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RECORDS AND REPORTING

August 3, 1998

Mrs. Blanca S. Bayó
Director, Division of Records and Reporting
Florida Public Service Commission
2540 Shumard Oak Boulevard
Tallahassee, FL 32399-0850

Re: Docket No. 980696-TP (HB4785) Universal Service

Dear Ms. Bayó:

Enclosed is an original and fifteen copies of BellSouth Telecommunications, Inc.'s Direct Testimony of Dr. Randall S. Billingsley, Dr. Robert M. Bowman, D. Daonne Caldwell, G. David Cunningham, Dr. Keven Duffy-Deno and Peter F. Martin, which we ask that you file in the captioned matter.

A copy of this letter is enclosed. Please mark it to indicate that the original was filed and return the copy to me. Copies have been served to the parties shown on the attached Certificate of Service.

RECEIVED & FILED
FPSC-BUREAU OF RECORDS

Sincerely,

Nancy B. White

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NBW/vf

cc: All parties of record
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Billingsley DOCUMENT NUMBER-DATE 08175 AUG-3 98 FPSC-RECORDS/REPORTING

Bowman DOCUMENT NUMBER-DATE 08176 AUG-3 98 FPSC-RECORDS/REPORTING

Caldwell DOCUMENT NUMBER-DATE 08177 AUG-3 98 FPSC-RECORDS/REPORTING

Cunningham DOCUMENT NUMBER-DATE 08178 AUG-3 98 FPSC-RECORDS/REPORTING

Duffy-Deno DOCUMENT NUMBER-DATE 08179 AUG-3 98 FPSC-RECORDS/REPORTING

Martin DOCUMENT NUMBER-DATE 08180 AUG-3 98 FPSC-RECORDS/REPORTING

CERTIFICATE OF SERVICE
DOCKET NO. 980696-TP (HB4785)

I HEREBY CERTIFY that a true and correct copy of the foregoing was served via Federal Express this 3rd day of August, 1998 to the following:

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(+) Protective Agreements

ORIGINAL

DIRECT TESTIMONY

OF DR. KEVIN DUFFY-DENO

ON BEHALF OF BELLSOUTH TELECOMMUNICATIONS, INC.

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

DOCKET NO. 980696-TP

AUGUST 3, 1998

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME AND BUSINESS AFFILIATION.

A. My name is Kevin T. Duffy-Deno. I am the Managing Director-Market Research at *INDETEC* International, a telecommunications consulting firm.

Q. PLEASE DESCRIBE YOUR WORK EXPERIENCE AND EDUCATIONAL BACKGROUND.

A. As the Managing Director-Market Research at *INDETEC* International, I manage the development of economic models and the evaluation of existing models and their supporting data. I am responsible for database acquisition and data analysis. In particular, I have participated in the ongoing analysis of the HAI Model and the development of the Benchmark Cost Proxy Model. My participation includes providing testimony on both of these cost proxy models in Alabama, Kentucky, Louisiana, Minnesota, Mississippi, North Carolina, South Carolina, Tennessee, and Wyoming.

I have over 12 years of experience in conducting quantitative and economic analysis and modeling. I served as an economist with the Utah Division of Public Utilities where I directed the Division's analysis of telecommunications loop costing models. As an economist with the Utah Office of Energy, I analyzed a wide range of resource, energy, and electric utility issues.

I have a Ph.D. in economics from the University of Oregon; I have served as an assistant professor at three universities; and, I am currently an adjunct professor in the MBA program at Westminster College of Salt Lake City. I have authored or co-authored 17 academic papers as well as numerous reports. I have attached my curriculum vitae as Exhibit KDD-1.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of my testimony is to respond to the second issue specified by the Florida Public Service Commission regarding "the appropriate cost proxy model to determine the total forward-looking cost of providing basic local telecommunications service pursuant to Section 364.025(4)(b)." My testimony describes several key features of the model that BellSouth is proposing the Commission use to determine the cost of universal service in BellSouth's Florida territory: the Benchmark Cost Proxy Model version 3.1 (BCPM 3.1). The task the Commission faces is to determine if BCPM 3.1 can arrive at a reasonable estimate of the forward-looking cost of universal service. In this regard, the Commission's attention should be focused on three aspects of a cost proxy model: (1) how does the model locate customers and how does it aggregate customers into telephone service areas; (2) the engineering criteria that influence the design of the wireline network "built" by the model; and, (3) the values for the literally hundreds of user-adjustable inputs used by the model. Dr. Bowman's testimony addresses item (2); Ms. Caldwell of BellSouth addresses item (3) in her testimony. My testimony focuses on item (1). Specifically, I describe the key features of BCPM 3.1 pertaining to its customer location and customer aggregation methodologies.

