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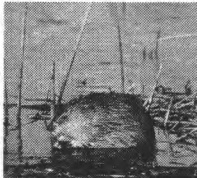


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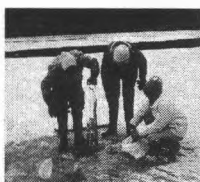
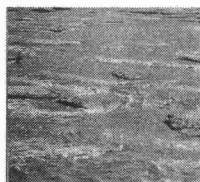


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Northern River Basins Study



NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 126
**A SPILL RESPONSE MODEL,
USER'S MANUAL**



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Prepared for the
Northern River Basins Study
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by

B. Aitken
Environment Canada

NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 126

**A SPILL RESPONSE MODEL,
USER'S MANUAL**

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PREFACE:

The Northern River Basins Study was initiated through the "Canada-Alberta-Northwest Territories Agreement Respecting the Peace-Athabasca-Slave River Basin Study, Phase II - Technical Studies" which was signed September 27, 1991. The purpose of the Study is to understand and characterize the cumulative effects of development on the water and aquatic environment of the Study Area by coordinating with existing programs and undertaking appropriate new technical studies.

This publication reports the method and findings of particular work conducted as part of the Northern River Basins Study. As such, the work was governed by a specific terms of reference and is expected to contribute information about the Study Area within the context of the overall study as described by the Study Final Report. This report has been reviewed by the Study Science Advisory Committee in regards to scientific content and has been approved by the Study Board of Directors for public release.

It is explicit in the objectives of the Study to report the results of technical work regularly to the public. This objective is served by distributing project reports to an extensive network of libraries, agencies, organizations and interested individuals and by granting universal permission to reproduce the material.

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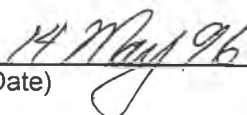
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this publication be subjected to proper and responsible review and be considered for release to the public.



(Dr. Fred J. Wrona, Science Director)



(Date)

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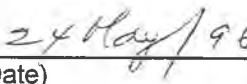
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SUPPLEMENTAL COMMENTARY HAS BEEN ADDED TO THIS PUBLICATION: [] Yes [] No



(Dr. P. A. Larkin, Ph.D., Chair)



(Date)

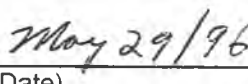
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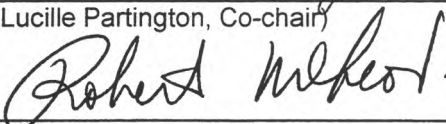
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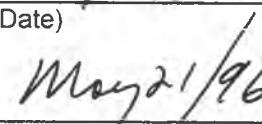
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(Date)



(Robert McLeod, Co-chair)



(Date)

A SPILL RESPONSE MODEL, USERS MANUAL

STUDY PERSPECTIVE

Water is essential to life and it can be an important vector for conveying contaminants into humans. To assist the Northern River Basins Study (NRBS) Board in making recommendations about the safety of drinking water supplies, the Drinking Water component designed a program of studies.

Spills, unlike licensed discharges into surface waters, are unplanned events and most often influence the quality of water for human drinking purposes. A need was expressed for a capability to predict the movement of a hazardous spill into surface waters. Two significant elements of such a model would include: identification on the timing for a spill to reach a given downstream point, and the length of time until effects subside to pre-spill water quality values. Initial attention was focused on development of a predictive capability for determining the arrival of a spill at downstream sites. The Athabasca River was chosen for the development of a spill response model because of existing development and its flow.

This report provides a spill response model and a user's manual for the Athabasca River. The model provides the capability for downstream sites from a spill to develop a prediction of the likely time when the spilled material is likely to come into contact with a water intake point. The model affords a predictive capability to users not previously available. It affords the opportunity for users to be warned of the onset of likely contamination thereby presenting an opportunity to take corrective action to avoid use of contaminated drinking water supplies. The model does not predict the interval of time when contamination is no longer an issue.

A preliminary version of the model was displayed at the Board's February 1995 Science Forum in Grande Prairie. Several changes were made to the model based on public comments. Regulators, communities, industry and private individuals can use this model to predict the time of arrival and concentration of a spill at various points along the river.

Related Study Questions

- 13.a) *What predictive tools are required to determine the cumulative effects of man made discharges on the water and aquatic habitat?*
- b) *What are the cumulative effects of man made discharges on the water and aquatic environments?*
14. *What long term monitoring programs and predictive models are required to provide an ongoing assessment of the state of the aquatic ecosystems. These programs must ensure that all stakeholders have the opportunity for input.*

REPORT SUMMARY

During the public consultation portions of the Northern River Basin Study several requests were received to setup a system that would warn communities of a potentially hazardous spill. Environment Canada in consultation with the Drinking Water Component of the study developed a terms of reference and awarded a contract to Golder Associates of Calgary. The Terms of Reference required a user friendly map based system that would allow a plant operator to make an informed decision to help protect the community drinking water supply. A working version of the model was on display at the NRBS Science Forum in Grand Prairie. Several changes were made to the model as a result of comments received at the Science Forum and the model development was completed in March of 1995. This manual was produced by Environment Canada.

