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4. Water table is within cable placement depth.[1]

Using the above data a weighted average copper and fiber placement difficulty level was calculated for each company by the following method:

Say a company had levels of placement difficulty for copper and fiber such as those found in Table 1.

Table 1: Weighting Methodology Example 1

Company	Census Block Group Number	Total Lines	Populated Area-sq Miles	Copper Placement Difficulty Level	Fiber Placement Difficulty Level	Weighted Copper Placement Difficulty by area	Weighted Fiber Placement Difficulty by area	Weighted Copper Placement Difficulty by Lines	Weighted Fiber Placement Difficulty by Lines
Any Telco	210319905001	179	27.27543	1	1	1.663939	2.327879	1.71152309	2.4230462
Any Telco	210319905002	441	53.88686	2	3				

To calculate the **Weighted Copper Placement Difficulty by area** for the company Any Telco, the formula [(1*27.27543) + (2*53.88686)]/(27.27543+53.88686) was used. The other three weighted placement difficulty calculations were performed in a similar manner.

EQUIPMENT TYPING METHODOLOGY

In consultation with personnel from the Rural Utilities Service (RUS), an assignment table was established which was used to assign RUS engineering unit code designations to the appropriate **equipment types** (See Appendix A, below). An Excel lookup function was used to perform this task within the data base. Using the lookup function every **RUS unit code** which had been entered into the data base was assigned an **equipment type**.

Equipment type designations ending with the term " ***loading***" had their unit labor and material costs distributed to the appropriate **equipment type** by a weighting methodology described later in this section. For example, **equipment types** designated as "*pole loading*" had their unit costs reassigned to poles, **equipment types** designated as "*Buried Cable, Loading*" had their unit costs reassigned to Buried Fiber and/or Buried Copper, and so on. This was done on a contract by contract basis so that unit costs were only reassigned to the **equipment types** found in specific contract.

For those instances where the **RUS unit code** designation was ambiguous, the HC and HO units can be either buried, underground, or aerial, for example, the lookup function would return "*Aerial, buried, or underground Loading*" as an **equipment type**.

---

[1] Benchmark Cost Proxy Model: Model Methodology, Presented by: Pacific Bell, Sprint, US West, p. 15.

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In this case the lookup function was augmented by referring to the contract, in order narrow the scope of reference so that unit cost assignments would be as accurate as possible. For those relatively rare instances where the scope of the reference could not be narrowed sufficiently, the unit costs for the designated equipment were spread, by appropriate weighting, among the costs of the cable units appearing in the contract.

COST WEIGHTING METHODOLOGY

Once the appropriate **equipment types** had been assigned the next step was to assign the units costs for those **equipment types** designated as "*loading*". This was done on a contract by contract basis. For example, say a contract had data similar to that found in the table below.

Table 2: Weighting Methodology Example 2

RUS unit code	Equipment Type	No. of Units	Labor Unit Cost	Extended Labor Cost
PM 2A	pole Loading	14.00	8.30	116.20
PM 11	pole Loading	9.00	5.25	47.25
PM 52-1	pole Loading	29.00	5.25	152.25
pole 30'	Poles	5.00	139.95	699.75
pole 35'	Poles	3.00	160.77	482.31
pole 40'	Poles	1.00	180.87	180.87

Here there are three different types of poles and three **RUS unit code** designations which have been assigned the *pole loading* **equipment type**. What needs to be done here is to spread the unit costs of the ***pole loading*** **equipment types** among the different **pole** types. In the case of the labor unit cost this was done by using a weighting methodology which assigns the *pole loading* costs to the respective ***pole*** **equipment types** according to the ratio of the extended labor cost for each *pole* type divided by the total extended labor costs for all the *pole* types.

Using the data from the table above, the formula for this ratio for "Pole 30' " would be (5*139.95)/(5*139.95+3*160.77+1*180.87)=.51.

This ratio was then used to determine that portion of the total extended labor cost for the ***pole loading*** **equipment types** which should be assigned to the *pole* type " Pole 30' ". This was done according to the formula .51 * (14.00*8.30+9.00*5.25+29.00*5.25)=162.09.