Q. WHAT ARE YOUR PRIMARY FINDINGS AND CONCLUSIONS?

A. All cost proxy models that seek to arrive at a reasonable estimate of a geographically disaggregated cost of basic local service face a fundamental challenge. This challenge is to locate customers at the sub-Census Block level. The U.S. Census reports housing unit counts at the Census Block level. However, since Census Blocks can be quite large in the rural, low-density areas, areas of particular interest in the universal service arena, further locating customers within these potentially large areas is important. The exact spatial location, i.e., latitude and longitude, of <u>every</u> potential telephone customer is not known. Hence, BCPM uses an alternative methodology to geocoding. BCPM's customer location methodology is based on the plausible assumption that customers tend to live on or near a road. This assumption facilitates the use of a geographically comprehensive road-network database provided by the U.S. Bureau of the Census.

In low-density areas, BCPM allocates Census Block level data across a Census Block based on the amount of livable road mileage that occurs in each section of the Census Block. The fundamental unit of analysis used by BCPM is called a "microgrid," an area roughly the size of 4 by 3 typical city blocks. Each Census Block is overlaid with a "fishing net" of these rectangular microgrids. If a particular microgrid has 10 % of the livable road mileage within its borders, then

10 % of the Census Block housing units are allocated to this microgrid. The end result is a statistical distribution of customer locations. In other words, the methodology yields the likely (*estimated*) location of customers.

Once customer locations are estimated in this manner, telephone serving areas are formed by aggregating contiguous microgrids into larger areas. This aggregation is governed by engineering network design criteria. The resulting serving areas, or "ultimate grids," are also geographically comprehensive and rectangular in shape. In the rural, low-density areas, the ultimate grids are typically approximately 6 square miles in size. Some ultimate grids may be unpopulated, to which BCPM does not "build" plant.

Once the serving areas are determined, BCPM then divides each ultimate grid into quadrants. A modeling tool referred to as the "road-reduced area" is used to estimate the amount of branch, backbone, and drop cable needed to serve each populated quadrant. The amount of cable required to connect the road-centroid of the ultimate grid, where the sub-feeder terminates, with the road-centroid of each populated quadrant is also estimated.

In sum, the BCPM road-based methodology addresses the issue of how to estimate customer locations when a complete set of data on exact customer locations, i.e., latitudes and longitudes, does not exist. In addition, the methodology used to aggregate these estimated locations into serving areas is consistent with standard engineering design principles, as discussed by Dr. Bowman, and is logically consistent. The estimated customer locations are preserved spatially throughout the aggregation process. There is no transformation of grids from one shape to another other than simply aggregating, where appropriate, contiguous rectangles into a larger geographic area, that corresponds to serving area. Moreover, customer locations are never moved. Hence, the methodology used by BCPM facilitates its estimation of a reasonable forward-looking cost of basic local service in Florida.

Q. HOW IS YOUR TESTIMONY ORGANIZED?

A. *Section II.* of my testimony provides a general description of a cost proxy model, including key assumptions made by cost proxy models. *Section III.* provides an overview of BCPM 3.1's customer location and aggregation algorithms.

Q. ARE THERE EXHIBITS TO YOUR TESTIMONY?

A. Yes. The following is a list of the exhibits that accompany my testimony:

KDD-1	Qualifications
KDD-2	Census Blocks in the Bunnell Wire Center, FL

Q. PLEASE BRIEFLY DESCRIBE THE HISTORY OF THE BCPM.

A. Two models, the Benchmark Cost Model 2 (BCM2) and the Cost Proxy Model (CPM), are the direct predecessors of the BCPM. BCM2 was developed in a joint effort by Sprint Corporation and U S WEST and was filed with the FCC on July 3, 1996, for consideration in CC Docket 96-45 (Federal-State Joint Board on Universal Service). Pacific Telesis and *INDETEC* International developed the CPM, which was filed with the FCC at the same time. The California Public

Utilities Commission in its universal service cost proceeding accepted the CPM.

