flexibility than HM2.2.2 because it is more adaptable to a piecemeal approach to costing out loops. For example, the user can omit all Bell CBGs from the data set and run the model on only the independent telcos. HM2.2.2 does not allow the user to drop any of the CBGs from the analysis. We tried to run both models on just one CBG and just one CLLI code in order to see the impact of parameter changes. The BCM2 allowed us to do both while the Hatfield Model would not process. Further, the HM2.2.2 input data cannot be expanded to include non-Bell CBGs.

Overall, the BCM2 is considerably more "user friendly" as a platform to compute costs for determining universal service support according to the Joint Board's criteria.

VII. Concluding Remarks

Our evaluation of the Benchmark Cost Model 2 and the Hatfield Model Version 2.2, Release 2 has established that the BCM2 model has distinct advantages over the Hatfield model in terms of model operation. In simulations of the models, we found that the majority of the cost differences can be explained by two major differences in the default assumptions between the two models and the fact that the Hatfield model only estimates costs for Bell-served territories. Overall, adjusting for Bell-only CBGs and eliminating these two major differences explains between 83% (Arkansas) and 109% (Utah) of the difference

in per-line costs between the two models. This implies that the FCC should focus its attention on the values of these inputs.

Because HM2.2.2 estimates costs for Bell-only CBGs, the default results of HM2.2.2 can be misleading for non-Bell-served portions of a state. We found that costs for Bell-only CBGs significantly understated the costs for the rest of the state in all five states we analyzed.

Appendix A

Parameterization of BCM2 and Hatfield Model Scenarios

This appendix describes modifications to default parameters of the BCM2 and Hatfield (HM2.2.2) models in the scenarios described in Section VI.

1. BCM2 parameters modified to HM values

1.1 Business line density adjustment

The BCM2 concept of CBG density is based on customer locations per square mile whereas the HM2.2.2 uses lines per square mile. The BCM2 business line density adjustment has a default value of 10 (lines/business customer location). Setting this parameter to 1 in Scenarios B5 and B6 bases all BCM2 density-related calculations on lines per square mile.

1.2 Distribution and Feeder fill factors

Distribution and feeder fill factors are interchangeable between the BCM2 and HM2.2.2, though the defaults do not necessarily have identical interpretations because of the models' different concepts of density group. The default factors for each model are presented in the table below. The HM2.2.2 values are used in Scenarios B2, B4, B5, and B6.

	BCM2		Hatfield	
Density	Feeder	Distribution	Feeder	Distribution
0	0.75	0.40	0.65	0.50
5	0.80	0.45	0.75	0.55
200	0.80	0.55	0.80	0.60
650	0.85	0.65	0.80	0.65
850	0.85	0.75	0.80	0.70
2550	0.85	0.80	0.80	0.75

1.2 Aerial/below ground placement mix

The BCM2 allocates structures between aerial and "below ground" installations, the latter aggregating buried and underground (conduit) cable placements. The buried/underground placement mix in the BCM2 is outside the model. The buried/underground mix is user adjustable in the HM2.2.2. To implement the HM2.2.2 mix in the BCM2, we aggregated the buried and underground percents. As above, note that the density groups are not directly comparable at the model defaults. The BCM2 and HM2.2.2 defaults are presented in the tables below. The HM2.2.2 defaults were used in Scenarios B2, B4, B5, and B6.

Distribution

Density	BCM2		Hatfield	
	Below Ground	Aerial	Below Ground	Aerial
0	90	10	50	50
5	80	20	50	50
200	70	30	50	50
650	70	30	50	50
850	80	20	60	40
2550	90	10	35	65

Copper feeder

Density	BCM2		Hatfield	
	Below Ground	Aerial	Below Ground	Aerial
0	70	30	50	50
5	72	28	50	50
200	75	25	50	50
650	75	25	60	40
850	80	20	90	10
2550	90	10	95	5

Fiber feeder

Density	BCM2		Hatfield	
	Below Ground	Aerial	Below Ground	Aerial
0	95	5	65	35
5	85	15	65	35
200	70	30	65	35
650	70	30	80	20
850	80	20	90	10
2550	90	10	95	5

1.3 Line length factors for terrain slope

The BCM2 uses three user-adjustable factors which increase cable distance for CBGs where the terrain has a high average slope, labeled the MinSlopeFactor, MaxSlopeFactor, and CombSlopeFactor. The default values are 1.1, 1.05, and 1.2, respectively. The HM2.2.2 does not incorporate terrain slope information; to reflect this in the BCM2, these factors were set to 1 for Scenarios B2, B4, B5, and B6.

1.4 CBG data: Bell versus Non-Bell

The BCM2 data files include all CBGs served by Tier 1 and Tier 2 ILECs, whereas the HM2.2.2 data includes only CBGs served by the Bell company. We constructed comparable data files for the BCM2 by manually deleting the records for CBGs associated with non-Bell carriers per Page 3 of the BCM2 instructions. Scenarios B3, B4, B5, and B6 employ the Bell-only input data.

2. HM2.2.2 parameters modified to BCM2 values

2.1 Distribution and feeder fill factors

These factors are interchangeable with the BCM2. Scenarios H2 and H3 use BCM2 default values. See section 1.1, above.

2.2 Structure costs allocated to telephony

The HM2.2.2 contains six user adjustable factors specifying the percentage of aerial, underground, and buried structure costs assigned to telephony for feeder and distribution cable. The default value for each is 33%. The BCM2 assumes all structure costs are borne by telephony; this is not user-adjustable. To reflect the BCM2 treatment, all six factors were set to 100% in Scenario H3.

2.3 Variable overhead factor

The HM2.2.2 contains a user-adjustable percentage to account for non-plant specific overhead, with a default value of 10%. The BCM2 does this using a fixed adjustment of $8.33 per month per loop. To reconcile these, we set the HM2.2.2 variable overhead percentage to zero, and manually added $8.33 to the monthly unit costs.

2.4 Cost of Capital

The HM2.2.2 has user-adjustable inputs for the cost of debt and cost of equity, defaulting to 7.7% and 11.9% respectively. The weighted cost of capital implied by these defaults is 10.01%. The BCM2 incorporates a cost of capital of 11.25%, which we implement in the HM2.2.2 by specifying a cost of debt of 8.8% and cost of equity of 13.25%. These values are used in Scenarios H2 and H3.

