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URB1 Data Development Procedures

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Introduction

This technical note describes the procedural steps and techniques used to develop input data for the URB1 computer program when computing urban flood damages. It should be used in conjunction with the URB1 users manual. This technical note does not provide detailed guidance in general planning, urban flood damage methods, or concepts. Many other references are available that discuss concepts, definitions, and general evaluation procedures. These references include:

1. SCS National Planning Procedures Handbook,
2. Principles and Guidelines, Chapter 2, Section IV, NED Benefit Evaluation Procedures: Urban Flood Damage,
3. National Bulletin 200-7-2, Economics Handbook, Part II, Part 623, - Urban Flood Damage, and
4. EWP Technical Guide NO. 21, Supplement 1, Floodwater Damage Estimates for Residential and Commercial Property.

URB1 is used to compute urban flood damages using the storm frequency analysis. Inputs needed include stage damage coefficients, hydraulic cross section data, elevation survey information, and hydraulic flow frequencies. Benefits are computed by comparing future without project flood damage conditions to future with project flood damage conditions.

Flood damage analysis of urban damages requires the input and expertise of an interdisciplinary team consisting of an hydraulic engineer, structural engineer, and economist as a minimum. The steps are necessary to conduct a detailed urban flood damage analysis. The scope and intensity of each step should be commensurate with the desired accuracy of the answer.

Step 1. Delineate Watershed Boundaries. The planning team should delineate the watershed boundaries through the examination of topographic maps.

Step 2. Delineate flood plain boundaries. The planning team will delineate the boundaries of the flood plain in the study area. The 500-year storm frequency flood plain boundary should be delineated because Section 2.4.17(a)(2) of Principles and Guidelines requires that the flood damages and effects be shown for this storm. The 500-year flood plain is defined as the area flooded by the 500-year storm, or a .2 percent chance flood. This area must be delineated and displayed on either a map, aerial photography, or overlay. Damages to flood plain improvements located within this defined area will be evaluated in the planning process.

Step 3. Locate cross sections and reaches. The planning team should locate cross sections and evaluation reaches that can accurately model present condition flooding. A cross section must be upstream and downstream from any improvements to be evaluated.

The physical characteristics of the flood plain and its improvements should be examined to locate cross sections and identify evaluation reaches. Physical characteristics to consider include stream tributaries, building structure types and locations, topography, possible engineering solutions, number of cross sections, and bridges.

An evaluation reach is simply an area that has similar characteristics that can be evaluated together. For example, if the upper part of the urban flood plain contains residential structures and the lower portion contains commercial structures, then separating the flood plain into two reaches will simplify the analysis of the URB1 output data.

If any tributary to the mainstream flood plain has cross sections and improvements to be analyzed, then it should be defined as a separate reach. This allows urban flood damages for the entire watershed to be evaluated by the URB1 program in a single run. URB1 summarizes damages and benefits by evaluation reach.

Caution should be taken in locating cross sections close enough together to accurately model flooding conditions for the improvements between the cross sections. Experience is the best guide in locating cross sections and evaluation reaches.

Naming of cross sections should be done carefully. Each of the two hydrology programs and the URB1 program have different cross section naming conventions. WSP2 can use a five characters alphanumeric identifier. TR-20 is restricted to cross section names from 1 to 200. URB1 allows a five character alphanumeric cross section name. Therefore, when considering the restrictions of all three programs and to keep from having to rename cross sections between the three program runs, the following naming conventions and program options should be used.

For WSP2, TR-20, and URB1 enter cross section names between 1 and 200. Do not use **anything** other than the numbers 1 through 200. This means no spaces, dashes, underlines or leading zero's in cross section numbers (i.e. 001). Using anything other than 1 through 200 will require cross sections to be renamed in one of the programs.

Step 4. Strip Map. Prepare a strip map of the flood plain study area. This map should include all physical features of the flood plain, such as stream locations, and flood plain improvements, such as streets, bridges, homes, businesses, and utilities. It should also include cross sections and evaluation reaches. If stationing measurements are to be taken, this map should be prepared to scale.

