIMATE WATER DEPTH IS 334 FEET
THIS SPILL IS ALL-AT-ONCE

```
ANY MORE SPILL ORIGINS FOR THIS RUN?
(ENTER Y.. . OR.. . N)
YES
INPUT LATITUDE OF SPILL # 8
   IN      DEG, MIN, SEC       (E.G. 44,06,00)
   OR IN DECIMAL DEGREES (E.G. 44.1,0,0)
42.47.0
INPUT LONGITUDE OF SPILL # 8
   IN      DEG, MIN, SEC       (E. G. 84,18,30)
   OR IN DECIMAL DEGREES (E.G. 84.35,0,0)
87,23,49
ORIGIN OF SPILL NUMBER 8
LATITUDE   42 DEG 47.0 MIN
LONGITUDE 87 DEG 23.8 MIN
IS SPILL # 8 LEAKING? (ENTER NO FOR ALL-AT-ONCE SPILL)
(ENTER Y.. . OR.. . N)                                              Footnotes
YES                                                                     (23)
DO YOU WANT TO USE STANDARD WIND AND CURRENT EFFECTS
ON THIS SPILL (SPILL #8)?
THEY RRE.. . WIND=  2%, CURRENT=100%
(ENTER Y.. . OR.. . N)
YES
      ______________  _______________________

ORIGIN OF SPILL # 8
LATITUDE   42 DEG 47.0 MIN
LONGITUDE 87 DEG 23.8 MIN
WIND EFFECT=   2.0% CURRENT EFFECT= 100.0%
APPROXIMATE WATER DEPTH IS 334 FEET
THIS SPILL IS LERKING ONE UNIT EVERY 3 HOURS
  _________              _____________

ANY MORE SPILL ORIGINS FOR THIS RUN?
(ENTER Y.. . OR.. . N)
NO                                                                      (24)
CALCULATING TRAJECTORIES...PLEASE STAND BY                              (25)
INPUT LATITUDE OF SUBGRID CENTER
   IN      DEG, MIN, SEC       (E. G. 44,06,00)
   OR IN DECIMAL DEGREES (E.G.44.1,0,0)
42.37.0                                                                 (26)
INPUT LONGITUDE OF SUBGRID CENTER
   IN      DEG, MIN, SEC       E.G. 84,18,00)
   OR IN DECIMAL DEGREES (E.G.84.35,0,0)
87.30.0
SUBGRID CENTER:
LATITUDE   42 DEG 37.0 MIN
LONGITUDE 87 DEG 29.9 MIN
DO YOU WANT STANDARD SUBGRID SIZE OF 60.0 NAUTICAL MILES?
(ENTER Y.. . OR.. . N)
NO
INPUT SIZE OF SUBGRID IN NAUTICAL MILES
30                                                                      (27)
```

YOU HAVE CHOSEN A 30.0 NAUTICAL MILE SQUARE SUBGRID
LATITUDE AND LONGITUDE OF SUBGRID CORNERS:

SW CORNER
LATITUDE 42 DEG 21.7 MIN
LONGITUDE 87 DEG 50.0 MIN

NW CORNER
LATITUDE 42 DEG 51.8 MIN
LONGITUDE 87 DEG 50.7 MIN

NE CORNER
LATITUDE 42 DEG 52.2 MIN
LONGITUDE 87 DEG 9.8 MIN

SE CORNER
LATITUDE 42 DEG 22.2 MIN
LONGITUDE 87 DEG 9.4 MIN

DO YOU WANT TO SEE A DEPTH MAP?
(ENTER Y...OR...N)