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1. SUMMARY OF THE MODEL

The model is designed as a first response tool to be used by local authorities who are required to develop immediate plans to reduce the impacts of a reported spill on the Athabasca River.

The consultant has developed a user-friendly computer based system that will estimate the time of arrival and concentration of a contaminate at any point downstream of a spill. The model assumes that a conservative type contaminate has been spilled and therefore makes no adjustment to the downstream concentration to account for losses by evaporation, deposit on sediment, etc. Therefore the modeled concentration for a non-conservative contaminate may be higher than what is experienced in the field.

The system runs under MS-Windows Ver. 3.1. The system operator uses a mouse to point to the spill location and the model, through an array of default values, will produce a plot of concentration of the contaminate vs. time for all downstream municipal water intakes. Although default values can be used in the model the operator should use any additional information that is available. The consultant used methodology developed in two NRBS reports (Van Der Vinne, G. and Andres, D. 1993a and Van Der Vinne, G. and Andres, D. 1993b) as well as previous works by Beltaos, 1979, and Andres, D. et al. 1989, to produce relationships for time of travel and the concentration profiles.

Adjustments are made to the coefficients to reflect the different hydraulic characteristics during periods of ice cover and open water.'

2. INSTALLING NRBS-SPILL MODEL

The following section describes how to install NRBS-SPILL directly on your computer's hard disk from the floppy disk provided.

1. Start Windows. Your computer may boot up with Windows already running. If this is the case then go to step 2. If your computer boots up to a DOS C:\> prompt you can start Windows by typing WIN and then pressing the {ENTER} key.
2. Insert the NRBS-SPILL diskette in your disk drive.
3. Click on 'FILE' in the Windows Program Manager Toolbar. A pull down menu will appear(see Figure 1).

