APPENDIX IV-D

STJ-EROS ARC MACRO LANGUAGE (AML) CODE

```
/*****************************************************************************/
/* APPENDIX IV-D                                                             */
/*                                                                           */
/* FILE NAME:   stj_eros.aml                                                 */
/*                                                                           */
/* PROGRAMMER:  Carlos E. Ramos Scharron                                     */
/*              Colorado State University- Ft Collins CO                     */
/*                                                                           */
/* DATE:        November 25, 2003                                            */
/*                                                                           */
/* PURPOSE:     This program, written in Arc Macro Language is intended to   */
/*              estimate rates of erosion and sediment delivery for unpaved  */
/*              roads and natural processes on the island of St. John,       */
/*              US Virgin Islands.                                           */
/*                                                                           */
/* RUN COMMAND: Once in the correct workspace type '&run stj_eros' at the ARC*/
/*              command line.                                                */
/*                                                                           */
/* DEPENDENCIES:This program is run in ArcInfo 8.2 and in its Tables module. */
/*                                                                           */
/* TERMINATING  This program does not call any additional programs once it   */
/* CONVENTIONS: terminates.                                                  */
/*                                                                           */
/* CALLING      The program requires the user to define the following        */
/* CONVENTIONS: variables:                                                   */
/*                  (1) %BASIN% as the name of the basin (watershed) for which*/
/*                  analysis is to be conducted.                             */
/*                  (2) %YEARS% as the total number of years over which erosion*/
/*                  and sediment delivery are to be calculated               */
/*                  (3) %RAIN_RATE% as an annual rainfall rate.              */
/*                  (4) %ROAD_NAME% as the name for the output file, data layer,*/
/*                  and shapefile containing road erosion and sediment delivery*/
/*                  results.                                                 */
/*                  (5) %NAT_NAME% as the name for output file, data layer, and*/
/*                  and shapefile containing natural erosion and sediment    */
/*                  delivery results.                                        */
/*                                                                           */
/* TERMINATING     This program does not call any additional programs when it*/
/* CONVENTIONS:    terminates.                                               */
/*                                                                           */
/* ALGORITHMS:     After initializing variables that will be used to calculate*/
/*                 sediment production rates, it performs some housekeeping  */
/*                 commands to delete any pre-existing GIS data layers with  */
/*                 the same names as those that will be created by the       */
/*                 program. An interface then asks the user whether to       */
/*                 continue with a brief on-screen introduction to the       */
/*                 program or to move directly to begin entering model       */
/*                 parameters. The MODEL routine is then invoked to control  */
/*                 the general flow of the model. Once all of the routines are*/
/*                 called the program asks the user whether to view a summary*/
/*                 of the results by invoking the SUMMARY_RESULTS routine or */
/*                 to exit the program. Before exiting an on-screen message  */
/*                 reminds the user of the names given to the GIS data layer */
/*                 and text files containing the model results.              */
/*                                                                           */
/*****************************************************************************/

&terminal 9999

&sv treethrow = 0.17 /* tons per km of channel length per year
&sv bank_er = 10 /* kg per m^2 of bank surface per year
&sv undisturbed = 0.000064 /* kg per m^2 of undisturbed hillslope surface
  /* per cm of precipitation occurring during events exceeding 6 cm of rain
&sv abandoned = 0.071 /* kg per m^2 of road surface, cm of precipitation
    /* unit gradient
&sv graded = 4.73 /* kg per m^2 of road surface, cm of precipitation &
    /* unit gradient to the 1.5th power
&sv ungraded = 1.88 /* kg per m^2 of road surface, cm of precipitation &
    /*unit gradient to the 1.5th power
&sv cutslope = 9 /* % of sediment produced at the segment scale
```

```
&sv un_sus_fr = 0.59 /* Fraction of sediment produced from ungraded roads
    /* that is finer than 2 mm
&sv gr_sus_fr = 0.64 /* Fraction of sediment produced from graded roads
    /* that is finer than 2 mm
&sv ab_sus_fr = 0.40 /* Fraction of sediment produced from abandoned
    /* roads that is finer than 2mm
&sv bank_sus_fr = 0.75 /* Fraction of sediment produced from streambanks
    /* that is finer than 2mm
&sv tree_sus_fr = 0.75 /* Fraction of sediment produced from treethrow
    /* that is finer than 2mm
&sv se_sus_fr = 0.577 /* Fraction of sediment produced from undisturbed
    /* hillslopes that is finer than 2 mm
&sv silt_u_rd_fr = 0.04 /* Fraction of sediment produced from ungraded
    /* roads that is in the silt-size category
&sv silt_g_rd_fr = 0.06 /* Fraction of sediment produced from graded
    /* roads that is in the silt-size category
&sv silt_a_rd_fr = 0.001 /* Fraction of sediment produced from abandoned
    /* roads that is in the silt-size category
&sv silt_se_fr = 0.004 /* Fraction of sediment produced from undisturbed
    /* hillslopes that is in the silt-size category
&sv silt_loss = 9 /* Silt and clay estimated loss ratio of true yield
    /* to that measured by sediment traps
&if [exists rds_del -cover] &then kill rds_del all
&if [exists drain -cover] &then kill drain all
&if [exists dra_del -cover] &then kill dra_del all
&if [exists del_bd -cover] &then kill del_bd all
&if [exists temp_rd -cover] &then kill temp_rd all
&if [exists temp_del -cover] &then kill temp_del all
&if [exists pt_del -cover] &then kill pt_del all
&if [exists bank_del -cover] &then kill bank_del all
&if [exists str_del -cover] &then kill str_del all
&if [exists str_bd -cover] &then kill str_bd all
&if [exists buf_str -cover] &then kill buf_str all
&if [exists temp_tre -cover] &then kill temp_tre all
&if [exists tr_del -cover] &then kill tr_del all
&if [exists se_bd -cover] &then kill se_bd all
&if [exists temp_bd -cover] &then kill temp_bd all
&if [exists buf_cst -cover] &then kill buf_cst all
&if [exists cst_bd -cover] &then kill cst_bd all


&type ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
&type ^                                                                           ^
&type ^    Welcome to the St. John Erosion and Sediment Delivery ArcGIS Model!     ^
&type ^                                                                           ^
&type ^                       Author: Carlos E. Ramos Scharron                    ^
&type ^                   Colorado State University, Fort Collins CO              ^
&type ^                                                                           ^
&type ^                              November 25, 2003                            ^
&type ^                                                                           ^
&type ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^

&if [query 'Press enter for brief introduction or "no" to start entering model ~
parameters.' .true.] &then &call intro
&call model
&if [query 'Press enter for brief summary of results or "no" to exit.' .true.] ~
  &then &call summary_results
&type /&^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
&type ^
&type ^ Road erosion and sediment delivery results are available at:
&type ^      %road_name%.txt and %road_name% line data layer.
&type ^      The order of column (items) shown in %road_name%.txt
&type ^      is as follows:
&type ^       length_m surface grading potential rd_pr_rate
&type ^       rd_ttl_del_rate rd_sus_del_rate cs_pr_rate cs_ttl_del_rate
&type ^       cs_sus_del_rate
&type ^
&type ^ Natural erosion and sediment delivery results are available at:
&type ^     %nat_name%.txt and %nat_name% polygon data layer.