YES

Footnotes
(28)

```
DEPTH IN FEET
 0= 15.22     TO  108.5
 1= 108.5     TO  201.8
 2= 201.8     TO  295.1
 3= 295.1     TO  388.3
 4= 388.3     TO  481.6
**42,51. 8**87,50.7***************************42,52.2**87, 9.8**
* 0 0 0 0 0 0 0 1 1 1 1 1 2 2 2 2 2 3 3 3 3 3 3 3 3 3 3 4 4 4*
* 0 0 0 0 0 0 0 1 1 1 1 1 2 2 2 2 2 3 3 3 3 3 3 3 3 3 4 4 4 4*
* 0 0 0 0 0 0 0 1 1 1 1 1 2 2 2 2 2 3 3 3 3 3 3 3 3 4 4 4 4 4*
* 0 0 0 0 0 0 0 0 1 1 1 1 2 2 2 2 2 3 3 3 3 3 3 3 4 4 4 4 4 4*
* 0 0 0 0 0 0 0 0 1 1 1 1 2 2 2 2 2 3 3 3 3 3 3 4 4 4 4 4 4 4*
* 0 0 0 0 0 0 0 0 1 1 1 1 2 2 2 2 2 3 3 3 3 3 3 4 4 4 4 4 4 4*
* 0 0 0 0 0 0 0 0 1 1 1 1 2 2 2 2 3 3 3 3 3 3 4 4 4 4 4 4 4 4*
●     0 0 0 0 0 0 0 1 1 1 1 1 2 2 2 2 3 3 3 3 3 3 4 4 4 4 4 4 4 4″
* 0 0 0 0 0 0 0 1 1 1 1 1 2 2 2 2 3 3 3 3 3 3 4 4 4 4 4 4 4 4*
●     0 0 0 0 0 0 0 1 1 1 1 1 2 2 2 2 3 3 3 3 3 4 4 4 4 4 4 4 4 4 *
* 0 0 0 0 0 0 0 1 1 1 1 2 2 2 2 2 3 3 3 3 3 4 4 4 4 4 4 4 4 4*
* 0 0 0 0 0 0 0 1 1 1 1 2 2 2 2 3 3 3 3 3 3 4 4 4 4 4 4 4 4 4*
* 0 0 0 0 0 0 0 1 1 1 1 2 2 2 2 3 3 3 3 3 3 4 4 4 4 4 4 4 4 4*
* 0 0 0 0 0 0 1 1 1 1 1 2 2 2 2 3 3 3 3 3 3 4 4 4 4 4 4 4 4 4*
* 0 0 0 0 0 0 1 1 1 1 1 2 2 2 2 3 3 3 3 3 3 4 4 4 4 4 4 4 4 4*
* 0 0 0 0 0 0 1 1 1 1 2 2 2 2 2 3 3 3 3 3 3 4 4 4 4 4 4 4 4 4*
* 0 0 0 0 0 0 1 1 1 1 2 2 2 2 2 3 3 3 3 3 3 4 4 4 4 4 4 4 4 4*
* 0 0 0 0 0 0 1 1 1 1 2 2 2 2 2 3 3 3 3 3 3 4 4 4 4 4 4 4 4 4*
●     0 0 0 0 0 0 1 1 1 1 2 2 2 2 2 3 3 3 3 3 3 4 4 4 4 4 4 4 4 4 *
* 0 0 0 0 0 0 1 1 1 1 2 2 2 2 2 3 3 3 3 3 3 3 4 4 4 4 4 4 4 4*
* 0 0 0 0 0 1 1 1 1 1 2 2 2 2 2 3 3 3 3 3 3 3 4 4 4 4 4 4 4 4*
* 0 0 0 0 0 1 1 1 1 1 2 2 2 2 2 3 3 3 3 3 3 3 4 4 4 4 4 4 4 4*
* 0 0 0 0 0 1 1 1 1 1 2 2 2 2 2 3 3 3 3 3 3 3 3 4 4 4 4 4 4 4*
* 0 0 0 0 0 1 1 1 1 1 2 2 2 2 2 3 3 3 3 3 3 3 3 4 4 4 4 4 4 4*
* 0 0 0 0 0 1 1 1 1 1 2 2 2 2 2 2 3 3 3 3 3 3 3 3 4 4 4 4 4 4*
* 0 0 0 0 0 1 1 1 1 1 2 2 2 2 2 2 3 3 3 3 3 3 3 3 3 4 4 4 4 4*
* 0 0 0 0 0 1 1 1 1 1 2 2 2 2 2 2 3 3 3 3 3 3 3 3 3 4 4 4 4 4*
* 0 0 0 0 0 0 1 1 1 1 2 2 2 2 2 2 2 3 3 3 3 3 3 3 3 3 3 4 4 4*
* 0 0 0 0 0 0 1 1 1 1 1 2 2 2 2 2 2 3 3 3 3 3 3 3 3 3 3 3 4 4*
* 0 0 0 0 0 0 1 1 1 1 1 2 2 2 2 2 2 2 3 3 3 3 3 3 3 3 3 3 3 3*
**42,21.7**87,50.0***************************42,22.2**87, 9.411
```

```
ENTER L IF  YOU WRNT TO SEE SPILL LOCATIONS
ENTER T IF  YOU WRNT TO SEE TRACK OF FIN INDIVIDUAL SPILL
ENTER S IF YOU WANT A NEW SUBGRID
ENTER Q TO QUIT OR TO CHRNGE SPILL LOCATIONS
L
ENTER THE NUMBER(S) OF THE SPILL(S) YOU WANT TO SEE PLOTTED
ONE ENTRY PER LINE, END THE LIST WITH 0 (ZERO)
1
2
3
4
5
0
ENTER THE TIME(S) IN HOURS (0-  96) AFTER THE START TIME
 3/27/1982 2:00 AT WHICH YOU WANT TO SEE SPILL LOCRTIONS
YOU MAY MAKE UP TO 25 ENTRIES, ONE ENTRY PER LINE
END THE LIST WITH -1
24
48
72
96
-1
SPILL LOCATIONS FIT 24 HOURS 3/28/1982 2:00
 A = ORIGIN OF SPILL 1
 B = ORIGIN OF SPILL 2
 C = ORIGIN OF SPILL 3
 D = ORIGIN OF SPILL 4
 E = ORIGIN OF SPILL 5
 F = 1, 2
**42,51.8**87,50.7**************************42,52.2**87, 9.8**
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                        C                    *
*                                      B A D                  *
*                            3           E                    *
*                          F 4                                *
*                          5                                  *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
**42,21.7**87,50.0**************************42,22.2**87, 9.4**
```