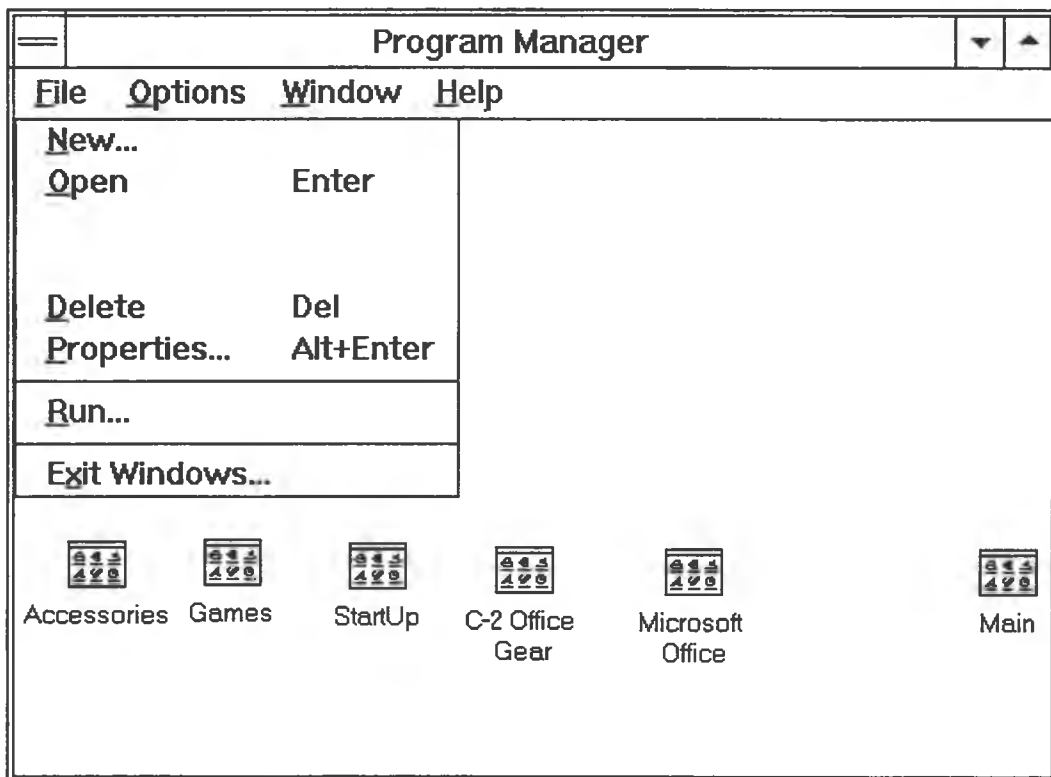


Figure 1

4. Select 'RUN' from the File Menu. The 'RUN' control box will be displayed(see Figure 2).

5. In the Command Line box type: A:\install.exe {ENTER}

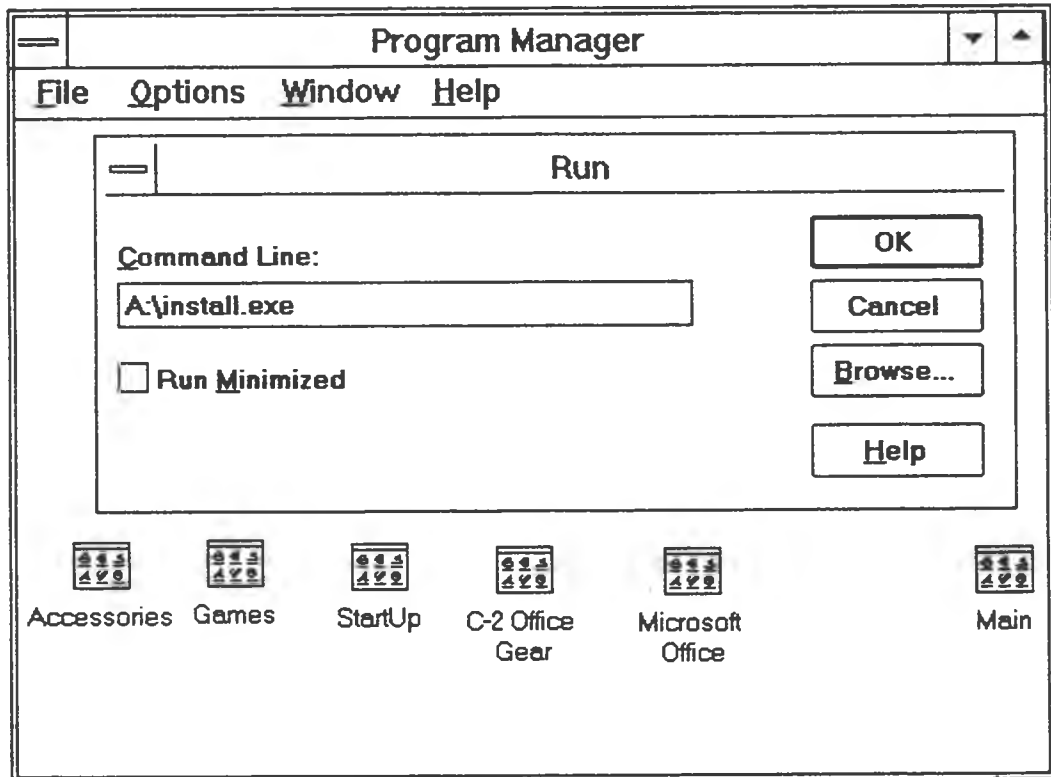


Figure 2

5. Read the Introduction and press continue to advance to the next page. Click the 'Continue' button on the next two screens. The install program will copy the required files from the diskette to your hard drive.

6. Click on the 'Create' button on the Icons Screen. This will load the NRBS-SPILL icon to your windows desktop.

7. Click on the 'OK' button to complete the installation and return to the Windows Program Manager(see Figure 3). You may use the mouse to move and size the spill program group window.

You are now ready to run the NRBS-SPILL model.

