JACKRABBIT WASH
FLOODPLAIN DELINEATION STUDY
FCD 90-05

CONTRACT AMENDMENT NUMBER ONE:
HYDROLOGIC MODEL SENSITIVITY ANALYSES

FLOOD CONTROL
DISTRICT
of
MARICOPA
COUNTY
1959

Prepared For:

**FLOOD CONTROL DISTRICT OF
MARICOPA COUNTY, ARIZONA**

July, 1991

Prepared By:

BURGESS
& NIPLE
ENGINEERS
ARCHITECT

To: Tom Hieb

From: Ted Lehman

Re: comments for changes to Change Order #1, FCD 90-05
Jackrabbit Wash FDS

The sensitivity analyses performed for FCD 90-05 are considered satisfactory. However, a few alterations of the report presentation are requested. The desired changes are as follows:

1) the addition of an abstract or executive summary at the front of the report which outlines the general purpose of the report and summarizes the report's recommendations

2) elimination of the sentence in section 2.1.1 the begins "The latter method ..." and replacement with a sentence which reads something like "The Appendices reflect only Major soils and do not account for Minor soils or rock outcrops."

3) revision of section 2.2.1 to indicate that Method 2 is a "Major soils only" method or "Appendices only" method -- The reference to the Design Manual guidelines are misleading as the Manual guidelines per Example #5 recommend use of minor soils as performed in Method 1 which was used in the JW FDS.

4) addition of a sentence in section 2.2.2 which indicates the actual recommendations -- The present section alludes to the endorsement of the Grid Method which is ultimately not suggested.

5) addition of an explanation in section 2.2.3 as to which parameters are changed between <u>columns</u> in Table 3A that produces the 0-7% change when Rangeland is converted to Hillslope

6) addition of an explanation in section 2.2.1 of the method used to derive those map unit XKSAT values in the APPENDIX for Method 2 which differ from values in Table 4.2 of the Design Manual (e.g. Aguila-Carefree units 48, 49, 51, 52, 61-64, etc.)

7) addition of a statement as to the treatment of RTIMP in the method comparisons in section 2.2.1

8) correction of typo on NOTE in Table 1A -- "<u>C</u>esign Manual"

July 26, 1991

To: Amir Motamedi
Through: Tom Hieb

From: Ted Lehman

Re: Comments on Change Order #1, FCD 90-05
Jackrabbit Wash FDS

The following is a running list of comments concerning the sensitivity analysis report by Burgess and Niple for Change Order #1 to the Jackrabbit Wash FDS. The comments are listed in no particular order but are segregated according to the different tasks.

<u>TASK 1 - SCS Soil Map Units</u>

1) Does the inclusion of minor soil types from drainageways and similar geomorphic environments get 'counted twice' to some extent if transmission losses are also calculated?

2) Note that the average of the differences between Rock modified Method 1 and Method 2 is 6.5 %. Under Task 2 the grid method supposedly 'adequately accounts' for sub-basin soil variations compared to the planimeter method with an average difference of 6.25 %.

3) I agree that the variations in discharge introduced by the incorporation of minor soils should be 'smoothed out' as basin area increases. This is the central part of Steve Waters' argument about the need for geomorphic specific soils type identification when working with very small watersheds. Notice that the sub-basins shown in Table 1A aren't very small!

4) What does this work tell us (if anything) about how to deal with RTIMP from rock outcrops or otherwise?

5) Although it is obvious that large differences between XKSAT values for minor soils and the other soils present may produce misleading average map unit values, how should we deal with this problem? Perhaps log averaging of minor soils or of all map unit soils? This would require less 'hydrologic judgement' and produce more reproducable hydrology if reproducability remains one of our goals. However, if tables for the map unit values can be provided in the Manual to replace Appendices A-C, the 'judgement' only needs to be made once!

6) How did B&N arrive at some of the XKSAT values in their Appendix A for Method 2? see Aguila-Carefree units 48, 49, 51, 52, 61-64, etc.

TASK 2 - Sub-Basin Soil-Type Representation

1) Comments on p. 7 give a different impression from those that follow in the conclusions section. I was expecting a recommendation for use of the grid method. However, I'm pleased to see that the planimeter was endorsed as the preferred method.

TASK 3 - Phoenix S-Graphs

1) Does a 'liberal' method of comparison have a particular meaning? If so, is this what they did?

2) The percent change between the assignment of land to Hillslope or Rangeland appears to be directly related to the amount of area in the sub-basin which is switched from one 'land use' to another (i.e. 10W has almost no Rangeland and experiences essentially no change while 6D contains no Hillslope and the reassignment results in a 7 % change). It is still unclear to me if this reassignment of land use means that the XKSAT adjustment for cover is the only change made to the model or if more is done to alter the model between the columns of Table 3A. What would happen if all Hillslope was changed to Rangeland?

3) The difference in selection of S-Graphs is not surprising. The suggestion to clarify the selection of S-Graph is clearly needed. Does B&N have any specific suggestions as to the nature of the 'relationship' between slope and land use (or some other measurable qunatities) that might be used or developed to make this selection?

4) Does the model's sensitivity to S-Graph selection reflect a need for the development of a greater variety of S-Graphs? (e.g. a "Hillslope" S-Graph, etc.)

5) Could a reproducable formula for S-Graph selection as suggested in #3 be created for more than two S-Graphs?

6) This entire section seems confusing and could benefit from some more specific description of what was done.

TASK 4 - Channel Routing Infiltration Losses

1) What would a comparison of measured transmission losses from a real, observed event to a reconstructed model using SCS Map Units look like?

GENERAL COMMENTS

The report could use some 'shoring up.' The three Sections are disconnected and do not stand well alone. One needs to read the entire report with periodically looking back to the introduction to discern what exactly was done. Even this sometimes does not suffice (i.e. the S-Graph section). Nevertheless, I generally like the recommendations.

7/24/91
SDW

COMMENTS CONCERNING:

"HYDROLOGIC MODEL SENSITIVITY ANALYSIS, JACKRABBIT WASH FDS"

1. Page 2, Sec. 2.1.1 This paragraph could use some clarification. It sounds like the first method comes from the Soil Surveys, and the second method (from the Design Manual) does not account for Minor soils or Rock outcrop.

2. Page 17-18, Sec. 3.1.1 The report recommends that Appendices A, B, C be modified to include the effects of Minor soils on a map unit scale. This is probably reasonable for floodplain studies and ADMSs where subbasin areas are generally larger than 1 sq. mile. However, it must be remembered that the <u>Drainage</u> Design Manual has applications down to watersheds the size of parking lots, and in these cases, assumption # 3 (page 17, "The effects of terrain specific Minor soil characteristics ...") breaks down. For instance, if a small offsite watershed (say ½ acre) is being analized and it is nowhere near a wash, then one would omit any Minor soils listed as being present in drainageways. This is why minor soils were left out of the Appendices, so people would read the Survey books and apply the appropriate minor soils to their site.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

JACKRABBIT WASH
FLOODPLAIN DELINEATION STUDY
FCD 90-05

CONTRACT AMENDMENT NUMBER ONE: HYDROLOGIC MODEL SENSITIVITY ANALYSES

Prepared For:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
3335 West Durango Street
Phoenix, Arizona 85009
(602) 262-1501

Prepared By:

BURGESS & NIPLE, INC.
5025 East Washington Street
Phoenix, Arizona 85034
(602) 244-8011

Project No. 10310

Registered Professional Engineer (Civil)
Certificate No. 12739
THOMAS R. LOOMIS
Date Signed 7-15-91
ARIZONA, U.S.A.

TABLE OF CONTENTS

Registered Professional Engineer (Civil) — Certificate No. 12739 — THOMAS R. LOOMIS — Date Signed 7/5/91 — ARIZONA, U.S.A.

SECTION 1: INTRODUCTION

This report is a supplement to the Jackrabbit Wash Floodplain Delineation Study (Bibliography Reference No. 1). Hydrologic analysis for the Jackrabbit Wash Floodplain Delineation Study (Jackrabbit Wash) utilized HEC-1 computer modeling for estimating flowrates at key locations within the 442 square mile watershed. Generally followed were guidelines set forth in the Hydrologic Design Manual for Maricopa County, Arizona, (Design Manual) and engineering judgment was applied where appropriate (Bibliography Reference No. 2). See Bibliography Reference No. 1 for specific hydrologic methods used in the study.

The contract between the FCDMC and Burgess & Niple, Inc. was amended to scrutinize the accuracy of methods used to estimate Green & Ampt rainfall loss parameters, and to determine the sensitivity of the HEC-1 models to changes in selected parameters. The contract amendment includes four tasks entitled:

- Task 1 - SCS Soil Map Units
- Task 2 - Sub-Basin Soil-Type Representation
- Task 3 - Phoenix S-Graphs
- Task 4 - Channel Routing Infiltration Losses

The purpose in preparing this report is to document results of sensitivity comparisons and to identify procedures to reduce the amount of judgment required when estimating selected HEC-1 input parameters.

SECTION 2: METHODOLOGIES AND RESULTS

2.1 General

Four major HEC-1 input parameters were examined and modified, then four separate and new HEC-1 models were run to compare resulting flowrates to the previously submitted HEC-1 models.

The four major parameters examined are discussed in order, as follows:

2.1.1 Task 1 - SCS Soil Map Units

When determining Green & Ampt rainfall losses for each SCS Soil Map Unit, the SCS soil surveys Maricopa County - Central Part and Aguila - Carefree (see Bibliography References No. 3 and No. 4, respectively) were used extensively to account for soil-types and rock outcrop, both Major and Minor, listed under each Map Unit. The terms Major and Minor refer to major and minor soil complexes defined in the SCS soil surveys for each Soil Map Unit. Compared to this method was the method of accounting for only those soils listed in Appendix "A" (Aguila-Carefree) and Appendix "C" (Maricopa County - Central Part) of the Design Manual. The latter method uses only Major soils and no Minor soils or rock. The purpose of this comparison is to determine if the additional effort required to detail Minor soils results in more realistic flowrates.