The BCPM was initially designed to incorporate the best attributes of two models, BCM2 and the CPM, and to add capabilities that did not exist in either of the earlier models. *INDETEC* International was retained to aid in the development of the BCPM as well.

II. GENERAL DESCRIPTION OF A COST PROXY MODEL

Q. PLEASE DESCRIBE THE CHARACTERISTICS TYPICAL OF A COST PROXY MODEL.

A. The term "cost proxy model" has emerged only recently in the telecommunications industry. There is, therefore, no precise definition of "cost proxy model" in economics. In industry usage, the term has come to mean a mechanism used to estimate the forward-looking economic cost of universal service or unbundled elements. A cost proxy model for use in the universal service arena is generally considered to have the following characteristics: (1) it relies largely upon public information that is available nationwide; (2) many of its key inputs can be modified; (3) its complexity does not preclude its application nationwide; and, (4) it is generic enough so that it can estimate the forward-looking cost of any company that chooses to be a universal service provider.

Q. WHAT IS FORWARD-LOOKING ECONOMIC COST?

A. Forward-looking cost represents the economic cost an efficient provider of universal service would likely incur to serve the area in question, in this case, BellSouth's Florida service territory. This cost is forward-looking in the sense that it reflects the economic cost that would be incurred today if the wireline network were rebuilt entirely. Hence, it relies on current market prices and current, but proven, technology.

Q. HOW DOES A COST PROXY MODEL ARRIVE AT AN ESTIMATE OF THE COST OF BASIC LOCAL SERVICE?

A. Conceptually, there are four steps in the estimation process. The first step is the design of a new wireline telephone network to serve customers in their current locations from central offices also in their current locations. This requires that customers be spatially located, that customers be aggregated into telephone serving areas, and that a feeder/sub-feeder network be designed to serve these groupings of customers in an efficient manner, yet still adhere to the requirements of the 1996 Telecommunications Act and of the Florida Commission.

The second step is the estimation of the investment needed to actually build such a network from scratch. Such diverse items as the cost of poles, the investment multiplier required when "difficult terrain" is encountered, and the cost of digital switches are taken into account.

The third step is the application of factors, such as the rate-of-return, to the estimated investment to yield the annual capital cost.

Finally, the fourth step is the estimation of the recurring costs, i.e. expenses, associated with the operation of such a network.

Q. WHAT ARE SOME OF THE KEY ASSUMPTIONS MADE BY COST PROXY MODELS?

R. One key assumption concerns the determination of customer locations. The challenge faced by the cost proxy models is the spatial location of customers at the sub-Census Block level. This is especially important in rural, low-density areas where Census Blocks tend to be very large. Since information on the exact latitude and longitude of customer locations is sparse for rural, low-density areas, customer locations must be estimated. Hence the methodology used by the models to estimate customer locations is important.

Another key assumption is the models' definition of "customer." In terms of residential customers there are three possibilities: housing units, households, and households who currently have telephones. Which definition is used depends on the model developers' interpretation of what the FCC meant when it stated in Criteria 6 of paragraph 250 of the FCC Universal Service Order, "The cost study or model must estimate the cost of providing service for all businesses and *households* within a geographic region." (italics added). Did the FCC mean housing units that are currently occupied, which is the U.S. Census definition of households? Did they mean all inhabitable structures (housing units)? Or did they mean only households with current phone service? Which definition is used affects the amount of plant "built" by the model, affects the economies of scale, and, hence, affects the estimated cost of basic local service.

Another key assumption is the engineering criteria that govern the aggregation of customers into serving areas and the design of the feeder/sub-feeder network needed to serve these areas. These criteria are important for they affect whether the network is capable of providing access to advanced services in both urban and rural areas, as required by the 1996 Telecommunications Act, Section 254. Items of design interest are the maximum length of copper loop beyond the digital loop carrier (DLC) and the maximum number of lines per DLC.

A third key assumption, actually set of assumptions, are the values for the hundreds of user-adjustable inputs. The user is allowed to specify values for a wide range of items that can affect the model's estimated cost. For example, the user can specify values for a wide range of items such as the cost of drop wire, the cost of 200 pair cable, the activity-share of "cut and replace sod" in the underground placement of cable in the 5 to 100 line per square mile density zone, the cost of money, and the recurring cost of buried cable maintenance, to name just a few.