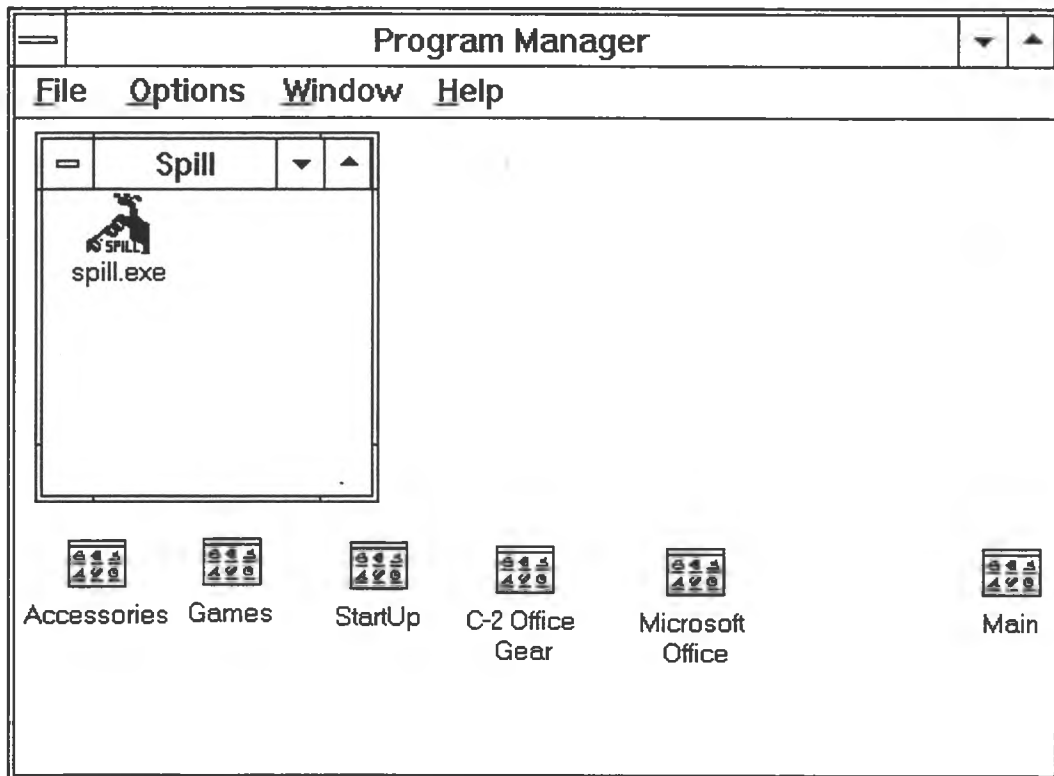


Figure 3

3. GETTING STARTED

a) Introduction

This section will describe the most basic procedure for using the NRBS-SPILL model. The procedure will use the default values supplied by the program. If more detailed information is available then that information should be used. Procedures on how to add this information are included in the section entitled Advanced Users. It should be noted that without adding more information the model will give results that are not realistic. Although the time of travel estimates are still acceptable the concentration estimates may not be completely accurate.

b) Starting the Program

This program will only run from Windows so you must start Windows in the usual manner and close all other applications. Select the SPILL program group from the Program Manager window. This can be done either by double clicking on the icon or by single clicking and then selecting 'Restore' in the pop-up menu that appears.

To start the program double click on the Spill icon. There will be a short wait while the program generates the map(see Figure 4). To make the map easier to see and work with the Spill1 window should be enlarged. This can be done by clicking on the upward pointing triangle in the top right corner of the Spill1 window. This enlarges the map to the full screen. The model is now ready to run.

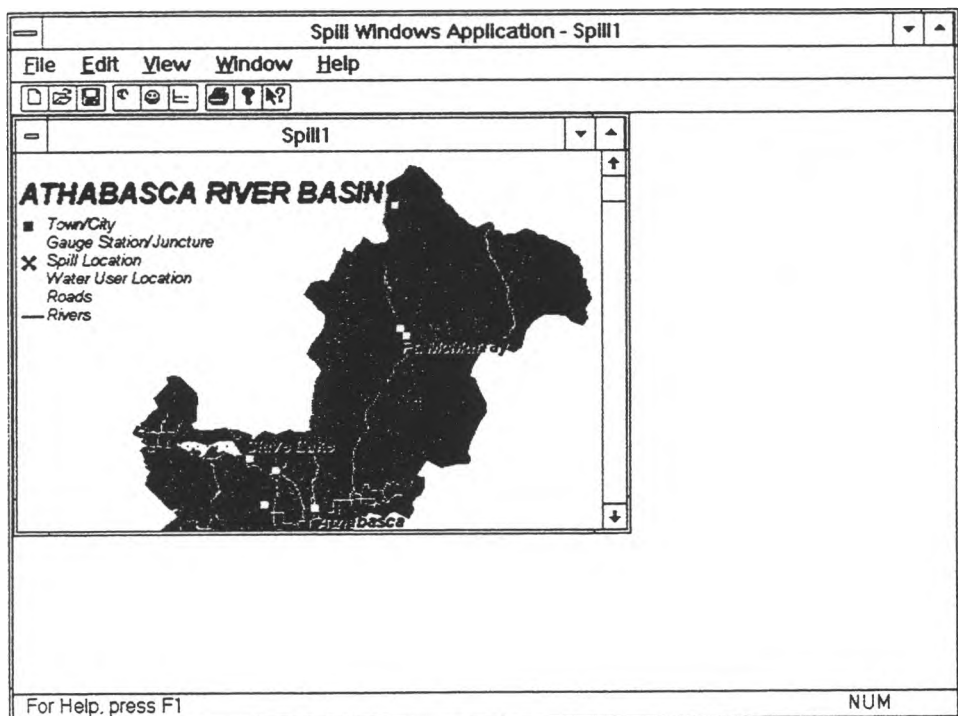


Figure 4

4. RUNNING THE MODEL

a) Spill Location

The first step in running the model is to select the location of the spill. This is done by positioning the arrow at the location of the spill and then clicking the **RIGHT** mouse button. A Pop-up menu (see Figure 5) is displayed. Clicking on the 'Set Spill' item in the menu will cause the menu to disappear and a red 'X' to be placed at the location that you selected. If the location is not correct you can select a new location by repeating this procedure.