2.1.2 Task 2 - Sub-Basin Soil-Type Representation

When determining average Green & Ampt rainfall losses for each sub-basin on the watershed, the Grid Method was used to represent soil map units contained within the sub-basin. This method consisted of overlaying a 1/4-mile interval grid on the sub-basin and the SCS Soils Map, thus accounting for only those soils that grid points fall on. Significant judgment was then made to assure that a soil type was not overweighted or entirely eliminated due to the relative randomness of the Grid Method. This method was compared to the Planimetering Method in which each Soil Map Unit in four representative sub-basins were positively identified and assigned an area to calculate composite sub-basin Green & Ampt Parameters. The purpose of this comparison is to determine if the additional effort and time required by the Planimetering Method results in more reasonable flowrates.

2.1.3 Task 3 - Phoenix S-Graphs

An S-Graph is a dimensionless form of a unit hydrograph used to calculate a runoff hydrograph. The Design Manual lists two types of S-Graphs approved for use in

Maricopa County. These are the Phoenix Mountain and Phoenix Valley S-Graphs. The selection of an appropriate S-Graph for the Jackrabbit Wash Study was based on land characteristics. If over 50% of the sub-basin was Rangeland, then the Phoenix Valley S-Graph was selected. If over 50% of the sub-basin was Mountain and Hillslope, the Phoenix Mountain S-Graph was selected. Judgment was used to place the boundary between Hillslope and Rangeland. Comparisons were made on four representative sub-basins by moving the boundary between Hillslope and Rangeland then using the appropriate S-Graph. The purpose of this comparison is to determine the HEC-1 model's sensitivity to required judgment.

2.1.4 Task 4 - Channel Routing Infiltration Losses

Infiltration of runoff occurring within a wash was modeled using the Normal Depth channel routing method. Infiltration rates were estimated by calculating the hydraulic conductivity (XKSAT) of the soils within the channel and overbanks derived from the SCS Soil Map Units. Compared with these infiltration rates were values based on physical percolation tests performed during field reconnaissance by Burgess & Niple, Inc., and tests performed by the Arizona Department of Water Resources (ADWR). The purpose of this comparison is to determine what effects the varied infiltration rates have on peak flowrates at key locations in the watershed.

The 100-year frequency, 24-hour duration storm was selected as the test storm for all comparisons.

2.2 Comparison Tests

2.2.1 Task 1 - SCS Soil Map Units

The Design Manual includes Appendices "A", "B", and "C" to provide soil textural classes for each Major soil in a Soil Map Unit. The Jackrabbit Wash study area is comprised of soils covered by Appendices "A" and "C" only. Minor soils are not accounted for, and Design Manual guidelines indicate that rock outcrops be identified as impervious based on a percentage of the sub-basin area (RTIMP). Using the Major soils and Soil Textural Class in Appendices "A", "B", and "C", the SCS soil surveys, and Design Manual Table 4.2, composite Green & Ampt Parameters can be estimated. This procedure was performed and the results labeled "Method 2". The final hydrologic analysis for the Jackrabbit Wash Study is labeled "Method 1". Method 1 cannot be directly compared to Method 2 since Method 1 included rock outcrop as part of the composite Green & Ampt calculations, thus eliminating the need for "RTIMP". Therefore, Method 1 was modified to exclude rock outcrops and labeled "Rock-Modified Method 1".

Summaries of composite Green & Ampt values for SCS Map Units and sub-basins present on the Jackrabbit Wash watershed for Rock-Modified Method 1 and Method 2 are provided in Appendix "A" of this report. Refer to Tables A-1 through A-4.

It should be noted that neither Rock-Modified Method 1 nor Method 2 is the recommended procedure for use. The Green & Ampt values estimated using these two methods were used to compute peak discharges. These peak discharges were then compared to determine the effect Minor soils may have on peak discharges. The calculated peak discharges are only valid for comparison purposes.

Rock-Modified Method 1 and Method 2 was implemented on each sub-basin in the watershed and peak discharges at key locations on the watershed are compared in Table 1A. Results indicate that using Appendices "A and "C" of the Design Manual on this watershed causes a reduction in flowrate from 1% to 17% as compared to Rock-Modified Method 1. This suggests that the Minor soils have a significant impact on this watershed. Further investigation revealed that sub-basin area is not a major factor in the difference in peak flowrates. Figure 1 is a log-log plot of change in flowrate versus sub-basin area. Although a slight decrease in overall model sensitivity is recognized as watershed area increases, it should not be interpreted as a definite pattern. Instead, it is most likely due to the more varied soil types present in larger sub-basins which tends to average the effects of Minor soils present in the watershed.

TABLE 1A

Comparison of Peak Discharges At Key Locations On The Watershed

HEC-1 Id.	Description	24-Hr. Peak Discharge (cfs) Rock-Mod Method 1	Method 2	% Diff.	Area (sm)
C44	Coyote Wash Upstream of Split	7,400	6,500	12%	34.5
CP44W	Coyote Wash (West Fork) Downstream of Split	3,400	3,100	9%	34.5
CP44E	Coyote Wash (East Fork) Downstream of Split	3,900	3,400	13%	34.5
C119	Coyote Wash (West Fork) at 371st Avenue	1,400	1,300	7%	36.4
C99	Daggs Wash at Hassayampa River	3,000	2,900	3%	28.1
C12	Jackrabbit Wash at Deadhorse Wash	18,100	17,900	1%	79.1
C33	Jackrabbit Wash at Vulture Mine Road	20,200	20,100	0%	138.1
C34	Jackrabbit Wash at Wickenburg Road	19,200	19,100	1%	140.3
R34-37	Jackrabbit Wash Upstream of Confluence with W.F.J.R.W.	18,800	18,800	0%	140.3
C37	Jackrabbit Wash at W.F. Jackrabbit Wash	18,900	18,900	0%	148.7
C38I.1	Jackrabbit Wash Upstream of Confluence with Star Wash	18,400	18,400	0%	152.4
C38I	Jackrabbit Wash at CAP Canal CAP-5 (upstream)	31,800	30,000	6%	319.2
C38I	Jackrabbit Wash at CAP Canal CAP-5 (downstream)	31,800	30,000	6%	319.2
C94	Jackrabbit Wash at East Fork Coyote Wash	32,100	30,300	6%	363.1
C98	Jackrabbit Wash at Hassayampa River	31,100	29,300	6%	372.1
R36-37	Jackrabbit Wash (W.F.) Upstream of Confluence with J.R.W.	2,800	2,400	14%	8.4
6A	Jackrabbit Wash (West Fork) at Vulture Mine Road	3,000	2,500	17%	3.7
C36	Jackrabbit Wash (West Fork) at Wickenburg Road	3,000	2,500	17%	8.4
C84.1	Powerline Wash Upstream of Confluence with Star Wash	4,900	4,600	6%	34.9
C84.2	Star Wash Upstream of Confluence with Powerline Wash	13,400	13,300	1%	125.7
C84	Star Wash at Powerline Wash	16,900	15,400	9%	160.6
C38I.2	Star Wash Upstream of Confluence with Jackrabbit Wash	16,600	15,000	10%	166.8

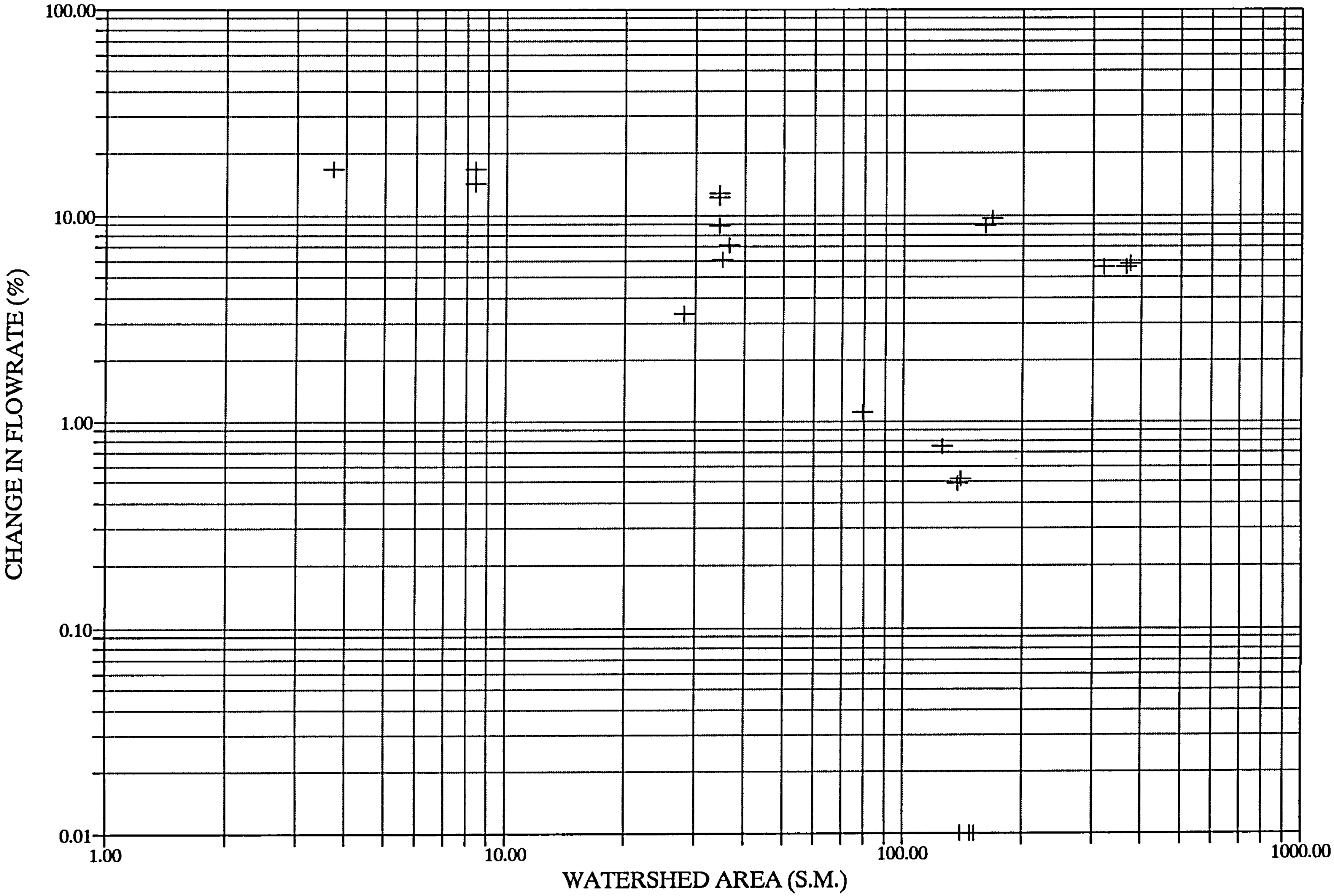
$\bar{x} = 6.59$

NOTE:
"Method 1" utilizes Green & Ampt parameter estimation by Example #5 of the Example Section in the FCDMC Hydrologic Cesign Manual, which accounts for minor soils and rock.
"Rock-Modified Method 1" eliminates rock, both major and minor, to compare more directly with Method 2.