Tables A1 and A2 present the results for the various scenarios for all five states.

Table A1: Monthly line costs for selected states

Scenario #	Description	Arkansas	California	Texas	Utah	Washington
B1	BCM2 w/ default parameters	$40.97	$24.50	$29.98	$31.21	$29.41
B2	BCM2 w/ Hatfield default parameters	$41.41	$22.60	$30.12	$29.96	$29.04
B3	BCM2 w/ default parameters, BOC CBGs	$34.24	$23.97	$27.25	$28.82	$26.16
B4	BCM2 w/ Hatfield defaults, BOC CBGs	$34.37	$22.04	$27.14	$27.59	$25.74
B5	BCM2 w/ Hatfield defaults & density, BOC CBGs	$35.11	$23.36	$27.91	$29.23	$26.44
B6	Scenario B5 w/ Hatfield line distribution by density grp.	$35.03	$23.29	$27.15	$28.51	$26.22
H1	Hatfield w/ default parameters	$21.59	$14.86	$16.80	$20.43	$16.89
H2	Hatfield w/ BCM2 defaults, 33% structures to tel.	$27.20	$20.74	$22.62	$26.06	$22.68
H3	Hatfield w/ BCM2 defaults, 100% structures to tel.	$30.90	$23.86	$26.43	$29.74	$26.35

Table A2: Development of "apples-to-apples" comparison of monthly line costs

State Arkansas

Hatfield		BCM2		Difference	Explained	Cumulative % Explained	Notes
(H1)	$21.59	(B1)	$40.97	-$19.38			Defaults
(H2)	$27.20	(B1)	$40.97	-$13.78	$5.61	29%	Explained by overhead, cost of capital (H2-H1)
(H3)	$30.90	(B1)	$40.97	-$10.07	$3.71	48%	Explained by structures cost sharing assumption (H3-H2)
(H3)	$30.90	(B3)	$34.24	-$3.34	$6.73	83%	Explained by Bell-only data (B3-B1)
(H3)	$30.90	(B4)	$34.37	-$3.46	-$0.13	82%	Result of adopting HM fill factors and BG/aerial mix (B4-B3)
(H3)	$30.90	(B5)	$35.11	-$4.21	-$0.75	78%	Result of removing BCM2 business line adjustment (B5-B4)
(H3)	$30.90	(B6)	$35.03	-$4.12	$0.09	79%	Explained by line distribution by density group (B6-B5)
(H3)	$30.90	(B6)	$35.03	-$4.12	–	79%	

Table A2: Development of "apples-to-apples" comparison of monthly line costs

State California

Hatfield		BCM2		Difference	Explained	Cumulative % Explained	Notes
(H1)	$14.86	(B1)	$24.50	-$9.64			Defaults
(H2)	$20.74	(B1)	$24.50	-$3.76	$5.88	61%	Explained by overhead, cost of capital (H2-H1)
(H3)	$23.86	(B1)	$24.50	-$0.64	$3.12	93%	Explained by structures cost sharing assumption (H3-H2)
(H3)	$23.86	(B3)	$23.97	-$0.12	$0.53	99%	Explained by Bell-only data (B3-B1)
(H3)	$23.86	(B4)	$22.04	$1.82	$1.94	119%	Result of adopting HM fill factors and BG/aerial mix (B4-B3)
(H3)	$23.86	(B5)	$23.36	$0.49	-$1.33	105%	Result of removing BCM2 business line adjustment (B5-B4)
(H3)	$23.86	(B6)	$23.29	$0.57	$0.07	106%	Explained by line distribution by density group (B6-B5)
(H3)	$23.86	(B6)	$23.29	$0.57	--	106%	

Table A2: Development of "apples-to-apples" comparison of monthly line costs

State Texas

Hatfield		BCM2		Difference	Explained	Cumulative % Explained	Notes
(H1)	$16.80	(B1)	$29.98	-$13.18			Defaults
(H2)	$22.62	(B1)	$29.98	-$7.36	$5.83	44%	Explained by overhead, cost of capital (H2-H1)
(H3)	$26.43	(B1)	$29.98	-$3.56	$3.80	73%	Explained by structures cost sharing assumption (H3-H2)
(H3)	$26.43	(B3)	$27.25	-$0.83	$2.73	94%	Explained by Bell-only data (B3-B1)
(H3)	$26.43	(B4)	$27.14	-$0.71	$0.11	95%	Result of adopting HM fill factors and BG/aerial mix (B4-B3)
(H3)	$26.43	(B5)	$27.91	-$1.48	-$0.77	89%	Result of removing BCM2 business line adjustment (B5-B4)
(H3)	$26.43	(B6)	$27.15	-$0.73	$0.75	94%	Explained by line distribution by density group (B6-B5)
(H3)	$26.43	(B6)	$27.15	-$0.73	--	94%	

Table A2: Development of "apples-to-apples" comparison of monthly line costs

State Utah

Hatfield		BCM2		Difference	Explained	Cumulative % Explained	Notes
(H1)	$20.43	(B1)	$31.21	-$10.78			Defaults
(H2)	$26.06	(B1)	$31.21	-$5.15	$5.64	52%	Explained by overhead, cost of capital (H2-H1)
(H3)	$29.74	(B1)	$31.21	-$1.47	$3.68	86%	Explained by structures cost sharing assumption (H3-H2)
(H3)	$29.74	(B3)	$28.82	$0.92	$2.39	109%	Explained by Bell-only data (B3-B1)
(H3)	$29.74	(B4)	$27.59	$2.15	$1.23	120%	Result of adopting HM fill factors and BG/aerial mix (B4-B3)
(H3)	$29.74	(B5)	$29.23	$0.51	-$1.64	105%	Result of removing BCM2 business line adjustment (B5-B4)
(H3)	$29.74	(B6)	$28.51	$1.23	$0.72	111%	Explained by line distribution by density group (B6-B5)
(H3)	$29.74	(B6)	$28.51	$1.23	--	111%	