Footnotes
(29)

```
SPILL LOCATIONS AT 48 HOURS 3/29/1982 2:00
 A = ORIGIN OF SPILL 1
 B = ORIGIN OF SPILL 2
 C = ORIGIN OF SPILL 3
 D = ORIGIN OF SPILL 4
 E = ORIGIN OF SPILL 5
 F = 1, 3

**42,51.8**87,50.7**************************42,52.2**87, 9.8**
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                        C                   *
*                                      B A D                 *
*                                        E                   *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                          F 4                               *
*                       2 5                                  *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
**42,21.7**87,50.0**************************42,22.2**87, 9.4**
```

SPILL LOCATIONS FIT 72 HOURS 3/30/1982 2:00

A = ORIGIN OF SPILL 1
B = ORIGIN OF SPILL 2
C = ORIGIN OF SPILL 3
D = ORIGIN OF SPILL 4
E = ORIGIN OF SPILL 5
F = I, 4

```
**42,51.8**87,50.7*************************42,52.2**87, 9.8**
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                       C                   *
*                                     B A D                 *
*                                       E                   *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                     3                                     *
*                       F                                   *
*                     2 5                                   *
*                                                           *
*                                                           *
*                                                           *
**42,21.7**87,50.0*************************42,22.2**87, 9.4**
```

SPILL LOCATIONS FIT 96 HOURS 3/31/1982 2:00
A = ORIGIN OF SPILL 1
B = ORIGIN OF SPILL 2
C = ORIGIN OF SPILL 3
D = ORIGIN OF SPILL 4
E = ORIGIN OF SPILL 5

```
**42,51.8**87,50.7**************************42,52.2**87, 9.8**
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                       C                    *
*                                     B A D                  *
*                                       E                    *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*           3                                                *
*           4                                                *
*         2 1                                                *
*           5                                                *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
**42,21.7**87,50.0**************************42,22.2**87, 9.4**
```