"Method 2" utilizes Green & Ampt parameter estimation by accounting for only those major soils listed in Appendices 'A' and 'C' of the FCDMC Hydrologic Design Manual, which does not account for minor soils nor rock.

FIGURE 1: % Change in Flow vs Area

ROCK-MOD. METHOD 1 Vs. METHOD 2



2.2.2 Task 2 - Sub-Basin Soil-Type Representation

Four sub-basins were chosen to be representative of the watershed. Sub-basins 6D, 10U, 10W, and 13A contain mountains, hillslopes, rangeland, and washes, as well as a wide variety of soil types. Therefore, these sub-basins were selected for this comparison.

The Soil Map Units within each sub-basin were planimetered then composite Green & Ampt Rainfall Loss Parameters were calculated for the sub-basins based on weighted area. The calculation results along with the original Grid Method values are tabulated in Table 2A. The composite values were then input into Record "LG" of the HEC-1 model and peak discharges calculated. The comparison results are shown in Table 2B. "Method 1" represents the Grid Method procedure submitted as part of the Jackrabbit Wash Study. "Method 2" represents the planimetered method. "Method 2" decreased peak discharges in the range of 4% to 10% as compared to "Method 1". These results indicate that soil-types can adequately be accounted for by using the Grid Method provided care is taken to add points to the grid if some soils are obviously missed.

TABLE 2A

COMPARISON OF GRID SOILS METHOD VS. PLANIMETERED AREA METHOD

Sub-Basin	Total Area (sq. mi.)	Final S-Basin Values	Value Desc.	Individual Soil Map Unit Values												
6D			Map Unit No.	11	20	71	92	102	4							
	3.67		Map Unit Area	0.61	1.03	0.56	1.4	0.03	0.04							
			Wtg. Factor	1.00	1.00	1.00	1.00	1.00	1.00							
		31	— Vegetation Cover Density (%)													
		1.23	— Ck: XKSAT(Adj)/XKSAT(Unadj) - Applied EXCEPT where XKSAT > =1.2													
			XKSAT (Unadj	2.43	0.27	0.33	0.76	0.52	1.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.85	0.94	... XKSAT (Adj)	2.43	0.33	0.40	0.94	0.64	1.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3.3	3.3	... PSIF	2.2	3.6	3.9	3.4	4.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.35	0.35	... DTHETA	0.35	0.35	0.35	0.35	0.35	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	... RTIMP	0	0	0	0	0	0	0	0	0	0	0	0	0
10U			Map Unit No.	81	117	56	4	30	48	99	75					
	4.26		Map Unit Area	0.23	0.61	0.3	0.16	2.29	0.4	0.2	0.07					
			Wtg. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00					
		27	— Vegetation Cover Density (%)													
		1.19	— Ck: XKSAT(Adj)/XKSAT(Unadj) - Applied EXCEPT where XKSAT > =1.2													
			XKSAT (Unadj	0.13	0.43	0.42	1.89	0.53	0.10	0.21	0.25	0.00	0.00	0.00	0.00	0.00
	0.47	0.56	... XKSAT (Adj)	0.16	0.51	0.49	1.89	0.63	0.12	0.25	0.29	0.00	0.00	0.00	0.00	0.00
	4.9	4.5	... PSIF	6.9	4.2	4.3	2.3	4.0	7.5	4.7	3.6	0.0	0.0	0.0	0.0	0.0
	0.36	0.35	... DTHETA	0.38	0.35	0.35	0.35	0.35	0.35	0.37	0.35	0.00	0.00	0.00	0.00	0.00
	0	0	... RTIMP	0	0	0	0	0	0	0	0	0	0	0	0	0
10W			Map Unit No.	43	73	64	42	74	13	110	3	32	48	94	93	105
	5.3		Map Unit Area	0.9	2.26	0.07	1.35	0.05	0.09	0.09	0.03	0.23	0.07	0.08	0.05	0.03
			Wtg. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
		40	— Vegetation Cover Density (%)													
		1.33	— Ck: XKSAT(Adj)/XKSAT(Unadj) - Applied EXCEPT where XKSAT > =1.2													
			XKSAT (Unadj	0.07	0.09	0.09	0.08	0.06	0.03	0.24	1.89	0.27	0.10	0.33	0.21	0.07
	0.11	0.14	... XKSAT (Adj)	0.09	0.11	0.11	0.10	0.08	0.04	0.32	1.89	0.35	0.14	0.45	0.28	0.09
	8.0	7.7	... PSIF	8.4	7.9	7.9	8.1	8.6	10.3	3.7	2.3	3.6	7.5	4.0	4.7	8.3
	0.30	0.30	... DTHETA	0.27	0.31	0.31	0.30	0.25	0.27	0.35	0.35	0.35	0.35	0.35	0.37	0.28
	0	0	... RTIMP	0	0	0	0	0	0	0	0	0	0	0	0	0
13A			Map Unit No.	69	119	92	71	53	4							
	0.9		Map Unit Area	0.03	0.12	0.04	0.64	0.04	0.03							
			Wtg. Factor	1.00	1.00	1.00	1.00	1.00	1.00							
		25	— Vegetation Cover Density (%)													
		1.17	— Ck: XKSAT(Adj)/XKSAT(Unadj) - Applied EXCEPT where XKSAT > =1.2													
			XKSAT (Unadj	0.11	0.10	0.76	0.33	0.04	1.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.38	0.39	... XKSAT (Adj)	0.12	0.12	0.89	0.38	0.04	1.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3.9	4.7	... PSIF	7.4	7.5	3.4	3.9	10.6	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.35	0.35	... DTHETA	0.36	0.35	0.35	0.35	0.29	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	... RTIMP	0	0	0	0	0	0	0	0	0	0	0	0	0

NOTE:

0.38 These values, in italics, represent the coresponding parameters
3.9 calculated using the grid method.
0.35
0

TABLE 2B

Green & Ampt Parameters using Planimetered Soil Map Units Vs The Grid Method

HEC-1 Id.	Description	24-Hr. Peak Discharge (cfs)			Area (sm)
		Method 1	Method 2	% Diff.	
6D	Jackrabbit Wash N.W. of C.A.P. Canal	1,830	1,650	10%	3.7
10U	Middle section of Star Wash	2,790	2,620	6%	4.3
10W	N.E. portion of watershed in the Vulture Mountains	3,750	3,610	4%	5.3
13A	East side of watershed North of C.A.P. Canal	1,200	1,140	5%	0.9

x̄ = 6.25%

NOTE:
"Method 1" utilizes Green & Ampt Loss Parameters derived from the Grid Method.
"Method 2" utilizes Green & Ampt Loss Parameters derived from planimetering the Soil Map Units.

2.2.3 Task 3 - Phoenix S-Graphs

The same four sub-basins compared in Section 2.2.2 were selected for S-Graph comparisons. Refer to Table 3A for results.

A liberal method comparison was performed for this test. Where the original sub-basins contained Mountain, Hillslope, and Rangeland, all Rangeland was converted to additional Hillslope. Totally eliminating Rangeland resulted in a 0% to 7% increase in flowrates as compared to using Rangeland.

Another test was performed to determine the effects of using the opposite S-Graph. The appropriate S-Graph was selected based on whether Rangeland occupied more than 50% or less than 50% of the sub-basin. Results indicate that if another method was used to select the appropriate S-Graph, significant changes in flowrates in the range of 13% to 18% can be expected.

TABLE 3A

COMPARISON OF INDIVIDUAL SUB-BASIN MODELS USING RANGELAND Vs HILLSLOPE LANDUSE AND PHOENIX MOUNTAIN Vs PHOENIX VALLEY S-GRAPHS

24-Hour Storm

SUB-BASIN 6D	Rangeland		Hillslope		%
Area = 3.67 sm	(cfs)	(cfs/sm)	(cfs)	(cfs/sm)	Change
Phoenix Mountain	1570	428	1680	458	7
Phoenix Valley	1830	499	1950	531	7
% Change	17		16		

SUB-BASIN 10U	Rangeland		Hillslope		%
Area = 4.26 sm	(cfs)	(cfs/sm)	(cfs)	(cfs/sm)	Change
Phoenix Mountain	2400	563	2520	592	5
Phoenix Valley	2790	655	2930	688	5
% Change	16		16		

SUB-BASIN 10W	Rangeland		Hillslope		%
Area = 5.30 sm	(cfs)	(cfs/sm)	(cfs)	(cfs/sm)	Change
Phoenix Mountain	3750	708	3760	709	0
Phoenix Valley	4440	838	4440	838	0
% Change	18		18		

SUB-BASIN 13A	Rangeland		Hillslope		%
Area = 0.90 sm	(cfs)	(cfs/sm)	(cfs)	(cfs/sm)	Change
Phoenix Mountain	1060	1178	1090	1211	3
Phoenix Valley	1200	1333	1240	1378	3
% Change	13		14		

Note: The 'Rangeland' columns represent rangeland land use as shown on Exhibit "B". The 'Hillslope' column represents all rangeland areas changed to hillslope.

2.2.4 Task 4 - Channel Routing Infiltration Losses

Infiltration rates for each Normal Depth channel route on the watershed were adjusted as shown in Table 4A. Field percolation tests were taken during the field reconnaissance for the Jackrabbit Wash study at five locations. A single falling head permeameter tests was done by ADWR on field samples taken at Concentration Point 33. The results of these tests are shown in Table 4A in the "Field Percolation Test Results" columns.

