
CHAPTER 7

Evaluation

Under **Evaluation** you may review the study status, perform two types of analyses, and evaluate results. The two analysis options are of plans by individual analysis years and equivalent annual damage over the specified analysis period (project life) for the plan. **Note:** the plan evaluation for both the base and most likely future analysis years must be successfully computed before performing equivalent annual damage computations for that plan.

In general, data developed and displayed under **HydEng** and **Economics** represent the best estimates of the median values of the exceedance probability, stage, and damage functions for without- and with-project conditions. Uncertainty parameters of the functions are also developed for study conditions. The analyses performed and results displayed under **Evaluation** use the median valued functions and associated uncertainties to produce expected values. The computational procedure used is Monte Carlo. Appendix F describes the computation procedures in detail.

Contents

- # Study Status Report
- # Evaluation of Plans by Analysis Years
- # Equivalent Annual Damage Analysis
- # Results

Study Status Report

The **Study Status Report** under the main **Evaluation** window is an important report that displays the completeness of the exceedance probability, stage, and damage data for specific plans and analysis years required for computations. Figure 7.1 shows the report. The report keys off the assignment tables found under the **View Menu** for each of the individual functions. The following process is used: when the exceedance probability assignments for all streams and damage reaches for a given plan and analysis year are complete a P for exceedance probability completeness is indicated for that plan and analysis year on the **Study Status Report**. A Similar process is followed for stage (S). For damage (\$), the functions are required for all study damage categories, streams, and damage reaches.

Plan Name	Plan Description	Base Year 1999	Most Likely Future Year 2020
Without	Without project condition	P S \$	P S \$
Plan 1	Detention + Channel Imp.	P S \$	P S \$
Plan 2	Floodwall Only	P S \$	P S \$
Plan 3	Detention, Channel Imp., and Floodwall	P S \$	P S \$

Legend

- P: All exceedance probability functions for this plan are completed.
- S: All stage-discharge functions for this plan are complete.
- \$: All stage-damage functions for this plan are complete.
- *Data is incomplete.

Figure 7.1 Study Status Report

Once an analysis year for a plan has designated P S \$ in the **Study Status Report**, you can perform the analysis for that condition under the **Evaluation of Plans by Analysis Year** menu. If one or more labels (P S \$) are not shown, an * appears, indicating that some data are missing and HEC-FDA will not perform the analysis. You should return to the appropriate function assignment tables to review what data are needed for that plan and analysis year.

Evaluation of Plans by Analysis Years

HINT: We recommend you review the **Study Status Report** prior to attempting to compute the plan and analysis year damage and performance results.

You compute information on damage and engineering performance under **Evaluation of Plans by Analysis Years**. The base and most likely future conditions analysis years of a plan must be successfully executed prior to performing **Equivalent Annual Damage Analysis**.

Figure 7.2 shows the selection table for analysis. You must include the without-project conditions if not previously successfully run. You can click on a plan and analysis year to highlight it for computations. You click and drag to highlight a sequential series of analysis years and plans. You hold Control and individually click on analysis years and plans to select a set of nonsequential analysis and plans for computations. You may run the program without using the uncertainty of the functions (no risk-based analysis) by not checking (leave blank) the boxes for a plan under Use Uncertainty. For this condition, the analyses are performed as conventional studies prior to risk-based analysis being required. The expected probability function is used along with the stage-discharge and damage-stage functions without uncertainty to compute expected annual damage.

Execute	Use Uncertainty	Plan Name	Plan Description	Analysis Year	Date of Execution
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Without	Without project condition	1999	Thu Nov 6, 1997 7:52:27 AM Pacific Star
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Without	Without project condition	2020	Thu Nov 6, 1997 8:09:13 AM Pacific Star
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Plan 1	Detention + Channel Imp.	1999	Thu Nov 6, 1997 8:10:08 AM Pacific Star
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Plan 1	Detention + Channel Imp.	2020	Thu Nov 6, 1997 8:11:24 AM Pacific Star
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Plan 2	Floodwall Only	1999	Thu Nov 6, 1997 8:13:09 AM Pacific Star
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Plan 2	Floodwall Only	2020	Thu Nov 6, 1997 8:15:12 AM Pacific Star
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Plan 3	Detention, Channel Imp., and Floodwall	1999	Thu Nov 6, 1997 8:16:35 AM Pacific Star
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Plan 3	Detention, Channel Imp., and Floodwall	2020	Thu Nov 6, 1997 8:18:40 AM Pacific Star

Without Project Base Year Performance Target Criteria

Event Exceedance Probability:

Percent Residual Damage:

Figure 7.2 Evaluation of Plans by Analysis Years

Plan and damage reach performance analyses are based on target standards defined for without-project conditions for the study. The standards used by the HEC-FDA program are based on the residual damage associated with a specific exceedance probability event. Performance targets are essentially the zero damage stage but normally considers minor damage to the infrastructure as acceptable and significant damage to structures as not acceptable. Consistent criteria for comparing the impacts of different measures and plans is also a goal. Experience at HEC has shown that a 5 percent residual damage associated with the .01 exceedance probability event is normally a good target stage and was adopted as the HEC-FDA default. You may enter other values if they are deemed better for your study conditions.

You press Compute to execute the program after highlighting the desired analysis years and plans and specifying target performance criteria. A program status dialog box (not shown) is displayed to monitor the computational status of the program. A check mark (✓) is shown under execution for a successful computation results. A date stamp of the program execution is also output. Upon leaving and returning to the screen a check indicates that the data associated with the computations and results have remained unchanged and that there is no need to run the program again. A blank indicates the given Plan and Analysis Year needs to be run or rerun (data has changed).

Equivalent Annual Damage Analysis

The flood damage associated with a plan are calculated in average annual equivalent terms (see ER 1105-2-100). The procedures discount the expected annual damage stream to the beginning of the period of analysis or the base year. Future year damage values are linearly interpreted between the base and most likely future year conditions and assumed constant from the most likely future year to the end of the analysis period. The analysis period (project life) is the period of time over which the plan has significant beneficial or adverse effects. It is normally 50 years and is not to exceed 100 years.

You may perform equivalent annual damage computations for a plan after the base and most likely future analysis years conditions are successfully completed under the **Evaluation of Plans by Analysis Years** menu. Figure 7.3 shows the data entry screen for the equivalent analysis. You must include the without-project plan if not previously successfully run. You press Compute to execute the program after highlighting the desired analysis years and plans and specifying the project life in years and discount rate as a percent. A program status dialog box (not shown) is displayed for you to continuously monitor the computational status of the program. A check mark (✓) is shown under execution for successful computation results. A date stamp of the program execution is also output. You must run both the base year and future

year of the plan for either risk based-analysis or no risk-based analysis conditions to perform the analysis.