&type ^      The order of column (items) shown in %nat_name%.txt
&type ^      is as follows:
```

```
&type ^        area potential se_ton se_ttl_del se_sus_del bank_ton
&type ^        bank_ttl_del bank_sus_del tree_ton tree_ttl_del tree_sus_del
&type ^        nat_pr_rate nat_t_del_rate nat_s_del_rate
&type ^
&type ^ The user may find the following covers useful for display purposes:
&type ^      %basin%_bd    del_bd    pt_del
&type ^
&type ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
&return


&ROUTINE MODEL
/*****************************************************************************/
/*                                                                           */
/* PURPOSE:    Controls the flow of the model by calling routines.           */
/*                                                                           */
/* REQUIRED    None                                                          */
/* PRE-DEFINED                                                               */
/* VARIABLES:                                                                */
/*                                                                           */
/* IMPORTANT   None                                                          */
/* CREATED                                                                   */
/* VARIABLES:                                                                */
/*                                                                           */
/* SIDE        None                                                          */
/* EFFECTS:                                                                  */
/*                                                                           */
/* ALGORITHM: Routines are called in the following order:                    */
/*                                                                           */
/*            (1) SET_SDR- Assigns the value of variables %HI_POT% and       */
/*            %MOD_POT% according to values chosen from a menu or entered    */
/*            by the user. These two variables are used as sediment delivery */
/*            ratios (SDR's) to estimate sediment yields.                    */
/*            (2) DEL_POTENTIAL- Assigns sediment delivery ratio values to the*/
/*            entire basin of interest according to its pre-determined       */
/*            sediment delivery potential.                                   */
/*            (3) SET_YEARS- Assigns the value of variable %YEARS% according */
/*            to a value chosen from a menu or entered by the user. This     */
/*            variable defines the total number of years over which sediment */
/*            yields are to be estimated.                                    */
/*            (4) SET_RAIN- Assigns the value of variable %RAIN_RATE%        */
/*            according to a value chosen from a menu or entered by the user.*/
/*            %RAIN_RATE% defines the annual rainfall rate in cm per year.   */
/*            (5) ROADS_NAME- Assigns the variable %ROAD_NAME% according to  */
/*            a value chosen from a menu or entered by the user. %ROAD_NAME% */
/*            is the name that will be given to the GIS data layer and text  */
/*            file containing the sediment yield estimates for all road-     */
/*            related sediment sources.                                      */
/*            (6) NAT_NAME- Assigns the value of variable %NAT_NAME% according*/
/*            to a value chosen from a menu or entered by the user.          */
/*            %NAT_NAME% is the name of the GIS data layer and text file     */
/*            containing the sediment yield estimates for all natural sediment*/
/*            sources.                                                       */
/*                                                                           */
/*            Once all parameters have been chosen by the user, the program  */
/*            provides an on-screen list of all of the parameters            */
/*            that were chosen. The user is ask whether to exit the program  */
/*            to re-enter the parameter values or to run the program with    */
/*            the values already chosen. Exiting quits the program, otherwise*/
/*            the program calls routine #7.                                  */
/*                                                                           */
/*            (7) RD_EROSION- Calculates sediment production and yield rates */
/*            for all road-related sediment sources and stores them into a   */
/*            line GIS data layer and into a text file.                      */
/*            (8) STREAMBANK- Calculates streambank sediment production and  */
/*            yield rates and stores them into a polygon GIS data layer.     */
/*            (9) STREAM_TOTAL- Calculates treethrow sediment production and */
/*            yield rates and stores them into a polygon GIS data layer. The */
/*            final layer also contains streambank sediment yield estimates. */
/*            (10) SURF_EROSION- Calculates sediment production and yield    */
/*            rates from undisturbed surfaces and stores them into a polygon */
```

```
/*            GIS data layer.                                                  */
/*                                                                             */
/*            (11) NAT_EROSION- Combines streambank, treethrow, and surface    */
/*            erosion and yield estimates into a single polygon GIS data       */
/*            layer.                                                           */
/*                                                                             */
/*******************************************************************************/

&call set_SDR
&call del_potential
&call set_years
&call set_rain
&call roads_name
&call nat_name
&type ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
&type +
&type + The following is a list of all user defined parameters:
&type +
&type + Basin: %watshed%
&type + Time: %years% year(s)
&type + Rainfall rate: %rain_rate% cm per year
&type + Total rainfall: %rain% cm
&type + Sediment delivery ratio for high potential areas: %hi_pot%
&type + Sediment delivery ratio for moderate potential areas: %mod_pot%
&type + Road erosion and sediment delivery results will be available at:
&type +       %road_name%.txt and %road_name% line data layer
&type + Natural erosion and sediment delivery results will be available at:
&type +       %nat_name%.txt and %nat_name% polygon data layer
&type +
&type ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++/&

&if [query 'Press enter to run model with these values or "no" to quit and ~
start over.' .true.] &then
   &do
    &call rd_erosion
    &call streambank
    &call stream_total
    &call surf_erosion
    &call nat_erosion
      &type /&All routines successfully completed!/&
   &end
  &else
   &do
     &type /&Bailing out.../&
     &return
   &end
&return


&ROUTINE INTRO

&type /&^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
&type /&This model is intended to estimate the rates of sediment production and
&type delivery into the marine environment in St. John, USVI.
&type /&Rates of sediment production are estimated from unpaved road surfaces,
&type cutslopes as well as from natural sources. Any changes in the default
&type values used in this model can be made by making the appropriate changes
&type in the AML file only when they are supported by scientifically-sound
&type evidence.
&type /&The regression equations and erosion rates currently set for this
&type model are:
&type   /&  Treethrow sediment production rates:
&type           %treethrow% kg per m of stream per year
&type   Streambank sediment production rates:
&type           %bank_er% kg per m^2 of bank area per year
&type   Surface erosion on natural hillslopes:
&type           %undisturbed% kg per m^2 of hillslope area per cm of
&type           precipitation during events > 6 cm in total rainfall
&type   Graded road erosion in kg per m^2 =
&type           (-0.432+(4.73 * slope^1.5 * cm of rainfall)
&type   Ungraded road erosion in kg per m^2 =
```

```
&type            (-0.432+(1.88 * slope^1.5 * cm of rainfall)
&type   Abandoned roads:
&type            %abandoned% kg per m^2, cm of precipitation & unit gradient
&type   Cutslopes:
&type            %cutslope% percent of total sediment production from road segment/&

&type /&The user will be requested to choose or enter the following information:/&
&type   1) The name of the basin (watershed) for which analysis is to be conducted.
&type   2) The total number of years over which erosion and sediment delivery
&type      are to be calculated.
&type   3) An annual rainfall rate in cm per year.
&type   4) Sediment delivery ratios for areas designated as having high and
&type      moderate delivery potential.
&type   5) A name for output file, data layer, and shapefile containing road erosion
&type      and delivery results.
&type   6) A name for output file, data layer, and shapefile containing natural
erosion
&type      and delivery results.
&type /&^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
&return

&ROUTINE SET_SDR
/*****************************************************************************/
/*                                                                           */
/* PURPOSE:    Assigns the value of variable %HI_POT% and %MOD_POT% according to  */
/*             values chosen from a menu or entered by the user.             */
/*                                                                           */
/* REQUIRED    None                                                          */
/* PRE-DEFINED                                                               */
/* VARIABLES:                                                                */
/*                                                                           */
/* IMPORTANT   %HI_POT% is the sediment delivery ratio for areas designated as    */
/* CREATED     having a high sediment delivery potential.                    */
/* VARIABLE    %MOD_POT% is the sediment delivery ratio for wetland areas or      */
/*             those designated as having a moderate delivery potential.     */
/*                                                                           */
/* SIDE       None                                                           */
/* EFFECTS:                                                                  */
/*                                                                           */
/* ALGORITHM: The user is prompted to choose the sediment delivery values for     */
/*            high and moderate potential areas. The user is given the option    */
/*            to choose values from a menu or to choose another value. The       */
/*            value entered is then assigned to the %HI_POT% and %MOD_POT%       */
/*            variables. The value of the %HI_POT% and %MOD_POT% variables are   */
/*            then tested to verify that they are between 0.5 and 1.0 and        */
/*            between 0.0 and 0.5, respectively. If this criteria is not         */
/*            satisfied an error message prints on the screen and the user is    */
/*            asked to once again enter the values.                          */
/*                                                                           */
/*****************************************************************************/

&type /& Now the user will be requested to enter the sediment delivery ratios
&type (SDR's) for areas designated as having high and moderate potential for
&type delivering sediment into the bay. SDR's represent the fraction of
&type sediment produced that is delivered to the basin outlet. For high
&type potential areas it represents the fraction not retained by the fluvial
&type network. On moderate areas it represents the portion of sediment not
&type retained by the fluvial network nor by coastal wetlands. SDR's values
&type of 0.8 and 0.3 are recommended for high and moderate potential areas,
&type respectively./&
&type SDR's can be chosen by selecting a value from choices in
&type a menu or by entering a value once the "other" option has been selected.