Q. WITH RESPECT TO CUSTOMER LOCATION, WHY IS THE ACCURACY OF A COST PROXY MODEL'S ABILITY TO LOCATE CUSTOMERS IMPORTANT?

A. It is important that a cost proxy model locates customers with a reasonably high level of accuracy because the size of the universal service fund and the appropriate targeting of eligible recipients depend upon the degree of accuracy with which customers are located. The more accurately customers are located, the greater the accuracy in cost estimation across geographic areas. Thus, it is essential that an evaluation of a cost proxy model include not only an assessment of the relative accuracy of the cost proxy models in locating customers but also of how these customers are then aggregated into telephone serving areas.

Q. AT WHAT LEVEL OF GEOGRAPHIC DETAIL SHOULD THE CALCULATION BE PERFORMED?

A. Because costs vary substantially across geographic areas, the calculation should be done with as much geographic specificity as possible, such as at the level of a grid cell or a census block group or, at a minimum, a wire center. Traditional Incumbent Local Exchange Carrier (ILEC) forward-looking economic cost studies will be difficult or impossible to apply because they were generally designed to reflect the costs for much broader geographic areas.

III. BCPM 3.1'S CUSTOMER LOCATION AND AGGREGATION ALGORITHMS

A. Some Basics

Q. WHAT FUNDAMENTAL CHALLENGE DO COST PROXY MODELS FACE?

A. Cost proxy models that seek to estimate cost at geographically disaggregated levels must locate customers with a reasonable degree of accuracy. The smallest geographic unit for which U.S. Census data are available is the Census Block. However, in the rural, low-density areas Census Blocks can be very large.

Q. WOULD YOU BRIEFLY EXPLAIN THE DISTINCTION BETWEEN "CENSUS BLOCK GROUPS" AND "CENSUS BLOCKS"?

A. The U.S. Bureau of the Census has devised a tiered geographic reference system. Starting at the state level, states are disaggregated into counties, which are further disaggregated into census tracts. Census tracts usually have between 2,500 and 8,000 persons. They were originally designed to be homogenous with respect to population characteristics and do not cross county boundaries. On average, there are 28 Census Tracts in a county.

Census tracts are further disaggregated into Census Block Groups. A Census Block Group is a collection of Census Blocks generally containing between 250 and 550 housing units, with an ideal size of 400 housing units. On average, there are three Census Block Groups in a Census Tract.

The finest level of geography, for which Census data are provided, such as housing units, is the Census Block. The U.S. Bureau of the Census defines Census Blocks as "small areas bounded on all sides by visible features such as streets, roads, streams, and railroad tracks, and by invisible boundaries such as city, town, township, and county limits, property lines, and short, imaginary extensions of streets and roads." On average, there are 31 Census Blocks in a Census Block Group.

Q. HOW LARGE CAN CENSUS BLOCKS BE?

A. In urban areas, Census Blocks are fairly small. For example, in a downtown area they tend to be 0.005 square miles in size. In a typical suburban area they tend to be in the 0.5 to 1.0 square mile range. In rural areas, Census Blocks tend to be much larger. Census Blocks as large as 60 square miles are not uncommon, with

20 square miles being more typical.

Q. HOW LARGE ARE CENSUS BLOCKS IN FLORIDA?

A. Table 1 shows U.S. Census Block data for Florida by density zone. The maximum size populated Census Block in Florida is 544 square miles. In the two lowest density zones, zero to 20 housing units per square mile, populated Census Blocks constitute approximately 5.3 % of the total populated Census Blocks and span 69 % of the total populated land area in Florida. In Florida, there are 98,285 unpopulated Census Blocks. A cost proxy model's customer location methodology for placing customers within a Census Block is much more critical in these rural, low-density areas.