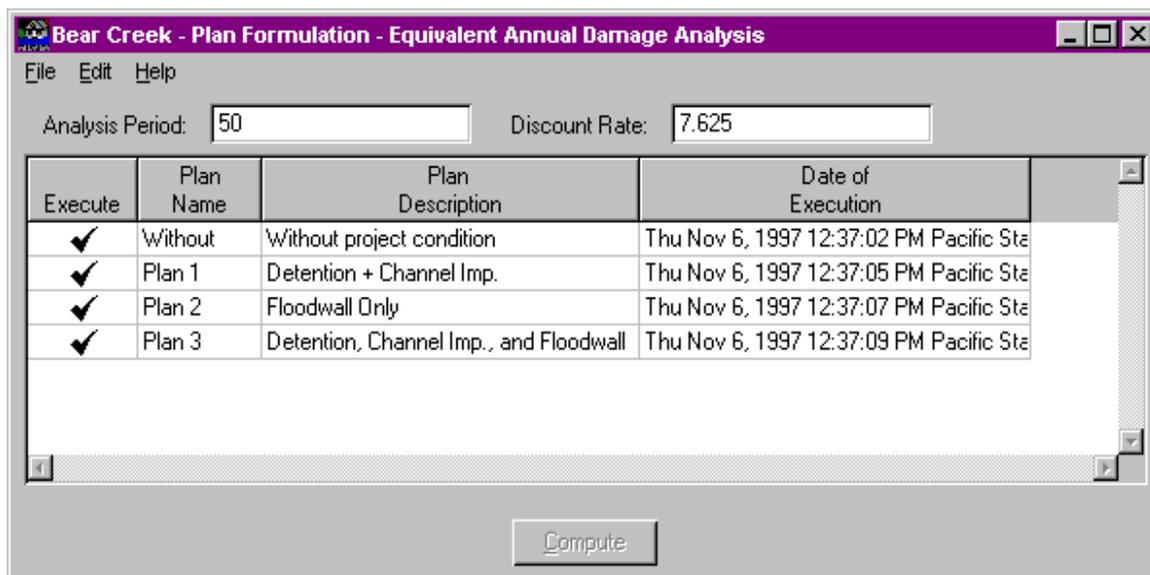


Figure 7.3 Equivalent Annual Damage Screen

Results

HEC-FDA output is consistent with requirements of Corps planning regulations for formulation and evaluation of flood damage reduction plans. A list of various output reports are available under **Evaluation/Results**. You may select **Evaluation by Analysis Year, Equivalent Annual Damage, and Plan Performance**. Results of Evaluation by Analysis Year and Plan Performance are from computing under **Evaluation by Analysis Year**. Equivalent Annual Damage results are from computing under Equivalent Annual Damage. Example output may be viewed by reviewing the results of the enclosed Beargrass Creek Study test example included with the program.

Damage by Analysis Year Reports

A list of output reports are available under this menu item as shown in Figure 7.4. You review a report from the main menu. You highlight the appropriate report button on the left of the report and select from the active Summary Information and Report Information dialogs. Some reports also enable plots of the results. You may print the report information using the menu options under **File**. The following pages illustrate the individual reports available under **Damage by Analysis Year**.

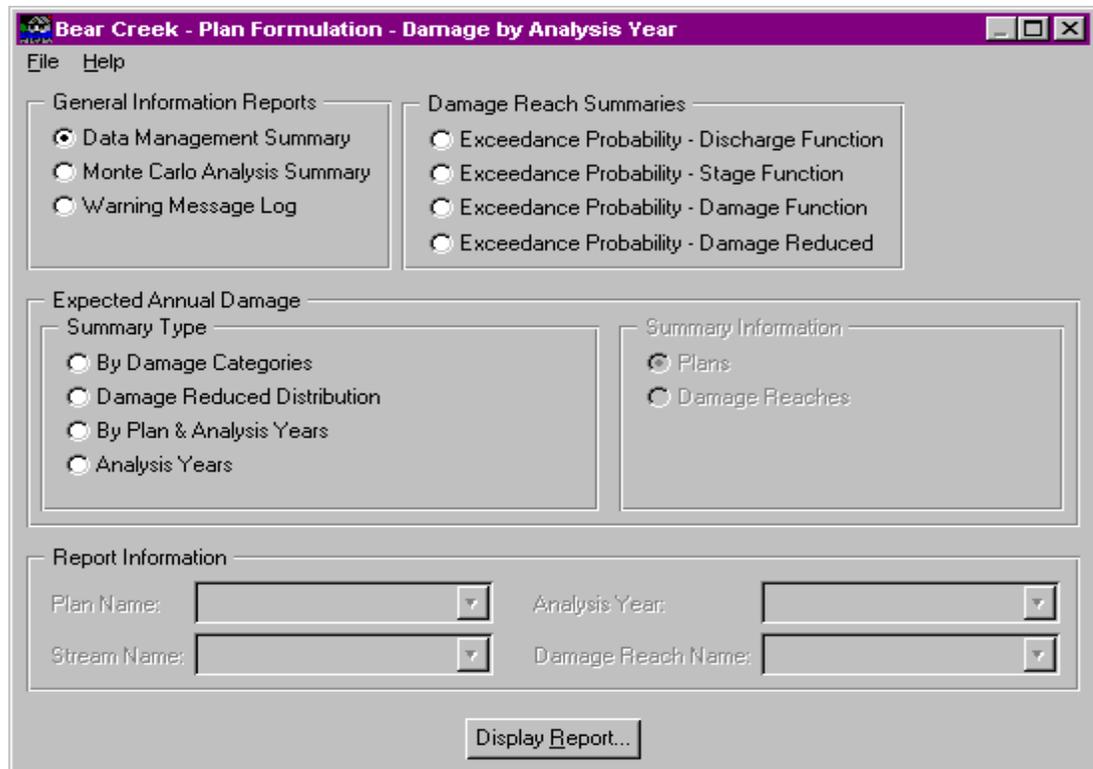


Figure 7.4 Damage by Analysis Year Report Selection Menu

Figure 7.4 depicts the primary screen for viewing the HEC-FDA output results by analysis year. The General Information Reports provide information on the program computations and conditions of the analyses performed. The Warning Message Log should be reviewed after each run. It is a text file and may be edited, i.e. previous run information deleted as desired.

The Damage Reach Summaries are Monte Carlo simulation results performed under the Risk-based Analysis approach. They consider the uncertainties associated with the various functions and thus are expected values. They are not the same as the median function values specified under **HydEng** and **Economics**. The Damage Reach Summaries are therefore not active when the “Use Certainty” box under **Evaluation of Plans by Analysis Year** shown in Figure 7.2 is blank.

The Expected Annual Damage summaries provide detailed analysis results and plan comparisons of flood inundation damage reduction. The output may be viewed by damage reach or plans by selection under Summary Information.