&type Please note that the model will only accept values between 0.4 and 1.0 for
&type the high potential areas and between 0.0 and 0.4 for those with moderate
&type potential./&
&if [query 'Press enter to continue.' .true.] &then &type Continuing...
&sv hi_pot [getchoice 0.5 0.6 0.7 0.8 0.9 1.0 -prompt ~
    'Choose SDR for high potential areas' -other]
&sv mod_pot [getchoice 0.0 0.1 0.2 0.3 0.4 0.5 -prompt ~
    'Choose SDR for moderate potential areas' -other]
&if %hi_pot% < 0.5 &then
```

```
   &do
     &type /&ERROR!!! SDR for high potential areas must be greater than 0.5!
     &call set_sdr
   &end
  &else
   &do
     &if %hi_pot% > 1 &then
      &do
       &type /&ERROR!!! SDR for high potential areas cannot be greater than 1.0!
       &call set_sdr
      &end
  &end
&if %mod_pot% < 0.0 &then
   &do
     &type /&ERROR!!! SDR for moderate potential areas cannot be negative!
     &call set_sdr
   &end
  &else
   &do
     &if %mod_pot% > 0.5 &then
      &do
       &type /&ERROR!!! SDR for moderate potential aras cannot be greater than 0.5!
       &call set_sdr
      &end
  &end
&return


&ROUTINE DEL_POTENTIAL
/*****************************************************************************/
/*                                                                           */
/* PURPOSE:    Assigns sediment delivery ratio values to the entire basin of */
/*             interest according to its pre-determined sediment delivery    */
/*             potential.                                                    */
/*                                                                           */
/* REQUIRED    HI_POT is the sediment delivery ratio (SDR) assigned to areas */
/* PRE-DEFINED which have been identified as having a high potential for sediment */
/* VARIABLES:  delivery to the marine environment.                           */
/*             MOD_POT is the SDR for areas with a moderate delivery potential. */
/*                                                                           */
/* IMPORTANT   %BASIN% is the code name of the basin for which analysis is to be */
/* CREATED     conducted. The user chooses the name from a menu listing the  */
/* VARIABLES:  currently available choices.                                  */
/*             %WATSHED% is the full name of the basin chosen for analysis.  */
/*                                                                           */
/* SIDE       (1)A new polygon cover called del_bd is created.               */
/* EFFECTS    (2)TABLES is invoked.                                          */
/*                                                                           */
/* ALGORITHM: The user is prompted to choose a basin name from a menu list. The */
/*            choice is assigned as the value of variable %BASIN%. The value of */
/*            variable %WATSHED% is assigned according to the value of %BASIN%. */
/*            In TABLES a new item called DEL_RATIO is added to the table.   */
/*            a new cover is created by clipping the sed_del layer with the  */
/*            %basin%_bd layer.  Sediment delivery ratios chosen by the      */
/*            user in the SET_SDR routine are then assigned to this new      */
/*            layer. The numerical value of DEL_RATIO for each polygon is    */
/*            assigned according to its POTENTIAL and to the pre-established */
/*            values of the variables %HI_POT% and %MOD_POT%.                */
/*                                                                           */
/*****************************************************************************/

&type /&The user is now required to choose a basin for analysis. The model can be
&type applied to the following basins:
&type /&  Cinnamon Bay (cb)
&type   Fish Bay (fb)
&type   Lameshur Bay (lb)/&
&if [query 'Press enter to continue.' .true.] &then &type Continuing...
&sv basin = [ getchoice cb fb lb -prompt 'Select a basin for analysis' ]
&select %basin%
  &when cb
   &sv watshed = Cinnamon Bay
```

```
  &when fb
   &sv watshed = Fish Bay
  &when lb
   &sv watshed = Lameshur Bay
&end
&type /&Creating sediment delivery cover for %watshed% .../&
clip sed_del %basin%_bd del_bd poly
tables
select del_bd.pat
additem del_bd.pat del_ratio 8 8 n 1
reselect potential = 'high'
calculate del_ratio = %hi_pot%
aselect
reselect potential = 'moderate'
calculate del_ratio = %mod_pot%
aselect
reselect potential = 'wetland'
calculate del_ratio = %mod_pot%
reselect potential = 'no'
calculate del_ratio = 0
quit
&type Done creating sediment delivery cover for %watshed%...
&return



&ROUTINE SET_YEARS
/*****************************************************************************/
/*                                                                           */
/* PURPOSE:    Assigns the value of variable %YEARS% according to a value    */
/*             chosen from a menu or entered by the user.                    */
/*                                                                           */
/* REQUIRED    None                                                          */
/* PRE-DEFINED                                                               */
/* VARIABLES:                                                                */
/*                                                                           */
/* IMPORTANT   %YEARS% is the total number of years for which sediment production */
/* CREATED     and delivery are to be estimated.                             */
/* VARIABLES:                                                                */
/*                                                                           */
/* SIDE       None                                                           */
/* EFFECTS:                                                                  */
/*                                                                           */
/* ALGORITHM: The user is prompted to choose the number of years over which  */
/*            sediment production and delivery are to be estimated from a number */
/*            of options. The user is given the option to enter another value not */
/*            offered in the menu.  The value entered is then rounded and    */
/*            assigned to the %YEARS% variable. The years value is then tested */
/*            to verify that it is greater than 0 and does not exceed 50. If this */
/*            is not satisfied an error message prints on the screen and the user */
/*            is asked to once again enter a value.                          */
/*                                                                           */
/*****************************************************************************/

&type /& Now the user will be requested to enter the total number of years
&type over which sediment production and sediment delivery will be calculated.
&type The number of years can be chosen by selecting a value from choices in
&type a menu or by entering a value once the "other" option has been selected.
&type Please note that any real values entered manually will be rounded and
&type that the model will only accept values between 1 and 50 years./&
&if [query 'Press enter to continue.' .true.] &then &type Continuing...
&sv time [getchoice 1 5 10 25 50 -prompt 'Choose total number of years' -other]
&sv years = [round %time%]
&if %years% <= 0 &then
   &do
     &type /&ERROR!!! Number of years must be greater than 0!
     &call set_years
   &end
  &else
   &do
     &if %years% > 50 &then
```

```
      &do
       &type /&ERROR!!! Number of years must be less than or equal to 50.
       &call set_years
      &end
  &end
&return

&ROUTINE SET_RAIN
/*****************************************************************************/
/*                                                                           */
/* PURPOSE:    Assigns the value of variable %RAIN_RATE% according to a value     */
/*             chosen from a menu or entered by the user.                    */
/*                                                                           */
/* REQUIRED    %YEARS% is the total number of years chosen by the user in the     */
/* PRE-DEFINED SET_YEARS routine.                                            */
/* VARIABLES:                                                                */
/*                                                                           */
/* IMPORTANT   %RAIN_RATE% is the rainfall (in cm per year) for which sediment    */
/* CREATED     production and delivery are to be estimated.                  */
/* VARIABLES:  %RAIN% is the total rainfall (in cm)used to calculate sediment     */
/*             production from roads and undisturbed hillslopes.             */
/*                                                                           */
/* SIDE       None                                                           */
/* EFFECTS:                                                                  */
/*                                                                           */
/* ALGORITHM: The user is prompted to choose an annual rainfall rate for which    */
/*            sediment production and delivery are to be estimated from a number  */
/*            of options. The user is given the option to enter another value not */
/*            offered in the menu.  The value entered is then rounded and assigned*/
/*            to the %RAIN_RATE% variable. The %RAIN_RATE% value is then tested to*/
/*            verify that it is greater than 70 and does not exceed 160. If this  */
/*            test is not satisfied an error message prints on the screen and the */
/*            user is asked to enter another value. The %RAIN% value is then      */
/*            calculated as the product of %RAIN_RATE% times %YEARS%.             */
/*                                                                           */
/*****************************************************************************/

&type /& Now the user will be requested to enter an annual rainfall rate in
&type cm per year. A rate can be chosen by selecting a value from choices in
&type a menu or by entering a value once the "other" option has been selected.