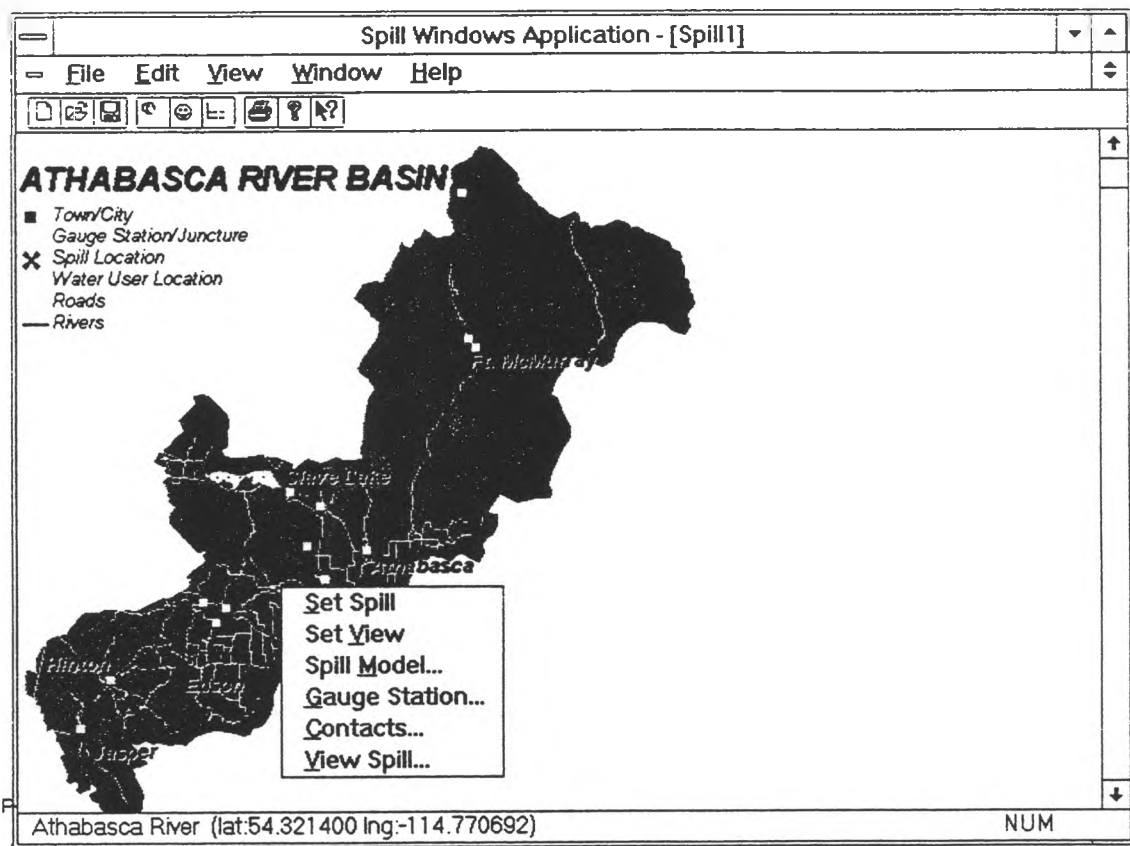


Figure 5

b) Spill Information

Any information available about the spill should be added at this point. Default values are supplied with the model and will be used in this example. If more information is available the 'Advanced Users' section describes how to add it.

To bring up the 'Spill Information' window click on the 'Spill Information' button on the 'Spill Model Tool Bar(see Figure 6). It is the 4th button from the left.



Figure 6

Figure 7 shows the Spill information window. The first item that may require change is the 'Month of the Spill'. By choosing a particular month the model will use the mean monthly discharge for that month in the following calculations. To select a month click on the downward pointing arrow at the right end of the 'Month of Spill' box. This will open a window that shows the months of the year. Click on the month in which the spill has occurred. The default values for 'Spill Location' and 'Spill Amount' will be used in this example. Click the OK button to close the spill information window. The model now has all the information required to proceed.