Table 1. Florida Populated Census Blocks

Density (HU/sqmi)	CB Size (sqmi)		CB Counts		1995 Housing Units		CB Area	
	Maximum	Minimum	Number	%	Number	%	SQMI	%
< 5	543.62	0.20	3,965	1.81%	24,768	0.37%	16,322.10	43.79%
5 – 19	85.03	.05	7,721	3.52%	99,163	1.48%	9,401.10	25.22%
20 – 99	39.72	0.01	15,861	7.23%	267,125	3.98%	5,997.15	16.09%
100 – 199	23.62	0.01	11,003	5.02%	201,539	3.00%	1,428.38	3.83%
200 – 649	5.694	0. 002	29,477	13.44%	669,837	9.99%	1,801.51	4.83%
650 – 849	3.37	0.001	10,362	4.72%	227,611	3.39%	371.27	1.00%
850 – 2549	3.25	0.0004	77,296	35.24%	2,050,259	30.57%	1,330.87	3.57%
2550 – 4999	0.97	0.0002	44,509	20.90%	1,529,693	22.81%	453.83	1.22%
5000 – 9999	0.41	0.0001	13,275	6.05%	822,800	12.27%	122.88	0.33%
> 10000	0.31	0.0000006	5,851	2.67%	814,858	12.15%	45.08	0.12%
Total	692.85	0	219,320		6,707,653		37,274.17	

Visually, the challenge faced by a cost proxy model is shown in Exhibit KDD-2. KDD-2 shows the Census Blocks in BellSouth's Bunnell wire center in Flagler County, Florida. The wire center is 18.7 miles wide (East-West) and 14.1 miles such large areas make it difficult to reflect actual underlying population location and population dispersion. Second, large Census Block Groups make it difficult to aggregate accurately Census Block Groups to higher levels of geography, such as wire centers. Consequently, using Census Block Groups to assign customers to the appropriate wire center and the appropriate serving incumbent local exchange carrier is problematic. Third, large irregular shaped Census Block Groups may not readily correspond to meaningful telephone plant design areas.

Q. HOW DOES BCPM 3.1 DEFINE A RESIDENTIAL "CUSTOMER" IN TERMS OF THE CENSUS DATA?

A. BCPM 3.1 defines a residential customer based on the U.S. Census designation of housing units. Recall that housing units consist of both occupied and unoccupied inhabitable structures, as opposed to households that consist of only occupied inhabitable structures. The difference is important because BCPM 3.1 builds a network to serve housing units. The developers of BCPM 3.1 believe that a sound and proper cost model should reflect the costs to provide service to all housing units, currently occupied or unoccupied. Because of its obligation to provide timely service to customers, an ILEC must place facilities to serve all housing units, not just those units that are occupied at one point in time. Any particular housing unit is likely to be occupied at some points in time, and unoccupied at other points in time. To assume otherwise requires costly new installation to serve a previously unoccupied housing unit.

Q. WHAT IF THE COMMISSION DEEMED THAT IT IS MORE APPROPRIATE FOR BCPM TO "BUILD" ONLY TO HOUSEHOLDS?

A. Although the assumption that a residential customer is a housing unit is integral to the base BCPM 3.1 model, a module does exist that would allow the model to "build" only to households if this is what the Commission deems is reasonable. In addition (or alternatively), there is a "wireless cap" on loop investment. This cap says that if the investment for any given loop exceeds a user-defined amount, that loop cost would be capped at that amount assuming that in reality either some other, less costly technology would be used or the customer would share in the cost of installing the loop. This prevents the model from estimating too much investment for housing units that are far removed from the central office.

Q. WHAT DATA DOES BCPM 3.1 USE TO ESTABLISH WIRE CENTER BOUNDARIES?

A. BCPM 3.1 uses wire center boundaries provided by Business Location Research (BLR).

Q. HOW DOES BCPM 3.1 ENSURE THAT CUSTOMERS ARE ASSIGNED TO THE APPROPRIATE WIRE CENTER?

A. BCPM 3.1 ensures that customers are assigned to the appropriate wire center by utilizing Census Block data. Those customers located in Census Blocks that fall within the BLR wire center boundary are assigned to that wire center.

B. Customer Location

Q. WHAT KEY ASSUMPTION DOES BCPM 3.1 MAKE REGARDING THE LOCATION OF CUSTOMERS WITHIN CENSUS BLOCKS?

A. BCPM 3.1 assumes that customers are located on or near roads and uses detailed road-mileage information to allocate U.S. Census housing units counts within Census Blocks. BCPM 3.1 attains greater precision than that obtained using Census Block information alone, by using road data for both interior and perimeter roads to place customers within the Census Block. The end result is a statistical distribution of customer locations. In other words, the process yields the *likely* (estimated) location of customers within a wire center.