Bear Creek - Plan Formulation
Data Management Summary
Monetary Units: \$1,000's

Plan Name	Plan Description	Analysis Year	Date of Execution
Without	Without project condition	1999	Thu Nov 6, 1997 7:52:27 AM Pacific Stand
Without	Without project condition	2020	Thu Nov 6, 1997 8:09:13 AM Pacific Stand
Plan 1	Detention + Channel Imp.	1999	Thu Nov 6, 1997 8:10:08 AM Pacific Stand
Plan 1	Detention + Channel Imp.	2020	Thu Nov 6, 1997 8:11:24 AM Pacific Stand
Plan 2	Floodwall Only	1999	Thu Nov 6, 1997 8:13:09 AM Pacific Stand
Plan 2	Floodwall Only	2020	Thu Nov 6, 1997 8:15:12 AM Pacific Stand
Plan 3	Detention, Channel Imp., and Floodwall	1999	Thu Nov 6, 1997 8:16:35 AM Pacific Stand
Plan 3	Detention, Channel Imp., and Floodwall	2020	Thu Nov 6, 1997 8:18:40 AM Pacific Stand

***** - Computations have not been completed.
+ - Something has changed and computations need to be redone.

Figure 7.5 Data Management Summary

The Data Management Report shows the Plan Name, Plan Description, Analysis Year, Date of Program Execution and if Risk-based Analysis was used during the computations. The report enables you to check the status of the analyses performed and depicted in other reports under Damage by Analysis Year. A *xxxxx in the Date of Execution indicates that the computations for this Plan and Analysis Year have not been completed. A + indicates that something (such as the discharge-exceedance probability, stage-discharge, structure inventory, or damage reach specification data) has changed and the analysis needs to be redone.

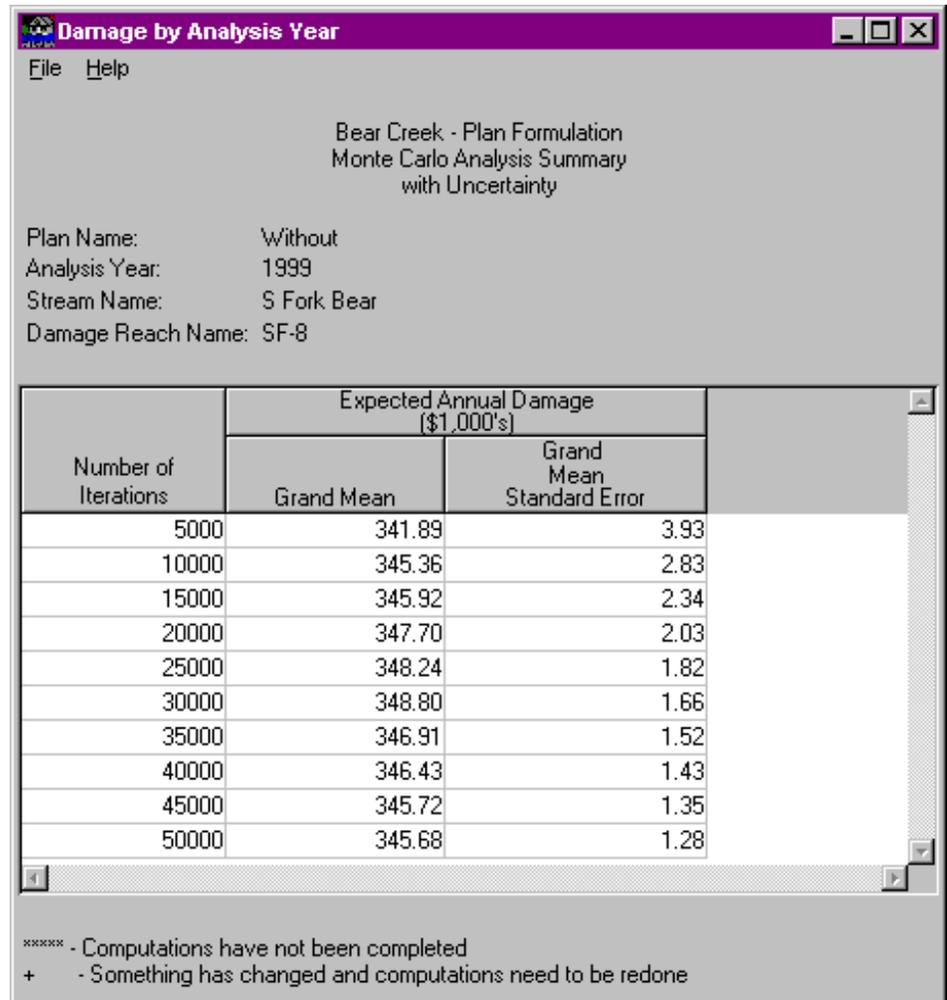


Figure 7.6 Monte Carlo Analysis Summary

The report shown in Figure 7.6 displays the number of Monte Carlo iterations performed for a specific Plan, Analysis Year, Stream, and Damage Reach. The table shows the variation in the expected annual damage (Grand Mean) and the Grand Mean Standard Error throughout the progression of the iterations performed. The computations are terminated when the grand mean is within an allowable tolerance (less than one percent) between successive sets of 2000 iteration. The procedures are described in Appendix F.

```
Thu Nov 6, 1997 8:16:35 AM Pacific Standard Time

Begin computing expected damage for plan Plan 3, year 2020,
stream S Fork Bear, reach SF-8
*** warning rating curve extended ***
    the rating curve did not extend to largest
    upper confidence limit flow value
    rating curve flow extended from      6873.000000 to
57971.130000
    rating curve stage extended from      474.980000 to
474.981000

Thu Nov 6, 1997 8:17:26 AM Pacific Standard Time

Begin computing expected damage for plan Plan 3, year 2020,
stream S Fork Bear, reach SF-9
*** warning rating curve extended ***
    the rating curve did not extend to largest
    upper confidence limit flow value
```

Figure 7.7 Warning Message Log

The Warning Message Log shown in Figure 7.7 is a text file that should be reviewed after each program computation. It provides information such as the rating function was extended, damage not zero at the minimum, etc. for each run. From this information you might need to modify the input data used in the analysis.