Actual field percolation test results appear to be abnormally high. Although steps were taken to measure only vertical percolation rates, the extremely dry granular soils at the test sites accounted for significant lateral seepage, thus resulting in high percolation values. The tests performed by ADWR on the samples from Concentration Point 33 resulted in overbank rates of 2 inches per hour, which appear reasonable, and a channel rate of 40 inches per hour, which may be somewhat high. The Burgess & Niple, Inc. results near the same location were 12 in./hr. at the overbanks and 180 in./hr. in the channel. Therefore, the Burgess & Niple, Inc. percolation values shown in Table 4A were reduced by a factor of five (5), with a maximum allowed value of 20 in./hr. The new percolation rates at the five sites were used to estimate new composite loss rates for the seven affected routing reaches. These new composite loss rates for the seven reached averaged four (4) times higher than hydraulic conductivity values (XKSAT) derived from SCS Map Units (identified as Method 1). Therefore, a field adjustment factor of four (4) was applied to each routing reach and the Adjusted Method 1 values input into Record RL.3 of the HEC-1 model. Resulting flowrate comparisons at key watershed locations are shown in Table 4B. Depending on the increased infiltration rates of Adjusted Method 1, flowrates decreased from 0% to 35%.

TABLE 4A

ROUTING REACH CHANNEL INFILTRATION LOSS

Reach	100-Yr 24-Hr Composite Loss Rate Method 1 (cfs/acre)	Field Adjustment Factor	Adjusted Method 1 (cfs/acre)	Field Percolation Test Results (in/hr) L.O.B.	CHANNEL	R.O.B.
R1-2	0.03	4	0.13	N/A	N/A	N/A
R2-4	0.03	4	0.13	N/A	N/A	N/A
R3-4	0.17	4	0.68	N/A	N/A	N/A
R4-7	2.45	4	9.81	N/A	N/A	N/A
R5-7	0.27	4	1.08	N/A	N/A	N/A
R6-7	0.27	4	1.08	N/A	N/A	N/A
R7-8	2.45	4	9.81	N/A	N/A	N/A
R8-10	2.45	4	9.81	N/A	N/A	N/A
R9-10	2.45	4	9.81	N/A	N/A	N/A
R10-11	2.45	4	9.81	N/A	N/A	N/A
R11-12	1.90	4	7.61	N/A	N/A	N/A
R13-14	0.52	4	2.07	N/A	N/A	N/A
R14-15	2.45	4	9.81	N/A	N/A	N/A
R15-17	1.70	4	6.82	N/A	N/A	N/A
R16-18	0.11	4	0.46	N/A	N/A	N/A
R17-18	2.45	4	9.81	N/A	N/A	N/A
R18-12	1.90	4	7.61	N/A	N/A	N/A
R12-21	1.90	4	7.61	N/A	N/A	N/A
R19-21	1.90	4	7.61	N/A	N/A	N/A
R20-21	1.90	4	7.61	N/A	N/A	N/A
R21-22	1.90	4	7.61	N/A	N/A	N/A
R22-25	1.90	4	7.61	12	1200	12
R23-24	1.90	4	7.61	N/A	N/A	N/A
R24-25	1.90	4	7.61	N/A	N/A	N/A
R25-32	1.90	4	7.61	N/A	N/A	N/A
R26-27	0.26	4	1.05	N/A	N/A	N/A
R27-29	0.10	4	0.40	N/A	N/A	N/A
R28-29	0.28	4	1.11	N/A	N/A	N/A
R29-30	0.23	4	0.93	N/A	N/A	N/A
R30-31	0.33	4	1.31	12	>20	9
R31-84	0.33	4	1.31	N/A	N/A	N/A
R32-33	2.45	4	9.81	N/A	180	12
R33-34	2.45	4	9.81	N/A	180	12
R34-37	2.45	4	9.81	N/A	N/A	N/A
R35-36	0.40	4	1.61	N/A	N/A	N/A

TABLE 4A

ROUTING REACH CHANNEL INFILTRATION LOSS

Reach	100-Yr 24-Hr Composite Loss Rate Method 1 (cfs/acre)	Field Adjustment Factor	Adjusted Method 1 (cfs/acre)	Field Percolation Test Results (in/hr) L.O.B.	CHANNEL	R.O.B.
R36-37	0.40	4	1.60	N/A	N/A	N/A
R37-38	2.45	4	9.81	N/A	N/A	N/A
R38-94	2.45	4	9.81	N/A	N/A	N/A
R39-40	1.22	4	4.90	N/A	N/A	N/A
R40-41	2.45	4	9.81	N/A	N/A	N/A
R41-43	0.77	4	3.08	N/A	N/A	N/A
R42-43	0.77	4	3.08	N/A	N/A	N/A
R43-44	2.01	4	8.06	N/A	N/A	N/A
R44-45	0.70	4	2.81	N/A	N/A	N/A
R44-47	0.44	4	1.75	N/A	N/A	N/A
R45-46	0.54	4	2.15	N/A	N/A	N/A
R46-94	0.47	4	1.89	N/A	N/A	N/A
R47-119	1.19	4	4.77	N/A	N/A	N/A
R48-101	1.90	4	7.61	N/A	N/A	N/A
R49-101	0.52	4	2.08	N/A	N/A	N/A
R50-51	0.54	4	2.15	N/A	N/A	N/A
R51-57	0.54	4	2.15	N/A	N/A	N/A
R52-55	0.54	4	2.15	N/A	N/A	N/A
R53-54	0.38	4	1.52	N/A	N/A	N/A
R54-59	0.54	4	2.15	N/A	N/A	N/A
R55-57	0.54	4	2.15	N/A	N/A	N/A
R57-58	0.43	4	1.72	N/A	N/A	N/A
R58-59	1.90	4	7.61	N/A	N/A	N/A
R59-61	2.74	4	10.96	N/A	N/A	N/A
R60-61	0.54	4	2.15	N/A	N/A	N/A
R61-82	1.90	4	7.61	15	>20	6
R63-68	0.42	4	1.69	N/A	N/A	N/A
R67-68	0.65	4	2.61	N/A	N/A	N/A
R68-72	0.54	4	2.15	N/A	N/A	N/A
R69-71	0.48	4	1.91	N/A	N/A	N/A
R70-71	0.54	4	2.15	N/A	N/A	N/A
R71-72	0.54	4	2.15	N/A	N/A	N/A
R72-81	0.54	4	2.15	N/A	N/A	N/A
R73-74	0.21	4	0.85	N/A	N/A	N/A
R74-76	0.17	4	0.68	N/A	N/A	N/A

TABLE 4A

ROUTING REACH CHANNEL INFILTRATION LOSS

Reach	100-Yr 24-Hr Composite Loss Rate Method 1 (cfs/acre)	Field Adjustment Factor	Adjusted Method 1 (cfs/acre)	Field Percolation Test Results (in/hr) L.O.B.	CHANNEL	R.O.B.
R75-76	0.08	4	0.33	N/A	N/A	N/A
R76-77	0.54	4	2.15	N/A	N/A	N/A
R77-80	0.54	4	2.15	N/A	N/A	N/A
R78-79	0.21	4	0.85	N/A	N/A	N/A
R79-80	0.54	4	2.15	N/A	N/A	N/A
R80-81	0.33	4	1.31	N/A	N/A	N/A
R81-82	1.90	4	7.61	N/A	N/A	N/A
R82-84	1.90	4	7.61	N/A	N/A	N/A
R83-84	0.21	4	0.83	N/A	N/A	N/A
R84-38	1.50	4	6.02	N/A	N/A	N/A
R85-95	0.43	4	1.72	N/A	N/A	N/A
R86-88	0.21	4	0.85	N/A	N/A	N/A
R87-88	0.42	4	1.68	N/A	N/A	N/A
R88-89	1.10	4	4.41	N/A	N/A	N/A
R89-90	0.77	4	3.08	N/A	N/A	N/A
R90-99	2.45	4	9.81	N/A	N/A	N/A
R94-96	2.45	4	9.81	N/A	N/A	N/A
R95-96	0.43	4	1.72	N/A	N/A	N/A
R96-97	2.45	4	9.81	N/A	N/A	N/A
R97-98	2.45	4	9.81	N/A	N/A	N/A
R104-105	0.43	4	1.72	N/A	70	9
R105-106	0.33	4	1.31	N/A	70	9
R108-109	0.27	4	1.09	N/A	N/A	N/A
R109-110	0.52	4	2.08	N/A	N/A	N/A
R116-117	0.39	4	1.56	N/A	N/A	N/A
R118-64	0.40	4	1.61	N/A	N/A	N/A

NOTE:
Method 1" utilizes infiltration rates (XKSAT) derived from SCS Soil Map Units.
Adjusted Method 1" also utilizes field Percolation Test results from the watershed to adjust the infiltration rates.

TABLE 4B

Comparison of Peak Discharges At Key Locations On The Watershed

HEC-1 Id.	Description	24-Hr. Peak Discharge (cfs)			Area (sm)
		Method 1	Adjusted Method 1	% Diff.	
C44	Coyote Wash Upstream of Split	7,800	7,200	8%	34.5
CP44W	Coyote Wash (West Fork) Downstream of Split	3,600	3,400	6%	34.5
CP44E	Coyote Wash (East Fork) Downstream of Split	4,100	3,800	7%	34.5
C119	Coyote Wash (West Fork) at 371st Avenue	1,500	1,300	13%	36.4
C99	Daggs Wash at Hassayampa River	3,000	2,700	10%	28.1
C12	Jackrabbit Wash at Deadhorse Wash	18,800	16,800	11%	79.1
C33	Jackrabbit Wash at Vulture Mine Road	21,100	17,400	18%	138.1
C34	Jackrabbit Wash at Wickenburg Road	20,000	15,000	25%	140.3
R34-37	Jackrabbit Wash Upstream of Confluence with W.F.J.R.W.	19,700	14,200	28%	140.3
C37	Jackrabbit Wash at W.F. Jackrabbit Wash	19,800	14,300	28%	148.7
C38I.1	Jackrabbit Wash Upstream of Confluence with Star Wash	19,300	12,900	33%	152.4
C38I	Jackrabbit Wash at CAP Canal CAP-5 (upstream)	33,200	24,300	27%	319.2
C38I	Jackrabbit Wash at CAP Canal CAP-5 (downstream)	33,200	24,300	27%	319.2
C94	Jackrabbit Wash at East Fork Coyote Wash	33,600	23,700	29%	363.1
C98	Jackrabbit Wash at Hassayampa River	32,500	21,000	35%	372.1
R36-37	Jackrabbit Wash (W.F.) Upstream of Confluence with J.R.W.	2,900	2,800	3%	8.4
6A	Jackrabbit Wash (West Fork) at Vulture Mine Road	3,000	3,000	0%	3.7
C36	Jackrabbit Wash (West Fork) at Wickenburg Road	3,000	3,000	0%	8.4
C84.1	Powerline Wash Upstream of Confluence with Star Wash	5,000	4,800	4%	34.9
C84.2	Star Wash Upstream of Confluence with Powerline Wash	14,000	11,700	16%	125.7
C84	Star Wash at Powerline Wash	17,600	15,200	14%	160.6
C38I.2	Star Wash Upstream of Confluence with Jackrabbit Wash	17,300	14,300	17%	166.8

NOTE:
"Method 1" utilizes infiltration rates (XKSAT) derived from SCS Soil Map Units for estimating infiltration losses throughout the channel routing reach.