Step 5. Identification of improvements. Assign each improvement to be evaluated an alphanumeric identifier. This identification should be limited to 8 characters and should be used in columns 73 through 80 on the house input line for the URB1 program (version 1 and later). Use numbers and letters that represent important information about the improvement, such as location, type of improvement (business or residence), and damage category. Record the identifier on the flood plain strip map at the appropriate location.

Step 6. Stationing. The planning team should station each flood plain improvement and cross section along a common base line. Stationing is simply assigning a distance to each cross section and improvement to be evaluated. The purpose of stationing an improvement or cross section is to establish the distance relationship between the improvements to be evaluated and the cross sections. All improvements to be evaluated in the delineated flood plain should be stationed on the flood plain strip map or an enlarged aerial photograph. Stationing measurements must be made on aerial photos taken on scale or on the flood plain strip map drawn to scale.

Stationing begins by drawing a line perpendicular to the mainstream channel. See figure 1 for an example of stationing. Begin measuring from the furthest downstream cross section (beginning point) in the project evaluation area. Measure the distance to each improvement and cross section from the beginning point. The measurement is usually expressed in surveying terms where the first number represents hundreds of feet and the second number represents tens of feet (i.e. station 150+25 would be located 15,025 feet upstream from the beginning point.)

After stationing of the mainstream is complete, station the tributaries beginning with the furthest downstream tributary and proceeding upstream until complete. Stationing of tributaries requires some adjustments in order to run the mainstream and all tributaries in one URB1 run. A station can be used only once in the URB1 program; therefore, tributary stationing can be accomplished by incrementally increasing station numbers from the mainstream to tributaries. As example, assume the uppermost mainstream station is 45+00, then the first station number of the first tributary should be incrementally increased by an arbitrarily selected amount, such as station 61+00, and proceed. Start stationing at the second tributary by rounding up the last station used in the first tributary and so on. This is illustrated in figure 1. Since each reach is computed separately in the program, the actual distance used by the program is the distance between cross sections. Adding or rounding up to begin stationing for the first station of an evaluation reach does not change the results of the URB1 run.

Step 7. Flood plain inventory. Inventory flood plain improvements to determine the types, damageable values, historical damages, elevations, and other important parameters. During this inventory, houses and commercial buildings should be categorized based on their use, condition class, size, and construction type. An example would be RGAF, which represents **R**esidential use, **G**ood condition, **A**verage size, and **F**rame on foundation construction. See EWP Technical Guide 21 for further examples. A five digit alphanumeric damage coefficient code is allowed as input in URB1 on the DAMAGE COEFFICIENT DATA input record and the BUILDING DATA input record. The user defined codes, such as RGAF and RPSB, are used by the program to assign a damage coefficient table code to a residential or commercial structure or other floodplain improvement. In this manner the program can use a damage coefficient table over and over. Often, a picture of the property is helpful in assigning and evaluating damage coefficient tables. The category classification scheme should be formulated before going to the field to inventory properties.

The evaluation team should also obtain elevation surveys for the affected flood plain improvements. As a minimum the survey of each improvement should include the elevation at which damage begins. The survey of each building should include the first floor elevation, the elevation at which damage begins, and the elevation of zero damage.

Use of the elevation at which damage begins is not required in URB1, but should be used when floodwater must reach an elevation higher than the elevation of zero damage before damage actually begins. An example is a building with a basement or a dike around a building. Usually the elevation of zero damage and the elevation at which damage begins are the same, unless the building has a basement or a dike around it. If the building has a basement, the elevation damage begins may be the lowest basement window sill and the elevation of zero damage is the carpet on the basement floor. The program uses the zero point on the stage damage curve as the elevation of zero damage.

Step 8. Collect Damage Schedules. Using the OMB approved Form SCS-ECN-002, complete damage schedule interviews for each category of residential flood plain improvements. SCS-ECN-003 should be used to complete interviews for commercial and industrial flood plain improvements. SCS-ECN-004 should be used to complete interviews for transportation and utility floodplain improvements. Examples of forms that have been used to summarize residential and commercial/industrial information are shown by attachments 1 and 2.