Q. HOW DOES BCPM 3.1 ESTIMATE CUSTOMER LOCATIONS WITHIN A CENSUS BLOCK?

A. The BCPM 3.1 customer location algorithm begins by partitioning the area of a wire center into "microgrids," roughly 1,500 feet by 1,700 feet in size (i.e., roughly 1/10th of a square mile or 4 x 3 city blocks). Thus, each Census Block within the serving wire center is overlaid with microgrids (unless the entire Census Block falls within a single microgrid). In the rural areas of the wire center, the allocation of customer locations is based on the road network, the location of which is known in every Census Block. Census Block housing units are apportioned to microgrids based on the share of the Census Block's road mileage that occurs in a given microgrid.

In fact, there are actually two methodologies for allocating housing units to microgrids used in BCPM 3.1. For Census Blocks greater than 0.25 square miles in area, relative road lengths are used. For small Census Blocks, housing units are apportioned based on the land area of the microgrid relative to the Census Block's total area. Since large Census Blocks characterize rural areas, the road methodology applies to rural areas.

Q. WHAT IS THE SOURCE OF THE ROAD DATA USED TO ALLOCATE CUSTOMERS TO THE MICROGRIDS?

A. The 1994 U.S. Census Topologically Integrated Geographic Encoding (TIGER) files form the foundation for the road database. The 1994 TIGER files use the NAD27 datum unit, which corresponds to the datum unit used in the BLR wire center boundaries data. This is important for ensuring that the BCPM customer location process, which is based on locations of roads, is consistent with the boundaries of wire centers. The BCPM developers made a determination as to which of the TIGER road types people are likely to live and work along. This subset of the TIGER data was then used in the customer allocation process.

Q. WHAT TYPES OF ROADS WERE INCLUDED AND WHICH TYPES OF ROADS WERE EXCLUDED?

A. Examples of an included road type are a neighborhood street and state highway. Examples of road types that were excluded are four-wheel drive dirt roads, access ramps, limited access highways, and any road type that is in a tunnel or is an underpass.

Q. IS THERE ANY EMPIRICAL EVIDENCE TO SUPPORT THE ASSUMPTION THAT CUSTOMERS TEND TO BE LOCATED ALONG ROADS?

A. Yes. Causal observation suggests that this is true. In addition, if one examines the relationship between the number of housing units in a Census Block and the total road miles in a Census Block, one will find a reasonably high correlation.

Table 2 presents the correlation between housing units and road mileage for Florida, Kentucky, and Mississippi for four density zones less than 200 housing units per square mile.

Table 2. Census Block Road Mile - Housing Unit Correlation

Density Zone	Florida	Kentucky	Mississippi
0 – 5	0.69	0.78	0.68
5 – 20	0.86	0.86	0.81
20 – 100	0.87	0.93	0.87
100 – 200	0.91	0.93	0.92

The correlation is always positive, and indicates a strong association between housing unit locations and road miles. A measure of correlation ranges between –1 and +1. Values that approach either extreme indicate a strong association, either directly (positively) or inversely (negatively).

It should be noted that the road miles used in this analysis are the road miles used in the BCPM customer allocation process. In addition, the analysis is suggestive as the correlation is between aggregate measures of location and roads. It is not a correlation between actual location coordinates, i.e., latitude and longitude, and road segement coordinates. A full set of the former would negate this discussion entirely as no estimation of customer location would be needed.

C. Customer Aggregation

Q. HOW ARE THE ESTIMATED CUSTOMER LOCATIONS AGGREGATED INTO TELEPHONE SERVING AREAS?

A. Contiguous microgrids (along with the estimated locations within each microgrid) are aggregated into telephone engineering Carrier Service Areas (CSAs) according to engineering design criteria. A CSA is referred to as an "ultimate grid." The maximum size of an ultimate grid is usually approximately 12,000 feet by 14,000 feet, (roughly 6 square miles) to comport with engineering guidelines. Although the BCPM ultimate grids are geographically comprehensive, many can be unpopulated. If an ultimate grid is unpopulated, then no plant is "built" to serve the grid.