"Adjusted Method 1" also utilizes field Percolation Test results to adjust the infiltration rates.

SECTION 3: CONCLUSIONS

3.1 General

The Hydrologic Design Manual For Maricopa County, Arizona was created to provide a more uniform hydrologic methodology. The results estimated using the new manual would hopefully be more reproducible, and more accurately depict the watershed. The goal of better reproducibility is obtained by reducing the engineering judgment involved in selection of physical and statistical parameters. The primary reason for preparing this report is to divulge the lessons learned from applying the Design Manual to the Jackrabbit Wash study. The process of checking the sensitivity of the HEC-1 model to selected parameter changes is the vehicle used to quantify what has been learned.

3.1.1 Task 1 - SCS Soil Map Units

Analysis of the results indicate the Minor soils specified in the SCS soil surveys are important. Composite Green & Ampt parameters for each SCS Soil Map Unit should reflect the effects of Minor soils, or consistently low peak flowrates will likely result. It is recognized that many assumptions must be made in order to include the effects of Minor soils. The most significant are:

- The percentage of each Minor soil present is assumed to be an even split of the total Minor soil percentage.
- Composite XKSAT values were estimated for each SCS Soil Map Unit. Then the remaining parameters were interpolated using Table 4.2 of the Design Manual.
- The effects of terrain specific Minor soil characteristics are assumed to be present in each Soil Map Unit, regardless of whether the different types of terrain exist where any given Soil Map Unit is present on the watershed.
- The soil horizon which controls the infiltration rate must be selected, taking into account the available water storage capacity of the layer or layers above the chosen horizon.
- The method of accounting for the effects of rock outcrops, for both Major and Minor soils, must be determined and implemented.
- Minor soils which have either extremely high or low XKSAT values in comparison with the other soils present must be evaluated. One Minor soil, even in a small

percentage, can unduly influence the composite XKSAT value if the other soils are markedly different. It is often appropriate to neglect the effects of the Minor soil. An example would be a Carrizo sand with an XKSAT of 4.6 inches per hour, present in wash bottoms, when the remaining soils have an average XKSAT value 0.04 inches per hour. If only 5% of the map unit is Carrizo sand, the composite XKSAT value would be 0.27 inches per hour. To make the situation worse, the stream bottom containing the Carrizo soil may also be a routing reach which is being modeled to reflect transmission losses.

Application of these assumptions on a sub-basin by sub-basin basis, and evaluating composite Green and Ampt parameters for individual SCS Soil Map Units specific to a sub-basin, is not practical. For the Jackrabbit Wash study, using the above assumptions to estimate average Green & Ampt parameter values for each SCS Soil Map Unit was found to be the most feasible approach.

It is recommended that Appendices "A", "B", and "C" of the Design Manual be modified to reflect composite Green & Ampt parameter values for each SCS Soil Map Unit. Minor soils should be accounted for. Using the above assumptions, and averaging the various components, is the realistic and cost effective method of handling the problem. This approach will also increase the reproducibility of the methodology. The effects of rock outcrops should be handled on a separate basis, either using RTIMP, or modifying the XKSAT values.

3.1.2 Task 2 - Sub-Basin Soil-Type Representation

The Planimetering Method, or calculation of areas by digital means, is preferable to the Grid Method. The Grid Method did not result in substantial time savings because of the judgment evaluations and discussion which were necessary to ensure accuracy of the method.

3.1.3 Task 3 - Phoenix S-Graphs

The choice of which S-Graph to use is a significant judgment. Additional guidance should be included in the Design Manual to aide in the selection. The Jackrabbit

Wash model is not nearly as sensitive to the distinguishment between Hillslope and Rangeland land use as it is to the choice of the S-Graph. The reproducibility of the methodology would be improved if additional guidance is provided. It may be appropriate to develop a definitive relationship between land use characteristics and average watershed slope or slope classes.

3.1.4 Task 4 - Channel Routing Infiltration Losses

The results of the Jackrabbit Wash field reconnaissance indicate that actual transmission losses in the various channel reaches may be greater than those derived from the literature. the Jackrabbit Wash HEC-1 model is quite sensitive to the increased infiltration rates that were based on the field data. The differences noted are significant enough to warrant additional study, but pending such analyses, it is recommended that channel infiltration parameters continue to be estimated using values derived from the SCS soil surveys.

SECTION 4: BIBLIOGRAPHY

1. Jackrabbit Wash Floodplain Delineation Study, Final Technical Data Notebook, Hydrology, Book 1 of 2 and 2 of 2, Burgess & Niple, Inc., February, 1991.

2. Hydrologic Design Manual for Maricopa County, Arizona, Flood Control District of Maricopa County, Hydrology Division, Special Projects Branch, September, 1990.

3. Soil Survey of Maricopa County, Arizona, Central Part, United States Department of Agriculture, Soil Conservation Service, September, 1977.

4. Soil Survey of Aguila-Carefree Area, Parts of Maricopa County and Pinal Counties, Arizona, United States Department of Agriculture, Soil Conservation Service, April, 1986.

APPENDIX "A"

APPENDIX "A", TABLE A-1

SUMMARY of ROCK-MODIFIED METHOD 1 GREEN & AMPT VALUES BY SCS MAP UNIT

SCS Soil Map Unit	XKSAT (Unadj)	PSIF	DTHETA	RTIMP
1	0.56	3.9	0.35	0
2	0.56	3.9	0.35	0
3	1.89	2.3	0.35	0
4	1.89	2.3	0.35	0
5	1.04	2.8	0.35	0
6	1.04	2.8	0.35	0
7	1.04	2.8	0.35	0
8	0.56	3.9	0.35	0
10	2.43	2.2	0.35	0
11	2.43	2.2	0.35	0
13	0.03	10.3	0.27	0
14	4.04	2.0	0.35	0
16	0.38	4.2	0.35	0
17	0.38	4.2	0.35	0
18	0.90	3.1	0.35	0
19	0.27	3.6	0.35	0
20	0.27	3.6	0.35	0
21	0.08	7.9	0.31	0
22	0.01	12.2	0.16	0
24	0.05	8.3	0.25	0
25	0.05	8.3	0.25	0
26	0.02	9.6	0.22	0
27	0.02	9.5	0.21	0
28	0.05	8.4	0.25	0
29	0.53	4.0	0.35	0
30	0.53	4.0	0.35	0
32	0.36	4.1	0.35	0
33	0.02	9.6	0.22	0
34	0.02	9.6	0.22	0

APPENDIX "A", TABLE A-1

SUMMARY
of
ROCK-MODIFIED METHOD 1
GREEN & AMPT VALUES BY SCS MAP UNIT

SCS Soil Map Unit	XKSAT (Unadj)	PSIF	DTHETA	RTIMP
35	0.02	9.6	0.22	0
36	0.03	9.8	0.23	0
38	0.10	7.6	0.34	0
42	0.08	8.1	0.30	0
43	0.07	8.4	0.27	0
44	0.04	8.2	0.25	0
45	0.04	8.2	0.25	0
46	0.06	8.5	0.26	0
47	0.12	7.2	0.37	0
48	0.10	7.5	0.35	0
49	0.10	7.5	0.35	0
50	0.25	3.6	0.35	0
51	0.12	7.2	0.37	0
52	0.39	4.3	0.35	0
53	0.04	10.6	0.29	0
54	0.28	3.7	0.35	0
55	0.39	4.2	0.35	0
56	0.42	4.3	0.35	0
57	0.18	5.8	0.39	0
60	0.21	4.9	0.37	0
61	0.08	8.1	0.30	0
62	0.08	8.1	0.30	0
63	0.11	7.4	0.36	0
64	0.11	7.4	0.36	0
65	0.27	3.6	0.35	0
66	0.27	3.6	0.35	0
67	0.03	10.2	0.26	0
68	0.11	7.4	0.36	0
69	0.11	7.4	0.36	0

APPENDIX "A", TABLE A-1

SUMMARY
of
ROCK-MODIFIED METHOD 1
GREEN & AMPT VALUES BY SCS MAP UNIT

SCS Soil Map Unit	XKSAT (Unadj)	PSIF	DTHETA	RTIMP
70	0.33	3.9	0.35	0
71	0.33	3.9	0.35	0
72	0.11	7.3	0.36	0
73	0.11	7.3	0.36	0
74	0.06	8.6	0.25	0
75	0.25	3.6	0.35	0
76	0.10	7.5	0.35	0
77	0.10	7.6	0.34	0
78	0.08	8.0	0.31	0
81	0.13	6.9	0.38	0
82	0.23	4.1	0.36	0
83	0.23	4.1	0.36	0
84	0.23	4.2	0.36	0
85	0.06	8.5	0.26	0
86	0.24	3.8	0.36	0
87	0.22	4.5	0.37	0
88	0.12	7.1	0.37	0
89	0.24	3.7	0.35	0
91	0.76	3.4	0.35	0
92	0.76	3.4	0.35	0
94	0.33	4.0	0.35	0
95	0.04	10.6	0.29	0
96	0.08	8.1	0.29	0
97	0.08	8.1	0.29	0
98	0.21	4.7	0.37	0
99	0.21	4.7	0.37	0
100	0.80	3.4	0.35	0
102	0.52	4.0	0.35	0
103	0.16	6.4	0.40	0