&type Please note that any real values entered manually will be rounded and
&type that the model will only accept values between 70 and 160 cm per year./&
&type Mean annual rainfall in St. John is spatially variable. While the
&type driest portions on East End and lower elevations of Fish Bay and
&type Lameshur Bay basins receive approximately 90 cm of rainfall per year,
&type the highest elevations around Bordeaux Mountain typically receive
&type about 130 cm per year. A 115 cm per year value is considered to be a
&type reasonable approximation to long-term mean rainfall rates for most
&type basins on the island. /&
&if [query 'Press enter to continue.' .true.] &then &type Continuing...
&sv annual_rain [getchoice 90 115 140 -prompt 'Choose an annual rainfall rate' -other]
&sv rain_rate = [round %annual_rain%]
&if %rain_rate% < 70 &then
   &do
     &type /&ERROR!!! Rainfall rate must be greater than 70 cm per year!
     &call set_rain
   &end
  &else
   &do
     &if %rain_rate% > 160 &then
      &do
       &type /&ERROR!!! Rainfall rate must be less than or equal to 160 cm per year.
       &call set_rain
      &end
  &end
&sv rain = [calc %rain_rate% * %years%]
&return
```

```
&ROUTINE ROADS_NAME
/*****************************************************************************/
/*                                                                           */
/* PURPOSE:    Assigns the value of variable %ROAD_NAME% according to a value     */
/*             chosen from a menu or entered by the user. %ROAD_NAME% is the      */
/*             name of the new output coverage and text file to be created by     */
/*             this model.                                                        */
/*                                                                           */
/* REQUIRED    %BASIN% is the code name of the basin for which analysis is to be  */
/* PRE-DEFINED conducted.                                                         */
/* VARIABLES:                                                                */
/*                                                                           */
/* IMPORTANT   %ROAD_NAME% is the user chosen name used for the layer and text    */
/* CREATED     file containing the results of the sediment production and delivery*/
/* VARIABLES:  estimates for roads.                                           */
/*             %NAME_LENGTH% is the number of characters used by %ROAD_NAME%.     */
/*                                                                           */
/* SIDE       None                                                            */
/* EFFECTS:                                                                  */
/*                                                                           */
/* ALGORITHM: The user is prompted to choose a name from a number of options      */
/*            in a menu. The user is given the option to enter another name not   */
/*            offered in the menu.  The number of characters in the chosen name   */
/*            is assigned to variable %NAME_LENGTH% which is used to test whether */
/*            the chosen name has been given a name less than 8 characters in     */
/*            length.  If this test is not satisfied an error message prints on   */
/*            the screen and the user is asked to enter another name.             */
/*                                                                           */
/*****************************************************************************/

&type /& Now the user will be requested to enter the names of the final coverages
&type and txt files containing the sediment production and delivery estimates
&type for roads and natural erosion processes. The names can be chosen by
&type selecting a value from choices in a menu or by entering a value once the
&type "other" option has been selected. Please note that the model will only take
&type names that are less than or equal to 8 characters in length./&
&if [query 'Press enter to continue.' .true.] &then &type Continuing...
&sv road_name [getchoice  %basin%_rd r_%basin% -prompt~
    'Choose a name for road erosion layer and results file' -other]
&sv name_length = [length %road_name%]
  &if %name_length% = 0 &then
   &do
     &type /&ERROR!!! Please enter a name!
     &call roads_name
   &end
  &if %name_length% > 8 &then
      &do
       &type /&ERROR!!! Please, enter a name with no more than 8 characters!
       &call roads_name
      &end
  &if [exists %road_name% -cover] &then
   &do
     &type /&Cover %road_name% already exists!!
     &if [query 'Delete current cover (yes or no)' .false.]~
      &then kill %road_name% all
      &else &call roads_name
   &end
&return


&ROUTINE NAT_NAME
/*****************************************************************************/
/*                                                                           */
/* PURPOSE:    Assigns the value of variable %NAT_NAME% according to a value     */
/*             chosen from a menu or entered by the user. %NAT_NAME% is the       */
/*             name of the new natural erosion coverage and text file to          */
/*             be created by this model.                                          */
/*                                                                           */
/* REQUIRED    %BASIN% is the code name of the basin for which analysis is to be */
/* PRE-DEFINED conducted.                                                         */
/* VARIABLES:                                                                */
```

```
/*                                                                            */
/* IMPORTANT   %NAT_NAME% is the user chosen name used for the cover and text    */
/* CREATED     file containing the results of the sediment production and        */
/* VARIABLES:  delivery estimates for natural processes.                         */
/*             %NAME_LENGTH% is the number of characters used by %NAT_NAME%.     */
/*                                                                               */
/* SIDE       None                                                               */
/* EFFECTS:                                                                      */
/*                                                                               */
/* ALGORITHM: The user is prompted to choose a name from a number of options     */
/*            in a menu. The user is given the option to enter another name not  */
/*            offered in the menu.  The number of characters in the chosen name  */
/*            is assigned to variable %NAME_LENGTH% which is used to test whether*/
/*            the chosen name has been given a name less than 8 characters in    */
/*            length.  If this test is not satisfied an error message prints on  */
/*            the screen and the user is asked to enter another name.            */
/*                                                                               */
/*********************************************************************************/

&sv nat_name [getchoice  %basin%_nat n_%basin% -prompt~
    'Choose a name for natural erosion layer and results file' -other]
&sv name_length = [length %nat_name%]
  &if %name_length% = 0 &then
   &do
     &type /&ERROR!!! Please enter a name!
     &call nat_name
   &end
  &if %name_length% > 8 &then
      &do
       &type /&ERROR!!! Please, enter a name with no more than 8 characters!
       &call nat_name
      &end
  &if %nat_name% = %road_name% &then
      &do
       &type /&ERROR!!! Please, enter a name other than %road_name%!
       &call nat_name
      &end
  &if [exists %nat_name% -cover] &then
   &do
     &type Cover %nat_name% already exists!!!