The purpose of collecting damage schedule information is to determine the types and extent of damages present for the various categories of flood plain improvements. This damage information is used to develop stage damage curves and damage coefficient for the URB1 program. The dates and depths of flooding events are used by the hydrologist to calibrate the hydrology data for the URB1 program.

The owner or occupant of the house, building, or flood plain improvements is the primary source of establishing information needed to compute damages. A review of published historical flood data, current sales, tax records, and other such information can also provide needed data. The sources of data needed to establish damage vary with each watershed project, and the economist must determine the location and applicability of available data.

Information to collect includes:

- building and content values
- flood dates,
- depths, and damage sustained for each floodplain improvement,
- structural damages to building and houses,
- damage to contents for all flood events possible.

Building values can be obtained from courthouse records, current value of similar properties, realtors, and professional appraisers. The content value of a residential building can be based on a representative sample of the replacement costs for similar damage categories in which the analyst computes the content value as a percent of the home value. The value of commercial inventories is not linked to the structural value and will be determined from an interview with the property owner. Since a great variation in value of commercial contents exists, a sample procedure may not reflect the damage incurred. The data obtained from property owners and other local sources for evaluating flood water damages are confidential and subject to the Privacy Act.

If many similar flood plain improvements are in the same damage categories, a sample of part of the flood plain improvements in each damage category may be used instead of completing a damage schedule form on each property. The sampling procedure should be developed before interviewing begins. The sample size, number, and location of each building type must be established so that the inventory of sampled improvements accurately reflects information for those building types not included in the sample. Parameters to consider when deciding on sampling scheme and size include the number of similar flood plain improvements, data requirements, and planning time limitations. The development and use of statistically reliable sample procedures will provide accurate data.

Step 9. Compute damage factors. Summarize damage schedules by damage category. Use the damage schedule interviews to establish historical structural and content damage by 1 foot increments for each damage category. These historical damage coefficient factors require updating to present values. Forms similar to those in Attachment 1 and 2 may be useful in summarizing damage schedules.

Data obtained for several improvements in the same damage category will probably produce a range of monetary damages representing different storm events and depths. This wide range of data can be graphed or mathematically plotted using curve linear or linear projections so that damage coefficients for 1 foot increments can be computed.

When developing content damages for businesses, each business type will require the development of a specific set of damage factors. This must be done because the content value can vary greatly.

To develop a depth increment damage coefficient factor for the structure damage, divide the current value of damages incurred at each foot of flooding by the total value of the structure. To develop a depth increment damage coefficient factor for the content damage, divide the current value of damages incurred at each foot of flooding by the total value of contents. Follow this procedure for each depth to be evaluated in the URB1 program.

Example: Calculate the structural damage coefficient factor for 1 foot of flooding for a structure valued at \$90,000 and sustaining \$6,300 damage: $\frac{\$6,300}{\$90,000} = 7\ \%$ damage coefficient.

After developing a damage coefficient factor for each depth required for each damage category, the damage coefficient table needed by the URB1 program will have been completed and ready to be input into URB1. Attachment 3 illustrates the computation of damage coefficients for a house using interview information collected during a field interview.

Development of damage coefficient factors and tables for all flood plain improvements, such as utilities (telephone, gas, electric, sewer) should follow the same procedures.

Published damage factors are available from different sources including the Federal Emergency Management Agency and the U.S. Army Corps of Engineers. Usually these factors are not site-specific to the area where the SCS evaluation is being conducted. Because of this, great care should be exercised when using or adjusting existing factors to ensure that they reflect the damage for the watershed being evaluated. Detailed damage schedule information must be collected before these factors can be modified and used in the evaluation.

Section 623.02 of the Economics Handbook - Part II provides additional information on urban damage factors.