Table A2: Development of "apples-to-apples" comparison of monthly line costs

State		Washington				Cumulative	
Hatfield		BCM2		Difference	Explained	% Explained	Notes
(H1)	$16.89	(B1)	$29.41	-$12.52			Defaults
(H2)	$22.68	(B1)	$29.41	-$6.73	$5.79	46%	Explained by overhead, cost of capital (H2-H1)
(H3)	$26.35	(B1)	$29.41	-$3.06	$3.67	76%	Explained by structures cost sharing assumption (H3-H2)
(H3)	$26.35	(B3)	$26.16	$0.18	$3.24	101%	Explained by Bell-only data (B3-B1)
(H3)	$26.35	(B4)	$25.74	$0.61	$0.43	105%	Result of adopting HM fill factors and BG/aerial mix (B4-B3)
(H3)	$26.35	(B5)	$26.44	-$0.09	-$0.70	99%	Result of removing BCM2 business line adjustment (B5-B4)
(H3)	$26.35	(B6)	$26.22	$0.13	$0.23	101%	Explained by line distribution by density group (B6-B5)
(H3)	$26.35	(B6)	$26.22	$0.13	--	101%	

Appendix B

Impact of Density Calculations on Proxy Model Results

The BCM2 and the HM2.2.2 do not assign CBGs to density categories the same way. In the Hatfield Model, the assignment to density categories is based on the model's estimated number of access lines per square mile.[17] The BCM2 assigns CBGs to density categories by, first, dividing its business line count by a user-adjustable input density adjustment.[18] The default value for the density adjustment is 10. The adjusted business lines are then summed with the CBG households, and this sum is divided by the square miles of the CBG.[19] This figure is the basis for assignment to density category in the BCM2.

Table B.1 compares the total line counts by density category for the BCM2 and HM2.2.2 models for the five states we have analyzed. The "BCM2 Default" column shows the BCM2 results for all CBGs in the state. The "BCM2 BOC, BusDens = 10" column shows the BCM2 results for Bell-only CBGs in the state with the business line density adjustment factor set at its default value of

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[17] The Hatfield Model estimates the number of residence lines in each CBG by multiplying the number of households by the ratio of total reported residence lines to total households in the study area which contains the CBG. The model controls its total line count to the number of lines that each company reports to the FCC in the ARMIS 43-08 report. The total number of Business, Centrex, Special Access, and Public Access lines are reported to the FCC at the study area level. These lines are assigned to each CBG by the ratio of business employees in the CBG to the total number of business employees in the study area. See Model Description, Hatfield Model Version 2.2, Release 2, p.13.

[18] Business lines and private lines are allocated to each CBG based on a third party database of employees per CBG. If the CBG line count is greater than 2016, a variable percentage of lines is terminated at the DS1 level to reflect the costs of providing service to digital PBXs and providing wideband private line services. Additional residential lines are calculated by a user-adjustable factor with a default value of 1.2. See Benchmark Cost Model 2 Methodology, p. 2.

[19] Benchmark Cost Model 2 Methodology, p. 8. While the business line density adjustment factor is appropriate, supporting documentation should be required in establishing its value.

10. The "BCM2 BOC, BusDens = 1" column shows the BCM2 results for Bell-only CBGs in the state with the business line density adjustment factor set at 1. The "Hatfield Default" column shows results for the default run of the Hatfield model, which is estimated on Bell-only CBGs.

Table B.1

Comparison of Line Counts Estimated by Each Model

Arkansas

	Lines			
Density group	BCM2	BCM2 BOC	BCM2 BOC	Hatfield
	Default	BusDens = 10	BusDens = 1	Default
0 - 5	5,085	1,755	638	16,810
5 - 200	749,206	349,874	300,676	274,917
200 - 650	208,215	172,526	149,542	145,907
650 - 850	70,008	54,991	52,368	49,463
850 - 2550	344,046	307,802	268,290	270,190
> 2550	41,412	40,958	156,391	219,514
Total	1,417,972	927,906	927,906	976,801

California

	Lines			
Density group	BCM2	BCM2 BOC	BCM2 BOC	Hatfield
	Default	BusDens = 10	BusDens = 1	Default
0 - 5	52,290	17,835	15,509	41,879
5 - 200	1,712,747	1,166,323	852,183	889,805
200 - 650	1,880,068	1,310,885	815,280	934,541
650 - 850	738,650	546,729	309,705	398,195
850 - 2550	5,855,141	4,305,051	2,585,433	3,109,880
> 2550	10,013,141	8,083,642	10,852,354	13,064,112
Total	20,252,037	15,430,465	15,430,465	18,438,413

Table B.1 (Continued)

Texas

	Lines			
Density group	BCM2	BCM2 BOC	BCM2 BOC	Hatfield
	Default	BusDens = 10	BusDens = 1	Default
0 - 5	116,312	30,234	25,796	60,971
5 - 200	2,170,023	1,115,542	855,600	814,728
200 - 650	1,678,570	1,187,660	788,225	787,611
650 - 850	630,977	489,688	333,010	297,588
850 - 2550	4,268,068	3,643,126	2,860,332	2,519,894
> 2550	1,961,830	1,788,447	3,391,735	5,005,201
Total	10,825,780	8,254,697	8,254,697	9,485,994

Utah

	Lines			
Density group	BCM2	BCM2 BOC	BCM2 BOC	Hatfield
	Default	BusDens = 10	BusDens = 1	Default
0 - 5	9,018	8,528	5,987	18,617
5 - 200	148,903	147,339	118,216	116,373
200 - 650	131,861	131,861	95,866	94,437
650 - 850	44,575	44,575	27,652	27,708
850 - 2550	412,717	412,717	339,196	291,769
> 2550	158,032	158,032	316,136	602,674
Total	905,106	903,053	903,053	1,151,577

Washington

	Lines			
Density group	BCM2	BCM2 BOC	BCM2 BOC	Hatfield
	Default	BusDens = 10	BusDens = 1	Default
0 - 5	26,849	4,259	3,206	14,278
5 - 200	634,397	266,280	202,932	195,672
200 - 650	487,515	307,276	198,596	192,602
650 - 850	181,135	116,098	95,176	74,459
850 - 2550	1,181,569	843,547	633,173	645,433
> 2550	782,457	699,211	1,103,589	1,346,229
Total	3,293,923	2,236,671	2,236,671	2,468,673

The "BCM2 BOC, BusDens = 10" column represents the BCM2 default run that is comparable in territory covered to the Hatfield default run. In every

state we tested, the BCM2 estimated fewer lines in the highest density category (>2550) than HM2.2.2. In the 5-200, 200-650, 650-850, and 850-2550 categories, the BCM2 consistently estimates more lines than HM2.2.2 does. In the lowest density category (0-5), the BCM2 consistently estimates fewer lines than HM2.2.2 does.