This result is then added to the **extended labor cost** of "Pole 30' " to give the **Adjusted extended labor cost** for **pole 30'** which would be 162.09 + 699.75 = 861.84. This **Adjusted extended labor cost** is then divided by the **No. of units** (5) to give the **adjusted unit labor cost**, 861.84/5= 172.37. This same calculation was then performed

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for each *pole* type. A similar calculation was used for the **Material unit cost** of each *pole* type.

The procedure outlined above for poles was used in spreading the labor and material unit costs of all **equipment type** designations ending with the term "loading". If a particular contract had some ***Aerial, buried, or underground Loading*** **equipment types** but that contract was only concerned with the installation of aerial copper or fiber then the **equipment types** were changed to read ***Aerial Cable:Loading*** and the costs spread among the Aerial copper and fiber **equipment types** using the weighting methodology illustrated above. If the contract had a mix of Aerial and Buried units then the **equipment types** were changed to ***Aerial and Buried loading*** and the costs spread accordingly.

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Appendix A: RUS Engineering Symbols — Outside Plant

RUS Engineering Symbols--Outside Plant

RUS unit code	Equipment Type	Description
BA	Buried Cable; Loading	Buried Plant Housing Stub Pole Units
BC	Buried Cable; Loading	Cross-Connecting Assembly Units
BD	Buried Pedestal	Buried Plant Pedestal Units
BDS	Buried Cable; Loading	Serving Area Interface
BFC	Buried Copper	Buried Filled Cable Assembly Units
BFO	Buried Fiber	Buried Filled Fiber Optic Cable Units
BG	Buried Cable; Loading	Buried Plant Loading Coil Units
BM	Buried, or Aerial Loading	Miscellaneous Assembly Units
C	Aerial Copper	Aerial Nonfilled Cable Units
CF	Aerial Cable:Loading	Aerial Figure 8 Cable Unit
CO	Aerial Fiber	Aerial Filled Fiber Optic cable Units
CW	Aerial Copper	Aerial Filled Cable Units
HA	Aerial Cable:Loading	Aerial Splice Closure Unit
HBF	Buried Cable; Loading	Buried Filled Splice Closure
HC	Aerial, buried, or underground Loading	Cable Splicing Unit
HO	Aerial, buried, or underground Loading	Fiber Optic Cable Splicing Unit
HU	Underground Cable: loading	Underground Splice Closure Units
innerduct	conduit	
NIP	NIP	Network Interface Device
PC	Aerial Cable:Loading	Cross-Connecting Assembly Units
PDS	Aerial Cable:Loading	SA Interface Cabinet Units
PE	pole loading	Guy Assembly Units
PF	pole loading	Anchor Assembly Units
PG	Aerial Cable:Loading	Aerial Plant Terminal/Loading Coil Units

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PM	Ground & Assembly	Ground and Misc. Assembly Units
PM 1	pole Loading	Ground and Misc. Assembly Units
PM 11	pole loading	Ground and Misc. Assembly Units
PM 12	pole loading	Ground and Misc. Assembly Units
PM 14	pole Loading	Ground and Misc. Assembly Units
PM 2	pole Loading	Ground and Misc. Assembly Units
PM 21	Aerial or Buried; loading	Central office cable entrance
PM 2-1	pole Loading	Ground and Misc. Assembly Units
PM 22	Aerial or Buried; loading	Central office ground system
PM 2A	pole Loading	Ground and Misc. Assembly Units
PM 4	pole Loading	Ground and Misc. Assembly Units
PM 4A	pole Loading	Ground and Misc. Assembly Units
PM 5	pole Loading	Ground and Misc. Assembly Units
PM 6	pole Loading	Ground and Misc. Assembly Units
PM 7	pole Loading	Ground and Misc. Assembly Units
PM 8	pole Loading	Ground and Misc. Assembly Units
PM 9	pole Loading	Ground and Misc. Assembly Units
pole	poles	
R	Aerial Cable:Loading	Right-of-Way Clearing Units
SE	Service Entry	Service Entry Assembly Units
Strand	Aerial Cable:Loading	Cable Support Strand
U	Underground Cable. Copper	Underground Nonfilled Cable Units
UD	conduit	Underground Conduit Assembly Unit

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UF	Underground Copper	Underground Filled Cable Units
UG	Underground Cable, Loading	U/G Cable Loading Coil Units
UH	Handhole units	Handhole Assembly Unit
UM	Manhole Unit	Manhole Assembly Units
UO	Underground Fiber	Underground Filled Fiber Optic Cable