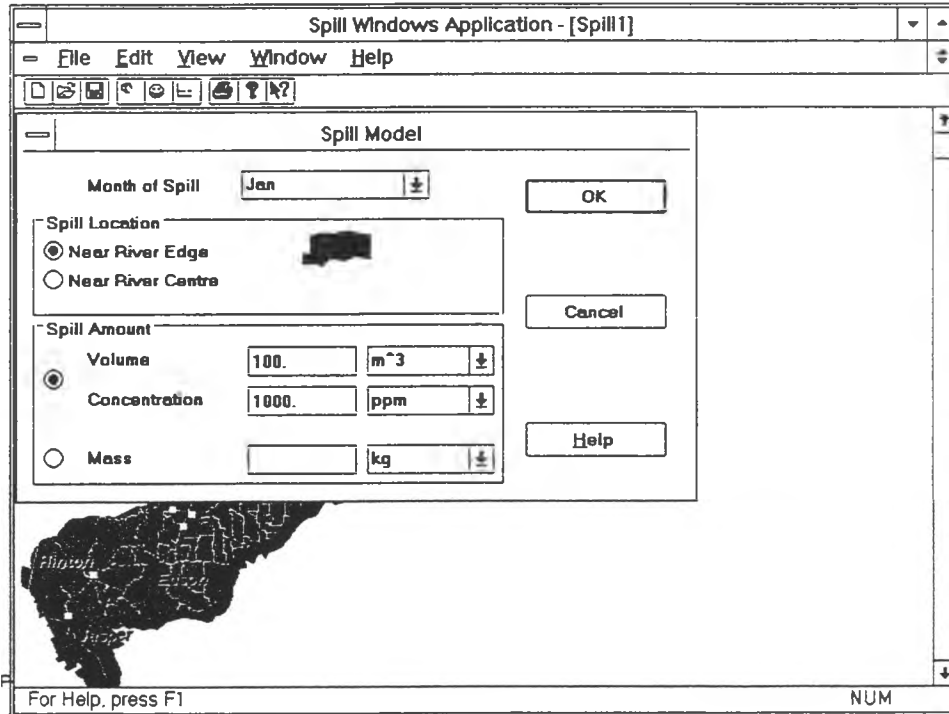


Figure 7

c) Downstream Contacts

Clicking the 'Down Stream Contacts' button on the tool bar(5th button from the left) will open the 'Down Stream Contacts' window. The window (see Figure 8) lists all of the municipal water intakes down stream of the spill and the Lake Athabasca Inflow. To get information about the spill's characteristics at any of these locations, click on the community name and then click on the 'View Spill' button at the bottom of the window.

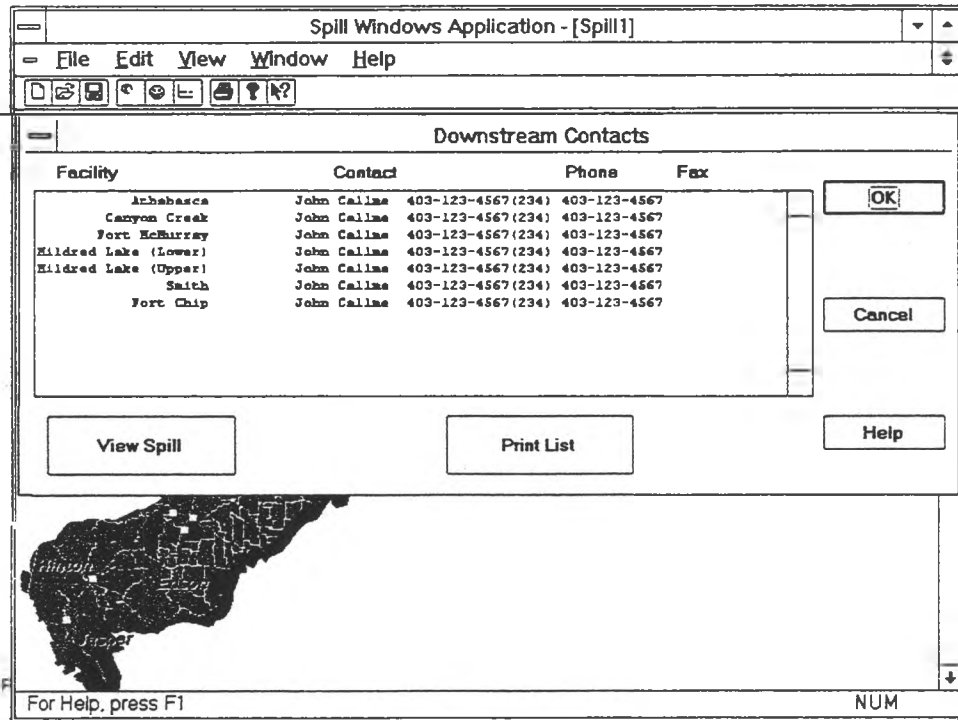


Figure 8

d) Spill Profile

Clicking on the 'View Spill' button opens a 'Spill Profile' window. The window is comprised of two parts(see Figure 9), a concentration hydrograph and an information section. The hydrograph gives the user a quick graphical representation which can be used to answer three important questions:

1. When will the contaminate arrive?
2. When will it have passed?
3. What will the peak concentration be?

In the example shown in Figure 9 the contaminate will start arriving at this location about 5 days after the spill occurred and will have passed by the 22nd day. The hydrograph indicates that the peak concentration should occur on the 12th day. The value of 0.5 ppb. for the peak concentration is totally unreliable because the default values for the size and concentration of the spilled contaminate were used. The remainder of the window gives information on the location of the spill, the location that the spill hydrograph is plotted, the travel time the peak concentration, the name of the water user, a contact person and the phone and FAX numbers. This information would be required if the plant operator had to be notified.