The fact that BCM2 produces a lower number of lines in the highest density category and a higher number of lines in the 5-200, 200-650, 650-850, and 850-2550 categories can be explained by the BCM2's user-adjustable business line density adjustment. The default value of 10 reduces the counts in each density category in proportion to the number of business lines in each category—i.e., the greater the number of business lines in the density category, the greater the reduction. Thus, by using the business line density adjustment, the BCM2 is shifting CBGs out of higher density categories and into lower density categories.

The BCM2's estimate of fewer access lines in the lowest density category (0-5) can be explained by the area reduction that takes place when there are fewer than 20 households per square mile in a CBG. Many CBGs that may have fallen in the 0-5 density category have been shifted to higher density categories. HM2.2.2 does not alter the area of low-density CBGs, so no CBGs are shifted out of the lowest density category.

We were able to obtain data from Pacific Bell to assess the accuracy of the proxy models' line distribution estimates in California.[20] Table B.2 compares the line counts by density category for the BCM2 model run on Bell-only CBGs in California, the Hatfield model run on California, and Pacific Bell actuals. Table B.3 computes the percentage distribution of the proxy model line counts and the Pacific Bell actuals by each density category. Tables B.2 and B.3 indicate that the BCM2 comes closest to replicating Pacific Bell's line count.

Table B.2
Comparison of BCM2 and HM2.2.2 Line Distributions by Density Group Versus Pacific Bell Actuals

Density Group	BCM2 Bell Only	Hatfield	Pacific Bell Actuals
0 - 5	17,835	41,879	20,490
5 - 200	1,166,323	889,805	1,694,167
200 - 650	1,310,885	934,541	1,785,176
650 - 850	546,729	398,195	441,528
850 - 2550	4,305,051	3,109,880	3,370,145
> 2550	8,083,642	13,064,112	7,776,500
Total	15,430,465	18,438,413	15,078,006

Table B.3
Comparison of BCM2 and HM2.2.2 Line Distributions by Density Group Versus Pacific Bell Actuals
Percentage Distribution

Density Group	BCM2 Bell Only	Hatfield	Pacific Bell Actuals
0 - 5	0.12%	0.23%	0.14%
5 - 200	7.56%	4.83%	11.24%
200 - 650	8.50%	5.07%	11.84%
650 - 850	3.54%	2.16%	2.93%
850 - 2550	27.90%	16.87%	22.35%
> 2550	52.39%	70.85%	51.51%
Total	100.00%	100.00%	100.00%

[20] Data were obtained from Pacific Bell. The figures represent residence and business lines for 1995. Special access and private lines are not included in the Pacific Bell figures.

The following set of charts compares the density distributions produced by BCM2 and HM2.2.2 for each of the five states we have analyzed. The first chart for each state compares the density distributions using the default value of BCM2's business line density adjustment. The second chart sets the BCM2 adjustment to a value of 1 to make it more comparable to the Hatfield model.

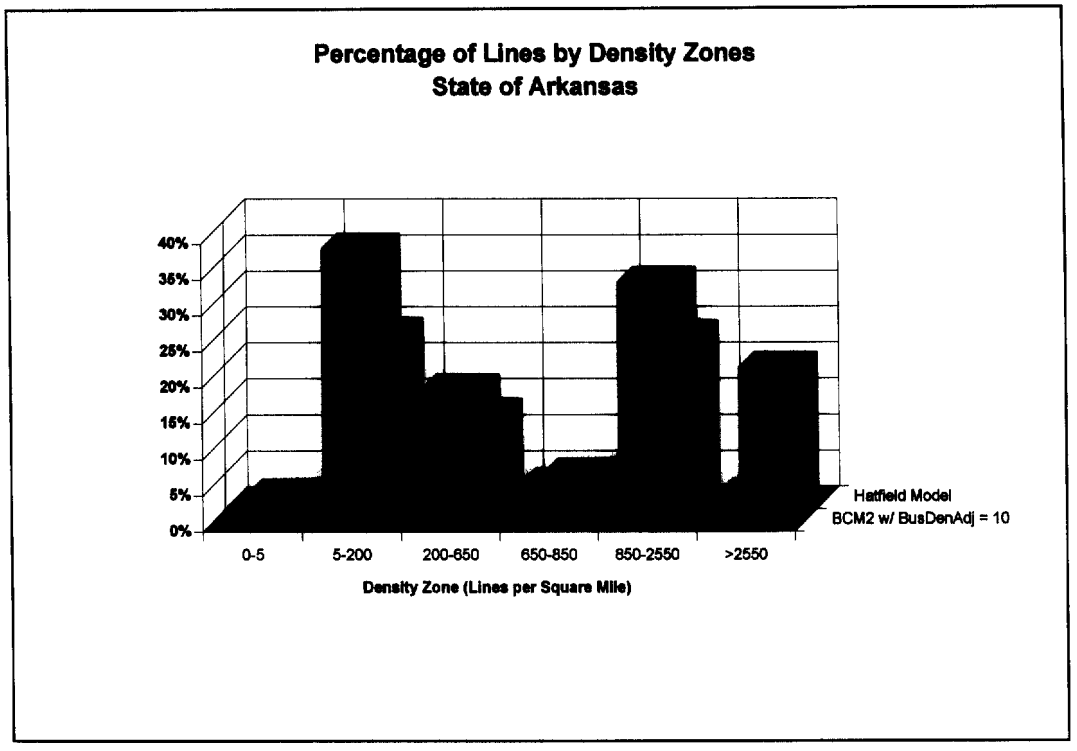

Figure 1. Distribution of lines across density zones for the state of Arkansas. BCM2 with default business line density adjustment compared to the HM2.2.2