     &if [query 'Delete current cover (yes or no)' .false.]~
      &then kill %nat_name% all
      &else &call nat_name
   &end
&return


&ROUTINE RD_EROSION
/*********************************************************************************/
/*                                                                               */
/* PURPOSE:    Calculates sediment production and delivery rates for the basin   */
/*             chosen in the DEL_POTENTIAL routine using the attributes stored in */
/*             GPS_RDS and GPS_DRA covers and the total rainfall and total time  */
/*             values chosen by the user during the SET_YEARS and SET_RAIN       */
/*             routines.                                                         */
/*                                                                               */
/* REQUIRED    %BASIN% is the code name of the basin for which analysis is to be */
/* PRE-DEFINED conducted.                                                        */
/* VARIABLES:  %UNGRADED% is the regression coefficient used to calculate        */
/*             sediment production from ungraded roads.                          */
/*             %GRADED% is the regression coefficient used to calculate          */
/*             sediment production from graded roads.                            */
/*             %ABANDONED% is the rate of sediment production from abandoned     */
/*             roads.                                                            */
/*             %RAIN% is the total rainfall (in cm) used to calculate road       */
/*             sediment production rates.                                        */
/*             %YEARS% is the total time in years over which sediment production */
/*             and delivery rates are calculated.                                */
/*             %ROAD_NAME% is the user-given name of the final cover and text    */
/*             file that contain the final results of the road erosion and       */
/*             sediment delivery analysis.                                       */
```

```
/*             %SILT_LOSS% is the ratio of actual sediment production for the     */
/*             silt-size sediment fraction to that measured from sediment traps.  */
/*             %SILT_U_RD_FR%, %SILT_G_RD_FR%, %SILT_A_RD_FR%, %SILT_A_RD_FR% are */
/*             the percent of sediment produced in the silt-size category for     */
/*             ungraded roads, graded roads, and abandoned roads, respectively.   */
/*             %UN_SUS_FR%, %GR_SUS_FR%, %AB_SUS_FR% are the percentages of       */
/*             sediment finer than 2 mm for ungraded roads, graded roads, and     */
/*             abandoned roads, respectively.                                     */
/*                                                                                */
/* IMPORTANT   None                                                               */
/* CREATED                                                                        */
/* VARIABLES:                                                                     */
/*                                                                                */
/* SIDE       (1)A new polygon cover called DRAIN is created and killed.          */
/* EFFECTS    (2)A new point cover called PT_DEL is created.                      */
/*            (3)A new line cover called %ROAD_NAME% is created.                  */
/*            (4)TABLES is invoked.                                               */
/*            (5)A file called %ROAD_NAME%.txt is created.                        */
/*                                                                                */
/* ALGORITHM: The GPS_DRA point cover is clipped with the %BASIN%_BD cover to     */
/*            eliminate all road drainage point outside of %BASIN%. The resulting */
/*            cover (DRAIN) is then intersected with the DEL_BD cover created     */
/*            during the DEL_POTENTIAL routine to assign DEL_RATIO values to each */
/*            drainage structure according to its geographical location. The      */
/*            %ROAD_NAME% line cover is copied from the GPS_RDS cover.  TABLES is */
/*            invoked to dropitems from the PT_DEL.PAT and %ROAD_NAME%.AAT. A     */
/*            joinitem function is invoked from ARC using the DRAIN_ID item       */
/*            as the relate item to assign DEL_RATIO values to %ROAD_NAME%.AAT.   */
/*            TABLES is invoked once again to add and calculate the value of      */
/*            items that will contain the sediment production and delivery        */
/*            estimates for each road segment within %BASIN% according to their   */
/*            values stored in the following items: LENGTH_M, WIDTH_M, SLOPE,     */
/*            GRADING, and DEL_RATIO.  The variables %YEARS% and %RAIN% are also  */
/*            used to calculate these items.  Sediment delivery rates are         */
/*            estimated for both total loads and the fraction expected to be      */
/*            carried as suspended load. Finally, the results are unloaded        */
/*            into a file called %ROAD_NAME%.txt before exiting TABLES.           */
/*                                                                                */
/**********************************************************************************/

&type /&Beginning rd_erosion routine...
&type /&Selecting drainage points within %watshed%...
clip gps_dra %basin%_bd drain point /* Eliminates all drainage points outside
  /* of %basin%
intersect drain del_bd pt_del point
kill drain all
copy gps_rds %road_name%
tables
dropitem pt_del.pat (! drain# drain-id type del_bd# del_bd-id !)
dropitem %road_name%.aat source
quit
joinitem %road_name%.aat pt_del.pat %road_name%.aat drain_id
build %road_name% line
tables
additem %road_name%.aat temp_sed 12 12 n 1 /* Total road sed production
additem %road_name%.aat cslope_kg 10 10 n 1 /* Cutslope sediment production
/* equals 9% of total road sediment production
additem %road_name%.aat sed_kg 12 12 n 1 /* Road travelway sediment production
/* equals 91% of total road sediment production
additem %road_name%.aat rd_ton 8 8 n 2 /* Road travelway sed prod in tons
additem %road_name%.aat rd_del 8 8 n 2 /* Road travelway sed delivery in tons
additem %road_name%.aat cs_ton 8 8 n 1 /* Cutslope sed prod in tons
additem %road_name%.aat cs_del 8 8 n 2 /* Cutslope sed delivery in tons
additem %road_name%.aat rd_pr_rate 12 12 n 3 /* Travelway production rate
/*  equals total production in tons divided by variable %YEARS%
additem %road_name%.aat rd_t_del_r 8 8 n 3 /* Travelway delivery rate
/* equals total delivery in tons divided by variable %YEARS%
additem %road_name%.aat cs_pr_rate 12 12 n 3 /* Cutslope production rate
/* equals cutslope production in tons divided by %YEARS%
additem %road_name%.aat cs_ttl_del_rate 15 15 n 3 /* Cutslope delivery rate
/* equals cutslope delivery in tons divided by %YEARS%
```

```
additem %road_name%.aat rd_sus_del_rate 15 15 n 3 /* Travelway suspended
/* sediment delivery rates
additem %road_name%.aat cs_sus_del_rate 15 15 n 3 /* Cutslope suspended
/* sediment delivery rates
additem %road_name%.aat un_ttl_del_rate 15 15 n 3 /* Travelway suspended
/* sediment delivery rates for ungraded roads
additem %road_name%.aat gr_ttl_del_rate 15 15 n 3 /* Travelway suspended
/* sediment delivery rates for graded roads
additem %road_name%.aat ab_ttl_del_rate 15 15 n 3 /* Travelway suspended
/* sediment delivery rates for abandoned roads
select %road_name%.aat
&type /&Beginning to calculate road erosion rates...
aselect
reselect basin cn [quote %basin%]
reselect grading = 'ungraded'
calculate temp_sed = length_m * width_m * ( -0.432 + ( %ungraded% * %rain% * ( slope
** 1.5 ) ) ) ~
* ( 1 + ( %silt_loss% * %silt_u_rd_fr% ) )
reselect temp_sed < 0
calculate temp_sed = 0
aselect
reselect basin cn [quote %basin%]
reselect grading = 'graded'
calculate temp_sed = length_m * width_m * ( -0.432 + ( %graded% * %rain% * ( slope **
1.5 ) ) ) ~
* ( 1 + ( %silt_loss% * %silt_g_rd_fr% ) )
reselect temp_sed < 0
calculate temp_sed = 0
aselect
reselect basin cn [quote %basin%]
reselect grading = 'abandoned'
calculate temp_sed = length_m * width_m * %rain% * %abandoned% * slope * ~
( 1 + ( %silt_loss% * %silt_a_rd_fr% ) )
aselect
reselect basin cn [quote %basin%]
calculate cslope_kg = temp_sed * %cutslope% / 100
calculate sed_kg = temp_sed - cslope_kg
reselect sed_kg < 0
calculate sed_kg = 0
aselect
calculate rd_ton = sed_kg / 1000
calculate cs_ton = cslope_kg / 1000
&type /&Beginning to calculate road sediment delivery rates for %watshed%...
calculate rd_del = rd_ton * del_ratio
calculate cs_del = cs_ton * del_ratio
calculate rd_pr_rate = rd_ton / %years%
calculate cs_pr_rate = cs_ton / %years%
calculate rd_t_del_r = rd_del / %years%
calculate cs_ttl_del_rate = cs_del / %years%
reselect basin cn [quote %basin%]
reselect grading = 'ungraded'
calculate rd_sus_del_rate = rd_t_del_r * %un_sus_fr%
calculate cs_sus_del_rate = cs_ttl_del_rate * %un_sus_fr%
calculate un_ttl_del_rate = rd_t_del_r
aselect
reselect basin cn [quote %basin%]
reselect grading = 'graded'
calculate rd_sus_del_rate = rd_t_del_r * %gr_sus_fr%
calculate cs_sus_del_rate = cs_ttl_del_rate * %gr_sus_fr%
calculate gr_ttl_del_rate = rd_t_del_r
aselect
reselect basin cn [quote %basin%]
reselect grading = 'abandoned'
calculate rd_sus_del_rate = rd_t_del_r * %ab_sus_fr%
calculate cs_sus_del_rate = cs_ttl_del_rate * %ab_sus_fr%
calculate ab_ttl_del_rate = rd_t_del_r
aselect
&type /&Done calculating road erosion & delivery rates!
dropitem %road_name%.aat (! gps_rds_ gps_rds_id area perimeter temp_sed ~
  sed_kg cslope_kg pt_del# pt_del-id del_ratio rd_ton rd_del cs_ton cs_del !)
select %road_name%.aat
```

```
aselect
&type /&Unloading %road_name%.txt ...
reselect basin cn [quote %basin%]
unload %road_name%.txt length_m surface grading potential ~
 rd_pr_rate rd_t_del_r rd_sus_del_rate cs_pr_rate cs_ttl_del_rate ~
 cs_sus_del_rate delimited init
  /* creates a file with all of the results, replaces any file with same
  /* name, comma-delimited file may be opened in Excel
quit
kill pt_del all
build %road_name% line
&type /&Exiting rd_erosion routine...