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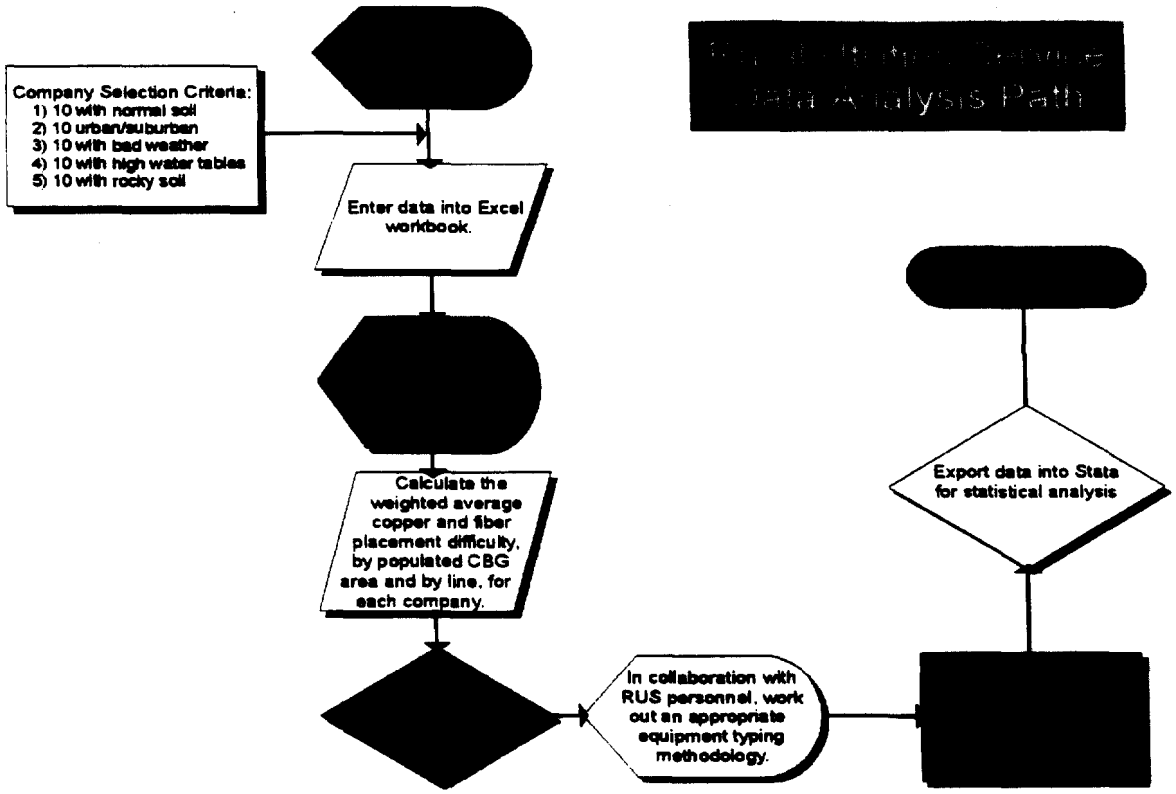
Appendix B— Rural Utilities Service Data Analysis Flow Chart