Step 10. Input data. Assemble and input data into an URB1 input file using the URB1 Data Entry Program. Assemble and input the following information:

A. Storm frequencies (expressed as percent chance of occurrence) used in the hydraulic analysis. Care should be taken to include the 500-year storm frequency, 100-year storm frequency, and a storm that is small enough that it causes no damages, such as the 1/4 or 1/2 year storm frequency.

B. Cross section numbers included in each evaluation reach.

C. Coefficient damage curves for all damage categories.

D. Building data for each house, business, or improvement. This includes damage category or house type, first floor elevation, station, the elevation of zero damage, the house and content values, the elevation at which damage begins, and the house identification code.

E. Update header cross section data including stationing of cross sections and bridge sections and the percent of the flood plain inventoried. The program assumes a 100 percent inventory if no flood plain inventory data are entered. Most SCS projects should have a 100 percent inventory of flood plain improvements.

F. Cross Section rating curve data for each cross section. Provide rating curve data (elevation and CFS) that exceeds the CFS produced by the largest storm analyzed. Input of the cross section rating curve data can be accomplished by using the redirect feature to transfer an economic rating curve output file from the WSP2 hydrology program to the URB1 input data file.

G. Flow frequency data for each cross section and bridge section. Input of the flow frequency data file can be accomplished by using the redirect feature to transfer an economic output flow frequency file from the TR20 hydrology program.

The redirect feature allows a WSP2 or TR20 output file to be incorporated into the URB1 data stream at the appropriate location. Therefore, the hydrology data do not have to be entered using the Data Entry program.

Step 11. Compute present condition damages. Execute the URB1 program using the input file created. After computing present condition damages, the planning team should carefully examine the damages calculated to ascertain that the modeled results are representative of the damages indicated through the damage schedules. This is a critical step. Adjustments of cross section data, elevations, or other parameters may be needed to accurately reflect present condition flooding.

Step 12. Compute future without condition damages. Any enhancements or major changes in the flood plain or major changes in watershed runoff in the future should be computed into the hydrology programs and URB1 input data, and the URB1 program should be rerun. If there are no major changes, then present conditions can be assumed to also be the future without conditions.

To compute future with project alternative conditions, simply redirect the appropriate hydrology files into the future without project input data file. If the future with project alternative consists of floodwater retarding structures or other measures to prevent floodwater runoff, the hydrology flow frequencies will change. When only flow frequencies change, only a new flow frequency file needs to be redirected into the future without project input data to create the future with runoff prevention alternative. The cross section rating curves do not change unless a channel is modified.

Compute the average annual benefits to the alternative by subtracting the with project run from the future without project run.

Attachment 1 - Residential Flood Damages Information Summary Form

Watershed Name: ____________________
Building Number: ____________________
Building Code: ____________________

Single story ____ Brick ____ Stone ____ Wood ____ Other ____________
Two story ____ Brick ____ Stone ____ Wood ____ Other ____________
Mobile home ____ Brick ____ Stone ____ Wood ____ Other ____________
Split level ____ Brick ____ Stone ____ Wood ____ Other ____________
Other ____________________

Building has a basement: Yes ________ No ________
Basement is finished: Yes ________ No ________
Dollar damages if basement is flooded ($): ________

Building Value($) ________ Content Value ($) ________
Percent of contents value by floor:
Basement ________ % First floor ________ % Second floor ________ %

The building has experienced flooding: Yes ________ No ________

	Year		Feet		Dollars
Flood	________	Depth	________	Damages	________
Flood	________	Depth	________	Damages	________
Flood	________	Depth	________	Damages	________

Estimated building damages by flooding depth:

Feet		Dollars		Dollars
1:	Structure	________	Contents	________
2:	Structure	________	Contents	________
3:	Structure	________	Contents	________
4:	Structure	________	Contents	________
5:	Structure	________	Contents	________
6:	Structure	________	Contents	________
7:	Structure	________	Contents	________
8:	Structure	________	Contents	________
9:	Structure	________	Contents	________
10:	Structure	________	Contents	________
11:	Structure	________	Contents	________
12:	Structure	________	Contents	________
13:	Structure	________	Contents	________
13+:	Structure	________	Contents	________