Footnotes (30)

```
ENTER L IF  YOU WANT TO SEE SPILL LOCATIONS
ENTER T IF  YOU WANT TO SEE TRACK OF AN INDIVIDUAL SPILL
ENTER S IF YOU WANT A NEW SUBGRID
ENTER Q TO QUIT OR TO CHANGE SPILL LOCATIONS
T
ENTER THE NUMBER OF THE SPILL YOU WANT TO SEE PLOTTED
1
TRACK OF SPILL # 1 FROM 3/27/1982 2:00  TO  3/31/1982 2:00
ONE POSITION EVER 3.5 HOURS
 A = ORIGIN OF SPILL  1
 B = 0, 1
 C = 3, 4
 D = 5, 6
 E = 1, 2
**42,51.8**87,50.7*************************42,52.2**87, 9.8**
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                           6 5 4 3 2 1 A                   *
*                           7                               *
*                         8                                 *
*                         9                                 *
*                                                           *
*                         0                                 *
*                         1                                 *
*                                                           *
*                         2                                 *
*                                                           *
*                         3                                 *
*                         4                                 *
*                                                           *
*                         5                                 *
*                         6                                 *
*           E                                               *
*           0             7                                 *
*             9         8                                   *
*             8         9                                   *
*               7     B                                     *
*                 D C 2                                     *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
**42,21.7**87,50.0*************************42,22.2**87, 9.4**
```

```
ENTER L IF YOU WANT TO SEE SPILL LOCATIONS
ENTER T IF YOU WANT TO SEE TRACK OF AN INDIVIDUAL SPILL
ENTER S IF YOU WANT A NEW SUBGRID
ENTER Q TO QUIT OR TO CHANGE SPILL LOCATIONS                Footnotes
        OK TO CHANGE WINDS
T                                                              (31)
ENTER THE NUMBER OF THE SPILL YOU WANT TO SEE PLOTTED
6
TRACK OF SPILL # 6 FROM 3/27/1982 2:00 TO 3/31/1982 2:00
ONE POSITION EVERY 3. HOURS
 A = ORIGIN OF SPILL 6
 B = A, 1, 2, 3, 4, 5, 6. 7, 8, 9, 0, 1, 2, 3, 4
 c = 5, 6, 7, a
 D = 9, 0
 E = 2, 3, 4
 F = 5, 6, 7
 G = 8, 9, 0
 H = 1, 2
**42,51.8**87,50.7**************************42,52.2**87, 9.8**
*                                     H                      *
*                                     G                      *
*                                     F                      *
*                                   E                        *
*                                   1 D                      *
*                                     C B                    *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*                                                            *
**42,21.7**87,50.0**************************42,22.2**87, 9.4**
```

```
ENTER L IF YOU WANT TO SEE SPILL LOCATIONS
ENTER T IF YOU WANT TO SEE TRACK OF AN INDIVIDUAL SPILL
ENTER S IF YOU WANT A NEW SUBGRID
ENTER Q TO QUIT OR TO CHANGE SPILL LOCATIONS
        OR TO CHANGE WINDS
T
ENTER THE NUMBER OF THE SPILL YOU WANT TO SEE PLOTTED
7
TRACK OF SPILL # 7 FROM 3/27/1982 2:00 TO 3/31/1982 2:00
ONE POSITION EVERY 3. HOURS
 A = ORIGIN OF SPILL 7
 B = 6, 7
 C = 8, 9
 D = 0, 1
 E = 2, 3
 F = 4, 5
**42,51.8**87,50.7*************************42,52.2**87, 9.8**
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                          B 5 4 3 2 1 A                      *
*                          8                                  *
*                        9                                    *
*                                                             *
*                        0                                    *
*                        1                                    *
*                        2                                    *
*                        3                                    *
*                                                             *
*                          4                                  *
*          2 1             5                                  *
*            0 9           6                                  *
*              8 7       7                                    *
*                6     D C                                    *
*                  F E                                        *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
**42,21.7**87,50.0*************************42,22.2**87, 9.4**
```

Footnotes
(32)

ENTER L IF YOU WANT TO SEE SPILL LOCATIONS
ENTER T IF YOU WRNT TO SEE TRACK OF FIN INDIVIDURL SPILL
ENTER S IF YOU WANT A NEW SUBGRID
ENTER Q TO QUIT OR TO CHANGE SPILL LOCATIONS

ENTER THE NUMBER(S) OF THE SPILL(S) YOU WANT TO SEE PLOTTED

Footnotes (33)

8
Ø
ONE ENTRY PER LINE, END THE LIST WITH 0 (ZERO)
ENTER THE TIME(S) IN HOURS (Ø-96) AFTER THE START TIME
3/27/1982 2:ØØ FIT WHICH YOU WANT TO SEE SPILL LOCATIONS
YOU MAY MAKE UP TO 25 ENTRIES, ONE ENTRY PER LINE
END THE LIST WITH -1
96
-1

```
SPILL LOCATIONS FIT 96 HOURS 3/31/1982 2:ØØ
 A = ORIGIN OF SPILL 8
 B = A, 8
 C = 8, 8
**42,51.8**87,50.7*************************42,52.2**87, 9.8**
*                         8         8                       *
*                       8           8                       *
*                       8             8                     *
*                                     8                     *
*                       8               C                   *
*                       8               B                   *
*                                                           *
*                       8                                   *
*                     8                                     *
*                                                           *
*                     8                                     *
*                     8                                     *
*                                                           *
*                     8                                     *
*                   8                                       *
*                 8 8                                       *
*               8                                           *
*             8                                             *
*             8                                             *
*                                                           *
*           8                                               *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
*                                                           *
**42,21.7**87,50.0*************************42,22.2**87, 9.4**
```

```
ENTER L IF YOU WANT TO SEE SPILL LOCATIONS
ENTER T IF YOU WANT TO SEE TRACK OF AN INDIVIDUAL SPILL
ENTER S IF YOU WANT A NEW SUBGRID
ENTER Q TO QUIT OR TO CHANGE SPILL LOCATIONS                    Footnotes
        OR TO CHANGE WINDS
Q                                                                (34)
PLEASE TYPE AS MANY LINES AS YOU WISH IF YOU HAVE ANY
COMMENTS OR SUGGESTIONS CONCERNING THIS SPILL MODEL
END WITH A CARRIAGE RETURN
WE ARE ALWAYS INTERESTED IN WHY THE MODEL WAS RUN AND HOW THE MODEL (35)
MAY HAVE HELPED YOU.  THANKS.

TYPE 'LOCATIONS' IF YOU WANT NEW SPILL LOCATIONS SAME WINDS OR
TYPE 'WINDS' IF YOU WANT NEW WINDS SAME LOCATIONS OR
PRESS THE CARRIAGE RETURN KEY IF YOU WANT TO QUIT
OPTION:_                                                         (36)
GOODBYE
```