APPENDIX "A", TABLE A-1

SUMMARY
of
ROCK-MODIFIED METHOD 1
GREEN & AMPT VALUES BY SCS MAP UNIT

SCS Soil Map Unit	XKSAT (Unadj)	PSIF	DTHETA	RTIMP
105	0.13	7.0	0.38	0
106	0.55	3.9	0.35	0
107	0.55	3.9	0.35	0
108	0.10	7.5	0.35	0
109	0.08	8.1	0.29	0
110	0.25	3.5	0.35	0
112	0.50	4.1	0.35	0
114	0.43	4.2	0.35	0
115	0.47	4.1	0.35	0
116	0.51	4.0	0.35	0
117	0.43	4.2	0.35	0
119	0.10	7.5	0.35	0
120	0.09	7.7	0.33	0
121	0.49	4.1	0.35	0
122	0.96	3.0	0.35	0
123	0.50	4.1	0.35	0
125	0.73	3.5	0.35	0
AGB	0.40	4.3	0.35	0
AL	0.40	4.3	0.35	0
AgA	0.25	3.5	0.35	0
GgA	0.25	3.5	0.35	0
GxA	0.40	4.3	0.35	0
GxB	0.40	4.3	0.35	0
GYD	0.40	4.3	0.35	0
HLC	0.04	8.2	0.25	0
HM	0.04	8.2	0.25	0
HrB	0.04	8.2	0.25	0
LcA	0.25	3.5	0.35	0
PeA	0.40	4.3	0.35	0

APPENDIX "A", TABLE A-1

SUMMARY
of
ROCK-MODIFIED METHOD 1
GREEN & AMPT VALUES BY SCS MAP UNIT

SCS Soil Map Unit	XKSAT (Unadj)	PSIF	DTHETA	RTIMP
RbA	0.40	4.3	0.35	0
RbB	0.40	4.3	0.35	0
RhB	0.40	4.3	0.35	0
AVERAGE:	0.37	5.7	0.33	0

SENSITIVITY ANALYSIS: TASK 1

APPENDIX "A", TABLE A-2

SUMMARY OF ROCK-MODIFIED METHOD 1 SUB-BASIN PARAMETERS

Sub-Basin	Area (s.m.)	IA (in.)	DTHETA (in.)	PSIF (in.)	XKSAT (in./hr.)	RTIMP (%)	LAG (min.)	S-GRAPH TYPE
1A	6.69	0.34	0.32	6.8	0.16	0	34	Valley
1B	5.70	0.34	0.31	6.8	0.17	0	31	Valley
1C	0.81	0.35	0.36	5.4	0.23	0	22	Valley
1D	3.27	0.35	0.29	7.2	0.14	0	27	Valley
1E	1.11	0.27	0.36	4.9	0.26	0	24	Valley
1F	3.06	0.15	0.34	4.5	0.29	0	44	Mountain
1G	2.56	0.30	0.31	6.0	0.37	0	26	Valley
1H	7.55	0.27	0.34	4.5	0.42	0	40	Valley
1I	6.88	0.16	0.35	4.9	0.42	0	64	Mountain
1J	2.57	0.19	0.36	5.4	0.48	0	47	Mountain
1K	5.02	0.22	0.35	5.2	0.46	0	60	Mountain
1L	5.93	0.15	0.34	7.3	0.22	0	58	Mountain
2A	7.76	0.16	0.36	5.6	0.32	0	42	Mountain
2B	4.31	0.17	0.35	4.4	0.61	0	38	Mountain
2C	3.82	0.16	0.35	5.1	0.77	0	31	Mountain
2D	5.12	0.15	0.36	5.4	0.55	0	68	Mountain
2E	2.09	0.16	0.35	4.8	0.48	0	32	Mountain
2F	4.89	0.15	0.36	5.3	0.51	0	75	Mountain
3A	5.97	0.22	0.35	6.7	0.29	0	54	Mountain
3B	6.25	0.16	0.34	5.9	0.42	0	68	Mountain
3C	5.70	0.25	0.35	6.0	0.39	0	75	Mountain
3D	5.01	0.24	0.35	6.3	0.30	0	65	Mountain
3E	2.90	0.31	0.35	4.0	0.57	0	39	Valley
4A	7.43	0.15	0.36	5.2	0.40	0	96	Mountain
4B	4.07	0.17	0.35	4.9	0.39	0	73	Mountain
4C	2.65	0.33	0.35	5.9	0.20	0	44	Valley
5A	8.03	0.26	0.35	5.1	0.42	0	62	Valley
5B	7.36	0.19	0.35	6.1	0.46	0	62	Mountain
5C	3.56	0.35	0.35	6.3	0.49	0	43	Valley
6A	3.66	0.34	0.36	6.8	0.22	0	47	Valley
6B	4.76	0.35	0.35	4.4	0.59	0	62	Valley
6C	2.23	0.35	0.35	4.4	0.96	0	51	Valley

APPENDIX "A", TABLE A-2

SUMMARY OF ROCK-MODIFIED METHOD 1 SUB-BASIN PARAMETERS

Sub-Basin	Area (s.m.)	IA (in.)	DTHETA (in.)	PSIF (in.)	XKSAT (in./hr.)	RTIMP (%)	LAG (min.)	S-GRAPH TYPE
6D	3.67	0.35	0.35	3.3	0.85	0	48	Valley
7A	5.19	0.26	0.34	6.6	0.22	0	62	Valley
7B	6.11	0.34	0.35	5.2	0.41	0	60	Valley
7C	6.81	0.27	0.34	5.7	0.43	0	65	Valley
7D	5.84	0.35	0.35	4.8	0.48	0	46	Valley
7E	8.30	0.35	0.35	4.5	0.38	0	84	Valley
7F	2.63	0.35	0.35	4.2	0.51	0	57	Valley
8A	6.27	0.35	0.35	3.9	0.57	0	74	Valley
9A	4.64	0.21	0.35	4.5	0.45	0	56	Mountain
9B	8.49	0.25	0.35	5.4	0.41	0	58	Mountain
9C	7.32	0.29	0.35	6.3	0.33	0	51	Valley
9D	6.24	0.25	0.32	7.0	0.24	0	60	Mountain
9E	6.08	0.29	0.36	5.1	0.67	0	39	Valley
9F	1.75	0.23	0.35	4.8	0.63	0	28	Mountain
9G	1.00	0.35	0.35	4.0	0.60	0	35	Valley
9H	1.47	0.23	0.35	3.9	0.86	0	27	Mountain
9I	4.81	0.35	0.35	3.7	0.51	0	35	Valley
10A	2.01	0.15	0.34	5.9	0.33	0	47	Mountain
10B	5.36	0.35	0.35	4.5	0.62	0	55	Valley
10C	5.66	0.35	0.35	4.1	0.63	0	59	Valley
10C1	1.43	0.35	0.35	4.2	0.65	0	35	Valley
10C2	4.23	0.35	0.35	4.1	0.62	0	49	Valley
10D	4.54	0.15	0.33	7.2	0.18	0	63	Mountain
10E	2.72	0.32	0.36	4.8	0.51	0	42	Valley
10F	5.68	0.21	0.34	7.4	0.17	0	53	Mountain
10G	4.28	0.20	0.36	5.1	0.42	0	60	Mountain
10H	6.74	0.35	0.35	3.9	0.76	0	68	Valley
10I	6.93	0.23	0.34	6.6	0.28	0	71	Mountain
10J	7.08	0.35	0.35	4.4	0.61	0	65	Valley
10K	5.44	0.32	0.35	5.1	0.46	0	63	Valley
10K1	0.88	0.16	0.35	5.6	0.46	0	31	Mountain
10K2	4.56	0.35	0.36	4.9	0.43	0	52	Valley

SENSITIVITY ANALYSIS: TASK 1

APPENDIX "A", TABLE A-2

SUMMARY OF ROCK-MODIFIED METHOD 1 SUB-BASIN PARAMETERS

Sub-Basin	Area (s.m.)	IA (in.)	DTHETA (in.)	PSIF (in.)	XKSAT (in./hr.)	RTIMP (%)	LAG (min.)	S-GRAPH TYPE
10L	6.34	0.35	0.35	3.9	0.69	0	59	Valley
10M	6.17	0.21	0.34	6.9	0.21	0	63	Mountain
10M1	1.85	0.22	0.32	7.8	0.12	0	27	Mountain
10M2	1.48	0.17	0.33	7.3	0.18	0	41	Mountain
10M3	2.84	0.23	0.35	5.9	0.30	0	49	Mountain
10N	3.47	0.35	0.36	4.6	0.47	0	58	Valley
10O	3.08	0.17	0.33	7.8	0.11	0	36	Mountain
10P	6.15	0.20	0.35	6.6	0.25	0	64	Mountain
10Q	2.61	0.22	0.32	7.1	0.24	0	38	Mountain
10R	4.93	0.16	0.35	5.8	0.32	0	63	Mountain
10S	3.92	0.30	0.36	5.5	0.23	0	49	Valley
10T	3.81	0.34	0.35	5.4	0.36	0	51	Valley
10U	4.26	0.35	0.36	4.9	0.47	0	47	Valley
10V	3.12	0.35	0.35	4.9	0.46	0	48	Valley
10W	5.30	0.20	0.32	7.7	0.13	0	59	Mountain
10X	2.74	0.30	0.34	6.6	0.20	0	52	Mountain
10Y	3.70	0.35	0.36	4.7	0.49	0	61	Mountain
10Z	3.69	0.35	0.35	4.4	0.65	0	49	Mountain
10AA	1.63	0.35	0.36	6.3	0.29	0	43	Mountain
10AB	4.31	0.35	0.35	5.2	0.33	0	61	Mountain
11A	2.18	0.35	0.35	4.1	0.50	0	47	Valley
12A	4.88	0.19	0.35	7.5	0.13	0	55	Mountain
12B	4.79	0.27	0.34	5.7	0.59	0	70	Valley
12C	3.64	0.30	0.34	5.6	0.48	0	63	Valley
12D	5.29	0.35	0.34	5.9	0.35	0	58	Valley
12E	7.54	0.35	0.35	5.6	0.38	0	67	Valley
13A	0.90	0.35	0.35	3.9	0.38	0	19	Valley
14A	0.09	0.35	0.35	3.9	0.38	0	8	Valley
14B	0.03	0.35	0.35	3.9	0.38	0	3	Valley
15A	3.59	0.35	0.35	3.5	1.00	0	33	Valley
15B	2.08	0.35	0.35	4.2	0.50	0	42	Valley
15C	1.83	0.35	0.35	4.1	1.18	0	22	Valley