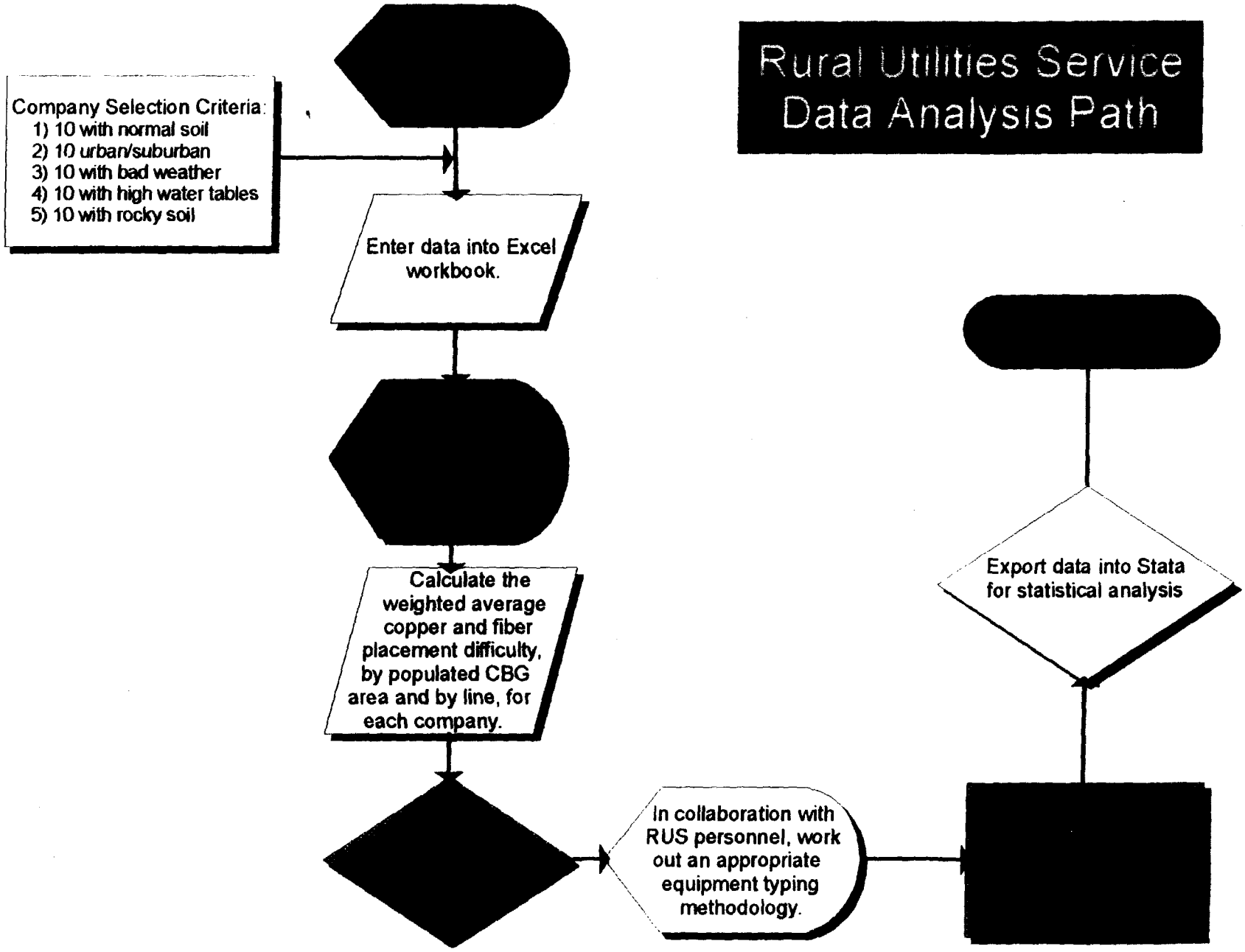
Estimating the Cost of Switching and Cables Based on Publicly Available Data--Status Report

David Gabel

Queens College

August 20, 1997

Rural Utilities Service Data Analysis Path



Outside Plant

- Use of existing models require analyst to have a good sense of the appropriate mix of different activities (e.g., bore cable, plow, trench)
- Data obtained from different companies on the cost of installing different cables and structures for different type of terrain
- Have obtained data for approximately 50 companies (competitive bids)

avid Gabel

Outside Plant (continued)

- Data linked to Geo code and water depth data. Estimate statistical relationship between level of difficulty of installation and contract costs.
- Data provided on both the material and labor cost of installing facilities
- Data set includes the cost of miscellaneous investments (e.g. guy wires)
- Can be used to determine mix of new installations by soil type, water depth, and hardness of rock

Outside Plant Continued

- Data will be summarized in a fashion so that it can be used in the existing proxy models
- The raw outside plant and switching data will also be provided through the NRRI
- Paper does not address the reasonableness of the slope factors
- Collecting additional data for hard rock