FOOTNOTES

1. Contact the authors for instructions to access the GLERL computer over the telephone system. When a connection has been established with the GLERL computer, press the return key to get initial system message.

2. After initial system message, type "SPILL" in response to "Usernumber:" prompt.

3. In response to "ENTER LAKE NAME:" prompt, enter "SUPERIOR", "MICHIGAN", "HURON", "ST.CLAIR", "ERIE", or "ONTARIO".

4. Name and agency are used to keep track of who's using the model.

5. Starting date and time are used only to label wind input messages and current and spill location maps with the corresponding time and date.

6. The user types in the wind data. See section 3 of this report for more details about wind input.

7. The forecast is extended to 48 h.

8. The forecast is extended to 72 h.

9. The forecast is extended to 96 h. It is possible to forecast up to 672 h (28 days).

10. The forecast will stop at 96 h.

11. If the user enters "N" at this point, wind data can be changed by retyping new values.

12. Depending on the wind data, the length of the forecast, and which lake grid is being used, it may take 5-30 min to calculate the currents.

13. Enter "N" if you are not interested in maps or time series of current speed and direction.

14. User selects current speed map at 96 h.

15. User selects corresponding current direction. (0°= from north).

16. User selects corresponding streamline map. Some selected streamlines (-50, 0, 50) have been sketched in to indicate the general pattern of circulation in the lake. Currents are parallel to the streamlines, with higher values of stream function to the right of the current direction.

17. User selects time series of currents at latitude 42°47' and longitude 87°23'49".

18. User is done looking at currents and moves on to spill location specification. If the restart feature for new spill locations with same winds is used at the end of the run, the programs start over at this point.

19. A single marker is released at 42°47'N, 87'23'49"W at time 0.

20. The next four spills will be 1 minute west, north, east, and south of the first spill to get an idea of how much effect an error in the initial location will have on the location after 96 h.

21. Spill #6 is at the same location as spill #1, but will have no wind effect, only current.

22. Spill #7 is also at the same location as spill #1, but will have no current effect, only wind. This spill and spill #6 will show the relative effects of wind and current on the final spill location.

23. Spill #8 is the same as spill #1, except that it is leaking one particle every 3 h.

24. The user is done entering spill data. Up to nine different spills can be specified.

25. The trajectory calculation should only take a few minutes.

26. The subgrid center is the center of the square window through which the user can examine spill locations and tracks. Usually it is the same as the initial spill location, but here the user moved it south and west to see as much of the track as possible.

27. A 30-nautical-mile square is used to improve the resolution of the display.

28. Depths in the subgrid are divided into five categories and displayed as numbers 0 to 4.

29. The user decides to look at the locations of spills #1, #2, #3, #4, and #5 at 24, 48, 72, and 96 h. All four maps will be printed out before another prompting message appears, so the user can leave the terminal temporarily.

30. The user selects the track of spill #1. A spill track shows its position as a function of time.

31. Track of spill #6 (current only).

32. Track of spill #7 (wind only). Note that the combined effect of wind and current can be very different from the sum of the individual effects.

33. Spill locations of leaking spill #8. These are the positions of the particles released from the spill site after 96 h. One particle was released every 3 h, so there are 33 particles in all.

34. The user terminates the run.

35. Comments here would be appreciated.

36. The user elects not to restart with new spill locations or winds.