HINT: You may edit and/or print the Warning Message Log

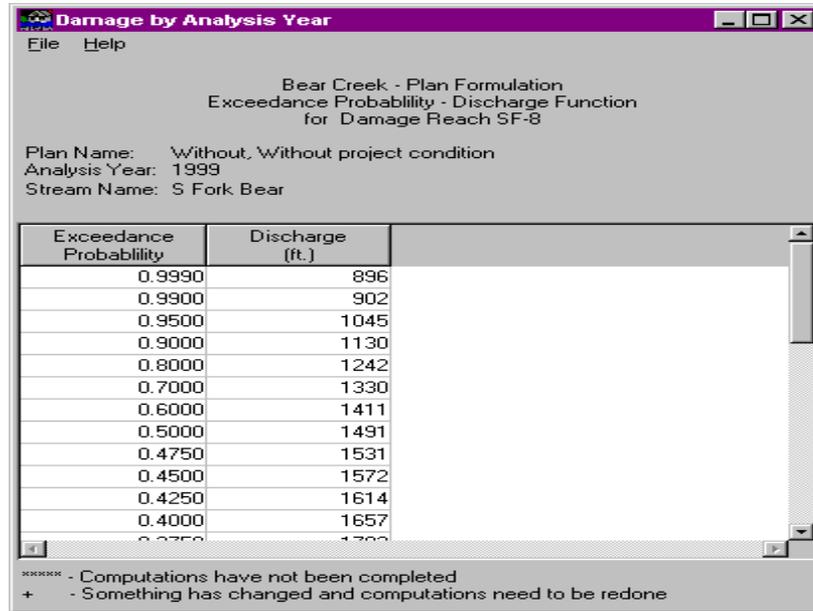


Figure 7.8 Damage Reach Summaries: Exceedance Probability-Discharge Function

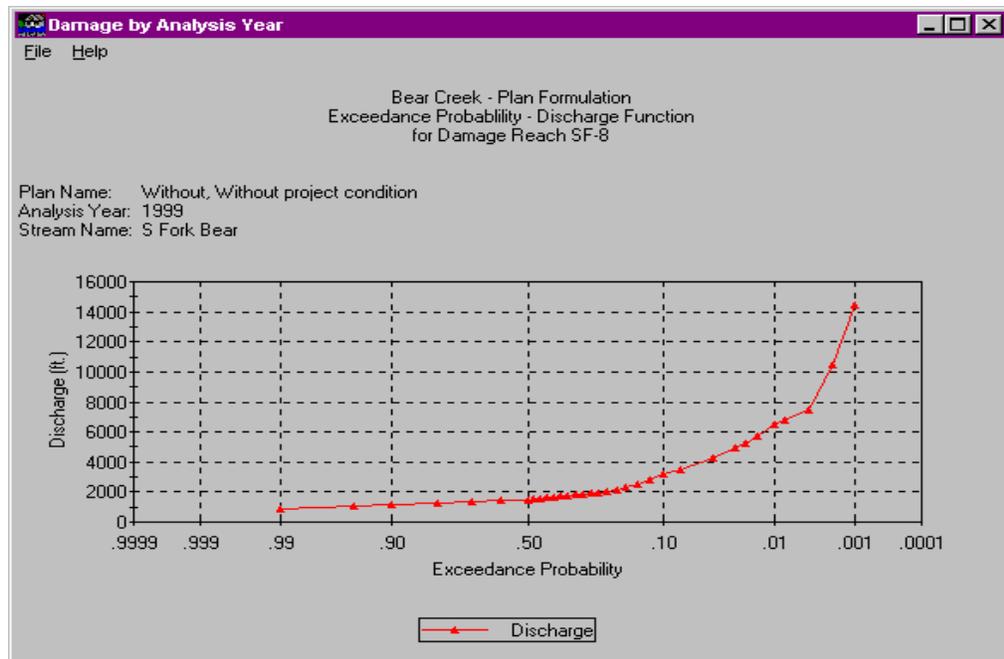


Figure 7.9 Exceedance Probability - Discharge Function Plot

The report shown in Figure 7.8 and plot of Figure 7.9 depict the average exceedance probability-discharge function generated by the Monte Carlo simulation risk-based analysis. The analytical procedures used to develop the function are described in Appendix F. The report is inactive (not available) if risk-based analysis was not used in the computations. You may plot the function under File/Plot or print the report under File/Print.

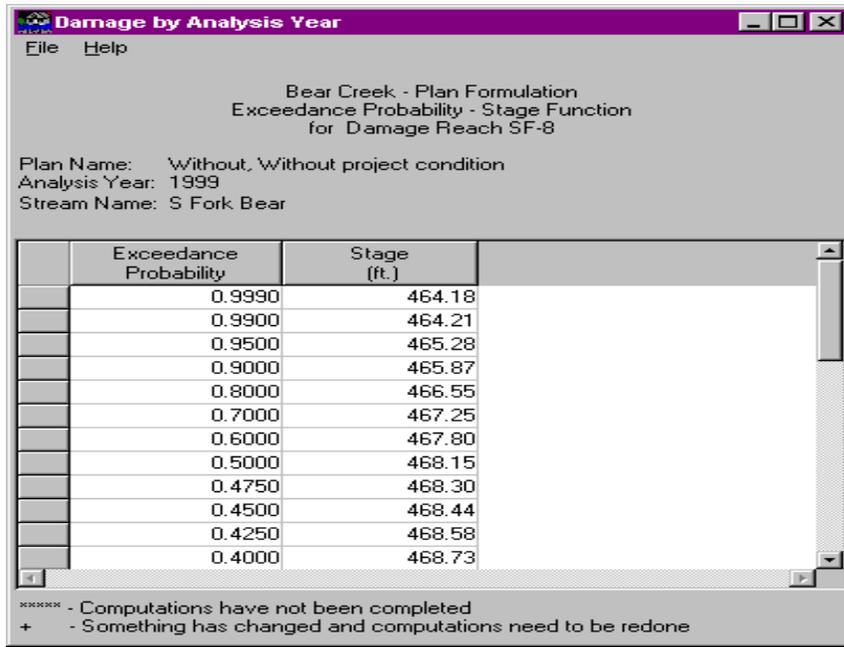


Figure 7.10 Damage Reach Summaries: Exceedance Probability-Stage Function

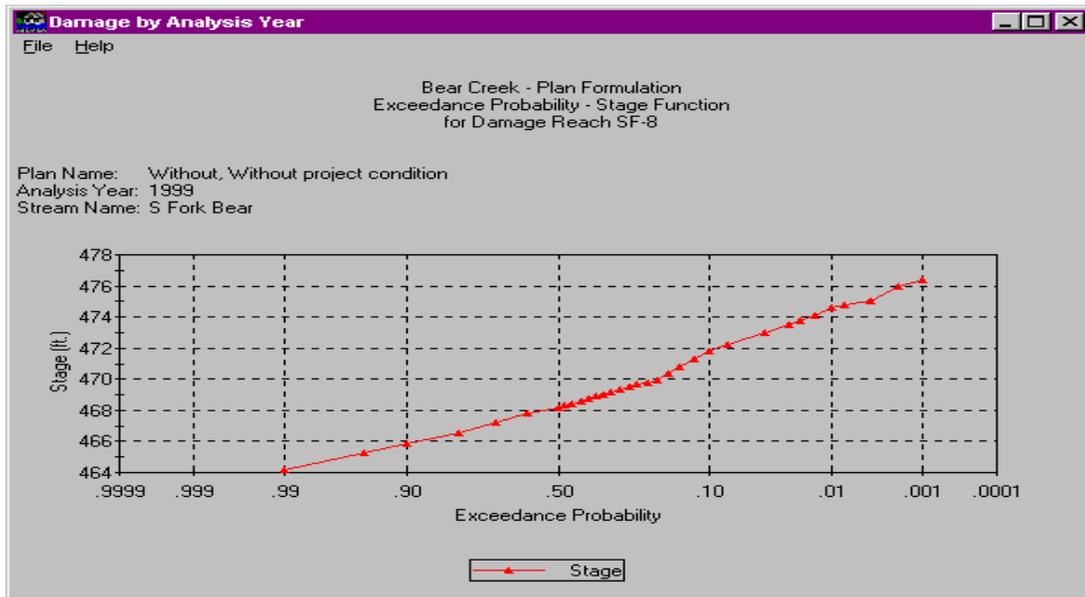


Figure 7.11 Exceedance Probability-Stage Function Plot

The report shown in Figure 7.10 and plot of Figure 7.11 depict the average exceedance probability-stage function generated by the Monte Carlo simulation risk-based analysis. The analytical procedures used to develop the function are described in Appendix F. The report is inactive (not available) if no uncertainty (see Figure 7.2) was used in the computations. You may plot the function under File/Plot or print the report under File/Print.