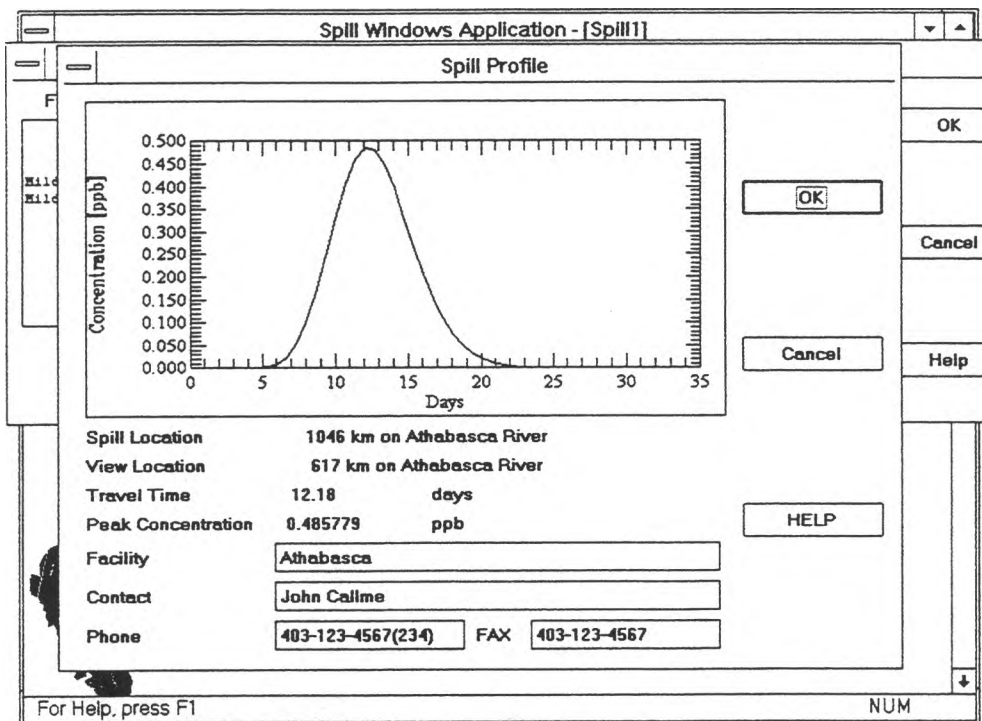


Figure 9

If the effect of the spill at another location is required click on the 'OK' button on the 'Spill Profile' window, click on the community name that you want the information for, click the 'View Spill' button. A new 'Spill Profile' window will be displayed with a hydrograph and other information for the new location.

e) Ending the Program

If you want to end the program click the 'OK' on the Spill Profile window, then click the 'OK' on the Downstream Contacts window. Click 'File' on the Spill Toolbar, then select Exit from the pop up menu that appears. This will take you back to the Windows Program Manager where you can run other programs.

5. ADVANCED USERS

The preceding example showed how to use the model defaults to determine the effect of a spill. The following sections will describe how to improve the estimates made by the program .

a) Changing Spill Information

Several changes can be made to the information on the Spill Model Information window(see Figure 7). Selecting the appropriate button in the Spill Location box will give better estimates of time of travel and concentration.

The Spill Amount box is where you can enter the volume and concentration or the mass of the spilled material. If this information is available the model will give much better estimates of the peak concentration.

b) Changing Streamflow Data

Often if time permits more up to date stream flow information can be obtained. If this information is available the following procedure should be used.

Select the hydrograph icon button on the Spill Model Toolbar(see Figure 6). It is the 6th button from the left. The Gauging Station Data window will appear(see Figure 10).

Click the downward pointing arrow beside the Gauging Station name box. A list of stations available to the model will be displayed. The stations downstream of the spill location will be marked with an asterisk. Click on the station name for which you have new flow data. The monthly flows for that station will be displayed.