Landscaping, Driveways and other damages: ____________________
Other data: ____________________
____
____
____

Attachment 2 - Commercial Flood Damages Information Summary Form

Watershed Name: ______________________________
Building Number: ______________________________
Building Code: ______________________________
Description of the Business: ______________________________
____

Building has a basement: Yes __________ No __________
Dollar damages if basement is flooded ($): __________

Percent of inventory value by floor:
Basement ______% First floor ______% Second floor ______%

The building has experienced flooding: Yes __________ No __________

	Year		Feet		Dollars
Flood	______	Depth	______	Damages	______
Flood	______	Depth	______	Damages	______
Flood	______	Depth	______	Damages	______

Estimated building damages by flooding depths:

Feet		Dollars		Dollars
1:	Structure	______	Inventory	______
2:	Structure	______	Inventory	______
3:	Structure	______	Inventory	______
4:	Structure	______	Inventory	______
5:	Structure	______	Inventory	______
6:	Structure	______	Inventory	______
7:	Structure	______	Inventory	______
8:	Structure	______	Inventory	______
9:	Structure	______	Inventory	______
10:	Structure	______	Inventory	______
11:	Structure	______	Inventory	______
12:	Structure	______	Inventory	______
13:	Structure	______	Inventory	______
13+:	Structure	______	Inventory	______

Landscaping, Driveways and other damages: ______________________________
Other data: ______________________________
____

The estimated commercial damages by flood increments should be completed for each commercial building. The actual and extrapolated values should be used to develop the damage coefficient factors used by URB1.

Attachment 3 - Damage Coefficient Development

This damage coefficient table development is for a single story, frame home with basement. The house category is RFLFB, which identifies it as **R**esidential, **F**air condition, **L**arge in size, **F**rame construction, and with a **B**asement. The house number identification is HE1ST124, which identifies it as being a house at 124 Elm Street. The house is stationed at station 16+70. The structure value of the house is $93,000, and the content value is $46,500.

	Structural Damages By Depths	Content Damages by Depths	Flooding Depths (feet)
1954 interview data indexed to PV	$76,400	$41,850	12
Extrapolated data	74,400	41,385	11
Extrapolated data	66,960	32,550	10
1973 interview data indexed to PV	55,800	30,690	9
Extrapolated data	45,570	27,900	8
Extrapolated data	40,920	26,040	7
Extrapolated data	38,130	23,250	6
1964 interview data indexed to PV	34,410	21,855	5
Extrapolated data	31,620	20,460	4
Extrapolated data	27,900	16,275	3
1982 interview data indexed to PV	24,180	9,300	2
Extrapolated data	22,320	6,045	1