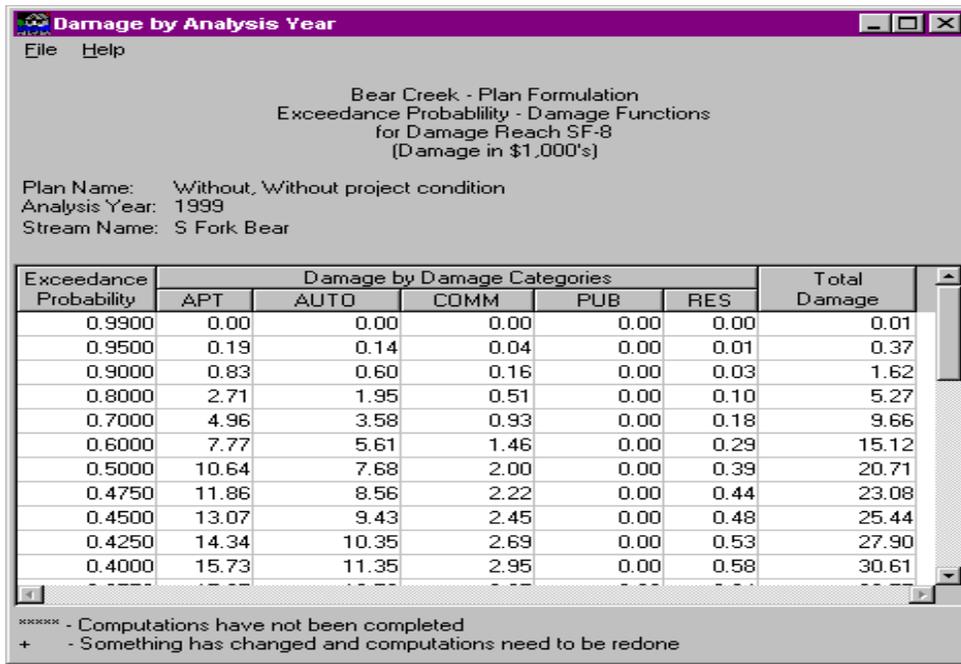


Figure 7.12 Damage Reach Summaries: Exceedance Probability-Damage Functions

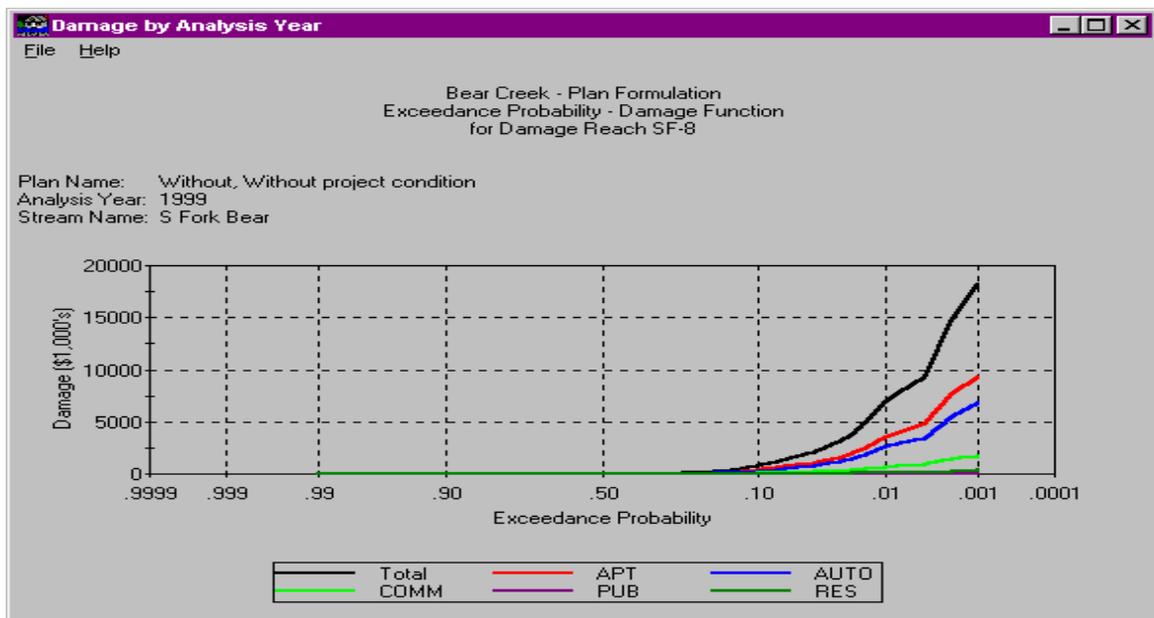


Figure 7.13 Exceedance Probability-Damage Functions Plot

The report shown in Figure 7.14 depicts the average exceedance probability-damage function by categories relationships resulting from the Monte Carlo simulation risk-based analysis. The analytical procedures used to develop the function are described in Appendix F. The report is inactive (not available) if risk-based analysis (see page 7-3) was not used in the computations. You may plot the relationships under File/Plot or print the report under File/Print.

Damage by Analysis Year

Bear Creek - Plan Formulation
Exceedance Probability - Damage Reduced
for Damage Reach SF-9
(Mean Damage in \$1,000's)

Plan Name: Plan 2, Floodwall Only
Analysis Year: 1999
Stream Name: S Fork Bear

Exceedance Probability	Total Mean Damage		Mean Damage Reduced
	Without Project	With Project	
0.9990	142.90	0.00	142.90
0.9900	143.18	0.00	143.18
0.9500	185.56	0.00	185.56
0.9000	214.91	0.00	214.91
0.8000	257.19	0.00	257.19
0.7000	295.76	0.00	295.76
0.6000	335.97	0.00	335.97
0.5000	371.00	0.00	371.00
0.4750	383.66	0.00	383.66
0.4500	395.37	0.00	395.37
0.4250	406.67	0.00	406.67
0.4000	417.92	0.00	417.92
0.3750	429.12	0.00	429.12