&return

&ROUTINE STREAMBANK
/*****************************************************************************/
/*                                                                           */
/* PURPOSE:    Calculates streambank sediment production and delivery rates for   */
/*             the basin chosen in the DEL_POTENTIAL routine using the           */
/*             attributes stored in the BANKS cover and the total time values    */
/*             chosen by the user during the SET_YEARS routine.                  */
/*                                                                           */
/* REQUIRED    %BANK_ER% is the rate of sediment production from erodible        */
/* PRE-DEFINED streambanks.                                                      */
/* VARIABLES:  %YEARS% are the years over which sediment production              */
/*             and delivery rates are calculated.                                */
/*                                                                           */
/* IMPORTANT   None                                                              */
/* CREATED                                                                       */
/* VARIABLES:                                                                    */
/*                                                                           */
/* SIDE       (1)A new polygon cover called BANK_DEL is created.                 */
/* EFFECTS    (2)TABLES is invoked.                                              */
/*                                                                           */
/* ALGORITHM: The BANKS polygon cover is intersected with the DEL_BD cover created*/
/*            during the DEL_POTENTIAL routine to assign DEL_RATIO values to each */
/*            stream segment according to its geographical location within       */
/*            %BASIN%. TABLES is invoked once again to add and calculate the     */
/*            value of items that will contain the sediment production and       */
/*            delivery estimates for each stream segment according to the        */
/*            values stored in the following items: PERIMETER, BANK_HT_M, and    */
/*            DEL_RATIO. The variables %BANK_ER% and %YEARS% are also used to    */
/*            calculate these items. Sediment delivery rates are estimated for   */
/*            both total loads and for the fraction of sediment finer than 2 mm, */
/*            which is expected to be transported in suspension. Command is      */
/*            transferred back to the ARC prompt before the end of the routine.  */
/*                                                                           */
/*****************************************************************************/

&type /&Beginning streambank erosion routine...
intersect banks del_bd bank_del poly /*Used to assign delivery potential to
  /* banks cover
tables
additem bank_del.pat bank_ton 8 8 n 3 /* Bank erosion in tons
additem bank_del.pat bank_ttl_del 12 12 n 3 /* Bank delivery total in tons
additem bank_del.pat bank_sus_del 12 12 n 3 /* Bank suspended sediment
/* delivery total in tons
select bank_del.pat
reselect inside = 100 /* Used to avoid calculating erosion for universal polygon.
calculate bank_ton = ( perimeter / 2 ) * 2 * bank_ht_m * %years% ~
* %bank_er% / 1000
calculate bank_ttl_del = bank_ton * del_ratio
calculate bank_sus_del = bank_ttl_del * %bank_sus_fr%
quit
&type /& Exiting streambank erosion routine...
&return
```

```
&ROUTINE STREAM_TOTAL
/*****************************************************************************/
/*                                                                           */
/* PURPOSE:    Calculates treethrow sediment production and delivery rates for   */
/*             the basin chosen in the DEL_POTENTIAL routine using the           */
/*             STJ_STR line layer and the total time value chosen by the user    */
/*             during the SET_YEARS routine. The final polygon layer contains    */
/*             sediment production and delivery from both treethrow rates and    */
/*             streambank erosion.                                               */
/*                                                                           */
/* REQUIRED    %TREETHROW% is the rate of sediment production by overthrown trees*/
/* PRE-DEFINED in the proximity of streams.                                      */
/* VARIABLES:  %YEARS% is the total time in years over which sediment production */
/*             and delivery rates are calculated.                                */
/*                                                                           */
/* IMPORTANT   None                                                          */
/* CREATED                                                                   */
/* VARIABLES:                                                                */
/*                                                                           */
/* SIDE       (1)A new polygon layer called STR_BD is created and killed.        */
/* EFFECTS    (2)A new polygon layer called BUF_STR is created and killed.       */
/*            (3)A new polygon layer called TR_DEL is created and killed.        */
/*            (4)A new polygon layer called TEMP_TRE is created and killed.      */
/*            (5)A new polygon layer called STR_DEL is created.                  */
/*            (6)TABLES is invoked.                                              */
/*            (7)The polygon layer BANK_DEL is killed                            */
/*                                                                           */
/* ALGORITHM: The STJ_STR line layer is clipped with DEL_BD-created              */
/*            during the DEL_POTENTIAL routine to eliminate stream segments      */
/*            located outside of %BASIN% in the new layer STR_BD.                */
/*            STR_BD is buffered to create the polygon layer BUF_STR.  BUF_STR   */
/*            is then used in an UNION overlay with BANK_DEL-created             */
/*            during the STREAMBANK routine to assign bank erosion values to     */
/*            the stream polygons in BUF_STR. Some items in the new polygon layer*/
/*           (TR_DEL) are removed from its INFO table in TABLES in order to      */
/*            prepare it for the INTERSECT with DEL_BD which will                */
/*            assign delivery ratios to the polygons. Some items from this new   */
/*            polygon layer TEMP_TRE are dropped in TABLES to prepare it for the */
/*            DISSOLVE command. DISSOLVE is performed using all remaining items  */
/*            so that polygons in original BANKS layer remain the same in        */
/*            order to avoid double counting of bank erosion. TABLES is invoked  */
/*            once again to add necessary items where the treethrow sediment     */
/*            production and delivery rate estimates are going to be stored.     */
/*            Treethrow production and delivery rates are a function of the      */
/*            PERIMETER and DEL_RATIO items and the %TREETHROW% and %YEARS%      */
/*            variables. Sediment delivery rates are estimated for both total    */
/*            loads and the fraction of sediment finer than 2mm, which is        */
/*            expected to be transported in suspension.  The TABLES session is   */
/*            then terminated and the STR_BD, BUF_STR, TEMP_TRE, TR_DEL, and     */
/*            BANK_DEL layers are killed before the end of the routine.          */
/*                                                                           */
/*****************************************************************************/

&type /&Beginning with stream_total routine...
clip stj_str del_bd str_bd line
buffer str_bd buf_str # # 0.25 # line
union buf_str bank_del tr_del
tables
dropitem tr_del.pat (! potential del_ratio !) /* Done to avoid having empty
 /* records in temp_tre after intersect command
quit
intersect tr_del del_bd temp_tre poly
tables
dropitem temp_tre.pat (! del_bd-id del_bd# tr_del# tr_del-id buf_str# buf_str-id ~
  inside bank_del# bank_del-id banks# banks_ banks_id !) /* Needed for dissolve
  /* function to work as intended- to dissolve along all remaining items.
select temp_tre.pat
reselect bank_ht_m = 0 /* Selects polygons that were not in the BANKS cover.
 /* These records actually have no value in the bank_ht_m item, but can be
 /* selected with this command.
reselect temp_tre-id > 0 /* Eliminates the Universal polygon from the selection.
```

```
calculate bank_ht_m = 0 /* Assigns a 0 value to polygons not included in BANKS.