APPENDIX "A", TABLE A-2

SUMMARY OF ROCK-MODIFIED METHOD 1 SUB-BASIN PARAMETERS

Sub-Basin	Area (s.m.)	IA (in.)	DTHETA (in.)	PSIF (in.)	XKSAT (in./hr.)	RTIMP (%)	LAG (min.)	S-GRAPH TYPE
15D	2.87	0.35	0.35	3.8	0.92	0	42	Valley
16A	1.94	0.35	0.35	3.3	0.92	0	37	Valley
17A	2.17	0.35	0.35	5.3	0.43	0	43	Valley
18A	0.25	0.35	0.35	2.8	1.51	0	14	Valley
18B	1.81	0.33	0.35	3.9	0.47	0	33	Valley
18C	1.90	0.33	0.35	3.7	0.43	0	43	Valley
18D	3.60	0.35	0.35	3.8	0.47	0	49	Valley
18E	3.83	0.35	0.35	4.2	0.42	0	44	Valley
18F	0.80	0.35	0.35	4.0	0.45	0	26	Valley
18G	2.03	0.35	0.35	5.3	0.29	0	43	Valley
18H	2.63	0.35	0.35	5.2	0.41	0	32	Valley
18I	2.57	0.35	0.35	6.2	0.31	0	39	Valley
18J	2.35	0.35	0.35	4.2	0.48	0	35	Valley
18K	0.80	0.35	0.35	4.0	0.49	0	22	Valley
18L	2.40	0.35	0.35	4.4	0.49	0	32	Valley
18M	1.50	0.35	0.33	4.9	0.31	0	51	Valley
18N	2.40	0.35	0.33	4.9	0.31	0	57	Valley
18O	0.90	0.35	0.35	4.1	0.43	0	31	Valley
18P	1.36	0.35	0.31	6.0	0.28	0	41	Valley
18Q	1.13	0.35	0.35	3.9	0.37	0	28	Valley
18R	2.17	0.35	0.34	4.3	0.34	0	59	Valley
18S	1.35	0.35	0.34	4.5	0.38	0	32	Valley
18T	0.39	0.35	0.35	3.5	1.04	0	19	Valley
19A	0.06	0.25	0.35	4.1	0.58	0	4	Mountain
19B	0.77	0.21	0.35	4.4	0.57	0	17	Mountain

APPENDIX "A", TABLE A-2

SUMMARY OF ROCK-MODIFIED METHOD 1 SUB-BASIN PARAMETERS

Sub-Basin	Area (s.m.)	IA (in.)	DTHETA (in.)	PSIF (in.)	XKSAT (in./hr.)	RTIMP (%)	LAG (min.)	S-GRAPH TYPE

Note:

Average IA for the watershed, based on area, is	0.28	inches
Average XKSAT for the watershed, based on area, is	0.43	inches/hour
The smallest LAG for the watershed is	3	min.
The largest LAG for the watershed is	96	min.
The average LAG for the watershed is	47	min.
The standard deviation of the sub-basin LAG values is .	17	min.
The selected hydrograph Main Time Interval is	5	min.

SENSITIVITY ANALYSIS: TASK 1

APPENDIX "A", TABLE A-3

SUMMARY
of
METHOD 2
GREEN & AMPT VALUES BY SCS MAP UNIT

SCS Soil Map Unit	XKSAT (Unadj)	PSIF	DTHETA	RTIMP
1	0.40	4.3	0.35	0
2	0.40	4.3	0.35	0
3	1.87	2.3	0.35	0
4	1.87	2.3	0.35	0
5	1.20	2.4	0.35	0
6	1.20	2.4	0.35	0
7	1.20	2.4	0.35	0
8	0.40	4.3	0.35	0
10	2.90	2.2	0.35	0
11	2.90	2.2	0.35	0
13	0.12	7.2	0.37	0
14	4.60	1.9	0.35	0
16	0.40	4.3	0.35	0
17	0.40	4.3	0.35	0
18	1.20	2.4	0.35	0
19	0.40	4.3	0.35	0
20	0.40	4.3	0.35	0
21	0.06	8.6	0.25	0
22	0.04	10.8	0.30	0
24	0.04	10.8	0.30	0
25	0.01	0.0	0.00	0
26	0.04	10.8	0.30	0
27	0.16	6.4	0.40	0
28	0.05	8.3	0.25	0
29	0.40	4.3	0.35	0
30	0.40	4.3	0.35	0
32	0.40	4.3	0.35	0
33	0.40	4.3	0.35	0
34	0.40	4.3	0.35	0

APPENDIX "A", TABLE A-3

SUMMARY
of
METHOD 2
GREEN & AMPT VALUES BY SCS MAP UNIT

SCS Soil Map Unit	XKSAT (Unadj)	PSIF	DTHETA	RTIMP
35	0.40	4.3	0.35	0
36	0.24	3.9	0.36	0
38	0.25	3.5	0.35	0
42	0.25	3.6	0.35	0
43	0.25	3.6	0.35	0
44	0.06	8.6	0.25	0
45	0.06	8.6	0.25	0
46	0.05	8.4	0.25	0
47	0.48	4.1	0.35	0
48	0.57	3.9	0.35	0
49	0.57	3.9	0.35	0
50	0.25	3.5	0.35	0
51	0.19	5.4	0.38	0
52	0.19	5.4	0.38	0
53	0.01	0.0	0.00	0
54	0.25	3.5	0.35	0
55	0.25	3.5	0.35	0
56	0.25	3.5	0.35	0
57	0.04	10.8	0.30	0
60	0.15	6.6	0.40	0
61	0.22	4.4	0.36	0
62	0.22	4.4	0.36	0
63	0.22	4.4	0.36	0
64	0.22	4.4	0.36	0
65	0.36	4.1	0.35	0
66	0.27	3.6	0.35	0
67	0.01	0.0	0.00	0
68	0.40	4.3	0.35	0
69	0.40	4.3	0.35	0

APPENDIX "A", TABLE A-3

SUMMARY
of
METHOD 2
GREEN & AMPT VALUES BY SCS MAP UNIT

SCS Soil Map Unit	XKSAT (Unadj)	PSIF	DTHETA	RTIMP
70	0.40	4.3	0.35	0
71	0.40	4.3	0.35	0
72	0.06	8.6	0.25	0
73	0.06	8.6	0.25	0
74	0.21	4.6	0.37	0
75	0.25	3.5	0.35	0
76	0.25	3.5	0.35	0
77	0.25	3.5	0.35	0
78	0.04	10.8	0.30	0
81	0.17	5.9	0.39	0
82	0.25	3.5	0.35	0
83	0.25	3.5	0.35	0
84	0.25	3.5	0.35	0
85	0.04	10.8	0.30	0
86	0.04	10.8	0.30	0
87	0.25	3.5	0.35	0
88	0.15	6.6	0.40	0
89	0.25	3.5	0.35	0
91	0.76	3.4	0.35	0
92	0.76	3.4	0.35	0
94	0.34	4.0	0.35	0
95	0.04	10.8	0.30	0
96	0.06	8.6	0.25	0
97	0.06	8.6	0.25	0
98	0.21	4.6	0.37	0
99	0.21	4.6	0.37	0
100	0.92	3.1	0.35	0
102	0.40	4.3	0.35	0
103	0.06	8.6	0.25	0

APPENDIX "A", TABLE A-3

SUMMARY
of
METHOD 2
GREEN & AMPT VALUES BY SCS MAP UNIT

SCS Soil Map Unit	XKSAT (Unadj)	PSIF	DTHETA	RTIMP
105	0.06	8.6	0.25	0
106	0.20	5.2	0.38	0
107	0.20	5.2	0.38	0
108	0.06	8.6	0.25	0
109	0.06	8.6	0.25	0
110	0.19	5.4	0.38	0
112	0.40	4.3	0.35	0
114	0.40	4.3	0.35	0
115	0.40	4.3	0.35	0
116	0.50	4.1	0.35	0
117	0.50	4.1	0.35	0
119	0.25	3.6	0.35	0
120	0.06	8.6	0.25	0
121	0.54	4.0	0.35	0
122	0.40	4.3	0.35	0
123	0.40	4.3	0.35	0
125	0.40	4.3	0.35	0
AGB	0.40	4.3	0.35	0
AL	0.40	4.3	0.35	0
AgA	0.25	3.5	0.35	0
GgA	0.25	3.5	0.35	0
GxA	0.40	4.3	0.35	0
GxB	0.40	4.3	0.35	0
GYD	0.40	4.3	0.35	0
HLC	0.04	8.2	0.25	0
HM	0.04	8.2	0.25	0
HrB	0.04	8.2	0.25	0
LcA	0.25	3.5	0.35	0
PeA	0.40	4.3	0.35	0

APPENDIX "A", TABLE A-3

SUMMARY
of
METHOD 2
GREEN & AMPT VALUES BY SCS MAP UNIT

SCS Soil Map Unit	XKSAT (Unadj)	PSIF	DTHETA	RTIMP
RbA	0.40	4.3	0.35	0
RbB	0.40	4.3	0.35	0
RhB	0.40	4.3	0.35	0
AVERAGE:	0.41	5.0	0.33	0