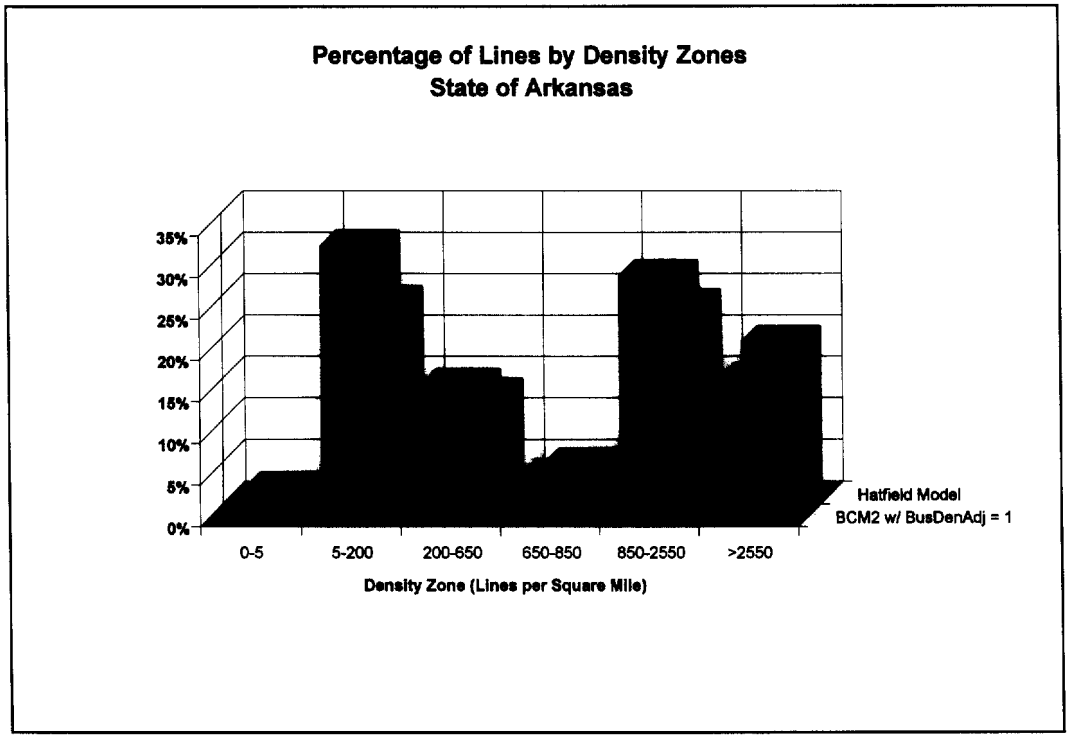

Figure 2. Distribution of lines across density zones for the state of Arkansas. BCM2 with business line density adjustment set to 1 compared to the HM2.2.2

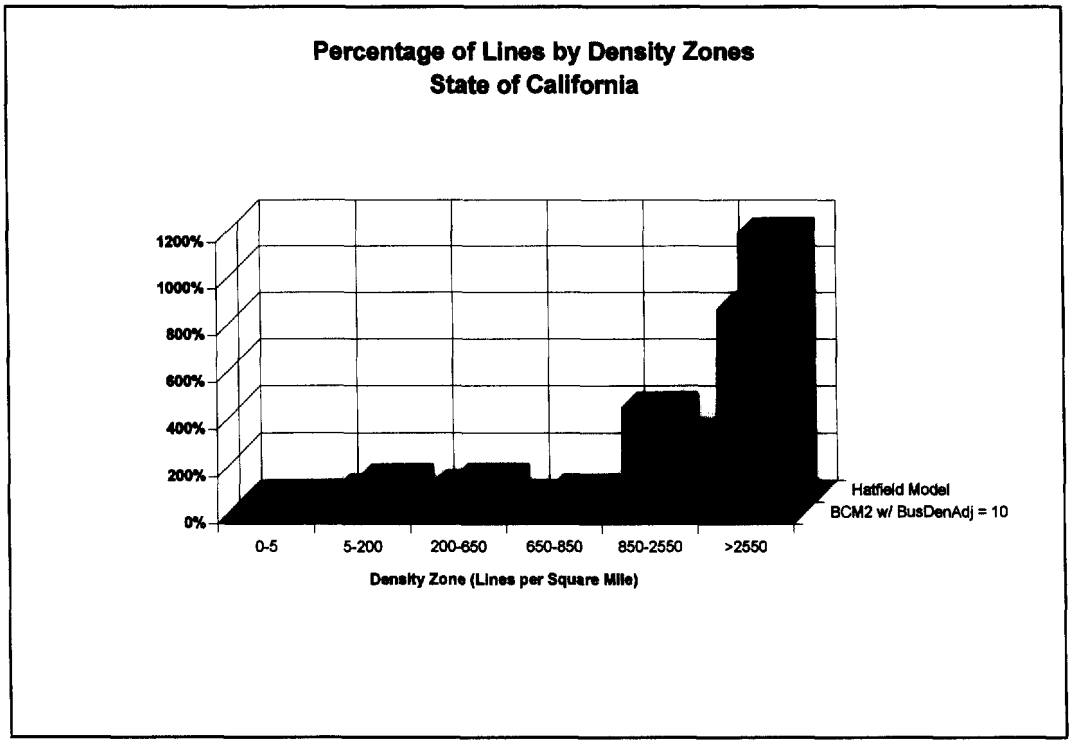

Figure 3. Distribution of lines across density zones for the state of California. BCM2 with default business line density adjustment compared to the HM2.2.2