Q. ONCE "ULTIMATE GRIDS" ARE FORMED, HOW ARE CUSTOMER LOCATIONS TREATED WITHIN THE ULTIMATE GRID?

A. BCPM 3.1 does not assume that customers are uniformly distributed within each ultimate grid. Rather, customers are located within the ultimate grid based on the micrograms to which they were originally allocated based on road mileage. Each ultimate grid is divided into four distribution quadrants. The latitude and longitude coordinates of the distribution quadrants are determined by first establishing the road centroid, i.e. weighted average of the road coordinates, of the ultimate grid. The quadrants are centered on this road centroid. If a distribution quadrant does not contain any roads, that distribution quadrant is simply treated as an empty distribution quadrant. Hence, road information is used to further locate customers within the ultimate grids.

Q. HOW LARGE ARE THESE DISTRIBUTION QUADRANTS?

A. The maximum size ultimate grid is typically 12,000 by 14,000 feet or roughly, 6 square miles. If we assume that the road centroid of such an ultimate grid falls at the geographic centroid, i.e. geographic center, then each distribution quadrant will be roughly 1.5 square miles in size. Each distribution quadrant in this case will be comprised of 4 contiguous microgrids.

Q. HOW DOES BCPM 3.1 ESTIMATE THE AMOUNT OF PLANT NEEDED TO SERVE THE ESTIMATED CUSTOMER LOCATIONS IN EACH OF THE POPULATED DISTRIBUTION QUADRANTS?

A. BCPM uses a tool called the "road-reduced area" to estimate the amount of branch, drop, and backbone cable needed to serve the estimated customer locations within each populated distribution quadrant. The exact methodology is described in the BCPM Release 3.1 Model Methodology. Each populated distribution quadrant must then be connected to the road-centroid of the ultimate grid at which point the sub-feeder terminates (in low-density grids, this will also be the location of the DLC). The determination of the length of these "connecting cables" is also described in detail in the BCPM 3.1 Model Methodology.

It is important to make clear that BCPM does not locate customers within the road-reduced areas. Estimated customer locations reside in the microgrids and are not "moved" to the road-reduced areas. Rather, the road reduced area is used as a tool to estimate the amount of cable needed to serve the estimated customer locations that reside within the microgrids in the populated distribution quads.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

Kevin T. Duffy-Deno, Ph.D.

Kevin Duffy-Deno, Ph.D., is the Managing Director -Market Research at INDETEC International. He manages the development of economic models and the evaluation of existing models and their supporting data. He is also responsible for database acquisition and data analysis. Kevin has over 11 years of experience in conducting quantitative and economic analysis and modeling. He has served as an economist with the Utah Division of Public Utilities where he directed the Division's analysis of telecommunication loop costing models. As an economist with the Utah Office of Energy, Kevin applied his analytical skills to a wide range of resource, energy, and electric utility issues. He has served as an assistant professor at three universities and is currently an adjunct professor in the MBA program at Westminster College of Salt Lake City. Kevin has authored or co-authored 17 academic papers as well as numerous reports. Professionalism, strong initiative, superior organizational skills, and a commitment to detail, quality, and timeliness are his trademarks.

Education

Ph.D., Economics, University of Oregon, Eugene, 1986
MA, Economics, University of Oregon, Eugene, 1984
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Professional History

1997 to present:	Managing Director – Market Research, INDETEC International.
1992 to present:	Adjunct Instructor, MBA Program, Westminster College, Salt Lake City
1996 to 1997:	Economist, Utah Division of Public Utilities, Salt Lake City
1991 to 1996:	Senior Economist, Utah Office of Energy and Resource Planning, Salt Lake City
1990 to 1991:	Visiting Assistant Professor, Weber State University, Ogden
1987 to 1990:	Assistant Professor, University of Massachusetts, Dartmouth
1986 to 1987:	Visiting Assistant Professor, University of Connecticut, Storrs

Testimony

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Publications - Professional

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Publications - Academic

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"Institutional Constraints on Local Jurisdiction Formation," with Stephen Mehay, *Public Finance Quarterly*, January 1987.

Publications - Government

The Economic Effect of State Parks on the County Economies of the West, (primary author) for the Utah Division of Parks and Recreation, May 1996.

The Economic Effect of State Building Lighting Retrofit Programs Along the Wasatch Front, (co-author), under contract for the U.S. Department of Energy, April 1996.

The Economic and Fiscal Impacts of Coalbed Gas Drilling in Central Utah, (co-author), for the County Commissioners of Carbon and Emery Counties, Utah, December 1995.