 /* This step is also needed for the dissolve command to dissolve along polygons
 /* in the BANKS original coverage and avoid double counting of bank erosion.
quit
dissolve temp_tre str_del #all
tables
additem str_del.pat tree_ton 8 8 n 3
additem str_del.pat tree_ttl_del 12 12 n 3
additem str_del.pat tree_sus_del 12 12 n 3
select str_del.pat
reselect potential = ''
nselect
calculate tree_ton = ( perimeter / ( 2 * 1000 ) ) * %years% * %treethrow%
calculate tree_ttl_del = tree_ton * del_ratio
calculate tree_sus_del = tree_ttl_del * %tree_sus_fr%
quit
kill (! str_bd buf_str temp_tre tr_del bank_del !) all
&type /&Exiting stream_total routine.../&
&return


&ROUTINE SURF_EROSION
/*****************************************************************************/
/*                                                                           */
/* PURPOSE:    Calculates sediment production and delivery rates by surface  */
/*             erosion on undisturbed hillslopes for the basin chosen in the */
/*             DEL_POTENTIAL routine.                                        */
/*                                                                           */
/* REQUIRED    %UNDISTURBED% is the rate of sediment production by surface   */
/* PRE-DEFINED erosion on undisturbed hillslopes.                            */
/* VARIABLES:  %YEARS% is the total time in years over which sediment production */
/*             and delivery rates are calculated.                            */
/*             %RAIN_RATE% is the annual rainfall rate in cm per year.       */
/*             %RAIN% is the total rainfall in centimeters.                  */
/*             %SILT_LOSS% is the ratio of actual sediment production for silt- */
/*             sized material to that measured with sediment traps.          */
/*                                                                           */
/* IMPORTANT   None                                                          */
/* CREATED                                                                   */
/* VARIABLES:                                                                */
/*                                                                           */
/* SIDE       (1)A new line layer called TEMP_BD is created and killed.      */
/* EFFECTS    (2)A new polygon layer called BUF_CST is created and killed.   */
/*            (3)A new polygon layer called CST_BD is created and killed.    */
/*            (4)A new polygon layer called SE_BD is created.                */
/*            (5)TABLES is invoked.                                          */
/*                                                                           */
/* ALGORITHM: A copy of STJ_BD called TEMP_BD, which contains the entire St. John*/
/*            coastline is built as a line. A 30 m buffer is created around it */
/*            and stored as the BUF_CST layer. This layer is then clipped by  */
/*            %BASIN%_BD to eliminate the entire buffered coasline with the   */
/*            excetion of the landward side of the coasline inside %BASIN%. The */
/*            resulting layer (CST_BD)is then used in an UNION command with   */
/*            DEL_BD to assign the DEL_RATIO to the new layer SE_BD. TABLES is */
/*            invoked to add items where production and delivery data will    */
/*            be stored.  Manipulations using the reselect command avoid      */
/*            calculating sediment production and delivery for wetland areas  */
/*            and areas within 30 m of the coastline. Production and delivery */
/*            are calculated as a function of the AREA and DEL_RATIO items and */
/*            the %UNDISTURBED% and %RAIN% variables. Sediment delivery ratios */
/*            are estimated for both total loads and the fraction finer than  */
/*            2 mm, which is expected to be transported in suspension. The    */
/*            TABLES session is then terminated and the TEMP_BD, BUF_CST, and */
/*            CST_BD layers are killed before the end of the routine.         */
/*                                                                           */
/*****************************************************************************/

&type /& Beginning with surface erosion routine.../&
copy stj_bd temp_bd
build temp_bd line
buffer temp_bd buf_cst # # 30 # line /* Creates a buffer around entire coastline.
```

```
   /*  No surface erosion is calculated for buffered coastline area.
clip buf_cst %basin%_bd cst_bd poly  /* Conserves buffer for %basin% only
union cst_bd del_bd se_bd /* Combines buffered coastline with del_bd.
   /* This then allows to calculate sed prod and delivery for each area and
   /* to prevent calculating erosion for wetland and coastline areas.
tables
additem se_bd.pat se_kg 8 8 n 2
additem se_bd.pat se_ton 8 8 n 3
additem se_bd.pat se_ttl_del 12 12 n 3
additem se_bd.pat se_sus_del 12 12 n 3
select SE_BD.PAT
&type /& Calculating surface erosion on undisturbed surfaces.../&
reselect potential = '' /* Selects Universal polygon
nselect /* Eliminates universal polygon.
reselect inside = 1 /* Eliminates buffered coastline areas.
calculate se_kg = ( area * 0.14 * %rain% * %undisturbed% ) * ~
 ( 1 + ( %silt_loss% * %silt_se_fr% ) ) /* This last portion of the equation is
/* meant to compensate for loss of silt over sediment traps that were
/* used to develop the empirical erosion rate function.
aselect
reselect potential = 'wetland'
calculate se_kg = 0 /* Surface erosion is not calculated for wetland areas.
aselect
calculate se_ton = se_kg / 1000
calculate se_ttl_del = se_ton * del_ratio
calculate se_sus_del = se_ttl_del * %se_sus_fr%
quit
kill (! temp_bd buf_cst cst_bd !) all
&type /&Exiting surface erosion routine.../&
&return

&ROUTINE NAT_EROSION
/*****************************************************************************/
/*                                                                           */
/* PURPOSE:    Places all sediment production and delivery estimates derived from*/
/*             natural processes in a single polygon layer and text file.        */
/*                                                                           */
/* REQUIRED    %NAT_NAME% is the user-given name of the final layer and text     */
/* PRE-DEFINED file containing the final results of the natural erosion and      */
/* VARIABLES:  sediment delivery analysis.                                       */
/*             %YEARS% is the total time in years over which sediment production */
/*             will be calculated.                                               */
/*                                                                           */
/* IMPORTANT   None                                                          */
/* CREATED                                                                   */
/* VARIABLES:                                                                */
/*                                                                           */
/* SIDE       (1)A new polygon cover called %NAT_NAME% is created.           */
/* EFFECTS    (2)TABLES is invoked.                                          */
/*                                                                           */
/* ALGORITHM: An UNION command is used to join STR_DEL and SE_BD into one single */
/*            layer called %NAT_NAME% that contains sediment production and      */
/*            delivery estimates from treethrow, streambank erosion, and surface */
/*            erosion of undisturbed hillslopes. TABLES is invoked and several   */
/*            manipulations are used to avoid double counting of surface erosion */
/*            rates. Items that contain total sediment production and delivery   */
/*            estimates from natural processes are added and calculated.         */
/*            Production and delivery are calculated as a function of the        */
/*            SE_TON,BANK_TON, TREE_TON, SE_DEL, BANK_DEL, and TREE_DEL items    */
/*            and the %YEARS% variable. A file named %NAT_NAME%.txt containing   */
/*            all of the results is unloaded before the TABLES session is        */
/*            terminated. The SE_BD and STR_DEL layers are killed before exiting */
/*            the routine.                                                       */
/*                                                                           */
/*****************************************************************************/

&type /&Beginning nat_erosion routine...
union se_bd str_del %nat_name% /* Unions treethrow, streambank and surface erosion
   /* estimates into one coverage.
tables
select %nat_name%.pat
```

```
reselect tree_ton > 0
calculate se_ton = 0 /* Avoids double counting of surface erosion estimates.
calculate se_ttl_del = 0 /* Avoids double counting of sediment delivery estimates.
calculate se_sus_del = 0
aselect
additem %nat_name%.pat nat_ton 8 8 n 2
additem %nat_name%.pat nat_ttl_del 12 12 n 2 /* Total sediment delivery
additem %nat_name%.pat nat_sus_del 12 12 n 2 /* Suspended sediment delivery
additem %nat_name%.pat nat_pr_rate 12 12 n 2 /* Total sediment production
additem %nat_name%.pat nat_t_del_rate 12 12 n 2 /* Total delivery rate
additem %nat_name%.pat nat_s_del_rate 12 12 n 2 /* Suspended delivery rate
select %nat_name%.PAT
calculate nat_ton = se_ton + bank_ton + tree_ton
calculate nat_pr_rate = nat_ton / %years%
calculate nat_ttl_del = bank_ttl_del + tree_ttl_del + se_ttl_del
calculate nat_sus_del = bank_sus_del + tree_sus_del + se_sus_del
calculate nat_t_del_rate = nat_ttl_del / %years%
calculate nat_s_del_rate = nat_sus_del / %years%
dropitem %nat_name%.pat (! se_bd# se_bd-id cst_bd# cst_bd-id inside del_bd# ~
 del_bd-id se_kg str_del# str_del-id !)