***** - Computations have not been completed
+ - Something has changed and computations need to be redone

Figure 7.14 Damage Reach Summaries: Probability-Damage Reduced

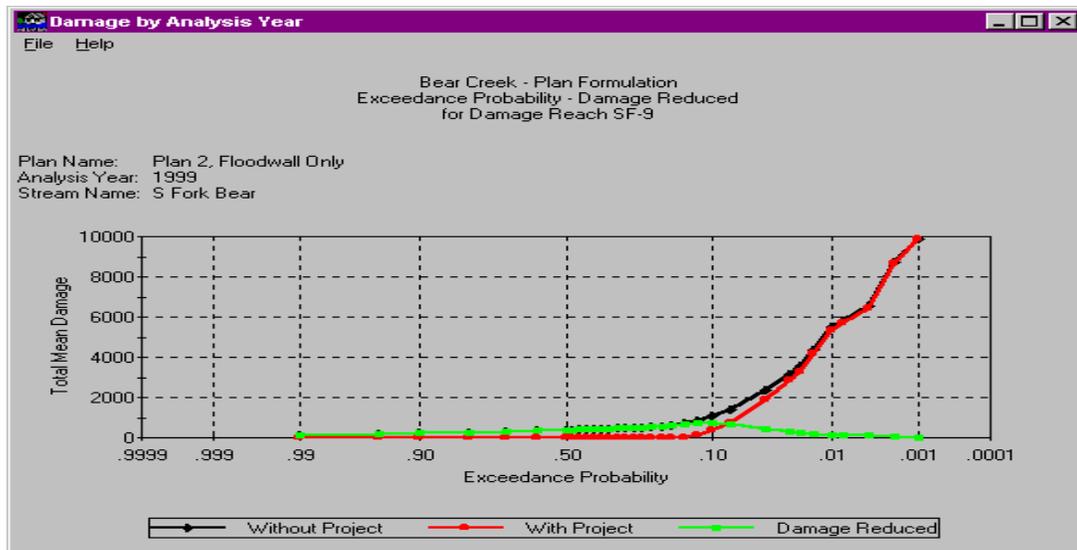


Figure 7.15 Exceedance Probability-Damage Reduced Plot

The report shown in Figure 7.15 depicts the exceedance probability-mean damage values for the without-and with-project conditions and the associated mean damage reduced generated by the Monte Carlo simulation risk-based analysis. The analytical procedures used to develop the function are described in Appendix D. The report is inactive (not available) if risk-based analysis (see page 7-3) was not used in the computations. You may plot the function under File/Plot or print the report under File/Print.

Bear Creek - Plan Formulation
 Expected Annual Damage Reduced and Distributed
 by All Plans for Analysis Year 1999
 (Damage in \$1,000's)

Plan Name	Plan Description	Expected Annual Damage			Probability Damage Exceeds Indicated Values		
		Total Without Project	Total With Project	Damage Reduced	.75	.50	.25
Without	Without project condition	955.30	955.30	0.00	0.00	0.00	0.00
Plan 1	Detention + Channel Imp.	955.30	493.34	461.96	205.00	357.58	613.18
Plan 2	Floodwall Only	955.30	570.84	384.46	367.86	393.90	400.67
Plan 3	Detention, Channel Imp., and Floodwall	955.30	87.85	867.45	563.69	761.14	1057.56

***** - Computations have not been completed
 + - Something has changed and computations need to be redone

Figure 7.16 Expected Annual Damage by Categories

The report shown in Figure 7.16 depicts the expected annual damage by damage categories and also sums the total damage by Plans. You may also choose to see summaries by damage reaches. The report is generated for computations whether or not risk-based analysis was specified. A label, shown in the report header, denotes when risk-based analysis is not used.

Bear Creek - Plan Formulation
Expected Annual Damage by Damage Categories and Plans
for Analysis Year 1999
(Damage in \$1,000's)

Plan Name	Plan Description	Damage Categories					Total Damage
		APT	AUTO	COMM	PUB	RES	
Without	Without project condition	636.23	140.17	104.67	0.09	74.14	955.30
Plan 1	Detention + Channel Imp.	421.78	3.72	9.81	0.01	58.02	493.34
Plan 2	Floodwall Only	276.02	138.57	120.89	0.11	35.25	570.84
Plan 3	Detention, Channel Imp., and Floodwall	61.06	2.94	12.31	0.01	11.52	87.85

***** - Computations have not been completed
+ - Something has changed and computations need to be redone

Figure 7.17 Expected Annual Damage Reduced and Distributed

The report shown in Figure 7.17 shows the expected annual damage for the without- and with-project conditions. The damage reduced is also shown. The table also shows the .75, .50, and .25 probability values of the damage reduced value for with-project conditions exceeding the results shown in the table. For example, there is a .75 probability that the damage reduced for Plan 1 exceeds 596.96, a .50 probability that it exceeds 850.09 and a .25 probability it exceeds 1200.59. You may also view the results by damage reaches.

Damage by Analysis Year

File Help

Bear Creek - Plan Formulation
Expected Annual Damage by Plans and Analysis Years
(Damage in \$1,000's)

Plan Name	Plan Description	Base Year 1999	Most Likely Future 2020
Without	Without project condition	955.30	1258.53
Plan 1	Detention + Channel Imp.	493.34	549.48
Plan 2	Floodwall Only	570.84	888.55
Plan 3	Detention, Channel Imp., and Floodwall	87.85	138.51

***** - Computations have not been completed
+ - Something has changed and computations need to be redone

Figure 7.18 Expected Annual Damage by Plans and Analysis Years

Figure 7.18 shows the expected annual damage by Plans report. The base year and Most Likely Future year expected annual damage values are shown.

Bear Creek - Plan Formulation
Expected Annual Damage by Analysis Years for Plan 2 (Floodwall Only) Plan
(Damage in \$1,000's)

Stream Name	Stream Description	Damage Reach Name	Damage Reach Description	Base Year 1999	Most Likely Future 2020
S Fork Bear	S. Fork Bear Creek	SF-8	BASHFORD MANOR LN TO BARDSTOWN RD	345.68	522.36
		SF-9	BARDSTOWN RD TO DOWNING WY SM. 9.:	225.15	366.19
Total for stream: S Fork Bear				570.84	888.55

***** - Computations have not been completed
+ - Something has changed and computations need to be redone

Figure 7.19 Expected Annual Damage by Analysis Years

The report shown in Figure 7.19 summarizes the expected annual damage by Damage Reaches for a specific plan. The total base year and most likely future damages are reported by damage reaches and summed by streams. The report is generated for both with risk and without risk-based analysis computations. A label in the report header is used to indicate when no risk-based analysis was performed.

Equivalent Annual Damage Analysis Report

A list of output reports are available under this menu item. You select the output report to view from the Equivalent Annual Damage Analysis Screen shown in Figure 7.20. You may view a data management summary report, or reports on equivalent annual damage and damage categories.