Utah County Economic Profiles, (co-author), September 1995.

Bear Lake Valley Recreation Survey, (co-author), for the Utah Division of Parks and Recreation, November 1995.

Utah Energy Outlook 1995, (co-author), May 1995.

Statistical Recoupling in Utah, (co-author), for the DSR Cost Recovery Collaborative, March 1995.

The Western Sawmill Industry in Transition, (co-author), for the Southern Utah Planning Authorities Council, March 1995.

The Economics of Air Quality: Benefit-Cost Analysis, (primary author), for the Utah Division of Air Quality, January 1995.

The Economics of the Mining Sector in San Juan County, (primary author), for the San Juan County Commissioners, December 1994.

Professional Associations

American Economics Association
National Association of Business Economists
Wasatch Front Economic Forum

Bunnell Wire Center
Flagler County, Florida
Census Block Study

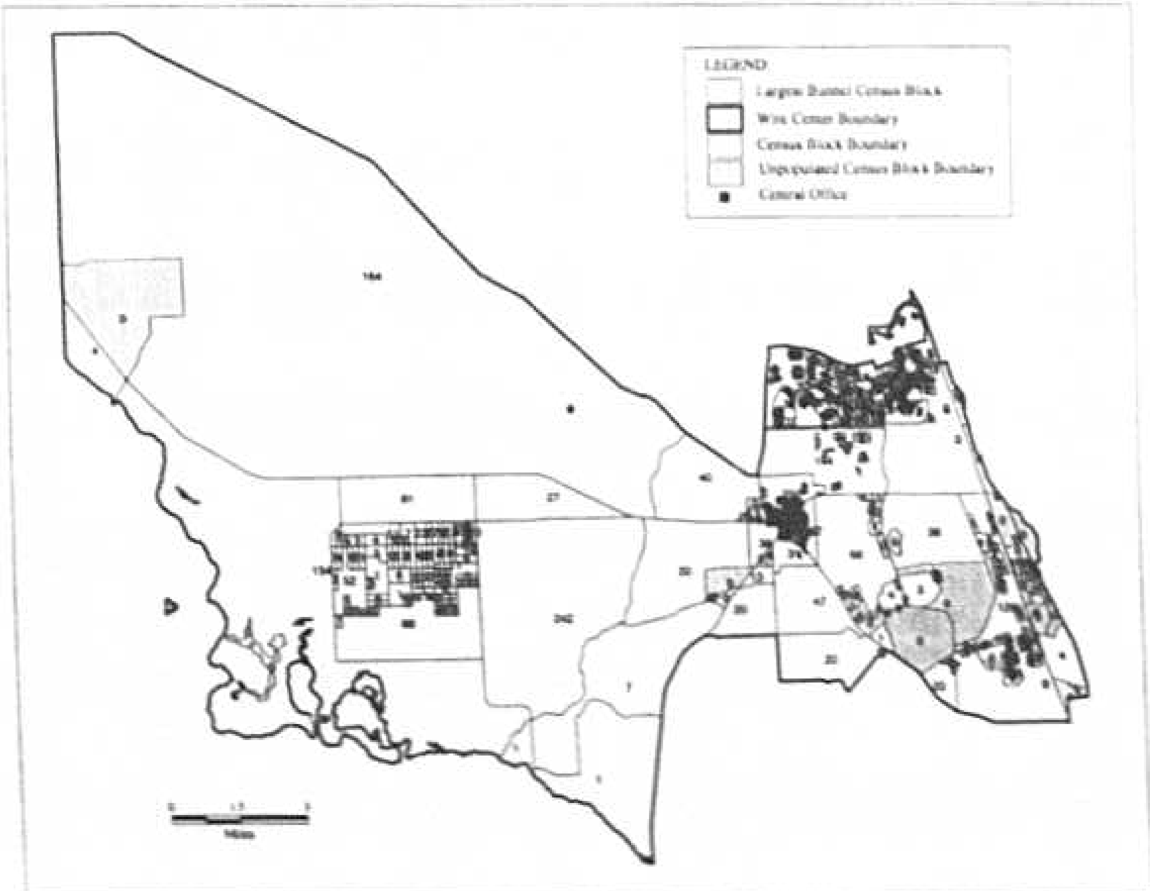

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Exhibit KDD-2