SENSITIVITY ANALYSIS: TASK 1

APPENDIX "A", TABLE A-4

SUMMARY OF METHOD 2 SUB-BASIN PARAMETERS

Sub-Basin	Area (s.m.)	IA (in.)	DTHETA (in.)	PSIF (in.)	XKSAT (in./hr.)	RTIMP (%)	LAG (min.)	S-GRAPH TYPE
1A	6.69	0.34	0.34	5.7	0.21	0	34	Valley
1B	5.70	0.34	0.32	4.8	0.23	0	31	Valley
1C	0.81	0.35	0.37	4.8	0.28	0	22	Valley
1D	3.27	0.35	0.35	5.0	0.25	0	27	Valley
1E	1.11	0.27	0.37	5.0	0.34	0	24	Valley
1F	3.06	0.15	0.30	3.4	0.35	0	44	Mountain
1G	2.56	0.30	0.35	4.5	0.46	0	26	Valley
1H	7.55	0.27	0.35	4.3	0.50	0	40	Valley
1I	6.88	0.16	0.36	4.7	0.40	0	64	Mountain
1J	2.57	0.19	0.37	4.9	0.48	0	47	Mountain
1K	5.02	0.22	0.33	4.8	0.52	0	60	Mountain
1L	5.93	0.15	0.31	6.8	0.26	0	58	Mountain
2A	7.76	0.16	0.38	5.4	0.23	0	42	Mountain
2B	4.31	0.17	0.37	4.6	0.55	0	38	Mountain
2C	3.82	0.16	0.35	4.6	0.87	0	31	Mountain
2D	5.12	0.15	0.36	4.6	0.60	0	68	Mountain
2E	2.09	0.16	0.36	4.7	0.43	0	32	Mountain
2F	4.89	0.15	0.37	4.9	0.49	0	75	Mountain
3A	5.97	0.22	0.34	5.1	0.37	0	54	Mountain
3B	6.25	0.16	0.31	5.7	0.44	0	68	Mountain
3C	5.70	0.25	0.35	4.3	0.48	0	75	Mountain
3D	5.01	0.24	0.36	4.2	0.43	0	65	Mountain
3E	2.90	0.31	0.35	4.3	0.56	0	39	Valley
4A	7.43	0.15	0.37	5.0	0.33	0	96	Mountain
4B	4.07	0.17	0.38	5.2	0.25	0	73	Mountain
4C	2.65	0.33	0.37	4.9	0.33	0	44	Valley
5A	8.03	0.26	0.37	5.1	0.35	0	62	Valley
5B	7.36	0.19	0.35	4.1	0.69	0	62	Mountain
5C	3.56	0.35	0.35	4.7	0.64	0	43	Valley
6A	3.66	0.34	0.36	4.4	0.48	0	47	Valley
6B	4.76	0.35	0.35	4.0	0.63	0	62	Valley
6C	2.23	0.35	0.35	3.4	1.13	0	51	Valley

SENSITIVITY ANALYSIS: TASK 1

APPENDIX "A", TABLE A-4

SUMMARY OF METHOD 2 SUB-BASIN PARAMETERS

Sub-Basin	Area (s.m.)	IA (in.)	DTHETA (in.)	PSIF (in.)	XKSAT (in./hr.)	RTIMP (%)	LAG (min.)	S-GRAPH TYPE
6D	3.67	0.35	0.35	3.7	1.02	0	48	Valley
7A	5.19	0.26	0.36	4.4	0.35	0	62	Valley
7B	6.11	0.34	0.35	4.1	0.53	0	60	Valley
7C	6.81	0.27	0.36	4.1	0.53	0	65	Valley
7D	5.84	0.35	0.35	4.5	0.49	0	46	Valley
7E	8.30	0.35	0.35	4.2	0.46	0	84	Valley
7F	2.63	0.35	0.35	4.2	0.56	0	57	Valley
8A	6.27	0.35	0.35	4.0	0.67	0	74	Valley
9A	4.64	0.21	0.38	5.3	0.26	0	56	Mountain
9B	8.49	0.25	0.36	5.0	0.42	0	58	Mountain
9C	7.32	0.29	0.33	5.1	0.50	0	51	Valley
9D	6.24	0.25	0.30	6.2	0.39	0	60	Mountain
9E	6.08	0.29	0.36	3.8	0.83	0	39	Valley
9F	1.75	0.23	0.35	3.6	0.83	0	28	Mountain
9G	1.00	0.35	0.35	4.1	0.54	0	35	Valley
9H	1.47	0.23	0.35	3.4	1.06	0	27	Mountain
9I	4.81	0.35	0.35	4.1	0.64	0	35	Valley
10A	2.01	0.15	0.35	4.8	0.43	0	47	Mountain
10B	5.36	0.35	0.35	4.4	0.59	0	55	Valley
10C	5.66	0.35	0.35	4.2	0.57	0	59	Valley
10C1	1.43	0.35	0.35	4.1	0.60	0	35	Valley
10C2	4.23	0.35	0.35	4.2	0.54	0	49	Valley
10D	4.54	0.15	0.36	4.3	0.40	0	63	Mountain
10E	2.72	0.32	0.35	4.2	0.54	0	42	Valley
10F	5.68	0.21	0.33	5.6	0.25	0	53	Mountain
10G	4.28	0.20	0.35	4.5	0.48	0	60	Mountain
10H	6.74	0.35	0.35	3.9	0.68	0	68	Valley
10I	6.93	0.23	0.34	4.6	0.41	0	71	Mountain
10J	7.08	0.35	0.35	4.4	0.52	0	65	Valley
10K	5.44	0.32	0.35	4.4	0.55	0	63	Valley
10K1	0.88	0.16	0.35	3.9	0.74	0	31	Mountain
10K2	4.56	0.35	0.35	4.7	0.44	0	52	Valley

APPENDIX "A", TABLE A-4

SUMMARY OF METHOD 2 SUB-BASIN PARAMETERS

Sub-Basin	Area (s.m.)	IA (in.)	DTHETA (in.)	PSIF (in.)	XKSAT (in./hr.)	RTIMP (%)	LAG (min.)	S-GRAPH TYPE
10L	6.34	0.35	0.35	3.7	0.63	0	59	Valley
10M	6.17	0.21	0.36	4.2	0.48	0	63	Mountain
10M1	1.85	0.22	0.36	4.4	0.32	0	27	Mountain
10M2	1.48	0.17	0.36	4.1	0.44	0	41	Mountain
10M3	2.84	0.23	0.35	4.1	0.63	0	49	Mountain
10N	3.47	0.35	0.36	4.2	0.43	0	58	Valley
10O	3.08	0.17	0.30	6.8	0.18	0	36	Mountain
10P	6.15	0.20	0.35	4.9	0.36	0	64	Mountain
10Q	2.61	0.22	0.35	4.0	0.42	0	38	Mountain
10R	4.93	0.16	0.36	4.2	0.54	0	63	Mountain
10S	3.92	0.30	0.36	4.4	0.40	0	49	Valley
10T	3.81	0.34	0.35	4.7	0.46	0	51	Valley
10U	4.26	0.35	0.36	4.6	0.43	0	47	Valley
10V	3.12	0.35	0.35	4.2	0.49	0	48	Valley
10W	5.30	0.20	0.31	5.9	0.21	0	59	Mountain
10X	2.74	0.30	0.36	4.2	0.51	0	52	Mountain
10Y	3.70	0.35	0.36	4.4	0.49	0	61	Mountain
10Z	3.69	0.35	0.35	4.0	0.65	0	49	Mountain
10AA	1.63	0.35	0.36	4.3	0.40	0	43	Mountain
10AB	4.31	0.35	0.35	4.3	0.48	0	61	Mountain
11A	2.18	0.35	0.35	4.2	0.53	0	47	Valley
12A	4.88	0.19	0.28	7.4	0.15	0	55	Mountain
12B	4.79	0.27	0.36	4.3	0.83	0	70	Valley
12C	3.64	0.30	0.36	4.4	0.56	0	63	Valley
12D	5.29	0.35	0.35	4.2	0.46	0	58	Valley
12E	7.54	0.35	0.33	3.8	0.53	0	67	Valley
13A	0.90	0.35	0.35	4.3	0.47	0	19	Valley
14A	0.09	0.35	0.35	4.3	0.47	0	8	Valley
14B	0.03	0.35	0.35	4.3	0.47	0	3	Valley
15A	3.59	0.35	0.35	3.6	1.20	0	33	Valley
15B	2.08	0.35	0.35	4.1	0.59	0	42	Valley
15C	1.83	0.35	0.35	3.3	1.48	0	22	Valley

APPENDIX "A", TABLE A-4

SUMMARY OF METHOD 2 SUB-BASIN PARAMETERS

Sub-Basin	Area (s.m.)	IA (in.)	DTHETA (in.)	PSIF (in.)	XKSAT (in./hr.)	RTIMP (%)	LAG (min.)	S-GRAPH TYPE
15D	2.87	0.35	0.35	3.7	1.17	0	42	Valley
16A	1.94	0.35	0.35	3.7	1.10	0	37	Valley
17A	2.17	0.35	0.35	4.0	0.68	0	43	Valley
18A	0.25	0.35	0.35	2.9	1.47	0	14	Valley
18B	1.81	0.33	0.35	3.9	0.52	0	33	Valley
18C	1.90	0.33	0.35	4.0	0.54	0	43	Valley
18D	3.60	0.35	0.35	4.1	0.58	0	49	Valley
18E	3.83	0.35	0.35	4.2	0.54	0	44	Valley
18F	0.80	0.35	0.35	4.3	0.49	0	26	Valley
18G	2.03	0.35	0.35	4.2	0.45	0	43	Valley
18H	2.63	0.35	0.35	4.2	0.52	0	32	Valley
18I	2.57	0.35	0.35	4.3	0.47	0	39	Valley
18J	2.35	0.35	0.35	4.3	0.47	0	35	Valley
18K	0.80	0.35	0.35	4.3	0.47	0	22	Valley
18L	2.40	0.35	0.35	4.2	0.44	0	32	Valley
18M	1.50	0.35	0.33	5.1	0.34	0	51	Valley
18N	2.40	0.35	0.33	5.1	0.34	0	57	Valley
18O	0.90	0.35	0.35	4.1	0.43	0	31	Valley
18P	1.36	0.35	0.31	6.0	0.28	0	41	Valley
18Q	1.13	0.35	0.35	3.9	0.37	0	28	Valley
18R	2.17	0.35	0.34	4.7	0.45	0	59	Valley
18S	1.35	0.35	0.34	4.6	0.37	0	32	Valley
18T	0.39	0.35	0.35	3.2	1.03	0	19	Valley
19A	0.06	0.25	0.35	4.3	0.47	0	4	Mountain
19B	0.77	0.21	0.35	3.7	0.75	0	17	Mountain

APPENDIX "A", TABLE A-4

SUMMARY OF METHOD 2 SUB-BASIN PARAMETERS

Sub-Basin	Area (s.m.)	IA (in.)	DTHETA (in.)	PSIF (in.)	XKSAT (in./hr.)	RTIMP (%)	LAG (min.)	S-GRAPH TYPE

Note:

Average IA for the watershed, based on area, is	0.28	inches
Average XKSAT for the watershed, based on area, is	0.50	inches/hour
The smallest LAG for the watershed is	3	min.
The largest LAG for the watershed is	96	min.
The average LAG for the watershed is	47	min.
The standard deviation of the sub-basin LAG values is .	17	min.
The selected hydrograph Main Time Interval is	5	min.