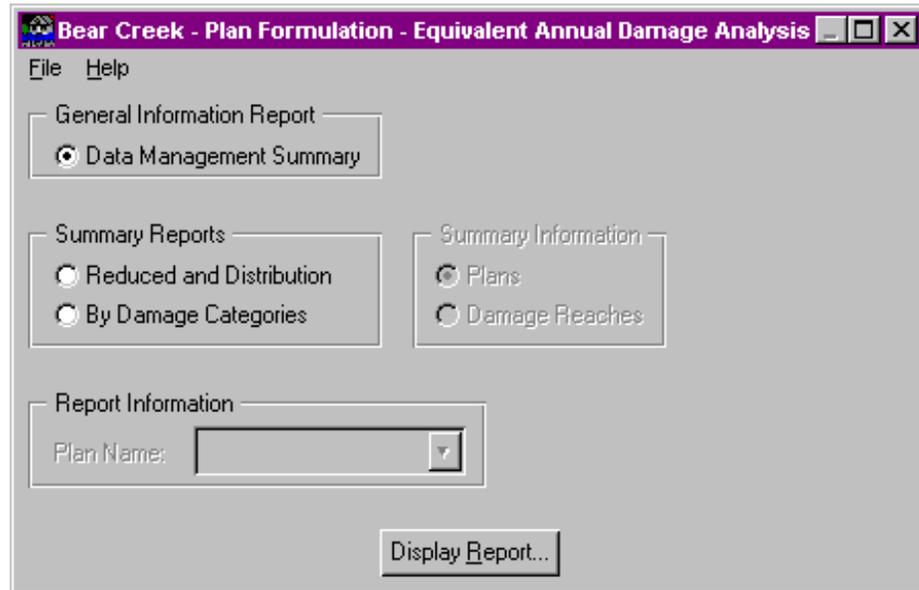


Figure 7.20 Equivalent Annual Damage Analysis Report Screen

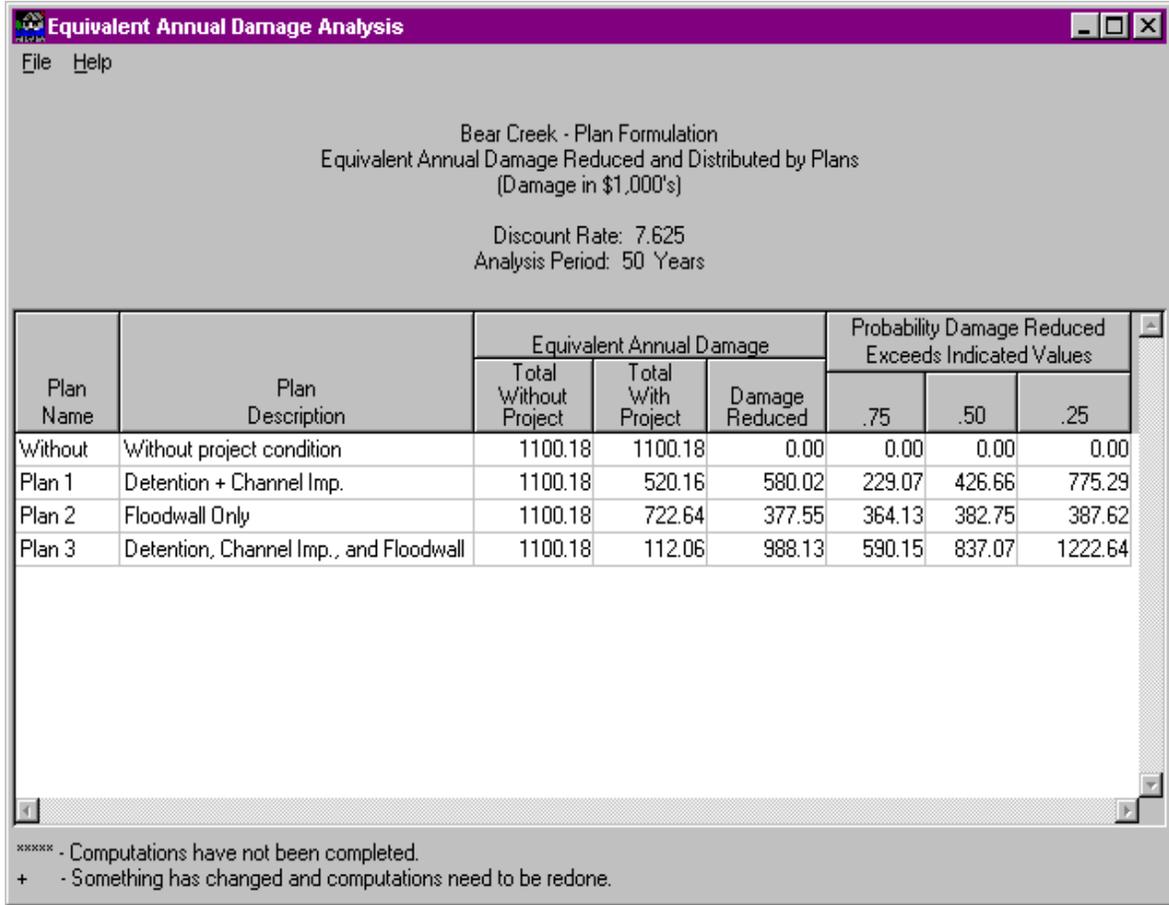
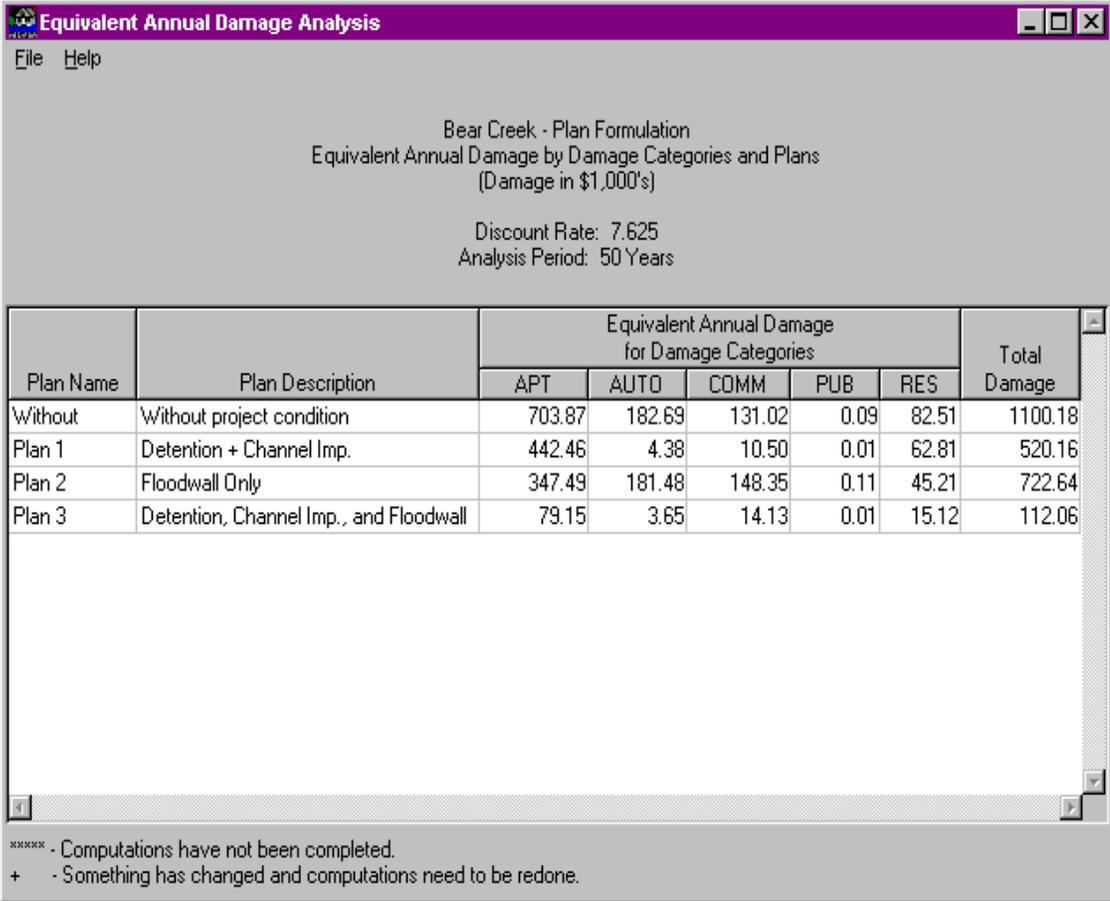


Figure 7.21 Equivalent Annual Damage Analysis

The report shown in Figure 7.21 shows the equivalent annual damage for the without- and with-project conditions and the associated damage reduced. The report also shows there is a .75 probability that the equivalent annual damage reduced is greater than 3169.32, a .50 probability it is greater than 4741.81, and a .25 probability it is greater than 7020.42.