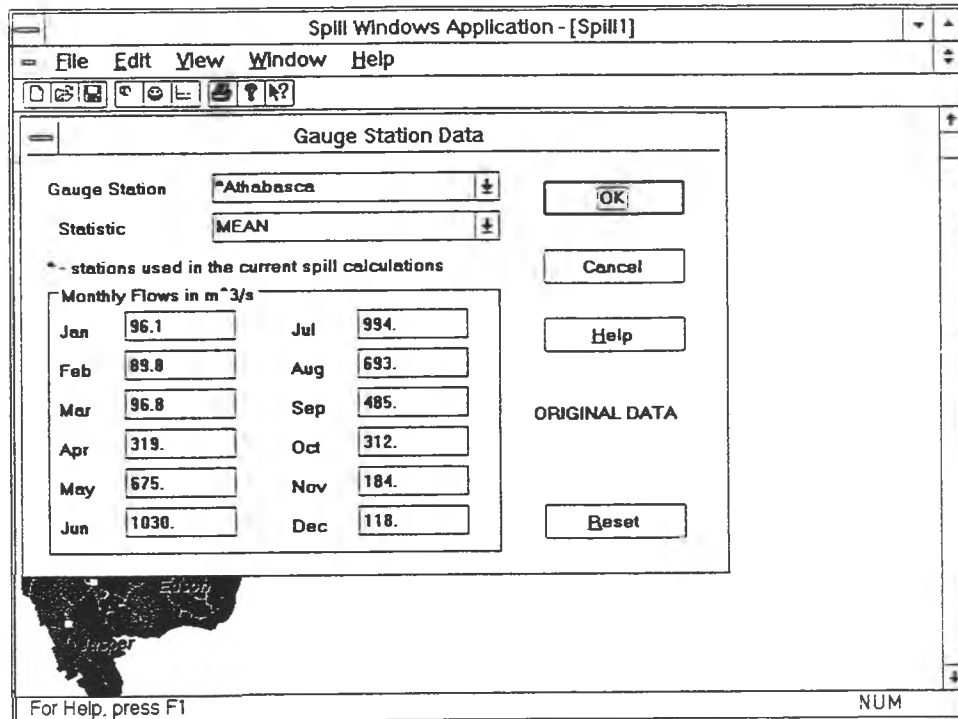


Figure 10

Move the cursor to the month you wish to change and click the mouse button. Use the backspace or delete keys to erase the existing numbers and type in the new flow. To change another station click the down arrow again and repeat this procedure. There is an indicator on the screen that tells you that the data has been changed. If you wish to go back to the original data values just click the reset button. Once you have made all the changes that you want to make click the 'OK' button. You can now proceed as described in earlier sections of this manual.

c) Selecting A View Location

This model was originally produced to help protect municipal drinking water supplies so the output section of the model automatically generates information at the downstream water intakes. Some users may wish to view the effect the spill will have at a different location. This can be done by selecting a 'View Location'. After the user has set the spill location a view location can be set by moving the cursor to the location of interest and clicking the **RIGHT** mouse button. A pop-up menu (see Figure 5) will be displayed. Clicking on the 'Set View' item in the window will cause the menu to disappear and a yellow 'X' will be placed at the location that you selected. The downstream contacts list will now contain the additional item 'User Location' Clicking on this item and then on the View Spill button will generate information for the selected location. If another location is required click the OK button on the Spill Profile window and the OK button on the

Downstream Contacts window. Then move the cursor to the new view location and repeat the above procedure.

d) New Downstream Contacts

Over time the Downstream Contacts list will have to be revised as phone numbers change or new people become responsible for these duties. The procedure to make these changes may prove difficult for novice computer users so these people should seek assistance. The description following is quite general because the procedure will vary greatly from one computer to the next.

To make changes you must exit from the NRBS-SPILL program. The contact information is stored in a file called C:\SPILL\CONTACTS.LST. This file will have to be changed. This can be done using the Windows Text Editor or a DOS text editor of your choice. The file contains 13 lines of information, one line for each contact. Each line has the following information:

Location name, Latitude, Longitude, Contact Name, Phone No., FAX No.

Any of these items can be replaced with the new information. It is important that there is a comma between each of the items. In addition the Latitude and Longitude should not be changed. After the changes are made the file should be saved and then exit from the text editor. The program will now run in the same manner as before and will display the revised information in the Down Stream Contacts window.

6. REFERENCES

- Van Der Vinne, G. and Andres, D., Alberta Research Council, Northern River Basins Study Project Report No. 7, Winter Low Flow Tracer Dye Studies, Athabasca River, Athabasca to Bitumont, February and March, 1992, Part I: Time of Travel, Edmonton, Alberta, Canada, June, 1993.
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- Andres, D., Van Der Vinne, G. and Trevor, B., Low Flow Winter Travel Time Characteristics of the Athabasca River, Hinton to Athabasca. Surface Water Engineering Report No. SWE-89/06, Resource Technologies Department, Alberta Research Council, 1989.

APPENDIX A: TERMS OF REFERENCE

No contractual Terms of Reference were prepared for the work documented in this report. The work was undertaken by the author as a contribution in kind from his employing agency and represents a part of his responsibilities to the working committee of the Drinking Water Component of the Northern River Basins Study.

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APPENDIX B: SPILL MODEL PROGRAM AND DATA

The disk provided in the sleeve as the last page of this report contains the Spill Response Model as supplied by the author and can be installed on your micro-computer by following the instructions in Section 2 of this report (NRBS Project Report No. 126).

The disk contains 16 files, using 522,474 bytes.

- | | | | |
|----|--------------|-----|--------------|
| 1. | contacts.lst | 9. | zzbasin.xy |
| 2. | edi3d.bin | 10. | zzgauge.dat |
| 3. | install.bin | 11. | zzlake.xy |
| 4. | install.exe | 12. | zzlm.dat |
| 5. | install.inf | 13. | zzriver.xy |
| 6. | readme.txt | 14. | zzroads.xy |
| 7. | spill.exe | 15. | zzslope.data |
| 8. | spill.ini | 16. | zztown.xy |

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