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Pedestal Costs

- Indicate Cost of Material and Labor

Variable	Obs	Mean	Std. Dev.	Min	Max
unitlabor	5	81.07	56.96539	42.58	175
unitmaterial	5	289.968	384.5786	35.73	932.86
unittotal	5	371.038	441.3966	81.73	1107.86

nd Gabel

Investment Per foot Aerial Fiber

- Regressions results using a very small part of the data set--R-squared = 0.9903

unitfoot	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
fibpairs	.0371532	.0007766	47.839	0.000	.0355466	.0387597
difcfiba	.1942309	.097608	1.990	0.059	-.0076867	.3961485
_cons	.6945786	.1433235	4.846	0.000	.3980914	.9910657

Fixed cost 69.45 cents per foot. Cost per fiber/foot 3.715 cents. Terrain difficulty has a positive (19.42 cents) but not statistically significant impact.

avid Gabel

Switching Investment

- Large Companies--Data from RBOCs
- Small Companies--Data from Rural Utility Service
- Ability to Distinguish Between the Cost of a remote and a host switch

Switching Data Large Companies

- Data Obtained from Depreciation Reports
- Data Indicates the embedded investment and the number of lines
- Embedded Investment Converted to Current Investment Using telephone plant indexes
- Data on over 3,000 switches from around the country

Large Switches (continued)

- Data set includes information on
  - State
  - Year Installed
  - Switch Manufacturer
  - Type of Switch (host or remote)
- Regression results indicate the fixed investment for hosts and remotes, as well as investment per line

David Gabel

Data Limitations

- Data set does not indicate busy-hour usage per line
- Need to make assumptions regarding portion of cost that are traffic sensitive (same limitation in current proxy models)

Data for Small Independents

- Small telephone companies often buy from different suppliers than RBOCs
- Switches are designed for small offices
- Data set distinguishes between the cost for a competitive bid versus upgrade
- Upgrades are more expensive than competitive bids

Small Independents (continued)

- Fixed cost of switches lower than for RBOCs.
- Outcome reflects that the RUS type companies are buying different types of switches than RBOCs
- Data from recent contracts (hence little or no need for telephone plant indexes)

RBOC Switches Used in the Regression

Descriptive Statistics: RBOC Switches Used In Regressions		
	Remotes	Hosts
1%	1,024	3,584
5%	1,208	6,400
10%	1,280	8,960
25%	1,920	13,162
50%	3,072	21,856
75%	5,147	36,928
90%	7,616	55,422
95%	9,243	67,429
99%	13,376	98,490
Mean	3,958	27,845
Std. Dev.	3,397	20,716
Observations	1,409	1,439

Descriptive Switches:RUS Data

Descriptive Statistics: RUS Switches		
	Remotes	Hosts
1%	36	350
5%	73	350
10%	109	412
25%	200.5	500
50%	301.5	937
75%	779	1920
90%	1342	2561
95%	1664	17020
99%	2480	17020
Mean	579	2339
Std. Dev.	624	4479
Observations	112	13

Results Relative to FCC Staff's Estimates

- Further Notice of Purposed Rulemaking, CC Docket No. 97-160, Par. 131 reported the following results:
- embedded cost = 185,374+378 - 24.71*time
- Time =1 in 1985, 11 in 1995. Hence in 1995, the per line cost is $107
- Model specification only permits slope to change over time, not intercept

FCC's Analysis (continued)

- As time increases, cost per line goes to zero
- Results are not robust. The data set reports time by year. If the value for time in 1985 is the year, 1985, rather than 1, the results are noticeably different:
- embedded cost = 185,167+49,316 - 24.67*time

DMS100, 5ESS, and their remotes (with the exception of the d5orm)

```
    Source |       SS       df       MS              Number of obs =    2718
---------+------------------------------           F(  3,  2714) = 3731.78
   Model |  1.4907e+16     3  4.9690e+15           Prob > F      =  0.0000
Residual |  3.6138e+15  2714  1.3315e+12           R-squared     =  0.8049
---------+------------------------------           Adj R-squared =  0.8047
   Total |  1.8521e+16  2717  6.8166e+12           Root MSE      =  1.2e+06

------------------------------------------------------------------------------
cost1997 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------+--------------------------------------------------------------------
    host |   1065014   76323.88    13.954   0.000     915354.8    1214672
linehost |   101.8178   1.502589    67.762   0.000     98.87145    104.7641
lineremo |   98.23993   11.80466     8.322   0.000      75.0929    121.387
   _cons |   180286.6   54962.32     3.280   0.001     72514.34    288058.8
------------------------------------------------------------------------------
```