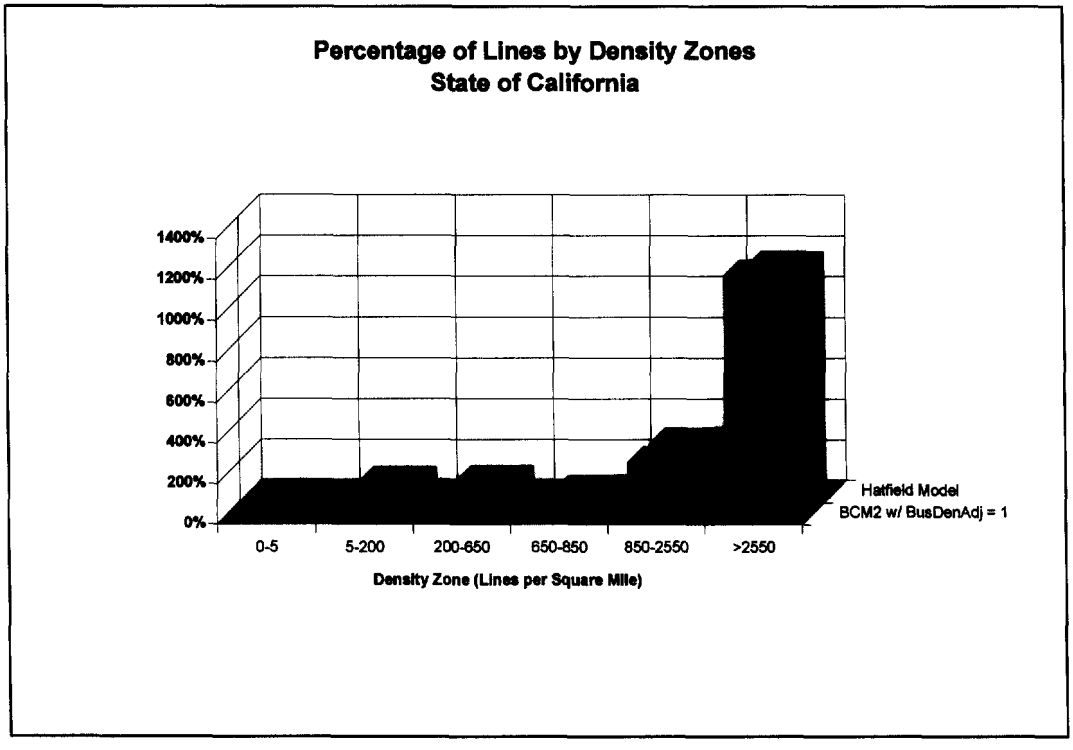

Figure 4. Distribution of lines across density zones for the state of California. BCM2 with business line density adjustment set to 1 compared to the HM2.2.2

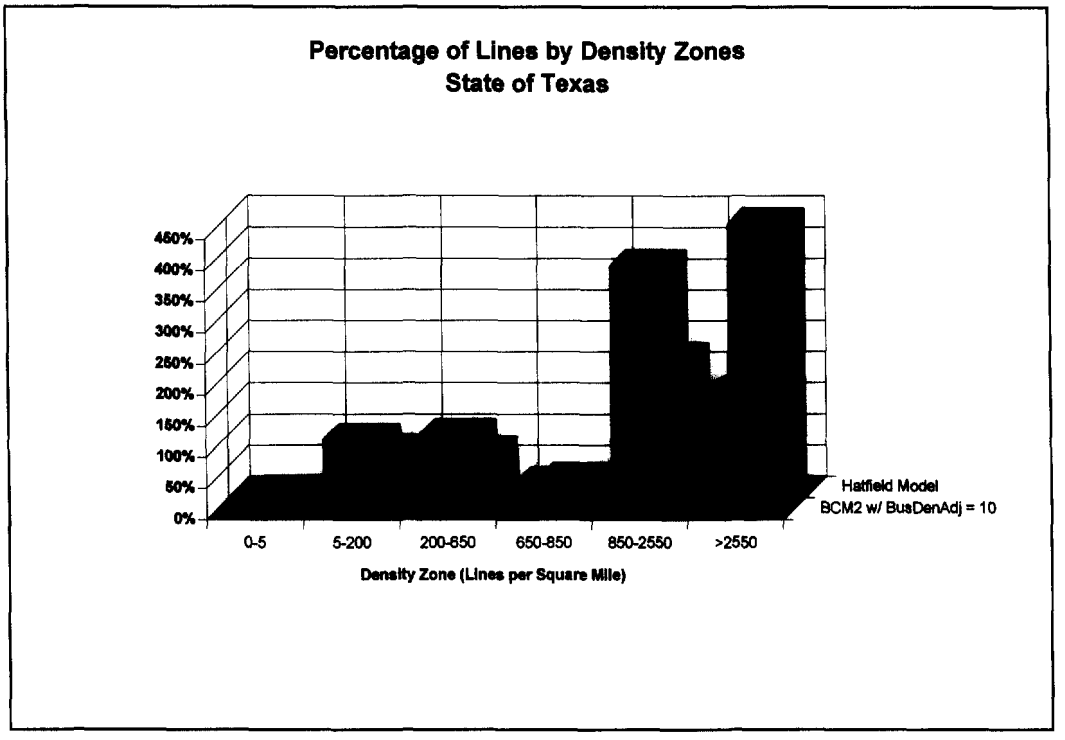

Figure 5. Distribution of lines across density zones for the state of Texas. BCM2 with default business line density adjustment compared to the HM2.2.2