&type Unloading %nat_name%.txt ...
unload %nat_name%.txt area potential se_ton se_ttl_del se_sus_del bank_ton ~
 bank_ttl_del bank_sus_del tree_ton tree_ttl_del tree_sus_del nat_pr_rate ~
 nat_t_del_rate nat_s_del_rate delimited init
  /* creates a file with all of the results,
  /* replaces any file with same name, comma-delimited file may be opened
  /* from Microsoft Excel
quit
kill (! se_bd str_del !) all
build %nat_name% poly
&type /&Done with nat_erosion routine...
&return

&ROUTINE SUMMARY_RESULTS
/*****************************************************************************/
/*                                                                           */
/* PURPOSE:    Displays a summary of results for both road and natural erosion   */
/*             and delivery rates on the screen.                             */
/*                                                                           */
/* REQUIRED    %NAT_NAME% is the user-given name of the final cover and text     */
/* PRE-DEFINED file containing the final results of the natural erosion and      */
/* VARIABLES:  sediment delivery analysis.                                   */
/*             %ROAD_NAME% is the user-given name of the final cover and text    */
/*             file containing the final results of the road erosion and         */
/*             sediment delivery analysis.                                   */
/*                                                                           */
/* IMPORTANT    A total of 22 new variables are created by this routine.         */
/* CREATED                                                                   */
/* VARIABLES:                                                                */
/*                                                                           */
/* SIDE       (1) ARCEDITs invoked.                                          */
/* EFFECTS    (2) TABLES is invoked.                                         */
/*                                                                           */
/* ALGORITHM: The statistics command is used to sum the sediment delivery totals */
/*            of a number of items in %NAT_NAME%.PAT and %ROAD_NAME%.AAT.        */
/*            ARCEDIT is invoked to set the values of several new variables.     */
/*            After exiting ARCEDIT the TABLES module is invoked to drop         */
/*            a number of items from the %ROAD_NAME% data layer. Finally, the    */
/*            routine prints on the screen a table summarizing the overall       */
/*            model results.                                                 */
/*                                                                           */
/*****************************************************************************/
&if [exists %nat_name%.sta] &then kill %nat_name%.sta
&if [exists %road_name%.sta] &then kill %road_name%.sta
statistics %nat_name%.pat %nat_name%.sta
sum bank_ttl_del
sum bank_sus_del
sum tree_ttl_del
sum tree_sus_del
sum se_ttl_del
sum se_sus_del
```

```
sum nat_ttl_del
sum nat_sus_del
end
statistics %road_name%.aat %road_name%.sta
sum un_ttl_del_rate
sum gr_ttl_del_rate
sum ab_ttl_del_rate
sum cs_ttl_del_rate
sum cs_sus_del_rate
end
arcedit
edit %nat_name%.sta info
&sv bank_ttl_del_r = [show info 1 item sum-bank_ttl_del] / %years%
&sv bank_sus_del_r = [show info 1 item sum-bank_sus_del] / %years%
&sv tree_ttl_del_r = [show info 1 item sum-tree_ttl_del] / %years%
&sv tree_sus_del_r = [show info 1 item sum-tree_sus_del] / %years%
&sv se_ttl_del_r = [show info 1 item sum-se_ttl_del] / %years%
&sv se_sus_del_r = [show info 1 item sum-se_sus_del] / %years%
&sv nat_ttl_del_r = [show info 1 item sum-nat_ttl_del] / %years%
&sv nat_sus_del_r = [show info 1 item sum-nat_sus_del] / %years%
edit %road_name%.sta info
&sv un_ttl_del_r = [show info 1 item sum-un_ttl_del_rate]
&sv gr_ttl_del_r = [show info 1 item sum-gr_ttl_del_rate]
&sv ab_ttl_del_r = [show info 1 item sum-ab_ttl_del_rate]
&sv un_sus_del_r = %un_ttl_del_r% * %un_sus_fr%
&sv gr_sus_del_r = %gr_ttl_del_r% * %gr_sus_fr%
&sv ab_sus_del_r = %ab_ttl_del_r% * %ab_sus_fr%
&sv cs_ttl_del_r = [show info 1 item sum-cs_ttl_del_rate]
&sv cs_sus_del_r = [show info 1 item sum-cs_sus_del_rate]
&sv rd_ttl_del_r = ( %un_ttl_del_r% + %gr_ttl_del_r% + %ab_ttl_del_r% + %cs_ttl_del_r%
)
&sv rd_sus_del_r = ( %un_sus_del_r% + %gr_sus_del_r% + %ab_sus_del_r% + %cs_sus_del_r%
)
&sv min_cur_nat = ( ( %rd_sus_del_r% + %nat_ttl_del_r% ) / %nat_ttl_del_r% )
&sv max_cur_nat = ( ( %rd_ttl_del_r% + %nat_sus_del_r% ) / %nat_sus_del_r% )
&sv total_sus_del_r = ( %bank_sus_del_r% + %tree_sus_del_r% + %se_sus_del_r% + ~
 %un_sus_del_r% + %gr_sus_del_r% + %ab_sus_del_r% + %cs_sus_del_r% )
&sv total_del_r = ( %bank_ttl_del_r% + %tree_ttl_del_r% + %se_ttl_del_r% + ~
 %un_ttl_del_r% + %gr_ttl_del_r% + %ab_ttl_del_r% + %cs_ttl_del_r% )
quit
tables
dropitem %road_name%.aat (! un_ttl_del_rate gr_ttl_del_rate ab_ttl_del_rate ~
 rd_sus_del_rate cs_sus_del_rate rd_pr_rate cs_pr_rate !)
quit
&type /&/&
&type _____________________________________________________/&
&type  Source name     Susp. del. rate     Total del. rate
&type                    (tons/year)         (tons/year)/&
&type _____________________________________________________/&
&type  Streambank            [round %bank_sus_del_r% ]       [round %bank_ttl_del_r% ]
&type  Treethrow             [ %tree_sus_del_r% ]            [ %tree_ttl_del_r% ]
&type  Undisturbed           [ %se_sus_del_r% ]              [ %se_ttl_del_r% ]
&type  Ungraded rds          [round %un_sus_del_r% ]         [round %un_ttl_del_r% ]
&type  Graded rds            [round %gr_sus_del_r% ]         [round %gr_ttl_del_r% ]
&type  Abandoned rds         [ %ab_sus_del_r% ]              [ %ab_ttl_del_r% ]
&type  Cutslopes             [round %cs_sus_del_r% ]         [round %cs_ttl_del_r% ]
/&
&type  TOTAL                 [ round %total_sus_del_r% ]     [round %total_del_r% ]
&type _____________________________________________________/&/&
&type Natural sediment yield rates for the %watshed% basin range from
&type     [round %nat_sus_del_r% ] to [round %nat_ttl_del_r% ] tons per year./&
&type Road sediment yield rates for the %watshed% basin range from
&type     [round %rd_sus_del_r% ] to [round %rd_ttl_del_r% ] tons per year./&
&type Current sediment delivery rates into %watshed% range between
&type     [round %min_cur_nat% ] and [round %max_cur_nat% ] times above undisturbed
conditions.
&type /&/&
&if [query 'Press enter to exit.' .true.] &then ~
&return
```