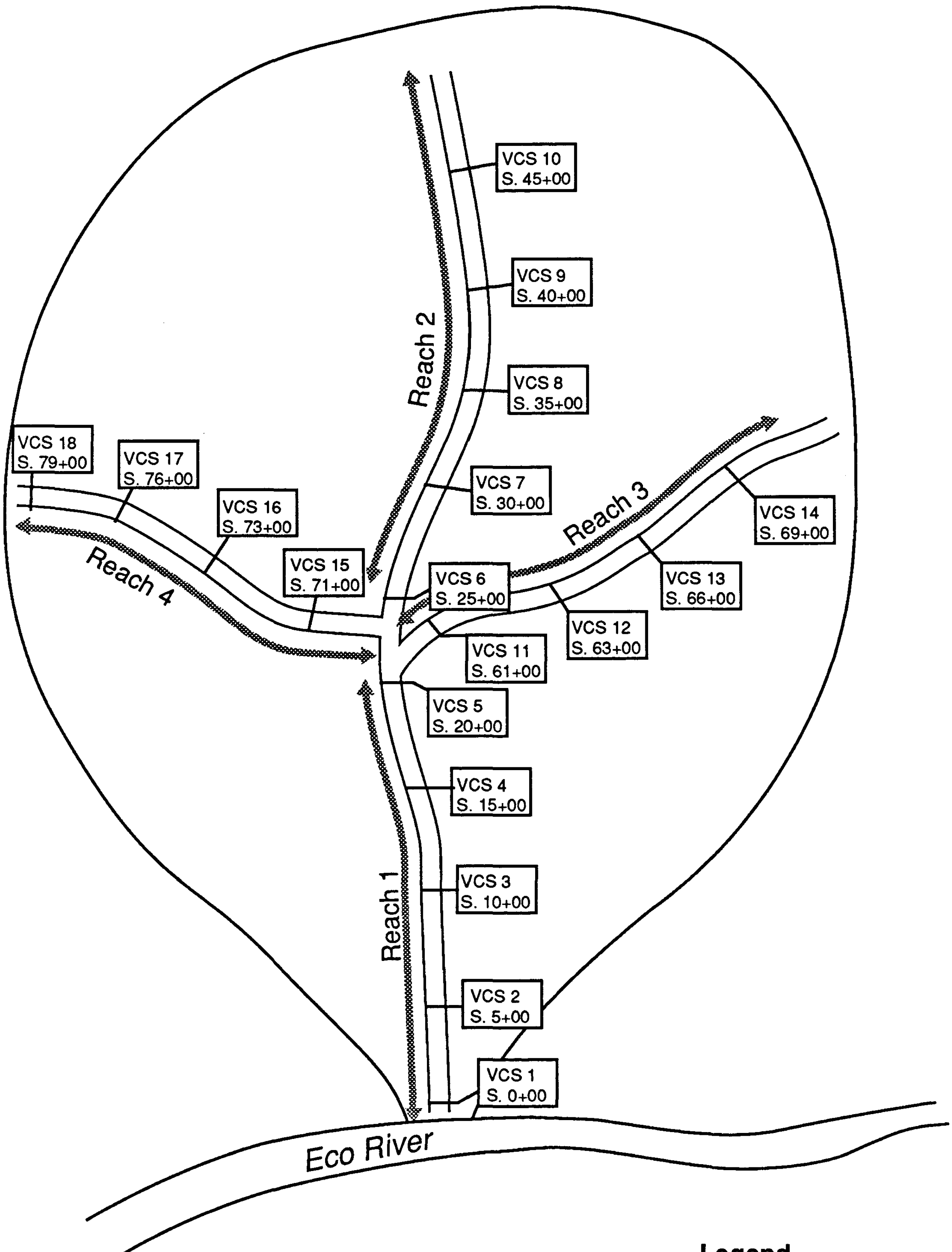
Computation of Damage Coefficients

Depth of Flooding 1/ (feet)	Structure Damages (dollars)	Content Damages (dollars)	Calculated Structure Damage Factors 2/ percent	Calculated Content Damage Factors 3/ percent
0	0.00	0.00	0.0	0.0
1	22,320	6,045	24.0	13.0
2	24,180	9,300	26.0	20.0
3	27,900	16,275	30.0	35.0
4	31,620	20,460	34.0	44.0
5	34,410	21,855	37.0	47.0
6	38,130	23,250	41.0	50.0
7	40,920	26,040	44.0	56.0
8	45,570	27,900	49.0	60.0
9	55,800	30,690	60.0	66.0
10	66,960	32,550	72.0	70.0
11	74,400	41,385	80.0	89.0
12	76,400	41,850	82.0	90.0

1/ Depth of flooding is relative to basement floor elevation.
2/ Structure Damage Calculation for 1 foot is:
$22,320/$93,00 = 24.0 %
3/ Content Damage Calculation for 1 foot is:
$6,045/$46,500 = 13.0 %

Bottom of basement window level is at elevation 201. The ground elevation is at 200. The first floor elevation is at 202. The basement floor elevation is at 193. The elevation at which damage begins should be set at 201. The elevation of zero damage should be set at 193. This means that when the water is 1 foot deep in the basement, then structural damages of $22,320 have occurred.

Eco Watershed



Legend
VCS = Valley Cross Section
S. = Stationing Measurement