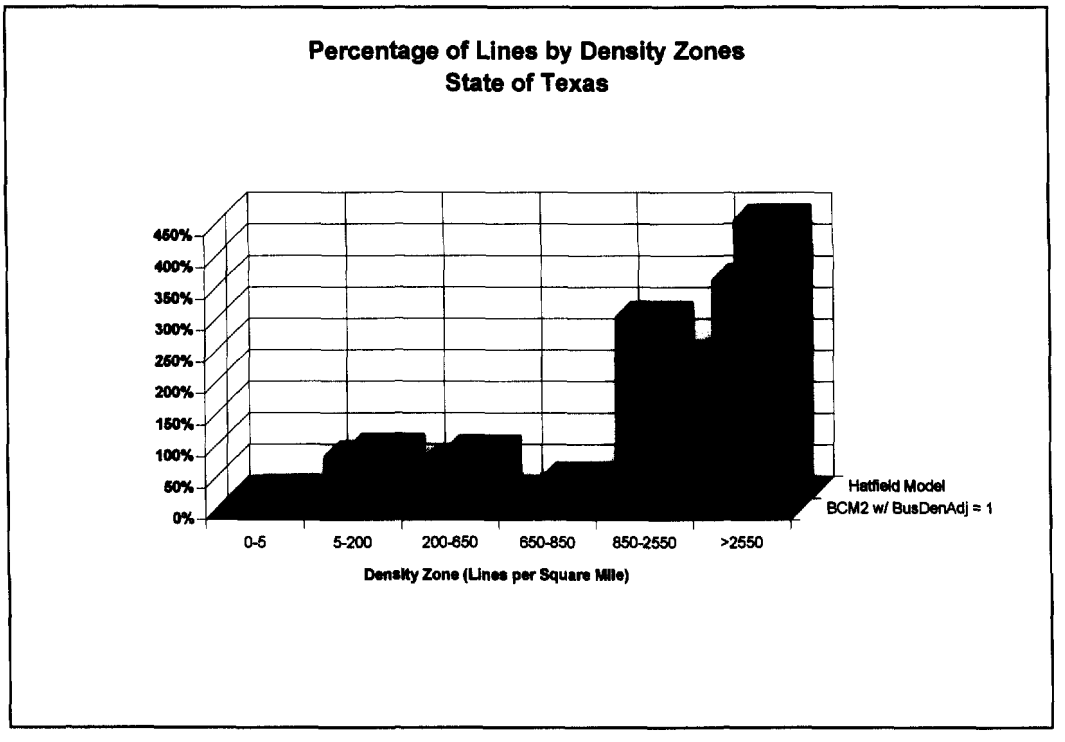

Figure 6. Distribution of lines across density zones for the state of Texas. BCM2 with business line density adjustment set to 1 compared to the HM2.2.2

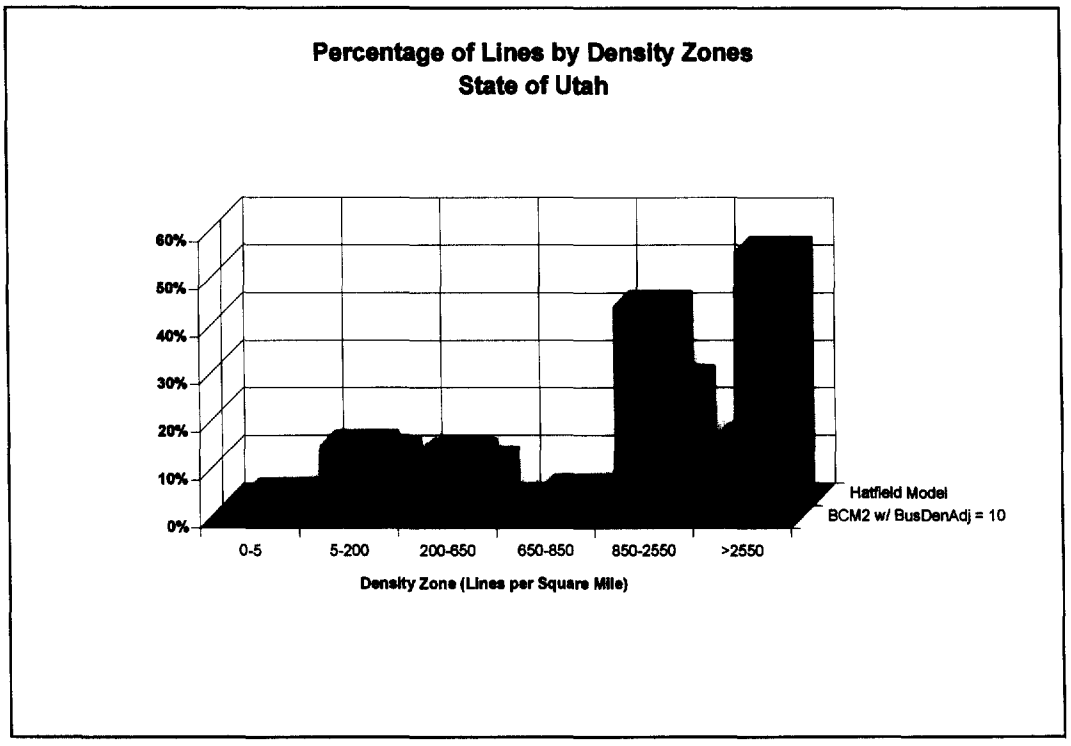

Figure 7. Distribution of lines across density zones for the state of Utah. BCM2 with default business line density adjustment compared to the HM2.2.2

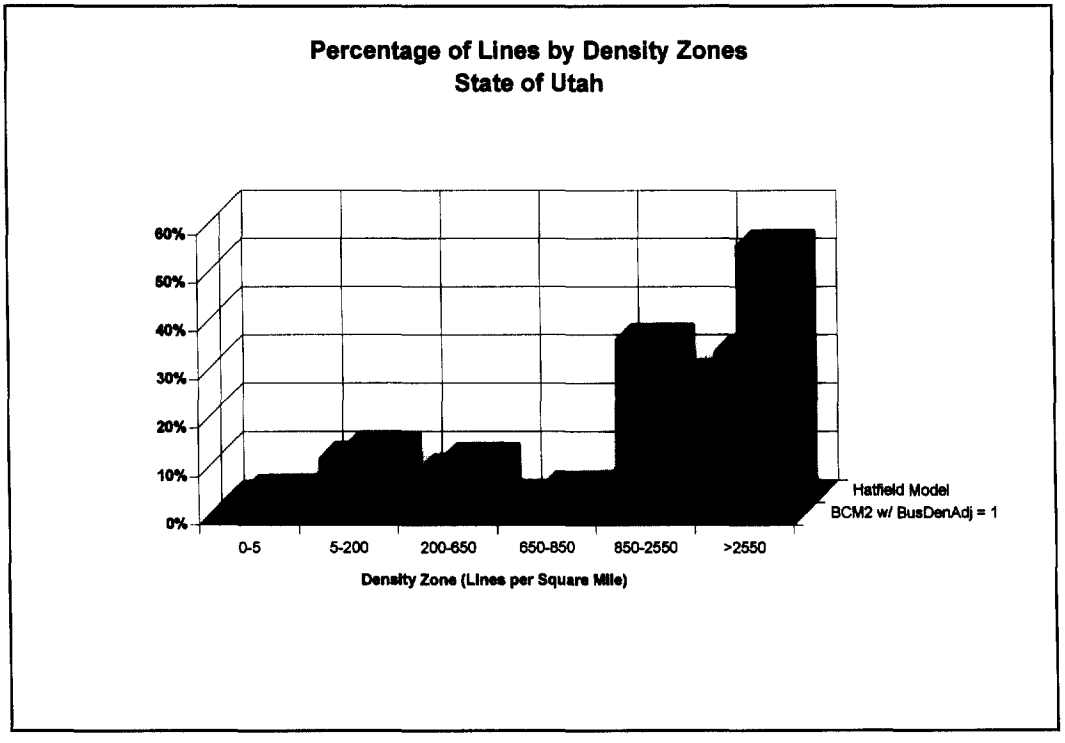

Figure 8. Distribution of lines across density zones for the state of Utah. BCM2 with business line density adjustment set to 1 compared to the HM2.2.2