Bear Creek - Plan Formulation
Equivalent Annual Damage by Damage Categories and Plans
(Damage in \$1,000's)

Discount Rate: 7.625
Analysis Period: 50 Years

Plan Name	Plan Description	Equivalent Annual Damage for Damage Categories					Total Damage
		APT	AUTO	COMM	PUB	RES	
Without	Without project condition	703.87	182.69	131.02	0.09	82.51	1100.18
Plan 1	Detention + Channel Imp.	442.46	4.38	10.50	0.01	62.81	520.16
Plan 2	Floodwall Only	347.49	181.48	148.35	0.11	45.21	722.64
Plan 3	Detention, Channel Imp., and Floodwall	79.15	3.65	14.13	0.01	15.12	112.06

***** - Computations have not been completed.
+ - Something has changed and computations need to be redone.

Figure 7.22 Equivalent Annual Damage by Damage Categories

The report shown in Figure 7.22 depicts the equivalent annual damage for without- and with-project conditions by damage categories. You may also view the report summaries by streams and damage reaches.

Project Performance

The project performance report displays information about the hydrologic/hydraulic performance of a plan. Figure 7.23 shows the menu selection options. Figure 7.24 shows the output report.

Target Stage - The stage typically associated with the start of significant damage for the without-project conditions. In HEC-FDA, the stage is specified under the **Economics/Evaluation of Plans by Analysis Year** screen. To ensure consistency with various damage reaches, the stage is determined as the stage associated with the percent of residual damage of a specific exceedance probability event. For levees or floodwalls, the top of the project is the target stage.

Expected Annual Target Stage Exceedance Probability - The median and expected annual exceedance probabilities associated with the target stage.

Long-Term Risk - The probability of the target stage being exceeded in a 10-, 25-, and 50- year period.

Conditional Non-Exceedance Probability by Events - The chance of containing the specific .10-, .04-, .02-, .01-, .004-, and .002 exceedance probability within the target stage, should that event occur.

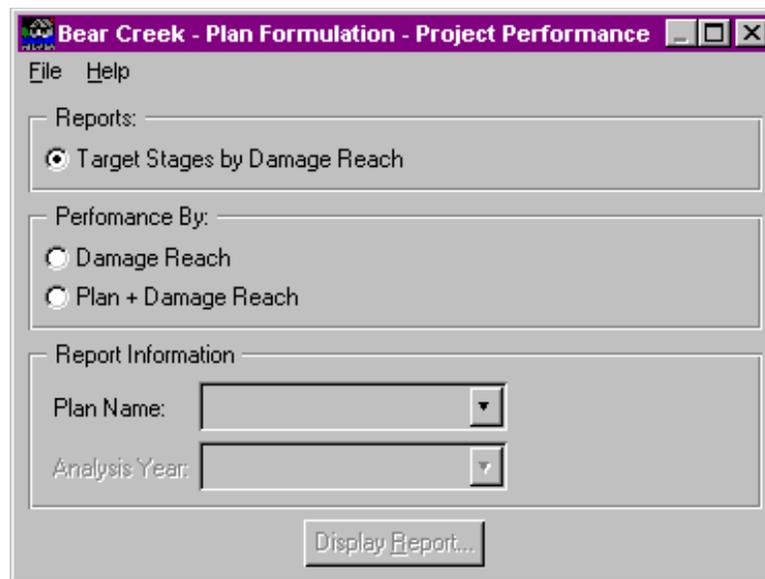


Figure 7.23 Project Performance

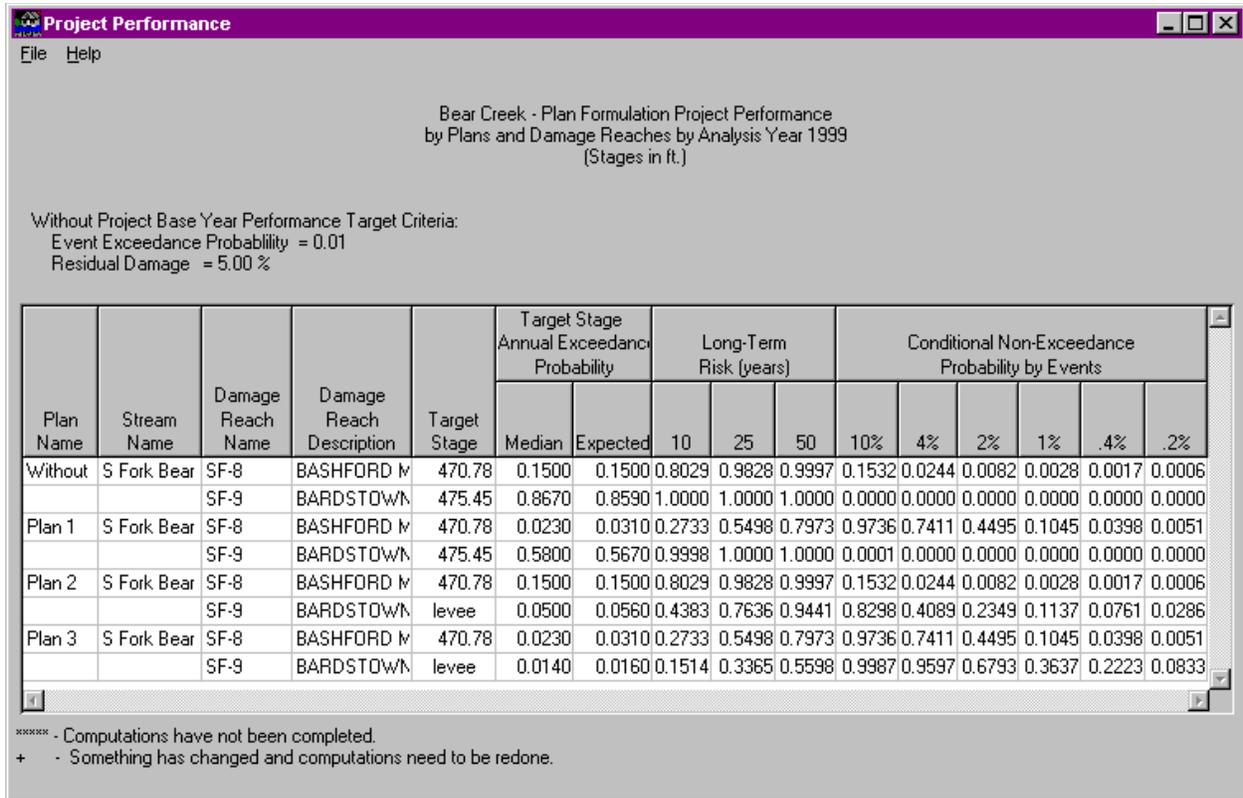


Figure 7.24 Project Performance Output Report