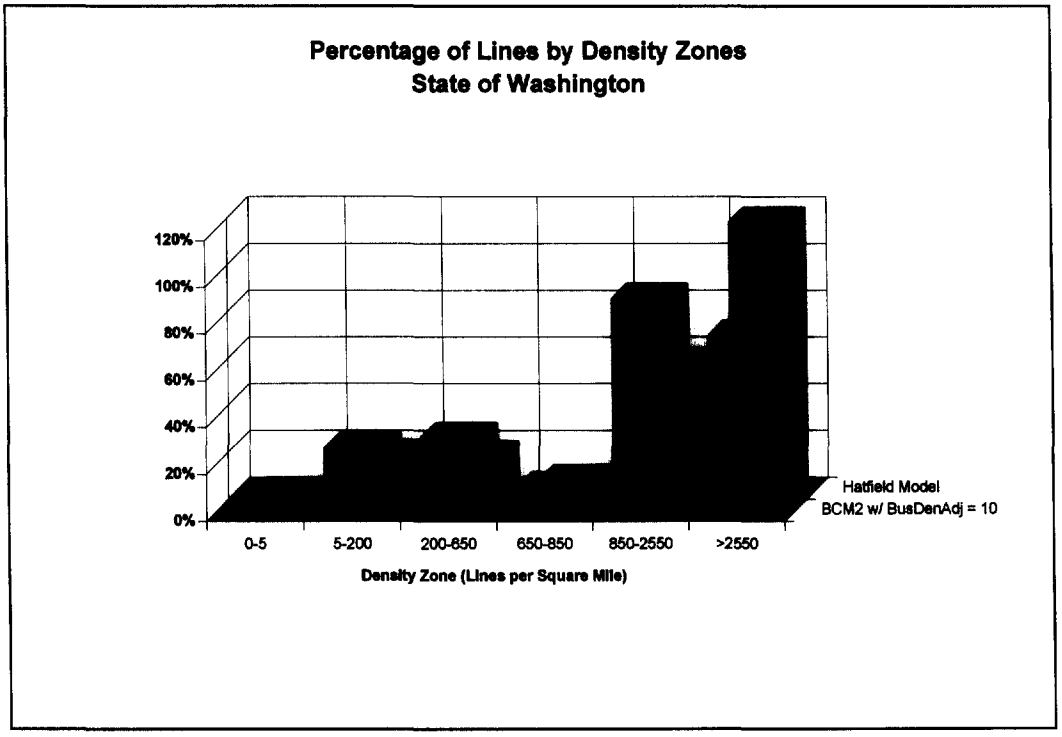

Figure 9. Distribution of lines across density zones for the state of Washington. BCM2 with default business line density adjustment compared to the HM2.2.2

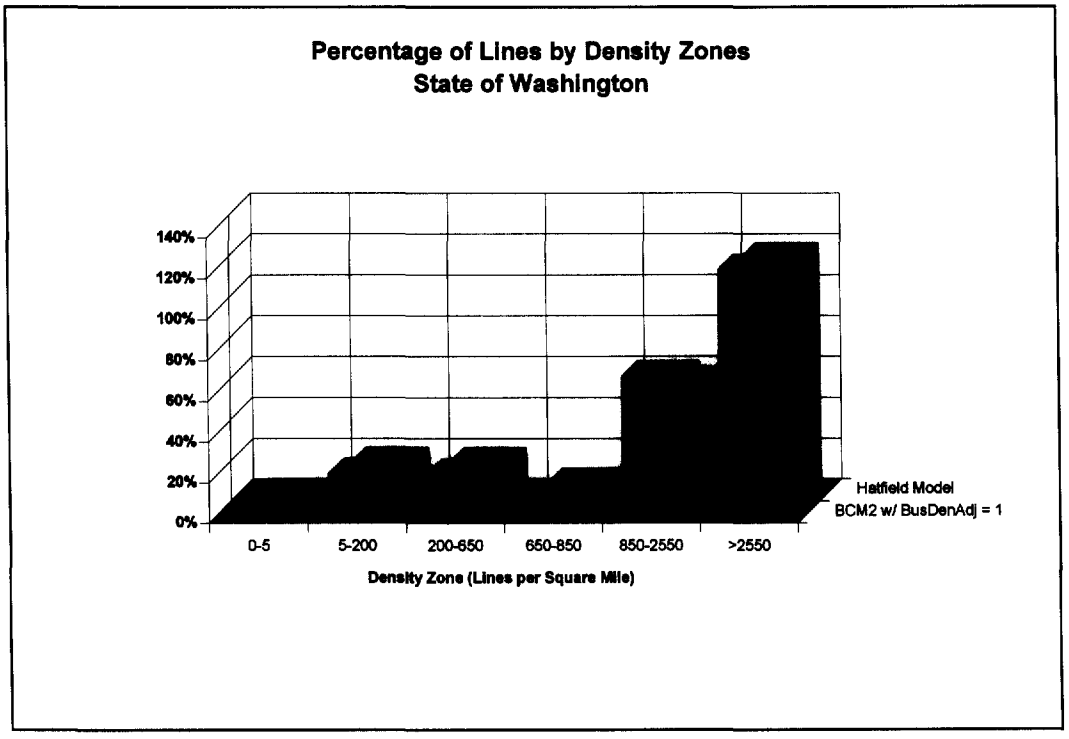

Figure 10. Distribution of lines across density zones for the state of Washington. BCM2 with business line density adjustment set to 1 compared to the HM2.2.2

CERTIFICATE OF SERVICE

I, David L. Anderson, do certify that on January 10, 1997 Reply Comments of the United States Telephone Association were either hand-delivered, or deposited in the U.S. Mail, first-class, postage prepaid to the persons on the attached service list.

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